Assessment of Dust Emissions, Chemistry, and Mineralogy for Management of Natural and Disturbed Surfaces at Nellis Dunes Recreation Area, Nevada

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Final Report to Bureau of Land Management for Task Agreement Number FAA010017: Assessing Factors Contributing to Dust Emissions from Public Lands On Air Quality in Areas of Clark County, Nevada
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Cover photo:

Driving a dune buggy in the Nellis Dunes Recreation Area
(courtesy: Rhonda Fairchild)

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Chapter 1

INTRODUCTION

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RATIONALE FOR STUDY

Like many places in the southwestern USA, poor air quality is a concern for the Las Vegas Valley in southern Nevada. The southernmost county in Nevada, Clark County, is designated as being in serious non-attainment for PM10 (Fig. 1). The Environmental Protection Agency (EPA) created a PM10 standard for air quality in 1987, and later added a PM2.5 standard as well. These standards replaced the older Total Suspended Particulate (TSP) standard.

The PM10 standard measures the concentration of airborne particles with a diameter of 10 μm or less, and was implemented because research has shown that these smaller particles can have serious health implications. The smaller the particle, the deeper it can penetrate into the lung (Plumlee et al., 2006), therefore PM2.5 (particulates less than 2.5 μm) are thought to be even more hazardous. Exposure to particulate matter is associated with an increased risk of cardiovascular and respiratory morbidity, asthma, lung cancer, inflammation and increased mortality (e.g. Dockery et al., 1993; Besancenot et al., 1997; Peters et al., 1997; Lambert et al., 1999; Donaldson et al., 2000; Ichinose et al., 2005; Griffin and Kellogg 2004; Chow et al., 2006; Laden et al., 2006; Wang et al., 2008; Hildebrandt et al., 2009; Laing et al., 2010; Soto-Martinez and Sly, 2010). These health effects are particularly strong for children, older adults and those with asthma (Sacks et al., 2010). Additional known health hazards with respect to inhaled dust are asbestosis, silicosis, mesothelioma, valley fever, meningitis, and inhalation of heavy metals that can cause cancer, hypertension, cardiovascular disease, kidney damage, diminished intellectual capacity in children and skeletal damage (e.g. Korenyi-Both et al., 1992; Jinadu 1995; Athar et al 1998; Järup, 2003; Komatsu et al., 2003; Sultan et al., 2005; Otsuki et al., 2007; Constantopoulos, 2008; Roggli et al., 2010).

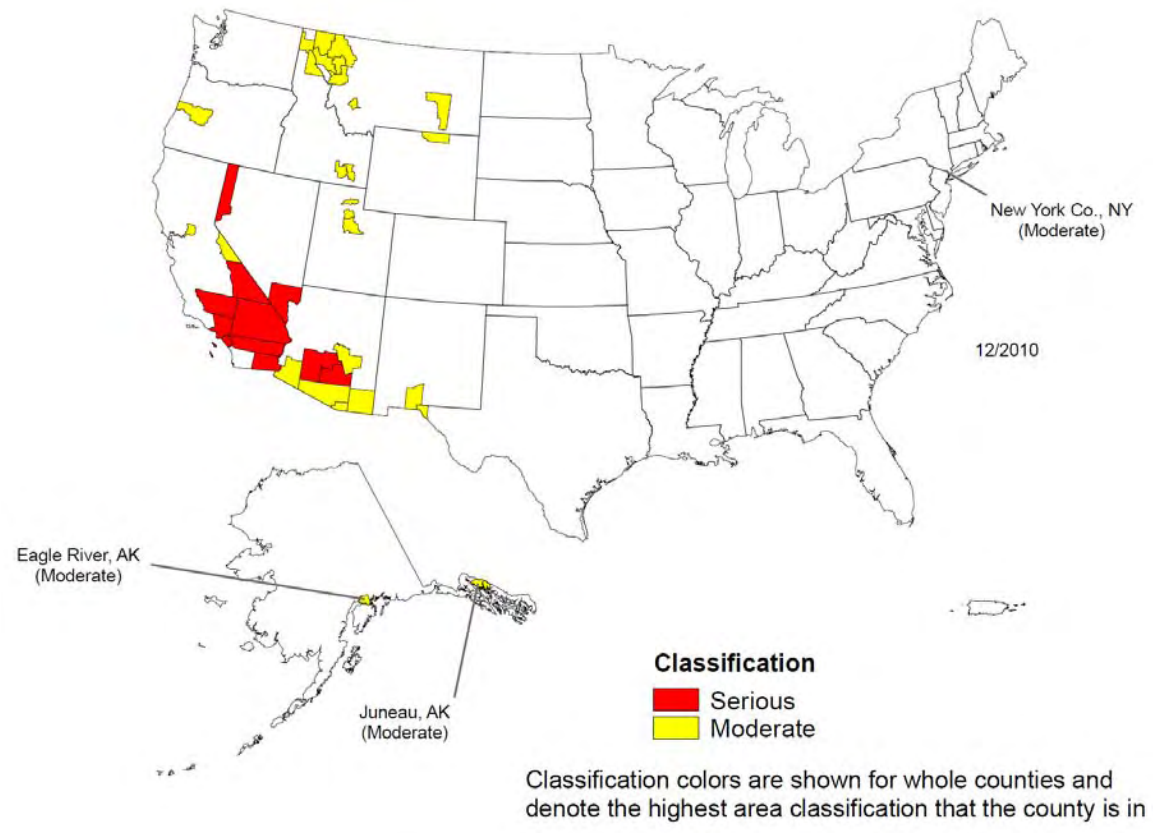

Fig. 1: Counties designated as non-attainment for PM10. Clark County, southern Nevada is in serious non-attainment. (From EPA 2010: http://www.epa.gov/oaqps001/greenbk/mappm10.html)

Nationally, the largest single source of both PM10 and PM2.5 is road dust (Fig. 2) (EPA, 2005). Because of the health concerns associated with particulate matter, and because human activities, especially those that stir up dust, are known to impact air quality, this study was designed to assess dust emissions from the Nellis Dunes Recreational Area (NDRA). The NDRA is managed by the Bureau of Land Management (BLM) and lies in the northeastern portion of the Las Vegas Valley, Clark County. The NDRA is located approximately 8 km from the margin of the conurbation Las Vegas - North Las Vegas - Henderson and is the only location in Clark County that is freely accessible to the public for off-road driving. For over 40 years, NDRA has been heavily used for ORV recreation. Off-road vehicle (ORV) driving is one of the most prevalent and fastest growing recreational activities on public lands worldwide (Cordell, 2004; Cordell et al., 2008; Outdoor World Directory, 2010). Southern Nevada is no exception – the number of off-road drivers has quadrupled in the last few years (Spivey, 2008). In 2008, the BLM

estimated that the number of off-road-drivers at NDRA was over 300,000, which is over 15% of the population (Goossens and Buck, 2009). Prior to this study, the contributions of ORV activity to dust emissions were not known at this site.

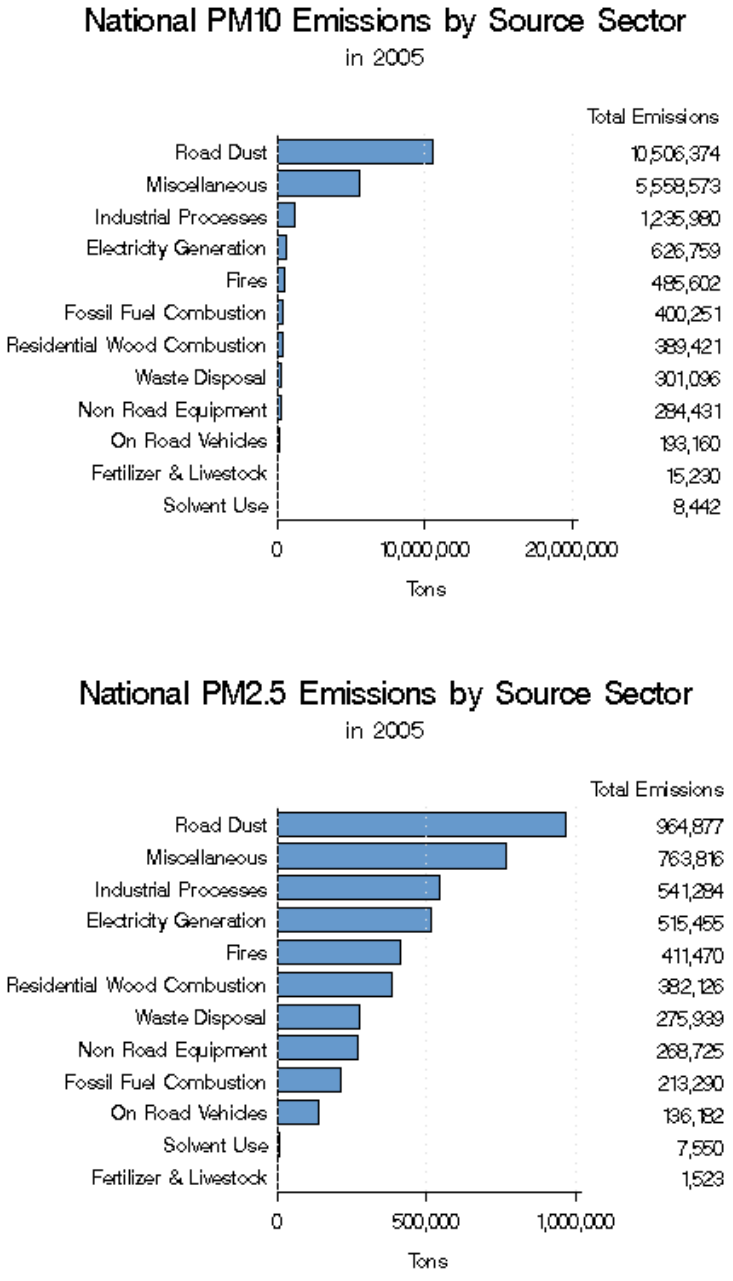

Fig. 2: National sources of PM10 and PM2.5 Emissions
(From EPA 2005:http://www.epa.gov/air/emissions/pm.htm)

Wind erosion, especially in arid regions such as southern Nevada, is a well-known mechanism for producing dust emissions (Shao, 2008). Sand particles and sand-sized aggregates of silt and clay are easily eroded by the wind and liberate substantial amounts of dust upon impact on the ground. In deserts, most dust production by wind erosion has been associated with the presence of sand-sized grains although aerodynamic emissions of dust not initiated by sand movement have been reported as well (Cole and Kerch, 1990). Prior to this study, it was known that wind erosion plays an important role at NDRA because of the presence of the active sand dunes for which the site is named. However, it was not known how much wind erosion contributes to dust emissions at the site, or what interactions, if any, occur between wind erosion and ORV activities.

With increasing use of NDRA for ORV recreational activities, increasing population growth in the Las Vegas Valley, and a need to improve air quality here and in other similar desert locations in the southwestern USA, data were needed to better understand the processes controlling dust emissions for land use management decisions. A thorough understanding of these processes requires detailed field and laboratory data collection combined with surficial maps that link processes to specific types of land surface characteristics. This research project linked aerial data (surficial maps) with dust emissions generated by ORV activities and natural wind processes, with chemical and mineralogical data, and with an *in vivo* toxicological study.

This report describes the results of this research, which includes: (1) a map of the different surfaces at NDRA and how their characteristics relate to dust emissions, (2) a study of how ORV emissions vary with vehicle type, speed, and across different surface types (3) a study of how dust emissions vary between surfaces disturbed by ORV activities and undisturbed surfaces, (4) an assessment of wind erosion and its contribution to dust emission in the Nellis Dunes area, (5) an assessment of total emissions (wind and ORV-generated), (6) an assessment of PM10 concentrations in the area, (7) characterization of the mineralogy of the different surface types as sources for dust, (8) characterization of the chemical composition of soils and dust, (9) an assessment of the arsenic content in soils and dust, (10) the results of an *in vivo* experiment conducted in mice to examine the toxicological and histopathological effects following exposure to dust samples from three surface types in the Nellis Dunes area, and (11) land management recommendations based on these data.

Each topic is presented as a separate chapter in this report. Each chapter describes the problem, explains the methodologies, discusses the results, summarizes the conclusions and provides bibliographical references. Therefore, each chapter can be read independently although references to other chapters may appear. An overall summary of the main results of the entire project is given in section 2 of Chapter 12 (Land Management Recommendations for the Nellis Dunes Recreation Area), pp. 234-249 in this report.

Portions of this research have been published in peer-reviewed scientific journals and are available upon request. Contact Brenda Buck (buckb@unlv.nevada.edu) or Dirk Goossens (Dirk.Goossens@ees.kuleuven.be) for reprints.

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