2001 LAKE LAS VEGAS WATER QUALITY MONITORING REPORT

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Submitted to:

Nevada Division of Environmental Protection
(NDEP)

January 2002

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I. INTRODUCTION

A. Project History

J. Carlton Adair, then President of the Port Holiday Authority conceived the idea of Lake Las Vegas in 1964. The 2243-acre development project was known as Port Holiday, and the lake was called "Lake Adair." Project land was acquired from the federal government under a land exchange act (PL88-639) authorized by Congress on October 8, 1964. Approximately 170 acres of privately owned land in the Lake Mead National Recreation Area (LMNRA) was exchanged for 2,243 acres in Las Vegas Wash (LVW). That property was located along the western border of the LMNRA in the LVW (Figure 1).

Carlton Adair halted the project in 1971, though a considerable amount of engineering and feasibility work had been done. The project remained idle until 1982 when it was reinitiated as the Lake at Las Vegas Project by Barry Silverton and the Pacific Malibu Development Corporation of Los Angeles, CA. Pacific Malibu and its primary consultant J. M. Montgomery (JMM) Consulting Engineers conducted extensive engineering and environmental studies during 1984-1987. Transcontinental Corporation of Santa Barbara, California, acquired controlling interest in the project in 1988. Transcontinental Corporation and its consultants completed the engineering and environmental studies and obtained the necessary local, state, and federal permits required to start construction of the project. Construction began on April 1, 1989. The project is now called "Lake Las Vegas Resort."

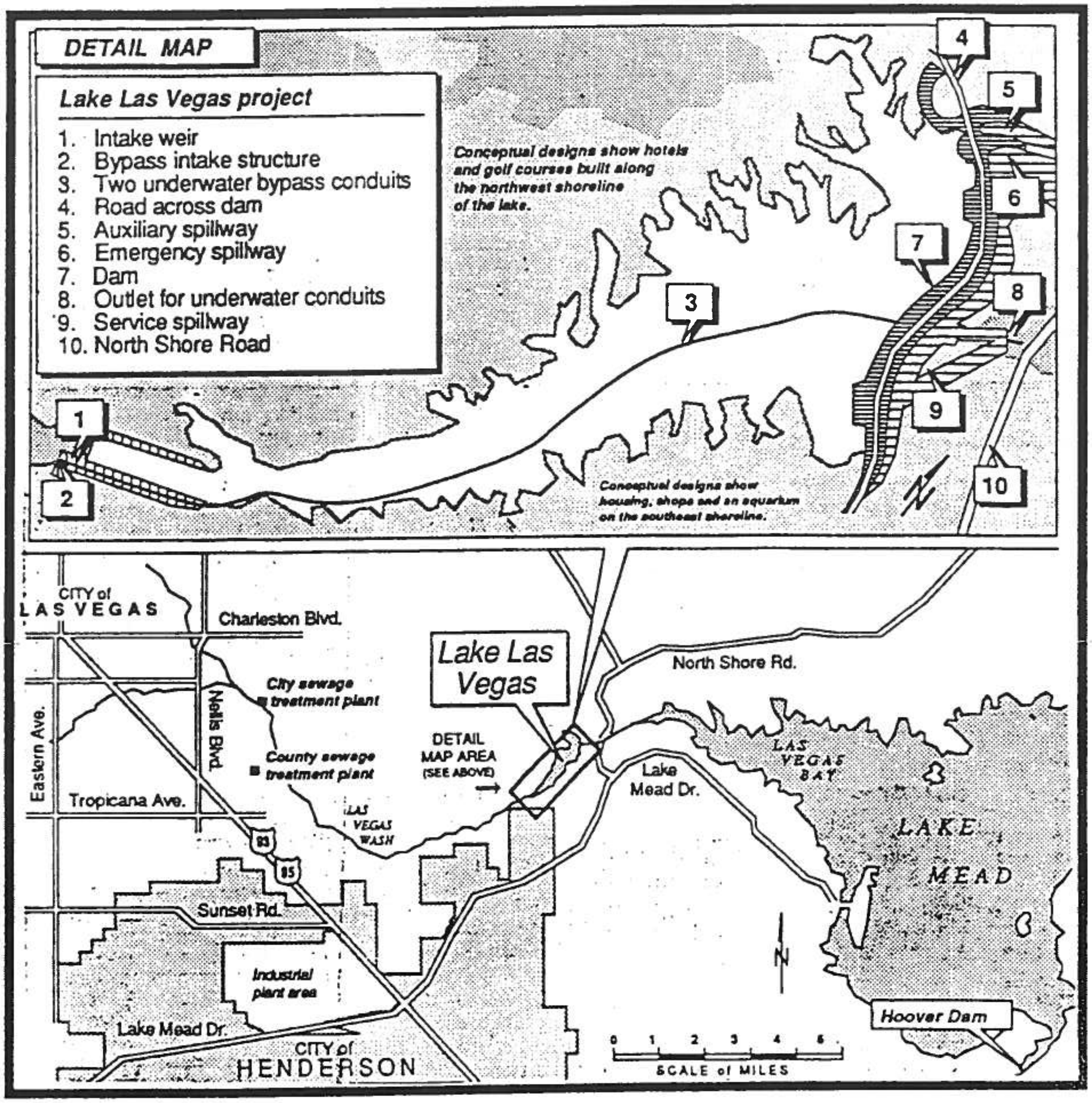
B. Project Description

Lake Las Vegas may ultimately consist of six resort hotels, six golf courses, 3,500 - 5,000 dwelling units, condominium developments, and commercial and civic developments. At full development, it will have an estimated population of 12,500 people, 4000 residents and 3000 hotel rooms.

The focal point of the project is a 320-acre recreational lake that is developed behind a 4800-ft., S-shaped earthen dam, 1500 ft. upstream of North Shore Road. The 190-ft. high dam was constructed with 3.0 million cubic yards of locally available materials. Lake elevation is maintained between 1400 ft. and 1403 ft. above msl. At an elevation of 1403 ft., the Lake has a storage capacity of approximately 10,000-acre feet, comprises 320 surface acres, a two-mile length, a one-mile width, and 12.3 miles of shoreline. Lake fill water is drawn from Lake Mead, and conveyed by the Basic Management Incorporated Pipeline (BMI). Approximately 7,000 acre-feet of Lake Mead water is required annually for project irrigation, seepage and evaporative losses from the Lake.

Las Vegas Wash flows are by-passed under the Lake through two 84-inch diameter reinforced concrete pipelines. The bypass system is 9,450 ft. in length and designed to pass Las Vegas Wash (LVW) flows up to approximately 1,200 cubic feet per second (cfs). Flows currently average approximately 225 cubic feet second in the LVW in 2001.

Figure 1. Location and description of Lake Las Vegas Resort (Las Vegas Review Journal map by Jim Day July 28, 1999)



II. METHODS

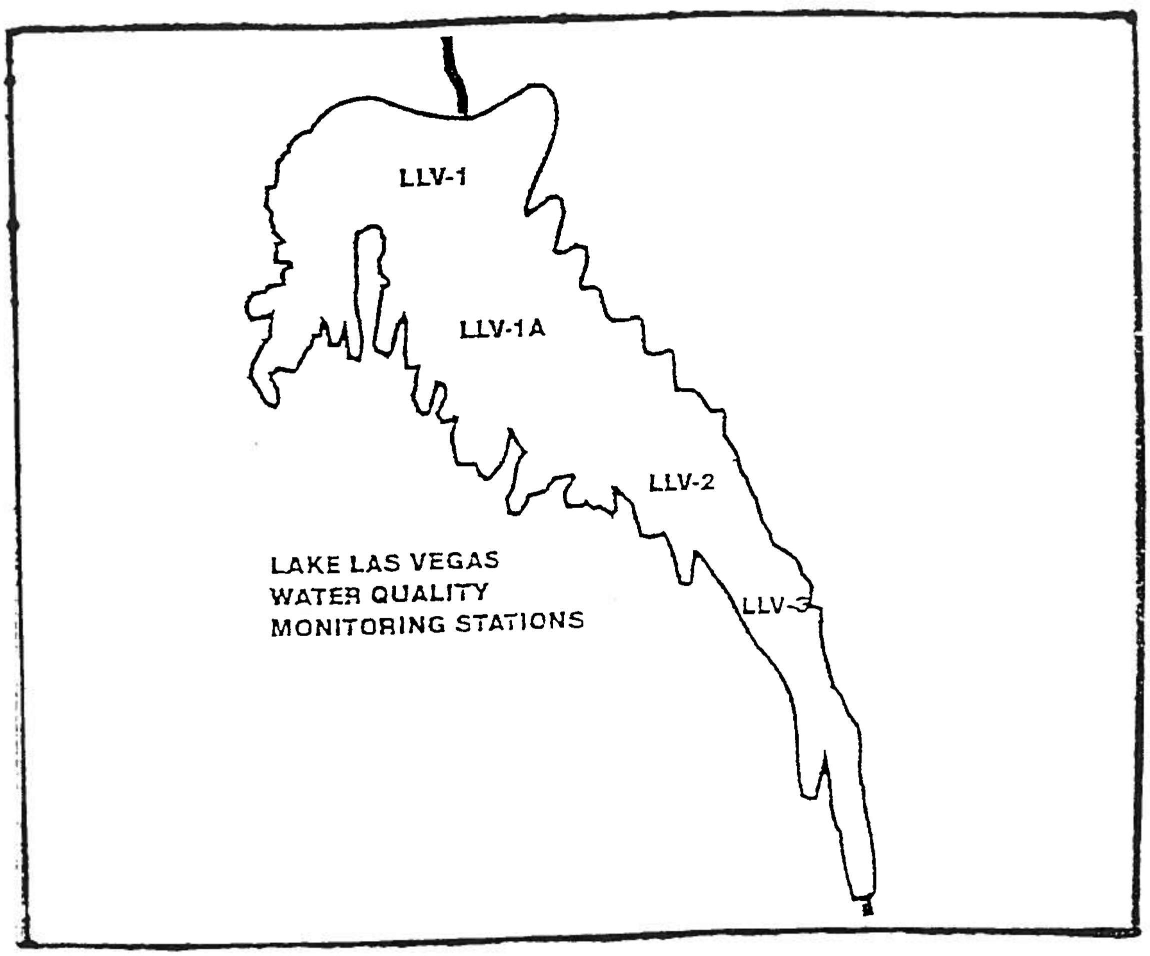
The revised Clark County 208 Water Management Plan was approved by the Clark County Board of County Commissioners on April 5, 1988 and certified by the State of Nevada on August 8, 1988. This plan required a water quality-monitoring program be developed for Lake Las Vegas Resort. The monitoring was required to insure that construction activities and operations of the reservoir did not violate the Las Vegas Wash water quality standards. The water quality-monitoring program was initiated in June 1991, and Lake Las Vegas has submitted annual reports to Nevada Division of Environmental Protection for review.

A. Lake Las Vegas Monitoring Sites

Since 1991, water quality monitoring was conducted on Lake Las Vegas monthly in January, February, November, and December, biweekly during March and October, and weekly during April through September.

Water quality monitoring was conducted at sites shown in Figure 2, at fixed points along the historical center channel in the deepest part of the Lake.

Figure 2. **Location of water quality monitoring stations at Lake Las Vegas.**



B. Field Measurements

Temperature, dissolved oxygen, pH, and specific conductance were measured throughout the vertical column at all sites with a Hydrolab Surveyor Model III Water Quality Analyzer (Table 1). Transparency was measured at each lake site with a Secchi disc. Duplicate measurements were made on approximately 10% of the measurements.

Table 1. 2001 Lake Las Vegas physical, chemical and biological analyses.

Sampling Program			
Measurements	Depth(s)	Frequency	Method(s)
Physical			
Temperature (°C)	1.0 m Intervals Surface to Bottom	Variable	Leavitt et al. (1990)
Dissolved Oxygen (mg/l)	"	"	"
pH (Std. Units)	"	"	"
Conductivity (μmhos/cm)	"	"	"
Secchi Depth (m)	Surface	"	"
Turbidity (NTU)	0 - 2.5 m Int.	"	"
Chemical			
Total Nitrogen (μg/l)	0 - 2.5 m Int.	"	APHA (1992)
Ammonia-N (μg/l)	"	"	"
Nitrite + Nitrate-N (μg/l)	"	"	"
Total Phosphorus (μg/l)	"	"	"
Ortho-Phosphorus (μg/l)	"	"	"
Total Suspended Solids (mg/l)	"	"	"
Total Dissolved Solids (mg/l)	"	"	"
Major Anions/Cations (mg/l)	"	"	"
Biological			
Chlorophyll-a (μg/l)	"	"	Leavitt et al.
Phytoplankton Counts (ng/m3)	"	"	(1990)
Zooplankton Counts (No./l)	0 - 15 m Tow		"

C. Chemical and Biological Analysis

Upper epilimnium water samples were collected from 0 - 2.5 m at main-lake sampling sites (Figure 2). Additional depth samples were collected quarterly at 5 m, 10 m, and 20 m at site LLV-1A with a Van Dorn sampler. Samples requiring filtration were filtered through 0.45 μm millipore filters.

Analyses were run on field duplicates at a frequency of approximately 10% of the samples. A State of Nevada certified laboratory ran the chemical and biological analyses with EPA-approved methods. Samples were collected from the surface and near the bottom at site LLV-1 in December 2001 and immediately shipped to the National Water Testing Laboratory in Cleveland, Ohio for analysis of toxic substances.

Monthly Zooplankton samples were collected at LLV-1 in a vertical tow from 0-15 m with an 80 μm Wisconsin plankton net. Phytoplankton (algae) was collected quarterly from the surface (0 - 2.5 m) from site LLV-1. Phytoplankton samples were identified to the level of species when possible.

D. Statistical Analysis

Statistical analysis was performed using Jandels Sigma Stat Analytical software. All data sets were tested for normality and heterogeneity. Data sets were analyzed using appropriate non-parametric statistical tests for non-normal distributed data. Statistical significance was defined at an alpha of < 0.05 unless otherwise noted.

The water quality guidelines presented in table 2 are patterned after standards established for Lake Mead (NAC 445.1351). These guidelines were established and adapted as part of the Clark County 208 Amendment to protect and enhance the following beneficial uses at Lake Las Vegas:

1). Irrigation;
2). Recreation not involving contact with the water (boating, sailing, canoeing);
3). Recreation involving contact with the water (swimming, bathing, diving);
4). Propagation of wildlife; and
5). Propagation of aquatic life, including a warm water fishery.

Table 2. Water quality guidelines for Lake Las Vegas

1. The lake waters should be free of:
   a. Visible floating, suspended, or settleable solids,
   b. Sludge banks, lime infestations, heavy growths of attached plants (Periphyton) and animals, or of floating algae mats,
   c. Discoloration or excessive turbidity,
   d. Visible oil or slicks,
   e. Surfactant concentrations that produce foam when water is agitated or aerated,
   f. Toxicants in toxic amounts;
2. The pH as measured in standard units should range between 7.0 and 9.0 in 90% of the measurements;
3. Dissolved oxygen concentrations should be 5 mg/l in the epilimnion during stratification, and 5 mg/l throughout the water column the rest of the year;
4. The average chlorophyll-a concentration in the epilimnion (0-2.5 m) should not exceed 0.005 mg/l during April through September. The average must include at least two samples per month. The single value must not exceed .010 mg/l in 10% of the samples;
5. In all lake areas, the log mean of not less than five fecal coliform samples taken over a 30 day period during the recreational season (April-September) should not exceed 200 MPN/100 ml and not over 10% of such samples should exceed 400 MPN/100 ml;
6. Average temperature in the epilimnion should not exceed 2°C above ambient temperature (e.g. temperature in epilimnion in Lake Mead);
7. Total dissolved solids concentrations should not exceed an annual average of 2000 mg/l throughout the water column;
8. Turbidity must not exceed that characteristic of natural conditions by more than 10 NTU.

III. WATER QUALITY RESULTS

A. Lake Water Surface Elevation

Water for Lake Las Vegas is pumped from the hypolimnion of Lake Mead through the Basic Management Incorporated (BMI) pipelines. Lake Las Vegas' Lake Mead inflows totaled two thousand thirty nine (2,039) acre-feet during 2001. Lake elevation decreased from 1401.9 feet in January 2001 to 1400.85 feet at the end of December 2001 (Figure 3). Two thousand eighteen (2,018) acre-feet of lake water was lost to seepage/evaporation.

One thousand nine hundred twenty seven (1,927) acre-feet of stormwater was harvested during 2001. Lake Las Vegas released one thousand six hundred forty four (1,644) acre-feet of water from the Lake during the months of February 2001. All releases from the dam were performed under the guise of dam management as opposed to water quality management (related to storm events).

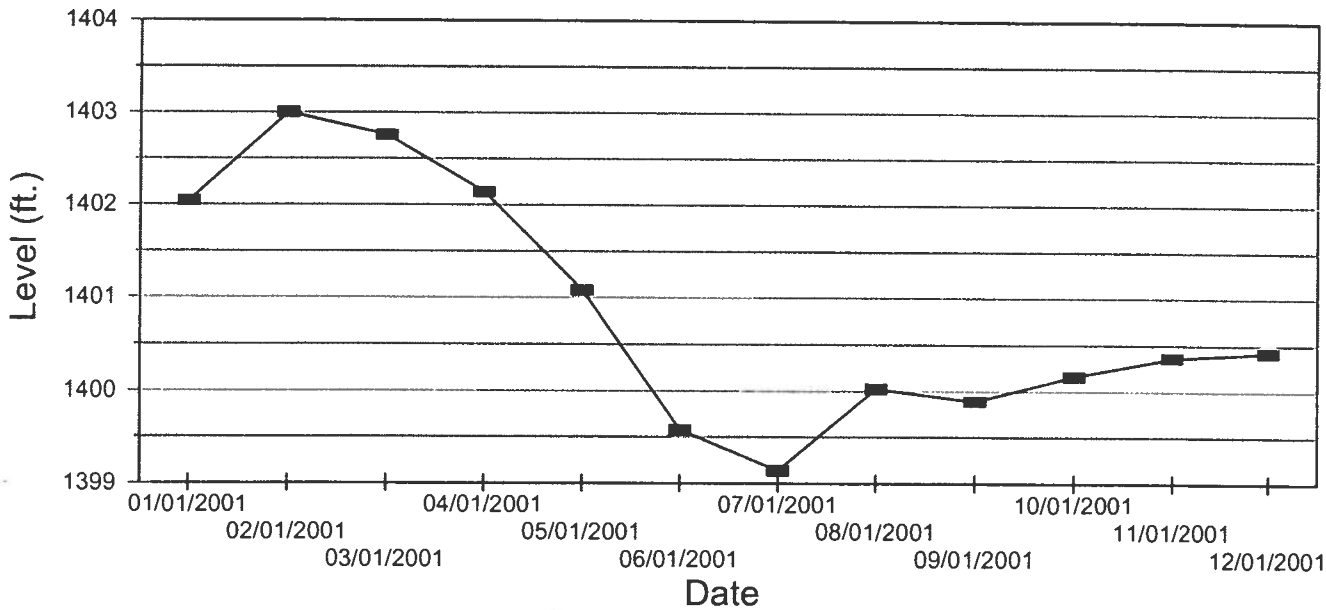


Figure 3. **2001 Lake Las Vegas surface elevations.**

A. Physical Analysis

Temperature

Surface temperatures in Lake Las Vegas ranged from 8.0°C to 32.0°C during 2001, with the lowest temperatures found in January and the highest in July and August (Figure 4). The Lake was uniformly mixed top to bottom during December, but reflected various stages of thermal stratification during the remaining quarters through early spring. By June, the Lake stratified with the thermocline defined between ten to eighteen meters (Figure 5). The Lake remained stratified during the summer and early fall months.

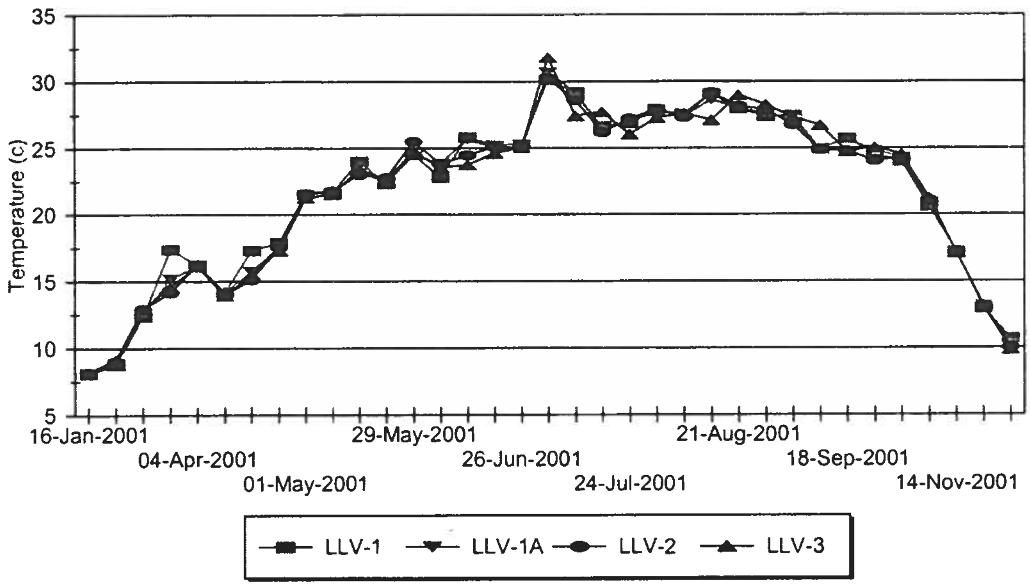


Figure 4. **Surface temperature measurements at Lake Las Vegas monitoring stations LLV-1, LLV-1A, LLV-2, LLV-3 in 2001.**

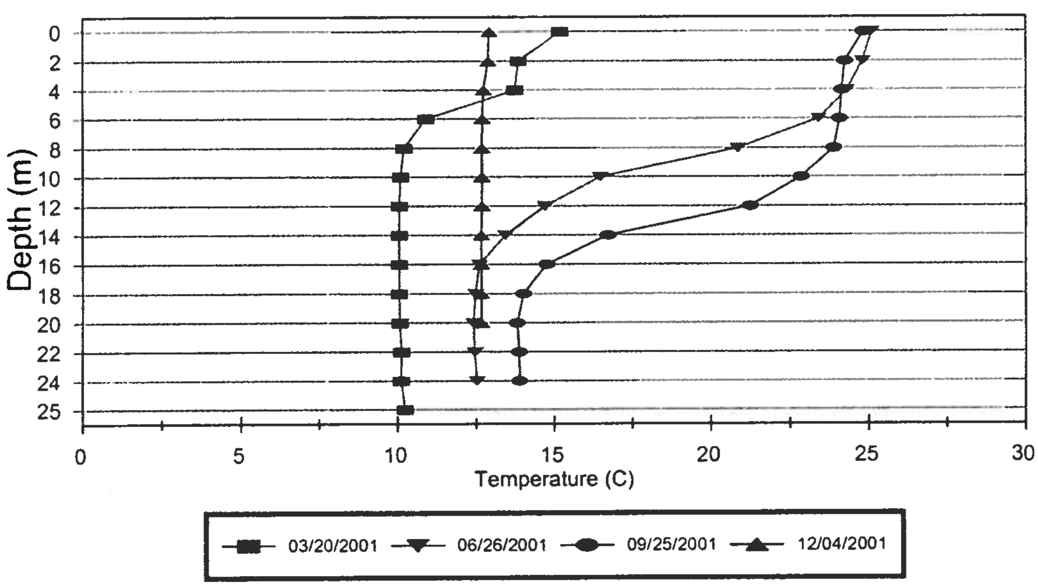


Figure 5. **Lake Las Vegas temperature profiles at Lake monitoring station LLV-1A during March, June, September, and December 2001.**

Dissolved Oxygen and Bio-chemical Oxygen Demand

Dissolved oxygen concentrations at the lake surface had considerable variations between the sites throughout the year (Figure 6). Concentration ranged from approximately 7.0 to 14.0 mg/l. Concentrations at depth exhibited the common dissolved oxygen trends found within dimictic lakes that stratify (Figure7).

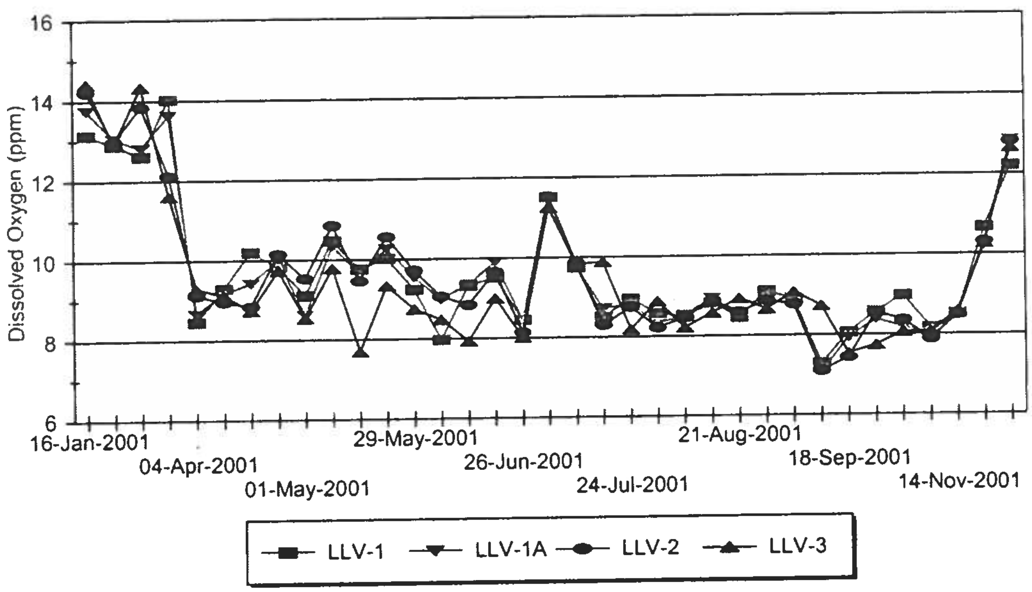


Figure 6. **Lake Las Vegas dissolved oxygen in surface waters (0m) at Lake monitoring stations during January – December 2001.**

The Lake remained relatively well mixed during the late fall through late spring with concentrations ranging from 11-13 mg/l throughout the water column. During the period of stratification, dissolved oxygen concentrations, below the thermocline (12-18 meters), were less than 5.0 mg/l (Figure 7).

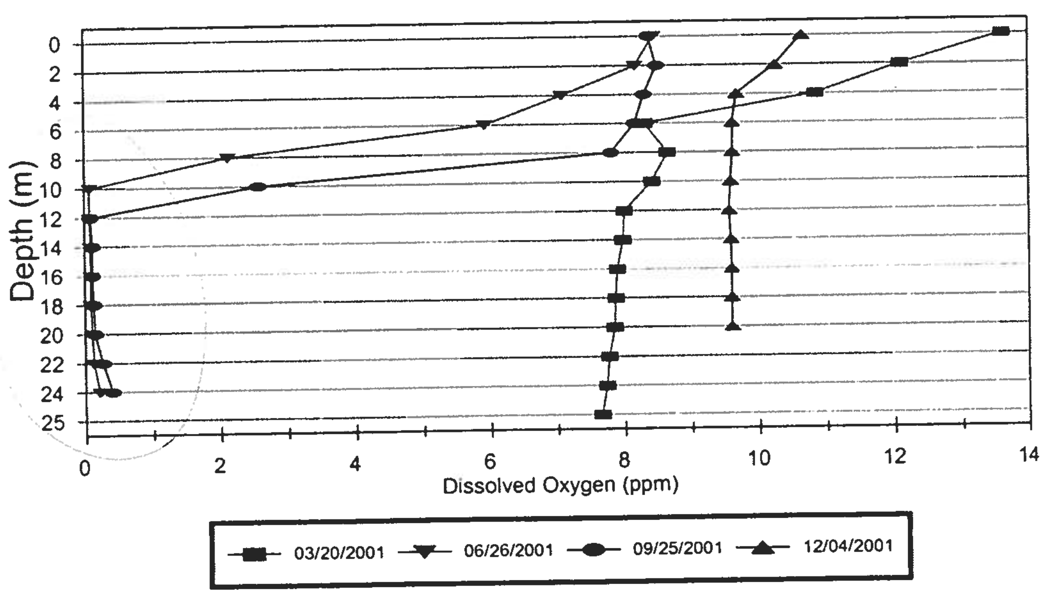


Figure 7. **Lake Las Vegas dissolved oxygen profiles at station LLV-1A during March, June, September, and December 2001.**

In 2001 Bio-chemical oxygen demands (BOD_5) concentrations ranged between 2 and 7 mg/l. Concentrations were the greatest during the spring. This coincided with the high algal concentrations also observed (Table 3).

pH

There were some seasonal variation in pH of surface waters in Lake Las Vegas during 2001 (Figure 8). Surface water pH values varied slightly between the four Lake sites ranging between 8.0 and 8.8 in 2001 (Figure 8). Depth profiles of pH indicated the pH followed a similar trend of dissolved oxygen. During periods of stratification pH values decreased as bicarbonate concentrations declined with the onset of anaerobic conditions (Figure 9).

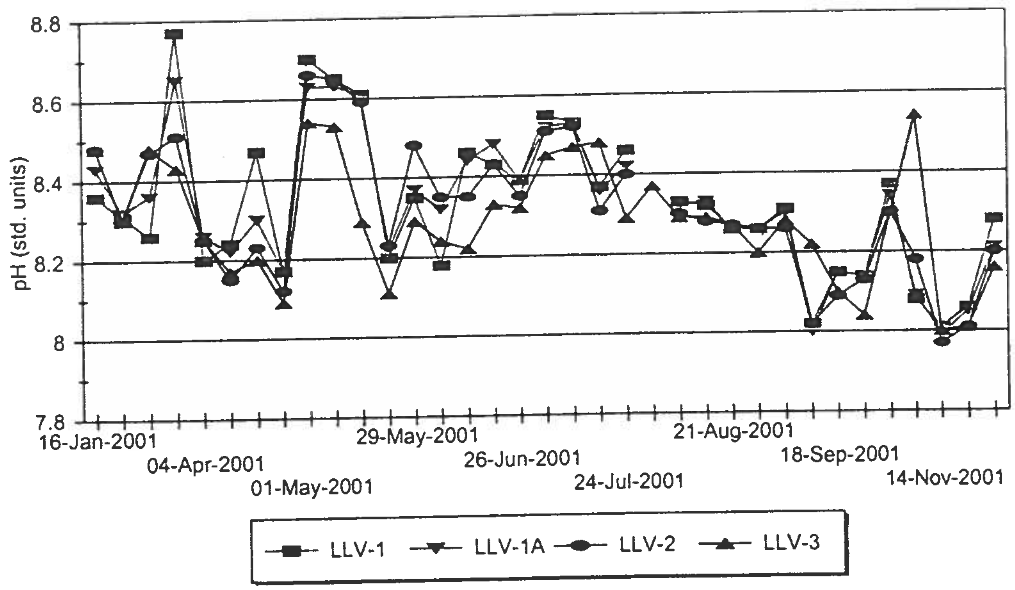


Figure 8. **Lake Las Vegas pH in surface water (0m) at the main-lake monitoring stations during January – December 2001.**

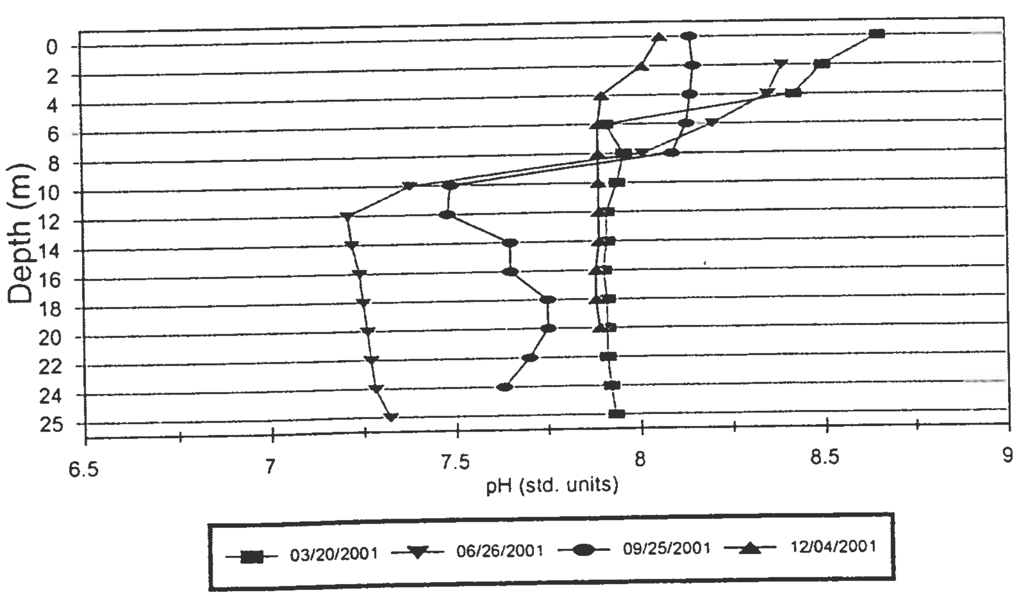


Figure 9. **Lake Las Vegas pH profiles at station LLV-1A during March, June, September, and December 2001.**

Conductance

Lake water conductivity ranged between roughly 2330 µmho/cm to 3550 µmho/cm at the surface during 2001 (Figure 10). Conductivity did not vary significantly between the four lake sites. Conductivity did not vary greatly with depth. In March samples at site LLV-1A there was a zone of lower conductivity water present between 0 and 4 meters. This is related to the late February storm events and the lower TDS stormwater floating on the surface (figure 11).

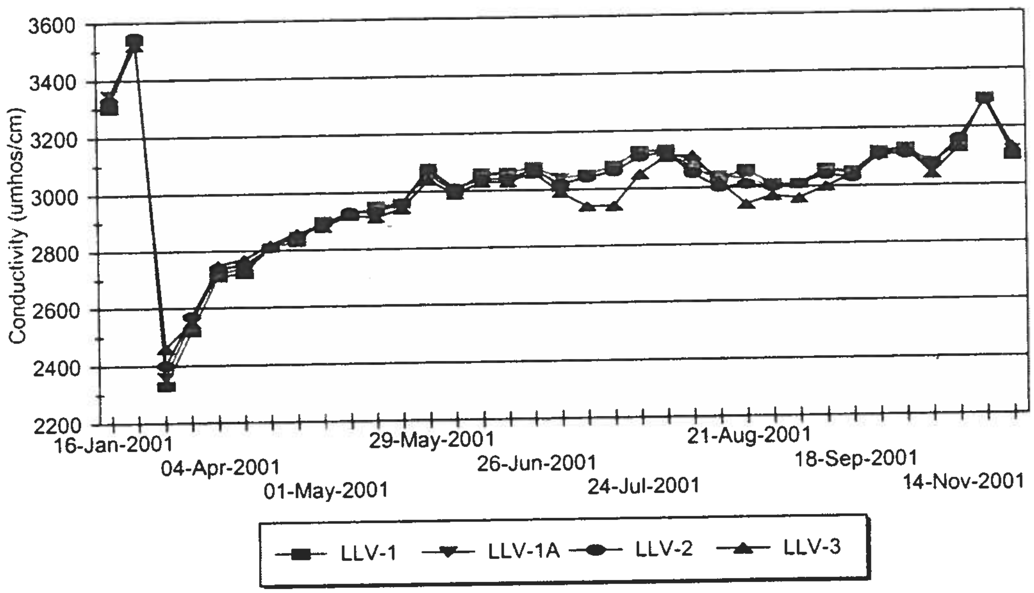


Figure 10. **Lake Las Vegas conductance in surface waters (0m) at main-lake stations during January–December 2001**

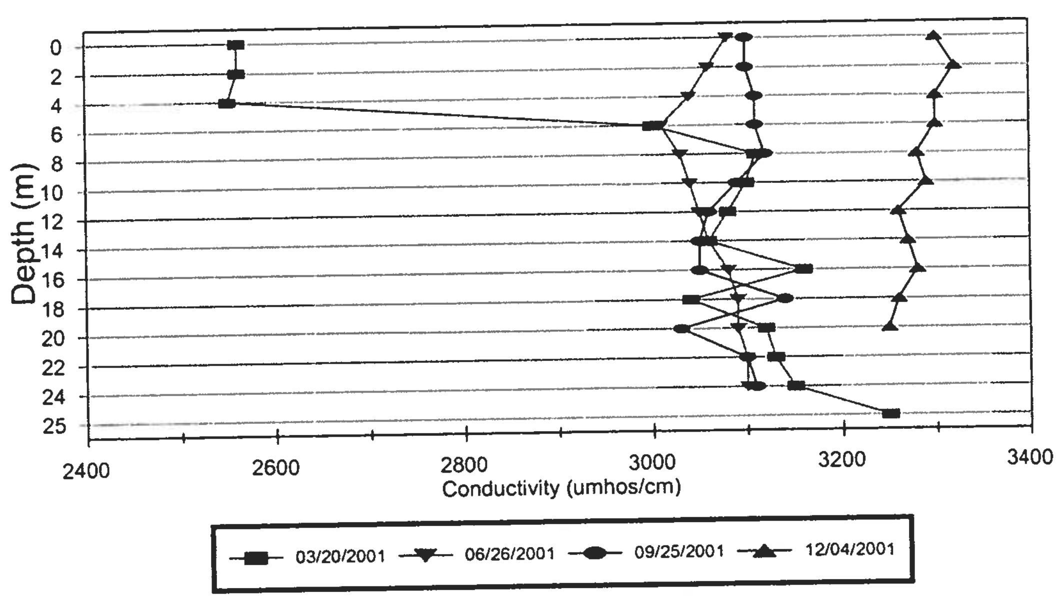


Figure 11. **Lake Las Vegas conductance profiles at station LLV-1A during March, June, September, and December 2001.**

Transparency

There was considerable seasonal and spatial variability in Lake transparency values during 2001 with values ranging between 0.25 and 3.75 meters of lake depth. These compared to 0.75 and 7.3 meters in 2001. Transparency was typically greatest at sites LLV-1 and LLV- 1A on the deeper East End of the Lake. (Figure 12). These differences were related to the shallow nature of the West End of the Lake and the influence of wind mixing at sites LLV-2 and LLV- 3.

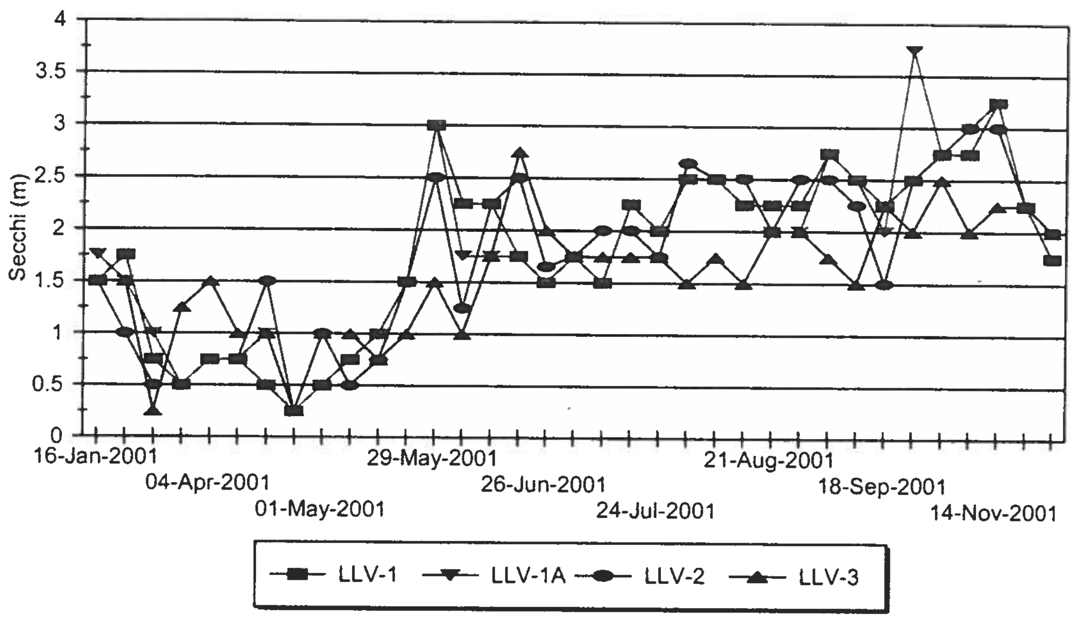


Figure 12. **Lake Las Vegas transparency measurements in surface water (0m) at Lake monitoring station during 2001.**

Turbidity

Monthly Turbidity values did not vary significantly between the four sites with concentrations varying between 2.6 and 17.0 NTU at the surface (0-2.5m) ($p>0.05$) (Figure 13). There was a significant difference in turbidity concentrations between depths at site LLV-1A in 2001 ($p < 0.05$) (Table 3). Pair wise multiple comparison analysis showed that there was a significant difference between the 0m and 5m depths. There were no other significant differences observed with depth.

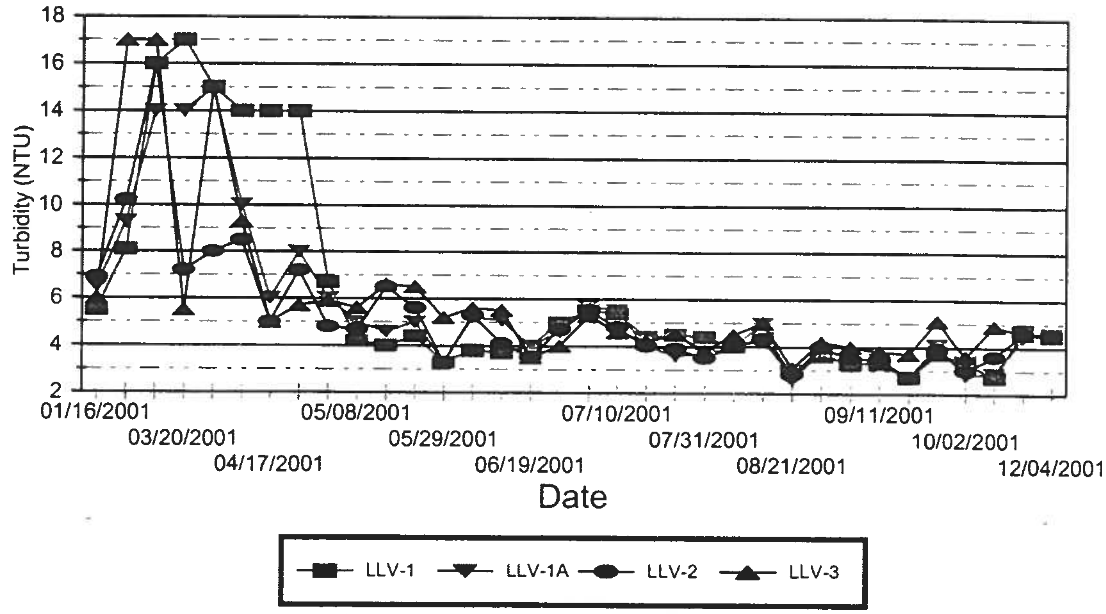


Figure 13. **Lake Las Vegas turbidity concentrations in surface waters (0m) at Lake monitoring stations during 2001.**

C. Chemical Analysis

Total Suspended Solids

Monthly total suspended solids concentrations varied between 2.0 and 26.0 mg/l with no significant differences between sites ($p > 0.05$) (Figure 14). There was an increase in the maximum observed concentration at the surface from 10.0 mg/l (2000) to 26.0 mg/l in 2001. The early year algae bloom and the USACE permitted dredging project on the west end of Lake Las Vegas potentially may have helped in this observed increase in TSS (Figure 14). There were no significant differences in total suspended solids concentrations between depth at site LLV-1A in 2001 ($p > 0.05$) (Figure)

Table 3. Lake Las Vegas BOD5 (mg/l) in surface waters (0 - 2.5m) at Lake Monitoring Stations during 2001

Date	Station	BOD5
3/20/01	LLV-1	7
3/20/01	LLV-2	6
3/20/01	LLV-3	2
6/26/01	LLV-1	3
6/26/01	LLV-2	2
6/26/01	LLV-3	2
9/26/01	LLV-1	3
9/26/01	LLV-2	2
9/26/01	LLV-3	2
12/4/01	LLV-1	2
12/4/01	LLV-2	2
12/4/01	LLV-3	3

Table 4. 2001 Lake Las Vegas chemical concentrations at site LLV-1A during the months of March, June, September, and December at 0, 5, 10 and 20m depths

Date	Depth (m)	BOD5	TDS (mg/l)	TSS (mg/l)	Turb (NTU)	Chl-a (ug/l)	OP (ug/l)	TP (ug/l)	NO2+NO3 (ug/l)	NH4 (ug/l)	TKN (ug/l)	TN (ug/l)	Ca (mg/l)	CL (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	Na (mg/l)	K (mg/l)	Mg (mg/l)
03/20/01	0		2,063	17	14.0	59.9	8	96	1,261	32	2,072	3,333	297	220	82	1,088	176	62	69
03/20/01	5		2,144	5	4.3	7.9	14	25	1,232	29	896	2,128	297	220	76	1,081	181	68	75
03/20/01	10		2,516	4	3.7	3.2	5	22	919	32	896	1,815	361	280	90	1,565	270	93	96
03/20/01	20		2,543	4	4.3	4.2	5	28	889	41	784	1,673	361	275	90	1,388	248	87	3
06/26/01	0		2,514	4	4.6	9.1	1	33	829	36	1,120	1,949	353	285	76	1,453	289	96	101
06/26/01	5		2,506	2	3.5	5.8	1	15	912	32	1,288	2,200	361	280	76	1,420	303	111	108
06/26/01	10		2,479	4	4.2	2.9	1	19	1,103	60	1,008	2,111	337	265	90	1,485	327	117	109
06/26/01	20		2,580	6	4.0	1.9	18	24	1,008	60	1,092	2,100	345	270	94	1,534	299	107	100
09/26/01	0		2,476	4	4.1	3.6	3	24	203	22	1,064	1,267	329	290	70	1,792	265	95	90
09/26/01	5		2,496	3	3.8	3.6	3	30	210	27	1,288	1,498	337	295	70	1,382	291	55	96
09/26/01	10		2,514	2	3.9	3.5	4	22	216	152	1,288	1,504	329	285	76	1,284	269	76	89
09/26/01	20		2,494	1	8.4	2.7	17	44	1	1007	1,008	1,009	329	285	116	1,049	240	85	88
12/04/01	0		2,547	5	4.6	11.4	2	28	250	110	784	1,034	353	305	86	1,359	269	100	99
12/04/01	5		2,517	4	3.9	6.6	3	20	314	125	840	1,154	345	305	86	1,342	290	97	96
12/04/01	10		2,499	3	3.9	4.2	4	19	364	168	1176	1,540	337	305	86	1,428	279	101	91
12/04/01	20		2,492	6	5.3	5.0	2	24	330	148	1176	1,506	337	315	86	1,290	298	98	87

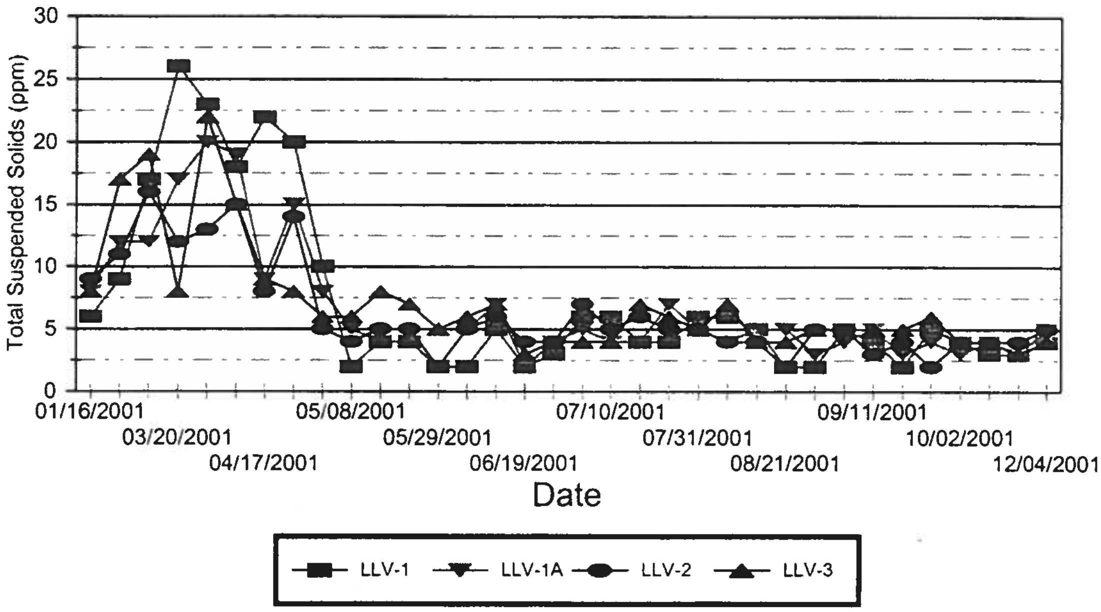


Figure 14. **Lake Las Vegas total suspended solids concentrations in surface waters (0m) at monitoring stations during 2001.**

Total Dissolved Solids

There was no significant difference in monthly total dissolved solids (TDS) concentrations between the four Lake sites ($p > 0.05$) (Figures 15). Monthly concentrations averaged between 2025 and 2643 mg/l at the surface (0-2.5m). Low TDS concentrations of Las Vegas Wash Storm flow in February caused the 400 mg/l decrease in lake water concentrations early in the year. The increase TDS over the course of the rest of the year was due to lake fill being limited to replace evaporation to accommodate the construction of the Ritz Carlton Bridge over the lake. (Figure 3). Lake levels will be returned to normal in 2002 following the completion of lake edge improvements.

Total Dissolved Solids concentrations were not significantly different with depth at site LLV-1A in 2001 ($p > 0.05$) (Table 3).

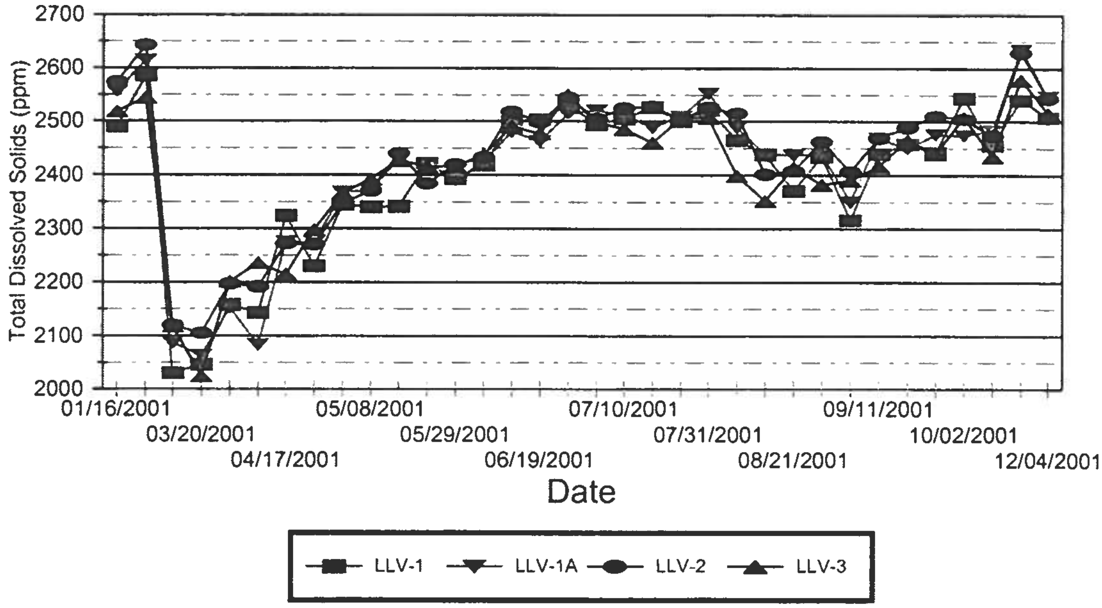


Figure 15. **Lake Las Vegas total dissolved solids concentrations at Lake monitoring station during 2001.**

Major Ion Concentrations

Quarterly depth samples did not vary significantly at site LLV-1A for the ions of calcium, sodium, chloride, potassium, sulfate and magnesium ($p > 0.05$) (Table 3). Quarterly bicarbonate samples did vary significantly ($p < 0.05$). Pair wise multiple comparison analysis showed a significant difference occurred between the 5m and 20m depth. Based on turbidity and TSS concentrations it appears that the 5m depth was below the influence of the surface algal bloom.

Total Phosphorus

Monthly concentrations ranged between 14 and 129 µg/l at the surface (0-2.5m). This is compared to 5 and 87 mg/l last year. As observed in previous years, monthly total phosphorus concentrations exhibited a significant difference between site LLV-3 and sites LLV-1 and LLV-1A, but in 2001 there was no significant difference ($p > 0.005$) (Figure 16). Monthly total phosphorus concentrations varied slightly between depths at site LLV-1A, but were not significantly different ($p > 0.05$) (Table 3).

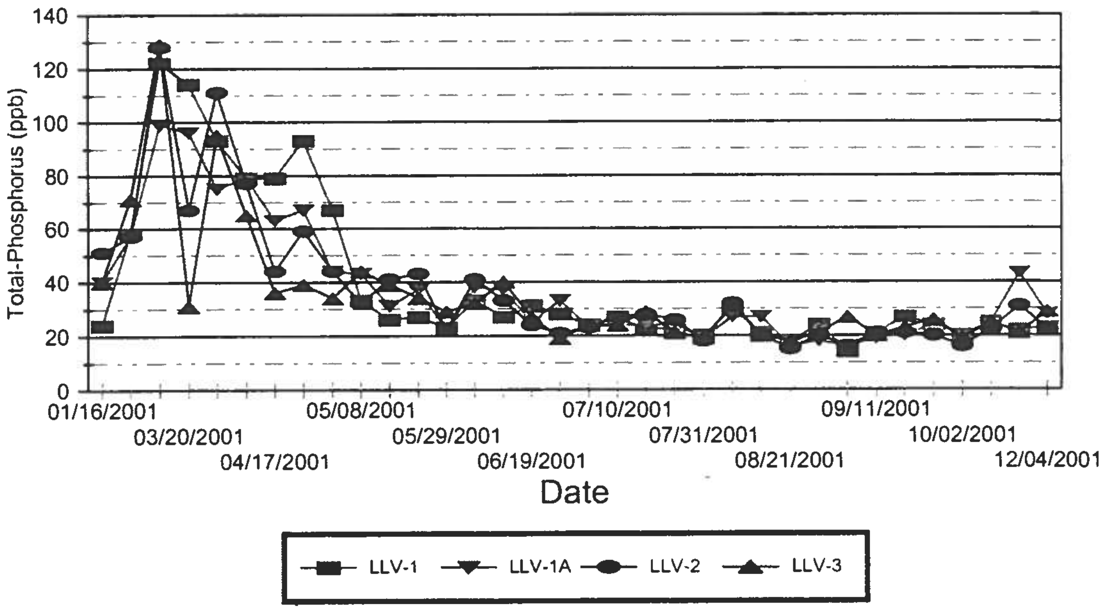


***Figure 16.* Lake Las Vegas total phosphorus concentrations in surface waters (0m) at Lake monitoring sites during 2001.**

Ortho – Phosphorus

Monthly Ortho-phosphorus concentrations did not vary significantly between sites and ranged between 1 and 16 μg/l ($p>0.05$) (Figure 17). Ortho-phosphorus maximums were considerably less than the maximum observed value of 56μg/l in 2000. Monthly ortho-phosphorus concentrations did not show a significant difference between depth. ($p>0.05$) (Table 3).

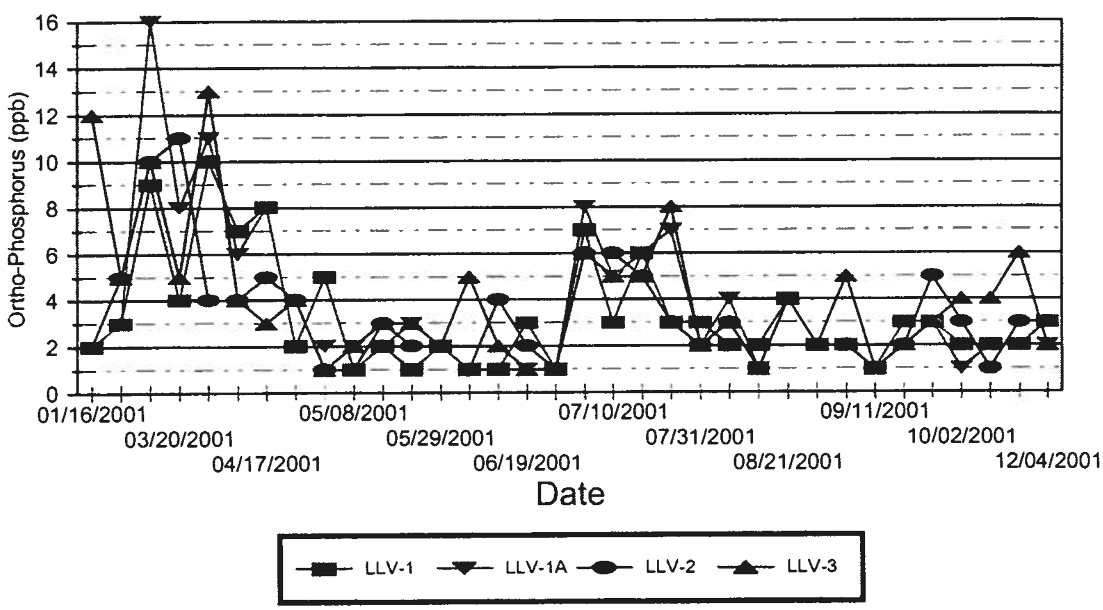


***Figure 17.* Lake Las Vegas ortho – phosphorus concentrations in surface waters (0m) at Lake monitoring stations during 2001.**

Nitrite + Nitrate - Nitrogen

Monthly nitrite plus nitrate surface water concentrations ranged between 167 and 1529 µg/l at the four Lake sites in 2001 with no significant difference ($p > 0.05$) (Figure 18). Monthly nitrite plus nitrate concentrations were not significantly different by site or depth ($p > 0.05$) (Figure 18 and Table 3).

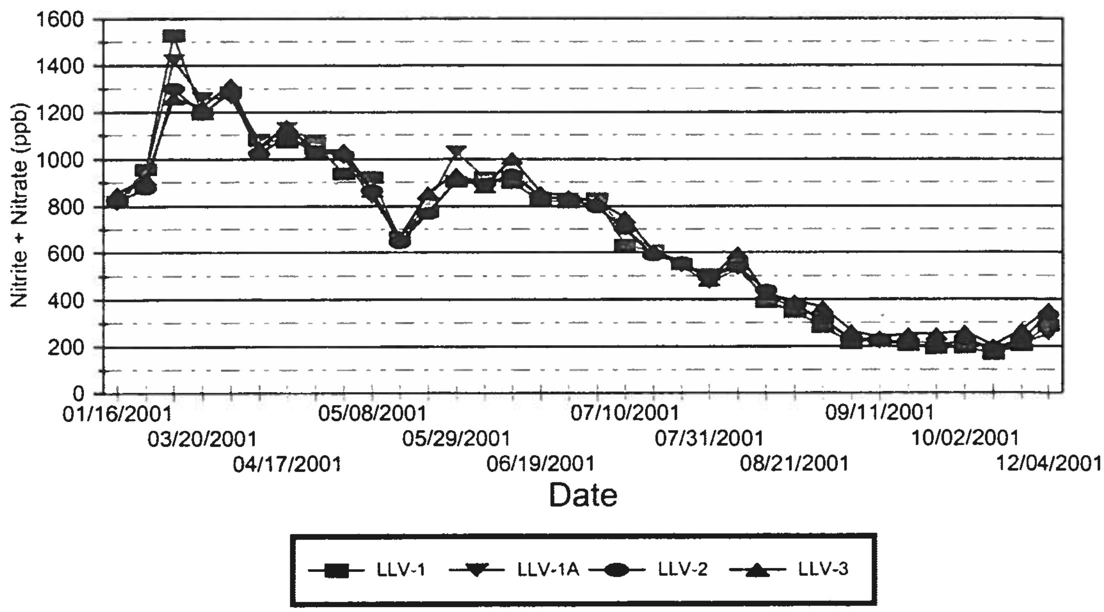


Figure 18. **Lake Las Vegas nitrite + nitrate concentrations in surface waters (0m) at Lake monitoring stations during 2001.**

Ammonia - Nitrogen

Monthly ammonia surface water concentrations ranged between 2.0 to 140 µg/l during 2001, with no significant difference between the four Lake sites ($p > 0.05$) (Figure 19). Concentrations were highest during the late fall turnover period (Figure 19). Variability in concentrations between depths was not found significant for ammonia during 2001 at site LLV-1A ($p > 0.05$) (Table 3).

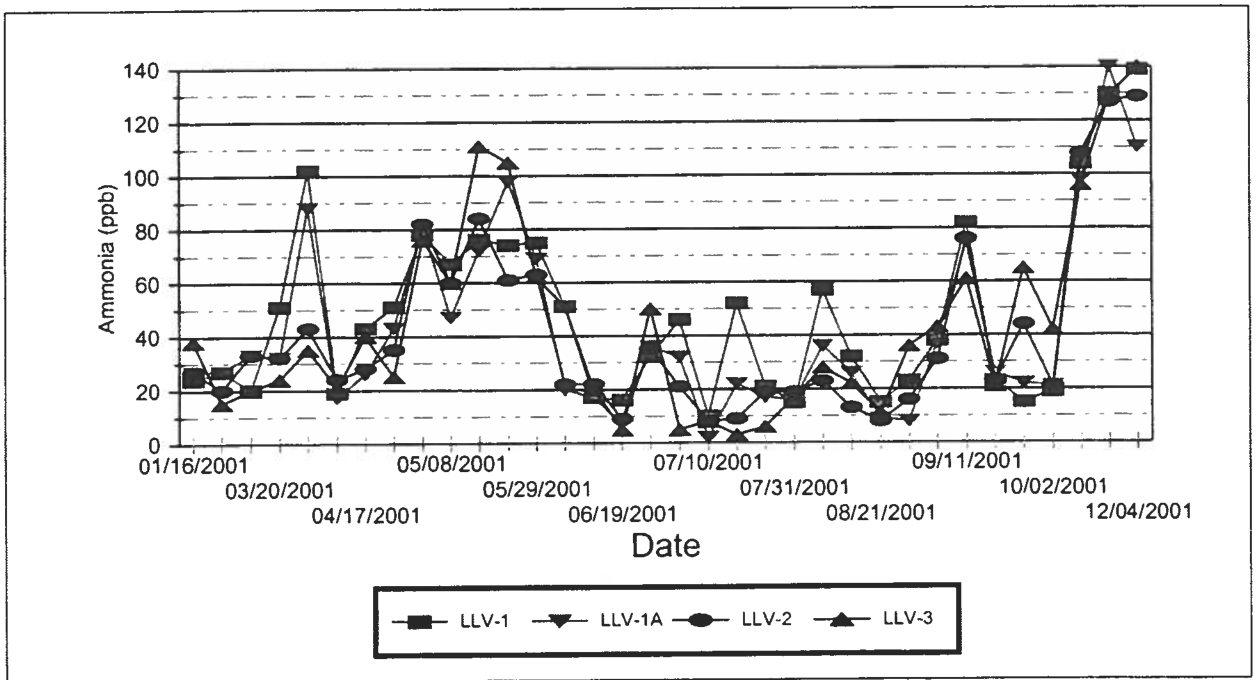


Figure 19. **Lake Las Vegas ammonia-N concentrations in surface waters (0m) at Lake monitoring stations during 2001.**

Total Nitrogen

Monthly total nitrogen concentrations ranged between 258 and 3509 µg/l and were not significantly different between sites ($p>0.05$) (Figure 20) as with the other chemical characteristics sampled total nitrogen concentrations exhibited a declining trend from 2000 to 2001. No significant difference was found between the 0m and 20m depths at site LLV-1A during 2001 ($p> 0.05$).

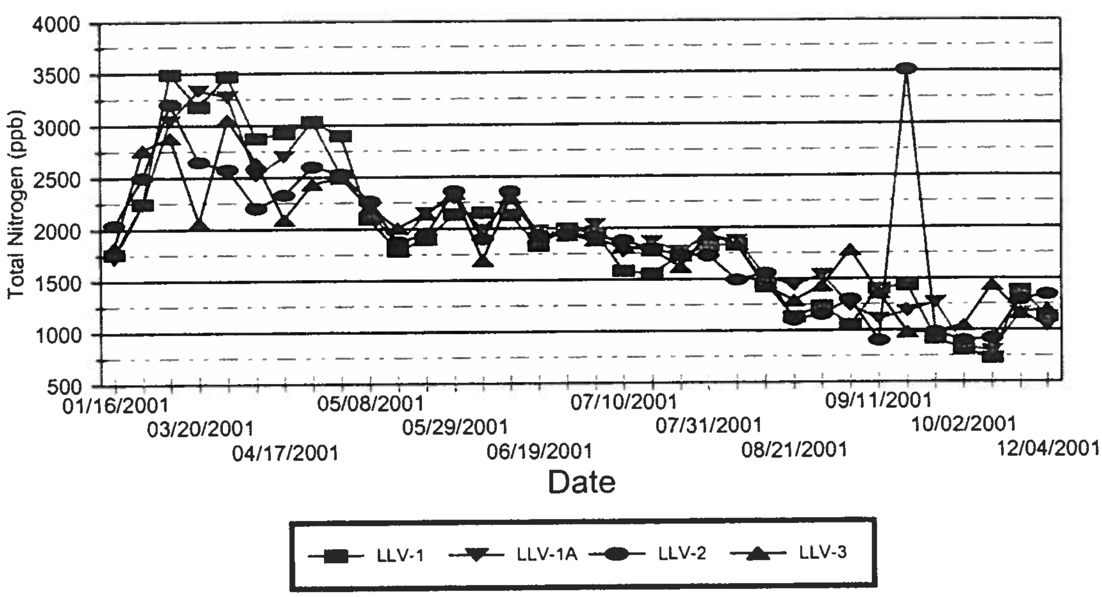


Figure 20. **Lake Las Vegas Total Nitrogen concentrations in surface waters (0m) at Lake monitoring stations during 2001.**

D. Biological Analysis

Zooplankton Species Composition and Abundance

Numerous species of zooplankton have been identified in 0 - 15 m vertical plankton tows at station LLV-1 in 2001 (Table 4). Copepods were the most diverse zooplankton group in the lake with four (4) species, followed by the rotifers with two (2) and cladocerans with one (1) species each. Cladocerans dominated the population with a frequency of (64%), followed by Copepods (35%) and Rotifers (1%) during 2001.

Daphnia pulex and Diaptomus Sp exhibited the greatest average annual average density in 2001 (Table 4). Of the Cladoceran family, *Daphnia pulex and juvenile cladoceran* dominated with average densities of 22,294 and 9,406 adults/m^3. This genus is well known for their ability to control Phytoplankton populations in pelagic zones.

Rotifer densities were very low in respect to the other two families represented. *Brachionus sp.* was most common with an average density of 2,649 adults/m^3 (Table 4).

	No./cu.m	No./cu.m
Species	Average	Total
COPEPODS:		
Diacyclops bicuspidatus	1,382	8,291
Mesocyclops edax	1,266	20,256
Diaptomus sp.	8,700	287,091
Juvenile Copepods	6,809	231,495
Misc. Copepods	4,089	126,752
TOTAL COPEPODS		673,885
CLADOCERANS:		
Daphnia pulex	22,294	780,299
Juvenile Cladocerans	9,406	310,400
Misc. Cladocerans	4,556	141,247
TOTAL CLADOCERANS		1,231,946
ROTIFERS:		
Asplanchna sp.	128	256
Brachionus sp.	2,649	18,546
TOTAL ROTIFERS		18,802

Table 4. Lake Las Vegas zooplankton species identified in the 0 – 15 m vertical plankton tows at station LLV-1 during 2001.

Chlorophyll-a

Compared to a maximum of 21μg/l during 2000chlorophyll-a concentrations in surface waters were ranged from 2.6 to 183μg/l during 2001 (Figure 21). Annual average concentrations were not significantly different between sites ($p>0.05$). Average chlorophyll concentrations were significantly different with depth at site LLV-1A ($p<0.05$) (Figure 21 and Table 3). Pair wise comparison analysis showed that a significant difference occurred between the surface sample (0m) and the 5m, 10m and 20m depths.

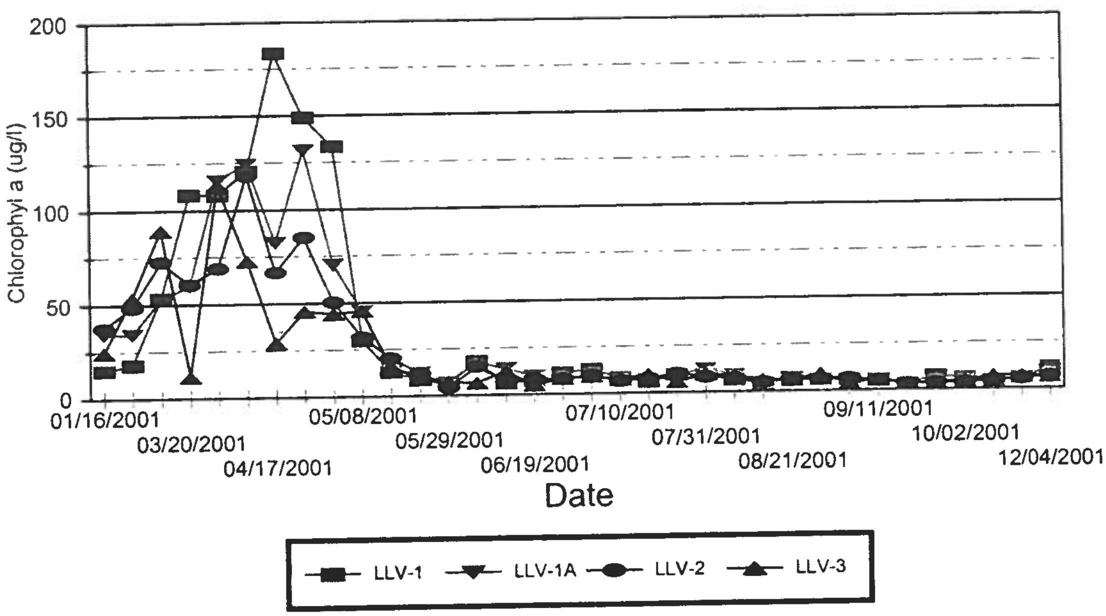


***Figure 21*. Lake Las Vegas chlorophyll "a" concentrations in surface waters (0m) at Lake monitoring stations during 2001.**

Phytoplankton

Six (6) taxonomic divisions of phytoplankton were found at LLV-1 during 2001 (Table 5). By abundance the most frequently observed division was *Cyanophyta* in 2001 (78%) (Figure 22). The remaining four divisions, *Bacillariophyta (1%)*, *Cryptophyta (1%)*, *Pyrrhophyta (0%)*, and *Chlorophyte (20%), and Chrysophyta (1%)*, were distributed in relation to *Cyanophyta* during the year. (Figure 22). In contrast by biomass the most frequently observed division was Chlorophyta at (93%). Cyanophyta only represented (2%) of the total algae biomass in 2001. *Pyramichlamys sp.* (formally identified as *Platymonas eliptica* in previous years) represented the greatest producer of algae biomass at Lake Las Vegas. This is the same species that caused such great problems at Lake Mead in 2001.

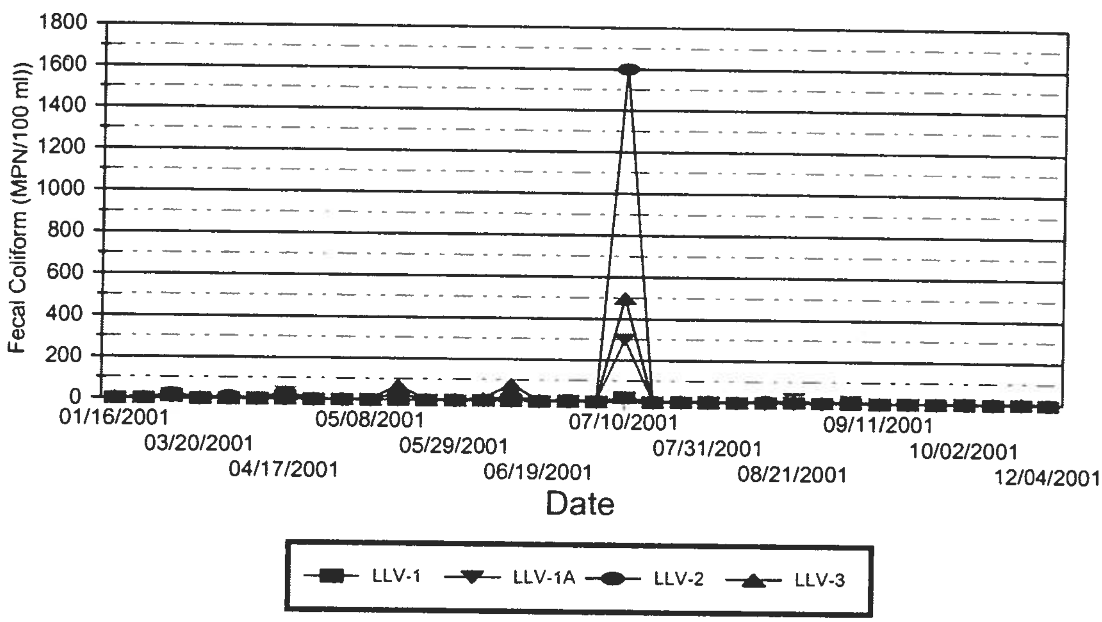
Date	Division	Station	Genus/Species	Abundance Cells/mL	Biomass mg/m3
6/26/01	Bacillariophyta (Diatoms)	LLV-1	*Cyclotella sp.*	375	46
9/26/01	Bacillariophyta (Diatoms)	LLV-1	*Anomoeoneis vitrea*	83	66
9/26/01	Bacillariophyta (Diatoms)	LLV-1	*Cyclotella sp.*	1,417	264
9/26/01	Bacillariophyta (Diatoms)	LLV-1	*Nitzschia sp.*	83	42
12/4/01	Bacillariophyta (Diatoms)	LLV-1	*Nitzchia sp.*	21	10
			Average	396	86
			Total	1,979	428
			%Freq	1	3
3/20/01	Chlorophyta (Greens)	LLV-1	*Ankistrodesmus falcatus*	83	2
3/20/01	Chlorophyta (Greens)	LLV-1	*Pyramichlamys sp.*	45,458	10,155
6/26/01	Chlorophyta (Greens)	LLV-1	*Botryococcus braunii*	3,167	71
6/26/01	Chlorophyta (Greens)	LLV-1	*Pyramichlamys sp.*	2,583	568
9/26/01	Chlorophyta (Greens)	LLV-1	*Ankyra judayi*	42	4
9/26/01	Chlorophyta (Greens)	LLV-1	*Chlamydomonas sp.*	213	43
9/26/01	Chlorophyta (Greens)	LLV-1	*Dictyosphaerium pulchellum*	425	2
9/26/01	Chlorophyta (Greens)	LLV-1	*Pyramichlamys sp.*	667	142
9/26/01	Chlorophyta (Greens)	LLV-1	*Sphaerocystis schroeteri*	167	14
12/4/01	Chlorophyta (Greens)	LLV-1	*Pyramichlamys sp.*	3,688	783
			Average	5,649	1,178
			Total	56,491	11,784
			%Freq	20	93
3/20/01	Chrysophyta (Goldens)	LLV-1	*Chrysochromulina parva*	167	5
6/26/01	Chrysophyta (Goldens)	LLV-1	*Chrysochromulina parva*	333	10
9/26/01	Chrysophyta (Goldens)	LLV-1	*Chrysochromulina parva*	2,338	66
12/4/01	Chrysophyta (Goldens)	LLV-1	*Chrysochromulina parva*	63	2
			Average	725	21
			Total	2,900	82
			%Freq	1	1
3/20/01	Cryptophyta (Cryomonads)	LLV-1	*Rhodomonas minuta*	583	36
6/26/01	Cryptophyta (Cryomonads)	LLV-1	*Rhodomonas minuta*	250	16
9/26/01	Cryptophyta (Cryomonads)	LLV-1	*Cryptomonas spp.*	208	21
9/26/01	Cryptophyta (Cryomonads)	LLV-1	*Katablepharis ovalis*	213	3
9/26/01	Cryptophyta (Cryomonads)	LLV-1	*Rhodomonas minuta*	167	10
12/4/01	Cryptophyta (Cryomonads)	LLV-1	*Katablepharis ovalis*	21	0
12/4/01	Cryptophyta (Cryomonads)	LLV-1	*Rhodomonas minuta*	146	9
			Average	227	14
			Total	1,587	95
			%Freq	1	1
3/20/01	Cyanophyta (Bluegreens)	LLV-1	*Aphanocapsa delicatissima*	2,667	1
6/26/01	Cyanophyta (Bluegreens)	LLV-1	*Aphanocapsa delicatissima*	6,667	1
6/26/01	Cyanophyta (Bluegreens)	LLV-1	*Merismopedia minima*	333	0
6/26/01	Cyanophyta (Bluegreens)	LLV-1	*Oscillatoria sp.***	42	21
9/26/01	Cyanophyta (Bluegreens)	LLV-1	*Aphanizomenon flos aquae*	125	91
9/26/01	Cyanophyta (Bluegreens)	LLV-1	*Chroococcus dispersus*	86,700	17
9/26/01	Cyanophyta (Bluegreens)	LLV-1	*Coelosphaerium pallidum*	8,000	3
9/26/01	Cyanophyta (Bluegreens)	LLV-1	*Dactylococcopsis acicularis*	213	5
9/26/01	Cyanophyta (Bluegreens)	LLV-1	*Merismopedia minina*	1,700	1
9/26/01	Cyanophyta (Bluegreens)	LLV-1	*Microcystis incerta*	107,458	22
9/26/01	Cyanophyta (Bluegreens)	LLV-1	*Oscillatoria limnetica*	250	19
9/26/01	Cyanophyta (Bluegreens)	LLV-1	*Phormidium sp.*	83	4
12/4/01	Cyanophyta (Bluegreens)	LLV-1	*Aphanocapsa delicatissima*	11,083	4
12/4/01	Cyanophyta (Bluegreens)	LLV-1	*Oscillatoria angustissima***	21	1
			Average	16,096	14
			Total	225,342	190
			%Freq	78	2
9/26/01	Pyrrhophyta (Dinoflagellates)	LLV-1	*Glenodinium pulvisculus*	42	15
9/26/01	Pyrrhophyta (Dinoflagellates)	LLV-1	*Peridinium wisconsinense*	6	6
12/4/01	Pyrrhophyta (Dinoflagellates)	LLV-1	*Gymnodinium sp.*	104	6
			Average	51	9
			Total	152	27

Table 5. Lake Las Vegas phytoplankton species identified in the 0 – 15 m vertical plankton tows at station LLV-1 during 2001.

Bacteria

Fecal coliform monitoring was completed on a monthly basis at Lake sites LLV-1, LLV-2, and LLV-3 in 2001 during the months of November through May. In 2001, bacteria sampling frequency was completed weekly during the months of April through October due to increased recreational use. Fecal coliform counts in surface waters were typically at or below detection limits during each quarter of 2001 with an exception in the month of July. There is no reasonable explanation for this spike in concentrations. (Figure 22).

Figure 22. Lake Las Vegas fecal coliform counts (MPN/100ml) in surface waters (0-2.5m) at Lake monitoring stations during 2001.



Toxic Substances

Water samples for toxic analysis were collected from the surface (0m) and bottom (1m from bottom) of station LLV-1 during December 2001, when the lake was completely mixed. These samples were analyzed at the National Testing Laboratory in Cleveland, Ohio for toxic metals, trihalomethanes, pesticides, herbicides, PCBs, and various other organic and inorganic chemicals. Trace metal concentrations were well below the recommended MCLs. Concentrations of pesticides, herbicides and other toxic organic compounds also were below levels of detection. (Appendix C).

IV. SUMMARY

The water quality in Lake Las Vegas was within the proposed water quality guidelines for recreational uses. Average chlorophyll-a concentrations were at or below the proposed guideline of five- (5) μg/l during the April - September growing season. The chlorophyll-a guideline is applied at that time of year to protect water quality during the peak recreation period. Fecal coliform concentrations were below the body contact standards concentrations of toxic metals, pesticides, herbicides and other toxic organic compounds were at or below detection limits. Except for total dissolved solids and its related ions, water quality in Lake Las Vegas continues to be very good. Total dissolved solids in Lake Las Vegas exceeded the proposed guideline of 2000 mg/l all of 2001. The total dissolved solids guideline was established to keep salinity in the Lake at levels acceptable for irrigation. The project was designed so lake water can be withdrawn for on-site irrigation. Evaporation will continue to increase total dissolved solids until ions reach saturation and precipitate, or are diluted by inflows from Lake Mead. It will take several years for development to reach the point where irrigation demands are sufficient to keep total dissolved solids in the Lake at acceptable levels. Currently, water drawn from the Lake for irrigation is blended with Lake Mead water to dilute the total dissolved solids concentrations for Lake Las Vegas current three golf courses.

In November 1996, Lake Las Vegas was issued a NPDES Discharge Permit to release 2,500-acre feet of Lake water per year from the dam. This permit was acquired to facilitate the recommended water quality plan indicated in the Clark County 208 Water Quality Management Plan. Since 1992 Lake Las Vegas has released approximately two thousand seven hundred (2700) acre-feet of Lake water to the Las Vegas Wash for water quality purposes.

2001 proved a challenging year for Lake Management due to the heavy algae blooms early in the year. Lake Las Vegas staff work closely with the Lake Mead Water Quality Forum to determine the environmental conditions that prompted such a bloom in both Lake Las Vegas and Lake Mead. To date there are a number of theories, but no one answer to why has been agreed to by the experts.

IV. REFERENCES

208 Amendment for the City of Henderson - Lake at Las Vegas Project. Transcontinental Properties/City of Henderson. March 1988.

Methods for Biological, Chemical and Physical Analyses in Lakes and Reservoirs. Suzanne Leavitt, Michele Salas, Larry J. Paulson and Marcia Schmeltzer. West Lakes. Las Vegas, NV. August 1990.

VI. APPENDIX

Table of Drinking Water Analysis

DATE COLLECTED	DATE RECEIVED	DATE COMPLETED	SAMPLE CODE
12/04/01	12/07/01	12/20/01	41531

NATIONAL TESTING LABORATORIES LTD.
6555 Wilson Mills Road
Cleveland, OH 44143
(440) 449-2525

DRINKING WATER ANALYSIS RESULTS

CUSTOMER ADDRESS

DEALER ADDRESS
WEST LAKES LAB
2545 CHANDLER AVE.
SUITE 8
LAS VEGAS, NV 89120-

ID: LLV-1A 20M
WELL WATER

NOTE:
- "*" The MCL (Maximum Contaminant Level) or an established guideline has been exceeded for this contaminant.
- "**" Bacteria results may be invalid due to lack of collection information or because the sample has exceeded the 30-hour holding time.
- "ND" This contaminant was not detected at or above our stated detection level.
- "NBS" No bacteria submitted.
- "P" = PRESENCE
- "EP" = E. COLI PRESENCE
- "NA" Not Analyzed
- "NBR" No Bacteria Required.
- "A" = ABSENCE
- "EA" = E. COLI ABSENCE

Analysis Performed	MCL (mg/l)	Det. Level	Level Detected
Total coliform	P	P	NBS
Inorganic chemicals - metals:			
Aluminum	0.2	0.1	ND
Arsenic	0.05	0.010	0.015
Barium	2	0.30	ND
Cadmium	0.005	0.002	ND
Chromium	0.1	0.010	ND
Copper	1.3	0.004	0.005
Iron	0.3	0.020	0.037
Lead	0.015	0.002	ND
Manganese	0.05	0.004	0.013
Mercury	0.002	0.001	ND
Nickel	0.1	0.02	ND
Selenium	0.05	0.020	ND
Silver	0.1	0.002	ND
Sodium	---	1.0	250
Zinc	5	0.004	0.006
Inorganic chemicals - other, and physical factors:			
Alkalinity (Total as CaCO3)	---	20	78
Chloride	250	5.0	280*
Fluoride	4	0.5	1.3
Nitrate as N	10	0.5	ND
Nitrite as N	1	0.5	ND
Sulfate	250	5.0	1100*
Hardness (suggested limit = 100)		10	1300*
pH (Standard Units)	6.5-8.5	---	7.8
Total Dissolved Solids	500	20	2200*
Turbidity (Turbidity Units)	1.0	0.1	1.0
Organic chemicals - trihalomethanes:			
Bromoform	0.080	0.004	ND
Bromodichloromethane	0.080	0.002	ND
Chloroform	0.080	0.002	ND
Dibromochloromethane	0.080	0.004	ND
Total THMs	0.080	0.002	ND

Analysis performed	MCL (mg/l)	Detection Level	Level Detected
Benzene	0.005	0.001	ND
Vinyl Chloride	0.002	0.001	ND
Carbon Tetrachloride	0.005	0.001	ND
1,2-Dichloroethane	0.005	0.001	ND
Trichloroethene	0.005	0.001	ND
1,4 Dichlorobenzene	0.075	0.001	ND
1,1-Dichloroethene	0.007	0.001	ND
1,1,1,-Trichloroethane	0.2	0.001	ND
Bromobenzene	---	0.002	ND
Bromomethane	---	0.002	ND
Chlorobenzene	0.1	0.001	ND
Chloroethane	---	0.002	ND
Chloromethane	---	0.002	ND
2-Chlorotoluene	---	0.001	ND
4-Chlorotoluene	---	0.001	ND
Dibromochloropropane (DBCP)	---	0.001	ND
Dibromomethane	---	0.002	ND
1,2-Dichlorobenzene	0.6	0.001	ND
1,3-Dichlorobenzene	0.6	0.001	ND
Dichlorodifluoromethane	---	0.002	ND
1,1-Dichloroethane	---	0.002	ND
Trans-1,2-Dichloroethene	0.1	0.002	ND
cis-1,2-Dichloroethene	0.07	0.002	ND
Dichloromethane	0.005	0.002	ND
1,2-Dichloropropane	0.005	0.002	ND
trans-1,3-Dichloropropene	---	0.002	ND
cis-1,3-Dichloropropene	---	0.002	ND
2,2-Dichloropropane	---	0.002	ND
1,1-Dichloropropene	---	0.002	ND
1,3-Dichloropropane	---	0.002	ND
Ethylbenzene	0.7	0.001	ND
Ethylenedibromide (EDB)	---	0.001	ND
Styrene	0.1	0.001	ND
1,1,1,2-Tetrachloroethane	---	0.002	ND
1,1,2,2-Tetrachloroethane	---	0.002	ND
Tetrachloroethene (PCE)	0.005	0.002	ND
1,2,4-Trichlorobenzene	0.07	0.002	ND
1,2,3-Trichlorobenzene	---	0.002	ND
1,1,2-Trichloroethane	0.005	0.002	ND
Trichlorofluoromethane	---	0.002	ND
1,2,3-Trichloropropane	---	0.002	ND
Toluene	1	0.001	ND
Xylene	10	0.001	ND
Methyl-Tert-Butyl-Ether	---	0.004	ND

Organic chemicals - pesticides, herbicides and PCBs

Alachlor	0.002	0.001	ND
Atrazine	0.003	0.002	ND
Chlordane	0.002	0.001	ND
Aldrin	---	0.002	ND
Dichloran	---	0.002	ND
Dieldrin	---	0.001	ND
Endrin	0.002	0.0001	ND
Heptachlor	0.0004	0.0004	ND
Heptachlor Epoxide	0.0002	0.0001	ND
Hexachlorobenzene	0.001	0.0005	ND
Hexachlorocyclopentadiene	0.05	0.001	ND
Lindane	0.0002	0.0002	ND
Methoxychlor	0.04	0.002	ND
PCBs	0.0005	0.0005	ND
Pentachloronitrobenzene	---	0.002	ND
Silvex(2,4,5-TP)	0.05	0.005	ND
Simazine	0.004	0.002	ND
Toxaphene	0.003	0.001	ND
Trifluralin	---	0.002	ND
2,4-D	0.07	0.010	ND

I certify that the analyses performed for this report are accurate, and that the laboratory tests were conducted by methods approved by the U.S. Environmental Protection Agency or variations of these EPA methods.

These test results are intended to be used for informational purposes only and may not be used for regulatory compliance.

Deborah J Slusher

DEBORAH J. SLUSHER

DATE COLLECTED	DATE RECEIVED	DATE COMPLETED	SAMPLE CODE
12/04/01	12/07/01	12/20/01	41532

NATIONAL TESTING LABORATORIES LTD.
6555 Wilson Mills Road
Cleveland, OH 44143
(440) 449-2525

CUSTOMER ADDRESS

DEALER ADDRESS
WEST LAKES LAB
2545 CHANDLER AVE.
SUITE 8
LAS VEGAS, NV 89120-

DRINKING WATER ANALYSIS RESULTS

ID: LLV-1A OM

NOTE:
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- "A" = ABSENCE
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- "EA" = E. COLI ABSENCE
- "NA" Not Analyzed

Analysis Performed	MCL (mg/l)	Det. Level	Level Detected
Total coliform	P	P	NBS
Inorganic chemicals - metals:			
Aluminum	0.2	0.1	ND
Arsenic	0.05	0.010	0.022
Barium	2	0.30	ND
Cadmium	0.005	0.002	ND
Chromium	0.1	0.010	ND
Copper	1.3	0.004	ND
Iron	0.3	0.020	ND
Lead	0.015	0.002	ND
Manganese	0.05	0.004	0.019
Mercury	0.002	0.001	ND
Nickel	0.1	0.02	ND
Selenium	0.05	0.020	ND
Silver	0.1	0.002	ND
Sodium	---	1.0	240
Zinc	5	0.004	0.006
Inorganic chemicals - other, and physical factors:			
Alkalinity (Total as CaCO3)	---	20	88
Chloride	250	5.0	280*
Fluoride	4	0.5	1.2
Nitrate as N	10	0.5	ND
Nitrite as N	1	0.5	ND
Sulfate	250	5.0	1100*
Hardness (suggested limit = 100)		10	1300*
pH (Standard Units)	6.5-8.5	---	7.9
Total Dissolved Solids	500	20	2200*
Turbidity (Turbidity Units)	1.0	0.1	1.5*
Organic chemicals - trihalomethanes:			
Bromoform	0.080	0.004	ND
Bromodichloromethane	0.080	0.002	ND
Chloroform	0.080	0.002	ND
Dibromochloromethane	0.080	0.004	ND
Total THMs	0.080	0.002	ND

Analysis performed	MCL (mg/l)	Detection Level	Level Detected
Benzene	0.005	0.001	ND
Vinyl Chloride	0.002	0.001	ND
Carbon Tetrachloride	0.005	0.001	ND
1,2-Dichloroethane	0.005	0.001	ND
Trichloroethene	0.005	0.001	ND
1,4-Dichlorobenzene	0.075	0.001	ND
1,1-Dichloroethene	0.007	0.001	ND
1,1,1,-Trichloroethane	0.2	0.001	ND
Bromobenzene	---	0.002	ND
Bromomethane	---	0.002	ND
Chlorobenzene	0.1	0.001	ND
Chloroethane	---	0.002	ND
Chloromethane	---	0.002	ND
2-Chlorotoluene	---	0.001	ND
4-Chlorotoluene	---	0.001	ND
Dibromochloropropane (DBCP)	---	0.001	ND
Dibromomethane	---	0.002	ND
1,2-Dichlorobenzene	0.6	0.001	ND
1,3-Dichlorobenzene	0.6	0.001	ND
Dichlorodifluoromethane	---	0.002	ND
1,1-Dichloroethane	---	0.002	ND
Trans-1,2-Dichloroethene	0.1	0.002	ND
cis-1,2-Dichloroethene	0.07	0.002	ND
Dichloromethane	0.005	0.002	ND
1,2-Dichloropropane	0.005	0.002	ND
trans-1,3-Dichloropropene	---	0.002	ND
cis-1,3-Dichloropropene	---	0.002	ND
2,2-Dichloropropane	---	0.002	ND
1,1-Dichloropropene	---	0.002	ND
1,3-Dichloropropane	---	0.002	ND
Ethylbenzene	0.7	0.001	ND
Ethylenedibromide (EDB)	---	0.001	ND
Styrene	0.1	0.001	ND
1,1,1,2-Tetrachloroethane	---	0.002	ND
1,1,2,2-Tetrachloroethane	---	0.002	ND
Tetrachloroethene (PCE)	0.005	0.002	ND
1,2,4-Trichlorobenzene	0.07	0.002	ND
1,2,3-Trichlorobenzene	---	0.002	ND
1,1,2-Trichloroethane	0.005	0.002	ND
Trichlorofluoromethane	---	0.002	ND
1,2,3-Trichloropropane	---	0.002	ND
Toluene	1	0.001	ND
Xylene	10	0.001	ND
Methyl-Tert-Butyl-Ether	---	0.004	ND
Organic chemicals - pesticides, herbicides and PCBs			
Alachlor	0.002	0.001	ND
Atrazine	0.003	0.002	ND
Chlordane	0.002	0.001	ND
Aldrin	---	0.002	ND
Dichloran	---	0.002	ND
Dieldrin	---	0.001	ND
Endrin	0.002	0.0001	ND
Heptachlor	0.0004	0.0004	ND
Heptachlor Epoxide	0.0002	0.0001	ND
Hexachlorobenzene	0.001	0.0005	ND
Hexachlorocyclopentadiene	0.05	0.001	ND
Lindane	0.0002	0.0002	ND
Methoxychlor	0.04	0.002	ND
PCBs	0.0005	0.0005	ND
Pentachloronitrobenzene	---	0.002	ND
Silvex(2,4,5-TP)	0.05	0.005	ND
Simazine	0.004	0.002	ND
Toxaphene	0.003	0.001	ND
Trifluralin	---	0.002	ND
2,4-D	0.07	0.010	ND

I certify that the analyses performed for this report are accurate, and that the laboratory tests were conducted by methods approved by the U.S. Environmental Protection Agency or variations of these EPA methods.

These test results are intended to be used for informational purposes only and may not be used for regulatory compliance.

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