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Dr. Thomas To Shen died Saturday, March 26, 2005, at the home of his daughter, Mrs. Grace Shen Law, in South Salem, New York. He was the husband of Cynthia Shen, whom he married in 1959, and the father of two daughters, Grace Shen Law and Joyce Shen Shavers. Thomas is survived by his wife, Cynthia, of Delmar; his daughter Grace Shen Law, son-in-law Randall K. Law, and his grandson Nicholas R. Law of South Salem, New York; and his daughter Joyce Shen Shavers, and son-in-law Timothy B. Shavers of Manhattan, New York; and niece Kaiting Shen Huang of North Wales, Pennsylvania.

Thomas was born August 14, 1926, in Chia Hsin, a town outside Shanghai, China. He arrived in the United States in 1959 and has since devoted more than 30 years to a career in environmental engineering and science. He served as a senior engineer with the Washington State Health Department and a senior research scientist with the New York State Departments of Health and Environmental Conservation. He taught in the Public Health Department at Columbia University and was a member of the USEPA Science Advisory Board. He also served as a consultant to the United Nations' Development Program and the World Health Organization and was one of the technical reviewers for President Bush's 1991 and 1992 Annual Environment and Conservation Challenge Awards. In 1993 he received the Air and Waste Management Association's Frank Chamber Award and Taiwan's National Industrial Waste Minimization Excellent Performance Award. He remained an active lecturer and published writer of many papers and books until the end. He was a devout Christian and loved God dearly.

He was educated at St. John's University in Shanghai, China (B.S. in Civil Engineering); graduated from Northwestern University in Evanston, Illinois (M.S. in Sanitary Engineering); and received his Ph.D. in Environmental Engineering from Rensselaer Polytechnic Institute in Troy, New York, in 1972.

He was a co-founder and active member in the Chinese Community Center; Rotary Club; Torch Club; 2nd Miler Club; Emeritus Board Member, Bethlehem Public Library; and a member of the Phi Tau Phi Scholastic Honor Society; American Civil Engineering; Overseas Chinese Engineers and Scientists Association (OCEESA), St. John’s Alumni Association; and Chinese Institute of Engineers; among others. He was very active in the tri-state Chinese community, sponsored and supported several overseas scholars, traveled the world and swam daily (slowly, but ever so persistently).

He was the 13th President of OCEESA in 1993 and has been a long time faithful member. He was a pioneer and a leader of OCEESA with great contribution to OCEESA. He has been involved in the planning and organization of many Mainland Taiwan Environmental Protection Conferences. He co-chaired second MTEPC, in Taipei, Taiwan, 1993. His efforts in promoting the exchange and communication among Chinese environmental scholars are also appreciated by the environmental communities in China and Taiwan. He has published numerous excellent papers in pollution prevention in OCEESA Journal.

A memorial service will be held on April 16, 2005, at the Emmanuel Baptist Church, 275 State Street, Albany, at 7:00pm. Friends and colleagues are invited. In lieu of flowers, contributions may be made in memory of Prof. Thomas To Shen to either Emmanuel Baptist Church (275 State Street, Albany, New York 12210) or the Chinese Community Center, Capital District of New York (P.O. Box 13951, Albany, New York 12212).
OCEESA MEMBER NEWS  (February 2005)

1. Dr. Thomas To Shen, 13th OCEESA President in 1993 and a long time faithful OCEESA member, passed away on March 26, 2005, at the home of his daughter, Mrs. Grace Shen Law, in South Salem, New York. Dr. Shen was a world known researcher and educator on pollution prevention. He has made very important contributions to OCEESA for many years. Our deepest sympathy and condolence to Dr. Shen’s family. This issue of OCEESA Journal is dedicated to the loving memory of Dr. Thomas To Shen.

2. Dr. Yung-Sung Cheng has been elected to OCEESA President in 2005.

3. Results of Election of OCEESA Officers of 2005

President (2005) Dr. Yung-Sung Cheng 鄭永松  Lovelace Respiratory Research Institute
Vice President (2005) Dr. Francis Hun-I Chang 張恆一  FC Consulting., Toronto, Canada
Secretary/Treasurer (2005) Dr. Pao-Chaing Yuan 袁保強  Jackson State University
Directors (2005-2006)

Dr. Howard Hung-Hsin Lo 罗鴻鑫  Cleveland State University
Dr. Tsau-Don Tsai 蔡朝棟  California EPA
Dr. Jiann-Long Chen 陳建隆  North Carolina A & T State University

Congratulations to our new President, Vice President, Secretary-Treasurer, and new Directors and Officers. We are looking forward to their excellent service and contributions to OCEESA in 2005

3. The continuing directors (2004-2005) of OCEESA are as follows:

Dr. Ben Hsueh-Hai Chen 陳學海  Chen and Associates, Fort Lauderdale, Florida
Dr. Jia-Ping Paul Chen 陳嘉平  National University of Singapore
Dr. Ernest Lieng-Chen Siew 蕭亮楨  Hudson Valley Community College, New York

4. Dr. Chein-Chi Chang 張建祺, OCEESA President in 2004, has become Ex Officio of OCEESA in 2005.

5. OCEESA directors, who have just completed their 2 years term (2003-2004) ending December 31, 2004, are listed below:

Dr. Junn-Ling Chao 趙震陵  Montgomery Watson Harza
Dr. Yei-Shong Shieh 謝義雄  Envir-O-Process Technologies, Inc
Dr. Pao-Chaing Yuan 袁保強  Jackson State University

Our sincere thanks to their outstanding services to our OCEESA during the past year.

6. Dr. Ben H. Chen’s company, Chen and Associates, has become the first company’s sponsor of OCEESA in April 2005. As Silver Sponsor of OCEESA, Chen and Associates will be eligible to have advertisement in our OCEESA journal and OCEESA directory for 1/4 pages for 1 year and 1 year listing of company’s logo on OCEESA web site. Our sincere thanks to Dr. Ben H. Chen, who is our OCEESA Director and President of Chen and Associates.

OCEESA members are encouraged to become company’s sponsor for OCEESA and to ask company’s to become sponsor for OCEESA. Please contact Dr. Yung-Sung Cheng, OCEESA President, Email: ycheng@lrri.org, or Dr. Yung-Tse Hung, OCEESA Executive Director, Email: yungtsehung@yahoo.com, for information.

6. 10th MTETS (2005) will be held in Hung Kuang University of Science and Technology, Taichung, Taiwan, October 24-29 (M-Sat), 2005. The conference is co-sponsored by Hung Kuang University of Science and Technology, Taichung, Taiwan, Xian Jiao-Tong University, Xian, China, and OCEESA. The host universities in China and in Taiwan alternate between China and Taiwan. The 3 co-sponsors include one university in China, one university in Taiwan, and OCEESA. The co-sponsor universities in China and In Taiwan change each conference. However, OCEESA is co-sponsor for every conference. OCEESA is the originator for MTEPC. OCEESA members and friends are encouraged to submit abstracts for the conference. If you are interested in submitting abstracts or in
attending conference, please contact Dr. Yung-Sung Cheng 鄭永松, OCEESA President, Email: ycheng@lrri.org, or Dr. Yung-Tse Hung 洪永哲, OCEESA Executive Director, Email: yungtsehung@yahoo.com, y.hung@gbgconsulting.com

7. Mr. Joseph M. Wong, P.E., DEE, long time OCEESA member, is now Technical Director (Lead National Water Engineer), Parsons, Inc., Walnut Creek, CA 94596 Email: joe.wong@parsons.com

8. Dr. Lawrence Kong-Pu Wang, Ph.D., P.E., DEE, OCEESA Past President and long time OCEESA member, is now Water Facilities Manager, City of Albany, New York, who oversees over 300 staff. Email: larrykwang@juno.com

9. Since the beginning of OCEESA in 1980 to present our OCEESA has 25 Presidents. Three OCEESA Past Presidents have passed away. These include 1st OCEESA President (1980-81), Dr. Robert Hsi-Lin Howe 侯希臨, 4th President (1983-84), Mr. Eugene Y. Hsi 席與錚, and 13th President (1993), Dr. Thomas To Shen 沈鐸, who passed away on March 26, 2005.

10. OCEESA World Wide Web Homepage: http://www.oceesa.org
OCEESA members are encouraged to visit our OCEESA web site and update their membership information.

EDITOR'S NOTE
The editors of this issue of OCEESA Journal are Dr. Chein-Chi Chang, Dr. Ben Hsueh-Hai Chen, and Dr. Ernest Lieng-Chen Siew. The editors for the next issue, October 1, 2005, are Dr. Yung-Sung Cheng, Dr. Francis Hun-I Chang, Dr. Pao-Chaing Yuan, Dr. Tsau-Don Tsai. OCEESA members are encouraged to email before September 15, 2005, news items and papers with a maximum length of 5 typed pages (single space, letter size 10, put all figures and tables after your text) to: Dr. Yung-Tse Hung, Editor, OCEESA Journal, Professor, 16945 Deerfield Dr., Strongsville, Ohio 44136-6214 USA. Tel: (216) 687-2596 Fax: (216) 687-5395 Email: yungtsehung@yahoo.com, y.hung@gbgconsulting.com. Photos and pictures must be scanned and must be put in electronic version or digital photos.

OCEESA World Wide Web Homepage: http://www.oceesa.org
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Vice President
Dr. Francis Hun-I Chang 張恆一 FC Consulting., Toronto, Canada

Secretary/Treasurer
Dr. Pao-Chaing Yuan 袁保強 Jackson State University

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Dr. Tsau-Don Tsai 蔡朝棟 California EPA
Dr. Jiann-Long Chen 陳建隆 North Carolina A & T State University

Ex-Officio
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Permanent Executive Director:
Dr. Yung-Tse Hung 洪永哲 Cleveland State University

Assistant Executive Director:
Dr. Howard Hung-Hsin Lo 羅鴻鑫 Cleveland State University
PAST OVERSEAS CHINESE ENVIRONMENTAL ENGINEERS AND SCIENTIST ASSOCIATION (OCEESA) PRESIDENTS

海外華人環境保護學會 會長

1. 1980-81 (6-1-80 to 5-31-81) Dr. Robert Hsi-Lin Howe (Deceased) 侯希臨
2. 1981-82 (6-1-81 to 5-31-82) Dr. Howard Ju-Chang Huang 黃汝常
3. 1982-83 (6-1-82 to 5-31-83) Dr. Edward Shing-Ke Chian 謝興格
4. 1983-84 (6-1-83 to 5-31-84) Mr. Eugene Y. Hsi (Deceased) 席與緯
5. 1984-85 (6-1-84 to 5-31-85) Dr. Allen Chia-Chen Chao 趙家珍
6. 1985-86 (6-1-85 to 5-31-86) Dr. Yung-Tse Hung 洪永哲
   (Also Executive Director 6-1-86 to present)
7. 1986-87 (6-1-86 to 5-31-87) Dr. Charles Chi-Su Chou 周基樹
8. 1987-88 (6-1-87 to 5-31-88) Dr. James Wen-Chi Ku 谷文琦
9. 1988-89 (6-1-88 to 5-31-89) Dr. Wei-Chi Ying 應維琪
10. 1989-90 (6-1-89 to 12-31-90) Dr. Lawrence Kong-Pu Wang 王抗曙
11. 1991 (1-1-91 to 12-31-91) Dr. Don Tsye-Lang Tang 唐次朗
12. 1992 Dr. Chin-Pao Huang 黃金寶
13. 1993 Dr. Thomas To Shen (deceased 3-26-05) 沈鐸
14. 1994 Dr. James Shia-Pin Whang 黃夏平
15. 1995 Dr. Ching-Tzone Tien 田慶宗
16. 1996 Dr. Jen-Tai Yang 楊仁泰
17. 1997 Dr. Shoou-Yuh Chang 張守玉
18. 1998 Dr. John Chao-Piao Huang 黃肇鑣
19. 1999 Dr. Oliver Jing-Ching Hao 郝晶瑾
20. 2000 Dr. Chang-Lu Lin 林昌爐
21. 2001 Dr. Tsen-Cheng Wang 王增辰
22. 2002 Mr. Anmin Liu 劉安民
23. 2003 Mr. Edward T. Chen 陳天生
24. 2004 Dr. Chein-Chi Chang 張建祺
25. 2005 Dr. Yung-Sung Cheng 鄭永松

CALL FOR ABSTRACTS

10th MTEPC (Mainland Taiwan Environmental Protection Conference)
Taichung, Taiwan, May 24 to 29, 2005 (M-Sat)

The 10th MTETS (2005) will be held in Hung Kuang University of Science and Technology, 弘光科技大學
Taichung, Taiwan, October 24-29 (M-Sat), 2005. OCEESA members and friends are encouraged to submit 200 to
300 words abstract (letter size 10, single space typing, 1 page), preliminary registration form, and 1 page resume by
email before April 15, 2005, to the following. Dr. Yung-Tse Hung, Professor, Department of Civil and
Environmental Engineering
Cleveland State University, Cleveland, Ohio 44115-2214 USA Tel: (216) 687-2596 Fax: (216) 687-5395 Email:
yungtsehung@yahoo.com, y.hung@gbgconsulting.com Please send email to Dr. Hung, if you have questions.
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NOTE: Please contact Dr. Yung-Tse Hung, OCEESA Executive Director, Email: yungtsehung@yahoo.com, for information.
Abstract

The key policy and technology lessons in pollution management will be described by two approaches: Pollution Control and Pollution Prevention. This paper explains why and how the progress of pollution management policy has been gradually shifting from media-specific pollution control toward multimedia pollution prevention (M2P2). Discussions include U.S. pollution management policy and some potential benefits and barriers of P2M2. The purpose of the paper is to encourage and stimulate environmental practitioners toward career opportunities in this vital area of M2P2 challenges and opportunities.

Key words: Technology, Pollution Prevention, Pollution Control, Benefits and Barriers.

Introduction

In the past, environmental professionals have responded to obvious pollution problems caused by releasing excessive concentrations of pollutants in waste from human daily activities. We have been adopting waste treatment technology to control pollutants in wastes releasing from mainly industries and power plants. This is important but cannot continue to be the dominant driving force for solving environmental problems.

Environmental issues in recent years, particularly concerned about toxic chemicals and hazardous wastes from industrial processes, are receiving more attention in policy, program and media dimensions worldwide. Pollution from toxic chemicals and hazardous wastes is more extensive and difficult to manage than originally believed. When toxic chemicals and hazardous wastes contaminate the environment, all life is exposed to the potential high risks. There is evidence that such risks may also cause subtle harm, which does not show up until it is too late to prevent human disease or ecological disruption. To add to the problem, significant amounts of toxic pollutants are cycling and recycling in the environment not only from industrial sources, but also from industrial waste treatment and disposal activities (Ling, 1998).

Hazardous waste dumpsites usually contain a complex array of chemicals spanning the entire spectrum of toxicity and physicochemical properties. Over 200 chemicals typically have been identified as contaminants of soil and groundwater at such sites, with acute and chronic toxicities ranging over several orders of magnitude. The growing number of chemicals in use and being introduced, the lack of knowledge about their behavior in the environment or their potential effects, and evidence that even at low levels chemicals can have serious adverse effects to humans and the environment are important motivators for pollution prevention strategies. Pathways of migration of contaminants from a hazardous waste site include surface water runoff, transport in groundwater, volatilization into air, and fugitive dust emissions. Growing issues involve multimedia pollution prevention considerations of not only pollutants and wastes, but also those environmentally harmful products and services that must be addressed (Shen, 2002).

A M2P2 approach is suggested because of the deeply ingrained fragmentation of the current laws, regulations, and approaches. In the United States for example, more than 30 different congressional committees oversee the work of U.S. EPA. More than a dozen major laws provide the ground rules for federal pollution control efforts, and the response to each new problem is to create a new law. Most U.S. State agencies are even more fragmented than federal ones, and efforts to achieve a more unified approach at the state level have usually ended in disappointment.
Changing Pollution Management Policy and Strategy

Pollution management may be divided into two approaches: Pollution control and pollution prevention (P2). Pollution control focuses on end-of-pipe, media-specific, command-and-control, and short-term abatement approach. It has involved costly measures and controversial political decisions. Present assignments of departmental responsibilities do not reflect this interrelatedness. Progress toward managing pollution has relied mainly on pollution control technologies. Such control technologies are now technically possible to greatly reduce or entirely eliminate discharges of certain major pollutants. However, this approach is yielding decreasing benefits per unit of expenditure. At the same time, most companies fear that pollution control is an expensive luxury that will divert resources (manpower and finance) from more productive uses. This perspective is giving way to a new paradigm stating that neglecting pollution management can impose high economic and even financial costs while many environmental benefits can in fact be achieved at a low cost by preventing pollution at the very early stage from the root causes of the pollution.

Pollution prevention seeks more lasting and cost-effective reduction of environmental pollution problems. P2 practice embraces waste minimization, source reduction, and cleaner production. P2 also involves processes to assist enterprises for life-cycle assessment (LCA), environmental performance indicators (EPI), corporate environmental reports (CER), eco-labeling; waste minimization and recycling/reuse options; as well as waste treatment and disposal if waste cannot be prevented. For this to work, however, we need to better understand what motivates those responsible for pollution management and their reacts to different environmental policy, regulations, incentives and pressures. Moreover, we can no longer afford to manage pollution by various control technologies for treatment and disposal wastes. The new approach can be summed up by the expression of pollution prevention, not just pollution control (Shen, 1999).

As pollution prevention becomes the dominant industrial and regulatory strategy in developed countries for preserving environmental quality and conserving natural resources, the decision-makers of industry and government in China and Taiwan will require more pollution prevention education. Educators will be the forefront in pursuing pollution prevention through their educational institutions, professional societies, government infrastructures, and local or national advocacy groups. In view of the apparent appreciation of the need for pollution prevention education, it is surprising that so few of the environmental protection agencies and industries have staff members who are by education and experience skilled in pollution prevention. The educators and decision-makers are responsible to carry out educational programs of various subjects on pollution prevention not only in academic institutions and industries, but also to general public. Presently, pollution prevention laws and regulations are yet to be established, but a quite and yet profound transformation is beginning through various preventive approaches such as waste minimization, recycling and reuse, and cleaner production and others with emphasis on long-range capital investment for prevention and advantage.

The U.S. Pollution Management Policy and Technologies

In the United States, the pollution management laws adopted by Congress in the 1970s, such as the Clean Air Act and the Clean Water Act were “command-and-control laws” with little or no flexibility. The laws and policies required companies to reduce releases pollutants in waste by installing end-of-pipe control facilities and equipment.

Since 1976, the U.S. Toxic Substance Control Act signaled a shift from primary concern with conventional pollutants to toxic pollutants in the environment. These pollutants tend to be highly persistent and can migrate from one part of the environment to another. As a result, cross-media pollution became a more important consideration in formulating policy. The case for integrated environmental management was further strengthened when new evidence showed that conventional pollutants also lead to inter-media transfers. To control adverse impacts of toxic chemicals and hazardous wastes on human health and the environment, environmental laws and regulations have grown greatly in the past 25 years.

During the 1980s, the Conservation Research and Foundation undertook a series of research projects to examine the nature and extent of the problems created by fragmented laws and institutions and developed solutions for the problems. The researchers revealed that the components of our natural environment are interrelated in many complex ways, and pollutants tend to travel from one part of environment to another. The basic underlying rationale for paying attention to the cross-media problems is the disparity between the multiplicity of environments defined by laws, regulations, and jurisdictions and the unity of the natural phenomena with which those policies and institutions try to deal.
The Pollution Prevention Act, created in October 1990, shifts toward preventive approach to move up toward preventing all releases at the sources of pollution and foster the widespread adoption of the P2 ethic policy. Today, many environmental pollution statutes still focus on the control, management, and disposal of pollutants and wastes, rather than on their prevention. However, some environmental policies do indirectly promote pollution prevention through establishing regulatory programs that relate to the cost, potential liability, and public scrutiny associated with managing hazardous materials (U.S. EPA, 1997).

Multimedia Pollution Prevention (M2P2)

A multimedia approach is closely tied to a risk-based approach to environmental problems. If all aspects of the environment (all media) are considered together, some common metric is needed to establish priorities, make trade-offs, and formulate regulations. The concept of risk provides that metric although it is essential that risk be define to include damage to the natural environment as well as injury to human health.

M2P2 is a management tool to establish a society-oriented approach towards sustainable development. Multimedia transport can lead to ecological accumulations of and human exposure pathways for toxic chemicals that are not regulated by the existing medium-specific regulatory structure. However, P2/M2P2 should complement not replace pollution control. As M2P2 will be the future industrial and regulatory strategy for preserving environmental quality and conserving natural resources, the need for public information and education of M2P2 activities should be well recognized.

Benefits of M2P2 must be known to all sectors of the society. Some large enterprises in the developed countries practicing M2P2 have already enjoyed the benefits of reduced consumption of energy, water, raw materials, and chemicals as well as decreases in the amount of waste generated. With M2P2 practice, enterprises can meet the regulatory compliance, enhance their reputation, reduce environmental risk, streamline operations, improve workman’s health risks, satisfying contractual requirements, and give themselves a competitive advantage in the market. Yet, some companies, especially small and medium-sized enterprises (SMEs) experience difficulties in adopting M2P2 concept and practices.

Conclusions and Recommendations

On the policy side, the fractional medium-specific pollution control approaches are unlikely able to manage problems, such as toxic substance, pollutants in wastes as well as environmentally harmful products and services without upgrading toward multimedia pollution prevention approaches. It is necessary, therefore, to develop sound M2P2 policy and technologies. The understanding of environmental pollution management needs to stretch far beyond the boundaries of traditional waste management to a broader approach of pollution management that can help national environmental goals and coincides with industry’s interests. Pollution management strategies need to take a broad approach that seeks more lasting and complete solution to environmental pollution problems.

My recommendations to improve Mainland and Taiwan’s environmental pollution policy and management programs are:

? Apply facility-specific and multimedia permits that provide an alternative to traditional issuance of multiple permits for one location.
? Set up electronic reporting systems to provide a quicker, easier and more accurate means of submitting information.
? Establish new compliance assistance centers can encourage and help facilities better understanding regulatory requirements.
? Create a stronger pollution prevention partnership system and encourage all concerned parties (such as government agencies, NGOs, business and industry) to participate in regulatory planning and implementation.
? Improve the current management system for applying pollution prevention, which does not mean replacing control pollution.
? Emphasize manage environmental pollution at local level by developing more community-based environmental tools such as grants, websites, a right-to-know program.
? Improving public access to environmental information, a system more responsive to local priorities.
References


About the Author

Thomas T. Shen, Ph.D., is an international environmental advisor with more than 40 years of environmental research and teaching experiences. He worked as a senior research scientist with New York State and taught graduate courses at Columbia University. He served as a member of the USEPA’s Science Advisory Board and as a consultant to the United Nations, World Bank and USAEP. Dr. Shen has been active in several environmental professional associations and has lectured at over 30 universities and research institutes as well as conducted seminars in the United States, Asia and Europe. Dr. Shen has published numerous books, technical papers and reports. His recent book, the second edition Industrial Pollution Prevention was published in 1999.

(Paper presented at 9 th MTEPC, Xian, China, May 10-14, 2004. This is the last paper of Dr. Thomas To Shen published in OCEESA Journal. Dr. Thomas To Shen passed away in South Salem, New York on March 26, 2005)
Dear OCEESA Members:

Happy Chinese New Year! I am honored to be the OCEESA President. The OCEESA has a great tradition in serving our members and in providing a communication means between the environmental communities in China and Taiwan. For examples, in previous year, many OCEESA members participated the 9th Mainland Taiwan Environmental Protection Conference (MTEPC) in Xian, China, and Modern Engineering and Technology Seminar (METS) in Taipei, Taiwan. I am hoping to continue this great accomplishments from past presidents.

This year, we will again be a co-sponsor of the 10th MTEPC to be held in Taichung, Taiwan by Hung Kuang University, October 2005. I had an opportunity to visit the university in 2004 and discussed with the university president and the chairman of the Environmental Engineer Department about the organization and preparation of the conference. They have a very good conference facility and the organizers are young and enthusiastic about this event. In the next few weeks, I will receive and disseminate the first call for paper. I hope you will be interested in participating the conference again.

The second event is the Sino-China Technology and Engineering Conference (SATEC), which holds every two years. I was elected as the administrator of next conference, which will be held in 2006. The exact time and place of the conference have not been finalized. I will keep you informed as the detailed information is developed.

As our association stabilizes and becomes mature we also have to face new challenges. In order to continue the great tradition of our association we also need the financial means. My goal is to initiate a fund raising activity through a sponsorship program similar to many other associations. I also hope to bring in new members. Please consider some of your friends and colleagues as potential members.

Please feel free to contact me if you have any suggestions or comments. My contact information is

Dr. Yung Sung Cheng
Tel: O: (505) 348-9410  Tel:H: (410) 275-7008
Email: ycheng@lrri.org

Finally, I would like to wish every member a prosperous new year. With your contribution and support, we can put together an excellent association to be proud of.
OCEESA 2004 activities are summarized as follows.

1. Mainland-Taiwan Environmental Protection Conference (MTEPC)

The 9th MTEPC conference was held in Xi’an Jiaotong University, China from May 10 to May 15, 2004. The conference participants were 254 environmental professionals from Mainland (147), Taiwan (86), and overseas (21). Technical papers (472) were compiled into conference proceedings of 8 main categories in 2 volumes:

Volume I (1014 pages) containing,

(1) Water Resources Prevention and Water Pollution Prevention (219 papers)
(2) Energy Utilization and Atmospheric Pollution, Prevention (23 papers)

Volume II (1016 pages) containing,

(3) Energy Utilization and Atmospheric Pollution, Prevention-continued (26 papers)
(4) Soil Pollution, Prevention and Agricultural Environmental Protection (28 papers)
(5) Industrial Waste Reduction and Waste Management (31 papers)
(6) Ecological Impact and Environmental Risk Assessment (40 papers)
(7) Environmental Monitoring and Techniques (24 papers)
(8) Environmental Legislations, Planning and Education (33 papers)
(9) Municipal Projects and Environmentally Related Domain (48 papers)

Three roundtable discussion sessions were also held: (1) Collaborative Research between Mainland and Taiwan, (2) The Environmental Education in Mainland and Taiwan, and (3) Exchange of Technologies for Sustainable Environment

During the conference, a General Membership Meeting of OCEESA was held during lunch hour and attended by 14 OCEESA members on May 11, 2004. Please see the attached photograph for the OCEESA participants in the General Membership Meeting.
2. Environmental Panel Session under the CIE-USA/GNYC 2004 Annual Convention

OCEESA, OCEESA/Albany Chapter, and CIE-USA/GNYC cosponsored an environmental session under the CIE-USA/GNYC 2004 Annual Convention. There are many thanks to the OCEESA Albany Chapter President, Professor Ernest Siew for his effort in organizing this session. Here is the program description for our session.

Panel Session – Environmental Issues at the 21st Century (This session is co-sponsored by OCEESA and OCEESA/Albany Chapter)

Session Chairperson, Dr. Ernest Siew, Professor, Dept. of Chemistry, SUNY, Albany, NY

1. Dr. Yei-Shong Shieh, Vice President, Envir-O-Process Technologies, NJ, Resource Recovery – Balance of Social and Economic Drivers
2. Dr. Thomas Shen, Researcher & Professor (Retired), SUNY, Albany, NY, Changing Environmental Problems and Technologies
3. Dr. Ben H. Chen, President, Chen & Associates, Florida, Opportunity for Enhancing the Environment through Infrastructure Rehabilitation
4. Dr. Larry Wang, Manager, Water Facilities, Dept. of Water Supply, City of Albany, NY, Solutions to Contaminations of Radon, Lead, Asbestos and Oil Tanks at Commercial and Residential Sites

3. The Modern Engineering and Technology Seminar 2004 (METS 2004)

This seminar was held in Taiwan from November 12 to 16, 2004. There was 10 sessions presented in this seminar. They are:

1. Biotechnology & Medical Technologies 生物科技與醫療技術
2. Resource Recycle and Reuse Technologies 資源回收再利用技術
4. Nano and MEMS Technology 奈米與微機電技術
5. Broadband Communication and Network System integration 寬頻通訊與系統整合
6. Flat Panel Display and Optoelectronics 平面顯示與光通訊技術
There are nine members from OCEESA participating in the seminar. Their roles and topics for these participants are:

1. Dr. John C. P. Huang 黃肇鷗, US Planning Committee Advisor
2. Dr. Chein-Chi Chang 張建祺, US Planning Committee Administrator
3. Dr. Yei-Shong Shieh 謝義雄, US Session 2 Chair, Presentation Title: Recycling Technologies for Mercury Bearing Materials
4. Dr. Pao-Chiang Yuan 袁保強, US Session 2 Speaker, Presentation Title: Trend of Recycling
5. Dr. Larry Wang 王抗曝, US Session 2 Speaker, Presentation Title: Recycling and Disposal of Electrical and Electronic Appliances
6. Dr. Francis Chang 張恒一, US Session 3 Chair, Presentation Title: Current Status and Long-term Sustainability of Fuel Cell Technology
7. Dr. Junn-Lin Chao 趙震陵, US Session 3 Speaker, Presentation Title: Water Resources Risk Management
8. Dr. David Shaw 蕭台戈, US Session 4 Chair, Presentation Title: Nanotechnology: From Vision to Commercialization
9. Dr. James Woo 吳纘文, US Session 9 Speaker, Presentation Title: Generation and Utilization of Intellectual Properties - A Practical Inquiry

This seminar was a big success. Please see the attached photograph for the OCEESA participants and their spouses.
OCEESA and CIE-USA/new Mexico Chapter co-host the CIE-USA National Council meeting. The national council meeting was held in Albuquerque, New Mexico on October 3, 2004.

5. The Albany, New York Chapter Activities

In 2004, the Albany Chapter was engaging in activities to interconnecting with community services. The Chapter held two meetings for internal facilitation and two meetings with local and interstate networking.

On July 3, 2004 OCEESA President, Chein-Chi Chang had a meeting with members of Albany Chapter. We discussed the planning for the OCEESA cosponsored environmental session of CIE-USA/GNYC annual convention. It was a great opportunity for the OCEESA President meeting with local chapter members.

On August 8, 2004, the Chapter joined with CAAPS and the Chinese Community Center in a fraternal picnic at the Thatcher State Park in New Salem, NY. There were more than hundred participants, adults and children. On September 18, 2004 the Chapter joined CIE in the annual convention at Marriott Hotel in Newark, NJ where there were more than hundred fifty professionals registered.

OCEESA President, Dr. Chein-Chi Chang with the OCEESA Albany Chapter President, Professor Ernest L. Siew and other members
6. The OCESA Canadian Chapter Activity
On July 14, 2004, the OCEESA 1998 president, Dr. John Huang, came to visit Halifax with his wife. Several of our Chapter members invited them to a seafood dinner. Please see the attached photograph for this gathering.
7. Future Collaboration with China or Taiwan Universities
During this year, I have visited the following universities and introduced them our association.

China:
1. Xi’an University of Architecture & Technology
2. Xi’an Shiyou University
3. Sichuan University
4. Central South University
5. Hunan University
6. Zhejiang University
7. Beijing Science & Technology University
8. Tianjin University
9. Nan-Kai University
10. Harbin Institute of Technology

Taiwan:
1. Hung-Kuang Science and Technology
Background: OCEESA is a member chapter of Chinese Institute of Engineers – USA (CIE/USA), which was founded in 1916 by a group of Chinese engineers educated in US and is a non-profit, non-political organization. Currently it has membership close to 10,000 in six chapters throughout USA.

OCEESA is one of the six member chapters and occupies three seats on the National Council (NC) being represented by the officers (President, V.P., and Secretary-Treasurer) of each year. In current year, 2004, OCEESA has the added distinction of a member, Dr. John Huang, being elected as one of the national advisors on the NC. OCEESA this year therefore has 4 representatives on the NC.

The NC held its 2004 Fall meeting recently and a brief summary is prepared to keep members informed. This is not an official minutes of meeting, which shall be documented by Secretary of the CIE/USA NC.

Incidentally, CIE/USA and CIE/ROC are the proud co-organizers of the bi-annual Modern Engineering and Technologies Seminar (METS), which is celebrating its 40th Anniversary this November in Taiwan.

Summary of Meeting

Date: October 3, 2004 Place:  Wyndham Garden Hotel
6000 Pan American Freeway
Time: 9:30 am-12:30 pm Albuquerque, New Mexico, U.S.A.
Attendance: New Mexico Chapter, Dallas Chapter, New York Chapter, San Francisco Chapter, Seattle Chapter, OCEESA Chapter.

Agenda and Highlights

? Welcome and Introduction: A special highlight is in introducing the new president of the hosting New Mexico Chapter, Frank Hung, which is relatively very young and is a second generation American of Chinese descend. Much appraise was attributed to NM Chapter for its success in recruiting new, and young members. Other Chapters all made a point to step up efforts to do the same.

? Officers’ Reports: Chairman Ted Lee is ill in Taiwan while of METS business but is now under stable condition. All present offered well wishing to be conveyed after meeting. Vice-Chair James Lee oversaw the NC meeting in Ted’s absence. Treasurer Joe Jeng summarized account balances.

? SATEC 2004 Report: The 6th Sino-American Technology and Engineering Conference (SATEC) was delayed by a year from 2003 because of SARS occurrence, and was successfully concluded on April 28, 2004. Sixty three speakers from US and Taiwan attended. A 9-day tour and discussion ended on April 27 with a Special Forum entitled: “Technology Innovation and Business Development” in Beijing, and the speakers were received by the Vice Premiere Tseng during the concluding ceremony on April 28. Preparation for SATEC 2005 will begin soon.

? METS 2004 Report: All planning is proceeding well and event will be held during Nov. 11-16 this year. Being the 40th anniversary of this memorable even, a special CD will be prepared to contain historical backgrounds and achievements. CIE/ROC tentatively committed to fund this endeavor, and CIE/USA also voted to allocate some funds as contingency.

? National Engineers Week 2005 and CIE-USA AAEOY Award Banquet: Report given by Allen Chen of New York Chapter, which is organizing the event for 2005, indicates all is going well. No major obstacle is expected; a CD from San Francisco Chapter documenting past experiences will be given (or may have already been sent) to NY Chapter to assist.

? Yearbook 2003: San Francisco Chapter, which kindly took up the work, has all layouts ready for printing; only need three more photos from other chapter executives to complete the document. Costs approved.
Chapter Activities: All chapters reported an active year so far. OCEESA reported on 9th MTEPC held in Xian in May, participation at CIE-USA New York Chapter’s annual convention with an Environmental Panel Session, and a proposal to US EPA to conduct “Taiwan Environmental Study Tours”.

San Francis Chapter expressed some interest in having OCEESA to participate and present an Environmental Panel Session at their annual convention in early 2005 if OCEESA can gather enough resource in SF area.

Guidelines proposals by Taskforce to consider new member applications or for existing members to separate were deferred because a Detroit area application has been withdrawn and a longer term consideration will be undertaken by the Taskforce.

Meeting adjourned and Allen Chen of NY Chapter will document official minutes of meeting.
Introduction

The Modern Engineering & Technology Seminar (METS) was founded in 1966 jointly by the Chinese Institute of Engineers in USA, or CIE/USA; and the Chinese Institute of Engineers in ROC, or CIE/ROC. METS is a biennial event that brings engineers and scientists in the US and Taiwan together for a weeklong seminar in Taipei. These seminars have successfully promoted technology exchange and stimulated Taiwan’s industrial advancement. METS has also played a vital role in attracting experienced technical talents and businesses to serve and invest in Taiwan. It is regarded by many as being instrumental in creating the “economic miracle” in Taiwan.

Considerable sponsorship is required to host such an event, and recently the funding support has become increasingly difficult. Owing to the innovative ideas of this year’s organizers, the event this time was for the first time held jointly with the ROC-USA Business Conference organized by the ROC-USA Business Council (ROC-USA BC). The technical program became not only fully supported, but was expanded from the original 10 sessions to 15 sessions to include the business and economic topics. Tours, banquets and cultural events also became better fund and were provided with the highest standards.

Technical Program

The most important part of METS is the technical program. The first ten technical sessions were presented by CIE and the five business sessions by ROC-USA BC:

<table>
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<tr>
<th>Session No. &amp; Title</th>
<th>(1) Biotechnology &amp; Pharmaceuticals</th>
<th>(2) Resource Recycle &amp; Reuse Technologies</th>
<th>(3) Water resource &amp; Energy Development and Conservation</th>
<th>(4) Nanotechnology and MEMS</th>
<th>(5) Broadband Communication &amp; Network Integration</th>
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<tr>
<td>Session No. &amp; Title</td>
<td>(6) Flat Panel Display &amp; Optoelectronics</td>
<td>(7) Management of Knowledge &amp; Digital-Based Industry</td>
<td>(8) Radio Frequency Identification</td>
<td>(9) Industrial Transition &amp; Transformation</td>
<td>(10) Medical Emergency Responses &amp; Technology</td>
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<tr>
<td>Session No. &amp; Title</td>
<td>(11) Banking &amp; Finance</td>
<td>(12) Purchasing Strategies &amp; Opportunities of Multinat’l Corp</td>
<td>(13) Creative Design Industries</td>
<td>(14) Technology Transfer &amp; Industrial Upgrading</td>
<td>(15) Taiwan’s Role in Bridging Busi. Opp. in Asia Pacific Region</td>
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The CIE/USA Delegation includes:

**OCEESA**
- OCEESA very good address sustainable issues. OCEESA provided nine. The following list technical content contribution.

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<th>Session&gt;Title</th>
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<td>Tim Chen</td>
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<td>David Fong</td>
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<td>Pi-Chun Chen</td>
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<td>John C.P. Huang</td>
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<td>Pai-Chih Kao</td>
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<td>Augustine Lin (Chair)</td>
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<td>Robin Ma</td>
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<td>Yei-Shong Shieh (Chair)</td>
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<td>Pao-Chiang Yuan</td>
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<td>Larry Wang</td>
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<td>Francis Chang (Chair)</td>
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<td>Chieh Wu</td>
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<td>Junn-Ling Chao</td>
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<td>William Tang</td>
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<td>Tai-Rang Hsu</td>
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<td>Jun-Min Liu (Chair)</td>
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<td>Charlie Liu</td>
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<td>R. C. Liang</td>
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<td>Mr. Chie-Jin Cheng (Chair)</td>
<td>程其敬</td>
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<td>S. J. (SHIUNN-JANG) WANG</td>
<td>王訓章</td>
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<td>Jason Huang</td>
<td>黃啟瑞</td>
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<td>Alfred Pan</td>
<td>潘益宗</td>
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<td>Yi-Chi Shih</td>
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<td>James Woo</td>
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**Participation**

Members had a representation to environmental and development member Dr. John President, Dr. served as Advisor respectively, and recommendation 3 chairmen and presentations. illustrates the of OCEESA.
1. Dr. John C. P. Huang, US Planning Committee Advisor
2. Dr. Chein-Chi Chang, US Planning Committee Administrator
3. Dr. Yei-Shong Shieh, US Session 2 Chair, Presentation Title: Recycling Technologies for Mercury Bearing Materials
4. Dr. Pao-Chiang Yuan, US Session 2 Speaker, Presentation Title: Trend of Recycling
5. Dr. Larry Wang, US Session 2 Speaker, Presentation Title: Recycling and Disposal of Electrical and Electronic Appliances
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8. Dr. David Shaw, US Session 4 Chair, Presentation Title: Nanotechnology: From Vision to Commercialization
9. Dr. James Woo, US Session 9 Speaker, Presentation Title: Generation and Utilization of Intellectual Properties - A Practical Inquiry

**Facility, Hospitality and Cultural Events**

Different sessions conducted technical tours to facilities that are relevant to their areas of expertise, some began immediately upon arrival. Active exchange of technical information and ideas took place at many local facilities, where some demonstrated extremely modern, advanced technologies that are adequate to be world class showcases.

The opening ceremony was held at the central hall of the Taipei International Convention Centre with all the latest audiovisual supports at a seating capacity of 3000. Meeting rooms for subsequent technical sessions were also well equipped with seating capacities in the hundreds.

Consistent with the Chinese tradition, the hospitality provided by the sponsors was of the highest standard. The hotel accommodation at Grand Hyatt was superb, every meal was of gourmet quality and in addition there were cultural events. Musical and dancing performances followed each of the three main banquets: the welcome banquet, a Taipei Night hosted by Mayor Ma and the farewell banquet. During Taipei Night, Mayor Ma unveiled his ambitious plans to make Taipei a truly international city, a city that will draw international investments to Taipei for distribution to foster technology developments in other parts of the island. Direct air passage between Taipei and Shanghai is being pursued. Nehihu Industrial Park will be expanded. Culturally, the heritage of the aborigines will be protected and nurtured. Children of the aborigine tribes performed during Taipei Night and presented welcome speeches in their own native language that sounded as unique as any of those unfamiliar tribes elsewhere in the world. Translations word by word into Mandarin were necessary for us to understand. Employment in Taipei public offices must reserve 5% for these natives to help them integrate into modern society. On the weekend, one-day excursions to Folk-Arts Village and Hsueh Shan Tunnel were arranged. A brief but orderly visit with the vice-president was well attended on the last departing morning. Madam Vice-president Lui emphasized technology development to be a focal point of the current government.

**Concluding Remarks**

As always, conclusion of an enjoyable event is always disheartening. However, much of the METS 2004 was so rewarding in the exchange of technical knowledge as well as that of friendship between the technical professionals of the two continents. METS 2004 cannot be described as anything other than a well planned, well executed event to be remembered by all. Some photographs are attached below to recapture some of the fond memories.
CIE-USA NATIONAL COUNCIL MEETING REPORT
WHIPPANY, NJ, FEBRUARY 27, 2005

Dr. Pao-Chiang Yuan, Ph.D.
Treasurer/Secretary, OCEESA
Professor, Technology Department
Jackson State University
Jackson, Mississippi, USA 39217
Email: pcyuan@yahoo.com

Date: Feb. 27, 2005, 8 am - 12 noon
Location: Ballroom, Hanover Marriot Hotel, Whippany, NJ
OCEESA Participants:
Dr. Yung Sung Cheng (President)
Dr. Francis H. Chang (Vice President)
Dr. Pao-Chiang Yuan (Secretary/Treasurer)
Dr. Chein-Chi Chang (Ex-Officio, Past President)

Background: OCEESA is a member chapter of Chinese Institute of Engineers – USA (CIE/USA), which was founded in 1916 by a group of Chinese engineers educated in US and is a non-profit, non-political organization. Currently it has membership close to 10,000 in six chapters throughout USA.

OCEESA is one of the six member chapters and occupies three seats on the National Council (NC) being represented by the officers (President, Vice President, and Secretary-Treasurer) of each year.

Incidentally, CIE/USA and CIE/ROC are the proud co-organizers of the bi-annual Modern Engineering and Technologies Seminar (METS), which is celebrating its 40th Anniversary this November in Taiwan.

Summary of Meeting
Date: Feb. 27, 2005
Place: Hanover Marriot Hotel
Whippany, NJ
Time: 8:00 am-12:00 noon
Attendance: New Mexico Chapter, Dallas Chapter, New York Chapter, San Francisco Chapter, Seattle Chapter, OCEESA Chapter.

Agenda and Highlights

- Welcome and Introduction
- Chairman’s Remark: Ted Lee
- Presenting 2003 CIE_USA National Council Officers Recognition Plaques
- Approval of 2004 Fall Meeting Minutes
- Officers’ Reports: Vice Chair – James Lee
  Executive Secretary – Shenchuan Lin
  Treasure Report – Joe Jeng
- SATEC 2004 Report: Wen Lin
- Engineers Week and CIE-USA AAEOY 2005 Award Banquet (Feb. 26, 2005)
- METS 2004 Report: Tim Chen/David Fong/Pi-Chun
- Chapter Activity Reports: DFW Chapter, NM Chapter, NY Chapter
  SF Chapter, OCEESA Chapter, Seattle Chapter, and DECA. OCEESA reported on 9th MTEPC held in Xian, China, in May 2004.
- Yearbook 2004 Planning Status and Budget Process: Ted Lee and Shenchuan Lin
- Advisors Status Update
- Election: CIE-USA National Council Officers (Chairperson, VC and Treasurer)
- Break (10 minutes)
Appointment of NC Secretary/Confirmation
Election: METS US Committee Members(Chairperson, VC, and Administrator)
Follow-up on the discussion of DECA CIE-USA Membership
Follow-up on Bylaws Update Status
Status of CIE-USA National Council Registration
Next NC meeting data/time and place
MEETING Adjourn

Here are important things related to the OCEESA. We were elected in two important positions. We will host 2007 Asian American Engineers of The Year Award Banquet in accordance with CIE practice and may have New Mexico Chapter as partner.

a. Election: CIE-USA 2005 US Committee Members (Chairperson, VC and Treasurer)
   Chair: Dr. James Lee (Seattle Chapter)
   Vice Chair: Dr. Francis H. Chang (OCEESA)
   Treasurer: Dr. An-Yu Kuo (SF Chapter)

b. Election: 2006 METS US Committee
   Chair: Dr. David Fong (SF Chapter)
   Vice Chair: Dr. Chein-Chi Chang (OCEESA)
   Administrator: Dr. Allen Chen (NY Chapter)

c. SATEC: Dr. Wen Lin stated that SATEC 2005 was being postponed and a new date has not been set. Dr. Yung Sung Cheng of OCEESA remains administrator of next conference when this activity is reconvened
OCEESA EXECUTIVE COUNCIL MEETING REPORT
WHIPPANY, NJ, FEBRUARY 26, 2005

Dr. Pao-Chiang Yuan, Ph.D. 袁保強
Treasurer/Secretary, OCEESA
Professor, Technology Department
Jackson State University
Jackson, Mississippi, USA 39217
Email: pcyuan@yahoo.com

Date: 2-26-05, 2-4 pm.
Location: Room 212, Hanover Marriot Hotel, Whippany, NJ
Participants:
Dr. Yung Sung Cheng (President)
Dr. Francis H. Chang (Vice President)
Dr. Pao-Chiang Yuan (Secretary/Treasurer)
Dr. Chein-Chi Chang (Ex-Officio, Past President)

Agenda and Actions

(1) Call for meeting
(2) President’s Remark
(3) Treasurer report: Transfer of Treasurer/Secretary’s Office
   Dr. Francis H. Chang transferred all bank documents to Dr. Pao-Chiang Yuan. Due to no Bank of America
   located in Jackson, Mississipi, the account will be at Albuquerque, New Mexico. President, Vice-President and
   Treasurer can sign checks.
(4) 2005 Budget: Approve the budget
(5) Fund Raising: Encourage members to donate money and also contact possible
   private companies. A sponsorship program was discussed and approved. Dr. Yung Sung
   Cheng was the Fund Raising Chair.
(6) 10th MTEPC: Hung Kuang University of Science and Technology, Taichung, Taiwan, Oct. 24-29, 2005.
   Call for papers, Dr. Yung-Tse Hung will be responsible for collecting all abstracts, CV as in the past, final
   due day is March 15, 2005
(7) 11th MTEPC: The site will be decided at 10th MTEPC
(8) METS: 2004 meeting 9 OCEESA members participated, was a successful meeting
(9) SATEC: Dr Cheng reported that no progress was made and SATEC 2005 may be
   postponed.
(10) Membership: Encourage members to recruit new members, but still limit to
    Overseas, include such as Singapore and other countries.
(11) Other Old Business: None
(12) New Business: None
(13) Meeting Adjourns
The infrastructures in a well-developed urban area can sometime easily be fifty to one-hundred years old. These infrastructures are exhibiting different degrees of deterioration and causing environmental problems. For example, a sewer system receiving large amounts of inflow/infiltration, will have higher energy requirements for pumping and treatment of the sewage. A second example is the loss of water in an old water distribution system which will require more energy for treatment and distribution of potable water. A third example is the lack of an adequate drainage system which may result in higher level of pollutants entering into the receiving waters. Dr. Chen will discuss these problems that occur in Broward County, Florida.

Broward County is a county with a population of over 1.7 million sandwiched between Palm Beach and Miami-Dade Counties. The tri-county area has a total population of over 5 million. Out of the 1.7 million in Broward County, only about 250,000 are still in the unincorporated county area. The provision of municipal services in the unincorporated county areas become more and more inefficient, especially when these areas also have old and deteriorating infrastructures. To entice the surrounding cities to annex these areas, Broward County started the neighborhood improvement projects in 1992. It is the twelfth year of this program and it will be at least another ten years before the program is completed. The work includes the replacement of old (and sometimes construction of new) water, sewer, and drainage pipes, as well as road repaving, sidewalk repair and construction, landscaping and placement of neighborhood signs. The funding of the entire program, which is now estimated to be over $300 million, is from several sources: utilities enterprise funds, local gas taxes, general revenues and grants such as a HUD community block grant.

Although the projects are in the United States, many elements of these projects can be applied to any place facing a similar situation when infrastructure is old and outdated.
The author presented lecture at the International Symposium on Environmental Management for Human Development, “Hazardous Materials Management for Sustainable Community”, Baku, Azerbaijan, March 16, 2005. The primary goal of the project is the training of a new generation of environmental managers who will be equipped with the knowledge and skills necessary to plan and implement economic and social programs and projects which meet the requirements of international, national and corporate sustainable human development. The author’s power point presentation was to talk about hazardous materials management in recent years. The program collaborates by Western University, Azerbaijan Republic, Mississippi Valley State University, Jackson State University, Mississippi Center of International Development (MCID) and funded by USAID. Following are summary of the author’s presentation

People concerned for the natural environment began developing sustainable communities. Communities that can persist over generations, enjoy healthy environment, a prosperous economy and vibrant civic lives is wanted. Sustainable development is defined as meeting the needs of the present without comprising the ability of future generations to meet their needs. Look around your community and compare with others. See any hidden materials or hazardous materials around you, you may never notice them but they are existing. Hazardous materials pose continuous and growing environmental risks for global jurisdictions across countries. For example, Asbestos derived from Greek meaning inextinguishable. It was considered to be a miracle mineral due to its soft and plaint properties and withstand heat. It used on thermal insulation for boilers, pipes and other high temperature applications. It is a naturally occurring mineral but form into long, thin fibers. It will cause cancer. How many gas stations? They contain concrete, due to corrosion, faulty installation, piping failure and overfill. The oil will leak into the ground and contaminate the groundwater aquifer that is drinking water supply. It damages our environment and is a potential health threat. Lead is an accumulative poison. Increasing amounts build up in the body and eventually a point is reached when symptoms and disability occur, especially in children. All of the above mentioned hazardous materials cause chronic diseases or long-term effects to the environment.

In the past three decades, the communities of the United States have focused on asbestos removal, lead paint removal, underground storage tank removal, and proper handling of infectious waste. Now, as we go into this century, we consider E-waste (electronic waste). These materials were fantastic for our living and were used by us for many years before becoming hazardous to us, and a threat our living environment according to scientific studies. The situations were changed dramatically in developed counties but not in third world and developing countries. In this presentation attention is drawn to a few hazardous materials of communities. It is hoped non-governmental organizations (NGO) play an important role in the efforts to help communities remove the hazardous materials. Also, governments should be pushed to establish rules and change our living areas to a sustainable community.
The Idea of Users Group

It was a hot summer afternoon in 2003. A group of engineers from Howard County, Maryland, Department of Public Works (HCDPW) and the Washington Suburban Sanitary Commission (WSSC) met at the WSSC headquarters building in Laurel, enthusiastically discussing a mutual problem - corrosion protection of ductile iron (D. I.) pipes.

On numerous occasions early in 2003, sales representatives from the various ductile iron pipe (DIP) manufacturers informed us that they would no longer quote or sell pipe products where a bonded dielectric coating system was specified as a corrosion protection method. In lieu of bonded coatings, the DIP manufacturers recommended that users specify polyethylene encasement (PE) for corrosion protection of ductile iron pipe systems. The Ductile Iron Pipe Research Association (DIPRA) announced that its members - the eight leading DIP manufacturers in North America - will no longer honor a warranty for their pipes without PE as a corrosion protection system.

As civil/pipeline designers, we generally design a project, depending on its size and importance, in the following steps:

1. Pre-design study.
2. Site specific investigation.
3. Technical research. (World wide experience and practices)
4. Studies of alternative pipe materials
5. Cost comparison associated with pipe material. (Value Engineering)
6. Risk analysis.
7. Select the pipe material and complete the design.

The decision, made by the DIP manufacturers not to sell users the pipe when bonded coatings are specified, has taken away some of our freedom to design pipeline systems. We are forced to use PE as a corrosion protection method for D. I. pipes even though our technical research and subsurface investigations of the proposed job site may indicate that this may not be the best protection for pipeline in a given situation.

As pipeline designers, specification writers, and purchasers, we are the owners and end users. It is our belief that the end users should be able to design what they have determined to be the best method; and to be able to specify what they think is a good product, even if it is necessary to modify that product after purchase to reach the required specification. It is disturbing that the end users should allow the merchants to dictate the design method and the specified product. As we are in a free enterprise country, we should be able to communicate with the pipe suppliers for products that we want to design, specify, and purchase. Compare this with the oil and gas industry practices where the end user can purchase steel pipe manufactured to a material specification and then is free to protect the pipe with a wide range of coating systems and cathodic protection.

We do believe that DIP is a great product. We do believe that we will specify it using PE as the corrosion protection method in most cases. However, we also believe that we should have the option of using bonded coatings with cathodic protection as a corrosion protection method in some situations. In a free enterprise society, the customers should have such freedom and choices.

Before meeting with the staff of the Howard County Department of Public Works, WSSC was being approached on an increasingly frequent basis by other engineers in the water industry. They were facing the same frustrations as we were in designing corrosion protection for our DIP water mains. It was becoming obvious that the DIP manufacturers, with the support of DIPRA, were banding together in their refusal to provide DIP with bonded coatings. As individual engineers and individual organizations, our voices and opinions were ignored. We could not deliver our professional services to the best of our ability because the DIP manufacturers would not allow us the freedom to exercise our knowledge and services to the public.
The Howard County engineers informed us that they and many of the surrounding jurisdictions were having similar problems with specifying DIP with bonded coatings. By the end of the meeting, we came to the conclusion that we should get together to talk; just talk about our mutual concerns among the engineers in the surrounding municipal agencies. The idea for a users group representing the agencies around the Washington, D.C. and Baltimore areas was born.

**Users Group Meetings**

The first group meeting was held at the Washington Suburban Sanitary Commission in September 2003, with representatives from Howard County, Maryland, the District of Columbia Water and Sewer Authority (DC WASA) and WSSC in attendance. The engineers presented brief overviews of their water systems, accomplishments and the problems they were facing on their current water main projects. The decision of the ductile iron pipe manufacturers not to sell or provide quotes for DIP designed with bonded coatings was briefly discussed.

The second group meeting was held at the Howard County Department of Public Works in January 2004. Representatives from eight (8) municipal water agencies who are serving 5 million customers in the Greater Baltimore-Washington Metropolitan Area attended. The primary pipe material for the majority of the water distribution systems in the Baltimore-Washington Metropolitan area is DIP and a common problem that the organizations faced was DIP corrosion. The Howard County Department of Public Works presented their recently developed Geographic Information System Pipeline Corrosion Database. The attendees also discussed a range of corrosion protection design alternatives for DIP and steel water mains.

The third group meeting was also held at the Howard County Department of Public Works in April 2004. Eight (8) municipal agencies and four (4) major DIP manufacturers that supplied pipe to the Baltimore-Washington Metropolitan area attended the meeting. Also in attendance were the Ductile Iron Pipe Research Association (DIPRA) and representatives from the Corrpro Companies, Inc. (Corrpro). Corrpro, under contract to DIPRA, had prepared a Design Decision Model for DIP corrosion protection. The model was presented to the municipalities for the first time during that meeting. The Corrpro model strongly advocated the use of polyethylene encasement (PE) for corrosion protection design. The Design Decision Model alternatives ruled out the use of bonded coatings for corrosion protection of DIP. In discussion, DIP manufacturers and DIPRA presented their position and decision not to sell DIP to users who choose to adopt bonded coatings as their choice for corrosion protection. They also stated that all users should use the Design Decision Model that is based on the use of PE encasement.

The fourth group meeting was held at the WSSC headquarters building in November 2004. Representatives from eleven (11) municipal water agencies attended the meeting. The keynote speaker was Bob Walker, Executive Director of the UNIBELL PVC Pipe Association. Mr. Walker spoke on the use of PVC water mains in the United States and Canada, and the advantages associated with PVC water mains. DC WASA presented their on-going project on the use of high-density polyethylene (HDPE) pipe lining for water main rehabilitation. WSSC presented their planned work on PVC for a water main project in their utility district. Harford County presented their experiences on the PVC water main use in Harford County over the past 30 years.

All too often we, as end users or owners, learn of each other's trials and successes only through vendors or through mutual consulting firms that we have contacted with. These meetings have demonstrated that the users can learn and grow from the past experiences and successes of other jurisdictions. There are options to using DIP with PE applications in corrosive areas. The users indeed have the alternative of using PVC water mains if they can not acquire DIP with bonded coatings due to the manufacturers' refusal to sell the product. These meetings have allowed us to grow and to reach a comfort level with alternate pipe materials based on the success of other jurisdictions using those materials under similar circumstances.

**Convert Many Individual Low Voices into One Loud Voice**

The general consensus of the members was that the end users can meet with other users to share concerns on various aspects of water main design and application, e.g. DIP corrosion protection. We share our problems and solutions. For an area that has predominately relied on cast/ductile iron pipe for the majority of its distribution system, we have found that other users have successfully used pipe materials other than DIP for water mains. We have also learned that we should diligently look for other alternatives as proper corrosion protection methods. We should educate our selves about other practices and experiences being used overseas. We should continue to look at other pipe materials even beyond PVC water mains, and other corrosion protection methods for DIP beyond PE or bonded coatings. The
larger the users group becomes, the louder our voice will be heard by the ductile iron pipe manufacturers and by DIPRA.

Cooperation versus Confrontation

In late 2004, the users group finally decided its name to be "Municipal Drinking Water Industry Users Group". We are a bunch of municipal workers loosely grouped together to face our common problems and to seek better solutions. We do not have any fixed agenda, no permanent officials, no budget, nobody reports to anybody, and no by-laws. Anyone involved in drinking water activity, working for any municipal agency in the Greater Baltimore-Washington Metropolitan Area is welcome to join us without any obligation or assigned responsibility. We have had a very cordial working relationship with the DIP manufacturers for past decades. We have no other quarrels with our old friends but we question their new path. We ask that they do not act unilaterally without input from their customers. Collectively, the end users have more experience than the resources of DIPRA. Cooperation and sharing knowledge will make a better product.

On page 46 of the 1927 Handbook of Cast Iron Pipe, it states that,

"It has been largely through the generous cooperation and thoughtful criticism of the users of cast iron pipe that the manufacturers have been able to make improvements in their products, and in return the pipe makers offer their experience in the field with the dual hope that it may be of immediate assistance, and also uncover new lines of improvement in composition, design, durability or finish of cast iron pipe."

Such a statement could not be found in the DIPRA handbook, at least in the introduction pages. Such a spirit of cooperation seems to have disappeared. Does DIPRA consider there is no need for cooperation between the users and pipe makers?

We just want to resolve our corrosion problems - and provide a range of corrosion protection designs that can best serve the public. We do not see any reason for not being able to sit down with the ductile iron pipe manufacturers to resolve our differences - provided we are free to choose a corrosion protection method that we arrived at through our engineering processes that we have been trained to use. We should try to accommodate each other instead of adopting any unilateral attitude - "my way or the highway". It is the users/owners who ultimately have responsibility for their water systems and it is the users/owners who will have the ultimate decision on which pipe materials will go into construction of their water systems. By working together, we hope to build a better product for our customers and to maintain a long and lasting relationship with an old friend. There are agencies that may want to follow the DIP manufacturers' preferred method for corrosion protection design. For those, they are still welcome to come to our future meetings. The topics are many and varied. If anyone is interested in attending the next Municipal Drinking Water Industry Users Group meeting, please contact us at email addresses: dlieu@co.ho.md.us, pli@wsscw.com.
I. Introduction

Mercury is a persistent, bioaccumulated toxin that has been used for ages because of its unique combination of chemical and physical properties. Mercury is easily volatilized because of its low boiling point. It can be dispersed widely through the air and transported thousands of miles. As it cycles among air, land, and water, it undergoes complex chemical and physical changes. Humans, plants, and animals may be exposed to mercury resulting in ecological and human health impacts. Its tendency to build up in the aquatic food chain makes it a contaminant of special concern. The primary health effects from mercury are on the neurological development of children exposed through fish consumption and fetuses exposed through their mother’s consumption of fish \[1\].

The U.S. Environmental Protection Agency (USEPA) has created the Safe Mercury Management Program to reduce the health risk from mercury exposure. Mercury recycling and other proper mercury waste management help prevent mercury vapor releases to air or groundwater. Under the Resource Conservation and Recovery Act (RCRA) promulgated in 1986, thermal retort or roasting technologies are required for all hazardous mercury containing wastes with mercury greater than or equal to 260 mg/kg (high mercury category) \[2\]. Incineration unit with proper design may be used for high mercury wastes containing organics. For low mercury (< 260mg/kg) category, the waste is defined as hazardous waste if the mercury is leached out at a rate of 0.2 mg/l or greater using the toxicity characteristic leaching procedure (TCLP). Stabilization can be used to reduce the mercury from leaching out for the low mercury wastes.

To streamline environmental regulations for small generators, USEPA issued the Universal Waste Rule in May 1995 covering hazardous batteries and mercury containing thermostats. In July 1999, hazardous waste lamps (including mercury containing lamps) were added to the federal list of universal wastes regulated under RCRA. It is designed to reduce the amount of hazardous items in the municipal solid waste stream. Handlers of universal wastes are subject to less stringent standards for transporting, storing, and collecting these wastes \[3\]. In October 2001, USEPA banned the dumping of Cathode Ray Tubes (CRT’s) and began fining companies that disposed CRT’s through landfills and incineration. Some states (e.g., Massachusetts) launched a voluntary dental amalgam recycling program to reduce the amount of mercury released into its environment. In June 2002, more recycling and reuse were proposed under universal wastes for electronic wastes and mercury containing equipment such as barometers, meters, temperature gauges, pressure gauges, and sprinkler system contacts. The Universal Waste Rule encourages the recycling and proper disposal of some common hazardous wastes.

Internationally, parties in the Basel Convention have agreed in 1995 to ban all export of hazardous wastes (including mercury containing wastes) from Annex VII (members of the EU, OECD and Liechtenstein) to non-Annex VII countries for final disposal and recycling as an amendment \[4\]. The banned amendment has been ratified by three-fourths of the parties. U.S. and Taiwan are not the signatory parties.

In addition to recycling, waste minimization at the sources is a logical alternative. For example, mercury thermometers can be replaced with red alcohol or mineral spirit filled thermometers. Mercury containing batteries can also be replaced by non-mercury bearing batteries to minimize the mercury contaminating sources. Manometers can be phased out in favor of pressure transducers, electronic pressure gauges or oil-based manometers.

II. Mercury Containing Materials

E-wastes (from electric and electronic wastes) and processing wastes (from chemical and mining operations) are the major mercury containing materials. The following is a summary of the major categories of these wastes:
Batteries – Mercury containing batteries include alkaline dry cells, button cells, carbon-air, large zinc air, mercury oxide, and silver cells.

Thermometers – Mercury containing devices include barometers, industrial thermometers, manometers, medical thermometers, and sphygmomanometers.

Lamps – Mercury is used in all fluorescent tubes including compact fluorescent bulbs and neon lights. Other mercury containing lamps include HID, high pressure sodium, mercury vapor, metal halides, quartz, and ultraviolet.

Cathode ray tubes (CRT) - CRT is within every television and non-LCD monitors. It contains hazardous materials including mercury, lead, cadmium, phosphorus and PCB’s.

Mercury containing equipment – This category includes meters, switches, pressure regulators, rectifiers, relays, thermocouples, thermostats, and ignitron tubes.

Dental amalgam – Dental amalgam is mainly mercury and silver. Dentists in the practice areas that generate mercury containing waste amalgam are encouraged to install an amalgam separator system to recover amalgam for recycling.

Mercury contaminated wastes are generated in large quantities from chlorine caustic soda operations, gold mining, and zinc mining.

The USEPA promotes removing mercury from mercury-containing articles and wastes before they are landfilled. Universal Rule streamlines the management of these wastes.

III. Mercury Recycling Technologies

In response to this challenge, various mercury recycling technologies have been developed. Commercial mercury recycling centers continue to grow in U.S. Thermal recovery and metal extraction using acid leaching are the key technologies used. Acid leaching is limited to low mercury content materials, non-wastewaters, high volume wastes such as contaminated soils and mining wastes. Thermal recovery technologies (e.g., retort unit, rotary kiln) are more suitable for higher mercury concentration materials.

Thermal Recovery Approach

Mercury freezes at -38.9°C (-38°F) and boils at 356.9°C (674°F). Other mercury compounds such as mercury oxide (HgO) in battery application and mercury sulfide (HgS) from gold mining operation have much higher boiling points or converting temperatures. Specific additives can be incorporated in the processing to facilitate decomposition of these mercury compounds. By heating the materials over the boiling point, the mercury contained in the wastes reach the vapor pressure of atmospheric conditions (760 mm Hg) and vaporizes. Due to partial pressure, mercury vapor begins to emit into the atmosphere even at the room temperature.

The speed of mercury vaporization depends on the temperature of waste material, surface area exposure and vacuum level in the system. If the vacuum is increased, this will result in a lower vaporization temperature. If the mercury wastes are not properly managed, the ambient air in the waste area under the atmospheric conditions can easily exceed the extremely low OSHA mercury threshold level. It will increase the health risk to workers in the area. U.S. Department of Labor, Occupational Safety & Health Administration (OSHA) sets permissible exposure limits (PELs) to protect workers against the health effects of exposure to hazardous substances [5]. PELs are regulatory limits on the amount or concentration of a substance in the air based on an 8-hour time weighted average. The current PEL for mercury vapor is 0.1 mg/m^3 of air. The American Conference of Governmental Industrial Hygienists (ACGIH) sets an even lower Threshold Limit Value (TLV) of 0.05 mg/m^3.

The selection of a mercury recycling technology depends upon waste material type, processing capacity, mercury compounds in the waste, and mercury purity requirements. Thermal desorption technology has become a cost effective and environmentally acceptable alternative to incineration for the treatment of wastes contaminated with mercury and organic compounds such as VOCs, SVOCs, PAHs, PCBs, herbicides, pesticides and dioxins [6][7]. There are different types of thermal desorption systems for various applications. Equipment capabilities are critical to the selection of this technology: 1) Direct vs. Indirect Heat, 2) Continuous vs. Batch, 3) High Vacuum vs. Slightly Negative Pressure, 4) Temperature Limit, 5) Internal Agitation, and 6) Heat Transfer Efficiency.
Direct heated systems use fuel burners to heat air and force it through a rotary drum unit in direct contact with the wastes as the heat source for the process. High volumes of off-gas from the direct heated systems normally pass through a dust collection unit and a secondary combustion afterburner. The applications for these systems are generally limited to low concentration fuel contaminated soils and certain chlorinated volatile organic compounds. It is not suitable for mercury recovery.

Indirect heated systems transfer heat from air, steam, heat-transfer fluid, molten salt or electric source through metal surfaces to the waste materials. The equipment designs include continuous systems such as screw, paddle, double rotary drum and stationary systems with drum or pizza oven design. The continuous systems are typically used to physically separate organic contaminants from the media (e.g., soil) through thermal desorption \([8]\). Desorbed organic compounds are condensed and recovered. Carbon adsorption may be used to polish the off-gas prior to discharge into the atmosphere. Particulate carryover is minimized due to the lower volume of exhaust gas. For sludge, sediment, and wastes with high moisture and/or contaminant content, the indirect heated systems with internal agitation are more suitable. These systems are gradually being applied for the treatment of wastes contaminated with high hazard chlorinated organics such as PCBs, dioxins, pesticides, herbicides and pentachlorophenol (PCP) \([9]\). Medium temperature thermal desorption (“MTTD”) units capable of heating the waste materials to 800°F – 1200°F are required for these applications. An MTTD system can be used to remove polychlorinated biphenyls (PCBs) from the oil-filled capacitors contained in the Lamp ballasts.

Recently, batch vacuum MTTD units with rotary and pizza oven designs are being used to achieve very stringent treatment standards for these high hazard compounds including mercury and chlorinated organics.

**IV. Mercury Recycling System**

For commercial operations, most recyclers use retort units to vaporize and recover mercury from the mercury bearing articles. The recovered mercury will then be distilled either off-site or on-site under vacuum to produce high purity elemental mercury for sale. Commercial systems are designed to operate in the temperature range of 370°C (700°F) to 650°C (1200°F) and vacuum range from slightly negative (2” Hg) to high vacuum at 26”Hg.

Facility design including waste material handling, processing system, and health and safety requirements are critical to ensure the safety of operational personnel. Vacuum is typically applied to a retort unit to prevent mercury from leaking out. Multiple mercury recycling technologies or designs are normally required for a commercial operation to provide the flexibility to process a wide variety of waste materials.

Based on our experience in thermal recovery technologies and mercury retorts, we have worked with an equipment manufacturer to provide a turnkey Mercury Recycling System. The system can be used to process nearly all of the mercury containing articles and wastes listed above. Our systems typically operate within the temperature range of 425°C to 540°C (797°F to 1004°F) and vacuum range of 22-24” Hg of mercury which is equivalent to 150 – 200 torr (mm Hg absolute pressure). The standard atmospheric pressure is 760 torr.

**Design Consideration**

Some feed materials require no preparation. For example, sludges and contaminated soils can be placed into the retort units without pre-processing. Thermometers, thermostats and switches need to be broken prior to retorting. For mercury containing batteries, a shredder is typically required. Other materials may need to be sorted to remove the potential troublesome materials such as larger amounts of plastic, rubber, paper and wood. Small quantities of these materials are not likely causing major problems. Fluorescent lamps need to be crushed in order to separate mercury containing phosphor powder from glass and aluminum.

Control of mercury vapor emissions is critical to the safety of workers in the material handling and processing areas. Enclosed material handling equipment is necessary to control the fugitive emissions. Ventilation with dust collection and carbon adsorption are required to maintain the work area below the TLV.

**Lamp Recycling System**

Fluorescent lamps and bulbs require a lamp processing system to crush and physically separate the lamps into aluminum end caps, glass, and mercury containing phosphor powder. Phosphor powder will be further processed in a mercury retort unit to recover and recycle mercury. After confirming tests, aluminum end caps will be transported to
a metal recovery facility for recycling. The glass will be shipped off-site for recycling or disposal. The lamp processing system typically consists of a rock crusher, screen separator, enclosed conveyor, powder collecting baghouses, and a carbon adsorption unit for final polishing of discharge air.

The material handling system should be totally enclosed and operated under a slightly negative pressure. The enclosed system is required to prevent mercury vapor from migrating into the work area resulting in workers’ health risk.

Mercury Retort System

Mercury retorts and a vacuum distillation system as shown in Figures 1 & 2 include retort ovens, mercury condensing, mercury trap, sulfur impregnated carbon filtration, and vacuum pump operating units. The systems are available in both gas and electric models. Vacuum is applied at approximately 22”-24” of mercury to promote the vacuum distillation at a lower temperature and prevent mercury from leaking out during retort operations. For high volume design, each retort unit can process 40 ft³ of wastes. Multiple retort units can be packaged together to increase the capacity if necessary.

Figure 2 - Condensing and carbon system
(Courtesy of Summit Valley)

Figure 1 - Vacuum thermal retort units
(Courtesy of Summit Valley)
The time for processing will vary depending on the feed material and the mercury content requirements of the processed materials. Most mercury containing articles and fluorescent lamp phosphor powders can be processed to near non-detect level in 8 hours at 425°C (797°F) \[10\]. A 12 hour cycle for mercury contaminated soils is generally adequate. Precious metal sludge, Precious metal sludge, Merrill-Crowe precipitates and chlor-alkali sludge can take 24 hours or more to remove the required levels of mercury.

Mercury Distillation

The mercury recovered from the retort systems requires further distillation to achieve the high purity commercial grade mercury for resale. Triple distillation will increase the mercury content to at least 99.99% purity as Technically Pure Mercury. Virgin quality mercury at 99.99995% purity can be produced using quadruple vacuum distillation.

More than thirty (30) mercury recycling systems have been installed at lamp recycling facilities, gold mining operations and hazardous waste processing centers internationally.

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ENVIRONMENTAL IMPACT AND ECONOMIC DEVELOPMENT IN CHINA (in Chinese)

Dr. Rubin Yu, Ph.D. 禹如斌
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Source: Seattle Chinese Post, Seattle, Washington, USA, p. 13, February 26, 2005
REPORT ON SABBATICAL LEAVE AT CURTIN UNIVERSITY OF TECHNOLOGY, PERTH, AUSTRALIA, IN SPRING SEMESTER 2004

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The author spent his sabbatical leave of Spring semester 2004 at the Department of Civil Engineering, Curtin University of Technology, Perth, Western Australia, Australia, from 2-25-04 (W) to 7-18-04 (S)). The author left Cleveland on February 20, 2004 (F) by Northwest Airlines and arrived in Tokyo on February 21, 2004 (Sat). He left Tokyo on February 23, 2004 (M) by Northwest Airlines and arrived Singapore. He left Singapore on February 24, 2004 (T) by Singapore and arrived Perth on the same day. He spent his second semester of sabbatical leave at Department of Civil Engineering, Curtin University of Technology, Perth, Western Australia, Australia, from 2-25-04 (W) to 7-18-04 (S). He returned to Cleveland on 7-31-04 (Sat) via Singapore, Tokyo and Hawaii. During his sabbatical leave he has visited 11 universities in Australia, and 2 universities in New Zealand. He presented research seminar in several of these universities. He has also visited 5 water and wastewater treatment plants in overseas countries. Table 1 presents the list of universities and water and wastewater treatment plants visited. This report describes his work tasks and visits and observations during his sabbatical leave in Spring semester 2004.

After the sabbatical leave, the author and his wife also visited scenery places along the middle and south coastal area of Western Australia, Ayers Rock, Melbourne, Canberra, Sydney, Brisbane, Golden Coast, Cairns, Great Barrier Reef, in Australia, and Christchurch, Dunedin, Auckland, Franz Josef Glacier, Fox Glacier, Milford Sound, in New Zealand, Singapore, and Hawaii.

I. Curtin University of Technology, Perth, Western Australia, Australia

The author spent his second semester sabbatical leave at the Department of Civil Engineering, Curtin University of Technology, Perth, Western Australia, Australia, from 2-25-04 (W) to 7-18-04 (S)). His host was Prof. David Scott , Head, Department of Civil Engineering, and Prof. B Vijaya Rangan, Dean, School of Engineering and Computing. The Civil Engineering Department has 7 faculty members and has about 240 undergraduate students and about 20 post graduate students, and offers B.S., M.S. and Ph.D. degrees. Most of graduate students are international students from Southeast Asia.

The author taught 2 courses at Curtin University of Technology: Water Engineering 362 and Environmental Engineering 461. Water Engineering 362 is a third year Civil Engineering course with enrollment of 63 students. The course was 2 hours per week for 12 weeks period. Environmental Engineering 461 is a fourth year Civil Engineering course with an enrollment of 23 students. The course was 3 hours per week for 12 weeks. He also participated in their on-going research projects in environmental area. He has provided advice to post graduate students regarding their thesis research. During his stay at Curtin University of Technology he has actively engaged in book chapter preparation.

II. Visited 2 Universities in Perth, Western Australia, Australia

During his stay at Curtin University of Technology, the author visited 2 universities in Perth: Murdoch University and University of Western Australia. Murdoch University is a relatively young and small university in Australia. Murdoch University has Environmental Technology Center, which was established by funds from United Nations. The environmental research conducted deals with environmental technology applicable in Aboriginals in Australia and applicable to developing countries. The author has visited School of Water Research at University of Western Australia. The school is very strong in modeling of water quality and environmental system in lakes, estuaries and coastal areas. School of Water Research at University of Western Australia is one of the best in Australia. The School offers degrees in environmental engineering. The faculty is mainly environmental biologists and environmental chemists. There are no environmental engineering faculty in the school. In the Civil Engineering Department the environmental engineering courses are taught by water resources faculty.
III. Visited 8 Universities in Australia outside Western Australia

During his stay at Curtin University of Technology, the author visited 8 universities outside Western Australia. These include 3 universities in Melbourne, Victoria: Deakin University, Monash University, and RMIT University; 2 universities in Sydney, New South Wales: University of Technology Sydney, and University of Western Sydney; and 3 universities in Brisbane, Queensland: Queensland University of Technology, Griffith University, and University of Queensland.

It is interesting to note that most of water and wastewater treatment research conducted at universities in Australia was conducted in the Chemical Engineering Department. Quantity of water is much more important than quality of water in Australia. The Civil Engineering Departments at universities in Australia place heavy emphasis on water resources such as surface and ground water hydrology. Faculty member who teach hydrology teach the environmental engineering courses to Civil Engineering students. A high percentage of environmental engineering faculty in Australia are foreigners such as British, French, German, Russians, and Asians who have obtained Ph.D. from Australia or from western countries. The number of international students from Southeast Asia is very significant in universities in Australia and also in New Zealand. There are about 32 national universities in Australia. The universities are very actively engaged in recruitment of Asian students. It will be very common to have 20 to 30% of student body at university from Southeast countries. Many international students will come to Australia to attend high school or the last year of high school to prepare them to enter universities in Australia.

It takes 4 years undergraduate study to get a B.S.C.E. degree from Australia. There are 12 weeks of lecture each semester. The first semester is from March to June and the second semester is from July to October. There is a 2 weeks semester break after the 6th week of lecture. The pace of teaching and study is much faster in Australia than in the U.S. The students need to use the 2 weeks of mid-semester break to catch up with their project assignment and term paper or home work assignments. At the Civil Engineering Department, Curtin University of Technology, major courses such as structure design, are 6 to 8 cr. hr. which consists of 2 or 3 different subject areas and is equal to 2 or 3 of 3 cr. hr. courses in the U.S. If a student fails one subject of the 6 to 8 cr. courses, the student must repeat the entire course. This is a very good way to generate tuition money for the university. The Civil Engineering students at Curtin are very hard working and are good students. The teaching load of Civil Engineering faculty at Curtin is very heavy and about 10 lecture hours per week. As in universities in the British system, post graduate students who pursue M.S. or Ph.D. degree at Curtin University do not require to take post graduate courses and are only required to do thesis research and preparation and defense of thesis for their post graduate degree requirement. For the Ph.D. degree there are both on-shore and off-shore degree students. For the on-shore students they will conduct their research at Curtin University, which the off-shore post graduate students will conduct their research in their own country and come to Perth may be once a year to meet with their supervising professor. The number of off-shore Ph.D. students are very significant in the Civil Engineering Department at Curtin. There is no environmental engineering lab at the Civil Engineering Department at Curtin. Some of the thesis research in environmental area are conducted at the field sites. The administration structure at Curtin University consists of department chair, school dean, and then executive dean, then vice chancellor. School dean is college dean. Executive dean is the boss of few or several deans. In U.S. there is no executive dean between deans and provost. At Murdoch University the teaching load for environmental engineering faculty is about 3 hours per week. This allows faculty to have time to do research and to publish papers. It has a very strong environmental science school. There is no environmental engineering undergraduate program at Murdoch University. However, environmental engineering students can pursue M.S. or Ph.D. degree in environmental engineering at Murdoch University through research conducted at Environmental Technology Center. This works out quite well, since there is no course requirement for research students pursuing post graduate degree.

IV. UNIVERSITIES VISITED IN NEW ZEALAND

On his way back to U.S., the author visited 2 universities in New Zealand: University of Canterbury, Christchurch and University of Auckland, Auckland. The period of visit in New Zealand was from 7-15-04 (Th) to 7-22-04 (Th). The author started his university teaching career at University of Canterbury back in 1972, which was over 33 years ago. He was the first full time faculty member, lecturer in Public Health Engineering, at University of Canterbury. He taught there for one and one half years before he returned to U.S. It was quite an emotional trip for him to present his lecture to the Civil Engineering senior students at the same university where he taught 33 years ago. Some of the students’ parents may be the author’s students back in 1972. Most of his former colleagues in the Civil Engineering Department he taught with in 1972 have either
retired or are about to retire. He was so happy to see some of his old colleagues during his seminar visit at University of Canterbury. He also has the chance to visit some old friends whom he has not seen for over 32 years. It is a memorable and emotional trip for him and his wife to be back to Christchurch after 32 years absence. Now the author is also near the end of his teaching career after he has taught at 16 universities in 8 different countries.

The Civil Engineering Department at University of Canterbury has 3 faculty members in environmental engineering. One in water and wastewater treatment, the second one in solid waste, and the third one in natural resources engineering. The environmental engineering lab is well equipped. The Department of Civil Engineering at University of Auckland has the largest environmental engineering program in New Zealand with 5 faculty members. The environmental engineering lab is well equipped.

V. ENVIRONMENTAL FACILITIES VISITED

During the sabbatical leave in the Spring semester, 2004, the author visited 3 wastewater treatment plants and 1 water treatment plant in Australia and 1 wastewater treatment in New Zealand. These include (a) Woodman Point Wastewater Treatment Plant, Perth, Western Australia, (b) Jandakot Groundwater Treatment Plant, Perth, Western Australia, (c) Black Rock Sewage Treatment Plant, Geelong, Victoria, Australia, (d) Logan City Water Pollution Centre, Logan, Queensland, Australia, (e) Littleton Sewage Treatment Plant, City Care Ltd., Littleton, Canterbury, New Zealand.

Australia is a very big country with the same size as U.S.A. excluding Alaska. However, most of the land is arid or semi-arid. Only the area along east coast and along the southwest coast and near Darwin area has enough precipitation. In Western Australia the rainfall is winter rain and period is from May to August and is the period for raising crops. Water is very starting couple of hundred kilometers north from Perth and all the way to the north along the coast. Inland area is arid or semi-arid.

(A) Water and wastewater treatment in Perth, Western Australia

(a) Water Treatment

Western Australia has about one third of total area of Australia and is the largest state in the whole world and is larger than Alaska. Total population of Australia is 20 millions in 2003. Total population of Western Australia is 2 millions. Perth is the capital of Western Australia with 1.5 million population. Population of Western Australia concentrates along the coastal area from Perth to the southwestern part of Western Australia coastal area such as Albany. In the Perth metropolitan area there are 2 main sources of water supply. Approximately fifty percent of the water supply comes from groundwater; the other half comes from surface water. The supply of water to Perth is a big issue as rainfall is decreasing and the temperature is gradually increasing. This has prompted new developments in the collection and conservation of water. Groundwater has only been used as a water source for the past forty years and new ways of replenishing the supply are being found to ensure a continuous water supply. Due to the climate changes taking place “the stream flow into Perth’s dams” are “down forty percent in the last quarter century”(1). This has seen the accelerated development of water supply and treatment processes. Other sources are being looked at too such as desalination of unused lakes and a greater reuse of water. The demand of water is also increasing as Perth’s population is increasing; this growth rate is 1.7 percent per year (1). In Australia, there are more than 400 dams.

There are 3 major water treatment plants in Perth: Jandakot Water Treatment Plant, Mirrabooka Water Treatment Plant, and Wanneroo Water Treatment Plant. The treatment processes generally include aeration, coagulation/Flocculation, clarification, filtration, pH adjustment, disinfection and fluoridation, clear Water storage and pumping, and sludge disposal (1). The water treatment plants at Wanneroo, Lexia, Mirrabooka, Gwelup and Jandakot currently use aeration for ground water treatment. In the coastal area north of Perth, which is arid or semi-arid, the main source of water supply is groundwater. The groundwater has high salinity or total dissolved solids, reverse osmosis process is the main water treatment process. The cost of water is very high. In area starting about 100 km north of Perth, the cost of 1 L bottle water (Australian $2.50) is more than the cost of 1 L gasoline (A$1.50).

(b) Wastewater Treatment
The Water Corporation in Western Australia treats over 280 million liters of wastewater daily. This is produced by the approximately 1.4 million residences located in Perth’s metropolitan area. Three major wastewater treatment plants at Beenyup, Subiaco and Woodman Point treat around 80% of Western Australia’s wastewater. The majority of residential wastewater produced in Perth is from kitchens, toilets and laundries. The system comprises of more than 10,000 km of sewer pipes, over 500 pump stations that convey the wastewater to three main wastewater treatment plants in Perth. All three wastewater treatment plants are secondary treatment plants, which provide primary and secondary treatment to raw wastewater before it is discharged to the ocean.

The treated wastewater from Beenyup is discharged 1.6 km offshore at Ocean Reef, treated wastewater from Subiaco is discharged 1 km offshore at Swanbourne and treated wastewater from Woodman Point is discharged 4.2 km into the 20 m deep Sepia Depression (west of Garden Island).

There are also smaller wastewater treatment plants around the metropolitan area at Yanchep, Two Rocks, Bullsbrook, Kwinana, Point Peron, Port Kennedy and Mundaring. The treated wastewater from Point Peron is discharged to the Sepia Depression outlet and the Mundaring treated wastewater is discharged to a constructed wetland for further treatment before being re-used or discharged off site through an infiltration pipe. All the other smaller wastewater treatment plants discharge their treated wastewater on-site.

Perth is very unique in using SBR (sequencing batch reactor) in treating its municipal wastewater. Usually SBR is used in the small communities and not for large cities. Activated sludge treatment is the main type of treatment process for municipal wastewater treatment in Australia.

(B) TREATMENT PLANTS VISITED

(a) Jandakot Water Treatment Plant

The Jandakot Water Treatment Plant has been in operation since 1979 to supply much of Perth’s southern suburbs and is the second most recently built water treatment plant in Perth. Groundwater is obtained from the massive natural aquifers that are part of Perth’s geographical characteristics. The groundwater that flows through Perth is some of the cleanest in the world. It sources its water from the Jandakot Borefield, which utilizes 15 shallow unconfined wells (gravity wells) and 2 confined wells (artesian wells). Water from both the unconfined and confined wells require treatment for water quality. The plant serves the rapidly expanding southern corridor of Perth and has a capacity of 28 megalitres a day and a future capacity of 45 megalitres per day and then 90 megalitres a day. The Jandakot Water Treatment Plant in peak season supplies 18000 homes with assistance from the hills water. The Water Corporation is conscious of protecting the sensitive wetland areas around Jandakot such as Thomson Lake, Forestdale Lake and Bibra Lake.

Treatment processes at Jandakot Water Treatment Plant consists of pre-chlorination, aeration, combined flocculation-clarifier, rapid sand filtration, clear water storage with disinfection. Pre-chlorination was used to remove H₂S odor from groundwater and also partially disinfects the water. Jandakot uses around 6 mg/L depending on the amount of free chlorine. In aeration the water runs through large pipes with holes in them in order to allow air to mix with the water. Aeration allows for the removal of volatile dissolved components that are in excess of their saturation concentration. After aeration the water is treated in flocculation-clarifier. The subsequent treatment are clarification and rapid sand filtration. The Jandakot plant uses the mediums coal (600 mm layer), sand (300 mm layer) and blue metal (70 mm layer) in rapid sand filters. Sodium hydroxide is added to adjust pH levels. The filtered water is stored in clear water storage tank. The water is also post-chlorinated and floridated. The water is then pumped to the reservoirs for distribution.

During the first stages the plant capacity was 28 megalitres per day, the plant has expanded to a capacity of 45 megalitres per day. Jandakot Treatment Plant is licensed to abstract a total of 9.8 gigalitres of water per year. The coagulant used at Jandakot is aluminum sulfate (Al₂(SO₄)₃) and the dosage used varies between 80 and 120 mg/L. The flocculant used is Polyelectrolyte LT25s and is used at a dose rate between 0.25 and 0.5 mg/L. Chlorine gas used for disinfection is usually dosed between 2 and 4 mg/L.

(b) Woodman Point Wastewater Treatment Plant

Woodman Point wastewater treatment plant (WWTP) serves a population in excess of half a million residences from Perth’s southern suburbs. The raw wastewater flow rate for Woodman Point wastewater treatment plant is 120,000 m³/day. Design capacity is 160 million liters of water and the current daily flow is about 100 million liters daily. Once the water has been treated it is dispersed 4 km offshore into the ocean where it then returns to the water cycle. The treatment processes include bar screen, grit chamber,
primary setting tank, sequencing reactors, balancing dam. Treated effluent is discharged to ocean through ocean outfall. Part of the treated effluent is used in industries. Sludge is treated in 2 egg shaped anaerobic digesters.

The raw wastewater flow rate for the Woodland Wastewater treatment Plant is 120,000 cubic meters per day. Raw wastewater contains 300 mg/L BOD, 350 mg/L TSS, 65 mg/L total N, 50 mg/L NH₃, 13 mg/L P. The primary effluent contains 180 mg/L BOD, 130 mg/L TSS, 60 mg/L total N, 12 mg/L total P. The final effluent contains 20 mg/L BOD, 10 mg/L TSS, 15 mg/L total N, 3 mg/L NH₃, and 10 mg/L total P. Primary settling removes 40% BOD and 62.85% TSS. Overall treatment removes 93.33% BOD, 97.14% TSS, 76.92% N, 94% NH₃, and 23% total P. The pH of raw wastewater and final effluent is 7-7.6, and 6.7-7.5, respectively.

For SBR (sequencing batch reactor) the sludge age is 16 days in summer and 18 days in winter. Sludge production is 2000 m³/day, DO (dissolved oxygen) is 1.5 mg/L and SVI (sludge volume index) is 90 and MLSS (mixed liquor suspended solids) is 3500 mg/L in summer and 5000 mg/L in winter.

There are 2 egg shaped anaerobic sludge digesters with 8,000 m³/digester. Feed sludge is 800 m³/day and hydraulic detention time of 200 days. The feed has with 6% TSS and 85% of TSS is VSS. Gas production is 16,000 m³/day with CH₄ content of 60%. Wet digested sludge is 100 tons/day. The digested sludge has 3% TSS and 75% of TSS is VSS.

(C) Black Rock Sewage Treatment Plant, Black Rock, Geelong, Victoria, Australia

The plant is operated by Barwon Water. The current daily flow is 55 million liters per day (ML/day) from the region. The design average dry weather daily flow is 70 ML/day and a peak dry weather flow of 100 ML/day. In wet weather, the daily flow can be 165 ML/day. The design peak wet weather flow is 210 ML/day.

The intermittently Decanted Extended Aeration (IDEA) treatment process is used in the plant. The treatment process include coarse screen, rotating milliscreening, selector tank, aeration tank, setting, decant, and effluent discharged to ocean outfall. In selector tank the screened sewage is mixed with return sludge from aeration tank. It is a sequencing batch reactor process. The cycling time for each aeration tank is 4 hours. Sewage undergoes up to 48 hours treatment at SBR before ocean outfall discharge. The effluent can be reused to water the trees or as wash-down water. Filter press is used to dewater the sludge. The dewatered sludge is stored in lagoon for drying.

(D) Logan City Water Pollution Center, Logan, Queensland, Australia

Logan WWTP is operated by Logan Water. The plant has 4 bioreactors for biological nutrient removal (BNR). The plan has a current capacity of 240,000 equivalent population. Primary sludge fermentation is used in the treatment process. The treatment processes include bar screen, grit chamber, high rate primary settling tank (60 m³/m²/day), bioreactor, final settling tanks (40 m diameter, 4.5 m depth), chlorine contact tank. Effluent is discharged to Logan River. Primary sludge is pumped to fermenter (HDT 14 hours, sludge age 5 days). Fermenter effluent is thickened in fermenter thickener. Thickened effluent, which contains VFA (volatile fatty acids) is added to the inlet of bioreactor. Existing oxidation ditch is converted to bioreactor. Settled sludge from fermenter thickener is recycled to fermenter. Waste fermenter sludge is added to the inlet of bioreactor. The bioreactor is a plug flow BNR (biological nutrient removal) reactor which is modified University of Cape Town Process (Mod UCT). Submersible mixers are used in mixing bioreactor. The hydraulic detention time varies from 15.6 hr at design flow to 10.4 hr at peak flow. Sludge age varies from 10 to 15 days. The bioreactor consists of 2 cells of anaerobic, 4 cells of anoxic, 7 cells of aerobic zones. Return sludge (0.7 Q) from final settling tank is returned to the first cell of anoxic zone. Recycle flow (1 Q) is from cell 3 and 4, anoxic zone, to cell 1, anaerobic zone. Recycle flow (3 Q) is from cell 10 and 13, aerobic zone, to cell 5 and 6, anoxic zone. Average design flow for bioreactor is 12 ML/day. There are 13 cells. Average depth over diffusers is 3.8 m. Final settling tank sludge is thickened in sludge thickener. Thickened sludge is dewatered in belt filter press to 14 to 16% solids. The dewatered sludge is mixed with lime and cement kiln dust to stabilize the sludge, which has beneficial reuse. The raw wastewater contains 318 mg/L BOD, 398 mg/L TSS, 60 mg/L total N, 15 mg/L total P, <20 mg/L VFA (volatile fatty acids), 254 mg/L alkalinity. The effluent nutrient limits are 5 mg/L total N, and 2 mg/L total P, 15 mg/L BOD, 20 mg/L TSS. ML/day flow treated / ML of bioreactor = 1.54 minimum at design flow.

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Semester 2004.

REFERENCES

2. Woodman Point Student Tour Facility, Tertiary Student Briefing Note, Wastewater Treatment Plant
4. Jandakot Water Treatment Plant (Brochure), Water Corporation.
5. Woodman Point Wastewater Treatment Plant, Treatment Performance Data and Operation Data,
   Woodman Point Wastewater Treatment Plant.

TABLE 1 VISITS AT UNIVERSITIES IN AUSTRALIA, NEW ZEALAND FROM 2-25-04 TO 7-31-04
(A) Universities visited
* Seminar presented, “Treatment of Heavy Metals Containing Wastewaters by Electrocoagulation Flotation
  Process”
(a) Australia (2-25-04 (W) to 7-18-04 (S)) (11 universities visited)
1. *Department of Civil Engineering, Curtin University of Technology, Perth, Western Australia,
   Australia Host: Prof. David Scott, Head, 2-25-04 (W) to 7-18-04 (S), 4-19-04 (M) seminar presented.
2. School of Engineering and Computation, Curtin University of Technology, Perth, Western Australia,
   Australia Host: Prof. B. Vijaya Rangan, Dean, 2-26-04 (Th)
3. *Environmental Technology Centre, School of Environmental Science, Murdoch University,
   Murdoch, Western Australia, Australia Host: Professor Goen Ho, Chair, 4-7-04 (W)
4. Water and Sanitation in Developing Countries (SANDEC), Duebendorf, Switzerland Host: Mr.
   Roland Schertenleib, Director, 4-7-04 (W). Met him at Murdoch University, Perth, Australia
5. Centre for Organic Waste Management, School of Environmental Science, Murdoch University,
   Murdoch, Western Australia, Australia Host: Dr. Pratap Pullammanappallil, Lecturer, Director, 4-
   8-04 (Th)
6. Centre for Fuel and Energy, Curtin University of Technology, Perth, Western Australia, Australia
   Host: Dr. Hongwei Wu, Associate Director, 5-28-04 (F)
7. Centre for Fuel and Energy, Curtin University of Technology, Perth, Western Australia, Australia
   Host: Prof. Dong-Ke Zhang, Director, 6-1-04 (T)
8. Chemical Engineering Department, Curtin University of Technology, Perth, Western Australia,
   Australia Host: Prof. Moses Oludayo Tade, Head, 6-3-04 (Th).
9. *School of Engineering & Technology, Deakin University, Geelong, Victoria, Australia
   Host: Dr. Kanagaratnam Baskaran, Associate Professor, Head, 5-12-04 (W)
10. *School of Environmental Engineering, Faculty of Environmental Sciences, Griffith University,
    Nathan, Queensland, Australia Host: Prof. Bofu Yu, Associate Professor, Head, 5-18-04 (T)
11. *School of Civil Engineering, Queensland University of Technology, Brisbane, Queensland
    Host: Dr. Ashantha Goonetilleke, Senior Lecturer & Researcher, 5-17-04 (M)
12. Division of Engineering, Science and Computing, Curtin University of Technology, Perth, Western
    Australia, Australia Host: Prof. Peter L. Lee, Executive Dean, 6-11-04 (F).
13. Department of Environmental Engineering, School for Water Research, University of Western
    Australia, Perth, Western Australia, Australia Host: Dr. Anas Ghadouani, Lecturer, 6-21-04 (M).
14. School of Civil and Resource Engineering, University of Western Australia, Perth, Western Australia,
    Australia Host: Dr. Liang Cheng, Associate Professor, 6-21-04 (M).
15. School of Engineering and Industrial Design, University of Western Sydney, Penrith South DC, New
    South Wales, Australia Host: Prof. Steven Riley, Head, 7-2-04 (F)
(b) New Zealand (7-15-04 (Th) to 7-22-04 (Th)) (2 universities visited)

20. *Department of Civil Engineering, University of Canterbury, Christchurch, New Zealand Host: Dr. David G. Wareham, Senior Lecturer, 7-15-04 (Th)
21. Division of Environmental and Geosystem Engineering, Kangwon National University, Chunchon, Kangwon-Do, Korea Host: Dr. Chan-Ki Lee, Professor, 7-15-04 (Th), Met at University of Canterbury
22. Department of Environmental Engineering, Sancheok National University, Sancheok, Korea Host: Dr. Chan-Ki Lee, Professor, 7-15-04 (Th), Met at University of Canterbury
23. City Water and Waste, City of Christchurch, Christchurch, New Zealand Host: Mr. Rex Donnelly, Field Engineering Officer, 7-15-04 (Th), Met at University of Canterbury
24. Department of Chemical Engineering, University of Canterbury, Christchurch, New Zealand Host: Dr. Khim Chu, Lecturer, 7-20-04 (T)
25. Soil, Plant and Ecological Sciences Division, Lincoln University, Lincoln, Canterbury, New Zealand Host: Prof. Kuan M. Goh, Professor, 7-21-04 (W)
26. Department of Civil and Environmental Engineering, University of Auckland, Auckland, New Zealand Host: Dr. P. Takis Elefsiniotis, Senior Lecturer, 7-22-04 (Th)

(B) Water and Wastewater Treatment Plants Visited (4 treatment plants in Australia, 1 treatment plant in New Zealand)

(a) Australia
1. Woodman Point Wastewater Treatment Plant, Perth, Western Australia, Australia Host: Ms. Jane Harris, Ms. Diana Frylinck, Education Officer, Water Corporation, 3-16-04 (T)
2. Jandakot Groundwater Treatment Plant, Perth, Western Australia, Australia Host: Ms. Jane Harris, Ms. Diana Frylinck, Education Officer, Water Corporation, 3-16-04 (T)
3. Black Rock Sewage Treatment Plant, Geelong, Victoria, Australia Host: Mr. T. Dutton, Operator, 5-12-04 (W)
4. Logan City Water Pollution Centre, Logan, Queensland, Australia Host: Mr. Stephen Scotfield, Senior Operator, 5-17-04 (M)

(b) New Zealand
5. Littleton Sewage Treatment Plant, City Care Ltd., Littleton, Christchurch, New Zealand Host: Mr. Bryan Stevenson-Wright, Operator, 7-15-04 (Th)
I. INTRODUCTION

The treatment process separates the wastewater into two final products, these being treated wastewater and biosolids. At present, a portion of treated wastewater finds a reuse application usually in the form of one of the following: greywater recycling, watering for parks and ovals, agricultural and horticultural watering (turf farms, tree plantations and market gardens), industrial reuse (often as cooling water), recharging groundwater areas (replenishing aquifers), preventing saltwater intrusion into fresh ground water, second class water dual reticulation systems or treating the water to potable quality. Land disposal currently comprises approximately 12% of Western Australia’s wastewater. Most of the wastewater is discharged to the ocean through ocean outfalls in Western Australia.

The activated sludge process is used at Beenyup Wastewater Treatment Plant, Busselton Wastewater Treatment Plant, Subiaco Wastewater Treatment Plant and Woodman Point Wastewater Treatment Plant, Perth, Western Australia, Australia. Pond-based treatment plants are currently employed at Coral Bay and Geraldton. The ponds are aerated to assist in the biological treatment by supplementing the amount of oxygen produced by photosynthesis. The water is then allowed to flow into the polishing ponds where it is detained for a number of days. The treated wastewater from the polishing ponds is pumped through sprinklers and allowed to infiltrate the ground surface. Water from is then reclaimed from the ground and used for irrigation at various playing fields nearby. The Coral Bay plant currently under construction is designed as a totally lined pond-based wastewater treatment plant to prevent the treated wastewater from seeping into the ground and contaminating the water below. Tertiary treatment is used only when a receiving body requires protection from excess nutrients. Tertiary treatment processes generally achieve TSS equal to 10 mg/L, BOD5 equal to 10 mg/L and phosphorous concentration equal to 1 mg/L. Advanced treatment systems produce treated wastewater with reduced nutrient levels suitable for land applications.

II. TREATMENT REQUIREMENT

(A) Treatment Requirement for Land Reuse And Disposal

All wastewater treatment plants in Perth, Western Australia, Australia, are licensed by the Department of Environmental Protection. Treatment of effluent intended for land reuse or disposal should be of at least secondary level (biological treatment).

Woodman Point Wastewater Treatment Plant is an advanced secondary treatment plant to allow the effluent for reuse. The portion of effluent that is reused is piped to a recycling plant in the Kwinana industrial area. Here the water is treated to lower the salt content and filter out any organic material. It can then be used as recycled water to the nearby industries. The final effluent leaving the plant has 20 mg/L BOD, 10 mg/L TSS, 6.7 to 7.5 pH, 15 mg/L N and 10 mg/L P (Table 1) (1).

(B) Treatment Requirement for Marine Disposal

Discharge to the ocean is required to meet the Department of Environmental Protection’s Water Quality Criteria. The three large wastewater treatment plants in Perth (Beenyup, Subiaco and Woodman Point) dispose of much of their treated wastewater to the ocean. These plants are all secondary treatment plants.
The level of treatment required depends principally on the depth of water at the location of the outlet and the energy (as waves and currents) of the ocean, which is the method for diffusion. The distance from any sensitive marine areas and habitats such as reefs and fishing spots should also be taken into consideration. Each marine environment’s ability to process the nutrients and other components differs. It is necessary to determine the impact the wastewater will have on the marine life, and in particular, phytoplankton. When disposing of treated wastewater to marine environments that have low diffusion rates (or small wave activity) it is often necessary to additionally treat the wastewater before disposal to further reduce the nutrient concentrations contained in it.

III. LAND REUSE AND DISPOSAL OF TREATED WASTEWATER

Using the land as a reuse or disposal option is often practical and feasible because the land becomes a medium for the treated wastewater to be replaced in the water cycle. When water is disposed of to the land it re-enters the water cycle by run-off to surface waters, infiltration to ground waters and evaporation to water vapor. In major urban areas approximately 2.6% of treated wastewater is reused, and slightly more in rural areas (2). In Western Australia 8 million liters of water is reused per day, which amounts to 0.3% of total water use (2). Reuse still only forms a very small amount of total water use.

(A) REUSE APPLICATIONS

Typical applications of reuse commonly include watering for parks and playing fields, irrigation for agriculture, watering for tree plantations and industrial reuse although it is primarily confined to irrigation of recreational facilities and some irrigation of pasture and tree lots (2). Reticulation of recreational facilities is currently employed in 47 schemes in country areas in Western Australia (2). The wastewater used here has been secondary or tertiary treated and further disinfected before being distributed to the various parks and playing fields. This application comprises a total of approximately 10 megaliters per day of reuse (2). In spite of this, reuse for this application is still unlikely to be rapidly increasing due to the availability of bore water obtainable at no cost. Ground water contamination by high nitrogen concentration levels in the wastewater still poses as an issue threatening the spread of this application.

One application that is looking promising for large scale reuse is in industries in the Kwinana area. Much of the groundwater in the area is no longer available, forcing industries to look elsewhere for cheap water. Schemes are proposed that will link the Woodman Point Wastewater Treatment Plant with industries in the area in order to supply them with a secondary treated wastewater suitable for non primary contact applications such as cooling water. Costs will be kept at a considerable level if the industries are located nearby. Once reused, the water may be discharged to the ocean via the Sepia Depression outlet currently used by the Woodman Point Plant.

Perth in particular has a large supply of groundwater sourced from the large unconfined aquifer located below. The aquifer provides a third of potable water in Perth and about two thirds of all water used in Perth (2). This water is provided for commercial, agricultural and private use. It can then be seen that recharging this supply is important. An opportunity for this exists in applying treated wastewater to the aquifer (or artificially recharging it). A study was conducted by the Water Corporation during the period 1979 to 1985 to assess the feasibility of this practice (2). It concluded that the significant removal of nutrients would be required in order to prevent the contamination of wetlands and ground water (2). Although this option is still available, it has not yet been carried out due to the relative risks involved and the area of land required for such an operation (2).

Greywater recycling is an area of reuse under current investigation. Greywater is household wastewater excluding that produced from toilets. There may exist possibilities to reuse this water for such applications as garden watering, but at this stage it is not allowed by the Health Department of Western Australia due to the large risk to health and soil and ground water pollution concerns derived from concentrations of nutrients, salts and detergents. The use of dual water supply systems for high rise buildings in Perth and new housing developments is being investigated in a trial in Sydney (2). The proposal would consist of high rise buildings using treated wastewater to flush toilets and houses to use treated wastewater for flushing toilets and reticulation. There are concerns about saltwater intrusion into the Cottesloe/Mosman Park area due to an increase in the usage of groundwater (2). It is possible that treated wastewater could be used to form a barrier for this saltwater but currently the costs remain too high compared to other sources (2).
1. Albany

Agro-forestry (or woodlots) involves growing trees using treated wastewater (2). Currently reuse in the form of this application is employed 13 km north of Albany. Here, 4 megaliters of treated wastewater per day is required to grow half a million gum trees over 575 hectares of land (3). Before this scheme was introduced in 1995, all treated wastewater was directed to the waters at King George Sound. The new land disposal/reuse scheme proves a far better solution to the wastewater disposal problem. Tasmanian Blue Gum Eucalypt trees were selected because of their capability to absorb a large amount of water. Harvesting of the trees has now begun and are being processed into woodchips available for export. The revenue generated from the sales of these woodchips adds to the economic benefit of reusing the treated wastewater. About 50 hectares per year are harvested (3). It is important to be aware of the possibility of runoff and ground water infiltration of the wastewater. Because of this 120 hectares of rain-fed eucalypts have been planted downstream from the plantation to act as a barrier for the runoff. The nitrogen in the wastewater is taken up by the trees or allowed to flood irrigate pasture land nearby (3). The site comprises clay soils well suited to capture phosphorous contained in the wastewater (3). The entire scheme is monitored by computers to ensure the correct amount of water is contained in the soil. A large dam at the site is used for storage of the wastewater during the winter months when the climate is too wet to add irrigation. Research is being undertaken to investigate the possibility of selling the timber from the trees as a higher value product, this requires necessary testing to ensure the products fed with treated wastewater are safe for those purposes. Plans to expand the Albany site to incorporate septage treatment and disposal in addition to the treated wastewater disposal/reuse are also being investigated. This would put an end to the current schemes of disposing the septage to an unlined, open pit (3).

2. Bunbury

The Bunbury Wastewater Treatment Plant disposed of its treated wastewater via ground infiltration until June 2002 (3). Since then an ocean outlet has been commissioned. Bunbury plans to reuse some of its water for reticulating the Hay Park playing fields in addition to disposing of it to the ocean. The Australind and the Eaton wastewater treatment plants have been replaced with the Kemerton Wastewater Treatment Plant, a plant capable of producing 3 million liters of tertiary treated wastewater each day (4). This wastewater is reused on a 60 hectare tree farm (or woodlot) located in Binningup and also made available for reuse in nearby industries (15, 16). The woodlot contains a 10 megaliter storage tank (5).

4. Dunsborough

The new wastewater treatment plant at Dunsborough has replaced the old pond-based system and now features Intermittently Decanted Extended Aeration (IDEA) technology. This technology produces a tertiary treated wastewater and is beneficially used to irrigate a blue gum plantation during summer (6). The irrigated area covers 40 hectares of Tasmanian Blue Gums (6). Like the scheme at Albany, this plantation is intended to be harvested for use as woodchips in 2006. The plantation area is also expected to increase to 100 hectares (6). The soil of the plantation is well monitored to ensure correct amounts of moisture and the site uses a subsoil drainage system (6). During times of high rainfall, the treated wastewater is directed to the Station Gully Drain after being further filtered and disinfected with chlorine (6). Since the wastewater is tertiary treated, public health and environmental impacts are well protected. Schemes such as these are leading the way in providing suitable, economic options for the disposal and reuse of treated wastewater.

5. Geraldton

At the Wonthella Wastewater Treatment Plant located in Geraldton, treated wastewater from the pond based treatment system is allowed to infiltrate the ground through a reticulated sprinkler system (7). The water is then reclaimed by pumping the groundwater out to supply the nearby turf club, golf club and playing fields with reticulation (7).

6. Port Hedland

Port Hedland has been reusing its wastewater for 28 years to water its verges, parks and ovals (8). Between 1200 and 1500 kilolitres of treated wastewater are reused each day (8). The local golf course has now been successfully developed using the treated wastewater and the town council is in control of allocating the wastewater to more reuse options (8). The wastewater treatment plant at Derby is also planned to be upgraded so that its golf course can be irrigated with treated wastewater (8).

7. Kemerton Treated Wastewater Reuse at Binningup Woodlot
The woodlot at Binningup covers an area of 60 hectares and contains Tasmanian blue gum trees. The trees are irrigated by the treated wastewater pumped 7.4 km from the treatment plant. Ground water at the site varies between 4 and 10 m below the surface and the Binningup ground water supply source is located at the northern end of the woodlot. During proposal, there was some concern regarding ground water containing nutrients from the woodlot site flowing into adjacent horticultural land. It was deemed unlikely that significant runoff or overflow from the storage facility would occur. Irrigation was planned for summer and winter, meaning during winter, greater ground infiltration would occur. It was recognized that leaching of nutrients (nitrogen and phosphorous) would occur and that up to 2.5 ton of nitrogen could reach the ground water. The nutrients will most likely be fed to the Parkfield Drain, which is of poor water quality due to the Eaton and Australind Wastewater Treatment Plants discharging their nutrients into it also. This was not too great a concern however, as both these plants were soon to become redundant with the Kemerton Wastewater Treatment Plant being built and so the nutrient loading on the area would be greatly reduced to compensate. To ensure runoff did not occur and the nutrient loading rate met the Water and River Commission’s guidelines, a rain-fed tree buffer, like that employed at Albany, was proposed to be installed if required at some point in time. Other disposal options were agreed to be investigated if the nutrient application rate into the Parkfield Drain was found to be unacceptable. These options included groundwater recovery, industrial reuse, ocean discharge, reuse at a golf course in Binningup and wetland reinstatement.

(B) DISPOSAL APPLICATIONS

Land disposal schemes are relatively common in inland areas of Western Australia but are rare in coastal areas and those areas exhibiting high rainfall rates. During the high rainfall months of each year, approximately one third or 8 megaliters of wastewater per day is disposed of to the land. This portion is what is reused in the hotter, summer periods but the reuse applications cannot be sustained during winter, forcing the water to be disposed of. Land disposal typically incorporates treatment systems to relieve part of the pressure placed on the environment by the disposal. These treatment systems are often in the form of a series of ponds which allow the wastewater to move to a suitable disposal site. The effects on the surrounding environment need to be assessed and this is often done by monitoring bores at locations around the site and checking nutrient levels in the soils and ground waters (9). Typically, shallow ground waters at disposal sites experience increased nutrient levels and in particular, nitrogen pollution.

There exist desirable characteristics of land for areas to be appropriate for treated wastewater disposal. In areas of heavy rainfall, storage systems need to be provided for the wastewater because the land should not be over watered. Semi-arid and arid conditions are preferable (9). Runoff and erosion need to be controlled and so slopes of land should be limited to 15% for pasture irrigation (9). Clay soils are possibly the best type but many sands and clay loams are still acceptable. Subsoil drainage should be provided for soils with poor drainage abilities (9). Discontinuities in land formations represent undesirable characteristics as cracks in foundations may provide easy flow paths for wastewater to enter other water bodies. Groundwater should be located at least 1.5 m below the soil surface to ensure that the soil does not become oversaturated and the wastewater can be properly aerated (4). Wastewater applied to the land should not be done in the presence of people, that is to say not in close proximity of roads and dwellings. 4 hours should pass before people are allowed to come near land applied with treated wastewater to ensure no damage to health is incurred (9). The land should not be in close proximity to other water bodies either, as large a buffer zone as possible is preferred to prevent contamination. It is desirable, however if the land is located close to the water treatment plant to keep the distribution costs low. A large land area is of advantage as much of the time storage lagoons are needed to be provided (9). In addition, any surrounding vegetation should be able to take up a large amount of water and nutrients (9).

Irrigation is the most common form of wastewater reuse/disposal in Western Australia. The water reaches other bodies of water through evapotranspiration or ground water infiltration through soil (percolation). Where ground water infiltration occurs, the soil must be fairly permeable and this allows for the breakdown of nutrients and salts. This water may have the affect of boosting underground aquifer supplies. Bacteria and viruses contained in the wastewater may be killed after spending time in the soil or being exposed to sunlight although phosphorous and heavy metals may be retained in the soil (9). Also, vegetation may take up the nutrients and heavy metals and nitrogen often remains in the runoff water or is retained in the soil. In cases of hot and dry conditions, much of the water may be evaporated and leave behind salts, this is a negative impact and should be monitored.
Busselton Wastewater Treatment Plant uses a constructed wetland and a nutrient reducing program to dispose of its treated wastewater (10). The constructed wetland uses the natural processes of the soils and water to further treat the water and allow it to infiltrate the ground. A reuse lagoon is also utilized. Coral Bay’s new treatment facilities use a pond-based disposal system. The ponds are totally lined to prevent any treated wastewater from entering the ground water (11). The particularly sensitive surrounding marine and coral areas cannot handle any increases in nutrient concentrations so it is essential for a lined pond. The pond allows for evaporation of the treated wastewater.

Currently in Australia, national guidelines are being developed to provide a unified system for the safe and environmentally sustainable reuse of wastewater across Australia (12). These guidelines are intended to fill in the gaps and inconsistencies in current State guidelines relating to the reuse of sewage effluent (12). The existing guidelines are based on a variety of authority’s including the Agricultural Resource Management Council of Australia and New Zealand (ARMCANZ), the Australian and New Zealand Environment and Conservation Council (ANZECC), the National Health and Medical Research Council (NHMRC), the Environmental Protection Authority (EPA) and the Department of Environmental Protection (DEP). The new national guidelines are expected to be completed by December 2004 (12). At present, any company wishing to utilize reclaimed water for any purpose or dispose of treated wastewater, must seek a license from the Department of Environmental Protection. These licenses are an agreement on the emission levels and pollution control with regard to each specific company.

Land reuse and disposal of treated wastewater is beneficial in a number of ways. These benefits can include maximizing the use of an available and valuable resource, minimizing the amount of effluent discharged via outfalls, conserving existing water supplies, recycling of nutrients and increasing production in industries such as agriculture (13). Despite these benefits, a number of disadvantages remain with reusing treated wastewater. These can include risks to public health, risks to the environment (salinity and nutrient problems), high land requirements and considerable costs for treatment and distribution. Often the overall cost of choosing reclaimed water outweighs the cost of using scheme water, and so can become uneconomical from a business’s point of view. The reuse of reclaimed water should be encouraged, but never without the relevant authorities ensuring that public health risks and harmful environmental impacts are not created during the process (14). This includes the treatment, application and reuse processes.

IV. MARINE DISPOSAL OF TREATED WASTEWATER

In large coastal cities, marine disposal is the most common form of treated wastewater disposal. The ocean has a large capacity to further process and treat the disposed water but our actions must still be critically monitored and regulated. Perth has many beautiful and environmentally healthy beaches and marine disposal solutions must be well thought out to maintain this reputation. Most marine disposal in Western Australia occurs in Perth and three main ocean outfall systems exist at Ocean Reef, Swanbourne and the Sepia Depression. These systems serve the Beenyup, Subiaco and Woodman Point wastewater treatment plants, respectively, where treated wastewater is pumped through pipes from the plants to an ocean outlet on a daily basis. Usually the pipes carrying the water are located underground until a few hundred meters offshore from the beach.

The ocean’s salt and sunlight both assist in reducing the number of bacteria contained in treated wastewater and the ocean’s typically high dissolved oxygen concentrations often help to decompose organic material. Wave action and currents allow for the mixing and dispersion of the wastewater plume. The decision for the length and location of the pipelines carrying the water to the oceans is governed by the ability of the ocean to dilute the wastewater rapidly. Wastewater is less dense than seawater, so it rises to the water surface. For example, treated wastewater from a 20 m deep outlet is typically diluted about 200 times before reaching the water surface (15). During rougher conditions, this rate may be higher, and calmer conditions, the rate lower. The ocean outlets contain diffusers which commonly have about 50 outlet ports, 150 mm in diameter over the end section of the pipe for a few hundred meters. At this location the depth to the pipes may be between 10 and 20 m (15). Swimming is usually prohibited in a zone around the diffuser section as well as collecting some fish for consumption (15). All three wastewater treatment plants in Perth, Western Australia, utilizing ocean outfall
systems produce at least a secondary treated wastewater. Bunbury Wastewater Treatment Plant also now utilizes a 1.7 km ocean outlet.

A. CASE STUDIES

(a) Ocean Reef Outlet - Beenyup Wastewater Treatment Plant

By 1978 the Beenyup Wastewater Treatment Plant had commissioned plans for a gravity outfall system enabling the treated wastewater to be discharged to the ocean at Ocean Reef (16). The wastewater is discharged in 10 m deep waters through two outlets (16). One outlet is located 1850 m offshore and the other 1650 m offshore (16). These outlets discharge 100 million litres of wastewater each day (16). Ocean Reef consists of rocky limestone reef and sand and is part of the Marmion Marine Park.

The nutrient plume due to the disposal can extend up to 2.5 km from the outlets and Ocean Reef in particular experiences higher levels of nutrient concentrations compared to the Sepia Depression and Swanbourne outlets. These high nutrient levels can have damaging effects on marine plants such as phytoplankton, algae and seagrasses. The Ocean Reef area has experienced increased populations of nuisance algae in the outlet area have been reported, but again, no particular concerning levels have been found (16). Pollutants such as metals and pesticides in the wastewater can harm marine animals, however, the Water Corporation reports that fish, sea shells and mussels collected in the area met the national standards required for eating supplied by ANZFA 1996 (16). Monitoring has shown that the nearby beaches are safe for swimming and the wastewater plume generally migrates north (16).

(b) Swanbourne Outlet - Subiaco Wastewater Treatment Plant

Treated wastewater pumped from the Subiaco plant is discharged 1.1 kilometres offshore and 10 metres below the water surface at Swanbourne Beach (17). 55 million litres of treated wastewater is disposed of every day from Subiaco (17). Nutrient concentrations in the plume generated by the Swanbourne outlet are usually lower than that at Ocean Reef. The Water Corporation reports that the population of phytoplankton in the area is healthy and that studies are being conducted to determine the impacts on seaweed and seagrasses in the area (17). Marine animal numbers are said to not have been affected and the beaches are considered safe for swimming by the ANZECC guidelines, 2001 (17).

(c) Sepia Depression Outlet - Woodman Point Wastewater Treatment Plant

100 million litres of treated wastewater per day is pumped into the Sepia Depression 4 km off shore at a depth of 20 m (18). The wastewater entering the Sepia Depression is well dispersed and the plume experienced there is 2 km long, usually the largest plume (18). The Water Corporation states that the phytoplankton population in the area is healthy, despite admitting the area has seen increased levels in the amount of phytoplankton (18). Phytoplankton use the excess nutrients for growth. Marine animals including shellfish have been monitored in the area and results show no detectable impacts. The shellfish were deemed fit to eat by ANZFA 1996 (18). There has been considerable concern for health as bacteria levels around the outlets were reported high in 2001. Divers make regular checks on the pipeline to monitor trends in water quality and to ensure protection of the ecological processes (19).

(d) Bunbury Outlet - Bunbury Wastewater Treatment Plant

Bunbury Wastewater Treatment Plant treats 7 million liters of wastewater per day and much of the treated wastewater is discharged 1.7 km offshore at a depth of 11 m below the surface (15). The diffuser on the end of the pipeline is 120 m in length (15). Swimming is prohibited within 100 m of the diffuser and taking shellfish for consumption is prohibited within 500 m of it (15).

(e) Ocean Outlet for Treated Wastewater at Bunbury Wastewater Treatment Plant

In July 2001, a report titled “Ocean Outlet for Treated Wastewater, Bunbury Wastewater Treatment Plant” containing recommendations of the EPA for the Water Corporation’s Proposal to construct an ocean outlet in the area was filed. The ocean outlet would eventually allow 6000 megaliters of treated wastewater to be disposed of to the ocean (by the year 2040). Bunbury Wastewater Treatment Plant is located 7 km south of Bunbury and 300 m inland from the coast. At the time of proposal the plant was treating 6.6 megaliters of wastewater per day. The plant produces wastewater using a combination of the trickling filter process and an
IDEA plant, each processing up to 3.8 megaliters per day and 5.4 megaliters per day, respectively. Treated wastewater from the trickling filter system has 35 mg/L total N and 10 mg/L total P. The IDEA plant produces water with 10 mg/L total N and 10 mg/L total P. There are plans to replace the trickling filter system with another IDEA plant to improve the quality of treated wastewater leaving the site. The construction plans involved the lagoons being drained, scraped and lined and being transformed to polishing lagoons to allow further reduction in bacterial levels. The tertiary treated water would then flow by gravity to the outlet pipeline through a 900 mm pipe. The diffuser section of the outlet is 120 m in length and located 11 m below the water surface, at the end of the outlet. It is fitted with 30 ports each with diameter 80 mm.

B. WATER QUALITY STANDARDS

Like the land reuse and disposal quality standards, marine disposal outlets must comply with licenses set out and agreed on by the Department of Environmental Protection (DEP). These agreements involve detailed studies into the effects on marine life (including algae, phytoplankton and seagrasses) and public health. Licenses are reviewed on a yearly basis and monitoring results are collected through the year (15). The Water Corporation is also required to comply with criteria set out by the Department of Health (15). ANZECC and ARMCANZ have published the Australian Water Quality Criteria for Fresh and Marine Waters which establish desirable ambient water quality goals to suit a range of purposes.

V. CONCLUSIONS

It is recommended that the Water Corporation should continue allocating funding towards treating wastewater to a drinking water quality standard and keep up its extensive monitoring, studies and research program. Wastewater treatment plants need to be constantly assessed and considered for upgrades, reuse options should continue to be sought out and marine and land disposal methods should always be questioned. It has been stated that national guidelines for the safe and environmentally sustainable reuse of treated wastewater are being developed. From the research in this paper, it is clear that the absence of any unified system presented a point of difficulty and discussion regarding acceptable standards for the numerous cases of reuse and disposal. It is noted, however, that each case and proposal additionally needs to be analyzed on an individual basis in order to properly assess the conditions and risks pertaining to particular situations. Currently, this is being well controlled by the DEP license approval systems. With the guidelines, further encouragement and support for reuse alternatives should come. Ultimately, all used water returns to the water cycle by some means. It is how we control this return which is important and which gives us opportunities and responsibilities for the safe and careful management of our water supplies.

Table 1 Woodman Point Wastewater Treatment Plant Data (1)

<table>
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<th>Wastewater</th>
<th>BOD</th>
<th>TSS</th>
<th>pH</th>
<th>Total N</th>
<th>NH3</th>
<th>NO3</th>
<th>Total P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw</td>
<td>300</td>
<td>350</td>
<td>7-7.6</td>
<td>65</td>
<td>50</td>
<td>0</td>
<td>13</td>
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<tr>
<td>Primary Effluent</td>
<td>180</td>
<td>130</td>
<td>7-7.5</td>
<td>60</td>
<td>40</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Final Effluent</td>
<td>20</td>
<td>10</td>
<td>6.7-7.5</td>
<td>15</td>
<td>3</td>
<td>7</td>
<td>10</td>
</tr>
</tbody>
</table>

Note: All units given are in mg/L except pH

REFERENCES

I. INTRODUCTION

The mining of uranium ores in Australia has potential to cause serious environmental pollution. In years past the mining industry generally only considered water as polluted when the water was rendered unfit for human or livestock consumption (1). Nowadays with considerably stricter laws governing the practices of mining companies many environmental considerations are taken into account before operations begin. There are two main types of mining practices used for the extraction of uranium ore in Australia. The most common is the open pit method and is the only method that has been employed in Australia. This involves digging a large pit, extracting the ore in the form of uranium oxide (commonly known as yellow cake), and then processing it at a milling plant. The other process is called in-situ-leaching (ISL). It involves chemical extraction of the ore using solutions that are injected into aquifers surrounding the uranium rich ore, causing the uranium to enter solution. The uranium rich solution is then pumped back to the surface where it is processed. It should be noted that at all stages of each mining process there is a potential for water contamination.

II. WASTE PRODUCTS

There are a number of waste products that are common to all uranium mining and milling processes (Table 1). Three major categories of waste products are seepage, runoff and the failure of a containment mechanism. Most contaminants have the ability to enter the environment by all three because they are or can be dissolved in water.

(A) Chemical Contaminants Resulting from Uranium Mining and Milling

Three common contaminants from uranium processing include; sulfates (SO$_4^{2-}$), radionuclides (radium, uranium, and thorium), ammonium (NH$_4^+$), and heavy metals (iron, copper, lead, zinc, mercury, manganese, cadmium).

(a) Sulfates: These are usually of the highest concentration within tailings water (20,000 mg/L) and process water (50,000 mg/L). They are produced as a result of the use of large quantities sulfuric acid during the extraction process. The acidic leaching solution used in the ISL process can also contribute to sulfate problems.

(b) Radionuclides: These are naturally occurring radioisotopes that are present in and result from the decay of uranium ores (Table 2). They have an affinity for water and enter solution readily, thus it is common for them to be present in any runoff from ore stockpiles, waste rock or open pit mines. They can also be found in waste concentrates as Ba(Ra)SO$_4$ and barren solutions from the ISL process.

(c) Ammonium: Like sulfates, it is a by-product of the use of large quantities of sulfuric during the milling process. High concentrations of this contaminant are therefore present in process water and tailings water.

(d) Heavy Metals: The unstable nature of uranium means that heavy metals are often present within uranium ores. As a result tailings, tailings water and process water are all abundant in these elements. Manganese, copper and iron in the form of pyrite (FeS$_2$) are the most common. High levels of manganese and copper can be toxic for some fish species and tend to be retained in tissues within these species. Iron pyrite on the other hand has the ability to produce sulfuric acid in the presence of water and oxygen, potentially raising the pH of soils and waterways;

\[ 4\text{FeS}_2 + 2\text{H}_2\text{O} + 15\text{O}_2 \rightarrow 2\text{Fe}(	ext{SO}_4)_3 + 2\text{H}_2\text{SO}_4 \]
All contaminants resulting from uranium mining and milling have the potential to present problems in the future, therefore careful management is required now. Water contamination is often irreversible or can be removed at great cost so in all cases prevention is the best cure.

III. CASE STUDIES

(A) The Ranger Uranium Mine (Open Cut)

(a) Location

The Ranger Uranium Mine is the only operating uranium mine in the Northern Territory (2). Located in the picturesque Alligator River region of the Northern Territory, it is approximately 260 km east of Darwin. Excavation commenced at the site in August 1980 it is still in operation today. There are two major ore bodies being targeted. The first, Ore Body No.1, lies to the south of the mill area, opposite the tailings dam. This was the original focus of all operations and was exhausted by October 1994, thus it was abandoned. The second ore body, Ore Body No.3, is located to the north of the mill area, and is currently under excavation.

Ranger mine is an open-pit operation. This has lead to a number of interesting complications concerning pollution control. Since the commencement of operations in 1980, there have been tailings leaks, water contamination, and incidents involving runoff from areas infected with radionuclides and other chemicals. As a result there have been numerous calls for the closure of the mine since it presents a danger to the surrounding Kakadu National Park, a heritage listed zone with one of the greatest levels of biodiversity that can be seen within Australia. Contamination of ground and surface water could have a significant impact on this region, as well as any future land use prospects.

(b) Surface Water

As a result of its location in Kakadu, there are numerous watercourses that weave there way through the areas surrounding the Ranger mine. The major watercourse in the area is to the north east – Magela Creek. It passes within close proximity to Pit No. 3 (currently operational) and the land application zone, and has numerous other smaller tributaries that are open to contamination. One of these tributaries, Coonjimba Creek, drains into Coonjimba Billabong and is often subject to contaminated runoff from Retention Pond One. Other surface water is to the west (Gulungul Creek), the east (Georgetown Billabong) and to the south-east (Georgetown Creek and Corridor Creek). The latter are the two that are most in danger of contamination as they are located very close to the tailings corridor.

(c) Groundwater

One of the potential pathways for escape of both radioactive and chemical pollutants from the RRZ is that of groundwater seepage (3). There are two sources of groundwater within the Ranger area. One is a shallow unconfined aquifer that varies between two and 20 m below the surface. Being unconfined, there is no layer of impermeable material above it making it very easy for contaminants to enter the groundwater. The second aquifer lies much further below the surface and is a confined aquifer. It is bounded by a layer of low permeability silty clay above, and weathered bedrock below. Due to high rainfall, it is still reasonable to claim that high levels of contaminants could find there way into this aquifer.

(d) Waste Management

The waste management scheme that has been adopted at the Ranger mine is that of a restricted release zone (RRZ) in which it is expected that some contamination due to mining and milling (ie. material with >0.02% dry weight of U_{234} exposed to water) is expected to occur. Ideally all contaminants resulting from the operations should be retained within this containment zone for processing, storage or redistribution. To achieve this, the operators established two main circuits within the RRZ (4). One of these is the Ranger Tailings Corridor and the other the retention ponds RP1, RP2, and RP4. Unfortunately, as it has been proven on a number of occasions, the waste water management system at the Ranger mine site cannot provide 100 percent protection to the surrounding environment.

(1) The Ranger Tailings Corridor: The Ranger Tailings Corridor is approximately 16 km wide and 2.5 km long. It runs from the milling plant to the tailings dam and houses the pipelines that connect these two facilities. There are two pipelines within the corridor; one for the disposal of tailings to the tailings dam, and another for the return of the process water back to the mill. Both are considered a primary containment measure for contaminated water. Should these fail there is a secondary containment measure in the form of a bunded roadway that collects the contaminated water and directs it to the Tailings Dam Corridor Sump. A
series of large embankments along the southern edge of the corridor prevents the escape of surface runoff or pipe leakages and also form part of the secondary containment structure. Finally, should the secondary containments fail, wetland filters are in place as a tertiary containment structure which can remove some of the harmful contaminants before the water reaches streams and rivers. As a further measure a compaction of the earth within the corridor was originally undertaken to 300 mm at 95% relative dry density to form a relatively impermeable surface layer that would reduce groundwater seepage as a result of pipe leakages and leaching.

(2) Retention Ponds: Retention ponds in the Ranger waste water management system are used to retain water that contains higher than recommended levels of radionuclides, heavy metals or other chemical contaminants produced during the mining and milling process. RP1 was originally a small tributary of Magela Creek, but today serves as collection point for poor quality water with high levels of uranium, sulfates and electrical conductivity (2). Periodically water from this pond and RP4 is discharged via a spillway into the many creeks, billabongs and tributaries surrounding the mine site. RP4 collects runoff from the below-grade and waste rock dumps. The water in this pond contains elevated levels of magnesium, calcium, sulfur, and sodium. Unlike the other two ponds, RP2 is contained within the RRZ and retains all water that is recognized as unsafe for redistribution to the environment. Runoff from the ore stockpiles, the pits and the process plant contains high levels of uranium and other elements that may have a detrimental effect on vegetation, fauna, and water quality. Despite this, the excess water from this retention pond which is also meant to be retained is sprayed onto 35 hectares of nearby woodland during the dry season, and released through the wetland filters to a flood irrigation area (2).

(e) Water Contamination as a Result of the Ranger Uranium Mine

(1) Environmental Breaches: The Ranger Uranium Mine has an infamous record when it comes to environmental breaches. Throughout its 24 year history there have been numerous pipe leakages, chemical spills, and other waste water containment failures. However, of the total of 106 incidents that have been reported since mining began at Ranger in 1979, only one incident has been assessed as being of moderate ecological significance. The most unfortunate fact about all incidents is that the real impacts may not be realized for many years to come.

(2) Surface Water and Groundwater Contamination: Since the commencement of operations in 1980, there has been a steady increase in the level of all of the common contaminants present in surface water and groundwater at Ranger. As a result an intensive monitoring program of boreholes and test sites have been set up to ensure that any contamination is detected early, minimizing the environmental impact of any spills or leakages.

(3) Tailings Water Leak of 1999/2000: During the wet season of 1999-2000 a failing of the primary containment structure resulted in a significant tailings water leak. An estimated 2000 m$^3$ of water escaped. The runoff carried contaminants into the nearby Very Low Grade Corridor Road Culvert (VLGCRC) that drains into the nearby Corridor Creek, which in turn drains into Magela Creek. Ammonium has a normal background level of about 0.009 mg/L. During the three months that the leak went undetected ammonium levels were as high as 1.5 mg/L, more than 150 times greater.

(B) HONEYMOON URANIUM PROJECT (ISL EXTRACTION)

The Honeymoon Mineral Lease in South Australia is located approximately 400 km north-east of Adelaide between the Olary Ranges and Lake Frome. Discovered in the early 1970’s, it was decided that the concentration of uranium ore within the ore body was too small to make traditional open pit mining economic. With the development of the in-situ-leaching (ISL) process in the late 70’s and early 80’s the project became viable and all the necessary facilities were built, but due to a change in government regulations concerning uranium mining the mine was not commissioned, and the project abandoned. In recent years the project has been reconsidered and an environmental impact statement prepared, thus data concerning the possible impacts of ISL on the environment is now available.

(a) The In-Situ-Leaching Mining Process

The leaching and extraction process at Honeymoon involve an acidic solution with the use of solvent extraction. The leaching solution is also designed to mobilize radionuclides, so it is theoretically possible that
any excess leach solution could escape and raise the level of radionuclides in other adjoining aquifers. In the case of the Honeymoon Project this was of some concern. It wasn’t the fact that the water in the aquifer being used for the leaching process was of high quality; it was the risk of contamination of the groundwater above.

(b) Groundwater Quality

Regarding the groundwater system that lies beneath the Honeymoon Lease there is the basal sands aquifer which contains the mineralized zone. This is confined by the weathered bedrock below a near impermeable layer of silty clay above. Beyond the layer of clay is the middle sands aquifer. It is not certain that the layer of clay between it and the basal sands aquifer is completely continuous or not, but borehole tests to date suggest this is so. Overlaying the middle sands is the upper sands. As seen in the schematic, this layer does not have a continuous boundary of silty clay, hence it would be possible for water from the middle sands to migrate into the upper sands and vice versa.

The water within each of the aquifers is of no exceptional quality as it is already contaminated with the numerous naturally occurring radioisotopes of uranium, radium and thorium. Most are present in the form of salts. The total dissolved solids for each aquifer are listed in the Table 3. The high levels of salt can be attributed to the low levels of recharge that the aquifers receive each year. It is no surprise then that the water from each of the zones is not considered fit for human consumption without treatment.

(C) Waste Management

(a) Disposal of Solid Waste

An advantage that the ISL process has over traditional open-pit operations is the reduction in solid waste. The ISL process only produces about 65 tons of filter sludge per year compared to the thousands of tons of waste rock and tailings from open-pit operations. Sludge is easily disposed of in drying ponds where any seepage and runoff that eventuates is already under control. It should be ensured that a near impermeable layer of silt or clay be laid on the bottom of pond during construction to reduce the seepage of contaminants into the local groundwater reserves.

(b) Disposal of Waste Solution

The most significant waste that needs to be considered is the liquid waste, that is, the barren or waste solution. Being high in radionuclides and sulfates, the waste from the Honeymoon Project would have to be disposed of in an environmentally friendly manner. Southern Cross Resources examined four possible methods for the disposal of this waste:

1. Reinject the waste solution into the Basal Sands Aquifer
2. Evaporate the liquid in drying ponds and dispose of the solid wastes that would result.
3. Chemically precipitate Ra-226 and inject the resulting solution into the Basal Sands Aquifer.
4. Dispose of the solution in a deep well that had been drilled basement rock beneath the deposit.

The simplest and by far the most cost-effective is the first option. It was proposed that the wastewater be injected at a rate of 4 to 8 liters per second for short periods without pressurization (5). According to the International Atomic Agency (6), ‘where suitable hydrological conditions can be demonstrated to exist, it may be satisfactory to dispose of effluent by injecting it into a confined underground aquifer containing non-potable water’. As discussed earlier the quality of the water in the Basal Sands Aquifer is of very poor quality so injecting the waste solution into the aquifer may be a viable solution. The only concern with doing so is the possible contamination of the Middle Sands Aquifer. If it can be demonstrated conclusively that there will be no significant effect on this aquifer as a result, then this option will no doubt go ahead.

(D) Potential Water Contamination As a Result of the Honeymoon Project

(a) Contamination of the Middle Sands Aquifer and Upper Sands Aquifer

It is the possibility of the contamination of the two aquifers above the Basal Sands Aquifer which is of most concern to the developers. The upper and middle sands aquifers form an essential supply of water that can be drawn by local farmers for the watering of sheep and other livestock. Contamination would only occur if the leaching solution or waste solution could somehow find its way into the aquifers. This could occur through a leak in well or through a discontinuity in the clay layer between the Basal Sands Aquifer and the Middle Sands
Aquifer. Unfortunately, until the commencement of operations nobody will know for sure whether the latter is a possibility or not.

(b) Contamination of Neighboring Aquifers
The potential for water contamination in neighboring aquifers as a result of the Honeymoon Project is seen as minimal. Although the leaching solution tends to mobilize radionuclides such as uranium and radium, elevated levels of substances tend to extend only a few hundred meters from the boundary of the leached area (7). There have been instances in countries of the former Soviet Union such as Kazakhstan, the Czech Republic and Uzbekistan where elevated levels of contaminants have entered other aquifers, but these are mainly due to the lack of sound management. In these cases the priority was placed on production of uranium rather than environmental protection. In other countries where mining was successful, monitoring has shown that fifteen to twenty years after the cessation of mining the aquifers contaminated with the leach solution return to a near pre-mining condition. In terms of water contamination this is a relatively short time period.

(c) The Great Artesian Basin
Some concern has been raised over the proximity of the deposit to the Arrowie sub-basin of the Great Artesian Basin (GAB), but flow in the area of the deposit is generally out of the basin to the south. Secondly, little recharge of the GAB occurs in the Honeymoon region due to the limited rainfall. In fact, most of the recharge occurs on the western slopes of the Great Dividing Range in New South Wales and Queensland (7). This minimizes the chance of contaminated surface water percolating into the groundwater below.

IV. CONCLUSIONS
There are two types of uranium mining and milling processes; the open cut method and the in-situ leaching or ISL method. Both yield a number of harmful contaminants that can potentially contribute to a reduction in the quality of surface water and groundwater resources. Sulfates, radionuclides, ammonium, and heavy metals are the most common of these, and are associated with almost all waste that results from the uranium mining process. These contaminants make their way into the environment through a number of paths; commonly seepage, drainage or runoff, and spillages or leaks.

In Australia, there is currently only one operational uranium mine. Many know of the Ranger Mine in the Northern Territory, due to its infamous environmental record. Mismanagement and infrequent maintenance have contributed somewhat to the breaches of the waste management system. Since the commencement of operations in 1980, there have been more than 100 incidents, but fortunately to now only a few have been of any real significance (eg. The tailings water leak of 1999/2000). Despite this there has still been a substantial increase in the level of all contaminants in the surface water surrounding the mine. Concentrations of manganese and sulfates in groundwater have also risen to alarming levels.

The proposed Honeymoon ISL method on the other hand promises to be much more efficient and much more thorough when it comes to environmental protection. The operation is designed to have minimal impact on the surrounding environment. The main concern however is the means by which the waste solution will be disposed of. It is still unclear as to whether injecting the waste solution back into the ore-bearing aquifer will have any impact on the aquifers above. However, claims that neighboring aquifers or the Great Artesian basin may be jeopardized by this operation have been dismissed.

Overall, uranium mining and milling, like any other mining or milling process, has a significant impact on the environment, particularly water quality. Contaminants will inevitably find their way into both surface water and groundwater resources, but it is to what extent that matters. With sound management and adequate levels of maintenance and monitoring at all levels of a mining operation, the impact of the mining process can be minimized. In doing so, it will become a realistic goal for us to maintain the quality of water, near and around uranium mine sites, both now and for the years to come.
Table 1 Waste products from mining processes

<table>
<thead>
<tr>
<th>Waste Product</th>
<th>Description</th>
<th>Pathways for Contamination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mine Wastes (open pit)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- waste rock</td>
<td>Non-ore bearing rock or low grade ore which had to be removed to reach ore body. May also be contaminated by exposure to radionuclides.</td>
<td>Seepage and direct runoff.</td>
</tr>
<tr>
<td>- liquid waste</td>
<td>Contaminated water from vehicle washing or water trapped from runoff within the mine.</td>
<td>Seepage from mine and storage facilities or escape from a containment system eg. Pipes, retention ponds.</td>
</tr>
<tr>
<td>Mill Wastes (open pit)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- tailings</td>
<td>Non-ore bearing material that is left after extraction of the uranium oxide.</td>
<td>Seepage or direct runoff from tailings dam or retention ponds.</td>
</tr>
<tr>
<td>- liquid wastes (tailings water)</td>
<td>Water used during the milling process.</td>
<td>Seepage or escape from a containment system eg. Pipes, retention ponds, tailings dam.</td>
</tr>
<tr>
<td>- waste concentrates</td>
<td>Concentrated chemical residues produced during the milling process.</td>
<td>Seepage or direct runoff from tailings dam or retention ponds.</td>
</tr>
<tr>
<td>In-Situ-Leaching (ISL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- filter sludge</td>
<td>The dirt and sand left behind after the uranium has been extracted.</td>
<td>Seepage from storage ponds or direct runoff from drying beds.</td>
</tr>
<tr>
<td>- barren solutions</td>
<td>The solution left behind after the extraction process is complete.</td>
<td>Seepage or escape from containment system.</td>
</tr>
</tbody>
</table>

Table 2 – Half Life of Radium Isotopes

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Half - life</th>
<th>Decay Series</th>
<th>Parent Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ra - 226</td>
<td>1600 yrs</td>
<td>Uranium</td>
<td>U – 238</td>
</tr>
<tr>
<td>Ra - 223</td>
<td>11 days</td>
<td>Actinium</td>
<td>U - 235</td>
</tr>
<tr>
<td>Ra - 224</td>
<td>3.7 years</td>
<td>Thorium</td>
<td>Th - 232</td>
</tr>
<tr>
<td>Ra - 228</td>
<td>5.8 years</td>
<td>Thorium</td>
<td>Th - 232</td>
</tr>
</tbody>
</table>

Table 3 – Water Quality in the Yarramba Palaeochannel

<table>
<thead>
<tr>
<th>Aquifer</th>
<th>Total Dissolved Solids (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Sands</td>
<td>10,000 – 11,000</td>
</tr>
<tr>
<td>Middle Sands</td>
<td>10,000 – 12,900</td>
</tr>
<tr>
<td>Basal Sands</td>
<td>9,400 – 20,000</td>
</tr>
</tbody>
</table>

REFERENCES


**BIBLIOGRAPHY**


NOTE:
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0408 Lagoons - stabilization
0409 Methanogenesis
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0412 Septic tanks
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1008 Management
1009 Physical treatment
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1104 Land use
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1409 Stochastic processes
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1411 Systems analysis
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1502 Algae
1503 Anaerobic
1504 Disinfection
1505 Groundwater
1506 Kinetics
1507 Marine
1508 Pathogens
1509 Soil
1510 Toxicology
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1807 Dewatering, evaporative
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2103 Maintenance and construction
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