Annual Water Quality Report

HENSLEY LAKE

Water Year 2002

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Hensley Lake

I. Purpose

This report is part of an environmental monitoring program that began at Hensley Lake in August 1976. The monitoring program determines the level of water quality in the lake for both recreation and environmental health and satisfies the requirement for an annual water quality report in Department of Army Engineering Regulation 1110-2-8154, "Water Quality and Environmental Management for Corps Civil Works Projects".

II. Brief Description of Hensley Lake

Hensley Lake is located in central California, 17 miles northeast of Madera. The lake is nestled in the Sierra Nevada foothills and is surrounded by grasslands and blue oaks. At maximum capacity, the lake has 1,500 surface acres and holds 90,000 acre-feet of water. The lake was created by the construction of Hidden Dam on the Fresno River. The dam is 163 feet high and 5,730 feet in length. Since being built by the US Army Corps of Engineers for flood control and irrigation, the lake has become a popular destination for recreation. Summers are warm and the winters mild, allowing for year-round recreation.

Water quality monitoring by the United States Army Corps of Engineers (USACE) began at Hensley Lake in August 1976. Generally there are two sample events a year, spring (April) and late summer (August). Since the start of the monitoring program, a water quality report is produced yearly to list results and addresses any concerns of the previous water year.

Generally Hensley Lake has a depth of < 90 ft during the sampling events, and is considered a eutrophic (nutrient rich) lake when characterized by its clarity. One of the common characteristics of a eutrophic lake such as Hensley Lake is that during warm late summer months the lower depths are low in dissolved oxygen (DO). Additionally Hensley Lake is warm (>20ºC) in the late summer. Due to both the low DO concentrations and high temperatures, only warmwater fish species could reliably survive in the lake. Warmwater fish species include bass, carp, perch, bluegill, crappie, and catfish. Another characteristic of eutrophic (nutrient rich) lakes is their low water clarity due to algal blooms. In addition, shallow water sediments can be suspended by wind action which is another detractor to clarity. Water clarity is often measured in terms of Secchi Disc depth or SD (Appendix A). Historically the water clarity in Hensley Lake has been fairly low with ~26 % of the samples not meeting the recreational goal of 4 feet or greater (Figure 1). In 2001 the Spring SD measure was 11.33 feet, but the late summer sample was below the goal of 4 feet (SD = 3.33).

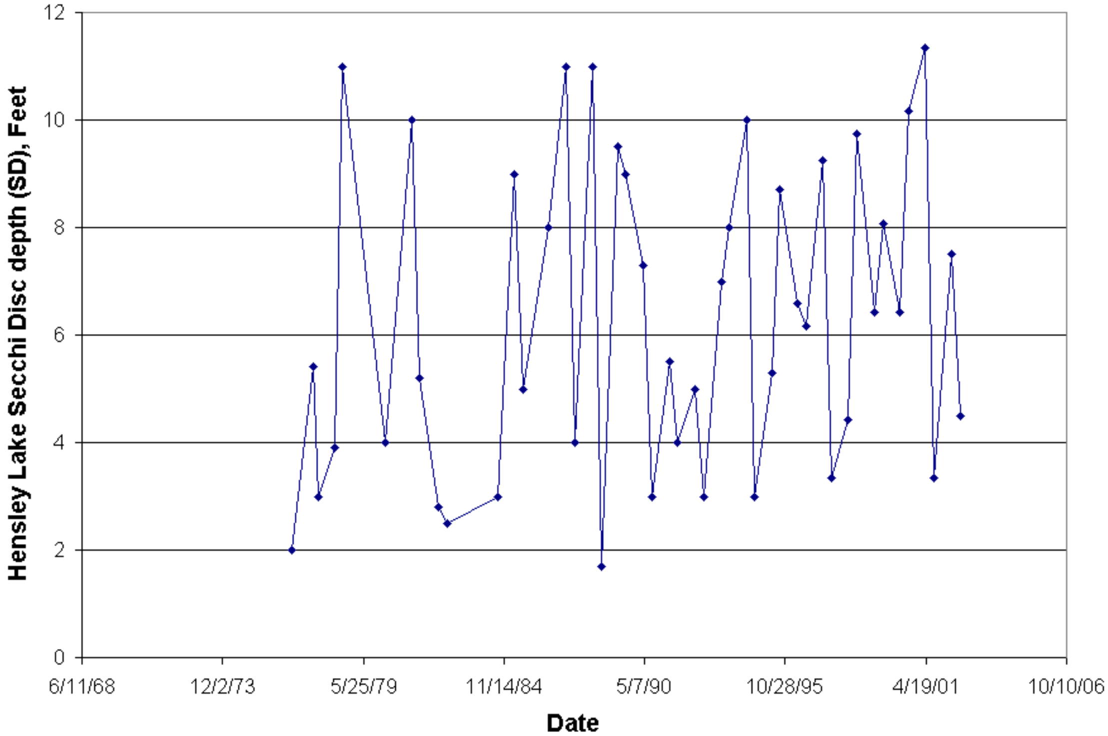


Figure 1. Historical Secchi Depth Values at Hensley Lake(2002 values included).

The 2001 Water Quality Report listed no significant contaminants of concern in Hensley Lake. One thing to note is that historically the concentration of mercury found in fish tissue was at the USEPA's action level concentration (0.3 ppm Hg) to continue monitoring.

III. Sample Summaries for this year.

Introduction

The following general summaries are split into their respective sample types. Each type of sample summary includes a discussion of both the spring (April) and late summer

(August) samples to better examine trends within the current year. The types of parameters monitored this year include: Secchi Disc depths, water column profiles (temperature, DO and pH), phytoplankton characterization, metals concentrations, MTBE concentrations, Inorganic characterization (alkalinity, phosphorous, nitrogen, etc..), and fish mercury concentrations. For a more detailed explanation of the importance for each type of sample, please see Appendix A.

SECCHI DEPTH

The Secchi Disc depths found during spring and late summer sampling were similar to previous events. Traditionally the lake varies in its clarity. More often the clarity is better in the spring than in the late summer. In spring the water clarity was higher and had a SD of 7.5 feet. The late summer SD of 4.5 feet was above the recreational goal of 4 feet and an improvement from last year (Summer 2001 SD = 3.33) (Appendix B).

TEMPERATURE VALUES

The temperature profiles for Hensley Lake are indicative of a seasonally well-mixed shallow lake. The lake is well stratified in the spring, but the layers disappear by the warm temperatures of late summer. The difference in the depth of the lake between the spring and late summer sampling events was minimal (spring depth = 59.1 feet, late summer depth= 52.5 feet), but the average temperatures were very different (spring average temp. = 10.95 ºC, late summer average temp.= 24.49 ºC). Hensley Lake does not have a deep water region to buffer it from the warm summer air temperatures. Due to the warmth of the water, Hensley Lake probably wouldn't be able to support coldwater fish species for long term survival. For detailed results obtained during the sampling events, please see Appendix B.

DISSOLVED OXYGEN

The dissolved oxygen (DO) concentration differs greatly from spring to late summer. In the spring DO concentrations are super saturated (10.50 mg/l DO) near the surface and lower at the bottom (6.76 mg/L) of the lake. DO concentrations near the surface are above saturation (9.14 mg/l at 19.7 ºC) due to phytoplankton photosynthesis. DO concentrations in the late summer are much lower and have a steady gradient from near the surface (DO = 5.05 mg/l) to the bottom of the lake (DO =1.29 mg/l). The low DO values at the bottom of the lake are associated the decomposition of waste materials at accelerated rates due to the warm temperatures. Fish species that require greater than 5 mg/l DO at cooler water temperatures (< 20ºC) would be unlikely to survive year round in Hensley Lake. For detailed results obtained during the sampling events, please see Appendix B.

pH.

In the spring sample event, pH values in the lake were slightly basic (pH = ~7.7) throughout the water column. The pH values in the late summer profile varied widely. The pH was more basic towards the surface and middle waters (max pH = 9.20) and less basic [because 7 is neutral and rainwater is 6.5, I wonder if we can say that it is basic as opposed to just more basic] at the bottom (pH = 7.86). Lower pH values at the bottom of the lake increase the likelihood that higher soluble metal concentrations will be found in lake bottom samples. For detailed results obtained during the sampling events, please see Appendix B.

PHYTOPLANKTON

In the spring sample, the algal biomass within the lake was high (Biomass = 3070.7 μg/L) compared to spring 2001 (2001 Spring biomass = 420.24 μg/L). In spring 2001 dinoflagellates were the most dominant species, but in spring 2002 diatoms dominated. In late summer the same trend occurred and the phytoplankton population was much lower in summer 2001 (2001 Summer Biomass = 2357.8 ug/L) than summer 2002 (Biomass = 9357.3 ug/L). Blue green algae was the most dominant species during the 2002 late summer sampling events, but diatoms dominated in summer 2001. While most phytoplankton species must obtain nitrogen (a required nutrient for growth) from aqueous forms in the lake, bluegreen algae have the ability to use the atmospheric form or nitrogen gas (nitrogen fixation). In lakes that are limited in nitrogen availability, the ability to fix nitrogen is a distinct advantage. Bluegreen algae are often thought of as a nuisance due to the inability of it to be used in the aquatic food chain it has a deleterious impact on water clarity. For detailed results obtained during the 2002 sampling events, please see Appendix C.

METALS

Most of the dissolved heavy metal samples did not exceed the maximum contaminant level (MCL) or the freshwater fishery criteria during either the spring or summer except for dissolved iron and manganese. Although dissolved mercury samples did not exceed any criteria, the concentration in one sample while only in the parts-per-billion range was an uptick from last year, but less than previous year's values. It should be noted that when testing for mercury at such low limits, variations in field technique can result in relatively "large" values.

While dissolved iron concentrations had exceeded the Secondary Maximum Contaminant Level (MCL) (Iron MCL = 300 ppb) in the past, the late summer bottom iron concentration was extremely high (Iron on the bottom in summer 2002 = 1400 ppb). The summer bottom sample even exceeded the fish criteria limit (Fish Criteria Limit =1000 ppb).

In late summer 2002, water at the bottom of the lake had a manganese concentration of 220 ppb. This was the highest manganese concentration since monitoring began in 1998. The concentration was above the secondary MCL (manganese = 50 ppb). This criteria is termed "secondary" because it relates to water hardness not health.

The dissolved mercury concentration in late summer sample at the bottom of the lake did not exceeded the fish criteria limit of 0.77 ppb. The concentrations of dissolved mercury in bottom lake samples for spring and late summer sampling events were 0.0049 ppb and 0.065 ppb respectively. For detailed results obtained during the sampling events, please see Appendix D.

MTBE

Concentrations for MTBE around the lake were found to be 3 ppb during both spring and late summer sampling events. For detailed results obtained during the sampling events, please see Appendix F.

INORGANIC ANALYSIS

The spring sample analysis had several results worth discussion involving chloride, and nitrates. The chloride concentration in the spring sampling event was high (Spring lake chloride = 21 ppm, Spring inflow chloride =21 ppm) when compared to previous years (Spring 2001 lake chloride = 18 ppm, Spring 2001 inflow chloride =19 ppm) and was higher than most of the other lakes monitored by the USACE. The summer chloride concentration was also higher in the lake than last year (Summer lake chloride = 19 ppb, Summer 2001 lake chloride = 11 ppb).

Late summer 2002 sampling also indicated detectable levels of nitrate in the lake. While nitrate values were below detection in the spring (< 0.1 mg/L), a concentration of 1.3 mg/L was found in the lake during the late summer sampling event. Interestingly, Total Kjeldahl nitrogen (TKN) in the lake remained steady at 0.4 mg/L. For detailed results obtained during the 2002 sampling events, please see Appendix E.

FISH TISSUE ANALYSIS

Fish tissue analysis for total mercury was performed on a composite sample composed of tissue from three black bass collected in April 2002. The composite sample had a resulting total mercury concentration of 0.72 ppm. This is below the U.S. F.D.A. criteria for a fish advisory (1 ppm), but well above the concentrations found in the other lakes monitored. The 2002 composite sample had a higher mercury concentration than both the 2000 (0.30 ppm) and 2001 (0.70 ppm) fish composite samples. Due to two consecutive years of high mercury concentrations within samples, a more detailed fish analysis is suggested. For detailed results obtained during the sampling events, please see Appendix G.

IV. Conclusions.

Hensley Lake is a relatively shallow eutrophic lake that can support warmwater fish species. Coldwater fish that require temperatures below 20°C and dissolved oxygen concentrations greater than 5 mg/L would have difficulties surviving the summer conditions at Hensley Lake. Due to a lower pH and the anaerobic conditions ideal for bacterial growth near the bottom of the lake during the late summer, some heavy metals within lake sediments are being converted into soluble forms.

A contaminants of concern in Hensley Lake is dissolved iron . Iron results were higher than fish criteria levels at the bottom of Hensley Lake during the 2002 sample year. Manganese concentrations were above the secondary MCL for domestic use.

Fish tissue mercury concentrations were high for a second consecutive year (~0.7 ppm). While the concentration of mercury in the fish was below the U.S.F.D.A. 1 ppm action level, a more detailed examination of mercury in the lake is suggested.

V. References

North American Lake Management Society (1990). *Lake and Reservoir Restoration Guidance Manual*, EPA 440/4-90-006, U.S. Environmental Protection Agency, Washington, DC.

Novotny, V., and H. Olem (1994). *Water Quality: Prevention, Identification, and Management of Diffuse Pollution*, Van Nostrand Reinhold, New York, New York.

Tchobanoglous, G., F. L. Burton, and H. D. Stensel (2003) *Wastewater engineering: treatment and reuse / Metcalf & Eddy, Inc.*, McGraw-Hill, Boston, MA.

Welch, E.B. (1992) *Ecological Effects of Wastewater: Applied limnology and pollutant effects,* Chapman and Hall, Cambridge University Press, Great Britain.

Wetzel, R.G. (1975). *Limnology*, W.B. Saunders Company, Philadelphia, PA.

VI. Appendices

Appendix A: Glossary of Sample Types

Glossary of Sample Types

This glossary of sample types is intended to provide a general background and indicate the importance of each sample in determining water quality. These are meant to be brief and basic. If a further explanation is desired please refer to the list of references provided in this report.

Secchi Depth

One of the oldest and easiest methods to determine lake clarity is the Secchi depth (SD). The Secchi depth is determined by dropping a Secchi disc into a water body and determining the depth that it is last visible from the surface of the water. Secchi discs are generally white and 20 cm in diameter. Secchi depth values are most impacted by the light intensity at the time of sampling and the scattering of light by solid particulates within the water column. Algal growth (phytoplankton) and sediment re-suspension are often major constituents of solid particulates within the water column. Secchi depth values can be used to estimate the Trophic state or the nutrient levels within the lake. The more nutrients are available, the larger likelihood of algal blooms that limit water clarity. Due to recreational concerns for safety, the goal for Secchi depth values is four feet or greater.

Temperature Profiles and Data Points

The temperature profile of a lake provides information how a lake is operating and the potential for aquatic biota to live within the lake. The temperature profile is a direct indicator if a lake is stratified. Stratification in lakes is created generally by temperature affecting the density of water molecules. Stratification is usually indicated by a region of similar temperature nearer the surface of the water (epilimnion), then a region of temperature transition (metalimnion), to another layer of nearly constant temperature at the bottom of the lake (hypolimnion). Each layer in a stratified lake is important, but the existence of a hypolimnion can drastically impact how well a lake can handle warmer temperatures such as those found in northern California during the summer. The hypolimnion acts as a buffer against large temperature shifts. The nature of dam operation is that water is discharged near the bottom, releasing the hypolimnion, and eliminating stratification. This operation limits the ability of reservoirs to regulate their temperature during the summer months. Stratification isn't always desirable. When a lake isn't stratified and is instead well mixed, the required nutrients near the bottom of the lake become available to phytoplankton for growth. Temperatures within lakes also indicate which species of fish will survive within a lake. Coldwater species of fish require temperatures below 20 degrees C in order to spawn and survive. If a lake is often above 20 degrees C, then only warmwater fish species will survive.

Dissolved Oxygen (DO) Concentration Profiles

DO is required by organisms for respiration and for chemical reactions within lake waters. The recommended level for DO for most aquatic species survival is 5mg/L. In lakes, biota waste (detritus) falls to the bottom of the lake to be utilized by bacteria. The bacteria need oxygen and will deplete levels near the bottom of a lake, especially during warm temperature, high respiration conditions. For nutrient rich (eutrophic) lakes more organisms will grow, create wastes, and cause oxygen depleted regions at the lowest areas. Under these conditions only aquatic species that can survive low DO conditions in warm water near the surface will survive.

PH Profiles

The pH profiles of the lakes indicate the potential for certain chemical reactions to occur. In high pH (greater than pH = 7 or basic) aquatic systems, metal pollutants tend to form into insoluble compounds that fall onto the lake floor. In low pH (less than pH = 7 or acidic) systems or areas metal ions become soluble and available for uptake into aquatic organisms. Other compounds like ammonia that are introduced into a low pH aquatic environment will transform into soluble nitrate and be utilized by organisms.

Phytoplankton Analysis

Phytoplankton analysis indicates the health, nutrients, and biodiversity within a lake. Lakes that have few nutrients available (Oligotrophic) will generally have a much lower quantity of phytoplankton (high Secchi depth) but the number of phytoplankton species seen will be large. In a lake that is nutrient rich (eutrophic) there are generally large phytoplankton blooms (low Secchi depth), but they are made up of a couple of phytoplankton species. Certain species of phytoplankton are preferred food sources for zooplankton (small invertebrates). Generally species like diatoms and green algae can be consumed by the filter-feeding zooplankton, but species like bluegreen algae are low in nutrients and are difficult to consume. Some species like the dinoflagellates can grow horn like points to discourage potential predators. In nutrient rich waters where there is plenty of phosphorous, nitrogen can be limited for biological growth. While most species can't grow due to the lack of nitrogen, bluegreen algae (cyanobacteria) have the ability to utilize nitrogen from the atmosphere when required. This gives bluegreen algae the ability to dominate in many eutrophic lakes.

Soluble Metals Analysis

The soluble metals analysis indicates the exposure of humans and aquatic organisms to toxic metals. These metals often build up as they are consumed through the food chain. Water samples provide an indicator for additional problems. Soluble forms of metal ions are more prevalent in low pH (pH <7, or acidic) environments.

MTBE Analysis

MTBE (methyl tertiary-butyl ether) is a chemical additive to gasoline to improve combustion. Due to its high solubility, MTBE travels and blends into aquatic systems rapidly. While not found to be extremely hazardous at low levels, the offensive smell and taste is detectible by humans at extremely low concentrations. The effect of MTBE on humans and aquatic systems is still under investigation.

Inorganic Analysis

Alkalinity

Alkalinity is measured in terms of mg/L of calcium carbonate. It indicates a lakes ability to buffer incoming acidic pollution and situational changes.

Ammonia

Ammonia is a gas that is toxic to fish and is more visible at a higher pH. Ammonia is created through anthropogenic inputs, bacteria cell respiration, and the decomposition of dead cells. Due to being a gas, given time ammonia will volatilize from the water. At a lower pH, much of the ammonia is converted to ammonium (a nutrient for root bound plant life) and utilizes DO in the nitrification process.

Chloride

The chloride ion is an indicator of any salinity increases within a lake. Most fresh water aquatic species are sensitive to salinity changes.

Nitrate

Nitrate is the nitrogen product created through the nitrification of ammonium. Nitrate is a soluble form of the nutrient nitrogen and is utilized by phytoplankton.

Total Phosphorous

The total phosphorous provides a measure of both utilized and soluble phosphorous within water samples. Phosphorous is a required nutrient for plant growth and development.

Ortho Phosphorous

Ortho phosphorous is the soluble form of phosphorous that is utilized by free-floating aquatic plants (phytoplankton).

Kjeldahl N

Kjeldahl nitrogen or total Kjeldahl nitrogen (TKN) is a measure of the total concentration of nitrogen in a sample. This includes ammonia, ammonium, nitrite, nitrate, nitrogen gas, and nitrogen contained within organisms.

COD

Chemical Oxygen Demand (COD) is a measure of the total oxygen required to complete the chemical and biological demands of a sample.

Fish Tissue Analysis

Fish tissue is analyzed to examine potential exposure of humans to toxicants as well as the health of the aquatic food chain. In aquatic systems toxic contaminants can build up (or bioaccumulate) within animals at the top of the food chain. Contaminants (especially organic pollutants) are retained within the fat tissue of an organism, therefore in fish samples the lipid content is often measured.

Lake Code Designation

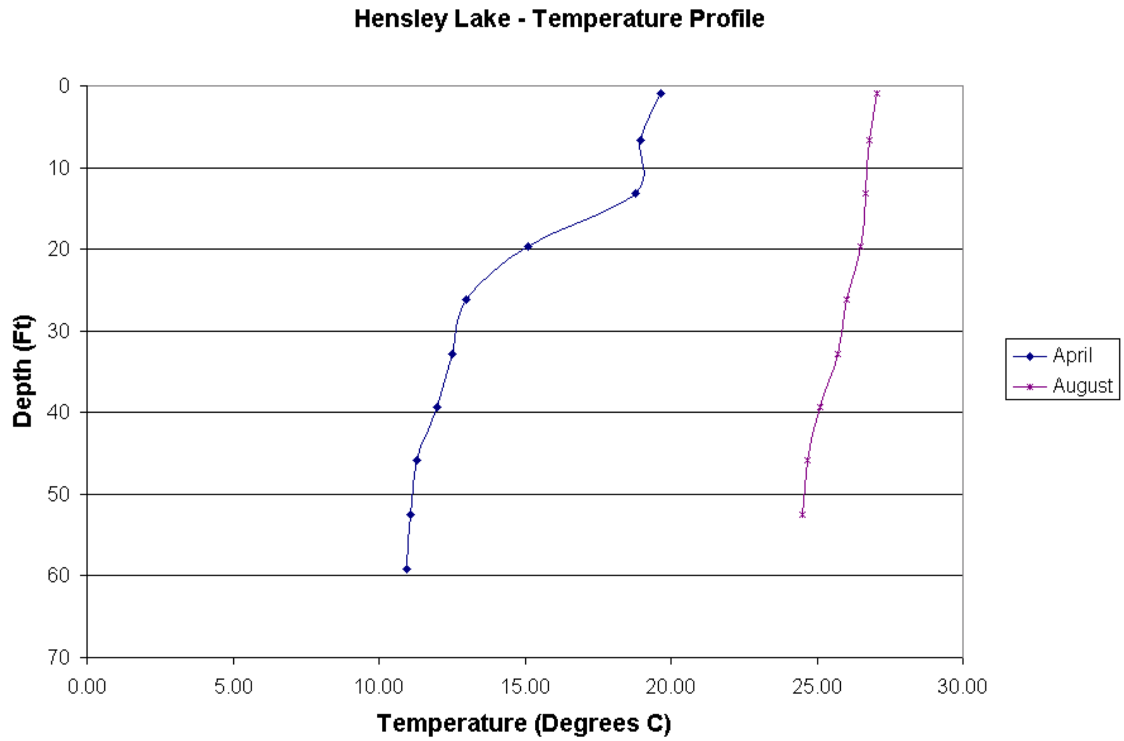
Laboratory Reports are provided in the previous sections.

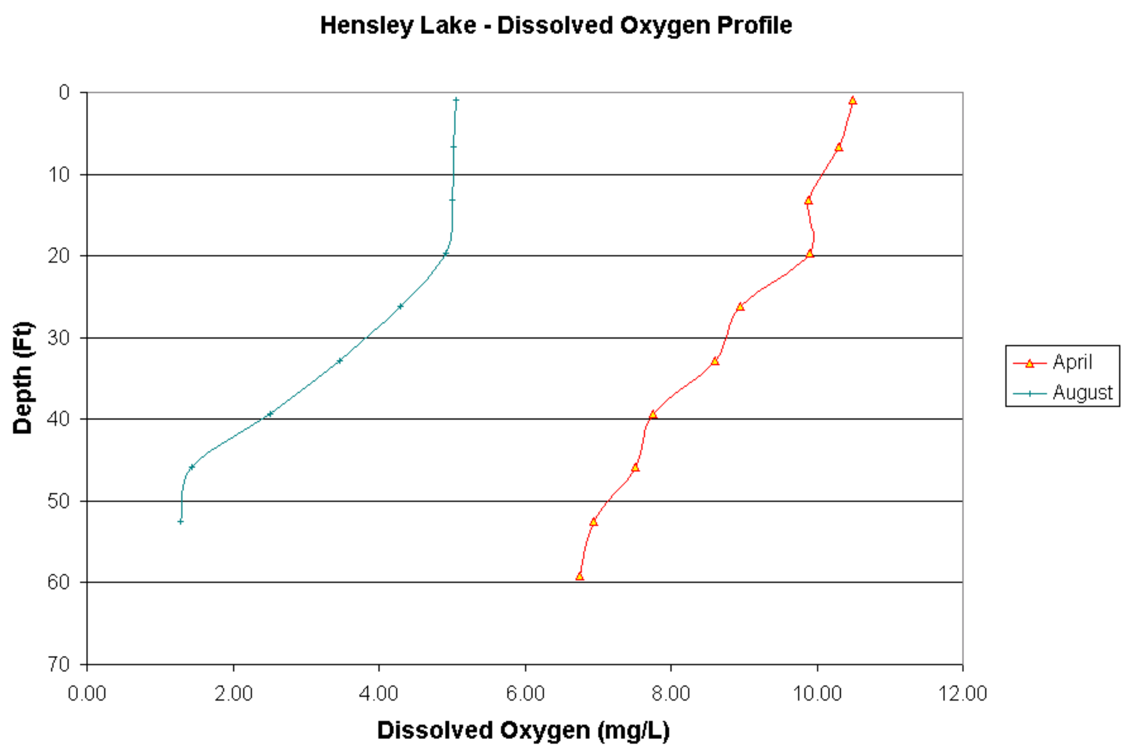
Sample ID is "XX-YY-ZZ" where

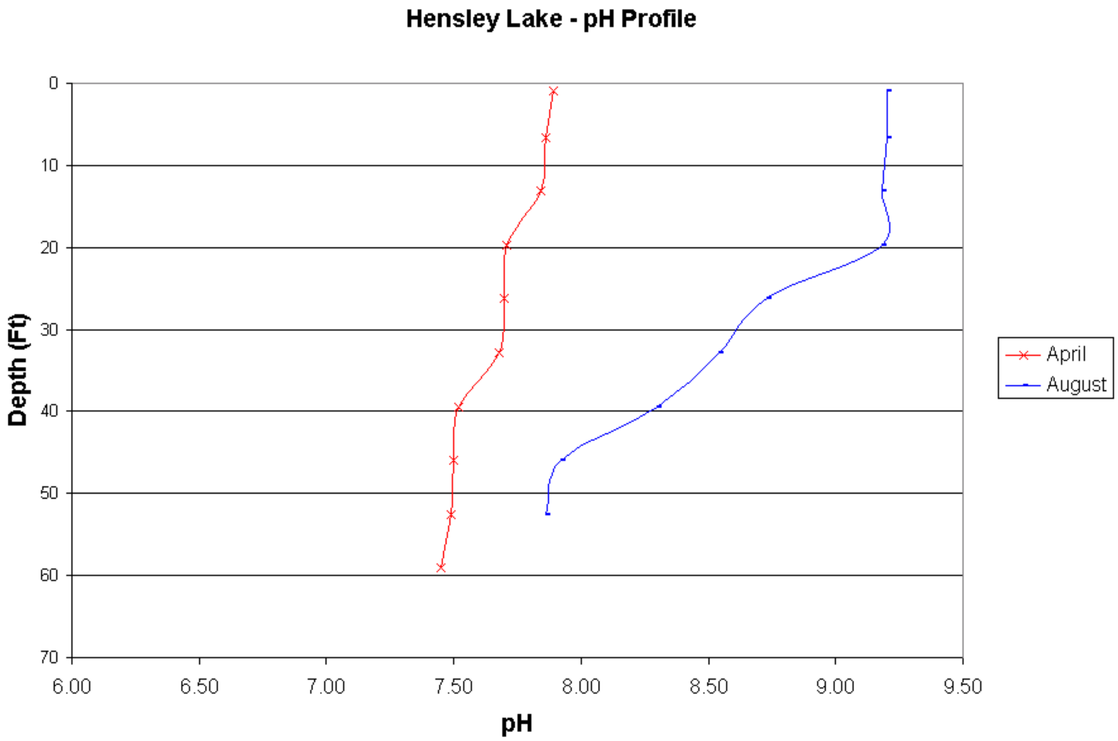
XX designation:	YY designation	ZZ designation
BB for Black Butte	SP for Spring	S for surface of Lake
EA for Eastman	SU for Summar	B for bottom of Lake
EN for Englebright		I-1 for inflow1
HE for Hensley		I-2 for inflow 2
IS for Isabella		O for outflow
KA for Kaweah		
ME for Mendocino		
MC for Martis Creek		
NH for New Hogan		
PF for Pine Flat		
SO for Sonoma		
SU for Success		

Example: BB-SU-S is for a water sample taken from Black Butte in the Summer on the Lake's Surface.

Appendix B: Profile Data and Charts (Secchi Disc, Temperature, DO, and pH)


Hensley Lake - Temperature Profile
Depth (Ft)
0
10
20
30
40
50
60
70
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Temperature (Degrees C)
April
August

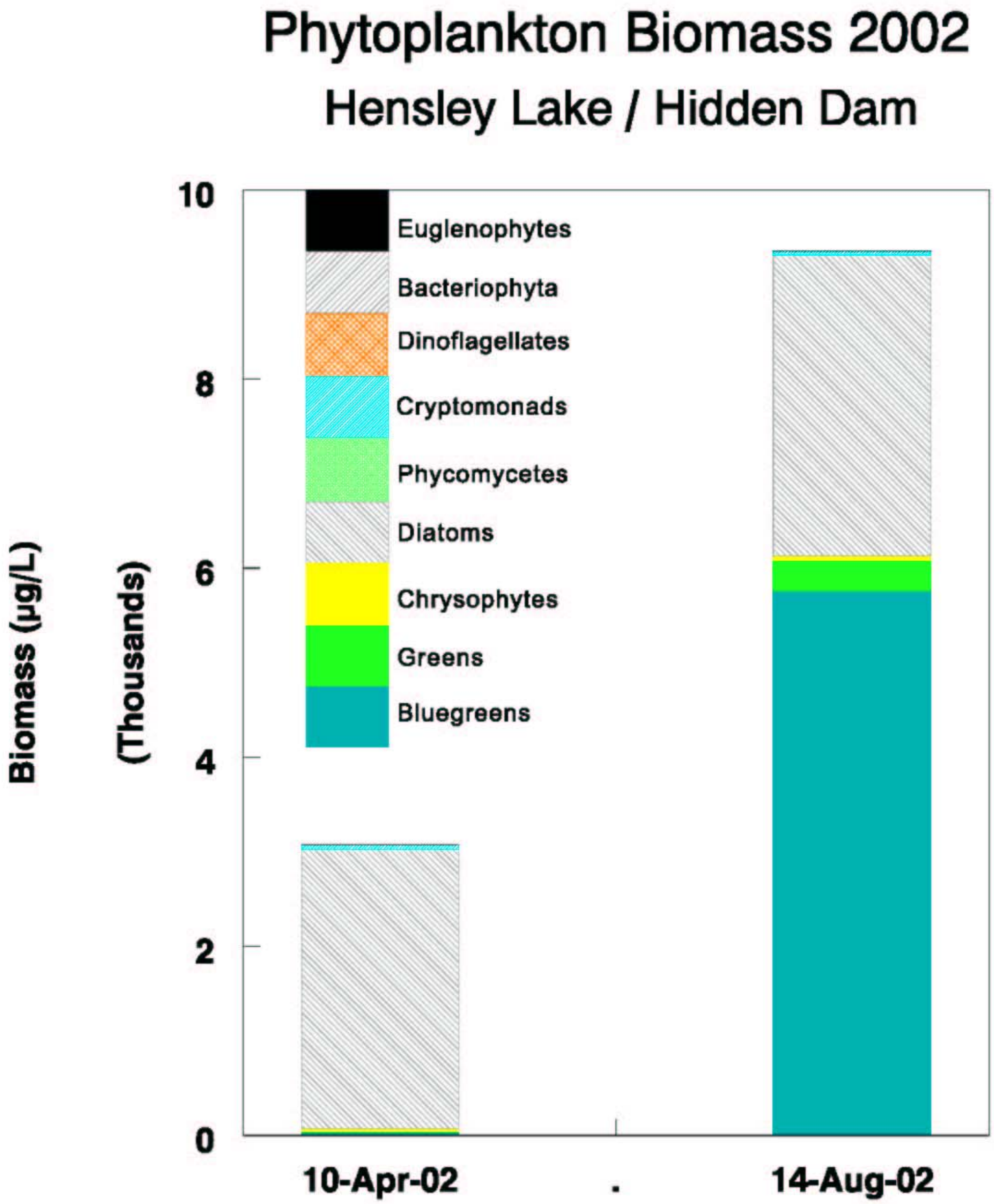

Hensley Lake - Dissolved Oxygen Profile
Depth (Ft)
0
10
20
30
40
50
60
70
0.00
2.00
4.00
6.00
8.00
10.00
12.00
Dissolved Oxygen (mg/L)
April
August


Hensley Lake - pH Profile
Depth (Ft)
0
10
20
30
40
50
60
70
6.00
6.50
7.00
7.50
8.00
8.50
9.00
9.50
pH
April
August

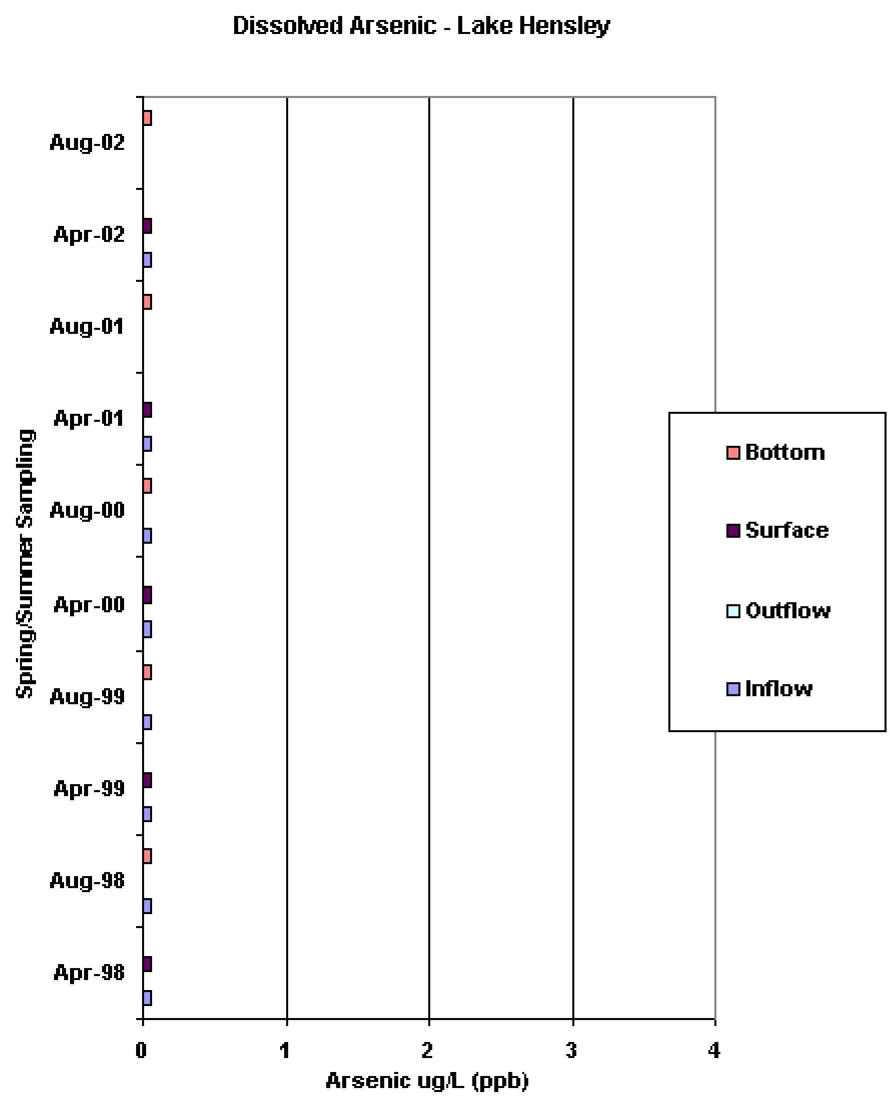
LAKE HENSLEY					
Sample Location: Behind dam				**Date:** 4/10/02	
Observers: Tim McLaughlin				**Time:**	
Lake Elevation: 494.07					
Weather Conditions:					
Wind Speed: 20		**Precipitation:** 0		**Temp (F):** 60	
SECCHI Depth: 7 feet and 6 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
17.6	59.1	10.95	128	6.76	7.45
16	52.5	11.10	128	6.95	7.49
14	45.9	11.30	129	7.52	7.50
12	39.4	11.98	129	7.76	7.52
10	32.8	12.53	129	8.61	7.68
8	26.2	13.00	128	8.96	7.70
6	19.7	15.12	126	9.90	7.71
4	13.1	18.80	129	9.89	7.84
2	6.6	18.94	131	10.30	7.86
0.03	1	19.67	130	10.50	7.89
FRESNO (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs)**
65.9	7.35		-	-	56
VISUAL OBSERVATIONS: Lots of floating algae-like material in lake.					

LAKE HENSLEY					
Sample Location: Behind dam				**Date:** 8/14/02	
Observers: Tim McLaughlin				**Time:** 9:45 am	
Lake Elevation: 469.57					
Weather Conditions:					
Wind Speed: 10		**Precipitation:** 0		**Temp (F):** 75	
SECCHI Depth: 4 feet and 5 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
15.8	52.5	24.49	186	1.29	7.86
14	45.9	24.67	186	1.43	7.92
12	39.4	25.10	186	2.51	8.30
10	32.8	25.72	187	3.47	8.54
8	26.2	26.01	186	4.30	8.73
6	19.7	26.49	186	4.91	9.18
4	13.1	26.66	186	5.01	9.18
2	6.6	26.80	187	5.02	9.20
0.03	1	27.07	187	5.05	9.20
FRESNO (Inflow) - DRY					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs)**
-	-		-	-	-
VISUAL OBSERVATIONS: Strong hydrogen sulfide smell on lake surface.					

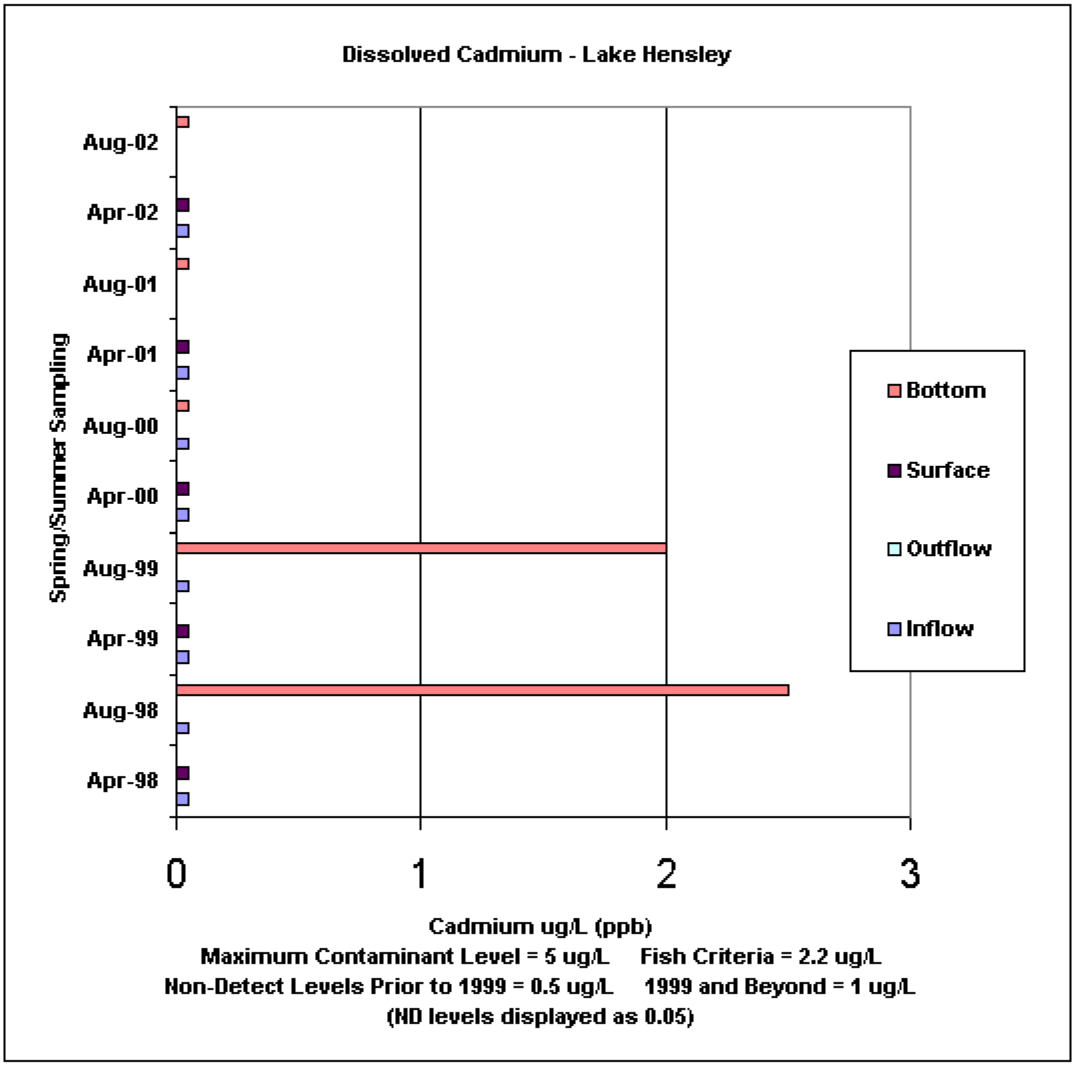
Appendix C: Phytoplankton Data and Charts

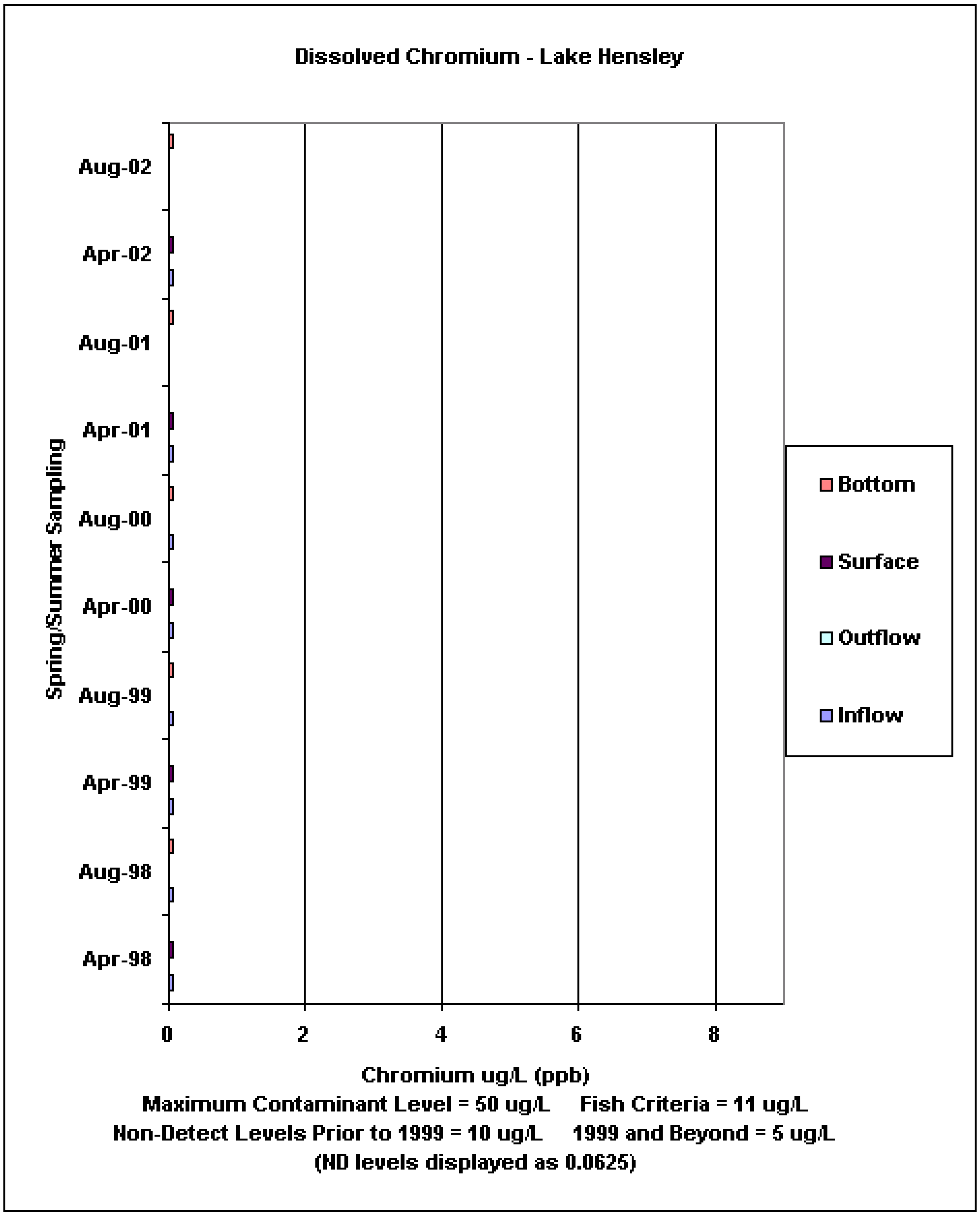

Phytoplankton Biomass 2002
Hensley Lake / Hidden Dam
Biomass (µg/L)
(Thousands)
10
8
6
4
2
0
Euglenophytes
Bacteriophyta
Dinoflagellates
Cryptomonads
Phycomycetes
Diatoms
Chrysophytes
Greens
Bluegreens
10-Apr-02
.
14-Aug-02

Appendix D: Metals Data and Charts

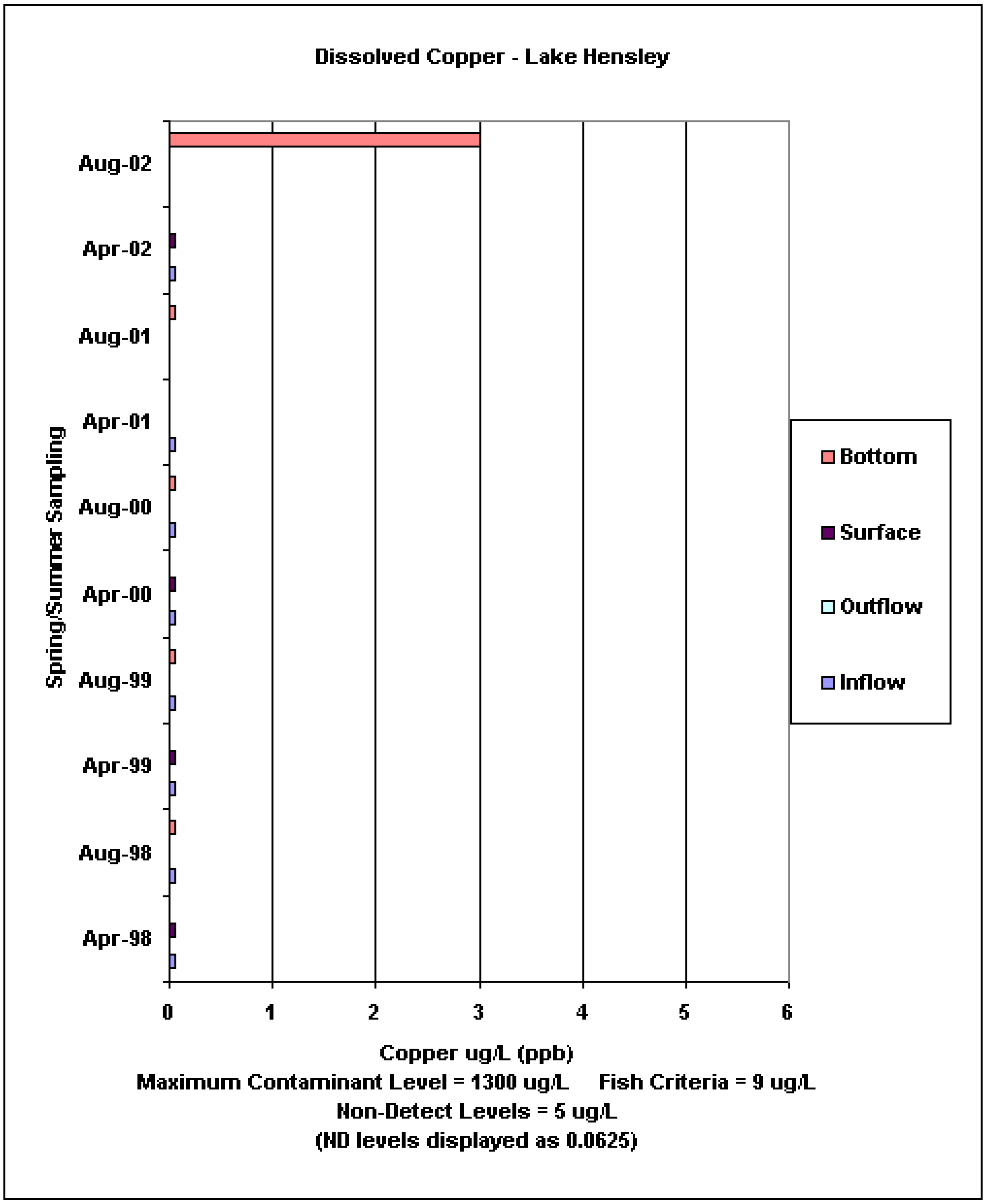


Maximum Contaminant Level = 10 ug/L Fish Criteria = 150 ug/L
Non-Detect Levels = 1 ug/L before 1999, 4 ug/L after 1999
(ND levels displayed as 0.05)

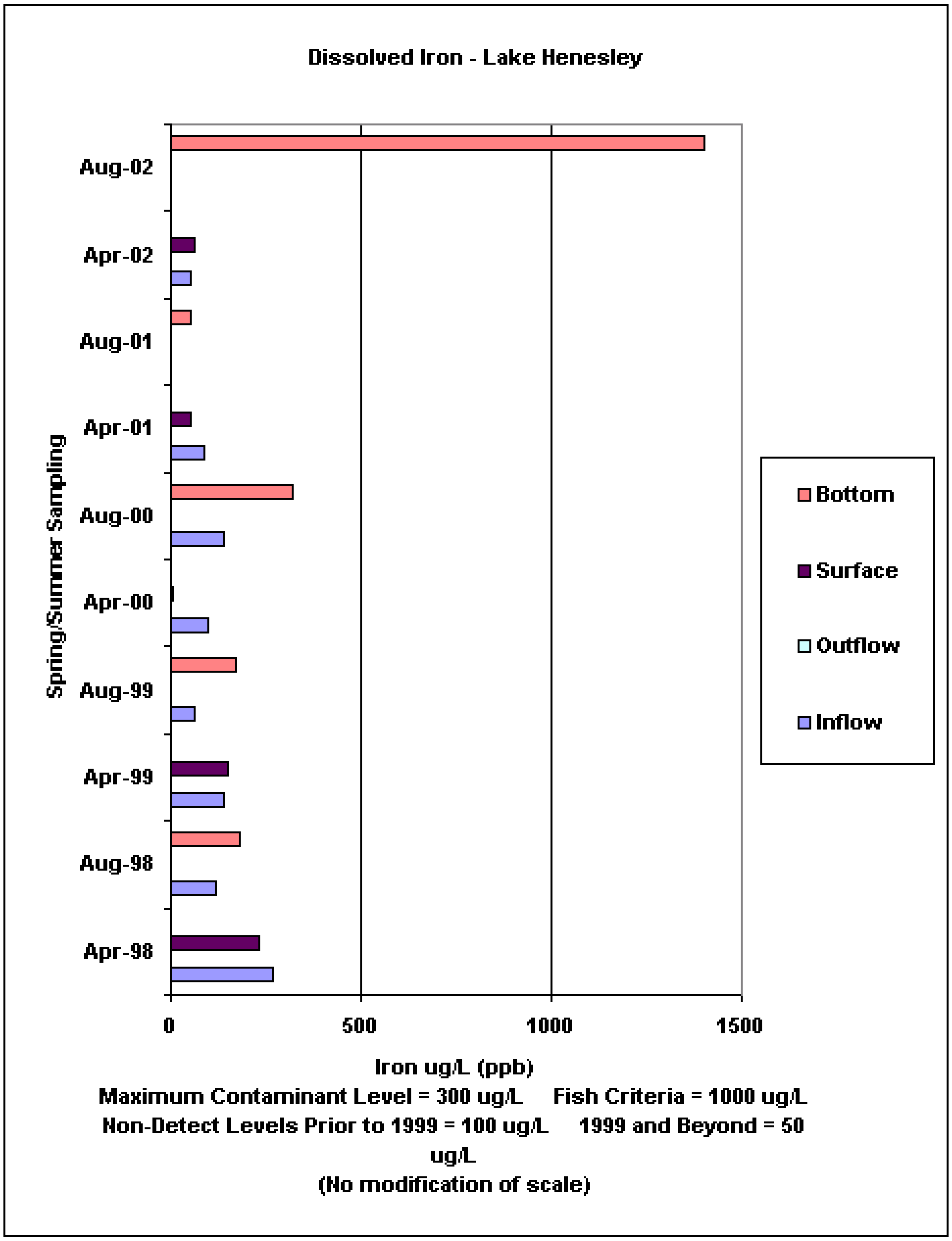

Dissolved Cadmium - Lake Hensley
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
Bottom
Surface
Outflow
Inflow
Cadmium ug/L (ppb)
Maximum Contaminant Level = 5 ug/L Fish Criteria = 2.2 ug/L
Non-Detect Levels Prior to 1999 = 0.5 ug/L 1999 and Beyond = 1 ug/L
(ND levels displayed as 0.05)

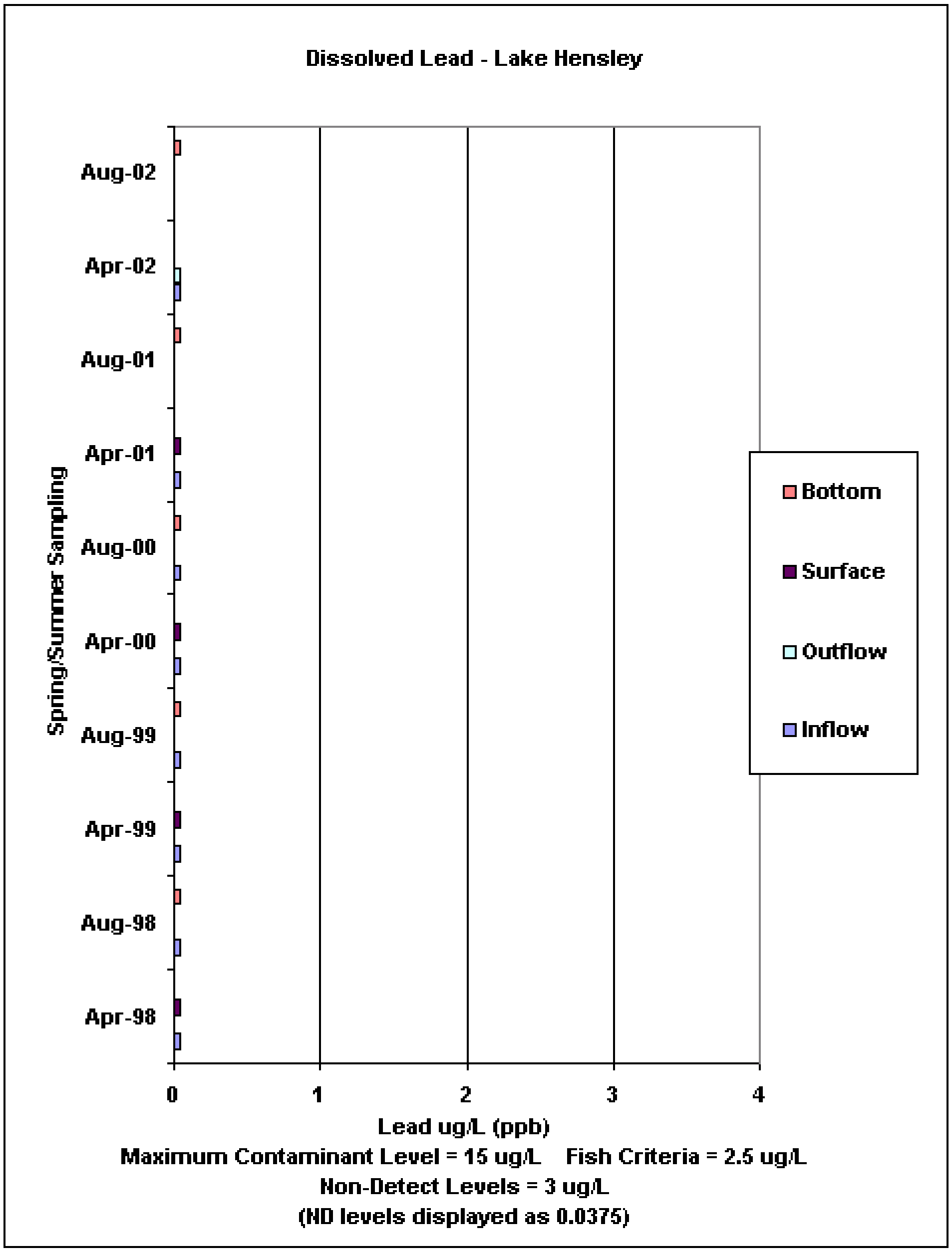


Dissolved Chromium - Lake Hensley
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
Bottom
Surface
Outflow
Inflow
Chromium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = 11 ug/L
Non-Detect Levels Prior to 1999 = 10 ug/L 1999 and Beyond = 5 ug/L
(ND levels displayed as 0.0625)

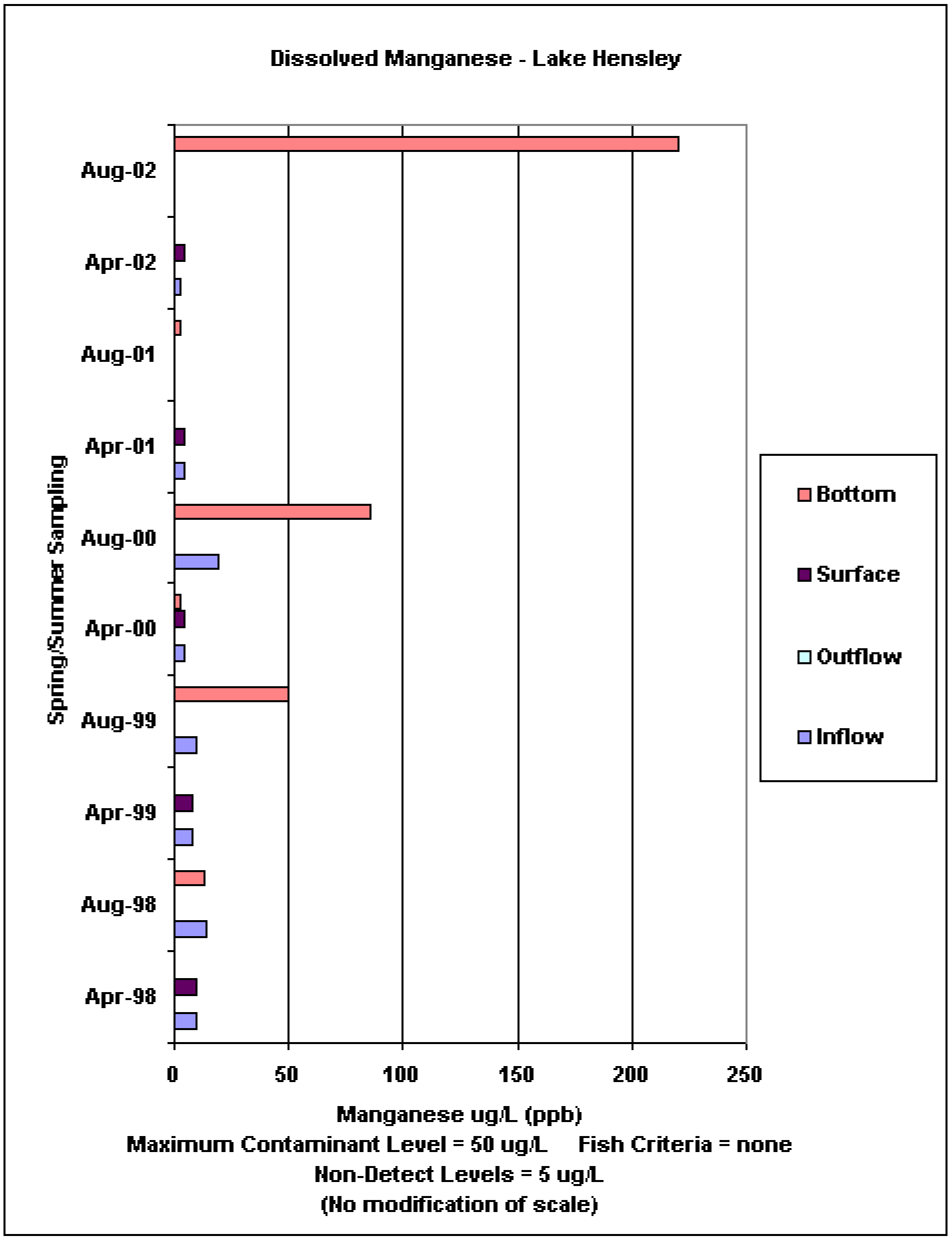


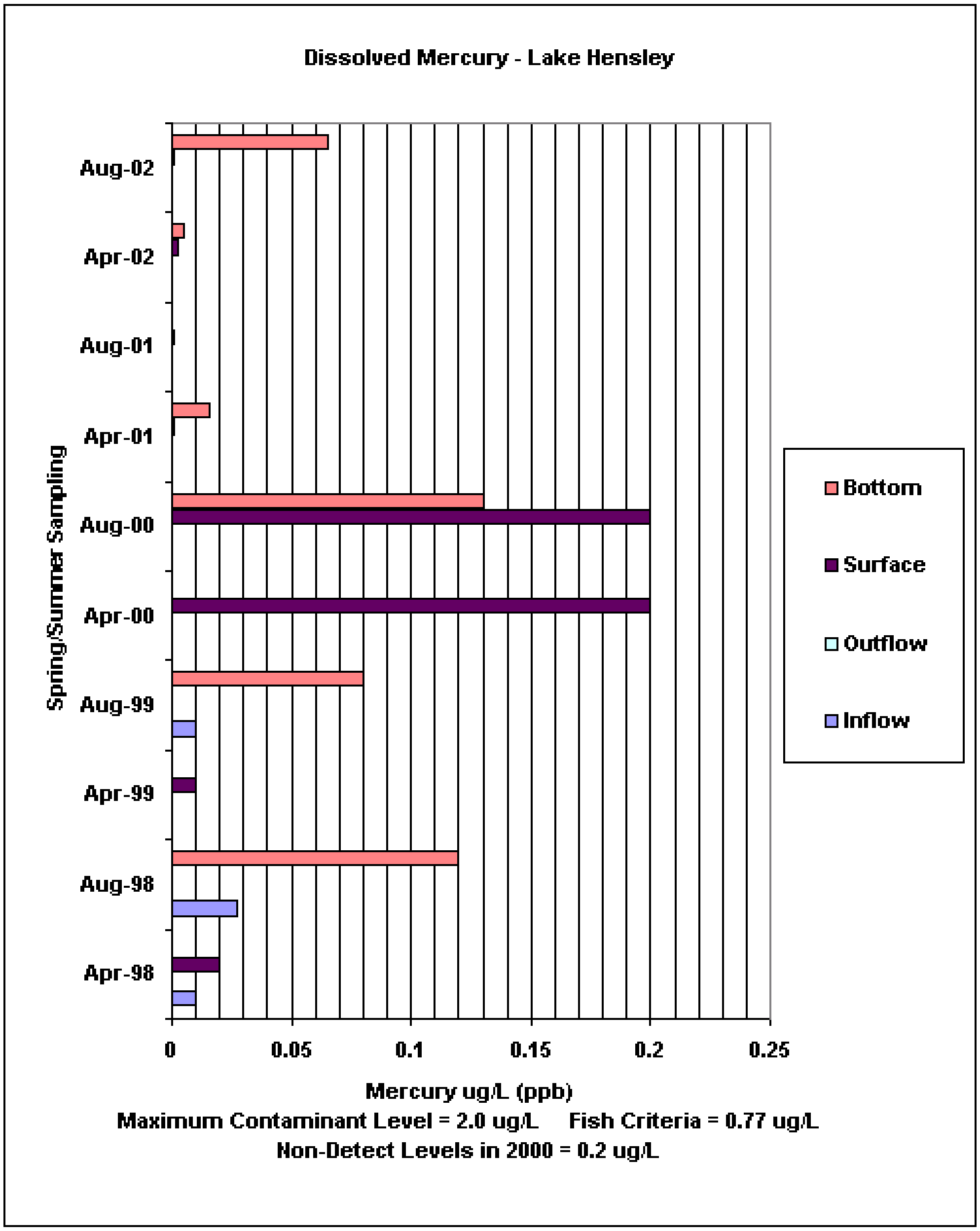
Dissolved Copper - Lake Hensley
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
1
2
3
4
5
6
Bottom
Surface
Outflow
Inflow
Copper ug/L (ppb)
Maximum Contaminant Level = 1300 ug/L Fish Criteria = 9 ug/L
Non-Detect Levels = 5 ug/L
(ND levels displayed as 0.0625)


Dissolved Iron - Lake Henesley
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
500
1000
1500
Bottom
Surface
Outflow
Inflow
Iron ug/L (ppb)
Maximum Contaminant Level = 300 ug/L Fish Criteria = 1000 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L 1999 and Beyond = 50 ug/L
(No modification of scale)

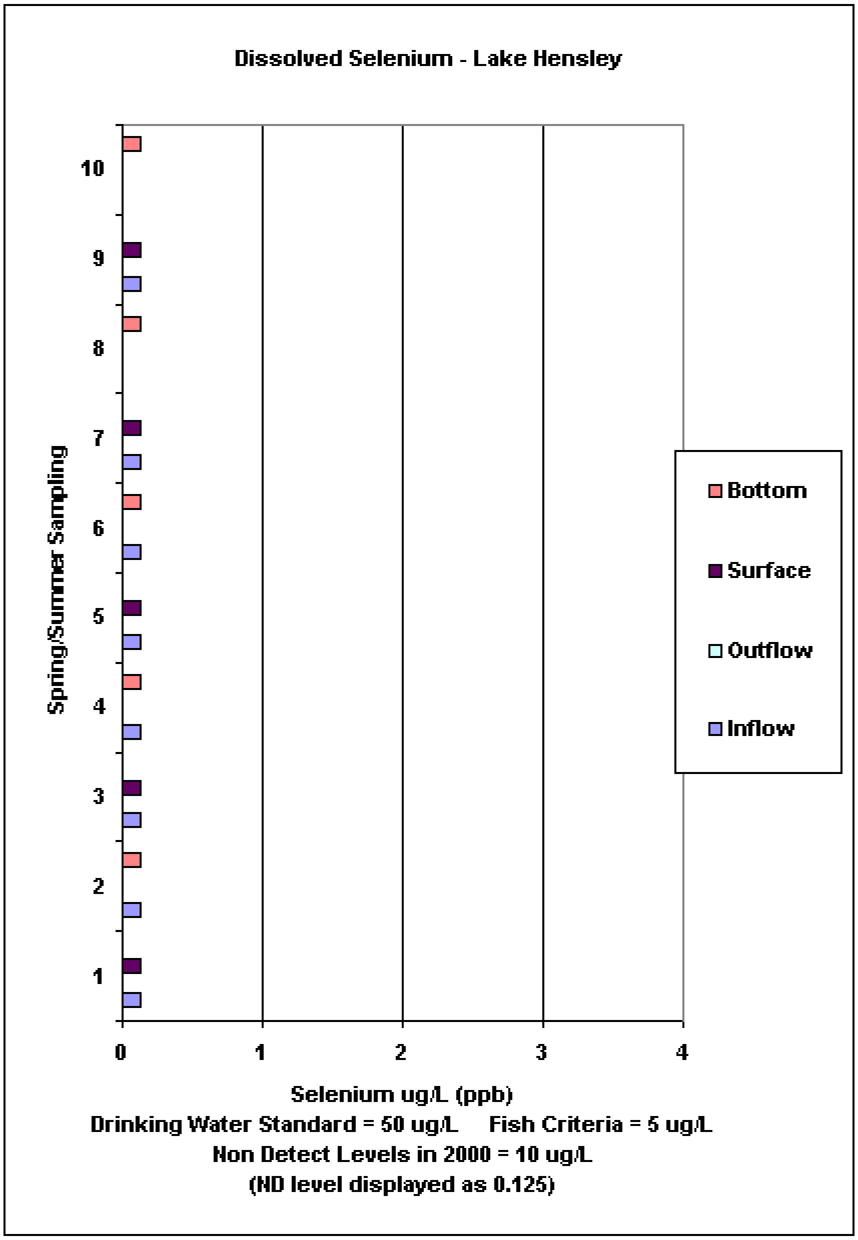


Dissolved Lead - Lake Hensley
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Bottom
Surface
Outflow
Inflow
0
1
2
3
4
Lead ug/L (ppb)
Maximum Contaminant Level = 15 ug/L Fish Criteria = 2.5 ug/L
Non-Detect Levels = 3 ug/L
(ND levels displayed as 0.0375)

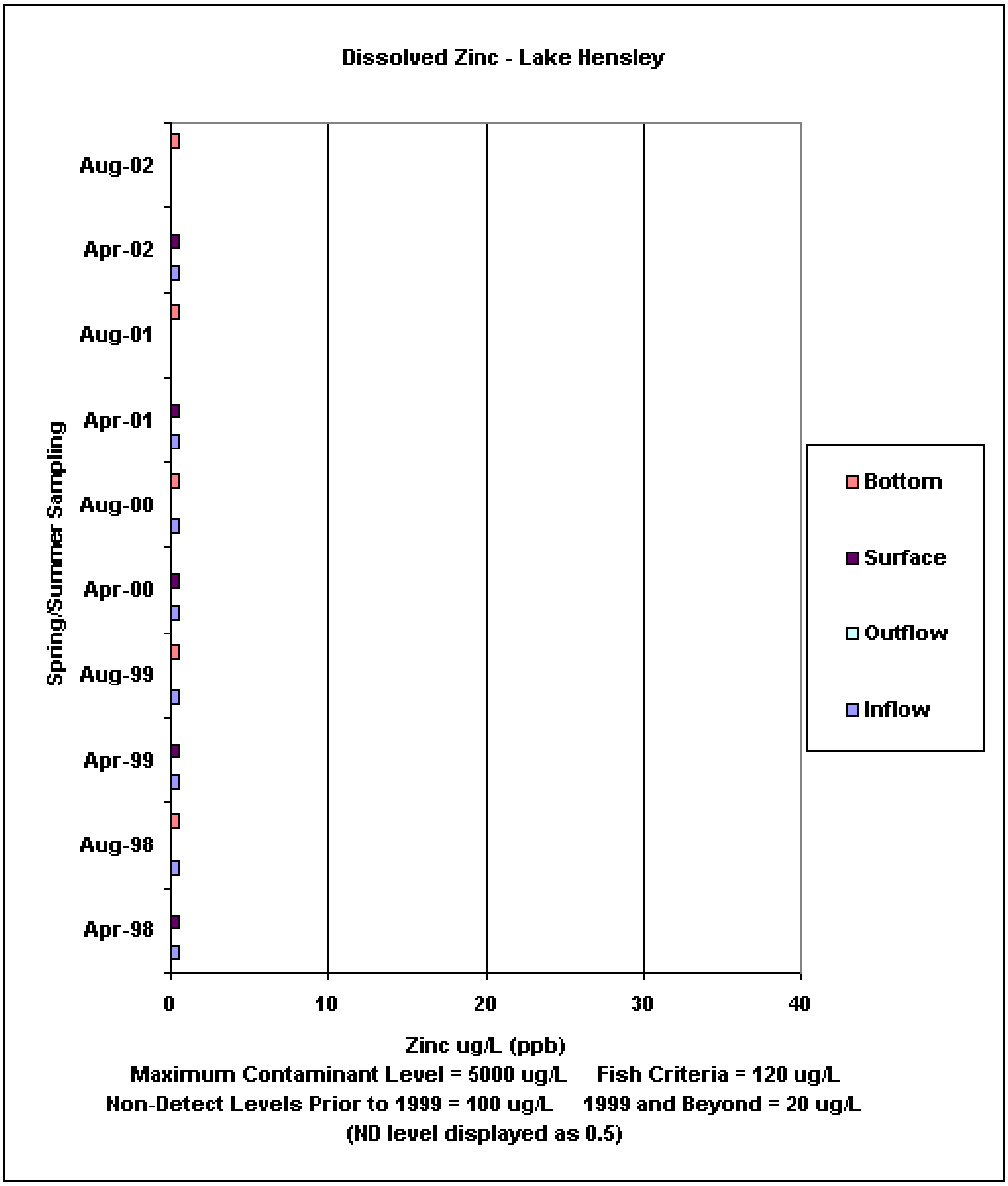

Dissolved Manganese - Lake Hensley
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
50
100
150
200
250
Bottom
Surface
Outflow
Inflow
Manganese ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = none
Non-Detect Levels = 5 ug/L
(No modification of scale)



Dissolved Mercury - Lake Hensley
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.05
0.1
0.15
0.2
0.25
Mercury ug/L (ppb)
Maximum Contaminant Level = 2.0 ug/L
Fish Criteria = 0.77 ug/L
Non-Detect Levels in 2000 = 0.2 ug/L
Bottom
Surface
Outflow
Inflow



Dissolved Selenium - Lake Hensley
Spring/Summer Sampling
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
Bottom
Surface
Outflow
Inflow
Selenium ug/L (ppb)
Drinking Water Standard = 50 ug/L Fish Criteria = 5 ug/L
Non Detect Levels in 2000 = 10 ug/L
(ND level displayed as 0.125)


Dissolved Zinc - Lake Hensley
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
10
20
30
40
Zinc ug/L (ppb)
Maximum Contaminant Level = 5000 ug/L
Fish Criteria = 120 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L
1999 and Beyond = 20 ug/L
(ND level displayed as 0.5)
Bottom
Surface
Outflow
Inflow

Appendix E: Inorganic Sample Data

Inorganic Results (mg/L) For surface lake waters (spring)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity		60	40	50	60	30	40	70	80	20		100
Ammonia		<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Chloride		21	2	21	4	4	3	<1	6	5		4
Nitrate		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1		<0.1
Total P		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Sulfate		5.3	2.6	4.2	8.9	2	1	8.2	9	2.1		4.7
Kjeldahl N		0.6	0.1	0.4	0.2	<0.1	0.3	0.2	0.2	0.2		<0.1
COD					<50							
Tot Solids		120	70	100	110	60	78	100	120	21		150

Inorganic Results (mg/L) For inlet waters to the lakes (spring) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	100	70	40	50	20	30	40	80	90	10	100	50
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride	13	25	3	21	<1	<1	4	<1	6	4	3	2
Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Total P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	
Sulfate	18	2.1	2.3	3	2.8	1.9	0.8	8.8	11	1.6	11	3.5
Kjeldahl N	<0.1	0.2	<0.1	0.3	<0.1	<0.1	0.2	0.2	0.1	0.1	0.1	<0.1
COD	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	170	130	59	110	60	60	90	110	150	30	130	90

Inorganic Results (mg/L) For surface lake waters (summer)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	140	70	40	50	50	40	70	90	80	10	80	110
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1
Chloride	16	26	4	19	6	5	5	5	9	3	5	8
Nitrate	<0.1	1.5	<0.1	1.3	0.7	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1
Total P	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	16	4.1	3.6	3.5	5.9	2	0.7	7.4	14	1.6	6.4	4.4
Kjeldahl N	<0.1	2.7	<0.1	0.4	0.4	0.3	<0.1	0.2	<0.1	<0.1	0.2	0.6
COD	<50	60	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	200	190	50	120	98	80	80	120	120	52	100	170

Inorganic Results (mg/L) For inlet waters to the lakes (summer) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	150	90	40		60	40	80	100	130	20	110	180
Ammonia												
Chloride	16	490	5		10	8	3	5	14	4	5	22
Nitrate												
Total P												
Ortho P												
Sulfate	16	4.5	3		9.8	3.2	<0.5	6	14	2.7	5.4	8.7
Kjeldahl N												
COD												
Tot Solids	200	1300	50		140	100	100	150	200	50	140	280

Appendix F: MTBE Table

2002 MTBE Results
Units are ug/L (ppb)

The following table provides an overview of the lab results for the 2002 MTBE monitoring program.

Lake	Spring S	Spring S-1	Spring S-M	Spring S-C	Summer S	Summer S-1	Summer S-M	Summer S-C	Remarks
Black Butte	2		2		<2		<2		
Eastman	5				<2				
Englebright	3		3		10		10	10	
Hensley	3		3		3		3		
Isabella	<2	<2	<2	<2	<2	<2	<2	<2	
Kaweah	2		2	<2	8		6	6	
Martis Cr.	<2				<2				
Mendocino	<2				<2				
New Hogan	<2				3				
Pine Flat	<2		<2		2		2		
Sonoma		3	<2		<2		2		
Success	4		4	4	11	12	11	11	

Notes:

1. Non-Detect is indicated by “<2” since the Reporting Limit is 2 ppb or 0.002 ppm.

2. No enforceable acceptance criteria has been established for MTBE. See EPA Fact sheet.

3. Maps are provided to illustrate the sampling locations for samples: S / S-1, S-M, and S-C. Sample S and sample S1 are located near the dam; sample S-M is located within 50 ft of the Marina; and sample S-C is located near the center of the lake.

4. For 2002, the number of MTBE water sampling at each lake is based on last year’s lab results.

5. 2 samples were taken from Eastman, Martis Creek, Mendocino, and New Hogan because MTBE was historically non-detectable. The 2002 results of non-detectable levels were similar except Lake Eastman and New Hogan now reported low, detectable levels of MTBE.

6. 4 samples were taken from Black Butte, Hensley, Pine Flat and Sonoma because of historically low detectable levels of MTBE.

7. 6 to 8 samples were taken from Englebright, Isabella, Kaweah and Success because of historically higher MTBE being found. The 2002 results were similar except Isabella now reported non-detectible levels.

8. In 2001, very high MTBE levels were reported at Lake Isabella during the Spring (18 ug/L near the marina) . During Spring 2000, Lake Isabella reported 21 ug/L. The 2002 results indicate that the previous MTBE problem near the marina was not visible during the Spring 2002 sampling event, and may have been rectified.

H. Fish tissue analysis table

2002 Fish Tissue Results

The following table provides an overview of the lab results for the 2002 fish tissue program. N/A indicates data is not available due to lack of fish collection. Sample Preparation, filleting and Extraction were in accordance with EPA 823-R-95-007, Sep 95, Volume 1, Section 7.2 (Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisory) which requires the following: Only the edible portion of the fillet shall be analyzed (i.e no skin, tail, fin, head). Tissue digestion shall be accomplished by adding concentrated nitric acid and heating the tube in an aluminum block to reflux the acid. The digestate shall be cooled, diluted to a final volume of 25 ml and analyzed by CVAA. The laboratory conductng the preparation and analysis was Toxscan, Inc in Watsonville, CA and the laboratory mercury analysis was in accordance with CVAA per EPA 7471. The Percent Lipids were per EPA 1664. The FDA criteria for a fish advisory is 1 ppm. The California OEHHA's action level to continue fish tissue monitoring is 0.3 ppm.

Lake	Type of Fish	Type of Analysis (number of fish)	Date collected	Percent Lipids	Mercury Total ppm	FDA Criteria
Black Butte	Sm M Bass	Composite (3)	6/12/02	0.24	0.26	1 ppm
Eastman	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Englebright	Note 5	N/A	N/A	N/A	N/A	
Hensley	Black Bass	Composite (3)	4/23/02	<0.10	0.72	1 ppm
Isabella	Black Bass	Composite (3)	6/4/02	0.20	0.21	1 ppm
Kaweah	Sm M Bass	Composite (3)	7/14/02	0.11	0.53	1 ppm
Martis Cr	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Mendocino	Note 6	N/A	N/A	N/A	N/A	
New Hogan	Lg M Bass	Single (1)	6/3/02	<0.10	0.34	1 ppm
Pine Flat	Note 4	--------------------	-----------	----------	-----------	< Mon 01
Sonoma	Note 6	N/A	N/A	N/A	N/A	
Success	Black Bass	Composite (3)	4/15/02	<0.10	0.18	1 ppm

Notes:

9. Non-Detect is indicated by "<0.02". The lab Detection Limit for mercury is 0.02 ppm.
10. Total Mercury was reported in mg/g or ppm.
11. Total Mercury was conducted instead of Methyl Mercury since EPA 832 allows Total Mercury analysis for an initial screening program. When specific problem areas are identified, methyl mercury analysis are normally performed later as part of the actual health risk assessment.
12. The fish tissue program was terminated at Eastman and Martis Creek in 2001 and in Pine Flat in 2002 due to low total mercury results. In 2000, the total mercury was only 0.089 ppm for Eastman (Catfish) and the total mercury was <0.02 ppm for Martis Creek (Brown Trout). For Pine Flat total mercury was 0.21 ppm in 2000 (composite of three Sacramento Sucker fish) and 0.23 in 2001 (composite of three spotted bass).

13. Due to seasonal conditions, a fish could not be successfully collected at Lake Englebright. Another attempt will be accomplished for the 2003 report.
14. Fish were not collected at Mendocino or Sonoma due to communication difficulties.

The above 2002 total mercury results indicate only Hensley is higher than average. However, in 2001, the total mercury results were only 0.30 ppm for Hensley (small mouth bass). The 2003 fish tissue program should provide additional data. EPA fact sheet on fish advisories (EPA-823-F-99-016) indicates that the mean average mercury results from numerous lakes in the Northeast United States were found to be 0.46-0.51 ppm for largemouth bass and 0.34-0.53 for smallmouth bass.