

Christopher H. Keller

Environmental Engineer

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General

Mr. Keller is experienced in a wide range of environmental engineering disciplines, including water and air quality engineering, monitoring, treatment, and permitting. Mr. Keller has particular expertise in treatment wetlands design, performance optimization, data interpretation, and trouble shooting. Mr. Keller has also conducted tracer studies in wetland and lagoon systems ranging from 50 square feet to 900 acres in surface area.

Education

M.E., Environmental Engineering, University of Florida (1994)
Graduate Wetlands Certificate, University of Florida (1994)
B.S., Environmental Engineering, University of Florida (1992)

Professional Registrations

Professional Engineer: Florida (No. 54040)

Relevant Experience

Treatment Wetlands

Mr. Keller is currently preparing a conceptual design for a stormwater treatment wetland for the Sweetwater Branch watershed in Gainesville, Florida.

Mr. Keller assisted with an analysis of stormwater pollutant loadings to Lake Parker in Lakeland, Florida. He assisted with delineation of drainage sub-basins, calculation of hydrologic parameters required for modeling the volume of annual stormwater runoff, and selection of the most cost-effective stormwater treatment technologies to reduce pollutant loadings to the lake. Mr. Keller managed the permitting and design of the Lake Parker Southwest Basin Water Quality Enhancement Project, a series of wetlands designed to capture and treat urban runoff discharging to the lake.

Mr. Keller developed conceptual and final designs for several other natural stormwater treatment systems for the City of Lakeland. Two projects, the Buckingham Road Wetland Study and the Lake Parker Tributary Swamp Conceptual Design, evaluated the

use of existing, dehydrated forested swamps for stormwater retention and treatment. Mr. Keller also designed the Anchor Park Stormwater Treatment Wetland Project for the City of Lakeland which involves the creation of a wetland system to treat stormwater that discharges to Lake Hollingsworth.

Mr. Keller developed a conceptual design for a 40-acre demonstration treatment wetland adjacent to the eastern boundary of Everglades National Park. The design was prepared for the U.S. Army Corps of Engineers to evaluate the phosphorus removal effectiveness of engineered wetland ecosystems.

Mr. Keller led the final design of a pilot-scale treatment wetland system for the Village of Wellington, Florida. The design combined several different wetland ecosystem types to evaluate the lower limit of phosphorus removal from polluted stormwater. The Village of Wellington Aquatics Pilot Program was the first operational research-scale treatment system to combine floating aquatic plant, emergent marsh, submerged aquatic vegetation, and periphyton ecosystems in series.

Mr. Keller recently assisted with two projects for the South Florida Water Management District's Ecologically Engineered Systems Research Division. These projects, the Periphyton-based Stormwater Treatment Area (PSTA) and the Managed Wetlands Treatment System (MWTS), are research and demonstration projects designed to assess supplemental technologies to reduce phosphorus loadings in agricultural runoff that discharges to the Everglades. Both projects involved the construction, operation, and performance evaluation of mesocosm-scale and field-scale pilot treatment wetland systems. Mr. Keller assembled the mesocosm-scale system, performed routine water quality monitoring tasks, and led tracer studies to determine the hydraulic characteristics of the various research platforms.

Mr. Keller developed a preliminary design for the 150-acre Winsberg Farm Wetlands in Palm Beach County, Florida. The design blends various native wetland habitats with significant public access and educational components.

Mr. Keller completed the design for a 5-acre treatment wetland to be constructed at Cathedral Caverns State Park in Alabama. He was responsible for sizing the wetland to meet specific effluent standards, modeling seasonal variation in wetland performance, and developing design drawings and specifications.

Mr. Keller assisted with the design of the Wakodahatchee Wetlands, a 40-acre constructed wetland treatment system in Palm Beach County, Florida. He evaluated acceptable hydraulic loading rates and modeled the expected treatment performance of the emergent marsh system. Mr. Keller also assisted with development of the planting plan, design of hydraulic control structures, and preparation of construction drawings and specifications. He has also assisted with a feasibility study to create a network of treatment wetland flow-ways through 25 square miles of agricultural land in western Palm Beach County.

Mr. Keller assisted the City of Lakeland with the design of a bypass structure for its wetland treatment system (WTS). The construction of the bypass has provided significant operational flexibility, enabling the City to control concentrations of algal solids in the WTS effluent without resorting to the use of algaecides. He has also

provided the City with technical assistance, planning, and data interpretation for a lithium chloride tracer study at the WTS.

For the City of Show Low, Arizona, Mr. Keller assisted with a performance evaluation of the City's existing wetland treatment system. He also assisted with data analysis for the Net Ecological Benefits Use Attainability Analysis, which helped the City obtain an NPDES permit for the wetland system. Mr. Keller prepared a conceptual design plan to convert four polishing ponds at the City's wastewater treatment plant into treatment wetlands. The conceptual design plan included estimates of the expected performance of the converted pond system, proposed modifications to inlet and outlet hydraulic control structures, and operational and maintenance considerations.

Mr. Keller assisted with the permit renewal of the Deer Park wetlands treatment system, a 146-acre natural cypress dome system in Pasco County, Florida. This project included analysis of water quality data, nutrient removal modeling to determine possible impacts to the receiving waters, and preparation of an Operations and Monitoring plan.

Mr. Keller assisted with the establishment of baseline monitoring programs for several proposed natural treatment wetlands in northern Florida. He performed both biological and water quality sampling within the wetlands and in the receiving water bodies. Mr. Keller has also performed vegetation, biological, and water quality monitoring for an impounded natural treatment wetland in central Florida.

Mr. Keller has prepared numerous feasibility studies to evaluate the potential application of treatment wetlands technology for municipal and industrial wastewaters, stormwater, and contaminated ground water throughout the United States. Mr. Keller has also designed and permitted several mitigation wetlands in Florida.

Ecological Monitoring Projects

Mr. Keller managed wellfield monitoring programs for the City of Fort Myers and Bonita Springs Utilities. Hydrologic and biological data were collected and interpreted to evaluate the effects of groundwater withdrawals on existing wetlands and surface waters.

Mr. Keller has assisted Tampa Bay Water with ongoing permit negotiations for the proposed Cone Ranch Wellfield in Hillsborough County, Florida. Mr. Keller has led field wetland studies to evaluate existing conditions and has used the ecological data to develop a GIS-based landscape model to predict the location and extent of potential wetland impacts under varying groundwater withdrawal scenarios.

Mr. Keller assisted with site feasibility studies for the Public Service Electric and Gas Company's (PSE&G) Estuary Enhancement Program. In partial fulfillment of its Salem Generating Station NJPDES Permit, PSE&G is undertaking the restoration of up to 14,500 acres of degraded coastal wetlands within the Delaware Estuary. Mr. Keller assisted with determining the restoration potential of two 500-acre sites along the Cohansey River in New Jersey. He was involved with field verification of the wetland/upland edge and herbaceous vegetation identification, topographic surveying and determination of tidal ranges based on ecological indicators, and determination of practical methods for controlling Phragmites, an invasive reed dominating the sites. Mr.

Keller also assisted with the preparation of conceptual designs and cost analyses for the two potential restoration sites.

Mr. Keller assisted with the ecological monitoring of three wellfields and two reference sites in and around Hillsborough County, Florida. Monitoring activities included measuring upland and wetland vegetation diversity and density, estimating wildlife populations through visual observation and trapping of fish, reptiles, amphibians, mammals, and birds, and collecting water quality data from lakes and wetlands. Data from the three wellheads were compared to data from the reference sites in support of water use permit renewal applications.

Mr. Keller also has assisted the City of Cocoa with quarterly monitoring of vegetation communities to determine the response to surface water withdrawals from the Taylor Creek Reservoir in Osceola County, Florida. The monitoring is part of the 3-year baseline ecological monitoring for the City's Consumptive Use Permit (CUP).

Mr. Keller assisted with the delineation of wetlands for a road widening project along a 23-mile segment of Interstate 4 in central Florida. Potentially impacted wetlands were identified on aerial photographs and jurisdictional boundaries were verified in the field.

Mr. Keller assisted with the identification, delineation, and classification of wetlands at the Florida Army National Guard's 70,000-acre Camp Blanding facility. Wetlands were identified and delineated on digital aerial photographs at computer workstations. This "heads up" delineation procedure greatly reduced the level of effort required to prepare wetland maps for the facility.

Water and Wastewater Treatment Projects

Mr. Keller was the task manager for a reverse osmosis wellfield siting study for Bonita Springs Utilities. Potential sites were selected based on ease of construction, pipeline routing, environmental constraints, and hydrogeologic conditions.

Mr. Keller was the project manager for an effluent disposal alternatives feasibility study for a food processing client in central Florida. The study evaluated several effluent disposal methods including underground injection, wetlands treatment, reverse osmosis, and ion exchange. Mr. Keller is currently assisting the client with construction of an exploratory monitoring well to further evaluate the underground injection alternative.

Mr. Keller was the field sampling task manager for a water quality-based effluent limitation study for an industrial wastewater client in central Florida. This study was conducted to characterize the client's effluent water quality and the receiving water quality in support of an NPDES permit renewal application. Other study elements included benthic invertebrate sampling and deployment and recovery of recording current meters.

Mr. Keller assisted with preparation of a reclaimed water aquifer storage and recovery (ASR) feasibility study for the Englewood Water District (EWD). Components of the study include an analysis of EWD's reclaimed water supply and demand, an investigation of ambient hydrogeologic conditions and groundwater quality, and an inventory of competing groundwater users. Successful implementation of ASR

technology will allow EWD to store reclaimed water during wet weather periods for subsequent withdrawal during high irrigation demand periods.

Mr. Keller performed a water treatment plant sludge management evaluation for Bonita Springs Utilities, Inc. (BSU) in Bonita Springs, Florida. He evaluated BSU's current method of sludge disposal to determine whether it complied with existing regulations and permit conditions. Mr. Keller worked with the FDEP and the Army Corps of Engineers to renew the operating permit for BSU's sludge disposal site.

Mr. Keller assisted the City of Lakeland with a Title V Operating Permit evaluation for its two wastewater treatment plants. The project required identification and characterization of all air emissions sources, quantification of regulated pollutants released to the atmosphere, and analysis of existing regulations to determine whether a Title V Operating Permit was required.

Mr. Keller was the resident engineer for wastewater treatment plant improvements, including the relocation of a reclaimed effluent surface water discharge in Hillsborough County, Florida.

Wetland Permitting for Transportation Projects

For the Hillsborough County Aviation Authority, Mr. Keller was involved in permitting for the Runway 9-27 Re-establishment Project at Plant City Airport in Plant City, Florida. His responsibilities included setting wetland jurisdictional lines in coordination with the Hillsborough County Environmental Protection Commission (EPC) and the U.S. Army Corps of Engineers (USACE), as well as obtaining EPC permits for tree-topping to clear runway approach surfaces. Mr. Keller also developed a mitigation plan to compensate for the tree canopy gaps caused by the tree-topping activities. He also performed a protected species survey for gopher tortoises, and provided preliminary coordination with the Florida Game and Freshwater Fish Commission for relocation of the tortoises.

Mr. Keller assisted with the delineation of wetlands along a large segment of Interstate 4 (I-4) in and near Orlando, Florida, as part of a Project Development and Environmental (PD&E) Study. The study covered a 23-mile segment of I-4 proposed for widening to accommodate projected traffic volume increases. This Florida Department of Transportation (FDOT) project involves planning level assessments of wetland areas, upland vegetation communities, water quality, wildlife resources, and endangered and threatened species. Wetland Evaluation Technique (WET II) assessments were conducted of representative wetlands within the proposed corridor. The results were summarized in a Wetland Evaluation Report, WET II Report, and documented in an Environmental Impact Statement (EIS) for the project.

For the Pine Street Extension project in Sarasota County, Mr. Keller conducted USACE and Southwest Florida Water Management District (SWFWMD) wetland delineations and wetland permitting. He also prepared a mitigation plan and wetland design to compensate for wetlands disturbed by the roadway extension.

Mr. Keller provided innovative color infrared photo-based digital wetland delineation services for the Englewood Interstate Connector Environmental Impact Statement prepared for Sarasota County. This method cut several steps from the traditional procedure for photographic wetland delineation, saving the client time and money. As

part of the project, geographic information system (GIS) data on protected species sightings and other parameters as recorded in the Florida Natural Areas Inventory (FNAI) were used to facilitate roadway corridor selection.

For the Winchester Boulevard in Sarasota County, Mr. Keller conducted USACE and SWFWMD wetland delineations and wetland permitting. He also prepared a mitigation plan and 15-acre wetland design to compensate for wetlands affected by the roadway construction.

Mr. Keller assisted with a literature review of river restoration technology for the U.S. Bureau of Reclamation, Boulder City, Nevada. Follow-on work included the preparation of a report assessing habitat requirements for endangered fish and bird species in the Lower Colorado River basin, and the conceptual design of habitat restoration sites.

Professional Organizations

Society of Wetland Scientists
Water Environment Federation
International Water Association
American Ecological Engineering Society

Publications

Keller, C.H. and J.S. Bays. Hydraulic Considerations and Performance Modeling for Treatment Wetland Design. Presented at the American Ecological Engineering Society's 3rd Annual Meeting - Designing Green Partnerships of Nature and Humanity, College Park, Maryland. May 28-30, 2003.

C.H. Keller. Ecological Engineering in the Consulting Profession: Connecting the Theory with the Practice. Presented at the American Ecological Engineering Society's 2nd Annual Meeting - Ecological Engineering: Implementing the Profession, Burlington, Vermont. April 28-30, 2002.

Zarbock, H.W., C.H. Keller, and A. Adams. Ecological Considerations in Decision Support Systems for Water Resources Enhancement. Presented at AWRA's Decision Support Systems for Water Resources Management, Snowbird, Utah. June 27-30, 2001.

Majer-Newman, J., T. Lynch, and C.H. Keller. Comparison of Tracer Studies from Stormwater Treatment Area 1 West (STA-1W) Test Cells and Mesocosm Tanks. Presented at the Seventh Symposium on Biogeochemistry of Wetlands, Durham, North Carolina. June 17-20, 2001.

Martin, J.R., C.H. Keller, R.A. Clarke, Jr., and R.L. Knight. Long-term Performance Summary for the Boot Wetland Treatment System. Presented at the International Water Association's Seventh International Conference on Wetland Systems for Water Pollution Control, Lake Buena Vista, Florida. November 11-16, 2000.

Keller, C.H. and J.S. Bays. Tracer Studies for Treatment Wetlands. Presented at the Society of Wetland Scientists 21st Annual Meeting – Millennium Wetland Event, Quebec, Canada. August 6-12, 2000.

Bays, J.S., G. Dernlan, H. Hadjimiry, K. Vaith, and C.H. Keller. Treatment Wetlands for Multiple Functions: Wakodahatchee Wetlands, Palm Beach County, Florida. Presented at WEFTEC 2000.

Keller, C.H., J.S. Bays, R.H. Kadlec, and D.P. Gleckler. Lithium Chloride Tracer Study for Treated Municipal Wastewater in Lakeland, Florida. Presented at Wetlands for Wastewater Recycling Conference, Baltimore, Maryland. November 3-5, 1999.

Keller, C.H., J.S. Bays, and D.P. Gleckler. Effluent TSS Improvement at the Lakeland Wetland Treatment System, Florida. Presented at the Society of Wetland Scientists 19th Annual Meeting, Anchorage, Alaska. June 8-12, 1998.

Bays, J.S., C.H. Keller, and R.L. Knight. Structure of an Arid Riparian Ecosystem Receiving Treated Wastewater. Presented at the Society of Wetland Scientists 19th Annual Meeting, Anchorage, Alaska. June 8-12, 1998.

Bays, J.S., C.H. Keller, T.R. Sear, and G.W. Medley. Implementation of the Lake Parker Southwest Basin Water Quality Enhancement Project; Lakeland, Florida. Proceeding of the Fifth Biennial Stormwater Research Conference. Tampa, Florida. November 5-7, 1997.

Summary of Mr. Keller's Treatment Wetland Experience

Summarized below is a list of treatment wetland projects that Mr. Keller has been involved with in the United States.

<u>State</u>	<u>Project</u>	<u>Type</u>	<u>Status</u>	
FL	Sweetwater Branch	F	O	
	Chevron Port Tampa	F	C	
	Lake Parker Southwest Basin	F,D	O	
	Anchor Park Stormwater Wetland	F,D	O	
	Buckingham Stormwater Wetland	F	C	
	Lake Parker Tributary Swamp	F	C	
	Lake Hollingsworth Stormwater Treatment	F	C	
	Target Stormwater Pond	R	C	
	Bonita Springs Utilities Wetland Study	F	C	
	Broward County Wetlands	F	C	
	Cargill SP-10 Enhancement	F,D	C	
	Cargill South Ft. Meade Mine	F	C	
	Lakeland Wetland Bypass	D	C	
	Lakeland Wetland Tracer Study	M	C	
	Florida Power Wetland Study	F	C	
	Wakodahatchee Wetlands	D,M,R	C	
	Winsberg Wetlands	D	C	
	Deer Park Wetlands	R	C	
	Tropicana Ft. Pierce	F	C	
	C-111 Basin Demonstration	F,D	O	
	SFWMD Managed Wetlands	M	C	
	SFWMD PSTA	F,M	C	
	Wellington Aquatics Pilot Program	D,M,R	C	
	Poinciana Boot WTS	M	O	
	Blacks Ford Swamp	M	O	
	Yulee Swamp	M	C	
	SC	Beaufort/Jasper	M	O
	AZ	Show Low	M,D	C
		Roger Road Wetlands	F,M	C
	LA	Ascension Parish Wetlands	F	C
MS	Leaf River	R	C	
GA	Clayton County	D	C	
VA	Louden County	F	C	
CA	Dominguez Gap	F	C	
	Sepulveda	F	C	
NC	Beaman Lake	F,D	C	
	Edward's Branch	D	C	
AL	Cathedral Caverns	D	C	

Abbreviations:

F = Feasibility study/conceptual design.

M = Monitoring and/or data analysis.

O = Ongoing.

D = Participated in design.

R = Data review/re-analysis.

C = Completed.