

BIOGRAPHICAL SKETCH FOR DAVID W. HAND

(Revised 1/06/16)

PERSONAL INFORMATION:

David W. Hand
Professor & Chair, Civil and Environmental Engineering
Michigan Technological University
Houghton, Michigan 49931
Phone: (906) 487-2777
Email: dwhand@mtu.edu

EDUCATION:

Associate of Science, September 1975 - June 1977
Lansing Community College, Lansing Michigan

B.S. - Engineering, September 1977 - May 1980
Michigan Technological University, Houghton, Michigan
Major Area of Study - Environmental Engineering

M.S. - Civil Engineering, June 1980 - May 1982
Michigan Technological University, Houghton, Michigan
Major Area of Study - Environmental Engineering

Ph.D., September 1988 - November 1991
Michigan Technological University, Houghton, Michigan
Dissertation Title - "Destruction of Disinfection By-Product Precursors Using
Photoassisted Heterogeneous Catalytic Oxidation."

HONORS:

- 2012 – Recognition of Support and Service for Ballast Water Treatment, Isle Royale National Park
- 2011 –Board Certified Environmental Engineering Member, American Academy of Environmental Engineers.
- 2009 - Co-Recipient of the Rudolph Hering Medal awarded by ASCE for the most valuable contribution to the Journal of Environmental Engineering Division Proceedings of ASCE.
- 2006 - Recipient of the Association of Environmental Engineering and Science Professors 2006 Outstanding Teaching in Environmental Engineering and Science Award.
- 2006 - Co-Recipient of the 2005 Journal of Environmental Science and Technology's Runner-Up Editor's Choice Award for "Preparation of a Novel TiO₂-Based p-n Junction Nanotube Photocatalyst" (*Environ. Sci. Technol.* 2005, 39(5): 1201-1208)
- 2001 – Recipient of the Willard F. Shepard Award for twenty years of membership and devoted service to the Michigan Water Environment Association.

2000 – AEESP Landmark Achievement Award. This award is presented annually to authors of an outstanding publication that has made a valuable contribution to the field and has withstood the test of time. The citation is: Crittenden, J.C., D.W. Hand, H. Arora, and B.W. Lykins Jr., "Design Considerations for GAC Treatment of Organic Chemicals," Journal of American Water Works Association, Vol. 79, No. 1, pp. 74-82 (1988).

1988 - Co-recipient of the Construction and Engineering Division's Best Paper Award in the AWWA Journal in 1987.

PATENTS:

D.W. Hand (Co-Inventor), "Regeneration of Adsorbents Using Photocatalytic Oxidation," U.S. Patent, Effective Date: January 26, 1993; Serial Number 5,182,030.

D.W. Hand (Co-Inventor), "Method and Apparatus for Destroying Organic Compounds in Fluid U.S. Patent Number 5,501,801, Issued March 26, 1996.

PROFESSIONAL EXPERIENCE:

Chair, Department of Civil & Environmental Eng. (2011 - present)
Professor, Department of Civil & Environmental Eng. (2003 - present)
Coordinator, Conflict of Interest Michigan Technological University, (2004 – 2011)
Associate Professor, Department of Civil & Environmental Eng. (1996- 2003)
Program Manager U.S. EPA Center for Clean and Industrial Technologies (CenCITT) (1997 – 2001)
Assistant Professor, Department of Civil & Environmental Eng. (1992-1996).
Senior Research Engineer (1987 - 1992), Research Engineer (1984 - 1987),
Assistant Research Engineer (1982 - 1984)
Environmental Engineering Center for Water and Waste Management
Michigan Technological University, Houghton, Michigan 49931

PROFESSIONAL AFFILIATIONS & RELEVANT SERVICE

2013 – Present American Water Works Association Research Foundation Project Advisory Committee
Member for a project involving air stripping and adsorption of cVOCs from water.
1999 – 2009 Served on annual review panel for U.S. EPA SBIR Phase I Nano Material proposals, EPA, Washington D.C.
2001 – 2005 Served on annual review panel for U.S. EPA SBIR Phase II proposals, EPA, Washington D.C.
2002 – 2004 American Water Work Association Research Foundation Project Advisory Committee
Member for a project involving Impacts of Water Quality Parameters on Adsorbent Treatment Technologies.
2001 – 2010 American Water Work Association Research Foundation Project Advisory Committee
Member for projects involving development of processes for Arsenic Removal from Drinking Water.
1999 – 2001 American Water Works Association Research Foundation Project Advisory Committee
Member for a project involving the regeneration of GAC used to remove perchlorate

- removal and the other involving development of a Standard Method for the Measurement of UV light intensity in UV reactors.
- 2001 American Water Works Association Research Foundation Project Advisory Committee Member for Review of Proposals involving Arsenic Removal from Drinking Water.
- 1998 – 2000 American Water Works Association Research Foundation Project Advisory Committee Member for a project involving electrocatalysis and photocatalysis to remove perchlorate from water.
- 1997 – 2005. Planning Committee Member serving on the Michigan Section American Water Works Association UP Coordinating Committee for Continuing Education and Workshops.

PROFESSIONAL MEMBERSHIPS & JOURNAL REVIEWS:

American Water Works Association
 American Chemical Society
 Water Environment Federation
 Association Environmental Engineering & Science Professors
 American Society Engineering Education

MAJOR RESEARCH INTERESTS:

Physical-Chemical Treatment Processes, Mass Transfer, Adsorption, Air Stripping, Mathematical Modeling of Adsorption Processes, Homogeneous and Heterogeneous Advanced Oxidation Processes, Adsorbent Regeneration Processes, Modeling Water Treatment and Wastewater Treatment Processes, Pollution Prevention, Engineering Software Design Tools.

RESEARCH PROJECTS:

1. D.W. Hand (PI), Z. Ahmed, D.L. Perram, Z. You, P. Doskey, "Scrap Market Development Grant Program: Assessment of Emissions of Crumb Rubber Modified Asphalt" Michigan Department of Environmental Quality, Lansing MI, \$ 690,000, 2014 – 2016
2. D.W. Hand (PI), Z. Ahmed, D.L. Perram. "Removal of Volatile Organic Contaminants (VOCs) from Drinking Water via Multi-Stage Low Profile Aeration Technology." Water Research Foundation, Denver CO, \$ 50,000, 2014 – 2015.
3. D.W. Hand (PI), P.V. Doskey, "Upgrade of comprehensive Two-Dimensional Gas Chromatograph with Time-of-flight Mass Spectrometer," Research Excellence Fund, Dept. of Commerce, State of Michigan 48910 \$ 32,000, 2013-2014.
4. D.W. Hand, "Design and Cost Estimation of a Ballast Water Disinfection System for the Ranger III," Isle Royale National Park, \$ 10,000 (May 2010 – October 2012)
5. D.W. Hand, "Evaluation of the Removal of Ethylene Gas in Refrigerators using GAC," Access Business Group, \$ 7,900 (June 2010 – Sept 2010)
6. L.S. Sutter, S. Schlorholtz, R. D. Hooton, J. Dong, D.W. Hand (Advising 2 PhD students), "NCHRP 18-13 Specifications and Protocols for Acceptance Tests of Fly Ash Used in Highway Concrete," National Cooperative Highway Research Program, \$ 749,410.00, 05/01/07 – 09/30/12.

7. D. W. Hand (PI), D.R. Hokanson, J.C. Crittenden, "Development of Environmental Technologies Design Option Tools, 179 Software Licenses Issued, \$ 62,900.00 (May 1997 – present)
8. D.W. Hand, Q. Zhang, D.L. Perram " Development of a Mathematical Model for an Indoor Air Purification System," Access Business Group, \$ 98,000.00, 03/01/06 – 09/31/08
9. D.W. Hand, Treatment of Aggregate Wash Water for Rinker Materials of Florida, Inc." Rinker Materials, Orlando Florida, \$ 16,000.00, 05/01/06 - 09/30/06.
10. D.R. Hokanson, D.W. Hand, D. Johnson, J.R. Mihelcic, Q. Zhang "Clean Water for The World" Caterpillar Corporation, \$ 150,000, 01/01/05 – 06/15/05
11. D.W. Hand (PI), D.R. Hokanson "Development of a Test Protocol for Monitoring the Capacity of NBC Filters Onboard Halifax Class Ships" Office of Naval Research Canada, \$ 18,561, 11/04 – 3/31/05
12. D.W. Hand (PI), C.L. Wojik, C.R. Baillo," Development of an Environmental Engineering Unit Operations Laboratory and Simulation Center for Undergraduate Education,"National Science Foundation, NSF-CCLI-A&I, Washington, D.C., \$ 213,509, 08/01/00 – 07/31/03.
13. J.C. Crittenden, Y.S. Chen, S.A. Hackney, and D.W. Hand (Co-PI), Design, Synthesis, and Characterization of Nanotube p-n Junction Photocatalyst for Destruction of Environmental Pollutants," Nation Science Foundation, Washington D.C., \$ 99,378, 05/01/01 – 12/31/02
14. J.C. Crittenden, D.R. Hokanson, D.W. Hand (Co-PI), J.R. Baker, Michigan Research Excellence Fund," Program for the Advancement of Environmental Engineering Research: Development of Clean Manufacturing and Processing Research Centers," \$ 50,000, 1997-2000.
15. D.W. Hand (PI), J.C. Crittenden, D.R. Hokanson, ION/NASA, Huntsville, AL., " Phase II - Developing an Analytical Model of the SSF Water Processor Catalytic Oxidation Reactor on-board the International Space Station." \$ 203,550, 1996-1998.
16. D.W. Hand (PI), D.R. Hokanson, J.C. Crittenden, T.N. Rogers, A.S. Mayer, "Development and Demonstration of Environmental Technologies Design Option Tools (ETDOTs) for CPAS," U.S.E.P.A. Center for Clean Industrial and Manufacturing Technologies, Michigan Tech. Univ., Houghton, MI \$ 473,610, 1997-1999.
17. D.L. Perram and D.W. Hand (Co-PI)," Analytical Support for NASA Volatile Reactor Assembly Space Shuttle Support and Terrestrial Support," ION Electronics, Huntsville, AL. \$ 32,670 9/1/97 – 4/30/98.
18. J.R. Mihelcic , J.C. Crittenden, D.W. Hand (Co-PI), and D.R. Hokanson, "Development of Environmental Indices for Green Chemical Production and Use," U.S.E.P.A. National Center for Clean Industrial and Treatment Technologies, Michigan Tech. Univ., Houghton, MI \$ 117,908, 1998-2000.

19. D.R. Hokanson, D.W. Hand (Co-PI), J.C. Crittenden, "Continuation of Phase II of the Multifiltration Bed Model Development for the International Space Station Water Processor," NASA/Ion Electronics, \$ 12,000, 1998.
20. J.L. Bulloch, J.C. Crittenden, D.W. Hand (Co-PI), and Y.S. Chen, "Industrial Implementation of the P2 Framework," U.S.E.P.A. National Center for Clean Industrial and Treatment Technologies, Michigan Tech. Univ., Houghton, MI \$ 110,997; 1998-2000.
21. D.W. Hand (PI), Y.S. Chen, J.C. Crittenden and D.L. Perram, "Development of a High Performance Photocatalytic Reactor System for the Production of Methanol from Methane in the Gas Phase," U.S.E.P.A. National Center for Clean Industrial and Treatment Technologies, Michigan Tech. Univ., Houghton, MI \$ 205,648; 1998-2000.
22. D. W. Hand (PI), David L. Perram, and J. C. Crittenden, ION Electronics/NASA, Huntsville, AL., "Development and Verification of Multifiltration Unit for the Potable Water Processor On-board the International Space Station (ISS)," \$ 1,104,000, 1994 - 1997.
23. D.W. Hand (PI), M. E. Mullins, A.A. Kline, and J.C. Crittenden, ION/NASA, Huntsville, AL., "Phase II - Developing an Analytical Model of the SSF Water Processor Catalytic Oxidation Reactor on-board the International Space Station." \$ 104,500, 1996-1997.
24. J.C. Crittenden, D.W. Hand (Co-PI), T.N. Rogers, and A.A. Kline, "Recovery of Organics from Fluid Streams Using Adsorption and Distillation," U.S.E.P.A. Center for Clean Industrial and Manufacturing Technologies, Michigan Tech. Univ., Houghton, MI \$ 384,625, 1995-1996.
25. D.W. Hand (PI), V.H. Selzer, J.C. Crittenden, "Photocatalytic Oxidation of Air Borne Trace Contaminants," NASA JSC, Houston TX, \$ 22,500, 12/96 - 5/97.
26. J.C. Crittenden, D.W. Hand (Co-PI), and Y. Zhang, "Pollution Prevention and Remediation through Photocatalytic Oxidation Processes," U.S.E.P.A. Center for Clean Industrial and Manufacturing Technologies, Michigan Tech. Univ., Houghton, MI \$ 150,651, 1993-1996. Project completed.
27. D. W. Hand (PI), David L. Perram, and John C. Crittenden, NASA/Ames Research Center, Sunnyvale, CA., "Development of a Rational Modeling Approach for the Design, and Optimization of the Multifiltration Unit" \$ 238,575, 1993-1996.
28. D.W. Hand (PI), A. Mayer, J.R. Mihelcic, T.N. Rogers, J.C. Crittenden, and S.A. Green, "Development of Environmental Technologies Design Option Tools," U.S.E.P.A. Center for Clean Industrial and Manufacturing Technologies, Michigan Tech. Univ., Houghton, MI \$ 155,756, 1995-1996.
29. J.C. Crittenden, D.W. Hand (Co-PI), T.N. Rogers, and A.A. Kline, "Recovery of Organics from Fluid Streams Using Adsorption and Distillation," U.S.E.P.A. Center for Clean Industrial and Manufacturing Technologies, Michigan Tech. Univ., Houghton, MI \$ 384,625, 1995-1996.
30. M. E. Mullins, A. C. Kline, and D. W. Hand (Co-PI), ION Electronics/NASA, Huntsville, AL., "Phase I - Developing an Analytical Model of the SSF Water Processor Catalytic Oxidation Reactor on-board the International Space Station." \$ 185,500, 1994-1995.

31. J.C. Crittenden, D.W. Hand (Co-PI), and Y. Zhang, " Pollution Prevention and Remediation through Photocatalytic Oxidation Processes," U.S.E.P.A. Center for Clean Industrial and Manufacturing Technologies, Michigan Tech. Univ., Houghton, MI \$ 150,651, 1993-1996.
32. D.W. Hand (PI), E.G. Marchand, and J.C. Crittenden,"Ambercat Catalytic Oxidation," U.S. Air Force, Tyndall AFB, FL \$ 17,014, 1994-1996.
33. J. R. Mihelcic, A. S. Mayer, D. W. Hand (Co-PI), D. R. Lueking, U.S.E.P.A. Center for Clean Industrial and Manufacturing Technologies, Michigan Tech. Univ., Houghton, MI., " Integrating Pollution Treatment Models with Manufacturing Process Models to Optimize Pollution Prevention", \$ 198,067, 1992-1994.
34. D.W. Hand (PI), C.R. Baillod, J.C. Crittenden, N.J. Hutzler, and D.L. Perram; Title: "Clean Technologies for Water and Waste Processing;" Funding Source: Research Excellence Fund, Dept. of Commerce, State of Michigan \$226,000, 1993-1994.
35. J. C. Crittenden, D. W. Hand (Co-PI), and M. E. Mullins, "Phase IV - Evaluation of the Technical Feasibility of Photocatalytic Oxidation and Phase Transfer Catalysis for Removal and Destruction of Contaminants from Water," U.S. Air Force, Tyndall AFB, FL 32403 \$ 460,051, 1992-1996.
36. C. R. Baillod, J. C. Crittenden, N. J. Hutzler, D. W. Hand (Co-PI), D. L. Perram, K. B. Rundman, and J. R. Mihelcic, "Clean Technologies for Water and Waste Processing," Research Excellence Fund, Dept. of Commerce, State of Michigan \$ 150,000, 1990-1991.
37. D. W. Hand (PI), and J. C. Crittenden, "Performance Evaluation of New Synthetic Adsorbent Resins for Liquid Phase Application," Rohm & Haas Company, Philadelphia, PA 19105 \$ 105,000, 1989-1991.
38. J. C. Crittenden, and D. W. Hand (Co-PI), "Evaluation of GAC for Removal of Low Level Synthetic Organics from Surface Waters," Health Research Institute, NY. \$ 55,000, 1989-1991.
39. J. C. Crittenden, D.W. Hand (Co-PI), and D. L. Perram, "Destruction of Toxic Organics Using Phase Transfer Oxidation," National Science Foundation, Washington D.C., \$ 199,000, 1991-1993.
40. D. W. Hand (PI), J. C. Crittenden, and D. L. Perram" Destruction of Toxic Organics Using Adsorption and Photocatalytic Regeneration with Sunlight or Low Intensity Artificial Lights," American Water Works Association Research Foundation, Denver CO 80235 \$ 200,664, 1991-1993.
41. J. C. Crittenden, D. W. Hand (Co-PI), D. L. Perram, and G. S. Gierke, "Development of a Mathematical Model to Evaluate the Operation of the Multifiltration Unit in the Space Station Freedom," McDonnell Douglas Space Systems Company, Huntsville, AL 35806 \$ 172,689, 1992-1993.
42. D. W. Hand (PI), and J. C. Crittenden, "Destruction of Disinfection By-Products and Precursors Using Photocatalytic and Phase Transfer Oxidation," American Water Works Association Research Foundation, Denver, CO 80235 \$ 217,660, 1989-1991.

43. D. W. Hand (PI), M. E. Mullins, and J. C. Crittenden, "Phases I,II & III - Evaluation of the Technical Feasibility of Photocatalytic Oxidation and Phase Transfer Catalysis for Removal and Destruction of Contaminants from Water," U.S. Air Force, Tyndall AFB, FL 32403 \$ 123,000.
44. D.W. Hand (PI), C. R. Baillod, J. C. Crittenden, N. J. Hutzler, and D. L. Perram, "Clean Technologies for Water and Waste Processing," Research Excellence Fund, Dept. of Commerce, State of Michigan 48910 \$ 60,500, 1989-1990.
45. D. W. Hand (PI), and J. C. Crittenden, "Performance of Evaluation of Molecular Sieve Adsorbents for Gas and Liquid Phase Applications," Union Carbide/Allied Signal Co., Tarrytown, NY 10591 \$ 60,500, 1988-1989.
46. D. W. Hand (PI), and J. C. Crittenden, "Cleanup of an Industrial Waste Stream at the Hilton-Davis Plant, Cincinnati, OH," Conestoga-Rovers Ltd., Waterloo, Ontario \$ 16,248, 1988-1989.
47. J. C. Crittenden, and D. W. Hand (Co-PI), "Development of Rapid Small Adsorption Tests," American Water Works Research Foundation, Denver CO 80235 \$ 125,000, 1987-1989.
48. D. W. Hand (PI), and J. C. Crittenden, "Groundwater Cleanup of the Twin Cities Army Ammunition Plant," Conestoga-Rovers, Ltd., Waterloo, Ontario \$ 38,900, 1986-1988.
49. J. C. Crittenden, and D. W. Hand (Co-PI), "Fixed-Bed Adsorption Modeling of Known and Unknown Components in a Complex Mixture," National Science Foundation, Washington D.C., \$ 216,632, 1986-1988.
50. J. C. Crittenden, and D. W. Hand (Co-PI), "Removal of Low-Levels of Trihalomethane Precursors Using Granular Activated Carbon at the Metropolitan Water District of Southern California," Metropolitan Water District of Southern California and AWWA Research Foundation Denver, CO 80235 \$ 60,623, 1986-1988.
51. D. W. Hand (PI), "Air Stripping Tower Design for the City of Monon, Ind.," PEI Associates, Chicago, IL \$ 3000, 1986.
52. J. C. Crittenden, D. W. Hand (Co-PI), and S. Kato, "Recovery of Volatile Organic Chemical Vapors from Air Stripping Towers Using Gas Phase Adsorption: Cleanup of a Contaminated Well for the City of Wausau, WI," American Water Works Research Foundation, Denver, CO 80235 \$ 213,105, 1984-1986.
53. D. W. Hand (PI), J. C. Crittenden, "GAC Bench Scale Studies," CECA Inc., Oklahoma \$ 15,500, 1986.
54. D. W. Hand (PI), and J. C. Crittenden, "Adsorption Studies of Pesticides in a Groundwater in Suffolk County, NY.," Suffolk County Department of Health Services, NY \$ 43,891, 1986-1987.
55. J. C. Crittenden, and D. W. Hand (Co-PI), "Evaluation of GAC Treatment and Packed Tower Aeration to Remove Volatile Organic Chemicals and Total Organic Halogen Precursors from a Contaminated Groundwater Supply," U.S. Environmental Protection Agency, Cincinnati, OH \$ 653,031, 1983-1987.

56. J. C. Crittenden, D. W. Hand (Co-PI), "Modeling the Fate of Complex Mixtures and Known Components in Fixed-Bed Adsorbers," National Science Foundation, Washington D.C. \$ 134,345, 1983-1985.

PUBLICATION AND PRESENTATION ACTIVITY:

Peer Reviewed Journal Articles

1. Ahmed, Z. and David W. Hand, "The Direct Adsorption Isotherms of AEAs and Fly Ash Alpha Olefin Sulfonate and Combination Admixtures, ACS Sustainable Chem. Eng., Vol. 3, No. 2, pp. 216 – 223 (2015).
2. Kueber-Watkins, M., Z. Ahmed, L. Sutter, D. Hand, "Characterization of Coal Fly Ash by the Absolute Foam Index," American Concrete Institute Journal of Materials, Vol. 112, No. 3, May-June 2015.
3. Ahmed, Z. and David W. Hand, "Quantification of Adsorption Capacity of Fly Ash," Industrial & Engineering Chemistry Research Journal, dx.doi.org/ie500484d I, Vol 53, pp. 6985 – 6989 2014.
4. Ahmed, Z., D.W. Hand, L.L. Sutter, and M.E. Watkins, "Fly Ash Iodine Number for Measuring the Adsorption Capacity of Coal Fly Ash." ACI Materials Journal, V. III, No. 4 July-August, 2014.
5. Ahmed, Z., D.W. Hand, M.E. Kueber, and L.L. Sutter, "Combined Adsorption Isotherms for the Quantification of Air Entraining Admixtures Adsorption by Fly Ash in Concrete." ACS Sustainable Chemistry & Engineering, dx.doi.org/sc500043s I, Vol 2 pp. 614 – 620, 2014.
6. Ahmed, Z., D.W. Hand, M.E. Kueber, and L.L. Sutter, "Air Entraining Admixtures and Adsorption by Coal Fly Ash in Concrete." Industrial & Engineering Chemistry Research Journal, dx.doi.org/10.1021/ie4018594, Vol 53, pp. 4239 – 4246 2014.
7. Yao, M., Q. Zhang, D.W. Hand, and R. Taylor "Modeling Adsorption and Regeneration of Volatile Organic Compounds on Activated Carbon Fiber Cloth," Journal of American Society of Civil Engineers, Vol. 135, No. 12, pp. 1371 - 1379, December (2009).
8. Zhang, Q, J.C. Crittenden, K. D. Hristovski, D.W. Hand and P.K. Westerhoff "User-Oriented Batch Reactor Solutions to the Homogeneous Surface Diffusion Model for Different Activated Carbon Dosages" Water Research Journal, Vol. 43 Issue 7, April, (2009).
9. M. Yao, Q. Zhang, D.W. Hand, and R. Taylor "Adsorption and Regeneration on Activated Carbon Fiber Cloth for Volatile Organic Compounds at Indoor Concentration Levels," Journal of Air and Waste Management, Vol. 59, No. 1, January, (2009)
10. Meng, Y, Q. Zhang, D.W. Hand, D. Perram, R. Taylor, "Investigation of the Treatability of the Primary Indoor VOCs on Activated Carbon Fiber Cloths at Typical Indoor Concentrations," J. of Air & Waste Management, 59(7): 882-890, 2009.

11. M.E. Jarvie, and D.W. Hand "Predicting Influent Estradiol and Estrone Concentrations for Wastewater Treatment Facilities" *Journal of Water Environment Research*, Vol. 81, No. 2, February, (2009).
12. Taylor, R. M., G. K. Evans, and D. W. Hand, "Test Method for Reduction of Formaldehyde by a Portable Air Treatment System," *American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)* 2008.
13. Sanongraj, W., Y.S. Chen, J.C. Crittenden, H. Destailats, D.W. Hand, and D.L. Perram,"Mathematical Model for Photocatalytic Destruction of Organic Contaminants in Air," *Air and Waste Management Journal*, Vol 57 pp 1112 – 1122, September (2007).
14. K.L. Endres, A. Mayer, and D.W. Hand "Groundwater Treatment Modeling in the Optimal Design of Pump-and-Treat Groundwater Remediation Systems" *ASCE Jour. Environmental Engineering*, Vol 133(8), 809 – 819 (August, 2007)
15. H. Li, D.W. Hand, Y.S. Chen, J.C. Crittenden, and R. Taylor "Modeling of Indoor Air Treatment of Polychlorinated Dibenzo-*p*-dioxins and Dibenzofurans (PCDD/Fs) Using HEPA-Carbon Filtration" *Air and Waste Management Journal*, Vol 56 pp 1155 – 1166, August (2006).
16. M.E. Jarvie, D.W. Hand, S. Bhuvendralingam, J.C. Crittenden and D.R. Hokanson Simulating the performance of fixed-bed granular activated carbon adsorbers: Removal of synthetic organic chemicals in the presence of background organic matter" *Water Research*, Volume 39, Issue 11, June 2005, 2407-2421
17. Y.S. Chen, J.C. Crittenden, J.C. Hackney, L. Sutter, D.W. Hand"Preparation of a Novel TiO₂ based p-n Junction Nanotube Photocatalyst" *Environ. Sci Technol.* 39(5) 1201-1208 (2005)
18. Ramakrishnan, B., G.A. Sorial, T.F. Speth, P. Clark, A. Zaffiro, C. Paterson and D.W. Hand. Remediation of MTBE from Drinking Water: Air Stripping Followed by Off-Gas Adsorption *Journal of Air and Waste Management Association*, 54, 529 – 539 (2004).
19. Yang, J., D.W. Hand, J.C. Crittenden, D.R. Hokanson, E.J. Oman, and D. Audeves, "Dynamic Mathematical Modeling of an Isothermal Three-Phase Reactor: Model Development and Verification," *Journal of Environmental Engineering*, 129(7), 586-594 (2003).
20. Yang, J., D.W. Hand, D.R. Hokanson, J.C. Crittenden, and E.J. Oman, "Catalytic Wet Oxidation: Mathematical Modeling of Multi-Compound Destruction," *Water Environment Research*, 75(2), 180-189 (2003).
21. Yang, J., D.W. Hand, D.R. Hokanson, and J.C. Crittenden, "Application of an Isothermal, Three-Phase Catalytic Reactor Model to Predict Unsteady-State Fixed-Bed Performance," *Environmental Science and Technology*, 37(2), 428-436 (2003).
22. Crittenden, J.C., S. Sanongraj, J.L. Bulloch, D.W. Hand, T.N. Rogers, T.F. Speth, and M. Ulmer, "Correlation of Aqueous Phase Adsorption Isotherms", *Environmental Science & Technology*, 33, pp. 2936-2933 (March 1999).

23. Burns, R.A., J.C. Crittenden, D.W. Hand, V.H. Selzer, L.L. Sutter, S.R. Salman, "Effect of Inorganic Ions in the Heterogenous Photocatalysis of Trichloroethene," *Journal of Environmental Engineering*, Vol 125, No. 1, pp. 77 – 85. (1999).
24. Crittenden, J.C., S. Hu, D.W. Hand, and S. Green, " A Kinetic Model for H₂O₂/UV Process in a Completely Mixed Batch Reactor," *Water Research*, 33(10), pp. 2315-2328 (1999).
25. Suri, R.P.S., J. Liu, J.C. Crittenden, D.W. Hand, and D.L. Perram, "Removal and Destruction of Organic Contaminants in Water Using Adsorption, Steam Regeneration, and Photocatalytic Oxidation: A Pilot Scale Study", *Journal of Air and Waste Management*, Volume 49, pp. 951 – 958, (August 1999).
26. Hand, D. W. A. N. Ali, J. L. Bulloch, M. L. DeBraske, J. C. Crittenden, D. R. Hokanson, "Adsorption Equilibrium Modeling of Space Station Waste Waters," *ASCE Journal of Environmental Engineering*, 125(6), pp. 540-547 (1999).
27. Bulloch, J.L., D.W. Hand, and John C. Crittenden, "Model for Predicting Contaminant Removal by Adsorption Within the International Space Station Water Processor: 1. Multicomponent Equilibrium Modeling," *Water Environment Research*, Vol. 70, No. 1, pp. 14-26, (1998).
28. Crittenden, J.C., R.P.S. Suri, D.L. Perram, and D.W. Hand, " Decontamination of Water Using Adsorption and Photocatalysis," *Water Research*, 31 (3), pp. 411-418 (1997).
29. Crittenden, J.C., J. Liu, D.W. Hand, and D.L. Perram, "Photocatalytic Oxidation of Chlorinated Hydrocarbons in Water" *Water Research*, **31**(3), pps. 429-438 (1997).
30. Hand, D. W., J.C. Crittenden, D.R. Hokanson, and J. Bulloch, "Predicting the Performance of Fixed-bed Granular Activated Carbon Adsorbers," *Water Science and Technology*, **35** (7), pp. 235-241 (1997).
31. Crittenden, J.C., Y. Zhang, D.W. Hand, and D.L. Perram, " Destruction of Organic Compounds in Water Using Fixed-Bed Photocatalysts," *Journal of Solar Energy Engineering*, (ASME), **118** (5), pp. 123 -129 (1996).
32. Liu, J., J.C. Crittenden, D. W. Hand, and D.L. Perram, "Regeneration of Adsorbents Using Heterogeneous Photocatalytic Oxidation," *ASCE Journal of Environmental Engineering*, Vol. 122, No. 8, pp. 707 - 713, (1996).
33. Zhang, Y., J.C. Crittenden, D.W. Hand, and D.L. Perram,," Destruction of Organic Compounds in Water Using Supported Photocatalysts," *Journal of Solar Energy Engineering*, , May 1996, Vol. 118, pp. 123 - 129, (1996).
34. Crittenden, J.C., Y. Zhang, D.W. Hand, and D.L. Perram, "Solar Detoxification of Fuel-Contaminated Groundwater Using Fixed-Bed Photocatalysts," *Water Environment Research*, 68 (3), pp. 270-278 (1996).
35. Hokanson, D.R., B.L. Clancey, D.W. Hand, J.C. Crittenden, D.L. Carter and J.D. Garr II. "Ion

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10. Crittenden, J. C., and D. W. Hand, "Removal of Vinylidene Chloride Using Air Stripping," Report Prepared for Williams and Works Inc. Grand Rapids, Mich. 1982.

Contributions to Conferences and Symposia, which are not given in Proceedings

1. Ahmed, Z (speaker), and D.W. Hand, "Removal of Volatile Synthetic Organic Chemicals from Drinking Water Using Fixed-bed Adsorption," Michigan AWWA Conference, Manistee, MI, September 10 - 13, 2014.
2. Hand, D.W. (speaker), "Application of the Environmental Design Option Tools for Removal of Volatile Synthetic Organic Chemicals from Drinking Water," AWWA Water Quality Technology Conference and Exposition (WQTC) on November 13th - 17th, 2011, Phoenix AZ.
3. Hand, D.W. (speaker) and Z. Ahmed, "Designing Fixed-bed Adsorbers for Removal of Volatile Synthetic Organic Chemicals from Drinking Water," AWWA Workshop, Washington DC, October 25 - 26, 2011.

4. Minakata, D., K. Li, J. C. Crittenden, D. W. Hand, "Rational Design of Advanced Oxidation Processes using Computational Chemistry," 16th International Conference on Advanced Oxidation Processes, San Diego, CA, November 15 -18, 2010
5. Jarvie, M.E., D.W. Hand, D.R. Hokanson, and J.C. Crittenden (Speaker), "Simulating the Performance of Fixed-Bed Granular Activated Carbon Adsorbers: Removal of Synthetic Organic Chemicals in the Presence of Background Organic Matter." Presented at the 2007 American Chemical Society Conference held in Chicago, IL April (2007)
6. Hand, D.W. (Speaker) Considerations for Implementing Point-of-Use and Point-of-Entry Devices for Compliance with the Safe Drinking water Act. Presented at the 2005 Upper Michigan AWWA Conference, Escanaba, MI May (2005).
7. Hand, D.W. (Speaker), C.R. Baillod, and C. Wojick,"The Environmental Process Simulation Center (EPSC) Combining Theory and Practice through a Unit Operations Laboratory," Proceedings of the American Society of Engineering Education, June 23- 25, Nashville Tennessee, 2004.
8. Hand, D.W. (Speaker), and D.R. Hokanson, "Removal of VOCs from Water,"Presentation at the Annual Michigan Upper Peninsula Water Institute Conference held in Marquette, MI, May 5, 2004.
9. Hand, D.W. (Speaker), D.R. Hokanson, J.C. Crittenden, and T.N. Rogers,"Effluent Treatment Design Option Tools," Presented at the 1995 Summer Meeting of the American Institute of Chemical Engineers Conference held in Boston, MA, July 31 - August 4, 1995.
10. Hand, D.W. (Speaker), D.R. Hokanson, J.L. Bulloch,"Software Tools for Adsorption Analysis and Design," Invited paper at the annual American Institute of Aeronautics and Astronautics Life Sciences and Space Medicine Conference held in Houston, TX, April 10-13, 1995.
11. Hand, D.W. (Speaker), J. Liu, J.C. Crittenden,"Removal and Destruction of Synthetic Organic Chemicals using Synthetic Adsorbents and Photocatalytic Oxidation," Invited paper at the Florida Environmental Chemistry Conference held at the Sheraton Palm Coast, Palm Coast, FL. October 19-25, 1994.
12. Gobin, F. (Speaker), D.W. Hand, D.R. Hokanson, J.C. Crittenden, and T.N. Rogers,"Adsorption Simulation Software," Presented at the National Annual AIChE Meeting, San Francisco, CA, November 1994.
13. Zhang, Y. (Speaker), J.C. Crittenden, D.W. Hand, D.L. Perram, E.G. Marchand,"Detoxification of Fuel-Contaminated Groundwater using Continuous Flow Reactor Packed with Supported Photocatalysts," Presented at the National Annual AIChE Meeting, San Francisco, CA, November 1994.
14. Zhang, Y. (Speaker), J.C. Crittenden, D.W. Hand, D.L. Perram, E.G. Marchand,"Solar Detoxification of Groundwater using Photocatalysts," Presented at the 67th Annual Water Environment Federation Conference, Chicago, IL, October 1994.

15. Hand, D.W. (Speaker), J.C. Crittenden, S. Buvendralingham, F. Gobin, "Predicting the Performance of Fixed-Bed Granular Activated Carbon Adsorbers," Presented at the 1994 AWWA National Conference, June 18-24, 1994.
16. Hand, D. W. (Speaker), J. Liu, and J. C. Crittenden, "Removal and Destruction of Organic Contaminants in Water Using Adsorption and Photocatalytic Oxidation," Presented at the 1993 Summer Meeting of the American Institute of Chemical Engineers Conference, August 15-18, 1993.
17. Hand, D. W. (Speaker), J. R. Mihelcic, A. S. Mayer, C. N. Nesbitt, T. N. Rogers, "Integration of Manufacturing and Pollution Treatment Models," EPA Center for Clean Industrial and Treatment Technologies Conference, held at Michigan Technological University, Houghton, MI, August 1-3, 1993.
18. Hand, D. W. (Speaker), J. A. Herlevich, Jr., D. L. Perram, and J. C. Crittenden, "Evaluation of Synthetic Adsorbents for Water Treatment," Presented at the 1992 AWWA Conference, June 6-10, San Antonio, Texas.
19. Zhang, Y (Speaker), J. C. Crittenden, D. W. Hand, and D. L. Perram, "Fixed-Bed Photocatalysts for Solar Decontamination of Water," Presented at the 1993 AWWA Conference, June 6-10, San Antonio, Texas.
20. Liu, J. (Speaker), D. W. Hand, J. C. Crittenden, and D. L. Perram, "Destruction of Toxic Organics Using Adsorption and Photocatalytic Regeneration," Poster Presented at the 1993 National AWWA Conference held in San Antonio, Texas, June 6-10.
21. Hand, D. W. (Speaker), J. C. Crittenden, J. Liu, S. Notthakun and D. L. Perram "Destruction of Disinfection By-Product Presursors Using Photocatalytic Oxidation," Presented at the AWWA Seminar on Disinfection and Disinfection By-Product Identification and Control, Held in Jupiter, FL, February 25-26, 1993.
22. Hand, D. W. (Speaker), J. C. Crittenden, J. Liu, S. Notthakun and D. L. Perram "Destruction of Organic Pollutants Using Photoassisted Heterogeneous Catalytic Oxidation," The Advanced Oxidation Process Workshop sponsored by IWSA and AWWA held in Coral Gables, Florida, April 13-14, 1992.
23. R.S. Suri (Speaker), J. Liu, D. W. Hand, J. C. Crittenden, D. L. Perram, Y. Zhang, D. R. Hokanson, and M. E. Mullins, "Destruction of Organic Compounds in Water Employing Heterogeneous Photocatalysis," Poster Session held at the National AWWA Conference in Vancouver B.C., Canada, June 18-25, 1992.
24. J. Liu (Speaker), D. W. Hand, J. C. Crittenden, D. L. Perram, and D. Hokanson, "Destruction of Toxic Organics Using Adsorption and Photocatalytic Regeneration" Poster Session held at the Annual AWWA Conference in Vancouver B.C., Canada, June 18-25, 1992.
25. D. W. Hand, J. C. Crittenden (Speaker), Yin Zhang, and Erich G. Klun, "Photocatalytic Decontamination of Water Using Sunlight and TiO₂ Impregnated Adsorbent and Non-adsorbent Supports," presented at The First International Conference on TiO₂ Photocatalytic Purification and

Treatment of Water and Air on November 8-13, (1992).

26. Crittenden, J. C. (Speaker), Y. Zhang, D. W. Hand, R.P.S. Suri, J. Liu, D. L. Perram, E. G. Klun, S. Notthakun, and M. E. Mullins, "Photocatalytic Decontamination of Water," Hazardous Waste Conference, Notre Dame, IN, August 1992.
27. Hand, D. W. (Speaker), J. C. Crittenden, J. Liu, S. Notthakun, and D. L. Perram, "Destruction of Organic Pollutants Using Photoassisted Heterogeneous Catalytic Oxidation," The Advanced Oxidation Processes Workshop sponsored by the IWSA and AWWA held in Coral Gables, Florida, April 13-14, 1992.
28. Hand, D. W. (Speaker), J. C. Crittenden, D. L. Perram, and S. Notthakun, "Destruction of Disinfection By-Product Precursors Using Photocatalytic Oxidation and Phase Transfer Catalysis," presented at the AWWA Seminar on Disinfection and Disinfection By-Product Identification and Control, Held in Anaheim, CA, February 25-26, 1992
29. Suri, R. (Speaker), D. L. Perram, D. W. Hand, J. C. Crittenden, and M. E. Mullins, "Destruction of Organic Contaminants From Water Using Photocatalytic Oxidation," presented at the Water Pollution Control Federation Conference, Held in Toronto, Ont. Canada, October 6-10, 1991.
30. Hand, D. W. (Speaker), "Air Stripping Organics in Drinking Water," presented at the Michigan Section AWWA conference held in Shanty Creek, MI., September 10-13, 1991.
31. Notthakun, S. (Speaker), J. C. Crittenden, D. W. Hand, D. L. Perram, and M. E. Mullins, "Solar Regeneration of Adsorbents," Presented at the 1991 AWWA Conference, June 24-28, Philadelphia, PA.
32. Hand, D. W. (Speaker), J. C. Crittenden, D. L. Perram, S. Notthakun, and M. E. Mullins, "Destruction of Disinfection By-Products and Precursors Using Photocatalytic and Phase-Transfer Oxidation," presented at the AWWA conference held in Cincinnati, Ohio, June 18-22, 1990.
33. Mullins, M. E. (Speaker), J. C. Crittenden, D. W. Hand, D. L. Perram, and E. Kalis, "Application of Heterogeneous Photocatalysis to Oxidation of Halogenated Contaminants in Water," Presented at the AIChE conference held in San Diego, CA August 19-22, 1990.
34. Hand, D. W. (Speaker), J. C. Crittenden, S. Reddy, and H. Arora, "Design of Rapid Small Scale Column Tests," presented at the AWWA conference held in Orlando, Fla., June 19-23, 1988.
35. Hand, D. W. (Speaker), and J. C. Crittenden, "Design of Air Stripping Towers," presented at the AEEP conference held at Mich. Tech. Univ., Houghton, Mich., July 20-23, 1986.
36. Hand, D. W. (Speaker), J. C. Crittenden, T. F. Speth, H. Arora, and B. W. Lykins, "Design of Fixed-Bed Adsorbents to Remove Multicomponent Mixtures of Volatile Organic Compounds," presented at the ASCE Env. Div. Conference held in Cincinnati, Ohio, July 8-10, 1986.
37. Arora, H. (Speaker), J. C. Crittenden, D. W. Hand, T. F. Speth, and B. W. Lykins, "Design and Control Parameters of Fixed-Bed Adsorbents to Remove Volatile Organic Compounds from A Contaminated Groundwater," presented at the American Water Works Association Meeting Held in

Denver, CO. on June 22-26, 1986.

38. Hand, D. W. (Speaker), J. C. Crittenden, J. Gehin, "Design and Economic Evaluation of a Full-Scale Air-Stripping Tower for the Treatment of VOCs from a Contaminated Groundwater," presented at the American Water Works Association Meeting held in Washington D. C. on June 24-27, 1985.
39. Crittenden, J. C. (Speaker), J. Berrigan, M. Dobrzelewski, G. Friedman, D. W. Hand, and T. Speth, "Design of Fixed-Bed Adsorbers to Remove Multicomponent Mixtures of VOCs," Proceedings of the American Water Works Association Meeting held in Washington D. C., on June 24-27, 1985.
40. Luft, P. J. (Speaker), J. C. Crittenden, D. W. Hand, and G. Friedman, "Predicting the Fixed-Bed Removal of Known Organic Compounds in Unknown Mixtures," presented at the 1984 National AIChE Meeting, San Francisco, CA, November 26-29, 1984.
41. Crittenden, J. C. (Speaker), P. J. Luft, G. Friedman, and D. W. Hand, "Prediction of Fixed-Bed Adsorber Removal of Known Organics and Total Organic Halogen in Competing Background Mixtures of Unknown Composition," presented at the Water Pollution Control Federation Meeting, held at New Orleans, LA, October 1-4, 1984.
42. Berrigan, J. K. (Speaker), J. C. Crittenden, G. Friedman, and D. W. Hand, "Scale-up of Rapid Small-Scale Adsorption Tests to Field-Scale Adsorbers," presented at the Water Pollution Control Federation Meeting, held at New Orleans, LA, October 1-4, 1984.
43. Crittenden, J. C. (Speaker), J. K. Berrigan, and D. W. Hand, "Treatment of Contaminated Groundwaters Using Granular Activated Carbon and Air Stripping," presented at the 1984 Michigan AWWA meeting, Sept. 19-21, 1984.
44. Crittenden, J. C. (Speaker), and D. W. Hand, "Design Considerations for the Removal of Trihalomethanes and THM Precursors Using Granular Activated Carbon," presented at the National American Water Works Association Meeting, held at Las Vegas, Nevada, June 5-9, 1983.
45. Crittenden, J. C. (Speaker), D. W. Hand, M. Ari, and J. Oravitz, "Competitive Interactions between Synthetic Organic Chemicals and Pretreated and Untreated Fulvic Acids in Fixed-Bed Adsorbers," presented at the National American Water Works Association Meeting held in Las Vegas, Nevada, June 5-9, 1983.
46. Crittenden, J. C. (Speaker), M. Ari, D. W. Hand, J. Oravitz, V. L. Snoeyink, W. E. Thacker, "Prediction of Adsorption, Desorption and Displacement in Fixed-Beds for Multicomponent Mixtures of Known and Unknown Composition," presented at the International Engineering Conference on Fundamentals of Adsorption, held at Schloss Elmau, Klais, Upper Bavaria, West Germany, May 6-11, 1983.
47. Hand, D. W. (Speaker), and J. C. Crittenden, "User-Oriented Solutions to the Homogeneous Surface Diffusion Model" Adsorption Research Workshop conducted at Pritzker Department of Environmental Engineering, Illinois Institute of Technology, Chicago, Illinois, August 2-6, 1982.
48. Crittenden, J. C. (Speaker), D. W. Hand, and W. E. Thacker, "User-Oriented Solutions to the Homogeneous Surface Diffusion Model," presented at the National meeting of AIChE, held at New

Orleans, LA, November 8-12, 1981.

49. Crittenden, J. C. (Speaker), D. W. Hand, W. E. Thacker, "Adsorption Process Design Using the Homogeneous Surface Diffusion Model for Adsorption Process Design Calculations," presented at the Water Pollution Control Federation Meeting, held at Detroit, Michigan, Oct. 4-9, 1981.

COURSES TAUGHT BY DR. HAND

Michigan Technological University

CE5501 – Physical Chemical Processes (Graduate level course)
CE5503 – Advanced water Treatment (Graduate level course)
CE4509 – Environmental Process and Simulation Laboratory (Senior level undergraduate course)
CE4507 – Water Distribution, Wastewater Collection & Pumping (Senior level undergraduate course)
CE4508 – Water and Wastewater Treatment and Design (Senior level undergraduate course)
CE 3600 - Hydromechanics (Junior level undergraduate course)
CE4502 - Wastewater Treatment Design & Collection (Senior level undergraduate course)
CE 4503 - Water Treatment Design & Distribution (Senior level undergraduate course)
CE 3503 - Introduction to Environmental Engineering (Junior level undergraduate course)
CE 456 - Industrial Waste Treatment and Disposal (Senior level undergraduate course)
CE 552 - Industrial Waste Treatment (Graduate level course)

Graduate Students Advised

16 MS graduated (as Major Advisor)
4 MS graduated (as Co-Advisor)
9 PhD graduated (Major Advisor)
3 PhD graduated (as Co-Advisor)

Department, University, and Other Service

Service as MTU Conflict of Interest Coordinator, 2004 – 2011
Service as member of the University Honors and Awards Committee, 2008 – Present (Chair)
Served on University Senate Research Policy Committee (Committee Chair), 2005
Served 3 years as CEE representative on University Senate
Served 1 term as CEE representative on the COE Promotion and Tenure Committee (Chair)
Served 2 or 3 terms on the CEE Promotion Tenure & Policy Committee
Service as Advisor for Theta Tau Fraternity 2006 – Present
Service as EPD2 Program Director, Sept. 2010 – 2012
Served several terms on CEE Industry and Alumni Contact Committee, 1991 – 1997
Served 2 terms on CEE Budget Committee

Professional Consulting (partial list):

Litigation: Pascoag Utility District Plaintiffs, Exxon Mobil Corp. Defendants, Expert Report: Treatment of MTBE in Well PW-3A In Pascoag Utility District v. Exxon Mobil Corp. prepared for Exxon Mobil, April 20 2009.

Litigation: City of New York Plaintiffs, MDL No. 1358, Amerada Hess Corp., et al. Defendants, Expert Report and Testimony: Treatment of MTBE in Selected Wells In City of New York v. Amerada Hess Corp. et al. prepared for McDermott, Will & Emery, March 9, 2009. Supplemental Report Prepared September 26, 2009 and Testimony Given September 30 and October 1, 2009..

Litigation: County of Suffolk and Suffolk County Water Authority Plaintiffs, MDL No. 1358, Amerada Hess Corp., et al. Defendants, Expert Report: Treatment of SCWA Focus Wells prepared for McDermott, Will & Emery, September 27, 2007.

Plexus Scientific Corp., Washington D.C., Plexus Engineering Group, Washington D.C. – Physical/Chemical Process Reviewer for Treatment Systems of Contamination Sites at U.S. Defense Department Base Closure Sites. 1998 - 2002

Calgon Carbon Corp., Pittsburgh, PA. Advice on liquid-phase adsorption processes. 1998

Amway Corporation, Ada, MI, Advice for development of water treatment carbon block filters and indoor air filtration system. 1988 - Present

Moen Inc., North Olmstead, OH. Developed a model for the design of a point of use system removing organic and inorganic compounds. 1995

Camp, Dresser, and McKee, Irvine, CA, Advice was given with respect to air stripping and gas-phase and liquid-phase adsorption process design for groundwater treatment, 1995-1996.

Montgomery Watson Consulting Engineers, Pasadena, CA. Advice was given with respect to adsorption process design for gas-phase and liquid-phase applications, 1993.

Black and Veatch Waste Science and Technology, Kansas City, MO. Performed adsorption isotherms and rapid small scale column tests, 1993.

Amoco Research Center, Naperville IL. Advice was given on the removal of freons using gas-phase activated carbon, 1991.

NASA/Ames Research Center, Sunnyvale CA. Advice was given with respect to adsorption process design for gas-phase and liquid-phase applications, 1991.

John Carollo Engineers, Santa Ana, CA. Advice was given for the design of an air stripping system with off-gas control, and an liquid-phase adsorption system, 1991.

American Water Works Research Foundation, Denver, CO. Developed a research document dealing with non-thermal regeneration techniques for spent activated carbon, 1990.

Cascade Earth Sciences Ltd., An engineering firm for which advice was given for the design of an air stripping system in cold regions, 1990.

Perrier Inc., Vergeze, France, A supplier of bottled drinking water for which advice was given on removing benzene from a carbon dioxide system, 1990.

Calgon Carbon Corp., Pittsburgh, PA. A Carbon Manufacturing Co. for which advice was given on experimental laboratory techniques for conducting rapid small-scale carbon tests, 1989.

Lockheed Missiles and Space Company, Inc., Sunnyvale, CA., An engineering firm for which advice was given on the removal of contaminants in NASA's space shuttle cabin, 1988, 1989, 1990.

Dow Corning Corp., Midland, MI., A chemical company for which advice was given on the design of VOC off-gas control systems, 1989.

Black and Veatch, Aurora, CO. A consulting firm for which computer software pertaining to gas- and aqueous-phase adsorption was given, 1988.

Martin Marietta Energy Systems, Oak Ridge, Tennessee, Provided air stripping and adsorption calculations for the removal of jet fuel from air and aqueous streams, 1988.

Boyle Engineering Inc., Newport Beach, CA., An engineering firm for which advice was given on the design and cost comparison of air stripping and GAC for the removal of trichloroethene from a contaminated groundwater, 1988.

Woodward, Clyde and Associates, Inc., Walnut Creek, CA. An engineering firm for which advice was given an adsorption computer software, 1987.

Kraus and Kriscunas, P.C., Grand Rapids, MI. An environmental engineering consulting for which advice on air stripping and adsorption of gasoline components from air and aqueous solution were given, 1987, 1988, 1989.

EDI, Grand Rapids, MI., An environmental engineering consulting firm for which advice was given on the design procedures for air stripping systems, GAC fixed-bed adsorbers, and photo-oxidation, 1987, 1990.

Amway Global Inc., Grand Rapids, MI. A manufacturer for which advice on water treatment of household tapwater using adsorption was given, 1986, 1987, 1988, 1991, 2004, 2008, 2009.

Shell Oil, Houston, TX. An industry for which advice on air stripping of gasoline components from groundwater was given, 1986.

Camp Dresser and McKee, Newark, NJ. A consulting firm for which advice on groundwater cleanup was given using air stripping, 1986.

GCA, Technology Division, New Bedford, Mass., Consulting firm for which air-stripping and adsorption processes were designed to remove industrial solvents from a contaminated groundwater, 1985.

Carbon Air Services Inc., Minneapolis, MN, a manufacturer for which advice on air-stripping tower design and granular activated carbon adsorber design was given on a regular basis, 1984-1991.

James M. Montgomery Engineers, Reston Virginia; McClaren Plansearch, Inc., Toronto, Canada, performed many mathematical model calculations to determine target compounds and a sampling schedule for a GAC pilot plant process to treat Niagara river water for the Niagara Falls Water treatment plant, 1985.

Zimpro, Inc., Rothchild, Wisconsin. A manufacturer for which advice on groundwater treatment alternatives was given for the development of new products, 1985, 1989, 1991.

Walker Process Corporation, a division of Chicago Bridge and Iron, Aurora, Illinois, a manufacturer for which advice on air-stripping tower design was given for their development of new inexpensive towers, 1985.

Westvaco Corp., Charleston, South Carolina, Carbon manufacturer for which a fixed-bed process is being developed to recover industrial solvents from groundwaters, 1983-1985.

Williams and Works, Grand Rapids, Michigan. Consulting firm for which several air-stripping processes were designed to remove industrial solvents from a wastewater, 1983.

Williams and Works, Grand Rapids, Michigan. Consulting firm for which an air-stripping process was designed to remove dissolved gasoline from a contaminated groundwater, 1982.

James M. Montgomery Engineers, Washington, D.C. Consulting firm for which input was given for the conceptual design of a granular activated carbon process to renovate coagulated secondary effluent and contaminated surface water, 1981-1983.

Williams and Works, Grand Rapids, MI., Consulting firm for which adsorption data for the removal of trichloroethylene from a contaminated groundwater was evaluated, 1982.