



A Primer on Lake Water Quality

The Association regularly receives questions on lake management issues, so we developed this comprehensive outline of the Association's goals, actions, results achieved thus far and future plans for these matters. We hope this will help our Members better understand how we work to manage, maintain, and improve the lake. Managing the lake is a high priority to the Association's board and staff, but it is one of many priorities. We must also manage and maintain Association-owned infrastructure and lands, plan and coordinate recreational activities for Members, pursue greater water and energy efficiency, and conscientiously manage the Association's budget.

Similarly, multiple elements are involved in managing the lake: maintaining the lake's water level; working to maintain water quality that supports fishing, swimming and boating; dealing with challenges posed by quagga mussels and golden algae, and ensuring that the lake's recreational components are in good working order. This is made all the more challenging because all our efforts must be carried out within the limitations of the Association's budget.

Our lake management team – staff and consultants under direction of the board – has been recognized for being highly knowledgeable, proactive, and forward-thinking on matters like golden algae and water quality, and we will continue to broaden our understanding of these challenges to continue to meet the Association's Vision Statement, to provide a premier freshwater lake.

Priorities regarding water quality of the lake:

Our efforts are focused on finding the best overall strategy, within our means, to continue to support fishing and swimming in Lake Mission Viejo.

Governing document requirements of the board and staff regarding the lake:

We are directed to preserve, protect and maintain the lake's water quality and provide a premier freshwater lake. The Association's rapid and successful response to the threat quagga mussels posed to the lake is an indication of how seriously we take our responsibilities. We continue to be proactive to our water quality as experienced in our APW facility, continued habitat monitoring, etc.

Why salt levels have increased:

Total Dissolved Solids, also known as TDS, are inorganic compounds found in water such as salts, heavy metals and some traces of organic compounds that are dissolved in water. It can be expressed in units of milligrams per unit volume of water (mg/L) and can be also referred to as parts per million (ppm). TDS levels in the lake have increased over time, which is to be expected because Lake Mission Viejo is not

a natural lake that has upstream-to-downstream flow-through, which would continuously flush out salts. Instead, as water evaporates from the lake, salts are left behind and gradually build up. Evaporation is the biggest cause of increased salinity. Our records show that each year, about 500 acre-feet of water, 163 million gallons, evaporate from the lake's 124-acre surface, leaving salts behind.

This is compounded due to the lake's age – it has had more years for salts to build up – and its location. Being in the South County, our sources of water are saltier than that of nearby lakes in Irvine and Yorba Linda. For years, one of the lake's primary water sources was drinking water from SMWD, nearly 100% of which came from the Colorado River, which is saltier than imported water in the North County, which comes from the Sacramento Delta. This water has been replaced with water containing much lower salt content from our Advanced Purified Water plant, but because the lake holds 1.2 billion gallons of water and the APW plant produces at most 195 million gallons annually for the lake, the improvement will be gradual.

South County groundwater, which is very limited, is much saltier than groundwater in the North County. We need local groundwater from the Farmhouse Well, which dates back to when Mission Viejo was a cattle ranch, to keep the lake full because the APW plant on its own can't produce enough water to make up for the 650 acre-feet of water the lake loses in the average year – 500 to evaporation and 150 to natural seepage. We are currently purchasing 350 acre-feet a year from the APW plant and we get varying amount of rainfall – no runoff, just the rain that falls on the lake. The APW plant could produce more water, but it is expensive, so alternatives need to be considered. When the APW plant's output and rainwater together don't provide enough water to maintain lake levels, the Farmhouse Well remains necessary to make up the balance.

We are not alone – SAMLARC in Rancho Santa Margarita is also struggling to lower its lake TDS, and San Juan Capistrano has spent millions of dollars to remove salts from the water it gets from its wells.

Reduction of salts:

The Board has been and is currently working to find the best long-term strategy to maintain and enhance the lake's water quality. We are working with expert consultants to research and evaluate options to determine how best to reduce salts within the Association's budget.

Our \$5.5 million investment in the APW plant is part of a long-term salt reduction strategy. While the decision to fund the plant was driven by new state water conservation requirements that made it no longer possible to purchase drinking water from SMWD for lake refill, we never considered purchasing normal recycled water because of its high salt content. This led to the development of the APW concept and construction of the plant, which adds three levels of treatment above the normal recycled water treatments, producing water with very low salt (60 ppm TDS).

Fish dying from golden algae blooms:

No one in the world has found a way to stop golden algae blooms – it is an intractable problem no matter where it occurs, but we are working diligently to

determine the best course of action specific to Lake Mission Viejo. This will involve tailoring our approach to the lake's various environmental conditions (pH, TDS, nutrients, etc.), with the goal of lessening the toxicity and limiting the frequency of blooms of the algae.

Since the first outbreak of golden algae in 2014, we have invested thousands of hours of staff time and \$50,000 in scientific studies to find possible solutions to the golden algae blooms that have diminished the lake's clarity and caused terrible fish die-offs. We have coordinated with the managers of other area lakes, particularly with East Lake in Yorba Linda, and we recently worked with SAMLARC and the Woodbridge Village Association to commission a study by Dr. David Caron to determine possible strategies to manage golden algae blooms. Dr. Caron's bio is provided at the end of this document.

We are hopeful that a new study by Dr. Caron that we commissioned will lead to the development of more effective golden algae response protocols tailored to Lake Mission Viejo's specific environmental conditions.

Possible golden algae solution:

East Lake is using floating islands to filter water and SAMLARC is planning to do the same in Rancho Santa Margarita. We are interested in this approach but, frankly, there is only anecdotal evidence of success, and that success does not extend to the lowering of salt levels. We haven't ruled out the approach, but before committing to it, we have asked Dr. Caron to see if he can find better scientific proof of its effectiveness.

TDS levels and its effect on golden algae blooms:

While there is some evidence that golden algae prefer saltier water, the research is mixed. East Lake in Yorba Linda, for example, has had a reduction in golden algae blooms without addressing TDS levels. Also, lakes with lower TDS also suffer from golden algae blooms. Again, we are working on a long-term management plan backed by science to ensure that the lake water quality continues to support fishing, swimming and boating.

Advanced Purified Water effects on reducing golden algae blooms:

Switching to APW water absolutely has had a positive and immediate effect with maintaining water levels. It will also help to gradually reduce TDS levels since APW water has only about 60 ppm of TDS. Whether lowering the lake's TDS will reduce the frequency of golden algae blooms is an open question, unfortunately. Research on the matter is mixed, and some scientific studies indicate it could reduce the severity of the problem.

Clarity of lake water:

The decline of the lake's clarity is exacerbated by golden algae blooms. Lakes throughout California and the west are suffering the same problem, and no solution has been found, despite years of scientific research and testing. LMVA is currently funding a study by Dr. David Caron (See bio below), one of the country's foremost experts in this matter, which should lead to customized treatments that will help to

improve the situation. Our ongoing efforts to lower salt levels in the lake will also contribute to improved water clarity.

Timing of improvement process:

We appreciate and understand the desire for more immediate improvements – the Board and staff feel the same way. However, with a large-volume lake like ours, the high costs associated with addressing salinity and golden algae, and the budget we have available to us, it is important to first develop a comprehensive approach that is backed by scientific evidence supporting a high potential for success. Once the plan is developed and approved, we expect progress will be incremental because of the lake's size – but it will be progress!

Property values:

Property values have increased since the first golden algae bloom in 2014 and LMVA will continue to invest in efforts to improve the lake's water quality. We believe the lake will continue to be known for its beauty and its recreational values, and that will be reflected as one element of strong local property values.

Association transparency:

The Association's work on lake water quality is discussed openly and publicly at our board meetings. We report on these efforts in our Member newsletter and on the Association's website and are stepping up these communications efforts as we move towards future consideration of the options for water quality improvements available to us.

Cost to purchase additional APW or potable water:

Purchasing potable (drinking) water is no longer an option because of new State regulations designed to protect California from the impacts of future droughts. This almost certainly will never change, so it is not something the Board considers. The current APW plant's output would have to be doubled at a minimum to replace the Farmhouse Well's contribution to lake water levels. This will be very costly, but we are investigating this option with SMWD, as one of multiple approaches being considered.

Fiduciary responsibility to the Association:

We must balance lake management with other priorities. Rising water costs and the growing unavailability of potable water for landscape irrigation drove the move to replace water-intensive landscaping with drought-tolerant landscaping. In addition, all landscape irrigation was converted to reclaimed water, saving another 50-acre feet of potable water each year. The Board is also responsible for maintaining our facilities, safety, accessories, ADA requirements, etc. If this is put off for too long, maintenance expenses will only get higher. It also makes sense to spend money to reduce the energy and water use of our facilities, and to better serve our Members by improving access throughout our facilities.

Dr. Caron Bio:

Dr. David A. Caron is Chief Science Officer for Aquatic EcoTechnologies, LLC. Dr. Caron is also a Professor in the Marine Environmental Biology section of the Department of Biological Sciences at the University of Southern California. He is currently a holder of the Captain Allan Hancock Endowed Chair in Marine Sciences at USC. He has degrees in Microbiology (B.S.) and Oceanography (M.S.) from the University of Rhode Island, and in Biological Oceanography (Ph.D.) conferred jointly by Massachusetts Institute of Technology and Woods Hole Oceanographic Institution. His research interests involve marine and freshwater microbial ecology. Ongoing research programs include studies of harmful blooming-forming species of microalgae, and investigations of the biodiversity and physiology of tropical, temperate and polar microbial communities. He has authored or co-authored more than 250 scientific articles and book chapters. He is a Fellow of the American Academy of Microbiology, and a member of the American Society for Microbiology, the International Society of Protistologists, The Oceanography Society and the International Society of Microbial Ecology. He is a recipient of the Mary Sears Chair for Excellence in Biological Oceanography (from Woods Hole Oceanographic Institution), the Seymour Hutner Award (from the Society of Protozoologists), the Albert S. Raubenheimer Award for Excellence in Teaching, Research and Service, and a past president of the International Society of Protistologists.