November 11, 2016

Sonoma County Water Agency
Attn: Fish Flow DEIR
404 Aviation Boulevard, Santa Rosa, CA 95403

Dear Sonoma County Water Agency:

Friends of Villa Grande (FOVG) is a 501(c)(3) non-profit organization, established in July, 2007. The organization's primary purpose is to preserve and protect the property it owns in Villa Grande known as Patterson Point Preserve. Patterson Point Preserve's two acres of alluvial redwood habitat includes 26 coastal redwoods, significant native flora and fauna, and two public-access beaches on the Russian River. As stewards of Patterson Point, FOVG has been restoring and maintaining the natural features of the property for the benefit of wildlife, residents, visitors and the public at large. Acquisition of the preserve and initial restoration work were funded in part by Sonoma County Agricultural Preservation and Open Space District (SCAPOSD), which holds a conservation easement on the property. The proposed project addressed on the Draft Environmental Impact Report (DEIR) would significantly and adversely affect all aspects of the work completed to date by FOVG, and negatively impact the objectives of SCAPOSD set forth in the open space easement.

We are writing to question what we perceive to be deficiencies, inadequacies and omissions in the DEIR. We consider these to be significant. The document is fundamentally flawed. We are presenting questions that need to be addressed before the DEIR is certified.

According to the agency's Fish Habitat Flows and Water Rights Project Draft Environmental Impact Report, the plan to reduce water flows "could result in a violation of water quality standards of waste discharge requirements or otherwise degrade water quality relating to biostimulatory substances in the Russian River." This degradation will negate decades of efforts to improve the quality of water in the Russian River.

The following is a partial list of questions and concerns that need to be addressed by the DEIR:

Recreation:

The DEIR incorrectly states that the impacts to recreation on the lower river will be "less than significant."

It analyzes the impacts to recreation primarily as they relate to canoeing, kayaking, swimming and sunbathing, upstream of the dam at Vacation Beach. There is little analysis of impacts to beach areas and recreational uses on the 15 mile stretch from the Vacation Beach dam

downstream to the ocean other than to say that areas that are less than 9 feet mean sea level will become inundated when the river mouth is closed. The DEIR then goes on to state that these conditions are similar to baseline conditions prior to the project implementation. This statement is entirely erroneous. The lower flows from the project will cause the river mouth to be closed more frequently and for longer periods of time (as documented in the DEIR).

- *What are the true impacts of lower river flows to public-use recreation at Patterson Point and the lower river? What mitigation measures are available to mitigate recreation impacts and how will they be monitored?*

The beaches downstream of Vacation Beach include the Monte Rio beach, Patterson Point Preserve, Casini Ranch, Russian River Sportsmen's Club and Duncans Mills campground. There is also river access at Sonoma Coast State Park's Willow Creek environmental campground. We will address the conditions at Patterson Point since that is the primary concern of the FOVG, but similar conditions exist at the other river access points.

The DEIR incorrectly states that FOVG provides "limited access to the river through their property for community members." In fact, the beaches at Patterson Point have been used by residents of Villa Grande, residents of the lower river community, and people visiting the area since the late nineteenth century. However, the Preserve is one of only two public access points to the river for the entire 8-mile stretch between Monte Rio and Jenner. As such, it is an important asset that needs to be protected.

The DEIR states that an impact to recreation is significant when it will "substantially alter or inhibit access to recreational facilities or activities." Based on this criterion, the recreational impact to Patterson Point and the other beaches below Vacation Beach should be listed as a significant impact of the project. The normal conditions at Patterson Point are that the river mouth will close several times during the summer for relatively brief periods causing inundation of the beaches. This inundation occurs for a limited period until the flow of the river causes the mouth to reopen. During the long periods of low flow proposed by the project, the river mouth will remain closed for extended periods, as is acknowledged in the DEIR. However, as has been demonstrated on several prior occasions, the increase in water level caused by the project will cause the two beaches to become fully inundated, terminating all recreational use of the Preserve's beaches for extended periods. This impact is certainly significant enough to cause comment. One visitor's online remarks on a nearby vacation rental stated in 2016: the house was described as "on the river, WRONG! On an inlet, swampy, mossy, yuck!"

- *What mitigation measures are being incorporated into the project to protect the beaches at Patterson Point Preserve and the lower river? How will these mitigation measures be implemented and who is the responsible agency for monitoring these measures?*

Friends of Villa Grande contends that Sonoma County Water Agency (SCWA) has not thoroughly explored alternatives to the project with National Marine Fisheries Service (NMFS).

- *Why have no mitigation measures been proposed that will provide protection to salmonids while maintaining the recreational value of our river beaches? Why is SCWA proposing lower flows than those required by the Biological Opinion*?

As a non-profit corporation providing a public access point to the river, FOVG expects SCWA to thoroughly explore alternatives that do not severely degrade the recreational value of the Preserve before implementing a project that will have disastrous consequences.

- *What are alternative mitigation measures that will provide protection to salmonids while maintaining recreational uses of Patterson Point Preserve and the lower river?*

As stated below, there are most likely impacts from this project that will stimulate algae growth including "toxic algae." These conditions will have direct effects on the recreational desirability of Patterson Point and the lower river.

- *What mitigations are incorporated to control algae growth to maintain Patterson Point as a recreation area? How will these mitigations be monitored?*

If the low flow plan results in more summers of a river tainted by toxic algae, our Russian River communities will be negatively impacted in several ways:

Tourism and our local economy could decline.

We would need to be concerned about the health of our children and pets and other mammals when they are around the river.

And our way of life, which includes spending time swimming, kayaking, and wading on the river's shores could be dramatically altered.

The veracity of these scenarios has been verified by recent events. The discovery of toxic algae and the correct and reasonable response of the Health Department in posting warning signs have combined to bring about an observable decline in beach usage, despite a long period of warm weather this summer.

Water Quality

The DEIR clearly states that there will be significant, unavoidable, adverse impacts to water quality from biostimulatory substances as a result of the project. These substances lead to algae blooms including the toxic algae blooms that we have experienced in 2015 and 2016. The toxic algae causes severe health impacts to dogs and is dangerous to small children and people who eat fish from the river. These are impacts to human health. It is simply inexcusable to propose a project that will cause human health impacts and cause poisoning of people's pets, wildlife and

possibly fish and aquatic mammals as well. This issue has broad impacts for recreation, fishing, boating and swimming that have not been thoroughly addressed in the DEIR. There should be study of methods to remediate the toxic algae blooms and phosphorous levels in the river before embarking on this project.

- *What methods are available to mitigate phosphorous levels in the Russian River and to control the growth of algae? What are the potential effects of Cyanobacteria on swimmers, dogs, boaters, fishermen, aquatic mammals and bird life resulting from this project? How will these effects be mitigated and who will monitor the effectiveness?*

There is no concurrence from the North Coast Regional Water Quality Control Board (NCRWQCB) that the project will meet their Basin Plan guidelines. Conformance with established water quality standards is an important environmental issue and should be thoroughly addressed in the DEIR.

- *Why was no determination by the Water Quality Control Board included in the DEIR? How will the proposed project conform to established water quality standards? How will the project meet the Basin Plan of the North Coast Regional Water Quality Control Board?*

There is no analysis in the DEIR of the effects on the ocean from the discharge of the contaminated water from the project. The DEIR should address the potentially detrimental effects on the ocean from biostimulatory substances including potential to cause toxic algae problems, potential effects on marine mammals and aquatic life, and potential health hazards to surfers, swimmers and fishermen. The most recent National Geographic discusses how sea lions are dying from toxic algae. This has not been evaluated.

- *Why have ocean impacts not been addressed? What are potential effects on marine mammals, shellfish, crabs and other marine life? What are the health hazards to people who consume fish and shellfish? How will these effects be mitigated and monitored?*

David Farrer of the Oregon Health Authority describes what is known about the toxicity of cyanotoxins: "Since the molecular target of these environmental toxins is common to all mammals, I suspect that the ultimate toxic effect will just depend on the dose (what volume of water is consumed and at what concentration of toxin) and the physiology of the animal or human (body weight, etc .)." If you look at Table 2 in the Farrer article, the tolerable daily intake for humans (and dogs) is 0.1 micrograms/Kg body weight per day. If we have a bloom of algae resulting in anatoxin-a concentration of 48.9 mcg/L (as occurred at Steelehead Beach on Sept. 21st 2015), then a typical glass of water (250 mL or 1/4 of a liter) would have 12 mcg of anatoxin-a. If the Tolerable Daily Instake is 0.1 mcg/Kg then a human (70 Kg) would tolerate 7 mcg but a dog (10 Kg) would only tolerate 1 mcg. So the dog dose would be 10 times the tolerable limit set by the Oregon Health Authority. If we take a small river otter (body weight = 5 Kg) then the tolerable limit would only be 0.5 mcg. So on Sept. 21, 2015 the otter should have tried not to drink more than 0.01 L (~ 2 teaspoons)." *Why has this not been evaluated?*

At the September 13, 2016 Board of Supervisor's meeting, Michael Bolger, Ph.D., presented an analysis of cyanotoxins, low flow and temperature. He states the following in a letter to the Press Democrat: "Does the 'Fish Habitat Flows and Water Rights Project,' DEIR adequately represent the threat of cyanotoxins in Russian River?" "The Sonoma County Water Agency (SCWA) states that lower flow could cause the release of cyanotoxins into the river. These cyanotoxins were responsible for the death of a dog that drank contaminated river water in August of 2015. The SCWA contends that this threat is significant but unavoidable and they claim that there is no simulation model available to predict cyanotoxin concentrations under a range of different river flows. I developed a simulation model that accurately predicts the observed concentrations of anatoxin-a in the Russian River. The model predicts a significant increase in anatoxin-a levels and toxicity in animals and humans if the lower flow SCWA proposal is adopted. This work reveals a glaring deficiency in the SCWA draft EIR and it is recommended that the Sonoma County Board of Supervisors do not proceed to implement the lower flow recommendations until the impact of this new toxic threat can be mitigated."

We attach this document as an appendix. Friends of Villa Grande maintains that if Michael Bolger can in two weeks research and produce such a document, then the water agency has a moral and legal obligation to produce such research for their DEIR and for public input. Exclusion of this is begging for legal challenges to the entire process.

- *What is the DEIR response to Michael Bolger's comments and concerns? What are alternative mitigation measures for reducing the impacts from cyanotoxins? What are the potential negative effects from increasing concentrations of anatoxin-a?*

- *Why has the DEIR not addressed the possibility of remediating sources of phosphorous that contribute to the cyanobacteria growth? What is the feasibility of treating phosphorous contaminated water entering into the river from the Laguna de Santa Rosa (the major source of phosphorous in the river)?*

303d listing NCRWQCB list of degraded waterways)

There is no discussion in the DEIR of the existing 303d listing for indicator bacteria that exists from Fife Creek to Dutch Bill Creek in the Russian River. The DEIR should thoroughly discuss this issue and review whether or not mitigation measures are necessary or available.

- *How will the reduced flow proposed by this project affect concentration of contaminants in this stretch? What impacts may result if contaminants are increased in the affected area? What mitigation measures are proposed to address potential exacerbation of the contamination problems in the 303d listed stretch of the river and how will these be monitored?*

Wastewater

The unincorporated communities downstream of the Russian River County Sanitation District sewer system rely on individual onsite wastewater treatment systems for sewage disposal. The North Coast Regional Water Quality Control Board (NCRWQCB) has expressed concerns that these systems may individually or collectively be affecting the water quality in the Russian River. They are currently conducting a Total Maximum Daily Load (TMDL) study to determine what level of discharge from onsite sewage disposal systems is sustainable.

The DEIR should examine how the reduced flows in this stretch of the river may affect the concentration of contaminants from onsite systems.

- *Will changes in river flow affect the TMDL study? Will changes in river flow make it more difficult for the* NCRWQCB *and individual property owners to meet water quality standards? What are the impacts of the reduced flow as it relates to concentrations of contaminants from onsite sewage disposal systems? What mitigation measures are available or proposed? How will these mitigation measures be implemented? How has SCWA coordinated with the TMDL project under review by the Water Quality Control Board? Is there a potential need to extend public sewerage facilities that may result from implementing this project? What agencies will be conducting ongoing monitoring to assess impacts in the un-sewered areas?*

Ludwigia hexapetala

The lower Russian River and Patterson Point Preserve have experienced a significantly increased growth of Ludwigia hexapetala in the past ten years. This is a non-native invasive plant species that has caused extensive degradation of water bodies in Sonoma County, including the Laguna de Santa Rosa. Repeated remediation efforts have been largely unsuccessful in eliminating Ludwigia growth from the Laguna. The Ludwigia completely covers the water surface of portions of the Laguna and renders these areas unusable for recreation and fishing as well as affecting aquatic life. In the DEIR here is no mention or analysis of the effects of the project on the growth of Ludwigia hexapetala in the mainstem of the Russian River.

- *What are the impacts of increased levels of biostimulatory substances, the reduced water surface area and the increased water temperature on the growth of Ludwigia hexapetala? What ancillary impacts will result from increased Ludwigia hexapetala growth? What are the impacts to fish, mammals, water quality and recreation? What mitigation measures are available to address these impacts and how will they be monitored? How will any additional growth of Ludwigia hexapetala in the Russian River main stem be mitigated, and how will the mitigation be monitored?*

Salinity

The lower Russian River has salinity problems that have moved upstream as far as Casini Ranch. The salinity intrusion into the river will be affected by sea level rise from global climate change.

The reduced water flows resulting from the proposed project could cause the salinity to move further upstream. If salinity moves upstream as far as Monte Rio, it could cause degradation of water supply wells for the Sweetwater Springs Water District and for the Camp Meeker/Occidental water system.

The DEIR should explore whether the project in conjunction with the effects of sea level rise will affect public water supplies or groundwater recharge due to increases in salinity levels. It should address the availability and practicality of mitigation measures for impacts from the intrusion of salinity.

- *What are the potential salinity level changes that will result from the project? What is the threat to public water supplies, private water supplies and groundwater quality? What mitigation measures are available or proposed to address changes in salinity levels? Who will monitor salinity level changes and implement mitigation measures? How will funding be provided for new water sources to be found and water transported if the present water sources for Guerneville, Monte Rio and Camp Meeker become unusable due to river salination?*

Fish

While an Appendix to the DEIR points to the Estuary Project (upon which this DEIR is based) no studies correlating the combined impacts of the estuary project and low flow have actually been conducted. That this has not been studied is troubling and is a major flaw in the DEIR.

In the presentation to the Board of Supervisors, SCWA admits that warmer water temperatures "may be less than optimal" for the salmon. The Biological Opinion states that the increase in water temperatures is approaching the lethal limit for salmonids during estuary closing and during low flow. Low flow and closing of the mouth of the river also results in a lower dissolved oxygen level, which negatively impacts fish. Nevertheless, this project proposes even lower flows than those required by the Biological Opinion. One purpose of this project is to help increase salmonids. However, there appears to be no discussion in the DEIR of how this project will measure increasing the fish species that it purports to be assisting. Moreover, impacts on other wildlife native to the river have been ignored.

- *Why is SCWA proposing lower flows than those required by the Biological Opinion*? *How will these lower flows help increase salmonids? How will this increase be measured and monitored? What are the real impacts on the fish and other wildlife native to the river? What are the combined impacts of the estuary project and this proposed project? How will negative impacts of the two projects be mitigated? How will these mitigations be monitored?*

The project proposes maintaining reduced flow until 2040. By requesting the extension to 2040, the water agency abdicates responsibility for proving that this experiment – which is what this is - is successful. This turns this project from a scientific DEIR into a biased and non-productive fait accompli and appears to simply be a grab for more water, despite assertions to the contrary. The "management of water supply" has never actually gone to the stated cubic feet in the DEIR.

The "alternatives" cited in the DEIR are literally non alternatives and poor at best. SCWA should be required to provide realistic alternatives to the Board of Supervisors and to the general public at large.

- *What are realistic alternatives? What measures are proposed for the continued monitoring of the effects of the project on fish populations? What adaptive measures are included? How will SCWA modify the project if negative impacts to fish populations result?*

Environmental Justice

In the DEIR there is no evaluation of the differential environmental impacts on the lower income communities in the lower river area. "Environmental justice" is defined in the Government Code as "the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies." (Gov. Code, § 65040.12, subd. (e)). A report by The California Attorney General's Office defines "fairness" in this context to mean that "the benefits of a healthy environment should be available to everyone, and the burdens of pollution should not be focused on sensitive populations or on communities that already are experiencing its adverse effects."

The communities of Monte Rio and Guerneville are low income communities which are heavily impacted by the significant adverse environmental impacts of this project. Both of these communities have been classified as Disadvantaged Unincorporated Areas (DUCs) by the Sonoma County Local Agency Formation Commission (LAFCO). These communities will be subject to disproportionate levels of impacts from this project due to their location in the lower reaches of the project area which will be more heavily impacted from water quality and recreational impacts. These communities are heavily dependent on tourism as a major source of revenue to the local economy. These low income communities should not have to bear the brunt of the negative effects of the project.

- *Why was the subject of environmental justice not even discussed in the DEIR? How will the project ensure environmental justice for the Guerneville and Monte Rio communities? What mitigations can be included to lessen the environmental effects to disadvantaged communities and how will they be monitored? What are the reasonably foreseeable environmental impacts that will result from the potential economic decline of the lower river areas? Does this project result in disproportionate public health burdens to these communities? Why or why not?*

Alternatives to the project

The number of project alternatives evaluated in the DEIR is extremely minimal, especially considering the magnitude of the project and the large number of significant environmental impacts. FOVG requests consideration of the following alternatives in the DEIR:

1. The decision by NMFS is presented as an immutable mandate. There should be discussion with NMFS regarding alternatives that could mitigate the adverse environmental impacts while still achieving the goals of the Biological Opinion. The biological opinion is just that, an opinion. If NMFS was aware of the adverse impacts when it developed the opinion, they may have considered alternatives that are not as environmentally destructive. Renegotiation of the biological opinion should be presented as an alternative to the project and should be evaluated and discussed in the DEIR.

- *How can renegotiating the Biological Opinion mitigate the adverse environmental impacts of the proposed project?*

2. The primary source of phosphorous in the lower Russian River is the Laguna de Santa Rosa. The adverse impacts from biostimulatory substances could be mitigated by reducing the level of phosphorous entering into the mainstem of the river from the Laguna. This could be done by proactive programs to abate the sources of phosphorous in the Laguna, by treating the water entering the river from the Laguna or by introducing clean water into the Laguna to reduce the phosphorous levels. These alternatives should be considered and evaluated in the DEIR.

- *How would reducing the level of biostimulatory substances entering the mainstem of the river mitigate adverse impacts?*

Conclusion

We request that the concerns and questions that we have raised be thoroughly addressed prior to certification of the DEIR. The project as proposed will result in serious, unmitigated impacts to residents of the lower river area and to the recreational, biotic and scenic resources of the area. This is a deeply flawed project which needs to be thoroughly re-evaluated.

Respectfully Submitted, Friends of Villa Grande

Ken Wikle, President
Kyla Brooke, Vice President
Rich Holmer, Past President
Roberto Esteves, Executive Director
Tim Cahn, Treasurer,
Kyra Wink, Secretary,
Sukey Robb-Wilder, Board Member
Ruben Garcia, Board Member
With significant contributions from Andrea Buffa, Victoria Wikle and Jon Box

Appendix:

Does the “Fish Habitat Flows and Water Rights Project”, EIR (dated 8/19/16) adequately represent the threat of cyanotoxins in Russian River?

Copy to:

Sonoma County Board of Supervisors:

Supervisor Carrillo
Supervisor Gore
Supervisor Zane
Supervisor Rabbitt
Supervisor Gorin

Lynda Hopkins
Noreen Evans

State Water Resources Control Board
North Coast Regional Water Quality Control Board
Governor Jerry Brown
Attorney General Kamala Harris
Assembly member Jim Wood
Senator Mike McGuire
Congressman Jared Huffman

Sonoma County Agricultural Preservation and Open Space District
Sonoma Coast State Park
Sweetwater Springs Water District
Monte Rio Parks and Recreation District
Monte Rio Chamber of Commerce
Russian River Chamber of Commerce
Russian River Parks and Recreation District
Russian River Watershed Protection Committee

Santa Rosa Press Democrat
Sonoma West Times News
The Healdsburg Tribune
Windsor Times
The Bohemian
Sonoma County Gazette
Russian River Times

APPENDIX

Does the "Fish Habitat Flows and Water Rights Project", EIR (dated 8/19/16) adequately represent the threat of cyanotoxins in Russian River?

Michael B. Bolger, Ph.D.
15537 Riverside Dr. Guerneville, CA 95446 (707)869-9155

Introduction:

In response to a National Marine Fisheries Service published Biological Opinion (BO) dated Sept. 24, 2008, the Sonoma County Water Agency (SCWA) has proposed changes to the regulation of Russian River water flow that are proposed to be enacted by 2017. The water agency released an environmental impact report (EIR) on Aug. 19th 2016 that describes the rationale and potential impacts of these river flow changes.

In section 4.2-4 of the EIR, SCWA states that "Changes to minimum instream flows could result in a violation of water quality standards or waste discharge requirements or otherwise degrade water quality relating to biostimulatory substances in the Russian River" that are "(Significant and Unavoidable)". In addition, SCWA stated that "High concentrations of biostimulatory substances including nitrogen, phosphorus, and algae (chlorophyll-a) could have a negative effect on water quality in the Russian River, including the Estuary. High levels of nutrients can contribute to excessive algal growth in river and streams, causing nuisance conditions which can affect dissolved oxygen, pH, and temperature and the overall quality of aquatic habitat. Excessive algal growth can affect the aesthetics of the river negatively impacting contact and non-contact recreation. Excessive algal growth can also contribute to the proliferation of blue-green algae, which in turn can pose a risk to contact recreation through the release of cyanotoxins into the water column." and that "There is no simulation model available for the Russian River that can adequately simulate algal biomass or nutrient and chlorophyll-a concentrations under a range of different flows."

The purpose of this report is to challenge the assumption that the impact of lower flows on water quality and specifically to the prediction of the concentration of cyanotoxins as a function of river flow, water temperature, and high ambient air temperature cannot be predicted. This report describes a simulation model for 2015 and 2016 that accurately predicts the observed concentrations of anatoxin-a in the Russian River below the merge between Dry Creek and the Upper Russian River.

Biological Significance of Cyanotoxin Pollution:

"In August of 2009, a series of dog deaths occurred along the South Umpqua River in Douglas County, Oregon. One of those deaths was confirmed to be the result of exposure to a toxin produced by certain genera of photosynthetic cyanobacteria, also called blue-green algae. The deceased dog's stomach contents contained 10 μg/L anatoxin-a. In August of 2010, another dog death was confirmed to be caused by exposure to anatoxin-a. This dog, a healthy six month old black Labrador retriever, was vomiting, staggering, and convulsing within 10 min of drinking and playing in water from an isolated pool along the banks of the same stretch of the South Umpqua River and was dead within an hour. The treating veterinarian reported that her hands were "burning" after handling the dog's body [1].

On Aug. 29rd 2015 a dog died from anatoxin-a poisoning as a result of drinking water from the Russian River north of Wohler Bridge (Press Democrat Article 9/3/2016). Anatoxin-a is one of three types of cyanotoxin found in the Russian River during 2015 and 2016. It is produced by cyanobacteria associated with blooms of blue-green algae. Anatoxin-a is a neurotoxin that strongly inhibits the acetylcholine nicotinic receptor at the neuromuscular junction in skeletal muscle which is responsible for coordinated movement and breathing. Anatoxin-a poisoning is characterized by skin tingling, burning, and numbness, drowsiness, incoherent speech, and respiratory paralysis leading to death [2]. The other two types of cyanotoxin found in the Russian River and many other locations in California are known to be hepatotoxic. According to the California Department of Fish and Wildlife (CDFW) Water Pollution Control Lab (WPCL) report, these other

two cyanotoxins are microcystin and cylindrospermopsin. This report will focus on the environmental factors along the Russian River that can be included in a simulation model to predict the daily concentrations of anatoxin-a.

Tolerable Daily Limits and Allowable Anatoxin-a concentrations

In the absence of federal criteria for cyanotoxins in recreational water, the Oregon Health Authority (OHA) developed guideline values for the four most common cyanotoxins in Oregon's fresh waters (anatoxin-a, cylindrospermopsin, microcystins, and saxitoxins). OHA developed three guideline values for each of the cyanotoxins found in Oregon. Each of the guideline values is for a specific use of cyanobacteria-affected water: drinking water, human recreational exposure and dog recreational exposure [1]. Table 2 was copied from the work of Farrer and lists the tolerable daily limits of several cyanotoxins.

Table 2. Summary of Oregon's tolerable daily intakes and guideline values for four cyanotoxins for use in acute or short-term exposures.

Guideline value	Anatoxin-a	Cylindrospermopsin	Microcystin	Saxitoxin
Human TDI (μg/kg-day)	0.1	0.03	0.05	0.05
Dog TDI (μg/kg-day)	None—used human TDI	None—used human TDI	None—used human TDI	0.005
Drinking Water (μg/L)	3.0	1.0	1.0	1.0
Recreational Water (μg/L)	20.0	6.0	10.0	10.0
Dog-specific (μg/L)	0.4	0.1	0.2	0.02

Since the molecular target of these environmental toxins is common to all mammals the toxic effect will depend on the dose (what volume of water is consumed and at what concentration of toxin) and the physiology of the animal or human (body weight, etc .). According to OHA and the Farrer article, the tolerable daily intake (TDI) for humans (and dogs) is 0.1 ug/Kg body weight per day. A bloom of blue-green algae resulting in anatoxin-a concentration of 48.9 μg/L (as occurred at Steele Beach on Sept. 21st 2015), then a typical glass of water (250 mL or 1/4 of a liter) would have 12 μg of anatoxin-a. If the TDI is 0.1 μg/Kg then a human (70 Kg) would tolerate 7 μg but a dog (10 Kg) would only tolerate 1 μg. So the dog dose would be 10 times the tolerable limit set by the Oregon Health Authority. In the case of a small river otter (body weight = 5 Kg) then the tolerable limit would only be 0.5 μg. So on Sept. 21, 2015 it would be recommended that the otter should not to drink more than 0.01 L (~ 2 teaspoons) of river water.

Environmental Factors that Influence the Production and Degradation of Cyanotoxins

Basic research on cyanobacteria suggests that they will thrive under the conditions predicted for global climate change [3]. Anatoxin-a was first detected in the Russian River in August of 2015 and as such represents a newer subject of environmental concern that may not have been adequately studied in the EIR. The subject of cyanotoxins is only mentioned twice in the entire 3602 pages of the EIR and anatoxin-a is never once mentioned. This is a serious deficiency in the EIR and represents an important reason to immediately halt the implementation of lower flow recommendations until these issues can be mediated.

Cyanotoxin production is thought to be influenced by a number of different physical and environmental parameters, including nitrogen, phosphorous, trace metals, growth temperature, light and pH [4]. Conditions that can contribute to blue-green algae blooms, include decreased water flow and decreased water mixing, elevated water temperature, and the presence of excess nutrients (Draft Voluntary Statewide Guidance for Blue-Green Algae Blooms – July 2010 from the Blue Green Algae Work Group of the State Water Resources Control Board (SWRCB), the California Department of Public Health (CDPH), and Office of Environmental Health and Hazard Assessment (OEHHA)). As water temperatures approach and exceed 70 deg. C, the growth rates of normal freshwater algae generally stabilize or decrease while growth rates of many cyanobacteria increase, providing a competitive advantage [3]. It only makes sense that increased river flow will result in dilution of any cyanotoxins produced resulting in lower concentrations than would be found at lower flows. The SCWA concluded that appropriate models to predict cyanotoxin concentration are not

available and therefore the impact might be significant but cannot be avoided. Finally, anatoxin-a degrades readily, especially in sunlight and at high pH, to nontoxic degradation products such as the stable alkaloid dihydroanatoxin-a [5].

Development of a Simulation Model for Anatoxin-a in Russian River

Data for daily flow in cubic feet per second (cfs) along the Russian River at Hacienda (HAC) was obtained for the years 2012 to 2016 from the California Department of Water Resources, California Data Exchange Center (http://cdec.water.ca.gov). There was missing data for some days due to flow being below the lower limit of the flow gauge range. In those cases the flow was averaged from data one day before and one day after the missing values. In August of 2015, several days in a row had missing flow data and in those cases the model assumed 50 cfs. Data for ambient air temperature was collected from historical values found at the web site "Weather Underground" (https://www.wunderground.com). Data for Russian River water temperature measured near Guerneville, CA was collected from the United States Geological Survey National Water Survey Information System (http://nwis.waterdata.usgs.gov). Data for the measured concentrations of anatoxin-a during 2015 and 2016 was obtained from multiple sources. First, a web site developed by Stephanie K. Baer (a reporter for many Southern California news outlets) in June of 2016 (http://projects.sgvtribune.com/blue-green-algae/) provides an interactive map of California with geographical locations and cyanotoxin levels for many lakes and streams. In addition, the author of this report obtained the original source data for cyanotoxin locations and levels measured by the California Department of Fish and Wildlife (CDFW) Water Pollution Control Lab (WPCL) and the US EPA. Finally, the cyanotoxin concentrations measured in 2016 were obtained from the Sonoma County Department of Health Services blue-green algae information website (http://www.sonoma-county.org/health/services/bluegreen.asp).

This data was compiled in a MS-Excel spreadsheet and plotted in order to observe the basic trends and relationships in river flow, water temperature, high air temperature, and anatoxin-a concentrations. It was hypothesized that anatoxin-a levels would increase as river water temperature increased, decrease as river flow increased, and would decrease as sunlight and UV radiation increased. The influence of sunlight was represented by the daily high ambient air temperature. A simple ordinary differential equation (Eqn. 1) for the rate of anatoxin-a concentration as a function of time was developed.

$$\frac{dAnatoxin}{dt} = +(Kform * WaterTemp) - (Kdeg * HighAirTemp) - (Kflow * HACFlow)^N \qquad \text{Eqn. 1}$$

Where:

Kform = rate constant for formation of anatoxin-a
WaterTemp = Russian River water temperature (deg. F) near Guerneville, CA
Kdeg = rate constant for degradation of anatoxin-a
HighAirTemp = daily high ambient air temperature (deg. F) near Rio Nido, CA
KFlow = rate constant for the influence of river flow at Hacienda (HAC)
HACFlow = Russian River flow (cfs) at Hacienda (HAC)
N = exponent for the relationship of *KFlow* time river flow.

Parameter estimates used for the following figures are:

Kform = 0.17 day^{-1}
Kdeg = 0.022 day^{-1}
Kflow = 4900 day^{-1}
N = 0.1815

Results:

Figure 1 shows the important variables assumed to be important in predicting the anatoxin-a concentrations along with bars for the sparse data available for the observed levels of anatoxin-a during 2015 and 2016. In addition, a solid line for the simulation model predictions for daily anatoxin-a concentration is shown.

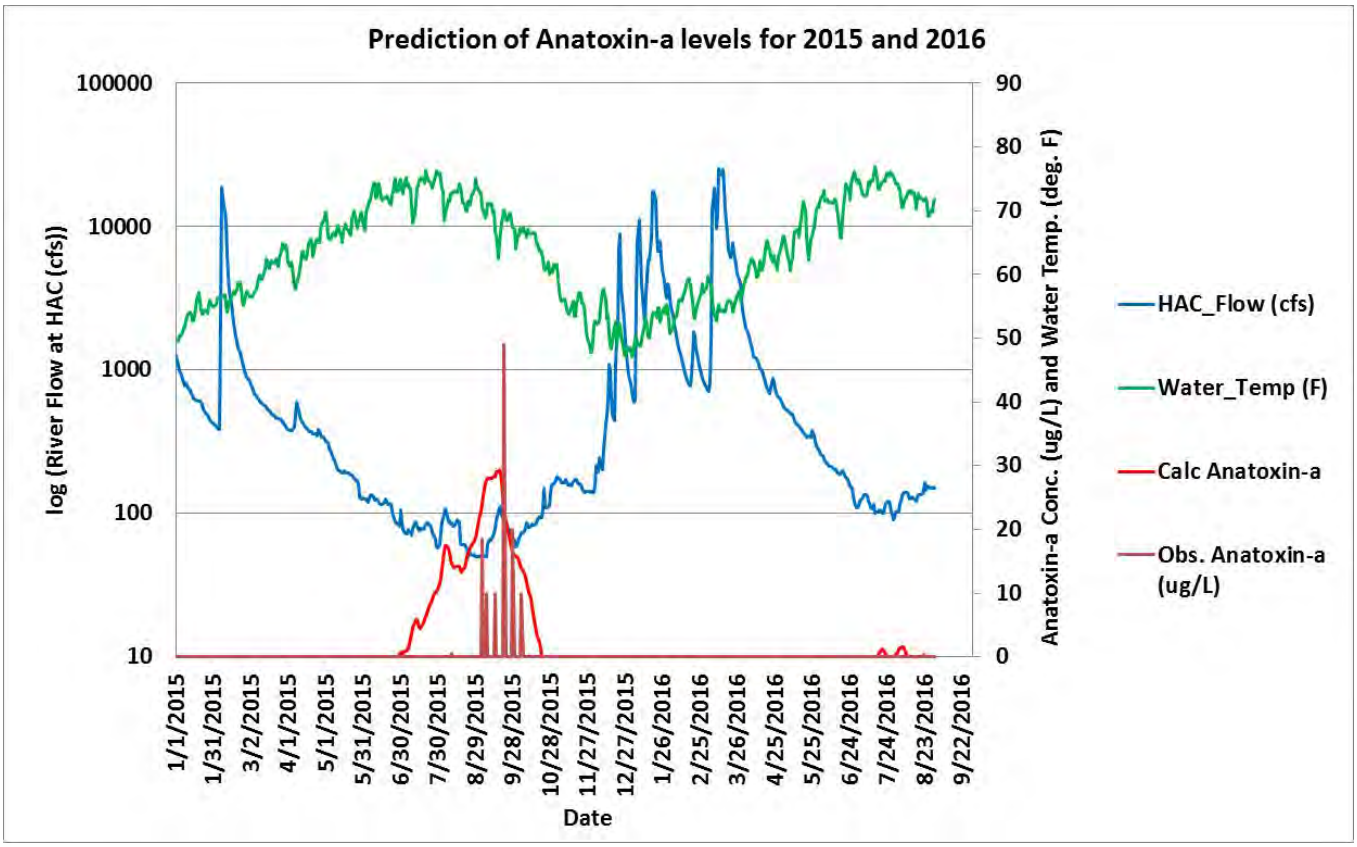

Figure 1. Daily predicted and observed anatoxin-a concentrations for 2015 to 2016. The right hand axis represents the log of the river flow at HAC (cfs) and is shown as the blue line. The left hand axis is tied to both anatoxin-a concentration and water temp. The observed anatoxin-a concentrations (μg/L) for 2015 and 2016 are shown as brown spikes along with observed water temperature (solid green line, in deg. F). The simulation model predicts anatoxin-a concentration (μg/L) (shown as a solid red line) for 2015 and 2016.

One can easily see from Fig. 1 that the combination of high water temperature and low river flow presumably results in a bloom of blue-green algae and production of higher levels of anatoxin-a in the Russian River. A low level of anatoxin-a was measured in an algal-mat collected near Rio Nido on August 10th 2015. The predicted concentrations for that time period exceed that measured value by a wide margin. However, since this was the earliest date that anatoxin-a was detected and a regular program of sampling was not in place it is possible that higher concentrations were in the river but just not detected.

Figure 2 shows the results of a simulation for the years from 2012 to 2014 indicating that much lower levels of anatoxin-a would have been expected to be formed due to the higher river lows during that time. It's impossible to know if those levels were in the river at that time since no data was collected in those years and the predicted levels are low enough that toxic effects on animals and humans may not have been detected.

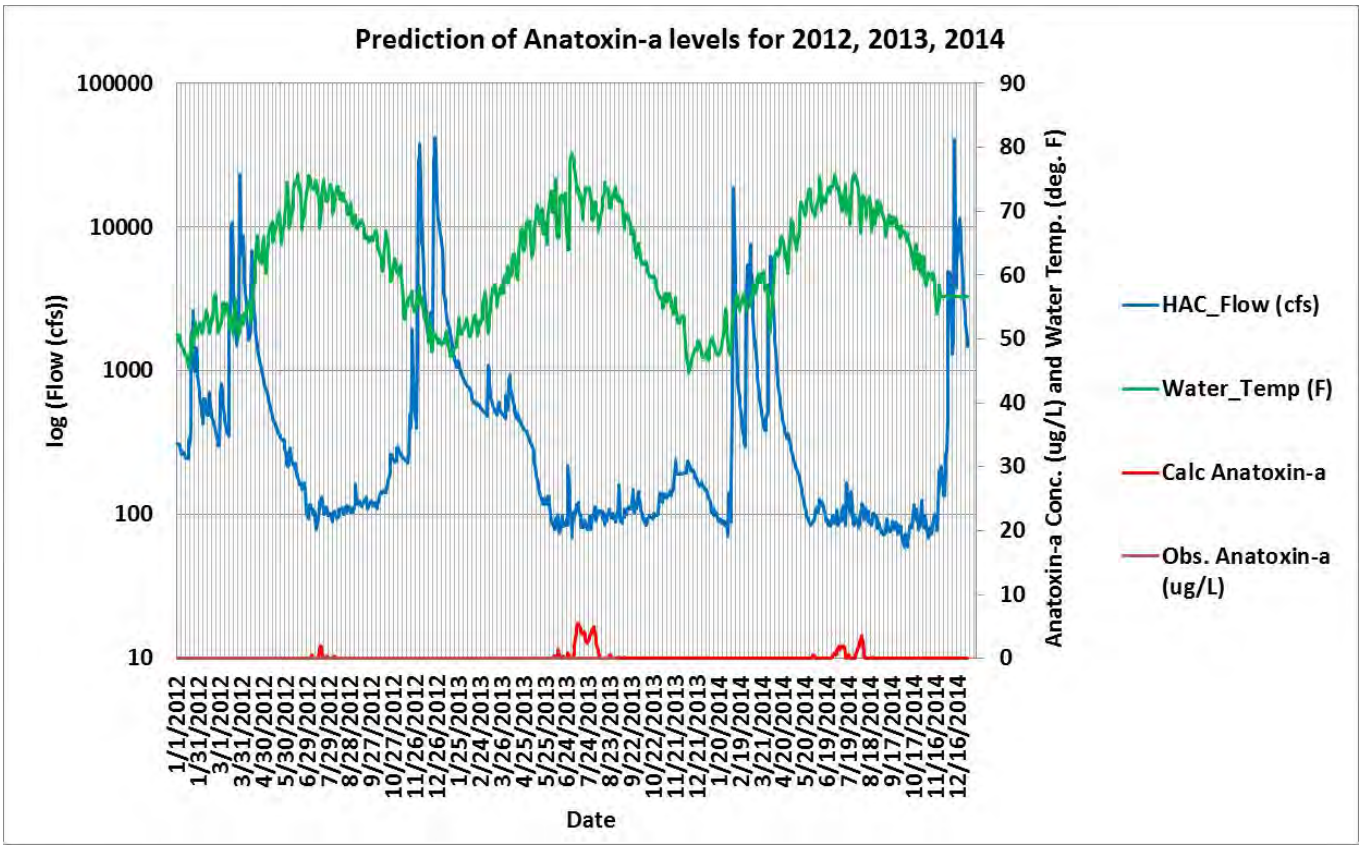

Figure 2. Daily predicted and observed anatoxin-a concentrations for 2012 to 2014. The right hand axis represents the log of the river flow at HAC (cfs) and is shown as the blue line. The left hand axis is tied to both predicted anatoxin-a concentration and water temp. Anatoxin-a was not measured in 2012 to 2014. Water temperature is shown as a solid green line, in deg. F. The simulation model predicts anatoxin-a concentration (µg/L) (shown as a solid red line) for 2012 to 2014.

As seen in Fig. 2, the river flows from 2012 through 2014 rarely went below 100 cfs and the predicted anatoxin-a concentrations are quite low and would not be expected to produce toxic effects in animals or humans.

Figures 3, 4, and 5 show the 2015 and 2016 predicted anatoxin-a levels if we keep all the same water temperature and air temperature data but simply substitute the proposed lower "Fish Flow" proposals from May 1st through October 15th for levels 1to 3, 4, and 5 of hydrological drought categories.

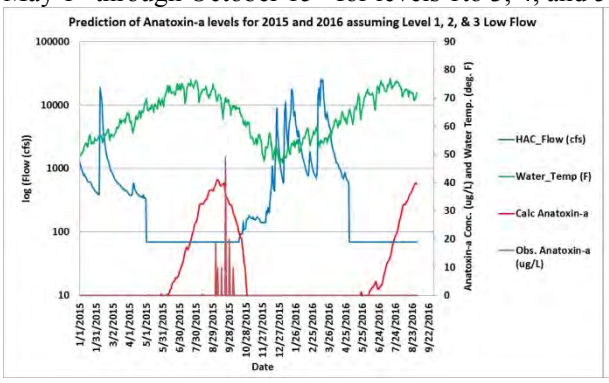

Figure 3

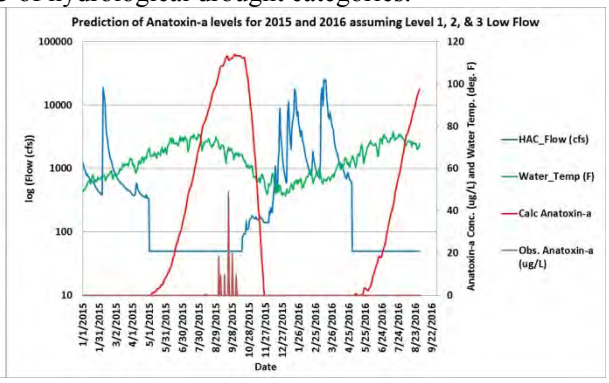

Figure 4.

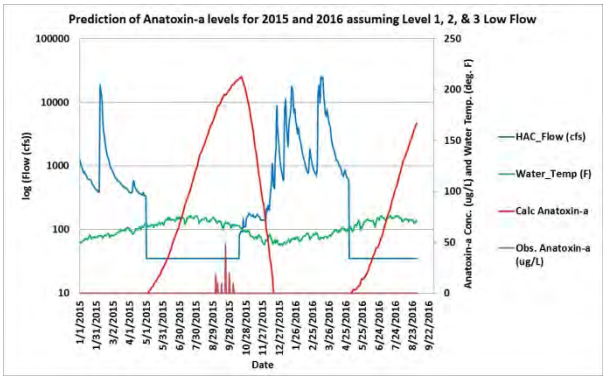

Figure 5.

Of course these predictions would be the worst possible scenario if the recommendations in the EIR are enacted since the river flows in May and June are usually higher than the minimum flows represented by Level 1,2, and 3 (70 cfs), Level 4 (50 cfs), and Level 5 (35 cfs). However, it is clear from this simulation model that the SCWA should consider this type of scientific simulation tool in conjunction with their recommendations for lower river flows to prevent the harmful effects in animals and humans.

Summary and Conclusions:

This study reveals a glaring deficiency in the SCWA draft with regard to the prediction of cyanotoxin levels due to the proposed lower Russian River flows. The SCWA has neglected to discuss the growing problem and significance of this type of water quality degradation. The physiological consequences of exposure to high levels of cyanotoxins in river water cannot be ignored. Data was collected and used to build a simulation model to predict the concentration of anatoxin-a as a function of river flow, water temperature, and ambient air temperature. The simulation model was able to accurately estimate the observed anatoxin-a levels measured in 2015 and 2016. Finally, the consequences of implementation of the recommendations in the Biological Opinion to lower the minimum river flows were simulated and show alarming high predicted anatoxin-a concentrations. It is recommended that the Sonoma County Board of Supervisors **do not proceed to implement the lower flow** recommendations until the impact of this new toxic threat can be mitigated. I'd be pleased to meet with SCWA scientists on the development of this model.

References:

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