

Measurement and Modeling of Fugitive Dust from Off-road DoD Activities

(SISON-10-03: Fugitive Dust Emissions Due to Department of Defense Activities)

Abstract

Background: The U.S. Department of Defense (DoD) conducts military training and testing activities on approximately 30 million acres of land. These activities can create significant air quality challenges, including emissions of regulated particulate matter (i.e., PM₁₀ and PM_{2.5}) and have the potential to impact the local and regional air quality. State/local regulatory agencies enforce the U.S. EPA-designated PM standards and can require reductions from sources which contribute significantly to PM concentrations in areas that exceed the National Ambient Air Quality Standards (NAAQS). Unfortunately, many military installations are located in, or near, existing or proposed air quality non-attainment areas. Accurately quantifying and assessing spatial and temporal surface conditions for soil-specific, vehicle-specific, and activity-specific characteristics, is critical to understanding the impact of surface conditions on potential emissions in the near-source area and the downrange area, especially at the installation fence-line.

Objective: The central goal of the proposed project is to utilize a combination of soil science and meteorological and traditional air quality sampling methods to accurately measure soil and surface characteristics, identify those characteristics significant to fugitive PM emissions and wind erosion and develop lidar instrumentation to measure fence-line concentrations from large area emission sources produced by military activities on DoD installations.

Summary of Process/Technology: The assembled collaborative research team consists of scientists from the USDA-ARS Engineering and Wind Erosion Research Unit (EWERU); Kansas State University, Biological and Agricultural Engineering Department (BAE); Utah State University, Department of Civil and Environmental Engineering (CEE); and Energy Dynamics Laboratory (EDL). These researchers will evaluate the PM_{2.5} and PM₁₀ emission potentials for a variety of different soil/surface/vegetation combinations disturbed by military vehicles (tracked and wheeled) under different conditions using standardized soil science and laboratory wind tunnel measurement techniques. In addition, they will develop and test a prototype, eye-safe wind and aerosol sensing lidar for real-time monitoring of installation fence-line PM levels.

The objectives will be achieved through a comprehensive set of tasks that are designed to obtain specific data required to: 1) adequately characterize changes in soil and surface conditions due to off-road military vehicle activities and determine the sites' changes in susceptibility to wind erosion; and 2) measure incoming and outgoing PM at the installation fence-line.

Benefits: Limited field data are available on the impact of military activities on surface characteristics and fence-line concentrations of PM. This research will provide a critical step in understanding the impact from off-road military activities on off-road training sites and their impact on the subsequent susceptibility to wind erosion as well as evaluating best management practices for mitigating wind erosion events.

Transition Plan: Project results will be published in peer-reviewed publications. Results from the study will culminate in algorithms useful for assessing the susceptibility of soils and surface conditions to excessive fugitive dust and wind erosion emissions due to military training activities. Applications using research results will be presented at DoD workshops such as the Army Sustainable Range Program Workshop. We anticipate that improved PM-monitoring instrumentation will be developed that may be good candidates for ESTCP projects.

Technical Section

SERDP Relevance

Training activities at DoD facilities can present significant environmental challenges, including emissions of regulated atmospheric particulate matter (i.e., PM₁₀ and PM_{2.5}). For example, a primary source of air quality degradation in terms of concentration and near-source visibility is the resultant airborne dust produced by military vehicles and related activities. Complicating matters is that many military installations are located in, or nearby, existing or proposed air quality non-attainment areas. These concerns elevate the importance of accurately assessing and minimizing air quality impacts to maintain compliance with local, state and federal air quality targets.

A typical base range environmental manager needs to assess the following: 1) immediate training impact on and recovery rates to less degraded states for plants and soils on training lands; 2) training impact on PM emissions (mainly PM₁₀ and PM_{2.5}); 3) wind erosion potential from both disturbed and undisturbed training lands; 4) effect of wind erosion and fugitive dust emissions from military activities on the entire base, particularly PM₁₀ and PM_{2.5} concentrations at the base boundaries and personnel and family facilities; and 5) minimizing the detrimental effects of training activities on the environment.

Unfortunately, very little data are available for assessing the immediate impact of military training and testing activities upon the soil, surface and vegetation status. The destruction of vegetation and surface crusts as well as pulverizing soil aggregates on the soil surface by military activities is documented but not adequately characterized (Veranth et al., 2008). Likewise, recovery rates to less degraded states of such surfaces following training activities have not been well studied. Even though fugitive dust emissions from military vehicles have been studied and measured by previous SERDP funded projects (SI-1190, SI-1191, SI-1399, and SI-1400), they have not been adequately correlated to the soil, surface and vegetative conditions present at the time of activity, as is apparent by the lack of such data in reports and articles resulting from previous SERDP projects (Gillies et al., 2005; Gillies et al., 2007; Veranth et al., 2008). In addition, while the near-source transport and deposition of the generated PM has been investigated and quantified from unpaved roads by Veranth et al. (2008) and Gillies et al. (2005), there has not been an attempt to quantify deposition from military off-road travel. Further, near-source deposition has not been adequately quantified in commonly used atmospheric dispersion models. Thus, downwind fence-line PM concentrations are not easily predicted from military training activities. We propose to perform field measurement campaigns at Ft. Riley and at least three additional DoD installations, which will be identified in consultation with SERDP management personnel based upon our experimental needs, the installation's potential impact on nearby air quality issues and expected synergy with the recently selected SERDP proposal, 10 S103-015 (PI, Dr. John Gillies). Candidate DoD installations include Ft. Irwin, 29 Palms, Camp Pendleton, Fort Carson, Fort Bliss, Fort Sill, Yuma Proving Grounds and Yakima Training Center.

The research proposed attempts to address some of the above listed deficiencies and has assembled a team of researchers with the background and special expertise to conduct specific experiments developed to meet the selected SERDP objectives. USDA-ARS Engineering and Wind Erosion Research Unit (EWERU) has decades of experimental research in wind erosion (Zingg and Chepil, 1950; Woodruff, 1971; Hagen and Woodruff, 1975; Hagen, 1984; Skidmore and Layton, 1988; Hagen, 1996; Mirzamostafa, 1998; Hagen and James, 1999; Wagner and Hagen, 2001; Hagen, 2001) and soil characterization experience (Chepil, 1950a, 1950b, 1951a, 1951b, 1951c 1958; Lyles, et al. 1970; Skidmore and Powers, 1982; Wagner and Ding, 1993, 1994; Wagner and Nelson, 1994) on agricultural lands. They have also developed the physically based Wind Erosion Prediction System (WEPS) model which estimates wind erosion soil loss and direction based upon the daily simulated changes to the surface, soil and vegetation state based upon climatic and management effects on the study site. The

Energy Dynamics Laboratory (EDL), Logan, Utah has developed a three-wavelength lidar (AgLite) to capture the concentration and dynamics of plumes (on a 10-meter scale) and, in concert with researchers from the Utah State University (USU) Department of Civil and Environmental Engineering, has demonstrated the ability to use the lidar to measure PM₁, PM_{2.5}, PM₁₀ and TSP mass concentrations over areas up to 3 km² in a variety of agricultural settings (SDL, 2007; Bingham, et al. 2009; Marchant et al. 2009). EDL and USU personnel have also performed atmospheric dispersion modeling to calculate agricultural activity emission rates and factors using an inverse modeling approach (Martin et al., 2006; Martin et al., 2007). In addition, researchers from the Department of Biological and Agricultural Engineering (BAE) at Kansas State University have extensive experience in measuring fugitive emissions from large animal feeding operations (Guo et al., 2009; Razote et al., 2006, 2007a, 2007b, 2008).

Technical Objectives

The proposed project will be designed to specifically address the following objectives in the Statement of Need (SoN). Specific tasks for each objective are as follows:

1. Improve understanding of fugitive dust emission potential from military activities.
 - a. Characterize and model individual military vehicle (tracked and wheeled) impacts on the changes in temporal surface and soil properties as functions of the intrinsic soil properties and specific physical attributes/parameters of the vehicles involved.
 - b. Characterize relevant temporal and intrinsic soil and surface properties, via laboratory wind tunnel tray studies, to measure total dust as well as PM₁₀ emission potential on a range of disturbed and undisturbed military land soils.
 - c. Collect soil and plant data from plot studies conducted on selected military sites before and after training activities and seasonally thereafter to determine both the impact of the activities on erodibility and the recovery times to less degraded states for the disturbed sites.
 - d. Use data collected in tasks 1a, 1b, and 1c to develop algorithms and incorporate them into the WEPS model to predict changes in susceptibility to wind erosion due to military vehicle disturbances on DoD training lands and their natural recovery to less degraded states.
3. Improve DoD's ability to achieve source compliance and ambient fence-line monitoring for fugitive dust emissions at their installations.
 - a. Develop and test a prototype, eye-safe, aerosol sensing lidar for real time fugitive dust concentration measurement suitable for monitoring installation fence-line PM levels.

Technical Approach (Background, Methods and Milestones)

Task 1a: Characterize and model individual military vehicle (tracked and wheeled) off-road impacts on the changes in temporal surface and soil properties as functions of the intrinsic soil properties and specific physical attributes/parameters of the vehicles involved.

Background: Fugitive dust from military vehicle traffic at off-road sites may come from both initial emissions during vehicle passage and from wind erosion initiated on both the disturbed and initial undisturbed surfaces. In general, wind erosion from significant areas of bare, disturbed soil will have the largest likelihood of causing fence-line PM violations for a military installation. In addition, there is a tremendous range in off-road surface conditions that are subjected to military vehicle traffic during training operations. The majority of the published PM emission rates found in literature for military vehicles are derived from experiments conducted on unpaved roads (Gillies et al., 2005; Veranth et al., 2008). Additionally, one of the technical gaps identified at the Workshop on Research Needs for Assessment and Management of Non-Point Air Emissions from Department of Defense Activities was that algorithms for measurement-based emission factors need site and activity-specific measurable parameters (HydroGeoLogic, 2008).

Methods: Pre- and post vehicle soil disturbance measurements will be conducted on selected sites at cooperating DoD installations over a range of soil types. Two or more soil types (locations) will be selected based upon their perceived or known vulnerability to wind erosion and potential to generate high vehicle dust emissions. A minimum of one tracked and one wheeled vehicle will be used at each DoD installation for generating soil disturbances. At least two vehicle speeds will be investigated and up to three subsequent passes will be made at each site on some experimental plots. Each plot will be replicated three times, if possible.

We propose to construct plots and take measurements first at Ft. Riley and later at additional DoD installations in concert with DRI's SERDP funded proposal. Some of these site plots will also be additionally sampled for the laboratory wind tunnel studies outlined in task 1b. The longer term field studies in this project (task 1c) will also be carried out on a subset of these sample data set locations. This will be done to reduce the redundant data collection and to better correlate the measurements across the individual tasks, if desired. Figure 1 shows the links between the proposed task items, synergies in measurements and how the components of the SoN objectives are addressed.

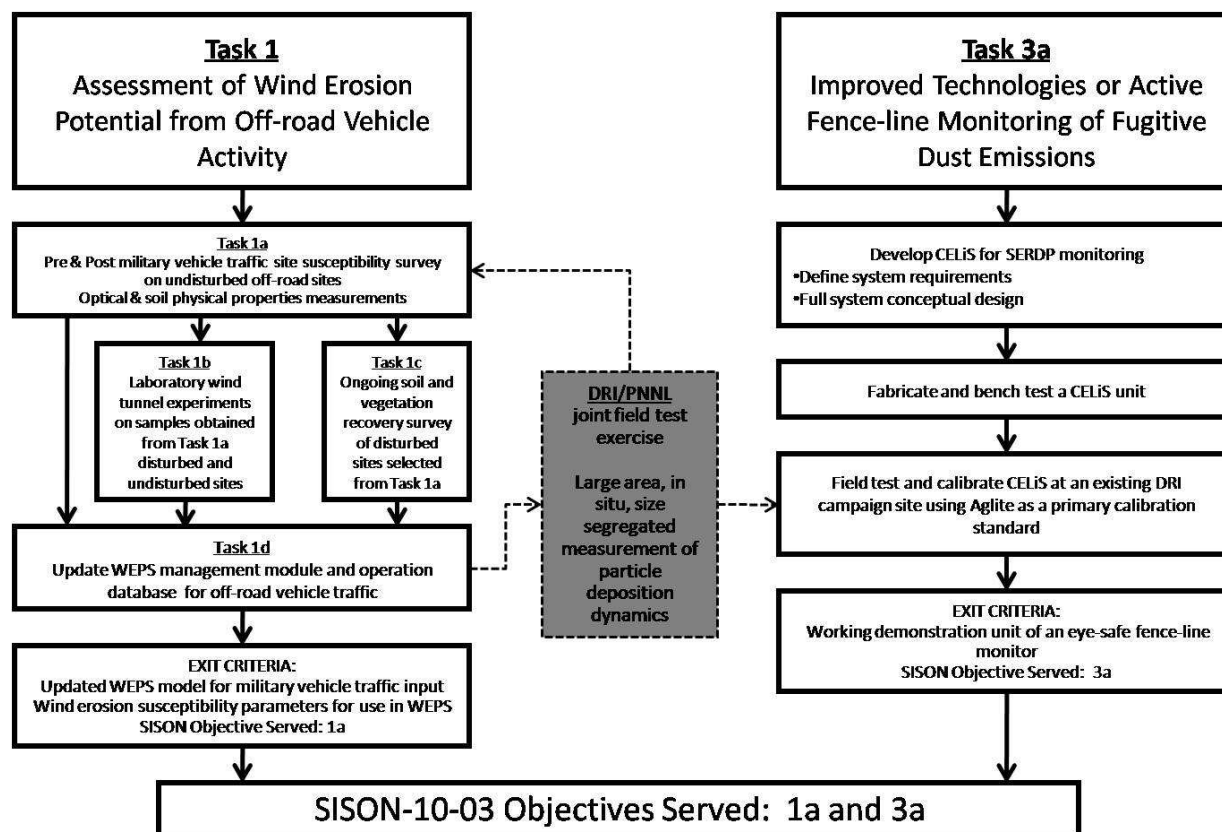


Figure 1. Links between proposed task items illustrating the synergies between the measurements and how the components of the SoN objectives are addressed.

Characterization of the soil, surface and vegetative conditions present both before and after disturbances created by trafficking of selected military vehicles will be performed at each site. This characterization will include at least the following properties using standard field and laboratory measurement methods:

1. Soil intrinsic properties
 - a. Sand, silt and clay particle mass fractions of mineral component of the soil
 - b. Organic matter mass fraction of the soil
 - c. Mass fractions of standard sand classes (course, medium, fine and very fine)
 - d. Volume fraction of rocks greater than 2mm in diameter
 - e. Soil pH
 - f. Calcium Carbonate (CaCO_3)
 - g. Cation Exchange Capacity (CEC)
 - h. Dry soil albedo
2. Soil temporal properties
 - a. Dry bulk density
 - b. 1/3 bar bulk density
 - c. Water content (measured)
 - d. Saturated water content (zero matric potential)
 - e. Field capacity water content (1/3 bar matric potential)
 - f. Wilting point water content (15 bar matric potential)
 - g. Linear Extensibility
 - h. Aggregate size distribution (ASD)
 - i. Aggregate density (AD)
 - j. Dry aggregate stability (DAS)
 - k. PM10 and PM2.5 mass fractions
3. Soil surface properties
 - a. Crust fraction present on the surface
 - b. Crust thickness
 - c. Dry crust stability
 - d. Mass of loose, erodible soil on the crusted surface
 - e. Random roughness (RR)
 - f. Oriented roughness (wheel track and ridge height, width, spacing and orientation)
 - g. Document biotic crusts, if present
4. Surface vegetative/residue properties
 - a. Stem diameter, heights and number
 - b. Stem area index (SAI)
 - c. Leaf area index (LAI)
 - d. Flat vegetative cover
 - e. Spatial distribution of stems on the surface (clumpiness of plant distribution)

In addition, PI-SWERL (Figure 2) measurements will be collected for possible correlation with wind tunnel emission measurements (task 1b) and to provide comparisons with previous PI-SWERL measurements conducted on unpaved military roads (Gillies et al., 2007).



Figure 2. PI-SWERL (Portable In-Situ Wind Erosion Lab)

The degree and area of soil disturbance caused by various military vehicles will be measured by treating vehicle disturbances as a series of physical processes that cause aggregate breakdown, crust disruption, surface roughening or smoothing, soil compaction and, if present, changes in vegetation status (cover, height, population, etc.). This is similar to the proven approach taken in the Wind Erosion Prediction System (WEPS) with respect to tillage operations impact on the soil and surface state (Wagner and Ding, 1993; Wagner, 2000). Simple 1st order relationships representing these physical processes will be developed based on the measured parameters characterizing the temporal soil conditions and the speed, weight, wheel/track coverage and other pertinent vehicle physical characteristics. Multiple vehicle passes will be conducted with the relevant temporal properties measured after each vehicle pass to determine the degree of non-linearity between the original condition and the resulting condition for each measured parameter. Developing parameters for individual physical processes represented as simple 1st order relationships will allow one to simulate the final soil conditions after passage by arbitrary, but known, combinations of vehicles, or even untested vehicles, for which vehicle characteristics are known.

Milestones: Algorithms using 1st order relationships will be developed that predict changes in temporal soil and surface conditions resulting from military vehicle traffic similar to those developed for tillage and other agricultural implements in the WEPS model. These results can then be combined with those developed under tasks 1b and 1c to estimate emission potential from a wind erosion event. In addition, these algorithms can be used in other models to predict the changes in the temporal soil and surface conditions due to military vehicle traffic, which in turn could be employed for predicting emissions from subsequent military trafficking activities on those sites.

Task 1b: Characterize relevant temporal and intrinsic soil and surface properties, via laboratory wind tunnel tray studies, to measure total dust as well as PM₁₀ emission potential on a range of off-road disturbed and undisturbed military land soils.

Background: The dust emission potential of a bare soil varies temporally and is controlled by surface roughness, response of the immobile crust and aggregates to breakdown forces, as well as the amount, size distribution and wetness of the mobile aggregates. Thus, standardized laboratory wind tunnel tray experiments, commonly applied in wind erosion studies (Hagen, 2001; Kohake et al., 2010) will be conducted to determine the dust emission potential for a range of soils on military facilities.

Methods: A subset of the experimental sites in task 1a will be selected for determination of PM10 emission potential from standardized laboratory wind tunnel tray experiments. Sites selected will include all soil types, including at least the undisturbed condition and at least one disturbed condition created from both tracked and wheeled vehicles. At least three replications will be conducted for each selected plot site condition. Test variables will include aggregate size distribution, dry stability of aggregates and crusts, and surface roughness obtained from the task 1a measurements. Additional variables determined from the wind tunnel experiments will include friction velocity and amount of sand abraded applied. PI-SWRL measurements collected on these sites will be included for possible correlation with the wind tunnel emission measurements. Crust status and other surface conditions will be properly documented and measured on-site. Loose mobile material on crusted surfaces will be removed during sampling at the site and analyzed in the lab. Only the surface crusts are relevant to the proposed laboratory wind tunnel measurements. The surface crusts will be documented and carefully removed and placed in wind tunnel trays and packaged to minimize transportation damage. During the wind tunnel tray experiments, the goal is to obtain the emission potential caused by sand abrasion of these crusts. Crusts are more sensitive to the actual crust stability and thickness properties, than the continuity of the crust on the surface, where cracks often develop under dry conditions. Similarly, soil samples from disturbed areas will be placed in trays and transported to the lab for testing. Both the amount of mobile material and dry stability of the immobile material in the soil control response of disturbed surfaces to wind erosion.

These experiments will demonstrate the relative significance of the soil temporal variables we propose to measure in the plot studies. Hypothetical examples of wind tunnel results are illustrated in Figure 3.

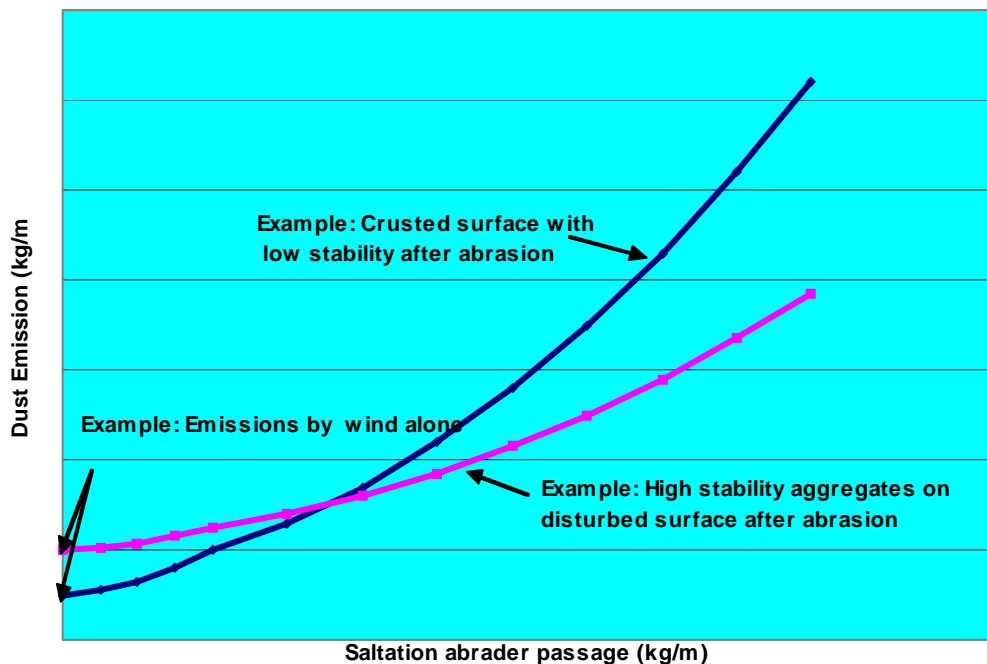


Figure 3. Hypothetical examples of lab wind tunnel test results on two differing soils.

Milestones: The laboratory wind tunnel tray study will provide data tables showing the following:
 a) Intrinsic properties of test soils: Mass fractions of total sand (50-2000 μm), very fine sand (50-100 μm), coarse silt (10-50 μm), fine silt (2-10 μm), clay (< 2 μm), organic matter, calcium carbonate, cation exchange capacity and fraction of non-erodible material >2000 μm (rock fragments).

- b) Temporal properties of test soils: Surface roughness, dry aggregate and crust stabilities, fraction crusted, crust thickness, loose material mass on surface of crusted soils and aggregate size distributions on mass basis including cut points at >2000 μm , 840 μm , 100 μm , 50 μm and 10 μm .
- c) Emission results of test soils: Calculated atmospheric wind speed at 10 m, aerodynamic roughness, friction velocity, total dust, PM_{10} and $\text{PM}_{2.5}$ emission mass to stability by wind alone, total dust, PM_{10} and $\text{PM}_{2.5}$ emission with various levels of sand abrader and PI-SWERL measurements.

Task 1c: Collect soil and plant data from plot studies conducted on selected off-road military sites following training activities (vehicle trafficking) and seasonally thereafter to determine both the impact of the activities on erodibility and the recovery times to less degraded states for the disturbed sites.

Background: Soil and vegetation characteristics are altered when exposed to known physical forces and also respond to naturally occurring changes in the environment (e.g., weather events). This behavior is influenced by both the intrinsic and temporal properties of the soil, surface state and vegetation type, size and population density. To determine these responses, long term (possibly multi-year) field plots are proposed on selected DoD sites where measurements are made immediately before and after specified military activities and periodically afterwards (i.e., after precipitation events >10 mm, wind erosion, freeze/thaw cycling, etc.) to pick up the effects of natural weather factors and specific environmental events (e.g., precipitation, wind erosion, etc.). Measurements taken over time can then be used to determine the effects of long-term use, short-term use and how quickly, if ever, a trafficked site returns to its initial undisturbed state.

Methods: Field plot locations on cooperating DoD installations will be a subset selected from the sites identified for task 1a and will be based upon the soil type and degree of degradation due to vehicle traffic. Sites selected will cover all soil types covered in task 1a and include at least one disturbed condition created from both tracked and wheeled vehicles. Three replications will be conducted for each selected plot site condition. Some of these sites will likely be part of the wind tunnel tray study (task 1b) as well to provide continuity of the data sets and reduce duplication of measurement data. Field plots will be setup and samples will be collected to measure intrinsic soil properties and the initial temporal properties as outlined in task 1a. Plots will be initially disturbed by military vehicle traffic. An undisturbed site from each soil type will also be monitored and used as a baseline for measurements. Additional measurements of temporal properties will be conducted at least seasonally (4 times) throughout each year and after any major environmental events (precipitation, wind erosion, etc.) as indicated by the onsite meteorological station data.

Characterization data will include soil surface aggregate size distribution, dry aggregate stability and random roughness measurements. Crust characteristics (stability, thickness and amount of loose erodible material on the crusted surfaces) as well as the extent of biotic crusts (lichen) will also be recorded. In addition, vegetation characteristics (type, extent of cover, mass, height and population of plants) will be taken. Assistance from those trained in ecology will be consulted for proper characterization and identification of vegetation on plot sites. In addition, they will train our students in proper data collection and possibly assist in the vegetative identification data collection itself. Meteorological data will be collected at the sites, using cell or satellite phone transmission of met data. These plots will be identified and marked as off limits for future military activity for the duration of the study. It is understood that even if sites are identified and labeled off limits with the assistance and knowledge of the DoD staff that there is no guarantee that they will not be disturbed, accidentally or on purpose. If plots do require additional subsequent planned activity (additional controlled and/or uncontrolled vehicle traffic, etc.), measurements will be taken immediately before and after this activity takes place.

Milestones: The study will provide data tables for each site showing the following:

- a) Measurement dates and values for surface roughness, dry aggregate and crust stabilities, fraction of surface crusted, crust thickness, loose material mass on surface of crusted surfaces and aggregate size distributions on mass basis including cut points at >2000 μm , 840 μm , 100 μm , 50 μm and 10 μm . If vegetation is present, these tables will include vegetative characterization data as well.
- b) Dates and magnitudes of major climate driven effects on the sites, e.g., precipitation amounts, freeze/thaw events, freeze/dry events and wind speed and direction for wind erosion periods, etc.

Task 1d: Use data collected in tasks 1a, 1b, and 1c to develop algorithms and incorporate them into the WEPS model to predict changes in susceptibility to wind erosion due to military vehicle disturbances on DoD training lands and their natural recovery to less degraded states.

Background: WEPS is a physically based, daily time step wind erosion model that updates the surface conditions due to climatic effects and management specified operations and predicts wind erosion emissions including saltation/creep, suspended dust and PM_{10} . Predictions for $\text{PM}_{2.5}$ emissions will be added during this research. Most WEPS modules can be directly applied to DoD lands because WEPS uses physically-based parameters. WEPS users may add additional data to the WEPS climate database to refine local weather simulations. Additional parameters needed for simulating vehicle disturbance, recovery to less degraded states from disturbance, and crust/clod abrasion for a range of soils on DoD installations will be developed in this study. Although developed primarily for agricultural conditions, the modular, process-based design allows a wide range of management operations, including military vehicle activities, to be simulated once appropriately parameterized. Thus, the surface and temporal soil property changes caused by military traffic can be simulated within the model, allowing WEPS to be employed as a tool for predicting wind erosion susceptibility following military training activities.

Methods: 1st order soil disturbance algorithms developed from task 1a will be coded into the WEPS model so that it can simulate the physical processes unique to both tracked and wheeled military vehicles. Military vehicles used in the task 1a experiments will be added to the WEPS management operation database and will include their vehicle specific parameters obtained as part of task 1a. Finally, the coefficients for the 1st order equations representing the physical impacts upon the soil and surfaces by military vehicles will be determined for each vehicle from the task 1a data and included into the military vehicle operation database records. These changes and additions to WEPS will allow the impact of military activities upon the military installation soils to be more accurately represented, allowing improved assessments of the susceptibility of those disturbed soils to wind erosion with the model.

Milestones: An improved WEPS model appropriately modified for military installations for use in estimating the probability of wind erosion events and their intensity, based upon local historical meteorological data and identified vehicle activities (dates, vehicle numbers and types, intensities of trafficking activity, etc.).

Task 3a: Develop and test a prototype, eye-safe, aerosol sensing lidar for real time fugitive dust concentration measurement suitable for monitoring installation fence-line PM levels.

Background: Lidar has a long heritage of aerosol sensing, finding uses from agricultural emission monitoring (Marchant et al., 2009, Zavyolov et al. 2009) to national security (Mayor, et al, 2009). Energy Dynamics Laboratory has over 5 years of lidar aerosol sensing experience using a multi-wavelength lidar system called AgLite. We have used this system to monitor whole facility PM emission rates and whole facility PM fluxes for agricultural operations such as cotton harvesting/ginning, conventional tillage and swine finishing barns. In these cases we were able to generate size segregated PM maps of each facility to characterize each particular operation. Figure 4 shows a picture of the AgLite research trailer (left panel) and some representative data of from an agricultural monitoring experiment (right panel). The right panel is a waterfall plot where the laser pointing is stationary, with downrange distance shown on

the bottom axis and time shown on the vertical axis. There are two main features that are important in Figure 4b; the first is a moderately dense dust plume from the tractor plowing the field which is relatively constant in time and the second is very dense plumes from traffic on unpaved farm roads. This is an example of a lidar measurement of the exact phenomenon to be addressed in SoN Task 3a.

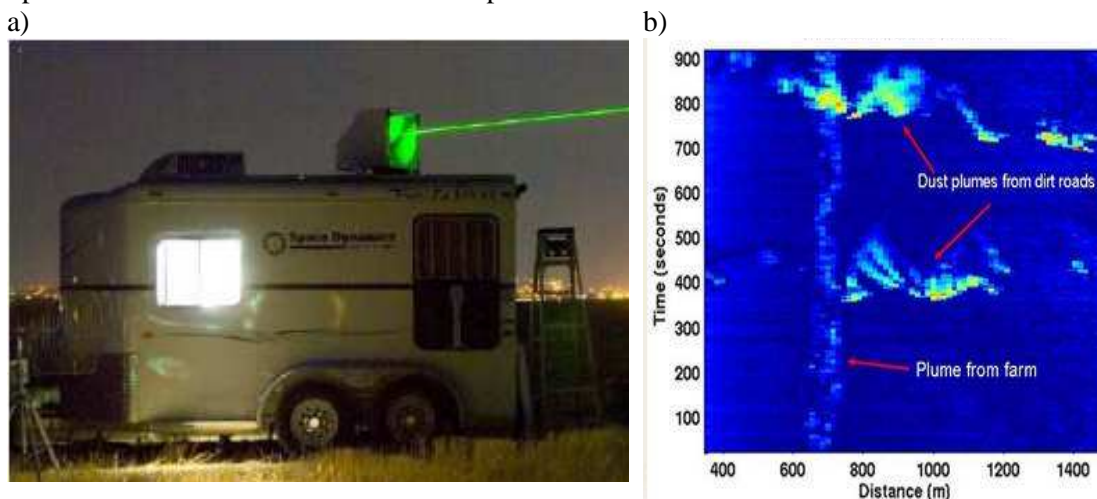


Figure 4. a) EDL’s multi-wavelength lidar system AgLite; b) PM₁₀ size fraction data from AgLite showing both low mass loading events (farm tractor) and high mass loading events (off-road traffic).

AgLite is a powerful analytical research tool for PM characterization. AgLite simultaneously operates at 1064 nm, 532 nm and 355 nm wavelengths, though it is unfortunately not completely eye-safe. Under typical operating conditions AgLite has an eye safe distance of about 1200 m. Any lidar system that will be used to monitor fence-line PM emissions related to off-road training activities will be subject to a strict eye-safety requirement to protect both troops and wildlife.

A good example of an eye-safe aerosol sensing lidar is REAL (Raman Shifted Eye-safe Lidar). REAL (Mayor, et al, 2004, Swerdlin, 2004) has a long track record of aerosol cloud identification and tracking, but suffers from two main drawbacks. The first is that REAL is large, heavy and power hungry – with a power consumption well over 10 kW and a volume of a half-size sea container, and second it does not measure PM concentration, it only reports uncalibrated relative aerosol concentration.

To address SoN Task 3a we propose to demonstrate the ability of a small, low power, eye-safe lidar system capable of monitoring the PM fence-line concentration of fugitive dust from off-road vehicle activity. The design will be based on an existing prototype already under development at EDL, called WiLD (Wind Lidar Detection). Figure 5 shows an image of an early prototype of WiLD along with some WiLD lidar data. The heart of the WiLD technology is a high repetition rate micropulse fiber laser operating at 1.6 μm wavelength coupled with a high sensitivity avalanche photodiode. Images of an early WiLD prototype and some example data are shown in Figure 5. As will be discussed later, the CONOPS surrounding a peacetime fence-line monitoring scenario may not require rapid beam scanning, therefore the bulky beam scanning mirrors (for rapid 3D volume imaging) shown in the figure will be replaced with a more compact pan-tilt stage (e.g. Quickset).

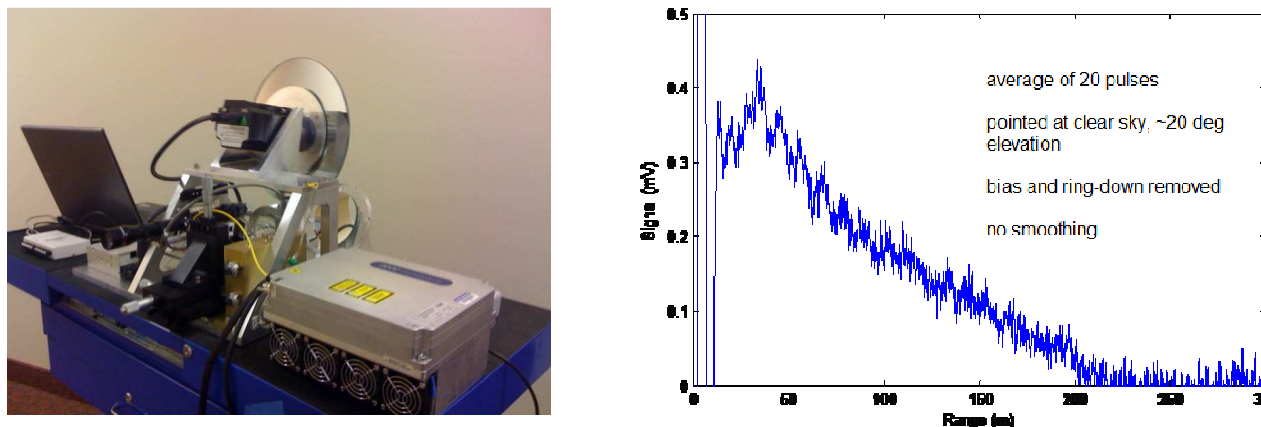


Figure 5. *left*, an early prototype of WiLD; *right*, clear sky WiLD lidar return data (unsmoothed, not range corrected).

Methods: We propose to apply lessons learned from AgLite and REAL to the WiLD system architecture and generate a new instrument CELiS, Compact Eye-safe Lidar System. CELiS will be a ruggedized eye-safe elastic lidar capable of retrieving aerosol concentrations in real time. The core of the transmitter/receiver technology would be taken from WiLD, implanted into a ruggedized enclosure and then mated to a telescope and commercial MIL-Spec pan-tilt stage.

Based on the current development cycle of WiLD, our prior experience with using lidar to detect aerosols from off-road vehicle traffic, and from the anticipated CONOPS of CELiS, we will propose a CELiS system with the following performance specifications (Table 1).

Table 1. Summary of the proposed CELiS instrument.

System Metric	Description
Size, weight, power	<1 m ³ , <200 lb , 500W
Optical fussiness	Low. CELiS will be a basic elastic lidar system
Pointing requirements	COTS pan-tilt stage 1D, 2D, slow-3D scanning
Range bin size	10 m
Total system range	>1000 m
Initial WiLD TRL status	5
Final CELiS TRL status	6

Some of the preliminary CELiS instrument development is already underway through other EDL funded programs; therefore some of the basic system building blocks have already been fabricated and tested. The main components of CELiS will be a laser transmitter, an avalanche photodiode detector, a COTS telescope, a COTS pan-tilt stage and a COTS computer for data acquisition and analysis. The laser transmitter and photo-detector are proven technologies while the telescope, pan-tilt stage and computer are COTS. Therefore the proposed CELiS development path is a low-risk endeavor which will demonstrate an enabling technology for the monitoring of fugitive dust emissions. That enabling

technology is compact eye-safe lidar. The aerosol concentration information received from CELiS will serve as an important management tool for facility operators.

The CELiS development cycle is a three year effort. The development cycle is shown graphically in Figure 1. Year 1 will see no CELiS activity. The majority of Year 2 will be to finalize a CELiS design that meets performance specifications relevant to DoD training facility environmental regulations. This task has two sub-parts, each of ~4 month duration: a requirements definition phase that formalizes the required performance metrics of CELiS followed by a rigorous mechanical design phase to ensure that CELiS will meet these requirements. Input into the performance requirements will be solicited from all stakeholders, examples of important stakeholders are SERDP staff, installation operations managers, and local air quality guidelines. Year 3 will be a procurement and construction phase during which CELiS will be fabricated, assembled and laboratory tested. During the final year (Year 4) we will perform a final field test of the CELiS unit. To the extent possible, these field activities will be coordinated with other funded research projects, such as DRI, Inc., so that the field test can occur at a scheduled field campaign site.

A critical component for meeting the performance requirements is to operate CELiS side-by-side with additional referee instrumentation. Due to its proven track record (Figure 4b) and its ability to deliver calibrated, PM segregated area concentrations, we will use AgLite as a referee system to serve as our primary calibration standard. As stated above, AgLite is a micropulse elastic lidar designed and constructed by EDL to quantitatively interrogate aerosol mass loading in agricultural environments.

The final data product from CELiS will be an image, either 1D like Figure 4b or 2D like Figure 6 (below) that will show the mass concentration over some area of regard. A software product would be able to analyze the image and identify areas with high concentrations and alarm at a predefined threshold. Such analysis could aid in source apportionment and the planning of vehicle logistics. The calibration of the CELiS image from relative photons to actual particle concentration is accomplished through the use of an optical particle counter (OPC) placed in the field of regard of CELiS. Periodically during vehicle operations CELiS would be pointed directly at the OPC so as to measure the same air mass. Through a wireless data link CELiS would then query the OPC for the particle size distribution. The final step would be to calibrate the CELiS image using the combination of soil density information (from a database, Tasks 1a and 1d) and particle size distribution.

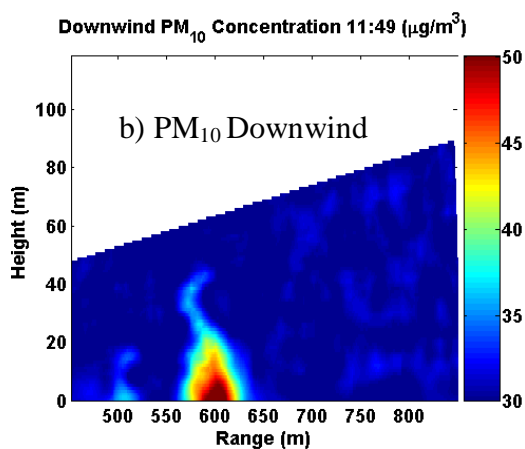


Figure 6. A vertical 2D scan generated from Aglite showing a clear high concentration plume, similar to what CELiS will generate.

Milestones: Year 2: A complete conceptual design for CELiS that will include physical dimensions and key performance data. Year 3: A fully operational prototype CELiS unit. Year 4: participation in a joint field campaign and demonstration of the CELiS unit in an operational environment.

Research Team

Dr. Larry Wagner is the PI of this project and will be responsible for coordination and execution of the entire project. Dr. Wagner is currently an Agricultural Engineer with 20 years experience at the USDA-ARS Engineering and Wind Erosion Research Unit. Dr. Wagner has researched the physical effects of tillage operations upon agricultural soils and their surfaces and vegetative cover with respect to wind erosion susceptibility and is the current leader of the WEPS modeling project.

Dr. John Tataro is currently a Soil Scientist with 28 years experience at the Engineering and Wind Erosion Research Unit of the USDA-ARS and is also an Adjunct Professor in the Department of Agronomy at Kansas State University. His research interests include field and laboratory characterization of soil conditions affecting wind erosion, wind erosion simulation modeling, and weather driven and temporal changes in soil wind erodibility.

Dr. Mark Casada, P.E., is an Agricultural Engineer with USDA-ARS in Manhattan, Kansas. Prior to joining ARS he was an Assistant/Associate Professor for 10 years at the University of Idaho. He specializes in computer modeling of heat and mass transfer during grain drying and storage, having worked in CFD modeling, dust emissions from grain handling operations, and related grain storage and handling issues. He will be involved in task 1 activities.

Dr. Larry Hagen is a retired Agricultural Engineer formerly with USDA-ARS Wind Erosion Research Unit and is currently an official ARS collaborator. He has extensive (40+ years) experience in wind erosion mechanics, control practices and modeling. He will be providing advice and suggestions on both field plot design and setup of wind tunnel experiments. No SERDP funding is requested for these duties.

Dr. Ronaldo Maghirang is a professor in air quality engineering at the Department of Biological and Agricultural Engineering at Kansas State University. Current research includes measurement, modeling and control of air emissions from large area sources, including open beef cattle feedlots, and environmental and military applications of nanotechnology. Dr. Maghirang will be involved in task 1 activities and on transmissometer measurements.

Dr. James Steichen is a Professor of Biological and Agricultural Engineering and Associate Director of the National Institute for Land Management and Training at Kansas State University. He was PI of a SERDP project (SI-1339, completed in 2008) researching the impact of maneuver training on water quality and stream stability at Ft. Riley. He will consult and may co-advise graduate and undergraduate students. He is familiar with military training land requirements and their relation to readiness.

Philip B. Woodford is the Fort Riley ITAM Coordinator. He will advise the research team and help coordinate activities at Army installations. He has over 30 years of experience with the military in engineering, environment, safety and natural resources. No SERDP funding is requested for these duties.

Dr. Michael D. Wojcik is currently the Branch Chief for Environmental Measurement at Energy Dynamics Laboratory at Utah State University where his research interests are remote sensing of wind

and aerosols as well as trace level detection of atmospheric gas species using molecular laser spectroscopy. Prior to working at Energy Dynamics Laboratory Dr. Wojcik was a senior scientist at Pacific Northwest National Laboratory and worked to develop laser based chemical sensors, during which time he also served as an IPA at Dugway Proving Ground to provide expertise on chemical and biological warfare agent detection.

Dr. Robert Foltynowicz, Ph.D. is a senior scientist at EDL. His expertise is in laser system design and construction. He has over 15 years of experience in the laser instrumentation field and held a staff position at Sandia National Laboratory for five years before moving to private sector employment. While at Sandia National Laboratory he developed several novel detection architectures for THz laser sources and also non-destructive detection of explosives.

Kori D. Moore has performed air quality research work for seven years, with the last two at Energy Dynamics Laboratory. Mr. Moore has been focused on agricultural impacts on air quality for nearly four years, including the quantification of fugitive dust emissions from tillage activities and confined feeding operations. Kori is currently pursuing his PhD in Environmental Engineering with an emphasis on air quality, his major advisor is Dr. Randal S. Martin.

Cooperative Development

The Energy Dynamics Laboratory (EDL), a unit of the Utah State University Research Foundation, has a specific cooperative agreement (number 58-3625-4-121) with the United States Department of Agriculture, Agriculture Research Service (USDA-ARS), to measure the emissions and dispersion of gases and particulates from agricultural operations, thereby defining the operations that generate the emissions and identifying the practices that can help mitigate those emissions. The objective of the cooperative agreement is to work jointly to provide the data and analysis required to make increasingly large-scale agriculture production operations less objectionable. Specific objectives include the following: 1) develop new methods and improve existing methods of measuring emissions of particulate matter and gases from animal feeding operations, 2) develop and determine the effectiveness of management practices and control technologies to reduce emissions, and 3) develop tools to predict emissions and their dispersion across a range of animal production systems, management practices, and environmental conditions. In addition, EDL maintains an active role in the support and development of aerosol science and lidar technology for Dugway Proving Ground. As an operational test center for the DoD, Dugway has relied on EDL to provide strategic technical support for its point and standoff aerosol referee equipment.

For the five years of the cooperative agreement, EDL and ARS have addressed these objectives as a multi-faceted program that includes a range of experimental and theoretical studies. The studies conducted are helping determine the particulate emission from livestock and cropping systems. EDL is also using their observations to refine existing dispersion models for more realistic conditions in agriculture. The years 2007 through 2009 have been very successful periods during which EDL has demonstrated their measurement techniques with the ARS.

The development of the CELiS components are being funded jointly using EDL Internal Research and Development (IR&D) resources and USTAR (Utah Science and Technology and Research) funding directly from the State of Utah. The opportunity to accelerate this development and testing work for CELiS, through the outlined military site field studies, provides benefit to the DoD via leveraged development of a stand-alone system that may be used for monitoring particulate matter concentrations at their fence-lines without shouldering the entire development cost of the hardware itself.

Transition Plan

Project results will be published in peer-reviewed publications generating at least 5 refereed manuscripts directly from tasks 1a, 1b, 1c & 1d, and 3a respectively. Results from the study will culminate in algorithms useful for assessing the susceptibility of soils and surface conditions to excessive fugitive dust and wind erosion emissions due to military training activities. Applications using research results will be presented at DoD workshops such as the Army Sustainable Range Program Workshop.

Emission factors for PM₁₀ emissions caused by wind on DoD lands are generally not available. WEPS can be used to provide emission source strength data on an hourly or sub-hourly basis for input into the diffusion models used by EPA for simulating downwind impacts. For example, WEPS emission predictions were used by EPA personnel to evaluate health hazards posed by potential particulate emissions from the Indiana Harbor Confined Disposal Facility (Hagen, L.J., et al., 2009).

Experiments from tasks 1a, 1b and 1c will obtain the necessary intrinsic and temporal soil properties as well as measured emission potential and seasonal variability from the test soils under a variety of weather and disturbance (trafficking) levels. The data relationships will be codified into algorithms which can be used to: a) relate the degradation of the soil and surface conditions due to military trafficking levels and b) relate the soil and surface recovery rates to less degraded states driven by pertinent weather events. These algorithms will be incorporated into the WEPS model for improved applicability to military conditions, but they can also be employed in other models as well.

As an autonomously operating device, the CELiS unit will have the ability to monitor fence-line concentrations of airborne particulates near installation boundaries and report its measurements back to a central command post. We anticipate that this improved PM-monitoring instrumentation will also be a good candidate for ESTCP projects.

Appendix: References

- Bingham, G.E., C.C. Marchant, V.V. Zavyalov, D.J. Ahlstrom, K.D. Moore, D.S. Jones, T.D. Wilkerson, L.E. Hips, R.S. Martin, J.L. Hatfield, J.H. Prueger, and R.L. Pfeiffer, 2009. "Lidar based emissions measurement at the whole facility scale: Method and error analysis," *J. Applied Remote Sensing*. *in press*.
- Brabec, D.L., R.G. Maghirang, M.E. Casada, and E.L. Haque. 2005. Characterization and modeling of a high-pressure water fogging system for grain dust control. *Trans. ASAE* 48(1):331-339.
- Fluent. 2002. *User's Guide*. Lebanon, N.H.: Fluent, Inc.
- Chepil, W.S. 1950a. Properties of soil which influence wind erosion: I. The governing principle of surface roughness. *Soil Sci.* 69:149-162.
- Chepil, W.S. 1950b. Properties of soil which influence wind erosion: I. The governing principle of surface roughness. *Soil Sci.* 69:149-162.
- Chepil, W.S. 1951a. Properties of soil which influence wind erosion: III. The effect of apparent density on erodibility. *Soil Sci.* 71:141-153.
- Chepil, W.S. 1951b. Properties of soil which influence wind erosion: IV. State of dry aggregate structure. *Soil Sci.* 72:387-401.
- Chepil, W.S. 1951c. Properties of soil which influence wind erosion: V. Mechanical stability of structure. *Soil Sci.* 72:465-478..
- Chepil, W.S. 1958. Soil conditions that influence wind erosion. USDA Tech. Bul. No. 1185..
- Etyemezian, V., S. Ahonen, D. Nikolic, J. Gillies, H. Kuhns, D. Gillete, and J. Veranth. 2004. Deposition and removal of fugitive dust in the arid Southwestern United States: measurements and model results. *Journal of the Air and Waste Management Association.* 54:1099-1111.
- Faulkner, W.B., Shaw, B.W., Grosch, T. 2008. Sensitivity of two dispersion models (AERMOD and ISCST3) to input parameters for a rural ground-level area source. *Journal of the Air & Waste Management Association.* 58:1288-1296.
- Fluent. 2002. *User's Guide*. Lebanon, N.H.: Fluent, Inc.
- Fryrear, D.W., Stout, J.E., Hagen, L.J., and Vories, E.D. 1991. Wind erosion: field measurements and analysis. *Trans. Amer. Soc. Agric. Engin.* 34(1):155-160.
- Gillies, J.A., W.P. Arnott, V. Etyemezian, H. Kuhns, H. Moosmüller, D. DuBois, M. Abu-Allaban, G. Schwemmer, D.A. Gillete, W.G. Nickling, T. Wilkerson, and R. Varma. 2005. Final Report: Characterizing and quantifying local and regional particulate matter emissions from Department of Defense installations. SERDP Project CP-1191.
- Gillies, J.A., V. Etyemezian, H. Kuhns, H. Moosmüller, J. Engelbrecht, J. King, S. Uppapalli, G. Nikolich, J.D. McAlpine, D.A. Gillete, and K.J. Allwine. 2007. Particulate matter emissions for dust from unique military activities, Annual Report. SERDP Project SI-1399.

Guerra, D., G. Schwemmer, A. Wooten, S. Chaudhuri, T. Wilkerson, 1999: "Prototype Holographic Atmospheric Scanner for Environmental Remote Sensing", *Journal of Geophysical Research*, **104**, No. D18, pp. 22,287 - 22,292.

Guo, L., R.G. Maghirang, E.B. Razote, J. Tallada, J.P. Harner, and W. Hargrove. 2009. Field comparison of PM₁₀ samplers. *Applied Engineering in Agriculture* (accepted).

Hagen, L.J. and N.P. Woodruff. 1975. Particulate loads caused by wind erosion in the Great Plains. *APCA J.* 25(8):860-861..

Hagen, L.J. 1984. Soil aggregate abrasion by impacting sand and soil particles. *Trans. Am. Soc. Agric. Engin.* 27(3):805-808, 816..

Hagen, L.J. 1996. PM-10 generation by wind erosion. International Conference on Air Pollution from Agricultural Operations, February 7-9, Kansas City, MO, pp.76-86.

Hagen, L.J., Wagner, L.E. and Skidmore, E.L. 1999. Analytical solutions and sensitivity analyses for sediment transport in WEPS. *Trans. Amer. Soc. Agric. Engin.* 42(6):1715-1721.

Hagen, L.J. and D.E. James. 1999. The PM-10 production potential of soils in the Las Vegas Valley of Nevada. In S. Basacca, S. Lilligren and K. Newell (eds.) *Dust Aerosol, Loess Soils and Global Change*. Washington State Univ. College of Agriculture and Home Economics, Misc. Pub. No. MISC0190, Pullman, WA, pp.45-48.

Hagen, L.J. 2001. Assessment of wind erosion parameters using wind tunnels. In: D.E. Stott, R.H. Mohtar, and G.C. Steinhardt (eds.). *Sustaining the Global Farm. Proc. of 10th International Soil Conservation Organization Conference*, May 24-29, 1999, Purdue Univ., West Lafayette, IN, pp. 742-746.

Hagen, L.J. 2004. Evaluation of the Wind Erosion Prediction System (WEPS) erosion submodel on cropland fields. *Environmental Software & Modeling* 2:171-176.

Hagen, L.J. 2004a. Fine particulates (PM₁₀ and PM_{2.5}) generated by breakage of mobile aggregates during simulated wind erosion. *Trans. Amer. Soc. Agric. Engin.* 47(1):107-112.

Hagen, L.J., S. Van Pelt, T. M. Zobeck, A. Retta. 2007. Dust deposition near an eroding source field. *Earth Surface Processes and Landforms* 32(2):281-289.

Hagen, L.J. 2008. Updating soil surface conditions during wind erosion events using the Wind Erosion Prediction System (WEPS). *Trans. ASABE* 51(1): 129-137.

Hagen, L.J., Schroeder, PR. and Thai, L. 2009. Estimated particulate emissions by wind erosion from the Indiana Harbor Confined Disposal Facility. *ASCE Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management* 13: 21-28.

HydroGeoLogic, 2008. Proceedings from the Workshop on Research Needs for Assessment and Management of Non-Point Air Missions from Department of Defense (DoD) Activities, 19-21 February 2008, Research Triangle Park, North Carolina. Prepared for the Strategic Environmental Research and Development Program and Environmental Security Technology Certification Program by HydroGeoLogic, Inc., Reston, Virginia.

Kohake, D.J., L.J. Hagen, E.L. Skidmore. 2010. Wind erodibility of organic soils. *Soil Sci. Soc. Am. J.* 74(1):250:257.

Marchant, C.C., T.D. Wilkerson, G.E. Bingham, V.V. Zavyalov, J.M. Andersen, C.B. Wright, S.S. Cornelsen, R.S. Martin, P.J. Silva, and J.L. Hatfield. 2009. "AgLite lidar: A portable elastic lidar system for investigating aerosol and wind motions at or around agricultural production facilities," *J. Applied Remote Sensing*, *in press*.

Martin, R.S., V. Doshi, K. Moore. 2006. Determination of Particle (PM₁₀ and PM_{2.5}) and Gas-Phase Ammonia (NH₃) Emissions from a Deep-Pit Swine Operation using Arrayed Field Measurements and Inverse Gaussian Plume Modeling. In *Proceedings, Workshop on Air Quality: State of the Science. Bolger Conference Center, Potomac, MD, June 5-8, 2006*; pp 890-894.

Martin, R.S., K.D. Moore, V.S. Doshi. 2007. Determination of particle (PM₁₀ and PM_{2.5}) and gas-phase ammonia (NH₃) emissions from a deep-pit swine operation using arrayed field measurements and inverse Gaussian plume modeling. *Atmospheric Environment*. In review.

Mayor, S.D. et al. National Academy of Sciences, 2009: *BioWatch and Public Health Surveillance: Evaluating Systems for the Early Detection of Biological Threats*. Washington, D.C

Mayor, S. D., and S. M. Spuler, 2004: Raman-shifted Eye-safe Aerosol Lidar, *Appl. Optics*, **43**, 3915-3924

Mirzamostafa, N., L.J. Hagen, L.R. Stone, and E.L. Skidmore E.L. 1998. Soil and aggregate texture effects on suspension components from wind erosion. *Soil Sci. Soc. Am. J.* 62:1351-1361.

National Research Council of the National Academies (NRC). 2003. Air emissions from animal feeding operations: current knowledge, future needs. National Academic Press, Washington, D.C. 263 p.

Razote, E.B., R.G. Maghirang, B.Z. Predicala, J.P. Murphy, B.W. Auvermann, J.P. Harner, and W.L. Hargrove. 2006. Laboratory evaluation of the dust emission potential of cattle feedlot surfaces. *Transactions of the ASABE* 49(4):1117-1124.

Razote, E.B., R.G. Maghirang, J.P. Murphy, B.W. Auvermann, J.P. Harner III, D.L. Oard, W.L. Hargrove, and J.M. Sweeten. 2007a. Ambient PM₁₀ concentrations at a beef cattle feedlot in Kansas. *Proceedings of the International Symposium on Air Quality and Waste Management*, Broomfield, CO. St. Joseph, MI: ASABE.

Razote, E.B., R.G. Maghirang, J.P. Murphy, B.W. Auvermann, J.P. Harner III, D.L. Oard, W.L. Hargrove, and J.M. Sweeten. 2007b. Air quality measurements from a water-sprinkled beef cattle feedlot in Kansas. ASABE Paper No. 07-4108. St. Joseph, MI.: ASABE.

Razote, E.B., R.G. Maghirang, L. Guo, J.G. Tallada, B.W. Auvermann, J.P. Harner, and W.L. Hargrove. 2008. TEOM measurements of PM₁₀ and PM_{2.5} concentrations at cattle feedlots in Kansas. ASABE Paper No. MC08-108. St. Joseph, MI: ASABE.

Space Dynamics Laboratory. 2007. "Los Banos, CA Fall 2007 Tillage Campaign: Data Analysis," SDL/08-107.

Skidmore, E.L. and D.H. Powers. 1982. Dry soil-aggregate stability: Energy-based index. *Soil Sci. Soc. Am. J.* 46:1274-1279..

Skidmore, E.L. and J.B. Layton. 1988. Soil measurements to estimate erodibility by wind. Proc. 1988 Wind Erosion Conf., Lubbock, Texas, pp. 133-138.

Swerdlin, S. 2004. Pentagon Shield Overview <http://www.ral.ucar.edu/projects/shield/references/gmu04/Swerdlin-GMU-2004-07-13.pdf>

Veranth, J.M., K. Perry, E. Pardyjak, S. Speckart, R. Labban, E. Kaser, J. Watson, J.C. Chow, V. Etyemezian, and S. Kohl. 2008. Final Report: Characterization of PM_{2.5} dust emissions form training/testing range operations. SERDP Project SI-1190.

Wagner, L.E. and D.J. Ding. 1993. Stochastic modeling of tillage-induced aggregate breakage. Trans. ASAE 36(4): 1087-1092.

Wagner, L.E. and D.J. Ding. 1994. Representing aggregate size distributions as modified lognormal distributions. Trans. ASAE 37(3):815-821.

Wagner, L.E. and R.G. Nelson. 1994. Mass Reduction of Standing and Flat Crop Residues by Selected Tillage Implements. Trans of the ASAE; 38(2):419-427.

Wagner, L.E. 1996. An overview of the Wind Erosion Prediction System. In *Proceedings of the International Conference on Air Pollution from Agricultural Operations*. Midwest Plans Service, Ames, Iowa.

Wagner, L.E. 1996. Overview of the WEPS management submodel. ASAE Paper no. 96-2114 St. Joseph, MI.

Wagner, L.E., and E.L. Skidmore. 2000. Assessment of Current Methods to Quantify Residue, Surface Roughness, and Soil Aggregate Properties in Wind Erosion Studies. In John M. Laflen, Junliang Tian, and Chi-Hua Huang (eds) *Soil Erosion and Dryland Farming*, Soil and Water Conservation Society, CRC Press, 663-671.

Wagner, L.E. 2000. "Modeling of tillage processes in the wind erosion prediction system (WEPS)". ISTRO 2000, 15th Conference of the Int. Soil Till. Res. Org., Ft. Worth, TX. 2-7 July.

Wagner, L.E. and L.J. Hagen 2001. "Application of WEPS generated soil loss components to assess off-site impacts." In: D.E. Stott, R.H. Mohtar, and G.C. Steinhardt (eds.) *Sustaining the Global Farm*. Proc. of 10th International Soil Conservation Organization Conference, May 24-29, 1999, Purdue Univ., West Lafayette, IN , pp. 935-939.

M.L. Wilson, D.C. Linne von Berg, M.R. Kruer, N. Holt, S.A. Anderson, D.G. Long, Y. Margulis, "DUSTER: An Integrated LWIR-VNIR-SAR Imaging System," Military Sensing Symposia Passive, Nellis AFB, NV 4-8 Feb 2008.

M.L. Wilson, D.C. Linne von Berg, M.R. Kruer, N. Holt, S.A. Anderson, D.G. Long, Y. Margulis, "DUSTER: An Integrated LWIR-VNIR-SAR Imaging System," SPIE Defense and Security, Orlando, FL 17-20 Mar 2008.

Woodruff, N.P. 1971. Closure "Sediment measurement techniques: E. Airborne sediment". J. Hydraulics Div., Proc. of ASCE, Vol. 97, No. HY1, Proc. Paper 7783, pp. 173-174.

Zingg, A.W. and W.S. Chepil. 1950. Aerodynamics of wind erosion. *Agric. Engin.* 31:279-282, 284.

Zavyalov, V.V., C.C. Marchant, G.E. Bingham, T.D. Wilkerson, J.L. Hatfield, R.S. Martin, P.J. Silva, K.D. Moore, J. Swasey, D.J. Ahlstrom, and T.L. Jones. 2009. "AgLite lidar: Calibration and retrievals of well characterized aerosols from agricultural operations using a three-wavelength elastic lidar," *J. Applied Remote Sensing*, *in press*.

Appendix: Proposed Schedule

Year 1:

Site visit to Ft. Riley

Begin collecting samples for tasks 1a and 1b at Ft. Riley and process data

Begin collecting data for task 1c at Ft. Riley and process data

Year 2:

Complete task 1c sampling from Ft. Riley

Site visit to 2nd and 3rd DoD installation (TBD with DRI)

Begin task 3a, requirements definition and conceptual design phases

Collect samples for tasks 1a and 1b from 2nd and 3rd DoD installations and process data

Begin collecting data for task 1c from 2nd and 3rd DoD installations and process data

Year 3:

Continue task 3a, fabrication and bench testing phases

Continue collecting samples for task 1c from 2nd and 3rd DoD installation sites

Site visit to 4th DoD installation (TBD with DRI)

Collect samples for tasks 1a and 1b from 4th DoD installations and process data

Begin collecting data for task 1c from 4th DoD installation

Year 4:

Continue task 3a, field test and CELiS delivery phases

Complete collection of samples for task 1c from 2nd, 3rd and 4th DoD installations

Complete task 1d

Complete task 3a, field demonstration

Dissemination of results

Timeline:

The project is scheduled to begin in June 2010 and last 4 years. The first year will be dedicated to developing the field site and collecting field data from Ft. Riley. Year two and three will focus on collecting additional field data from at least two additional DoD installations each year. Year four will be primarily dedicated towards data analysis, software development and publication of results and final report.

Time		Objective(s)
Year	Month	
2010	June	Project begins
	June	Site visit to Ft. Riley (Select sampling sites (tasks 1a & 1b))
	June	Setup weather station for task 1c location at Ft. Riley
	June	Begin tasks 1a and 1b sampling at Ft. Riley
	September	Quarterly field sampling for task 1c at Ft. Riley
	December	Quarterly field sampling for task 1c at Ft. Riley
	March-December	Analyze laboratory data collected at Ft. Riley
	December	Attend SERDP Symposium
2011	February	Site trip to determine locations for 2 nd and 3 rd DoD sites with DRI
	February	Select sampling sites (tasks 1a and 1b) on 2 nd & 3 rd DoD sites
	February	In-Progress Review meeting
	March	Setup weather station for task 1c location at 2 nd and 3 rd DoD sites
	March	Begin tasks 1a and 1b sampling at 2 nd and 3 rd DoD sites
	March	Quarterly field sampling for task 1c at Ft. Riley
	June	Quarterly field sampling for task 1c at Ft. Riley and 2 nd & 3 rd DoD sites
	June	Begin requirements definition for CELiS
	July	Requirements defined, begin CELiS design
	September	Finish quarterly field sampling for task 1c at Ft. Riley
	September	Quarterly field sampling for task 1c at 2 nd and 3 rd DoD sites
	December	Quarterly field sampling for task 1c at 2 nd and 3 rd DoD sites
	March-December	Analyze laboratory data collected at Ft. Riley and 2 nd & 3 rd DoD sites
	December	Attend SERDP Symposium
	December	Submit interim report
2012	January	Design phase complete, begin CELiS fabrication
	February	Site trip to determine location for 4 th DoD site with DRI
	February	Select sampling sites (tasks 1a and 1b) on 4 th DoD site
	March	Setup weather station for task 1c location at 4 th DoD site
	March	Begin tasks 1a and 1b sampling at 4 th DoD site
	March	Quarterly field sampling for task 1c at 2 nd and 3 rd DoD sites
	April/May	In-Progress Review meeting
	June	Quarterly field sampling for task 1c at 2 nd , 3 rd and 4 th DoD sites
	September	Quarterly field sampling for task 1c at 2 nd , 3 rd and 4 th DoD sites
	December	Quarterly field sampling for task 1c at 2 nd , 3 rd and 4 th DoD sites
	March-December	Analyze laboratory data collected at 2 nd , 3 rd and 4 th DoD sites
	December	Attend SERDP Symposium
2013	January	CELiS fabrication complete
	March	Quarterly field sampling for task 1c at 2 nd , 3 rd and 4 th DoD sites
	June	Finish quarterly field sampling for task 1c at 2 nd , 3 rd and 4 th DoD sites
	June	CELiS field test
	March-November	Analyze laboratory data collected at 2 nd , 3 rd and 4 th DoD sites
	March-November	Address task 1d items
	December	Attend SERDP Symposium
	December	Submit final reports

The following Gantt chart provides a general project timeline by major project tasks.

Task item	Task Description	Y1 (FY10)				Y2 (FY11)				Y3 (FY12)				Y4 (FY13)				Comments
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Task 1a	Site visit, soil survey, sample collection																	Ft Riley, KS
	Laboratory testing																	
	Site visit, soil survey, sample collection																	TBD (site 2)
	Laboratory testing																	
	Site visit, soil survey, sample collection																	TBD (site 3)
	Laboratory testing																	
	Site visit, soil survey, sample collection																	TBD (site 4)
	Laboratory testing																	
Summary report preparation																		
Task 1b	Sample collection																	Ft Riley, KS
	Laboratory wind tunnel testing																	
	Sample collection																	TBD (site 2)
	Laboratory wind tunnel testing																	
	Sample collection																	TBD (site 3)
	Laboratory wind tunnel testing																	
	Sample collection																	TBD (site 4)
	Laboratory wind tunnel testing																	
Summary report preparation																		
Task 1c																		Ft Riley, KS
	Ongoing soil and vegetation recovery to less degraded states survey of Task 1a sites as conditions and meteorology dictate																	TBD (site 2)
																		TBD (site 3)
																		TBD (site 4)
	Summary report preparation																	
Task 1d	Ongoing WEPS model development/integration																	Ongoing modeling and data integration task
Task 3a	Requirements definition																	
	Conceptual design																	
	Fabrication and bench testing																	
	Field test and CELIS delivery																	

Appendix: List of Acronyms

3-D	Three Dimensional
AERMOD	AMS/EPS Regulatory MODel
APS	Aerodynamic Particle Sizer spectrometer
AMS	American Meteorological Society
ARS	Agricultural Research Service
BAE	Biological and Agricultural Engineering Department, Kansas State University
BSNE	Big Spring Number Eight sediment sampler
CEE	Department of Civil and Environmental Engineering, Utah State University
CELiS	Compact Eye-safe Lidar System
CFD	Computation Fluid Dynamics
CONOPS	Concept of Operations
COTS	Commercial Off-The-Shelf
DoD	U.S. Department of Defense
DUSTRAN	DUST TRANsport
DWL	Doppler Wind Lidar
EDL	Energy Dynamics Laboratory (formerly Space Dynamics Laboratory)
EPA	U.S. Environmental Protection Agency
ESTCP	Environmental Security Technology Certification Program
EWERU	Engineering and Wind Erosion Research Unit
FEM	Federal Equivalent Method
FTIR	Fourier Transform InfraRed spectrometer
GIS	Geospatial Information System
IPA	Intergovernmental Personnel Act
IR&D	Internal Research and Development
ISCST3	Industrial Source Complex Short Term, version 3.0
ITAM	Integrated Training Area Management
KSU	Kansas State University
lidar	LIght Detection And Ranging
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NRC	National Research Council
OPC	Optical Particle Counter
PFPA	Pentagon Force Protection Agency
PG	Department of Physics and Geosciences, California State University, Chico
PI	Principle Investigator
PI-SWERL	Portable In-Situ Wind Erosion Lab
PM	Particulate Matter
PM ₁	Particulate Matter with an aerodynamic diameter less than or equal to 1.0 μm
PM _{2.5}	Particulate Matter with an aerodynamic diameter less than or equal to 2.5 μm
PM ₁₀	Particulate Matter with an aerodynamic diameter less than or equal to 10 μm
PM _{course}	Particulate Matter with aerodynamic diameters between 2.5 and 10 μm
REAL	Raman Shifted Eye-Safe Aerosol Lidar
SERDP	Strategic Environmental Research and Development Program
SMPS	Scanning Mobility Particle Sizer
SNR	Signal to Noise Ratio
SoN	Statement of Need
TBD	To Be Determined
TEOM	Tapered Element Oscillating Microbalances PM sampler

TRL	Technology Readiness Level
TRL1	Basic principles observed and reported
TRL2	Technology concept and/or application formulated (simple proof of concept)
TRL3	Analytical & experimental critical function and/or characteristic proof of concept
TRL4	Component and/or breadboard validation in laboratory environment
TRL5	Component and/or breadboard validation in relevant environment
TRL6	System/subsystem model or prototype demonstration in a relevant environment
TRL7	System prototype demonstration in an operational environment
TSP	Total Suspended Particulate
USDA	U.S. Department of Agriculture
USTAR	Utah Science and Technology And Research
USU	Utah State University
VAEPRS	Vehicle Aerosol Emission Prediction System
VIL	Volume Imaging Lidar
VSACEM	Vertical Soil Aggregate Crushing Energy Meter
WiLD	Wind Lidar Detection
WEPS	Wind Erosion Prediction System

Abbreviations

B.S.	Bachelor of Science
Corp.	Corporation
Dept.	Department
Dr.	Doctor
etc.	Etcetera
Fig.	Figure
Ft.	Fort
ft	foot
Hz	Hertz
Inc.	Incorporated
km	kilometer, 1×10^3 meter
kw	kilowatt, 1×10^3 watt
m	meter
min	minute
mm	millimeter, 1×10^{-3} meter
M.S.	Master of Science
Ph.D.	Doctor of Philosophy
Univ.	University
μm	micrometer, 1×10^{-6} meters
V	volt

State Abbreviations

CA	California
CO	Colorado
DC	District of Columbia
KS	Kansas
MN	Minnesota
NH	New Hampshire
NM	New Mexico
UT	Utah

Appendix: List of Research Equipment

Table 2. Inventory of available KSU BAE Air Quality Laboratory measurement instrumentation

Equipment	Number of Units	Function
Weather stations	2	Measurement of weather conditions
Instrument trailers	2	Transport and/or storage of instruments

Table 3. Inventory of available USDA-ARS EWERU measurement instrumentation

Equipment	Number of Units	Function
Rotary Sieves (cuts of 44.45, 14.05, 16.35, 2.0, 0.84, 0.42 mm)	2	Measurement of soil aggregate size distribution
Vertical Soil Aggregate Crushing Energy Meter (VSACEM)	1	Measurement of soil aggregate and crust stability
Laser Distance Scanning System and Roughness Pin Meter	1 each	Measurement of soil surface roughness (oriented and random)
Outdoor Laboratory Wind Tunnel with abrader material feeder	1	For generating selected wind speeds and applying desired abrader levels upon selected soil surfaces in the lab
10m meteorological towers with anemometers (@ selected heights, 10m, 2m, etc.)	2	Measurement of wind speed profiles
Meteorological station(s) with data acquisition system to measure wind direction, air temperature, relative humidity, solar radiation, and rainfall	2	Measurement of additional weather data required for Task 1c
Plant and residue measurement equipment, leaf area meter, sampling frame or steel tape	1 each	Measurement of plant material characteristics affecting wind flow and erosion
Soil characterization lab equipment including particle size distribution apparatus and sonic sieve systems	1 each	Measurement of additional soil characteristics affecting wind erosion
Loose material collection system	1	Characterization of soil crusts
Trailer mounted generator (15kW)	1	For providing power in the field
Honda portable generator (5kW)	1	For providing portable 110V power

Appendix: Letter Supporting Collaborative Efforts



REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST INFANTRY DIVISION and FORT RILEY
580 1ST DIVISION ROAD
FORT RILEY, KANSAS 66442-7000

January 11, 2010

Larry E. Wagner
Agricultural Engineer
USDA-ARS Wind Erosion Research Unit
1515 College Ave
Manhattan, Kansas 66502


SUBJECT: Strategic Environmental Research and Development programs
(SERDP) Proposal

Dear Mr. Wagner:

The proposal you are presenting to SERDP has significant potential to benefit Fort Riley and the United States Army. You are encouraged to present your proposal with the assurance of Fort Riley's interest in seeing that this research is undertaken, and that we will cooperate with the research team assigned to the task.

There will be a requirement to coordinate the access to Fort Riley's training and maneuver areas when establishing and monitoring test sites. I have directed Mr. Chris Otto from the Integrated Training Area Management (ITAM) Program, to be your point of contact. He will assist your team and insure the accomplishment of this project.

Mr. Otto can be reached at (785) 239-8747 or christopher.l.otto@us.army.mil for further assistance or information. Thank you for your interest and support of Fort Riley.



PHILIP B. WOODFORD
ITAM Coordinator
Fort Riley, Kansas

Larry E. Wagner - Agricultural Engineer

Contact Information:

USDA-ARS, CGAHR EWERU
1515 College Ave.
Manhattan, KS 66502

Phone: 785-537-5544
Fax: 785-537-5550
Email: larry.wagner@ars.usda.gov

Education:

Ph.D.	1984-88	Kansas State University, Manhattan, KS; Engineering
M.S.	1982-83	Kansas State University, Manhattan, KS; Agricultural Engineering
B.S.	1978-82	Kansas State University, Manhattan, KS; Agricultural Engineering

Experience:

1988-present	Agricultural Engineer, USDA-ARS, Manhattan, KS
1984-88	Grad. Teaching Asst., Kansas State Univ., Manhattan, KS
1982-88	Grad. Research Asst., Kansas State Univ., Manhattan, KS
1982	Designer, Caterpillar Tractor Company, Peoria, IL

Committees:

American Society of Agricultural and Biological Engineers

1990-present Member, SW-223 Erosion Control Research Committee
2001-2007 Member, M-141 Paper Awards Committee (chair 2007)

Soil and Water Conservation Society

1996-2000 Secretary/Treasurer, Manhattan Chapter

Kansas Crop Residue Alliance

1992-2006 Member, Board of Advisors

Kansas Technical Committee (NRCS)

2008-present Member

Other

2000-2001 Member, Organizing committee for international symposium, "*Soil Erosion Research for the 21st Century*" ASAE (Jan. 2-4, 2001)
1992-present Member, Graduate Faculty at Kansas State University, Manhattan, KS.

Accomplishments (1999-present):

Dr. Wagner serves as an Agricultural Engineer in the Engineering and Wind Erosion Research Unit, GMPRC, Manhattan, KS. The interdisciplinary research mission addresses all aspects of wind erosion, including: identification and quantification of physical processes; development of simulation prediction models; development and evaluation of control practices; and evaluating off-site impacts of soil erosion by wind. This research contributes to the ARS National Program Areas #203 (Air Quality) and #202 (Soil Resource Management). Within the research unit, the incumbent is part of a team conducting research on wind erosion processes, prediction, and control. Dr. Wagner leads a national multi-unit, multi-disciplinary core team (since Sep. 1999) assigned to develop, test, and deliver a new Wind Erosion Prediction System (WEPS). He provides special expertise on soil/residue/tillage interactions and leadership in both science and interface modeling issues as well as responsibility for the MANAGEMENT submodel component of WEPS.

Selected Relevant Publications:

Wagner, L.E., Ambe, N.M., and Barnes, P. *Tillage-induced effects on temporal soil properties*. ASAE Paper No. 91-2018, St. Joseph, MI. 21 pp. 1991.

Wagner, L.E., and Yu, Y. *Digitization of profile meter photographs*. TRANSACTIONS of the ASAE 34(2):412-416. 1991.

Wagner, L.E., and Hagen, L.J. *Relationship between shelter angle surface roughness and cumulative sheltered storage depth*. 10 pp. International Wind Erosion Workshop. Sep. 10-12, 1991 in Budapest, Hungary. In J. Karacsony, Gy. Szalai (eds.) Proc. of the International Wind Erosion Workshop of CIGR; v. Section I. 1992.

Wagner, L.E., Ambe, N.M. and Barnes, P. *Tillage-induced soil aggregate status as influenced by water content*. TRANSACTIONS of the ASAE 35(2):499-504. 1992.

Wagner, L.E., Tatarko, J., and Skidmore, E.L. *WIND-GEN: A statistical database and generator for wind data*. ASAE Paper No. 92-2111, St. Joseph, MI. 7 pp. 1992.

Wagner, L.E. *Modeling tillage actions on soil aggregates*. ASAE Paper No. 92-2133, St. Joseph, MI. 17 pp. 1992

Ambe, N.M. and Wagner, L.E. *Tillage-induced bulk density as influenced by initial soil condition, water content, and implements*. ASAE Paper No. 93-2092, St. Joseph, MI. 9 pp. 1993.

Wagner, L.E. and Ding, D.J. *Stochastic modeling of tillage-induced aggregate breakage*. TRANSACTIONS of the ASAE 36(4):1087-1092. 1993.

Wagner, L.E. and Ding, D.J. *Representing aggregate size distributions as modified log-normal distributions*. TRANSACTIONS of the ASAE 37(3):815-821. 1994.

Wagner, L.E., Ambe, N.M., and Ding, D.J. *Estimating a proctor density curve from intrinsic soil properties*. TRANSACTIONS of the ASAE 37(4):1121-1125. 1994.

Skidmore, E.L., Hagen, L.J., Armbrust, D.V., Durar, A.A., Fryrear, D.W., Potter, K.N., Wagner, L.E. and Zobeck, T.M. "Methods for investigating basic processes and conditions affecting wind erosion". In R. Lal (editor) *Soil Erosion Research Methods - 2nd Edition*. Soil and Water Conservation Soc. Ankeny, Iowa. Chapter 12, pp 295-330. 1994.

Wagner, L.E., and Nelson, R. *Mass reduction of standing and flat crop residues by selected tillage implements*. TRANSACTIONS of the ASAE. 38(2):419-427. 1995.

Wagner, L.E., and Ding, D. *WEPS technical documentation: management submodel*. Proceedings from the WEPP/WEPS Symposium sponsored by Soil and Water Conservation Society. 1995.

Tatarko, J., Skidmore, E.L. and Wagner, L.E. *WEPS technical documentation: weather submodel*. Proceedings from the WEPP/WEPS Symposium sponsored by Soil and Water Conservation Society. 1995.

Hagen, L.J., Wagner, L.E. and Tatarko, J. *WEPS technical documentation: introduction*. Proceedings from the WEPP/WEPS Symposium sponsored by Soil and Water Conservation Society. 1995.

Wagner, L.E. *An overview of the wind erosion prediction system.* International Conference on Air Pollution from Agricultural Operations sponsored by MidWest Plan Service. pp 73-78. 1996.

Wagner, L.E. *Wind erosion prediction system (WEPS): overview.* In E.L. Skidmore and J. Tartarko (eds.). Wind Erosion: An International Symposium/Workshop. Proc. USDA-ARS Wind Erosion Research Unit, Kansas State University, Manhattan, KS. 1997.

Wagner, L.E. *Wind erosion prediction system: management submodel.* In E.L. Skidmore and J. Tartarko (eds.). Wind Erosion: An International Symposium/Workshop Proc. USDA-ARS Wind Erosion Research Unit, Kansas State University, Manhattan, KS. 1997.

Hagen, L.J., Wagner, L.E. and Skidmore, E.L. *Wind erosion processes in WEPS: I. Analytic solutions and sensitivity analyses for saltation/creep and suspension components.* TRANSACTIONS of the ASAE 37(4):1121-1125. 2000

Wagner, L.E. and Skidmore, E.L., *Methods to quantify residue, roughness, and soil aggregates in wind erosion studies.* In J. Laflen, J. Tian, and C. Huang (eds.). Soil Erosion and Dryland Farming. CRC Press, Boca Raton, FL. Chapter 65, pp 663-671. 2000.

Wagner, L.E. *Modeling of tillage processes in the wind erosion prediction system (WEPS).* ISTRO 2000, 15th Conference of the Int. Soil Till. Res. Org., Ft. Worth, TX. 2-7, July 2000.

Fox, F.A. and Wagner, L.E. *A laser distance based method for measuring standing residue.* In J.C. Ascough and D.C. Flanagan (eds.). Soil Erosion Research For the 21st Century - Proceedings of the International Symposium. pp 207-210 . ASAE, St. Joseph, MI. 2001.

Tatarko, J., Wagner, L.E. and Boyce, C.A. *Effects of overwinter processes on stability of dry soil aggregates.* In J.C. Ascough and D.C. Flanagan (eds.). Soil Erosion Research For the 21st Century - Proceedings of the International Symposium. pp 459--462. ASAE, St. Joseph, MI. 2001.

Wagner, L.E. and Fox, F.A. *Simulation of tillage and other management operations in WEPS.* In J.C. Ascough and D.C. Flanagan (eds.). Soil Erosion Research For the 21st Century - Proceedings of the International Symposium. pp 625--628. ASAE, St. Joseph, MI. 2001.

Tatarko, J. and L.E. Wagner. *Using WEPS with measured data.* In: Lee, Jeffrey A. and Zobeck, Ted M. (eds). Proceedings of ICAR5/GCTE-SEN Joint Conference, International Center for Arid and Semiarid Lands Studies, Texas Tech University, Lubbock, Texas, USA Publication 02-2, pp 282-284. 2002.

Wagner, L.E. *Design philosophy behind MCREW - Management/Crop Rotation Editor for WEPS.* ASAE Paper No. 04-2195, St. Joseph, MI, St. Joseph, MI. 2004.

van Donk, S.J., L.E. Wagner, E.L. Skidmore and J. Tatarko. 2005. *Stochastic wind generation, comparing the Weibull model with a more direct approach.* Transactions of the ASAE 48:503-510.

Ronaldo G. Maghirang

Contact Information:

Department of Biological and Agricultural Engineering
159 Seaton Hall
Kansas State University
Manhattan, KS
Phone: 785-532-2908; E-mail: rmaghir@ksu.edu

Professional Preparation

University of the Philippines at Los Baños, Philippines, B.S. (magna cum laude) in Agricultural Engineering, 1982.
University of the Philippines at Los Baños, Philippines, M.S., 1986.
Pennsylvania State University, University Park, PA, Ph.D. in Agricultural Engineering, 1992.

Appointments

Professor, Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, KS, 2004 - present.
Special Assistant to the Dean, College of Engineering, Kansas State University, Manhattan, KS, 2006 – 2007.
Associate Professor, Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, KS, 1999 - 2004.
Visiting Scientist, Veterinary Programs in Agriculture and Department of Agricultural Engineering, University of Illinois at Urbana-Champaign, Urbana, IL, Fall 2000 (while on sabbatical from Kansas State University), and Summer 2002.
Assistant Professor, Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, KS, 1994 – 1999.

Synergistic Activities

Division Program Chair, Structures and Environment Division, American Society of Agricultural and Biological Engineers (ASABE), 2005-08.
Associate Editor, Transactions of the ASABE and Applied Engineering in Agriculture, 2000-2009.
Program Chair, Third International Conference on Air Pollution from Agricultural Operations, October 2003, Raleigh, NC.
As Special Assistant to the Dean of Engineering, provided leadership on the activities of the Office of Student Services, Office of Recruitment & Leadership Development, Women in Engineering & Science Program (WESP), Multicultural Engineering Program (MEP), and Engineering Computing Services in the College of Engineering, Kansas State University.

Honors and Awards

Making a Difference Awards (3 awards in 2007 and 2 awards in 2008), Women in Engineering & Science Program (WESP), Kansas State University.
Outstanding Advisor Awards (2007-08 - Biological & Agricultural Engineering; 2007-08 and 2006-07 - Agricultural Technology Management), Department of Biological and Agricultural Engineering, Kansas State University.
Outstanding Paper Awards (3: Superior Paper – 2006; Honorable Mention Paper – 2004, 2007), American Society of Agricultural and Biological Engineers (ASABE).
2005 Engineering Research Excellence Award, College of Engineering, Kansas State University.
2002 Outstanding Professor, Advisor and Mentor Award, Mortar Board Senior Honor Society, Kansas State University.
2000 James L. Hollis Memorial Award for Excellence in Undergraduate Teaching, College of

Engineering, Kansas State University.
 2000 Young Member Engineer of the Year, Mid-Central Section of the ASAE (for Nebraska, Kansas, Iowa, Missouri).

Recent Publications

- Almuhanna, E., R.G. Maghirang, J.P. Murphy, and L.E. Erickson. 2009. Electrostatically-assisted particulate wet scrubber for controlling dust in livestock buildings. *Applied Engineering in Agriculture* (accepted).
- Pjesky, S.C. and R.G. Maghirang. 2009. Relative chargeability of nanostructured and conventional particles by tribocharging. *Particulate Science & Technology* (in press).
- Guo, L., R.G. Maghirang, E.B. Razote, J. Tallada, J.P. Harner, and W. Hargrove. 2009. Field comparison of PM₁₀ samplers. *Applied Engineering in Agriculture* (accepted).
- Maghirang, R.G. and E.B. Razote. 2009. Smoke dissipation with solid particles and charged water sprays. *Fire Safety Journal* (in press).
- Yang, X., C. Cao, L. Erickson, K. Hohn, R.G. Maghirang, and K.J. Klabunde. 2008. Synthesis of visible-light-active TiO₂-based photocatalysts by carbon and nitrogen doping. *Journal of Catalysis* 260:128-133.
- Boac, J.M., M.E. Casada, and R.G. Maghirang. 2008. Feed pellet and corn durability and breakage during repeated elevator handling. *Applied Engineering in Agriculture* 24(5):637-643.
- Almuhanna, E., R.G. Maghirang, J.P. Murphy, and L. Erickson. 2008. Effectiveness of electrostatically-charged water spray in reducing dust concentration in enclosed spaces. *Transactions of the ASABE* 51(1):279-286.
- Yadav, R., R.G. Maghirang, L.E. Erickson, B. Kakumanu, and S.G. Castro. 2008. Laboratory evaluation of the effectiveness of nanostructured and conventional particles in clearing smoke in confined spaces. *Fire Safety Journal* 43(1):36-41.
- Zhang, N., Z.C. Zheng, and R.G. Maghirang. 2008. Numerical simulation of smoke dissipation with dispersed nanoparticle aggregates. *International Journal for Numerical Methods in Engineering* 74:601-618.
- Mulukutla, R., P. Malchesky, R.G. Maghirang, J.S. Klabunde, K.J. Klabunde, and O. Koper. 2007. Metal oxide nanoparticles for smoke clearing and fire suppression. U.S. Patent No. 7,276,640.
- Yang, X., C. Cao, K. Hohn, L. Erickson, R.G. Maghirang, D. Hamal, and K.J. Klabunde. 2007. Highly visible-light active C-, V-doped TiO₂ for oxidation of acetaldehyde. *Journal of Catalysis* 252:296-302. **[Selected as one of Top 25 Hottest Articles].**
- Ingles, M.E.A., M.E. Casada, R.G. Maghirang, T.J. Herrman, and J.P. Harner III. 2006. Effects of grain-receiving configuration on grain commingling in a country elevator. *Applied Engineering in Agriculture* 22(5):713-721.
- Razote, E.B., R.G. Maghirang, B.Z. Predicala, J.P. Murphy, B.W. Auvermann, J.P. Harner, and W.L. Hargrove. 2006. Laboratory evaluation of the dust emission potential of cattle feedlot surfaces. *Transactions of the ASABE* 49(4):1117-1124. **[Received 2007 ASABE Honorable Mention Paper Award].**
- Brabec, D.L., R.G. Maghirang, M.E. Casada, and E.L. Haque. 2005. Characterization and modeling of a high-pressure water fogging system for grain dust control. *Transactions of the ASAE* 48(1):331-339. **[Received 2006 ASABE Superior Paper Award].**
- Razote, E., R.G. Maghirang, L. Seitz, and I. Jeon. 2004. Characterization of volatile organic compounds on airborne dust in a swine finishing barn. *Transactions of the ASAE* 47(4):1231-1238.
- Miller, G.Y., R.G. Maghirang, G.L. Riskowski, A.J. Heber, M.J. Robert, and M.E.T. Muyot. 2004. Influences on air quality and odor from mechanically ventilated swine finishing buildings in Illinois. *Journal of Food, Agriculture & Environment* 2(2):353-360.
- Brabec, D.L., R.G. Maghirang, and M.E. Casada. 2004. Effectiveness of high-pressure, water fogging system in controlling dust emissions at grain receiving. *Transactions of the ASAE* 47(2):505-511.
- Billate, R.D., R.G. Maghirang, and M.E. Casada. 2004. Measurement of particulate matter emissions

from corn receiving operations with simulated hopper-bottom trucks. *Transactions of the ASAE* 47(2):521-529.

- Predicala, B.Z. and R.G. Maghirang. 2004. Measurement of particulate matter emission rates from mechanically ventilated swine barns. *Transactions of the ASAE* 47(2):557-565.
- Predicala, B.Z. and R.G. Maghirang. 2003. Numerical simulation of particulate matter emissions from mechanically ventilated swine barns. *Transactions of the ASAE* 46(6):1685-1694. [**Received 2004 ASAE Honorable Mention Paper Award**].
- Ingles, M.E., M.E. Casada, and R.G. Maghirang. 2003. Handling effects on commingling and residual grain in an elevator. *Transactions of the ASAE* 46(6):1625-1631.
- Jerez, S.B. and R.G. Maghirang. 2003. Effectiveness of local supply ventilation in improving worker zone air quality in swine confinement buildings – a pilot study. *ASHRAE Transactions* 109 (Part 2):822-828.
- Predicala, B.Z. and R.G. Maghirang. 2003. Field comparison of inhalable and total dust samplers for assessing airborne dust in swine confinement barns. *Applied Occupational and Environmental Hygiene Journal* 18:694-701.

Current Grants and Contracts

- Principal Investigator, “Characterization and measurement of air emissions from large open cattle feedlot,” USDA CSREES NRI, with S. Trabue, L. McConnell, J. Prueger, C. Hapeman, W. Schmidt, K. Ro, J. Harner, and W. Hargrove. April 2009 – March 2012. \$399,981.
- Principal Investigator, “Air quality: Reducing emissions from cattle feedlots and dairies,” USDA CSREES (subcontract through Texas Agricultural Experiment Station), with W. Hargrove, J. Harner, and J. Pickrell. September 2008 – August 2009. \$142,000.
- Principal Investigator, “Impacts of water sprinkler systems on air quality at cattle feedlots,” USDA CSREES NRI, with S. Trabue, L. McConnell, J.P. Harner III, W.L. Hargrove, and F. Mercurio. January 2007 – December 2009. \$499,378.
- Principal Investigator, “Improved handling of grain in commercial elevators,” USDA ARS. July 2005 – June 2010. \$63,800.
- Principal Investigator, “Air quality: odor, dust and gaseous emissions from concentrated animal feeding operations in the Southern Great Plains,” USDA CSREES (subcontract through the Texas Agricultural Experiment Station), with W. Hargrove, J.P. Murphy, J. Harner, and J. Pickrell. May 2002 – March 2009. \$640,699.
- Principal Investigator, “Improved sensing system for grain measurement and storage,” USDA ARS, September 1, 2007 – August 31, 2010. \$26,300.
- Co-Principal Investigator, “Center for Nanostructured Materials for Indoor Air Quality,” KSU Targeted Excellence Program, with S. Eckels, C. Sorensen, K. Klabunde, L. Erickson, D. Zollman, A. Chakrabarti, Z. Zheng, J. Pickrell, and G. Marchin. July 2007 – June 2010. \$625,000.
- Co-Principal Investigator, “Urban operations laboratory,” US DoD (subcontract through M2 Technologies, Inc.), with L. Erickson, L. Glasgow, M. Hosni, K. Klabunde, Z. Zheng, S. Eckels, and others. August 2002 – March 2009. \$8,173,000 (Amount for our research in BAE: \$836,600).
- Collaborator, “Air quality extension and education: enhanced learning opportunities for addressing air quality issues in animal agriculture,” USDA CSREES NRI, with R. Stowell, D. Schulte, R. Koelsch, and others. February 1, 2007 – January 31, 2010. \$498,562.

Michael D. Wojcik

Energy Dynamics Laboratory
1695 North Research Park Way
North Logan, UT 84341

michael.wojcik@energydynamicslab.com
435.797.4109

Citizenship

Born 08 February 1974, Springfield, MA, United States

Security Clearance

DOD TS clearance granted November 2008

DOE Q clearance granted February 2006 (presently inactive)

Education

1992-1996, Rensselaer Polytechnic Institute, Troy, NY. B.S. Chemistry.

1996-2001, University of Idaho, Moscow, ID. PhD. Chemical Physics

2001-2003, JILA-NIST, University of Colorado, Boulder, CO. Post-doctoral Research Associate

Work History

2007-present, Energy Dynamics Laboratory, Utah State University, North Logan, UT
Branch Chief and Senior Scientist for Environmental Measurements Division

2003-2007, Pacific Northwest National Laboratory, Richland, WA.
Senior Research Scientist, Chemical and Biological Sciences Group

May 2007-November 2007, Dugway Proving Ground, Dugway, UT.
Project Scientist, Chemical Test Division, 6-month IPA while working for PNNL

Teaching Experience

1998-1999, University of Idaho, Moscow, ID. Teaching Assistant for Physical Chemistry Laboratory.

1996-1998, University of Idaho, Moscow, ID. Teaching Assistant for General Chemistry.

1995-1996, Shaker High School, Latham, NY. Student teaching experience, General Chemistry, A.P. Chemistry, Earth Science.

1995, Doyle Middle School, Troy, NY. Student teaching experience, General Science.

Selected Peer Reviewed Publications

“A directly-dissociative stepwise reaction mechanism for gas phase peroxyacetic acid.” BK Keller, MD Wojcik, TR Fletcher. Journal of Photochemistry and Photobiology A: Chemistry. Vol. 195, pp. 10-22, 2008

“External cavity quantum cascade laser for quartz tuning fork photoacoustic spectroscopy of broad absorption features.” MC Phillips, TL Myers, MD Wojcik, BD Cannon. Optics Letters, Vol. 32 (9) pp. 1177-1179, 2007

“Gas Phase Photoacoustic Spectroscopy in the Mid-Wave Infrared Using Quartz Tuning Forks and Amplitude Modulated Quantum Cascade Lasers.” MD Wojcik, MC Phillips, and BD Cannon, Applied Physics B, Vol. 85 (2-3), pp. 307-313, 2006

“Direct evidence for nonadiabatic dynamics in atom plus polyatom reactions: Crossed-jet laser studies of $F+D_2O \rightarrow DF+OD$ ” M. Ziemkiewicz, Michael D. Wojcik, D.J. Nesbitt Journal of Chemical Physics, Vol. 123 (22) 224307, 2005

“Using Lambda Doublet Ratios to Understand Collision Geometry in Direct Bimolecular Reactions” Michael D. Wojcik, T. Rick Fletcher. Journal of Chemical Physics, Vol. 117, pp. 1507-1510, 2002

“The Role of Translationally Excited Species in Atmospheric Reactions” T. Rick Fletcher, Michael D. Wojcik. Physics and Chemistry of the Earth, Part C Vol. 26/7, pp. 487-493, 2001

Selected Invited Talks

“Laser Photoacoustic Spectroscopy of Chemical Weapons Using Quantum Cascade Lasers and Quartz Tuning Forks”, 234th Annual Meeting of the American Chemical Society. Boston, MA. 2007

“Laser Photoacoustic Spectroscopy of Chemical Weapons Using Quantum Cascade Lasers and Quartz Tuning Forks”, Washington State University. Pullman, WA. 2005

“Quantum Cascade Laser Development Efforts for Implementation into Chemical and Remote Sensing Systems”, Michael D. Wojcik, Tanya L. Myers, Matthew S. Taubman, Bret D. Cannon, Bryan Brooks, Trinesha Mosely. SPIE – Optically Based Biological and Chemical Sensing for Defence, London, UK. 2004

“Toward a Quantum Cascade Laser Photoacoustic Sensor: QC-LPAS”, Michael D. Wojcik, Tanya L. Myers, Matthew S. Taubman, Bret D. Cannon, SPIE – Photonics West, San Jose, CA. 2005

Professional Organizations

SPIE. American Geophysical Union, American Chemical Society, Air & Waste Management Association, Psi Alpha Upsilon

Awards

Pacific Northwest National Laboratory Outstanding Performance Award

DARPA - Laser Photoacoustic Sensor Team, 2005 & 2006

Nasa Langley Research Center Team Award, 2009

Far-Infrared Observations of the Radiative Greenhouse Effect (FORGE) Team

Robert J. Foltynowicz, PhD

3633 Odom Drive. · New Port Richey, FL 34652 Mobile: (505) 250-8131 · rjfolty@yahoo.com

EDUCATION

Ph.D., Physical Chemistry, Purdue University, 2000

B.S., Chemistry, United States Military Academy at West Point, 1992

Chartered Financial Analyst (CFA) Level III Candidate

E.M.B.A., University of New Mexico 13 hours completed

Certificate in Applied Business Management Principles, Purdue University, 2000

Sandia National Laboratory Pre-Management Curriculum, July 2005

Research Experience Risk Modeling, Wachovia Corporation, 2007-Present

Developed a sophisticated, statistical-based, credit risk model which estimated the conditional probability surface for loss-given default (LGD) using the maximum expected utility approach. This model was the first of its kind within Wachovia and was used to benchmark internal LGD probability models. Responsible for assessing the model risk and the validation of credit, market, business, and operational risk models used to forecast Wachovia's economic capital and allowances for loan losses.

Research Associate (Senior Member of Technical Staff), Sandia National Laboratories, 2002-2007

Lead the establishment of the first terahertz (THz) spectroscopy program at Sandia National Laboratories utilizing terahertz technology to detect explosive vapors for homeland security applications. Successfully measured the first, gas-phase THz spectrum of an explosive material. This information has impacted the design of novel prototypes of explosive detecting entry portals used for airport security.

Research & Development Scientist, IBM Corporation, 2001-2002

Led the integration and development of the first cobalt, tungsten, and phosphorous electroless plating process in the semiconductor industry into 0.1-micron logic integrated circuit technology. Established analytical, spectroscopic process control methods, process improvements and provided technical assistance in the research and development of the first electroless-plating tool. The plating process was successfully integrated into IBM's line of microprocessors.

Research Assistant, Purdue University, 1996-2000

Led novel investigations on the excited vibrational energy level structure of HCO^+ and DCO^+ using laser spectroscopic techniques. First in the world to report critical spectroscopic constants of these molecules. These constants are routinely referenced by the scientific community through the NIST databases.

SPECTROSCOPY SKILLS

Terahertz Time-Domain Spectroscopy Ultrafast Laser Spectroscopy Resonance Enhanced Multi-Photon Ionization Spectroscopy Laser Induced Fluorescence Spectroscopy Optogalvanic Spectroscopy Zero Kinetic Energy Spectroscopy Photoionization Efficiency Spectroscopy Mass Spectroscopy (Quadrupole and Time of Flight)

Robert J. Foltynowicz, PhD

3633 Odom Drive. · New Port Richey, FL 34652 Mobile: (505) 250-8131 · rjfolty@yahoo.com

LASER SKILLS

Ultrafast Lasers and Diagnostics Continuous Wave Lasers Pulsed Nanosecond Laser Systems OPOs
Linear and Non-linear Optics

SEMICONDUCTORS SKILLS

Integrated Circuit Fabrication Scanning Electron Microscopy Statistical Process Control Metrology
Semiconductor Tools (AFM) Microchip Circuit Design

PROGRAMMING

Visual C++ SAS / R Matlab MathCAD Modeling Mathematica Modeling MS Excel Modeling LabVIEW
(Experimental Automation)

RESEARCH FUNDING EXPERIENCE

2006-2007 Sandia National Laboratories Terahertz Grand Challenge, \$150,000. Measure and
establish a library of gas-phase explosive spectra utilizing terahertz spectroscopy.

2005 Transportation Security Administration, \$350,000. Develop explosive detection system for
airport entry portals using terahertz spectroscopy.

2005 Sandia National Laboratories Non-proliferation Nuclear Weapons Funds, \$100,000. Use
terahertz spectroscopy to study corrosion effects inside nuclear weapon components.

2004 Technical Support Workgroup, \$300,000. Prove the feasibility of using terahertz spectroscopy to
detect explosive vapor.

TEACHING EXPERIENCE 2009-Present IB Chemistry Teacher, Carrollwood Day School (CDS)

Teaching and leading the development of the introductory (grade 10) and IB SL/HL (grade 11
and 12) programs in chemistry. Also, teaching and leading the development of a laboratory
program that supports the theoretical portions of each program. Currently, teaching five classes
with three different curricula in place. Responsible in leading the development of the character
education program at CDS to educate the students and faculty on integrating both moral
character and performance character in an academic setting.

2007-2008 Calculus Instructor, Cross of Hope Church Voluntarily designed and taught private
evening instruction on an undergraduate level calculus course for adults.

Robert J. Foltynowicz, PhD

3633 Odom Drive. · New Port Richey, FL 34652 Mobile: (505) 250-8131 · rjfolty@yahoo.com

1999-2000 Physical Chemistry Laboratory Instructor, Purdue University

Taught and lead discussions for an undergraduate physical chemistry laboratory course for chemistry and chemical engineering majors.

1998-1999 Quantum Mechanics Instructor, Purdue University

Voluntarily conducted private instructional sessions for undergraduate chemistry majors in introductory quantum mechanics.

1997-1998 Thermodynamics Instructor, Purdue University

Taught and lead discussions for an undergraduate thermodynamics course for chemistry majors.

1996-1997 Mathematica for Pharmacy Instructor, Purdue University

Taught and led undergraduate pharmacy students in a computer lab course designed to use Mathematica for data analysis applications.

1994-1995 Army Electronic Warfare Instructor, US Army

Developed a curriculum for conventional US Electronic Warfare Doctrine and used it to teach senior Egyptian officers while stationed in Cairo, Egypt.

1992-1993 Briefing and Presentation Skills Training, US Army

Received training in preparing and delivering presentations at the Military Intelligence Officer Basic Course in Ft. Huachuca, AZ.

CONFERENCE PRESENTATIONS 58th Southeast Regional American Chemical Society

Meeting, "Terahertz absorption measurement for gas-phase 2, 4 dinitrotoluene (DNT) from 0.05 to 2.7 THz," November 2006.

Physical Sciences Incorporated, "The Spectroscopic Characterization of the Vibrational Force Field for the Transient Species of Formyl Cations," December 2000.

International Symposium on Molecular Spectroscopy Conference, "An Experimental Determination of Anharmonic Terms in the Vibrational Hamiltonian of HCO^+ ," June 1999.

International Symposium on Molecular Spectroscopy Conference, "Rydberg States Converging to Higher Vibrationally Excited States of HCO^+ ," June 1998.

LIST OF PUBLICATIONS

Foltynowicz, R.J., Allman, R.E., and Zuckerman, E. Terahertz absorption measurement for gas-phase 2,4-dinitrotoluene from 0.05 to 2.7 THz. *Chemical Physics Letters* Vol. 431, Issues 1-3, 2006.

Foltynowicz, R.J. and Allman, R.E. Terahertz time-domain spectroscopy of atmospheric water vapor from 0.4 to 2.7 THz, *Sandia National Laboratory Report*, 2005.

Foltynowicz, R.J. and Allman, R.E. Atmospheric propagation of THz radiation, *Sandia National Laboratory Report*, 2005.

Robert J. Foltynowicz, PhD

3633 Odom Drive. · New Port Richey, Fl 34652 Mobile: (505) 250-8131 · rjfolty@yahoo.com

Wanke, M. and Foltynowicz, R.J. Continuous wave intersubband terahertz sources, *Sandia National Laboratory Report*, 2005. Foltynowicz, R.J. Ultrafast low-power transient digitizer, *Sandia National Laboratory Report*, 2004.

Robinson, J.D., Foltynowicz, R.J., Prentice, K., Bell, P., and Grant, E.R. Laser-assisted (1+1')-photon ionization-detected absorption spectrum of the 3pPi (2) Pi state of HCO and DCO, *Journal of Chemical Physics*, Vol. 116, 2002.

Robinson, J.D., Foltynowicz, R.J., Prentice, K., Bell, P., and Grant, E.R. Bend-stretch Fermi resonance in DCO⁺, *Journal of Chemical Physics*, Vol. 116, 2002.

Foltynowicz, R.J., Robinson, J.D., and Grant, E.R. An experimental measure of anharmonicity in the bending of DCO⁺, *Journal of Chemical Physics*, Vol. 115, 2001.

Foltynowicz, R.J., Robinson, J.D., and Grant, E.R. Double resonant photoionization efficiency spectroscopy: A precise determination of the adiabatic ionization potential of DCO, *Journal of Chemical Physics*, Vol. 114, 2001.

Zuckerman, E.J., Mayer, E.E., Foltynowicz, R.J., Robinson, J.D., Jen, S.H., Konopka, M.C., Sanford, T., Hedderich, H.G., Chen, I.C., and Grant, E.R. Double resonance spectroscopy of the high Rydberg states of HCO V. Rovibronic interactions and *l*-uncoupling in the (010) manifold, *Journal of Chemical Physics*, Vol. 113, 2000.

Foltynowicz, R.J., Robinson, J.D., Zuckerman, E.J., Hedderich, H.G., and Grant, E.R. Experimental characterization of the higher vibrationally excited states of HCO⁺: Determination of ν_2 , ν_{22} , ν_{22} and B_[030], *Journal of Molecular Spectroscopy*, Vol. 199, 2000.

Robinson, J.D., Foltynowicz, R.J., and Grant, E.R. Double resonance spectroscopy of the high Rydberg states of HCO IV. Vibrational autoionization dynamics as a function of bending amplitude, *Journal of Chemical Physics*, Vol. 112, 2000.

Foltynowicz, R.J., Rupp, W., Hedderich, H.G., and Grant, E.R. Photoionization spectrum of the B² A₁ state of HCO, *Chemical Physics Letters*, Vol. 315, 1999.

REFERENCES

Dr. Edward Grant, Professor and Department Head of Chemistry, University of British Columbia Dr. Patrick Owens, Chair of Chemistry and Physics, Winthrop University Dr. Eric Zuckerman, Associate Professor of Chemistry, Augusta State University

DR. JOHN TATARKO

Soil Scientist
USDA-ARS Engineering & Wind Erosion Research Unit
1515 College Avenue
Manhattan, KS 66502

Voice: (785) 537-5542
FAX: (785) 537-5507
E-mail: john.tatarko@ars.usda.gov

EDUCATION

1976 B.S. Agriculture, Stephen F. Austin State University, Nacogdoches, TX
1980 M.S. Soil Science, Texas Tech University, Lubbock, TX
1991 Ph.D. Soil Science, Kansas State University, Manhattan, KS

EMPLOYMENT HISTORY

2001 - present Soil Scientist, USDA-ARS Engineering & Wind Erosion Research Unit,
Manhattan, KS

2003 - present Adjunct Faculty, Department of Agronomy, Kansas State University,
Manhattan, KS

1998 - 2003 Research Assistant Professor, USDA-ARS Wind Erosion Research Unit
and Kansas State University, Manhattan, KS

1998 - 2000 Instructor, Agronomy 635 – Soil Conservation and Management, Kansas
State University, Manhattan, KS

1991 - 1998 Research Associate, USDA-ARS Wind Erosion Research Unit and Kansas
State University, Manhattan, KS

1981 - 1991 Research Assistant, USDA-ARS Wind Erosion Research Unit (WERU),
Manhattan, KS

PROFESSIONAL ORGANIZATION MEMBERSHIPS

Soil Science Society of America, International Erosion Control Association, Soil
Conservation Society of America, American Society of Agronomy, Gamma Sigma Delta.

SIGNIFICANT HONORS AND AWARDS

USDA Certificates of Merit for superior performance, 2002, 2003, 2005, 2006 & 2008 and outstanding performance, 2004 & 2007.

USDA Certificate of Special Recognition and cash award in appreciation for contributions to the Weather Submodel, Main Program, and Training Manuals for the Wind Erosion Prediction System, April, 2005.

American Society of Agronomy, 2004 Educational Materials Awards Program, Certificate of Excellence in the Audio Video category for "Soil Erosion by Wind and its Control".

American Society of Agronomy, 2001 Educational Materials Awards Program, Certificate of Excellence in the Internet Web Sites category for "Kid's Field Day: A virtual site for kids to learn about agronomy".

USDA Certificate of Appreciation and cash award for outstanding contributions in planning, organizing, and conducting "Wind Erosion: An International Symposium/Workshop", June 1997.

SELECTED PEER-REVIEWED PUBLICATIONS

Tatarko, J. and N.A. Stefonick. 2007. Wind erodibility of biosolids - amended soils: A Status Report. Water Environment Federation. 12(5):12-15.

van Donk, S. J., L.E. Wagner, E.L. Skidmore, and J. Tatarko. 2005. Comparison of the Weibull model with a wind speed distributions for stochastic wind generation. Trans. of the ASAE. v48(2), pages 503-510.

Lui, L.Y., E.L. Skidmore, E. Hasi, L. Wagner, and J. Tatarko. 2005. Dune sand transport as influenced by wind directions, speed and frequencies in the Ordos Plateau, China. Geomorphology. 67:283-297.

Coen, G.M., J. Tatarko, T.C. Martin, K.R. Cannon, T.W. Goddard, and N.J. Sweetland. 2003. A method for using of WEPS to map wind erosion risk assessment of Albert soils. Environmental Modelling and Software. Vol. 19, No. 2, pp 185-189.

Tatarko, J. and L.E. Wagner. 2002. Using WEPS with measured data. In: Lee, J.A. and Zobeck, T.M. (eds), Proceedings of ICAR 5/ GCTE-SEN Joint Conference, International Center for Arid and Semiarid Land Studies (ICASALS), Texas Tech University, Lubbock, ICASALS Publication 02-2, pp. 282-284.

Tatarko, J., L.E. Wagner, and C.A. Boyce. 2001. Effects of overwinter processes on stability of dry soil aggregates. *In*: J.C. Ascough II and D.C. Flanagan, (eds.), Soil Erosion Research for the 21st Century - An International Symposium, ASAE, pp 459-462. ASAE, St. Joseph, MI.

Tatarko, J. 2001. Soil aggregation and wind erosion: processes and measurements. *Annals of Arid Zone* 40(3): 303-322.

SIGNIFICANT INVITED PRESENTATIONS

Walker, D.G., J. Tatarko, and D. Stenlund. 2008. Theory in practice: Wind erosion prediction system (WEPS). International Erosion Control Association Annual Meetings. 2006, Anaheim, CA; 2007, Reno, NV; & 2008, Orlando, FL.

Tatarko, J. 2007. Wind Erosion: Processes, control, and simulation. Invited Seminar to the faculty of The Center for Atmospheric Science of the National Autonomous University of Mexico. 29 March, 2007. Mexico City, Mexico.

Invited lecturer to the Department of Agronomy Soil Conservation and Management class at Kansas State University. Deliver lecture on topics of wind erosion damage, processes, and control and provide a tour of the wind erosion laboratory facilities. (2001–2008).

Invited lecturer to the Department of Biological & Agricultural Engineering class, Natural Resources Engineering at Kansas State University. Deliver a lecture on topics of wind erosion damage, processes, and control and provide a tour of the wind tunnel laboratory facilities. (2000 – 2009).

Invited to conduct a two-day WEPS training workshop for Canadian agricultural scientists of Agriculture and Agri-Foods Canada in Lethbridge, Alberta. (2000).

Invited to present a lecture titled “Wind Erosion: Processes and Control” to the Natural Resources and Environmental Science Capstone Course at Kansas State University. (2003).

Mark Casada

Lead Scientist and Agricultural Engineer – USDA-ARS, CGAHR, EWERU, 1515 College Ave. Manhattan, Kansas 66502; phone: 785-776-2758; fax: 785-537-5550; email: mark.casada@ars.usda.gov

Education

Ph.D., Biological and Agricultural Engineering (minor: Mechanical Engineering), North Carolina State University, Raleigh, 1990

M.S., Agricultural Engineering, University of Kentucky, Lexington, 1985

B.S., Mechanical Engineering, University of Kentucky, Lexington, 1981

Professional Experience

1999–present, **Lead Scientist and Agricultural Engineer**. USDA–ARS, Grain Marketing and Production Research Center, Manhattan, KS. Lead scientist responsible for grain handling and storage research. Focusing on research on reducing dust emissions from grain handling operations, modeling temperature and moisture changes in stored grain, improved aeration control strategies, heat as a sanitation pre-treatment to control insects in on-farm grain bins, and identity preserved grain handling.

1999–present, **Adjunct Professor**. Kansas State University, Biological and Agricultural Engineering Department. Member of graduate faculty.

1990–1999, **Associate/Assistant Professor**. University of Idaho, Biological and Agricultural Engineering Department. Taught and conducted research on grain drying and storage, modeling of transport phenomena in crop storage and food engineering, and potato transportation. Member of graduate faculty.

1989–1990, **Research Assistant**, Biological and Agricultural Engineering Department, North Carolina State University. Studied the effect of livestock and poultry waste on global warming due to the greenhouse effect from increasing levels of atmospheric methane.

Major Committees

American Society of Agricultural Engineers (ASAE):

FPE-04, Publications Group, Chair, 2008 to present

FPE-702, Crop and Feed Processing and Storage committee, Chair, 2003–2005

FPE-704, Special Crops Processing, Chair, 1990–1991

American Society for Engineering Education (ASEE):

Biological and Agricultural Engineering. Division, Chair, 1999–2000;

Biological and Agricultural Engineering. Division, Proceedings Editor, 1998–1999

IWQC-II, International Wheat Quality Conference:

Advances in Processing Technology Technical Committee, Chair, 2000–2001

College Committees (University of Idaho):

Engineering Curriculum Committee, 1995-1999
Engineering College Strategic Planning Group, 1994, 1995

Major Committees (continued)

Department Committees (University of Idaho, Biological & Agricultural Engineering Department):

ABET 2000 Chair, 1998–1999
Curriculum Committee Chair, 1995–1999

Other Professional:

Industry Advisory Board, Biological Systems Engineering Department, Washington State University. 1998-1999
ASABE-FPEI Associate Editor (*Transactions of the ASABE; Applied Engineering in Agriculture*). 1997–present
NC-213 Multistate Research Project, “The U.S. Quality Grains Research Consortium,” Chair, 2001–2002, 2009 to present

Theses Supervised

University of Idaho:

Alghannam, A. 1995. Safe rewetting of grain in the pacific northwest. M.S. Thesis.
Albaloushi, N.S. 1998. Tray drying of potato slices. M.S. Thesis.
Zhu, H. 2000. Control of soft rot during transportation of fresh potatoes. Ph.D. Dissertation.
Albaloushi, N.S. 2004. Heat and mass transfer during French frying. Ph.D. Dissertation.

Kansas State University (Co-Major Professor):

Billate, R. 2003. Dust emission and air entrainment during grain unloading. M.S. Thesis.
Ingles, M.E. 2005. Identity preservation of grain in elevators. Ph.D. Dissertation.
Tilley, D.R. 2007. Heat treatment for disinfestation of empty grain storage bins. M.S. Thesis
Boac, J.M. Expert system for identity preservation of grain. Ph.D. Dissertation (In Progress)
Tilley, D.R. Evaluation and economic modeling of incidence and spread of insects from bucket elevator leg boots. Ph.D. Dissertation. (In progress)

Honors and Awards

Member, Sigma Xi, Alpha Epsilon, Member, Pi Tau Sigma

ASABE Manuscript Reviewer Award, 2007. Outstanding reviewer for FPEI division of ASABE

ASABE Superior Paper Award, 2006, “Characterization and modeling of a high-pressure fogging system for grain dust control. *Transactions of the ASAE*. 48(1): 331-339. (top 2.5% of papers)

ASAE Paper Award 1995, “Model for heat and moisture transfer in arbitrarily shaped two-dimensional porous media” *Transactions of the ASAE*. 37(6):1927-1938. (top 5% of papers)

Recent Publications

- Boac, J.M., R.G. Maghirang, and M.E. Casada.* 200X. Effect of repeated handling on particle size distribution of grain dust emissions. In Press: *Transactions of the ASABE*.
- Boac, J. M., M.E. Casada, and R.G. Maghirang.* 2008. Feed pellet and corn durability and breakage during repeated elevator handling. *Applied Engineering in Agriculture* 24(5): 637-643.
- Casada, M.E., M.S. Ram, and P.W. Flinn.* 2008. Thermal design of shipping containers for beneficial insects. *Applied Engineering in Agriculture* 24(1): 63-70.
- Casada, M.E., and P. R. Armstrong.* 2008. Evaluation of fringing field capacitive sensor for wheat moisture measurements. ASAE Paper No. 085207.
- McIntosh, R.B., and M.E. Casada.* 2008. Fringing field capacitance sensor for measuring the moisture content of agricultural commodities. *IEEE Sensors Journal* 8(3): 240-247.
- Tilley, D.R., M.E. Casada, and F.H. Arthur.* 2007. Heat treatment for disinfestation of empty grain storage bins. *Journal of Stored Product Research* 43(3): 221-228.
- Tilley, D.R., M.R. Langemeier, M.E. Casada, and F.H. Arthur.* 2007. Cost and risk analysis of heat and chemical treatments. *Journal of Economic Entomology* 100(2): 604-612.
- Akdogan, H., and M.E. Casada.* 2006 Climatic humidity effects on controlled summer aeration in the hard red winter wheat belt. *Transactions of the ASABE* 49(4): 1077-1087.
- Ingles, M.E., M.E. Casada, R.G. Maghirang, T.J. Herrman, and J.P. Harner III.* 2006. Effects of grain receiving configuration on commingling in a country elevator. *Applied Engineering in Agriculture* 22(5): 713-721.
- Akdogan, H., M. Casada, A. Dowdy, and B. Subramanyam.* 2005. A novel approach for analyzing grain facility heat treatment data. *Journal of Stored Product Research* 41(2): 175-185.
- Arthur, F.H., and M.E. Casada,* 2005. Evaluation of temperature management strategies to control insects in stored wheat. *Applied Engineering in Agriculture* 21(6): 1027-1038.
- Brabec, D.L., R.G. Maghirang, and M.E. Casada.* 2005. Characterization and modeling of a high-pressure fogging system for grain dust control. *Transactions of the ASAE* 48(1): 331-339.
- Billate, R.D., R.G. Maghirang, and M.E. Casada.* 2004. Measurement of particulate emissions from corn receiving operations with simulated hopper bottom trucks. *Transactions of the ASAE* 47(2): 521-529.
- Brabec, D.L., R.G. Maghirang, and M.E. Casada.* 2004. Effectiveness of a high-pressure, water-fogging system in controlling dust emissions at grain receiving. *Transactions of the ASAE* 47(2): 505-511.

Current Grant Support

2009-2011, *Incidence and Spread of Insects from Bucket Elevator Leg Boots*. PI. Andersons Research Grant Program, Team Competition. (\$146,000)

KORI D. MOORE

Environmental Engineer
Energy Dynamics Laboratory
1695 North Research Park Way
North Logan, UT 84341

Phone: (435) 797-4227

Fax: (435) 797-4599

Email: kori.moore@energydynamicslab.com

EDUCATION

- PhD. Civil and Environmental Engineering *in progress*
Utah State University, Logan, UT
- M.S./B.S. Civil and Environmental Engineering (Concurrent Program) 2007
Utah State University, Logan, UT
- M.S. Thesis Derivation of Agricultural Gas-Phase Ammonia Emissions and Application to the Cache Valley
- B.S. Design Projects
- Senior Thesis: Feasibility Study of Constructing a Spawning and Rearing Channel on the Virgin River for Woundfin Minnow Population Restoration
 - Air Quality Management: Feasibility Study of Implementing a Vehicle Inspection and Maintenance Program in Cache County, UT

EMPLOYMENT HISTORY

- 2007 - Present Energy Dynamics Laboratory
North Logan, UT
Environmental Engineer
- 2005 - 2007 Utah Water Research Laboratory
Utah State University
Logan, UT
Research Assistant
- 2003 – 2005, Summers Summer Undergraduate Research Experience,
Global Change Education Program
2004, 2005 Aerodyne Research, Inc.
Billerica, MA
2003 Pacific Northwest National Laboratory
Richland, WA
SURE Fellow
- 2002 - 2005 Utah Water Research Laboratory
Utah State University
Logan, UT
Research Technician

AFFILIATIONS

Air and Waste Management Association
American Society of Agricultural and Biological Engineers
American Association of Aerosol Researchers

RECENT AND RELEVANT PUBLICATIONS AND PRESENTATIONS

Bingham, G.E., C.C. Marchant, V.V. Zavyalov, D.J. Ahlstrom, K.D. Moore, D.S. Jones, T.D. Wilkerson, L.E. Hipps, R.S. Martin, P.J. Silva, and J.L. Hatfield (2009), Lidar based emissions measurements at the whole facility scale: Method and error analysis, *J. Applied Remote Sensing*, accepted for publication.

V.V. Zavyalov, C.C. Marchant, G.E. Bingham, T.D. Wilkerson, J.L. Hatfield, R.S. Martin, P.J. Silva, K.D. Moore, J. Swasey, D.J. Ahlstrom, and T.L. Jones (2009), AgLite lidar: Calibration and retrievals of well characterized aerosols from agricultural operations using a three-wavelength elastic lidar, *J. Applied Remote Sensing*, in final (2nd) review.

Wojcik, M.D., G.E. Bingham, C.C. Marchant, V.V. Zavyalov, D.J. Ahlstrom, K.D. Moore, T.D. Wilkerson, L.E. Hipps, R.S. Martin, J.L. Hatfield, and J.H. Prueger. 2008. "Lidar Based Particulate Flux Measurements" Proceedings of the IEEE, IGARSS, Boston, MA: pp. IV, 263-266.

Going, C., G. Bingham, N. Pougatchev, E. Day, K. Moore, R. Martin, and E. Reese. 2008. "Multi Path FTIR Agriculture Air Pollution Measurement System," Paper Number 08, 2008 ASABE Annual International Meeting, Providence, Rhode Island, June 29-July 2, 2008.

Martin, R.S., P.J. Silva, K. Moore, M. Erupe, and V.S. Doshi. 2008. Particle Composition and Size Distributions in and around a Deep Pit Swine Operation, *J. Atmos. Chemistry*, 59(2), 135-150.

G.E. Bingham, R.S. Martin, V.V. Zavyalov, T.D. Wilkerson, C.C. Marchant, K. Moore, D. Jones, P. Silva, C. Going, J. Bowman, and N. Pougatchev. 2007. "Agricultural Pollutant Emissions Determined via Standard Emission Rate Estimation Methods and Lidar Techniques," presented at AAAR 2007 Annual Meeting, Reno, NV, September 2007.

Bingham, G.E., T. Wilkerson, V. Zavyalov, J. Bowman, C. Marchant, K. Moore, R. Martin, P. Silva, L. Hipps, and J. Hatfield. 2007. "Integrated Whole Facility Aerosol Fluxes," Western Dairy Air Quality Symposium, Las Vegas, NV, April 26, 2007.

Martin, R.S., V.S. Doshi, and K. Moore. 2006. Determination of particulate (PM₁₀ and PM_{2.5}) and gas-phase ammonia (NH₃) emissions from a deep-pit swine operation using arrayed field measurements and inverse Gaussian plume modeling, pp. 890-894, in: Viney, P.A. *et al.* (Ed.), Proceedings: Workshop on Agricultural Air Quality: State of the Science. Dept. of Communication Services, North Carolina State University, Raleigh, NC.

Silva, P., R.S. Martin, V.S. Doshi, K. Moore, and M. Erupe. 2006. Variations in particle composition and size distributions in and around a deep pit swine operation, pp. 584-585, in: Viney, P.A. *et al.* (Ed.), Proceedings: Workshop on Agricultural Air Quality: State of the Science. Dept. of Communication Services, North Carolina State University, Raleigh, NC.

JAMES M. STEICHEN, Associate Director, National Institute for Land Management and Training, and Professor of Biological and Agricultural Engineering, Kansas State University

Degrees: Ph.D., Agricultural Engineering Oklahoma State University, 1974
BS, Agricultural Engineering Oklahoma State University, 1970

PROFESSIONAL: Licensed Professional Engineer—Kansas # 10,037
Certified Professional in Erosion and Sediment Control—CPESC # 1750

AREAS OF SPECIALIZATION: Hydrology, water quality, military training lands management, soil erosion control, ecological engineering.

EXPERIENCE:

Associate Director, National Institute for Land Management and Training, Kansas State University, 1996-
Professor, Kansas State University, 1988-
Associate Professor, Kansas State University, 1980-1988
Assistant Professor, Kansas State University, 1978-1980
Assistant Professor, University of Missouri-Columbia, Extension Soil and Water Specialist, 1974-78
Maintainability Engineer, Army Materiel Command, Texarkana, Texas, 1970-1971
Professional Summer Employment:
U.S. Geological Survey, Lawrence, Kansas, 1988-1991
Kansas Department of Health & Environment, 1991

CURRENT DUTIES:

Administrative—Associate Director, National Institute for Land Management and Training, Kansas State University, Manhattan, Kansas, January, 1996 to present

Teaching—Professor, Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, Kansas, 1988 to present

Courses taught (current and previous): ATM 661—Water and Waste in the Environment (On-campus & Internet), ATM 451—Water Resources and Hydrology (Internet course), BAE 551—Hydrology, BAE 530—Natural Resources Engineering, BAE 533—Applied Hydrology, BAE 815—Graduate Seminar, ATM 653—Water Management and Irrigation Systems, ATM 654—Irrigation Systems Lab, BAE 690—Non-Point Pollution Engineering, ATM 558—Soil Erosion & Sediment Pollution Control, ATM 160—Engineered Systems and Technology in Agriculture. Team taught DEN 582—NRES Environmental Project.

Research—Member of the Graduate Faculty.

CURRENT AND PREVIOUSLY COMPLETED PROJECT REFERENCES

- Principal Investigator for “Assessing the Impact of Maneuver Training on NPS Pollution and Water Quality” funded by the Strategic Environmental Research and Development Program (SERDP) of the Department of Defense. (\$1,337,512) (2003 – 2008) Project SI-1339.
- Co-Principal Investigator for “Continuous, Wireless Monitoring of Sediment Flux at Multiple Low-Water Stream Crossings on Tank Trails.” DOD ESTCP Project. Co-PI, \$229,655 1st year, Project started in 2008. This project resulted from work in the previous SERDP project.
- Principal Investigator for "Vehicle Impact Tracking Study" funded by U.S. Army Construction Engineering Research Laboratories, Champaign, IL. (\$204,966) (2000 - 2001)
- Principal Investigator for various "Integrated Training Area Management (ITAM) Program Support" contracts funded by U.S. Army Environmental Center. Aberdeen Proving Ground, MD. (Approximately \$3.5 million since 2000)

SELECTED PUBLICATIONS:

- Kalita, P.K., G.J. Kluitenberg, P.L. Barnes, A.P. Schwab, J.K. Koelliker, J.M. Steichen, D. Black, M.J. Borah, and D.L. Oard. 1998. A monolith weighing lysimeter system for characterizing fate and transport of agricultural chemicals in soils. *Applied Engineering in Agriculture* 14(5):485-491.
- Sample, Larry J., James Steichen, and John R. Kelley, Jr. 1998. Water quality impacts from low water fords on military training lands. *Journal of the American Water Resources Association*. 34(4):939-949.
- Stoll, Quentin, Zhang, Naiqian, Hutchinson, Stacy, and Steichen, James. 2003. Methods for measuring suspended-sediment concentration in streams, Paper Number: 033147, 2003 ASAE Annual International Meeting, ASAE, St. Joseph, MI.
- Steichen, James. 2003. A strategy for military training lands to comply with TMDL requirements. Published Abstract, SERDP/ESTCP Partners in Environmental Technology Symposium.
- Doyle, Geoffrey L., Charles W. Rice, Dallas E. Peterson, and James Steichen. 2004. Biologically defined soil organic matter pools as affected by rotation and tillage. *Environmental Management* 33:S528-S538.
- Watanabe, Hirozumi, Nathan L. Watermeier, James M. Steichen, Phillip Barnes, Thai K. Phong. 2006. Impacts of tillage and application method on atrazine and alachlor losses from upland fields. Accepted for publication. *Weed Biology and Management*.
- Malinga, Gilbert, James Steichen, Timothy Keane, Stacy L. Hutchinson, and Philip B. Woodford. 2007. Assessing Impact of Low Water Fords on Stream Stability, Fort Riley, Kansas. *In Proc. 2007 International ASABE Annual Meeting*, CD-ROM. ASABE Paper No. 073079. St. Joseph, Mich.: ASABE.
- Malinga, Gilbert, James Steichen, Timothy Keane, and Philip B. Woodford. 2007. Design, Site Selection and Construction of Low Water Fords at Fort Riley, Kansas. *2007 Army Sustainable Range Workshop*, Hampton, VA.
- Malinga, Gilbert, James Steichen, Timothy Keane, Stacy L. Hutchinson, and Philip B. Woodford. 2007. Low Water Fords: Site Selection, Design and Construction. 2007. American Ecological Engineering Society Annual Meeting. Manhattan, KS.
- Steichen, E. Marie, Alok Bhandari, James Steichen, and Larry E. Erickson. 2007. Educating Students for Participation as Members of Multidisciplinary Teams. *In Innovations 2008*. International Network for Engineering Education and Research, Arlington, VA. Book chapter, accepted for publication.
- Zhang, Yali, Naiqian Zhang, Gerhard M. Grimm, Carl Johnson, Darrell Oard, and James Steichen. 2007. Long-term Field Test of an Optical Sediment-Concentration Sensor at Low-Water Stream Crossings. ASABE Paper No. 072137. St. Joseph, Mich.: ASABE.

SYNERGISTIC ACTIVITIES:

From about 1997 – 2003 the National Institute for Land Management and Training (NILMT) implemented demonstration projects and provided support services for the U.S. Army Integrated Training Area Management (ITAM) Program. The purpose of ITAM is to support military training by assuring the sustainable use of military training lands and ranges. NILMT worked with Army and National Guard installations in several states to provide assistance in managing their training lands, implementing innovative land rehabilitation projects, developing LCTA programs, range design, and creating comprehensive GIS-based land management systems. From 1997 – 2003 NILMT implemented demonstration projects and provided support services for the ITAM Program. The SERDP-funded “Assessing the Impact of Maneuver Training on NPS Pollution and Water Quality” research project at Ft. Riley evaluated the effectiveness of native grass filter strips in improving water quality, evaluated the impact of hardened stream crossings on stream stability, developed a real-time in-stream sediment concentration sensor, and developed GIS tools for making land management decisions by Army officials. The 2006 ITAM Workshop held at K-State and Ft. Riley was attended by over 500 people. The field day was a major technology transfer activity for demonstrating SERDP research results for Army professionals.