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ACRONYMS

TECHNICAL ACRONYMS

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<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ATP</td>
<td>Adenosine Triphosphate</td>
</tr>
<tr>
<td>BASINS</td>
<td>Better Assessment Science Integrating Point &amp; Non-point Sources</td>
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<tr>
<td>BTEX</td>
<td>Benzene, toluene, ethylbenzene, and xylene</td>
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<tr>
<td>CADDIS</td>
<td>Causal Analysis/Diagnosis Decision Information System</td>
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<tr>
<td>CCL</td>
<td>Contaminant Candidate List</td>
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<tr>
<td>CP</td>
<td>Communities of Practice</td>
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<tr>
<td>CWA</td>
<td>Clean Water Act</td>
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<tr>
<td>CWR</td>
<td>Cross Well Radar</td>
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<tr>
<td>DNA</td>
<td>Deoxyribonucleic Acid</td>
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<td>DNAPL</td>
<td>Dense Non-Aqueous Phase Liquid</td>
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<tr>
<td>EMAP</td>
<td>Environmental Monitoring and Assessment Program</td>
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<tr>
<td>ERC</td>
<td>Explosive-Related Compounds</td>
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<tr>
<td>GEOSS</td>
<td>Global Earth Observation System of Systems</td>
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<tr>
<td>GIS</td>
<td>Geographic Information System</td>
</tr>
<tr>
<td>HCV</td>
<td>Human Caliciviruses</td>
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<tr>
<td>HFGP</td>
<td>Horizontal Flow Gravel Pre-Filter</td>
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<tr>
<td>MOU</td>
<td>Memorandum of Understanding</td>
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<tr>
<td>MTBE</td>
<td>Methyl tertiary-butyl ether</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-governmental organization</td>
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<tr>
<td>NPDWR</td>
<td>National Primary Drinking Water Regulations</td>
</tr>
<tr>
<td>PCB</td>
<td>Polychlorinated biphenyl</td>
</tr>
<tr>
<td>PCR</td>
<td>Polymerase Chain Reaction</td>
</tr>
<tr>
<td>PFGE</td>
<td>Pulsed Field Gel Electrophoresis</td>
</tr>
<tr>
<td>ppm</td>
<td>parts per million</td>
</tr>
<tr>
<td>QPCR</td>
<td>Quantitative Polymerase Chain Reaction</td>
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<tr>
<td>SDE</td>
<td>Sustainable Development &amp; Environmental Health</td>
</tr>
<tr>
<td>SDWA</td>
<td>Safe Drinking Water Act</td>
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<tr>
<td>SWMM</td>
<td>Storm Water Management Model</td>
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<tr>
<td>SSF</td>
<td>Slow Sand Filter</td>
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<tr>
<td>UCMR</td>
<td>Unregulated Contaminant Monitoring Rule</td>
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INSTITUTIONAL ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>AID</td>
<td>Agency for International Development</td>
</tr>
<tr>
<td>CARDI</td>
<td>Caribbean Agricultural Research and Development Institute</td>
</tr>
<tr>
<td>CARICOM</td>
<td>Caribbean Community and Common Market</td>
</tr>
<tr>
<td>CBWMP</td>
<td>Caribbean Basin Water Management Programme, Inc.</td>
</tr>
<tr>
<td>CCAD</td>
<td>Central American Development Commission</td>
</tr>
<tr>
<td>CDC</td>
<td>Centers for Disease Control</td>
</tr>
<tr>
<td>CECIA</td>
<td>Center for Education, Conservation &amp; Environmental Interpretation</td>
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<tr>
<td>CEHI</td>
<td>Caribbean Environmental Health Institute</td>
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<tr>
<td>CEPIS</td>
<td>Pan American Center for Sanitary Engineering and Environmental Sciences (Spanish acronym)</td>
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<tr>
<td>Acronym</td>
<td>Full Name</td>
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<tr>
<td>COHEMIS</td>
<td>Center for Hemispherical Cooperation in Research and Education in Engineering and Applied Science</td>
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<tr>
<td>CONAGUA</td>
<td>National Commission of Water</td>
</tr>
<tr>
<td>CTO</td>
<td>Caribbean Tourism Organization</td>
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<tr>
<td>CWWA</td>
<td>Caribbean Water and Wastewater Association</td>
</tr>
<tr>
<td>DIGESA</td>
<td>Environmental Health Division of the Ministry of Health of Peru</td>
</tr>
<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
</tr>
<tr>
<td>GEO</td>
<td>Group on Earth Observations</td>
</tr>
<tr>
<td>IAEA</td>
<td>International Atomic Energy Agency</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>IICA</td>
<td>Inter-American Institute for Cooperation on Agriculture</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>NCER</td>
<td>National Center for Environmental Research (U.S. EPA)</td>
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<tr>
<td>NELAC</td>
<td>National Environmental Laboratory Accreditation Conference</td>
</tr>
<tr>
<td>NERL</td>
<td>National Exposure Research Laboratory (U.S. EPA)</td>
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<tr>
<td>NRMRL</td>
<td>National Risk Management Research Laboratory (U.S. EPA)</td>
</tr>
<tr>
<td>OARM</td>
<td>Office of Administration and Resources Management (U.S. EPA)</td>
</tr>
<tr>
<td>OGWDW</td>
<td>Office of Groundwater and Drinking Water (U.S. EPA)</td>
</tr>
<tr>
<td>PAHO</td>
<td>Pan American Health Organization</td>
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<tr>
<td>PRWRERI</td>
<td>Puerto Rico Water Resources and Environmental Research Institute</td>
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<tr>
<td>RELAC</td>
<td>Laboratory Network of Latin America and the Caribbean</td>
</tr>
<tr>
<td>UPRM</td>
<td>University of Puerto Rico at Mayagüez</td>
</tr>
<tr>
<td>UPRR</td>
<td>University of Puerto Rico at Rio Piedras</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
</tr>
<tr>
<td>WASA</td>
<td>Water and Sewerage Authority of Trinidad and Tobago</td>
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<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>WSWRD</td>
<td>Water Supply and Water Resource Division (U.S. EPA)</td>
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The U.S. Environmental Protection Agency (EPA) and the University of Puerto Rico at Mayagüez (UPRM) hosted the Colloquium on Water Quality Monitoring and Testing in Latin America and the Caribbean on October 25-27, 2005, at the El San Juan Hotel, San Juan, Puerto Rico. The Colloquium focused on the water quality issues in Latin America and the Caribbean and the creation of a Center of Excellence for Water Quality. It provided a forum for information exchange among EPA, academia, and other interested organizations. Appendix A provides a copy of the Colloquium agenda. Appendix B contains a list of Colloquium attendees.

**Colloquium Vision Statement**

The University of Puerto Rico at Mayagüez (UPRM), with support and cooperation from the U.S. Environmental Protection Agency, is considering the establishment of a Center of Excellence for Water Quality (herein referred to as the Center) at UPRM. The proposed Center would work with all Latin American and Caribbean countries, provide education and training, and present information on the latest technologies available to address issues of water quality unique to the region.

A first step in the establishment of a Center is to bring together representatives of all Latin American nations and the Caribbean to discuss water quality issues unique to their respective countries. The Colloquium will introduce the concept of a Center at UPRM and will solicit feedback from meeting participants on the most effective means for implementing this new idea. The long-term vision for this new Center would be to provide a bridge between UPRM and the countries of Latin America and the Caribbean that would lead to increased laboratory capacity and capabilities, training programs in state-of-the-art analytical technologies for measuring water quality, and the exchange of education programs. All of these would contribute to improving the overall quality of drinking and recreational waters in the various regions of Latin America and the Caribbean.

**Welcome, Introductions, and Meeting Overview**

Jorge Rivera-Santos, Director of the Puerto Rico Water Resources and Environmental Research Institute (PRWRERI) at UPRM, Bill Henderson, EPA’s Office of Administration and Resources Management (OARM), and James Owens, EPA’s National Exposure Research Laboratory (NERL), welcomed all attendees to the Colloquium on Water Quality. Mr. Henderson provided an overview of the three-day meeting.

Mr. Henderson provided some background on the purpose and necessity of the Colloquium. EPA and UPRM signed a Memorandum of Understanding (MOU) two years ago. As a part of this MOU, one of EPA’s senior scientists, Alfred Dufour, proposed a Center of Excellence for Water Quality be established. The purpose of this Center would be to work with Latin American and Caribbean countries to provide information on the latest technologies available to address the water quality issues in their regions. EPA felt that UPRM would be a good bridge to the Caribbean and Latin American countries. The purpose of the Colloquium was to introduce the idea of the Center, discuss water quality issues unique to Latin American and Caribbean regions, and gather information on how, if established, the Center would benefit those regions. Group breakout sessions were held on the third day of the Colloquium to determine the priority interests of each region.
Mr. Henderson also introduced members of the Colloquium Steering Committee. Dr. Rivera-Santos is the lead for the Colloquium and for efforts to establish the Center at UPRM. The Steering Committee is also comprised of Alfred Dufour and James Owens (EPA/NERL); Henry Salas (Pan American Health Organization/PAHO); Ivonne Santiago, Fernando Gilbes, and Felix Román (UPRM); Gary Toranzos (University of Puerto Rico at Rio Piedras/UPRR); Antonio Quiñones, (EPA/Region 4); Carl Soderberg (EPA/Region 2); and Jim Goodrich (EPA/National Risk Management Research Laboratory (NRMRL)).

KEYNOTE PRESENTATIONS

Jorge I. Vélez-Arocho, Chancellor of the University of Puerto Rico at Mayagüez

Dr. Vélez-Arocho expressed his great pleasure in working with EPA on water quality initiatives, such as the Integrated Management of Watersheds project. Dr. Vélez-Arocho’s presentation focused on water quality, specifically preservation and management of water resources. Very few topics have the attention that water does. Therefore, water quality is something that we need to reach a consensus on. One aspect of the consensus must address data and information sharing. Gathered information and data is of no use if it is not transferred to affected regions.

Seventy-seven million people in Latin America and the Caribbean do not have access to suitable drinking water. Even though the percentage of the population with running water has increased from 33 percent to 85 percent in recent years, water preservation is critical. Another problem these regions face is that 100 million people do not have sanitation connections. In recent years, the percentage of the population with sanitation connections has increased from 14 percent to 49 percent, but that percentage is still far below achievement goals. Latin American and Caribbean officials believe it is the right of the entire population to have their basic sanitation needs met. Currently, 256 million people in Latin America and the Caribbean are known to use outhouses or latrines. These people are looking to the government and universities to help them obtain their rights to have access to safe drinking water and sanitation connections.

Less than 14 percent of wastewater generated in homes is treated, which increases long-term environmental damage. The remaining untreated 86 percent of sewage is discharged into rivers and lakes or underground. This kind of waste management results in an increased risk of intestinal diseases that can cause death in children. There is also inequality in prices of water, as the poor are charged more for safe drinking water than are the well-off portions of the population. There has been progress in the improvement of water quality and management in the region, but not enough has been accomplished. In order to accomplish our goals, this critical issue must be addressed by governments, non-governmental organizations (NGOs), academia, and legislators. Due to financial constraints, it is more difficult for poor countries to reach their goals. We need to identify resources that would allow us to make our goals a reality.

A greater challenge we face is the diminishing water supply. The water supply will be reduced by 33 percent in the next 30 to 40 years. In greater demand than jobs and security, access to quality water is critical for survival. The World Forum estimates that the average person’s water supply will be reduced by one third due to industrialization and climate change. Water quality is a serious issue elsewhere in the world as well. Intestinal diseases cause the deaths of thousands of people each day in Africa, Asia, Europe, and China. Most fatalities are among children under the age of 5.
Most water resource preservation and management objectives have not been researched. Attitudes toward the issues are a major problem, as the population does not fully comprehend them. It is of utmost importance that efforts help raise awareness among those affected. For example, the lack of control of contaminants spilled into the water is one of the most neglected issues. The population should be better prepared and educated. Many ideas have been proposed in the region, but this is a huge and complex problem. We need to focus on one problem and reach a consensus on how it should be resolved. We should focus on developing a framework of political action to present to our decision makers. Water quality is of immediate urgency. It is up to the stakeholders and all of us to manage it.

**Javier Vélez-Arocho, Secretary of the Department of Natural and Environmental Resources, Puerto Rico**

A great challenge is faced in finding the right balance between environmental resources and finances. There are three issues to address in meeting our objectives: water research, water reservoirs, and reforestation. Puerto Rico is developing a water research management document that will go to legislation in Summer 2006. The Department of Water Resources, State and Federal agencies, and NGOs are acquiring 6,000 acres of land for development of water reservoirs. There is a very aggressive reforestation process in progress as well, and the objective is to plant 4 million trees. Latin American and Caribbean countries will continue to work with developers and agricultural workers to avoid problems with water flow, overflow, and water runoff. Everyone must work arduously to protect and conserve the natural resources.

**Carl-Axel Soderberg, U.S. EPA, Region 2**

Carl-Axel Soderberg, Director of the Caribbean Environmental Protection Division, U.S. EPA Region 2, presented a perspective of the availability of water resources in Latin America and the Caribbean. South America has twice the available water resources of North America, and North America has twice the amount of Central America. Further, the Caribbean has one-third the resources of Central America.

Haiti is in a desperate situation as far as water resources are concerned. The Antilles are the poorest in water quality and resources. The United Nations Educational, Scientific and Cultural Organization (UNESCO) conducted a water resources availability ranking, in which the Bahamas ranked last in geographical, renewable water resources. Water resource availability is tied to the population. There are three water-stressed nations: Haiti, Mexico, and Peru. In Puerto Rico, 40 percent of the population is located where there is 11 percent water availability. Fifty percent of potable water produced is lost, but Puerto Rico is not the exception.

Climatic changes resulting from the natural cycle, or problems related to the ozone layer, reduce river flows. Increases in agricultural demand will require more water, as 70 percent of the water in the world is used for cultivation. In some cases, water has to be transported to needy areas. These problems result in water being much more expensive. The water source is also a factor. If the source is bad, there are additional costs for chemical treatment.

In the next 50 years, the population of Latin America and the Caribbean is expected to rise from 527 million to 815 million inhabitants. This population increase will result in a 500 percent increase in water usage. We must find water for all of these people. We also need to find more land to cultivate. In addition to the 77 million inhabitants who do not have access to safe drinking water, there are 200 million that rely on cistern systems. Only 20 percent of the population has access to disinfection systems. In regard to wastewater, only 14 percent of sewage is treated. Sixty-one percent of industrial wastewater does not receive treatment.
As the population increases, the quantity of heavy metals, synthetic chemicals, and waste contaminants in water will double, and home construction on the water basin (aquifer) will affect the water quality. In the World Bank’s definition of possible impacts of an expected population increase, it stated deaths will increase due to lack of good drinking water. Further, the United Nations (UN) says the main water sources are not sufficient. There is an intrusion of salt water in the Antilles, Colombia, and Venezuela that also will affect the quality of groundwater. According to EPA, 40 percent of our rivers do not meet water quality requirements. El Salvador estimates that 90 percent of their rivers are contaminated, and Mexico says that 93 percent of their river water is not suitable for use. Poor water quality has both human health and ecological effects. If we do not take action now, it will cost more money to address the problems in the future.

Peter Toft, Pan American Health Organization

Dr. Peter Toft, formerly of the World Health Organization (WHO), is currently an advisor to PAHO. PAHO has functioned as the international public health agency for the last 100 years, and is WHO’s Regional Office for the Americas. Headquartered in Washington, D.C., it has 8 regional centers and representatives in 29 countries. PAHO provides technical support to countries in an effort to protect human and environmental health.

For the last 2 years, PAHO has undergone a transformation. In 2003, it established the Sustainable Development & Environmental Health (SDE) Area. SDE work areas include: environmental risk assessment and management, human ecology and environmental health, healthy settings and local development, tobacco, and education and social communication. PAHO’s water quality laboratory is located in Lima, Peru, and is in the process of being transferred to the Ministry of Health in Peru.

Of the 10 Millennium Development Goals established by the UN, goal number 7, to ensure environmental sustainability, is the most important to the Colloquium discussions. It is a sobering comment that despite all efforts, 77 million people (15 percent of the population) in the Americas still do not have access to safe drinking water. The heads of state have set a goal to reduce that number by 50 percent in the next 10 years; however, efforts should strive to reduce that percentage by more than 50 percent in less than a decade.

There is a need for reliable data that will allow more meaningful judgments to be made about the health risks from pollutants in the environment. In the absence of good data, resources may be wasted and/or misdirected. There are only a relatively small number of laboratories in Latin America and the Caribbean that are capable of developing the necessary data. Environmental health data generated by industry, university, and private laboratories is likely to vary substantially. There is a need to improve the continuity of environmental health laboratories in the region. It also is important to inform the entire region which laboratories are capable of producing reliable data.

PAHO held a meeting on October 17-18, 2005, to develop a strategy to improve the competency and ability of the laboratories in the region. It was concluded in the meeting that International Organization for Standardization (ISO) accreditation should be a principal goal for laboratories in Latin America and the Caribbean. Laboratory accreditation is a formal recognition that a laboratory is competent to perform certain specified tests or measurements. The primary purpose of accreditation is to provide confidence to the data user of the competency of the laboratory. It is important to note that accreditation does not guarantee the analytical results. The accrediting body must be satisfied that the laboratory is capable of continuing to carry out the test successfully and consistently. There are two principal aspects to accreditation: satisfactory performance on proficiency testing and technical assessments. Proficiency
testing is mandatory, and samples are provided for all parameters. Assessments focus on quality management systems and the technical capability of the laboratories.

Although few published studies measure the benefits of laboratory accreditation, there is some published data that show an improvement in laboratories after the first five or six rounds of testing. Benefits include: improved laboratory performance, better quality data, international comparability, ongoing third-party review, and improved confidence in the data produced.

PAHO encourages countries to establish accreditation programs based on ISO 17025 standards and will support the accreditation of national and regional laboratories. As a part of its strategy, PAHO will provide and facilitate training on accreditation programs; work with international accreditation coordination bodies; promote the use of accredited laboratories; and continue to develop and support networks of laboratories for exchanging information.

Session Wrap-Up – Jorge Rivera-Santos, UPRM
Dr. Rivera-Santos stated that we must narrow our focus to what we are able to do and what is within our reach. The Colloquium’s goal is to focus on monitoring and testing of water quality. Water quality laboratories play a significant role in improving the quality of water. It is essential that all data and information gathered be in a uniform format so that it can be used in a universal manner.

Questions & Answer/Discussion Session
An attendee questioned whether the planned transition of the PAHO laboratory in Lima to the Peruvian government would affect the laboratory accreditation program in his region. Dr. Toft stressed that laboratory accreditation is the way to proceed, and that the transfer of the PAHO laboratory to the Ministry of Health in Peru should not affect the laboratory or accreditation program for the attendee’s region. Henry Salas added that the water quality control program would continue to work through CEPIS, and that there should be no future change; however, CEPIS will no longer have an analytical laboratory.

SESSION I - WATER QUALITY PROBLEMS IN LATIN AMERICA AND THE CARIBBEAN
Session I included two presentations that focused on the research program conducted at UPRM and programs being conducted by the Caribbean Environmental Health Institute in St. Lucia, respectively.

Advancing Towards a Century of Excellence - Jorge I. Vélez-Arocho
Dr. Vélez-Arocho, Chancellor of UPRM, presented a history of UPRM and an overview of the University’s research program. The University of Puerto Rico, established in 1911, offers Bachelor, Master, and Doctoral degrees to more than 70,000 students on 11 campuses. The university system in Puerto Rico began in 1903 as a public university. The Mayagüez campus is a well-known land grant institution. It is also a sea grant institution receiving U.S. Government funding for marine sciences and biology research. It is also a space grant institution receiving other grants including the National Aeronautics and Space Administration research grants. The University is comprised of four colleges: Engineering, Agricultural Sciences, Arts & Sciences, and Business Administration. The University also has a Research and Development Center, 7 agricultural experiment stations, and an agricultural extension service with offices in 65 municipalities.
UPRM’s mission is “To provide our society with cultured and educated citizens, capable of thinking critically and professionally, prepared in the areas of agriculture, engineering, natural and social sciences, humanities, and business administration. Prepare students in the above areas so that they can contribute to the cultural, social, and economic development of Puerto Rico and the world.” UPRM is comprised of 1,064 academic and 1,909 administrative staff members. Of the 12,135 registered students, 49.7 percent are female. UPRM receives three times as many applications as the number of students it can admit.

In the 2003-2004 academic year, UPRM received $25 million in external funding from various government agencies and industry. These research funds benefited 1,096 students involved in research projects and resulted in 5 patents being awarded; 2 patents are still in progress. Research topics at UPRM include: information technologies, remote sensing, geographic information systems (GIS) and remote sensors, power electronics, materials science and engineering, technology transfer, natural resources, agriculture, water resources and environmental engineering, humanities and social sciences, and education. The university offers 32 Masters Degree programs and 9 Doctoral programs.

UPRM has developed partnerships with industry and government, including the Center for Hemispheric Cooperation in Research and Education in Engineering and Applied Science (COHEMIS) which represents an international, cooperative effort.

Water Quality in the Caribbean - Vincent Sweeney

Vincent Sweeney, with the Caribbean Environmental Health Institute (CEHI) in St. Lucia, discussed regional programs and initiatives. CEHI serves English-speaking Caribbean nations. The regional inter-governmental organization, the Caribbean Community and Common Market (CARICOM), based in St. Lucia, provides technical and advisory services to 16 Member States in all areas of environmental management. More information can be found on the organization’s website: www.cehi.org.lc.

The southern Caribbean faces varied problems, including competing agricultural, domestic, industrial, and commercial activities that have had impacts from the watershed areas to coastal and marine environments. These impacts can affect drinking and recreational water quality. Levels of social, economic, infrastructural, and industrial development vary in the Caribbean. Water quality impacts may be based on the size of the country, demographics, natural resources, or national policies. Water in the Caribbean is of relatively good quality based on WHO guidelines. The main threats to water quality are the destruction of watershed areas from pollution such as agricultural run-off, industrial effluent, and domestic wastewater. Drinking water quality is threatened by anthropogenic sources such as poor sanitation at intakes, agricultural activity in the watershed, watershed destruction, and poor distribution system maintenance.

Coastal recreational water quality is not monitored as regularly as drinking water, and freshwater recreational waters may be even less frequently monitored. Research has indicated that harbors, marinas, and bays surrounded by large populations, commercial, and industrial activities are severely impacted. Freshwater recreational water bodies that are monitored are often related to tourism and commercial activities such as waterfalls, water parks, and hotel and public swimming pools.

Factors impacting water quality include pollution, limited resources for training, financial constraints, lack of regular monitoring, broad legislation, and slow technological improvement. Natural disasters also impact water quality and the water supply. Damage to utilities and distribution system infrastructure can negatively impact water quality. In addition, damage to coastal and freshwater recreational areas can cause flooding which can disperse pollutants.
Drivers to improve water quality include trade and the public. There is international pressure for standards related to the export of goods and services, and the tourism industry will suffer and bear liability if water quality is poor. An informed and aware public can demand water quality improvements.

**SESSION II – LEGISLATION/REGULATIONS IN WATER QUALITY**

Session II included two presentations focusing on local and federal water quality regulations and strategies to restore water bodies.

**The Quality of Water in Puerto Rico - Rubén González**

Eng. Rubén González, Director of the Water Quality Division of the Puerto Rico Environmental Quality Board, discussed water quality and monitoring, local and federal water quality regulations, and strategies to restore the region’s water bodies.

Eng. González provided some background information on the creation of the Environmental Quality Board. On June 18, 1970, the law on environmental public policy was approved. Known in Puerto Rico as Law #9, it created the Environmental Quality Board, the first environmental agency created in Latin America. Law #9 has recently been substituted by Law #416, a new public policy and environmental law. This law requires that the Environmental Quality Board prepare and submit to the governor and legislature an annual report on the state of the environment in Puerto Rico. This annual report includes a chapter on water quality. The Clean Water Act (CWA) requires that U.S. states and territories complete a biannual water quality assessment. This biannual report must include the results of the assessment and be made available to the public. Those waters that exceed the water quality standards can be included in the 303(d)-Impaired Water Bodies List. Each U.S. territory can establish their own regulations that are either the same or more stringent than the Federal EPA Regulations.

The basic regulatory objective is to preserve the quality of waters in Puerto Rico in such a manner that they are compatible with the social and economic needs of the island. The laws contain parameters to be monitored and the allowable limits of contaminants. The standards define waters of Puerto Rico as all coastal and surface waters, estuaries, groundwater, and the land abutting these water bodies. The standards further classify the waters according to their uses. Eng. González discussed the water classifications and the monitoring networks. He also discussed 2 new projects: the Non-Point Source Network, established 3 years ago, collects data from 20 monitoring stations on a quarterly basis to determine which sources are contributing to contaminant concentrations; and the Beach Monitoring and Public Notices Project assesses data collected at 22 of the most visited beaches on a bi-monthly basis, and then makes the assessment results available to the public.

To develop strategies for restoration of water bodies, the government needs to work in partnership with NGOs and universities. They are establishing strategies to preserve the health of the basins, and 18 prioritized watersheds have been identified. These 18 watersheds make up 70 percent of the waters of Puerto Rico; therefore, restoration and remediation efforts are being concentrated on them. The goal is to improve the water quality in the watersheds so that they can support designated uses.
Regulation Model for Wastewater in Central America - Antonio Quiñones

Mr. Quiñones, with EPA Region 4, discussed the development of a water quality regulations model for use in Central America.

EPA Region 4 is assisting the International Development Agency with some of their projects. EPA can assist other countries in environmental matters, but only if EPA has been invited to assist. In 2001, an agreement declaration was ratified between the United States and Central American countries. EPA’s work is not limited to Latin America and the Caribbean. The Agency has also been working in southern Africa, the former USSR, and Egypt.

The Central American Development Commission (CCAD) receives funding from the ministries of the Central American republics and from other donors. CCAD was the instrument used to coordinate EPA activities in Central America, such as meetings with Central American communities. To begin, EPA talked to community groups to assess their needs. Through these conversations, it was found that they had problems with drinking water, wastewater treatment, control and management, and solid waste issues. Pilot projects initiated were focused on creating a level of trust and credibility among the different committees and the EPA. The platform established by these pilot projects enables EPA to launch other projects. For example, EPA created a joint body of legal and technical consultants. When EPA learned that all countries had basically the same problem, EPA came up with the idea to work on the countries as one entity. The idea was to harmonize all of the republics as far as the legal framework and treatment of residual waters. In April 2002, EPA invited all members of the health and environmental ministries of the republics to its first meeting to present the idea. Since EPA was trying to force limiting parameters, it was a delicate situation. After creating a common technical and legal language, EPA identified laws. It was found that almost all countries had some kind of legislation that mentioned water quality protection. However, with the exception of Panama, no countries had established a clear methodology for sampling, sampling frequency, or classification. Existing permits lacked information on renewal, sanctions imposed, or penalties. There was an agreement that discharge limits must be centralized.

The countries decided to use the CWA as a model; however, no law was established. What was designed is simply a model that the republics can adjust according to their existing regulations.

During this process, EPA had the participation of the technical and legal personnel, communities, and the industrial sector. The industrial sector was invaluable to the establishment of this model. All the republics’ ministers (except Belize) agreed to accept this model. Once ratified in the next few months, this model will allow all Central American countries to have the same regulations.

Questions & Answers/Discussion Session
An attendee asked Mr. González if the well water samples were representative of the water in the distribution system or the water in the aquifers. Mr. González said that the samples were taken from drinking water wells. The attendee then suggested that groundwater samples be monitored as well. He further added that the same type of model used to harmonize the drinking water regulations of Central America could be adopted by all countries for maintaining groundwater as a sustainable resource.

The Puerto Rico Water Quality Division of the Environmental Quality Board monitors surface waters every 3 to 4 months. The operating cost for the entire monitoring network is $1.5 million per year.

Law #9 was revised based on the concern over nutrients such as nitrogen and phosphorous.
An attendee then asked that since the Water Quality Division of the Environmental Quality Board standards are stricter than those of the Puerto Rico Department of Health, which standards would prevail? Another attendee answered that if the issue were health-related, the health department’s standards would prevail. However, if it were a question of the legality of water quality, then the Environmental Quality Board’s standards would prevail. The overall objective is to preserve the water for the citizens’ use.

An attendee asked if the risk of illness is greater from drinking the water or coming into contact with the water. Mr. González stated that the problems Puerto Rico faces are sedimentation of rivers and lakes and bacteria. Mr. González clarified that there is no general law in Puerto Rico for water not meant for human consumption, and monitoring stations were chosen based on contamination and discharge points.

The watershed restoration plan is publicly available. The Environmental Quality Board, in cooperation with other agencies, is implementing the plan. There are 14 government agencies intervening in control of non-point sources of contamination of waters. There is also a cooperative partnership to develop this mechanism for preservation of the watershed.

Mr. González clarified that data collection was not conducted simply to comply with regulations, but also to obtain parameters to determine the type of restoration activities that are necessary. The data is used to develop strategies and action plans. Once a parameter is identified, it can be used to develop a strategy to bring the water body into compliance. Currently, there are not enough resources to conduct studies necessary for adopting new parameters. However, there are efforts to develop a local nutrient standard for the lakes.

An attendee commented that copying the federal law has not worked out so far; therefore, it is time to change the paradigm.

Mr. Quiñones clarified that his presentation was referring to parameters for maximum limits in effluents and wastewater. The improvement process is gradual. Since there has been no progression in many Central American countries, the process should begin with simple systems (i.e., sand filter systems). Such systems can provide much better effluents in these areas. The goal is not to reach the levels of developed countries, but instead to gradually move towards better levels. The CWA is not being used in Central America, as we have to work up to that. Panama and Costa Rica opposed its use. The model regulation affords the way of accomplishing the objective of somewhat standardized regulations. The ministries of health existed prior to the ministries of the environment and are more powerful. Working together, the ministries might have the financial and human resources necessary to move this effort forward.
SESSION III – ENVIRONMENTAL MICROBIOLOGY
Session III consisted of two presentations that focused on the use of bacterial indicators to assess the
good water quality of recreational and drinking water.

Bacterial Indicators in Recreational Waters: What Do They Indicate? - Elia Sanchez
Ms. Sánchez, a microbiology doctoral student at UPRR, discussed the results of several studies conducted
in the Caribbean. The studies included beach studies, *Escherichia coli* survival studies, and an
epidemiological study.

The objectives of the beach studies conducted in the U.S. Virgin Islands and Puerto Rico were to establish
temporal and spatial data for bacterial indicators and analyze the indicator concentrations. The two
analytical methods used in the studies were membrane filtration and Colilert. Four samples were taken at
ankle and torso water depths from locations 400 meters apart over 2 consecutive days at different time
intervals. The indicators measured were total coliforms, thermotolerant coliforms, *E. coli*, and
*enterococci*. Indicators were present at all beaches; however, results varied significantly within each
beach. No statistically significant differences in bacterial concentrations were found within spatial or
temporal variables. The Colilert method detected higher concentrations of indicators than were detected
with the membrane filtration method. Analyses were conducted to determine which indicators were
above and below the EPA standards. A significant percent of the samples had indicator concentrations
above the EPA standards on both islands.

Characteristics of a good indicator should be that it indicatse the presence of pathogens in the water and
does not remain in the water for a long period of time. For survival studies, sand and water samples were
sterilized and inoculated with *E. coli*, and then analyzed by membrane filtration. The test results
indicated that *E. coli* could survive for up to 105 days in water and up to 52 days in beach sand. These
lengthy survival rates make it unclear if *E. coli* is a good indicator of recent fecal contamination in
tropical waters. What these survival rates mean in terms of human health is also unclear.

An epidemiological study is currently being conducted in Puerto Rico using both membrane filtration and
Colilert analytical methods. Using both methods in this study will aid in determining which method will
be helpful in lowering the health threat for beach-goers. The study involves interviewing both bathing
and non-bathing beach-goers while they are at the beach. There are currently 157 study participants. The
initial beach interview is followed up by a phone interview 1 week later, during which the study
participants answer questions regarding any gastrointestinal, respiratory, skin, or other illness symptoms
they may have experienced. The initial test results have indicated that swimming beach-goers have a
higher risk of developing illness symptoms than non-swimming beach-goers.

Water Quality in Potable and Recreational Waters in Puerto Rico - Graciela Ramírez-Toro
Dr. Ramírez-Toro, Director of the Center for Education, Conservation & Environmental Interpretation
(CECIA) at the InterAmerican University of Puerto Rico, discussed two water quality studies. The first
study focused on recreational water use and the second on a drinking water system in Puerto Rico.

The first study, on recreational water use, took place in a small fishing village with residential areas. The
classification of the area has been changed many times to create a special tourist area. While
infrastructure development has not increased, the number of homes in the village has. This development
has negatively impacted water quality in the village. To find the source of the contamination, 30
sampling stations were established in both the old and new development areas of the village. The sample
analyses revealed that although all sampling stations had a standards violation at some point, the ones located in the new development area had significantly higher values.

The second study focused on the occurrence of *Salmonella spp* in very small drinking water systems. There are many problems associated with small drinking water systems including lack of awareness and uncertainty regarding potential risks and lack of regulatory knowledge on the parts of both the enforcers and the compliers. The objectives of the project were to join regulators with the regulated and to show that training activities could be an effective strategy. A four-year, three-phased strategy was developed, which included research, operator training, and an epidemiological study. The research phase consisted of students taking samples to test water quality and look for indicators. The operator-training phase of the study involved training and educating community members so that they would be able to operate the system effectively. The third phase, the epidemiological study, involved a questionnaire. Students interviewed community members monthly regarding their illnesses. *Salmonella* was found in samples taken from both well water and distributed water. Though the community was initially opposed to chlorination, once the sampling began and the community became aware of the risks associated with drinking contaminated water, the number of samples of distributed water that tested positive for *Salmonella* decreased. The study results indicated a significant difference in the number of positives before and after the students participated in the sampling. In addition, there was a significant decrease in the number of intestinal illnesses observed before and after the intervention.

**Question & Answer/Discussion Session**

Ms. Sánchez clarified that the membrane filtration could be used to determine if a beach meets the standards.

Attendees commented on the problem with false positives causing alarm.

Attendees also commented that 157 test subjects were too few to base any conclusions on, and suggested that Ms. Sánchez include 500 or more test subjects in her study.

Ms. Sánchez indicated that during the survival studies the criterion used to determine when to stop taking samples was the time at which the bacteria were no longer detectable. Sampling was ceased when the researchers observed zero colonies for a period of 2 days.

An attendee asked Ms. Sánchez about the salinity of the water she worked with and what affect it could have on the organisms. Ms. Sánchez said that microorganisms survive very well in water with 3.5 percent salinity. Even though marine water pH is supposed to be 8 to 8.2, and some water sample pH values ranged from 7.2 to 9, they still survived quite well. The researchers expected *E. coli* to die quickly, but they did not. Microorganism survival is dependent on a mixture of variables.

Dr. Ramírez-Toro said that the community member trained to operate the village’s water system was able to take a test issued by the state. The project group developed a post-secondary degree that complied with the state regulation for the students who were interested in becoming operators.

An attendee asked what the most acceptable indicator of recreational and beach water quality is. The response was that as far as the data shows, there is not a single one or a battery of indicators that is better than others. The indicator base cannot be changed unless it is health based. Since these microorganisms are present all the time, it seems that it cannot reasonably be said that they indicate anything. New indicators cannot be proposed without epidemiological studies, for nobody would believe them.

Epidemiological studies have been conducted all over the world. Most of those studies say *enterococci* are most effective in relating to health effects. An attendee asked if they hold up as good indicators in
tropical waters. Perhaps they can grow in environments other than gastrointestinal tracts of animals. Whether they can grow in beach water or sand is also unknown. There will be two studies discussed tomorrow that show how the indicators relate to health effects in swimmers.

An attendee questioned whether an indicator of risk could be determined if you have an unidentified point source.

An attendee commented on over-the-limit concentrations of \textit{E. coli} found in water well samples taken on indigenous reservation communities with primal forest and a much dispersed population. Dr. Ramírez-Toro said that the elevated \textit{E. coli} concentrations in the well water samples could possibly be attributed to contamination from the intestinal tracts of wildlife in the area. Further, if the community is accustomed to such elevated \textit{E. coli} concentrations, they may not be as predisposed to illness. The problem with \textit{E. coli} is that its presence does not constitute an obvious contamination. There are animals that have \textit{E. coli} present all the time. There are also native strains of \textit{E. coli} that are constantly present and do not necessarily come from fecal contamination.

In rural communities, water is considered a need and not a service, so the work on the system is donated to the community. Dr. Ramírez-Toro said that her project examined different levels of training. One aspect of training is informal education; however, an uncertified operator would constitute a violation. Therefore, the project included a formalized educational program in which agencies will travel to such communities on a monthly basis to properly educate them. It is important to keep in mind that the average education of the communities is at a sixth-grade level.

An attendee commented that we have to get the message through to communities that if a contaminant is able to get through the disinfection barrier, the water supply may not be sufficiently protected. There is no disinfection or treatment infrastructure.

**Summary of the Day – Jorge Rivera-Santos, UPRM**

There is a series of common problems in all of Latin America and the Caribbean: water quality, pollutants, industrial discharges, lack of funding, wastewater treatment, technical obstacles, etc. In Puerto Rico, there are pollution sources from agriculture and mismanagement of watersheds. This is a global program. We have a series of situations to analyze together, and then make suggestions on actions we can initiate to find solutions. Because test result variance is due to, at least in part, the analytical method used, interpretation of the data is difficult.

Although Puerto Rico has been developing environmental legislation for more than 30 years, contamination is still a significant problem. The U.S. EPA has given its support in order to develop initiatives. Latin American and Caribbean authorities want to participate and cooperate in the endeavor to find solutions to recurring problems and identify common needs. Once needs are identified, there must be a united front to find and share solutions as well as technological advances.
SESSION IV – WATER QUALITY MONITORING
Session IV included three presentations that focused on innovative detection technologies.

Detection and Monitoring of Contaminants in Subsurface Environments: Novel Approaches - Ingrid Padilla
Dr. Padilla, with UPRM’s Department of Civil Engineering and Land Surveying, discussed some novel approaches for subsurface contamination detection and monitoring, which included the use of cross well radar (CWR) for the detection of dense, non-aqueous phase liquids (DNAPLs), and a project on the detection and monitoring of the fate and transport of explosive-related compounds (ERCs) in soils.

Groundwater contamination can occur as a result of accidental spills, poor storage facilities, inadequate disposal practices, and inadequate land use practices in the agricultural and mining sectors. Major worldwide groundwater contaminants include: energy-related contaminants, such as benzene, toluene, ethylbenzene, and xyylene (BTEX); methyl tertiary-butyl ether (MTBE), radionuclides; and polychlorinated biphenyls (PCBs); solvents, such as chlorinated hydrocarbons and DNAPLs; nitrates from agriculture and septic tanks; and, heavy metals from both naturally occurring and industrial sources. Once in the groundwater, these contaminants can travel as dissolved solutes and vapor, negatively impacting the environment and threatening human health and safety. Restoration of groundwater includes characterization, detection, and monitoring of contaminants.

Traditional invasive detection and monitoring techniques are expensive and can promote the spread of contaminants. Non-invasive techniques, while often rapid and less expensive, yield results that lack adequate resolution and specificity.

CWR involves the use of wells equipped with antennas for transmitting and receiving electromagnetic waves at high frequencies. Detection of the contaminant is based upon differences between the dielectric properties of the contaminant and the media. Because the dielectric properties of DNAPL contaminated soils significantly contrast uncontaminated soils, there is great potential for the use of CWR in DNAPL detection and monitoring. As part of an ongoing project at UPRM to evaluate the use of CWR for this purpose, researchers have developed a two-dimensional flow and electromagnetic Soil-Bed, determined that loop antennas provide the best response, and developed a calibration method to test DNAPL distribution with an antenna signal. Current and future project work includes optimizing the antenna signal, experimenting with radar antenna, evaluating signal response for image development, and incorporating modeling and image processing.

Dr. Padilla then briefly discussed another project being conducted at UPRM to study detection and monitoring of the fate and transport of ERCs in soil. Detection of ERCs requires an understanding of how the chemicals move and how environmental factors affect their movement. To understand ERC movement, researchers have built a set of physical models to measure spatial and temporal distribution data and characterize and quantify fate and transport processes.

Future Approaches for Rapid and Routine Determination of Microorganisms in Environmental Waters - Mark Rodgers
Dr. Rodgers, U.S. EPA, discussed rapid detection technologies currently in developmental stages.

One common problem is the inability to determine the health risk from contaminated water at the time of the exposure. Currently a good sample analysis takes 18 to 48 hours to complete, and this long after
exposure, only symptoms can be treated. Measurement of the risk prior to exposure is needed so that exposure can be avoided altogether. Rapid detection technologies currently available, or in developmental stages, include molecular, immunoassay, and bioluminescence methods.

One molecular method is quantitative polymerase chain reaction (QPCR). QPCR targets only a small fragment of the cell’s deoxyribonucleic acid (DNA). The method is based on DNA primer sequences that recognize the target DNA. QPCR specificity can be very high. The more DNA you have, the more rapidly you get a signal. As you increase the amount of DNA in the sample, you get a quicker response above the background. Using a standard curve, you can determine how many microorganisms are in a sample. QPCR is a promising rapid detection method.

Mr. Rodgers discussed two immunoassay methods, flow cytometry and a fiber optic system. In flow cytometry, antibodies bind to a bead. These antibodies can be labeled for measurement. The bead has both antibodies and markers. In a flow cytometer, the sample moves through a very narrow aperture one bead at a time, passing through two lasers. To get a positive result, the machine would have to detect antibodies with both lasers. This is also a very promising methodology. The fiber optics method discussed is called Raptor. This robust instrument was developed with the U.S. Navy. Disposable test coupons, four assays per coupon, are the heart of this method. This method also uses antibodies that bind to the target, but it includes the use of a second, labeled antibody. It uses laser light to generate wave excitation. A fluorescent marker allows one to measure the change in the light wave. This is a very sophisticated idea.

Adenosine triphosphate (ATP) analysis is a bioluminescence method. ATP is a molecule found in all living things; therefore, it is a very convenient target molecule to measure. Some advances have made this a more promising technology. This technology is commercially available in a hand-held unit. The promise of this method remains to be seen.

There are advantages and disadvantages to all of the methods. Their sensitivity is pretty good, but consistency is a big problem. Dr. Rodgers said that QPCR has worked the best for his research team. If you use an antibody method, you have to examine avidity and affinity. Work is needed on sample concentrations and method validation. Methods have to be developed in the laboratory and transferred out into the work areas.

**New Detection Technologies for Pathogens and Indicators of Microbial Water Quality - Gary Toranzos**

Dr. Toranzos, Director of UPRR’s Environmental Microbiology Laboratory, discussed the use of microbial assays for the detection of pathogens and microbial indicators.

Dr. Toranzos began with the experience at Walkerton, Ontario, Canada, with a waterborne outbreak. Walkerton is an agricultural community of approximately 5,000 inhabitants that experienced an epidemic of waterborne intestinal illnesses. Half of the population was affected. One biological agent to blame was *E. coli* 0157:H7. The consequences of this contamination included a 6-month boil water advisory, school closings, stigmatization from neighboring communities, and a decline in tourism and real estate values. The epidemic cost the town of Walkerton over $64 million. Responsible parties for this epidemic include the operators, the local health unit, and the community members. The operators are the first line of defense against illnesses; they routinely dosed less chlorine than required, failed to monitor chlorine levels, and falsified monitoring records. In addition, they were not adequately trained and did not understand the risk they were bringing to their community. They also lacked the capability to respond to the event. The local health unit took little interest in drinking water safety and was unprepared for an
epidemic of this magnitude. The people of Ontario are also partially to blame because most residents were complacent about the need to invest in the water system to ensure safety.

Human caliciviruses (HCV) are the most important in terms of gastrointestinal illnesses. The bird flu virus has already been detected in Colombia. The role of water in the transmission of this illness is not known, but it may be important. The people who deal with this must have the knowledge to communicate with the public. It is our job to look out for these types of viruses and indicators.

Dr. Toranzos discussed microbial assays including cell culture; polymerase chain reaction (PCR); coliphage, coliform, and other bacteriophage; and the hydrogen sulfide paper strip. He stressed that it is important to know the ecological structure of our own country and the reason why we are sampling in order to choose the most appropriate sampling technique. Different sampling methods are used in various crisis situations. For example, the hydrogen sulfide paper strip test is inexpensive, less than two cents per test, and effective. Coliphage, a rather new technique, is also inexpensive and relatively easy to use.

Pulsed field gel electrophoresis (PFGE) is a new technique that creates electrophoresis patterns of restricted nucleic acids. The resulting pathogen patterns can be compared with the Centers for Disease Control’s (CDC) database called Pulse-Net. PFGE has been helpful with pathogens, but not with indicators. We need to understand the limitations of the analytical tests and use methods that have been tested and verified.

Dr. Toranzos also mentioned an ongoing research project for determining the occurrence of *Aeromonas spp.* in Puerto Rico’s lakes. *Aeromonas spp* is on the latest EPA Contaminant Candidate List (CCL).

**Question & Answer/Discussion Session**

An attendee commented to Dr. Padilla that because these technologies have the potential to be applied in all Latin American countries, our interaction should include applying these technologies in the countries where there is no access to advanced technologies or water analysis. These technologies should be modified to each country’s level of development.

Dr. Toranzos said that he agreed with the “leap-frog” approach mentioned by the attendee. However, before buying costly equipment and training personnel, it is important to recognize that many of these technologies could be used in laboratories located all over Latin America that already have trained personnel. A nucleic acid analysis machine, such as the one used for PFGE, may cost at least $25,000, and each test will cost between $220 and $250. In a private laboratory, these costs will be adjusted for profit. International agencies should be involved to help with these expenses.

Dr. Padilla said that sometimes the cost of site clean-up far exceeds the cost of the technology because what should have been done in the beginning was not done.

An attendee asked if EPA is using any of these methods. Dr. Rodgers replied that EPA is using QPCR. The results appear promising, and QPCR will be the first EPA-approved molecular method. In the ongoing beach study, nothing has been as promising as QPCR. There are inconsistencies and sensitivity issues with the other methods being tested. Some companies have done field tests with QPCR (e.g., lifeguards doing sample testing). Field devices are not as robust as EPA would like, but they are coming down in price.
SESSION V – SATELLITE IMAGING – REMOTE SENSING AS IT APPLIES TO WATER QUALITY

Session V included three presentations that focused on the use of remote sensing technologies in water quality monitoring.

GEOSS and Water Quality - Gary Foley

Dr. Foley, Director of EPA’s National Center for Environmental Research (NCER), discussed the Group on Earth Observations (GEO) and the Global Earth Observation System of Systems (GEOSS).

GEO began in July 2003 at the initial Earth Observation Summit where ministers, leaders from 34 nations, and delegates from international organizations discussed the potential benefits of an integrated earth observation system. Current members of the GEO include 58 countries and 43 participating organizations. A 10-year implementation plan for GEOSS was endorsed in February 2005 to integrate all global observation systems, thereby improving our understanding of the Earth system and enhancing our ability to sustain and promote the environment, human health, safety, and welfare.

The GEOSS architecture involves earth monitoring systems, water and air quality models, and decision support systems. There is a lot of work to be done to ensure that information support systems are a part of GEOSS.

More western hemisphere membership is needed. Neither WHO nor the PAHO are participating organizations. It is easy to join GEO. Information on joining can be found at http://earthobservations.org/how_to_join.asp.

The User Interface Group is a two-tiered user interface mechanism: Communities of Practice (CP) and a User Interface Panel. CP is a user-led community forum where stakeholders work together on GEO interests, while the User Interface Panel addresses cross-cutting issues and oversees the CPs.

There are nine GEOSS societal benefit areas, all of which are important to the Latin American and Caribbean regions. GEO program activities include improving data sharing and management, engaging user communities, creating a GEO fellowship program, building capacity where needed, developing outreach and communication, and implementing activities specific to each societal benefit area. Water area activities include organizing a workshop, coordinating a demonstration project, organizing an event at the World Water Forum IV to be held in Mexico in March 2006, and producing global dataset mapping catchments. Health area activities include establishing a human health task force, organizing a workshop with WHO to address human health issues, facilitating and coordinating demonstration pilot-projects, and raising awareness of the possible uses of Earth observation for health issues.

Remote Sensing Techniques for Monitoring Water Quality in Coastal Waters of Puerto Rico - Fernando Gilbes Santaella

Dr. Gilbes, UPRM, discussed linking the traditional monitoring and detection methods with the new remote sensing methods.

Although traditional methods are good and reliable, they are difficult to coordinate, time consuming, and expensive. Therefore, new techniques need to be developed. Remote sensing appears promising for easy and cost effective water quality monitoring.
Dr. Gilbes discussed UPRM remote sensing studies conducted in Mayagüez Bay and San Juan Estuary. The first project sought to estimate the water quality parameters in Mayagüez Bay using a bio-optical package and 24 sampling stations. The study findings indicated that Mayagüez Bay has significant spatial and temporal variability of bio-optical properties between the rainy and dry seasons. Better bio-optical algorithms and different sensors are needed to estimate chlorophyll in the bay. Another study was conducted in Mayagüez Bay using a new sensor and IKONOS imagery with high spatial resolution to identify movement of sediments. This study yielded a good data set that is currently being analyzed.

Dr. Gilbes discussed another study conducted in the San Juan Estuary to monitor nutrient content using hyperspectral imagery. Thirty-eight stations were established in the San José Lagoon to measure nutrient concentrations. The results showed high levels of phosphorus as compared to nitrates. The next steps are to obtain new Hyperion images without clouds, conduct field measurements, and generate a water quality model capable of predicting nutrient concentrations.

**Detailed Land Use Classification of the Mayagüez Bay Watershed - Luis Olivieri**

Mr. Olivieri, UPRM, discussed the development of a detailed land use classification for the Mayagüez Bay Watershed using remote sensing technology and field visits.

Mr. Olivieri said that an investigation conducted by the Water Resources and Environmental Research Institute revealed that the classification of available lands is too generalized. To remedy the situation, UPRM developed a detailed land use classification for the Mayagüez Bay Watershed. The remote sensing technologies used were Landsat TM image classification and aerial photography. Global Positioning Systems (GPS) technologies, a PC-Tablet model, and other data, such as roads and watershed boundaries, were used in field visits.

The Anderson land use/land cover classification system was used for the study. The primary focus of the study was crop types. Cultivation practices will make a huge difference in mathematical models. The results of the remote sensing portion of the study indicated there was good supervised classification of urban areas, forest, bare soils, water, natural pastures, rock outcrops and gravel pits, and shrub and brush rangeland; however, agriculture identification was poor. For example, young coffee trees were classified as bare soil and adult coffee was classified as forest. Therefore, it was necessary to develop another way to classify agriculture.

Field visits were conducted by driving throughout the entire watershed. An antenna attached to a car was connected to a laptop computer. The advantage of this approach was the ability to differentiate crops on the screen. Binoculars were used to identify crops. The study enabled the researchers to properly identify all land uses in the basin.

The land use classification will be used as input to the Better Assessment Science Integrating Point & Non-point Sources (BASINS) computer model. It will also be used to characterize soil erosion and pollution at the watershed level, develop watershed management plans, inventory land use, and detect land use changes. It is hoped that the classification will lead to an improvement in the water quality in the Mayagüez Bay Watershed.

**Question & Answer/Discussion Session**

An attendee asked Dr. Gilbes if the technologies he described could be used to measure heavy metal contamination in rivers and lakes. Dr. Gilbes responded by saying that the problem with that approach is that optical sensors need to reflect. The first step would be to analyze the change in light made by the heavy metals. In these cases, when the signal produced is not enough, we would use a proxy signal.
An attendee asked Dr. Gilbes if it was possible to discriminate between the types of nutrients. Dr. Gilbes said the multi-spectral sensors have few bands and are limited; however, the new hyper-spectral sensors are more sensitive, and tests are being conducted to differentiate the nutrients with the new sensors.

An attendee commented that because suspended sediments absorb most of the heavy metals, there is great difficulty in using sensors. Estimating the level of contamination can only be done in the field.

Dr. Gilbes said depth posed a limitation to remote sensing. The more turbidity in the water, the less we can see. Only surface water will be examined in the study, since there is a correlation between the amount of chlorophyll at the surface and the amount in the middle.

Dr. Foley clarified that only countries can become members of GEO. Organizations can join as participants but will not be members. The Institute of Electrical and Electronics Engineers (IEEE) has joined, and a group that works on Great Lakes border issues, part of the international joint commission, is considering joining as well. Dr. Foley said he was uncertain about limitations on what types of organizations can join GEO.

Dr. Rivera-Santos also stated the Mayagüez Bay projects discussed are part of a much more encompassing project to develop actions and strategies for watershed management. Water quality and transport simulations are needed. Remote sensing technologies will enable us to identify the potential contamination sources in the entire basin without having to take field samples.

SESSION VI – WATER QUALITY GUIDELINES FOR TROPICAL WATER RECREATION
Session VI contained three presentations that focused on guidelines for recreational waters in Latin America and the Caribbean.

WHO Guidelines for Safe Recreational Water Environments - Henry Salas
Henry Salas, PAHO, discussed the recreational water guidelines established by WHO in 2003. To date, Mexico and New Zealand have adopted the guidelines. The guidelines will be released in two volumes: Volume 1 covers coastal and fresh waters, and Volume 2 will cover artificial waters (e.g., swimming pools, spas, etc.).

The primary goal of the guidelines is to protect public health. The guidelines are simply advisories, as WHO cannot establish mandatory standards. The guidelines emphasize health benefits and hazards, the need for a risk-benefit approach, and the need for inter-sector activity. Because they are health centered, they take into account the full range of adverse health effects but do not include criteria for environmental protection. The guidelines are science-based and developed from the best available evidence and scientific consensus.

Health outcomes taken into account by the WHO guidelines include self limiting infectious disease; drowning and near drowning; paraplegia; skin and eye irritation; and, the effects of heat, cold, and sunlight. Excluded from the guidelines are foodstuffs, protection of aquatic life and environment, occupational exposure, and water used for religious purposes, ancillary facilities, and aesthetics.
In the future, PAHO will promote epidemiological studies in Latin America and the Caribbean and advise countries to adapt the guidelines into their legislation at a level of acceptable risk as defined by their socioeconomic factors. PAHO will also serve as an advisor on monitoring and control issues.

The full text version of the WHO Guidelines for Safe Recreational Water Environments can be found at http://www.who.int/water_sanitation_health/bathing/en/.

A Prospective Study of Swimming-Related Illnesses at Four Popular Beaches in Trinidad, West Indies - Christine Bullock
Ms. Bullock, a microbiologist at the Institute of Marine Affairs, Trinidad & Tobago, West Indies, discussed an epidemiological study on swimming-related illnesses at beaches. The purpose of the study was to determine the population at risk, the exposure level, and the adverse health outcomes of exposure.

The objectives of the study were to compare the morbidity rates of bathers and non-bathers, determine the most prevalent symptoms associated with swimming at beaches in Trinidad, determine the best water quality indicators for Trinidad and Tobago, and develop health effects criteria for marine recreational areas. These criteria could then be used to develop guidelines and standards.

The experimental approach included an evaluation of the bacterial quality of the water in the swimming areas, an evaluation of the health risks among swimmers, and a comparative analysis of the experimental variables to establish a statistically significant association. The evaluation was conducted at six sites located on four beaches: Maracas Bay, Chagville Beach, Welcome Bay, and Macqueripe Bay. The locations were selected based upon their high rate of use on the weekends and their proximity to laboratories. Samples were collected on 11 Sundays (4 during the dry season and 7 during the wet season). The bacterial indicators evaluated were total coliforms, fecal coliforms, E. coli, and enterococci.

The target population was 8,000 persons and, preferably, family groups. The initial beach interviews conducted on Sunday were followed up with another interview. Morbidity symptoms investigated included ear, eye, and skin infections; respiratory, gastrointestinal, and other symptoms, such as fever and headache; and allergies. Eighty-five percent of the test subjects were swimmers, and 98 percent of the swimmers reported getting their head wet. Ninety-seven percent of the swimmers reported swimming for at least 10 minutes, which indicates that the length of exposure was long enough that any illness contracted after swimming could have been from exposure to the water. The study results showed that most test participants who reported illness symptoms were swimmers.

Marine Bathing Water Quality: Microbiological Indicators and Swimming-Associated Gastroenteritis - María Inés Sato
Dr. Sato, manager of the Environmental Analysis Division at the Sao Paulo Department of the Environment, Brazil, discussed a 1999 epidemiological study of recreational water quality.

Extending over 8,500 kilometers, the Brazilian coastline is one of the largest in the world. Twenty-two percent of the Brazilian population lives in coastal areas. Sao Paulo has 2,700 kilometers of beaches. Currently, water quality is monitored weekly at 149 sampling sites on 129 beaches. Flags displayed on the beach indicate the water quality; green means good, and red means the water quality is not suitable for bathing.

The objectives of the 1999 epidemiological study were to investigate the association between gastrointestinal symptoms and bathing in seawater, study the relationship between microbial indicators
and health outcomes, and develop a scientific background for marine recreational standards. The study included 6,353 families or groups interviewed at 5 beaches. Microbial indicators examined were thermotolerant coliforms, *E. coli*, *enterococci*, and *Salmonella typhimurium*.

The study variables included contact with recreational waters, seafood consumption, consumption of food prepared at the beach, occupational exposure, age/race/sex, previous illnesses, socioeconomic data, seawater exposure level, and contact with beach sand. Each initial beach interview was followed up 1 week later with a telephone interview. During the phone interview, study participants answered questions relating to the following illness endpoints: vomiting, diarrhea, nausea, fever, stomachache, conjunctivitis, and ear and nose infections. While 87 percent of the study participants were bathers, 13 percent of the study participants reported having at least one of the aforementioned illness symptoms. In relation to socioeconomic factors, the lowest income beaches had the highest incidences of illness symptoms.

The results indicated that children under the age of 7 were more susceptible to illness. Contact with the beach sand was a risk factor for diarrheal illness. There was a direct correlation between the study participants’ exposure level and their risk of becoming ill. *Enterococcus* was the microbiological indicator that best correlated with gastroenteritis symptoms.

**Question & Answer/Discussion Session**

An attendee commented that the research being conducted continues to avoid the salinity issue. He believes that there is a correlation between salinity and what is going on at the beach. He added further that enough resources, time, and people are available to make area assessments and, therefore, the researchers should not focus so much on indicators.

An attendee warned of the dangers associated with bringing a study from one country to another. A country cannot borrow studies, and problems, from other countries.

**SESSION VII – ADVANCES IN ANALYTICAL METHODS**

Session VII included two presentations that focused on advances made in the use of analytical methods for the detection of perchlorate in drinking water, and the assessment of the quality of groundwater at the aquifer level.

**New Methods for the Determination and Confirmation of Perchlorate in Potable Water: The Real Perchlorate Situation in the United States and Puerto Rico - Felix Román**

Dr. Román, UPRM, discussed the properties of perchlorate, its health affects, the Unregulated Contaminant Monitoring Rule (UCMR), and new methods developed for handling the contaminant. Dr. Román also discussed the UPRM research facility and possible collaboration projects for dealing with perchlorate.

Perchlorate, an oxidizing agent typically of synthetic origin, is a very toxic material. It is used primarily in the production of military explosives and munitions. It is also a component of non-military products, such as pyrotechnics and automobile safety airbags.

Perchlorate is currently on the EPA CCL. The UCMR requires that perchlorate be monitored in small and large water systems on a quarterly basis. The 1999 rule mandated that EPA Method 314 be used for monitoring, but we need to use other types of methodologies now. EPA Method 314.1 is a review of Method 314, and many new methods have been developed in the last year. The proposed perchlorate
exposure level is extremely low, 30 nanograms/kilograms/day. The compound’s effect on the central nervous system was taken into account in the proposed level. Sensitive populations are highly susceptible to perchlorate exposure. The recommended concentration limit of 1 microgram/liter is going to be a challenge; however, analytical techniques are being developed that have the ability to measure in parts per trillion.

Perchlorate contamination has been detected in U.S. and Puerto Rican waters. Significant concentrations of perchlorate, levels exceeding 4 ppb, have been detected in 35 states. More than 11 million people drink water at these toxic levels every day. This contamination is attributed to aquifers that have been contaminated by military activities. Elevated perchlorate levels have also been detected in milk and other beverages, and produce, such as lettuce and fruit.

Perchlorate contamination is mainly found in the west and northeastern areas of the U.S. Geographical interpretation of elevated perchlorate level sites indicates a relationship between contaminated areas and military and industrial sites that use perchlorate. Puerto Rico also has perchlorate contamination. The amount of contamination in Puerto Rico is 10 times greater than in New Mexico. Dr. Román gave an example of an extremely high perchlorate concentration level detected in a Puerto Rican inland sample. He theorized that the elevated concentration level was a result of a recent fireworks display in the sampling area.

Elevated perchlorate levels could seriously impact Puerto Rico’s economy. For example, if the U.S. regulates perchlorate levels, it could impact Puerto Rico’s export of produce to the country.

The EPA needs to measure perchlorate in drinking water. The U.S. Food and Drug Administration, CDC, and the U.S. Department of Agriculture currently measure perchlorate levels in their studies. UPRM has the necessary instrumentation for such studies and is eager to collaborate with other organizations and agencies in this endeavor.

**Groundwater Monitoring in Latin America: An Urgent Need - Edmundo García Agudo**

Dr. García Agudo, formerly with the International Atomic Energy Agency (IAEA) in Austria, discussed IAEA’s project on sustainable management of groundwater in Latin America. The project objective was to develop and validate a mathematical model for each aquifer to be used as a tool by water resource administrators. The 4-year project, conducted from 2001 to 2004, was based on technology transfer. Models for 11 aquifers in 7 countries (Costa Rica, Nicaragua, Colombia, Ecuador, Peru, Chile, and Uruguay) were developed. More than 50 institutions and 35 counterparts were involved in the project.

The use of groundwater as a public drinking water supply has increased due to contamination of surface waters. Extraction is being done based on how much water can be taken out of the well and not how much can be extracted from the aquifer. Few studies are conducted to evaluate the sustainability of the resource. Currently, only basic water quality parameters are analyzed. The presence of harmful chemical contaminants cannot be confirmed through standard processes. Because of this, the potential exists for toxic chemicals to be present in distributed drinking water from groundwater sources. Regulations on water resources are usually old, incomplete, and focused on surface water.

Groundwater management improvements are needed on both the national and aquifer levels. More than laws are needed; a framework for enforcing and complying with the laws is also required. At the aquifer level, there must at least be a minimal knowledge of the aquifer’s physical parameters, dynamics, recharge capabilities, water quality status, and existing contamination risks.
Current groundwater study activities include development of an inventory of existing wells, a publicly accessible information database, a well monitoring network, measurement of absolute water table levels and selected chemical parameters, and aquifer vulnerability and risk assessment studies. Additional studies to be conducted in critical aquifers include water isotopic composition and water hydrogeochemical analyses; drilling of multilevel monitoring wells and/or nest piezometers; and mathematical models for water management decisions. Since the problems are common to all countries in the region, a master plan could be developed with a series of activities to be performed. Each country could perform activities as their resources allow. A proper methodology needs to be generated based on existing experience from both developed and developing countries, and the approach should be holistic and ensure the future sustainability of the aquifers.

**Question & Answer/Discussion Session**

Dr. Román said that perchlorate blocks the absorption of iodine in the thyroid gland. The resulting health effects include tumors, abnormal fetus development, and mental retardation. It is a very persistent, stable compound that resists chemical treatment. It can only be broken down with certain bacteria. According to the EPA and the Puerto Rico Department of Health, there does not seem to be a large problem with perchlorate in Puerto Rico. However, the elevated perchlorate incident discussed in the presentation indicates certain activities, such as pyrotechnic (firework) shows, can cause problems. The Department of Health gave the impression that the sample producing the high perchlorate levels was from a groundwater sample. Further, studies have indicated that perchlorate is not a component of many insecticides and fertilizers.

An attendee asked Dr. Garcia Agudo if there was a plan to inventory and protect the most susceptible aquifers. Dr. García Agudo replied that there is an area known as the Guaraní Aquifer that encompasses four countries. The basis of the plan’s characterization is to establish protection guidelines to be adopted by the countries. The project is concerned with contamination discharges in Argentina and Uruguay from sources in Brazil and Paraguay. There is no existing inventory plan for the most susceptible aquifers, and an international entity is required to get the national authorities to do what they are asked to do.

An attendee commented that his organization had once suggested that well drillers be certified to address the serious problems associated with drilling wells, and the Colloquium presents an opportunity to propose such an action, as $220,000 to completely model an aquifer is not really that expensive.

An attendee commented on the study of groundwater used for irrigation. The biggest problem is lack of information. If information exists, it is not easily found or accessible. Currently, groundwater use for irrigation purposes is not managed. The quality and the management of monitoring data are very important.

An attendee commented on a previous groundwater well inventory conducted by the Puerto Rico Water Resources and Environmental Research Institute. That study indicated that gathering information from agricultural well owners was problematic. Puerto Rico has 1,800 wells used for agriculture activities, water consumption, and industry use. The process of inventoring them has been difficult.

**SUMMARY OF THE DAY – Fernando Gilbes Santaella, UPRM**

Dr. Gilbes Santaella summarized the key points made during the second day of the Colloquium:

- New monitoring and detection methods and techniques including QPCR, coliphages, remote sensors, EPA methods for perchlorate monitoring, and ionic chromatography were discussed.
- Methods need to be more rapid and sensitive.
- Many techniques are not quantitative.
- There is a lack of training and staff to analyze data.
• Need to know ahead of time how the data will be used.
• Many techniques can be used in many countries, but they will have to be adapted. International organizations can help with costs.
• How can we apply and fund remote sensing and GIS techniques?
• In determining the appropriate method to use, sometimes it is necessary to use invasive techniques. Once you obtain results, you have to go to the next step.
• How will data help manage water supplies? Databases are great, but we have to use them.
• Different organizations offer support including GEO, WHO, and PAHO.
• We need to develop a proactive plan.
• To ensure safe drinking water, we have to put all that we have learned from the studies into practice.
• Latin American and Caribbean countries can benefit and learn from studies conducted in other countries.
• We must comprehend the possible effects of groundwater contamination.
• The proposed Center would benefit all Latin American and Caribbean nations.

**SESSION VIII – WATER QUALITY CONTROL**

Session VIII included four presentations focused on management and mitigation of risk.

**Monitoring of Filtration Systems Integrated to Remote Telemetry Systems in the Río Piedras Community in San Germán, Puerto Rico - Ivonne Santiago**

Dr. Santiago, UPRM, discussed a joint project between UPRM and EPA. The goal of the project was to demonstrate that instrumentation can be used to monitor watershed and drinking water quality, and the data collected can be used for self-monitoring of the system and self-shutdown if necessary. Good progress has been made since the beginning of the project in May 2005.

The project is being conducted in Río Piedras, San Germán, Puerto Rico, a small community with approximately 245 residents. The Shaw Group, EPA contractors, refurbished an existing slow sand filter (SSF) and horizontal flow gravel pre-filter (HFGP) system and installed a web-enabled remote monitoring and control system. UPRM’s Civil Engineering Department is managing the system on-site and through on-line monitoring. The UPRM staff monitors instrumentation readings and calibrates the instrument weekly. The existing water treatment systems worked on gravity, and the components of the refurbished system include a small dam with water intake at the bottom of the structure, two HFGPs, two SSFs, and a distribution tank.

The objectives of the project are to determine the feasibility of remotely operating a small water treatment plant, evaluate the performance of the remote monitoring and telemetry systems remotely used, and analyze the conditions and changes in water quality at both the water source and in the distribution tank. The telemetry system includes an intake structure upstream of the dam, the distribution tank, and a HFGP. The intake structure consists of a tower with a solar panel and data node equipped with a radio antenna and a YSI 6920 sonde. The tower sends signals, via radio, to a master control node box located near the distribution tank, while the sonde measures depth, turbidity, temperature, and specific conductivity at the source. The distribution tank is equipped with two sondes (one inside the tank and one on the effluent of the tank), and a tower equipped with a solar panel, master control node, radio receiver, and cellular communication device. The HFGP is automated and set to close when turbidity readings at the source reach 20 units. Gel batteries, charged by the solar panels, fuel the system. The master node is connected to a cellular modem. Data is sent from the master node to the Data Center located in Atlanta, GA. UPRM staff monitors the data on the Internet, and the data can be exported for analysis.
General system maintenance includes weekly calibration of the sondes and solar panel cleaning. Sonde calibration is done using either EcoWatch software or handheld calibration tools. On-site calibration is easier. The project has been temporarily halted due to a landslide in late October 2005 that destroyed the sonde located at the source.

This EPA-led project serves as a model for finding practical solutions to remotely monitoring drinking water quality in rural communities all over the world. This study has illustrated that it is feasible to remotely operate a small water treatment system. However, it is important to note that the system is not “hands free,” and does not run itself. Trained monitoring staff and community involvement are necessary to the success of the system. Future work on the project will include replacing the lost sonde, performing minor improvements to the current system, installing a chlorine sensor in the distribution tank, providing public access to the monitoring data on the EcoNet website, and enabling email or pager alerts to be sent from the system directly to UPRM staff.

Managing Water Quality at the Watershed Level: U.S. EPA’s Watershed Approach - Jim Goodrich

Dr. Goodrich, EPA/NRMRL, discussed the necessity of taking a watershed approach to managing water quality, EPA’s water approach, and EPA’s tools and research to support this approach.

Dr. Goodrich stated that EPA is taking a holistic approach to its mission to protect human health and the environment, including source water protection, ecological habitat protection, and the prevention of intentional contamination. The Agency is considering what can be done at the watershed level to protect and preserve the watershed and control water quality, as opposed to building more engineered structures, such as treatment plants. EPA’s approach includes delineation of watershed boundaries; development of objectives and goals based on resource vulnerability and the needs of the ecosystem and community; identification of priority problems using sanitary surveys and monitoring; development of specific management options and action plans; implementation and evaluation of effectiveness and revision of plans; and public involvement.

EPA watershed-based tools include Watershed Academy, BASINS, Causal Analysis/Diagnosis Decision Information System (CADDIS), the Environmental Monitoring and Assessment Program (EMAP), and the Storm Water Management Model (SWMM). Watershed Academy is a great tool that was originally designed for state watershed managers and officials; BASINS links national water databases; CADDIS is developing an expert system for biological community assessments to aid decision makers in determining the cause of aquatic ecosystem impairment; EMAP is a multi-tier database and a starting point for watershed characterization; and SWMM has recently been updated and is the standard model for examining runoff and pollutant loads.

EPA’s Water Supply and Water Resource Division (WSWRD) research is linked with UPRM. Part of the purpose of establishing the Center is to provide training and information.

Strategic Plan for Monitoring and Control of Drinking Water in El Salvador - Douglas García Sarmiento

Chemist García Sarmiento, with the National Drinking Water Supply and Sewerage Administration, El Salvador, discussed the administration’s strategic plan for monitoring and control of drinking water. The administration’s mission is to help people obtain good drinking water services and strive to achieve
continuity and equilibrium with the environment. The strategic plan matrix includes treatment plant and technology optimization, development of legislation, control and management efforts, education, and identification of the consequences of non-compliance.

With the help of EPA funding, a project was conducted from 1998 to 2004 to supply better quality drinking water service in three countries: Honduras, Nicaragua, and El Salvador. The goal was to build an infrastructure to ensure quality drinking water in these three countries, and through this project, the El Salvador National Drinking Water Supply and Sewerage Administration was able to obtain accreditation.

They also have a pilot laboratory with the German Cooperation Agency. Through this collaboration, the necessary equipment and materials for surface water quality control have been obtained. Treatment plant staff has been trained, and the quality control laboratory staff is able to oversee functions of the laboratory. Prior to this collaboration, the laboratories were very rudimentary and not in good condition. Aside from funding, the German Cooperation Agency also provides technical support.

In 2003, the administration in El Salvador implemented a strategic plan to improve water quality service. Treatment plant and technology optimizations were an obstacle that had to be overcome. Analyses revealed high levels of arsenic, manganese, and iron in high temperature waters, and technologies are currently being implemented to remove these chemicals.

The political and legislative aspects of the strategy are important as well. Before, there was no criterion for protection. Now it has been established and regulated that there must be a radius of 25 meters around sources for both wells and groundwater. Further, control and monitoring of the supply system is crucial; however, the supply system is mainly for urban areas. Actions must also be taken in rural areas. In some rural areas, levels of pollution can be attributed to the fact the people are not educated on water quality protection, and their actions contribute to the contamination of their water supply.

The administration in El Salvador produces monthly reports that include information on the identified problems, control activities, and overall progress towards a solution. Through the use of their strategic plan, 60 to 70 percent improvement has been achieved in their water supply.

**National Network for Measurement of Water Quality (RNM) - Enrique Mejía Maravilla**

Eng. Mejía Maravilla with the National Water Commission in Mexico, discussed the National Monitoring Network. The strategic objective of the network is to develop standards and update reliable data. The network management is currently certified with the ISO 9001 standard. Mexico has had a primary network since the 1970s; however, the system has improved since then and the secondary network is now mobile.

Studies are being conducted in three different zones to determine how water quality is affected by events such as storms. Nine parameters are measured including dissolved oxygen, nitrogen, phosphates, nitrates, conductivity, total coliforms, and fecal coliforms. Variables used include pH and total dissolved solids. Water quality parameters include color, alkalinity, greases, and detergents. Data are generated on site in each zone. There are 32 departments throughout the republic, 1 in each state. All data generated are analyzed and validated in the regional offices and then sent to the central information repository where the information can be given to the public. The network conducts bacterial studies, and these studies began last year on a national level. Measurements are taken onsite and calculated through an index, and determinations are made on the level of contamination. The network also monitors exotoxicological organisms to determine the toxicity of the water.
The national network has 29 high quality laboratories, and the regional laboratories are used for sampling, measurement, and analyses. The national reference laboratory verifies that all regional laboratories in the country have reliable data and participates in technological capability testing at the national level. Synthetic samples are distributed to all laboratories (including private ones). All laboratories must be accredited by Mexican law and approved by the water quality board. Laboratory personnel are often called as experts before the judiciary when there is any hydroecological emergency, such as a large truck spill that contaminates the water. When the network data shows there is contamination, the board decides if the problem will be dealt with by region or area.

**Question & Answer/Discussion Session**

Mr. García Sarmiento said that the cost of the telemetry system discussed was $40,000. Website maintenance is an additional $2,000/year.

An attendee commented that it might be necessary to have multiple sites use one such system to distribute the cost among them. In the U.S., it has been decided to invest more money up front in order to have better water quality and spend less money on remedying problems in the long-term.

Mr. García Sarmiento said that as of today, most communities do not comply with water quality regulations and are in danger of paying fines. These fines and health costs amount to a lot more money than the cost of the system.

An attendee asked Mr. Garcia Sarmiento if there has been any follow-up on the water users in the arsenic contamination study that he briefly mentioned. Mr. García Sarmiento said that the arsenic concentration was 6 parts per million (ppm). The problem was that the source water was 62 degrees Fahrenheit. Now in El Salvador, the suppliers are in direct communication with the Ministry of Health. This source was closed, and a different source was drilled and complemented with a stream only 3 meters away. There is monitoring at the source due to its close proximity to an active volcano. The attendee stated that sources should not be changed based upon arsenic concentrations.

An attendee asked Mr. Mejía Maravilla if a water institute exists in Mexico. Mr. Mejía Maravilla said that in 2003, the National Commission of Water (CONAGUA) signed an agreement with the National Science and Technology Department. Every peso that one donates is matched by the other. A trust fund was established to operate this investigation, and efforts are being made to establish a tropical waters study. The door has been opened for research and university laboratories should be utilized.

**SESSION IX – LABORATORY QUALITY, CAPACITY, CERTIFICATION, OVERSIGHT PROGRAMS**

Session IX included three presentations that focused on the importance of drinking water laboratory certification, improvements in analytical capabilities, and effective management of water basins.

**Drinking Water Laboratory Certification - Jennifer Best**

Ms. Best, with EPA’s Office of Groundwater and Drinking Water’s (OGWDW) Technical Support Center, discussed EPA’s role in drinking water regulation and laboratory certification.

The 1974 Safe Drinking Water Act (SDWA) authorizes EPA to set enforceable health standards for contaminants in drinking water through the National Primary Drinking Water Regulations (NPDWR). The Code of Federal Regulations, 40 CFR, Subpart C – Monitoring and Analytical Requirements, 141.28
Certified Laboratories states “For the purpose of determining compliance… samples may be considered only if they have been analyzed by a laboratory certified by the State…”

Laboratory certification protects public health by ensuring consistency of sample analysis and accuracy of results, and protects laboratories by providing defensibility. If certified, a laboratory must comply with all federal regulations, use promulgated methods, meet criteria when specified in regulations, and successfully analyze proficiency testing samples. In addition, the laboratories must be able to meet acceptance criteria and pass an on-site audit.

All states and territories, with the exception of Wyoming and the District of Columbia, have primacy. They are required to establish and maintain a certification program for drinking water analysis laboratories. States that accept primacy must enforce regulations at least as stringent as NPDWR, but many states are more stringent. The program is conducted through an oversight hierarchy, and OGWDW’s Technical Support Center oversees the activities of the 10 EPA Regions. Regional offices oversee the states with primacy and the commercial laboratories operating in states without primacy. Further, the states with primacy oversee the activities of the commercial laboratories within their borders. The OGWDW oversees all aspects of drinking water regulation in the U.S. and is responsible for establishing regulations, developing methods, overseeing the national drinking water laboratory certification program, and providing guidance and technical knowledge of regulated methods to states and private laboratories.

The National Environmental Laboratory Accreditation Conference (NELAC) is a new EPA concept; the program gives reciprocity with other accredited NELAC laboratories. There are currently 12 states participating in this voluntary program and university laboratories are also eligible to seek certification.

**How to Improve the Capacity and Quality of the Analytical Information on Water - María Luisa Esparza**

Chemist Esparza, PAHO, discussed the improvement of drinking water analytical capabilities.

Readily available information is required to make decisions, provide guidance on environmental risk management, and monitor the health of the environment. Information must be available to all, including the communities. PAHO uses strategies that deal with healthy cities, focusing primarily on health. People must take care of their own environment. Water for human consumption has been a priority for the last 30 years. Environmental analytical information is important, and laboratories are being developed as a result of the demand for analytical services.

PAHO sent a survey to laboratories in Latin America to assess their capabilities. Forty-three countries responded to the survey, which included a series of questions regarding guideline compliance at critical points in the laboratories. The survey results indicate that: most laboratories have the capability to measure basic parameters (e.g., 62 percent can measure fecal contamination); most laboratories are related to health monitoring but few have the capability to measure nutrients; more than half of the laboratories can measure parameters for organic material, but metal measurement capability varies greatly among laboratories; very few can measure PCBs (58 percent of the laboratories use modified methodologies that have not been validated); sampling procedures are one main source of error in the laboratories (only 32 have responsible sample reception, 30 have receiving criteria, and 30 have procedures for receiving samples). In addition, very few laboratories have an operational safety program, quality assurance program, security, or data and document safety. The laboratories need to cooperate more in terms of technology, quality assurance, and analytical data.
Healthy Management of the Water Resources in Peru. Standards of environmental water quality and strategies for its application – Segundo Fausto Roncal Vergara

Eng. Roncal, with the Environmental Health Division (DIGESA) of the Ministry of Health in Peru, discussed the need for legislation to effectively manage water basins.

Peru has problems with water quality and quantity. Previously, there was no legislation regarding water quality management; however, basic criteria for basin management now exist. There are indicators that show coverage, but they must also incorporate quality aspects and different uses. Health is another criterion for management design, but legislation is needed to define what that entails. In the law, the government must oversee the non-contaminated waters and the clean up of contaminated waters. Community involvement is a key to success.

Peru recently passed the general law on the environment that provides more support for health concerns. Prior to this, no law defined water conservation and preservation, but these terms have been redefined. With regard to water quality, the health authority will establish limits for harmful substances. The guidelines are currently being updated and focus on human consumption. The Minister of Health is expected to accept the revised guidelines.

In regard to frontier and border waters, DIGESA is helping with the Amazon Treaty between Peru and Bolivia. Filtration is a major problem. The rivers have deposited a lot of nutrients into lakes, and laboratory assistance is needed. Mercury is also a tremendous problem in the Amazon River.

Water basin management is fundamental for human survival. DIGESA wants to prevent problems through the Ministry of Health. The state must be responsible for monitoring discharge, and the government must control treatment and prevention standards. Although DIGESA establishes the concentrations and limits that correspond to the environmental quality standards, all parties involved must share the costs.

Question & Answer/Discussion Session

An attendee asked Eng. Roncal for his personal opinion of how Peru should establish a water quality management design. Eng. Roncal said that he would put political issues aside in his response. Every time the Environmental Resources Institute has to deal with agricultural aspects, it falls under the agricultural department. Therefore, the farmers have the ball. It is important to remember that the rest of the users have rights too. Some inroads have finally been gained and those folks are already in understanding with the Ministry of Health. We are working on new environmental laws that will compliment existing health laws, and hope to be talking about positive results in 3 to 4 years.

An attendee asked Eng. Roncal how long the process to change legislation has taken. Eng. Roncal said that the process to develop a new human consumption standard that began in 1999 is only now ready for approval by the Ministry of Health. DIGESA has been working with different institutions to create drinking water quality standards and worked all last year with institutions in charge of water quality in Peru, and the laboratories, to develop a document that is currently awaiting approval. Peru has a political scenario, as an election is coming up in May. Nevertheless, the groups have all talked and NGOs have participated. We began with a set of definitions and have added technical content.

An attendee asked what actions were being taken to train water laboratory personnel. Another attendee replied that a project is being developed by a Canadian entity (Aquatox) to try to make youngsters aware of the environment and stimulate them to do research in that area. The program has been ongoing for a year in Uruguay and Brazil, but laboratory certification is necessary. Laboratories that are not well qualified should be eliminated and only accredited laboratories and accredited methods should be utilized.
Private, government, and university laboratories can be accredited. The Latin Americans in the Laboratory Network of Latin America and the Caribbean (RELAC) program are trying to promote private laboratory participation in government programs. RELAC was originally focused on governments and universities but now wants to include private laboratories and the community. There appears to be no difference in the quality of results obtained from accredited laboratories, whether private or government.

PRESENTATIONS OF SURVEY RESULTS – IVONNE SANTIAGO
Dr. Santiago, UPRM, discussed the results of the survey distributed to all participants prior to the beginning of the Colloquium. The results provided the Colloquium steering committee with a guideline to start their work on the Center.

The survey asked the participants to prioritize their needs. Most responded that drinking water was their primary priority, followed by source water and beach water. A second analysis of the survey results was conducted, separating the responses into groups of countries. The purpose for this was to divide the countries by similar geography and language into six discussion groups.

On the issue of fresh water availability, integrated water management ranked first in priority and the size of the public sector affected ranked second. The survey results also indicated a great degree of concern with wastewater discharges (e.g., chemicals, suspended solids, and eutrophication).

Most countries reported having water quality standards or guidelines. Enforcement of standards is done mostly at the state level, but the federal and local governments also play an important role. All countries have some type of enforcement. The trend changes when you look at the country groups, specifically when you look at how the federal government has evolved.

According to the survey results, the 12 major needs in water quality testing and treatment are the following:

- Low-tech solutions for on-site delivery of safe drinking water
- Development of biological indicators
- Training for managing a laboratory
- Wastewater discharges
- Monitoring surface water quality
- Training as a quality assurance/laboratory certification auditor
- Increase in waterborne pathogens
- Integrated water management
- Training for laboratory analysts
- Sanitation and drinking water availability for small communities
- Sanitation and drinking water availability for cities
- Monitoring drinking water safety.

Groundwater was not a priority in the responses.

The 6 country groups were asked to reevaluate and rank the aforementioned 12 major needs during a breakout session. Each group was asked to describe the needs to be addressed and solved, rank their importance, recommend an approach to resolving the issues, list individuals who could facilitate implementation of the approaches, and express how UPRM could help satisfy the needs.
GROUP DISCUSSIONS

Group 1: Bolivia, Colombia, Ecuador, Mexico, Peru, and Venezuela
The primary need of Group 1 is the delivery of safe water. Pathogens are a very serious problem in Latin America. Group 1 discussed high infant mortality rates due to bacteria and parasites. Access to good quality drinking water is also an issue. In some places, it is difficult to detect contaminants.

These issues can be resolved through education. Awareness should be raised, knowledge disseminated, barriers erased to eliminate these contaminants, and on-site water conditioning for immediate consumption conducted. The most effective means for implementation is to design projects that can be presented and sold to the funding entities. UPRM could act as a bridge for technological capability, resources, and proximity. Environmental legislation guidelines need to be established. UPRM could work on identifying sources. UPRM has knowledge and experience with recreational water, bi-lingual instruction, channel papers, work, training, statistics, and epidemiology. Data management needs to be homogenized. The challenge is obtaining the funding necessary for the development of these projects. The awareness of government and the general public needs to be raised. The public must have adequate water quality, and these important ideas must be established with project agendas so that they can be efficiently managed.

Group 2: Panama, Dominican Republic, El Salvador, Nicaragua, and Puerto Rico
Availability and sanitation of drinking water for cities and integrated management were the major issues identified by Group 2. The problem is not only the availability and quality of water but also lack of planning, prevention, and detection methods. Cities have grown, and water sources have either dried up or become contaminated, which includes both groundwater and surface water sources. Sanitation is an economic problem. Money is needed to invest and politics have not helped out on this issue. In rural areas, there is not 100 percent coverage, as there are not enough skilled, trained, technical people.

Affordable technologies are important, and perhaps UPRM could assist with the development of affordable technologies and sustainable techniques, and obtain project funding. Integrated water management resources are also of importance. A general, integrative, water law is needed, as there is no centralized information. As a result, agencies and other interested parties have to go to different institutions to get the information and develop a plan. Funding sources need to be identified and demonstration projects should be conducted that have the support and help of the community. Others, such as RELAC, U.S. Agency for International Development (AID), universities, governments, NGOs, OPS/OMS, industry, and commerce should be invited to assist in the efforts. Workshops should be conducted to exchange information and demonstrate programs.

Group 3: Argentina, Brazil, Paraguay, and Uruguay
Monitoring of surface water quality is a priority. Reliable information should be generated and made available so that decisions can be made for sustainable development. It is necessary to know the goal of the monitoring. Reliable information is often unavailable. There is no frequency or data recording system. Monitoring data would provide trends the governments could use to implement prevention policies.

UPRM could help design implementation strategies for monitoring networks. There is an interest in training for unconventional monitoring techniques, and Group 3 stated an interest in state-of-the-art technologies; however, this cannot be done without money. In addition, the difference between need,
importance, and priority must be distinguished. The solution lies in raising the awareness of government entities to the importance of these issues. Governments, universities, and industry could assist in the efforts.

The treatment of effluent discharge is another priority, as there is sufficient technical knowledge. Water sources must be protected to reduce contaminants from this source, and money is needed to accomplish this. Countries in the region all have standards that make effluent treatment mandatory. If offenders get fined enough, they treat their effluents. Group 3 stated the problem is sewage, not industrial discharges, and the government has to oversee sewage treatment. Because government officials are elected, participation of the general public and NGOs would help the effort. UPRM could help with conducting operating station training and developing lower cost treatment methodologies. It is important to disseminate information on innovative technologies, and private industry, universities, and world agencies could assist in the efforts.

**Group 4: Belize, Jamaica, and Nevis**

The group’s first priority is training for laboratory managers. Properly trained managers would improve laboratory performance data quality. If data improved, it could influence policy makers. There could be a short course for management combined with follow-up training by mail on proper use of equipment, personnel management, quality control, budget, and laboratory personnel training. UPRM could provide short courses and develop a website for laboratory managers where they could take refresher courses or access new information. Challenges faced include funding, logistics, public interest, government interest, and support of senior management.

The group’s second priority is drinking water sanitation for small communities. Training on the importance of sanitation, the conduct of sanitary surveys, and the use of GIS technology is needed, in addition to data on drinking water/sewage problems and public health. Technology needs to be appropriate to each region, and technology transfer is very important. UPRM could assist with writing grants, accessing funding, developing new technologies for water transport, and facilitating discussions in the countries to adopt standards. Advocates are needed to push for drinking water and sanitary services in small communities and to assist in providing wells for communities that require them. Education is important to public health, and potential stakeholders include industry, universities, government agencies, and world agencies.

**Group 5: Montserrat, St. Lucia, and Antigua/Barbuda**

Identification of individuals for training and retraining and the recruitment of suitable laboratory staff are the priorities of Group 5. They are priorities because training improves consumer confidence and provides more accurate, reliable data, which could be used in legal proceedings and to improve decision-making and mobilize additional funds. Training could also reduce the cost of external audits and allow for timely remedial action. Assessment of laboratories must be conducted to make recommendations for a forward plan. Another solution may be to establish attachments and internships with CEHI, the University of Puerto Rico, and other utilities. Technical cooperation among the countries, exchange of personnel, in-country training, and use of external experts is needed. UPRM can help by supporting or establishing a distance-learning program, maintaining a bilingual training staff, transferring technology, facilitating further training on campus, acting as a bridge to funding from non-traditional sources, and providing cheap labor from UPRM research students. Challenges include funding for equipment, political will, language barriers, and logistics for releasing staff and proximity to training institutes. Other stakeholders include Ministries of Health, Agriculture, and Tourism; Caribbean Water and Wastewater Association (CWWA); Caribbean Basin Water Management Programme, Inc. (CBWMP); CEHI;
Caribbean Agricultural Research and Development Institute (CARDI); CARICOM; Caribbean Tourism Organization (CTO); Inter-American Institute for Cooperation on Agriculture (IICA); PAHO; UN; universities; and the general public. Capacity building is needed to eliminate laboratory deficiencies. This will require creative mechanisms for funding. The proposed improvements will result in generation of reliable data that can be used to identify public health risks.

**Group 6: Barbados, Grenada, Trinidad & Tobago, and Suriname**

Monitoring drinking water safety is the priority of Group 6 because it protects the public against waterborne illnesses. Monitoring allows for intervention to solve and mitigate problems at the source. Tourism and farming are important, and water quality analyses are constantly being requested from the farming and tourism industry.

A routine monitoring program is needed that would include training in sample collection, analysis, interpretation of results, and chain of custody protocols. Funding is also needed to update local water quality laboratories. Stakeholders include the Ministry of Health, Ministry of Environment, and Water and Sewerage Authority of Trinidad and Tobago (WASA). UPRM can help by being a bridge between Latin America and the Caribbean via regional institutions.

The challenges include funding, logistics, and government interest. Funding could be obtained from government, private grants, or private industry. The language barrier to technology transfer needs to be remedied. Other stakeholders include private industry, universities, government agencies, and world agencies.

**CONFERENCE WRAP-UP**

**Jorge Rivera Santos, UPRM/ Al Dufour, U.S. EPA/ Henry Salas, PAHO**

Dr. Dufour stated he was impressed with the research from Latin America and the Caribbean, which has generated a lot of information. Frequently, these countries will use information generated by EPA, but it is important to use information generated in Latin America and Caribbean countries to develop regulations and standards applicable to them. Participation by the attending countries was also impressive. One goal was to identify the needs. The needs were well addressed here, and contributions will be used in developing a plan. Dr. Dufour is confident that UPRM will be able to establish a Center that will be able to address many of the issues discussed during the Colloquium. Funding is always an issue, but technology transfer can meet some of these needs. EPA has the personnel and resources to help UPRM in this endeavor, and the goals established are very ambitious. Some constraints on these goals need to be considered further before they can be addressed. The organizational support was also impressive. PAHO and CEHI implied there could be collaboration with UPRM. The next step is to review all the suggestions and needs raised during the Colloquium and determine where UPRM can be of assistance. Then EPA can determine where it can help, and UPRM can collaborate with PAHO. The Colloquium was a success in achieving its objective to gather information for the establishment of the Center. Success in establishing the Center depends on the will of all Latin American and Caribbean participants.

Dr. Salas said that very good conclusions had been made, and that UPRM is capable of serving as a Center for Excellence. Each participant needs to relay that message back to his or her institution. The support of high-level decision makers is needed in this endeavor. PAHO will support this initiative.
Dr. Rivera said that meeting goals have been fulfilled, and that a working plan will continue to be developed so that the Center can become a reality. Through UPRM, administrative support will be provided. Other actors and players involved will also give their support and commitment. Dr. Rivera thanked all participants for their support and valuable contributions.
APPENDIX A – Colloquium Agenda

COLLOQUIUM ON WATER QUALITY MONITORING AND TESTING
IN LATIN AMERICA AND THE CARIBBEAN
October 25-27, 2005
El San Juan Hotel
San Juan, Puerto Rico

AGENDA

MONDAY, OCTOBER 24, 2005

1:00-5:00p  Conference Registration        Tropicoro Room

TUESDAY, OCTOBER 25, 2005

7:30a  Conference Registration        Tropicoro Room

8:30a  Opening Plenary Session
   Welcome & Introductions   Jorge Rivera-Santos, UPRM
   Bill Henderson, U.S. EPA
   Jim Owens, U.S. EPA

9:00a  Introduction of Keynote Speaker   Bill Henderson, U.S. EPA

9:05a  Jorge I. Vélez-Arocho, Chancellor University of Puerto Rico/Mayagüez

9:40a  Introduction of Keynote Speaker   Jorge Rivera-Santos, UPRM

9:45a  Carl-Axel Soderberg, Director Caribbean Environmental Protection Division, U.S. EPA Region 2

10:20a  Break

10:35a  Introduction of Keynote Speaker   Al Dufour, U.S. EPA
10:40a  Peter Toft, Advisor
       Pan American Health Organization

11:15a  Wrap-up  Jorge Rivera-Santos, UPRM

11:45a  Lunch (on your own)

PLENARY SESSIONS

1:15p  Session I  Water Quality Problems in Latin America and the Caribbean

   1:15-1:40p  Jorge I. Vélez-Arocho, University of Puerto Rico/Mayagüez
   1:40-2:05p  Vincent Sweeney, Caribbean Environmental Health Institute, St. Lucia
   2:05-2:30p  Session Wrap-up: Henry Salas, PAHO, Moderator

2:30p  Session II  Legislation/Regulations in Water Quality

   2:30-2:55p  Rubén González, Puerto Rico Environmental Quality Board
   2:55-3:20p  Antonio Quiñones, U.S. Environmental Protection Agency, Region 4
   3:30-3:45p  Session Wrap-up: Ivonne Santiago, UPRM, Moderator

3:45p  Break

4:00p  Session III  Environmental Microbiology

   4:00-4:25p  Elia Sánchez, Doctoral Student, University of Puerto Rico
   4:25-4:50p  Graciela Ramírez-Toro, CECIA, UIPR, Puerto Rico
   4:50-5:15p  Session Wrap-up: Gary Toranzos, UPRR, Moderator

5:15p  Summary of the Day  Jorge Rivera-Santos, UPRM

5:30p  Poster Session -- Showcase for University of Puerto Rico Students

WEDNESDAY, OCTOBER 26, 2005

8:30a  Report of Day's Events // Logistics  Steering Committee

8:45a  Session IV  Water Quality Monitoring

   8:45 - 9:05a  Ingrid Padilla, University of Puerto Rico/Mayagüez
   9:05 - 9:25a  Mark Rodgers, U.S. Environmental Protection Agency
   9:25 - 9:45a  Gary Toranzos, University of Puerto Rico/Rio Piedras
   9:45 - 10:00a  Session Wrap-up: Fred Hauchman, U.S. EPA, Moderator

10:00a  Break
10:15a  **Session V** Satellite Imaging - Remote Sensing as it Applies to Water Quality

10:15-10:35a  Gary Foley, U.S. Environmental Protection Agency
10:35-10:55a  Fernando Gilbes, University of Puerto Rico/Mayagüez
10:55-11:15a  Luis Olivieri, University of Puerto Rico/Mayagüez
11:15-11:30a  Session Wrap-up:  Jim Owens, U.S. EPA, Moderator

11:30a  **Lunch (on your own)**

1:00p  **Session VI** Water Quality Guidelines for Tropical Water Recreation

1:00 - 1:20p  Henry Salas, Pan American Health Organization
1:20 - 1:40p  Christine Bullock-Ramsumair, Institute of Marine Affairs, Trinidad
1:40 - 2:00p  María Inés Sato, CETESB, Brazil
2:00 - 2:15p  Session Wrap-up:  Al Dufour, U.S. EPA, Moderator

2:15p  **Break**

2:30p  **Session VII** Advances in Analytical Methods

2:30 - 2:55p  Felix Román, University of Puerto Rico/Mayagüez
2:55 - 3:20p  Edmundo García Agudo, International Atomic Energy Agency (Ret.) Brazil
3:20 - 3:45p  Session Wrap-up:  Jorge Rivera Santos, UPRM, Moderator

3:45p  Summary of the Day  Fernando Gilbes, UPRM

4:00p  Adjourn

4:30p  RELAC Meeting (Optional) Tropicoro Room

7:30p  Social Event

**THURSDAY, OCTOBER 27, 2005**

8:30a  Report of Day's Events // Logistics  Steering Committee

8:45a  **Session VIII** Water Quality Control

8:45 - 9:00a  Ivonne Santiago, University of Puerto Rico/Mayagüez
9:00 - 9:15a  Jim Goodrich, U.S. Environmental Protection Agency
9:15 - 9:30a  Douglas García Sarmiento, National Drinking Water Supply and Sewerage Administration, El Salvador
9:30 - 9:45a  Enrique Mejía Maravilla, National Water Commission, Mexico
9:45 -10:00a  Session Wrap-up:  Jim Goodrich, U.S. EPA, Moderator

10:00a  **Break**
10:15a  Session IX  Laboratory Quality/Capacity/Certification/Oversight Programs

10:15-10:35a  Jennifer Best, U.S. Environmental Protection Agency
10:35-10:55a  María Luisa Esparza, Pan American Health Organization
10:55-11:15a  Segundo Fausto Roncal Vergara, DIGESA, Perú
11:15-11:30a  Session Wrap-up:  Phil Oshida, U.S. EPA, Moderator

11:30a  Lunch (on your own)

1:00p  Presentation of Survey Results  Ivonne Santiago, UPRM

1:30p  Break-Out Sessions  Ivonne Santiago, UPRM
      Facilitators:
      Al Dufour, U.S. EPA
      Jorge Rivera-Santos, UPRM
      Ivonne Santiago, UPRM
      Gary Toranzos, UPRR
      Henry Salas, PAHO
      Fernando Gilbes, UPRM

3:30p  Group Presentations  Tropicoro Room

4:30p  Conference Wrap-up  Jorge Rivera-Santos, UPRM
      Al Dufour, U.S. EPA
      Henry Salas, PAHO

5:00p  Adjourn
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