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Letter Report
Environmental Monitoring Systems Initiative

Twelve Months of Air Quality Monitoring at Ash Meadows National Wildlife Refuge, Southwestern Rural Nevada, U.S.A.

prepared by

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EXECUTIVE SUMMARY

The one year of air quality monitoring data collected at the Ash Meadows National Wildlife Refuge (NWR) was the final part of the air quality "Scoping Studies" for the Environmental Monitoring Systems Initiative (EMSI) in southern and central Nevada. The objective of monitoring at Ash Meadows was to examine aerosol and meteorological data, seasonal trends in aerosol and meteorological parameters as well as to examine evidence for long distance transport of some constituents.

The 9,307 hectare refuge supports more than 50 springs and 24 endemic species, including the only population of the federally listed endangered Devil's Hole pupfish (*Cyprinodon diabolis*) (U.S. Fish and Wildlife Service, 1990). Ash Meadows NWR is located in a Class II air quality area, and the aerosol measurements collected with this study are compared to those of Interagency Monitoring of Protected Visual Environments (IMPROVE) sites. Measurements taken at Ash Meadows NWR over a period of 12 months provide new baseline air quality and meteorological information for rural southwestern Nevada, specifically Nye County and the Amargosa Valley.

All mass measurements fall well below the US EPA National Ambient Air Quality Standards (NAAQS) for PM_{10} (150 $\mu g/m^3$ for 24 hr averaging interval) and $PM_{2.5}$ (35 $\mu g/m^3$ for 24 hr averaging interval, 15 $\mu g/m^3$ for annual averaging interval). The averaged levels measured on Teflon® filters at Ash Meadows NWR for both PM_{10} (12 $\mu g/m^3$) and $PM_{2.5}$ (5 $\mu g/m^3$), are similar to those previously measured at four rural IMPROVE sites.

The mineral dust (soil) components, including the silicate oxides, minor oxides and gypsum, together make up the largest percentage of the aerosol, being on average 58% of PM_{10} by mass and 37% of $PM_{2.5}$ by mass, the difference being ascribed to the coarser nature of the soil forming minerals.

The highest concentrations of mineral dust components were measured during drier fall months of October and November, 2009. Although halite (NaCl) was found at all sites, the percentages were always very low, except for the filter samples collected on 10/04/2009. The anomalously high values of 8% halite for PM_{10} and 10% for $PM_{2.5}$ points to an evaporite (salt) source such as an alkaline playa dust. Playas are common in the region around Ash Meadows NWR.

Although secondary ammonium sulfate concentrations vary with season, they are similar for PM_{10} and $PM_{2.5}$, implying that this species occurs in the finer fraction. Average values for PM_{10} were 0.5 $\mu g/m^3$, and 0.7 $\mu g/m^3$ for $PM_{2.5}$, with the highest concentrations in spring, 2009 and the lowest in the following late fall and winter. Secondary ammonium sulfate is from SO_2 emitted by distant power plants and other combustion sources, and transported into the Amargosa Valley.

Secondary ammonium nitrate concentrations fluctuate by month, with both the lowest (0.08 $\mu g/m^3$ for PM_{10} and 0.03 $\mu g/m^3$ for $PM_{2.5}$) and highest (1.11 $\mu g/m^3$ for PM_{10} and 0.77 $\mu g/m^3$ for $PM_{2.5}$) measured values occurring in fall of 2009. Secondary nitrates form from nitrogen oxides emitted from vehicle emissions, possibly transported to Amargosa Valley from the Las Vegas - Los Angeles corridor.

Elemental carbon (EC) is generally very low (on average < 0.2 $\mu g/m^3$) except for the sample taken on 8/29/2009 when high values for EC of 1.20 $\mu g/m^3$ for PM_{10} and 1.04 $\mu g/m^3$ for $PM_{2.5}$ were measured. Similarly, OC remains low (on average < 1.8 $\mu g/m^3$) except for the sample taken on 8/29/2009 when high values for OC of 8.5 $\mu g/m^3$ for PM_{10} and 7.5 $\mu g/m^3$ for $PM_{2.5}$ were measured. These high carbon measurements in the last week of August, 2009 are ascribed to woodsmoke, transported from wildfires in California.

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INTRODUCTION

The one year of air quality monitoring data collected at the Ash Meadows National Wildlife Refuge (NWR) was the final part of the air quality "Scoping Studies" for the Environmental Monitoring Systems Initiative in southern and central Nevada. Results of six to nine week monitoring campaigns were previously published from eight sites in Nye and Lincoln counties, including an earlier collection phase at Ash Meadows NWR [Engelbrecht et al. 2007a]; Beatty [Engelbrecht et al. 2007b], Rachel [Engelbrecht et al. 2007c], Sarcobatus Flat [Engelbrecht et al. 2007d], Caliente [Engelbrecht et al. 2008a], Crater Flat [Engelbrecht et al. 2008b] Pahranagat NWR [Engelbrecht et al. 2008c] and Tonopah [Engelbrecht et al. 2008d]. In addition, unpublished data were collected from Lower Forty Mile Wash on the Nevada National Security Site. The objectives of monitoring at Ash Meadows were to examine aerosol and meteorological data, seasonal trends, as well as to examine evidence for long-distance transport of some constituents. The instrumented trailer was deployed at Ash Meadows from May 20, 2009 until June 4, 2010.

Ash Meadows NWR is in the Amargosa Valley in Nye County in southern Nevada (36^o25'N, 116^o20'W, 750 meter elevation), 145 kilometers (km) northwest of Las Vegas and approximately 65 km east of Death Valley National Park (Trammell et al., 2008) (Figure 1).

Located in the northern Mojave Desert, Ash Meadows NWR is a wetland complex created by a series of faults that force groundwater from the Death Valley Regional Flow System to the surface (Belcher, 2004). Based on a 10 year record from the a meteorological monitoring station in Amargosa Valley, the area average annual precipitation is 95 mm (3.74 inches), with the highest monthly averages occurring in January and February (Shafer and Hartwell, 2011). The warmest month is July with an average daily maximum temperature of 40.2 ^{o}C (104.3 °F). December, on average, is the coolest month, with average lows being just above freezing (0.2 ^{o}C or 32.3 °F). The 9,307 hectare refuge supports more than 50 springs and 24 endemic species, including the only population of the federally listed endangered Devil's Hole pupfish (*Cyprinodon diabolis*) (U.S. Fish and Wildlife Service, 1990). Ash Meadows NWR is designated a Class II air quality area, and particulate matter (PM) levels are compared to those at Interagency Monitoring of Protected Visual Environments (IMPROVE) (http://vista.cira.colostate.edu/IMPROVE/Overview/Overview.htm) sites in the region.

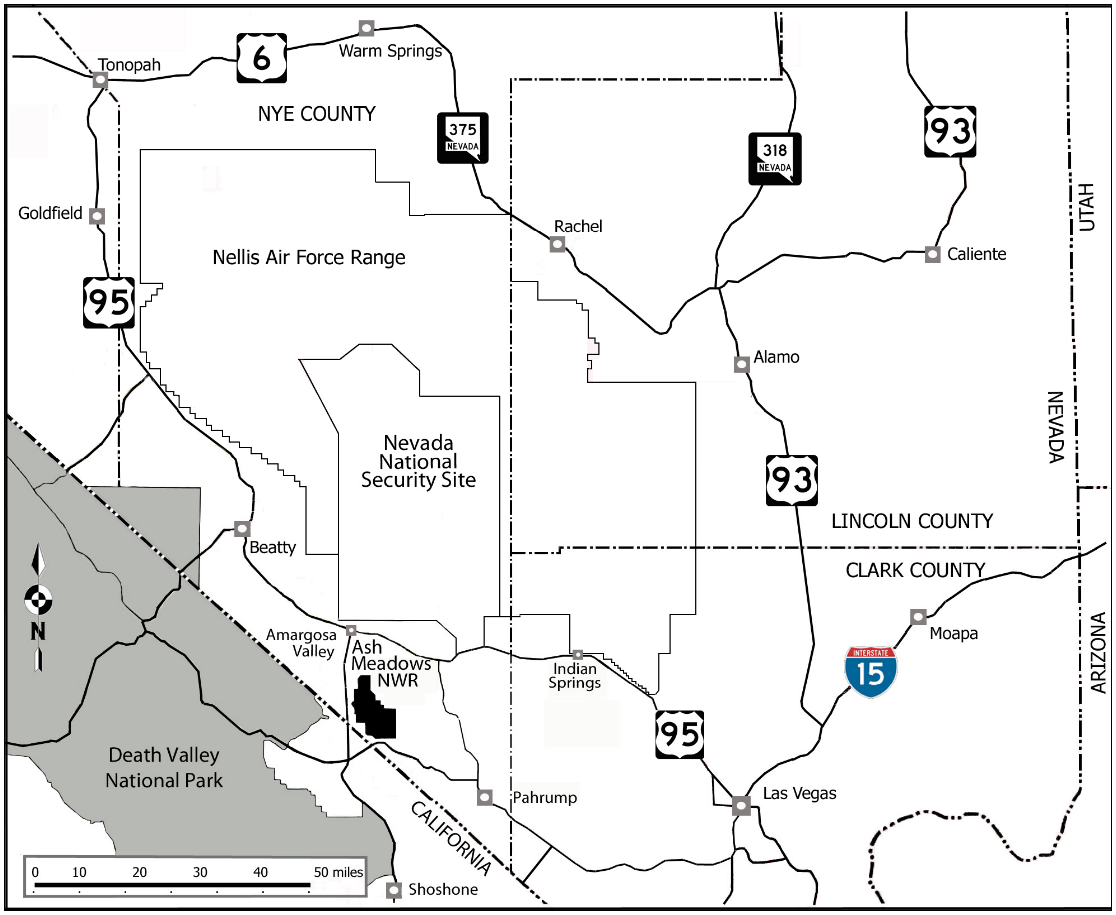

Figure 1. Location of the Ash Meadows National Wildlife Refuge (NWR) in southwestern Nevada, in relation to Death Valley National Park as well as surrounding urban and rural areas.

Monitoring was performed at two sites on the refuge, first for about eight months at an abandoned farmhouse [Engelbrecht et al. 2007a], and then for the remaining four months at the Ash Meadows NWR administrative complex (Table 1, Figure 2), 5.4 km northwest of the first site.

Table 1. Localities of two sites at Ash Meadows NWR sampled over the course of approximately one year

Site #	Locality	Coordinates	Elevation (m)	Date Start (m/d/yr)	Date End (m/d/yr)
1a	Farmhouse site	36° 23' 10.41" N 116° 17' 11.35" W	858	5/20/09	1/26/10
1b	Administration site	36° 25' 12.19" N 116° 19' 48.50" W	750	1/26/10	6/4/10

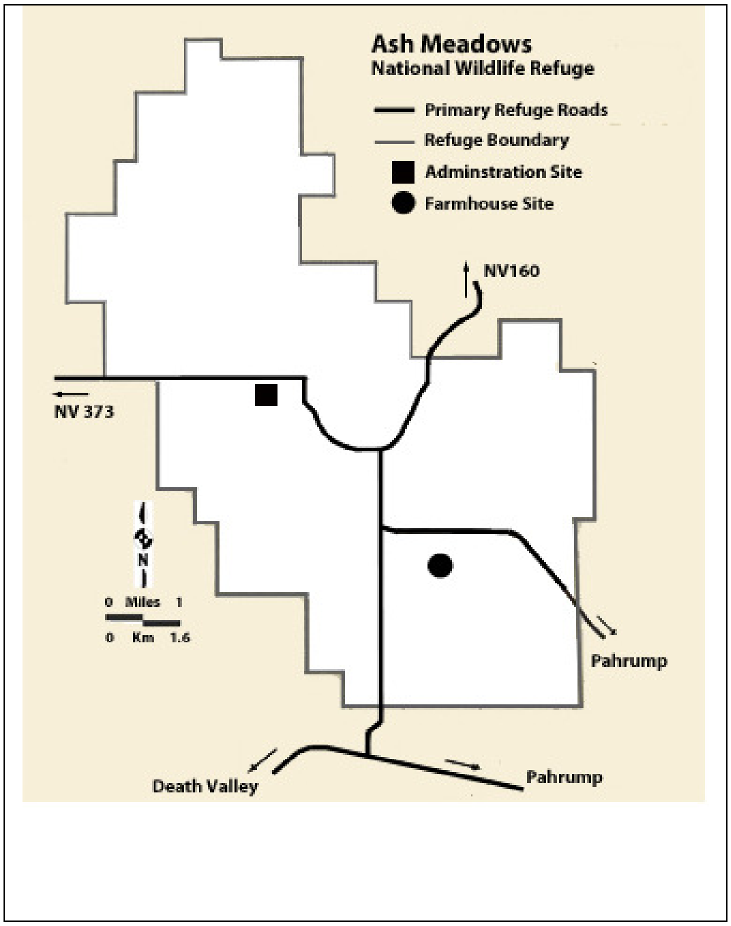

Figure 2. Locality map showing the Farmhouse (●) and Administrative (■) sampling and monitoring sites at the Ash Meadows National Wildlife Refuge in Amargosa Valley, southwestern Nevada.

EQUIPMENT

Mobile Shelter

The equipment in the instrumented mobile shelter (Figure 3) was normally powered off 120V AC, and where not available, off 12V DC batteries that are charged by solar panels. A retractable tower was mounted with an array of meteorological equipment, including wind, precipitation, temperature, and solar radiation monitors. Instruments housed inside the trailer included rack mounted continuous aerosol monitors and sequential filter samplers. The trailer was equipped with a data logger and a satellite communication system. Continuous data were logged and transmitted via a Geostationary Operational Environmental Satellite (GOES) to the Western Regional Climate Center (WRCC) at DRI in Reno.

Figure 3. Instrumented mobile shelter at Ash Meadows NWR, showing the meteorological tower with instruments, aerosol sampling inlets, and solar panels.

Aerosol Monitors

Two Tapered Element Oscillating Microbalance (TEOM®) continuous particulate monitors, one each for PM_{10} (particulate matter < 10 µm in aerodynamic diameter) and $PM_{2.5}$ (particulate matter < 2.5 µm in aerodynamic diameter) (Figure 4) were operated at both sites. The TEOM®s were configured to continuously record particulate mass (PM) concentrations, averaged over 15 minute intervals. To validate data from the TEOM® continuous monitors, comparisons were made with results from the BGI PQ100® (PM_{10}) and PQ200® ($PM_{2.5}$), 24 hr filter-based samplers.

Figure 4. Two rack mounted TEOM® continuous particulate matter (PM) monitors in the mobile shelter, $PM_{2.5}$ to the left, PM_{10} to the right.

Filter Samplers

BGI, Inc., PQ100®, and PQ200® Ambient $PM_{2.5}$ Federal Reference Method (FRM) samplers (Figure 5) collected 24 hr integrated PM_{10} and $PM_{2.5}$ aerosol filter samples. Both PQ100® (Designation No. RFPS-1298-124) and PQ200® (Designation No. RFPS-0498-116) samplers met the U.S. EPA criteria for collecting 24 hr ambient samples. The PM_{10} fraction was collected by a filter located downstream of the size selective inlet. For the collection of $PM_{2.5}$, particles in the range between 2.5 and 10 µm were removed by the Very Sharp Cut Cyclone (VSCC) (U.S. Environmental Protection Agency [EPA] Equivalent Designation No. EQPM-0202-142), before collection of $PM_{2.5}$ particles on Teflon® membrane or quartz fiber filters.

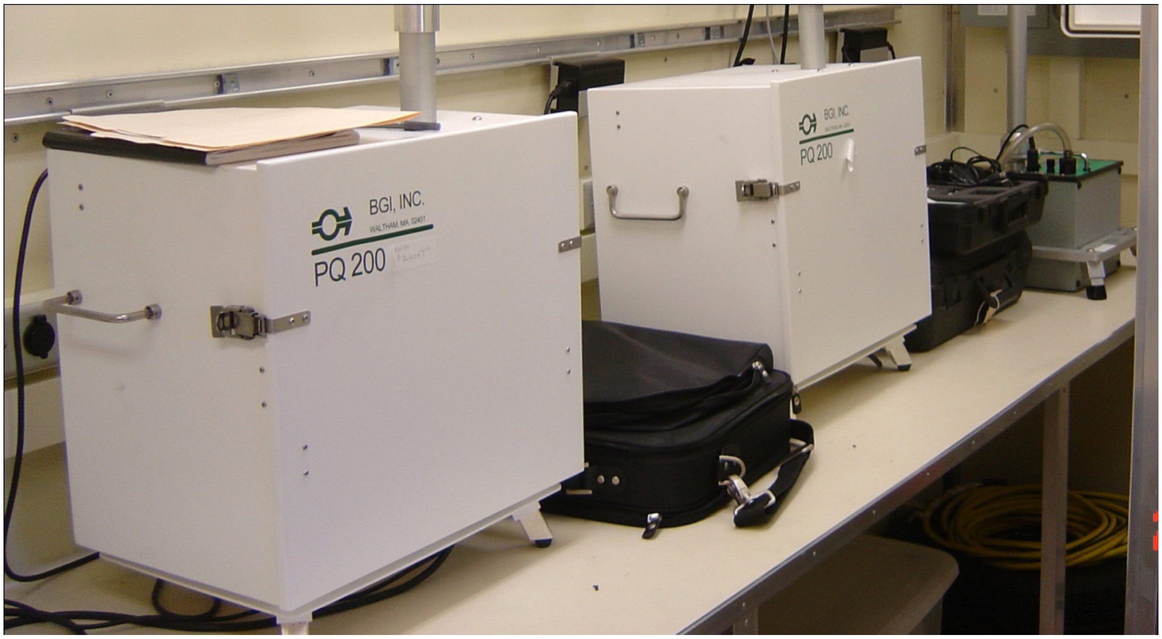

Figure 5. Two BGI PQ200® ($PM_{2.5}$) (foreground), and one BGI PQ100® (PM_{10}) (green top box in far background) filter samplers mounted on a counter top in the mobile shelter.

Aerosol samples were collected on a US EPA 1-in-12-day sampling schedule. For both PQ100® and PQ200® samplers, aerosols were collected at a volumetric flow rate of 16.67 liters per minute (l/min). The samplers were set up to operate from internal 12V DC batteries, charged by solar panels or from 120V AC. Sets of PQ100® and PQ200® samplers collected PM_{10} and $PM_{2.5}$ aerosol samples, respectively. The Teflon® membrane filters collected particulate matter for gravimetric analysis, light absorption by densitometry, and elemental analysis by X-ray fluorescence (XRF) spectrometry [Watson et al. 1999]. Quartz fiber filters were analyzed for water-soluble ions by atomic absorption spectrometry (AA), ion chromatography (IC), and automated colorimetry (AC) [Chow and Watson 1999], and also for measurement of carbon species by thermal optical reflectance (TOR) [Chow et al. 1993]. The flow rates were calibrated against a BGI Tri-Cal® National Institute of Technology traceable standard.

Meteorological Equipment

The datalogger recorded wind speed and direction, precipitation, temperature, humidity and solar radiation at 15 minute intervals. The power for the meteorological instrumentation on the shelter was from 12V DC batteries, charged by a solar panel.

Data Capture

Continuous data from the air quality and meteorological monitors were stored on a Campbell CR1000® data logger. The measurements from the data logger were automatically polled and relayed to the WRCC at DRI in Reno. This occurs every three hours via the GOES satellite communication system. In addition, data stored in the data logger were routinely downloaded onto a laptop computer. A list of the instrumentation is presented in Table 2.

Table 2. Equipment installed on or inside the mobile air quality shelter

CATEGORY	TYPE	INSTRUMENT	SUPPLIER
Shelter	Mobile unit	EKTO customized	EKTO
Air Quality	Filter based PM_{10} (2 of each plus one spare)	PQ100® – U.S. EPA Federal Reference Method	BGI
	Filter based $PM_{2.5}$ (2 of each plus one spare)	PQ200® – U.S. EPA Federal Reference Method	BGI
	Continuous PM_{10} (1 of each)	TEOM® Series 1400A ambient particulate monitor – U.S. EPA equivalency approval (EQPM-1090-079)	Thermo Electron
	Continuous $PM_{2.5}$ (1 of each)	TEOM® Series 1400A ambient particulate monitor – U.S. EPA acceptable (40 CFR 58)	Thermo Electron
Calibration	Air Flow Rate, Barometric Pressure Temperature	triCal®, NIST traceable standard	BGI
Meteorological	Wind speed & direction	Met One, RM Young	Met One, Campbell
	Precipitation	Met One, Texas Electronics	Met One, Campbell
	Temperature/RH	Met One, Vaisala	Met One, Campbell
	Barometric Pressure	Met One, Vaisala	Met One, Campbell
	Solar Radiation	Met One, Li-Cor	Met One, Campbell
Data Collection	Data acquisition system	Campbell CR1000®	Campbell
Communication	GOES satellite transmitter	TX312 HDR	Campbell
	GPS	Garmin	Campbell
Off-grid Power	Solar (5 panels)	4 x 40W, 1 x 55W (215W total)	BGI, BP Solar

RESULTS

Continuous PM & Meteorological Monitoring

Particulate Matter (PM) concentrations were measured by TEOM® monitors. PM_{10} levels varied on average from 4.6 µg/m^3 in winter to 10.8 µg/m^3 in fall, both well below the 24 hr US Environmental Protection Agency National Ambient Air Quality Standard (NAAQS) for PM_{10} of 150 µg/m^3. The average levels for $PM_{2.5}$ varied from 0.8 µg/m^3 in winter to 5.2 µg/m^3, which are also below the 24 hr NAAQS of 35 µg/m^3, as well as the annual average NAAQS of 15 µg/m^3. Due to instrument failure, no PM_{10} TEOM® data are available for spring 2010.

Table 3. Average PM_{10} and $PM_{2.5}$ gravimetric results measured at Ash Meadows NWR, by TEOM® continuous monitors, as well as US EPA National Ambient Air Quality Standards (NAAQS) for particulate matter.

Season	Months	Date Start (m/d/yr)	Date End (m/d/yr)	Avg. (Unc.) PM_{10} µg/m^3	Avg. (Unc.) $PM_{2.5}$ µg/m^3	$PM_{2.5}/PM_{10}$
Summer	Jun, Jul, Aug	06/01/09	08/31/09	10.3 (17)	5.2 (1.5)	0.50
Fall	Sep, Oct, Nov	09/01/09	11/30/09	10.8 (6.8)	4.3 (1.2)	0.39
Winter	Dec, Jan, Feb	12/01/09	02/28/10	4.6 (1.1)	0.8 (0.4)	0.18
Spring	Mar, Apr, May	03/01/10	05/31/10	n.a.	4.0 (1.6)	
Ave. (Std. Dev.)				8.6 (3.4)	3.6 (1.9)	0.36 (0.16)
US EPA	NAAQS 24hr			150	35	
US EPA	NAAQS annual				15	

Seasonally averaged particulate matter (PM) and meteorological data are shown in Tables 4 to 7 and seasonal wind roses are shown in Figures 6 to 9.

Table 4. Statistics of continuous particulate mass (PM) and meteorological monitoring, as well as Teflon filter measurements, for summer 2009.

Ash Meadows 6/1/09 to 8/31/09

Daily	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)	Wind Speed (mph)	Air Temp (F)	Relative Humidity (%)	Total Precip (in)	Solar Radiation (ly)
mean	10.29 ± 16.94	5.18 ± 1.49	8.9	87.1	17.3	0.00	26
max	42.20	26.13	20.5	98.5	43.8		31
stdev	8.91	3.59	3.7	7.3	7.8	0.00	4
n_obs	22	78	92	92	92	92	92
recovery	24%	85%	100%	100%	100%	100%	100%
Hourly							
mean	9.97 ± 0.57	5.21 ± 0.18	8.9	87.1	17.3	0.00	
max	96.50	84.10	29.0	111.8	84.6		
stdev	13.86	7.95	5.4	11.5	10.6	0.00	
n_obs	588	1912	2208	2208	2208	2208	
recovery	27%	87%	100%	100%	100%	100%	
Filters							
mean	14.73 ± 3.39	8.51 ± 2.55					
max	26.87	17.85					
stdev	7.59	5.69					
n_obs	5	5					

uncertainties shown are the standard error of mean *

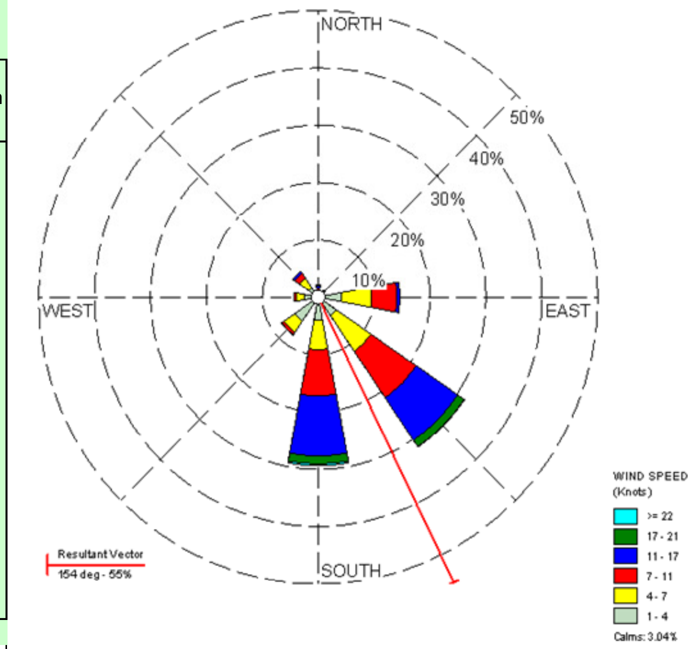

Figure 6. Wind rose shows the predominant wind from the south-southeast for summer 2009.

Table 5. Statistics of continuous particulate mass (PM) and meteorological monitoring, as well as Teflon filter measurements, for fall 2009.

DATA PRESENTED IN THIS REPORT ARE PRELIMINARY AND ARE SUBJECT TO CHANGE

Ash Meadows 9/1/09 to 11/30/09

Daily	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	Wind Speed (mph)	Air Temp (F)	Relative Humidity (%)	Total Precip (in)	Solar Radiation (ly)
mean	10.77 ±6.84	4.25 ±1.22	8.2	71.0	17.7	0.00	21
max	52.67	17.63	21.5	90.2	41.9		29
stdev	7.96	3.30	4.3	13.1	6.2	0.00	4
n_obs	86	80	73	73	73	73	73
recovery	95%	88%	80%	80%	80%	80%	80%
Hourly							
mean	10.76 ±0.48	4.20 ±0.11	8.3	71.4	17.5	0.00	
max	653.90	57.82	31.4	105.1	68.9		
stdev	21.80	5.03	6.2	15.4	8.7	0.00	
n_obs	2075	1943	1731	1731	1731	1731	
recovery	95%	89%	79%	79%	79%	79%	
Filters							
mean	10.76 ±2.12	3.67 ±0.60					
max	18.26	5.37					
stdev	4.73	1.33					
n_obs	5	5					

uncertainties shown are the standard error of mean *

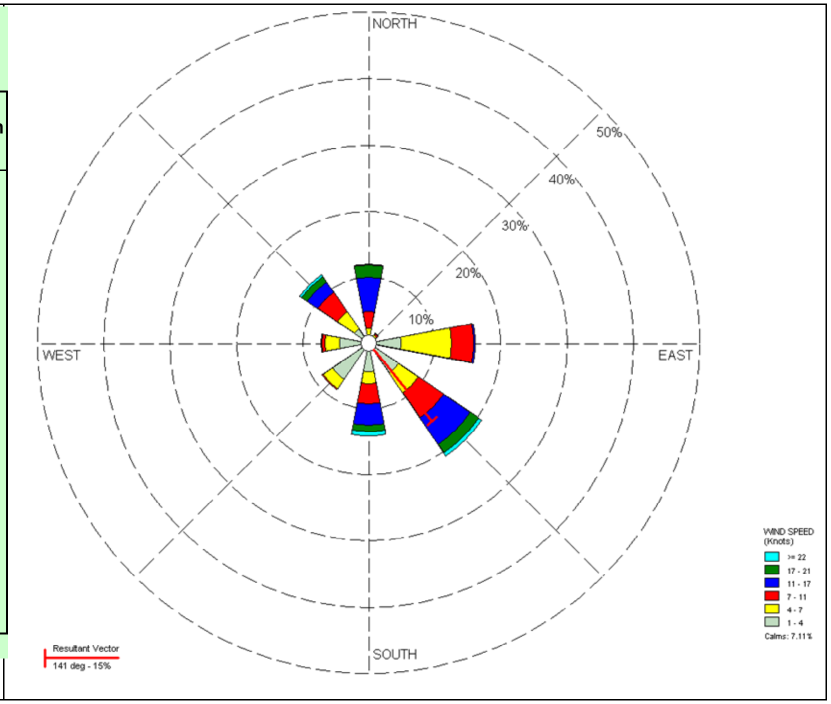

Figure 7. Wind rose shows the predominant wind from the southeast but also with weaker northern to northwesterly and easterly winds in fall 2009.

Table 6. Statistics of continuous particulate mass (PM) and meteorological monitoring, as well as Teflon filter measurements, for winter 2009/10.

DATA PRESENTED IN THIS REPORT ARE PRELIMINARY AND ARE SUBJECT TO CHANGE

Ash Meadows 12/1/09 to 2/28/10

Daily	PM_{10} ($\mu g/m^3$)		$PM_{2.5}$ ($\mu g/m^3$)		Wind Speed (mph)	Air Temp (F)	Relative Humidity (%)	Total Precip (in)	Solar Radiation (ly)
mean	4.62	± 1.11	0.83	± 0.38	6.0	46.4	55.1	0.00	11
max	8.28		2.11		18.5	55.1	86.2		19
stdev	1.47		0.56		3.9	4.4	15.3	0.00	4
n_obs	41		45		79	79	79	79	79
recovery	46%		50%		88%	88%	88%	88%	88%
Hourly									
mean	5.01	± 0.18	1.06	± 0.06	6.0	46.4	55.3	0.00	
max	84.80		18.95		27.6	72.0	98.2	0.17	
stdev	6.30		2.08		5.0	9.2	22.7	0.00	
n_obs	1260		1349		1899	1899	1899	1899	
recovery	58%		62%		88%	88%	88%	88%	
Filters									
mean	3.04		1.48	± 0.35					
max	3.04		1.83						
stdev			0.50						
n_obs	1		2						

uncertainties shown are the standard error of mean *

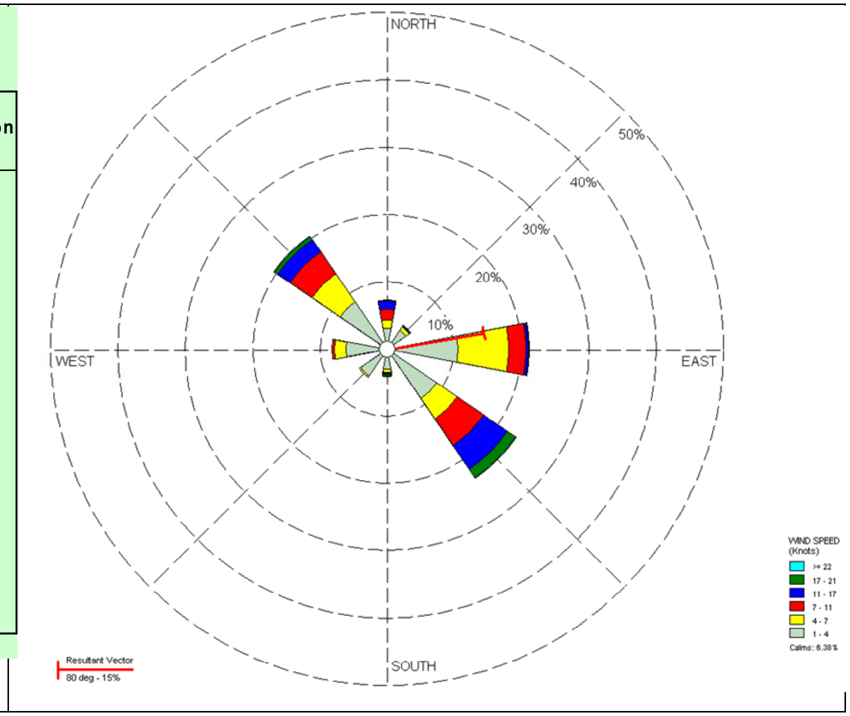

Figure 8. Wind rose shows similar winds from the southeast and northwest, with periods from the east, during winter 2009/10.

Table 7. Statistics of continuous particulate mass (PM) and meteorological monitoring, as well as Teflon filter measurements, for spring 2010.

DATA PRESENTED IN THIS REPORT ARE PRELIMINARY AND ARE SUBJECT TO CHANGE

Ash Meadows 3/1/10 to 5/31/10

	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)	Wind Speed (mph)	Air Temp (F)	Relative Humidity (%)	Total Precip (in)	Solar Radiation (ly)
Daily							
mean		3.96 ± 1.56	8.6	61.4	29.4	0.41	24
max		9.73	18.8	77.7	73.3	13.02	32
stdev		2.68	4.3	8.0	12.3	2.02	5
n_obs	0	21	92	92	92	92	92
recovery	0%	23%	100%	100%	100%	100%	100%
Hourly							
mean		4.10 ± 0.25	8.6	61.5	29.4	0.41	
max		67.17	30.5	94.6	95.5	77.24	
stdev		5.81	5.8	12.6	18.1	4.00	
n_obs	0	529	2202	2202	2202	2202	
recovery	0%	24%	100%	100%	100%	100%	
Filters							
mean	10.61 ± 2.16	4.48 ± 1.44					
max	13.86	8.70					
stdev	3.73	2.88					
n_obs	3	4					

uncertainties shown are the standard error of mean *

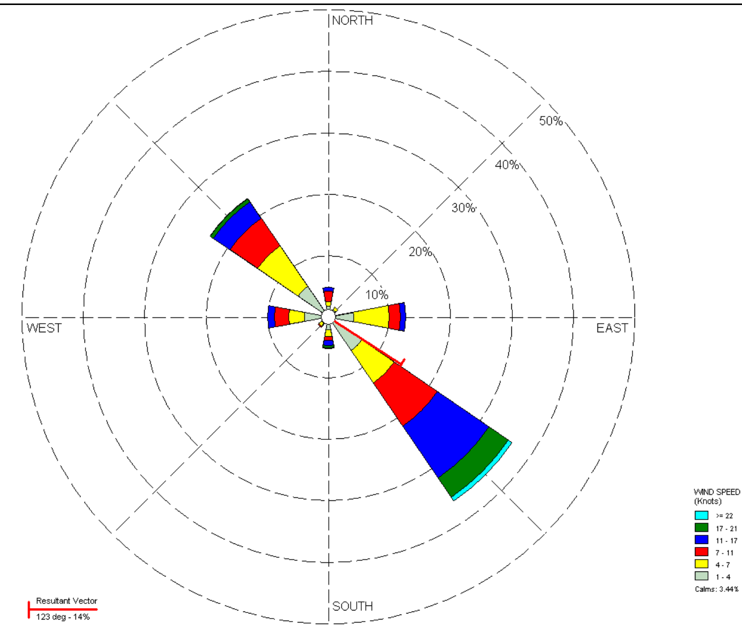

Figure 9. Wind rose shows the predominant wind from the southeast and to a lesser degree from the northwest, for spring 2010.

Filter Sampling and Analysis

Fourteen PM_{10} and $PM_{2.5}$ filter sample sets collected during the year-long sampling campaign were gravimetrically and chemically analyzed (Tables 8 to 12).

Gravimetric Results

The particulate mass measured on Teflon® filters varied from 3.0 $\mu g/m^3$ on 12/27/2009 to as high as 26.9 $\mu g/m^3$ on 08/29/2009 for PM_{10}, and from 1.1 $\mu g/m^3$ to as high as 17.9 $\mu g/m^3$ for $PM_{2.5}$ on the same two days (Figure 10). The elevated mass values for both PM_{10} and $PM_{2.5}$ measured on 08/29/2009 are ascribed to smoke from several wildfires in Los Angeles County, California. These include the Station and Morris fires, both in the Angeles National Forest late in August 2009 (2009http://en.wikipedia.org/wiki/Station_Fire_%282009%29#Los_Angeles_County). The Hysplit backward trajectory model for August 27-29 shows airflow from California towards Ash Meadows NWR for that period (Figure 11).

The $PM_{2.5}/PM_{10}$ mass ratios (Table 13) increased from 0.24 on 10/28/2009 to 0.66 on 08/29/09, the latter indicating that atmospheric aerosol was dominated by smoke. Table 13 shows a comparison of the seasonal average gravimetric results from Ash Meadows NWR to eight urban sites in southwestern Nevada [Engelbrecht et al. 2011], the urban Chemical Speciation Network (CSN) and rural IMPROVE sites in the southwestern U.S. The eight rural sites in Nevada include Ash Meadows NWR [Engelbrecht et al. 2007a], Beatty [Engelbrecht et al. 2007b], Rachel [Engelbrecht et al. 2007c], Sarcobatus Flat [Engelbrecht et al. 2007d], Caliente [Engelbrecht et al. 2008a], Crater Flat [Engelbrecht et al. 2008b], Pahranagat NWR [Engelbrecht et al. 2008c], and Tonopah airport [Engelbrecht et al. 2008d]. The five urban sites are in Las Vegas and Tonopah, Nevada; Los Angeles and Calexico, California; and Phoenix, Arizona, which form part of USEPA's CSN monitoring program. The four rural IMPROVE sites are Domeland Wilderness Area and Joshua Tree National Park (NP) in California, and the Bosque del Apache National Wildlife Refuge (NWR) and Salt Creek Wilderness Area in New Mexico.

Table 8. Chemical and normative mineral compositions for spring and summer 2009 samples.

SITE	Ash Meadows NWR				Ash Meadows NWR				Ash Meadows NWR			
TID	YUCTT137				YUCTT140				YUCTT141			
DATE	05/25/09				07/12/09				07/25/09			
SIZE	PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$	
	Conc	Unc	Conc	Unc	Conc	Unc	Conc	Unc	Conc	Unc	Conc	Unc
Cl^-	0.0000	0.0210	0.0311	0.0212	0.0185	0.0209	0.0070	0.0208	0.0223	0.0210	0.0000	0.0208
NO_3^-	0.4062	0.0339	0.5590	0.0423	0.2366	0.0260	0.1015	0.0219	0.8208	0.0579	0.3201	0.0296
$SO_4^=$	1.2646	0.0672	1.5494	0.0810	1.1068	0.0597	0.9997	0.0546	1.8212	0.0944	1.5866	0.0828
NH_4^+	0.4778	0.0336	0.5540	0.0370	0.3076	0.0268	0.3297	0.0276	0.5310	0.0359	0.4828	0.0338
Na^+	0.0936	0.0057	0.2239	0.0133	0.1088	0.0065	0.0580	0.0036	0.3102	0.0183	0.2213	0.0131
Mg^{2+}	0.0351	0.0019	0.0389	0.0021	0.0338	0.0019	0.0101	0.0010	0.0932	0.0048	0.0308	0.0018
K^+	0.0744	0.0045	0.0511	0.0034	0.0510	0.0034	0.0272	0.0025	0.1001	0.0057	0.0669	0.0041
Ca^{2+}	0.3185	0.0193	0.1579	0.0132	0.3559	0.0209	0.0836	0.0112	0.7431	0.0393	0.1439	0.0127
O1TC	0.5510	0.2733	0.1298	0.0660	0.2835	0.1412	0.1174	0.0600	0.1924	0.0964	0.2072	0.1037
O2TC	0.7436	0.0495	0.6498	0.0453	0.9663	0.0600	0.8771	0.0557	1.3132	0.0774	0.7357	0.0491
O3TC	0.8694	0.1458	0.7411	0.1332	0.8220	0.1410	0.5767	0.1185	1.0470	0.1645	0.5844	0.1192
O4TC	0.4225	0.1302	0.3637	0.1135	0.4375	0.1344	0.2040	0.0703	0.6808	0.2048	0.2355	0.0785
OPTTC	0.5736	0.1316	0.2249	0.0569	0.4010	0.0939	0.1829	0.0487	0.5116	0.1179	0.2349	0.0589
OPTRC	0.6416	0.1443	0.2592	0.0630	0.2443	0.0600	0.1829	0.0482	0.5215	0.1183	0.2542	0.0620
OC	3.2281	0.4241	2.1436	0.2989	2.7535	0.3684	1.9581	0.2784	3.7550	0.4868	2.0170	0.2849
E1TC	0.6449	0.0570	0.3109	0.0324	0.3555	0.0354	0.1829	0.0248	0.5857	0.0524	0.2991	0.0316
E2TC	0.1920	0.0469	0.0928	0.0312	0.1819	0.0451	0.0497	0.0266	0.2850	0.0642	0.0933	0.0313
E3TC	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082
EC	0.1954	0.0503	0.1445	0.0427	0.2932	0.0670	0.0497	0.0327	0.3491	0.0773	0.1382	0.0418
TC	3.4235	0.4665	2.2881	0.3317	3.0467	0.4209	2.0078	0.3001	4.1041	0.5501	2.1552	0.3165
Na	0.1087	0.0691	0.2046	0.0723	0.0000	0.0654	0.0513	0.0674	0.0845	0.0683	0.0000	0.0645
Mg	0.0000	0.0210	0.0000	0.0211	0.0000	0.0210	0.0000	0.0211	0.0000	0.0211	0.0000	0.0210
Al	0.3654	0.0192	0.1263	0.0079	0.0997	0.0068	0.0417	0.0049	0.4924	0.0254	0.1670	0.0097
Si	1.1828	0.0596	0.3445	0.0177	0.4480	0.0228	0.1134	0.0064	1.5171	0.0764	0.4385	0.0223
S	0.6519	0.0327	0.6541	0.0328	0.4212	0.0212	0.3877	0.0195	0.7003	0.0351	0.6225	0.0312
Cl	0.0238	0.0014	0.0076	0.0008	0.0087	0.0009	0.0021	0.0007	0.0279	0.0016	0.0079	0.0008
K	0.1892	0.0095	0.0674	0.0035	0.0766	0.0040	0.0306	0.0018	0.2760	0.0139	0.1088	0.0055
Ca	0.3776	0.0193	0.0641	0.0045	0.1341	0.0075	0.0043	0.0031	0.5611	0.0284	0.1054	0.0062
Ti	0.0302	0.0019	0.0097	0.0012	0.0138	0.0013	0.0038	0.0011	0.0416	0.0024	0.0121	0.0012
V	0.0016	0.0007	0.0008	0.0007	0.0000	0.0007	0.0000	0.0007	0.0023	0.0007	0.0000	0.0007
Mn	0.0053	0.0022	0.0017	0.0022	0.0013	0.0021	0.0000	0.0021	0.0129	0.0023	0.0020	0.0021
Fe	0.3469	0.0174	0.1021	0.0052	0.1439	0.0073	0.0358	0.0019	0.4497	0.0225	0.1256	0.0063
Cu	0.0017	0.0025	0.0005	0.0025	0.0014	0.0025	0.0015	0.0025	0.0034	0.0025	0.0015	0.0025
Zn	0.0000	0.0007	0.0000	0.0007	0.0010	0.0007	0.0022	0.0007	0.0068	0.0008	0.0015	0.0007
Br	0.0037	0.0007	0.0026	0.0007	0.0001	0.0007	0.0013	0.0007	0.0051	0.0007	0.0036	0.0007
Rb	0.0010	0.0007	0.0007	0.0007	0.0000	0.0007	0.0000	0.0007	0.0010	0.0007	0.0004	0.0007
Sr	0.0046	0.0007	0.0007	0.0007	0.0014	0.0007	0.0000	0.0007	0.0044	0.0007	0.0015	0.0007
Pb	0.0006	0.0008	0.0000	0.0008	0.0000	0.0008	0.0007	0.0008	0.0004	0.0008	0.0020	0.0008
Silicate Oxides												
Na_2O	0.1262		0.1913		0.1305		0.0719		0.3986		0.1664	
K_2O	0.0896		0.0616		0.0615		0.0328		0.1206		0.0806	
CaO	0.2663		0.0000		0.2229		0.0000		0.4306		0.0000	
MgO	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
Al_2O_3	0.6904		0.2386		0.1884		0.0788		0.9304		0.3156	
SiO_2	2.5298		0.7368		0.9582		0.2425		3.2448		0.9379	
Silicates	3.7023		1.2284		1.5614		0.4260		5.1251		1.5005	
Oxides												
TiO_2	0.0504		0.0162		0.0230		0.0063		0.0694		0.0202	
V_2O_5	0.0057		0.0029		0.0000		0.0000		0.0082		0.0000	
MnO_2	0.0084		0.0027		0.0021		0.0000		0.0204		0.0032	
Fe_2O_3	0.4960		0.1460		0.2057		0.0512		0.6429		0.1796	
Oxides	0.5604		0.1677		0.2308		0.0575		0.7410		0.2029	
Ionic Compounds												
NH_4NO_3	0.5244		0.7216		0.3054		0.1310		1.0596		0.4132	
$(NH_4)_2SO_4$	1.3170		1.4332		0.8744		1.0993		1.0700		1.4270	
$CaSO_4.2(H_20)$	0.5506		0.6782		0.8444		0.3591		1.8697		0.6180	
NaCl	0.0000		0.0513		0.0305		0.0115		0.0368		0.0000	
Na_2SO_4	0.0000		0.1909		0.0000		0.0004		0.0000		0.3022	
K_2SO_4	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
Carbon												
EC	0.1954		0.1445		0.2932		0.0497		0.3491		0.1382	
OC	3.2281		2.1436		2.7535		1.9581		3.7550		2.0170	
Sum of Species	10.0782		6.7594		6.8936		4.0926		14.0063		6.6191	
Measured Mass	15.3078	0.7826	7.3719	0.4033	7.2795	0.3990	3.9967	0.2582	16.1398	0.8234	7.1577	0.3935
$PM_{2.5}/PM_{10}$		0.48				0.55				0.44		

Table 9. Chemical and normative mineral compositions for summer and fall 2009 samples.

SITE	Ash Meadows NWR				Ash Meadows NWR				Ash Meadows NWR			
TID	YUCTT143				YUCTT145				YUCTT146			
DATE	08/05/09				08/29/09				09/10/09			
SIZE	PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$	
	Conc	Unc	Conc	Unc	Conc	Unc	Conc	Unc	Conc	Unc	Conc	Unc
Cl^-	0.0000	0.0208	0.0000	0.0211	0.0065	0.0208	0.0069	0.0208	0.0772	0.0231	0.0000	0.0210
NO_3^-	0.4833	0.0380	0.1416	0.0228	0.8562	0.0601	0.5986	0.0446	0.7017	0.0507	0.2475	0.0264
$SO_4^{=}$	1.2281	0.0655	1.0289	0.0560	1.3686	0.0722	1.3007	0.0689	0.9121	0.0506	0.7865	0.0449
NH_4^+	0.3856	0.0297	0.3187	0.0272	0.4778	0.0336	0.4658	0.0331	0.2537	0.0251	0.2362	0.0246
Na^+	0.1537	0.0092	0.0636	0.0040	0.1146	0.0069	0.0773	0.0047	0.2611	0.0155	0.1172	0.0070
Mg^{2+}	0.0454	0.0024	0.0120	0.0010	0.1166	0.0059	0.0267	0.0016	0.1268	0.0064	0.0297	0.0017
K^+	0.0485	0.0033	0.0201	0.0023	0.4926	0.0263	0.4422	0.0236	0.0865	0.0050	0.0378	0.0029
Ca^{2+}	0.4546	0.0254	0.0716	0.0110	-99	-99	0.2443	0.0162	1.3092	0.0675	0.2103	0.0149
O1TC	0.0988	0.0511	0.0504	0.0290	0.3049	0.1517	0.1891	0.0948	0.1905	0.0955	0.0079	0.0152
O2TC	0.9712	0.0602	0.6129	0.0437	1.4604	0.0850	1.8235	0.1041	0.7130	0.0481	0.7186	0.0483
O3TC	0.8294	0.1418	0.4120	0.1062	3.0621	0.4103	2.7445	0.3700	0.7532	0.1343	0.5821	0.1190
O4TC	0.4058	0.1254	0.1203	0.0506	2.1202	0.6288	1.1348	0.3380	0.4324	0.1330	0.2794	0.0902
OPTTC	0.3936	0.0923	0.0771	0.0314	1.8191	0.4099	1.9093	0.4301	0.3208	0.0767	0.2005	0.0521
OPTRC	0.2033	0.0520	0.0530	0.0286	1.5216	0.3375	1.6065	0.3562	0.2162	0.0545	0.1378	0.0401
OC	2.5085	0.3402	1.2485	0.2054	8.4691	1.0641	7.4984	0.9442	2.3054	0.3170	1.7258	0.2534
E1TC	0.3321	0.0338	0.0771	0.0206	2.4411	0.2033	2.4500	0.2041	0.3208	0.0330	0.2005	0.0257
E2TC	0.1620	0.0417	0.0324	0.0254	0.2846	0.0641	0.1955	0.0475	0.1771	0.0443	0.1186	0.0348
E3TC	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082
ECTRC	0.2908	0.0666	0.0565	0.0331	1.2040	0.2460	1.0390	0.2129	0.2817	0.0650	0.1812	0.0481
TC	2.7993	0.3913	1.3051	0.2267	9.6732	1.2555	8.5375	1.1104	2.5871	0.3663	1.9070	0.2889
Na	0.0000	0.0656	0.0000	0.0641	0.0940	0.0686	0.0000	0.0659	0.0000	0.0644	0.0000	0.0651
Mg	0.0000	0.0208	0.0000	0.0210	0.0183	0.0214	0.0000	0.0211	0.0182	0.0214	0.0000	0.0210
Al	0.2930	0.0156	0.0890	0.0064	0.3870	0.0202	0.1223	0.0078	0.2154	0.0119	0.1298	0.0081
Si	0.8253	0.0417	0.2000	0.0106	1.0429	0.0526	0.2118	0.0111	0.8713	0.0440	0.2091	0.0110
S	0.4746	0.0238	0.4075	0.0205	0.5517	0.0277	0.5123	0.0257	0.3236	0.0163	0.3158	0.0159
Cl	0.0133	0.0010	0.0000	0.0007	0.0293	0.0017	0.0173	0.0011	0.0284	0.0016	0.0053	0.0008
K	0.1285	0.0065	0.0373	0.0021	0.6637	0.0332	0.4582	0.0230	0.1725	0.0087	0.0559	0.0030
Ca	0.2660	0.0138	0.0305	0.0035	1.1037	0.0555	0.1464	0.0081	1.0652	0.0536	0.2088	0.0110
Ti	0.0228	0.0016	0.0055	0.0011	0.0337	0.0020	0.0057	0.0011	0.0192	0.0014	0.0051	0.0011
V	0.0009	0.0007	0.0000	0.0007	0.0012	0.0007	0.0000	0.0007	0.0008	0.0007	0.0001	0.0007
Mn	0.0038	0.0022	0.0000	0.0021	0.0167	0.0023	0.0026	0.0022	0.0038	0.0022	0.0018	0.0021
Fe	0.2568	0.0129	0.0631	0.0033	0.3387	0.0170	0.0626	0.0032	0.2032	0.0102	0.0512	0.0027
Cu	0.0024	0.0025	0.0010	0.0025	0.0053	0.0025	0.0009	0.0025	0.0025	0.0025	0.0023	0.0025
Zn	0.0003	0.0007	0.0000	0.0007	0.0082	0.0008	0.0075	0.0008	0.0000	0.0007	0.0013	0.0007
Br	0.0012	0.0007	0.0014	0.0007	0.0053	0.0007	0.0061	0.0008	0.0044	0.0007	0.0045	0.0007
Rb	0.0005	0.0007	0.0000	0.0007	0.0014	0.0007	0.0002	0.0007	0.0007	0.0007	0.0000	0.0007
Sr	0.0015	0.0007	0.0000	0.0007	0.0125	0.0010	0.0021	0.0007	0.0091	0.0009	0.0006	0.0007
Pb	0.0000	0.0008	0.0000	0.0008	0.0009	0.0008	0.0000	0.0008	0.0007	0.0008	0.0001	0.0008
Silicate Oxides												
Na_2O	0.2072		0.0092		0.0000		0.0982		0.2845		0.1580	
K_2O	0.0584		0.0242		0.0746		0.5328		0.1042		0.0455	
CaO	0.2998		0.0000		0.0000		0.0357		1.3763		0.0903	
MgO	0.0000		0.0000		0.0303		0.0000		0.0302		0.0000	
Al_2O_3	0.5536		0.1682		0.7313		0.2311		0.4070		0.2453	
SiO_2	1.7652		0.4278		2.2306		0.4530		1.8636		0.4472	
Silicates	2.8843		0.6294		3.0668		1.3508		4.0658		0.9863	
Oxides												
TiO_2	0.0380		0.0092		0.0562		0.0095		0.0320		0.0085	
V_2O_5	0.0032		0.0000		0.0043		0.0000		0.0029		0.0004	
MnO_2	0.0060		0.0000		0.0264		0.0041		0.0060		0.0028	
Fe_2O_3	0.3671		0.0902		0.4842		0.0895		0.2905		0.0732	
Oxides	0.4144		0.0994		0.5712		0.1031		0.3314		0.0849	
Ionic Compounds												
NH_4NO_3	0.6239		0.1828		1.1053		0.7728		0.9059		0.3195	
$(NH_4)_2SO_4$	0.8972		1.0162		0.8375		1.0680		0.1814		0.6013	
$CaSO_4.2(H_20)$	1.0321		0.3075		-99		0.9396		1.3982		0.6261	
NaCl	0.0000		0.0000		0.0107		0.0114		0.1273		0.0000	
Na_2SO_4	0.0000		0.1753		0.3410		0.0000		0.0000		0.0000	
K_2SO_4	0.0000		0.0000		0.9599		0.0000		0.0000		0.0000	
Carbon												
EC	0.2908		0.0565		1.2040		1.0390		0.2817		0.1812	
OC	2.5085		1.2485		8.4691		7.4984		2.3054		1.7258	
Sum of Species	8.6511		3.7156		16.5654		12.7831		9.5970		4.5251	
Measured Mass	9.8170	0.5173	4.1199	0.2630	26.8719	1.3535	17.8527	0.9075	12.3128	0.6370	4.4528	0.2762
$PM_{2.5}/PM_{10}$	0.42				0.66				0.36			

Table 10. Chemical and normative mineral compositions for fall 2009 samples.

SITE	Ash Meadows NWR				Ash Meadows NWR				Ash Meadows NWR			
TID	YUCTT148				YUCTT149				YUCTT151			
DATE	10/04/09				10/22/09				10/28/09			
SIZE	PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$	
	Conc	Unc	Conc	Unc	Conc	Unc	Conc	Unc	Conc	Unc	Conc	Unc
Cl^-	0.5160	0.0708	0.2379	0.0375	0.0000	0.0208	0.0000	0.0211	0.0059	0.0208	0.0000	0.0210
NO_3^-	0.5866	0.0439	0.2609	0.0270	0.0608	0.0212	0.0265	0.0209	0.0751	0.0214	0.0427	0.0210
$SO_4^=$	0.8254	0.0466	0.5846	0.0361	0.4103	0.0294	0.3599	0.0276	0.2950	0.0256	0.2453	0.0242
NH_4^+	0.2008	0.0236	0.1617	0.0226	0.1404	0.0222	0.1215	0.0219	0.0941	0.0214	0.0926	0.0214
Na^+	0.5156	0.0304	0.2549	0.0151	0.0344	0.0024	0.0137	0.0015	0.0684	0.0042	0.0190	0.0017
Mg^{2+}	0.1290	0.0065	0.0372	0.0020	0.1133	0.0057	0.0191	0.0013	0.0895	0.0046	0.0105	0.0010
K^+	0.1056	0.0060	0.0326	0.0027	0.0376	0.0029	0.0147	0.0022	0.0411	0.0030	0.0195	0.0023
Ca^{2+}	1.0847	0.0562	0.1479	0.0128	1.4478	0.0745	0.2305	0.0157	1.5520	0.0798	0.1741	0.0137
O1TC	0.1654	0.0832	0.0540	0.0305	0.0465	0.0273	0.0700	0.0377	0.0624	0.0343	0.1411	0.0714
O2TC	0.5820	0.0424	0.3364	0.0334	0.2287	0.0305	0.2316	0.0306	0.2067	0.0300	0.2745	0.0316
O3TC	0.8377	0.1426	0.3333	0.1014	0.3336	0.1013	0.2981	0.0995	0.6078	0.1211	0.6393	0.1238
O4TC	0.4797	0.1465	0.0659	0.0409	0.2189	0.0741	0.0922	0.0451	0.4194	0.1293	0.1873	0.0661
OPTTC	0.1654	0.0455	0.0127	0.0263	0.1589	0.0443	0.0629	0.0297	0.1283	0.0389	0.0000	0.0261
OPTRC	0.2812	0.0675	0.0032	0.0261	0.0937	0.0334	0.0222	0.0266	0.2615	0.0635	0.0470	0.0281
OC	2.3461	0.3216	0.7927	0.1665	0.9213	0.1764	0.7141	0.1609	1.5578	0.2359	1.2892	0.2092
E1TC	0.2812	0.0305	0.0111	0.0197	0.1050	0.0215	0.0272	0.0197	0.2732	0.0300	0.0902	0.0210
E2TC	0.1173	0.0346	0.0016	0.0245	0.0540	0.0270	0.0357	0.0256	0.1186	0.0348	0.0243	0.0250
E3TC	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082
ECTRC	0.1173	0.0391	0.0095	0.0311	0.0652	0.0337	0.0407	0.0321	0.1302	0.0407	0.0675	0.0339
TC	2.4634	0.3518	0.8022	0.1838	0.9866	0.1980	0.7549	0.1804	1.6881	0.2653	1.3567	0.2316
Na	0.1875	0.0716	0.1976	0.0720	0.0000	0.0642	0.0000	0.0642	0.0000	0.0635	0.0000	0.0656
Mg	0.0000	0.0210	0.0000	0.0211	0.0066	0.0213	0.0000	0.0212	0.0000	0.0210	0.0000	0.0212
Al	0.3180	0.0169	0.1205	0.0077	0.1217	0.0077	0.0223	0.0045	0.1409	0.0085	0.0505	0.0051
Si	1.0207	0.0515	0.4164	0.0212	0.5289	0.0269	0.1607	0.0086	0.7923	0.0400	0.1540	0.0083
S	0.2396	0.0121	0.2413	0.0121	0.1567	0.0079	0.1527	0.0077	0.1057	0.0054	0.1001	0.0051
Cl	0.3474	0.0175	0.2159	0.0109	0.0015	0.0007	0.0051	0.0008	0.0185	0.0012	0.0035	0.0007
K	0.1553	0.0079	0.0711	0.0037	0.0842	0.0043	0.0267	0.0017	0.1206	0.0061	0.0379	0.0021
Ca	0.3031	0.0156	0.1133	0.0066	1.0782	0.0542	0.2190	0.0115	1.1446	0.0575	0.1821	0.0097
Ti	0.0252	0.0017	0.0102	0.0012	0.0076	0.0011	0.0024	0.0010	0.0134	0.0013	0.0029	0.0011
V	0.0001	0.0007	0.0002	0.0007	0.0000	0.0007	0.0002	0.0007	0.0000	0.0007	0.0000	0.0007
Mn	0.0075	0.0022	0.0018	0.0022	0.0007	0.0021	0.0000	0.0021	0.0022	0.0021	0.0018	0.0021
Fe	0.2672	0.0134	0.1030	0.0052	0.0943	0.0048	0.0284	0.0016	0.1494	0.0075	0.0300	0.0017
Cu	0.0024	0.0025	0.0000	0.0025	0.0000	0.0025	0.0000	0.0025	0.0011	0.0025	0.0002	0.0025
Zn	0.0000	0.0007	0.0000	0.0007	0.0000	0.0007	0.0000	0.0007	0.0000	0.0007	0.0000	0.0007
Br	0.0016	0.0007	0.0000	0.0007	0.0002	0.0007	0.0000	0.0007	0.0000	0.0007	0.0020	0.0007
Rb	0.0000	0.0007	0.0010	0.0007	0.0003	0.0007	0.0000	0.0007	0.0003	0.0007	0.0000	0.0007
Sr	0.0049	0.0007	0.0023	0.0007	0.0064	0.0008	0.0023	0.0007	0.0101	0.0009	0.0008	0.0007
Pb	0.0000	0.0008	0.0000	0.0008	0.0000	0.0008	0.0000	0.0008	0.0000	0.0008	0.0006	0.0008
Silicate Oxides												
Na_2O	0.2439		0.1345		0.0464		0.0185		0.0870		0.0256	
K_2O	0.1272		0.0393		0.0453		0.0177		0.0495		0.0235	
CaO	1.0827		0.0000		1.9769		0.2893		2.1116		0.2250	
MgO	0.0000		0.0000		0.0109		0.0000		0.0000		0.0000	
Al_2O_3	0.6009		0.2277		0.2300		0.0421		0.2662		0.0954	
SiO_2	2.1831		0.8906		1.1312		0.3437		1.6946		0.3294	
Silicates	4.2378		1.2921		3.4407		0.7113		4.2090		0.6989	
Oxides												
TiO_2	0.0420		0.0170		0.0127		0.0040		0.0224		0.0048	
V_2O_5	0.0004		0.0007		0.0000		0.0007		0.0000		0.0000	
MnO_2	0.0119		0.0028		0.0011		0.0000		0.0035		0.0028	
Fe_2O_3	0.3820		0.1473		0.1348		0.0406		0.2136		0.0429	
Oxides	0.4363		0.1678		0.1486		0.0453		0.2394		0.0506	
Ionic Compounds												
NH_4NO_3	0.7573		0.3368		0.0785		0.0342		0.0970		0.0551	
$(NH_4)_2SO_4$	0.1103		0.3142		0.4494		0.4167		0.2646		0.2936	
$CaSO_4.2(H_20)$	1.3354		0.6352		0.1499		0.1021		0.1840		0.0571	
NaCl	0.8506		0.3922		0.0000		0.0000		0.0097		0.0000	
Na_2SO_4	0.0000		0.0026		0.0000		0.0000		0.0000		0.0000	
K_2SO_4	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
Carbon												
EC	0.1173		0.0095		0.0652		0.0407		0.1302		0.0675	
OC	2.3461		0.7927		0.9213		0.7141		1.5578		1.2892	
Sum of Species	10.1911		3.9431		5.2536		2.0644		6.6917		2.5120	
Measured Mass	18.2612	0.9276	5.3705	0.3144	6.2396	0.3522	2.5801	0.2083	8.6938	0.4644	2.1223	0.1949
$PM_{2.5}/PM_{10}$		0.29				0.41				0.24		

Table 11. Chemical and normative mineral compositions for fall 2009, winter 2009/10 and spring 2010 samples.

SITE	Ash Meadows NWR				Ash Meadows NWR				Ash Meadows NWR			
TID	YUCTT152				YUCTT157				YUCTT163			
DATE	11/09/09				12/27/09				03/26/10			
SIZE	PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$	
	Conc	Unc	Conc	Unc	Conc	Unc	Conc	Unc	Conc	Unc	Conc	Unc
Cl^-	0.0000	0.0221	0.0000	0.0225	0.0000	0.0210	0.0000	0.0211	0.1610	0.0297	0.0000	0.0208
NO_3^-	0.3488	0.0310	0.1074	0.0220	0.1532	0.0231	0.0753	0.0214	0.2305	0.0258	0.0982	0.0218
$SO_4^=$	0.6670	0.0396	0.5730	0.0357	0.2436	0.0242	0.1918	0.0230	2.0760	0.1070	0.3865	0.0285
NH_4^+	0.2246	0.0242	0.2172	0.0240	0.0955	0.0215	0.0885	0.0214	0.0708	0.0212	0.1128	0.0217
Na^+	0.0912	0.0055	0.0307	0.0022	0.0344	0.0024	0.0105	0.0014	1.2074	0.0712	0.0871	0.0053
Mg^{2+}	0.1685	0.0085	0.0229	0.0014	0.0366	0.0020	0.0049	0.0009	0.0914	0.0047	0.0158	0.0012
K^+	0.0807	0.0048	0.0303	0.0026	0.0240	0.0024	0.0117	0.0022	0.0673	0.0041	0.0215	0.0024
Ca^{2+}	3.3290	0.1700	0.2885	0.0180	0.5531	0.0300	0.0974	0.0115	1.4146	0.0728	0.1614	0.0133
O1TC	0.0000	0.0147	0.0709	0.0381	0.0000	0.0147	0.0326	0.0219	0.0043	0.0149	0.1483	0.0750
O2TC	0.2144	0.0302	0.2291	0.0305	0.2502	0.0310	0.1768	0.0294	0.3791	0.0348	0.3978	0.0354
O3TC	0.3016	0.0996	0.3143	0.1003	0.2752	0.0983	0.7432	0.1334	0.3994	0.1054	0.2699	0.0980
O4TC	0.4384	0.1347	0.1033	0.0472	0.0937	0.0454	0.2156	0.0732	0.2380	0.0792	0.0724	0.0418
OPTTC	0.3426	0.0814	0.0935	0.0335	0.0423	0.0278	0.0592	0.0293	0.1389	0.0408	0.0284	0.0269
OPTRC	0.2295	0.0571	0.0490	0.0283	0.0877	0.0325	0.0000	0.0261	0.0858	0.0323	0.0222	0.0266
OC	1.1839	0.1993	0.7666	0.1646	0.7068	0.1603	1.1682	0.1979	1.1066	0.1924	0.9105	0.1756
E1TC	0.3426	0.0345	0.1153	0.0218	0.0423	0.0199	0.3108	0.0324	0.1512	0.0233	0.0284	0.0197
E2TC	0.1586	0.0411	0.0271	0.0252	0.0453	0.0263	0.1319	0.0368	0.1273	0.0361	0.0205	0.0249
E3TC	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082	0.0000	0.0082
ECTRC	0.2718	0.0632	0.0935	0.0364	0.0000	0.0310	0.4427	0.0950	0.1928	0.0499	0.0267	0.0315
TC	1.4557	0.2414	0.8601	0.1881	0.7068	0.1771	1.6109	0.2572	1.2995	0.2262	0.9372	0.1941
Na	0.1061	0.0690	0.0000	0.0640	0.0000	0.0632	0.0930	0.0686	0.0000	0.0659	0.0369	0.0670
Mg	0.0081	0.0213	0.0073	0.0213	0.0000	0.0211	0.0000	0.0212	0.0000	0.0208	0.0000	0.0211
Al	0.0597	0.0054	0.2107	0.0117	0.0435	0.0049	0.0094	0.0043	0.2770	0.0149	0.1153	0.0075
Si	0.2218	0.0116	0.8578	0.0433	0.2510	0.0130	0.0546	0.0040	1.0171	0.0513	0.4036	0.0206
S	0.2092	0.0105	0.2058	0.0104	0.1035	0.0053	0.0729	0.0038	0.3777	0.0190	0.1562	0.0079
Cl	0.0000	0.0007	0.0059	0.0008	0.0031	0.0007	0.0000	0.0007	0.0663	0.0034	0.0167	0.0011
K	0.0497	0.0027	0.1348	0.0068	0.0446	0.0024	0.0129	0.0012	0.1604	0.0081	0.0590	0.0031
Ca	0.2025	0.0107	0.6639	0.0335	0.3062	0.0158	0.0158	0.0032	0.6153	0.0311	0.1248	0.0071
Ti	0.0045	0.0011	0.0199	0.0015	0.0054	0.0011	0.0007	0.0010	0.0216	0.0015	0.0068	0.0011
V	0.0000	0.0007	0.0006	0.0007	0.0002	0.0007	0.0000	0.0007	0.0000	0.0007	0.0000	0.0007
Mn	0.0000	0.0021	0.0032	0.0022	0.0020	0.0021	0.0002	0.0021	0.0058	0.0022	0.0011	0.0021
Fe	0.0452	0.0024	0.2493	0.0125	0.0556	0.0029	0.0128	0.0010	0.2267	0.0114	0.0750	0.0038
Cu	0.0010	0.0025	0.0029	0.0025	0.0021	0.0025	0.0005	0.0025	0.0021	0.0025	0.0007	0.0025
Zn	0.0000	0.0007	0.0038	0.0008	0.0000	0.0007	0.0000	0.0007	0.0000	0.0007	0.0000	0.0007
Br	0.0027	0.0007	0.0028	0.0007	0.0005	0.0007	0.0002	0.0007	0.0007	0.0007	0.0000	0.0007
Rb	0.0000	0.0007	0.0004	0.0007	0.0000	0.0007	0.0003	0.0007	0.0003	0.0007	0.0000	0.0007
Sr	0.0012	0.0007	0.0035	0.0007	0.0014	0.0007	0.0003	0.0007	0.0085	0.0008	0.0026	0.0007
Pb	0.0000	0.0008	0.0000	0.0008	0.0000	0.0008	0.0000	0.0008	0.0000	0.0008	0.0000	0.0008
Silicate Oxides												
Na_2O	0.1229		0.0414		0.0464		0.0142		1.4868		0.1174	
K_2O	0.0972		0.0365		0.0289		0.0141		0.0811		0.0259	
CaO	4.4599		0.3581		0.7108		0.1278		0.7731		0.1311	
MgO	0.0134		0.0121		0.0000		0.0000		0.0000		0.0000	
Al_2O_3	0.1128		0.3981		0.0822		0.0178		0.5234		0.2179	
SiO_2	0.4744		1.8347		0.5368		0.1168		2.1754		0.8632	
Silicates	5.2807		2.6810		1.4052		0.2906		5.0399		1.3555	
Oxides												
TiO_2	0.0075		0.0332		0.0090		0.0012		0.0360		0.0113	
V_2O_5	0.0000		0.0021		0.0007		0.0000		0.0000		0.0000	
MnO_2	0.0000		0.0051		0.0032		0.0003		0.0092		0.0017	
Fe_2O_3	0.0646		0.3564		0.0795		0.0183		0.3241		0.1072	
Oxides	0.0721		0.3968		0.0924		0.0198		0.3693		0.1203	
Ionic Compounds												
NH_4NO_3	0.4503		0.1386		0.1978		0.0972		0.2976		0.1268	
$(NH_4)_2SO_4$	0.4509		0.6810		0.1865		0.2439		0.0137		0.3085	
$CaSO_{4.}2(H_20)$	0.6079		0.1397		0.1936		0.0260		3.7024		0.2908	
NaCl	0.0000		0.0000		0.0000		0.0000		0.2654		0.0000	
Na_2SO_4	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
K_2SO_4	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
Carbon												
EC	0.2718		0.0935		0.0000		0.4427		0.1928		0.0267	
OC	1.1839		0.7666		0.7068		1.1682		1.1066		0.9105	
Sum of Species	8.3176		4.8972		2.7822		2.2884		10.9876		3.1390	
Measured Mass	8.2848	0.4454	3.8270	0.2516	3.0379	0.2232	1.1236	0.1729	11.4393	0.5949	3.0795	0.2246
$PM_{2.5}/PM_{10}$		0.46				0.37				0.27		

Table 12. Chemical and normative mineral compositions for spring 2010 samples

SITE	Ash Meadows NWR				Ash Meadows NWR			
TID	YUCTT164				YUCTT168			
DATE	04/07/10				05/25/10			
SIZE	PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$	
	Conc	Unc	Conc	Unc	Conc	Unc	Conc	Unc
Cl^-	0.0515	0.0219	0.0000	0.0209	-99	-99	0.0000	0.0209
NO_3^-	0.1132	0.0221	0.0844	0.0215	-99	-99	0.3489	0.0310
$SO_4^=$	0.6996	0.0410	0.2993	0.0257	-99	-99	0.6074	0.0371
NH_4^+	0.0965	0.0215	0.1072	0.0216	-99	-99	0.2290	0.0243
Na^+	0.2687	0.0159	0.0391	0.0026	-99	-99	0.1173	0.0070
Mg^{2+}	0.0514	0.0027	0.0114	0.0010	-99	-99	0.0228	0.0014
K^+	0.0276	0.0025	0.0142	0.0022	-99	-99	0.0240	0.0024
Ca^{2+}	0.6918	0.0368	0.1051	0.0117	-99	-99	0.1700	0.0135
O1TC	0.0858	0.0450	0.0747	0.0398	-99	-99	0.1347	0.0683
O2TC	0.2463	0.0309	0.3736	0.0346	-99	-99	0.4042	0.0356
O3TC	0.3326	0.1013	0.3409	0.1018	-99	-99	0.3923	0.1048
O4TC	0.1967	0.0684	0.0949	0.0456	-99	-99	0.1609	0.0597
OPTTC	0.1353	0.0401	0.0225	0.0266	-99	-99	0.1339	0.0399
OPTRC	0.0000	0.0261	0.0348	0.0273	-99	-99	0.0666	0.0300
OC	0.8614	0.1717	0.9189	0.1763	-99	-99	1.1587	0.1970
E1TC	0.0878	0.0209	0.0044	0.0196	-99	-99	0.1324	0.0225
E2TC	0.0641	0.0279	0.0305	0.0253	-99	-99	0.0468	0.0264
E3TC	0.0000	0.0082	0.0000	0.0082	-99	-99	0.0000	0.0082
ECTRC	0.1519	0.0437	0.0000	0.0310	-99	-99	0.1125	0.0385
TC	1.0133	0.2003	0.9189	0.1927	-99	-99	1.2712	0.2234
Na	0.0000	0.0628	0.0000	0.0647	0.0592	0.0676	0.1177	0.0693
Mg	0.0000	0.0211	0.0000	0.0211	0.0221	0.0214	0.0000	0.0211
Al	0.1535	0.0091	0.0534	0.0052	0.2912	0.0156	0.0551	0.0052
Si	0.5932	0.0301	0.2517	0.0131	1.0461	0.0528	0.2107	0.0111
S	0.2016	0.0102	0.1200	0.0061	0.3219	0.0162	0.2599	0.0131
Cl	0.0145	0.0010	0.0027	0.0007	0.0694	0.0036	0.0044	0.0007
K	0.0836	0.0043	0.0345	0.0020	0.1769	0.0089	0.0410	0.0023
Ca	0.5004	0.0254	0.0758	0.0050	0.9764	0.0491	0.1322	0.0074
Ti	0.0125	0.0012	0.0075	0.0011	0.0264	0.0017	0.0037	0.0011
V	0.0000	0.0007	0.0000	0.0007	0.0000	0.0007	0.0001	0.0007
Mn	0.0049	0.0022	0.0004	0.0021	0.0053	0.0022	0.0000	0.0021
Fe	0.1330	0.0067	0.0625	0.0032	0.2801	0.0141	0.0552	0.0029
Cu	0.0009	0.0025	0.0017	0.0025	0.0017	0.0025	0.0000	0.0025
Zn	0.0000	0.0007	0.0000	0.0007	0.0033	0.0008	0.0036	0.0008
Br	0.0000	0.0007	0.0013	0.0007	0.0026	0.0007	0.0020	0.0007
Rb	0.0001	0.0007	0.0000	0.0007	0.0000	0.0007	0.0000	0.0007
Sr	0.0026	0.0007	0.0000	0.0007	0.0105	0.0009	0.0007	0.0007
Pb	0.0000	0.0008	0.0000	0.0008	0.0016	0.0008	0.0000	0.0008
Silicate Oxides								
Na_2O	0.3172		0.0527		0.0000		0.1581	
K_2O	0.0333		0.0171		0.0000		0.0289	
CaO	0.6583		0.1008		0.0000		0.0814	
MgO	0.0000		0.0000		0.0366		0.0000	
Al_2O_3	0.2900		0.1009		0.5502		0.1041	
SiO_2	1.2688		0.5383		2.2374		0.4507	
Silicates	2.5676		0.8098		2.8243		0.8232	
Oxides								
TiO_2	0.0209		0.0125		0.0440		0.0062	
V_2O_5	0.0000		0.0000		0.0000		0.0004	
MnO_2	0.0078		0.0006		0.0084		0.0000	
Fe_2O_3	0.1902		0.0894		0.4005		0.0789	
Oxides	0.2188		0.1025		0.4529		0.0854	
Ionic Compounds								
NH_4NO_3	0.1461		0.1090		-99		0.4504	
$(NH_4)_2SO_4$	0.2328		0.3027		-99		0.4669	
$CaSO_4.2(H_20)$	0.9505		0.1421		-99		0.4803	
NaCl	0.0849		0.0000		-99		0.0000	
Na_2SO_4	0.0000		0.0000		-99		0.0000	
K_2SO_4	0.0000		0.0000		-99		0.0000	
Carbon								
EC	0.1519		0.0000		-99		0.1125	
OC	0.8614		0.9189		-99		1.1587	
Sum of Species	5.2139		2.3849		-99		3.5774	
Measured Mass	6.5308	0.3652	2.2888	0.1996	13.8577	0.7119	3.8686	0.2532
$PM_{2.5}/PM_{10}$		0.35				0.28		

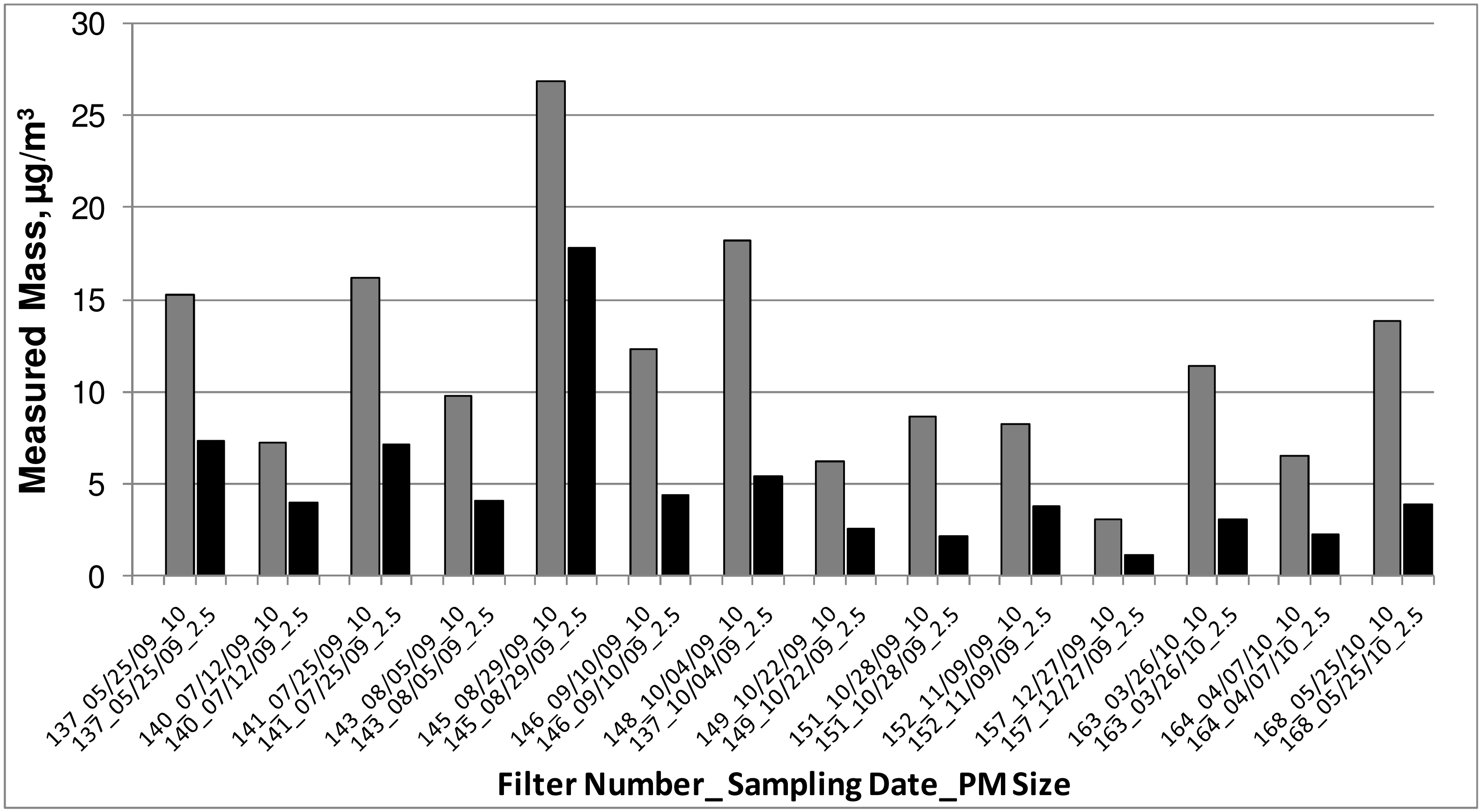

Figure 10. PM_{10} (gray) and $PM_{2.5}$ (black) gravimetric data as measured on Teflon® filters, collected on a 1-in-12 day schedule, for 14 individual sampling days. Sample labels include the sample numbers, sampling dates, and particulate size cut.

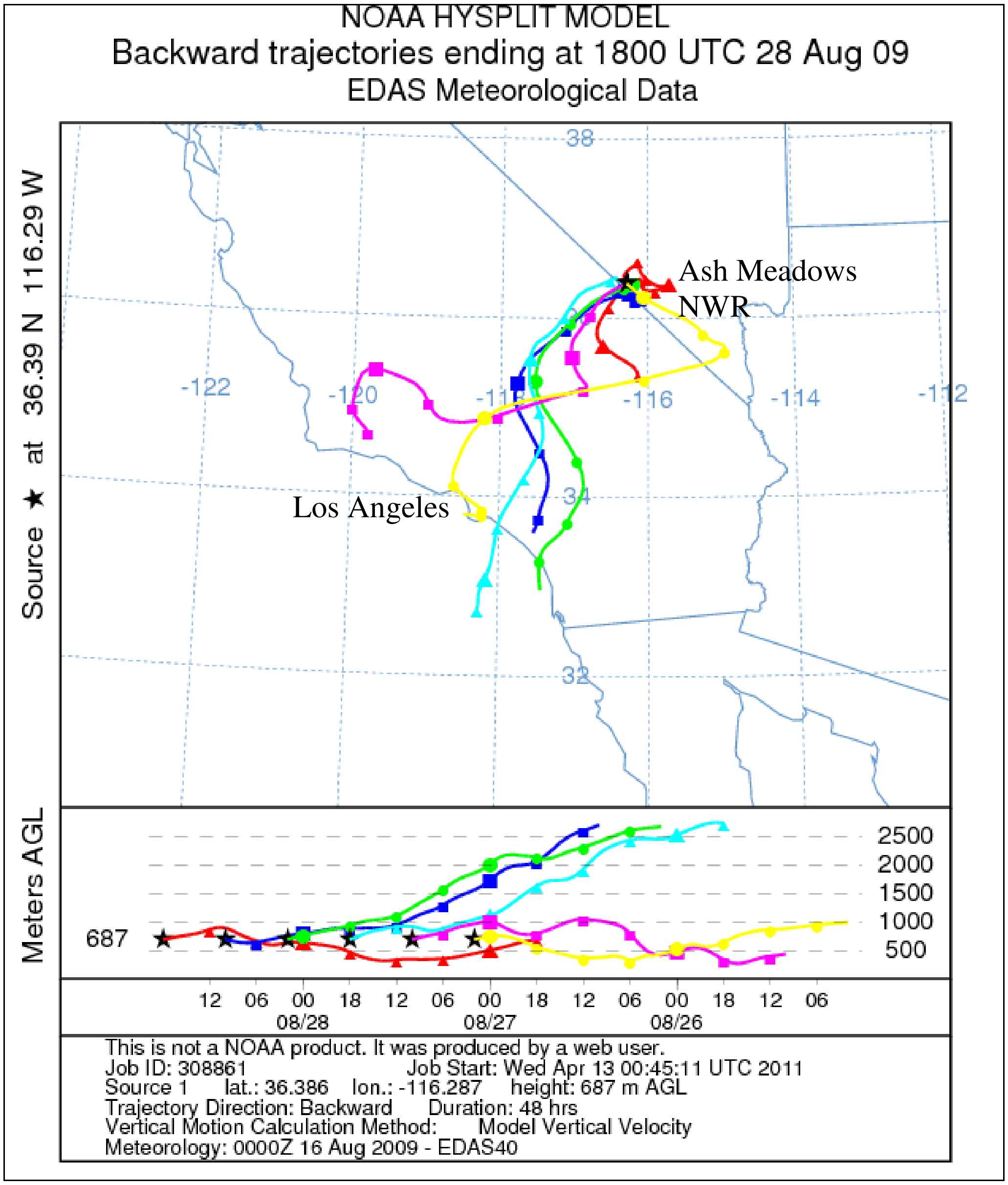

Figure 11. Hysplit backward trajectory model showing airflow from California towards Ash Meadows NWR for the August 27-29 period, coinciding to reported large wildfires in Los Angeles County during that period.

Table 13 shows the average aerosol concentrations at Ash Meadows NWR being low in PM_{10}, but variable by season. It was lowest in winter (3 µg/m^3) and highest (15 µg/m^3) in spring and summer. Similarly for $PM_{2.5}$, the lowest concentrations were found in winter (1 µg/m^3) with higher (4 to 9 µg/m^3) values for the other three seasons. The PM levels are on average similar to those from the eight sites in southwestern Nevada and to the four IMPROVE sites. The measurements taken in the course of this Ash Meadows NWR campaign are substantially lower than those from the urban CSN sites. Both the PM_{10} and $PM_{2.5}$ levels are substantially lower than the 24 hr and the annual US EPA National Ambient Air Quality Standards (NAAQS).

Table 13. Comparison of seasonal average gravimetric results from this study (Ash Meadows NWR, 05/25/09 to 05/25/10) with those from the preceding study at eight sites in rural southwestern Nevada, urban southwestern U.S.A. (CSN) and rural southwestern U.S.A. (IMPROVE) sites.

Region	Date Start	Date End	Avg. PM_{10} µg/m^3	Avg. $PM_{2.5}$ µg/m^3	$PM_{2.5}/PM_{10}$	Days of 24 hr Data
Ash Meadows NWR - Filters -Spring 09	05/25/09	05/25/09	15	7	0.48	1
Ash Meadows NWR - Filters-Summer	07/12/09	08/29/09	15	9	0.58	4
Ash Meadows NWR - Filters - Fall	09/10/09	11/09/09	11	4	0.34	5
Ash Meadows NWR - Filters Winter	12/27/09	12/27/09	3	1	0.49	1
Ash Meadows NWR - Filters - Spring 10	03/26/10	05/25/10	11	4	0.42	3
Ash Meadows NWR - Filters - Average	05/25/09	05/25/10	11	5	0.47	14
S-W Nedvada - Filters - 8 sites	03/24/06	12/19/07	10	4	0.47	86
S-W USA - 5 Urban CSN sites	2006	2007	38	11	0.29	>500
S-W USA - 4 Rural IMPROVE sites	03/24/06	12/19/07	13	5	0.39	>500
US EPA NAAQS 24 hr			150	35		
US EPA NAAQS annual				15		

There are differences between the average PM_{10} gravimetric values measured on the Teflon® filters (11 µg/m^3, Table 13), compared to the TEOM® monitor (9 µg/m^3, Table 3). For $PM_{2.5}$, the differences between Teflon® filters (5 µg/m^3), and the TEOM® monitor (4 µg/m^3) are less. These discrepancies between the TEOM® and Teflon® filter results are ascribed to differences in the instrumentation and sampling techniques - the TEOM® sampling chamber and filter stub are heated to 50 °C, resulting in the evaporation of semi-volatiles such as water and organic compounds from the sampled particulate matter on the filter, with a resultant loss in mass.

Filter Chemistry

In the course of this study, Teflon® filters, including field and laboratory blanks were analyzed by Energy Dispersive X-ray Fluorescence Spectrometry (EDXRF) for 40 chemical elements including total sodium (Na), magnesium (Mg), aluminum (Al), silicon (Si), sulfur (S), chlorine (Cl), potassium (K), calcium (Ca), titanium (Ti), vanadium (V), manganese (Mn), iron (Fe), copper (Cu), zinc (Zn), bromine (Br), rubidium (Rb), strontium (Sr), and lead (Pb).

Water extractions were performed on one half of each of the quartz fiber filters, including field and laboratory blanks. Aliquots of the extractions were analyzed by Ion Chromatography (IC) for water soluble anions, sulfate (SO_4^{2-}), nitrate (NO_3^-), and chloride (Cl^-). An aliquot thereof was analyzed for the ammonium (NH_4^+) cations by Automated Colorimetry (AC). Further aliquots of the extractions were analyzed by Atomic Absorption (AA) for water soluble cations including sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), and magnesium (Mg^{2+}).

Punches from the remaining half of each of the quartz fiber filters were analyzed by Thermal Optical Reflectance (TOR) for four fractions of organic carbon (OC) and three fractions of elemental carbon (EC), by the IMPROVE method (http://vista.cira.colostate.edu/IMPROVE /Overview/Overview.htm).

Tables 8 to 12 list the analytical results of 14 individual days of 24 hr filter sampling at Ash Meadows NWR, for both PM_{10} and $PM_{2.5}$, for each season. The chemical results were calculated for oxides and ionic compounds, and grouped into four categories: silicate oxides (Na_2O, K_2O, CaO, MgO, Al_2O_3, SiO_2), minor oxides (TiO_2, V_2O_5, MnO_2, Fe_2O_3), ionic compounds (NH_4NO_3, $(NH_4)_2SO_4$, $CaSO_4.2(H_2O)$, NaCl, Na_2SO_4, K_2SO_4), elemental carbon (EC), and organic carbon (OC).

The silicates (Figure 12) are a major component in all samples, varying from 23-66% of the sample mass for PM_{10} and 10-55% of the sample mass for $PM_{2.5}$, with larger fractions in the three samples collected in October and November 2009. This can be ascribed to airborne mineral dust prevailing during the late fall of 2009. Small amounts of gypsum were found in all samples, together with trace to minor amounts of evaporites such as halite and water soluble sulfates.

Secondary ammonium sulfate and secondary ammonium nitrate, both largely from combustion processes, occur mostly in the $PM_{2.5}$ fractions, with the highest concentrations for both these secondary compounds in samples collected during the period May - October, 2009. High concentrations of both elemental carbon (1.2 $\mu g/m^3$) and organic carbon (8.5 $\mu g/m^3$) in PM_{10} with similar amounts in $PM_{2.5}$ were analyzed in the 08/29/09 sample, providing additional evidence of smoke from wildfires in Los Angeles County, California.

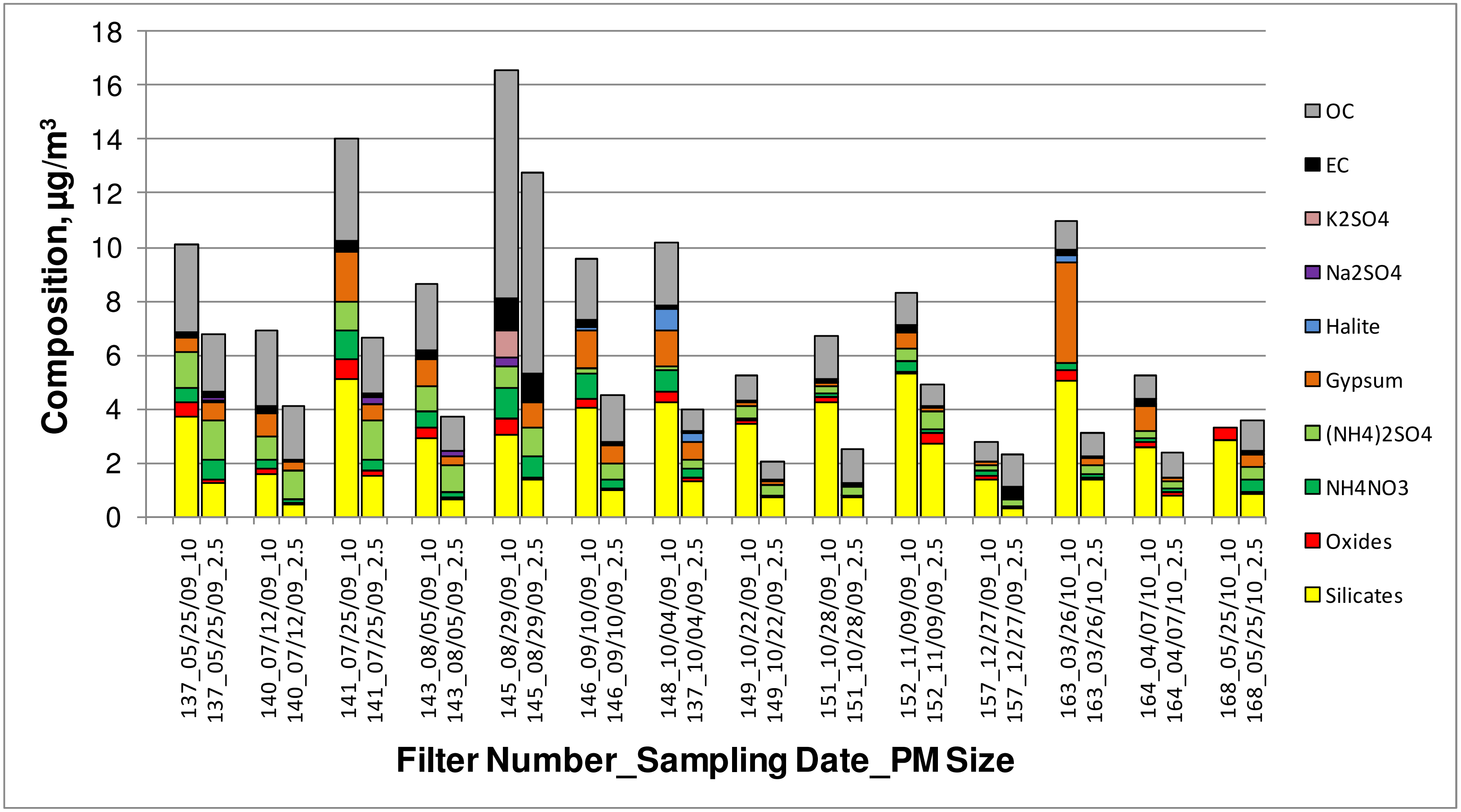

Figure 12. Chemical measurements combined as silicate oxides, minor metal oxides, ammonium sulfate, ammonium nitrate, gypsum, halite, sodium sulfate, potassium sulfate, elemental carbon (EC) and organic carbon (OC), for PM_{10} and associated $PM_{2.5}$ size fractions. Sample labels include the sample numbers, sampling dates, and particulate size cut.

CONCLUSIONS

- The instrumented trailer provided a versatile mobile platform for housing and transporting an array of air quality and meteorological instrumentation. Besides the two continuous particulate matter (PM) monitors (TEOM®s), all instrumentation in the trailer could also be powered from photovoltaic charged 12 V DC batteries.
- Measurements taken at Ash Meadows NWR over a period of 12 months in 2009 and 2010 provided baseline air quality and meteorological information for rural southwestern Nevada, specifically Nye County and the Amargosa Valley.
- There are inconsistent differences between the average PM_{10} gravimetric results from the Teflon® filters (12 $\mu g/m^3$), and the TEOM® monitors (9 $\mu g/m^3$). There is less of a difference for $PM_{2.5}$, being on average 5 $\mu g/m^3$ for the Teflon® filters and 4 $\mu g/m^3$ for the TEOM® monitor. The corresponding $PM_{2.5}/PM_{10}$ ratios vary between the 0.42 for the Teflon® filters and 0.36 for the corresponding TEOM® measurements. These discrepancies are attributed to the loss of semi-volatile organic compounds and water from the heated TEOM®'s sampling stub.
- All mass measurements fall well below the NAAQS for PM_{10} (150 $\mu g/m^3$ for 24 hr averaging interval) and $PM_{2.5}$ (35 $\mu g/m^3$ for 24 hr averaging interval, 15 $\mu g/m^3$ for annual averaging interval). The averaged levels measured on Teflon® at Ash Meadows NWR for both PM_{10} (12 $\mu g/m^3$) and $PM_{2.5}$ (5 $\mu g/m^3$), are similar to those previously measured at four rural IMPROVE sites.
- The mineral dust (soil) components, including the silicate oxides, minor oxides and gypsum, together make up the largest percentage of the aerosol, being on average 58% of PM_{10} by mass and 37% of $PM_{2.5}$ by mass, the difference being ascribed to the coarser nature of the soil-forming minerals. The highest concentrations of mineral dust components were measured during drier fall months of October and November, 2009.
- Although halite (NaCl) was found in all samples, the percentages are always very low, except for the filter samples collected on 10/04/2009. The anomalously high values of 8% halite for PM_{10} and 10% for $PM_{2.5}$ point to an evaporite (salt) source such as an alkaline playa dust. Playas are common in the region around Ash Meadows NWR.
- Although secondary ammonium sulfate concentrations vary with season, they are, within margins of uncertainty, similar for PM_{10} and $PM_{2.5}$, implying that this species occurs in the finer fraction. Average values for PM_{10} were 0.5 $\mu g/m^3$, and 0.7 $\mu g/m^3$ for $PM_{2.5}$, with the highest concentrations in spring 2009 and the lowest in following late fall and winter. Secondary ammonium sulfate is from SO_2 emitted by distant power plants and other combustion sources, and transported into the Amargosa Valley.

- Ammonium nitrate concentrations fluctuate by the month with both the lowest (0.08 µg/m^3 for PM_{10} and 0.03 µg/m^3 for $PM_{2.5}$) and highest (1.11 µg/m^3 for PM_{10} and 0.77 µg/m^3 for $PM_{2.5}$) measured values being in fall of 2009. Secondary nitrates form from nitrogen oxides emitted from vehicle emissions, possibly transported to Amargosa Valley from the Las Vegas - Los Angeles corridor.
- The elemental carbon (EC) is generally very low (on average < 0.2 µg/m^3) except for the samples collected on 8/29/2009 when high values for EC of 1.20 µg/m^3 for PM_{10} and 1.04 µg/m^3 for $PM_{2.5}$ were measured. Similarly, OC was low (on average < 1.8 µg/m^3) except for the sample of 8/29/2009 when high values for OC of 8.5 µg/m^3 for PM_{10} and 7.5 µg/m^3 for $PM_{2.5}$ were measured. These elevated carbon levels are attributed to woodsmoke from wildfires in Los Angeles County, California.

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