Physical and Chemical Characteristics of Lake Powell at the Forebay and Outflows of Glen Canyon Dam, Northeastern Arizona, 1990–91

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CONTENTS

	Page
Abstract	1
Introduction	1
Purpose and scope	2
Acknowledgments	2
Previous investigations	2
Description of Glen Canyon Dam and Lake Powell.	3
Approach to sample collection and measurement of physical and chemical constituents	5
Lake-profile measurements	7
Lake sampling	8
Outflow measurements and sample collection	11
Sample processing	11
Light-penetration and water-transparency measurements	12
Quality assurance	13
Physical and chemical characteristics of the forebay	14
Stratification and destratification	14
Chemical distribution	21
Major ions	21
Nutrients	21
Metals	24
Organic carbon	24
Light penetration and water transparency	26
Characteristics and comparison of the forebay with the outflows	26
Summary	30
Characteristics of the forebay	30
Characteristics and comparison of the forebay with the outflows	30
Selected references	31
Basic data	33
Depth-profile data	35
Nutrient and organic-carbon data	50
Major ions and metal data	58

FIGURES

1 Map showing location of the study area ... 4

2. Sketch showing cross section of Glen Canyon Dam ... 5

3. Hydrograph showing lake-level elevations of Lake Powell and releases from Glen Canyon Dam, 1990–91 ... 6

4–5. Sketches showing:

4. Plan view of forebay, tailwater, and sampling grid, Glen Canyon Dam ... 7

5. Cross section of draft-tube sampling area, Glen Canyon Dam ... 12

6–8. Graphs showing:

6. Specific conductance in grid 3 of the forebay of Lake Powell, 1990–91:

A. Lines of equal specific conductance ... 15

B. Profiles of specific conductance ... 15

7. Spatial specific-conductance profiles of the forebay, September 19, 1990 ... 15

8. pH in grid 3 of the forebay of Lake Powell, 1990–91:

A. Lines of equal pH ... 20

B. Profiles of pH ... 20

9–19. Graphs showing:
9. Spatial pH profiles of the forebay, September 19, 1990 20
10. Water temperatures in grid 3 of the forebay of Lake Powell, 1990–91:
A. Lines of equal water temperature 22
B. Profiles of water temperature 22
11. Spatial water-temperature profiles of the forebay, September 19, 1990 22
12. Vertical distribution of water temperature in the epilimnion, in the metalimnion, at penstock depth, and in the hypolimnion in grid 3 of the forebay of Lake Powell and at the outflows of Glen Canyon Dam, August 1990 to September 1991 23
13. Dissolved oxygen in grid 3 of the forebay of Lake Powell, 1990–91:
A. Lines of equal dissolved oxygen 23
B. Profiles of dissolved oxygen 23
14. Spatial dissolved-oxygen profiles of the forebay, September 19, 1990 24
15. Boxplots showing vertical distribution of dissolved sodium, dissolved sulfate, dissolved calcium, and dissolved magnesium in grid 3 of the forebay of Lake Powell and outflows of Glen Canyon Dam, September 1990 to August 1991 25
16. Lines of equal nitrite plus nitrate in grid 3 of the forebay of Lake Powell, 1990–91 26
17. Vertical distribution of dissolved strontium and dissolved lithium in grid 3 of the forebay of Lake Powell and outflows of Glen Canyon Dam, January 1991 to August 1991 27
18. Vertical distribution of dissolved organic carbon in grid 3 of the forebay of Lake Powell and outflows of Glen Canyon Dam, September 1990 to August 1991 27
19. Attenuation of incident light as photosynthetically active radiation in grid 18 of the forebay of Lake Powell, 1991 28

TABLES

1. Summary of physical and chemical measurements and analyses, 1990–91 8
2. Summary of turbine operation and sample locations in the forebay and draft tubes, Glen Canyon Dam, 1990–91 9
3. Statistical summary of selected physical and chemical constituents in the epilimnion in grid 3 of the forebay of Lake Powell 16
4. Statistical summary of selected physical and chemical constituents in the metalimnion in grid 3 of the forebay of Lake Powell 17
5. Statistical summary of selected physical and chemical constituents in the hypolimnion in grid 3 of the forebay of Lake Powell 18
6. Statistical summary of selected physical and chemical constituents in the penstock depth in grid 3 of the forebay of Lake Powell 19
7. Summary of Secchi-disk measurements and euphotic-zone depths in grid 18 of the forebay of Lake Powell, 1990–91 26
8. Statistical summary of selected physical and chemical constituents of the outflows (draft tubes) of Glen Canyon Dam 29
9–12. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations of the forebay of Lake Powell:
9. Grid 2, 1990 35
10. Grid 3, 1990–91 36
11. Grid 4, 1990 45
12. Grid 33, 1990–91 46

13. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in the outflows of Glen Canyon Dam, 1990–91 49
14–21. Concentrations of dissolved ammonia, nitrite, nitrite plus nitrate, orthophosphorus, and organic carbon of the forebay of Lake Powell:
14. Grid 2, 1990–91 50
15. Grid 3, 1990–91 52
16. Grid 4, 1990–91 56
17. Grid 33, 1990–91 56
18. Concentrations of dissolved ammonia, nitrite, nitrite plus nitrate, orthophosphorus, and organic carbon in the outflows (draft tubes) of Glen Canyon Dam, 1990–91 57
19. Concentrations of dissolved chloride and sulfate in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91 58
20. Concentrations of dissolved calcium, iron, magnesium, sodium, silica, and strontium in in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91 61
21. Concentrations of dissolved metals in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91 67

CONVERSION FACTORS

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
square foot (ft^2)	0.0929	square meter
mile (mi)	1.609	kilometer
acre-foot (ft)	0.001233	cubic hectometer
pound per square inch ($lb/in.^2$)	6,895	Pascal

Water temperatures are given in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by the following equation:

$$°F = 1.8 (°C) + 32$$

ABBREVIATED WATER-QUALITY UNITS

Chemical concentration is given only in metric units. Chemical concentration in water is given in milligrams per liter (mg/L) or micrograms per liter (μg/L). Milligrams per liter is a unit expressing the solute mass per unit volume (liter) of water. One thousand micrograms per liter is equivalent to 1 milligram per liter. For concentrations less than 7,000 milligrams per liter, the numerical value is about the same as for concentrations in parts per million. Specific conductance (conductivity) is given in microseimens per centimeter (μS/cm) at 25°C. Chemical concentration in material from core samples is given in grams per kilogram (g/kg) or micrograms per gram (μg/g). Micrograms per gram is equivalent to parts per million. Nanometer is a measurement of the position of the light spectrum that is being measured by the quantum sensor and is equal to a billionth of a meter.

VERTICAL DATUM

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—A geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

DEFINITION OF TERMS

[Definitions from Cole (1975), Merritt and Johnson (1977), Potter and Drake (1989), Wetzel (1983), and Wetzel and Likens (1991)]

Advective flow—A circulation process that is imposed by river inflows, outflows, and wind shear at the reservoir surface.

Chemocline—The zone where salinity or specific conductance increases rapidly with depth.

Convective flow—A vertical circulation process that is induced by density instability caused by cooling of the reservoir.

Epilimnion—The upper stratum of the water column of the reservoir. This layer generally is warm, circulating, and fairly turbulent.

Euphotic zone—The region in the reservoir from the surface to the depth at which 99 percent of the surface light has disappeared.

Forebay—The area of the reservoir that is immediately upstream from the dam face.

Hydraulic retention—The storage time of a reservoir that is determined by the reservoir volume divided by the annual discharge from the reservoir.

Hypolimnion—The lower stratum of the water column of the reservoir. This layer generally is undisturbed, and respiration and decomposition predominate.

Meromictic—A circulation process in which the reservoir does not undergo complete mixing; therefore, the upper layers of the reservoir do not mix with the bottom layer.

Metalimnion—The stratum between the epilimnion and the hypolimnion. This layer is defined by a steep thermal gradient.

Metalimnetic-oxygen maxima—Water that is supersaturated with oxygen and generally is a result of oxygen produced by algal populations that develop more rapidly than they sink.

Metalimnetic-oxygen minima—Water that is severely reduced in oxygen by various components such as zooplankton.

Penstocks—Dam structures that conduct water from the reservoir through the dam to the turbines in the powerplant. Glen Canyon Dam has eight penstocks and eight turbines.

Photosynthetically active radiation (PAR)—Radiation in the 400–700 nanometer waveband that is the light used by photosynthetic organisms.

Physical and Chemical Characteristics of Lake Powell at the Forebay and Outflows of Glen Canyon Dam, Northeastern Arizona, 1990–91

By Robert J. Hart *and* Kent M. Sherman

Abstract

The physical and chemical characteristics of Lake Powell have a direct effect on the quality of water below Glen Canyon Dam. Understanding the physical and chemical characteristics of the lake and outflows from the dam is essential in order to effectively manage the operation of the dam. During August 1990 to September 1991, physical and chemical measurements were made and water samples were collected in the forebay of Lake Powell and at the outflows (draft tubes) of Glen Canyon Dam to document the physical and chemical characteristics of water entering the Colorado River.

A persistent chemocline in the forebay of Lake Powell fluctuated seasonally during the study. Thermal stratification began in mid-April and persisted into late October. Spatial variation of specific conductance, pH, water temperature, and dissolved-oxygen concentration in the forebay was negligible. Sodium and sulfate were the dominant ions. Major ions, nutrients, and metals generally increased in concentration with depth in the forebay. Concentrations of dissolved nitrogen (as nitrite plus nitrate) in the forebay ranged from less than 0.02 to 0.58 milligrams per liter. Strontium and lithium were the most abundant metals. Dissolved organic carbon ranged from about 2.6 to 4.9 milligrams per liter with larger concentrations generally occurring in the epilimnion. No diel variations of chemical constituents were observed. Vertical-attenuation coefficients of light penetration in the forebay ranged from 0.058 to 0.080 microeinsteins per meter squared per second, and the euphotic depth ranged from about 82 to 113 feet.

Generally, the physical and chemical characteristics of outflows through the draft tubes of Glen Canyon Dam were similar to the physical and chemical characteristics of the water at penstock depth and deeper depths. Specific conductance ranged from 803 to 1,090 microsiemens per centimeter, and pH values ranged from about 7.2 to 8.0. Water temperatures measured in the outflows ranged from 7.0 to 9.0 degrees Celsius, and dissolved oxygen ranged from about 6.5 to 9.1 milligrams per liter. Concentrations of dissolved nitrogen (as nitrite plus nitrate) ranged from 0.13 to 0.74 milligrams per liter. Dissolved phosphorus (as orthophosphate) and ammonia (NH_4) generally were less than the minimum reporting level of 0.01 milligrams per liter.

INTRODUCTION

Understanding the physical and chemical characteristics of Lake Powell and outflows from Glen Canyon Dam is essential for effective management of the operation of the dam because these characteristics and outflows have a direct effect on downstream water quality. The Glen Canyon Environmental Studies (GCES), a program of the Bureau of Reclamation (BOR), was begun in 1982 to support the collection of scientific data and information on the effects of dam operation on the downstream ecosystem of the Colorado River. An Environmental Impact Statement (EIS) on the effects of dam operation was prepared using information from the GCES during this study. To help meet the goals of the GCES, the U.S. Geological Survey (USGS) was asked to determine the physical and chemical characteristics of Lake Powell in the forebay area of the dam and outflows from the dam and the relation of these characteristics to the downstream environment. Retrofitting the dam with a multiple-intake structure is being considered. This structural alteration to the dam would provide flexibility for management of reservoir releases from Lake Powell in the quality of water released from the lake, especially during the stratified periods. Information from this study can be used to evaluate the effects that alteration of the intake structure would have on the general water chemistry of the lake and river.

The influence of Lake Powell on the Colorado River below Glen Canyon Dam is a long-term process and is extensive in the length of the river. The properties and productivity of the river water depend on the thermal and chemical properties of the outflow water and also on the release pattern from the dam. Many ecological changes in the Colorado River are caused by the presence of Glen Canyon Dam. For example, (1) the constant low temperature (approximately 8°C) of the river is due to the thermal stratification in Lake Powell and to the depth of the penstock intakes in the water column of the lake, (2) the lack of suspended sediment in the river below the dam is due to sediment deposition in the lake, and (3) the nutrient regime in the river below the dam varies in response to physical, chemical, and biological processes that occur in the lake.

Purpose and Scope

The purpose of the report is to describe and compare the physical and chemical characteristics of water in the forebay and outflows (draft tubes) of Glen Canyon Dam. The scope of the report includes a description of field and laboratory methods, discussion and statistical summary of the physical and chemical characteristics of the forebay and outflow waters, and tabulation of basic data collected during the study.

Acknowledgments

Richard White, BOR, arranged for access to Glen Canyon Dam draft tubes and supplied information. William Vernieu, BOR, loaned equipment and assisted with sampling. Charles Wood, Glen Canyon National Recreation Area (GCNRA) provided laboratory and storage space. Brian Bagley and Ted Angradi of the Arizona Game and Fish Department (AGFD) contributed substantial time for sampling and use of equipment. In addition, many volunteers from across the United States assisted with sampling in two intensive water-quality synoptic studies during this study.

Previous Investigations

The Lake Powell Research Project (LPRP) was a comprehensive investigation done from 1971 to 1976 during the initial filling stage of the reservoir, which was from 1963 to 1980. Potter and Drake (1989) summarized the major findings of the LPRP and listed reports produced by LPRP in an appendix. Lake Powell was found to be thermally and chemically stratified from late spring through early winter (Merritt and Johnson, 1977). The LPRP also documented that the stratification of Lake Powell influences many chemical and biological processes in the lake and, as a result, influences the characteristics of water that is released to the Colorado River below the dam. Although the water that came into the lake mixed with water at the bottom of the upstream end of the lake, the greater depths (about 600 feet) in relation to the surface area in the forebay probably prevented complete vertical mixing in some years. Cold high-salinity water entered the lake in the winter. In other seasons a warmer, less saline water that contained greater amounts of sediment entered the lake. Stratification occurred as the warmer, less dense water formed a surface layer as it flowed toward the dam. Warming of surface water by solar radiation in the summer contributed to the development of stratification (Potter and Drake, 1989, chapter 11).

Several studies relating to the water chemistry in the lake were made during the 1970's. Kidd and Potter (1978) concluded that the lake served as a cation trap for all the elements that were studied except lead. Kidd and Potter examined the dissolved and particulate phase of the elements investigated. Reynolds and Johnson (1974) found that from 1971 to 1973 the average salinity of the lake was about 500 mg/L. Staniford and others (1973) analyzed sediments and biota for accumulation of mercury and found that concentrations of mercury in bottom sediments averaged about 30 µg/L.

Blinn and others (1976) measured transparency and light extinction of the shallow side canyon and open bay of Warm Creek from 1972 to 1974. Secchi-disk and photometer measurements were made to determine seasonal light conditions of the bay at Warm Creek. Blinn and others (1976) determined that the mean depth penetration of 1-percent surface incident light was 28.5 and 38.4 ft for the shallow canyon and bay area, respectively. Extinction coefficients for the bay area of Warm Creek ranged from 0.265 to 0.480 near the surface and from 0.020 to 0.049 at about 65 ft below the water surface during October 1973 to June 1974.

The BOR has been measuring chemical and physical characteristics of the lake and collecting water samples for analysis of selected constituents since 1963 (William Vernieu, BOR, written commun., 1991). The primary objective is to monitor the salinity of the lake. The AGFD investigated the biological and chemical characteristics of the forebay and tailwaters of the dam concurrently with this study as a part of the GCES program. The main objective of the AGFD study was to determine primary production, organic matter, nutrient-loading rates, and budgets for the tailwater area from just below the dam to Lees Ferry. In addition to the work by the BOR and AGFD, the GCNRA has a summer coliform-monitoring program for selected camping beaches along the lake.

Description of Glen Canyon Dam and Lake Powell

Water is released from Lake Powell to the Colorado River below Glen Canyon Dam through eight penstocks (figs. 1 and 2). The penstock intakes are at an elevation of 3,470 ft and withdraw water from the hypolimnion when the lake is near maximum capacity. The minimum lake-level elevation necessary to produce power is 3,490 ft, which is 20 ft above the elevation of the penstocks (fig. 2). The placement and construction of Glen Canyon Dam was a result of the Colorado River Compact of 1922. The BOR operates the dam on a daily basis to meet power-production requirements established by the Western Area Power Administration (WAPA).

The water chemistry of Lake Powell is controlled by the inflows of the three major tributaries to the lake—the San Juan, Green, and Colorado Rivers. Reynolds and Johnson (1974) determined that water in the San Juan River was a sulfate type, water in the Green River was a bicarbonate type, and water in the Colorado River was a chloride type. The physical mixing of the three tributaries occurs in the lake by advective and convective processes. Three distinct advective inflow periods occur in the lake: (1) During the winter, cold, saline water enters the reservoir and moves along the bottom of the lake as an underflow-density current (the inflow currents flow along the bottom of the reservoir); (2) during the spring and into early summer, warm, low-salinity, and sediment-ladened inflows enter the reservoir from snowmelt runoff as an overflow-density current (the inflow currents flow on the top of the reservoir); and (3) during the summer and into the fall, an interflow-density current (the inflow currents flow into the reservoir as a wedge dividing the top from the bottom waters) prevails because of warm, clear, and high-salinity waters that enter the lake. Convective mixing is incomplete in the forebay because of the small surface-to-volume ratio. The zone of withdrawal that is caused by the penstock intakes probably has a major influence on circulation patterns particularly in the forebay. The lake is chemically and thermally stratified in the forebay during the summer; the lower 250 ft or so has a constant cold temperature of about 8°C.

Lake Powell began storing water in 1963 and reached full conservation pool elevation (3,700 ft above sea level) during 1980. The lake is more than 140 mi in length and can reach a depth of about 600 ft, depending on the water elevation. Storage capacity of the lake is 27,000,000 acre-ft, and the "law of the river" (a series of legal

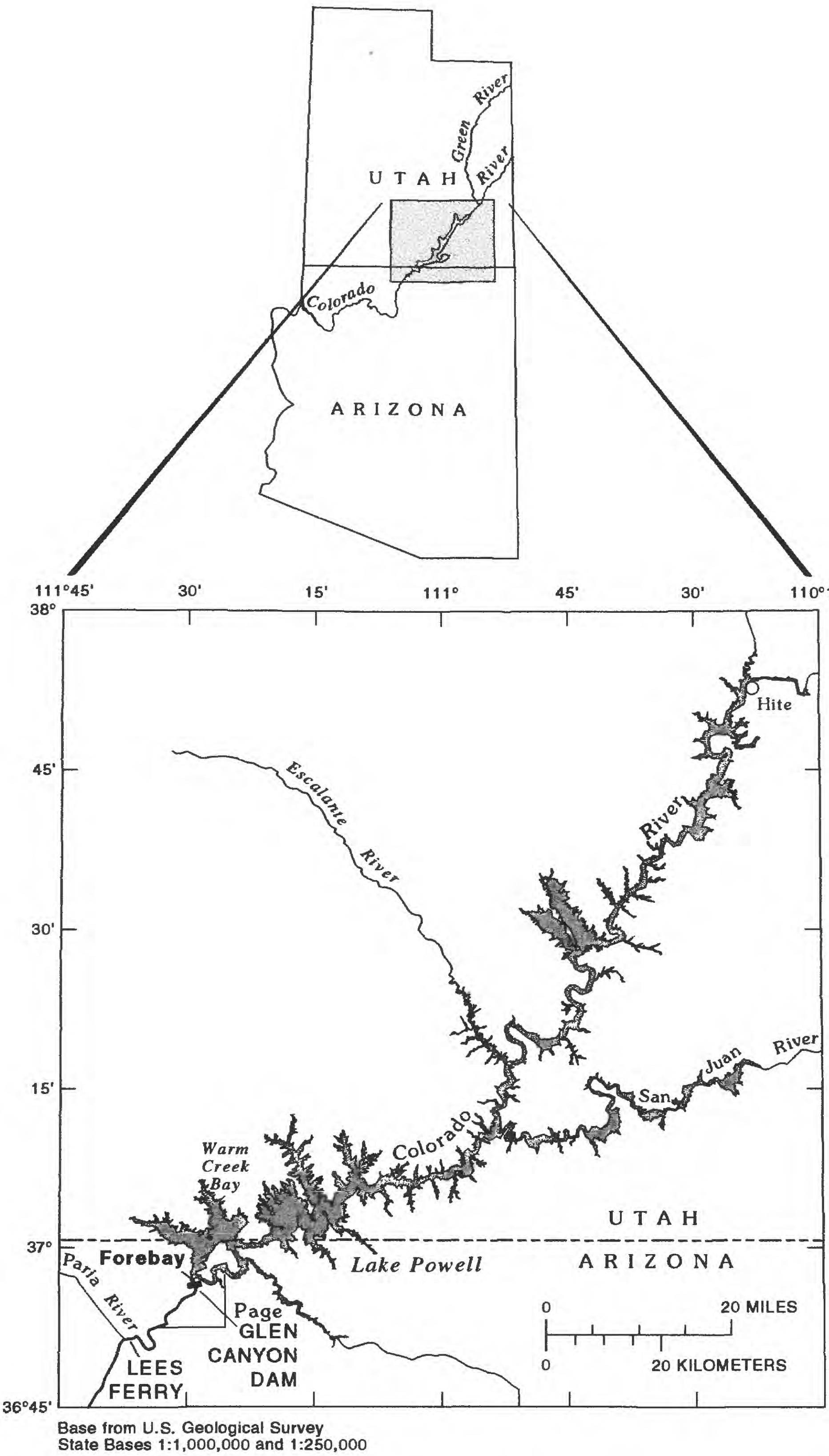

Figure 1. Location of the study area.

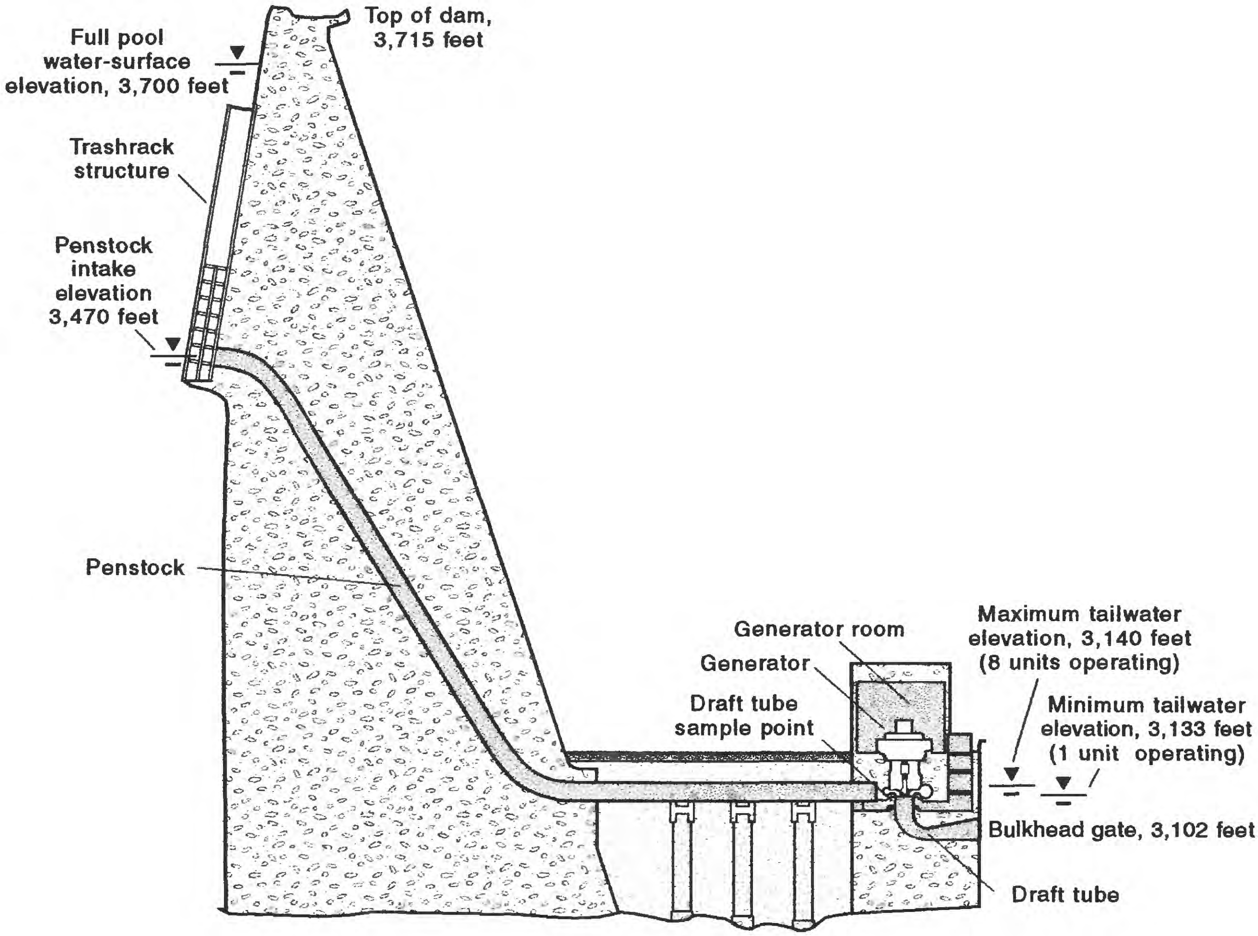

Figure 2. Cross section of Glen Canyon Dam. Elevations are in feet above sea level.

documents that control mass allocations of water between the upper and lower Colorado River basins) requires an annual release of 8,230,000 acre-ft to downstream users. The hydraulic retention time of the lake varies but could reach about 3.3 years as compared with 3.7 years for Lake Mead, 0.2 years for Lake Mohave, and 0.1 years for Lake Havasu, Arizona (Paulson and Baker, 1984). A long-term drought has affected much of the southwestern United States since the mid-1980's and contributed to the decline of the levels of Lake Powell during this period. The water level declined about 19 ft during 1990–91, and the elevation in September 1991 was about 70 ft below full conservation-pool elevation (fig. 3). During the past decade, lake levels have been such that the penstocks were withdrawing water from the hypolimnion, the deep layer of water where water temperatures are 7 to 8°C. Because lake levels have been declining, the upper boundary of the hypolimnion approached the elevation of the penstocks during the latter part of the sampling period of this study.

APPROACH TO SAMPLE COLLECTION AND MEASUREMENT OF PHYSICAL AND CHEMICAL CONSTITUENTS

Water samples were collected, and measurements were made from a 17-foot V-hull boat equipped with a 150-horsepower outboard motor. A 10-horsepower motor was used to position the boat. Positioning was achieved by observing a distinguishing mark on the face of the dam and a physical feature on the canyon wall. A sonic-depth sounder was used as an aid for positioning the boat observations were made at 6-hour intervals for 48 hours (R.C. Averett, hydrologist, USGS, written commun., 1991).

Lake-Profile Measurements

Vertical profiles of specific conductance, pH, water temperature, and dissolved-oxygen concentration were measured with a multiparameter instrument (all probes housed in a single sounder unit). The multiparameter instrument was calibrated with specific conductance and pH buffer standards before each sampling trip. The specific-conductance probe was calibrated with known standards that bracketed the expected field values. The pH probe was calibrated using buffer solutions of pH 7.0 and 10.0 and checked with a buffer

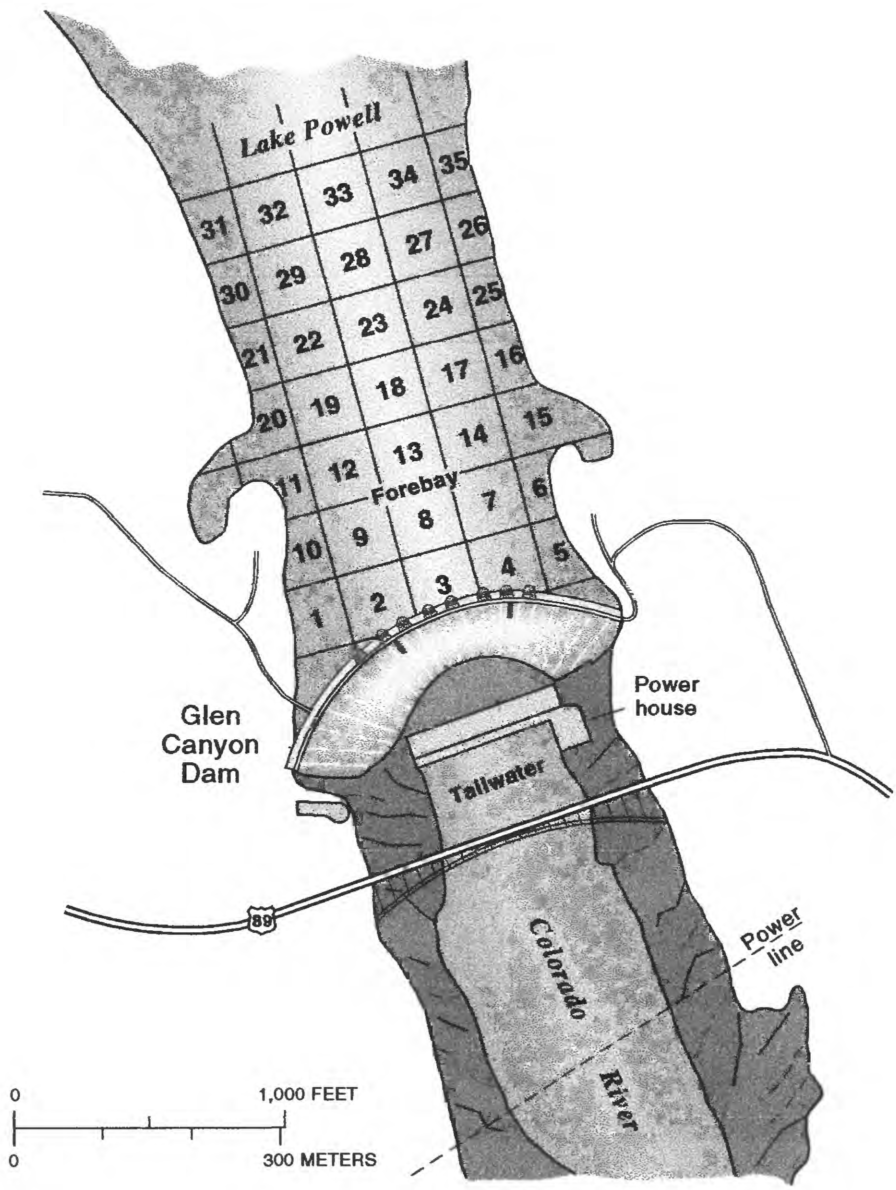

Figure 4. Plan view of forebay, tailwater, and sampling grid, Glen Canyon Dam.

Table 1. Summary of physical and chemical measurements and analyses, 1990–91

[P, depth profile; L, lake sample; D, draft-tube sample. Dashes indicate no data]

Date of sample	Lake elevation, in feet above sea level	Method of sampling	Depth profiles	Physical and chemical measurements				Light penetration	
				Major ions	Metals	Nutrients	Organic carbon	Submarine-quantum sensor	Secchi disk
1990									
August 15–16	3,644	([1])	P	---	---	L	---	---	---
September 5–6	3,640	([1])	P	L/D	L/D	L/D	L/D	---	L
September 19–20	3,639	([1])	P	L/D	L/D	L/D	L/D	---	---
November 3–6	3,637	([2])	P	L/D	L/D	L/D	L/D	---	---
December 7	3,636	([3])	P	---	---	---	---	---	L
1991									
January 15–17	3,632	([2])	P	L/D	L/D	L/D	L/D	---	L
February 27	3,629	([3])	P	---	---	---	---	---	L
March 27–29	3,628	([2])	P	L/D	L/D	L/D	L/D	---	L
April 24–25	3,627	([3])	P	---	---	---	--	L	L
May 22–23	3,629	([2])	P	L/D	L/D	L/D	L/D	L	L
June 15–20	3,637	([2])	P	L/D	L/D	L/D	L/D	L	L
July 31–August 1	3,636	([3])	P	---	---	---	---	L	L
August 28–29	3,632	([2])	P	L/D	L/D	L/D	L/D	L	L
September 23	3,630	([3])	P	---	---	---	---	L	L

[1]Samples collected by hose and peristaltic pump.
[2]Samples collected by Van Dorn-type sampler.
[3]Samples were not collected.

solution of pH 4.0. The water-temperature probe was checked for accuracy with a thermometer approved by the American Society for Testing and Materials (ASTM) or the National Institute of Standards and Technology (NIST). The dissolved-oxygen probe was calibrated and compared to a solution having a zero dissolved-oxygen concentration. After field measurements were made, calibration of the sounder unit was rechecked with known standards, and all values were within 5 percent of the initial calibration.

Measurement points in the water column at a sampling grid were selected to define the change with depth of each constituent. The smallest measurement interval of 5 ft was in the metalimnion; whereas, the largest interval of 30 ft was in the hypolimnion.

Lake Sampling

Sampling points and times were selected to define seasonal, spatial (longitudinally and laterally in the forebay at a given position in the water column), vertical, and diel variations. Point samples generally were collected at four different depths in the water column at each sampling time. Fixed-sampling depths of 3 ft (not sampled during nonstratified conditions) and 390 ft were selected to represent the epilimnetic and hypolimnetic waters, respectively. A sample also was collected at the elevation of the penstocks, which varied depending on the lake elevation. The fourth sampling point, at a depth of 40 to 50 ft, was at the maximum concentration of dissolved oxygen in the metalimnion during stratified lake conditions. Sample locations and times depended on turbine operation (table 2).

Table 2. Summary of turbine operation and sample locations in the forebay and draft tubes, Glen Canyon Dam, 1990–91

[S, sample obtained; X, turbine operating; M, draft tube mechanically faulty, no sample obtained; A, draft tube discharging mostly air, no sample obtained. Dashes indicate no data]

Date of sam–pling	Time of sampling	Samples collected from grids on Lake Powell				Samples collected from turbine operation and draft tubes								Remarks
		2	3	4	33	1	2	3	4	5	6	7	8	
1990														
08–16	1400–1530	---	---	---	S	X	X	X	X	X	X	X	X	Draft tubes not sampled.
09–06	0830–0950	---	S	---	---	X,M	X,S	X,S	X,M	X,S	---	X,S	---	Turbines 1 and 3 activated during sampling period.
09–06	1538–1615	---	S	---	---	X,M	X,S	X,S	X,M	X,S	X,S	X,S	X,S	
09–06	2125–2207	---	S	---	---	X,M	X,S	X,S	X,M	X,S	X	X,S	---	Turbine 6 shut down during sampling period.
09–20	0925–1105	---	S	---	---	X,M	X,S	X,S	X,M	X,S	X,S	X,S	X,S	
09–20	1515–1645	---	S	---	X,S	X,S	X,S	X,S	X,S	X,S	X,S	X,S	X,S	
09–20	2125–2245	---	S	---	---	X	X,S	X,S	---	X,A	---	---	---	Turbines 1, 2, and 3 shut down during sampling period.
11–05	0545–0910	S	S	S	---	X	X	X	X,A	---	---	---	---	Turbines 1, 2, and 3 activated during sampling period.
11–05	1120–1300	S	S	---	---	X,S	X,S	X,S	X,S	---	---	---	---	
11–05	1740–1830	S	S	---	---	X,S	X,S	X,S	X,S	---	---	X	---	Turbine 7 activated during sampling period.
11–06	0001–0200	S	S	---	---	X,A	---	X,S	---	---	---	---	---	Partial sample at grid 3 due to bad weather.
11–06	0600–0645	S	S	---	---	X,A	---	X,S	---	---	---	---	---	
11–06	1200–1300	S	S	S	---	---	X,S	X,S	X	---	---	X,S	---	Turbine 4 shut down during sampling period.
11–06	1800–1900	S	S	--	X,S	X,S	X,S	X,S	---	---	---	X,S	---	
11–06/07	2350–0200	S	S	--	---	---	X,A	X,S	---	---	---	X	---	Turbine 7 shut down during sampling period.
1991														
01–16	0655–0745	---	---	---	---	X,S	---	X,S	X,S	X,S	X	X,S	---	Draft-tube sample only; no lake sample due to faulty generator. Turbine 6 activated during sampling period.
01–16	1300–1515	S	S	S	---	X,S	---	X	X,S	X,S	X	X,S	---	Turbines 3 and 6 shut down during sampling period.

Table 2. Summary of turbine operation and sample locations in the forebay and draft tubes, Glen Canyon Dam, 1990–91—Continued

Date of sam–pling	Time of sampling	Samples collected from grids on Lake Powell				Samples collected from turbine operation and draft tubes								Remarks
		2	3	4	33	1	2	3	4	5	6	7	8	
1991—Continued														
01–16	1955–2155	S	S	S	---	X,S	---	X,S	X,S	X,S	X	X,S	---	Turbine 1 shut down during sampling period.
01–17	0700–0900	S	S	S	---	X,S	---	S	X	X,S	X,S	X	---	Turbine 7 activated during sampling period.
03–28	0700–0945	S	S	---	S	X,A	---	---	X	X,S	X,S	X,S	X,S	Turbines 4 and 7 activated during sampling period.
03–28	1300–1605	S	S	---	S	X,S	---	---	X,S	X,S	X,S	X,S	X,S	Turbines 1 and 7 shut down during sampling period.
03–28	2005–2243	S	S	---	S	X,S	---	---	X,S	X,S	X,S	X,S	X,S	Turbines 1 and 8 shut down during sampling period.
05–23	0740–0950	S	S	---	---	---	---	X,S	X,S	X,S	X,S	X,S	---	
05–23	1430–1630	S	S	---	---	---	---	X,S	X,S	X,S	X,S	X,S	---	
05–23	2120–2306	S	S	---	---	---	---	X,S	X,S	X,S	X,S	X,S	---	
06–18	1200–1500	S	S	---	---	X,S	X,S	X,S	X	X,S	X,S	X,S	X,S	
06–18	1800–1915	S	S	---	---	X,S	X,S	X,S	X,S	X,S	X,S	X,S	X,S	Partial sample at both grids due to bad weather
06–18/19	2305–0100	S	S	---	---	---	X,S	X	X,S	X,S	X	X,S	X	Turbines 3, 6, 7, and 8 shut down during sampling period.
06–19	0530–0800	S	S	---	---	X,S	X,S	S	X,S	X,S	X,S	S	X,S	Turbines 1, 4, 6, and 8 activated during sampling period.
06–19	1200–1415	S	S	---	---	X,S	X,S	X,S	X,S	X,S	X,S	X,S	X,S	
06–19	1740–2005	S	S	---	---	X,S	X,S	X,S	X,S	X,S	X,S	X,S	X,S	Partial sample at grid 2 due to bad weather.
06–19/20	2315–0120	S	S	---	---	X	X	X	X,S	X,S	X	X	X	Turbines 1, 2, 3, 6, 7, and 8 shut down during sampling period.
06–20	0500–0740	S	S	---	---	---	X	---	X,S	X,S	X	---	X	Turbines 2 and 8 activated during sampling period.
08–29	0630–0830	---	S	---	---	X,S	---	X,S	X,S	X,S	X	---	---	Turbine 5 activated during sampling period.
08–29	1200–1430	---	S	---	---	X,S	---	X,S	X,S	X,S	X,S	---	X,S	
08–29	1910–2045	---	S	---	---	X,S	---	X,S	X,S	X,S	X,S	---	X,S	

Water samples collected on August 15–16 and September 6 and 20, 1990, were obtained by pumping water from predetermined depths using a peristaltic pump and polyethylene tubing. Beginning with the sampling trip on November 5, 1990, Van Dorn-type samplers were used to collect samples instead of the pumping method. The Van Dorn-type samplers (beta bottle) were suspended from an electrically powered winch cable. One 6-liter sampler was used for each depth sampled. Concern for possible contamination of the samples by exterior metal hardware and molds used in manufacturing the sampler prompted the change to a nonmetallic Kemmerer bottle for the collection of water for metal analyses beginning with the sampling trip in January 1991. The Kemmerer bottle was suspended by a nylon cord and triggered with a nonmetallic messenger.

To meet quality-assurance and quality-control specifications, samplers were rinsed thoroughly with lake water and then refilled with lake water and left overnight before the sampling time. Additionally, one spare Van Dorn-type sampler and the Kemmerer bottle were rinsed several times with deionized water and stored with deionized water. After the samplers had soaked in deionized water for about a half hour, a complete sample was decanted and prepared for analysis of major ions, nutrients, metals, and organic carbon in the same manner as a lake sample.

The boat used during sample collection was positioned at the center of the desired station location (grid) and measurements of specific conductance, pH, water temperature, and dissolved oxygen were made. Samples for chemical analysis were collected from the bow of the boat at the same time as field measurements were being made. Water for chemical analysis was decanted from the samplers into teflon bottles and chilled until filtering could be completed at the field laboratory.

Outflow Measurements and Sample Collection

Outflow from the dam was measured and sampled through the dam's eight draft-tube structures (fig. 5). Simultaneous operation of all turbines occurred only when dam releases were large, and only those draft tubes with flow were measured and sampled (table 2). Draft tubes that pulsated excessively with little discharge were not sampled. Water was drawn from each draft tube by a "T" valve. Water temperature and dissolved-oxygen concentrations were measured before samples were collected. To facilitate sampling, a hose with a PVC fitting was adapted to screw or pressure fit to the draft-tube "T" valve. The end of the hose was set in the base of a plastic bottle so that water welled up past the dissolved-oxygen probe. Dissolved-oxygen concentrations were monitored until a stable reading was obtained. Water samples were collected in a teflon-coated, brass, churn splitter (about 7-liter capacity). Equal water volumes were collected from all sampled draft tubes to make up the outflow sample. The sample was immediately transported to the field laboratory where specific conductance, pH, and alkalinity measurements were made.

Sample Processing

Water samples were transported from the lake and draft tubes to a field laboratory for immediate processing and preservation in preparation for shipment to the analytical laboratory. The same care was taken with the filtration process of the samples for laboratory analysis as in collection of the sample. A chemically inert apparatus designed by the USGS National Research Laboratory (NRL) was used to split and filter samples for analysis of major ions and metals. This apparatus was made of teflon components, and the samples were filtered with a vacuum pump (at no greater than 25 $lb/in.^2$) through a 0.4-micrometer nucleopore filter. These samples were preserved using NRL methods. Samples collected for nutrient and organic-carbon analysis were filtered through a stainless-steel apparatus using nitrogen gas to force the sample through the filter. A 0.45-micrometer silver-membrane filter was used for filtering water for nutrient and organic-carbon analysis. The filtrate was preserved using NRL methods. Teflon tweezers were used to handle all filters during processing (H.E. Taylor, hydrologist, USGS, written commun., 1990).

Lake and draft-tube samples were analyzed by the NRL and the USGS National Water Quality

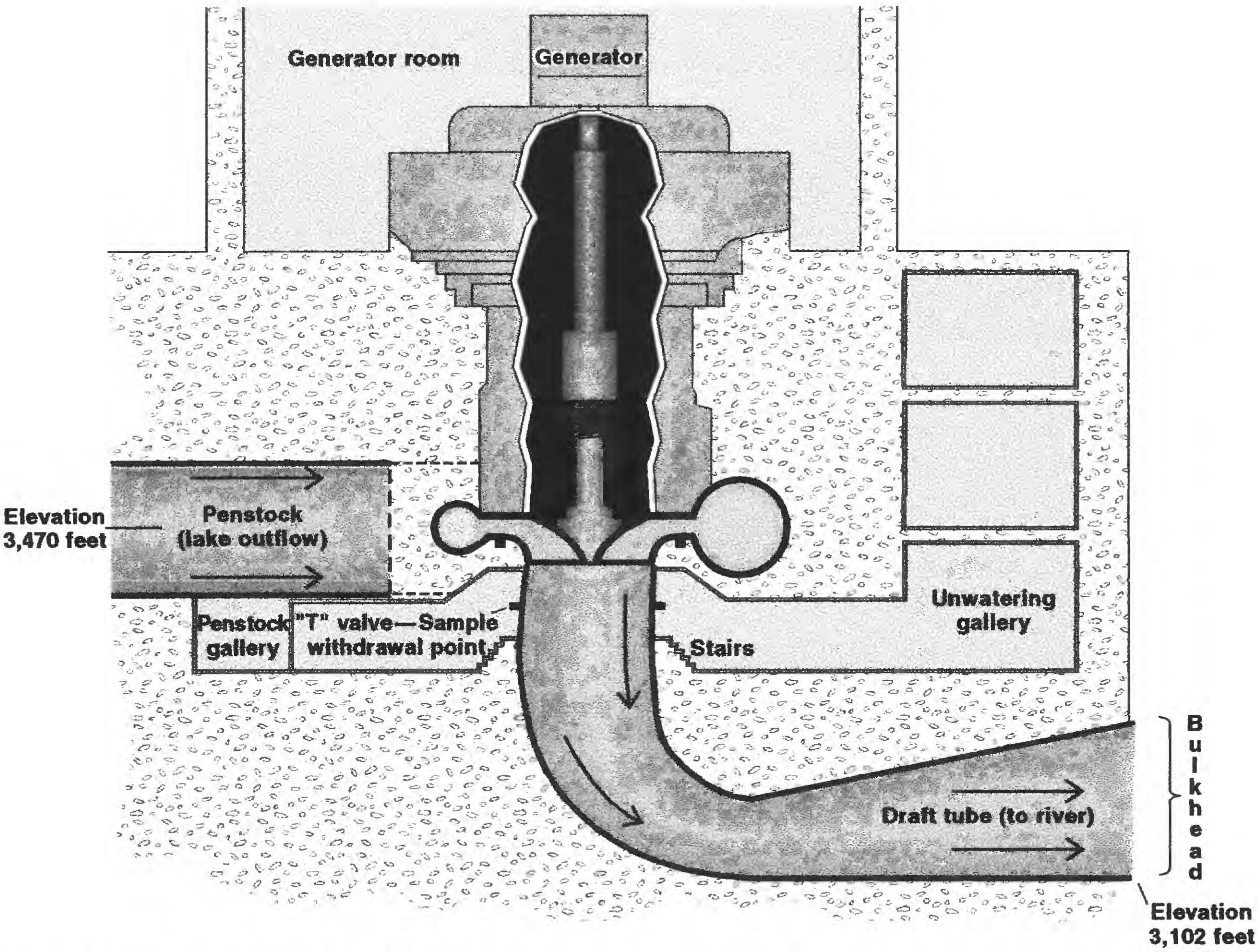

Figure 5. Cross section of draft-tube sampling area, Glen Canyon Dam. Elevations are in feet above sea level.

Laboratory (NWQL). Concentrations of major cations and metals were determined by either atomic adsorption and inductively coupled plasma atomic-emission spectrometry or a combination of electrothermal-vaporization atomic-absorption spectrometry and inductively coupled plasma-mass spectrometry (ICP-MS). These methods were developed by the NRL specifically for the simultaneous multielement analysis of natural waters (Garbarino and Taylor, 1979, 1985). The ICP-MS technique provides for the direct analysis in water of most elements in the periodic table to minimum reporting level on levels ranging from 0.01 to 0.5 μg/L, depending on the specific element. Relative precisions of 5 percent or better are achieved routinely. Concentrations of major anions, nutrients, and organic carbon were measured using ion chromatography, ultraviolet-visible-infrared adsorption spectrometry, and electrochemical procedures (Garbarino and Taylor, 1987; Taylor, 1987, 1989).

Light-Penetration and Water-Transparency Measurements

Light penetration in the forebay (grid 18) was measured with a submarine quantum sensor to determine the amount of photosynthetically active radiation (PAR). The quantum sensor measures PAR as the number of quanta received on a plane surface in the 400- to 700-nanometer range of the light spectrum. Measurements are expressed in microeinsteins per meter squared per second ($\mu E/m^2$)/s, where 1 μE equals 6.02 x10^{17} quanta. Measurements were made near the water surface in direct sun and where light reflection off the hull of the boat was at a minimum. Measurements were made at enough points in the vertical to determine a mean vertical-attenuation coefficient ($\bar{k}$) for characterizing the extent to which PAR was attenuated. Calculations were made for each depth measured using the equation:

$$k = \frac{(lnI_o - lnI_z)}{z}, \qquad (1)$$

where

k = attenuation coefficient,

l_n = natural log,

I_o = initial quantum irradiance just below the water surface,

I_z = quantum irradiance at depth, z, and

z = depth.

The attenuation coefficient (k) for a vertical profile of incident light was derived by averaging the individual attenuation coefficients at each measured depth in the profile. The euphotic zone (the depth where 1 percent of the surface incident light remains) was estimated by the equation:

$$z_{1\%} = \frac{(ln100 - ln1)}{\bar{k}}, \qquad (2)$$

where

$z_{1\%}$ = depth where 1 percent of the surface-incident light remains, and

$\bar{k}$ = mean vertical-attenuation coefficient.

Water transparency of the forebay was measured at grid 18 using an 8-inch Secchi disk. An effort was made to make measurements during cloudless periods between 1000 and 1400 hours, and measurements generally were made at about 1200 hours when atmospheric and lake scattering and (or) absorption of light was less than at lower sun angles. Secchi-disk measurements are more convenient to make and require less time than quantum-sensor measurements; however, they generally underestimate the euphotic-zone depth. Secchi-disk measurements, therefore, were correlated with quantum-sensor measurements, and correction factors were computed and applied to the Secchi-disk values. Correction factors will vary for water depending on the color and turbidity of the water.

Quality Assurance

For quality-assurance purposes during each sampling trip, samples of deionized water were collected and analyzed from holding containers, lake samplers, and the Teflon-coated churn splitter that was used to collect water samples from the draft tubes of the dam. These samples are referred to as equipment blanks. Some concentrations of metals, including chromium, manganese, copper, and zinc in the blanks, indicate that contamination may have been introduced during some sampling trips. Contamination of samples can be caused by several factors including sample handling and collection procedures, materials of samplers and holding containers, improper cleaning of samplers and containers, and laboratory processing. Elevated concentrations of metals were not observed in all sampling trips. Laboratory analyses of these samples are included in the Basic Data section of this report. The NRL provided deionized (DI) water for the program that was used for rinse and sampler preparation. The specific conductance of the DI water always had a value of less than 10 μS/cm. Before water samples were collected from the draft tubes and from the lake, DI water was decanted and stored in the churn splitter and lake samplers (beta and Kemmerer bottles) for a specified amount of time. Water from the splitter and samplers then were decanted into appropriate water bottles used to store water samples for laboratory analysis.

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE FOREBAY

Stratification and Destratification

Water in the forebay of Glen Canyon Dam underwent a stratification and destratification process during the study. Stratification occurs when lake waters form temperature layers—the epilimnion, metalimnion, and hypolimnion. The epilimnion consisted of water from the lake surface to about 59 ft below the lake surface. The metalimnion consists of waters ranging from about 60 to 180 ft below the lake surface, and the hypolimnion began at about 181 ft below the lake surface. Water withdrawn from the penstock (elevation 3,470 ft) generally was from the deep zone of the metalimnion into the hypolimnion during the study. Because of fluctuating lake levels during the study, the elevation of the penstocks ranged from about 157 to 177 ft below the lake surface.

The withdrawal of water through the eight penstocks of the dam produces a hydraulic effect that can alter stratification and destratification, particularly in the forebay area. The circulation effects caused by this zone of withdrawal were not measured during this study. The absence of those data leaves a gap in understanding the effects of the penstocks on the circulation or stratification-destratification processes in the forebay. On the basis of the results of a numerical model, Merritt and Johnson (1977) determined that withdrawal affects a zone that extends from 100 ft above to 120 ft below the center line of the penstock openings. The size of the zone depends on the withdrawal rate and, to some extent, on the density stratification. The zone was poorly defined because of limitations in field methods and model assumptions. Because of the interactions that the withdrawal zone has on the circulation processes in the lake, alternative methods for measuring this zone may be needed in future studies.

Specific-conductance measurements in the forebay showed a well-defined chemocline that persisted throughout the study period, indicating incomplete mixing or meromictic conditions (fig. 6). In this study, the chemocline was defined as the zone between the upper and lower layers of the lake where a steep specific-conductance gradient occurs. The chemocline fluctuated at depth probably because of seasonal variations of inflows and circulation patterns in the forebay. The depth of the chemocline was shallowest from spring to early summer and deepest during the winter. The chemocline fluctuated between the elevations of 3,320 and 3,550 ft and was about 70 to 100 ft thick. Specific conductance in this zone ranged from about 900 to 1,050 μS/cm from shallowest to deepest. Mean specific conductance was 851 μS/cm in the epilimnion, 872 μS/cm in the metalimnion, and 1,055 μS/cm in the hypolimnion (tables 3–6). Mean specific conductance at the penstock depth was 906 μS/cm (table 6). The chemocline was persistent and showed little spatial variability in the forebay area (fig. 7). No diel variations in specific conductance were observed during the study.

The pH ranged from a minimum of 6.7 in the hypolimnion to a maximum of 8.6 in the epilimnion (fig. 8 and tables 3 and 5). The larger values in the upper epilimnion of the forebay probably are related to photosynthetic processes because they generally occurred during the summer months. pH gradually decreased with depth through the metalimnion during periods of photosynthetic activity (summer, fall, and spring). During the winter months, pH ranged from about 7.8 in the epilimnion to 7.4 in the hypolimnion. In the forebay at penstock depth, pH ranged from about 7.0 to 8.1. Diel or vertical differences were not observed among four sites sampled in the forebay on September 19, 1990. Significant spatial differences were not observed (fig. 9).

Mixing of water in the forebay (destratification) began in October and continued through December during the study. A constant water temperature of about 8°C persisted during the winter months of January through March (fig. 10). Mean water temperatures in the epilimnion, metalimnion, and hypolimnion were 18.0, 9.8, and 7.3°C, respectively (tables 3–5). At penstock depth, mean water temperature was 7.8°C. The stratification process began in mid-April. A strongly stratified system that consisted of a well-defined epilimnion, metalimnion, and hypolimnion was developed by early June.

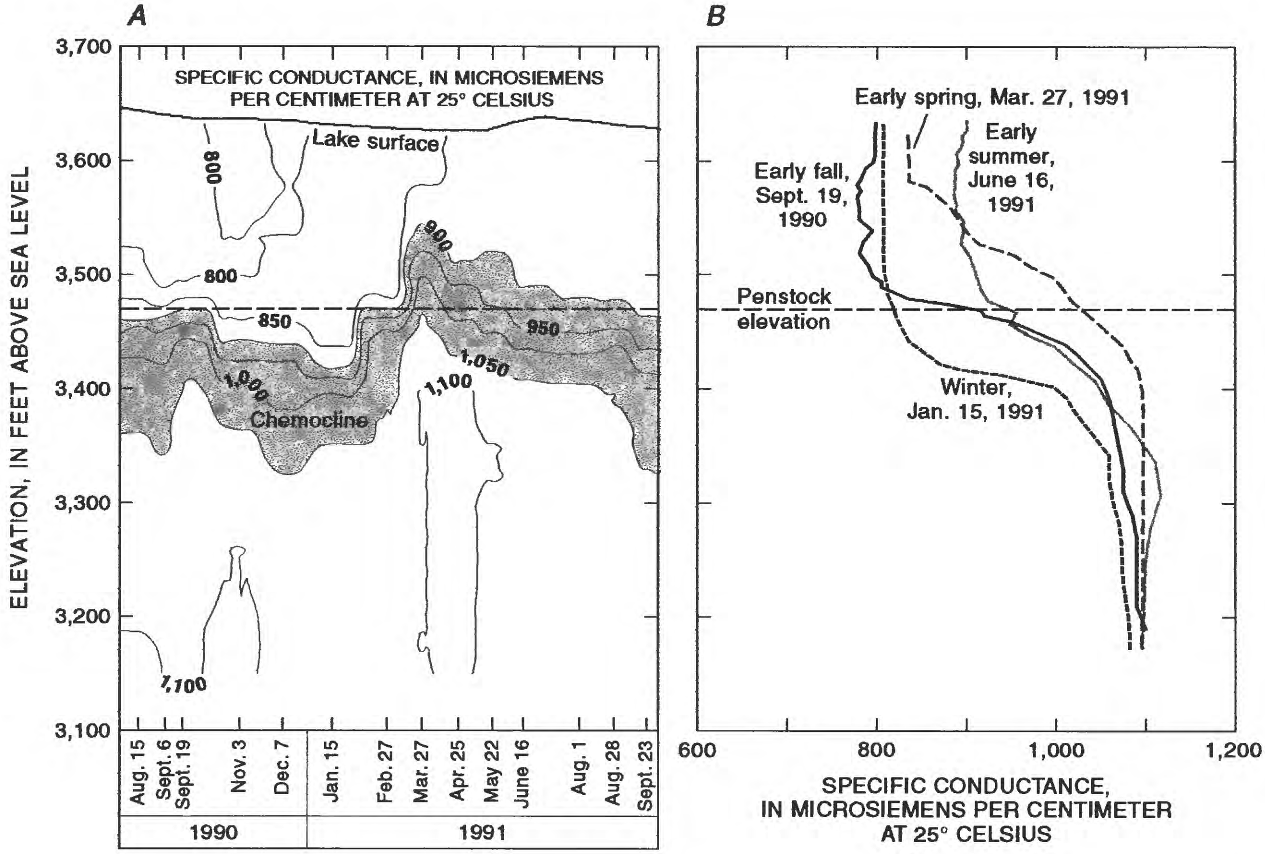

Figure 6. Specific conductance in grid 3 of the forebay of Lake Powell, 1990–91. *A,* Lines of equal specific conductance. *B,* Profiles of specific conductance.

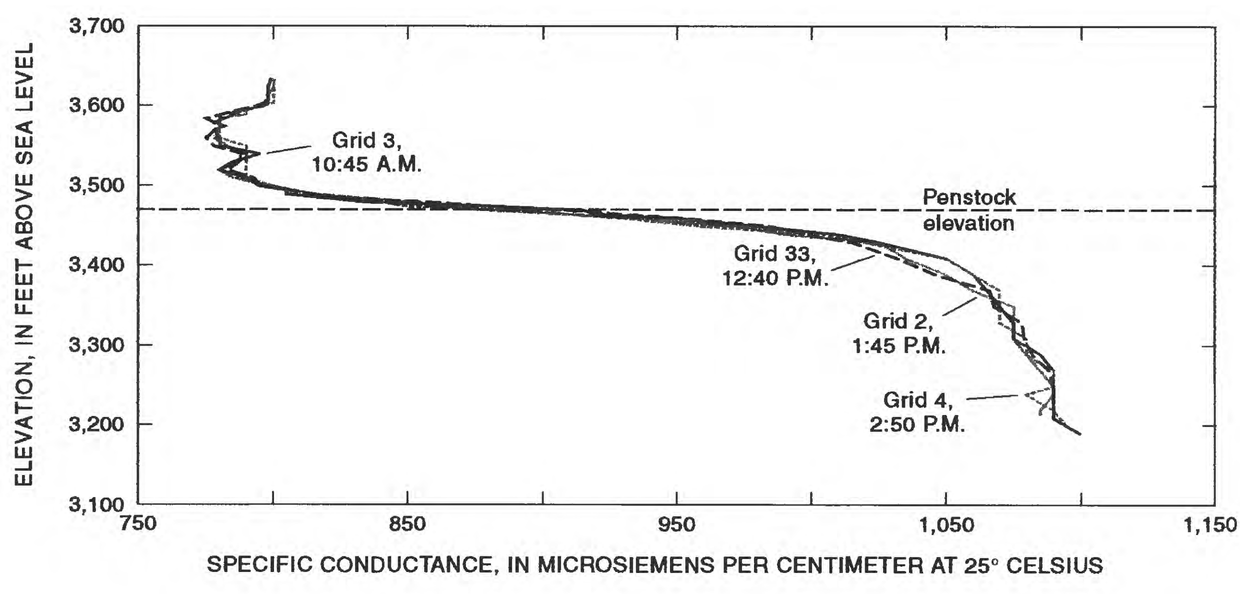

Figure 7. Spatial specific-conductance profiles of the forebay, September 19, 1990.

Table 3. Statistical summary of selected physical and chemical constituents in the epilimnion in grid 3 of the forebay of Lake Powell

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25°C; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than. Depth of epilimnion is 0–59 feet below water surface. Dashes indicate no data]

Constituent	Number of observations	Mean	Standard deviation	Minimum	Maximum
Field measurements, August 1990 to September 1991					
Water temperature (°C)	211	18	5.9	7.8	27
Specific conductance (µS/cm)	223	851	39.8	760	920
Oxygen, dissolved (mg/L)	187	8.9	1.0	7.1	11
pH	225	8.2	.2	7.7	8.6
Dissolved major ions (mg/L), September 1990 to August 1991					
Calcium	57	65.6	4.60	55.6	79.0
Magnesium	57	28.1	2.41	23.3	33.8
Sodium	57	76.8	6.99	63.4	94.5
Potassium	36	3.58	.22	3.20	4.00
Sulfate (November 1990 to August 1991)	40	233	10.9	213	253
Chloride (November 1990 to August 1991)	40	47.2	3.77	39.2	52.3
Bicarbonate	31	161	7.92	145	173
Silica	57	7.36	.90	5.00	9.60
Dissolved nutrients (mg/L), September 1990 to August 1991					
Phosphorus ortho as P	60	---	---	<.01	.04
Nitrogen ammonia as N	60	---	---	<.01	.04
Nitrite plus nitrate as N	60	.14	.09	<.02	.40
Dissolved metals (µg/L), January 1991 to August 1991					
Beryllium	37	---	---	<.02	.10
Cadmium	37	---	---	<.10	.40
Chromium	37	---	---	<.02	8.10
Cobalt	37	---	---	<.01	.68
Copper	37	.92	.38	.51	2.55
Iron	37	---	---	<5.00	60.0
Lead	37	---	---	<.06	.60
Manganese	37	---	---	<.10	1.64
Thallium	37	---	---	<.05	.18
Molybdenum	37	4.02	.39	3.50	4.90
Strontium	37	876	62.0	770	1,030
Vanadium	37	3.13	4.66	.70	17.0
Zinc	37	3.20	.89	1.70	5.70
Aluminum	37	2.86	1.18	1.50	7.40
Lithium	37	33.4	2.07	29.1	37.6
Selenium	16	2.94	.77	1.00	5.00
Uranium, natural	37	5.23	.52	3.80	5.90
Mercury	32	.06	.02	.04	.12
Dissolved organic carbon (mg/L), September 1990 to August 1991					
Carbon, organic	42	3.38	.47	2.90	4.60

Table 4. Statistical summary of selected physical and chemical constituents in the metalimnion in grid 3 of the forebay of Lake Powell

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25°C; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than. Depth of metalimnion is 60–180 feet below water surface. Dashes indicate no data]

Constituent	Number of observations	Mean	Standard deviation	Minimum	Maximum
Field measurements, August 1990 to September 1991					
Water temperature (°C)	288	9.8	3.1	6.9	22
Specific conductance (µS/cm)	299	872	66.6	772	1,060
Oxygen, dissolved (mg/L)	265	7.0	1.3	4.2	9.9
pH	279	7.8	.3	7.0	8.4
Dissolved major ions (mg/L), September 1990 to August 1991					
Calcium	50	71.6	7.60	53.3	91.9
Magnesium	50	28.8	3.35	24.0	37.3
Sodium	50	80.0	11.9	58.1	106
Potassium	19	3.75	.36	3.20	4.40
Sulfate (November 1990 to August 1991)	34	232	18.6	197	267
Chloride (November 1990 to August 1991)	34	48.1	7.93	37.0	69.5
Bicarbonate	36	172	14.6	146	197
Silica	50	8.18	.68	5.90	9.30
Dissolved nutrients (mg/L), September 1990 to August 1991					
Phosphorus ortho as P	55	---	---	<.01	.02
Nitrogen ammonia as N	57	---	---	<.01	.06
Nitrite plus nitrate as N	56	.33	.11	.02	.52
Dissolved metals (µg/L), January 1991 to August 1991					
Beryllium	22	---	---	<.02	.12
Cadmium	22	---	---	<.10	.30
Chromium	22	---	---	<.20	8.00
Cobalt	22	---	---	<.01	.82
Copper	22	.91	.29	.52	1.74
Iron	22	---	---	<5.00	9.00
Lead	22	---	---	<.06	.19
Manganese	22	.30	.12	.11	.58
Thallium	22	---	---	<.05	.10
Molybdenum	22	4.40	.57	3.60	5.60
Strontium	22	937	76.5	830	1,170
Vanadium	22	2.75	4.30	.50	16.5
Zinc	22	3.39	1.08	1.70	6.00
Aluminum	22	2.15	.70	1.30	4.20
Lithium	22	35.4	3.54	30.3	41.8
Selenium	7	3.14	.69	2.00	4.00
Uranium, natural	22	5.39	.58	3.90	6.10
Mercury	19	.05	.01	.04	.07
Dissolved organic carbon (mg/L), September 1990 to August 1991					
Carbon, organic	42	3.21	.44	2.60	4.00

Table 5. Statistical summary of selected physical and chemical constituents in the hypolimnion in grid 3 of the forebay of Lake Powell

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25°C; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than. Depth of hypolimnion is greater than 180 feet below water surface. Dashes indicate no data]

Constituent	Number of observations	Mean	Standard deviation	Minimum	Maximum
Field measurements, August 1990 to September 1991					
Water temperature (°C)	229	7.3	0.3	6.5	7.8
Specific conductance (µS/cm)	237	1,055	54.5	835	1,135
Oxygen, dissolved (mg/L)	218	5.6	1.2	2.6	8.4
pH	215	7.6	.2	6.7	8.4
Dissolved major ions (mg/L), September 1990 to August 1991					
Calcium	35	83.6	9.70	56.0	97.8
Magnesium	35	32.3	2.87	26.5	38.9
Sodium	35	96.9	10.4	70.7	121
Potassium	12	4.16	.37	3.40	4.80
Sulfate (November 1990 to August 1991)	25	286	11.5	246	297
Chloride (November 1990 to August 1991)	25	75.4	5.90	49.7	83.0
Bicarbonate	15	183	16.6	151	197
Silica	35	8.09	.57	6.80	9.10
Dissolved nutrients (mg/L), September 1990 to August 1991					
Phosphorus ortho as P	35	---	---	<.01	.02
Nitrogen ammonia as N	36	---	---	<.01	.02
Nitrite plus nitrate as N	36	.45	.16	.02	.58
Dissolved metals (µg/L), January 1991 to August 1991					
Beryllium	22	---	---	<.02	.09
Cadmium	22	---	---	<.10	.20
Chromium	22	---	---	<.20	7.90
Cobalt	22	---	---	<.01	.91
Copper	22	.96	.26	.61	1.49
Iron	22	---	---	<5.00	10.0
Lead	22	---	---	<.06	.33
Manganese	22	.68	.42	.12	1.47
Thallium	22	---	---	<.05	.14
Molybdenum	22	5.10	.88	4.00	7.00
Strontium	22	1,036	84.2	900	1,170
Vanadium	22	2.64	4.41	.40	16.3
Zinc	22	3.97	1.74	1.90	8.80
Aluminum	22	2.24	.74	1.40	5.0
Lithium	22	41.0	4.53	33.8	47.9
Selenium	6	3.83	.41	3.00	4.00
Uranium, natural	22	6.25	.51	5.30	7.30
Mercury	17	.05	.02	.04	.11
Dissolved organic carbon (mg/L), September 1990 to August 1991					
Carbon, organic	27	3.23	.59	2.60	4.90

Table 6. Statistical summary of selected physical and chemical constituents in the penstock depth in grid 3 of the forebay of Lake Powell

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25°C; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than. Depth of penstock is 157–177 feet below water surface. Dashes indicate no data]

Constituent	Number of observations	Mean	Standard deviation	Minimum	Maximum
Field measurements, August 1990 to September 1991					
Water temperature (°C)	114	7.8	0.5	6.9	9.4
Specific conductance (µS/cm)	117	906	70.6	794	1,060
Oxygen, dissolved (mg/L)	97	6.3	1.0	4.4	8.8
pH	106	7.7	.2	7.0	8.1
Dissolved major ions (mg/L), September 1990 to August 1991					
Calcium	20	75.0	5.90	68.7	91.9
Magnesium	20	30.1	3.60	26.0	36.6
Sodium	20	84.9	11.8	69.9	105
Potassium	4	4.00	.34	3.60	4.40
Sulfate (November 1990 to August 1991)	16	235	14.2	214	257
Chloride (November 1990 to August 1991)	16	47.7	5.20	39.9	54.8
Bicarbonate	12	178	15.9	146	195
Silica	20	8.14	.79	5.90	9.30
Dissolved nutrients (mg/L), September 1990 to August 1991					
Phosphorus ortho as P	21	---	---	<.01	<.01
Nitrogen ammonia as N	22	---	---	<.01	.02
Nitrite plus nitrate as N	22	.37	.08	.22	.52
Dissolved metals (µg/L), January 1991 to August 1991					
Beryllium	9	---	---	<.02	.12
Cadmium	9	---	---	<.10	.30
Chromium	9	---	---	<.20	8.00
Cobalt	9	---	---	<.01	.08
Copper	9	.66	.07	.52	.77
Iron	9	---	---	<5.00	<5.00
Lead	9	---	---	<.06	.19
Manganese	9	.20	.06	.11	.27
Thallium	9	---	---	<.05	.10
Molybdenum	9	3.89	.23	3.60	4.30
Strontium	9	979	80.5	900	1,170
Vanadium	9	4.53	6.49	.80	16.5
Zinc	9	3.31	.33	2.90	3.80
Aluminum	9	1.89	.47	1.30	2.60
Lithium	9	33.0	1.67	31.5	35.9
Selenium	1	---	---	3.00	3.00
Uranium, natural	9	5.61	.28	5.10	6.10
Mercury	8	.05	.01	.04	.07
Dissolved organic carbon (mg/L), September 1990 to August 1991					
Carbon, organic	19	3.11	.36	2.60	4.00

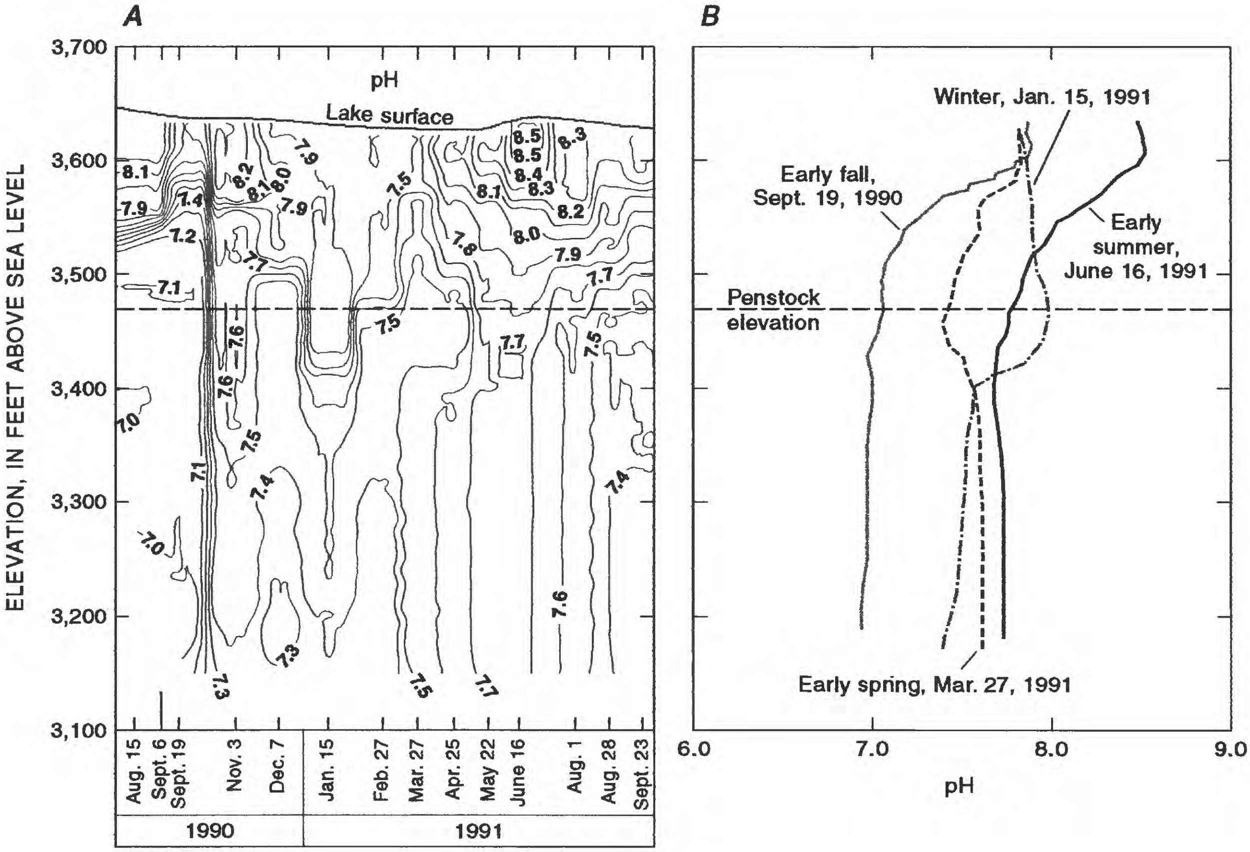

Figure 8. pH in grid 3 of the forebay of Lake Powell, 1990–91. *A*, Lines of equal pH. *B*, Profiles of pH.

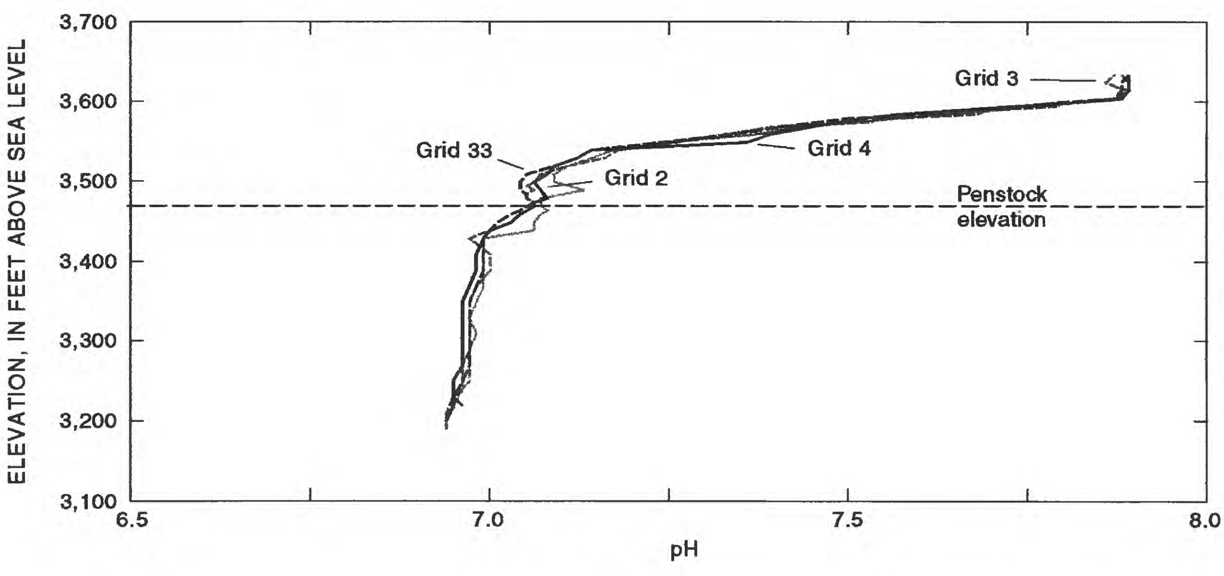

Figure 9. Spatial pH profiles of the forebay, September 19, 1990.

Stratification persisted into October. The metalimnion was between 3,470 and 3,600 ft in elevation (the center line of the penstocks) and at times was 100 ft thick. The thickness of the metalimnion was within the range of the zone of withdrawal estimated by Merritt and Johnson (1977). Diel and spatial-temperature variations in the forebay were insignificant during the study (fig. 11). Vertical distribution of mean water temperature in the forebay for the study period is shown in figure 12).

From late summer through the winter, dissolved-oxygen concentrations decreased with time (from late summer through the winter) and depth in the hypolimnion of the forebay (fig. 13). Smaller concentrations of dissolved oxygen in the hypolimnion probably were caused by respiration and (or) chemical-reduction processes. A period of oxygen mixing occurred in the hypolimnion during February and March. Metalimnetic-oxygen maxima were measured during August 1990 and 1991 when concentrations exceeded 9 mg/L (fig. 13). These metalimnetic maxima probably were produced by phytoplankton thriving in this zone. This phenomenon is common in lakes where strong stratification exists and ratios of surface area to depth are small (Wetzel, 1983, p. 165). Metalimnetic-oxygen minima of less than 5 mg/L were observed during late fall and winter. Oxygen minima are not as commonly observed in lakes as are oxygen maxima (Wetzel, 1983, p. 166). Several factors—such as respiration of nonmigrating zooplankton, density currents that can interposition low-oxygenated waters with high-oxygenated waters, and decaying organic matter—could have caused the oxygen minima measured in the forebay. Dissolved-oxygen profiles were similar at different grid locations in the forebay, which indicates that little spatial variation occurred (fig. 14). No diel variations in dissolved oxygen were observed during the study.

Chemical Distribution

Data from grid 3 of the forebay were analyzed statistically. These data constitute the largest data set and were considered representative of the forebay water.

Major Ions

Concentrations of the major ions (ions present in concentrations exceeding 1 mg/L), generally increased with depth in the forebay (fig. 15). The vertical distribution may have been due to varying densities, decomposition and mineralization of plankton, and reduction-oxidation conditions (Wetzel, 1983, p. 314–316). Sodium and sulfate were the dominant cation and anion, respectively, in the forebay during the study. Sodium concentrations in grid 3 during September 1990 to August 1991 ranged from a minimum of 58.1 mg/L in the metalimnion to a maximum of 121 mg/L in the hypolimnion (tables 4 and 5). Sulfate concentrations ranged from a minimum of 197 mg/L in the metalimnion to a maximum of 297 mg/L in the hypolimnion. Calcium also was abundant in the forebay, and concentrations ranged from a minimum of 53.3 mg/L in the metalimnion to a maximum of 97.8 mg/L in the hypolimnion. Magnesium concentrations ranged from a minimum of 23.3 mg/L in the epilimnion to a maximum of 38.9 mg/L in the hypolimnion (tables 3 and 5). Silica (as SiO_2), an essential nutrient for diatoms, averaged 7.36, 8.18, 8.09, and 8.14 mg/L in the epilimnion, metalimnion, hypolimnion, and at penstock depth, respectively. Bicarbonate was the dissolved carbon-dioxide species responsible for the alkalinity of the forebay. Bicarbonate concentrations ranged from a low of 145 mg/L in the epilimnion to a high of 197 mg/L in the metalimnion and hypolimnion. Spatial variation of these ions was not observed in the forebay.

Nutrients

The availability of phosphorus and nitrogen is important for phytoplankton growth in Lake Powell and in the downstream riverine environment. The distribution of nutrients in a reservoir can be affected by several factors including lake inflows (density patterns), sediment-water interactions, nutrient recycling within the lake, and operation of the dam (reservoir releases). Reactive soluble orthophosphate (PO_4) is the most readily available form of phosphorus for autotrophic plants. Concentrations of dissolved PO_4 generally were less than the minimum reporting level of 0.01 mg/L in the forebay. Concentrations of

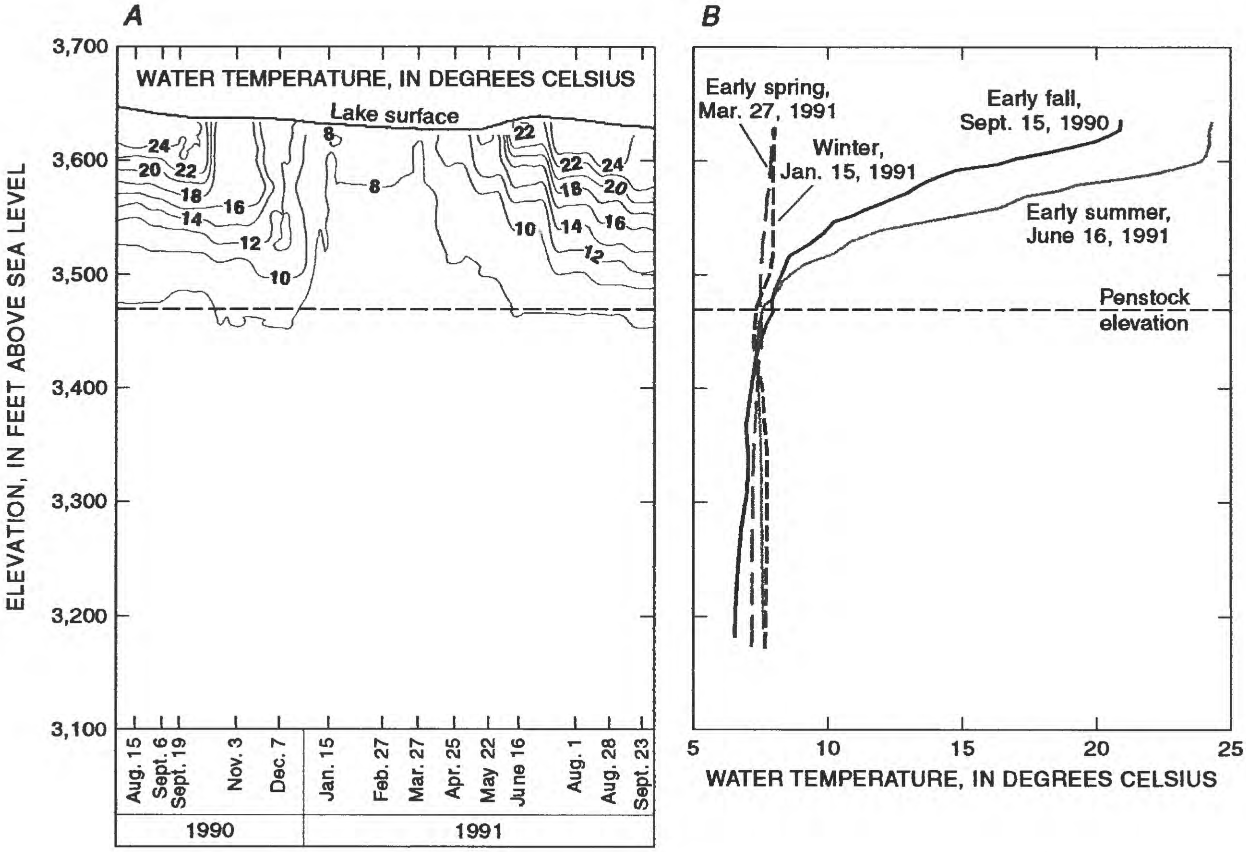

Figure 10. Water temperatures in grid 3 of the forebay of Lake Powell, 1990–91. *A*, Lines of equal water temperature. *B*, Profiles of water temperature.

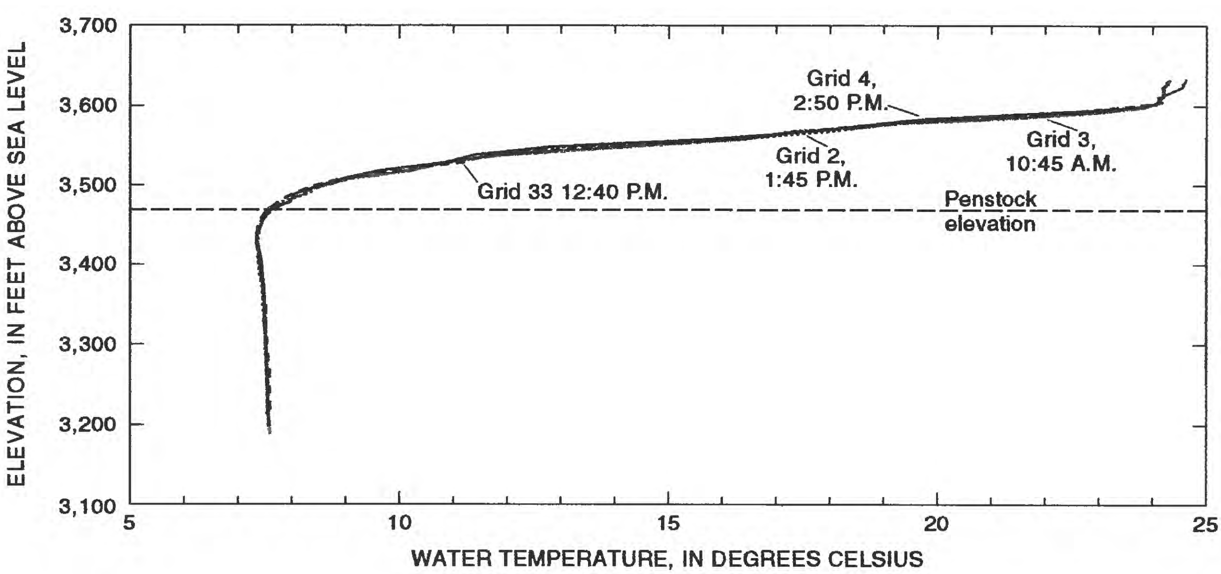

Figure 11. Spatial water-temperature profiles of the forebay, September 19, 1990.

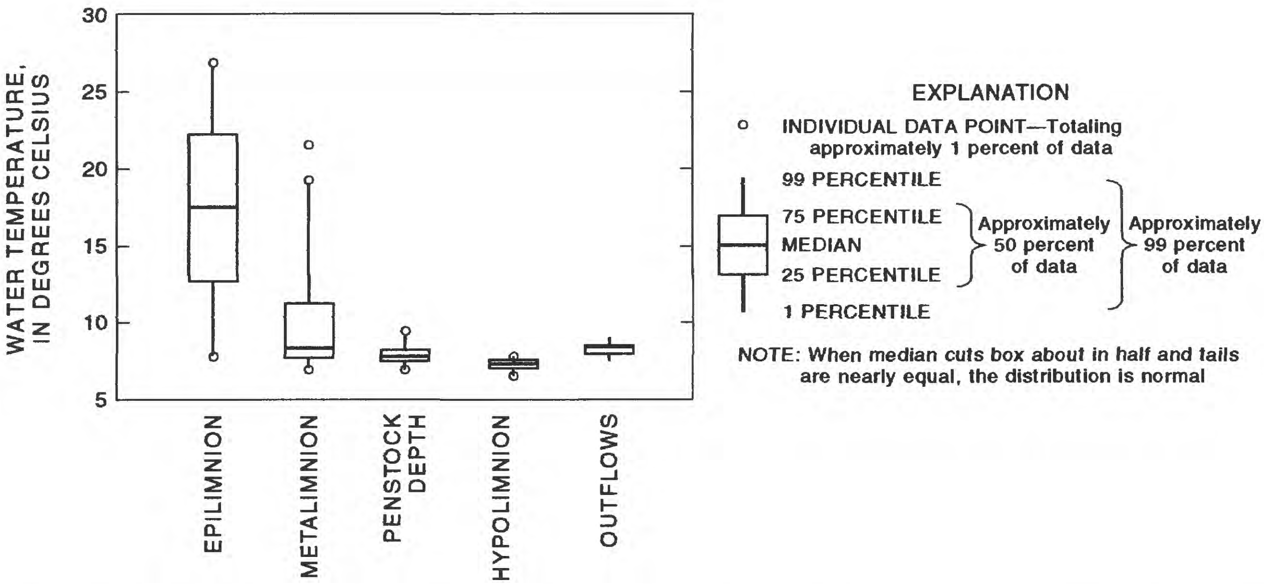

Figure 12. Vertical distribution of water temperature in the epilimnion, in the metalimnion, at penstock depth, and in the hypolimnion in grid 3 of the forebay of Lake Powell and at the outflows of Glen Canyon Dam, August 1990 to September 1991.

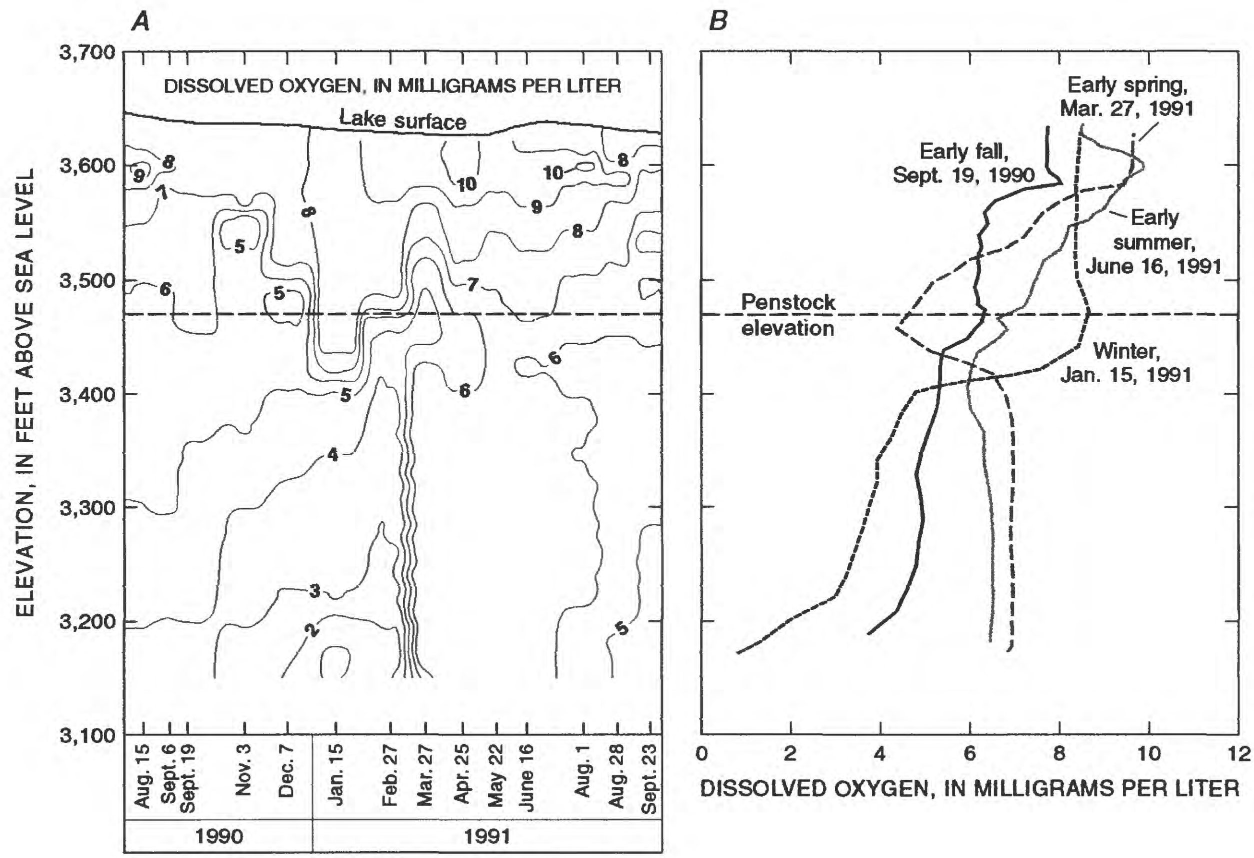

Figure 13. Dissolved oxygen in grid 3 of the forebay of Lake Powell, 1990–91. *A*, Lines of equal dissolved oxygen. *B*, Profiles of dissolved oxygen.

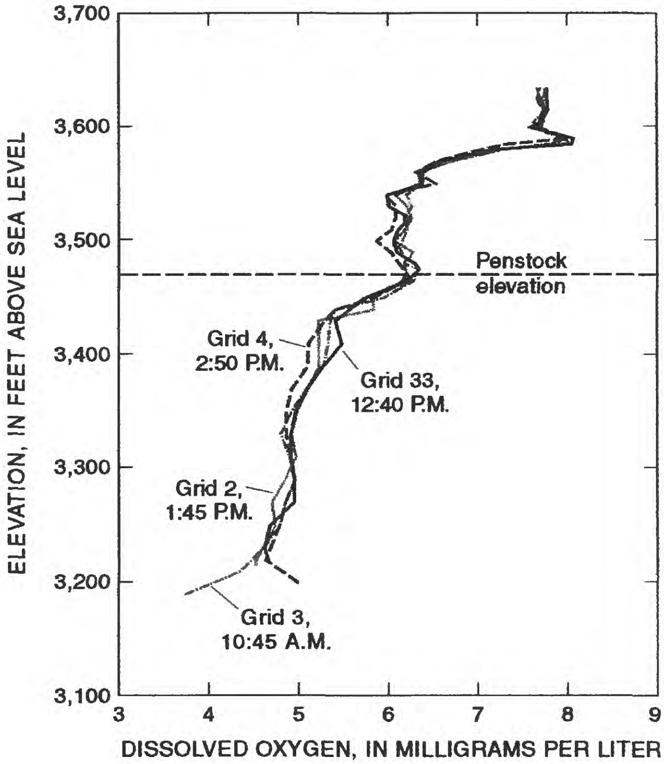

Figure 14. Spatial dissolved-oxygen profiles of the forebay, September 19, 1990.

dissolved ammonia generally were less than the minimum reporting level of 0.01 mg/L. Because the concentrations were less than the minimum reporting levels, temporal or diel variations in concentrations were not observed. Concentrations of dissolved nitrite plus nitrate (NO_2+NO_3) in grid 3 of the forebay ranged from less than 0.02 mg/L in the epilimnion to a maximum of 0.58 mg/L in the hypolimnion. Temporal variations in NO_2+NO_3 were observed in the forebay during the study (fig. 16). Concentrations at the penstock depth ranged from 0.22 to 0.52 mg/L, depending on the time of the year. No evidence of diel variations was observed in the epilimnion, metalimnion, or hypolimnion. No significant spatial variations in distribution or concentrations were observed in the forebay.

Metals

For the most part, concentrations of metals were small in the forebay. Iron concentrations generally were less than the minimum reporting level of 5 µg/L, and manganese ranged from less than 0.10 µg/L in the epilimnion to a maximum of 1.47 µg/L in the hypolimnion of grid 3 of the forebay during January to August 1991 (tables 3 and 5). Manganese varied seasonally, and the smallest concentrations occurred in the summer months. Concentrations of copper were largest in the epilimnion in grid 3 of the forebay with values ranging from 0.51 to 2.55 µg/L. Zinc ranged from a minimum of 1.70 µg/L in the upper layers of the lake to a maximum of 8.80 µg/L in the hypolimnion. The largest concentrations of copper and zinc were observed during the fall season. Spatial variation in concentrations of these elements was not observed in the forebay.

Strontium and lithium were the dominant metals observed in the forebay. Concentrations of these elements generally increased with depth (fig. 17). Strontium concentrations ranged from 770 µg/L in the epilimnion to 1,170 µg/L in the metalimnion and hypolimnion in grid 3 during January to August 1991. Lithium concentrations in grid 3 during January to August 1991, ranged from 29.1 µg/L in the epilimnion to 47.9 µg/L in the hypolimnion. Significant seasonal variations in concentrations were not observed.

Organic Carbon

Nearly all organic carbon in natural waters is in the form of dissolved organic carbon (DOC) and particulate organic carbon (POC); DOC is in the greatest quantity in lake and stream environments (Wetzel and Likens, 1991). POC was not determined in this study. Generally, mean concentrations of DOC were larger in the epilimnion during the study (fig. 18). Mean concentrations of DOC ranged from 3.23 mg/L in the hypolimnion to 3.38 mg/L in the epilimnion of the forebay (tables 3 and 5). Mean concentration of DOC at penstock depth was 3.11 mg/L. DOC concentrations were largest in the summer and early fall. Diel variations of DOC in the forebay were not observed.

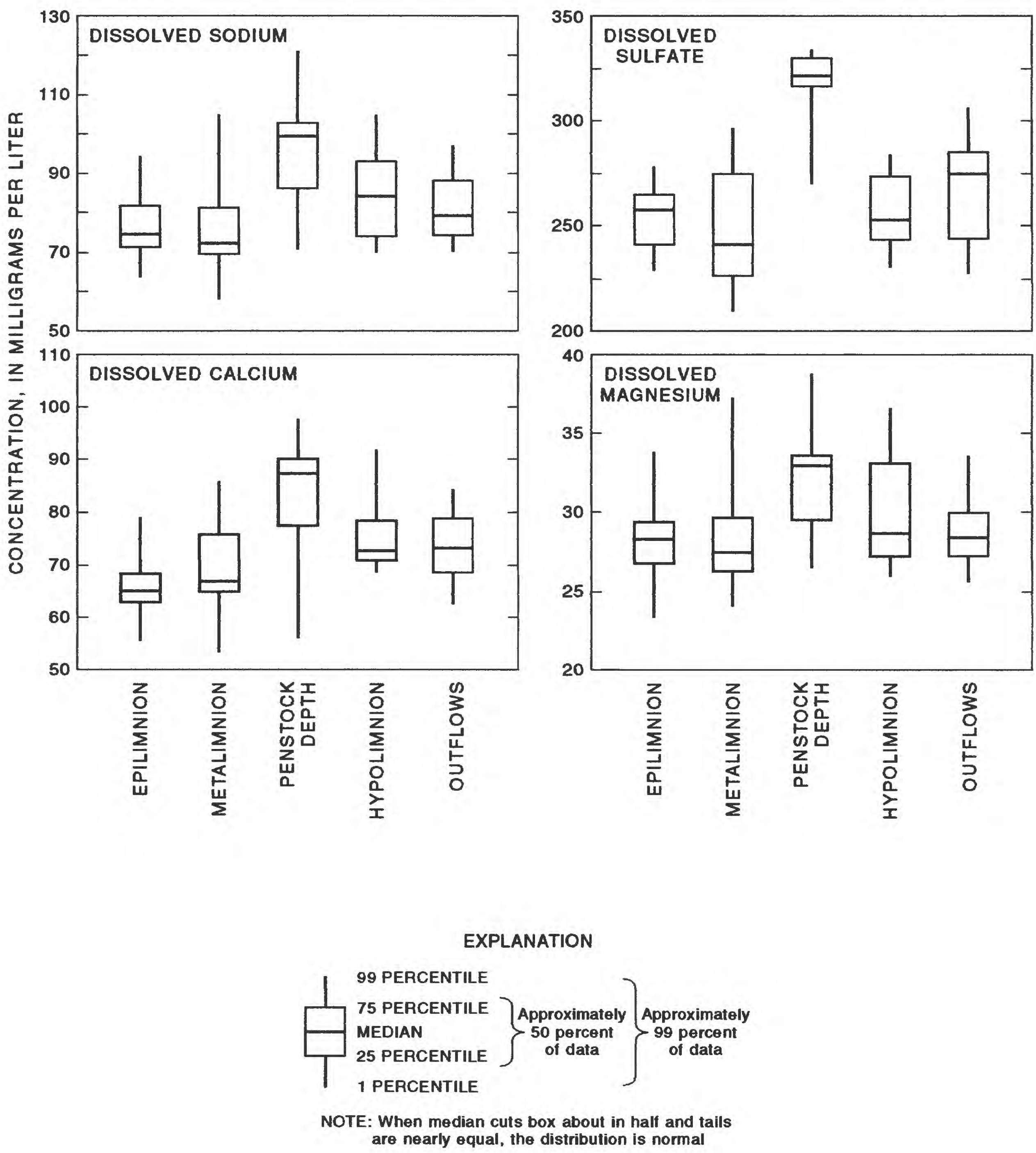

Figure 15. Vertical distribution of dissolved sodium, dissolved sulfate, dissolved calcium, and dissolved magnesium in grid 3 of the forebay of Lake Powell and outflows of Glen Canyon Dam, September 1990 to August 1991.

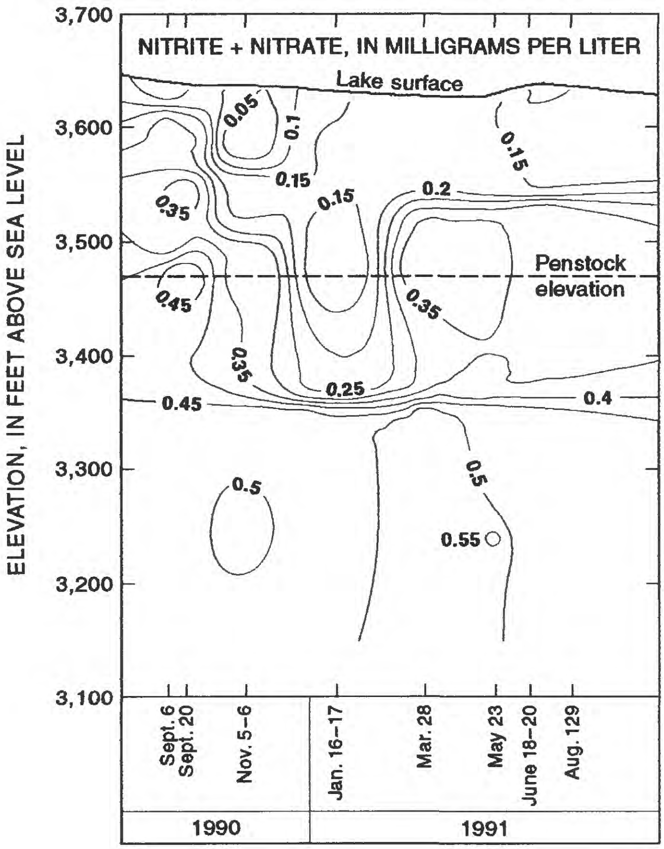

Figure 16. Lines of equal nitrite plus nitrate in grid 3 of the forebay of Lake Powell, 1990–91.

Light Penetration and Water Transparency

The attenuation of photosynthetically active radiation (PAR) in natural waters is influenced by the interaction of various environmental factors, including atmospheric lighting; light absorption; absorption by water, algal cells, and dissolved substances; and light scattering by water, plankton, and particulate matter (Roemer and Hoagland, 1979). Variability in underwater light plays a significant role in regulating the phytoplankton assemblages (Blinn and others, 1976). Vertical-attenuation coefficients (light reduction per unit depth) of PAR ranged from 0.058 on June 16, 1991, to 0.080 on September 23, 1991, in grid 18 of the forebay (fig. 19).

The euphotic zone ranged from 82 ft on September 23, 1990, to 113 ft on June 16, 1991. Secchi-disk values ranged from 25.4 to 47.5 ft during the winter months, from 16 to 36 ft during the spring, and from 17 to 31 ft during the summer (table 7). The ratio of the euphotic zone to the Secchi-disk depth ranged from 2.7 to 5.6 and averaged 3.9 for April through September 1991.

CHARACTERISTICS AND COMPARISON OF THE FOREBAY WITH THE OUTFLOWS

Water released through the turbines and penstocks of the dam leaves the lacustrine environment of the forebay and enters the riverine environment of the Colorado River. Outflow samples were collected from the draft tubes to determine the physical and chemical characteristics of outflows from Lake Powell to the Colorado River. Selected chemical constituents in samples from the draft tubes of the dam were summarized statistically (table 8).

Table 7. Summary of Secchi-disk measurements and euphotic-zone depths in grid 18 of the forebay of Lake Powell, 1990–91

[Dashes indicate no data]

Date	Water transparency (Feet)	Euphotic-zone depth (Feet)	Date	Water transparency (Feet)	Euphotic-zone depth (Feet)
09–06–90	25.7	---	05–22–91	27.0	108
12–07–90	25.4	---	06–16–91	31.0	113
01–16–91	30.0	---	06–18–91	23.0	---
02–27–91	47.5	---	08–01–91	17.0	95
03–28–91	26.5	---	08–28–91	22.0	96
03–29–91	21.0	---	08–29–91	19.0	---
04–24–91	36.0	96	09–23–91	24.0	82
04–25–91	16.0	---			

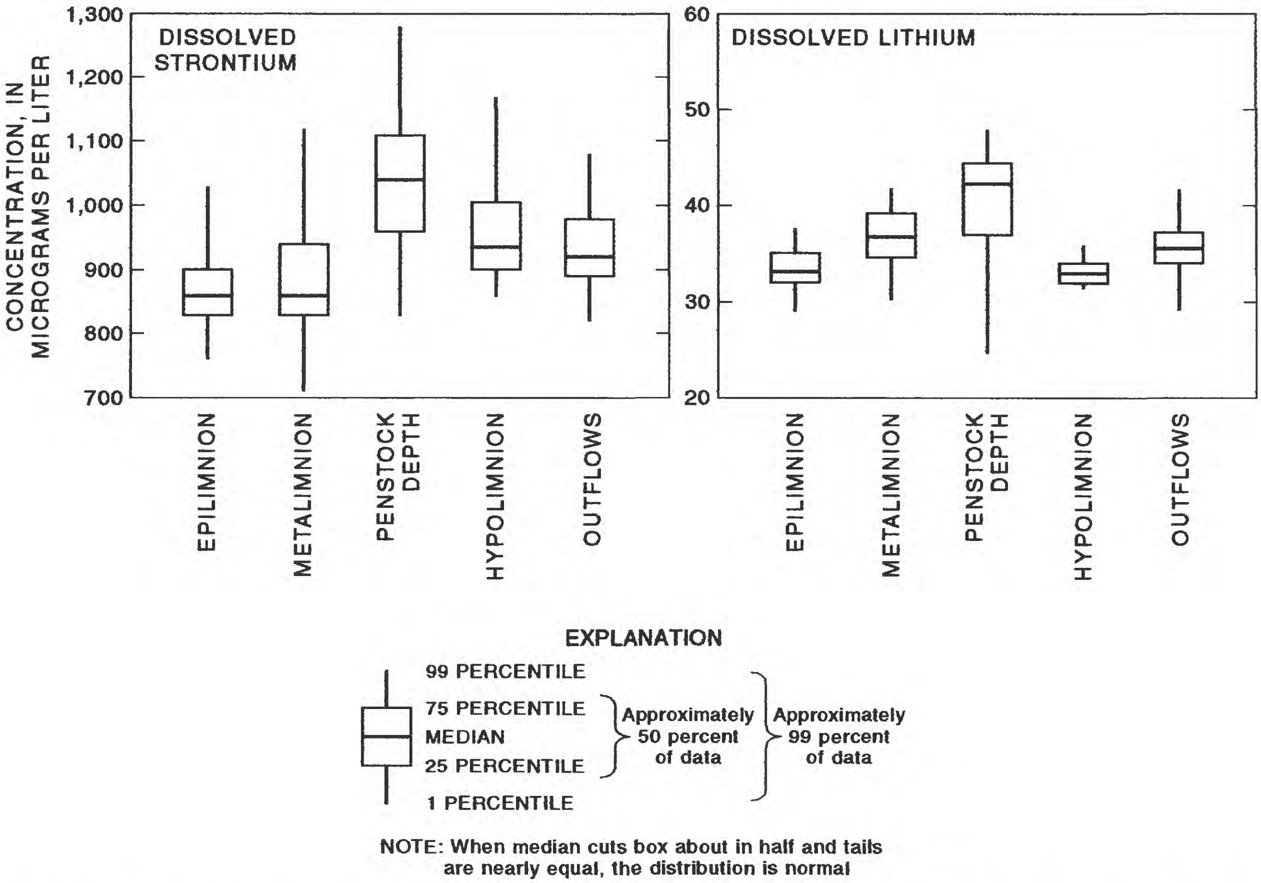

Figure 17. Vertical distribution of dissolved strontium and dissolved lithium in grid 3 of the forebay of Lake Powell and outflows of Glen Canyon Dam, January to August 1991.

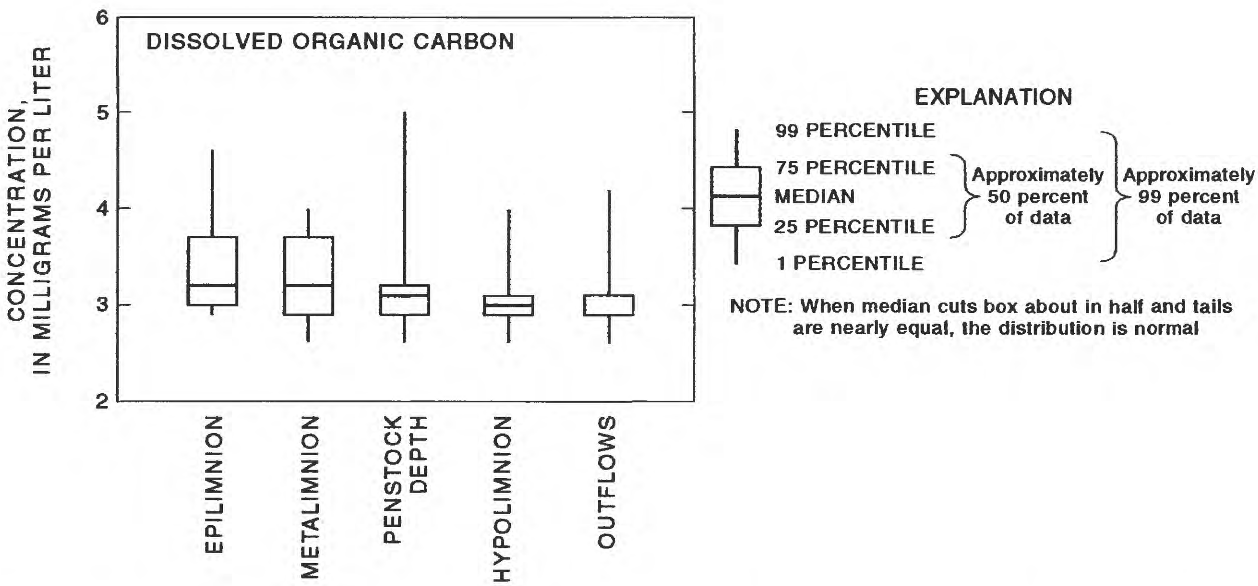

Figure 18. Vertical distribution of dissolved organic carbon in grid 3 of the forebay of Lake Powell and outflows of Glen Canyon Dam, September 1990 to August 1991.

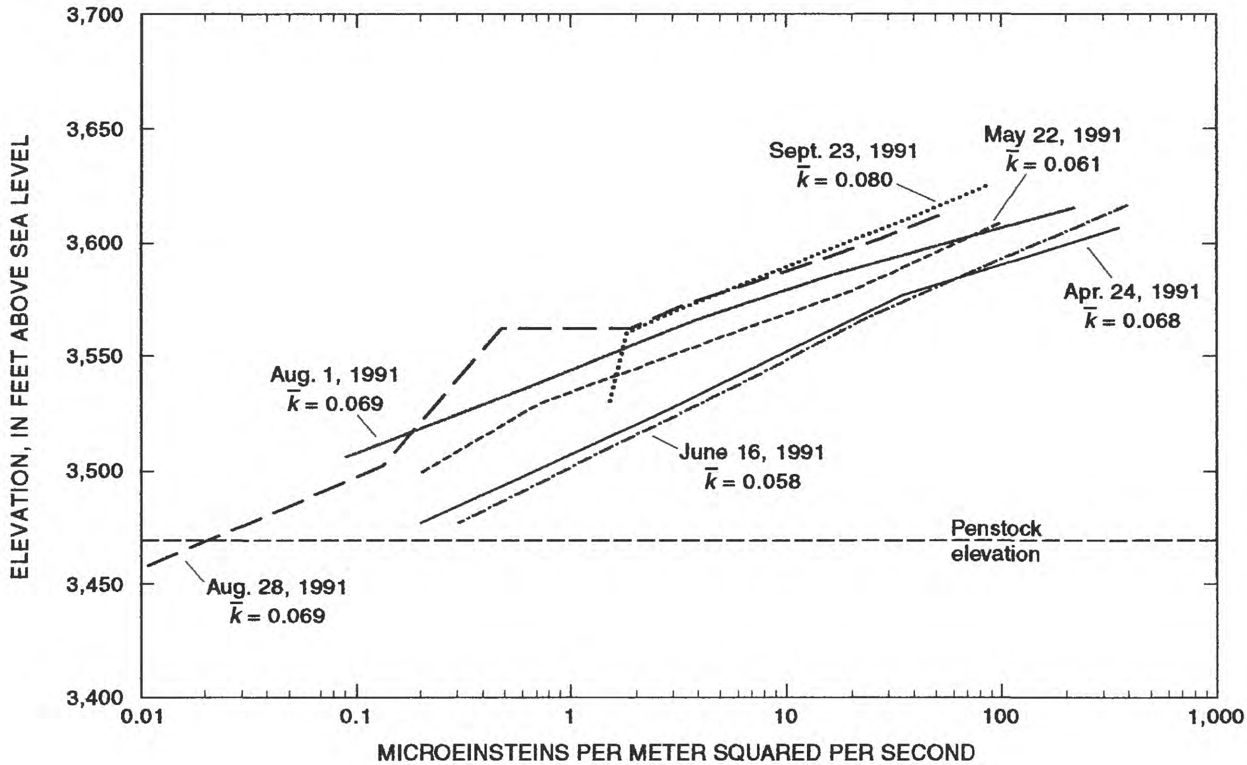

Figure 19. Attenuation of incident light as photosynthetically active radiation in grid 18 of the forebay of Lake Powell, 1991.

Generally, physical and chemical characteristics of the draft-tube outflows were similar to characteristics of the water in the forebay at penstock depths, into the interface of the metalimnion and hypolimnion (tables 4–6 and 8). Specific conductance varied with reservoir releases and ranged from 803 to 1,090 μS/cm, which is similar to the range of 794 to 1,060 μS/cm measured at penstock depths of the forebay. pH ranged from 7.2 to 8.0 in the draft tubes and from 7.0 to 8.1 at penstock depth in the forebay. Temperature of the outflows averaged 8.3°C. At penstock depth of the forebay, the mean temperature was 7.8°C. Mean dissolved-oxygen concentrations of the outflows ranged from 6.5 to 9.1 mg/L. Diel variations in these field measurements were not observed.

As was found in the forebay, sodium and sulfate were the dominant cation and anion, respectively, in the outflows. Sodium concentrations ranged from 70.2 to 97.0 mg/L, and sulfate concentrations ranged from 212 to 275 mg/L and averaged 243 mg/L. Calcium concentrations ranged from 62.6 to 84.4 mg/L. Average concentrations of the major ions were similar to concentrations collected near the penstock depth in grid 3 of the forebay (tables 6 and 8). The general distribution of major ions through the outflows was similar to that of the deeper waters of the forebay (fig. 15). Concentrations of orthophosphorus and ammonia generally were less than the minimum reporting levels, and concentrations of NO_2+NO_3 ranged from 0.13 to 0.74 mg/L. Values for water at the penstock depth of the forebay ranged from 0.22 to 0.52 mg/L (table 6). Strontium and lithium were the dominant metals released to the Colorado River through the dam. Mean concentrations in samples from the outflows were 954 and 35.9 μg/L for strontium and lithium, respectively (table 8). These values are similar to mean concentrations of strontium and lithium of 979 and 33.0 μg/L, respectively, at penstock depth in grid 3 of the forebay (tables 6 and 8). As with major ions, the

Table 8. Statistical summary of selected physical and chemical constituents of the outflows (draft tubes) of Glen Canyon Dam

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25°C; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than. Dashes indicate no data]

Constituent	Number of observations	Mean	Standard deviation	Minimum	Maximum
Field measurements, August 1990 to September 1991					
Water temperature (°C)	41	8.3	0.3	7.5	9.0
Specific conductance (µS/cm)	35	919	70.6	803	1,090
Oxygen, dissolved (mg/L)	36	7.6	.6	6.5	9.1
pH	39	7.8	.2	7.2	8.0
Dissolved major ions (mg/L), September 1990 to August 1991					
Calcium	34	73.5	6.16	62.6	84.4
Magnesium	34	28.6	1.98	25.6	33.6
Sodium	34	81.0	7.85	70.2	97.0
Potassium	12	3.74	.36	3.30	4.30
Sulfate (November 1990 to August 1991)	23	243	19.9	212	275
Chloride (November 1990 to August 1991)	23	53.2	8.66	41.8	72.2
Bicarbonate	31	171	8.98	155	188
Silica	34	8.02	.44	7.30	8.90
Dissolved nutrients (mg/L), September 1990 to August 1991					
Phosphorus ortho as P	36	---	---	<.01	.02
Nitrogen ammonia as N	37	---	---	<.01	.06
Nitrite plus nitrate as N	37	.34	.11	.13	.74
Dissolved metals (µg/L), January 1991 to August 1991					
Beryllium	21	---	---	<.02	.11
Cadmium	21	---	---	<.10	.40
Chromium	21	---	---	<.20	8.60
Cobalt	21	---	---	<.01	.84
Copper	21	3.24	3.09	.81	12.3
Iron	21	---	---	<5.00	55.0
Lead	21	---	---	<.06	.52
Manganese	21	.80	.86	.10	3.55
Thallium	21	---	---	<.05	.14
Molybdenum	21	4.53	.55	3.70	5.80
Strontium	21	954	75.7	820	1,080
Vanadium	21	3.63	5.46	.50	17.7
Zinc	21	4.38	1.58	2.40	8.00
Aluminum	21	4.39	10.4	1.00	49.6
Lithium	21	35.9	3.13	29.2	41.7
Selenium	17	3.11	.43	2.90	4.20
Uranium, natural	21	5.53	.65	4.10	6.30
Mercury	21	.04	.005	.03	.04
Dissolved organic carbon (mg/L), September 1990 to August 1991					
Carbon, organic	27	3.09	.42	2.60	4.20

general distribution of metals through the outflows was similar to that of the deeper waters of the forebay (fig. 17). DOC concentrations of water discharged through the draft tubes ranged from 2.60 to 4.20 mg/L and were similar to DOC concentrations of water measured in the metalimnion and at penstock depth in the forebay, which were 2.60 to 4.00 mg/L, respectively. Diel variations were not observed for the major ions, nutrients, metals, or organic carbon.

SUMMARY

The physical and chemical characteristics of Lake Powell have a direct effect and relation to the characteristics of water below Glen Canyon Dam. Depth-profile measurements were made and water samples were collected from August 1990 to September 1991 in the forebay and outflows of Glen Canyon Dam to define these characteristics. Understanding the physical and chemical characteristics of the lake and outflows from the dam are essential in order to effectively manage the operation of the dam.

Characteristics of the Forebay

A. Stratification and destratification processes occurred during the study period.
   1. Specific-conductance measurements showed a well-defined chemocline that fluctuated seasonally and indicated incomplete mixing of the forebay waters.
   2. Values of pH were less during the winter months and decreased with depth compared with the summer or photosynthetic period.
   3. The mean water temperature at penstock depth was 7.8°C. Temperature stratification was well developed by early June and persisted into October. Toward the latter part of the study when lake levels were low, withdrawals were from the metalimnion-hypolimnion boundary.
   4. Metalimnetic-oxygen maxima occurred during the summer months, and metalimnetic-oxygen minima occurred during the fall and winter.

B. Chemical distribution in the forebay varied with depth and time during the study.
   1. Major ions generally increased with depth, and sodium and sulfate were the dominant cation and anion, respectively. Calcium also was abundant.
   2. Nutrients as NO_2+NO_3 generally increased in concentration with depth and ranged from 0.22 to 0.52 mg/L at the penstock depth of the forebay. Values for PO_4 and NH_4 generally were less than the laboratory minimum reporting level of 0.01 mg/L.
   3. Strontium and lithium were the dominant metals. Iron concentrations generally were less than 5.0 μg/L. Metals generally increased in concentration with depth.
   4. Dissolved-oxygen content averaged 3.11 mg/L at penstock depth, and the largest concentrations generally occurred in the epilimnion. Concentrations increased during the summer months.

C. Light penetration in the forebay is an important process that governs productivity.
   1. Small vertical-attenuation coefficients for the forebay indicate a deep euphotic zone.
   2. Values ranged from 0.058 to 0.080 (μE/m^2)/s during the spring and summer. The euphotic-zone depth was estimated to range from 82 to 113 ft during the spring and summer on the basis of Secchi-disk measurements.

Characteristics and Comparison of the Forebay with the Outflows

Generally, the physical and chemical characteristics of the outflows from Lake Powell were similar to those of water in the forebay in the deep zone of the metalimnion into the hypolimnion.

1. Specific conductance ranged from 803 to 1,090 μS/cm.
2. pH ranged from 7.2 to 8.0.
3. Water temperature ranged from 7.5 to 9.0°C.
4. Dissolved-oxygen concentration ranged from 6.5 to 9.1 mg/L.
5. Sodium and sulfate were the dominant cation and anion, respectively, entering the Colorado River.
6. Strontium and lithium were the most abundant metals in the outflows.
7. Dissolved organic carbon in the draft tubes ranged from 2.60 to 4.20 mg/L.
8. Concentrations of NO_2+NO_3 entering the Colorado River ranged from 0.13 to 0.74 mg/L.
9. The influence of the lake on the physical and chemical characteristics of the outflow waters discharging from the dam was evident during this study. As the lake underwent various processes, the characteristics of the outflow water responded accordingly.

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BASIC DATA

Depth-Profile Data

Nutrient and Organic-Carbon Data

Major Ions and Metal Data

Depth-Profile Data

Table 9. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in grid 2 of the forebay of Lake Powell, 1990

[μS/cm, microsiemens per centimeter at 25°C; °C, degrees Celsius; mg/L, milligrams per liter]

Time	Sampling depth, in feet	Specific conductance (μS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)
September 19, 1990					
1445	5.00	800	7.9	24.5	7.7
1443	15.0	800	7.9	24.5	7.7
1441	25.0	798	7.9	24.0	7.8
1439	35.0	798	7.9	24.0	7.6
1437	40.0	795	7.8	23.5	7.7
1436	45.0	790	7.8	23.0	7.8
1434	50.0	790	7.7	22.0	8.0
1432	55.0	780	7.6	20.5	7.8
1431	60.0	780	7.6	19.5	7.3
1430	70.0	780	7.4	18.0	6.7
1429	80.0	778	7.4	16.5	6.3
1428	90.0	783	7.3	13.0	6.4
1427	100	788	7.2	12.0	6.1
1426	110	787	7.1	11.0	6.2
1425	120	780	7.1	9.5	6.3
1424	130	785	7.1	9.0	6.2
1422	140	800	7.1	8.5	6.1
1420	150	815	7.1	8.5	6.3
1419	160	853	7.1	8.0	6.2
1417	165	860	7.1	7.5	6.2
1416	170	880	7.1	7.5	6.2
1414	175	910	7.1	7.5	6.3
1412	180	933	7.1	7.5	6.0
1410	190	973	7.1	7.5	5.8
1408	200	990	7.1	7.5	5.8
1406	210	1,030	7.0	7.5	5.2
1404	230	1,040	7.0	7.5	5.2
September 19, 1990—Continued					
1402	250	1,050	7.0	7.5	5.2
1400	270	1,060	7.0	7.5	5.1
1359	290	1,080	7.0	7.5	5.0
1358	310	1,080	7.0	7.5	4.9
1356	330	1,080	7.0	7.5	5.0
1354	350	1,080	7.0	7.5	4.9
1352	370	1,090	7.0	7.5	4.7
1351	390	1,090	7.0	7.5	4.7
1349	400	1,090	7.0	7.5	4.7
1347	420	1,090	7.0	7.5	4.5
1345	425	1,090	7.0	7.5	4.5
November 3, 1990					
1652	3.00	812	8.2	17.5	7.3
1651	30.0	814	8.2	17.5	7.4
1650	60.0	815	8.2	17.5	7.2
1648	70.0	814	8.2	17.0	7.1
1647	75.0	814	8.1	17.0	6.8
1645	80.0	805	7.8	16.0	5.4
1643	85.0	800	7.7	14.5	4.2
1636	90.0	804	7.6	14.0	4.1
1633	110	795	7.7	10.5	5.4
1630	130	798	7.6	9.0	5.5
1621	150	816	7.6	8.5	5.5
1620	170	843	7.6	8.0	5.9
1618	190	890	7.6	8.0	5.9
1616	210	971	7.6	7.5	5.9

Table 10. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in grid 3 of the forebay of Lake Powell, 1990–91

[µS/cm, microsiemens per centimeter at 25°C; °C, degrees Celsius; mg/L, milligrams per liter. Dashes indicate no data]

Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)
August 15, 1990					
1400	3.00	802	8.1	25.0	7.6
1357	17.0	802	8.1	25.0	7.6
1354	33.0	795	8.0	24.0	8.2
1351	49.0	781	8.1	20.5	9.4
1348	67.0	783	8.6	17.5	7.7
1345	80.0	784	8.7	14.5	7.7
1342	99.0	793	8.5	11.0	6.8
1339	131	803	8.5	10.0	6.5
1336	131	803	8.5	9.0	6.2
1333	146	815	8.5	8.5	6.0
1330	176	860	8.5	8.0	5.8
1327	197	967	8.4	7.5	5.4
1324	230	1,020	8.5	7.5	5.2
1321	263	1,030	8.4	7.5	5.3
1318	295	1,060	8.5	7.5	5.1
1315	329	1,070	8.4	7.5	5.0
1312	369	1,090	8.4	7.5	4.9
1309	407	1,100	8.3	7.5	4.6
1303	432	1,100	8.3	7.5	4.5
1306	443	1,090	8.3	7.5	4.0
1300	464	1,100	8.3	7.5	4.0
1257	467	1,110	8.3	7.5	3.6
September 5, 1990					
1430	1.00	795	8.3	26.0	7.1
1428	10.0	794	8.3	24.5	7.3
1426	20.0	792	8.3	24.5	7.4
1424	30.0	791	8.3	24.0	7.5
1422	40.0	775	8.2	21.5	8.3
1420	50.0	773	8.1	19.5	7.4
1419	60.0	773	8.0	18.5	6.9
1418	70.0	774	8.0	16.5	6.6
1416	80.0	775	7.9	15.0	6.5
1414	90.0	775	---	13.0	6.7
1412	100	780	---	12.0	6.7
1410	110	783	---	11.0	6.6
1408	120	775	---	10.0	6.4
September 5, 1990—Continued					
1407	130	772	---	9.5	6.3
1405	140	785	---	8.5	6.1
1403	150	800	---	8.5	5.9
1402	160	820	---	8.0	5.8
1358	170	850	---	8.0	5.9
1400	180	915	---	7.5	5.8
1356	190	950	---	7.5	5.6
1354	210	980	---	7.5	5.4
1352	230	1,010	---	7.5	5.4
1350	250	1,030	---	7.5	5.2
1348	270	1,040	---	7.5	5.2
1346	290	1,040	---	7.5	5.3
1344	310	1,060	---	7.5	5.2
1342	330	1,070	---	7.5	5.1
1340	350	1,070	---	7.5	5.0
1338	370	1,080	---	7.5	4.9
1336	390	1,080	---	7.5	4.8
1334	410	1,080	---	7.5	4.5
1332	430	1,080	---	8.0	4.1
1330	450	1,080	---	8.0	3.7
1820	1.00	794	8.3	25.0	7.3
1818	10.0	793	8.3	24.5	7.4
1816	20.0	792	8.3	24.5	7.4
1814	30.0	791	8.3	24.5	7.6
1812	40.0	774	8.2	21.0	8.2
1810	50.0	773	8.2	20.0	8.0
1808	60.0	772	8.1	19.0	7.8
1806	70.0	776	8.0	17.5	6.7
1804	80.0	775	7.9	14.0	6.4
1800	90.0	778	7.9	12.0	6.4
1757	100	782	7.8	11.5	6.2
1754	110	780	7.8	10.5	6.2
1751	120	775	---	10.5	6.2
1748	130	772	---	9.5	6.2
1745	140	782	---	8.5	6.2
1742	150	794	---	8.5	5.8

Table 10. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in grid 3 of the forebay of Lake Powell, 1990–91—Continued

Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)
September 5, 1990—Continued					
1739	160	825	---	8.0	5.7
1736	170	838	---	8.0	5.9
1733	180	882	---	7.5	5.8
1730	190	910	---	7.5	5.7
1729	210	992	---	7.5	5.2
1726	230	1,020	---	7.5	5.2
1723	250	1,030	---	7.5	5.1
1721	270	1,030	---	7.5	5.1
1718	290	1,040	---	7.5	5.1
1716	310	1,050	---	7.5	5.0
1714	330	1,070	---	7.5	4.9
1712	350	1,070	---	7.5	4.9
1710	370	1,070	---	7.5	4.7
1707	390	1,080	---	7.5	4.7
1705	410	1,080	---	7.5	4.6
1703	430	1,080	---	8.0	4.5
1700	450	1,080	---	8.0	4.1
September 19, 1990					
1209	5.00	799	7.9	24.5	7.8
1206	15.0	798	7.9	24.0	7.7
1203	25.0	798	7.9	24.0	7.7
1201	35.0	798	7.9	24.0	7.7
1158	40.0	796	7.8	24.0	7.7
1200	45.0	788	7.8	23.0	7.8
1157	50.0	785	7.7	22.0	8.0
1155	55.0	782	7.7	21.0	8.0
1153	60.0	778	7.5	19.5	7.2
1151	65.0	782	7.5	18.5	6.9
1149	70.0	778	7.4	17.5	6.6
1147	80.0	780	7.3	16.5	6.3
1145	90.0	780	7.3	14.0	6.4
1143	100	795	7.2	12.0	6.2
1141	110	785	7.2	11.0	6.3
1139	120	780	7.1	10.0	6.2
1137	130	790	7.1	9.0	6.2
1135	140	795	7.1	8.5	6.1
1133	145	805	7.1	8.5	6.1
1131	150	805	7.1	8.0	6.1
September 19, 1990—Continued					
1129	155	820	7.1	8.0	6.2
1127	160	835	7.1	8.0	6.2
1126	165	880	7.1	7.5	6.3
1124	170	915	7.1	7.5	6.3
1122	175	920	7.1	7.5	6.3
1120	180	950	7.0	7.5	6.1
1118	190	980	7.0	7.5	5.9
1116	200	1,010	7.0	7.5	5.4
1114	210	1,030	7.0	7.5	5.4
1112	230	1,050	7.0	7.5	5.3
1110	250	1,060	7.0	7.5	5.3
1108	270	1,070	7.0	7.5	5.1
1106	290	1,070	7.0	7.5	4.9
1104	310	1,080	7.0	7.5	4.8
1102	330	1,080	7.0	7.5	4.9
1100	350	1,090	7.0	7.5	5.0
1058	370	1,090	7.0	7.5	4.9
1056	390	1,090	7.0	7.5	4.8
1054	410	1,090	7.0	7.5	4.6
1052	430	1,090	6.9	7.5	4.4
1050	450	1,100	6.9	7.5	3.7
November 3, 1990					
1320	3.00	814	8.2	17.5	7.3
1318	10.0	814	8.2	17.5	7.3
1317	20.0	815	8.2	17.5	7.2
1316	30.0	815	8.2	17.5	7.2
1315	40.0	815	8.2	17.5	7.2
1314	50.0	815	8.2	17.5	7.2
1313	60.0	815	8.2	17.5	7.1
1311	70.0	816	8.2	17.5	7.3
1310	75.0	813	8.1	17.0	6.9
1305	80.0	799	7.8	15.5	4.7
1303	85.0	798	7.7	14.5	4.6
1302	90.0	800	7.7	14.0	4.6
1300	100	800	7.7	13.5	4.8
1257	110	801	7.7	12.0	5.0
1249	120	792	7.7	10.5	5.5
1247	130	792	7.7	9.5	5.6

Table 10. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in grid 3 of the forebay of Lake Powell, 1990–91—Continued

Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)
		November 3, 1990—Continued			
1245	140	801	7.6	9.0	5.5
1244	150	807	7.6	8.5	5.4
1237	160	824	7.6	8.0	5.6
1236	170	838	7.6	8.0	5.7
1234	180	863	7.6	8.0	5.9
1233	190	880	7.6	8.0	5.9
1232	200	925	7.6	7.5	5.9
1224	220	966	7.6	7.5	5.4
1220	230	1,010	7.6	7.5	5.1
1218	250	1,030	7.6	7.5	5.1
1217	270	1,050	7.6	7.5	5.0
1207	290	1,070	7.5	7.5	4.4
1205	320	1,080	7.5	7.5	4.3
1157	350	1,090	7.5	7.5	3.9
1155	380	1,100	7.5	7.5	3.6
1153	400	1,100	7.5	7.5	3.6
1148	420	1,100	7.5	7.5	3.5
1146	430	1,100	7.5	7.5	3.6
1144	440	1,110	7.4	7.5	3.1
1138	450	1,110	7.4	7.5	2.0
		January 15, 1991			
1120	3.00	807	7.8	8.0	8.5
1123	10.0	808	7.8	8.0	8.5
1126	30.0	807	7.9	8.0	8.4
1128	50.0	807	7.9	8.0	8.4
1129	70.0	807	7.9	8.0	8.4
1130	90.0	808	7.9	8.0	8.4
1133	110	807	7.9	8.0	8.3
1135	130	808	7.9	8.0	8.4
1137	140	811	8.0	7.5	8.5
1139	150	812	8.0	7.5	8.6
1141	160	818	8.0	7.5	8.7
1143	170	822	8.0	7.5	8.6
1146	190	835	8.0	7.0	8.4
1148	210	870	7.9	7.5	7.6
1154	215	894	7.8	7.5	7.0
1151	220	942	7.7	7.5	6.0
1158	230	997	7.6	7.5	4.8
1200	240	1,010	7.6	7.5	4.6
		January 15, 1991—Continued			
1201	250	1,020	7.6	7.5	4.5
1202	270	1,040	7.5	7.5	4.3
1204	290	1,060	7.5	7.5	3.9
1205	310	1,060	7.5	7.5	3.9
1206	330	1,060	7.5	7.5	3.8
1208	350	1,070	7.5	7.5	3.6
1209	370	1,070	7.5	7.5	3.4
1210	390	1,070	7.5	7.5	3.3
1211	410	1,080	7.5	7.5	3.0
1213	430	1,080	7.4	7.5	2.0
1214	450	1,080	7.4	7.5	1.3
1216	460	1,080	7.4	7.5	0.8
1605	3.00	807	8.0	8.5	8.5
1604	10.0	807	8.0	8.0	8.4
1603	50.0	806	8.0	8.0	8.3
1601	80.0	806	8.0	8.0	8.3
1559	110	807	8.0	8.0	8.3
1557	140	812	8.0	7.5	8.5
1556	160	815	8.0	7.5	8.6
1548	190	835	7.9	7.0	8.4
1546	210	852	7.9	7.5	7.9
1545	215	870	7.8	7.5	7.7
1543	220	894	7.8	7.5	7.0
1542	225	904	7.7	7.5	6.8
1540	230	981	7.6	7.5	5.1
1538	250	1,020	7.5	7.5	4.4
1537	290	1,050	7.5	7.5	4.1
1535	330	1,060	7.5	7.5	3.8
1533	370	1,070	7.5	7.5	3.4
1527	400	1,080	7.5	7.5	3.1
1525	430	1,080	7.4	7.5	2.0
1523	450	1,080	7.4	7.5	1.1
		February 27, 1991			
1206	3.00	805	7.9	9.0	9.8
1209	10.0	806	7.9	8.5	9.8
1213	30.0	806	7.9	8.5	9.7
1216	50.0	805	7.9	8.0	9.4
1219	70.0	805	7.8	7.5	8.8
1221	90.0	806	7.8	7.5	8.7

Table 10. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in grid 3 of the forebay of Lake Powell, 1990–91—Continued

Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)
February 27, 1991—Continued					
1223	110	807	7.8	7.0	8.7
1225	130	813	7.8	7.0	8.7
1237	145	833	7.8	7.0	8.1
1227	150	834	7.8	7.0	8.2
1229	155	874	7.6	7.0	7.0
1231	160	913	7.6	7.5	6.0
1233	165	936	7.5	7.5	5.5
1240	170	989	7.5	7.5	5.0
1241	175	1,000	7.5	7.5	4.9
1244	190	1,020	7.4	7.5	4.6
1246	210	1,040	7.4	7.5	4.1
1248	230	1,040	7.4	7.5	3.9
1250	250	1,050	7.4	7.5	3.6
1252	280	1,050	7.4	7.5	3.3
1254	310	1,060	7.4	7.5	3.2
1256	340	1,060	7.3	7.5	3.0
1258	370	1,060	7.3	7.5	2.8
1300	400	1,060	7.3	7.5	2.7
1302	430	1,060	7.3	7.5	2.1
1305	450	1,070	7.3	7.5	1.6
1307	455	1,070	7.3	7.5	1.5
1308	460	1,070	7.3	7.5	1.5
1551	3.00	806	7.9	9.5	9.8
1553	10.0	805	7.9	9.0	9.8
1555	30.0	804	7.9	8.5	9.6
1557	50.0	803	7.9	8.0	9.3
1559	70.0	804	7.9	7.5	8.8
1600	90.0	805	7.9	7.5	8.7
1602	110	807	7.9	7.0	8.7
1603	130	818	7.8	7.0	8.4
1605	145	841	7.8	7.0	8.0
1606	150	833	7.8	7.0	8.2
1610	155	880	7.7	7.0	6.9
1611	160	924	7.6	7.5	5.8
1613	165	971	7.5	7.5	5.1
1615	170	994	7.5	7.5	4.9
1617	175	1,010	7.5	7.5	4.7
1618	190	1,020	7.5	7.5	4.5
1619	210	1,040	7.4	7.5	4.0
February 27, 1991—Continued					
1621	230	1,050	7.4	7.5	3.7
1622	250	1,050	7.4	7.5	3.5
1624	280	1,060	7.4	7.5	3.4
1625	310	1,060	7.4	7.5	3.2
1626	340	1,060	7.4	7.5	3.0
1627	370	1,060	7.4	7.5	2.8
1629	400	1,060	7.4	7.5	2.6
1631	430	1,060	7.3	7.5	2.2
1632	450	1,070	7.3	7.5	1.9
1633	455	1,070	7.3	7.5	1.8
March 27, 1991					
0956	1.00	834	7.8	8.0	9.7
0957	3.00	835	7.8	8.0	9.6
0958	10.0	835	7.8	8.0	9.6
0959	30.0	836	7.8	8.0	9.6
1015	40.0	836	7.8	8.0	9.5
1016	45.0	836	7.8	8.0	9.5
1001	50.0	856	7.8	8.0	8.5
1013	60.0	871	7.6	7.5	8.0
1012	70.0	884	7.6	7.5	7.6
1020	90.0	901	7.6	7.5	7.2
1026	100	914	7.6	7.5	6.8
1022	110	954	7.5	7.5	6.0
1027	120	971	7.5	7.5	5.6
1023	130	998	7.5	7.5	5.2
1029	150	1,020	7.4	7.5	4.8
1032	170	1,050	7.4	7.5	4.4
1034	190	1,080	7.4	7.5	5.1
1038	200	1,080	7.5	7.5	5.9
1035	210	1,090	7.5	7.5	6.5
1039	230	1,100	7.6	7.5	6.8
1041	250	1,100	7.6	7.5	6.9
1043	270	1,100	7.6	7.5	7.0
1046	300	1,100	7.6	7.0	7.0
1049	330	1,100	7.6	7.0	6.9
1052	360	1,100	7.6	7.0	6.9
1054	390	1,100	7.6	7.0	7.0
1056	420	1,100	7.6	7.0	6.9
1100	450	1,100	7.6	7.0	6.9

Table 10. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in grid 3 of the forebay of Lake Powell, 1990–91—Continued

Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)
March 27, 1991—Continued					
1103	455	1,100	7.6	7.0	6.8
April 24, 1991					
1254	1.00	852	8.0	13.5	10.3
1256	3.00	852	8.1	13.5	10.2
1258	10.0	852	8.1	13.5	10.2
1313	15.0	855	8.1	12.5	10.4
1315	20.0	852	8.1	12.0	10.6
1318	30.0	844	8.1	11.0	10.6
1320	40.0	849	8.0	10.5	10.5
1327	50.0	850	8.0	9.5	10.4
1329	60.0	854	7.9	9.0	9.9
1332	70.0	861	7.9	8.5	9.4
1333	80.0	865	7.8	8.5	9.1
1334	90.0	869	7.8	8.5	8.8
1335	100	871	7.8	8.5	8.7
1337	110	880	7.7	8.0	8.3
1339	120	902	7.7	8.0	7.7
1340	130	933	7.6	7.5	6.9
1342	140	965	7.5	7.5	6.3
1344	150	999	7.5	7.5	5.7
1346	160	1,010	7.5	7.5	5.5
1347	170	1,030	7.4	7.5	5.3
1349	180	1,060	7.4	7.5	5.4
1350	190	1,090	7.5	7.5	5.9
1352	210	1,100	7.5	7.5	6.7
1354	230	1,110	7.6	7.5	7.0
1356	250	1,110	7.6	7.0	7.0
1358	280	1,110	7.6	7.0	6.9
1359	310	1,110	7.6	7.0	6.9
1400	340	1,110	7.6	7.0	6.8
1401	370	1,110	7.6	7.0	6.8
1402	400	1,110	7.6	7.0	6.7
1405	430	1,110	7.6	7.0	6.6
1406	450	1,110	7.6	7.0	6.6
0915	1.00	853	8.2	12.0	10.3
0917	3.00	857	8.2	11.5	10.3
0919	10.0	855	8.2	11.5	10.4
0921	15.0	857	8.2	11.0	10.4
0923	20.0	856	8.2	11.0	10.4
April 24, 1991—Continued					
0926	30.0	856	8.2	10.0	10.3
0929	40.0	856	8.2	9.5	10.2
0935	50.0	863	8.1	9.0	9.7
0937	60.0	872	8.0	8.5	9.0
0938	70.0	875	8.0	8.5	8.8
0940	80.0	875	8.0	8.5	8.7
0942	90.0	877	8.0	8.5	8.7
0943	100	883	8.0	8.0	8.3
0945	110	891	8.0	8.0	8.1
0946	120	906	7.9	8.0	7.6
0948	130	929	7.9	7.5	7.1
0952	140	963	7.8	7.5	6.4
1000	150	978	7.8	7.5	6.1
1001	160	994	7.7	7.5	5.9
1003	170	1,000	7.7	7.5	5.7
1004	180	1,030	7.7	7.5	5.4
1005	190	1,040	7.7	7.5	5.3
1006	210	1,080	7.7	7.5	5.4
1014	220	1,100	7.8	7.5	5.8
1008	230	1,110	7.8	7.5	6.3
1016	250	1,110	7.8	7.5	6.5
1018	280	1,120	7.8	7.0	6.8
1020	310	1,120	7.8	7.0	6.7
1021	340	1,120	7.8	7.0	6.6
1023	370	1,120	7.8	7.0	6.5
1024	400	1,120	7.8	7.0	6.5
1026	430	1,120	7.8	7.0	6.4
1027	450	1,120	7.8	7.0	6.3
May 22, 1991					
0627	1.00	875	8.2	13.0	9.6
0630	3.00	876	8.2	13.0	9.6
0632	10.0	877	8.2	13.0	9.6
0634	20.0	875	8.2	12.5	9.6
0637	40.0	873	8.2	12.0	9.5
0642	50.0	874	8.1	11.0	9.3
0644	55.0	877	8.1	10.5	9.2
0647	60.0	878	8.0	9.5	8.8
0649	70.0	881	8.0	9.5	8.4
0654	80.0	887	7.9	9.0	8.2

Table 10. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in grid 3 of the forebay of Lake Powell, 1990–91—Continued

Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)
May 22, 1991—Continued					
0656	90.0	888	7.9	8.5	8.0
0658	100	891	7.9	8.5	7.9
0705	110	891	7.9	8.5	7.9
0707	120	900	7.8	8.0	7.6
0710	130	906	7.8	8.0	7.3
0712	140	922	7.8	8.0	7.2
0713	150	937	7.8	8.0	6.9
0715	160	953	7.7	7.5	6.7
0718	170	967	7.7	7.5	6.4
0720	180	997	7.7	7.5	6.1
0721	190	1,020	7.7	7.5	5.9
0723	200	1,040	7.7	7.0	6.1
0727	210	1,060	7.7	7.0	6.3
0728	230	1,080	7.7	7.0	6.5
0730	250	1,100	7.7	7.0	6.6
0731	280	1,100	7.7	7.0	6.5
0733	310	1,100	7.7	7.0	6.6
0735	340	1,080	7.7	7.0	6.7
0739	370	1,080	7.7	6.5	6.8
0740	400	1,070	7.7	6.5	6.8
0742	430	1,070	7.7	6.5	6.8
0743	450	1,070	7.7	6.5	6.8
1219	1.00	877	8.2	14.5	9.5
1221	3.00	876	8.2	14.5	9.5
1223	10.0	876	8.3	14.0	9.5
1224	15.0	876	8.3	14.0	9.5
1225	20.0	875	8.3	13.5	9.5
1227	30.0	874	8.3	13.5	9.5
1229	40.0	872	8.2	12.5	9.4
1234	45.0	873	8.2	11.5	9.4
1232	50.0	872	8.2	11.0	9.3
1237	55.0	875	8.1	10.0	8.7
1239	60.0	878	8.0	9.5	8.7
1241	70.0	884	8.0	9.0	8.3
1243	80.0	886	7.9	9.0	8.1
1245	90.0	887	7.9	8.5	8.0
1246	100	891	7.9	8.5	7.8
1248	110	900	7.9	8.0	7.6
May 22, 1991—Continued					
1250	120	913	7.8	8.0	7.4
1251	130	925	7.8	8.0	7.1
1253	150	941	7.8	7.5	6.9
1255	170	973	7.7	7.5	6.3
1259	180	998	7.7	7.5	6.1
1257	190	1,020	7.7	7.5	6.1
1301	210	1,050	7.7	7.0	6.1
1302	230	1,080	7.7	7.0	6.4
1304	250	1,080	7.8	7.0	6.4
1306	280	1,100	7.8	7.0	6.6
1307	310	1,100	7.8	7.0	6.6
1311	330	1,090	7.8	7.0	6.7
1309	340	1,080	7.8	7.0	6.8
1313	370	1,080	7.8	6.5	6.8
1314	400	1,080	7.8	6.5	6.8
1316	430	1,070	7.8	6.5	6.8
1317	450	1,070	7.8	6.5	6.8
June 15, 1991					
2038	1.00	895	8.3	21.5	8.3
2040	3.00	895	8.3	21.5	8.3
2042	10.0	895	8.3	21.5	8.4
2045	15.0	895	8.4	20.5	8.6
2048	20.0	888	8.3	18.5	9.5
2050	25.0	887	8.3	18.0	9.6
2053	30.0	888	8.3	17.5	9.6
2056	40.0	889	8.3	17.0	9.7
2059	45.0	889	8.3	16.5	9.8
2102	50.0	884	8.2	14.5	9.5
2104	55.0	885	8.1	13.5	9.3
2107	60.0	884	8.0	12.5	9.0
2110	65.0	885	8.0	11.5	8.8
2116	70.0	866	7.9	11.5	8.7
2118	80.0	888	7.9	10.5	8.5
2120	90.0	895	7.8	10.0	8.1
2122	100	890	7.8	9.5	8.0
2124	110	893	7.7	9.0	7.8
2127	130	905	7.6	8.5	7.4
2129	150	928	7.6	8.0	7.1

Table 10. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in grid 3 of the forebay of Lake Powell, 1990–91—Continued

Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)	Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)
June 15, 1991—Continued						**June 16, 1991—Continued**					
2130	160	937	7.6	8.0	6.9	0623	140	912	7.8	8.0	7.4
2135	170	964	7.5	7.5	6.5	0626	150	916	7.8	8.0	7.4
2133	180	993	7.5	7.5	6.2	0628	160	924	7.8	8.0	7.2
2137	190	1,010	7.5	7.5	6.0	0629	170	956	7.8	8.0	6.6
2138	200	1,040	7.5	7.0	5.9	0631	180	948	7.8	7.5	6.8
2140	220	1,070	7.5	7.0	6.0	0632	190	969	7.7	7.5	6.6
2142	240	1,080	7.5	7.0	6.2	0633	200	999	7.7	7.5	6.2
2144	270	1,100	7.5	7.0	6.3	0635	210	1,010	7.7	7.5	6.1
2145	300	1,110	7.5	7.0	6.3	0638	230	1,040	7.7	7.0	6.0
2147	330	1,100	7.5	7.0	6.4	0639	250	1,060	7.7	7.0	6.0
2149	360	1,100	7.5	6.5	6.4	0641	270	1,080	7.7	7.0	6.3
2151	390	1,100	7.5	6.5	6.4	0643	300	1,110	7.7	7.0	6.3
2153	420	1,090	7.5	6.5	6.4	0645	330	1,120	7.7	7.0	6.5
2154	450	1,090	7.5	6.5	6.4	0646	360	1,100	7.7	7.0	6.5
2156	455	1,090	7.5	6.5	6.4	0648	390	1,100	7.7	6.5	6.5
2158	460	1,090	7.5	6.5	6.2	0649	420	1,100	7.7	6.5	6.5
June 16, 1991						0651	455	1,100	7.7	6.5	6.5
0527	1.00	900	8.5	21.0	8.5	1241	1.00	887	8.5	22.0	8.5
0529	3.00	900	8.5	21.0	8.5	1243	3.00	887	8.5	22.0	8.5
0531	10.0	900	8.5	21.0	8.5	1244	10.0	886	8.5	21.5	8.5
0533	15.0	895	8.5	20.5	8.7	1248	15.0	888	8.5	21.5	8.4
0536	20.0	896	8.5	20.0	8.9	1250	20.0	887	8.5	21.0	8.5
0540	25.0	894	8.5	19.0	9.4	1252	25.0	886	8.5	20.0	8.9
0543	30.0	889	8.5	18.0	9.7	1256	30.0	879	8.5	19.0	9.5
0546	35.0	890	8.5	17.0	9.9	1259	35.0	878	8.5	17.5	9.9
0548	40.0	891	8.5	16.5	9.9	1302	40.0	878	8.5	16.0	9.9
0551	45.0	887	8.4	15.0	9.6	1304	45.0	876	8.4	15.0	9.8
0554	50.0	888	8.4	14.0	9.4	1307	50.0	876	8.4	15.0	9.8
0557	55.0	887	8.3	13.5	9.4	1310	55.0	876	8.4	14.5	9.6
0559	60.0	887	8.3	13.5	9.3	1313	60.0	876	8.3	14.0	9.5
0600	65.0	886	8.3	13.0	9.1	1315	65.0	875	8.3	13.0	9.3
0602	70.0	887	8.2	12.5	9.1	1316	70.0	874	8.2	12.5	9.1
0608	75.0	889	8.2	12.0	9.0	1321	75.0	876	8.2	11.5	8.9
0605	80.0	887	8.1	11.5	8.7	1324	80.0	881	8.1	11.0	8.7
0610	85.0	892	8.1	11.0	8.6	1327	85.0	884	8.0	10.5	8.5
0613	90.0	897	8.0	10.0	8.2	1329	90.0	886	8.0	10.0	8.4
0615	100	896	8.0	10.0	8.1	1331	100	885	8.0	10.0	8.2
0618	110	894	8.0	9.5	8.0	1336	110	882	8.0	9.5	8.1
0621	120	903	7.9	8.5	7.6	1338	120	889	7.9	9.0	7.8

Table 10. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in grid 3 of the forebay of Lake Powell, 1990–91—Continued

Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)	Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)
June 16, 1991—Continued						**August 1, 1991—Continued**					
1340	130	892	7.9	8.5	7.6	0829	40.0	878	8.3	21.5	9.7
1341	140	895	7.9	8.5	7.6	0833	45.0	875	8.3	21.0	9.5
1343	150	902	7.8	8.5	7.4	0835	50.0	877	8.3	20.0	9.0
1344	160	910	7.8	8.0	7.3	0838	55.0	875	8.3	19.5	8.9
1346	170	919	7.8	8.0	7.1	0840	60.0	873	8.3	18.0	8.8
1347	180	950	7.8	8.0	6.5	0842	65.0	871	8.3	17.5	8.8
1349	190	957	7.7	7.5	6.5	0845	70.0	873	8.3	16.5	8.6
1351	200	994	7.7	7.5	6.1	0847	80.0	872	8.2	15.5	8.3
1352	210	1,020	7.7	7.5	5.9	0849	85.0	874	8.2	14.5	8.4
1354	230	1,050	7.7	7.0	6.1	0852	90.0	874	8.1	14.0	8.0
1356	250	1,070	7.7	7.0	6.3	0854	100	879	8.0	13.5	7.6
1357	270	1,080	7.7	7.0	6.4	0856	110	875	8.0	12.5	7.8
1359	300	1,100	7.7	7.0	6.4	0859	120	867	7.9	11.5	7.3
1400	330	1,100	7.7	7.0	6.5	0902	130	877	7.8	10.5	7.1
1401	360	1,090	7.7	7.0	6.5	0904	140	889	7.7	9.5	6.8
1403	390	1,090	7.7	6.5	6.5	0906	150	893	7.7	8.5	6.7
1404	420	1,080	7.7	6.5	6.5	0908	160	904	7.7	8.5	6.6
1405	455	1,080	7.7	6.5	6.5	0910	170	907	7.6	8.0	6.5
July 31, 1991						0912	180	930	7.6	7.5	6.3
1456	1.00	880	8.3	26.5	7.9	0913	190	961	7.6	7.5	6.0
1457	3.00	880	8.3	26.5	7.9	0915	200	1,000	7.6	7.0	5.8
1459	10.0	881	8.3	26.5	8.0	0916	220	1,040	7.6	7.0	5.9
1500	20.0	881	8.3	26.5	8.0	0918	240	1,060	7.6	7.0	6.0
1505	25.0	881	8.3	25.5	8.4	0920	260	1,070	7.6	7.0	6.1
1508	30.0	871	8.3	24.5	10.0	0921	290	1,070	7.6	7.0	6.0
1510	35.0	868	8.3	23.5	10.6	0923	320	1,090	7.6	7.0	6.1
1512	40.0	867	8.3	22.0	10.3	0924	350	1,090	7.6	7.0	6.1
1515	45.0	870	8.3	21.0	9.6	0926	380	1,090	7.6	7.0	6.3
1517	50.0	871	8.3	20.5	9.2	0927	410	1,090	7.6	6.5	6.1
1519	55.0	867	8.3	19.0	9.0	0928	440	1,090	7.6	6.5	5.9
1521	60.0	865	8.3	18.5	8.9	0930	455	1,090	7.6	6.5	5.6
August 1, 1991						**August 28, 1991**					
0815	1.00	891	8.2	25.5	8.4	0909	1.00	889	8.2	26.0	7.7
0817	3.00	891	8.3	25.5	8.4	0910	3.00	889	8.2	26.0	7.7
0818	10.0	891	8.3	25.5	8.5	0912	10.0	889	8.2	26.0	7.7
0820	20.0	888	8.3	25.5	8.6	0914	20.0	891	8.3	26.0	7.6
0822	25.0	887	8.3	25.0	8.8	0916	30.0	890	8.2	25.5	8.0
0824	30.0	881	8.3	24.5	9.4	0919	35.0	885	8.2	24.5	8.5
0827	35.0	873	8.3	22.5	10.6	0921	40.0	880	8.2	24.0	9.2

Table 10. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in grid 3 of the forebay of Lake Powell, 1990–91—Continued

Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)	Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)
August 28, 1991—Continued						**September 23, 1991—Continued**					
0924	45.0	873	8.2	22.0	9.6	1450	20.0	870	8.3	23.5	8.2
0927	50.0	877	8.1	20.5	8.8	1453	30.0	871	8.3	23.0	8.1
0929	55.0	876	8.1	19.5	8.4	1454	40.0	871	8.3	23.0	7.9
0932	60.0	874	8.1	19.0	8.1	1459	50.0	872	8.2	22.5	7.5
0935	70.0	873	8.0	18.0	7.9	1500	60.0	851	8.0	21.5	8.0
0937	75.0	875	8.0	17.5	7.7	1501	70.0	850	7.9	19.0	6.9
0939	80.0	873	8.0	16.5	7.6	1503	80.0	850	7.9	17.5	6.5
0942	90.0	875	8.0	15.5	7.3	1505	90.0	856	7.8	16.0	6.0
0945	100	875	7.9	14.5	7.0	1507	100	858	7.7	15.0	5.1
0948	110	873	7.9	13.5	7.1	1508	110	852	7.8	14.0	6.5
0951	120	873	7.8	12.0	7.0	1510	120	858	7.7	13.0	6.3
0953	125	877	7.8	11.5	6.9	1511	130	857	7.6	11.5	5.9
0955	130	876	7.7	11.0	6.8	1516	140	866	7.5	10.0	6.0
0958	140	883	7.6	10.0	6.8	1517	150	874	7.5	9.0	6.0
1000	150	886	7.6	9.0	6.6	1518	160	892	7.5	8.5	6.1
1002	160	910	7.5	8.0	6.3	1520	170	903	7.5	8.0	6.1
1003	170	924	7.5	8.0	6.3	1521	180	920	7.4	8.0	6.1
1006	180	946	7.5	7.5	6.1	1522	190	933	7.4	7.5	6.0
1009	190	992	7.4	7.5	5.6	1523	200	964	7.4	7.5	5.7
1011	200	1,010	7.4	7.0	5.4	1524	220	1,010	7.4	7.5	5.1
1013	220	1,040	7.4	7.0	5.8	1525	240	1,020	7.4	7.0	5.3
1015	240	1,050	7.4	7.0	5.8	1528	260	1,030	7.4	7.0	5.6
1017	270	1,070	7.4	7.0	5.5	1530	280	1,040	7.4	7.0	5.4
1018	300	1,070	7.4	7.0	5.7	1532	300	1,050	7.4	7.0	5.4
1020	330	1,080	7.4	7.0	5.7	1533	320	1,050	7.4	7.0	5.2
1021	360	1,080	7.4	7.0	5.8	1534	340	1,060	7.3	7.0	5.0
1022	390	1,080	7.4	7.0	5.7	1535	360	1,060	7.3	7.0	4.9
1023	420	1,090	7.4	6.5	5.7	1537	380	1,060	7.3	7.0	4.8
1025	450	1,080	7.4	6.5	4.9	1538	400	1,060	7.3	7.0	4.9
September 23, 1991						1539	420	1,060	7.3	7.0	4.9
1444	1.00	871	8.3	24.5	7.8	1540	440	1,060	7.3	7.0	4.6
1446	3.00	871	8.3	24.0	7.8	1541	450	1,060	7.3	7.0	4.2
1449	10.0	872	8.3	24.0	7.9						

Table 11. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in grid 4 of the forebay of Lake Powell, 1990

[µS/cm; microsiemens per centimeter at 25°C; °C, degrees Celsius; mg/L, milligrams per liter]

Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)	Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)
		September 19, 1990						November 3, 1990			
1540	5.00	800	7.9	24.5	7.7	1609	3.00	812	8.2	17.5	7.5
1538	15.0	800	7.9	24.5	7.7	1608	10.0	813	8.2	17.5	7.4
1536	25.0	800	7.9	24.0	7.7	1607	20.0	814	8.2	17.5	7.4
1534	35.0	800	7.9	24.0	7.7	1606	30.0	814	8.2	17.5	7.3
1532	40.0	795	7.8	23.5	7.7	1605	40.0	814	8.2	17.5	7.3
1529	45.0	790	7.7	22.5	7.8	1604	50.0	814	8.2	17.5	7.3
1528	50.0	780	7.6	21.0	8.0	1603	60.0	814	8.2	17.5	7.3
1527	55.0	780	7.6	19.5	7.3	1602	70.0	817	8.2	17.0	7.3
1525	60.0	780	7.5	19.0	7.0	1600	75.0	820	8.1	16.5	6.9
1523	70.0	780	7.5	17.5	6.5	1559	80.0	805	7.7	15.0	4.7
1521	80.0	780	7.4	16.0	6.3	1558	85.0	800	7.7	14.5	4.2
1520	90.0	790	7.4	13.0	6.5	1552	90.0	803	7.7	14.0	4.4
1519	100	790	7.1	11.5	6.0	1550	100	799	7.7	12.5	4.8
1517	110	790	7.1	11.0	6.1	1547	110	788	7.7	10.5	5.6
1516	120	790	7.1	9.5	6.1	1542	120	794	7.6	9.5	5.6
1515	130	790	7.1	9.0	6.0	1541	130	800	7.6	9.0	5.5
1513	140	800	7.1	8.5	5.9	1540	140	808	7.6	8.5	5.4
1512	150	815	7.1	8.0	6.0	1539	150	816	7.6	8.5	5.5
1511	160	802	7.1	8.0	6.1	1538	160	832	7.6	8.0	5.7
1510	165	850	7.1	8.0	6.2	1537	170	848	7.6	8.0	5.8
1509	170	890	7.1	7.5	6.2	1536	180	860	7.6	8.0	5.8
1508	175	910	7.1	7.5	6.2	1535	190	855	7.6	8.0	5.7
1507	180	930	7.0	7.5	6.1	1532	200	927	7.6	7.5	6.0
1506	190	960	7.0	7.5	5.8	1531	210	968	7.6	7.5	5.9
1505	200	1,010	7.0	7.5	5.4	1530	220	990	7.6	7.5	5.6
1503	210	1,020	7.0	7.5	5.3	1528	230	1,000	7.6	7.5	5.0
1502	230	1,050	7.0	7.5	5.1	1527	250	1,020	7.6	7.5	4.9
1501	250	1,060	7.0	7.5	5.1	1526	270	1,040	7.5	7.5	4.5
1500	270	1,070	7.0	7.5	4.9	1525	290	1,070	7.5	8.0	4.4
1459	290	1,070	7.0	7.5	4.9	1524	320	1,080	7.5	8.0	4.4
1458	310	1,070	7.0	7.5	4.9	1522	340	1,090	7.5	7.5	3.9
1456	330	1,080	7.0	7.5	4.9	1521	360	1,090	7.5	7.5	3.8
1455	350	1,080	7.0	7.5	5.0	1520	380	1,100	7.5	7.5	3.6
1454	370	1,090	7.0	7.5	4.9	1519	400	1,100	7.5	7.5	3.6
1453	390	1,090	7.0	7.5	4.8	1518	420	1,100	7.5	7.5	3.5
1452	400	1,080	7.0	7.5	4.7	1517	430	1,100	7.5	7.5	3.5
1451	420	1,090	7.0	7.5	4.6	1515	440	1,100	7.5	7.5	3.2
1450	440	1,100	6.9	7.5	5.0						

Table 12. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in grid 33 of the forebay of Lake Powell, 1990–91

[µS/cm, microsiemens per centimeter at 25°C; °C, degrees Celsius; mg/L, milligrams per liter. Dashes indicate no data]

Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)
August 16, 1990					
1140	3.00	805	8.0	25.0	7.7
1135	16.0	805	8.1	24.5	7.7
1131	32.0	806	8.1	24.5	7.7
1128	50.0	786	8.4	19.5	8.8
1125	65.0	785	8.5	17.0	7.7
1122	82.0	789	8.5	13.5	7.5
1120	99.0	796	8.5	11.0	6.9
1117	115	803	8.4	10.0	6.7
1114	133	803	8.3	8.5	6.2
1112	165	829	8.3	8.0	6.1
1109	196	951	8.3	7.5	5.6
1107	231	1,020	8.3	7.5	5.4
1104	263	1,050	8.2	7.5	5.3
1101	295	1,060	8.1	7.5	5.3
1059	328	1,080	8.0	7.5	5.1
1056	361	1,080	7.9	7.5	5.1
1053	395	1,090	7.8	7.5	5.1
1050	426	1,090	7.7	7.5	4.9
1048	463	1,090	7.6	8.0	4.5
1045	476	1,120	7.5	8.0	3.1
September 5, 1990					
1600	1.00	793	8.3	25.0	7.3
1558	10.0	793	8.3	24.5	7.4
1555	20.0	794	8.3	24.5	7.4
1551	30.0	794	8.3	24.0	7.5
1547	40.0	776	8.2	21.0	8.5
1544	50.0	773	8.2	19.0	7.6
1541	60.0	772	8.1	18.0	7.0
1538	70.0	773	8.1	17.0	6.7
1536	80.0	772	8.0	14.5	6.6
1534	90.0	781	7.9	12.5	6.4
1532	100	782	---	11.5	6.2
1530	110	780	---	10.5	6.3
1529	120	775	---	10.0	6.2
1528	130	772	---	9.0	6.2
1526	140	787	---	8.5	6.0
1524	150	800	---	8.5	5.8
1522	160	830	---	8.0	5.7
1521	170	860	---	8.0	5.8
1519	180	903	---	7.5	5.7
1517	190	930	---	7.5	5.6
September 5, 1990—Continued					
1515	210	980	---	7.5	5.2
1513	230	1,000	---	7.5	5.2
1511	250	1,020	---	7.5	5.2
1509	270	1,040	---	7.5	5.0
1507	300	1,050	---	7.5	5.0
1505	330	1,060	---	7.5	4.9
1503	360	1,070	---	7.5	4.8
1501	390	1,070	---	7.5	4.5
1459	420	1,080	---	7.5	4.5
1457	450	1,070	---	8.5	4.4
1455	465	1,070	---	8.5	4.5
1332	5.00	799	7.9	24.5	7.8
1331	15.0	798	7.9	24.0	7.8
1330	25.0	798	7.9	24.0	7.8
1328	35.0	797	7.9	24.0	7.7
1327	40.0	793	7.8	23.5	7.6
1326	45.0	786	7.7	22.5	7.8
1324	50.0	781	7.7	21.5	8.1
1323	55.0	775	7.6	20.0	8.0
1322	60.0	778	7.5	19.0	7.1
1321	70.0	778	7.4	17.5	6.6
1320	80.0	775	7.3	16.5	6.4
1319	90.0	778	7.2	14.0	6.4
1318	100	789	7.1	11.5	6.0
1317	110	787	7.1	11.0	6.0
1316	120	783	7.1	10.0	6.2
1315	130	793	7.1	9.0	6.1
1313	140	795	7.0	8.5	6.1
1312	150	815	7.0	8.0	6.1
1311	155	827	7.1	8.0	6.2
1310	160	858	7.1	7.5	6.3
1309	165	881	7.1	7.5	6.3
1307	170	909	7.1	7.5	6.3
1305	175	930	7.0	7.5	6.2
1304	180	953	7.0	7.5	6.0
1303	190	985	7.0	7.5	5.7
1301	200	998	7.0	7.5	5.6
1259	210	1,020	7.0	7.5	5.4
1257	230	1,030	7.0	7.5	5.5
1255	250	1,050	7.0	7.5	5.3
1253	270	1,070	7.0	7.5	5.1

Table 12. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in grid 33 of the forebay of Lake Powell, 1990–91—Continued

Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)
September 5, 1990—Continued					
1251	290	1,070	7.0	7.5	5.0
1249	310	1,080	7.0	7.5	4.9
1247	330	1,080	7.0	7.5	4.9
1246	350	1,080	7.0	7.5	5.0
1245	370	1,090	7.0	7.5	5.0
1243	390	1,090	7.0	7.5	4.7
1242	410	1,090	7.0	7.5	4.6
1240	420	1,090	7.0	7.5	4.7
November 8, 1990					
1502	3.00	812	8.2	17.5	7.4
1501	10.0	813	8.2	17.5	7.4
1500	20.0	813	8.2	17.5	7.4
1458	30.0	814	8.2	17.5	7.3
1457	40.0	814	8.2	17.5	7.3
1456	50.0	814	8.2	17.5	7.3
1455	60.0	814	8.2	17.5	7.4
1454	70.0	814	8.2	17.5	7.3
1452	75.0	815	8.2	17.5	7.3
1449	80.0	802	7.8	16.0	4.9
1446	85.0	804	7.6	14.5	4.1
1444	90.0	806	7.6	14.0	4.1
1443	100	805	7.6	12.5	4.6
1441	110	807	7.6	11.0	4.7
1439	120	791	7.6	10.0	5.6
1438	130	794	7.6	9.0	5.6
1436	140	808	7.6	8.5	5.4
1435	150	818	7.6	8.5	5.5
1433	160	830	7.6	8.0	5.6
1431	170	849	7.6	8.0	5.8
1430	180	871	7.6	8.0	5.9
1429	190	901	7.6	7.5	5.9
1428	200	927	7.6	7.5	6.0
1427	210	963	7.6	7.5	6.0
1425	220	990	7.6	7.5	5.6
1423	230	1,010	7.6	7.5	5.0
1421	250	1,030	7.6	7.5	4.9
1420	270	1,050	7.5	7.5	4.9
1417	290	1,070	7.5	8.0	4.4
1416	320	1,090	7.5	8.0	4.0
1414	340	1,090	7.5	7.5	3.9
1413	360	1,090	7.5	7.5	3.9
1412	380	1,090	7.5	7.5	3.6
1410	400	1,100	7.5	7.5	3.6
November 8, 1990—Continued					
1408	410	1,100	7.5	7.5	3.5
January 15, 1991					
1408	3.00	806	7.8	8.5	8.7
1410	10.0	804	7.8	8.0	8.6
1411	30.0	804	7.9	8.0	8.5
1413	50.0	805	7.9	8.0	8.5
1414	70.0	805	7.9	8.0	8.5
1415	90.0	805	7.9	8.0	8.5
1416	130	805	7.9	8.0	8.4
1418	150	809	7.9	7.5	8.6
1419	160	812	8.0	7.5	8.7
1420	170	826	8.0	7.5	8.6
1421	190	836	7.9	7.5	8.4
1422	210	852	7.9	7.5	8.1
1424	215	854	7.9	7.0	8.0
1425	220	865	7.9	7.5	7.8
1427	225	960	7.6	7.5	5.6
1429	230	992	7.6	7.5	4.9
1430	240	1,000	7.6	7.5	4.8
1432	250	1,020	7.5	7.5	4.4
1433	270	1,040	7.5	7.5	4.3
1434	290	1,050	7.5	7.5	4.1
1436	310	1,060	7.5	7.5	4.0
1437	330	1,060	7.5	7.5	3.8
1439	350	1,070	7.5	7.5	3.7
1440	370	1,070	7.5	7.5	3.5
1441	390	1,080	7.5	7.5	3.3
1442	410	1,070	7.5	7.5	3.0
1444	420	1,080	7.5	7.5	3.0
February 27, 1991					
1423	3.00	806	7.9	8.5	9.7
1421	10.0	807	7.9	8.5	9.7
1418	30.0	806	7.9	8.0	9.5
1416	50.0	804	7.9	7.5	9.1
1414	70.0	804	7.9	7.5	8.8
1412	90.0	806	7.9	7.5	8.6
1410	110	807	7.9	7.0	8.6
1408	130	814	7.8	7.0	8.5
1406	145	832	7.8	7.0	8.2
1404	150	821	7.8	7.0	8.4
1402	155	856	7.7	7.0	7.4
1400	160	914	7.5	7.5	5.9
1358	165	959	7.5	7.5	5.1

Table 12. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in grid 33 of the forebay of Lake Powell, 1990–91—Continued

Time	Sampling depth, in feet	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)
February 27, 1991—Continued					
1356	170	997	7.5	7.5	4.8
1355	175	997	7.4	7.5	4.8
1353	190	1,030	7.4	7.5	4.2
1351	210	1,040	7.4	7.5	4.0
1350	230	1,040	7.4	7.5	3.9
1346	250	1,040	7.4	7.5	3.7
1344	280	1,050	7.4	7.5	3.3
1342	310	1,060	7.3	7.5	3.1
1340	340	1,060	7.3	7.5	2.8
1338	370	1,060	7.3	7.5	2.6
1335	400	1,060	7.3	7.5	2.5
1333	420	1,060	7.3	7.5	2.6
March 29, 1991					
1032	3.00	832	7.7	8.5	10.2
1034	10.0	838	7.8	8.5	10.2
1037	30.0	833	7.8	8.5	10.2
1038	40.0	832	7.8	8.0	10.1
1040	50.0	833	7.8	8.0	10.0
1042	60.0	834	7.9	8.0	9.9
1043	70.0	837	7.8	8.0	9.7
March 29, 1991—Continued					
1046	80.0	855	7.8	8.0	8.8
1048	90.0	858	7.7	8.0	8.6
1052	100	870	7.7	8.0	8.1
1050	110	885	7.7	7.5	7.7
1055	120	894	7.6	7.5	7.4
1102	130	917	7.6	7.5	6.7
1059	140	969	7.5	7.5	5.7
1103	150	979	7.5	7.5	5.5
1135	160	1,020	7.5	7.5	4.8
1105	170	1,020	7.4	7.5	4.7
1108	190	1,040	7.4	7.5	4.6
1110	210	1,060	7.4	7.5	4.4
1116	220	1,070	7.5	7.5	5.0
1113	230	1,090	7.5	7.5	6.0
1118	250	1,100	7.6	7.5	6.5
1119	270	1,100	7.6	7.5	6.8
1121	300	1,100	7.6	7.5	6.9
1123	330	1,100	7.6	7.0	6.9
1125	360	1,100	7.6	7.0	6.9

Table 13. Specific conductance, pH, water temperature, and dissolved-oxygen concentrations in outflows (draft tubes) of Glen Canyon Dam, 1990–91

[µS/cm, microsiemens per centimeter at 25°C; °C, degrees Celsius; mg/L, milligrams per liter. Dashes indicate no data]

Time	Specific conductance (µS/cm)	pH, water whole field (standard units)	Temperature, water (°C)	Oxygen, dissolved (mg/L)
		September 6, 1990		
0900	910	8.0	8.4	7.4
0901	910	7.9	8.4	7.4
1550	875	7.8	8.5	7.6
1551	875	7.8	8.5	7.5
2145	888	8.0	8.5	7.7
2146	888	8.0	8.5	7.7
		September 20, 1990		
0940	920	8.0	8.3	8.3
0941	920	8.0	8.3	8.3
1540	880	7.8	8.5	8.3
1541	880	7.8	8.5	8.3
2140	840	7.8	8.5	8.6
2141	840	7.8	8.5	8.6
		November 5, 1990		
0600	803	7.6	8.5	7.2
1200	850	7.8	9.0	6.9
1800	---	---	9.0	6.7
2400	830	7.8	8.0	6.9
		November 6, 1990		
0600	840	7.8	8.5	78.0
1200	970	7.2	8.9	7.5
1800	930	7.7	8.5	7.2
2400	879	7.5	8.5	---
		January 16, 1991		
0700	865	7.8	7.5	---
1400	860	8.0	8.0	---
		January 16, 1991—Continued		
2100	919	7.8	8.0	---
		January 17, 1991		
0700	870	8.0	8.0	9.1
		March 28, 1991		
0720	1,060	7.7	7.5	---
1415	---	7.6	8.0	8.2
2115	1,070	7.8	8.0	7.8
		May 23, 1991		
0830	992	7.7	8.0	7.9
1535	1,090	7.6	8.0	7.7
2200	1,040	8.0	8.0	7.2
		June 18, 1991		
1330	963	7.4	8.0	7.3
1830	---	7.8	8.0	7.4
2400	960	7.8	8.5	7.9
		June 19, 1991		
0615	---	7.8	8.0	7.4
1300	---	---	8.0	7.2
1900	950	7.6	8.0	7.5
2340	960	8.0	8.0	7.0
		June 20, 1991		
0545	---	7.8	8.0	7.0
		August 29, 1991		
0730	935	7.8	8.5	6.9
1400	930	7.7	8.5	6.5
2000	980	7.8	8.5	6.5

Nutrient and Organic-Carbon Data

Table 14. Concentrations of dissolved ammonia, nitrite, nitrite plus nitrate, orthophosphorus, and organic carbon in grid 2 of the forebay of Lake Powell, 1990–91

[mg/L, milligrams per liter; <, less than. Dashes indicate no data]

Time	Sampling depth, in feet	Nitrogen, ammonia (mg/L as N)	Nitrogen, nitrite (mg/L as N)	Nitrogen, nitrite plus nitrate (mg/L as N)	Phosphorus, ortho (mg/L as P)	Carbon, organic (mg/L as C)
November 5, 1990						
0600	50.0	<0.02	<0.01	0.03	<0.01	3.0
0601	100	<.02	<.01	.24	<.01	2.8
0602	167	<.02	<.01	.35	<.01	2.8
0603	390	<.02	<.01	.52	<.01	2.9
1200	50.0	.07	<.01	.02	<.01	3.2
1201	100	<.02	<.01	.22	<.01	2.8
1202	167	<.02	<.01	.33	<.01	2.8
1203	390	<.02	<.01	.49	<.01	2.9
1800	50.0	<.02	<.01	<.02	<.01	2.8
1801	100	<.02	<.01	.22	<.01	3.0
1802	167	<.02	<.01	.36	<.01	2.9
1803	390	<.02	<.01	.52	<.01	2.8
2357	50.0	<.02	<.01	<.02	<.01	3.2
2358	100	<.02	<.01	.22	<.01	2.9
2359	167	<.02	<.01	.34	<.01	2.9
2400	390	<.02	<.01	.50	<.01	2.9
November 6, 1990						
0600	50.0	.02	<.01	.03	<.01	3.2
0601	100	<.02	<.01	.22	<.01	2.9
0602	167	.02	<.01	.36	<.01	3.0
0603	390	<.02	<.01	.50	.01	3.1
1200	50.0	<.02	<.01	.04	<.01	3.0
1201	100	<.02	<.01	.22	<.01	2.9
1202	167	<.02	<.01	.34	<.01	2.9
1203	390	<.02	<.01	.50	.01	2.6
1800	50.0	<.02	<.01	.04	<.01	3.2
1801	100	<.02	<.01	.22	.01	2.8
1802	167	<.02	<.01	.34	<.01	2.9
1803	390	<.02	<.01	.50	.01	2.8
2357	50.0	<.02	<.01	.04	<.01	3.2
2358	100	<.02	<.01	.15	<.01	---
2359	167	<.02	<.01	.33	<.01	2.6
2400	390	<.02	<.01	.04	<.01	3.1
January 16, 1991						
1401	50.0	<.02	<.01	.16	<.01	2.9
1402	155	<.02	<.01	.12	<.01	2.9
1403	390	<.02	<.01	.48	<.01	2.9
2101	50.0	<.02	<.01	.16	<.01	2.9
2102	155	.02	<.01	.13	<.01	2.9
2103	390	<.02	<.01	.48	<.01	2.9
January 17, 1991						
0701	50.0	<.02	<.01	.16	<.01	3.4
0702	155	.02	<.01	.12	<.01	3.4
0703	390	<.02	<.01	.48	<.01	3.3
March 28, 1991						
0900	40.0	<.02	<.01	.17	.01	3.1
0901	151	<.02	<.01	.44	<.01	3.2
0902	390	<.02	<.01	.57	<.01	3.2
1520	40.0	<.02	<.01	---	<.01	3.1
1521	151	<.02	<.01	---	<.01	3.0
1522	390	<.02	<.01	---	<.01	3.1
2150	40.0	<.02	<.01	.19	.01	2.9
2151	151	<.02	<.01	.44	<.01	2.8
2152	390	<.02	<.01	.56	<.01	3.0

Table 14. Concentrations of dissolved ammonia, nitrite, nitrite plus nitrate, orthophosphorus, and organic carbon in grid 2 of the forebay of Lake Powell, 1991—Continued

Time	Sampling depth, in feet	Nitrogen, ammonia, (mg/L as N)	Nitrogen, nitrite (mg/L as N)	Nitrogen, nitrite plus nitrate (mg/L as N)	Phosphorus, ortho, (mg/L as P)	Carbon, organic (mg/L as C)
			May 23, 1991			
0910	3.00	<0.01	<0.01	0.16	0.01	---
0911	50.0	.02	<.01	.31	.01	---
0912	152	<.01	<.01	.38	.01	---
0913	390	<.01	<.01	.57	.01	---
1545	3.00	<.01	<.01	.15	.01	---
1546	50.0	<.01	<.01	.18	.01	---
1547	152	<.01	<.01	.40	.01	---
1548	390	<.01	<.01	.56	.02	---
2306	3.00	<.01	<.01	.15	.01	---
2307	50.0	<.01	<.01	.20	.01	---
2308	152	<.01	<.01	.39	.01	---
2309	390	<.01	<.01	.56	.01	---
			June 18, 1991			
1500	3.00	<.02	<.01	.11	<.01	3.1
1501	40.0	.02	<.01	.13	<.01	3.2
1502	160	<.02	<.01	.31	<.01	3.1
1503	390	<.02	<.01	.51	<.01	3.1
			June 19, 1991			
0040	3.00	<.02	<.01	.10	<.01	3.2
0041	40.0	<.02	<.01	.14	<.01	3.1
0042	160	<.02	<.01	.35	<.01	2.9
0043	390	<.02	<.01	.57	<.01	3.1
0745	3.00	<.02	<.01	.10	<.01	3.3
0746	40.0	<.02	<.01	.13	<.01	3.1
0747	160	<.02	<.01	.37	<.01	3.0
0748	390	<.02	<.01	.58	<.01	3.0
1210	3.00	<.02	<.01	.10	<.01	3.3
1220	40.0	.02	<.01	.12	<.01	3.3
1230	160	<.02	<.01	.35	<.01	3.0
1240	390	<.02	<.01	.58	<.01	3.1
1805	3.00	---	---	---	---	---
1810	40.0	---	---	---	---	---
1817	160	---	---	---	---	---
1850	390	---	---	---	---	---
			June 20, 1991			
0050	3.00	.02	<.01	.10	<.01	3.2
0051	40.0	.02	.01	.12	<.01	3.1
0052	160	<.02	<.01	.37	<.01	3.0
0053	390	<.02	<.01	.55	<.01	3.0
0635	3.00	<.02	<.01	.10	<.01	3.1
0636	40.0	<.02	<.01	.11	<.01	3.0
0637	160	<.02	<.01	.36	<.01	3.0
0638	390	<.02	<.01	.48	<.01	3.2

Table 15. Concentrations of dissolved ammonia, nitrite, nitrite plus nitrate, orthophosphorus, and organic carbon in grid 3 of the forebay of Lake Powell, 1990–91

[mg/L, milligrams per liter. Dashes indicate no data]

Time	Sampling depth, in feet	Nitrogen, ammonia (mg/L as N)	Nitrogen, nitrite (mg/L as N)	Nitrogen, nitrite plus nitrate (mg/L as N)	Phosphorus, ortho (mg/L as P)	Carbon, organic (mg/L as C)
September 5, 1990						
0904	390	<0.02	<0.01	0.50	<0.01	---
0923	140	<.02	<.01	.50	<.01	---
0937	4.0	<.02	<.01	.38	<.01	---
0951	3.00	<.02	<.01	.02	<.01	---
1529	390	<.02	<.01	.48	<.01	---
1546	140	<.02	<.01	.20	<.01	---
1600	4.0	<.02	<.01	<.02	<.01	---
1611	3.00	<.02	<.01	.02	<.01	---
2133	390	<.02	<.01	.48	<.01	---
2148	140	<.02	<.01	.28	<.01	---
2159	4.0	<.02	<.01	.40	<.01	---
2208	3.00	<.02	<.01	.11	<.01	---
September 6, 1990						
0955	390	<.02	<.01	.46	<.01	3.8
1011	168	<.02	<.01	.48	<.01	3.9
1023	150	<.02	<.01	.49	<.01	4.0
1041	100	<.02	<.01	.36	<.01	3.8
1054	5.0	<.02	<.01	.32	<.01	3.7
1106	3.00	<.02	<.01	.24	<.01	4.0
1546	390	<.02	<.01	<.02	<.01	5.0
1556	168	<.02	<.01	.48	<.01	3.7
September 20, 1990						
1606	150	<.02	<.01	.34	<.01	3.7
1621	100	<.02	<.01	.30	<.01	3.7
1631	5.0	<.02	<.01	.22	<.01	3.7
1646	3.00	<.02	<.01	.04	<.01	4.2
2134	390	<.02	<.01	.08	---	3.7
2147	168	<.02	<.01	.50	---	4.0
2201	150	<.02	<.01	.42	---	3.6
2216	100	<.02	<.01	---	<.01	3.6
2231	5.0	<.02	<.01	.22	<.01	3.7
2246	3.00	<.02	<.01	.02	<.01	4.6
November 5, 1990						
0600	5.0	<.02	<.01	.02	<.01	3.1
0601	100	<.02	<.01	.24	.01	2.9
0602	167	<.02	<.01	.34	<.01	3.0
0603	390	<.02	<.01	.52	.01	2.8
1200	5.0	<.02	<.01	<.02	<.01	3.4
1201	100	<.02	<.01	.22	<.01	2.7
1202	167	<.02	<.01	.34	<.01	3.1
1203	390	<.02	<.01	.51	<.01	2.8
1800	5.0	<.02	<.01	<.02	<.01	3.2
1801	100	<.02	<.01	.22	<.01	2.8
1802	167	<.02	<.01	.34	<.01	2.8
1803	390	<.02	<.01	.52	<.01	2.8

Table 15. Concentrations of dissolved ammonia, nitrite, nitrite plus nitrate, orthophosphorus, and organic carbon in grid 3 of the forebay of Lake Powell, 1990-91—Continued

Time	Sampling depth, in feet	Nitrogen, ammonia (mg/L as N)	Nitrogen, nitrite (mg/L as N)	Nitrogen, nitrite plus nitrate (mg/L as N)	Phosphorus, ortho (mg/L as P)	Carbon, organic (mg/L as C)
November 5, 1990—Continued						
2357	5.0	<.02	<.01	<.02	<.01	3.1
2358	100	<.02	<.01	.02	<.01	3.5
2359	167	<.02	<.01	.32	<.01	3.0
0600	5.0	.02	<.01	.06	<.01	3.0
0601	100	<.02	<.01	.22	<.01	2.6
0602	167	<.02	<.01	.34	<.01	2.9
0603	390	<.02	<.01	.48	.01	3.1
1200	5.0	<.02	<.01	.03	<.01	3.3
1201	100	<.02	<.01	.22	<.01	2.7
1202	167	<.02	<.01	.34	<.01	2.6
1203	390	<.02	<.01	.49	.01	2.6
1800	5.0	<.02	<.01	.04	<.01	3.0
1801	100	<.02	<.01	.22	<.01	3.2
1802	167	<.02	<.01	.34	<.01	3.1
1803	390	<.02	<.01	.48	.01	2.9
2357	5.0	<.02	<.01	.03	<.01	3.0
2358	100	<.02	<.01	.21	<.01	2.9
2359	167	<.02	<.01	.34	<.01	2.8
2400	390	<.02	<.01	.50	.01	2.8
January 16, 1991						
1431	5.0	.04	<.01	.15	<.01	2.9
1432	155	<.02	<.01	.12	<.01	3.0
1433	390	<.02	<.01	.48	<.01	2.9
2131	5.0	<.02	<.01	.16	<.01	2.9
2132	155	.02	<.01	.14	<.01	3.0
2133	390	.02	<.01	.48	<.01	2.9
0731	5.0	<.02	<.01	.15	<.01	3.4
0732	155	.06	<.01	.12	<.01	3.4
0733	390	<.02	<.01	.48	<.01	3.2
March 28, 1991						
0910	4.0	---	---	---	---	---
0911	151	---	---	---	---	---
0912	390	---	---	---	---	---
0915	4.0	<.02	<.01	.20	.04	3.0
0916	151	<.02	<.01	.45	<.01	3.0
0917	390	<.02	<.01	.54	<.01	3.2
1500	4.0	<.02	<.01	.14	<.01	3.0
1501	151	<.02	<.01	.25	<.01	2.9
1502	390	<.02	<.01	.56	.02	3.1

Table 15. Concentrations of dissolved ammonia, nitrite, nitrite plus nitrate, orthophosphorus, and organic carbon in grid 3 of the forebay of Lake Powell, 1990-91—Continued

Time	Sampling depth, in feet	Nitrogen, ammonia (mg/L as N)	Nitrogen, nitrite (mg/L as N)	Nitrogen, nitrite plus nitrate (mg/L as N)	Phosphorus, ortho (mg/L as P)	Carbon, organic (mg/L as C)
			March 28, 1991—Continued			
2122	4.0	<.02	<.01	.20	.03	3.0
2123	151	<.02	<.01	.44	<.01	2.8
2124	390	<.02	<.01	.55	<.01	3.1
			May 23, 1991			
0930	3.00	<.01	<.01	.16	.01	---
0931	5.0	<.01	<.01	.18	.01	---
0932	152	<.01	<.01	.39	.01	---
0946	390	<.01	<.01	.57	.01	---
1600	3.00	<.01	<.01	.15	.01	---
1615	5.0	<.01	<.01	.19	.01	---
1616	152	<.01	<.01	.40	.01	---
1617	390	<.01	<.01	.55	.01	---
2225	3.00	<.01	<.01	.16	.01	---
2240	5.0	<.01	<.01	.19	.01	---
2241	152	<.01	<.01	.38	.02	---
2242	390	<.01	<.01	.56	.02	---
			June 18, 1991			
1310	3.00	<.02	<.01	.11	<.01	3.2
1311	4.0	<.02	<.01	.13	<.01	3.0
1312	160	<.02	<.01	.34	<.01	3.1
1313	390	<.02	<.01	.57	<.01	3.1
1915	3.00	<.02	<.01	.10	<.01	3.2
1916	4.0	<.02	<.01	.12	<.01	3.1
1917	160	<.02	<.01	.34	<.01	2.9
1918	390	<.02	<.01	.10	<.01	3.2
0100	3.00	<.02	<.01	.10	<.01	3.0
0101	4.0	<.02	<.01	.14	<.01	3.0
0102	160	<.02	<.01	.36	<.01	3.0
0103	390	<.02	<.01	.57	<.01	3.0
0638	3.00	<.02	<.01	.09	<.01	3.2
0639	4.0	<.02	<.01	.13	<.01	3.1
0640	160	<.02	<.01	.34	<.01	3.0
0641	390	<.02	<.01	.57	<.01	3.1
1310	3.00	.02	<.01	.10	<.01	3.5
1320	4.0	.03	.01	.14	<.01	3.2
1330	160	.02	.01	.22	<.01	3.1
1340	390	<.02	<.01	.41	<.01	3.1
1945	3.00	<.02	<.01	.11	<.01	3.2
1946	4.0	<.02	<.01	.19	<.01	3.0
1947	160	<.02	<.01	.28	<.01	3.0

Table 15. Concentrations of dissolved ammonia, nitrite, nitrite plus nitrate, orthophosphorus, and organic carbon in grid 3 of the forebay of Lake Powell, 1990-91—Continued

Time	Sampling depth, in feet	Nitrogen, ammonia (mg/L as N)	Nitrogen, nitrite (mg/L as N)	Nitrogen, nitrite plus nitrate (mg/L as N)	Phosphorus, ortho (mg/L as P)	Carbon, organic (mg/L as C)
June 18, 1991—Continued						
1948	390	<.02	<.01	.58	<.01	3.1
June 19, 1991						
0120	3.00	---	---	---	---	---
0121	4.0	---	---	---	---	---
0122	160	---	---	---	---	---
0123	390	---	---	---	---	---
0124	3.00	<.02	<.01	.07	<.01	3.1
0125	4.0	<.02	<.01	.06	<.01	3.1
0126	160	<.02	<.01	.35	<.01	3.1
0127	390	<.02	<.01	.48	<.01	3.1
0620	3.00	<.02	<.01	.09	<.01	3.2
0621	4.0	<.02	<.01	.11	<.01	3.1
0622	160	<.02	<.01	.36	<.01	3.0
0623	390	<.02	<.01	.56	<.01	2.9
August 29, 1991						
0800	3.00	---	---	---	--	4.5
0801	45.0	---	---	---	--	4.1
0802	155	---	---	---	--	4.0
0804	390	---	---	---	--	4.0
1300	3.00	---	---	---	--	4.2
1301	45.0	---	---	---	--	4.0
1302	155	---	---	---	--	4.0
1318	390	---	---	---	--	4.9
2045	3.00	---	---	---	--	4.0
2046	45.0	---	---	---	--	4.0
2047	155	---	---	---	--	4.0
2048	390	---	---	---	--	3.8

Table 16. Concentrations of dissolved ammonia, nitrite, nitrite plus nitrate, orthophosphorus, and organic carbon in grid 4 of the forebay of Lake Powell, 1990–91

[mg/L, milligrams per liter; <, less than]

Time	Sampling depth, in feet	Nitrogen, ammonia (mg/L as N)	Nitrogen, nitrite (mg/L as N)	Nitrogen, nitrite plus nitrate (mg/L as N)	Phosphorus, ortho (mg/L as P)	Carbon, organic (mg/L as C)
November 5, 1990						
0600	5.0	0.04	<0.01	0.02	<0.01	3.1
0601	100	.04	<.01	.22	<.01	2.7
0602	167	.04	<.01	.34	<.01	2.8
0603	390	.06	<.01	.52	.04	3.1
November 6, 1990						
1200	5.0	<.02	<.01	.04	<.01	3.2
1201	100	<.02	<.01	.21	<.01	3.2
1202	167	<.02	<.01	.35	<.01	2.8
1203	390	<.02	<.01	.48	.01	3.6
January 16, 1991						
1501	5.0	<.02	<.01	.15	<.01	2.8
1502	155	.02	<.01	.13	<.01	2.9
1503	390	<.02	<.01	.46	<.01	3.0
2201	5.0	<.02	<.01	.16	<.01	3.4
2202	155	.02	<.01	.16	<.01	3.5
January 17, 1991						
0801	5.0	.03	<.01	.15	<.01	3.4
0802	155	.03	<.01	.13	<.01	3.8
0804	390	.03	<.01	.48	<.01	3.5

Table 17. Concentrations of dissolved ammonia, nitrite, nitrite plus nitrate, orthophosphorus, and organic carbon in grid 33 of the forebay of Lake Powell, 1990–91

[mg/L, milligrams per liter; <, less than. Dashes indicate no data]

Time	Sampling depth, in feet	Nitrogen, ammonia (mg/L as N)	Nitrogen, nitrite (mg/L as N)	Nitrogen, nitrite plus nitrate (mg/L as N)	Phosphorus, ortho (mg/L as P)	Carbon, organic (mg/L as C)
August 16, 1990						
1330	390	<0.01	<0.01	0.500	<0.01	---
1331	390	<.02	<.01	.50	---	---
1400	140	<.01	<.01	.300	.01	---
1401	140	<.02	<.01	.28	---	---
1430	40	<.01	<.01	<.100	.01	---
1431	40	<.02	<.01	.04	---	---
1500	3	<.01	<.01	<.100	.01	---
1501	3	<.02	<.01	<.02	---	---
March 28, 1991						
0945	4.0	<.02	<.01	.19	<.01	3.1
0946	151	<.02	<.01	.46	<.01	3.0
0947	390	<.02	<.01	.57	.02	3.2
1540	4.0	<.02	<.01	.18	<.01	3.0
1550	151	<.02	<.01	.42	<.01	3.1
1605	350	<.02	<.01	.57	<.01	3.2
1606	390	---	---	---	---	---
2220	4.0	<.02	<.01	.18	<.01	3.2
2221	151	<.02	<.01	.46	<.01	2.9
2242	350	<.02	<.01	.56	<.01	3.1
2243	390	---	---	---	---	---

Table 18. Concentrations of dissolved ammonia, nitrite, nitrite plus nitrate, orthophosphorus, and organic carbon in outflows (draft tubes) of Glen Canyon Dam, 1990–91

[mg/L, milligrams per liter; <, less than. Dashes indicate no data]

Time	Nitrogen, ammonia, (mg/L as N)	Nitrogen, nitrite (mg/L as N)	Nitrogen, nitrite plus nitrate (mg/L as N)	Phosphorus, ortho (mg/L as P)	Carbon, organic (mg/L as C)
September 6, 1990					
0900	<0.01	<0.01	0.40	<0.01	---
0901	<.02	<.01	.36	<.01	---
1550	<.01	<.01	.30	.02	---
1551	<.02	<.01	.34	<.01	---
2145	<.01	<.01	.30	<.01	---
2146	<.02	<.01	.50	<.01	---
September 20, 1990					
0940	0.02	<.01	.40	<.01	---
0941	<.02	<.01	.35	<.01	3.8
1540	<.01	<.01	.30	<.01	---
1541	<.02	<.01	.33	<.01	3.7
2140	<.01	<.01	.30	<.01	---
2141	<.02	<.01	.74	---	3.5
November 5, 1990					
0600	---	---	---	---	---
1200	.06	<.01	.35	<.01	2.6
1800	<.02	<.01	.34	<.01	2.9
2400	<.02	<.01	.34	<.01	2.9
November 6, 1990					
0600	<.02	<.01	.36	<.01	2.7
1200	.02	.01	.36	<.01	2.9
1800	<.02	<.01	.36	<.01	2.8
2400	<.02	<.01	.34	<.01	2.8
January 16, 1991					
0700	.02	<.01	.13	<0.01	2.9
1400	<.02	<.01	.14	<.01	2.9
January 16, 1991—Continued					
2100	.02	<0.01	0.14	<0.01	2.9
January 17, 1991					
0700	<.02	<.01	.14	<.01	3.4
March 28, 1991					
0720	<.02	<.01	.35	<.01	3.1
1415	<.02	<.01	.40	.01	3.0
2115	<.02	<.01	.42	<.01	2.9
May 23, 1991					
0830	<.01	<.01	.40	.01	---
1535	<.01	<.01	.41	.02	---
2200	<.01	<.01	.41	.01	---
June 18, 1991					
1330	<.02	<.01	.35	<.01	2.9
1830	.02	<.01	.39	<.01	2.9
2400	<.01	<.01	.36	<.01	2.9
June 19, 1991					
0615	<.02	<.01	.36	<.01	2.9
1300	<.02	<.01	.36	<.01	3.9
1900	<.02	<.01	.38	<.01	3.0
2340	<.02	<.01	.18	<.01	2.9
June 20, 1991					
0545	<.01	<.01	.37	<.01	2.9
August 29, 1991					
1730	---	---	---	---	---
1400	---	---	---	---	4.2
2000	---	---	---	---	4.2

Major Ions and Metal Data

Table 19. Concentrations of dissolved chloride and sulfate in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91

[mg/L, milligrams per liter; DT, draft tubes; N/A, not applicable; BL, blank; NRP, National Research Program; BETA, beta bottle; DI, deionized water. N/A, not applicable. Dashes indicate no data]

Grid number	Depth (feet)	Time	Chloride (mg/L as Cl)	Sulfate (mg/L as SO_4)
November 5, 1990				
2	50	0600	41	221
2	100	0600	39.8	210
2	167	0600	41.7	218
2	390	0600	73.8	274
2	50	1200	40.9	221
2	100	1200	39	209
2	167	1200	42.3	221
2	390	1200	70.1	265
2	50	1800	39.2	212
2	100	1800	39.6	209
2	167	1800	41.7	221
2	390	1800	75.3	284
2	50	2400	40.4	220
2	100	2400	40	211
2	167	2400	42.6	224
2	390	2400	72.9	280
3	50	0600	39.2	213
3	100	0600	40	210
3	167	0600	39.9	214
3	390	0600	76.8	285
3	50	1200	39.9	217
3	100	1200	37	197
3	167	1200	43.2	225
3	390	1200	74.7	281
3	50	1800	40.9	224
3	100	1800	39.8	213
3	167	1800	41	219
3	390	1800	75.6	283
3	50	2400	40.5	220
3	100	2400	41	225
3	167	2400	42.6	224
4	50	0600	39.6	217
4	100	0600	39.5	209
4	167	0600	40.5	218
4	390	0600	76.1	285
DT	N/A	1200	44.2	220
DT	N/A	1800	44.4	222
DT	N/A	2400	41.8	219
November 6, 1990				
2	50	0600	40.8	222
2	100	0600	39.3	210
2	167	0600	44.5	228
2	390	0600	76	287
2	50	1200	40.4	220
2	100	1200	40.5	207
2	167	1200	45.7	227
2	390	1200	76.5	286
2	50	1800	41.9	221
2	100	1800	38.8	201
2	167	1800	44.1	225
2	390	1800	76.3	286
2	50	2400	42	221
2	100	2400	41.1	214
November 6, 1990—Continued				
2	390	2400	43.1	223
3	50	0600	41.6	217
3	100	0600	40.6	207
3	167	0600	45	222
3	390	0600	74.8	287
3	50	1200	41.7	219
3	100	1200	40.8	210
3	167	1200	42.9	228
3	390	1200	75.8	280
3	50	1800	41.8	221
3	100	1800	41.1	211
3	167	1800	44.2	225
3	390	1800	74.8	282
3	50	2400	41.8	221
3	100	2400	41.1	211
3	167	2400	44.8	226
3	390	2400	76.2	288
4	50	1200	40.3	212
4	100	1200	40.9	212
4	167	1200	44.8	227
4	390	1200	74.2	280
DT	N/A	0600	43.8	227
DT	N/A	1200	45.8	225
DT	N/A	1800	49.1	231
DT	N/A	2400	42.3	212
January 16, 1991				
2	50	1401	45.9	220
2	155	1402	45.2	221
2	390	1403	77.3	278
2	50	2101	46	220
2	155	2102	47.8	226
2	390	2103	81.5	256
3	50	1431	45	215
3	155	1432	46.7	222
3	390	1433	78.8	284
3	50	2131	45.4	218
3	155	2132	47.4	221
3	390	2133	81.3	260
4	50	1501	46.2	223
4	155	1502	47.3	224
4	390	1503	77.6	288
4	50	2201	46.5	221
4	155	2202	47.5	224
4	390	2203	79.7	287
DT	N/A	1400	46	217
DT	N/A	2100	48.4	226
January 17, 1991				
DT	N/A	0700	49.2	228
2	50	0701	44.9	219
2	155	0702	48.2	227
2	390	0703	45.5	216
3	50	0731	46.8	222
3	155	0732	47.2	224

Table 19. Concentrations of dissolved chloride and sulfate in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Grid number	Depth (feet)	Time	Chloride (mg/L as Cl)	Sulfate (mg/L as SO_4)
January 17, 1991—Continued				
3	390	0733	78.6	286
4	50	0801	46.5	221
4	155	0802	44.2	226
4	390	0804	73.4	256
March 28, 1991				
DT	N/A	0720	68.1	272
DT	N/A	1415	70.5	273
DT	N/A	2115	72.2	275
2	40	0900	48.1	229
2	151	0900	71	277
2	390	0900	78.8	299
2	40	1520	49.3	228
2	151	1520	71.4	270
2	390	1520	78.4	294
2	40	2150	50	233
2	151	2150	72.7	276
2	390	2150	80.3	295
3	40	0910	49.4	228
3	151	0910	67.6	257
3	390	0910	79.3	295
3	40	1500	49.2	228
3	151	1500	69.5	267
3	390	1500	83	286
3	40	2122	50.6	232
3	390	2122	80.2	296
4	40	0945	49.1	224
4	151	0945	74.8	279
4	390	0945	77.9	291
4	40	1540	50.7	231
4	151	1540	71	272
4	40	2220	50.2	231
4	151	2220	75.6	285
May 23, 1991				
DT	N/A	0830	61	254
DT	N/A	1545	50.1	243
DT	N/A	2306	50.7	241
2	3	0910	47.7	229
2	50	0910	49.8	235
2	152	0910	59.6	256
2	50	1545	49.5	238
2	152	1545	62.3	263
2	390	1545	73.5	283
2	3	2225	49.6	241
2	152	2306	61.3	262
2	390	2306	74.3	293

Grid number	Depth (feet)	Time	Chloride (mg/L as Cl)	Sulfate (mg/L as SO_4)
May 23, 1991—Continued				
3	390	0910	75.6	291
3	3	0930	49.5	241
3	50	0930	48.1	228
3	3	1600	50	240
3	50	1615	47.5	228
3	152	1615	60.5	259
3	50	2240	49.8	237
3	152	2240	59.5	257
3	390	2240	74.9	290
4	152	0930	60.2	259
4	390	0946	72.9	282
4	N/A	1535	63.8	265
4	390	1615	73.3	296
4	N/A	2200	63.3	264
4	3	2306	50.2	246
June 18, 1991				
2	390	1415	76	298
2	160	1430	52.2	250
2	3	1450	48	237
2	40	1500	48.5	239
2	390	2348	75.2	299
2	160	2354	56.5	260
2	40	2400	49	241
3	3	1220	49.3	242
3	40	1235	48.5	237
3	160	1245	51.2	242
3	390	1300	75.1	294
3	3	1803	49.2	244
3	40	1811	46.2	231
3	160	1850	51.8	247
4	390	1605	80.6	301
4	390	2220	81.8	280
3	160	2315	54.2	257
3	40	2321	41.3	236
3	3	2325	49.6	246
DT	N/A	1330	57.1	254
DT	N/A	1830	55.8	254
DT	N/A	2400	55.6	258
June 19, 1991				
2	3	5	49	242
2	3	5	49	242
2	3	0655	49.5	249
2	40	0700	48.6	240
2	160	0730	56.3	261
2	390	0740	75.6	298

Table 19. Concentrations of dissolved chloride and sulfate in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Grid number	Depth (feet)	Time	Chloride (mg/L as Cl)	Sulfate (mg/L as SO_4)
June 19, 1991—Continued				
2	3	1210	50.8	240
2	40	1220	49.9	237
2	160	1230	54.3	251
2	390	1240	75.9	289
3	3	0605	49.5	248
3	40	0610	48.7	243
3	160	0630	51.9	251
3	390	0640	75.1	296
3	3	1310	50.8	241
3	40	1320	49.8	238
3	160	1330	51.1	240
3	390	1340	2.1	---
3	390	1825	75.3	292
3	3	1900	2.1	---
3	40	1907	50.1	236
3	160	1915	49.9	236
3	3	2335	48.5	236
3	40	2345	49.9	241
3	160	2400	54.6	254
3	390	1855	49.7	246
3	390	2300	75.9	296
DT	N/A	0615	55.8	261
DT	N/A	1200	56.7	263
DT	N/A	1745	2.1	---
DT	N/A	2345	54.5	248
June 20, 1991				
2	3	0610	49.9	241
2	40	0620	49.6	239
2	160	0630	54.7	253
2	390	0640	72	280
3	390	10	76.5	295
3	3	0710	49.9	240
3	40	0720	48.7	233
3	160	0730	54.8	255
3	390	0740	76.3	297
BL	NRP DI BETA	2200	0.1	0.1
August 29, 1991				
DT	N/A	0730	54.5	252
DT	N/A	1400	53.6	250
DT	N/A	2000	53.6	252
3	3	0820	51.8	251
3	45	0820	49.7	244
3	155	0820	51.5	250
3	390	0820	73.4	287
3	3	1315	52.3	253
3	45	1315	50.5	244
3	155	1315	52.1	249
3	390	1315	75.9	293
3	3	2045	50.8	246
3	45	2045	46.5	228
3	155	2045	48.9	239
3	390	2045	72	279

Table 20. Concentrations of dissolved calcium, iron, magnesium, sodium, silica, and strontiumin grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91

[mg/L, milligrams per liter; <, less than; DT, draft tubes; N/A, not applicable. Dashes indicate no data]

Grid Number	Depth (feet)	Time	Calcium (mg/L as Ca	Iron (mg/L as Fe)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Silica (mg/L as Si)	Strontium (mg/L as Sr)
September 6, 1990								
3	390	0903	97.8	<0.005	38.9	121.4	8.3	1.28
3	140	0922	85.7	<.005	35.4	105.6	7.7	1.12
3	40	0936	69.7	<.005	28.4	76.7	8.3	.95
3	3	0950	57.5	.211	26.9	68.9	6.7	.83
3	390	1528	87.8	<.005	36.3	105.8	8.1	1.13
3	140	1545	65	<.005	28.2	71.4	8.5	.88
3	40	1559	64.4	<.005	29	74.3	7.8	.91
3	3	1610	63.7	<.005	29	75.3	7.5	.91
3	390	2132	67.9	<.005	29.5	82.5	6.8	.87
3	140	2147	53.3	<.005	24	58.1	7.4	.71
3	40	2158	71.4	<.005	30.3	76.7	9.6	.96
3	3	2207	67.3	<.005	30.4	76.3	8.4	.94
DT	N/A	0900	67	<.005	28.1	77.5	7.3	.91
DT	N/A	1550	72.7	<.005	30	81.6	8.3	.97
DT	N/A	2145	68.9	<.005	28.4	75.9	8.3	.92
September 20, 1990								
3	390	0954	83.8	<.005	36.8	104.6	8	1.09
3	168	1010	83.1	<.005	36.6	104	7.9	1.08
3	150	1022	84.2	<.005	37.3	105.2	8	1.1
3	100	1040	67.6	<.005	29.7	77.1	7.9	.92
3	50	1053	64	<.005	28.4	71.7	7.9	.88
3	3	1105	60.1	<.005	28.3	68.8	8.1	.83
3	390	1545	56	<.005	28.8	70.7	7.6	.83
3	168	1555	82.8	<.005	36.6	102.8	7.9	1.08
3	150	1605	69.1	<.005	30.5	78.4	8.2	.94
3	100	1620	65	<.005	28.6	71.9	8.4	.89
3	50	1630	61.8	.015	28.5	70.5	8.4	.85
3	3	1645	59.6	<.005	28.5	70.6	7.4	.85
3	390	2133	57.9	<.005	29.4	72.7	7.6	.84
3	168	2146	79.5	<.005	35.6	98.6	7.8	1.03
3	150	2200	60.4	<.005	27.4	67.3	7.7	.83
3	100	2215	58.3	<.005	26.5	64.6	7.8	.8
3	50	2230	55.6	<.005	26	63.4	7.7	.76
3	3	2245	55.7	<.005	27.4	66.6	7.1	.8
DT	N/A	0940	68.5	.006	30.2	79	8.1	.92
DT	N/A	1540	66.3	<.005	30	76.3	8.1	.89
DT	N/A	2140	62.6	.007	28.4	70.4	7.9	.85
November 5, 1990								
2	50	0600	60.2	<.005	26	68.7	8.1	.79
2	100	0600	61.1	<.005	24.8	64.4	8.4	.75
2	167	0600	69.6	<.005	27.1	71.9	8.6	.87
2	390	0600	86.5	<.005	34.1	99.7	8.6	1.03
2	50	1200	62.9	<.005	27.6	72.5	8.4	.84
2	100	1200	63.1	<.005	25.6	66.5	9	.78
2	167	1200	67.8	<.005	25.9	70	8.4	.84
2	390	1200	83.9	<.005	32.3	95.2	8.4	.99

Table 20. Concentrations of dissolved calcium, iron, magnesium, sodium, silica, and strontium in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Grid Number	Depth (feet)	Time	Calcium (mg/L as Ca	Iron (mg/L as Fe)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Silica (mg/L as Si)	Strontium (mg/L as Sr)
				November 5, 1990—Continued				
2	50	1800	60.4	<.005	26.1	68.9	8.2	.79
2	100	1800	61.8	<.005	25	65.1	8.4	.76
2	167	1800	70.4	<.005	27	71.8	8.8	.88
2	390	1800	87.6	<.005	34.6	101.1	8.6	1.05
2	50	2400	62.2	<.005	27.2	70.8	8.3	.82
2	100	2400	64	<.005	26.6	68.4	8.8	.81
2	167	2400	70.3	<.005	27.7	73.6	8.9	.9
2	390	2400	87	<.005	34	99.7	8.6	1.05
3	50	0600	63.6	<.005	28	73.2	8.4	.85
3	100	0600	68.1	<.005	27.9	72.2	9.1	.85
3	167	0600	71.6	<.005	27.5	73.6	8.9	.91
3	390	0600	84.7	<.005	32.7	97	8.3	1
3	50	1200	62.3	<.005	27.4	71.2	8.4	.82
3	100	1200	63.8	<.005	26.6	68.1	8.8	.8
3	167	1200	72.1	<.005	28.4	75.7	9	.92
3	390	1200	89.3	<.005	34.8	103.4	8.6	1.07
3	50	1800	63.6	<.005	28.4	74.2	8.6	.86
3	100	1800	64.9	<.005	26.9	69.2	8.9	.81
3	167	1800	68.7	<.005	26	69.9	8.5	.86
3	390	1800	84.8	<.005	32.4	96.8	8.4	1
3	50	2400	61	<.005	26.4	69.4	8.2	.8
3	100	2400	63.6	<.005	27.7	72.2	8.5	.83
3	167	2400	69.7	<.005	27.3	72	8.9	.86
4	50	0600	60.1	<.005	25.9	68.5	8.1	.79
4	100	0600	62.8	<.005	25.4	66	8.6	.78
4	167	0600	68.5	<.005	26.7	70.1	8.8	.86
4	390	0600	85.8	<.005	33.9	99.1	8.4	1.02
DT	N/A	1200	72.5	<.005	28.3	76.1	8.9	.91
DT	N/A	1800	67.7	<.005	26.1	70.2	8.3	.83
DT	N/A	2400	70.6	<.005	27.2	72.1	8.8	.87
				November 6, 1990				
2	100	0600	66.4	<.005	27.3	71	9	.84
2	167	0600	71.5	<.005	27.6	74.7	8.8	.91
2	390	0600	87.6	<.005	34.2	102.8	8.8	1.07
2	50	1200	62.3	<.005	27.6	71.9	8.4	.83
2	100	1200	64.1	<.005	26.5	69.7	8.9	.82
2	167	1200	68.9	<.005	26.7	73.2	8.6	.88
2	390	1200	88.4	<.005	34	102.9	8.6	1.07
2	50	1800	60.9	<.005	27.2	70.5	8.2	.82
2	100	1800	64.1	<.005	26.5	68.5	9.1	.81
2	167	1800	69.5	<.005	26.9	73.3	8.6	.9
2	390	1800	83.3	<.005	32.4	97.6	8.3	1.01
2	50	2400	60.7	<.005	26.6	70.9	8.3	.82
2	100	2400	62.1	<.005	26.2	69.1	8.6	.81
2	167	2400	70	<.005	26.8	73	8.8	.89
2	390	2400	63.8	<.005	27.5	73.7	8.5	.85
3	50	0600	60.7	<.005	26.8	71	8.3	.82
3	100	0600	64.6	<.005	26.4	69.6	8.9	.82
3	167	0600	71.1	<.005	27.2	74.4	8.8	.9
3	390	0600	87.3	<.005	34.4	101.4	8.6	1.06
3	50	1200	62.1	<.005	26.9	72	8.3	.84
3	100	1200	66	<.005	27.4	70.9	9	.84

Table 20. Concentrations of dissolved calcium, iron, magnesium, sodium, silica, and strontium in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Grid Number	Depth (feet)	Time	Calcium (mg/L as Ca)	Iron (mg/L as Fe)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Silica (mg/L as Si)	Strontium (mg/L as Sr)
November 6, 1990—Continued								
3	167	1200	70.2	<.005	27.2	72.8	8.5	.89
3	390	1200	87.8	<.005	34.5	101.8	8.6	1.06
3	50	1800	63.1	<.005	27.4	73.1	8.5	.85
3	100	1800	64.7	<.005	26.3	69.4	8.9	.82
3	167	1800	71.6	<.005	27.9	74.7	8.8	.92
3	390	1800	84.7	<.005	33.5	98.4	8.4	1.02
3	50	2400	63	<.005	28	73.1	8.4	.85
3	100	2400	65.3	<.005	27.2	70.4	8.9	.83
3	167	2400	70.3	<.005	26.8	73.4	8.7	.89
3	390	2400	86.6	<.005	33.4	100.9	8.6	1.05
4	50	1200	62	<.005	27.3	73	8.5	.85
4	100	1200	62.4	<.005	25.9	67.8	8.7	.8
4	167	1200	70.5	<.005	26.7	73.4	8.6	.9
4	390	1200	86.9	<.005	33.5	100.6	8.6	1.05
DT	N/A	0600	70.7	<.005	27.9	74.2	8.9	.9
DT	N/A	1200	70.9	<.005	28	75.5	8.6	.89
DT	N/A	1800	73.8	<.005	28.9	78.7	8.9	.93
DT	N/A	2400	70	<.005	27.4	73.2	8.6	.88
January 16, 1991								
2	50	1401	65.2	<.005	25.4	69.6	8.3	.82
2	155	1402	63.9	<.005	25.4	70	8.2	.81
2	390	1403	85.2	<.005	31.3	97.4	8.6	1.01
2	50	2101	65.3	<.005	25.3	69.7	8.3	.82
2	155	2102	66.3	<.005	25.9	71.9	8.4	.84
2	390	2103	87.8	<.005	31.9	98.5	8.6	1.02
3	50	1431	66.4	<.005	25.6	71.2	8.3	.84
3	155	1432	65.2	<.005	25.7	71	8.3	.83
3	390	1433	90	<.005	32.9	101.2	8.7	1.05
3	50	2131	65.6	<.005	25.5	70.3	8.3	.83
3	155	2132	65.6	<.005	25.9	71.7	8.4	.84
3	390	2133	87.5	<.005	32.3	99.8	8.6	1.03
4	50	1501	66.1	<.005	25.6	70.5	8.5	.83
4	155	1502	65.6	<.005	25.7	71.2	8.4	.83
4	390	1503	86.5	<.005	31.5	97.2	8.6	1.01
4	50	2201	65.6	<.005	25.6	70.7	8.3	.83
4	155	2202	64.9	<.005	25.6	71.1	8.3	.83
4	390	2203	86.8	<.005	32	99.1	8.6	1.03
DT	N/A	1400	65.8	<.005	26.1	72.1	8.3	.84
DT	N/A	2100	65.2	<.005	25.6	70.8	8.3	.82
January 17, 1991								
2	50	0701	64.3	<.005	25.3	70.1	8.3	.83
2	155	0702	65.5	<.005	25.9	71.8	8.3	.83
2	390	0703	87.2	<.005	31.8	98.4	8.6	1.02
3	50	0731	65	<.005	25.5	70.6	8.3	.83
3	155	0732	67.7	<.005	26.4	73.3	8.6	.86
3	390	0733	87.7	<.005	32.1	99.4	8.7	1.03
March 28, 1991								
DT	N/A	0720	81.7	.012	3.9	91.1	8.3	.99
DT	N/A	1415	82.7	<.005	31.2	92.6	8.5	1
DT	N/A	2115	82.1	<.005	31.2	92.4	8.5	.98
2	40	0900	65.6	<.005	26.4	72.7	7.8	.84

Table 20. Concentrations of dissolved calcium, iron, magnesium, sodium, silica, and strontium in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Grid Number	Depth (feet)	Time	Calcium (mg/L as Ca)	Iron (mg/L as Fe)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Silica (mg/L as Si)	Strontium (mg/L as Sr)
				March 28, 1991—Continued				
2	151	0900	78.9	<.005	29.8	88.9	8.5	.96
2	390	0900	91.7	<.005	32.8	100.1	8	1.1
2	40	1520	67.6	.006	27	74.7	8	.86
2	151	1520	70.8	<.005	28	78.4	8.1	.89
2	390	1520	85.1	<.005	31.6	93.4	8.1	1.03
2	40	2150	67.5	<.005	27.1	74.5	8	.86
2	151	2150	82.2	<.005	31.3	92.9	8.7	.98
2	390	2150	91.6	<.005	33	100.1	8.1	1.09
3	40	0910	67.3	<.005	26.9	74.4	7.9	.86
3	151	0910	81.6	<.005	31	92.1	8.6	.98
3	390	0910	91.7	<.005	33.1	99.9	8	1.1
3	40	0915	67.5	<.005	26.9	74.6	7.9	.86
3	151	0915	83.3	<.005	31.8	94.4	8.7	1
3	390	0915	92.7	<.005	33.4	10.8	8.1	1.11
3	40	1500	67.6	<.005	26.8	74.9	8	.86
3	151	1500	77.2	<.005	29.7	86.8	8.4	.94
3	390	1500	92.6	<.005	33.1	100.7	8.1	1.11
3	40	2122	66.8	<.005	26.8	74	8	.85
3	151	2122	77	<.005	29.6	86.5	8.5	.94
3	390	2122	75.5	<.005	28.9	83.3	8.1	.93
4	40	0945	66.8	<.005	26.8	73.7	7.9	.85
4	151	0945	79.1	<.005	30.4	88.9	8.5	.96
4	390	0945	90.5	<.005	32.3	98.5	7.9	1.08
4	40	1540	67.1	<.005	26.9	74.1	7.9	.85
4	151	1540	84.2	<.005	31.9	95.2	8.6	1
4	390	1605	91.8	<.005	33.1	100	7.9	1.09
4	40	2220	64.3	<.005	25.9	71.4	7.8	.82
4	151	2220	83.5	<.005	31.6	94.5	8.7	.99
4	390	2220	86.5	<.005	31.7	94.6	8.1	1.04
				May 23, 1991				
DT	N/A	0830	73.7	.055	27.7	82.6	7.6	.91
DT	N/A	1535	74.8	.011	27.2	83.6	7.6	.92
DT	N/A	2200	78.7	.009	28.1	88.1	7.9	.97
2	3	0910	62.9	.008	25.5	71.6	6.6	.81
2	50	0910	53	.007	21.5	60.5	5.7	.68
2	152	0910	62.8	.011	24.7	70.8	6.7	.79
2	390	0910	89.9	.006	32.6	99.5	8.2	1.09
2	3	1545	69.4	<.005	25.4	78.3	6.9	.89
2	50	1545	68.6	.007	26.1	76.9	7.2	.88
2	152	1545	68.2	.017	25.2	76	7.2	.86
2	390	1545	84.4	.007	29.8	93.3	7.8	1.02
2	3	2306	60.5	.01	23.2	68.6	6.2	.78
2	50	2306	53.4	.015	20.6	60.3	5.8	.68
2	152	2306	63.7	.016	23.3	71.4	6.6	.79
2	390	2306	74.4	.011	26.8	82.9	7.2	.92
3	3	0930	75.8	<.005	30.1	85.1	7.9	.98
3	50	0930	65.3	.005	25	73.7	7.1	.84
3	152	0930	69.5	<.005	25.3	78	7.3	.86
3	390	0946	73.4	.006	26.5	81.9	7.2	.9
3	3	1600	63.1	.009	24.3	71	6.6	.81
3	50	1615	63.1	.016	23.8	70.5	6.8	.81
3	152	1615	70	.009	25.4	78.2	7.2	.87

Table 20. Concentrations of dissolved calcium, iron, magnesium, sodium, silica, and strontium in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Grid Number	Depth (feet)	Time	Calcium (mg/L as Ca	Iron (mg/L as Fe)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Silica (mg/L as Si)	Strontium (mg/L as Sr)
May 23, 1991—Continued								
3	390	1615	77.5	.01	27.2	86.1	7.2	.94
3	3	2225	60.8	.009	23.3	68.8	6.3	.78
3	50	2240	70.3	<.005	27	81.2	7.3	.89
3	152	2240	75.7	<.005	27.5	82.4	7.7	.93
3	390	2240	87.7	<.005	30.6	96.5	7.7	1.04
June 18, 1991								
2	390	1415	76.1	<.005	28.4	89.6	5.2	.92
2	160	1430	78.6	<.005	29.6	90.4	6.2	1.01
2	3	1450	74	<.005	29.7	88.6	6	.96
2	40	1500	77	<.005	30.5	91.1	5.8	.99
2	390	2348	87.6	<.005	34.2	102.2	8.5	1.09
2	160	2354	82.7	<.005	32.8	96.1	8.6	1.04
2	40	2400	73.1	<.005	30.9	86.6	7.2	.94
3	3	1220	70.2	<.005	28.6	84.1	5	.9
3	40	1235	67.2	<.005	30.7	84.7	6.6	.87
3	160	1245	79.8	<.005	30.1	91.9	5.9	1.02
3	390	1300	88.9	.005	33.6	103.3	8.7	1.1
3	3	1803	69.4	.006	29.2	83.3	6.9	.9
3	40	1811	64.7	.005	30.2	81.6	6.3	.83
3	160	1850	91.9	<.005	34.9	105.4	9.3	1.17
3	390	1855	93.4	<.005	35.5	108.1	9.1	1.17
3	390	2300	89.5	<.005	35.8	104.7	8.7	1.13
3	160	2315	75.9	<.005	30.6	89	7.9	.95
3	40	2321	63.9	<.005	30.9	81.3	6.4	.82
3	3	2325	73.5	<.005	31	87.9	7.1	.95
DT	N/A	1330	---	<.005	29.2	84.3	8	.99
DT	N/A	1830	74.5	<.005	29.1	86.9	7.7	.94
DT	N/A	2400	79.8	<.005	32.8	92.4	8	1.01
June 19, 1991								
2	3	0005	71.1	<.005	31.8	91	7.4	.97
2	3	0655	72.9	<.005	30.3	87.7	7.1	.95
2	40	0700	68.7	.005	27.1	78.7	6.8	.89
2	160	0730	75	<.005	28.2	84.8	7.9	.95
2	390	0740	75.4	<.005	28.7	85.7	7.4	.95
2	3	1210	65.8	<.005	25.8	75.9	6.4	.85
2	40	1220	63.6	.008	29.6	80.2	6.3	.82
2	160	1230	67.2	<.005	30.2	83.1	7	.86
2	390	1240	72.5	<.005	31.9	89.7	7	.91
2	3	1805	71.8	<.005	34.1	92.9	7.2	.95
2	40	1810	72.1	<.005	33.5	91.7	7.3	.95
2	160	1817	78.1	<.005	33.7	94.3	8.3	1.01
2	390	1850	79.3	<.005	34.4	98	7.9	1.01
3	3	0605	79	<.005	32.3	94.5	7.7	1.03
3	40	0610	60	<.005	28.8	76	5.9	.77
3	160	0630	76.3	<.005	28.9	86.2	7.9	.97
3	390	0640	79.1	<.005	29.7	89.6	7.9	1
3	3	1310	66.9	.06	31.3	84.7	6.5	.87
3	40	1320	70.2	.007	32.1	87.5	6.8	.9
3	160	1330	73.5	<.005	32.3	90.2	7.6	.95
3	390	1340	77.4	.007	33	94.7	7.4	.96
3	390	1825	77.4	<.005	33.2	95.9	7.6	.97
3	3	1900	70.6	<.005	33.4	91.5	7.2	.94

Table 20. Concentrations of dissolved calcium, iron, magnesium, sodium, silica, and strontium in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Grid Number	Depth (feet)	Time	Calcium (mg/L as Ca	Iron (mg/L as Fe)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Silica (mg/L as Si)	Strontium (mg/L as Sr)
June 19, 1991—Continued								
3	40	1907	73.9	<.005	33.8	92.6	7.5	.96
3	160	1915	77.1	<.005	33.8	94.4	8.1	.99
3	3	2335	62.4	<.005	24.3	71.9	6.2	.8
3	40	2345	68.2	<.005	30.8	85.6	6.7	.88
3	160	2400	71.3	<.005	30.6	87.5	7.4	.91
DT	N/A	0615	83.8	<.005	33.6	97	8.8	1.07
DT	N/A	1200	---	<.005	30.5	93.4	8.4	1.05
DT	N/A	1300	83.2	---	---	---	---	---
DT	N/A	1745	---	<.005	28.7	85.3	8	.97
DT	N/A	1900	76.2	---	---	---	---	---
DT	N/A	2345	72.4	<.005	26	81.1	7.5	.92
June 20, 1991								
DT	N/A	0545	79.7	.005	22.7	88.3	8.2	1.01
2	3	0610	61.6	<.005	24	70.8	5.9	.79
2	40	0620	62.3	<.005	24	71.6	5.9	.8
2	160	0630	71.7	.008	31.3	88.8	7.4	.92
2	390	0640	75.2	<.005	28.5	86.1	7.4	.95
3	390	0010	75.4	.005	28.5	85.1	7.5	.96
3	160	0120	73.9	<.005	27	82.2	7.7	.95
3	3	0120	63.9	.005	24.6	73.4	6.2	.82
3	390	0120	92.9	<.005	32.8	104.4	8.3	1.12
3	40	0120	61.2	<.005	23.7	70.5	6.1	.79
3	3	0710	68.5	<.005	27.4	79.3	6.7	.89
3	40	0720	68.4	<.005	30.9	85.7	6.7	.88
3	160	0730	70.3	<.005	26.6	79.1	7.3	.9
3	390	0740	76	<.005	28.3	86.1	7.4	.94
August 29, 1991								
DT	N/A	0730	73.6	<.005	27.3	78.3	7.5	.94
DT	N/A	1400	74.5	<.005	27.2	79.2	7.6	.95
DT	N/A	2000	84.4	<.005	30.2	88.7	8.4	1.08
3	3	0820	65.3	<.005	28.9	80.5	6.7	.92
3	45	0820	65.1	<.005	27.3	75.6	6.3	.88
3	155	0820	65.2	<.005	24.4	69.3	6.7	.84
3	390	0820	77.8	<.005	28.7	84.1	7.1	.94
3	3	1315	66.7	<.005	29.3	81.7	6.7	.95
3	45	1315	68.8	<.005	29	82.2	6.8	.95
3	155	1315	77.2	<.005	28.1	81.1	8	.99
3	390	1315	90	<.005	32.6	96.7	8.4	1.11
3	3	2045	69.8	<.005	29.4	85.1	7.1	.99
3	45	2045	65.2	<.005	26.6	77.3	6.5	.9
3	155	2045	72.3	<.005	25.8	75.8	7.6	.93
3	390	2045	96.4	<.005	33.4	103.4	8.7	1.16

Table 21. Concentrations of dissolved metals in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91

[Concentrations are dissolved. μg/L, micrograms per liter. Site, grid number or draft tube at dam; <, less than; N/A, not applicable; BL, blank; DT, draft tubes; NRP, National Research Program; DI, deionized water; CAR, container; BETA, beta bottle; KEM, Kemmerer bottle; FLAG, Flagstaff. Dashes indicate no data]

Site number	Depth, in feet	Time	Aluminum (μg/L as Al)	Arsenic (μg/L as As)	Beryllium (μg/L as Be)	Cadmium (μg/L as Cd)	Chromium (μg/L as Cr)	Cobalt (μg/L as Co)	Copper (μg/L as Cu)	Lead (μg/L as Pb)	Lithium (μg/L as Li)	Manganese (μg/L as Mn)	Mercury (μg/L as Hg)	Molybdenum (μg/L as Mo)	Selenium (μg/L as Se)	Thallium (μg/L as Tl)	Uranium (μg/L as U)	Vanadium (μg/L as V)	Zinc (μg/L as Zn)
September 6, 1990																			
BL	Sample hose	0740	---	---	---	---	---	---	---	0.79	0.74	0.43	---	0.16	---	---	---	---	---
3	390	0903	13.4	1.0	0.07	<0.1	<0.2	<0.01	1.26	.13	39.3	1.58	---	4.9	4.0	0.08	6.9	0.4	2.7
3	140	0922	14.1	2.0	<.02	<.1	<.2	<.01	1.22	.19	37	1.09	---	4.7	3.0	.06	6.4	.3	3.5
3	40	0936	14.3	1.0	<.02	<.1	<.2	<.01	1.11	.19	29.3	.92	---	3.8	3.0	.07	4.5	.8	3
3	3	0950	8.9	1.0	<.02	<.1	38.8	.38	1.29	.16	28.3	3.61	---	3.9	3.0	.07	4.8	43.2	3.1
3	390	1528	2.3	2.0	<.02	<.1	<.2	<.01	1.4	.1	39.5	.5	---	4.7	2.0	<.05	6.7	.1	2.5
3	140	1545	4.4	2.0	.03	<.1	<.2	<.01	1.22	.19	30.1	.23	---	3.9	3.0	<.05	4.5	.6	2.7
3	40	1559	5.1	1.0	<.02	<.1	<.2	<.01	1.19	.14	29.6	.32	---	3.7	2.0	<.05	4.9	.7	3
3	3	1610	3.3	1.0	<.02	<.1	<.2	<.01	1.23	.16	30.9	<.1	---	3.8	2.0	<.05	4.8	.7	2.7
3	390	2132	2.6	1.0	<.02	<.1	<.2	<.01	.87	.1	39.9	.72	---	4.8	4.0	.06	6.8	.1	2.3
3	140	2147	2.7	1.0	<.02	<.1	<.2	<.01	.76	.11	28.2	.25	---	3.3	3.0	<.05	4.4	.4	2
3	40	2158	2.2	1.0	<.02	<.1	7	<.01	.51	<.06	28	<.1	---	3.4	2.0	<.05	4.6	9.3	1.4
3	3	2207	1.9	1.0	.05	<.1	7.2	<.01	.56	<.06	28.8	<.1	---	3.5	3.0	<.05	4.7	9.7	1.9
DT	N/A	0900	5.2	2.0	.04	<.1	<.2	<.01	9.7	.5	30.5	.39	---	3.8	2.0	.07	5.2	.6	11.7
DT	N/A	1550	3.4	1.0	<.02	<.1	<.2	<.01	6.02	.4	32	.34	---	3.9	3.0	.08	5.1	.6	7.2
DT	N/A	2145	3.2	<1.0	<.02	<.1	<.2	<.01	2.63	.36	33.2	.3	---	4	3.0	<.05	5.2	.5	6.9
September 20, 1990																			
3	390	0954	3.7	2.0	.03	.3	<.2	<.01	1.36	.18	43.8	1.25	---	4.7	3.0	<.05	7	.5	3.5
3	168	1010	3.9	2.0	.06	.5	1.9	<.01	5.39	.17	42	9.03	---	4.6	3.0	<.05	6.8	2.6	13.1
3	150	1022	8	2.0	.06	.3	<.2	<.01	.99	.09	42.8	1.14	---	4.8	4.0	<.05	7.3	.5	2.9
3	100	1040	12.8	2.0	.09	.3	<.2	<.01	1.25	.31	35	2.52	---	3.8	3.0	<.05	5.4	.9	4.3
3	50	1053	3.8	2.0	.04	.1	<.2	<.01	1.17	.22	32.9	.61	---	3.6	2.0	<.05	4.8	.9	2.6

Table 21. Concentrations of dissolved trace elements in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Site number	Depth, in feet	Time	Aluminum (µg/L as Al)	Arsenic (µg/L as As)	Beryllium (µg/L as Be)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Cobalt (µg/L as Co)	Copper (µg/L as Cu)	Lead (µg/L as Pb)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Mercury (µg/L as Hg)	Molybdenum (µg/L as Mo)	Selenium (µg/L as Se)	Thallium (µg/L as Tl)	Uranium (µg/L as U)	Vanadium (µg/L as V)	Zinc (µg/L as Zn)
September 20, 1990—Continued																			
3	3	1105	2.6	1.0	0.07	<.1	<0.2	<0.01	0.9	<0.06	30.9	0.45	----	3.6	2.0	<0.05	4.8	0.6	1.9
3	390	1545	5.1	1.0	.08	.7	<.2	<.01	.9	.08	32.5	.34	----	3.7	2.0	<.05	4.7	.8	1.9
3	168	1555	5.8	2.0	.1	<.1	<.2	<.01	.89	<.06	39.8	1.02	---	4.5	3.0	<.05	6.7	.3	3.5
3	150	1605	2.2	2.0	.07	<.1	<.2	<.01	.89	<.06	34.2	.71	---	3.5	3.0	<.05	4.9	.6	2
3	100	1620	6	2.0	.08	<.1	<.2	<.01	1.18	<.06	32.4	1.09	---	3.7	2.0	.06	4.7	.8	2.4
3	50	1630	5.4	2.0	.08	.1	2.1	<.01	1.11	.07	31.7	.76	---	3.6	2.0	<.05	4.8	3.1	2.3
3	3	1645	1.8	1.0	.04	<.1	<.2	<.01	1.11	<.06	32.3	.33	---	4	2.0	<.05	4.7	.8	2.8
3	390	2133	2.8	2.0	.04	.4	<.2	<.01	1.23	<.06	34.1	.22	---	4.1	2.0	<.05	5.2	.8	3.5
3	168	2146	1.9	2.0	.06	<.1	<.2	<.01	1.74	.13	39.3	.34	---	4.5	3.0	<.05	6.7	.2	3.5
3	150	2200	2	1.0	.03	<.1	<.2	<.01	1.27	<.06	31.7	.29	---	3.4	2.0	<.05	4.5	.4	2.3
3	100	2215	5.2	1.0	<.02	.1	<.2	<.01	1.62	.59	30.6	6.98	---	3.6	2.0	<.05	4.6	.8	8.7
3	50	2230	2.7	1.0	.09	<.1	.2	<.01	1.27	<.06	31.5	.44	---	3.5	2.0	<.05	4.4	1.2	2.1
3	3	2245	2.1	2.0	.07	<.1	<.2	<.01	1.98	<.06	31.9	.13	---	3.6	3.0	.08	4.6	.8	3.6
DT	N/A	0940	5.7	2.0	.03	.1	<.2	<.01	5.06	.42	35	1.12	---	3.9	3.0	<.05	5.1	.8	6.1
DT	N/A	1540	2.5	2.0	<.02	<.1	<.2	<.01	11.42	.39	34.6	.4	---	3.9	3.0	<.05	5.1	.6	9.4
DT	N/A	2140	5.1	2.0	.03	.1	.6	.28	2.24	.07	34.2	1.5	---	3.8	2.0	<.05	4.9	1.4	4.7
November 5, 1990																			
BL	NRP DI BETA	0600	---	---	---	---	---	---	---	---	---	---	0.068	---	---	---	---	---	---
BL	NRP DI BETA	2400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2	50	0600	2.5	---	<.02	<.1	8.4	.59	.81	.48	36.7	<.1	---	5.9	---	.4	12.7	4.59	4.3
2	100	0600	2	---	<.02	<.1	8.5	.6	.88	.55	35.5	.1	---	5.3	---	.31	12.6	4.25	3.8
2	167	0600	2	---	.05	<.1	8.4	.73	.95	.45	39.7	.48	.049	5.4	---	.36	14	4.4	4.6
2	390	0600	2.5	---	.06	<.1	9.6	.85	1.26	.47	51	.29	---	7.1	---	.48	18.9	4.08	5.2
2	50	1200	2.6	---	<.02	<.1	8	.59	.76	.66	39.3	<.1	---	5.6	---	.49	14.9	4.77	5.1
2	100	1200	3.4	---	.08	.5	15.3	.55	1.31	1.61	36.1	.16	---	5.7	---	1	15.3	6.46	5
2	167	1200	2.4	---	.04	<.1	9.3	.64	.98	.53	39.8	.14	.083	5.2	---	.4	14.5	4.82	4.1
2	390	1200	2.8	---	.08	<.1	9.2	.87	1.22	.46	52.4	.11	---	7	---	.43	19.3	4.2	5.1

Table 21. Concentrations of dissolved trace elements in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Site number	Depth, in feet	Time	Aluminum (µg/L as Al)	Arsenic (µg/L as As)	Beryllium (µg/L as Be)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Cobalt (µg/L as Co)	Copper (µg/L as Cu)	Lead (µg/L as Pb)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Mercury (µg/L as Hg)	Molybdenum (µg/L as Mo)	Selenium (µg/L as Se)	Thallium (µg/L as Tl)	Uranium (µg/L as U)	Vanadium (µg/L as V)	Zinc (µg/L as Zn)
November 5, 1990—Continued																			
2	50	1800	2.8	---	0.06	<.1	8.2	0.67	0.82	0.52	40.3	0.12	---	5.6	---	0.38	15	4.79	5
2	100	1800	2.8	---	.03	<.1	8.3	.62	.88	.51	38.7	.15	---	5.5	---	.38	13.9	4.55	19
2	167	1800	1.4	---	.05	<.1	9.8	.71	1.17	.73	37	.13	0.049	5.6	---	.52	13.7	5.02	9.3
2	390	1800	1.5	---	.07	<.1	8.4	.92	1.25	.92	51.7	.1	---	7.5	---	.58	19.6	4.15	5.3
2	50	2400	1.4	---	.04	<.1	7	.65	.7	.88	40.6	<.1	---	5.5	---	.53	14.9	4.66	4
2	100	2400	1.4	---	.05	<.1	7.6	.69	.92	.66	36.4	<.1	---	5.2	---	.57	13.3	4.38	4.3
2	167	2400	1.4	---	.04	<.1	8.3	.7	.92	.73	39	.12	.068	5.3	---	.48	14.3	4.71	4.1
2	390	2400	1.7	---	.04	<.1	9.7	.87	.89	.94	48.6	.21	---	7.1	---	.58	19.6	4.46	5.1
3	50	0600	2.3	---	.02	<.1	8.2	.57	.92	.43	38	<.1	---	5.6	3.0	.53	14.3	4.83	3.9
3	100	0600	2.1	---	<.02	<.1	8.2	.58	1.06	.49	35.2	<.1	---	5.2	---	.37	13.8	4.18	3.5
3	167	0600	2	---	.03	<.1	8.3	.64	1	.43	38.7	.13	.094	5.3	---	.42	13.5	4.41	3.8
3	390	0600	2.3	---	.03	<.1	9	.85	1.15	.5	50.5	.58	---	7.3	---	.4	18.9	3.98	4.7
3	50	1200	2.5	---	.03	<.1	7.7	.65	.68	.62	40.3	<.1	---	5.6	2.0	.56	15.7	4.71	4.5
3	100	1200	2.5	---	.02	<.1	7.6	.66	1.05	.56	39.9	<.1	---	5.5	---	.38	14.7	4.5	4
3	167	1200	2.3	---	.05	<.1	7.3	.73	1.03	.54	43.6	.11	.059	5.5	---	.31	14.8	4.4	4.3
3	390	1200	3	---	.05	<.1	10	.88	1.22	.41	55.8	.16	---	7.3	---	.37	20.6	4.57	5.1
3	50	1800	1.5	---	.04	<.1	8.9	.64	.82	.71	37.3	<.1	---	5.7	3.0	.57	13.7	5.07	20
3	100	1800	1.3	---	<.02	<.1	7.8	.58	.91	.7	36.3	<.1	---	5.3	---	.55	13.8	4.37	3.8
3	167	1800	1.3	---	.06	<.1	8.5	.66	1.14	.75	38.8	.15	.056	5.3	---	.52	13.6	4.65	4.1
3	390	1800	2.1	---	.13	.5	15.5	.87	1.32	1.21	48.3	.23	---	7.5	---	.87	19.6	6.06	5.2
3	50	2400	1.6	---	<.02	<.1	7.3	.69	.68	.75	39.4	.11	---	5.5	3.0	.5	15.5	4.89	4
3	100	2400	1.7	---	.05	<.1	6.9	.65	.88	.8	41.2	.12	---	5.8	---	.48	14.7	4.88	3.9
3	167	2400	1.6	---	.06	<.1	8	.72	.99	.7	40.1	.24	.061	5.3	---	.5	14.9	4.71	4.4
4	50	0600	2.2	---	<.02	<.1	8	.6	.87	.47	39.3	<.1	---	5.6	---	.39	15	4.51	3.7
4	100	0600	2.2	---	.02	<.1	8	.61	.91	.52	37.2	.11	---	5.2	---	.57	15	4.27	3.6
4	167	0600	1.9	---	<.02	<.1	7.6	.62	1.09	.51	39.8	.16	.052	5.2	---	.42	15.4	4.15	3.7
4	390	0600	2.4	---	.02	<.1	9.1	.8	1	.55	53.2	.38	---	6.9	---	.4	19.7	4.05	4.9
DT	N/A	1200	2.4	---	.05	<.1	9.2	.71	1.8	.48	39.5	.12	---	5.8	---	.48	14.9	4.55	4.7

Table 21. Concentrations of dissolved trace elements in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Site number	Depth, in feet	Time	Aluminum (µg/L as Al)	Arsenic (µg/L as As)	Beryllium (µg/L as Be)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Cobalt (µg/L as Co)	Copper (µg/L as Cu)	Lead (µg/L as Pb)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Mercury (µg/L as Hg)	Molybdenum (µg/L as Mo)	Selenium (µg/L as Se)	Thallium (µg/L as Tl)	Uranium (µg/L as U)	Vanadium (µg/L as V)	Zinc (µg/L as Zn)
November 5, 1990—Continued																			
DT	N/A	1800	2.6	---	0.05	<.1	7.7	0.75	1.78	0.53	42.2	0.12	---	5.4	---	0.34	14.9	4.43	7.2
DT	N/A	2400	1.4	---	.04	<.1	8.8	.68	1.14	.71	37.2	.74	---	5.2	---	.52	13.9	4.7	4.5
November 6, 1990																			
2	50	0600	1.6	---	.04	<.1	7.6	.67	.83	.88	40.1	.1	---	5.7	---	.52	15	5.01	3.9
2	100	0600	1.6	---	.04	.1	9.6	.61	1.16	.82	36.9	<.1	---	5.6	---	.59	14.7	5.24	4.1
2	167	0600	1.7	---	.06	<.1	7.9	.74	1.11	.7	40.6	.17	0.051	5.3	---	.55	14.6	4.7	3.9
2	390	0600	1.9	---	.04	.1	8.6	1.05	1.12	.84	55.5	.52	---	7.5	---	.55	22.2	4.49	4.9
2	50	1200	1.4	---	.06	<.1	8.4	.77	.99	1	40.7	<.1	---	6	---	.75	14.5	5.24	4.3
2	100	1200	1.7	---	.06	<.1	8.9	.73	1.21	1	38.3	0.23	---	5.4	---	0.62	13.8	4.55	3.9
2	167	1200	1.3	---	.06	<.1	8.3	.79	1.03	.88	41.2	.1	.039	5.4	---	.77	15.2	4.53	4.1
2	390	1200	1.5	---	.07	<.1	9.5	.94	1.04	.77	51.1	.11	---	7.2	---	.54	20.4	4.16	4.8
2	50	1800	1.2	---	.06	<.1	7.7	.63	.8	.93	38.8	<.1	---	5.4	---	.63	15	4.86	4.1
2	100	1800	1.4	---	.08	<.1	8.5	.71	1.08	1.07	37.6	<.1	---	5.3	---	.69	12.7	4.85	4.1
2	167	1800	1.2	---	.06	<.1	9.3	.69	.96	.77	41.5	.11	.045	5.4	---	.64	14	4.99	3.8
2	390	1800	1.4	---	.07	<.1	8.6	.92	1.09	.87	55.4	.15	---	6.9	---	.49	18.7	4.26	5.1
2	50	2400	1.6	---	.09	<.1	10	.62	.92	1.16	38.9	.14	---	5.6	---	.7	16.1	5.81	4.2
2	100	2400	1.5	---	.07	<.1	9	.66	.99	1	39.3	<.1	---	5.3	---	.67	15.1	5.21	4.5
2	167	2400	1.6	---	.11	<.1	8.2	.76	1.15	.77	41.4	.15	.057	5.7	---	.7	15.3	5.25	4.7
2	390	2400	1.5	---	.06	<.1	7.7	.72	.93	.77	42.7	.11	---	5.6	---	.7	15.3	5.17	4.2
3	50	0600	1.7	---	.09	<.1	7.9	.69	.71	.72	41.9	<.1	---	5.4	3.0	.42	16.5	5.27	4.1
3	100	0600	1.7	---	.07	<.1	7.9	.74	.76	.71	37.1	<.1	---	5.5	---	.54	16.5	4.84	4.1
3	167	0600	1.7	---	.07	<.1	7.3	.79	.9	.52	42.9	.35	.129	5.4	---	.49	16.5	4.74	4.3
3	390	0600	2.3	---	.06	.4	13.4	.88	1.1	1.07	50.1	.2	---	7.8	---	.71	20.4	5.85	6
3	50	1200	1.9	---	.08	.6	14.8	.59	1.1	1.67	36.5	.15	---	5.9	3.0	1.16	15.6	6.66	4.4
3	100	1200	1.4	---	.08	<.1	9.1	.66	.9	.86	37.5	<.1	---	5.4	---	.64	14.5	4.47	3.7
3	167	1200	1.3	---	.05	<.1	8.1	.75	1.06	.71	41.3	.1	.037	5.4	---	.57	14.8	4.56	3.8
3	390	1200	1.5	---	.08	<.1	9.5	.98	1.1	.75	54.4	.19	---	7	---	.49	18.2	4.3	4.5
3	50	1800	1.4	---	.07	.1	8.1	.7	.92	.94	39.2	<.1	---	5.5	3.0	.74	13.8	5.28	4.1

Table 21. Concentrations of dissolved trace elements in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Site number	Depth, in feet	Time	Aluminum (µg/L as Al)	Arsenic (µg/L as As)	Beryllium (µg/L as Be)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Cobalt (µg/L as Co)	Copper (µg/L as Cu)	Lead (µg/L as Pb)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Mercury (µg/L as Hg)	Molybdenum (µg/L as Mo)	Selenium (µg/L as Se)	Thallium (µg/L as Tl)	Uranium (µg/L as U)	Vanadium (µg/L as V)	Zinc (µg/L as Zn)
November 6, 1990—Continued																			
3	100	1800	1.4	---	0.03	<.1	8.3	0.73	1.04	0.98	39.4	0.13	---	5.6	---	0.69	14.1	4.82	3.8
3	167	1800	1.4	---	.08	<.1	10.9	.72	1.18	1.13	40.5	.36	0.044	5.4	---	.42	13.8	5.52	3.8
3	390	1800	1.6	---	.05	<.1	9.7	1.01	1.16	.87	54.7	.26	---	6.9	---	.65	19.4	4.68	5
3	50	2400	1.3	---	.05	<.1	8	.67	.81	.92	39.3	<.1	---	5.5	3.0	.67	14.7	5.16	4
3	100	2400	1.4	---	.1	<.1	8.1	.67	.93	.8	38.1	<.1	---	5.2	---	.7	14.7	4.96	4.3
3	167	2400	1.5	---	.11	.2	9.4	.77	.99	.91	40.3	.36	.049	5.6	---	.67	15.2	5.44	4.2
3	390	2400	1.5	---	.06	<.1	8.8	1.02	1.21	.97	55.5	.84	---	7.2	---	.48	20	4.36	5.6
4	50	1200	1.2	---	.11	<.1	7.9	.63	.84	1.05	38.7	<.1	---	5.5	---	.6	14.2	4.93	3.8
4	100	1200	1.3	---	<.02	<.1	8.6	.71	.84	.73	38.8	.12	---	5.4	---	.74	14.8	4.53	3.3
4	167	1200	1.2	---	.07	<.1	8.9	.72	.91	.96	39.8	.22	.047	5.3	---	.69	15.2	4.92	3.8
4	390	1200	1.4	---	.08	<.1	9	.93	1.1	.91	52	.14	---	7	---	.66	19.5	4.37	4.9
DT	N/A	0600	1.5	---	.04	<.1	8.6	.75	1.43	.67	41.8	.32	---	5.5	---	.62	15.2	4.85	4.7
DT	N/A	1200	1.6	---	.02	<.1	8.4	.78	2.89	.59	42.8	.11	---	5.6	---	.59	15.9	5.04	4.3
DT	N/A	1800	1.3	---	.07	<.1	8.2	.76	1.42	.92	42.3	.47	---	5.7	---	.63	15	4.57	4.1
DT	N/A	2400	1.2	---	.09	<.1	8.8	.73	1.33	.93	42.3	.49	---	5.4	---	.53	14.3	5.14	4.4
January 15–16, 1991—Blanks																			
BL	NRP DI CAR	1730	.4	---	<.02	<.1	<.2	<.01	.25	<.06	<.1	<.1	.034	<.1	---	<.05	<.1	<.1	1.3
BL	FLAG DI CAR	1800	2.1	---	<.02	<.1	<.2	.05	.89	<.06	.1	<.1	.037	<.1	---	<.05	<.1	<.1	.8
BL	NRP DI BETA	0830	2.2	---	<.02	<.1	<.2	<.01	.63	<.06	.2	<.1	.320	<.1	---	<.05	<.1	<.1	34.9
January 16, 1991																			
2	50	1401	2.1	---	.06	<.1	.5	.54	1.06	<.06	32.4	.29	---	4.5	---	.09	4	2.35	4.4
2	155	1402	2.4	---	.04	<.1	.3	.55	.93	.09	34	.45	.047	4.5	---	.07	4.2	2.34	4.8
2	390	1403	2.3	---	.04	<.1	.3	.78	1.29	.07	43.9	1.07	---	5.9	---	.07	5.5	1.54	6
2	50	2101	2.4	---	.06	<.1	<.2	.63	1.03	<.06	33.3	.23	---	4.5	---	.06	4.2	2.33	4
2	155	2102	1.8	---	.07	<.1	<.2	.52	1.08	<.06	31.4	.38	.033	4.5	---	.08	4.3	2.24	3.9
2	390	2103	2.5	---	.04	<.1	.3	.73	1.78	.1	43.4	1.15	---	5.8	---	<.05	5.3	1.58	5.7
3	50	1431	1.9	---	.05	<.1	.7	.46	1	.14	29.1	.25	.056	4.6	3.0	.13	3.8	2.35	4.1

Table 21. Concentrations of dissolved trace elements in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Site number	Depth, in feet	Time	Aluminum (µg/L as Al)	Arsenic (µg/L as As)	Beryllium (µg/L as Be)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Cobalt (µg/L as Co)	Copper (µg/L as Cu)	Lead (µg/L as Pb)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Mercury (µg/L as Hg)	Molybdenum (µg/L as Mo)	Selenium (µg/L as Se)	Thallium (µg/L as Tl)	Uranium (µg/L as U)	Vanadium (µg/L as V)	Zinc (µg/L as Zn)
January 16, 1991—Continued																			
3	155	1432	3.3	---	0.03	<.1	0.7	0.53	0.99	0.1	30.3	0.58	---	4.5	2.0	0.09	3.9	2.22	4.6
3	390	1433	2.6	---	.07	<.1	.7	.82	1.33	<.06	32.4	.29	---	4.5	4.0	.14	6	1.68	7.1
3	50	2131	1.8	---	.06	<.1	.3	.5	1.05	<.06	33.2	.22	---	4.2	3.0	.09	4	2.26	4.1
3	155	2132	2.2	---	.07	<.1	<.2	.56	.89	.08	32.6	.29	0.042	4.5	3.0	.08	4.5	2.16	3.7
3	390	2133	2.2	---	.03	.2	.3	.79	1.1	<.06	43.8	1.11	---	5.8	4.0	.08	5.7	1.56	5.8
4	50	1501	2.2	---	.08	<.1	.2	.52	1.02	.08	32.5	.28	---	4.6	---	.09	4.3	2.39	6.1
4	155	1502	2.7	---	<.02	<.1	.2	.52	.86	.11	31.9	.48	.084	4.4	---	.07	4.3	2.09	6.8
4	390	1503	2.2	---	.06	<.1	<.2	.82	1.23	.1	43.5	1.18	---	6	---	.09	5.8	1.57	7.3
4	50	2201	1.6	---	.03	<.1	.3	.59	1.33	<.06	31.4	.29	---	4.5	---	.08	4	2.14	4.5
4	155	2202	2.9	---	.04	<.1	.3	.54	1.48	.09	32.2	.32	.045	4.5	---	.09	4.3	2.24	5.9
4	390	2203	3.6	---	.04	<.1	.3	.78	1.89	.11	41.9	.99	---	5.8	---	.1	5.5	1.53	6
DT	N/A	0700	49.6	---	<.02	<.1	<.2	.58	12.33	<.06	29.2	.96	---	4.6	---	<.05	4.7	2.15	8
DT	N/A	1400	2.5	---	.04	<.1	.5	.62	2.88	.13	34.8	.86	---	4.8	3.0	<.05	4.1	2.41	4.4
DT	N/A	2100	1.9	---	.08	<.1	.2	.61	1.67	<.06	34.6	.57	---	4.5	3.0	.09	4.2	2.2	4.9
January 17, 1991																			
2	50	0701	1.8	---	.06	<.1	.4	.57	.97	---	---	---	---	---	---	.12	4.3	2.18	3.6
2	155	0702	2.1	---	.06	<.1	.3	.58	1.21	.09	32	.47	.076	4.7	---	.1	4.4	2.18	5.6
2	390	0703	2.1	---	.06	<.1	.3	.82	1.11	.14	41.5	1.2	---	5.8	---	.09	6.1	1.44	5.5
3	50	0731	2.3	---	.04	<.1	<.2	.59	1.3	.16	31.6	.25	---	4.4	---	.08	4.3	2.35	3.5
3	155	0732	2	---	.05	<.1	<.2	.62	1.24	.09	32.9	.44	.047	4.5	---	.06	4.2	2.14	3.7
3	390	0733	1.8	---	<.02	<.1	<.2	.8	1.18	.14	42.9	.98	---	5.9	---	.12	5.9	1.58	4.6
4	50	0801	2.1	---	.08	.2	1.4	.47	1.3	.19	27.7	.25	---	4.5	---	.16	4	2.48	3.6
4	155	0802	1.8	---	.05	<.1	<.2	.56	1.06	.12	33.3	.43	.038	4.4	---	<.05	4.5	2.12	3.9
4	390	0804	2.3	---	<.02	<.1	.3	.73	1.31	.12	40.5	.89	---	5.7	---	.1	5.5	1.52	5.2
DT	N/A	0700	2.9	---	.04	.3	.9	.69	7.08	.22	31.2	2.91	---	4.7	---	.06	4.3	1.89	6.6
March 27–28, 1991—Blanks																			
BL	NRP DI CAR	1630	<.2	---	<.02	<.1	<.2	<.01	.13	<.06	<.1	<.1	<.06	<.1	---	<.05	<.1	<.1	.2

Table 21. Concentrations of dissolved trace elements in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Site number	Depth, in feet	Time	Aluminum (µg/L as Al)	Arsenic (µg/L as As)	Beryllium (µg/L as Be)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Cobalt (µg/L as Co)	Copper (µg/L as Cu)	Lead (µg/L as Pb)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Mercury (µg/L as Hg)	Molybdenum (µg/L as Mo)	Selenium (µg/L as Se)	Thallium (µg/L as Tl)	Uranium (µg/L as U)	Vanadium (µg/L as V)	Zinc (µg/L as Zn)
March 27–28, 1991—Blanks																			
BL	NRP DI BETA	0630	<0.2	---	<0.02	<0.1	<0.2	<0.01	0.37	<0.06	<0.1	<0.1	<0.06	<0.1	---	<0.05	<0.1	<0.1	1.7
BL	NRP DI KEM	1730	<.2	---	<.02	<.1	<.2	<.01	.4	<.06	<.1	<.1	<.06	<.1	---	<.05	<.1	<.1	.3
March 28, 1991																			
2	40	0900	3.9	---	.03	<.1	1.1	.6	1.09	.16	33.7	.5	---	4.3	---	<.05	4.3	2.33	3.5
2	151	0900	1.9	---	.04	.1	.9	.74	1.23	.12	38.6	.3	.098	5.2	---	<.05	5	2.05	3.7
2	390	0900	2.4	---	.03	<.1	.9	.86	1.44	.12	48.5	1.21	---	6.7	---	<.05	6.1	1.91	6.6
2	40	1520	2.4	---	.04	<.1	<.2	.63	1	.16	30.8	.49	---	4.7	---	.09	5	1.94	4.5
2	151	1520	2.1	---	.04	<.1	<.2	.65	1.83	.09	34.9	.49	.043	4.7	---	<.05	4.9	2.18	4.4
2	390	1520	1.8	---	.03	<.1	<.2	.8	1.13	.09	39.9	.72	---	5.8	---	.07	5.5	1.88	4.4
2	40	2150	2.6	---	<.02	<.1	.9	.66	.85	<.06	34.8	.53	---	4.4	---	<.05	4.6	2.06	4.4
2	151	2150	2.6	---	<.02	<.1	1	.72	1.18	<.06	45	.28	.031	5.3	---	<.05	5.9	2.28	5.1
2	390	2150	2.8	---	<.02	<.1	1.2	.89	1.09	.11	45	1.15	---	6.1	---	<.05	7.1	1.86	5.8
3	40	0910	2.1	---	.07	.2	2	.56	1.69	.24	29.3	.52	---	4.9	---	.18	4	2.58	4.5
3	151	0910	1.7	---	.05	<.1	.3	.82	1.27	.14	41.7	.26	---	5.5	---	<.05	5.4	1.87	4.2
3	390	0910	1.8	---	.05	<.1	.5	.88	1.29	.07	47.5	1.17	---	6.5	---	<.05	6.5	1.72	4.4
3	40	0915	2.8	---	.04	<.1	.8	.68	1.46	.1	32.6	.56	.038	4.7	---	.06	4.7	2.49	4.3
3	151	0915	2.2	---	<.02	<.1	.8	.82	1.74	.12	41.8	.29	.041	5.6	---	<.05	5.5	1.94	6
3	390	0915	2.1	---	.05	<.1	.6	.91	1.49	.11	47.9	1.13	.060	7	---	.07	6.4	1.95	8.8
3	40	1500	3.7	---	<.02	<.1	.3	.57	2.55	<.06	33.1	.6	.038	4.3	3.0	<.05	4.4	2.11	5.7
3	151	1500	2.2	---	<.02	<.1	.7	.74	1.04	<.06	39.2	.42	.048	5.1	4.0	<.05	5.1	2.04	5
3	390	1500	2.4	---	<.02	<.1	1	.83	1	<.06	47.3	1.05	.055	6.2	4.0	<.05	6	1.89	5
3	40	2122	2.8	---	<.02	<.1	1.1	.68	.95	<.06	35.1	.76	.036	4.3	3.0	<.05	4.8	2.44	4.1
3	151	2122	2.3	---	<.02	<.1	.7	.81	.98	<.06	39.2	.35	.041	4.9	4.0	<.05	5.7	1.83	4.7
3	390	2122	2.5	---	<.02	<.1	.5	.86	1.22	.12	41.5	.61	.052	4.9	3.0	<.05	5.3	2.05	5.9
4	40	0945	2	---	.07	.1	<.2	.7	1.19	.08	33.3	.48	---	4.7	---	.07	4.6	2.16	3.7
4	151	0945	2.4	---	.03	<.1	<.2	.8	1.33	.22	39.5	.33	.047	5.4	---	.09	5.8	2.08	4.4
4	390	0945	2.2	---	.05	<.1	<.2	.91	1.42	.13	46.6	2.03	---	6.6	---	.06	6.3	1.64	4.7

Table 21. Concentrations of dissolved trace elements in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Site number	Depth, in feet	Time	Aluminum (µg/L as Al)	Arsenic (µg/L as As)	Beryllium (µg/L as Be)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Cobalt (µg/L as Co)	Copper (µg/L as Cu)	Lead (µg/L as Pb)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Mercury (µg/L as Hg)	Molybdenum (µg/L as Mo)	Selenium (µg/L as Se)	Thallium (µg/L as Tl)	Uranium (µg/L as U)	Vanadium (µg/L as V)	Zinc (µg/L as Zn)
March 28, 1991—Continued																			
4	40	1540	2.2	---	<0.02	<0.1	0.5	0.59	1.89	0.08	32.4	0.51	---	4.4	---	<0.05	4.7	2.31	4.8
4	151	1540	2.2	---	<.02	<.1	1.1	.81	.88	<.06	42.5	.3	0.041	5.2	---	<.05	5.6	1.91	4.5
4	390	1605	2.9	---	<.02	<.1	1.3	1.01	1.04	<.06	49.1	1.19	---	6.2	---	<.05	6.7	2.13	5.6
4	40	2220	2.3	---	<.02	<.1	.2	.72	1.08	<.06	34.4	.54	---	4.5	---	<.05	4.6	2.39	4.3
4	151	2220	2.5	---	<.02	<.1	1.2	.86	1.46	<.06	39	.32	.039	5.5	---	.08	6.1	1.77	5.9
4	390	2220	2.2	---	.03	<.1	1.3	.77	1.48	.18	43.4	.88	---	6.3	---	.09	6	2.1	7.1
DT	N/A	0720	3.4	---	.03	.2	1.5	.74	1.26	.23	39.6	1.24	---	5.8	---	.08	5.3	2.17	4.5
DT	N/A	1415	2.2	---	<.02	.2	<.2	.84	5.52	.18	40.5	.49	---	5.5	4.0	<.05	5.5	1.7	5.1
DT	N/A	2115	2.8	---	<.02	<.1	1	.78	1.78	.17	39.6	.49	---	5.4	4.0	<.05	5.6	1.89	5.2
May 22–23, 1991—Blanks																			
BL	NRP DI CAR	1500	<.2	---	.11	<.1	<.2	<.01	1.11	<.06	.1	.23	---	<.1	---	<.05	<.1	.3	1.1
BL	NRP DI BETA	0900	.8	---	.05	<.1	.2	<.01	.82	.07	.1	.15	.079	<.1	---	<.05	<.1	.4	8.3
BL	NRP DI KEM	0910	2.5	---	.08	<.1	.5	.07	.33	<.06	.8	.25	---	<.1	---	<.05	<.1	1.5	3.4
May 23, 1991																			
2	3	0910	2.3	---	.06	<.1	<.2	<.01	.99	.07	33.6	1.2	.062	4.2	---	<.05	5.1	.9	1.9
2	50	0910	2.2	---	.05	<.1	<.2	<.01	1.18	<.06	33.2	.84	.057	4.1	---	<.05	5.1	.7	1.7
2	152	0910	2	---	.06	<.1	<.2	<.01	.98	.27	35.5	.58	.048	4.4	---	<.05	5.5	.7	1.8
2	390	0910	2.3	---	.08	<.1	<.2	<.01	1.29	.1	41.9	.59	.051	5.4	---	<.05	6.8	.6	2.4
2	3	1545	4	---	.11	<.1	<.2	<.01	1.53	.17	35.6	1.61	.070	4.3	---	.06	5.6	1.3	2.1
2	50	1545	4.2	---	.04	<.1	<.2	<.01	1.39	.12	38.2	1.1	.056	4.3	---	<.05	5.6	1.4	2.2
2	152	1545	3.1	---	.05	<.1	<.2	<.01	1.32	.17	35.2	.72	.066	4.4	---	.14	5.8	1	2.2
2	390	1545	2.4	---	<.02	<.1	<.2	<.01	1.02	.07	44.3	.9	.074	4.9	---	.07	6.9	.8	2.2
2	3	2306	4.6	---	.06	<.1	<.2	<.01	1.3	.14	35.9	1.69	.047	3.8	---	.05	5.4	1.1	3.3
2	50	2306	4.3	---	<.02	<.1	<.2	.02	1.55	.09	36	1	.047	4.1	---	<.05	5.7	1.5	2.4
2	152	2306	3.2	---	.13	<.1	<.2	<.01	1.57	.1	39.3	.58	.045	4.5	---	<.05	6	1.4	2.3
2	390	2306	2.9	---	.03	<.1	<.2	<.01	1.37	.09	40.8	.67	.073	4.6	---	<.05	6.5	1	2.1

Table 21. Concentrations of dissolved trace elements in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Site number	Depth, in feet	Time	Aluminum (µg/L as Al)	Arsenic (µg/L as As)	Beryllium (µg/L as Be)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Cobalt (µg/L as Co)	Copper (µg/L as Cu)	Lead (µg/L as Pb)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Mercury (µg/L as Hg)	Molybdenum (µg/L as Mo)	Selenium (µg/L as Se)	Thallium (µg/L as Tl)	Uranium (µg/L as U)	Vanadium (µg/L as V)	Zinc (µg/L as Zn)
May 23, 1991—Continued																			
3	3	0930	2.6	---	0.05	<0.1	<0.2	<0.01	1.25	0.6	33.2	1.22	0.054	4.1	---	<0.05	5.3	0.7	2.1
3	50	0930	2.5	---	<.02	<.1	<.2	<.01	.93	.06	35.6	.99	.048	4.4	---	.09	5.7	1.5	1.7
3	152	0930	2.7	---	.07	<.1	<.2	<.01	1.2	.09	38.8	.41	.056	4.2	---	.06	6	1.3	2.1
3	390	0946	2.2	---	.07	<.1	<.2	<.01	.96	.1	42.8	.57	.073	4.9		.05	6.6	1	2.1
3	3	1600	3.6	---	.07	<.1	<.2	<.01	1.18	.22	36.2	1.64	.045	4.1	3.0	.07	5.6	1.2	2
3	50	1615	4.6	---	<.02	<.1	<.2	<.01	1.21	.23	34.6	.93	.047	3.9	2.0	.07	5.4	1.4	2.8
3	152	1615	4.2	---	.04	<.1	<.2	<.01	1.07	.12	36.8	.53	.039	5.1	3.0	<.05	6.1	1.1	2.2
3	390	1615	2.6	---	.07	<.1	<.2	<.01	1.09	.1	42.8	.75	.037	5.1	4.0	.06	6.9	1.2	1.9
3	3	2225	3.9	---	.02	<.1	<.2	<.01	1.24	.1	37.6	1.59	.053	4	1.0	<.05	5.7	1.3	2.9
3	50	2240	3.4	---	<.02	<.1	<.2	<.01	1.17	.1	36.2	.88	.050	4.1	3.0	.05	5.5	1	2.5
3	152	2240	2.9	---	.04	<.1	<.2	<.01	1.2	.1	41.5	.4	.057	4.5	3.0	.05	6	1	1.9
3	390	2240	2.9	---	.05	<.1	<.2	<.01	1.29	<.06	44.8	.35	.047	5	4.0	<.05	7.3	.8	2.1
DT	N/A	0830	2	---	.06	<.1	<.2	.02	1.4	<.06	34	3.55	---	4.6	---	<.05	5.9	1	2.5
DT	N/A	1535	2.8	---	.05	<.1	<.2	<.01	4.09	.26	40.1	.83	---	4.3	3.0	<.05	6.3	1.1	7.6
DT	N/A	2200	3.2	---	.11	<.1	<.2	<.01	9.85	.12	41.7	.71	---	4.6	4.0	<.05	6.2	1.3	3
June 18–19, 1991 — Blanks																			
BL	NRP DI CAR	1000	.9	---	<.02	<.1	<.2	.09	.15	.21	<.1	.1	.050	.1	---	<.05	<.1	.4	.9
BL	NRP DI KEM	1100	1.6	---	<.02	<.1	<.2	.14	.45	.18	9.5	.16	---	1.1	---	<.05	1.2	.5	1.8
BL	NRP DI BETA	2200	.6	---	.05	.1	2.3	.11	.4	.1	8.8	.15	.042	1.1	---	.12	.8	4.7	10.9
June 18, 1991																			
2	390	1415	1.8	---	.03	.3	<.2	.13	.83	.26	40.1	.3	.087	4.9	---	.12	6.8	1.4	4.1
2	160	1430	1.6	---	.05	.1	<.2	.06	.88	.24	36.1	.31	.056	4.1	---	.06	5.9	1.5	4.7
2	3	1450	3.5	---	<.02	.2	.3	.03	1.06	.43	33.9	.5	.045	3.9	---	.06	5.5	2.3	4.1
2	40	1500	2.8	---	<.02	<.1	<.2	<.01	.97	.26	34.5	.39	.053	4	---	.09	5.6	1.8	4.2
2	390	2348	1.3	---	.11	<.1	8.2	<.01	.63	.15	38.6	<.1	.054	4.5	---	<.05	6.3	16.9	3.3
2	160	2354	1.5	---	.07	<.1	7.6	<.01	.61	<.06	38	.13	.048	4.3	---	.06	5.9	15.8	3.1

Table 21. Concentrations of dissolved trace elements in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Site number	Depth, in feet	Time	Aluminum (µg/L as Al)	Arsenic (µg/L as As)	Beryllium (µg/L as Be)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Cobalt (µg/L as Co)	Copper (µg/L as Cu)	Lead (µg/L as Pb)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Mercury (µg/L as Hg)	Molybdenum (µg/L as Mo)	Selenium (µg/L as Se)	Thallium (µg/L as Tl)	Uranium (µg/L as U)	Vanadium (µg/L as V)	Zinc (µg/L as Zn)
June 18, 1991—Continued																			
2	40	2400	1.2	---	0.09	0.1	7.2	<0.01	.52	<0.06	32.3	<0.1	0.038	3.9	---	<0.05	5.4	15	3.3
3	3	1220	2.2	---	.05	<.1	<.2	<.01	.67	.09	35.5	.42	.124	4	---	.1	5.3	1.7	3.6
3	40	1235	3	---	.04	<.1	<.2	.08	.72	.3	30.6	.24	.078	3.5	3.0	.12	5.6	1.5	3.6
3	160	1245	1.3	---	.02	.3	<.2	<.01	.72	.1	35.7	.26	.068	4.3	---	.1	5.7	1.8	3.8
3	390	1300	1.7	---	<.02	.2	<.2	<.01	.67	.12	38.3	.4	.052	4.7	---	.07	6.2	1.4	3.6
3	3	1803	2.7	---	.07	.2	<.2	<.01	.65	.08	34	.34	.080	3.9	---	.08	5.5	1.8	4.1
3	40	1811	3.6	---	.04	<.1	<.2	.06	.61	.09	31.1	.25	.095	3.7	3.0	.06	5.3	1.1	3
3	160	1850	1.4	---	.05	<.1	<.2	<.01	.77	.17	35.9	.22	.070	4.1	---	<.05	5.8	1.6	3.4
3	390	1855	1.4	---	.04	.2	<.2	<.01	.83	<.06	37	.26	.112	4.1	---	.08	6.2	1.4	3.8
3	390	2300	1.4	---	.08	<.1	7.9	<.01	.63	.07	37.3	.12	---	4.6	---	.12	6.1	16.3	3.1
3	160	2315	1.4	---	.12	.1	8	.08	.6	.19	33.8	.11	---	4.1	---	.08	6.1	16.5	2.9
3	40	2321	1.5	---	.05	<.1	7	.03	.51	<.06	31.5	<.1	---	3.5	---	<.05	5.1	15.6	2.7
3	3	2325	2	---	.1	<.1	8.1	<.01	.73	.13	33.3	.11	---	4.1	---	.08	5.5	16.9	3
DT	N/A	1330	1.6	---	.07	<.1	<.2	.2	2.84	.52	36.1	.47	---	4.6	---	.07	5.8	1.9	5.6
DT	N/A	1830	1.4	---	.07	<.1	<.2	.02	1.33	.46	34.9	.38	---	4.1	---	.14	5.9	1.6	4.1
DT	N/A	2400	1.4	---	.05	<.1	7.9	<.01	.81	.13	37.2	.18	---	4.2	---	.08	6	16.4	3.5
June 19, 1991																			
2	3	0005	1.4	---	.06	<.1	6.6	<.01	.51	<.06	34.8	.11	.076	3.9	---	.06	5.3	14	3.6
2	3	0655	3.1	---	.07	.3	<.2	<.01	.68	.15	35	.23	.051	4.2	---	.14	5.8	1.9	3.4
2	40	0700	2.9	---	.07	<.1	<.2	.07	.68	.13	34	.29	.050	3.6	---	.07	5.4	1.2	3
2	160	0730	2.2	---	.06	<.1	<.2	.09	.82	<.06	33.1	.25	.036	4	---	<.05	5.6	.9	4.1
2	390	0740	2.2	---	<.02	<.1	<.2	.02	.69	.12	33.9	.25	.044	3.8	---	<.05	5.7	.9	3
2	3	1210	3.9	---	<.02	<.1	<.2	.12	.87	.2	32.4	.28	.057	3.6	---	.07	5.6	1.7	3.8
2	40	1220	3.3	---	<.02	<.1	<.2	.09	.66	.25	31.4	.29	.048	3.7	---	.08	5.3	1.5	3.3
2	160	1230	3.1	---	.03	<.1	<.2	.03	.71	<.06	32	.27	.052	3.7	---	.06	5.4	1	3.1
2	390	1240	3.1	---	.02	<.1	<.2	.05	.96	.21	36.3	.34	.080	4.1	---	<.05	5.9	1.2	4.3
2	3	1805	2.2	---	.03	<.1	7.6	.03	.59	.18	32.8	<.1	---	3.6	---	.1	5.2	16	3.1
2	40	1810	2	---	.06	.2	8.8	<.01	.58	.08	31.6	<.1	---	3.4	---	.13	5.3	18.3	3.2
2	160	1817	1.7	---	.07	<.1	7.4	<.01	.59	.16	33.6	<.1	---	3.6	---	<.05	5.2	16.4	2.8

Table 21. Concentrations of dissolved trace elements in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Site number	Depth, in feet	Time	Aluminum (µg/L as Al)	Arsenic (µg/L as As)	Beryllium (µg/L as Be)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Cobalt (µg/L as Co)	Copper (µg/L as Cu)	Lead (µg/L as Pb)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Mercury (µg/L as Hg)	Molybdenum (µg/L as Mo)	Selenium (µg/L as Se)	Thallium (µg/L as Tl)	Uranium (µg/L as U)	Vanadium (µg/L as V)	Zinc (µg/L as Zn)
June 19, 1991—Continued																			
2	390	1850	1.7	---	0.05	<.1	7.7	<0.01	0.55	<0.06	34.2	<0.1	---	3.8	---	<0.05	5.7	16.8	2.9
3	3	0605	2.8	---	.02	.4	<.2	<.01	.71	<.06	34.6	.27	0.051	3.9	---	.11	5.8	1.7	3.8
3	40	0610	3	---	.03	<.1	<.2	.14	.71	.16	31.8	.25	.055	3.5	3.0	.09	5.2	1.5	3.3
3	160	0630	1.8	---	.05	<.1	<.2	<.01	.62	<.06	31.5	.23	.047	3.7	---	<.05	5.7	1	3
3	390	0640	2	---	<.02	<.1	<.2	.06	.69	.11	35.8	.26	.040	4.1	---	.06	5.8	.9	3.2
3	3	1310	5.1	---	.03	<.1	<.2	.09	.76	.15	32.9	1.61	.088	3.7	---	<.05	5.4	1.4	3.8
3	40	1320	7.4	---	<.02	<.1	<.2	.13	.95	.21	33.5	.4	.058	3.7	3.0	.17	5.4	1.9	3.7
3	160	1330	2.4	---	<.02	<.1	<.2	.01	.64	<.06	34	.27	.057	3.8	---	<.05	5.4	1.2	3.1
3	390	1340	2.5	---	.05	<.1	<.2	.09	.86	.33	34.9	.36	.065	4	---	.09	5.7	1.2	4
3	390	1825	2.2	---	.04	<.1	7.8	.03	.61	.09	33.8	.13	.062	4	---	.11	6.1	16.1	3.3
3	3	1900	1.6	---	.07	<.1	6.9	<.01	.57	<.06	32	<.1	.062	3.6	---	<.05	5.3	15.5	2.9
3	40	1907	2.1	---	.08	<.1	8.1	.07	.68	.17	33	.15	.051	3.6	3.0	.12	5	17	3.3
3	160	1915	2.1	---	.05	<.1	7.3	<.01	.52	<.06	32	.11	.053	3.6	3.0	.06	5.1	15.4	3.2
3	3	2335	3.7	---	<.02	<.1	<.2	.01	.77	.18	31.2	.5	---	3.5	---	.07	5.6	1	3.6
3	40	2345	3	---	<.02	<.1	<.2	<.01	.6	<.06	30.5	.29	---	3.5	3.0	.14	5.4	1.5	3.4
3	160	2400	2.2	---	.02	<.1	<.2	.05	.65	.15	32	.21	---	3.8	---	.1	5.6	1.5	3.8
DT	N/A	0615	1.7	---	.08	.4	8.6	<.01	4.26	.17	36.9	.11	---	4.2	---	.1	6	17.7	4.3
DT	N/A	1200	2.6	---	.03	<.1	<.2	<.01	1.7	.2	34.6	.45	---	3.9	---	.06	6	.9	4.3
DT	N/A	1745	1.8	---	.06	<.1	7.1	.01	2.56	<.06	33.6	<.1	---	3.9	---	<.05	5.6	15.7	3.5
DT	N/A	2345	2.2	---	.04	<.1	<.2	.08	1.46	.15	33.7	.3	---	3.7	---	.1	5.7	1.3	3.7
June 20, 1991																			
2	3	0610	3.9	---	.02	<.1	<.2	.21	.67	.1	34.3	.25	.053	3.7	---	.09	5.5	1.7	3.4
2	40	0620	3.1	---	.05	<.1	<.2	.07	.66	<.06	30.6	.25	.044	3.6	---	<.05	5.3	1.2	3
2	160	0630	2.5	---	.05	<.1	<.2	<.01	.71	.38	31.9	.26	.047	3.7	---	.11	5.8	1.5	3.6
2	390	0640	2.9	---	.04	<.1	<.2	<.01	.73	.47	32.6	.4	.066	4	---	<.05	5.9	.7	3.1
3	390	0010	2.6	---	<.02	<.1	<.2	.07	.68	<.06	34.2	.27	---	4.1	---	<.05	5.6	1.5	4
3	[1]3	0120	3.1	---	.04	<.1	<.2	.11	.78	<.06	33.5	.24	.063	3.7	---	<.05	5.5	1.3	3.4
3	[1]40	0120	3.6	---	.02	<.1	<.2	.14	.71	.13	32	.29	.051	3.7	---	.1	5.4	1.9	3.6
3	[1]160	0120	1.8	---	.03	<.1	<.2	<.01	.67	<.06	31.8	.19	.049	3.8	---	<.05	5.6	1	3.5

See footnote at end of table.

Table 21. Concentrations of dissolved trace elements in grids 2, 3, and 4 of the forebay of Lake Powell and outflows (draft tubes) of Glen Canyon Dam, 1990–91—Continued

Site number	Depth, in feet	Time	Aluminum (µg/L as Al)	Arsenic (µg/L as As)	Beryllium (µg/L as Be)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Cobalt (µg/L as Co)	Copper (µg/L as Cu)	Lead (µg/L as Pb)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Mercury (µg/L as Hg)	Molybdenum (µg/L as Mo)	Selenium (µg/L as Se)	Thallium (µg/L as Tl)	Uranium (µg/L as U)	Vanadium (µg/L as V)	Zinc (µg/L as Zn)
June 20, 1991—Continued																			
3	[1]390	0120	2.2	---	<0.02	<0.1	<0.2	<0.01	0.76	0.15	39.7	0.25	0.051	4.5	---	0.12	7.1	1	4
3	3	0710	3.7	---	.03	<.1	<.2	.18	.8	.07	33.7	.25	.062	3.9	---	<.05	5.1	1.6	3.5
3	40	0720	3.2	---	.04	<.1	<.2	.09	.63	<.06	32.8	.26	.052	3.6	5.0	<.05	5.3	1.3	3.4
3	160	0730	2.6	---	.03	<.1	<.2	.01	.71	.13	33	.22	.050	3.8	---	<.05	5.5	.8	3.1
3	390	0740	5	---	.02	<.1	<.2	.14	.74	.19	35.8	.57	.040	4.3	---	.06	6.2	1.3	3.6
DT	N/A	0545	2.3	---	<.02	<.1	<.2	<.01	1.42	.13	33.4	.38		3.8	---	.1	6	1.1	3.6
August 29, 1991 — Blanks																			
BL	NRP DI KEM	0830	1	---	.11	<.1	<.2	.1	.75	.11	.1	.13	---	<.1	---	<.05	<.1	<.1	3.2
BL	NRP DI CAR	1545	<.2	---	.04	<.1	<.2	.08	<.02	<.06	.1	.22	.035	<.1	---	<.05	<.1	<.1	.2
August 29, 1991																			
3	3	0820	1.6	---	.05	<.1	<.2	<.01	.84	.11	36.7	<.1	.072	4.6	---	<.05	5.7	1	2
3	45	0820	1.5	---	.03	<.1	<.2	<.01	.9	<.06	35.4	.12	.062	4.4	---	<.05	5.5	.9	2.4
3	155	0820	1.5	---	.04	<.1	<.2	<.01	.96	.15	35.4	.3	.047	4.6	---	<.05	5	.8	3
3	390	0820	1.4	---	<.02	<.1	<.2	<.01	1.01	<.06	44.3	1.06	.048	5.8	---	<.05	6.7	.5	2.7
3	3	1315	2.4	---	.09	<.1	<.2	<.01	.75	.1	35.5	.17	.074	4.3	---	<.05	5.6	1.2	2
3	45	1315	1.8	---	.05	<.1	<.2	<.01	.83	.07	34.8	.23	.044	4.3	---	<.05	5.5	1	2
3	155	1315	1.5	---	.06	<.1	<.2	<.01	.81	<.06	34.9	.31	.044	4.5	---	.08	5.5	.9	1.7
3	390	1315	1.9	---	.08	<.1	<.2	<.01	.82	<.06	40.5	1.47	.041	5.1	---	<.05	6.3	.4	1.9
3	3	2045	1.8	---	.07	<.1	<.2	<.01	.77	.07	36.1	.22	.048	4.4	---	<.05	5.9	1.1	1.7
3	45	2045	1.5	---	.1	<.1	<.2	<.01	.76	.06	33.1	<.1	.040	4.3	---	.05	5.3	.8	2.2
3	155	2045	1.6	---	.04	<.1	<.2	<.01	.73	<.06	34.6	.27	.038	4.3	---	<.05	5.3	.5	2
3	390	2045	2	---	.09	<.1	<.2	<.01	.86	<.06	45.2	1.05	.040	5.8	---	<.05	6.9	.6	2.4
DT	N/A	0730	1	---	.06	<.1	<.2	<.01	1.29	.08	35.6	.65	---	4.6	---	.06	5.8	.6	2.6
DT	N/A	1400	1.6	---	.04	<.1	<.2	<.01	1.19	.09	35.8	.51	---	4.7	---	<.05	5.6	.5	2.5
DT	N/A	2000	1.4	---	.07	<.1	<.2	<.01	1.37	.12	36.7	.63	---	4.7	---	<.05	5.6	.7	2.4

[1]Water sample collected with beta bottle.