WATER CURRENTS

Center for the Management, Utilization and Protection of Water Resources • Winter 2006 Newsletter • Volume 5, Issue 2

CENTER FORMS RESEARCH PARTNER-SHIPS

Representatives from Tennessee State University recently met at the Center to hammer out details of the research partnership. (Photo by Amy Knox)

The Center for the Management, Utilization and Protection of Water Resources (Center) recently began spearheading an effort to establish collaborative partnerships with institutions both in the state and overseas. For one of the international agreements, the Center worked closely with Tennessee Technological University hydrologist and Center faculty associate Faisal Hossain.

"During these days of growing awareness on water issues and cross-disciplinary research, establishing strategic partnerships with research institutes worldwide is critical for the Center to maintain its capability to address water concerns effectively for the state, the nation and beyond," Hossain said.

The partnerships have been established with the Institute of Water Modelling in Bangladesh and the Faculty of Sciences in Tunisia. An agreement with Tennessee State University is being formalized. The purpose of these coalitions is to help facilitate an exchange of faculty, students, nonproprietary academic and research data, and educational and development programs between the Center and the participating institution. The faculty and staff exchange will involve travel to the other institutions to develop research contacts, deliver lectures or participate in research activities within the framework of the agreed-upon programs.

"Humans have available less than 0.08 percent of all the Earth's water," Dennis George, Center director and environmental engineer, said. "Yet, over the next two decades our use is estimated to increase by about 40 percent. Water shortage is one of the two most worrying problems for the new millennium (the other is global warming.)

"It is appropriate for the Center to engage with other professionals throughout the world to find answers to the numerous water-related problems facing the world, our nation and state."

Access to libraries and laboratories will also be provided for the participants, who will explore means of financing joint projects through grant writing, special government funding and other funding sources. The institutions will also seek opportunities for joint consulting on projects that can enhance the image of the institutions in the international arena.

"These institutes offer a complementary forum for technical collaboration where new ideas can be assimilated by Center researchers and be applied outside the United States, increasing the international visibility of the Center," Hossain said.

Inside This Issue

CENTER COSPONSORS WEF WEBCAST

TOPIC FOCUSED ON COMPOUNDS OF EMERGING CONCERN IN WASTEWATER TREATMENT

Hosting the latest presentations on environmental information important to the public is becoming routine for the Center, which recently cosponsored the Tennessee Tech presentation of the Water Environment Federation's (WEF) webcast, titled "Compounds of Emerging Concern (CECs) in Wastewater Treatment." Tennessee Tech faculty, staff, and students, and water utility personnel were invited to attend. Martha J.M. Wells, environmental chemist with the Center, coordinated the on-campus viewing.

CECs are the pharmaceuticals, personal care products, pesticides, industrial chemicals and other contaminants that infiltrate water sources. According to WEF, the compounds are becoming more of a concern to the general public as scientists continue to find more and more of them in our water. Participants of the webcast learned what happens to CECs during wastewater treatment and how to communicate that information to the public. Regulatory thought processes and constraints were also considered as part of the effort to comprehend CECs.

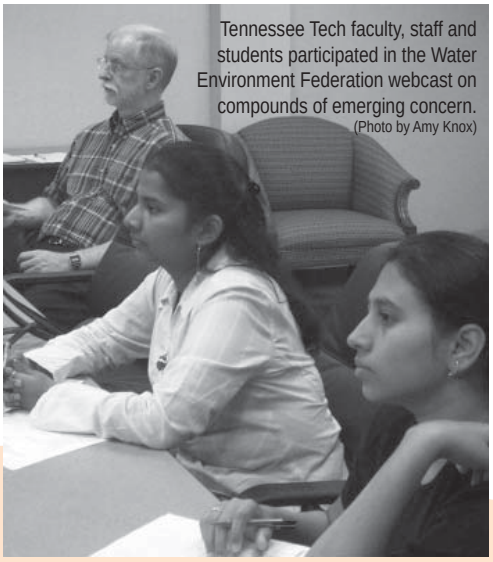
Sam Jeyanayagam of Malcolm Pirnie, Inc., moderated the event. Speakers included Mark LaGuardia of the Virginia Institute of Marine Science, College of William and Mary; Linda Macpherson of CH2M Hill; Octavia Conerly of the U.S. Environmental Protection Agency; and Jay Witherspoon of CH2M Hill and chair of the WEF CEC Community of Practice.

"EPA estimates that there are more than 100,000 compounds currently in commerce whose toxicological properties are largely uncharacterized," said LaGuardia, in his presentation that reviewed the impact of CECs on wastewater treatment. "Here we refer to the 'new' contaminants as CECs."

LaGuardia says that increasing concerns over some CECs has triggered voluntary restrictions aimed at limiting or reducing their exposure, and monitoring will eventually be required.

Other presenters spoke on public education and outreach regarding CECs and ways to speak about CECs that neither create undue alarm or complacency; legislation involving clean water; and the community of practice group being formed that will provide a place for participants to share their common concern on this emerging topic.

More information about the webcast and CECs is available at www.wef.org.



Tennessee Tech faculty, staff and students participated in the Water Environment Federation webcast on compounds of emerging concern. (Photo by Amy Knox)

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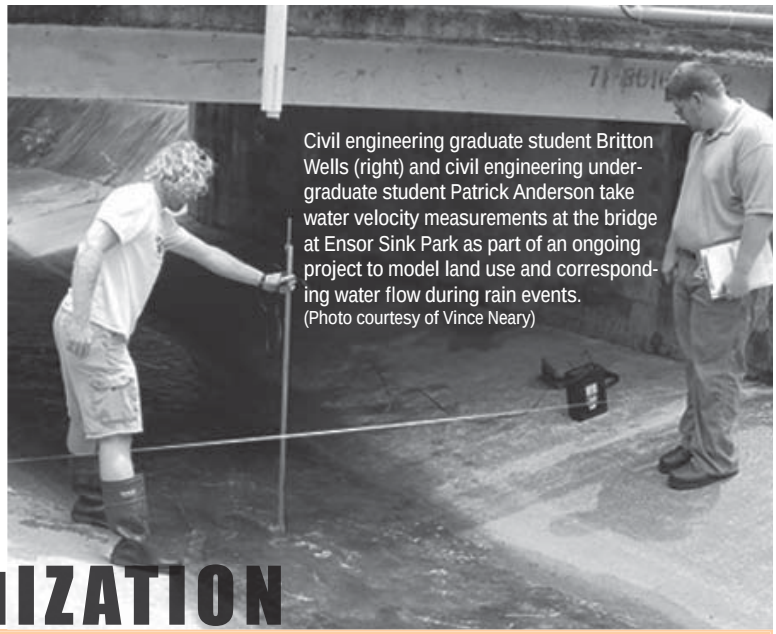


Civil engineering graduate student Britton Wells (right) and civil engineering undergraduate student Patrick Anderson take water velocity measurements at the bridge at Ensor Sink Park as part of an ongoing project to model land use and corresponding water flow during rain events. (Photo courtesy of Vince Neary)

RESEARCHERS EVALUATE IMPACTS OF URBANIZATION ON HYDROLOGY

As Cookeville, Tennessee, continues to grow at higher-than-average rates, the likelihood for downstream flooding also grows because increasing urbanization, which yields large paved and other impervious areas, can intensify the volume and flow of storm water runoff.

In a project funded by the Tennessee Department of Agriculture Non-point Source Program, hydrologist Vince Neary is examining the impacts of urbanization on hydrology through the use of hydrologic modeling techniques. A mitigation plan, which will incorporate best management practices (BMPs) and low impact development (LID) techniques to help offset these impacts within the Pigeon Roost Creek watershed, will be developed. Neary and his graduate student, Britton Wells, are implementing a pilot study in the Ensor Sink subwatershed to determine the mitigation plan's effectiveness for the entire Pigeon Roost watershed. As a first step, land use and corresponding water flow during rain events within Ensor Sink are being modeled.

Geographical information systems (GIS) techniques and the Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) have been used to determine the existing conditions of the watershed. HEC-HMS allows for the simulation of runoff processes in certain watershed systems, and hydrographs created with this program can be used with other software to study water availability, urban drainage flow forecasting, and the impacts of future urbanization. The hydrologic model of the Ensor Sink catchment, which incorporates historic rainfall and runoff data monitored in the region, is being used to evaluate the impacts of urbanization on the Ensor Sink hydrological system and develop the proposed mitigation strategy.

To evaluate the various strategies, Neary and Wells are using 2, 5, 10, 20, 50 and 100-year design storms to study the peak flow rates and total runoff volumes at the outlets of each major subwatershed and the outlet of the Ensor Sink watershed. Whichever plan is shown to significantly alleviate the impacts of urbanization will be the one chosen. According to Neary, the successful method will be the one in which the runoff volume and peak flow rates most closely reach pre-development levels.

Some of the LID practices for consideration include installing greenways, wetlands, retention basins, green roofs and porous pavement. Increasing green areas and reducing impervious pavement should help decrease water flow and flooding during storm events.

"There are many low impact development approaches being used around the country," Kim Stearman, soil scientist and project investigator, said. "These practices not only reduce flooding but beautify cities and improve opportunities for growth and development.

"This type of development is a win/win situation. Getting the word out and changing development practices in small ways lead to large reductions in flooding and erosion."

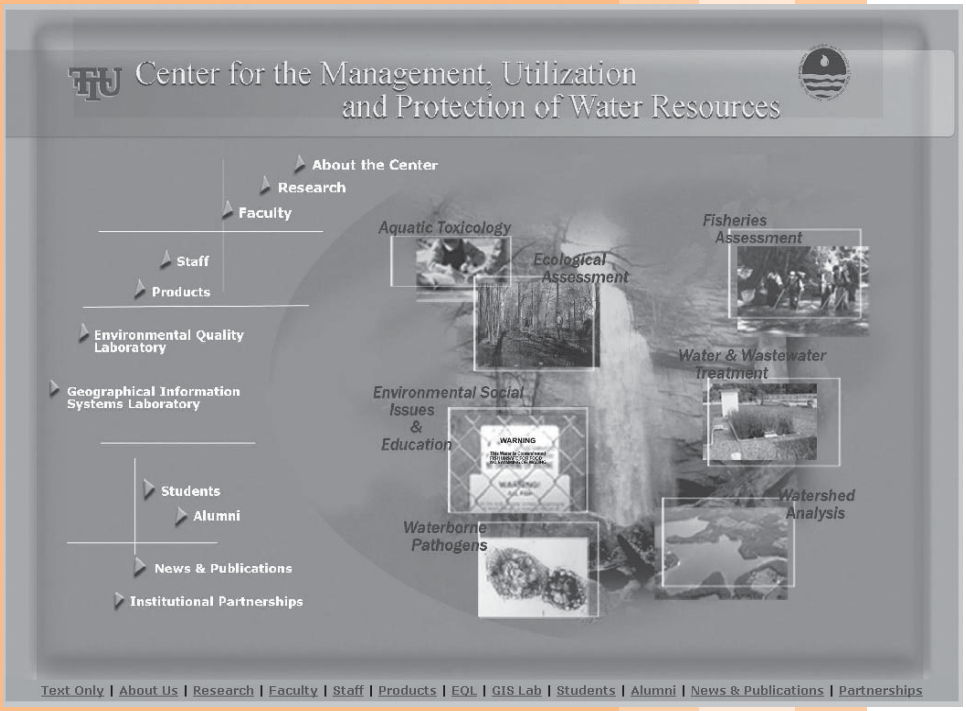
Detention basins, or on-site storage/release systems, are the most commonly implemented mitigation strategy. According to Neary, these structures are "not designed to restore site infiltration to pre-development conditions and provide little or no pollutant removal."

Yvette Clark, research and development engineer and GIS specialist with the Center, has been involved in the GIS aspects of the project. Dennis George, Center director, has also provided support through the Center.

CENTER'S WEB SITE GETS A NEW LOOK

SITE ALSO FEATURES HELPFUL RESEARCH PRODUCTS DEVELOPED BY THE CENTER

The Center's Web site recently underwent a transformation to make it even more accessible, informational and user-friendly. The site, which is located at www.tntech.edu/wrc, houses information on the Center's research, core faculty, faculty associates and staff.



Several products that have been developed by the Center were also linked from the new site. One of these is the digital annotated bibliography created for the Duck River watershed. The project was funded by the Tennessee Duck River Development Agency and includes information about the river flow/quality, biology, history, community and culture of the region. Other products linked from the Web site are the "Chattanooga Creek Watershed: Environmental Testing" and "Pollution in Our Communities: Air, Water, Soil and You" projects, the creation of which was led by environmental chemist Martha J.M. Wells. Both projects were funded by the U.S. Environmental Protection Agency. The Chattanooga Creek work consists of historical information (from 1973-1992) about water quality testing in the Chattanooga Creek area, and it also includes archived documents from 1997 analytical tests in South Chattanooga. The pollution project provides an overview of pollutants and how people can determine their risk from exposure to them. The other products on the site include a budget calculator, which can assist researchers in preparing proposals, and the watershed quality index (WQI), which is a watershed model tool for conceptually assessing environmental and financial costs associated with changes in land- and water-resource practices.

The institutional research partnerships in which the Center has recently become involved to enhance faculty exchange and collaboration are also featured, along with in-depth descriptions of faculty and their research expertise. The site continues to highlight the extensive environmental research for which the Center is nationally and internationally acclaimed.

WEB SITE
UPDATE

CHEMIST MONA WELLS AND RESEARCH TEAM USE BIOSENSORS TO STUDY CONTAMINANTS IN WATER

The term “electronic tongue” conjures up all sorts of science fiction-type images of mechanical appendages put to use by robotic figures. The electronic tongue that chemist Mona Wells is working on is actually very different.

Much like the human tongue, which can distinguish the difference among varying tastes, the “tongue” that Wells is developing can potentially distinguish among the various chemical compounds found in water. This is important as the U.S. Environmental Protection Agency grows increasingly more concerned with the presence of particular chemicals that researchers are terming “endocrine disrupting compounds,” which originate from anthropogenic activities and are being shown to affect the reproductive health of fish.

Wells is using genetically engineered biosensor bacteria -- developed at the Hebrew University of Jerusalem by Shimshon Belkin, Wells’s senior collaborating partner in this work -- to provide information on the presence of certain chemicals in water. Other biosensors that have been used for this type of study were designed to turn color, fluoresce, or luminesce in the presence of the specific compound, like arsenic, they were designed to detect. The biosensors Belkin is providing are selective and can alert to several of the compounds present in the water, but not all.

“Chemical tests have been used for this work in the past,” Wells said, “but now we’re proposing the use of biosensors because of the limitations of the tests.

“Chemical tests show just how much of a chemical is present, whereas the biosensors can show how much of a contaminant is bioavailable, that is, the amount of it that’s actually toxic. We’re not suggesting to replace chemical tests but to use them in conjunction with biosensors.”

Bioavailability and bioaccessibility, or the amount of the contaminant that can potentially be toxic if in the presence of certain other compounds, are emerging hot topics in chemical research.

“I am one of a growing number of people who are dealing almost exclusively in bioavailability,” Wells said. “And the EPA has a plan for increasing assessment based on bioavailability of toxins, rather than just the chemical load of the compounds.”

The importance of Wells’s work is evident in the recent funds she received from BARD, the Binational Agricultural Research and Development Foundation. The goal of the three-year project is to develop the electronic tongue that will provide a schematic of compounds present in water based on what the biosensors reveal. From there, the researchers will attempt to determine the toxicity of the compounds by looking at the oxidative stress on the biosensors, the DNA damage and the mutagenicity.

“From that, we will develop a sort of fingerprint of the toxicity of the compounds,” Wells said. “We hope to be able to use those fingerprints to classify the ones that are causing the endocrine disruption.”

Wells and her research team are using artificial neural networks, which mimic the activity that the human brain engages in when interpreting senses received from a human tongue, to process the data gleaned from the electronic tongue.

Master’s student Sirisha Busam has been working with Wells for a year-and-a-half on the preliminary research. Wells foresees that their work will be important to both industrialized and nonindustrialized nations where the safety of water supplies can be compromised, either intentionally or unintentionally.

“This research can also have implications for homeland security,” Wells said. “It’s not so important to know which chemicals may have been introduced to water supplies through terrorist activities as it is to know how much of those chemicals are actually harmful, thus, the bioavailability.”

CENTER FACULTY & STAFF LEND THEIR TALENT TO PRESIDENT'S ACADEMY

For the Center's faculty and staff, there is no end to the demand for their expertise. Recently, Martha J.M. Wells, environmental chemist, and Yvette Clark, research and development engineer, were asked to teach sessions of the Tennessee Tech President's Academy for Emerging Technologies.

Wells taught lessons in nanotechnology, nanoscience and environmental studies. Clark taught sessions on using geographical information systems (GIS) technology. This makes the second year that they have taken part in the event that offers an opportunity for students entering grades 10-11 to partake in the university experience.

"In teaching these students, I wanted to share my passion of science and help them realize that going to college and furthering their education are achievable goals," Wells said.

Wells's environmental sciences Ph.D. student Tammy Boles has helped both years with the lab portion of Wells's sessions. Boles is also a program coordinator/advisor for the university's School of Interdisciplinary Studies and Extended Education.

The summer program is directed by Ken Hunter, associate professor in basic engineering, and participants are chosen through a competitive selection process. Thanks to funding from private contributions, the program is free to students who get to take part in university life firsthand by living in the residence hall and dining in the campus cafeteria.

That is only the beginning of the college experience as students also get to meet professionals in emerging technology fields and take part in lectures, hands-on activities, assignments and field trips. Faculty who are involved include researchers from Tennessee Tech, Vanderbilt University, the University of Tennessee Space Institute, and Oak Ridge National Laboratory.

The participants' curriculum focuses on emerging technology and includes a look at biotechnology. The students also learn about micro- and nanotechnology, including microelectromechanical systems (MEMS) research and the use of nanotechnology in materials research and medicine. Information technology is also explored through an evaluation of modern engineering software tools, including solids modeling, chemical modeling, water quality simulation and biological algorithms. The students examine current research in fuel cell technology, construction and operation of a working hydrogen fuel cell, and the engineering applications of mathematics in operations research.

Field trips include visits to Oak Ridge National Laboratory, the University of Tennessee Space Institute, the Vanderbilt Institute for Nanoscale Science and Engineering, and Tennessee companies where emerging technologies are put in practice. For Clark's classes, the field trips involved exploring the Tennessee Tech campus.

"For demonstration purposes, I gave the kids some GIS coordinates, some trivia questions, and a GPS [global positioning system] unit and sent them off around campus on a scavenger hunt," Clark said. "I really think it helped them put into practice what they had been learning in the classroom about the many uses of GIS technology."

MICRO-BIOLOGIST BERK RECEIVES NATIONAL ATTENTION

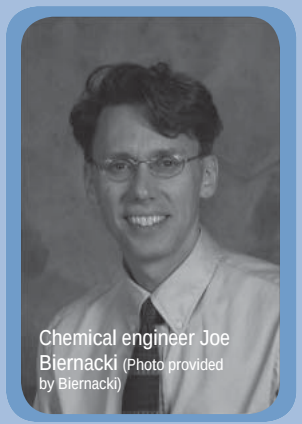
The research in which Center faculty are involved continues to receive recognition not only from peers, but also the general public. That fact has become increasingly apparent recently. In a span of only a couple of months, microbiologist Sharon Berk and her research team's work on the bacteria that cause Legionnaire's disease was highlighted in the *Environmental Science and Technology* (ES&T) journal and a nationally syndicated radio broadcast by Paul Harvey. Those spotlights led to even more attention with two news articles and a blurb in the weekly magazine *Science News*. According to ES&T's latest online news, Berk's *Environmental Science and Technology* publication was the most-accessed article by subscribers to the journal's Web site during the July through September period.

Berk and her team's work suggests that amoebae infected with *Legionella* bacteria, which lead to Legionnaire's disease, are more likely to be found in cooling towers than natural environments. Their study compared 40 natural aquatic environments with 40 cooling tower environments. In 22 of the cooling tower samples, predictors of the occurrence of infected amoebae were found. The same predictors were found in only three of the natural environment samples. According to Berk, infected amoebae, which may be hosts of other disease-causing bacteria, can spread through the aerosols from cooling towers.

FACULTY ASSOCIATES RECOGNIZED WITH NATIONAL AWARDS

Chemical engineer Don Visco (Photo by TTU Photo Services)

"The recognition our department and university obtain from these national awards is very satisfying."
~ Don Visco



Chemical engineer Joe Biernacki (Photo provided by Biernacki)

"With this system, faculty can offer real-time intervention at both the course and individual levels."
~ Joe Biernacki

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Two Tennessee Tech chemical engineering faculty associates who work with the Center captured national attention at the recent American Society for Engineering Education Conference and Exposition in Chicago. Don Visco and Joe Biernacki were honored with two of the top awards in the chemical engineering division for their scholarship and research.

Visco received the Ray W. Fahien Jr. Award, given in honor of the founding father of the journal *Chemical Engineering Education*. The award, limited to faculty within the first 10 years of their careers, is given annually to an educator who has shown evidence of vision and contribution to chemical engineering education.

Visco's nomination cited his vast mentoring of students at all levels, from undergraduates to doctoral candidates, in both technical research and education-based scholarship. Additionally, Visco has developed a model for using graduate students as co-instructors, not just teaching assistants, in undergraduate classes.

Other ways Visco has contributed to engineering education include his formation of a workshop for new faculty on campus related to education, his service as the American Society for Engineering Education (ASEE) campus representative coordinating Brown Bag lunch seminars on educational topics, and his development of the Chemical Engineering Division of the Southeastern Section of ASEE.

"It is nice to be honored from a personal standpoint since it validates, at some level, my career choice," Visco said. "But the recognition our department and university obtain from these national awards is very satisfying. When we mention as a vision being an 'acknowledged leader in engineering and technology education,' such awards go a long way toward supporting this vision."

Joe Biernacki's commitment to creating new ways to assess the quality of classroom education earned him the first award received by any Tennessee Tech chemical engineering faculty member from ASEE's Chemical Engineering Division.

His article "A Quantitative Course-level Strategy for Using ABET-based Assessment Outcomes" garnered him ASEE's prestigious 2006 William H. Corcoran Award. The same article also won the 2006 Thomas C. Evans Instructional Paper Award at the ASEE-SE meeting and was a featured article in the *Annals of Research on Engineering Education*.

Biernacki took it upon himself to fill a gap he found in the knowledge that existed about assessing and tracking student performance as it relates to accreditation by ABET, the recognized accreditor for college and university programs in applied science, computing, engineering, and technology. In a three-year case study, he implemented an outcomes-based approach and assessed the relationship between student performance and classroom teaching.

"Traditionally, most of us do not design our courses around outcomes, but rather around requirements," Biernacki explained. "Prior to ABET's putting an emphasis on explicitly defining outcomes and tracking performance, most of us faculty members placed value in course requirements such as homework, exams, attendance and projects, typically with a single lumped grade for each."

He suggested, rather, a week-by-week approach in which homework, quizzes, projects and the like are broken down into outcomes, modified accordingly and then implemented.

"In the old system, students were assessed according to what fraction of the overall problem was correct, generally irrespective of what skill-based elements of the problem were correct or incorrect," he said. "With an outcomes-based system, skill-based outcomes are identified and elements are independently scored.

"With this system, faculty can offer real-time intervention at both the course and individual levels," said Biernacki, whose paper was published in *Chemical Engineering Education* (2005). "Students performing poorly against a specific outcome can be given extra help, and changes at the classroom level can be made if large numbers of students are having trouble in a given outcome area."

EASTERLY PLACES FIRST IN STUDENT POSTER CONTEST

Melissa Easterly and her graduate advisor Martha J.M. Wells (right)
(Photos by Amy Knox, left, and TTU Photo Services, right)

FLUORESCENCE

Graduate student Melissa Easterly* won first place in a student poster contest for her presentation, titled "Fluorescence Mapping of Dissolved Organic Matter (DOM) in Surface Water, Drinking Water, and Wastewater," at the July 2006 Water Professionals Conference of the Kentucky and Tennessee Chapters of the American Water Works Association and Water Environment Association. Environmental chemist and Easterly's graduate advisor Martha J.M. Wells coauthored the poster. The conference was held in Chattanooga.

In their research, Wells and Easterly use ultraviolet-visible light and 3D fluorescence to reveal the properties of DOM to help understand its effect on water treatment. If DOM comes in long-term contact with chlorine during the water treatment process, potentially harmful disinfectant by-products can form. By studying the differences in the DOM spectra, Wells and Easterly can determine the geographic area where it originated and which of the organic compounds are not removed through the purification processes of drinking water and wastewater treatment plants.

*Easterly graduated December 2006 with her master's in chemistry.

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If you are an alumnus of the Center, please help us update our records by sending an e-mail to cmupwr@tntech.edu with your current address and employer information.

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