2008 Monitoring Report

Araujo Fish Passage and Water Quality Improvements Project

SWQCB Agreement # 07-541-550-1, Component #2.1

Shasta Valley Resource Conservation District

Submitted
February 2009

Introduction

The Shasta Valley Resource Conservation District (RCD) has contracted to implement the Araujo Fish Passage and Water Quality Improvements Project for the State Water Resources Control Board. This project is also funded by California Department of Fish and Game, Natural Resources Conservation Service, U.S. Fish and Wildlife Service, National Fish and Wildlife Foundation, and the County of Humboldt.

The monitoring of pre-construction and post-construction water quality and fish passage parameters is outlined in the Monitoring Plan submitted as part of the contract. Monitoring is an essential component of improvement projects by providing documentation and quantitative measures of the success of the project.

Project Background

The Araujo Dam, a summer flashboard diversion structure with an associated impoundment, was identified as a high priority project for remediation in the North Coast Regional Water Quality Control Board (NCRWQCB) Total Maximum Daily Load (TMDL) for the Shasta River (2006) and the Recovery Strategy for California Coho Salmon (2004). The dam created poor water quality conditions in the river that included low dissolved oxygen content and high water temperatures, both of which are critical factors in fish survival. The dam also obstructed both juvenile and adult passage to colder waters upstream. Implementation of the flashboard dam removal project will assist the RCD, NCRWQCB and California Department of Fish and Game in meeting their goals of improving water quality and restoring coho, Chinook, and steelhead in the Shasta River.

The Araujo Dam project implementation included replacing the existing dam with a boulder weir that provides fish passage to juvenile and adult salmonids as well as reduces the volume of impounded water necessary to supply agricultural water to the five landowners. The pre-project gravity-fed irrigation system was replaced by a pumping system that includes a new fish screen and pumping station. Existing irrigation ditches used to transport water were replaced with underground piping in order to reduce ditch losses and avoid the use of herbicides that were used to maintain the ditches.

Project-specific pre-construction monitoring data was collected from June 2007 through early October 2007. The construction phase of the project was implemented in the fall of 2007. Post-construction monitoring began just prior to the beginning of the irrigation season, in late March 2008 and continued through September 2008, the end of the irrigation season. This monitoring report presents both first-year post-construction data from 2008 as well as a comparison to the pre-construction data collected in 2007. Details on the 2007 monitoring data can be found in the 2007 Monitoring Report submitted to the NCRWQCB by the Shasta Valley Resource Conservation District. Determining current conditions and identifying trends in the project area to date will aid the RCD in determining the degree to which the water quality and fish passage goals have been met.

Monitoring procedures in 2008 were followed as directed in the contract monitoring plan and the Quality Assurance Project Plan, and all Quality Assurance/ Quality Control protocol were followed. As agreed to in the contract, continued monitoring is to be conducted through the field season of 2009.

One significant but less obvious monitoring component of this project is to capture data to document costs to the diverters before and after implementation. The pre-project costs of the no-cost gravity diversion along with existing open ditches will be compared to the post-project costs of assuming a significant electrical cost without the costs or risks of maintaining open ditches and using aquatic plant herbicides in ditches very near to the stream.

Monitoring Details and Methods

Parameters that were monitored include water temperature, dissolved oxygen, and width of wetted channel within the project area. Fish passage was also monitored, as well as electric power and ditch maintenance costs. Digital photos were taken at established photo points in August 2008. The 2008 data collection period began in March 2008 and extended through September 2008. See Figure 1 for the sampling locations.

Water temperature

Continuous water temperature data was collected at six sites. In order to make direct comparisons, three of those sites were the same, and one was within 300 feet, as those measured in 2007 with Onset/HOBO probes. Zebra-Tech D-Optologgers, which record both dissolved oxygen and temperature, were installed at these four sites in March 2008. The D-Optologgers were not used in 2007 due to funding delays and unavoidable interference to the devices from construction activities.

The two remaining temperature collection sites were located downstream outside of the project area in order to document changes due to project implementation. Two Onset/ HOBO Tidbit temperature probes were deployed in April 2008. One probe was located upstream of the Oregon Slough confluence, and the other was located upstream of the bridge at Yreka-Ager Road.

Both types of water temperature devices recorded continuous hourly water temperature readings throughout the irrigation season. The probes were housed in a shading device where they were not exposed to direct sunlight, and were closely monitored to best assure submersion during extremely low flow periods. As directed in the monitoring plan, the Fish, Farms, and Forest Communities protocol was followed for calibration of the Onset/ HOBO instruments. Calibration and maintenance procedures from the manufacturer's manual were followed for the D-Optologgers. The accuracy of the Onset/ HOBO probe is +/- 0.2 °C while the accuracy of the D-Optologger is +/- 0.1 °C.

In addition, an Onset/HOBO temperature probe was installed at the project site on a tree near the new pumping station to collect continuous air temperature data. This probe recorded hourly readings in a shaded location from mid-April through September. As directed in the monitoring plan, the Fish, Farms, and Forest Communities protocol was followed for calibration of the instrument.

Dissolved Oxygen

Dissolved oxygen (DO) data was collected by the four Zebra-Tech D-Optologgers that were simultaneously recording water temperature data. Installed in 2008 at the same four sites that were measured twice for dissolved oxygen in 2007, the D-Optologgers recorded continuous hourly dissolved oxygen readings. The D-Optologger utilizes fluorescence to measure dissolved oxygen which provides accurate readings over a long period of time, particularly as compared to membrane-type DO meters. The D-Optologgers were not installed in 2007 due to funding delays and unavoidable interference to the devices from construction activities; therefore, limited dissolved oxygen data was collected in 2007 with which to make comparisons. Calibration and maintenance procedures from the D-Optologger manual were followed. The accuracy of the D-Optologger is +/- 0.02 ppm.

In addition, grab samples using a Yellow Springs Instruments YSI-55 meter were occasionally collected in 2008 in order to compare readings to those recorded by the D-Optologgers. Calibration and maintenance procedures outlined in the YSI-55 manual were followed. Measurements were taken in areas where water was flowing at a level recommended by the manufacturer for accurate sampling. The accuracy of the YSI-55 meter is +/- 0.5 ppm.

Width of Wetted Channel

Six permanent cross-sections had been established in 2007 throughout the project area with permanently installed T-posts and reference stakes. Using a horizontal string-line as a reference point, coupled with a tape measure for horizontal distance, depth measurements were taken of the channel depth, including the top and bottom of any sediment deposits. The procedure used in 2007 to collect cross-section data was duplicated for the 2008 data collection.

Aerial photos were used to visually examine changes in wetted channel as a result of the project. A pre-construction NRCS National Agriculture Imagery Program (2005) photo was compared to a post-construction image obtained from 2008 LiDAR data. It is important to note that these two images are constructed from very different technology, as LiDAR is formulated from laser point data rather than photography. The LiDAR data that was used in the comparison shows only the bare earth surface without the vegetation component. The appearance of surface characteristics differs between the two images, and this difference should be considered when comparing the two images.

Photo Points

Digital photographs were taken both upstream and downstream at five established photopoints on August 20, 2008. The photo points were documented and tagged in August 2007. Annual photos at each photopoint will help document changes in channel configuration, flow characteristics, and vegetation due to the implementation of the project. Photo point protocol followed the Photopoint Monitoring Handbook (PNW-GTR-526, USFS 2005).

Improved Fish Passage
One of the major goals of the project was to remove a flashboard dam at the Araujo site in order to provide for improved fish passage. Project implementation plans included the construction of a boulder weir upstream of the old dam site to provide a minimum amount of ponding at the new pump and screen site to assure proper pump operation. Digital photographs were taken before, during, and after the construction phase of the boulder weir to document a maximum jump height of twelve inches.

Ditch Maintenance/ Electrical Demand
Prior to project implementation, the irrigation ditches throughout the project area were open, earthen ditches. These ditches required maintenance by the landowner, including herbicide treatment to minimize vegetation growth. One element of the project included installing piping in existing irrigation ditches to improve water delivery efficiency and eliminate the amount of herbicides needed to maintain the ditches. The ranchers within the project area were asked to record ditch labor and herbicide costs for 2007, 2008, and 2009 to monitor changes in maintenance costs for their delivery system.

Upon completion, the project replaced a four-diversion gravity-fed irrigation water diversion and delivery system with a single-diversion pumped system. This change created a new electrical cost for the ranchers that did not exist pre-project. To account for the project costs, ranchers were asked to track the additional electrical costs throughout the post-project irrigation seasons to help quantify the fiscal effect of the improved system.

<u>Monitoring Results</u>
All data is stored on a Shasta Valley Resource Conservation District computer hard drive and back-up drive, as well as on a CD stored at the main SVRCD office. The 2008 data and photos are provided with this report, either as electronic files or on a CD. Results of each parameter are summarized in this report. The pre-construction monitoring data provides a short but valuable baseline to which post-construction monitoring data can be compared. Post-construction monitoring data, while limited to only one year to date, provides information that facilitates the evaluation of the success of the project.

Continuous monitoring data was collected throughout the 2008 irrigation season and verified for accuracy. Some data gaps occurred due to normal download and calibration procedures. Others were due to equipment malfunction caused by a battery connection failure in several D-Optologgers, which was remedied upon diagnosis. Other data gaps occurred due to extremely low flow levels resulting from irrigation practices, causing the meters to be exposed to air for a period of time.

Water temperature
Water temperature data from the four D-Optologgers and the two Onset/ HOBO temperature probes is summarized in Table 1 and shown graphically in Appendix A. In comparing the six sites, the two highest maximum temperature readings of 28.8°C and 28.2°C were measured downstream outside of the project area, with the highest from the most downstream site. These two sites, near the Yreka-Ager bridge and the Oregon

Slough confluence, also had the highest maximum daily average temperatures as well. This is consistent with the expected results, as the river temperature generally increases in a downstream direction from the headwaters to the mouth.

The remaining four water temperature sites were all within the project area. As shown in Table 1, little variation in values was apparent among the maximum readings. The highest maximum temperature was measured at the most upstream site, at the Highway 3 bridge, at 27.5°C. The lowest maximum reading of 27.1°C was taken at the most downstream site within the project area, just below the dam site. The maximum daily averages also showed little variation between the four project area sites, with the highest below the dam site and the lowest at the Highway 3 bridge. A graph of the daily average water temperatures for all six sites in 2008 is included in Appendix A.

Water temperature data from 2007 and 2008 is compared in Table 1. The 2007 and 2008 monitoring sites were the same with the exception of the Highway 3 temperature sites, as the 2007 site (Site 5) was approximately three hundred feet upstream of the 2008 site (Site 4). Due to the short monitoring period in 2007, the ability to compare the 2008 water temperature data to the 2007 data is limited. The common sampling period for both years for all four sites within the project area is from August 17 to September 7 of 2007 and 2008.The maximum temperature and maximum daily average temperature measured at each site during this period for both years is shown in Table 1. All values presented in the table showed an increase in temperature from 2007 to 2008. However, in 2007 the maximum temperatures showed more variation between sites than in 2008, indicating a more consistent flow pattern throughout the project area after construction. This implies the removal of the dam reduced ponding and improved flow throughout the project area, resulting in progress towards improving water quality. Annual differences in air temperature and irrigation practices may have influenced the overall increase in water temperature post-project versus pre-project.

Air temperature was measured near the new pump station throughout the 2008 irrigation season. This data is shown graphically in Appendix A.

Dissolved Oxygen

Dissolved oxygen (DO) measurements were taken continuously at hourly increments with the four Zebra-Tech D-Optologgers within the project area. This data is shown for each site in graphed form in Appendix A. A summary of the minimum, maximum, and average DO concentration measured at each site during the entire season is shown in Table 2. The lowest minimum of 1.559 ppm was recorded at the most upstream site, at the Highway 3 bridge, on August 16, 2008 at 0600. The highest minimum, 2.546 ppm, was measured at the site just upstream of the pump station on May 20, 2008 at 0300. The average DO level for the season was lowest just downstream of the dam site at 9.347 ppm, and the highest average of 9.840 was at the site upstream of the pump station. Although data that was known to be inaccurate, due to a problem such as vegetation wrapped around a meter or a lack of submersion, was not used in the analysis, it is possible that the remaining extreme lows and highs are due to a similar situation. The dissolved oxygen graphs in Appendix A provide an overall visual display of the data readings throughout the season.

The minimum, maximum, and average dissolved oxygen concentrations per month for the four sites are summarized in Table 3. The number of days per month that had at least one reading below 6.0 ppm is also shown, in order to facilitate a better understanding of when critical DO levels are more likely to occur. The lowest monthly minimum DO reading occurred in August while the lowest monthly average occurred in September. Based on the data presented in the summary, relative DO concentrations between the sites appeared to vary randomly, with no one site appearing to be consistently lowest or highest.

Table 2 includes DO grab sample data that was collected in 2007 using a YSI-55 meter at pre-dawn on two different days. Dissolved oxygen fluctuates diurnally, and at pre-dawn photosynthesis by aquatic vegetation is at a minimum, resulting in minimum dissolved oxygen levels. The days during which grab samples were taken were chosen based on extended hot summer days during the mid to late irrigation season in order to capture some of the lowest DO measurements for the season. However, these few data points provide for limited comparisons to the 2008 data, as many variables affect daily dissolved oxygen levels and no direct comparisons can be made between the 2007 grab samples and the 2008 continuous measurements. To graphically show this comparison, the DO measurements for each site during the month of July 2008 are plotted along with a point for the corresponding grab sample taken during July 2007 (Appendix A).

Dissolved oxygen grab sample data was also collected in 2008 in order to compare readings between the YSI-55 and the D-Optologger continuous meter. This data is presented in Table 4, comparing the grab samples to the nearest sample in time taken by the D-Optologger, and is shown graphically in Appendix A. Considering an accuracy of +/- 0.5 ppm with the YSI-55 meter and +/- 0.02 ppm with the D-Optologger, the readings from the two instruments are generally very similar, providing validity to the dissolved oxygen monitoring methods.

Width of Wetted Channel

Cross-sections of the river channel, including depth of sediment deposits, were measured in July 2008 at six permanent locations throughout the project area. The resulting profiles of the riverbank were then graphed over the profiles taken in 2007 for comparison (Appendix B). Measuring a change in width of wetted channel, or ponded surface area, will help determine whether a reduction in surface area available to aquatic vegetation and fine sediment, both of which reduce dissolved oxygen in the river, has occurred as a result of the project. However, the cross-section profile is only a snapshot in time and may not reflect long-term changes in the project area. No major differences were observed between profiles, as any significant channel changes are expected to take many years to evolve.

An aerial photo taken in 2005 is shown alongside a LiDAR image taken in January 2008 (Figure 2). As discussed in the Methods section, technology differences must be kept in mind when comparing the two very different images. Other than the removal of the dam, no major differences in channel configuration are apparent from the pre- and post-construction image comparison.

Photopoints

Post-construction photographs were taken from the established photopoints on August 20, 2008. Photos were taken both upstream and downstream. A pre- and post-construction comparison from three photopoints is shown in Appendix C. Visual documentation of the project site before and after construction is useful in determining post-construction changes in the channel configuration, flow characteristics, and vegetation growth.

Improved Fish Passage

Digital photographs were taken upon completion of the boulder weir as well as during a period of low flow (25 cfs) to document that the weir structure provided a maximum jump height of twelve inches. These photos are shown in Figure 3.

Ditch Maintenance/ Electrical Demand

As describes in the 2007 Monitoring Report, the ranchers involved with the project reported a total cost of $7,000 for herbicides and labor for pre-construction ditch maintenance in 2007. This responsibility fell on the water users that utilized the ditches to transport the water to their property. After the open earthen ditches were replaced with underground pipeline as part of the project, they reported that they had no costs for ditch maintenance in 2008. The intent of the new pipeline is to not only keep the water cleaner and cooler and reduce water loss, but also to reduce the need for labor and herbicide treatment for ditch weed control.

Implementation of the project resulted in electrical pumping costs that did not exist with the previous no-cost gravity-fed irrigation system. For the westside diversion which serves five users, the ranchers reported a total electrical cost of $2590. Power costs for the three remaining diversions, which serve one user each, were reported at a total of $6381. These figures resulted in a total annual cost of $8971 for electrical power to run the new pumping system.

By subtracting the pre-project ditch maintenance cost of $7000 from the post-project power cost of $8971, the project-wide net difference in costs to the five diverters is a total increase of $1971. Since ditch maintenance was the responsibility of only those using the ditches, and individual pumping requirements differ, individual net cost reductions or increases vary to make up the total overall increase of $1971.

Future Monitoring

As outlined in the project’s Monitoring Plan, post-construction monitoring will continue to take place during the 2009 irrigation season. While the two-year post-construction period will be adequate to document immediate changes within the project area, many river processes occur slowly over time and may not be measurable for many years. The Shasta Valley RCD intends to continue to pursue funding to allow continued monitoring within the basin to increase the base of knowledge about the Shasta River and to document continued improvements due to restoration projects. Continued monitoring of the parameters measured in 2007 and 2008 will be performed as specified in the monitoring plan for the Araujo project.

Water Temperature

Post-construction water temperature will continue to be measured at the same six sites that were measured in 2008. Four Zebra-Tech D-Optologgers will again be installed at the four sites within the project area, which will store continuous records of hourly water temperature readings. Continuous temperature data will again be collected at the two sites downstream of the project area using two Onset/ HOBO temperature probes. As in 2008, an Onset/ HOBO temperature probe will be placed near the Araujo pumping station to record air temperature throughout the field seasons. All equipment will be installed in a shaded area or housed in a shading device, and instream devices will be monitored regularly to ensure submersion during periods of low flow.

Dissolved Oxygen

Post-construction dissolved oxygen measurements will also be taken using the four Zebra-Tech D-Optologgers at the four sites within the project area. The D-Optologger utilizes fluorescence to measure dissolved oxygen, providing accurate readings over a long period of time. The meters will record hourly readings, resulting in a continuous record throughout the field season. Calibration and maintenance procedures from the D-Optologger manual will be followed. In addition, grab sample readings with the YSI-55 hand-held meter will be taken several times during the season in order to compare results.

Width of Wetted Channel

The six permanent pre-construction cross-sections established in 2007 will be revisited and measured. This data will be collected at the same time of year as in 2007 and 2008. New aerial photos will be utilized if available to compare to pre-construction aerial photos in order to help document changes in width of wetted channel due to the project.

Photopoints

Digital photographs will be taken in August 2009 at the established photopoints to create a continuous visual record of the project area.

Improved Fish Passage

Digital photographs will be taken in 2009, including during low flows, to document whether any significant change had occurred at the weir structure, assuring a maximum jump height of twelve inches at the boulder weir.

Ditch Maintenance/ Electrical Demand

The Shasta Valley Resource Conservation District has asked the ranchers to continue to track their labor and herbicide costs for ditch maintenance, and their electricity costs for the irrigation pumps, during 2009.

Summary

Pre-construction monitoring data collected in 2007 and post-construction monitoring data collected in 2008 for the Araujo project has helped facilitate evaluation of the success of the project. Due to the lack of a well-documented baseline and a short monitoring period in 2007, direct comparison between the data for the two years is limited. However, as discussed in the Results section of this report, general trends in improved water quality may be emerging from the interpretation of the data. Monitoring by the Shasta Valley Resource Conservation District will continue in order to collect quality data to help determine the effects of the diversion removal project on the river system and the habitat it provides.

This project data will also provide interesting points of comparison for older grab sampling data captured by the NCRWQCB and the Shasta Valley RCD at the upstream end of the project area at the Highway 3 bridge. Data from that site was intermittently collected between 1992 and the initiation of this project, and can be found in the final TMDL staff report for the Shasta River.

The Shasta River is a unique river system with its spring-fed, low-gradient characteristics and agricultural influences. Much progress has been made in the last decade by various agencies to study and understand its processes. Projects such as the Araujo Dam removal not only meet short-term goals to improve water quality, habitat, and passage, but also contribute to the base of knowledge needed for sound resource management.

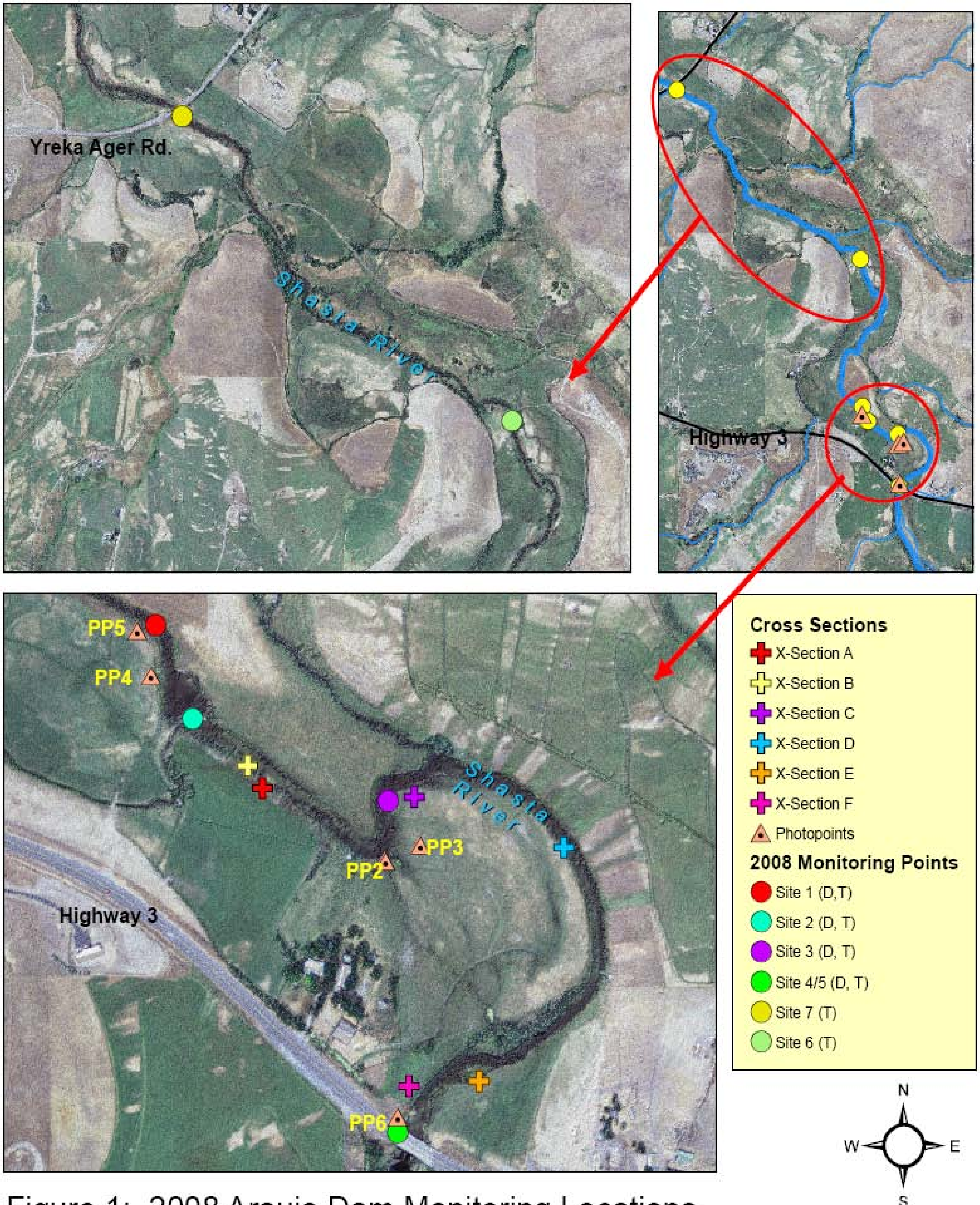


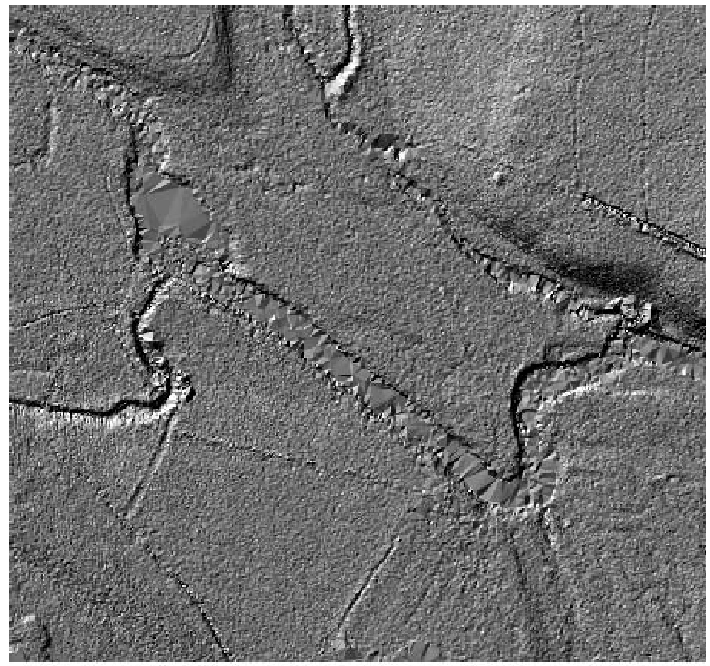
Figure 1: 2008 Araujo Dam Monitoring Locations

0 1,150 2,300 4,600 6,900 9,200 Feet

RCD
SHASTA VALLEY
RESOURCE CONSERVATION DISTRICT

Figure 2: Pre-Construction Aerial Photograph and Post-Construction Bare Earth LiDAR Image of Araujo Project

2005 NAIP Aerial Photograph



2008 Bare Earth LiDAR image

Figure 3: Araujo Boulder Weir

December 2007

June 2008

Table 1
2008 WATER TEMPERATURE SUMMARY AND COMPARISON WITH 2007 DATA

Site #	Continuous Monitoring Location	Latitude	Longitude	2008 Season		Common Sampling Period Aug 17 - Sep 7			
						2008		2007	
				Maximum Temp °C	Maximum Daily Avg Temp °C	Maximum Temp °C	Maximum Daily Avg Temp °C	Maximum Temp °C	Maximum Daily Avg Temp °C
1	Downstream Araujo Dam Site	41.730361	-122.561167	27.1	24.87	24.7	22.94	22.5	20.75
2	Upstream Araujo Dam Site	41.729639	-122.560778	27.2	24.80	24.9	22.92	23.2	20.74
3	Upstream Pump/ Screen Site	41.729000	-122.558694	27.3	24.82	25.1	22.98	23.2	20.64
4	Highway 3 Bridge	41.726444	-122.558611	27.5	24.79	25.0	22.92	NS	NS
5	Upstream Highway 3 Bridge	41.725780	-122.558690	NS	NS	NS	NS	24.4	20.73
6	Upstream Oregon Slough Confluence	41.737694	-122.561389	28.2	24.93	24.8	23.11	NS	NS
7	Upstream Yreka-Ager Rd. Bridge	41.746028	-122.574083	28.8	24.92	25.0	23.05	NS	NS

NS *Not Sampled*

Table 2
2008 DISSOLVED OXYGEN SUMMARY FOR 2008 SEASON AND COMPARISON WITH 2007 DATA

Site #	Location	Latitude	Longitude	Post-Construction Continuous Data Collection			Pre-Construction Grab Samples	
				2008 Minimum DO ppm	2008 Maximum DO ppm	2008 Average DO ppm	6/12/2007 Pre-Dawn DO ppm	7/9/2007 Pre-Dawn DO ppm
1	Downstream Araujo Dam Site	41.730361	-122.561167	1.983	18.206	9.347	5.59	4.33
2	Upstream Araujo Dam Site	41.729639	-122.560778	2.222	29.667	9.475	5.26	4.18
3	Upstream Pump/ Screen Site	41.729000	-122.558694	2.546	21.372	9.840	5.44	3.91
4	Highway 3 Bridge Site	41.726444	-122.558611	1.559	17.444	9.390	5.93	3.89

Table 3
2008 DISSOLVED OXYGEN SUMMARY BY MONTH

Site #	Continuous Monitoring Location	April Month Min	April Month Max	April Month Avg	April # Days DO < 6 ppm at least 1 hr	May Month Min	May Month Max	May Month Avg	May # Days DO < 6 ppm at least 1 hr	June Month Min	June Month Max	June Month Avg	June # Days DO < 6 ppm at least 1 hr	July Month Min	July Month Max	July Month Avg	July # Days DO < 6 ppm at least 1 hr	August Month Min	August Month Max	August Month Avg	August # Days DO < 6 ppm at least 1 hr	September Month Min	September Month Max	September Month Avg	September # Days DO < 6 ppm at least 1 hr
1	Downstrm Dam Site	6.425	18.077	11.075	0	3.906	18.206	9.532	17	2.796	18.004	9.383	17	1.983	16.293	8.516	31	2.117	15.593	8.410	31	2.780	14.818	8.780	19
2	Upstrm Dam Site	5.270	20.360	10.976	1	3.640	29.667	9.382	21	3.012	17.656	9.366	17	2.295	20.420	10.019	31	2.222	18.286	8.925	31	3.207	13.669	7.786	26
3	Upstrm Pump Stn	6.533	17.180	10.823	0	2.546	18.648	9.320	17	2.929	16.904	9.254	17	3.054	19.200	9.660	31	2.986	21.372	9.721	30	INC	INC	INC	INC
4	Hiway 3 Bridge	6.300	17.260	10.725	0	INC	INC	INC	INC	2.849	16.081	9.309	16	2.455	17.444	9.130	31	1.559	16.610	8.356	31	4.455	14.337	8.970	14

Lowest value among sites during month
INC *Incomplete record for month*

Table 4
2008 CONTINUOUS DATA AND GRAB SAMPLE DATA COMPARISON

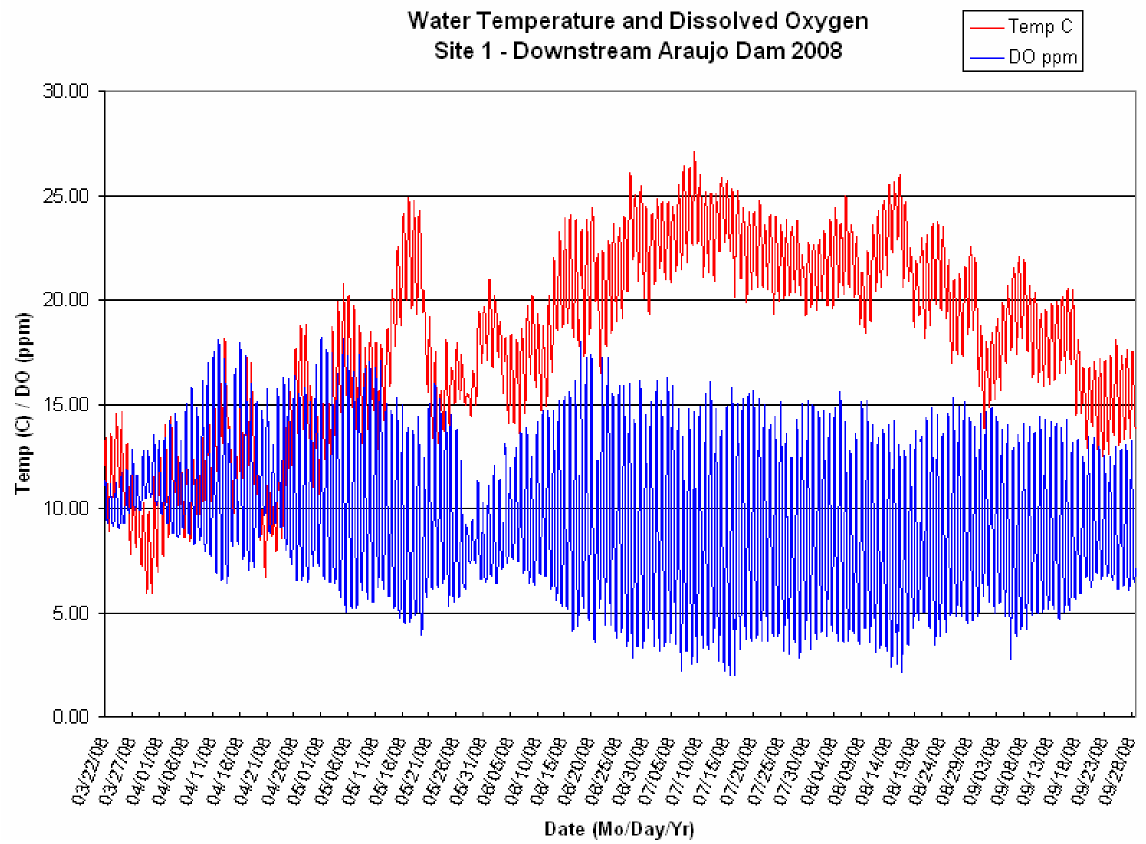
Sampling Date 4/16/08

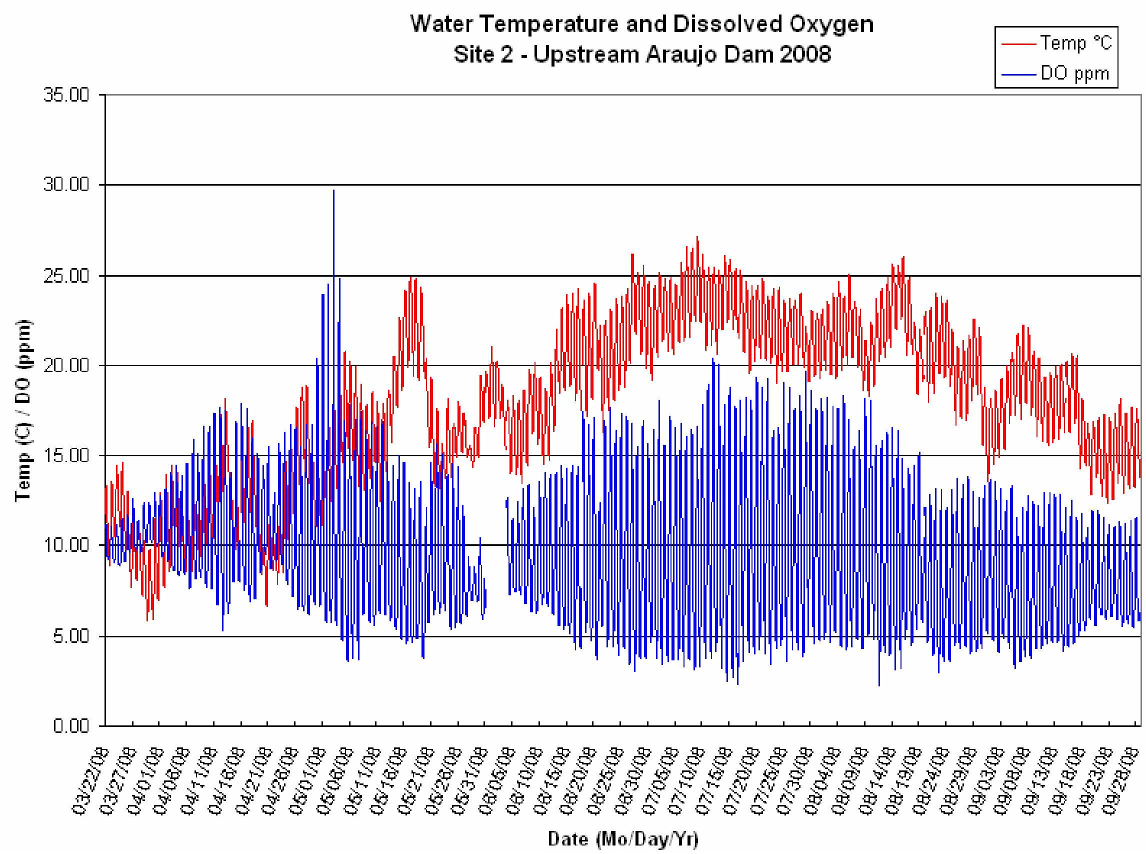
Site #	Location	Continuous Hourly Data Time	Continuous Hourly Data DO ppm	Continuous Hourly Data Temp °C	YSI-55 Grab Samples Time	YSI-55 Grab Samples DO ppm	YSI-55 Grab Samples Temp °C
1	Downstream Araujo Dam Site	9:48 AM	10.42	9.8	10:35 AM	10.53	10.4
2	Upstream Araujo Dam Site	9:29 AM	10.35	9.8	10:40 AM	10.53	10.7
3	Upstream Pump/ Screen Site	10:27 AM	11.10	10.0	11:04 AM	11.00	10.5
4	Highway 3 Bridge Site	11:00 AM	11.73	10.1	11:21 AM	11.70	10.5

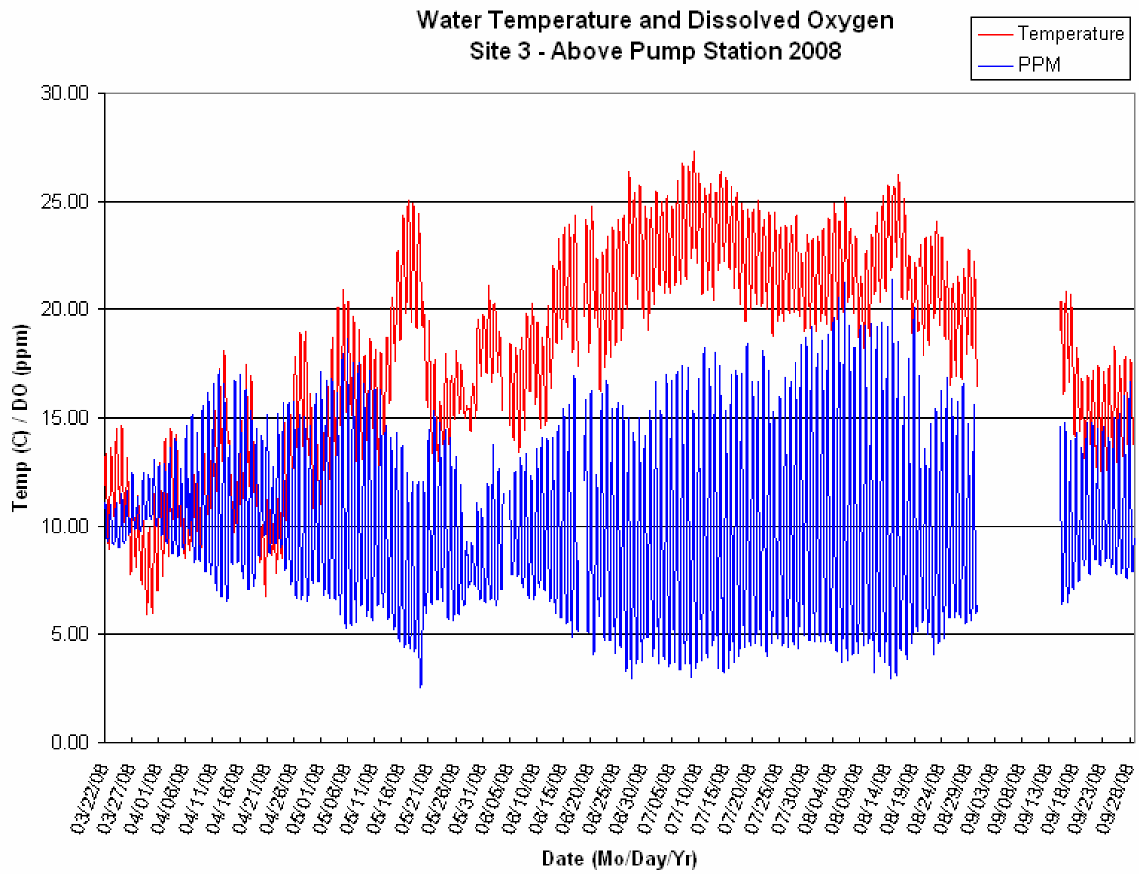
Sampling Date 7/10/08

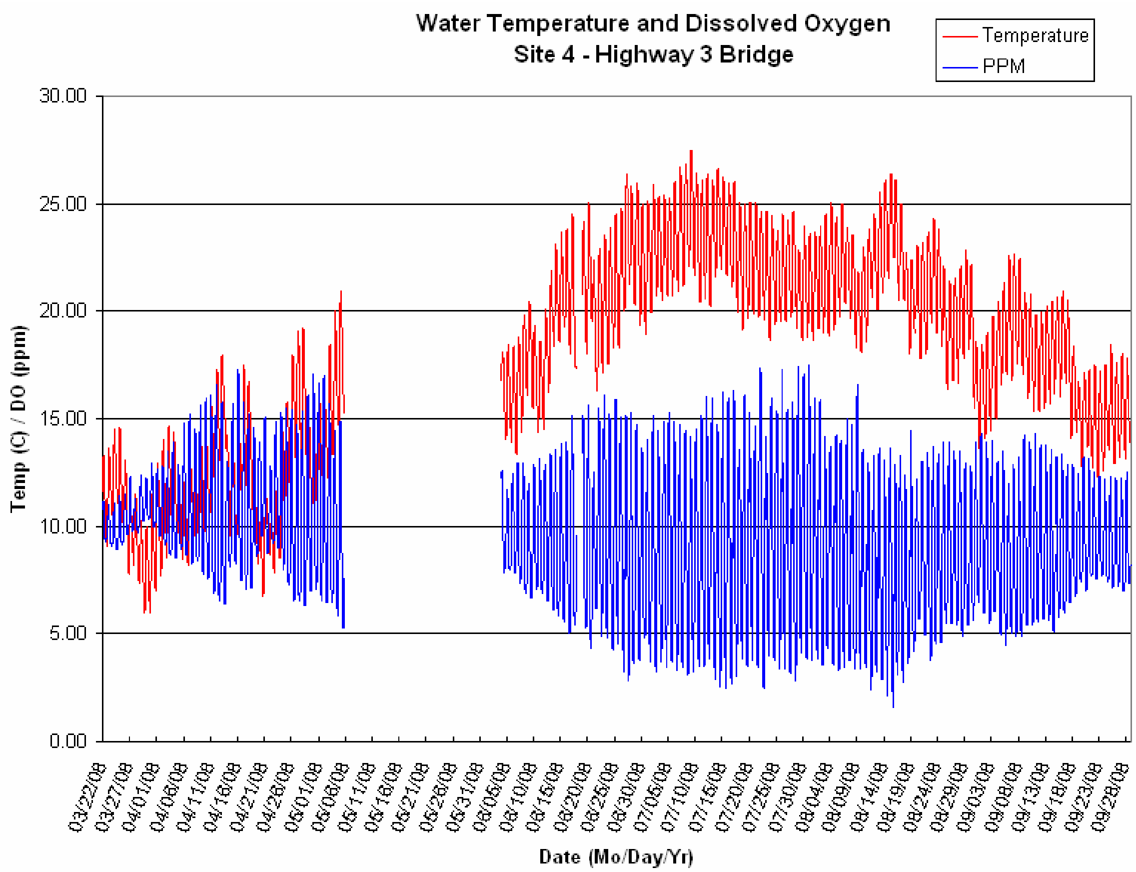
Site #	Location	Continuous Hourly Data Time	Continuous Hourly Data DO ppm	Continuous Hourly Data Temp °C	YSI-55 Grab Samples Time	YSI-55 Grab Samples DO ppm	YSI-55 Grab Samples Temp °C
1	Downstream Araujo Dam Site	5:00 AM	2.74	23.8	5:25 AM	2.82	23.6
2	Upstream Araujo Dam Site	5:00 AM	3.27	23.7	5:20 AM	2.29	23.3
3	Upstream Pump/ Screen Site	5:00 AM	3.43	23.6	5:09 AM	3.13	23.4
4	Highway 3 Bridge Site	5:00 AM	3.25	23.5	5:00 AM	3.20	23.3

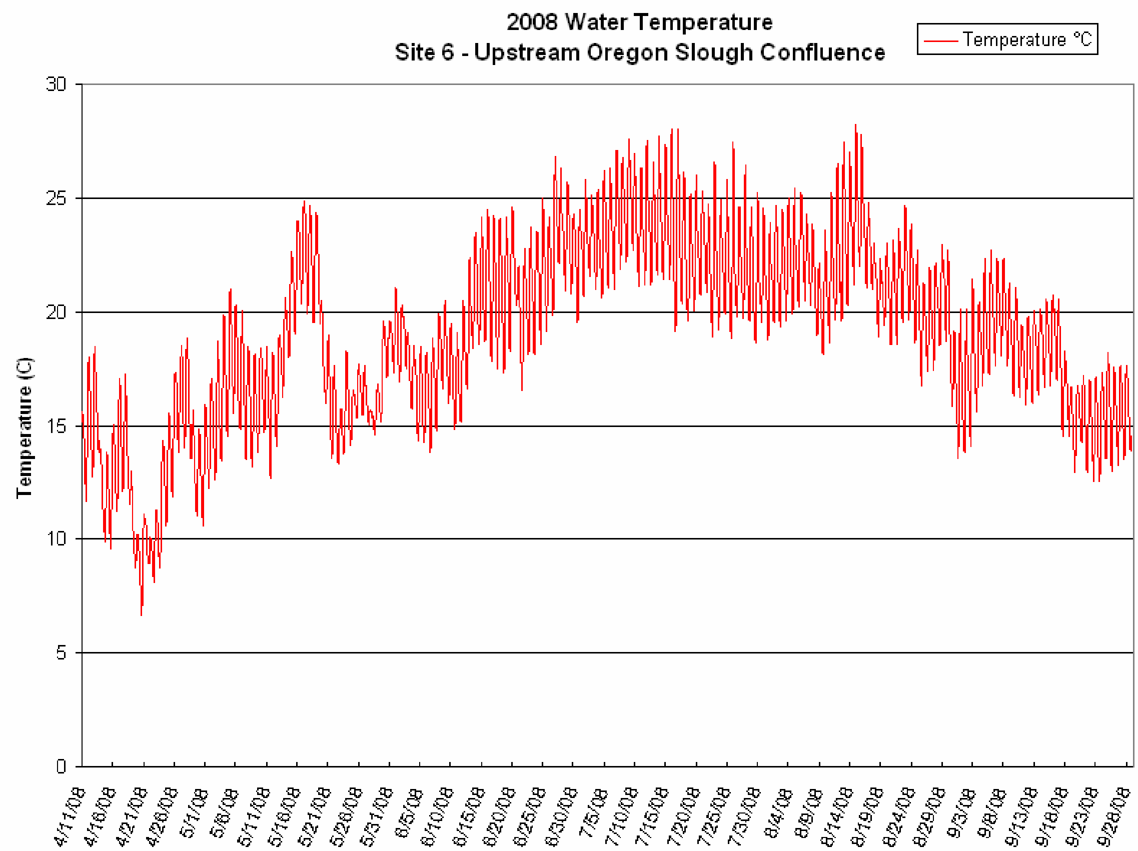
Appendix A. Temperature & Dissolved Oxygen Graphs






Water Temperature and Dissolved Oxygen
Site 3 - Above Pump Station 2008
Temperature
PPM
Temp (C) / DO (ppm)
Date (Mo/Day/Yr)


Water Temperature and Dissolved Oxygen
Site 4 - Highway 3 Bridge
Temperature
PPM
Temp (C) / DO (ppm)
Date (Mo/Day/Yr)



2008 Water Temperature
Site 6 - Upstream Oregon Slough Confluence
Temperature °C
Temperature (C)
30
25
20
15
10
5
0
4/11/08
4/16/08
4/21/08
4/26/08
5/1/08
5/6/08
5/11/08
5/16/08
5/21/08
5/26/08
5/31/08
6/5/08
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8/19/08
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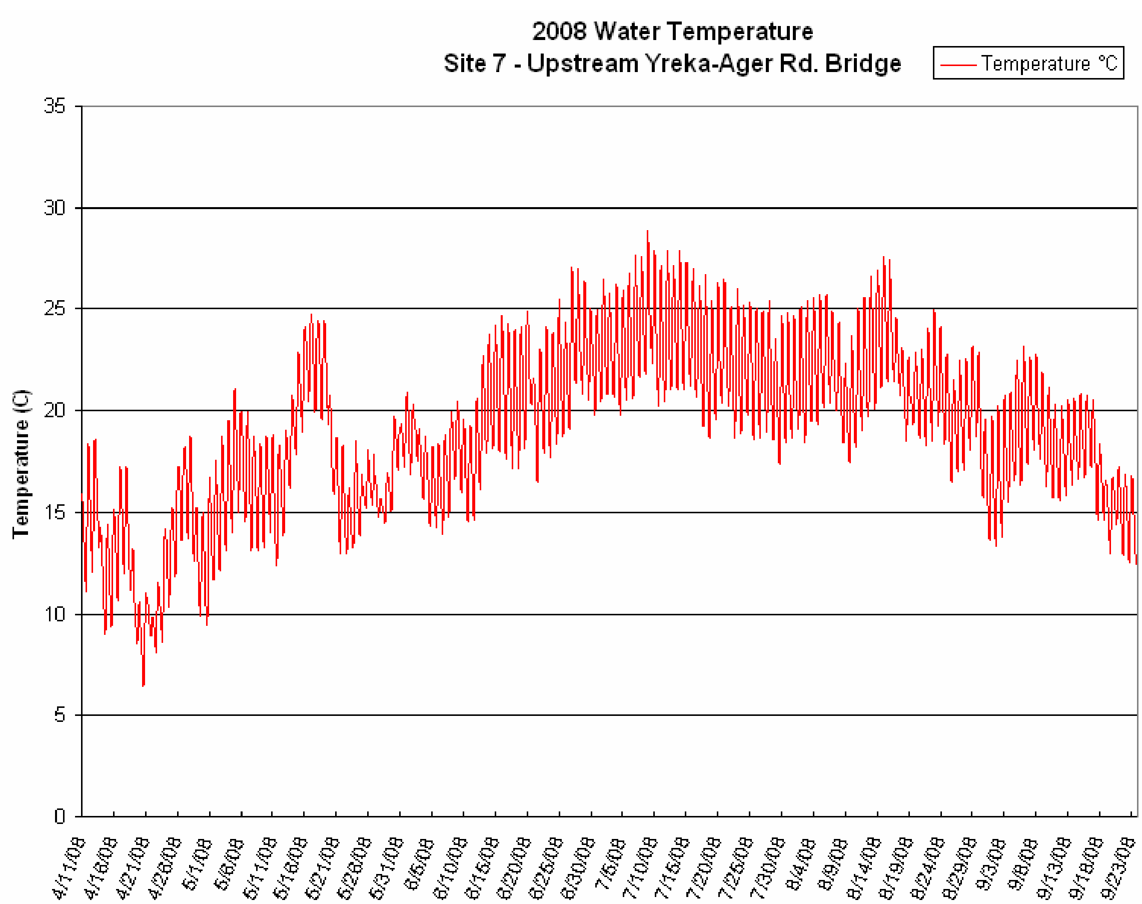
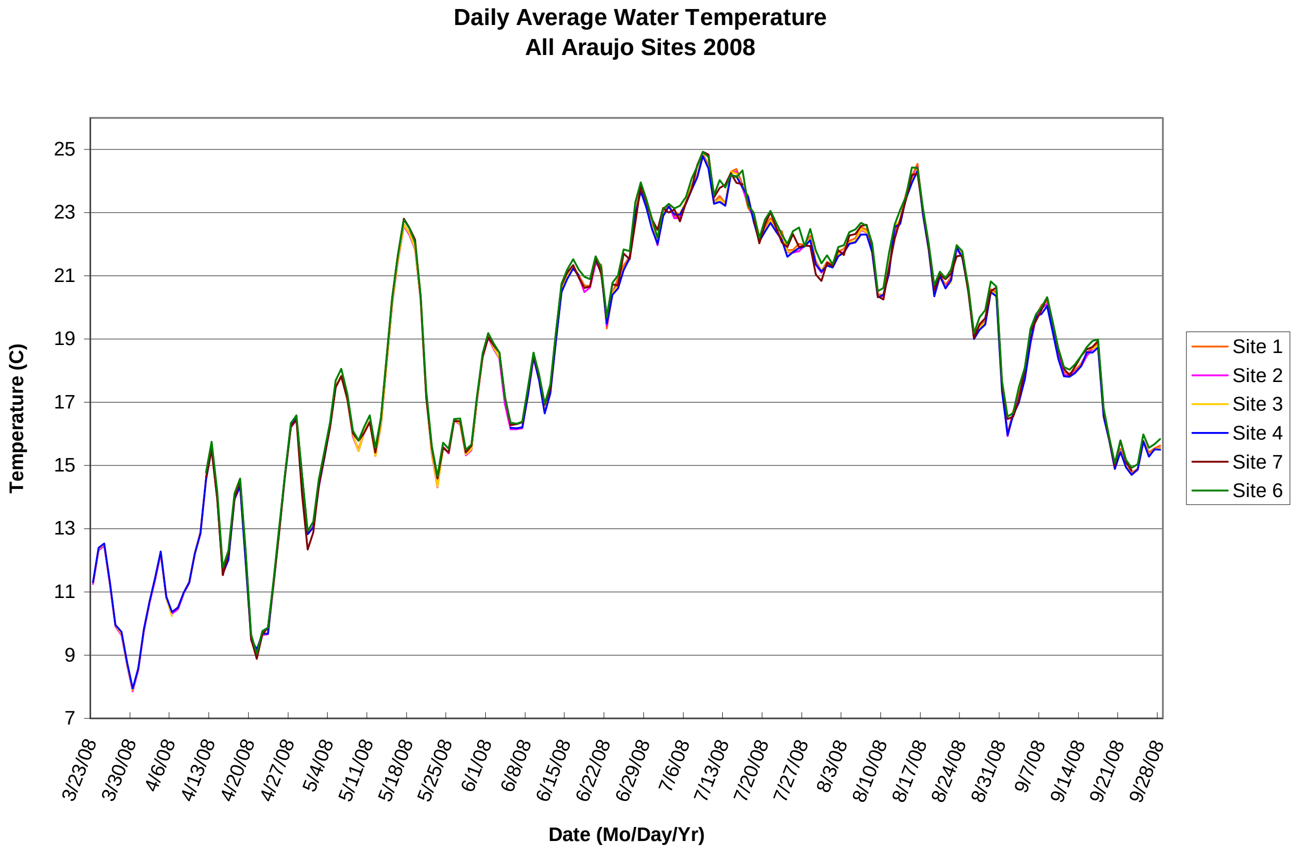
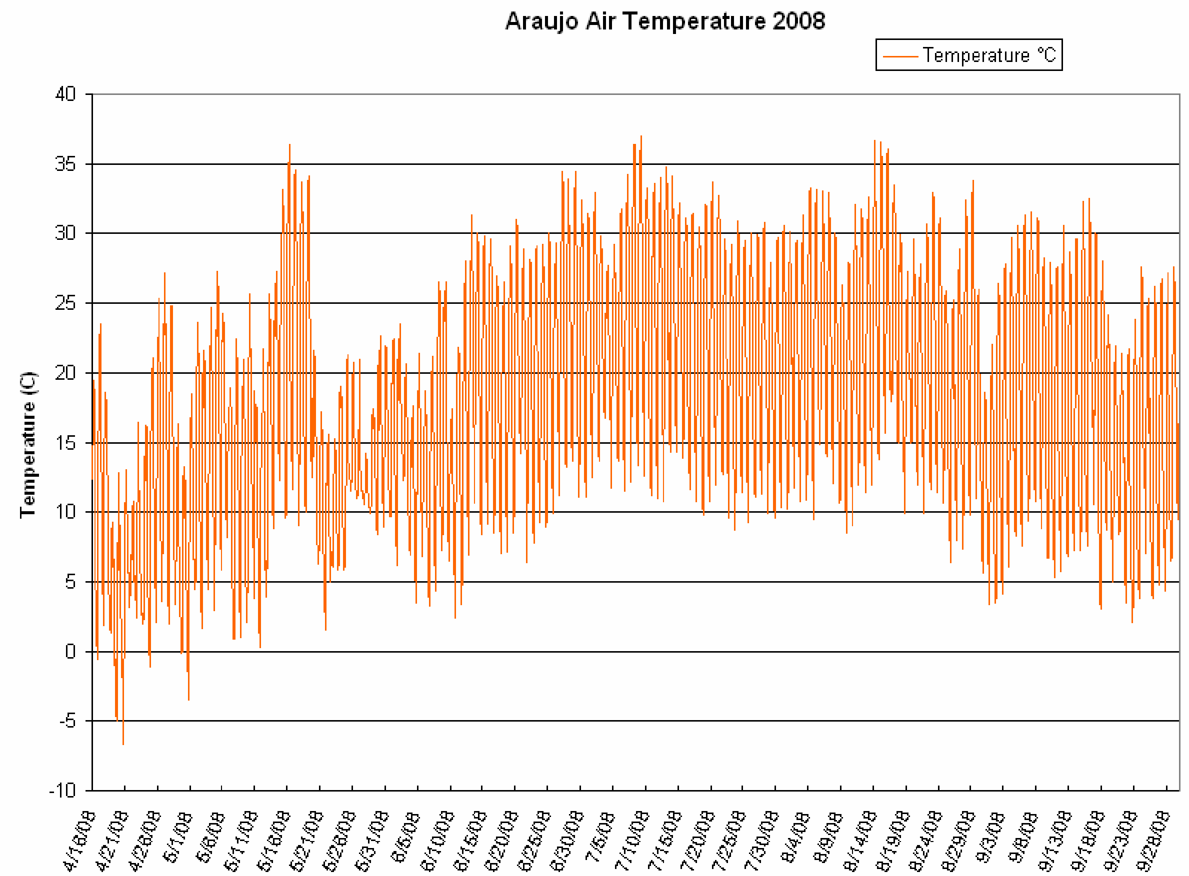
9/13/08
9/18/08
9/23/08
9/28/08



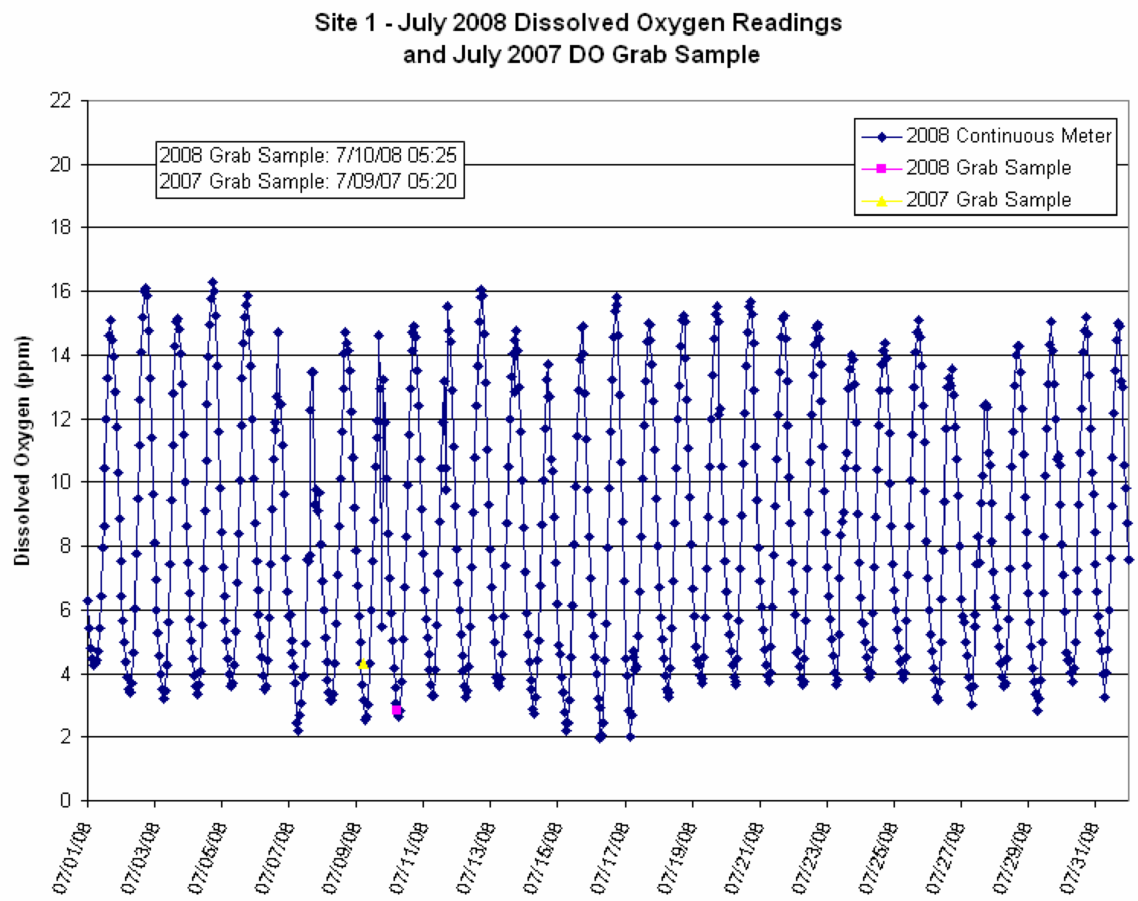
2008 Water Temperature
Site 7 - Upstream Yreka-Ager Rd. Bridge
Temperature °C
Temperature (C)
35
30
25
20
15
10
5
0
4/11/08
4/16/08
4/21/08
4/26/08
5/1/08
5/6/08
5/11/08
5/16/08
5/21/08
5/26/08
5/31/08
6/5/08
6/10/08
6/15/08
6/20/08
6/25/08
6/30/08
7/5/08
7/10/08
7/15/08
7/20/08
7/25/08
7/30/08
8/4/08
8/9/08
8/14/08
8/19/08
8/24/08
8/29/08
9/3/08
9/8/08
9/13/08
9/18/08
9/23/08

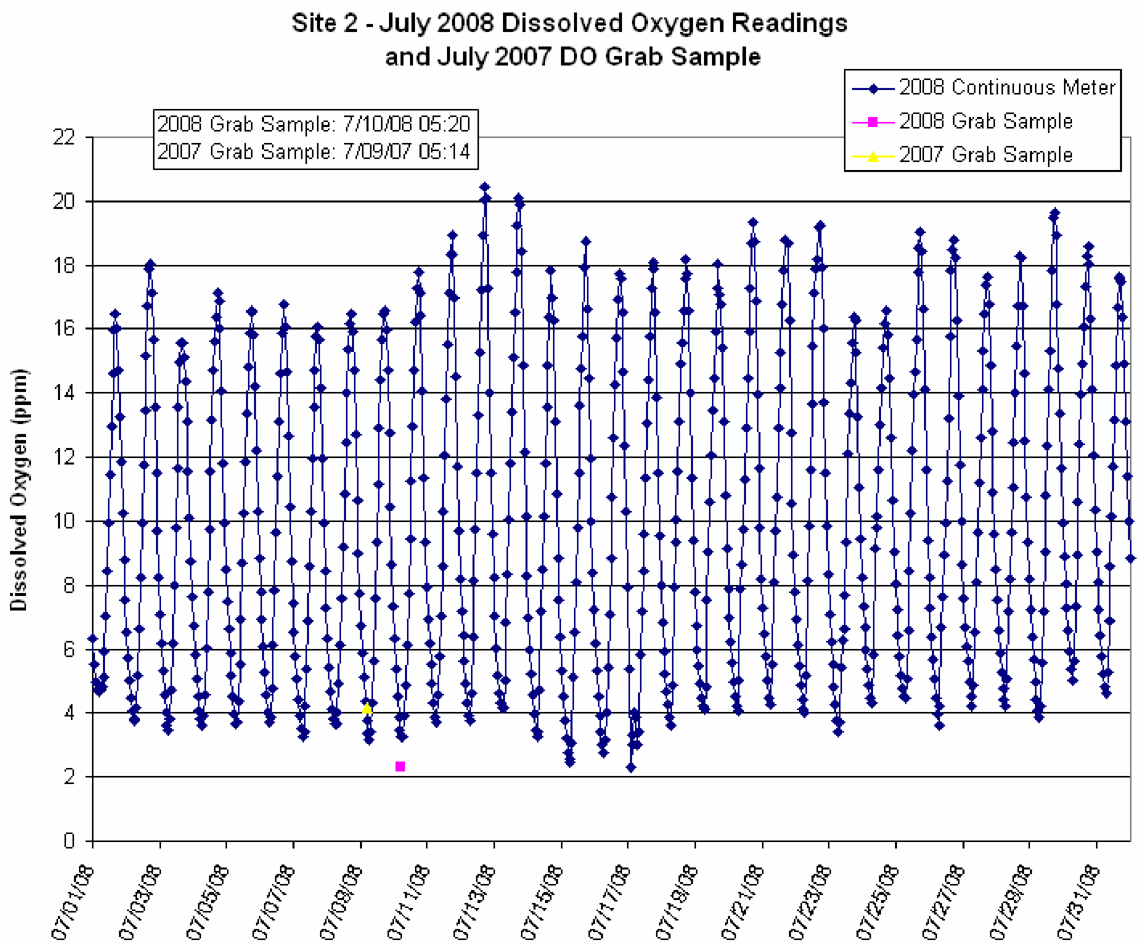


Daily Average Water Temperature
All Araujo Sites 2008
Temperature (C)
Date (Mo/Day/Yr)
Site 1
Site 2
Site 3
Site 4
Site 7
Site 6



Araujo Air Temperature 2008
Temperature °C
Temperature (C)


Site 1 - July 2008 Dissolved Oxygen Readings
and July 2007 DO Grab Sample
2008 Grab Sample: 7/10/08 05:25
2007 Grab Sample: 7/09/07 05:20
2008 Continuous Meter
2008 Grab Sample
2007 Grab Sample
Dissolved Oxygen (ppm)
0
2
4
6
8
10
12
14
16
18
20
22
07/01/08
07/03/08
07/05/08
07/07/08
07/09/08
07/11/08
07/13/08
07/15/08
07/17/08
07/19/08
07/21/08
07/23/08
07/25/08
07/27/08
07/29/08
07/31/08


Site 2 - July 2008 Dissolved Oxygen Readings
and July 2007 DO Grab Sample
2008 Grab Sample: 7/10/08 05:20
2007 Grab Sample: 7/09/07 05:14
2008 Continuous Meter
2008 Grab Sample
2007 Grab Sample
Dissolved Oxygen (ppm)
0
2
4
6
8
10
12
14
16
18
20
22
07/01/08
07/03/08
07/05/08
07/07/08
07/09/08
07/11/08
07/13/08
07/15/08
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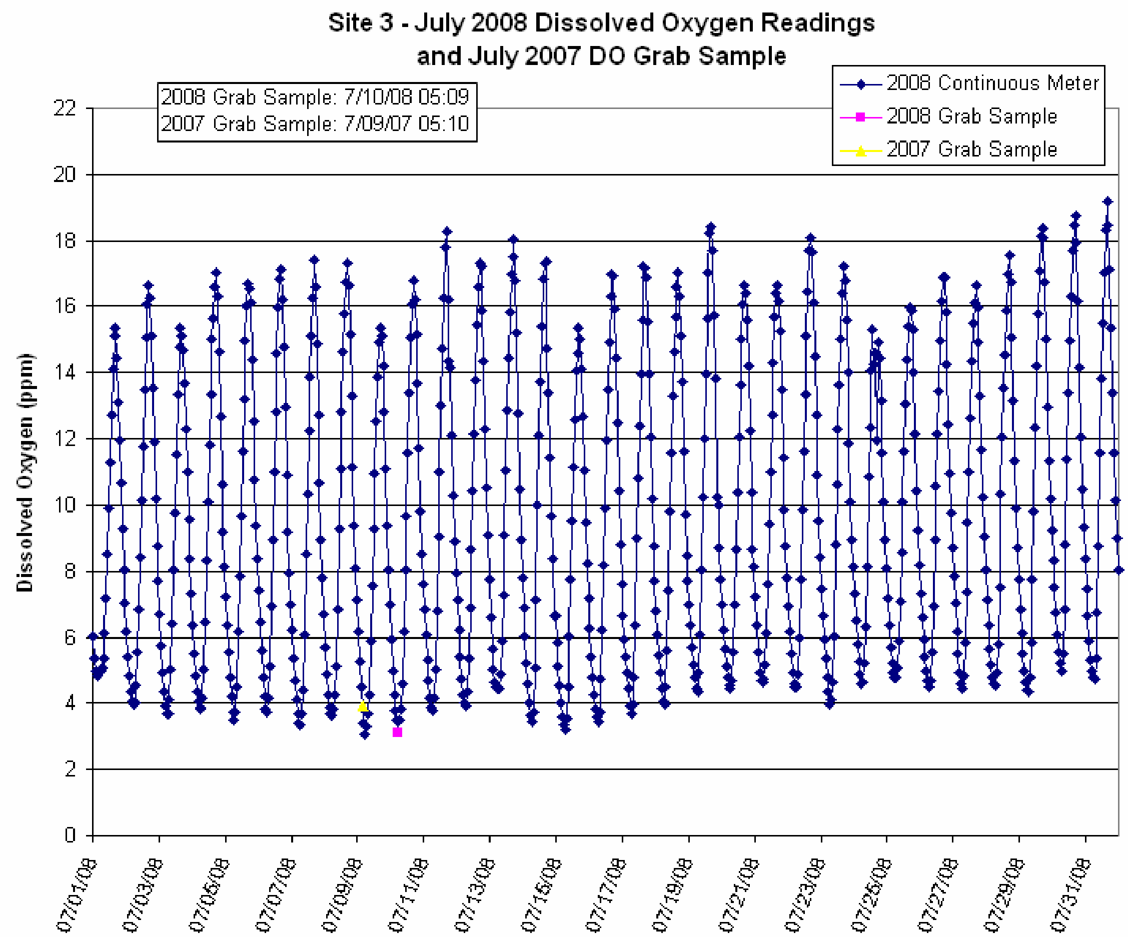
07/23/08
07/25/08
07/27/08
07/29/08
07/31/08


Site 3 - July 2008 Dissolved Oxygen Readings
and July 2007 DO Grab Sample
2008 Grab Sample: 7/10/08 05:09
2007 Grab Sample: 7/09/07 05:10
2008 Continuous Meter
2008 Grab Sample
2007 Grab Sample
Dissolved Oxygen (ppm)
0
2
4
6
8
10
12
14
16
18
20
22
07/01/08
07/03/08
07/05/08
07/07/08
07/09/08
07/11/08
07/13/08
07/15/08
07/17/08
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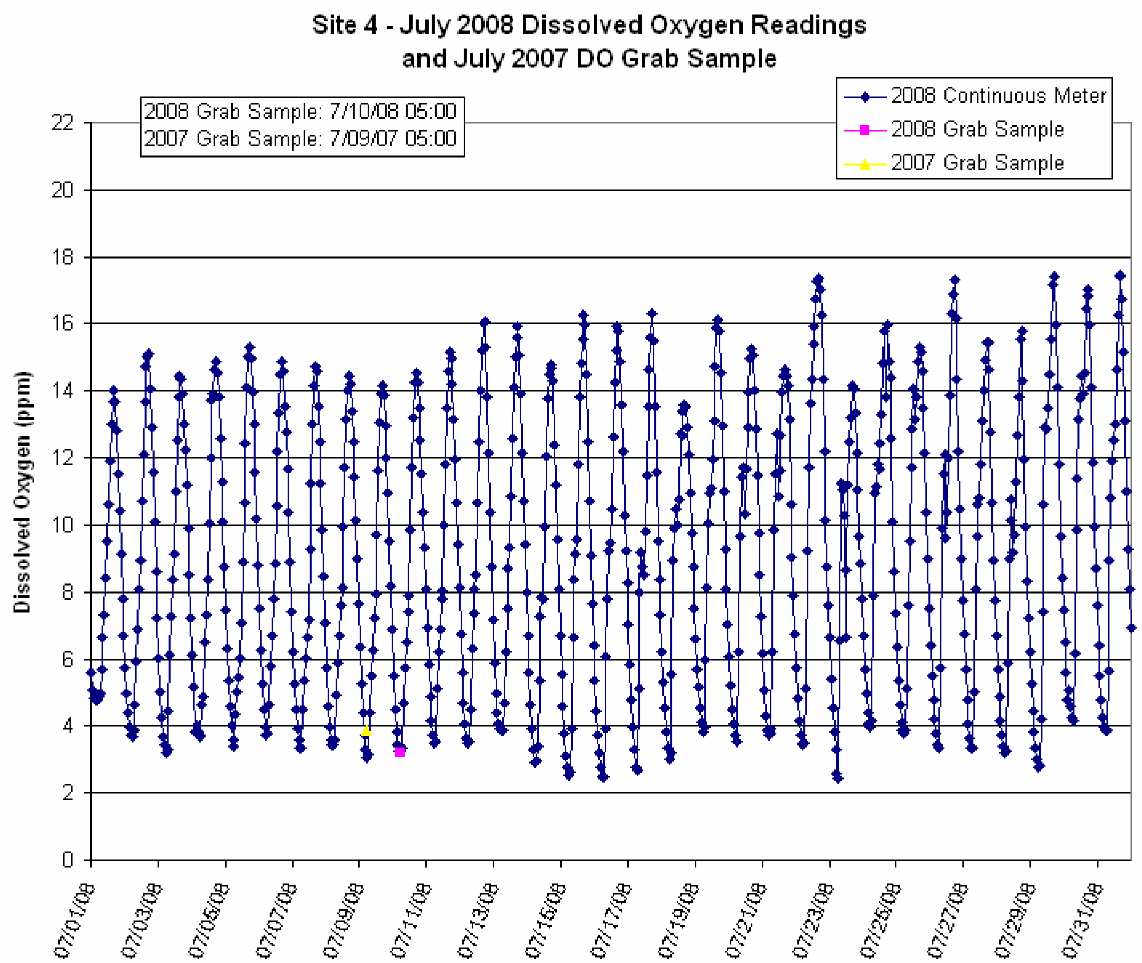
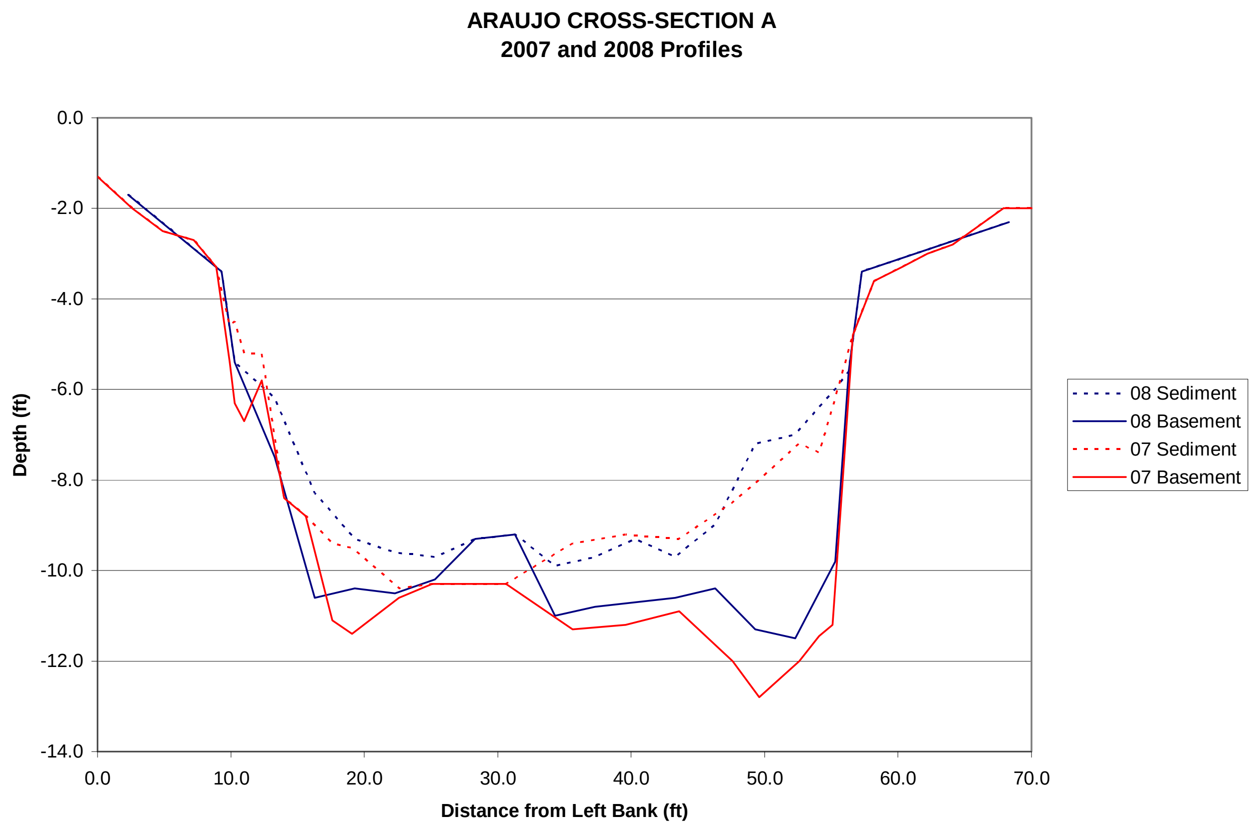
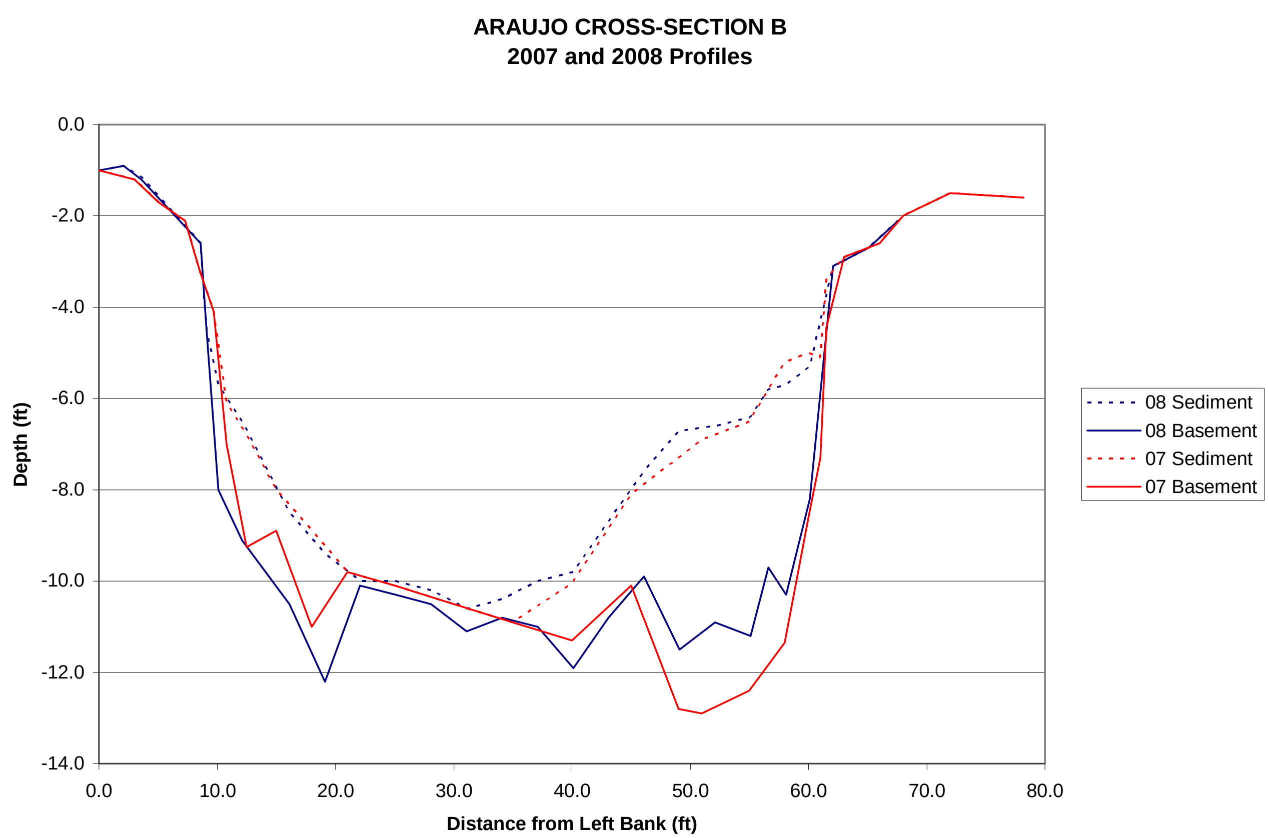
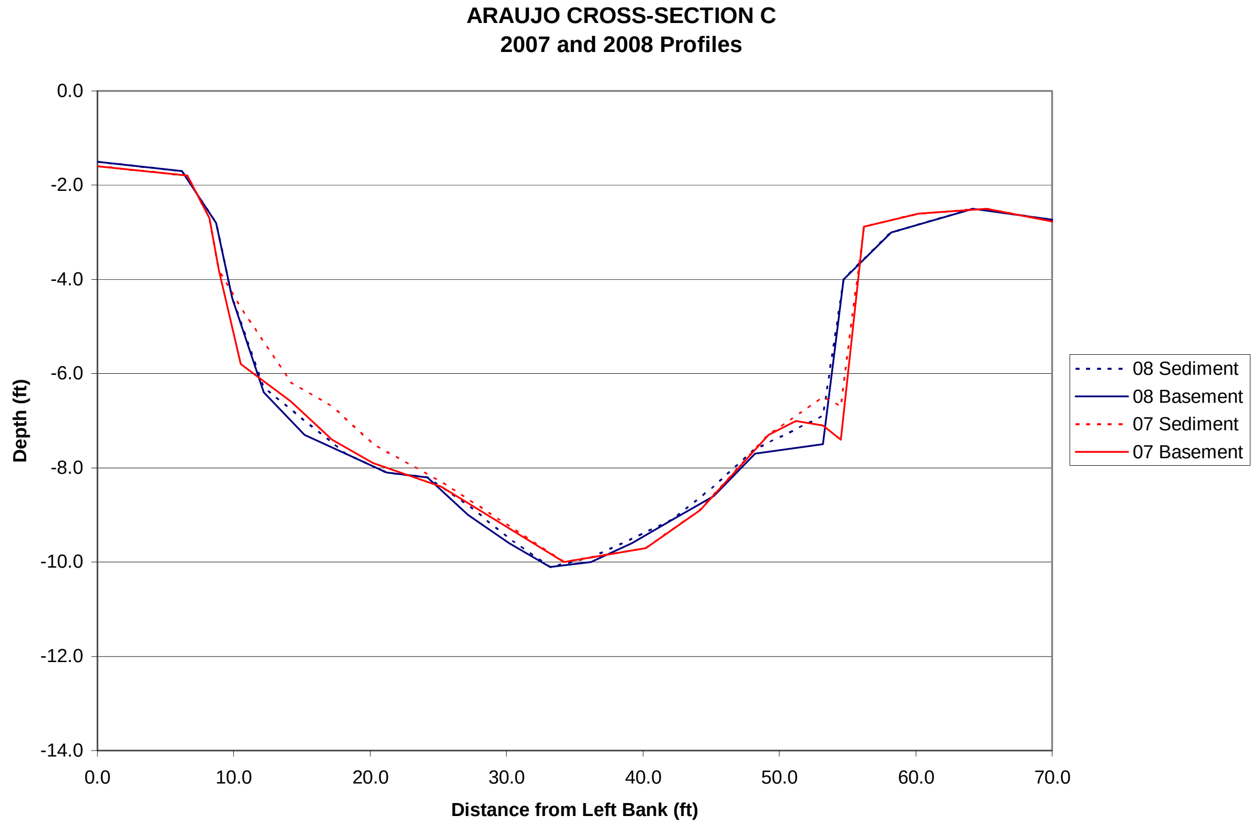
07/21/08
07/23/08
07/25/08
07/27/08
07/29/08
07/31/08


Site 4 - July 2008 Dissolved Oxygen Readings
and July 2007 DO Grab Sample
2008 Grab Sample: 7/10/08 05:00
2007 Grab Sample: 7/09/07 05:00
2008 Continuous Meter
2008 Grab Sample
2007 Grab Sample
Dissolved Oxygen (ppm)
0
2
4
6
8
10
12
14
16
18
20
22
07/01/08
07/03/08
07/05/08
07/07/08
07/09/08
07/11/08
07/13/08
07/15/08
07/17/08
07/19/08
07/21/08
07/23/08
07/25/08
07/27/08
07/29/08
07/31/08

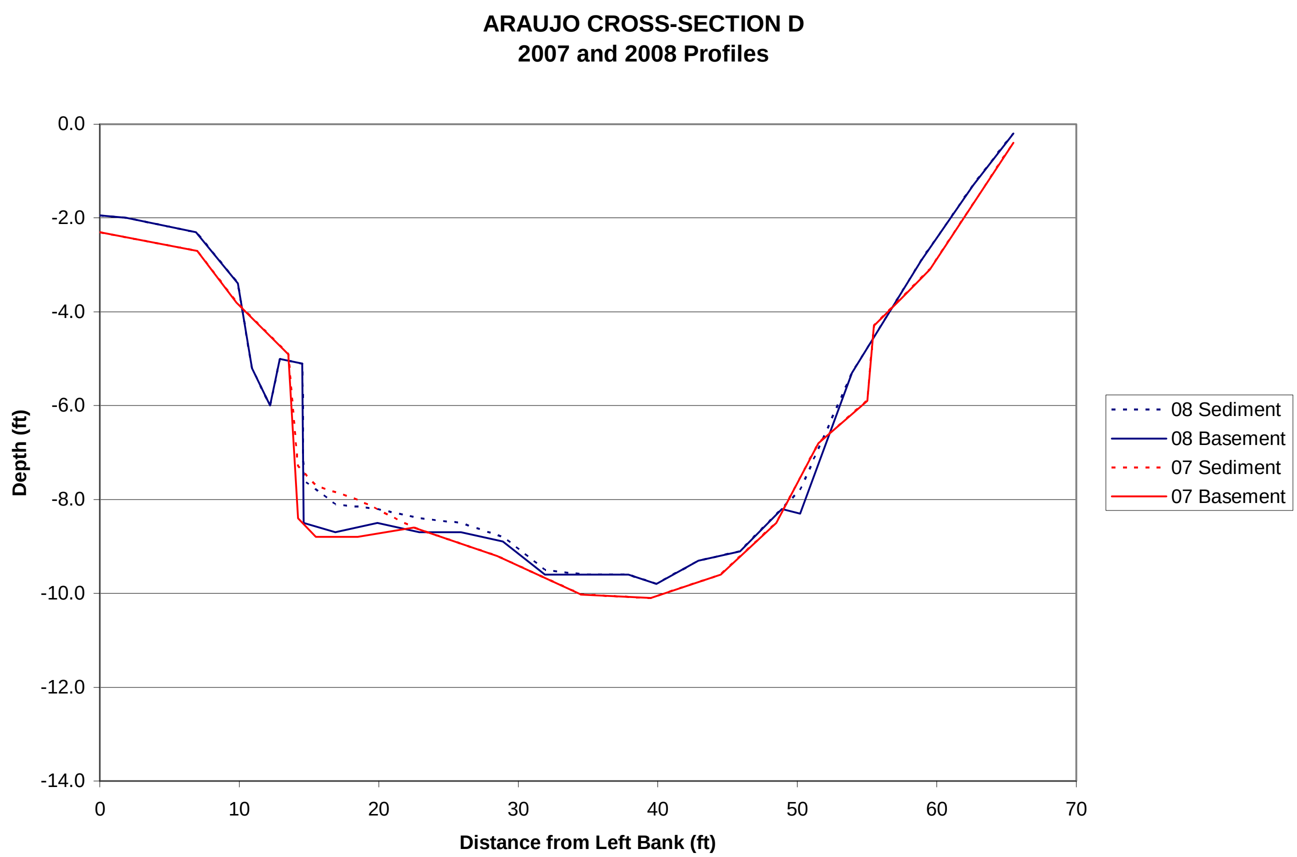
Appendix B. Channel Profiles at Cross-sections





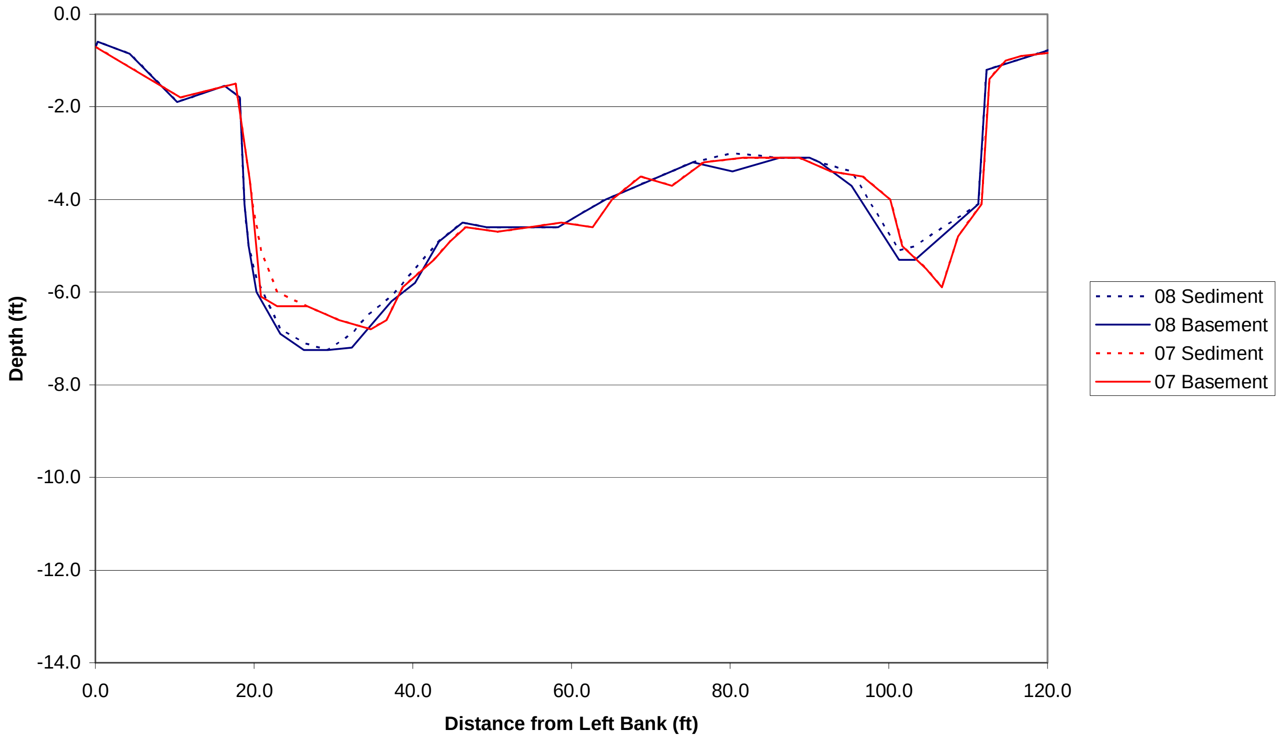


ARAUJO CROSS-SECTION C
2007 and 2008 Profiles
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
-14.0
Depth (ft)
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
Distance from Left Bank (ft)
08 Sediment
08 Basement
07 Sediment
07 Basement

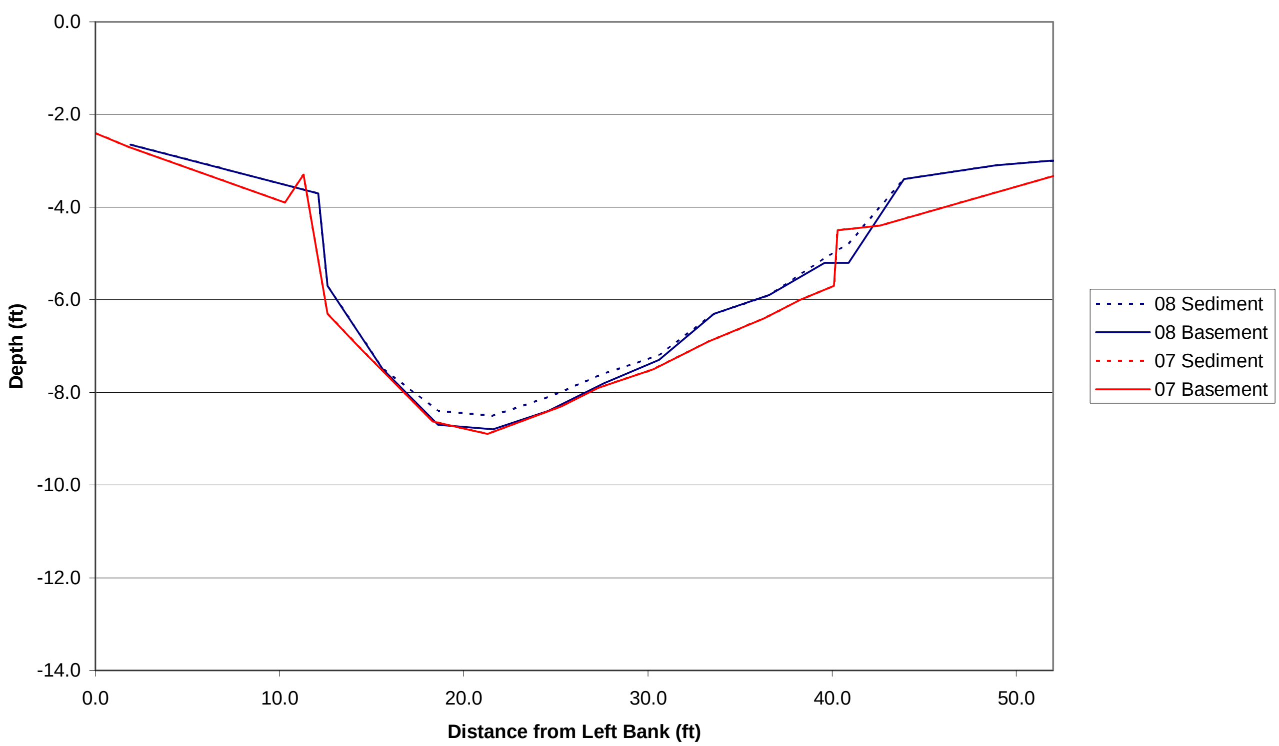


ARAUJO CROSS-SECTION D
2007 and 2008 Profiles
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
-14.0
Depth (ft)
0
10
20
30
40
50
60
70
Distance from Left Bank (ft)
08 Sediment
08 Basement
07 Sediment
07 Basement

ARAUJO CROSS-SECTION E
2007 and 2008 Profiles



ARAUJO CROSS-SECTION F
2007 and 2008 Profiles



Appendix C. Photo Monitoring 2007 and 2008

Photo Point 2: Downstream 2007 2008

Photo Point 2: Upstream 2007 2008

Photo Point 3: Downstream 2007 2008

Photo Point 5: Upstream 2007 2008