Executive Summary

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Research papers revised for Journal Publications
The following papers were revised this quarter and re-submitted for peer-review:

- Goossens, D. and Buck, Brenda, *in review*, Effects Of Wind Erosion, Off-Road Vehicular Activity, Atmospheric Conditions And The Proximity Of A Metropolitan Area On PM10 Characteristics In A Recreational Site Near Las Vegas, NV, USA, *Atmospheric Environment*

The abstracts for each paper are listed below, to summarize the results:

*McLaurin, B., Goossens, D., and Buck, Brenda, in review, Combining Surface Mapping and Process Data to Assess, Predict, and Manage Dust Emissions from Natural and Disturbed Land Surfaces, Geosphere*
Abstract:

The impact of dust emission on air quality is a significant health and environmental concern. Accurately determining the source (natural vs. anthropogenic) and load of dust is an important component of any mitigation effort. We develop an approach to assess dust emission potential based on study of Nellis Dunes Recreation Area, a popular off-road vehicle area close to Las Vegas, NV. A mapping approach to assess dust emission potential is presented, which may serve as a template to assess other areas for this hazard. A 1:10,000 map delineating units based upon surficial characteristics affecting dust emission (e.g. soil texture, rock cover, surface crusts, vegetation) was created. Seventeen surface units are grouped into four major classes (sand, silt/clay, rock covered, active drainages). A >500 km network of trackways was digitized into a GIS to determine the distribution of tracks across surface types to assess the density of disturbance. Wind erosion measurements and off-road experiments using different vehicles (ATV, motorcycle, dune buggy) were performed on the various surface types to assess the amount of dust generated. Dust emission risk maps for NDRA are presented for two types of processes: off-road vehicular activity and wind erosion. Highest dust emissions for ORV activity occur on map units composed of silt/clay and desert pavements. These areas can also produce large amounts of dust through natural wind erosion when disturbed. In contrast, the sandy units produce high emissions through natural wind erosion and therefore limiting ORV use in those areas provides no benefit to air quality.

Goossens, D. and Buck, Brenda, in review, Effects Of Wind Erosion, Off-Road Vehicular Activity, Atmospheric Conditions And The Proximity Of A Metropolitan Area On PM10 Characteristics In A Recreational Site Near Las Vegas, NV, USA, Atmospheric Environment

Abstract

PM10 concentrations were measured at Nellis Dunes Recreation Area (NDRA), Nevada, USA. NDRA is a desert area located 6 km northeast of the metropolitan area of Las Vegas. Three sources contribute to the dust at the site: local wind erosion, off-road vehicular activity and dust production in the city of Las Vegas. PM10 concentrations were measured during one complete year and stored as 20-min averages. Grain-size distribution was also determined from sediment collected in sediment traps. PM10 concentrations at NDRA are greater, and dust is finer in April-September as compared to October-March. Concentrations are also higher during the day than at night. The diurnal pattern of PM10 concentration at NDRA is characterized by a maximum in the early afternoon and a minimum in the morning. In all months except June-August, a secondary peak in concentration occurs around midnight. The higher concentrations during the day are not explained by local wind erosion, by meteorological parameters such as wind speed, wind direction, atmospheric stability or ventilation, or by the supply of dust from the Las Vegas metropolis. The diurnal pattern of PM10 concentration in NDRA also differs from that observed at other rural sites in the Las Vegas Valley and in the city itself. The aberrations in the PM10 pattern at NDRA are caused by intense off-road vehicular driving in this area.
Research paper accepted for Publication
The following paper was accepted for publication in *Earth Surface Processes and Landforms*. The abstract is presented below, which contains a summary of this work.

*Goossens, D., and Buck, Brenda, in press, Gross erosion, net erosion and gross deposition of dust by wind: field data from 17 desert surfaces, Earth Surface Processes and Landforms*

**Abstract**

Wind erosion measurements were carried out in Nellis Dunes Recreation Area, southern Nevada, USA. Gross erosion (the total mass of sediment effectively blown away from a surface), gross deposition (the total mass of sediment effectively depositing on a surface) and net erosion (the difference in sediment mass before and after an event) were measured for 1 year, on 17 different types of surfaces developed on loose dune sand, compacted sand, loose silt, compacted and/or aggregated silt, rock-covered sands and silts, mixtures of sand, silt and clay, exposed petrocalcic horizons, gravelly substrata and bedrock. Results showed that net erosion, which is the type of erosion measured in field and laboratory experiments, strongly differs from gross erosion. Activity on a surface is much higher than classic net erosion measurements suggest. Future studies on wind erosion should better acknowledge the distinction between the two types of process. Also, a grain diameter of maximum susceptibility to wind erosion ("optimum deflation diameter") near 70 µm as proposed by the aeolian literature only exists for net wind erosion. We found no such optimum diameter for gross wind erosion within the particle range 0-100 µm delineating the transport modes of suspension and modified saltation. In addition, desert surfaces predominantly composed of sand did not show an optimum deflation diameter (for net erosion) around 70 µm. Instead, there was a preferential grain size around 15 µm at which particles were most vulnerable to net emission. Desert surfaces poor in sand showed the classic value of 70 µm. This suggests that interactions exist between the type of surface and the susceptibility of particles to wind erosion. This study is solely based on field data. Although results are supported by two previous wind tunnel studies, more wind tunnel experiments documenting the interactions between gross erosion and gross deposition are necessary.

**Interpretation of Chemical & Mineralogical Data (continuing)**

Results from the chemical and mineralogical analyses of soils and dust currently indicate two areas of concern for human health, (1) widespread presence of the fibrous mineral, palygorskite; and (2) high concentrations of arsenic throughout the field area. In the next quarter, research will continue in these areas as well as consider other potential elements and minerals of concern.

**Mineralogy Results**
X-ray diffraction (XRD) analyses were made on soil samples collected from 17 dust stations representing the 17 different surface types in the Nellis Dunes area. Soil samples from five parking areas were also collected for XRD analyses. The following size fractions were analyzed: <2 µm, 2-20 µm, 20-60 µm and 60-100 µm. The mineralogical composition of the 20-60 µm and 60-100 µm fractions of the 17 dust station and 5
parking lot samples is relatively uniform, consisting mainly of quartz and calcite, with lesser amounts of plagioclase and alkali feldspars. Nearly all of the samples contain palygorskite; palygorskite is more commonly observed in the finer fractions of the samples. Several of the samples also contain amphiboles and a few contain a trace of kaolinite, gypsum, and mica/illite. Most of the gypsum that may have been present in these samples would have been removed during the distilled water rinses prior to fractionation. The mineralogical composition of the clay (<2 µm) and silt (2-20 µm) fractions is also relatively uniform consisting mainly of smectite with lesser amounts of mica/illite, kaolinite, quartz, and calcite. Nearly all of the samples also contain chlorite, palygorskite, and plagioclase and alkali feldspars. Three of the silt samples contain amphiboles and one sample contains a 1:1 interstratified illite/smectite within the clay and silt fractions. Trace amounts of gypsum were also detected in many of the samples, although much of the gypsum in these samples would have been removed during the distilled water rinses.

**Mineralogical Hazards to Health**

Many different minerals have been found to accumulate in lung tissue and adversely affect health (quartz, mica, gypsum, apatite, talc, rutile, pyroxene, feldspar, numerous clay and zeolite minerals) (Churg, 1983). Palygorskite is of special concern because its fibrous morphology is similar to asbestos and it has been found to induce lung cancer in rats as well as shown many other deleterious health effects (Bignon et al, 1980; Rom et al., 1983; Begin et al., 1987; Wagner et al., 1987; Lemaire et al., 1989; Duzgoren-Aydin, 2008; Krewski et al., 2008). In addition to inhalation, swallowing inhaled fibrous minerals or ingesting food or beverages containing these minerals has been linked to gastrointestinal cancer, although palygorskite is believed to be much less dangerous than asbestos minerals (Reiss et al. 1980). At NDRA, palygorskite in the less than 20 µm fraction occurs in the highest concentrations in the active dunes with vegetation and sandy disturbed surfaces (1.2, 1.3 and all of the parking lots tested). However, palygorskite has a significant presence in most areas in NDRA. Palygorskite is a common authigenic mineral in stage II pendants and stage III-VI petrocalcic horizons (i.e. Watts, 1980; Jones and Galan, 1988; Monger and Daugherty, 1991, Brock and Buck, 2005; Francis et al., 2007; Brock and Buck, 2009; Buck et al., 2010).

Additionally, minerals with high cation exchange capacity such as smectite, can pose increased risk because known carcinogens may be absorbed onto them (Nettesheim and Griesemer, 1978; Guthrie, 1997;Duzgoren-Aydin, 2008). At Nellis Dunes, smectite clay minerals in the <2 µm fraction are found in all of the sandy and rock-covered units (1.1, 1.2, 1.3, 1.4, 1.5, 3.1, 3.2, 3.3, 3.4, 3.5), and almost all of the silt/clay and drainage units (2.2, 2.3, 2.4, 4.2, 4.3).

**Chemistry Results**

Soil samples collected from the 17 different surface types in the Nellis Dunes area and five parking areas were initially scanned for 66 different elements using inductively coupled plasma mass spectroscopy (ICP-MS). The purpose of the initial semi-quantitative scan was to identify potential elements of environmental concern in the samples. The <2 mm fraction of the soil samples was obtained by sieving and digested in
accordance with EPA Method 3052 prior to analysis. Based on the results of the semi-quantitative scan, the following elements were identified as elements of potential concern: arsenic (As), cobalt (Co), chromium (Cr), cesium (Cs), copper (Cu), cadmium (Cd), silver (Ag), nickel (Ni), lead (Pb), strontium (Sr), uranium (U), vanadium (V), thallium (Tl), boron (B), molybdenum (Mo), antimony (Sb), and mercury (Hg). The soil and parking area samples were then re-analyzed quantitatively for these elements using ICP-MS.

Dust samples collected using the Portable In-Situ Wind Erosion Laboratory (PI-SWERL) were also analyzed for the potential elements of environmental concern. The PI-SWERL samples were collected from 16 of the 17 different surface types on both ORV trails and on undisturbed surfaces near the trails; samples could not be collected from areas of outcropping bedrock or outcropping petrocalcic horizons. PI-SWERL samples were also collected from 5 parking areas. The <10 µm and 10-60 µm size fractions were separated by sedimentation and wet sieving and digested in accordance with EPA Method 3052 prior to analysis. Additionally, 10:1 water:soil extracts were prepared to determine the water soluble constituents in the PI-SWERL samples. The 10:1 extracts were used instead of a saturated paste because of limited sample sizes. These samples were allowed to sit overnight and were then filtered to obtain the supernatant. The supernatant was also analyzed for the potential elements of environmental concern by ICP/MS.

The pH values of the soluble PI-SWERL extracts were near neutral to slightly alkaline, ranging from 7.44 to 9.11. Electrical conductivity of the extracts was from 0.43 to 2.43 dS m⁻¹. The analytical results indicate elevated concentrations of As, Sr, U, V, B, and Mo in some of the samples. Arsenic concentrations ranged from 0.419 to 14.71 µg g⁻¹, Sr from 4.37 to 1344.6 µg g⁻¹, U from 0.005 to 1.168 µg g⁻¹, V from 0.30 to 10.80 µg g⁻¹, B from 2.80 to 174.4 µg g⁻¹, and Mo from 0.038 to 13.52 µg g⁻¹.

In neutral to alkaline soils impacted by sodium (Na), arsenic may be highly mobile and form soluble sodium arsenates (McBride, 1994, Matera and Le Hécho, 2001). Strontium is a relatively common trace element in the Earth’s crust and is likely to be concentrated in intermediate magmatic rocks and in carbonate sediments. Strontium also behaves similarly to calcium (Ca) in the environment and is often associated with Ca in soil and sediments. Strontianite (SrCO₃) is easily solublized and its dissolution may be responsible for the elevated Sr concentrations (Kabata-Pendias, 2001). Under arid conditions, U forms compounds with varying solubility with oxides, carbonates, phosphates, vanates, and arsenates (Kabata-Pendias, 2001). The elevated concentrations of soluble B may result from the presence of soluble sodium borate salts, which commonly occur in alkaline soils in arid regions (McBride, 1994). Vanadium and Mo are also known to have high availability and bioavailability in oxidized soils that are neutral to alkaline.

Concentrations of Co, Cr, Cs, Tl, Sb, Sr, and Hg in the insoluble fraction of the soil, parking lot, and PI-SWERL samples were generally similar. However, concentrations of
As, Cu, Cd, Ag, Ni, Pb, U, V, B, and Mo in the soil samples were up to one order of magnitude lower as compared to the PI-SWERL samples. These results are expected because of the larger particle size (<2 mm) of the soil samples as compared to the PI-SWERL samples (<10 µm and 10-60 µm). The XRD results demonstrated that the finer fractions of the samples are dominated by smectite minerals, which are known to be major contributors to soil CEC and therefore, affect the retention of metals in the soil (Reid-Soukup and Ulery, 2002). The amount of smectite in the dust station and parking lot soil samples is “diluted” relative to that in the PI-SWERL samples, because smectite is only present in the finest portions of these samples. Therefore, the finer fractions, which are more likely to be inhaled, contain the highest concentration of harmful elements and minerals.

In general, the lowest elemental concentrations reported in the soil and parking lot soil samples occurred in the sand areas, particularly in Unit 1.2 (dunes with vegetation). These results are expected because the sand areas have the lowest proportion of clay and silt. As stated previously, the XRD results demonstrated that the finer fractions of the samples are dominated by smectite minerals which retain metals. The lowest reported concentrations of Pb, Sr, Mo, Sb, and Tl occurred in samples from the parking lots. The highest concentrations of most elements, as expected, occurred in samples from silt/clay areas, particularly in Units 2.2 (silt/clay with gravel) and 2.3 (aggregated silt).

In contrast, the lowest elemental concentrations in the PI-SWERL samples occurred in various units, and not within the sand areas. This may be caused by variations in clay mineral chemical composition as well as other minor mineralogical differences between samples. XRD analyses show that the mineralogical composition of the clay (<2 µm) and silt (2-20 µm) fractions of the samples is relatively uniform, and dominated by smectite minerals. The highest elemental concentrations are reported primarily in Unit 1.5, which consists of outcrops of very fine sand and coarse silt. The results of the XRD analyses show that the <2 µm and 2 to 20 µm fractions of this sample are dominated by highly crystalline smectite. The Unit 1.5 smectite may have a lower layer charge than most of the other smectites present in the Nellis Dunes area. Smectites with lower layer charge have a greater shrink-swell capacity than smectites with higher layer charge resulting in greater amounts of water, hydrated cations and organic molecules being attracted to the interlayer region (Reid-Soukup and Ulery, 2002).

The reported concentrations of elements in the soil, parking lot and PI-SWERL samples were also compared with the USEPA Region 3, 6, and 9 screening levels (SLs) for chemical contaminants in residential soils and soil concentrations considered to be protective of groundwater resources (USEPA, 2010). The SLs are developed using risk assessment guidance from the EPA Superfund program and are used for site “screening: and as initial cleanup goals, if applicable. The risk-based SLs are considered by the EPA to be protective for humans (including sensitive groups) over a lifetime. However, it should be noted that the SLs may not be applicable at a particular site and they do not
address non-human health endpoints, including ecological impacts. The EPA has also established SLs for residential and industrial air which are applicable to human inhalation; these SLs are based on chemical concentrations in the air (µg m⁻³). Future work will include recalculating the chemical concentrations in terms of mass per volume air (µg/m³) by combining the chemical concentrations in the soil with the emission rates measured during the ORV experiment. These results are not yet available. The reported concentrations of As in the soil and parking lot soil samples ranged from 3.49 to 83.02 µg g⁻¹ or parts per million (ppm) and from 16.13 to 312 µg g⁻¹ in the insoluble fraction of the PI-SWERL samples. Arsenic concentrations in the soluble fraction of the PI-SWERL samples ranged from 0.601 to 7.78 µg g⁻¹. The arsenic concentrations in all of the samples analyzed exceed the EPA’s SL of 0.39 µg g⁻¹ for As in residential soil.

Chemical Hazards to Health
Arsenic has long been recognized as a poison. Exposure to arsenic has been strongly linked to heart disease, hypertension, peripheral vascular disease, diabetes, immune suppression, acute respiratory infections, intellectual impairment in children, and skin, lung, prostate, bladder, kidney and other cancers (Chen, 1992; Abernathy et al., 1999; Tseng et al., 2003; Smith et al., 2006; von Ehrenstein et al., 2007; Kozul et al., 2009). Additionally, arsenic has been found to be uniquely harmful to lung tissue by inhibiting wound repair and altering genes associated with immune functions in lung tissue (Olsen et al., 2008; Kozul et al., 2009a; Kozul et al., 2009b). Therefore, exposure to arsenic can significantly increase the negative health effects caused by PM10.

All soils at NRDA contain arsenic concentrations at levels significantly above EPA regional screening levels – in some cases up to 200 times higher than screening levels for residential soil and 2.2 x 10⁵ times higher than the screening levels for groundwater protection. In airborne samples arsenic concentrations are even much higher. The Screening Levels are developed using risk assessment guidance from the EPA Superfund program and are used for site "screening" and as initial cleanup goals, if applicable. The groundwater protection concentrations shown are soil concentrations considered to be protective of groundwater.

- EPA Screening Level for residential soil is 0.39 ppm; for groundwater protection it is 0.0013 ppm.
- Arsenic concentrations in Nellis Dunes PM10 fraction vary from a low of 18.56 ppm (unit 2.3) up to 290.01 ppm (unit 1.5).

Naturally occurring background concentrations of arsenic vary regionally because of a combination of climatic, geologic, and anthropogenic factors. Sources of As in the environment include weathering of As-bearing rocks and minerals, volcanic eruptions, fly ash from coal burning plants, smelter fumes released during the treatment of As-containing metallic ores, and application of arsenical pesticides, herbicides and corrosion inhibitors.

It is believed that the arsenic at Nellis Dunes is naturally-occurring as a result of regional
geologic processes. If funding is available, future research could determine the source of the arsenic, which would be highly useful for future regional land-use planning and management.

Average background concentrations of arsenic in soils throughout the world reportedly range from 2.2 to 25 ppm, and in the United States at average concentrations ranging from 3.6 to 8.8 ppm (McBride, 1994). These values are significantly lower than those found at Nellis Dunes. In a 1975 study of 21 soil samples collected in the western United States, As concentrations ranged from non-detectable to 97 ppm with an average concentration of 6.1 ppm (Connor and Shacklette, 1975). In another study, arsenic analyses were performed on 50 soils collected throughout California. Arsenic concentrations in these soils ranged from 0.6 to 11 ppm, with an average concentration of 3.5 ppm (Bradford et al., 1996). Reheis et al. (2009) conducted a compositional study of modern dust and surface sediments in the desert southwest, United States. These investigators reported median As concentrations of 20 ppm in dust and 10 ppm in surface soil samples. Based on the results of their study, Reheis et al. (2009) also concluded that modern dust compositions in their study area have been influenced by anthropogenic sources and emissions from Owens (dry) Lake after its artificial desiccation in 1926.

The reported concentrations of As and Co in all of the samples exceed the EPA SLs considered to be protective of groundwater. The SL for Sb is exceeded in all samples except for the parking lot soil samples. Eight of the soil samples and nearly all of the PI-SWERL samples exceed the SL for Hg. Nearly all of the PI-SWERL samples also exceed the SL for Mo, and all of the PI-SWERL samples exceed the SL for B. Three of the PI-SWERL samples exceed the SLs for Cu and Ag, and two PI-SWERL samples exceed the SL for Cd. None of the reported concentrations of Ni, Sr, U, and V in the samples exceeded the SLs for groundwater for these elements. The EPA has not established SLs for groundwater for Cr, Cs, Tl, and Pb. Although the reported elemental concentrations in many samples exceed one or more of the EPA SLs, the potential risk to groundwater resources from leaching of these elements is considered to be minimal because of the arid climate and depth to groundwater (>100 feet below ground surface). However, the high soluble concentrations of metals in these soils are a concern for downstream contamination from runoff.
Preliminary Results of study to measure Health affects of Nellis Dust

In vivo experiments were conducted in mice to examine the immunotoxicological effects following exposure to dust samples collected from three recreational desert sites bordering the Nellis AFB and the city of Las Vegas, NV (NDRA). Samples were collected from 3 different soil types in the NDRA: Unit 2.2 = a silt/clay unit with some surface gravel that forms a portion of ‘badlands’ topography in the NDRA; median diameter of 4.3 microns; Unit 3.1 = a well developed desert pavement with underlying silty Av soil horizon; median diameter of 2.4 microns; Unit 3.2 = a rock-covered surface with silt/clay zones that comprises the greatest amount of surface area in the NDRA; median diameter of 3.1 microns. All dust was extracted from samples taken from the uppermost cm of the topsoil using a cyclone dust separator that only collects the finest particles.

To simulate the potential health impacts of a weekend exposure to dust at the NDRA, adult female B6C3F1 mice were exposed by tracheal aspiration to dust samples with a median diameter of 4.3 microns or less at 0, 0.1, 1.0, 100, or 1000 mg/kg/day daily for 3 days. Dust was administered in a vehicle of sterile phosphate buffered saline via intratracheal aspiration into the lungs. Descriptive and functional immunological assays and lung pathology were performed to assess human health risks. Daily intratracheal administration exposure occurred on days 1, 2 and 3. Intra-peritoneal challenge with sRBC was on day 1. Mice were assessed on Day 6 immunological function and lung pathology. This protocol was approved by the Animal Care and Use Committee (IACUC) and conducted in an AAALAC accredited facility.

The lowest adverse effect level (LOAEL) based on immunotoxicology studies is 0.1 mg/kg for map unit 2.2 and 1.0 mg/kg for map units 3.1 and 3.2.

These values are exceeded for 70 kg male driving at 10 km/hr or greater for 1 hour only, for all three ORV vehicles (dune buggy, 4 wheeler, dirt bike) for unit 2.2. These values are exceeded for units 3.1 and 3.2 for 70 kg males driving a dune buggy at 20 km/hr or greater, a 4 wheeler at 10 km/hr or greater, and a dirt bike at 30 km/hr for 1 hour. Under the same conditions, a 3-day 8 hr/day accumulative ‘weekend’ dose is up to 322.5 mg/kg.

For a male adolescent (14-15 yr old, 59.4 kg weight) the LOAEL values for unit 2.2 are exceeded for all three ORV vehicles driving at 10 km/hr or greater for 1 hour. For units 3.1 and 3.2 LOAEL values are exceeded driving a dune buggy at 20 km/hr or greater; a 4-wheeler at 10 km/hr or greater; and a dirt bike at 30 km/hr or greater for 1 hour. Under these same conditions, a 3-day 8 hr/day accumulative ‘weekend’ dose is up to 389.6 mg/kg.

The estimated exposure to dust while resting in the vicinity of Nellis Dunes Recreation Area with 10 km/hr winds exceeds the LOAEL value for unit 2.2 for 1 hr exposure for 10 yr old 30 kg child, a 1 yr old 10 kg child, and a 70 kg male adult. LOAEL values are exceeded for units 3.1 and 3.2 for a 3-day 8 hr/day accumulative ‘weekend’ dose.

Research and continued interpretation of these results will continue during the next quarter.
Current Recommendations
Our data show that substances known to negatively impact human health occur in dust from all surfaces in the Nellis Dunes Recreation Area.

Previously, we published emissions data that showed that driving on the sand dunes did not significantly increase emissions whereas driving on silty areas did. At that time we recommended continued ORV driving on the sand dunes. However, these new data now show that both natural wind and ORV emissions from the sand dunes contain significant arsenic and palygorskite and thus avoiding human inhalation of these emissions is strongly recommended. In addition, the health study using mice shows that even small amounts of dust from NDRA can significantly compromise the immune system.

The risks to populations downwind from the Nellis Dunes Recreation Area are not known, but both natural wind erosion and continued ORV use do create emissions. For approximately half the year, wind direction does blow from the Nellis Dunes Recreation Area towards the cities of North Las Vegas, Las Vegas, and Henderson.

Western Regional Cooperative Soil Survey Western Society of Soil Science/Western Society of Crop Science Joint Conference Las Vegas
The Western Regional Cooperative Soil Survey, Western Society of Soil Science/Western Society of Crop Science Joint Conference was held in Las Vegas June 21-24, 2010. This meeting was co-sponsored by the BLM and largely organized by Robert Boyd (BLM). During this meeting Brenda Buck presented the results of this project in poster form and on June 23rd, nearly 80 participants visited the northern overlook of the site as stop 1 of the fieldtrip. A fieldtrip guidebook was published and contains an overview of the results of this study to-date:


A link to download the fieldtrip guidebook was submitted to Lisa Christianson on June 8, 2010.

Meetings with BLM personnel
During the Western Regional Cooperative Soil Survey Western Society of Soil Science/Western Society of Crop Science Joint Conference in Las Vegas, Brenda Buck met informally with Robert Boyd (BLM) and Sarah Peterson (BLM) who also attended this meeting.
On June 25, 2010, Drs Buck, Goossens, Soukup, Sudowe, Teng, and Baron; and 3 students met with Lisa Christianson (BLM), Bob Ross (BLM), Shonna Dooman (BLM), and Sarah Peterson (BLM) at the northern parking lot to Nellis Dunes. Brenda Buck presented an overview of the results of this project thus far. During the discussion it was noted that Dave Smith (NRCS) had told Brenda Buck during the conference and fieldtrip that a BLM ORV recreational area in California had been found to contain naturally-occurring asbestos and was currently closed because of the associated health risks. Following discussion of the results, Bob Ross and Shonna Dooman left while the remainder of the group continued on a tour through the field area.

Submitted by:

Brenda Buck, Project Administrator

Date July 14, 2010