1998 LAKE LAS VEGAS WATER QUALITY MONITORING REPORT

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Submitted to:

Nevada Division of Environmental Protection
(NDEP)

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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 2243 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 ultimately will consist of six hotels, four 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 and a tourist population of 20,000.

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 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 1200 cubic feet per second (cfs). Flows currently average approximately 225 cubic feet second in the LVW in 1998.

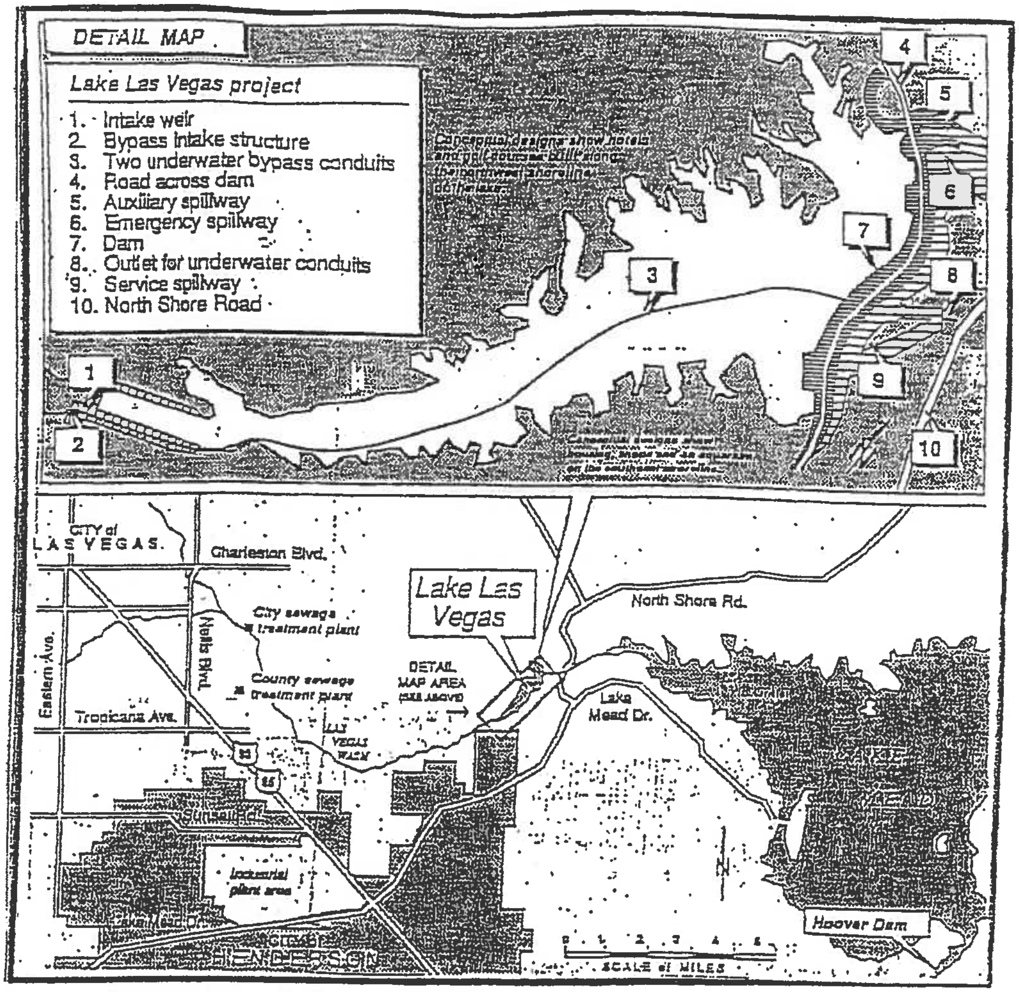

Figure 1. **Location and description of Lake Las Vegas Resort (Las Vegas Review Journal map by Jim Day July 28, 1999)**

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.

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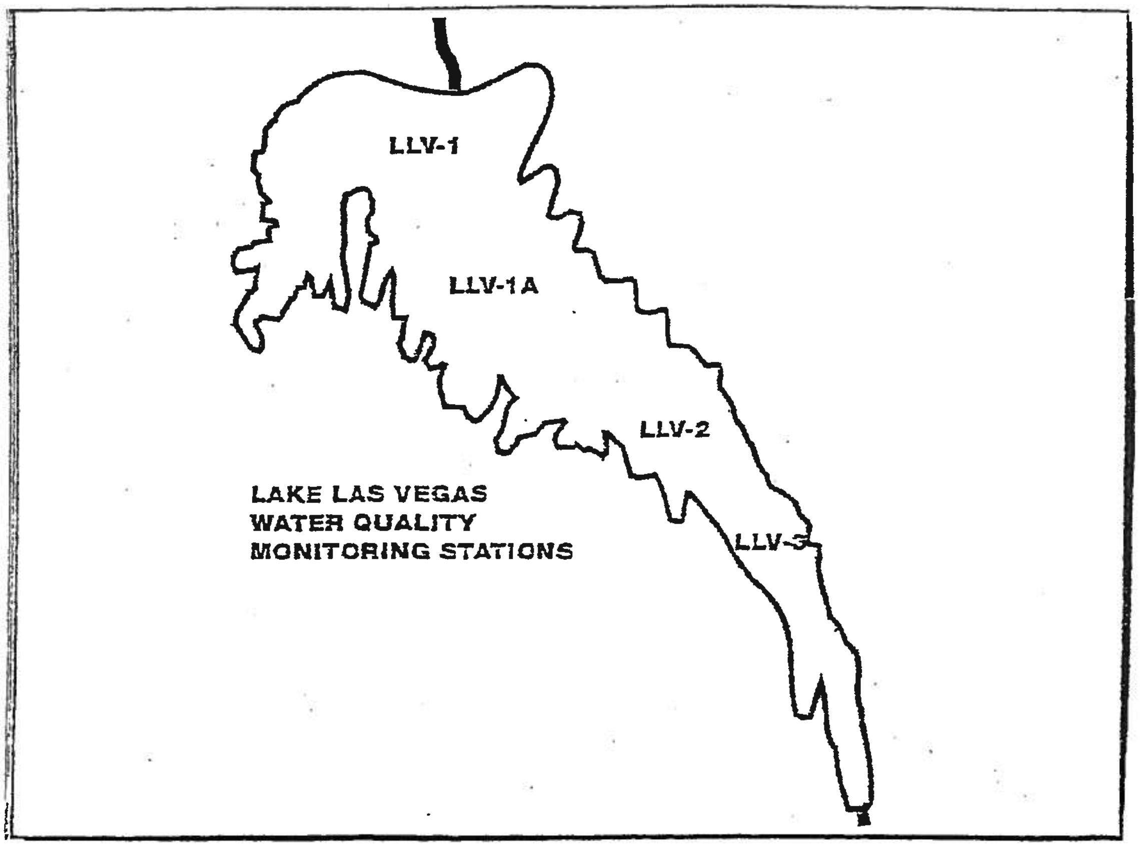

***Figure* 2. Location of water quality monitoring stations at Lake Las Vegas.**

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 or a Solomat 4007 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. 1998 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

Depth integrated 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 1998 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 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.

E. Water Quality Guidelines

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 7.09.0 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 three thousand two hundred nineteen (3,219) acre-feet during 1998. Lake elevation increased from 1402.3 feet in January 1998 to 1403.1 feet at the end of December 1998 (Figure 3). Two thousand two hundred sixty (2,260) acre-feet of lake water was lost to seepage/evaporation.

Two thousand one hundred thirty nine (2,139) acre-feet of stormwater was harvested during 1998. Lake Las Vegas released six hundred seventy four (674) acre-feet of water from the Lake during the months of February, March and September 1998. An additional five thousand six hundred forty eight (5,648) acre-feet of stormwater spilled over the dam's spillways during the September 11, 1998 stormevent. All releases from the dam were performed under the guise of dam management as opposed to water quality management (related to storm events).

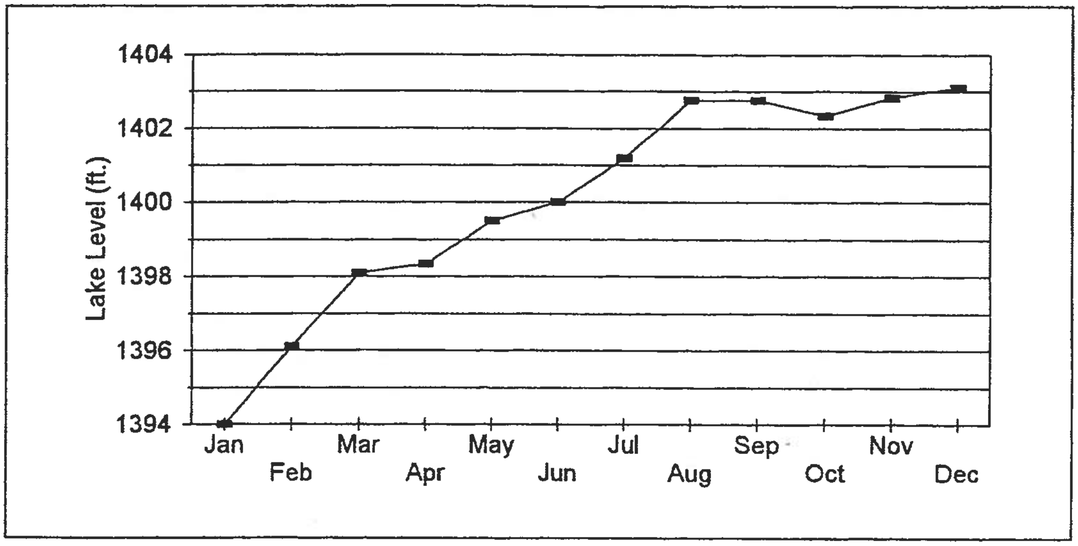

Figure 3. **1998 Lake Las Vegas surface elevations.**

B. Physical Analysis

Temperature

Surface temperatures in Lake Las Vegas ranged from 8.6°C to 29°C during 1998, 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). Storm flows significantly influenced the Lakes stratification in 1998 as reflected by the influence of thermal stratification during three of four quarters. February and September storms accounted for this phenomenon. The Lake remained stratified during the summer months, but the large volume of stormwater that entered the Lake weakened the nature of the spring and early fall profiles.

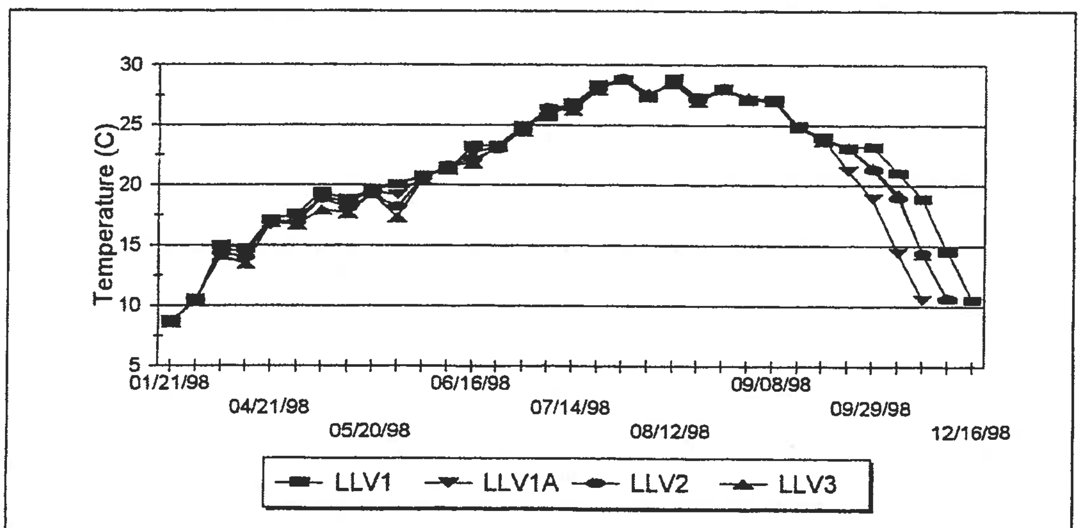

Figure 4. **Surface temperature measurements at Lake Las Vegas monitoring stations LLV-1, LLV-1A, LLV-2, LLV-3 in 1998.**

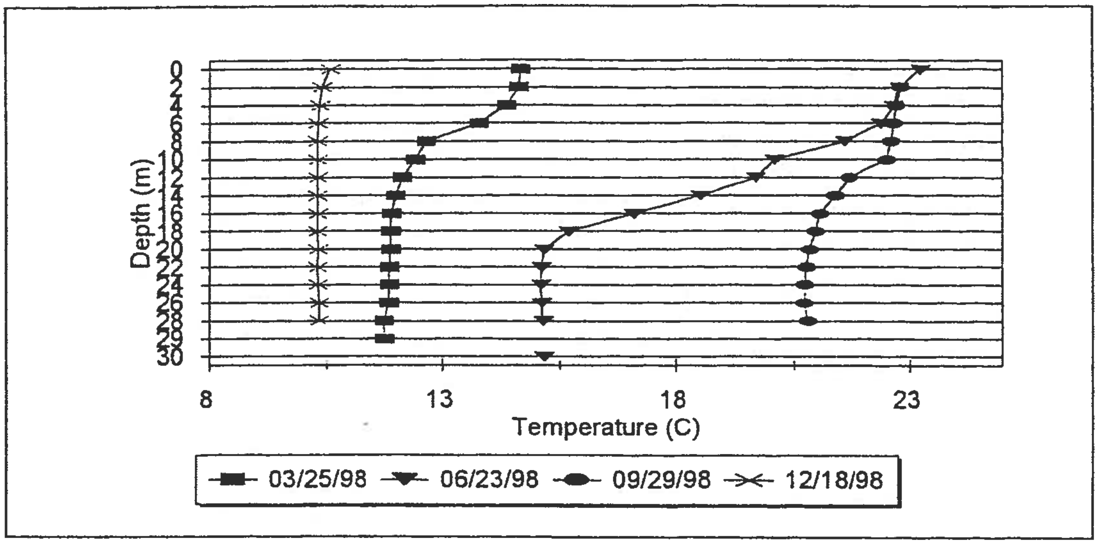

Figure 5. **Lake Las Vegas temperature profiles at Lake monitoring station LLV-1A during March, June, September, and December 1998.**

Dissolved Oxygen

Dissolved Oxygen concentrations at the lake surface had slight variations between sites throughout the year (Figure 6). Concentration ranged from approximately 6.0 to 15.4 mg/l. Concentrations both at the Lake's surface and depth exhibited the common dissolved oxygen trends found within dimictic lakes that stratify (Figure7).

The Lake remained relatively well mixed during the late fall through late spring with concentrations ranging from 9-10 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).

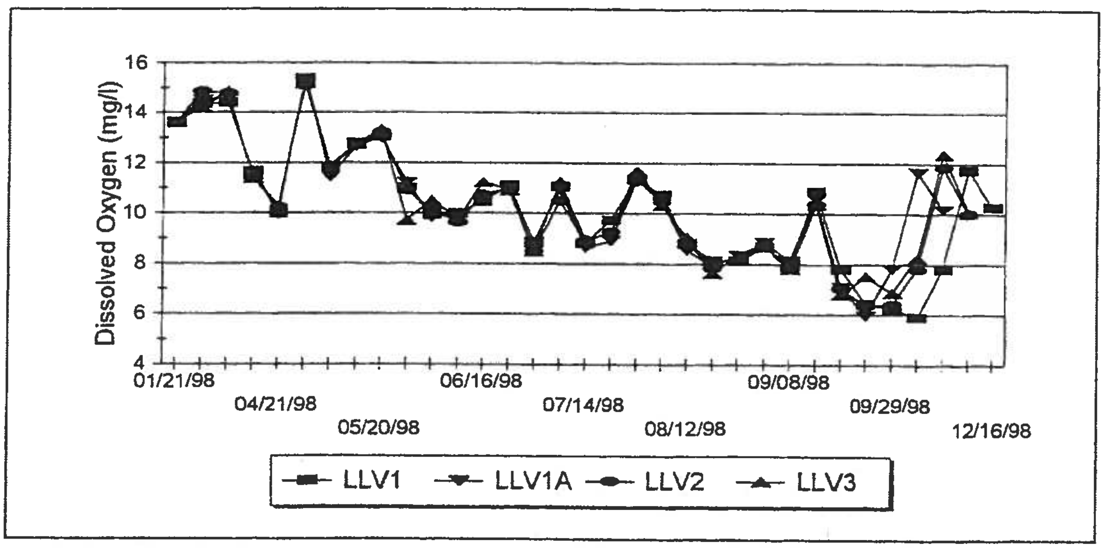

Figure 6. **Lake Las Vegas dissolved oxygen in surface waters (0m) at Lake monitoring stations during January – December 1998.**

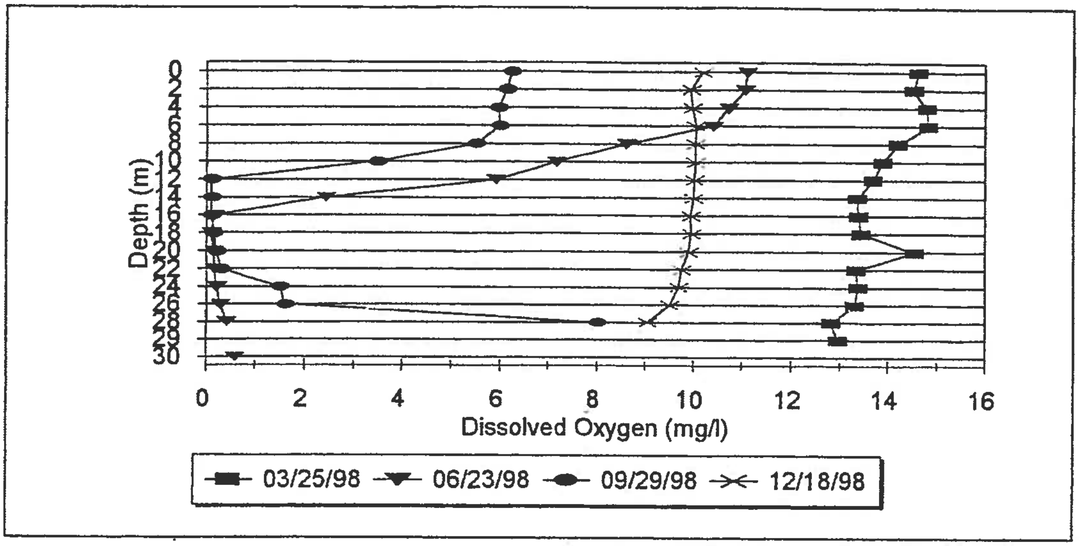

Figure 7. **Lake Las Vegas dissolved oxygen profiles at station LLV-1A during March, June, September, and December 1998.**

pH

There was some seasonal variation in pH of surface waters in Lake Las Vegas during 1998 (Figure 8). Surface water pH values varied slightly between the four Lake sites ranging between 7.4 and 8.5 in 1998 (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 declined with the onset of anaerobic conditions (Figure 9).

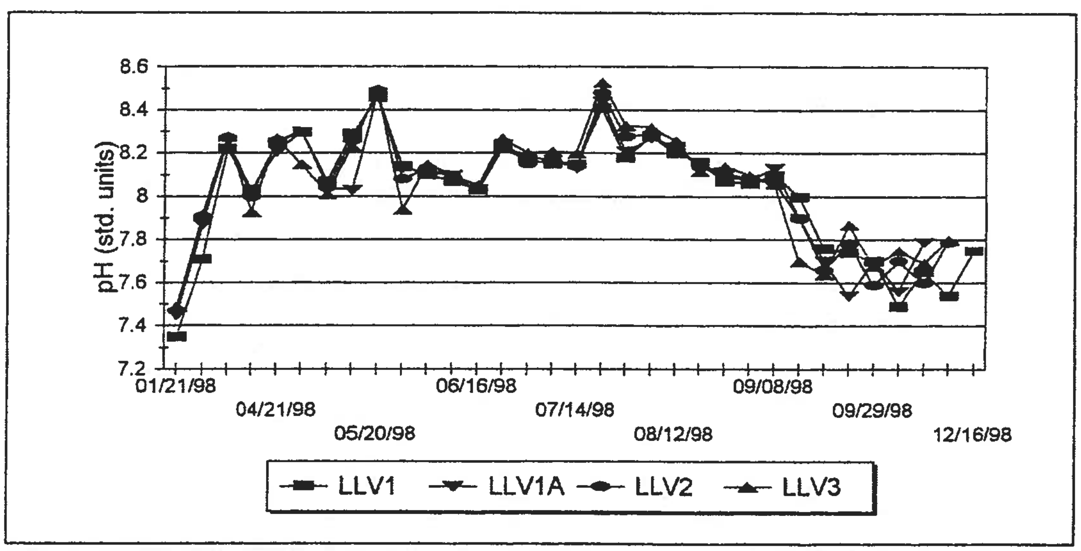

Figure 8. **Lake Las Vegas pH in surface water (0m) at the main-lake monitoring stations during January – December 1998.**

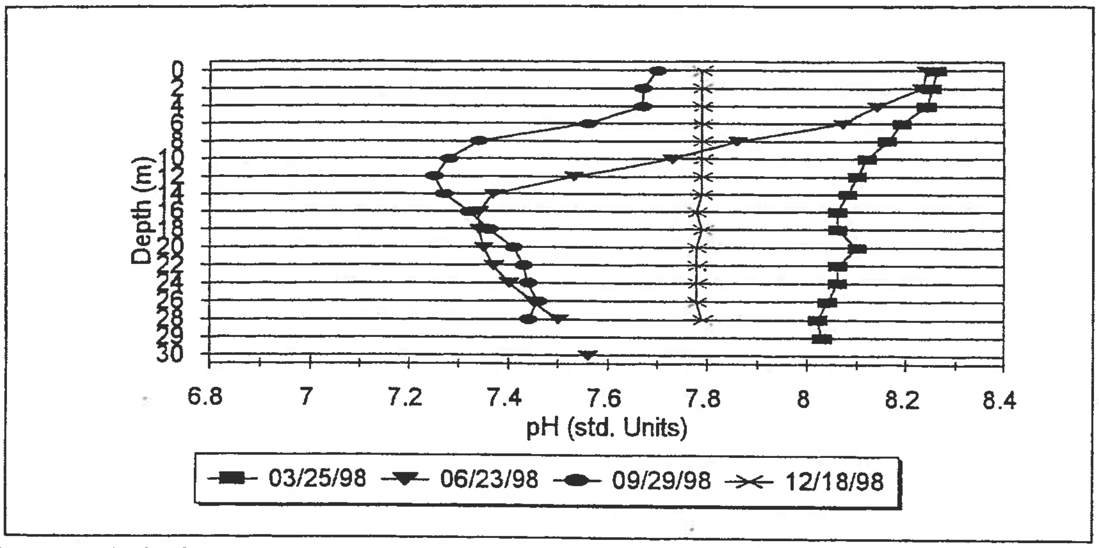

Figure 9. **Lake Las Vegas pH profiles at station LLV-1A during March, June, September, and December 1998.**

Conductance

Lake water conductivity ranged between roughly 2850 μmho/cm to 3310 μmho/cm at the surface during 1998 (Figure 10). Conductivity varied very slightly between the four lake sites. Conductivity did not vary greatly with depth. During periods of thermal stratification, conductivity showed the greatest variability in the hypolimnion (Figure 11).

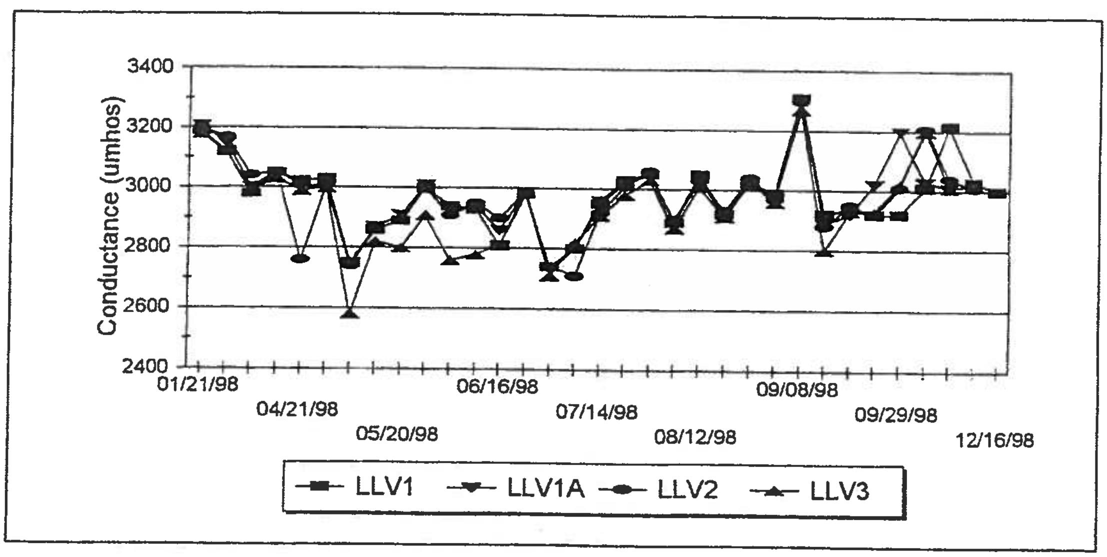

Figure 10. **Lake Las Vegas conductance in surface waters (0m) at main-lake stations during January – December 1998.**

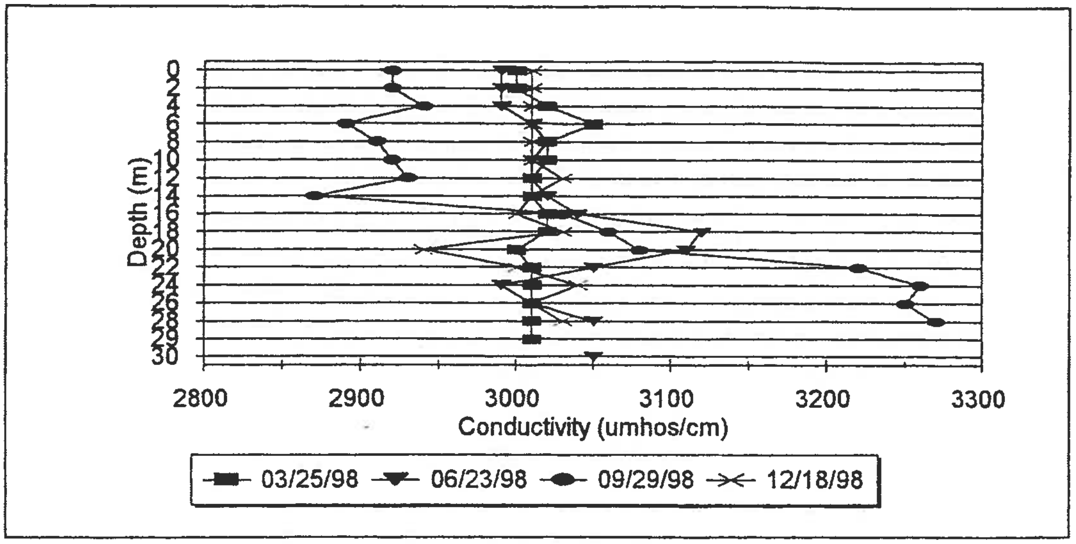

Figure 11. **Lake Las Vegas conductance profiles at station LLV-1A during March, June, September, and December 1998.**

Transparency

There was considerable seasonal and spatial variability in Lake transparency values during 1998 with values ranging between 0.5 and 7.5 meters of lake depth. 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.

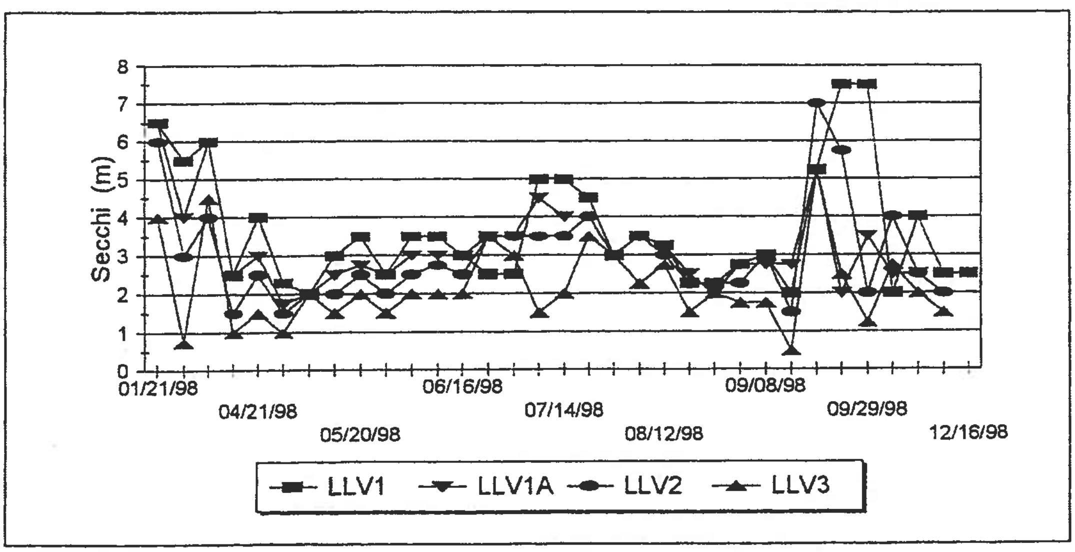

Figure 12. **Lake Las Vegas transparency measurements in surface water (0m) at Lake monitoring station during 1998.**

Turbidity

Monthly Turbidity values varied significantly between the four sites with concentrations varying between 2.0 and 13.0 NTU at the surface (0-2.5m) ($p<0.05$) (Figure 13). Pair-wise multiple comparison analysis showed that site LLV-3 exhibited significantly greater levels of turbidity than the other three sites during 1998 ($p < 0.05$). This trend was also seen in 1997. There was no significant difference in turbidity concentrations between depths at site LLV-1A in 1998 ($p > 0.05$) (Table 3).

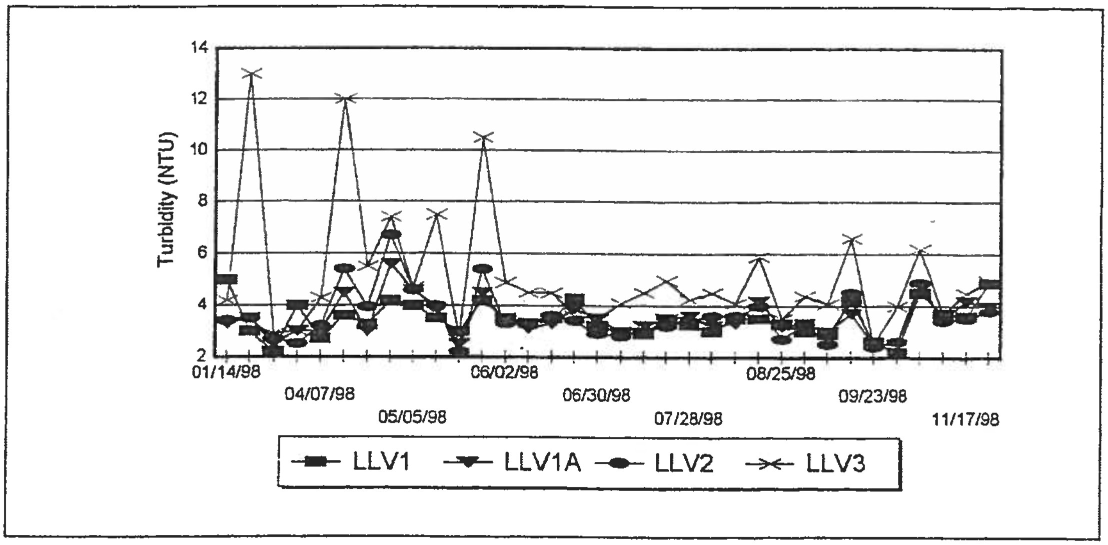

Figure 13. **Lake Las Vegas turbidity concentrations in surface waters (0m) at Lake monitoring stations during 1998.**

C. Chemical Analysis

Total Suspended Solids

Monthly total suspended solid concentrations varied between the east and west ends of the lake. Concentrations varied during the year primarily due to the frequent storm events that spilled into Lake Las Vegas. Monthly total suspended solids concentrations varied between 1.0 and 18.0 mg/l with significant differences between site LLV-1, LLV-1A and site LLV3 ($p < 0.05$) (Figure 14). As seen in previous years, LLV-3 typically displays concentrations higher (2-3 mg/l) than the other three sites. LLV-3 is the shallowest of the four sites and is impacted the greatest by wind and storm inflows. The highest concentrations were observed during the month of May (Figure 14). There were no significant differences in total suspended solids concentrations between depth at site LLV-1A in 1998 ($p > 0.05$) (Table 3)

DATE	Depth (m)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)	Chl - a (µg/L)	O. Phos (µg/L)	T. Phos (µg/L)	NO2+NO3 (µg/L)	NH4 (µg/L)	TKN (µg/L)	TN (µg/L)	Ca (mg/l)	Cl (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	Na (mg/l)	K (mg/l)	Mg (mg/l)
03/25/98	0	2274	3	3	1	1	14	687	20	728	1415	360	320	100	1025	340	27	88
03/25/98	5	2344	4	2	1	1	15	657	23	644	1301	369	315	90	1077	310	28	89
03/25/98	10	2398	2	3	1	1	20	649	25	1036	1685	313	330	90	1033	310	29	91
03/25/98	20	2270	1	3	1	1	51	657	20	1036	1693	305	325	90	717	280	28	90
06/23/98	0	2154	5	4	1	1	11	875	10	1148	2023	361	390	80	988	290	27	92
06/23/98	5	2168	5	3	1	1	13	871	12	868	1739	377	315	80	1022	290	27	91
06/23/98	10	2052	6	8	1	1	28	854	26	1008	1862	377	310	86	971	280	27	90
06/23/98	20	2248	3	5	1	14	36	692	75	1036	1728	377	330	100	1026	300	28	96
09/29/98	0	2322	1	3	1	8	24	1261	81	840	2101	337	262	76	1219	260	28	86
09/29/98	5	2356	3	2	1	10	27	1277	73	1060	2337	337	284	76	1174	250	27	83
09/29/98	10	2438	1	3	1	25	51	1539	69	900	2439	353	254	78	1198	230	26	79
09/29/98	20	2670	2	3	1	69	85	1959	209	770	2729	401	235	81	1440	240	28	83
12/18/98	0	2478	8	4	1	7	32	1277	32	730	2007	377	270	88	1220	270	30	91
12/18/98	5	2558	4	4	2	6	29	1288	46	810	2098	369	265	87	1240	250	29	86
12/18/98	10	2480	6	4	1	6	28	1255	37	560	1815	361	265	88	1228	260	30	91
12/18/98	20	2436	5	4	1	7	41	1320	53	560	1880	345	265	88	1220	260	29	91

Table 3. 1998 Lake Las Vegas chemical concentrations at site LLV-1A during the months of March, June, September and December at 0.5, 10 and 20 m depths.

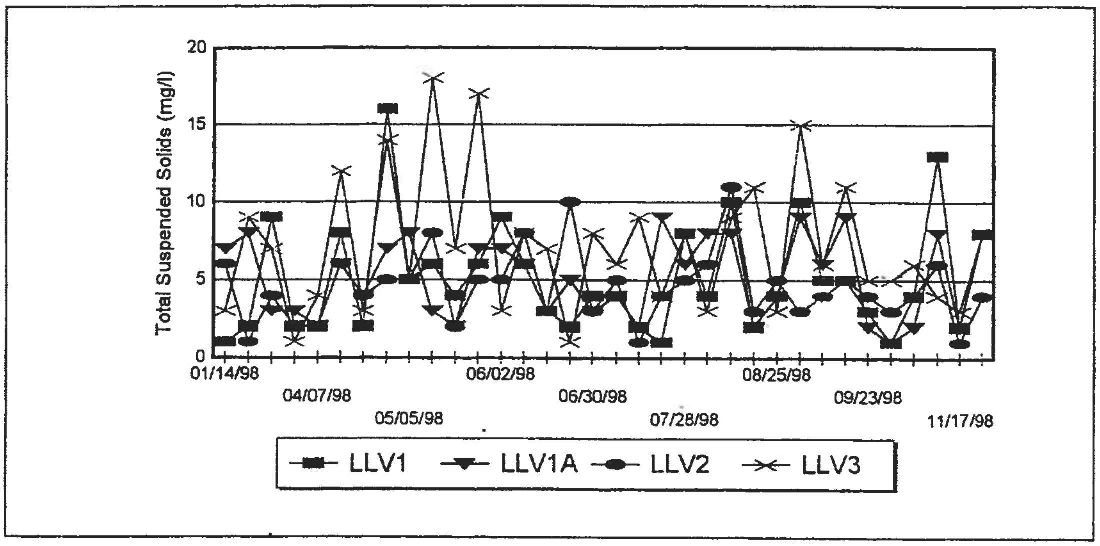

Figure 14. **Lake Las Vegas total suspended solids concentrations in surface waters (0m) at monitoring stations during 1998.**

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 2030 and 2608 mg/l at the surface (0-2.5m). Lake Las Vegas was aggressively filling the Lake during January with Lake Mead water. Lake Las Vegas continued to fill throughout the year with storm events augmenting the Lake fill. Site LLV-3 is located at the confluence where the raw water source enters the lake causing periodic declines in total dissolved solids at this site. Concentrations decreased throughout 1998 due to lake fill and low total dissolved solids (Figure 15). Lake Las Vegas passed approximately five thousand five hundred (5,500) acre-feet of stormwater from the dam's spillway during the stormevent on September 11, 1998 (Figure 15). The average stormwater TDS for the September 11th storm was 2,600 mg/l resulting in the Lake TDS increasing an additional 200 mg/l.

Total dissolved solids concentrations were not significantly different with depth at site LLV-1A in 1998 ($p > 0.05$) (Table 3).

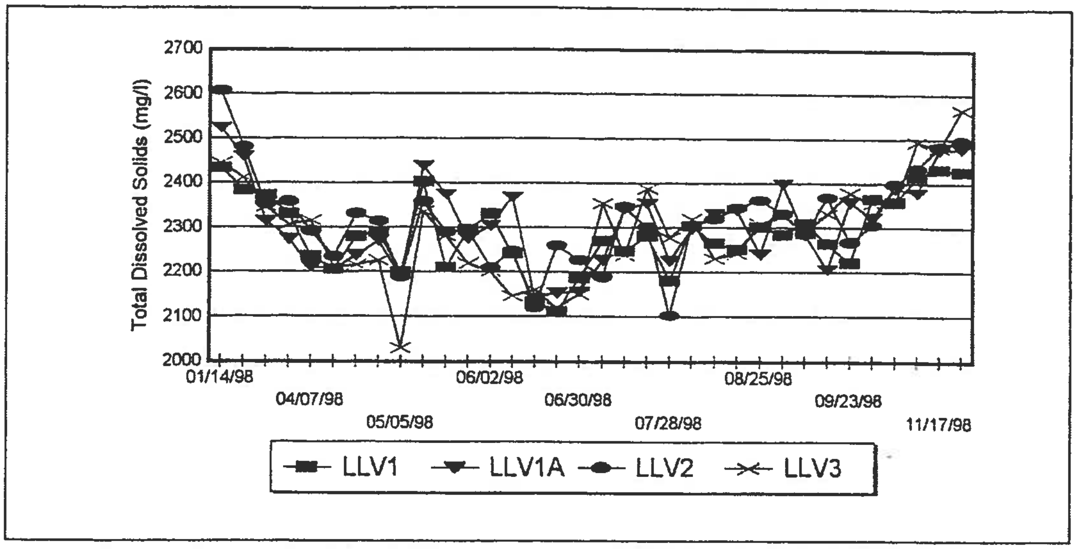

Figure 15. **Lake Las Vegas total dissolved solids concentrations at Lake monitoring station during 1998.**

Major Ion Concentrations

Quarterly depth samples did not vary significantly at site LLV-1A for the ions of calcium, sodium, chloride, potassium, sulfate, magnesium and bicarbonate ($p > 0.05$) (Table 3).

Total Phosphorus

Monthly concentrations ranged between 10 and 86 µg/l at the surface (0-2.5m). Monthly total phosphorus concentrations exhibited a significant difference between site LLV-3 and sites LLV-1 and LLV-1A ($p < 0.005$) (Figure 16). Site LLV-3 is located in an area where both the Lake fill is delivered to the Lake and significant wind related mixing is experienced. The variability in total phosphorus concentrations is related to the addition of colloidal materials from storm/flood activities. Monthly total phosphorus concentrations varied slightly between depths at site LLV-1A, but were not significantly different ($p < 0.05$) (Table 3).

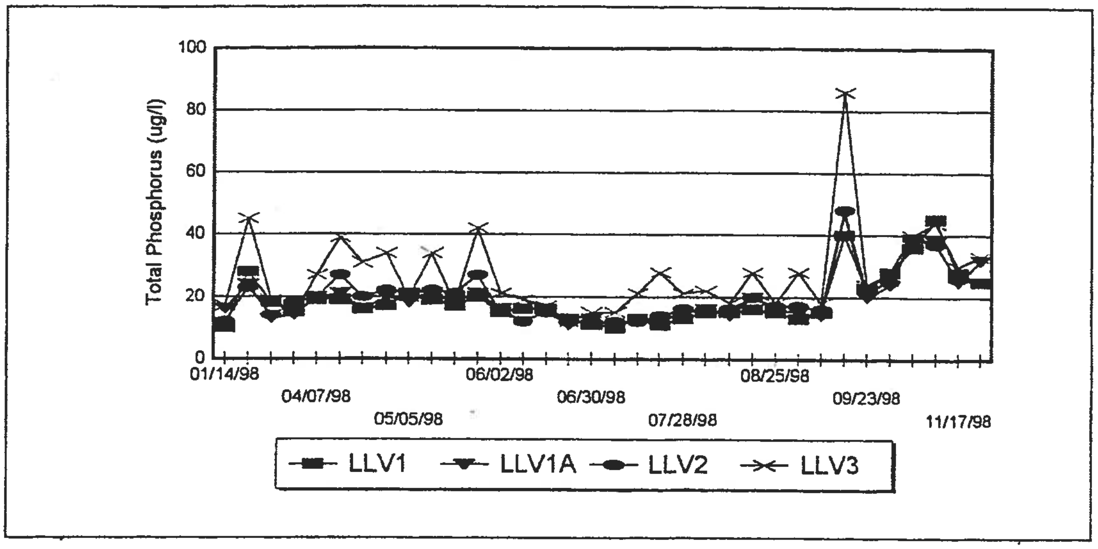

Figure 16. **Lake Las Vegas total phosphorus concentrations in surface waters (0m)at Lake monitoring sites during 1998.**

Ortho – Phosphorus

Monthly Ortho - phosphorus concentrations did not vary significantly between sites and ranged between 1 and 22 ug/l (p>0.05) (Figure 17). Concentrations were greatest during the month of October during the fall turnover period. Monthly ortho - phosphorus concentrations did not show a significant difference between depth. (p=>0.05) (Table 3).

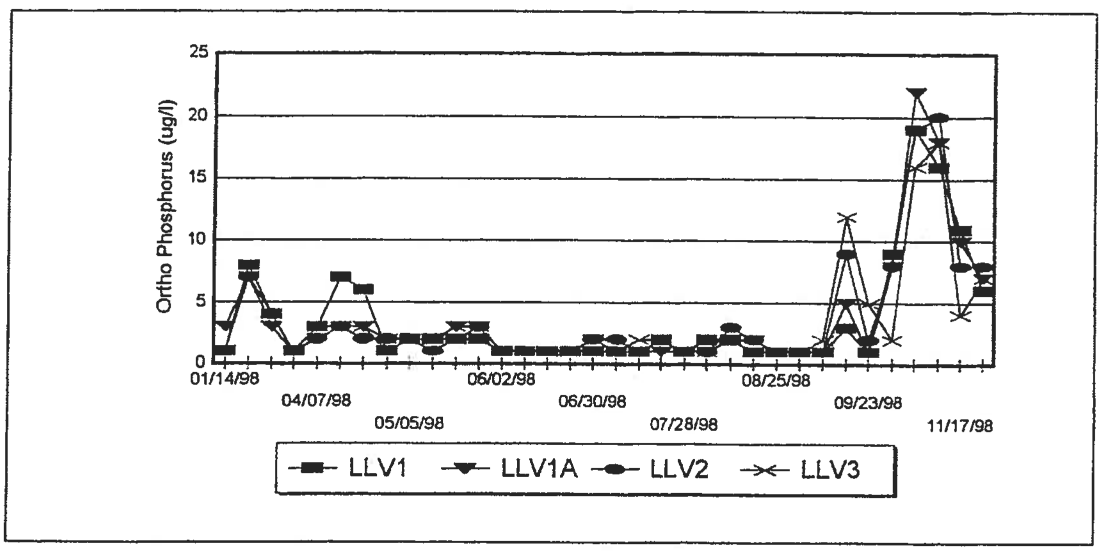

Figure 17. **Lake Las Vegas ortho – phosphorus concentrations in surface waters (0m) at Lake monitoring stations during 1998.**

Nitrite + Nitrate - Nitrogen

Monthly nitrite plus nitrate surface water concentrations ranged between 602 and 1498 mg/l at the four Lake sites in 1998. (Figure 18). In 1997, concentrations ranged between 352 mg/l and 579 mg/l, roughly half the 1998 values. This is attributable to the added nutrient input from stormwater. As in the case of phosphorus, monthly average concentrations of nitrite plus nitrate were lower at the 20-meter depth due to anaerobic conditions present during summer stratification. Monthly nitrite plus nitrate concentrations were not significantly different by site or depth (p> 0.05) (Figure 18 and Table 3).

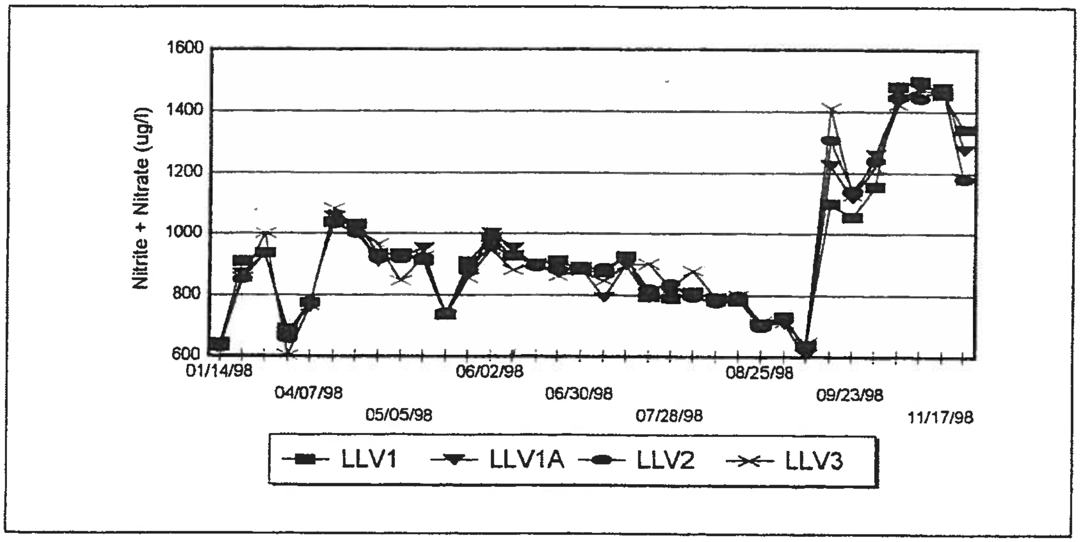

Figure 18. **Lake Las Vegas nitrite + nitrate concentrations in surface waters (0m) at Lake monitoring stations during 1998.**

Ammonia - Nitrogen

Monthly ammonia surface water concentrations ranged between 10 to 133 ug/l during 1998, with no significant difference between the four Lake sites (p > 0.05) (Table 3). While ortho phosphorus and nitrite plus nitrate exhibited lower average concentration at the 20-meter depth, ammonia was slightly higher due to the presence of anaerobic conditions in the hypolimum during the summer months (Table 3). Variability in concentrations between depths was not found significant for ammonia during 1998 at site LLV-1A (p >0.05) (Table 3).

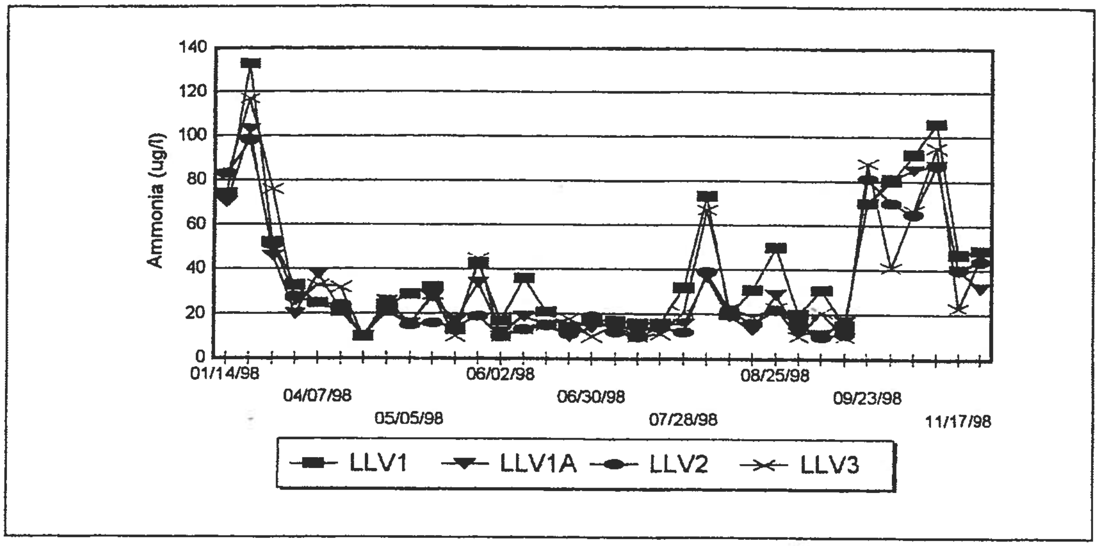

Figure 19. **Lake Las Vegas ammonia-N concentrations in surface waters (0m) at Lake monitoring stations during 1998.**

Total Nitrogen

Monthly total nitrogen concentrations ranged between 1300 and 3151 ug/l and were not significantly different between sites or with depth (p>0.05) (Figures 20 and Table 3).

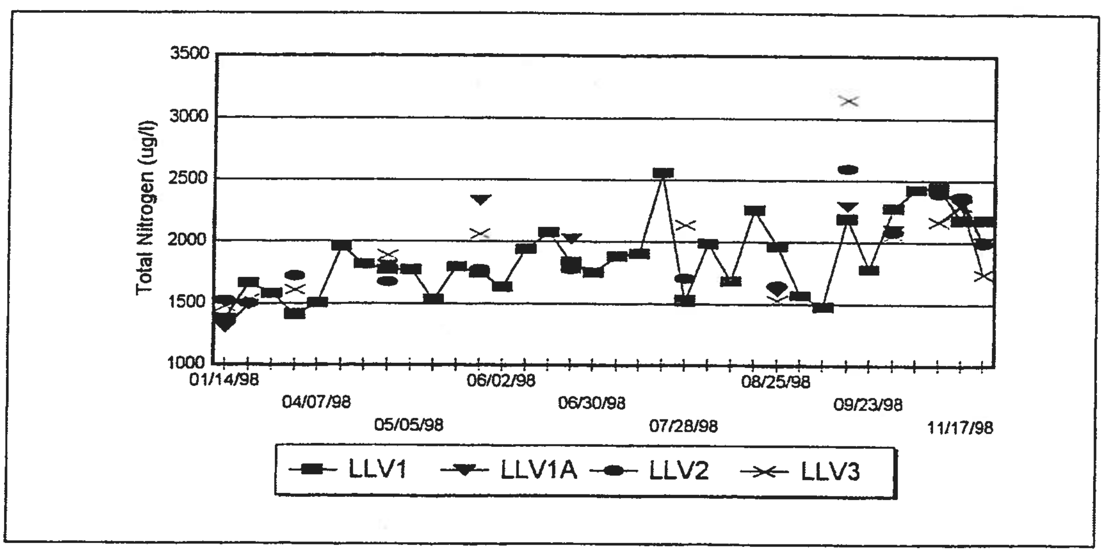

Figure 20. **Lake Las Vegas ortho – phosphorus concentrations in surface waters (0m) at Lake monitoring stations during 1998.**

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 1998 (Table 4). Rotifers were the most diverse zooplankton group in the lake with seven (7) species, followed by the copepods and cladocerans with six (6) species each. Copepods dominated the population with an average frequency of 73%, followed by Cladocerans (26%) and Rotifers (1%) during 1997.

Diaptomus Sp., *Juvenile Copepods* and *Daphnia pulex* exhibited the greatest average annual average density in 1998 (Table 4). Of the Cladoceran family, *Ceriodaphnia Sp.* and *Daphnia pulex* dominated with average densities of 9,916 and 2,621 adults/m^3. This genus is well known for their ability to control Phytoplankton populations in pelagic zones. Average *Daphnia pulex* densities were roughly three times greater in 1998 than 1997. The increase in nutrient availability from storm water possibly influenced this increase.

Rotifer densities were very low in respect to the other two families represented. *Polyarthra sp.* was most common with an average density of 808 adults/m^3. *Cladocerans* were the second most abundant zooplankton group in the Lake during 1998 (Table 4).

Table 4. Lake Las Vegas zooplankton species identified in the 0 – 15 m vertical plankton tows at station LLV-1 during 1998.

ZOOPLANKTON SPECIES	Average #/m3	Total #/m3	Total %Freq	Total %RFreq
COPEPODS:				
Cylops vernalis	256	1793	0	0
Diacyclops bicuspidatus	3769	128143	12	8
Mesocyclops edax	592	4143	0	0
Diaptomus sp.	13849	470849	43	31
Juvenile Copepods	14288	485776	44	32
Misc. Copepods	437	10916	1	1
TOTAL COPEPODS	**32401**	**1101620**	**100**	**73**
CLADOCERANS:				
Daphnia galeata mendotae	448	3582	1	0
Daphnia pulex	9916	337160	84	22
Ceriodaphnia sp.	2621	18350	5	1
Juvenile Cladocerans	1866	41050	10	3
TOTAL CLADOCERANS	**14852**	**400142**	**100**	**26**
ROTIFERS:				
Brachionus sp.	492	983	9	0
Filinia sp.	77	77	1	0
Keratella sp.	171	341	3	0
Lecane sp.	215	1077	9	0
Polyarthra sp.	808	8888	78	1
TOTAL ROTIFERS	**1762**	**11366**	**100**	**1**

Chlorophyll-a

Chlorophyll-a concentrations in surface waters were very low ranging from 1 to 9.0 ug/l during 1998 (Figure 21). Annual average concentrations were significantly different between sites LLV-1, LLV-1A, LLV-2 and LLV-3 ($p < 0.05$). Average chlorophyll concentrations were not significant with depth at site LLV-1A ($p<0.05$) (Figure 21 and Table 3).

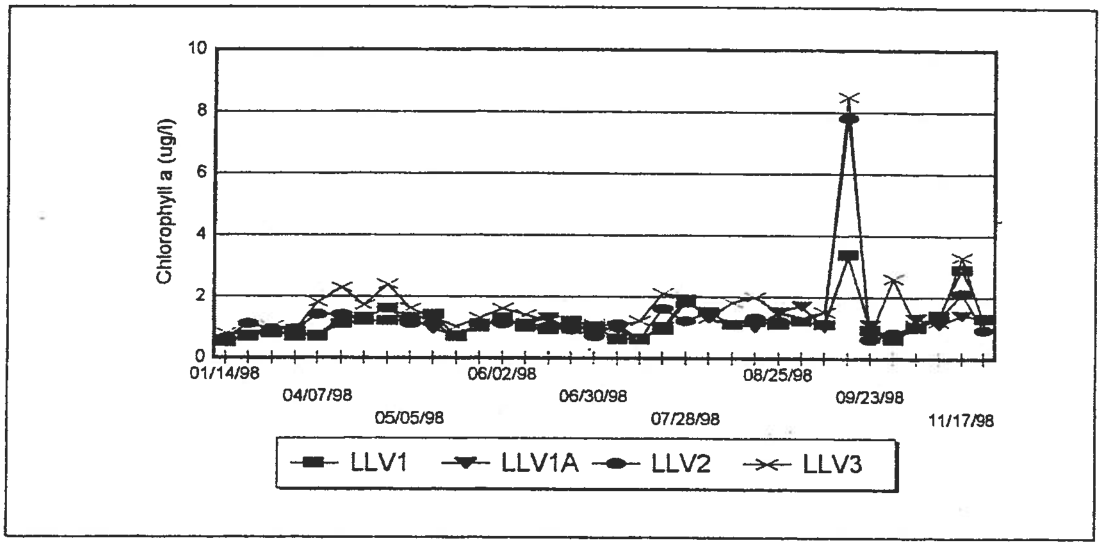

Figure 21. **Lake Las Vegas chlorophyll "a" concentrations in surface waters (0m) at Lake monitoring stations during 1998.**

Phytoplankton

Six (6) taxonomic divisions of phytoplankton were found at LLV-1 during 1998 (Table 5). The most frequently observed division was *Chlorophyta* in 1998 (Figure 22). The remaining four divisions *Bacillariophyta, Cryptophyta, Pyrrhophyta*, and *Cyanophyta* were equally distributed in contrast to *Chlorophyta* during the year. (Figure 22). As reflected by the chlorophyll-a concentrations, phytoplankton populations were very low. The presence of a healthy zooplankton population appears to maintain the phytoplankton community to less than nuisance levels.

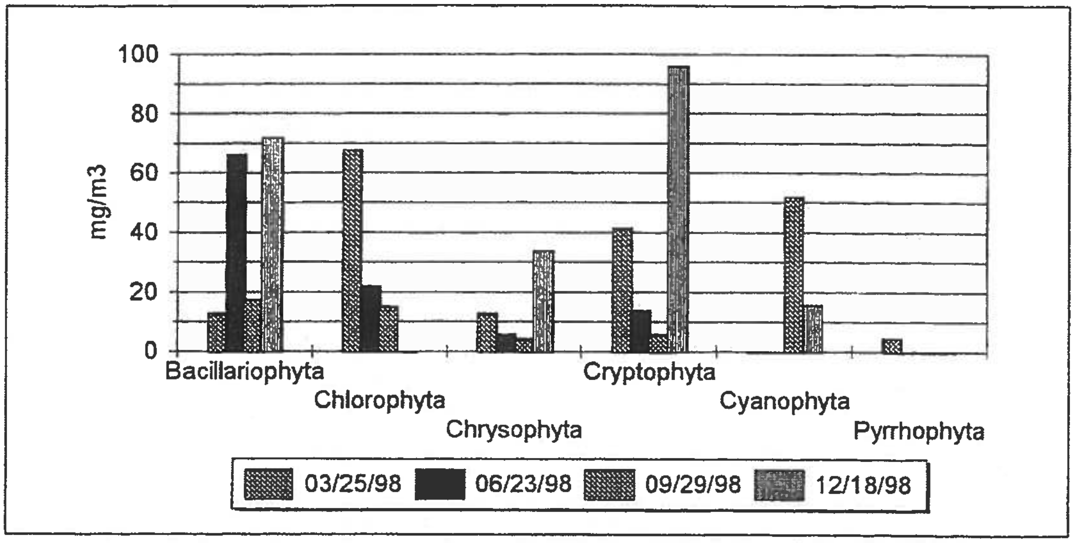

Figure 22. **Seasonal changes in phytoplankton biomass by division in 0-15 m composite sample collected at LLV-1 during January – December 1998.**

Table 5. Lake Las Vegas phytoplankton species identified at the 0 – 2.5 m composite sample collected at LLV-1A during January – December 1998.

Division	Genus/Species	Total Biomass (mg/m3)	Total %Freq	Total %RFreq
Bacillariophyta	*Achnanthes sp*	4	3	1
Bacillariophyta	*Cyclotella sp.*	13	8	2
Bacillariophyta	*Stephanodiscus astrea*	147	87	28
Bacillariophyta	*Synedra sp.*	4	3	1
Chlorophyta	*Chlamydomonas sp.*	1	1	0
Chlorophyta	*Gloeocystis gigas*	31	29	6
Chlorophyta	*Oocystis sp.*	46	44	9
Chlorophyta	*Platymonas elliptica*	20	19	4
Chlorophyta	*Scenedesmus bijuga*	7	7	1
Chrysophyta	*Chrysochromulina parva*	53	94	10
Chrysophyta	*Ochromonas sp.*	3	6	1
Cryptophyta	*Cryptomonas spp.*	2	1	0
Cryptophyta	*Rhodomonas minuta*	112	99	22
Cyanophyta	*Aphanocapsa delicatissima*	68	100	13
Pyrrhophyta	*Microflagelettes*	5	100	1

Bacteria and Biological Oxygen Demand

Currently recreational use of Lake Las Vegas is insignificant due to the limited access to the Lake. Fecal coliform monitoring has been completed on a monthly basis at Lake sites LLV-1, LLV-2, and LLV-3 in 1998. In 1999 bacteria sampling frequency will be increased to weekly during the months of April through October due to anticipated increased use. Fecal coliform counts and BOD_5 concentrations in surface waters were typically at or below detection limits during each quarter of 1998 with a few exceptions. (Table 6).

Table 6. Lake Las Vegas fecal coliform counts (MPN/100ml) and biochemical oxygen demand (mg/l) in surface waters (0-2.5m) at Lake monitoring stations during 1998.

STATION	DATE	FC	BOD5
		MPN/100ml	mg/l
LLV-1	03/25/98	2	2
LLV-2	03/25/98	2	4
LLV-3	03/25/98	2	5
LLV-1	06/23/98	2	2
LLV-2	06/23/98	2	2
LLV-3	06/23/98	2	2
LLV-1	07/21/98	11	NA
LLV-2	07/21/98	110	NA
LLV-3	07/21/98	1600	NA
LLV-1	09/15/98	22	NA
LLV-2	09/15/98	240	NA
LLV-3	09/15/98	500	NA
LLV-1	09/29/98	2	2
LLV-2	09/29/98	4	2
LLV-3	09/29/98	8	2
LLV-1	10/06/98	2	NA
LLV-2	10/06/98	2	NA
LLV-3	10/06/98	2	NA
LLV-1	10/20/98	2	NA
LLV-2	10/20/98	2	NA
LLV-3	10/20/98	2	NA
LLV-1	11/17/98	2	NA
LLV-2	11/17/98	4	NA
LLV-3	11/17/98	2	NA
LLV-1	12/18/98	2	2
LLV-2	12/18/98	2	2
LLV-3	12/18/98	2	2

Toxic Substances

Water samples for toxic analysis were collected from the surface (0m) and bottom (1m from bottom) of station LLV-1 during December 1998, 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 with the exception of the period immediately following the September storm event. The chlorophyll-a guideline is applied at that time of year to protect water quality during the peak recreation period. Fecal coliform bacteria was at, or below, the limits of detection, as were concentrations of toxic metals, pesticides, herbicides and other toxic organic compounds. Except for total dissolved solids and its related ions, water quality in Lake Las Vegas continues to be very good even though about 60-70% of the Lake's volume has come from stormwater inflows. Total dissolved solids in Lake Las Vegas exceeded the proposed guideline of 2000 mg/l all of 1998. 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 will be blended with Lake Mead water to dilute the total dissolved solids concentrations.

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.

V. 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

12/17/98	12/18/98	01/06/99	8360787

NATIONAL TESTING LABORATORIES LTD.
6555 Wilson Mills Road
Cleveland, OH 44143
(216) 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 20M

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. "NBR" No Bacteria Required.
"P" = PRESENCE "A" = ABSENCE
"EP" = E. COLI PRESENCE "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	0.020	ND
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	0.005
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	75
Chloride	250	5.0	280*
Fluoride	4	0.5	ND
Nitrate as N	10	0.5	1.0
Nitrite as N	1	0.5	ND
Sulfate	250	5.0	1300*
Hardness (suggested limit = 100)		10	1300*
pH (Standard Units)	6.5-8.5	---	8.0
Total Dissolved Solids	500	20	2400*
Turbidity (Turbidity Units)	1.0	0.1	2.6*
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 (sum of four above)	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

Organic chemicals - pesticides, herbicides and PCBs

Analysis performed	MCL (mg/l)	Detection Level	Level Detected
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.

DR. ALAN A. LEFF
VICE PRESIDENT, OPERATIONS, NATIONAL TESTING LABORATORIES, LTD.

12/17/98	12/18/98	01/06/99	8360788

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DRINKING WATER ANALYSIS RESULTS

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Copper	1.3	0.004	ND
Iron	0.3	0.020	ND
Lead	0.015	0.002	ND
Manganese	0.05	0.004	0.008
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	0.007
Inorganic chemicals - other, and physical factors:			
Alkalinity (Total as CaCO3)	---	20	90
Chloride	250	5.0	270*
Fluoride	4	0.5	ND
Nitrate as N	10	0.5	1.0
Nitrite as N	1	0.5	ND
Sulfate	250	5.0	1300*
Hardness (suggested limit = 100)		10	1300*
pH (Standard Units)	6.5-8.5	---	7.7
Total Dissolved Solids	500	20	2400*
Turbidity (Turbidity Units)	1.0	0.1	1.1*
Organic chemicals - trihalomethanes:			
Bromoform	0.080	0.004	ND
Bromodichloromethane	0.080	0.002	ND
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Chloromethane	---	0.002	ND
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4-Chlorotoluene	---	0.001	ND
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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
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cis-1,3-Dichloropropene	---	0.002	ND
2,2-Dichloropropane	---	0.002	ND
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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
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Heptachlor Epoxide	0.0002	0.0001	ND
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