M E M O R A N D U M

TO: Matt St. John

North Coast Regional Water Quality Control Board
5550 Skylane Blvd., Suite A
Santa Rosa, California 95403

VIA: David M. Siegel, Ph.D., Chief
Integrated Risk Assessment Branch

FROM: Karlyn Black Kaley, Ph.D., D.A.B.T., Staff Toxicologist
Applied Risk Assessment Unit

DATE: September 1, 2005

SUBJECT: COMMENTS ON THE CYANOBACTERIAL/MICROCYSTIN TOXIN SUMMER 2005 WATER SAMPLING RESULTS FOR THE COPCO/IRONGATE RESERVOIR.

As you have requested we have briefly reviewed the water sampling data found in the following first three documents. We have referenced the later two documents as part of our review as well.

1) Memo dated August 18, 2005 re: Copco Lake Toxic Cyanobacteria Results to Karuk Tribe/NCWQCB from Jacob Kann, Ph.D.;

2) Memo dated August 19, 2005 re: Copco/Irongate Reservoir Toxic Cyanobacteria Results: followup to Karuk Tribe/SWRCB/NCWQCB from Jacob Kann, Ph.D.;

3) Memo dated August 30, 2005 re: Copco/Irongate Reservoir Toxic Cyanobacteria Results: 7/26-27 to Karuk Tribe/SWRCB/NCWQCB from Jacob Kann, Ph.D.;

4) 1999 World Health Organization, Toxic Cyanobacteria in Water: A guide to their public health consequences, monitoring and management, Ed. I. Chorus and J. Bartrum (html version found at: http://www.who.int/water_sanitation_health/resourcesquality/toxicyanbact/en/); and,

5) World Health Organization Guidelines for Drinking Water Quality, 3rd Edition (html version found at: http://www.who.int/water_sanitation_health/dwq/gdwq3/en/index.html).

Given the time frame of less than two weeks for review, it was not possible for us to conduct a comprehensive risk analysis or assessment of the potential microcystin toxin exposure situation you have presented. However, based on the data you have presented, we can offer with confidence the following public health statement and supporting observations:

> The Microcystis aeruginosa cyanobacteria levels and resulting microcystin toxin concentrations detected in water samples collected from both shoreline and open water locations in the Copco and Irongate Reservoirs in California pose a significant potential threat of adverse health affects in human and animals exposed through direct ingestion of contaminated water as well as incidental ingestion during recreational water activities and bathing.

Adverse Health Effects

Health effects that might be expected to be observed—following exposure to the microcystin toxin levels detected in the water samples reviewed—could range from mild non-life threatening skin conditions to permanent organ impairment and death, depending on exposure. More specifically, depending on exposure concentration, duration and individual sensitivity, symptoms could include mild to severe eye and ear irritation, allergic skin rash, mouth ulcers, fever, cold/flu like symptoms, vomiting, diarrhea, pneumonia, liver damage, kidney damage, complete liver failure, increased incidence of liver cancer and death. Children and animals are at greatest risk of serious life threatening affects because of their smaller body size and higher water ingestion rates.

World Health Organization Risk Levels

The World Health Organization (WHO) has established a Tolerable Daily Intake (TDI) as well as Guideline Values (GV's) for microcystin toxin in water. These are useful in valuating potential risk of adverse health impacts from exposure via drinking water as well as recreational water activities. The TDI applies primarily to drinking water, while the GV's have been developed to specifically address the probability of adverse effects occurring in individuals exposed to contaminated water during specific water use scenarios. GV's have been developed for drinking water consumption as well as recreational water exposure.

According to WHO, a TDI is the amount of a potentially harmful substance that can be consumed daily, via ingestion, over a lifetime, with negligible risk of adverse health effects. TDI's are based on scientific data and controlled laboratory studies of observed adverse health impacts. The TDI for microcystin in this case was based on observed acute effects on the liver. The primary study used to develop the TDI is a 13-week oral ingestion mouse study. Because of lack of data, no long term chronic effects or carcinogenicity potential was used in the development of this TDI. Although TDI's do not account for multiple routes of exposure or cumulative risk due to exposure to multiple toxins, they are highly valuable in assessing the potential risk of adverse health

effects from a single toxin. The WHO TDI for microcystin toxin is 0.04 mg/kg body weight.

WHO guideline values represent a scientific consensus, based on broad international participation, of the health risk to humans associated with exposure to microbes and chemicals found in water. For recreational water exposure GV's are defined at three primary concentration levels: mild or low, moderate and high probability of risk for adverse health impacts if exposed at a given toxin concentration. GV's are calculated values. They are derived using the TDI for a given chemical along with a persons' average body weight and the estimated amount of contaminated water that may be ingested on a daily basis during a given activity. GV's do not take into account health risks that may be attributed to other routes of exposure, such as aerosol inhalation or skin contact. The WHO GV for moderate risk of adverse health effects from recreational exposure to microcystin in water is 20 mg/liter (or a density of approximately 100,000 cyanobacteria cells per milliliter (ml) of water). The WHO GV for high risk is the presence of active algal scums, which can increase cell densities a 1000 to 1,000,000 fold.

The maximum Microcystis aeruginosa cyanobacteria density detected in the water samples reviewed was 11,402,943 cells/ml in the CRSH shoreline site sample. This sample had a laboratory detected microcystin toxin concentration of 667 mg/liter. Open water locations varied from 151,004 to 916,548 cells/ml. We understand that it is possible that higher concentrations of microcystin toxin than those detected in these samples may exist in other areas of these reservoirs. The presence of active scum may suggest a higher risk of adverse health effects for humans and animals exposed along shorelines. However, using only the data provided, if we take the maximum detected microcystin value of 667 mg/liter and compare it to the WHO GV for moderate risk of adverse health impacts for exposure to microcystin toxin in water, we can confirm your conclusion that microcystin toxin levels in this sample are 33 times that identified by WHO as posing a moderate risk of adverse health impact for recreational waters. WHO recommends taking some kind of mitigating action to reduce or eliminate human exposure when microcystin toxin concentrations are found at or above a moderate risk GV level of 20 mg/liter.

Recreational Incidental Ingestion Levels

Using the maximum detected toxin value reported above, the WHO values mentioned previously, and a number of general assumptions, we also calculated potential human exposure based on incidental ingestion of contaminated water during recreational water activities and bathing (i.e. swimming).

Adult Incidental Ingestion: For a 60 kilogram (kg) adult, incidentally ingesting 100 mls of contaminated water in any given day, the amount of microcystin toxin consumed would be 1.11 mg/kg body weight. This amount is 28 times greater than the accepted WHO Tolerable Daily Intake value of 0.04 mg/kg body weight. This calculation is based

on a single one-hour "swimming event" per day. More swimming events or activities of longer duration could result in greater exposure.

Child Incidental Ingestion: With respect to children that may be exposed to microcystin at these levels there is an even greater potential health concern. For a 15 kilogram (kg) child (roughly 3 years of age), incidentally ingesting an estimated 250 mls of contaminated water in any one "swimming event" on any given day, the amount of microcystin toxin consumed would be 11.1 mg/kg body weight. This amount of microcystin toxin is 278 times greater than the accepted WHO Tolerable Daily Intake value of 0.04 mg/kg body weight. As with adults, more swimming events or activities of longer duration could result in greater exposure.

Exposure Routes During Recreational Activities

There are three main routes of exposure from recreational bathing and participation in water sports in waters contaminated with cyanobacteria and subsequent microcystin toxins. These include: 1) direct contact with exposed skin including the highly sensitive ear, eye, nose and throat membranes, 2) accidental or intentionally swallowing (oral ingestion), and 3) inhalation of contaminated water aerosols. Given the data presented and the risk values available, we can practically address only the potential risk associated with ingestion exposure in this limited review. Clearly the greatest risk of adverse affects to humans and animals would be associated with direct deliberate ingestion of contaminated water as a source of drinking water. However, incidental ingestion could also present a significant risk, especially for small children, in recreational settings. Ways to minimize or prevent all routes of exposures to contaminated reservoir water include prohibiting use of the water body as a source of drinking water and reducing contact with contaminated water by limiting and/or prohibiting recreational access.

Thank you for the opportunity to comment on the data set provided. If you have any questions please feel free to call me at (916) 323-2808.

cc: George V. Alexeeff, Ph.D., D.A.B.T.

Deputy Director for Scientific Affairs

Office of Environmental Health Hazard Assessment

Barbara Washburn, Ph.D.

Office of Environmental Health Hazard Assessment