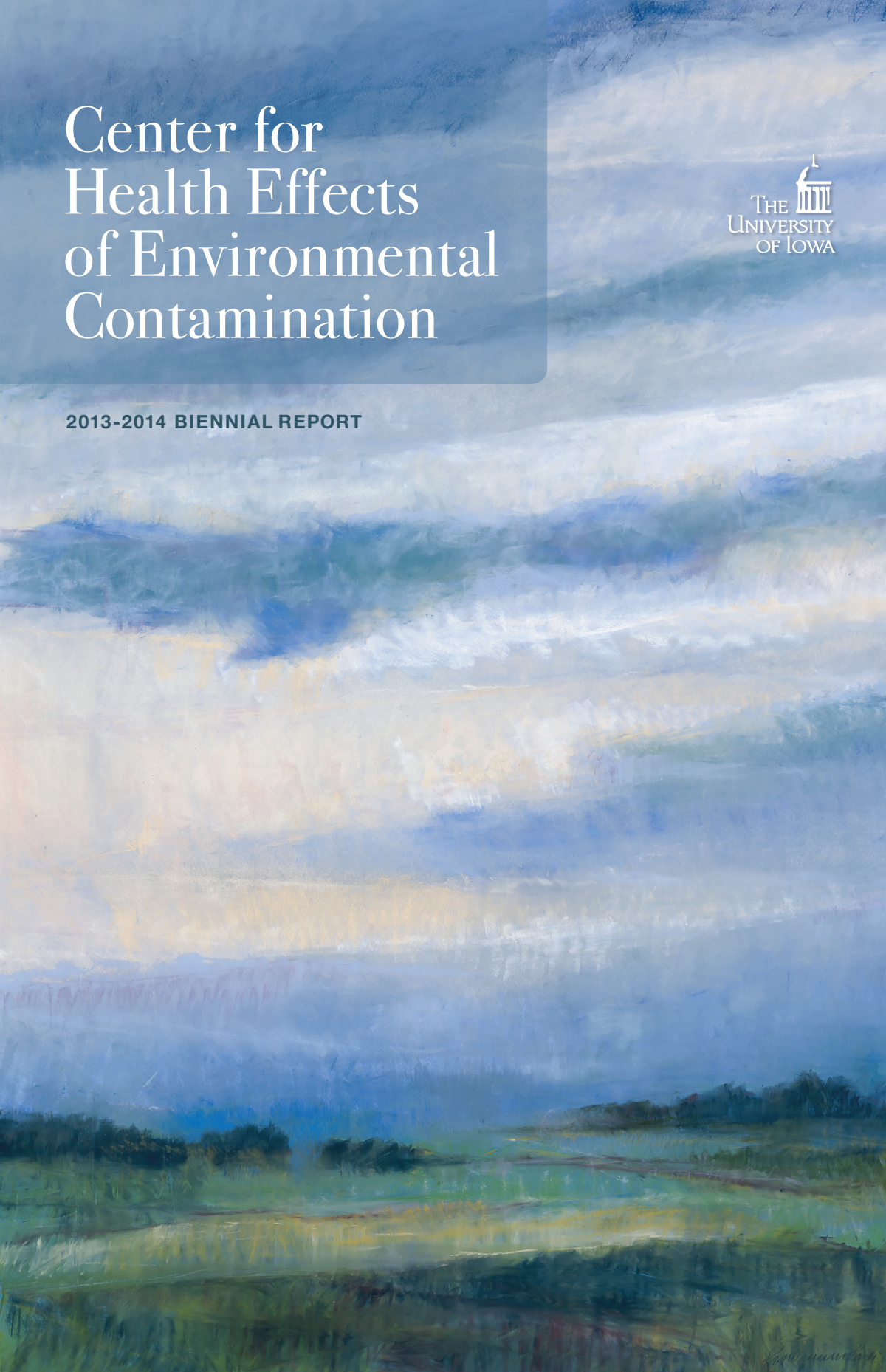


# Center for Health Effects of Environmental Contamination



2013-2014 BIENNIAL REPORT



**THE UNIVERSITY OF IOWA (UI) CENTER FOR HEALTH EFFECTS OF ENVIRONMENTAL CONTAMINATION (CHEEC)** is a multidisciplinary environmental research center that supports and conducts research to investigate possible health outcomes related to exposure to environmental toxins. CHEEC activities include 1) developing and maintaining environmental databases to be used in conducting research, 2) collaborating on environmental health research programs and projects, 3) managing a seed grant program to support environmental research, and 4) providing a variety of education and service programs to the citizens of Iowa and the region. CHEEC is comprised of UI faculty and researchers from the Colleges of Engineering, Public Health, Liberal Arts and Sciences, and the State Hygienic Laboratory. CHEEC cooperates and collaborates with the Iowa Departments of Public Health (IDPH), Natural Resources (IDNR), and Agriculture and Land Stewardship (IDALS).

This report presents an overview of research activities and education programs conducted by or supported by CHEEC during 2013–2014.

# Environmental Databases

Environmental databases are a central component of CHEEC operations. CHEEC created and maintains databases on Iowa drinking water quality, including the Iowa Historical Municipal Water Supply Source and Treatment Database, the Municipal Analytical Water Quality Database, and the Iowa Private Well Water Database. The municipal supply databases are used in conducting drinking water quality and health effects research. The private well databases are used to look at trends in private well water quality, and to collect baseline data on emerging contaminants.

## **Iowa Municipal (Public) Water Supplies**

The CHEEC Municipal Analytical Water Quality Database contains information from numerous sources including state and federal special surveys, regulatory programs (Safe Drinking Water Act), and various academic studies. This database houses information from the 1930s and from the 1960s to the present. The Historical Municipal Water Supply Source and Treatment Database contains information dating back through the early 1900s. This database is updated every 5 years by contacting public water utilities across Iowa about changes to their water treatment process and new water sources. The most recent update was completed in 2012.

## **Iowa Private Drinking Water Wells**

CHEEC maintains data from a number of surveys of Iowa private drinking water wells. The Iowa Statewide Rural Well Water Survey (SWRL, 1988–89) was conducted by CHEEC and the Iowa Geological Survey Bureau (IDNR) as part of the implementation of the Iowa Groundwater Protection Act. SWRL provided a statistically valid assessment of the proportion of private rural wells and rural residents affected by various environmental contaminants, and a cross-section of the quality of Iowa groundwater. A total of 686 wells were sampled for coliform bacteria, nitrate, 27 pesticides (and 5 metabolites) and major inorganic ions. A second phase of the SWRL study (SWRL2) was conducted in 2006–08. In this study, 473 private rural

drinking water wells were sampled; 116 of the wells were original SWRL study wells; the other wells were randomly selected from the IDNR's Private Well Tracking System. SWRL2 tested for the same contaminants as the original SWRL, with the addition of arsenic and several pesticide degradates. The Iowa Community Private Well Study (2002–03) includes water quality data for 230 private drinking water wells in 50 incorporated Iowa towns not served by a public water supply system.

## Research and Data Management

In 2013–2014, CHEEC staff participated in the following projects as Investigators, in developing and maintaining project databases, and in providing applications programming.

### **Exposure assessment method for disinfection byproducts in drinking water**

**COLLABORATORS:** National Birth Defects Prevention Study centers, U.S. EPA, CHEEC

This project is estimating disinfection byproducts (DBP) exposures in public drinking water systems for participants in the National Birth Defects Prevention Study (NBDPS). The exposure assessment includes linking geocoded maternal addresses to appropriate drinking water utilities, linking relevant DBP water quality data to those residences, and modeling the DBP data to account for possible spatial and temporal variability.

### **Water quality data for private wells for the Agricultural Health Study**

**COLLABORATORS:** National Cancer Institute, State Hygienic Laboratory at UI, CHEEC

This project provided nitrate, pesticide and other water quality data for private wells and public water utilities across Iowa to use in modeling drinking water exposures for participants in the Agricultural Health Study. Over 89,000 persons are in this Study (Iowa and North Carolina); the goal is to investigate the effects of environmental, occupational, dietary, and genetic factors on the health of the agricultural population.



## Iowa Women's Health Study Drinking Water Exposures and Cancer Risk

**COLLABORATORS:** National Cancer Institute, Univ. of Minnesota School of Public Health, CHEEC

This project involves analyzing drinking water contaminant data (nitrate, pesticides, disinfection byproducts) in Iowa municipal water supplies in communities where over 21,000 participants in the Iowa Women's Health Study resided during the 1960s through the 1980s. Drinking water exposure data is included with lifestyle, dietary and other data to evaluate risks for thyroid, bladder and ovarian cancer.



# Seed Grant Program

CHEEC awards approximately one-third of its annual state allocation to pilot-scale research projects. Since the inception of the CHEEC Seed Grant Program in 1988, 136 projects have been funded. A recent review of the Program showed that over 50 students have received advanced degrees resulting from these research projects, and 90 articles have been published in peer-reviewed journals describing research methods and results. While recently funded seed grant projects are still in progress, 50 project proposals using seed grant project results have been awarded external funding (federal or private grants and contracts) with a ten dollar return on every dollar invested by CHEEC.

CHEEC awarded the following seed grants in FY 2013 and FY 2014:

## **Point-of-use electrocatalytic filters for reduction of persistent contaminants from drinking water**

**INVESTIGATORS:** D. Cwiertny, D. Shuai, R. Valentine, Department of Civil and Environmental Engineering, The University of Iowa

**SUMMARY:** Although regulated by the USEPA for the risk they pose to human health, nitrate and disinfection byproducts are pervasive contaminants often encountered in drinking water. Traditional approaches have proven inadequate for their removal; this project will develop a promising, point-of-use (POU) electrocatalytic filtration unit targeting these pollutants. With the potential for high pollutant removal efficiency and self-cleaning ability, this research will demonstrate the feasibility and sustainability of this technology. Specific tasks include synthesis and characterization of nanofiber supported metal catalysts exhibiting systematically varied physicochemical properties, assessing electrocatalytic filter performance when exposed to various water chemistries, and a preliminary environmental impact assessment addressing the cost and sustainability of this innovative technology. This work represents the first step in the development of a low-cost, POU water treatment device with the potential to lower health risks associated with drinking water sources compromised by persistent pollutant classes.

## **Enhanced CNS exposure to glyphosate following inhalation resulting from olfactory uptake**

**INVESTIGATORS:** M. Donovan, Department of Pharmaceutical Sciences and Experimental Therapeutics; The University of Iowa; H. Lehmler, P. O'Shaughnessy, Department of Occupational and Environmental Health, The University of Iowa

**SUMMARY:** While glyphosate, the ingredient present in the widely used RoundUp® family of herbicides, has an excellent safety profile following topical and oral exposure, it presents a potential CNS exposure risk if it is able to access the olfactory transfer pathways within the nasal mucosa. These pathways afford the opportunity for molecules to access the brain without needing to cross the blood-brain barrier. This study will evaluate whether glyphosate and several commercial glyphosate herbicide formulations are able to permeate through the olfactory mucosa into the olfactory bulb and nearby brain regions following direct nasal instillation and aerosol exposure. Preliminary results will provide initial quantitative evidence regarding the risk of CNS glyphosate exposure following nasal inhalation and will support further investigations to evaluate the exposure risk along with identifying methods to limit inhalation exposure to herbicide applicators or those in close proximity to spraying operations.

## **Effects of PCBs on adipocytes and the development of metabolic syndrome**

**INVESTIGATOR:** A.J. Klingelhutz, Department of Microbiology, The University of Iowa

**SUMMARY:** Recent epidemiological studies indicate that exposure to polychlorinated biphenyls (PCBs) is associated with an increased risk of metabolic syndrome, a group of disorders that includes obesity, glucose intolerance, high cholesterol, and hypertension. Metabolic syndrome increases the risk of developing type 2 diabetes. PCBs accumulate in adipocytes, which are known to play a key role in the genesis of metabolic syndrome. Recently generated extended lifespan human pre-adipocytes will provide a unique opportunity to assess the short and long term effects of PCBs on adipocyte biology. These cells will be used to test the hypothesis that exposure of adipocytes to PCBs causes long-term effects on gene expression to alter adipocyte differentiation and function. This study will lead to further understanding of how PCBs cause metabolic syndrome, may provide useful biomarkers for assessment of disease risk, and could point to new targets for therapy.

### **Predicting the transport and fate of emerging contaminants using multi-tracer characterization of reactive pathways**

**INVESTIGATORS:** A. Ward, Department of Geoscience, The University of Iowa; D. Cwiertny, Department of Civil and Environmental Engineering, The University of Iowa; D. Kolpin, U.S. Geological Survey

**SUMMARY:** Contaminants of emerging concern (CECs, unregulated compounds including pharmaceuticals and personal care products) are ubiquitous in environmental and drinking waters, posing potential risks to human and ecosystem health. This proof-of-concept study will characterize the transport and fate of CECs in a stream reach using a suite of tracers with well-characterized, complementary reactivities. Specific research tasks include quantifying reaction pathways within the environmental system, laboratory experiments linking tracer and CEC reaction rates, and numerical modeling to predict transport and fate of CECs. The overall goal of this research is to quantify reaction pathways in the environment and successfully predict the transport and fate of CECs. A major outcome will be a mechanistic understanding of transport and fate processes that can be applied to any CEC in the system; this will enable prediction of the spatial extent and temporal persistence of CECs in streams.

### **Simple and fast detection of pathogens in recreational waters**

**INVESTIGATORS:** R. Cademartiri, Department of Chemical & Biological Engineering, Iowa State University; M. Soupier, Department of Agricultural & Biosystems Engineering, Iowa State University

**SUMMARY:** Harmful microorganisms are the leading cause of water quality impairments in the United States, and are thought to be responsible for 900,000 illnesses and 900 deaths per year. Quick and accurate detection techniques are badly needed to better identify waters posing a risk to human health. The objective of this study is to generate preliminary data in three important areas for the development of a paper-based test for the detection of pathogens in recreational waters: 1) the stability of bacteriophages on paper, 2) the pre-concentration of bacteria in water samples, and 3) the development of a sensitive colorimetric assay for bacteria on paper. The development of a paper-based device for detection of water-borne pathogens will provide information on the presence of pathogens in recreational waters at low-cost in a short period of time and can be used by volunteer groups, beach managers, and other public health officials.



## **Toxicity of organophosphate and carbamate pesticides for neuronal and non-neuronal cells**

**INVESTIGATOR:** J. Doorn, Department of Pharmaceutical Sciences and Experimental Therapeutics, The University of Iowa

**SUMMARY:** Organophosphate (OP) and carbamate pesticides are widely used in agriculture. Acute exposure to high doses may cause cholinergic toxicity; however, recent work demonstrates that exposure to low levels causes adverse effects in humans from neurological deficits to oxidative stress/reactive oxygen species (ROS). The mechanism for this “non-canonical” toxicity is unknown but concerning given the ubiquitous nature of OP and carbamates in the environment and significant human exposure. Such adverse consequences are likely due to effects of these pesticides on cell types found in the brain other than cholinergic neurons, such as other neurons or glial cells (non-neuronal). The goal of this project is to determine which neuron types (i.e., cholinergic, glutamatergic, dopaminergic) or non-neuronal cells (i.e., astrocyte) are most sensitive to OP and carbamate pesticides, yielding toxicity and/or oxidative stress/ROS. In addition, the investigator seeks to identify the insulting species of the OP agent, i.e., phosphorothioate or bioactive oxon metabolite.





### **Estimating prenatal exposure to lead in Iowa newborns**

**INVESTIGATOR:** A. Saftlas, K. Ryckman, Department of Epidemiology, The University of Iowa

**SUMMARY:** Lead is a highly potent human toxicant that readily crosses the placenta of the developing fetus and impairs the development and function of multiple organ systems. Developing effective methods for measuring prenatal lead exposure and identifying women at risk for high lead levels in pregnancy is an essential public health priority. This project will: 1) estimate the correlation of lead concentrations measured from 50 paired newborn dried blood spot and fetal cord blood samples; and 2) identify geographical “hot spots” for prenatal lead exposure in Iowa based on a consecutive sample of 1,866 Iowa newborns with lead concentrations measured from newborn blood spot cards. These pilot data will be used to design a larger investigation with the objectives of establishing baseline levels of lead exposure in newborns and identifying high-risk subgroups for intervention.

### **Naturally-occurring radioactivity liberated by new natural gas mining technologies: A pilot study of the geochemical partitioning and potential for radionuclide migration and exposure to higher organisms and humans**

**INVESTIGATORS:** M. Schultz, Departments of Radiology and Radiation Oncology, The University of Iowa; T. Forbes, Department of Chemistry, The University of Iowa

**SUMMARY:** New drilling and hydraulic-fracturing technologies have unlocked economically-lucrative reserves of natural gas and the practice is proliferating rapidly. However, solid and liquid waste from these activities is enriched in naturally-occurring radioactive materials (NORM), and sediments downstream from wastewater treatment facilities are NORM-enriched. Similarly, NORM levels in solid waste are too high for disposal in many municipal facilities and are often buried on homesites. This study will collect and analyze surface water, sediments, and plants at a West Virginia wastewater treatment site that accepts hydraulic-fracturing wastewater, and will also collect and determine the leachability of NORM from solid-waste.



CHEEC's mission, as described in the 1987 Iowa Groundwater Protection Act, is to "determine the levels of environmental contamination which can be specifically associated with human health effects."



*L. Williams*

# Cooperative Research Projects

The CHEEC Cooperative Research Program seeks to leverage research monies from university, state, and federal entities to conduct research in areas of mutual interest. The collaboration requires matching funds from participating entities; the program seeks to establish innovative lines of environmental health research leading to preliminary results that may be used in seeking larger grant funding from federal and private sources. Since the Program began in 1999, 11 projects have been funded. Over the life of the Cooperative Research Program, there has been an average of a 5 dollar match from Cooperators for every dollar CHEEC has invested. Cooperators include the U.S. Geological Survey, the U.S. Department of Agriculture, the U.S. Department of Energy, the U.S. Environmental Protection Agency, IDNR, IDPH, the Leopold Center for Sustainable Agriculture at Iowa State University, Iowa County Health Departments, and Departments in the UI Colleges of Public Health, Engineering, Medicine, and Liberal Arts and Sciences.

CHEEC awarded the following cooperative research grant in FY 2014:

**Development of novel, composite nanomaterials for water filtration**

**INVESTIGATORS:** S. Larsen, Department of Chemistry, The University of Iowa; D. Cwiertny, G. Parkin, Department of Civil and Environmental Engineering, The University of Iowa

**COOPERATORS:** Savannah River National Laboratory; EPA

**SUMMARY:** Almost 1/3 of the world's population lacks access to safe drinking water. Human exposures to drinking water contaminants, such as arsenic, have been linked to cancer, neurological, cardiovascular and pulmonary health problems. In a recent survey of private wells in Iowa, 48% were found to contain arsenic and 8% were determined to have arsenic levels greater than the EPA's drinking water standard of 10 ppb.



It is critical, both globally and locally, to develop improved methods for removing groundwater contaminants. Investigators in this study will design, fabricate and evaluate mesoporous silica-coated electrospun iron oxide nanofibers for arsenic adsorption from water. The Larsen Lab is developing functionalized mesoporous silica materials for adsorption of radioactive contaminants; these materials are also promising for application as arsenic adsorbents. The Cwiertny/Parkin Lab is developing electrospun nanofibers for use as chemically active filtration materials. CHEEC funds will allow the two Labs to work collaboratively to develop and evaluate these novel composite adsorbents.

## Education Programs and Service Activities

### Education Grants

CHEEC Education Grants provide funding for educational programs that encompass the broad interdisciplinary nature of environmental health. Education programs with a public health or an environmental education focus that demonstrate a link to environmental health issues are encouraged. In 2013, a CHEEC grant was awarded to the following project:

#### **Pollution, the Environment and Your Health in Muscatine, Iowa: An Educational Toolkit and Outreach Strategy**

Clean Air Muscatine, Muscatine, IA

### Seminars and Conferences

CHEEC staff gave a number of seminars on the University of Iowa campus, and gave invited presentations at professional meetings across the state in 2013–2014.

#### **Arsenic in Iowa's Groundwater Sources – Surveillance, Research, Education and Policy**

UI Department of Occupational and Environmental Health Seminar (Iowa City)

#### **Water quality in Iowa: Longstanding issues and emerging concerns**

UI Interdisciplinary Program in Human Toxicology Seminar (Iowa City)

#### **Current issues in Iowa water quality: A public health perspective**

UI Department of Geoscience Seminar (Iowa City)

**Ingestion of nitrate/nitrite from drinking water and dietary sources:  
What are the health risks?**

Iowa Rural Water Association Fall Conference (Dubuque and Okoboji, IA)

**Surface and groundwater contaminants: An overview of health concerns**

Iowa Association of Water Agencies Annual Meeting, (Moravia, IA)

**Groundwater contaminants: An overview of health concerns**

Iowa Groundwater and Public Health Symposium (Des Moines, IA)

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CHEEC sponsors, co-sponsors and hosts conferences, symposia and workshops on a variety of issues related to environmental health (<http://www.cheec.uiowa.edu/outreach/conference.html>).

In 2014, the Iowa Groundwater and Public Health symposium was co-sponsored by the Iowa Ground Water Association and CHEEC.

**Iowa Groundwater and Public Health Symposium (Des Moines, IA)**

Most of us drink, bathe, cook and clean with groundwater every day. Despite groundwater's prevalence in our daily lives, there is still much that needs to be understood involving the connection of groundwater and our health. This symposium provided expert, informed presentations and networking opportunities for drinking water professionals, public health professionals, researchers, policy makers, agencies, and communities. This symposium highlighted recent research and surveillance projects on viruses, arsenic and nitrate contamination combined with cutting edge groundwater characterization. Potential health impacts of these common drinking water contaminants were discussed, and a look at possible future groundwater contaminant issues was presented. Full Proceedings are available in audio and power point presentation at: [http://www.cheec.uiowa.edu/outreach/groundwater\\_presentations.html](http://www.cheec.uiowa.edu/outreach/groundwater_presentations.html)

CHEEC was also a co-sponsor (with the U.S. Geological Survey and various research units at the University of Iowa) of the Fourth International Conference on Emerging Contaminants in the Environment (EmCon) in Iowa City in 2014, which provided a forum for scientists to present information on a number of emerging contaminant topics: sources and exposure pathways; treatment processes and technologies; waste, wastewater recycling and reuse; sampling, analytical, and characterization methods; fate and transport in aquatic and terrestrial ecosystems; aquatic and terrestrial effects; and risk assessment, risk management, regulations, and policy frameworks.

CHEEC staff participated as members of the Environmental Public Health Tracking Program Advisory Board (Iowa Dept. of Public Health) and the Board of External Advisors, State Hygienic Laboratory at The University of Iowa.

# Who We Are

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