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May 11, 2015
Via Email: tbly@agfc.state.ar.us

Mr. Tom Bly
District Biologist
Arkansas Game & Fish Commission
Fisheries District 10
213A Highway 89 South
Mayflower, AR 72106

RE: Craig D. Campbell Lake Conway Reservoir and Inflow Tributaries
Water Quality and Sediment Study
FTN No. R03017-0020-001

Dear Mr. Bly:

Please find attached the final version of the referenced report on Craig D. Campbell Lake Conway. This version was prepared at the request of the Arkansas Game & Fish Commission and includes minor supplemental work performed following the lake study that is now included in Appendix E. Please note that the remainder of the report was not modified from the February 11, 2013, draft.

Thank you for the opportunity to conduct these studies. If you have any questions or comments regarding this submittal, please feel free to contact me or Philip Massirer, PE, at (501) 225-7779.

Kindest regards,
FTN ASSOCIATES, LTD.

Jim Malcolm
Project Manager

JTM/tas

Attachment

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CRAIG D. CAMPBELL LAKE CONWAY RESERVOIR & INFLOW TRIBUTARIES

WATER QUALITY AND SEDIMENT STUDY

MAY 11, 2015

CRAIG D. CAMPBELL LAKE CONWAY RESERVOIR AND INFLOW TRIBUTARIES WATER QUALITY AND SEDIMENT STUDY

Prepared for

Arkansas Game and Fish Commission
2 Natural Resources Drive
Little Rock, AR 72205

Prepared by

FTN Associates
3 Innwood Circle, Suite 220
Little Rock, AR 72211

FTN No. 3017-110

May 11, 2015

EXECUTIVE SUMMARY

The Arkansas Game and Fish Commission (AGFC) contracted with FTN Associates, Ltd. (FTN) to conduct a watershed study of Lake Conway. The purpose of the project was to conduct a baseline water quality and sedimentation study of the lake and inflow streams and to provide associated recommendations.

FTN collected routine (i.e., once per month) water samples from five in-lake sites, six tributary sites, and the lake outlet for one year. Storm-event samples were also collected at the tributary sites and the outlet. The samples were analyzed for various parameters including nutrients, dissolved minerals, and total suspended solids (for calculating sediment loads). On certain occasions, the lake samples were also analyzed for chlorophyll-*a*, which was used along with nitrogen and phosphorus data to evaluate trophic state of the lake. The analysis of trophic state indicated that Lake Conway is eutrophic to hypereutrophic based on published thresholds of chlorophyll-*a* and total phosphorus.

Continuous water levels were measured at the six tributary sites; the water level data were converted to continuous flow data using rating curves that were developed from field measurements of streamflow. The continuous flow data and the sampling data were used together to estimate loads of sediment, nutrients, and other constituents. The tributary with generally the lowest loadings to the lake was Pierce Creek, which is a small stream in a forested watershed. The tributary with the largest sediment loading was Palarm Creek because its drainage area is larger than the other monitored tributaries. For nutrients, though, the tributary with by far the largest loading was Stone Dam Creek; most of its nutrient loading is from the City of Conway wastewater treatment plant (WWTP). The WWTP accounts for about 29% to 37% of the total load to the lake for total phosphorus, orthophosphate, ammonia nitrogen, and nitrate+nitrite nitrogen. The WWTP discharge will be removed from the Lake Conway watershed when the new Tupelo Bayou plant is built (anticipated mid-2014).

Sediment loads were calculated for the monitored tributaries using TSS concentrations. These loads were small compared to published values in literature. These loads may be underestimates of the actual loads because the TSS concentrations were from grab samples taken at the surface of the stream and did not include any contributions from bedload (sediment particles that move along the bottom of the stream).

A sediment investigation was conducted to measure the elevation of the top of the sediment and the thickness of the accumulated sediment. These measurements were made at over 300 locations throughout the lake by pushing a cone penetrometer into the sediment until a certain resistance was reached. The results were mapped in geographic information system (GIS) software. The measured thickness of accumulated sediment averaged 2.4 ft over the whole lake. As expected, the depth of accumulated sediment was greatest and the depth of water was shallowest in the upper parts of the lake. The northwestern bay of the lake appears to have significant amounts of sediment flowing in to the bay from Little Creek, Stone Dam Creek, and Gold Creek; this is based on large amounts of sediment that have accumulated in the bay and Google Earth aerial images for selected dates that show turbid plumes of water in the northwestern bay.

The sediment thickness data were used along with other information to estimate how quickly sediment will buildup in different parts of the lake. Based on the amount of sediment that has accumulated in different parts of the lake since the lake was impounded (as measured with the penetrometer), sediment appears to be building up in the upper parts of the lake at a rate of about 1 ft every 15 or 20 years. However, this rate assumes that (1) the penetrometer measurements provided a reasonable estimate of the thickness of the post-impoundment sediment accumulation without penetrating the original ground level, and (2) the future rate of sediment accumulation will be the same as the historical rate of sediment accumulation.

The sediment measurements need to be repeated in the future so that the elevations of the top of the sediment can be measured again and compared with the current elevations to obtain a more accurate estimate of the current rate of sediment buildup in different parts of the lake.

A supplemental service was requested by AGFC to address the effect the decommissioning of the City of Conway Stone Dam Wastewater Treatment Plant would have on the water levels of the lake. This memorandum is included as Appendix E.

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GLOSSARY

ADCP	acoustic Doppler current profiler
ADEQ	Arkansas Department of Environmental Quality
ADPC&E	Arkansas Department of Pollution Control & Ecology
AGFC	Arkansas Game & Fish Commission
CFR	Code of Federal Regulations
cfs	cubic feet per second
DO	dissolved oxygen
ECO	Ecological Conservation Organization
EPA	US Environmental Protection Agency
FTN	FTN Associates, Ltd.
GIS	geographic information systems
MSL	mean sea level
NLCD	National Land Cover Database
NRCS	Natural Resources Conservation Service
NRI	Natural Resources Inventory (NRCS program)
NTU	Nephelometric turbidity units
OBU	Ouachita Baptist University
PVC	polyvinyl chloride
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TSS	total suspended solids
USGS	United States Geological Survey
WWTP	wastewater treatment plant

1.0 INTRODUCTION

The Arkansas Game and Fish Commission (AGFC) contracted with FTN Associates, Ltd. (FTN) to conduct a watershed study of Lake Conway. The purpose of the project was to conduct a baseline water quality and sedimentation study of the lake and inflow streams and to provide associated recommendations. Specific tasks of this project were as follows:

1. Compile and analyze historical hydrologic, water quality, and sediment data on Lake Conway and its watershed;
2. Develop and implement a water quality monitoring program to collect baseline data on Lake Conway;
3. Develop and implement a storm event sampling program to quantify storm inputs to Lake Conway;
4. Develop a bathymetric map of Lake Conway and quantify the amount and extent of sedimentation;
5. Conduct a watershed management study of the Lake Conway watershed including recommendations for reducing inputs to Lake Conway; and
6. Initiate development of a water management model for Lake Conway.

The results of the first five tasks are provided and discussed in this report. The water management model was provided under separate cover.

Water quality data were collected for a period of 12 months. These data include routine (i.e., once per month) samples from five lake sites and seven stream sites (six tributaries plus the outlet). Storm-event samples were also collected from the seven stream sites. Water levels (i.e., stage data) were recorded at 15-minute intervals at each of the six tributary sites. Continuous stream flow rates were estimated from the stage data using rating curves that were developed from field measurements of stream flow at different water levels. Pollutant loads were estimated utilizing water quality data and the continuous stream flow data.

Field measurements were made to determine the elevation of the top of the sediment in the lake and to estimate the thickness of the accumulated sediment. Maps of the top of sediment elevation and the sediment thickness were generated. Calculations were developed to estimate the rate of sediment accumulation in different parts of the lake.

FTN partnered with state agencies, a university, and a local nonprofit organization to assist and contribute to the success of this project. The following is a summary of partnerships and their key roles in the project:

- Arkansas Game and Fish Commission (AGFC) provided key funding and cooperation that allowed the project development, implementation, and success.
- Arkansas Department of Environmental Quality (ADEQ) provided support through its Water Division by analyzing water samples for all parameters except chlorophyll-a.
- Ouachita Baptist University (OBU) assisted the project through its School of Natural Science's Chemistry Department by analyzing water samples for chlorophyll-a.
- Equilibrium Arkansas, a newly formed nonprofit in Little Rock, contributed to the project by working with FTN to measure stream flows during storm events using acoustic Doppler equipment. Equilibrium Arkansas specializes in scientific investigations pertaining to water resources and restoration and land stewardship projects.

2.0 BACKGROUND

2.1 General Information

The Craig D. Campbell Lake Conway Reservoir, located in Faulkner County, Arkansas, is a man-made reservoir constructed by AGFC between 1948 and 1951. The lake was created by impounding Palarm Creek (Bly et al. 2010). The lake has a length of about 8 miles, a surface area of 5,625 acres, and has about 56 miles of shoreline with residential dwellings, fishing piers, and boat houses. The Lake Conway watershed covers approximately 136 square miles, including most of the Conway metropolitan area, extending eastward to Vilonia and southward to Mayflower. Figure 2.1 provides an overview of the project area.

Issues such as accelerated silt accumulation in the lake, flash flooding from increased surface runoff, and nuisance aquatic vegetation have been attributed to development of the watershed (Bly et al. 2010). Lake Conway’s water level is managed with a 1,000-ft earthen dam and a 100-ft gated spillway that consists of 15 manually operated gates. The normal water level is 263 ft above mean sea level (MSL). The dam is located at the southern end of the lake and drains into Palarm Creek. One of the 15 gates directs water into a 24-inch diameter pipe that carries water to Grassy Lake in the Bell Slough Wildlife Management Area.

2.2 Geologic Setting

The surface geology of the study area is dominated by the Atoka Formation, which is comprised of tan to gray silty sandstones and grayish-black shales (Taff 1900). The Hartshorne Sandstone lies above the Atoka Formation and is comprised of brown to light-gray medium-grained sandstones. It is known to be a prominent ledge-former as it is observed capping Round Mountain west of Lake Conway. Also observed in the study area are much younger age (Quaternary) alluvium deposits which are found on the floodplains of the Arkansas River and significant tributaries. These deposits include gravels, sands, silts, and clays. Figure 2.2 provides a geologic map of Lake Conway and the surrounding area.

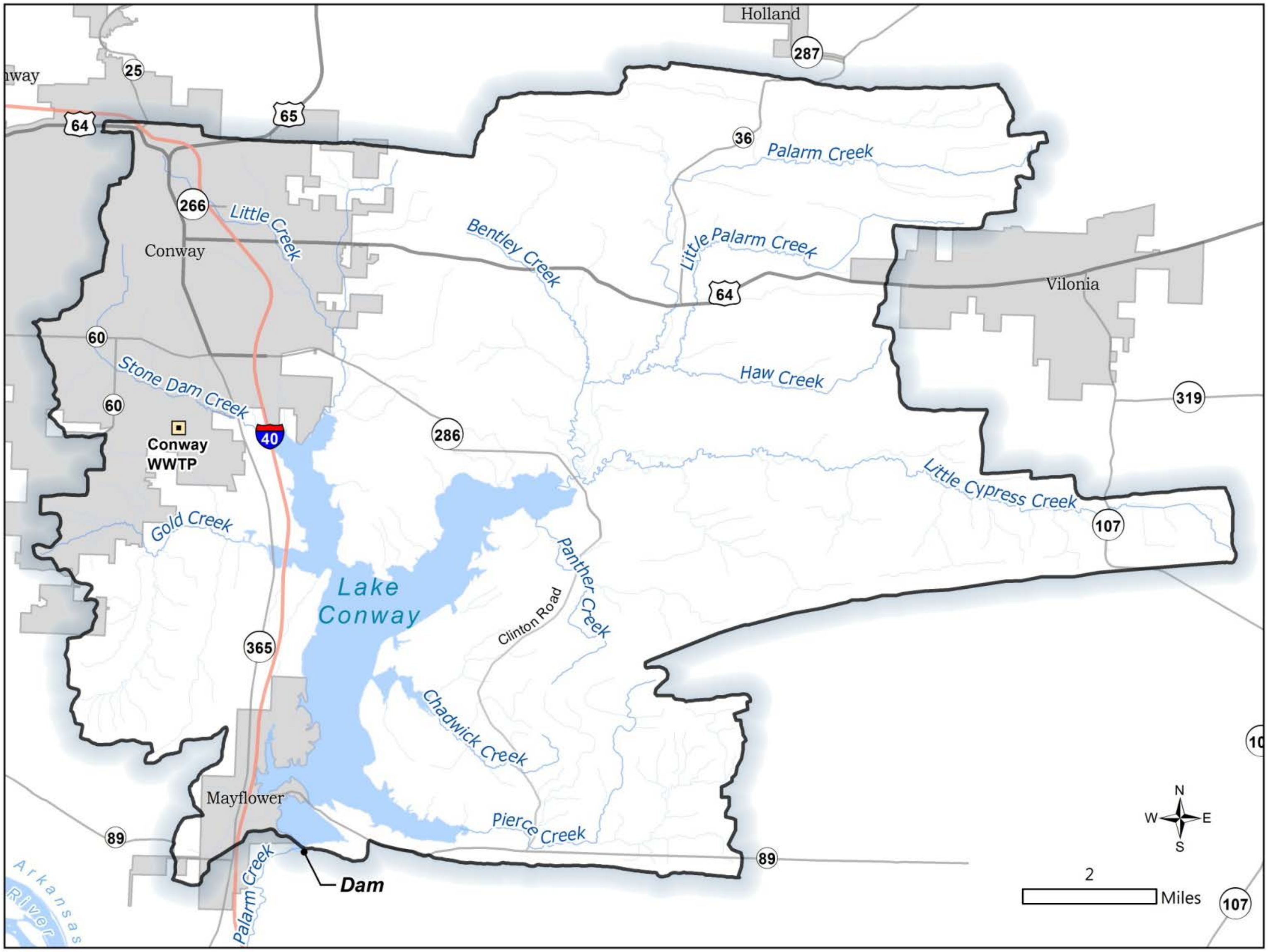

Figure 2.1. Overview of project area.

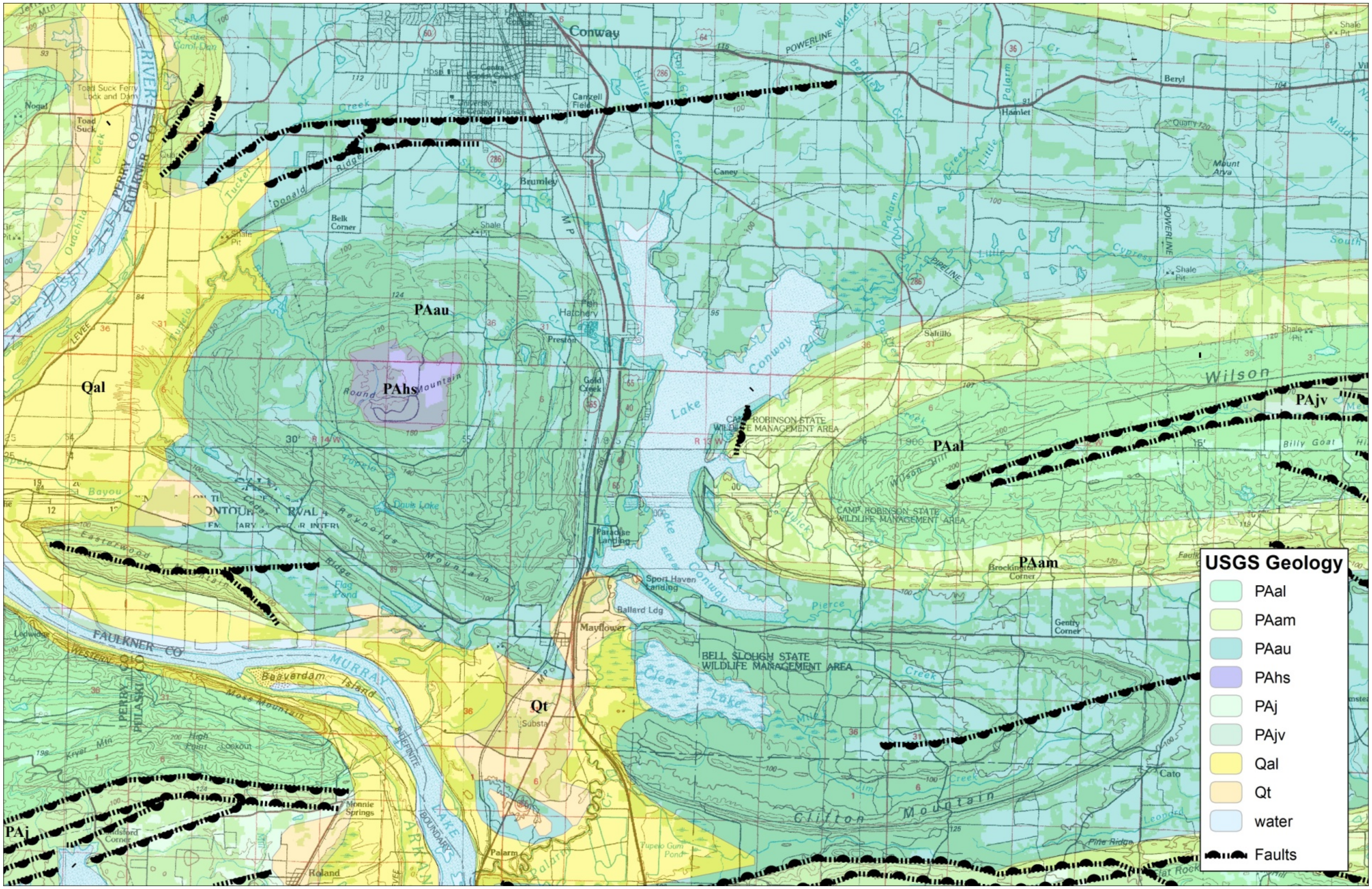

Figure 2.2. Geologic map of Lake Conway and surrounding area.

2.3 Land Use Data

Land use within the Lake Conway watershed was characterized using National Land Cover Database (NLCD) 2006 data which were obtained from the Multi-Resolution Land Characterization consortium (MRLC 2011). These data were based on satellite imagery from 2006. The spatial distribution of these land uses is shown on Figure 2.3 and percentages of the watershed covered by different land uses are shown in Table 2.1. Forest comprises a little over one third of the watershed, while pasture, hay, and grass together cover about another third of the watershed. The northwest corner of the watershed is mostly urban land in and around Conway; much of this urban area drains into Little Creek and Stone Dam Creek. Less than 2% of the watershed is cultivated cropland.

Table 2.1. Land use statistics for the project area (MRLC 2011).

Description of Land Use	Percentage of Watershed
Open Water	6.3%
Developed, Open Space	5.9%
Developed, Low Intensity	5.8%
Developed, Medium Intensity	1.8%
Developed, High Intensity	1.3%
Barren Land (Rock/Sand/Clay)	0.1%
Deciduous Forest	34.2%
Evergreen Forest	2.7%
Mixed Forest	0.6%
Shrub	0.5%
Grassland/Herbaceous	3.0%
Pasture/Hay	33.5%
Cultivated Crops	1.8%
Woody Wetlands	2.3%
Emergent Herbaceous Wetlands	0.2%
TOTAL	**100.0%**

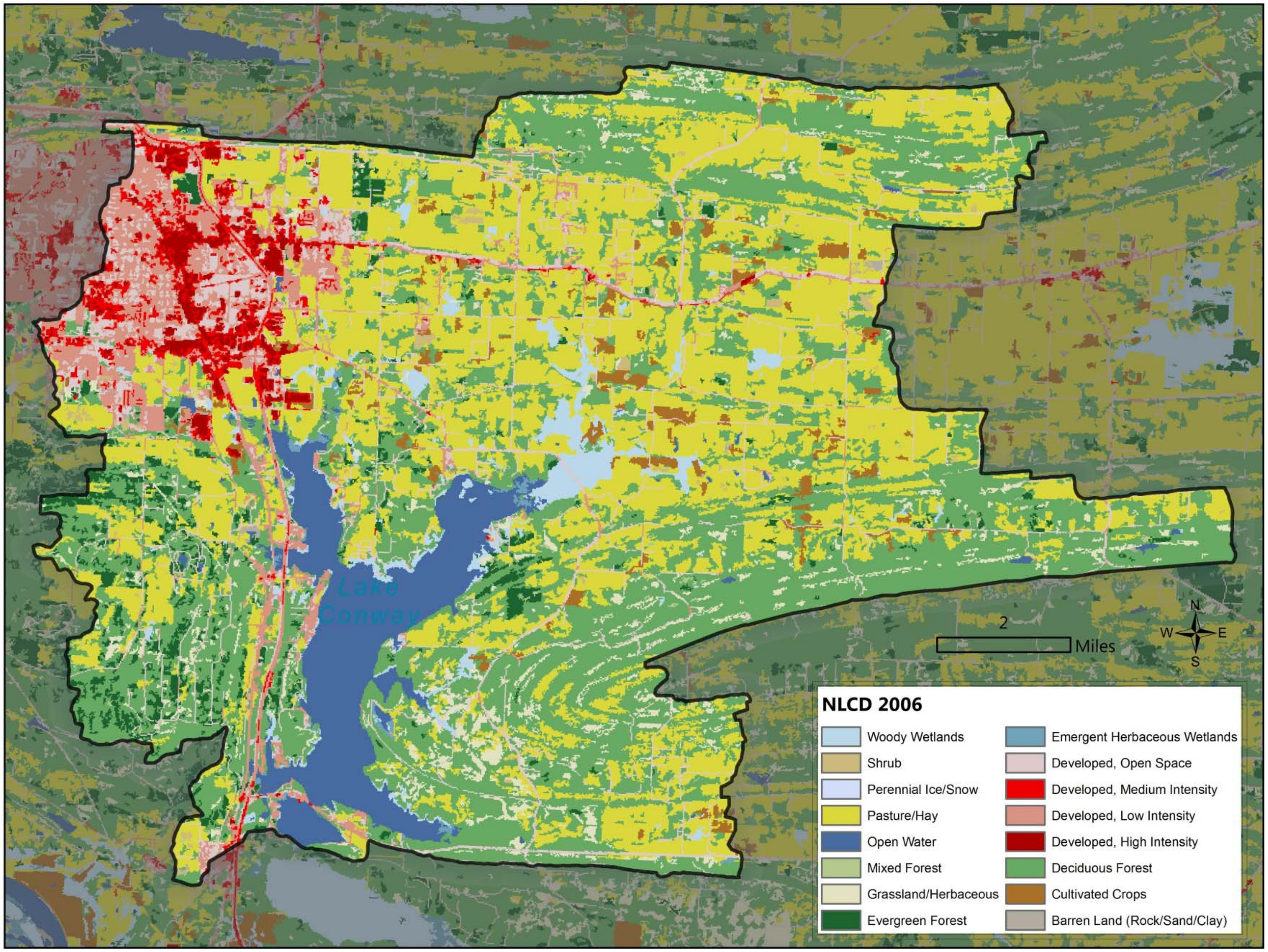

Figure 2.3. Land use in the project area.

2.4 Previous Studies

Several studies have been conducted on Lake Conway and its tributaries. Relevant studies are described below, including a brief summary of the results.

2.4.1 ADEQ Water Quality Sampling in Lake Conway

ADEQ published a report in 2001 titled *Data Summary of Special Water Quality Sampling on Lake Conway, Arkansas* that summarized data compiled from five sampling events that occurred during October 1998, July 1999, March 2001, April 2001, and August 2001. Water samples were collected for chemical analyses at seven in-lake locations. Three of those locations were in the northwestern bay along the edge of the lake where inflows enter from Gold Creek, Stone Dam Creek, and Caney Creek. The samples collected near the mouth of Stone Dam Creek had much higher concentrations of nutrients and dissolved minerals than the samples at any other location. ADEQ considered these concentrations to be “noticeably elevated” but “typical” of conditions downstream of a municipal wastewater treatment plant (WWTP) (ADEQ 2001). The data from the ADEQ study cannot be directly compared to the results of the current study because the sampling locations from the ADEQ study do not coincide with the sampling locations of this current study, and ADEQ data represent only a small number of sampling events spread out over several years.

2.4.2 ECO Stone Dam Creek Monitoring

Ecological Conservation Organization (ECO) conducted a study during 2006 and 2007 titled *Guidelines, Standard Procedures, Analysis and Results for Continuous Water Quality Monitoring in the Lake Conway-Point Remove Watershed of Arkansas* that established a monitoring station on Stone Dam Creek at the same location where samples were collected for the current study. A considerable number of samples were collected and annual pollutant loads were estimated (ECO 2007). Table 2.2 summarizes the results from 27 grab samples collected from August 2006 to June 2007.

Table 2.2. Summary of Stone Dam Creek data collected by ECO during 2006 and 2007.

Sample Date	Temp (°F)	pH (su)	Conductivity (µS/cm)	DO (mg/L)	Turbidity (NTU)	TP (mg/L)	TKN (mg/L)	Ammonia (mg/L)	Nitrate (mg/L)	TSS (mg/L)
Average	65.9	6.7	519	7.2	19.0	1.85	4.85	3.87	3.51	19
Minimum	46.9	5.1	174	2.1	7.2	0.45	0.96	0.13	0.34	2.0
Maximum	85.5	8.8	1,000	12.3	47.8	4.16	15.4	14.2	9.80	38
Median	65.4	6.6	554	7.1	17.1	1.89	2.74	2.49	2.60	19

2.4.3 ADEQ Stone Dam Creek TMDL Investigation

Stone Dam Creek was listed as impaired on the 1994 Arkansas 303(d) list due to periodic ammonia nitrogen levels that exceeded toxicity values for the aquatic life designated use. In July 1996, ADEQ (then the Arkansas Department of Pollution Control & Ecology, or ADPC&E) conducted a total maximum daily load (TMDL) investigation on Stone Dam Creek to determine the impact of the City of Conway WWTP and two minor point source discharges on water quality and aquatic life in the creek (ADPC&E 1997). ADEQ collected physical, chemical, and biological data in Stone Dam Creek, but no data were collected in Lake Conway. ADEQ concluded that elevated nutrient concentrations (e.g., nitrates and phosphates) in Stone Dam Creek were supporting increased plant growth, in turn causing significant daily fluctuations in pH and DO. ADEQ also concluded that ammonia toxicity had resulted in adverse impacts to the fish community in Stone Dam Creek (ADPC&E 1997). The report did not evaluate the effects of water quality in Stone Dam Creek on Lake Conway.

2.4.4 Stone Dam Creek Ammonia and Nitrate TMDL Report

Quantitative Environmental Analysis, LLC, and Parsons prepared a TMDL report for Stone Dam Creek for ammonia and nitrate. The report summarized data from ADEQ routine monitoring station ARK0051 and did not include any new field data collection. Allowable loadings were calculated for critical low-flow conditions. Under these conditions, the discharge from the City of Conway WWTP represents nearly all of the flow in Stone Dam Creek. The report included allowable loads for both ammonia and nitrate (Quantitative Environmental Analysis, LLC, and Parsons 2003). The report focused entirely on Stone Dam Creek and did not consider water quality in Lake Conway in the calculation of allowable loads.

3.0 METHODS

The following sections detail the methods and procedures for sampling and analysis for this project.

3.1 Water Quality and Flow Monitoring

FTN collected stream flow and water quality data through the establishment of monitoring stations on six tributary streams, the outlet (at the dam), and five in-lake sampling locations. A grab sample was collected once a month from each sampling location throughout the course of the one-year project. Additionally, multiple storm events were monitored at all inflow streams and at the outlet of the dam. In situ measurements of temperature, pH, conductivity, dissolved oxygen, and turbidity were taken at the time of each sampling. Laboratory analyses were conducted by ADEQ for total organic carbon (TOC), total phosphorus, orthophosphate as phosphorus, nitrate-nitrite nitrogen, ammonia nitrogen, total Kjeldahl nitrogen (TKN), total suspended solids (TSS), fluoride, bromide, chloride, sulfate, and total dissolved solids (TDS). Ouachita Baptist University (OBU) conducted the analyses for chlorophyll-*a* (lake samples only).

3.1.1 Monitoring Station Locations

Stream sampling locations were selected based on location within watersheds, stream confluences, accessibility, and localized flow conditions.

Six monitoring stations were established on six major tributaries to Lake Conway. Water quality samples, continuous stage data, and discharge data were collected at each of the six stations. Figure 3.1 shows the stream sampling locations.

Additionally, five in-lake sampling locations were selected to characterize water quality in various parts of Lake Conway, including the northwestern arm (LC-1), the northeastern arm (LC-2), the middle of the lake (LC-3 and LC-4), and the southern end between the Highway 89 bridge (the Narrows) and the dam (LC-5). Figure 3.1 shows the location of each in-lake sampling site.

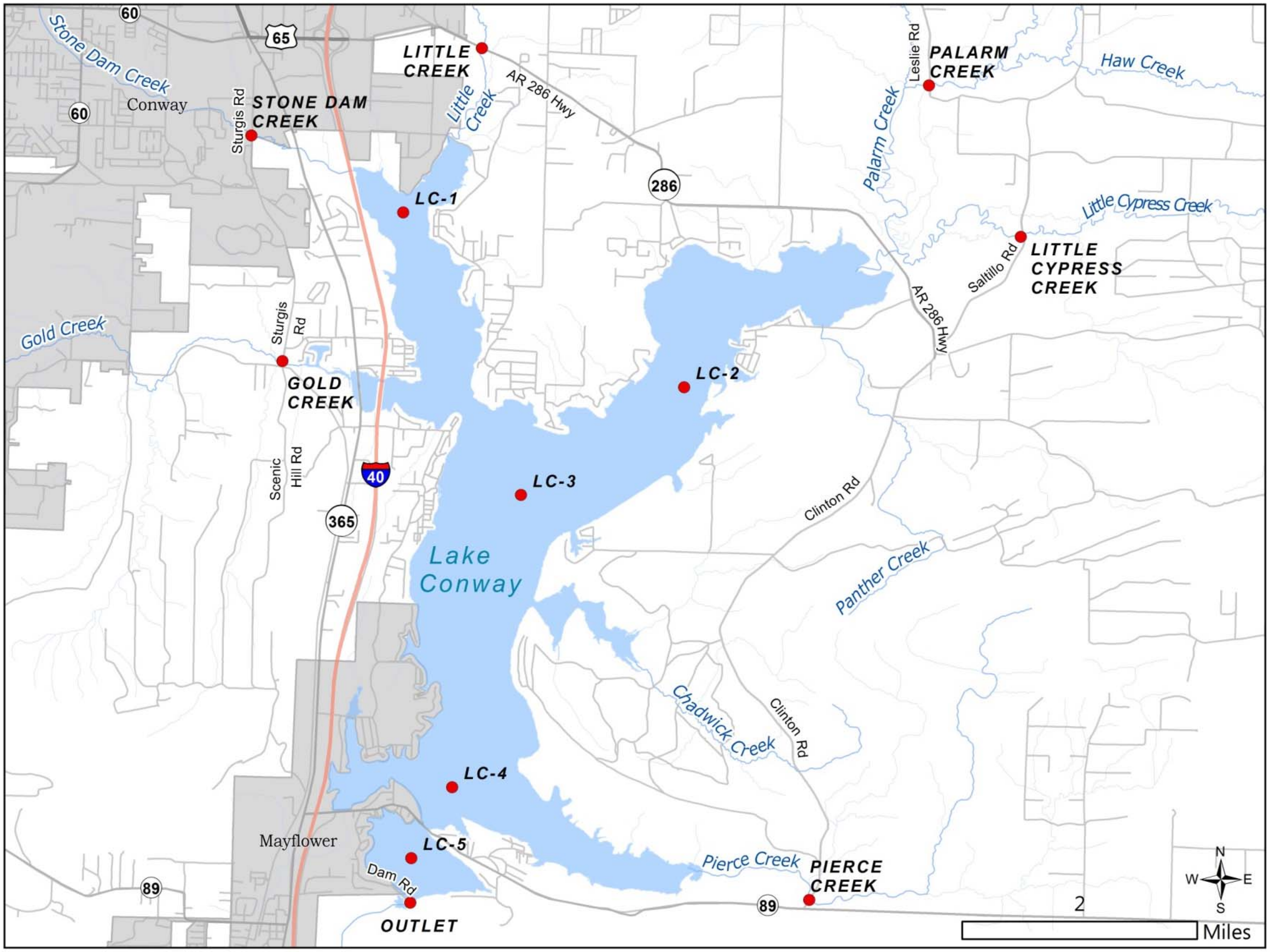

Figure 3.1. Stream and in-lake sampling locations.

3.1.2 Sample Collection Protocols

FTN collected water quality samples on a monthly basis at all sampling locations. Additionally, samples were collected during five storm events over the course of the project. Routine and storm-event samples were collected as grab samples according to FTN protocol by qualified and trained field personnel.

In situ measurements of water temperature, pH, conductivity, dissolved oxygen and turbidity were taken concurrently with each sample. For in-lake samples, a vertical profile of in situ water quality data were collected at the surface and at 1.0 meter depth increments.

Upon the recognition that an approaching storm event would provide ample rain, FTN field personnel mobilized to attempt to collect the “first-flush” at each stream sampling location. Hydrograph characteristics of the monitored streams varied based on the watershed characteristics. For example, Stone Dam Creek, which receives urban runoff from Conway, rises much more rapidly (i.e., it is a “flashy” creek) than Pierce Creek. Pierce Creek has a more forested watershed, which allows more rainfall to infiltrate into the ground, resulting in less runoff and lower peak flows. FTN personnel attempted to collect between four and six samples during each storm event for each stream. Storm samples were intended to be collected somewhat evenly across the hydrograph. The ideal scenario was that the first sample was to be collected upon the initial rise (>0.25 ft) as the stream became turbid; the second and third samples were to be collected during the rising limb of the hydrograph; another sample was to be collected at or near the peak of the hydrograph; and finally, one or two more samples were to be collected during the recessional side of the hydrograph. Because of the unpredictable nature of rain events, this was often a complex undertaking. Figure 3.2 depicts a generic hydrograph, its components and the target sampling scheme for storm events.

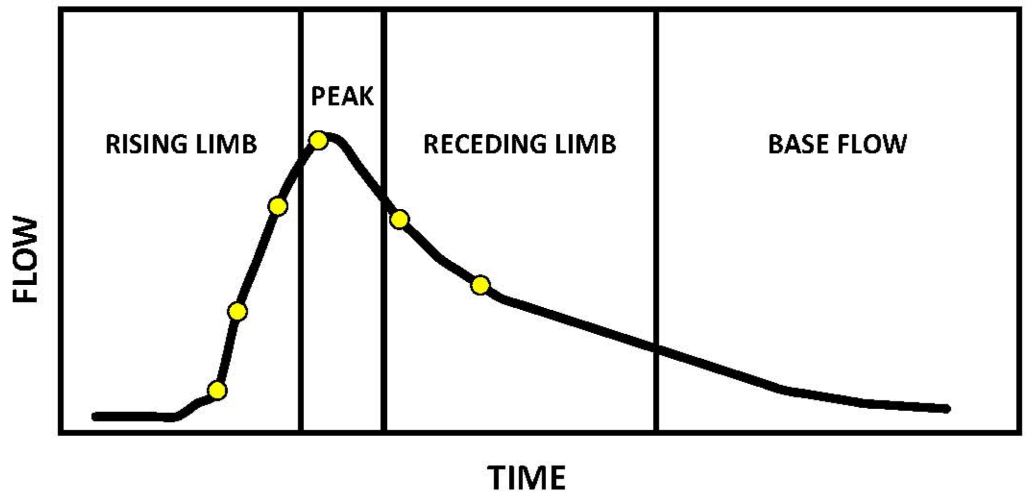

Figure 3.2. Generic hydrograph and target sampling scheme for storm events.

3.1.3 Sample Handling and Quality Assurance

Sample integrity was maintained for each sampling event by ensuring that samples were placed on ice immediately after collection. Samples remained in possession of sampling personnel or laboratory personnel at all times. All laboratory analyses were conducted within the prescribed holding times. In situ meters were calibrated prior to use according to manufacturer's instructions. Chain-of-custody and calibration forms for field data were maintained by FTN and are provided in Appendix A. For each sampling event at least one field blank and one duplicate sample were collected to be analyzed by the laboratory for quality assurance purposes.

Analytical services and reporting were provided by the ADEQ Water Quality Laboratory for all parameters except chlorophyll-a, which was analyzed by the OBU Water Quality Laboratory. All laboratory procedures were conducted according to *Guidelines Establishing Test Procedures for the Analysis of Pollutants under the Clean Water Act* (Title 40 Code of Federal Regulations [CFR] Part 136). The analytical methods employed by the laboratories for this project are listed in Table 3.1.

Table 3.1. Analytical methods used by the laboratories.

Parameter	Source/Method	Units
Ammonia Nitrogen	SM 4500-NH_3 H	mg/L
Nitrate-Nitrogen	SM 4500-NO_3 I	mg/L
Orthophosphate as Phosphorus	SM 4500-P G	mg/L
Total Dissolved Solids	EPA 160.1	mg/L
Total Suspended Solids	EPA 160.2	mg/L
Total Kjeldahl Nitrogen	SM 4500-N C	mg/L
Total Organic Carbon	EPA 5310B	mg/L
Total Phosphorus	SM 4500-P J	NTU
Turbidity	EPA180.1	mg/L
Fluoride	EPA 300.0	mg/L
Bromide	EPA 300.0	mg/L
Chloride	EPA 300.0	mg/L
Sulfate	EPA 300.0	mg/L
Chlorophyll-a	EPA 1983, 10200H	µg/L

3.1.4 Stage Measurements

Water level loggers were installed at all stream sampling locations (with the exception of the dam site) in order to measure the stage at 15-minute intervals (i.e., “continuously”). Additionally, a staff gauge was secured to the substructure pier on the bridge at each stream sampling location. The water level loggers were housed in a PVC casing secured to a T-post that was driven into the streambed. As a precaution, the casing was tied-off to a substructure on the bridge to prevent loss of the unit in the event of swift water. Following each data download from the water level loggers, the loggers were returned to their exact same elevation so that water level readings at each site would be consistent throughout the project.

3.1.5 Stream Flow Measurements

Separate methods were used to measure instantaneous stream flows during low- and high-flow conditions. During low-flow conditions when streams were wadeable, a wading rod coupled with a Marsh McBirney electromagnetic velocity meter was utilized in accordance with standard US Geological Survey (USGS) procedures. During high-flow conditions when streams were not wadeable, flows were measured with an acoustic doppler current profiler (ADCP), which is a fully integrated stream flow measurement system. As the ADCP instrument is slowly moved across the stream, it measures both depth and velocity of the water using sound waves. Figure 3.3 shows the ADCP and its operation at high-flow conditions.

Figure 3.3. Use of ADCP during high-flow conditions.

3.2 Lake Bed Sediment Investigation

FTN conducted measurements to determine the elevation of the top of the sediment and to estimate the thickness of the accumulated sediment throughout the lake. A GIS-based grid system was produced for the entire lake with measurement points located at approximately 400-ft intervals, resulting in a total of approximately 300 measurement locations. A static cone penetrometer (Figure 3.4) was used to measure the depth to the top of sediment and the sediment thickness at each measurement point.

Figure 3.4. Static cone penetrometer used to measure sediment thickness in Lake Conway.

A static cone penetrometer is typically used to evaluate the consistency and level of compaction of fine-grained and soft soils. A dual rod isolates the cone resistance from shaft friction and is coupled with a pressure gauge. This allowed a repeatable pressure to be applied at each measurement point. Rod extensions were attached so that the cone penetrometer had a 14-ft reach. At each measurement point, FTN first measured the depth to the top of sediment and then pushed the cone penetrometer into the lake-bed sediment to estimate the thickness of the sediment that has accumulated since the lake was impounded. The depth to the top of sediment was subtracted from the lake's water level elevation for each day, which resulted in an elevation value (ft above MSL) for the top of sediment at each point across the lake. These data produced a bathymetric profile of the top of the existing sediment. After determining the depth to the top of the sediment at each point, the cone penetrometer was slowly pushed straight down into the sediment until the target pressure of 5 kg/cm^2 was attained. Upon reaching the target pressure, the depth of the rod was again measured from the top of the water, resulting in top- and bottom-of-sediment measurements.

3.3 Data Analysis

3.3.1 Rating Curves and Continuous Tributary Flows

To convert the continuous stage data to continuous flow data, a stage-discharge rating curve was developed for each sampling location. A rating curve is a graph of discharge (i.e., flow) on the Y axis versus stage on the X axis for a specific site. At each sampling location where continuous stages were being measured, multiple measurements of stream flow were made over a range of stream stages. The measured flow rates were plotted with the stage values that were measured at the same time and an equation to characterize flow as a function of stage was developed using a trend line in a spreadsheet. The "power function" option for the trend lines provided the best fit for the data. The equations for the trend lines were then applied to the continuous stages in order to estimate continuous flows at each tributary sampling site.

3.3.2 Flows at Outlet (Dam)

Outflows from the lake were estimated using lake elevations that were reported by AGFC, number of gates open at the dam and the date/time when they were opened and closed (also reported by AGFC), and rating curves for the dam (outlet) that were simulated by FTN and presented in a companion report, *Lake Conway Watershed Model & Review of Water Level Management Procedures* (FTN 2012). Each rating curve was a relationship between outflow through the dam and pool elevation for the lake based on a certain number of gates open. Separate rating curves were established for different numbers of gates open and for the Bell Slough pipe. The rating curves take into account tailwater and hydraulic effects that occur when water is released from the dam. The simulated rating curves and associated data tables for the Lake Conway dam are provided in Appendix B.

3.3.3 Estimation of Parameter Loadings

For each water quality constituent, continuous loads were calculated by multiplying each of the continuous flow values with an estimated concentration for that constituent. This requires assumptions to be made about unknown concentrations that occurred in between the sampling events. For this project, the hydrograph at each tributary sampling site was manually divided between base flow conditions and storm flow conditions. Then the periods with storm flow conditions were further divided between periods on the rising limb, peak, and falling limb of each storm. Results from routine sampling events were used to estimate concentrations during base flow periods, and results from storm sampling were used to estimate concentrations during storm periods. During base-flow conditions, measured concentrations were applied forward until the next measured concentration. This approach was then adjusted where necessary to account for specific hydrologic conditions. For example, concentrations from water samples collected during base-flow conditions would only be extended to the beginning of succeeding storm events, and concentrations from the first water sample collected during a storm event would be applied backwards to the beginning of the event. Therefore, storm events were managed separately from base-flow concentration.

Although there were numerous significant storm events during the project timeframe, water quality samples were taken at each stream monitoring station during five storm events. For monitored storm events, the actual concentration data were applied to that individual storm event for an individual monitoring station. A summary of all storm event data was generated to provide insight to the differences between the rising-limb, peak, and receding-limb components of the hydrograph for each monitoring station as well as an encompassing dataset with all collected storm event samples. The average concentration of samples collected from each component of the hydrograph (rising limb, peak, and receding limb) was then applied to storm events lacking actual sampling data.

It should be noted that sediment loads for tributaries and the outlet were computed using TSS concentrations. Suspended solids that are measured in a TSS analysis provide a good estimate of organic and inorganic sediment that is susceptible to settling in the lake.

4.0 RESULTS

4.1 Water Quality and Flow Monitoring

FTN initiated sampling on September 23, 2011, and continued until August 31, 2012. During the course of the project, for all sampling stations (outlet, six tributary streams, and five in-lake), a total of 201 samples were collected and analyzed (112 routine samples and 89 storm event samples). Table 4.1 provides the number and type of samples collected from each sampling location.

Table 4.1. Routine and storm event samples collected from each location.

Station Name	Routine Samples	Storm Event Samples	Total
Outlet	10	9	19
Pierce Creek	4	14	18
Little Cypress Creek	9	12	21
Palarm Creek	10	12	22
Little Creek	10	15	25
Stone Dam Creek	10	15	25
Gold Creek	9	12	21
LC-1	10	NA	10
LC-2	10	NA	10
LC-3	10	NA	10
LC-4	10	NA	10
LC-5	10	NA	10
TOTAL	**112**	**89**	**201**

Additionally, there were 10 field blanks and 10 duplicate samples collected as quality assurance samples. The laboratory results for individual samples are summarized in Appendix C.

4.1.1 In-Lake Data

The Lake Conway pool elevation was measured daily by AGFC at a staff gauge located near the District 10 AGFC Fisheries Office in Pierce Creek Bay. During times when the lake was rising or dropping rapidly, multiple measurements were made each day. Figure 4.1 depicts the pool elevation of Lake Conway during the course of the project.

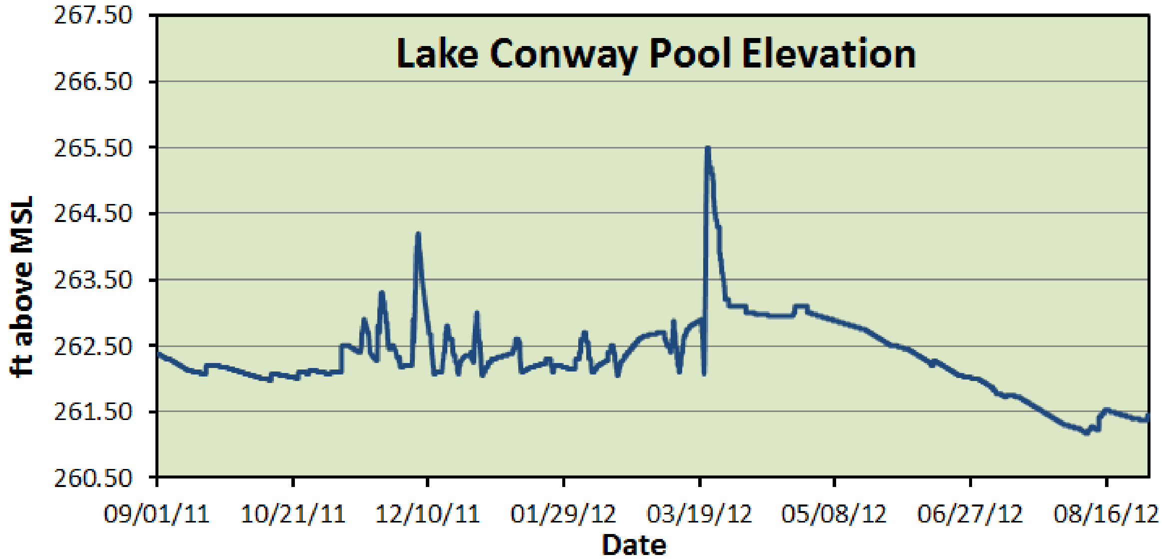

Figure 4.1. Lake Conway pool elevation during the course of the project.

The normal pool elevation of the lake is 263 ft above MSL. The lowest elevation observed during the project was 261.18 ft on August 8, 2012. The highest pool elevation was 265.50 ft on March 22, 2012.

Water quality data in the lake exhibited a fairly uniform concentration range across the entire lake, with the exception of LC-1, which is located in the northwestern bay of the lake where inflows enter from Stone Dam Creek and Little Creek. For most parameters, average concentrations at LC-1 were generally twice as high as those observed at other lake stations. Table 4.2 shows average concentrations for surface water quality samples collected from the in-lake sampling locations.

In situ measurements of temperature, pH, specific conductance, DO, and turbidity were taken at the surface and at 1.0-meter intervals below the surface. Plots of these vertical profiles of in situ data can be found in Appendix D.

Table 4.2. Average concentrations at each lake sampling station (n=10).

Sampling Site	Total Phosphorus (mg/L)	Orthophosphate as Phosphorus (mg/L)	TKN (mg/L)	Ammonia Nitrogen (mg/L)	NO_2+NO_3– Nitrogen (mg/L)	TSS (mg/L)
LC-1	0.18	0.048	1.24	0.11	0.17	20
LC-2	0.10	0.014	1.04	0.04	0.05	14
LC-3	0.117	0.012	1.09	0.04	0.04	12
LC-4	0.095	0.011	1.00	<0.03	<0.03	11
LC-5	0.095	0.011	1.01	<0.03	<0.03	11

In addition to the chemical analyses, in-lake samples were analyzed for chlorophyll-*a* on three sampling events (Table 4.3). Chlorophyll is an indirect measure of the amount of photosynthesizing plants (algae or phytoplankton) found in a sample. Chlorophyll can also be an indicator of the trophic state of a lake.

Table 4.3. Chlorophyll-*a* concentrations from three sampling events.

Date	LC-1	LC-2	LC-3	LC-4	LC-5
11/30/11	0.50	7.20	17.7	20.2	17.9
05/22/12	43.9	29.4	49.0	32.0	50.7
07/25/12	102	48.8	43.0	52.7	17.7

Figures 4.2 through 4.4 provide time-series plots of chlorophyll-*a*, total phosphorus, and turbidity at each lake sampling station. All sampling locations showed a general increase in chlorophyll-*a* from November to May with less consistency among stations from May to July when chlorophyll-*a* concentrations either increased (LC-1, LC-2, and LC-4), decreased (LC-5), or remained essentially the same (LC-3). LC-1 showed the greatest degree of seasonality with nearly non-detectable chlorophyll-*a* (0.5 µg/L) in November and by far the highest concentration (102 µg/L) in July. During this time turbidity decreased steadily from 53 to 15 NTU.

The plots show somewhat similar levels of total phosphorus and turbidity among LC-2 through LC-5. These stations showed a general increase in total phosphorus and turbidity from the November and May dates to the July sampling date.

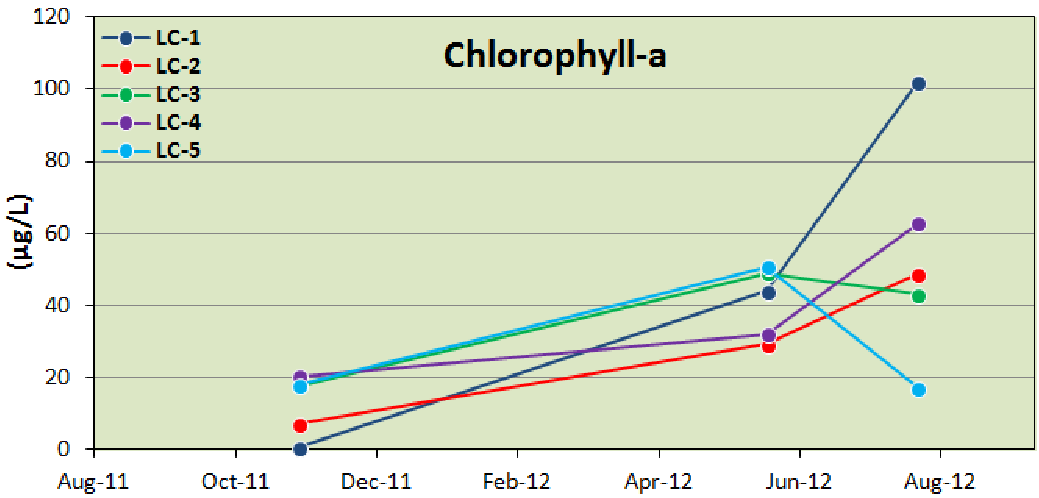

Figure 4.2. Time-series plot of chlorophyll-*a* concentrations in Lake Conway.

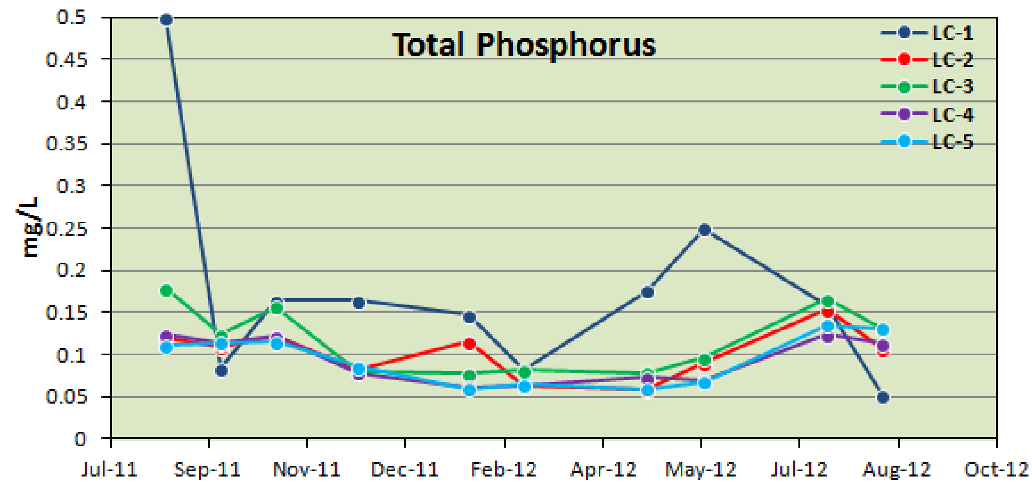

Figure 4.3. Time-series plot of total phosphorus concentrations in Lake Conway.

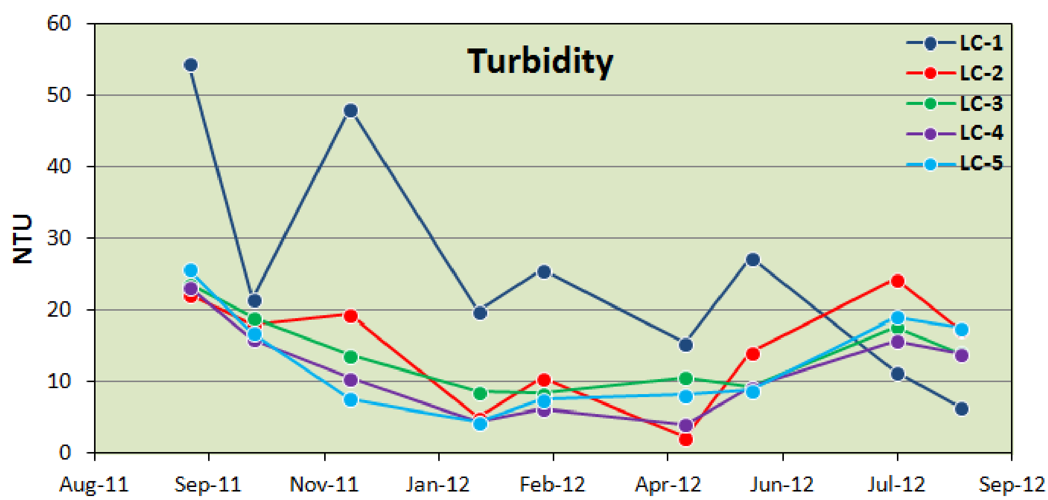

Figure 4.4. Time-series plot of turbidity values in Lake Conway.

Lake-wide averages showed a general increase in chlorophyll-*a* with increasing phosphorus. Lake-wide averages also showed low chlorophyll-*a* and higher turbidity during the November sampling, indicating the limiting effects of cooling temperatures, decreasing day length, and non-algal turbidity on primary production. Rising temperature and increasing day length results in increased primary production in the spring, which in turn decreases non-algal turbidity, as demonstrated by the May samples. As the growing season progresses, algal growth continues, resulting in increased turbidity and light-limited primary production due to high algal biomass.

Spatial patterns changed seasonally and individual sampling locations showed variations on the overall seasonal pattern: all sampling locations showed decreased turbidity and increased chlorophyll from November to May, but the trend continued into July at LC-1, which showed a greater degree of clearing and higher algal biomass. In the November and May samples chlorophyll-*a* concentrations were somewhat similar among all locations, staying within a range of approximately 20 µg/L. Chlorophyll-*a* concentrations from the July samples were much more variable, ranging from 17 µg/L at LC-5 to 102 µg/L at LC-1.

Growing season (average of May and July samples) differences among stations are summarized in Table 4.4. The highest chlorophyll-*a* and total phosphorus values were observed at LC-1 while concentrations at other stations were somewhat similar. There was a slight tendency for the lowermost station (LC-5) to show lower chlorophyll-*a* and total phosphorus. Nitrogen/phosphorus ratios (N/P) ranged from approximately 10 to 13 at LC-2 through LC-5 while the ratio at LC-1 was 7.6. Ratios of chlorophyll-*a* to total phosphorus (Chl-a/TP) were predicted using measured values of total phosphorus and the following relationship from Carlson (1977):

$$\ln(\text{Chl-a}) = [1.446 \times \ln(\text{TP})] - 2.442$$

Chl-a/TP values predicted by this equation exceeded the observed ratios by a factor of about two. Sampling sites LC-2 through LC-5 and the lake as a whole were classified as eutrophic and hyper-eutrophic based on chlorophyll-*a* and total phosphorus, respectively, as indicated by the trophic classification system summarized in Table 4.5. LC-1 was classified as hyper-eutrophic based on both chlorophyll-*a* and total phosphorus.

Table 4.4. Summary of growing season trophic parameters in Lake Conway.

Sampling Site	Growing Season Average (May and July Samples)						Trophic Class	
					Chl-a/TP			
	Chl-a	TP	Turbidity	N/P	Observed	Predicted	Based on Chl-a	Based on TP
LC-1	73.0	0.20	18.9	7.6	0.4	0.9	Hyper-eutrophic	Hyper-eutrophic
LC-2	39.1	0.12	25.1	10.6	0.3	0.7	Eutrophic	Hyper-eutrophic
LC-3	46.0	0.13	17.3	11.4	0.4	0.8	Eutrophic	Hyper-eutrophic
LC-4	47.4	0.10	15.7	13.2	0.5	0.7	Eutrophic	Hyper-eutrophic
LC-5	33.9	0.10	17.7	11.6	0.4	0.7	Eutrophic	Hyper-eutrophic
Lake-wide Average	47.9	0.13	18.9	10.9	0.4	0.8	Eutrophic	Hyper-eutrophic

Table 4.5. Trophic state classification categories based on chlorophyll and total phosphorus from Carlson and Simpson (1996).

Trophic Class	Chlorophyll-*a* (μg/L)	Total Phosphorus (μg/L)
Oligotrophic	0 – 2.6	0.0 – 0.012
Mesotrophic	2.6 – 20	0.012 – 0.024
Eutrophic	20 – 56	0.024 – 0.096
Hyper-eutrophic	56 – 155+	0.096 – 0.384+

There was a slight upstream-downstream gradient in trophic status with the most upstream station (LC-1) having the highest chlorophyll-*a* and total phosphorus concentrations and a hyper-eutrophic classification. The N/P of 7.6 observed at LC-1 indicates that that part of the lake might be marginally nitrogen-limited. Primary production at all stations is light-limited, which is most likely due to algal self-shading.

Seasonal nutrient and water clarity data suggest that Lake Conway is a nutrient-enriched, eutrophic to hyper-eutrophic system. While overall primary production is light-limited, borderline nitrogen limitation conditions might exist, especially in the upper lake, which can affect algal species composition. If nitrogen limitation were to become more pronounced, it could result in selection for algal communities that cause water quality problems associated with noxious forms of algae.

The higher values of predicted Chl-a/TP compared to observed Chl-a/TP indicates that primary production is light-limited, probably due to both algal and non-algal turbidity, depending on local conditions. Although N/P values near 10 indicate that phosphorus is the limiting nutrient, these values are near the range at which nitrogen limitation might also occur.

4.1.2 Stream Data

The continuous stage data that were collected for the six tributaries are shown on Figures 4.5 through 4.10. The purpose of the collecting continuous stage data was to be able to estimate continuous stream flows. Raw stage data were missing at Pierce Creek for 135 days (October 9, 2011, to February 20, 2012) and at Little Cypress Creek for 17 days (September 4 to September 21, 2011). The Pierce Creek data were missing due to a failed download, while the Little Cypress Creek data were missing due to an apparent vandal that removed the water level logger from the creek.

For both Pierce Creek and Little Cypress Creek, missing stage data were estimated using data from other monitored streams. For Pierce Creek, stages outside of the missing data period were found to be similar to the stages at Stone Dam Creek and Little Cypress Creek averaged together. Therefore, the missing stages at Pierce Creek were estimated as the stages at Stone Dam Creek and Little Cypress Creek averaged together. For Little Cypress Creek, missing stages were estimated using stages from Palarm Creek based on a similar evaluation.

4.1.3 Rating Curves and Stream Flow Data

As discussed in Section 3.3.1, rating curves were developed based on field measurements of stream flow. The rating curves that resulted from this process are shown on Figures 4.11 through 4.16. The accuracy of the rating curves was enhanced by having flow measurements during large storms.

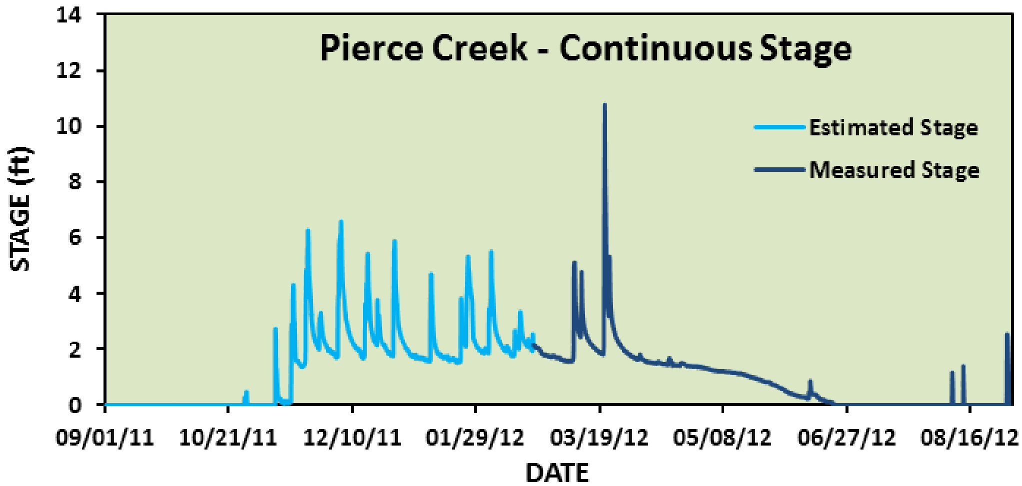

Figure 4.5. Stage data for Pierce Creek during the course of the project.

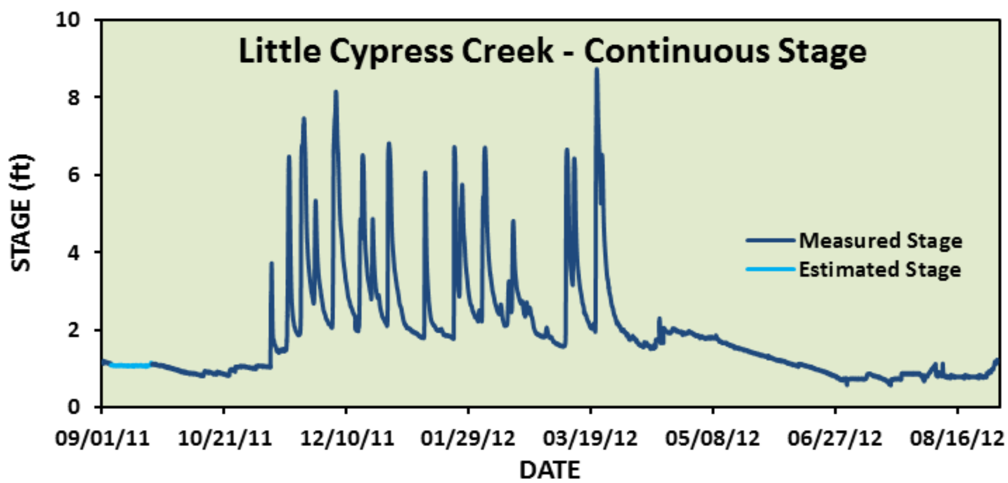

Figure 4.6. Stage data for Little Cypress Creek during the course of the project.

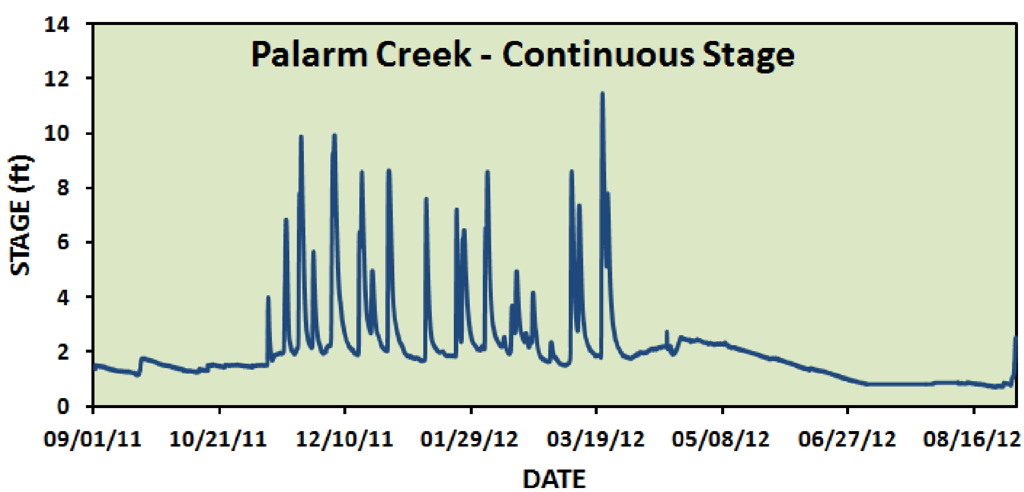

Figure 4.7. Stage data for Palarm Creek during the course of the project.

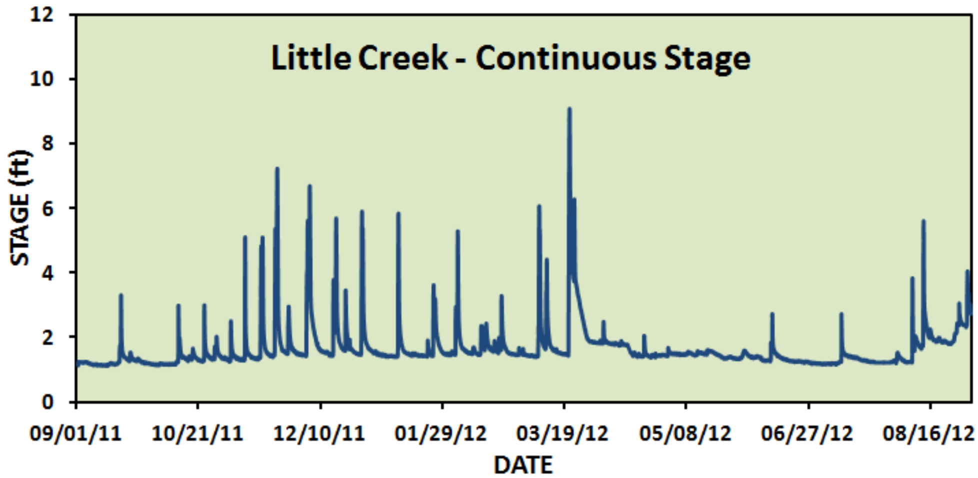

Figure 4.8. Stage data for Little Creek during the course of the project.

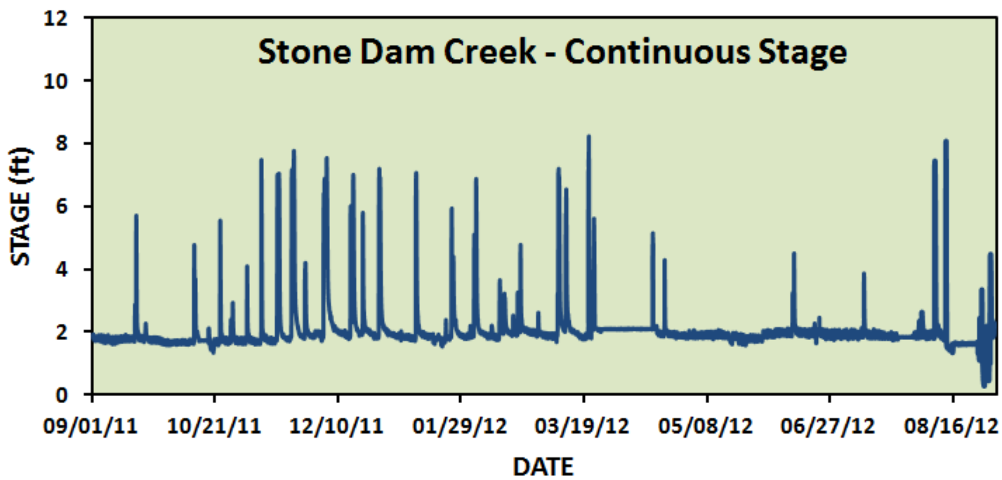

Figure 4.9. Stage data for Stone Dam Creek during the course of the project.

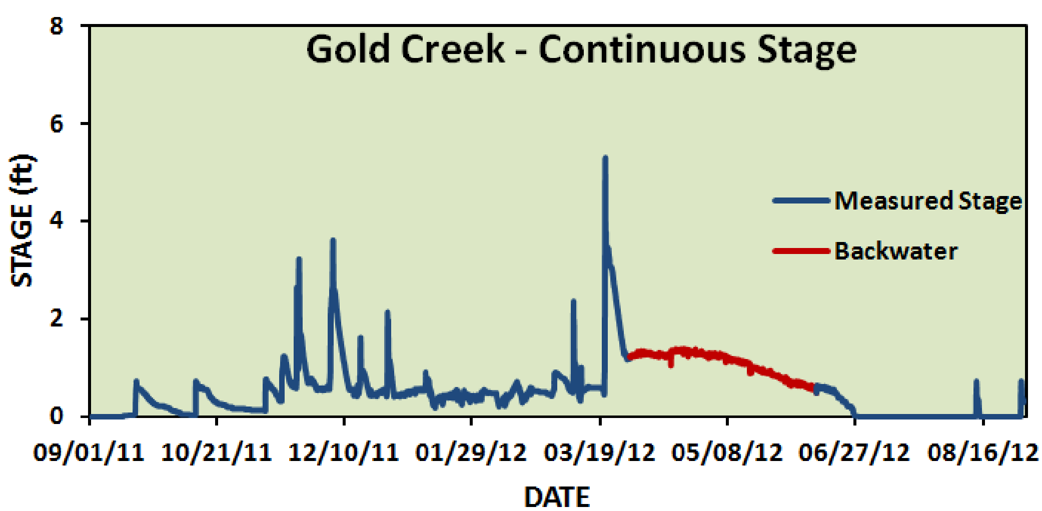

Figure 4.10. Stage data for Gold Creek during the course of the project.

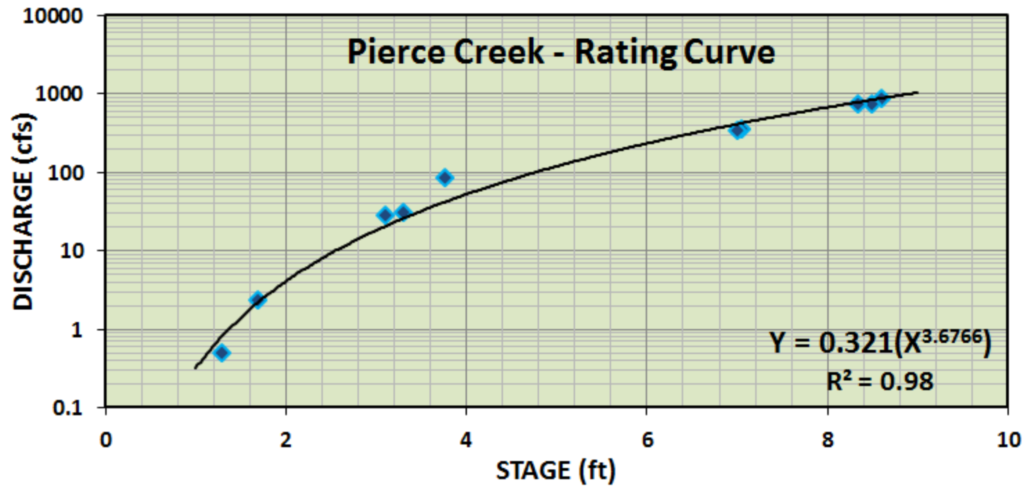

Figure 4.11. Rating curve for Pierce Creek.

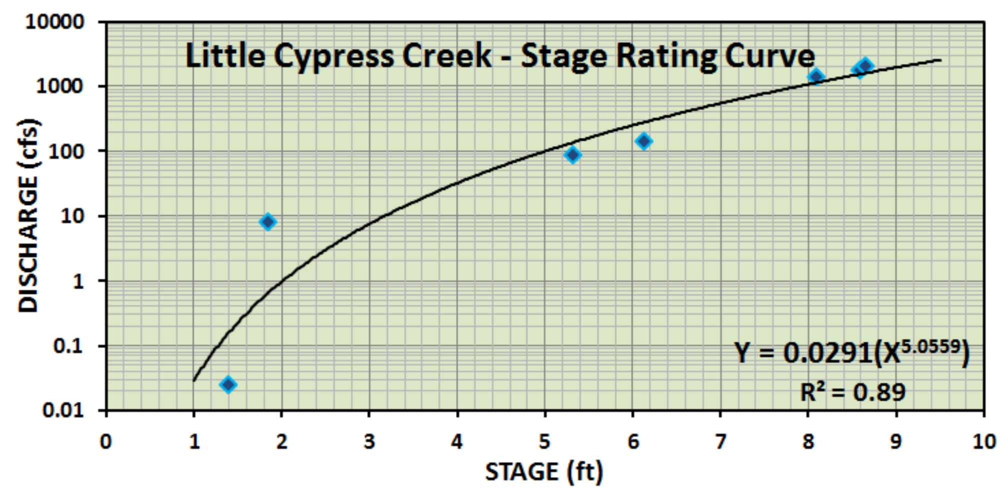

Figure 4.12. Rating curve for Little Cypress Creek.

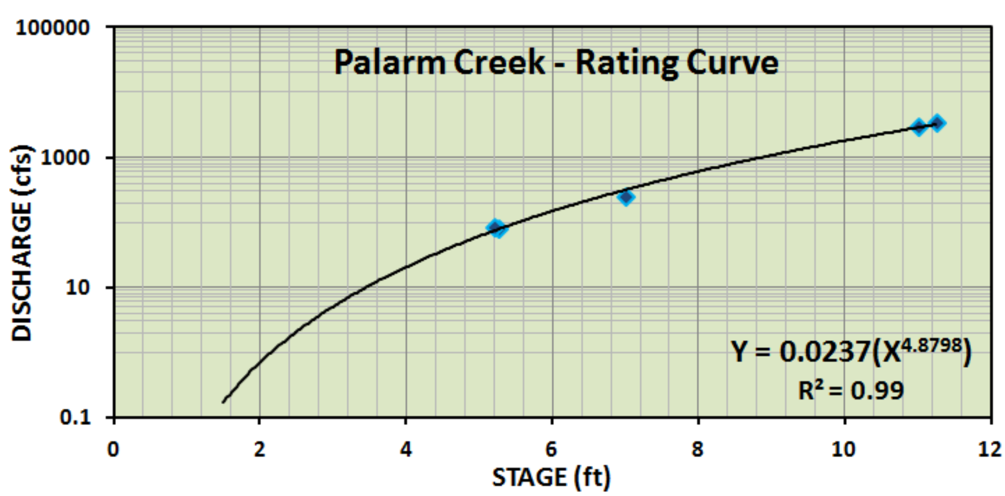

Figure 4.13. Rating curve for Palarm Creek.

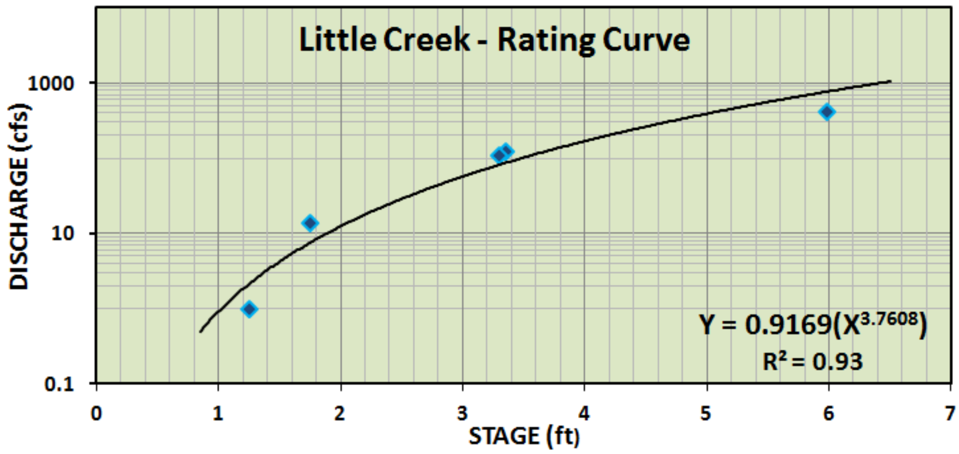

Figure 4.14. Rating curve for Little Creek.

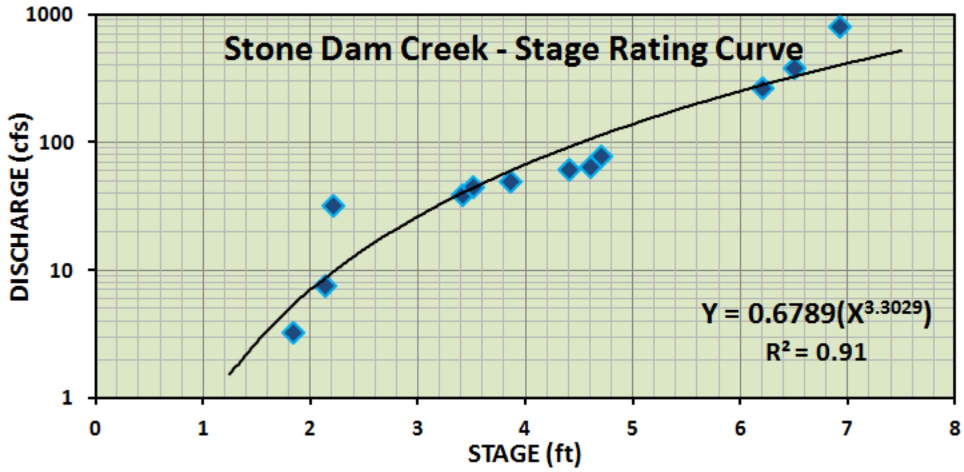

Figure 4.15. Rating curve for Stone Dam Creek.

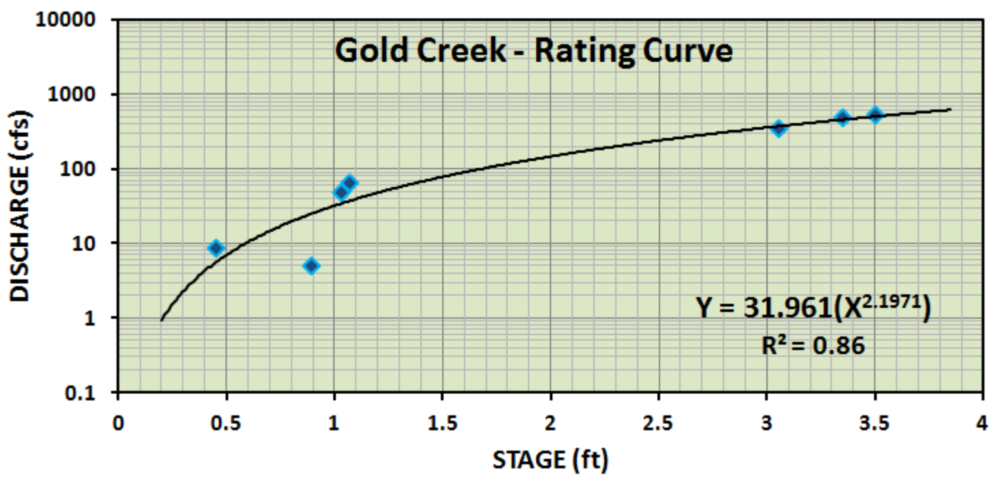

Figure 4.16. Rating curve for Gold Creek.

The continuous flow data that were estimated for the six tributaries are shown on Figures 4.17 through 4.22. The purpose of the estimating the continuous flow data was to be able to calculate loads of various constituents.

At each of the tributary sites, the flows from large storms are several orders of magnitude greater than the base flows. This is typical for most streams. Stone Dam Creek exhibited a higher base flow than the other streams due to the effluent discharged by the City of Conway WWTP located just upstream of the Stone Dam Creek monitoring station.

Continuous outflow from the lake was estimated as described in Section 3.3.2. A graph of the outflow is shown on Figure 4.23. Releases are made based on the water level of the lake. The gates were closed during the drier parts of the year when there was not sufficient inflow to raise the lake level enough for water to be released at the dam. The total volume of outflow during the project was 45,800 million gallons (6.12 billion cubic feet).

4.1.4 Stream Water Quality Data

The baseline (routine sampling) water quality was similar among the six monitored tributaries with the exception of Stone Dam Creek, which exhibited higher concentrations of phosphorus, nitrogen, chloride, and sulfate because of the City of Conway WWTP effluent. The influence of the WWTP on the Stone Dam Creek data is expected because the distance from the WWTP outfall to the Stone Dam Creek monitoring station was only about 0.5 mile.

Five storm events were monitored resulting in 89 storm samples collected from the tributaries and the outlet. Storm samples exhibited significantly higher TSS concentrations compared to base flow samples. During storm events, most streams had moderate concentration increases for all measured parameters, except for Stone Dam Creek. Storm sample concentrations from Stone Dam Creek remained stable or were diluted due to the influx of ambient runoff. Lack of dilution of the WWTP effluent causes the base flow samples to exhibit higher concentrations than the storm samples.

Data from storm events were separated into the various components of the hydrograph and are presented as mean and median concentrations. Figure 4.24 shows the position along the hydrograph for each individual storm sample collected during the course of the project.

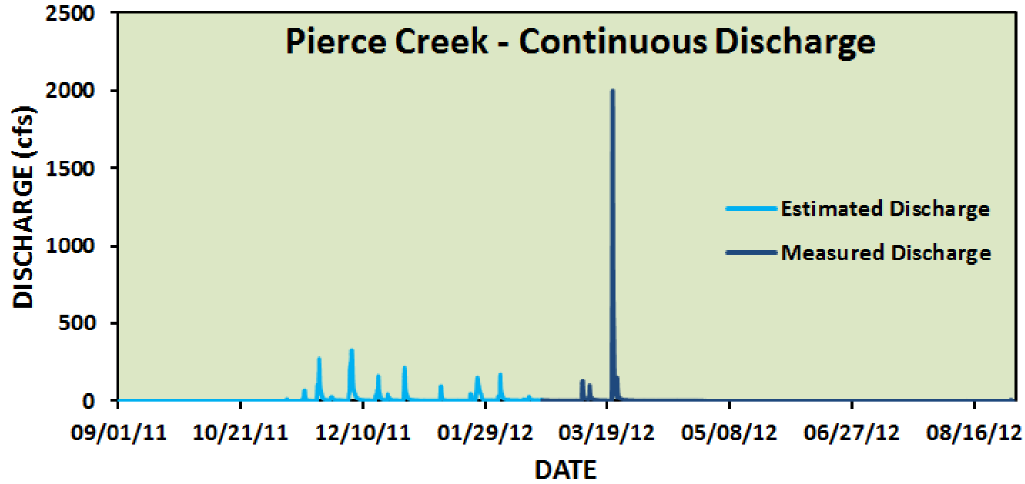

Figure 4.17. Discharge data for Pierce Creek during the course of the project.

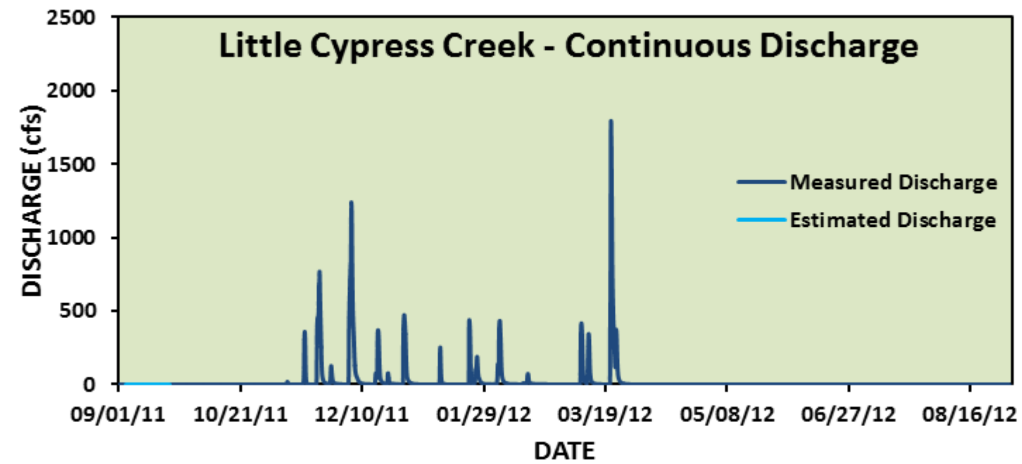

Figure 4.18. Discharge data for Little Cypress Creek during the course of the project.

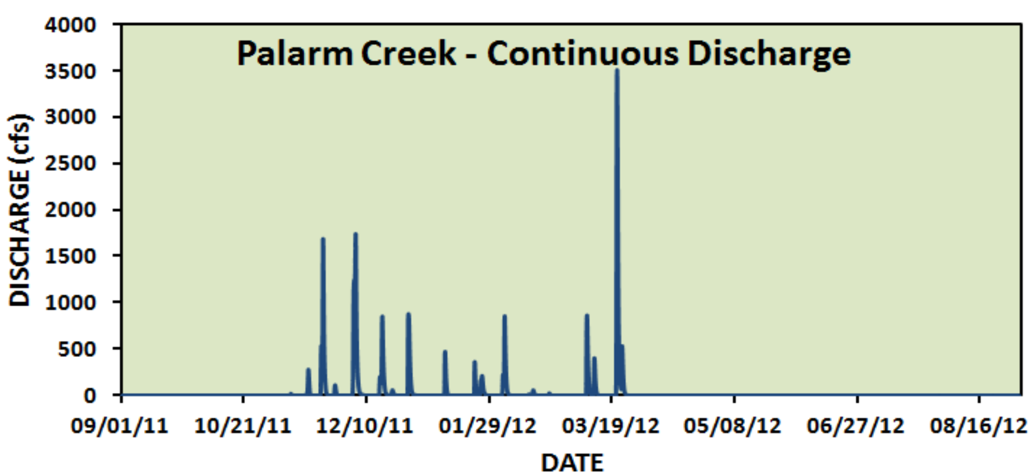

Figure 4.19. Discharge data for Palarm Creek during the course of the project.

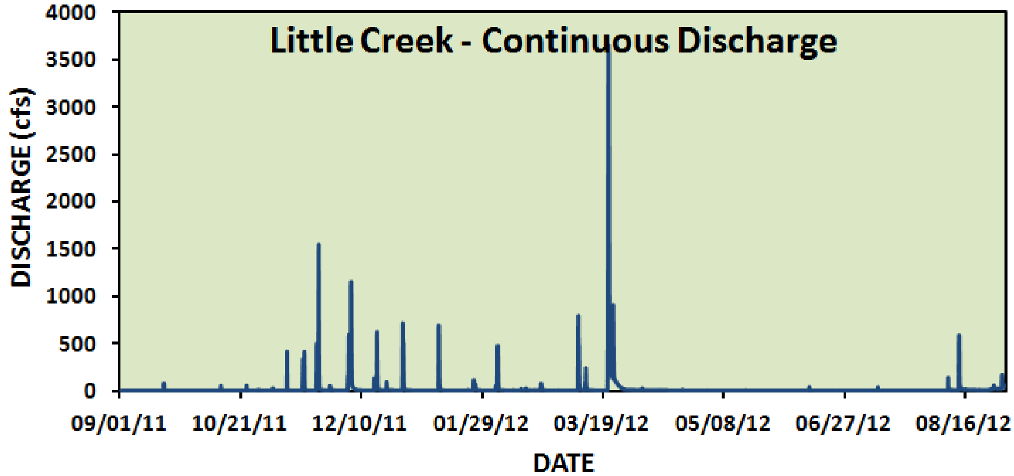

Figure 4.20. Discharge data for Little Creek during the course of the project.

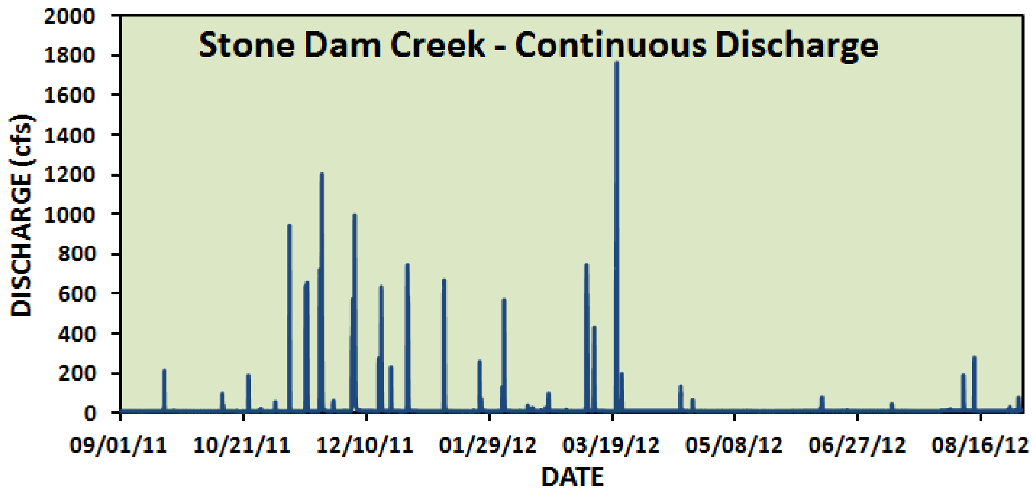

Figure 4.21. Discharge data for Stone Dam Creek during the course of the project.

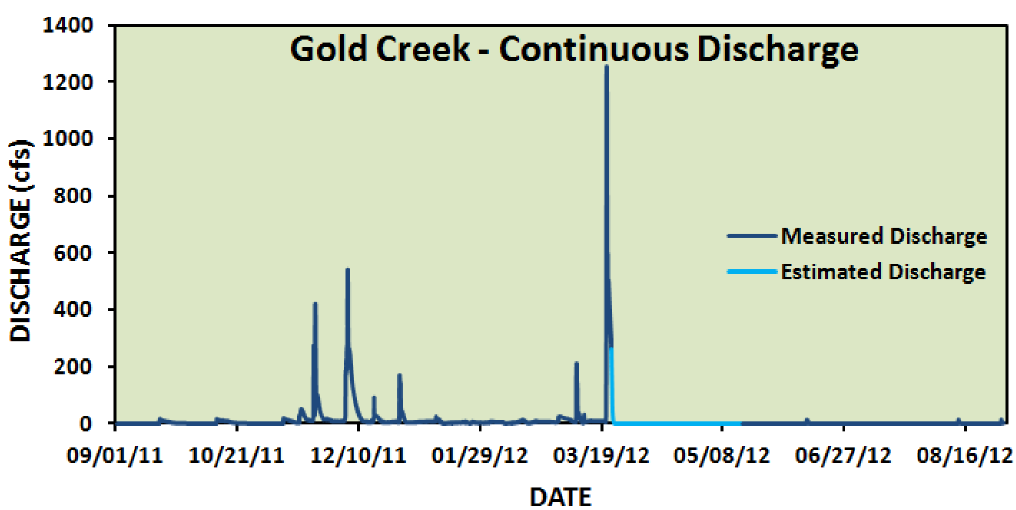

Figure 4.22. Discharge data for Gold Creek during the course of the project.

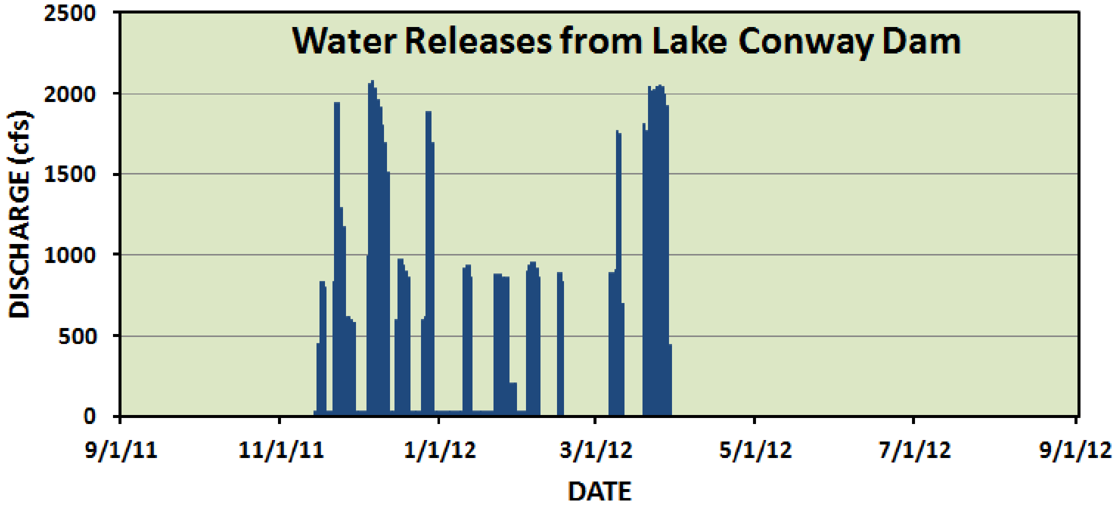

Figure 4.23. Water releases from Lake Conway dam during the course of the project.

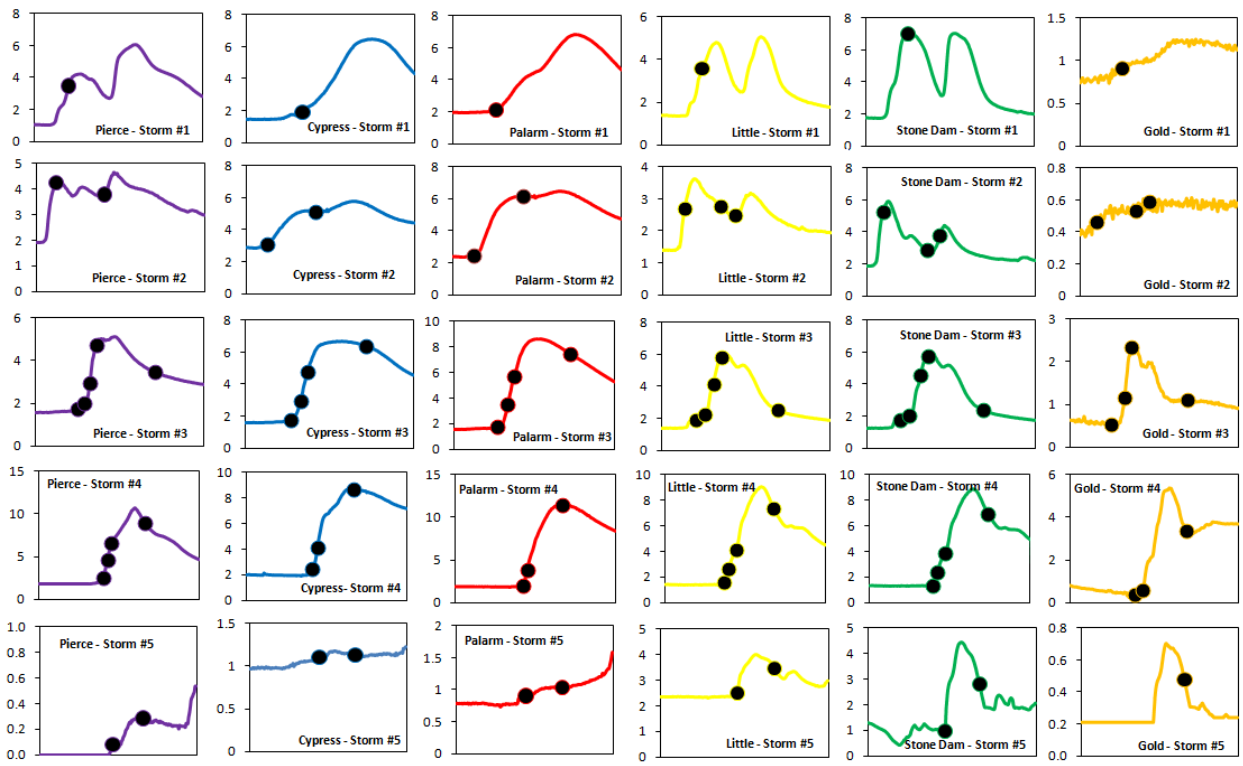

Figure 4.24. Hydrographs of each monitored storm event at each stream. Each plot shows an approximate 2-day time span of the hydrograph.

Tables 4.6 and 4.7 provide the averages and medians of selected parameters for all stream sampling locations for routine and storm samples, respectively.

Table 4.6. Average and median concentrations for routine samples at stream stations.

Date	Statistic	Total Phosphorus (mg/L)	Orthophosphate as Phosphorus (mg/L)	TKN (mg/L)	Ammonia Nitrogen (mg/L)	NO_2+NO_3–Nitrogen (mg/L)	TSS (mg/L)
Pierce Creek	Average	0.029	0.013	0.312	<0.03	0.10	4.38
	Median	0.029	0.012	0.172	<0.03	0.08	3.00
Little Cypress Creek	Average	0.083	0.023	0.70	0.04	0.17	23
	Median	0.060	0.017	0.68	<0.03	0.17	16
Palarm Creek	Average	0.119	0.029	0.95	0.12	0.12	12
	Median	0.068	0.019	0.83	0.06	0.04	6.0
Little Creek	Average	0.064	0.017	0.70	0.10	0.18	16
	Median	0.066	0.015	0.73	0.05	0.10	8.8
Stone Dam Creek	Average	2.01	1.84	2.53	1.13	6.99	11
	Median	2.05	1.97	2.53	0.27	5.04	8.0
Gold Creek	Average	0.163	0.108	0.90	0.13	0.60	9.7
	Median	0.055	0.014	0.90	0.03	0.05	7.0
Outlet	Average	0.098	0.016	1.02	0.113	0.067	10.7
	Median	0.105	0.013	1.02	0.075	0.055	10.8

Table 4.7. Average and median concentrations for storm event samples at stream stations.

Date	Statistic	Total Phosphorus (mg/L)	Orthophosphate as Phosphorus (mg/L)	TKN (mg/L)	Ammonia Nitrogen (mg/L)	NO_2+NO_3–Nitrogen (mg/L)	TSS (mg/L)
Pierce Creek	Average	0.061	0.020	0.63	0.06	0.22	24
	Median	0.051	0.017	0.58	<0.03	0.06	14
Little Cypress Creek	Average	0.189	0.072	1.02	0.10	0.16	139
	Median	0.162	0.042	1.00	0.10	0.18	88
Palarm Creek	Average	0.161	0.059	0.87	0.08	0.13	65
	Median	0.131	0.050	0.89	0.07	0.11	56
Little Creek	Average	0.132	0.045	0.91	0.09	0.26	79
	Median	0.129	0.052	0.86	0.10	0.27	47
Stone Dam Creek	Average	0.470	0.361	1.22	0.40	1.67	55
	Median	0.270	0.171	1.05	0.19	0.68	29
Gold Creek	Average	0.115	0.038	0.74	0.05	0.19	66
	Median	0.091	0.032	0.66	0.05	0.19	45
Outlet	Average	0.089	0.014	0.79	0.07	0.04	18
	Median	0.078	0.012	0.69	0.04	<0.03	17

Pierce Creek

Because Pierce Creek was dry for about 6 months during the project, only four routine samples were collected. The water quality of Pierce Creek reflects its setting of a primarily forested and relatively undisturbed watershed. Sampling results from Pierce Creek showed the lowest concentrations for all parameters of all the streams monitored for this project. TSS and TDS were considerably lower than the other streams.

Little Cypress Creek

Little Cypress Creek flows primarily through bottomland forests and pastures to its downstream confluence with Palarm Creek. Little Cypress Creek was flowing for the vast majority of the project timeframe; however, during the summer months there was little water and minimal flow. Little Cypress Creek exhibited the highest TSS concentrations.

Palarm Creek

Palarm Creek has a similar setting, flow characteristics, and water quality to Little Cypress Creek. Palarm Creek meanders through agricultural fields, pastures and some forested areas before its confluence with Lake Conway. Much like Little Cypress Creek, Palarm Creek exhibited high TSS concentrations. Palarm Creek exhibited the second highest concentrations of TDS, behind only Stone Dam Creek. Nutrient concentrations at Palarm Creek were slightly higher than those observed at the other streams.

Little Creek

Little Creek drains an assemblage of agricultural fields and pastures. The stream additionally receives some urban runoff from the east side of the city of Conway. The water quality measured at Little Creek did not exhibit extremely high concentrations of any parameter except TDS. Little Creek TDS concentrations were similar to those of Palarm Creek; however, they were not as high as those observed in Stone Dam Creek.

Stone Dam Creek

Of all the tributary streams sampled during this project, Stone Dam Creek exhibited the highest concentrations of all parameters except TSS. The high nutrient concentrations originated from the effluent that Stone Dam Creek received from the City of Conway WWTP located just upstream from the sampling location. Concentrations of most measured parameters were higher than those measured at the other streams.

Gold Creek

Gold Creek became an intermittent stream during the summer months and tended to have little to no flow during that time. The water quality of Gold Creek is generally good, having similar concentrations to those measured at the other streams.

4.1.5 Comparison of Flow Contributions

The total inflow from the six monitored tributaries during the 1-year project period was approximately 23,900 million gallons (3.2 billion cubic feet). This volume corresponds to an annual average inflow rate of 101.4 cfs from the monitored areas. The total drainage area upstream of the monitoring sites was 93.2 square miles. Therefore, the monitored flow per unit of drainage area was 1.09 cfs per square mile. For comparison purposes, the long term average annual runoff (i.e., water that becomes streamflow) for the Lake Conway area is approximately 17 to 18 in/yr (USGS 1984). This depth of runoff corresponds to a flow rate of about 1.3 cfs per square mile. The monitored value (1.09 cfs per square mile) is slightly less than, but similar to, the published value.

Monitoring efforts did not account for the entire area of the Lake Conway drainage basin; therefore, these values do not represent the total inflow of water to Lake Conway. Calculations to estimate the unmonitored inflows are presented later in this report.

Table 4.10 compares the base flow and storm flow contributions to the total annual flow. Stone Dam Creek contributes the most base flow due to the Conway WWTP. Palarm Creek contributes the most storm flow and total flow because its drainage area at the monitoring station (34.2 square miles) is nearly twice as large than the next largest monitored drainage area

(19.4 square miles for Little Cypress Creek). Figure 4.25 presents these same data graphically with units for volumes rather than average flow rates.

Table 4.8. Base flow and storm flow contributions to total annual flow.

Site	Contribution to Total Annual Flow (cfs)		
	Base Flow	Storm Flow	Total
Pierce Creek	2.3	5.8	8.1
Little Cypress Creek	1.7	20.3	22.0
Palarm Creek	1.1	27.0	28.1
Little Creek	5.0	14.0	19.0
Stone Dam Creek	6.5	7.3	13.8
Gold Creek	3.7	6.7	10.4
TOTAL	20.3	81.1	101.4

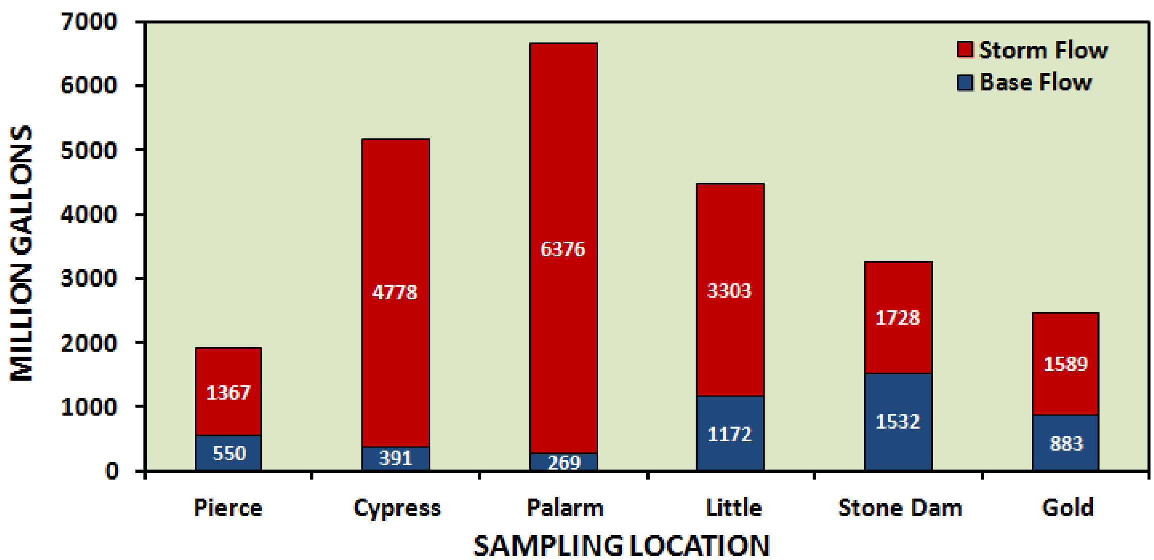

Figure 4.25. Base flow and storm flow contributions from monitored streams.

4.1.1 Constituent Loads

As discussed in Section 3.3.3, loads of various constituents were calculated for each monitored tributary as well as the outlet. Table 4.9 shows the loads for each monitored tributary divided into base flow and storm flow contributions. Pierce Creek had the lowest load for each constituent; this was due to both the lower stream flow values and lower concentrations in Pierce Creek. Stone Dam Creek had the largest loads of nitrogen and phosphorus due to inputs from the City of Conway WWTP. Table 4.10 presents the percentages of the total monitored load that are contributed by each stream. Stone Dam Creek contributed 60% to 75% of the total phosphorus, orthophosphate, ammonia nitrogen, and nitrate+nitrite nitrogen that was monitored.

The City of Conway WWTP will be taken offline and will no longer discharge wastewater to Stone Dam Creek after the new Tupelo Bayou WWTP is completed (anticipated completion is mid-2014). The Tupelo Bayou WWTP will discharge to the Arkansas River, which means that the nutrient load to Lake Conway will be reduced. Table 4.11 shows the results of calculations for the WWTP loads as percentages of the total loads to the lake. These calculations indicate that when the Conway WWTP stops discharging into Stone Dam Creek, the total loads to the lake will be reduced by 29% to 37% for total phosphorus, orthophosphate, ammonia nitrogen, and nitrate+nitrite nitrogen. The reduction will not be as large for TKN (14%).

The load of TSS in the outflow from the dam was calculated using the average TSS concentration from storm samples collected at the outlet. The TSS (sediment) mass discharged from the dam during the course of the project was estimated to be 2,961 tons.

Table 4.9. Estimated pollutant loads for each monitored stream.

Stream	Flow	Total Phosphorus (lbs)	Orthophosphate as Phosphorus (lbs)	TKN (lbs)	Ammonia Nitrogen (lbs)	NO_2+ NO_3 Nitrogen (lbs)	TSS (lbs)
Pierce Creek	Base	140	57	34	141	412	11,457
	Storm	744	258	221	463	1410	356,031
	TOTAL	**884**	**315**	**255**	**604**	**1,822**	**367,488**
Cypress Creek	Base	163	56	1,222	100	575	24,949
	Storm	5,425	2,582	31,260	2,562	5,039	1,320,646
	TOTAL	**5,588**	**2,638**	**32,482**	**2,662**	**5,614**	**1,345,595**
Palarm Creek	Base	214	58	1479	104	244	21,748
	Storm	6,635	2,692	42,894	2,746	4,577	2,140,117
	TOTAL	**6,849**	**2,750**	**44,373**	**2,850**	**4,821**	**2,161,865**
Little Creek	Base	521	151	5566	542	2,429	94,506
	Storm	3,756	1,464	24,330	2,278	6,715	1,615,421
	TOTAL	**4,277**	**1,615**	**29,896**	**2,820**	**9,144**	**1,709,927**
Stone Dam Creek	Base	29,420	27,013	46,072	26,156	98,725	120,502
	Storm	4,546	3,335	14,770	3,870	14,015	624,308
	TOTAL	**33,966**	**30,348**	**60,842**	**30,026**	**112,740**	**744,810**
Gold Creek	Base	2,791	2,188	7,586	2,304	12,185	111,760
	Storm	1,692	732	9,100	856	3,067	795,717
	TOTAL	**4,483**	**2,920**	**16,686**	**3,160**	**15,252**	**907,477**

Table 4.10. Percentages of total monitored loads contributed by each stream.

Stream	Total Phosphorus	Orthophosphate as Phosphorus	TKN	Ammonia Nitrogen	NO_2 + NO_3 Nitrogen	TSS
Pierce	1.6%	0.8%	0.1%	1.4%	1.2%	5.1%
Cypress	10.0%	6.5%	17.6%	6.3%	3.8%	18.6%
Palarm	12.2%	6.8%	24.1%	6.8%	3.2%	29.9%
Little	7.6%	4.0%	16.2%	6.7%	6.1%	23.6%
Stone Dam	60.6%	74.7%	33.0%	71.3%	75.5%	10.3%
Gold	8.0%	7.2%	9.0%	7.5%	10.2%	12.5%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 4.11. Percentage of total loads to the lake contributed by the Conway WWTP.

Stream	Total Phosphorus (lbs)	Orthophosphate as Phosphorus (lbs)	TKN (lbs)	Ammonia Nitrogen (lbs)	$NO_2 + NO_3$ Nitrogen (lbs)	TSS (thousands of lbs)
Total monitored load	56,047	40,586	184,534	42,122	149,393	7,237
Unmonitored load [1]	43,853	31,756	144,384	32,957	116,889	5,662
Total load to the lake	99,900	72,342	328,918	75,079	266,282	12,899
WWTP load [2]	29,420	27,013	46,072	26,156	98,725	121
WWTP load as percent of total load	29%	37%	14%	35%	37%	1%

Notes: 1. The ratio of the unmonitored load to the monitored load was assumed to be the same as the ratio of the unmonitored inflow (18,700 million gallons) to the monitored flow (23,900 million gallons).
2. The WWTP load was assumed to be equal to the base flow load measured in Stone Dam Creek.

4.2 Sediment Survey

4.2.1 Comparison of Sediment Loads Among Monitored Streams

The sediment loads that were measured for each stream are expressed as loads per unit of drainage area in Table 4.12. The stream with the lowest load per unit of drainage area was Pierce Creek, which drains a watershed that is heavily forested and is partly within the Camp Robinson State Wildlife Management Area.

The two streams with the highest load per unit of drainage area were Little Creek and Stone Dam Creek, both of which drain heavily urban areas in and around Conway. These measured loads likely include some sediment from stream bank erosion as well as sheet erosion from land surfaces. During storms, urban areas tend to generate high stream flows due to runoff from impervious land surfaces. These high stream flows can erode stream banks and transport sediment downstream without much settling.

Table 4.12. Sediment loads per unit of drainage area.

Stream	Measured Sediment Load (thousand lbs/yr)	Measured Sediment Load (tons/yr)	Drainage Area at Monitoring Site (acres)	Sediment Load Per Unit of Drainage Area (tons/ac/yr)
Pierce	367	183.5	5,350	0.03
Cypress	1,346	673.0	12,420	0.05
Palarm	2,162	1,081	21,910	0.05
Little	1,710	855.0	8,270	0.10
Stone Dam	745	372.5	4,860	0.08
Gold	907	453.5	6,870	0.07

4.2.2 Estimation of Unmonitored Inflow and Associated Sediment Load

In order to estimate the total sediment load to the lake, it was necessary to include the sediment load from unmonitored inflow. The unmonitored inflow to Lake Conway represents inflow from areas downstream of monitoring sites and other unmonitored tributaries (e.g., Panther Creek and Chadwick Creek). The unmonitored inflow also includes some flow from monitored streams that bypassed the monitoring sites via alternate flow paths (i.e., multiple bridge openings within the floodplain of one stream, water flowing over a road instead of under the bridge where monitoring occurred). The volume of unmonitored inflow during the course of the project was estimated using an annual mass balance approach for the lake, which is expressed with the following equation:

Unmonitored inflow = *outflow volume – monitored inflow volume + change in storage -- direct precipitation + evaporation*

The values for the terms in the equation above were as follows:

- Outflow volume = 45,800 million gallons (see Section 4.1.3);
- Monitored inflow volume = 23,900 million gallons (see Section 4.1.5);
- Change in storage from beginning to end of monitoring period = -1,700 million gallons (the ending pool elevation was 0.925 ft lower than the beginning pool elevation);
- Direct precipitation on lake surface = 7,100 million gallons (46.71 inches of rain at Conway airport during monitoring period); and

- Evaporation from lake surface = 5,600 million gallons (average annual lake evaporation of 36.9 inches was estimated using pan evaporation data from Russellville and Blakely Mountain Dam from National Climatic Data Center, along with pan coefficient of 0.74).

Therefore, unmonitored inflow was calculated as follows (all units are million gallons):

Unmonitored Inflow = 45,800 – 23,900 + (-1,700) – 7,100 + 5,600
= 18,700 million gallons

The sediment load associated with the unmonitored inflow was estimated by assuming that the ratio of monitored sediment to unmonitored sediment would be the same as the ratio of monitored flow to unmonitored flow. Therefore, the annual sediment load for the unmonitored inflow was calculated as follows:

Unmonitored sediment load = *monitored sediment load* × *(unmonitored inflow ÷ monitored inflow)*
= 3,620 tons/yr × (18,700 million gal ÷ 23,900 million gal)
= 2,830 tons/yr

Using this result, the total sediment load to the lake during the one-year monitoring period was calculated as follows:

Total sediment load = *monitored sediment load* + *unmonitored sediment load*
= 3,620 tons/yr + 2,830 tons/yr
= 6,450 tons/yr

This sediment load can also be expressed per unit of land draining to the lake:

Sediment load per unit of drainage area = 6,450 tons per year ÷ 81,400 acres
= 0.08 tons per acre per year

4.2.3 Comparison of Sediment Load to Published Data

The sediment load per unit of land area is lower than published estimates of erosion from pasture in Arkansas combined with sediment delivery ratios based on drainage area. According to the 2007 National Resources Inventory (NRI) conducted by the Natural Resources Conservation Service (NRCS), the average erosion rate for pasture in Arkansas is approximately 1.1 tons/ac/yr (USDA 2009). This value represents erosion on a field scale and must be multiplied by a sediment delivery ratio in order to estimate sediment loads on a watershed basis. Using a simplified relationship between sediment delivery ratio and drainage area (Roehl 1962), a reasonable range of values for sediment delivery ratios for the Lake Conway tributaries would be 10% to 30%. Applying this range of sediment delivery ratios (10% to 30%) with the average annual erosion rate for pasture in Arkansas (1.1 tons/ac/yr) yields a range of estimated sediment loads of 0.11 ton/ac/yr to 0.33 ton/ac/yr. This range is higher than the value above that was derived from field measurements in this project (0.08 ton/ac/yr). Also, it should be noted that the published erosion rate used in these calculations represents only sheet erosion from pasture land and does not account for erosion from other areas with higher erosion rates (e.g., cropland or construction sites), nor does it account for stream bank erosion. In other words, the actual sediment load is expected to be slightly higher than the range calculated here (0.11 ton/ac/yr to 0.33 ton/ac/yr).

The sediment load derived from field measurements in this project (0.08 ton/ac/yr) was probably an underestimate of the actual sediment load because the TSS samples that were collected during this project and used to develop sediment loads were simply grab samples from the surface of the stream and did not account for bedload. Bedload is defined as the load of heavier sediment particles that are transported along the bottom of a stream, particularly during storms when water velocities are higher.

The rainfall at the Conway airport during the one-year monitoring period was 46.71 inches, which is slightly less than, but similar to, the long-term average annual precipitation (49.08 inches).

4.2.4 Reservoir Trap Efficiency

Some of the sediment entering a lake settles to the bottom of the lake (i.e., is “trapped” in the lake) and the remainder is discharged through the outlet of the lake. The percentage of the inflowing sediment that is trapped in a lake or reservoir is referred to as the trap efficiency. The trap efficiency for Lake Conway for the one-year monitoring period was calculated as follows:

Trap efficiency = 100% × (inflow sediment load–outflow sediment load) ÷ inflow sediment load
= 100% × (6,450 tons/yr – 2,960 tons/yr) / 6,450 tons/yr
= 54%

The result of the trap efficiency calculation was compared with published information for estimating trap efficiency (Brune 1953). The published relationship is a graph of trap efficiency versus the ratio of lake capacity to annual inflow and is based on data from numerous reservoirs across the US. Using information for Lake Conway, this published relationship yields an estimated trap efficiency of approximately 85% to 97%. This is a generalized relationship that does not take into account detailed site-specific information, but it suggests that the value of 54% calculated above may be an underestimate of the actual trap efficiency. If the inflow sediment load is underestimated (as discussed above), the trap efficiency will also be underestimated. The published information suggests that a large percentage of the inflowing sediment is trapped within Lake Conway.

4.2.5 Sedimentation Study

Using methods described in Section 3.2, the thickness of sediment accumulated on the bottom of the lake was measured at more than 300 locations across the entire lake using a static cone penetrometer. The following figures demonstrate the locations where sediment depths were measured (Figure 4.26), the measured sediment thickness (Figure 4.27), and the water depth at normal pool elevation (Figure 4.28). This sedimentation study was designed and carried out such that the study can be repeated in the future to allow a direct comparison for evaluating changes over time.

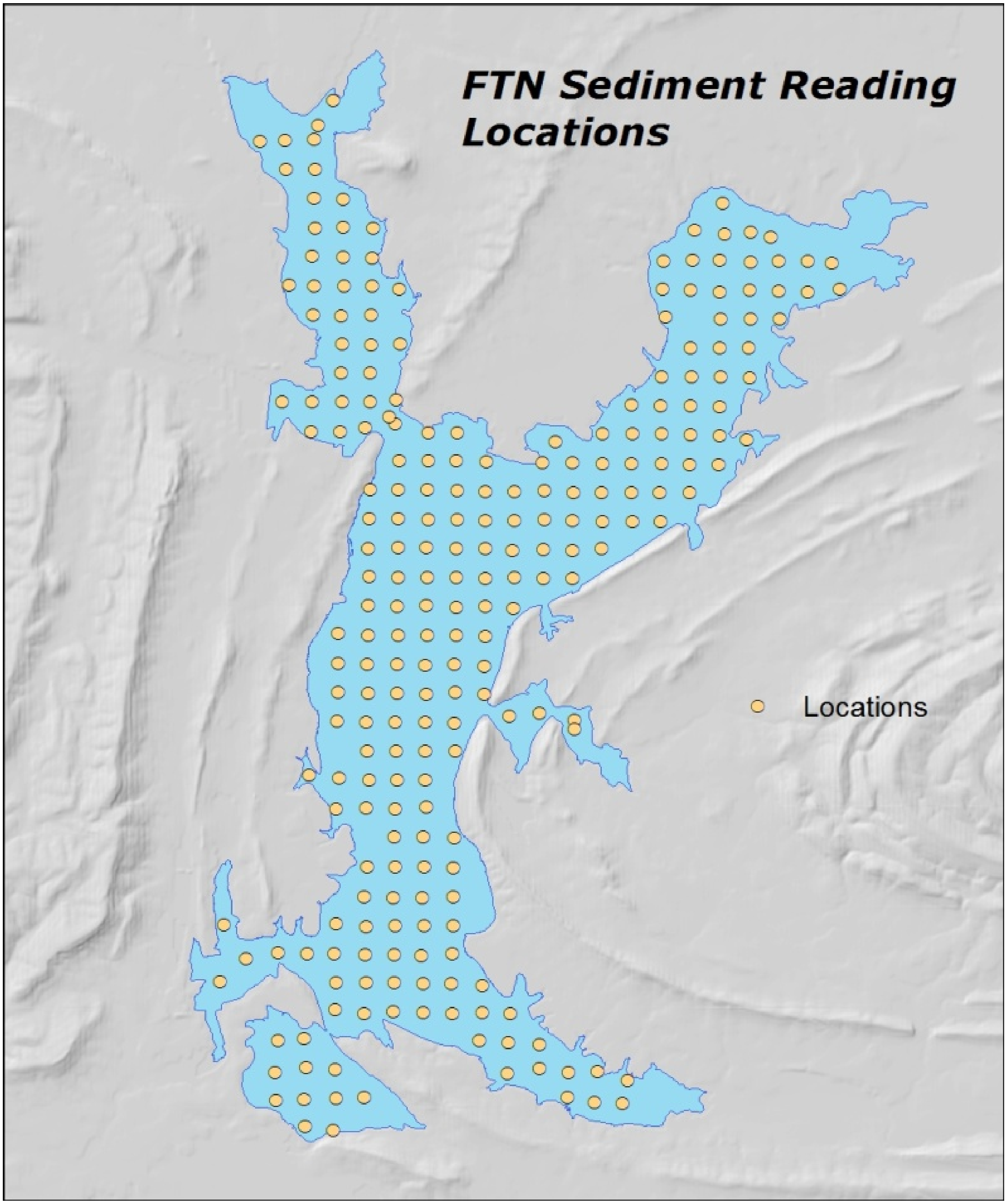

Figure 4.26. Locations of individual measurements for sedimentation study.

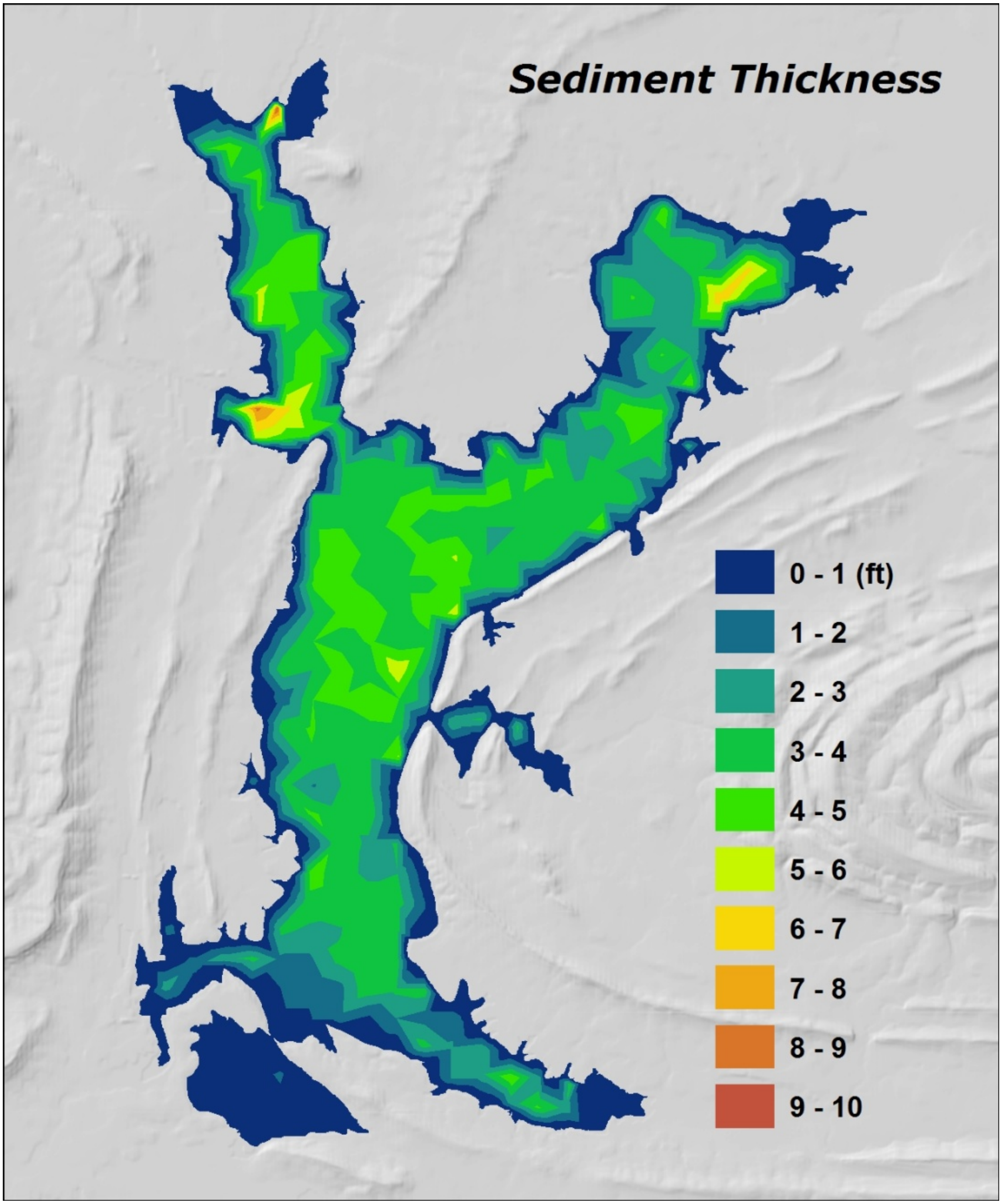

Figure 4.27. Measured sediment thickness in Lake Conway.

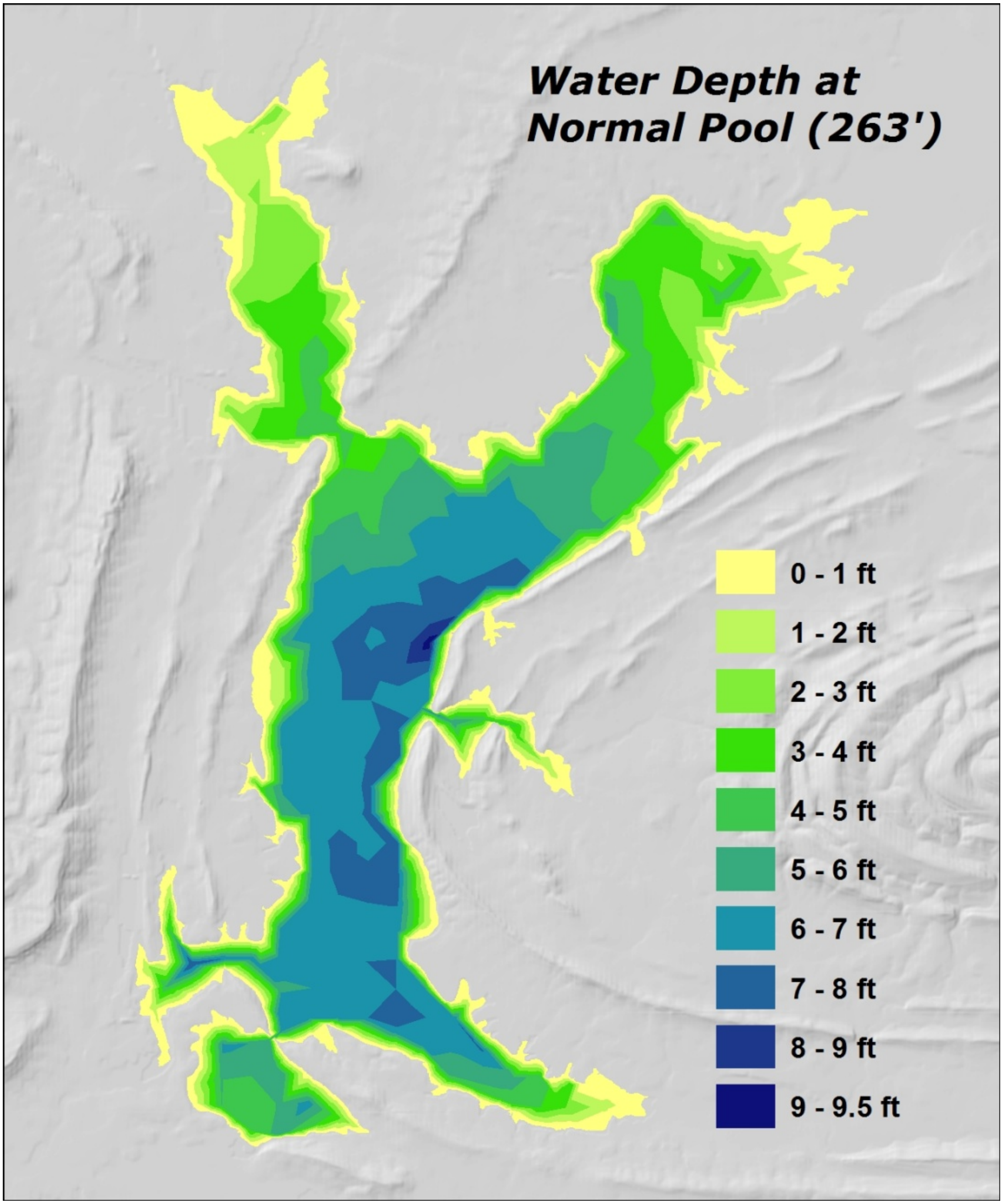

Figure 4.28. Water depth of Lake Conway at normal pool elevation.

The field measurements of top of sediment and sediment thickness were recorded on multiple days at different lake levels, but they were normalized to a pool elevation of 263 ft before being imported as x,y,z point locations into the ESRI ArcGIS software environment for analysis. Using the 3D Analyst extension, the measurements for the top of sediment and bottom of sediment were used to create a Triangular Irregular Network (TIN). The two TINs are a three-dimensional model representation of the sample locations depicting their respective datasets. Additional TIN editing was done to help estimate areas where sampling did not occur via TIN interpolation methods. Using the resultant TIN datasets, the volume of accumulated sediment was calculated as the volume between the top of sediment and the bottom of sediment.

4.2.6 Comparison of Sediment Accumulation in Different Areas

The depth of accumulated sediment was greatest and the depth of water was shallowest in the bays where sediment enters the lake and begins to settle to the bottom as the velocity of the water decreases greatly going from the stream channel to the lake. This is a typical pattern of sediment accumulation for lakes and reservoirs. The deepest measurements of sediment depth were near the mouths of Gold Creek, Little Creek, and Palarm Creek / Cypress Creek. Except for a small area of deep sediment near the mouth of Palarm Creek and Cypress Creek, the northeastern bay has generally less sediment accumulation than the northwestern bay. The high sediment accumulation rates in the northwestern bay are consistent with visual observations of high turbidity in the northwestern bay that is evident from aerial images of Lake Conway on Google Earth dated January 2006 and February 2012. The portion of the lake with the least amount of sediment accumulation was the area between the Highway 89 bridge and the dam.

4.2.7 Volume of Accumulated Sediment and Corresponding Loads

The volume of accumulated sediment was calculated to be approximately 596 million ft^3, or 13,700 ac-ft. Based on a surface area of 5,625 ac for the lake, this corresponds to an average depth of accumulated sediment of 2.4 ft across the entire lake. If only the lake surface area upstream of the Highway 89 bridge is used (because most of the sediment accumulated upstream of the Highway 89 bridge), the average depth of accumulated sediment is 2.6 ft.

The amount of accumulated sediment in the lake can also be evaluated in terms of average annual sediment loads per unit of drainage area over the years since the lake was impounded. This calculation includes an assumed sediment bulk density of 50 lbs/ft^3 based on literature values that are summarized in Table 4.13. The calculation is shown below:

Sediment accumulation/drainage area = 596 million ft^3 × 50 lbs/ft^3 / 2000 lbs/ton / 81,400 ac / 61 yrs

= 3.0 tons/ac/yr

The value for annual sediment load to the lake is calculated to be much higher using the sedimentation study results (3.0 tons/ac/yr) than using the TSS sampling data (0.08 tons/ac/yr). This suggests a strong possibility that the penetrometer went below the layer of accumulated sediment and into the pre-impoundment ground level. Prior to impoundment, much of the lake was a wetland and may have had relatively soft, organic soils. If pre-impoundment sediment is soft, it may provide a resistance to the penetrometer that is similar to that of accumulated sediment.

Table 4.13. Published values of sediment bulk density.

Lake(s)	**Number of values**	**Sediment bulk density (lbs/ft^3)**		**Data source**
		Range	**Average**	
Grenada Lake, Mississippi (10 sites with geochronological analysis)	10	36 - 80	49	Bennett and Rhoton 2003
Cedar Lake and Olathe Lake, Kansas	8	28 - 61	41	Mau 2002
Schmidt Lake, Minnesota	16	32 - 58	48	McComas 2008
25 lakes in Iowa	25	33 - 92	59	Downing et al 2008
Lake Lemon, Indiana	22	38 - 64	54	Hartke and Hill 1974
Overall Average =			50	--

4.2.8 Rates at Which Sediment Will Fill Different Parts of the Lake

Another value that was calculated was the remaining time until the lake fills with sediment. This calculation was carried out for different parts of the lake due to spatial differences in sediment accumulation rates and existing water depths. This calculation assumes that sediment will continue to accumulate in each area at a rate equal to the current accumulated depth divided by the length of time over which it has accumulated (61 yrs). To keep the analysis simple and manageable, this calculation also assumes that sediment will accumulate all the way up to the normal pool elevation without being scoured. The calculations are summarized in Table 4.14.

Table 4.14. Calculations for length of time for sediment to fill different parts of the lake.

	Northwestern Bay	**Northeastern Bay**	**Middle of Lake**
Average depth of sediment accumulation (visually estimated from Figure 4.27)	4 ft	3 ft	3 ft
Long term sediment accumulation rate (depth of sediment accumulation ÷ 61 yrs)	0.066 ft/yr	0.049 ft/yr	0.049 ft/yr
Number of years to accumulate 1 ft of sediment (1.0 ÷ sediment accumulation rate)	15	20	20
Average depth of water at normal pool (visually estimated from Figure 4.28)	3 ft	3 ft	6 ft
No. of years until filled with sediment (water depth ÷ sediment accumulation rate)	45 yrs	60 yrs	120 yrs

Although it is unrealistic to assume that accumulating sediment will not be scoured as the top of sediment approaches the water level, these calculations are still useful to see how quickly the sediment is expected to build up in certain areas. For example, if a certain area within the northwestern bay will become a concern for boat access if sediment builds up by 1 ft more, these calculations indicate that it would take approximately 15 years for that to occur.

This analysis assumes that sediment loads to the lake will continue as they have since the lake was impounded. It is possible that future sediment loads to the lake may be less than historical sediment loads. There have likely been major improvements over time regarding implementation of best management practices to control erosion from construction areas as well as agricultural land.

5.0 CONCLUSIONS

The following overall conclusions are based on the results of this project:

- This project successfully established baseline data to characterize (1) tributary water quality during base flow and storm flow conditions; (2) loads of nutrients, sediment, and other parameters from six tributaries; (3) water quality in the lake; (4) current thickness of accumulated sediment; and (5) elevation of the top of the sediment throughout the lake.
- The majority of annual constituent loading to the lake occurs during storm events, especially for sediment. The exception to this is Stone Dam Creek; a large portion of the total nutrient loading for Stone Dam Creek occurs during base flow conditions as it receives effluent from the City of Conway WWTP.
- The City of Conway WWTP effluent accounts for about 29% to 37% of the total load to the lake for total phosphorus, orthophosphate, ammonia nitrogen, and nitrate+nitrite nitrogen. The WWTP discharge will be removed from the Lake Conway watershed when the new Tupelo Bayou plant is built (anticipated mid-2014).
- The northwestern bay appears to receive and accumulate more sediment than other areas of the lake. This is based on the following:
    1. The two streams with the highest sediment loads per unit of drainage area were Little Creek and Stone Dam Creek (both of which drain into the northwestern bay);
    2. As a whole, the northwestern bay appears to have a greater thickness of accumulated sediment, and
    3. Aerial images on Google Earth show high turbidity in the northwestern bay.
- The measured thickness of accumulated sediment averaged 2.4 ft over the whole lake. Based on other calculations, there is a possibility that the penetrometer went into the original ground level prior to impoundment. If that is the case, the thickness of the accumulated sediment has been overestimated.
- The current water depth at normal pool averages approximately 3.7 ft over the whole lake.
- Based on the amount of sediment that has accumulated in different parts of the lake since the lake was impounded (as measured with the penetrometer), sediment appears to be building up in the upper parts of the lake at a rate of about 1 ft every 15 or 20 years.

- If sediment accumulation rates are calculated based on sediment loads measured in the tributaries during this project, the rates that are much slower than 1 ft of buildup every 15 to 20 years. However, the tributary sediment loads that were measured during this project may be underestimates of the actual loads for those tributaries.
- The sediment survey should be repeated in the future so that the elevations of the top of the sediment can be measured again and compared with the current elevations to obtain a more accurate estimate of the current rate of sediment buildup in different parts of the lake. The calculations presented here about sediment accumulation rates are based on assumptions that:

  1. The penetrometer measurements provided a reasonable estimate of the thickness of the post-impoundment sediment accumulation without penetrating the original ground level, and
  2. The future rate of sediment accumulation will be the same as the historical rate of sediment accumulation.

6.0 REFERENCES

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APPENDIX A

Chain-of-Custody and Calibration Forms

Date: 8/23/11 | Project Name: LAKE CONWAY W. Q. | Project No.: 3017-110 | Project Manager (Print): JIM MALCOLM | Page 1 of 2

Laboratory Name: ~~American Interplex Laboratories~~ ADEQ

Phone:

Submitted by:
FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211
(501) 225-7779 • Fax (501) 225-6738

Sampler Signature(s): Robert Gregory [signature]

Recorded By (Print): ROBERT GREGORY Jeff Ward

Lab Turn-Around-Time:
- ☐ 24 Hours
- ☐ 48 Hours
- ☒ Normal
- ☐ Other: Due: __/__/__

SAMPLE DESCRIPTION

Sample Identification	Date	Time	Matrix* W	S	O	No. of Containers	Comp	Grab	TOC	TP, orthophosphate	TKN, Ammonia, Nitrite + Nitrate	TSS, TDS					Laboratory Notes
OUTFALL-1	8/23/11	0800	✓			2		✓									
LC-4-1 a & b	8/23/11	0930	✓			3		✓									
LC-5-1 a & b	8/23/11	1000	✓			3		✓									
LC-2-1 a & b	8/23/11	1100	✓			3		✓									
LC-3-1 a & b	8/23/11	1130	✓			3		✓									
LC-1-1	8/23/11	1215	✓			2		✓									
LITTLE CYPRESS -1	8/23/11	1340	✓			2		✓									
PALARM LESLIE	8/23/11	1400	✓			✓		✓									
Container Type																	
Preservative																	

* Matrix: W = Water S = Soil O = Other

G = Glass P= Plastic V = VOA vials H = HCl to pH2 T = Sodium Thiosulfate
NO = None S = Sulfuric acid pH2 N = Nitric acid pH2 B = NaOH to pH12 Z = Zinc acetate

Relinquished By (Signature)	Print Name	Date	Time	Received By (Signature)	Print Name	Date	Time
[signature]	Jeff Ward	8/23/11	1555		[signature]	8/23/11	

Relinquished By (Signature)	Print Name	Date	Time	Received By Laboratory (Signature)	Print Name	Date	Time
					Jeff Rucker		1535

a = top of lake
b = bottom of lake

Laboratory Remarks:

ftn

Date 8/23/11	Project Name LAKE CONWAY W. Q.	Project No. 3017-110	Project Manager (Print) JIM MALCOLM	Page 2 of 2

Laboratory Name: ~~American Interplex Laboratories~~ ADEQ

Phone:

Submitted by:
FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211
(501) 225-7779 • Fax (501) 225-6738

Sampler Signature(s): [signature]

Recorded By (Print): ROBERT GREGORY

Lab Turn-Around-Time
- ☐ 24 Hours
- ☐ 48 Hours
- ☐ Normal
- ☐ Other: Due: __/__/__

Laboratory Notes

SAMPLE DESCRIPTION

Sample Identification	Date	Time	Matrix* W	Matrix* S	Matrix* O	No. of Containers	Comp	Grab	TOC	TP, orthophosphate	TKN, Ammonia, Nitrite + Nitrate	TSS, TDS				
LITTLE CREEK-1	8/23/11	1430	✓			2		✓								
STONE DAM-1	8/23/11	1440	✓			2		✓								
STONEDAM-1 REP.	8/23/11	1440	✓			2		✓								
BLANK-1	8/23/11	1440	✓			2		✓								
GOLD CREEK-1	8/23/11	1505	✓			2		✓								
Container Type																
Preservative																

* Matrix: W = Water S = Soil O = Other

G = Glass P= Plastic V = VOA vials H = HCl to pH2 T = Sodium Thiosulfate
NO = None S = Sulfuric acid pH2 N = Nitric acid pH2 B = NaOH to pH12 Z = Zinc acetate

Relinquished By (Signature)	Print Name	Date	Time	Received By (Signature)	Print Name	Date	Time
[signature]	Jeff Ward	8/23/11	1355	[signature]	Jeff Ruehr	8/23/11	
Relinquished By (Signature)	Print Name	Date	Time	Received By Laboratory (Signature)	Print Name	Date	Time
						15	35

Laboratory Remarks:

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Chain of Custody Record
for nonenforcement samples only

Print Names of Sample Collectors	ADEQ Division or Other (Describe Other)	Project Name	Function Code
Jeff Ward	Water	Lake Conway	

Sample ID	Date (mm/dd/yy)	Time (hh:mm ?m)	Gage/Flow	DO (mg/L)	pH	Water Temp (°C)	Sample Remarks	Log Number (Lab Use Only)
LC1	9/20/2011	12:30						
LC2	9/20/2011	12:00						
LC3	9/20/2011	10:30						
LC4	9/20/2011	9:00						
LC5	9/20/2011	9:10						
Blank	9/20/2011	10:50						
Outfall-2	9/20/2011	10:00						
Little Cypress-2	9/20/2011	11:00						
Little Palarm-2	9/20/2011	11:10						
Little Creek-2	9/20/2011	13:00						
Gold Creek-2	9/20/2011	13:20						
Stone Dam-2	9/20/2011	13:10						
Stone Dam-2 Dup	9/20/2011	13:10						

Relinquished by	Date	Time	Received by	Date	Time	Remarks
[signature]	9/20/11	1408				
Relinquished to laboratory by	Date	Time	Received for laboratory by	Date	Time	
			[signature]	9/20/11	14:08	* = GAGE, **BOLD = BOD**

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Chain of Custody Record
for nonenforcement samples only

Print Names of Sample Collectors	ADEQ Division or Other (Describe Other)	Project Name	Function Code
Jeff Ward	Water	Lake Conway	

Sample ID	Date (mm/dd/yy)	Time (hh:mm ?m)	Gage/Flow	DO (mg/L)	pH	Water Temp (°C)	Sample Remarks	Log Number (Lab Use Only)
LC1-3	10/18/2011	11:45						
LC2-3	10/18/2011	12:15						
LC3-3	10/18/2011	12:45						
LC4-3	10/18/2011	13:10						
LC5-3	10/18/2011	13:25						
Blank-3	10/18/2011	9:10						
Outfall-3	10/18/2011	9:45						
Little Cypress-3	10/18/2011	10:30						
Little Palarm-3	10/18/2011	10:45						
Little Creek-3	10/18/2011	11:00						
Gold Creek-3	10/18/2011	9:10						
Stone Dam-3	10/18/2011	9:30						
LC2-3 Dup	10/18/2011	12:15						

Relinquished by	Date	Time	Received by	Date	Time	Remarks
[signature]	10/18/11	1430				
Relinquished to laboratory by	Date	Time	Received for laboratory by	Date	Time	
			[signature]	10/18/11	14:30	* = GAGE, **BOLD** = **BOD**

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Chain of Custody Record
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Print Names of Sample Collectors	ADEQ Division or Other (Describe Other)	Project Name	Function Code
Jeff Ward		Lake Conway	10201

Sample ID	Date (mm/dd/yy)	Time (hh:mm ?m)	Gage/Flow	DO (mg/L)	pH	Water Temp (°C)	Sample Remarks	Log Number (Lab Use Only)
LC1-5	11/29/2011	12:45						2011-3602
LC2-5	11/29/2011	12:00						2011-3603
LC3-5	11/29/2011	11:10						2011-3604
LC4-5	11/29/2011	10:45						2011-3605
LC5-5	11/29/2011	13:30						2011-3606
Blank-5	11/29/2011	9:30						2011-3607
Outfall-5	11/29/2011	9:30						2011-3608
Little Cypress-5	11/29/2011	11:30						2011-3609
Little Palarm-5	11/29/2011	11:45						2011-3610
Little Creek-5	11/29/2011	12:20						2011-3611
Gold Creek-5	11/29/2011	8:30						2011-3612
Stone Dam-5	11/29/2011	8:40						2011-3613
Pierce Creek-5	11/29/2011	10:55						2011-3614
Outfall-5 Dup	11/29/2011	9:30						2011-3608 Dup

Relinquished by	Date	Time	Received by	Date	Time
Relinquished to laboratory by	Date	Time	Received for laboratory by	Date	Time
Jeff Ward	11/29/2011	14:30	Jeff Ruehr	11/29/2011	14:30

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Chain of Custody Record
for nonenforcement samples only

Print Names of Sample Collectors	ADEQ Division or Other (Describe Other)	Project Name	Function Code
Jeff Ward	Water	Lake Conway	

Sample ID	Date (mm/dd/yy)	Time (hh:mm ?m)	Gage/Flow	DO (mg/L)	pH	Water Temp (°C)	Sample Remarks	Log Number (Lab Use Only)
LC1-6	1/24/2012	10:45						2012-0184
LC2-6	1/24/2012	12:15						2012-0185
LC3-6	1/24/2012	13:30						2012-0186
LC4-6	1/24/2012	14:30						2012-0187
LC5-6	1/24/2012	14:15						2012-0188
Blank-6	1/24/2012	10:15						2012-0189
Outfall-6	1/24/2012	9:30						2012-0190
Little Cypress-6	1/24/2012	12:45						2012-0191
Little Palarm-6	1/24/2012	13:00						2012-0192
Little Creek-6	1/24/2012	10:20						2012-0193
Gold Creek-6	1/24/2012	10:00						2012-0194
Stone Dam-6	1/24/2012	10:15						2012-0195
Pierce Creek-6	1/24/2012	13:45						2012-0196
Gold Creek-6 Dup	1/24/2012	10:00						2012-0194D

Relinquished by	Date	Time	Received by	Date	Time	Remarks
Relinquished to laboratory by	**Date**	**Time**	**Received for laboratory by**	**Date**	**Time**	* = GAGE, **BOLD = BOD**

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Chain of Custody Record
for nonenforcement samples only

Print Names of Sample Collectors	ADEQ Division or Other (Describe Other)	Project Name	Function Code
Jeff Ward	Water	Lake Conway	

Sample ID	Date (mm/dd/yy)	Time (hh:mm ?m)	Gage/Flow	DO (mg/L)	pH	Water Temp (°C)	Sample Remarks	Log Number (Lab Use Only)
Little Cypress-7	1/25/2012	5:40						2012-0228
Little Cypress-8	1/25/2012	19:41						2012-0229
Stone Dam-7	1/25/2012	4:30						2012-0230
Stone Dam-8	1/25/2012	16:55						2012-0231
Stone Dam-9	1/25/2012	20:42						2012-0232
Gold Creek-7	1/25/2012	5:00						2012-0233
Gold Creek-8	1/25/2012	17:08						2012-0234
Gold Creek-9	1/25/2012	20:55						2012-0235
Gold Creek-9 Dup	1/25/2012	21:05						2012-0235D
Little Creek-7	1/25/2012	6:10						2012-0236
Little Creek-8	1/25/2012	16:30						2012-0237
Little Creek-9	1/25/2012	20:25						2012-0238
Outfall-8	1/25/2012	18:05						2012-0239
Little Palarm-7	1/25/2012	5:55						2012-0240
Little Palarm-8	1/25/2012	20:03						2012-0241
Pierce Creek-7	1/25/2012	5:25						2012-0242
Pierce Creek-8	1/25/2012	19:18						2012-0243

Relinquished by	Date	Time	Received by	Date	Time	Remarks
Relinquished to laboratory by Robert Gregory	Date 1/26/2012	Time 10:00	Received for laboratory by Jeff Ruehr	Date 1/26/2012	Time 10:00	* = GAGE, **BOLD = BOD**

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Print Names of Sample Collectors	ADEQ Division or Other (Describe Other)	Project Name	Function Code
Jeff Ward	Water	Lake Conway	

Sample ID	Date (mm/dd/yy)	Time (hh:mm ?m)	Gage/Flow	DO (mg/L)	pH	Water Temp (°C)	Sample Remarks	Log Number (Lab Use Only)
Outfall	2/21/2012	9:00						
LC1	2/21/2012	13:15						
LC2	2/21/2012	14:00						
LC3	2/21/2012	10:30						
LC4	2/21/2012	14:30						
LC5	2/21/2012	14:45						
Pierce Creek	2/21/2012	9:20						
Pierce Creek-Dup	2/21/2012	9:40						
Cypress	2/21/2012	11:00						
Little Palarm	2/21/2012	11:15						
Little Creek	2/21/2012	11:45						
Stone Dam	2/21/2012	15:25						
Gold Creek	2/21/2012	15:35						
Blank	2/21/2012	9:35						

Relinquished by	Date	Time	Received by	Date	Time	Remarks
[signature]	2/21/12	16:30				
Relinquished to laboratory by	Date	Time	Received for laboratory by	Date	Time	* = GAGE, **BOLD** = BOD

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Chain of Custody Record
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Print Names of Sample Collectors	ADEQ Division or Other (Describe Other)	Project Name	Function Code
Jeff Ward	Water	Lake Conway	

Sample ID	Date (mm/dd/yy)	Time (hh:mm ?m)	Gage/Flow	DO (mg/L)	pH	Water Temp (°C)	Sample Remarks	Log Number (Lab Use Only)
Outfall	3/8/2012	13:15						
Outfall	3/8/2012	16:15						
Outfall	3/8/2012	17:45						
Outfall	3/9/2012	9:45						
Little Creek	3/8/2012	14:50						
Little Creek	3/8/2012	17:00						
Little Creek	3/8/2012	9:50						
Little Creek	3/8/2012	12:15						
Little Creek	3/9/2012	8:55						
Stone Dam	3/8/2012	15:20						
Stone Dam	3/8/2012	17:15						
Stone Dam	3/8/2012	9:30						
Stone Dam	3/8/2012	12:05						
Stone Dam	3/9/2012	9:15						
Gold Creek	3/8/2012	15:35						
Gold Creek	3/8/2012	17:25						
Gold Creek	3/8/2012	11:50						

Relinquished by	Date	Time	Received by	Date	Time	Remarks
Relinquished to laboratory by	Date	Time	Received for laboratory by	Date	Time	
[signature]	3-9-12	13:38	[signature]	3-9-12	1338	* = GAGE, **BOLD** = BOD Jimmy Rogers, Blake Griffis

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Print Names of Sample Collectors	ADEQ Division or Other (Describe Other)	Project Name	Function Code
Jeff Ward	Water	Lake Conway	

Sample ID	Date (mm/dd/yy)	Time (hh:mm ?m)	Gage/Flow	DO (mg/L)	pH	Water Temp (°C)	Sample Remarks	Log Number (Lab Use Only)
Gold Creek	3/9/2012	9:30						
Pierce Creek	3/8/2012	11:55						
Pierce Creek	3/8/2012	13:54						
Pierce Creek	3/9/2012	15:28						
Pierce Creek	3/8/2012	17:15						
Pierce Creek	3/9/2012	10:05						
Little Cypress Creek	3/8/2012	12:40						
Little Cypress Creek	3/8/2012	15:48						
Little Cypress Creek	3/8/2012	17:42						
Little Cypress Creek	3/9/2012	10:25						
Little Param Creek	3/8/2012	13:00						
Little Param Creek	3/8/2012	16:08						
Little Param Creek	3/8/2012	18:00						
Little Param Creek	3/9/2012	10:40						

Relinquished by	Date	Time	Received by	Date	Time	Remarks
Relinquished to laboratory by	**Date**	**Time**	**Received for laboratory by**	**Date**	**Time**	
[signature]	3-9-12	13:38	[signature]	3-9-12	1338	* = GAGE, **BOLD** = BOD

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Chain of Custody Record
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Print Names of Sample Collectors	ADEQ Division or Other (Describe Other)	Project Name	Function Code
Jeff Ward	Water	Lake Conway	

Sample ID	Date (mm/dd/yy)	Time (hh:mm ?m)	Gage/Flow	DO (mg/L)	pH	Water Temp (°C)	Sample Remarks	Log Number (Lab Use Only)
Outfall-A	3/20/2012	17:10						
Outfall-B	3/21/2012	9:30						
Pierce Creek-A	3/20/2012	19:10						
Pierce Creek-B	3/20/2012	20:35						
Pierce Creek-C	3/20/2012	21:45						
Pierce Creek-D	3/21/2012	7:45						
Stone Dam-A	3/20/2012	17:30						
Stone Dam-B	3/20/2012	18:45						
Stone Dam-C	3/20/2012	21:00						
Stone Dam-D	3/21/2012	9:00						
Little Cypress Creek-A	3/20/2012	19:50						
Little Cypress Creek-B	3/20/2012	21:20						
Little Cypress Creek-C	3/21/2012	8:10						
Little Creek-A	3/20/2012	17:45						
Little Creek-B	3/20/2012	19:00						
Little Creek-C	3/20/2012	20:15						
Little Creek-D	3/21/2012	8:35						

Relinquished by	Date	Time	Received by	Date	Time	Remarks
Relinquished to laboratory by	**Date**	**Time**	**Received for laboratory by**	**Date**	**Time**	
Robert Gregory	3/21/12	11:00	[signature]	3/21/12	11:00	* = GAGE, BOLD = BOD

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Print Names of Sample Collectors	ADEQ Division or Other (Describe Other)	Project Name	Function Code
Jeff Ward	Water	Lake Conway	

Sample ID	Date (mm/dd/yy)	Time (hh:mm ?m)	Gage/Flow	DO (mg/L)	pH	Water Temp (°C)	Sample Remarks	Log Number (Lab Use Only)
Palarm Creek-A	3/20/2012	20:10						
Palarm Creek-B	3/20/2012	21:30						
Palarm Creek-C	3/21/2012	8:20						
Gold Creek-A	3/20/2012	18:30						
Gold Creek-B	3/20/2012	20:45						
Gold Creek-C	3/21/2012	9:05						

Relinquished by	Date	Time	Received by	Date	Time

Relinquished to laboratory by	Date	Time	Received for laboratory by	Date	Time
Robert Gregory	3/21/12	11:00	Jeff Rueda	3/21/12	11:00

Remarks

* = GAGE, **BOLD** = BOD

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Print Name of Sample Collectors: Robert Gregory RPG/JAS

ADEQ Division or Other (Describe Other):

Project Name: Lake Conway Study

Function Code:

Sample ID	Date (mm/dd/yy)	Time (hh:mm ?m)	Gage/Flow	DO (mg/L)	pH	Water Temp (°C)	Sample Remarks	Log Number (Lab Use Only)
Little Cypress	5-22-12	1020						2012-1523
Stone Dam Creek	"	1330						-1524
Little CRK		1245						-1525
Gold Crk		1350						-1526
Outfall		0735						-1527
Palarm Crk		1040						-1528
LC-1		1210						-1529
LC-2		1120						-1530
LC-3		0915						-1531
LC-4		0850						-1532
LC-5		0830						-1533
Blank (DI)		0735						-1534
Dup.		0735						-1535

Relinquished by	Date	Time	Received by	Date	Time	Remarks
Robert Gregory	5/22/12	1436				[illegible]
Relinquished to laboratory by	Date	Time	Received for laboratory by	Date	Time	
			Dane Hurley	5/22/12	1436	

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Print Names of Sample Collectors	ADEQ Division or Other (Describe Other)	Project Name	Function Code
Jeff Ward		Conway Lake Study	

Sample ID	Date (mm/dd/yy)	Time (hh:mm ?m)	Gage/Flow	DO (mg/L)	pH	Water Temp (°C)	Sample Remarks	Log Number (Lab Use Only)
LC1	7/24/2012	12:20						
LC2	7/24/2012	11:00						
LC3	7/24/2012	9:50						
LC4	7/24/2012	9:10						
LC5	7/24/2012	8:51						
Stone Dam	7/24/2012	12:35						
Gold Creek	7/24/2012	12:45						
Little Creek	7/24/2012	11:25						
Cypress Creek	7/24/2012	10:20						
Palarm Creek	7/24/2012	10:30						
Outfall	7/24/2012	8:15						

Relinquished by	Date	Time	Received by	Date	Time	Remarks
[signature]	7/24/12	1340				
Relinquished to laboratory by	Date	Time	Received for laboratory by	Date	Time	
			[signature]	7/24/12	1340	* = GAGE, BOLD = BOD

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Chain of Custody Record
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Print Names of Sample Collectors	ADEQ Division or Other (Describe Other)	Project Name	Function Code
ROBERT GREGORY Jim Craig		LAKE CONWAY SAMPLING 3017-110	

Sample ID	Date (mm/dd/yy)	Time (hh:mm ?m)	Gage/Flow	DO (mg/L)	pH	Water Temp (°C)	[illegible]	Log Number (Lab Use Only)
OUTFALL	8/21/12	0720	—	3.20	6.5	25.18	2	
DUPE	8/21/12	0730	—	"	"	"	3	
BLANK	8/21/12	0725	—	—	—	—	3	
LC-5	8/21/12	0800	—	5.15	6.77	[illegible]	2	
LC-4	8/21/12	0820	—	5.47	6.75	[illegible]	2	
LC-3	8/21/12	0920	—	[illegible]	[illegible]	[illegible]	2	
FALARM CR	8/21/12	1000	—	2.47	[illegible]	[illegible]	2	
LC-2	8/21/12	1035	—	[illegible]	6.63	[illegible]	2	
LC-1	8/21/12	1110	—	5.41	6.82	28.5	2	
LITTLE CR	8/21/12	1125	—	1.74	7.44	28.5	2	
STONE DAM CR	8/21/12	1145	—	7.10	8.04	30.5	2	

Relinquished by	Date	Time	Received by	Date	Time	Remarks
ROBERT GREGORY	8/21/12	1245				
Relinquished to laboratory by	**Date**	**Time**	**Received for laboratory by**	**Date**	**Time**	
			[signature]	8/21/12	1245	

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Chain of Custody Record
for nonenforcement samples only

Print Names of Sample Collectors	ADEQ Division or Other (Describe Other)	Project Name	Function Code
Jeff Ward / Robert Gregory		Lake Conway	

Sample ID	Date (mm/dd/yy)	Time (hh:mm ?m)	Gage/Flow	DO (mg/L)	pH	Water Temp (°C)	Sample Remarks	Log Number (Lab Use Only)
Stone Dam-1	8/30/12	20.40		6.31	6.75	26.04		
Little-1	8/30/12	21.30		2.83	6.85	24.96		
Stone Dam-2	8/30/12	21:55		6.29	6.86	26.14		
Gold-1	8/31/12	07:40		6.29	6.95	24.91		
Stone Dam-3	8/31/12	07:45		5.41	6.76	24.75		
Little-2	8/31/12	08:00		6.38	6.42	24.66		
Little Cypress	8/30/12	21:00		6.10	6.14	24.38		
Palarm	8/30/12	21:20		4.53	6.78	24.17		
Pierce	8/30/12	22:10		2.39	5.66	24.03		
Pierce	8/31/12	07:30		2.34	5.48	23.72		
Little Cypress	8/31/12	0800		5.83	6.21	23.77		
Palarm	8/31/12	0830		4.19	6.72	23.77		

Relinquished by	Date	Time	Received by	Date	Time	Remarks
ROBERT GREGORY	8/31/12	9:38 AM				
Relinquished to laboratory by	**Date**	**Time**	**Received for laboratory by**	**Date**	**Time**	
			[signature]	8/31/12	938 AM	

ftn

FTN Associates Calibration Form

Date/Time: 8/23/11 700

Prepared By: JRW

Location: FTN

Project #: 3017-110

Instrument Type	Instrument ID	Parameter	Standard (su)	Units	Temp. of Standard (degrees C)	Reading Prior to Calibration	Calibrated	Post Calibration Reading	Comments
MS-5	#7	pH	7	su	23.46	7.15	(Y) N	7.60	
		pH	4	su	23.68	4.28	(Y) N	4.01	
		pH	10	su	—	—	Y N		
		Cond	0	uS/cm	22.70	0.1	(Y) N	0.0	
		Cond	447	uS/cm	23.60	455.7	(Y) N	447.0	
		DO	761.5	mm/Hg	22.42	9.06 mg/l	Y N	8.66 mg/l	
		Temp	—	Degrees C	—	—	Y N	N/A	
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		

Notes:

pH Calibration (pH Method: EPA 150.1)

Specific Conductivity Calibration: Calibrate first to zero using air, then to standard using standard solution.

DO Calibration: Use 100% air saturation method. Use pressure in mm/Hg as standard to calibrate in DO% saturation. Record readings in mg/l.

Temperature Calibration: No calibration is necessary. Simply record temperature of standard using thermometer while in calibration cup. Then record hydrolab temperature reading.

Precision and accuracy targets are commonly based on relative percent differences. Precision is either based on a relative percent difference between replicates (analytical precision) or duplicate samples (method precision) as follows:

Relative Percent Difference (RPD) = 100 * (rep1 - rep2)/(rep1 + rep2)/2

The standard deviation of the average of a group of replicate (or duplicate) pairs represents the precision for a measurement parameter. For accuracy, percent difference is determined relative to a known or target value and is as follows:

Percent Difference = 100 * (observed - target)/target

FTN Associates Calibration Form

Date/Time: 9/20/11 700am
Prepared By: JLW
Location: FTN
Project #: 3017-110

– Lake Conway Sampling –

Instrument Type	Instrument ID	Parameter	Standard (su)	Units	Temp. of Standard (degrees C)	Reading Prior to Calibration	Calibrated	Post Calibration Reading	Comments
MS-5	5	pH	7	su	20.48	6.95	(Y) N	7.00	
		pH	4	su	20.78	4.09	(Y) N	4.00	
		pH	10	su			Y N		
		Cond	0	uS/cm	21.22	0	(Y) N	0	
		Cond	447	uS/cm	20.78	420	(Y) N	447	
		DO	763.1	mm/Hg	20.80	9.06 mg/l	(Y) N	8.98 mg/l	
		Temp		Degrees C			Y N	N/A	
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		

Notes:

pH Calibration (pH Method: EPA 150.1)
Specific Conductivity Calibration: Calibrate first to zero using air, then to standard using standard solution.
DO Calibration: Use 100% air saturation method. Use pressure in mm/Hg as standard to calibrate in DO% saturation. Record readings in mg/l.
Temperature Calibration: No calibration is necessary. Simply record temperature of standard using thermometer while in calibration cup. Then record hydrolab temperature reading.

Precision and accuracy targets are commonly based on relative percent differences. Precision is either based on a relative percent difference between replicates (analytical precision) or duplicate samples (method precision) as follows:

$$\text{Relative Percent Difference (RPD)} = 100 * (\text{rep1} - \text{rep2})/(\text{rep1} + \text{rep2})/2$$

The standard deviation of the average of a group of replicate (or duplicate) pairs represents the precision for a measurement parameter. For accuracy, percent difference is determined relative to a known or target value and is as follows:

$$\text{Percent Difference} = 100 * (\text{observed} - \text{target})/\text{target}$$

FTN Associates Calibration Form

Date/Time: 10/18/11 7am
Prepared By: JLW
Location: FTN
Project #: 3017-110

Instrument Type	Instrument ID	Parameter	Standard (su)	Units	Temp. of Standard (degrees C)	Reading Prior to Calibration	Calibrated	Post Calibration Reading	Comments
MS-5	#7	pH	7	su	21.11	7.13	(Y) N	7.00	
		pH	4	su	21.04	4.10	(Y) N	4.01	
		pH	10	su	—	—	Y N	—	
		Cond	0	uS/cm	21.03	6	(Y) N	0	
		Cond	447	uS/cm	21.90	439.8	(Y) N	447	
		DO	758	mm/Hg	21.04	9.11 mg/l	(Y) N	8.88 mg/l	
		Temp		Degrees C			Y N	N/A	
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		

Notes:
pH Calibration (pH Method: EPA 150.1)
Specific Conductivity Calibration: Calibrate first to zero using air, then to standard using standard solution.
DO Calibration: Use 100% air saturation method. Use pressure in mm/Hg as standard to calibrate in DO% saturation. Record readings in mg/l.
Temperature Calibration: No calibration is necessary. Simply record temperature of standard using thermometer while in calibration cup. Then record hydrolab temperature reading.

Precision and accuracy targets are commonly based on relative percent differences. Precision is either based on a relative percent difference between replicates (analytical precision) or duplicate samples (method precision) as follows:

Relative Percent Difference (RPD) = 100 * (rep1 - rep2)/(rep1 + rep2)/2

The standard deviation of the average of a group of replicate (or duplicate) pairs represents the precision for a measurement parameter. For accuracy, percent difference is determined relative to a known or target value and is as follows:

Percent Difference = 100 * (observed - target)/target

FTN Associates Calibration Form

Date/Time: 1/24/12
Prepared By: JLW
Location: FTN
Project #: 3017-110

Instrument Type	Instrument ID	Parameter	Standard (su)	Units	Temp. of Standard (degrees C)	Reading Prior to Calibration	Calibrated	Post Calibration Reading	Comments
MS-5	#7	pH	7	su	20.11	7.22	(Y) N	7.60	
		pH	4	su	19.99	3.82	(Y) N	4.00	
		pH	10	su	—	—	Y N	—	
		Cond	0	uS/cm	20.27	0	(Y) N	0	
		Cond	447	uS/cm	20.47	422.1	(Y) N	447	
		DO	763	mm/Hg	20.15	8.54 mg/l	Y N	9.08 mg/l	
		Temp	?	Degrees C	20.15	20.15	~~Y N~~	N/A	
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		

Notes:
pH Calibration (pH Method: EPA 150.1)
Specific Conductivity Calibration: Calibrate first to zero using air, then to standard using standard solution.
DO Calibration: Use 100% air saturation method. Use pressure in mm/Hg as standard to calibrate in DO% saturation. Record readings in mg/l.
Temperature Calibration: No calibration is necessary. Simply record temperature of standard using thermometer while in calibration cup. Then record hydrolab temperature reading.

Precision and accuracy targets are commonly based on relative percent differences. Precision is either based on a relative percent difference between replicates (analytical precision) or duplicate samples (method precision) as follows:

Relative Percent Difference (RPD) = 100 * (rep1 - rep2)/(rep1 + rep2)/2

The standard deviation of the average of a group of replicate (or duplicate) pairs represents the precision for a measurement parameter. For accuracy, percent difference is determined relative to a known or target value and is as follows:

Percent Difference = 100 * (observed - target)/target

FTN Associates Calibration Form

Date/Time: 1/25/12 3:45am
Prepared By: TLW
Location: B Field (Stone Dam)
Project #: 3017-110

Instrument Type	Instrument ID	Parameter	Standard (su)	Units	Temp. of Standard (degrees C)	Reading Prior to Calibration	Calibrated	Post Calibration Reading	Comments
MS-5	#7	pH	7	su	13.24	6.59	(Y) N	7.00	
		pH	4	su	13.75	4.06	(Y) N	4.00	
		pH	10	su	—	—	Y N	—	
		Cond	0	uS/cm	13.28	0.6	(Y) N	0.0	
		Cond	447	uS/cm	13.61	450.2	(Y) N	447.0	
		DO	763	mm/Hg	14.27	10.45 mg/l	(Y) N	10.31 mg/l	
		Temp	—	Degrees C	—	—	Y N	N/A	
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		

Notes:

pH Calibration (pH Method: EPA 150.1)

Specific Conductivity Calibration: Calibrate first to zero using air, then to standard using standard solution.

DO Calibration: Use 100% air saturation method. Use pressure in mm/Hg as standard to calibrate in DO% saturation. Record readings in mg/l.

Temperature Calibration: No calibration is necessary. Simply record temperature of standard using thermometer while in calibration cup. Then record hydrolab temperature reading.

Precision and accuracy targets are commonly based on relative percent differences. Precision is either based on a relative percent difference between replicates (analytical precision) or duplicate samples (method precision) as follows:

Relative Percent Difference (RPD) = 100 * (rep1 - rep2)/(rep1 + rep2)/2

The standard deviation of the average of a group of replicate (or duplicate) pairs represents the precision for a measurement parameter. For accuracy, percent difference is determined relative to a known or target value and is as follows:

Percent Difference = 100 * (observed - target)/target

FTN Associates Calibration Form

Date/Time: 25 JAN 12 16:50
Prepared By: JMR
Location: Lab
Project #: 3017 - 110

Instrument Type	Instrument ID	Parameter	Standard (su)	Units	Temp. of Standard (degrees C)	Reading Prior to Calibration	Calibrated	Post Calibration Reading	Comments
Hydrolab MS5	8	pH	7	su	19.88	6.94	(Y) N	7.00	
		pH	4	su	19.83	3.71	(Y) N	4.00	
		pH	10	su			Y N		
		Cond	0	uS/cm		0	(Y) N	0	
		Cond	447	uS/cm	19.37	449	(Y) N	447	
		DO	753.1	mm/Hg	18.81	8.45 mg/l	(Y) N	9.23 mg/l	
		Temp		Degrees C	18.85	19.00	Y N	N/A	
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		

Notes:

pH Calibration (pH Method: EPA 150.1)

Specific Conductivity Calibration: Calibrate first to zero using air, then to standard using standard solution.

DO Calibration: Use 100% air saturation method. Use pressure in mm/Hg as standard to calibrate in DO% saturation. Record readings in mg/l.

Temperature Calibration: No calibration is necessary. Simply record temperature of standard using thermometer while in calibration cup. Then record hydrolab temperature reading.

Precision and accuracy targets are commonly based on relative percent differences. Precision is either based on a relative percent difference between replicates (analytical precision) or duplicate samples (method precision) as follows:

$$\text{Relative Percent Difference (RPD)} = 100 * (\text{rep1} - \text{rep2})/(\text{rep1} + \text{rep2})/2$$

The standard deviation of the average of a group of replicate (or duplicate) pairs represents the precision for a measurement parameter. For accuracy, percent difference is determined relative to a known or target value and is as follows:

$$\text{Percent Difference} = 100 * (\text{observed} - \text{target})/\text{target}$$

FTN Associates Calibration Form

Date/Time: 25 JAN 12 16:50
Prepared By: JMR
Location: Lab
Project #: 3017 - 110

Instrument Type	Instrument ID	Parameter	Standard (su)	Units	Temp. of Standard (degrees C)	Reading Prior to Calibration	Calibrated	Post Calibration Reading	Comments
Hydrolab MS5	8	pH	7	su	19.88	6.94	(Y) N	7.00	
		pH	4	su	19.83	3.71	(Y) N	4.00	
		pH	10	su			Y N		
		Cond	0	uS/cm		0	(Y) N	0	
		Cond	447	uS/cm	19.37	449	(Y) N	447	
		DO	753.1	mm/Hg	18.81	8.45 mg/l	(Y) N	9.23 mg/l	
		Temp		Degrees C	18.85	19.00	Y N	N/A	
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		

Notes:
pH Calibration (pH Method: EPA 150.1)
Specific Conductivity Calibration: Calibrate first to zero using air, then to standard using standard solution.
DO Calibration: Use 100% air saturation method. Use pressure in mm/Hg as standard to calibrate in DO% saturation. Record readings in mg/l.
Temperature Calibration: No calibration is necessary. Simply record temperature of standard using thermometer while in calibration cup. Then record hydrolab temperature reading.

Precision and accuracy targets are commonly based on relative percent differences. Precision is either based on a relative percent difference between replicates (analytical precision) or duplicate samples (method precision) as follows:

Relative Percent Difference (RPD) = 100 * (rep1 - rep2)/(rep1 + rep2)/2

The standard deviation of the average of a group of replicate (or duplicate) pairs represents the precision for a measurement parameter. For accuracy, percent difference is determined relative to a known or target value and is as follows:

Percent Difference = 100 * (observed - target)/target

ftn

FTN Associates Calibration Form

Date/Time: 2/21/12
Prepared By: JEW
Location: FTN
Project #: 3017-110

Instrument Type	Instrument ID	Parameter	Standard (su)	Units	Temp. of Standard (degrees C)	Reading Prior to Calibration	Calibrated	Post Calibration Reading	Comments
		pH	7	su	19.99	6.94	(Y) N	7.00	
		pH	4	su	19.86	4.08	(Y) N	4.00	
		pH	10	su	—	—	Y N		
		Cond	0	uS/cm	18.62	0	(Y) N	0	
		Cond	447	uS/cm	19.85	443.	(Y) N	447	
		DO	761	mm/Hg	19.81	10.20 mg/l	Y N	9.78 mg/l	
		Temp		Degrees C			Y N	N/A	
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		

Notes:

pH Calibration (pH Method: EPA 150.1)

Specific Conductivity Calibration: Calibrate first to zero using air, then to standard using standard solution.

DO Calibration: Use 100% air saturation method. Use pressure in mm/Hg as standard to calibrate in DO% saturation. Record readings in mg/l.

Temperature Calibration: No calibration is necessary. Simply record temperature of standard using thermometer while in calibration cup. Then record hydrolab temperature reading.

Precision and accuracy targets are commonly based on relative percent differences. Precision is either based on a relative percent difference between replicates (analytical precision) or duplicate samples (method precision) as follows:

Relative Percent Difference (RPD) = 100 * (rep1 - rep2)/(rep1 + rep2)/2

The standard deviation of the average of a group of replicate (or duplicate) pairs represents the precision for a measurement parameter. For accuracy, percent difference is determined relative to a known or target value and is as follows:

Percent Difference = 100 * (observed - target)/target

ftn

FTN Associates Calibration Form

Date/Time: 09:30 23 Apr 2012
Prepared By: BJG
Location: FTN
Project #: Lake Conway 3017-110

Instrument Type	Instrument ID	Parameter	Standard (su)	Units	Temp. of Standard (degrees C)	Reading Prior to Calibration	Calibrated	Post Calibration Reading	Comments
Minisonde	8	pH	7	su	20.31	7.04	(Y) N	7.00	
		pH	4	su	20.23	4.07	(Y) N	4.00	
		pH	10	su			Y N		
		Cond	0	uS/cm		0	(Y) N	0	
		Cond	447	uS/cm	20.28	372	(Y) N	447	
		DO	754	mm/Hg	19.45	8.81 mg/l	(Y) N	9.11 mg/l	
		Temp		Degrees C			Y N	N/A	
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		

Notes:

pH Calibration (pH Method: EPA 150.1)

Specific Conductivity Calibration: Calibrate first to zero using air, then to standard using standard solution.

DO Calibration: Use 100% air saturation method. Use pressure in mm/Hg as standard to calibrate in DO% saturation. Record readings in mg/l.

Temperature Calibration: No calibration is necessary. Simply record temperature of standard using thermometer while in calibration cup. Then record hydrolab temperature reading.

Precision and accuracy targets are commonly based on relative percent differences. Precision is either based on a relative percent difference between replicates (analytical precision) or duplicate samples (method precision) as follows:

Relative Percent Difference (RPD) = 100 * (rep1 - rep2)/(rep1 + rep2)/2

The standard deviation of the average of a group of replicate (or duplicate) pairs represents the precision for a measurement parameter. For accuracy, percent difference is determined relative to a known or target value and is as follows:

Percent Difference = 100 * (observed - target)/target

FTN Associates Calibration Form

Date/Time: 7/24/12 715
Prepared By: JLW
Location: FTN
Project #: 3017-110

Instrument Type	Instrument ID	Parameter	Standard (su)	Units	Temp. of Standard (degrees C)	Reading Prior to Calibration	Calibrated	Post Calibration Reading	Comments
		pH	7	su	22.21	6.03	(Y) N	7.00	
		pH	4	su	22.61	4.27	(Y) N	4.00	
		pH	10	su	—	—	Y N	—	
		Cond	0	uS/cm	22.91	0.0	(Y) N	0	
		Cond	447	uS/cm	22.30	442.8	(Y) N	447.0	
		DO		mm/Hg	23.76	8.37 mg/l	Y N	8.48 mg/l	
		Temp	—	Degrees C	—	—	Y N	N/A	
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		

Notes:
pH Calibration (pH Method: EPA 150.1)
Specific Conductivity Calibration: Calibrate first to zero using air, then to standard using standard solution.
DO Calibration: Use 100% air saturation method. Use pressure in mm/Hg as standard to calibrate in DO% saturation. Record readings in mg/l.
Temperature Calibration: No calibration is necessary. Simply record temperature of standard using thermometer while in calibration cup.
Then record hydrolab temperature reading.

Precision and accuracy targets are commonly based on relative percent differences. Precision is either based on a relative percent difference between replicates (analytical precision) or duplicate samples (method precision) as follows:

Relative Percent Difference (RPD) = 100 * (rep1 - rep2)/(rep1 + rep2)/2

The standard deviation of the average of a group of replicate (or duplicate) pairs represents the precision for a measurement parameter. For accuracy, percent difference is determined relative to a known or target value and is as follows:

Percent Difference = 100 * (observed - target)/target

FTN Associates Calibration Form

Date/Time: 8/21/12 0600
Prepared By: RPG
Location: FTN
Project #: 3017-110

Instrument Type	Instrument ID	Parameter	Standard (su)	Units	Temp. of Standard (degrees C)	Reading Prior to Calibration	Calibrated	Post Calibration Reading	Comments
Hydrolab	#7	pH	7	su	21.97	7.07	(Y) N	6.99	
11	11	pH	4	su	21.90	4.09	(Y) N	4.00	
—	—	pH	10	su	—	—	~~Y N~~	—	
↓	↓	Cond	0	uS/cm	6	0	(Y) N	0	
		Cond	447	uS/cm	21.86	516.5	(Y) N	451.8	
		DO		mm/Hg	23.15	8.77 mg/l	(Y) N	8.60 mg/l	762 mm Hg
		Temp		Degrees C	[illegible]	[illegible]	Y N	N/A	
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		

Notes:

pH Calibration (pH Method: EPA 150.1)
Specific Conductivity Calibration: Calibrate first to zero using air, then to standard using standard solution.
DO Calibration: Use 100% air saturation method. Use pressure in mm/Hg as standard to calibrate in DO% saturation. Record readings in mg/l.
Temperature Calibration: No calibration is necessary. Simply record temperature of standard using thermometer while in calibration cup. Then record hydrolab temperature reading.

Precision and accuracy targets are commonly based on relative percent differences. Precision is either based on a relative percent difference between replicates (analytical precision) or duplicate samples (method precision) as follows:

Relative Percent Difference (RPD) = 100 * (rep1 - rep2)/(rep1 + rep2)/2

The standard deviation of the average of a group of replicate (or duplicate) pairs represents the precision for a measurement parameter. For accuracy, percent difference is determined relative to a known or target value and is as follows:

Percent Difference = 100 * (observed - target)/target

* Storm Event *

FTN Associates Calibration Form

Date/Time: 8/30/12 / 1315
Prepared By: RPG
Location: FTN LAB
Project #: 3011-117

Instrument Type	Instrument ID	Parameter	Standard (su)	Units	Temp. of Standard (degrees C)	Reading Prior to Calibration	Calibrated	Post Calibration Reading	Comments
HYDROLAB	SN	pH	7	su	21.55	6.94	(Y) N	7.09	
8	48171	pH	4	su	21.27	4.05	(Y) N	4.00	
		pH	10	su	—	—	Y N	—	
		Cond	0	uS/cm	22.16	0	(Y) N	0	
		Cond	1413	uS/cm	22.20	1624	(Y) N	1400	
		DO	745.5	mm/Hg	22.43	8.47 mg/l	(Y) N	8.53 mg/l	745.5
		Temp		Degrees C	22.40	22.0	Y N	N/A	
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		

Notes:

pH Calibration (pH Method: EPA 150.1)
Specific Conductivity Calibration: Calibrate first to zero using air, then to standard using standard solution.
DO Calibration: Use 100% air saturation method. Use pressure in mm/Hg as standard to calibrate in DO% saturation. Record readings in mg/l.
Temperature Calibration: No calibration is necessary. Simply record temperature of standard using thermometer while in calibration cup. Then record hydrolab temperature reading.

Precision and accuracy targets are commonly based on relative percent differences. Precision is either based on a relative percent difference between replicates (analytical precision) or duplicate samples (method precision) as follows:

Relative Percent Difference (RPD) = 100 * (rep1 - rep2)/(rep1 + rep2)/2

The standard deviation of the average of a group of replicate (or duplicate) pairs represents the precision for a measurement parameter. For accuracy, percent difference is determined relative to a known or target value and is as follows:

Percent Difference = 100 * (observed - target)/target

FTN Associates Calibration Form

Date/Time: 8/30/12 0700
Prepared By: RPG
Location: FTN LAB
Project #: 3010-117

Instrument Type	Instrument ID	Parameter	Standard (su)	Units	Temp. of Standard (degrees C)	Reading Prior to Calibration	Calibrated	Post Calibration Reading	Comments
HYDROLAB	#7	pH	7	su	21.99	7.27	(Y) N	7.00	
SN	#45796	pH	4	su	22.14	3.97	(Y) N	4.00	
		pH	10	su	—	—	Y N	—	
		Cond	0	uS/cm	22.99	1426	Y N	1413	
		Cond	0	uS/cm	22.07	0	(Y) N	0	
		DO	745.4	mm/Hg	23.70	8.70 mg/l	Y N	8.33 mg/l	745.4 mmg
		Temp		Degrees C	24.00	23.62	Y N	N/A	
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		
							Y N		

Notes:
pH Calibration (pH Method: EPA 150.1)
Specific Conductivity Calibration: Calibrate first to zero using air, then to standard using standard solution.
DO Calibration: Use 100% air saturation method. Use pressure in mm/Hg as standard to calibrate in DO% saturation. Record readings in mg/l.
Temperature Calibration: No calibration is necessary. Simply record temperature of standard using thermometer while in calibration cup. Then record hydrolab temperature reading.

Precision and accuracy targets are commonly based on relative percent differences. Precision is either based on a relative percent difference between replicates (analytical precision) or duplicate samples (method precision) as follows:

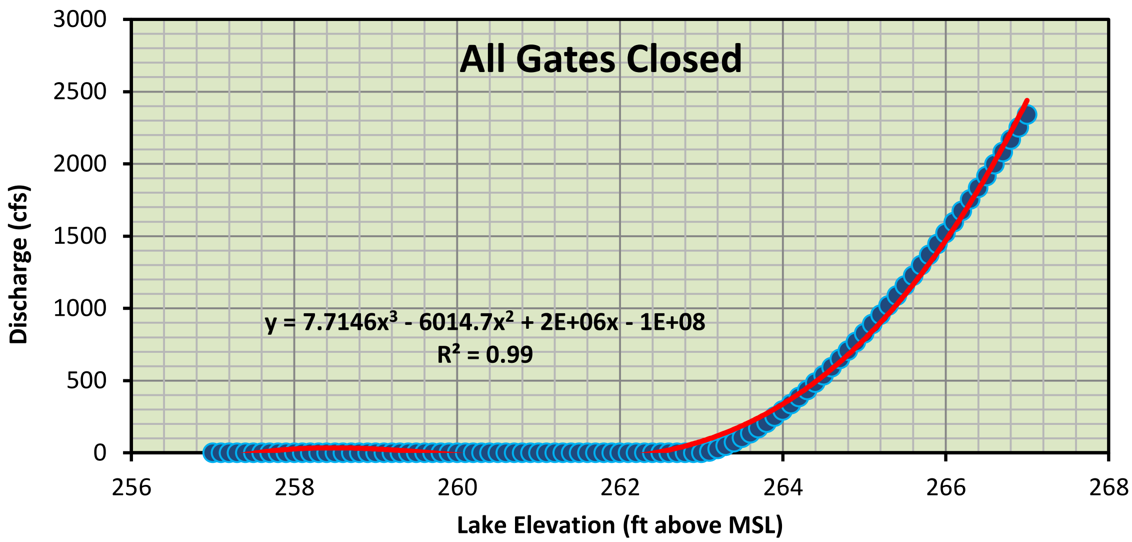
Relative Percent Difference (RPD) = 100 * (rep1 - rep2)/(rep1 + rep2)/2

The standard deviation of the average of a group of replicate (or duplicate) pairs represents the precision for a measurement parameter. For accuracy, percent difference is determined relative to a known or target value and is as follows:

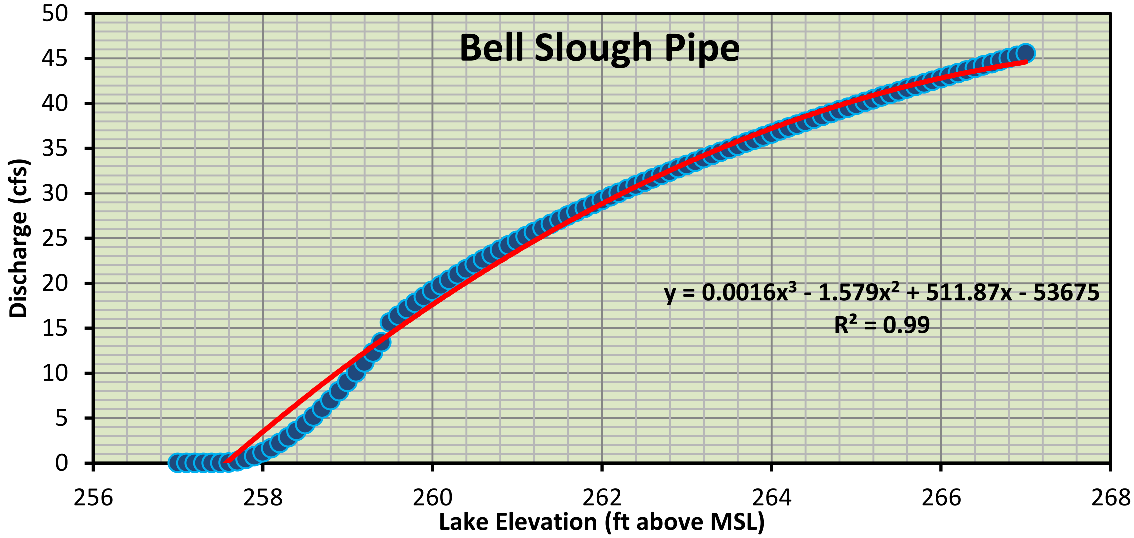
Percent Difference = 100 * (observed - target)/target

APPENDIX B

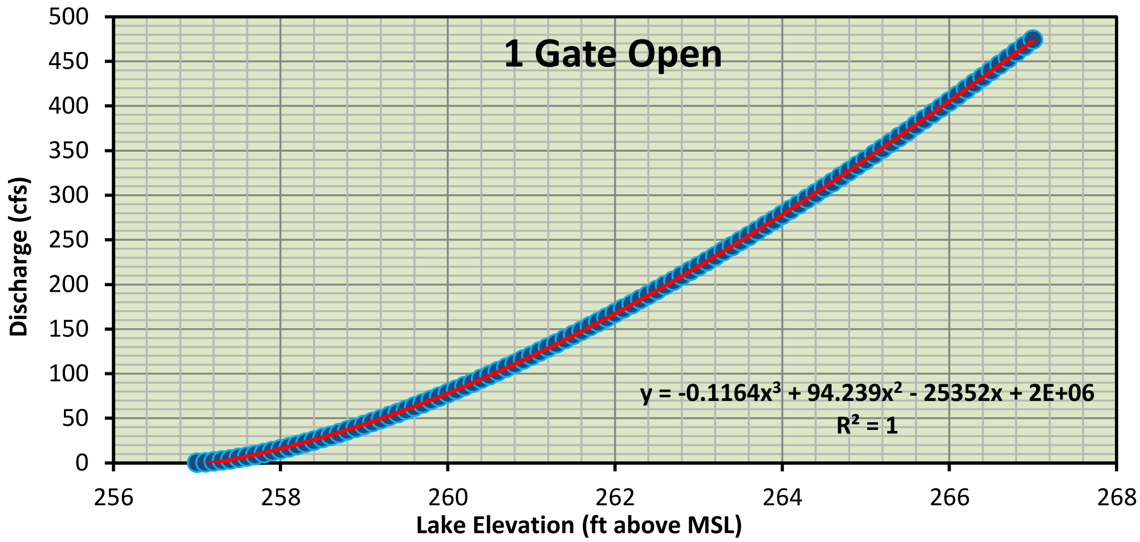
Modeled Rating Curves and Data Tables for Lake Conway Dam



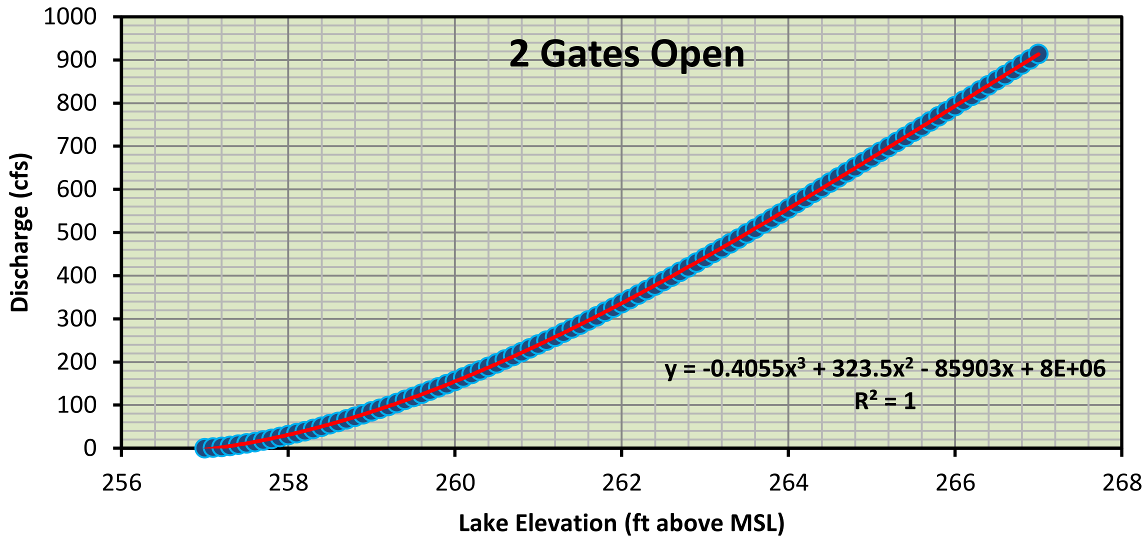
Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)
257	0	259.6	0	262.2	0	264.8	706.37
257.1	0	259.7	0	262.3	0	264.9	766.04
257.2	0	259.8	0	262.4	0	265	827.31
257.3	0	259.9	0	262.5	0	265.1	890.14
257.4	0	260	0	262.6	0	265.2	954.47
257.5	0	260.1	0	262.7	0	265.3	1020.27
257.6	0	260.2	0	262.8	0	265.4	1087.53
257.7	0	260.3	0	262.9	0	265.5	1156.21
257.8	0	260.4	0	263	0	265.6	1226.27
257.9	0	260.5	0	263.1	9.25	265.7	1297.70
258	0	260.6	0	263.2	26.16	265.8	1370.44
258.1	0	260.7	0	263.3	48.06	265.9	1444.51
258.2	0	260.8	0	263.4	74.00	266	1519.87
258.3	0	260.9	0	263.5	103.41	266.1	1596.50
258.4	0	261	0	263.6	135.94	266.2	1674.38
258.5	0	261.1	0	263.7	171.31	266.3	1753.45
258.6	0	261.2	0	263.8	209.29	266.4	1833.76
258.7	0	261.3	0	263.9	249.74	266.5	1915.26
258.8	0	261.4	0	264	292.50	266.6	1997.93
258.9	0	261.5	0	264.1	337.46	266.7	2081.76
259	0	261.6	0	264.2	384.51	266.8	2166.70
259.1	0	261.7	0	264.3	433.55	266.9	2252.80
259.2	0	261.8	0	264.4	484.52	267	2340.00
259.3	0	261.9	0	264.5	537.36		
259.4	0	262	0	264.6	591.98		
259.5	0	262.1	0	264.7	648.34		



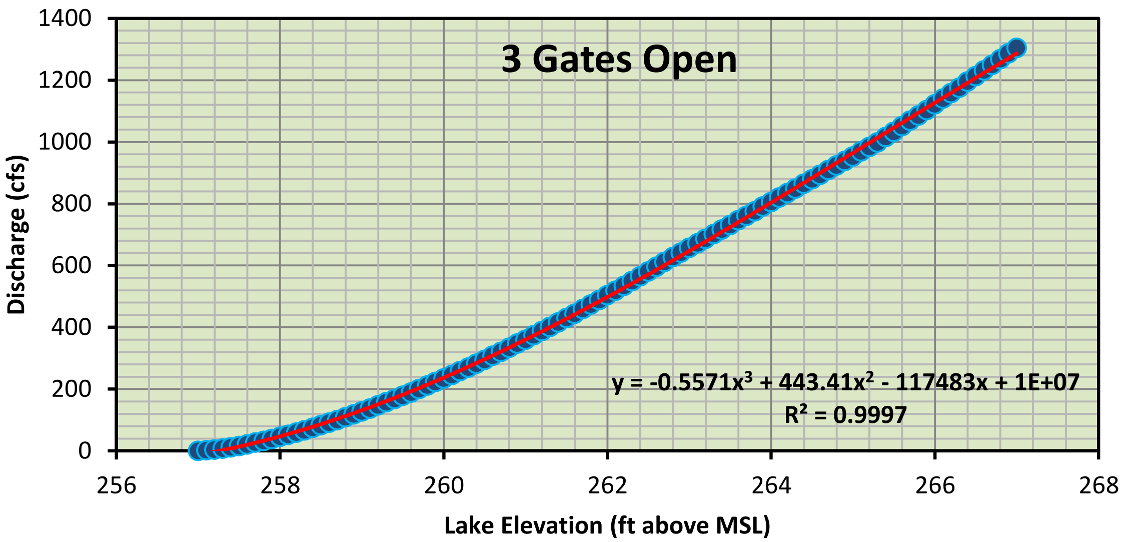
Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)
257	0.00	259.6	16.39	262.2	30.05	264.8	39.22
257.1	0.00	259.7	17.12	262.3	30.46	264.9	39.53
257.2	0.00	259.8	17.81	262.4	30.86	265	39.84
257.3	0.00	259.9	18.49	262.5	31.25	265.1	40.14
257.4	0.00	260	19.14	262.6	31.64	265.2	40.44
257.5	0.00	260.1	19.76	262.7	32.02	265.3	40.74
257.6	0.05	260.2	20.37	262.8	32.40	265.4	41.04
257.7	0.19	260.3	20.96	262.9	32.77	265.5	41.34
257.8	0.43	260.4	21.54	263	33.14	265.6	41.63
257.9	0.75	260.5	22.10	263.1	33.51	265.7	41.93
258	1.16	260.6	22.64	263.2	33.87	265.8	42.22
258.1	1.65	260.7	23.18	263.3	34.23	265.9	42.50
258.2	2.21	260.8	23.70	263.4	34.59	266	42.79
258.3	2.85	260.9	24.21	263.5	34.94	266.1	43.07
258.4	3.56	261	24.70	263.6	35.29	266.2	43.36
258.5	4.32	261.1	25.19	263.7	35.63	266.3	43.64
258.6	5.16	261.2	25.67	263.8	35.97	266.4	43.92
258.7	6.04	261.3	26.14	263.9	36.31	266.5	44.19
258.8	6.99	261.4	26.61	264	36.64	266.6	44.47
258.9	7.96	261.5	27.06	264.1	36.97	266.7	44.74
259	9.00	261.6	27.51	264.2	37.30	266.8	45.01
259.1	10.07	261.7	27.95	264.3	37.63	266.9	45.28
259.2	11.17	261.8	28.38	264.4	37.95	267	45.55
259.3	12.30	261.9	28.81	264.5	38.27		
259.4	13.43	262	29.23	264.6	38.59		
259.5	15.62	262.1	29.65	264.7	38.91		



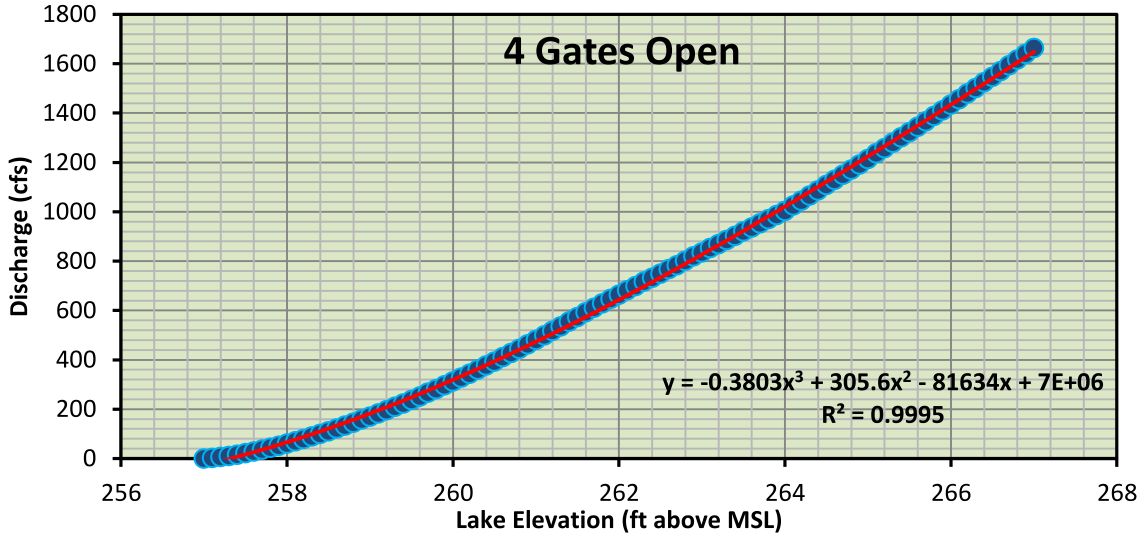
Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)
257	0.00	259.6	62.89	262.2	177.87	264.8	326.76
257.1	0.47	259.7	66.55	262.3	183.02	264.9	333.07
257.2	1.34	259.8	70.28	262.4	188.23	265	339.41
257.3	2.46	259.9	74.08	262.5	193.48	265.1	345.80
257.4	3.79	260	77.94	262.6	198.78	265.2	352.22
257.5	5.30	260.1	81.87	262.7	204.13	265.3	358.68
257.6	6.97	260.2	85.87	262.8	209.52	265.4	365.18
257.7	8.79	260.3	89.92	262.9	214.97	265.5	371.72
257.8	10.73	260.4	94.04	263	220.45	265.6	378.30
257.9	12.81	260.5	98.22	263.1	225.99	265.7	384.92
258	15.00	260.6	102.46	263.2	231.57	265.8	391.57
258.1	17.31	260.7	106.76	263.3	237.19	265.9	398.27
258.2	19.72	260.8	111.11	263.4	242.86	266	405.00
258.3	22.23	260.9	115.53	263.5	248.58	266.1	411.77
258.4	24.85	261	120.00	263.6	254.34	266.2	418.58
258.5	27.56	261.1	124.53	263.7	260.14	266.3	425.42
258.6	30.36	261.2	129.11	263.8	265.98	266.4	432.30
258.7	33.25	261.3	133.75	263.9	271.87	266.5	439.21
258.8	36.22	261.4	138.44	264	277.80	266.6	446.17
258.9	39.28	261.5	143.19	264.1	283.78	266.7	453.16
259	42.43	261.6	147.99	264.2	289.80	266.8	460.18
259.1	45.65	261.7	152.84	264.3	295.85	266.9	467.24
259.2	48.95	261.8	157.74	264.4	301.95	267	474.34
259.3	52.32	261.9	162.70	264.5	308.09		
259.4	55.77	262	167.71	264.6	314.28		
259.5	59.29	262.1	172.76	264.7	320.50		



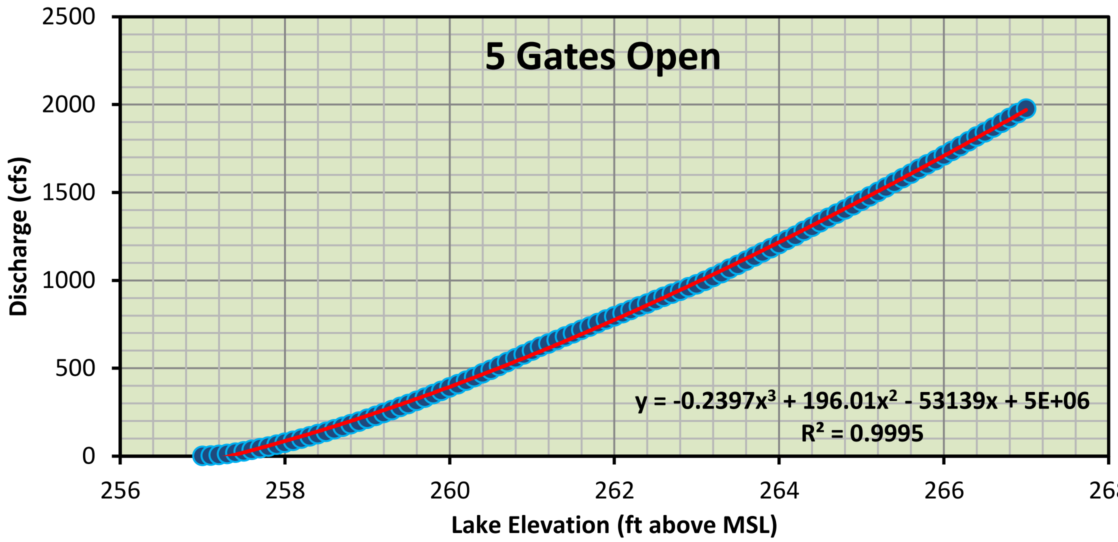
Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)
257	0.00	259.6	125.77	262.2	355.74	264.8	650.94
257.1	0.95	259.7	133.10	262.3	366.04	264.9	662.62
257.2	2.68	259.8	140.56	262.4	376.45	265	674.28
257.3	4.93	259.9	148.16	262.5	386.96	265.1	686.24
257.4	7.59	260	155.88	262.6	397.56	265.2	697.88
257.5	10.61	260.1	163.74	262.7	408.26	265.3	709.88
257.6	13.94	260.2	171.73	262.8	419.05	265.4	721.52
257.7	17.57	260.3	179.84	262.9	429.93	265.5	733.56
257.8	21.47	260.4	188.08	263	440.91	265.6	745.21
257.9	25.61	260.5	196.44	263.1	451.98	265.7	757.29
258	30.00	260.6	204.92	263.2	463.14	265.8	768.93
258.1	34.61	260.7	213.51	263.3	474.38	265.9	781.06
258.2	39.44	260.8	222.23	263.4	485.73	266	792.71
258.3	44.47	260.9	231.06	263.5	497.15	266.1	804.88
258.4	49.69	261	240.00	263.6	508.67	266.2	816.52
258.5	55.11	261.1	249.06	263.7	520.28	266.3	828.73
258.6	60.72	261.2	258.22	263.8	531.97	266.4	840.98
258.7	66.50	261.3	267.50	263.9	543.74	266.5	852.63
258.8	72.45	261.4	276.88	264	555.61	266.6	864.91
258.9	78.57	261.5	286.38	264.1	567.56	266.7	876.56
259	84.85	261.6	295.98	264.2	579.59	266.8	888.87
259.1	91.30	261.7	305.68	264.3	591.70	266.9	901.22
259.2	97.89	261.8	315.49	264.4	603.72	267	913.59
259.3	104.64	261.9	325.40	264.5	615.56		
259.4	111.54	262	335.41	264.6	627.32		
259.5	118.59	262.1	345.52	264.7	639.03		



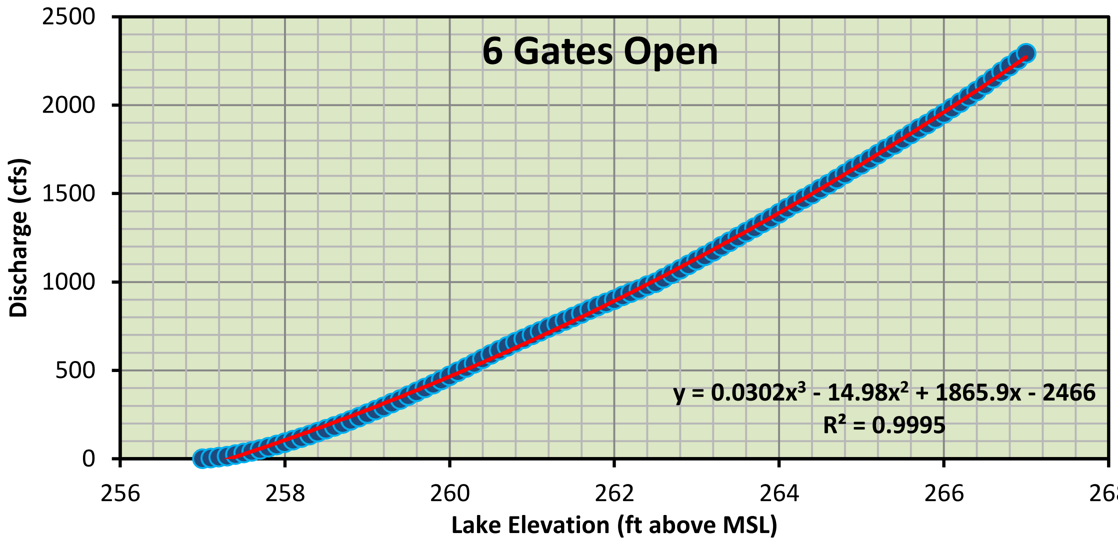
Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)
257	0.00	259.6	188.66	262.2	533.60	264.8	923.37
257.1	1.42	259.7	199.65	262.3	549.07	264.9	938.15
257.2	4.03	259.8	210.84	262.4	564.68	265	952.92
257.3	7.39	259.9	222.23	262.5	580.44	265.1	968.73
257.4	11.38	260	233.83	262.6	596.25	265.2	983.48
257.5	15.91	260.1	245.62	262.7	611.74	265.3	998.20
257.6	20.91	260.2	257.60	262.8	626.65	265.4	1015.23
257.7	26.36	260.3	269.76	262.9	641.87	265.5	1032.35
257.8	32.20	260.4	282.12	263	657.05	265.6	1050.76
257.9	38.42	260.5	294.66	263.1	671.47	265.7	1068.08
258	45.00	260.6	307.37	263.2	686.54	265.8	1085.49
258.1	51.92	260.7	320.27	263.3	701.37	265.9	1102.98
258.2	59.15	260.8	333.34	263.4	715.92	266	1121.86
258.3	66.70	260.9	346.58	263.5	730.92	266.1	1139.55
258.4	74.54	261	360.00	263.6	745.92	266.2	1157.33
258.5	82.67	261.1	373.58	263.7	760.32	266.3	1175.19
258.6	91.07	261.2	387.34	263.8	775.27	266.4	1194.52
258.7	99.74	261.3	401.25	263.9	790.22	266.5	1212.58
258.8	108.67	261.4	415.33	264	805.16	266.6	1230.73
258.9	117.85	261.5	429.57	264.1	819.38	266.7	1248.96
259	127.28	261.6	443.97	264.2	834.27	266.8	1267.27
259.1	136.94	261.7	458.52	264.3	849.15	266.9	1285.66
259.2	146.84	261.8	473.23	264.4	864.02	267	1304.15
259.3	156.96	261.9	488.10	264.5	878.89		
259.4	167.31	262	503.12	264.6	893.73		
259.5	177.88	262.1	518.28	264.7	908.56		



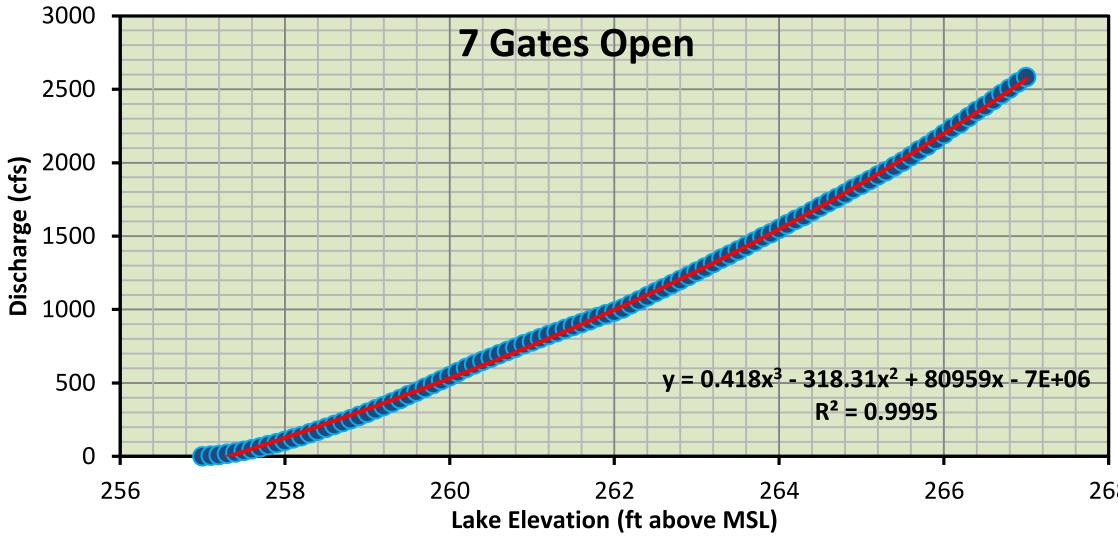
Elevation (ft above MSL)	Discharge (cfs)		Elevation (ft above MSL)	Discharge (cfs)		Elevation (ft above MSL)	Discharge (cfs)		Elevation (ft above MSL)	Discharge (cfs)
257	0.00		259.6	251.54		262.2	698.03		264.8	1170.63
257.1	1.90		259.7	266.20		262.3	715.98		264.9	1191.72
257.2	5.37		259.8	281.12		262.4	732.69		265	1212.92
257.3	9.86		259.9	296.31		262.5	749.20		265.1	1236.01
257.4	15.18		260	311.77		262.6	767.00		265.2	1257.48
257.5	21.21		260.1	327.49		262.7	783.24		265.3	1279.05
257.6	27.89		260.2	343.46		262.8	800.95		265.4	1300.75
257.7	35.14		260.3	359.68		262.9	818.66		265.5	1322.56
257.8	42.93		260.4	376.16		263	834.53		265.6	1344.48
257.9	51.23		260.5	392.87		263.1	852.14		265.7	1366.52
258	60.00		260.6	409.83		263.2	867.70		265.8	1388.66
258.1	69.22		260.7	427.03		263.3	885.72		265.9	1410.93
258.2	78.87		260.8	444.45		263.4	902.10		266	1433.30
258.3	88.93		260.9	462.11		263.5	919.53		266.1	1455.78
258.4	99.39		261	480.00		263.6	935.72		266.2	1478.38
258.5	110.23		261.1	498.11		263.7	953.05		266.3	1501.07
258.6	121.43		261.2	516.45		263.8	969.02		266.4	1523.88
258.7	132.99		261.3	535.00		263.9	986.24		266.5	1546.80
258.8	144.90		261.4	553.77		264	1003.41		266.6	1569.83
258.9	157.14		261.5	572.76		264.1	1024.92		266.7	1592.97
259	169.71		261.6	591.96		264.2	1045.14		266.8	1616.20
259.1	182.59		261.7	610.69		264.3	1065.47		266.9	1639.55
259.2	195.79		261.8	628.73		264.4	1085.94		267	1663.01
259.3	209.29		261.9	646.43		264.5	1108.09			
259.4	223.08		262	663.85		264.6	1128.82			
259.5	237.17		262.1	681.05		264.7	1149.67			



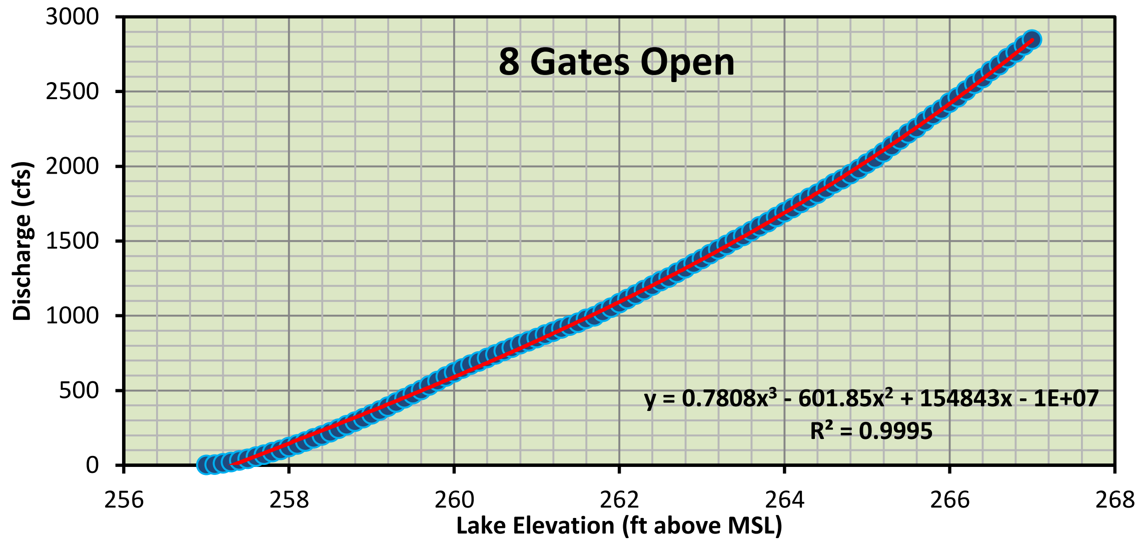
Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)
257	0.00	259.6	314.43	262.2	830.42	264.8	1402.03
257.1	2.37	259.7	332.74	262.3	850.36	264.9	1427.17
257.2	6.71	259.8	351.39	262.4	867.89	265	1452.45
257.3	12.32	259.9	370.39	262.5	887.70	265.1	1477.87
257.4	18.97	260	389.71	262.6	904.82	265.2	1503.42
257.5	26.52	260.1	409.36	262.7	924.45	265.3	1529.11
257.6	34.86	260.2	429.33	262.8	941.10	265.4	1554.93
257.7	43.93	260.3	449.60	262.9	960.54	265.5	1580.90
257.8	53.66	260.4	470.20	263	976.70	265.6	1607.01
257.9	64.04	260.5	491.09	263.1	995.91	265.7	1633.23
258	75.00	260.6	512.29	263.2	1018.53	265.8	1659.60
258.1	86.53	260.7	533.78	263.3	1040.42	265.9	1683.09
258.2	98.59	260.8	555.56	263.4	1065.15	266	1709.67
258.3	111.17	260.9	577.64	263.5	1088.26	266.1	1736.39
258.4	124.24	261	599.71	263.6	1111.52	266.2	1763.23
258.5	137.78	261.1	620.78	263.7	1134.92	266.3	1790.19
258.6	151.79	261.2	640.59	263.8	1158.47	266.4	1817.30
258.7	166.24	261.3	660.65	263.9	1182.18	266.5	1841.20
258.8	181.12	261.4	680.45	264	1206.03	266.6	1868.51
258.9	196.42	261.5	698.77	264.1	1230.03	266.7	1895.94
259	212.13	261.6	717.96	264.2	1254.17	266.8	1923.50
259.1	228.24	261.7	736.92	264.3	1280.67	266.9	1951.19
259.2	244.74	261.8	755.64	264.4	1305.14	267	1975.39
259.3	261.61	261.9	775.92	264.5	1329.77		
259.4	278.85	262	794.33	264.6	1354.53		
259.5	296.46	262.1	812.50	264.7	1379.44		



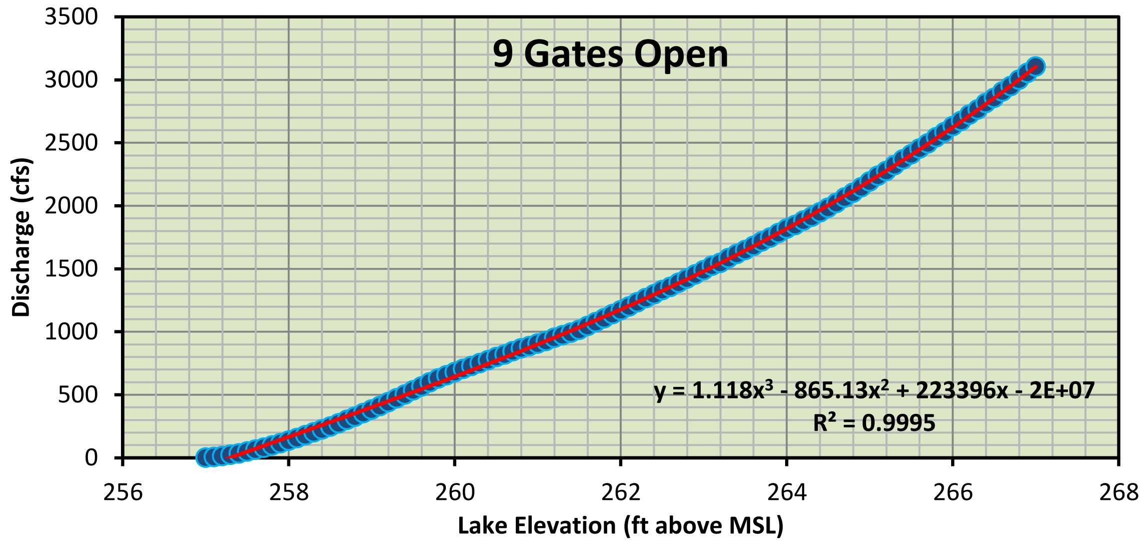
Elevation (ft above MSL)	Discharge (cfs)		Elevation (ft above MSL)	Discharge (cfs)		Elevation (ft above MSL)	Discharge (cfs)		Elevation (ft above MSL)	Discharge (cfs)
257	0.00		259.6	377.32		262.2	939.51		264.8	1609.84
257.1	2.85		259.7	399.29		262.3	957.19		264.9	1638.61
257.2	8.05		259.8	421.67		262.4	978.25		265	1664.03
257.3	14.79		259.9	444.47		262.5	995.27		265.1	1693.05
257.4	22.77		260	467.65		262.6	1020.14		265.2	1722.24
257.5	31.82		260.1	491.23		262.7	1045.19		265.3	1751.55
257.6	41.83		260.2	515.19		262.8	1070.41		265.4	1777.25
257.7	52.71		260.3	539.52		262.9	1095.82		265.5	1806.83
257.8	64.40		260.4	564.23		263	1121.42		265.6	1836.56
257.9	76.84		260.5	589.31		263.1	1147.19		265.7	1866.45
258	90.00		260.6	612.90		263.2	1173.14		265.8	1892.38
258.1	103.83		260.7	635.20		263.3	1200.48		265.9	1922.51
258.2	118.31		260.8	657.73		263.4	1226.81		266	1952.78
258.3	133.40		260.9	678.73		263.5	1253.31		266.1	1983.21
258.4	149.08		261	699.09		263.6	1279.99		266.2	2013.78
258.5	165.34		261.1	720.44		263.7	1306.84		266.3	2048.93
258.6	182.15		261.2	741.53		263.8	1333.85		266.4	2079.87
258.7	199.49		261.3	762.34		263.9	1361.04		266.5	2115.51
258.8	217.34		261.4	780.82		264	1388.40		266.6	2151.42
258.9	235.71		261.5	800.93		264.1	1415.93		266.7	2187.58
259	254.56		261.6	820.75		264.2	1443.61		266.8	2219.31
259.1	273.89		261.7	842.83		264.3	1471.47		266.9	2255.94
259.2	293.68		261.8	862.18		264.4	1496.37		267	2292.85
259.3	313.93		261.9	881.20		264.5	1524.50			
259.4	334.62		262	899.87		264.6	1552.79			
259.5	355.76		262.1	921.41		264.7	1581.24			



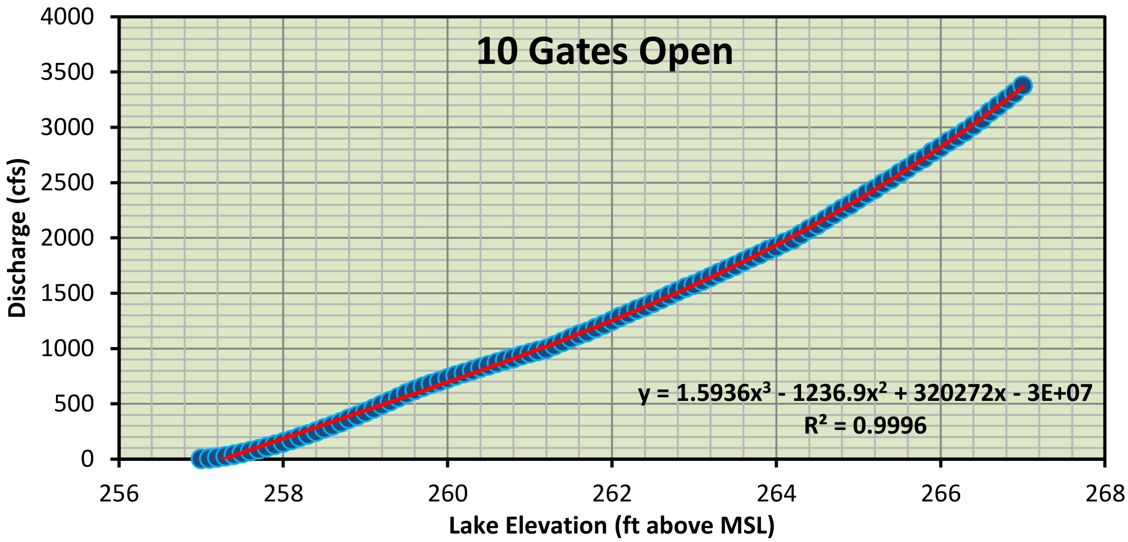
Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)
257	0.00	259.6	440.20	262.2	1034.40	264.8	1789.76
257.1	3.32	259.7	465.84	262.3	1061.57	264.9	1821.66
257.2	9.39	259.8	491.95	262.4	1088.94	265	1849.05
257.3	17.25	259.9	518.54	262.5	1116.53	265.1	1881.22
257.4	26.56	260	545.60	262.6	1144.32	265.2	1913.56
257.5	37.12	260.1	573.10	262.7	1172.32	265.3	1941.11
257.6	48.80	260.2	600.78	262.8	1200.52	265.4	1973.70
257.7	61.50	260.3	625.64	262.9	1228.92	265.5	2006.48
257.8	75.13	260.4	649.80	263	1257.52	265.6	2044.65
257.9	89.65	260.5	671.81	263.1	1286.33	265.7	2083.13
258	105.00	260.6	695.70	263.2	1315.33	265.8	2116.59
258.1	121.14	260.7	717.57	263.3	1346.13	265.9	2155.64
258.2	138.03	260.8	738.74	263.4	1372.27	266	2194.99
258.3	155.63	260.9	761.37	263.5	1401.82	266.1	2234.66
258.4	173.93	261	781.33	263.6	1431.56	266.2	2269.05
258.5	192.90	261.1	803.12	263.7	1461.49	266.3	2309.29
258.6	212.51	261.2	824.56	263.8	1491.62	266.4	2349.84
258.7	232.74	261.3	845.62	263.9	1518.24	266.5	2384.90
258.8	253.57	261.4	866.30	264	1548.66	266.6	2426.00
258.9	274.99	261.5	886.56	264.1	1579.27	266.7	2467.42
259	296.98	261.6	906.38	264.2	1610.07	266.8	2503.16
259.1	319.54	261.7	925.74	264.3	1637.01	266.9	2545.13
259.2	342.63	261.8	948.63	264.4	1668.10	267	2581.29
259.3	366.25	261.9	967.21	264.5	1699.36		
259.4	390.40	262	985.25	264.6	1730.80		
259.5	415.05	262.1	1007.45	264.7	1758.03		



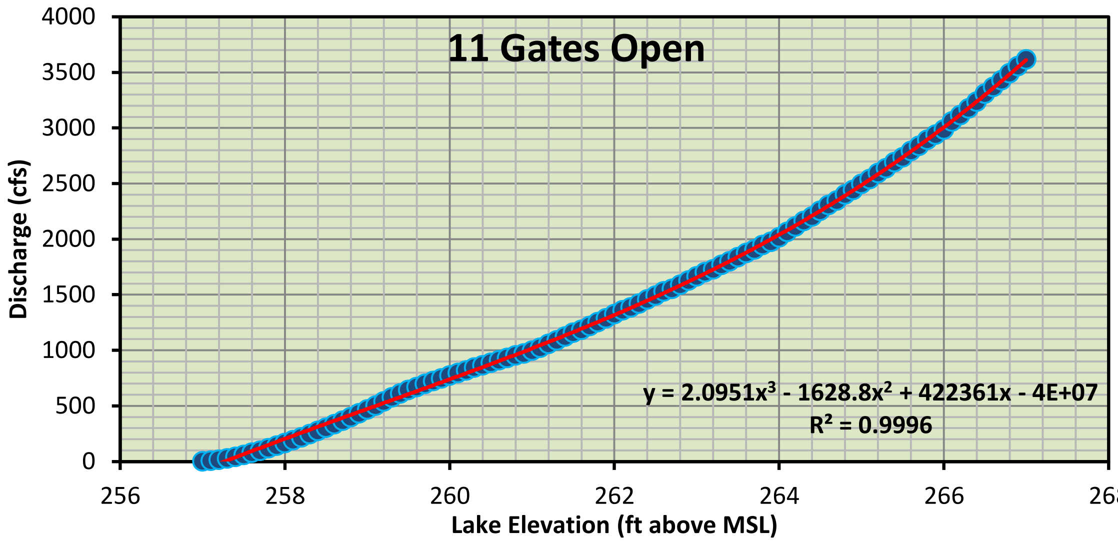
Elevation (ft above MSL)	Discharge (cfs)		Elevation (ft above MSL)	Discharge (cfs)		Elevation (ft above MSL)	Discharge (cfs)		Elevation (ft above MSL)	Discharge (cfs)
257	0.00		259.6	503.09		262.2	1141.39		264.8	1947.25
257.1	3.80		259.7	532.39		262.3	1171.28		264.9	1981.88
257.2	10.73		259.8	562.23		262.4	1201.40		265	2016.71
257.3	19.72		259.9	592.61		262.5	1231.76		265.1	2051.74
257.4	30.36		260	620.29		262.6	1255.47		265.2	2093.14
257.5	42.43		260.1	645.69		262.7	1286.09		265.3	2134.91
257.6	55.77		260.2	670.98		262.8	1316.93		265.4	2177.05
257.7	70.28		260.3	693.74		262.9	1348.00		265.5	2219.55
257.8	85.86		260.4	717.15		263	1379.30		265.6	2255.94
257.9	102.46		260.5	739.77		263.1	1410.81		265.7	2299.09
258	120.00		260.6	764.01		263.2	1442.54		265.8	2342.60
258.1	138.44		260.7	785.24		263.3	1472.42		265.9	2379.77
258.2	157.75		260.8	808.49		263.4	1504.52		266	2423.94
258.3	177.86		260.9	828.19		263.5	1532.52		266.1	2461.59
258.4	198.78		261	850.36		263.6	1564.96		266.2	2506.40
258.5	220.45		261.1	872.03		263.7	1597.61		266.3	2551.57
258.6	242.86		261.2	893.21		263.8	1625.81		266.4	2590.00
258.7	265.99		261.3	913.83		263.9	1658.77		266.5	2635.82
258.8	289.79		261.4	933.87		264	1691.93		266.6	2674.71
258.9	314.27		261.5	953.30		264.1	1720.32		266.7	2721.17
259	339.41		261.6	977.08		264.2	1753.79		266.8	2760.55
259.1	365.18		261.7	995.46		264.3	1787.45		266.9	2807.65
259.2	391.58		261.8	1024.17		264.4	1816.00		267	2847.48
259.3	418.57		261.9	1053.12		264.5	1849.97			
259.4	446.17		262	1082.31		264.6	1884.13			
259.5	474.34		262.1	1111.73		264.7	1912.81			



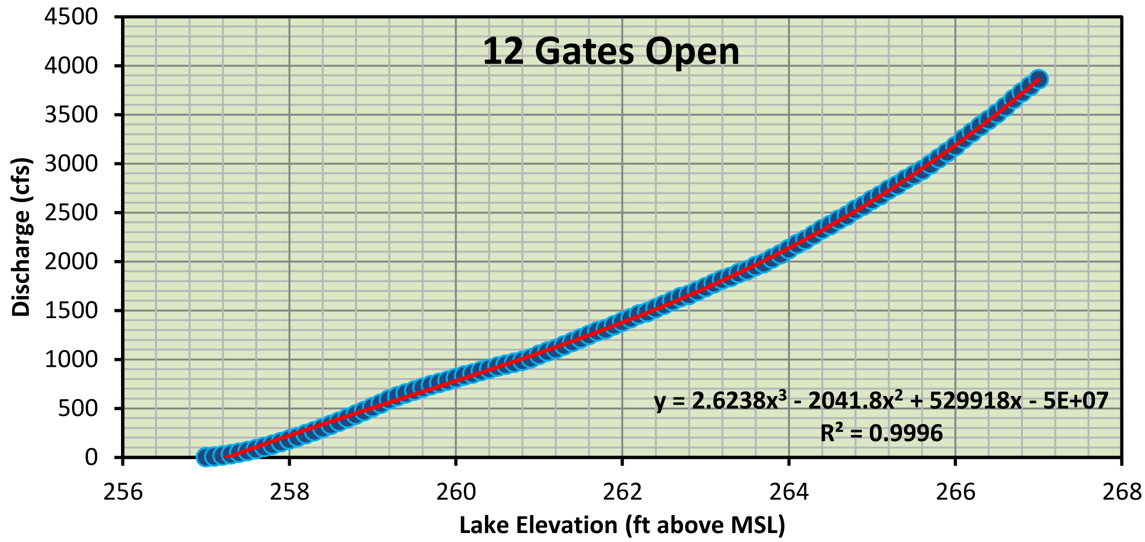
Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)
257	0.00	259.6	565.97	262.2	1233.24	264.8	2101.85
257.1	4.27	259.7	598.47	262.3	1265.45	264.9	2146.43
257.2	12.08	259.8	627.47	262.4	1297.92	265	2191.45
257.3	22.18	259.9	654.35	262.5	1330.62	265.1	2236.87
257.4	34.15	260	679.58	262.6	1355.00	265.2	2275.22
257.5	47.73	260.1	703.31	262.7	1387.98	265.3	2321.40
257.6	62.74	260.2	727.84	262.8	1421.19	265.4	2367.98
257.7	79.07	260.3	751.47	262.9	1454.64	265.5	2407.20
257.8	96.60	260.4	774.16	263	1488.34	265.6	2454.53
257.9	115.26	260.5	798.98	263.1	1522.27	265.7	2494.28
258	135.00	260.6	819.95	263.2	1546.35	265.8	2542.35
258.1	155.75	260.7	843.52	263.3	1583.11	265.9	2582.65
258.2	177.46	260.8	866.53	263.4	1617.55	266	2631.46
258.3	200.10	260.9	884.69	263.5	1646.80	266.1	2672.29
258.4	223.63	261	906.18	263.6	1681.58	266.2	2721.83
258.5	248.01	261.1	926.98	263.7	1716.58	266.3	2763.21
258.6	273.22	261.2	952.28	263.8	1745.99	266.4	2813.48
258.7	299.23	261.3	971.90	263.9	1781.32	266.5	2855.37
258.8	326.02	261.4	990.69	264	1816.86	266.6	2906.40
258.9	353.56	261.5	1014.88	264.1	1846.38	266.7	2948.80
259	381.84	261.6	1045.29	264.2	1882.22	266.8	3000.57
259.1	410.83	261.7	1075.98	264.3	1911.77	266.9	3052.70
259.2	440.53	261.8	1106.91	264.4	1947.92	267	3105.26
259.3	470.89	261.9	1138.12	264.5	1984.28		
259.4	501.94	262	1169.57	264.6	2020.86		
259.5	533.63	262.1	1201.28	264.7	2064.69		



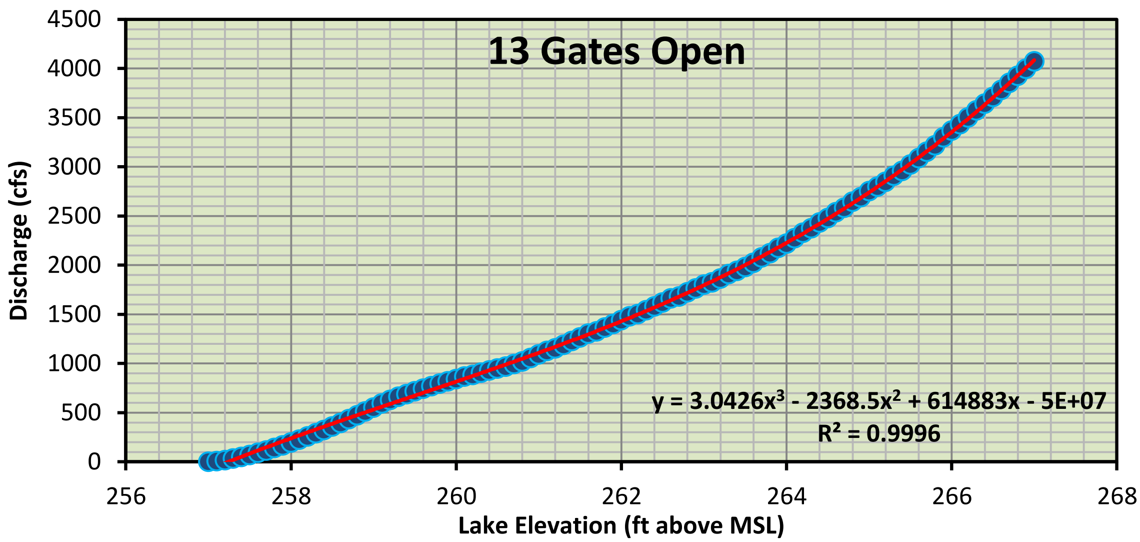
Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)
257	0.00	259.6	624.07	262.2	1316.76	264.8	2261.17
257.1	4.74	259.7	651.52	262.3	1351.08	264.9	2301.29
257.2	13.42	259.8	678.20	262.4	1375.72	265	2350.45
257.3	24.65	259.9	703.23	262.5	1410.30	265.1	2400.08
257.4	37.95	260	729.12	262.6	1445.14	265.2	2441.18
257.5	53.03	260.1	753.99	262.7	1480.25	265.3	2491.65
257.6	69.71	260.2	777.81	262.8	1515.62	265.4	2533.34
257.7	87.85	260.3	800.50	262.9	1551.24	265.5	2584.64
257.8	107.33	260.4	825.77	263	1575.35	265.6	2626.93
257.9	128.07	260.5	846.35	263.1	1611.19	265.7	2679.05
258	150.00	260.6	870.06	263.2	1647.27	265.8	2721.94
258.1	173.05	260.7	893.05	263.3	1680.42	265.9	2774.91
258.2	197.18	260.8	910.09	263.4	1716.92	266	2818.37
258.3	222.33	260.9	936.70	263.5	1746.98	266.1	2872.15
258.4	248.47	261	957.25	263.6	1783.83	266.2	2916.21
258.5	275.57	261.1	976.84	263.7	1820.88	266.3	2960.48
258.6	303.58	261.2	995.42	263.8	1851.02	266.4	3015.47
258.7	332.48	261.3	1027.22	263.9	1888.41	266.5	3070.90
258.8	362.24	261.4	1059.29	264	1918.50	266.6	3137.37
258.9	392.84	261.5	1091.66	264.1	1956.20	266.7	3193.80
259	424.26	261.6	1124.30	264.2	1986.21	266.8	3250.68
259.1	456.48	261.7	1149.19	264.3	2032.28	266.9	3307.98
259.2	489.47	261.8	1182.16	264.4	2078.83	267	3376.57
259.3	523.21	261.9	1215.40	264.5	2117.60		
259.4	557.71	262	1248.92	264.6	2164.99		
259.5	592.93	262.1	1282.71	264.7	2212.85		



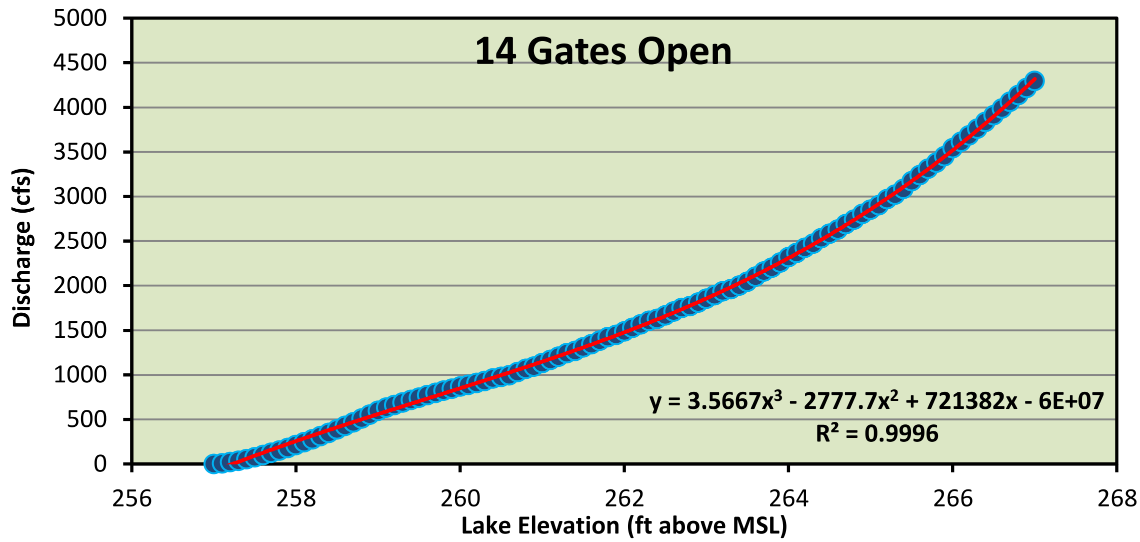
Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)
257	0.00	259.6	668.76	262.2	1383.42	264.8	2399.48
257.1	5.22	259.7	695.63	262.3	1419.40	264.9	2442.04
257.2	14.76	259.8	723.28	262.4	1455.68	265	2495.27
257.3	27.11	259.9	746.90	262.5	1492.21	265.1	2538.46
257.4	41.74	260	771.92	262.6	1529.02	265.2	2592.61
257.5	58.34	260.1	795.69	262.7	1553.01	265.3	2636.48
257.6	76.69	260.2	818.12	262.8	1590.05	265.4	2691.56
257.7	96.64	260.3	843.56	262.9	1627.34	265.5	2736.05
257.8	118.06	260.4	863.42	263	1664.91	265.6	2792.06
257.9	140.88	260.5	886.93	263.1	1702.73	265.7	2837.20
258	165.00	260.6	909.54	263.2	1725.81	265.8	2894.14
258.1	190.36	260.7	931.19	263.3	1767.66	265.9	2939.93
258.2	216.90	260.8	951.80	263.4	1798.11	266	2985.94
258.3	244.56	260.9	971.28	263.5	1836.52	266.1	3056.15
258.4	273.32	261	997.10	263.6	1875.18	266.2	3115.01
258.5	303.12	261.1	1022.57	263.7	1905.60	266.3	3174.38
258.6	333.94	261.2	1055.91	263.8	1944.58	266.4	3234.24
258.7	365.73	261.3	1089.55	263.9	1974.88	266.5	3306.79
258.8	398.46	261.4	1123.51	264	2014.16	266.6	3367.74
258.9	432.13	261.5	1157.76	264.1	2063.01	266.7	3429.18
259	466.69	261.6	1182.97	264.2	2112.40	266.8	3491.14
259.1	502.13	261.7	1217.53	264.3	2162.29	266.9	3553.58
259.2	538.42	261.8	1252.39	264.4	2203.11	267	3616.49
259.3	575.54	261.9	1287.54	264.5	2253.95		
259.4	611.07	262	1322.99	264.6	2305.31		
259.5	641.45	262.1	1358.72	264.7	2347.19		



Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)	Elevation (ft above MSL)	Discharge (cfs)
257	0.00	259.6	709.17	262.2	1457.48	264.8	2525.95
257.1	5.69	259.7	734.68	262.3	1481.42	264.9	2570.74
257.2	16.10	259.8	758.10	262.4	1519.22	265	2627.97
257.3	29.58	259.9	783.16	262.5	1557.29	265.1	2673.42
257.4	45.54	260	806.74	262.6	1595.65	265.2	2731.70
257.5	63.64	260.1	833.42	262.7	1634.31	265.3	2777.88
257.6	83.66	260.2	854.18	262.8	1657.13	265.4	2837.18
257.7	105.42	260.3	878.71	262.9	1695.97	265.5	2884.04
257.8	128.79	260.4	902.23	263	1735.06	265.6	2931.14
257.9	153.69	260.5	924.68	263.1	1774.43	265.7	2991.92
258	180.00	260.6	945.97	263.2	1814.08	265.8	3053.23
258.1	207.67	260.7	965.98	263.3	1840.18	265.9	3115.15
258.2	236.62	260.8	984.61	263.4	1880.07	266	3177.57
258.3	266.80	260.9	1010.50	263.5	1910.48	266.1	3254.24
258.4	298.17	261	1044.98	263.6	1950.64	266.2	3317.86
258.5	330.68	261.1	1079.78	263.7	1980.87	266.3	3382.05
258.6	364.30	261.2	1105.24	263.8	2031.80	266.4	3446.79
258.7	398.98	261.3	1140.39	263.9	2072.77	266.5	3512.07
258.8	434.69	261.4	1175.86	264	2124.73	266.6	3577.89
258.9	471.41	261.5	1211.64	264.1	2177.27	266.7	3658.40
259	509.12	261.6	1247.73	264.2	2219.43	266.8	3725.41
259.1	547.78	261.7	1284.14	264.3	2273.00	266.9	3792.96
259.2	587.37	261.8	1308.95	264.4	2327.20	267	3861.04
259.3	621.80	261.9	1345.66	264.5	2370.51		
259.4	652.19	262	1382.62	264.6	2425.69		
259.5	681.66	262.1	1419.88	264.7	2469.74		



Elevation (ft above MSL)	Discharge (cfs)		Elevation (ft above MSL)	Discharge (cfs)		Elevation (ft above MSL)	Discharge (cfs)		Elevation (ft above MSL)	Discharge (cfs)
257	0.00		259.6	740.96		262.2	1502.43		264.8	2643.23
257.1	6.17		259.7	768.05		262.3	1541.42		264.9	2690.05
257.2	17.44		259.8	793.58		262.4	1580.69		265	2751.30
257.3	32.04		259.9	817.46		262.5	1620.27		265.1	2798.84
257.4	49.33		260	839.51		262.6	1660.15		265.2	2846.68
257.5	68.94		260.1	865.33		262.7	1681.83		265.3	2909.55
257.6	90.63		260.2	883.82		262.8	1721.83		265.4	2958.16
257.7	114.21		260.3	906.87		262.9	1762.14		265.5	3022.16
257.8	139.53		260.4	928.63		263	1802.71		265.6	3086.76
257.9	166.49		260.5	948.95		263.1	1822.81		265.7	3152.00
258	195.00		260.6	967.70		263.2	1863.48		265.8	3217.81
258.1	224.97		260.7	994.15		263.3	1909.91		265.9	3299.67
258.2	256.34		260.8	1020.04		263.4	1940.03		266	3366.78
258.3	289.03		260.9	1055.66		263.5	1981.39		266.1	3434.49
258.4	323.02		261	1091.62		263.6	2023.01		266.2	3502.82
258.5	358.24		261.1	1127.93		263.7	2076.87		266.3	3571.72
258.6	394.65		261.2	1153.21		263.8	2119.31		266.4	3641.27
258.7	432.23		261.3	1189.81		263.9	2174.31		266.5	3711.37
258.8	470.91		261.4	1226.77		264	2217.50		266.6	3782.06
258.9	510.70		261.5	1264.03		264.1	2273.64		266.7	3853.36
259	551.54		261.6	1301.62		264.2	2330.38		266.8	3925.27
259.1	593.42		261.7	1326.00		264.3	2374.90		266.9	3997.73
259.2	628.16		261.8	1363.84		264.4	2432.78		267	4070.79
259.3	659.43		261.9	1402.02		264.5	2478.04			
259.4	687.50		262	1440.49		264.6	2537.06			
259.5	715.33		262.1	1479.27		264.7	2583.08			



Elevation (ft above MSL)	Discharge (cfs)		Elevation (ft above MSL)	Discharge (cfs)		Elevation (ft above MSL)	Discharge (cfs)		Elevation (ft above MSL)	Discharge (cfs)
257	0.00		259.6	770.96		262.2	1564.21		264.8	2738.72
257.1	6.64		259.7	796.71		262.3	1604.74		264.9	2803.38
257.2	18.78		259.8	820.56		262.4	1625.83		265	2852.38
257.3	34.50		259.9	842.33		262.5	1666.49		265.1	2901.66
257.4	53.13		260	868.20		262.6	1707.45		265.2	2968.10
257.5	74.25		260.1	885.84		262.7	1748.72		265.3	3018.17
257.6	97.60		260.2	908.48		262.8	1767.95		265.4	3085.81
257.7	122.99		260.3	929.55		262.9	1809.27		265.5	3171.28
257.8	150.26		260.4	957.92		263	1850.90		265.6	3240.32
257.9	179.30		260.5	976.23		263.1	1892.82		265.7	3310.04
258	210.00		260.6	992.59		263.2	1935.01		265.8	3380.37
258.1	242.28		260.7	1029.00		263.3	1958.32		265.9	3451.38
258.2	276.06		260.8	1065.80		263.4	2000.66		266	3540.55
258.3	311.26		260.9	1091.15		263.5	2043.29		266.1	3612.93
258.4	347.86		261	1128.25		263.6	2099.87		266.2	3685.99
258.5	385.79		261.1	1165.70		263.7	2157.16		266.3	3759.65
258.6	425.01		261.2	1203.53		263.8	2201.18		266.4	3834.03
258.7	465.48		261.3	1241.69		263.9	2259.70		266.5	3908.98
258.8	507.14		261.4	1265.96		264	2318.89		266.6	3984.58
258.9	549.98		261.5	1304.37		264.1	2364.30		266.7	4060.84
259	593.97		261.6	1343.12		264.2	2424.73		266.8	4137.71
259.1	630.08		261.7	1382.20		264.3	2471.00		266.9	4215.28
259.2	660.63		261.8	1421.62		264.4	2532.66		267	4293.42
259.3	689.20		261.9	1444.48		264.5	2579.74			
259.4	717.55		262	1484.05		264.6	2627.09			
259.5	743.48		262.1	1523.95		264.7	2690.54			

APPENDIX C

Summary of Sampling Data

Table 1. Pierce Creek routine samples: in situ data and laboratory analytical results.

Date	Time	Temperature (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
11/29/11	10:55	9.08	7.21	27.4	11.3	10.4	3.14	0.027	0.011	0.146	<0.03	0.15	1.00	27	0.06	<0.01	2.60	3.10
01/24/12	13:45	10.2	6.01	26.8	12.5	15.2	2.53	0.033	0.018	0.198	<0.03	0.08	4.00	33	0.06	<0.01	2.27	3.09
02/21/12	09:20	9.61	5.40	36.0	11.2	10.4	2.13	0.030	0.012	0.129	<0.03	0.05	2.00	34	0.06	<0.01	2.58	3.35
04/23/12	18:05	16.3	6.05	36.0	8.25	6.69	3.10	0.027	0.011	0.774	<0.03	<0.03	10.5	49	0.06	<0.01	2.42	2.32
AVERAGE	NA	11.3	6.17	31.6	10.8	10.7	2.73	0.029	0.013	0.312	<0.03	0.10	4.38	36	0.06	<0.01	2.47	2.97
MEDIAN	NA	9.91	6.03	31.7	11.3	10.4	2.82	0.029	0.012	0.172	<0.03	0.08	3.00	34	0.06	<0.01	2.50	3.10

Table 2. Pierce Creek storm event samples: in situ data and laboratory analytical results.

Date	Time	Temperature (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
11/15/11	09:35	16.0	7.37	30.0	6.20	NA	16.1	0.102	0.052	1.27	<0.03	0.21	26	59	0.07	<0.10	0.91	2.02
01/25/12	05:25	8.57	6.07	24.0	11.1	26.3	2.87	0.028	0.014	0.399	<0.03	0.06	16	16	0.05	<0.10	2.42	3.01
01/25/12	19:18	8.59	6.86	28.0	12.0	18.3	6.26	0.032	0.018	0.636	<0.03	0.08	6.0	22	0.06	<0.10	2.49	3.31
03/08/12	11:55	NA	NA	NA	NA	NA	2.80	0.030	0.010	0.176	<0.03	<0.03	13	28	0.06	<0.10	2.86	2.86
03/08/12	13:54	14.7	6.02	31.3	8.99	18.5	3.38	0.031	0.010	0.198	<0.03	<0.03	12	33	0.07	<0.10	2.72	2.81
03/08/12	15:30	13.8	5.86	30.0	9.07	32.0	4.31	0.049	0.015	0.351	<0.03	0.06	27	31	0.07	<0.10	2.42	2.64
03/08/12	17:15	13.2	6.2	41.2	9.15	133	10.8	0.084	0.019	0.898	0.05	0.11	79	54	0.07	<0.10	3.77	3.56
03/09/12	10:05	11.5	6.53	26.9	11.0	25.8	5.47	0.036	0.013	0.295	<0.03	0.07	7.0	35	0.07	<0.10	2.23	3.12
03/20/12	19:10	20.0	6.71	36.9	8.08	13.3	4.14	0.038	0.012	0.367	<0.03	<0.03	7.0	31	0.06	<0.10	2.34	2.53
03/20/12	20:35	19.4	6.55	32.0	7.04	21.1	4.19	0.052	0.013	0.620	<0.03	<0.03	22	40	0.06	<0.10	2.35	2.53
03/20/12	21:45	18.1	6.37	36.0	9.12	NA	11.9	0.108	0.020	0.762	<0.03	0.05	58	59	0.07	<0.10	2.49	2.38
03/21/12	07:45	16.9	5.77	20.0	10.1	NA	10.3	0.080	0.030	0.530	<0.03	<0.03	47	43	0.06	<0.10	0.88	1.80
08/30/12	22:10	24.0	5.66	115	2.39	NA	18.7	0.083	0.023	1.34	0.31	<0.03	10	99	0.10	<0.10	2.62	6.25
08/31/12	07:30	23.7	5.48	65.0	2.34	NA	15.0	0.096	0.026	0.990	0.09	2.19	9.0	83	0.09	<0.10	2.00	6.35
AVERAGE	NA	16.0	6.27	39.7	8.20	36.0	8.30	0.061	0.020	0.63	0.06	0.22	24	45	0.07	<0.10	2.32	3.23
MEDIAN	NA	16.0	6.20	31.3	9.07	23.4	5.87	0.051	0.017	0.58	<0.03	0.06	14	38	0.07	<0.10	2.42	2.84

Table 3. Little Cypress Creek routine samples: in situ data and laboratory analytical results.

Date	Time	Temperature (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
08/23/11	13:40	33.2	8.22	86.0	8.37	55.2	12.3	0.100	0.019	1.10	0.04	<0.03	16	90	NA	NA	NA	NA
09/20/11	11:00	21.3	6.16	77.8	3.84	265	8.41	0.210	0.064	1.04	0.07	0.37	82	122	0.14	<0.10	4.54	10.2
10/18/11	10:30	15.9	6.63	80.4	7.49	74.7	7.17	0.060	0.018	0.60	<0.03	<0.03	18	44	0.13	<0.10	5.13	8.09
11/29/11	11:30	9.99	6.72	37.8	11.5	27.1	4.42	0.050	0.017	0.32	<0.03	0.23	8.5	33	0.06	<0.10	3.09	3.63
01/24/12	12:45	10.9	6.65	40.2	11.9	26.1	6.07	0.052	0.017	0.43	<0.03	0.23	6.5	49	0.07	<0.10	3.05	3.92
02/21/12	11:00	11.7	6.12	45.0	11.2	26.8	2.96	0.044	0.017	0.24	<0.03	0.11	5.5	51	0.07	<0.10	3.70	3.94
04/23/12	17:40	18.4	6.25	59.0	8.78	19.3	4.91	0.050	0.013	0.68	<0.03	0.07	15	70	0.09	<0.10	3.33	3.10
05/22/12	10:20	22.6	6.28	82.0	3.87	47.6	8.04	0.097	0.027	0.89	0.05	<0.03	37	73	0.13	<0.10	4.08	2.19
07/24/12	10:20	29.6	6.88	129	4.60	101	10.4	0.083	0.012	1.04	0.08	<0.03	19	128	0.22	<0.10	9.06	3.00
AVERAGE	NA	19.3	6.66	70.8	7.95	71.4	7.19	0.083	0.023	0.70	0.04	0.17	23	73	0.11	<0.10	4.50	4.76
MEDIAN	NA	18.4	6.63	77.8	8.37	47.6	7.17	0.060	0.017	0.68	<0.03	0.17	16	70	0.11	<0.10	3.89	3.78

Table 4. Little Cypress Creek storm event samples: in situ data and laboratory analytical results.

Date	Time	Temperature (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
11/15/11	10:20	16.0	6.52	90.0	5.10	NA	14.4	0.375	0.199	1.45	0.12	0.06	89	98	0.11	<0.10	4.89	11.7
01/25/12	05:40	8.16	6.13	39.0	11.4	45.3	4.92	0.069	0.028	0.63	0.08	0.22	31	43	0.07	<0.10	3.31	3.92
01/25/12	19:41	8.21	6.67	45.0	11.9	32.2	8.45	0.067	0.033	0.69	0.06	0.19	9.5	47	0.07	<0.10	3.42	4.19
03/08/12	12:40	14.9	6.27	94.9	8.51	84.3	6.33	0.090	0.029	0.56	0.05	0.10	88	60	0.09	<0.10	4.75	4.77
03/08/12	15:48	13.9	6.15	73.4	8.56	168	12.9	0.293	0.114	1.45	0.18	0.20	116	74	0.08	<0.10	5.59	5.09
03/08/12	17:42	12.9	6.30	61.7	8.92	141	14.0	0.217	0.092	1.24	0.12	0.17	110	73	0.07	<0.10	4.50	4.28
03/09/12	10:25	11.5	6.31	37.1	10.2	42.2	10.3	0.067	0.023	0.68	0.05	0.14	18	42	0.07	<0.10	2.54	3.14
03/20/12	19:50	20.0	6.64	53.7	7.74	44.3	7.37	0.122	0.027	0.80	<0.03	0.08	40	57	0.08	<0.10	3.28	3.08
03/20/12	21:20	18.5	6.62	72.0	8.66	NA	22.0	0.398	0.173	1.50	0.18	0.19	161	97	0.10	<0.10	5.16	4.79
03/21/12	08:10	16.7	5.94	28.0	8.51	NA	10.8	0.144	0.080	0.61	0.05	0.07	36	49	0.06	<0.10	1.10	1.85
08/30/12	21:00	24.4	6.14	91.0	6.10	NA	7.54	0.179	0.017	1.39	0.16	0.22	665	229	0.18	<0.10	5.69	10.1
08/31/12	08:00	23.8	6.21	80.0	5.83	NA	10.6	0.246	0.050	1.21	0.15	0.23	310	165	0.16	<0.10	4.13	10.7
AVERAGE	NA	15.7	6.33	63.8	8.46	79.5	10.8	0.189	0.072	1.02	0.10	0.16	139	86	0.10	<0.10	4.03	5.63
MEDIAN	NA	15.5	6.29	66.9	8.54	45.3	10.5	0.162	0.042	1.00	0.10	0.18	88	67	0.08	<0.10	4.32	4.53

Table 5. Palarm Creek routine samples: in situ data and laboratory analytical results.

Date	Time	Temperature (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
08/23/11	14:00	29.9	7.35	163	0.28	158	12.3	0.221	0.031	1.51	0.35	<0.03	16	370	NA	NA	NA	NA
09/20/11	11:10	20.1	6.22	109	1.77	270	11.8	0.349	0.129	1.69	0.29	0.48	57	145	0.15	<0.10	4.92	9.32
10/18/11	10:45	15.6	6.49	120	2.49	61.2	9.99	0.193	0.021	0.82	<0.03	<0.03	13	77	0.16	<0.10	4.96	3.49
11/29/11	11:45	8.93	6.22	60.2	10.2	33.3	7.58	0.059	0.021	0.48	<0.03	0.18	4.0	58	0.06	<0.10	4.72	7.32
01/24/12	13:00	10.3	5.78	82.2	9.48	52.1	8.73	0.079	0.021	0.72	0.04	0.14	11	74	0.07	<0.10	4.82	6.49
02/21/12	11:15	11.8	6.08	81.0	11.6	24.4	3.66	0.066	0.017	0.37	0.04	0.04	6.0	68	0.07	<0.10	7.13	7.58
04/23/12	17:24	18.8	6.28	96.0	6.64	9.27	5.45	0.070	0.014	0.83	0.06	0.20	6.0	92	0.08	<0.10	6.17	6.24
05/22/12	10:40	21.0	6.12	131	1.87	7.22	7.56	0.062	0.015	1.26	0.23	0.04	5.0	88	0.06	<0.10	7.07	2.73
07/24/12	10:30	28.2	6.61	165	3.07	17.3	8.98	0.051	<0.010	0.71	0.05	<0.03	3.5	109	0.15	<0.10	7.93	0.34
08/21/12	10:00	23.9	6.83	142	2.47	146	9.48	0.036	0.014	1.07	0.12	<0.03	5.5	106	0.07	<0.10	7.93	0.74
AVERAGE	NA	18.9	6.40	115	4.99	77.8	8.55	0.119	0.029	0.95	0.12	0.12	12	119	0.10	<0.10	6.18	4.92
MEDIAN	NA	19.5	6.25	115	2.78	42.7	8.86	0.068	0.019	0.83	0.06	0.04	6.0	90	0.07	<0.10	6.17	6.24

Table 6. Palarm Creek storm event samples: in situ data and laboratory analytical results.

Date	Time	Temperature (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
11/15/11	10:45	15.5	6.80	50.0	5.60	NA	7.54	0.150	0.059	0.58	<0.03	0.04	63	61	0.10	<0.10	2.51	3.50
01/25/12	05:55	7.64	6.18	61.5	10.3	60.2	9.52	0.133	0.046	0.99	0.11	0.18	27	27	0.07	<0.10	5.66	5.85
01/25/12	20:03	7.82	6.72	59.0	11.2	57.5	13.2	0.128	0.054	0.97	0.06	0.15	24	22	0.07	<0.10	5.52	4.95
03/08/12	13:00	14.7	6.25	83.9	7.68	125	10.3	0.413	0.195	1.31	0.24	0.30	117	68	0.08	<0.10	7.15	5.93
03/08/12	16:08	13.6	6.18	87.2	7.86	188	9.25	0.196	0.054	1.02	0.14	0.14	146	74	0.09	<0.10	6.93	9.50
03/08/12	18:00	13.6	6.25	69.8	7.84	115	14.3	0.278	0.113	1.10	0.10	0.15	87	67	0.08	<0.10	6.12	3.37
03/09/12	10:40	11.1	6.21	43.2	10.2	44.8	10.9	0.100	0.046	0.80	0.04	0.07	11	63	0.07	<0.10	3.28	3.39
03/20/12	20:10	19.7	6.57	73.0	6.61	23.8	9.51	0.100	0.023	0.53	<0.03	0.05	27	56	0.08	<0.10	4.78	5.83
03/20/12	21:30	18.8	6.50	87.0	7.71	NA	10.0	0.168	0.025	0.78	<0.03	0.06	160	75	0.09	<0.10	5.29	8.99
03/21/12	08:20	16.8	5.90	29.0	8.47	NA	12.5	0.120	0.053	0.63	0.04	0.04	60	41	0.07	<0.10	1.62	2.07
08/30/12	21:20	24.2	6.78	148	4.53	NA	8.86	0.063	0.020	0.83	0.08	0.29	13	96	0.10	<0.10	7.34	1.25
08/31/12	08:30	23.8	6.72	140	4.19	NA	9.24	0.077	0.016	0.95	0.09	<0.03	53	100	0.13	<0.10	7.24	0.76
AVERAGE	NA	15.6	6.42	77.6	7.68	87.7	10.4	0.161	0.059	0.87	0.08	0.13	65	63	0.09	<0.10	5.29	4.62
MEDIAN	NA	15.1	6.38	71.4	7.78	60.2	9.76	0.131	0.050	0.89	0.07	0.11	56	65	0.08	<0.10	5.59	4.23

Table 7. Little Creek routine samples: in situ data and laboratory analytical results.

Date	Time	Temperature (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
08/23/11	14:30	30.8	7.21	194	6.61	14.7	6.30	0.096	0.012	0.84	<0.03	<0.03	70	112	NA	NA	NA	NA
09/20/11	13:00	21.5	6.63	98.2	5.29	33.2	6.55	0.077	0.015	0.82	<0.03	0.20	21	73	0.16	<0.10	4.65	11.7
10/18/11	11:00	16.2	6.55	137	3.81	16.4	5.80	0.042	0.012	0.47	0.04	0.05	6.5	78	0.23	<0.10	7.24	15.7
11/29/11	12:20	8.60	6.31	118	9.56	37.2	3.90	0.033	0.012	0.23	<0.03	0.62	2.0	42	0.06	<0.10	6.17	5.40
01/24/12	10:20	6.72	6.66	145	10.9	58.1	8.55	0.120	0.034	0.93	0.12	0.38	17	116	0.12	<0.10	14.0	13.8
02/21/12	11:45	12.7	6.33	129	11.3	56.9	5.66	0.066	0.021	0.56	0.05	0.26	15	96	0.11	<0.10	11.3	12.8
04/23/12	18:34	17.8	6.64	136	7.64	9.59	5.29	0.034	0.012	0.72	0.05	0.15	7.5	96	0.15	<0.10	7.61	11.3
05/22/12	12:45	24.1	6.27	228	3.75	16.6	5.90	0.065	0.015	1.02	0.13	<0.03	9.5	135	0.19	<0.10	15.0	18.6
07/24/12	11:25	29.9	6.95	231	7.67	8.79	8.80	0.072	0.016	0.73	0.34	<0.03	8.0	140	0.33	<0.10	12.0	14.6
08/21/12	11:25	27.7	7.44	156	1.74	8.51	6.16	0.039	0.016	0.67	0.13	<0.03	4.0	106	0.26	<0.10	8.56	17.9
AVERAGE	NA	19.6	6.70	157	6.83	26.0	6.29	0.064	0.017	0.70	0.10	0.18	16	99	0.18	<0.10	9.61	13.5
MEDIAN	NA	19.7	6.64	141	7.13	16.5	6.03	0.066	0.015	0.73	0.05	0.10	8.8	101	0.16	<0.10	8.56	13.8

Table 8. Little Creek storm event samples: in situ data and laboratory analytical results.

Date	Time	Temperature (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
11/15/11	11:30	16.3	6.97	79.0	6.00	NA	7.30	0.163	0.074	0.72	0.07	0.34	77	65	0.11	<0.10	3.75	7.28
01/25/12	6:10	7.83	6.33	70.5	11.2	112	8.84	0.129	0.052	1.03	0.13	0.35	96	62	0.10	<0.10	5.28	7.36
01/25/12	16:30	8.18	6.70	80.0	11.8	64.4	13.8	0.157	0.069	1.27	0.16	0.34	29	79	0.09	<0.10	6.16	7.55
01/25/12	20:25	8.07	6.78	79.0	11.7	82.6	12.7	0.132	0.058	1.16	0.11	0.36	40	73	0.09	<0.10	5.98	7.77
03/08/12	9:50	16.5	6.64	157	7.73	81.8	6.94	0.067	0.011	0.74	0.08	0.31	81	98	0.18	<0.10	12.1	15.9
03/08/12	12:15	15.7	6.39	127	8.66	126	6.56	0.095	0.015	0.86	0.10	0.27	137	96	0.14	<0.10	8.80	12.3
03/08/12	14:50	NA	NA	NA	NA	245	8.96	0.164	0.044	1.06	0.10	0.27	194	77	0.10	<0.10	4.50	6.17
03/08/12	17:00	NA	NA	NA	NA	86.4	13.7	0.186	0.060	1.22	0.07	0.13	47	71	0.08	<0.10	4.94	5.10
03/09/12	8:55	11.6	9.59	72.4	10.3	57.5	11.1	0.082	0.031	0.86	0.08	0.24	19	82	0.09	<0.10	4.87	5.62
03/20/12	17:45	19.5	6.63	165	6.35	NA	6.82	0.068	0.016	0.49	0.06	0.10	6.0	99	0.17	<0.10	12.9	12.7
03/20/12	19:00	19.5	7.35	179	9.15	NA	7.80	0.184	0.044	1.09	0.11	0.18	173	119	0.20	<0.10	12.4	15.3
03/20/12	21:15	18.5	6.67	76.0	8.68	NA	12.3	0.236	0.074	1.09	0.16	0.31	218	85	0.11	<0.10	3.94	6.70
03/21/12	8:35	16.8	5.88	33.0	8.23	NA	7.84	0.112	0.055	0.52	<0.03	0.10	24	44	0.07	<0.10	2.12	2.05
08/30/12	21:30	25.0	6.85	109	2.83	24.3	7.08	0.083	0.024	0.74	0.01	0.10	11	83	0.18	<0.10	4.89	12.9
08/31/12	8:00	24.7	6.42	64.2	6.38	88.5	6.97	0.122	0.052	0.76	0.05	0.48	40	66	0.12	<0.10	2.53	7.28
AVERAGE	NA	16.0	6.86	99.3	8.39	96.9	9.25	0.132	0.045	0.91	0.09	0.26	79	80	0.12	<0.10	6.34	8.80
MEDIAN	NA	16.5	6.67	79.0	8.66	84.5	7.84	0.129	0.052	0.86	0.10	0.27	47	79	0.11	<0.10	4.94	7.36

Table 9. Stone Dam Creek routine samples: in situ data and laboratory analytical results.

Date	Time	Temperature (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
08/23/11	14:40	33.3	7.41	752	7.56	16.6	9.22	2.80	2.71	0.85	0.10	11.9	7.0	475	NA	NA	NA	NA
09/20/11	13:10	26.3	6.56	608	6.56	20.8	7.66	2.23	2.22	1.80	0.07	12.6	5.0	385	0.70	<0.10	43.6	130
10/18/11	09:30	19.1	6.69	260	5.62	16.0	6.27	0.56	0.51	0.88	0.40	1.16	9.0	151	0.44	<0.10	16.0	47.9
11/29/11	08:40	13.8	6.71	360	9.94	12.9	8.43	0.07	0.03	0.57	0.06	0.39	6.5	92.0	0.11	<0.10	8.69	12.6
01/24/12	10:15	11.2	6.26	476	7.48	8.78	8.64	1.86	1.74	5.87	5.05	2.48	4.0	275	0.65	0.24	43.5	83.5
02/21/12	15:25	15.7	6.81	272	10.4	45.9	7.55	0.90	0.71	2.91	2.34	2.21	15	159	0.39	0.11	24.6	37.1
04/23/12	18:57	20.6	6.72	644	7.78	9.50	8.35	2.48	2.19	3.20	0.11	16.0	10	448	0.64	0.11	38.4	154
05/22/12	13:30	26.1	6.20	704	5.76	5.57	9.70	4.15	3.72	3.65	0.36	14.4	6.0	455	0.64	0.16	56.1	150
07/24/12	12:35	31.2	6.94	970	6.19	26.3	9.37	3.94	3.54	2.15	0.18	7.60	21	579	1.08	<0.10	73.4	225
08/21/12	11:45	30.5	8.04	359	7.10	98.2	7.19	1.14	1.02	3.43	2.66	1.13	29	241	0.66	<0.10	27.0	74.2
AVERAGE	NA	22.8	6.83	540	7.44	26.1	8.24	2.01	1.84	2.53	1.13	6.99	11	326	0.59	0.12	36.8	102
MEDIAN	NA	23.4	6.72	542	7.29	16.3	8.39	2.05	1.97	2.53	0.27	5.04	8.0	330	0.64	0.10	38.4	83.5

Table 10. Stone Dam Creek storm event samples: in situ data and laboratory analytical results.

Date	Time	Temperature (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
11/15/11	11:55	16.3	7.38	42.0	5.40	NA	8.62	0.189	0.140	0.64	0.05	0.37	21	50	0.12	<0.10	5.29	15.5
01/25/12	04:30	8.20	5.62	54.6	11.2	68.6	5.27	0.110	0.049	0.88	0.21	0.46	54	43	0.11	<0.10	2.68	6.12
01/25/12	16:55	9.55	6.68	177	10.7	44.0	10.6	0.476	0.386	2.31	1.37	1.36	14	118	0.22	<0.10	11.7	31.1
01/25/12	20:42	8.91	6.79	116	11.4	55.3	11.0	0.246	0.171	1.45	0.43	1.14	23	91	0.14	<0.10	6.64	17.3
03/08/12	09:30	17.2	6.16	185	7.64	47.5	8.68	0.066	0.018	0.79	0.14	0.65	22	74	0.18	<0.10	6.37	12.3
03/08/12	12:05	16.4	6.42	246	8.10	52.6	7.57	0.421	0.329	1.06	0.40	0.97	30	151	0.26	0.11	15.8	47.5
03/08/12	15:20	NA	NA	NA	NA	51.5	4.43	0.066	0.024	0.64	0.08	0.33	25	78	0.11	<0.10	3.11	19.4
03/08/12	17:15	NA	NA	NA	NA	98.1	7.62	0.251	0.171	0.98	0.19	0.71	56	83	0.11	<0.10	3.27	11.6
03/09/12	09:15	16.7	7.44	195	9.80	34.2	10.6	0.676	0.566	1.11	0.28	2.76	13	144	0.22	<0.10	11.7	40.4
03/20/12	17:30	20.0	6.29	265	7.88	NA	7.16	0.781	0.441	2.88	2.14	0.70	223	159	0.39	0.15	19.3	36.6
03/20/12	18:45	18.8	6.44	116	9.37	NA	12.2	0.374	0.178	1.72	0.63	0.46	181	90	0.20	<0.10	6.82	13.2
03/20/12	21:00	18.0	6.57	49.0	8.95	NA	17.6	0.289	0.150	1.14	0.20	0.36	111	63	0.10	<0.10	1.74	4.39
03/21/12	09:00	16.8	5.83	38.0	7.21	NA	7.35	0.130	0.067	0.48	0.05	0.16	37	55	0.08	<0.10	0.78	3.24
08/30/12	20:40	26.0	6.75	436	6.31	36.2	8.61	2.16	1.94	2.00	0.11	10.4	29	312	0.85	0.18	49.4	73.6
8/30/12	21:55	26.1	6.86	258	6.29	46.5	6.64	1.18	1.08	1.03	0.08	5.39	33	187	0.57	0.12	26.7	42.0
8/31/12	07:45	24.8	6.76	45.4	5.41	31.6	5.87	0.112	0.067	0.48	0.04	0.57	15	48	0.10	<0.10	1.22	5.22
AVERAGE	NA	17.4	6.57	159	8.26	51.5	8.74	0.470	0.361	1.22	0.40	1.67	55	109	0.24	0.11	10.8	23.7
MEDIAN	NA	17.0	6.63	147	7.99	47.5	8.12	0.270	0.171	1.05	0.19	0.68	29	87	0.16	0.10	6.51	16.4

Table 11. Gold Creek routine samples: in situ data and laboratory analytical results.

Date	Time	Temperature (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
08/23/11	15:05	33.4	7.42	112	8.29	11.0	7.42	0.044	0.014	0.83	<0.03	<0.03	5.0	68.0	NA	NA	NA	NA
09/20/11	13:20	26.2	7.18	139	8.99	15.0	7.08	0.127	0.013	1.36	<0.03	0.06	42	94.0	0.16	<0.10	8.89	16.2
10/18/11	09:10	17.1	6.54	127	3.89	10.9	7.84	0.050	<0.010	0.84	0.04	<0.03	7.0	71.0	0.18	<0.10	8.46	8.52
11/29/11	08:30	8.24	7.05	51.0	11.4	13.5	8.77	0.978	0.861	1.57	0.87	4.65	3.5	217	0.33	0.11	24.8	68.7
01/24/12	10:00	6.11	6.28	55.2	13.0	21.4	4.50	0.038	0.015	0.35	<0.03	0.27	3.5	55.0	0.07	<0.10	6.42	6.09
02/21/12	15:35	13.0	7.01	43.0	12.0	23.2	9.05	0.046	0.016	0.24	0.04	0.22	7.0	42.0	0.07	<0.10	5.74	5.78
04/23/12	19:15	19.4	6.99	70.0	10.8	8.74	5.11	0.059	0.015	0.90	<0.03	0.05	7.5	61.0	0.07	<0.10	5.37	5.90
05/22/12	13:50	29.2	6.17	73.0	5.29	5.94	6.12	0.055	0.012	1.07	<0.03	<0.03	7.5	42.0	0.06	<0.10	5.24	4.17
07/24/12	12:45	32.4	6.96	124	5.28	5.56	10.2	0.069	0.014	0.92	0.04	<0.03	4.5	87.0	0.18	<0.10	8.41	3.17
AVERAGE	NA	20.6	6.84	88.2	8.77	12.8	7.34	0.163	0.108	0.90	0.13	0.60	9.7	81.9	0.14	<0.10	9.17	14.8
MEDIAN	NA	19.4	6.99	73.0	8.99	11.0	7.42	0.055	0.014	0.90	0.03	0.05	7.0	68.0	0.12	<0.10	7.42	5.60

Table 12. Gold Creek storm event samples: in situ data and laboratory analytical results.

Date	Time	Temperature (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
11/15/11	12:25	16.3	7.38	100	6.00	NA	6.73	0.081	0.040	0.63	0.04	0.20	33	80	0.14	<0.10	5.29	15.5
01/25/12	05:00	8.20	5.62	54.6	11.2	68.6	7.03	0.076	0.026	0.74	0.05	0.30	35	47	0.07	<0.10	5.63	6.85
01/25/12	17:08	7.82	6.72	49.0	12.5	31.5	6.70	0.052	0.025	0.56	<0.03	0.25	11	49	0.07	<0.10	5.58	5.12
01/25/12	20:55	7.95	6.60	46.0	12.4	49.3	6.57	0.056	0.024	0.54	<0.03	0.26	19	42	0.07	<0.10	5.08	5.13
03/08/12	11:50	14.8	6.06	61.0	9.54	83.47	6.08	0.100	0.020	0.70	0.04	0.16	77	48	0.07	<0.10	5.90	5.99
03/08/12	15:35	NA	NA	NA	NA	229	12.6	0.247	0.074	1.42	0.11	0.18	202	69	0.08	<0.10	4.21	5.42
03/08/12	17:25	NA	NA	NA	NA	162	11.8	0.204	0.074	1.11	0.09	0.15	176	59	0.08	<0.10	3.09	3.98
03/09/12	09:30	10.8	7.13	39.6	10.9	35.8	5.86	0.053	0.02	0.37	0.04	0.23	12	48	0.05	<0.10	3.14	4.52
03/20/12	18:30	18.7	6.73	50.0	9.36	NA	5.92	0.123	0.037	0.54	0.06	0.13	65	36	0.08	<0.10	4.27	4.10
03/20/12	20:45	18.6	7.35	58.0	9.53	NA	9.29	0.214	0.060	0.94	0.06	0.16	107	42	0.08	<0.10	4.01	4.75
03/21/12	09:05	16.2	6.02	26.0	9.36	NA	9.46	0.100	0.039	0.56	0.04	0.09	55	32	0.07	<0.10	1.28	2.50
08/31/12	07:40	24.9	6.95	93.4	6.29	24.8	8.01	0.075	0.021	0.73	0.05	0.21	5.0	75	0.19	<0.10	5.00	12.1
AVERAGE	NA	14.4	6.66	57.8	9.70	85.5	8.00	0.115	0.038	0.74	0.05	0.19	66	52	0.09	<0.10	4.37	6.33
MEDIAN	NA	15.5	6.73	52.3	9.54	58.9	6.88	0.091	0.032	0.66	0.05	0.19	45	48	0.08	<0.10	4.64	5.13

Table 13. Outlet routine samples: in situ data and laboratory analytical results.

Date	Time	Temperature (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
08/23/11	08:00	NA	NA	NA	NA	NA	7.82	0.120	0.029	1.31	0.311	0.102	8.00	60	NA	NA	NA	NA
09/20/11	10:00	22.9	6.78	86.6	5.01	21.5	8.72	0.131	0.027	1.19	0.067	0.137	14.5	65	0.12	<0.10	5.25	2.20
10/18/11	09:45	18.7	6.79	92.5	7.22	20.2	8.45	0.118	0.020	1.06	0.082	0.080	13.3	<5.0	0.16	<0.10	5.99	2.86
11/29/11	09:40	9.46	5.96	86.4	11.4	18.2	7.28	0.082	0.010	0.84	<0.03	<0.03	8.50	56	0.12	<0.10	6.34	9.70
01/24/12	09:30	7.43	6.23	45.3	11.8	9.90	5.41	0.066	0.012	0.57	<0.03	<0.03	9.50	44	0.07	<0.10	3.56	5.58
02/21/12	09:00	10.1	6.43	53.0	11.5	12.2	5.22	0.055	0.012	0.57	<0.03	<0.03	4.50	51	0.06	<0.10	4.63	7.14
04/23/12	15:15	21.1	5.24	52.0	9.29	9.51	6.21	0.053	0.010	0.76	<0.03	<0.03	10.5	45	0.08	<0.10	3.08	3.46
05/22/12	07:35	24.8	6.20	57.9	3.80	8.61	7.78	0.091	0.012	0.97	0.090	<0.03	11.0	55	0.06	<0.10	3.36	3.17
07/24/12	08:15	29.5	6.70	95.9	4.78	16.4	9.38	0.127	0.013	1.31	0.148	0.081	12.5	68	0.08	<0.10	5.48	1.86
08/21/12	07:20	25.2	6.50	68.3	3.20	20.1	10.0	0.138	0.019	1.61	0.311	0.120	15.0	70	0.14	<0.10	6.32	1.80
AVERAGE	NA	18.8	6.31	70.9	7.56	15.2	7.63	0.098	0.016	1.02	0.113	0.067	10.7	52	0.10	<0.1	4.89	4.20
MEDIAN	NA	21.1	6.43	68.3	7.22	16.4	7.80	0.105	0.013	1.02	0.075	0.055	10.8	56	0.08	<0.1	5.25	3.17

Table 14. Outlet storm event samples: in situ data and laboratory analytical results.

Date	Time	Temperature (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
11/15/11	08:35	17.4	7.43	79.0	6.80	NA	7.59	0.127	0.017	0.99	<0.03	<0.03	42	53	0.12	<0.10	5.48	3.24
01/25/12	18:05	8.41	6.88	46.0	12.5	14.3	5.62	0.054	0.012	0.61	<0.03	<0.03	10	21	0.08	<0.10	3.54	5.51
03/08/12	13:15	14.2	6.51	57.0	9.97	26.1	5.36	0.078	0.011	0.72	0.05	<0.03	22	39	0.08	<0.10	4.70	7.60
03/08/12	16:15	NA	NA	NA	NA	26.5	4.98	0.074	0.012	0.64	0.04	<0.03	21	43	0.08	<0.10	4.64	7.58
03/08/12	17:45	NA	NA	NA	NA	23.1	4.92	0.085	0.012	0.72	0.04	<0.03	17	44	0.08	<0.10	4.63	7.60
03/09/12	09:45	12.9	6.21	54.9	11.0	20.7	4.90	0.076	0.012	0.69	0.04	<0.03	12	41	0.08	<0.10	4.74	7.88
03/20/12	17:10	21.4	7.10	64.6	8.36	36.0	5.81	0.077	0.016	0.55	<0.03	<0.03	11	43	0.09	<0.10	5.36	7.97
03/21/12	09:30	19.1	6.13	59.0	8.56	NA	5.89	0.088	0.016	0.58	0.04	<0.03	18	43	0.08	<0.10	4.83	6.96
08/31/12	07:20	25.2	6.50	68.3	3.20	20.1	10.0	0.138	0.019	1.61	0.31	0.12	15	70	0.14	<0.10	6.32	1.80
AVERAGE	NA	16.9	6.68	61.3	8.62	23.8	6.12	0.089	0.014	0.79	0.07	0.04	18	44	0.09	<0.10	4.92	6.24
MEDIAN	NA	17.4	6.51	59.0	8.56	23.1	5.62	0.078	0.012	0.69	0.04	<0.03	17	43	0.08	<0.10	4.74	7.58

Table 15. LC-1 routine lake samples: in situ data and laboratory analytical results.

Date	Time	Temp (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Chlorophyll-a (µg/L)
08/23/11	12:15	32.2	10.0	198	10.7	58.3	12.5	0.50	0.191	2.41	<0.03	<0.03	47	129	NA	<0.10	NA	NA	NA
09/20/11	12:30	22.9	6.52	110	3.65	51.4	6.76	0.09	0.023	0.90	0.16	0.26	21	78.0	0.18	<0.10	6.51	11.7	NA
10/18/11	11:45	18.1	6.57	162	5.35	26.9	8.48	0.17	0.024	1.18	0.12	0.14	17	92.0	0.24	<0.10	11.0	25.2	NA
11/29/11	12:45	9.80	5.08	86.9	7.73	53.4	10.9	0.16	0.050	1.14	0.25	0.34	24	86.0	0.09	<0.10	6.22	9.78	0.50
01/24/12	10:45	6.92	7.04	154	10.0	27.3	5.35	0.15	0.073	0.81	0.28	0.49	10	103	0.15	<0.10	13.1	18.2	NA
02/21/12	13:15	11.7	8.03	121	10.8	39.8	7.59	0.08	0.024	0.62	0.08	0.29	8.5	93.0	0.10	<0.10	11.7	11.8	NA
04/23/12	13:30	19.5	8.39	99.0	11.1	22.5	7.52	0.18	0.030	1.30	<0.03	<0.03	23	70.0	0.14	<0.10	6.32	12.9	NA
05/22/12	12:10	27.3	7.18	117	7.93	22.3	10.6	0.25	0.036	1.54	<0.03	<0.03	29	79.0	0.19	<0.10	8.03	14.3	43.9
07/22/12	12:20	34.2	7.28	194	11.0	15.4	12.9	0.16	0.020	1.40	<0.03	<0.03	13	134	0.30	<0.10	14.1	11.7	102
08/21/12	11:10	28.5	6.82	95.8	5.41	28.5	7.13	0.05	0.012	1.07	0.10	0.05	7.5	71.0	0.07	<0.10	4.98	16.7	NA
AVERAGE	NA	21.1	7.29	134	8.37	34.6	8.97	0.18	0.048	1.24	0.11	0.17	20	93.5	0.16	<0.10	9.11	14.7	48.8
MEDIAN	NA	21.2	7.11	119	8.97	27.9	8.04	0.16	0.027	1.16	0.09	0.10	19	89.0	0.15	<0.10	8.03	12.9	43.9

Table 16. LC-2 routine lake samples: in situ data and laboratory analytical results.

Date	Time	Temp (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Chlorophyll-a (µg/L)
08/23/11	11:00	31.3	7.35	92.0	7.25	17.5	9.16	0.12	0.012	1.29	<0.03	<0.03	12.0	66	NA	NA	NA	NA	NA
09/20/11	12:00	22.6	7.30	93.6	8.88	36.1	9.27	0.11	0.011	1.17	<0.03	<0.03	14.0	72	22.3	<0.10	5.60	3.24	NA
10/18/11	12:15	19.7	6.96	95.9	8.03	21.3	9.01	0.12	<0.010	1.12	<0.03	<0.03	16.0	54	18.1	<0.10	6.32	3.98	NA
11/29/11	12:00	9.11	6.15	45.7	9.46	22.8	9.09	0.08	0.019	0.70	0.132	0.082	7.50	61	19.6	<0.10	2.84	4.16	7.20
01/24/12	12:15	8.53	6.71	47.6	10.2	76.7	9.62	0.12	0.033	0.85	0.033	0.211	19.0	65	5.00	<0.10	3.89	4.71	NA
02/21/12	14:00	11.0	7.51	50.0	12.0	15.5	6.38	0.06	0.013	0.58	0.037	<0.03	6.50	57	10.6	<0.10	4.37	5.15	NA
04/23/12	14:10	20.0	5.77	48.0	10.3	15.5	6.73	0.06	<0.010	0.85	<0.03	<0.03	11.5	47	2.33	<0.10	2.44	3.49	NA
05/22/12	11:20	26.8	6.52	58.0	7.03	12.3	8.28	0.09	0.010	1.01	<0.03	<0.03	13.5	25	14.2	<0.10	3.05	3.25	29.4
07/22/12	11:00	30.6	7.28	100	7.67	38.0	11.4	0.15	0.013	1.46	<0.03	<0.03	24.0	76	24.4	<0.10	6.41	2.63	48.8
08/21/12	10:35	26.7	6.63	93.4	6.07	74.6	11.3	0.11	0.013	1.32	<0.03	<0.03	17.5	81	17.4	<0.10	7.28	1.98	NA
AVERAGE	NA	20.6	6.82	72.4	8.69	33.0	9.04	0.10	0.014	1.04	0.04	0.05	14.2	60	14.9	<0.10	4.69	3.62	28.5
MEDIAN	NA	21.3	6.84	75.0	8.46	22.1	9.13	0.11	0.013	1.07	0.03	0.03	13.8	63	17.4	<0.10	4.37	3.49	29.4

Table 17. LC-3 routine lake samples: in situ data and laboratory analytical results.

Date	Time	Temp (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Chlorophyll-a (µg/L)
08/23/11	11:30	31.4	7.72	96.2	7.53	16.0	10.1	0.179	0.012	1.44	<0.03	<0.03	13.0	60	NA	NA	NA	3.11	NA
09/20/11	10:30	21.6	7.04	90.3	8.31	16.3	9.05	0.125	0.012	1.28	<0.03	<0.03	13.0	69	0.13	<0.1	5.39	5.52	NA
10/18/11	12:45	19.9	6.82	98.3	7.12	19.2	8.98	0.157	0.012	1.16	<0.03	<0.03	17.3	49	0.18	<0.1	6.74	6.31	NA
11/29/11	11:10	9.60	6.34	63.3	10.67	15.5	7.40	0.081	0.016	0.77	0.053	0.158	8.00	54	0.09	<0.1	4.30	6.60	17.7
01/24/12	13:30	8.44	6.23	50.2	12.55	16.6	5.81	0.077	0.011	0.70	<0.03	<0.03	8.00	47	0.08	<0.1	3.96	7.76	NA
02/21/12	10:30	9.18	7.30	55.0	11.43	10.9	5.96	0.082	0.012	0.65	<0.03	<0.03	8.00	52	0.07	<0.1	4.50	3.59	NA
04/23/12	13:00	19.7	7.17	45.0	9.64	13.8	6.33	0.079	0.013	0.78	<0.03	<0.03	14.0	45	0.07	<0.1	2.48	3.30	NA
05/22/12	09:15	26.0	6.74	60.5	8	9.86	7.77	0.096	0.010	1.07	<0.03	<0.03	9.50	35	0.09	<0.1	3.06	2.82	49.0
07/22/12	09:50	30.6	6.80	101	5.26	24.8	10.4	0.166	0.012	1.59	<0.03	<0.03	17.5	79	0.08	<0.1	6.50	2.54	43.0
08/21/12	09:20	26.3	6.88	93.8	3.82	105	9.80	0.131	0.013	1.49	0.108	<0.03	13.5	77	0.17	<0.1	7.61	4.62	NA
AVERAGE	NA	20.3	6.90	75.4	8.43	24.8	8.16	0.117	0.012	1.09	0.040	0.043	12.2	57	0.11	<0.1	4.95	3.59	36.6
MEDIAN	NA	20.8	6.85	76.8	8.16	16.2	8.38	0.111	0.012	1.12	<0.03	<0.03	13.0	53	0.09	<0.1	4.50	3.11	43.0

Table 18. LC-4 routine lake samples: in situ data and laboratory analytical results.

Date	Time	Temp (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Chlorophyll-a (µg/L)
08/23/11	09:30	31.2	6.72	86.2	7.01	14.2	8.23	0.124	0.014	1.31	<0.03	<0.03	12.0	56	NA	NA	NA	NA	NA
09/20/11	09:00	21.5	7.00	87.8	8.39	18.4	8.52	0.114	0.011	1.15	<0.03	<0.03	13.5	64	0.14	<0.1	5.09	2.58	NA
10/18/11	13:10	19.9	7.00	89.4	8.26	15.4	8.18	0.122	<0.010	1.18	<0.03	<0.03	15.3	43	0.16	<0.1	5.97	3.33	NA
11/29/11	10:45	9.76	6.94	74.4	10.9	12.9	8.04	0.079	<0.010	0.87	<0.03	<0.03	11.0	57	0.08	<0.1	5.59	7.55	20.2
01/24/12	14:30	8.36	5.94	47.3	12.4	6.71	5.44	0.062	0.011	0.60	<0.03	<0.03	6.00	41	0.08	<0.1	3.55	5.69	NA
02/21/12	14:30	10.8	6.67	56.0	11.8	8.06	5.51	0.064	0.012	0.53	<0.03	<0.03	3.50	48	0.08	<0.1	4.64	7.80	NA
04/23/12	12:18	19.2	6.68	47.0	9.37	14.0	6.22	0.073	0.011	0.84	<0.03	<0.03	12.5	49	0.08	<0.1	2.53	3.25	NA
05/22/12	08:50	25.3	6.63	56.5	7.10	8.89	6.9	0.070	0.010	0.91	<0.03	<0.03	9.50	35	0.09	<0.1	3.06	3.30	32.0
07/22/12	09:10	30.5	6.74	92.4	5.49	22.5	8.97	0.124	<0.010	1.30	<0.03	<0.03	14.5	67	0.13	<0.1	5.22	2.16	62.7
08/21/12	08:20	26.5	6.75	82.8	5.47	102	9.25	0.114	0.012	1.31	<0.03	<0.03	13.0	67	0.14	<0.1	6.11	1.95	NA
AVERAGE	NA	20.3	6.71	72.0	8.62	22.3	7.53	0.095	0.011	1.00	<0.03	<0.03	11.1	53	0.11	<0.1	4.64	4.18	38.3
MEDIAN	NA	20.7	6.73	78.6	8.33	14.1	8.11	0.097	0.011	1.03	<0.03	<0.03	12.3	53	0.09	<0.1	5.09	3.30	32.0

Table 19. LC-5 routine lake samples: in situ data and laboratory analytical results.

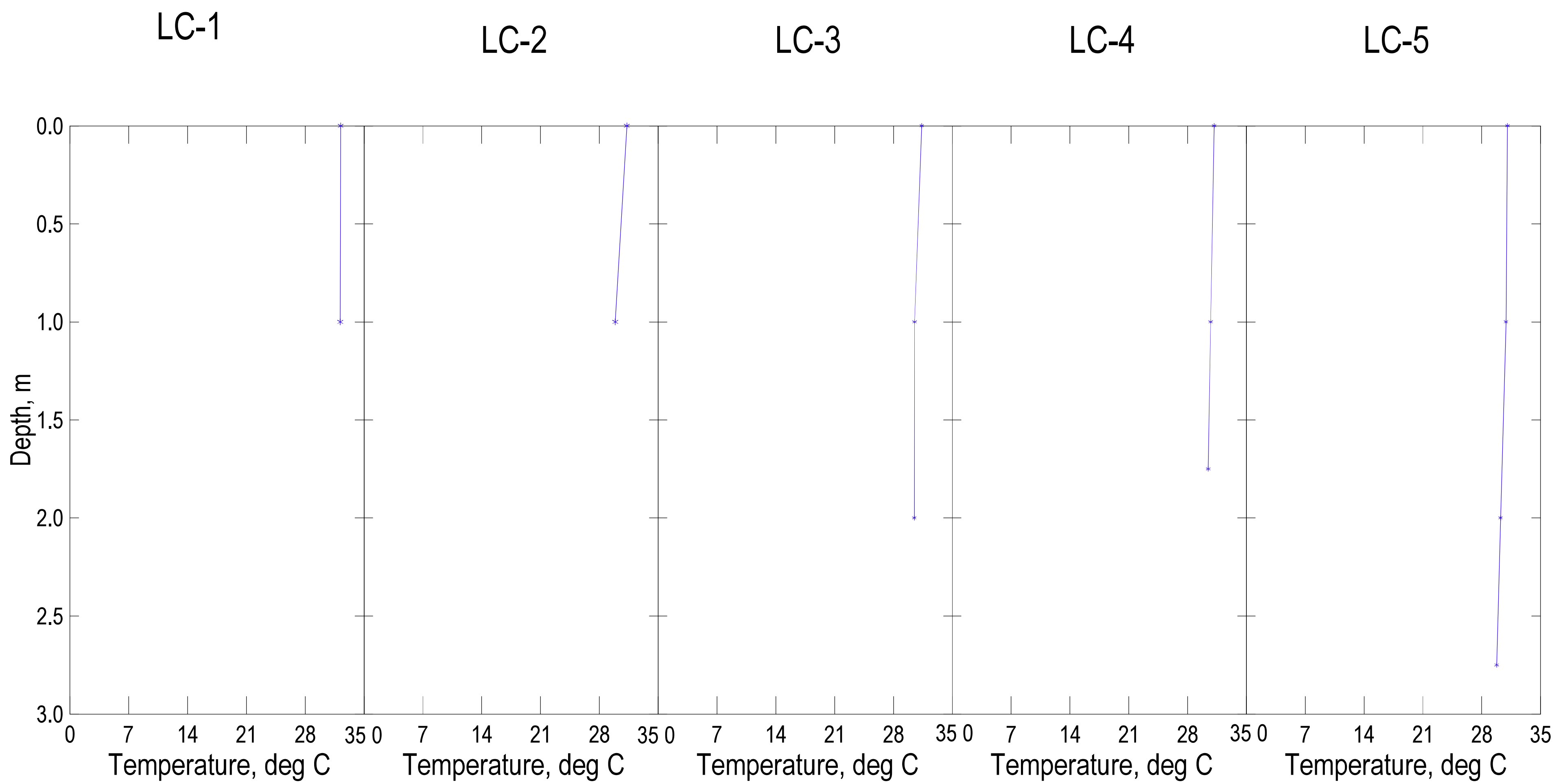
Date	Time	Temp (°C)	pH (su)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Organic Carbon (mg/L)	Total Phosphorus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrate + Nitrite – Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Fluoride (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Chlorophyll-a (µg/L)
08/23/11	10:00	31.08	7.13	88.4	7.50	15.9	8.04	0.111	0.011	1.25	<0.03	<0.03	8.70	45	NA	NA	NA	NA	NA
09/20/11	09:10	21.50	7.11	87.0	8.03	18.1	8.36	0.114	0.011	1.14	<0.03	<0.03	13.0	68	0.14	<0.10	5.19	2.24	NA
10/18/11	13:25	20.09	6.94	90.7	7.97	17.3	8.36	0.115	<0.010	1.09	<0.03	<0.03	15.0	53	0.16	<0.10	6.00	2.91	NA
11/29/11	10:30	9.49	6.89	82.5	11.5	16.5	7.49	0.086	<0.010	0.94	<0.03	<0.03	8.00	51	0.08	<0.10	6.22	8.94	17.9
01/24/12	14:15	8.33	6.75	47.1	12.4	9.74	5.54	0.059	0.012	0.56	<0.03	<0.03	6.00	45	0.08	<0.10	3.56	3.72	NA
02/21/12	14:45	10.68	6.56	53.0	11.8	9.88	5.40	0.065	<0.010	0.59	<0.03	<0.03	6.00	51	0.08	<0.10	4.48	7.22	NA
04/23/12	12:04	19.58	6.67	49.0	9.25	16.6	6.16	0.060	0.010	0.98	<0.03	<0.03	11.0	57	0.07	<0.10	2.81	3.34	NA
05/22/12	08:30	25.94	6.65	58.2	6.61	9.70	6.97	0.068	<0.010	0.85	<0.03	<0.03	6.00	39	0.06	<0.10	3.36	3.18	50.7
07/22/12	08:51	30.25	6.79	93.5	4.58	25.7	9.79	0.136	0.015	1.36	<0.03	<0.03	16.0	71	0.08	<0.10	5.53	1.92	17.1
08/21/12	08:00	26.40	6.77	82.7	5.18	81.0	9.46	0.131	<0.010	1.37	<0.03	<0.03	16.0	68	0.14	<0.10	6.34	1.75	NA
AVERAGE	NA	20.33	6.83	73.2	8.48	22.0	7.56	0.095	0.011	1.01	<0.03	<0.03	10.6	55	0.10	<0.10	4.83	3.91	28.6
MEDIAN	NA	20.80	6.78	82.6	8.00	16.6	7.77	0.099	0.010	1.04	<0.03	<0.03	9.85	52	0.08	<0.10	5.19	3.18	17.9

APPENDIX D

In Situ Data Plots

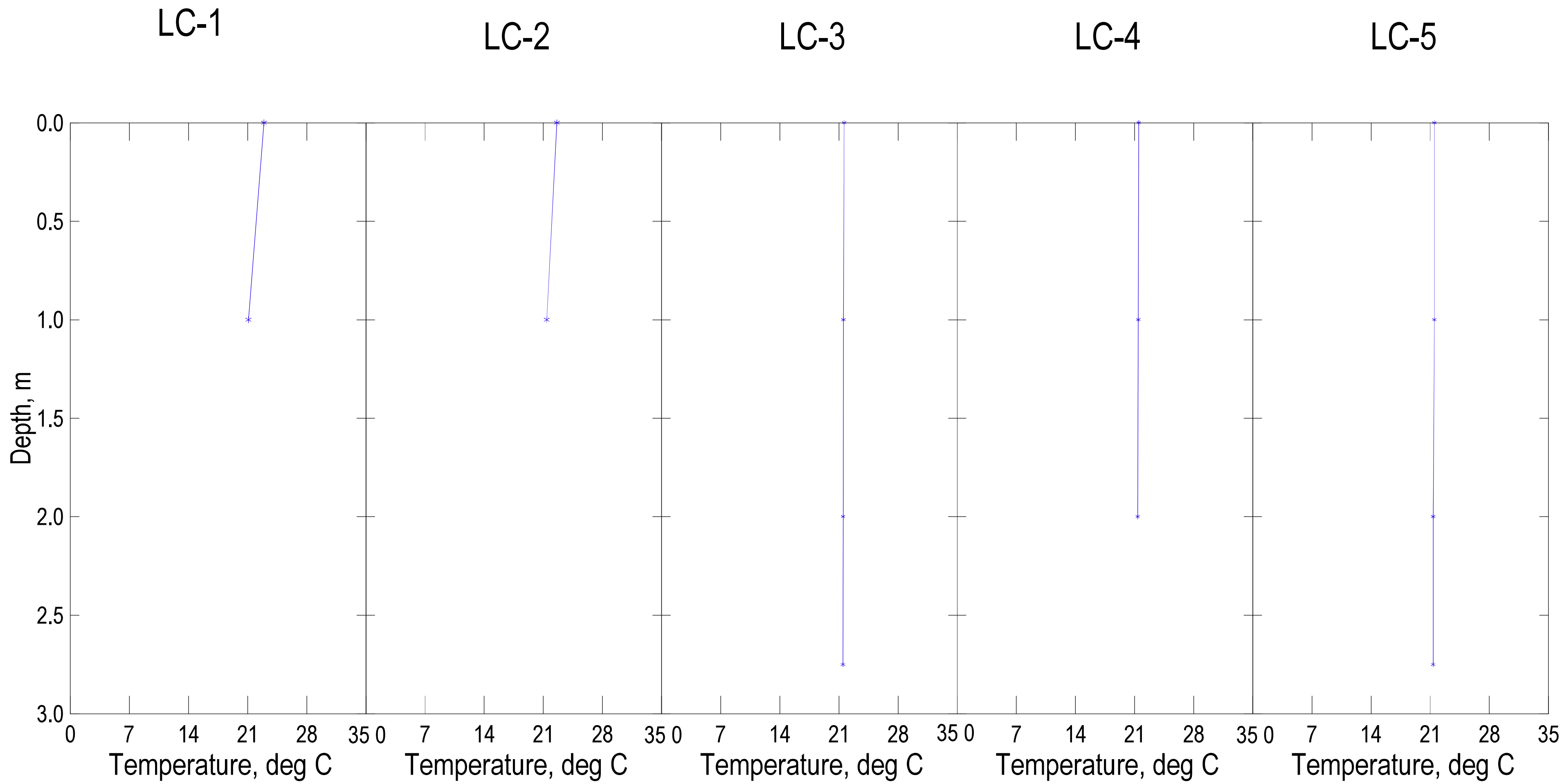
Lake Conway

8/23/2011



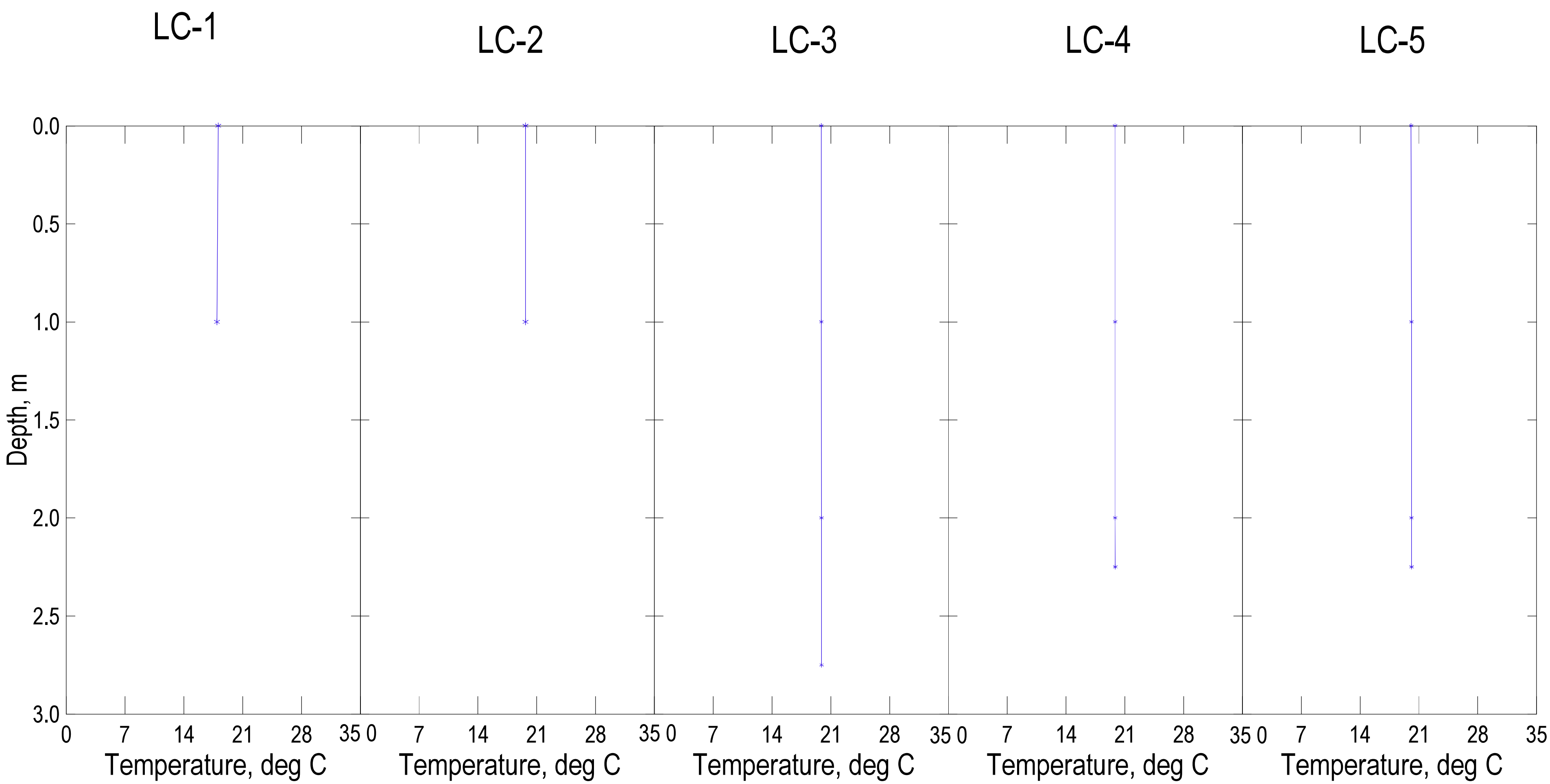
Lake Conway

9/20/2011



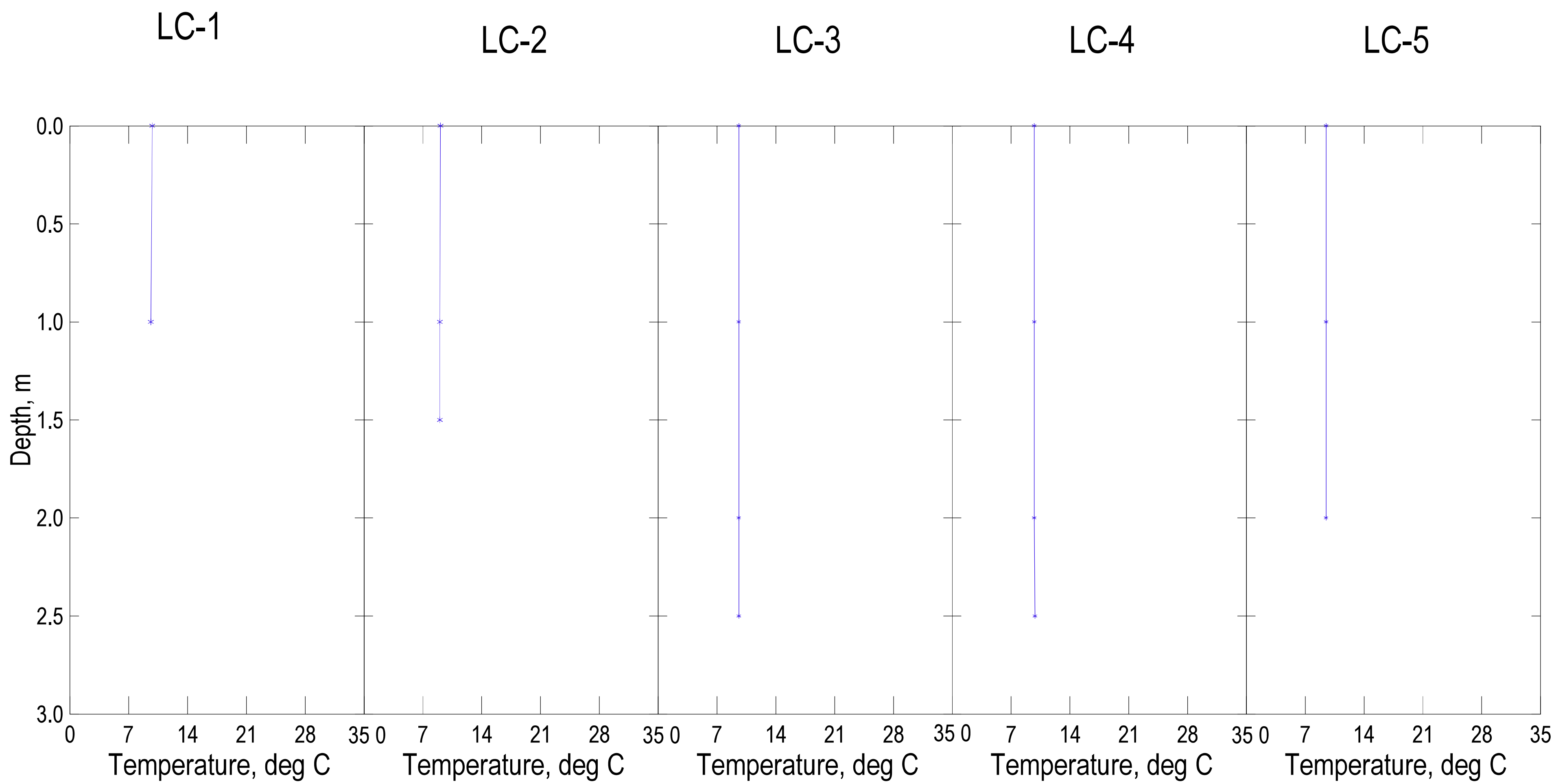
Lake Conway

10/18/2011



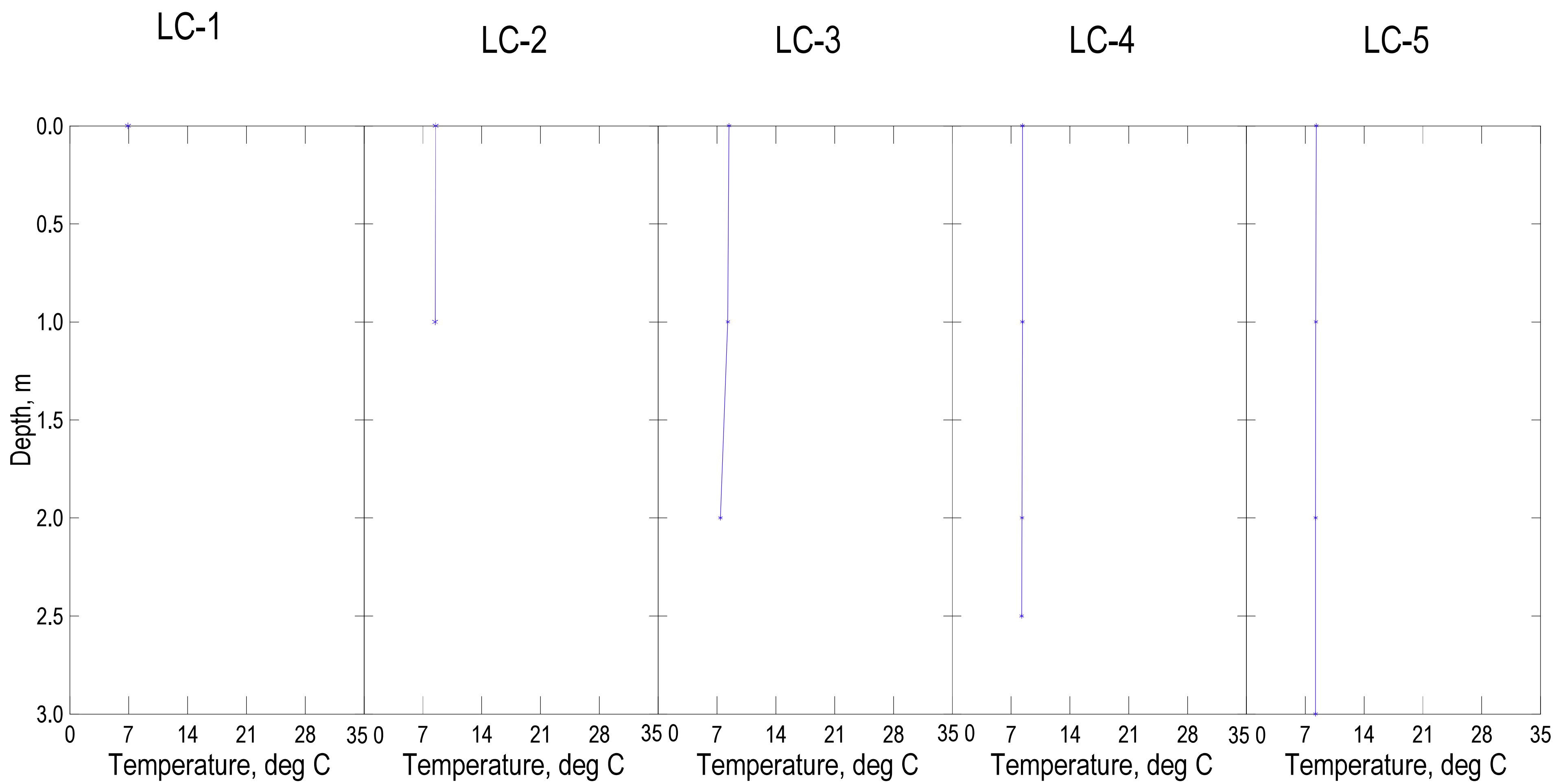
Lake Conway

11/29/2011



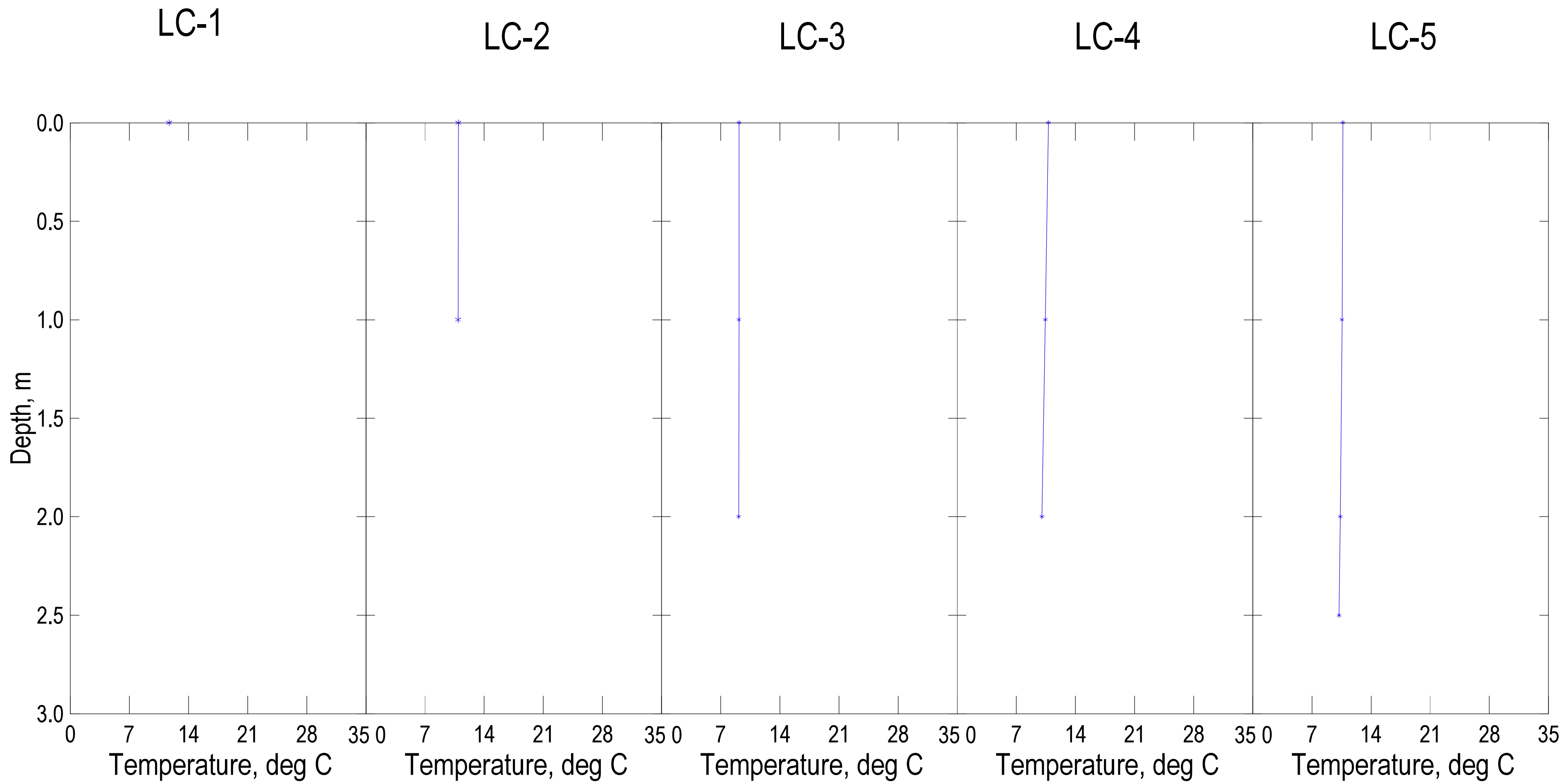
Lake Conway

1/24/2012



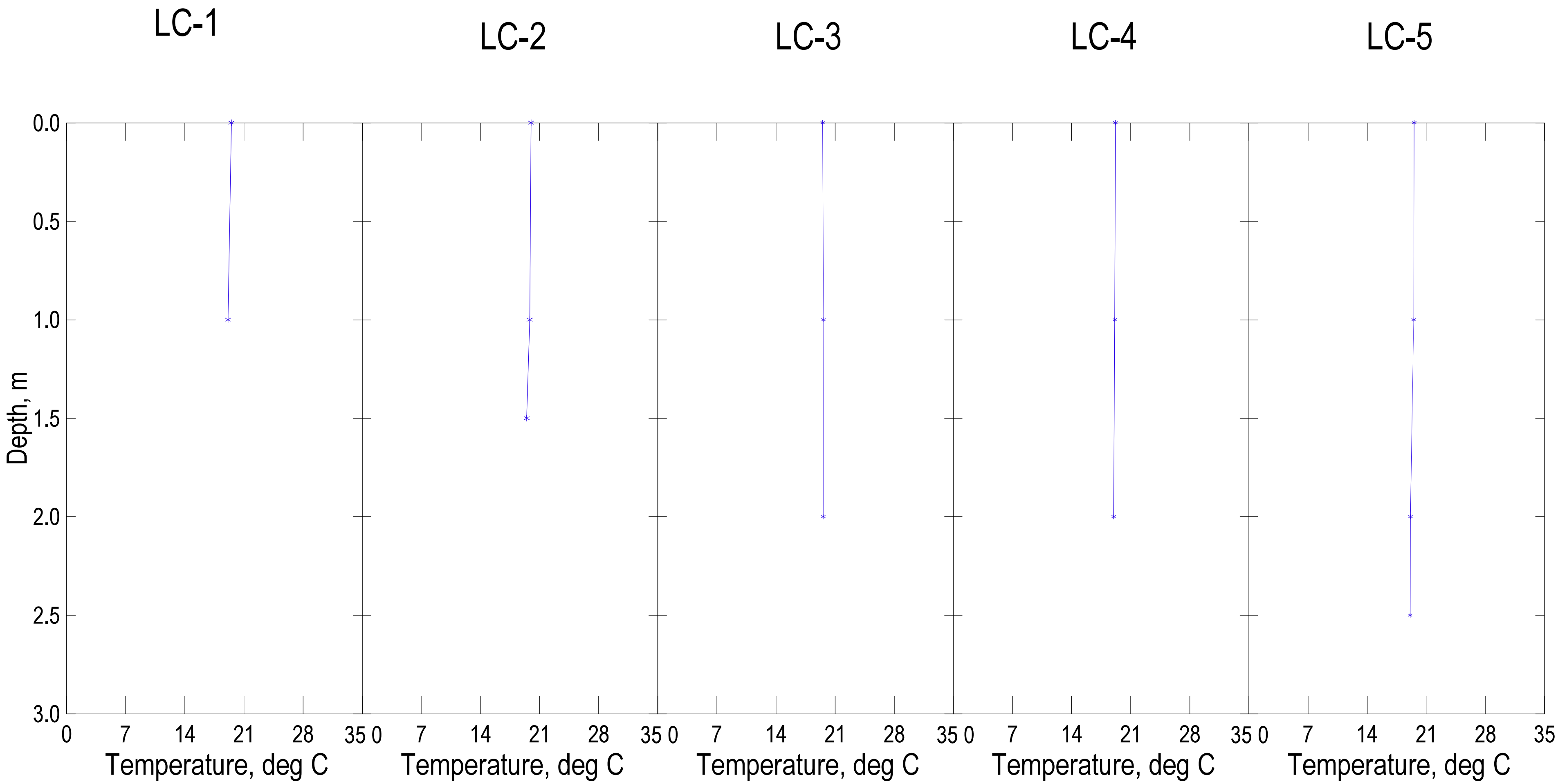
Lake Conway

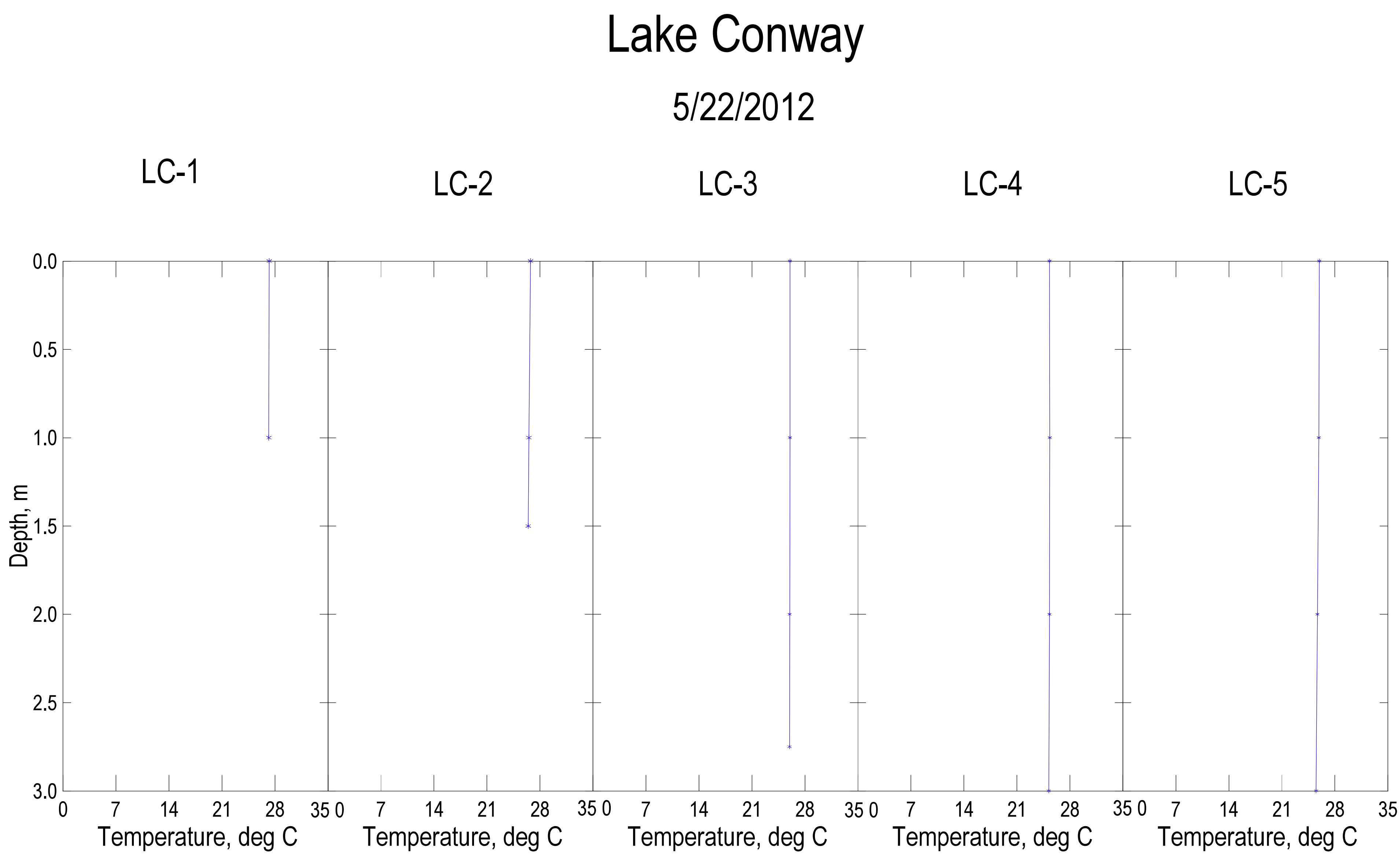
2/21/2012

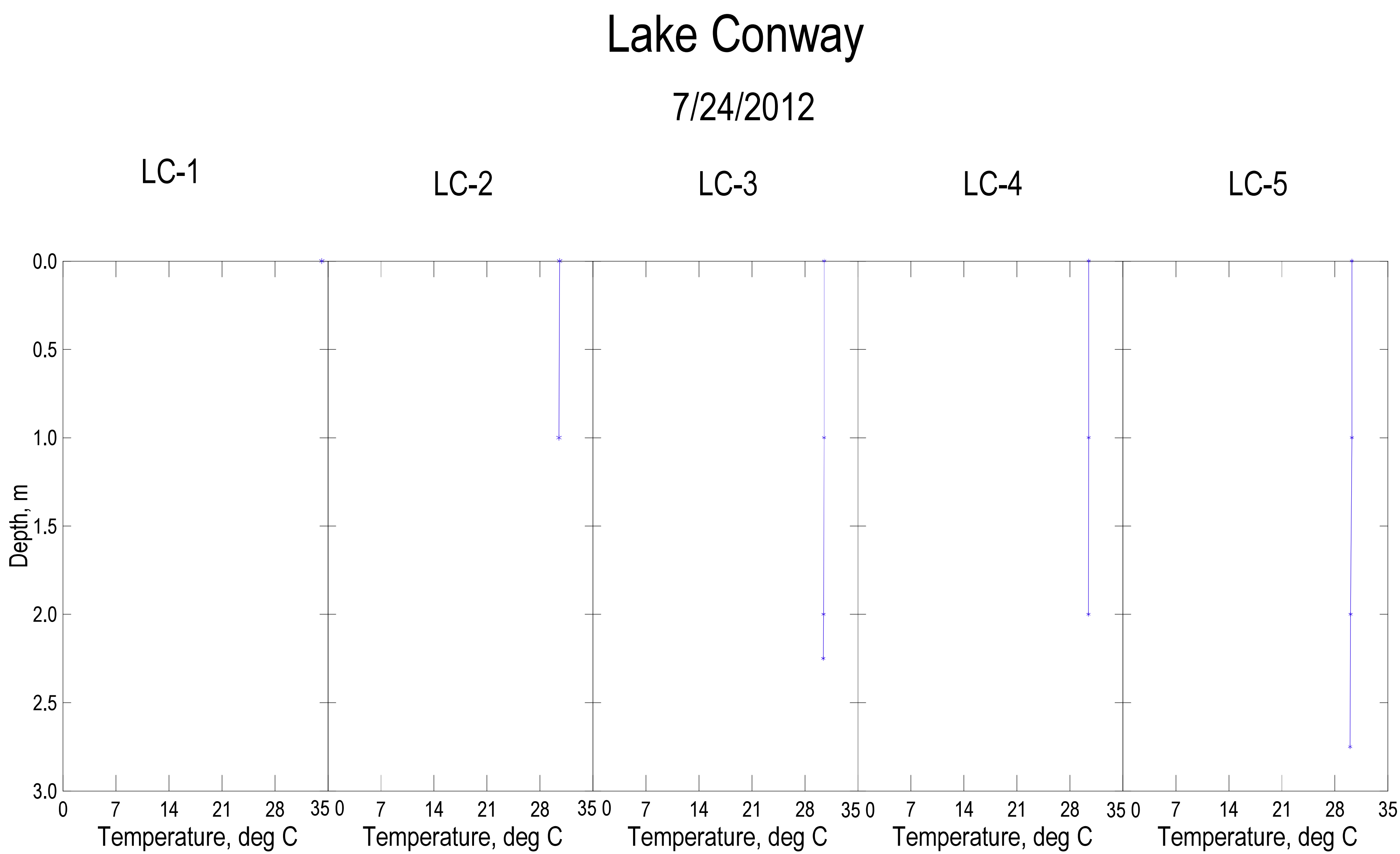


Lake Conway

4/23/2012



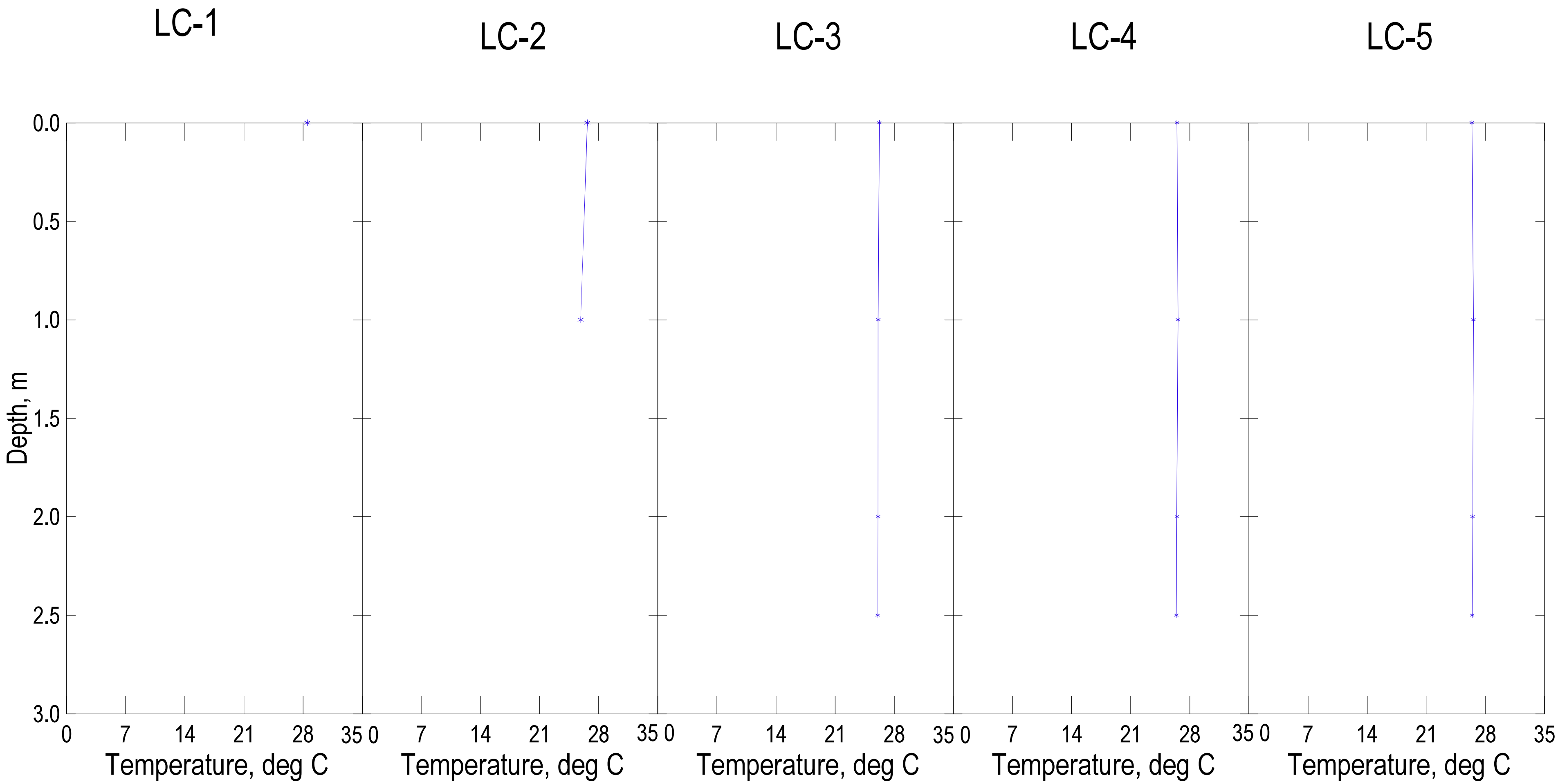

Lake Conway
5/22/2012
LC-1
LC-2
LC-3
LC-4
LC-5
Depth, m
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
7
14
21
28
35
Temperature, deg C



Lake Conway
7/24/2012
LC-1
LC-2
LC-3
LC-4
LC-5
Depth, m
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0 7 14 21 28 35
Temperature, deg C

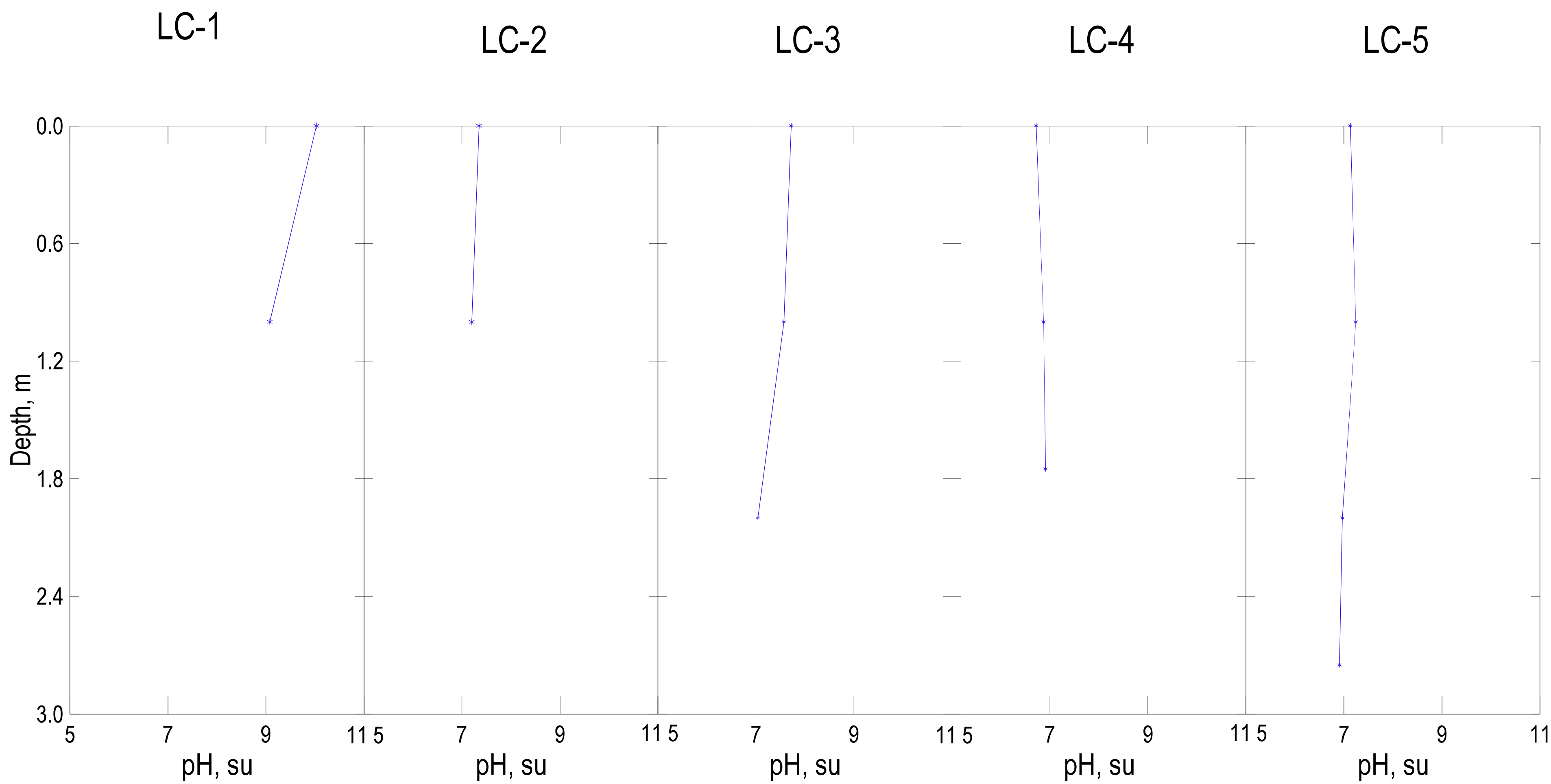
Lake Conway

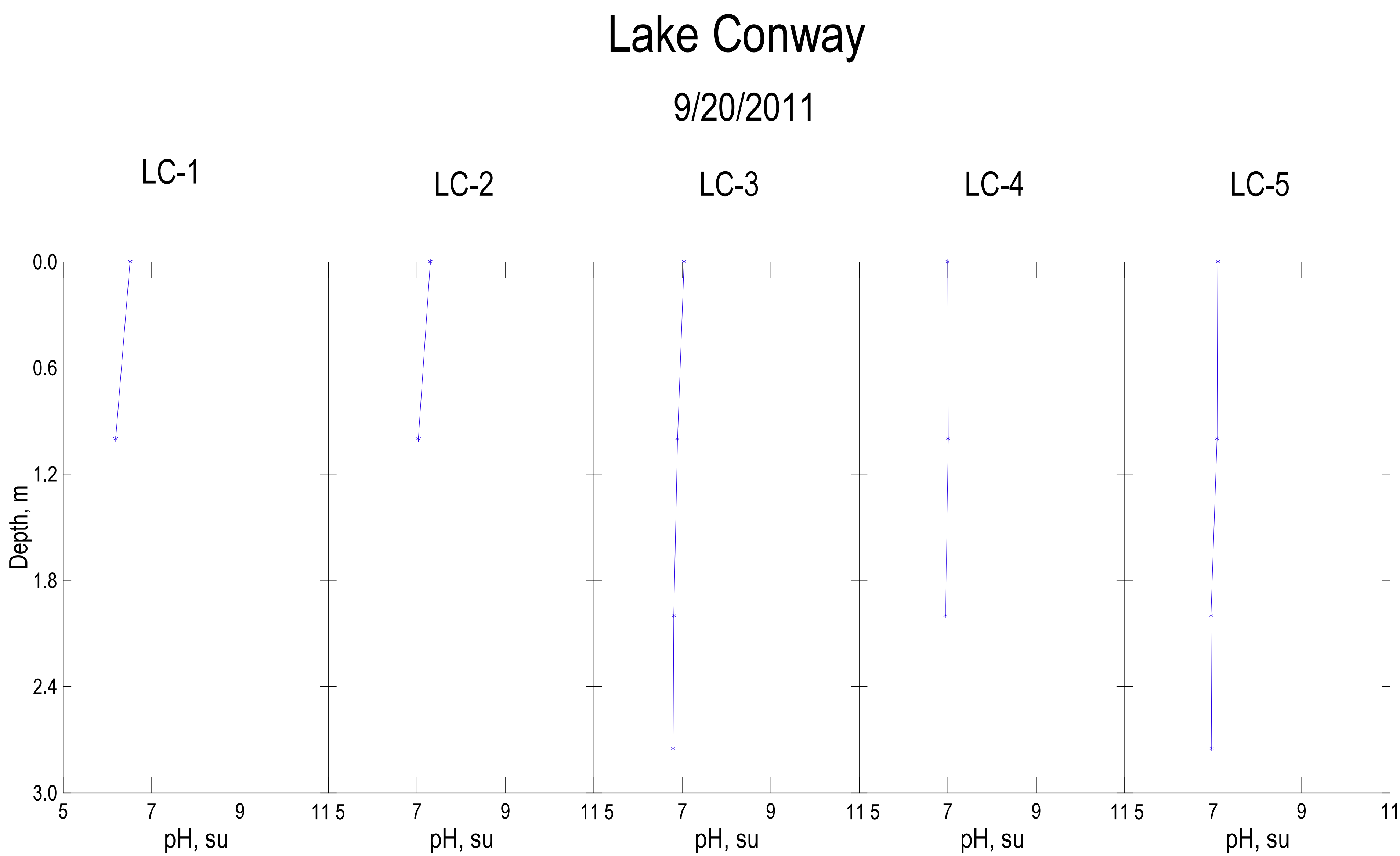
8/21/2012

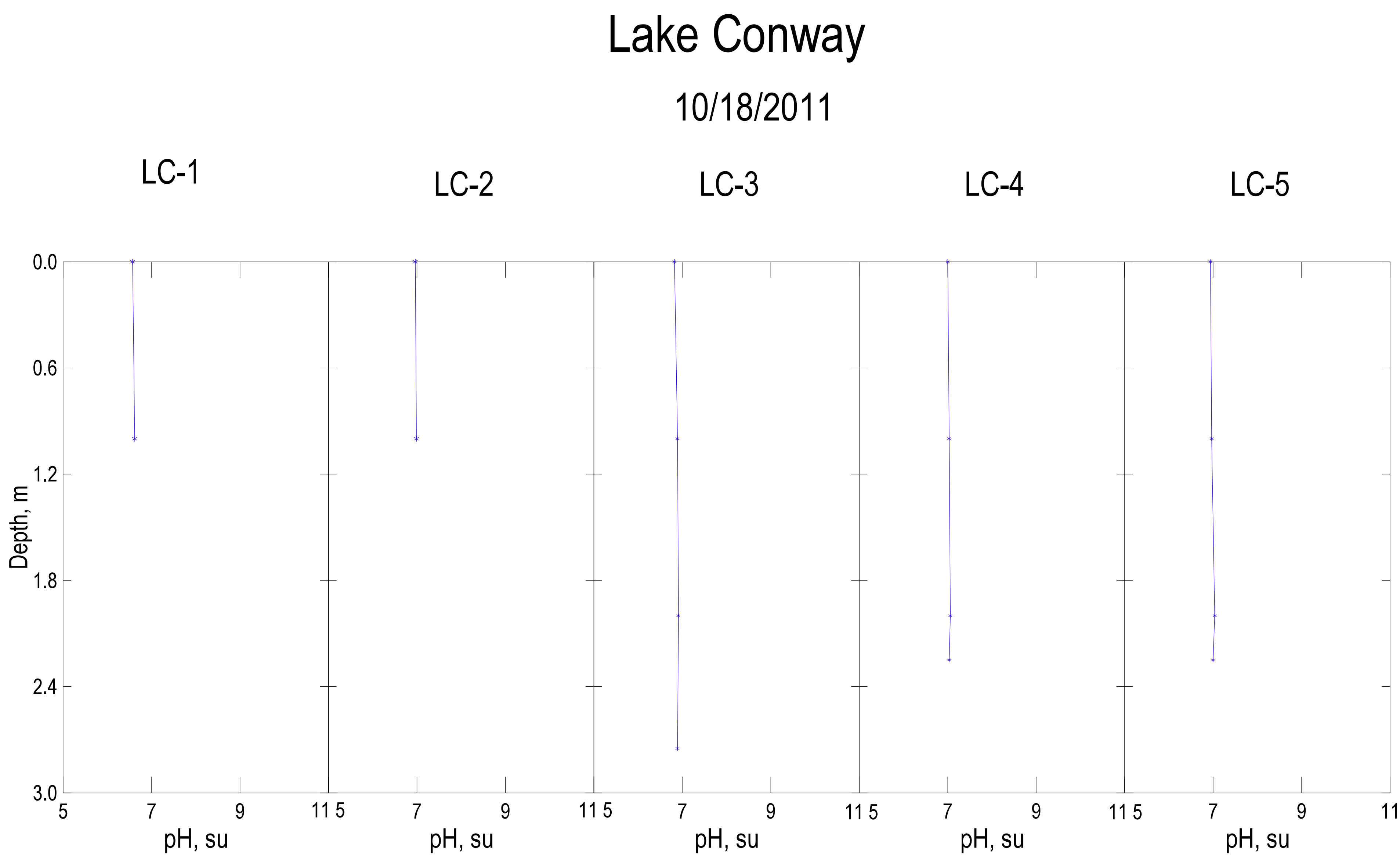


Lake Conway

8/23/2011



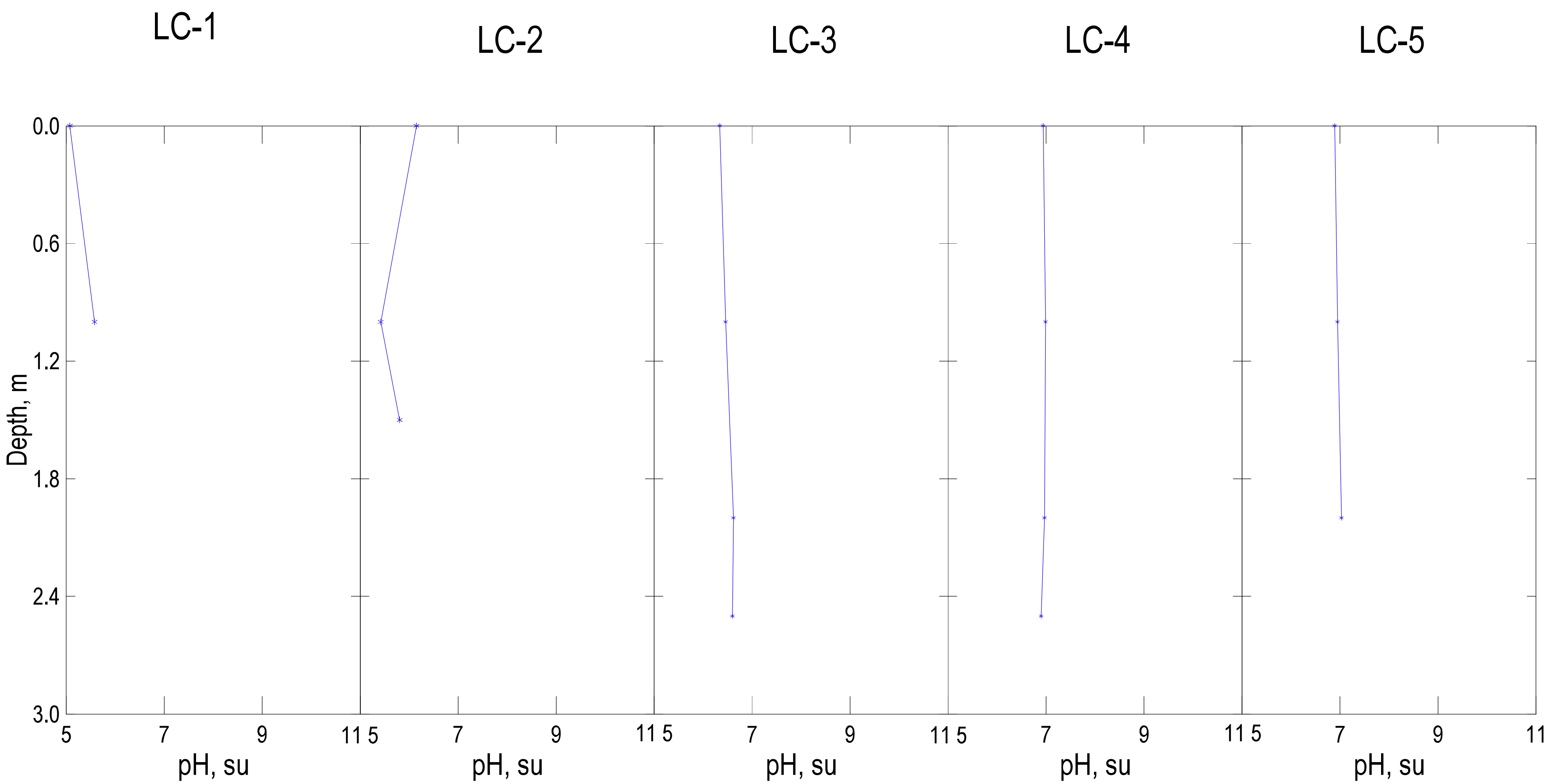

Lake Conway
9/20/2011
LC-1
LC-2
LC-3
LC-4
LC-5
Depth, m
0.0
0.6
1.2
1.8
2.4
3.0
5
7
9
11
pH, su



Lake Conway
10/18/2011
LC-1
LC-2
LC-3
LC-4
LC-5
Depth, m
0.0
0.6
1.2
1.8
2.4
3.0
5
7
9
11
pH, su

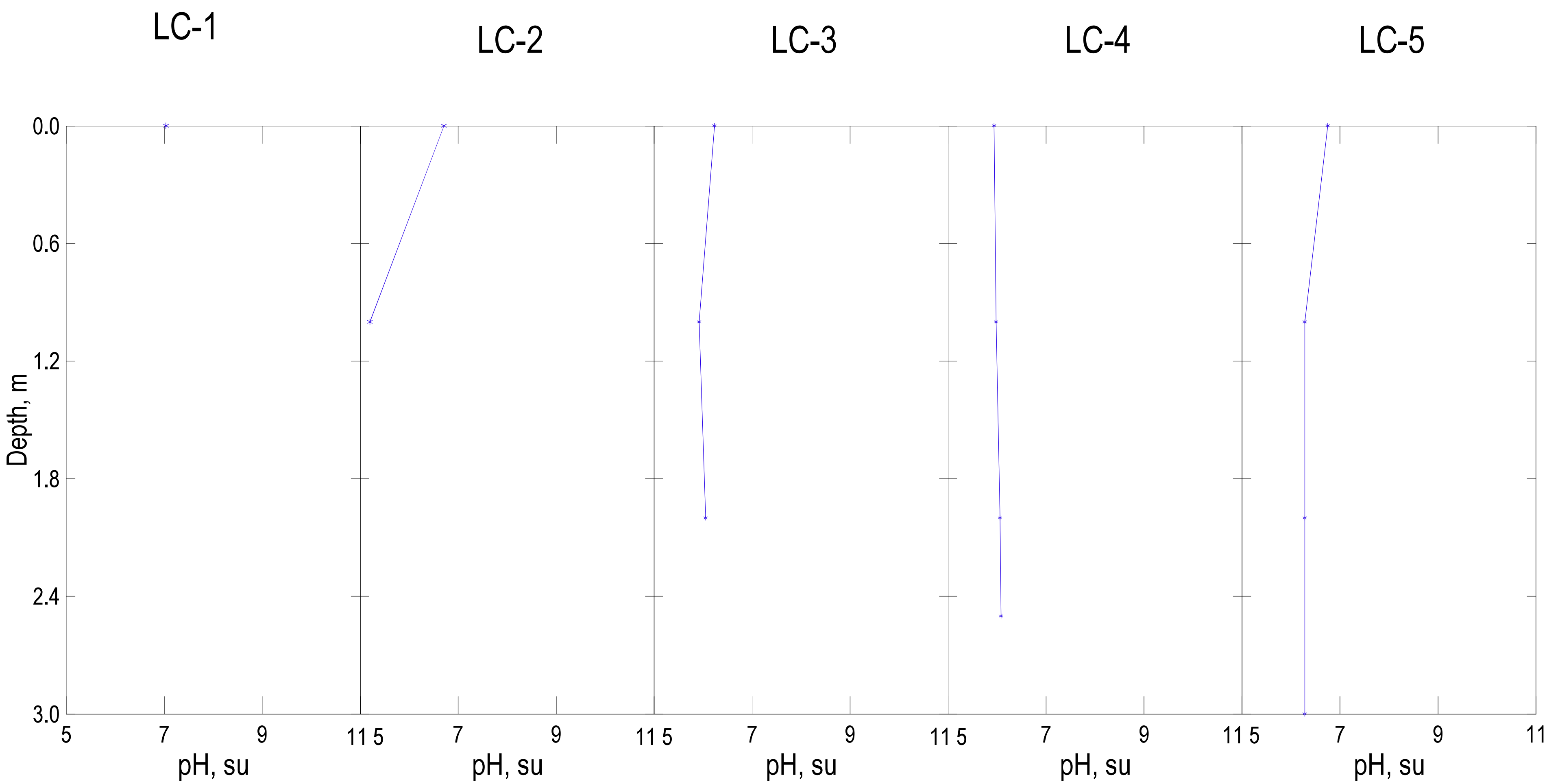
Lake Conway

11/29/2011



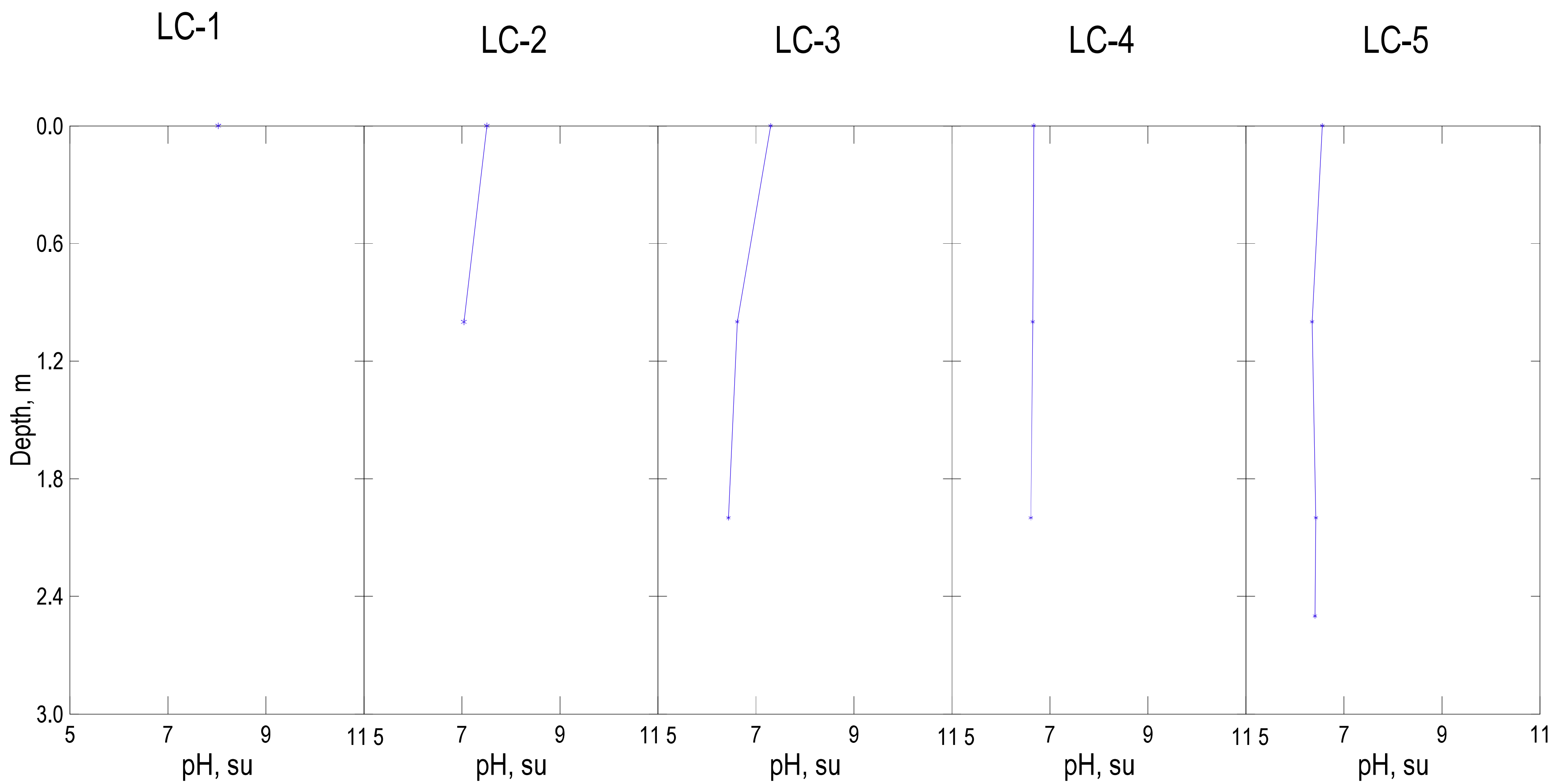
Lake Conway

1/24/2012



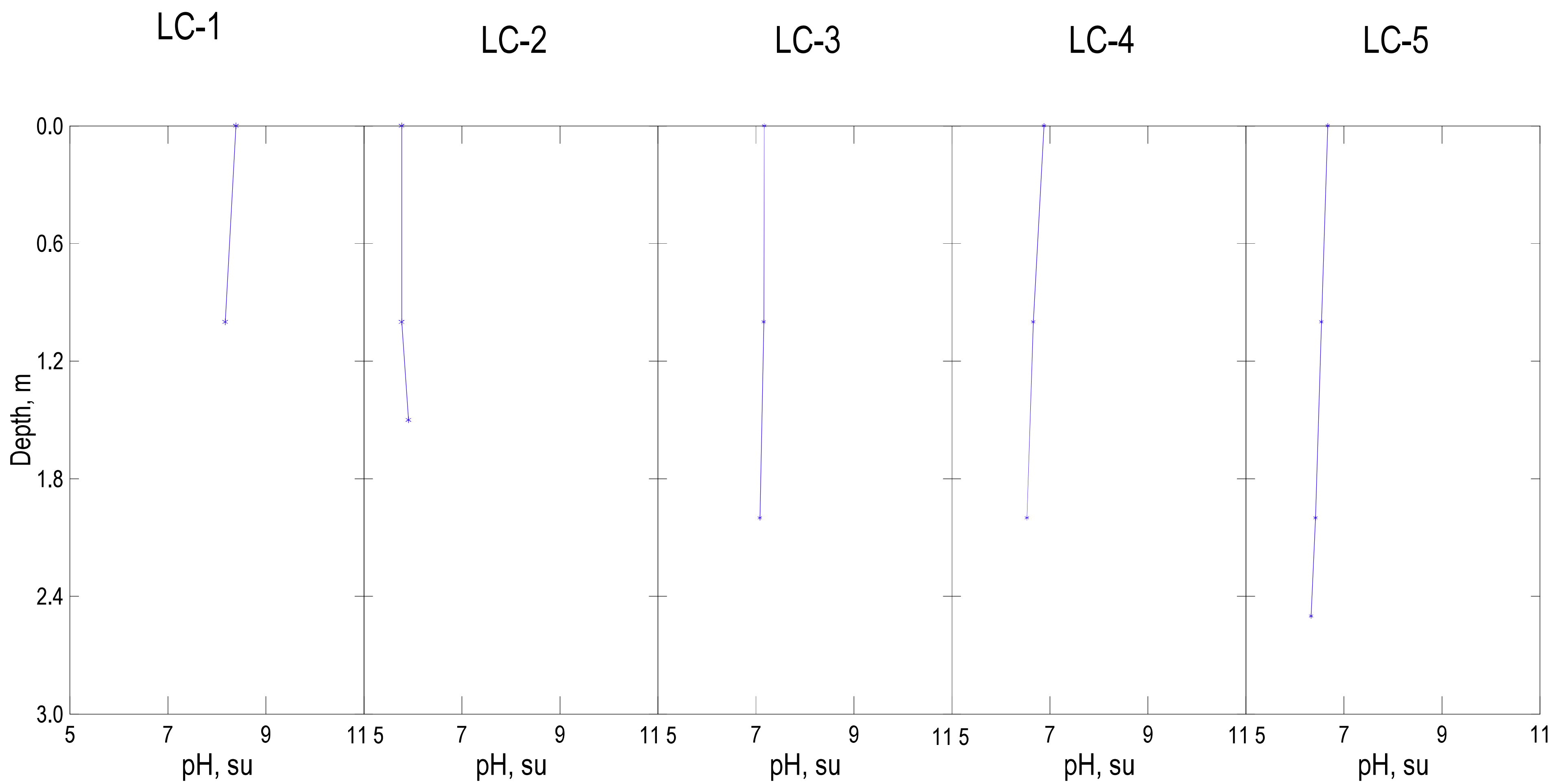
Lake Conway

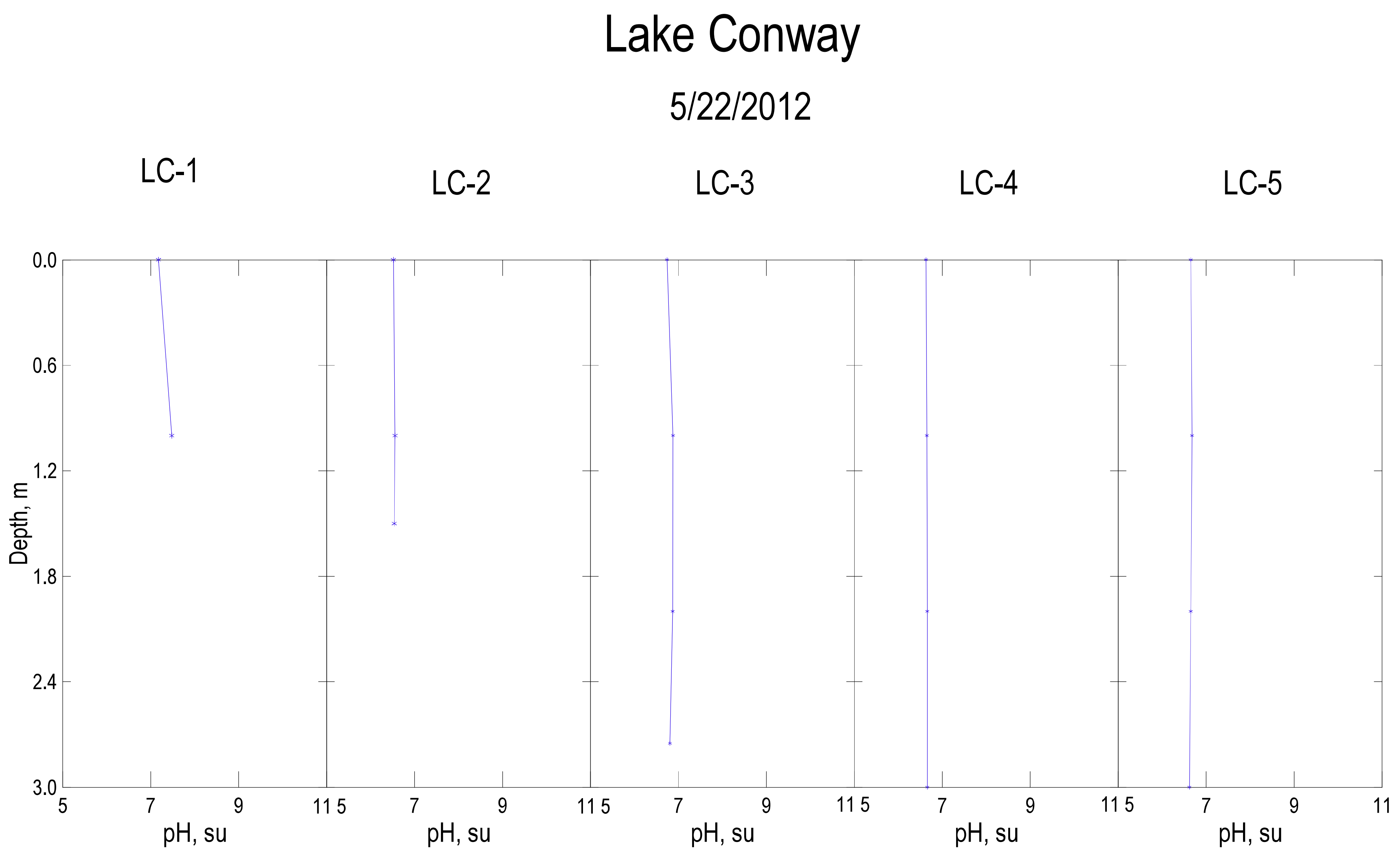
2/21/2012



Lake Conway

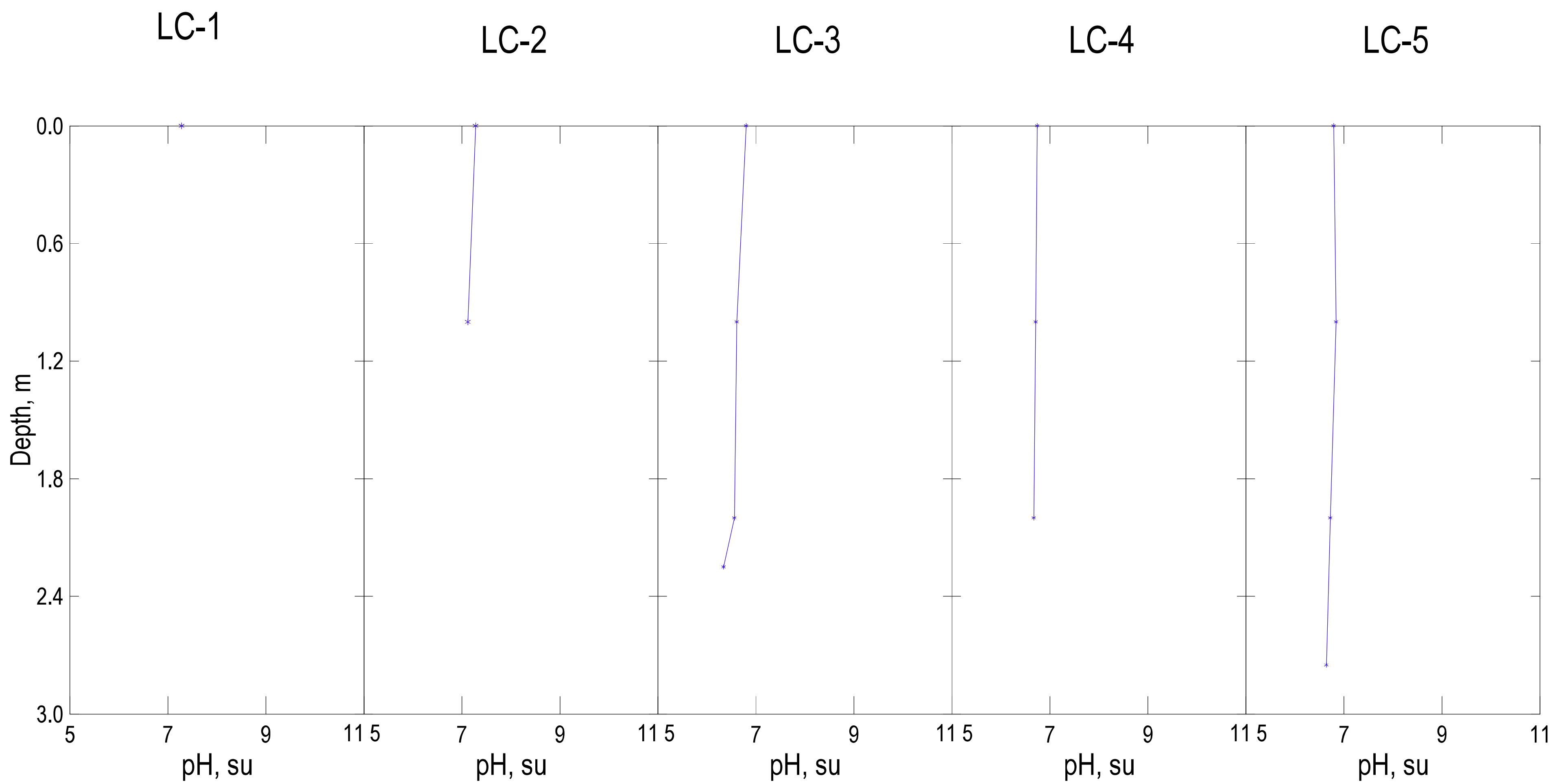
4/23/2012




Lake Conway
5/22/2012
LC-1
LC-2
LC-3
LC-4
LC-5
Depth, m
0.0
0.6
1.2
1.8
2.4
3.0
5
7
9
11
pH, su

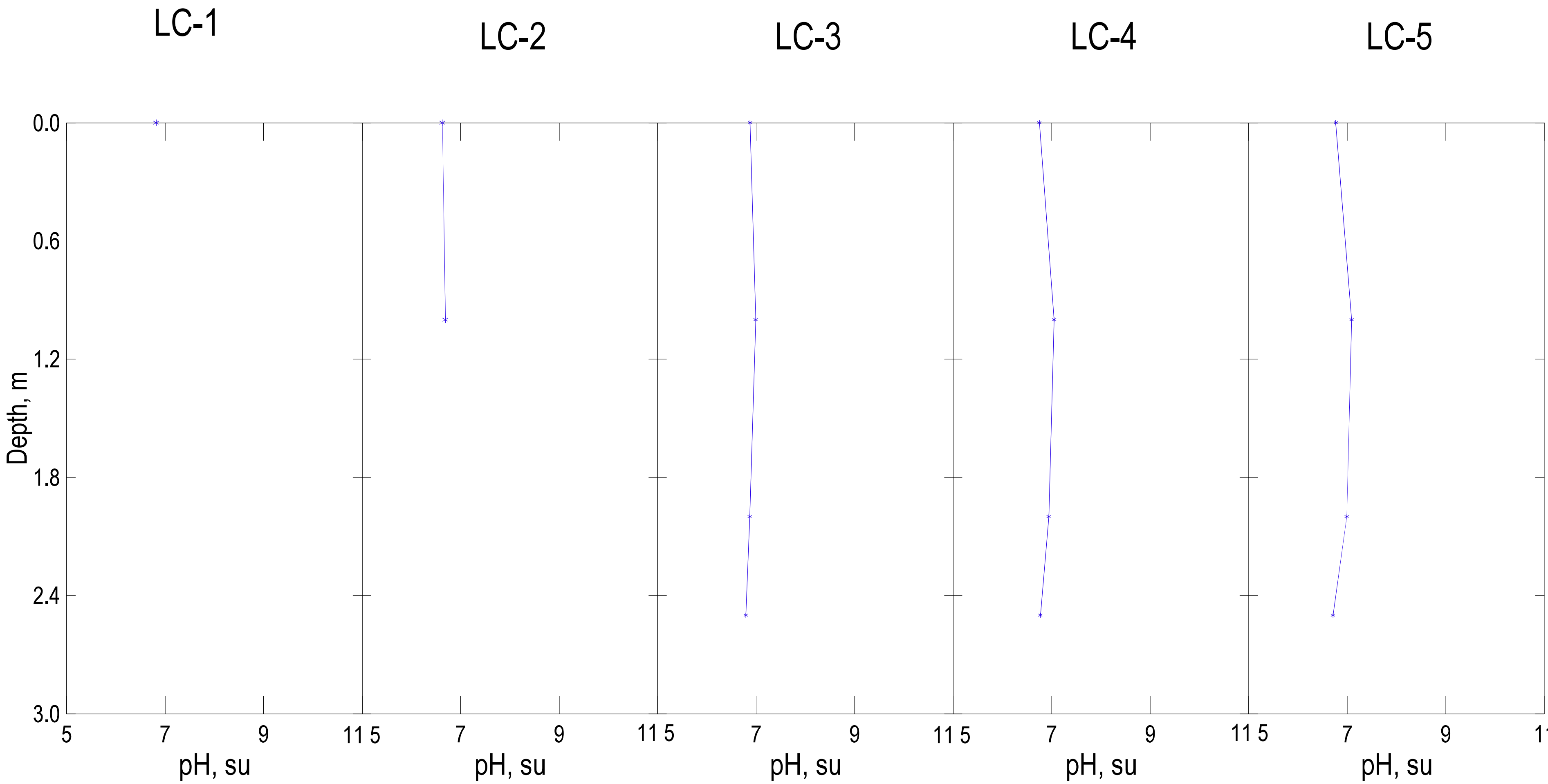
Lake Conway

7/24/2012



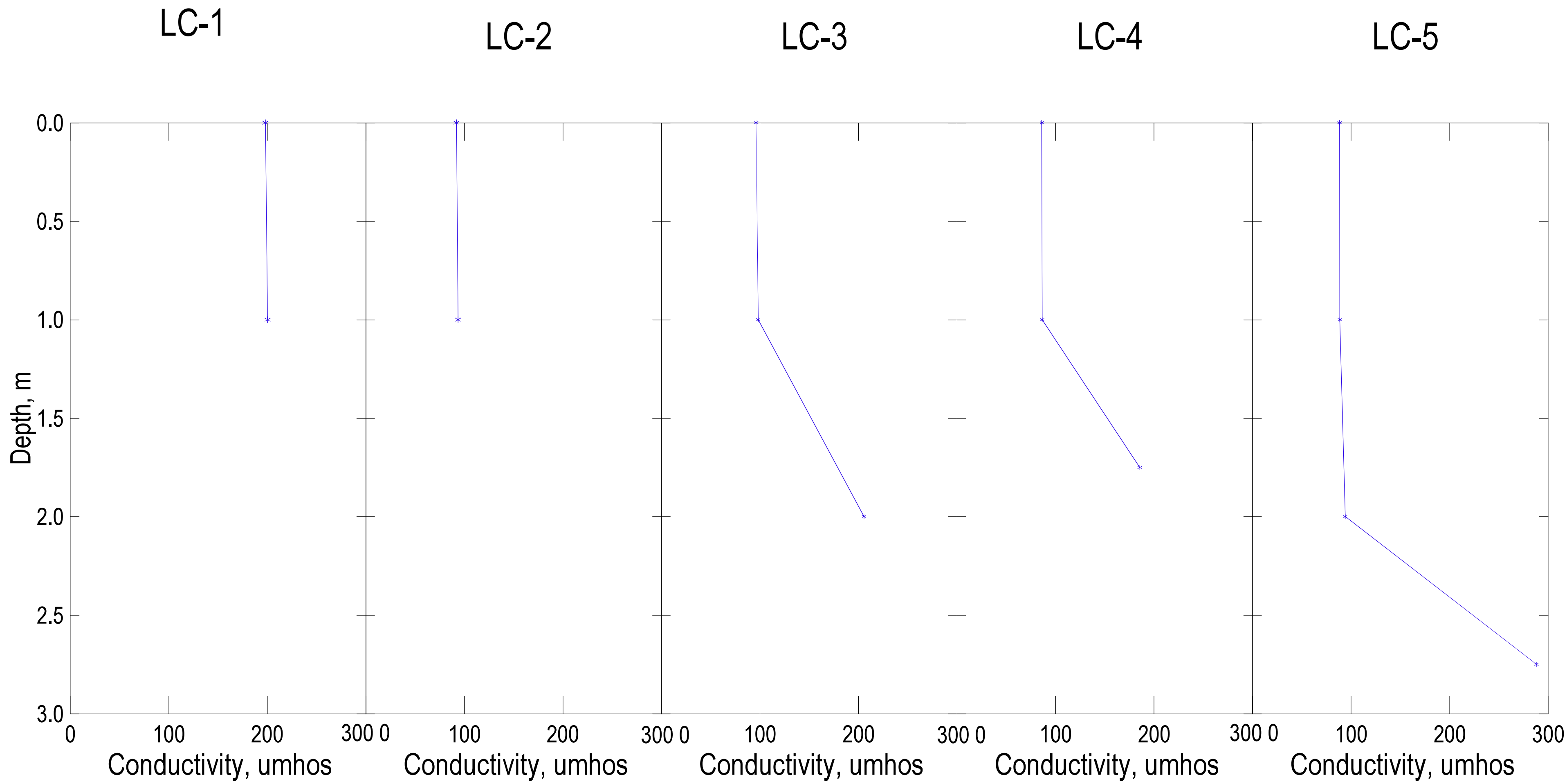
Lake Conway

8/21/2012



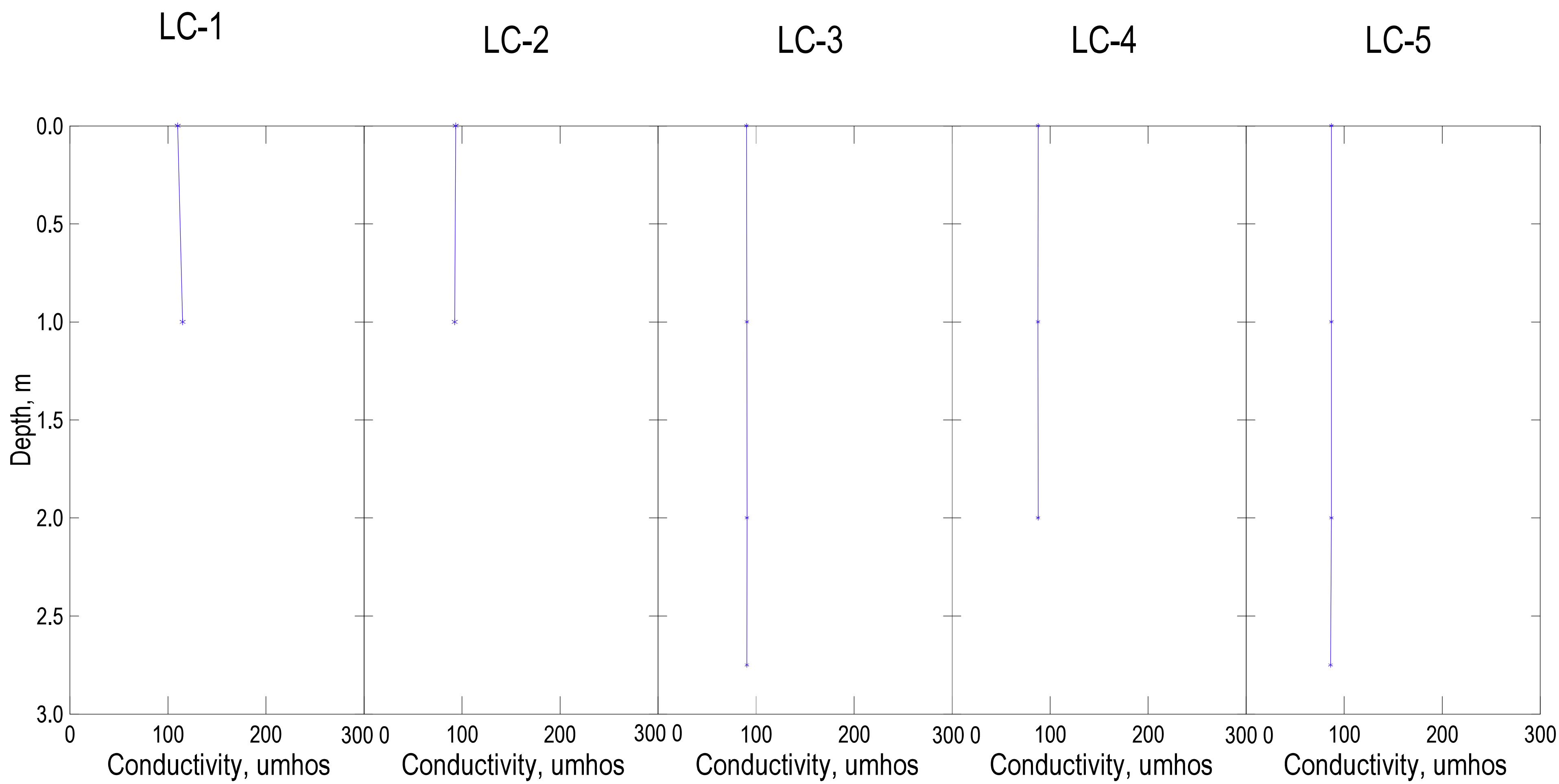
Lake Conway

8/23/2011



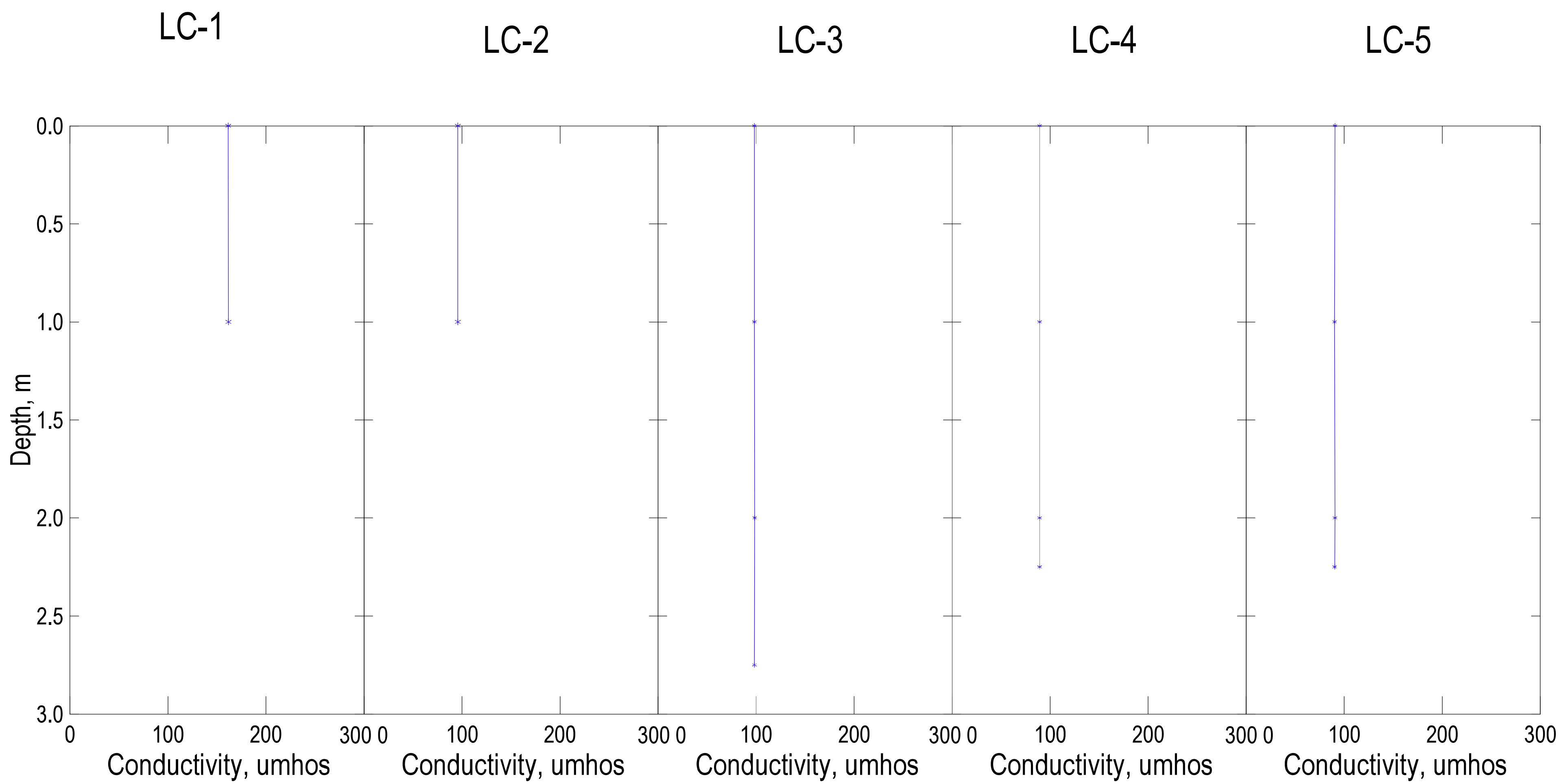
Lake Conway

9/20/2011



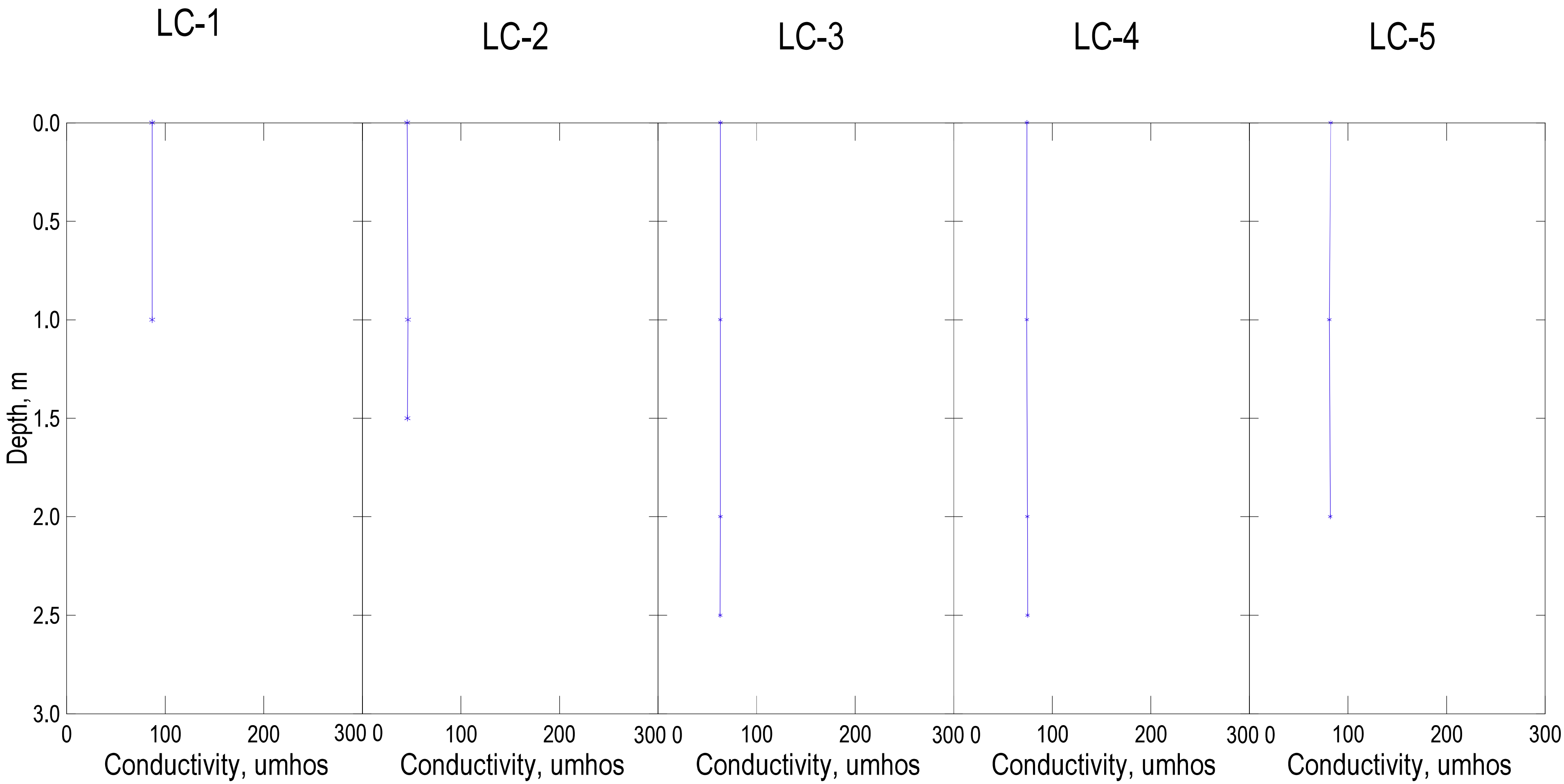
Lake Conway

10/18/2011



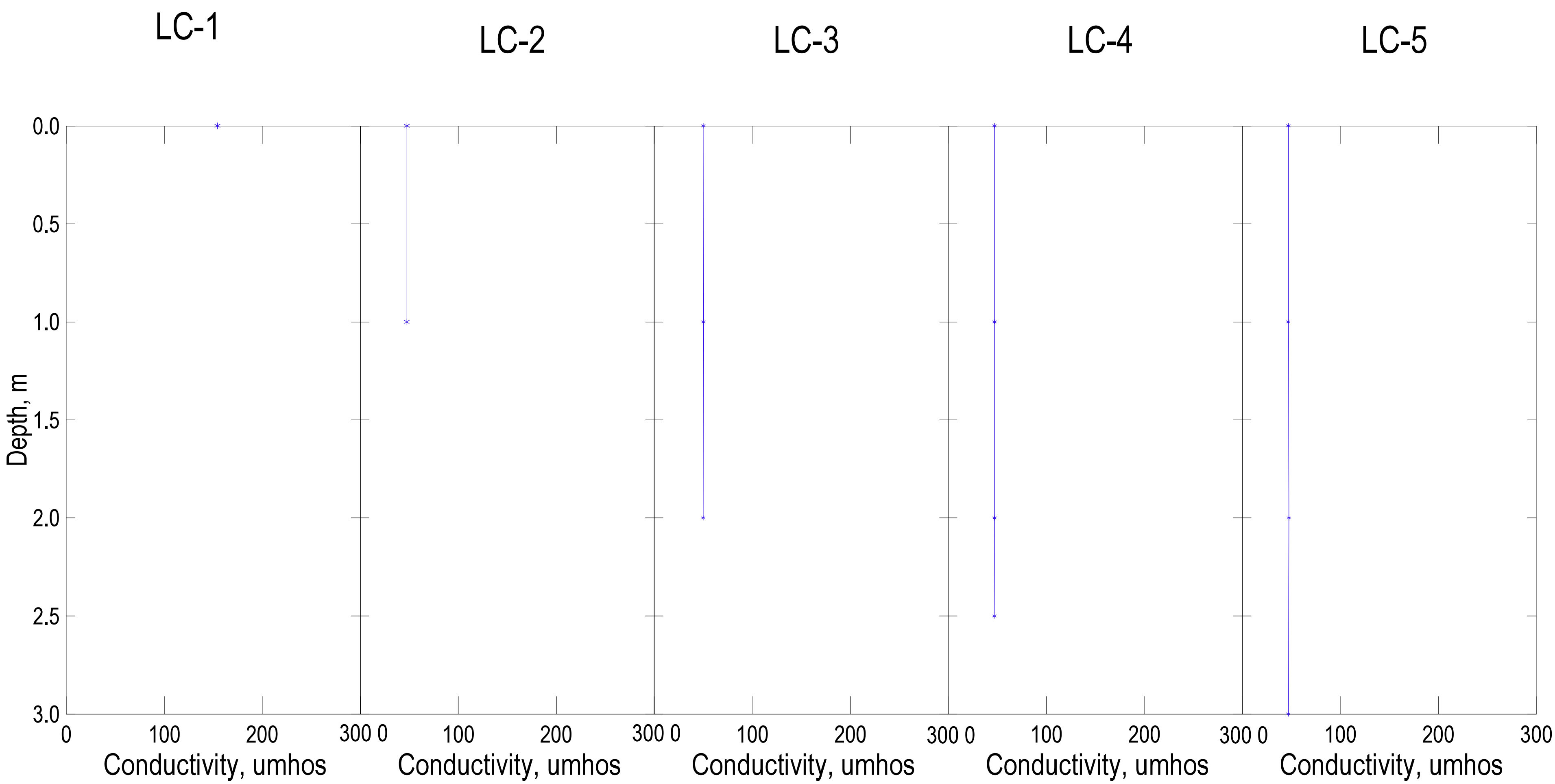
Lake Conway

11/29/2011



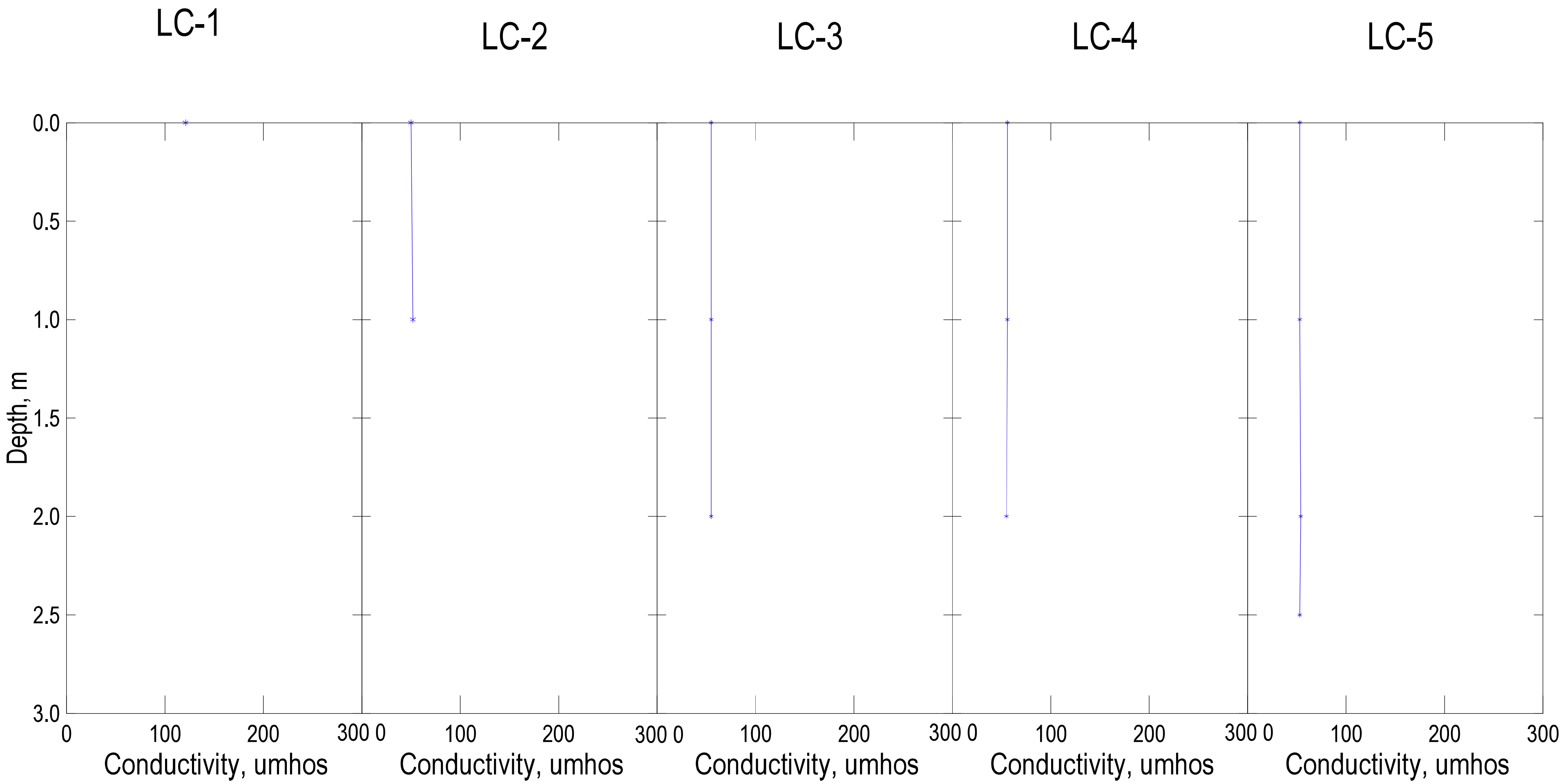
Lake Conway

1/24/2012



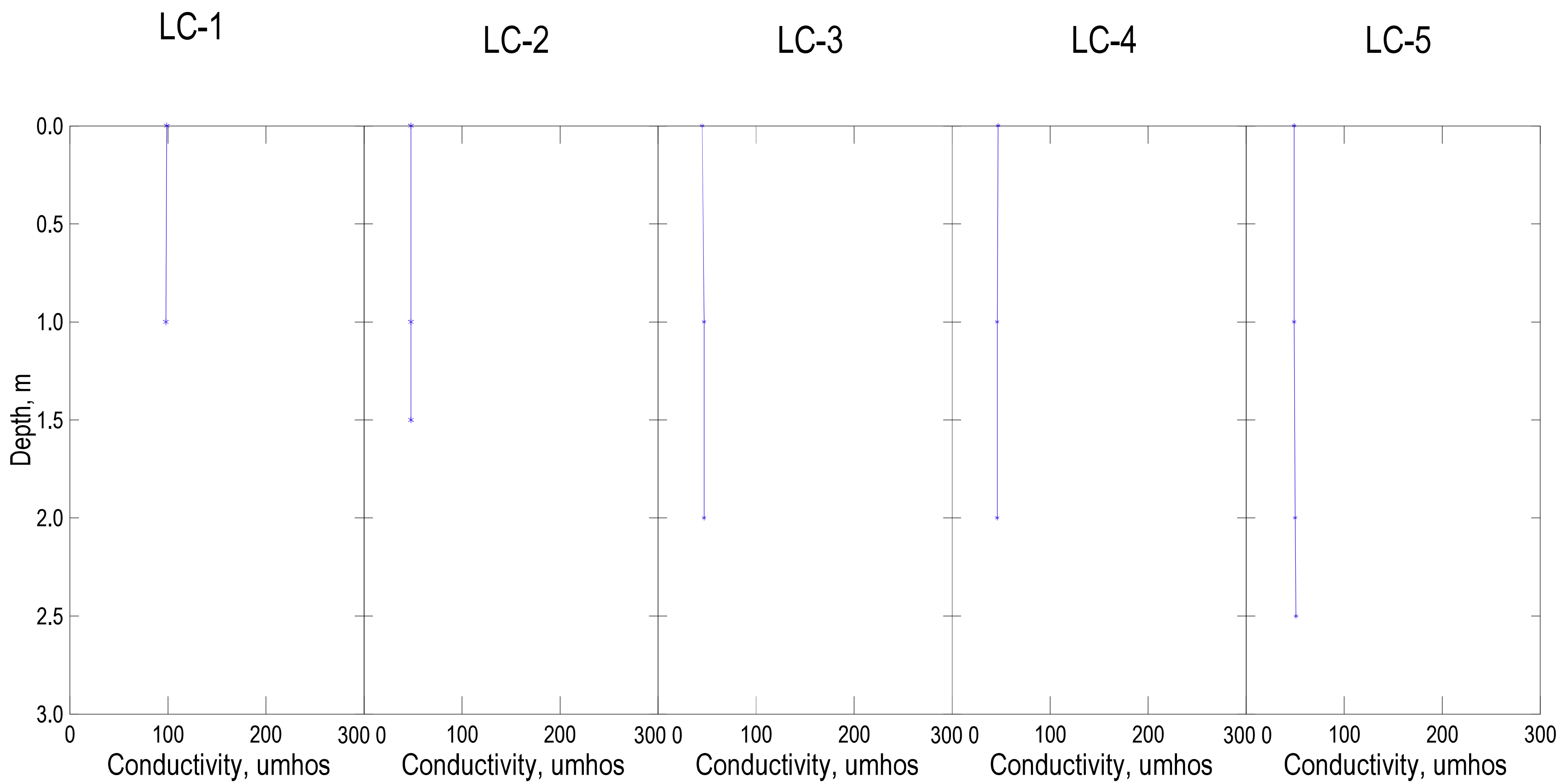
Lake Conway

2/21/2012



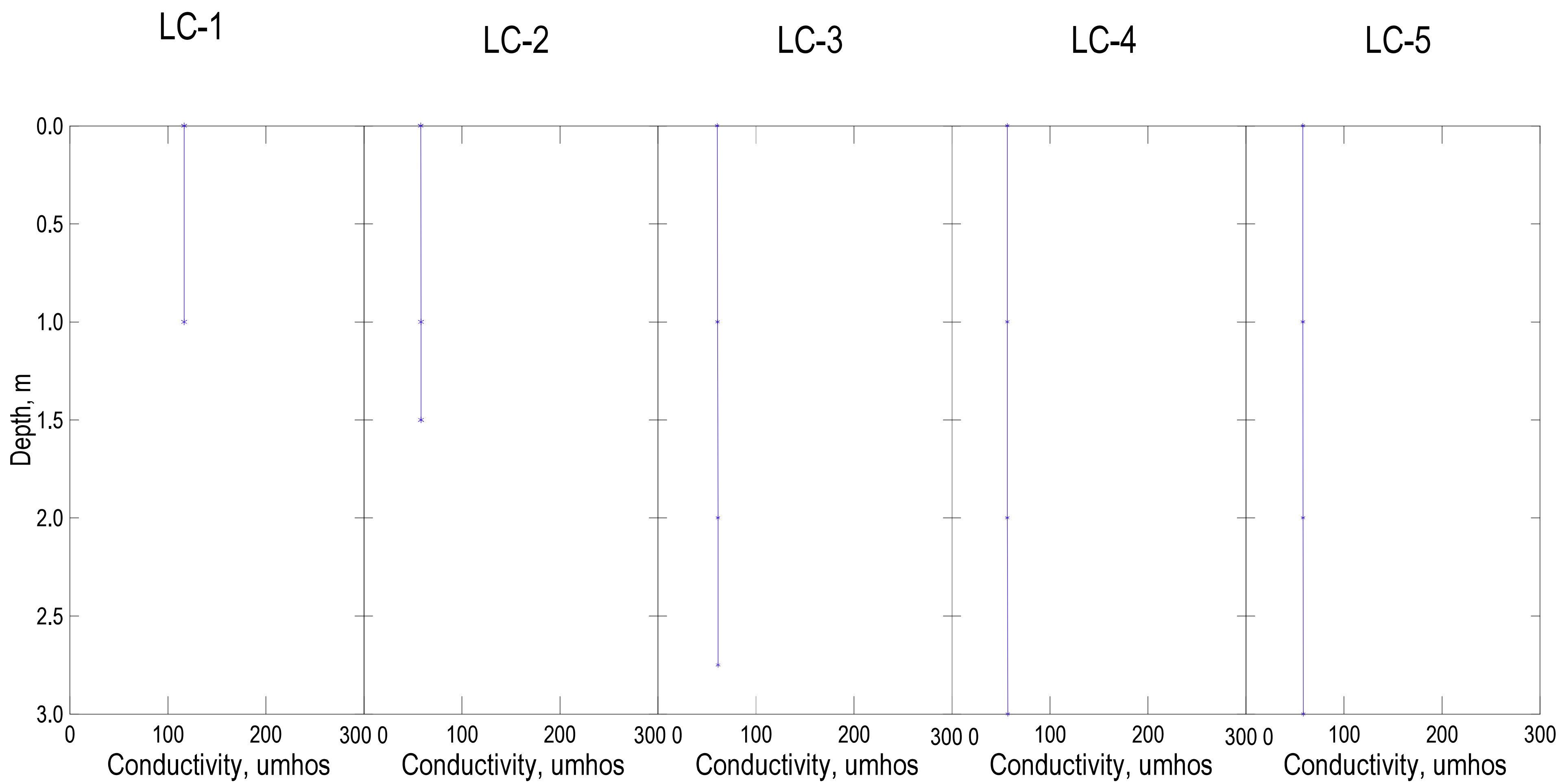
Lake Conway

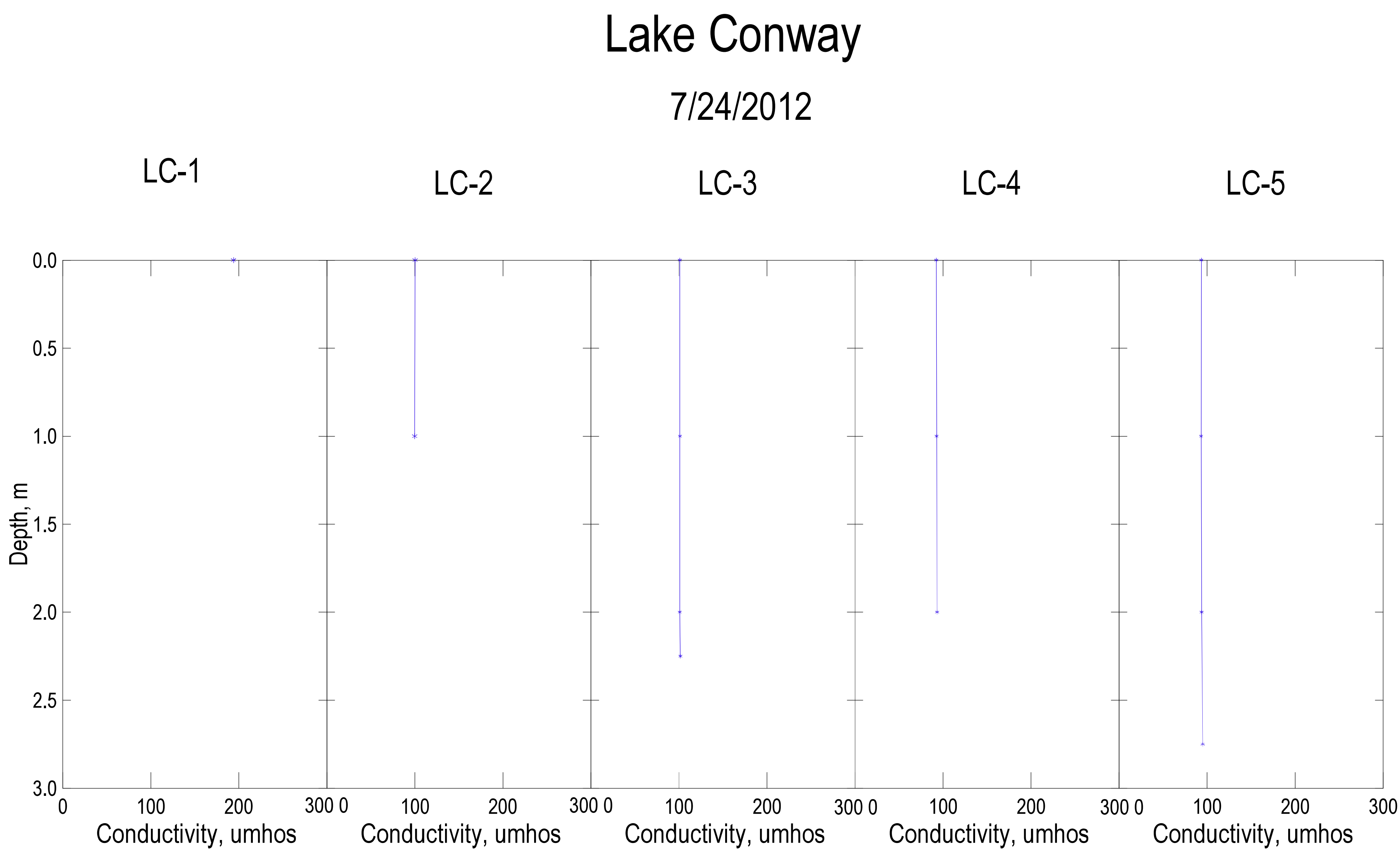
4/23/2012



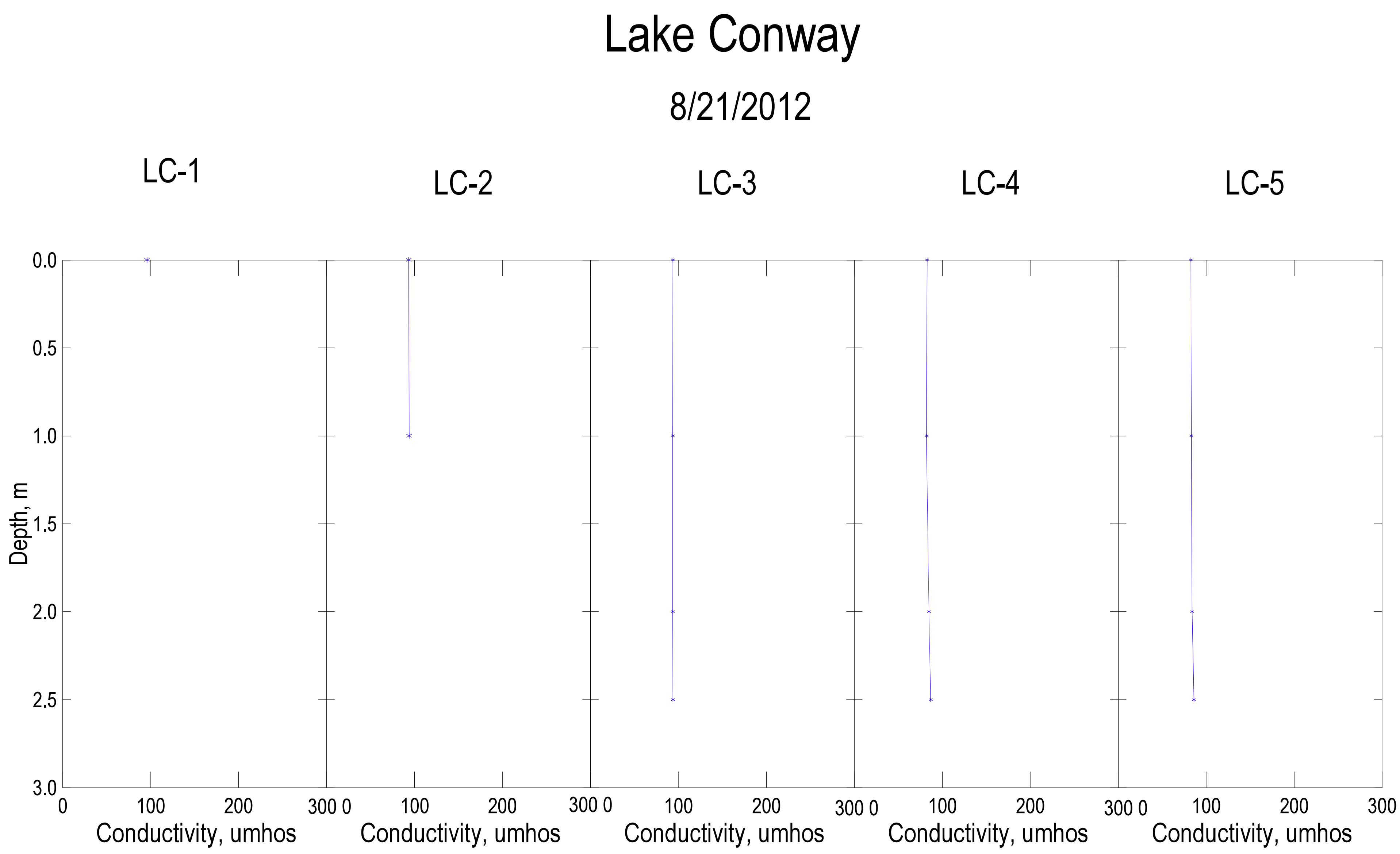
Lake Conway

5/22/2012

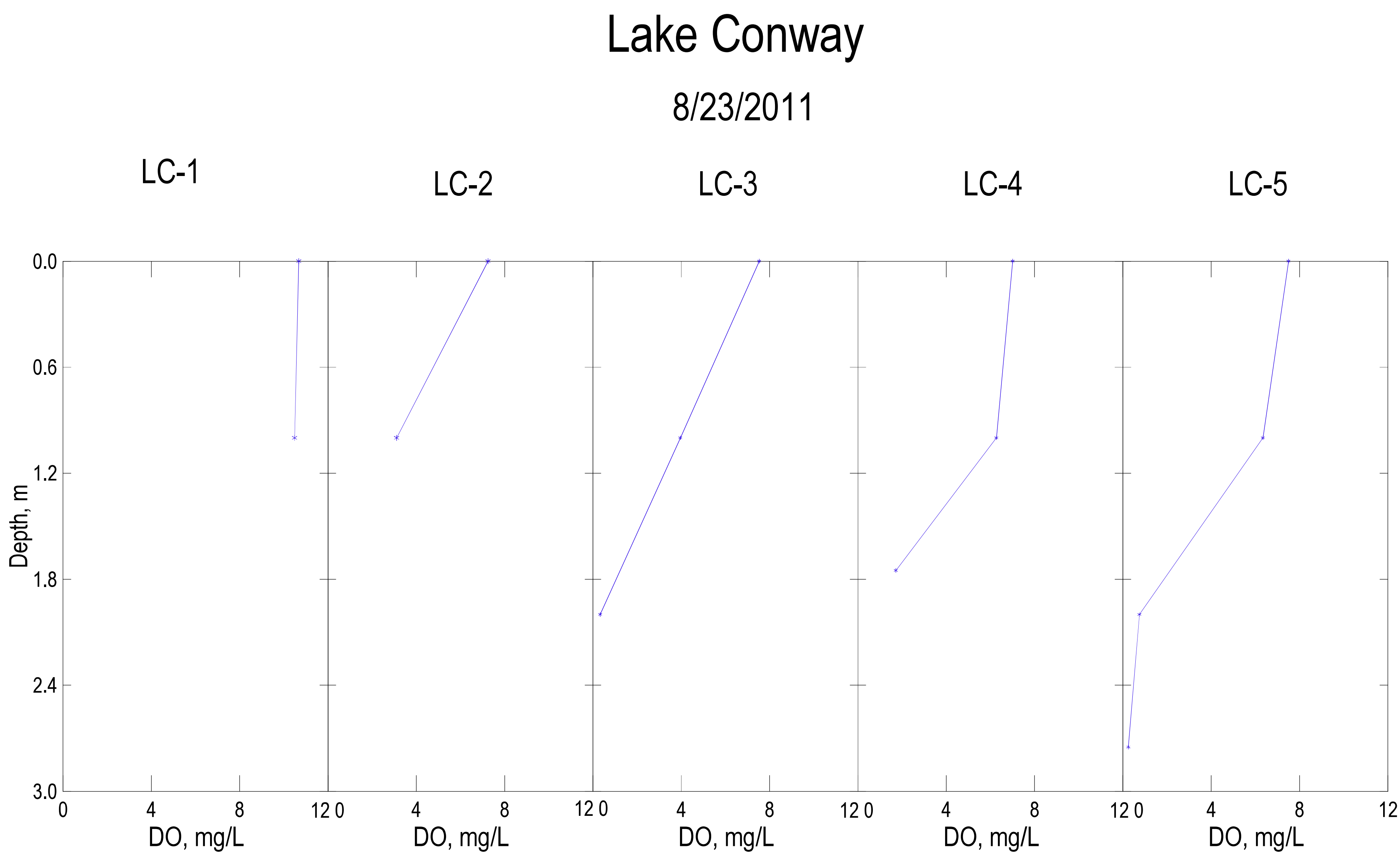


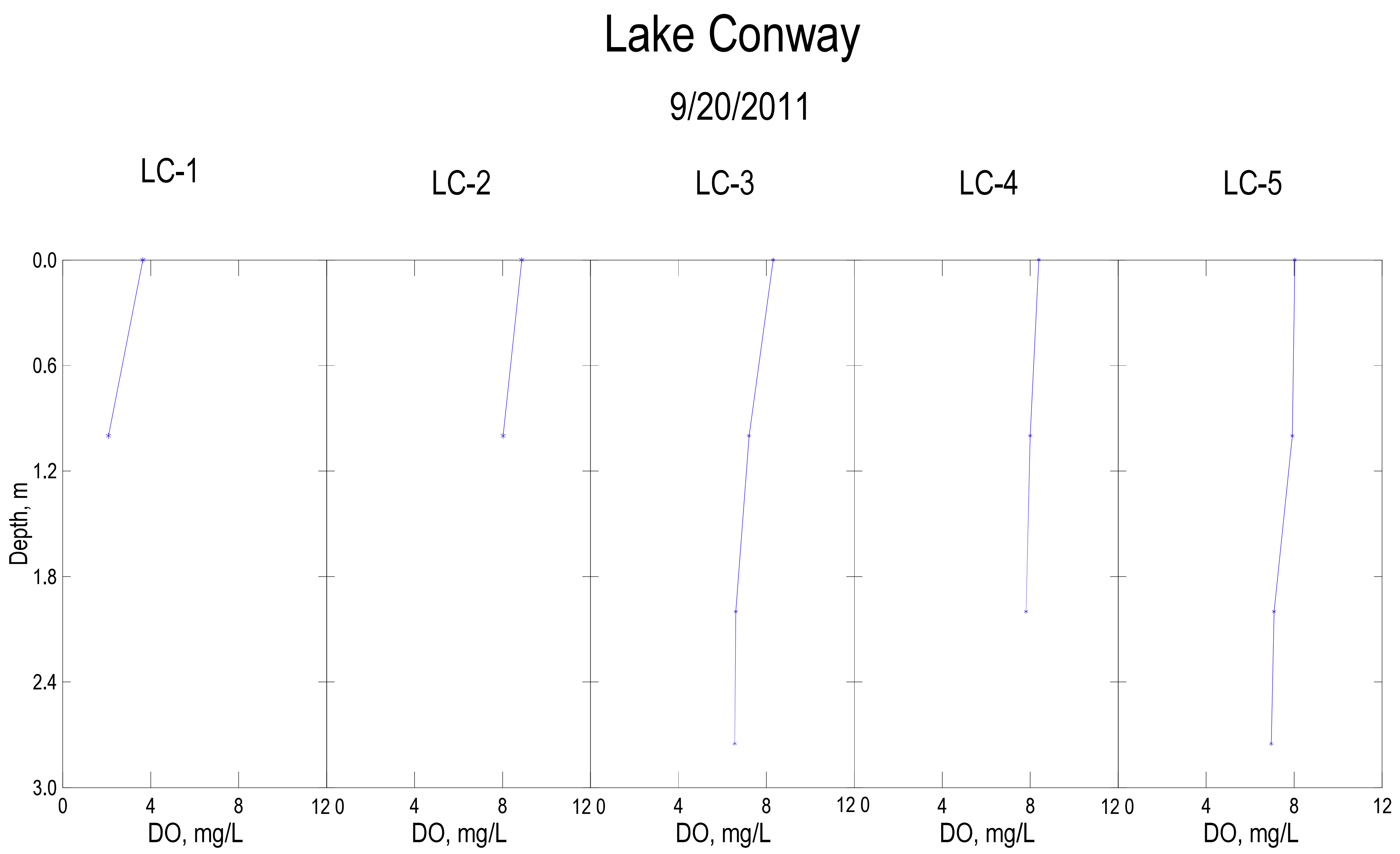


Lake Conway
7/24/2012
LC-1
LC-2
LC-3
LC-4
LC-5
Depth, m
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
100
200
300
Conductivity, umhos



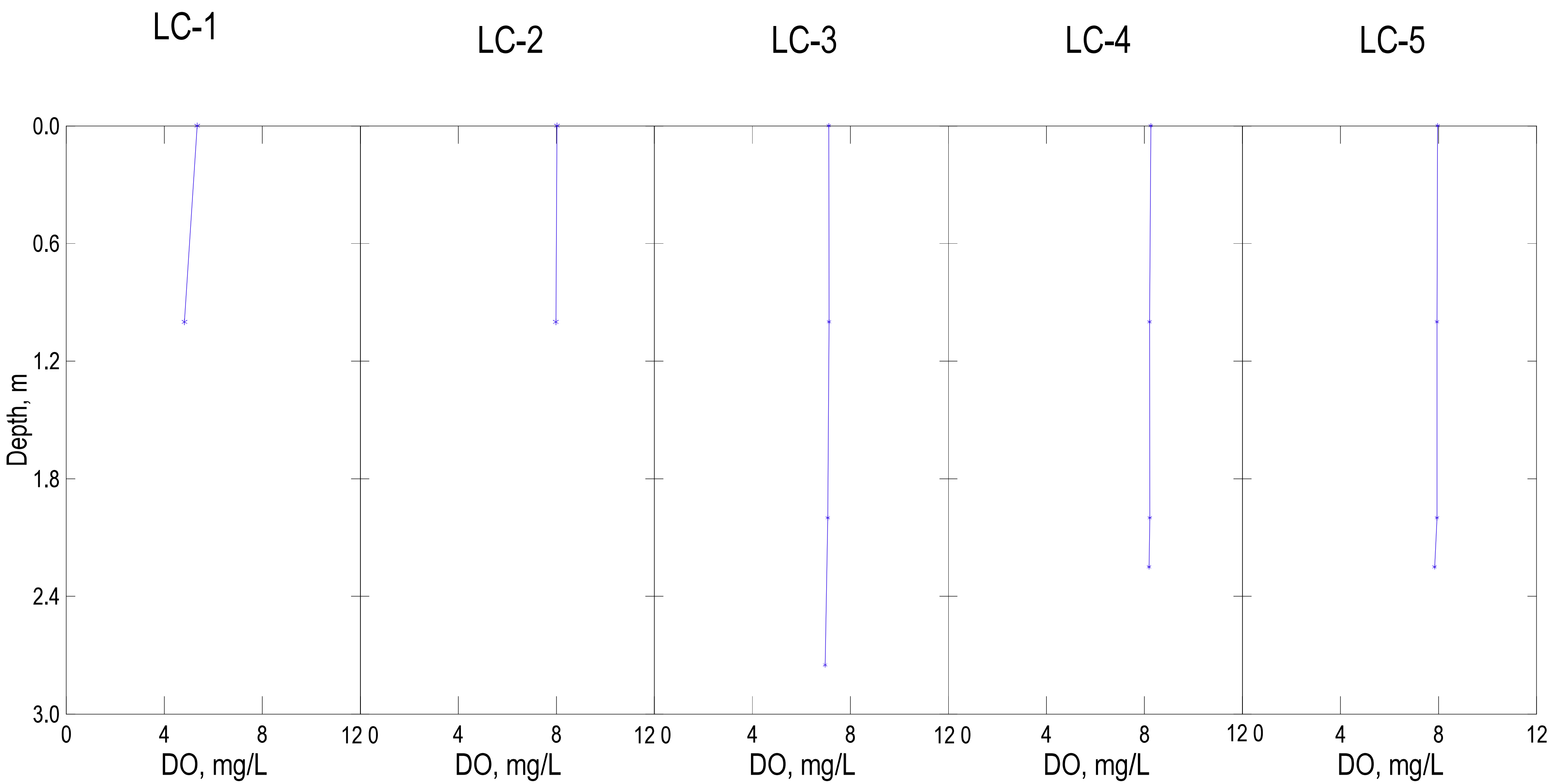
Lake Conway
8/21/2012
LC-1
LC-2
LC-3
LC-4
LC-5
Depth, m
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
100
200
300
Conductivity, umhos


Lake Conway
8/23/2011
LC-1
LC-2
LC-3
LC-4
LC-5
Depth, m
0.0
0.6
1.2
1.8
2.4
3.0
0
4
8
12
DO, mg/L


Lake Conway
9/20/2011
LC-1
LC-2
LC-3
LC-4
LC-5
Depth, m
0.0
0.6
1.2
1.8
2.4
3.0
0
4
8
12
DO, mg/L

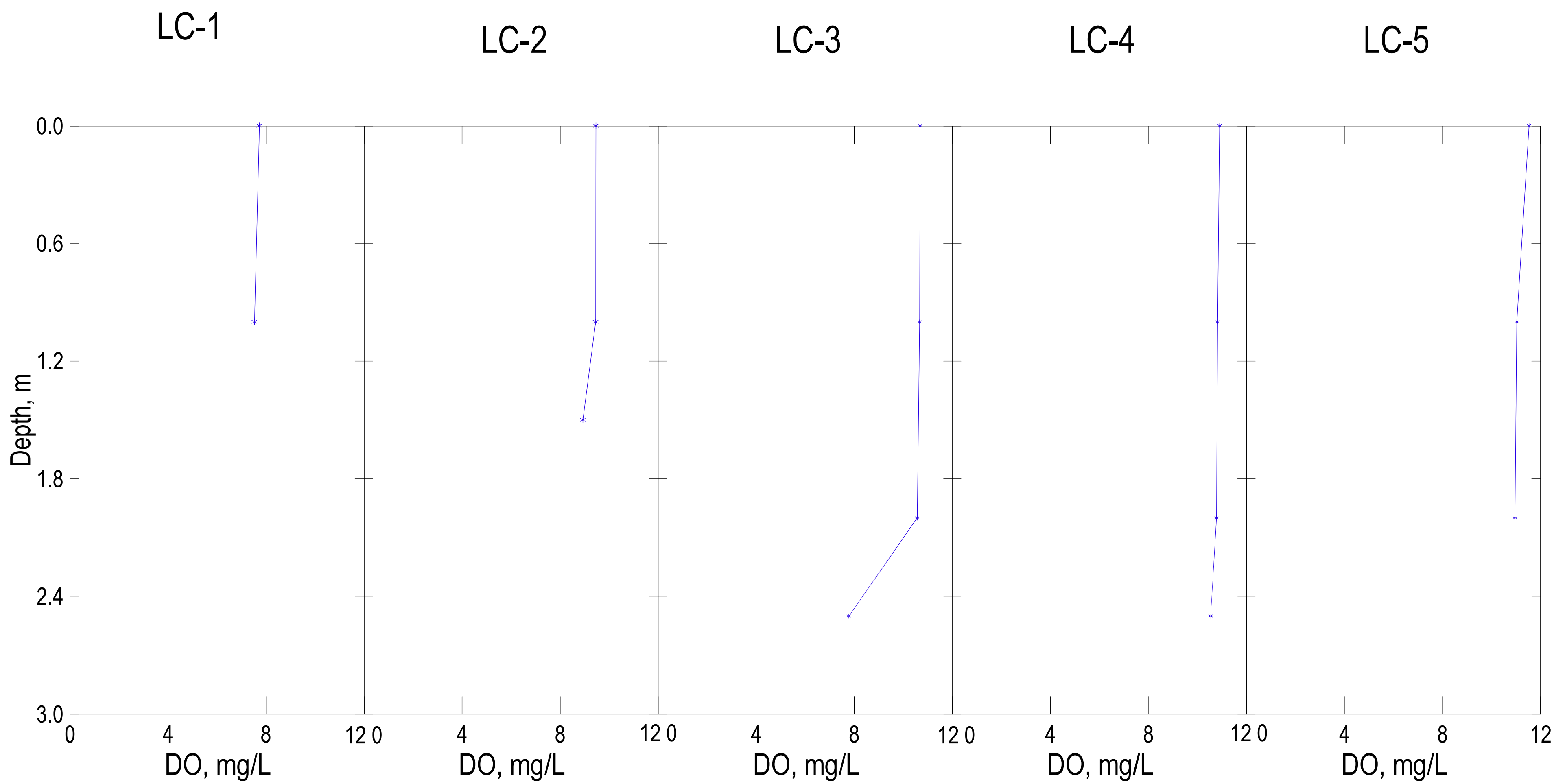
Lake Conway

10/18/2011



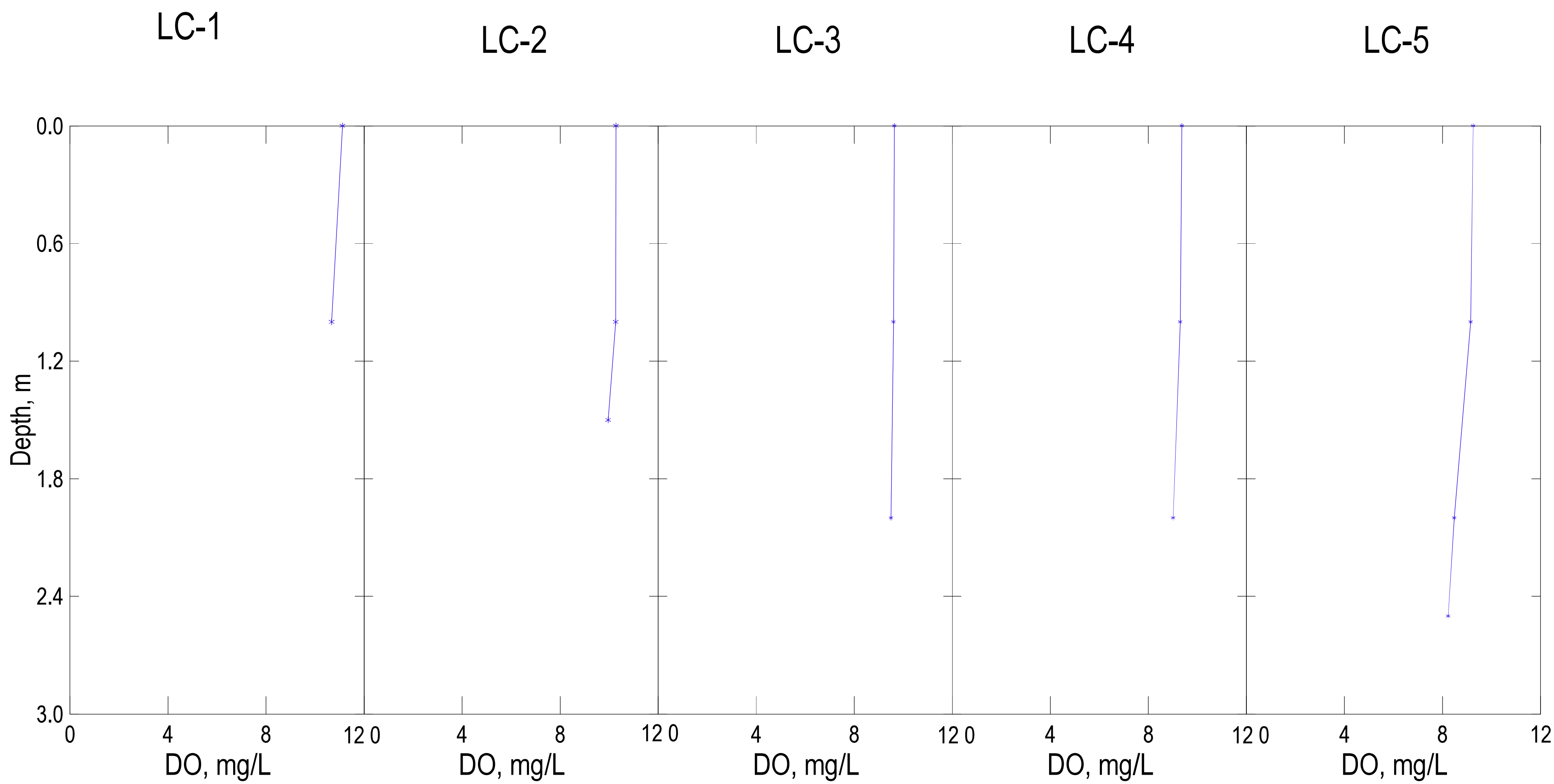
Lake Conway

11/29/2011



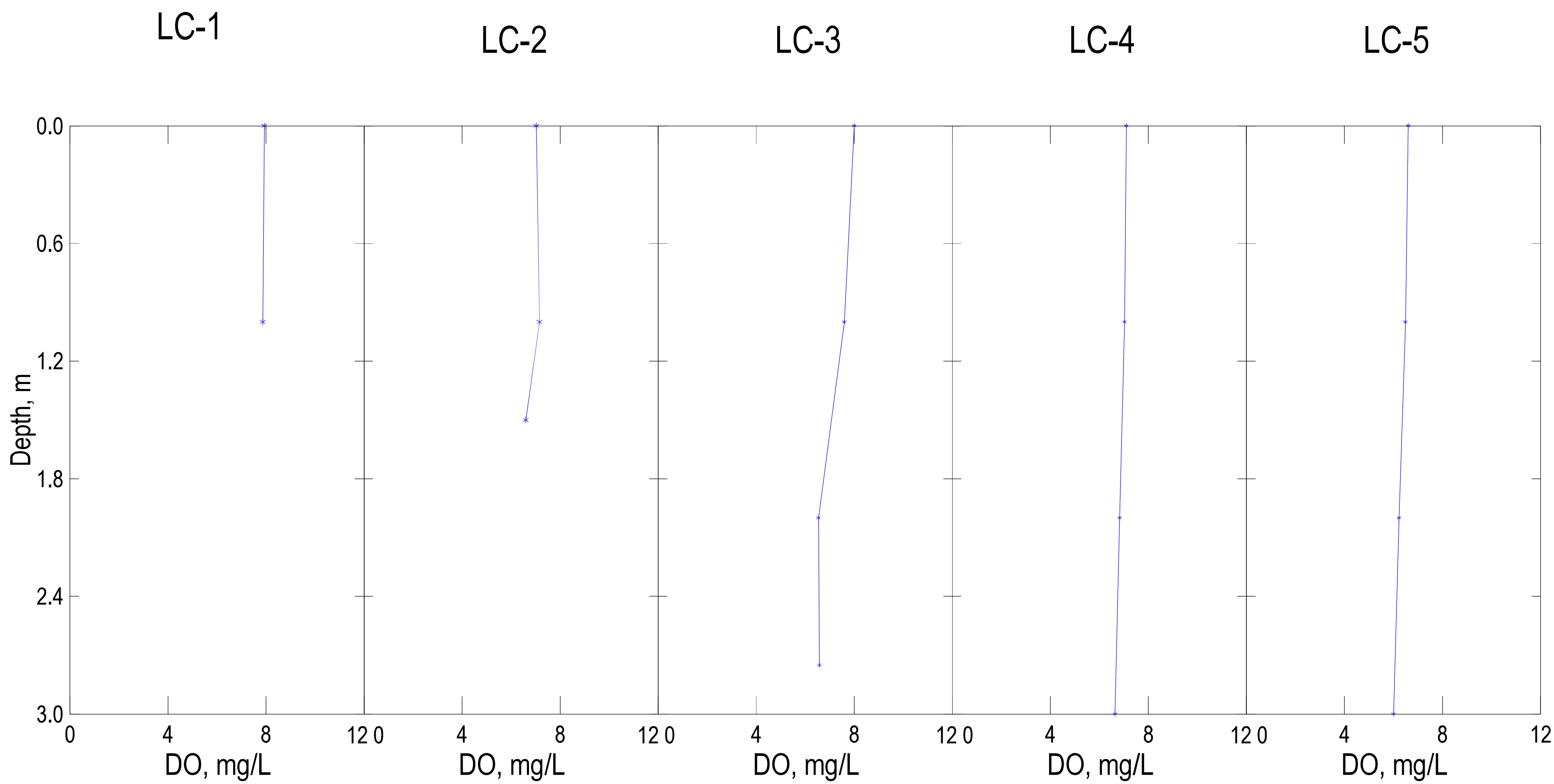
Lake Conway

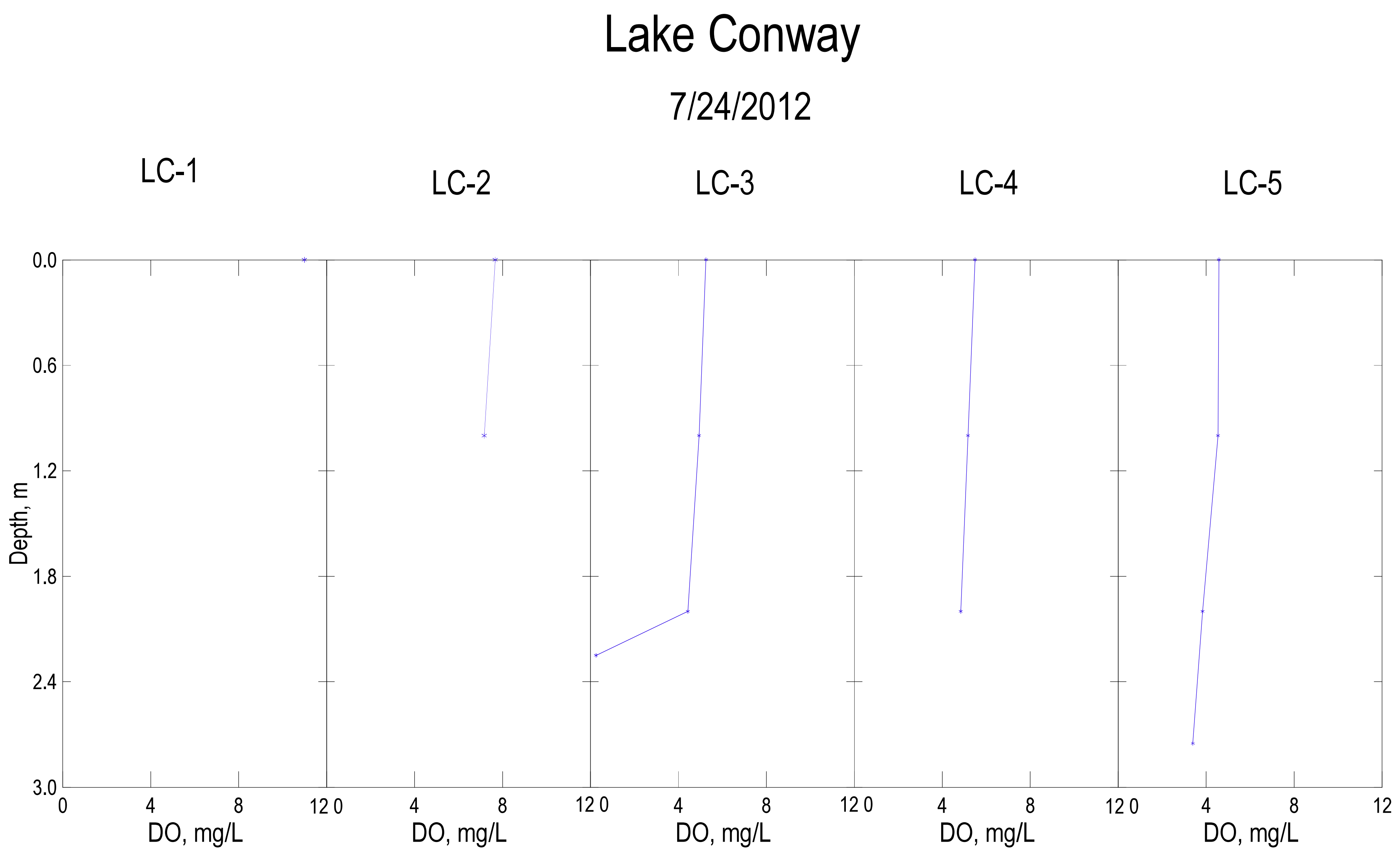
4/23/2012



Lake Conway

5/22/2012

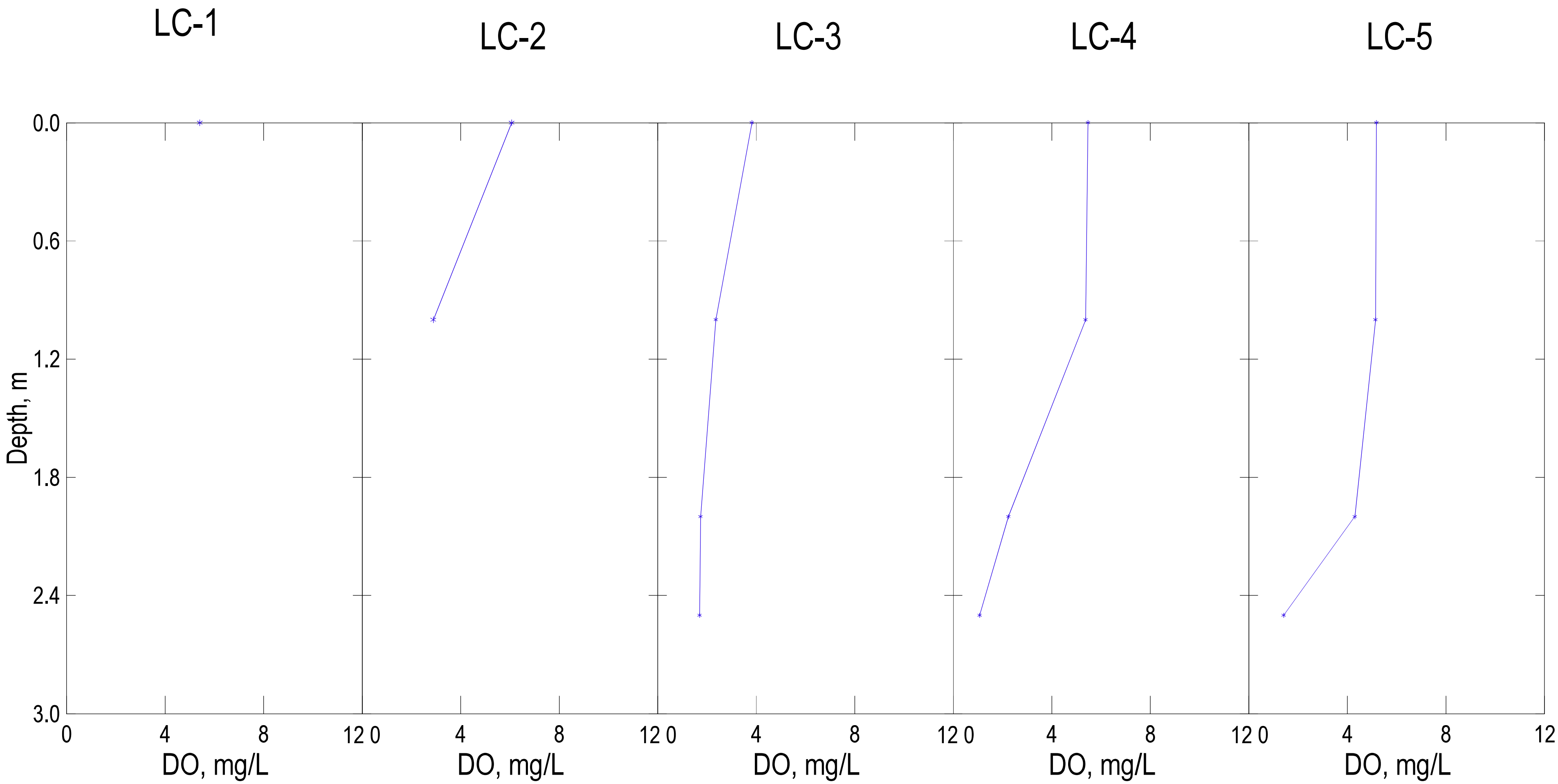




Lake Conway
7/24/2012
LC-1
LC-2
LC-3
LC-4
LC-5
Depth, m
0.0
0.6
1.2
1.8
2.4
3.0
0
4
8
12
DO, mg/L

Lake Conway

8/21/2012



APPENDIX E

Addendum to the Craig D. Campbell Lake Conway Reservoir and Inflow Tributaries Water Quality Sediment Study

FTN Associates Ltd.
water resources / environmental consultants
3 Innwood Circle, Suite 220 • Little Rock, AR 72211-2449 • (501) 225-7779 • Fax (501) 225-6738

ADDENDUM

DATE: November 19, 2013

TO: **Matt Horton**
Arkansas Game and Fish Commission

FROM: **Mark A. Hammons, PE** MAH
FTN Associates, Ltd.

Subject: Addendum to the Craig D. Campbell Lake Conway Reservoir and Inflow Tributaries Water Quality Sediment Study
FTN No. R03017-0020-001

The City of Conway Stone Dam Wastewater Treatment Plant (WWTP) that discharges effluent to Stone Dam Creek approximately one and one-half miles upstream from the boundary of Lake Conway is planned to be decommissioned in mid-2014. Upon the closure of the WWTP, Stone Dam Creek will no longer receive treated wastewater effluent; therefore, the volume of water flowing into Lake Conway will decrease. This memo addresses the impact of the loss of the WWTP effluent on Lake Conway water levels.

Discharge monitoring report data provided to the Arkansas Department of Environmental Quality for the Stone Dam WWTP through March 2013 are available from US Environmental Protection Agency's Enforcement and Compliance History Online (ECHO) database. For the 12-month period from April 2012-March 2013, the average WWTP effluent discharge was 3.64 million gallons per day (MGD). This is a total volume of 1,329 million gallons (MG) over the 12-month period, or about 4,100 acre-feet. For the 12-month period of data collected for the Water Quality and Sediment Study report by FTN Associates, Ltd. (FTN) dated February 11, 2013, this volume represents just over 3% of the total inflow volume to the lake.

The April 2012-March 2013 WWTP discharge could be equated to a volume of water sufficient to raise the water level in Lake Conway about 9.5 inches (from elevation 262.2 ft to 263.0 ft) over the entire 12-month period. As a comparison, the average annual evaporation loss from the lake is about 38 inches. The measured lake inflow volume for FTN's 12-month study was 23,900 MG and the estimated unmeasured inflow was 18,700 MG, for a total annual estimated inflow of 42,600 MG (130,700 acre-feet). This is approximately 5 times the total volume of water stored in the lake at elevation 263 ft. Therefore, on an average annual basis, the effect of the WWTP inflow on the lake level is small compared to other inflows and releases from the lake that are routinely managed in the operation of the lake.

Does inflow from the WWTP during the dry summer season have a significant effect on lake levels? In July 2012, the average Stone Dam WWTP effluent discharge was 3.07 MGD, or a total volume of 95.2 MG (292 ac-ft). This represents a difference of less than an inch of lake elevation over the month, assuming a lake elevation of 263 ft. Therefore, it can be concluded that even in a dry period, the impact of the loss of the WWTP effluent on lake levels would be negligible.

If you have any questions or comments about these data or conclusions, please contact Mark Hammons, PE, or Jim Malcolm at 501-225-7779. Mark's email address is mah@ftn-assoc.com and Jim's is jtm@ftn-assoc.com.

MAH/tas

CC: Mike Armstrong, Arkansas Game and Fish Commission
Tom Bly, Arkansas Game and Fish Commission
Mark Oliver, Arkansas Game and Fish Commission
Chris Racey, Arkansas Game and Fish Commission
Matt Schroeder, Arkansas Game and Fish Commission

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