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Annual Water Quality Report

MARTIS CREEK LAKE

Water Year 2000

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January 2001

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I DISCUSSION

Martis Creek Lake

2000 Results

The dissolved oxygen, water temperature, and pH profiles are shown on the attached figures in Section II. In the summer of 2000, dissolved oxygen depletion and thermal stratification were minimal. The depth of the lake is very shallow and dissolved oxygen is relatively high on the surface for spring and summer. The shallow depth of the lake allows it to remain vertically mixed during the summer from diurnal mixing. The lake may serve well as a warm water or cold water fishery.

The DO during the summer were 6.5 to 9.6 mg/L in 1999 and 5.5 to 7.8 mg/L in 2000. The surface water pH was 7.8 in 1999; and 9.0 in 2000 during the summer. The summer phytophankton biomass decreased from 7.4 mg/L in 1999 to 0.65 mg/L in 2000. This decreased amount of phytophankton biomass is not considered a problem and there should be sufficient biomass in the summer that can provide a food source for a fishery. However, the very low biomass of about 0.03 mg/L during the spring is a cause for concern since this indicates a low food source for the fish. It should be noted that levels of phytophankton will vary from year to year and will be monitored continuously to determine if eutrophication is occurring.

Eutrophication is the slow natural process in which a Lake moves from an oligotrophic condition to a mesotrophic condition then to a eutrophic condition. Oligotrophic waters contains low concentrations of essential nutrients such as nitrogen, phosphorus and iron and therefore life forms are generally present in small numbers. Lake Tahoe and Crater Lake in Oregon are examples of oligotrophic waters. Natural input of nutrients from runoff results in a gradual increase of phytophankton and higher life forms. This results in the transformation of oligotrophic waters into Mesotrophic waters which are characterized by the abundance of life forms at all levels. However, continued inflow of nutrients can further change the Mestrophic waters into Eutrophic waters which are characterized by high algue growth, high turbidity, and fewer species due to lower dissolved oxygen levels. The algue blooms and scarce fish makes Eutrophic waters less desirable. This process may occur over a long period of time but human activities almost always accelerate this process. One of the major goal of the water quality program is to reduce or mitigate the human effects on the eutrophication process. This requires a monitoring program to determine the levels of nutrient input and phytoplanton levels. The individual species within each individual phytoplankton group are shown in Section IV.

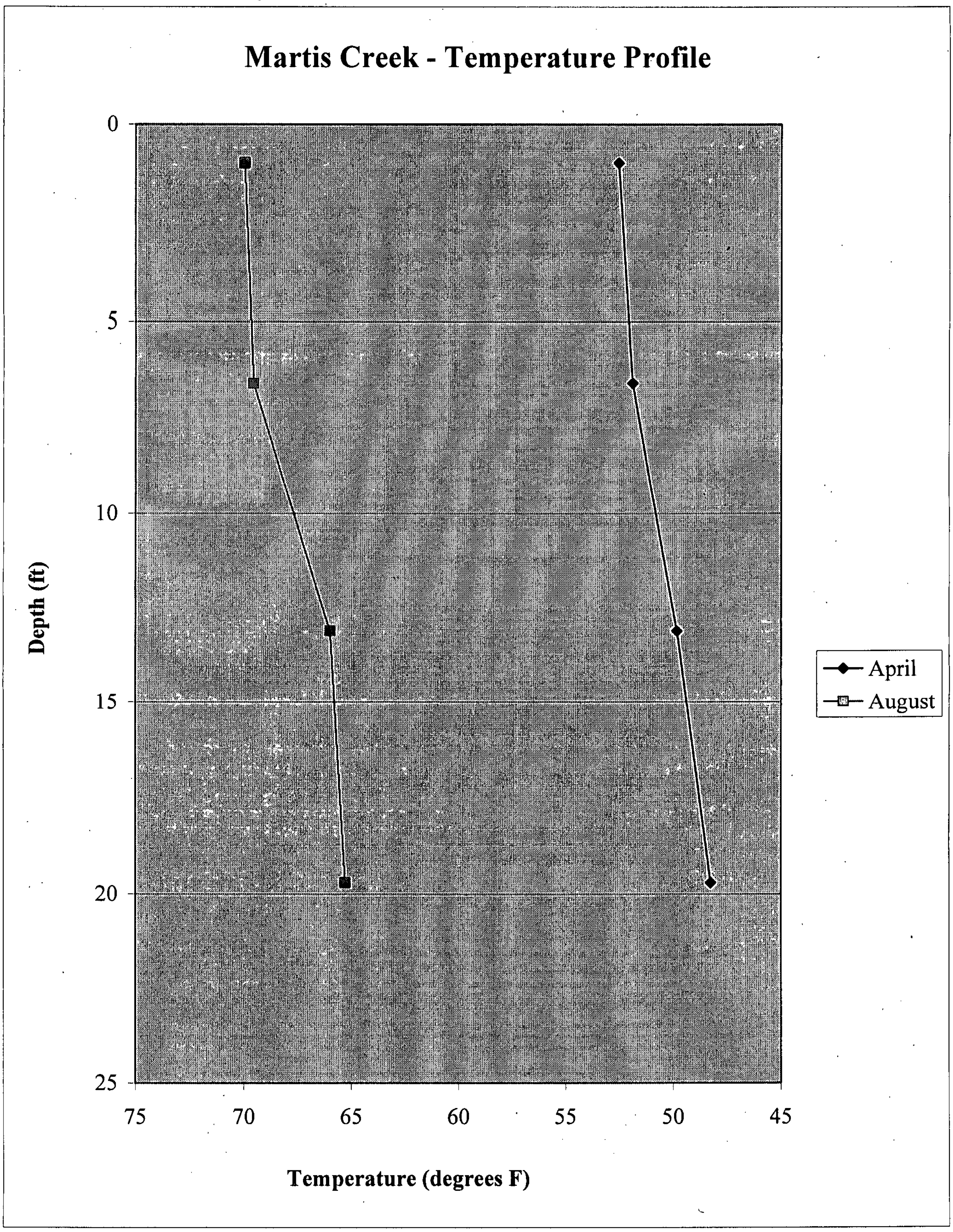
The nutrient, alkalinity and chemical oxygen demand (COD) data shown in Section V indicates that excessive nutrients are not present that would cause undesirable phytoplankton blooms, that the lake water is well buffered and there is not an excess of oxygen-demanding substances in the inflows. However, the amount of ammonia detected in the spring surface water was 1.2mg/L. This is 6 times higher than the other lakes but ammonia decreased to 0.2 mg/L in the summer. This may require increased monitoring for ammonia in 2001.

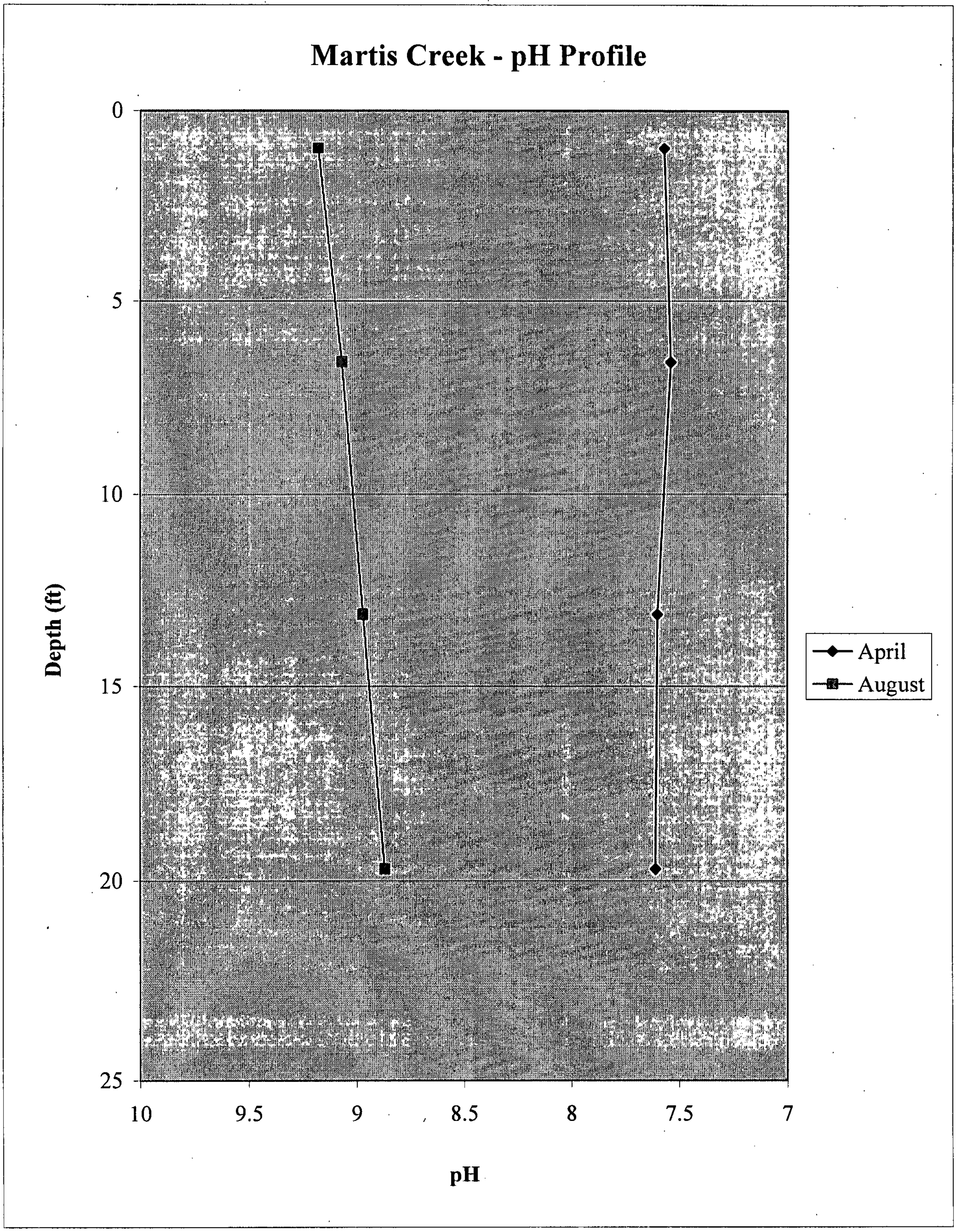
The dissolved heavy metals did not exceed the drinking water standard or the freshwater fishery criteria. It should be noted that the laboratory detection limit for dissolved cadmium was 1 ug/L which was slightly higher than the fish criteria of 0.55 ug/L. The graphs are shown in Section V for the surface and bottom waters of the Lakes and it's inflows and outflows.

The dissolved mercury levels were found to be below the laboratory detection limit of 0.01 ug/L on the lake surface and at the bottom of the lake for the Spring. This is relatively less than the mercury levels found in the other lakes. Based on mercury levels found in other lakes in 1999, a fish tissue program was initiated for all the lakes for the first time in 2000. The results from one uncomposited brown trout that was collected from Martis Creek Lake on Oct 26 2000 resulted in a fish tissue mercury level of less than 0.02 ppm. (below the detection limit) This was expected and since Martis Creek Lake has a catch and release program being enforced, the fish tissue program will be discontinued at Martis Creek. The results are provided in Section VI.

The MTBE results for 2000 were below the detection limit of 2 ppb for the spring and summer of 2000. This is very low compared to the mean average of all the lakes and therefore the number of MTBE water samples will be decreased for Martis Creek in 2001. The 2000 results are provided in Section VII. At the end of Section VII is the EPA fact sheet on MTBE in drinking water. Unlike mercury, which has a known toxic effect on humans, there is little data connecting MTBE to human toxicity. However, since MTBE is considered controversial, it is recommended that MTBE data be continued to be collected.

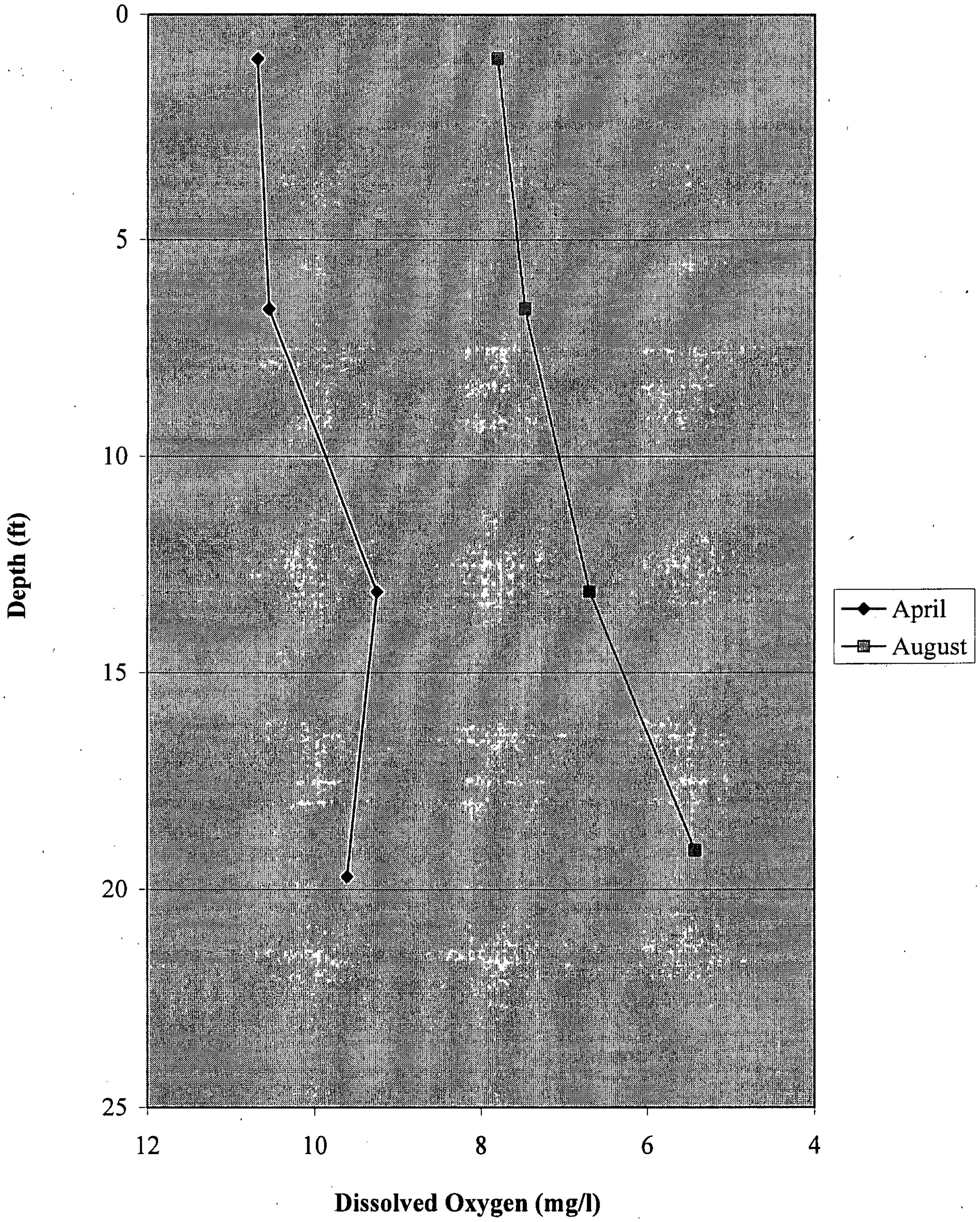
In summary, only ammonia during the spring is the only element of concerns at Martis Creek Lake. Additional sampling for ammonia will be taken in 2001for confirmation. The other elements such as inorganics, biomass, MTBE and mercury do not indicate any significant problems.


Martis Creek - Temperature Profile
Depth (ft)
0
5
10
15
20
25
75
70
65
60
55
50
45
Temperature (degrees F)
April
August



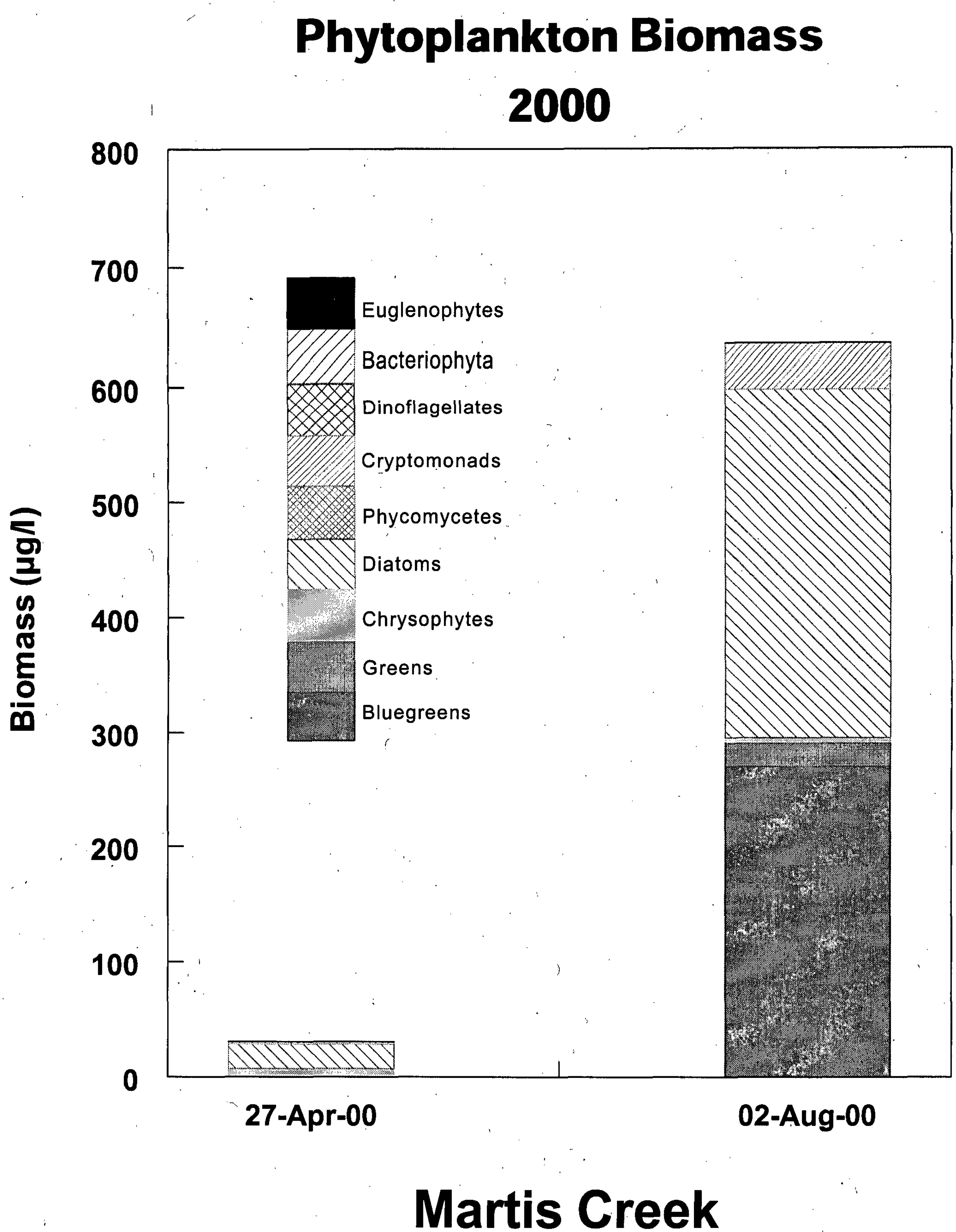
Martis Creek - pH Profile
Depth (ft)
0
5
10
15
20
25
10
9.5
9
8.5
8
7.5
7
pH
April
August

Martis Creek - Dissolved Oxygen Profile



MARTIS CREEK						
Sample Location: Behind dam					**Date:** 4/27/00	
Observers: Tim McLaughlin					**Time:** 10:30 am	
Lake Elevation: N/A						
Weather Conditions:						
Wind Speed: 15			**Precipitation:** 0		**Temp (F):** 60	
SECCHI Depth: 6 feet and 9 inches						
Depth-M	**Depth-F**	**Temp - F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
5.3	19.7	48.254	9.03	88	9.61	7.61
4	13.1	49.82	9.90	92	9.25	7.60
2	6.6	51.89	11.05	91	10.55	7.54
0.03	1	52.538	11.41	91	10.69	7.57
MARTIS CREEK (Inflow)						
Temp (F)	**pH**			**DOmg/L**	**EC**	**Flow rate (cfs)**
51.1	7.81			-	-	-
VISUAL OBSERVATIONS:						

MARTIS CREEK						
Sample Location: Behind dam					**Date:** 8/02/00	
Observers: Tim McLaughlin					**Time:** 10:30 am	
Lake Elevation:						
Weather Conditions:						
Wind Speed (mph): 0			**Precipitation:** 0		**Temp (F):** 80	
SECCHI Depth: 13 feet and 6 inches						
Depth-M	**Depth-F**	**Temp - F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
6	19.1	65.282	18.49	134	5.43	8.87
4	13.1	66.002	18.89	133	6.69	8.97
2	6.6	69.548	20.86	132	7.47	9.07
0.03	1.0	69.962	21.09	130	7.80	9.18
MARTIS CREEK (Inflow)						
Temp (F)	**pH**			**DOmg/L**	**EC**	**Flow rate (cfs)**
72.6	8.21			-	-	-
VISUAL OBSERVATIONS: Small hairlike algae on water surface.						


Phytoplankton Biomass
2000
800
700
600
500
400
300
200
100
0
Biomass (µg/l)
Euglenophytes
Bacteriophyta
Dinoflagellates
Cryptomonads
Phycomycetes
Diatoms
Chrysophytes
Greens
Bluegreens
27-Apr-00
02-Aug-00
Martis Creek

Phytoplankton Normalized Sample Summary
Army Corps of Engineers - Standard samples

Sample location: ***Martis Creek***
Sample description:
Sampled on 04/27/00 by AC
Sample type: Composite Cm settled: 2.00

Species	Species name	Group	Units/L	BioVol (μ g/L)
CRUCRE	Crucigeniella rectangularis	Chlorophytes	4000	0.268
KOLILO	Koliella longiseta	Chlorophytes	3500	0.588
		Chlorophytes Totals:	7500	0.856

Species	Species name	Group	Units/L	BioVol (μ g/L)
FLAGSM	Flagellates (<5μm)	Chrysophytes	43930	0.659
MALLTO	Mallomonas tonsurata	Chrysophytes	500	0.623
SYNURA	Synura sp.	Chrysophytes	3994	3.886
TETDIS	Tetramitus descisus	Chrysophytes	4000	0.512
		Chrysophytes Totals:	52424	5.680

Species	Species name	Group	Units/L	BioVol (μ g/L)
CRYPT	Cryptomonas sp.	Cryptomonads	1500	1.850
		Cryptomonads Totals:	1500	1.850

Species	Species name	Group	Units/L	BioVol (μ g/L)
OSCILS	Oscillatoria sp.	Cyanophytes	2000	0.684
		Cyanophytes Totals:	2000	0.684

Species	Species name	Group	Units/L	BioVol (μ g/L)
ACHNMI	Achnanthes microcephala	Diatoms	500	0.199
CYCSTE	Cyclotella stelligera	Diatoms	151757	13.962
FRAGCO	Fragilaria construens	Diatoms	4000	0.692
NAVIPU	Navicula pupula	Diatoms	500	0.453
SYNULN	Synedra ulna	Diatoms	1000	5.842
		Diatoms Totals:	157757	21.148

Species	Species name	Group	Units/L	BioVol (μ g/L)
STELEX	Stelexomonas dichotoma	Phycomycetes	8500	0.411
		Phycomycetes Totals:	8500	0.411

Sample total: 30.629

IV Nutrient and Miscellaneous Parameters

Phytoplankton Normalized Sample Summary
Army Corps of Engineers - Standard samples

Sample location: **Martis Creek**
Sample description:
Sampled on **08/02/00** **by AC**
Sample type: **Composite** **Cm settled: 2.00**

Species	Species name	Group	Units/L	BioVol (μ g/L)
COSMMA	Cosmarium margaritatum	Chlorophytes	500	1.951
KOLISL	Koliella spiculiformis	Chlorophytes	55911	4.456
KORSLI	Korschikoviella limnetica	Chlorophytes	500	0.143
OOCYBO	Oocystis borgei	Chlorophytes	2500	0.885
PARAMU	Paradoxia multiseta	Chlorophytes	1000	0.251
SPHAER	Sphaerocystis schroeteri	Chlorophytes	8000	0.454
STAURP	Staurasturm planctonicum	Chlorophytes	500	12.421
		Chlorophytes Totals:	68911	20.561

Species	Species name	Group	Units/L	BioVol (μ g/L)
FLAGSM	Flagellates (<5μm)	Chrysophytes	239617	3.594
		Chrysophytes Totals:	239617	3.594

Species	Species name	Group	Units/L	BioVol (μ g/L)
CRYPT	Cryptomonas sp.	Cryptomonads	20000	25.299
RHODOM	Rhodomonas lacustris	Cryptomonads	95847	10.639
		Cryptomonads Totals:	115847	35.938

Species	Species name	Group	Units/L	BioVol (μ g/L)
ANABSP	Anabaena spiroides	Cyanophytes	127000	5.626
APHANI	Apanizomenon flos-aque	Cyanophytes	1255285	264.865
NOSTOC	Nostoc sp.	Cyanophytes	195000	0.390
		Cyanophytes Totals:	1577285	270.881

Species	Species name	Group	Units/L	BioVol (μ g/L)
EPITSO	Epithemia sorex	Diatoms	500	3.142
FRAGCA	Fragilaria capucina	Diatoms	500	0.618
FRAGCR	Fragilaria crotonensis	Diatoms	171500	298.393
SYNDRA	Synedra radians	Diatoms	500	0.239
SYNUOX	Synedra ulna v. oxyrhynchus	Diatoms	500	0.848
		Diatoms Totals:	173500	303.240
			Sample total:	634.214

2000 Lake Monitoring Results for Organics

Pesticides and Herbicides were discontinued in 2001 since the results from 1995 to 2000 were consistently "non-detect" and the program's current effort is to focus on MTBE and mercury levels in fish tissue.

The following tables on the next page are the 2000 Lake Monitoring Results for general Organics related to nutrients (which may cause algue blooms) and miscellanous water quality parameters which may have an adverse impact on aquatic life such as Chemical Oxygen Demand and ammonia (which may cause a fish kill).

The results in the following tables indicate no potential for signficant adverse impact.

Notes:
Alkalinity is reported as "Total Alkalinity as CaCO3"
Ammonia is reported as "Ammonia as N"
Nitrate is reported as "Nitrate + Nitrate as N"
Total P is reported as "Phosphate as P. total"
Ortho P is reported as "Phosphate as P. Ortho"
Kjedahl N is reported as "Total Kjedahl Nitrogen"
COD is "Chemical Oxygen Demand"
Tot Solids is reported as "Solids, Tot"

Lake codes are as follows:

BB	Black Butte
EA	Eastmand
EN	Englebright
HE	Hensley
IS	Isabella
KA	Kaweah
MC	Martis Creek
ME	Mendocino
NH	New Hogan
PF	Pine Flat
SO	Sonoma
SU	Success

Inorganic Results (mg/L) For surface lake waters (spring)

	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	110	50	30	40	60	40	40	70	60	20	60	90
Ammonia	<.1	<.1	<.1	<.1	<.1	<.1	1.2	<.1	<.1	<.1	.2	.2
Chloride	9	5	<1	5	4	2	2	1	2	<1	2	5
Nitrate	<.1	.2	<.1	.1	<.1	<.1	<.1	<.1	.2	.3	.3	<.1
Total P	<.1	<.1	<.1	<.1	<.1	<.1	.04	<.1	<.1	<.1	<.1	<.1
Ortho P	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Sulfate	14	2.6	2.2	2.8	7.2	2.4	5.8	6.8	6.3	1.6	6	5
Kjeldahl N	.2	.5	<.1	.6	.2	.1	.2	.2	.3	<.1	.2	.3
COD					<50	<50		<50			<50	<50
Tot Solids	160	90	40	50	90	66	87	100	92	50	90	140

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	30	30	30	30	30	80	90	10	90	50
Ammonia	<.1	<.1	<.1	<.1	<.1	<.1	.2	<.1	<.1	<.1	<.1	<.1
Chloride	6	7	<1	5	2	1	1	2	4	<1	2	3
Nitrate	<.1	.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	.2
Total P	<.1	<.1	<.1	<.1	<.1	<.1	.03	<.1	<.1	<.1	<.1	<.1
Ortho P	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Sulfate	14	1.9	.7	3.4	3.8	1.4	6.5	8.2	14	1.3	8.2	4.7
Kjeldahl N	<.1	.1	<.1	<.1	.1	.1	.2	0.2	.1	<.1	.1	.2
COD	60	<50	<50	<50	<50	<50	<50	<50	80	<50	<50	
Tot Solids	160	110	60	80	60	50	80	140	140	40	120	100

Inorganic Results (mg/L) For surface lake waters (summer)

	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	130	60	40	40	40	50	70	80	70	10	70	110
Ammonia	<.1	.1	.0672	.04	.2	.08	.2	.04	<.1	.02	.06	.1
Chloride	12	10	<1	9	8	7	<1	1	1	<1	2	10
Nitrate	1.1	<.1	<.1	<.1	.6	<.1	<.1	<.1	<.1	<.1	.4	<.1
Total P	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Ortho P	<.1	<.1	<.1	<.1		<.1	<.1	<.1	<.1	<.1	<.1	<.1
Sulfate	16	2.1	2.6	2.2		1.8	.7	6.9	8.9	1.5	6.6	4.5
Kjeldahl N	.5	.3	.06	.3	.4	.3	.3	<.1	.3	.3	.3	.5
COD	<50	<50	<50	<50	<50	<50	<50		<50	<50		<50
Tot Solids	200	85	63	90	65	50	110	100	120	30	95	140

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		100	30	50	50	40	70	80	100	20	130	160
Ammonia												
Chloride		300	<1	14	10	9	<1	1	5	<1	4	12
Nitrate												
Total P												
Ortho P												
Sulfate		3.2	2	2.3	7.5	2.5	<.5	5.5	14	6	8.2	5.2
Kjeldahl N												
COD												
Tot Solids		660	50	110	90	80	110	110	170	220	170	230

Caltest
ANALYTICAL LABORATORY
ENVIRONMENTAL ANALYSES

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: A080159-1								
SAMPLE ID: MC-SU-S								
SAMPLED: 02 AUG 00 10:45								
Chemical Oxygen Demand	ND	50.	mg/L	1	410.4	08.08.00	B000221COD	
Solids, Suspended	ND	3.	mg/L	1	160.2	08.08.00	B000223TSS	
ALKALINITY				1	310.1	08.07.00	I000050ALK	
Bicarbonate as CaCO3	40.	10.	mg/L					
Hydroxide as CaCO3	ND	10.	mg/L					
Carbonate as CaCO3	30.	10.	mg/L					
Total Alkalinity as CaCO3	70.	10.	mg/L					
Ammonia as N	0.2	0.1	mg/L	1	350.2	08.14.00	I000083AMM	
Chloride	ND	1.	mg/L	1	SM4500	08.17.00	I000017CHL	
Nitrate + Nitrite as N	0.1	0.1	mg/L	1	353.2	08.18.00	I000034NNO	
Phosphate as P, Ortho	ND	0.1	mg/L	1	365.2	08.04.00	I000107PHO	1
Phosphate as P, Total	J0.02	0.1	mg/L	1	365.2	08.08.00	I000108PHO	2
Solids, Dissolved	110.	10.	mg/L	1	160.1	08.04.00	I000056TDS	
Solids, Total	110.	10.	mg/L	1	160.3	08.08.00	I000021TS	
Sulfate	0.7	0.5	mg/L	1	300.0	08.18.00	I000125IC	
Total Kjeldahl Nitrogen	0.3	0.1	mg/L	1	351.3	08.09.00	I000052TKN	
LAB NUMBER: A080159-3								
SAMPLE ID: MC-SU-I								
SAMPLED: 02 AUG 00 12:10								
Solids, Suspended	ND	3.	mg/L	1	160.2	08.08.00	B000223TSS	
ALKALINITY				1	310.1	08.07.00	I000050ALK	
Bicarbonate as CaCO3	70.	10.	mg/L					
Hydroxide as CaCO3	ND	10.	mg/L					
Carbonate as CaCO3	ND	10.	mg/L					
Total Alkalinity as CaCO3	70.	10.	mg/L					
Chloride	ND	1.	mg/L	1	SM4500	08.17.00	I000017CHL	
Solids, Dissolved	100.	10.	mg/L	1	160.1	08.09.00	I000058TDS	
Solids, Total	110.	10.	mg/L	1	160.3	08.08.00	I000021TS	
Sulfate	ND	0.5	mg/L	1	300.0	08.18.00	I000125IC	

1) Sample filtered prior to analysis.
2) A "J" flagged result reflects a value seen below the Reporting Limit (RL), but above the Method Detection Limit (MDL).

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Caltest

ANALYTICAL LABORATORY

ENVIRONMENTAL ANALYSES

LAB ORDER No.: A040695

INORGANIC ANALYTICAL RESULTS

LAB NUMBER: A040695-1
SAMPLE ID: MC-SP-S
SAMPLED: 27 APR 00 10:30

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Solids, Suspended	ND	3.	mg/L	1	160.2	05.04.00	B000126TSS	
ALKALINITY				1	310.1	05.01.00	I000026ALK	
Bicarbonate as CaCO3	40.	10.	mg/L					
Hydroxide as CaCO3	ND	10.	mg/L					
Carbonate as CaCO3	ND	10.	mg/L					
Total Alkalinity as CaCO3	40.	10.	mg/L					
Ammonia as N	1.2	0.1	mg/L	1	350.2	05.01.00	I000047AMM	
Chloride	2.	1.	mg/L	1	300.0	05.11.00	I000069IC	
Nitrate + Nitrite as N	ND	0.1	mg/L	1	353.2	05.19.00	I000021NNO	
Phosphate as P, Ortho	ND	0.1	mg/L	1	365.2	04.28.00	I000057PHO	1
Phosphate as P, Total	J0.04	0.1	mg/L	1	365.2	04.28.00	I000058PHO	2
Solids, Dissolved	90.	10.	mg/L	1	160.1	04.28.00	I000031TDS	
Solids, Total	87.	10.	mg/L	1	160.3	05.02.00	I000018TS	
Sulfate	5.8	0.5	mg/L	1	300.0	05.11.00	I000069IC	
Total Kjeldahl Nitrogen	0.2	0.1	mg/L	1	351.3	05.04.00	I000028TKN	

NUMBER: A040695-2
SAMPLE ID: MC-SP-I
SAMPLED: 27 APR 00 12:15

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Chemical Oxygen Demand	ND	50.	mg/L	1	410.4	05.11.00	B000132COD	
Solids, Suspended	4.	3.	mg/L	1	160.2	05.04.00	B000126TSS	
ALKALINITY				1	310.1	05.01.00	I000026ALK	
Bicarbonate as CaCO3	30.	10.	mg/L					
Hydroxide as CaCO3	ND	10.	mg/L					
Carbonate as CaCO3	ND	10.	mg/L					
Total Alkalinity as CaCO3	30.	10.	mg/L					
Ammonia as N	0.2	0.1	mg/L	1	350.2	05.01.00	I000047AMM	
Chloride	1.	1.	mg/L	1	300.0	05.11.00	I000069IC	
Nitrate + Nitrite as N	ND	0.1	mg/L	1	353.2	05.19.00	I000021NNO	
Phosphate as P, Ortho	ND	0.1	mg/L	1	365.2	04.28.00	I000057PHO	
Phosphate as P, Total	J0.03	0.1	mg/L	1	365.2	04.28.00	I000058PHO	
Solids, Dissolved	80.	10.	mg/L	1	160.1	04.28.00	I000031TDS	
Sulfate	6.5	0.5	mg/L	1	300.0	05.11.00	I000069IC	
Total Kjeldahl Nitrogen	0.2	0.1	mg/L	1	351.3	05.04.00	I000028TKN	

1) Sample filtered prior to analysis.
2) A "J" flagged result reflects a value seen below the Reporting Limit (RL), but above the Method Detection Limit (MDL).

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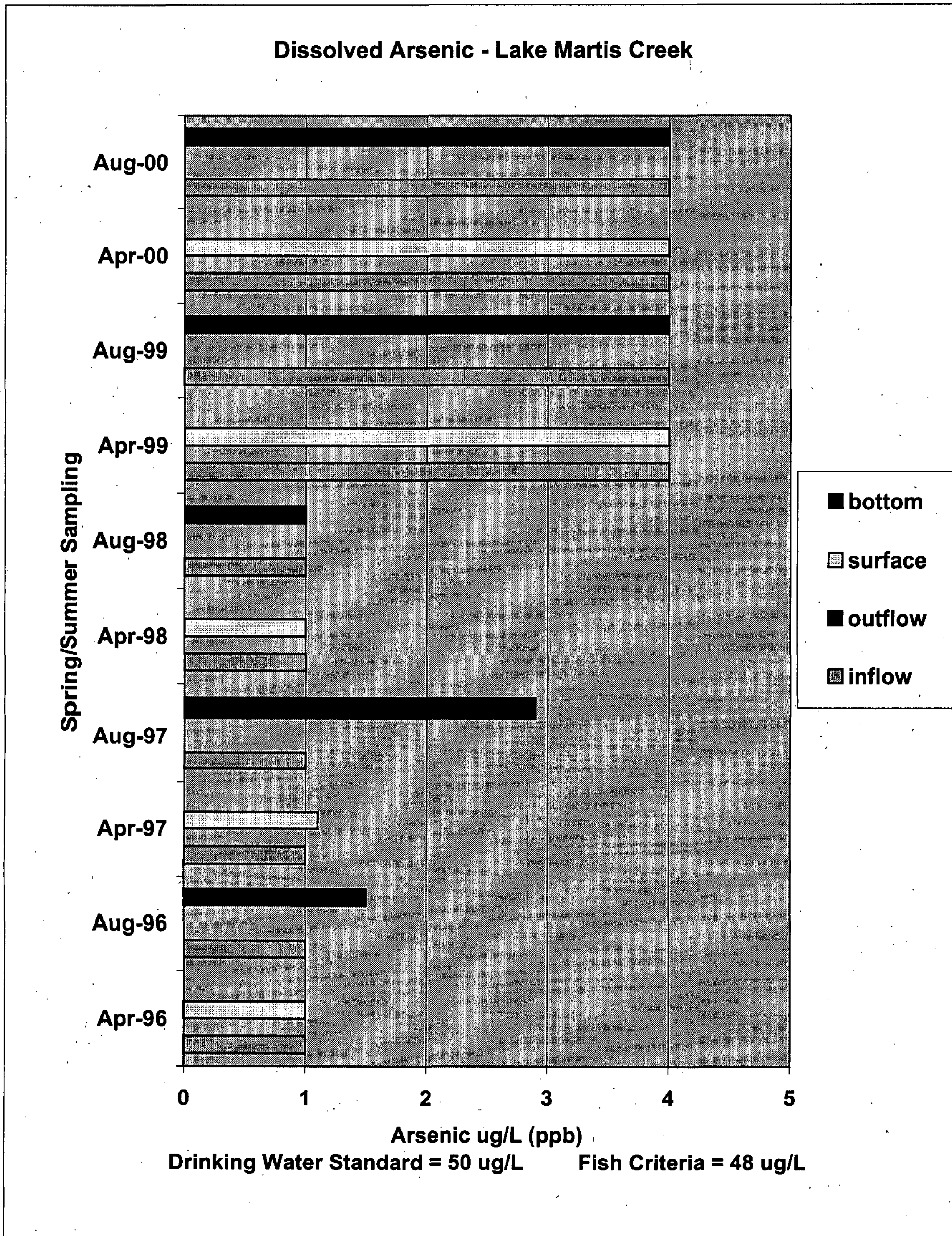
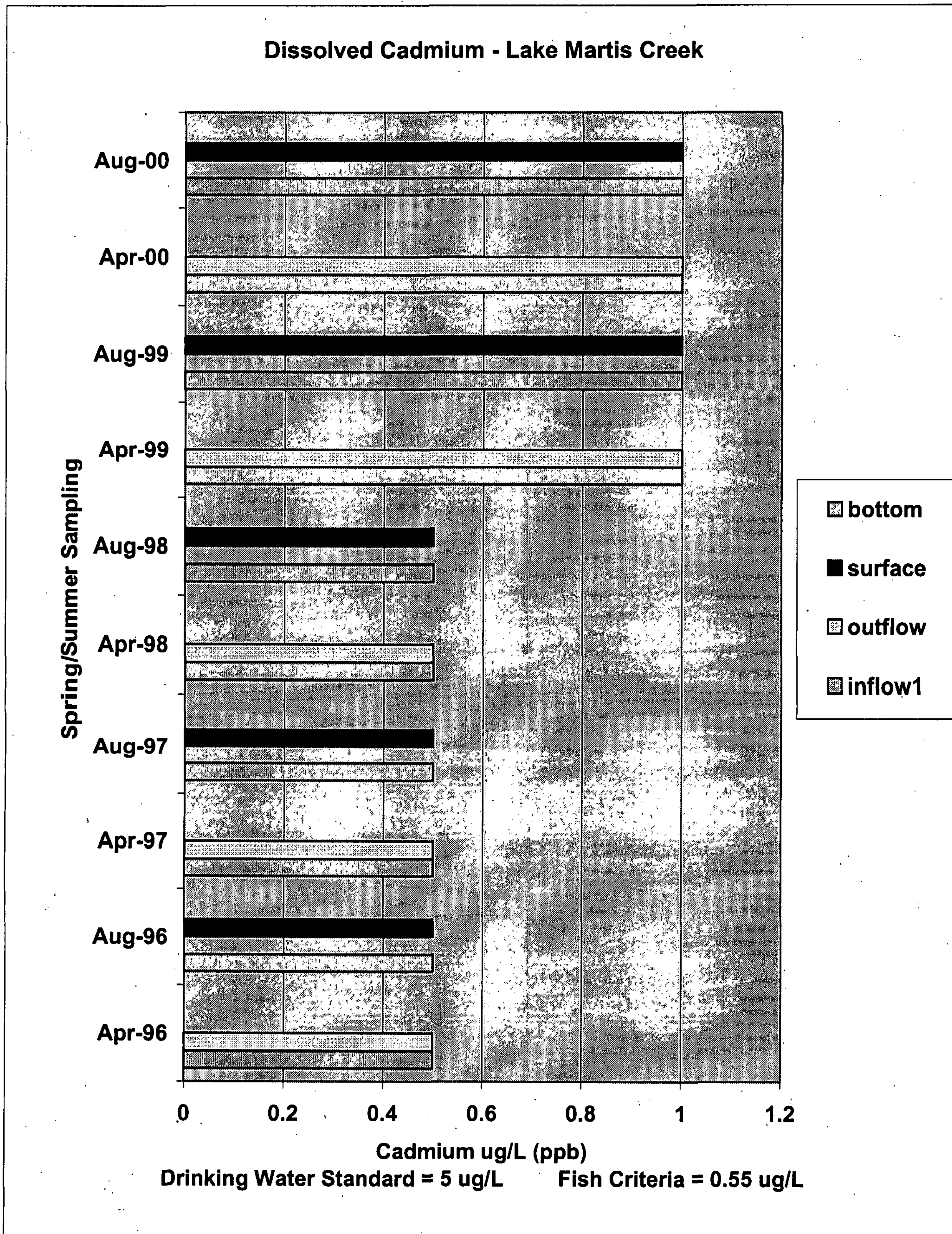
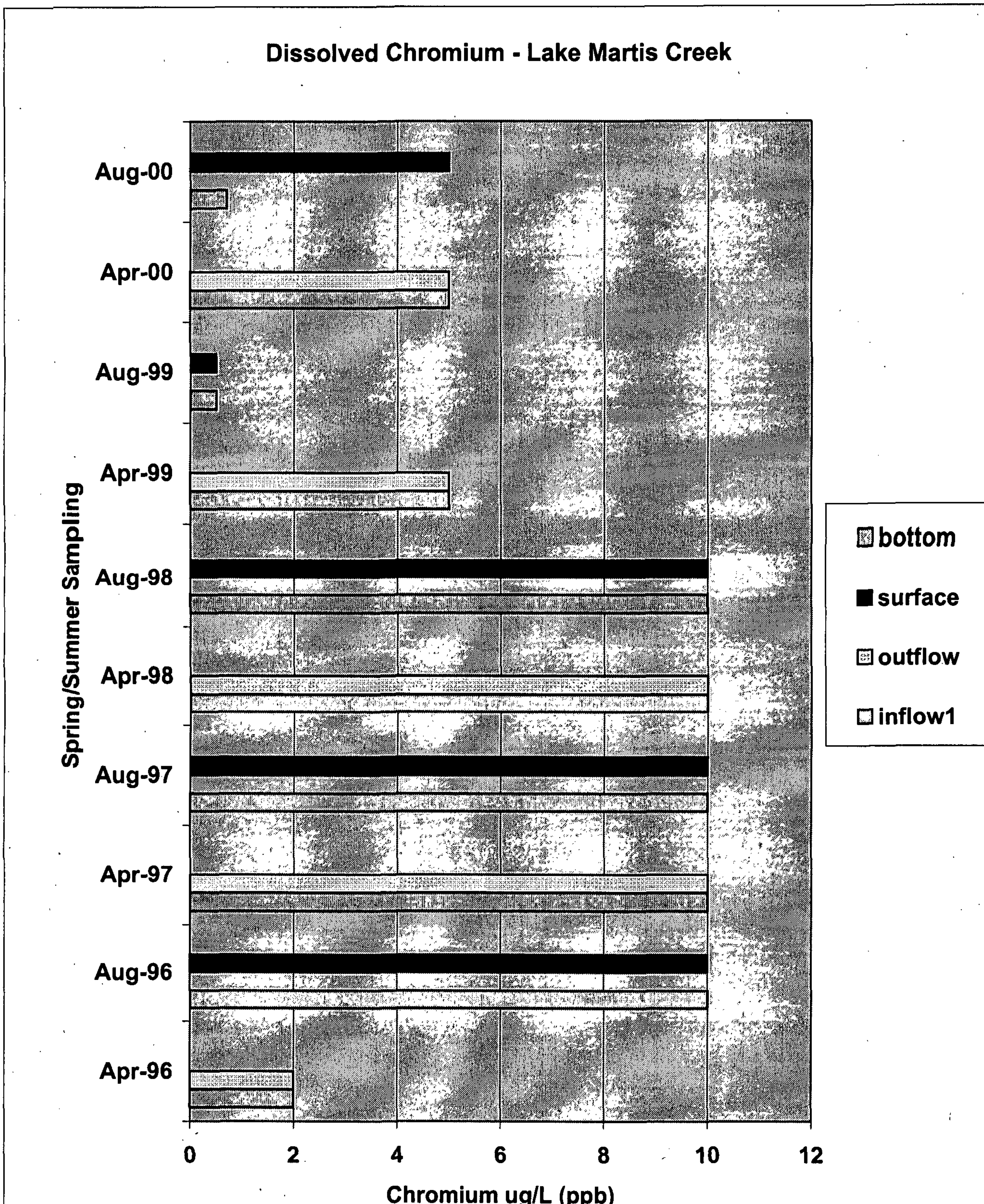
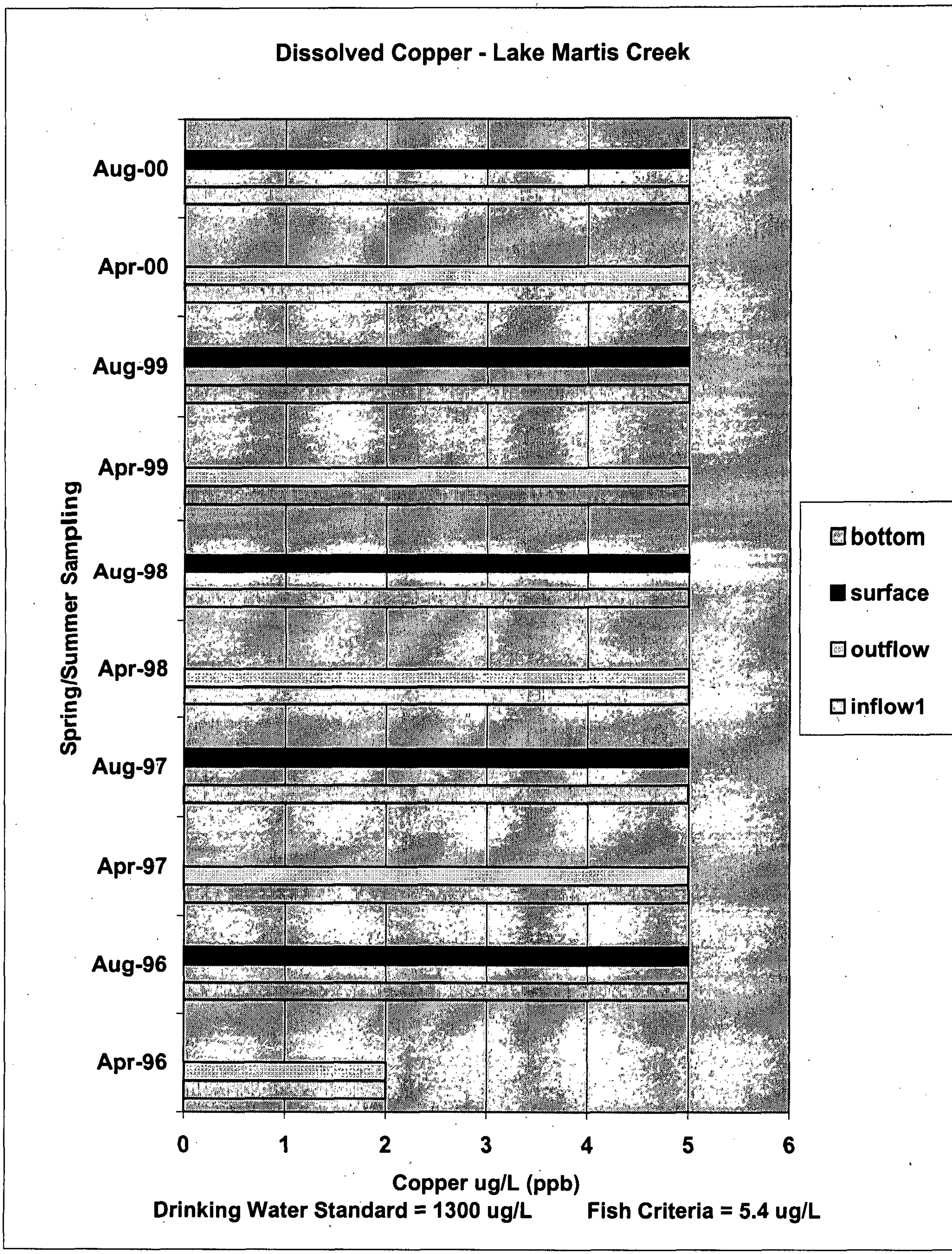
V Metals


Dissolved Arsenic - Lake Martis Creek
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
Aug-96
Apr-96
Spring/Summer Sampling
bottom
surface
outflow
inflow
0
1
2
3
4
5
Arsenic ug/L (ppb)
Drinking Water Standard = 50 ug/L
Fish Criteria = 48 ug/L

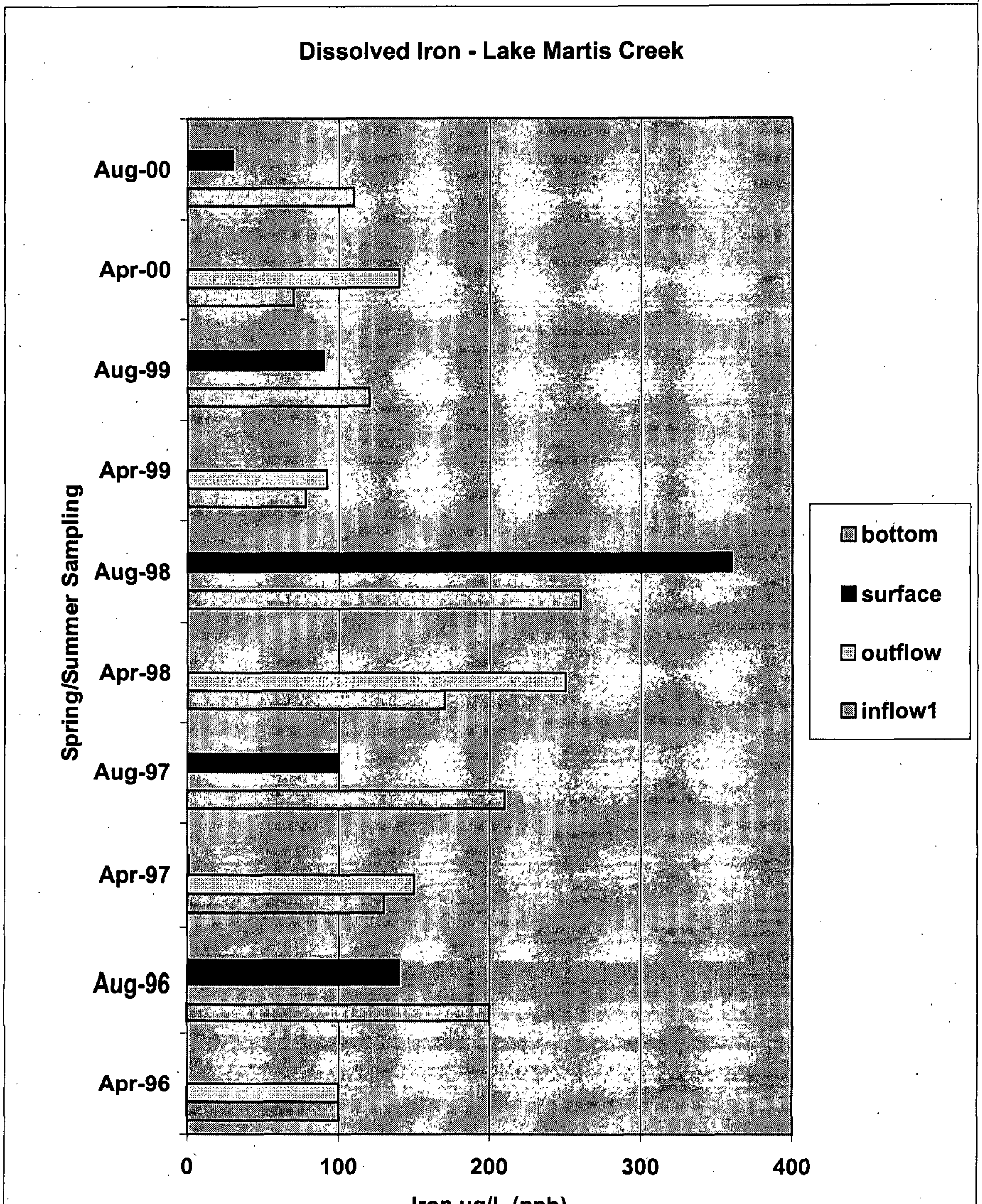

Dissolved Cadmium - Lake Martis Creek
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
Aug-96
Apr-96
Spring/Summer Sampling
bottom
surface
outflow
inflow1
0
0.2
0.4
0.6
0.8
1
1.2
Cadmium ug/L (ppb)
Drinking Water Standard = 5 ug/L
Fish Criteria = 0.55 ug/L



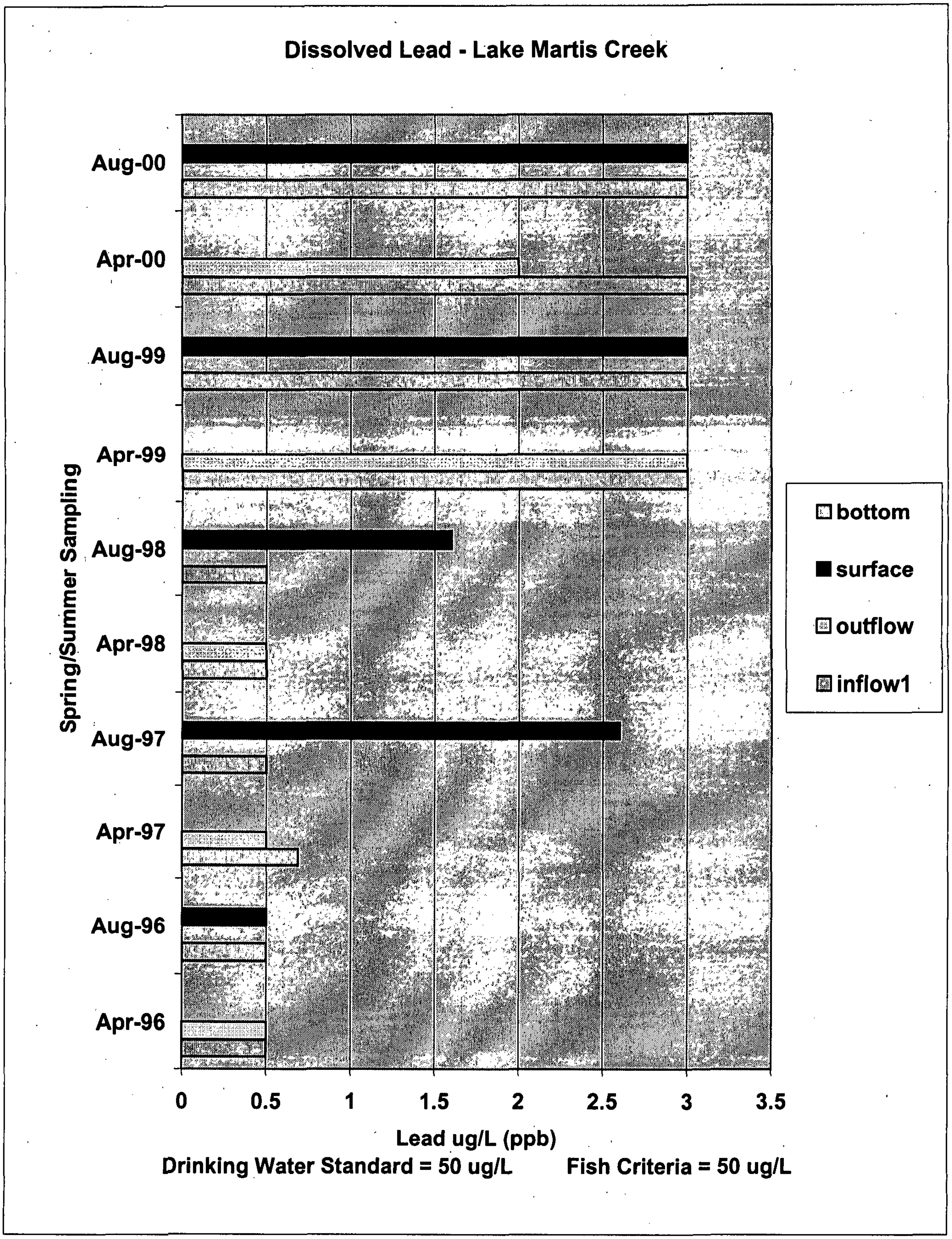
Drinking Water Standard = 100 ug/L Fish Criteria = 11 ug/L

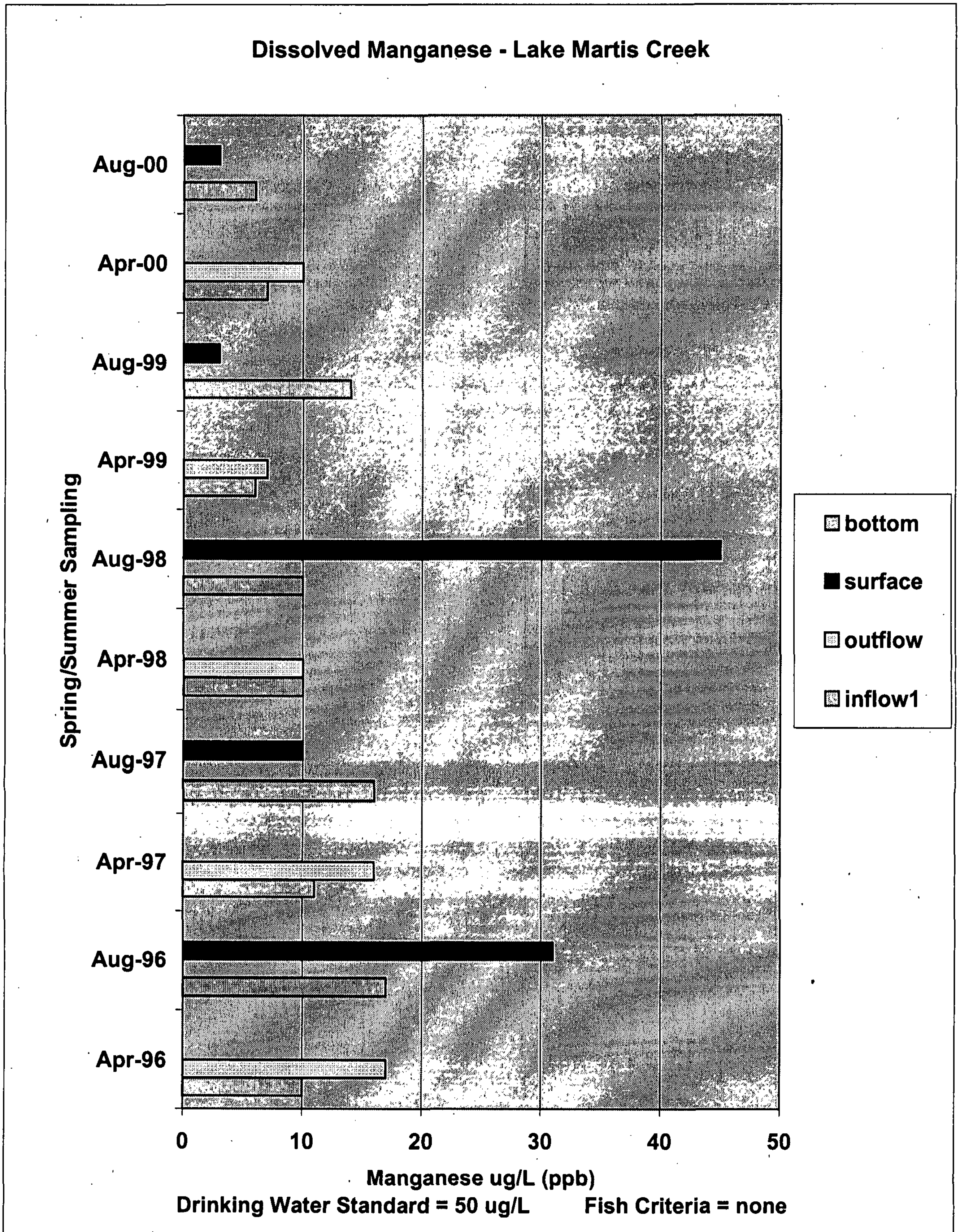


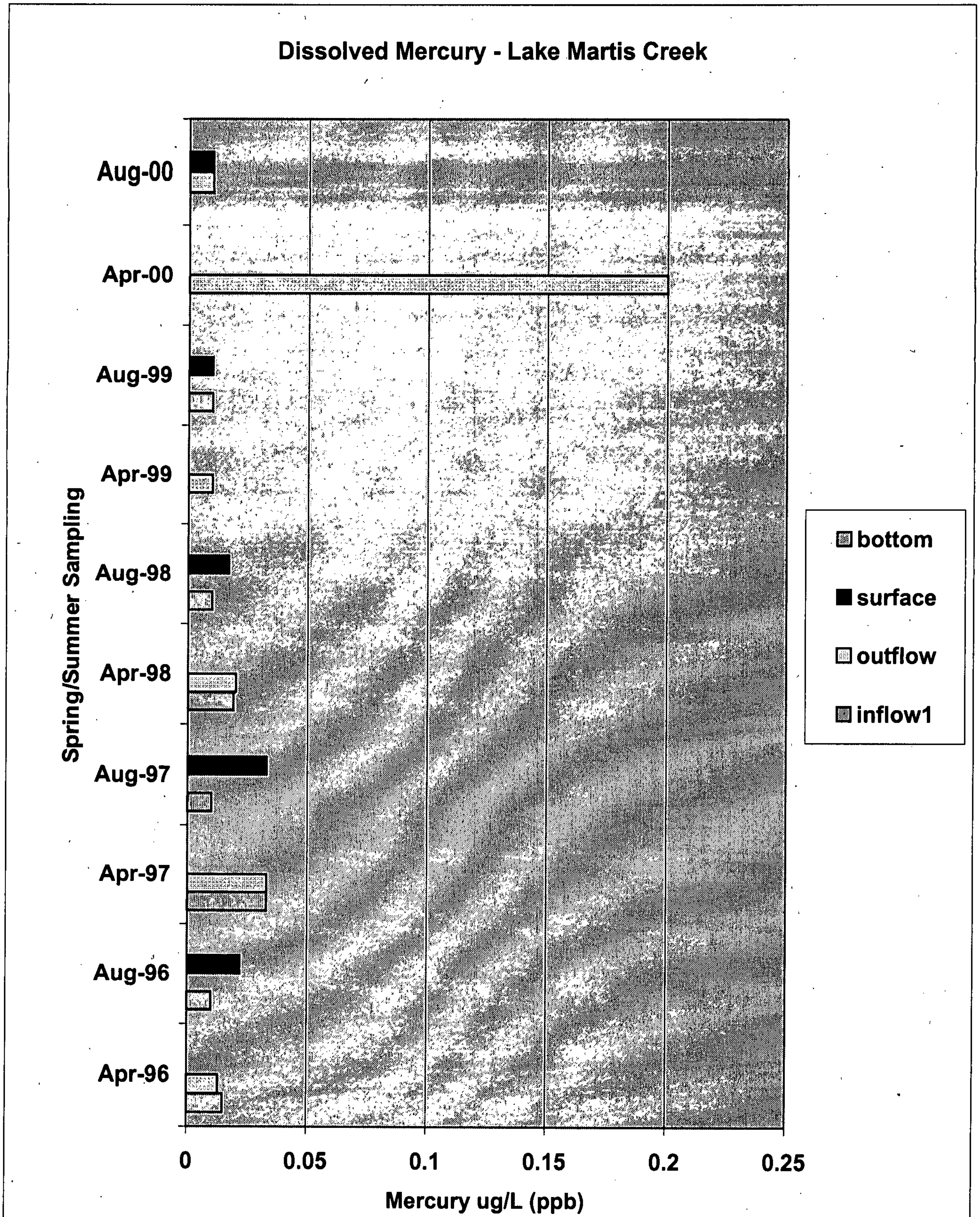
Dissolved Copper - Lake Martis Creek
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
Aug-96
Apr-96
Spring/Summer Sampling
bottom
surface
outflow
inflow1
0
1
2
3
4
5
6
Copper ug/L (ppb)
Drinking Water Standard = 1300 ug/L
Fish Criteria = 5.4 ug/L



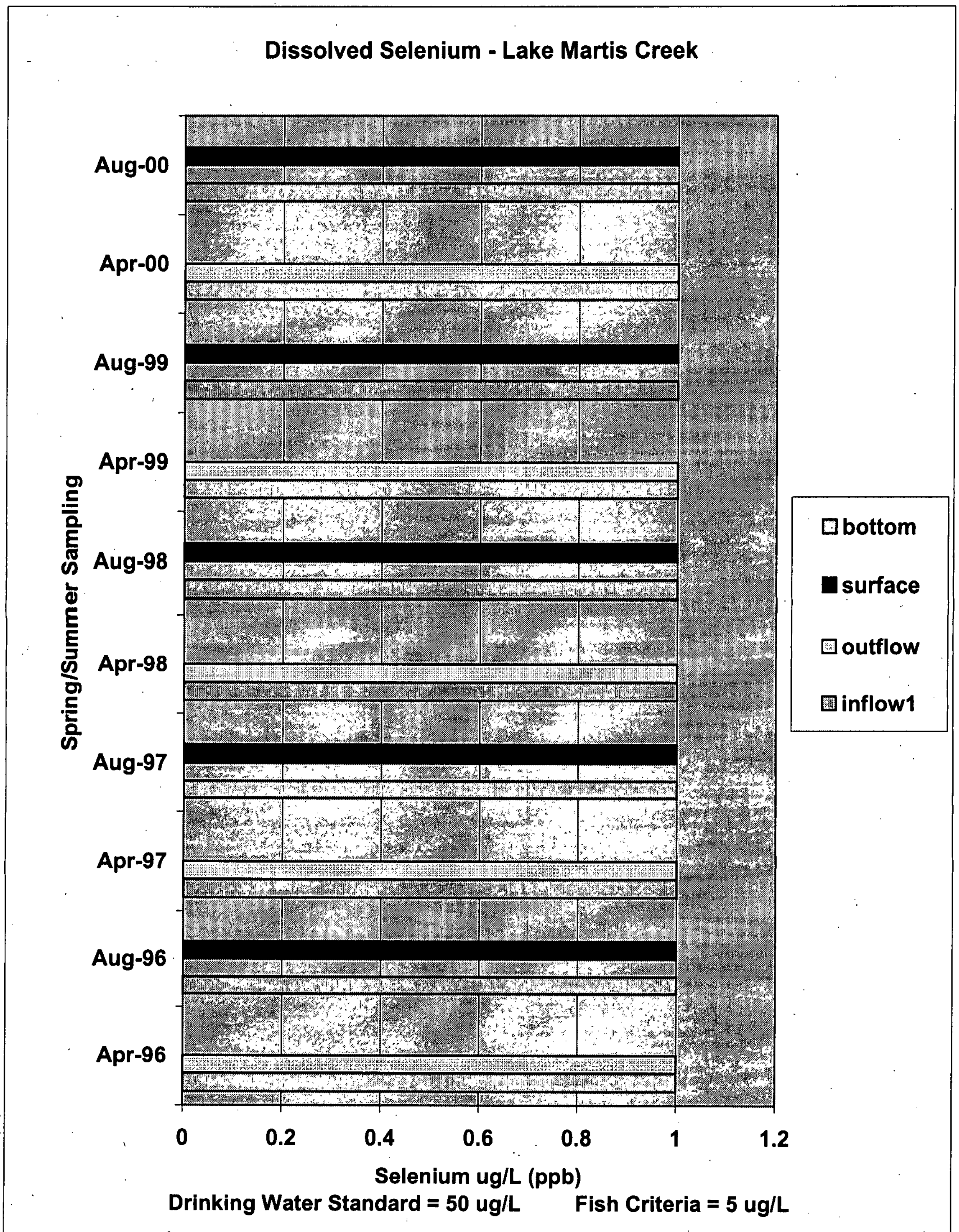
Drinking Water Standard = 300 ug/L Fish Criteria = 1000 ug/L


Dissolved Lead - Lake Martis Creek
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
Aug-96
Apr-96
Spring/Summer Sampling
bottom
surface
outflow
inflow1
0
0.5
1
1.5
2
2.5
3
3.5
Lead ug/L (ppb)
Drinking Water Standard = 50 ug/L
Fish Criteria = 50 ug/L

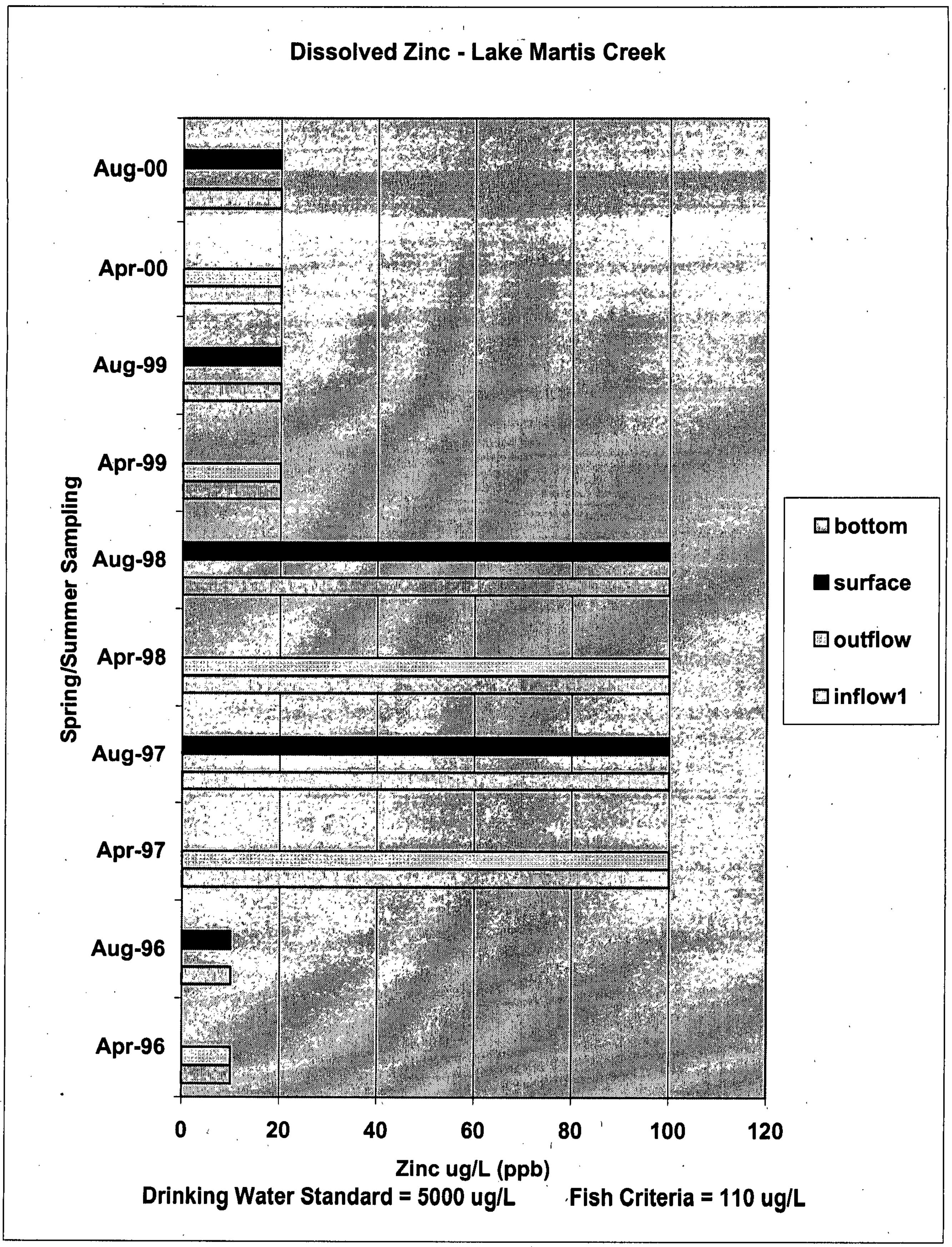

Dissolved Manganese - Lake Martis Creek
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
Aug-96
Apr-96
Spring/Summer Sampling
bottom
surface
outflow
inflow1
0
10
20
30
40
50
Manganese ug/L (ppb)
Drinking Water Standard = 50 ug/L
Fish Criteria = none



Drinking Water Standard = 2.0 ug/L Fish Criteria = 0.012 ug/L



Dissolved Selenium - Lake Martis Creek
Spring/Summer Sampling
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
Aug-96
Apr-96
0
0.2
0.4
0.6
0.8
1
1.2
Selenium ug/L (ppb)
Drinking Water Standard = 50 ug/L
Fish Criteria = 5 ug/L
bottom
surface
outflow
inflow1


Dissolved Zinc - Lake Martis Creek
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
Aug-96
Apr-96
Spring/Summer Sampling
0
20
40
60
80
100
120
Zinc ug/L (ppb)
bottom
surface
outflow
inflow1
Drinking Water Standard = 5000 ug/L
Fish Criteria = 110 ug/L

LAB ORDER No.: A04069

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: A040695-1								
SAMPLE ID: MC-SP-S								
SAMPLED: 27 APR 00 10:30								
Arsenic, dissolved	ND	0.004	mg/L	1	200.7	05.04.00	A000363ICP	
Cadmium, dissolved	ND	0.001	mg/L	1	200.7	05.04.00	A000363ICP	
Calcium, dissolved	7.9	0.5	mg/L	1	200.7	05.04.00	A000363ICP	
Chromium, dissolved	ND	0.005	mg/L	1	200.7	05.04.00	A000363ICP	
Copper, dissolved	ND	0.005	mg/L	1	200.7	05.04.00	A000363ICP	
Iron, dissolved	0.14	0.05	mg/L	1	200.7	05.04.00	A000363ICP	
Lead, dissolved	J0.002	0.003	mg/L	1	200.7	05.04.00	A000363ICP	1
Magnesium, dissolved	3.1	0.5	mg/L	1	200.7	05.04.00	A000363ICP	
Manganese, dissolved	0.010	0.005	mg/L	1	200.7	05.04.00	A000363ICP	
Mercury	ND	0.0002	mg/L	1	245.2	05.03.00	A000354MER	
Potassium, dissolved	2.	1.	mg/L	1	200.7	05.04.00	A000363ICP	
Selenium, dissolved	ND	0.001	mg/L	1	270.3	05.04.00	A000352FIA	
Sodium, dissolved	5.	1.	mg/L	1	200.7	05.04.00	A000363ICP	
Zinc, dissolved	ND	0.02	mg/L	1	200.7	05.04.00	A000363ICP	
LAB NUMBER: A040695-2								
SAMPLE ID: MC-SP-I								
SAMPLED: 27 APR 00 12:15								
Arsenic, dissolved	ND	0.004	mg/L	1	200.7	05.04.00	A000363ICP	
Cadmium, dissolved	ND	0.001	mg/L	1	200.7	05.04.00	A000363ICP	
Calcium, dissolved	5.8	0.5	mg/L	1	200.7	05.04.00	A000363ICP	
Chromium, dissolved	ND	0.005	mg/L	1	200.7	05.04.00	A000363ICP	
Copper, dissolved	ND	0.005	mg/L	1	200.7	05.04.00	A000363ICP	
Iron, dissolved	0.07	0.05	mg/L	1	200.7	05.04.00	A000363ICP	
Lead, dissolved	ND	0.003	mg/L	1	200.7	05.04.00	A000363ICP	
Magnesium, dissolved	2.4	0.5	mg/L	1	200.7	05.04.00	A000363ICP	
Manganese, dissolved	0.007	0.005	mg/L	1	200.7	05.04.00	A000363ICP	
Potassium, dissolved	1.	1.	mg/L	1	200.7	05.04.00	A000363ICP	
Selenium, dissolved	ND	0.001	mg/L	1	270.3	05.04.00	A000352FIA	
Sodium, dissolved	3.	1.	mg/L	1	200.7	05.04.00	A000363ICP	
Zinc, dissolved	ND	0.02	mg/L	1	200.7	05.04.00	A000363ICP	

1) Sample Preparation on 05-03-00 using 200.2 (Filtrate)
2) A "J" flagged result reflects a value seen below the Reporting Limit (RL), but above the Method Detect Limit (MDL).
3) Sample Preparation on 05-02-00 using 245.2
4) Sample Preparation on 05-01-00 using 206.5 (Filtrate)

Caltest

ANALYTICAL LABORATORY

ENVIRONMENTAL ANALYSES

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: A080159-1 SAMPLE ID: MC-SU-S SAMPLED: 02 AUG 00 10:45								
Mercury, Low Level	ND	0.01	ug/L	1	245.2	08.17.00	A000667MER	1.[illegible]
LAB NUMBER: A080159-2 SAMPLE ID: MC-SU-B SAMPLED: 02 AUG 00 11:00								
Arsenic, dissolved	ND	0.004	mg/L	1	200.7	08.10.00	A000651UND	[illegible]
Cadmium, dissolved	ND	0.001	mg/L	1	200.7	08.10.00	A000651UND	
Calcium, dissolved	13.	0.5	mg/L	1	200.7	08.10.00	A000651UND	
Chromium, dissolved	ND	0.005	mg/L	1	200.7	08.10.00	A000651UND	
Copper, dissolved	ND	0.005	mg/L	1	200.7	08.10.00	A000651UND	
Iron, dissolved	J0.03	0.05	mg/L	1	200.7	08.10.00	A000651UND	3,
Lead, dissolved	ND	0.003	mg/L	1	200.7	08.10.00	A000651UND	
Magnesium, dissolved	5.7	0.5	mg/L	1	200.7	08.10.00	A000651UND	
Manganese, dissolved	J0.003	0.005	mg/L	1	200.7	08.10.00	A000651UND	3,
Mercury, Low Level	ND	0.01	ug/L	1	245.2	08.17.00	A000667MER	1,
Potassium, dissolved	3.	1.	mg/L	1	200.7	08.10.00	A000651UND	
Selenium, dissolved	ND	0.001	mg/L	1	270.3	08.16.00	A000659FIA	5,
Sodium, dissolved	7.	1.	mg/L	1	200.7	08.10.00	A000651UND	
Zinc, dissolved	ND	0.02	mg/L	1	200.7	08.10.00	A000651UND	
LAB NUMBER: A080159-3 SAMPLE ID: MC-SU-I SAMPLED: 02 AUG 00 12:10								
Arsenic, dissolved	ND	0.004	mg/L	1	200.7	08.10.00	A000651UND	
Cadmium, dissolved	ND	0.001	mg/L	1	200.7	08.10.00	A000651UND	
Calcium, dissolved	12.	0.5	mg/L	1	200.7	08.10.00	A000651UND	
Chromium, dissolved	J0.0007	0.005	mg/L	1	200.7	08.10.00	A000651UND	3,
Copper, dissolved	ND	0.005	mg/L	1	200.7	08.10.00	A000651UND	
Iron, dissolved	0.11	0.05	mg/L	1	200.7	08.10.00	A000651UND	
Lead, dissolved	ND	0.003	mg/L	1	200.7	08.10.00	A000651UND	
Magnesium, dissolved	6.1	0.5	mg/L	1	200.7	08.10.00	A000651UND	
Manganese, dissolved	0.006	0.005	mg/L	1	200.7	08.10.00	A000651UND	
Potassium, dissolved	2.	1.	mg/L	1	200.7	08.10.00	A000651UND	

1) Sample Preparation on 08-15-00 using 245.2
2) Mercury was not seen at (or above) the Method Detection Limit (MDL) OF 0.0096 ug/L.
3) Sample Preparation on 08-10-00 using 200.2 (Filtrate)
4) A "J" flagged result reflects a value seen below the Reporting Limit (RL), but above the Method Detection Limit (MDL).
5) Sample Preparation on 08-14-00 using 206.5 (Filtrate)
6) Selenium was not seen at (or above) the Method Detection Limit (MDL) of 0.35 ug/L.

Caltest
ANALYTICAL LABORATORY

ENVIRONMENTAL ANALYSES

LAB ORDER No.: A0801§

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: A080159-3 (continued)								
Selenium, dissolved	ND	0.001	mg/L	1	270.3	08.16.00	A000659FIA	1
Sodium, dissolved	4.	1.	mg/L	1	200.7	08.10.00	A000651UND	
Zinc, dissolved	ND	0.02	mg/L	1	200.7	08.10.00	A000651UND	

1) Sample Preparation on 08-14-00 using 206.5 (Filtrate)
2) Selenium was not seen at (or above) the Method Detection Limit (MDL) of 0.35 ug/L.
3) Sample Preparation on 08-10-00 using 200.2 (Filtrate)

2000 Fish Tissue Results

The following table provides an overview of the lab results for the 2000 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 EPA'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	Total Mercury	FDA Criteria
Black Butte	Catfish	Composited (3)	Oct 10	3.2%	0.37 ppm	1 ppm
Eastman	Catfish	Non-composit (1)	Nov 1	<0.1%	0.089 ppm	1 ppm
Englebright	Rainbow Trout	Non-composit (1)	Dec 03	0.88%	<0.02 ppm	1 ppm
Hensley	Catfish	Composited (3)	Oct 18	0.1%	0.70 ppm	1 ppm
Isabella	Crappie	Composited (3)	Nov 8,16	1.5%	<0.02 ppm	1 ppm
Kaweah	Black Bass	Composited (3)	Oct 5	<0.1%	0.68 ppm	1 ppm
Martis Cr	Brown Trout	Non-composited	Oct 26	0.2%	<0.02	1 ppm
Mendocino	N/A	N/A	N/A	N/A	N/A	1 ppm
New Hogan	Catfish	Composited (3)	Oct 3, 9	0.95%	0.52 ppm	1 ppm
Pine Flat	Sacramento Sucker	Composited (3)	Dec 27	6.2%	0.21 ppm	1 ppm
Sonoma	N/A	N/A	N/A	N/A	N/A	1 ppm
Success	Black Bass	Composited (3)	Oct 5	<0.1%	0.32 ppm	1 ppm

Notes:

1. Non-Detect is indicated by "<0.02" since the lab Detection Limit is 0.02 ppm.
2. Total Mercury was reported in mg/L or ppm.
3. Total Mercury was conducted instead of Methyl Mercury since EPA 832 permits Total Mercury analysis for an initial screening program. When problem areas are identified, methyl mercury analysis are normally performed later as part of the actual health risk assessment, when sufficient data becomes available.
4. Henley and Kaweah Lake appears to have relatively higher levels of total mercury in fish tissue. Therefore, increased fish collection are now being planned for both Spring and Summer for 2 lakes. Methyl mercury analysis will also be performed for these two lakes.
5. Eastman, Isabella and Englebright Lake appear to be below the action level of 0.3 ppm. Therefore, fish collection may be discontinued after confirmation in 2001 and 2002. Martis Creek is discontinued immediately because a catch and release program is being enforced at Martis Creek.
6. For 2001, fish collection is being planned for late Spring for all the lakes except as follows: Hensley and Kaweah will have a second fish collection in late Summer per note 4 while the fish tissue program at Martis Creek will be discontinued per note 5.
7. Catfish was the preferred specie for 2000 with an alternate specie, if catfish collection became difficult. The alternate specie is likely to be caught by the public for that lake.

EPA United States Environmental Protection Agency

Office of Water

FACT SHEET

United States Environmental Protection Agency	Office of Water 4305	EPA-823-F-99-016 September 1999

Mercury Update: Impact on Fish Advisories

Summary

Mercury is distributed throughout the environment from both natural sources and human activities. Methylmercury is the main form of organic mercury found in the environment and is the form that accumulates in both fish and human tissues. Three major episodes of methylmercury poisoning through consumption of contaminated food have occurred; these resulted in central nervous system effects such as impairment of peripheral vision, mental symptoms, loss of feeling, and, at high doses, seizures, very severe neurological impairment, and death. Methylmercury has also been shown to be a developmental toxicant, causing subtle to severe neurological effects. EPA considers there is sufficient evidence for methylmercury to be considered a developmental toxicant, to be of concern for potential human mutagenicity, and to be a possible human carcinogen (Group C). As of December 1998, 40 states have issued 1,931 fish advisories for mercury. These advisories inform the public that concentrations of mercury have been found in local fish at levels of public health concern. State advisories recommend either limiting or avoiding consumption of certain fish from specific waterbodies or, in some cases, from specific waterbody types (e.g., all freshwater lakes or rivers).

The purpose of this fact sheet is to summarize current information on sources, fate and transport, occurrence in human tissues, range of concentrations in fish tissue, fish advisories, fish consumption limits, toxicity, and regulations for mercury. The fact sheets also illustrate how this information may be used for developing fish consumption advisories. An electronic version of this fact sheet and fact sheets for dioxins/furans, PCBs, and toxaphene are available at http://www.epa.gov/OST/fish. Future revisions will be posted on the web as they become available.

Sources of Mercury in the Environment

Mercury is found in the environment in the metallic form and in different inorganic and organic forms. Most of the mercury in the atmosphere is elemental mercury vapor; most of the mercury in water, soil, plants, and animals is inorganic and organic mercury (primarily methylmercury).

Mercury occurs naturally and is distributed throughout the environment by both natural processes and human activities. Solid waste incineration and fossil fuel combustion facilities contribute approximately 87% of the emissions of mercury in the United States. Other sources of mercury releases to the air include mining and smelting, industrial processes involving the use of mercury such as chlor-alkali production facilities and production of cement.

Mercury is released to surface waters from naturally occurring mercury in rocks and soils and from industrial activities, including pulp and paper mills, leather tanning, electroplating, and chemical manufacturing. Wastewater treatment facilities may also release mercury to water. An indirect source of mercury to surface waters is mercury in the air; it is deposited from rain and other processes directly to water surfaces and to soils. Mercury also may be mobilized from sediments if disturbed (e.g., flooding, dredging).

Sources of mercury in soil include direct application of fertilizers and fungicides and disposal of solid waste, including batteries and thermometers, to landfills. The disposal of municipal incinerator ash in landfills and the application of sewage sludge to crop land result in increased levels of mercury in soil. Mercury in air may also be deposited in soil and sediments.

Fate and Transport of Mercury

The global cycling of mercury is a complex process. Mercury evaporates from soils and surface waters to the atmosphere, is redeposited on land and surface water, and then is absorbed by soil or sediments. After redeposition on land and water, mercury is commonly volatilized back to the atmosphere as a gas or as adherents to particulates.

Mercury exists in a number of inorganic and organic forms in water. Methylmercury, the most common organic form of mercury, quickly enters the aquatic food chain. In most adult fish, 90% to 100% of the mercury is methylmercury. Methylmercury is found primarily in the fish muscle (fillets) bound to proteins.

Skinning and trimming the fish does not significantly reduce the mercury concentration in the fillet, nor is it removed by cooking processes. Because moisture is lost during cooking, the concentration of mercury after cooking is actually higher than it is in the fresh uncooked fish.

Concentrations of total mercury in fish at the top of the food chain, such as pike, shark, and swordfish, are approximately 10,000 to 100,000 times higher than the concentrations of inorganic mercury found in the surrounding waters. The bioconcentration factor (BCF) of methylmercury in fish is on the order of 3 million. The bioaccumulation of methylmercury is even greater. Methylmercury levels in predator fish are, on average, approximately 7 million times higher than the concentrations of dissolved methylmercury found in the surrounding waters.

In 1984 and 1985, the U.S. Fish and Wildlife Service collected 315 composite samples of whole fish from 109 stations nationwide as part of the National Contaminant Biomonitoring Program (NCBP). The maximum, geometric mean, and 85th percentile concentrations for mercury were 0.37, 0.10, and 0.17 ppm (wet weight), respectively. An analysis of mercury levels in tissues of bottom-feeding and predatory fish using the data from the NCBP study showed that the mean mercury tissue concentration of 0.12 ± 0.08 ppm in predatory fish species (e.g., trout, walleye, largemouth bass) was significantly higher than the mean tissue concentration of 0.08 ± 0.06 ppm in bottom feeders (e.g., carp, white sucker, and channel catfish).

Mercury, the only metal analyzed as part of EPA's 1987 National Study of Chemical Residues in Fish (NSCRF), was detected at 92% of 374 sites surveyed. Maximum, arithmetic mean, and median concentrations in fish tissue were 1.77, 0.26, and 0.17 ppm (wet weight), respectively. Mean mercury concentrations in bottom feeders (whole body samples) were generally lower than concentrations for predator fish (fillet samples) (see Table 1). Most of the higher tissue concentrations of mercury were detected in freshwater fish samples collected in the Northeast.

Most recently, the northeast states and eastern Canadian provinces issued their own mercury study, including a comprehensive analysis of mercury concentrations in a variety of freshwater sportfish collected from the late 1980s to 1996. Top-level predatory fish such as walleye, chain pickerel, and large and smallmouth bass were typically found to exhibit the highest concentrations, with mean tissue residues greater than 0.5 ppm and maximum residues exceeding 2 ppm. One largemouth bass sample was found to contain 8.94 ppm of mercury, while a smallmouth bass sampled contained 5 ppm. Table 2 summarizes the range and the mean concentrations found in eight species of sportfish sampled.

Mercury has also been detected in marine fish species. Concentrations of methylmercury in muscle tissue in nine species of Atlantic shark averaged 0.88 µg/g (ppm) (wet weight) and ranged from 0.06 to 2.87 µg/g (ppm). Bluefin tuna from the northwest Atlantic Ocean contained mercury at a mean muscle concentration of 3.41 µg/g (ppm)(dry weight).

Table 1. Mean Mercury Concentration in Freshwater Fish*

Species	Mean concentration (ppm)**
Bottom Feeders	
Carp	0.11
White sucker	0.11
Channel catfish	0.09
Predator Fish	
Largemouth bass	0.46
Smallmouth bass	0.34
Walleye	0.52
Brown trout	0.14

*EPA National Study of Chemical Residues in Fish conducted in 1987; species included freshwater, estuarine, and marine finfish, and a small number of marine shellfish.
**Concentration are reported on wet-weight basis.
Source: Bahnick et al., 1994

Table 2. Mercury Concentration for Selected Fish Species in the Northeast

Species	Mean concentration* (ppm)	Minimum-maximum range* (ppm)
Largemouth bass	0.51	0-8.94
Smallmouth bass	0.53	0.08-5.0
Yellow perch	0.40	0-3.15
Eastern chain pickerel	0.64	0-2.81
Lake trout	0.32	0-2.70
Walleye	0.77	0.10-2.04
Brown bullhead	0.20	0-1.10
Brook trout	0.26	0-0.98

*Concentration are reported on a wet weight basis.
Source: NESCAUM, 1998.

Because of the higher cost of methylmercury analysis, EPA recommends that total mercury rather than methylmercury concentrations be determined in state fish contaminant monitoring programs. EPA also recommends that the conservative assumption be made that all mercury is present as methylmercury in order to be most protective of human health.

Potential Sources of Exposure and Occurrence in Human Tissues

Potential sources of human exposure to mercury include food contaminated with mercury, inhalation of mercury vapors in ambient air, and exposure to mercury through dental and medical treatments. Dietary intake is by far the most important source of exposure to mercury for the general population. Fish and other seafood products are the main source of methylmercury in the diet; studies have shown that methylmercury concentrations in fish and shellfish are approximately 10 to 100 times greater than in other foods, including cereals, potatoes, vegetables, fruits, meats, poultry, eggs, and milk.

Individuals who may be exposed to higher than average levels of methylmercury include recreational and subsistence fishers who routinely consume large amounts of locally caught fish and subsistence hunters who routinely consume the meat and organ tissues of marine mammals.

Analytical methods are available to measure mercury in blood, urine, tissue, hair, and breast milk.

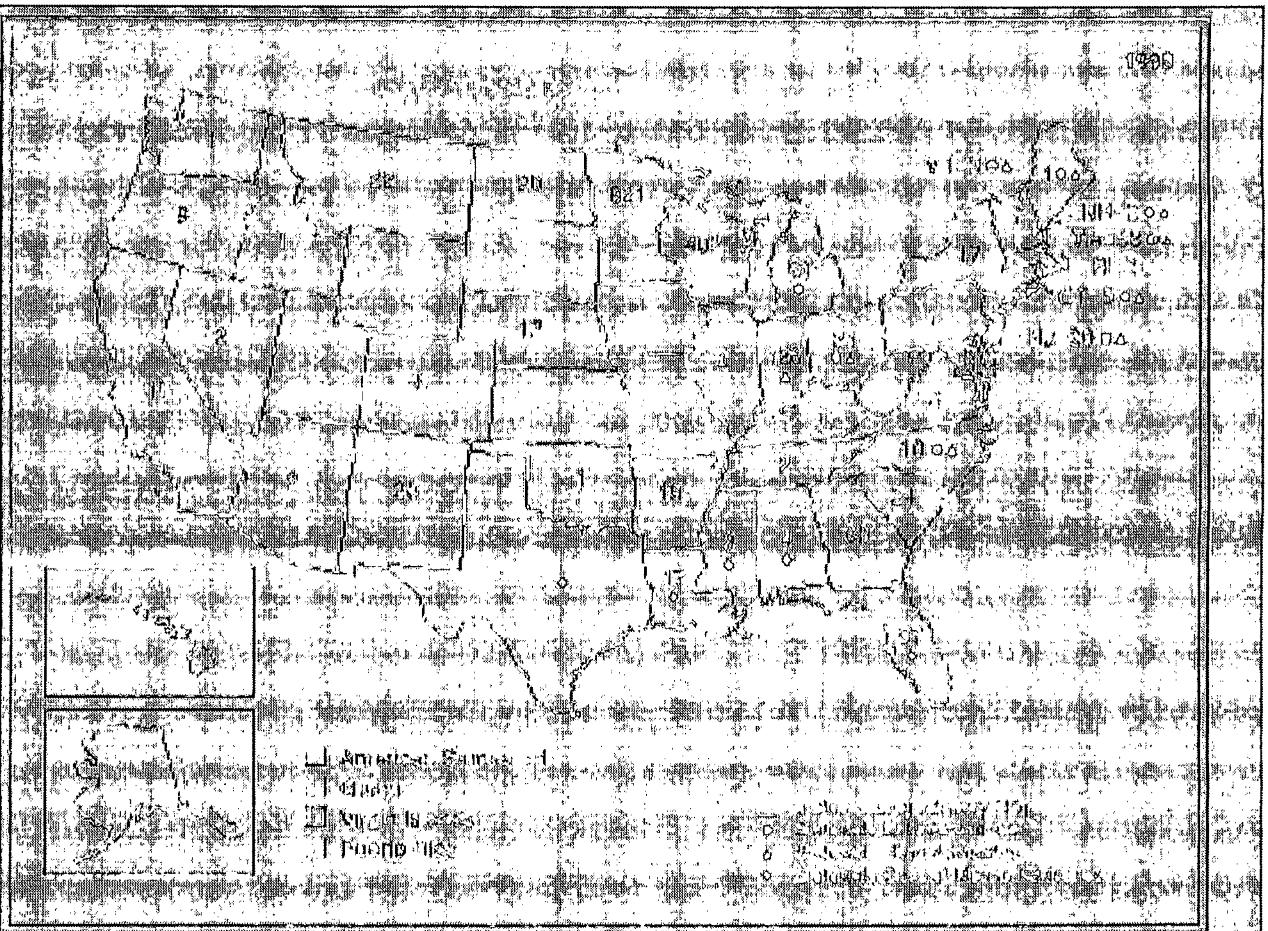
Fish Advisories

The states have primary responsibility for protecting their residents from the health risks of consuming contaminated noncommercially caught fish. They do this by issuing consumption advisories for the general population, including recreational and subsistence fishers, as well as sensitive subpopulations (such as pregnant women/fetus, nursing mothers and their infants, and children). These advisories inform the public that high concentrations of chemical contaminants, such as mercury, have been found in local fish. The advisories recommend either limiting or avoiding consumption of certain fish from specific waterbodies or, in some cases, from specific waterbody types (such as lakes or rivers).

As of December 1998, mercury was the chemical contaminant responsible, at least in part for the issuance of 1,931 fish consumption advisories by 40 states, including the U.S. territory of American Samoa. Almost 68% of all advisories issued in the United States are a result of mercury contamination in fish and shellfish. Advisories for mercury have increased steadily, by 115% from 899 advisories in 1993 to 1,931 advisories in 1998. The number of states that have issued mercury advisories also has risen steadily from 27 states in 1993 to 40 states in 1997, and remains at 40 states for 1998. Advisories for mercury increased nearly 8% from 1997 (1,782 advisories) to 1998 (1,931 advisories).

Ten states have issued statewide advisories for mercury in their freshwater lakes and/or rivers: Connecticut, Indiana, Maine, Massachusetts, Michigan, New Hampshire, New Jersey, North Carolina, Ohio, and Vermont. Another five Gulf Coast states (Alabama, Florida, Louisiana, Mississippi, and Texas) have statewide mercury advisories in effect for their coastal marine waters. To date, 90% of the 1,931 mercury advisories in effect have been issued by the following 11 states: Minnesota (821), Wisconsin (402), Indiana (126), Florida (97), Georgia (80), Massachusetts (58), Michigan (53), New Jersey (30), New Mexico (26), South Carolina (24), and Montana (22). Figure 1 shows the total number of fish advisories for mercury in each state in 1998.

Figure 1. Fish Advisories for Mercury



Fish Consumption Limits—EPA indicated in the *Mercury Study Report to Congress* (U.S. EPA, 1997) that the typical U.S. consumer was not in danger of consuming harmful levels of methylmercury from fish and was not advised to limit fish consumption on the basis of mercury content. This advice is appropriate for typical consumers who eat less than 10 grams of fish and shellfish per day with mercury concentrations averaging between 0.1 and 0.15 ppm, which are typical for most species of commercially obtained fish. At these rates of fish intake, methylmercury exposures are considerably less than the interim reference dose (RfD) of 1×10^{-4} mg/kg-d. However, eating more fish than is typical or eating fish that are more contaminated, can increase the risk to a developing fetus.

Two groups of women of childbearing age are of concern: (1) those who eat more than 10 grams of fish a day and (2) those who eat fish with higher methylmercury levels. Ten grams of fish is a little over one-quarter cup of tuna per week or about one fish sandwich per week. Based on diet surveys, 10% of women of childbearing age eat five times or more fish than does the average consumer. If the fish have average mercury concentrations of 0.1 to 0.15 ppm, the women's mercury exposures range from near or slightly over the interim RfD to about twice the interim RfD.

The second group of women of concern are those who eat fish with higher mercury concentrations (e.g., 0.5 ppm and higher). Examples of fish with above average mercury levels are king mackerel, various bass species, orange roughy, pike, swordfish, shark and freshwater fish from contaminated waters. Even women eating average amounts of fish (i.e., <10 g/d) have mercury exposures near the interim RfD, if the mercury concentration is 0.5 ppm. If women eat these fish species and their average fish intake is between 40 and 70 grams/day (or about a quarter cup per day), their mercury exposures would range from three to six times the interim RfD. Consumers who eat fish with 1 ppm mercury (e.g., swordfish and shark) at the level of 40 to 70 g/d have intakes that range from 6 to nearly 12 times the interim RfD.

Some women of childbearing age in certain ethnic groups (Asians, Pacific Islanders, and Native Americans) eat much more fish than the general population. Because of the higher amounts of fish in their diets, women in these ethnic groups need to be aware of the level of mercury in the fish they eat.

The RfD is not a "bright line" between safety and toxicity; however, there is progressively greater concern about the likelihood of adverse effects above this level. Consequently, people are advised to consume fish in moderate amounts and be aware of the amount of mercury in the fish they eat.

For sensitive populations, such as pregnant women, nursing mothers, and young children, some states have issued either "no consumption" advisories or "restricted consumption" advisories for methyl-mercury. Additional information on calculating specific limits for these sensitive populations is available in EPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 2, Section 3.

Table 3 shows the recommended monthly fish consumption limits for methylmercury in fish for fish consumers based on EPA's default values for risk assessment parameters. Consumption limits have been calculated as the number of allowable fish meals per month based on the ranges of methylmercury in the consumed fish tissue. The following assumptions were used to calculate the consumption limits:

- Consumer adult body weight of 72 kg
- Average fish meal size of 8 oz (0.227 kg)
- Time-averaging period of 1 mo (30.44 d)
- EPA's interim reference dose for methylmercury (1×10^{-4} mg/kg-d) from EPA's
- Integrated Risk Information System (U.S. EPA, 1999c).

For example, when methylmercury levels in fish tissue are 0.4 ppm, then two 8-oz. meals per month can safely be consumed.

Table 3. Monthly Fish Consumption Limits for Methylmercury

Risk-based consumption limit	**Noncancer health endpoints**
Fish meals/month	Fish tissue concentrations (ppm, wet weight)
16	> 0.03–0.06
12	> 0.06–0.08
8	> 0.08–0.12
4	> 0.12–0.24

3	> 0.24–0.32
2	> 0.32–0.48
1	> 0.48–0.97
0.5	> 0.97–1.9
None (<0.5)*	> 1.9

*None = No consumption recommended.
NOTE: In cases where > 16 meals per month are consumed, refer to EPA's *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories*, Volume 2, Section 3 for methods to determine safe consumption limits.

Toxicity of Mercury

Pharmacokinetics—Methylmercury is rapidly and nearly completely absorbed from the gastrointestinal tract; 90% to 100% absorption is estimated. Methylmercury is somewhat lipophilic, allowing it to pass through lipid membranes of cells and facilitating its distribution to all tissues, and it binds readily to proteins. Methylmercury binds to amino acids in fish muscle tissue.

The highest methylmercury levels in humans are generally found in the kidneys. Methylmercury in the body is considered to be relatively stable and is only slowly transformed to form other forms of mercury. Methylmercury readily crosses the placental and blood/brain barriers. Estimates for its half life in the human body range from 44 to 80 days.

Excretion of methylmercury is via the feces, urine, and breast milk. Methylmercury is also distributed to human hair and to the fur and feathers of wildlife; measurement of mercury in hair and these other tissues has served as a useful biomonitor of contamination levels.

Acute Toxicity—Acute high-level exposures to methylmercury may result in impaired central nervous system function, kidney damage and failure, gastro-intestinal damage, cardiovascular collapse, shock, and death. The estimated lethal dose is 10 to 60 mg/kg.

Chronic Toxicity—Although both elemental mercury and methylmercury produce a variety of health effects at relatively high exposures, neurotoxicity is the effect of greatest concern. This is true whether exposure occurs to the developing embryo or fetus during pregnancy or to adults and children. Human exposure to methylmercury has generally been through consumption of contaminated food. Two major episodes of methylmercury poisoning through fish consumption have occurred. The first occurred in the early 1950s among people, fish consuming domestic animals such as cats, and wildlife living near Minamata City on the shores of Minamata Bay, Kyushu, Japan. The source of the methylmercury contamination was effluent from a chemical factory that used mercury as a catalyst and discharged wastes into the bay where it accumulated in fish and shellfish that were a dietary staple of this population. Average fish consumption was reported to be in excess of 300 g/d, 20 times greater than is typical for recreational fishers in the United States.

By comparison, about 3% to 5% of U.S. consumers routinely eat 100 grams of fish per day. Among women of childbearing age, 3% routinely eat 100 grams of fish per day.

In 1965, another methylmercury poisoning incident occurred in the area of Niigata, Japan. The signs and symptoms of the disease in Niigata were similar to those of methylmercury poisoning in Minamata.

Symptoms of Minamata disease in children and adults included: impairment of peripheral vision, disturbances in sensations ("pins and needles" feelings, numbness) usually in the hands and feet and sometimes around the mouth; incoordination of movements; impairment of speech, hearing, and walking; and mental disturbances. It sometimes took several years before individuals were aware that they were developing the signs and symptoms of methylmercury poisoning. Over the years, it became clear that nervous system damage could occur to a fetus whose mother ate fish contaminated with methylmercury during the pregnancy.

Methylmercury poisoning also occurred in Iraq following consumption of seed grain that had been treated with a fungicide containing methylmercury. The first outbreak occurred prior to 1960; the second occurred in the early 1970s. Imported mercury-treated seed grains that arrived after the planting season were ground into flour and baked into bread. Unlike the long-term exposures in Japan, the epidemic of methylmercury poisoning in Iraq was short in duration lasting approximately 6 months. The signs and symptoms of disease in Iraq were predominantly in the nervous system: difficulty with peripheral vision or blindness, sensory disturbances, incoordination, impairment of walking, and slurred speech. Both children and adults were affected. Infants born to mothers who had consumed methylmercury contaminated grain (particularly during the second trimester of pregnancy) showed nervous system damage even though the mother was only slightly affected.

Recent studies have examined populations that are exposed to lower levels of methylmercury as a consequence of routine consumption of fish and marine mammals including studies of populations around the Great Lakes and in New Zealand, the Amazon basin, the Seychelles Islands, and the Faroe Islands. The last two studies are of large populations of children presumably exposed to methylmercury in utero. Very sensitive measures of developmental neurotoxicity in these populations are still being analyzed and published. A recent workshop discussed these studies and concluded that they have provided valuable new information on the potential health effects of methylmercury. Significant uncertainties remain, however, because of issues related to exposure, neurobehavioral endpoints, confounders and statistics, and study design.

Developmental Toxicity--Data are available on developmental effects in rats, mice, guinea pigs, hamsters, and monkeys. Also, convincing data from a number of human studies (i.e., Minamata, Iraq) indicate that methylmercury causes subtle to severe neurologic effects depending on dose and individual susceptibility. EPA considers methylmercury to have sufficient human and animal data to be classified as a developmental toxicant.

Methylmercury accumulates in body tissue, consequently, maternal exposure occurring prior to pregnancy can contribute to the overall maternal body burden and result in exposure to the developing fetus. In addition, infants may be exposed to methyl-mercury through breast milk. Therefore, it is advisable to reduce methylmercury exposure to women with childbearing potential to reduce overall body burden (see Fish Consumption Limits section).

Mutagenicity--Methylmercury appears to be clastogenic but not to be a point mutagen; that is, mercury causes chromosomal damage but not small heritable changes in DNA.

EPA has classified methylmercury as being of high concern for potential human germ cell mutagenicity. The absence of positive results in a heritable mutagenicity assay keeps methylmercury from being included under the highest level of concern. The data on mutagenicity are not sufficient, however, to permit estimation of the amount of methylmercury that would cause a measurable mutagenic effect in the human population.

Carcinogenicity--Experimental animal data suggest that methylmercury may be tumorigenic in animals. Chronic dietary exposures of mice to methylmercury resulted in significant increases in the incidences of kidney tumors in males but not in females. The tumors were seen only at toxic doses of methylmercury. Three human studies have been identified that examined the relationship between methylmercury exposure and cancer. There was no persuasive evidence of increased carcinogenicity attributable to methylmercury exposure in any of these studies. Interpretation of these studies was limited by poor study design and incomplete descriptions of methodology and/or results. EPA has not calculated quantitative carcinogenic risk values for methylmercury. EPA has found methylmercury to have inadequate data in humans and limited evidence in animals, and has classified it as a possible human carcinogen, Group C.

All of the carcinogenic effects in animals were observed in the presence of profound damage to the kidneys. Tumors may be formed as a consequence of repair in the damaged organs. Evidence points to a mode of action for methylmercury carcinogenicity that operates at high doses certain to produce other types of toxicity in humans. Given the levels of exposure most likely to occur in the U.S. population, even among consumers of large amounts of fish, methylmercury is not likely to present a carcinogenic risk.

Summary of EPA Health Benchmarks

- Chronic Toxicity–Interim Reference Dose: $1x10^{-4}$ mg/kg-d (U.S. EPA, 1999c)
- Carcinogenicity: No carcinogenic risk values calculated

Special Susceptibilities—The developing fetus is at greater risk from methylmercury exposure than are adults. Data on children exposed only after birth are insufficient to determine if this group has increased susceptibility to the adverse central nervous system effects of methylmercury. In addition, children are considered to be at increased risk of methylmercury exposure by virtue of their greater food consumption as a percentage of body weight (mg food/kg body weight) compared to adult exposures. Additional risk from higher mercury ingestion rates may also result from the apparent decreased ability of children's bodies to eliminate mercury.

Interactive Effects—Potassium dichromate and atrazine may increase the toxicity of mercury, although these effects have been noted only with metallic and inorganic mercury. Ethanol increases the toxicity of methylmercury in experimental animals. Vitamins D and E, thiol compounds, selenium, copper, and possibly zinc are antagonistic to the toxic effects of mercury.

Critical Data Gaps—Additional data are needed on the exposure levels at which humans experience subtle, but persistent, adverse neurological effects. Data on immunologic effects and reproductive effects are not sufficient for evaluation of low-dose methylmercury toxicity for these endpoints.

EPA Regulations and Advisories

- Maximum Contaminant Level in drinking water = 0.002 mg/L
- Toxic Criteria for those States Not Complying with CWA Section 303(c)(2)(B) - criterion concentration for priority toxic pollutants:
  - Freshwater: maximum = 2.10 µg/L, continuous = 0.012 µg/L
  - Saltwater: maximum = 1.80 µg/L, continuous = 0.025 µg/L
  - Human health consumption of water and organisms = 0.14 µg/L
  - Human health consumption of organisms only = 0.15 µg/L.
- Water Quality Guidance for the Great Lakes System — protection of aquatic life in ambient water:

- acute water quality criteria for mercury total recoverable: maximum = 1.694 µg/L
- chronic water quality criteria for mercury total recoverable: continuous = 0.908 µg/L
- water quality criteria for protection of human health, drinking water and nondrinking water: maximum = 1.8×10^{-3} µg/L
- water quality criteria for protection of human health (mercury including methylmercury) = 1.3×10^{-3} µg/L.

- Listed as a hazardous air pollutant under Section 112 of the Clean Air Act
- Emissions from mercury ore processing facilities and mercury chlor-alkali plants = 2,300 g maximum/24 h
- Emissions from sludge incineration plants, sludge drying plants, or a combination of these that process wastewater treatment plant sludge = 3,200 g maximum/24 h
- Ban of phenylmercuric acetate as a fungicide in interior and exterior latex paints
- Reportable quantities: Mercury, mercuric cyanide = 1 lb; mercuric nitrate, mercuric sulfate, mercuric thiocyanate, mercurous nitrate, mercury fulminate = 10 lb; phenylmercury acetate = 100 lb.
- Listed as a hazardous substance: Mercuric cyanide, mercuric nitrate, mercuric sulfate, mercuric thiocyanate, mercurous nitrate
- Reporting threshold for Toxic Release Inventory (proposed) = 10 lb

Sources of Information

ATSDR (Agency for Toxic Substances and Disease Registry). 1999. *Toxicological Profile for Mercury.* U.S. Department of Health and Human Services, Public Health Service, Atlanta, GA.

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National Institute of Environmental Health Sciences. 1999. *Scientific Issues Relevant to Assessment of Health Effects from Exposure to Methylmercury.* U. S. Department of Health and Human Services, Public Health Service, Research Triangle Park, NC. http://www.niehs.nih.gov/.

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Porcella, D.B. 1994. Mercury in the Environment: Biogeochemistry. In: Watras, C. J., Huckabee, J. W., eds., Lewis Publishers. *Mercury Pollution Integration and Synthesis,* Boca Raton, Florida. 3-19.

Schmitt, C. J., and W. G. Brumbaugh. 1990. National Contaminant Biomonitoring Program: Concentrations of arsenic, cadmium, copper, lead, mercury, selenium, and zinc in U.S. freshwater fish, 1978-1984. *Archives of Environmental Contamination and Toxicolol*gy. 19:731-747.

U.S. EPA (Environmental Protection Agency). 1997. *Mercury Study Report to Congress.* Office of Air Quality Planning and Standards and Office of Research and Development, Washington, DC. http://www.epa.gov/ttn/uatw/112nmerc/mercury.html

U.S. EPA (Environmental Protection Agency). 1999a. *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 2, 3rd edition. Risk Assessment and Fish Consumption Limits.* EPA 823-B-99-008. Office of Water, Washington, DC.

U.S. EPA (Environmental Protection Agency). 1999b. *Fact Sheet: Update: National Listing of Fish and Wildlife Advisories.* EPA-823-F-99-005. Office of Water, Washington, DC.

U.S. EPA (Environmental Protection Agency). IRIS (Integrated Risk Information System) for Methylmercury. 1999c. National Center for Environmental Assessment, Office of Research and Development, Cincinnati, OH.

For more information about the National Fish and Wildlife Contamination Program, contact:

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Office of Science and Technology
401 M St. SW (4305)
Washington, DC 20460

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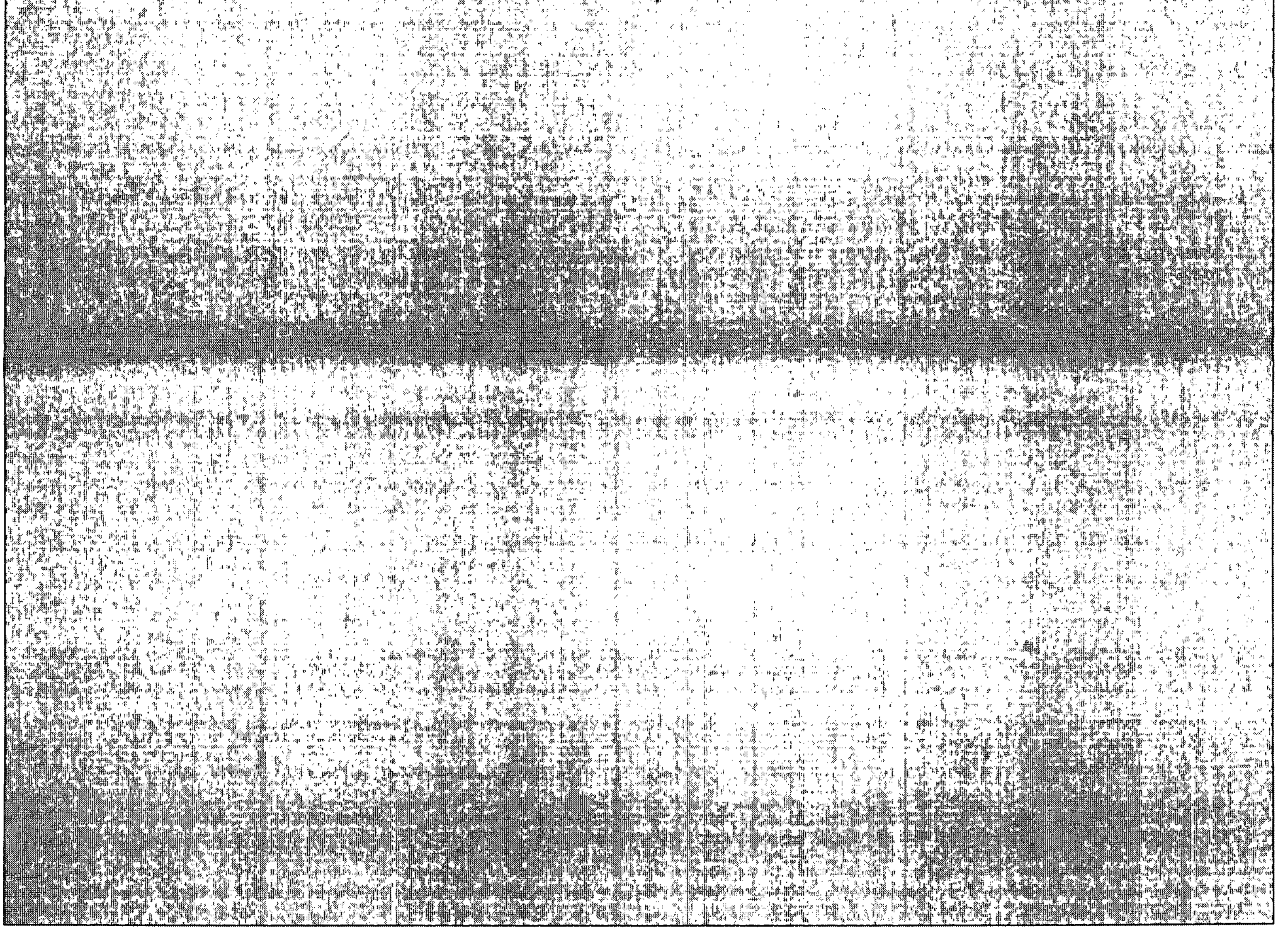
202 260-1305
202 260-9830 (fax)

The 1998 update of the database *National Listing of Fish and Wildlife Advisories* is available for downloading from the following Internet site: http://www.epa.gov/OST



ToxScan Inc.
42 Hangar Way ∘ Watsonville, CA 95076-2404 ∘ (831) 724-4522 ∘ FAX (831) 724-3188

January 02, 2001

ToxScan Number: T-19043

RR #7
#252
LINE 1

U.S. Army Corps of Engineers, Sacramento District
1325 "J" Street
Sacramento, CA 95814-2922

Attn: Vic Chan

Project Name:	2000 Lake Monitoring
Project Number:	Martis Creek Lake
Date Sampled:	October 26, 2000
Date Received:	November 14, 2000
Matrix:	Fish Tissue

Please find the enclosed test results for the parameters requested for analyses. The sample was analyzed within holding time using the following methods:

Percent Lipids by EPA Method 1664
Total Mercury by Cold Vapor AA by EPA Method 7471

The sample was received intact and was handled with the proper chain-of-custody procedures. Appropriate QA/QC guidelines were employed during the analyses on a minimum of a 5% basis. QC results were within limits and are reported with or following the data for each analysis.

Sample was analyzed out of hold time.

If you have any questions or require any additional information, please feel free to call.

Sincerely,

Philip D. Carpenter

Philip D. Carpenter, Ph.D.
President

Enclosures

This cover letter is an integral part of the report.

Client: U.S. Army Corps of Engineers, Sacramento District

ToxScan Number: T-19043

Method: EPA Method(s) 1664

Date Completed: 12/4/2000

Matrix: Fish Tissue

Units: Percent

Client Sample ID	ToxScan Lab ID	Analyte	Sample Value	Reporting Limit
MC-00-10-26-F1 Non Composite	19043-01	Percent Lipids	0.20	0.10

Client: U.S. Army Corps of Engineers, Sacramento District

ToxScan Number: T-19043

Method: EPA Method(s) 7471

Date Completed: 12/19/2000

Matrix: Fish Tissue

Units: mg/Kg

Total Metals

Client Sample ID	ToxScan Lab ID	Analyte	Sample Value	Reporting Limit
MC-00-10-26-F1 Non Composite	19043-01	Mercury	ND	0.020

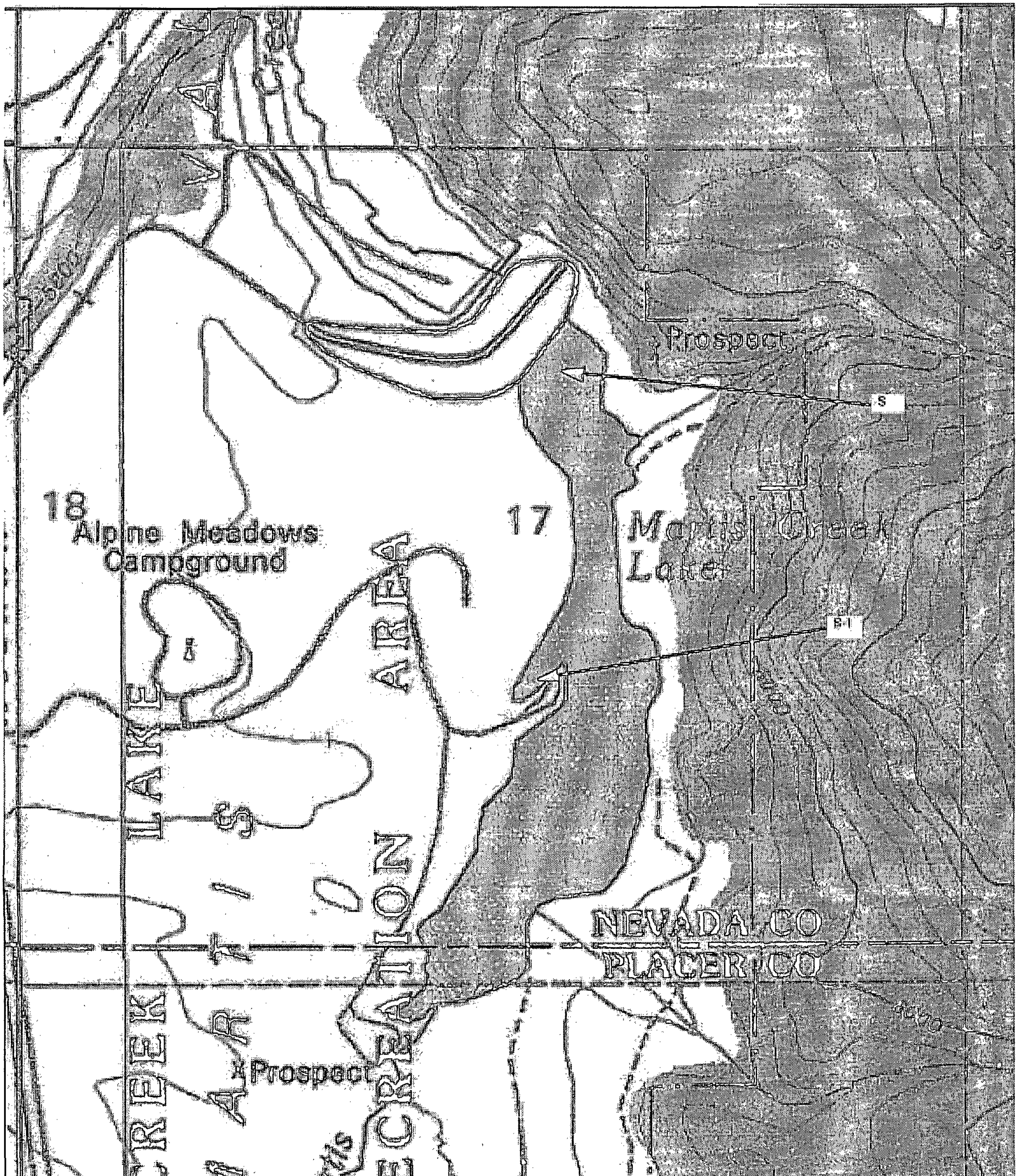
VII MTBE Results

2000 MTBE Results
Units are ug/L (ppb)

The following table provides an overview of the lab results for the 2000 MTBE monitoring program.

Lake	Spring S sample	Spring S-1 sample	Summer S sample	Summer S-1 sample	Remarks
Black Butte	<2		5	5	Summer Only
Eastman	<2		<2	<2	No MTBE
Englebright	5		10	10	See Note 5
Hensley	<2		3	5	Summer Only
Isabella	21		5	6	See Note 5 & 8
Kaweah	3		6	6	See Note 5
Martis Cr	<2		<2	<2	No MTBE
Mendocino	<2		<2	<2	No MTBE
New Hogan	<2		<2	<2	No MTBE
Pine Flat	<2		3	3	Summer Only
Sonoma	<2		2	3	Summer Only
Success	4		9	9	See Note 5

Notes:
1. Non-Detect is indicated by "<2" since the Detection Limit is 2 ppb or 0.002 ppm.
2. No enforceable acceptance criteria for MTBE has been established. See EPA Fact sheet.
3. Maps are provided to illustrated the sampling locations for sample S and sample S-1. The S sample is located near the dam while S-1 is near the marina.
4. For 2000, 3 water samples were taken at each Lake. No S-1 sample was taken in the Spring. Summer results indicates no significant differences between S sample and S-1 sample. S-1 samples will be taken in the Spring for 2001. For clarification, S-1 sample will be redesignated S-M for "Surface water near the Marina" in 2001.
5. Lake Englebright, Isabella, Kaweah, and Success have MTBE for both Spring and Summer and therefore 6 water samples are now being planned for these Lakes in 2001. Monitoring of MTBE will be increased for these four lakes in 2001 to determine if the MTBE levels are increasing or decreasing. After sampling in 2001, there should be sufficient data to indicate any trends and this will be reported in January 2002.
6. Lake Black Butte, Hensley, Pine Flat and Sonoma have MTBE in the summer only and the MTBE summer levels are less than the Lakes identified in Note 5. 4 water samples are now being planned for these Lakes in 2001.
7. The Lakes with "No MTBE" will only have 2 water samples taken in 2001.
8. The 21 ug/L result for Isabella for the spring was verified by a "QA duplicate" sample. However, this relatively high result is unexpected and therefore suspect. It is possible that samplers may have unknowingly sampled a gasoline plume from their boat or another boat and therefore the results may not be representative of the entire lake. The basis for the Spring data at Isabella being suspect is the Summer results. This theory will be confirmed in 2001 when 3 samples will be taken in the Spring and 3 samples will be taken in the Summer for Lake Isabella per Note 5.


Prospect
S
18
Alpine Meadows
Campground
17
Martis Creek
Lake
S-1
NEVADA CO
PLACER CO
Prospect
Martis
CREEK LAKE
RECREATION AREA

United States Environmental Protection Agency *Office of Water 4304* *EPA-822-F-97-009* *December 1997*

FACT SHEET

Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis on Methyl Tertiary-Butyl Ether (MtBE)

The Advisory

The U.S. Environmental Protection Agency (EPA) Office of Water is issuing an Advisory on methyl tertiary-butyl ether (MtBE)in drinking water. This Advisory provides guidance to communities exposed to drinking water contaminated with MtBE. This document supersedes any previous drafts of drinking water health advisories for this chemical.

What is an Advisory?

The U.S. EPA Health Advisory Program was initiated to provide information and guidance to individuals or agencies concerned with potential risk from drinking water contaminants for which no national regulations currently exist. Advisories are not mandatory standards for action. Advisories are used only for guidance and are not legally enforceable. They are subject to revision as new information becomes available. EPA's Health Advisory program is recognized in the Safe Drinking Water Act Amendments of 1996, which state in section 102(b)(1)(F):

> "The Administrator may publish health advisories (which are not regulations) or take other appropriate actions for contaminants not subject to any national primary drinking water regulation".

As its title indicates, this Advisory includes consumer acceptability advice as "appropriate" under this statutory provision, as well as a health effects analysis.

What is MtBE?

MtBE is a volatile, organic chemical. Since the late 1970's, MtBE has been used as an octane enhancer in gasoline. Because it promotes more complete burning of gasoline, thereby reducing carbon monoxide and ozone levels, it is commonly used as a gasoline additive in localities which do not meet the National Ambient Air Quality Standards.

In the Clean Air Act of 1990 (Act), Congress mandated the use of reformulated gasoline (RFG) in areas of the country with the worst ozone or smog problems. RFG must meet certain technical specifications set forth in the Act, including a specific oxygen content. Ethanol and MtBE are the primary oxygenates used to meet the oxygen content requirement. MtBE is used in about 84% of RFG supplies. Currently, 32 areas in a total of 18 states are participating in the RFG program, and RFG accounts for about 30% of gasoline nationwide.

Studies identify significant air quality and public health benefits that directly result from the use of fuels oxygenated with MtBE, ethanol or other chemicals. The refiners' 1995/96 fuel data submitted to EPA indicate that the national emissions benefits exceeded those required. The 1996 Air Quality Trends Report shows that toxic air pollutants declined significantly between 1994 and 1995. Early analysis indicates this progress may be attributable to the use of RFG. Starting in the year 2000, required emission reductions are substantially greater, at about 27% for volatile organic compounds, 22% for toxic air pollutants, and 7% for nitrogen oxides.

Why is MtBE a Drinking Water Concern?

A limited number of instances of significant contamination of drinking water with MtBE have occurred due to leaks from underground and above ground petroleum storage tank systems and pipelines. Due to its small molecular size and solubility in water, MtBE moves rapidly into groundwater, faster than do other constituents of gasoline. Public and private wells have been contaminated in this manner. Non-point sources, such as recreational watercraft, are most likely to be the cause of small amounts of contamination in a large number of shallow aquifers and surface waters. Air deposition through precipitation of industrial or vehicular emissions may also contribute to surface water contamination. The extent of any potential for build-up in the environment from such deposition is uncertain.

Is MtBE in Drinking Water Harmful?

Based on the limited sampling data currently available, most concentrations at which MtBE has been found in drinking water sources are unlikely to cause adverse health effects. However, EPA is continuing to evaluate the available information and is doing additional research to seek more definitive estimates of potential risks to humans from drinking water.

There are no data on the effects on humans of drinking MtBE-contaminated water. In laboratory tests on animals, cancer and noncancer effects occur at high levels of exposure. These tests were conducted by inhalation exposure or by introducing the chemical in oil directly to the stomach. The tests support a concern for potential human hazard. Because the animals were not exposed through drinking water, there are significant uncertainties about the degree of risk associated with human exposure to low concentrations typically found in drinking water.

How Can People be Protected?

MtBE has a very unpleasant taste and odor, and these properties can make contaminated drinking water unacceptable to the public. This Advisory recommends control levels for taste and odor acceptability that will also protect against potential health effects.

Studies have been conducted on the concentrations of MtBE in drinking water at which individuals can detect the odor or taste of the chemical. Humans vary widely in the concentrations they are able to detect. Some who are sensitive can detect very low concentrations, others do not taste or smell the chemical even at much higher concentrations. Moreover, the presence or absence of other natural or water treatment chemicals can mask or reveal the taste or odor effects.

Studies to date have not been extensive enough to completely describe the extent of this variability, or to establish a population threshold of response. Nevertheless, we conclude from the available studies that keeping concentrations in the range of 20 to 40 micrograms per liter (µg/L) of water or below will likely avert unpleasant taste and odor effects, recognizing that some people may detect the chemical below this.

Concentrations in the range of 20 to 40 µg/L are about 20,000 to 100,000 (or more) times lower than the range of exposure levels in which cancer or noncancer effects were observed in rodent tests. This margin of exposure is in the range of margins of exposure typically provided to protect against cancer effects by the National Primary Drinking Water Standards under the Federal Safe Drinking Water Act. This margin is greater than such standards typically provided to protect against noncancer effects. Thus, protection of the water source from unpleasant taste and odor as recommended will also protect consumers from potential health effects.

EPA also notes that occurrences of ground water contamination observed at or above this 20-40 μg/l taste and odor threshold -- that is, contamination at levels which may create consumer acceptability problems for water suppliers -- have to date resulted from leaks in petroleum storage tanks or pipelines, not from other sources.

What is Being Done About the Problem?

<u>Research</u>

The EPA, other federal and state agencies, and private entities are conducting research and developing a strategy for future research on all health and environmental issues associated with the use of oxygenates. To address the research needs associated with oxygenates in water, a public, scientific workshop to review the EPA's Research Strategy for Oxygenates in Water document was held on October 7, 1997.

Discussions included current, or soon to be started, oxygenate projects in the areas of environmental monitoring/occurrence, source characterization, transport and fate, exposure, toxicity, remediation, among others. The identified research will help provide the necessary information to better understand the health effects related to MtBE and other oxygenates in water, to further our knowledge on remediation techniques, and to direct future research planning towards the areas of highest priority. This document is expected to be available for external review by January, 1998. EPA plans to hold a workshop with industry to secure commitments on conducting the needed research in the Spring of 1998.

The EPA has also recently notified a consortium of fuel and fuel additive manufacturers of further air-related research requirements of industry under section 211(b) of the Clean Air Act (CAA). The proposed animal inhalation research focuses on the short and long term inhalation effects of conventional gasoline and MtBE gasoline in the areas of neurotoxicity, immunotoxicity, reproductive and developmental toxicity, and carcinogenicity. The testing requirements will also include an extensive array of human exposure research. This research will be completed at varying intervals over the next five years and could be very useful for assessing risks from MtBE in water, depending on the outcome of studies underway on the extrapolation of inhalation risks to oral ingestion.

When adequate research on the human health effects associated with ingestion of oxygenates becomes available, the EPA Office of Water will issue a final health advisory to replace the present advisory.

Monitoring

The EPA's Office of Water has also entered into a cooperative agreement with the United States Geological Survey (USGS) to conduct an assessment of the occurrence and distribution of MtBE in the 12 mid-Atlantic and Northeastem states. Like California, these States have used MtBE extensively in the RFG and Oxygenated Fuels programs. This study will supplement the data gathered in California and will attempt to shed light on the important issues of (1) whether or not MtBE has entered drinking water distribution systems or impacted drinking water source supplies, and (2) determine if point (land) or nonpoint sources (air) are associated with detections of MtBE in ground water resources. Activities are underway to begin collecting data in early 1998.

Underground Storage Tanks

Under EPA regulations, leaks from underground storage tank systems (USTs) which may cause contamination of groundwater with MtBE or other materials are required to be reported to the "implementing agency" which, in most cases, is a state agency. The EPA Office of Underground Storage Tanks and State and local authorities are addressing the cleanup of water contaminated by such leaks. All USTs installed after December 1988 have been required to meet EPA regulations for preventing leaks and spills. All USTs that were installed prior to December 1988 must be upgraded, replaced, or closed to meet these requirements by December 1998.

Safe Drinking Water Act Candidate List

The Safe Drinking Water Act (SDWA), as amended in 1996, requires EPA to publish a list of contaminants that may require regulation, based on their known or anticipated occurrence in public drinking water systems. The SDWA, as amended, specifically directs EPA to publish the first list of contaminants (Contaminant Candidate List, or CCL) by February 1998, after consultation with the scientific community, including EPA's Science Advisory Board, and after notice and opportunity for public comment. The amendments also require EPA to select at least five contaminants from the final CCL and make a determination of whether or not to develop regulations, including drinking water standards, for them by 2001. The EPA Office Water published a draft CCL for public comment in the Federal Register on October 6, 1997 (62 FR 52194). MtBE is included on the draft CCL based on actual MtBE contamination of certain drinking water supplies, e.g., Santa Monica, and the potential for contamination of other drinking water supplies in areas of the country where MtBE is used in high levels.

How Can I Get My Water Tested?

A list of local laboratories that can test your water for MtBE can be obtained from your state drinking water agency. The cost for testing is approximately $150 per sample. The analysis should be performed by a laboratory certified to perform EPA certified methods. The laboratory should follow EPA Method 524.2 (gas chromatography/mass spectrometry).

How Can I Get Rid of MtBE If It's In My Water?

In most cases it is difficult and expensive for individual home owners to treat their own water. Any detection of MtBE should be reported to your local water authority, who can work wth you to have your water tested and treated.

Are There Any Recommendation s for State or Public Water Suppliers?

Public water systems that conduct routine monitoring for volatile organic chemicals can test for MtBE at little additional cost, and some States are already moving in this direction.

Public water systems detecting MtBE in their source water at problematic concentrations can remove MtBE from water using the same conventional treatment techniques that are used to clean up other contaminants originating from gasoline releases, such as air stripping and granular activated carbon (GAC). However, because MtBE is more soluble in water and more resistant to biodegradation than other chemical constituents in gasoline, air stripping and GAC treatment requires additional optimization and must often be used together to remove MtBE effectively from water. The costs of removing MtBE will be higher than when treating for gasoline releases that do not contain MtBE. Oxidization of MtBE using UV/peroxide/ozone treatment may also be feasible, but typically has higher capital and operating costs than air stripping and GAC.

To Obtain the Advisory:
Call the National Center for Environmental Publications and Information (NCEPI) at 1-800-490-9198 to be sent a copy or write to NCEPI, EPA Publications Clearinghouse, P.O. Box 42419, Cincinnati, OH 45242.

Internet download:
www.epa.gov/OST/Tools/MtBEaa.pdf

To Obtain the Research Strategy on Oxygenates in Water, External Review Draft, Contact: Diane Ray, U.S. EPA, Office of Research and Development, NCEA, MD-52, RTP, NC 27711 or by phone (919)541-3637.

Internet download:
www.epa.gov/ncea/oxywater.htm

To Obtain the 211(b) Air-Related Resear ch Requirements, Contact:
John Brophy, U.S. EPA, Office of Air and Radiation; phone (202) 564-9068; www.epa.gov/omswww/omsfuels.htm

For Further Information on the Advisory, Contact:
Charles Abernathy
U.S. EPA, Office of Water, Mail Code 4304
1200 Pennsylvania Ave., Washington, DC. 20460
mtbe.advisory@epa.gov
(202)260-5374

For Further Information on the Researc h Strategy, Contact:
Diane Ray, U.S. EPA, Office of Research and Development, NCEA, MD-52, RTP, NC 27711 or by phone (919)541-3637.

Caltest
ANALYTICAL LABORATORY
ENVIRONMENTAL ANALYSES

ORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	ANALYZED	QC BATCH	NOTES
LAB NUMBER: A080159-1							
SAMPLE ID: MC-SU-S							
SAMPLED: 02 AUG 00 10:45							
METHOD: EPA 8260B							
VOLATILE ORGANIC COMPOUNDS				1	08.16.00	V000123MSA	
tert-Amyl-Methyl Ether (TAME)	ND	2.	ug/L				
Ethyl-tert-Butyl Ether (ETBE)	ND	1.	ug/L				
Diisopropyl Ether (DIPE)	ND	2.	ug/L				
Methyl tert-Butyl Ether (MTBE)	ND	2.	ug/L				
2-Methyl-2-Propanol (TBA)	ND	50.	ug/L				
Surrogate Dibromofluoromethane	98.		%				
Surrogate 1,2-DCA-d4	127.		%				
Surrogate Toluene-d8	129.		%				
Surrogate 4-BFB	117.		%				
LAB NUMBER: A080159-4							
SAMPLE ID: MC-SU-S-1							
SAMPLED: 02 AUG 00 10:45							
METHOD: EPA 8260B							
VOLATILE ORGANIC COMPOUNDS				1	08.16.00	V000123MSA	
tert-Amyl-Methyl Ether (TAME)	ND	2.	ug/L				
Ethyl-tert-Butyl Ether (ETBE)	ND	1.	ug/L				
Diisopropyl Ether (DIPE)	ND	2.	ug/L				
Methyl tert-Butyl Ether (MTBE)	ND	2.	ug/L				
2-Methyl-2-Propanol (TBA)	ND	50.	ug/L				
Surrogate Dibromofluoromethane	92.		%				
Surrogate 1,2-DCA-d4	128.		%				
Surrogate Toluene-d8	129.		%				
Surrogate 4-BFB	118.		%				

1) Sample Preparation on 08-15-00 using EPA 5030

1885 North Kelly Road • Napa, California 94558

ENVIRONMENTAL ANALYSES

ORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	ANALYZED	QC BATCH	NOTES
LAB NUMBER: A040695-1							
SAMPLE ID: MC-SP-S							
SAMPLED: 27 APR 00 10:30							
METHOD: EPA 8260B							
VOLATILE ORGANIC COMPOUNDS				1	05.03.00	V000049MSA	1.
tert-Amyl-Methyl Ether (TAME)	ND	2.	ug/L				
Ethyl-tert-Butyl Ether (ETBE)	ND	1.	ug/L				
Diisopropyl Ether (DIPE)	ND	2.	ug/L				
Methyl tert-Butyl Ether (MTBE)	ND	2.	ug/L				
2-Methyl-2-Propanol (TBA)	ND	50.	ug/L				
Surrogate Dibromofluoromethane	70.		%				
Surrogate 1.2-DCA-d4	66.		%				
Surrogate Toluene-d8	73.		%				
Surrogate 4-BFB	66.		%				

1) Sample Preparation on 05-03-00 using EPA 5030
2) Initial analysis of this sample failed surrogate recovery criteria. Reanalysis out of regulatory hold time showed acceptable surrogate recov eries with similar results.

VIII Lake Code Designation

Laboratory Reports are provided in the previous sections.

Sample ID is "XX-YY-ZZ" where

XX designation:
BB for Black Butte
EA for Eastman
EN for Englebright
HE for Hensley
IS for Isabella
KA for Kaweah
ME for Mendocino
MC for Martis Creek
NH for New Hogan
PF for Pine Flat
SO for Sonoma
SU for Success

YY designation
SP for Spring
SU for Summar

ZZ designation
S for surface of Lake
B for bottom of Lake
I-1 for inflow1
I-2 for inflow 2
O for outflow

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