National Water Research Institute
BRIEFINGS
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Dr. George Tchobanoglous Is Awarded the 2003 Clarke Prize

For 10 years, the Athalie Richardson Irvine Clarke Prize has been awarded to outstanding scientists for excellence in water research. This year, the Prize was awarded to George Tchobanoglous, Ph.D., P.E., for his dedication not only to research but, perhaps more importantly, to education.

Dr. George Tchobanoglous receives the 2003 Clarke Prize from Mrs. Joan Irvine Smith, patron of the award.

The 2003 Clarke Prize was presented to Dr. Tchobanoglous on July 17 by Mrs. Joan Irvine Smith, patron of the award, at the Tenth Anniversary of the Clarke Prize Award Ceremony and Lecture, held at the St. Regis Monarch Beach Resort and Spa in Dana Point, California.

Throughout the evening, friends, family, colleagues, and admirers — including President George W. Bush and Governor Gray Davis, who sent letters of commendation — honored Dr. Tchobanoglous for his devotion to water science.

"I commend Dr. Tchobanoglous for your remarkable contributions to environmental engineering," wrote President Bush. "…The greatest environmental progress in this century will come through technology and innovation. Through advances in science and technology, we will meet the environmental challenges of the future."

Richard C. Atkinson, President of the University of California system, also commended Dr. Tchobanoglous, who is Professor Emeritus in the Department of Civil and Environmental Engineering at the University of California, Davis.

"I can think of no finer recognition of the extraordinary contributions you have made to water-science research and technology than [the Clarke] prize," said Dr. Atkinson. "As a respected member of the faculty, you have enriched the University of California beyond measure, and your long association with the University of California is a source of great pride for us. We are grateful for all you have done and continue to do on behalf of your students and your profession."

Dr. Tchobanoglous has made myriad contributions to the practice of environmental engineering. He is widely recognized for advancing the use of new technologies in four key areas: constructed wetlands for wastewater treatment, the application of alternative filtration technologies, ultraviolet (UV) disinfection for wastewater reuse applications, and decentralized wastewater management.

His early work on the use of wetlands for wastewater treatment culminated in the first national conference on the subject in 1979. Applying the knowledge gained from his research into aquatic systems, he wrote the original Request for Proposal for the City of San Diego aquaculture facility, which operated for over 20 years. In addition, under his direction, a series of four regional guidance manuals for salt marsh restoration, rehabilitation, and creation techniques were prepared for the California Department of Transportation (Caltrans) and are still in use today.

Based on Dr. Tchobanoglous' filtration research, a variety of new filtration technologies have been approved for use in restrictive reclamation applications. In the early 1970s, only two conventional filters were approved. Recognizing that a number of new technologies were emerging that could be applied to the filtration of wastewater, Dr. Tchobanoglous pioneered a research program that used comparison testing of alternative and conventional filtration technologies to demonstrate to the Department of Health Services the potential of alternative technologies. As a result of his

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Bellagio Workshop Promotes Interest in Membrane Technology

Thirteen scientists from around the globe met in April 2003 to discuss the potential for membrane processes to promote water sustainability, particularly for developing countries. Membrane processes use synthetic membranes to separate solids from water and are used in drinking-water production and wastewater treatment.

The workshop — "The Bellagio Team Residency Exploration of the Potential of Membrane Technology for Sustainable Decentralized Sanitation" — was sponsored by the Rockefeller Foundation and held at its study center in Bellagio, Italy. The Bellagio International Residency Team included participants from Australia, Germany, Malaysia, Israel, Italy, South Africa, United Kingdom, and United States. This international group reflects the global concern of water sustainability and the growing potential of membrane technology.

One result of the conference is the "Bellagio Statement 2003," the Team's main conclusions from the workshop and their effort to encourage worldwide interest in sustainable water and membrane processes.

Bellagio Statement 2003

Population growth, rapid urbanization, and finite water resources lead to human misery, including catastrophes that can affect all of humankind. Today, water management responds too slowly to needs and is unsustainable; water institutions are falling farther behind, and not making gains toward water sustainability.

Due to plummeting costs and dramatically improving performance, water-treatment applications based on membranes are blossoming. In particular, membrane bioreactors today are robust, simple to operate, and ever more affordable. They take up little space, need modest technical support, and can remove many contaminants in one step. These advantages make it practical, for the first time, to protect public health and to safely reuse water for non-potable uses. Membranes also can be a component of a multi-barrier approach to supplement potable water resources. Finally, decentralization, which overcomes some of the sustainability limits of centralized systems, becomes more feasible with membrane treatment. Because membrane processes make sanitation, reuse, and decentralization possible, water sustainability can become an achievable goal for the developed and developing worlds.

Attaining water sustainability will require commitment and a holistic approach from policy makers, planners, funding agencies, educators, implementing agencies, and technology providers — all those concerned with economic, environmental, technical, and social/cultural aspects of development. The need is urgent, but an enabling technology for preventing unnecessary human misery and achieving water sustainability is ready.

The Bellagio International Residency Team recommends that all the stakeholders accelerate the development and use of membrane technology.

Ground Broken for GWRS Microfiltration Plant

OCWD Board President Denis R. Bilodeau (far left), OCWD General Manager Virginia Grebbien, OCSD General Manager Blake Anderson, and OCSD Board Chair Shirley McCracken break ground at the Fountain Valley, California, site.

On July 21, the Orange County Water District (OCWD) and Orange County Sanitation District (OCSD) broke ground on the initial microfiltration plant of the Groundwater Replenishment System (GWRS) project. Microfiltration is a membrane process used to prepare water for purification.

The initial microfiltration plant will provide purified water for the seawater intrusion barrier, which protects the Orange County Groundwater Basin from intrusion by the Pacific Ocean, until a new advanced water purification plant can be built as part of GWRS.

GWRS's purification process takes highly treated sewer water through an advanced water purification system that includes microfiltration, reverse osmosis, and ultraviolet light with hydrogen peroxide. The water produced by the system will be of near-distilled water quality and will meet the annual needs of 140,000 families in Orange County, California, when the project goes on line in 2007.

For further information about the Groundwater Replenishment System, please visit the project's website at www.gwrsystem.com.

Workshop Addresses Challenges to Water Reuse in Washington State

From May 30 to June 1, NWRI — in cooperation with the Washington State Department of Ecology — held an intensive 2-day workshop in Seattle, Washington, to address the main issues regarding Washington State's water reuse program

Over 10 years ago, the State of Washington directed its Department of Ecology to meet growing water requirements within the State. The Department's goals included not only encouraging reclaimed water use, but also establishing standards in consultation with the Department of Health. The standards were completed in 1997, but numerous challenges — including limited staffing and funding, outdated technologies, and new contaminants of concern — continued to trouble the current program.

"As is usually the case, experience with implementing a new program identifies its strengths and weaknesses," said Kathy Cupps, P.E., workshop organizer and Water Reclamation and Reuse Lead for the Department of Ecology. "It became increasingly apparent that the State should continue to implement and, simultaneously, refine our program to address these needs and concerns."

Conditions such as drought, population growth, and increasing competition between water resource users, including agriculture, municipalities, and industry, also need to be addressed if utilities in Washington are to optimize water reuse as a viable option to expand source waters.

"The State has over-allocated its water resources," said Craig Riley, P.E., workshop participant and Program Lead for the Water Reclamation Program of the Division of Drinking Water at the Department of Health. "Reclaimed water is seen as a 'new' water source that can answer these needs."

To respond to these challenges and the need for reclaimed water, the Department of Ecology, with support from the Department of Health and Washington State University, requested assistance from NWRI. The result was a Nominal Group Technique (NGT) workshop to discuss the question: *What issues must be addressed to enable the State of Washington to facilitate the development and implementation of a sustainable water reuse program?*

The NGT process allowed 33 participants the opportunity to identify, prioritize, and develop approaches that best addressed the question.

"The NGT workshop was selected as an opportunity to define a clear starting point and begin to build the needed momentum," said Ms. Cupps. "It was the fastest and most efficient method available to get input and support from national and regional experts, state agencies, reclaimed water utilities, consultants, and other interested stakeholders."

Participants decided that the most important issue was to develop rational, scientifically supportable water reuse standards that protect public health and the environment. Currently, Washington's water reuse standards are modeled after California's criteria, which do not reflect the unique attributes of Washington State and, therefore, may or may not be appropriate.

For example, according to Mr. Riley, "Washington State has significant differences in geology that limit how we can manage reclaimed water." Another major challenge is Washington's climate or, more specifically, its rainy reputation.

Gerald Anderson, P.E., of the Washington State Department of Ecology, James Hagstrom, P.E., of Carollo Engineers, and Bruce Willey, P.E., of HDR Engineering, Inc., work on defining the processes and resources needed to continually update Washington States' standards and criteria, and to review alternative technologies.

"It's true that the Hoh Rain Forest on the Olympic Peninsula receives about 150 to 160 inches per year, which is the heaviest precipitation in the country," said Mr. Riley. "But Seattle averages 38 inches per year, which is roughly equivalent to New York City or Washington, D.C. The City of Seattle, which serves over 1-million people, is producing the same amount of drinking water today as it did in 1977, even though the population has grown several times. The rainy reputation hurts because public perception in the State, as well as outside the State, is that there will always be enough water to go around."

Nine other issues were identified as crucial in developing and implementing a sustainable water reuse program in Washington. These included encouraging the State to take a greater leadership role, creating a water reuse research program, and developing incentives to encourage municipalities, utilities, and businesses to build and use reclaimed water systems.

"The NGT workshop was particularly helpful in getting stakeholders together and identifying priorities," said Ms. Cupps. "Now we must turn our focus toward answering the questions of how and when to implement these priorities. Some of the issues are national in scope, many are specific to the Pacific Northwest, and others are unique to Washington State. Combining our efforts with other in-state, regional, and national efforts is the only way we at the Department of Ecology will be able to stretch our resources to meet the challenges we face."

From Rainwater to Radishes, Water Science Wins at Science Fair

From rainwater and radishes to dirty restaurant ice, the outstanding, water-related science projects of 10 Southern California students were awarded the NWRI Water Prize at this year's Orange County Science and Engineering Fair.

The science fair winners received $100 awards, gift certificates to the Discovery Store, and dinner with NWRI's Research Advisory Board (RAB) to reward their hard work and dedication.

2003 Science Fair winners: (back row) John Griffith, Kathryn Nelson, Molly Niffenegger, Katie Williamson; (front row) Alan Foreman, Christina Hart, Alex Heiney, Jonathan Allison, Kim McFarland, and Joseph Henry.

"It was an incredible experience for Joseph — and for us — to sit at a table with some of the country's top scientists," Santa Ana resident Janet Henry said of dinner with the RAB members. Her son Joseph, 13, was a second-year science fair winner. His project, "Bacterial Contamination in Fast Food Drink Ice," was inspired by a KTLA news report about restaurants serving dirty ice. Intrigued by the news station's survey of 10 local restaurants, Joseph gathered samples of drinking ice from three Del Taco restaurants over 5 days and tested them for bacteria at the Orange County Sanitation District's microbiology laboratory. He concluded that the ice "isn't as clean as you think, but you can still drink it." His project won not only recognition from NWRI, but also second place in the microbiology category and a chance to compete in the state science fair.

Another second-year winner was Alex Heiney, 12, of Laguna Beach. His project, "Open Wide and Say AAAH: Aliso Creek Gets a Physical," focused on the water quality of Aliso Creek. After testing for pH, temperature, dissolved oxygen, low-range nitrates, total phosphates, and ammonia nitrogen, Alex concluded that Aliso Creek's water is healthy overall, but has a potential problem with phosphates.

Alex has already begun working on another water-related project for next year's science fair. "I get a lot of personal satisfaction out of researching a topic as important as the world's water supply and testing for possible solutions to its problems."

Christina Hart's interest in solving water quality problems is also evident. Christina, 14, of Huntington Beach, learned that blue baby syndrome — named for the blueness that appears around affected infants' mouth, hands, and feet — is a blood disorder that is caused by high nitrate levels in drinking water. High nitrate levels are the result of contamination from sewage disposal systems, livestock facilities, parks, and other sources.

Using a nitrate test kit she bought from an online tropical fish store, Christina tested water from 50 different sources all over Huntington Beach, including supermarkets, malls, and drinking fountains for her project, "Is the Nitrate Level of Huntington Beach Public Drinking Water Safe for Infants to Drink?" The answer: Huntington Beach water is safe, so drink up.

Another Huntington Beach resident, Kathryn Nelson, 13, tested four ponds in Huntington Beach and one in North Santa Barbara County for the effects of pollution. Her tests showed that the North Santa Barbara County pond was the healthiest — no pollution draining into it, low temperature, low pH — and that drainage from the streets was the main source of pollution in the other ponds.

"I enjoyed working on my science fair project," said the eighth-grade student at St. Bonaventure School in Huntington Beach. "I just want everyone to know that I owe a great deal of thanks to my science teacher, Mrs. Campos. Without her guidance, I would not have been as successful."

Jonathan Allison, 13, of Long Beach, elicited the help of more than just his science teacher; he involved people from around the country in his project, "It's Raining, It's Pouring, The Radishes Are Growing." Using rainwater and soil samples sent to him from Hawaii, New Jersey, South Carolina, Illinois, California, Washington, Tennessee, Florida, Virginia, and Massachusetts, he planted radishes and measured their growth. He also tested the water for pH and hardness. He discovered that the rainwater from South Carolina and Hawaii produced the best results on plant growth. The rainwater that had the worst pH and hardness levels — Virginia and Illinois, respectively — resulted in the worst radish growth, suggesting that pH and hardness significantly affect plant growth.

Whether they tested rainwater, beach water, drinking fountains, or fast food ice, the science fair winners agreed that their projects provided them with valuable insight into the field of water science.

"I was fascinated to understand and be a part of what scientists in this field actually do," said Katie Williamson, 15, of Villa Park. "Doing this project has really expanded my interest in ecology and water science. Although I haven't decided on my topic for next year's fair, I have made water science one of the best possible ideas on my list."

NWRI Sponsors New Research Projects

This May, the NWRI Research Advisory Board approved funding for the following new research projects and Fellowships:

Investigation of Spore Inactivation Behavior for Enhanced Understanding of Disinfection Processes

Principal Investigator: SARAHANN DOW, *University of Colorado, Boulder*

For her doctoral thesis project, Ms. Dow is examining the inactivation behavior of surrogate microorganisms such as *Bacillus subtilis* and *Bacillus megaterium*, which are not pathogenic, to better understand the mechanisms behind the inactivation of pathogenic microorganisms.

A Priori Predictions of Macroscopic Behavior of Simple Porous Media

Principal Investigator: MIKHAIL GLADKIKH, *University of Texas at Austin*

For his doctoral thesis, Mr. Gladkikh is focusing on the pore-scale modeling and transport processes of simple soils to better understand soil behavior — which is essential for soil cleaning and the protection of freshwater environments.

Feasibility Study: Applying LLNL's Practical Environmental Restoration Management Process to Water Reuse and Desalinization Project Management

Principal Investigator: ZAFER DEMIR, *Lawrence Livermore National Laboratory (California)*

The Environmental Restoration Division of the Lawrence Livermore National Laboratory (LLNL) has developed a practical environmental restoration management (PERM) process that has been useful in evaluating long-term costs associated with different cleanup alternatives and the impacts of regulatory changes. They will investigate whether the PERM process can be applied to water reuse, desalination, and salinity management issues.

The Treatment of Micropollutants in Potable Water

Principal Investigator: DEBORAH A. ROSS, *University of Michigan at Ann Arbor*

For her doctoral thesis, Ms. Ross is investigating the removal efficiency and degradation kinetics of two representative endocrine disrupting compounds — a new source of water contaminants — using both ultraviolet irradiation and superheated water as point-of-use treatment techniques.

Novel Membrane Biofilm Reactor for Groundwater Treatment and Remediation

Principal Investigator: SAMER ADHAM, Ph.D., *Montgomery Watson Harza (California)*

The objective of this project is to evaluate and optimize an innovative approach to treating groundwater contaminated with a variety of organic and inorganic oxidized contaminants by using a single process called the hydrogen-fed membrane biofilm reactor, which does not produce a residual.

Dynamics of Point and Nonpoint Source Fecal Pollution from an Urban Watershed in Southern California

Principal Investigator: STANLEY B. GRANT, PH.D., *University of California, Irvine*

A growing number of Southern California's rivers, estuaries, and coastlines are impaired by fecal indicator bacteria, which often results in swimming advisories and the closure of shellfish harvesting areas. This project will examine how storms affect fecal indicator bacteria sources, ecology, and transport within several subdrainages of the Santa Ana River watershed.

RESEARCH IN PROGRESS

Can Pteris vittata Ferns Remediate Selenium-Contaminated Groundwater?

Dr. Lena Q. Ma compares a sickly fern, left, with a healthy fern exposed to high levels of arsenic.

Dr. Lena Q. Ma, Associate Professor of the Soil and Water Science Department at the University of Florida, recently discovered that the Chinese Brake fern, *Pteris vittata*, is extremely efficient at removing arsenic from contaminated soil and water. Her research group is now investigating the fern's potential in removing selenium — a naturally occurring metalloid that can cause birth defects and death in both humans and animals — from groundwater. Irrigation drainage water contaminated with selenium is one of the most serious problems confronting agriculture in the western United States, especially California. Many remediation technologies are expensive and create hazardous byproducts, but ferns and other plants would provide natural, cost-effective treatment. At present, Dr. Ma and her research team have harvested the ferns after exposing them to selenium and are waiting for the selenium analysis to examine the results.

Visiting Scientist Tracks Pharmaceuticals in the Santa Ana River

Since 1994, NWRI has provided support for international scientists in the fields of water and wastewater to bring their research to the United States. This year, NWRI provided support to Dr. Traugott Scheytt, Associate Professor of the Technical University Berlin, Germany, by funding his research on the attenuation of pharmaceuticals during recharge at the Santa Ana River in Orange County, California.

Dr. Traugott Scheytt

"I am especially interested in California because it's a different climatic and geological situation from Berlin," said Dr. Scheytt. "In a humid climate like Berlin, where the water table is higher, usually groundwater flows into surface water. In the semi-arid climate of California, water and any other substances usually infiltrate into the ground."

In this case, the infiltration of pharmaceuticals is Dr. Scheytt's main concern. The Santa Ana River is the largest and most important water supply for Orange County's groundwater basin, providing most of the drinking water for most of Orange County. Upstream, a number of wastewater treatment plants discharge directly into the river.

"In the summer, the Santa Ana River is almost 100-percent treated sewage water," said Dr. Scheytt. Human medical pharmaceuticals — such as the pain killers acetaminophen (Tylenol), diclofenac (Voltaren), ibuprofen (Advil), and others — are washed off or expelled into sewage water, and may remain even after the water undergoes treatment at wastewater plants. Dr. Scheytt will test whether pharmaceuticals are present at these discharge points. If they are, he will investigate whether they persist as the river water receives further treatment at the Prado wetlands and undergoes natural filtering processes — including exposure to sunlight and microbial degradation — as it flows downstream into the Anaheim Lake basin.

"The pharmaceutical concentrations in the river are usually much lower than if someone actually used the product, and there is no clear evidence of adverse effects in low concentrations," said Dr. Scheytt. "But the point is if several compounds mix together, they have a greater chance of producing adverse effects. This is the real problem. This is the point of preventing pharmaceuticals from being recharged into groundwater. It's a proactive measure because we don't know what could happen."

In addition to working with NWRI, Dr. Scheytt is conducting his research in cooperation with the Orange County Water District (OCWD), which manages both the Santa Ana River flows and the groundwater basin.

"Once any non-degradable compounds enter groundwater, they stay there for a very long time, so you always have to think about groundwater in the long term," said Dr. Scheytt. "OCWD is very proactive. They have to think now about how to protect groundwater for the next 100 years."

Dr. Scheytt will present the preliminary results of his research at the Second International Riverbank Filtration Conference in September. Using his knowledge of pharmaceuticals and the results of laboratory column experiments conducted in Berlin, he will predict which pharmaceuticals may be found in the Santa Ana River, and then compare those predications with his preliminary results. Among the pharmaceuticals that might be expected are the anti-convulsants carbamazepine and primidone, the lipid regulating agent gemfibrozil, the anti-inflammatory drug naproxen, and hypertension medication such as metoprolol and propranolol.

NWRI Welcomes Josie Mihaila

NWRI is pleased to welcome its newest staff member, Josie Mihaila.

Ms. Mihaila — a native of Romania — is the smiling face that greets visitors at the door of the new NWRI offices. As the new Administrative Support Assistant, she is responsible for much of the phone, mail, and email correspondence for the office. She also assists in the organizing of events, such as the Clarke Prize Ceremony and Lecture.

In addition to her work responsibilities, Ms. Mihaila stays busy raising two children — Nicole, 11, and Jeremiah, 4 months — with her husband, John. She spends as much time as possible with her family at their home in Huntington Beach, California.

Before joining the NWRI staff, Ms. Mihaila worked as a customer service representative for Sycamore Tree Home School Education. She began working for NWRI this May.

"I wanted to be part of an organization that helps the community," she said. "It is an excellent company to work for — well known, respected, very professional, with an excellent environment and great people."

To contact Josie Mihaila, please call (714) 378-3278 or e-mail jmihaila@NWRI.USA.org.

Upcoming Events in the World of Water

Environmental Fair

Crystal Cove Environmental & Plein Air Art Fair

"Celebrating the Past... Rebuilding for the Future"

Sunday, September 21, 2003

10 am to 5 pm

Held by the Alliance to Rescue Crystal Cove

Restoration of the Crystal Cove Historic District is scheduled to begin in October 2003. In honor of this milestone, the Alliance to Rescue Crystal Cove will hold an all-day Fair at the Crystal Cove Historic District located between Corona Del Mar and Laguna Beach along Pacific Coast Highway in Orange County, California.

Join in the celebration! See exhibits from 15 environmental groups, enjoy over 100 works of Plein Air art by 50 local artists, and celebrate the preservation of historic Crystal Cove.

For further information, please contact Laura Davick at davick@earthlink.net or visit the website: www.crystalcove.net.

Conference

Second International Riverbank Filtration Conference: "The Future is NOW!"

September 16-19, 2003

Hilton Cincinnati Netherlands Plaza
Cincinnati, Ohio USA

This conference will focus on the experiences of waterworks worldwide and address the issues currently faced by users of RBF technology.

Field trip options include:

- The Greater Cincinnati Water Works/U.S. Geological Survey/Miami University Flowpath Study Tour
- The Louisville Water Company B.E. Payne Water Treatment Plant Tour.

Register for field trips by Friday, September 5, 2003.

Conference Registration Costs

Full registration:	$395.00
One-day attendance:	$200.00
Choice of field trip:	$ 35.00
Student rate:	$100.00

To register for the conference or to view the program, please visit www.nwri-usa.org.

Meet NWRI's Newest Research Advisory Board Member

NWRI is the only privately funded organization of its kind devoted to water research. Its success rests on its Research Advisory Board (RAB), which not only reviews and evaluates proposed and ongoing research projects supported by NWRI, but also guides and enhances NWRI's research goals.

The RAB represents water-science expertise from across the nation. At present, there are 49 RAB members. NWRI is pleased to announce the addition of its newest member:

Diana H. Gale, Ph.D.

Director, Office of Executive Education
University of Washington (Seattle, WA)

Diana Gale has provided over 20 years of leadership to the City of Seattle. She has directed the Legislative Department, the Office of Management and Budget, the Water Department, and Seattle Public Utilities, which she helped to create in 1996. Currently, she is the Director of the Office of Executive Education at the University of Washington, Seattle, and is responsible for the Cascade Institute, an educational center for the training and development of public and non-profit leaders and managers. Gale also owns Hillis Gale Associates — a consulting firm specializing in strategic and resource management planning and leadership development — and acts as a senior consultant for Red Oak Consulting, a division of Malcolm Pirnie, Inc. She is involved in community organizations such as the Whidbey Island Institute (a sustainability learning center) and the Seattle Opera Association. Gale received a B.A. in History and Political Science at Wellesley College, and an M.U.P. and Ph.D. in Urban Planning at the University of Washington, Seattle.

Dr. Diana H. Gale

Wastewater Expert Receives Clarke Prize

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efforts, over five new filter technologies have been approved for use in California.

Similarly, Dr. Tchobanoglous' successful studies on UV radiation have brought about the widespread acceptance of UV disinfection in water reuse applications. In the early 1990s, he recognized the potential application of UV disinfection to wastewater reclamation efforts. He conducted one of the first studies to determine whether this method could be used to meet California's most stringent disinfection requirements. In 1993, as Chair of NWRI's UV committee, he helped draft the first UV guidelines for water reuse. Since publication, the guidelines have become the standard for UV disinfection guidance in the United States.

Clarke Prize Laureates (from left): Dr. Charles O'Melia (2000), Dr. George Tchobanoglous (2003), Dr. Walter Weber (1996), and Dr. Harry Ridgway (2002).

More recently, Dr. Tchobanoglous' interests have turned to decentralized wastewater management (DWM) systems. He has been asked to give more than 40 keynote addresses on the subject in the past 3 years. His Clarke Prize Lecture detailed the importance of DWM today.

Dr. Tchobanoglous defined DWM as "the collection, treatment, and reuse/dispersal of wastewater from individual homes, clusters of homes, isolated communities, industries, or institutional facilities at or near the point of waste generation."

"The challenge in the twenty-first century," he said, "is to develop effective management systems that will protect public health and the environment, maximize reuse, and allow for the integration of DWM systems with other centralized facilities in the development of water resources management plans."

He concluded the lecture with heartfelt thanks to those who have supported him throughout his career. In addition to recognizing family, friends, and co-workers, Dr. Tchobanoglous acknowledged his students:

"I want to thank my many students who have helped to educate me and have made my teaching career most rewarding and worthwhile."

For over 30 years, Dr. Tchobanoglous taught courses on water and wastewater treatment and solid waste management at the University of California, Davis.

"The University has basically been my life," he said. He plans to donate the Prize's $50,000 award to fund a scholarship at the University of California, Davis, for students pursuing Masters of Science degrees.

"Ph.D. students generally write their own proposals, but Masters students don't have funding," he explained.

Perhaps Dr. Tchobanoglous' greatest impact has been in the training of environmental engineers. He completed his own training with a Bachelor of Science degree in Civil Engineering from University of the Pacific, a Masters of Science degree in Sanitary Engineering from the University of California, Berkeley, and a Ph.D. in Civil Engineering from Stanford University. He credits his professors for encouraging his interest in both water science and education.

"Three of my professors were also important mentors," he said. "Vern Harrison at the University of the Pacific, Erman Pearson at the University of California at Berkeley, and Rolf Eliassen, my Ph.D. advisor at Stanford University. I am grateful for the contributions that each of these individuals made to my education."

With the teachings of these mentors in mind, he has authored or coauthored over 350 publications, including 12 textbooks and three reference books. The textbooks have been used at more than 225 colleges and universities in the United States. They have also been used extensively in universities worldwide both in English and in translation. His books are famous for successfully bridging the gap between academia and the day-to-day world of the engineer. Notably, the textbook *Wastewater Engineering: Treatment, Disposal, Reuse*, now in its fourth edition, is one of the most widely read textbooks in the environmental engineering field by both students and practicing engineers.

On an international level, Dr. Tchobanoglous has taught courses and seminars dealing with water and wastewater treatment or solid waste management for universities around the world, including the University of the Andes and the University of Caracas in Venezuela, the University of Karlsrue in Germany, the Arab School on Science and Technology in Kuwait, and the University of Singapore.

As Nancy Pelosi, Democratic Leader of the U.S. House of Representatives, wrote in a letter of commendation, "Dr. Tchobanoglous, as both a teacher and research scientist, the education that you provide is an invaluable tool in building a healthy, clean, and safe community. Your lifelong dedication is indeed a cause for celebration."

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