APPENDIX H
TRAFFIC IMPACT STUDY

LINSCOTT
LAW &
GREENSPAN
engineers

TRAFFIC IMPACT STUDY

KEELER DUNES DUST MITIGATION PROJECT

Keeler, California
March 19, 2014

Prepared for:

Sapphos Environmental, Inc.
430 North Halstead Street
Pasadena, California 91107

LLG Ref. 1-07-3688-3

REGISTERED PROFESSIONAL ENGINEER
CLARE M. LOOK-JAEGER
TR1878
EXP. 06/30/14
TRAFFIC
STATE OF CALIFORNIA

Under the Supervision of:

Clare M. Look-Jaeger

Clare M. Look-Jaeger, P.E.
Principal

Linscott, Law & Greenspan, Engineers
600 S. Lake Avenue
Suite 500
Pasadena, CA 91106
626.796.2322 T
626.792.0941 F
www.llgengineers.com

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APPENDIX

TRAFFIC IMPACT STUDY

KEELER DUNES DUST MITIGATION PROJECT

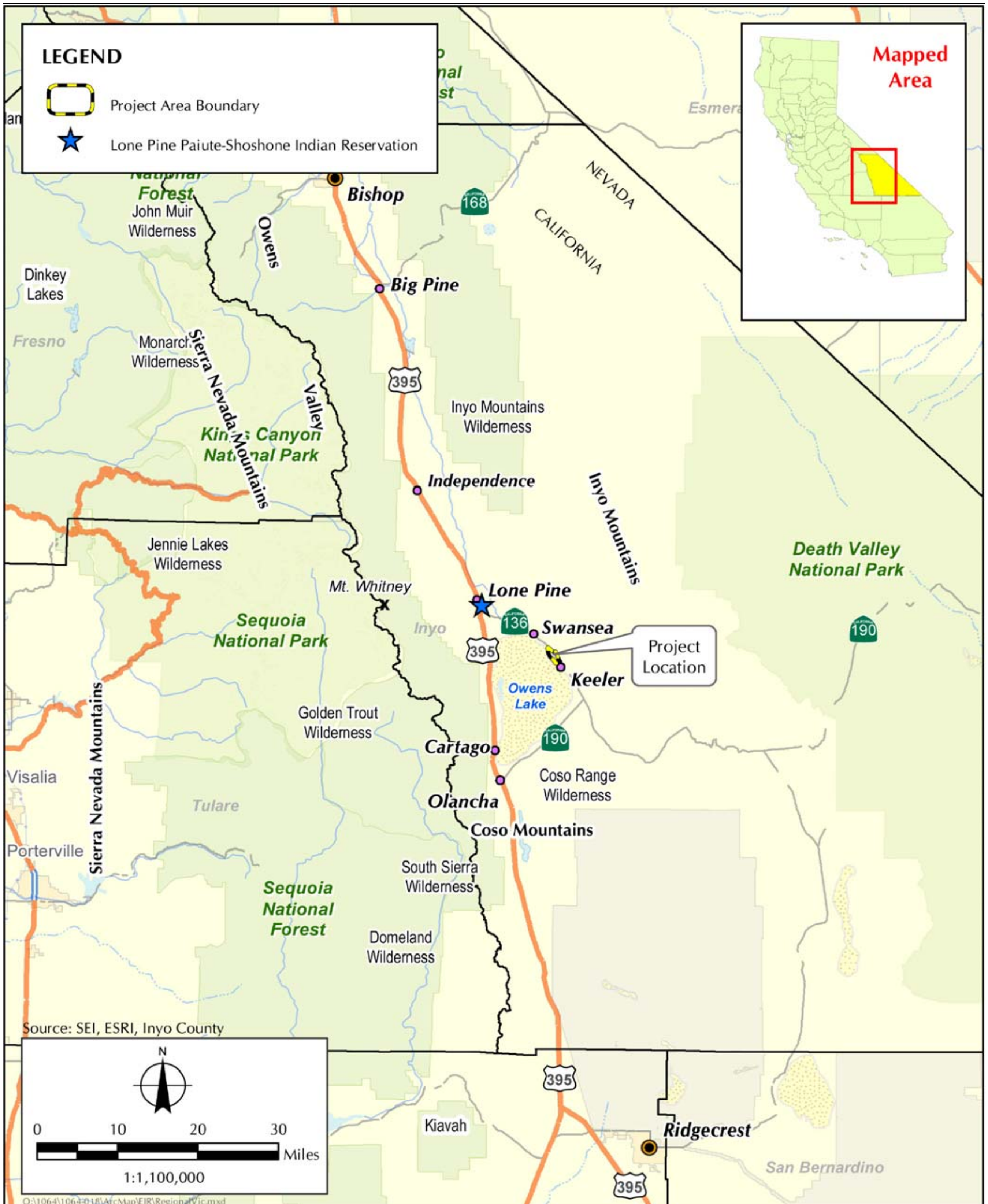
Keeler, California
March 19, 2014

1.0 INTRODUCTION

This traffic analysis has been prepared to identify and evaluate the potential transportation impacts associated with implementation of the proposed Keeler Dunes Dust Mitigation project for Owens Lake in Inyo County, California. The proposed Keeler Dunes Dust Mitigation project involves establishment of native vegetation cover coupled with straw bales as a temporary wind barrier to control fugitive dust emissions in the Keeler Dunes and to meet ambient air quality standards. The goal of the proposed project is stabilize the Keeler Dunes such that high wind events will not result in fugitive dust emissions that exceed the federal and state standards within the communities of Keeler and Swansea. The proposed project is anticipated to be constructed within approximately one year with periodic maintenance and monitoring for three years.

The proposed project is located immediately north-northwest of the community of Keeler, California, and east of the 110-square-mile (70,000-acre) dry Owens Lake bed, located within the Owens Valley, Inyo County, California. The proposed project area and regional vicinity are shown in ***Figure 1-1***. The proposed project is located approximately 65 miles southeast of the City of Bishop. The proposed project is located approximately 10 miles to the west of Death Valley National Park, approximately 11 miles to the east of Sequoia National Park, and approximately 48 miles north of the City of Ridgecrest. There are two communities in the vicinity of the proposed project located in the unincorporated area of Inyo County (the community of Keeler southeast and adjacent to the proposed project and the community of Swansea to the north). The Keeler Dunes project site and local vicinity are shown in ***Figure 1-2***. One designated Native American reservation, the Lone Pine Paiute-Shoshone Indian Reservation, is located approximately 10 miles to the northwest. The proposed project is located in Sections 30, 31, and 32, Township 16 South, Range 37 East; and Sections 24, 25, and 36, Township 16 South, Range 38 East, Mount Diablo Baseline and Meridian, California.

This traffic evaluation is being included as part of the proposed Keeler Dunes Dust Mitigation project and the corresponding Environmental Impact Report/Environmental Assessment (EIR/EA). The evaluation has been prepared in accordance with the California Environmental Quality Act (CEQA), as amended, and the Guidelines for Implementation of the California Environmental Quality Act (State CEQA Guidelines). This analysis is intended to describe the potential impacts of the proposed project and provide recommendations for mitigation requirements in the vicinity of the project within the context of existing traffic conditions as well as under future with project traffic conditions. Level of Service (LOS) C or better has been identified as satisfactory traffic operation conditions for roadway segments in the project vicinity. LOS is a letter scheme (A through F) used to describe traffic conditions for an existing or proposed roadway or intersection operating under current or projected traffic demand. Further discussion of the LOS concept and LOS C is provided in Subsection 6.1 herein.



MAP SOURCE: SAPPHOS ENVIRONMENTAL, INC.

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FIGURE 1-1
REGIONAL VICINITY MAP

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KEELER DUNES DUST MITIGATION PROJECT

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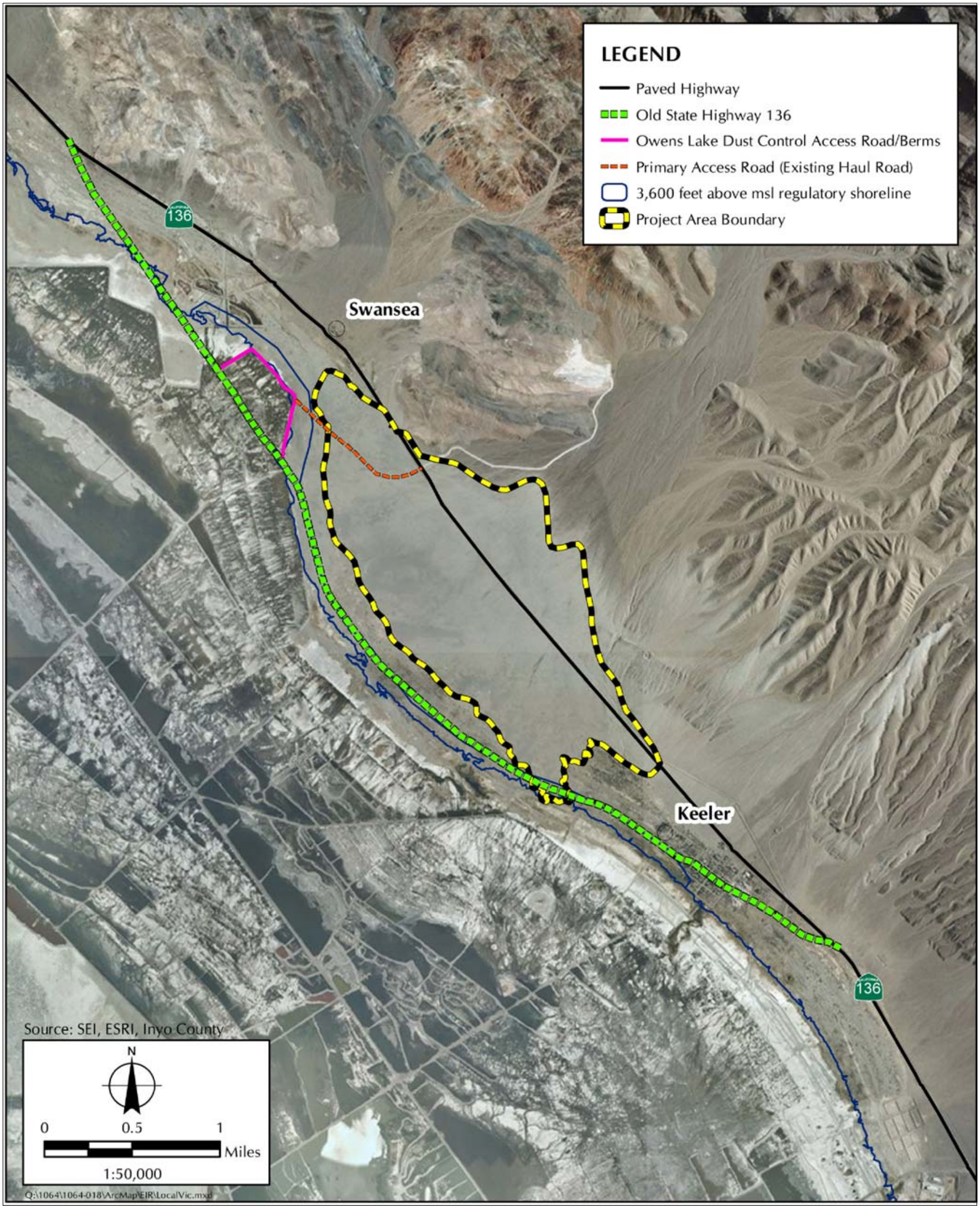

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FIGURE 1-2
PROJECT STUDY AREA

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2.0 PROJECT DESCRIPTION[1]

Consistent with the requirements of §15124 of the State of California Environmental Quality Act Guidelines (State CEQA Guidelines), the project description of the Keeler Dunes Dust Mitigation Project (proposed project) includes the precise location and boundaries of the proposed project; a brief characterization of the existing conditions at the proposed project site; a statement of objectives for the proposed project; a general delineation of the proposed project's technical, economic, and environmental characteristics; and a statement describing the intended uses of the EIR/EA.

2.1 Proposed Project Location

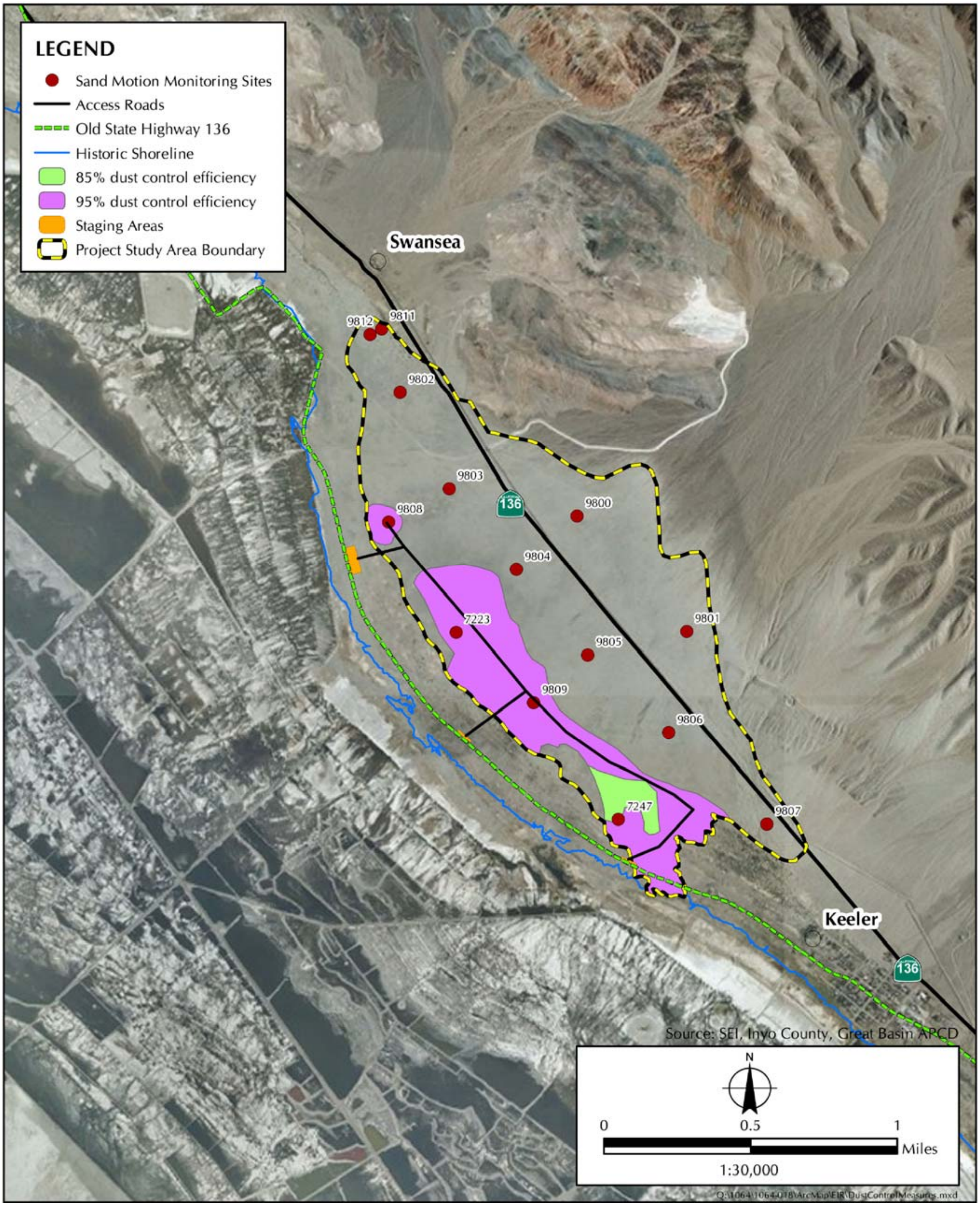
The proposed project is located immediately north-northwest of the community of Keeler, California, and east of the 110-square-mile (70,000 acres) dry Owens Lake bed, located within the Owens Valley, Inyo County, California. The proposed project is located approximately 10 miles southeast of the community of Lone Pine and approximately 65 miles southeast of the City of Bishop. The proposed project is located approximately 10 miles to the west of Death Valley National Park, approximately 11 miles to the east of Sequoia National Park, and approximately 48 miles north of the City of Ridgecrest. There are two communities in the vicinity of the proposed project located in the unincorporated area of Inyo County (the community of Keeler southeast and adjacent to the proposed project, the community of Swansea to the north) and one designated Native American reservation (Lone Pine Paiute-Shoshone Indian Reservation 10 miles to the northwest). The Keeler Dunes proposed dust control project is located within the Owens Valley Planning Area (OVPA). The OVPA is situated in the southern end of the Owens Valley and implementation of various dust control measures on the former bed of Owens Lake has been ongoing since the year 2000.

The proposed project is approximately 194 acres in size and is located within a 1.3 square mile project study area. The project study area is located on the Keeler alluvial fan situated between the base of the Inyo Mountains to the east-northeast and the dried bed of Owens Lake to the west-southwest. The project study area extends approximately 2.5 miles to the northwest from the community of Keeler and is dissected by SR 136. The proposed project is located on lands administered by the U.S. Department of Interior Bureau of Land Management Bishop Office (BLM) and the City of Los Angeles Department of Water and Power (LADWP). The proposed project dust control measure location map is presented in ***Figure 2-1***.

2.2 Project Purpose and Need

The Great Basin Unified Air Pollution Control District (District) regulates fugitive dust (PM_{10}) emissions in the Owens Valley Planning Area consistent with the requirements of the National Ambient Air Quality Standards (NAAQS). The dried Owens Lake bed has been the largest single source of PM_{10} emissions in the United States for many years, with annual PM_{10} emissions of more than 80,000 tons and 24-hour concentrations as high as 130 times the federal air quality standard. The air pollution at Owens Lake is caused by the City of Los Angeles's diversion of

[1] Source for Project Description: Sapphos Environmental, Inc.



MAP SOURCE: SAPPHOS ENVIRONMENTAL, INC.

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FIGURE 2-1
DUST CONTROL MEASURE LOCATION MAP

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KEELER DUNES DUST MITIGATION PROJECT

water from the Owens River and other streams that once flowed into Owens Lake. These waters have historically been diverted from the Owens Valley to the City of Los Angeles via the Los Angeles Aqueduct. By the 1920s, all that remained of the lake was a 26-square-mile hyper-saline brine pool, and by 1930, Owens Lake was virtually dry.[2]

Exposed dry lake bed sediments have been dispersed into the air by prevailing winds over the past nearly 100 years. The resulting severe dust storms occur primarily during October through June with the highest frequency of dust events occurring March through May and also in December. The northeastern portion of the Owens Lake bed, an area termed the North Sand Sheet (NSS), was one of the largest dust source areas. The NSS soil composition is primarily made up of sediment from the Owens River, with a smaller portion from the Inyo Mountains east of the lake. Exposure of the NSS to high winds following desiccation of Owens Lake resulted in movement of the lake bed sediments to the southeast, forming a deposit of aeolian material on the adjacent alluvial fan (Keeler Fan).[3] Over time, wind reworked the Keeler Dunes sand deposits, which currently extend over an approximately 1.3-square-mile area. The Keeler Dunes appear to be spreading to the east and southeast toward the community of Keeler and the foothills of the Inyo Mountains.

The material from Keeler Dunes becomes mobile during high-wind events and, since dust sources on the bed of Owens Lake are largely controlled, are one of the last main dust sources that contribute to exceedances of the state and federal 24-hour PM_{10} standard in the community of Keeler. As a result of data collected from sand-motion monitoring since April 2000, the District has identified the Keeler Dunes as one of the areas that need to be controlled to attain the NAAQS for PM_{10} within the Owens Valley Planning Area. The Keeler Dunes continue to cause an average of six PM_{10} standard exceedances every year since 1993. These standard exceedances threaten the health, property and environment of the residents of the Keeler/Swansea area. The airborne particulate matter from dust events can be inhaled deeply by humans and may result in serious respiratory ailments. In addition to the 66 residents of the community of Keeler, the District estimates that approximately 40,000 permanent residents that live in the area in addition to the visitors are affected by particulate emissions originating from Owens Lake.

The proposed project, in combination with other on-going dust control projects that have been and are being implemented on the lake bed by the LADWP, is designed to improve air quality through the reduction of PM_{10} emissions throughout the Owens Valley Planning Area but particularly in the community of Keeler. Dust control measures are necessary at the Keeler Dunes to bring the community of Keeler and greater Owens Lake area into compliance with the NAAQS for PM_{10} by 2017.

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[2] Great Basin Air Pollution Control District. January 2008. *2008 Owens Valley PM_{10} Planning Area Demonstration of Attainment State Implementation Plan – Final Subsequent Environmental Report*. Prepared by: Sapphos Environmental, Inc., Pasadena, CA.

[3] Lancaster, N., March 2012. Development of the Keeler Dunefield, Inyo County, California, Part 1 – Analysis of Aerial Photographs and Satellite Imagery. Prepared by DRI for GBUAPCD.

2.3 Project Background

The District has been conducting ongoing air monitoring in the Keeler dunes area since 2000 with the installation of two sand motion monitoring sites. In response to commitments made by the District in its 2006 Settlement Agreement with the LADWP and the 2008 Owens Valley PM_{10} State Implementation Plan (2008 SIP), an additional twelve sand monitor sites were added in 2010 for the purpose of establishing a monitoring program to gather information on the location and magnitude of dust emissions in the dunes and with the goal of developing a strategy for PM_{10} emission control. The 2008 SIP required control of the dust emissions from the Keeler Dunes on or before December 31, 2013 in order to demonstrate attainment of the federal standard within the Owens Valley Planning Area by 2017.[4] The District is responsible for developing a dust control strategy and plan for the Keeler Dunes PM_{10} emissions.

2.4 Existing Conditions

The existing conditions section provides a description of the physical environmental conditions in the vicinity of the proposed project site as they existed at the time of the Notice of Preparation of the EIR/EA from both a local and regional perspective (State CEQA Guidelines, Section 15125). This section constitutes the baseline physical conditions by which the District will determine if an impact is significant or not.

2.4.1 *Regional Environmental Setting*

The climate of the Owens Valley is semiarid to arid and is characterized by low precipitation, abundant sunshine, frequent winds, moderate to low humidity, and high potential evapotranspiration. The Sierra Nevada Mountains, trending north to south, west of the proposed project greatly influence the climate. Although a rain shadow is present east of the crest of the range, the Owens Valley floor and on the Inyo, White Mountains, and Coso Range receive appreciably less precipitation, ranging from 7 to 14 inches per year in the Inyo and White Mountains to approximately 5 in/year on the valley floor[5]. Air temperatures can range greatly from -2 degrees Fahrenheit (F) in the winter to 107 degrees F in the summer and can also range widely during a single day spanning more than 50 degrees F[6].

There are two communities in the vicinity of the project located in the unincorporated area of Inyo County (the community of Swansea to the north and the community of Keeler to the southeast). Existing regional activities include agricultural cattle grazing; mining; recreation, including hiking and bird-watching; water supply transfers; and on-going air quality monitoring

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[4] Great Basin Unified Air Pollution Control District, 2008 Owens Valley PM_{10} Planning Area Demonstration of Attainment State Implementation Plan, GBUAPCD, Bishop, California, 28 January 2008.

[5] Hollett, K.J., Danskin, W.R., McCaffrey, W.F., and Walti, C.L., 1991, Geology and water resources of Owens Valley, California: U.S. Geological Survey Water-Supply Paper 2370-B. Available at: http://onlinepubs.er.usgs.gov/djvu/WSP/wsp_2370-B.djvu

[6] Danskin, W.R. 1998. Evaluation of the Hydrologic System and Selected Water-Management Alternatives in the Owens Valley, California. U.S. Geological Survey Water-Supply Paper 2370. Prepared in cooperation with the Inyo County and the Los Angeles Department of Water and Power.

associated with the ongoing dust control activities that are a part of the 2008 SIP for controlling dust emissions from the Owens Lake bed.

2.4.2 *Local Environmental Setting*

The project study area is situated on the western portion of the Keeler alluvial fan that slopes from the Inyo Mountains on the east to the bed of Owens Lake on the west. The topographic relief of the project study area is 275 feet and extends from approximately 3,605 feet above mean sea level (MSL) near the historic shore of Owens Lake to approximately 3,880 feet above MSL on the alluvial fan. The location of the proposed project is depicted on USGS 7.5-minute series topographic quadrangles Owens Lake[7] and Dolomite[8].

The proposed project area is characterized by primarily two plant communities dominated by two populations: Parry's saltbush *(Atriplex parryi)* and greasewood *(Sarcobatus vermiculatus)*. The majority of the project area is dominated by open dry areas with little or no vegetation present.

2.4.3 *Existing Dust Control Areas at Owens Lake*

The proposed project is located adjacent to the Owens Lake bed where dust control measures (DCMs) have been implemented and are ongoing to control particulate emissions resulting from the desiccation of the Owens Lake due to City of Los Angeles water diversions. As of December 2012, 42 square miles of dust control will be implemented[9].

2.5 Statement of Project Goals and Objectives

2.5.1 *Project Goals*

The primary goal of the proposed project is to implement controls to reduce the elevated levels of windblown dust from the Keeler Dunes that are causing and contributing to exceedances of the NAAQS and California State standard for PM_{10} by 2014 in order to meet the March 2017 OVPA Area Revised 2008 State Implementation Plan attainment date. In addition, the proposed project must be consistent with the Department of Interior Bureau of Land Management Resource Management Plan.

The District's goal for control of dust emissions is to utilize measures that reduce PM_{10} exceedances while minimizing impacts to natural and cultural resources located within the Keeler Dunes. The dust control strategy includes establishment and management of native vegetation, and use of straw bales as temporary wind breaks in selected areas. The ultimate goal of the project is to develop a strategy that not only controls dust emissions from the Keeler Dunes but also creates a natural landscape that is self-sustaining and can be operated and maintained with minimal resources.

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[7] U.S. Geological Survey. 1987. 7.5-Minute Series Owens Lake, California, Topographic Quadrangle. Denver, CO.
[8] U.S. Geological Survey. 1987. 7.5-Minute Series Dolomite, California, Topographic Quadrangle. Denver, CO.
[9] The 42 mi^2 dust control area includes the 2.0 mi^2 Phase 8 Gravel and the 0.6 mi^2 sand fence area in T1A-1.

2.5.2 *Project Objectives*

The Owens Valley Planning Area Revised 2008 State Implementation Plan requires attainment of the NAAQS 24-hour PM_{10} standard by March 2017. Additionally, the District has a policy to achieve the California State PM_{10} standard within the District communities. The District and BLM identified and prioritized five basic objectives that are important to achieving the proposed project goals:

- Reduce the levels of windblown dust that are causing and contributing to exceedances of the NAAQS and California State standard for PM_{10} air pollution.
- Attain the NAAQS and State PM_{10} standards in the communities of Keeler and Swansea
- Minimize impacts to natural and cultural resources
- Create a landscape that mimics comparable natural environments
- Is self-sustaining and can be operated with minimal resources

2.6 Proposed Project Description

The proposed project is a program to stabilize a portion of the Keeler sand dunes and associated sand deposits and reduce dust emissions that are causing and contributing to exceedances of the NAAQS and California State Standard for PM_{10} in the Owens Valley Planning Area. The basis of any effective dust control strategy must be a program to stabilize the Keeler Dunes such that high wind events will not result in fugitive dust emissions that exceed the federal and state standards within the local communities. The District has determined, based on stakeholder input, that the most effective method to control fugitive dust emissions in the Keeler Dunes and to meet ambient air quality standards involves establishment of a native vegetation cover coupled with straw bales as a temporary wind barrier.

2.6.1 *Project Elements*

Elements of the proposed project include planting and establishment of native vegetation and placement of straw bales as a temporary wind break.

Dust Control Measures

Native Vegetation

This dust control measure involves the establishment of a mix of native vegetation within the areas. The goal would be to create a natural vegetated dune environment that mimics comparable natural environments such as the existing Swansea Dunes (located to the northeast) and other stable shoreline dunes in the region (Mono Lake). The establishment of native vegetation would act to prevent high emissions of dust by breaking up the wind and lowering the wind speed at the surface. Approximate spacing of plants necessary to achieve an estimated 85 and 95 percent dust control efficiency is summarized in ***Table 2-1***, Dust Control Measure Elements for Keeler Dunes Project.

TABLE 2-1

DUST CONTROL MEASURE ELEMENTS FOR KEELER DUNES PROJECT

Element	Minimum Control Efficiency	No. of Acres	No. Required per Acre	Total No. Required
Native Plants	95 percent	177	1,983	350,991[9]
Native Plants	85 percent	17	1,092	18,564
Total Plants				369,555
Straw Bales[10]	95 percent	177	661	116,997
Straw Bales	85 percent	17	364	6,188
Total Straw Bales				123,185

Atriplex polycarpa (ATPO) (two-thirds) and a mixture of other types of native vegetation (one-third) will be planted. ATPO was selected for its physiological characteristics, in addition to seed availability, low water needs, relatively rapid growth and adaptation to the regional area.[11] A list of native vegetation that will be considered for planting at the dunes in addition to the ATPO is shown in ***Table 2-2***, Native Vegetation List for Keeler Dunes Dust Control Project.

TABLE 2-2

NATIVE VEGETATION LIST FOR KEELER DUNES DUST MITIGATION PROJECT

Scientific Name	Common Name
Atriplex polycarpa (ATPO)	Cattle spinach, cattle saltbush
Atriplex confertifolia (ATCO)	Shadscale saltbush
Atriplex parryi (ATPA)	Parry's saltbush
Atriplex phyllostegia (ATPH)	Arrowscale

[10] The dimensions of the straw bales are 0.6 x 0.4 x 1.17 meter.
[11] HydroBio Advanced Remote Sensing. 2011. Report to Great Basin Unified Air Pollution Control District, Stabilizing Keeler Dunes Rapidly Using Native Vegetation and Minimal Inputs. October 2011

Cleomella obtusifolia (CLOB)	Mojave stinkweed, Mojave cleomella
Cleome sparsifolia (CLSP)	Fewleaf cleome, fewleaf spiderflower
Psathyrotes ramoissima (PSRA)	turtleback
Sarcobatus vermiculatus (SAVE)	greasewood
Suaeda moquinii (SUMO)	Inkweed, Mojave seablite

Native plants will be cultivated in a nursery and will be approximately 15 centimeters in height. Planting will involve initial placement of a straw bale (see additional project elements below) followed by installation of three native plants at the base of the straw bale. In addition, seeds of native plants will be dispersed in open areas between the straw bales.

Periodic watering of the plants is conservatively included in the project description once per year for up to three (3) years following the initial planting. It is anticipated that supplemental watering, if needed, would occur in March when the plants are breaking dormancy for the year. The long-term goal of this DCM would be the establishment of a self-sustaining native vegetation cover to control dust with minimal long-term maintenance. Continued air monitoring would be required and minimal long-term maintenance would be anticipated with this DCM.

Straw Bales

This is a temporary element of the dust control measure that would be used to stabilize emissive dust areas and provide a sheltered environment for plants during establishment. The proposed project will utilize straw bales installed in an irregular pattern across the emissive areas. *Table 2-1*, Dust Control Measure Elements, provides the number of straw bales necessary for 85 and 95 percent dust control. Straw bales are anticipated to degrade over a period of several years and would provide organic material to the existing soil. Limited maintenance of straw bales (replacement of broken bales) is anticipated.

Other Project Elements

Other project elements include infrastructure elements that may consist of access roads, staging areas, water supply, conveyance and water distribution facilities, and an effectiveness monitoring program.

Staging Areas

Temporary staging areas will be established to provide contractor(s) with storage and placement of equipment and straw bales, native plants, a temporary water storage tank and supplies. Staging area(s) will be located on land near the dust control areas. Several staging areas are currently proposed and are illustrated on *Figure 2-1*. The total area of the proposed staging areas is approximately three (3) acres.

One main staging area (Staging Area 1) will be established within the northwestern edge of the project area on land administered by the BLM. Located immediately east of Old State Highway 136, the facility will measure 200 feet by 500 feet in area and will be used by the contractor(s) for the storage of equipment, fuel, all-terrain vehicles (ATVs), wind barrier materials, native plants, and other supplies. It is also anticipated that the area will serve as an employee parking lot.

Staging Area 2 and Staging Area 3 will also be constructed for the proposed project along the Old State Highway 136, on land managed by BLM and LADWP, respectively. These areas is will be used for the temporary storage of equipment and materials needed for dust control measures in the central and southern portions of the project area.

Access Roads

A temporary access road for ATV travel will be constructed for use during placement of straw bales, planting and watering activities. The temporary access road will provide connectivity between the staging areas located adjacent to Old State Highway 136 and the project study area. The temporary access road will be constructed with minimal grading and flattening/removal of vegetation. No supplemental materials such as asphalt or gravel will be used. Following completion of planting and watering activities, the temporary access road will be restored utilizing straw bales and native plants for the dust control areas of the project. The temporary access road from the staging areas will be approximately 11,355 feet long (2.2 miles), ten (10) feet wide and even with the existing grade (total road area is 2.6 acres). The approximate location of access roads is shown in *Figure 2-1*.

All project-related vehicles including haul trucks, service/delivery vehicles, and employees shall utilize the existing gravel haul road at SR 136 for all access. This is an existing intersection which was used by trucks and workers for the ongoing Phase 8 of the Owens Lake dust control project. The existing gravel haul road/SR 136 intersection forms a four-way intersection with appropriate advance signage including intersection (W2-1) and truck (W11-10) signs. Further, the use of the existing gravel haul road to access the project study area would limit the number of project-related trips through the community of Keeler.

Water Supply, Conveyance, and Distribution

Approximately five (5) gallons of water will be applied under each straw bale prior to planting the ATPO. Total water needs for the ATPO are expected to be approximately two (2) acre-feet. It is expected that supplemental watering will be implemented when rainfall is less than forty (40) percent of the average annual rainfall during the first three (3) years until plants are well-established. It is assumed that up to 1.9 acre-feet of water would be applied annually during this time period. The total water demand for the proposed project is estimated at up to 7.6 acre-feet (2.6 million gallons) over a four year period.

The proposed project assumes that the water for plant irrigation will be supplied from the Fault Test Site, an existing well site located about 1.5 miles northwest of the proposed project area. Other available water sources include purchased water from the Keeler Community Services District Well or the Agrarian Wells. Water will be transported to the project via water trucks, and transferred to a water storage tank located near the project area. Subsequent distribution to individual plants in the project would be conducted through hoses from smaller water tanks transported via the access to the dust control areas.

Effectiveness Monitoring Program

The District is currently monitoring dust activity in the project area with a network of 16 sand motion monitoring sites. The monitoring program will continue to operate during and after DCM implementation. Review of dust control measure effectiveness will be completed one time per year.

2.6.2 *Construction Scenario*

Installation of the proposed project would require approximately 11 months to complete from August 2014 through June 2015. Construction of the proposed project would be divided into the following parts: (1) temporary access road and staging area(s), (2) bale placement and planting and watering, (3) project oversight and monitoring, and (4) supplemental watering and planting as required.

Site preparation of the staging area for plants and equipment and minimal grading and vegetation removal for temporary access roads would be required for project implementation. Construction of the project will require a temporary disturbance of 5.6 acres. Fugitive dust emissions shall be controlled and minimized, to comply with Great Basin Unified Air Pollution Control District Rules 400 and 401 through the application of best available control measures during project implementation. ATV’s will be restricted to travel at less than 5 miles per hour to minimize dust levels. Restoration of disturbed areas, such as staging areas and temporary access road, would occur at the end of 3 years or when the plants were established enough such that they did not need any supplemental watering. Supporting activities would include material delivery, planting, placement of straw bales, water delivery to plants, on-going air monitoring, and transportation of work crews. Site preparation and construction of the proposed project would be undertaken in accordance with all federal, state, and County of Inyo building codes.

A maximum of 72 workers would be expected to be on site during peak construction activity periods. Construction equipment would be turned off when not in use. The construction contractor would be required to ensure that all equipment is properly maintained. All vehicles would utilize exhaust mufflers and engine enclosure covers (as designed by the manufacturer) at all times.

The plans and specifications for the proposed project would include the requirements for construction equipment and average number of hours of operation of the type specified in ***Table 2-3***, Dust Control Activity, Duration, Equipment, and Workers. *Table 2-3* lists the duration of each activity and maximum number of workers on the site each day.

TABLE 2-3

DUST CONTROL ACTIVITY, DURATION, EQUIPMENT, AND WORKERS

Activity	Duration (months)	Equipment	Workers (maximum)
Site preparation	~ 1 week	GrubberAll-terrain vehicle Pickup truck Trailers	10
Deliver and distribute straw bales over the dust control areas	6 to 8 months	Semi-trucks with tandem trailers Loader with forks Hay Squeeze All-terrain vehicles	72
Planting and watering	6 to 8 months	All-terrain vehicles Loader with forks Water trucks	72
Cleanup/restoration	~ 2 weeks	Semi-trucks with tandem trailers All-terrain vehicles Loader with forks Dozers and trailers Water trucks Pick-up trucks	20
Supplemental Watering	1 to 3 months	All-terrain vehicles Water Trucks	13

Site ingress and egress for construction, delivery vehicles, haul routes, and emergency response and evacuation would be located at Staging Area 1 along Old State Highway 136 (refer to *Figure 2-1*). Vehicles would return to SR 136 via the existing gravel haul road.

Once the project elements are in place, the site would be monitored for a period of 3 years to evaluate the vegetation growth progress, assess plant mortality and predation, provide water as needed, check the physical condition of straw bales, replace plants that do not survive and supplement native vegetation in accordance with air monitoring data. Review of DCM effectiveness will be completed one time per year and will be reported with recommendations, as appropriate, for adding supplemental plants and/or straw bales as needed to achieve the NAAQS for PM_{10}.

3.0 EXISTING ROADWAY SYSTEM

The roadway network in the vicinity of the Owens Lake includes U.S. Highway 395, SR 136 and SR 190. It should be noted that there are several unimproved roads that provide access to the Owens Lake playa, including the existing improved gravel haul road which is located approximately 10 miles southeast from U.S. Highway 395 (i.e., roughly half-way between U.S. Highway 395 and SR 190). The existing lane configurations on U.S. Highway 395, SR 136 and SR 190, and at the intersections of these roadways are displayed in ***Figure 3-1***. A description of these roadways is provided in the following subsections.

3.1 Roadway Classifications

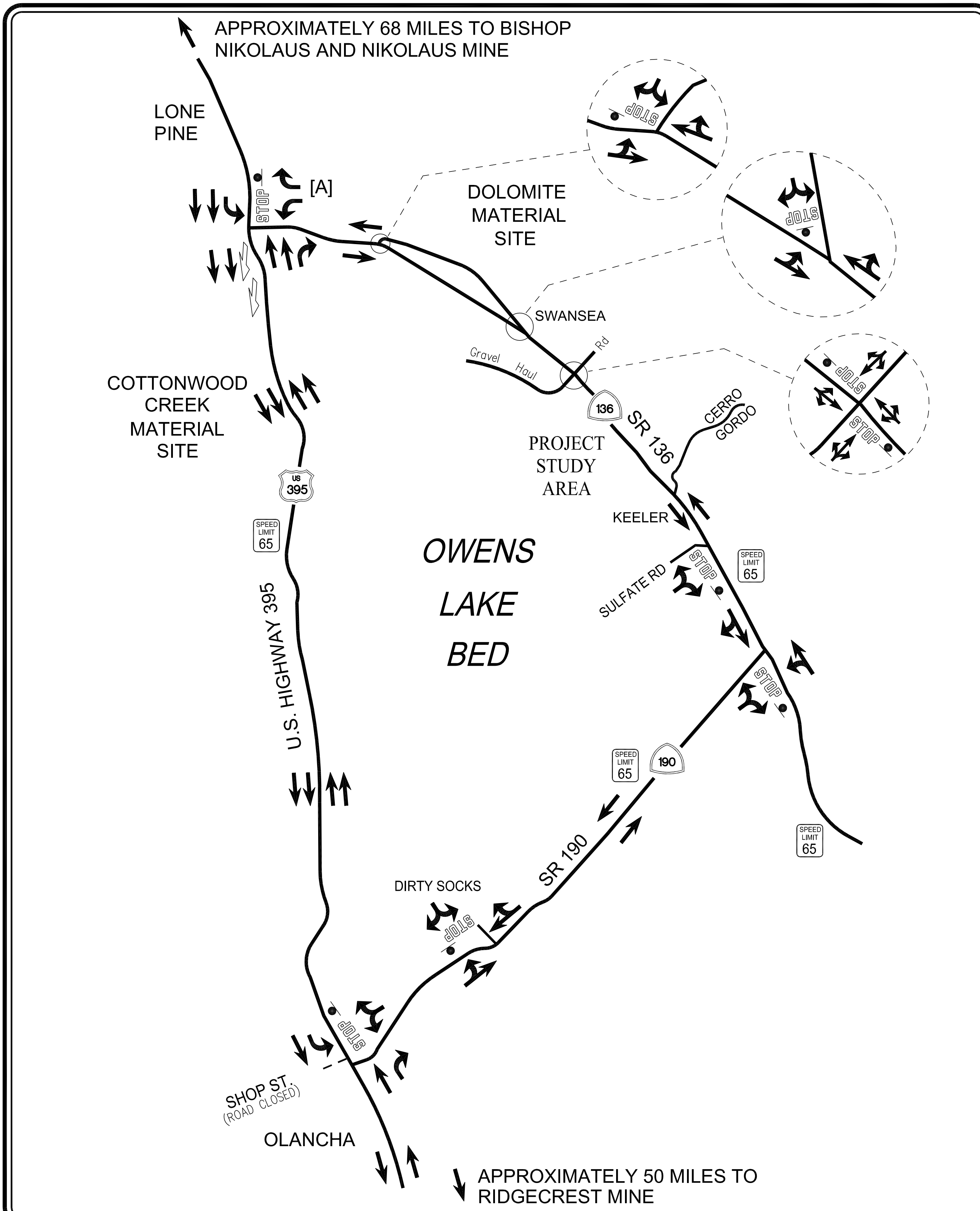
The following roadway categories are recognized by regional, state and federal transportation agencies. There are four categories in the roadway hierarchy, ranging from freeways with the highest capacity to two-lane undivided roadways with the lowest capacity. The roadway categories are summarized as follows:

- *Freeways* are limited-access and high speed travel ways included in the state and federal highway systems. Their purpose is to carry regional through-traffic. Access is provided by interchanges with typical spacing of one mile or greater. No local access is provided to adjacent land uses.

- *Arterial* roadways are major streets that primarily serve through-traffic and provide access to abutting properties as a secondary function. Arterials are generally designed with two to six travel lanes and their major intersections are signalized. This roadway type is divided into two categories: principal and minor arterials. Principal arterials are typically four-or-more lane roadways and serve both local and regional through-traffic. Minor arterials are typically two-to-four lane streets that service local and commute traffic. U.S. Highway 395 falls into the Rural Principal Arterial category and extends from the Mojave Desert near Hesperia on the south to the Canadian border near Laurier where the roadway becomes Highway 395 upon entering British Columbia to the north.

- *Collector* roadways are streets that provide access and traffic circulation within residential and non-residential (e.g., commercial and industrial) areas. Collector roadways connect local streets to arterials and are typically designed with two through travel lanes (i.e., one through travel lane in each direction) that may accommodate on-street parking. They may also provide access to abutting properties.

- *Local* roadways distribute traffic within a neighborhood, or similar adjacent neighborhoods, and are not intended for use as a through-street or a link between higher capacity facilities such as collector or arterial roadways. Local streets are fronted by residential uses and do not typically serve commercial uses.



[A] FREE-FLOW MOVEMENT

FIGURE 3-1
EXISTING ROADWAY CONFIGURATIONS

KEELER DUNES DUST MITIGATION PROJECT

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3.2 Roadway Descriptions

A brief description of the important roadways in the project site vicinity is provided in the following subsections.

3.2.1 *U.S. Highway 395*

U.S. Highway 395 is the main transportation route through Inyo County. U.S. Highway 395 is included on the Inter-Regional Road System and is functionally classified as a Rural Principal Arterial. The highway connects the project area with Mono County and Reno to the north and with the southern California metropolitan area to the south.

Adjacent to Owens Lake, the majority of U.S. Highway 395 is a divided four lane expressway with a posted speed limit of 65 miles per hour. U.S. Highway 395 is a major highway used by commercial traffic traveling within the Owens Valley and by recreational traffic traveling between Death Valley and the Sierra Nevada Mountain Range. From just south of State Route 136 to Cartago U.S. Highway 395 is a four-lane divided highway, where it transitions to a two-lane highway.

At the U.S. Highway 395 intersection with SR 136, one exclusive left-turn lane and two through lanes are provided at the southbound approach on U.S. Highway 395, and two through lanes and a channelized right-turn only lane are provided at the northbound approach on U.S. Highway 395. A southbound departure acceleration lane is also provided for the westbound left-turn movement from SR 136 to southbound on U.S. Highway 395. Twelve foot wide lanes with paved shoulders are provided in each direction on U.S. Highway 395 near the SR 136 intersection and in the project vicinity. The posted speed limit along U.S. Highway 395 at SR 136 varies from 55 miles per hour south of the intersection to 45 miles per hour north of the intersection.

At the U.S. Highway 395 intersection with SR 190, one exclusive left-turn lane and one through lane are provided at the southbound approach on U.S. Highway 395, and one through lane and one channelized right-turn only lane are provided at the northbound approach on U.S. Highway 395. A southbound departure acceleration lane is also provided for the westbound left-turn movement from SR 190 to southbound on U.S. Highway 395. Twelve foot wide lanes with paved shoulders are provided in each direction on U.S. Highway 395 near the SR 190 intersection and in the project vicinity. The posted speed limit along U.S. Highway 395 at SR 190 is 55 miles per hour just north of the intersection.

It is noted that the two-lane portion (i.e., one lane in each direction) of U.S. Highway 395 near Cartago/Olancha is planned to be improved to four lanes.[12] Caltrans plans to convert approximately 12.6 miles of the existing U.S. Highway 395 from a two-lane conventional highway into a four-lane expressway or partial conventional four-lane highway from post mile

[12] *Olancha/Cartago Four-Lane Project, Initial Study with Proposed Mitigated Negative Declaration/Environmental Assessment*, U.S. Department of Transportation, Federal Highway Administration and the State of California Department of Transportation, August 2010.

29.2 to post mile 41.8 in Inyo County. The new facility would have four 12-foot lanes with a variable median width and paved shoulders.

3.2.2 *State Route 136*

State Route 136 is a two-lane conventional highway that is classified as a Minor Arterial providing access to the historic sites of Dolomite, Swansea, and the community of Keeler.[13] Primary access to the northerly and easterly portions of Owens Lake also is provided via SR 136. SR 136 is a two-lane highway that is oriented northwest to southeast between U.S. Highway 395 to the north and SR 190 to the south. Twelve-foot wide lanes with unimproved gravel shoulders are provided in each direction on SR 136 in the project vicinity. The posted speed limit along SR 136 is 65 miles per hour.

At the SR 136 intersection with U.S. Highway 395, which is a "Tee" intersection, one-way stop sign control is provided at the westbound approach on SR 136. One left-turn lane and one channelized right-turn only lane are provided at the westbound approach on SR 136 at the U.S. Highway 395 intersection.

At the SR 136 intersection with SR 190, which is a "Tee" intersection, one-way stop sign control is provided at the eastbound approach on SR 190. One combination through/right-turn lane and one combination left-turn/through lane are provided at the southbound and northbound approaches on SR 136, respectively, at the SR 190 intersection.

3.2.3 *State Route 190*

State Route 190 is an interregional two-lane conventional highway that is classified as a Minor Arterial, which provides access from U.S. Highway 395 at the eastern flank of the Sierra Nevada Mountains to State Route 127 at Death Valley Junction near the California/Nevada border.[14] SR 190 is a two-lane highway that is oriented southwest to northeast between U.S. Highway 395 to the west and SR 136 to the east, and then is oriented to the southeast from the SR 136 intersection. Twelve-foot wide lanes with unimproved gravel shoulders are provided in each direction on SR 190 in the project vicinity. Primary access to the southerly portions of Owens Lake is provided via SR 190. The posted speed limit along SR 190 is 65 miles per hour.

At the SR 190 intersection with U.S. Highway 395, stop control is provided at the westbound approach on SR 190 and the west leg of the intersection is closed. One combination left-turn/right-turn lane is provided at the westbound approach on SR 190 at the U.S. Highway 395 intersection.

At the SR 190 intersection with SR 136, which is a "Tee" intersection, one-way stop sign control is provided at the eastbound approach on SR 190. One combination left-turn/right-turn lane is provided at the eastbound approach on SR 190 at the SR 136 intersection.

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[13] *State Route 136 Transportation Concept Report*, Caltrans District 9, Office of System Planning, June 2009.
[14] *State Route 190 Transportation Concept Report*, Caltrans District 9, Office of System Planning, 2003.

4.0 EXISTING TRAFFIC COUNTS

Recent traffic counts for U.S. Highway 395, SR 136 and SR 190 in the project vicinity were researched from data provided in *2012 Traffic Volumes on California State Highway System*, August, 2013, published by the California Department of Transportation (Caltrans). The Caltrans publication lists 2012 traffic volumes for all count locations on the California state highway system. Peak hours, peak month average daily traffic (ADT) volumes and annual ADT (AADT) volumes are shown for each count location in the publication. Significant volume changes (breakpoints) in the traffic profile along each route are counted and identified by name and milepost value.

Annual ADT is the total traffic volume for the year divided by 365 days. The traffic count year data is collected from October 1st through September 30th. Very few locations in California are actually counted continuously. Traffic counting is generally performed by electronic counting instruments moved from location to location throughout the State in a program of continuous traffic count sampling. The resulting counts are adjusted to an estimate of annual average daily traffic by compensating for seasonal influence, weekly variation and other variables which may be present. Annual ADT is necessary for presenting a statewide picture of traffic flow, evaluating traffic trends, computing accident rates, planning and designing highways and other purposes.

The annual ADT volumes on U.S. Highway 395, SR 136 and SR 190 in the vicinity of Owens Lake are presented in ***Figure 4-1***. The 2012 traffic counts were increased by 1.0 percent (1.0%) per year to reflect year 2014 existing traffic volumes. This ambient traffic growth factor was based on traffic trend data provided in the *2012 Traffic Volumes on California State Highway System* (i.e., year 2007 to 2012 annual traffic volume data) and traffic data provided in recent environmental documents.[15] Thus, the existing traffic volumes utilized in this analysis (i.e., annual ADT figure, etc.) to reflect year 2014 conditions. Summary data worksheets of the annual ADT counts from the Caltrans publication are contained in ***Appendix A***.

4.1 U.S. Highway 395 Traffic Volumes

The AADT volume on U.S. Highway 395 between SR 136 and SR 190 varies between 5,405 and 5,815 vehicles per day, respectively, with a peak hour traffic volume of approximately 1,175 vehicles (year 2012 traffic volumes adjusted to reflect year 2014 conditions). This AADT volume is well below the capacity of the four lane section of the highway, extending between SR 136 and SR 190.

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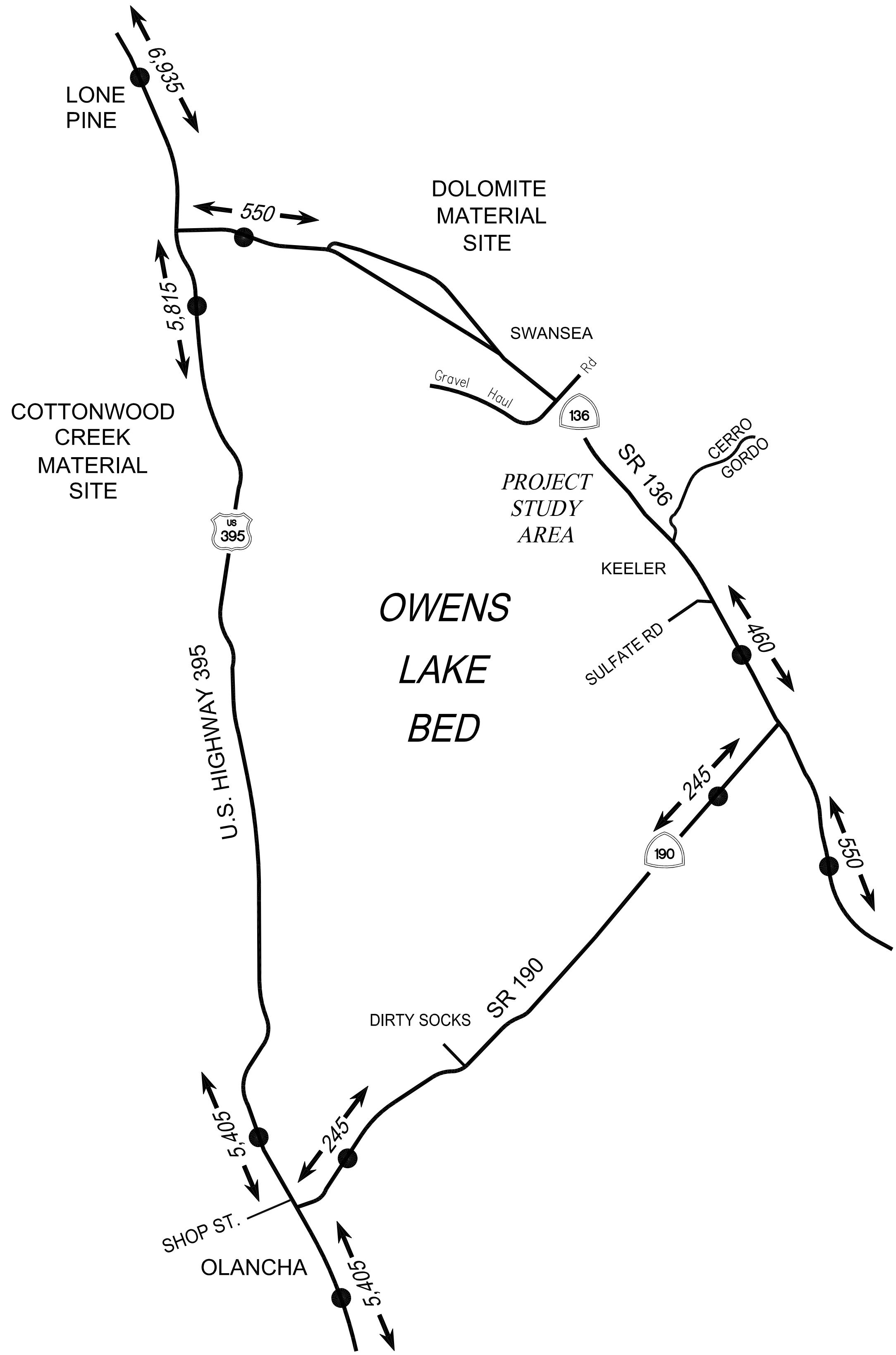
[15] *Olancha/Cartago Four-Lane Project, Initial Study with Proposed Mitigated Negative Declaration/Environmental Assessment*, U.S. Department of Transportation, Federal Highway Administration and the State of California Department of Transportation, August 2010.



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NOT TO SCALE

NOTE: YEAR 2012 COUNT DATA ADJUSTED TO REFLECT YEAR 2014 AADT VOLUMES

FIGURE 4-1
EXISTING ANNUAL ADT VOLUMES

LINSCOTT, LAW & GREENSPAN, engineers

KEELER DUNES DUST MITIGATION PROJECT

4.2 State Route 136 Traffic Volumes

The AADT along SR 136 ranges from approximately 550 vehicles east of U.S. Highway 395 to approximately 460 vehicles near SR 190 at the Olancha cutoff (year 2012 traffic volumes adjusted to reflect year 2014 conditions). The peak hour traffic volume at both of these locations varies from approximately 90 to 100 vehicles per hour. The current traffic volume data indicates that this route is currently operating well below capacity.

4.3 State Route 190 Traffic Volumes

The AADT volume along SR 190 is approximately 245 vehicles both east of U.S. Highway 395 and west of SR 136 (year 2012 traffic volumes adjusted to reflect year 2014 conditions). The peak hour traffic volume at both of these locations is approximately 50 vehicles per hour. The current traffic volume data indicates that this route is currently operating well below capacity.

5.0 TRAFFIC FORECASTING METHODOLOGY

In order to estimate the traffic impact characteristics of the Keeler Dunes Dust Mitigation project, a multi-step process has been utilized. The first step is trip generation, which estimates the total arriving and departing traffic volumes on a peak hour and daily basis. The traffic generation potential is forecast by applying appropriate vehicle trip calculations for the project development tabulation.

The second step of the forecasting process is trip distribution, which identifies the origins and destinations of inbound and outbound project traffic volumes. These origins and destinations are typically based on demographics and existing/anticipated travel patterns in the study area.

The third step is traffic assignment, which involves the allocation of project traffic to study area streets and intersections. Traffic assignment is typically based on minimization of travel time, which may or may not involve the shortest route, depending on prevailing operating conditions and travel speeds. Traffic distribution patterns are indicated by general percentage orientation, while traffic assignment allocates specific volume forecasts to individual roadway links and intersection turning movements throughout the study area.

With the forecasting process complete and project traffic assignments developed, the impact of the proposed project is isolated by comparing operational (i.e., Levels of Service) conditions at the selected key roadway locations using expected future traffic volumes with and without forecast project traffic. The need for area traffic improvements can then be evaluated and the significance of the project's impacts identified.

5.1 Project Traffic Generation

Traffic generation is expressed in vehicle trip ends, defined as one-way vehicular movements, either entering or exiting the generating land use. Traffic volumes to be generated by the proposed project were forecast for the weekday AM and PM peak hours and over a 24-hour period. The weekday AM and PM peak hours reflect the peak one hour during the traditional commuting peak periods of 7:00 to 9:00 AM and 4:00 to 6:00 PM. The resource typically used by traffic engineers to forecast trip generation for development projects is the Institute of Transportation Engineers' (ITE) *Trip Generation Manual*[16]. However, in this instance, the ITE manual does not provide trip rates for a land use or operations such as the proposed project. The Keeler Dunes Dust Mitigation project is unique due to the nature of the planned schedule of activities and operations. Therefore, it was determined that it would be appropriate to forecast the trips generated by the project based on the planned components of the project (refer to *Table 2-1*) for the peak period of activities in terms of truck arrival/departures and number of workers at the site. Based on review of the planned project components, the peak period of activities will occur during the Planting and Watering period as follows:

[16] Institute of Transportation Engineers *Trip Generation Manual*, 9th Edition, 2012.

- Workers

  - A maximum of 72 workers including planting crews, watering crews, cultural monitors, etc., will be on-site on a daily basis.

  - Workers would be present at the proposed project site between 7:00 a.m. and 5:00 p.m., Monday through Saturday. Thus, workers are assumed to arrive prior to the AM peak period.

  - It is assumed that a total of 2.5 construction personnel trips per day would be made to/from the project site.

  - It is also conservatively assumed that each worker arrives via single occupancy vehicle.

- Heavy Equipment

  - Heavy equipment (e.g., ATVs, dozers, forklifts, etc.) associated with this construction period will be on the site at any given time.

  - It is assumed that the majority of all equipment would be left on-site for the duration of construction.

  - The transport of the equipment to the project site, including the hauling of pipelines, may result in a one-time, temporary, short-term impact, and are not included in the trip generation forecasts.

- Delivery of Plants

  - A total of 3,000 plants will be delivered on a daily basis six days a week.

  - It is assumed 1,000 plants will be delivered in semi-trailer trucks for a total of three (3) trucks per day.

  - In order to provide a conservative forecast, it is also assumed that the delivery of plants during this construction period will occur during the AM peak hour.

  - A 2.5 passenger car equivalency (PCE) factor has been assumed for semi-trailer trucks used for delivery of plants to the project site.

The trip generation forecasts for the proposed project are summarized in ***Table 5-1***. As presented in *Table 5-1*, the proposed project is expected to generate 16 PCE vehicle trips (8 inbound trips and 8 outbound trips) in the AM peak hour during the peak construction period for the proposed project. During the PM peak hour, the proposed project is expected to generate 72 PCE trips (72 outbound trips) during the peak construction for the proposed project. Over a 24-hour period, the proposed project is forecast to generate 196 daily PCE trip ends (98 inbound

Table 5-1
PROJECT TRIP GENERATION [1]

LAND USE	SIZE	DAILY TRIP ENDS [2] VOLUMES	AM PEAK HOUR VOLUMES [2]			PM PEAK HOUR VOLUMES [2]		
			IN	OUT	TOTAL	IN	OUT	TOTAL
Workers								
Maximum Number of Workers [3]	72 Employees	180	----	----	----	0	72	72
Delivery of Plants								
Number of Semi-Trailer Trucks [4]	3 Trucks	16	8	8	16	----	----	----
TOTAL		**196**	**8**	**8**	**16**	**0**	**72**	**72**

[1] The project trip generation forecast is based on the peak period of activities in terms of truck arrival/departures and number of workers at the site. Based on review of the planned project components, the peak period of activities will occur during the Planting and Watering period for construction of the proposed project.
[2] Trips are one-way traffic movements, entering or leaving.
[3] The project trip generation forecasts for the Workers component during the Planting and Watering period for construction of the proposed project is based on the following data and assumptions:
- A maximum total of 72 workers including planting crews, watering crews, cultural monitors, etc., will be on-site on a daily basis for the delivery and distribution of straw bales, and the planting and watering activities.
- Workers would be present at the proposed project site between 7:00 AM and 5:00 PM, Monday through Saturday. Thus, workers are assumed to arrive prior to the AM peak period.
- It is assumed that 2.5 construction personnel trips per day would be to/from the project site for the daily traffic volume forecast.
- It is also conservatively assumed that each worker arrives via single occupancy vehicle.

[4] The project trip generation forecasts for the Delivery of Plants during the Planting and Watering period for construction of the proposed project is based on the following data and assumptions:
- A total of 3,000 plants will be delivered on a daily basis six days a week.
- It is assumed 1,000 plants will be delivered in semi-trailer trucks for a total of three (3) trucks per day.
- In order to provide a conservative forecast, it is also assumed that the delivery of plants during this construction period will occur during the AM peak hour.
- A 2.5 passenger car equivalency (PCE) factor has been assumed for semi-trailer trucks used for delivery of plants to the project site.

trips and 98 outbound trips) during a typical weekday of the peak construction period for the proposed project. It is noted that the peak construction period (i.e., Planting and Watering) planned for the Keeler Dunes Dust Mitigation project is substantially less intensive than what occurred during prior DCM projects in the area (e.g., the 1998 SIP which occurred in late spring and early summer of 2002 when approximately 250 pieces of equipment and 200 construction personnel were mobilized on-site, etc.).

5.2 Project Traffic Distribution and Assignment

Project-related (construction and subsequent operation) traffic volumes both entering and exiting the site have been distributed and assigned to the adjacent roadway system based on the following considerations:

- The site's proximity to major traffic corridors (i.e., U.S. Highway 395, SR 136, SR 190);
- Expected localized traffic flow patterns based on adjacent roadway channelization and presence of traffic signals;
- Existing intersection traffic volumes;
- Ingress/egress availability at the project site assuming use of the existing gravel haul road at SR 136 for all project-related truck and employee access; and
- The location of the proposed project study area.

As previously discussed, all project-related vehicles including haul trucks, service/delivery vehicles, and employees shall utilize the existing gravel haul road at SR 136 for all access. This is an existing intersection which is used by trucks and workers for the ongoing phase 8 of the Owens Lake dust control project. The existing gravel haul road/SR 136 intersection forms a four-way intersection with appropriate advance signage including intersection (W2-1) and truck (W11-10) signs. Further, the use of the existing gravel haul road to access the project study area would limit the number of project-related trips through the community of Keeler.

5.3 Related Projects and Ambient Traffic Growth

The forecast of future without project conditions was prepared in accordance to procedures outlined in Section 15130 of the CEQA Guidelines. Specifically, the CEQA Guidelines provide two options for developing the future traffic volume forecast:

> "(A) A list of past, present, and probable future projects producing related or cumulative impacts, including, if necessary, those projects outside the control of the [lead] agency, or

(B) A summary of projections contained in an adopted local, regional or statewide plan, or related planning document, that describes or evaluates conditions contributing to the cumulative effect. Such plans may include: a general plan, regional transportation plan, or plans for the reduction of greenhouse gas emissions. A summary of projections may also be contained in an adopted or certified prior environmental document for such a plan. Such projections may be supplemented with additional information such as a regional modeling program. Any such document shall be referenced and made available to the public at a location specified by the lead agency."

As the proposed Keeler Dunes Dust Mitigation project is short term in nature (i.e., construction period of approximately one year) and most area related projects will be completed after the proposed project is completed, it was determined to forecast future cumulative traffic volumes with incorporation of an ambient traffic growth factor (i.e., "B" option above).

In order to account for related projects and regional ambient traffic growth, the year 2014 existing traffic volumes (i.e., year 2012 traffic volumes adjusted to reflect year 2014 conditions) were increased by 2.0 percent (2.0%) to reflect year 2015 future without project traffic volumes. This ambient traffic growth factor was based on traffic trend data provided in the *2012 Traffic Volumes on California State Highway System* (i.e., year 2007 to 2012 annual traffic volume data) and traffic data provided recent environmental documents.[17] Based on a review of the most recent three year reporting periods in the Caltrans document, essentially stable traffic volumes for state highway travel (e.g., year 2012 over 2011 was +0.24% while the prior three years indicated slightly decreasing traffic volumes). Thus, application of the above annual growth factor is intended to account for both known and unknown related projects in the vicinity of the proposed project, as well as any potential regional ambient traffic growth during the period when the Keeler Dunes Dust Mitigation project is under construction.

[17] *Olancha/Cartago Four-Lane Project, Initial Study with Proposed Mitigated Negative Declaration/Environmental Assessment*, U.S. Department of Transportation, Federal Highway Administration and the State of California Department of Transportation, August 2010.

6.0 TRAFFIC IMPACT ANALYSIS METHODOLOGY

The number of vehicle trips anticipated to be generated by the proposed project was estimated based on information presented in the Sections 2.0 and 5.0 of this report. The *2012 Traffic Volumes on California State Highway System* publication was used to determine the existing traffic volumes. As the proposed project does not generate a considerable number of vehicle trips and effects on traffic would occur only during construction, no Level of Service analyses were prepared for the roadway system. Therefore, the impacts of the construction and subsequent operation of the project on roadway operations and safety were qualitatively analyzed and discussed.

6.1 Impact Criteria and Thresholds

Level of Service (LOS) is a qualitative measure of traffic operating conditions whereby a letter grade A through F, corresponding to progressively worsening operating conditions, is assigned to an intersection or roadway segment. LOS A, B, and C are generally considered satisfactory to most motorists, while LOS D is marginally acceptable. LOS E and F are associated with severe congestion and delay, and are unacceptable to most motorists.

For purposes of this EIR, LOS C is considered the minimum acceptable standard for roadway segments as identified in the Inyo County General Plan. Degradation of roadway segment LOS below an adopted County standard or concept is a potentially significant impact. The six qualitative categories of Level of Service for two lane highways as described in the *Highway Capacity Manual 2010*[1] are provided below:

- At LOS A, motorists experience high operating speeds on Class I highways and little difficulty in passing. Platoons of three or more vehicles are rare. On Class II highways, speed would be controlled primarily by roadway conditions. A small amount of platooning would be expected. On Class III highways, drivers should be able to maintain operating speeds close or equal to the free-flow speed (FFS) of the facility.

- At LOS B, passing demand and passing capacity are balanced. On both Class I and Class II highways, the degree of platooning becomes noticeable. Some speed reductions are present on Class I highways. On Class III highways, it becomes difficult to maintain FFS operation, but the speed reduction is still relatively small.

- At LOS C, most vehicles are traveling in platoons. Speeds are noticeably curtailed on all three classes of highway.

- At LOS D, platooning increases significantly. Passing demand is high on both Class I and Class II facilities, but passing capacity approaches zero. A high percentage of vehicles are not traveling in platoons, and percent time-spent following (PTSF) is quite noticeable. On Class III highways, the fall-off from FFS is now significant.

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[1] Chapter 15, Two-Lane Highways, in Volume 2 of the *HCM2010 Highway Capacity Manual*, Transportation Research Board of the National Academies, Washington, DC, 2010.

- At LOS E, demand is approaching capacity. Passing on Class I and Class II highways is virtually impossible, and PTSF is more than 80%. Speeds are seriously curtailed. On Class III highways, speed is less than two-thirds of FFS. The lower limit of this LOS represents capacity.

- LOS F exists whenever demand flow in one or both directions exceeds the capacity of the segment. Operating conditions are unstable, and heavy congestion exists on all classes of two-lane highways.

6.2 Traffic Impact Analysis Scenarios

Traffic impacts at the study intersections were analyzed for the following conditions:

[a] Existing conditions.

[b] Existing plus project conditions (i.e., traffic generation during peak activities during project construction).

[c] Condition [b] with implementation of project mitigation measures, where necessary.

[d] Condition [a] plus 2.0 percent (2.0%) ambient traffic growth through year 2015 (i.e., two percent per year).

[e] Condition [d] plus project conditions (i.e., traffic generation during peak activities during project construction).

[f] Condition [e] with implementation of project mitigation measures, where necessary.

The traffic volumes for each new condition were added to the volumes in the prior condition to determine the change in utilization and corresponding LOS at the study locations.

7.0 TRAFFIC ANALYSIS

As previously noted (refer to Section 4.0 herein), AADT volumes have been utilized in the traffic analysis for this report. Annual ADT is the total traffic volume for the year divided by 365 days. The traffic count year data is collected from October 1st through September 30th. Very few locations in California are actually counted continuously. Traffic counting is generally performed by electronic counting instruments moved from location to location throughout the State in a program of continuous traffic count sampling. The resulting counts are adjusted to an estimate of annual average daily traffic by compensating for seasonal influence, weekly variation and other variables which may be present. Annual ADT is necessary for presenting a statewide picture of traffic flow, evaluating traffic trends, computing accident rates, planning and designing highways and other purposes.

7.1 Existing Conditions

The following subsections present a summary of the existing conditions at each of the roadway segments included as part of this traffic analysis. It is important to note that the capacity of a two-lane highway is 1,700 passenger cars per hour in one direction, with a maximum of 3,200 passenger cars per hour in the two directions. The capacity of a multilane highway segment under base conditions varies with the free flow speed (FFS). For 60 miles per hour (mph) FFS, the capacity is 2,200 passenger cars per hour per lane. For less FFSs, capacity diminishes. For 55 mph FFS, the capacity is 2,100 passenger cars per hour per lane; for 50 mph FFS, 2,000 passenger cars per hour per lane; and for 45 mph FFS, 1,900 passenger cars per hour per lane.[2]

7.1.1 *U.S. Highway 395 Existing Conditions*

The AADT volume on U.S. Highway 395 between SR 136 and SR 190 varies between 5,405 and 5,815 vehicles per day, respectively, with a peak hour traffic volume of approximately 1,175 vehicles (year 2012 traffic volumes adjusted to reflect year 2014 conditions). This AADT volume is well below the capacity of the four lane section of the highway, extending between SR 136 and SR 190. U.S Highway 395 currently operates at LOS A under existing conditions for the four lane section of the highway. However, as noted in the Olancha/Cartago Four-Lane Project MND/EA, the two lane section of the highway near the communities of Cartago and Olancha currently operates at LOS D, but will operate at LOS A upon completion of the four-lane highway improvement project.

7.1.2 *State Route 136 Existing Conditions*

The AADT along SR 136 ranges from approximately 550 vehicles east of U.S. Highway 395 to approximately 460 vehicles near SR 190 at the Olancha cutoff (year 2012 traffic volumes adjusted to reflect year 2014 conditions). The peak hour traffic volume along the subject locations is approximately 100 vehicles per hour. The current traffic volume data indicates that this route is currently operating well below capacity. State Route 136 currently operates at LOS A under existing conditions.

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[2] *HCM2010 Highway Capacity Manual*, Transportation Research Board of the National Academies, Washington, DC, 2010.

7.1.3 *State Route 190 Existing Conditions*

The AADT volume along SR 190 ranges from approximately 245 vehicles both east of U.S. Highway 395 and west of SR 136 (year 2012 traffic volumes adjusted to reflect year 2014 conditions). The peak hour traffic volume at both of these locations is approximately 50 vehicles per hour. The current traffic volume data indicates that this route is currently operating well below capacity. State Route 190 currently operates at LOS A under existing conditions.

7.2 Existing With Project Conditions

As the Planting and Watering period for construction of the project results in the highest level of overall vehicle trip generation, the existing with project conditions analysis only considers this period of the project. In order to provide a conservative worst-case analysis, all 196 daily vehicle trips anticipated to be generated by the project during this construction phase were assigned to each highway in the project vicinity. Based on the roadway lane capacities of the highways, the existing year 2014 daily traffic volumes on the State highways, and the forecast daily project trip generation, no significant impacts are expected to occur along U.S. Highway 395, SR 136, and SR 190, as discussed further in the following sections. However, periodic events during which equipment is hauled to the site may result in safety hazards associated with other oncoming or turning vehicles on U.S. Highway 395, SR 136 and SR 190. In addition, overweight trucks transporting material, equipment, and other construction materials could potentially result in some damage to the roadway surface of the State Highways. Therefore, these impacts can be considered potentially significant. Refer to Section 8.0 of this report for further discussion.

7.2.1 *U.S. Highway 395 Existing With Project Conditions*

The AADT volumes on U.S. Highway 395 between SR 136 and SR 190 with the addition of temporary construction project-related traffic would vary between approximately 5,602 and 6,010 vehicles per day, respectively. This AADT volume is well below the capacity of the four lane section of the highway, extending between SR 136 and SR 190. U.S Highway 395 would continue to operate at LOS A under existing with project conditions for the four lane section of the highway. In addition, the two lane section of the highway near the communities of Cartago and Olancha would continue to operate at the existing LOS D conditions with the addition of temporary construction project-related traffic.

7.2.2 *State Route 136 Existing With Project Conditions*

The AADT volumes along SR 136 with the addition of temporary construction project-related traffic would range from approximately 747 vehicles east of U.S. Highway 395 to approximately 655 vehicles near SR 190 at the Olancha cutoff. State Route 136 would continue to operate at LOS A in the existing with project conditions.

7.2.3 *State Route 190 Existing With Project Conditions*

The AADT volume along SR 190 with the addition of temporary construction project-related traffic would range from approximately 441 vehicles both east of U.S. Highway 395 and west of SR 136. State Route 190 would continue to operate at LOS A in the existing with project conditions.

7.3 Future Without Project Conditions

The following subsections present a summary of the future without project conditions at each of the roadway segments included as part of this traffic analysis. In order to forecast the future without project traffic volumes, the year 2014 existing traffic volumes (i.e., year 2012 traffic volumes adjusted to reflect year 2014 conditions) were increased by 2.0 percent (2.0%) to reflect year 2015 future without project traffic volumes. This ambient traffic growth factor was based on traffic trend data provided in the *2012 Traffic Volumes on California State Highway System* (i.e., year 2007 to 2012 annual traffic volume data) and traffic data provided in recent environmental documents. Based on a review of the most recent three year reporting periods in the Caltrans document, essentially stable traffic volumes for state highway travel (e.g., year 2012 over 2011 was +0.24% while the prior three years indicated slightly decreasing traffic volumes) are indicated. Thus, application of the above annual growth factor is intended to account for both known and unknown related projects in the vicinity of the proposed project, as well as any potential regional ambient traffic growth during the period when the Keeler Dunes Dust Mitigation project is under construction.

7.3.1 *U.S. Highway 395 Future Without Project Conditions*

The future without project AADT volume on U.S. Highway 395 between SR 136 and SR 190 would vary between approximately 5,515 and 5,930 vehicles per day, respectively. This AADT volume is well below the capacity of the four lane section of the highway, extending between SR 136 and SR 190. U.S Highway 395 would continue to operate at LOS A in the future without project conditions for the four lane section of the highway. In addition, the two lane section of the highway near the communities of Cartago and Olancha would continue to operate at LOS D conditions in the future without project conditions (i.e., same LOS as under existing conditions). It is noted that with the Olancha/Cartago Four-Lane Project completion, the LOS for this segment will improve to LOS A under future conditions.

7.3.2 *State Route 136 Future Without Project Conditions*

The future without project AADT volume along SR 136 would range from approximately 560 vehicles east of U.S. Highway 395 to approximately 470 vehicles near SR 190 at the Olancha cutoff. State Route 136 would continue to operate at LOS A in the future without project conditions.

7.3.3 *State Route 190 Future Without Project Conditions*

The future without project AADT volume along SR 190 would range from approximately 250 vehicles both east of U.S. Highway 395 and west of SR 136. State Route 190 would continue to operate at LOS A in the future without project conditions.

7.4 Future With Project Conditions

As the Planting and Watering period for construction of the project results in the highest level of overall vehicle trip generation, the future with project conditions analysis only considers this period of the project. In order to provide a conservative worst-case analysis, all 196 daily vehicle trips anticipated to be generated by the project during this construction phase were assigned to each highway in the project vicinity. Based on the roadway lane capacities of the highways, the future year 2015 daily traffic volumes on the State highways, and the forecast daily project trip generation, no significant impacts are expected to occur along U.S. Highway 395, SR 136, and SR 190, as discussed further in the following sections. However, periodic events during which equipment is hauled to the site may result in safety hazards associated with other oncoming or turning vehicles on U.S. Highway 395, SR 136 and SR 190. In addition, overweight trucks transporting material, equipment, and other construction materials could potentially result in some damage to the roadway surface of the State Highways. Therefore, these impacts can be considered potentially significant. Refer to Section 8.0 of this report for further discussion.

7.4.1 *U.S. Highway 395 Future With Project Conditions*

The future with project AADT volume on U.S. Highway 395 between SR 136 and SR 190 would vary between approximately 5,710 and 6,126 vehicles per day, respectively. This AADT volume is well below the capacity of the four lane section of the highway, extending between SR 136 and SR 190. U.S Highway 395 would continue to operate at LOS A in the future with project conditions for the four lane section of the highway. In addition, the two lane section of the highway near the communities of Cartago and Olancha would continue to operate at LOS D conditions in the future with project conditions (i.e., same LOS as under existing conditions). It is noted that with the Olancha/Cartago Four-Lane Project completion, the LOS for this segment will improve to LOS A under future conditions.

7.4.2 *State Route 136 Future With Project Conditions*

The future with project AADT volume along SR 136 would range from approximately 758 vehicles east of U.S. Highway 395 to approximately 664 vehicles near SR 190 at the Olancha cutoff. State Route 136 would continue to operate at LOS A in the future with project conditions.

7.4.3 *State Route 190 Future With Project Conditions*

The future with project AADT volume along SR 190 would range from approximately 446 vehicles both east of U.S. Highway 395 and west of SR 136. State Route 190 would continue to operate at LOS A in the future with project conditions.

8.0 RECOMMENDED TRANSPORTATION MEASURES

The following transportation improvement measures are recommended to reduce the potential impacts due to the construction of the project to less than significant levels:

- All project-related vehicles including haul trucks, service/delivery vehicles, and employees shall utilize the existing gravel haul road at SR 136 for all access. This is an existing intersection which is used by trucks and workers for the ongoing phase 8 of the Owens Lake dust control project. The existing gravel haul road/SR 136 intersection forms a four-way intersection with appropriate advance signage including intersection (W2-1) and truck (W11-10) signs. Further, the use of the existing gravel haul road to access the project study area would limit the number of project-related trips through the community of Keeler.

- The State of California Department of Transportation shall determine the necessity for traffic safety equipment to be installed and maintained on U.S Highway 395, SR 136 and SR 190 in order to ensure traffic safety during the construction of the proposed project. Some examples of typical traffic safety equipment/measures include warning lights, signage, and cones. Any required traffic safety equipment, which would warn oncoming motorists that there may be large, slow-moving trucks ahead, would be designed consistent with Caltrans standards.

- Flag persons should be utilized where necessary to warn motorists that there may be large, slow-moving trucks ahead, particularly during peak periods and times of large load deliveries.

- Traffic safety equipment shall be installed prior to use of U.S. Highway 395, SR 136, and SR 190 for straw bale hauling or other heavy truck trips such as the delivery of heavy equipment and construction vehicles to the project site.

- Prior to commencement of project construction activities, a pre-construction road condition survey assessment shall be prepared in order to document existing roadway conditions. Any roadways that are damaged by project construction activities shall be repaired and the roadways shall be returned to pre-project conditions. All road repairs will be scheduled and conducted to ensure that safe operating conditions are maintained.

In addition to the above measures and as previously noted, traffic controls and signage and all additional safety specifications resulting from mitigation measures, permit conditioning, and conditions of approval shall be employed.

9.0 CONCLUSIONS

This traffic analysis has been prepared to identify and evaluate the potential transportation impacts associated with implementation of the Dust Mitigation Program for Owens Lake in Inyo County, California. The proposed Keeler Dunes Dust Mitigation project involves establishment of native vegetation cover coupled with straw bales as a temporary wind barrier to control fugitive dust emissions in the Keeler Dunes and to meet ambient air quality standards. The goal of the proposed project is stabilize the Keeler Dunes such that high wind events will not result in fugitive dust emissions that exceed the federal and state standards within the local communities. The proposed project is anticipated to be constructed within approximately one year with periodic maintenance in following years.

The impacts of the construction of the project on roadway operations and safety were qualitatively analyzed and discussed (refer to Section 7.0 herein). Based on the roadway lane capacities of the highways, the future year daily traffic volumes on the State highways, and the forecast daily project trip generation, it is concluded that no significant impacts are expected to occur along the U.S. Highway 395, SR 136, and SR 190. However, periodic events during which equipment is hauled to the site may result in safety hazards associated with other oncoming or turning vehicles on U.S. Highway 395, SR 136 and SR 190. In addition, overweight trucks transporting material, equipment, and other construction materials could potentially result in some damage to the roadway surface of the State Highways. Therefore, these impacts can be considered potentially significant. Transportation improvement measures are recommended to reduce the potential impacts due to the construction of the project to less than significant levels (refer to Section 8.0 herein).

APPENDIX

TRAFFIC COUNT DATA

2011 TRAFFIC VOLUMES

ON THE CALIFORNIA STATE HIGHWAY SYSTEM

STATE OF CALIFORNIA

BUSINESS, TRANSPORTATION AND HOUSING AGENCY

DEPARTMENT OF TRANSPORTATION

DIVISION OF TRAFFIC OPERATIONS

Sacramento, CA 95814

916-654-4578

Prepared in Cooperation with the

U.S. DEPARTMENT OF TRANSPORTATION

Federal Highway Administration

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PREFACE

Traffic Trend

A comparison of the 2011 over 2010 annual traffic volume data shows that state highway travel decreased in 2011. This year's decrease in vehicle miles of travel on California highways compares with prior years as follows:

*2011 over 2010	- 1.1%
2010 over 2009	- 0.2%
2009 over 2008	- 0.6%
2008 over 2007	+3.5%
2007 over 2006	+1.0%

Traffic Profile

This booklet lists 2011 traffic volumes for all count locations on the California state highway system. Peak hours, peak month ADTs and annual ADTs are shown at each count location. Significant volume changes (breakpoints) in the traffic profile along each route are counted and identified by name and milepost value. In addition to the profile breakpoints, the booklet lists county lines and landmarks to aid in orientation.

The numbers shown in this booklet apply to the highway immediately back and ahead of the locations. Therefore, between any two successive breakpoints along the route it may be assumed that traffic volumes will vary from one breakpoint to the next at a reasonably uniform rate of increase or decrease. Where only a single set of figures appears between two breakpoints, a constant volume of traffic may be assumed for the intervening section of highway.

All traffic volume figures listed in this booklet include traffic in both directions unless otherwise indicated.

Route Number

All California state highways are listed in this booklet in order of Legislative Route number.

Milepost

Each profile breakpoint is identified by the milepost value corresponding to that point on the highway. The milepost values increase from the beginning of a route within a county to the next county line. The milepost values start over again at each county line. Milepost values usually increase from South to North or West to East depending upon the general direction the route follows within the state.

The milepost at a given location will remain the same year after year. When a section of road is relocated, new mileposts (usually noted by an alphabetical prefix such as "R" or "M") are established for it.

---

* Based on the Traffic Data Branch's Estimated Monthly Vehicle Miles of Travel Report.

Dist	Route	CO		Postmile		Description	Back Peak Hour	Back Peak Month	Back AADT	Ahead Peak Hour	Ahead Peak Month	Ahead AADT
5	135	SB		16.77		SANTA MARIA, DONOVAN	2100	22000	20900	1800	20000	19000
5	135	SB		17.806		SANTA MARIA, JCT. RTE. 101	1800	20000	19000			
9	136	INY		0		JCT. RTE. 395				100	800	540
9	136	INY		17.73		JCT. RTE. 190	70	680	430			
6	137	KIN		0		JCT. RTE. 43				410	2950	2600
6	137	KIN		2.061		KINGS/TULARE CO LINE	380	3550	3300			
6	137	TUL		0		KINGS/TULARE CO LINE				310	2900	2700
6	137	TUL		1.86		RD 28	310	2900	2700	330	3000	2800
6	137	TUL		7.2		RD 228	370	3350	3150	240	2150	2000
6	137	TUL		13.28		RD 84	270	2400	2250	310	2850	2650
6	137	TUL		14.26		TULARE, SOUTH WEST ST	580	5300	5000	570	6100	5700
6	137	TUL		14.76		TULARE, PRATT/BROOKLYN	920	8500	7900	1050	9700	9000
6	137	TUL		14.98		SOUTH E ST	1050	9700	9000	1200	11300	10500
6	137	TUL	R	15.38		TULARE, M ST/TULARE	1200	11600	10700	1000	9900	9200
6	137	TUL	R	15.53		TULARE, SOUTH L ST	710	7000	6500	530	5900	5000
6	137	TUL	R	15.6		TULARE, M ST/INYO	530	5900	5000	620	6100	5600
6	137	TUL	R	15.78		TULARE, M ST	620	6100	5600	1150	10700	10500
6	137	TUL		15.94		TULARE, O ST	1150	10700	10500	1400	12600	12400
6	137	TUL		16.116		TULARE, CHERRY AVE	1350	12600	12400	1600	15300	15000
6	137	TUL		16.489		TULARE, BLACKSTONE AVE	1600	15300	15000	2550	24000	23500
6	137	TUL		16.628		TULARE, JCT. RTE. 99	2550	24000	23500	2000	19100	18700
6	137	TUL		17.01		TULARE, LASPINA/RD 112	2000	19100	18700	1350	16600	16300
6	137	TUL		17.511		TULARE, JCT. RTE. 63 N	1700	15900	15600	1400	15600	14000
6	137	TUL		20.46		LOVERS LANE/ RD 140	1000	11400	11200	900	10400	9900
6	137	TUL		23.897		FARMERSVILLE/RD 168	990	11600	11000	950	11700	10600
6	137	TUL		27.396		JCT. RTE. 65	960	11700	10600			
7	138	LA		0	R	JCT. RTE. 5				200	1850	1475
7	138	LA		1.392	R	END INDEP ALIGN	200	1850	1475	200	1850	1475
7	138	LA		0	L	BEGIN INDEP ALIGN LT LNS	200	1850	1475	200	1850	1475
7	138	LA		1.392	L	END INDEP ALIGN	200	1850	1475	400	3700	2950

Dist	Route	CO		Postmile	Description	Back Peak Hour	Back Peak Month	Back AADT	Ahead Peak Hour	Ahead Peak Month	Ahead AADT
6	190	TUL		24.45	TULE INDIAN RESERVATION/AVE 160	590	7100	6000	590	7000	6000
6	190	TUL		27.295	RIVER ISLAND RD	440	5300	4500	420	5000	4300
6	190	TUL	R	31.55	SPRINGVILLE, CRAMER DRIVE	410	4450	3800	390	4250	3650
6	190	TUL		31.701	JCT. OLD RTE. 190	440	4750	4050	420	5400	3900
6	190	TUL	R	32.704	BALCH PARK DRIVE	270	3500	2500	170	1250	850
6	190	TUL		47.98	CAMP NELSON RD	140	1050	700	80	590	400
6	190	TUL		56.567	QUAKING ASPEN CAMP	80	590	400			
9	190	INY		9.85	OLANCHA, JCT. RTE. 395				50	350	230
9	190	INY		24.55	JCT. RTE. 136 NW	50	350	230	110	730	520
9	190	INY		85.83	STOVEPIPE WELLS	150	1000	650	250	1200	900
9	190	INY		93.21	SCOTTY'S CASTLE RD	250	1200	900	180	1250	810
9	190	INY		99.77	BEATTY CUTOFF RD	220	1550	1050	200	1500	950
9	190	INY		110.72	FURNACE CREEK RANCH	370	2050	1250	340	1500	1050
9	190	INY		111.73	BAD WATER RD	340	1500	1050	170	1200	1000
9	190	INY		140.69	DEATH VALLEY, JCT. RTE. 127	150	1200	850			
3	191	BUT		0	JCT. RTE. 70				650	5300	4700
3	191	BUT		3.53	DURHAM/PENTZ RD	650	5300	4700	740	6200	6100
3	191	BUT		3.925	BUTTE COLLEGE DRIVE	740	6200	6100	580	5800	5700
3	191	BUT		8.655	PARADISE, AIRPORT RD	580	5800	5700	560	5800	5700
3	191	BUT		10.08	EASY ST	560	5800	5700	540	6000	5900
3	191	BUT		11.13	PARADISE, BUSHMAN RD	540	6000	5900	1000	10400	10100
3	191	BUT		11.386	PARADISE, PEARSON RD	1000	10400	10100			
5	192	SB	R	0.019	JCT. RTE. 154				1150	12000	10900
5	192	SB		0.18	CIENEGITAS AVE	1150	12000	10900	1400	11000	10000
5	192	SB		1.64	SANTA BARBARA, ONTARE	1400	11000	10000	1300	11000	10000
5	192	SB		4.15	SANTA BARBARA, MOUNTAIN	320	3300	3040	490	4000	3600
5	192	SB		5.99	SANTA BARBARA, JCT. RTE. 144 S	480	3700	3360	570	3700	3360
5	192	SB		8.28	HOT SPRINGS RD	550	4300	3900	1200	8000	7300
5	192	SB		8.82	SAN YSIDRO RD	1100	10500	9500	1050	8500	7700
5	192	SB		10.74	SHEFFIELD DRIVE	620	5100	4600	360	2900	2620

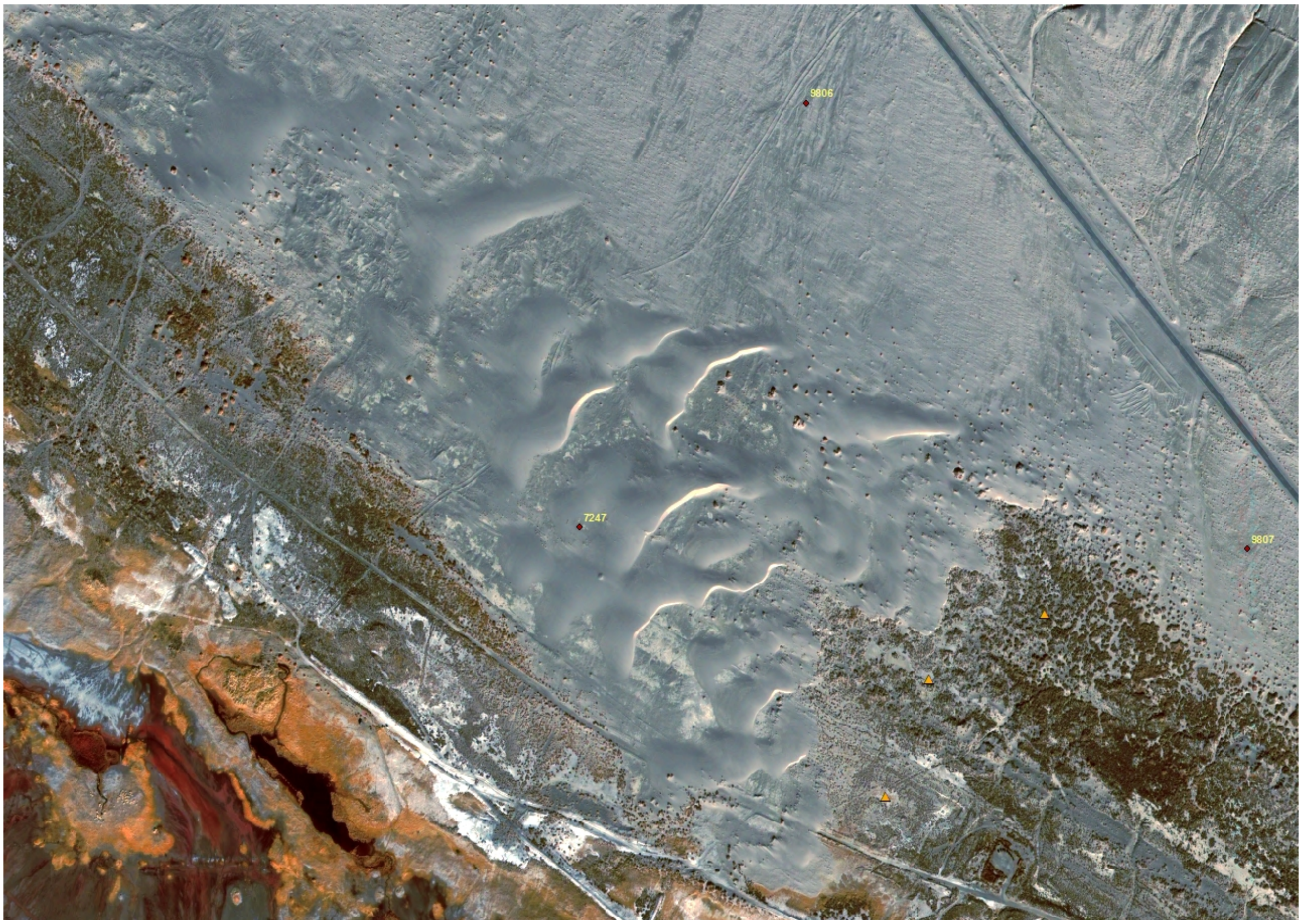
Dist	Route	CO		Postmile	Description	Back Peak Hour	Back Peak Month	Back AADT	Ahead Peak Hour	Ahead Peak Month	Ahead AADT
8	371	RIV		71.31	ANZA, CONTRERAS RD	710	7300	7000	710	7300	7000
8	371	RIV		77.148	JCT. RTE. 74	480	3950	3800			
4	380	SM	T	4.703	SAN BRUNO, JCT. RTE. 280				10500	147000	139000
4	380	SM		5.465	SAN BRUNO, JCT. RTE. 82	10500	147000	139000	12000	168000	159000
4	380	SM		6.373	S SAN FRANCISCO, JCT. RTE. 101	12000	168000	159000	13900	194000	184000
4	380	SM		6.76	SOUTH AIRPORT RD	13900	194000	184000			
8	395	SBD	R	3.981	JCT. RTE. 15				2050	25000	24000
8	395	SBD	R	5.613	PHELAN/MAIN ST	2300	28500	27000	2050	25000	24000
8	395	SBD		8.62	BEAR VALLY RD	2050	25000	24000	1850	23100	22000
8	395	SBD		10.213	LUNA RD	1850	23100	22000	1800	22100	21000
8	395	SBD		11.18	PALMDALE RD; JCT. RTE. 18	1800	22100	21000	1500	18800	18000
8	395	SBD		15.707	GEORGE AIR FORCE BASE	1450	19100	18000	1800	16800	15000
8	395	SBD		17.777	ADELANTO, EL MIRAGE	1800	16800	15000	1150	10600	9500
8	395	SBD		45.948	JCT. RTE. 58	840	7800	7000	490	4700	4100
8	395	SBD		72.77	TRONA RD	490	4700	4100	570	4700	4000
8	395	SBD		73.518	SAN BERNARDINO/KERN CO LINE	570	5000	4000			
6	395	KER		0	SAN BERNARDINO/KERN CO LINE				570	4950	4000
6	395	KER	R	1.152	REDROCK, RANDSBURG	580	5300	4200	590	5300	4200
6	395	KER	R	14.995	CHINA LAKE RD	570	5200	4100	410	3600	2950
6	395	KER	R	23.48	JCT. RTE. 178	420	4400	2850	450	3700	2750
6	395	KER	R	29.64	JCT. RTE. 14 S	450	3700	2750	1050	7200	5650
6	395	KER	R	36.824	KERN/INYO CO LINE	1050	7200	5400			
9	395	INY	R	0	KERN/INYO CO LINE				1050	7200	5400
9	395	INY		34.674	JCT. RTE. 190 E	940	7500	5400	1000	7300	5600
9	395	INY		55.827	JCT. RTE. 136 SE	1050	7400	5800	1100	8600	6600
9	395	INY		57.67	LONE PINE, WHITNEY PORTAL	1200	9300	7000	1150	8500	6500
9	395	INY	R	58.814	PANGBORN LANE	1050	7800	6000	1050	7800	6000
9	395	INY		73.41	INDEPENDENCE, MARKET	1100	8000	6200	1100	8200	6300
9	395	INY		73.85	INDEPENDENCE MAINT STA	1100	8200	6300	1050	7700	6050
9	395	INY		100.83	BIG PINE, JCT. RTE. 168 NE	1050	7800	6000	1100	9600	7800

APPENDIX I
KEELER DUNES INVESTIGATION: PROJECT STUDY PLAN

Keeler Dunes Investigation

Project Study Plan

September 2010



Great Basin Unified Air Pollution Control District

Bishop, California

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I. Project Questions. The Keeler Dunes Investigation can be defined as working to answer a series of questions. The project components are designed with the goal of obtaining answers to as many of these questions as possible. A list of the main questions is provided here.

1) When did the Keeler Dunes and sand deposit form?
2) What is the source of material for the dunes?
3) How did the dunes form?
4) How have the dunes changed over time?
5) What is the relationship of the Keeler Dunes to existing vegetated shoreline dunes and the Swansea Dunes?
6) Are the shoreline dunes a natural feature that was present before the lake desiccated?
7) What is the sand budget within the Keeler Dunes?
8) What is the sand flux rate within the dune system?
9) How much spatial variability is there in the sand motion?
10) What is the volume change within the dunes? By storm? Seasonal? Annual?
11) Where are the dunes moving to?
12) What is the rate of movement of the Keeler Dunes?
13) Is the Keeler sand deposit expected to move into Keeler? If so, when?
14) What is the estimate of material being fed into the dune system prior to dust controls?
15) What is the predicted change in the dunes in the future given no controls?
16) What is the threshold wind speed required for dust generation? Does it vary across the study area?
17) Can the shoreline dunes and Swansea dunes be used as a model for a stable natural system?
18) What is the sand motion within these naturally stable areas?
19) What is the vegetation cover within the Keeler Dunes? How does this compare to the shoreline and Swansea dune area?
20) Which areas within the study area need to be controlled?
21) What level of control is needed?
22) What are control strategy options?
23) What is the project timeline?
24) What environmental work needs to be done? Can we start some of it now?

Keeler Dunes Investigation

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September 2010

II. Keeler Dunes Project Overview

The Keeler Dunes and associated sand deposits are situated northwest from the community of Keeler on the Keeler alluvial fan east of the exposed bed of Owens Lake (Figure 1). The loose sands that compose the dunes and sand sheet are mobile and cause dust emissions during high wind events. The Keeler Dune area is one of the last main dust sources that cause and contribute to exceedances of the state and federal 24-hour PM10 standard in the community of Keeler (Figure 1). As a result of these high PM10 concentrations, the Great Basin Unified Air Pollution Control District (District) identified the Keeler Dunes as one of the areas that need to be controlled in order to attain the PM10 standard within the Owens Valley Planning Area (OVPA) (GB, 2008a).

The District first began formal monitoring of the sand motion in the Keeler Dunes in April 2000 with the installation of two monitoring sties. Ten additional sites were added in October 2008 as part of a project to collect more detailed temporal and spatial sand transport data within the Keeler sands. Two camera sites were also added with vantages over the dune area to view dust activity during wind events (Figure 2). Also, as part of the Keeler Dunes Investigation, work has begun to map and characterize the historical development of the sand deposit as well as to better understand the dynamic system and its future evolution. The purpose of this document is to present an overall study plan for the project in order to tie all of the components together with the goal of developing a dust control strategy and associated mitigation plan.

The timeline for this project is aggressive. The OVPA Revised 2008 State Implementation Plan (2008 SIP, (GB, 2008a)) requires attainment of the 24-hr PM10 standard by March 2017. In order to achieve attainment by that date, the District Board must issue an order for control by January 1, 2012 and controls must be fully implemented by January 1, 2014. Along with the development of a control strategy and an order by the Great Basin Governing Board for the control of the Keeler Dunes is an associated environmental analysis to meet the requirements of CEQA (California Environmental Quality Act) and possibly NEPA (National Environmental Policy Act).

III. Background

Historic Owens Lake prior to water diversions of the Owens River and tributary streams had a surface area of approximately 110 square miles and a shoreline at an elevation of about 3,597 feet MSL. Following water diversion from inflow sources and a subsequent drop in the water level of the lake, large expanses of lake bed sediments were exposed. Due to the bathymetry of the lake bottom, the broadest expanses of exposed lake bed were in a 2 to 3 mile wide band that wraps along the shore of the eastern side of the lake bed. Large dust sources developed on the exposed lake bed creating high particulate concentrations within the region during high wind events.

One of the largest dust source areas, in terms of frequency, repeatability, and magnitude, was located on the north eastern portion of the lake bed in an area termed the North Sand Sheet (NSS) (Figure 3). The soil composition in the NSS is predominantly sandy with the primary source of sediment from the Owens River and smaller component from the Inyo Mountains to the east of Owens Lake. With continual exposure to high winds since desiccation of the lake (in 1926), much of the sand in the NSS moved off of the lake bed forming a deposit of aeolian material on the adjacent alluvial fan (Keeler Fan). Reworking of the sands over time has caused the character of the sand deposit to change. Currently, the Keeler sand deposit is about 1.3 square miles in areal extent (Figure 2) and appears to be spreading to the east and southeast toward the community of Keeler and the foothills of the Inyo Mountains.

Most of the land on which the Keeler sand deposit is located is owned by the U.S. government and is under the jurisdiction of the Bureau of Land Management (BLM) (Figure 4). Other groups that also own land within the Keeler sands or are an interested party in their control include the City of Los Angeles, local Paiute-Shoshone Tribes, Southern Pacific Railroad, Keeler Community Services District and Keeler/Swansea residents. The work on this project is being done by a team of researchers from the District, the Desert Research Institute (DRI), and HydroBio INC.

IV. Project Components

The objective of the Keeler Dunes Investigation is to develop a control strategy for mitigation of the windblown dust that impacts the community of Keeler and the surrounding region. One of the main steps in achieving this goal is to identify the areas within the Keeler Dunes sand deposit that cause or contribute to violations of the federal 24-hour PM10 standard in the community of Keeler and therefore need to be controlled. However, there are other steps that need to be completed as well in order to achieve successful dust mitigation of the dunes.

The investigation itself is composed of multiple components. The components are designed to provide answers to questions that can be broadly grouped into the following categories:

1. What is the origin and development of the dunes?
2. What is the character of the Keeler Dunes deposit?
3. What is the nature of sand motion and dust emissions within the dunes?
4. What methods can be used for stabilization and control of the dunes and how can they be implemented?

The work tasks within the components of the project range from historical research on the development of the Keeler Dune sand deposit, to relative and absolute dating of material within the Keeler Dune deposit and adjacent shoreline dunes, to field mapping and surveying of the current aeolian deposit and associated features, to quantitative analysis of sand motion and emission rates within the Keeler Dune sand area, and finally to a numerical analysis to determine which areas need to be controlled. These components are discussed below.

a. <u>Development of the Keeler Dunes</u>

One of the components of the Keeler Dunes Investigation is to gain a more thorough understanding of the formation of the Keeler sand deposit and its development over time. Determining the origin, age and movement of the aeolian sands and dune formation within the Keeler deposit is central in determining who is responsible for their mitigation. Currently, there is no consensus among the different groups involved on when the Keeler Dunes and associated sand deposit developed (i.e., the age of the aeolian sand deposits), how they have changed over time, and the source of the material within the dune area. The District's current hypothesis is that the Keeler Dunes formed in response to the exposed material from the North Sand Sheet moving off of the lake bed following desiccation of Owens Lake. Completion of this portion of the project will provide information to test this hypothesis.

Several different avenues are being pursued in order to develop an understanding of when, where, and how the Keeler Dunes formed. The bulk of information on the development of the Keeler Dunes will come from analysis and interpretation of historic air photographs and satellite imagery on which the extent of the sand deposits and individual dune features are discernable. Written records and ground-based photographs from historical activities along the eastern shore of Owens Lake will be used to augment the record and provided insight on changes present in the landscape of the area over time.

Imagery - Air Photos and Satellite Imagery

The District and researchers from DRI are working on developing a library of air photos and satellite images of the Keeler Dune area that extend as far back in time as possible. Currently, the library contains photos and images that range from 1947 to 2010. The bulk of the imagery is from about 1990 to the present. Gaps in the photo/imagery record include the time period in the 1950s and 1960s as well as photos prior to 1947. An effort is being made to search for these critical gaps in the photographic record.

Features that are visible on the imagery include the extent of the aeolian sand deposits on the Keeler Fan, the presence of distinct dune forms, the presence of large greasewood mounds, changes in vegetation cover and type, the presence of exposed intra-dune mudflats, as well as other features depending on the resolution of the image being analyzed. Examination of these features through the sequence of photos and imagery provides answers to the questions concerning the growth and development of the sand deposit and dunes and insight into the evolution of the dunes in the future.

Dating of Dune Deposits

Defining the date in which the Keeler Dunes formed is important in the project since the answer has consequences in terms of who will be required to implement the dust control measures. Due to the potential youth of the dunes and their relative lack of organic matter, it appears that most radiometric age dating techniques are unsuitable.

A dating method that has promise for the sand deposits is an optical luminescence technique that provides an age for the last exposure of the material (quartz and potassium feldspar) to light. Due to the mobility of the aeolian material, most of the sand deposit would show very young ages when dated. However, of interest to this project is to determine the oldest dates present within the Keeler Dune area. The sampling methodology is critical to successful date results and sample collection has to be conducted carefully and with a detailed sampling plan in order to make the dates meaningful.

Two areas were sampled for optical luminescence dating in September 2010 by researchers from DRI and the District. Samples were transported to and are being analyzed by DRI's E.L. Cord Luminescence Geochronology Laboratory in Reno, Nevada. Initial results of the age from one of the samples should be available in early 2011 with the remaining results complete in the summer or fall of 2011. A total of ten samples were collected from the two areas of interest, two from the shoreline dunes and eight from the western portion of the Keeler Dunes.

The first sample area includes aeolian deposits that are covered with discontinuous layers of clays and silts (mudflat deposits). The mudflat layers are thought to have formed from deposition of flash flood material within the dune field. Over the last several years, many of the mudflat areas have become progressively exposed as overlying dune deposits are removed by continued aeolian activity. The mudflats are present at multiple elevations indicating that there have been multiple flooding episodes during the development of the dune deposits.

The areas that contain the mudflats are primarily located along the western edge of the dunes adjacent to large greasewood mounds. The target for sampling was the aeolian sands that were trapped and protected from subsequent movement by the deposition of the overlying mudflat layers. Dates from these buried layers should provide useful information on the age of the sand deposition. An emphasis was placed on sampling from the oldest mudflat deposits. Presumably, these are the mudflats lowest in elevation – however, given the dynamic nature of the landscape over time, a careful evaluation was conducted to survey and correlate the mudflat units prior to conducting the sample collection.

Another area of focus for luminescence dating was the shoreline dunes along the eastern side of the lake bed. It is thought that these dunes could represent part of a stable natural dune system developed along the historic Owens Lake prior to desiccation. If this is the case, then it may be possible to verify this by completing careful sampling and dating of samples from the base of the dunes. Since there is discussion on potentially using the shoreline dunes and Swansea dunes as an analog model for potential control in the Keeler Dunes, the results of age dating of the material present is important.

Historical Records and Anecdotal Information

Another avenue for learning about the formation of the Keeler Dunes and sand deposits is through review of historical records and photos. Development of the eastern side of Owens Lake and the area around Keeler began with mining and railroad activities starting in the late 1800's and early 1900's. The main mining activities included silver mines in the Inyo Mountains, salt mining on Owens Lake and in Saline Valley, dolomite mining in the Inyo Mountains, and talc and clay mining in the Coso Mountains.

A narrow gauge railroad was built around 1900 with the end of the line being in Keeler. Searches through historical records from sources with information from all of these activities are being conducted to see if there are any photos, historical records or anecdotal information on the landscape in the area of the Keeler Dunes.

Projection of Future Movement of Dunes and Sand Deposits

Through analysis on the origin and development of the Keeler Dunes it may be possible to project the movement of the dune deposit with time into the future. Prediction of the future development of the dunes is important in order to determine what will likely happen to the existing landscape should no controls be implemented within the dunes as well as what will happen to the deposit should there only be partial control (i.e., only part of the areas designated for mitigation).

One obvious question to answer concerns the dune encroachment into the community of Keeler. Preliminary estimates suggest that the southern portion of the dune deposit has moved approximately 165 meters to the southeast from 1994 to 2008. This yields an average rate of movement during this time span of about 12 meters per year. If this rate of movement continues, the Keeler Dunes deposit will move into the community of Keeler in about 65 years (Figures 5 and 6).

By completing a more comprehensive evaluation of the complete set of available images a more thorough understanding of the overall distance of movement of the dunes with time as well as the speed at which the dunes have moved. The current assumption is that the sand deposit is moving at a relatively uniform rate, however, this might not be the case. The overall dune movement may well be non-uniform such that it moves in pulses, with each pulse separated by a period of time with little or no movement. Gaining this type of information will be important for understanding the dynamic system and developing predictions of the state of the dune field in the future.

b. <u>Characterization of the Keeler Dunes and Sand Deposit – Data Collection and Analysis</u>

The purpose of the information collected as part of the Keeler Dune sand deposit characterization tasks is to understand the current conditions and to provide information on the processes that formed the dune system.

Sand Motion Monitoring

The District currently has a network of 12 sand motion monitoring sites within the Keeler Dune Sand deposit. The sites within the network are located in three transect that are oriented from northwest to southeast (Figure 1). Instrumentation at the monitoring sites includes:

- Sensit – electronic saltation particle count sensor to time resolve sand motion
- Cox Sand Catcher (CSC) – used to collect a physical sample of the saltation fraction
- Wind speed (WS) sensor – all 12 sites have WS at 1 meter height, 3 sites have WS at 1 and 2 meter height.
- Wind Direction (WD) sensor – at 3 sites
- Campbell Scientific datalogger system

The sites are visited regularly by a field technician to collect the sand catch from the CSCs as well as download data from the logger and to make sure the instrumentation is operating properly. The scheduling of the field visits can range from weekly to monthly and is based on the number and magnitude of wind events. The procedure for operation of each site and the processing of sand catches follows that described in the Dust ID Protocol (GB, 2008b). The sand catch from the site is removed from the field and is taken to the lab in the Keeler office and dried, if necessary, and then weighed on the analytical balance to obtain a mass for the catch. Samples are then placed in labeled zipperlock bags and stored. The sand catch mass data are processed with the time resolved particle count data from the Sensits to provide saltation flux rates for each site.

The 12 existing sand motion monitoring sites (as of June 2010) are installed in open areas within the Keeler Dunes and sand deposit. There can be occasional growth of annual plants following precipitation events but for the most part the sites are located in unvegetated open spaces where there is relatively high sand flux.

Six additional sand motion monitoring sites are proposed for installation in the network. The new sites are proposed for two areas (NW and SE) that are adjacent to the Keeler Dune deposit (Figure 7). The purpose of installing sites in these areas is to monitor the sand motion and wind field associated within what is thought to be relatively stable areas. The results from the sites within the areas with low dust emissions can be used as a natural model and can assist in projecting what the expected sand motion and wind reduction will be in areas of the Keeler Dunes if a replicated system is used as a dust control strategy.

Three sites are proposed NNW of the Keeler Dune sand deposit within the Swansea dunes (Figure 7A). This area consists of a dune field approximately 3-5 meters in height and containing scattered vegetation elements that disrupt the wind. The dominant vegetation consists of large greasewood mounds along with smaller saltbush and other phreatophytic plants. The new monitoring sites will be placed in areas of differing vegetation cover and composition in order to determine the sand flux and wind conditions present. The Swansea dunes sites will be instrumented in a similar fashion to the Keeler Dunes sites except that adjustments will be made to the height of the wind speed and wind direction sensors due to the presence of the surrounding vegetation.

The second set of new monitoring sites will be located in the heavily vegetated area between the south-end of the Keeler Dunes and the community of Keeler (Figure 7B). Again, the purpose of these sites is to determine the movement of sand within an area considered to be stable. The results can be used as a target when selecting a dust control strategy.

Sand Flux Data Analysis

Analysis of the sand flux in conjunction with WS, and WD provide information on the movement of sand across the Keeler monitoring network. Further analysis of these data will be completed as part of an air quality model in order to determine the contribution of each site to dust concentrations at modeled receptors (see Section IV.a.)

Analysis of data from November 2008 to April 2010 (following expansion of the network from 2 to 12 sites) provides preliminary results for the flux rates and direction of sand movement across the monitoring network (GB, 2009a, 2009b and 2010). From these reports it appears that the predominant sand flux within the Keeler Dunes deposit is to the east to southeast directions and that the highest flux rates are found in the western and southern portion of the aeolian deposit (Figure 8).

Additional analysis of sand flux and wind data also provide valuable results regarding the threshold winds needed for particle motion across the network. Data are evaluated by transect as well as location within the network. Results from February 2009 to April 2009 indicate that the threshold WS needed for saltation and saltation rates vary by location within the Keeler Dunes sands. Generally the threshold WS increases and the saltation rates decrease from the west to east (GB, 2009b).

Remote Camera Sites - Video Record During Dust Events

The District has two remote cameras located with vantages over the Keeler Dunes and sand deposit (Figure 3). The first camera (Dolomite 2) is located north of the Keeler Dune area on a hillside along the base of the Inyo Mountains. The current camera operating at the Dolomite location is high definition and has a resolution of 920x1080. The view from the Dolomite 2 camera is to the southeast with the main axis of aeolian activity in the dunes visible. The second camera (Keeler Dunes camera) is located northeast of the Keeler Dunes on a hill at the top of the Keeler Fan. This camera has a view to the west-southwest across the Keeler Fan toward the lake bed. The Keeler Dunes camera has a resolution of 640x480.

The cameras collect images continuously during daylight hours and transmit them to the District's Keeler field office through a remote transmission system. Processing of the camera footage is conducted regularly to remove periods of time without dust activity. The images with "dusty" days are complied and provide a useful visual summary of the location and intensity of dust events in the project area. An analysis of the video information in conjunction with the sand motion and wind data will be completed for selected dust storms so that the magnitude and intensity of the dust event can be compared with the visually observed activity.

Photo Record from Monitoring Sites

One of the tasks during each visit to the sand motion monitoring sites is to obtain photographs of the conditions in the area where the instrumentation is located. The purpose is to provide a record of the general conditions at the site. Important features that can be present on the photos include some of the following:

1) the presence (or absence) of annual vegetation growth
2) height of annual vegetation
3) density of annual vegetation
4) movement of sand sheets and sand tongues across the area
5) areas of inflation or deflation
6) scouring of the surface
7) movement of nearby dune forms
8) moisture from recent rains
9) other features that may influence the local sand movement near the site.

The photographs are downloaded and stored onto a computer following completion of the site visits within the network. Photographs are always taken from the same location (marked with a stake in the field) and orientation so that the fields of view of the photos are consistent over time.

c. Characterization of the Keeler Dune and Sand Deposit – Mapping and Survey Data

The conditions and nature of the Keeler sand deposit is obtained through characterization efforts that involve sample collection and analysis and mapping and surveying in the project area.

Particle Size Analyses

Analysis of the particle size distribution is a common technique used to characterize a soil or sediment sample. Typical particle size analyses provide information on the percentage of material within specified size ranges. By completing analyses on samples collected across an area it is possible to determine spatial changes in the particle size distribution across a deposit which in turn can provide useful information on their formation and development.

Numerous samples from Owens Lake and from the Keeler Dunes sands have been analyzed for their particle size distribution. The samples analyzed from the Keeler Dunes include sites from aeolian deposits at the surface as well as from material collected in the CSC devices. These samples were analyzed using a dry sieve method to provide data in 7 particle size bins. The results of the analyses show an overall decrease in particle size distribution from northwest to southeast and from west to east across the Keeler Dune sand deposit consistent with visual observations (Figure 9).

As part of work on the lake bed before the implementation of dust controls, soil samples were collected and analyzed for general particle size character during soil surveys as well as from early sand transport studies. During these projects, several samples were collected from the NSS area from the surface as well as down to 5-feet below surface in the soil profile. Additionally, a few of the catches from early sand transport studies were also analyzed. The method for analysis of the soil survey samples used the hydrometer method to aid in soil classification. Samples from the sand transport study were analyzed with the dry sieve method.

The soil on the NSS before dust control implementation contained a distinct lag deposit at the surface caused by the winnowing of finer grained material through continual aeolian activity. The lag deposit was composed of fine gravels and coarse grained sands with a thickness on the order of several centimeters. (Note: the lag deposit is no longer present due to the leveling and working of the areas during dust control construction and operations.) A careful review of the available soil data will be conducted to determine the estimated volume of material that was removed from the NSS through aeolian processes.

Mapping

Mapping is important for understanding the relationship of some of the visible features within the Keeler Dune area. Mapping efforts can be grouped into the following categories: sand movement, vegetation, mudflats, edges of dune forms, and changes in dune shape and volume. Methods for completion of mapping efforts range from analysis of air photos and high resolution satellite imagery, to use of a global position system (GPS) to delineate individual features and polygons, to surveying of transects with optical survey equipment.

By using the library of satellite imagery and air photos (see Section III.a.) the changes in large-scale features can de determined to help understand the historical development of the dune deposit. Mapping of bulk vegetation changes may also be determined by interpreting the available collection of photos and images. Also useful in characterizing the dune area is on-the-ground mapping of select features, such as the position of dune faces and dune boundaries, location and size of exposed mud-flat areas, and natural vegetation areas. In many cases, the on-the-ground mapping episodes provide excellent control for interpretation of imagery.

The deposits of clay and silt that form the cracked mudflat areas have changed significantly over time. Many of the mudflats present along the western portion of the dune field have become more exposed through deflation of the overlying sands. By mapping the size of the exposed mudflat areas using the satellite and air photo record it may be possible to develop an estimate of the rate of deflation and the volume of material that has been lost (Figure 10).

In order to accurately map the size and location of the existing dune field, the District conducted GPS mapping of the dune forms in 2002, 2008, 2009, and 2010 (Figure 11). Mapping is completed by traveling (via ATV in 2002 and via walking in 2008, 2009 and 2010) around the base of the dune forms to provide a polygon map of the outline of individual dunes. This mapping effort provides control for the interpretation of images in the library as well as further information on small-scale features of the dune that might not be visible on images and photos. Dune mapping will continue in the late spring to early summer of 2011 and will be used in conjunction with other data to provide an understanding of the movement of the dunes over time.

HydroBio INC has completed two high resolution air photo mosaics of the Keeler Dune area. The first was conducted in August and October of 2009 and the second in August 2010. Both sets of photo mosaics have been rectified and added to the photo/imagery library. From the 2009 mosaic, a map of the existing vegetation was created. This map will be used to determine the vegetation cover present within the dune area. Most of the active areas of the dunes are open and have very little vegetation. Use of this cover data combined with sand flux information will be used in the consideration of dust control methods for the dunes. The photos from August 2010 have been especially useful in conducting mapping and surveying efforts within the project area since small features (e.g. individual shrubs and plants) are easily visible.

Elevation Surveying

Elevation surveying within the Keeler Dunes is limited. HydroBio has established a series of transects across five of the dune features present in the deposit and has conducted two annual relative elevation surveys (the survey transects are not tied to absolute elevation above MSL) (HydroBio, 2009). The first survey was in 2008 and established the initial conditions across the five surveyed dunes. The second survey was completed in 2009. A third survey of will be conducted in October 2010. Data from the transect surveys will provide profiles across the dunes and an estimate of the volume changes present on an annual basis. (The reader is encouraged to read the report by HydroBio (2009) for more information on the survey and results of the work to date.)

In January 2010, the LADWP completed an air-borne LIDAR survey of portions the dust control project on the bed of Owens Lake. Fortunately, the Keeler Dunes area was included within the survey area and the data have been made available to the District. These data provide a detailed digital elevation model (DEM) of the Keeler Dunes and related sand deposit area and can be used in combination with other information to develop a sand budget and volume estimate for the project.

V. Development of Control Strategy

a. Air Quality Modeling

An air quality model will be used to help identify air pollution sources within the Keeler Dunes that contribute to PM10 violations in the community of Keeler and to evaluate control strategies to bring the area into attainment. The CALPUFF modeling system will be used as described in the 2008 SIP (GBUAPCD, 2008a) but with some modifications and refinements.

The model is an important tool that is used to help quantify the PM10 impacts caused by dust sources on the bed of Owens Lake and within the Keeler Dunes deposit. The sources of input into the model come primarily from the data collected within the dunes and the community of Keeler and include:

> Sand Flux Data: Collected from co-located Sensit and CSC sites. The total mass of saltating particles at the site is measured from the sand catches from the CSC. The Sensit data allows the horizontal sand flux to be time resolved for input into the model. The relationship between the sand flux and monitored PM10 concentrations (K-Factor) allow for the data to be converted to PM10 emissions for the model.
>
> Meteorological Data: The meteorological data from the CSC/Sensit monitoring sites within the Keeler Dunes network as well as from the Keeler meteorological tower will be used for wind speed and wind direction inputs into the model.
>
> PM10 Data: Hourly data from the TEOM PM10 monitor at the Keeler Air Monitoring Station will be used for dust concentration input in the model.
>
> Source Area Locations: The source area configuration for the CALPUFF model will be largely developed by combining observational dust mapping and from review of the footage from the two camera sites with vantage over the Keeler Dunes. However, landscape features such as dune form locations, vegetation, sand sheet presence, and other factors from on the ground mapping and observations will also be considered.

In the modeling analysis, emissions from individual dust source areas are simulated to assess whether they caused or contributed to an exceedance of the PM10 standard. Each control measure design and overall implementation strategy will be evaluated in the model to determine the effectiveness at reducing the PM10 emissions from the Keeler Dunes.

b. Control Area

It is generally known from previous results of air quality modeling through the Dust ID Program which areas within the Keeler Dunes need to be controlled. However, the results are generalized and may include portions of the sand deposit that have lower emissions and/or that may not need any or as much control.

Due to the scale of the dust sources on the lake bed, the current air quality model for Owens Lake uses source area contributions that have been descretized into blocks that range from 125 meters to 250 meters on a side. The Keeler Dune area is much smaller than the dust source area modeled on the lake bed (1.3 square miles versus approximately 50 square miles) such that the individual source contribution areas potentially can be smaller within the dune area allowing for more detail, where needed.

The air quality model for the control measure strategy developed for the Keeler Dunes will refine the existing model by focusing on the dune area and using a wide variety of input data from detailed monitoring. The areas that need to be controlled to reduce the PM10 concentrations in the community of Keeler will be determined through a combination of modeling, mapping, video and knowledge of features and terrain within the project area.

c. Control Method Ideas

There are a variety of control measure options for the Keeler Dunes. The strategy that is adopted and implemented will have to take into account the various needs of the different parties with jurisdiction in the control area and with interests in the future of the dune area. The District is required by government regulations to approve and order for implementation a control strategy that will reduce the PM10 emissions that impact the community of Keeler to a level below the standard.

The list of potential control measures range from a completely engineered solution that uses more of a brute force technique to one that leaves the area in as natural state as possible but at the same time is effective at controlling dust emissions. The most effective methods for control of dust emissions will utilize the data and knowledge obtained through other aspects of the project on the processes within the dune system. The final control strategy will have to be carefully crafted and will be selected taking the dust control effectiveness, natural and cultural resources, environmental impacts, technological feasibility and other factors into consideration.

VI. Project Timeline

Due to the proximity to the community of Keeler, dust emissions from the Keeler Dunes contribute significantly to exceedances of the federal PM10 standard in the community. After all the lake bed sources are controlled, the Keeler Dunes area is expected to be the main remaining dust source that cause exceedances of the standard in the planning area. The District will work with the City of Los Angeles and other federal, state and local agencies to develop a plan to control dust emissions from the Keeler Dunes. PM10 control measures required for the Keeler Dunes will be ordered by the District before January 1, 2012 and implemented by the responsible parties before January 1, 2014 in order to demonstrate attainment of the federal standard by 2017.

a. Control Strategy

The development of a successful dust control strategy for the Keeler Dunes and related sand deposits will involve collaboration between multiple government agencies and interested local parties. The existing natural and cultural resources present within the dunes are important considerations in the development of the control plan. Of particular concern to the BLM and local Native American Tribes is the presence of cultural sites within the dunes. It is important to develop a control plan that protects and preserves these sites as much as possible.

The Keeler Dunes are a unique place that is enjoyed by many of the residents from the local community for non-motorized recreational activities (the dunes have been closed to motorized traffic since 2005).

The folks that frequent the dunes have expressed a strong desire to preserve the existing dune area as much as possible. In order to get support from local residents for control of the dust emissions from the dunes, it will be important to develop a control strategy that takes into serious consideration and incorporates as much as possible the current usage of the dunes.

To meet the ultimate timeline for the project of attainment of the PM10 standard by 2017 a control strategy for the Keeler Dunes needs to be developed by January 2011. Once the control strategy is developed then an environmental analysis of its impacts can be determined.

b. <u>Environmental Analysis and Board Order</u>

A thorough environmental analysis of the proposed dust control project is required prior to implementation. The environmental analysis will have to meet the requirements of CEQA as well as NEPA, due to the location of most of the Keeler Dunes on federal lands, requiring a combined Environmental Impact Report (EIR) and an Environmental Impact Statement (EIS). Impacts to Biology, Geology, Hydrology, Cultural Resources, Land Use, Transportation, Air Quality, Visual Appearance and other fields will be evaluated as they relate to the proposed dust control strategy. The environmental analysis needs to be complete and ready for adoption by the responsible agencies by January 2012 so that an order by the Great Basin Unified Air Pollution Control Board may be issued for control of the dunes.

c. <u>Implementation and Attainment of the PM10 Standard</u>

Three years of clean air quality data are required in order for the EPA to designate the Owens Valley Planning Area as in attainment of the PM10 standard. Federal regulations require that the area be in attainment of the PM10 standard by 2017. Thus the party(ies) responsible for implementation of the dust control project in the Keeler Dunes must have all controls constructed and fully operational by January 2014.

VII. References

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VIII. Figures

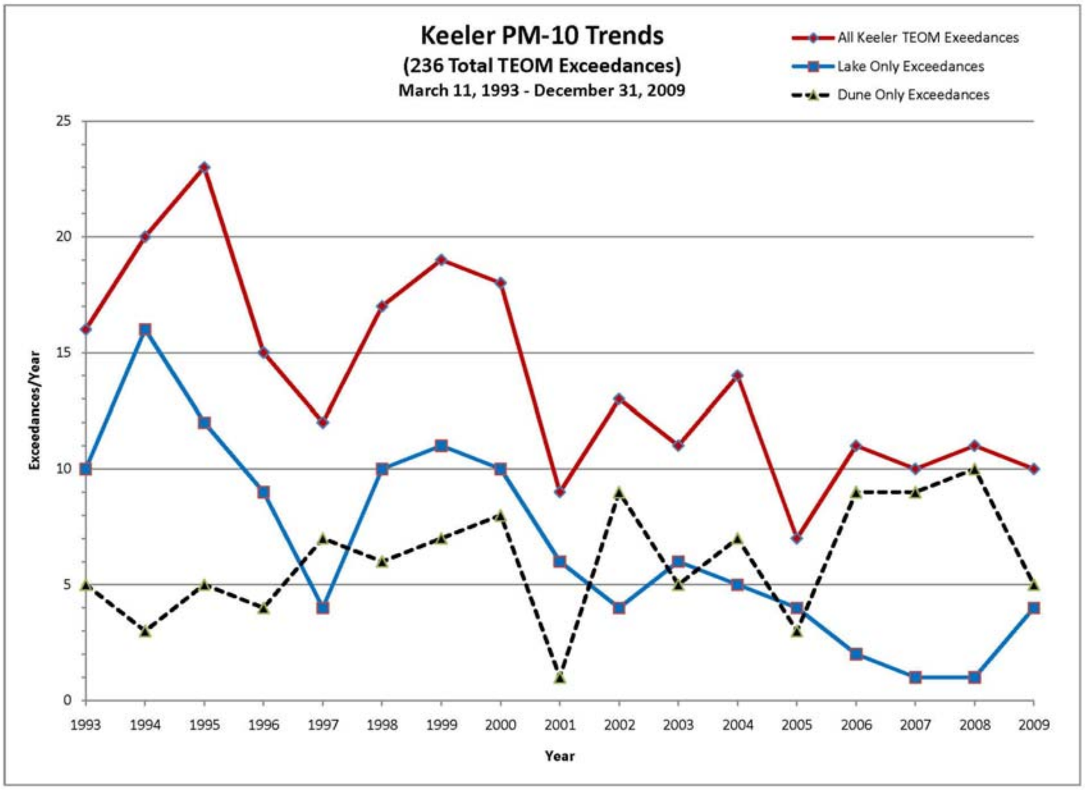

Figure 1. PM10 concentrations measured at the Keeler air quality monitoring station from 1993 to 2009.

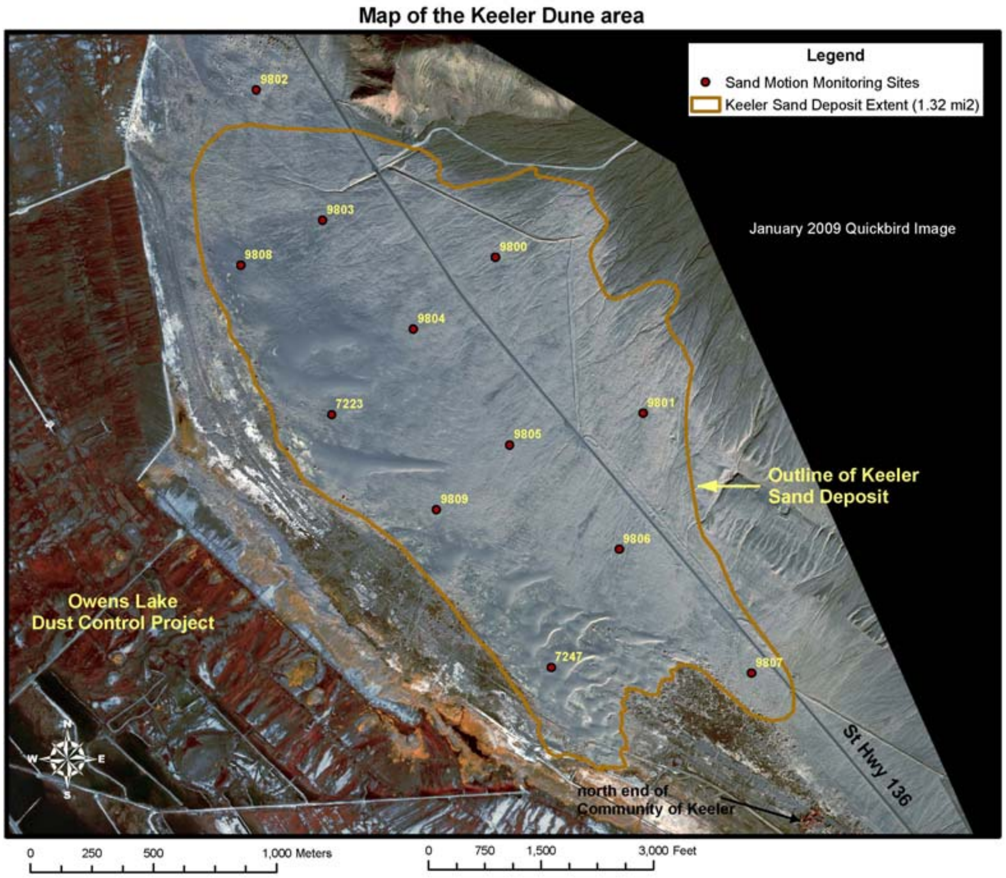

Figure 2. Map of the Keeler Dune area showing the approximate extent of the Keeler Dune sand deposit and sand motion monitoring sites (CSC/Sensit sites).

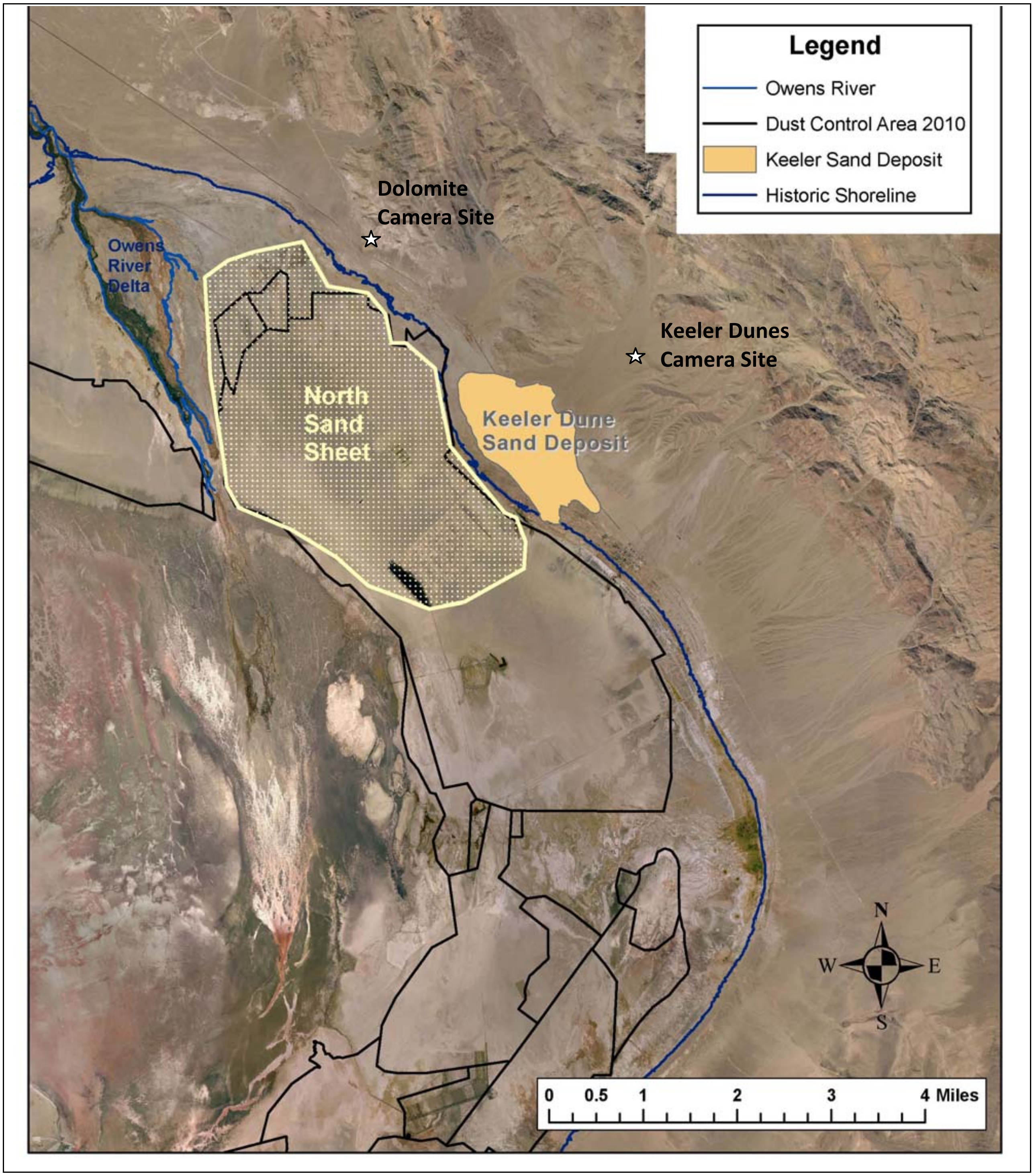

Figure 3. Map of the northeastern portion of Owens Lake showing the location of the North Sand Sheet (NSS) and the Owens River in relation to the Keeler Dune sand deposit. Background air photo was taken in September 2000 prior to dust control project construction. Dust control project footprint from 2010 is shown for reference. Also shown on the map are the locations of the two camera sites which overlook the Keeler Dunes (white stars).

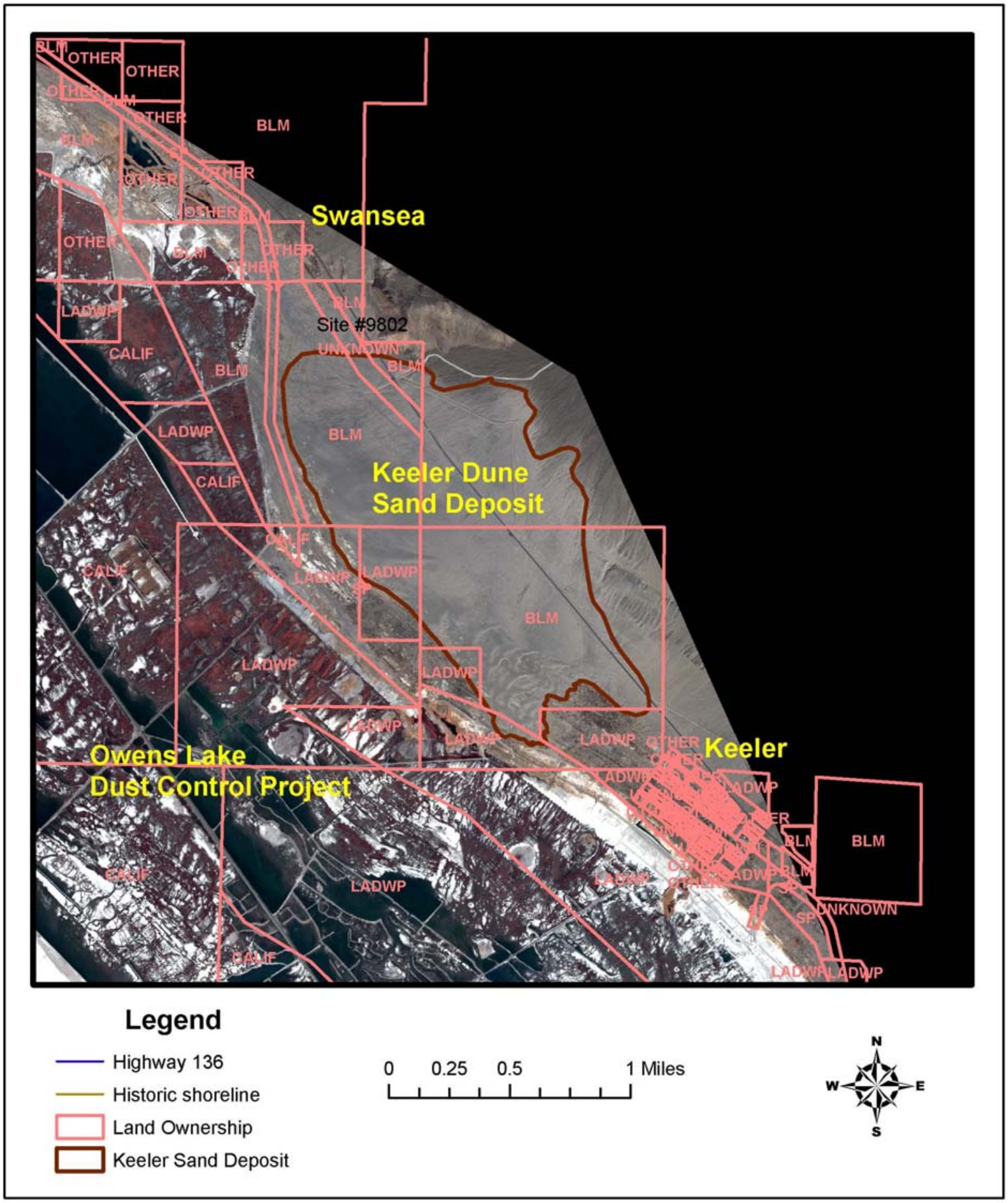

Figure 4. Map of the Keeler Dune area showing land ownership.

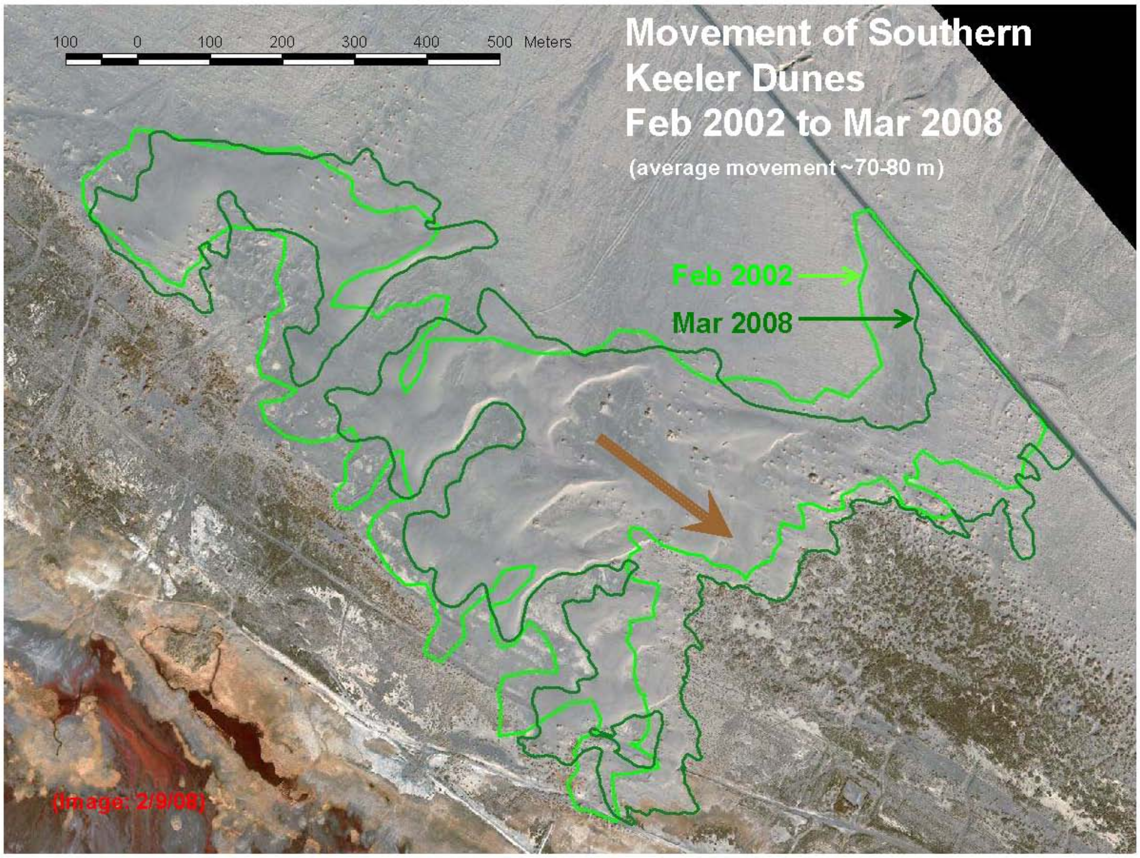

Figure 5. Map of the southern portion of the Keeler Dunes showing the movement from February 2002 to March 2008.

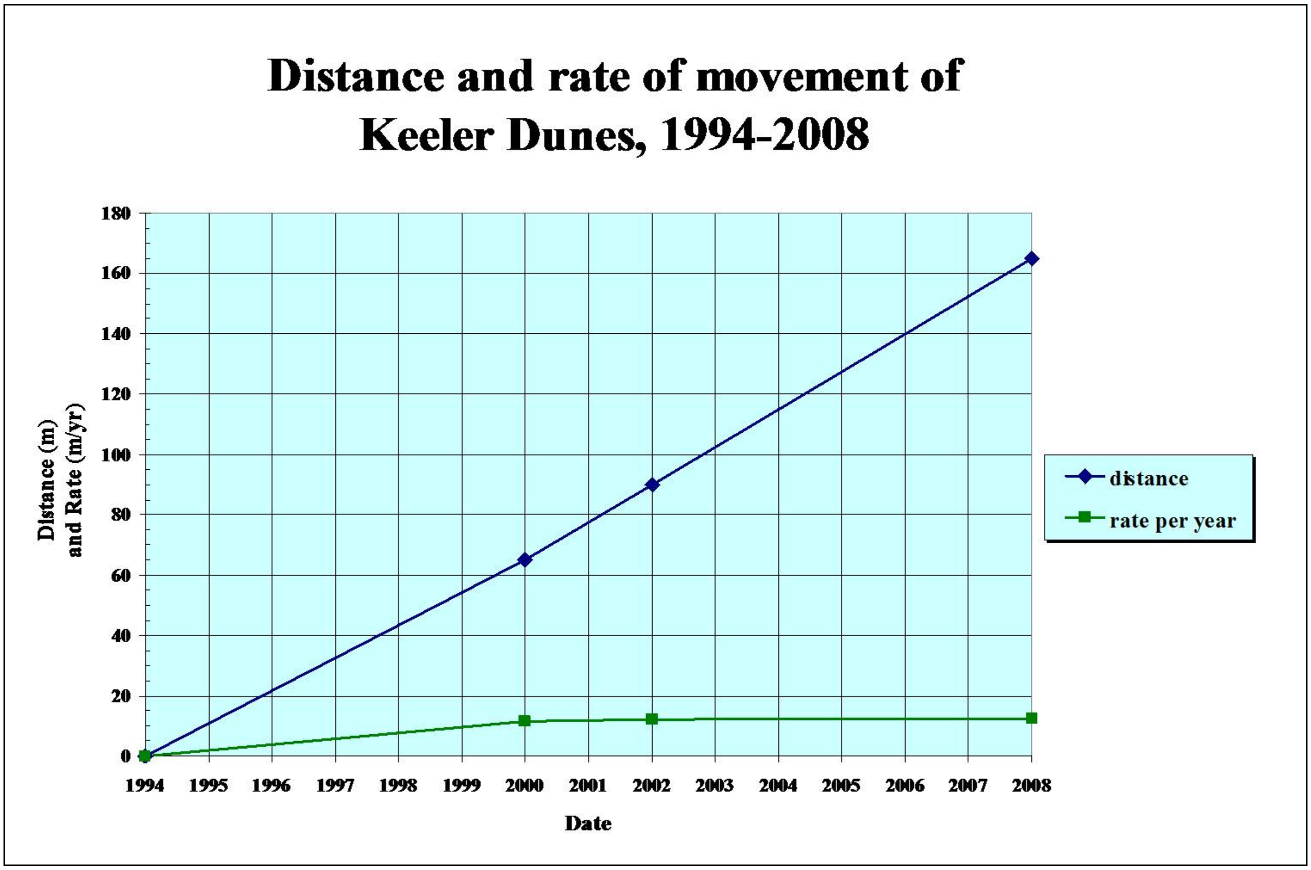

Figure 6. Graph showing the distance and rate of movement of the southern front of the Keeler Dunes from 1994 to 2008. Distance and rate of movement were determined from GPS mapping and satellite imagery interpretation of where the sand deposit covers the Old State Highway. The southern edge of the dune deposit has moved about 165 meters toward the southeast over this time period with an average rate of approximately 12 meters per year.

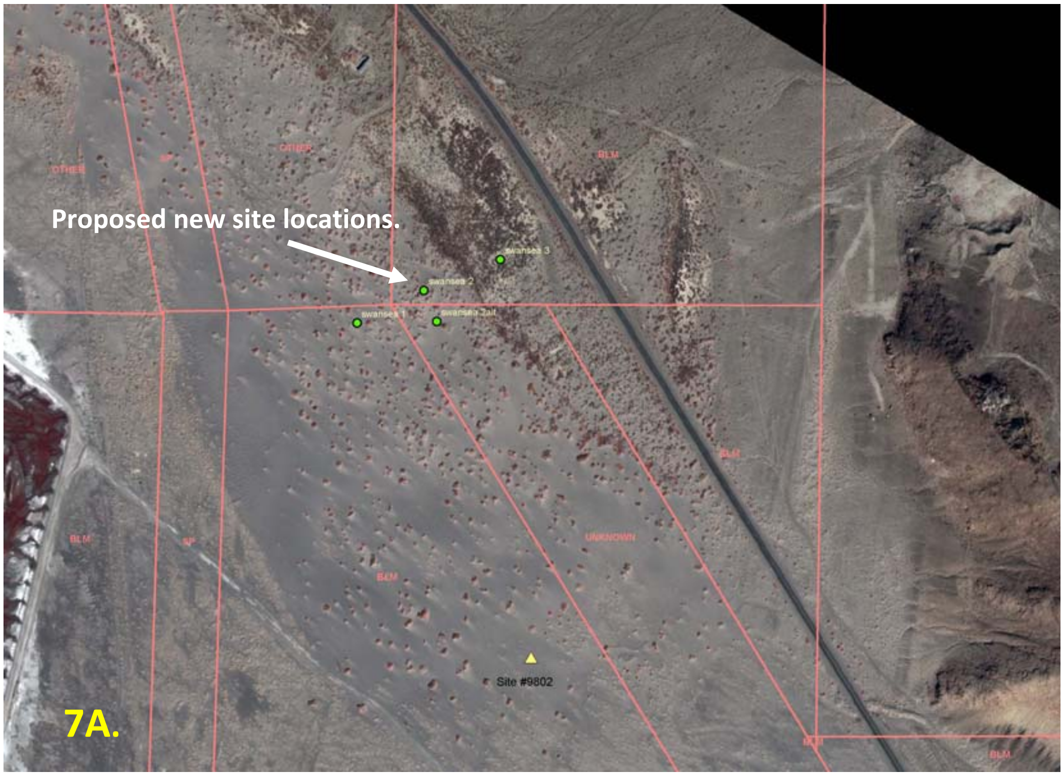

Figure 7. A.) Top Image – Map of the proposed new monitoring locations (green dots) within the Swansea Dunes. B.) Bottom Image – Map of the proposed new monitoring sites (blue dots) along the southeastern edge of the Keeler Dunes. Pink lines are property boundaries.

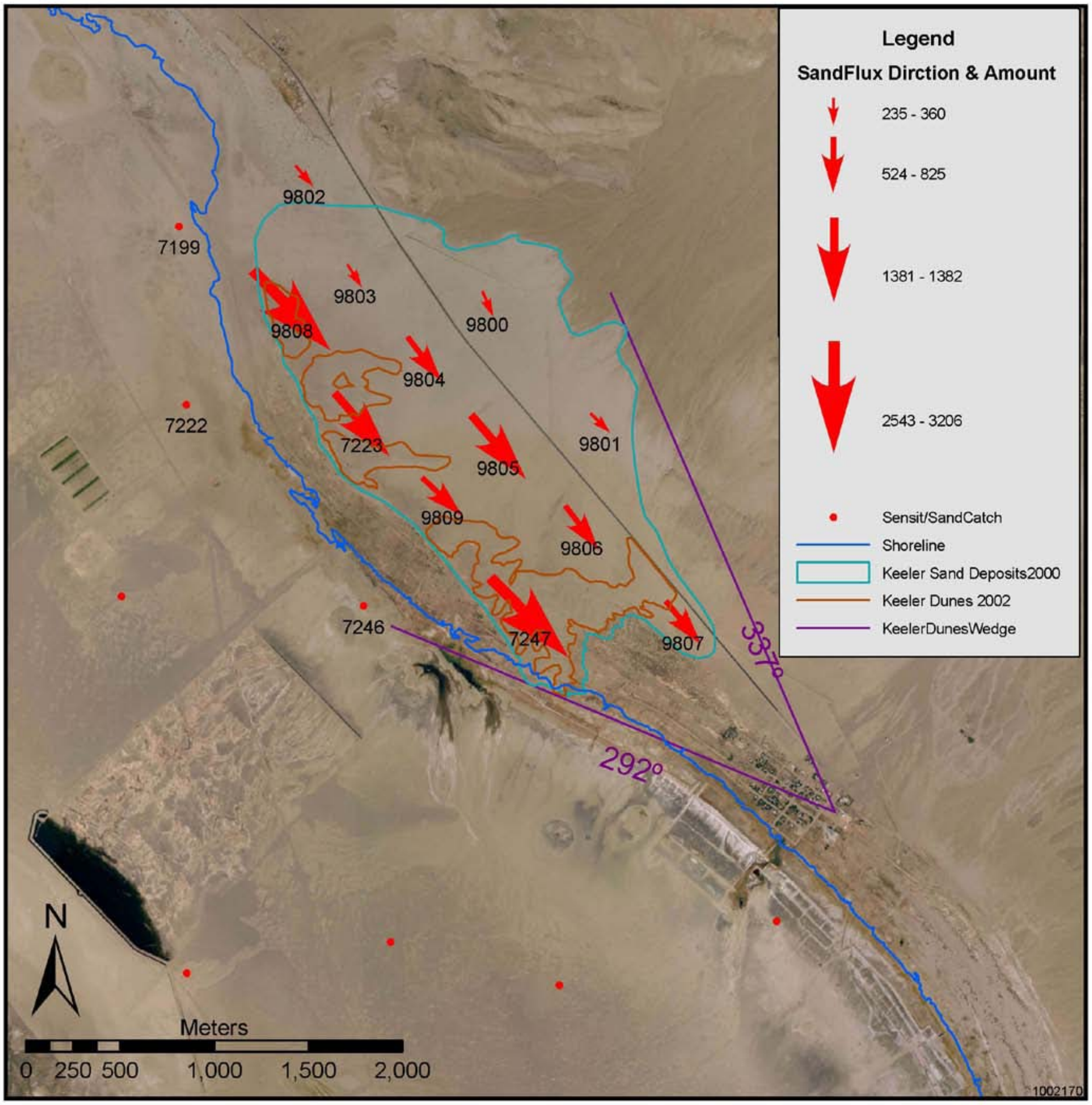

Figure 8. Map of the Keeler Dune sand deposit showing the net sand flux direction and sand flux amount (g/cm^2) as measured at the sand motion monitoring sites from November 2008 to April 2010 (Figure 9 from GB, 2010). Background image is from September 2000.

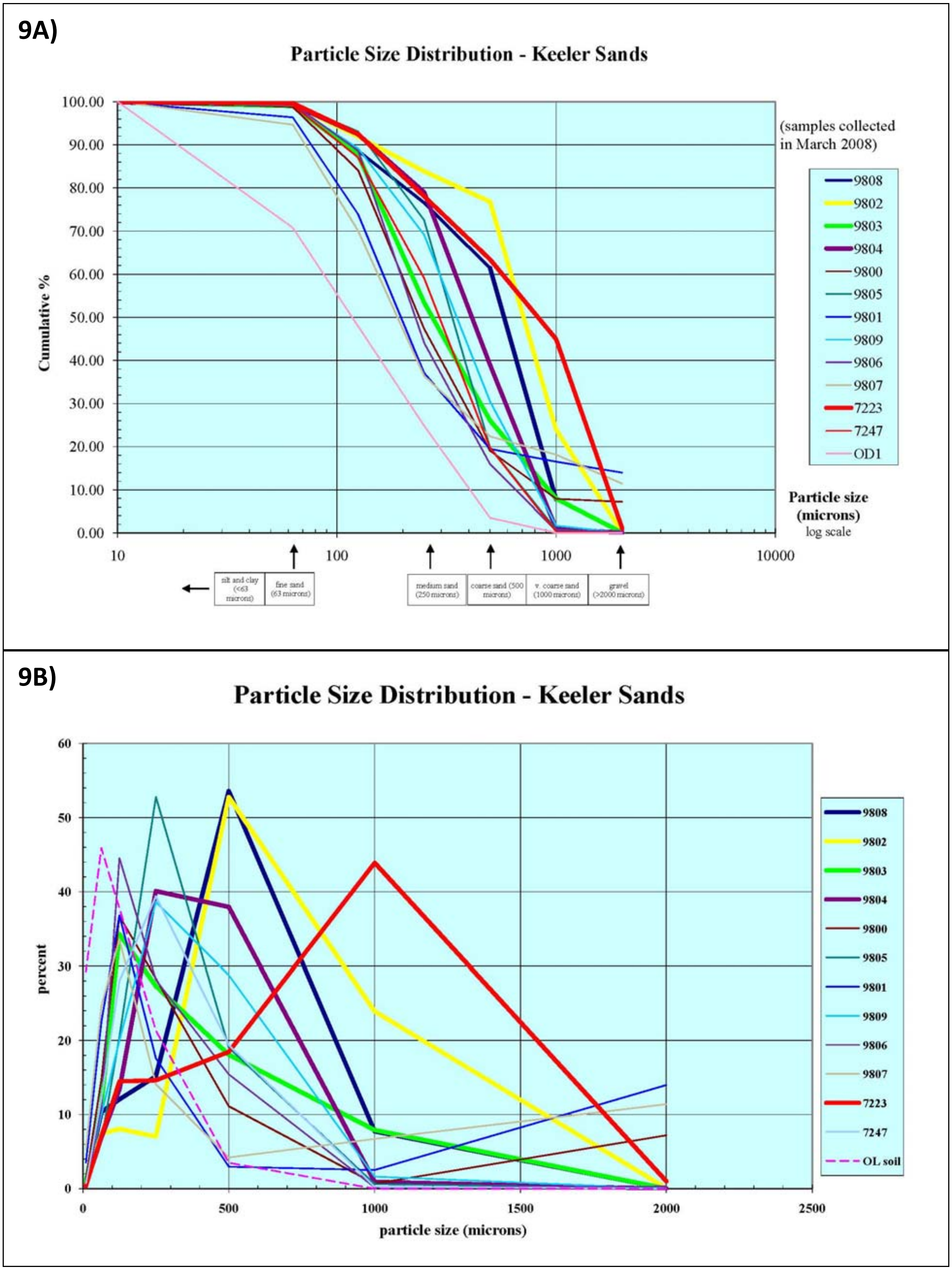

Figure 9. Particle size distribution plots from aeolian deposits collected in March 2008. Notice a general decrease in particle size from north to south and west to east across the study area. Refer to Figure 2 for monitoring site numbers.

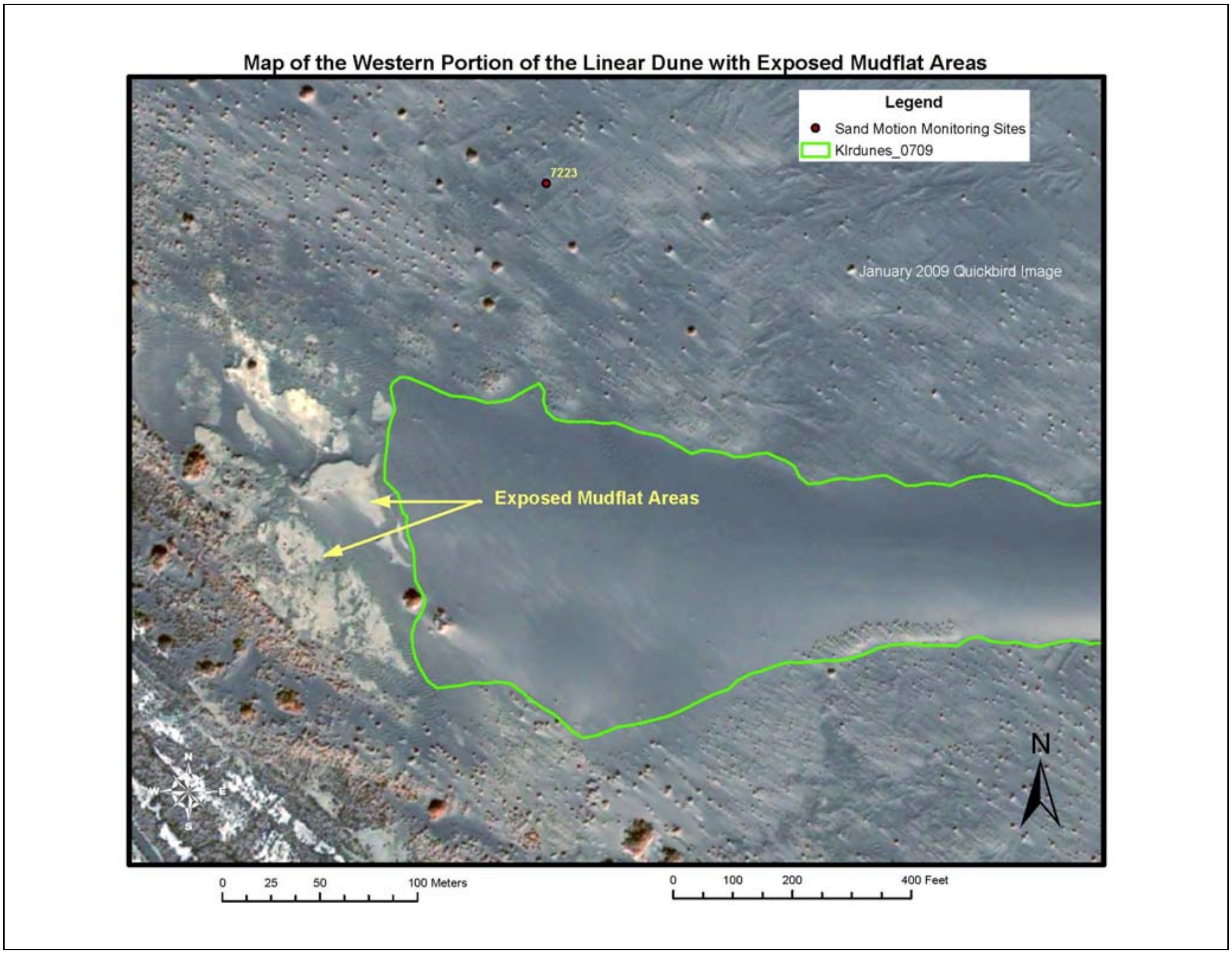

Figure 10. Map of a portion of the linear dune near site 7223 showing the exposed mudflat areas along the western edge.

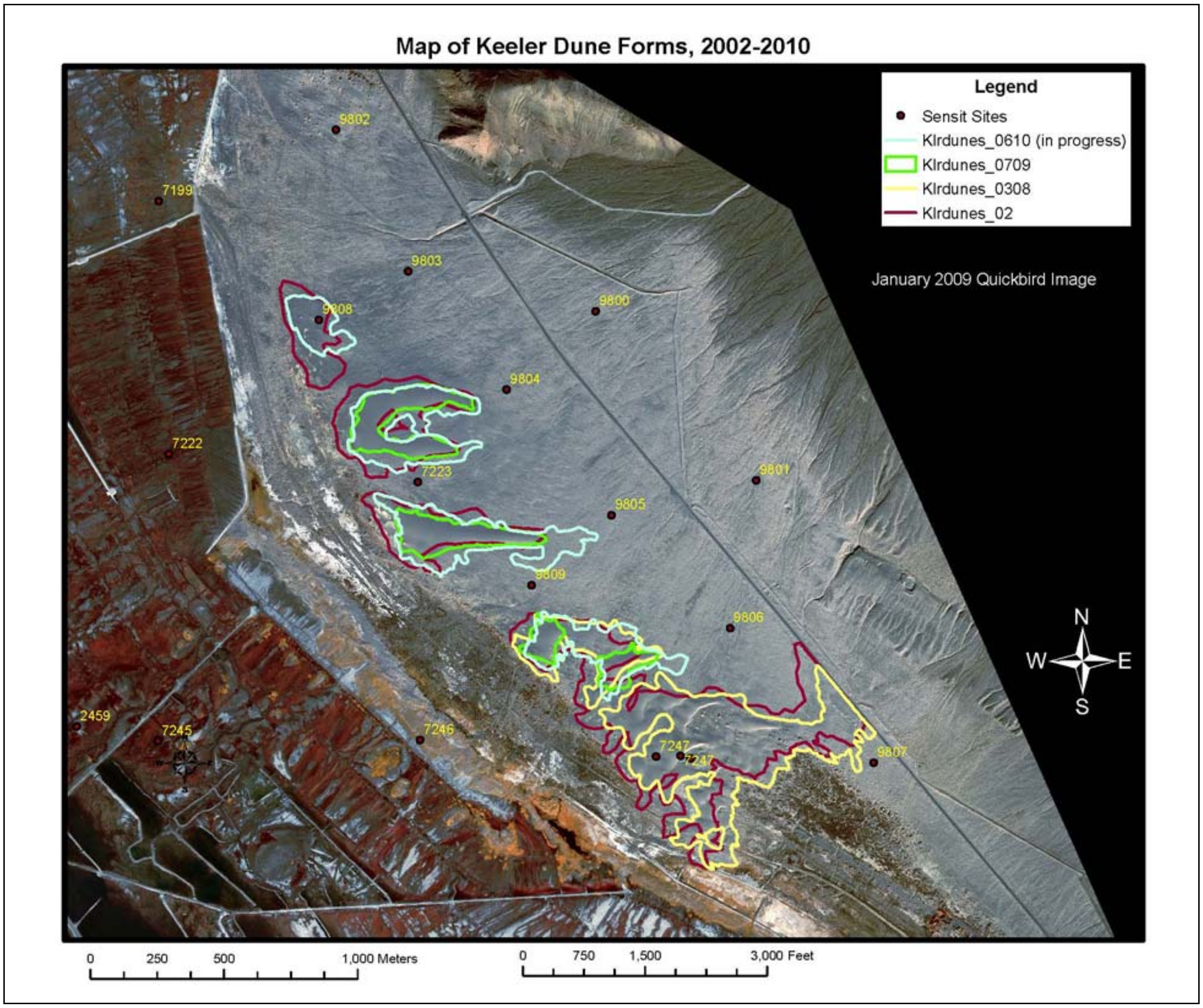

Figure 11. Map of the project area showing locations of distinct dune forms from 2002 to 2010 mapped via GPS. Mapping of the 2010 locations (light blue) are in progress.

APPENDIX J
KEELER DUNES PROJECT
IRRIGATION SYSTEM ANALYSIS

Keeler Dunes Project Irrigation System Analysis

Revised Draft

(with the Irrigation Supply from the East)

2/3/2014

An important component of successful establishment of native shrubs in the Keeler Dunes is providing water when the shrubs are planted and also providing supplemental water during the critical first three years of plant growth and development. The original project description for the Keeler Dunes Project calls for the initial watering as well as the supplemental watering events to be conducted by hand by means of hauling water into the project area via small ATV trailer mounted water tanks (~150 - 200 gallon). This is the irrigation method currently being used to provide water to the shrubs planted on the straw bale demonstration pilot project in the northern portion of the dunes. However, given the size of the project (over 123,000 bales need to be watered), the time and manpower requirements of conducting each watering event, and the potential impact from the required travel, the District feels that consideration needs to be given for use of a temporary irrigation system to improve efficiency and success of the project.

This document is a comparative analysis of three irrigation options for watering the shrubs in the Keeler Dunes dust control project. In this analysis a comparison of the amount of travel in the project, the amount of pipe required and the length of time required to water all of the plants will be completed. The first irrigation option consists of a hand watering system with water hauled into the dunes in small water tanks mounted on ATV trailers. The other irrigation options include the use of a temporary above ground irrigation system either across the entire project or only in areas without sensitive environmental resources. Common to all three irrigation options is the source of the water (Fault Test Well) and the method of transporting the water from the source to the project area (water trucks). The difference between the irrigation alternatives is how the water is delivered within the project area. Each irrigation option is summarized below.

Option 1. Hand Watering. The first irrigation option is simplest in terms of the infrastructure required – watering all of the plants by hand. Water obtained from the Fault Test Well would be transported to the staging areas along the Old State Highway via large water trucks. Water would then be transported to the project via small water tanks mounted on ATV trailers and water would be provided to each plant through a small hose. This option involves the highest amount of travel in the project.

Option 2. Mix of Hand Watering and Watering through a Temporary System. Water obtained from the Fault Test Well would be transported to the project via large water trucks which would connect to the water delivery system from turnouts off of State Highway 136. In sensitive areas, watering will be conducted by hand as in Option 1. Other portions of the project will have a temporary irrigation system installed as in Option 3. The ATV mounted tanks would be filled with water from the delivery system within the project. This option allows for a decrease in potential impacts to sensitive areas within the dunes. This option can be scaled up or down, as necessary.

Option 3. Temporary Irrigation System. This option provides for supplying the water for irrigation to the project through a system of small diameter above ground pipe lines. Water obtained from the Fault Test Well would be transported to the project via large water trucks which would connect to the water delivery system from turnouts off of State Highway 136. The water from the distribution system will be delivered to the plant locations through detachable hoses. This option includes travel into the project area by ATV to the hose attachment points. Watering of individual plants will be conducted by a worker on foot. This option involves the least amount of travel in the dunes.

Components of Irrigation Methods:

Table 1 provides a comparison of the main elements required for each of the three analyzed irrigation options. A description of each irrigation element is provided below. Maps for the infrastructure needed for irrigation Options 2 and 3 are provided in Figures 1 and 2, respectively.

Table 1: Component elements of irrigation system options.

Element	**Option 1** Hand Watering Method	**Option 2** Temporary System with partial Hand Watering	**Option 3** Temporary System
Water Truck at staging areas	X	-	-
Water truck at turnouts along SR 136	-	X	X
ATV with trailer mounted small-water tank	X	X	-
Trunk line (4-6" diameter)	-	X	X
Transmission line (4" diameter)	-	X	X
Distribution line (2" diameter)	-	X	X
Hose attachments	-	X	X

Water Trucks: Water trucks would be used to haul water from the District's Fault Test Well to designated locations where they would serve the purpose of providing water storage. The water trucks would have a hauling capacity of ~8,000 gallons. For Options 2 and 3 in which the water delivery to the irrigation system is from the east along SR 136, the trucks would only be parked at the designated delivery points (turnouts) during times of active watering. Three turnouts would be established along the west side of SR 136 for water truck parking. For the hand watering option (Option 1), the water trucks would park at the three staging areas along the Old State Highway during the day during times of active watering. For all three irrigation options, the water trucks would be parked off-site at night and on weekends, probably at the Fault Test Well site.

ATV with trailer mounted small water tank: This is the system used for hauling water to the current straw bale demonstration pilot project. A small water tank with a capacity of hauling ~150-200 gallons of water is mounted on a small trailer and pulled behind an ATV. Water delivery on the project site is conducted by use of a small booster pump to pressurize a 1-inch diameter fire-hose.

Trunk line: The trunk lines would be 4-6 inches in diameter and transport water from each of the designated water delivery turnouts along SR 136 to the distribution system in the project area. The trunk lines will be made out of rigid PVC and would be above ground.

Transmission line: The transmission lines will be rigid 4-inch diameter PVC pipes that convey water from the trunk lines to the smaller distribution lines (laterals). Where possible the transmission lines will follow the designated access route used for project construction.

Distribution line: The distribution lines (or laterals) will transport water across the project area and will be spaced 150 feet apart. Distribution lines will be above ground and made of rigid 2-inch PVC pipe.

Hose Attachments: Hose attachments will be placed every 150 feet along the length of the distribution lines. During active irrigation, workers on ATVs with hoses on reels will move along the irrigation laterals, attaching the hose and irrigating the plants within reach of that hose attachment (a maximum of ~75 feet away). The hose will then be detached, reeled up, and moved to the next attachment site. All travel associated with irrigation will be along the designated access routes and lateral lines.

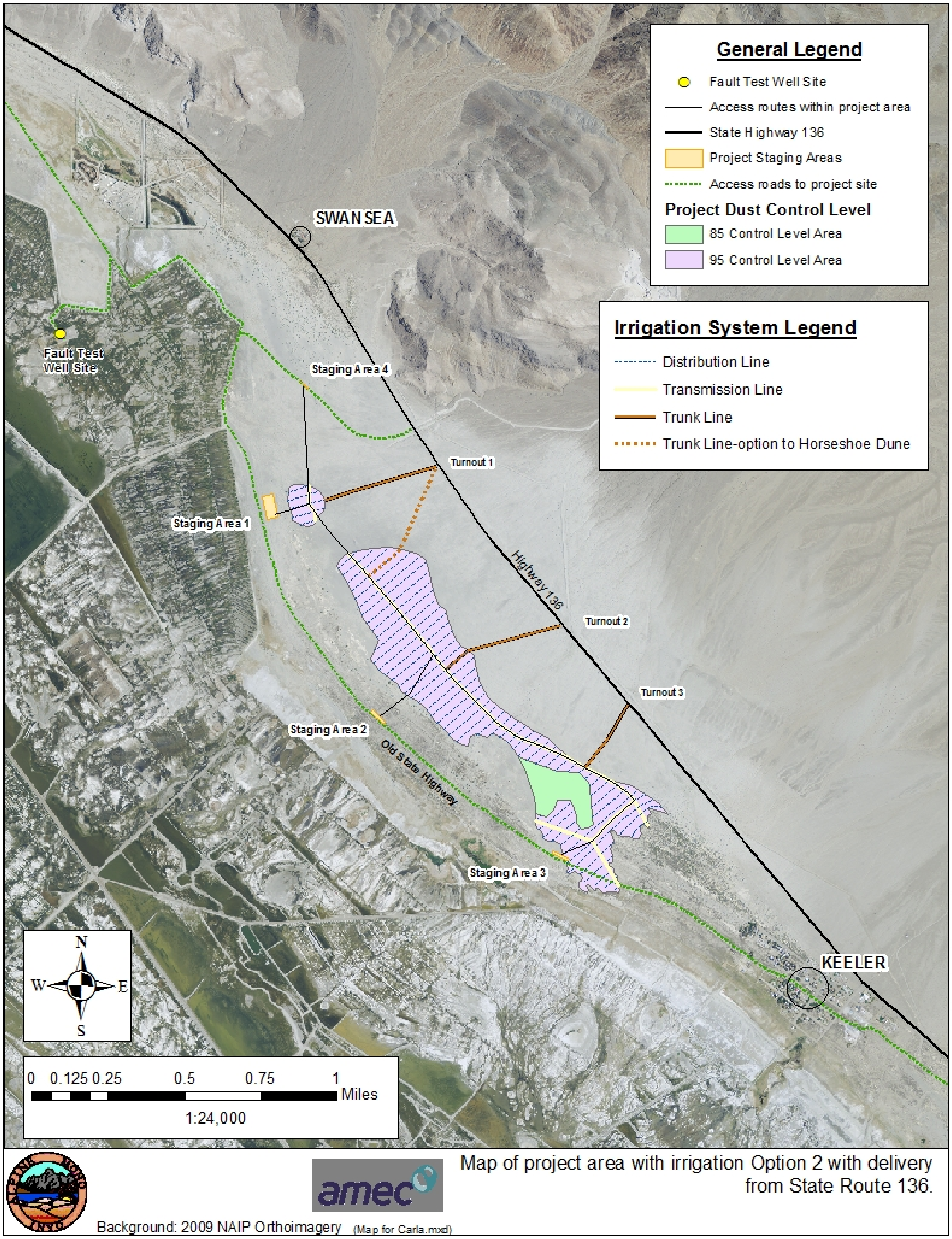

Figure 1. Map of irrigation Option 2. The 85% control level area would be irrigated by hand while the remaining portion of the project would be watered with a temporary irrigation system.

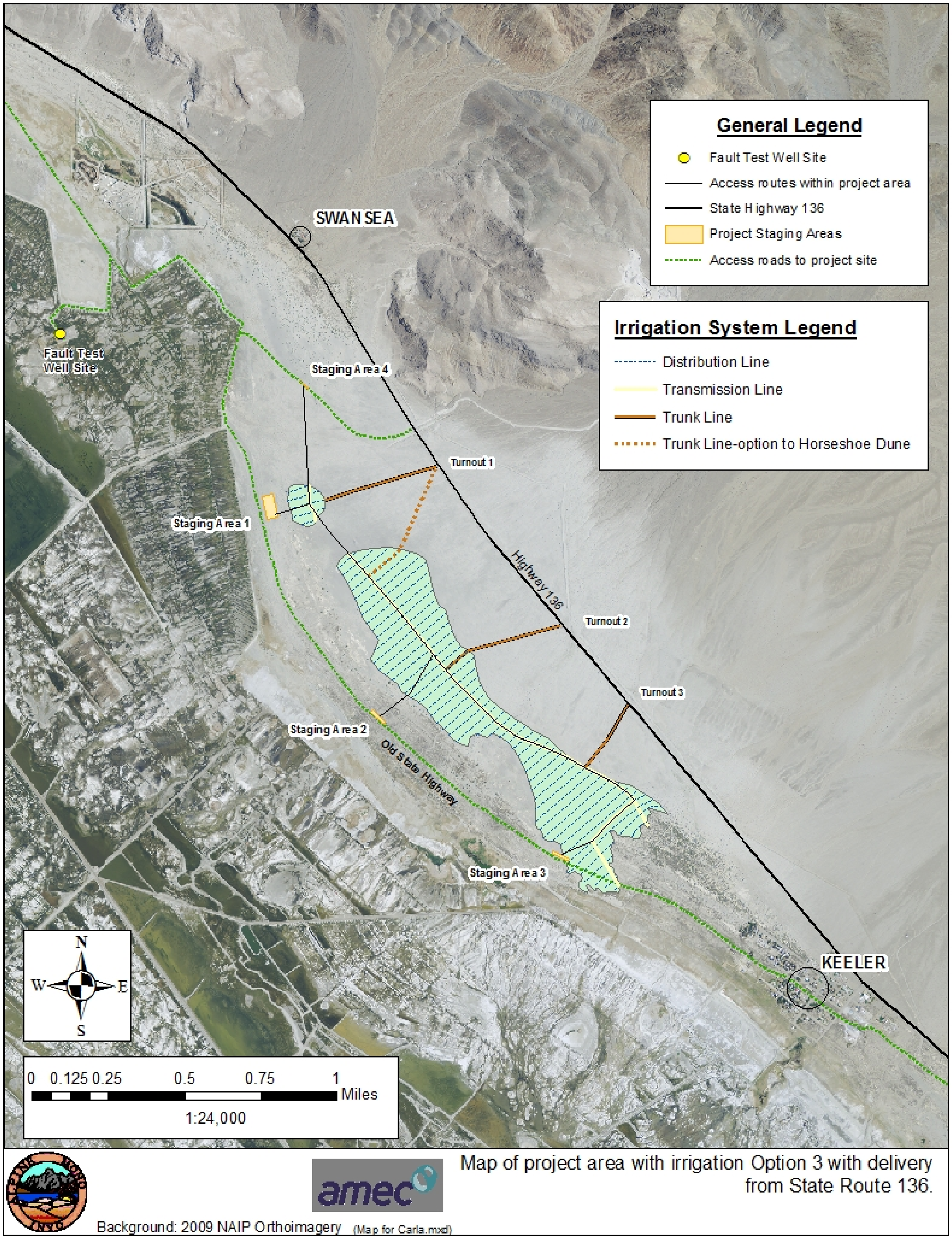

Figure 2. Map of irrigation Option 3 using a temporary irrigation system to water the entire project area.

A comparison of the elements required in the irrigation system options are provided in Table 2. The total pipe length needed for Options 2 and 3 are 13.23 and 14.03 miles, respectively. The pipe system would be a mix of 4 to 6-inch mainlines (trunk and transmission) and 2-inch distribution laterals. As much as possible, the 4 to 6-inch pipelines would be placed along the designated access routes in order to minimize the amount of disturbed area.

Table 2: Table of the amount of pipe and hose attachments needed for the different irrigation method options. Units for the pipe length are given in feet and miles (in parentheses). Hose attachment values are the total number needed.

Infrastructure element	**Option 1** Hand Watering Method	**Option 2** Temporary System with partial Hand Watering	**Option 3** Temporary System
Trunk lines	none	5,512 ft (1.04 mi)	5,512 ft (1.04 mi)
Trunk Lines (with optional line to northern project)	none	7,807 (1.48)	7,807 (1.48)
Transmission lines	none	10,706 (2.03)	9,663 (1.83)
Distribution lines	none	51,364 (9.73)	56,615 (10.72)
Hose attachment points	none	342	377
TOTAL PIPE (mi)	--	**13.23**	**14.03**

An estimate of the amount of travel needed for construction and irrigation events is provided in Table 3 for each irrigation option. The irrigation events are separated into that needed for watering at the time of planting (pre-planting and directly after planting) as well as supplemental watering events during plant establishment. In the project design, the bale locations would be irrigated with about 5 gallons prior to planting. Additionally, the plants would be watered with about 3 gallons per bale location (or about 1 gallon per plant) immediately following planting. If the weather conditions are unusually dry then the plants would be provided with supplemental water during the year. At most there would be two supplemental irrigation events per year – one in the spring and one in the late summer/early fall.

Table 4 summarizes the amount of travel potentially required during the first three years of the project. The highest amount of travel is during the first year of the project during construction, and planting of the plants. Each project year includes two supplemental irrigation events. These supplemental irrigation events would only occur if the amount of precipitation was well below normal or if dictated by poor plant health. The first supplemental irrigation event would occur in the spring as the plants begin to break dormancy for the growing season. The second supplemental irrigation event would occur in the late summer to early fall when the plants are conducting their late season plant growth episode. The work tables for the irrigation system calculations are provided at the end of the report.

Table 3: Table of mileage needed for construction, planting and supplemental watering with each irrigation option. The values for Option 1 and the hand watering portion of Option2 are provided using a 150 gallon hauling capacity for the ATV trailer mounted water tank. Mileage does not include water truck travel from the Fault Test Well.

Activity	**Option 1*** Hand Watering Method	**Option 2**** Temporary System with partial Hand Watering	**Option 3**** Temporary System
Construction miles	0	65	66
Pre-planting irrigation watering (5-gal/bale)	4,106	758	722
Watering at time of planting (3-gal/bale)	2,462	505	481
Total Supplemental Watering – 6 events	14,772	3,030	2,886
TOTAL MILEAGE	**21,340 mi**	**4,558 mi**	**4,155 mi**

* assumes each trip with ATV is = 1 mile
** values include a 25% contingency for construction miles, assumes each watering trip is ~1.5 mile

Table 4: Table of estimated mileage needed for irrigation in the first, second and third year of the project. Estimate assumes 3 irrigation events in the first year and two during each of the following two years. Mileage does not include water truck travel from the Fault Test Well to the project.

Activity	**Option 1** Hand Watering Method	**Option 2** Temporary System with partial Hand Watering	**Option 3** Temporary System
First project year*	11,492	2,338	2,231
Second project year)**	4,924	1,010	962
Third project year**	4,924	1,010	962

* During the first year: Total irrigation = construction + pre-planting + at time of planting + supplemental 1 + supplemental 2
* During years 2 and 3: Total irrigation = supplemental 1 + supplemental 2

As expected, irrigation Option 1 has the highest amount of travel required with over 11,000 miles traveled during the first year. Since each irrigation trip in Option 1 is estimated to be an average of 1 mile in length, there are also over 11,000 trips into and out of the dunes. During the second and third years of the project the amount of travel (and number of trips) drops to about 4,900 for Option 1. Options 2 and 3 include significantly less travel that Option 1 with about 2,300 and 2,200 miles in the first year of the project, respectively. This corresponds to about one-fifth the amount of the travel as compared to Option 1. During the second and third years of the project the mileage needed for the supplemental irrigation events in Options 2 and 3 is estimated at about 1,000 miles as compared to over 4,900 miles for Option 1.

Manpower Requirements and Irrigation Event Duration:

Irrigation of over 369,000 plants at over 123,000 straw bales is a big job regardless of the irrigation method used. The estimated number of people-days needed to conduct the irrigation events for the Keeler Project range from 770 to 385 days for the initial pre-plant watering to 513 to 257 days for successive watering events (both watering at the time of planting and supplemental watering events). These numbers represent the number of days that it would take one individual to conduct the irrigation work. It is anticipated that a crew of 10 people may be used for irrigation events such that the total number of days is reduced to 77-39 for the initial watering and 52-26 for each successive watering.

The length of time needed for watering the plants in the project with a temporary irrigation system is approximately half of that needed with a hand watering system. This time differential may play an important role in the success of plant establishment. In the hand watering irrigation option, it would take a crew of 10 people about 2 months to irrigate plants within the project. During this time the health of plants that need water will likely decline such that there may well be unnecessary plants deaths that compromise the success of the project. The length of time needed for a crew of 10 people to water the plants using the temporary irrigation system is about 4 weeks. The length of time needed for irrigation could be reduced by having larger irrigation crews in the dunes during each irrigation event.

Irrigation System Calculations
option 1 = hand watering
option 2 = mix of temp system and hand watering
option 3 = temporary system

Irrigation travel for initial watering (5 gallons per bale)			
Option 1	**Option 2**	**Option 3**	Notes
0	7807	7807	trunk - 4"
0	10706	9,663	transmission - 4"
0	51379	56615	distribution - 2"
0	69892	74085	total footage of irrigation system
0	13.23	14.03	total mileage of irrigation system
0	62	57	number of distribution lines
0	829	993	avg length of distribution line
0	342	377	number of hose attachments
0	6	7	avg number of attachments per line
0	360	326	number of bales per attachment
20	40	40	bales/hour
160	320 and 160	320	bales/day
770	404	385	people-days
77	40	38	days with 10 workers
15.4	8.1	7.7	weeks
5.3	1	1	number of trips per irrigation day
4106	404	385	total number of trips
1	1.5	1.5	avg distance per trip
5133	758	722	estimated mileage traveled (= # trips*avg distance*25% contingency)

Irrigation travel for supplemental watering (3 gallons per bale)			
Option 1	**Option 2**	**Option 3**	Notes
0	7807	7807	trunk - 4"
0	10706	9663	transmission - 4"
0	51379	56615	distribution - 2"
0	69892	74085	total footage of irrigation system
0	13.23	14.03	total mileage of irrigation system
0	62	57	number of distribution

			lines
0	829	993	avg length of distribution line
0	342	377	number of hose attachments
0	6	7	avg number of attachments per line
0	360	326	number of bales per attachment
30	60	60	bales/hour
240	480 and 240	480	bales/day
513	270	257	people-days
51	27	26	days with 10 workers
10.3	5.4	5.1	weeks
4.8	1	1	number of trips per irrigation day
2462	270	257	total number of trips
1	1.5	1.5	avg distance per trip
3078	505	481	estimated mileage traveled (= # trips*avg distance*25% contingency)

Construction travel			
Option 1	**Option 2**	**Option 3**	Notes
0	2569.0	2830.8	sticks of 2"
0	160	160	sticks per trip
0	16.1	17.7	trips
0	925.7	873.5	stick of 4"
0	50	50	sticks per trip
0	18.513	17.47	trips
0	35	35	Total trips
0	64.82	65.93	estmated total mileage (= #trips*avg distance*25% contingency)

APPENDIX K
USING ROUGHNESS (SOLID ELEMENTS AND PLANTS) TO CONTROL SAND MOVEMENT AND DUST EMISSIONS

Using Roughness (Solid Elements and Plants) to Control Sand Movement and Dust Emissions: Keeler Dunes Dust Demonstration Project, Interim Report

Prepared by: Jack Gillies, Desert Research Institute
Prepared for: Great Basin Unified Air Pollution Control District

September 26, 2013

Introduction

The delivery of dust-sized particles to the atmosphere is an aerodynamically-driven process. There is a complex interplay, however, between the resisting and driving forces that control the release and entrainment of these particles and the vertical flux of dust. The dust can be entrained from soils when the surface is susceptible and the shearing force of the wind is sufficient to entrain particles. Entrainment of dust into the wind also occurs when sand-sized particles transported by the wind (saltation) impact the surface and eject dust sized particles. Dust can also be released to the airflow as aggregates of sediment breakdown during the vigorous transport process. Developing effective controls for dust emissions at the local and regional scales is a scientific and engineering challenge and demanding of attention due to the effects of dust on human and animal health, visibility degradation, and other negative environmental impacts.

Recent research has indicated that roughness can be used effectively to modulate sand transport (and the associated dust emissions) and that prediction of sand flux reduction using the known geometric properties and the amount of roughness is possible using published relationships (e.g., Gillies et al., 2007; Gillies and Lancaster, 2013). Great Basin Unified Air Pollution Control District, based on sand flux and associated dust emission measurements, developed a sand flux reduction criterion for the Keeler Dunes that, if attained, is expected to achieve PM_{10} levels within the town of Keeler, CA, in compliance with State and Federal Air Quality regulations. The sand flux reduction target is 95%, which infers that sand flux within the area of control must be reduced to 5% of the flux that occurs in the absence of controls within open dune areas. The initial target of 95% reduction of sand flux was changed to 85% due to problems in receiving the contracted for amount of roughness elements, but this does not diminish the veracity of the testing procedures to demonstrate the effectiveness of the methodological approach to controlling sand transport and dust emissions.

Using the sand flux reduction criterion as a basis for designing effective dust control at the Keeler Dunes a dust control demonstration project was initiated within the Keeler Dunes in July 2013. This demonstration project will evaluate if the effectiveness of an array of roughness elements composed of solid elements and managed vegetation, which was designed based on published empirically-defined relationships between sand flux reduction and a dimensionless index of roughness (i.e., roughness density [λ]) achieves the required sand flux reduction. This project has two major goals: 1) to demonstrate that solid roughness elements placed on areas of the Keeler Dunes immediately arrest sand movement to specified levels, and 2) to assess whether native plant species, planted in the sheltered area of the solid roughness elements can effectively thrive and subsequently replace the solid roughness to achieve the desired sand flux reduction control efficiency.

This component of the report focuses on evaluating the effectiveness of the solid roughness elements to modulate the sand transport.

Methods

The solid element roughness used in the Keeler dust control demonstration project is straw bales. The straw bales are nominally 1.12 m long × 0.38 m high × 0.43 m wide. To create a roughness configuration using this size bale and achieve the target sand reduction, the relationship between normalized sand flux (NSF) and λ presented by Gillies and Lancaster (2013):

$$NSF = 0.0004\,\boldsymbol{\lambda}^{-1.871} \quad (1)$$

was used to calculate the value of λ that would be required to meet the design criterion (i.e., NSF=0.15). NSF is defined as the ratio of sand flux at a measurement location within the roughness array divided by a measurement external to the roughness on the upwind side. The roughness density (λ) is defined as:

$$\lambda = n\,b\,h\,/\,S \quad (2)$$

where n is the number of roughness elements occupying the ground area S (m^2), b is element breadth (m), and h is element height (m). A value of λ = 0.053 is needed, which required 502 bales be placed in the defined test area (50 × 100 m).

The positioning of the straw bales within the test area was established by copying a natural vegetation pattern nearby the Keeler Dunes composed of the species: x, y, and z. First, the spatial pattern was transferred to a representative model area of the same relative dimensions as the field scale area. Then the transferred pattern was adjusted in scale until 502 points fell within the scaled rectangle representing the field site. Each point within the scale model was ascribed a position (i.e., latitude and longitude) allowing these positions to be marked in the test plot area at the Keeler Dunes. Upon delivery of the straw bales to the site a bale was placed at each marker with the longest bale dimension oriented perpendicular to the expected mean prevailing wind directions. In this area winds with the highest frequency and magnitude that cause sand transport and dust emissions come from both the north and south. The centerline of the roughness array was oriented to 326°, to best capture the sand transport events driven by the bi-modal wind regime.

The test area was instrumented to measure: 1) sand flux external and internal to the array, and 2) wind speed and wind direction external and internal to the array. A diagram of the position of the instruments and the type of measurements at each position is shown in Fig. 1. Sand flux is measured using the GBUAPCD-designed Cox Sand Catcher (CSC) (Fig. 2), which is used on Owens Lake for the GBUAPCD Dust ID project. In addition Sensit piezoelectric saltation sensors (Fig. 2) are used to measure the on-set of saltation external and internal to the array, and the counts of sand particle impacts provides a second means to calculate NSF at each Sensit position within the roughness. Wind speed and direction are measured using NRG anemometers and wind vanes mounted on 4 m high masts (Fig. 3).

To further evaluate the movement of sand into and within the roughness array detailed topographic surveys of the sand surface and the straw bales are being collected through time using Terrestrial Lidar Scanning techniques (Fig. 4). This laser-based surveying method produces three-dimensional surface elevation data that can be used to map where sand deposits and agrades or erodes and deflates from

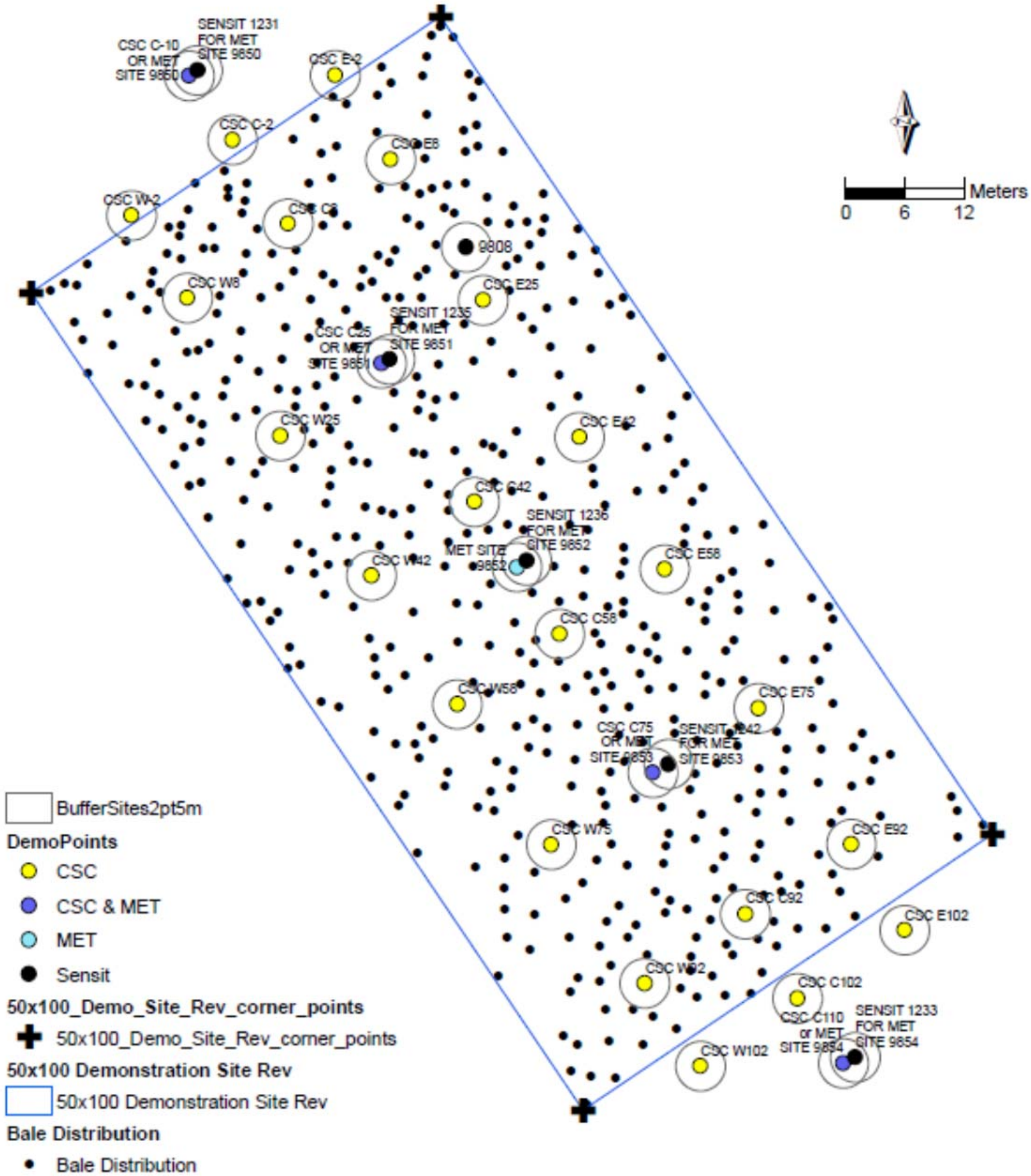

Figure 1. Schematic diagram showing placement of the roughness elements and instruments within the dust demonstration test are.

Figure 2. An image of a Cox Sand Catcher (left edge of image) and a Sensit piezolelectric saltation sensor (right edge of image) deployed within the roughness array.

Figure 3. The straw bale roughness elements and the 4 m high meteorological towers with anemometers and wind vanes.

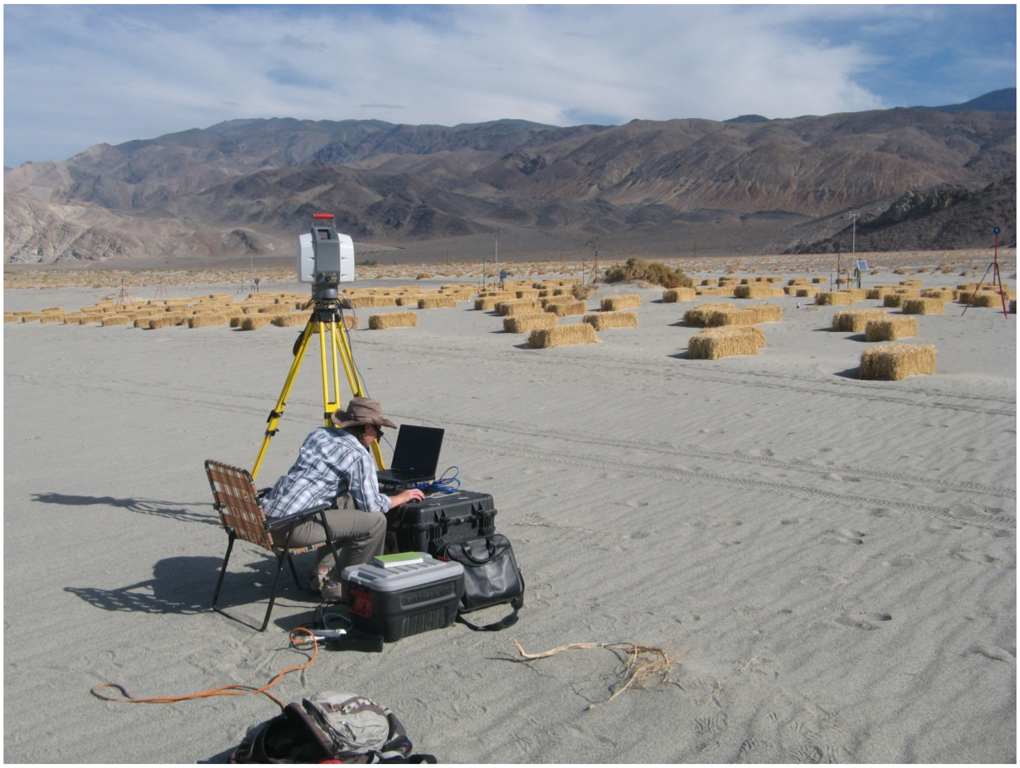

Figure 4. The Terrestrial Lidar Scanner deployed at the Keeler Dunes dust demonstration field site, September 11, 2013.

the test surface under the influence of the winds that exceed threshold. To date two scans of the test area have been acquired in July and September, 2013.

Results (through August 7, 2013)

Initial Sand Flux Measurements in the Presence of Existing Conditions Prior to Emplacement of the Roughness Elements and Vegetation

Prior to installation of the straw bales and vegetation CSCs were installed in a gridded array to measure the sand flux in the area where the roughness was to be emplaced. Measurements were initiated on 4/30/2013 and between that day and 5/22/2013, 18 events with the total mass in all traps $\geq$0.1 g were recorded with the CSCs. The mean NSF across each east-west grouping of CSCs as a function of distance from the leading northern edge of the roughness array is shown in Fig. 5. This figure shows that there was no discernible pattern in the transport of sand across the test site prior to emplacement of the roughness. The standard deviation of the mean NSF for each grouping of CSCs, represented by the error bars overlap for all cases, suggesting that within the uncertainty of the measurements sand flux was similar across and along the area in the presence of the roughness that existed prior to emplacement of the dust demonstration project roughness.

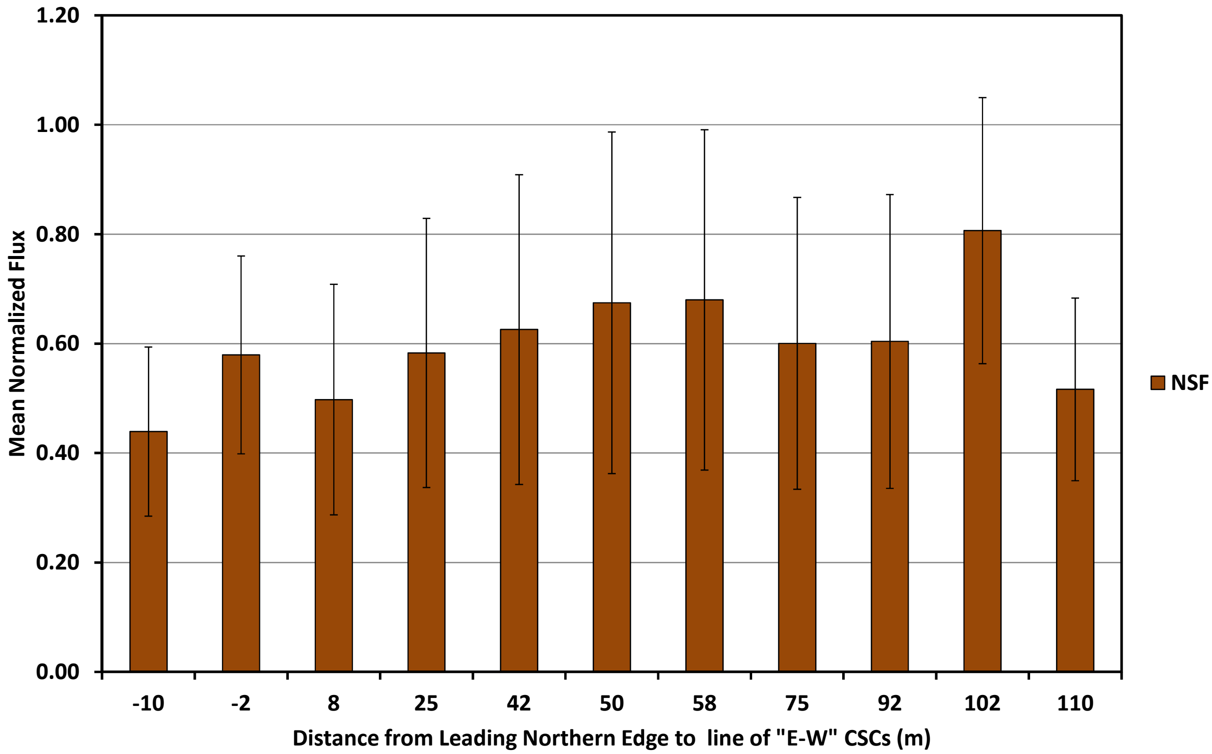

Figure 5. Mean NSF for the three CSC units across each east-west grouping CSCs as a function of distance from the leading northern edge of the roughness array.

Sand Flux Within and Exterior to the Roughness Array Following Emplacement of the Straw Bales

Following installation of the straw bales between 5/23/2013 and 8/7/2013, 74 transport events of varying duration and magnitude were recorded. The mean NSF as a function of normalized downwind distance (NDD=horizontal distance/element height) is shown if Fig. 6. As Fig. 6 shows the mean NSF decreases rapidly as a function of NDD from the north and south border of the roughness array to its interior. The mean NSF at the three positions at the deepest part of the roughness array (i.e., NDD=110.5, 131.6, and 152.6) is 0.06, suggesting that sand flux has dropped by 94% in the interior of the array compared to outside of the roughness array. The mean NSF value in the interior suggests that the roughness is performing better than expected. The roughness was expected to have an NSF=0.15.

These data can be separated based on the dominant transport directions, i.e., northerly and southerly wind events. The relationships between NSF and NDD for events representing transport events associated with northerly and southerly winds are shown in Figs. 7 and 8, respectively. For both transport directions the rate of change of decreasing NSF with increasing NDD is very similar, suggesting that there is no difference in the response of the sand flux to the roughness for either northerly or

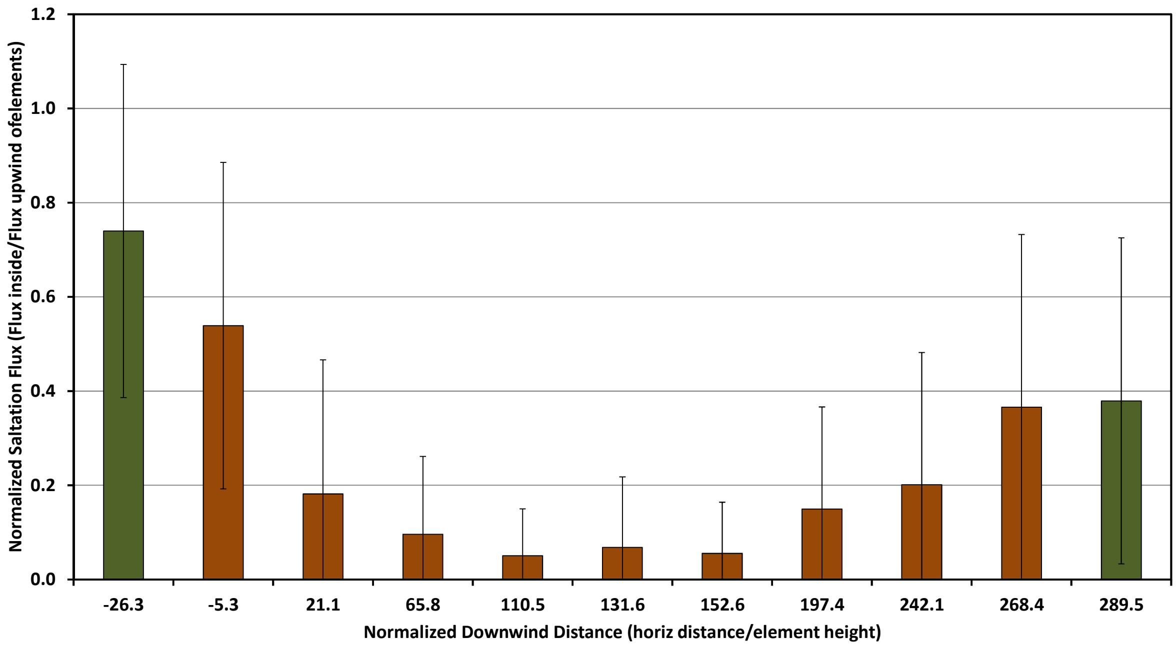

Figure 6. The mean NSF as a function of position within and exterior to the roughness array (refer to Fig. 1) showing that for all cases of sand transport the interior of the roughness shows a substantial reduction in the flux of sand. Green bars denote the two measurements exterior to the array on the northern and southern edges. Data represent transport of sand from multiple directions.

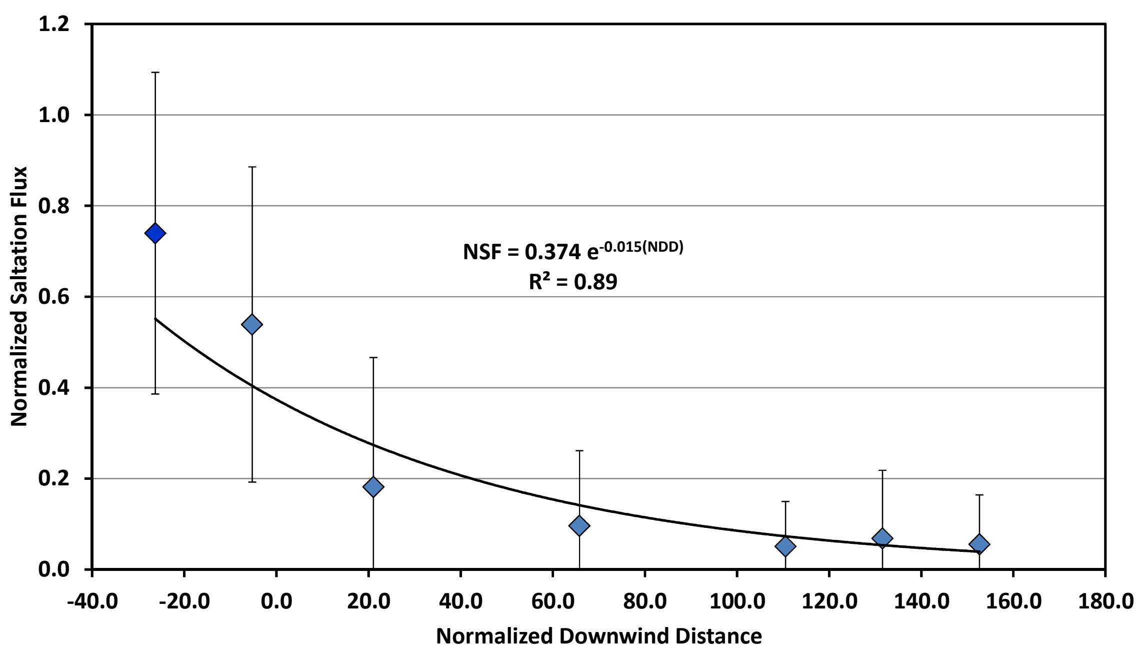

Figure 7. Mean NSF as a function of NDD for the north to south sand transport events. The dark blue data point on the left represents the measurement upwind and exterior to the roughness array.

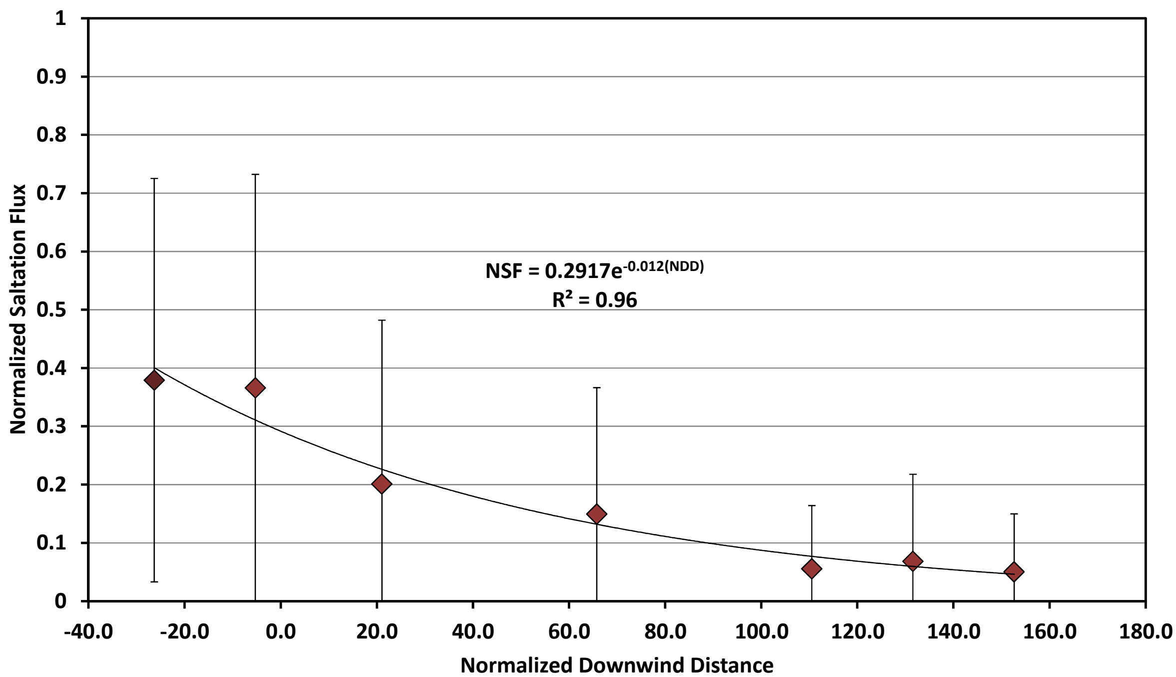

Figure 8. Mean NSF as a function of NDD for the south to north sand transport events. The dark red data point on the left represents the measurement upwind and exterior to the roughness array.

southerly transport events. The data can be combined into one general relationship showing how the NSF scales with increasing NDD into the roughness (Fig. 9).

The rate of change of NSF with increasing NDD for this project can be compared with other available studies (Fig. 10). This comparison of data shows that for the roughness array at the Keeler Dunes, the decrease in NSF with increasing NSF is less than has been observed at other locations. It must be noted that for Keeler Dunes the data collection to date is fairly limited and does not yet include any large scale and sustained transport events. The results to date indicate that the measured sand flux within the roughness is following expectations and corroborating the power of the empirical model used to design the array to meet the sand flux reduction target.

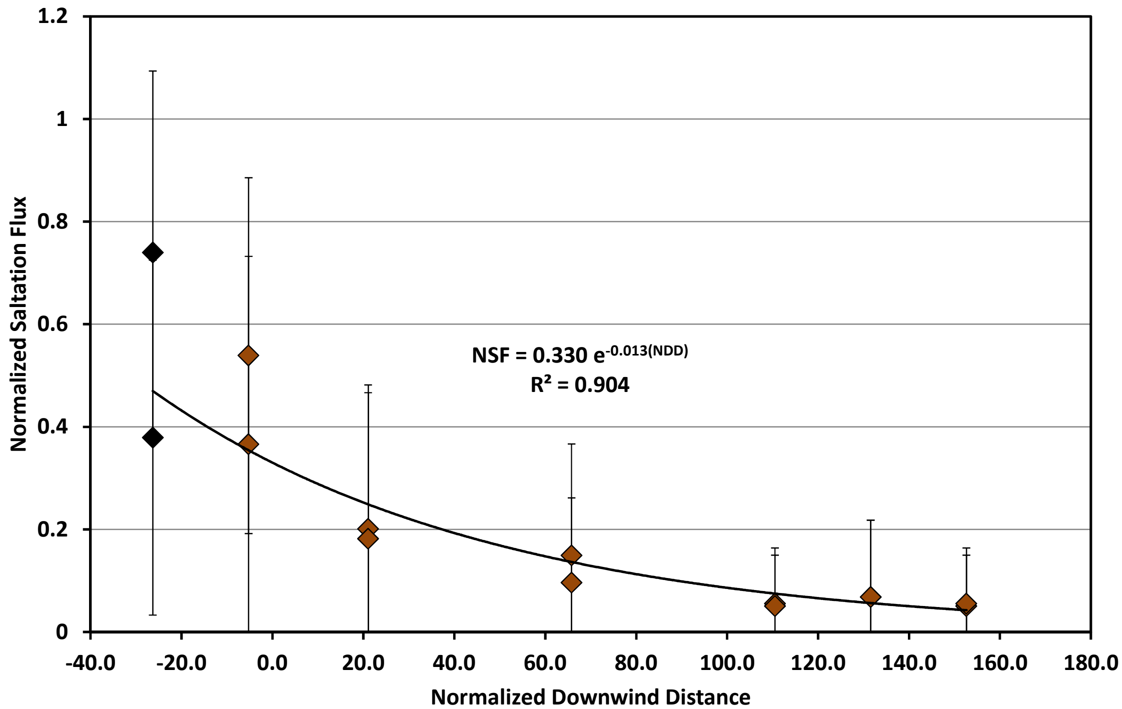

Figure 9. Mean NSF as a function of NDD for all sand transport events. The black points on the left represent the measurement upwind and exterior to the roughness array.

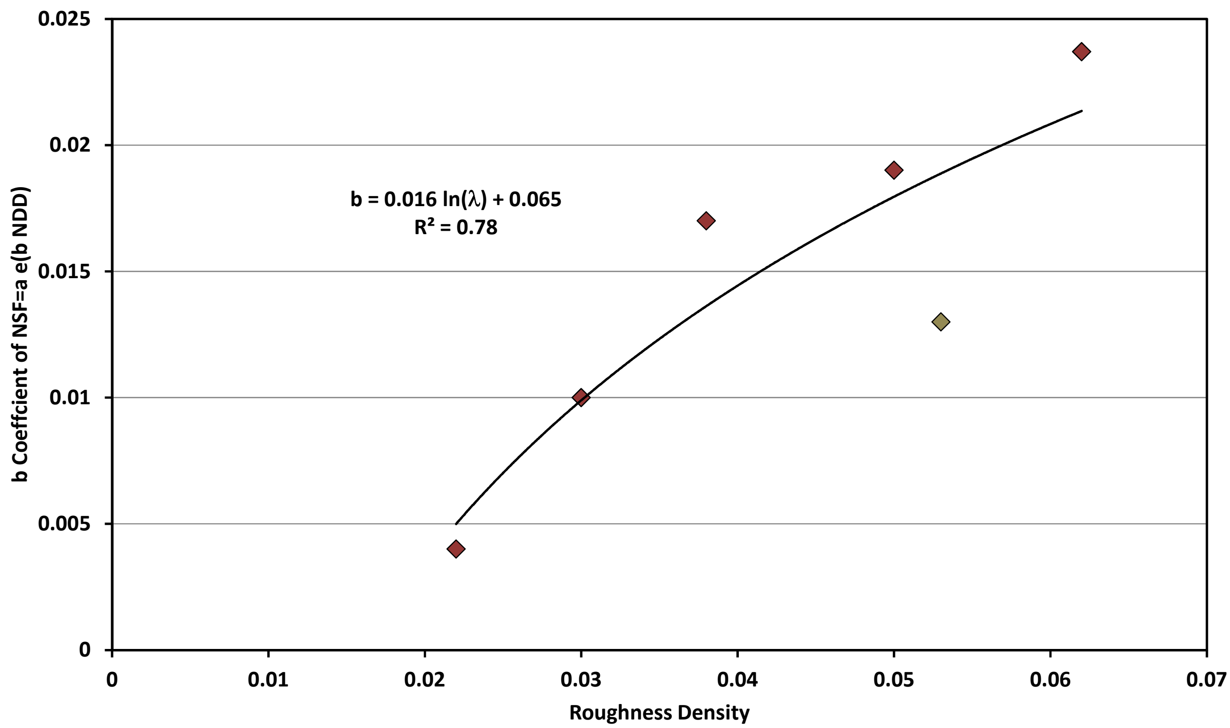

Figure 10. The relationship between the b coefficient in the NSF = a $e^{(b \times NDD)}$ and roughness density (λ) for data from Gillies et al. (2006) and Gillies and Lancaster (2013) and the roughness array at Keeler Dunes (green diamond). The regression-derived relationship combines all the data.

Wind Speed Threshold for Entrainment of Sand

The wind speed at which sand begins to be transported is an important environmental variable that characterizes the sensitivity of the sand surface to wind erosion and the accompanying dust emissions. Using the Sensit and wind speed data measured at 4 m above ground level (agl), an estimate of the threshold wind speed that causes entrainment of sand exterior and interior to the roughness elements at the study site. Threshold is defined here by the mean of all wind speed values that indicate saltation has been registered by the Sensit in the 5 minutes immediately following a 5 minute interval for which no Sensit counts were registered, and all wind speeds that show zero counts immediately following a 5 minute interval with counts. This takes into account the critical 5 minute long intervals where saltation begins and then ceases. The data are then sorted to represent the periods when the wind was northerly or southerly for each registered transport event. This procedure was carried out for days with measureable sand counts acquired by the Sensits. The mean threshold 4 m wind speed for each position along the centerline of the roughness for the southerly and northerly transport events is shown in Figs. 11 and 12, respectively. These figures show that the wind speed needed to reach threshold increases with distance from the leading edge of the roughness through to the last tower position before exiting the array. The relationship as expected is very similar for wind from both the south and the north. These figures illustrate several other important characteristics of the roughness array. First they show that once inside the roughness array it requires increasingly higher wind speeds to mobilize the sand, which means there is more protection afforded by this roughness configuration with distance from the leading edge. It also suggests that the size of the array does not allow the wind to come into equilibrium with the roughness over 75 m of fetch from the leading edge. The effect on threshold wind speed with increasing NDD is however, much less dramatic in affecting sediment transport rates than the roughness itself has on the change in flux rate (Figs. 7, 8, and 9).

Summary

The sand flux and wind data collected to date at Keeler Dunes Dust Demonstration Project clearly indicate that the straw bale roughness has modulated the sand flux compared to the flux in the absence of that roughness to a high degree. The mean reduction in the interior of the roughness array is approximately 94%, compared with flux in the absence of that roughness. To date the data suggest that the roughness is producing a higher control efficiency than the original design criteria specified.

The roughness also affects the threshold wind speed, showing that higher wind speeds as measured at 4 m above ground level are required to initiate saltation with increasing distance from the leading edge of the roughness. Based on measurements and visual observations it appears that the overall efficiency of this method to control sand movement and dust emissions increases with increasing area covered by the roughness elements. The edges of the roughness are most affected by higher winds and sand transport, but clearly the effectiveness to reduce sand motion occurs rapidly with increasing distance into the array. The perimeter to area ratio will decline as a power function meaning that the edge effect diminishes with respect to the effectiveness of control in the interior, so larger areas will have more area with maximum control efficiency for that roughness configuration than smaller areas. This also suggests that having higher roughness density around the edges can effectively increase overall control efficiency for smaller areas. These observations can be used to further increase the effectiveness of solid element roughness arrays to immediately arrest sand movement and dust emissions from the Keeler Dunes. This project will continue to collect data to refine the relationships and observations presented here.

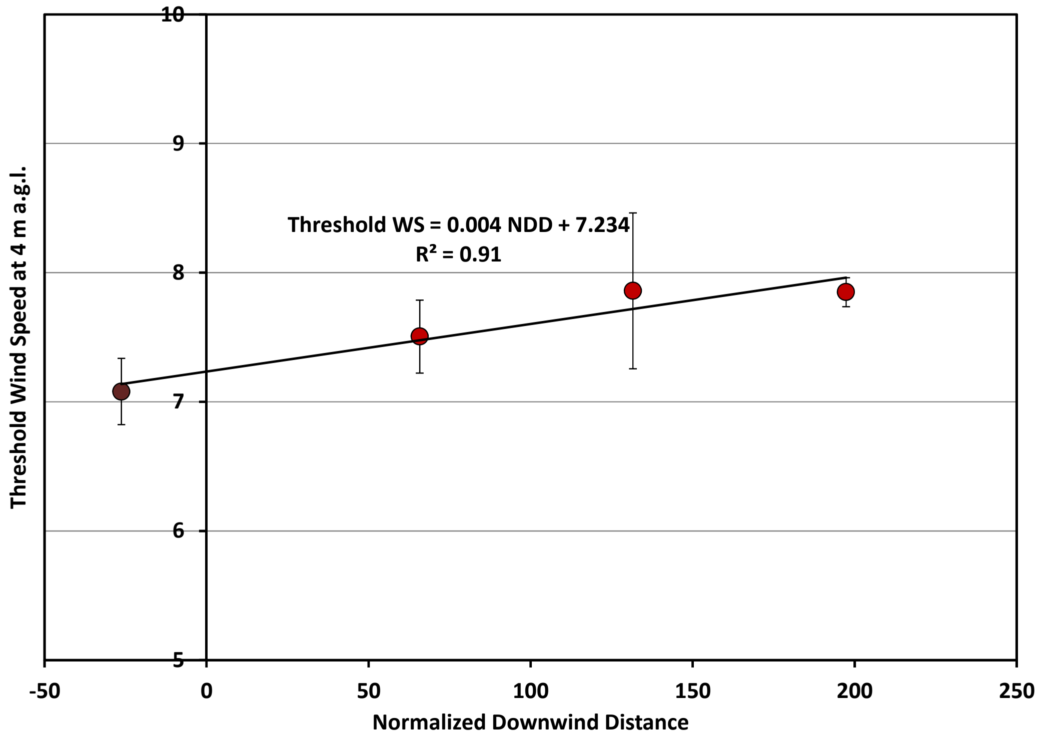

Figure 11. The relationship between mean threshold wind speed measured at 4 m a.g.l. and normalized downwind distance for southerly winds.

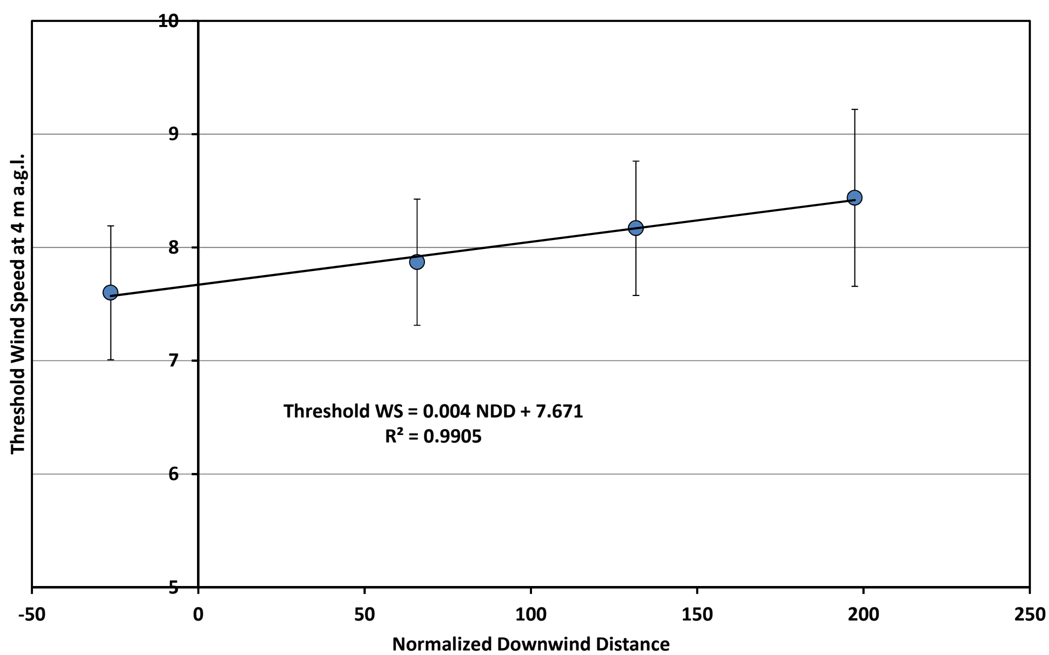

Figure 12. The relationship between mean threshold wind speed measured at 4 m a.g.l. and normalized downwind distance for northerly winds.

APPENDIX L
PRELIMINARY RESULTS OF PLANT ESTABLISHMENT

Theodore D. Schade
Air Pollution Control Officer

GREAT BASIN UNIFIED AIR POLLUTION CONTROL DISTRICT

157 Short Street, Bishop, California 93514-3537
Tel: 760-872-8211 Fax: 760-872-6109

Technical Memorandum

From: Grace A. McCarley Holder, Geologist

To: Sapphos Environmental INC.

Date: October 4, 2013

Subject: Preliminary Results of Plant Establishment in the Straw Bale Demonstration Dust Control Project

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Introduction

The District is currently testing a potential new dust control measure that uses straw bales and native plants. The straw bales act as roughness elements to stabilize an active source area and also as shelter for newly planted native shrubs. In the conceptual design of the measure, dust control will be transferred from the bales, as they degrade over time, to the plants as they mature and grow. The beauty of the conceptual design of the project is that immediate control of an active dust source area is achieved with the placement of the straw bales and that full dust control effectiveness is maintained throughout establishment and growth of the native shrubs. Additionally, the potential new control measure can be implemented with minimal impacts to existing natural resources and if placed in the right environment can ultimately be self-sustaining.

In order to determine if the conceptual design of the proposed new dust control measure will work within the design parameters, the District is conducting a small-scale test of the straw bale measure. The 50 meter by 100 meter (1.2 acre) test site for the project (Straw Bale Demonstration Project) is located in the northern portion of the Keeler Dunes on an active sand sheet. If successful, the new dust control measure could be used on a large scale within the dunes as well as on other active dust sources in the area, such as those on the bed of Owens Lake. In particular, this new control measure has applicability in the transition from Shallow Flooding to Managed Vegetation or to a Managed Vegetation-Shallow Flooding control combination (termed “Hybrid”).

The Straw Bale Demonstration Project has two main components being tested and monitored:

1) control effectiveness (reduction in the sand motion and surface winds across the site) and
2) establishment of selected native shrubs.

The purpose of this technical memorandum is to present the results, as of September 13, 2013, on the establishment of the native shrubs planted on the test site on May 30, 2013. An interim report on the control effectiveness or the effect of the straw bale array on the wind speed and sand motion across the test site is being prepared by Dr. Jack Gillies of the Desert Research Institute (DRI) in a separate technical report (Gillies, 2013).

Overview of Straw Bale Demonstration Test

The Straw Bale Demonstration Project site was instrumented with sand catchers, Sensits and meteorological equipment in April 2013. Placement of the 504 straw bales on the site occurred on two dates, May 23 (336 bales) and June 12 (168 bales). Several weeks of pre-bale monitoring was conducted on the test site prior to bale placement in order to measure the pre-control magnitude and the spatial variability of the sand motion and wind data across the site.

A critical component of the Straw Bale test is the establishment of native shrubs on the site. As such, the District contracted with Ms. Katie Quinlan of the Bristlecone Chapter of the California Native Plant Society in the spring of 2012 for propagation of shrubs in anticipation of the test beginning in the fall of 2012[1]. Five species of locally adapted native shrubs were planted and propagated at the White Mountain Research Station (WMRS) facility in Bishop, CA operated cooperatively by the Bristlecone Chapter of the California Native Plant Society, Bureau of Land Management (BLM), and the U.S. Forest Service. The five species (listed below) chosen for planting on the test site are found naturally within the Owens Lake area and were considered to have a high likelihood of success.

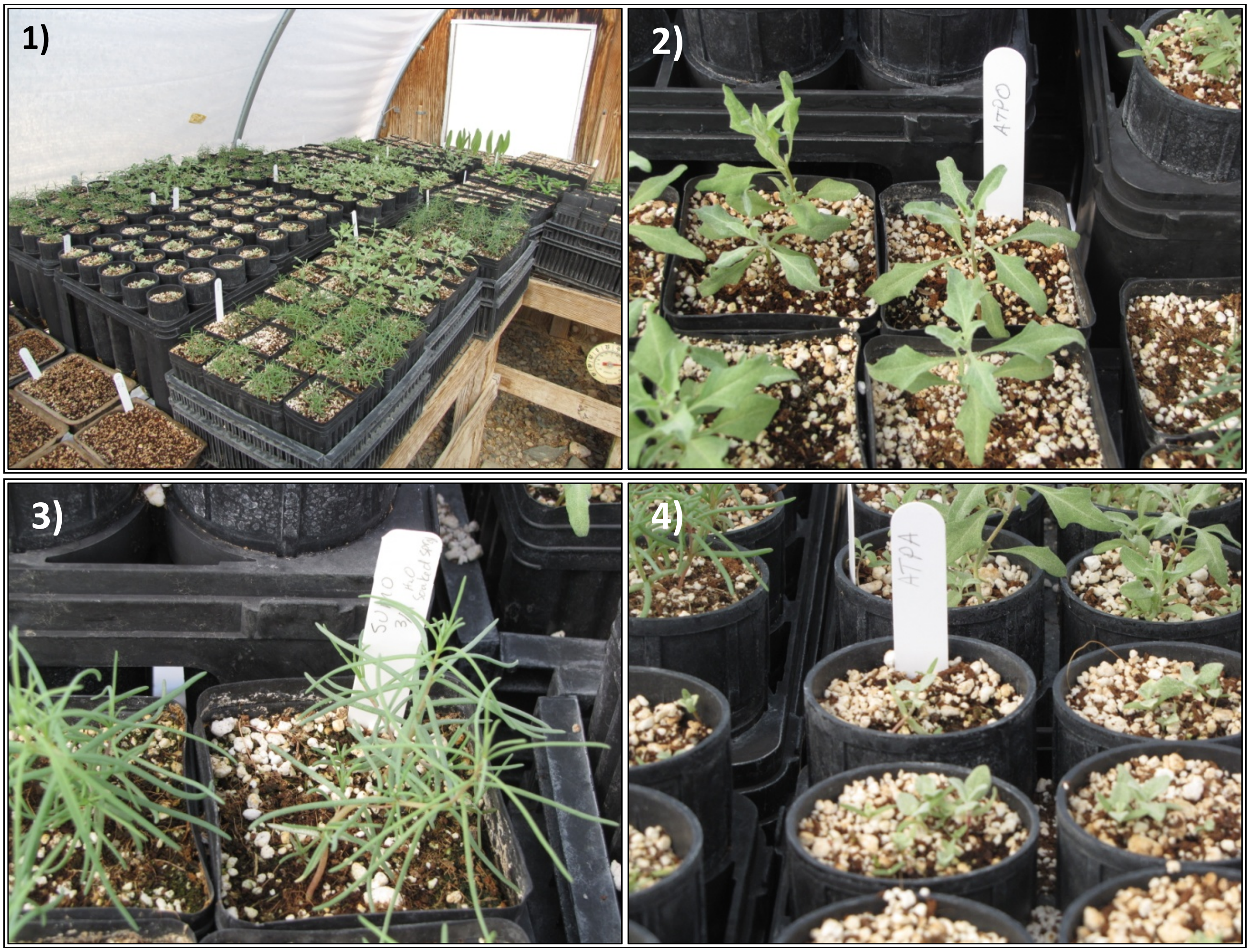
Atriplex polycarpa (ATPO) – cattle saltbush, cattle spinach
Atriplex parryi (ATPA) – Parry's saltbush
Atriplex confertifolia (ATCO) - shadscale
Sarcobatus vermiculatus (SAVE) - greasewood
Suaeda moquinii (SUMO)[2] – Mojave seablite, bush seepweed

Three hundred and twenty eight plants (328) were started in April 2012 from a combination of seed and stem cuttings. Seed used for the project was collected by District staff in the fall of 2011 from plants in the Owens Lake area. Literature research indicated that *S. vermiculatus* and *A. confertifolia* are difficult to propagate from seed such that stem cuttings of these two species were collected and placed in a cutting box for root development and cultivation. The other three species (*A. parryi, A. polycarpa, and S.moquinii)* were propagated from seed. Approximately one-third of the shrubs started in April 2012

[1] Note: The test was originally planned to begin in September of 2012. However, due to a delay in getting the funding for the test, the test did not begin until April of 2013, approximately 7 months behind schedule. The plants started in April 2012 were ready to plant in the fall of 2012 but had to be kept in pots over the winter. A combination of unusually cold weather in December and January, heavy herbivory, and lack of success of the cuttings reduced the number of plants from 328 to 143 over the winter. Two plants were in poor condition in May 2013 and were not planted leaving 141 total plants placed in the ground on May 30, 2013.

[2] Note: According to the current Jepson Manual of plant identification, the classification for this species has changed. The current species name is *Suaeda nigra* instead of *Suaeda moquinii.* For the purposes of this report and project the former name of *Suaeda moquinii* will continue to be used to avoid confusion.

were from cuttings and two-thirds from seed. Photos 1-6 provide pictures of the seedlings and stem cuttings of the native plants propagated for the Straw Bale Demonstration Test in April 2012.



Photos 1-4: Native plant seedlings in April 2012. Photo 1 (upper left) – overview of seedlings in the greenhouse at WMRS. Photo 2 (upper right) – ATPO seedlings. Photo 3 (lower left) – SUMO seedlings. Photo 4 (lower right) – ATPA seedlings.

Photo 5: Placement of SAVE cuttings into prepared perlite bed in the cutting box.

Photo 6: View of SAVE and ATCO cuttings in the cutting box on April 15, 2012.

Table 1 provides the number of planted individuals of each species and the method of propagation used. Notice that of the 328 plants originally propagated in April 2012 only 141 (or 43%) were actually placed in the ground in May 2013. This was due to a combination of a high rate of herbivory over the winter, extremely cold weather in December 2011 and January 2012 and poor success of the rooting and establishment of the stem cuttings (see footnote [1]).

Table 1. Native shrubs planted on the Straw Bale Demonstration Project site in May 2013.

Species – Scientific Name	Abbreviation	Common Name	Number of Plants started in April 2012	Propagation Method	Number of Shrubs Planted in May 2013
Atriplex confertifolia	ATCO	Shadscale saltbush	49	Cuttings	23
Atriplex parryi	ATPA	Parry's saltbush	59	Seed	46
Atriplex polycarpa	ATPO	Cattle spinach, Cattle saltbush	90	Seed	54
Sarcobatus vermiculatus	SAVE	Greasewood	64	Cuttings	12
Suaeda moquinii[2]	SUMO	Mojave seablite, bush seepweed	66	Seed	6
		TOTAL	**328**		**141**

Planting and Watering

Planting of the native shrubs on the test site was conducted on May 30, 2013 in association with the first shipment of bales. The shrubs were planted in a block of 47 bales located on the southeastern portion of the test site. Three shrubs were planted along the northern side of each bale. In between the plants, two watering tubes were installed to facilitate the delivery of water directly to the root zone area (Photos 7 and 8). Figure 1 provides a map of the test site and the block of bales where the native shrubs were planted.

Photo 7: Plants and watering tubes ready for placement in the ground, May 30, 2013.

Photo 8: Picture of the newly planted shrubs along the edge of a straw bale, May 30, 2013.

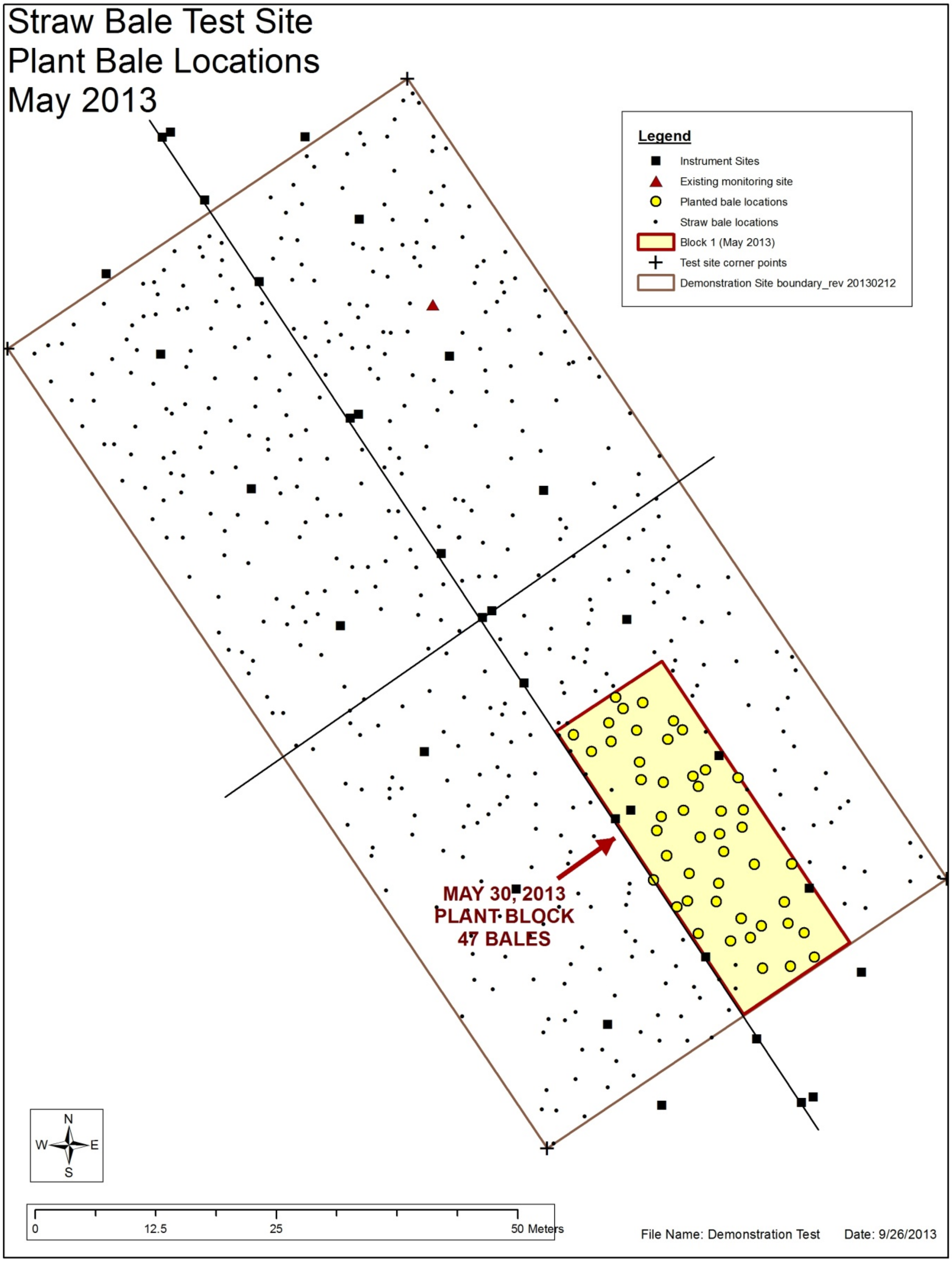


Figure 1. Map showing the location of the block of bales (highlighted in yellow) for the May 2013 planting of native shrubs on the Straw Bale Test Project.

Minimal preparation of the soil was conducted prior to planting of the shrubs. Due to the dry conditions of the sand sheet in the test area, the ground underneath and along the northern side of the selected bales was watered with approximately 5.4 gallons of water the day before (May 29, 2013) placement of the plants in the ground. Three teams of two people worked for approximately 2-3 hours in planting the shrubs and installing the watering tubes. The plants and watering tubes were placed in a trench approximately 18-20"long and 6-8" wide dug using a small hand shovel. The trench was backfilled with the borrowed sand and tamped around the plants and watering tubes. Care was taken by each team to remove each plant from the pot and in placing each plant in the ground in order to maintain the integrity of the soil around the roots. However this was particularly difficult for the ATPA which tended to fall apart when removed from their pots.

Following planting, each planted bale location was watered with approximately 5.4 gallons of water applied mostly through the watering tubes directly to the root zone of the plants. Due to the harsh conditions during June and July 2013, the newly planted shrubs were given supplemental water to assist in establishment. During the first month following planting, supplemental water was provided seven times with an average of 4 days between watering events. The watering frequency was reduced to an average of every 7-8 days during July through mid-September. Then in mid-September, the irrigation schedule was further reduced to approximately every two weeks. The District is planning on continuing to reduce the frequency of irrigation first to once every three weeks and then four weeks until the end of the growing season. During all of the supplemental watering events following planting on May 30, 2013, an average of 3.0 gallons of water was provided to each planted bale. A summary of the water use and irrigation schedule is provided in Table 2.

A portable watering system is used to provide water to the plants on the test site. The system consists of a 250 gallon plastic tank and small pump mounted on an ATV trailer. The water is transported from the tank to the planted bales through a 1-inch fire hose (Photo 9). The water tank is filled with water at the District's Keeler field office/yard. Fertilizer was applied once to the plants on the test site. The application was conducted on July 3, 2013 and consisted of approximately 1 teaspoon of slow release fertilizer pellets (Osmocote Smart-release Plant Food 14-14-14) added to each watering tube.

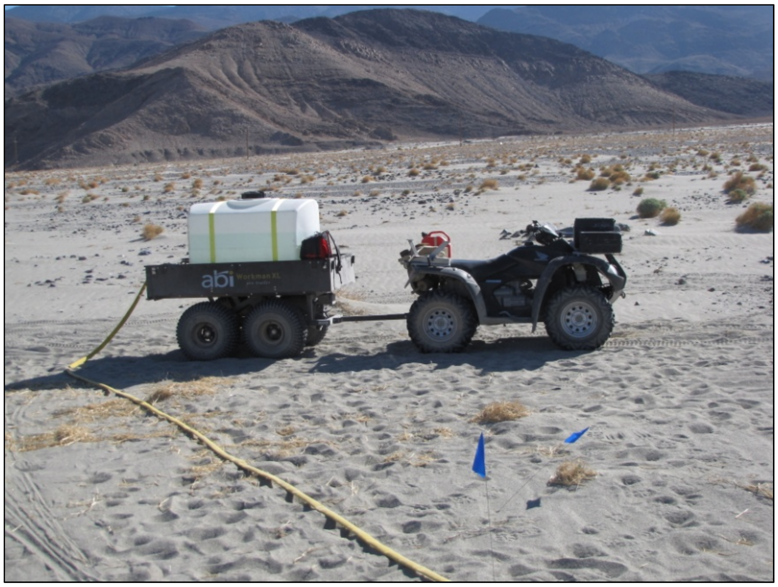


Photo 9. Water tank and fire hose system used to provide water to the plants on the test site.

Plant Survivorship

Following planting of the shrubs on the test site, the health of the plants was monitored regularly. During each monitoring event the vigor or overall health of each plant is assessed based on a qualitative ranking scale that ranges from 0-4: Excellent (4), Good (3), Fair (2), Poor (1), and Dead (0). The vigor rankings are based on factors such as number of leaves, leaf color, leaf size, presence of new growth, etc. Photographs were taken of the plants at each bale just after planting (5/30/2013), mid-summer (7/17/2013) and at the end of September (9/30/2013).[3] Tables 3 through 5 provide a summary of the plant vigor and mortality/survivorship data from May 30, 2013 to September 13, 2013.

As of September 13, 2013, the overall survivorship rate was at 72% for the 141 shrubs planted on May 30, 2013. Thirty-nine individual plants have died over the first 15 weeks of the test. The total number of plant deaths is primarily dominated by one species. Over two-thirds of the total number of plant deaths (27 out of 39 total dead) has occurred in the ATPA population. This accounts for over 50% of the 46 original ATPA planted on the test site.

Perhaps just as important as or perhaps even more important than focusing on the number of plants that have died is to look at the vigor of the surviving 102 plants on the test site. As of September 13, 2013, 66% of the living plants are doing well with a vigor rating of Good or Excellent while only 34% are in the Fair and Poor categories (Table 3).

[3] Note: Subsequent plant monitoring will include photos of the plants in the spring when they break dormancy (March or April), at peak plant biomass (July), and at the end of the season (November). Additional photos were taken during the initial plant establishment in order to document the plant establishment and growth.

Table 2. Summary of the water schedule and use on the Demonstration Test site as of September 13, 2013.

Date	Total gallons	Gallons per Bale	Water per plant	Notes
5/29/2013	255	5.4	N/A	pre-planting watering
5/30/2013	255	5.4	1.8	initial plant watering
6/03/2013	120	2.6	0.9	
6/06/2013	120	2.6	0.9	
6/10/2013	100	2.1	0.7	
6/14/2013	220	4.7	1.6	
6/20/2013	120	2.6	0.9	
6/25/2013	120	2.6	0.9	
6/28/2013	120	2.6	0.9	
7/03/2013	125	2.7	0.9	start watering once per week
7/15/2013	125	2.7	0.9	
7/22/2013	120	2.6	0.9	
8/01/2013	130	2.8	0.9	
8/06/2013	140	3.0	1.0	
8/15/2013	140	3.0	1.0	
8/22/2013	140	3.0	1.0	
8/30/2013	140	3.0	1.0	
9/06/2013	140	3.0	1.0	
9/13/2013	140	3.0	1.0	start watering every 2-4 wks
9/30/13				planned irrigation event
10/21/13				planned irrigation event
11/18/13				planned irrigation event
Total	**2,770**	**58.9**	**17.8**	
Average	**145.8**	**3.1**	**1.0**	

Table 3. Summary of plant vigor data from 5/30/2013 to 9/13/2013. Vigor results are given as the total number of plants within each vigor classification ranking. (ND = no data)

Date	Plant Vigor				
	Dead	Poor	Fair	Good	Excellent
5/30/2013	0	0	13	127	1
6/03/2013	2	2	ND	ND	ND
6/05/2013	4	3	19	112	3
6/10/2013	4	5	20	109	3
6/14/2013	3	3	27	88	19
6/20/2013	3	3	29	88	18
6/25/2013	4	3	28	88	18
6/28/2013	8	4	24	87	18
7/03/2013	9	3	16	92	21
7/15/2013	13	11	31	79	7
7/22/2013	18	6	31	79	7
8/01/2013	23	7	20	64	19
8/06/2013	23	21	23	55	19
8/15/2013	28	17	25	49	22
8/22/2013	32	18	20	47	24
8/30/2013	35	17	20	46	23
9/06/2013	38	19	15	45	24
9/13/2013	39	19	16	41	26

Table 4. Summary of plant mortality from 5/30/13 to 9/13/13.

Date	Number of Dead Plants by Species					Total # Dead	Overall % dead	Total # living	Overall % alive
	ATCO	ATPA	ATPO	SAVE	SUMO				
5/30/2013	0	0	0	0	0	0	0	141	100
6/03/2013	0	1	1	0	0	2	1	139	99
6/06/2013	0	3	1	0	0	4	3	137	97
6/10/2013	0	3	1	0	0	4	3	137	97
6/14/2013	0	2	1	0	0	3	2	138	98
6/20/2013	0	2	1	0	0	3	2	138	98
6/25/2013	0	3	1	0	0	4	3	137	97
6/28/2013	1	6	1	0	0	8	6	133	94
7/03/2013	1	7	1	0	0	9	6	132	94
7/15/2013	1	11	1	0	0	13	9	128	91
7/22/2013	1	14	2	0	1	18	13	123	87
8/01/2013	1	17	3	0	2	23	16	118	84
8/06/2013	1	17	3	0	2	23	16	118	84
8/15/2013	1	21	3	0	3	28	20	113	80
8/22/2013	1	24	3	0	4	32	23	109	77
8/30/2013	2	26	3	0	4	35	25	106	75
9/06/2013	2	27	3	1	5	38	27	103	73
9/13/2013	2	27	3	2	5	39	28	102	72

Table 5. Summary of the plant survivorship given as percentage of original number of shrubs planted for each species from 5/30/13 to 9/13/13.

Date	% Survivorship by species				
	ATCO	ATPA	ATPO	SAVE	SUMO
5/30/2013	100.0	100.0	100.0	100.0	100.0
6/03/2013	100.0	97.8	98.1	100.0	100.0
6/06/2013	100.0	93.5	98.1	100.0	100.0
6/10/2013	100.0	93.5	98.1	100.0	100.0
6/14/2013	100.0	95.7	98.1	100.0	100.0
6/20/2013	100.0	95.7	98.1	100.0	100.0
6/25/2013	100.0	93.5	98.1	100.0	100.0
6/28/2013	95.7	87.0	98.1	100.0	100.0
7/03/2013	95.7	84.8	98.1	100.0	100.0
7/15/2013	95.7	76.1	98.1	100.0	100.0
7/22/2013	95.7	69.6	96.3	100.0	83.3
8/01/2013	95.7	63.0	94.4	100.0	66.7
8/06/2013	95.7	63.0	94.4	100.0	66.7
8/15/2013	95.7	54.3	94.4	100.0	50.0
8/22/2013	95.7	47.8	94.4	100.0	33.3
8/30/2013	91.3	43.5	94.4	100.0	33.3
9/06/2013	91.3	41.3	94.4	91.7	16.7
9/13/2013	91.3	41.3	94.4	83.3	16.7

The cause for the high death rate for the ATPA is uncertain but is thought to be related to the long flexible ("leggy") plant stems and poor root development. Instead of having a stiff upright stem structure, the ATPA plants placed on the test site in May 30, 2013 were short in height and had long leggy stems (Photos 10 and 11). Observations made during plant monitoring events note that the APTA stems were buried and burned by the hot sand moving within the project. District staff uncovered the affected plants on several occasions from the sand that covered them but generally the damage was already done. Another contributing factor to the high mortality of the ATPA is thought to be the root development structure. While being planted on the test site, the soil of many of the ATPA "fell apart" when the plant was removed from the pot for placement into the prepared trench. This did not occur with the other plant species and is thought to have occurred due to the root distribution of the ATPA. Instead of having roots distributed throughout the soil column in the pot, roots were concentrated at the top near the surface and at the base of the pot with very few roots in-between creating poor soil-root integrity.

In addition to the high mortality rate for the ATPA, the SUMO population has also experienced high mortality with the death of 5 of the 6 original plants. However, unlike the ATPA which started to die within the first few days of being planted, all of the SUMO deaths have occurred since July 22, 2013 (Table 4). The main cause of the SUMO deaths is thought to be from browsing from small mammals that have started to utilize the test site. Similarly, browsing impact has been observed on the SAVE plants (although not as severe as the SUMO). Wire protective cages were constructed and placed around all plants at bales containing either SUMO or SAVE in mid- September 2013.

The most successful species, through 9/13/13, are the ATPO and ATCO. Both species have survivorship rates over 90% (see Table 5). The SAVE population also has a high survivorship rate of over 80%. Both SAVE deaths have occurred in September 2013 and, as mentioned above, are thought to be related to browsing activities from small rodents.

Figures 2 through 4 show plots of the plant monitoring data through September 13, 2013. The overall survivorship of the plants on the test site is 72% as of September 13, 2013. The weighted average vigor ranking for all of the plants on the test site has declined from 2.9 on May 30, 2013 to 1.97 on September 13, 2013 (Figure 4).

To illustrate the change over the first four months of the project, photo sequences of the plants at three different bales are presented in Photos 12-14. The photos were taken on three dates; at the time of planting (5/30/2013), mid-summer (7/17/2013), and at the end of September (9/30/13). The photos taken at bale numbers 5, 8 and 47 (see Photos 12- 14) illustrate the overall growth and Good to Excellent vigor rating of the ATPO and ATCO plants over the course of the summer. An example of one of the wire protective structures installed to protect the SAVE and SUMO plants is visible in Photo 12C.

Photos 10 and 11. Photos showing the long leggy stems of the ATPA on May 30, 2013. Photo 10 (left) shows the contrast in plant structure between the ATPA (in the tray near the cardboard box) and the rest of the plants. Photo 11 (right) shows a close up of an ATPA in its pot prior to planting. Notice the long leggy stems draped over the edge of the pot.

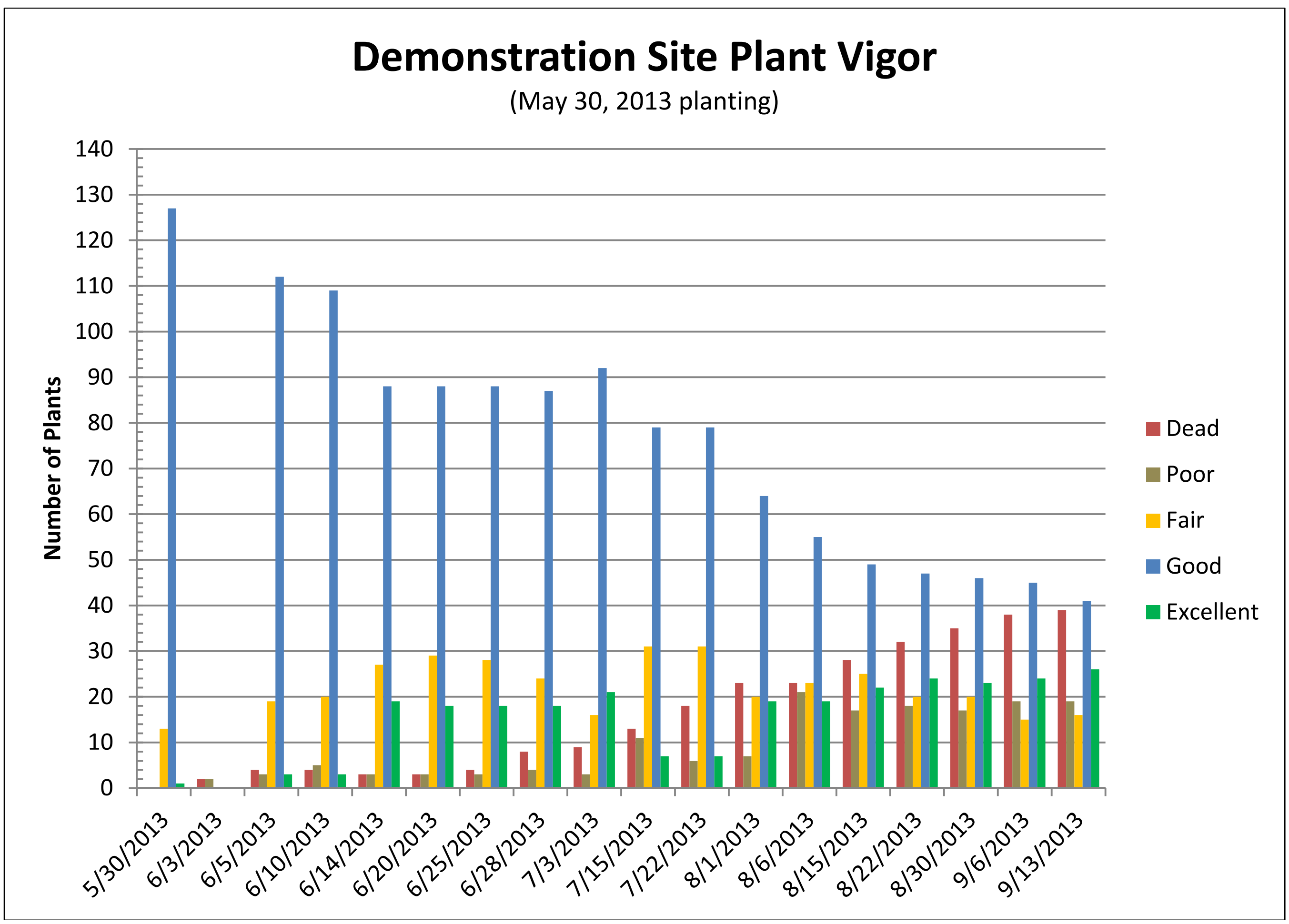


Figure 2. Plot showing the number of plants in each vigor ranking category through 9/13/2013.

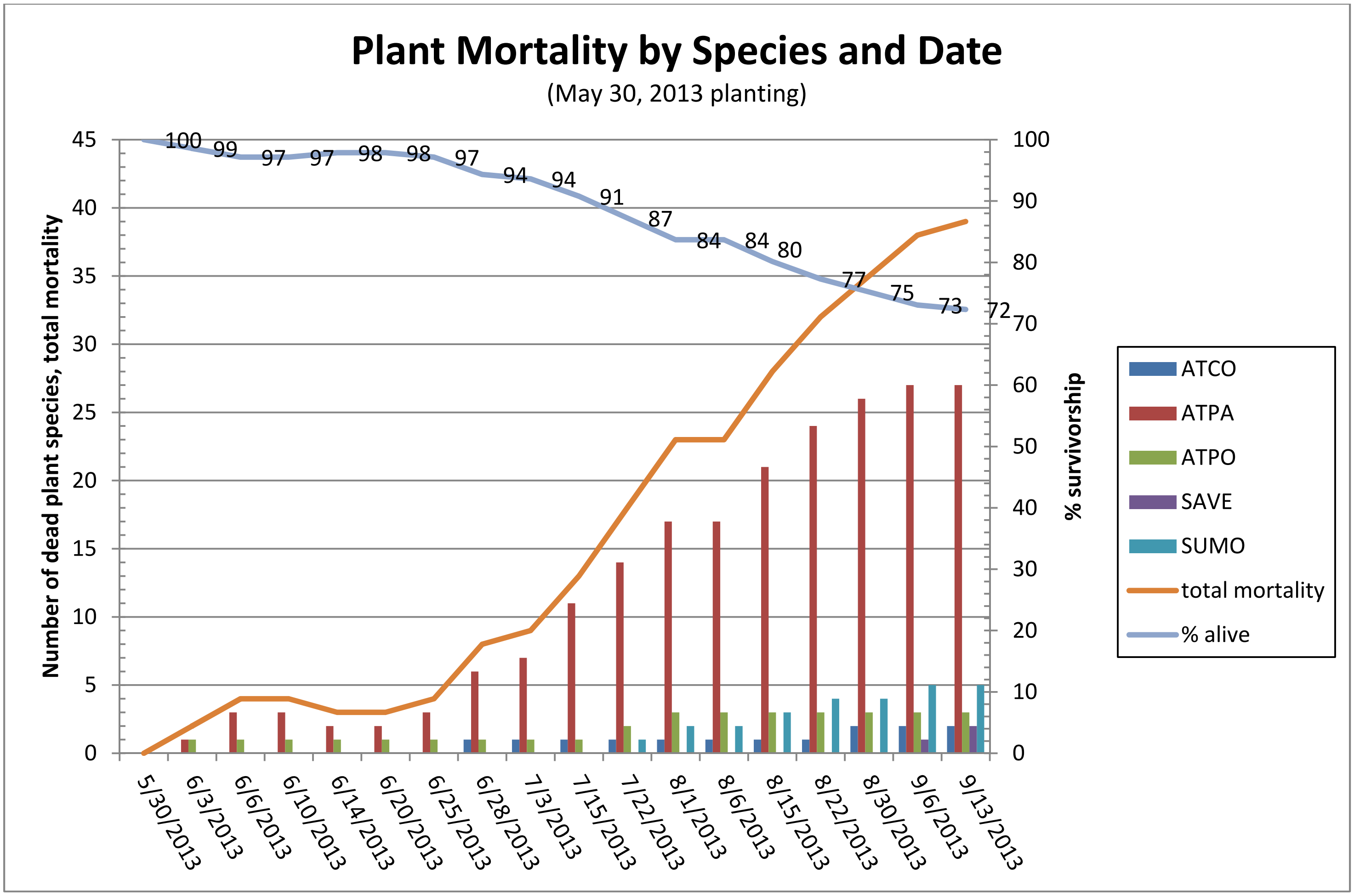


Figure 3. Plot showing the number of dead plants and total mortality (left axis) and percent survivorship (right axis) through September 13, 2013. The colored bars show the number of dead plants from each of the five species of native shrubs planted on the test site.

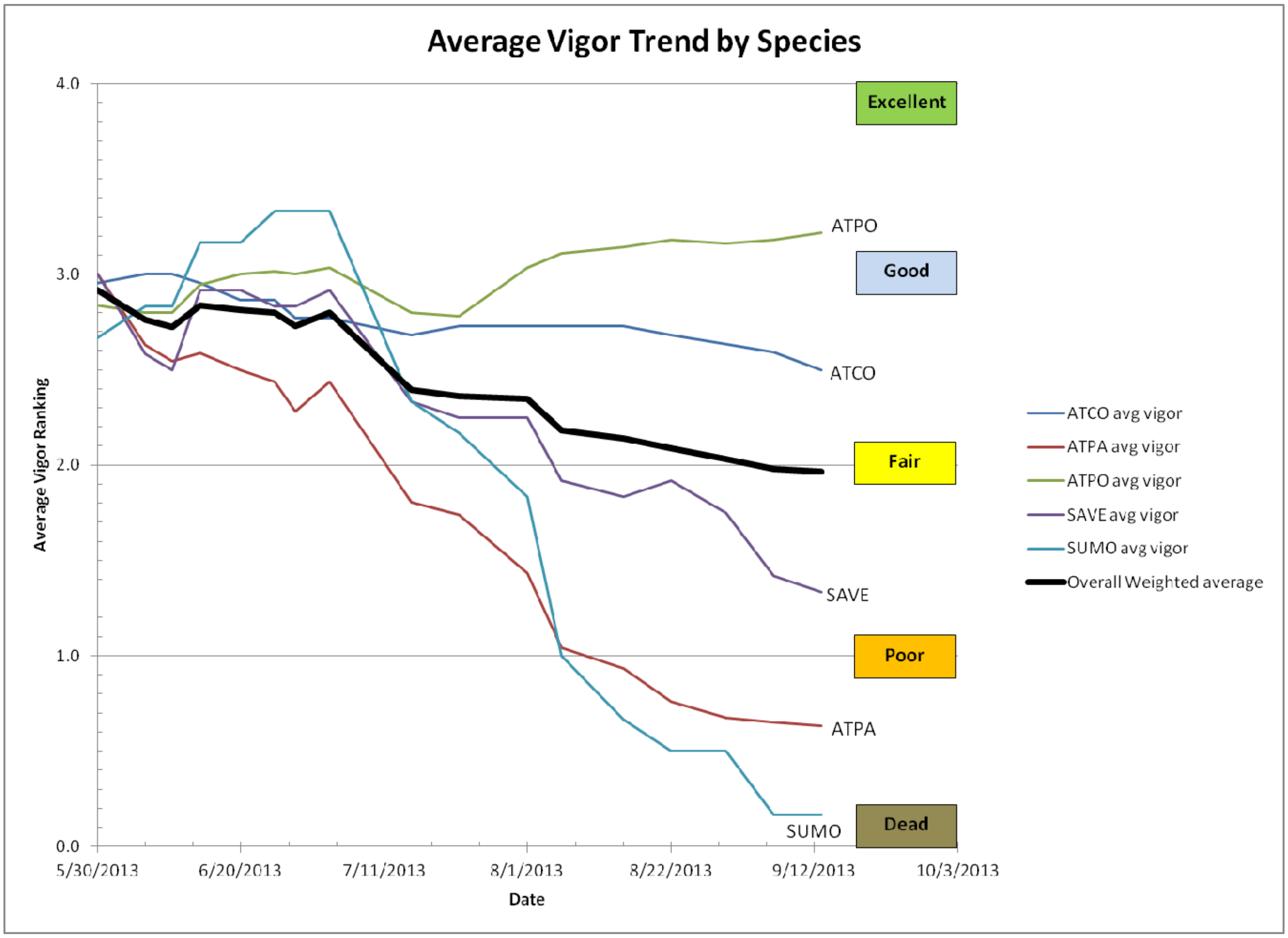


Figure 4. Plot of the average vigor ranking for each plant species from May 30, 2013 through September 13, 2013. An overall weighted average trend line is also provided. The ATPO and ATCO plants continue to have an overall high vigor ranking well above the weighted average line. ATPA and SUMO vigor has declined during the first 15 weeks of the test into an overall ranking of Poor.

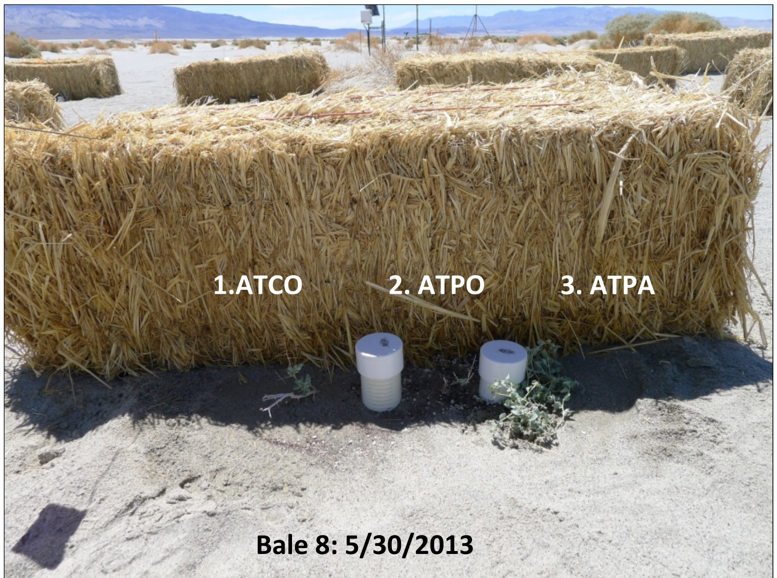
Photo 12: Monitoring photos taken of the plants at Bale number 5 showing the plants from three dates from May to September 2013. The plants are numbered 1, 2, and 3 sequentially from left to right. On September 30, 2013 (bottom photo) the vigor rankings were Plant 1 (ATPO) = Excellent, Plant 2 (SAVE) = Good, and Plant 3 (ATCO) = Good

A) May 30, 2013: date of planting

B) July 17, 2013:

C) September 30, 2013: Notice the wire protective structure placed around the plants to prevent browsing impacts on the SAVE.

Photo 13: Monitoring photos taken of the plants at Bale number 8 showing the plants from three dates from May to September 2013. The plants are numbered 1, 2, and 3 sequentially from left to right. On September 30, 2013 (bottom photo) the vigor rankings were Plant 1 (ATCO) = Excellent, Plant 2 (ATPO) = Excellent, and Plant 3 (ATPA) = Dead



A) May 30, 2013: Notice the leggy structure of the ATPA on the right.

B) July 17, 2013

C) September 30, 2013: Notice the Excellent vigor of the ATCO and ATPO and that the ATPA is now Dead.

Photo 14: Monitoring photos taken of the plants at Bale number 47 showing the plants from three dates from May to September 2013. The plants are numbered 1, 2, and 3 sequentially from left to right. On September 30, 2013 (bottom photo) the vigor rankings for all three ATPO plants was Excellent.

A) May 30, 2013

B) July 17, 2013

C) September 30, 2013: Notice the continued growth of the ATPO from May to September.

Summary

Most desert restoration projects consider a survivorship rate of 50% or higher to be successful (Abella and Newton, 2009). So far this success level has been achieved on the Straw Bale Demonstration project within the first 2 ½ months of the project. Due to the time of planting, right before the extended hot period at the peak of summer season, District staff made extra effort to provide water and conditions suitable for plant success. This level of effort is not sustainable for the proposed large scale dust control project which has a foot print of approximately 200 acres.

The optimum time for planting in desert vegetation projects is in the fall season right before the plants go dormant for the winter. A second set of approximately 500 native plants were started from seed in April 2013 for planting on the test site in October 2013. This second planting will provide valuable information on plant survivorship as designed for the full scale project.

Two main issues of concern that were identified in the first set of plants on the bale project include browsing impacts and plant/root structure. In order to address these issues for the next set of plants being planted on the test site at the end of October 2013, the District is going to place protection structures around the plants at each bale that has a SUMO or SAVE when the plants are placed in the ground and is also having the new ATPA plants pruned to promote an upright stem structure. The District plans to continue monitoring the health of the existing plants on the test site as well as begin monitoring the health and establishment of the new plants schedule for placement in the ground in October.

References

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