LAME

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Report of Significant Findings--Las Vegas Bay/ Boulder Basin Investigations

Prepared by

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U.S. Department of the Interior
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Report of Significant Findings--Las Vegas Bay/Boulder Basin Investigations
Sampling Date March 26, 1996

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INTRODUCTION

This report is a summary of findings from the March 26, 1996, limnological field survey of Boulder Basin, Lake Mead, Nevada. These data are presented to document and demonstrate, in a clear manner, the influence of effluent flows from Las Vegas Wash on the water quality and aquatic ecology of the Basin. Even though this typifies the water quality conditions, more comprehensive reports and publications are in preparation which will more thoroughly document the conditions from 1990 through 1995.

METHODOLOGY

Field sampling was carried out between 0830 and 1500 beginning at the confluence of Las Vegas Wash and the Inner Las Vegas Bay. Ten (10) locations were sampled, each in a similar manner. Locations of sampling stations are in line from the Wash-Bay confluence to a point midway between Saddle and Black Islands. In addition, sampling was done at a location midway between Sentinel Island and the base of Fortification Hill, and at the buoy line in front of Hoover Dam. Sampling stations are labeled from LV01, at Wash-Bay confluence, to LV17 at Hoover Dam. A significant data collection point is LV14, which is the aforementioned sampling location between Saddle and Black Islands.

The following data were collected from each location:

- Profile of the water column including temperature, pH, dissolved oxygen concentration, specific conductance (conductivity), and turbidity.
- Water transparency using Secchi disc, and water color
- Chlorophyll concentration (an index of algae biomass)
- Concentration of total inorganic plant nutrients ammonia, nitrate, and orthophosphate
- Abundance and kinds of algae
- Abundance and kinds of zooplankton (microscopic animal life)

Analyses of water samples for nutrient and chlorophyll concentrations were done by the Lower

Colorado Regional Water and Soil Analytical Laboratory. Laboratory analysis of algae and zooplankton samples were done, respectively, by contractors Dr. Ann St. Amand of St. Joseph, Michigan, and Dr. John Beaver of Shaker Heights, Ohio.

Data were plotted using software packages Quattro Pro and Surfer.

FINDINGS

Figure 1 illustrates the trend in water clarity or transparency at each of the ten sampling locations. Data are plotted from LV01 to LV17. Transparency progressively increased with distance from the Wash-Bay confluence. There was a marked increase in clarity (nearly double) from LV10 to LV14. This difference was most likely due to the fact that a spring algal bloom was beginning to occur within Las Vegas Bay. Algal blooms commonly occur each March-April, usually reaching a peak in June. Of note is that transparency does not stabilize throughout Boulder Basin, which indicates the influence of the Wash on the Basin. Choosing a sampling location which can be classified as untainted within the Basin may no longer be possible. On the other hand, Secchi depths of 16 meters and greater from LV12 to LV17 indicate this area of the Basin to be unusually clear, and relatively low in biological productivity. These observations, however, vary with season.

Figure 2 is the profile of physical-chemical data collected from LV14, between Saddle and Black Islands on March 26, 1996. Data are plotted from surface to near the bottom (115 meters deep). While thermal stratification (solid line) is present, higher specific conductance (dotted line) and turbidity (dash, double dot) just under the epilimnion (top mixing layer of the lake) are especially notable. These data indicate the presence, between 24 and 65 meters below the surface, of a layer of water higher in dissolved solids and almost three times less transparent as water above or below. This condition exists at all sampling locations from the Wash-Bay confluence to this point (LV14), and can be traced to the Las Vegas Wash inflow. Based upon previous years' data, this plume can be expected to be detectable throughout the remainder of the year, but at different depths and to a greater or lesser intensity depending upon the degree of stratification. The plume is thus quite predictable both in nature and location. Each year it is increasingly extensive spatially and temporally. As during the spring seasons of other years, the plume is not particularly notable at either LV15 or LV17. We do not sample in the middle of the Boulder Basin between Saddle and Sentinel Islands.

Figures 3 and 4 are plots of physical chemical data collected from all ten sampling locations on March 26, 1996. These plots are presented as a "slice" of the lake, showing it in a vertical and horizontal straightened plane from the Wash-Bay confluence to Hoover Dam. Figure 3 includes temperature (°C), and dissolved oxygen (mg/L) and pH (units) concentrations. Inflow (LV01) Saddle Island (LV14), and Hoover Dam (LV17) are noted on each graph. Note the apparent warming influence of the Las Vegas Wash inflow. This warm water moves downstream along the surface. There is nothing particularly notable regarding either dissolved oxygen or pH

concentrations. However, as thermal and density stratification increases, and the frequency of wind mixing decreases, dissolved oxygen concentration will drastically decrease in bottom layers in the Inner Bay. This area of the lake is highly eutrophic, and the extent of this trophic status is expanding as the load of nutrients continues to pour into the lake at an ever increasing rate.

Figure 4 includes plots of both specific conductance (µS/cm), and turbidity (NTU's). As in figure 3, the plots extend from Las Vegas Wash and Bay to Hoover Dam. These data demonstrate clearly the source of water of high conductance and turbidity. During early spring the plume extends at least to the point between Saddle and Black Islands. During this season of the year the plume simply "slides" along the bottom to a depth just below the epilimnion (upper mixing zone of the water column). On this date it was between 24 and 65 meters in depth (elevation=340 to 299 meters above mean sea level).This phenomenon is well documented during all the years of our study since 1990. The plume is present throughout the year, and moves in a fairly predictable manner. The greatest change since 1990 has been that its extent continues to increase, both temporally and spatially. The strength of this dense plume of water can be realized when one considers that at this time of year there is ample opportunity for extensive mixing in the Inner Bay due to lack of strong thermal structure, and the frequent occurrence of strong winds. In fact, the afternoon of March 25, until just before we began our survey, was an extremely windy period due to a strong weather front passing through the area.

SIGNIFICANCE

The data shown indicate a plume exists in Boulder Basin characterized by water high in specific conductance and up to 300 percent higher in turbidity than the surrounding water. The significance of this goes well beyond the fact that there is a saltier layer in the lake. As evidence, figure 5A plots total nitrogen (as the sum of nitrate and ammonia) from samples collected at LV14 on March 26, 1996, from the surface, 1 meter, 3 meters, and 33 meters (determined in the field to be within the plume). Nitrogen concentration at all sampling stations was highest within the plume (figure 5B). At each station the location of the plume was identified from the profile data, and water samples were collected. Figure 5B plots plume nitrogen concentration going from the confluence to Hoover Dam. These data demonstrate that the source of this nitrogen is Las Vegas Wash (LV01), and that the concentrations decrease as the plume moves downstream.

Although tertiary treatment and numerous upgrades at the wastewater treatment facilities on the Wash have resulted in obvious changes in the both water chemistry of water in the Bay, and in the resulting degree of biological productivity, there continues to be a loading effect. For example, about a year ago treatment began to successfully reduce ammonia discharge by conversion to nitrate. However, the total load of nitrogen has remained nearly the same, or may be increased due to increasing discharge volume as population grows. The significance of this is that there is a decreased loading of the toxic form of nitrogen, but the availability of nitrogen for use in biological production is just the same.

Studies at other locations have shown that with runoff from primarily urban areas, both point

source and non-point sources comes a myriad of organic, inorganic, and biological constituents which are seldom sampled understood. A few include organochlorides and organophosphates used as pesticides past and present, by-products of chlorine treatment, viral and bacterial pathogens, and other detrimental organisms such as <u>Cryptosporidium</u> and <u>Giardia</u>.

From our point of view, and experience in cases worldwide, there ought to be some attention paid to the location of this plume relative to any structure which would deliver water for domestic use. In addition, a rigorous program to understand the chemical and biological characteristics of the plume at various locations in the lake throughout the year should be undertaken and ongoing. A study published in the March 1, 1996, *Annals of Internal Medicine* titled "Cryptosporidium: An outbreak associated with drinking water despite state of-the-art water treatment," by Goldstein et al. documents that 78 people were diagnosed with <u>Cryptosporidium</u> infection in the Las Vegas area in the first quarter of 1994. It states: "Our epidemiologic data indicate that contaminated municipal drinking water was the most likely vehicle of transmission in this outbreak..." The problem is that there are few or no guidelines developed to detect these health risks since there is an absence of indicators that can reliably predict occurrence of an outbreak if the treatment plant is operating within existing federal and state standards.

An extensive report of findings from surveys of the Boulder Basin done since 1990 is forthcoming.

List of Figures

Figure 1.-Secchi depth (water transparency) readings from ten sampling stations of the Boulder Basin of Lake Mead, March 26, 1996. LV01 is loca
ted at the confluence of Las Vegas Wash and the Inner Las Vegas Bay. LV14 is located Between Saddle and Black Islands. Location LV17 is just above Hoover Dam.

Figure 2.-Profile of physical/chemical data collected on March 26, 1996 at a site between Saddle and Black Islands of Boulder Basin of Lake Mead. (temperature =°C, dissolved oxygen = mg/L, pH=units, conductivity =µS/cm, and turbidity=NTU's)

Figure 3.-Isopleths of temperature, dissolved oxygen, and pH, March 26, 1996 using data collected from ten locations in a ten mile line from the confluence of Las Vegas Wash to Hoover Dam.

Figure 4.-Isopleths of conductivity and turbidity, March 26, 1996 using data collected from ten locations in a line from the confluence of Las Vegas Wash to Hoover Dam.

Figure 5.-Plots of total nitrogen concentration calculated from ammonia and nitrate. Samples were collected March 26, 1996.

A.-Graph displays data from surface to bottom at station LV14.

B.-Graph displays data from samples collected in the plume detected in the water columns at each of the sampling stations.

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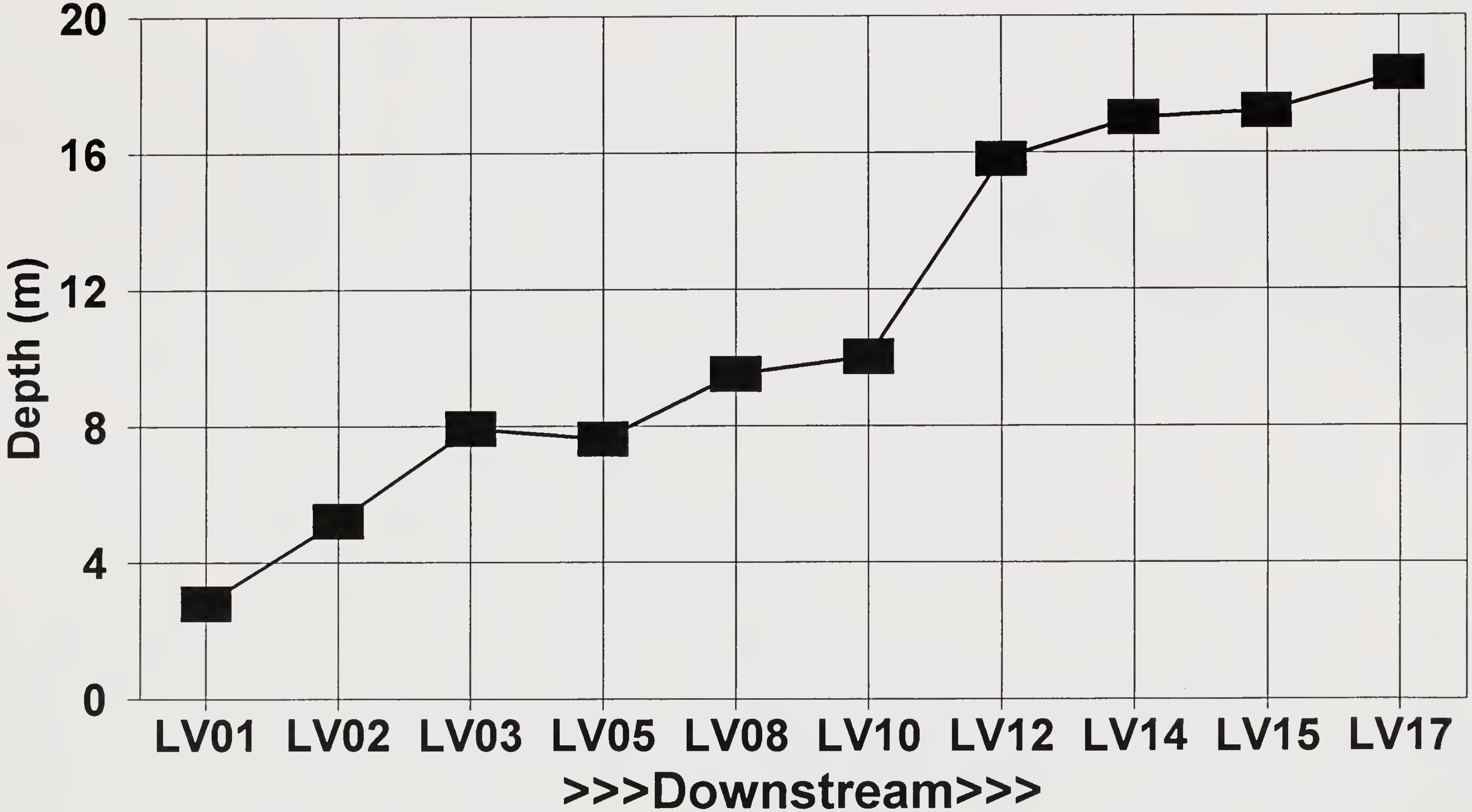
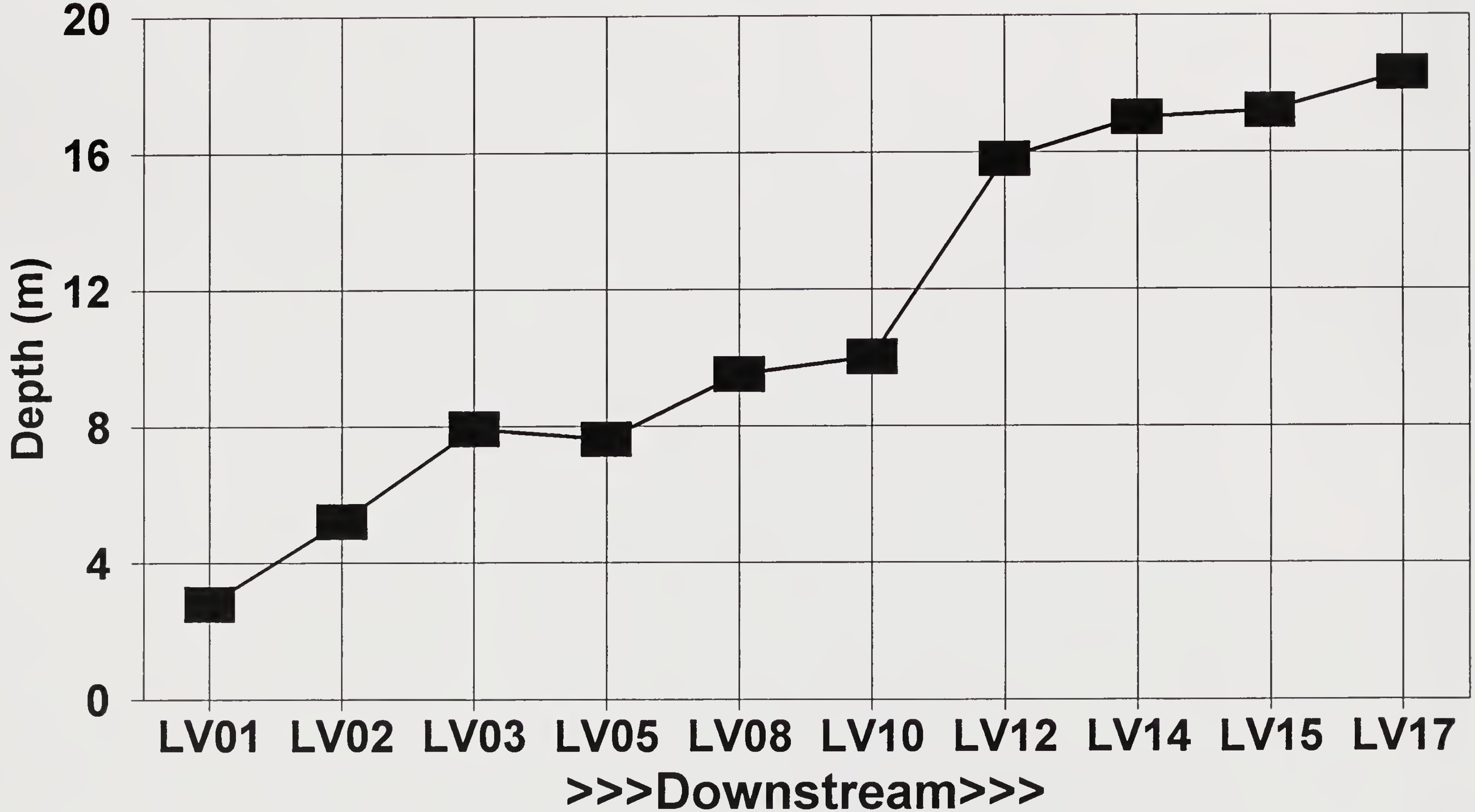
Secchi Depth (Water Transparency)

March 26, 1996



Secchi Depth (Water Transparency)

March 26, 1996



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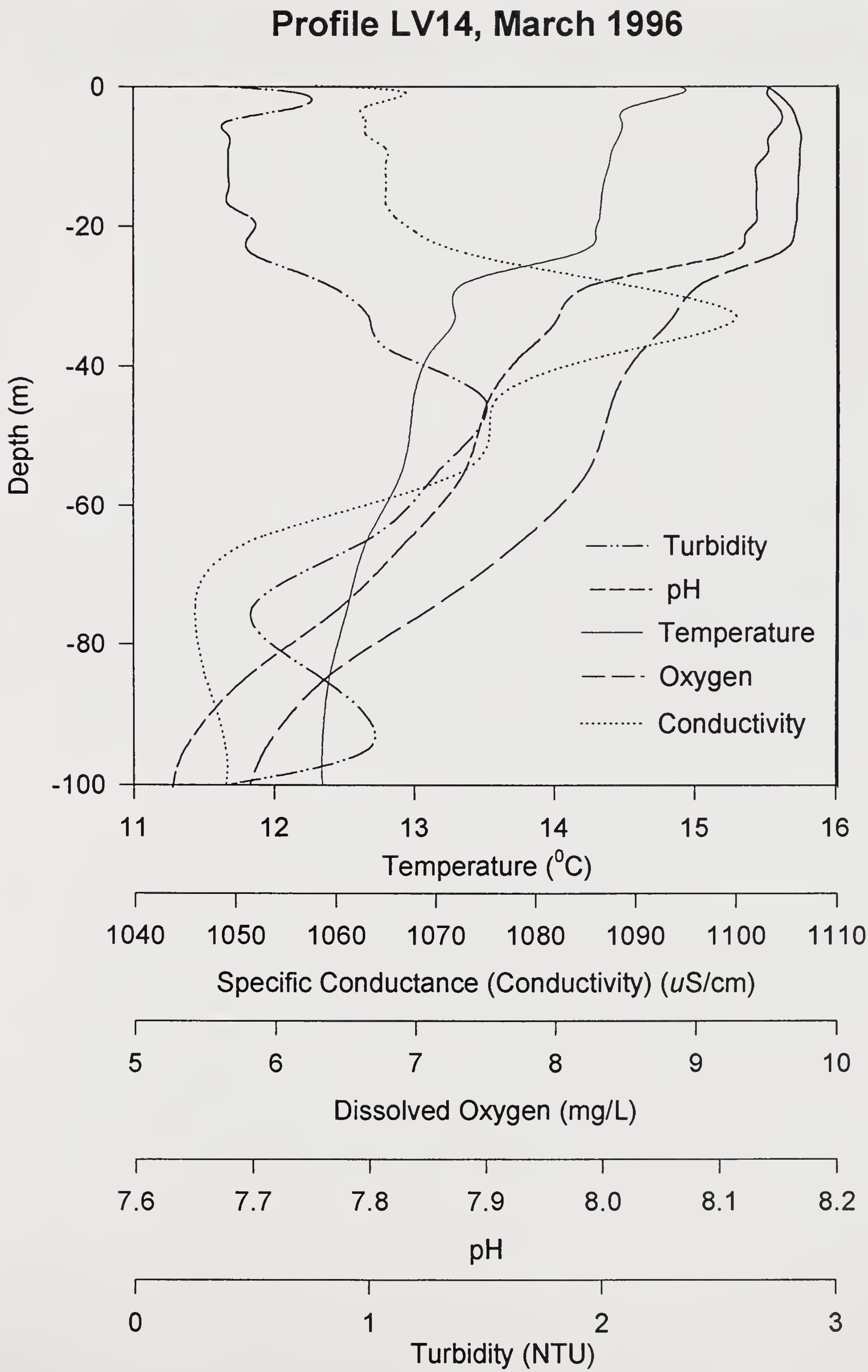
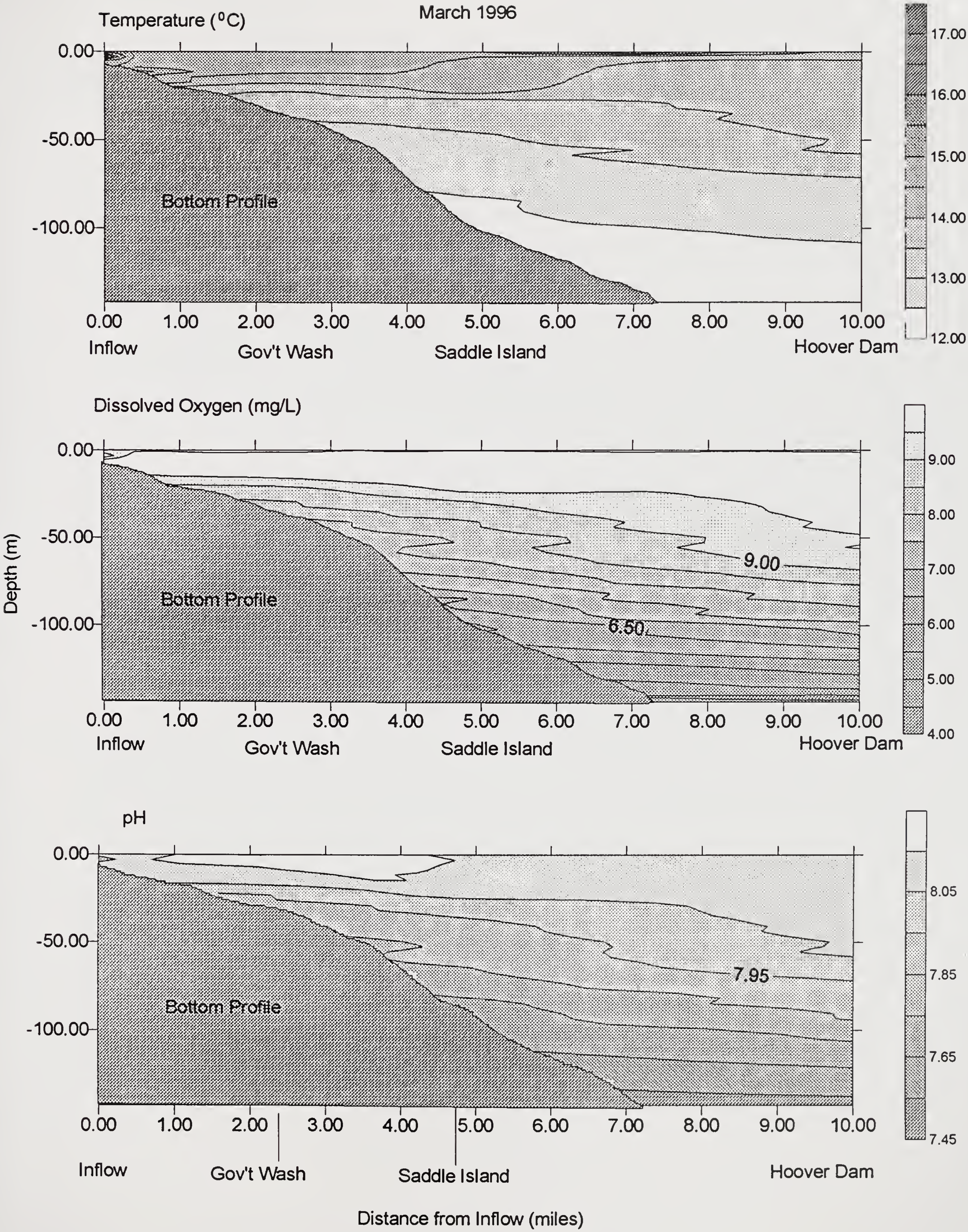
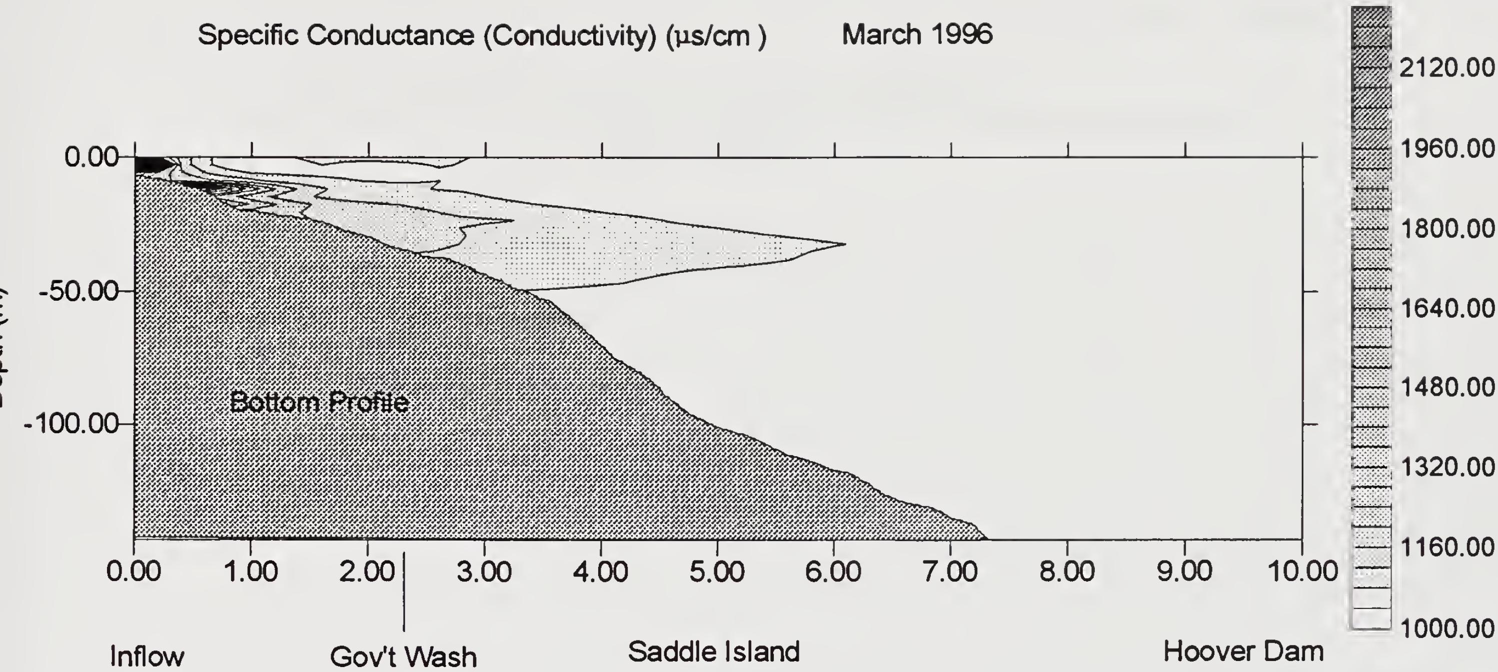

Profile LV14, March 1996
Depth (m)
0
-20
-40
-60
-80
-100
Turbidity
pH
Temperature
Oxygen
Conductivity
11
12
13
14
15
16
Temperature (°C)
1040
1050
1060
1070
1080
1090
1100
1110
Specific Conductance (Conductivity) (uS/cm)
5
6
7
8
9
10
Dissolved Oxygen (mg/L)
7.6
7.7
7.8
7.9
8.0
8.1
8.2
pH
0
1
2
3
Turbidity (NTU)

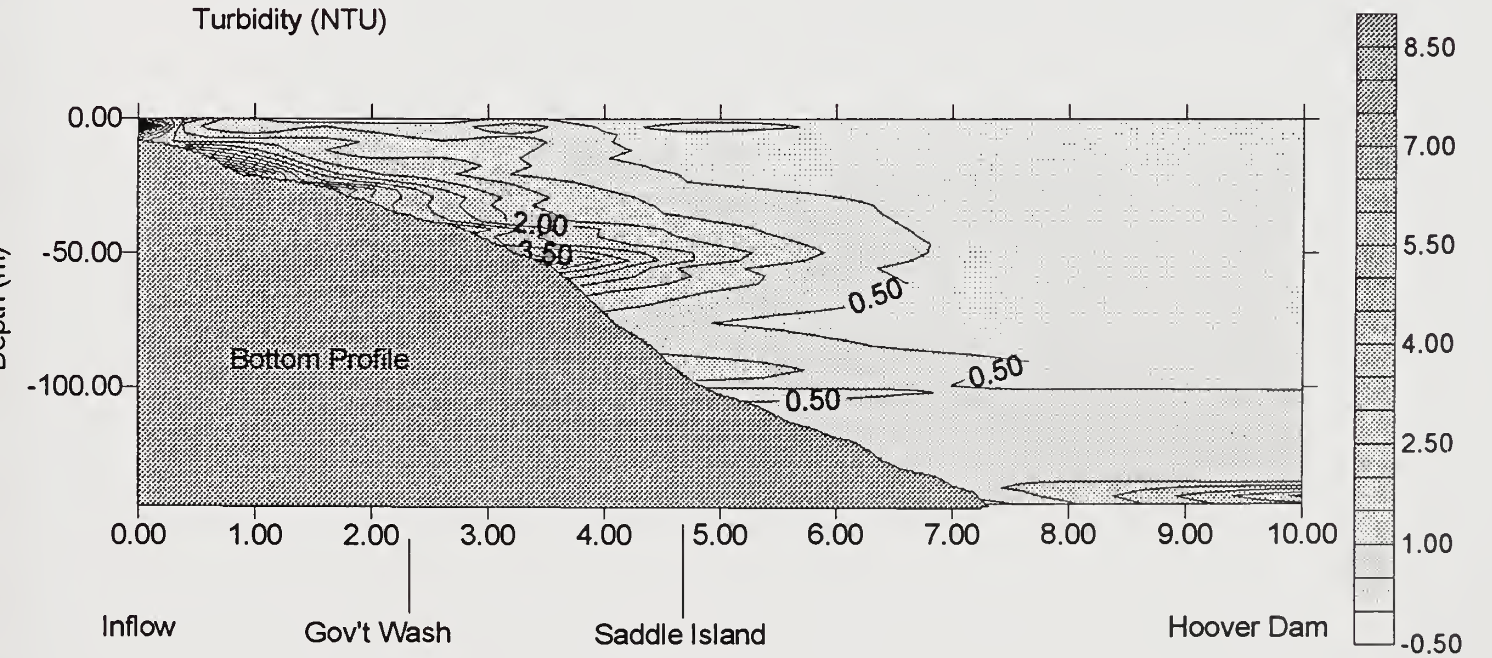
Figure 3.-Isopleths of temperature, dissolved oxygen, and pH, March 26, 1996 using data collected from ten locations in a ten mile line from the confluence of Las Vegas Wash to Hoover Dam.



March 1996
Temperature (°C)
Bottom Profile
0.00
-50.00
-100.00
0.00 1.00 2.00 3.00 4.00 5.00 6.00 7.00 8.00 9.00 10.00
Inflow
Gov't Wash
Saddle Island
Hoover Dam
17.00
16.00
15.00
14.00
13.00
12.00
Dissolved Oxygen (mg/L)
Depth (m)
9.00
6.50
Bottom Profile
9.00
8.00
7.00
6.00
5.00
4.00
pH
7.95
Bottom Profile
8.05
7.85
7.65
7.45
Distance from Inflow (miles)

Figure 4.-Isopleths of conductivity and turbidity, March 26, 1996 using data collected from ten locations in a line from the confluence of Las Vegas Wash to Hoover Dam.





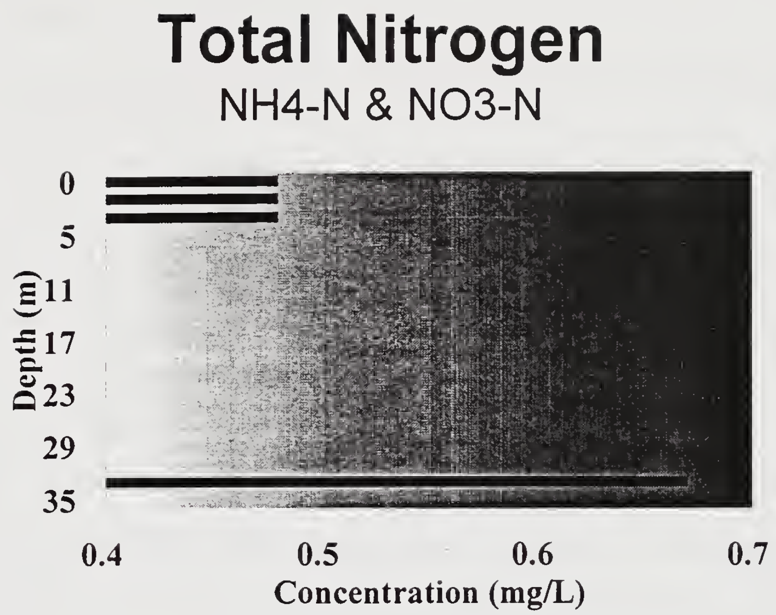
Distance from Inflow (miles)

Figure 5.-Plots of total nitrogen concentration calculated from ammonia and nitrate. Samples were collected March 26, 1996.

A.-Graph displays data from surface to bottom at station LV14.

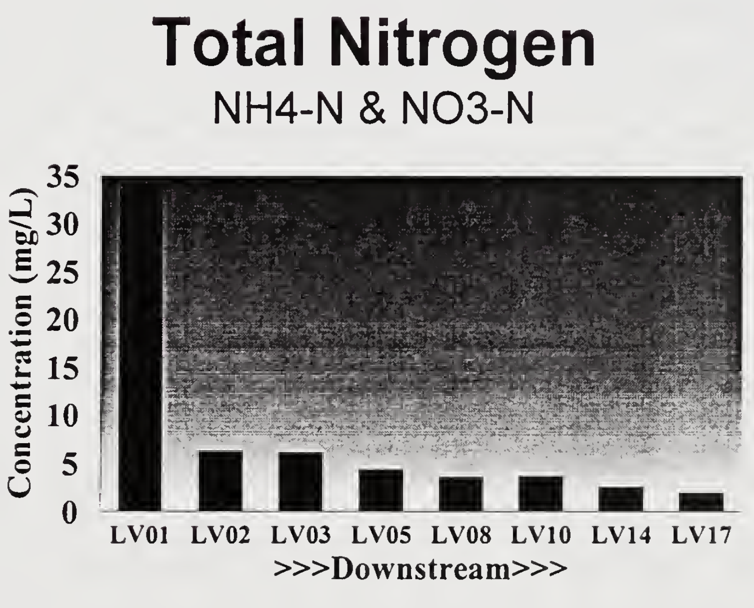
B.-Graph displays data from samples collected in the plume detected in the water columns at each of the sampling stations.

A



Total Nitrogen
NH4-N & NO3-N
Depth (m)
0
5
11
17
23
29
35
0.4
0.5
0.6
0.7
Concentration (mg/L)

B



Total Nitrogen
NH4-N & NO3-N
Concentration (mg/L)
35
30
25
20
15
10
5
0
LV01
LV02
LV03
LV05
LV08
LV10
LV14
LV17
>>>Downstream>>>

PEER REVIEW DOCUMENTATION

PROJECT AND DOCUMENT INFORMATION

Project Name Las Vegas Wash Effluent WOID LC089

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Leadership Team Member John C. Lease

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Document Author(s)/Preparer(s) James F. LaBounty and Michael Horn

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REVIEW REQUIREMENT

Part A: Document Does Not Require Peer Review

Explain ______________________

Part B: Document Requires Peer Review: SCOPE OF PEER REVIEW

Peer Review restricted to the following Items/Section(s): Reviewer:

REVIEW CERTIFICATION

Peer Reviewer - I have reviewed the assigned Items/Section(s) noted for the above document and believe them to be in accordance with the project requirements, standards of the profession, and Reclamation policy.

Reviewer: Richard Roline Review Date: 4/5/96 Signature

Reviewer: [signature] Review Date: 4-5-96 Signature

Preparer - I have discussed the above document and review requirements with the Peer Reviewer and believe that this review is completed, and that the document will meet the requirements of the project.

Team Member: James F. LaBounty Date: April 8, 1996
Signature