The state, nation, and world continue to grapple with major environmental and economic issues related to previous and new threats to our air, water, and soil. It is clear that society requires a multimodal approach that includes new technologies, changes to human behaviors, and policies that are targeted to address these issues. We at ISTC continue our focus on addressing and tackling these issues to protect our environment and simultaneously drive economic growth.

In order to address the critical issues listed above, ISTC continues to focus on the issues of emerging contaminants and carbon dioxide utilization. These areas address themes that are of great concern at the state, national, and global level. For example, the emerging contaminants area includes microplastics, pharmaceuticals, and per- and polyfluoroalkyl substances (PFAS), which are newly recognized pollutants in surface and groundwater.

Our proposal pipeline and success rate is a testament to our strong brand within the scientific community. We have been awarded projects for: conducting large pilots (10 MWe) and front-end engineering design studies (814 MW); reducing water usage at power plants; using carbon dioxide to fuel algae growth for energy; developing new carbon capture technologies; reducing aerosol formation during carbon capture; and examining alternative uses for coal (non-thermal generation usage), among other work.

ISTC continues to maintain its leadership role to protect the environment and drive economic development through the promotion of sustainable processes and practices.

Kevin C OBrien
Director, Illinois State Water Survey and Illinois Sustainable Technology Center
ENERGY & WASTE UTILIZATION
ISTC investigates biofuels and other renewable fuels, carbon capture, and wastewater to energy systems. The latter includes work in anaerobic digestion, hydrothermal liquefaction, and hydrothermal gasification. ISTC’s waste utilization program develops technologies for the cost-effective processing and recovery of materials for commercial-scale recycling.

POLLUTANTS
In partnership with the Illinois State Water Survey, ISTC investigates the occurrence, fate and transport, and mitigation of a wide range of contaminants in the environment, with an emphasis on emerging contaminants like microplastics and PFAS. In addition, the program raises awareness about these pollutants’ effects on human health and the environment.

TECHNICAL ASSISTANCE PROGRAM
ISTC’s Technical Assistance Program (TAP) shows companies and communities how to apply sustainable business practices and technologies to help them save money and improve their environmental performance, making them more competitive and resilient.
CARBON CAPTURE COLLABORATIONS LEAD CLEAN-ENERGY DRIVE

PRI’s Illinois Sustainable Technology Center (ISTC) is collaborating with three Illinois power plants (Prairie State Generating Company, City, Water, Light, and Power, and the University of Illinois’ Abbott Power Plant) to implement sophisticated technologies that remove carbon from air emissions (carbon capture).

ISTC and its sister surveys, the Illinois State Geological Survey (ISGS) and the Illinois State Water Survey (ISWS), along with partners Kiewit Engineering Group, Mitsubishi Heavy Industries America, and Sargent & Lundy, are working to complete a front-end engineering design (FEED) study for the retrofit of the Prairie State Generating Company in Marissa, Illinois.

The goal is to design a system to capture more than 90 percent of carbon emissions at the facility and incorporate additional carbon offset strategies to achieve net-zero CO₂ emissions. The FEED study is made possible through a $15 million grant from the U.S. Department of Energy’s (DOE) Office of Fossil Energy that is administered by the National Energy Technology Laboratory and $3.75 million from the Prairie State Generating Company.

ISTC also is overseeing a large pilot test of the performance, safety, and environmental compliance of a carbon capture technology developed by Linde Gas North America and BASF in Springfield, Illinois.

The aim of this project is to design, construct, and operate a 10 megawatt (MWe) carbon capture system at one of City, Water, Light, and Power (CWLP)’s coal-fired generators. This project team successfully completed planning and evaluation of this technology at the plant. The design phase that is now in progress will produce a shovel-ready plan for construction.

The effort has the potential to be the foundation for more easily accessible and attainable carbon capture systems at other facilities around the world, depending on the outcome of a $45 million DOE grant with a $20 million match from the state of Illinois. The DOE received nearly 30 proposals from power plants across the country for the grant, which is now narrowed down to five final candidates – CWLP being one.

If selected, ISTC would embark on the construction of a CO₂ separation unit at CWLP’s 200 megawatt Dallman Unit 4 using state-of-the-art air emission control technology as early as May 2021.

Abbott Power Plant currently hosts two DOE-funded carbon-capture research projects. In the first, ISTC is working with Linde to test three technologies for reducing aerosol particle concentrations in flue gas. This work is intended to help make solvent-based carbon capture technology more economical at commercial scales.

The second project, led by ISGS in a joint effort with ISTC and Trimeric Corporation, is working to advance the early development of a CO₂ absorption technology at 40 kilowatts (kWe) following successful proof-of-concept and lab-scale development research.

This technology uses a novel biphasic CO₂ absorption process that involves applying a proprietary solvent developed by ISGS researchers for post-combustion CO₂ capture, an approach that could dramatically improve energy efficiency, lower the equipment cost and footprint, and maintain operational simplicity.

FUNDED BY THE U.S. DEPARTMENT OF ENERGY.
Kirtika Kohli and BK Sharma developed a greener delignification method for biofuels refinery processes. Current processes have limited industrial applications because of their high costs, toxicity, and inability to recycle/reuse the chemicals used in the process. The team’s new method is more efficient, economical, and less toxic. It should ease operation/maintenance requirements and the need for special equipment, as well as increase cost-effectiveness and recyclability. Their process is able to extract 85–88% of the lignin from Birchwood and Miscanthus.

The team also developed a new lignin quantification method. The delignification process dissolves lignin into a green solvent that can be directly used for the quantification using a UV-Vis spectrophotometer. This new method is easier and more accurate than older lignin quantification methods, which were based on weight.

Their paper, *Effective Delignification of Lignocellulosic Biomass by Microwave Assisted Deep Eutectic Solvents*, is available online in *Bioresource Technology*.
ISTC researcher Lance Schideman is working with Yuan-Hui Zhang and BK Sharma on new, more efficient technologies and processes to treat wastewater while simultaneously capturing carbon, producing nutritional products, and turning waste products into sustainable energy feedstocks. Other collaborators include Chia-Fan Lee, Hong Yang, and Imad Al-Qabi.

Funded by the U.S. Department of Energy.
MICROPLASTICS ARE A POTENTIAL VECTOR FOR CHEMICAL CONTAMINANTS

Since the emergence of mass-produced plastics in the mid-19th century, it’s estimated that more than 6.3 billion metric tons of plastic waste have been generated—equivalent to the weight of 1 billion elephants. Unfortunately, only 9 percent of these materials are recycled, and plastics are now ubiquitous in the environment. Surface waters like oceans and the Great Lakes are the final destination for many of these materials, and plastic is the most common marine debris.

Many plastics have the potential to soak up pollutants from their environment. To investigate this problem, ISTC, the Annis Water Resources Institute at Grand Valley State University, and the University of Birmingham in the United Kingdom conducted a field experiment on Michigan’s Lake Muskegon.

The team deployed three microplastic types (polyethylene, polypropylene, and polyester) at two locations. After one- and three-month durations, the team retrieved the materials and analyzed them for more than 85 persistent organic pollutants.

Some materials were found to have adsorbed pollutants in large amounts: up to 280 times background water levels for polycyclic aromatic hydrocarbons and 380 times background water levels for some polychlorinated biphenyls.

They also found concentrations of per- and polyfluoroalkyl substances (PFAS) associated with some of their materials that were 259 times the background concentrations. This was surprising since the team previously found that microplastics in laboratory water alone concentrate PFAS at only one-fifth of background levels. This difference is most likely due to biological materials enhancing the adsorption of PFAS in the environment.

Although the team found that these materials can concentrate pollutants at hundreds of times the background levels, the concentrations are quite low and likely aren’t high enough to effect larger aquatic wildlife such as trout or bass. However, materials used in this study were only deployed for three months, and some researchers estimate that many of the microplastics in the environment are decades or more old. Further, we still do not know if all the chemicals and biological materials associated with microplastics work together to invoke adverse health effects in organisms that are exposed to them.

BIOCHAR PROJECT SET TO IMPROVE AG SUSTAINABILITY

ISTC scientist Wei Zheng and colleagues are creating a designer carbon-based biochar that captures phosphorus from tile drain runoff water and recycles it in soils to improve crop growth. Zheng hypothesizes that this will increase crop yields and reduce nutrient runoff from agricultural fields.

Phosphorus applied to fertilize crops tends to leach out through field tile lines, promoting algae growth in nearby waterways. Harmful algal blooms appear in lakes in the summer and die once the growing season ends, contributing to oxygen-depleted waters, which result in fish kills and other adverse effects on aquatic life.

By installing a bioreactor in the field with a biochar-sorption filter, water that runs through the tile system is filtered to remove nutrients before it reaches lakes and streams. In the lab, Zheng is studying designer biochars to find the one that most effectively captures phosphorus.

The team is scaling up their technology to test a bioreactor and biochar-sorption-channel system on a farm in Fulton County. In the second year of the project, the team will establish a bioreactor system that is able to treat drainage water received from a 12-acre field. Water testing will confirm how successful the system is at reducing phosphorous runoff.

The project also includes applying the phosphorus-rich biochar pellets to the fields after fertilizing season. There they will slowly release the captured nutrients into the soil. As a result, producers can keep fertilizer costs down and increase crop yields when applying the biochar pellets at optimal times in the growing season. Results from the project are expected in 2023.

Funded by the Illinois Nutrient Research & Education Council.

Project partners include the Illinois Farm Bureau and University of Illinois.
ISTC DELIVERS REPORT ON
CONTAMINANTS OF EMERGING CONCERN
TO ILLINOIS GENERAL ASSEMBLY

In 2018, Illinois’ governor signed House Bill IL-HB5741, which directed the Prairie Research Institute (PRI) to conduct a scientific literature review of contaminants of emerging concern (CEC) in wastewater treatment plant effluent. It also requested that PRI compile a listing of the actions recommended by various state and federal agencies to address the environmental or public health concerns associated with these chemicals.

The final report was filed with the General Assembly in February 2020. It reviews the state of scientific knowledge about CEC in wastewater treatment plants (WWTPs), discusses concentrations of CEC in WWTPs, and reviews existing treatment technologies and U.S. federal and state laws.

FUNDED BY THE ILLINOIS HAZARDOUS WASTE RESEARCH FUND.

WASTEWATER TREATMENT PLANTS WERE NOT DESIGNED TO REMOVE CEC
Cleaning and sanitation are critically important in manufacturing plants to ensure that food is safe for consumers. Although most plants use chemicals for cleaning, Troy Walker, project manager for one of the projects, has identified a viable option for U.S. plants, one that has been used in other countries.

**Aqueous ozone sanitation technology is a practical replacement for antimicrobials such as acid and chlorine-based solutions, with 10 to 4,000 times the concentration of chlorine.**

Pumped through existing sanitation equipment, ozone is safe and effective and reduces the cost of chemicals, heating, and sanitation labor. ISTC staff have written an aqueous ozone sanitation technology fact sheet and provided technical assistance to demonstrate the technique.

In the second project, funding continues for the Illinois Conservation of Resources and Energy (ICORE) project, now in its 12th year. Focusing on technical assistance for small and mid-size food and beverage manufacturers since October 2018, principal investigator Dan Marsch said that education about alternative options is key.

The team also co-hosted three workshops in Illinois for managers of food manufacturing companies to update participants on energy efficiency, safer sanitation methods, renewables to make facilities net-zero energy efficient, and ways to improve water conservation and develop a supply-chain sustainability program. Marketing materials included flyers and a new food and beverage manufacturing newsletter. Subscribe to the newsletter here.

**FUNDED BY THE U.S. ENVIRONMENTAL PROTECTION AGENCY.**
TAP AND SEDAC HELP COMMUNITIES REDUCE COSTS FOR WASTEWATER TREATMENT

Since 2018, the Illinois Environmental Protection Agency (IEPA) has provided funding for ISTC’s Technical Assistance Program and the University of Illinois’ Smart Energy Design Assistance Center (SEDAC) to help municipalities reduce the cost of wastewater treatment by providing no-cost energy usage assessments to publicly-owned wastewater treatment plants (POTW). Similar assessments would ordinarily cost between $6,000 and $12,000.

Wastewater treatment can be a significant cost for municipalities, especially when infrastructure is aged or inappropriately sized for the community it serves. This partnership helps municipalities identify ways to improve systems and save money.

It also positions them to be eligible for special grants from IEPA.

Reports include:

▶ upfront costs for equipment upgrades or retrofits;
▶ utility incentives available from energy providers;
▶ estimated time it will take for the upgrade costs to pay off in energy savings; and
▶ energy and monetary savings that could result from these upgrades and retrofits.

3,765,332 kWh in energy savings
[$297,784 cost savings]

3,573 MTCO2e in GHG emissions savings
ISTC TESTS FOR LEGIONNAIRES’ DISEASE BACTERIUM IN FACILITY WATER SYSTEMS

ISTC’s Institutional Water Treatment (IWT) program has developed a set of recommendations for facility managers to help them maintain their water systems in light of new federal, state, and local COVID-19 policies that change building use patterns. In addition, they are offering a new service to test water sources for Legionella, the bacterium that causes Legionnaires’ disease, to decrease exposure for clients with weak immune systems.

The IWT services group gives advice on controlling corrosion, mineral scale formation, and biological growth for facilities with institutional water systems. Most of their clients are state-operated facilities, such as Human Services, Department of Corrections, the Department of Veterans Affairs, and others that often have older facilities that need to be checked periodically and maintained.

For more information about IWT and to schedule a site visit, view www.istc.illinois.edu/techassist/iwt.

NEW ENVIRONMENTAL GUIDEBOOK FOR SALVAGE YARDS

ISTC’s Salvage Yard Environmental Guidebook and Self-Audit Checklist helps salvage yard operators better understand environmental issues, comply with state and federal environmental regulations, and implement best management practices to minimize risks and liabilities.

The manual details best management practices and pollution prevention options for safely managing all types of waste found in salvage yards, including lithium-ion batteries and spent air bags.

INCLUDES BEST MANAGEMENT PRACTICES FOR LITHIUM-ION BATTERIES