Typically, treatment plant processes and equipment are located outdoors. Buildings would be required for the chemical feed equipment, air blower, filter consoles, electrical, instrumentation equipment, plant operations and maintenance facilities. Figure 11.7 is a conceptual floor plan of an operations building. The size of the operations building is approximately 75 foot by 50 foot.

Once a site and specific type of plant technology is selected, a more detailed site plan can be prepared. Site criteria would be the same as for the membrane plant option.

11.4 Building Architectural Features

Given the industrial nature of the activities within the pumping station, treatment plant, and the membrane building, the most flexible and economical approach is to use a pre-engineered metal building structural system. These systems are readily available, have favorable delivery lead times, weather-in very quickly, are competitively priced, and are specifically designed for applications like this one. They can withstand considerable abuse, require limited maintenance, yet provide flexibility for customized exterior finishes, interior space planning, and industrial loadings such as overhead cranes. Erection procedures are also a positive consideration given that heavy construction equipment, i.e. cranes, are typically not required for buildings of the sizes anticipated here. The structure of all working spaces (pump stations, treatment building, maintenance areas) should be hot-dip galvanized to ensure the structural longevity of each building.

11.5 Building Envelope

11.5.1 Roof System

Given the structural system presented above, a standing-seam metal panel roof system is the logical choice. These panels come in several gages (20, 22, 24, 26), profile sizes (2", 2 ½", 3" rib height), and attachment methods (thru-fastener or concealed fastener). Selections are driven by span restrictions of the roof system, overhang requirements, and drainage considerations. The recommendation for this project is a 24-gage panel with a 2" rib in a thru-fastener attachment method. Abnormal roof span requirements, wide roof overhangs, or roof leakage concerns are not expected to be significant enough to justify the expense of the other panel options.

11.5.2 Wall Panels

The wall panel system probably has the most options to be considered. The pre-engineered metal building systems manufactured today easily accommodate either standard metal wall panels, masonry veneers, or stucco. On the following pages are photographs of various wall treatments from which to select. A brief description of the systems shown is presented along side each photo.

11.5.3 Interior Finish

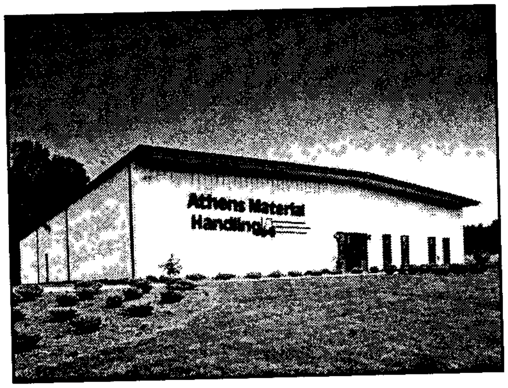
The interior side of all exterior walls in working spaces would receive a metal liner panel. This panel will provide a flat surface on which electrical panels, conduits, pipes, etc. could be mounted, and it protects the walls insulation and structure from splashing and spillage. In most cases, this liner only extends to a height of 8' above finish floor; however, it should extend the full height of walls in washdown or other wet areas. From the top of the liner panel to the underside of the roof, the backside of exterior metal panel or wall insulation is exposed.

11.6 Floor Plans

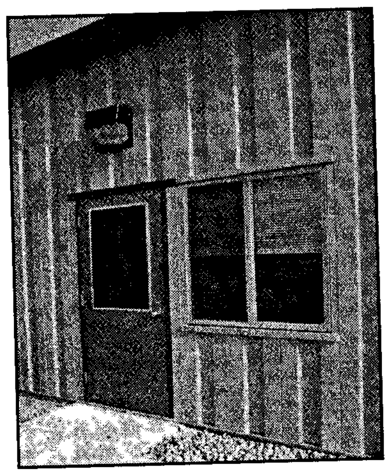
The floor plans for the high service pumping station and the water plant are driven by the special requirements of the equipment contained within them. The membrane building shown in Figure 11-1 could be arranged many different ways. By combining the operational functions and occupied spaces, i.e. lab, kitchen, office, etc., there is a need to control the noise and moisture generated by the treatment functions. To provide this control, the interior partitions creating these spaces need to be more substantial in mass and more detailed in terms of wall penetrations. CMU masonry is typically employed when occupied or conditioned spaces are provided within buildings housing working spaces. See figure 11-7 for conceptual floor plan of an independent operations building.

Consideration may be given to reducing the size of the membrane building by relocating as many as possible of the occupied spaces to an adjacent free standing building. This would provide "control" of the noise and moisture allowing conventional office-type construction within this building.

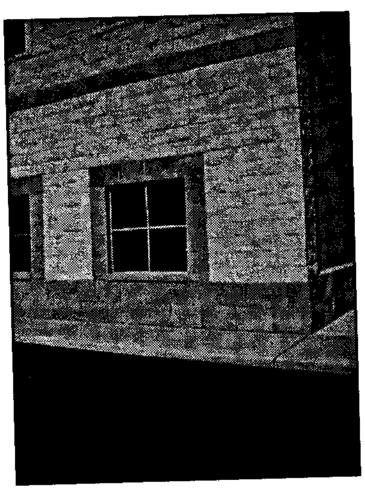
11.7 Building Concepts - Photographs



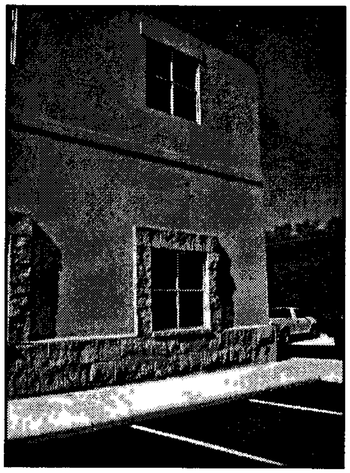
This shows a typical metal wall panel system available from most building system manufacturers. The panels come with a pre-finished baked enamel coating in a multitude of colors. Accessories such as doors, windows, vents, louvers, overhead doors, etc can be provided by the metal building manufacturer or purchased from commercial suppliers.



These photos show just two of the many panel profiles that are available from a relatively flat profile (left) to one with much more "shadow" (right).

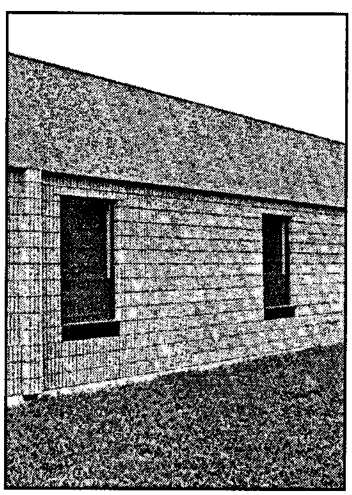


This photo shows a multi-color, multi-texture masonry veneer. Although this treatment can produce the most striking appearance, it comes at perhaps the highest per square foot cost of all options presented.

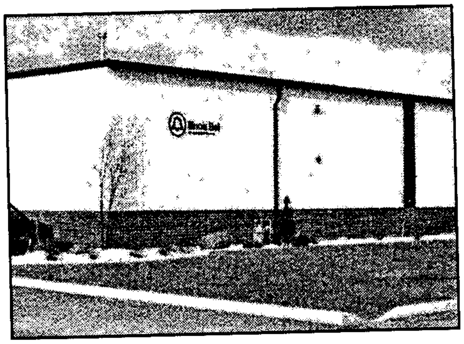


By combining masonry and stucco, an interesting façade can be created, however, the long-term maintenance cost of this option will generally be the highest. If the stucco is painted, exposure to sunlight will, over time, fade the intensity of the color, thus requiring repainting, and any chips in the surface will expose the "whole" stucco base beneath. Touch up painting is difficult given the faded color of the adjacent surface. The choice is to leave the scarred surface or repaint the entire wall/building. If stucco with an integral color is used (the color is mixed in the stucco itself, not surface applied), the frequency of repainting is decreased - not eliminated - but the cost of the initial construction increases since integral color stucco is more expensive then the painted stucco alternative.

The typical Texas Hill Country white limestone finish is shown here. This treatment would blend in with the surrounding structures but is more expensive than stucco.



By combing masonry walls with a textured mansard band, the function of the buildings can be disguised. The initial cost of construction would be significantly more then any of the metal siding options the metal building manufacturers could provide. Depending on the finish of the mansard band, the long-term maintenance cost could be held to a minimum.



This photo shows a metal panel siding with a masonry wainscot. This option offers perhaps the best balance between initial construction cost, appearance, long-term maintenance, and durability. By using the more durable material, masonry, at the bottom of the wall, where most of the abuse is likely to occur, you protect the appearance of the metal panel/paint finish above. Given the reduced square footage of the masonry, the initial construction cost of the wall system can be controlled.

Regional Water Supply Project for Portions of Comal, Kendall, and Bexar Counties

IT / SCADA System

Technical Memorandum

Table of Contents

12. Information Technology / SCADA

12.1 Introduction

The overall control of the proposed potable water treatment and transmission system as presently envisioned will be implemented via a Supervisory Control And Data Acquisition system (SCADA). In view of the complex system hydraulics and specific customer requirements, the SCADA system must be flexible, reliable, user friendly and effective over a large geographical area. The component architecture of such a SCADA system would be as shown on Figure 12-1.

12.2 System Architecture

The central component of this system, as shown, is the Programmable Logic Controller (PLC). The PLC's of this system will function as both a Remote Terminal Unit (RTU), a logic controller and as a redundant controller. A master redundant processor PLC will be located in the water treatment plant. This PLC will contain logic that will coordinate and supervise the operation of the Water Treatment Plant distributed PLC's, the Raw Water Pump Station PLC and the Remote Pump Station PLC. This master PLC will also manipulate system data and transmit to the supervisory computer and the Operator Machine Interface (OMI) station. The PLC's at the Raw Water Pump Station and the Remote Pump Station will also be redundant processor equipped units. Operational logic for both these PLC's will include stand alone logic execution for each of the stations with full duplex logic exchange with the master PLC. The Raw Water Pump Station will utilize tank level information from the Startz Hill Reservoir to determine pump operation.

Each of the customer metering and flow control sites will be equipped with a lower level PLC to serve as a communication device and execute control logic for the flow control equipment (see Figure 12-2).

The Host Computer/OMI will consist of a Personal Computer (PC) with Windows NT operating system running an OMI software such as Wonderware. Operator graphics, data archiving and report generation will be accomplished in this environment.

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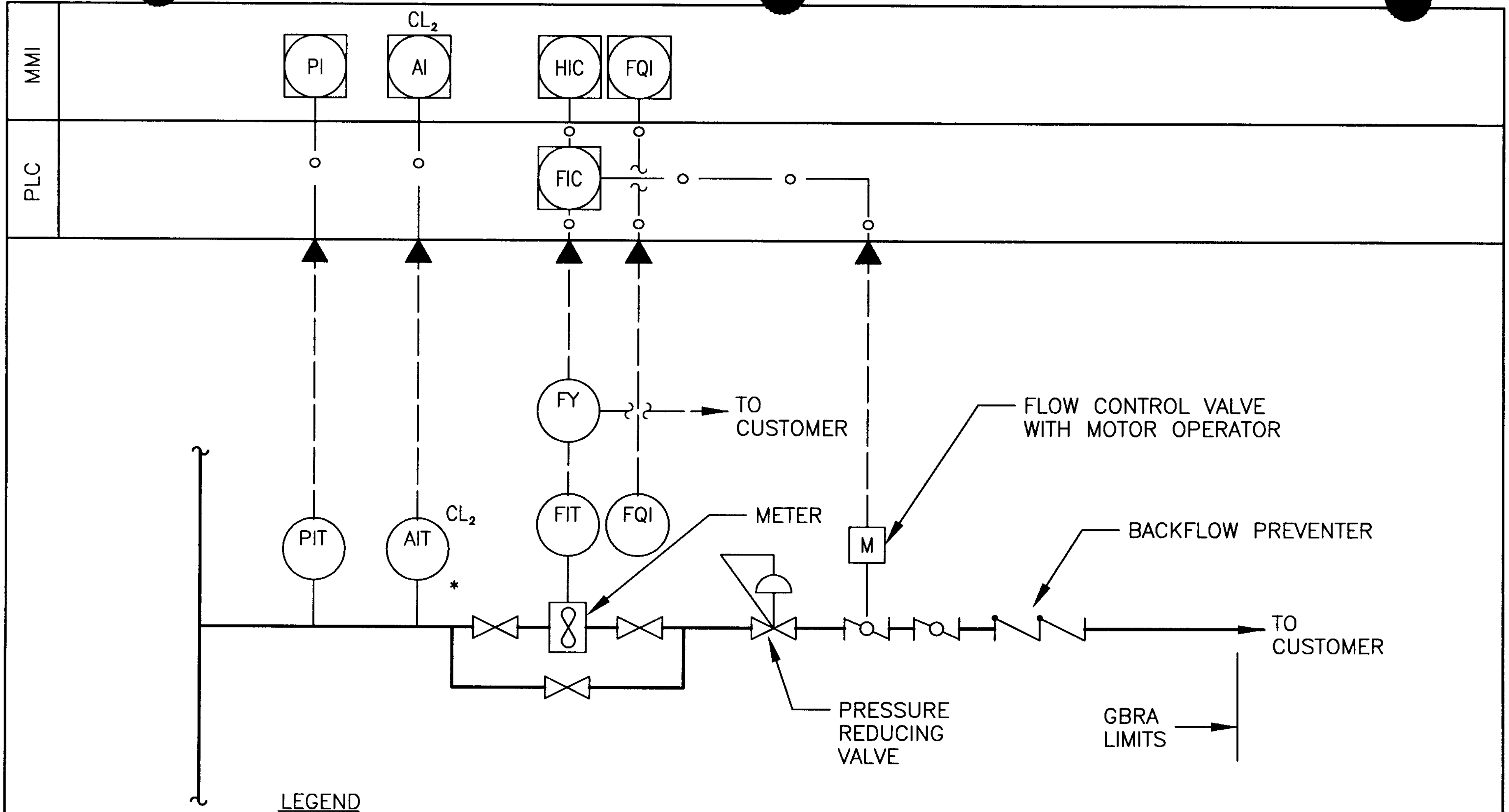


LEGEND

AI – ANALYSIS INDICATOR (CHLORINE RESIDUAL)
AIT – ANALYSIS INDICATOR TRANSMITTER
FIC – FLOW INDICATING CONTROLLER
FIT – FLOW INDICATING TRANSMITTER
FQI – FLOW TOTALIZING INDICATOR
FY – FLOW RELAY

* SAWS & BEXAR

MALCOLM PIRNIE | GBRA–REGIONAL WATER SUPPLY PROJECT | TYPICAL CUSTOMER CONNECTION P & ID | MALCOLM PIRNIE, INC. 12–2

12.3 Telemetry

The overall geographic area encompassed by this project spans approximately 46 miles. To facilitate high speed, reliable information transmission, a licensed, full duplex radio telemetry system similar to the existing GBRA facilities is envisioned. Buried fiber optic cable was considered the most reliable, but extremely high capital costs would be realized and is not cost effective. Spread spectrum radio and leased telephone is not considered reliable for this application.

12.4 Capital Costs

It is anticipated that the capital cost of the installation and implementation of the described SCADA system would be approximately $695,000 (including Contracts A and B). Approximately two-thirds of this total is allocated to the raw water intake and treatment plant (Contract A).

Table 12-1: Construction Cost Estimate for SCADA System (Contract A)

Item	*Estimated Cost*
SCADA Base Cost Opinion	$ 445,000
Contingency (10%)	$ 45,000
Subtotal	$ 490,000
Mobilization/Bonds/Ins. (5%)	$ 245,000
Contractor's OH&P (12%)	$ 59,000
Total	**$ 794,000**

Regional Water Supply Project for Portions of Comal, Kendall, and Bexar Counties

Permitting

Technical Memorandum

Table of Contents

13. Permitting

13.1 Introduction

The objective of this section is to describe the steps taken to obtain environmental permits for the construction of the raw water intake, raw water pipeline, and water treatment facility. As the permitting process is currently ongoing, only progress to date will be described within this report.

13.2 Pre-Application Agency Coordination

13.2.1 Texas Natural Resource Conservation Commission (TNRCC) Edwards Aquifer Rules and Water Treatment Plant Rules

On January 02, 2000, Mr. Scott Jecker of SWCA, Inc. Environmental Consultants (SWCA) contacted Mr. Tom Gutierrez with the TNRCC to determine if a permit would be required for construction of the proposed water distribution system. Mr. Gutierrez stated that, although the project would be located over the Edwards Aquifer, the project was exempt from some permit requirements since the pipelines would be carrying water. Permits will be required for construction of the water treatment plant.

It should be noted that although the project is exempt from the permitting associated with the Edwards Aquifer Rules, a Storm Water Pollution Prevention Plan will need to be prepared for the project.

13.2.2 U. S. Army Corps of Engineers (COE)

SWCA has been in continued contact with the Regulatory Branch of the COE Fort Worth District regarding the proposed project (project number 200000014) since its inception. The application will be processed under Nationwide Permit No. 12 (NWP 12) by Mr. Jim Herrington of the U.S. Army Corps of Engineers.

In addition to phone communications, two meetings were held with the COE at the Canyon Lake COE office. The first meeting introduced the project to the local COE representatives where site alternatives, intake configurations and COE initial concerns were discussed. The second meeting was held with local and district COE staff to discuss project concepts and permit procedure. Alternative configurations for the Canyon Lake intake and raw water pipeline will be submitted for COE review in early June 2000.

13.2.3 Texas General Land Office (TGLO)

In March 2000, Mr. Rob Meade of SWCA contacted Mr. Mark Neugebauer to determine if the proposed pipeline would cross any state-owned streams or lands. Mr. Neugebauer checked his files and determined that no state-owned lands or streams would be crossed by the pipeline. Therefore, no further coordination with the TGLO will be necessary.

13.2.4 U. S. Fish and Wildlife Service (FWS)

SWCA conducted a pre-application meeting at the FWS offices in Austin, Texas on February 18, 2000. Ms. Mary Orms indicated that the proposed project did not appear to impact any areas of significance. Ms. Orms requested that SWCA provide her with copies of the maps showing the pipeline routes under consideration. After reviewing the maps, Ms. Orms expressed that all portions of the project above Bulverde were in the Edwards Aquifer Contributing Zone.

13.2.5 Texas Parks and Wildlife Department (TPW)

A pre-application meeting was held on February 18, 2000. Mr. Roland MacRae of TPW stated that a Sand, Shell, Gravel, and Marl permit may be required for the project if any of the pipeline crosses state-owned streams. Mr. MacRae offered no specific comments on the project but stated that he did not believe there would be any significant impacts. Based on a closer review of the proposed route maps, Mr. MacRae stated that a Sand, Shell, Gravel, and Marl permit will not be required based on the TGLO's determination that no state-owned lands are crossed. Mr. MacRae had no specific comments regarding the proposed project.

13.2.6 Texas Historical Commission (THC)

SWCA archaeologists reviewed the Texas Historical Commission (THC) files contained at the Texas Archaeological Research Laboratory (TARL) to determine if any known archaeological sites had been recorded in or near the project area.

SWCA found that Alternative Route G had a very low probability for the presence of archaeological sites. All the remaining routes each contained a combination of high, medium and low probability areas for the presence of archaeological sites.

Field investigations of the selected route will be required in support of the USACE permit application. The scope of these field investigations will be determined through close coordination with the USACE staff archaeologist once a preferred route is selected.

13.3 Environmental Screening

The preferred raw water and plant site route were screened for environmental constraints. National Wetland Inventory maps, aerial photography, soil survey maps, threatened and endangered species files and archaeology files were reviewed. This was undertaken for the purposes of "grading" the possible routes, in terms of environmental resources. From an environmental standpoint, all of the routes were essentially equal.

13.4 Field Investigations

Field investigations of the project area for jurisdictional waters/wetlands and a baseline environmental inventory for endangered species will be completed after upon selection of the final plant site locations. Results will be submitted to the GBRA in a technical memorandum.

13.5 Environmental Assessment

An environmental assessment discussing the impacts of the proposed project on the existing environment and mitigation measures taken to offset impacts will be completed upon selection of the final plant site locations and submitted to the GBRA in a technical memorandum.

13.6 Archaeological Survey and Report

Following approval of the archaeological study plan by the USACE and SHPO, a survey will be conducted over the project area to determine the existence of any cultural resources. The survey will be described in a follow-up archaeological report and submitted to the GBRA separately from this basis of design report.

13.7 Application Preparation

Applications for each required permit will be completed per the schedules of each respective agency, following a review by the GBRA.

Regional Water Supply Project for Portions of Comal, Kendall, and Bexar Counties

Total Construction Probable Cost Opinion

Contract A

14. Construction Probable Cost Opinion

The total construction probable cost opinion for the Contract A portion of the project is detailed in Tables 14-1 (Membrane Alternative "E") and 14-2 (Conventional Alternative "B"). Costs are conceptual only and may require refinement based on input from the GBRA.

Table 14-1: Contract A Construction Cost Opinions (MF/UF Alternative)

Item		***Cost***
Capital Costs		
Facility Costs [1]		
1	Lake Intake and Raw Water PS	$2,230,000
2	Raw Water Pipeline and Storage Tank	$3,426,000
3	WTP	
	-liquids processing (Alt. E)	$11,218,000
	-residuals (DAF units, eq. tank, drying beds, etc.)	$1,796,000
4	SCADA System (intake and WTP)	$445,000
5	WTP HS Pump Station	$1,068,000
	Subtotal - Facilities	$20,183,000
Other Construction Costs		
	Miscellaneous Items and Contingencies	$3,279,000
	Mobilization/Contractor Bonds/Insurance	$1,107,000
	Contractor's OH and Profit	$2,831,000
	Subtotal - Other Capital Costs	$7,217,000
Total Construction Cost [2]		$27,400,000
Annual Costs		
	Annual Debt Service	(3)
	Debt Service Coverage	(3)
	Annual O&M Cost	
	Pump Stations	$50,000
	WTP (excluding TW Pump Station)	$1,324,000
	Storage Facilities	$5,000
	Annual Power Cost	$1,032,000
	Total Annual Cost	$2,411,000

[1] Facility costs are compiled from individual technical memorandum chapters and do not include contingency costs as presented within chapters.

[2] Note that the following project costs are not included in this Total Construction Cost figure and are included in the Overall Project Cost Table in Contract B Report: engineering and legal costs, environmental studies/mitigation, land acquisition, reserve account, financing and interest.

[3] Annual debt service and coverage are included in overall project costs presented in the Contract B report.

Table 14-2: Contract A Construction Cost Opinions (Conventional Alternative)

Item		Cost
Capital Costs		
Facility Costs [1]		
1	Lake Intake and Raw Water PS	$2,230,000
2	Raw Water Pipeline and Storage Tank	$3,426,000
3	WTP	
	-liquids processing (Alt. B)	$11,615,000
	-residuals (Thickener units, eq. tank, drying beds, etc.)	$1,441,000
4	SCADA System (intake and WTP)	$445,000
5	WTP HS Pump Station	$1,068,000
	Subtotal - Facilities	$20,225,000
Other Construction Costs		
	Miscellaneous Items and Contingencies	$3,288,000
	Mobilization/Contractor Bonds/Insurance	$1,110,000
	Contractor's OH and Profit	$2,837,000
	Subtotal - Other Capital Costs	$7,235,000
Total Construction Cost [2]		$27,460,000
Annual Costs		
	Annual Debt Service	(3)
	Debt Service Coverage	(3)
	Annual O&M Cost	
	Pump Stations	$50,000
	WTP (excluding TW Pump Station)	$1,191,000
	Storage Facilities	$5,000
	Annual Power Cost	$1,009,000
	Total Annual Cost	$2,255,000

[1] Facility costs are compiled from individual technical memorandum chapters and do not include contingency costs as presented within chapters.

[2] Note that the following project costs are not included in this Total Construction Cost figure and are included in the Overall Project Cost Table in Contract B Report: engineering and legal costs, environmental studies/mitigation, land acquisition, reserve account, financing and interest.

[3] Annual debt service and coverage are included in overall project costs presented in the Contract B report.

APPENDIX A
Canyon Lake Raw Water Quality Review

Data Collection Process
The attached data is a collection of raw water quality information from Canyon Lake. The original scope called for a review of turbidity, alkalinity, pH, hardness, total dissolved solids, total organic carbon, UV_{254}, aluminum, iron, sulfate, barium, manganese, taste and odor, microorganisms, temperature, bromide, fluoride, arsenic, and silica. Additional information, which is not in the scope, is also provided in graphic form. The following items are included in Appendix A:

- A map indicating the relative locations of data collection points and the proposed intake location
- Graphs describing characteristics from sampling points over the past 10 years
- Graphs summarizing the monthly averages for the above characteristics
- Existing Canyon Lake plant (Canyon Lake Water Services Corporation) influent turbidity and temperature data
- Graphs of characteristic variations based on depth for dissolved oxygen, pH, specific conductance, and temperature (USGS sampling data from the CLWSC Engineering Report, 1994)
- Cumulative plots for various characteristics, including conductivity, total hardness, total organic carbon, alkalinity, temperature, turbidity, and fecal coliforms
- A table with additional sampling data taken by Malcolm Pirnie, Inc on January 24, 2000 at the proposed intake location.

The preparation of these graphs is described below.

1) The information from four data collection points from two resources (GBRA and USGS) was collected and compiled into the first and second sets of attached graphs. Information from stations 12598 and 13700 were provided by GBRA. Data was provided from March 1987 to November 1999 for Station 12598 and from January 1998 to November 1999 for Station 13700 on a monthly basis.

   Information from stations 08167500 and 08167800 was provided by the USGS. Data was provided from November of 1980 to September of 1996 for Station 08167500 and from February 1981 to August 1995. The data is not on a monthly basis and the types of tests performed are extensive. Some of the data was measured using different test methods than the data provided from the GBRA. For example, turbidity is measured in NTUs (nephelometric turbidity units) in the GBRA data and in FTUs (Formazin Turbidity Units) in the USGS data. Because of the differences in data availability, the EPA test code was used to try to ensure comparable results were being evaluated.

Additional information on locations 12600 (in the lake) and 12601 (at the lake headwaters) was provided by the TNRCC. As the manipulation of the TNRCC data was very labor intensive, portions were only extracted and combined with the existing information for the parameters that lacked enough existing information to establish a reasonable quality range.

2) A monthly average of the characteristics sampled by the USGS and GBRA was then prepared to review the impacts of seasonal changes.

3) Information collected from the CLWSC was graphed to show variations in turbidity and temperature during 1999.

4) USGS data taken from the engineering report for the CLWSC WTP (The Hogan Corporation, 1994) was prepared to show variations in some characteristics by depth. Additional information from the USGS in this report is provided in the same attachment.

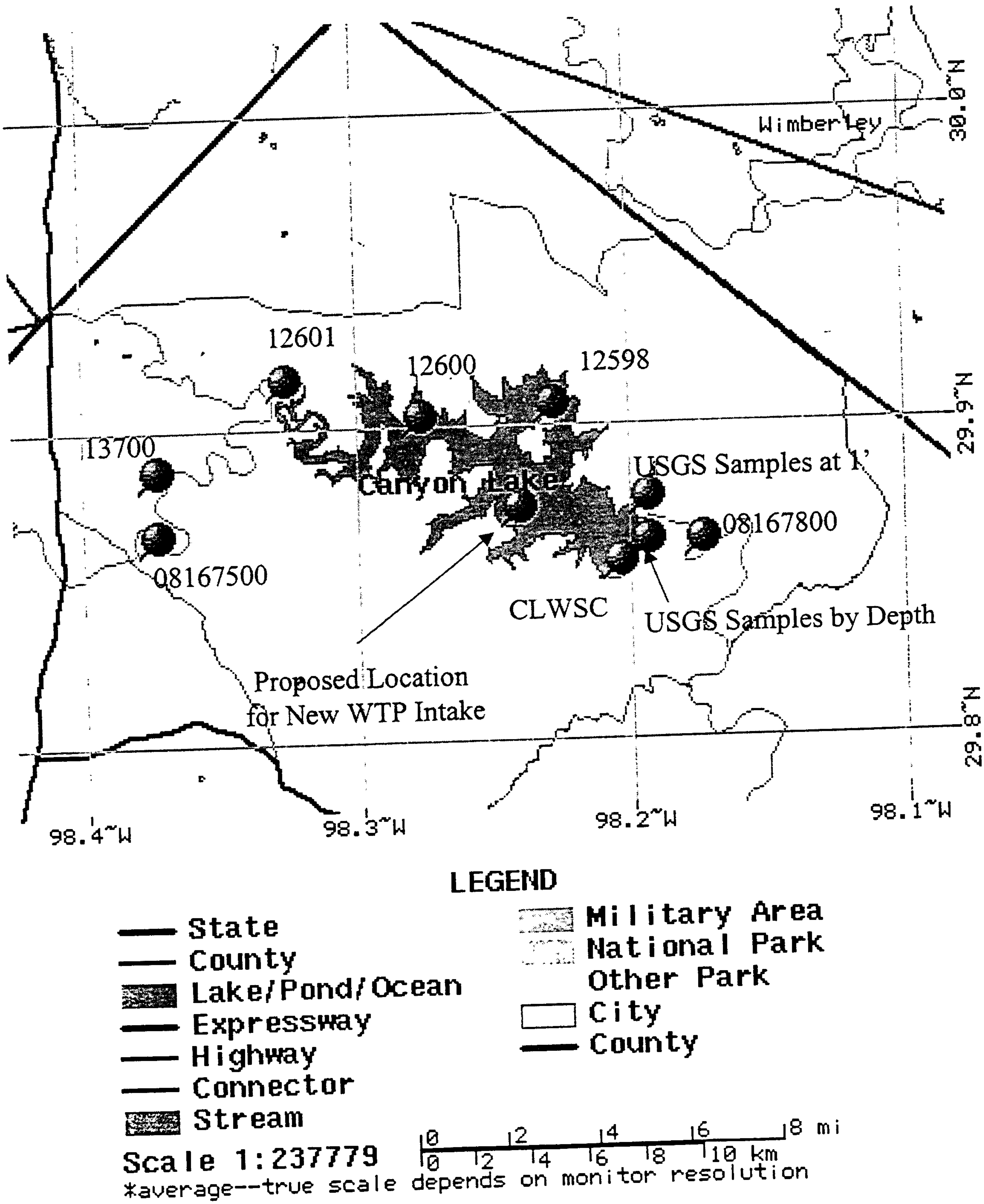
5) Cumulative plots were created for several characteristics to estimate likely conditions at the proposed intake. An attempt was made to limit the sampling information used in these graphs to points directly relevant to the proposed intake. For example, data collected upstream from the lake was excluded.

6) Additional sampling was performed by MPI and is included in a final table.

The taste and odor quality of the lake is expected to be quite high. The general manager of the existing CLWSC has stated they have no taste and odor complaints.

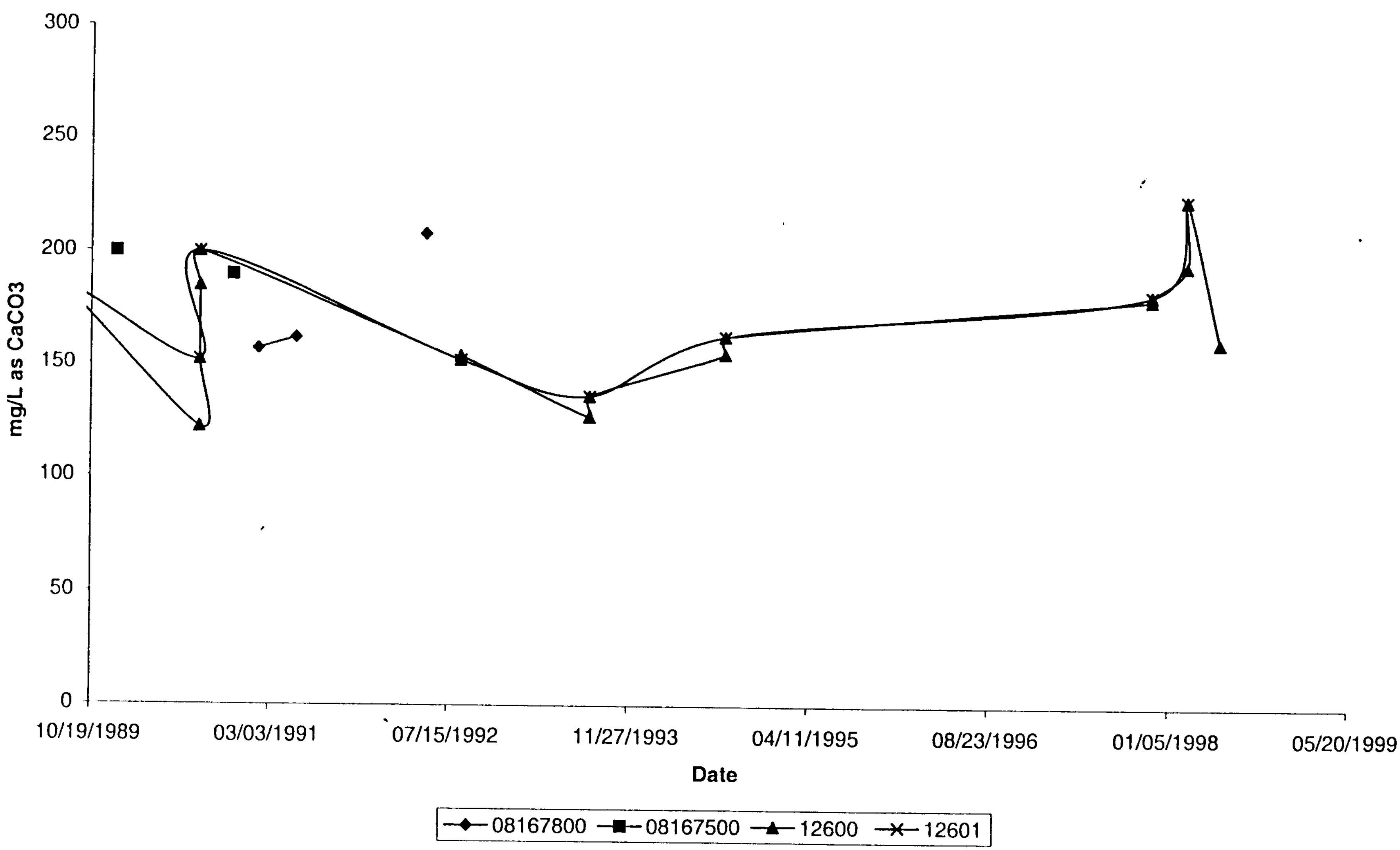
A summary table of which required data is provided in from each data source is attached.

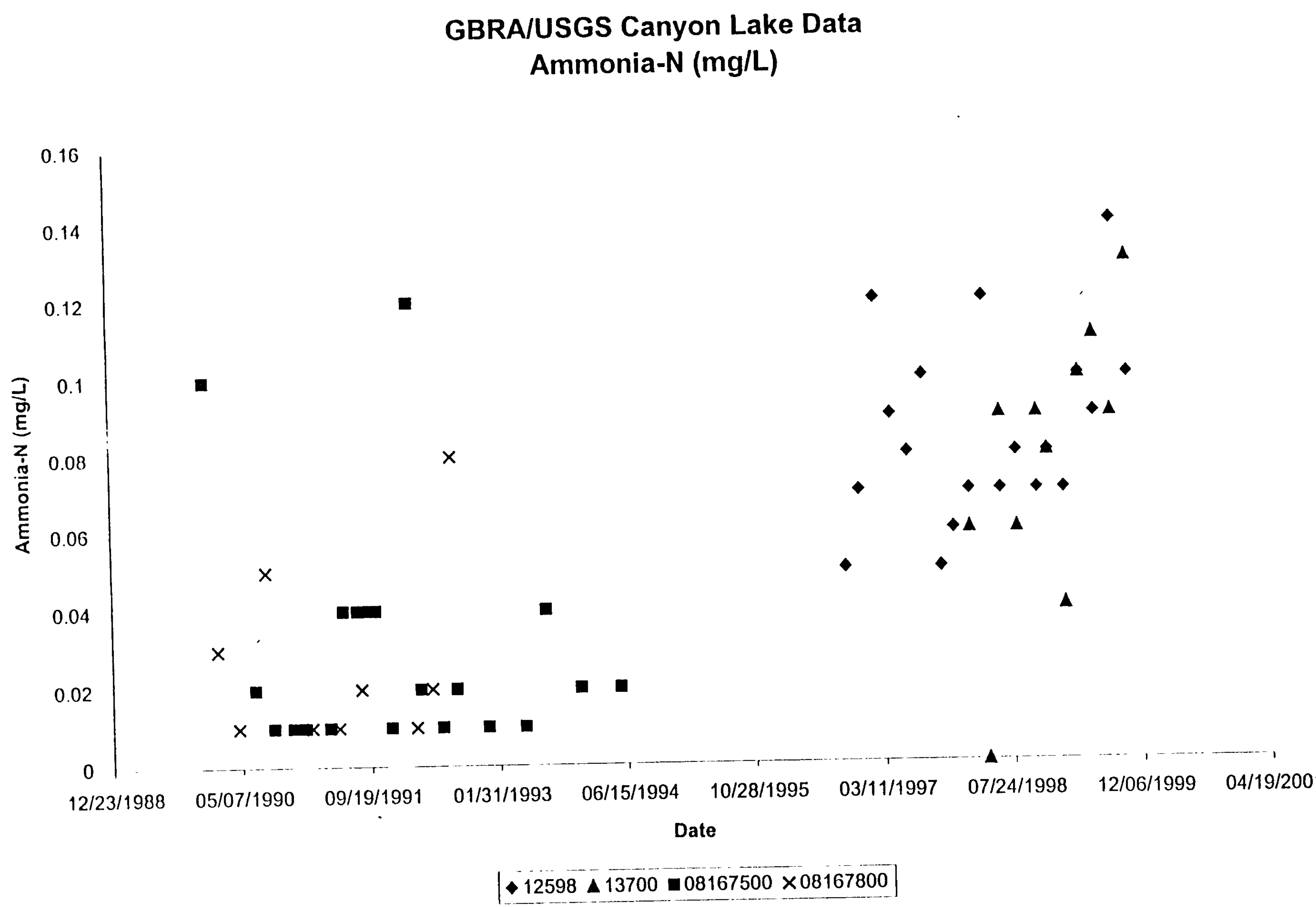
Data	GBRA 12598	GBRA 13700	USGS 08167500	USGS 08167800	CLWSC Influent	USGS (Multiple Depths)	USGS (1'Depth)	Additional Sampling
Turbidity	X	X	X	X	X			X
Alkalinity			X	X				X
pH	X	X	X	X		X	X	X
Hardness	X	X					X	X
Total dissolved solids			(pre-90's avail.)	(pre-90's avail.)			X	
Total organic carbon			X	X				X
UV_{254}								X
Aluminum								
Iron			X	X			X	
Sulfate	X	X	X	X			X	
Barium			X	X				
Manganese			X	X			X	
Taste and odor								
Microorganisms	X	X						
Temperature	X	X	X	X	X	X		
Bromide								X
Fluoride			X	X			X	
Arsenic			X	X				X
Silica			X	X				



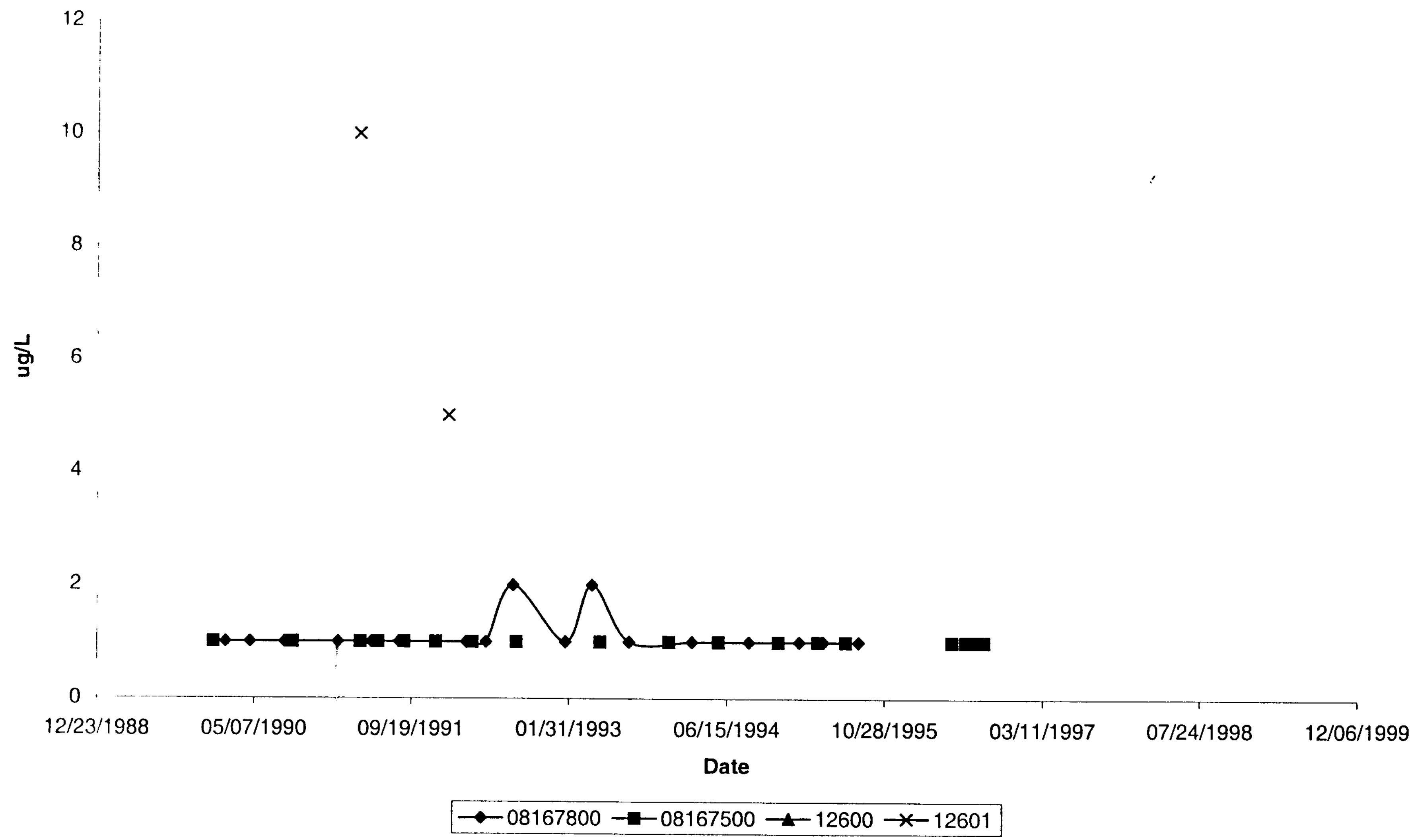
Positions of all sampling locations are approximate.

GBRA/USGS/TNRCC Canyon Lake Data
Alkalinity

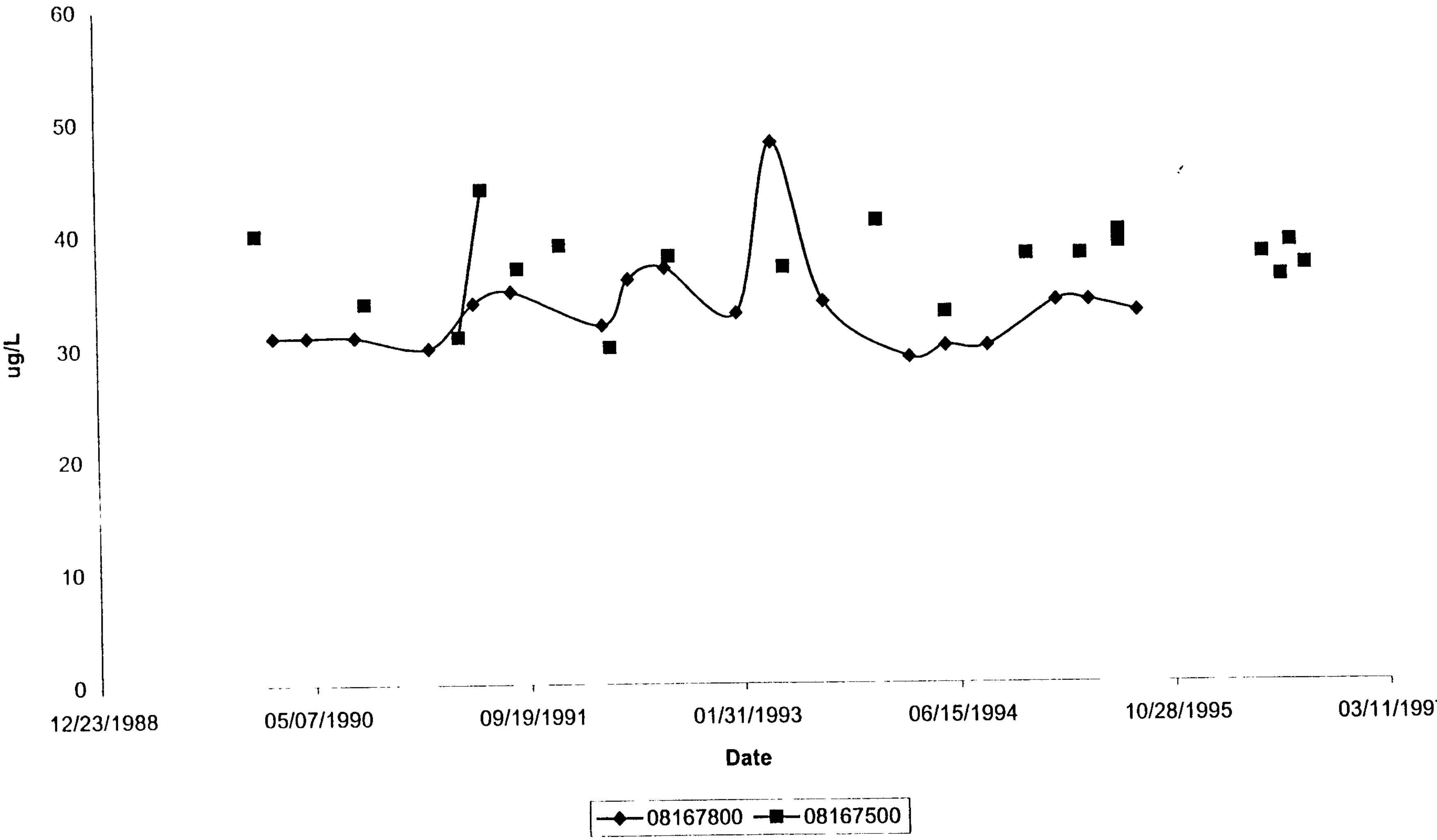



GBRA/USGS Canyon Lake Data
Ammonia-N (mg/L)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Ammonia-N (mg/L)
12/23/1988
05/07/1990
09/19/1991
01/31/1993
06/15/1994
10/28/1995
03/11/1997
07/24/1998
12/06/1999
04/19/2001
Date
◆ 12598 ▲ 13700 ■ 08167500 × 08167800

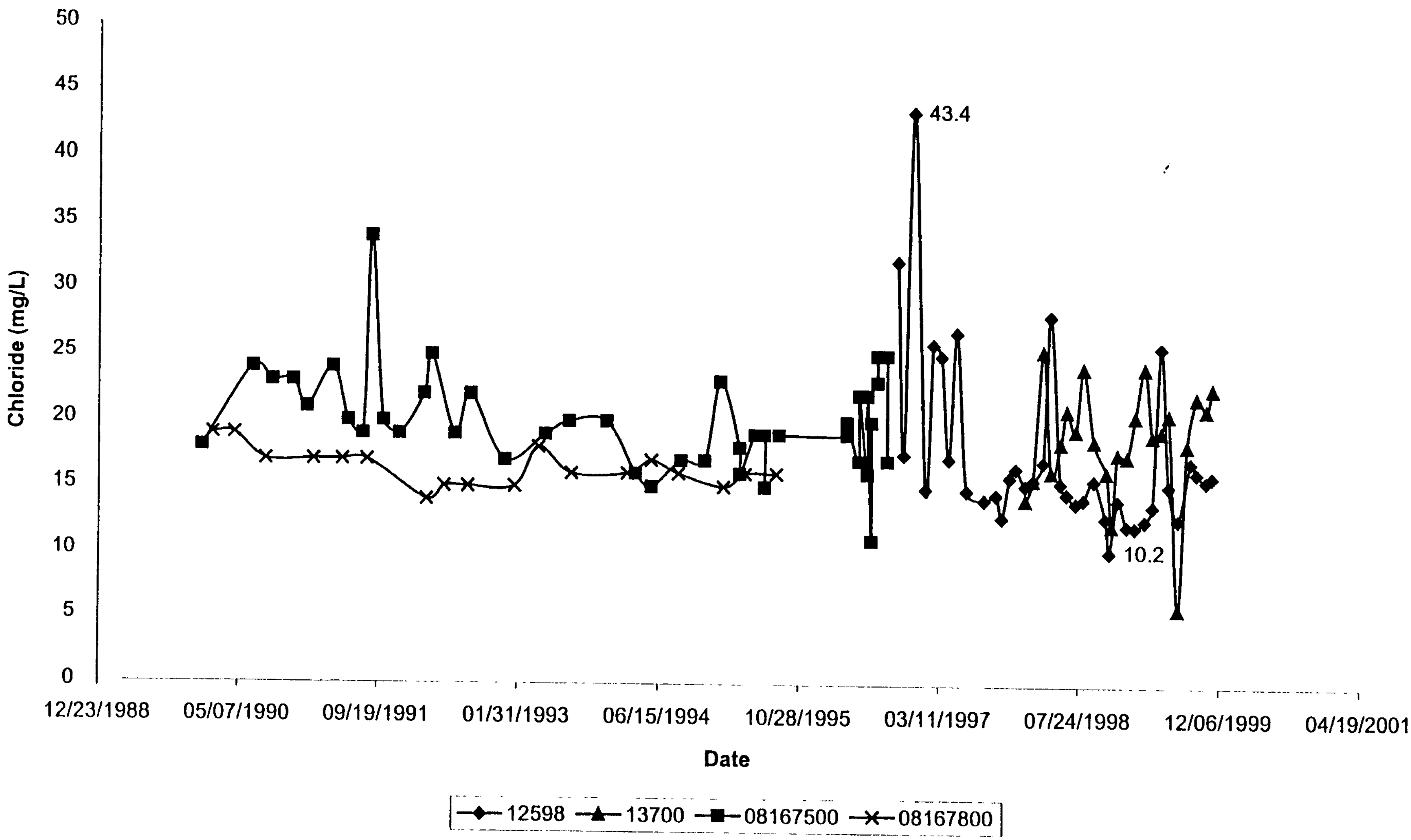
GBRA/USGS/TNRCC Canyon Lake Data
Arsenic



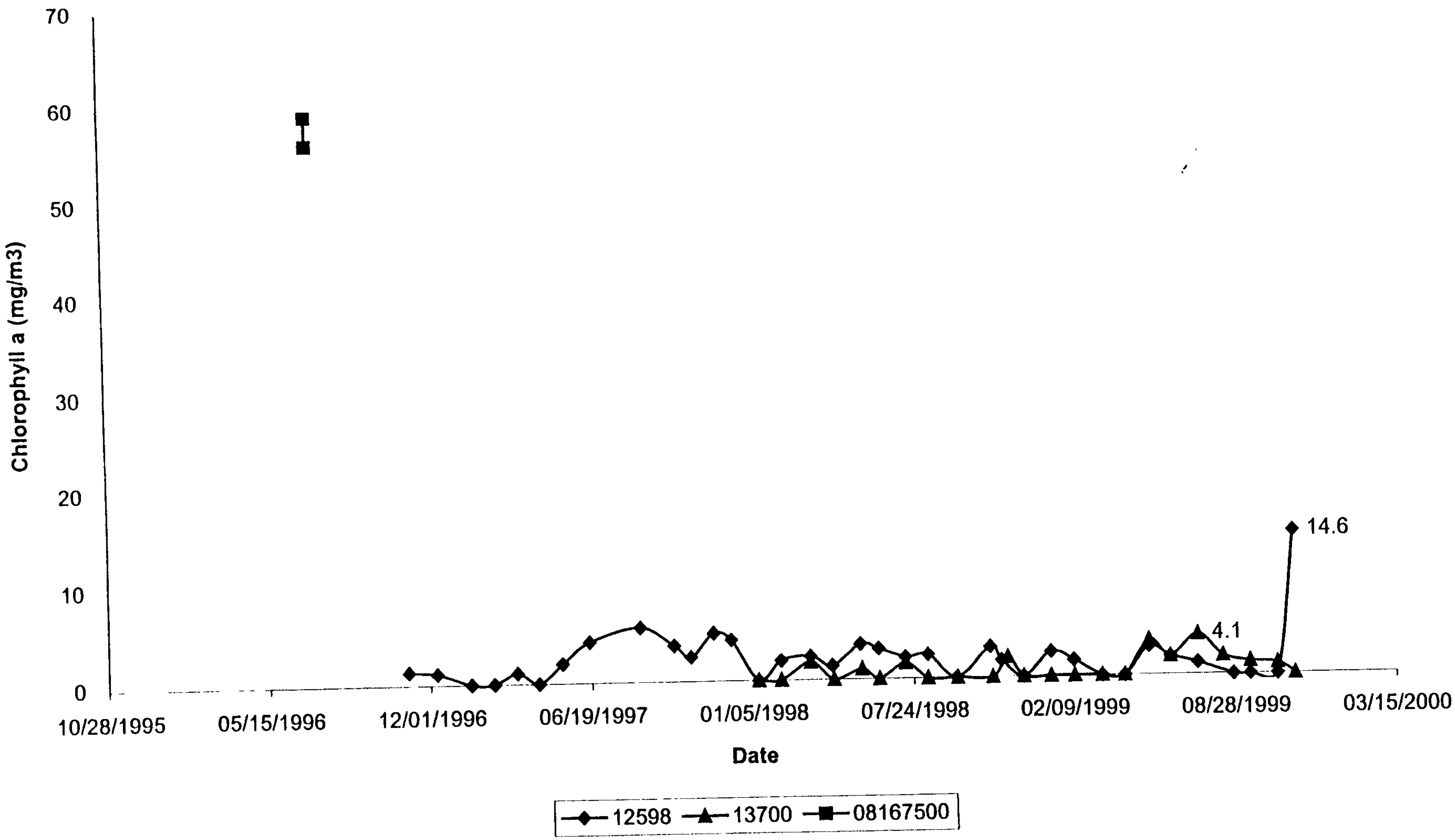
GBRA/USGS Canyon Lake Data
Barium

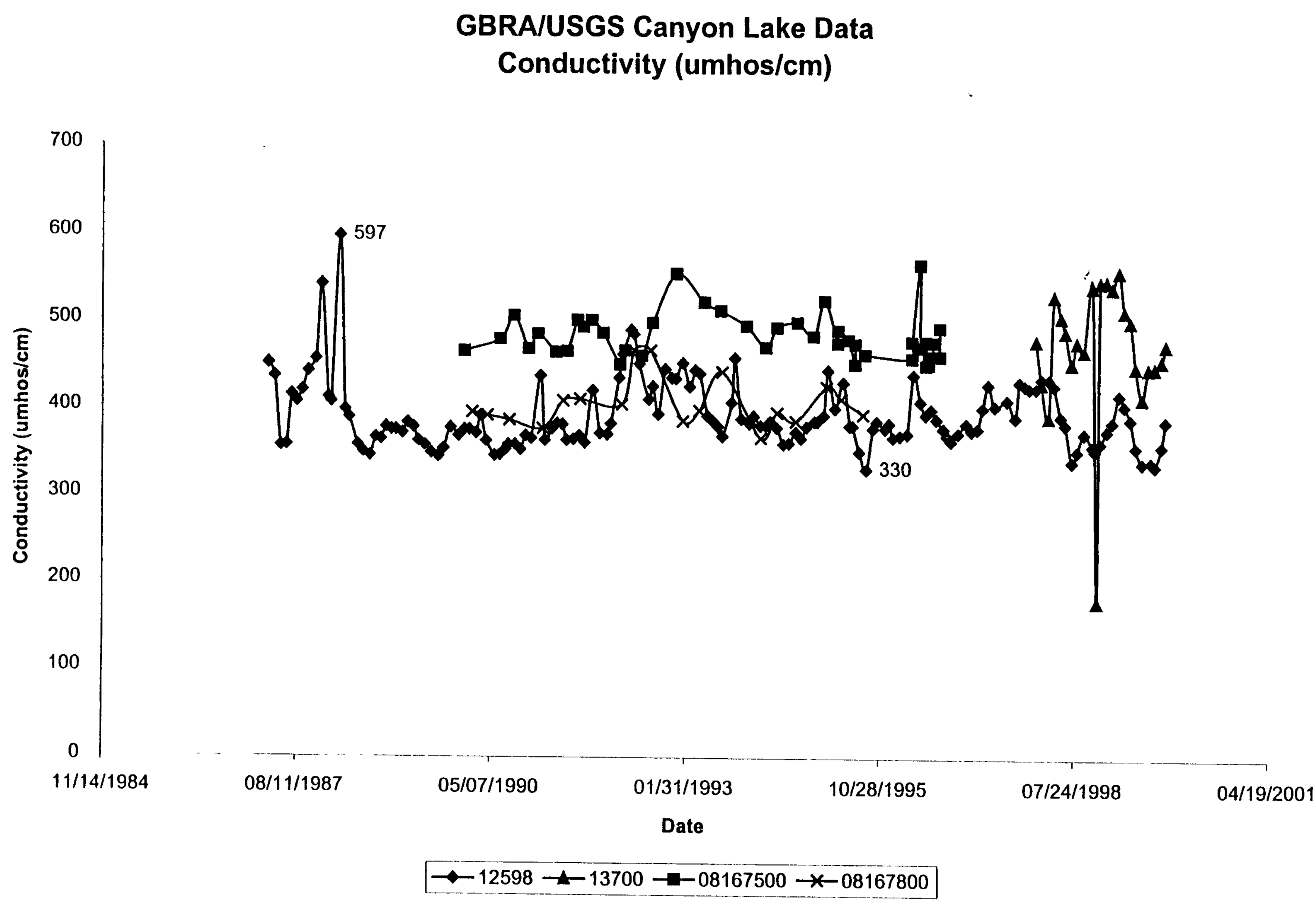


GBRA/USGS Canyon Lake Data
Chloride (mg/L)



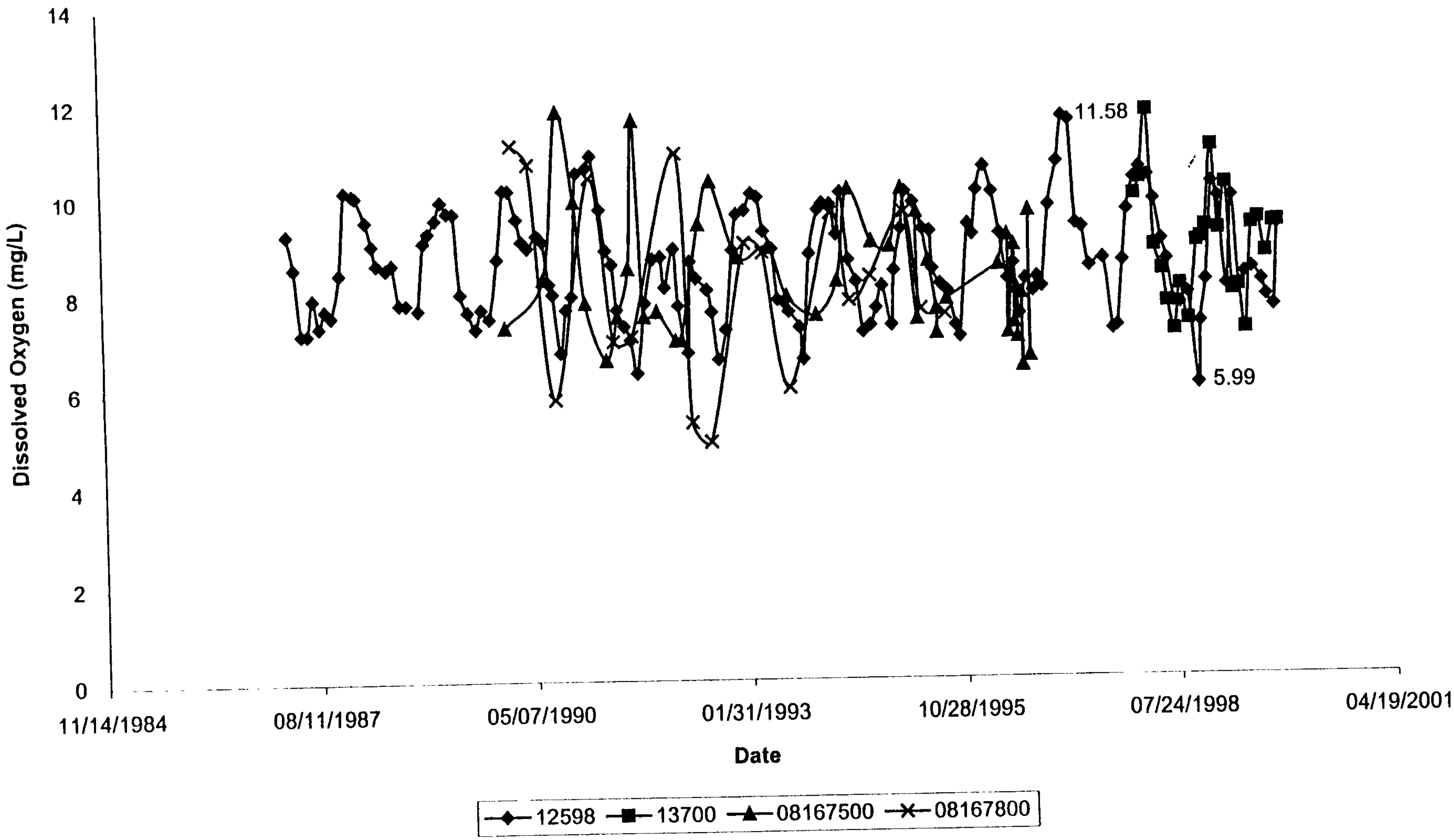
GBRA/USGS Canyon Lake Data
Chlorophyll a (mg/m3)



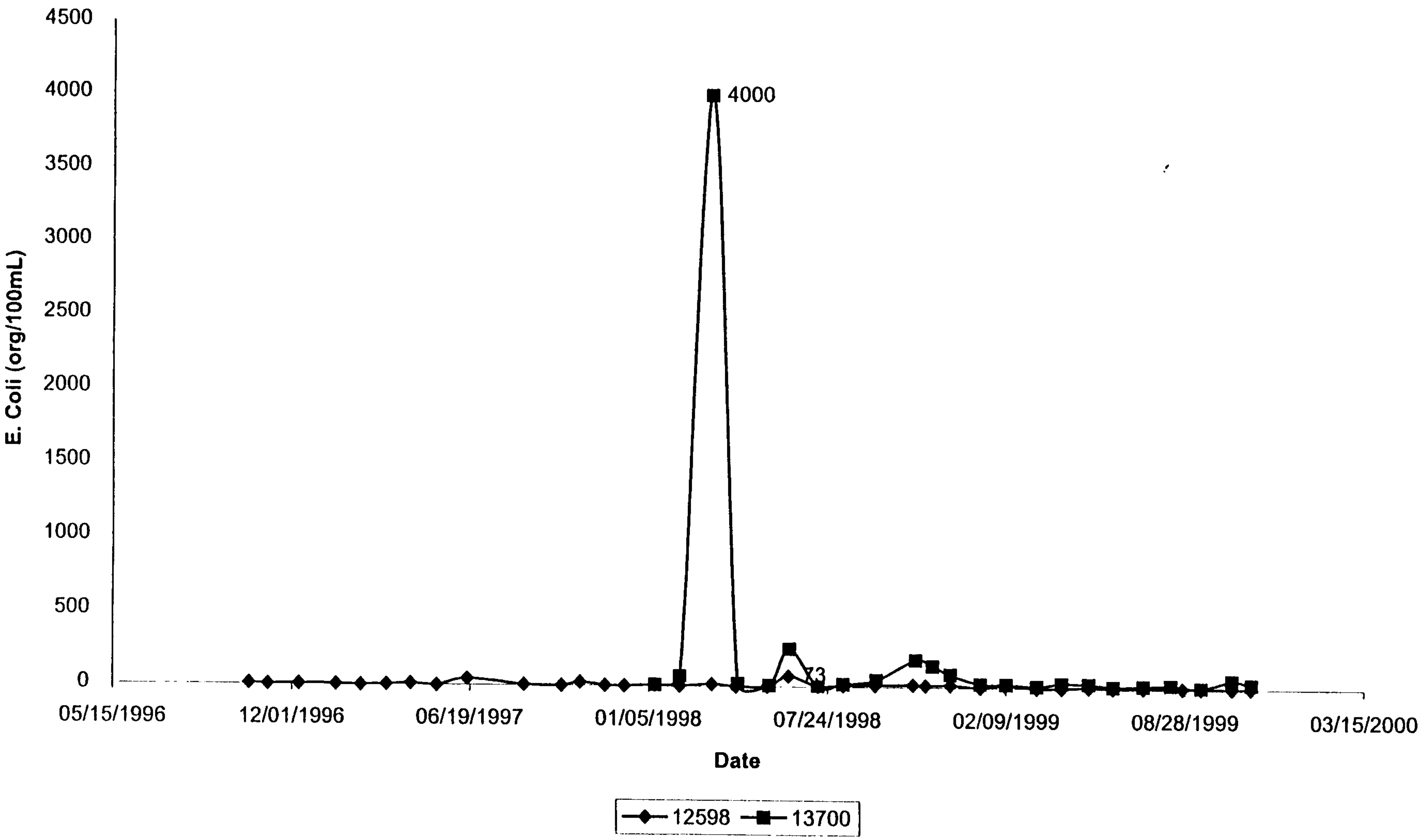


GBRA/USGS Canyon Lake Data
Conductivity (umhos/cm)
Conductivity (umhos/cm)
700
600
500
400
300
200
100
0
597
330
11/14/1984
08/11/1987
05/07/1990
01/31/1993
10/28/1995
07/24/1998
04/19/2001
Date
12598
13700
08167500
08167800

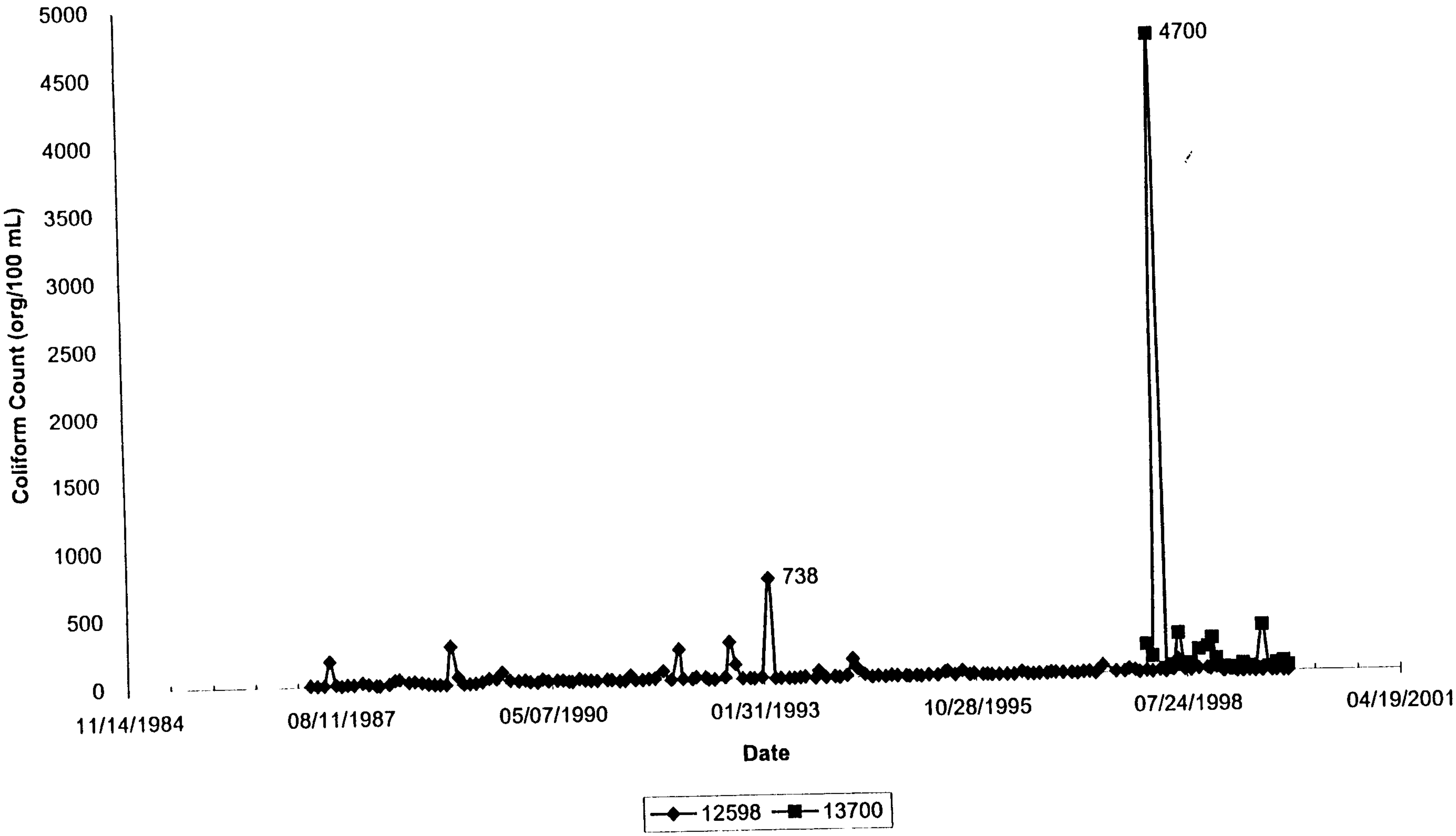
GBRA/USGS Canyon Lake Data
Dissolved Oxygen (mg/L)

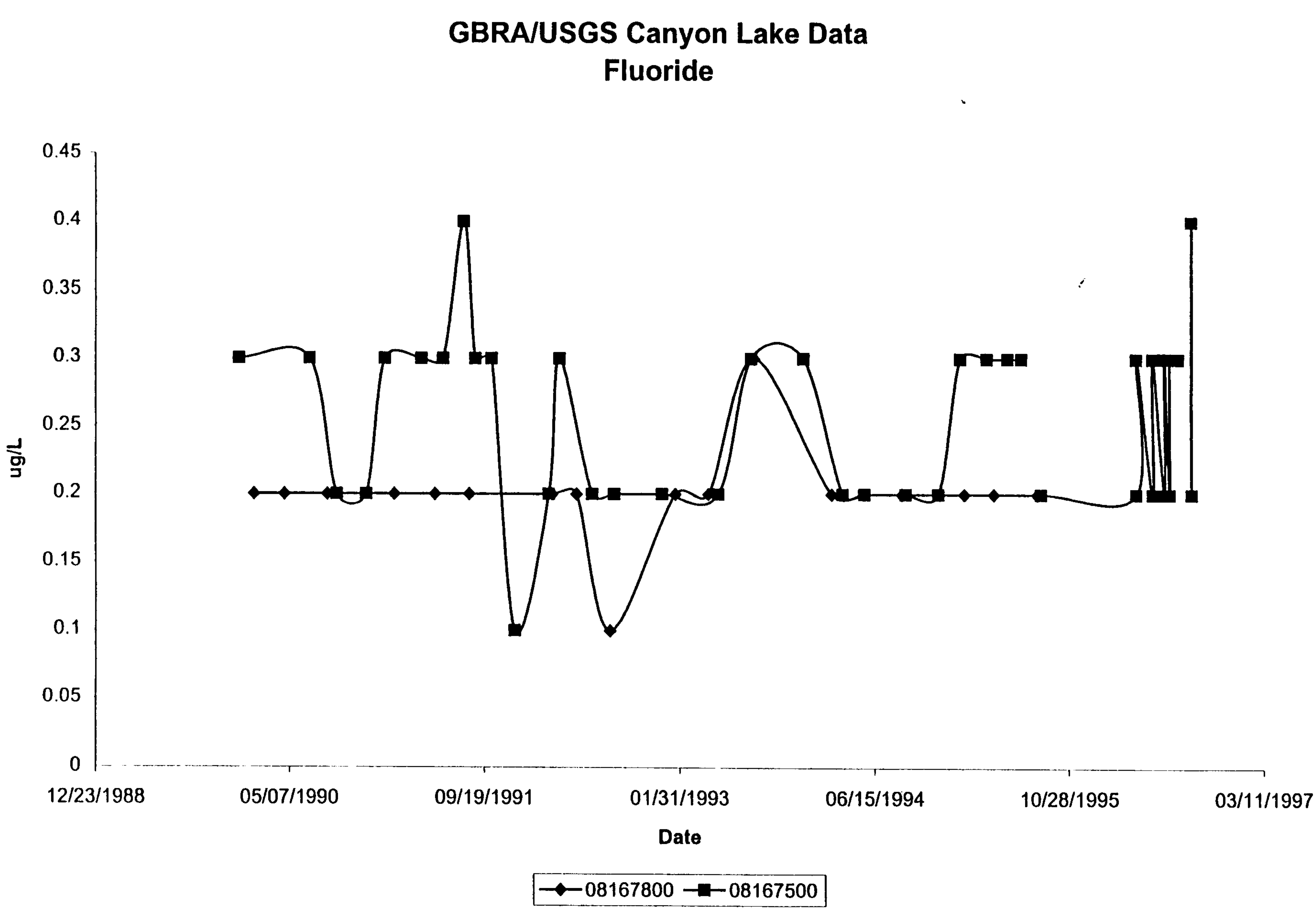


GBRA/USGS Canyon Lake Data
E.Coli (org/100mL)

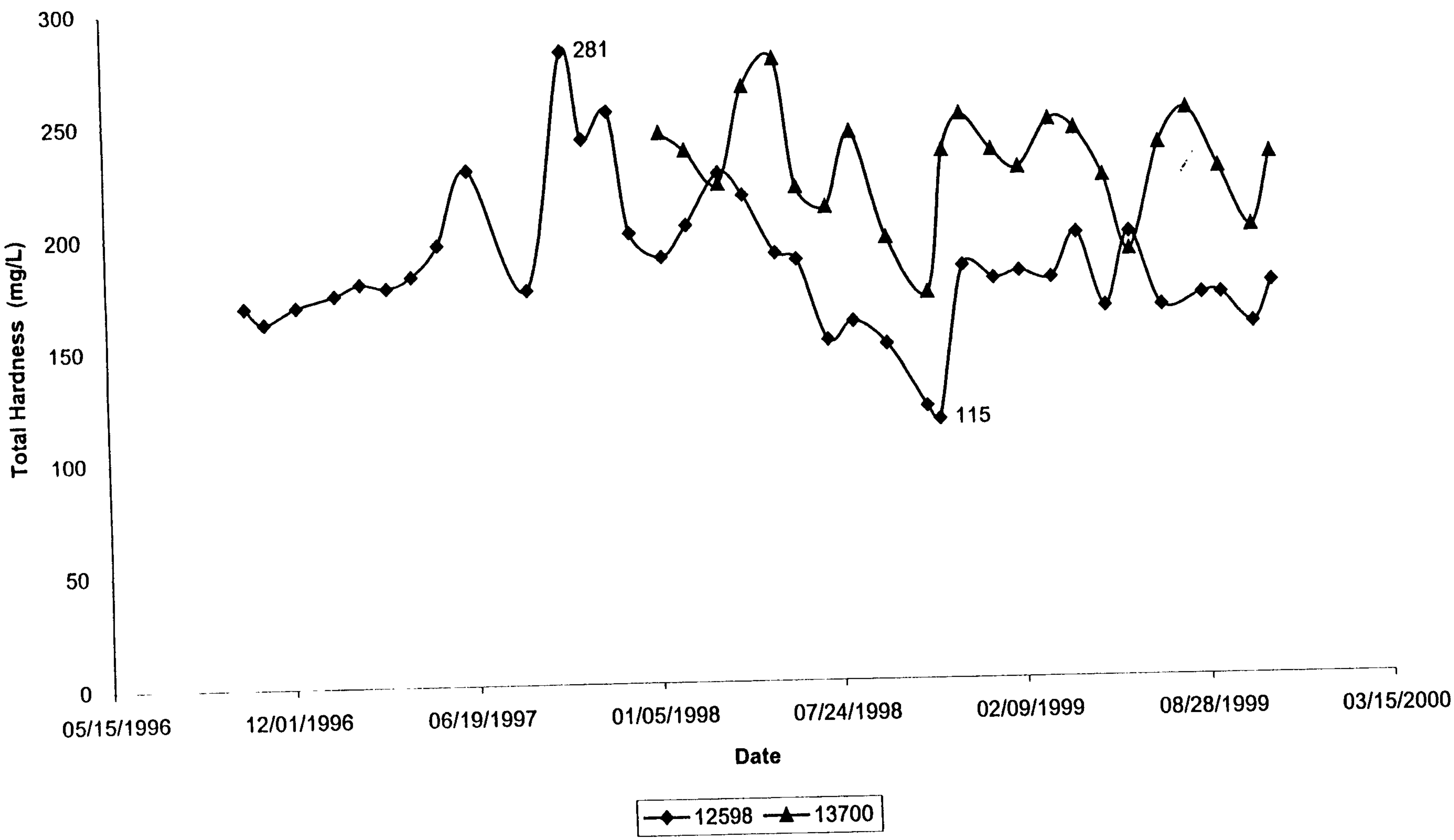


GBRA/USGS Canyon Lake Data
Fecal Coliforms

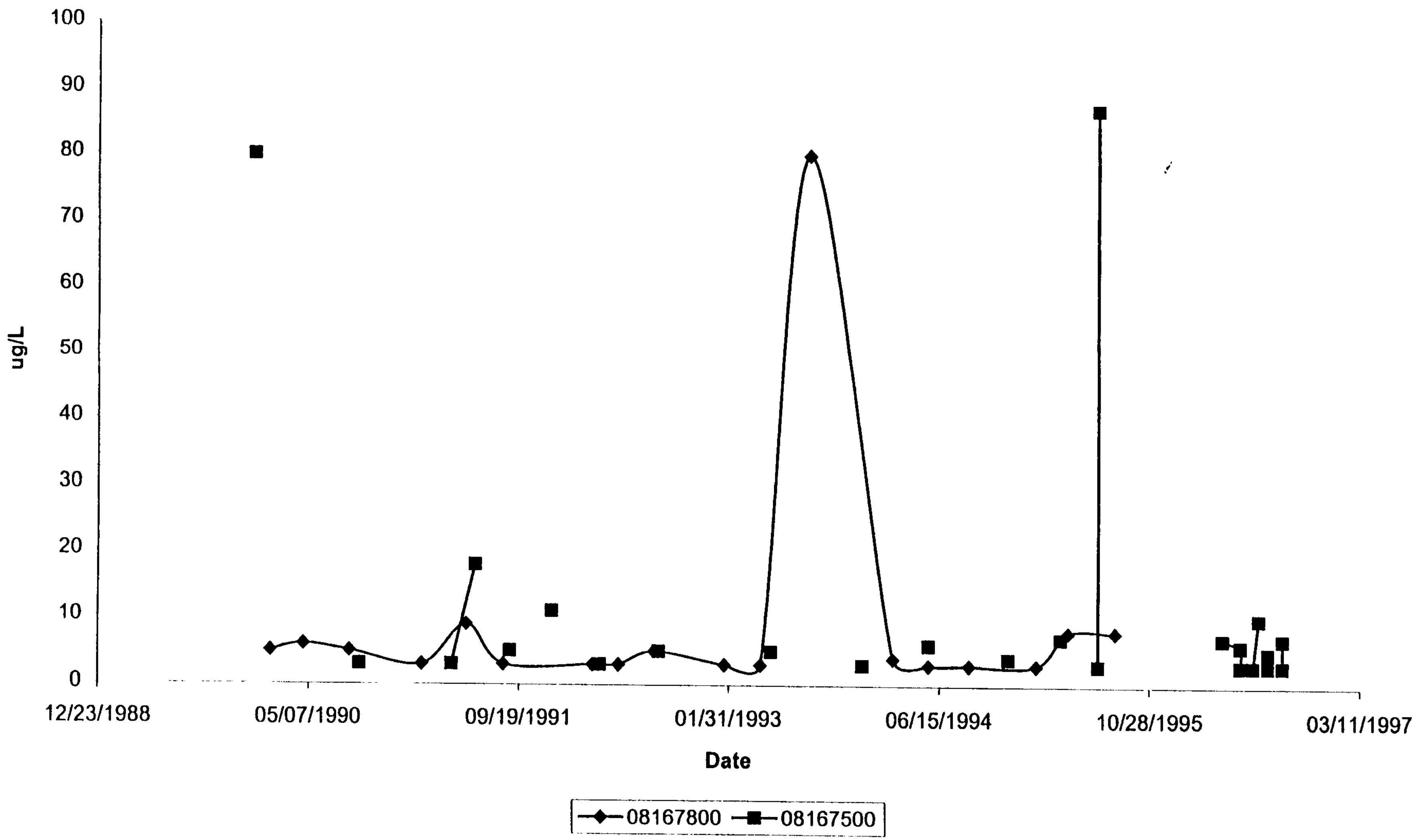


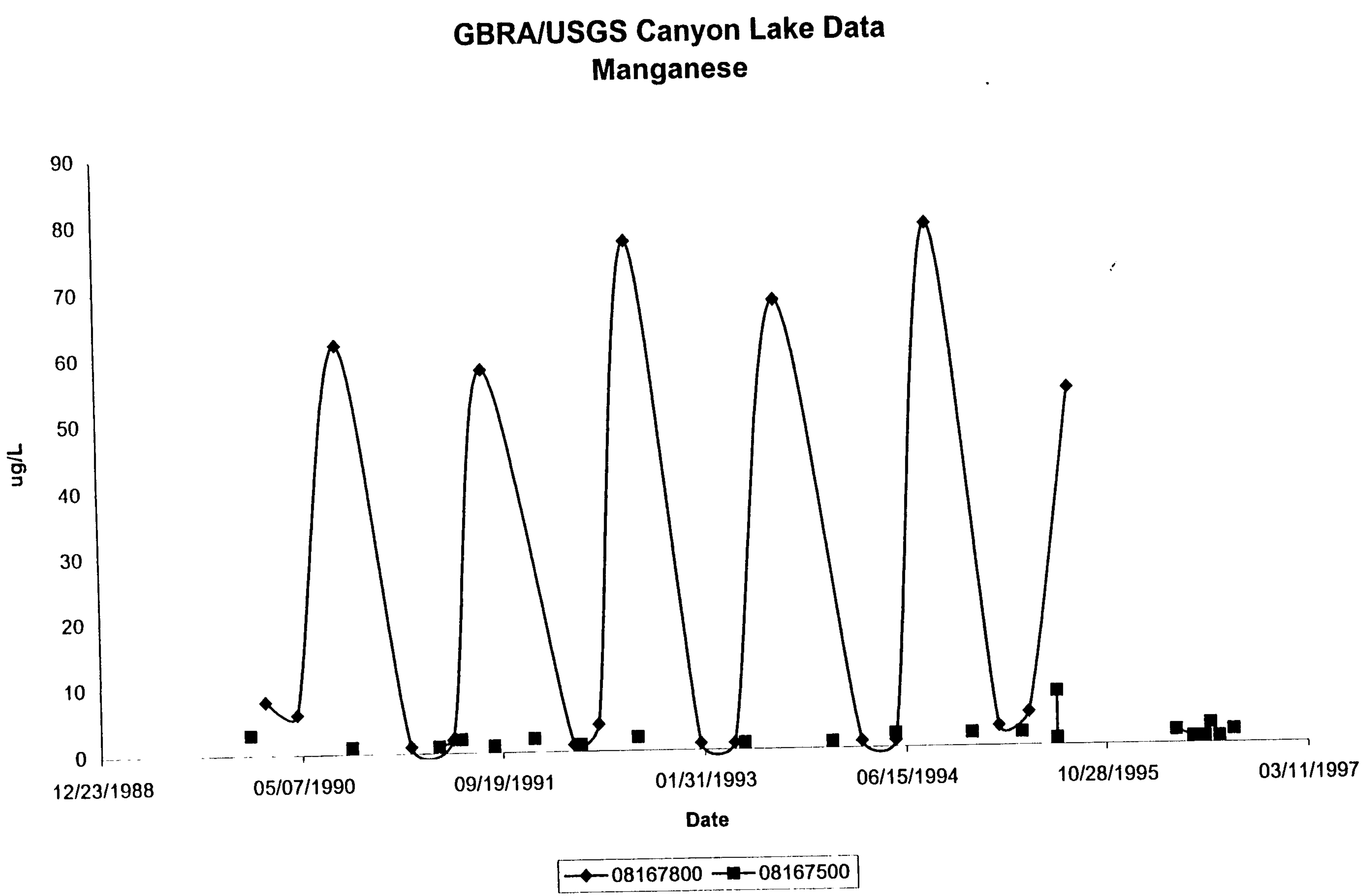

GBRA/USGS Canyon Lake Data
Fluoride
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
ug/L
12/23/1988
05/07/1990
09/19/1991
01/31/1993
06/15/1994
10/28/1995
03/11/1997
Date
08167800
08167500

GBRA/USGS Canyon Lake Data
Total Hardness (mg/L)

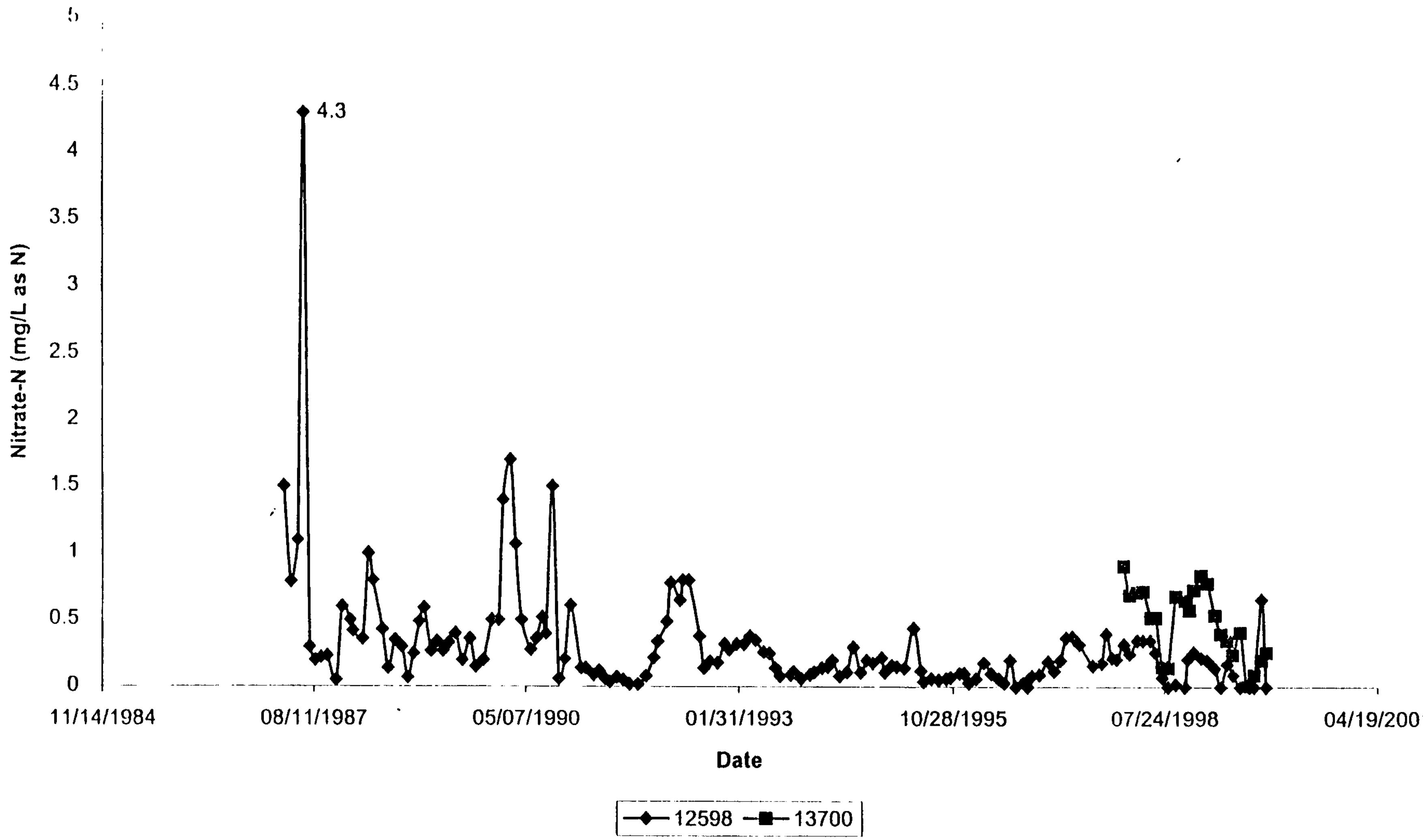


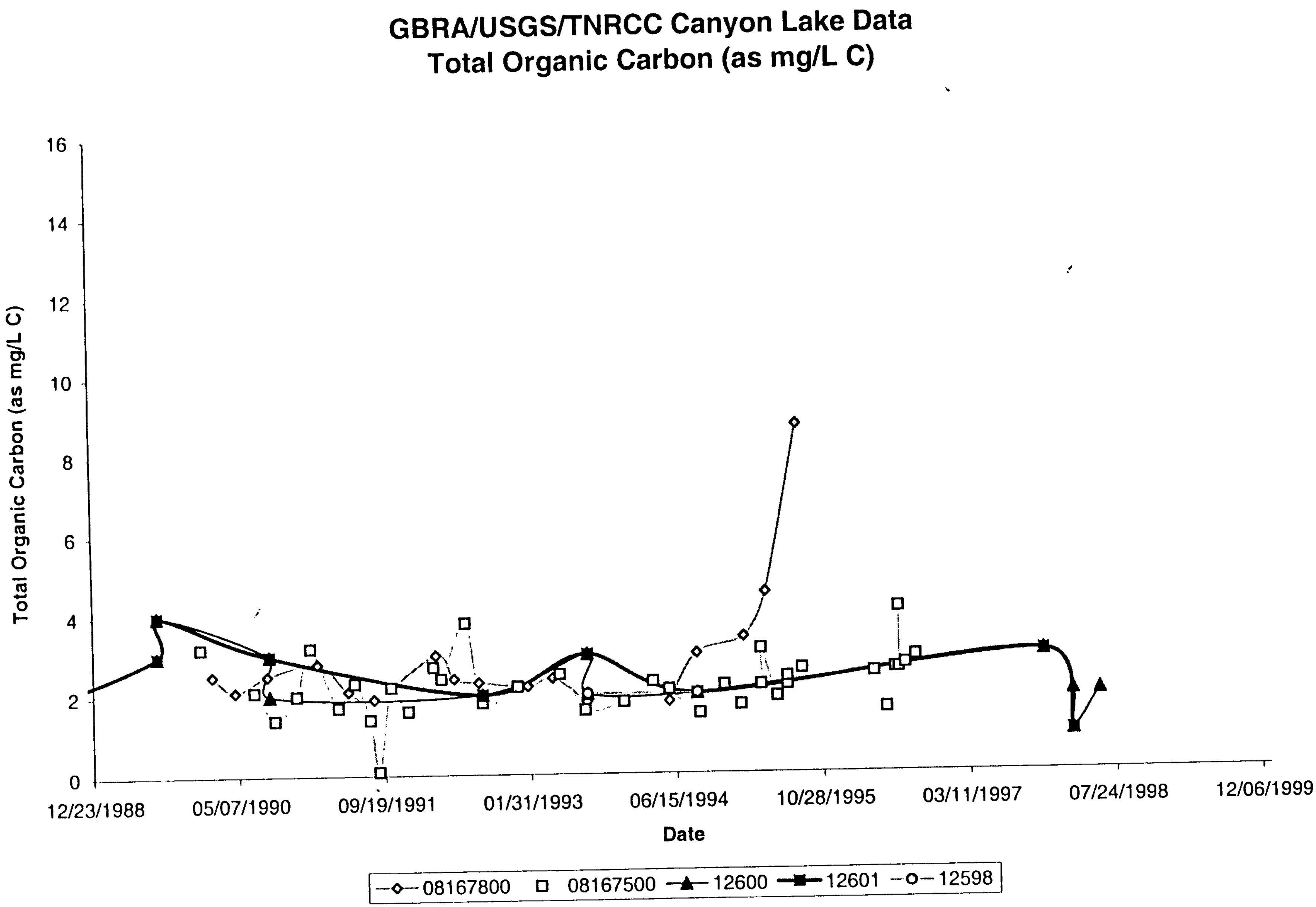
GBRA/USGS Canyon Lake Data
Iron

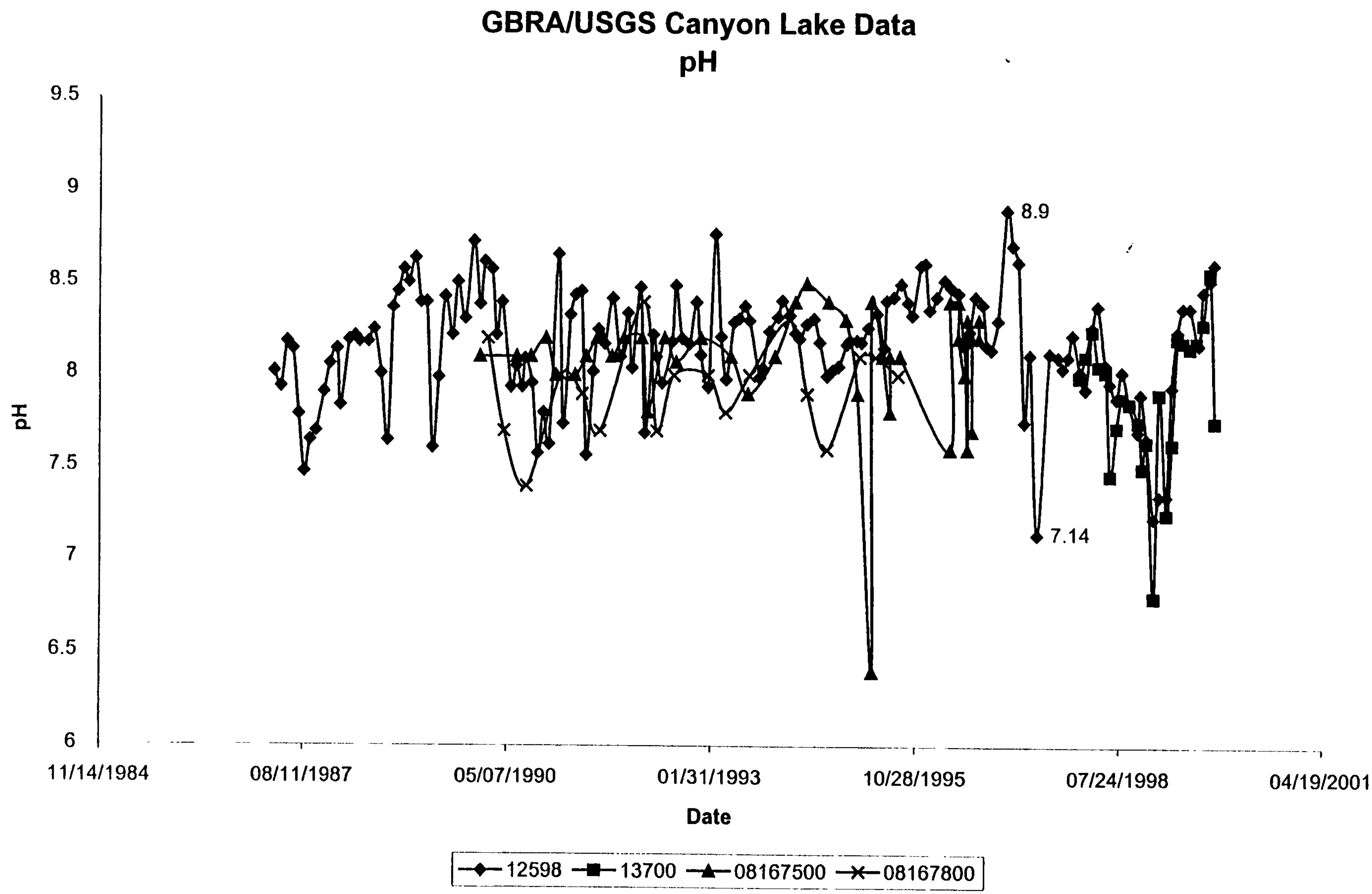


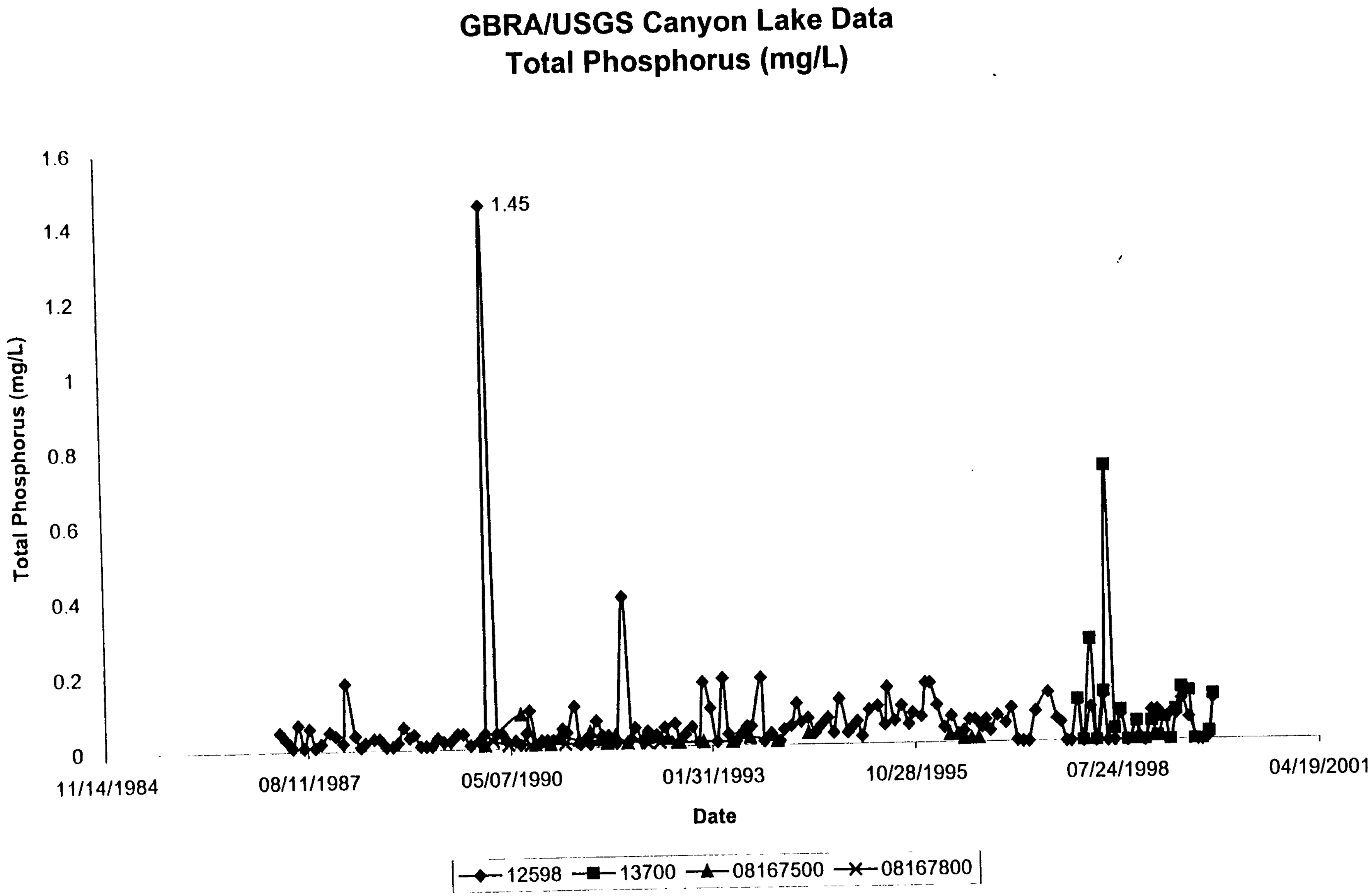

GBRA/USGS Canyon Lake Data
Manganese
ug/L
90
80
70
60
50
40
30
20
10
0
12/23/1988
05/07/1990
09/19/1991
01/31/1993
06/15/1994
10/28/1995
03/11/1997
Date
08167800
08167500

GBRA/USGS Canyon Lake Data
Nitrate-N (mg/L as N)

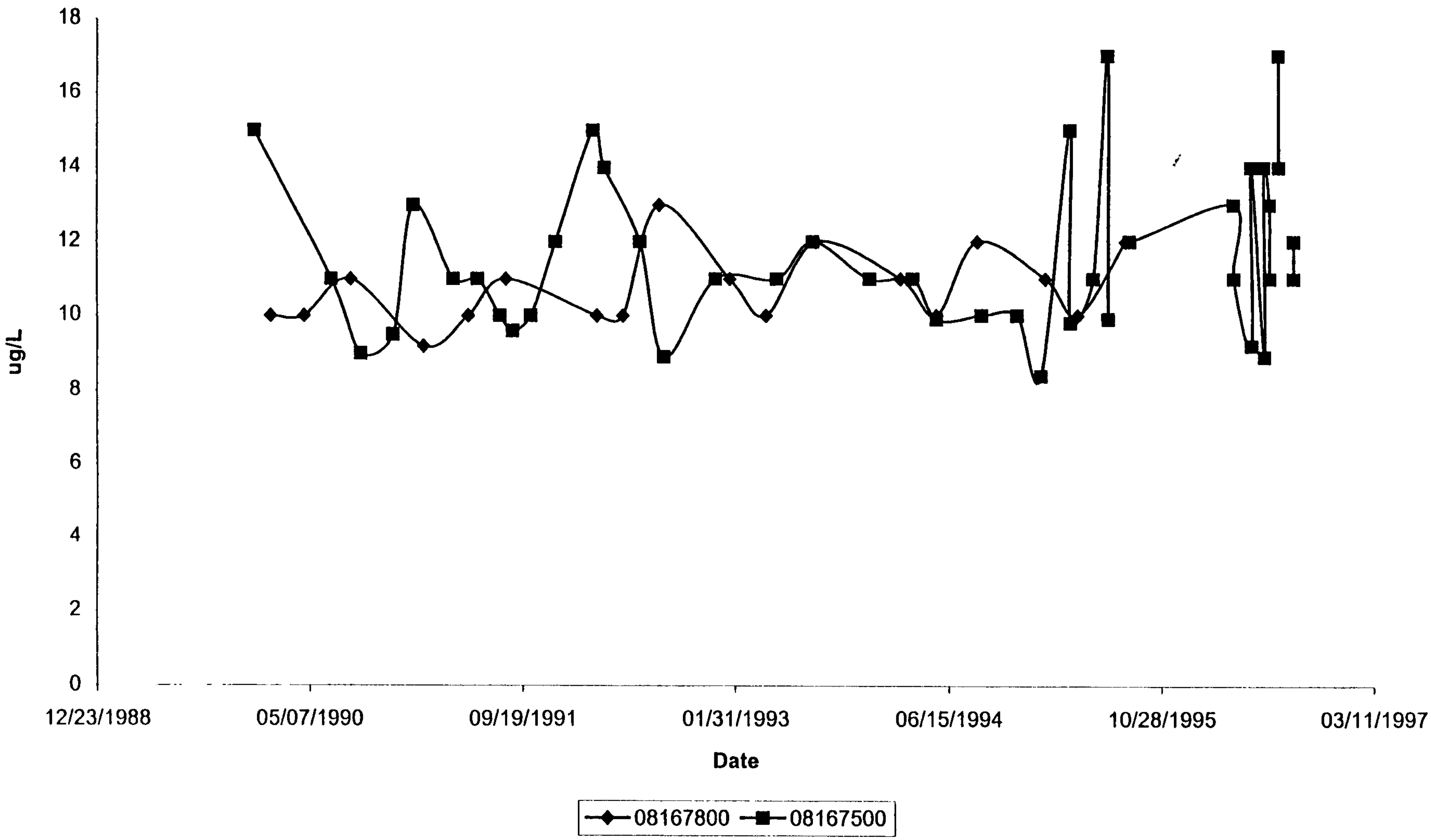



GBRA/USGS/TNRCC Canyon Lake Data
Total Organic Carbon (as mg/L C)
Total Organic Carbon (as mg/L C)
0
2
4
6
8
10
12
14
16
12/23/1988
05/07/1990
09/19/1991
01/31/1993
06/15/1994
10/28/1995
03/11/1997
07/24/1998
12/06/1999
Date
08167800
08167500
12600
12601
12598

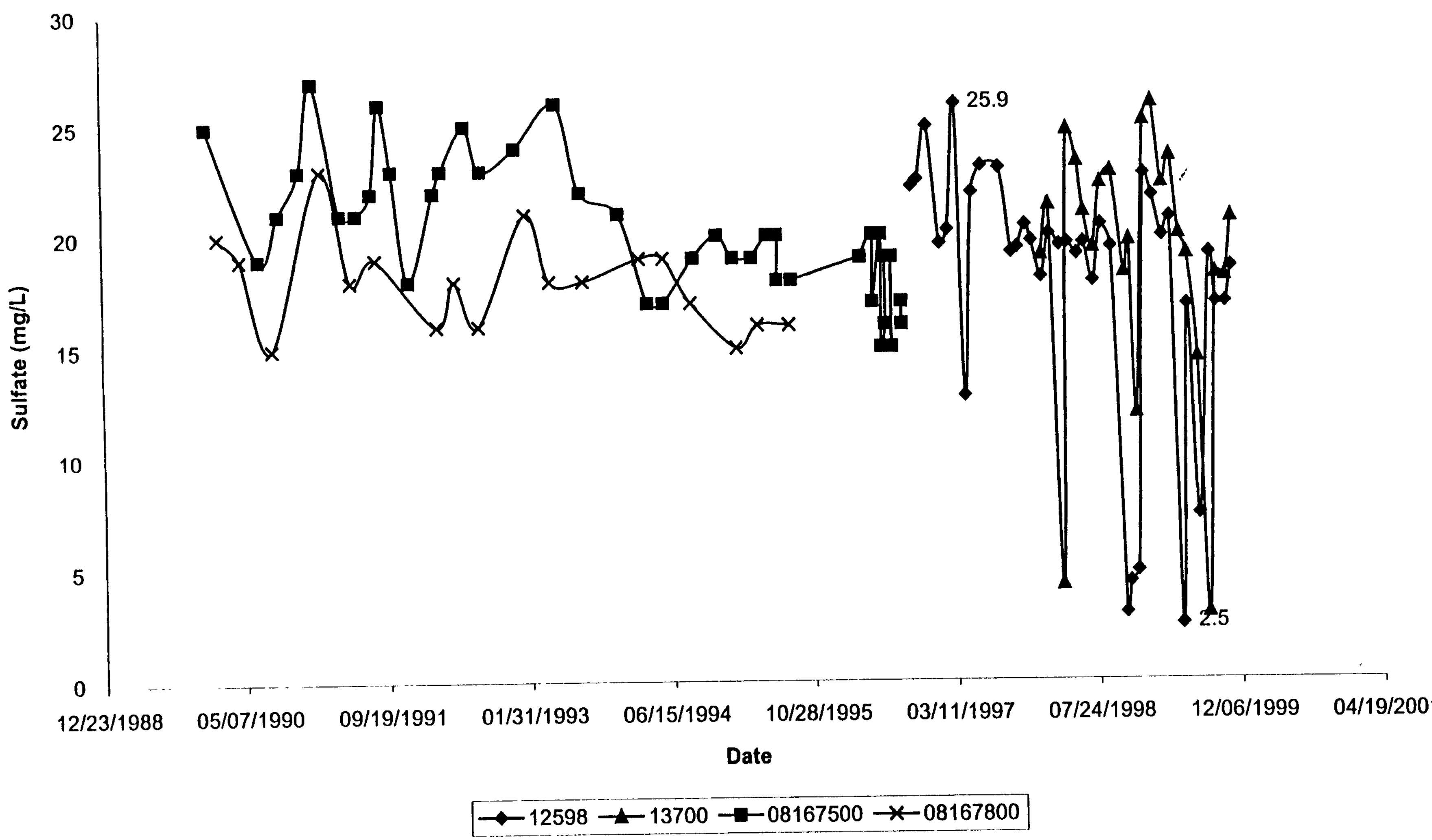

GBRA/USGS Canyon Lake Data
pH
9.5
9
8.5
8
7.5
7
6.5
6
pH
8.9
7.14
11/14/1984
08/11/1987
05/07/1990
01/31/1993
10/28/1995
07/24/1998
04/19/2001
Date
12598
13700
08167500
08167800

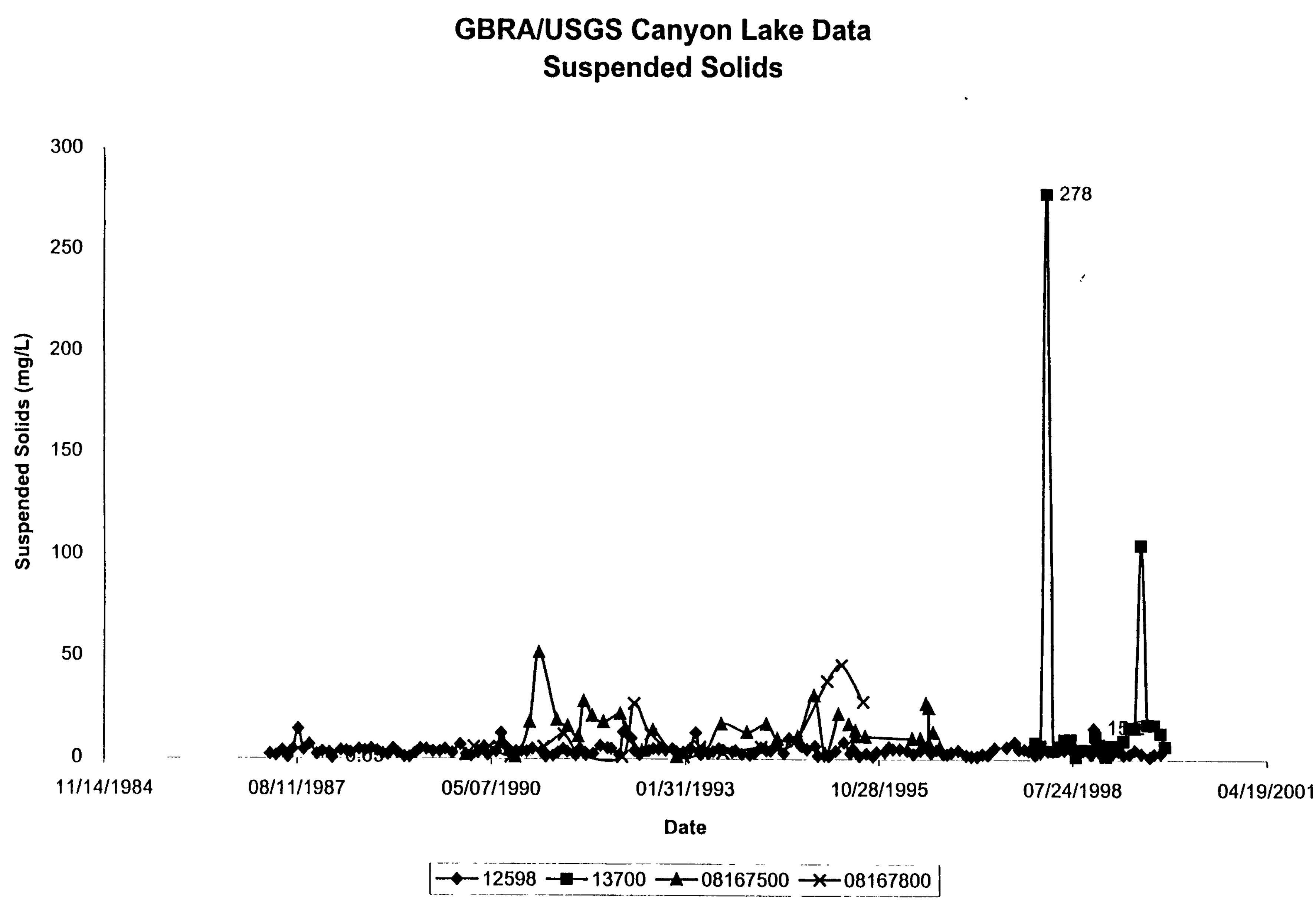

GBRA/USGS Canyon Lake Data
Total Phosphorus (mg/L)
Total Phosphorus (mg/L)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1.45
11/14/1984
08/11/1987
05/07/1990
01/31/1993
10/28/1995
07/24/1998
04/19/2001
Date
12598
13700
08167500
08167800

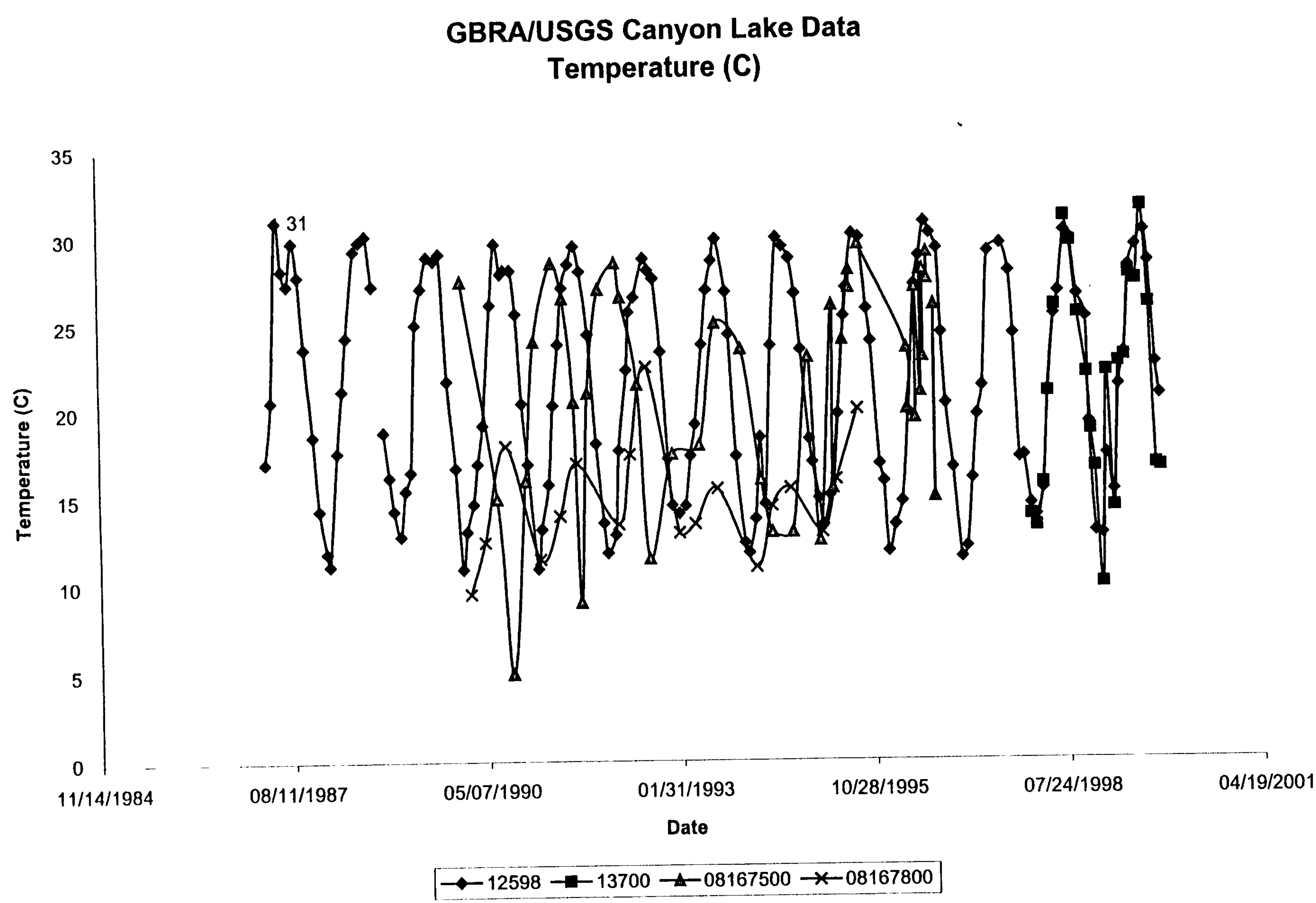
GBRA/USGS Canyon Lake Data
Silica



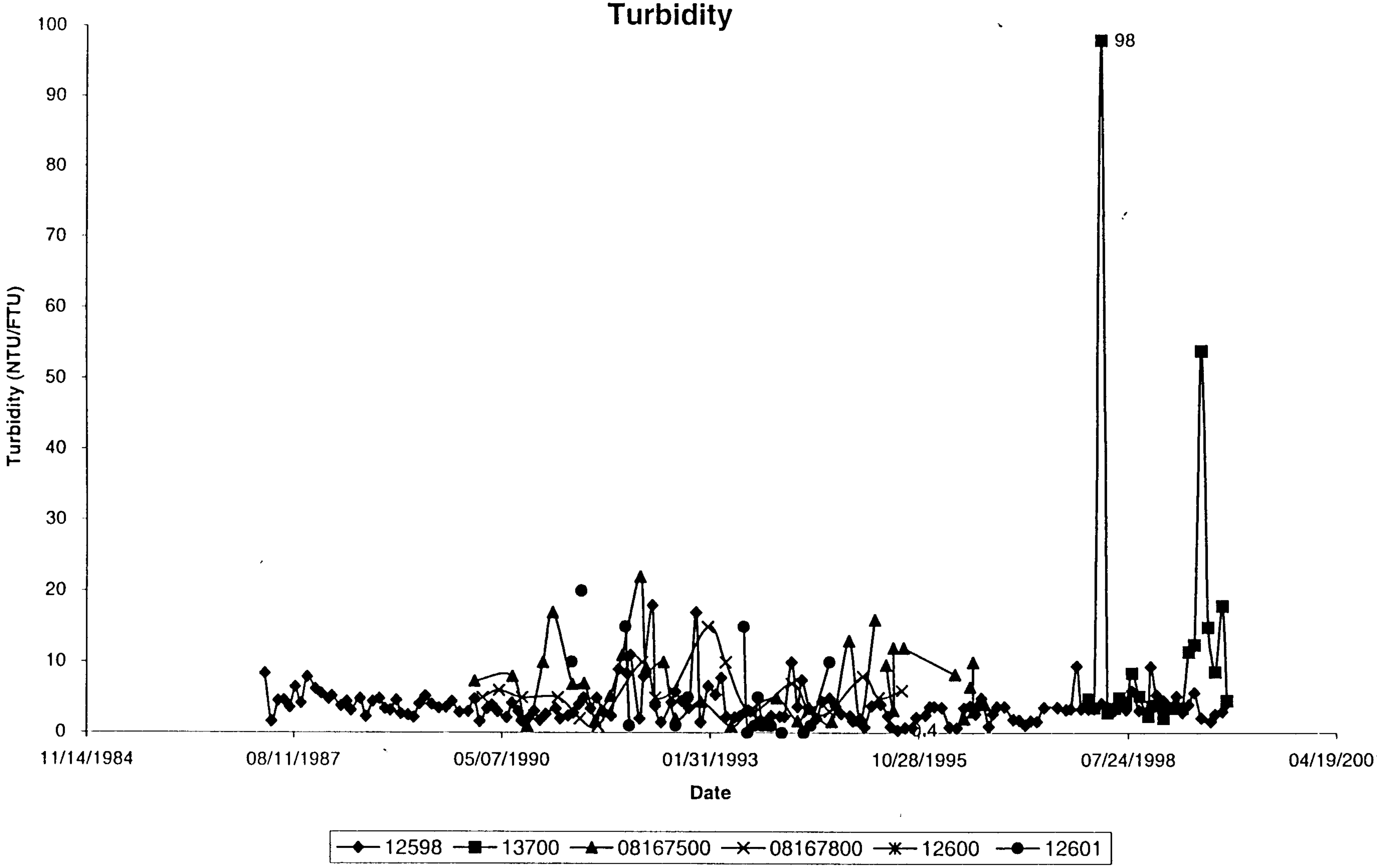
GBRA/USGS Canyon Lake Data
Sulfate (mg/L)



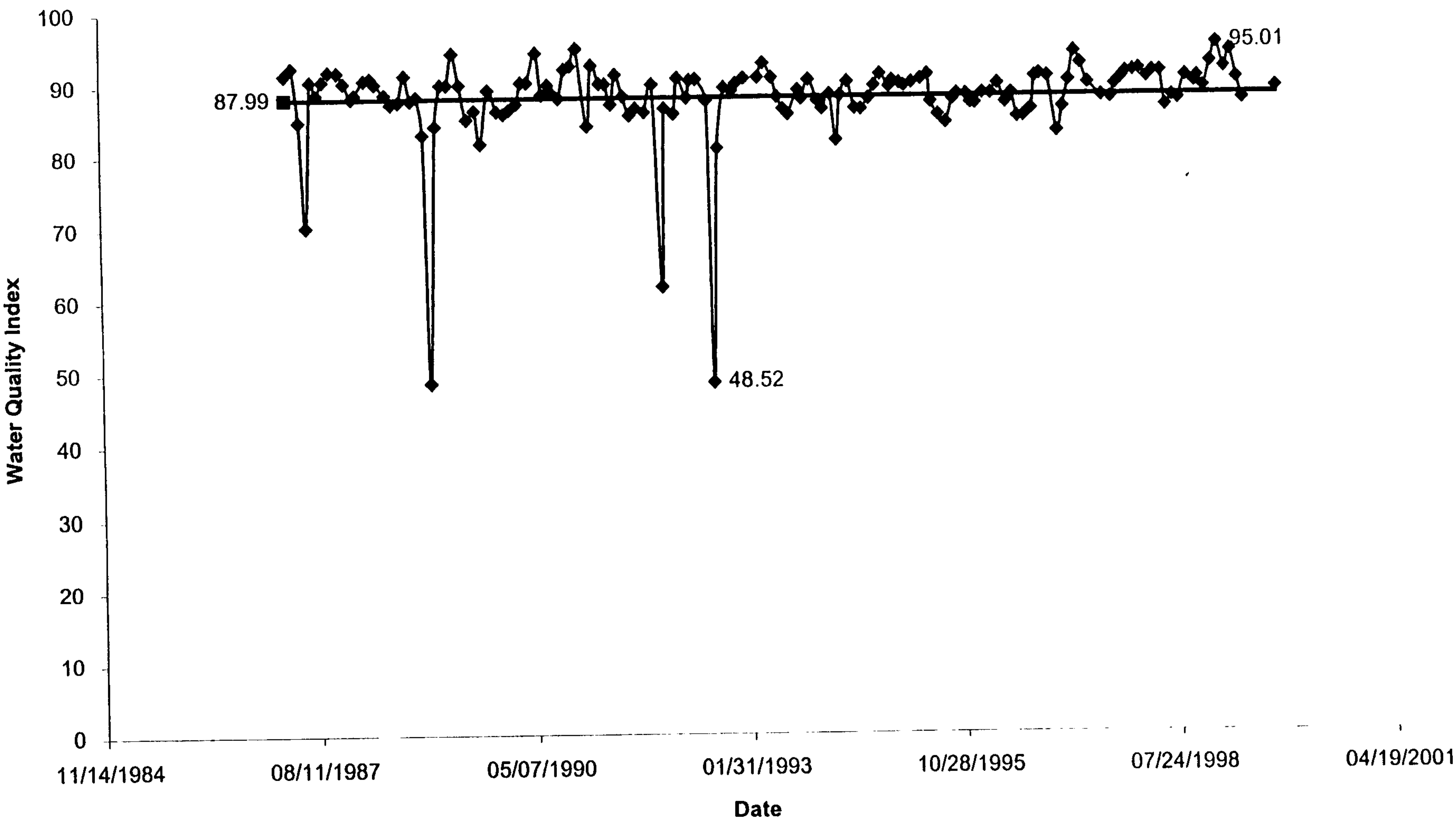

GBRA/USGS Canyon Lake Data
Suspended Solids
Suspended Solids (mg/L)
300
250
200
150
100
50
0
278
11/14/1984
08/11/1987
05/07/1990
01/31/1993
10/28/1995
07/24/1998
04/19/2001
Date
12598
13700
08167500
08167800


GBRA/USGS Canyon Lake Data
Temperature (C)
Temperature (C)
35
30
25
20
15
10
5
0
31
11/14/1984
08/11/1987
05/07/1990
01/31/1993
10/28/1995
07/24/1998
04/19/2001
Date
12598
13700
08167500
08167800

GBRA/USGS/TNRCC Canyon Lake Data
Turbidity



GBRA/USGS Canyon Lake Data
Water Quality Index (12598 Only)



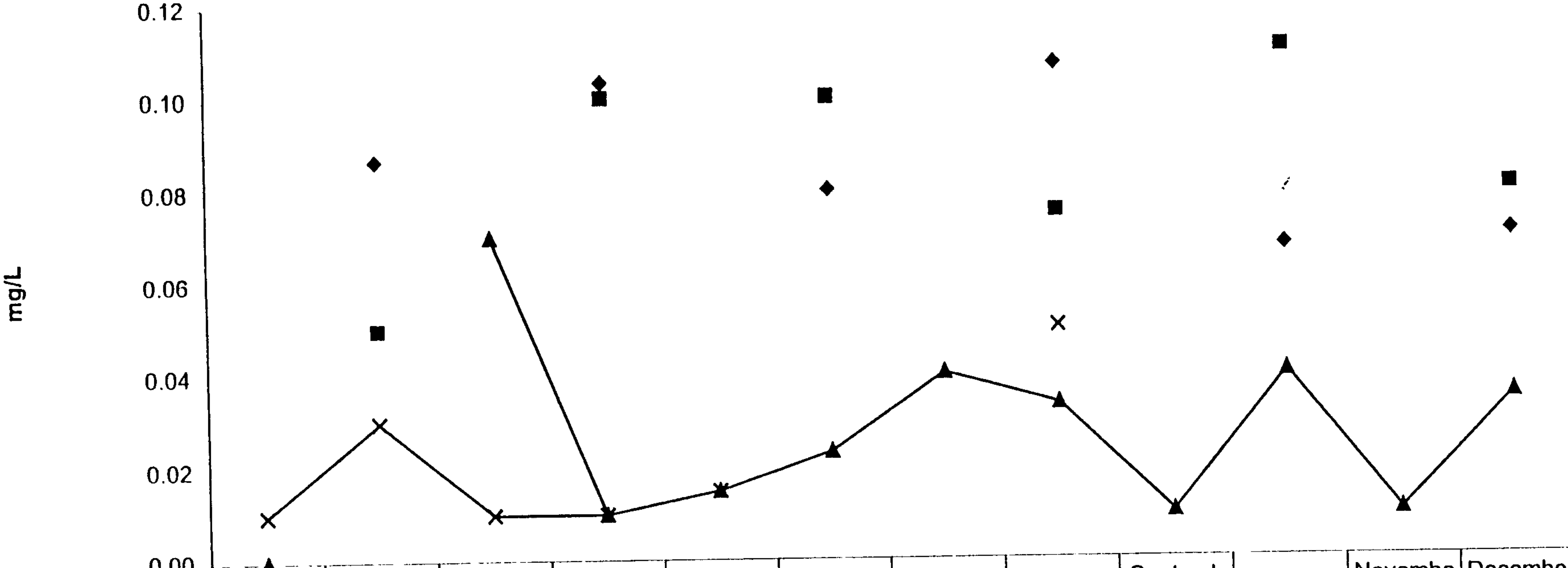
GBRA/USGS/TNRCC Canyon Lake Data
Alkalinity (Monthly Averages)

	1	2	3	4	5	6	7	8	9	10	11	12
8167500											190	200
8167800	157				185							
12600		210			161			156			181	
12601		224						162			182	

Month

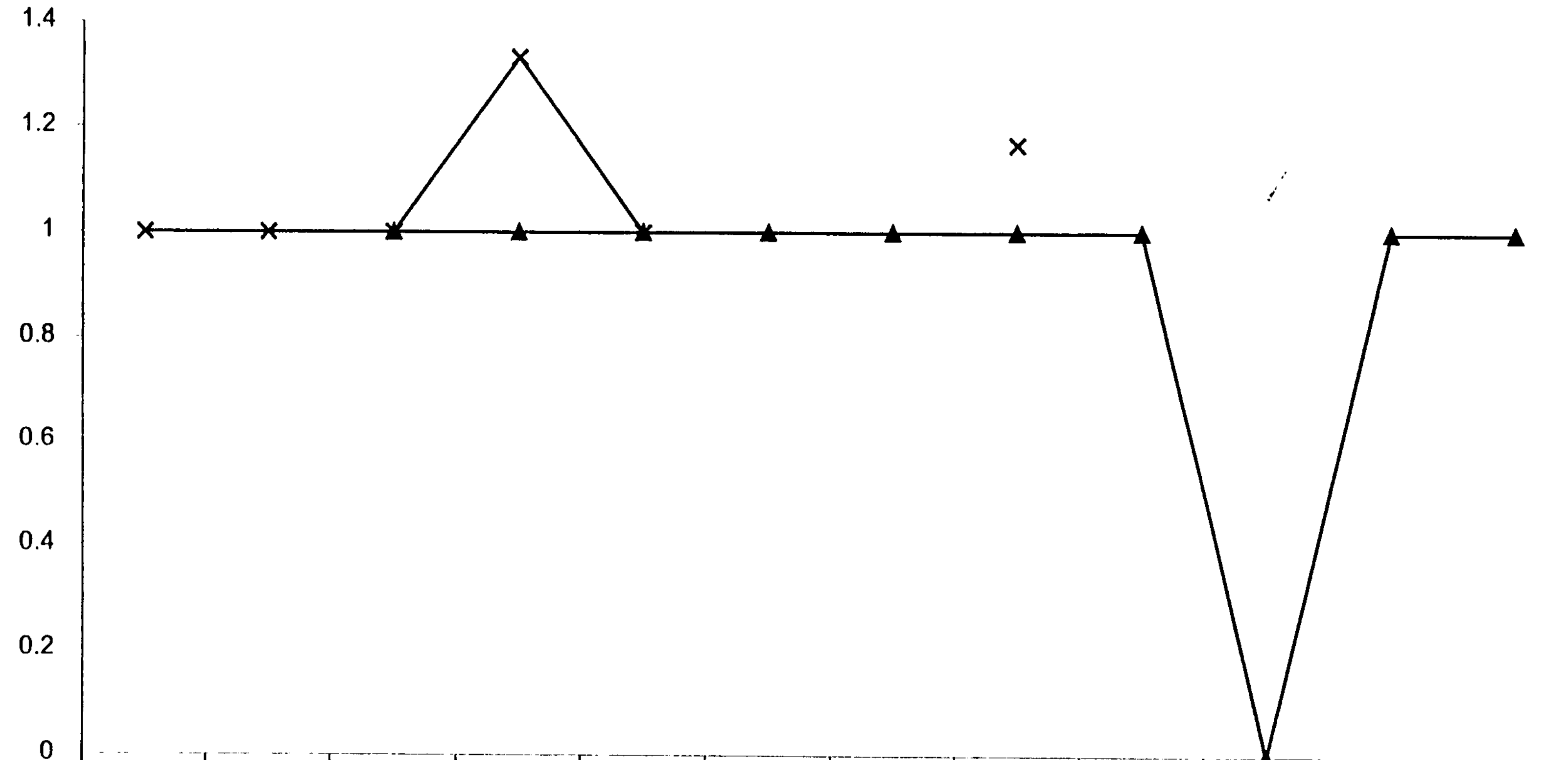
8167500 8167800 12600 12601

GBRA/USGS Canyon Lake Data
Ammonia (Monthly Averages)



	January	February	March	April	May	June	July	August	September	October	November	December
12598		0.09		0.10		0.08		0.11		0.07		0.07
13700		0.05		0.10		0.10		0.08		0.11		0.08
8167500	0.00		0.07	0.01	0.02	0.02	0.04	0.03	0.01	0.04	0.01	0.04
8167800	0.01	0.03	0.01	0.01	0.02			0.05				

GBRA/USGS Canyon Lake Data
Arsenic (Monthly Averages)



	1	2	3	4	5	6	7	8	9	10	11	12
8167500			1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00
8167800	1.00	1.00	1.00	1.33	1.00			1.17				

Month

8167500 8167800