

PHILIP J.W. ROBERTS, PHD, PE

Professor of Civil and Environmental Engineering
Georgia Institute of Technology, Atlanta, Georgia, USA

EDUCATION

PhD 1977 Environmental Engineering Science, California Institute of Technology
MS 1972 Environmental Engineering Science, California Institute of Technology
SM 1970 Mechanical Engineering, Massachusetts Institute of Technology
BSc 1968 Mechanical Engineering, Imperial College of Science and Technology,
University of London, First Class Honors.

AWARDS AND PROFESSIONAL QUALIFICATIONS

Distinguished Scholar, NOAA Oceans and Human Health Initiative, 2006-2008
UPS Foundation Visiting Professor, Stanford University, 1993-94
1980 Collingwood Prize of ASCE for paper: "Line Plume and Ocean Outfall Dispersion"
Fellow, American Society of Civil Engineers
Adjunct Professor of Oceanography, Skidaway Institute of Oceanography, Georgia
Associate Editor, Journal of Hydraulic Engineering, 1987 to 1992
Member of the Hydrologic Transport and Dispersion Committee, ASCE, 1988 to present.
Chairman of the ASCE Hydraulics Division Research Committee, 1986-1987
Co-Chairman, IAHR/IWA Committee on Marine Outfall Systems
Registered Professional Engineer number GA 12476, Georgia, United States

PROFESSIONAL EXPERIENCE AND RESEARCH INTERESTS

Dr. Roberts' professional interests are in environmental fluid mechanics, particularly its application to the engineering design of water intakes and ocean outfalls for disposal of wastewaters and desalination brine, and density-stratified flows in lakes, estuaries, and coastal waters. This includes mixing and dynamics of natural water bodies, mathematical modeling of water quality, field studies, and laboratory studies of turbulent mixing.

He is an authority on the fluid mechanics of outfall diffuser mixing and the development and application of mathematical models of wastewater fate and transport. He has extensive international experience in marine wastewater disposal including the design of ocean outfalls, review of disposal schemes, numerical modeling, and the design and analysis of oceanographic field study programs. Dr. Roberts has lectured widely on outfall design and is presently Co-Chairman of the IAHR/IWA Committee on Marine Outfall Systems.

Dr. Roberts' mathematical models and methods have been adopted by the U.S. EPA and are widely used around the world. He is a regular lecturer at workshops for the U.S. EPA on mixing zone analyses and on the use of mathematical models and outfall design for the Pan American Health Organization. He has developed innovative experimental techniques for research on diffuser mixing processes using three-dimensional laser-induced fluorescence and has published extensively in this area. For this research he was awarded the Collingwood Prize of ASCE in 1980 and was UPS Foundation Visiting Professor at Stanford University in 1993-94. He is presently one of only two Distinguished Scholars in the National Ocean and Atmospheric Administration (NOAA) Oceans and Human Health Initiative (OHHI) in which he is conducting research on the hydrodynamic aspects of bacterial and pathogen transport in coastal waters.

BOOKS, CHAPTERS, AND REVIEWS

- Roberts, P.J.W., Salas, H.J., Reiff, F.M., Libhaber, M., Labbe, A., and Thomson, J.C. (2010). "Marine Wastewater Outfalls and Treatment Systems," International Water Association, London, ISBN 9781843391890, 528pp, September 2010
- Roberts, P.J.W. "Ocean Outfall Design Considerations," in *Ocean Engineering Science: The Sea*, Volume 9, B. Le Mehaute and D. M. Haines, Eds., John Wiley and Sons, 1990.
- Roberts, P.J.W. "Mixing and Transport in Natural Streams," in *Encyclopedia of Fluid Mechanics, Volume 10*, N. P. Cheremisinoff, Ed., Gulf Publishing, 1990.
- Roberts, P.J.W. "Ocean Outfalls," in *Critical Reviews in Environmental Control*, Conrad P. Straub, Ed., Volume 20, Issues 5,6, CRC Press, Inc., 1991.
- Roberts, P.J.W. (1996). "Sea Outfalls," in *Environmental Hydraulics*, V. P. Singh and W. Hager, eds., Kluwer Academic Publishers, Dordrecht.
- Ettema, R., Arndt, R., Roberts, P.J.W., and Wahl, T. (2000). *Hydraulic Modeling: Concepts and Practice*, ASCE, Reston, Virginia.
- Roberts, P.J.W., and Webster, D.R. (2002). "Turbulent Diffusion," in *Environmental Fluid Mechanics - Theories and Applications*, H. Shen, Ed., ASCE, Reston, Va.
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INVITED PRESENTATIONS

- Roberts, P.J.W. and Williams, N. (1991), "Modeling of Ocean Outfall Discharges," IAWPRC International Conference on Marine Disposal Systems, Lisbon, Portugal, 20-22 November.
- Roberts, P.J.W. (1992). "Modeling Ocean Outfalls," Plenary Speaker, National Heat Transfer Conference, ASME, San Diego, August 8-12.
- Roberts, P.J.W. (1992). "New Instrumentation for Stratified Flow Experiments," Institute of Mathematics and Its Applications, Fourth Conference on Stably Stratified Flows, Surrey, England, September 21-23.
- Roberts, P.J.W. (1993). "Jets and Plumes and Ocean Outfall Design," NATO Advanced Research Workshop on Turbulent Jets and Plumes, Portugal, June 28-July 2.
- Roberts, P.J.W. (1993). "Fluid Mechanics Aspects of Ocean Outfalls," National Conference on Hydraulic Engineering, San Francisco, July 25-30, 1993.
- Roberts, P.J.W. (2001). "Turbulent Jets and Plumes Applied to Ocean Outfalls." Invited Keynote Address, Third International Environmental Hydraulics Symposium, Tempe, Arizona, December 5-8, 2001.
- Roberts, P.J.W. (2003). "Recent Developments in Marine Wastewater Discharge Technology." *Heleco '03*, Athens, Greece, Jan. 29-Feb. 1, 2003.
- Roberts, P.J.W. (2005). "Examples of New Instrumentation for Studying Turbulent Mixing." *Heleco '05*, Athens, Greece, Feb. 3-6, 2005.
- Roberts, P.J.W. (2007). "Wastewater Outfalls for Industrial Marine Discharges." *EnviroArabia 2007*, Bahrain, April 23-25, 2007.
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SELECTED PUBLICATIONS

- Roberts, P.J.W., Snyder, W.H., and Baumgartner, D.J. (1989a). "Ocean Outfalls. I: Submerged Wastefield Formation." *Journal of Hydraulic Engineering, ASCE*, 115(1), 1-25.
- Roberts, P.J.W., Snyder, W.H., and Baumgartner, D.J. (1989b). "Ocean Outfalls. II: Spatial Evolution of Submerged Wastefield." *Journal of Hydraulic Engineering, ASCE*, 115 (1), 26-48.
- Roberts, P.J.W., Snyder, W.H., and Baumgartner, D.J. (1989c). "Ocean Outfalls. III: Effect of Diffuser Design On Submerged Wastefield." *Journal of Hydraulic Engineering, ASCE*, 115 (1), 49-70.

- Roberts, P.J.W., and Snyder, W.H. (1993a). "Hydraulic Model Study for the Boston Outfall. I: Riser Configuration." *Journal of Hydraulic Engineering, ASCE*, 119 (9), 970-987.
- Roberts, P.J.W., and Snyder, W.H. (1993b). "Hydraulic Model Study for the Boston Outfall. II: Environmental Performance." *Journal of Hydraulic Engineering, ASCE*, 119 (9), 988-1002.
- Ferrier, A., Funk, D., and Roberts, P.J.W. (1993). "Application of Optical Techniques to the Study of Plumes in Stratified Fluids." *Dynamics of Atmospheres and Oceans*, 20, 155-183.
- Roberts, P.J.W., Ferrier, A., and Daviero, G. (1997). "Mixing in Inclined Dense Jets." *Journal of Hydraulic Engineering, ASCE*, 123(8), 693-699.
- Roberts, P.J.W., and Sternau, R.F. (1997). "Mixing Zone Analysis for a Coastal Wastewater Discharge." *Journal of Environmental Engineering, ASCE*, 123(12), 1244-1250.
- Roberts, P.J.W. (1999a). "Modeling the Mamala Bay Plumes. I: Near field." *Journal of Hydraulic Engineering, ASCE*, 125 (6), 564-573.
- Roberts, P.J.W. (1999b). "Modeling the Mamala Bay Plumes. II: Far field." *Journal of Hydraulic Engineering, ASCE*, 125 (6), 574-583.
- Carvalho, J.L.B., Roberts, P.J.W., and Roldao, J. (2001). "Field observations of the Ipanema beach outfall." *Journal of Hydraulic Engineering, ASCE*, 128 (2), 151-160.
- Daviero, G.J., Roberts, P.J.W., and Maile, K. (2001). "Refractive Index Matching in Large-Scale Stratified Experiments." *Experiments in Fluids*, 31, 119-126.
- Roberts, P.J.W., Maile, K., and Daviero, G.J. (2001). "Mixing in Stratified Jets." *Journal of Hydraulic Engineering, ASCE*, 127 (3).
- Webster, D. R., Roberts, P.J.W., and Ra'ad, L. (2001). "Simultaneous DPTV/PLIF Measurements of a Turbulent Jet." *Experiments in Fluids*, 30, 65-72.
- Tian, X., and Roberts, P.J.W. (2003). "A 3D LIF System for Turbulent Buoyant Jet Flows." *Experiments in Fluids*, 35, 636-647.
- Roberts, P.J.W., and Tian, X. (2004). "New Experimental Techniques for Validation of Marine Discharge Models." *Environmental Modelling & Software*, 19 (7-8), 691-699.
- Tian, X., Roberts, P.J.W., and Daviero, G.J. (2004a). "Marine Wastewater Discharges from Multiport Diffusers I: Unstratified Stationary Water." *Journal of Hydraulic Engineering*, 130(12), 1137-1146.
- Tian, X., Roberts, P.J.W., and Daviero, G.J. (2004b). "Marine Wastewater Discharges from Multiport Diffusers II: Unstratified Flowing Water." *Journal of Hydraulic Engineering*, 130(12), 1147-1155.
- Daviero, G.J., and Roberts, P.J.W. (2006). "Marine Wastewater Discharges from Multiport Diffusers III: Stratified Stationary Water." *Journal of Hydraulic Engineering*, 132(4), 404-410.
- Tian, X., Roberts, P.J.W., and Daviero, G.J. (2006). "Marine Wastewater Discharges from Multiport Diffusers IV: Stratified Flowing Water." *Journal of Hydraulic Engineering*, 132(4), 411-419.
- Carvalho, J.L.B., Feitosa, R.C., Rosman, P.C.C., and Roberts, P.J.W. (2006). "A Bacterial Decay Model for Coastal Outfall Plumes." *Journal of Coastal Research*, Special Issue 39, 1524-1528.
- Kim, D.-i., Elovitz, M., Roberts, P.J.W., and Kim, J.-H. (2008). "Investigating and Enhancing Performance of Multi-Chamber Ozone Contactors Using 3D Laser Induced Fluorescence " *Submitted to JAWWA; accepted for Pub 10/23/09*.
- Tian, X., and Roberts, P.J.W. (2008). "Mixing in Water Storage Tanks I: No Buoyancy Effects." *J. Env. Eng.*, 134(12), 974-985.

- Tian, X., and Roberts, P.J.W. (2008). "Mixing in Water Storage Tanks II: With Buoyancy Effects." *J. Env. Eng.*, 134(12), 986-995.
- Gungor, E., and Roberts, P.J.W. (2009). "Experimental Studies on Vertical Dense Jets in a Flowing Current." *J. Hydraul. Eng.*, 135(11), 935-948.
- Hunt, C.D., Mansfield, A.D., Mickelson, M.J., Albro, C.S., Geyer, W.R., and Roberts, P.J.W. (2010). "Plume tracking and dilution of effluent from the Boston sewage outfall" *Marine Environmental Research*, 70(2), 150-161.
- Kim, D., Nemlioglu, S., Roberts, P.J.W., and Kim, J.-H. (2010). "Ozone Contactor Flow Visualization and Quantification Using Three-Dimensional Laser-Induced Fluorescence (3DLIF)." *Journal AWWA*, 102(1), 90-99.
- Nekouee, N., Roberts, P.J.W., Schwab, D.J., and McCormick, M.J. (2010). "Buoyant River Plumes from Large Aspect Ratio Channels. I: Classification." *J. Hydraul. Eng.*, Submitted.
- Nekouee, N., Roberts, P.J.W., Schwab, D.J., and McCormick, M.J. (2010). "Buoyant River Plumes from Large Aspect Ratio Channels II: Near Field Dynamics." *J. Hydraul. Eng.*, Submitted.
- Roberts, P.J.W., Hunt, C.D., Mickelson, M.J., and Tian, X. (2011). "Field and Model Studies of the Boston Outfall." *J. Hydraul. Eng.*, In press.
- Roberts, P.J.W., Tian, X., and Jung, Y. (2011). "Physical Model Study of a Thermal Diffuser." *J. Hydraul. Eng.*, In press.
- Tian, X., and Roberts, P.J.W. (2011). "Experiments on Marine Wastewater Diffusers with Multiport Rosettes." *J. Hydraul. Eng.*, In press.

SELECTED CONSULTING ACTIVITIES

- AB2H Consultants, Hong Kong: Preliminary design of tunneled outfall diffuser for Hong Kong. 14 km long tunneled outfall, 6 m diameter, peak flow 44 m³/s.
- Aguas de Cartagena, Colombia: Three-dimensional modeling of wastewater dispersion from proposed ocean outfall.
- CH2M Hill, San Francisco: Field tests and numerical modeling for San Francisco ocean outfall.
- CETREL, Salvador, Brazil: Design and oceanographic studies for petrochemical and sewage outfall. Steel outfall is 4.8 km long, 1.34 m diameter, flows up to 3.5 m³/s.
- City of San Francisco, California: Responsible for extensive mathematical and physical modeling of ocean outfall. Outfall is 7 km long outfall, 3.6 m diameter, with average dry weather flow of 4 m³/s and peak wet weather flow about 20 m³/s.
- Engineering-Science, La Jolla, California: Dilution calculations for proposed San Diego outfall.
- Hydraulic & Water Resources Engineers, Waltham, Mass: Review of internal hydraulics calculations, Boston wastewater outfall.
- ICF Kaiser Engineers, Rio de Janeiro, Brazil. Design of Alegria outfall into Guanabara Bay and design of field data collection program.
- Mamala Bay Study Commission, Honolulu, Hawaii: Extensive mathematical modeling of Honolulu ocean outfalls. Developed new mathematical modeling scheme to directly use very extensive oceanographic data obtained from Acoustic Doppler Current Profilers and thermistor strings. Integrated near-field model into far-field model.
- Metcalf & Eddy, Massachusetts: Responsible for dilution hydraulic model studies of the Boston wastewater outfall. This is a 16 km long tunneled outfall 7.3 m diameter, diffuser length 2 km, peak flow 55 m³/s.
- Ministry for the Environment, New South Wales, Australia: Reviewed Sydney's ocean outfall program for the Ministry for the Environment, New South Wales. This system

consists of 3 tunneled outfalls, lengths 2.2 to 3.7 km, diameters 2.3 to 3.5 m, combined dry weather flow about 12 m³/s.

Multiservice Engenharia, Sao Paulo, Brazil: Rehabilitation design for 4 km long Santos outfall, 1.75 m diameter, flows up to 7 m³/s.

National Research Institute for Oceanology, Stellenbosch, South Africa: Design of ocean outfall system for discharge of dense and buoyant municipal and industrial wastewaters into the Indian Ocean at Richards Bay.

PB/CH2M Joint Venture, Singapore: Numerical modeling and design of 52 m³/s tunneled outfall.

TAHAL Consulting Engineers, Tel Aviv, Israel: Responsible for design and mathematical modeling of outfall to discharge dense industrial effluent into Mediterranean Sea at Haifa Bay.

State of Washington, USA: Member of expert panel to review wastewater disposal into Puget Sound.

STE, Rio de Janeiro, Brazil: Design of 5 km long outfall for City of Rio de Janeiro, for flow up to 5.4 m³/s.

World Bank, Washington, DC: Design and mathematical modeling of ocean outfalls for Dominican Republic.

World Bank, Washington, DC: Member of panel of experts to review outfall scheme in Cartagena, Colombia.

World Bank, Washington, DC: Member of panel of experts to review outfall scheme in Buenos Aires, Argentina.

Greeley and Hansen, Washington, DC: Expert Review Panel member for Combined Sewage Overflow (CSO) tunneled scheme for Washington, DC.

MWH Americas, Inc: Advise on outfall scheme for Las Vegas wastewater disposal into Lake Mead.

PB Water: Expert review of mixing and dispersion of brine for proposed desalination plant in Tampa, Florida.

Parsons, San Diego, California: Mathematical modeling of near field dilution for Los Angeles tunneled outfall.

MWH Americas, Inc: Design of ocean outfall for Lima, Peru.

Agua y Saneamientos Argentinos (AySA): Extensive near and far field modeling for design of 60 m³/s wastewater outfalls into the Rio de la Plata.

ASA Associates, San Francisco: Review of mathematical modeling of brine discharge from California American Water Company Coastal Water Project (CWA) Monterey.

MWH Americas, Inc: Dilution modeling for desalination plant discharge, Redondo Beach, California.

Hargett Resources, Inc: Design and modeling for thermal diffuser from nuclear power plant.