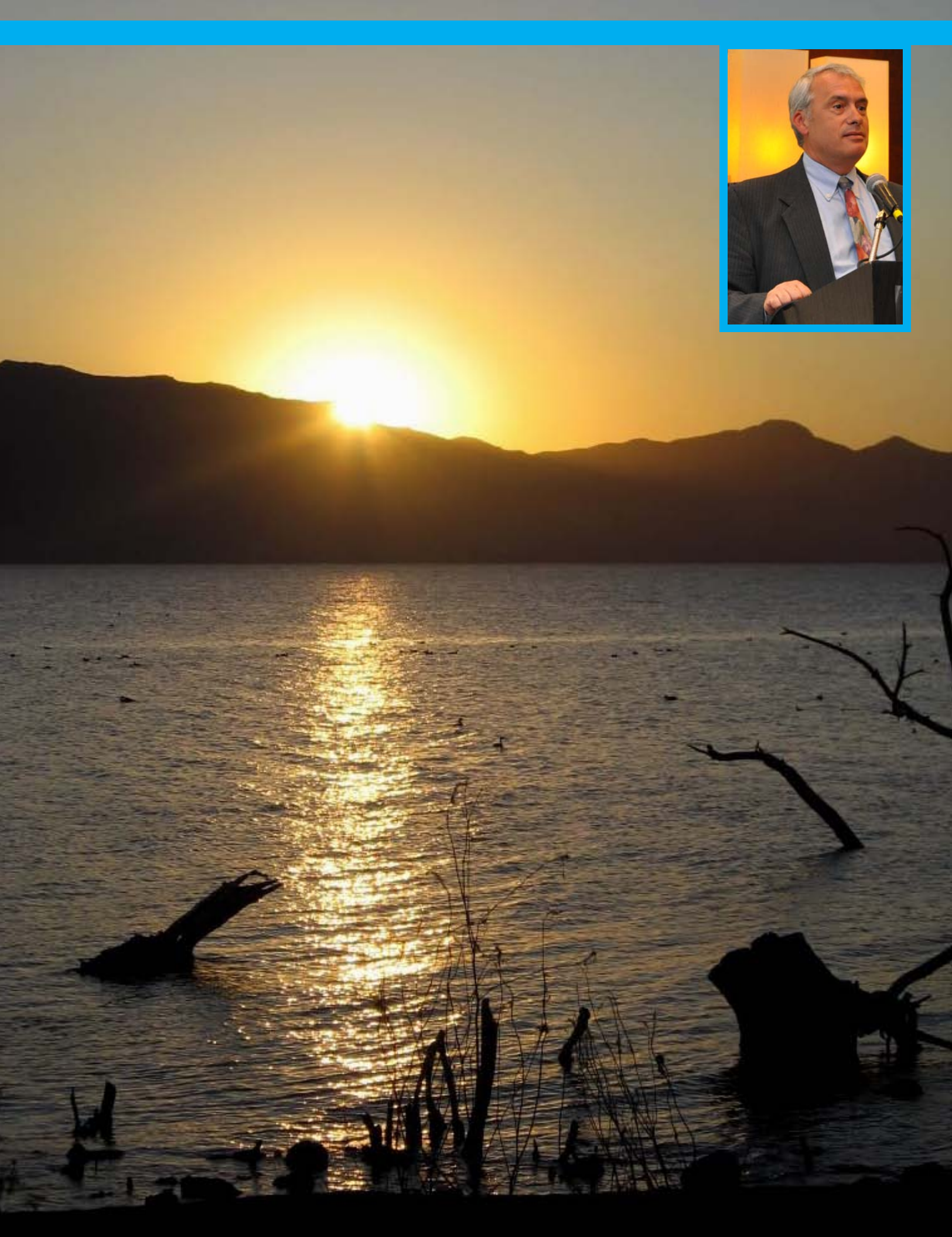# Science and Research at the U.S. Environmental Protection Agency

EPA Progress Report, 2012
Office of Research and Development

Innovation Today for a Sustainable Tomorrow

A message from Lek Kadeli
Principal Deputy Assistant Administrator
U.S. EPA Office of Research and Development

This report highlights just a small sample of the research results that the scientists and engineers at the U.S. Environmental Protection Agency's Office of Research and Development delivered in support of the American people in 2012. While just a snapshot, it reflects the enormous positive impact of what a group of dedicated, highly-skilled, and passionate researchers can accomplish when they work together to cultivate an atmosphere of innovation and common purpose in providing solutions to environmental health issues.

No other environmental research organization in the world offers the collective depth and breadth of expertise represented by EPA's research staff. From assessing the promise and potential risks of emerging technologies using tiny nanoparticles thousands of times smaller than the width of a human hair, to exploring the dynamics and far-reaching challenges of global climate change, EPA brings together experts from a diversity of environmental and human health fields.

Collectively, this body of experts, together with partners throughout the scientific community, provide the firm, scientific foundation the Agency needs to fulfill its mission on behalf of the American people: to safeguard human health and protect the environment.

EPA researchers are at the forefront of a movement to advance environmental and human health science into the next generation. Their goal is not only to support efforts to reduce pollution and lower the risks posed by environmental exposure and contamination, but to advance the science needed to achieve a more sustainable and prosperous future. In doing so, they are helping to fundamentally change the business of protecting human health and the environment from one focused on what should not be done, to one based on growth and opportunity. Together with their partners, EPA researchers are part of a growing community of scientists and engineers embracing an entrepreneurial spirit aimed at delivering the knowledge, tools, and solutions needed to meet today's most pressing environmental challenges in ways that simultaneously spark economic growth and lay the groundwork for the a new wave of American jobs.

This spirit of innovation is exemplified throughout this report, which highlights some of the research results and impacts achieved by EPA scientists and engineers and their partners during 2012. A few examples follow.

- Developing remote, mobile air monitoring sensors and technologies that will improve local air quality monitoring and are expected to help oil refineries and other industries save some $500 million over the next ten years. (See *New Technology to Improve Local Air Quality Monitoring, Reduce Costs*.)

- Working with partners from the Department of Health and Human Services to launch the "My Air, My Health" initiative. My Air, My Health provided the incentive to inventors, software and app developers, and engineers to develop personal, portable sensors for air quality and human health. (See *Sparking Innovation for Clean Air*).

- Testing a novel, proof-of-concept coastal water quality monitoring system that taps data gathered from the International Space Station's Hyperspectral Imager for Coastal Ocean (HICO) through an EPA Pathfinder Innovation Project. (See *Supporting Innovation*.)

- Advancing the science and engineering

of "green infrastructure" techniques such as rain gardens, rain barrels, and green roofs that mimic natural conditions to help urban water systems develop new ways to reduce stormwater and remove excess nutrients from runoff. This work will help communities improve local waterways while avoiding costly upgrades and replacements to sewer systems and other "gray" stormwater infrastructure. (See *Tapping Green Infrastructure and A Tool for Urban Stormwater Management*.)

- Working with collaborators from Rutgers University and a New Jersey Department of Environmental Protection team to use a remote-controlled, submarine-like "autonomous underwater vehicle" to monitor water quality off the coast of New Jersey, helping collect important data while reducing costly helicopter flights. (See *Gliding beneath the Surface*.)

- Developing new tools to help communities protect the health of their residents while advancing a more sustainable future, such as a sophisticated geographic information-based mapping tool called the EnviroAtlas (see Developing the EnviroAtlas to Support Community Decisions), and an on-line tool that helps illustrate the connections between natural ecosystems and human health. (See *The Eco-Health Relationship Browser*.)

- Combining advances in exposure science, biology, mathematical and computer modeling, and computer technology to advance the EPA's Computational Toxicology research and advance new, efficient, and fast high-throughput screening efforts. (See *EPA's Computational Toxicology Research; Chemical Evaluation Dashboards for Decision Makers, and ToxCast Partnership to Advance Chemical Testing, Reduce Animal Testing*).

- Growing EPA's widely-used Integrated Risk Information System ("IRIS") Program with a progress report to the U.S. Congress, highlighting continued improvements such as proactive stakeholder engagement and increased transparency, and the completion of several critical IRIS assessments, including dioxin (noncancer) and tetrachloroethylene (perc). (See *Growing IRIS: Advancing EPA's Integrated Risk Information System*.)

- Enhancing the nation's ability to detect, respond to, and recover from a deliberate or accidental release of chemical, biological, or radiological agents through updates and improvements to tools such as I-WASTE and the Wide Area Recovery and Resiliency Program (see *Supporting Emergency Response and Recovery*), and the Selected Analytical Methods for Environmental Remediation and Recovery. (See *Read to Respond: Improving the Nation's Emergency Preparedness*).

EPA's overall research strategy unites six complementary, highly-coordinated and Transdisciplinary research programs: **Air, Climate, and Energy; Sustainable and Healthy Communities; Safe and Sustainable Water Resources; Chemical Safety for Sustainability; Human Health Risk Assessment; and Homeland Security Research**.

This report highlights some of the many accomplishments EPA researchers and their partners have achieved working together across these programs throughout 2012. This report is dedicated to their service and exemplifies the innovative work they do everyday to support the American people and advance a healthy and sustainable future for the nation.

Table of Contents

Air, Climate, and Energy

American communities face health and environmental challenges from air pollution and the growing effects of climate change, both of which are intricately linked to the choices we make about energy production and use.

Improving air quality, reducing greenhouse gas emissions, and developing strategies to help communities and individuals address climate change are central to EPA's mission to protect human health and the environment.

EPA's Air, Climate, and Energy research program examines the interplay among air pollution, climate change, and energy use and production to develop innovative and sustainable solutions for improving air quality and addressing global climate change. EPA research efforts in that regard support policies with far-reaching health benefits across the nation.

This section highlights a few of the research results EPA researchers and their partners have achieved in 2012 in the areas of air, climate, and energy.

Learn More!

For more information and to learn more about the scope and impact of EPA Air, Climate, and Energy research, please visit: www.epa.gov/research/airscience/.

EPA research provides new insights into how pollution affects cardiovascular health.

Protecting Cardiovascular Health from Air Pollution

EPA scientists and grantees are making important new discoveries about the links between air pollution and cardiovascular health, part of the Agency's commitment to protecting human health. The research is giving medical experts new insights into how pollution affects the human cardiovascular system, including the finding that a combination of pollutants can cause much greater health problems that just a single agent alone.

In 2012, EPA and EPA-funded studies revealed important insights into the link between particulate matter air pollution and cardiovascular health, including the following.

- A team of EPA-supported epidemiologists from Harvard and Brown Universities examined the medical records of 1,700 stroke patients in the Boston area over a 10-year period, and compared them to hourly measurements of fine particle air pollution. They found a link between the pollution and an increased risk of ischemic strokes (the kind that occur when blood vessels to the brain are blocked).

- EPA scientists collaborated with researchers from Duke University to find that people exposed to a combination of particulate matter and nitrogen dioxide may suffer worse health effects than just particulate matter alone.

- In a study by EPA scientists, researchers found the potential for omega-3 fatty acids to protect the cardiovascular system from the harmful effects of fine particulate matter.

EPA scientists also advanced the understanding of the link between cardiovascular health and another air pollutant: ground level ozone. The scientists discovered links between ozone exposure and key indicators of cardiovascular health, including changes in heart rhythm, increased levels of an inflammation marker, and decreases in compounds that help dissolve artery-clogging blood clots. While previous studies had shown statistical associations between ozone exposure and such health problems, the EPA research identified a biologically-based explanation for these effects.

EPA modified this electric-powered car with state-of-the-art technology to measure levels of different air pollutants along major roadways and other pollution source locations.

New Technology to Improve Local Air Quality Monitoring, Reduce Costs

In 2012, EPA scientists and engineers continued to advance the use and development of innovative technologies for researching, monitoring, and managing air pollution. The research is providing new, low-cost capabilities to measure emissions near industry, roadways and other areas where air pollution may be a concern but has traditionally been difficult to study.
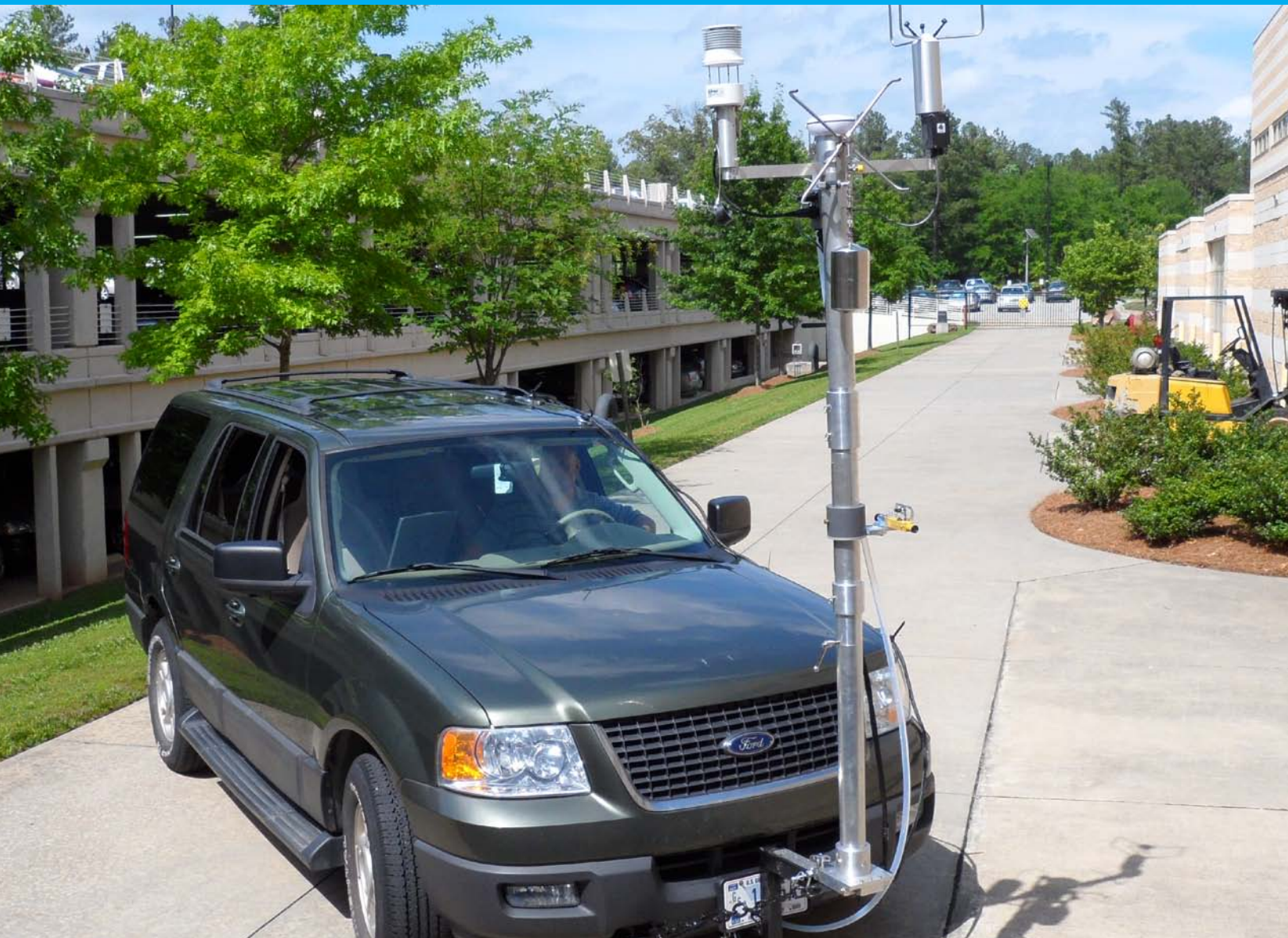
For example, in Wyoming, EPA researchers mounted air sensors on a vehicle to create a mobile monitoring platform for use along oil and gas pipelines. The device relays real-time data to occupants in the vehicle that they can use to identify spikes in emissions that could identify leaks.

In a similar project, EPA researchers used an electric-powered, modified vehicle or "air sniffing car" equipped with air monitoring technology to quantify emissions profiles along major roadways and study the potential health impact that traffic poses to those living, working, or going to school near major highways.

In addition to mobile air monitors, EPA researchers introduced novel monitoring approaches utilizing advanced stationary sensor technology. For example, a new approach was developed for monitoring air quality at petroleum refineries to more rapidly detect and identify leaks so that small problems can be found and fixed. Referred to as fence line monitoring, the system uses a series of sensors mounted along a facility's perimeter to capture emissions from all processes occurring within the facility rather than deploying more expensive monitoring devices targeted at individual processes within the facility.

The innovative, low-cost fenceline sampling approach has support from EPA's Office of Air and Radiation and partners in the industrial sector because it offers a highly cost effective

This mobile air monitoring device relays real-time data to occupants in the vehicle they can use to identify spikes in emissions that could indicate leaks along oil and gas pipelines.

approach to support a new refinery sector proposal under the Clean Air Act. The sensors are expected to result in significant savings at refineries and provide a more flexible compliance framework. The Agency estimates that industry will realize savings of some $500 million over 10 years in reduced compliance costs.

The new technologies EPA is advancing show the promise of establishing low cost, round-the-clock monitoring capabilities that would serve as both an early warning system for industry to stop potentially costly leaks and better protect neighboring communities from air pollution.

Improvements in stationary air sensor technology allow remote sensors to scan for "chemical footprints" of emission characteristics.

Sparking Innovation for Clean Air

My Air My Health

U.S. Department of Health and Human Services
U.S. Environmental Protection Agency

The My Air My Health competition challenged Americans to develop personal, portable sensors that measure air pollution and a person's physiological response to pollution.

In addition to advancing its own innovative use of air monitoring technologies, EPA is mining the collective efforts of inventors, software and application ("app") developers, independent engineers, and other innovators to spark the development of the next generation of air pollution monitoring devices and technologies.

The goal is to inspire the development of revolutionary, low-cost, accurate, and easy-to-use air monitors that will provide individual citizens and health protection professionals alike better pictures of local air quality, and support actions and decisions to protect public health.

In June, 2012, EPA and the Department of Health and Human Services (HHS) launched the "**My Air, My Health Challenge**," a call to innovators to create personal, portable, near-real-time, location-specific systems to simultaneously monitor and report air pollutants and potentially related health parameters such as heart rate and breathing.

On November 15, 2012 four finalists were selected from 39 proposals. The four projects and their teams were:

- Ultra-fine particle sensing devices that also measure respiratory function and vital signs.
- Mobile application and website to link exposures to carbon monoxide and fine particulate matter with heart rates and blood oxygen levels.
- "Smart" athletic clothing that measures airborne pollutants and relevant health metrics.
- Integrated modular air quality sensors, breathing games, and a software package that promote public sharing of health information.

Each received $15,000 to move their ideas from the design phase to working prototype, one of which will be selected as the overall winner and receive a cash award of $100,000 in June 2013.

Agency researchers are also providing technical support and evaluation to nine teams from across the United States and Europe who have developed portable sensors for continuous or near-continuous nitrogen dioxide and ozone monitoring.

This collaboration stemmed from the 2012 *Apps and Sensors for Air Pollution Monitoring Workshop*, which brought outside developers together with EPA researchers. The EPA evaluation team will issue a final report in summer 2013.

Leading the Way to Cleaner Cookstoves

EPA research on indoor cookstoves could benefit millions.

For roughly half the world's population, the source for both cooking and keeping warm is a simple fire pit surrounded by three large stones arranged to keep a pot, grill, or cooking surface above the flames. For the people who rely on them, these simple and inexpensive "solid fuel" cookstoves do the job.

They are also among the world's leading source of environmental death due to indoor air pollution. In its report, *Global Health Risks: Mortality and burden of disease attributable to*

selected major risks (World Health Organization, 2009, accessed December 2012 at http://bit.ly/UjXv8p) the World Health Organization estimates that indoor air pollution from typical household fires for heating and cooking contributes to nearly two million premature deaths annually.

"Indoor smoke from solid fuel causes about 21% of lower respiratory infection deaths worldwide, 35% of chronic obstructive pulmonary deaths and about 3% of lung cancer deaths," the report states. And because women and children typically spend more time in countries where such cookstoves are used, they are the most affected.

EPA engineers and scientists are helping to lead an international effort to develop a inside the home new generation of clean burning cookstoves that will bring relief to those exposed to cookstove emissions in the developing world.

In 2012, EPA research engineers and their colleagues published results from the most extensive independent study done to date to analyze emissions and energy efficiency of cookstoves. The researchers tested 22 different cookstove designs, measuring emissions of air pollutants that cause harmful health effects and contribute to climate change, including carbon monoxide, particulates, hydrocarbons, carbon dioxide, methane, and black carbon.

Results of the worldwide study revealed considerable differences in the amount of air pollutants emitted and in energy efficiency. Among the key findings, researchers found that emissions from some advanced cookstove technologies are significantly lower than the most widely used "three-stone" open fire.

A 2009 report by The World Health Organization estimates that the indoor air pollution from typical household cooking fires contributes to nearly 2 million premature deaths annually.

In addition to supporting the potential health benefits from developing new cookstove technologies, the ongoing research is providing important scientific insights into global climate change. Because traditional cookstoves account for approximately 20 percent of worldwide emissions of black carbon—a contributor to global climate change—they represent an important potential opportunity for taking action to address climate change.

A third study currently underway will provide additional information on cookstoves, including solar cookers. The work is supported by the EPA-led Partnership for Clean Indoor Air, now integrated with the Global Alliance for Clean Cookstoves, a United Nations Foundation initiative.

Biodiesel is fuel derived from plants, animals, or other living organisms.

Health Effects of Biodiesel

The potential benefits of biodiesel—fuels derived from plants, animals, or other living organisms—as a substitute for conventional fossil fuels are numerous: they can be produced domestically, are generally safe to handle, and are naturally biodegradable. The use of biodiesel fuels can both lower the nation's dependence on imported fossil fuels and convert waste streams, such as used cooking grease, into a marketable commodity sold to power vehicles or heat homes and businesses.

But while the allure of biodiesel is powerful, important questions about the long-term impacts associated with its use are largely unanswered. EPA researchers are working to solve that important knowledge gap, conducting studies to better understand the health effects of biodiesel, from producing the fuel, to burning it.

In 2012, EPA researchers continued to advance work examining how biodiesel fuels burn, working to identify the amount and types of pollutants in biodiesel exhaust, and how the pollutants in those emissions might affect human health.

Specifically, the researchers are looking to see if components of biodiesel emissions are likely to have properties that trigger adverse health effects, including changes in gene structures, lung and cardiac reactions such as altered electrocardiograms (known commonly as EKG), heart rate variability, blood pressure, and lung function in both healthy, normal individuals and those susceptible to health problems.

Another area of interest EPA researchers are advancing is the potential health effects of biodiesel blends, fuels that combine a percentage of bio-based fuels with more traditional petroleum diesel. Biodiesel fuel sources and the amounts used to create blends are a constantly moving target because innovative technologies and market forces can dramatically change the fuel type or blend. That work is developing the science needed to quickly test and evaluate the potential health and environmental impacts of emerging fuel sources.

What EPA researchers are learning will provide decision makers with critical information and guide further research in the quest to develop alternative fuel sources that do not have the unintended consequences of harmful emissions.

Research results provided key information used in the development of emission standards for industrial boilers, allowing for less costly, more efficient ways for boiler owners and operators to reach safer emissions targets.

Reducing Hazardous Air Pollutants from Industrial Boilers

New studies conducted by EPA researchers in 2012 are playing a critical role in Agency efforts to reduce hazardous air pollution while also making it easier and less costly for industries and boiler operators to comply with new National Emission Standard for Hazardous Air Pollutants (NESHAP) rules under the Clean Air Act.

Research results provided key information used in the development of emission standards for industrial boilers that EPA estimates will have a significant impact on protecting public health: preventing 6,500 premature deaths and 4,000 heart attacks a year starting in 2014. The rules are also expected to cut mercury emissions to the environment by as much as 90 percent.

The research was conducted at the 1.2 megawatt Multipollutant Control Research Facility at EPA's Research Triangle Park campus in North Carolina where engineers can burn coal, oil and gas under different operating conditions to test a variety of different pollutant control technologies. There, researchers tested air pollution control technologies for particulate matter (PM) to determine if the technologies might also be effective in reducing additional pollutants regulated under the new boiler NESHAP rules. The research produced quality data that supports the use of PM as a surrogate for regulating hazardous air pollutants.

Researchers also extensively tested another control technology called Dry Sorbent Injection (DSI) and showed its effectiveness in removing hazardous air pollutants.

EPA's Office of Air and Radiation incorporated the research findings into the development of the NESHAP rules, allowing less costly, more efficient ways for boiler owners and operators to reach safer emissions targets.

EPA engineers at the 1.2 megawatt Multipollutant Control Research Facility in North Carolina can burn coal, oil and gas under different operating conditions to test a variety of different pollutant control technologies.

EPA scientists are building and advancing computer models that calculate scenarios of the potential impacts of climate change.

Exploring Climate Change and Air Quality Scenarios

Predicting the likely impact that future climate change will have on air quality, the environment, and ecosystems is critical so that potentially damaging effects can be reduced.

EPA scientists are building and advancing computer models that calculate scenarios of the potential impacts of climate change, helping the public, policymakers, and community and business leaders incorporate sound science into their decisions.
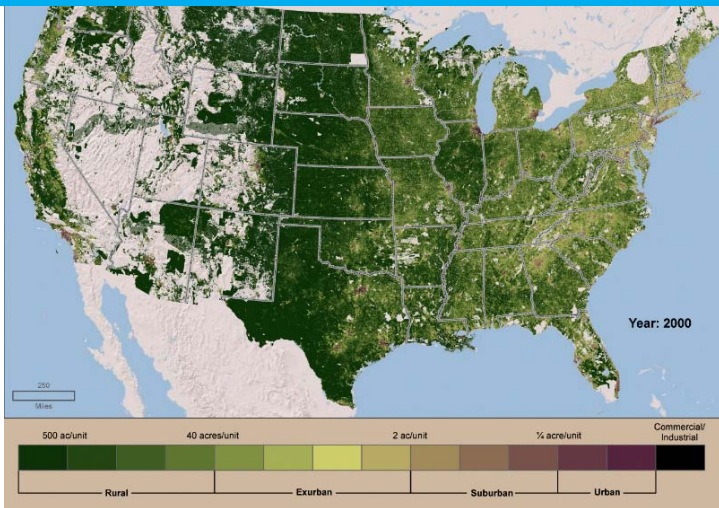
Examples of work advanced during 2012 include:

Climate change and land use: How will the complex interrelationships between land-use, such as housing density and development, and climate change drive environmental impacts in air and water quality, human health, ecosystems, and other environmental parameters? Increased knowledge of the dynamic connections between climate change and land use will help local communities better prepare and make important decisions today.

EPA's Integrated Climate and Land Use Scenarios (ICLUS) project is providing just that kind of information. ICLUS is an online tool and model that enables researchers to tap existing climate change science to run models that calculate potential environmental scenarios related to the connections between climate change and U.S. land use patterns.

In January of 2012, ICLUS researchers released data for each region in the contiguous United States to support the National Climate Assessment, a periodic report produced by the U.S. Global Change Research Program and delivered to the President and U.S. Congress.

Reducing pollution from the cement industry sector: EPA modelers are developing the Industrial Sector Integrated Solutions (ISIS) model to help industries better evaluate pollution reduction strategies. The model provides sophisticated calculations to illustrate the trade off and benefits of how various options and changes in operations will

Year: 2000

250
Miles

| 500 ac/unit | 40 acres/unit | 2 ac/unit | ¼ acre/unit | Commercial/Industrial |

Rural — Exurban — Suburban — Urban

affect multiple pollutants simultaneously, and how changes in emissions policy could affect production. The goal with ISIS is to present the optimal cost-effective controls needed to meet emissions reduction requirements.

EPA researchers completed the first ISIS model for the cement industry sector. It allowed the agency to better evaluate impacts on domestic and international competitiveness as well as plant-by-plant projections of likely control technology installations.

Exploring scenarios for complex environmental decisions: An EPA team combined components of several existing models to develop Geos-CHEM LIDORT Integrated with [MARKAL for the Purpose of Scenario Exploration](#) (GLIMPSE). This sophisticated decision-support tool examines the impacts of complex environmental decisions involving air quality, climate change, ecosystems, and energy production. For example, GLIMPSE can be used to determine the best strategy to simultaneously address black carbon emissions to reduce health effects while mitigating climate change impacts.

The model is designed to be fast and comprehensive allowing decision makers to explore a range of options to assess multiple environmental goals such as improved air quality, climate change mitigation and ecosystem conservation.

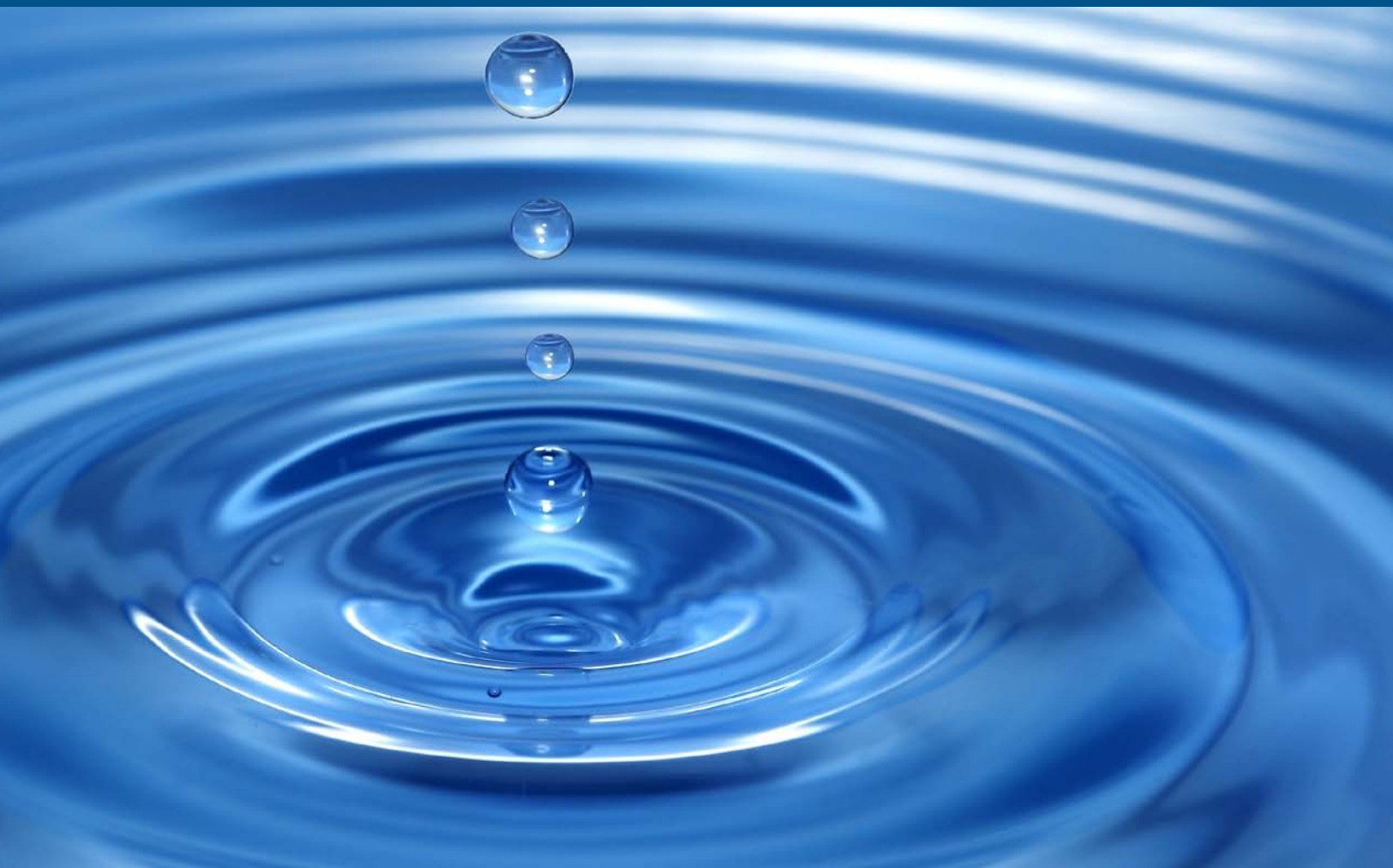# Climate Change and Human Health

In addition to advancing climate models, EPA researchers are exploring the impact that an increase in events such as heat waves, flooding, and poor air quality will have on the public, particularly vulnerable populations such as older adults.

EPA research is providing crucial information that can be used to better prepare and protect the public from a changing climate. Important published studies in 2012 include:

- EPA scientists conducted a review of the latest published research demographics, relevant climate stressors, and factors contributing to the vulnerability of older adults to those stressors. The study confirmed previous findings that older Americans are likely to be especially vulnerable to stressors associated with climate change.
- EPA scientists provided a better understanding of the potential range of estimated ozone-related human health impacts brought on by climate change. Through the use of multiple models, epidemiological studies, and population projections, the study was among the first to explicitly explore the uncertainty surrounding assessment of these impacts.

Older adults may be among the least able to cope with impacts of climate change.

Safe and Sustainable Water Resources

Across the nation, people are placing increased demands on the finite water resources that supply precious drinking water, support healthy aquatic ecosystems, and fill important societal and economic needs, including energy, agriculture, and industrial production.

EPA's Safe and Sustainable Water Resources research program provides the science and innovative technologies that the Agency—and the nation—need to maintain drinking water sources and systems, as well as to protect the chemical, physical, and biological integrity of our waters.

EPA scientists and engineers, together with their research partners, are addressing 21st century challenges to water supplies and infrastructures by integrating research across social, environmental, and economic disciplines. Together they are working to provide lasting, sustainable solutions to those challenges.

This section highlights a few of the research results EPA researchers and their partners achieved in 2012 to support safe and sustainable water resources.

Learn More!

For more information and to learn more about the scope and impact of EPA water research, please visit: www.epa.gov/research/waterscience/.

Hydraulic Fracturing Study: Progress and Outreach

[Hydraulic fracturing](#) is a technique used to release natural gas and oil from underground reservoirs. EPA is conducting a focused scientific study to determine potential impacts, if any, of hydraulic fracturing on drinking water resources. The study is looking at the full cycle of water as it is used in hydraulic fracturing.

In December, 2012, EPA released its first hydraulic fracturing progress report, *Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources*. The report describes 18 research projects undertaken as part of the study and summarizes the current status of each project. While the progress report outlines work currently underway, it does not draw conclusions about the potential impact of hydraulic fracturing on drinking water resources. A draft report, expected in late 2014, will synthesize results and address the study's research questions. The report has been designated a Highly Influential Scientific Assessment, meaning it will receive the highest level of peer review in accordance with EPA's Peer Review Handbook.

In 2012, EPA also announced an enhanced technical engagement and stakeholder outreach effort regarding the hydraulic fracturing study. EPA is taking several steps to meet its stakeholder engagement goals:

1. **Increase technical engagement with the stakeholder community to ensure that EPA has ongoing access to a broad range of expertise and data outside the Agency.** Five technical roundtables, held in November, 2012, focused on each stage of the water cycle as pertains to hydraulic fracturing. EPA will host in-depth technical workshops

A focused scientific study will determine the potential impacts, if any, of hydraulic fracturing on drinking water resources.

The five stages of the water cycle as pertains to the hydraulic fracturing process.

to address specific issues raised during these roundtables in greater detail.

2. **Obtain feedback on projects undertaken as part of the study and ensure that EPA is up-to-date on changes in industry practices and technologies.** The Agency is soliciting public involvement in identifying relevant data and scientific literature specific to inform the hydraulic fracturing study. In November, 2012, EPA published a Request for Information in the Federal Register.

3. **Improve public understanding of the goals and design of the study.** In addition to the organized technical meetings, EPA will seek opportunities (such as association or state organization meetings) to provide informal briefings and updates on the study to a diverse range of stakeholders, including states, non-governmental organizations (NGOs), academia, and industry. EPA will also increase the frequency of public webinars, hosting them after each technical meeting.

Hydraulic Fracturing Chemicals

Included in EPA's hydraulic fracturing progress report is a list of over 1000 chemicals associated with hydraulic fracturing processes. EPA researchers curated and reconciled multiple EPA, industry, and public chemical lists to produce this consolidated inventory of unique substances associated with hydraulic fracturing.

Bristol Bay, Alaska: Assessing Potential Mining Impacts on Salmon Ecosystems

Approximately 50% of the world's production of sockeye salmon comes from the Bristol Bay Watershed.

Bristol Bay watershed in southwestern Alaska supports the largest sockeye salmon fishery in the world, is home to 25 federally recognized tribal governments, and contains large mineral resources. The potential for large-scale mining activities in the watershed has raised concerns about the impact of mining on the sustainability of Bristol Bay's world-class fisheries, and the future of some of the Alaska Native tribes in the watershed who have maintained a salmon-based culture and subsistence-based lifestyle for at least 4,000 years.

This pristine and unique watershed supports all five species of Pacific salmon and half of the world's sockeye salmon population. The fishery (commercial, recreational, subsistence) is valued at more than $365 million per year, with hunting and sight-seeing bringing the total value to almost $500 million per year. The Bristol Bay watershed also holds large deposits of valuable minerals. One deposit—the Pebble Deposit—if fully developed, has the potential of becoming one of the largest mines of its type in the world.

EPA received petitions from nine federally recognized tribes and other stakeholders expressing concern that the salmon fishery would be at risk from large-scale mining and asking that EPA take action to protect salmon populations affected by the Bay's Watershed. Other tribes and stakeholders who support development in the Bristol Bay watershed requested EPA take no action until a permitting process begins.

In response to the petitions, EPA is conducting an assessment of the Bristol Bay Watershed to better understand how future large-scale mining may affect the salmon fishery. EPA will use the results of the assessment to evaluate options for assuring that the resources of Bristol Bay, are effectively protected.

EPA's draft report, *An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska*, was released in May 2012; it then underwent a 60-day public comment period and external peer review panel. The final report is expected to be completed and publicly available in 2013.

Bristol Bay is located at the northeastern end of the Alaskan peninsula.

Water pumped in and out of ship hulls to provide stability can introduce of non-native invasive species.

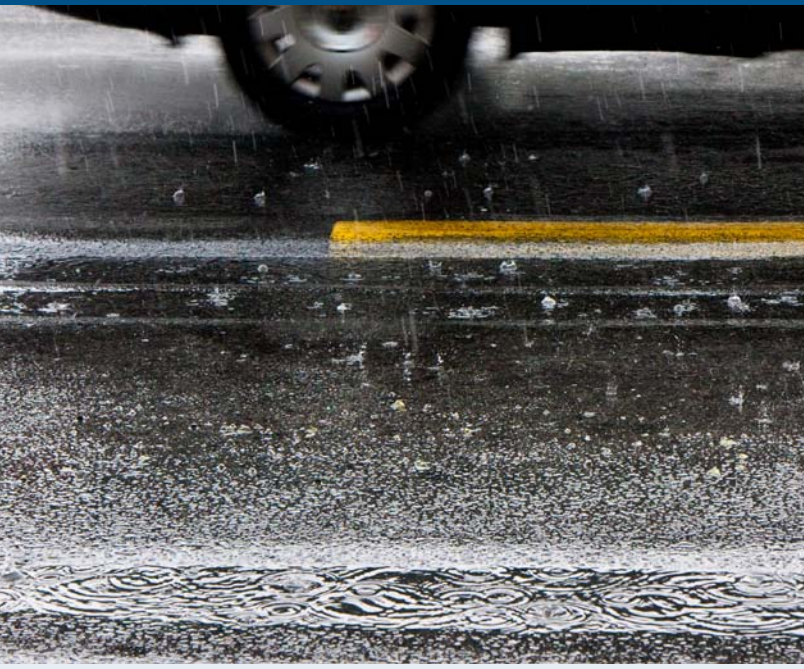# Stemming the Tide of Invasive Marine Species

In 2012, EPA scientists finalized an Atlas of non-native marine and estuarine species for the North Pacific Ocean. The Atlas provides a comprehensive reference to help biologists, marine and estuarine managers, and others identify species that were likely introduced by the release of ballast water—the water that ships pump in and out of their hulls to maintain stability. The Atlas provides key information for assessing which areas are prone to risk from invasive marine species, and identifies traits that make certain groups of species potentially disruptive when released outside their natural range.

In addition to the Atlas, EPA researchers partnered with colleagues from the U.S. Coast Guard to develop new performance verification protocols to ensure that disinfection technologies and devices used by ships for destroying organisms in ballast water are effective. The test protocols were subsequently validated by independent tests conducted by engineers and scientists at the Naval Research Laboratory (NRL) in Key West, Florida.

This research is expected to help stem the tide of economic and environmental impacts caused by the release of invasive species in ballast water.

The zebra mussel (Dreissena polymorpha) is native to Eastern Europe, but was discovered in the Great Lakes nearly 25 years ago.

Rainwater runs off of roads into the sewer system.
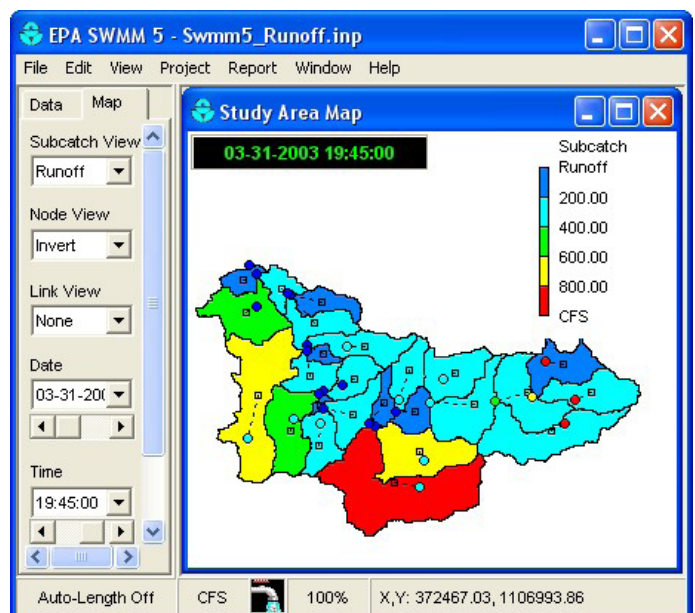
A Tool for Urban Storm Water Management

Stormwater overflow presents a big problem in many urban areas. Heavy rains send torrents of water running over pavement, rooftops, and all the other impervious surfaces that cover most city grounds. Not only does this excess water cause superficial flooding of roads and buildings, but it also floods city sewer systems. Combined sewer systems that collect municipal sewage and stormwater in a single pipe system can overflow during heavy rain resulting in 'combined sewer overflows' where sewage and other pollutants overflow into nearby waterways. EPA researchers are developing tools and strategies to help city planners, managers, and others address stormwater problems.

EPA's Storm Water Management Model (SWMM) is used widely for planning, analysis and design related to stormwater runoff, combined sewers, sanitary sewers, and other drainage systems in urban areas. SWMM is a rainfall-runoff simulation model that gives users important information about local water patterns. This helps inform

the design and implementation of natural and "green" (such as rain gardens and green roofs) as well as traditional "gray" (pipes) stormwater management alternatives. This publicly available model averages 2,000 downloads every month and is often used as a core modeling engine by municipalities.

EPA recently expanded SWMM (version 5) to explicitly model the performance of specific types of low impact development controls, such as porous pavement, bio-retention areas (e.g., rain gardens, and green roofs), infiltration trenches, vegetative swales, and other forms of green infrastructure (see "Tapping Green Infrastructure" on adjacent page). The updated model allows engineers and planners to accurately represent any combination of low impact controls within a study area to determine their effectiveness in managing stormwater and combined sewer overflows.

The development of predictive modeling tools like SWMM for the design of integrated green and gray infrastructure for use in urban watersheds is intended to improve resource management, criteria development, and regulatory decisions.

A screenshot from the Storm Water Management Model tool.

Rain garden pilot project with monitoring equipment at the St. Francis Court Apartments in Cincinnati.

Tapping Green Infrastructure

EPA researchers are studying green infrastructure, water management techniques that tap or mimic natural conditions to achieve efficient, sustainable stormwater management systems. Examples of green infrastructure include: rain gardens, rain barrels, green roofs, cisterns, daylighted streams, and retention ponds. The environmentally-friendly techniques of green infrastructure present sustainable options for reducing urban water problems and health risks.

The work will provide cities and local communities with tools and guidance they can use to combat water-quality issues such as flooding, combined sewer overflows, and nutrient impairment.

With research ranging from soil analysis to best placement modeling, EPA researchers are working to inform city managers and decision-makers about green infrastructure practices. Research data are also used to inform the development and evaluation of stormwater modeling tools such as the Storm Water Management Model.

- **Urban Soil Assessment:** Researchers assessed characteristics of urban soils in various locations to inform the development of an Urban Soil Assessment Protocol. By accounting for how excess stormwater will (or will not) move through surface and deeper soils, this protocol helps direct communities when and how to use green infrastructure in an economically feasible way.

- **Guiding Green Infrastructure in Omaha:** In collaboration with the City of Omaha and the Nebraska Department of Environmental Quality, EPA scientists analyzed soils and prepared monitoring equipment for the introduction of green infrastructure to selected sites througout the city. EPA is

Soil core samples were taken at various urban soil testing sites.

Researchers dig up and examine a soil core for analysis at a potential green infrastructure site in Omaha.

Researchers sample an open-air stream (top) and a buried stream pipe (bottom).

providing guidance on how the city and state can incorporate green infrastructure into their combined sewer overflow control plan. EPA will also work with the local U.S. Geological Survey (USGS) to establish monitoring sites around the green infrastructure installations to determine how well they perform with respect to water capture and infiltration.

- **Daylighting Streams to Improve Water Quality:** Researchers recently compared the effectiveness of buried streams (streams routed into underground pipes) versus open-air streams for removing harmful nitrogen from water systems. Early research results suggest that buried streams are less effective at removing nitrogen than daylighted streams— streams above ground and open to the air. These findings suggest that daylighting streams could prove a sustainable method for nitrogen removal and improved water quality. The outcomes of this study and further research will be used to inform a new modeling tool for urban managers. This tool will help identify places within a city where daylighting streams would be most effective.

- **Monitoring Green Infrastructure:** Green infrastructure pilot projects are underway in Cincinnati, Ohio, and EPA scientists are monitoring the hydrology (water flow patterns) and water quality at select rain garden and permeable pavement sites. The Metropolitan Sewer District of Louisville, Kentucky is working with EPA scientists to develop a monitoring plan to demonstrate the performance of individual green infrastructure controls and the aggregated effectiveness of these measures on combined sewer flow. Additionally, EPA is monitoring the long-term performance of green infrastructure best management practices at the EPA facility in Edison, New Jersey.

- **Cleveland's Vacant Lots:** Based on technical guidance from EPA experts, Cleveland, Ohio has incorporated a green infrastructure pilot program into its combined sewer overflow consent decree. This program takes advantage of the city's vacant land, turning that land into green spaces that not only absorb excess stormwater, but also improve the social and economic fabric of neighborhoods historically lacking green space.

This autonomous underwater vehicle can safely and efficiently collect water quality data.

Gliding Beneath the Surface

Low levels of dissolved oxygen (DO) in ocean environments have the potential to harm sea life and degrade the health of aquatic ecosystems. New Jersey's coastal waters have long suffered from low oxygen conditions, putting the state in violation of water quality standards.

In order to improve understanding of the highly variable ocean processes that influence oxygen levels in New Jersey's coastal zone, a collaborative team of researchers from New Jersey's Department of Environmental Protection and Rutgers University developed a robotic vehicle to investigate beneath the ocean surface. Supported by EPA's regional science programs, the team operated this autonomous underwater vehicle (AUV), named the "Slocum Glider" and evaluated its ability to capture data about coastal water quality efficiently.

Dissolved oxygen levels have historically been measured based on infrequent sampling, providing imprecise results. In contrast, the AUV takes rapid-fire readings of dissolved oxygen, salinity, and temperature at various depths, resulting in a much more comprehensive database for dissolved oxygen. The AUV also goes where ships and scientists cannot safely go, including sampling beneath Hurricane Irene, one of the few times an AUV captured data during such a powerful storm.

The Slocum Glider was relaunched on July 10, 2012 to collect water quality readings along more than 185 miles of the NJ coastline. This experiment monitored coastal conditions during the peak of summer, when a transitional, mixed layer of water separates warmer surface waters from colder layers below. Under certain conditions, this layering of the water column can lead to poor water quality and be harmful to humans and aquatic life.

Information gathered by the Slocum Glider is informing New Jersey's upcoming re-evaluation of impaired coastal waters. Use of this glider technology has already allowed EPA's regional office (Region 2) in New York to divest from its previous practice of monitoring dissolved oxygen by helicopter, which was a costly approach with limited results.

EPA's Virtual Beach software allows for real-time water quality monitoring at Wisconsin beaches.

Real-time Beach Monitoring

The principal cause for beach closings and advisories is water pollution caused by elevated levels of bacteria, primarily *E. coli*, which indicates human or animal waste contamination. However, by conventional methods, measurements of *E. coli* levels can take up to 24 hours. By the time results are compiled, water-quality conditions may have already changed.
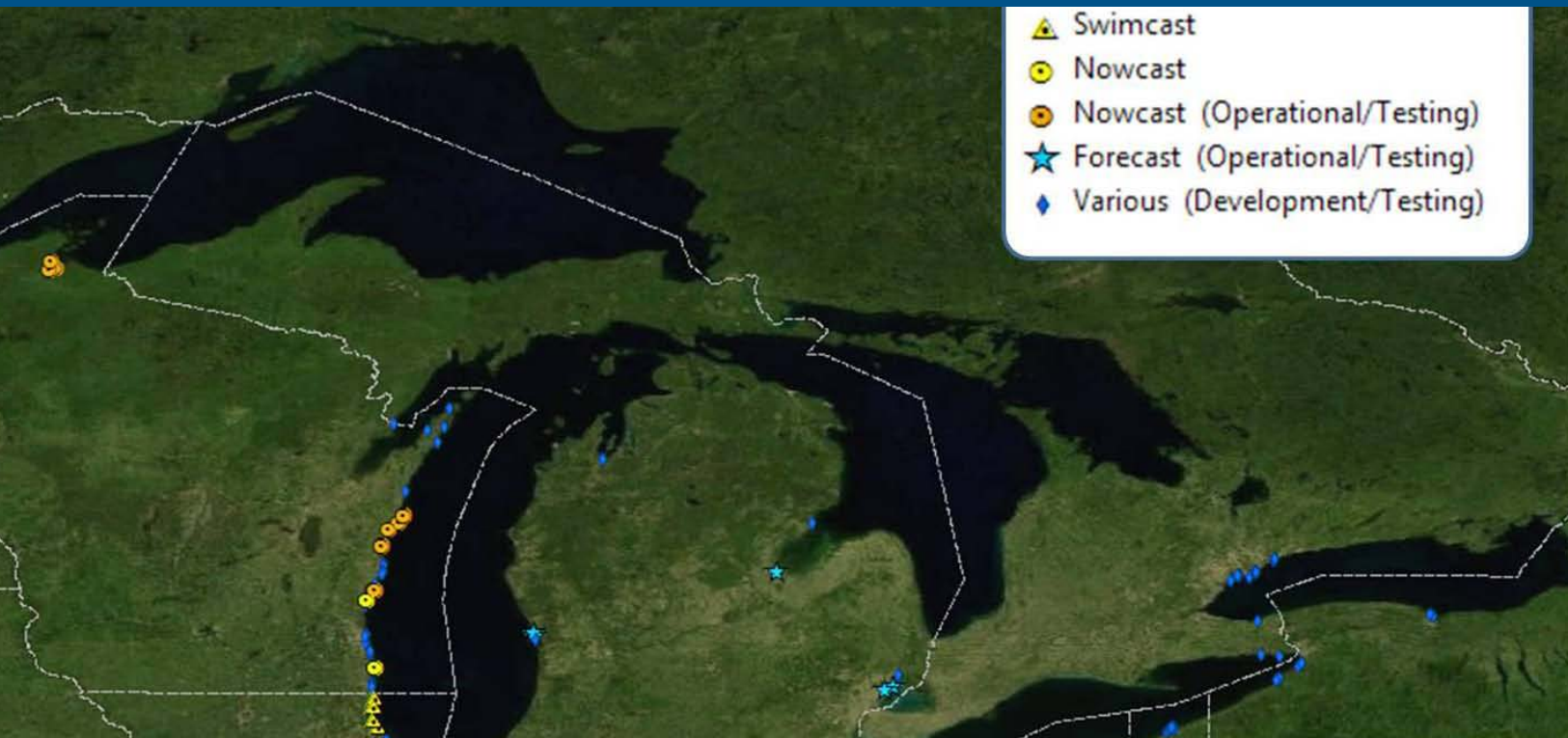

Bacteria indicative of human or animal waste is the principal cause for beach closings.

To improve beach water monitoring, EPA scientists developed Virtual Beach modeling software. This tool, updated in March 2012, is designed to predict pathogen indicator levels at recreational beaches, giving water-quality information in real-time or even before the contamination occurs.

Using the Virtual Beach software, managers can easily map their beach using an intuitive graphical interface. By looking at data on the local watershed, Virtual Beach's models can find correlations between certain weather and water conditions and bacterial outbreaks, giving beach managers advanced warning of the kinds of contamination events that lead to swim advisories and beach closures.

The Wisconsin Department of Natural Resources (WDNR) partnered with EPA and the U.S. Geological Survey (USGS) to tap EPA's Virtual Beach software for real-time water monitoring at Wisconsin beaches. The impact of that effort was the creation of the Nowcast Program,

Arial map of the Great Lakes showing beaches currently under Nowcast or other water quality monitoring programs.

which works with local public health departments along Wisconsin's Great Lakes coast to improve the timeliness, accuracy, and cost-effectiveness of water-quality monitoring at high-priority recreational beaches. The program creates and implements early-warning models that can predict the level of *E. coli* bacteria and the probability of exceeding water-quality guidelines in real-time.

In 2011, two beaches piloting Nowcast models reduced the number of missed advisories by 20 percent and reduced the number of incorrectly-posted advisories by 50 percent. As of June 2012, Nowcasts were being used to make management decisions at seven high-priority beaches on Lake Michigan. Models have been developed for an additional 21 beaches on Lake Michigan and Lake Superior by Wisconsin and the U.S. Geological Survey.

Legacy sediment layers are visible in this Big Spring Run stream bank (Photo credit: Dr. Dorothy Merritts)

Sediment Removal to Improve Water Quality

Excess sediments and nutrients, especially nitrogen and phosphorous, are a leading cause of water quality impairment in streams and wetlands throughout the nation, particularly in the mid-Atlantic region. Legacy sediments are the deposits of sediment and nutrients that built up as a result of historic mill dam construction. EPA scientists are researching the removal of legacy sediments as a cost-effective and sustainable means of reducing sediment and nutrient pollution in watersheds.

Historic damming of streams and rivers led to a huge backup of sediment and the destruction of natural water and soil systems. Most of the dams are now abandoned, but as the natural water systems return, they threaten to release massive amounts of sediment and nutrients to downstream waters. EPA, in collaboration with federal, state, and academic partners, focused
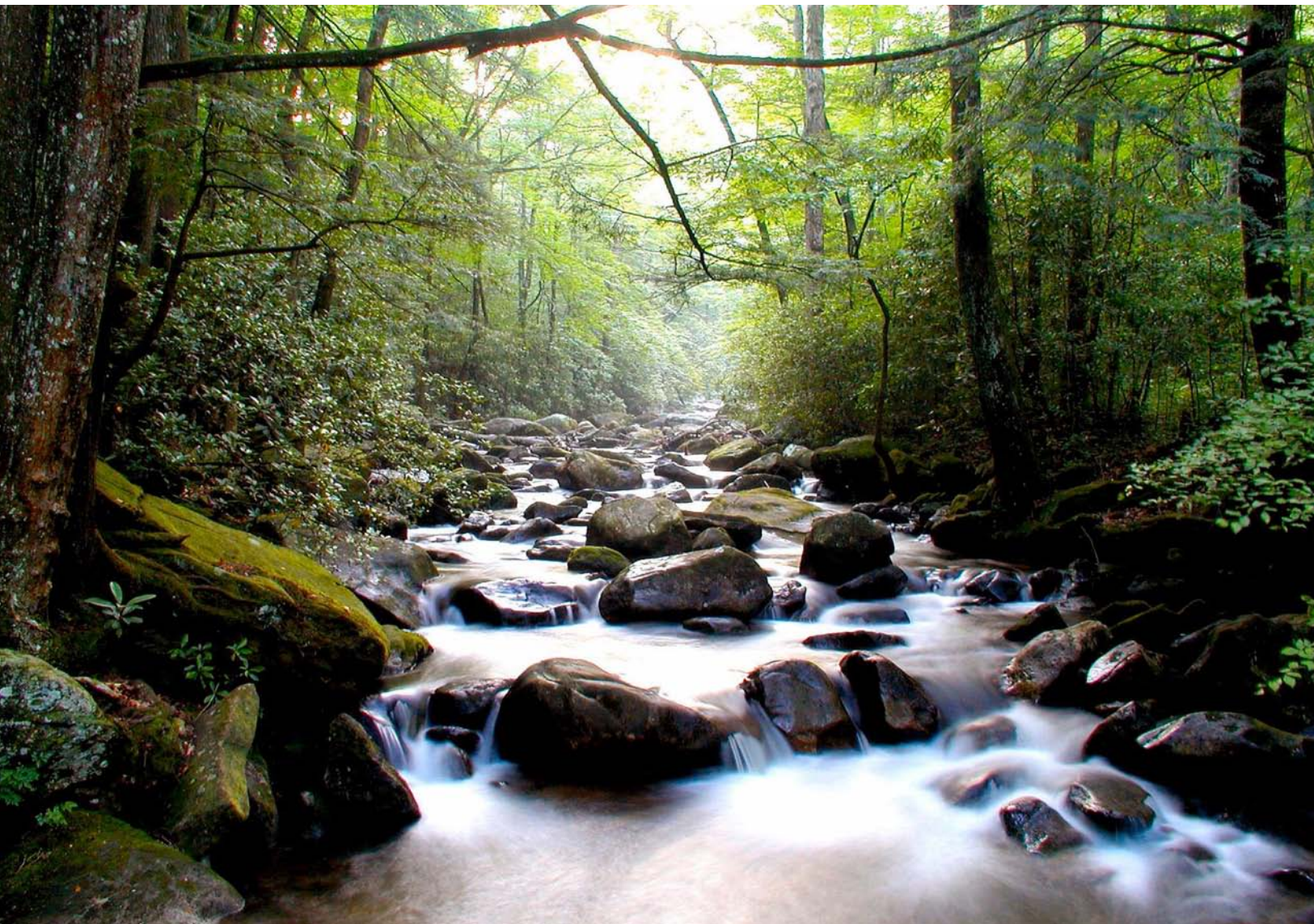
research efforts on Big Spring Run (BSR), a rural stream in Lancaster County, Pennsylvania that is impacted by legacy sediments.

Beginning in 2009, legacy sediments were removed from Big Spring Run and buried wetlands were exposed and reconnected to the floodplain water system. Water quality and geologic assessments of the area showed that stream bank erosion was more extreme than expected and nutrient levels were high in ground and surface waters. Restoration is expected to greatly reduce sediment transport and nutrient contamination, especially because healthy wetlands will naturally filter and convert harmful excess nutrients out of the water system.

Restoration of Big Spring Run was completed in September 2012. Researchers found that since September, the plant community composition at BSR has changed significantly, showing signs of healthy wetlands. These early results point to a promising method for protecting downstream waters from further sediment and nutrient pollution by the removal of legacy sediments and the associated wetland restoration.

One of two waste water treatment facilities at Ft. Riley, KS.

Partnering to Achieve "Net Zero"

EPA supports a United States Army sustainability initiative—called Net Zero—to reduce energy, water and waste from Army facilities. This cross-agency collaboration is a test case for new technologies to improve efficiency and to minimize waste of resources. Technologies that prove successful through this partnership will serve as examples of tools that can benefit other communities across the United States and world-wide.

The Net Zero-EPA collaboration began for EPA with the signing of a Memorandum of Understanding (MOU) between EPA and the Army. Two Army bases chosen to pilot this research collaboration are Fort Riley, Kansas and Joint Base Lewis-McChord (JBLM), Washington. The initial focus is on water issues such as stormwater management, water reuse, monitoring aging water infrastructure for leaks,

and ways to improve efficiency.

In July, 2012, EPA scientists met with Army staff at Fort Riley to discuss water infrastructure challenges and specific technology needs of the base. The site visit allowed an integrated project team to prioritize needs and identify potential

EPA collaboration with the United States Army will reduce waste and increase efficiency of Army facilities.

projects. Project plans were drafted in the fall and finalized in December, 2012.

Projects that were drafted include:

1. Perform assessment and introduce rehabilitation technologies that address the maintenance and upgrading of aging water infrastructure in a cost-effective manner
2. Implement small-scale water reuse systems to significantly reduce the need for potable water use
3. Facilitate a study to investigate education/ outreach approaches focused on behavior and culture changes needed to reduce water consumption

Similar project planning is underway for Joint Base Lewis-McChord, exploring stormwater management that incorporates green infrastructure approaches into current stormwater systems and decontamination techniques to improve understanding of handling and treatment of waste water.

An additional MOU, signed with the U.S. Department of Defense in February, 2012, complements the Army MOU, and expands EPA's opportunities to promote and transfer technology successes broadly to other communities and additional military installations.

Planned projects include introducing small-scale water reuse systems to conserve potable water.

Learn More about EPA Safe and Sustainable Water Research

- Visit: www.epa.gov/research/waterscience/.
- See the 2012 Water Research issue of EPA's *Science Matters* newsletter: http://1.usa.gov/WgsrVb
- Download a copy of *EPA's Safe and Sustainable Water Resources Strategic Research Action Plan*, 2012-2016: www.epa.gov/research/docs/sswr-strap.pdf.

The single largest Chesapeake Bay pollutant is excess nutrients, which come from wastewater treatment plants and stormwater runoff, among other sources.

Community-Based Chesapeake Bay Stormwater Management

Presidential Executive Order 13508 directs the federal government to lead efforts to restore and protect Chesapeake Bay, a body of water plagued by pollutants and poor water quality. The largest group of Bay pollutants is excess nutrients, which come from wastewater treatment plants and runoff from cropland, urban and suburban areas, and other sources. To address the problem of nutrient pollution from urban stormwater runoff in the Bay area, EPA's Science to Achieve Results (STAR) grant program sought applications for applied research aimed at identifying pathways for effective and durable community-based stormwater management.

In September, 2012, STAR announced a $700,000 award to the University of Maryland to work with local communities to improve urban stormwater management in the Chesapeake Bay area.

The awarded project, *Sustainable Community Oriented Stormwater Management: A Sensible Strategy for the Chesapeake Bay*, will use innovative community involvement methods. Maryland researchers will use information from community member submissions and interviews to create a model of troublesome stormwater areas within the community. Using this model, scientists and the community will collaborate to develop improved and sustainable stormwater management practices to reduce stormwater pollution from hot spots, maintain long-term water quality in Chesapeake Bay, and protect the health of the community.

In 2011, EPA awarded almost $2.5 million dollars to Penn State University to open an interdisciplinary research center that is studying green infrastructure to improve water quality in Chesapeake Bay. The team that runs this center works to combine decision making and green infrastructure issues to improve stormwater management. The Penn State and Maryland teams plan to work together and share information as they both strive to improve Chesapeake Bay.

Sustainable and Healthy Communities

EPA's Sustainable and Healthy Communities research program works to help communities meet their current needs in ways that protect the environment and enhance human health over the long term, so that future generations can meet their needs, too.

Working closely with community stakeholders and other decision makers to identify the information, science, and technologies they require, EPA scientists use a holistic approach to advance research that reflects the three pillars of sustainability: economy, society, and the environment. The work provides decision-support tools and information that communities need to develop proactive, strategic solutions for a prosperous and environmentally sustainable future.

This section highlights a few of the research results EPA researchers and their partners have achieved in 2012 to support sustainable and healthy communities.

Learn More!

For more information about the scope and impact of EPA research to support sustainable and healthy communities, please visit:
- EPA Sustainability: www.epa.gov/sustainability/
- EPA Ecosystems Research: www.epa.gov/research/ecoscience/
- Download a copy of *Sustainable and Healthy Communities Strategic Research Action Plan, 2012-2016*: www.epa.gov/research/docs/shc-strap.pdf.

Satellite imaging shows a smoke plume from the 2008 North Carolina peat fire.

Studying the Connections between Wildfire Smoke and Community Health

More than 73,000 wildfires broke out in the United States in 2011, and that figure is expected to rise with climate change. Results from a new EPA study will help state agencies and the EPA Office of Air and Radiation identify and assist vulnerable communities and individuals who are highly susceptible to air pollutants—especially those released by wildfires.

Researchers compared different health factors in counties in eastern North Carolina that were exposed to smoke from a 2008 peat wildfire in Pocosin Lakes National Wildlife Refuge. The peer-reviewed study shows that poorer residents had a much higher chance of getting sick from air pollutants caused by the wildfire.

During the fire, burning deposits of partially decayed vegetation released smoke and haze for several weeks. One particularly bad episode left dense ground-level smoke covering most of the eastern and central parts of the state for approximately three days. Researchers found that during this time, significantly more people than usual visited hospital emergency rooms for heart and lung complications linked to wildfire smoke inhalation.

Using data collected from 98 percent of all emergency departments in North Carolina, researchers examined health behaviors such as excessive alcohol consumption, access to clinical care, socio-economic status and unemployment rates, among other factors. By analyzing these factors for patients who visited hospitals following the 2008 fire, researchers found that a community's low socio-economic status was the best indicator of risk for worsening asthma and heart failure after smoke exposure.

Results from this study, titled *Cardio-respiratory Outcomes Associated with Exposure to Wildfire Smoke are Modified by Measures of Community Health*, were published in the September 2012 online edition of the scientific journal *Environmental Health*.

Protecting People from Arsenic and Lead in Soil

EPA research results in an effective way of protecting human health while guiding clean-up activities at Superfund and other contaminated sites.

A team of EPA scientists looked at the way the digestive system takes in arsenic after exposure to develop an innovative and efficient way to determine the bioavailablility of arsenic and lead in soils. They used that model to make a tool that shows how much bioavailable arsenic is in soil. The tool can detect how much arsenic is actually toxic. The result is an effective way of protecting human health while guiding cleanup activities at superfund and other contaminated sites.

Use of the tool, still in its testing stage, has led to significant cost savings at a number of regional Superfund site offices and could ultimately help EPA assess human exposure to soil contaminants in a much more cost effective way.

Toxics and human digestion may sound like a daunting pair, but EPA researchers have found a way to create a computer model of the digestive system and the way it absorbs arsenic to create a powerful science tool. This device is one of several innovative tools EPA researchers are developing to better estimate human exposure to arsenic and lead in soil.

Currently, mitigating the dangers of locations with contaminated soils means using heavy equipment to remove the entire top layer and hauling the soil to a landfill designed for hazardous material. Then the soil is treated and all the toxins are removed. This method, although effective, is expensive and inefficient because not all forms of soil contaminants are harmful to animals and humans, or "bioavailable" (can be absorbed into the bloodstream). Arsenic and lead are toxic only in this bioavailable form.

The EnviroAtlas maps ecosystem services such as air filtration provided by these urban trees.

Developing the "EnviroAtlas" to Support Community Decisions

EPA researchers are developing the EnviroAtlas, a Web-based mapping tool that will provide users with an easy-to-use, visual way to explore and better understand the benefits of natural ecosystems and how they can be conserved and enhanced for a sustainable future.

The tool provides information community decision makers need to make strategic choices about development and environmental policy, based on a more comprehensive understanding of the interactions between human activities and the many goods and amenities (often referred to as "ecosystem services") that people derive from nature.

The EnviroAtlas is a Web-based mapping application that allows users to view and analyze multiple ecosystem services in a specific region such as drinking water supplies or recreational and cultural amenities. Decision-makers can use the Atlas to forecast what will happen to these natural resources under future population growth and climate change.

EPA researchers are working with partner agencies to develop this online, interactive decision-support tool. The EnviroAtlas collaborators currently include the Natural Resources Conservation Service and U.S. Forest Service (both part of the U. S. Department of Agriculture), the U.S. Geological Survey (Department of the Interior), the National Geographic Society, the nonprofit organization NatureServe, and the City College of New York. Other organizations working with EPA researchers to take advantage of the information provided in the EnviroAtlas include:

- The Strategic Highway Research Program 2 of the National Academy of Sciences which is exploring the use of the Atlas for sustainable highway planning.

- [LandScope America](#), an online resource for the land-protection community, now includes multiple data layers from the EnviroAtlas.

Also, the EnviroAtlas will most likely be a major resource for the forthcoming EcoINFORMA, an online digital information system on ecosystem services and biodiversity currently in development. The development of EcoINFORMA was recommended in a report by the President's Council of Advisors on Science and Technology.

The EnviroAtlas will also feature detailed data on 50 to 250 cities and towns across the country. The community component of EnviroAtlas, will provide fine-scale information linking human health and well-being to environmental conditions such as urban heat islands, near-road pollution, and other quality of life indicators.

Ongoing development of the EnviroAtlas in 2012 focused heavily on this community component. The EnviroAtlas development team worked with all 10 EPA regional offices to identify communities for the next phase of high-resolution analyses, and current plans include six tribal communities. The first community pilot project is for Durham, North Carolina (see "The Durham Pilot" on this page).

In 2012, the EnviroAtlas became available to EPA's partners (other federal agencies and several universities). Public access to the tool is planned for 2013.

In September, EPA scientists ran a field monitoring project with Durham high school students in environmental science advanced placement classes. The goal was to engage students in participatory research and improve understanding about the extent to which tree cover reduces the urban heat island effect. Pictured here, students learned to use temperature sensors at EPA's research campus in Research Triangle Park, NC.

The Durham Pilot

In 2012, EPA completed the EnviroAtlas community component for the city of Durham, North Carolina. Working with the Durham community, researchers created map layers for supply and demand of ecosystem services, and societal implications for the city's natural resources.

Local partners in Durham will use EPA research products like the EnviroAtlas to diagnose environmental problems, analyze alternatives, and track the performance of implemented management approaches. Tools and approaches developed in Durham will be transferable to other communities around the country.

This aerial map of downtown Portland, ME, from the EnviroAtlas, is classified into open spaces (greens), impervious surfaces (pinks), and water (blue).

Shade trees in urban areas contribute to multiple ecosystem services such as heat mitigation and air filtration while also encouraging engagement with nature and other benefits as suggested by the Eco-Health Relationship Browser.

The Eco-Health Relationship Browser

Ecosystem services are the goods and services people derive from the natural environment, such as clean water, fertile soil for crop production, pollination, and flood control and water filtration from wetlands. While many of these services and their benefits are easily recognizable, many, such as air filtration, are not, and as a result are easy to under value.

To help communities and others better account for and protect the benefits they derive from the environment, in 2012 EPA researchers developed an Eco-Health Relationship Browser. The browser is designed to increase our understanding of the nation's ecosystems, the services they provide, and how those services benefit public health and well being.

The publicly-available, Web-based browser uses a series of interactive "info-bubbles" to help users easily identify linkages between human health and ecosystem services. For example, forests are ecosystems that contribute to cleaner air

through natural air filtration, and air pollution has been shown to be connected to the incidence of migraine headaches. Through this association, changes in forest ecosystems could be linked to frequency of migraines.

The info-bubbles also contain sidebar descriptions that briefly explain the selected topic and pop-up boxes that illuminate associated ecosystem service linkages, complete with citations of relevant scientific studies about the connections. A complete bibliography is also available from the browser webpage.

The Eco-Health Relationship Browser is one new tool in the Agency's efforts to better understand and quantify connections between ecosystems, ecosystem services, and human health. This information is critical for decision makers as they work to preserve and protect valuable and interconnected assets and strive to ensure sustainable and healthy communities.

A two-year EPA study investigated toxic vapors and radon concentrations in indoor air and underground soils near residences.

EPA Science Supports Vapor Intrusion Guidance

Most threats to people in buildings, such as fire, flood, hazardous spills, or structural damage, are dramatic and easy to identify. But while it may not be something worthy of coverage on the evening news, *vapor intrusion*—the contamination of indoor air by harmful gases, both naturally occurring (such as radon) or or resulting from chemical spills), that migrate upward from the ground or ground water—also poses serious health risks.

EPA scientists have provided measurements and analysis methods for a new guidance document to better evaluate the problems associated with toxic chemicals that seep into people's homes through vapor intrusion.

During a two-year study, EPA scientists investigated spatial and seasonal changes in the concentrations of vapors, including volatile organic compounds (VOS) and radon in indoor air.

The outcomes were published in October 2012 in a report titled, *Fluctuation of Indoor Radon and VOC Concentrations Due to Seasonal Variations*.

Results from the study, along with several other documents and tools were compiled as part of the Agency's Final Subsurface Vapor Intrusion Guidance, made publicly available on November 30, 2012.

This guidance document provides reliable ways to measure vapor intrusion and answers questions first posed in the 2002 EPA document on the same topic. The results of the research and guidance provide environmental managers and others from EPA Regional Offices and states with easy-to-understand ways to evaluate sites for VOC vapor intrusion.

Additional ongoing EPA research on vapor intrusion includes developing approaches for measuring vapor impacts, evaluating sampling tools to assess impacts at petroleum sites, and modeling studies to better understand the screening of certain vapor intrusion chemicals. The suite of research supports efforts to develop assessment approaches for contaminated sites and buildings, and to inform multiple regulatory efforts related to vapor intrusion issues.

Two 55 gallon drums (in series) for sand filtration are always in service while the third is undergoing backwash. Daniel Concepcion, a University of Puerto Rico student, completed his Masters Degree based on these drum sand filter studies.

Water Systems in Puerto Rico

EPA researchers are customizing innovative water treatment systems to help better protect people living in small communities in Puerto Rico that currently rely on untreated sources of drinking water, making them susceptible to periodic outbreaks of waterborne diseases.

To offer sustainable solutions to the water quality challenge, EPA scientists aimed to design treatment systems that could serve local populations. For example, they sought systems that would be inexpensive, fabricated from local parts and supplies, and easy to build, operate, and maintain—such as systems that could be operated via gravity or solar power.

The researchers delivered. The result of their work was the creation of two "slow" sand filtration systems constructed in a remote location in Rio Piedras. The systems not only provide a locally sustainable, clean drinking water supply, they also serve as demonstration and training centers for surrounding communities and water system operators.

Researchers plan to further customize their designs to address filtration needs of specific contaminants in certain rural communities, such as naturally occurring arsenic. The long-term objective is to create versatile systems that can be used by small communities anywhere in need of reliable, low-cost, and low-maintenance water purification systems.

Currently, the researchers have focused on nearly 250 local Puerto Rico water systems that are not under the regulation of the Puerto Rico Aqueduct and Sewer Authority (PRASA). A third of these non-PRASA systems either offer no treatment or have treatment systems that are out of order or not in use. Economical and technical challenges, including a lack of electricity, make it impossible to integrate traditional treatment systems into these communities; this makes the impact of EPA's research results critically important.

Sustainability Science: Understanding Ecosystem Services in Wetlands

The multitudes of benefits people derive from the environment are so abundant and free flowing that they are easy to overlook. Because these benefits are difficult to quantify, they are often left out or undervalued in risk assessments and other analyses that decision makers use to set environmental policies and protect human health.

EPA scientists have embarked on a research effort to help change this oversight. Research

in Tampa Bay, Florida is advancing the science of sustainability by focusing on aspects of the natural environment that form the foundation of ecology, economy, and overall well-being. These beneficial aspects of nature are what scientists refer to as "ecosystem services," and include such things as flood control, fertile soils, biological diversity, and the natural cycles that cleanse air and water.

In 2012, EPA scientists completed a two-year

The results of two-year study on wetlands and marshes near Tampa Bay, FL will become part of a dynamic model to understand how human disturbance affects the ecosystem services of wetlands.

study in nine mangrove wetlands and 18 freshwater riparian and marsh sites with varying levels of human disturbance in the Tampa Bay drainage basin. Analysis of the study results will become part of a dynamic model that allows users to understand how human disturbance affects the ecosystem services of wetlands, particularly regarding the removal of nutrient pollution and improved water quality. This project is part of an effort to illustrate the trade-offs in ecosystem services associated with alternative management decision scenarios. Research results are available through a new, user-friendly website for Tampa Bay.

Additionally, scientists are partnering with local governments, other research entities, planning organizations, and citizen and business groups to identify and assess the values a productive ecosystem provides to the community. All these experts will help paint a more complete picture of Tampa Bay that decision makers can use when establishing development and environmental plans.

A U.S. Human Well-being Index

A defining component of sustainability, as highlighted in the National Environmental Policy Act of 1969, is "to create and maintain conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic, and other requirements of present and future generations."

EPA's Human Well-being Index (HWBI), released as a draft in 2012, is being designed to help communities live more sustainably. When final, the HWBI will provide a Web-based predictive model to help communities better quantify the flow of ecosystem services, and make decisions that prioritize human well-being.

EPA's lakes web tool helps users understand the linkages between changing nutrient cycles and the delivery of important ecosystem services to residents and visitors of the Northeast.

Nutrient Tool for Lakes

EPA researchers in Narragansett, Rhode Island, recently updated an important online resource that contains information on more than 28,000 lakes in the northeastern United States. Scientists developed this Web tool to guide management decisions, particularly those that affect the flow of nutrients into the nation's lakes.

Lakes provide valuable benefits—called ecosystem services—to residents and visitors and are increasingly important for maintaining recreational opportunities and amenities. However, northeastern population growth threatens regional lakes by, for instance, increasing levels of nutrients entering lake waters.

EPA's updated Web tool helps users understand the linkages between changing nutrient cycles and the delivery of important ecosystem services to residents and visitors of the northeast.

The online lakes tool includes a Lakes Ecosystem Services Database, which combines information from a variety of sources such as EPA's National Lakes Assessment and the U.S. Geological Survey's SPARROW Model for water quality, among other datasets. The tool also includes a Geographic Information System (GIS) that provides geospatial visualization, search, and analysis options.

Users can go online and query, sort, and download data on lake location, depth, volume, land cover, and surrounding human population. They can also study the flow of nitrogen and phosphorus into certain lakes, as well as explore associations between those nutrients and the benefits that people obtain from lakes. The tool is intended to aid lake managers in the northeast and nationwide to foster a better understanding of the links between management decisions, nutrients, and lake ecosystem services.

Supporting Sustainable and Healthy Tribal and Native Alaskan Communities

The Tribal-Focused Environmental Risk and Sustainability Tool is designed to provide tribes with the best available human health and ecological scientific information.

The 565 federally recognized Tribal nations across the United States manage more than 95 million acres of land. EPA's American Indian Environmental Office works with those Tribes to protect human health and the environment by supporting and implementing federal environmental and related human health protection laws (as consistent with the Tribes' sovereign rights, federal responsibilities, and EPA's official Indian Policy).

That effort is supported by research exploring ways to advance sustainable and healthy Tribal communities. EPA scientists and the National EPA-Tribal Science Council work collaboratively to better understand environmental and human health issues important to Native American and Eskimo communities. (The EPA-Tribal Science Council is composed of a tribal representative from each of the nine Agency regions across the country.)

In 2012, EPA scientists and their partners from tribes across the country continued to develop and pilot a Web-based environmental decision-support tool called the **Tribal-Focused Environmental Risk and Sustainability Tool** (Tribal-FERST). The tool is designed to provide tribes with the best available human health and ecological scientific information.

Using stakeholder feedback from the National Tribal Caucus, numerous tribes, the consortium of United South and Eastern Tribes (USET), Tribal Colleges and Universities, and other stakeholders, EPA researchers incorporated a host of new enhancements into the beta version of Tribal-

FERST. These included additional tribal information resources, enhanced maps in a Geographic Information System database with the ability to overlay local data.

EPA researchers also collaborated with the Pleasant Point Passamaquoddy Tribe of eastern Maine to pilot Tribal-FERST and address priority issues facing the tribe, such as the need to consider adaptive coastal management strategies in the face of potential sea level rise. The tribe also piloted Tribal-FERST as a decision support tool for comparing different waste management options and outcomes, including the production of power, revenue, and jobs under various scenarios.

Also in 2012, the EPA Tribal-FERST team joined with the USET consortium to develop a tribal environmental assessment roadmap and link Tribal-FERST with the USET Tribal Water Quality database and exchange node.

These ongoing partnerships, as well as outreach at key tribal meetings across the country, serve to enhance Tribal-FERST and continue to connect EPA science with tribal environmental needs.

EPA scientists and the National EPA-Tribal Science Council work collaboratively to better understand environmental and human health issues important to Native American and Eskimo communities.

Protecting Children's Health for a Lifetime

For more than 14 years, EPA has partnered with the National Institute of Environmental Health Sciences (NIEHS) to expand knowledge about children's environmental health through the *EPA/NIEHS Children's Environmental Health and Disease Prevention Research Program*. Together, they have invested more than $150 million to support a network of multidisciplinary Children's Environmental Health and Disease Prevention Research Centers (Children's Centers).

Through the collaborative network, scientists, statisticians, pediatricians, epidemiologists, local community representatives, and other experts engage in cross-cutting research to understand and reduce children's health risks and promote health and well-being in the communities where they live, learn, and play.

Children's Center researchers are investigating environmental, genetic, and epigenetic changes in gene expression based on nutrition and other factors) components of disease and disease prevention, as well as how social and cultural factors may be linked to many of today's most pressing children's health challenges, including asthma, autism, attention deficit hyperactivity disorder (ADHD), neurodevelopmental deficits, childhood leukemia, diabetes, and obesity.

By design, a major emphasis of the Chidren Center's program is to effectively share research results with health care professionals, educators, community groups, and parents in accessible, practical ways that will have real-world impacts in preventing disease and improving the health and development of children.

A sample of the many recent Children's Center research findings over the past year include:

- A study by researchers at the Center for Environmental Research and Children's Health at the University of California, Berkeley found an association between levels of the chemical Bisphenol A (BPA) and lower levels of thyroid hormones in pregnant women and newborn boys. Thyroid hormone during pregnancy and the neonatal period is critical to proper development.

- Researchers from the Dartmouth Children's Center suggest that rice and food containing organic brown rice syrup can expose children to arsenic, a known carcinogen that can also adversely affect neurologic, respiratory, hematologic, cardiovascular, gastrointestinal, and other systems.

- Researchers at Columbia University's Center for Children's Environmental Health (CCCEH) found that children with exposures to phthalates (chemicals found in personal care and plastic products) have elevated risk of asthma-related airway inflammation.

- CCCEH researchers were the first to find a difference between how boys and girls respond to prenatal exposure to the insecticide chlorpyrifos. They found that boys appear to be more vulnerable and lower IQs have been seen in boys exposed in the womb to this chemical.

- A brain imaging study by CCCEH researchers found that even low to moderate levels of exposure to the insecticide chlorpyrifos during pregnancy may lead to long-term, potentially irreversible changes in the brain structure consistent with IQ deficits at age seven.

To learn more about EPA's Children's Environmental Health and Disease Prevention Research Centers, including how to sign up for monthly EPA-sponsored webinars presenting the latest research findings, please visit: www.epa.gov/ncer/childrenscenters/.

EPA is part of a collaborative network of experts who engage in cross-cutting research to understand and reduce children's health risks and promote health and well-being in the communities where they live, learn, and play.

Visitor to the Smithsonian's National Zoo learns about EPA research and the importance of biodiversity.

EPA, Smithsonian Biodiversity and Human Health Exhibit Opens

EPA science has taken its place as a featured exhibit alongside giant pandas, bald eagles, and tigers at the Smithsonian Institution's National Zoological Park in Washington, DC.

Working under a long-standing Memorandum of Understanding between EPA and the Smithsonian to support partnerships between the two organizations, zoo exhibit developers and EPA scientists joined forces to produce a new, permanent interpretive exhibit highlighting the Agency's leadership role supporting biodiversity and human health research, and the importance of healthy ecosystems for the well being of humans.

Opened in late 2012, the exhibit is housed in the zoo's *Amazonia Science Gallery*. It features a host of interpretive elements, including a computer-based "tick counting game" that invites children and other visitors to explore the forest as environmental scientists do, a suite of videos featuring EPA and partner field biologists, and a host of education materials such as posters, publications, and artifacts.

Chemical Safety for Sustainability

Chemical safety is a major priority for EPA. Achieving a safer and more sustainable future requires developing new, innovative methods to design, manufacture, use, and dispose of existing and new chemicals in cleaner, less toxic ways. With tens of thousands of chemicals currently in use and hundreds more introduced every year, it also demands faster, more efficient chemical testing and screening methods.

EPA chemical research is focused on advancing a better understanding of chemicals to maximize safety and sustainability. Researchers are developing fast, efficient, and less-costly ways to collect and analyze data, better predict chemical risk, and help reduce the current backlog of chemicals not fully assessed for potential human health and environmental effects.

The data and studies EPA researchers generate are publicly available through transparent, accessible, online tools, providing the latest science-based safety data to support better, more informed decisions protecting human health and the environment.

This section highlights some of the top research results in computational toxicology, nanotechnology, sustainable chemical design, pesticides, industrial chemicals, endocrine disrupting chemicals, and human health risk EPA researchers and their partners achieved in 2012.

Learn More!

For more information about the scope and impact of EPA research to support Chemical Safety for Sustainability, please visit: www.epa.gov/research/chemicalscience/.

EPA researchers are leading the development of innovative, new tools and toxicology screening and testing methods that are faster and less costly than traditional practices.

EPA's Computational Toxicology Research

There are currently more than 80,000 chemicals listed or registered for use under EPA authorities, many of which have not been thoroughly assessed for the health and environmental risks. With hundreds more introduced into the marketplace every year, it's easy to see the enormous challenge facing EPA officials and others tasked with ensuring the sustainable production, use, and disposal of chemicals.

To meet that challenge, EPA researchers are leading the development of innovative new tools and technologies to evaluate the safety of chemicals, products, and emerging materials. EPA computational toxicology researchers are using advances in exposure science, molecular and systems biology, chemistry, mathematical and computer modeling, and computer technology to predict chemical hazards and risk. In the process, they are ushering in a new generation of predictive tools to evaluate potential chemical risk to human health and the environment.

EPA's computational toxicology research continued to make important strides in 2012.

Researchers analyzed automated, high-throughput screening data and developed high-throughput exposure predictions for over 1,000 chemicals of interest. "High-throughput" refers to the speed of chemical tests (assays) or predictions, defined as being capable of generating test results or predictions for hundreds to thousands of chemicals in just days or weeks. The researchers also analyzed chemical structures to identify which chemical properties are more likely to influence toxicity and exposure potential.

These accomplishments promise to deliver advanced methods that are not only higher performing and faster, but also far less costly to use.

Tox21

EPA researchers and their partners conduct high-throughput chemical screening using robotics and a variety of other technologies available from a research partnership called *Toxicity Testing in the 21st Century ("Tox21")*. Tox21 is a collaborative federal research partnership uniting EPA, the National Institutes of Health, and the U.S. Food and Drug Administration to screen tens of thousands of chemicals.

The automated systems move small, specialized test plates, each with 1,536 tiny wells of liquid test solutions and containing human cells or proteins, through a series of computerized screening and analysis activities, in effect simultaneously running thousands of separate experiments at a time.

EPA researchers are working to provide web-based tools that supply summary information based on extensive chemical exposure and hazard data, decision-rules, and predictive models.

Increasing Transparency and Accessibility of Chemical Safety Information

EPA's computational toxicology research is building accessible, online databases on thousands of chemicals that can be shared with the public and those making policy and regulatory decisions about the safety of chemicals.

As these extensive, Web-accessible databases are being developed, EPA is collaborating with academia and industry partners to gather the "critical mass" of chemical hazard and exposure data needed to advance innovation, and to launch the next generation of sustainable chemical design. By using the data to identify the features of chemicals that contribute to their hazardous properties, chemical engineers and others will have the information they need to design new functional, yet safer, chemicals.

The public release of computational toxicology data provides opportunities to engage stakeholders and to promote transparency on how the data are used to inform EPA decisions. It is also expected that by actively engaging stakeholders and making research results widely accessible, EPA will promote the commercialization and use of the data and its research, facilitating chemical safety assessments

and the design of benign or less hazardous materials by industry and others.

An additional result of this investment in innovative science will be a reduction in the number of animals needed for evaluating chemical hazard and risk.

Chemical Evaluation Dashboards for Decision Makers

For those protecting human health and the environment by making decisions regarding chemical risks and health effects, the extensive databases and proliferation of additional scientific information being generated by EPA's CompTox and other research efforts can be daunting.

To overcome this obstacle, EPA computational toxicology researchers are developing customizable and user-friendly Web-based applications—called "Dashboards"—that provide accessible, useful summary information on chemical exposure and hazard data, decision-tools, and predictive models. The Dashboards compile information useful for predicting risk and prioritizing chemicals for further testing.

Prototype Dashboards were developed in 2012 for EPA's Endocrine Disruption Screening program, to support chemical prioritization for the Toxic Substances Control Act, and for chemicals of concern for the Safe Water Drinking Act's Candidate Contaminant List.

ToxCast Partnership to Advance Chemical Testing, Reduce Animal Testing

A major component of EPA's computational toxicology research (see previous stories) is EPA's toxicity forecaster, or "ToxCast." Researchers are using ToxCast as part of work to systematically screen chemicals to better understand the potential impact exposures have on processes in the human body that lead to adverse health effects.

Using ToxCast, EPA screened more than 1,000 chemicals in some 700 fast, automated tests called high throughput assays. Research results, presented in a host of published scientific papers in peer-reviewed journals, show ToxCast can be used to predict a chemical's potential for liver toxicity, developmental toxicity, reproductive toxicity, and cancer.

Based largely on the promising results of ToxCast

for advancing computational toxicology methods and for ushering in a new generation of chemical screening methods that will be faster, less costly, and greatly reduce the use of laboratory animals, in March 2012, EPA and the cosmetics company L'Oréal announced a collaboration to expand the work to include substances from the cosmetic sector.

As part of the partnership, L'Oréal is providing EPA with $1.2 million in collaborative research funding plus robust safety data from a set of representative cosmetic substances. Substances from L'Oréal are being assessed by ToxCast and results will be compared to the safety data L'Oréal provided.

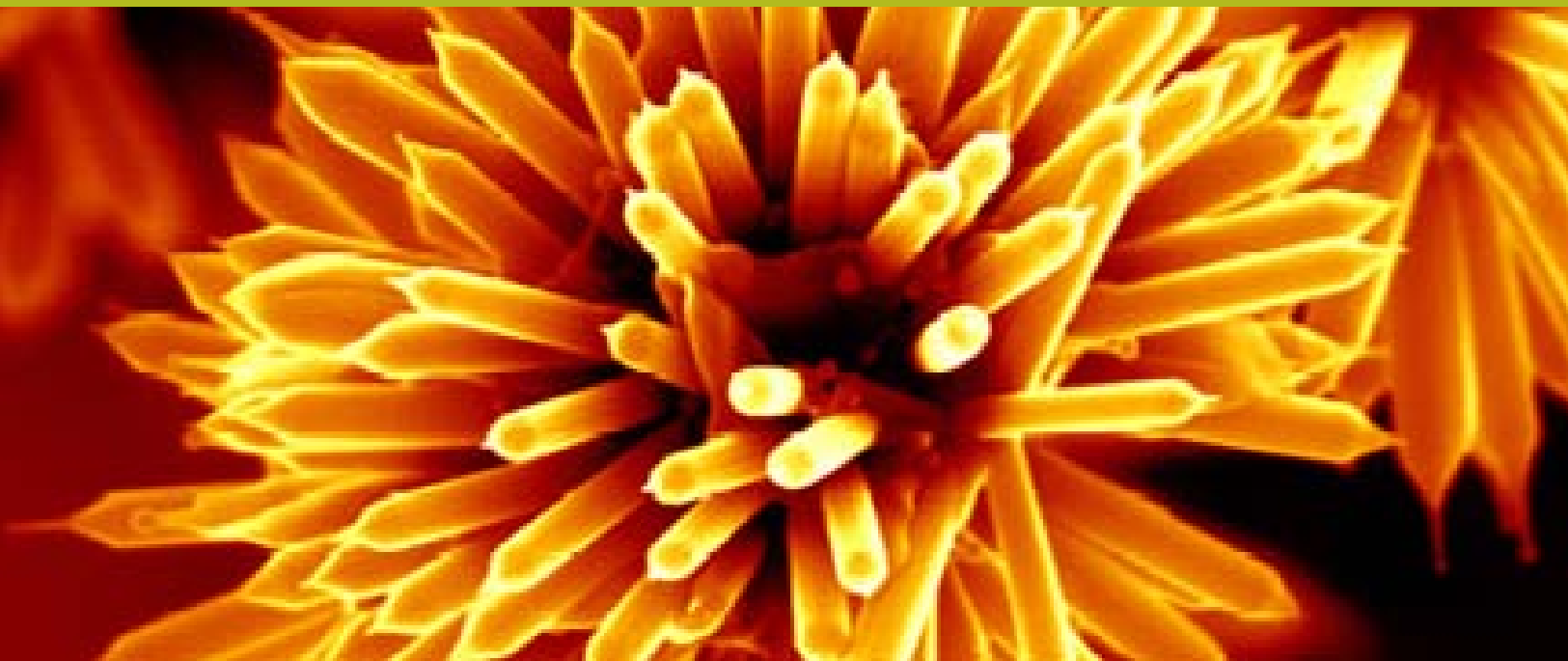For more than 30 years, L'Oréal has invested in animal-free toxicology tests and the EPA

Using ToxCast, EPA researchers and their partners are screening more than 1,000 chemicals in some 700 fast, automated tests , including robot-assisted ones (pictured) to better understand their potential impact on processes in the human body that lead to adverse health effects.

collaboration will help the company to make predictions on the safety of substances earlier in the development process. It also expands the types of chemical use groups that EPA researchers are now assessing in ToxCast.

The L'Oréal research partnership is just one of many that EPA researchers have fostered to increase the scope and impact of computational toxicology research efforts. One of the largest is the Toxicity Testing in the 21st Century (Tox21) collaboration with the U.S. Food and Drug Administration and the National Institutes of Health, which pools federal resources and expertise to screen more than 10,000 chemicals for potential toxicity (see *EPA's Computational Toxicology Research*).

EPA now has partners from more than [100 different organizations](#) ranging from industry, academia, trade associations, other federal agencies, state governments, and non-governmental organizations. Partners provide a wide variety of support, including chemicals, software, chemical toxicity study data and results, different kinds of high-throughput screening, and much more.

Partnerships are finalized through numerous types of agreements. Individuals and organizations with an interest in promoting the use of computational toxicology and exposure science are invited to participate in EPA's Computational Toxicology Communities of Practice; for more information, visit: http://1.usa.gov/fevgcF.

Ensuring Safe Nanotechnology and Nanomaterials

Nanomaterials are materials between one and 100 nanometers in size (a nanometer is one billionth of a meter). These tiny materials often exhibit unique properties that are different from those of the same substances in a larger size, and have been tapped for manufacturing processes and for applications in paint, cosmetics, treated wood, electronics, and other products. While nanomaterials offer important benefits, they may also present some risks.

EPA is leading scientific efforts to understand the potential risks to humans and the environment from nanomaterials. This work includes:

• **Collaborating on Nano-copper:** As part of the U.S. National Nanotechnology Initiative, EPA and the U.S. Consumer Product Safety Commission (CPSC) are collaborating in a worldwide effort to assess the effects of nanomaterials. Joint research includes exploring the potential human and environmental effects from exposure to copper nanomaterials used in wood treatment products for decks and fences.

• **Children's Exposure:** Another part of the EPA-CPSC collaboration focuses on the potential exposure of children to nanoparticles. Of particular interest is nanosilver, which can prevent the growth of some bacteria or fungi and is sometimes used in the manufacturing of children's toys. Researchers are developing the tools, approaches, and protocols needed to determine if nanosilver is released from children's products under real-world

conditions. Preliminary study results on 13 products indicate that the silver levels to which children may potentially be exposed during normal product use is low.

- **Nanosilver:** To investigate potential health risks of nanosilver in everyday products such as body soap, laundry detergent, and toothpaste, scientists from EPA and the University of Nevada, Las Vegas, researched the changes that occur when nanosilver interacts with the acidic environment of a synthetic human stomach.

  Results showed that nanomaterials could alter the amount of silver that is absorbed by the body. Researchers further developed methods and standard test procedures for characterizing the physical and chemical properties that influence the health risks associated with nanosilver.

EPA researchers also released the document: *Nanomaterial Case Study: Nanoscale Silver in Disinfectant Spray* (see next column).

EPA Case Study: Nanosilver in Disinfectant Spray

In 2012, EPA released *Nanomaterial Case Study: Nanoscale Silver in Disinfectant Spray*.

The case study was conducted to support research planning efforts for nanomaterials such as the studies mentioned previously. Researchers considered nanosilver in disinfectant sprays across the entire lifecycle of products, including how they are produced, shipped, stored, used, and disposed of or recycled. The report presents information about how nanosilver materials and waste by-products might move and change before coming into contact with people and other organisms, and the potential impacts of exposures in these populations.

For more information, and to download a copy of the report, see: http://1.usa.gov/W0o7v0.

EPA research advancements in 2012 included narrowing down the field of already confirmed endocrine disrupting chemicals to support targeted studies to identify specific mechanisms likely to cause harmful effects.

Endocrine Disrupting Chemical Research

Normal growth and development, from conception, through pregnancy and to childhood and adolescence, depends on the intricate timing and release of hormones by the body's endocrine system, which regulates growth, maturation, and reproduction in people and animals.

Scientists have discovered that exposures to excess hormones or to certain chemicals, known collectively as "endocrine disrupting chemicals," can disrupt the functioning of the endocrine system, which can lead to a series of development problems and other adverse effects, including cancer, diabetes, obesity, infertility, and childhood disorders.

As part of the effort to better protect human health and the environment, learning more about endocrine disrupting chemicals and how to screen and identify them from the thousands of chemicals in use has been a high priority for EPA researchers since the early 1990s.

In 2012, EPA scientists used innovative approaches to assess thousands of chemicals for potential endocrine disruption, and worked with outside research partners to investigate the effects of hormones in waste from concentrated animal feeding operations.

Innovative approaches included an EPA-developed Quantitative Structure Activity Relationship (QSAR)-based estrogen expert system, and the ToxCast approach (see previous stories), to screen thousands of chemicals and provide new information to EPA's Endocrine Disruptor Screening Program (EDSP). The expert

Reducing Endocrine Disrupting Chemicals in Chesapeake Bay

EPA scientists worked with the University of Maryland Wye Research Center to determine how to reduce the amounts of endocrine disrupting hormones associated with Concentrated Animal Feeding Operations from reaching nearby waterways. Hormone-containing wastes from these operations can get into soil and water, leading to adverse effects such as intersex conditions in fish.
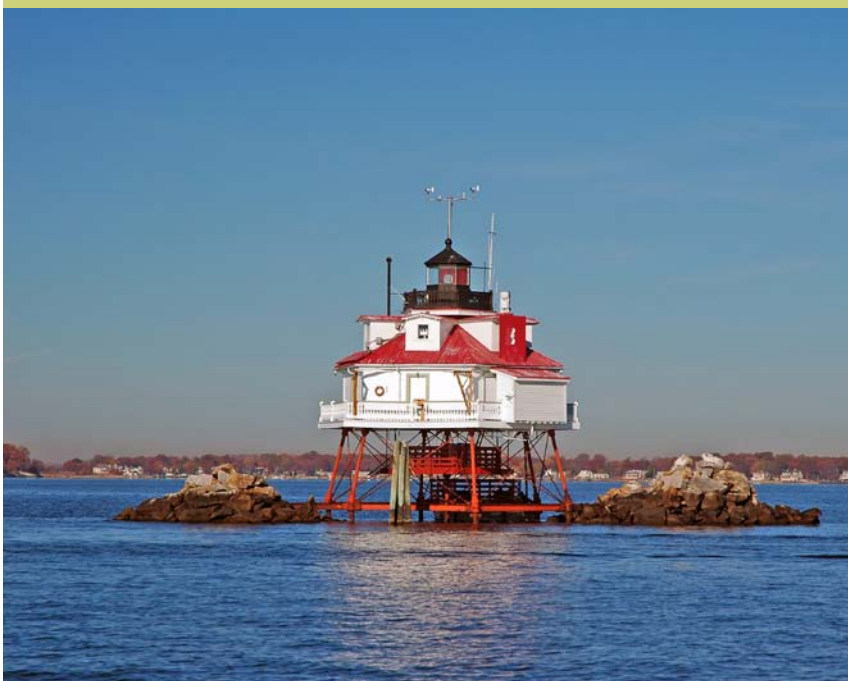
Research results from the collaboration showed that tilling poultry fecal waste into the soil and injecting the waste underground reduced endocrine disrupting hormones concentrations, as compared to not tilling the waste into the ground.

The findings will inform actions to reduce the amount of poultry steroid hormones in storm runoff coming from areas along Chesapeake Bay.

system predicts the potential for chemicals to bind to estrogen hormone receptors and activate genes that cause health effects.

EPA researchers worked closely with the EDSP to define the potential "chemical universe" of endocrine disrupting chemicals that require screening. In 2012, they identified more than 10,000 chemicals that make up this "chemical universe," by identifying properties that could cause them to interfere with natural hormones and disrupt the endocrine system.

Advancements in 2012 included narrowing down the field of already confirmed endocrine disrupting chemicals to support targeted studies and the identification of specific chemical interactions with important biological processes that are likely to cause toxicological effects. The scientific information is being used to help prioritize which chemicals should be tested first by EPA, and what additional tests are needed to assess the chemicals.

A series of EPA studies are providing key information to minimize exposure to PCBs in schools.

PCB Research Supports Safer Schools

In 2012, EPA researchers completed the first three of five studies they are conducting to answer questions about polychlorinated biphenyls, (PCBs) in schools. What they are learning is providing key information to minimize exposures and better protect students, teachers, and others.

PCBs are a structurally similar group of manmade chemicals useful for a variety of applications. Some PCBs, for example, are slippery, making them valuable as industrial lubricants. Heat and flame resistant, they were also used as insulators in transformers, electrical appliances, and fluorescent light fixtures. PCBs were also used as stabilizers in paints, adhesives, and caulking.

PCBs were widely used from 1950 until the late 1970s. Congress banned their use and manufacture in 1976 in the face of growing evidence linking their exposure with adverse human health effects, including cancer, reproductive problems, and neurological development.

While PCB exposures have been greatly reduced, the combination of their previous widespread use and persistence has meant they are still present in the environment. Buildings, including schools, built or renovated between 1950 and 1970 may contain PCBs, particularly in caulking or fluorescent lighting fixtures.

In response to concerns raised by parents, EPA scientists are identifying and evaluating potential PCB sources in schools and advancing a better understanding of how people might be exposed. The researchers are also investigating methods to minimize or eliminate PCB emissions in schools.

In 2012, EPA researchers released the results of three studies. The first two studies focused on primary sources (such as caulk and lighting fixtures) and secondary sources (paint, masonry walls, and dust that can absorb PCBs from primary sources) of PCBs in schools. The third study investigated a containment method known as "encapsulation" where PCB sources are covered with a coating material to reduce air and surface concentrations of PCBs.

Results of the studies include:

- Caulk put in place between 1950 and 1979 may contain as much as 30% PCBs and can emit PCBs into the surrounding air. PCBs from caulk may also contaminate adjacent materials such as masonry or wood.

- Fluorescent lighting fixtures that still contain their original PCB-containing light ballasts have exceeded their designed lifespan, and the chance for rupture and emitting PCBs is significant. Sudden rupture of PCB-containing light ballasts may result in exposure to the occupants and may also result in the addition of significant clean-up costs.

- Some building materials (e.g., paint and masonry walls) and indoor dust can absorb PCB emissions and become potential secondary sources. When the primary PCB-emitting sources are removed, the secondary sources often emit PCBs.

- Encapsulation is only effective at reducing air concentrations to desirable levels when PCB content in the source is low. Selecting high-performance coating materials is key to effective encapsulation. Multiple layers of coatings enhance the performance of the encapsulation.

As EPA researchers gain new information they will make further recommendations on how to best prevent harmful PCB exposure in schools.

Learn More about EPA Chemical Safety for Sustainability

For more information about the scope and impact of EPA Chemical Safety for Sustainability research, visit:

- EPA Chemical Safety for Sustainability: www.epa.gov/research/chemicalscience/.
- EPA Computational Toxicology Research: www.epa.gov/comptox/
- Download a copy of EPA's *Chemical Safety for Sustainability Strategic Research Action Plan, 2012-2016*: http://epa.gov/research/docs/css-strap.pdf

EPA and research partners are exploring how to incorporate the concepts of sustainability to advance the design of new, innovative, "green" products made of safe substances and manufactured with efficient, clean processes.

Promoting Chemical Sustainability

There is no doubt that chemicals can make our lives easier. They are ubiquitous in our medicines, the cleaning and disinfection products we use to clean our homes and workplaces, and used throughout industry to make the many products we use and enjoy everyday. What would be even better would be to continue to enjoy these multiple benefits with minimal or no negative impacts to human health and the environment.

Together with partners, EPA is exploring how to incorporate the concepts of sustainability to advance the design of new, innovative, "green" products made of safer substances and manufactured with more efficient, clean processes.

In September 2012, EPA signed a Memorandum of Understanding with the National Science Foundation (NSF) to collaborate to help steer more chemical research toward advancing sustainability. In December, EPA and the National Science Foundation released two requests for applications (RFAs) to support innovative research projects investigating ways to use benign, more natural materials in developing chemicals for use in everyday products.

The RFAs seek to fund innovative chemical safety research focused on two distinct areas: (1) sustainable, safe alternatives to existing chemicals, and (2) assessments looking at the entire life cycle of chemicals, from production to disposal.

In addition to the partnership with NSF, EPA's own scientists continued to advance chemical sustainability throughout 2012. One example is Greenscope, a six-year-effort that has identified and ranked 139 separate indicators of the chemical manufacturing processes on a "sustainability scale" from 0 to 100 percent sustainable.

In order to test Greenscope, researchers devised a computer model of a hypothetical biodiesel facility that included all the manufacturing processes and sustainability indicators. A published case study on the model illustrated how they were able to assess the sustainability of the plant. Also, in February 2012, EPA signed an MOU with the company Procter and Gamble to develop sustainability measures for its supply chain management system, and possibly deploy Greenscope at P&G facilities in the future.

Human Health Risk Assessment

EPA's Human Health Risk Assessment research program provides state-of-the-science products in support of risk assessment, such as independently peer-reviewed human health assessments for individual chemicals and chemical mixtures; integrated science assessments and technical support to meet partner and stakeholder needs; and tools to modernize human health risk assessment.

The research results and products of the program are used by local, state, national, and international authorities to guide waste site cleanups, protect the air, set exposure limits for chemicals in drinking water, and determine the potential risk to public health from exposures to multiple environmental contaminants.

EPA researchers are helping to advance the science of risk assessment through original research, consultation with experts, and by accepting new challenges. These include developing community risk assessment tools and tailoring risk assessments to inform key decisions.

This section highlights a few of the many achievements from EPA's Human Health Risk Assessment program from 2012. For more information on the scope and impact of EPA research on human health risk assessment, please visit: http://www.epa.gov/ncea/.

Learn More!

For more information about the scope and impact of EPA research to support Human Health Risk Assessment, please visit: http://www.epa.gov/nceawww1/hhra/index.htm

IRIS is a human health risk assessment program through which Agency scientists evaluate and present comprehensive risk information on the health effects that may result from exposures to contaminants in land, water, and air.

Growing IRIS: Advancing EPA's Integrated Risk Information System

EPA researchers provide leadership to assess the potential health effects posed by exposures to chemicals in the environment. A critical part of that effort is the Agency's Integrated Risk Information System, or "IRIS."

IRIS is a human health assessment program through which Agency scientists evaluate and present comprehensive information on the health effects that may result from exposures to contaminants in land, water, and air.

IRIS health assessments provide information on the hazards a chemical may pose as well as information on "dose-response" (the relationships between amounts of exposure and expected effects), resulting in reference doses, reference concentrations, cancer slope factors, and inhalation unit risks. When combined with information about people's environmental exposure to a chemical, IRIS assessments can be used to characterize health risks.

IRIS assessments are not full risk assessments or regulations, but they provide part of the scientific foundation that supports Agency decisions and actions for the nation's environmental laws, and are widely used throughout the country on the federal, state, and local levels to guide cleanup and other actions to protect human health.

Currently, IRIS contains information on more than 560 chemicals.

Over the past few years, EPA has taken steps to significantly improve the IRIS program. Those efforts continued throughout 2012.

On June 5, 2012, EPA publicly released an IRIS progress report to the U.S. Congress (*EPA's Integrated Risk Information System Program, Progress Report and Report to Congress*, U.S. Environmental Protection Agency). The report provided Congress, stakeholders, and the public with an update on the program, and on EPA's progress toward implementing recommendations to improve the program made by the National Research Council (NRC) in 2011.

Improvements were illustrated further with the release of the 2012 draft assessments for ammonia (*IRIS Toxicological Review of Ammonia, External Review Draft*, U.S. Environmental Protection Agency) and several isomers of trimethylbenzene (*IRIS Toxicological Review of Trimethylbenzenes, External Review Draft*,. U.S. Environmental Protection Agency). The assessments present a new, highly improved document structure which includes a template for describing the literature search approach used in the assessments. In addition, the documents clearly identify the strengths and weaknesses of the analyzed studies and explicitly describe how EPA guidance, methods, and criteria were applied in developing the assessments.

Continuing the Agency's commitment to improving the IRIS program, on May 16, 2012, EPA announced that the NRC would conduct a comprehensive review of the IRIS program's assessment development processes, review current methods for integrating data, and recommend approaches for weighing scientific evidence for chemical hazard identification.

For more information on the IRIS program, including opportunities to engage with EPA, please visit the IRIS website (www.epa.gov/IRIS/).

Strengthening IRIS

Because of the critical importance of IRIS in supporting EPA and beyond, a strong, vital and scientifically sound program is key to providing needed health risk information. Over the past two years, EPA has worked to strengthen and streamline the IRIS program, improving transparency and increasing the number of final assessments added to the IRIS database. Continually improving IRIS is a priority for the Agency, and efforts are underway to further strengthen and streamline this important program.

Confirming longstanding scientific understanding and research, the final assessment characterizes perc as a "likely human carcinogen."

EPA's IRIS Program Releases Final Health Assessment for "Perc"

In February 2012, EPA released the final health assessment for the chemical tetrachloroethylene, also known as perchloroethylene, or more commonly as "perc."

Perc is a chemical solvent widely used in the dry cleaning industry and to manufacture some consumer products and other chemicals; it is also a common environmental contaminant.

Confirming longstanding scientific understanding and research, the final assessment characterizes perc as a "likely human carcinogen." The assessment, which underwent rigorous, independent peer review, includes toxicity values for both cancer and non-cancer effects associated with exposure to perc over a lifetime.

EPA has already taken several significant actions to reduce exposure to perc. For example, the Agency established clean air standards for dry cleaners that use perc, including requirements that dry cleaners operating in residential buildings phase out its use by late 2020. EPA also set limits for the amount of perc allowed in drinking water.

The toxicity values reported in the perc IRIS assessment will be considered in future actions to protect public health, such as:

- Informing new Superfund clean up sites where vapor intrusion leads to indoor air contamination from perc,
- Revising EPA's Maximum Contaminant Level for perc as part of the carcinogenic volatile organic compounds group in drinking water, as described in the Agency's drinking water strategy, and
- Evaluating the need for additional limits on the perc emissions into the atmosphere; (perc is listed as a hazardous air pollutant under the Clean Air Act).

As a result of efforts by EPA, state governments and industry, known and measurable air emissions of dioxins in the United States have been reduced by 90 percent since 1987.

Final Non-Cancer Science Assessment for Dioxins Released

On February 17, 2012, EPA reached a major milestone by completing its non-cancer health assessment for dioxin. Dioxins are toxic chemicals that exist naturally and can be released to the environment through forest fires, backyard burning of trash, certain industrial activities, and residue from past commercial burning of waste.

Over the past two decades EPA has worked to significantly reduce emissions from all of the major industrial sources of dioxins. Today, the largest remaining source of dioxin emissions is backyard burning of household trash.

EPA's final report, Reanalysis of Key Issues Related to Dioxin Toxicity and Response to NAS Comments, Volume 1 (Dioxin Reanalysis), describes the health effects (other than cancer) that may result from exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), the most toxic of the many different forms of dioxin (also known as congeners).

The assessment also establishes, for the first time, a non-cancer oral reference dose (RfD) that represents the amount of dioxin a person can be exposed to every day over a lifetime that is not likely to cause harmful effects. Scientists can use this RfD to calculate the toxicity of the many other dioxin congeners relative to TCDD. This provides a way to add up the toxicity of all dioxin congeners that appear together in an environmental mixture.

Most Americans have low-level exposure to dioxins. The health effects associated with dioxins depend on several factors, including: how much dioxin a person is exposed to, when someone was exposed, and for how long and how often someone is exposed. Based on data from animal and human epidemiology studies, there is concern that exposure to low levels of dioxins over long periods (or exposures at sensitive times during the lifespan) might result in reproductive or developmental effects and other health effects.

The non-cancer health assessment for dioxin is a significant achievement for EPA and will contribute to the Agency's mission of protecting public health. The information in the assessment will be considered in a variety of Agency activities, such as establishing cleanup levels at Superfund sites, reviewing the drinking water standard for dioxin, and evaluating whether additional Clean Air Act limits on dioxin emissions are warranted.

Integrated Science Assessments: Gathering the Best Air Science to Protect Human Health and the Environment

EPA sets National Ambient Air Quality Standards (NAAQS) for six "criteria" air pollutants—ozone, particulate matter, carbon monoxide, sulfur dioxides, nitrogen oxides, and lead—considered harmful to human health and the environment.

Interdisciplinary teams of EPA scientists prepare the Integrated Science Assessments (ISAs) that review, synthesize, and evaluate the most policy-relevant science to serve as a scientific foundation for the review of NAAQS. The ISAs synthesize relevant information from a large body of literature, generally encompassing thousands of studies, from across scientific disciplines

including atmospheric chemistry, exposure science, epidemiology, animal and human toxicology, and terrestrial and aquatic ecology.

All ISAs are vetted through a rigorous scientific peer review process, which includes two reviews by the Clean Air Scientific Advisory Council, and are made available for public review and comment.

During 2012, EPA scientists continued to make significant progress in developing ISAs. In February, the Agency released the second external review draft of the ISA for lead for public review and comment, and in November released the third draft of the lead ISA. In June, EPA released the third external review draft of the ISA for ozone and related photochemical oxidants for public review and comment.

EPA also held a "kickoff" workshop to initiate the next review of the health-based NAAQS for nitrogen oxides, in keeping with the Clean Air Act requirement for periodic reviews of the standards.

In addition, EPA scientists are laying the groundwork for incorporating multipollutant analyses into their assessments. The Agency is currently developing multipollutant science documents to help evaluate the impacts of ambient air pollution mixtures on health and climate. The multipollutant assessments are expected to help EPA scientists and managers better understand uncertainties about the effects of pollutants within the air pollution mixture. The multipollutant assessment work will also stimulate additional research and data gathering activities to benefit future assessments.

Integrated Science Assessments Released in 2012:

Lead
- November 2012: EPA released the third external review draft of the ISA for Lead for public review and comment. [Federal Register Nov 27, 2012]
- February 2012: EPA released the second external review draft of the ISA for Lead for public review and comment. [Federal Register Feb 2, 2012]

Ozone
- June 2012: EPA released the third external review draft of the Integrated Science Assessment of Ozone and related Photochemical Oxidants (EPA/600/R-10/076C) for public review and comment. [Federal Register Jun 19, 2012]

EPA's draft assessment concludes that current ambient air concentrations of asbestos in the Libby, Montana mine area did not appear to cause levels of risk above EPA Superfund targets.

Asbestos Toxicity Estimates to Help Protect Health in Libby, Montana

In 2009, EPA Administrator Lisa P. Jackson declared a public health emergency in Libby, Montana. This unprecedented action by an EPA Administrator recognized serious health risks, including lung cancer, mesothelioma, asbestosis, and decreased lung function, posed from exposure to Libby Amphibole asbestos present in the community from past mining and vermiculate processing.

EPA started cleanup activities for the contaminated former Libby mine in 1999, and the area was listed as a Superfund site in 2002. Throughout that time, Agency researchers have worked closely with partners from EPA's Region 8 Office (serving Montana, Colorado, North Dakota, South Dakota, Utah, and Wyoming) and the local community to support those efforts and better protect public health.

In 2011, EPA released the IRIS Toxicological Review of Libby Amphibole (External Review Draft). This health assessment, when final, will support cleanup and related risk management initiatives at the Libby Superfund site.

The draft assessment presents conclusions about potential human health hazards for cancer and non-cancer health effects, and it provides toxicity values that will be used to help characterize risk in areas where people may be exposed to Libby Amphibole asbestos.

The draft assessment has undergone rigorous peer review and incorporates a transparent process including ample opportunity for community and stakeholder involvement and public comment. An explicit part of the process was to engage the affected community in the review process. Those efforts continued well into 2012.

In February of 2012, EPA's Scientific Advisory Board (SAB) held a public peer review meeting on the draft Libby Amphibole asbestos assessment and held two public teleconferences of the SAB Libby Amphibole Asbestos Panel in May to discuss the Panel's report on its review of the draft assessment.

EPA scientists will consider public and peer review comments as they finalize the assessment. The final assessment will help the Agency secure the best path forward for cleaning up Libby Amphibole asbestos and for protecting public health at the Libby Superfund site.

Learn More about EPA's Human Health Risk Assessment Research

For more information about the scope and impact of EPA Human Health Risk Assessment research, visit:

- EPA Human Health Risk Assessment Research: www.epa.gov/nceawww1/hhra/index.htm.
- EPA Integrated Risk Information System (IRIS): http://www.epa.gov/iris/
- Download a copy of EPA's *Human Health Risk Assessment Strategic Research Action Plan, 2012-2016*: http://epa.gov/research/docs/hhra-strap.pdf

Supporting and Building Partnerships

EPA supports the nation's leading scientists and engineers to facilitate the pursuit and dissemination of high-quality research to build a strong foundation for Agency actions and decisions. Additionally, EPA researchers cultivate and maintain partnerships with research colleagues at colleges and universities around the world, at partner federal and state human health and environmental agencies, and other entities throughout the scientific community.

The Agency's extramural research program funds research grants, graduate and undergraduate fellowships, and large research centers through a competitive solicitation processes and independent peer review. These programs engage the nation's best scientists and engineers in targeted research that complements EPA's own research.

EPA is also one of 11 federal agencies that participate in the Small Business Innovation Research (SBIR) program, established in 1982 to strengthen the role of small business in federal research and development, to create jobs, and to promote technical innovation. EPA's SBIR program awards funds to innovative small businesses that have novel concepts for products and technologies that will help spur economic growth while advancing a more sustainable future.

Learn More!

For more information on EPA research grants, fellowships, and awards, please visit: www.epa.gov/ncer/.

EPA Research Grants and Fellowships for 2012

EPA funds research grants and graduate fellowships in numerous environmental science and engineering disciplines through its Science to Achieve Results (STAR) program. The program engages the nation's best scientists and engineers in targeted research that complements EPA's own intramural research program and supports partners in other federal agencies.

The Agency awarded 126 Fellowships (87 graduate and 39 undergraduate), 114 grants (this includes funds awarded in Fiscal Year 2012, which includes late 2011), and 32 Small Business

Innovation Research (SBIR) awards to support environmental research conducted in 2012.

Grants are given through competitive solicitation processes followed by independent peer review.

In addition, through this same competitive process, EPA periodically establishes large research centers in specific areas of national concern. Currently, centers focus on children's environmental health, nanotechnology, clean air, computational toxicology, health effects of pollutants, and green infrastructure and stormwater management for Chesapeake Bay.

STAR Graduate Fellowships

The STAR Graduate Fellowship Program supports masters and doctoral candidates working towards advanced degrees and careers in environmental science and engineering. Students can pursue degrees in traditionally recognized environmental disciplines as well as other fields such as environmental anthropology, urban and regional planning, and decision sciences.

STAR fellowships are intended to help defray the ever-increasing costs associated with studies leading to advanced degrees in environmental sciences. Eighty-seven STAR Graduate Fellowships were awarded to support graduate work in human health and environmental research in 2012.

Greater Research Opportunities (GRO) Fellowships

The Greater Research Opportunities (GRO) fellowships support undergraduate students in environmental fields of study. The goals of the program are to bolster the next generation of environmental leaders, inspire and train diverse communities, and boost excellent research and development.

Eligible students receive support for their junior and senior years of undergraduate study and for an internship at an EPA facility during the summer between their junior and senior years. The fellowship provides up to $20,700 for academic support and up to $8,600 of support for a three-month summer internship. The Agency awards approximately 40 new fellowships each year.

STAR Grants to Support Air Quality Measurement Technology and Management

EPA awarded four grants totaling approximately $1.25 million to develop and demonstrate new air quality measurement technology.

The supported research will allow measurements of pollutants and the creation of smaller measurement devices for addressing emerging air pollution issues and improving air pollution measurement and data collection.

Additionally, five projects were supported with $2 million to create the scientific foundation for improving the air quality management system. These projects will increase the rate at which new information is incorporated into regional and local air quality management and develop techniques for improved air quality.

Summary of Air Quality Measurement Technology Grants

Recipients	Research Project	Amount Awarded
Washington University	Development of Cost-effective, Compact Electrical Ultrafine Particle (eUFP) Sizers and Wireless eUSF Sensor Network	$499,000
University of California-San Diego	A compact, low-cost, network accessible, optical particle counter for the real time measurement of submicron aerosol particle size distributions	$250,000
Princeton University	Compact Multi-Pollutant Mid-Infrared Laser Spectroscopic Trace-Gas Sensor	$250,000
University of Wisconsin-Madison	Assessing the Synergistic Impact of Anthropogenic and Biogenic Emissions on Air Pollution Using Novel High-Sensitivity, Real-Time Monitors for Fundamental Carbonyls	$250,00000
		Total: $1.25M

Summary of Air Quality Management Grants

Recipients	Research Project	Amount Awarded
University of Texas-Austin; Massachusetts Institute of Technology	Analysis of Dynamic, Flexible NOx and SO2 Abatement from Power Plants in the Eastern U.S. and Texas	$500,000
University of North Carolina-Chapel Hill; Pennsylvania State University-Main Campus	Dynamic Electricity Generation for Addressing Daily Air Quality Exceedances in the US	$250,000
Georgia Institute of Technology, Georgia Environmental Protection Division, Georgia Forestry Commission	Dynamic Management of Prescribed Burning for Better Air Quality	$500,000
Texas A&M University-Kingsville	Optimization of Multipollutant Air Quality Management Strategies	$249,115
SUNY-Albany, SUNY College of Environmental Science and Forestry	Creating Building Blocks for a More Dynamic Air Quality Management Framework	$499,945
		Total: $2.0M

The frequency of extreme events such as large storms and severe droughts, is expected to increase with continued climate change.

STAR Grants to Support Research on the Impacts of Global Climate Change

EPA awarded 14 grants, totaling more than $8 million, to support research exploring ways to provide the information and tools needed for effective air and water quality management during anticipated increases in extreme events such as large storms and severe droughts.

The Agency-supported research focuses on understanding the hazards of extreme events, and to establish ways for experts and stakeholders, such as climate scientists, impact assessment modelers, and air and water quality managers, to address water and air quality challenges and increase community resiliency in the face of extreme weather events and natural disasters.

Summary of STAR Grants for Extreme Event Impacts on Air Quality and Water Quality with a Changing Global Climate

Recipients	Research Project	Award Amount
Oregon State University	Prediction and quantification of Combined Sewer Outflows under extreme storm events: Flow dynamics and Reduction of Combined Sewer Outflows	$265,528
Georgia Institute of Technology - Main Campus	Air Quality Impacts of Extreme Weather Events: Historical Analysis and Future Projection	$749,859
Massachusetts Institute of Technology, Colorado State University, North Carolina State University	Using Advanced Statistical Techniques to Identify the Drivers and Occurrence of Historical and Future Extreme Air Quality Events in the United States from Observations and Models	$749,931
University of South Florida	Early Career: The hazards of Extreme Climatic Events: Predicting Impacts	$374,936
Michigan Technological University, University of Louisville	Impacts of Climate-induced Changes in Extreme Events on Ozone and Particulate Matter Air Quality	$374,960
University of Texas at Austin	Response of Regional Air Quality to Severe Drought	$750,000
Mississippi State University	Role of land use and BMPs in reducing the effect of extreme magnitude events on sediment and pollutant transport in the SE US Coastal Plain and Mississippi Alluvial Valley	$363,258
Public Policy Institute of California, Climate Central	Integrating Information from Climate Scientists and Resource Managers: Informing Preparedness and Adaptation to Extreme Event Impacts on Air and Water Quality in California	$710,529
Cornell University, National Center for Atmospheric Research	Extreme Air Quality Events Using a Hierarchy of Models: Present and Future	$746,825
Ohio State University - Main Campus	Ensuring Safe Drinking Water in Lake Erie: Quantifying Extreme Weather Impacts on Cyanobacteria and Disinfection Byproducts (DPBs)	
University of South Florida	Ecological Assessment of Generalized Littoral Environments Decision-Support System (EAGLE/OS)	$734,122

Summary of STAR Grants for Extreme Event Impacts on Air Quality and Water Quality with a Changing Global Climate, continued

Recipients	Research Project	Award Amount
University of Washington	Prediction of Effects of Changing Precipitation Extremes on Urban Water Quality	$699,905
Michigan State University	Forecasting and Evaluating Vulnerability of Watersheds to Climate Change, Extreme Events, and Algal Blooms	$750,000
Columbia University in the City of New York	Combining Empirical Orthogonal Function and Extreme Value Theory Methods to Characterize Observed and Future Changes in Extreme U.S. Air Pollution Events	$749,951
		Total: $8,019,534

STAR Grants to Support Chesapeake Bay

EPA awarded the University of Maryland a grant totaling $691,674 for supporting a research center to identify new, collaborative approaches to reduce urban stormwater from reaching Chesapeake Bay.

The center's research includes: applying existing stormwater-reduction techniques in new ways; developing new techniques and technologies; identifying why existing Chesapeake Bay restoration or protection strategies have succeeded or failed; developing methods and metrics to document water-quality improvements in Chesapeake Bay tributaries; and developing strategies for specific sectors (residential, industrial, commercial developments, transportation infrastructure) in the Chesapeake Bay watershed to contribute to a cleaner Bay.

The University of Maryland research will complement similar EPA-supported work conducted by Pennsylvania State University researchers to understand how decisions are made at multiple levels to improve the planning, design, adoption, and successful implementation of innovative, sustainable stormwater management systems to protect and restore Chesapeake Bay. EPA awarded Pennsylvania State University a grant of $2,173,026 in 2011 to support that research. (Also see Community-Based Chesapeake Bay Stormwater Management on page 30.)

Summary of Grants to Support Water and Watersheds, Pollution Prevention, and Sustainable Development for Chesapeake Bay

Recipients	Research Project	Amount Awarded
University of Maryland - College Park	Sustainable Community Oriented Stormwater Management: A Sensible Strategy for the Chesapeake Bay	$691,674
Pennsylvania State University	Center for Green Infrastructure and Stormwater Management (awarded in mid 2011)	$2,173,026
		Total: $2,864,700

Oil from the Deepwater Horizon oil spill coats the water's surface, June 2010.

STAR Grants to Support the Environmental Impact and Mitigation of Oil Spills

EPA awarded four grants totaling $1.9 million to explore the development of innovative oil spill mitigation technologies and to provide needed technical assistance to Gulf Coast communities impacted by the Deepwater Horizon oil spill.

The funding will enable Gulf Coast communities affected by the oil spill to effectively participate in research projects so that they can benefit from, and use, the results in restoration and cleanup activities. The EPA-supported research will develop cost-effective, innovative technologies with low environmental impact that can be used for mitigating the impacts of oil spills, including: oil dispersants, surface washing agents, and bioremediation agents; also supported are projects investigating the environmental effects of oil spills and the application of dispersants and other clean up measures.

Summary of Grants for studying the Environmental Impact and Mitigation of Oil Spills

Recipients	Research Project	Amount Awarded
Michigan State University, Louisiana State University-Baton Rouge	Environmental Impact and Mitigation of Oil Spills	$500,000
Clemson University, University of South Alabama	Dendritic Polymers as Biocompatible Dispersants for Oil Spill Remediation	$500,000
Iowa State University, Columbia University in the City of New York, Louisiana State University-Baton Rouge	Producing and Characterizing *Bacillus Subtilis* Biosurfactants with Potentially Lower Environmental Impact for Salt Water Applications	$500,000
Skidaway Institute of Oceanography, University of Maryland, University of Southern Mississippi	Uptake and Effects of Dispersed Oil Droplets and Emulsified Oil by Estuarine Crustaceans in the Gulf of Mexico	$476,553
		Total: $ 1,976,553

STAR Grants to Support Treatment Technologies for Small Drinking Water

EPA awarded 11 grants totaling $5.5 million to support research on and demonstration of new and existing drinking water treatment technologies in small, public water systems to reduce or eliminate chemical contamination.

The research aims to provide small systems with reliable and more cost-effective treatment technologies to better manage co-occurring chemicals or groups of chemical contaminants in their water systems, resulting in cleaner water and a reduction in waterborne illnesses.

Summary of EPA Grants Research and Demonstration of Innovative Drinking Water Treatment Technologies in Small Systems

Recipients	Research Project	Award Amount
University of Massachusetts, Amherst	Use of Ferrate in Small Drinking Water Treatment Systems	$497,078
Lincoln University-MO, University of Missouri - Columbia	Improving Drinking Water Quality for Small Rural Communities in Missouri	$499,996
University of Illinois at Urbana-Champaign	Sustainable Catalytic Treatment of Waste Ion Exchange Brines for Reuse During Oxyanion Treatment in Drinking Water	$500,000
University of Texas - Austin	Fluoride, DBP Precursors, and Particles: Simultaneous Removal with Aluminum Salts A Solution for Small Drinking Water Systems	$499,357
University of Nevada - Reno	Contaminant Removal Using Membrane Distillation for Sustainable Drinking Water Treatment	$499,743
Arizona State University, Main Campus; University of Alaska, Anchorage	Sustainable Sorbents and Monitoring Technologies for Small Groundwater Systems	$500,000
The City College of New York	Municipal Sewage Sludge Based Composite Adsorbents For Removal Of Contaminants from Drinking Water Sources	$499,746

Summary of EPA Grants Research and Demonstration of Innovative Drinking Water Treatment Technologies in Small Systems, continued

Recipients	Research Project	Award Amount
University of Texas at El Paso, New Mexico State University - Main Campus	Point Of Use (POU) Water Treatment Systems For Improving Sustainability And Environmental Justice in Colonias of the Paso del Norte Region	$498,906
Clarkson University, Southern Nevada Water Authority	Integration of Filtration and Advanced Oxidation: Development of a Membrane Liquid-Phase Plasma Reactor	$499,779
University of Florida, University of South Florida	Small, Safe, Sustainable (S3) Public Water Systems through Innovative Ion Exchange	$499,361
University of Iowa, Johns Hopkins University, University of California - Riverside,	Research and Demonstration of Electrospun Nanofiber Filters: Multifunctional, Chemically Active Filtration Technologies for Small-Scale Water Treatment Systems	$499,466
		Total: $5,493,432

STAR Grants to Support Computational Toxicology

EPA awarded eight grants totaling nearly $8.6 million to support research to develop new, innovative ways to test and screen chemicals and chemical mixtures.

In support of EPA's commitment for safe and sustainable chemicals, the Agency is supporting the development of computational toxicology methods (high-throughput assays; see more in the "Chemical Safety for Sustainability" section of this document). The supported work is advancing insight into the causal relationship between chemical exposures and adverse developmental and reproduction health effects.

Summary of Grants for Developing High-Throughput Assays for Predictive Modeling of Reproductive and Developmental Toxicity Modulated Through the Endocrine System or Pertinent Pathways in Humans and Species Relevant to Ecological Risk Assessment

Recipients	Research Project	Award Amount
University of Texas-Austin	High Information Content Toxicity Screening Using Mouse and Human Stem Cell Models of Endocrine Development and Function	$1,200,000
Batelle Memorial Institute, Pacific Northwest Division	High-Throughput Cellular Assays for Modeling Toxicity in the Fish Reproductive System	$1,199,908
University of California-Davis	In Vitro to In Vivo Screening of Thyroid Hormone Receptor Disrupting Chemicals	$649,345
University of Michigan-Ann Arbor	Cell-Free Neurochemical Screening Assays to Predict Adverse Effects in Mammals, Fish, and Birds	$1,199,222
North Carolina State University	Multi-Sensor Reporter Cell Technology to Assess Hazard Involving Endocrine Signaling Pathways	$950,507
University of North Carolina-Chapel Hill	Carolina Center for Computational Toxicology: Assays, models and tools for NextGen safety assessments	$1,200,000
Oregon State University	Toxicity Screening with Zebra fish Assay	$1,199,999
University of South Carolina at Columbia	Imaging Assessment of G-protein-coupled Estrogen Receptor Activation	$1,063,460
		Total: $8,662,441

Collaborating on Health Disparities Research

EPA is a partner in the Federal Collaboration on Health Disparities Research, a coordinated, federal effort to target health improvement in populations disproportionately affected by disease, injury, and/or disability. The collaboration pools scientific expertise and resources to advance the research needed to accelerate the elimination of health disparities in vulnerable populations.

Additionally, EPA is partnering with the National Institute on Minority Health and Health Disparities (NIMHD), a division of the National Institutes of Health. This partnership supports health disparities research that takes into account the complex interaction of biological, social, and environmental factors that influence the health of certain populations. EPA and NIMHD recently funded 10 grant awards to support research initiatives and activities within NIMHD Centers of Excellence program.

Institution	Project Titles	Award Amount
University of New Mexico Health Sciences Center	New Mexico Center for Advancement of Research, Engagement, & Science on Health Disparities (NM CARES HD) - Environmental Health Core	$792,750
Weill Cornell Medical College, Cornell University	Environmental Health Disparities Research Core	$860,901
Georgia State University	Center of Excellence: Environmental Health Disparities Core	$724,523
University of Kansas Medical Center	Central Plains Center for American Indian Health Disparities (CPC-AIHD) Revision	$791,461
Columbia University Medical Center	Environmental Health Disparities Research in NOCEMHD	$850,638
The University of Texas at El Paso, The University of Texas Health Science Center Houston	Revision Application to Support Environmental Health Disparities Research	$752,795
University of Illinois at Chicago	Improving Environmental Health Disparities: A Fundamental Cause Approach	$817,064
Meharry Medical College, Charles Drew University of Medicine & Science, National Space Science and Technology Center, Tulane University of Louisiana, University of Maryland - Baltimore, University of Tennessee - Knoxville	Environmental Context of Health Disparities	$684,465
University of South Carolina at Columbia, University of Maryland	Analysis and Action on the Environmental Determinants of Health and Health Disparities	$669,258
University of Michigan - Ann Arbor, Drexel University, Jackson State University	Center for Integrative Approaches to Health Disparities – Environment Assessment Core	$556,144
		Total: $7,499,999

Stoking the Economic Engine: EPA's Small Business Innovation Research Awards

There are approximately 25 million small businesses in the United States today. As the leading source of employment growth, these firms have generated 60 to 80 percent of new jobs over the past decade, and are responsible for developing most of the country's new technologies.

EPA is helping to stoke the economic engine and tap the entrepreneurial energy of small businesses to meet today's environmental challenges while also growing a green and sustainable economy.

EPA's Small Business Innovation Research (SBIR) program was established to ensure that new technologies are developed to solve priority environmental problems. In 2012 EPA awarded nearly $4.1 million to 32 small companies to support the development of new technologies for protecting the environment and public health.

Twenty-five small businesses received "proof of concept" awards up to $80, 000 (phase I recipients). In addition, seven companies that received similar awards in 2011 were awarded additional 2012 funding, up to $300,000, to move their technologies towards commercialization and implementation (phase II recipients).

Summary of EPA Phase I SBIR Awardees

Small Business	Project Titles	Award Amount
Aerodyne Research Inc.	Size-Selection Aerosol Characterization Instrument	$80,000
Luna Innovations Inc.	Non-Formaldehyde Bio-based Phenolic Resins	$80,000
OnTo Technology LLC	Recycling Rare Earth Metals from Nickel Metal Hydride Batteries	$80,000
Fungi Perfecti LLC	Comprehensive Assessment of Mycofiltration Biotechnology to Remove Pathogens from Urban Storm Water	$80,000
Orono Spectral Solutions Inc	Preconcentration Technology for Infrared Analysis of Organophosphates in Water	$80,000
GVD Corporation	Environmentally-Benign Polytetrafluoroethylene (PTEE) Coating for Mold Release	$80,000
ThornProducts LLC	New Technology for Electricity Monitoring & Reporting Built into Electrical Receptacles and Switches	$80,000
UES Inc.	Real-Time, In-Line Sensor for Wastewater Monitoring	$80,000
SolarBee Inc.	Improving TTHM Reduction Processing and Operational Efficiencies in Potable Water Distributions Systems Using Solar-Powered Circulation with Diffused, Near-Surface Aeration	$80,000
Fluidic microControls, Inc	A 10 Kilowatt, Rankine Cycle Agricultural Waste to Energy Conversion Module Utilizing Ultra Micro Turbo-Alternators	$80,000
Faraday Technology Inc.	Microelectrode Array to Enable Robust Water Monitoring for Multiple Contaminants at Sub-Nanomolar Concentrations	$80,000
Sunocs LLC	A Non-Toxic Composite Flame Retardant	$80,000
Los Gatos Research Inc.	Ultra-Sensitive Detection of Air Toxics Using Incoherent Cavity Ringdown Spectroscopy	$80,000
NEI Corporation	Siloxane Removal from Biogass Using a Novel Drop-In Technology	$80,000
Compact Membrane Systems Inc.	Enhanced Drying of Pipeline Ethanol	$80,000
Intelligent Optical Systems Inc.	Fiber Optic Distributed Chemical Sensors for Environmental Impact Monitoring in Carbon Sequestration	$80,000
T3 Scientific LLC	Forward Osmosis Water Purification Membranes for Small Operations	$80,000
Altex Technologies Corporation	Highly Efficient Water Management System for Lignocellulosic Biomass	$80,000
NanoSonic Inc.	VOC-free, Highly Flame Resistant HybridSil™ Insulation Coatings for Next Generation Thermal Insulation and Energy Efficiency	$80,000
Okeanos Technologies LLC	Cost Effective Seawater Desalination with ICP Element Arrays	$80,000

Summary of EPA Phase I SBIR Awardees, continued

Small Business	Project Titles	Award Amount
Synanomet LLC	Novel Lignin-Based Magnetite Nanocomposites for Removal of Phosphate from Contaminated Waters	$80,000
Adherent Technologies Inc.	Emission Control System for Small Boilers	$80,000
The Laser Sensing Company	InFRNO2: INfrared Faraday Rotation of NO2 for Portable Sub-Part-Per-Billion Sensors	$80,000
Electron Energy Corporation	Cost-Effective Rare Earth Element Recycling Process from Industrial Scrap and Discarded Electronic Products to Valuable Magnetic Alloys and Permanent Magnets	$80,000
Membrane Technology and Research Inc.	Membrane Process for Solvent Reclamation and Reuse	$80,000

Summary of EPA Phase II SBIR Awardees

Small Business	Project Title	Amount Awarded
OPTRA Inc.	Fourier Transform Infrared Phase Shift Cavity Ring Down Spectrometer	$299,956
FBS Inc.	Defect Detection in Water Pipelines Using Ultrasonic Guided Waves	$299,960
Adherent Technologies Inc.	Catalytic Emissions Reduction System for Outdoor Wood Boilers	$300,000
Advanced Diamond Technologies Inc.	Development of a Scalable, Low-cost, Ultrananocrystalline Diamond Electrochemical Process for the Destruction of Contaminants of Emerging Concern (CECs)	$299,686
Faraday Technology, Inc.	Functional Chrome Coatings on Hard to Access, Internal Surfaces of Industrial Parts from an Environmentally Benign Trivalent Chromium Bath	$299,981
TDA Research Inc.	Pipeline-Quality Methane from Anaerobic Digestion Streams	$300,000
Lynntech Inc.	Microelectrochmical Capillary System for Environmental Analytical Lab on a Chip	$299,999
		Total: $2,146,352

P3—Winning the Sustainable Future

On April 25, 2012 EPA announced the winners of its annual P3 Awards Competition for Sustainability. More than $1 million was awarded to university and college teams from across the country who participated in the 8th Annual National Sustainable Design Expo on the National Mall in Washington, D.C.

The three "Ps" of P3 are People, Prosperity and the Planet. Established in 2004, the competition is focused on supporting innovative designs that benefit people, promote prosperity, and protect the planet while advancing sustainability around the world.

The competition has two phases. In the Phase I, student teams and their faculty advisors submit research proposals for a chance to win up to $15,000 in seed money to research and develop designs for sustainable solutions to current environmental and human health challenges.

Phase I grantees are invited to Washington, DC each spring to display their research at the National Design Expo. At the Expo, a panel of experts convened by the American Association for the Advancement of Sciences evaluates the projects and passes along their recommendations to EPA officials for selecting the winners.

In addition to the coveted P3 Award, winning teams received additional funding of up to $90,000 for moving their projects into Phase II, when they start developing marketable prototypes of their sustainable designs.

Previous P3 award winners have started successful businesses and are marketing the technologies in the United States and around the world.

Winners of the 2012 awards include:
- [Appalachian State University](#) for developing an artificial wetland suitable for recycling of grey water from small businesses for immediate reuse.
- [Butte College](#) for developing structural insulated panels for building construction using rice hulls, an abundant agricultural waste, as the primary raw material.

- Embry-Riddle Aeronautical University for designing a foldable solar power water purification system that can fit into a backpack for easy transport for use after a disaster affecting drinking water supplies.
- Gonzaga University for developing a simple ventilation system for kitchens in rural dwellings using electrical power generated from thermoelectric cells driven by waste heat from cooking fires.
- Oregon State University for raising awareness of pollution associated with the production and use of plastic mulch by farmers and testing alternative biodegradable mulch material.
- Princeton University for developing, testing and deploying an electricity generation system that can be transported in a standard shipping container and rapidly set up in rural communities and post disaster areas.
- Santa Clara University for developing a fuel cell capable of continuous sustainable energy supply to meet energy demands in rural communities in developing nations lacking reliable energy grids.
- Southern Illinois University - Carbondale for developing methods to extract (recycle) metals from coal combustion byproducts to reduce mining waste and to produce a concrete with reduced carbon dioxide emissions.

- SUNY College of Environmental Science and Engineering for studying ways to recover struvite, a slow release fertilizer, from digested animal manures and assessing its marketability.
- Texas State University - San Marcos for converting rice husks, a byproducts of agriculture, into a starter material called lignocellulose for producing fabrics, biofuel and silica nanoparticles.
- University of California - Riverside for designing a solar collector to heat ambient air for use in home appliances, such as clothes dryers and space heaters, to reduce home energy consumption.
- University of Cincinnati for developing a pilot scale system to convert grease from restaurants, a waste sent to landfills, to renewable biodiesel.
- University of Connecticut for investigating ways to use local industrial byproducts such as steal slag and lime kiln dust to control erosion and to stabilize roads in Nicaragua.
- University of Oklahoma - Norman for designing, field-testing, constructing, analyzing, and documenting a habitat for humanity house built of compressed earth blocks.
- Vanderbilt University for developing a biohyrid solar panel that substitutes a protein from spinach for rare metals (mined) and is capable of producing electricity.

2012 Honorable Mention winners include:

- Christian Brothers University for developing technologies to improve energy efficiency in the building envelope of residences in Memphis, Tennessee, that focus on the thermal properties of materials, fire safety, material stability and cost.
- Clarkson University for studying the feasibility of using waste heat and leachate from a solid waste management facility for energy to produce biodiesel from algae.

- [Drexel University](#) for designing a pilot-scale reactor for a local landfill that uses algae to produce biofuels from landfill leachate and gas.
- [Missouri University of Science and Technology](#) for designing a novel way to reduce the energy lost when power coming into a house is converted to the current needed by many household electronics to run.
- [Purdue University](#) for designing, building and installing affordable "ram" pumps in Haiti to improve the availability of water for its citizens.
- [Rochester Institute of Technology](#) for designing a hydrofoil system that harvests energy from a river while minimizing the harmful effects that dams create for river flow and sediments.
- [Santa Clara University](#) for developing a high efficiency solar absorber/exchanger that can bring low cost energy to urbanites who have limited space for solar collectors.
- [Southern Illinois University -Edwardsville](#) for evaluating the use of selenium-polluted plant waste materials harvested from phytoremediation sites to produce selenium-enriched edible mushrooms.
- [University of California - Davis](#) for designing and monitoring an affordable green roof technology that uses the shading from plants to cool roof surfaces and reduce peak electricity demand by up to 75 percent.
- [University of North Carolina at Chapel Hill](#) for creating and implementing a point-of-use disinfectant for drinking water that is cheap, non-toxic and effective in reducing waterborne illness in developing nations.
- [University of Texas at Austin](#) for designing, constructing and testing vermicomposting (composting with worms) bins to improve public health in the Dominican Republic by reducing water contamination from organic waste.

Image of Chesapeake Bay taken from the International Space Station.

Supporting Innovation

Innovative organizations recognize the importance of tapping the collective expertise of their staff and encouraging everyone to contribute ideas and submit possible solutions that support the organizational mission. EPA's Office of Research and Development has embraced this concept to harness the talent and energy of its scientists and engineers.

The Agency's Pathfinder Innovation Projects (PIPs) encourage staff researchers to try bold ideas that could produce transformational advancements in environmental and human health protection. PIPs reward the ingenuity and entrepreneurial spirit of Agency scientists and provide seed funding for proof-of-concept research.

Like EPA's extramural granting programs (see previous stories on the STAR grants and EPA's P3 student competition for sustainability), the PIP program employs a competitive review process to identify and support the best, most innovative proposals.

External panels evaluate proposals on several criteria, including the potential to dramatically transform how EPA solves environmental problems and the potential for significant progress toward sustainability.

Teams selected for their PIP proposals receive funding and time to work on the research. Although the awards are for internal EPA studies, some scientists do work across disciplines and garner external support. For instance, an Agency research team collaborated with the Naval Research Laboratory and NASA on the International Space Station to test a novel proof-of-concept satellite system that can monitor coastal water quality.

In 2012, ten new PIPs—on topics that range from building a toxicity screening system that more closely mimics air pollution exposure in human lung cells, to making risk assessments of waterborne viruses more reliable—joined the growing list of projects that cultivate innovative solutions to support EPA's mission to protect human health and the environment.

Learn More about EPA research grants, fellowships, and awards
- EPA Extramural Research Funding and Award opportunities: www.epa.gov/ncer/
- EPA's Small Business Innovation Research Program: www.epa.gov/ncer/sbir/
- EPA Research Fellowships: www.epa.gov/ncer/fellow/

Homeland Security

EPA's Homeland Security research supports the Agency's role as the lead federal agency for protecting water systems and decontamination efforts following incidents involving chemical, biological, or radiological contamination.

The research strengthens the resiliency of communities to prepare for and respond to contamination incidents. The research enables water utility managers, laboratory technicians, on-scene coordinators, risk assessors, risk communicators, and emergency responders to detect, prepare for, respond to, and recover from terrorist attacks and other disasters.

This section highlights some of the results EPA researchers and their partners have achieved in 2012 advancing Homeland Security.

Learn More!

For more information abut the impact and scope of about EPA Homeland Security Research, please visit: www.epa.gov/nhsrc/.

EPA researchers develop monitoring and early warning technologies as well as help utilities and communities prepare response for potential contamination events.

Protecting Drinking Water Supplies

The vast majority of Americans need look no further than their kitchen faucet to find clean, safe, and abundant drinking water. The nation's water distribution system is a model of success for delivering this vital resource in ways that also protect public health. That success is underscored by the need for constant vigilance to protect water sources and distribution systems from deliberate or accidental contamination. This was a fact that became clear in the wake of the 9/11 terrorist attacks and the subsequent mailing of anthrax-tainted letters to U.S. Senators and media outlets.

EPA is the primary federal agency responsible for treating drinking water and decontaminating drinking water infrastructure in the event of a terrorist attack or other incident involving chemical, radiological, or biological agents introduced into the water supply. These responsibilities are supported by scientific and engineering research conducted in EPA's Homeland Security Research program.

EPA researchers are developing the scientific and technical solutions needed to secure and sustain the nation's water systems. A primary goal of that work is to prevent or minimize the impact

of any attempted or actual contamination event. This is done through the development of monitoring and early warning technologies and software to provide system-wide, real time surveillance.

In 2012, EPA researchers continued to advance the Agency's award-winning CANARY Event Detection software, a technology that serves as an early warning system for water utilities. CANARY is used to quickly distinguish between day-to-day variations in water chemistry and those variations from a contamination event. Researchers are pursuing ways to tap information collected simultaneously from multiple locations (rather than each location separately). In addition, researchers released a Quick Start Guide to make the software more accessible and user-friendly by providing step-by-step, downloadable instructions.

Along with threat detection and monitoring tools, EPA scientists and engineers are also working to help water utilities, communities, and the public be better prepared to respond and recover (decontaminate and clean up) once contamination occurs. To learn how to better respond to biothreat agents in drinking water, they studied the effectiveness of chlorination and chloramination for destroying anthrax.
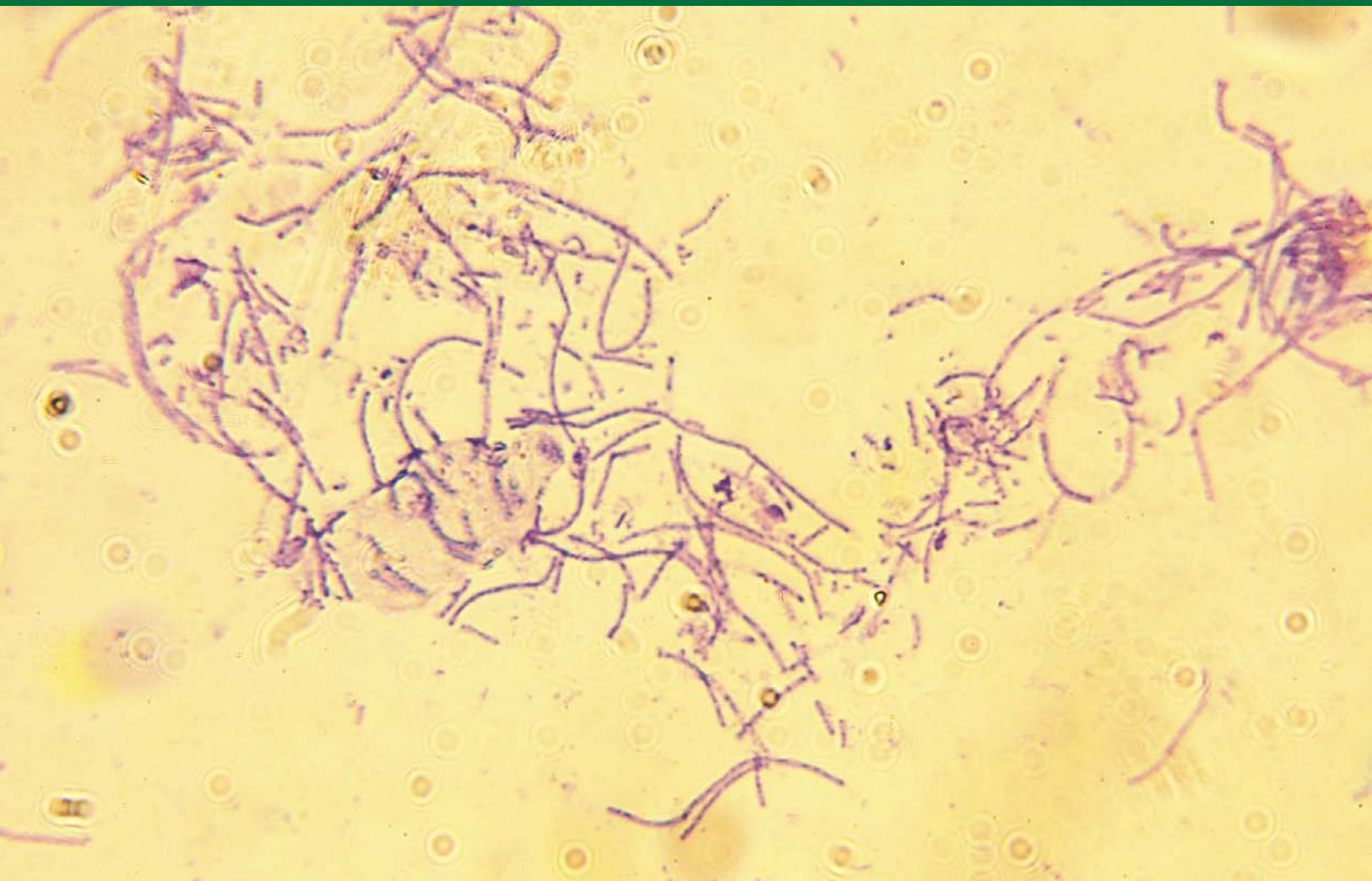
They also developed a standard protocol—the Standardized Persistence and Decontamination Experimental Design Protocol—that research laboratories across the country can follow when investigating the decontamination of water pipes. The use of such a protocol will facilitate comparability of research findings across studies and advance consistency and confidence in decontaminating water infrastructure.

Need to Know: Helping Water Utilities Prepare

As the lead federal agency for water security, EPA researchers play a critical role in helping their partners at water utilities and in the response community better prepare for emergencies. In 2012, EPA's National Homeland Security Research Center and the Water Information Sharing and Analysis Center (WaterISAC) teamed up to deliver the webcast "Anticipating the Public's Questions during a Water Emergency." The webcast provided practical information that drinking water utilities can use in formulating effective communication plans. These plans can then be employed during a water contamination event.

EPA also released a companion publication, *Need to Know: Water Emergency Questions*, presenting practical information that crisis communicators can directly apply to planning and response. The publication is the result of a series of interviews and webinars EPA conducted to identify the anticipated information needs of water utilities and the public following events that threaten the safety of drinking water. The report is available for downloading at: 1.usa. gov/QoyLtF.

Though microscopic, anthrax was the weapon involved in the worst act of bioterrorism in the country's history.

EPA Anthrax Research Aims to Eliminate Threat

In 2001, shortly after the terrorist attacks of 9/11, a series of anthrax-tainted letters were mailed to broadcast news outlets and two U.S. Senators. While those letters and their lethal contents never reached the specific network personalities or Senators they targeted, 27 people who came into contact with them became infected with anthrax. Five of those individuals died. At least 17 buildings were contaminated with anthrax spores, requiring extensive building decontamination.

In the past ten years, EPA scientists and engineers have been at the forefront of research to ensure that the nation is ready to respond to any event involving the deliberate or accidental release of anthrax. These researchers, in collaboration with other federal agencies with homeland security responsibilities, are finding new ways to limit human exposure, treat water supplies, and decontaminate buildings and other structures to neutralize anthrax spores.

That work continued in 2012 with the *Scientific Program on Reaerosolization and Exposure (SPORE)*, a set of coordinated studies conducted by EPA researchers in partnership with the Department of Homeland Security, the
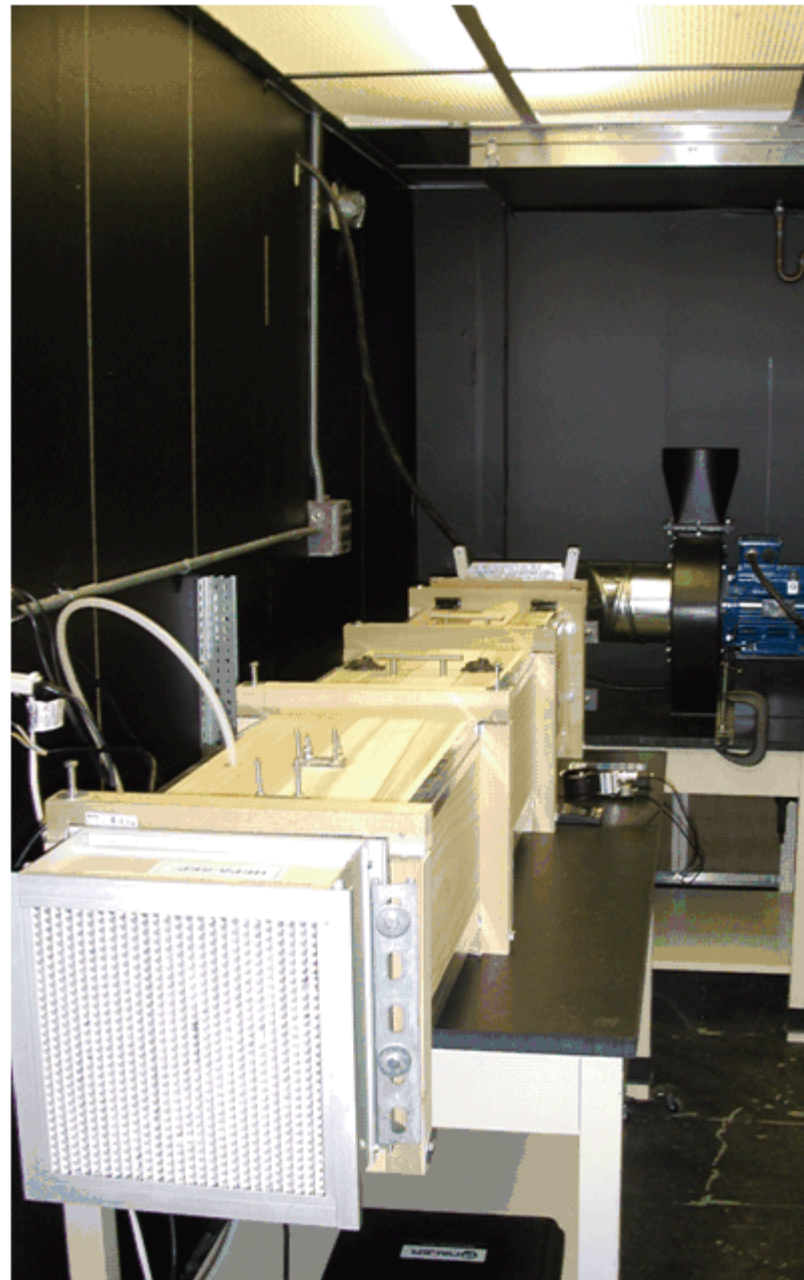
Department of Health and Human Services, the Department of Defense, and others.

Collectively they are working to find ways to inform the design of emergency response and decontamination procedures to eliminate the hazards posed by anthrax spores after an initial release. A focus of the program is to explore how anthrax spores might renter the air, ("reaerosolization") from surfaces where they settled after first being released. SPORE researchers conducted wind tunnel tests using anthrax surrogates and have found that reaerosolization of anthrax spores can occur even after the spores have settled, a key fact to consider for cleanup and disposal operations.

Another effort is underway in collaboration with the Centers for Disease Control and Prevention (CDC) to understand how best to eliminate the threat of an anthrax release in water. Researchers conducted seven laboratory-based studies in water using anthrax surrogates along with other microbes identified as potential bioterrorism agents.

Researchers from the EPA/CDC partnership found that the effectiveness of chlorine and other disinfectants in killing the various biological contaminants depended on how many microbes are present, the pH and temperature of the water, the type and quantity of organic and inorganic particles in the water and the kind of material used in construction of the pipes. The studies are providing important information to EPA's Office of Water and water utility managers who may have to deal with such biological contaminants.

The results of EPA's homeland security research will better inform and prepare the Agency and its stakeholders in responding to a terrorist threat or attack. These tools and techniques will result in quicker and more cost-effective response to and recovery from not just terrorist attacks, but other disasters, both natural and accidental.

Researchers conducted tests using this wind tunnel to determine that anthrax spores can reaerosolize, even after settling to the ground.

I-WASTE is a web-based tool that provides a suite of waste management information for cleaning up after natural disasters, terrorist attacks, and widespread outbreaks of animal disease.

Supporting Emergency Response and Recovery

Tragic events from the terrorist attacks of 2001 to the recent destruction left in the wake of Superstorm Sandy have made images of emergency response all too familiar: emergency crews rush in, search and rescue operations commence, and those affected are tended to and moved to more secure areas. Research products addressing terrorism response and recovery can also be employed in other situations.

For the past ten years, EPA's homeland security researchers have been conducting research that supports federal, state, and local decision makers working to prepare emergency responders and local communities with the information they need.

In 2012, EPA researchers continued to work with partners from the Department of Homeland Security on the **Wide Area Recovery and Resiliency Program (WARRP).** The program is a collaborative effort to develop and demonstrate actions to reduce the time and resources needed to recover from a large-scale chemical, biological, or radiological event, such as one affecting military installations, urban areas, or critical infrastructure.

Working with EPA's Office of Solid Waste and Emergency Response, public health officials, and waste management experts, EPA researchers have developed plans and tools to provide real-time information on waste disposal. EPA researchers updated the Agency's Incident Waste Assessment System and Triage Estimator (I-WASTE), a web-based, easily accessible tool that provides a suite of waste management information for cleaning up after natural disasters, terrorist attacks, and widespread outbreaks of animal disease.

I-WASTE 2012, available at http://bit.ly/12fs1EK, offers emergency response planners information on waste characterization, treatment, and disposal options, and how to incorporate safe, efficient waste management operations into emergency response plans.

To support emergency response operations involving hazardous biologicals and chemicals, in 2012 EPA researchers released SERRA 4.0 database (SERRA is an acronym for "Support for Environmental Risk Assessment). The "knowledge base" provides an extensive compilation of scientific information to assist scientists, emergency personnel, and decision makers responsible for planning and managing cleanup operations, including mitigating hazards, in the aftermath of a terrorist event.

Methods presented in SAM will allow for quicker and more efficient and effective lab analysis, communication, and support in the event of an emergency.

Ready to Respond: Improving the Nation's Emergency Preparedness

In the event of an environmental disaster involving potential contamination from radiation, biological, or chemical agents, the need for fast, accurate laboratory analysis is essential for supporting emergency response, recovery, and remediation operations. In the ten years since EPA's Homeland Security Research program was established, Agency researchers have helped the nation become significantly better prepared for just such response activities.

Agency scientists increased the nation's ability to analyze large quantities of environmental samples following the intentional or unintentional release of hazardous chemical, biological, or radiological (CBR) substances. To accomplish that, they have established the Environmental Response Laboratory Network (ERLN), a

nationwide network of analytical labs that can quickly support large-scale responses.

In support of the Network, EPA researchers have prepared *Selected Analytical Methods for Environmental Remediation and Recovery (SAM) – 2012*, the latest update of a compendium of methods for use in analyzing samples for chemical, biological, radiological, and biotoxin contamination.

The standardized analytical methods presented in SAM allow labs to share samples, increasing the speed of analysis, improving data comparability, and simplifying the task of recruiting and using commercial labs for rapid analytical support in the event of an emergency.

Researchers have prepared the latest update of a compendium of methods for use in analyzing samples for chemical, biological, radiological, and biotoxin contamination.

EPA researchers worked in collaboration with the Agency's Office of Emergency Management, the Office of Ground Water and Drinking Water, the Office of Radiation and Indoor Air, and EPA Region 10 (serving the Pacific Northwest) to update and improve SAM 2012.

The latest version of SAM 2012 incorporates revisions to the list of target sample types and provides the latest analytical methods and procedures. Method updates included are based on the availability of new methods or data, and now present more than 200 method summaries for biological, chemical, and radiochemical agents.

EPA has developed companion documents to provide information regarding field screening equipment, sample collection, rapid screening and preliminary analysis equipment, and sample disposal information to supplement the analytical methods included in SAM 2012.

In addition to providing access to the latest document, EPA's SAM-2012 website (www.epa. gov/sam) hosts a Methods Query, sample matrix type, and specific capabilities of a laboratory. The site also has full documentation of publicly available laboratory methods, companion documents, sample collection procedures, and links to technical contacts and key collaborators.

Learn More about EPA Homeland Security Research

- EPA Homeland Security Research: www.epa.gov/nhsrc/
- Read the Homeland Security issue of EPA's *Science Matters Newsletter*: http://epa.gov/research/sciencematters/september2011/index.htm
- Download EPA's *Homeland Security Strategic Research Action Plan, 2012-2016*: http://epa.gov/research/sciencematters/september2011/index.htm.

US EPA Research
@EPAresearch

Office of Research & Development is the scientific research arm of the US EPA.
11 states + DC · http://www.epa.gov/research

Follow

4,038 TWEETS
424 FOLLOWING
18,541 FOLLOWERS

Tweets

Meet ecologist Jana Compton! She researches the sources and effects of nitrogen pollution: http://1.usa.gov/YnHSPk #WHM #iamascientist

Mimi A G Wetherington Joy@SentryAir Norm Robert Rossa-chacj Lisa Klimek Mills
U.S. EP...

Chat w/@EPAwater ... hie ... ET on the importance of streams & wetlands. Submit questions now with #watercha...

RT @epalive: @MaryLuevano ... schools is about protecting the health of our children ... augues green @whitehouse ...

Creative #kids shine in SunW... http://1.usa.gov/aZMetW #teachers #parents #health #education

#PoisonPrevent Tip: Get your child tested for lead. There are no visible symptoms of lead poisoning: http://go.usa.gov/2kAV

Watch Women and the Environment today at 8:55 AM EDT. http://www.whitehouse.gov/live Join the conversation with #shegoesgreen and @EPAlive.

#PoisonPrevent Tip: 10,000 children are accidentally exposed to mouse & rat poison annually. Help prevent exposure: http://1.usa.gov/V4JTwg

Spring is here! Cleaning out your fridge? Remember to shop your fridge first before buying food! http://go.usa.gov/gQbz

Last year, we removed 6,200 pounds of chemicals from schools in the southeast. Read more about our work last year: http://go.usa.gov/2ycJ

Last year, we removed 6,200 pounds of chemicals from schools in the southeast. Read more about our work last year: http://go.usa.gov/23SB

#PoisonPrevent Tip: Keep all household products in their original container: http://1.usa.gov/xW4KSV

Welcome to the first day of spring, Capitol grounds will be in bloom soon. http://instagr.am/p/XFKEWOmN9w/

Learn about new training on reducing #agricultural #pesticides within the home at Project LEAF: http://go.usa.gov/2XQ9

#PoisonPrevent Tip: Use safer mouse and rat control products to prevent accidental child exposure: http://1.usa.gov/V4JTwg

How do we clean up contaminated sites? Scientist Kira Lynch shares the details: http://1.usa.gov/XIMpgy #WHM #iamascientist

Nominate your projects – buildings, parks, plazas, policies – for the our Smart Growth Awards! April 12 deadline. http://go.usa.gov/2bZF

A trip to Laos | Today's #StateoftheEnvironment #Photo http://blog.epa.gov/epplocations/2013/03/todays-photo-a-scene-from-laos/#.UUidz0Ul3eI.twitter … http://www.flickr.com/pho-

tos/94051914@N03/8556889477/in/pool-1667216@N23/ …

#Spring into sun safety and prevent #skincancer http://1.usa.gov/aZMetW #teachers #parents #kids #health #education

#PoisonPrevent Tip: Poisonings are preventable! Read the label before using pesticides and household products: http://1.usa.gov/

... rotect children and pets from mouse and rat #poison by using a tamper-resistant bait station: http://1.usa...

... ersense: Check water meter before & after 2hrs of ... u use it meter doesn't read exactly the same, you probably

... th! Her work helps communities make sustainable and healthy decisions: http://go.usa.gov/2Nxd #WHM #iamascientist

The #TRIUniversity Challenge application period is open! Students/Profs can send project ideas to EPA through 5/13 http://ow.ly/j9WKa

RT @epawatersense: We have #fixaleak information en Espanol too! http://go.usa.gov/296k

P2 webinar this week: Exploring TRI's Pollution Prevention Info on 3/20 @ 2:00 ET – details & register @ http://tinyurl.com/cbaakvt

Here's our full list of tips to fix leaks http://go.usa.gov/Unw #fixaleak

It's also easy to find and repair leaks yourself. It's as easy as Check. Twist. Replace. #fixaleak

We have folks from across the country! Awesome! Great to see you all here! Lets get this party started. #fixaleak

Hey #Wyoming ~ match your past w/ #DOCUMERICA #strip-mining, #cattle, #billboards http://blog.epa.gov/epplocations/#.UUc7kbid3mY.twitter … http://www.flickr.com/photos/usnation-alarchives/7065910079/ …

Every Monday – Take a blog road trip for a #NewEngland per-spective on environmental issues: http://ow.ly/inCE3

Who's ready for #fixaleak week!?! Kick things off w/ @EPAwa-tersense at our Twitter party Monday 3/18 1-2pm ET. See you then!

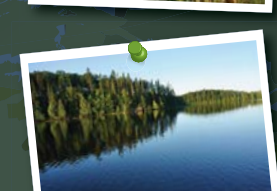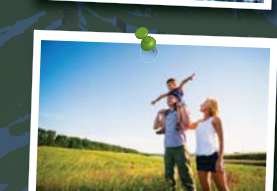#PoisonPrevent Tip: Store pesticides and household cleaning products out of children's reach: http://1.usa.gov/xW4KSV

Learn about new training on reducing #agricultural #pesticides within the home at Project LEAF: http://go.usa.gov/2XQ9 #AFOB

Happy St. Patrick's Day! Don't just wear green, BE green. Climb the Food Recovery Hierarchy and save green too! http://go.usa.gov/gQbG

Stay connected to EPA science throughout the year!
• Follow us on Twitter: @EPAresearch
• Subscribe to the EPA Science Matters newsletter: www.epa.gov/sciencematters
• Join the "Greenversation" on our It All Starts with Science blog: blog.epa.gov/science/

EPA