

## **Title: Controlled Environment Chamber to Support of Water Resources Research**

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**Amount of Funding Requested:** \$10,000

### **Project Description**

Soil, sediment, and water properties are strongly impacted by redox conditions. Hence, in the handling of natural soil and water samples, the maintenance and control of redox potential is of paramount importance. A major deficiency that currently exists in the soil chemistry section of the Soil & Crop Sciences Department (actually, the entire Soil & Crop Sciences Dept.) is adequate facilities to handle samples under reduced or anaerobic conditions. This deficiency is detrimentally impacting our current projects and also funding opportunities for future projects. The objective of this proposed project is to partially support the acquisition of an environmental chamber in support research and graduate instruction in water resources related activities. The proposed environmental chamber will be used for sample handling under anaerobic and low O<sub>2</sub> conditions and to maintain controlled environmental conditions where required for studies of soil, sediment, and water.

### **Project Need**

Several of our currently funded projects as well as our future grant acquisition efforts will be positively impacted by acquisition of the proposed environmental chamber. Our specific needs for this equipment are summarized below.

**Arsenic in Soil and Water.** The solubility of arsenic in soil and water and the speciation of dissolved arsenic is strongly impacted by redox potential. The introduction of even small amounts of O<sub>2</sub> to reduced systems can sometimes result in substantial changes in arsenic solubility. The solubilities of other toxic species (e.g., Cr, Cd, Pb) and nutrients (e.g., phosphate) also can be strongly impacted by introduction of O<sub>2</sub>. This effect is highly problematic at high soil and water pH values, especially pH >8.0, due to the relatively rapid rates of oxidation of Fe<sup>2+</sup>, Mn<sup>2+</sup>, and S<sup>2-</sup> under these conditions. An environmental chamber is needed for the improved sample handling of anaerobic soils, sediments, and water samples in support of current and future research activities.

**Reactions of Water Treatment Residuals.** Our research deals heavily with the land disposal and stability of water treatment residuals, with current emphasis on arsenic and chromium. The reactions of water treatment residuals are also strongly impacted by redox potential. An environmental chamber is needed for improved control of redox conditions during sample handling. Several graduate student projects, including that of Masue Yoko (TWRI research scholar), will be strongly impacted by improved sample handling capabilities in the soil and water chemistry laboratory.

**Reactions of Minerals under Wetland Conditions.** Some minerals under reduced wetland conditions are very strongly impacted by exposure to small amounts of O<sub>2</sub>. Two classes of minerals that are of special interest, because of their prevalence under some wetland conditions are the poorly crystalline ferrous sulfides and the mixed valency iron oxides (e.g., green rust). In wetland

conditions or in reduced sediments, these minerals likely play important roles in the control of solubility of toxic elements and beneficial nutrients. We are currently involved in studies of the reactions of arsenic and phosphate with both groups of minerals above. An environmental chamber is critically needed in these studies, for improved environmental control.

**Spectroscopy, x-ray Diffraction, and Imaging Experiments.** We make extensive use of Fourier transform infrared spectroscopy, x-ray diffraction, scanning electron microscopy, transmission electron microscopy, and electron microprobe in environmental studies of minerals from soils and sediments. Because of the very strong impact of redox conditions on mineral properties, all sample preparations for spectroscopic studies require good environmental control.

In our environmental studies, we are making increasing use of synchrotron facilities at both the National Synchrotron Light Source (NSLS, Brookhaven National Laboratory, Upton, Long Island, NY) and the Advanced Photon Source (APS, Argonne National Laboratory, Chicago, IL) for x-ray microprobe, micro XRD, XANES, and EXAFS experiments. Good environmental control is required for these studies. The proposed environmental chamber is identical to the chamber that we are currently utilizing on the X26A microprobe beamline at the NSLS. The proposed environmental chamber for our laboratory will greatly facilitate sample preparation, evaluation of sample preparation procedures, and the efficiency of our use of NSLS and APS facilities

**Studies of Plants in Wetland Systems.** Two of our current interests are in the absorption of arsenic by rice and the phytoremediation of Cr(VI) contaminated water. Our initial studies have indicated the significant effect that molecular O<sub>2</sub> (from the air) can have on the speciation of Cr in excised or homogenized plant tissue. Environmental control is therefore required during the excision and homogenization of plant tissue. The proposed environmental chamber will be utilized in sample preparation for chromatographic and spectroscopic studies of plant material.

### **Expected Outcomes**

- (1) Improved control of redox conditions of reduced soil, sediment, and water in support of water resource studies
- (2) Greatly improved sample handling capabilities for water, sediments, soils, and plants
- (3) Beneficial impact on future grant procurement efforts

### **Current Projects Impacted by this Proposal**

- (1) "Food security, agricultural sustainability and mitigation of arsenic contamination in Bangladesh", PIs - R. H. Loeppert (Texas A&M Univ.) and John Duxbury (Cornell Univ.), USAID, **\$920,000**, 2002-2005, **funded**.
- (2) "Assessment and optimized management of water treatment residuals", PIs – R. H. Loeppert (Soil & Crop Sciences) and T. Kramer (Civil Engineering), AWWA, **\$180,000**, 2002-2004, **funded**.
- (3) "Support of Graduate Student Activities", PI - Yoko Masue (Soil & Crop Sciences), TWRI, **\$5,000**, 2003, **funded**.

Though heavily supporting graduate education and research activities, none of these projects allows the acquisition of capital equipment, as is requested in the current proposal.

### **Signatures**

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Dr. Richard H. Loeppert  
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**TAES/TWRI  
Water Resources Research  
Project Budget Form**

<b>Expenditure</b>	<b>Amount Requested</b>	<b>Other Sources</b>	<b>Total</b>
Staffing Requirements			
1) Graduate Student Support		\$42,000	\$42,000
2)			
3)			
Fringe Benefits			
<b>Total Staff Cost</b>			
Travel			
Supplies and Materials		\$3,000	\$3,000
Capital Equipment (purchase over \$5,000)	\$10,000	\$6,000	\$16,000
Printing and Publications			
Other Direct Costs (describe in detail)			
<b>Total Project Costs</b>	\$10,000	\$51,000	\$61,000