DOE/NV/0000939-18

Project 57 Air Monitoring Annual Report - Fiscal Year 2013 (October 1, 2012 to September 30, 2013)

Prepared by

Julianne J. Miller, Greg McCurdy, and Steve A. Mizell

Submitted to

Nevada Field Office
National Nuclear Security Administration
U.S. Department of Energy
Las Vegas, Nevada

July 2014

Publication No. 45256

Nevada System of Higher Education

DOE/NV/0000939-18

Project 57 Air Monitoring Annual Report - Fiscal Year 2013 (October 1, 2012 to September 30, 2013)

Prepared by
Julianne J. Miller, Greg McCurdy, and Steve A. Mizell

Division of Hydrologic Sciences
Desert Research Institute
Nevada System of Higher Education

Publication No. 45256

Submitted to

Nevada Field Office
National Nuclear Security Administration
U.S. Department of Energy
Las Vegas, Nevada

July 2014

The work upon which this report is based was supported by the U.S. Department of Energy under Contract #DE-NA0000939. Approved for public release; further dissemination unlimited.

THIS PAGE INTENTIONALLY LEFT BLANK

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

AEC	Atomic Energy Commission
Am-241	Americium-241
CA	Contamination Area
CAS	Corrective Action Site
CAU	Corrective Action Unit
cfm	cubic feet per minute
cps	counts per second
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DRI	Desert Research Institute
FY	Fiscal Year
NFO	Nevada Field Office
NNSA	National Nuclear Security Administration
NNSS	Nevada National Security Site
NTTR	Nevada Test and Training Range
$PM_{2.5}$	Particulate Matter less than 2.5 µm
PM_{10}	Particulate Matter less than 10 µm
RCT	Radiological Control Technician
RMA	Radiological Material Area
TLD	Thermoluminescent Dosimeter

INTRODUCTION

The U.S. Department of Energy (DOE), National Nuclear Security Administration, Nevada Field Office (NNSA/NFO) is currently working to achieve regulatory closure of radionuclide-contaminated Soils sites under its auspices. Corrective Action Unit (CAU) 415, Project 57 No. 1 Plutonium Dispersion Site is located in Emigrant Valley, Nevada, on Range 4808A of the Nevada Test and Training Range (NTTR), and consists of one Corrective Action Site (CAS): NAFR-23-02, Pu Contaminated Soil.

Closure plans being developed for the CAUs both on and off of the Nevada National Security Site (NNSS) may include postclosure monitoring for the possible release of radioactive contaminants. Determining the potential for transport of radionuclide-contaminated soils under ambient climatic conditions will facilitate an appropriate closure design and postclosure monitoring program. The DOE has authorized the Desert Research Institute (DRI) to conduct field assessments of potential transport of radionuclide-contaminated soil from the Project 57 site during ambient wind events. The assessment is intended to provide site-specific information on meteorological conditions that result in airborne soil particle redistribution, as well as determine which, if any, radiological contaminants may be entrained with the soil particles and estimate their concentrations.

BACKGROUND

During the late 1950s, the Atomic Energy Commission (AEC, now the DOE) conducted a series of safety experiments to determine if a nuclear device subjected to a large conventional explosives detonation would result in a thermonuclear explosion. Project 57, one of the safety experiments, was detonated on April 24, 1957, in Emigrant Valley approximately 13 miles (21 kilometers) northeast of the north end of Yucca Flat (Figure 1). Although the test did not result in the fission of nuclear materials, it did cause the dissemination of plutonium across the ground surface.

The AEC obtained temporary use, from the U.S. Department of Defense (DOD), of a large portion of western Emigrant Valley for the Project 57 safety experiment. Following the safety experiment, control of the land returned to the DOD. Currently, the area is part of the NTTR. For safety and security reasons, the NTTR is controlled through the use of both physical (i.e., fences), and administrative (e.g., signs, postings) controls; as such, there are no known receptors with routine access to the site.

Various radiological surveys have been performed in the area since Project 57 was conducted. The original fence constructed by the AEC to control access to Project 57 was designated the initial Contamination Area (CA) boundary. However, subsequent ground and aerial radiological surveys determined that contamination extended beyond the fence line. The distribution of Americium-241 (Am-241) in the CA was identified in a 1997 flyover (written [electronic] communication from Navarro-Intera to DRI, 2010) that showed Am-241 concentrations ranging from as much as 70,000 counts per second (cps) at ground zero to background values (Figure 2). In 2007, the DOE expanded the CA by posting "Contamination Area" signs 200 to 400 feet (60 to 120 meters) outside of the original fence, forming a new concentric CA boundary. However, Am-241 concentrations in the range of 70 to 150 cps are found outside of the new CA boundary on the east side of the area (Figure 2).

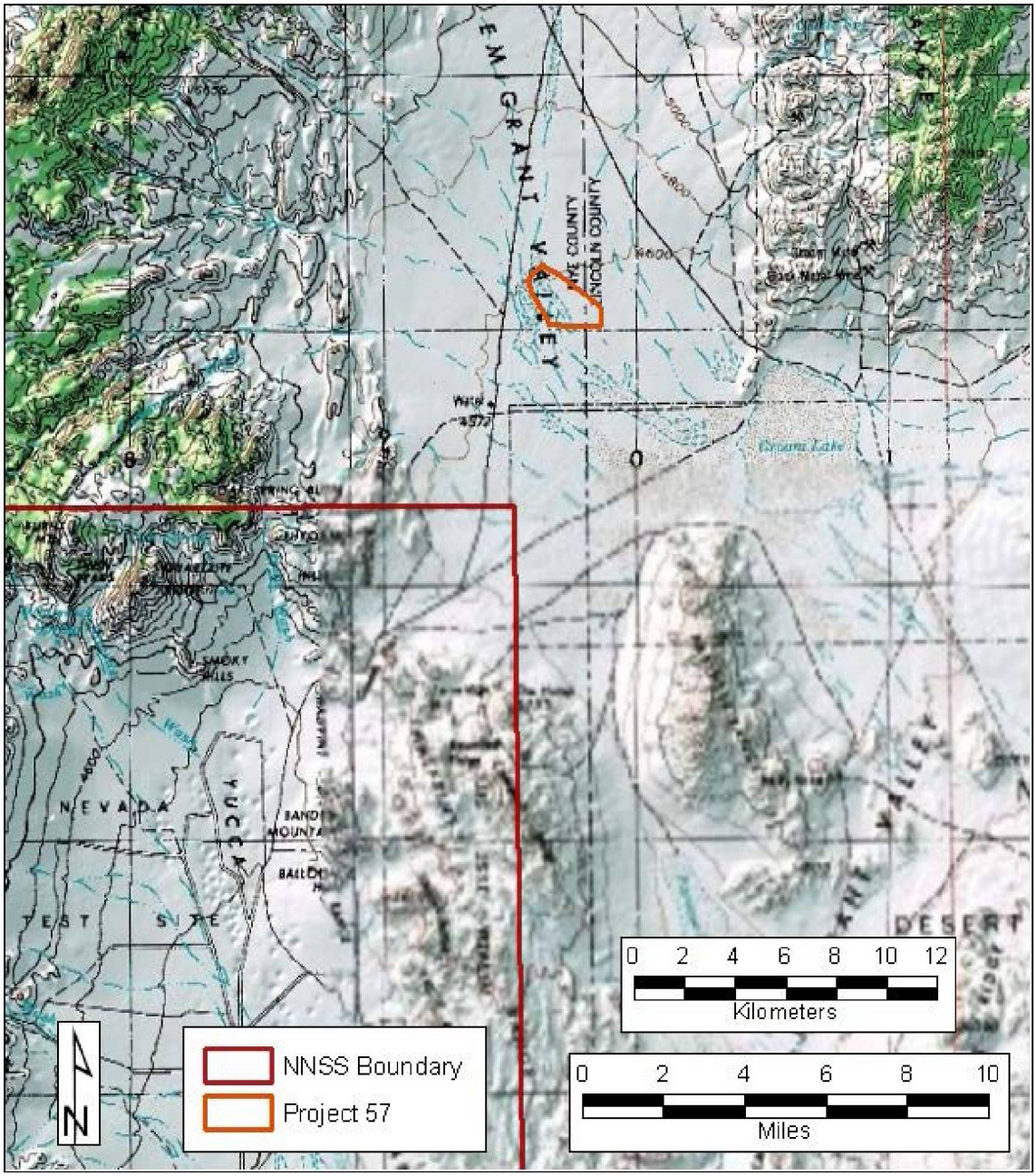

Figure 1. Project 57, outlined in orange, is off of the northeast corner of the Nevada National Security Site on the Nevada Test and Training Range at the Lincoln/Nye County border in western Emigrant Valley.

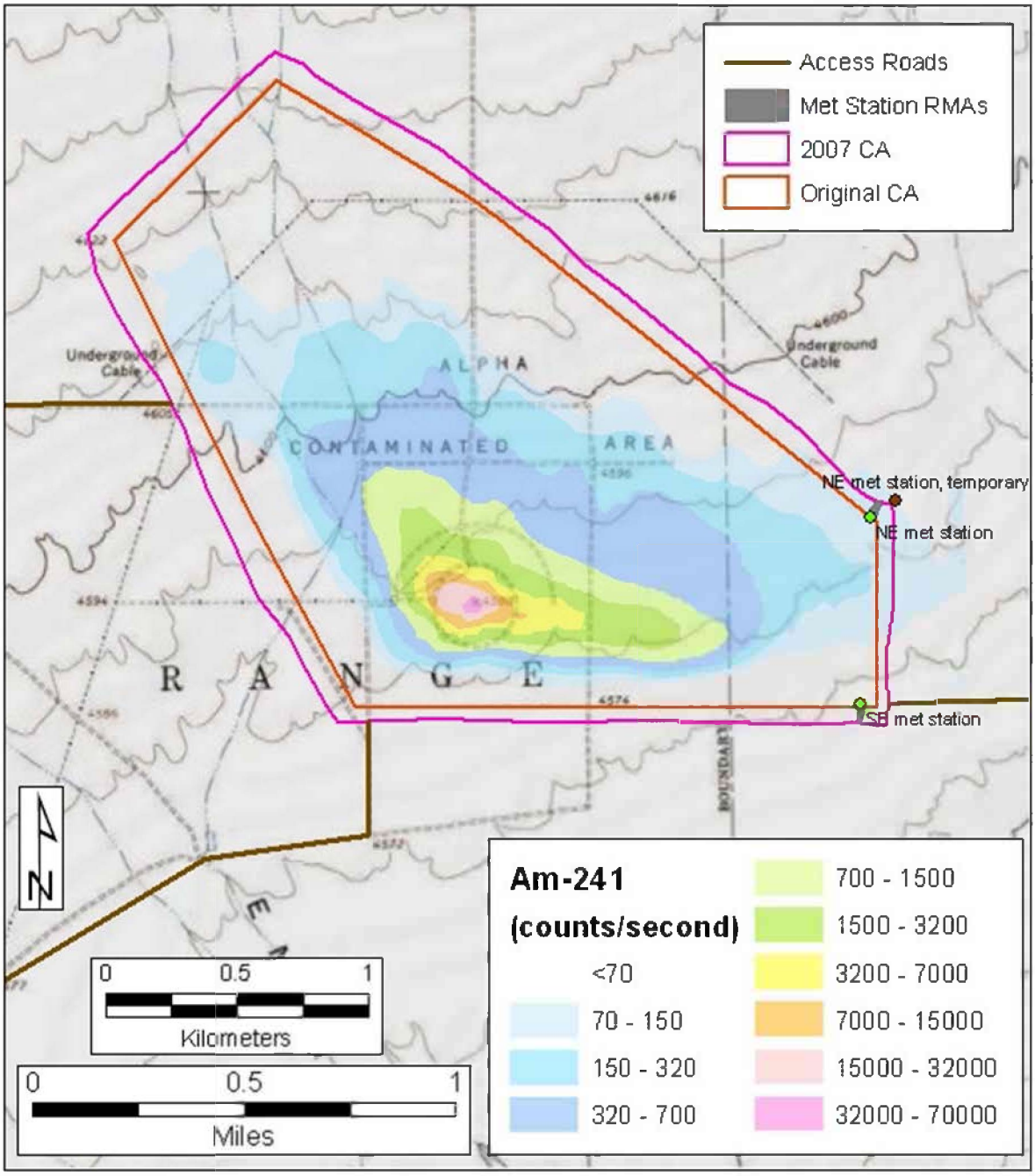

Figure 2. The 1997 radiological survey detected low levels of Americium-241 outside of the original Contamination Area (CA) demarcation fence line, which led to the establishment of the 2007 CA marked by signs. The green diamonds and red dot indicate the locations of the air-monitoring/meteorological stations. (Americium concentration data was provided in electronic format by Navarro-Intera.)

The Project 57 site is located near the center of the western part of Emigrant Valley. Soils in the area are dominated by fine particles that are subject to transport under moderate to strong winds. Tamura (1985), Friesen (1992), Murarik *et al.* (1992), and Misra *et al.* (1993) indicate that plutonium has a tendency to bind with fine soil particles. Therefore, the particles most likely to be transported by wind are also the particles most likely to be contaminated by radionuclides. Because plutonium is likely to reside in the upper few inches (or centimeters) of soil, soil erosion by wind can potentially lead to the mobilization and redistribution of radionuclide-contaminated soil. Additionally, the primary risk to receptors is the inhalation of airborne dust raised from the area of contaminated soil.

RESEARCH APPROACH

The presence of small-sized soil particles in the Project 57 area and the propensity for plutonium to bind to small particles suggests that contamination may be transported by wind. Area wind data provided by the stakeholder indicate that southwest winds are predominant during the spring, summer, and fall and that northwest winds are common during the winter. However, there are no historical site-specific data on wind or other climate parameters at the Project 57 site.

The DRI is currently performing a field-scale assessment of meteorological conditions that could potentially lead to the transport of contaminated soil from the Project 57 site. The research plan includes measuring local meteorological parameters, assessing airborne soil particle size profiles, measuring the occurrence and frequency of soil particles that are transported by saltation just above the soil surface, and collecting airborne particles for radionuclide concentration determination, if found. During Fiscal Year (FY) 2014, saltation traps will be added to collect saltating soil particles for laboratory analyses of grain sizes and possible associated radionuclides. The meteorological parameters being measured include wind direction and speed, air temperature, relative humidity, and precipitation.

Measurements are being made at two locations (Figure 2). A northeast location was selected to obtain downwind data along the predominant spring through fall southwest wind direction and a southeast location was selected to obtain similar downwind information for the northwest winds that are common during the winter. The National Security Technologies Radiological Control Technicians (RCTs) surveyed two corridors from the marked CA boundary to the fence boundary to allow the meteorological stations to be positioned at the fence. These corridors were downgraded from CA to Radioactive Material Areas (RMAs) to allow access to personnel with Radiological Worker II training.

Initially, the northeast meteorological station (P-57-1) was installed in June 2011 at a temporary location outside of the northeast corner of the marked CA boundary (Figure 2). After the RMA corridors were established, the P-57-1 station was moved to the fenced boundary in August 2011 (Figure 3). However, prior to its relocation, the P-57-1 station was dismantled and removed from the field location during July and August 2011, at the request of the stakeholder, so no measurements were obtained during this time. (The stakeholder has indicated that it is unlikely to be necessary in the future to remove the meteorological stations.) The southeast meteorological station (P-57-2) was installed within the southern RMA corridor at the fenced boundary during early November 2011 (Figure 4). Table 1 lists the coordinates and elevations of both meteorological stations.

Table 1. Project 57 meteorological stations are located in Emigrant Valley, Nevada, at the coordinates and elevations given.

Meteorological Station	Latitude	Longitude	Elevation
P-57-1	37° 19' 19"	115° 53' 20"	4,590 ft
P-57-2	37° 18' 53"	115° 53' 21"	4,575 ft

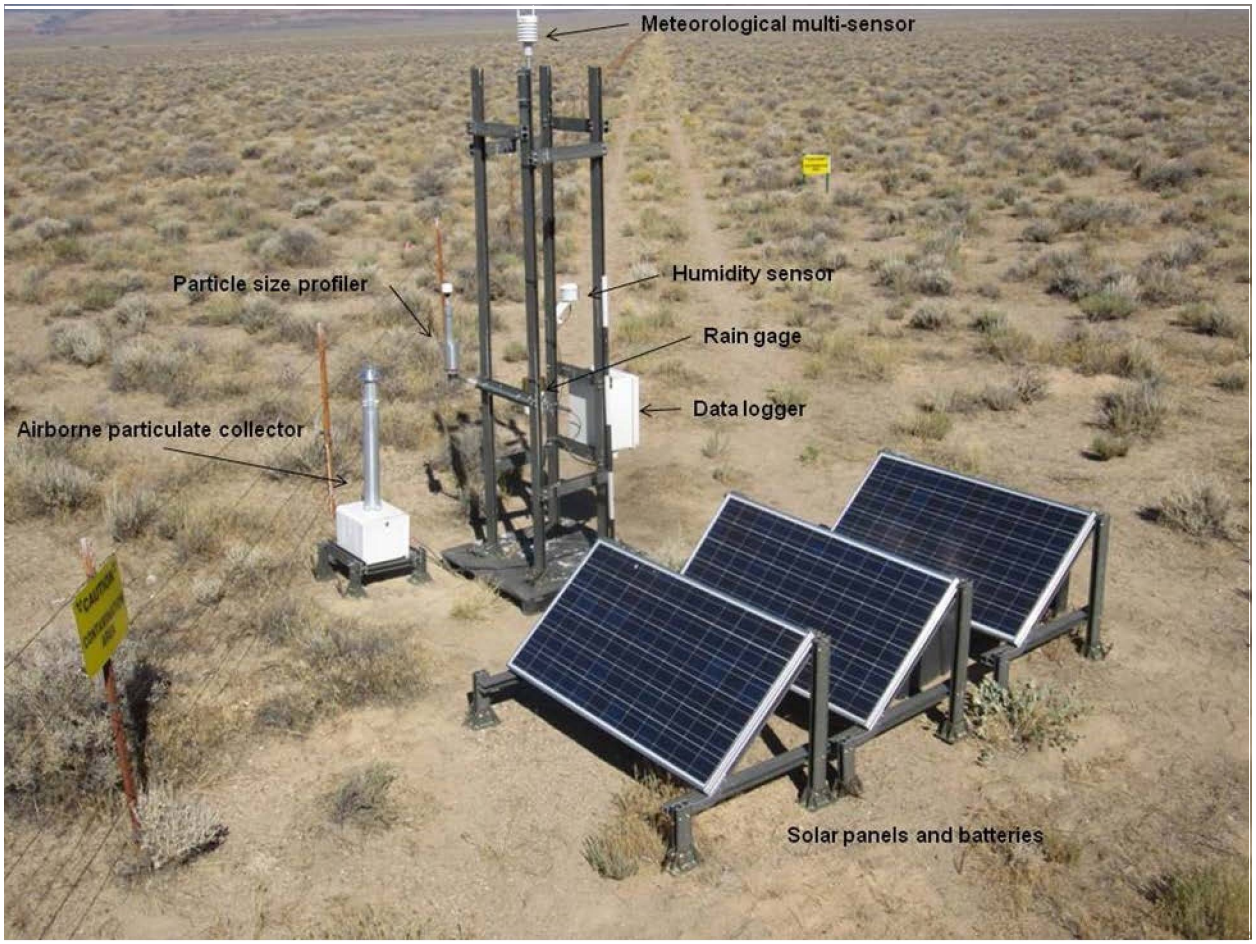

Figure 3. Project 57 meteorological station #1 (P-57-1) was installed at the northeast corner of the Project 57 fenced boundary in August 2011. The associated saltation sensor (not pictured) was installed in January 2012.

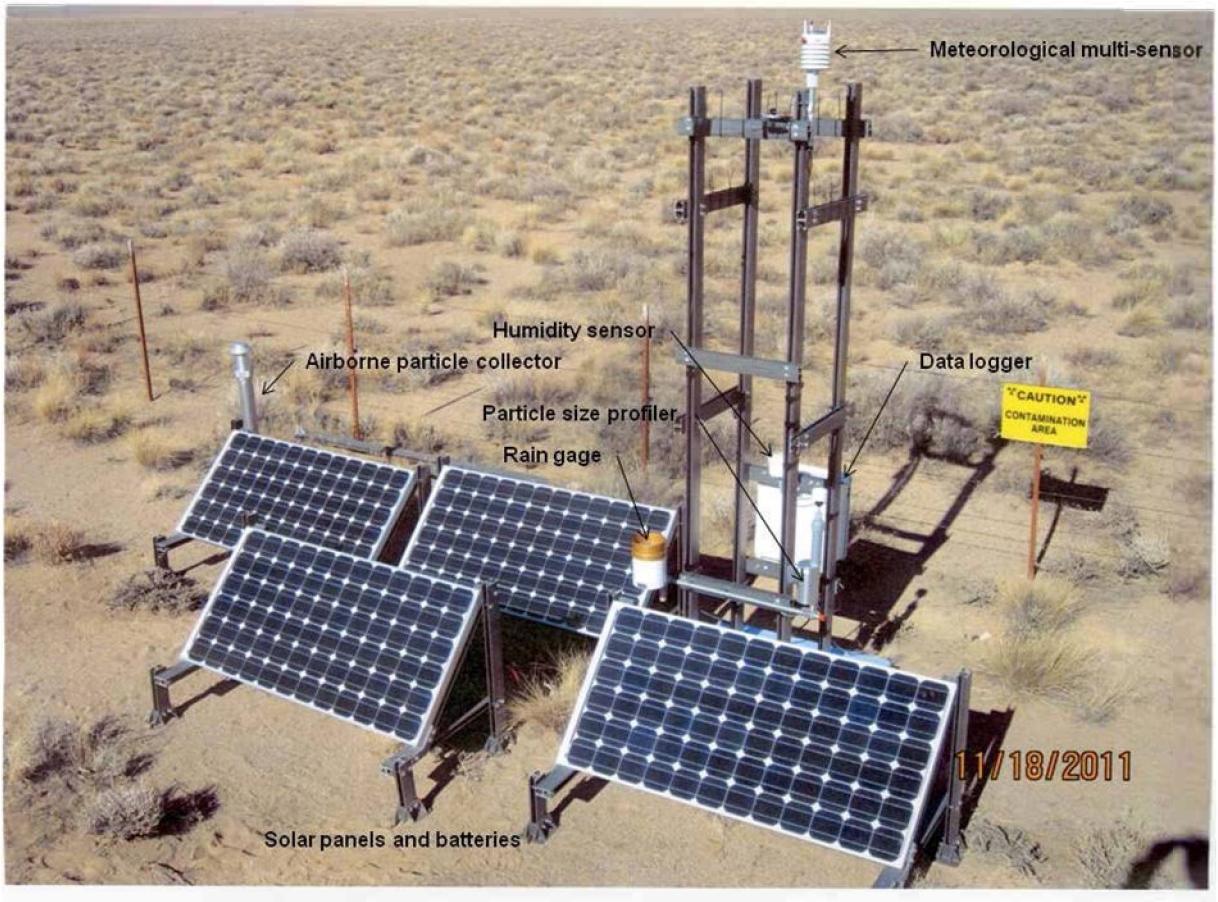

Figure 4. Project 57 meteorological station #2 (P-57-2) was installed at the southeast corner of the Project 57 fence boundary in November 2011. The associated saltation sensor was installed in December 2011.

Thermoluminescent dosimeters (TLDs) were installed at both stations in November 2011 and are collected on a quarterly basis for laboratory analysis. Saltation sensors, used to measure the occurrence and frequency of soil particles that are transported by saltation, were installed at the P-57-2 and P-57-1 stations during December 2011 and early January 2012, respectively.

Between October 1, 2012, and September 30, 2013 (i.e., FY 2013), 25 biweekly samples of airborne particulates were collected from P-57-1. The station air sampler was briefly out of service (four days) in mid-February while the unit was taken to the manufacturer for calibration and maintenance checkups. The unit passed calibration checks well within the manufacturer's specifications, even though it exhibited problems achieving upper-limit airflow (3 cubic feet per minute [cfm] and greater). The manufacturer indicated that this could be a sign of potential future pump failure, but stated that the unit could continue to operate without problems for an extended period. Because the unit exhibited no problems within the operational 2.0 cfm range, it was redeployed to the field. However, within a week of redeployment, the unit pump completely failed, most likely because it was

operating at colder temperatures that were not duplicated at the factory. Therefore, one biweekly sample was lost until parts were procured and the unit was repaired in the field. Lab analyses through September 3, 2013, of the biweekly samples have been received from the lab and the remaining sample from the operations period is currently in the laboratory queue.

Between October 1, 2012, and September 30, 2013 (i.e., FY2013), 25 biweekly samples of airborne particulates were collected from P-57-2. The station air sampler was briefly out of service in mid-February (four days) while the unit was taken to the manufacturer for calibration and maintenance checkups. The unit passed calibration checks well within the manufacturer's specifications. However, P-57-2 experienced an outage in late June due to a failing fuse that was later traced to a short that was developing in the pump. Parts were procured and the unit was repaired. Because of the experiences with both units, a spare pump is now in the project inventory and at the field site. Lab analyses through September 3, 2013, of the biweekly samples have been received and the remaining sample from the operations period is currently in the laboratory queue.

Summary of Collected Data (from October 1, 2012 to September 30, 2013)

Figures A1-A4 and A11-A15 (Appendix A) depict the general meteorological conditions at the P-57-1 and P-57-2 stations for October 1, 2012 to September 30, 2013 (i.e., FY2013). As is typical of a Great Basin Desert location, both sites are exposed to large diurnal temperature ranges with infrequent precipitation events and seasonally directional winds.

Total precipitation measured during FY13 was 5.23 inches and 5.64 inches at P-57-1 and P-57-2, respectively. Total monthly precipitation during October 2012 and September 2013 exceeded previous monthly maximum precipitation totals. In October 2012, the P-57-1 and P-57-2 stations recorded 1.41 inches and 1.45 inches of precipitation, respectively. Most of this precipitation occurred during a single 24-hour period (October 11, 2012) when the P-57-1 and P-57-2 stations recorded 1.31 inches and 1.33 inches, respectively. In September 2013, the P-57-1 and P-57-2 stations recorded 1.57 inches and 1.95 inches, respectively. However, these amounts occurred during several distinct precipitation events in early September. At station P-57-1 on September 1st, 4th, and 8th, 0.77 inches, 0.36 inches, and 0.40 inches of precipitation were recorded, respectively. At station P-57-2 on September 1st, 4th, and 8th, 0.96 inches, 0.34 inches, and 0.61 inches of precipitation were recorded, respectively.

Additional parameters collected at the P-57 stations include soil temperature, barometric pressure, and soil moisture. These parameters can be used to establish soil surface conditions and vegetation growth conditions. Currently, insufficient data have been collected to perform these analyses, but baseline conditions are being established. These parameters are depicted in Figures A5-A7 (Appendix A) for station P-57-1 and Figures A16-A18 (Appendix A) for P-57-2. Relative humidity and solar radiation measurements are made only at the P-57-2 station, which are shown in Figures A14 and A15 (Appendix A), respectively. Figures A8-A10 and A19-A21 (Appendix A) depict the data collected by the air particulate samplers and the saltation sensors for stations P-57-1 and P-57-2, respectively.

Figures A22-A24 and Figures A25-A 27 (Appendix A) depict the wind speed and direction (wind rose) for stations P-57-1 and P-57-2, respectively, including wind roses that illustrate the differences between winter and summer season wind patterns. Whereas the

winter season is dominated by northerly winds, the summer season has both northerly and southwesterly winds. Winds with speeds above 19 mph occur from both northerly and southwesterly directions during both seasons. The most significant wind event occurred on November 10, 2012, when wind speeds were recorded at greater than 90 and 70 miles per hour at the P-57-1 and P-57-2 stations, respectively. These data illustrate the need to continue monitoring at both locations in order to characterize the likely target zones for resuspension of radionuclide-contaminated soils by wind.

Summary of Airborne Particulate Filter Samples

Airborne particulate filter samples have been analyzed for both stations since late 2011. Laboratory radiochemistry results through September 3, 2013, are presented in Tables 2 and 3 for stations P-57-1 and P-57-2, respectively. These results indicate no detection of resuspended radionuclide-contaminated soils by wind to date.

FUTURE WORK

Meteorological data will continue to be retrieved by manual download on an approximately biweekly schedule. Airborne particulate filter samples also will be collected during the biweekly site visits. These site visits will also provide the opportunity to monitor the operation of the meteorological instrumentation and perform any necessary maintenance. The TLDs will be retrieved during the first week of each fiscal quarter. Site data will be reviewed monthly by project personnel to identify wind events that may cause resuspension of radionuclide-contaminated soil particles and to characterize the general meteorological conditions at the Project 57 site. Data quality control and assurance also will be accomplished during these reviews. During Fiscal Year (FY) 2014, saltation traps will be added to collect saltating soil particles for laboratory analyses of grain sizes and possible associated radionuclides.

Table 2. Radioactive chemical analysis of P-57-1 airborne particulate filter samples per Federal Fiscal Year.

Station P-57-1										
	Sample Intervals	**Sample Weight g**	**Gross Alpha Final mCi/mL 10^{-15}**	**Gross Beta Final mCi/mL 10^{-14}**	**Be-7 Final µCi/ml 10^{-13}**	**K-40 Final µCi/ml 10^{-14}**	**Pb-210 Final µCi/ml 10^{-14}**	**Pb-212 Final µCi/ml 10^{-13}**	**Bi-214 Final µCi/ml 10^{-13}**	**Pa-234m -- µCi/ml 10^{-14}**
FY2011										
Count	9[a]	0[b]	9	9	9	9	9	9	9	9
Mean	--	N/A	2.03	1.04	1.09	0.31	1.07	0.00	0.00	0.20
Std Dev	--	N/A	1.57	0.32	0.68	0.87	1.14	0.00	0.00	0.60
Min	--	N/A	0.26	0.64	0.00	0.00	0.00	0.00	0.00	0.00
Max	--	N/A	4.67	1.55	1.79	2.64	2.80	0.00	0.00	1.81
FY2012										
Count	31[a]	28[b]	31	31	31	31	31	31	31	31
Mean	--	0.0115	2.30	0.93	1.07	0.16	0.73	0.00	0.00	0.15
Std Dev	--	0.0059	1.28	0.29	0.74	0.51	0.92	0.00	0.00	0.58
Min	--	0.0010	0.56	0.45	0.00	0.00	0.00	0.00	0.00	0.00
Max	--	0.0241	5.68	1.54	3.18	2.06	2.67	0.00	0.00	2.40
FY2013										
Count	32[a,c]	31	31	31	31	31	31	31	31	31
Mean	--	0.0131	2.10	1.21	0.93	0.06	0.89	0.00	0.25	0.05
Std Dev	--	0.0084	1.05	0.37	0.73	0.35	1.15	0.00	1.40	0.30
Min	--	0.0008	0.79	0.35	0.00	0.00	0.00	0.00	0.00	0.00
Max	--	0.0290	5.42	1.92	2.23	1.95	3.80	0.00	7.79	1.66

[a] Includes duplicate samples in sample counts for all measurements.
[b] Sample weights were not determined for some or all filters (N/A).
[c] One sample was not obtained during FY2013 because of equipment failure during the sample interval.

Table 3. Radioactive chemical analyses of P-57-2 airborne particulate filter samples per Federal Fiscal Year.

Station P-57-2										
	Sample Intervals	**Sample Weight g**	**Gross Alpha Final mCi/mL 10^{-15}**	**Gross Beta Final mCi/mL 10^{-14}**	**Be-7 Final µCi/ml 10^{-13}**	**K-40 Final µCi/ml 10^{-14}**	**Pb-210 Final µCi/ml 10^{-14}**	**Pb-212 Final µCi/ml 10^{-13}**	**Bi-214 Final µCi/ml 10^{-13}**	**Pa-234m -- µCi/ml 10^{-14}**
FY2012										
Count	24[a]	24	24	24	24	24	24	24	24	24
Mean	--	0.0124	2.49	0.95	1.09	1.40	0.71	0.00	0.28	0.06
Std Dev	--	0.0072	1.23	0.27	0.74	6.25	0.97	0.00	1.38	0.28
Min	--	0.0007	0.56	0.54	0.00	0.00	0.00	0.00	0.00	0.00
Max	--	0.0264	5.38	1.44	3.37	30.60	2.40	0.00	6.77	1.38
FY2013										
Count	32[a,b]	30	30	30	30	30	30	30	30	30
Mean	--	0.0122	1.77	1.02	0.73	0.08	0.86	0.00	0.13	0.00
Std Dev	--	0.0080	1.19	0.41	0.58	0.30	1.07	0.00	0.68	0.00
Min	--	0.0023	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	--	0.0290	5.59	2.06	1.95	1.36	3.81	0.00	3.75	0.00

[a] Includes duplicate samples in sample counts for all measurements.
[b] Two samples were not obtained during FY2013 because of equipment failure during the sample intervals.

REFERENCES

Friesen, H.N., 1992. Summary of the Nevada Applied Ecology Group and Correlative Programs. DOE/NV-357. Prepared for the U.S. Department of Energy, Nevada Operations Office. Las Vegas, NV.

Misra, M., C. Neve, and A. Raichur, 1993. Characterization and Physical Separation of Radionuclides from Contaminated Soils. Proceedings of the Soil Decon '93: Technology Targeting Radionuclides and Heavy Metals, Gatlinburg, TN, ORNL-6769, Oak Ridge National Laboratory, Oak Ridge, TN.

Murarik, T.M., T.K. Wenstrang, and L.A. Rogers, 1992. Characterization Studies and Indicated Remediation Methods for Plutonium Contaminated Soils at the Nevada Test Site. Spectrum 1992: Nuclear and Hazardous Waste Management, Boise, Idaho.

Tamura, T., 1985. Characterization of Plutonium in Surface Soils, Area 13 of the Nevada Test Site. *The Radioecology of Plutonium and Transuranics in Desert Environments*, HVO, 153, 1973.

APPENDIX A

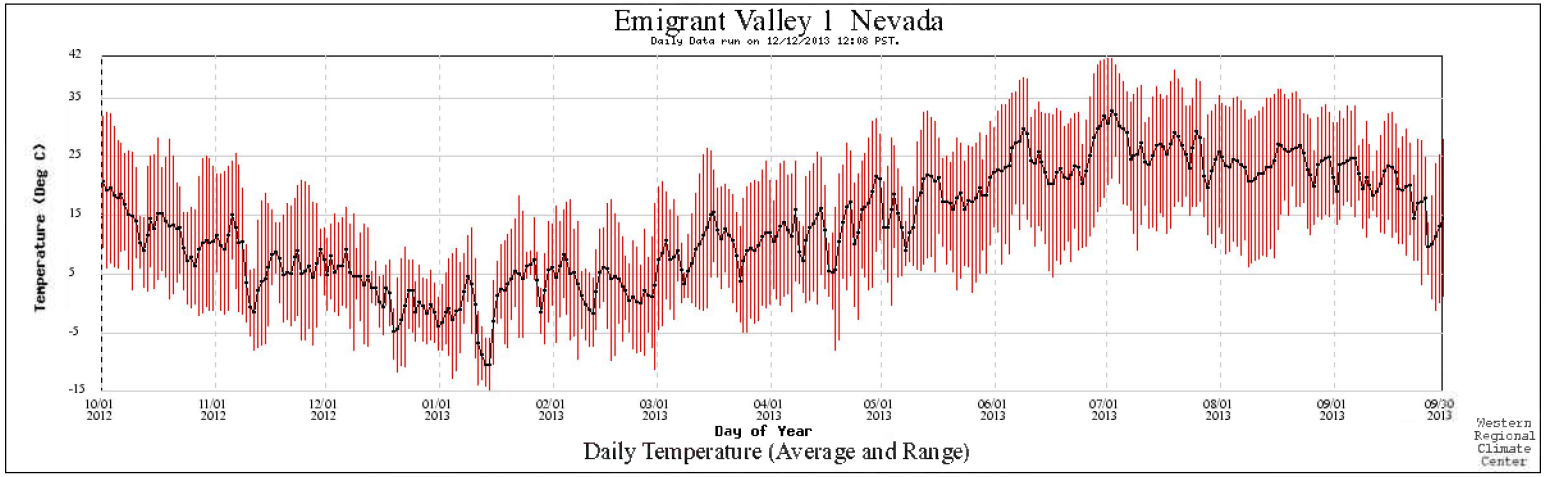

Figure A1. Daily maximum, minimum (range), and average air temperature at P-57-1.

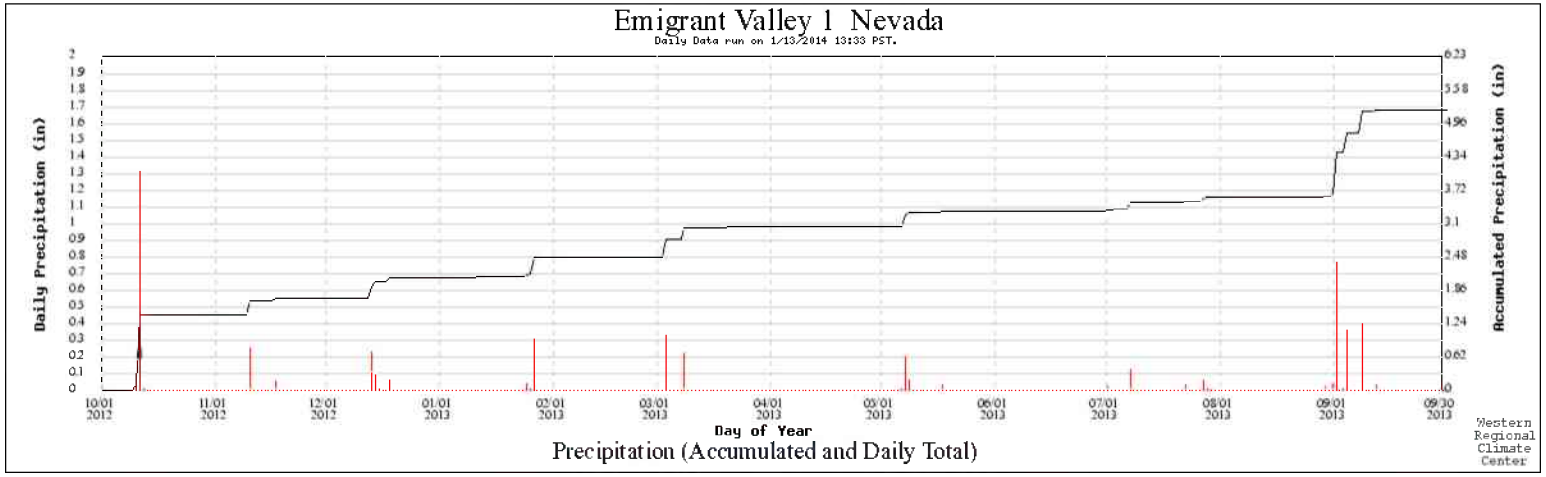

Figure A2. Annual accumulated and daily total precipitation at P-57-1.

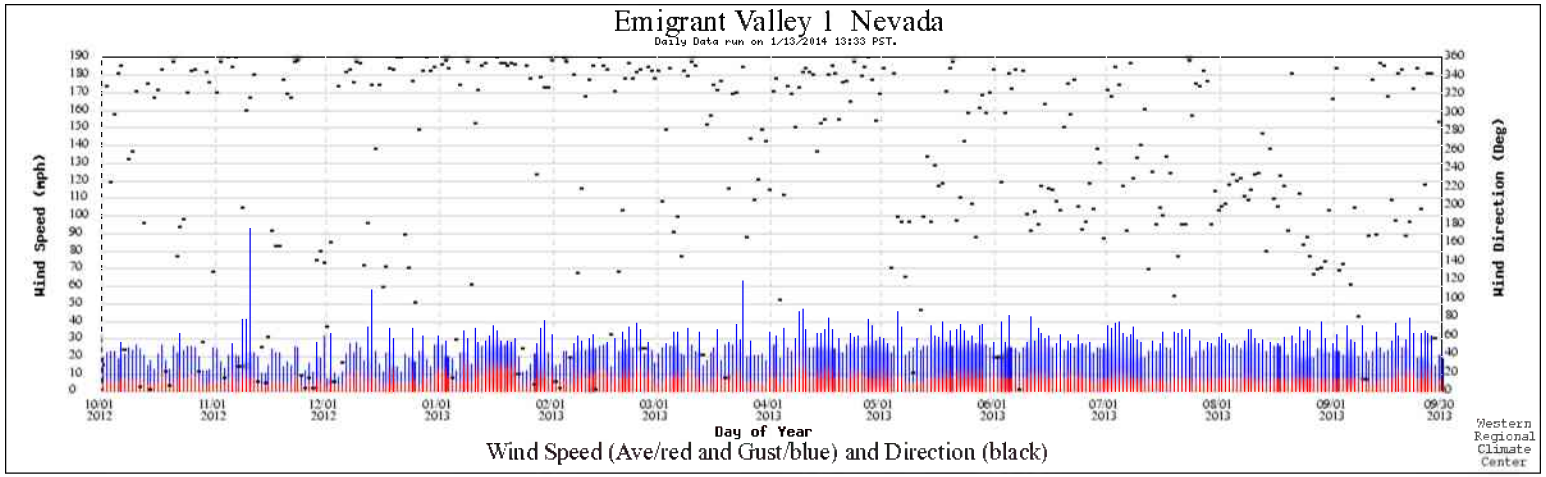

Figure A3. Daily average and maximum wind speed at P-57-1.

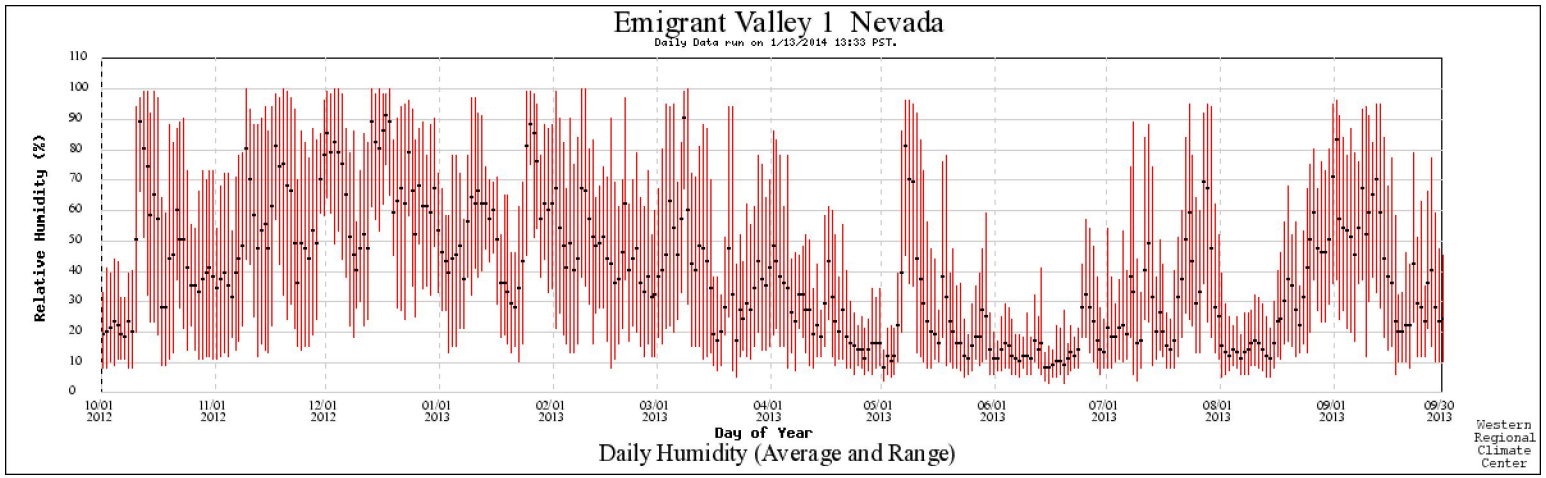

Figure A4. Daily maximum, minimum (range), and average relative humidity at P-57-1.

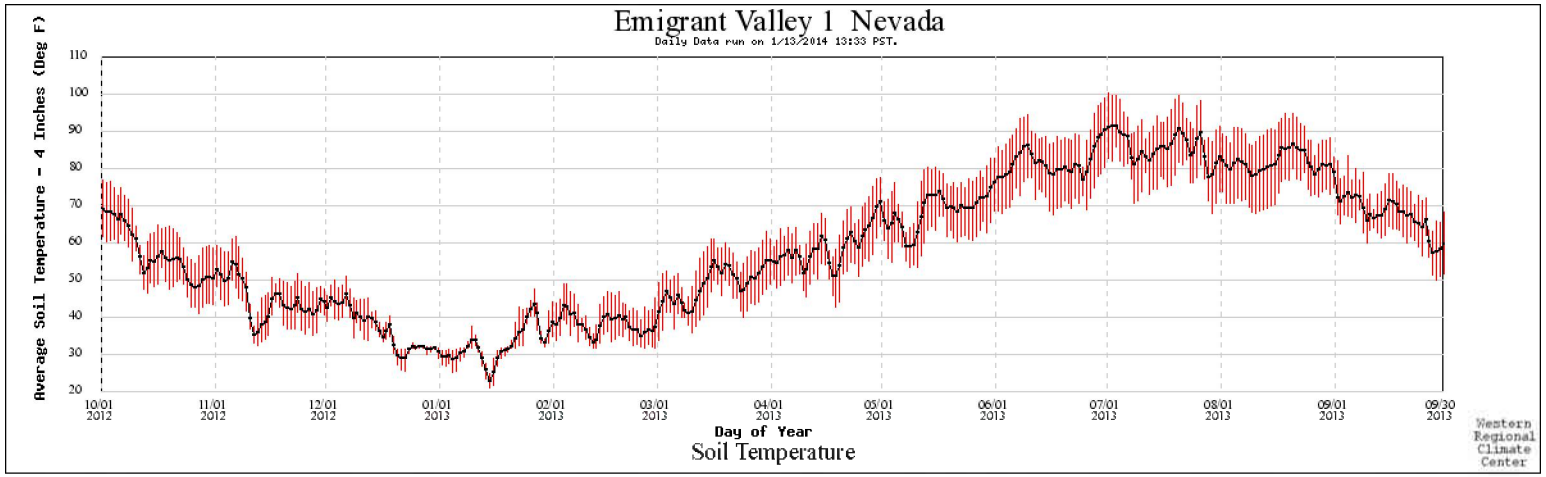

Figure A5. Daily maximum, minimum (range), and average soil temperature at P-57-1.

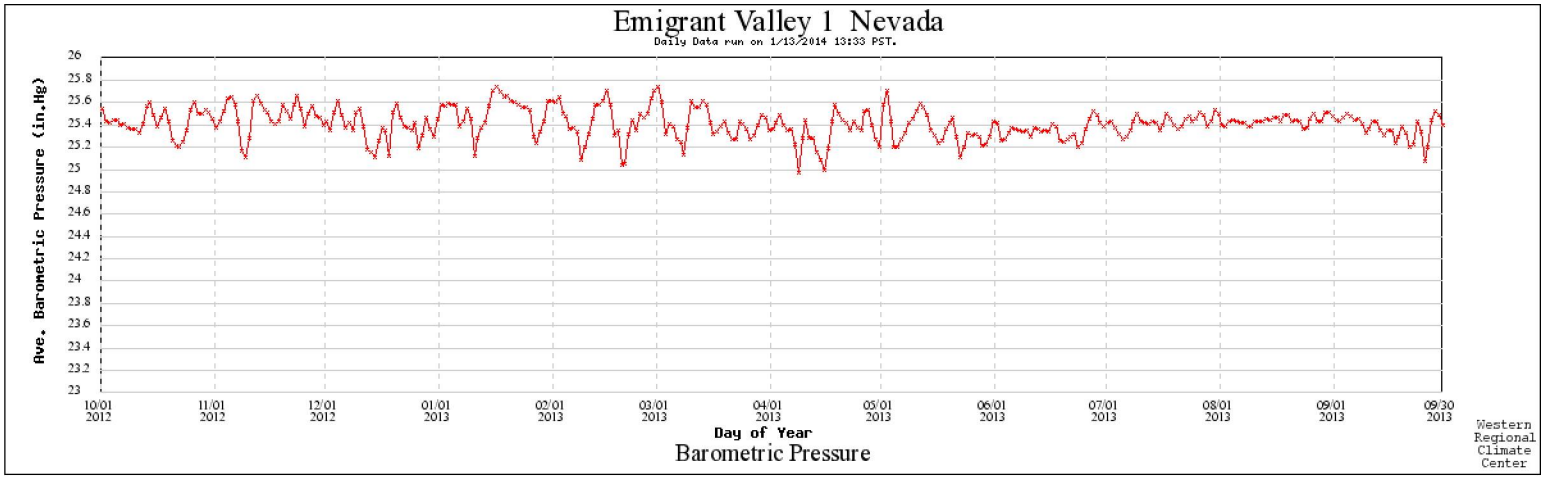

Figure A6. Daily average barometric pressure at P-57-1.

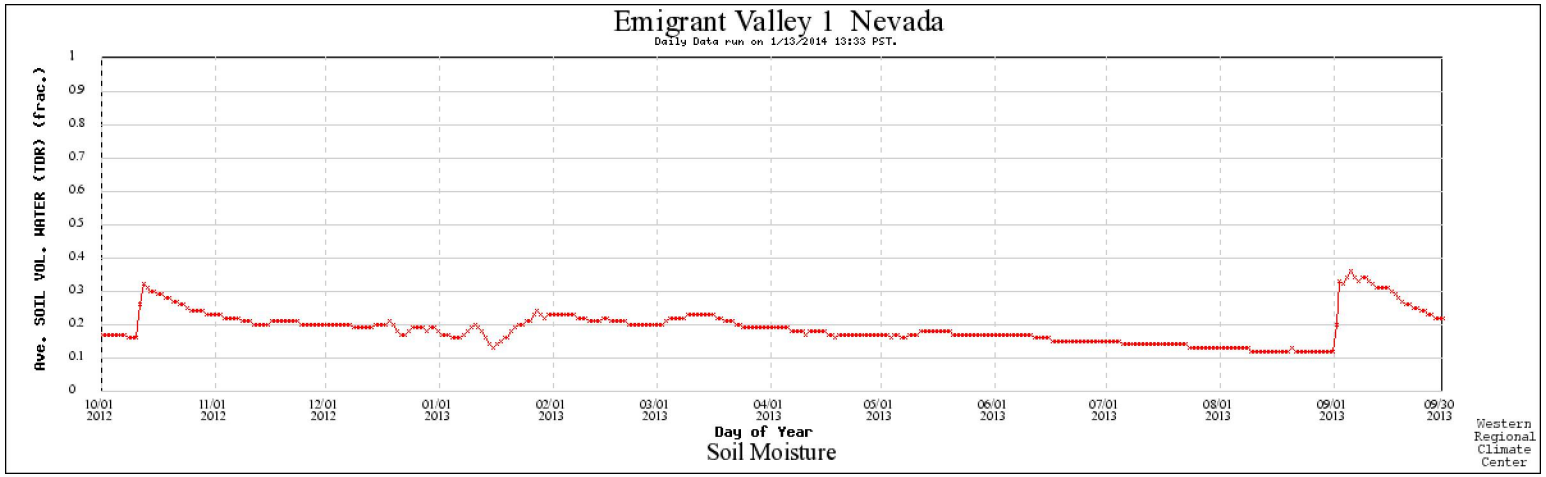

Figure A7. Daily average soil moisture (volumetric water content [fraction]) at P-57-1.

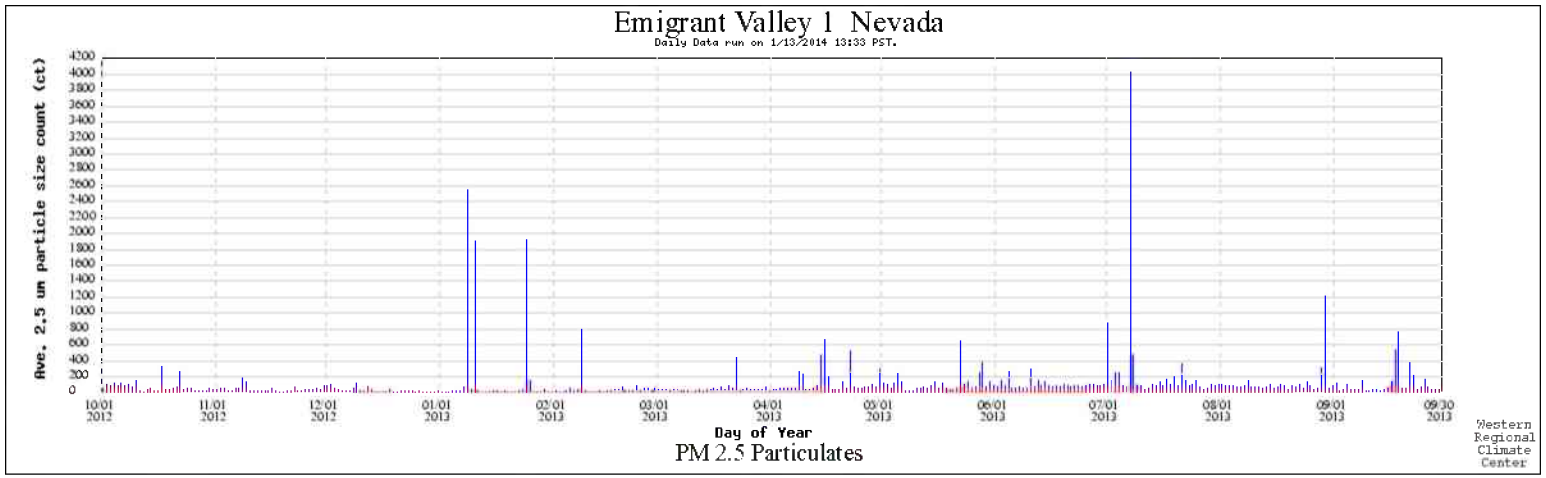

Figure A8. Daily average and maximum $PM_{2.5}$ counts at P-57-1.

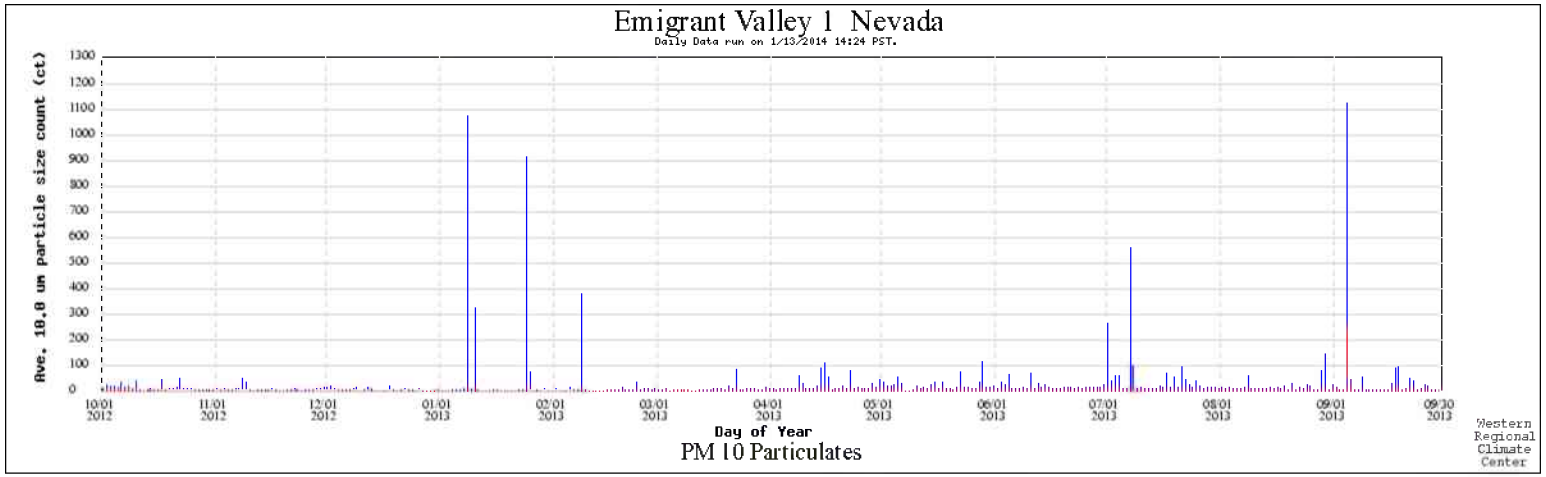

Figure A9. Daily average and maximum PM_{10} counts at P-57-1.

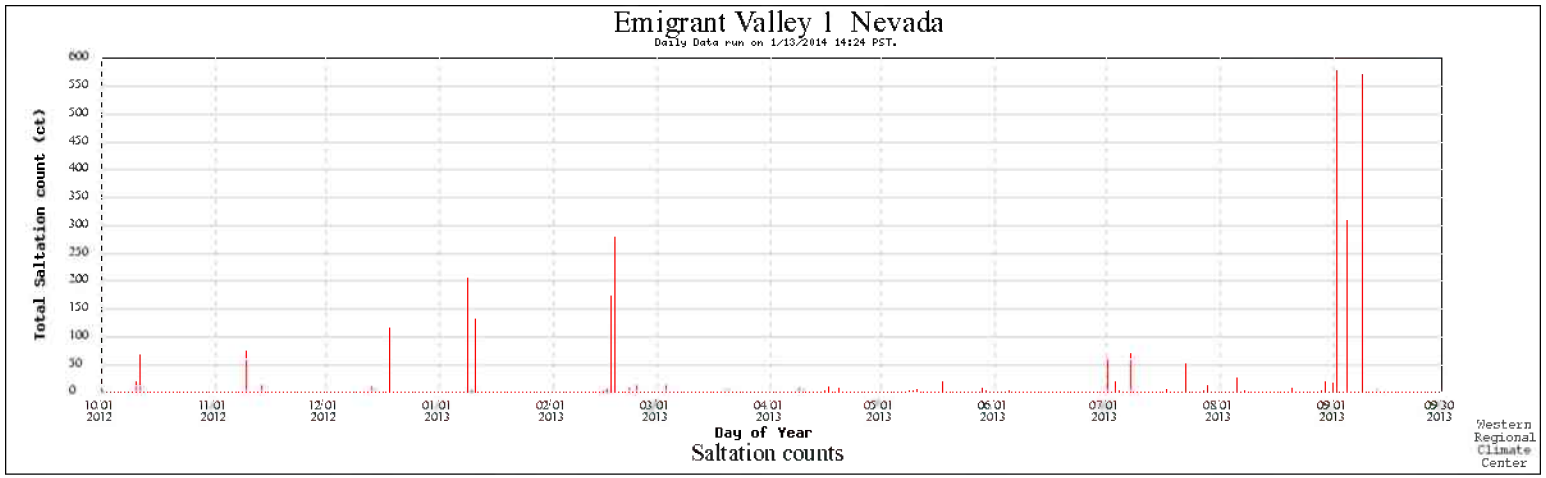

Figure A10. Daily saltation counts at P-57-1.

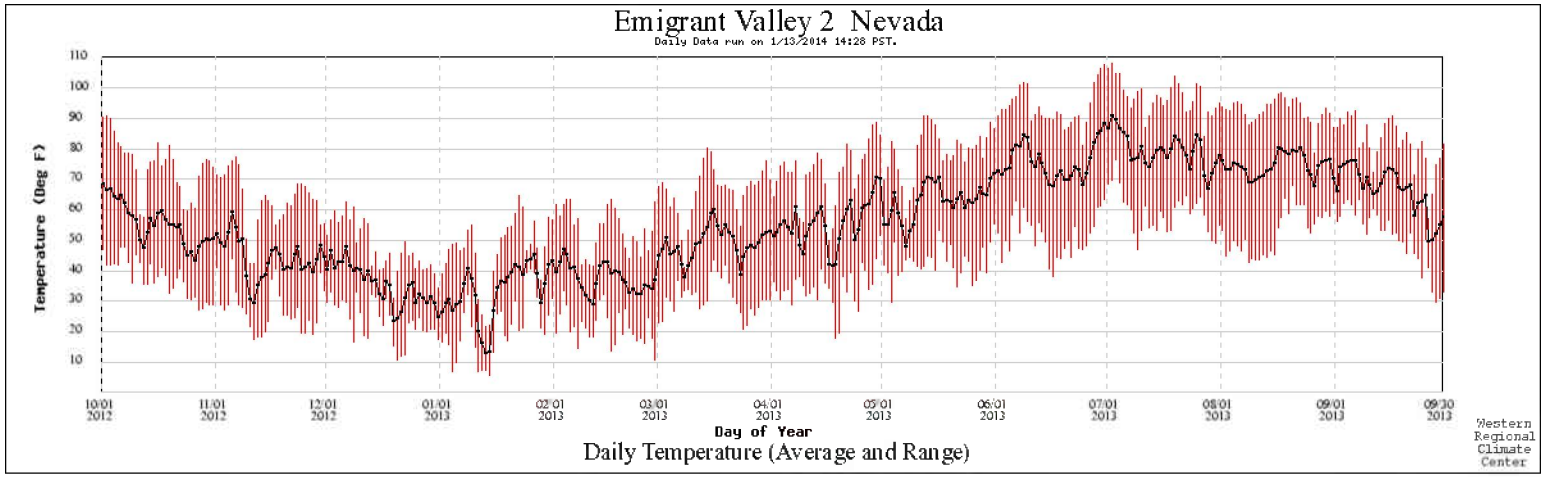

Figure A11. Daily maximum, minimum (range), and average air temperature at P-57-2.

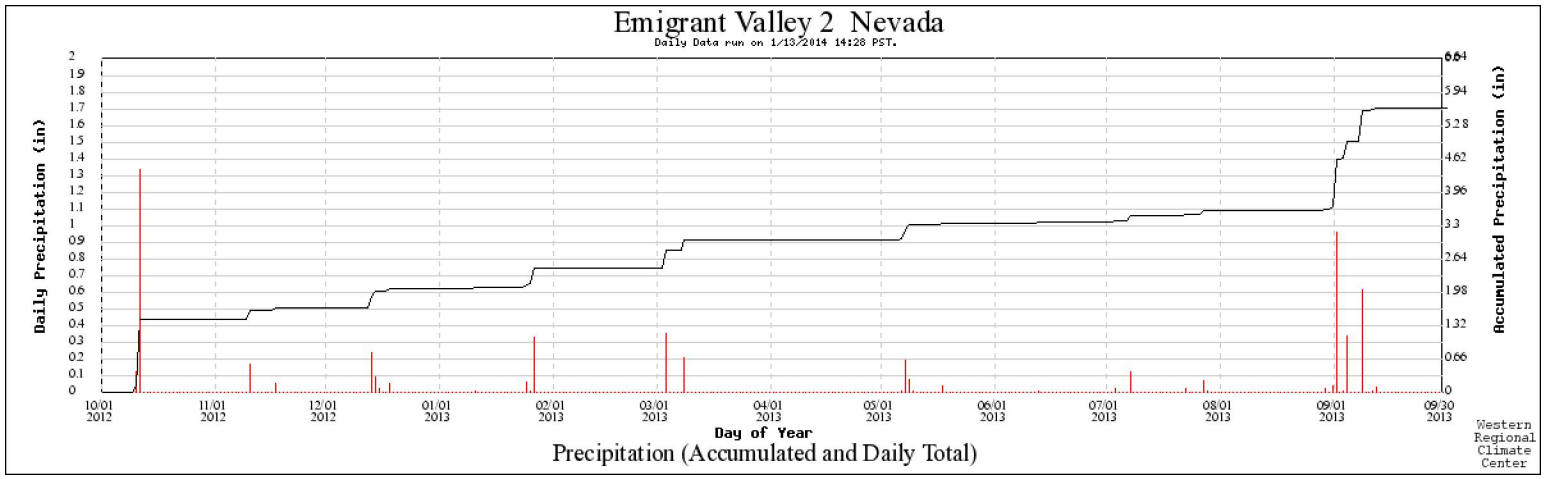

Figure A12. Annual accumulated and daily total precipitation at P-57-2.

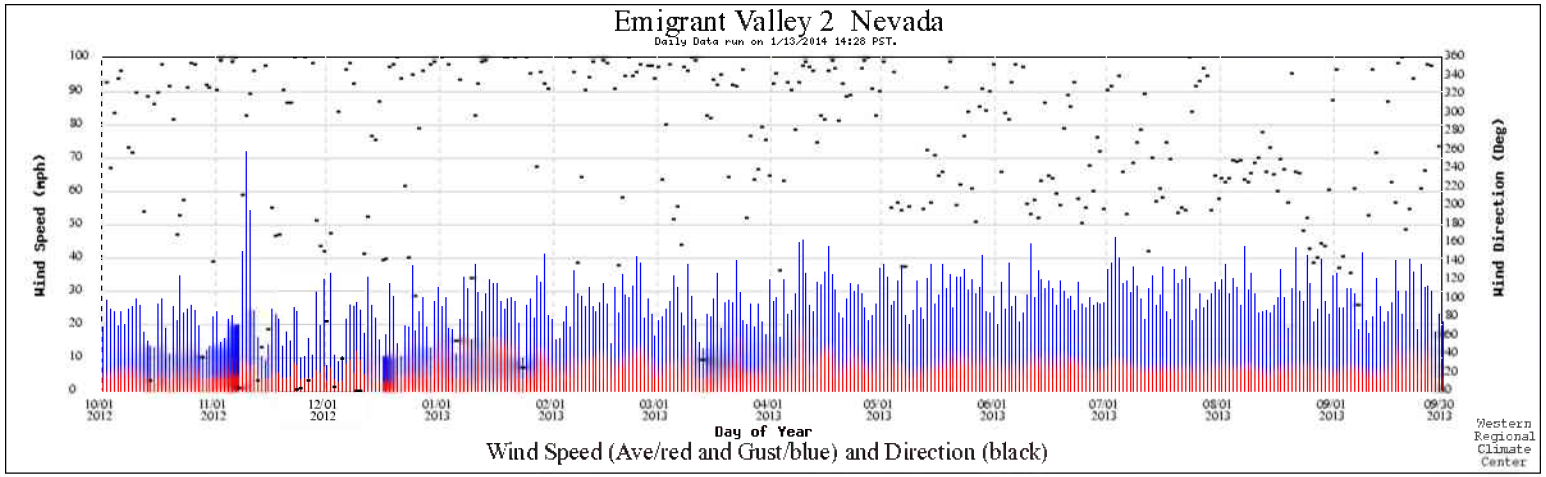

Figure A13. Daily average and maximum wind speed at P-57-2.

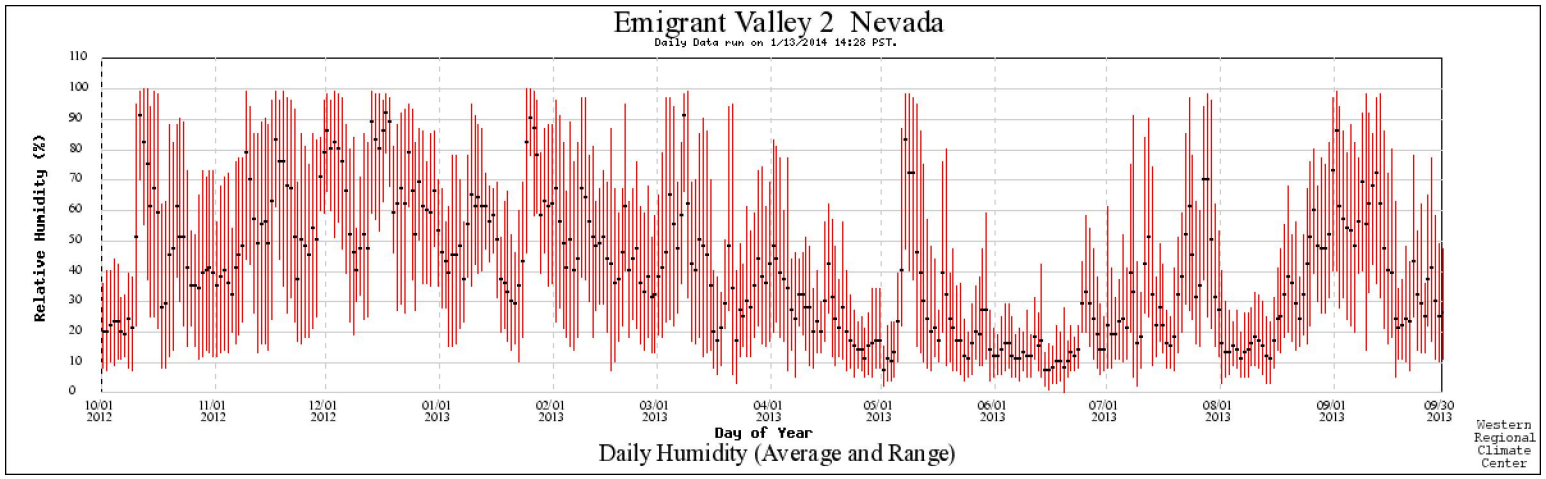

Figure A14. Daily maximum, minimum (range), and average relative humidity at P-57-2.

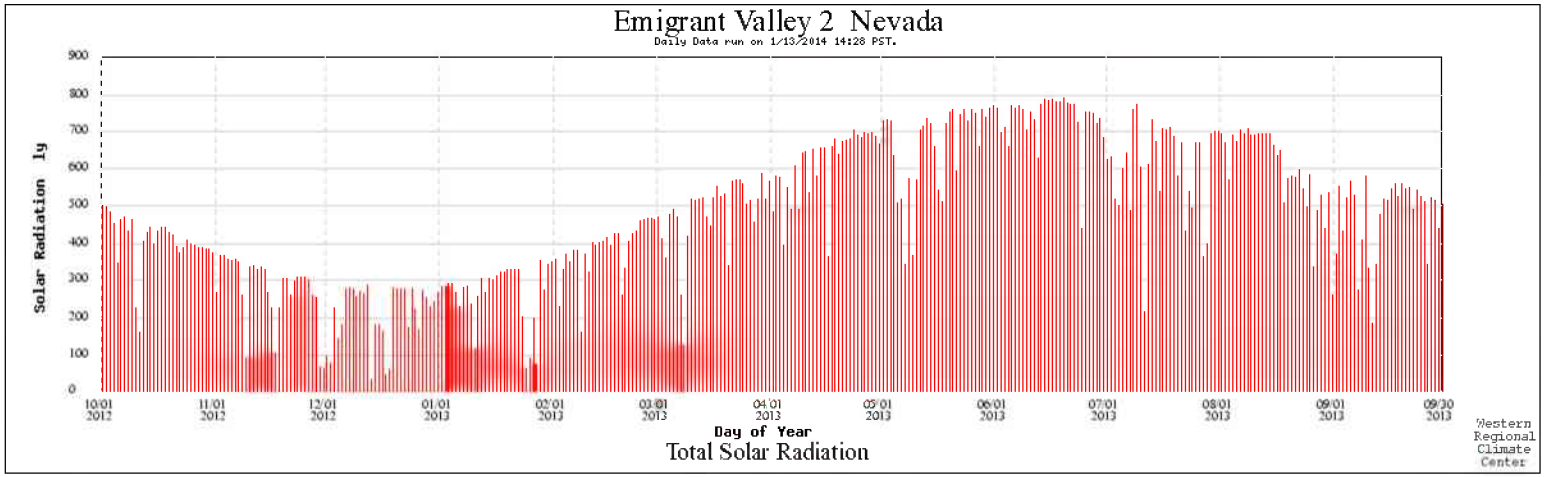

Figure A15. Daily total solar radiation at P-57-2.

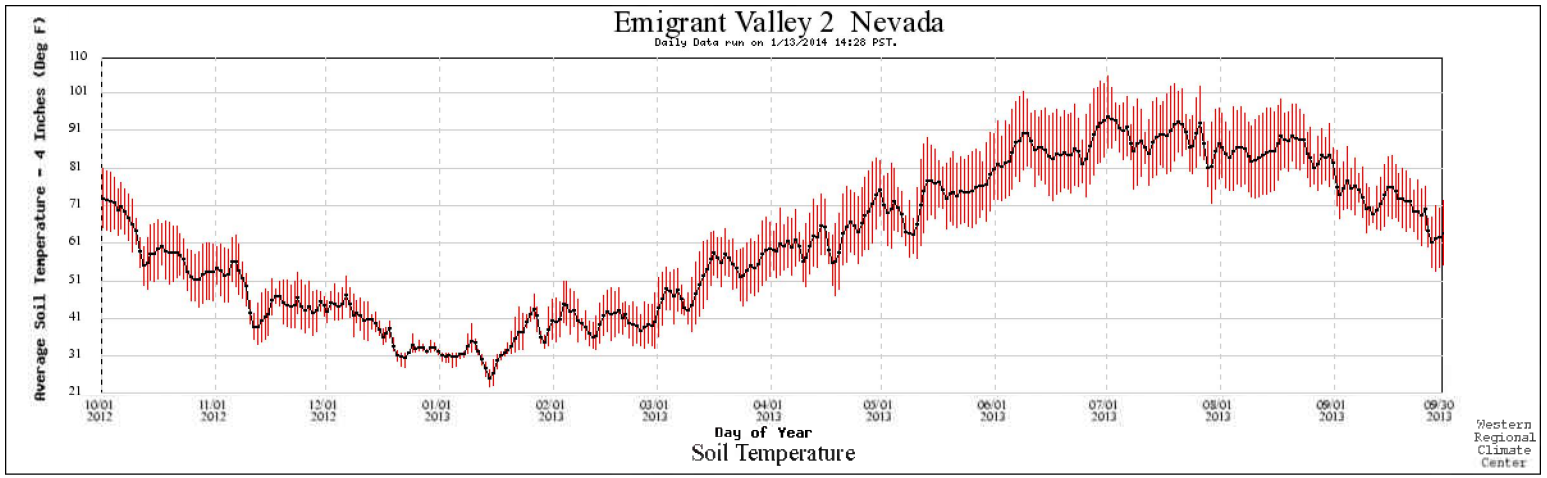

Figure A16. Daily maximum, minimum (range), and average soil temperature at P-57-2.

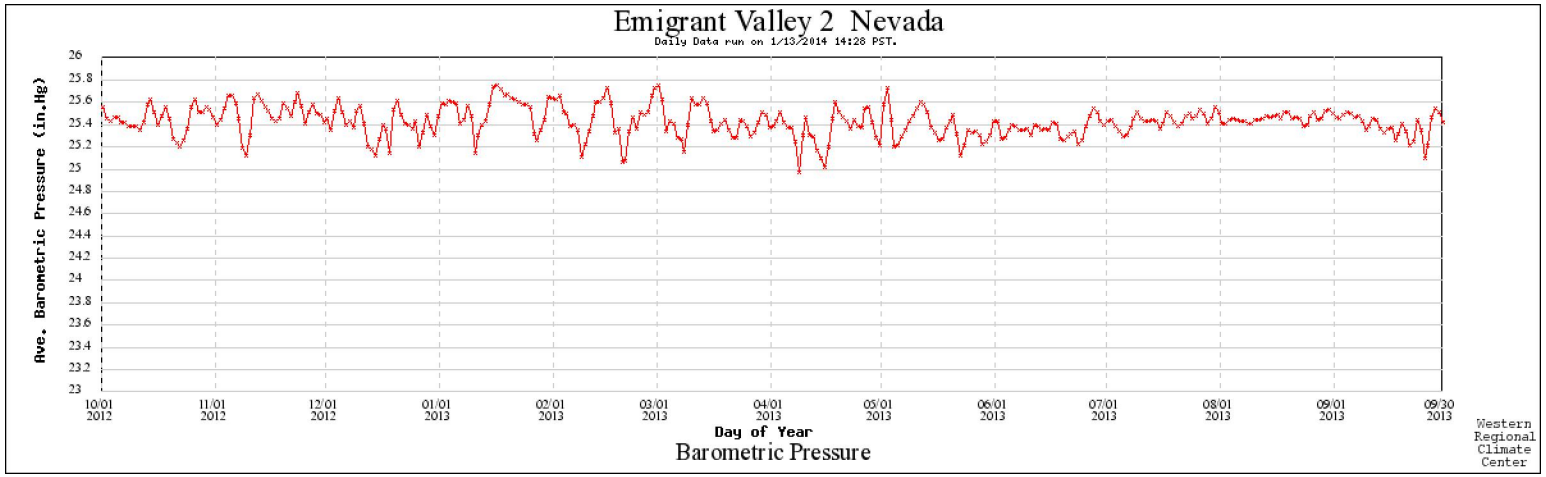

Figure A17. Daily average barometric pressure at P-57-2.

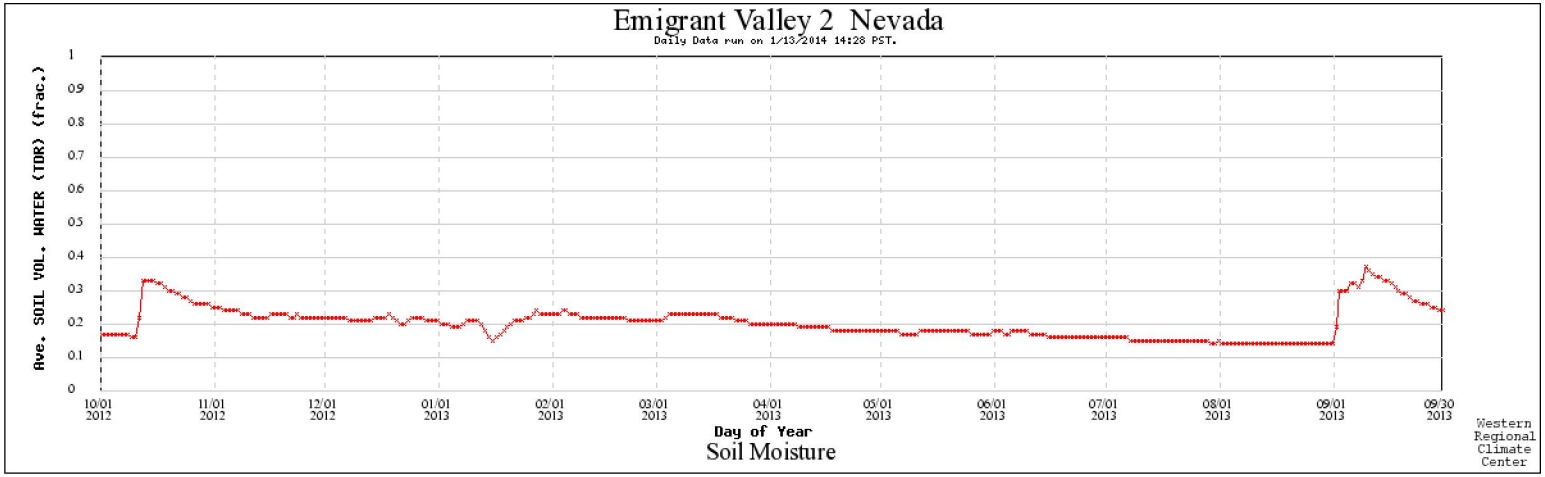

Figure A18. Daily average soil moisture (volumetric water content [fraction]) at P-57-2.

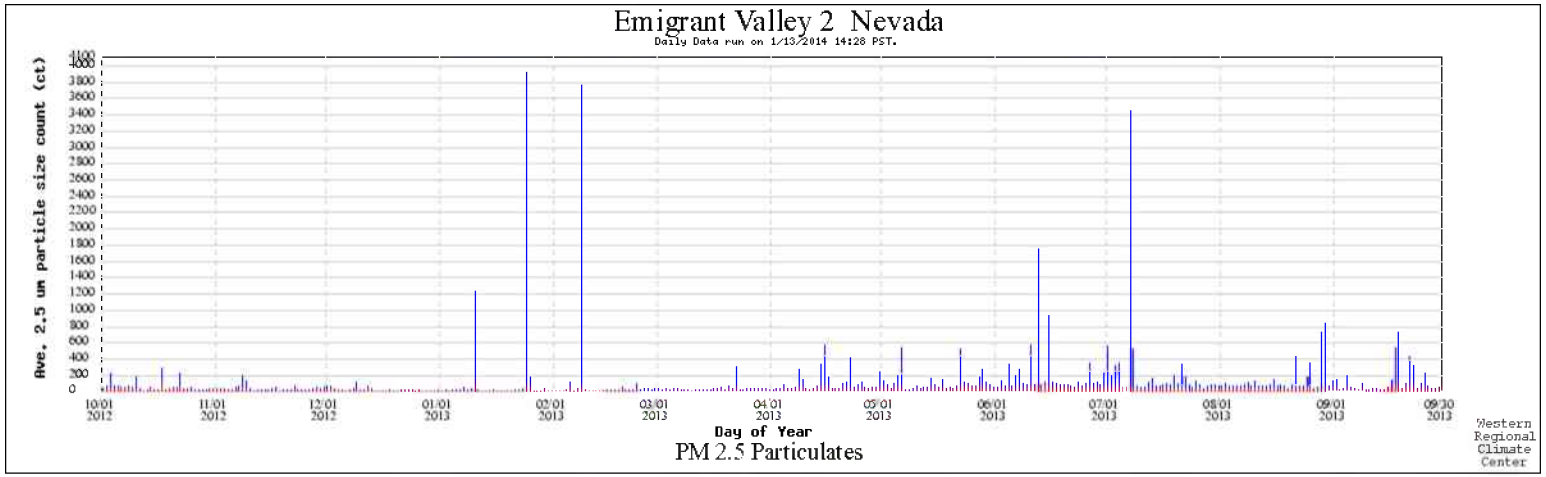

Figure A19. Daily average and maximum $PM_{2.5}$ counts at P-57-2.

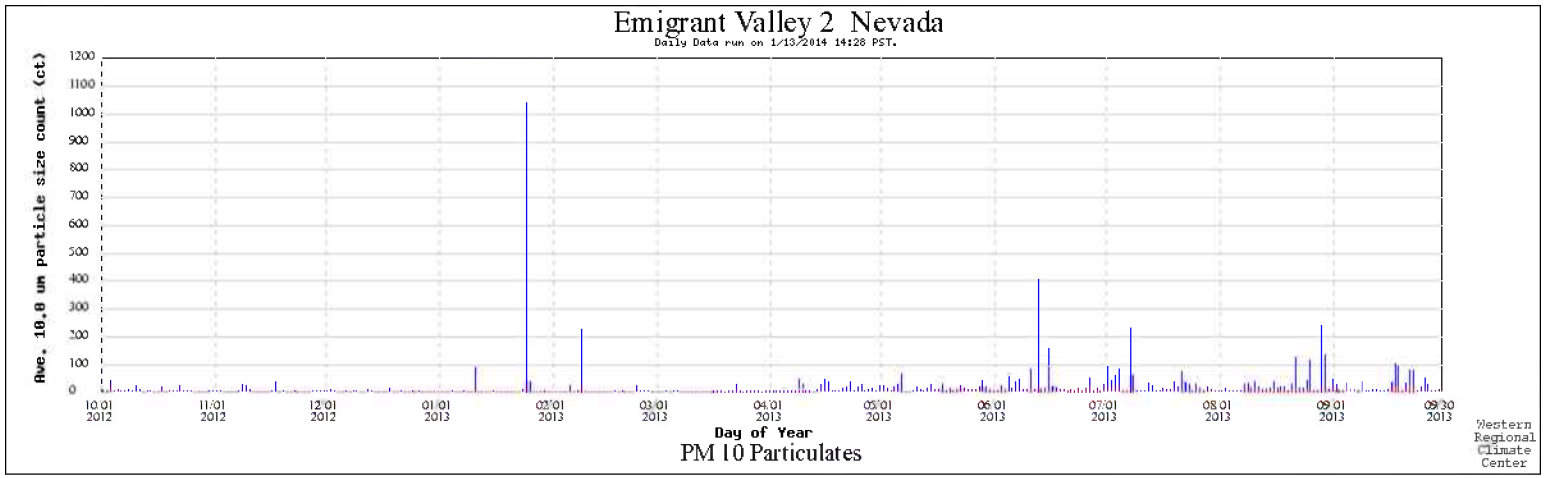

Figure A20. Daily average and maximum PM_{10} counts at P-57-2.

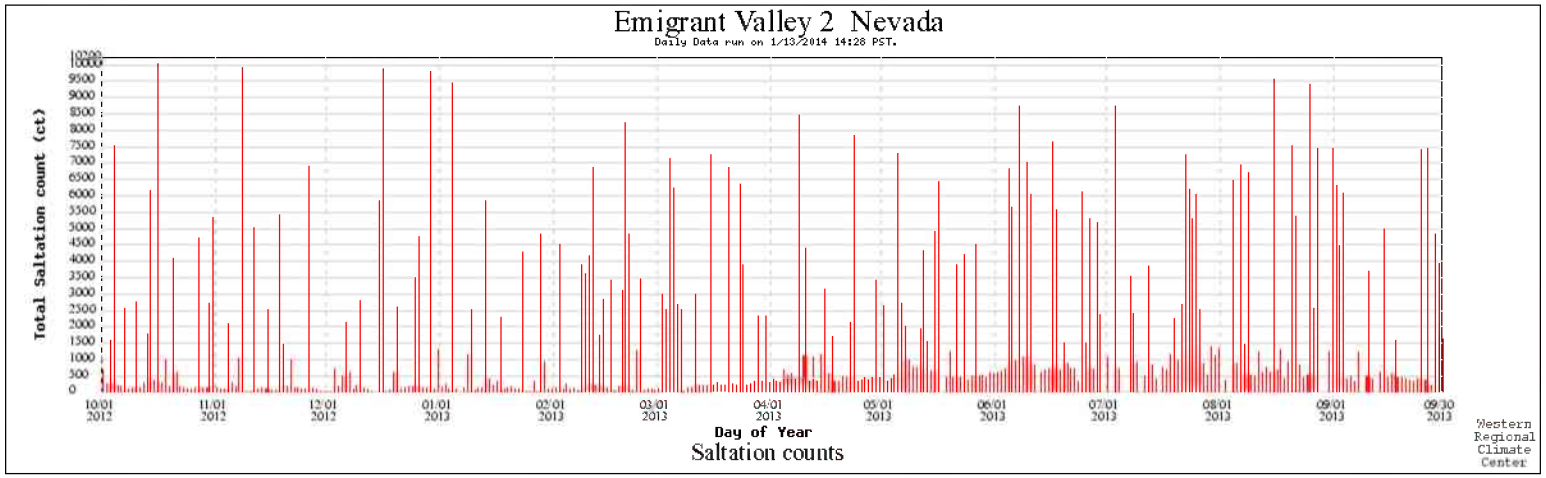

Figure A21. Daily saltation counts at P-57-2.

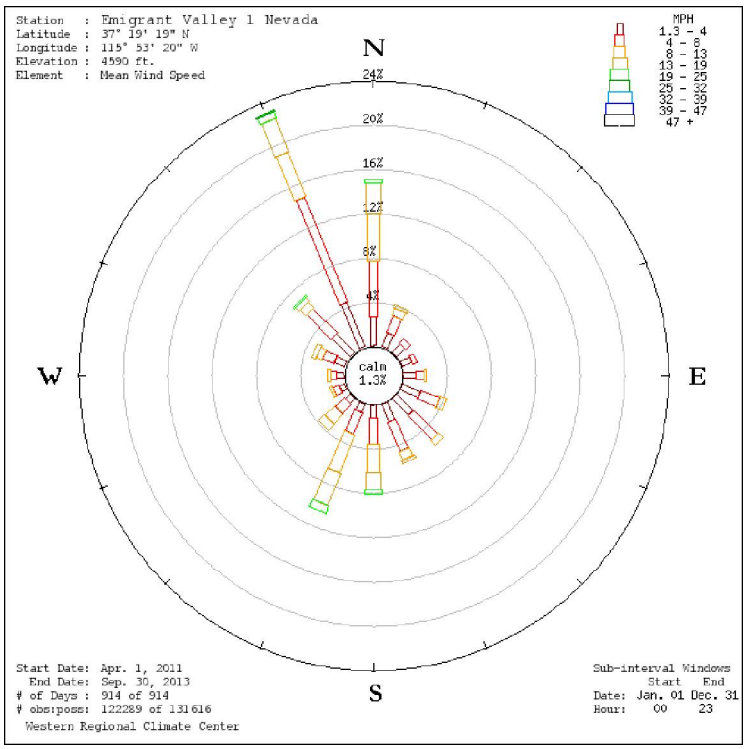

Figure A22. Wind rose: period of record, P-57-1.

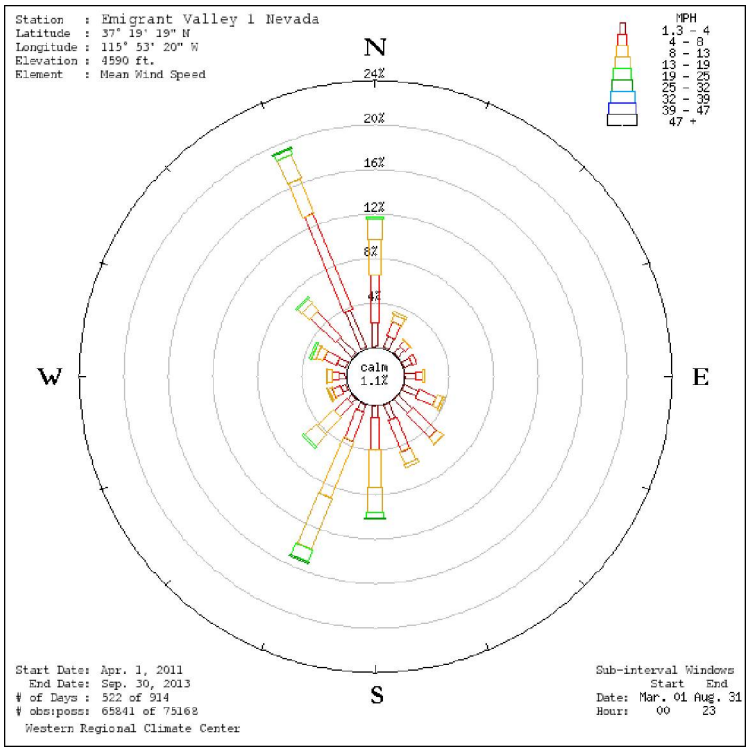

Figure A23. Wind rose: March 1, 2012 to September 1, 2012 (summer season), P-57-1.

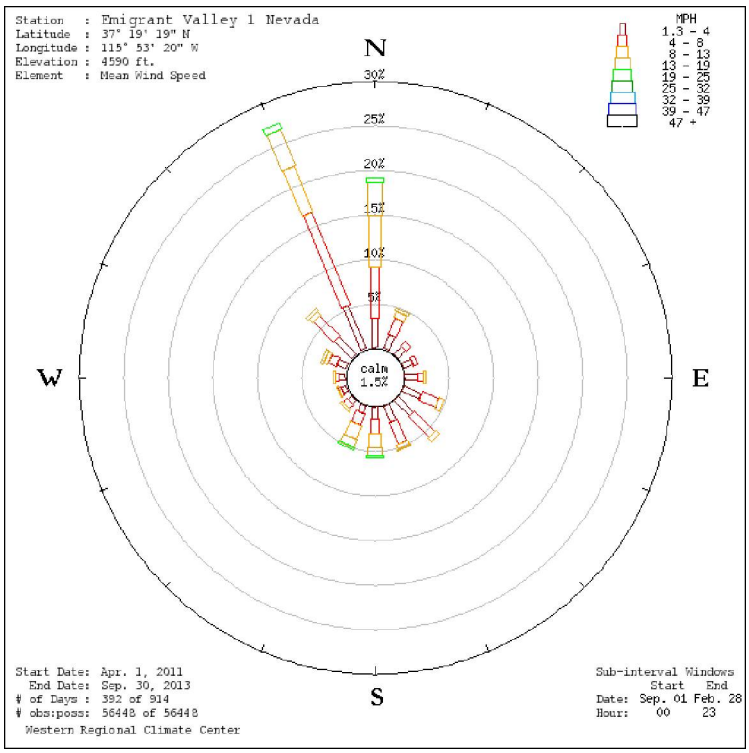

Figure A24. Wind rose: September 1, 2012 to March 1, 2013 (winter season), P-57-1.

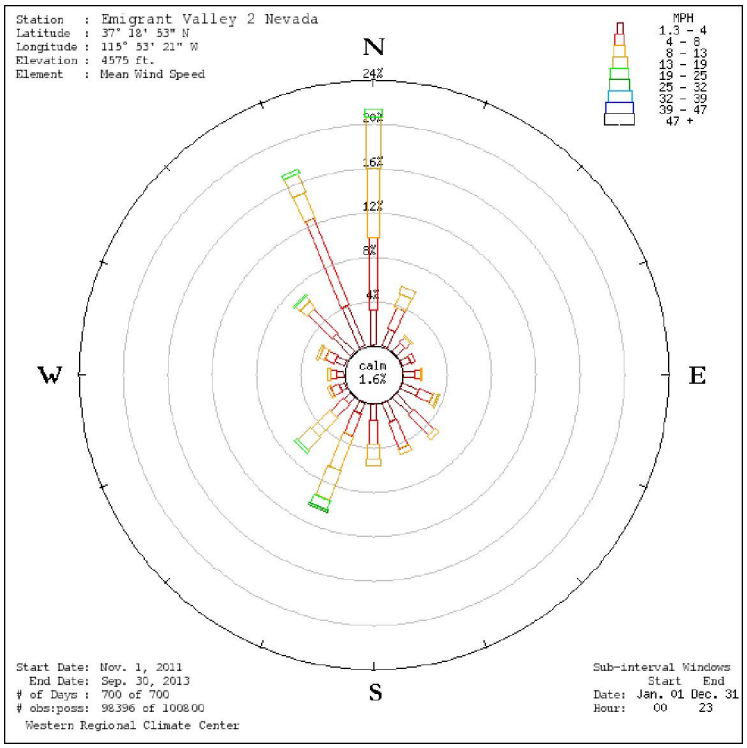

Figure A25. Wind rose: period of record, P-57-2.

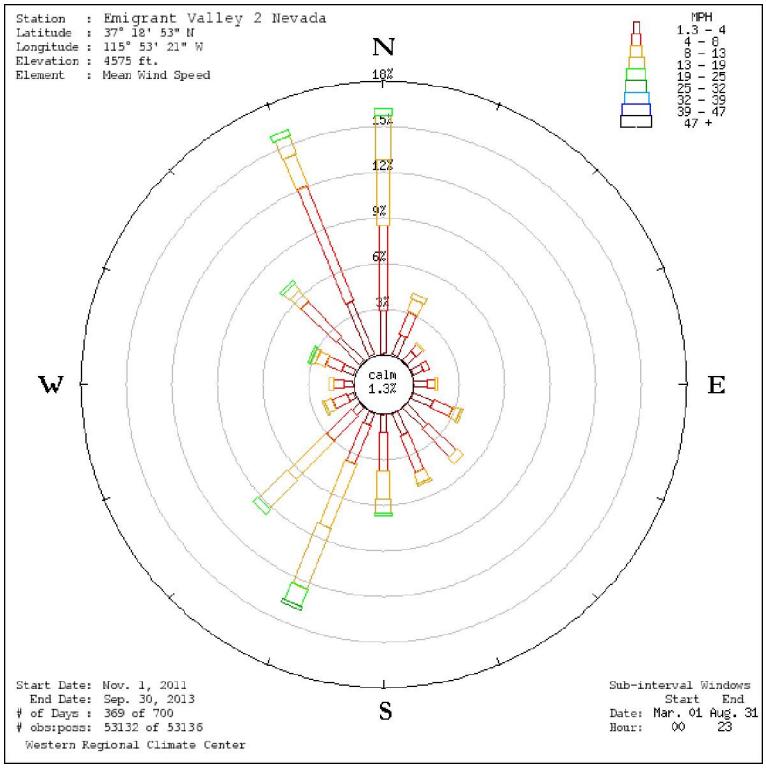

Figure A26. Wind rose: March 1, 2012 to September 1, 2012 (summer season), P-57-2.

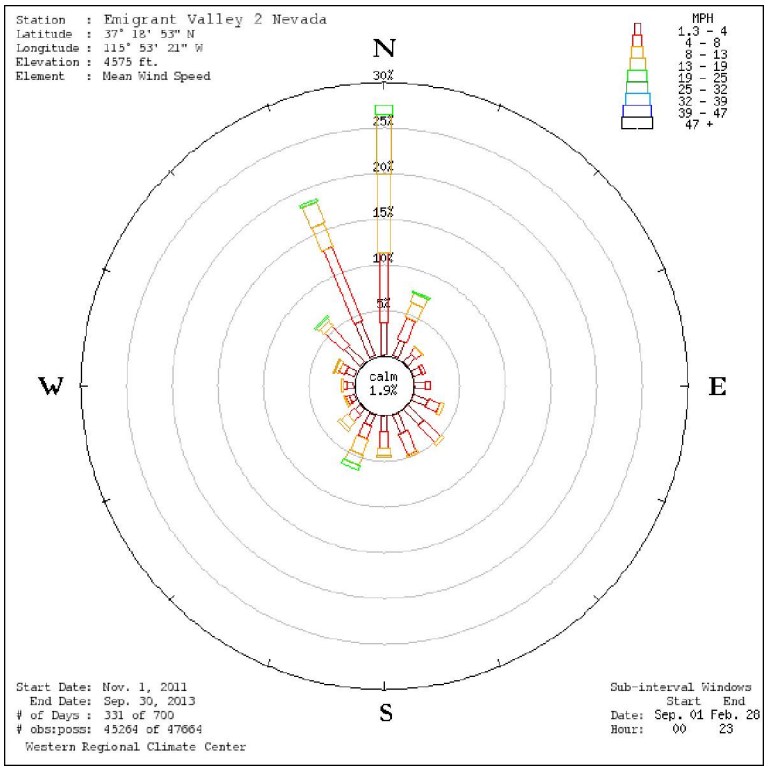

Figure A27. Wind rose: September 1, 2012 to March 1, 2013 (winter season), P-57-2.

STANDING DISTRIBUTION LIST

Scott A. Wade
Assistant Manager for Environmental Mgmt
Nevada Field Office
National Nuclear Security Administration
U.S. Department of Energy
P.O. Box 98518
Las Vegas, NV 89193-8518
Scott.Wade@nnsa.doe.gov

Robert Boehlecke
Nevada Field Office
National Nuclear Security Administration
U.S. Department of Energy
P.O. Box 98518
Las Vegas, NV 89193-8518
Robert.Boehlecke@nnsa.doe.gov

Tiffany Lantow
Nevada Field Office
National Nuclear Security Administration
U.S. Department of Energy
P.O. Box 98518
Las Vegas, NV 89193-8518
Tiffany.Lantow@nnsa.doe.gov

Kathryn Knapp
Nevada Field Office
National Nuclear Security Administration
U.S. Department of Energy
P.O. Box 98518
Las Vegas, NV 89193-8518
Kathryn.Knapp@nnsa.doe.gov

Reina Serino, Contracting Officer
Office of Acquisition Management
NNSA Service Center
Pennsylvania and H Street, Bldg. 20388
P.O. Box 5400
Albuquerque, NM 87185-5400
Reina.Serino@nnsa.doe.gov

Jenny Chapman
DOE Program Manager
Division of Hydrologic Sciences
Desert Research Institute
755 E. Flamingo Road
Las Vegas, NV 89119-7363
Jenny.Chapman@dri.edu

Julianne Miller
DOE Soils Activity Manager
Division of Hydrologic Sciences
Desert Research Institute
755 E. Flamingo Road
Las Vegas, NV 89119-7363
Julie.Miller@dri.edu

Pat Matthews
Navarro-Intera, LLC
P.O. Box 98952
M/S NSF167
Las Vegas, NV 89193-8952
Patrick.Matthews@nv.doe.gov

Reed Poderis
National Security Technologies, LLC
P.O. Box 98521
M/S NLV082
Las Vegas, NV 89193-8521
poderirj@nv.doe.gov

*Nevada State Library and Archives
State Publications
100 North Stewart Street
Carson City, NV 89701-4285

Archives Getchell Library
University of Nevada, Reno
1664 N. Virginia St.
Reno, NV 89557
dcurtis@unr.edu

DeLaMare Library
262
University of Nevada, Reno
1664 N. Virginia St.
Reno, NV 89557
dcurtis@unr.edu

Document Section, Library
University of Nevada, Las Vegas
4505 Maryland Parkway
Las Vegas, NV 89154
sue.wainscott@unlv.edu

†Library
Southern Nevada Science Center
Desert Research Institute
755 E. Flamingo Road
Las Vegas, NV 89119-7363

‡Nuclear Testing Archive
ATTN: Martha DeMarre
National Security Technologies, LLC
Mail Stop 400
PO Box 98521
Las Vegas, NV 89193-8521
(2 CDs)

ʃOffice of Scientific and Technical Information
U.S. Department of Energy
P.O. Box 62
Oak Ridge, TN 37831-9939

All on distribution list receive one electronic PDF copy, unless otherwise noted.

---

* 12 paper copies
† 3 paper copies; CD with pdf (from which to print)
‡ compact disc only
ʃ electronic copy (pdf) only