- Draft Final -

Blue-Green Algal Toxins Monitoring and Reporting Plan

Prepared by the

Algae Task Force

a subcommittee of the

Lake Mead Water Quality Forum

July 2004

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II. Background

The Algae Task Force (ATF) was originally formed as a subcommittee of the Lake Mead Water Quality Forum (Forum) to investigate the causes of a green algae bloom that occurred throughout Lake Mead in 2001. This bloom mainly consisted of a variety of alga named *Pyramichlamys disecta*. While algal blooms of this type typically occur during the Spring within limited areas (such as Las Vegas Bay), the 2001 event was more extensive both spatially and temporally. The algae dominated the surface of the Boulder Basin and much of the Lake's beach and cove areas from February through early fall, imparting an emerald green color (Figure 1) to the waterbody at times. The bloom became a concern to regulatory and management agencies, as well as the Lake Mead marinas and concessionaires, primarily because its appearance impaired the recreational value of the lake.

Of greater concern however, was the discovery of *Cylindrospermopsis*, a blue-green alga or cyanobacterium, at the confluence with the Overton Arm. Of the 50 known genera of freshwater cyanobacteria, about one-third are capable of producing toxins that may be harmful to animals and humans (Morris, 2000).

Figure 1. The 2001 *Pyramichlamys disecta* algae bloom that occurred in the Las Vegas Bay.

Commonly known as “Cylindro,” this particular species was originally considered a subtropical alga, having been identified circa 1913 in India. However, it has proven to be a prolific, invasive species that first appeared in Florida roughly 30 years ago. In the past 10-15 years, the species has spread throughout North America, probably transported by boats and/or waterfowl (St. Armand, 2002). This algae can grow almost as a single species bloom of considerable density that may persist for months. While large blooms have been attributed to eutrophication of surface waters, their causes are more complex. Multiple interacting physical, chemical and biotic factors, in the proper combination, lead to the development and persistence of nuisance algal blooms (Paerl 1988). The specific physiochemical requirements or factors that facilitate an individual blue-green species to dominate an aquatic ecosystem are largely unknown and probably vary between species.

In 2003, *Cylindrospermopsis* grew to concentrations of approximately 27,000 cells/ml in the Las Vegas Bay. However, toxins concentrations in samples collected during the bloom could only be detected once. In that case, the toxin Cylindrospermopsin was detected at a level of 0.054 µg/l, just slightly greater than the analytical detection limit of 0.05 µg/l. This concentration is, however, still well below the 1.0 µg/l guideline level that the World Health Organization (WHO) recommends as acceptable for drinking water (Chorus and Bartram 1999).

Monitoring is the best line of defense to ensure public health protection. This Plan is aimed at monitoring *Cylindrospermopsis* blooms and associated toxins concentrations, and reporting this information to the appropriate agencies (namely the National Park Service (NPS), Nevada State Health Division (NSHD), the Clark County Health District (CCHD), Southern Nevada Water Authority (SNWA) and the Arizona Department of Environmental Quality (AZ DEQ)) in the case that they may take action if a public health threat was determined to exist.

Cylindrospermopsis remains the alga of primary concern, Therefore, it is possible that future environmental conditions could facilitate the proliferation of a different blue-green algae species.

. Algae Task Force member agencies have pro-actively initiated this monitoring and reporting system to detect these potentially harmful toxins.
No standards or monitoring requirements currently exist in the United States for algal toxins, although the U.S. Environmental Protection Agency (USEPA) has initiated the process of establishing guidelines or standards. Cyanobacterial toxins are included as List 3 contaminants (methods in the early stage of development) on the revised Unregulated Contaminant Monitoring Rule (UCMR) and in May 2001, a panel of scientists convened to develop an algal toxin target list for the UCMR. The priority toxins include the microcystins, anatoxin-a and cylindrospermopsin, all produced by a variety of cyanobacteria genera (USEPA 2001). Microcystins (over 60 variants are known) and cylindrospermopsin are hepatatoxins that target the liver, but may also cause widespread tissue damage to the kidney, heart and/or lymph system. Anatoxin-a and saxitoxin, both produced by *Cylindrospermopsis*, are neurotoxins, which upon ingestion, can result in paralysis, respiratory distress, convulsions, asphyxiation, or death (Westrick 2003)

III. Agency Roles & Responsibilities

The Algae Task Force is composed of a variety of local, state and federal agencies, whose roles and responsibilities as related to the monitoring and reporting plan have been agreed upon as outlined below:

- Develop and distribute the Blue Green Algal Toxins Monitoring and Reporting Plan;
- Coordinate and conduct monitoring throughout Lake Mead, Lake Mohave and the Las Vegas Wash in accordance with this Plan;
- Provide regular updates of analytical information to the appropriate agencies and Lake Mead Water Quality Forum;
- Develop and distribute a Fact Sheet and/or additional outreach materials deemed necessary to raise public awareness regarding blue-green algae;
- Raise public awareness of and promote the use of Best Management Practices (BMPs) to minimize nutrients entering waterways;
- Respond to media inquiries seeking general information on algal blooms;
- Take action necessary to ensure that public health and safety is maintained as well as that of terrestrial and aquatic wildlife.

IV. Program Design

Samples will be collected for algal identification and enumeration throughout Lake Mead. However, resources dictate that the number of sampling events and the spatial extent of the monitoring must remain limited. Much of the time and money to carry out this Plan is being donated by Algae Task Force member agencies. Therefore, samples will be collected at ten select sites on Lake Mead and in the Las Vegas Wash (Figure 2) every other week from July through October, 2004. The sites were selected for one or more of the following reasons:

- *Cylindropermopsis* was previously reported at the location;
- the location is in a productive region of the lake;
- the sampling location is in proximity to a tributary input to Lake Mead;
- recreation involving contact with the water is occurring at or near the site.

Additional samples will be taken at two locations in the Las Vegas Wash (Figure 3) and at three locations in Lake Mohave (Figure 4) during the August 30 to September 3, 2004 sampling event.

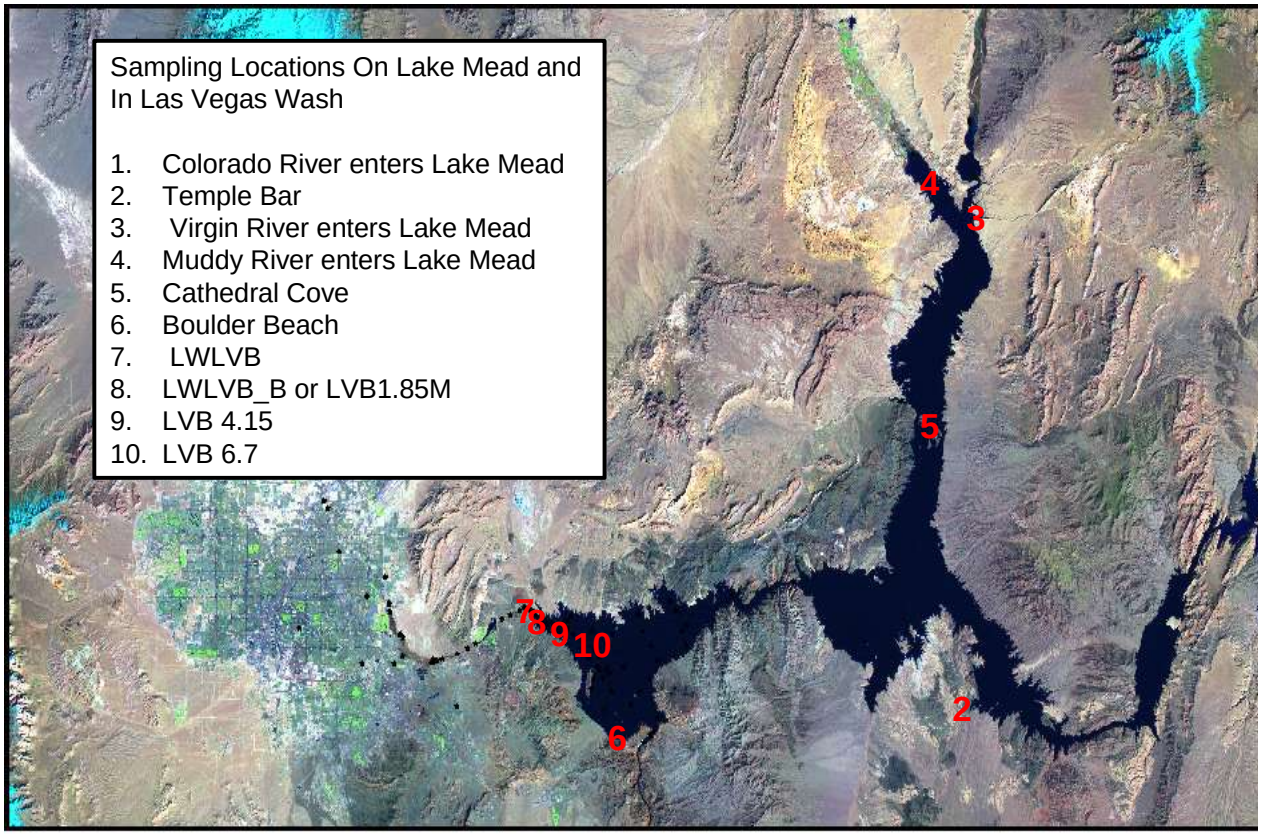

Figure 2: Monitoring locations in Lake Mead.

Since several agencies will be conducting the monitoring, protocols have been standardized to ensure the data are comparable. Operating procedures are outlined in the *Blue-Green Algal Toxins Monitoring Protocol and Standard Operating Procedures*, available upon request. This document further outlines the quality assurance/quality control plan for the project.

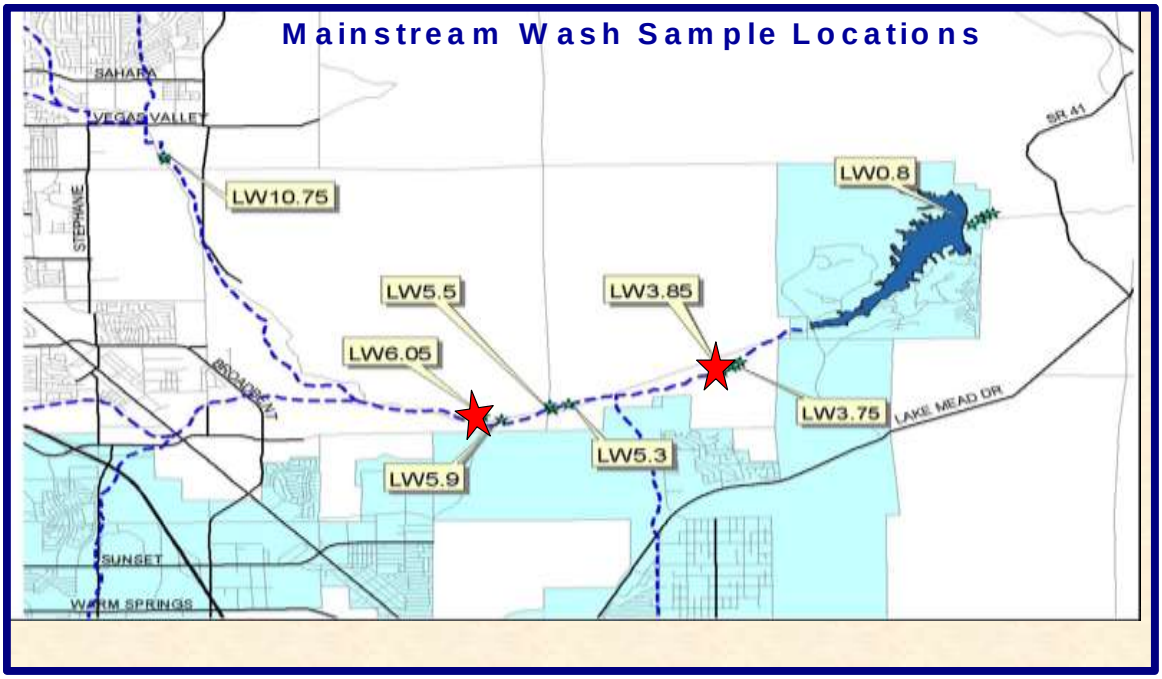

Figure 3: Las Vegas Wash sampling locations.

In an attempt to understand the potential environmental conditions that might promote a nuisance bloom, additional samples will be taken for quantification of physical, chemical and biological parameters at each site. Chemical parameters shall include the following nutrients: ammonia, nitrate, nitrite, total phosphorus, and orthophosphorus. These samples will also be analyzed for chlorophyll *a*, *b*, and *c*. Physical measurements will include: Secchi depth, wind speed, turbidity and if possible, light transmittance. Hydrolab profiles will be taken at each site to provide a profile of water quality and to give an indication of the stratification of the water column including dissolved oxygen, pH, temperature and conductivity.

Figure 4: Lake Mohave sampling locations.

Samples will be sent to PhycoTech, Inc for algal identification and enumeration. The concentration of *Cylindrospermopsis* cells contained in each sample will be reported to the data manager within one day. If PhycoTech observes a significant concentration of another blue-green algae that is a known toxins producer, they will report the identification and cell concentration of that organism to the data manager. It remains the responsibility of the monitoring entity to distribute nutrient and chlorophyll *a*, *b* and *c* samples to an appropriate lab for analyses.

V. Data Management and Reporting

The generalized procedure for reporting during the period of monitoring is outlined in Figure 5. All field and laboratory analyses results will be sent to the SNWA, the data manager for this project, for inclusion in the Las Vegas Water Quality database (http://www.lvwaterquality.org/agency/). The data manager will report to the Algae Task Force Chairperson or the LMWQF Chairperson (NDEP). The chairperson will then be responsible for reporting the monitoring results to the Nevada State Health Division, National Park Service, Clark County Health District, Arizona Department of Environmental Quality and other Forum/Algae Task Force agencies.

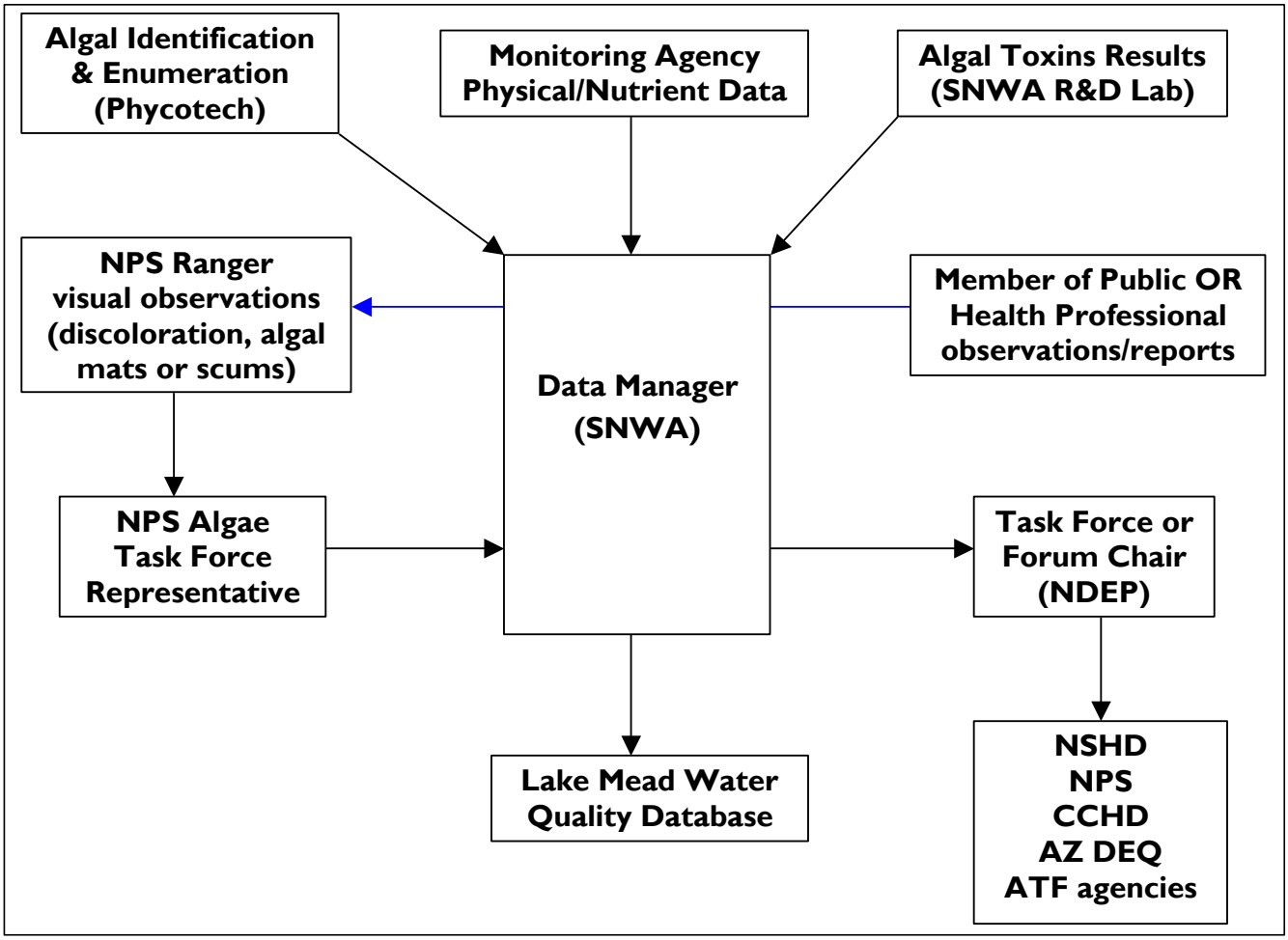

Figure 5. Generalized procedure for reporting observations and data results.

Monitoring staff will likely be the first to observe visual signs of a nuisance bloom, which should be reported to the data manger as soon as possible. NPS Rangers may provide valuable assistance in the monitoring effort by reporting discoloration, evidence of algal mats or scums, or foul odor or taste. For such cases, an Algae Reporting Form has been developed (Appendix A). Reports should be directed to the NPS Algae Task Force Representative, who will in turn relay the information to the Data Manager. The agency scheduled to conduct the next sampling round will be asked to collect a follow-up sample at the reported location. In addition, the NPS will follow-up on reports from the public to the extent feasible.

VI. Response Actions

While EPA has yet to establish standards for toxic strains of blue-green alga or associated toxins, the World Health Organization (WHO) established guidance levels for recreational waters based on the results from a human bathing epidemiological study (Pilotto et al., 1997 as cited in Chorus and Batram 1999). Although unlikely, WHO concluded that short-term health-effects (e.g. allergic responses, gastrointestinal illness) might be suffered from contact with and/or ingestion or inhalation of water containing 20,000 cells of potentially toxic blue-green algae/ml. Furthermore, WHO maintains that at levels of 100,000 cells of potentially toxic blue-green algae/ml, cyanotoxins may reach concentrations great enough to warrant a moderate probability of adverse health effects. Moreover, scums were identified as a high risk for health effects (Chorus and Batram 1999).

Using these WHO guidelines as a reference, if preliminary counts of any potentially toxic blue-green algae are greater than 20,000 cells/mL at any site, notification will be made to NDEP, NPS, NSHD, AZ DEQ and SNWA. At this time, water samples collected at the original sampling site/time will be sent out to SNWA's Research and Development Laboratory for toxins analyses. The laboratory will determine both the dissolved and total toxins for the identified species (primarily: anatoxin-a, cylindrospermopsin, saxitoxin and microcystin.) The dissolved toxins analyses will quantify the existing health threat at the time of sampling, while the total toxins analyses will quantify the potential health threat that could occur upon ingestion during recreational activities.

In addition, the SNWA and NPS will collect raw and finished drinking water samples for toxins analyses. (Note that finished water samples will only require the dissolved toxins analysis for each constituent.) Results of the toxins analyses will be reported to the above stated agencies. The data will be reviewed by these agencies, who will convene to determine what management actions, if any, are necessary to ensure the protection of public health.

VII. Fact Sheet

Appendix B contains the content of a fact sheet that has been developed to raise public awareness regarding blue-green algae. The Fact Sheet is aimed at providing information about the potential harmful health effects of these organisms, without over exaggerating the concern. The Fact Sheet is available for agency distribution or posting on agency websites. If your agency is interested, please contact Jason Kuchnicki, Algae Task Force Chair, at: jkuchnic@ndep.nv.gov.

VIII. References

Chorus, I. and J. Bartram (eds). 1999. Toxic Cyanobacteria in Water: A guide to Their Public Health Consequences, Monitoring and Management. Published on behalf of the World Health Organization by E & FN Spon, London.

Morris, T. 2000. Harmful Algal Blooms in North Carolina: Blue Green Algae and Human Health. http://www.schs.state.nc.us/epi/hab/bgahhtxt.html.

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St. Amand, A. 2002. Cylindrospermopsis: An Invasive Toxic Alga. LakeLine 22(1): 36-38.

USEPA, 2001. Creating a Target Cyanotoxin Target List for the Unregulated Contaminant Monitoring Rule. http://www.epa.gov/safewater/standard/ucmr/cyanotoxinmeeting0501.pdf.

Westrick, J. A. 2003. Everything a Manager Should Know About Algal Toxins but Was Afraid to Ask. *Journal AWWA*, September 2003.

IX. Appendix A

ALGAE REPORTING FORM

Please send immediately to: **Bryan Moore** **Fax: (702) 293-8008**
National Park Service **Phone: (702) 293-8901**

TO BE COMPLETED BY REPORTING PERSON/AGENCY **Date:**

CONTACT INFORMATION
Reporting Person's Name: _____ Phone: _____
E-mail: _____

TYPE OF REPORT:
- ☐ Visual Observation:
  - ☐ Discoloration
  - ☐ Algal Mat
  - ☐ Algal Scum
- ☐ Foul Taste
- ☐ Foul Odor

DETAILED LOCATION DESCRIPTION (Provide cove name, GPS or Lat-Long Coordinates):

_____

_____

ADDITIONAL INFORMATION/OBSERVASTIONS:

_____

TO BE COMPLETED BY DATA MANAGER

Follow-Up Agency:_____ **Follow-up sampling date:** _____

GPS COORDINATES: _____ _____

BLOOM OBSERVED? **Yes** **No** **Maybe**

BLOOM TYPE? **Dispersed through water column (discoloration/turbid)** **Scum** **Mat**

WATER OR ALGAL SAMPLE TAKEN? **Yes** **No**

ADDITIONAL INFORMATION/OBSERVASTIONS:

_____

_____

Sample Enumeration and Identification **Date:**
Dominant Species: _____
Known Toxins Producer? **Yes** **No**
Cells/ml: _____ ***NOTE: if > 20,000 cells/ml send for toxin analysis***

Toxins Analyses **Date:**
Cylindrospermopsin: _____ **µg/ml** **Anatoxin-a:** _____ **µg/ml**
Saxitoxin: _____ **µg/ml** **Microcystin:** _____ **µg/ml**
Other: _____ **µg/ml**

X. Appendix B

FREQUENTLY ASKED QUESTIONS ABOUT ALGAE IN LAKE MEAD

What are algae?

Algae are microscopic plants that are a natural part of aquatic ecosystems. Many environmental factors control the population of algae that exists in Lake Mead at any given time. Because these organisms are a primary part of the food chain, when the lake has too few algae, it becomes incapable of growing many fish. However, too many algae can produce scums and unsightly conditions. In Southern Nevada, federal, state, and local agencies continually work toward the goal of maintaining an appropriate balance of algae.

What are blue-green algae and why should I care?

Scientists categorize algae by dividing them into several groups, including green algae, blue-green algae, and golden-brown algae. Blue-green algae are the oldest and simplest form of plant life. They are widely dispersed around the world, and are probably present in every river and lake, including Lake Mead. Normally, blue-green algae are not harmful. However, some blue-green algae can produce toxins, at times and for reasons that are not understood.

What is being done about blue-green toxins?

Because reports of toxic effects are rare, toxins from blue-green algae have not been considered a high-priority issue. There are currently no federal or state requirements to monitor for blue-green toxins, or any regulatory limits on the amount of toxin that is acceptable. The U.S. Environmental Protection Agency (EPA) has identified blue-green toxins as a subject for future study, but no requirements are expected in the near future.

While the likelihood of people being affected by toxic strains of blue-green algae is very low, federal, state, and local agencies in Southern Nevada have pro-actively initiated a program to monitor and report excessive levels of potentially toxic blue-greens in Lake Mead and Lake Mohave.

Should I stop eating fish caught in Lake Mead?

Blue-green toxins do not appear to accumulate in fish and toxic poisoning from the consumption of affected fish has not been documented. However, anglers should always use common sense - do not eat fish that appear unhealthy or were dead prior to being caught.

How can I protect myself?

Monitoring efforts will serve as an early detection system to warn if a potential health threat is posed by potentially toxic blue-green algae. However, monitoring the entire extent of Lake Mead is impossible. Therefore, pay attention to public notices and be aware of the water in which you a recreating. Obey any warning or restriction if it is posted. Avoid contact with, and do not let children or pets get into water that contains algal mats or scums, appears discolored or emits a foul odor. If you note symptoms of skin or gastrointestinal irritation, consult your physician.