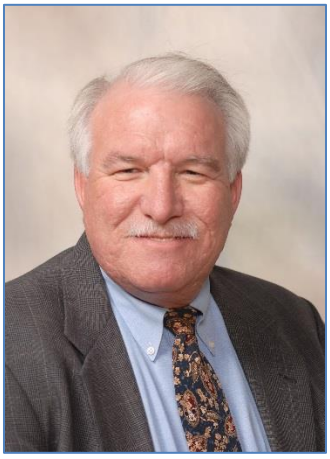
MWRRI Newsletter

MWRRI Newsletter Summer 2016

From the Director's Desk …



I hope that you have had an enjoyable summer... it's hard to believe that we are now into a new academic year! This summer has been a very busy time for MWRRI. I am happy to report that through an increase in our legislative support, we are in a position to seek a permanent Director and are currently developing plans for a national search. This increased support has come at a very timely point for our state and MWRRI. We continue to see increasing growth in the need for more water research and management support across the water resources spectrum – from ground and surface water quantity and quality in the natural environment to drinking and waste water within our public and private systems, from climatic research to water use efficiency and reuse, from water economics to the water resources-social science nexus, and beyond. Within this issue, you will find descriptions of these and other water resources topics that will guide MWRRI's research and management support efforts for the coming year.

We are currently awaiting finalization of our EPA grant award to support implementation of our social indicators/civic engagement project. This project supports the Hypoxia Task Force and will extend MWRRI's efforts across the Mississippi/Atchafalaya River Basin. We are also awaiting determination of the level and terms of potential funding support for the Red Bud-Catalpa Creek Restoration and Protection Project. This potential support will allow us to proceed with execution of the *Implementation Plan for the Red Bud–Catalpa Creek Watershed Phase 1* and, through our project teams, begin to expand our collaborative efforts throughout the entire watershed.

Within this issue, you will also read about the upcoming release of our 2017 104b Water Resources Research RFP, activities of the Gulf of Mexico Alliance's Water Resources Team, the formation of our new DW^3 Team, and a profile of one of MWRRI's collaborating researchers, Dr. Andy O'Reilly, with the University of Mississippi's Department of Geology and Geological Engineering.

Together we can make a difference,

Bill

Bill Herndon

2017 MWRRI/USGS 104b Water Resources Research RFP to be Released 9/1/16

The Mississippi Water Resources Research Institute will release its 2017 104b Request for Proposals on September 1, 2016. Faculty and staff at any Mississippi research university are encouraged to develop and submit proposals that address the following research topics. More information on each topic can be found at the end of this newsletter.

Research Priority Areas

Climatic Water Research Topics

- Predictions of future water needs in various regions of the State under various climatic and/or pumping scenarios
- Innovative water capture techniques and applications

Groundwater Research Topics

- Innovative approaches to estimate aquifer recharge
- Development of water budgets
- Determining aquifer transmissivities and characteristics

Surface Water Research Topics

- Evaluation of BMP effectiveness, site placement, reliability, and maintenance
- Research and development to support water quality and ecosystem health assessment applications
- Identification of appropriate response measures for Mississippi's waters and linkage between nutrient concentrations and the identified response measures
- Analysis of nutrient loading trends

Coastal-specific Research Topics

- Harmful algal bloom and early pathogen detection research for Mississippi coastal waters
- Various topics (see Full Descriptions)

Water Use Efficiency and Water Reuse Research Topics

- Water reclamation and reuse
- Water use efficiency

Drinking Water and Waste Water Research Topics

- Mitigation of lead corrosion in PWSs
- Protection of source water resources
- Innovative and affordable waste water treatment for small communities

Modeling and Tool Development

- Development of models and tools

Social Sciences Research

- Development of social indicators

- Development of social science applications to advance water resource management

Economics Research

- Economic analysis of reducing nutrient loadings

Emerging and Innovative Technologies

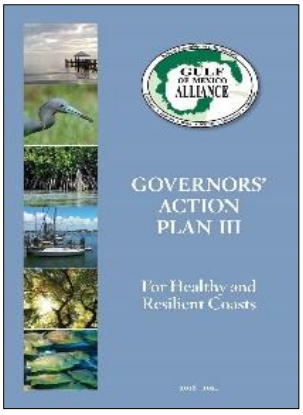
- Current and potential use of Unmanned Aerial Vehicles (UAVs)

The Water Resources Research Act of 1984 requires that federal funds (USGS) be matched by at least two non-federal dollars for each federal dollar. MWRRI, using USGS funds, will provide approximately $45,000-$55,000. MWRRI state appropriation funds, if available, will be provided as much as possible to help individual researchers to achieve their match requirement. Each research proposal must provide the remaining cost share match requirement not provided by MWRRI. Instructions and other relevant information concerning proposals will be included in the release. Non-tenured faculty members are strongly encouraged to submit proposals. The MWRRI strongly encourages applicants to collaborate with local, state, and federal agencies.

Timeline

September 1, 2016	RFP released on MWRRI website and ListServe.
October 31, 2016	**Proposals due in the MWRRI Office (311 Bost) by 5:00 p.m.**
November 18, 2016	MWRRI Advisory Board completes evaluation/selection.
November 28, 2016	Applicants notified of results and any modifications needed.
December 5, 2016	Revised final proposals returned to MWRRI (if requested).
January 13, 2017	Final MWRRI program package submitted to USGS.
March 1, 2017	Projects begin (assuming the federal budget has been signed).
June 12, 2017	Recipients notified of the amount of state appropriations available for cost share support for their project.
July 1, 2017	If available, state appropriations distributed to help meet MWRRI cost share requirements.

Gulf of Mexico Alliance Water Resources Team



The Gulf of Mexico Alliance (GOMA) was established in 2004 in response to the U.S. Oceans Action Plan which encouraged states sharing a common water body to work together to address issues affecting this water body. Since 2004, GOMA has developed and implemented two Action Plans, Governor's Action Plan 1 (2006-2009) and Governors' Action Plan II (2009-2014). In June 2016, GOMA introduced Governors' Action Plan III (2016-2021). GOMA has received continuous support from the governors of all five Gulf States from its initial efforts from Action Plan I to the most recently released, Action Plan III. MWRRI also actively supports GOMA's Water Resources Team.

GOMA's mission is to enhance the environmental and economic health of the Gulf of Mexico through increased regional collaboration about issues that are common to the all five states. GOMA is a formal partnership of the agencies of the five states, federal agencies, academia, NGO groups, and business partners. Currently, GOMA has over 900 members who work together to focus on common priorities. GOMA's numerous efforts are divided among six teams including: Water Resources, Habitat Restoration, Coastal Resilience, Education & Engagement, Data and Monitoring, and Wildlife and Fisheries.

The Water Resources Team efforts will center around three focus areas: (1) human health, (2) aquatic health, and (3) economic health. The team will cover a wide range of key water resource concerns that affect the region, including issues related to both water quality and water quantity. These may include pathogens, harmful algal blooms (HABs), nutrient pollution, hypoxia, freshwater inflows, water resource sustainability, and additional emerging water resource issues in the Gulf. The team will seek solutions to provide improved protection of human health and aquatic life. Team efforts will also aim to increase awareness of how water resources (quality, quantity, and sustainability) are directly related to both human and aquatic health within the region, and how all of these influence the economic health of the region. Understanding the relationships among these issues is essential for enhancing and sustaining this vital resource.

GOMA holds its annual meeting each year, hosted by one of its five Gulf States: Alabama, Florida, Louisiana, Mississippi, and Texas. This year's annual meeting was held in Baton Rouge, Louisiana in June. An icon of both Louisiana and the Gulf of Mexico Region, the Mississippi River was ever-present alongside the Capitol Hilton and provided a magnificent back drop to

numerous discussions ranging from habitat restoration to monitoring the large marine ecosystem to harmful algal blooms and hypoxia. At this year's annual meeting, the members of the Water Resources Team identified and prioritized activities and projects that will be used to achieve the goals established by the team in *Action Plan III*. There were extensive discussions and small group sessions as people and processes were identified to establish our foundation and take the first steps towards implementation.

The Water Resources Team identified numerous activities and projects that they will pursue. These include activities such as:

- Conducting a workshop focusing on risks to human health including compilation of information from existing water programs within the states regarding current monitoring for human health parameters;
- Expanding an existing nutrient reduction initiative being conducted by the Hypoxia Task Force to refine and improve social indicators to guide, evaluate, and accelerate implementation of reduction strategies;
- Expanding the ability of handheld HABs detection instruments to identify additional species of HABs for better prediction and management; and,
- Enhancing and expanding glider operations to identify HABs in unknown areas of the Gulf for improved forecasting of these events.

Source: Mote Marine

Anyone is welcome to join GOMA and its Priority Issue Teams; there are no dues or membership requirements. GOMA's Water Resources Team consists of a wide variety of members from various backgrounds including state water regulators, state health department personnel, federal partners, non-governmental organizations, academia/researchers, and many more. Each person on the Water Resources Team brings a unique skill set regarding their area of expertise. To join the Water Resources Team or to get more information, visit http://www.gulfofmexicoalliance.org/our-priorities/priority-issue-teams/water-resources-team/.

About the Gulf of Mexico Alliance: The Gulf of Mexico Alliance recognizes the economy and quality of life for citizens of the Gulf are linked to its ecological health. As the result of a shared vision for a healthy and resilient Gulf of Mexico region, the states of Alabama, Florida, Louisiana, Mississippi and Texas formalized the Alliance in 2004. As a large partnership network, the Alliance's mission is to enhance the ecological and economic health of the Gulf region by encouraging collaboration among government agencies, businesses, education providers and non-governmental organizations. Priority issues

addressed by the Alliance include water resources, habitat resources, community resilience, data and monitoring, wildlife and fisheries, and education and engagement. To learn more about the Gulf of Mexico Alliance, visit www.gulfofmexicoalliance.org.

MWRRI Forms Team to Provide Support on Drinking Water and Waste Water Issues

With encouragement from Region 4 of the U.S. Environmental Protection Agency, MWRRI recently formed a multi-disciplinary team to provide research and extension support on several drinking water and waste water issues identified by EPA. The issues encompass the Lead and Copper Rule as well as Region 4's WWTP (Waste Water Treatment Plant) Energy Optimization Initiative. The team includes faculty/staff of MSU's Extension Center for Government and Community Development; Department of Civil and Environmental Engineering; David Swalm School of Chemical Engineering; Department of Agricultural and Biological Engineering; Department of Wildlife, Fisheries, and Aquaculture; Social Science Research Center; and MWRRI. To promote efficiency and effectiveness of this support effort, the Drinking Water/Waste Water (DW^3) Team is organized around two areas of focus – education/outreach/training (extension) and technical/research – and two work groups have been established that address these areas of focus.

Efforts are also underway through engagement with the Mississippi Rural Water Association, Mississippi State Department of Health, Mississippi Department of Environmental Quality, and individual public water supply systems in Mississippi to gain a better understanding of the research and extension needs of these organizations related to drinking water and waste water.

Researcher Profile: Dr. Andy O'Reilly

Assistant Professor, Department of Geology & Geological Engineering, University of Mississippi

Tell us a little bit about your background and your current position.

I have Bachelor and Master of Civil Engineering degrees from Auburn University and a Ph.D. in Civil Engineering from the University of Central Florida. After completing my graduate studies at Auburn, I worked as a Hydrologist at the U.S. Geological Survey for 21 years in Orlando, Florida, during which time I completed my Ph.D., specializing in Water Resources Engineering. I became a faculty member at the University of Mississippi in 2014. My doctoral research focused on biogeochemical cycling and nutrient control strategies for groundwater at storm water infiltration basins and included development of a new storm water best management practice (BMP). The new BMP utilizes an innovative storm water infiltration basin and biosorption activated media, a functionalized soil amendment, to reduce inputs of nitrogen and phosphorus to groundwater. The study was particularly meaningful to me because it linked research and application, culminating in the design and construction of a functioning facility. Additionally, the new BMP is continuing to function effectively to reduce nutrient loading to groundwater and has served as a model for additional applications of similar nutrient reduction technology.

At the University of Mississippi (UM) I co-teach the two senior capstone courses for Geological Engineering majors and teach courses in contaminant transport, environmental geochemistry, and vadose zone hydrology in our graduate Geological Engineering and Hydrology programs. My research is in the geoenvironmental subfield of geological engineering, focusing on processes in shallow, heterogeneous, geologic environments in Earth's Critical Zone that govern aquifer recharge and groundwater quality. I endeavor to use knowledge gained from my research to develop and implement engineering solutions for maintaining and enhancing groundwater quantity and quality while fostering sustainable development within a wide range of geoenvironmental challenges facing society.

What are your current research activities and interests?

A new study funded by the Mississippi Water Resources Research Institute (MWRRI) is looking at the potential of oxbow lake-wetland systems as a source of recharge to the Mississippi River Valley alluvial aquifer. I serve as co-PI with Dr. Gregg Davidson (PI) at

UM; the study is supporting research for a graduate student's thesis and providing training on field research methods for an undergraduate student. Oxbow lakes are ubiquitous in the Delta and hold water that is potentially available for recharge, but their interaction with the underlying aquifer is largely unknown. Preliminary data from Sky Lake, just south of the area of greatest groundwater depletion in the Delta, suggests that recharge from the lake-wetland system may be significant. We are collecting new data during this study that will include well cuttings, sediment cores, and monitoring of water-table elevation and subsurface temperature, from which evidence of recharge from the lake to the aquifer may be inferred.

Other research I am conducting on groundwater recharge is funded by an internal grant from the UM Office of Research and Sponsored Programs, which is supporting the senior theses of two UM Honors College students. In this study we are investigating vertical groundwater recharge rates in the Delta using field and laboratory measured soil properties and numerical modeling. Modeling will include assessment of the feasibility of vadose-zone wells as a strategy for enhancing groundwater recharge in the Delta.

I am continuing research from my work at the USGS on data-driven and physics-based modeling, focusing on reconciling discrepancies in predicted aquifer forcing-response behavior. To address groundwater management needs, both physics-based groundwater flow models and data-driven empirical models are often applied to understand the effects of changing rainfall and groundwater-use conditions on aquifer water levels and flows. A comparison of results from a finite-difference model and artificial neural network models of aquifers in central Florida indicated that each approach reproduced the calibration data about equally well, but gave very different predictions of the future state of the aquifer. This comparison shows how different science-based approaches provide different yet potentially complementary information on the behavior of the hydrologic system. I am working with a graduate student to investigate further the causes of discrepancies in predictions from data-driven and physics-based modeling approaches.

My other research interests include contaminant transport and fate focusing on cyanobacterial toxins in groundwater, green infrastructure and sustainable development, microgravity measurement of changes in groundwater storage, and development of an atlas of water resources for the State of Mississippi.

How does the Water Resources Research Institute fit into your future plans? How can we help you be successful?

The MWRRI is an important supporter of my research and professional development. Shortly before moving from Florida, a colleague who worked in Mississippi in the late 1980s told me that in order to learn about water-related research in the state you must connect with the MWRRI. That has proven to be as true today as it was nearly 30 years ago, which is in itself a testament to the important role the MWRRI serves in our state. By providing research funding, the MWRRI has helped provide equipment that benefits current as well as future data collection. Financial support of graduate student research provided by MWRRI is particularly important, allowing the student to focus on research without teaching or outside job responsibilities. The leadership of the MWRRI in facilitating water-resources research by bringing partners together and providing a framework for collaboration has been especially valuable to me.

2017 MWRRI Water Resources Research Topics Finalized (Full Descriptions)

At a recent meeting of MWRRI's Advisory Board, the following water resources research topics were identified for 2017. These topics will be the focus of the upcoming MWRRI/USGS 104b RFP and will also guide MWRRI's efforts to facilitate collaborative research during the coming year.

Climatic Water Research

- Predictions of Future Water Needs in Various Regions of the State under Various Climatic and/or Pumping Scenarios
    - — Changes have occurred in the amount of rainfall, variability, and recurrence in the past and will occur in the future. Comparison of past climate trends to variations in groundwater and surface water pumpage for all beneficial uses and projections of future climatic conditions can be used to help predict future water needs.
- Innovative Water Capture Techniques and Applications

- Rain is the first form of water that we know in the hydrological cycle, hence it is a primary source of water for us. Rivers, lakes and groundwater are all secondary sources of water; however, today we depend almost entirely on these secondary sources. Water capture seeks first to understand the value of rain, and to make optimum use of the rainwater at the place where it falls. Mississippi's abundant rainfall presents numerous opportunities to achieve sustainability of our water resources through innovative water capture techniques and applications that include providing irrigation water; increasing groundwater recharge; reducing storm water discharges, urban flooding and overloading of sewage treatment plants; and reducing seawater ingress in coastal areas.

Groundwater Research

- Innovative Approaches to Estimate Aquifer Recharge
  - Groundwater is recharged naturally by rain and to a smaller extent by surface water (rivers and lakes). Rates of groundwater recharge are difficult to quantify, since other related processes, such as evapotranspiration and infiltration processes must first be measured or estimated to determine the balance. There is a need for innovative approaches to estimate recharge for all aquifers of the state as there are few scientifically defensible methods to determine recharge at this time. Having a more thorough knowledge of recharge would be invaluable in determining water budgets for the various aquifers in the state. Advances in our understanding of groundwater–surface water interaction is especially needed currently in the Delta and along streams in South Mississippi.
- Development of Water Budgets
  - A water budget is an accounting of inflows (recharge) to and outflows (pumpage/use) from a groundwater system. Ideally, under equilibrium conditions, when water levels are not changing, inflows should equal outflows. However, this is not the case in some areas of Mississippi where pumpage/use is exceeding recharge. As Mississippi's population grows and shifts within the state and its economy expands, knowledge of water availability throughout the state is vital as is the understanding of past and prediction of future trends related to demographics, industrial and agricultural water use, infrastructure needs, etc., especially in areas of competing water use.
- Determining Aquifer Transmissivities and Characteristics
  - Transmissivity is defined as a measure of how much water can be transmitted horizontally, such as to a pumping well. Transmissivity of a confined aquifer is determined by pump tests. While many pump tests have been conducted throughout the state of Mississippi, the hydrogeology of an aquifer can vary significantly from place to place. Additional information (transmissivities or ranges

of transmissivities and other aquifer properties) is needed to determining how much water can be pumped in a particular location.

— Naturally occurring aquifer characteristics such as color, high iron content, and low pH, among others, can affect the taste, color, odor, and use of water from different aquifers. This information is very useful in determining where and how deep groundwater wells should be drilled and what type of treatment would be necessary.

Surface Water Research

- Evaluation of BMP Effectiveness, Site Placement, Reliability, and Maintenance
  - — Reliable performance data for established and innovative best management practices (BMPs) in Mississippi is needed to develop effective responses to existing and evolving regulations and requirements regarding nutrients, fecal indicator bacteria, solids, metals, runoff volume and urban storm water. Public and private storm water dischargers will be spending substantial sums of money on these issues, primarily in the form of planning, designing, constructing, and maintaining structural and nonstructural BMPs. Research on BMP effectiveness, site placement, reliability, and maintenance (especially costs) continues to be a serious need. Specific applications of these BMPs include:
    - Implementing the load reductions identified by Total Maximum Daily Loads (TMDLs);
    - Implementing the requirements of numeric nutrient criteria;
    - Reducing nutrient loadings;
    - Reducing bacteria levels in water bodies used by the public for recreation; and
    - Reducing storm water runoff volume.
- Research and Development to Support Water Quality and Ecosystem Health Assessment Applications
  - – Water quality and ecosystem health assessment applications are needed for more efficient management of Mississippi's water resources. Research and development needs to support these applications include:
    - Investigation of the use of percent saturation of dissolved oxygen in waters as an indicator of aquatic life support;
    - Investigation of the use of diurnal flux as an indicator of water quality degradation;
    - Development of a simplified approach for ecosystem stressor identification;
    - Development of a fisheries index for Mississippi waters;
    - Study of algal community structure in Mississippi waters (especially within the Mississippi River Alluvial Plain);

- Further analysis of the potential use of DNA speciation of periphyton as a potential indicator of nutrient pollution; and
- Development of methods to measure and understand the impacts of pharmaceuticals, microplastics and other contaminants on aquatic ecosystems, agriculture and drinking water.
- Stream flow is an important habitat variable and research is needed to support water quality and ecosystem health assessment applications.
- Analysis and documentation of elements of hydrologic restoration (i.e., stream structure, sinuosity, etc.) and their effects on ecosystem health.

- Identification of Appropriate Response Measures for Mississippi's Waters and Linkage between Nutrient Concentrations and the Identified Response Measures
  - Nutrients, nitrogen (N) and phosphorus (P), are essential for plant growth, which then supports healthy aquatic ecosystems and provides habitat. In addition to natural sources, nutrients also come from anthropogenic sources related to agriculture, storm water discharges, wastewater discharges, etc. Excessive amounts of nitrogen and/or phosphorus (referred to as nutrient pollution) can lead to significant impacts on public health, aquatic ecosystems, and the economy. The link between nutrient concentrations and environmental impacts is well-supported by scientific literature; however, the ecosystem response to nutrient pollution can be variable due to the presence of confounding factors at a particular site, such as canopy cover, water column stratification, flow, turbidity, and others. These factors may inhibit a response at a particular site, but the effects of nutrient pollution may be observed where and when these factors subside. Existing research has shown that indicators (i.e., response parameters or assessment endpoints) that are most sensitive to nutrient pollution and most predictive of impacts to higher trophic levels were TN/TP concentrations, measures of primary production and algal assemblage, and, to a lesser extent, measures of ecosystem function (e.g., dissolved oxygen and pH). To develop appropriate and protective nutrient criteria for Mississippi, the following research is needed:
    - Identify the appropriate response measures for Mississippi's waters; and
    - Identification of linkage between nutrient concentrations and the identified response measures.
- Analysis of Nutrient Loading Trends
  - For several years now, MDEQ has gathered nutrient data with respect to NPDES point dischargers. With the ongoing work related to the development of numeric nutrient criteria and ongoing work related to implementation of the State's nutrient reduction strategies, a detailed analysis of nutrient loading trends from point sources would be of great value.

Coastal-specific Research

- Harmful Algal Bloom and Early Pathogen Detection Research for Mississippi Coastal Waters
  - Technological advancements associated with early detection and remediation efforts of Harmful Algal Blooms (HABs) and pathogens (such as Vibrio vulnificus) are critical for shellfish harvesting, fishing, swimming, and other industries that depend on clean coastal waters along Mississippi's shoreline. This research priority will fund efforts to create and assess such technologies. This effort encourages leveraging and partnership opportunities such as with the Gulf of Mexico Alliance Water Resources Team, which included Human Health as one of its priorities for its Tier 2 research initiatives. Examples of types of research associated with this priority include, but are not limited to:
    - Assess information from existing water programs from other Gulf States regarding current monitoring for human health parameters to assess suitability for Mississippi Coastal waters
    - Identify and evaluate existing methods for detecting pathogens of concern (such as Vibrio vulnificus)
    - Identify technologies or sampling approaches to detect HABs and pathogens simultaneously and conduct pilot study
    - Smart Phone Apps, identify and evaluate existing and initiate discussions of new or expanded smart phone applications for early detection of HABs and/or pathogens
    - Implement plan to fill informational gaps to ensure Mississippi water resource managers have capability for assessing HAB toxicity in monitoring programs
- A variety of research is needed in our coastal areas that addresses both surface water and groundwater quality and quantity. Following is a list of specific research that is needed:
  - Submarine groundwater discharge;
  - Fresh water inputs and the relationship to oysters, microplastics, and constructed wetlands for nutrient reduction;
  - Research to inform oyster restoration siting; and
  - Impacts of ocean acidification on coastal waters, animals and industries.

Water Use Efficiency and Water Reuse Research

- Water Reclamation and Reuse
  - In an effort to help meet growing demands being placed on available water supplies, many communities throughout the U.S. are turning to water reclamation and reuse. Water reclamation and reuse offers an effective means of conserving supplies while helping to meet the ever growing demands for water. The investment in treatment technologies required to meet restrictive discharge limits has lead an increasing

number of industries and communities to consider other uses for their treated waste water effluents. Further, as sources of water supplies have become limited, there has been greater use and acceptance of reclaimed waste water effluents as an alternative source of water for a wide variety of applications, including landscape and agricultural irrigation, industrial processing, power plant cooling, and wetland habitat creation, restoration and maintenance.

- Water Use Efficiency
  - Research aimed to utilize more practical, ecological, and economically feasible strategies in growing agricultural crops is a necessity. Research can include ways to identify best management practices aimed at preservation of water resources such as increases in efficiency of irrigation.
  - Both surface water and groundwater sources should be used efficiently for the purposes of addressing water quality and water quantity concerns. All sectors of water users would benefit from research and education promoting water use efficiency practices that save time and money as well as water.

Drinking Water and Waste Water Research

- Mitigation of Lead Corrosion in PWSs
  - Within Mississippi and across the United States, numerous reports of exceedances of lead standards in public water supplies are making headlines. EPA's Lead and Copper Rule is not a health-based standard; it uses action levels. It doesn't indicate a health risk or exposure; it indicates where resources are needed (i.e., where local communities – elected officials and/or management boards – should invest their resources). As such, it addresses asset management. Small drinking water systems are being overwhelmed by the rule, as well as some larger systems. Research is critically needed in Mississippi to address the following questions:
    - Where are the locations of lead service lines?
    - Where are the detects and non-detects (violations and non-violations) of lead and copper in PWSs?
    - Identifying potential sampling sites and providing monitoring assistance to assess how pH is maintained throughout a system.
    - Analysis of school infrastructure
    - What are the options available for corrosion treatment?
    - How can the life of current pipes be extended?
- Protection of Source Water Resources
  - Drinking water in Mississippi comes from groundwater and surface water sources. Protecting these source waters from contaminants is a major national priority in protecting public health by providing safe drinking water to the public. Continued

work is needed with some of our State's water systems to perform the following tasks:

- Delineate the source water protection areas;
- Identify known and potential sources of contamination;
- Develop protection measures; and
- Address emergency contingency planning.

- Innovative and Affordable Waste Water Treatment for Small Communities
  - Approximately 180 communities in Mississippi are facing the challenges of having to upgrade or enhance waste water treatment in order to meet new or more stringent effluent limitations. It is estimated that the potential cost of waste water treatment upgrades necessary to come into compliance with new effluent standards in Mississippi alone could exceed one billion dollars. Grant funds dedicated to waste water improvements are becoming increasingly difficult to obtain. Many of Mississippi's smaller communities have difficulty servicing debt on even low or no interest loans; therefore innovative and affordable technologies in waste water treatment and/or disposal for small communities are increasingly needed.

Modeling and Tool Development

- Development of Models and Tools
  - Models and tools are needed to predict future impacts of climatologic change (including extreme meteorological events), water use changes, social drivers, and proposed infrastructure on water resource availability and costs. The following applications have been identified as needs:
    - Options for simplified nutrient modeling;
    - WASP setup tools;
    - Methodologies, indicators, and decision support tools to inform decisions related to water quality and ecosystem health;
    - Predictive models to support beach actions (bacterial, algae, and storm water-related closures and advisories) as part of Mississippi's Beach Monitoring Program;
    - Model and predict frequency and magnitude of freshwater input to coastal areas; and
    - Prediction of storm water flooding.

Social Sciences Research

- Development of Social Indicators
  - Most water quality impairments in Mississippi are anthropogenic. Because of this, the development and use of social indicators to assist in the prioritization, planning, implementation, and evaluation of the effectiveness of water resources projects and

programs is important to track progress in the social aspects of water resources management.

- Development of Social Science Applications to Advance Water Resources Management
  - Social science applications can inform the education and outreach processes, reveal water resources champions at various scales, and identify potential opportunities and incentives to engage the business community. To accomplish this, a better understanding of stakeholder behaviors, perceptions and beliefs is of great importance.
- Development of Civic Engagement Indicators
  - A significant research need related to sustainable water resources management focuses on civic engagement and support. Recognizing that federal funding support is tenuous in the long term, surveys are needed to reveal potential civic support, identify incentives that could be developed for non-governmental support, and identify leadership that could rally support for water resource restoration and protection projects at multiple scales.

Economics Research

- Economic Analysis of Reducing Nutrient Loadings
  - Decisions affecting the use of our water resources are driven by economics. An example of this can be found in the rapid increase in agricultural irrigation permit applications, especially in the Delta. Economic analyses conducted by MSU during 2010 and 2012 revealed an increase in yield of 68-70% of some irrigated crops over dryland farming. The following research need is identified in Mississippi's nutrient reduction strategies:
    - What are the costs of nutrient reduction? What are the benefits/values? The answers and analyses of these questions are vital to inform the state's adaptive management implementation process. Specifically, analyses of the costs and benefits of selected BMPs designed to reduce nutrient content and improve/enhance water quality are needed to estimate impacts of various BMPs on agricultural productivity, values and uses of land, and tax revenues generated at the local, regional and state levels.

Emerging and Innovative Technologies

- Current and Potential Use of Unmanned Aerial Vehicles (UAVs)
  - Interest in potential UAV applications is very high. Current research interest that has been identified is listed below:
    - Help with the identification of unpermitted/undocumented surface mining activities;
    - Potential for use in environmental emergency response;
    - As a tool to document existing or potential BMP locations;

- As a tool to provide habitat mapping and data collection at remote locations;
- Exploring potential opportunities and applications to collect environmental/water resource-related data and images.

About the Mississippi Water Resources Research Institute (MWRRI)

The institute exists as both a federal and a state research unit. Established in 1964, the MWRRI is one of 54 institutes (one in each state, The District of Columbia, Guam, Puerto Rico, and the Virgin Islands) that form a national network to solve water problems of state, regional, or national significance. In 1983, the Mississippi legislature formally designated the MWRRI as a state research institute. Federal funds designated for the institute are used to consult with state water officials to develop coordinated research, technology transfer and training programs that apply academic expertise to water and related land-use problems. These various activities are funded through an annual grant from the United States Geological Survey (USGS). Mississippi state appropriations provide additional funds for cost share. The institute also assists state agencies in the development of a state water management plan, maintaining a technology transfer program, and serves as a liaison between Mississippi and federal funding agencies.

If you or someone that you know would like to receive this publication please email jessie.schmidt@msstate.edu to be added to the MWRRI listserv.

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