



## **Imad A. Hannoun, Ph.D.**

President, Water Quality Solutions, Inc.  
Years of Professional Experience: 36



### **Education**

Ph.D., Civil Engineering - California Institute of Technology, Pasadena, CA, 1987  
(minor in Environmental Engineering)  
M.S., Civil Engineering - California Institute of Technology, Pasadena, CA, 1983  
B.E., Civil Engineering - American University of Beirut, Lebanon, 1982

### **Professional Affiliations**

Registered Professional Engineer in NV, VA, and AZ  
Chair, North American Lake Management Society (NALMS) Publications Committee (2013 to present)  
Associate Editor, Lake and Reservoir Management Journal  
Past President, California Lake Management Society (CALMS)  
Past Director, NALMS Region III (mid-Atlantic region); Region IX (western US),

### **Qualifications**

Dr. Hannoun has provided technical analysis for numerous projects, working with engineering firms and government agencies. Over his career, he has acted as project manager for over 160 hydrodynamic and water quality investigations for clients including the City of San Diego, City of Seattle, Parsons, City of Los Angeles Department of Water & Power, Metropolitan Water District of Southern California, Southern Nevada Water Authority, and the U.S. Navy. He has authored reports and papers in the following areas: potable reuse in reservoirs, effects of discharges from power plants, harbor water quality, reservoir hydro-dynamics and water quality, computational fluid dynamics (CFD), eutrophication and nutrient dynamics, etc. Dr. Hannoun has extensive experience in the development and application of complex water quality models, ranging from one to three dimensional representations.

Dr. Hannoun is author or co-author of many technical publications in refereed journals and is an associate editor for NALMS' Lake & Reservoir Management journal. He has been an invited speaker at many conferences in the USA and abroad. He has served on several research and review committees. Dr. Hannoun was the primary author of one of the first articles on CFD modeling in the water industry. He was the Chair of the NALMS 2013 annual conference, a gathering of over 500 water quality professionals and stakeholders, held in San Diego, CA. He is currently the Chair of NALMS Publication Committee that oversees two publications: LakeLine and Lake and Reservoir Management journal.

Dr. Hannoun has been President of Water Quality Solutions Inc. since 2012. He has been the project manager of the modeling work for the City of San Diego for the proposed Indirect Potable Reuse (IPR) projects at Miramar, San Vicente, and Otay reservoirs. His experience also includes representing the City stakeholders in public presentations and private discussions. Dr. Hannoun presented to the California "State Expert Panel" to instruct them how the reservoir hydrodynamics and modeling results can be used in developing IPR regulations. He was the major speaker at many Independent Advisory Panel meetings for the IPR projects in San Diego. Over the years, Dr. Hannoun had many successful meetings with DDW and RWQCB staff to discuss the San Diego "one-off" projects that are proceeding before the regulations have been finalized. Through numerous discussions, he helped DDW personnel formulate the draft regulations. For the period 1992-2012, he was at Flow Science Inc. where he held various positions including President from 2005 to 2012. From 1986-1992, he was a Senior Scientist at JAYCOR in San Diego, California. His duties included the development of complex hydrodynamic simulation software that was used to compute the underwater trajectories of U.S. Navy TRIDENT missiles launched from submarines, underwater explosions near submarines, and pilot ejection from aircraft.

## Technical Publications for Imad Hannoun:

1. "Effect of Lake Water Level Fluctuation due to Drought and Extreme Winter Precipitation on Mixing and Water Quality of an Alpine Lake, Case Study: Lake Arrowhead, California", *Science of the Total Environment* **714**, January 2020 (with Ali Saber and David E. James).
2. "Hypolimnetic Oxygenation of Water Supply Reservoirs Using Bubble Plume Diffusers". *Lake and Reservoir Management* **35**, Issue 3, September 2019 (with Mark Mobley, Paul Gantzer, Pam Benskin, Susan McMahon, David Austin, and Roger Sharf).
3. "Three-Dimensional Management Model for Lake Mead, Nevada", Part 1: Model Calibration and Validation. *Lake and Reservoir Management* **30**, Issue 3, September 2014 (with Al Preston, Imad A. Hannoun, E. John List, Ira Rackley, and Todd Tietjen).
4. "Three-Dimensional Management Model for Lake Mead, Nevada", Part 2: Findings and Applications. *Lake and Reservoir Management* **30**, Issue 3, September 2014 (with Al Preston, Imad A. Hannoun, E. John List, Ira Rackley, and Todd Tietjen).
5. "Predicting Effects of Reservoir Expansion on Water Quality: Case Study of Los Vaqueros Reservoir", *Lake and Reservoir Management* **29**, Issue 4, January 2014 (with Benjamin Martin, Li Ding and E. John List).
6. "Development of a Phosphorus Budget in Lake Mead", *Lake and Reservoir Management*, **30**, Issue 2, June 2014, 2014 (with Li Ding, Todd Tietjen, E. John List, and Peggy Roefer).
7. Potential Ecological Consequences of Invasion of the Quagga Mussel (*Dreissena bugensis*) into Lake Mead, Nevada–Arizona, USA. *Lake and Reservoir Management* **26**: 306–315, 2011. (with W.H. Wong, T. Tietjen, S.L. Gerstenberger, C. Holdren, S.A. Muetting, E. Loomis, P. Roefer, B. Moore, and K. Turner).
8. "Evaluation of Hypolimnetic Oxygen Demand in a Large Eutrophic Raw Water Reservoir, San Vicente Reservoir, California", *Journal of Environmental Engineering*, **133** Issue 2, February 2007, (with Marc Beutel, Jeff Pasek and Kristen Bowman Kavanagh).
9. "Using Hydraulic Modeling to Optimize Contact Time", *Journal AWWA* **90**, August 1998 (with Paul Boulos).
10. "Simulation of Sludge Pumping", *Water Environment Research*, **70**, 2, pp. 197-204 (with E. J. List and W. Chiang), 1998.
11. "Optimizing Distribution Storage Water Quality: A Hydrodynamic Approach", *Journal Applied Mathematical Modeling* **21**, pp. 495 – 502, 1997.
12. "Turbulence Structure near a Sharp-Density Interface", *Journal of Fluid Mechanics* **189**, 189, 1988 (with E. J. List and H. J. S. Fernando).
13. "Turbulent Mixing at a Shear-free Density Interface", *Journal of Fluid Mechanics* **189**, 211, 1988 (with E. J. List).

14. "Nature of Turbulence near a Density Interface", *Bulletin of the American Physical Society*, **30**, 10, 1985 (with E. J. List and H. J. S. Fernando).

### Select Conference Presentations for Imad Hannoun:

1. "Developing IPR Guidance Manual to Assess Surface Water Augmentation Feasibility", to be presented at the 35<sup>th</sup> National WaterReuse Conference, September 14-16, 2020, Denver, CO (with David James, Ali Saber, and Tracy Vermeyen).
2. "Best-Practice Approaches for Indirect Potable Reuses through Surface Water Augmentation", AWWA Potable Reuse Symposium, February 10-11, 2020, Atlanta, GA (with Ali Saber, David James, Daniel Gerrity, and Tracy Vermeyen).
3. "Effects of Pumped Storage on Two San Diego Reservoirs", NALMS 2019, November 11-15, Burlington (with Jeff Pasek, Goldamer Herbon, and Sarah Brower).
4. "Hypolimnetic Oxygenation of Water Supply Reservoirs using Bubble Plume Diffusers", NALMS 2019, November 11-15, Burlington, VT (with Mark Mobley, Paul Gantzer, Pam Benskin, Susan McMahon, David Austin, and Roger Scharf).
5. "Hodges and Olivenhain: A Tale of Two Reservoirs", presented at the 34<sup>th</sup> Annual CALMS Conference, October 9-10, 2019, San Diego, CA (with Jeff Pasek, Goldamer Herbon, and Ira Rackley).
6. "Estimating Lake Mixing Parameters for Recycled Water Hydrodynamic Modeling: Lake Arrowhead", presented at the 33<sup>rd</sup> Annual CALMS Conference, October, 2018, Incline Village, NV (with Ali Saber Sichani, David James, and Donald Hayes).
7. "Augmenting Miramar Reservoir with Purified Water, or oh no! Too little Nutrients", *In the Proceedings of the NALMS 37<sup>th</sup> International Symposium*, Denver, Colorado, November, 2017 (with Jeff Pasek and Ira Rackley).
8. "The Benefits of Reservoirs in Potable Reuse: An Evaluation of Public Health Protections", *In the Proceedings of the Water Reuse California Annual Conference*, San Diego, CA, March, 2017 (with Brian Pecson, Shane Trussell, Rhodes Trussell, Sarah Triolo, and George Tchobanogolous).
9. "Initial Results for a Hypolimnetic Oxygenation System: Lake Casitas, California", *In the Proceedings of the NALMS 36<sup>th</sup> International Symposium*, Banff, Canada, November, 2016 (with Susan McMahon, Deena Giffen and Paul Gantzer).
10. "Modeling the Effects of a Purified Water Discharge in San Vicente Reservoir, San Diego", *In the Proceedings of the IWA International Symposium*, Pembroke, VA. August, 2015 (with Jeff Pasek).
11. "Thermoclinic Assessment of a Preliminary Circulation Model for Lake George In the Jefferson Project"; City University of New York (CUNY) International Conference on

Hydroinformatics; August 2014 (with Emanuele Ragnoli, Fearghal O Donncha, Jeffrey W. Short, Sandra A. Nierzwicki-Bauer, Lloyd A. Treinish, Anthony P. Priano, and Charles W. Boylen).

12. "Analysis of a Hypolimnetic Oxygenation System for Lake Casitas", *In the Proceedings of the NALMS 33<sup>rd</sup> International Symposium*, San Diego, CA, November, 2013 (with Susan McMahon and Ira Rackley).
13. "Emergency Planning for Potential Contamination in Inflows in Several Southern California Aqueduct Reservoirs", *In the Proceedings of the NALMS 33<sup>rd</sup> International Symposium*, San Diego, CA, November, 2013 (with Kristen Kavanagh, Al Preston, Tony Liudzius, and E. John List).
14. "Water Quality in Lake Mead: Climate Change, Algal Succession, and Operational Effects", *In the Proceedings of the NALMS 33<sup>rd</sup> International Symposium*, San Diego, Ca, November, 2013 (with Al Preston, Todd Tietjen, and E. John List).
15. "Planning for the Future: Modeling Anticipated Changes in Water Quality", *Hydrology & Water Resources 2012 Symposium*, Sydney, Australia, November 19-22, 2012, (with Al Preston, E. John List, Peggy Roefer, Ron Zegers and Todd Tietjen).
16. "Modeling the Effects of Future Climate Change on Water Quality in Lake Mead", *In the Proceedings of the NALMS 32<sup>nd</sup> International Symposium*, Madison, WI, November 7-9, 2012 (with Al Preston, E. John List, Todd Tietjen and Jeffery Pasek).
17. "Lake Casitas Water Quality Issues", presented at the *27<sup>th</sup> Annual CALMS Conference*, October 4-5, 2012, San Diego, CA (with Susan McMahon and Li Ding).
18. "Predictions of Effect of Climate Change on Water Quality in Lake Mead", presented at the *27<sup>th</sup> Annual CALMS Conference*, October 4-5, 2012, San Diego, CA (with Al Preston, E. John List, Rogn Zegers, Todd Tietjen, and Peggy Roefer).
19. "Development of a Three-Dimensional Hydrodynamic Model to Assess Indirect Potable Reuse/Reservoir Augmentation in San Vicente Reservoir", *16<sup>th</sup> Annual Water Reuse & Desalination Research Conference*, San Diego, CA, June 4-5, 2012 (with Jeffery Pasek, Li Ding).
20. "Understanding Nutrient Limitations in Lake Mead", *In the Proceedings of the Lake Mead Science Symposium*, March 5, 2012, Las Vegas, NV (with Li Ding, E. John List, Todd Tietjen, Peggy Roefer).
21. "Application of a Three-Dimensional Water Quality Model to Lake Mead for an Extended Drought Scenario", *In the Proceedings of the Lake Mead Science Symposium*, March 5, 2012, Las Vegas, NV (with Al Preston, E. John List, Todd Tietjen, Peggy Roefer, Ron Zegers).
22. "A Detailed Phosphorus Budget for Lake Mead", *In the Proceedings of the NALMS 31<sup>st</sup> International Symposium*, October 22, 2011, Spokane, WA (with Li Ding, E. John List, Todd Tietjen, Peggy Roefer).

23. "San Vicente Reservoir Augmentation Project", *In the Proceedings of the NALMS 31<sup>st</sup> International Symposium*, October 22, 2011, Spokane, WA (with Li Ding, E. John List, Jeffery Pasek).
24. "Predicting Water Quality in Lake Mead: Climate Change and Drought", *In the Proceedings of the American Water Resources Association Conference*, April 18, 2011, Baltimore, MD, (with Ronald E. Zegers, Peggy Roefer, Todd Tietjen).
25. "Modeling the Effect of Pump Back Operations on Water Quality in Olivenhain Reservoir, San Diego County", *In the Proceedings of the NALMS 30<sup>th</sup> International Symposium*, November 3, 2010, Oklahoma City, OK (with Al Preston, E. John List, Thomas Keller, Robin Stampbach, Joe Wegand).
26. "Overview of Southern California Reservoirs", *In the Proceedings of the CALMS Annual Symposium*, October 7, 2010, Palm Springs, CA.
27. "Los Vaqueros Reservoir Expansion, presented at the CALMS Annual Symposium, October 7, 2010, Palms Springs, CA (with Li Ding, Ben Martin, Matt Moses, Marguerite Naillon, Maureen Martin, Ed Nishikawa, Jean Zacher, Yoland Bartley).
28. "Joint Water Pollution Control Plant Outfall Modeling", *in the Proceedings of the MWWD 5<sup>th</sup> International Conference on Marine Waste Water Discharges and Coastal Environment*, October 27 – 31, 2008, Dubrovnik, Croatia. (with L. Ding, E. J. List, N. Hicks and A. Steele).
29. "Use of ELCOM-CAEDYM Modeling to Aid in the Design of a Hypolimnetic Oxygenation System for Lake Perris", *In the Proceedings of the 27<sup>th</sup> International Symposium of the North American Lake Management Society (NALMS)*, October 20, 2007 – November 02, 2007, Lake Buena Vista, FL.
30. "Use of Estuary and Lake COmputer Model (ELCOM) and Computational Aquatic Ecosystem DYnamics Model (CAEDYM) for Water Quality Simulation in Boulder Basin", *In the Proceedings of the Nevada Water Environment Association's (NWEA) Annual Conference*, March 21 - 23, 2007, Las Vegas, NV.
31. "Use of ELCOM and CAEDYM for Evaluation of Alternative Effluent Discharge Locations in Boulder Basin", *In the Proceedings of the 26<sup>th</sup> International Symposium of the North American Lake Management Society (NALMS)*, November 8 - 10, 2006, Indianapolis, IN.
32. "Use of ELCOM and CAEDYM for Water Quality Simulations", *in the Proceedings for the 79<sup>th</sup> Water Environment Federation Technical Exhibition and Conference (WEFTEC)*, October 21 - 25, 2006, Dallas, TX.
33. "Use of Models to Assess Water Quality Associated with a Regional Seawater Desalination Plant in Carlsbad, California", *in the Proceedings for the California and the World Ocean Conference 2006*, September 17 - 20, 2006, Long Beach, CA (with L. Ding, E. J. List, S. Paulsen).

34. "Receiving Water Analysis for Regional Seawater Desalination Plant in Carlsbad, California", *in the Proceedings of the American Membrane Technology Association (AMTA) 2006 Biennial Conference and Exposition*, August 2, 2006, Anaheim, CA (with E. J. List, L. Ding, N. Martin).
35. "Receiving Water Impacts from Desalination Plants", *In the Proceedings of the Desalination Conference*, May 12, 2006, Santa Barbara, CA.
36. "Use of ELCOM and CAEDYM for Water Quality Simulation in Boulder Basin", *In the Proceedings of the NALMS 25<sup>th</sup> International Symposium*, November 11, 2005, Madison, WI (with E. J. List, L. Ding, K. Bowman-Kavanagh, A. Preston, I. Rackley, D. Karafa).
37. "Use of ELCOM and CAEDYM for Water Quality Simulation in Boulder Basin", *in the Proceedings of the Water Environment Federation Total Maximum Daily Load (WEF TMDL) 2005 Conference*, Philadelphia, PA, June 27 - 29, 2005 (with E. J. List, K. Bowman-Kavanagh, W. Chiang, L. Ding, D. Karafa, I. Rackley).
38. "Use of the Dynamic Reservoir Water Quality Model (DYRESM-WQ) for Perchlorate Mixing and Dispersion Analysis of Lakes Mead/Mohave/Havasu", *in the Proceedings of the NALMS 2004 International Symposium*, November 3 - 5, 2004, Victoria, British Columbia (with L. Palencia, K. Bowman-Kavanagh).
39. "Use of ELCOM and CAEDYM for Water Quality Simulation in Boulder Basin", presented at the *California Lake Management Society (CALMS) Symposium*, November 13 - 14, 2003, Sacramento, CA (with E. J. List, L. Ding, K. Bowman-Kavanagh, W. Chiang, I. Rackley, D. Karafa).
40. "Use of ELCOM and CAEDYM for Water Quality Simulation in Boulder Basin", *in the Proceedings of the NALMS 23<sup>rd</sup> International Symposium*, November 4 - 8, 2003, Mashantucket, CT (with E. J. List, K. Bowman-Kavanagh, W. Chiang, L. Ding, D. Karafa, I. Rackley).
41. "Optimizing Water Quality in Clearwells and Distribution Storage Reservoirs Using Computational and Fluid Dynamics", *in the Proceedings of the Virginia American Water Works Association (AWWA) Section Meeting*, October 29, 2003, Roanoke, VA.
42. "Optimizing Water Quality in Distribution Storage Reservoirs", *in the Proceedings of the World Water & Environmental Congress 2003*, June 23, 2003, Philadelphia, PA (with K. Bowman-Kavanagh, D. LaMoreaux).
43. "CFD Modeling in re-Design of Reservoir Inlet/Outlet in San Francisco", *In the Proceedings of the AWWA Annual Conference*, June 16, 2003, Anaheim, CA (with K. Miller).
44. "Assessing Improvements to Sedimentation Basins Using Computational Fluid Dynamics Modeling", *in the Proceedings of the 2002 AWWA Water Quality Technology Conference*, November 10 - 14, 2002, Seattle, WA (with S. Seckinger, J. Herrick, P. Gadoury, R. Sheldon).

45. "Optimizing Water Quality in Distribution Storage Reservoirs Using Computational Fluid Dynamics Modeling", presented at the *Royal Scottish Hydraulic Group*, January, 2001, Edinburgh, Scotland.
46. "Evaluation of Hypolimnetic Oxygenation Alternatives Case Study: Lake Perris", presented at the *CALMS 15<sup>th</sup> Annual Meeting*, October 12, 2000, Temecula, CA (with K. Bowman-Kavanagh).
47. "Optimizing Disinfectant Residual in a Water Distribution Storage Reservoir", in *the Proceedings of the AWWA 1998 Residual Workshop*, April 27 - 29, 1998, Philadelphia, PA.
48. "The Design of a Second Inlet Structure to Meet Stringent Water Quality Criteria in the Eastside Reservoir", in *the Proceedings of the 1997 NALMS Conference*, December 2 - 5, 1997, Houston, TX (with W. D. Taylor, R. F. Losee, C. Bennett, E. J. List).
49. "Optimizing Water Quality in Water Distribution Storage Reservoirs", in *the Proceedings of the 1997 Rehabilitation and Development of Civil Engineering Infrastructure Systems*, pp. 1319-1327, June 9 - 11, 1997, Beirut, Lebanon (with P. Boulos).
50. "A Method for Determining the Mixing Characteristics of a Mid-Size Water Supply Reservoir", in *the Proceedings of the 1996 NALMS Symposium*, pp.108, November 13 - 16, 1996, St. Paul, MN (with J. Pasek, E. J. List, S. Paulsen).
51. "Computational Fluid Dynamics: An Emerging Computer Technology in the Water Industry", in *the Proceedings of the 1996 AWWA Computer Conference*, pp. 87-97, April 21 - 24, 1996, Chicago, IL.
52. "A Computational Model for Simulating the Pumping of Sludge Cake in a Wastewater Treatment Plant", in *the Proceedings of WEFTEC 68<sup>th</sup> Annual Conference*, October 21 - 25, 1995, Miami, FL (with E. J. List, W. Chiang).
53. "Application of Computational Fluid Dynamics to the Optimization of a Water Plant Clearwell", in *the Proceedings of the 1995 AWWA Computer Conference*, pp. 1-9, April 2 -5, 1995, Norfolk, VA (with P. Boulos).
54. "Gas Injection from a Solid Object into Moving Water", in *the Proceedings of the 1992 American Society of Mechanical Engineers (ASME) Fluids Engineering Conference*, Los Angeles, CA, 1992.
55. "Computations of a Solid Sphere Crossing an Air/Water Interface", in *the Proceedings of the Fourth International Symposium on Computational Fluid Dynamics*, 1991, Davis, CA.
56. "Air Injection into a Liquid Boundary-Layer", in *the Proceedings of the ASME Cavitation and Multiphase Flow Forum*, San Diego, CA, 1989.
57. "Trident II D5 Seal Impulse Analysis", in *the Proceedings of the U. S. Navy's Underwater Launch Technical Working Group (ULTWG) Meeting*, September 7, 1988, Sunnyvale, CA (with K. K. Kan, R. K. C. Chan, P. Chan, D. Long, J. H. Stuhmiller).

