Kacie Jensen

From: Alison Guth
Sent: Wednesday, November 23, 2005 12:02 PM
To: 'Dan Tufford'
Subject: RE: WQ RG

Water Quality Study Requests.d...

Dan,
I apologize that it has taken me this long to get back to you. I have attached the Study Requests document to this email. This was the only other document passed out in this group besides the agenda and copies of Lee's presentation (which will be posted on the website soon). Thanks and hope to see you at future meetings.

Alison

-----Original Message-----
From: Dan Tufford [mailto:tufford@sc.edu]
Sent: Friday, November 18, 2005 3:50 PM
To: Alison Guth
Subject: WQ RG

Hello Alison,

I understand some documents were handed out at the WQ group meeting. I've looked for them on the web site and not found anything. Please send a copy to me. I prefer e-mail attachments versus paper if possible.

Regards,
Daniel L. Tufford, Ph.D.
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University of South Carolina
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Saluda Hydro Project Relicensing
Public/Agency Information and Study Requests to be Addressed in the Resource Conservation Groups

10/10/05 ACG

Water Quality

Study Requests:

- **Water Quality Studies:** Request of studies in order to assess the effects of Project operations on water quality, and consequently the aquatic habitat in the lake and river segments. Suggested studies include those to determine the effectiveness of newly installed hub baffles, TMDL's in Lake Murray, effects of project operations on summer habitat for striped bass including mitigative measures for fish kills, effects of operations on water temperature as affecting the spawning and recruitment of diadromous and riverine fish in the Saluda and Congaree rivers, and the effects of D.O. and water temperature on mussel populations in the LSR and Congaree. SCDNR recommends that water quality models be developed to identify any relationships between point and non-point pollutants and operations. The Lake Murray Association (LMA) and Lake Murray Homeowners Coalition (LMHC) specifically request information to be collected on cove water quality. The League of Women Voters suggests that water quality studies also include a facet on the impacts of power boats and jet skis on drinking water quality.

  Requested by: CCL/American Rivers, American Whitewater, City of Columbia Parks and Recreation, SCDNR, LMA, LMHC, League of Women Voters, LSSRAC, National Marine Fisheries Service, S.C. Parks Rec and Tourism, SC Council Trout Unlimited, USFWS

- **Sediment Regimen and Sediment Transport Studies:** A request has been made that a study be performed on the sediment regimen in the Project area as well as the Project effects on the sediment regimen of the lower Saluda River. Should include such things as sediment composition, bedload movement, gravel deposition, sediment storage behind dams, and bedload changes below the dam; and project effects on downstream geomorphometry, sediment availability and streambank erosion, and the possible addition of gravel to mitigate for project impacts. Also, the effects of the Project operations on habitat requirements for spawning fishes.

  Requested by: CCL/American Rivers, USFWS

Information Needs:

- **Aquatic Habitat Decline Model**: In order to understand the reasons and contributing factors of seasonal habitat decline associated with the combination of increasing water temperature and decreasing dissolved oxygen. Thus resulting in a decrease in available cool-water habitat for some species. This model would be developed to better understand the causative factors that result in habitat declines, and to evaluate scenarios that could reduce or eliminate this problem.

Requested by: SCDNR

- Request information that will help to a) forecast striped bass habitat reductions with new operational protocol implemented, and b) help develop an operational protocol to minimize impacts on striped bass habitat. ***SCDNR***

- Temperature profiles, on at least a monthly basis, at the unit intakes in the reservoir (specifically June-September) to have a better understanding of the relationship between project operations and water temperature and dissolved oxygen as they pertain to our management programs. ***SCDNR***

- We recommend that trends in water quality data associated with Lake Murray and the Lower Saluda River be reviewed and summarized. Special attention should be given to the stations and parameters that did not meet State standards or are declining. ***SCDNR***

- Marina water quality monitoring records in order to understand the degree of water quality impacts related to large multi-slip docking facilities. ***Lake Murray Homeowners Coalition***

- An updated report on the status of dissolved oxygen concentrations in the lower Saluda River and the efficacy of existing enhancement measures. **USFWS**

Requests for Potential Mitigation: None

Danielle Fitzpatrick

From: Alan Stuart

Sent: Thursday, March 09, 2006 7:04 PM

To: 'Amanda Hill (Amanda_Hill@fws.gov)'; 'Dick Christie (dchristie@infoave.net)'; 'Hal Beard'; 'Prescott Brownell (Prescott.Brownell@noaa.gov)'; 'gjobsis@americanrivers.org'; 'Patrick Moore'; 'Gina Kirkland - DHEC'; 'cdwood@usgs.gov'; 'Sarah W Ellisor'; 'Richard Roos-Collins'; 'Julie Gantenbein'

Cc: BARGENTIERI@scana.com; 'Jim Ruane'; RMAHAN@scana.com; 'Ray Ammarell (RAmmarell@scana.com)'; 'Steve Summer'; 'Tom Eppink'; 'Brian J. McManus'; 'BOWLES, THOMAS M'; Alison Guth; 'EPPINK, THOMAS G'

Subject: 2005 Monitor relocation report

Good evening all,

Attached to this email you will find the 2005 draft Monitor Relocation Report for the Saluda Hydro Project. If you have questions please give me a call and do not forget our meeting on March 23, 2006 to discuss this report and the 2005 Aeration Report. Also, I hope to get the results/report of this past years turbine testing to you by the first of next week.

regards,

Alan

****

Alan W. Stuart
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SALUDA HYDROELECTRIC PROJECT

2006 USGS MONITOR RELOCATION ASSESSMENT

DRAFT

MARCH 2006

SALUDA HYDROELECTRIC PROJECT

2006 USGS MONITOR RELOCATION ASSESSMENT

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2006 USGS MONITOR RELOCATION ASSESSMENT

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SALUDA HYDROELECTRIC PROJECT

2006 USGS MONITOR RELOCATION ASSESSMENT

DRAFT

MARCH 8, 2006

1.0 INTRODUCTION

Prior to and during the low DO period of 2005, SCE&G undertook the following tasks:

1. Installed hub baffles on Units 1 through 4 to increase the effectiveness of the turbine venting system at higher gate settings;
2. Conducted turbine venting tests so that the effectiveness of the hub baffles on aeration in Units 1 and 5 could be determined; and
3. Evaluated various locations in the tailrace to install long-term water quality monitor(s) for DO and temperature.

This document describes the results of the field study conducted for evaluating the best location(s) for a water quality monitor(s), i.e., the above Task 3.

2.0 BACKGROUND

The report on 2004 operations included some of the following observations on the current monitoring system:

1. The monitor readings have been rated good in the past by USGS, ± 0.3-0.5 mg/L;
2. The location is not considered to be representative for all conditions in the tailwater, i.e., it's biased towards the DO in the discharge from the unit that's operating that is on the left descending bank (LDB);
3. The objectives for the current USGS monitor do not include the purpose of providing monitoring for compliance-type comparisons to State instream water quality standards;
4. Photosynthesis and respiration by aquatic plants in the tailwater can affect in some years the DO level at the location of the monitor;

5. The USGS gage occasionally malfunctions for several days;
6. Fouling is a significant issue that affects the reliability of the data; and
7. SCE&G spot measurements during the 2004 study period were usually higher than the USGS monitor (see annual aeration report for the 2004 low DO period.).

The monitor location study conducted in 2005 was designed considering the site-specific characteristics of the Saluda Hydroelectric Project, approaches used at other projects, and guidance from the SC USGS office as well as national guidelines (USGS, 2000).

3.0 EVALUATION OF ALTERNATIVE MONITOR LOCATIONS

This section identifies and outlines the scope of work, procedures, and methods of work used for evaluating monitor locations in the tailrace at the Saluda Project. This test plan used for the study specified the Saluda plant operating conditions and identified measurements used to evaluate alternative monitor locations.

Eleven water quality monitors were deployed across three transects in the tailrace to collect information needed to evaluate alternative monitoring locations (Figure 1.) During two testing periods (November 1 and 3, 2005), there were a wide range of pre-defined operating conditions. November was selected for the monitor evaluation study because it is during this time that water quality in the releases from Unit 5 is likely to be different than in the releases from the other units. It was best to conduct this latter evaluation after DO and conductivity at the intake of Unit 5 was different than at the intakes for Units 1 through 4 so that mixing characteristics between the unit discharges could be measured. As described in the annual aeration reports for 2004 and 2005, the DO at the intake of Unit 5 increases several weeks before the DO at the intakes of Units 1 through 4. Also, since conductivity in the water column of the lake is greater near the bottom of the lake (due to releases of anoxic products from the lake sediments) where the Unit 1 through 4 intakes are located, the conductivity in the releases from Unit 5 is lower.

The operating conditions are presented in Table 1. The operating conditions used for testing took into account the units that experienced outages, and the units were operated over a range of gate settings. These gate settings allowed the monitor locations to be evaluated for generation operating conditions at the Saluda Project. It should be noted that some of the runs were conducted with the air valves closed on one of the units to allow a more thorough evaluation of mixing in the tailrace, however, under normal operations when SCE&G would be aerating the discharges from the plant, none of the air valves would be closed and there would not be as much difference in DO in the tailrace as indicated by these test results.

For the purpose of this study, it was assumed that there were three potential monitoring schemes that could be used at a selected location in Saluda tailrace:

1. Two monitors could be used, one each on the LDB and RDB;
2. A multi-port intake pipe or a multi-pipe intake system could be installed across the tailrace and water could be pumped to one monitor on the stream bank; and
3. Multiple monitoring points could be used across the tailrace.

4.0 PLANT OPERATING MEASUREMENTS

During the two tests, the following information was recorded frequently enough to track conditions for each run:

- Wicket gate position for each unit operating;
- The settings on the air supply valves; and
- Discharge for each unit operating (for selected runs).

Water depth at the transects also was recorded at one-minute intervals using level loggers.

5.0 WATER QUALITY MEASUREMENTS

During the monitor location study, 24 hours per day, the following information was recorded in the tailwater at one-minute intervals:

- DO
- Conductivity
- Temperature

These data were collected using autologging water quality monitors that were placed in the tailrace for the duration of the study. The water quality monitors were placed in line with three transects across the tailrace (Figure 1):

1. One transect immediately downstream from the turbulent upwelling areas of the turbine discharges where the water flows downstream away from the powerhouse—one monitor each approximately below Units 1, 2, 3, and 5;
2. One transect across from the current USGS water quality monitor location—one monitor each at approximately one-third points across the channel, plus another monitor located next to the USGS monitor about 5% of the width of the river from the descending left bank (LDB); and
3. An intermediate transect between the above two transects—with two monitors located about 25% of the width from the RDB and LDB and another monitor located at the midpoint.

In addition to the deployed monitors, transects of DO, conductivity, and temperature were collected across the tailrace during each run using a rapid-measuring DO instrument after flow and water quality stabilized. Transect data provided information on how DO and conductivity varied across the entire tailwater including the areas where the water quality monitors were not deployed. These transect profiles provided the ability to determine the average DO for the transect using about 20-40 measurements for each transect profile.

Figure 1: Aerial View of Tailrace with Locations of Transects and Deployed Monitors

6.0 DATA ANALYSES

The results of the tests are summarized in Figures 2 through 13 (also see Table 1 and Figures T1-T15 in appendices). Figures 2 through 7 present the results of the deployed monitors at each transect, for each run, and for each day that tests were conducted. Figures 8 through 13 present comparisons of results between transects for three monitoring approaches (the means of boat measured transects, 3 to 4 deployed monitors at each transect, the LDB-RDB monitors at each transect) and comparisons of results at each transect using these same three monitoring approaches. Table 2 presents a summary of the responsiveness of measurements at transects 2 and 3 to changes in operations at the powerhouse.

Graphical observations are as follows:

1. At transect 1 on November 1 (see Figure 2), the DO recorded by the two T-N1, N2 monitors varied significantly when more than one unit was operating (see runs 2, 3, 5, 7, 9), probably due to high turbulence in the tailrace and the mixing of different unit discharges—single monitors and single port intake pipes would not be advised in this area.

2. The minimum DO values recorded by the two T-N1,N2 monitors were as low as 1 to 2 mg/L during runs 3, 5, 7, and 8 but the minimum DO values recorded by the boat monitor were near 3 mg/L during these runs (see Figures 2 and 11 and T-3,5,7,8, and Table 1). A review of the minimum recorded DO levels at transects 2 and 3 do not indicate a systematic difference between results the boat monitor and the deployed monitors. These results indicate that vertical mixing was incomplete at the location of transect 1.
3. At transect 3 (see Figures 4 and 7) the variability in recorded DO measurements by all monitors dampened significantly indicating that vertical, lateral, and longitudinal diffusion resulted in mixing of the turbulent waters noted at transect 1, even though complete lateral mixing had not yet occurred.
4. The monitor at T3-pipe (adjacent to the USGS monitor) was consistently the last monitor to respond (see Figures 4 and 7) to changes in operations at the powerhouse (see runs 1,2,3,6,7,8,9,10,11,12,14,15.) For several of these runs, this monitor had not even stabilized by the time the run was terminated. One reason for this slow response might be that the monitor is incased in a pipe where water exchange rate is much less than for monitors placed in-situ. Another reason for this slow response can be seen by reviewing the aerial photograph of the tailwater and tracing the predominant water currents that would occur in a system like this. As the turbine discharges leave the powerhouse, the flow goes straight in the direction of the LDB, passes downstream along the LDB, passes through the narrow passage between transects 2 and 3, and then flows predominantly towards the RDB as it passes transect 3. Streamflow lines in this depiction of predominant flow patterns would indicate slower water currents at the location of the USGS monitor, thus the slower response time to changes in operations at the powerhouse.
5. Figure 8 presents the mean values of all the DO monitors used in the boat transects for each run. These results show that the mean values from all three monitor locations studied for all the runs were similar without any systematic deviations. These results indicate that the values of low DO measured by some of the deployed monitors at T1 apparently did not represent significant masses of water.

6. Figure 9 presents the mean values of all the deployed DO monitors used at the transects for each run. These results show that the mean values from T1 demonstrated systematic lower values compared to the other locations. As discussed above some of the monitors at T1 indicated that this location was not completely mixed vertically. Complete vertical mixing likely occurred a short distance downstream, i.e., within a few hundred feet.
7. Figures 8, 9, 12, and 13 show that there was a predominant pattern of the boat measured DO values being slightly greater than DO values recorded by the deployed monitors (i.e., the difference in mean DO values for all runs at T3 between the boat measurements and the measurements by the deployed monitors was 0.3 mg/L.) The reason for this difference is not known, but might have been caused by less fouling of the monitor used in the boat. Another reason might have been that the boat monitor measurements were more accurate since this approach involved 4 to 5 times as many measurements as the deployed monitors and represented more of the cross-sectional area of the transect.
8. Figures 10, 11, 12, and 13 present the results of using the mean values of the LDB and RDB monitors compared to the other monitoring approaches. It appears that results at T3 were acceptable, but that results at T1 indicated that monitors at LDB-RDB differed from the means of all deployed monitors greater than 0.5 mg/L on four occasions (i.e., runs 7,8,14, 15).
9. Minimum DO values recorded within transect measurements at T3 varied within the cross-section depending on operations at the powerhouse, i.e., sometimes minimum DO values were near the LDB, sometimes near RDB, and sometimes near the middle of the channel (see Figures 2 through 7 and T-1 through T-15). When aeration capability is fully implemented in the future, these same minimum DO patterns might occur but variations in DO would be much less in magnitude. Operational procedures and operational monitoring would eliminate or significantly reduce the occurrence of minimum DO values within the cross-section.

10. The response times for DO monitors to reach a steady reading after changes in operations at the powerhouse are shown in Table 2. On average the monitors at T2 responded in about 8 minutes whereas those at T3 (not including T3-pipe) responded in about 18 minutes. The maximum response times were 12 minutes at T2 and 25 minutes at T3. The minimum response times were 4 minutes at T2 and 12 minutes at T3 The average, maximum, and minimum response times at T3-pipe were 45, 60, and 20 minutes, respectively. An examination of the gate settings for the runs in Table 1 and corresponding response times in Table 2 shows that the amount of flow through the powerhouse is a major factor affecting response times at T2 and T3. Due to the variability in flow and unit operations at the Saluda Project, more responsive and frequent operational monitoring would likely be needed to help maximize water quality so that the standards would be attained.

Table 1: Operating Conditions During Runs

Operating Conditions during the Monitor Location Study								
Run #	Day	Recorded Time (Beginning of Flow)	Recorded Time (End of Flow)	Level Logger Time (Beginning of Flow)	Level Logger Time (End of Flow)	Operating Conditions	Actual Gate Settings	Aeration Bypass Valves
1	01-Nov-05		10:25 AM	9:33 AM	10:36 AM	U5 - 40%	37	Open
2	01-Nov-05	10:40 AM	11:13 AM	10:38 AM	11:17 AM	U1 - 50%, U5 - 40%	50 / 37	Unit 1 Closed
3	01-Nov-05	11:20 AM	11:46 AM	11:19 AM	11:56 AM	U1 - 80%, U5 - 40%	80 / 37	Unit 1 Closed
4	01-Nov-05	11:58 AM	12:22 PM	11:58 AM	12:35 PM	U1 - 50%, U5 - 80%	50 / 74	Unit 1 Closed
5	01-Nov-05	12:39 PM	1:08 PM	12:39 PM	1:18 PM	U2 - 50%, U5 - 80%	na	Unit 2 Closed
6	01-Nov-05	1:19 PM	1:55 PM	1:20 PM	1:59 PM	U5 - 80%	na	Open
7	01-Nov-05	2:10 PM	2:40 PM	2:02 PM	2:43 PM	U2 - 80%, U5 - 40%	80 / 39	Unit 2 Closed
8	01-Nov-05	2:41 PM	3:08 PM	2:44 PM	3:11 PM	U2 - 50%, U5 - 40%	na	Unit 2 Closed
9	01-Nov-05	3:08 PM		3:19 PM	3:57 PM	U1, U3 - 50%, U5 - 40%	na	Unit 1 Open Unit 3 Closed
10	03-Nov-05	8:01 AM	8:50 AM	7:57 AM	8:53 AM	U1 - 2200 cfs	70	Open
11	03-Nov-05	8:57 AM	9:22 AM	8:53 AM	9:27 AM	U1, U2 -2200 cfs each	70 / 70	Open
12	03-Nov-05	9:35 AM	9:56 AM	9:32 AM	9:58 AM	U1, U2, U3 - 2200 cfs each	70 / 70 / 70	U3 Closed
13	03-Nov-05	11:06 AM	11:30 AM	11:02 AM	11:33 AM	U1,U3 - 2200 cfs each U5 - 6000 cfs	70 / 70 / 76	U3 Closed
14	03-Nov-05	10:05 AM	10:25 AM	9:59 AM	10:36 AM	U1, U2, U3 - 2200 cfs each U5 - 6000 cfs	70 / 70 / 70 / 76	U3 Closed
15	03-Nov-05	10:41 AM	10:57 AM	10:37 AM	11:00 AM	U1, U2, U3 - 3200 cfs each U5 - 6000 cfs	95 / 97 / 95 / 76	U3 Closed

Table 2: Responsiveness of Monitor Locations to Operations at Saluda Powerhouse

RUN NUMBER	TRANSECT 2 MINUTES	TRANSECT 3 (Excluding T3-Pipe) MINUTES	T3-PIPE MINUTES
1	6	20	60
2	9	25	60
3	8	18	45+
4	8	15	35
5	10	15	45
6	10	20	37
7	9	16	38
8	7	15	45
9	11	19	na
10	8	22	65
11	10	20	na
12	12	17	na
13	5	12	20
14	4	13	na
15	na	na	na
Averages	**8**	**18**	**45**
Maximum	**12**	**25**	**60**
Minimum	**4**	**12**	**20**

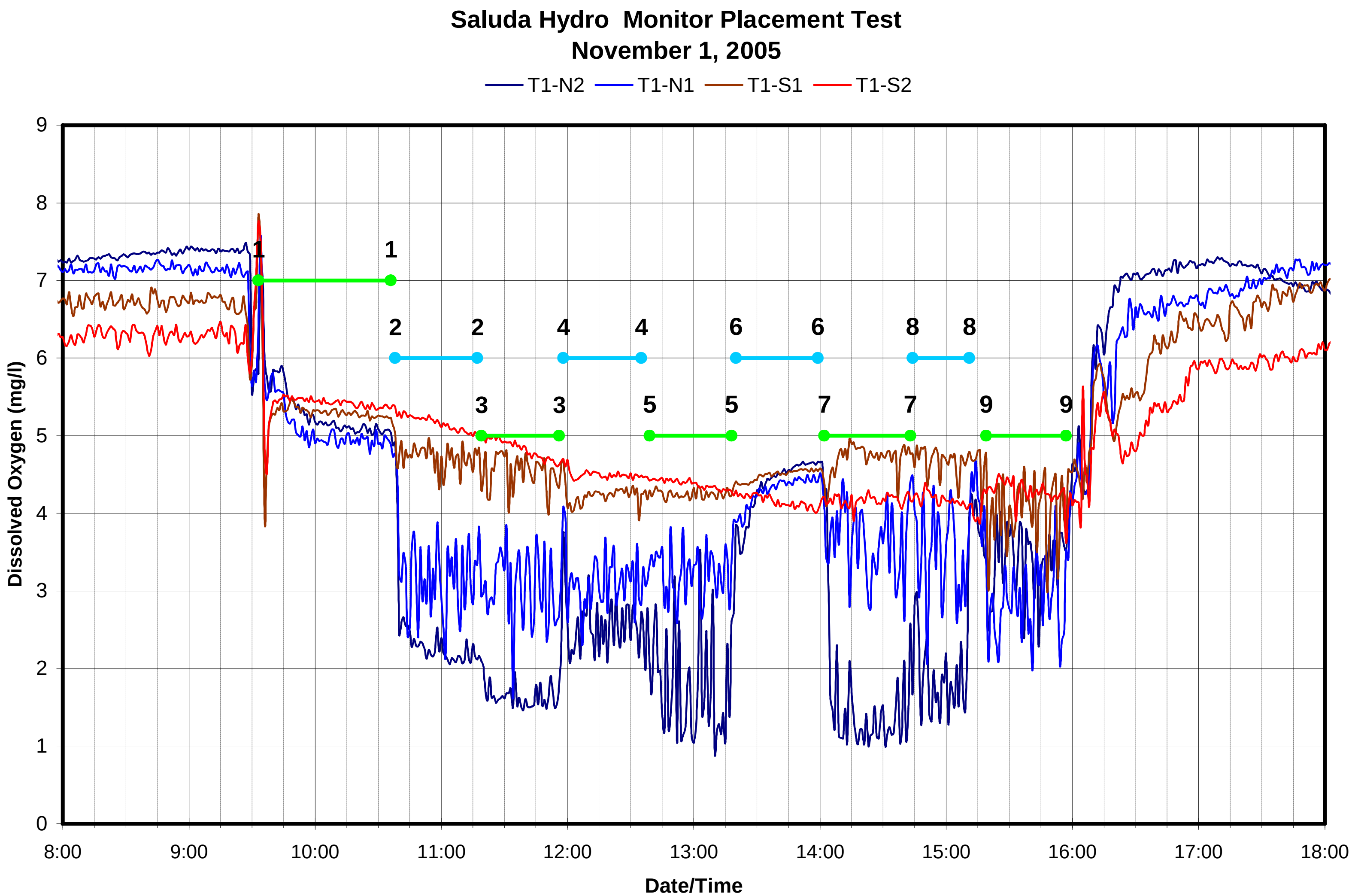


Figure 2: Results of Deployed DO Monitors at Transect 1 for Runs 1-9, November 1

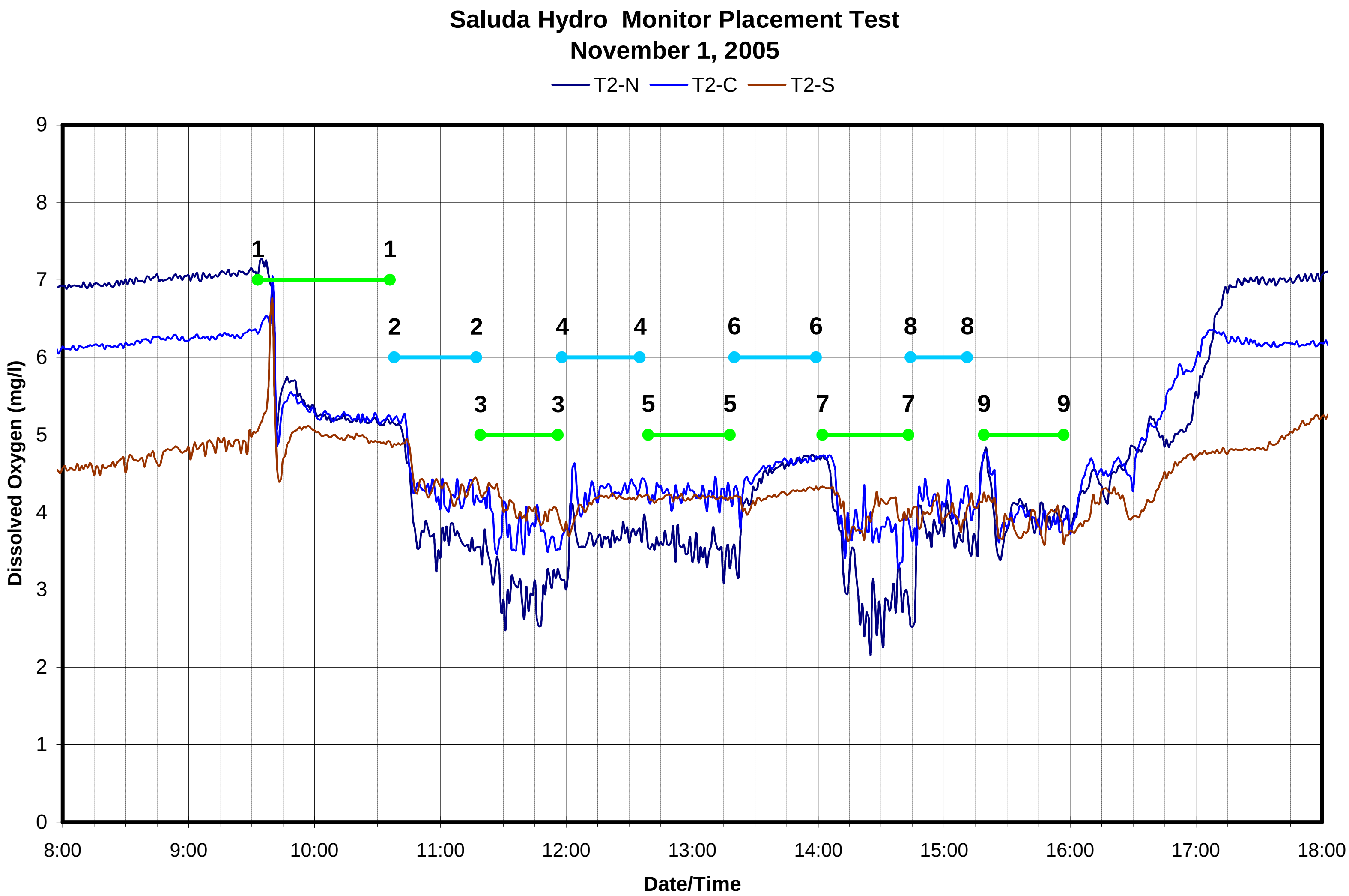


Figure 3: Results of Deployed DO Monitors at Transect 2 for Runs 1-9, November 1

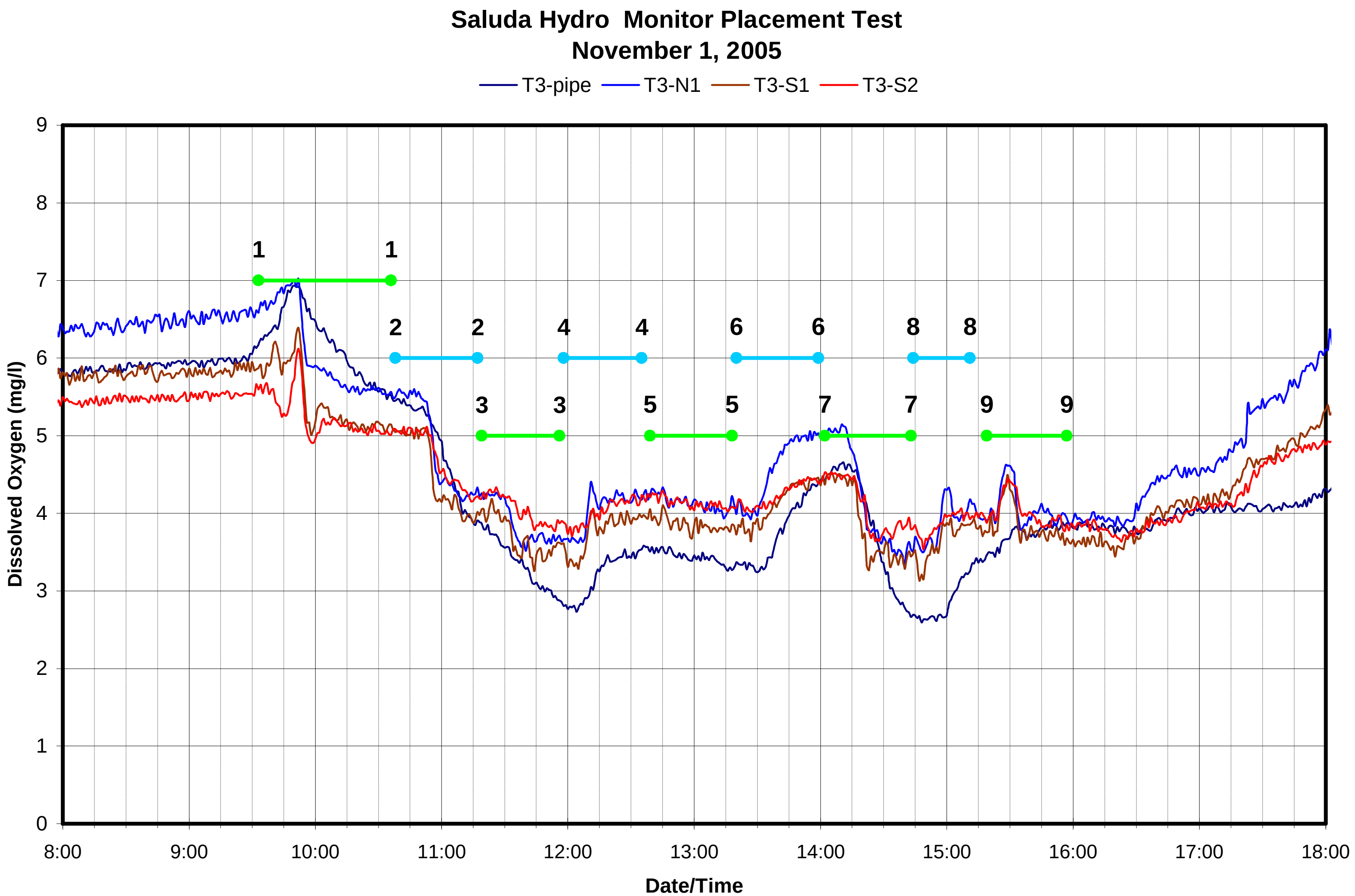


Figure 4: **Results of Deployed DO Monitors at Transect 3 for Runs 1-9, November 1**

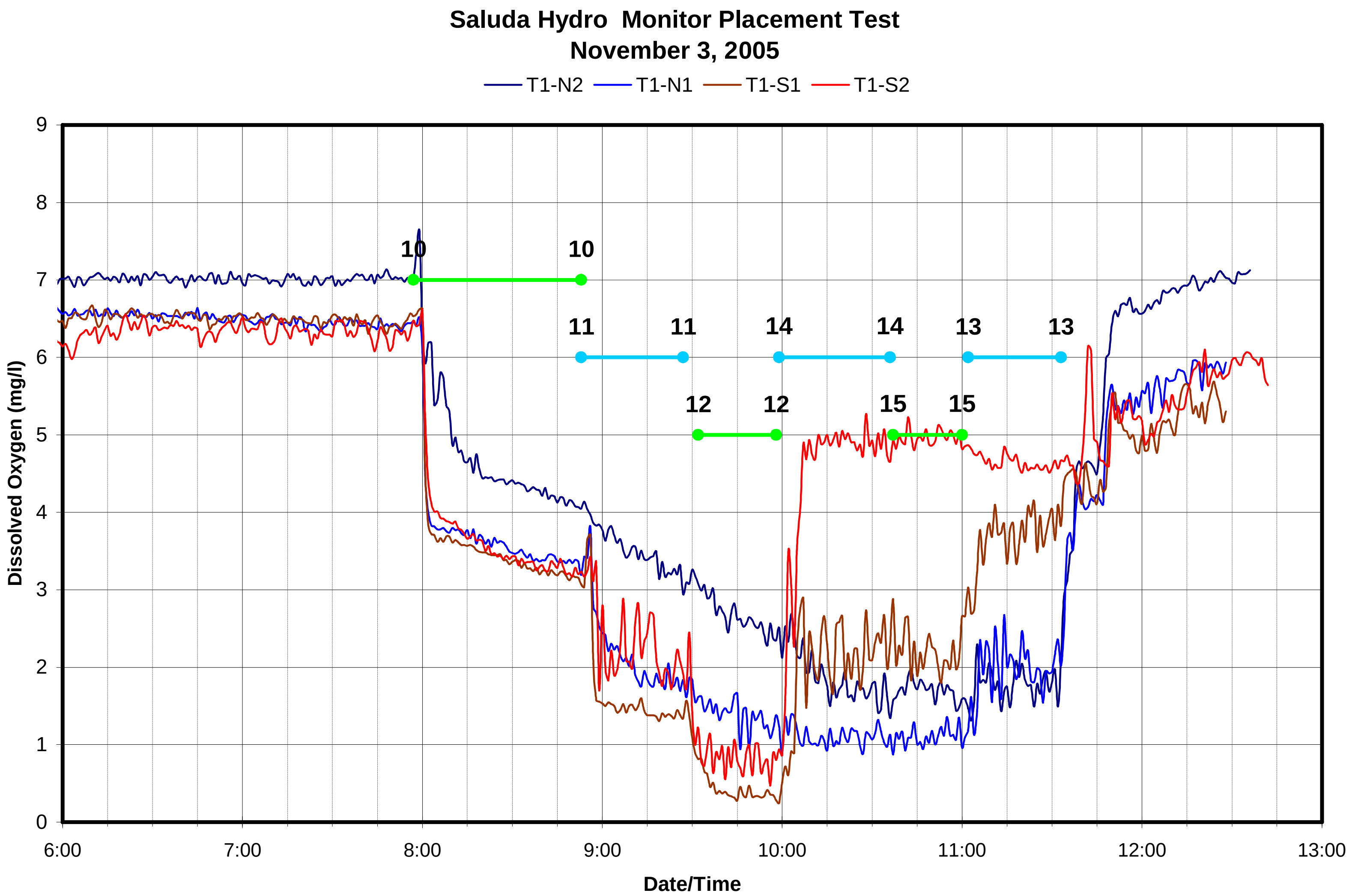


Figure 5: **Results of Deployed DO Monitors at Transect 1 for Runs 10-15, November 3**

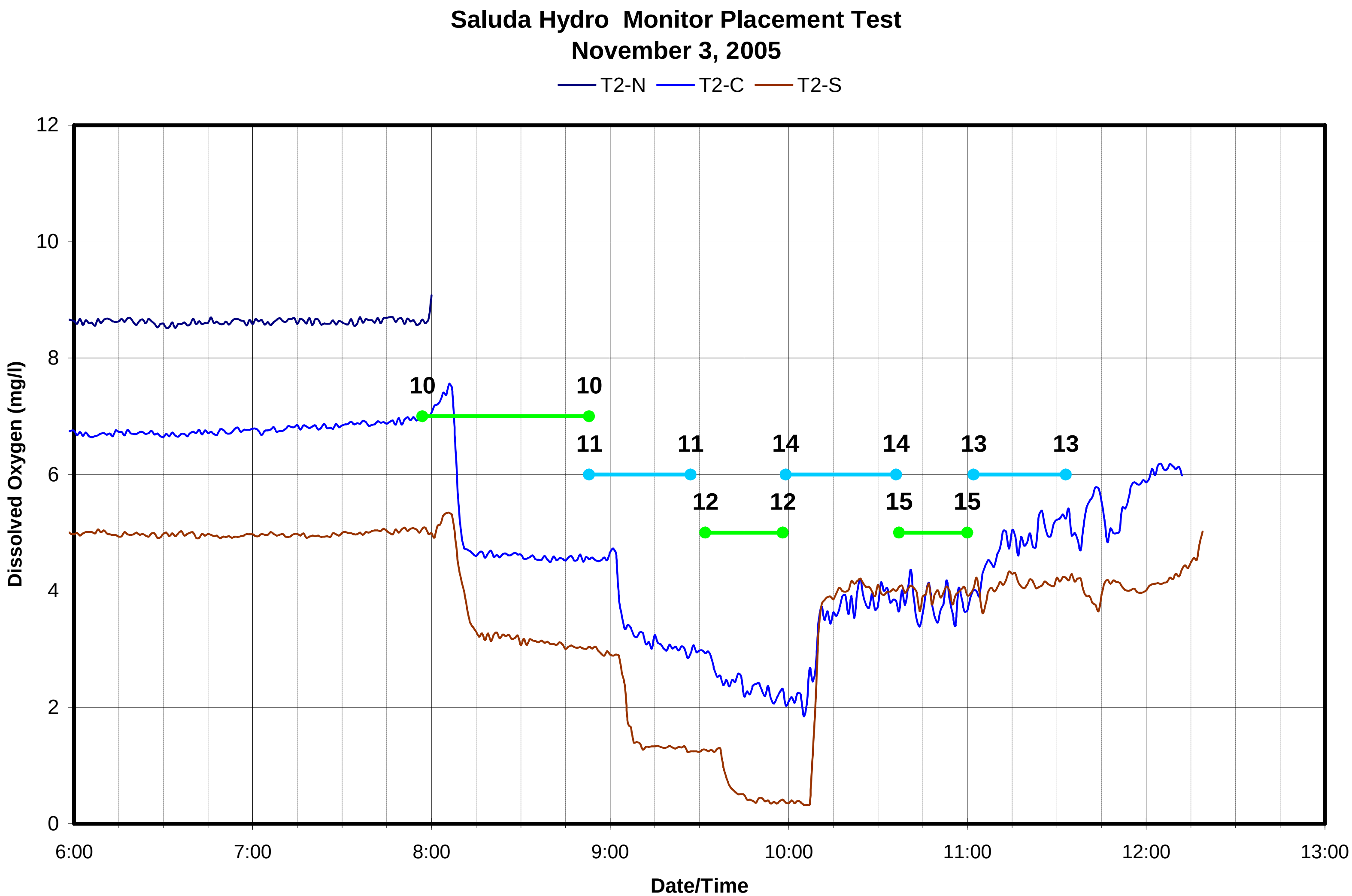


Figure 6: **Results of Deployed DO Monitors at Transect 2 for Runs 10-15, November 3**

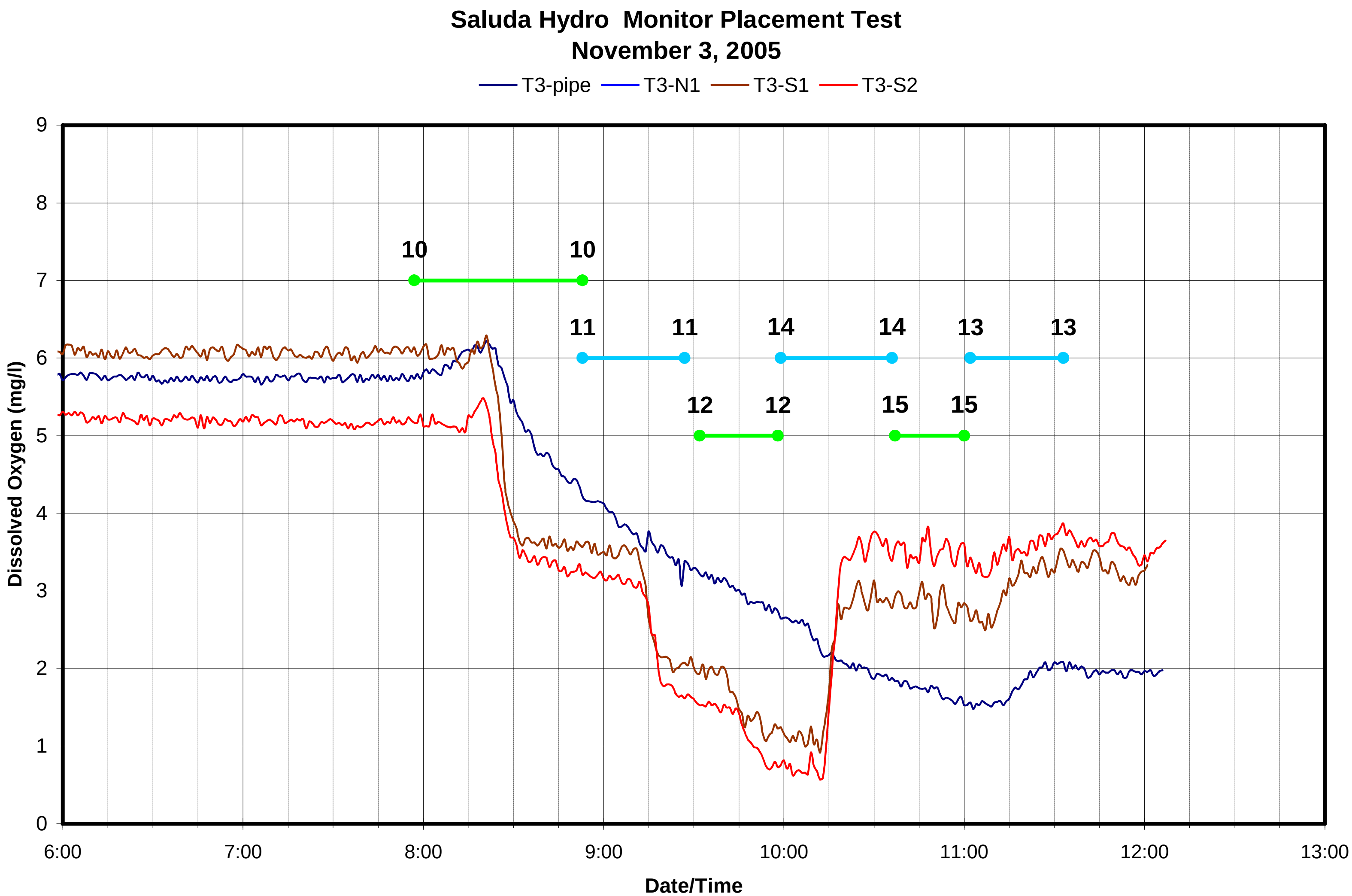


Figure 7: Results of deployed DO monitors at transect 3 for Runs 10-15, November 3 (note: N1 was not monitoring)

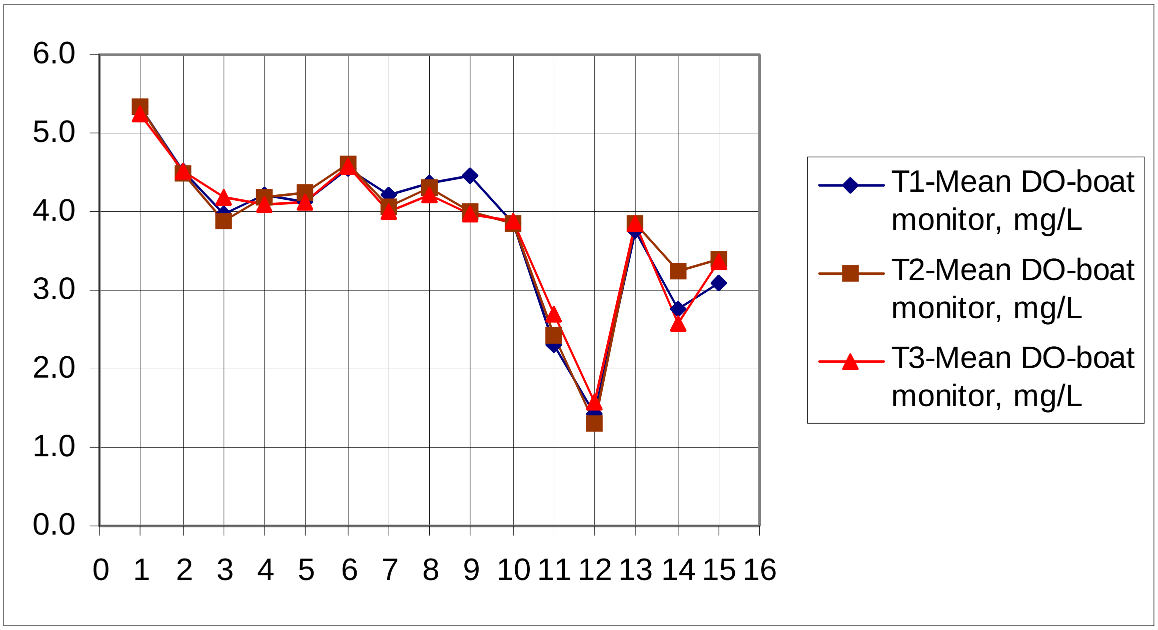


Figure 8: **Mean Values of DO Monitors Used in Boat Transects for Each Run**

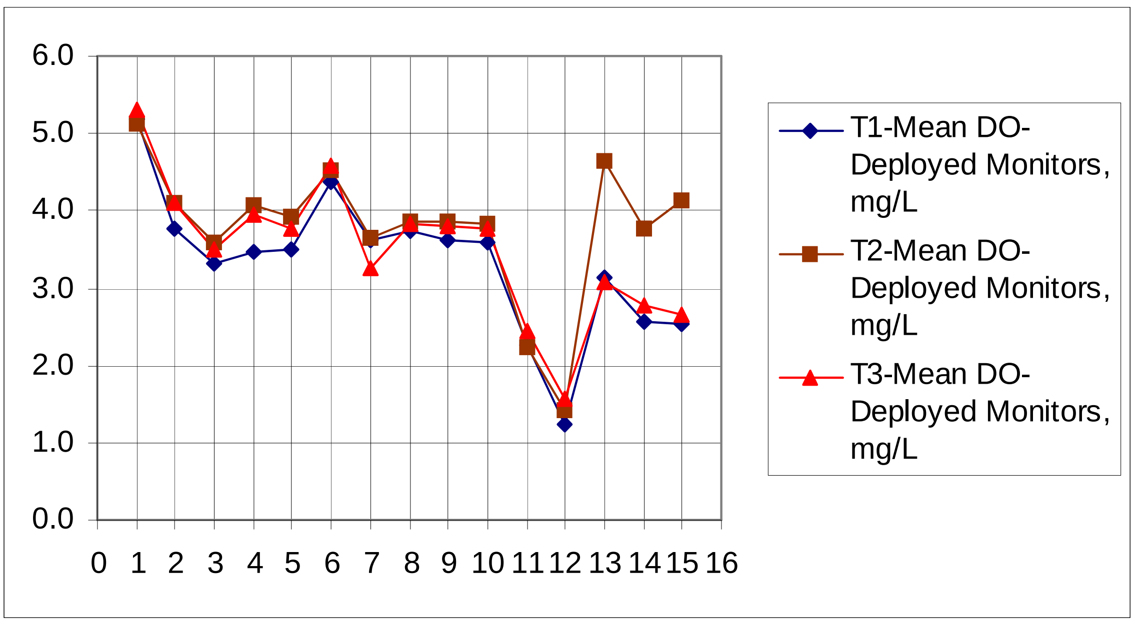


Figure 9: **Mean Values of Deployed DO Monitors at Each Transect for Each Run (note that one of the deployed monitors at T2 was not operating for runs 10-15 so results for runs 13,14,15 should not be compared to the results for T1 and T3)**

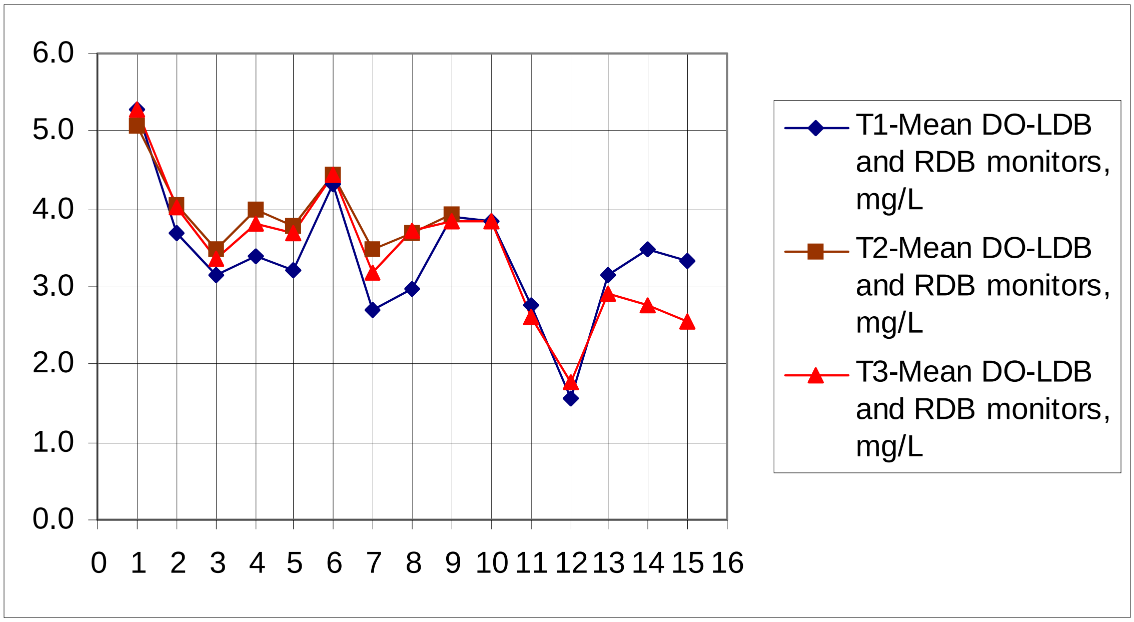


Figure 10: **Mean Values of Deployed DO Monitors on the LDB and RDB at Each Transect for Each Run (note that values were not available for T2 for runs 10-15)**

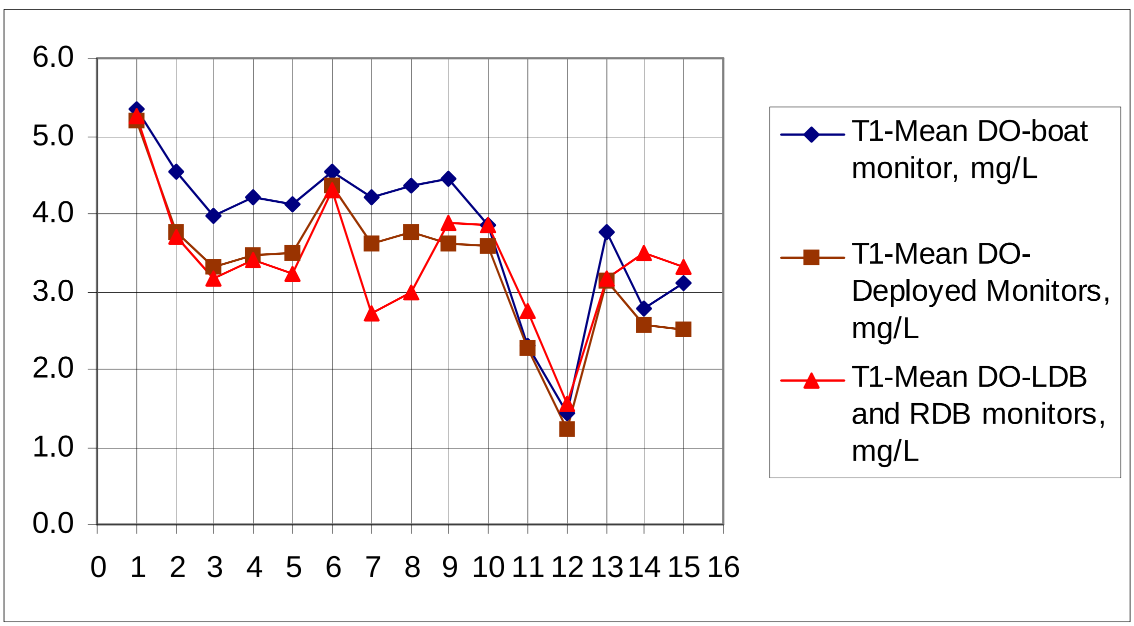


Figure 11: **Mean Values of DO Monitors Used in Boat Transects, All Deployed DO Monitors, and Deployed DO Monitors on LDB and RDB at Transect one for Each Run**

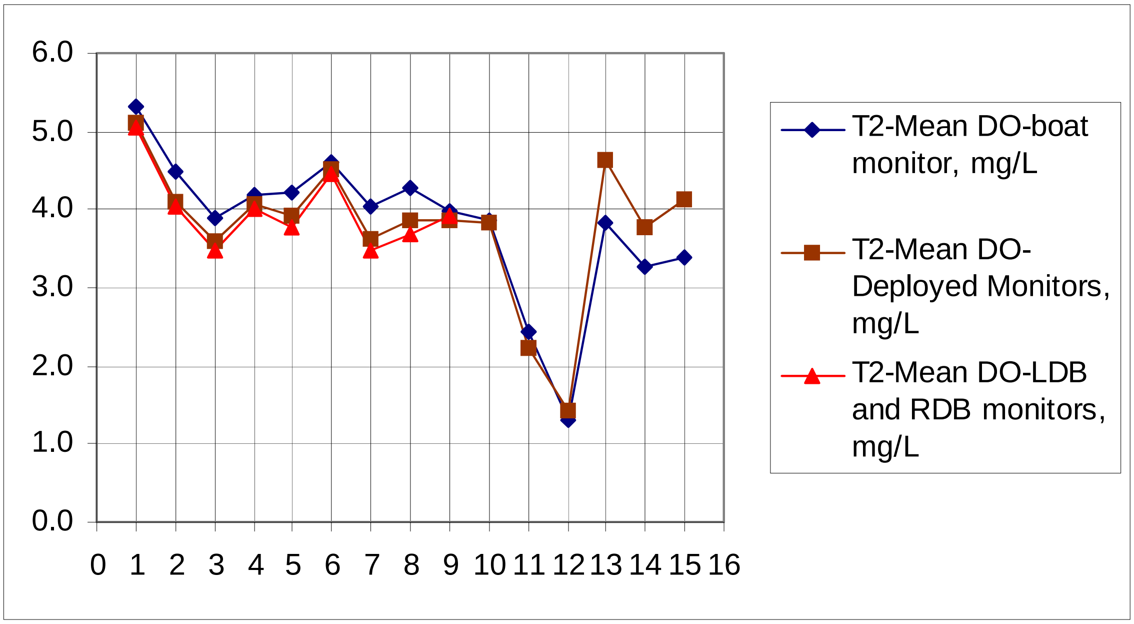


Figure 12: Mean Values of DO Monitors Used in Boat Transects, All Deployed DO Monitors, and Deployed DO Monitors on LDB and RDB at Transect Two for Each Run

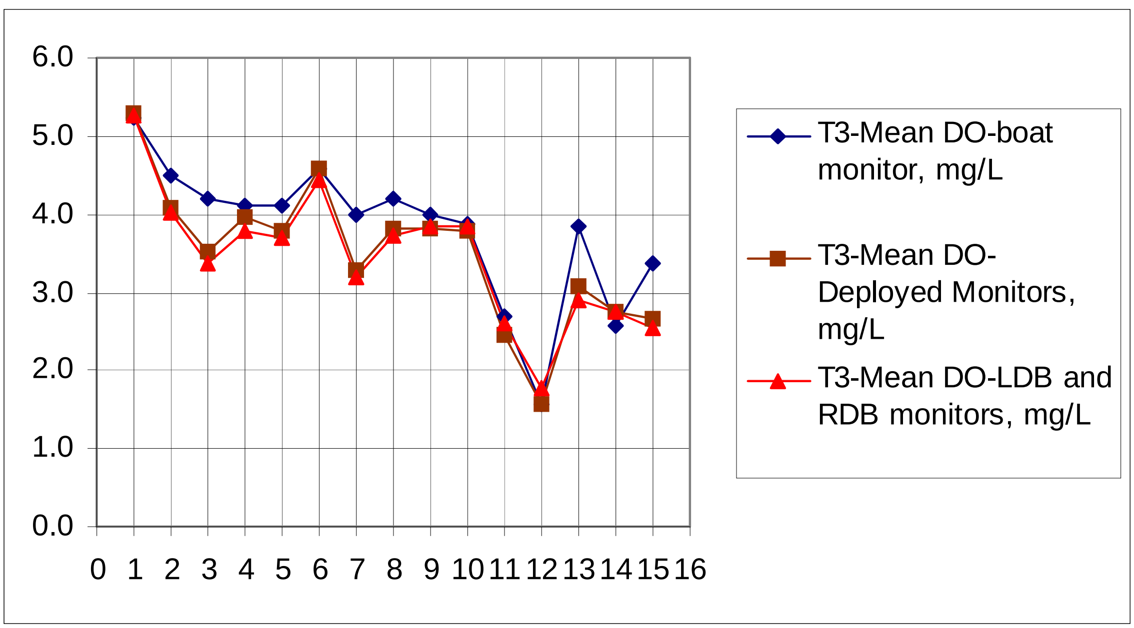


Figure 13: Mean Values of DO Monitors Used in Boat Transects, All Deployed DO Monitors, and Deployed DO Monitors on LDB and RDB at Transect Three for Each Run (note monitor T3-N1 did not record data during runs 10-15)

6.1 Effects of Aquatic Plants on DO Monitoring

Studies conducted in 2003 revealed the effects of aquatic plants on DO monitoring results at the current monitor. Figure 14 shows the effects that respiration by plants had on DO in the early morning hours. The effects of respiration by plants on DO should be minimized in designing a system for instream water quality monitoring. At some locations around the country, the effects of plant respiration have been documented to have caused the minimum DO to decrease to less than 4 mg/L (e.g., Holston River in Tennessee, Catawba River in NC and SC, North Platte River in NE).

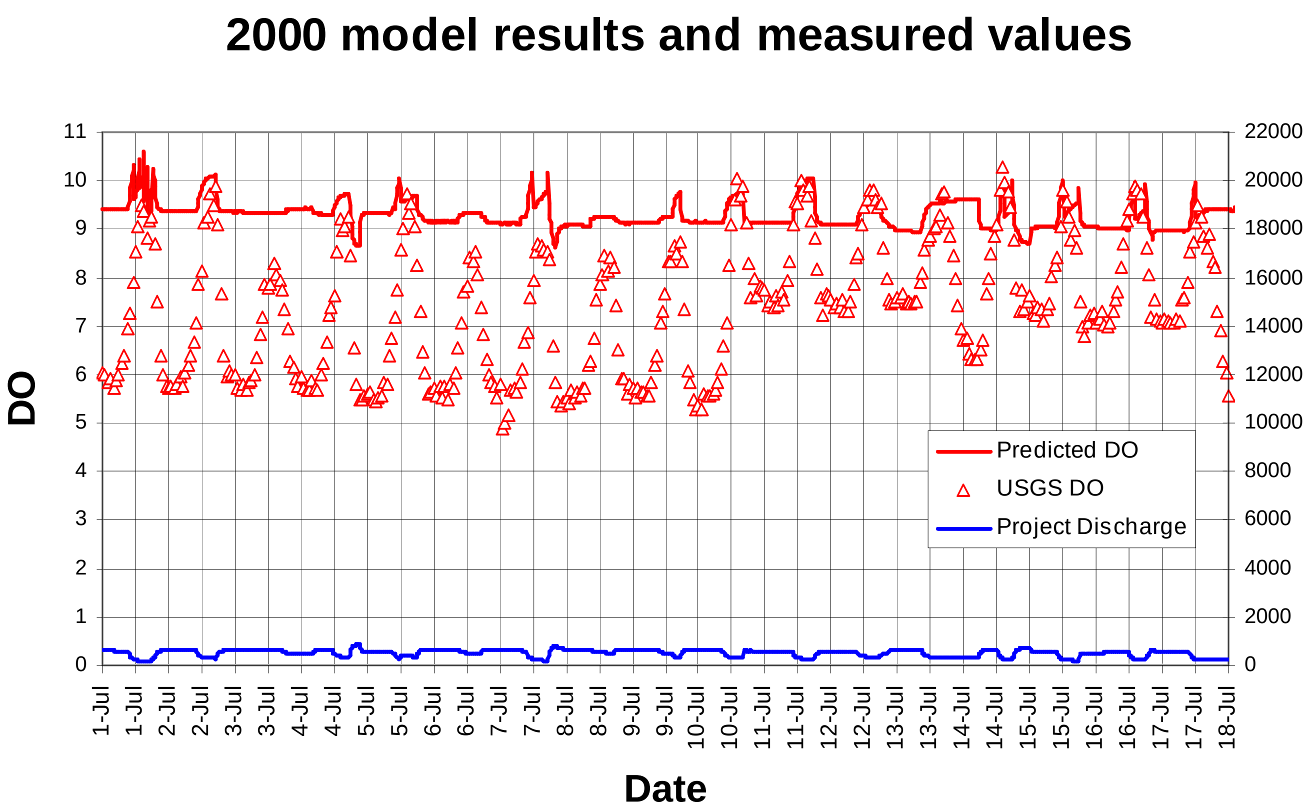


Figure 14: (Figure C-21 in 2003 Report on the Site-Specific DO Standard) Turbine Aeration Model Predictions for Discharges from Saluda Hydro Compared to Data from the USGS Monitor Downstream from the Dam – Showing the Effects of Respiration of the Aquatic Weeds on Measured DO During Early Morning Hours and Low Flow Conditions

6.2 Considerations for Selecting a Monitoring Location and Approach

There are a number of considerations when selecting a monitoring approach:

1. Instream water quality monitoring versus operational monitoring—each monitoring purpose has its own needs.
2. Instream water quality monitoring is for evaluating consistency with the water quality standards, which is linked to the protection of the aquatic life in the river.
3. Operational monitoring is for operating aeration systems and plant operations to enhance the probability that the instream water quality will conform to all elements of the water quality standard.
4. What is the most important variable to monitor protection of aquatic life, the mean DO at the instream water quality determination point (i.e., the location of a transect) or the minimum DO within the cross-section? The answer is the mean DO at the instream water quality determination point. The mean represents the mass of water moving downstream from the instream water quality determination point, whereas the minimum value represents only a small portion of the cross-section and a transient condition that occurs only periodically and continues only a short distance before mixing with water having higher DO and attaining the mean DO as measured at the instream water quality determination point. Minimum DO can occur at any location within a cross-section depending on unit operations and aeration of individual units. There is not a single-point location where a monitor can be placed to ensure accurate measurement of overall water quality vs. water quality criteria under all operations. For example, a LDB monitor at T3, only, would not always monitor the lowest DO.
5. The best location to monitor DO from an operational standpoint would be the first location downstream from the powerhouse where DO is mixed vertically in the water column, especially before aquatic plants can affect DO in the tailwater. Even with the most commonly used aeration method (i.e., turbine venting), there is still mixing and aeration in the tailrace even if only one unit is operating.

6. Under current operating conditions, response time is not too important since Saluda is not equipped with remote operating monitors and controls for the aeration systems now in place. However, when future aeration control systems may be in place, response time would be more important so that the systems could enhance the probability that the instream water quality will conform to the DO standard.
7. Due to the variability in flow and unit operations at the Saluda Project, more responsive and frequent operational monitoring would likely be needed to help maximize water quality so that the DO standards would be substantially attained.
8. Cost—initial installation and long-term maintenance. These considerations are important, but were not considered in this study.

6.3 Conclusions and Recommendations

- A DO monitoring system supplied with water from the river using a multi-port intake pipe or a multi-pipe intake system would provide the best measure of representative DO in the river. This approach is much less subject to bias than considering any one location in a cross-section, and it represents a more robust measurement of DO in the system than any other approach. This approach would produce a mean of 10-20 “measurements” in the cross-section and would be more accurate for mean DO measurements at a cross-section than a limited number (three or four) of monitors.
- The best location for an operational monitor is a short distance downstream from Transect 1. This location would be more responsive and minimize the effects of respiration by aquatic plants.
- An alternative location and monitoring approach could be a LDB-RDB monitor setup or multi-port intake pipe (or multi-pipe intake system) at the site of the USGS gage. This alternative may be more attractive for the current aeration and operational capabilities as well as considering costs and time for implementation.

- Future monitoring could be supplemented by operational monitoring of air flows to the units.
- After picking a monitoring location, velocity/flow profiles should be conducted to get the flow distribution across the channel under a range of power operations to determine how best to monitor the transect.

APPENDIX A

SUMMARY RESULTS OF TRANSECTS – TABULATED

Summary of DO Monitoring Results during Recorded Operating Conditions during the Monitor Location Study											
						Transect 1					
Run #	Day	Level Logger Time (Beginning of Flow)	Level Logger Time (End of Flow)	Operating Conditions and Gate Settings	Aeration Bypass Valves	T1-Mean DO-boat monitor, mg/L	Mean DO-Deployed Monitors, mg/L	Mean DO-LDB and RDB monitors, mg/L	Minimum DO-boat monitor, mg/L	Minimum DO-Deployed Monitors, mg/L	Minimum DO-LDB and RDB monitors, mg/L
1	01-Nov-05	9:33	10:36	U5 - 37%	Open	5.34	5.19	5.27	5.20	4.96	5.15
2	01-Nov-05	10:38	11:17	U1 - 50%, U5 - 37%	Unit 1 Closed	4.53	3.77	3.69	3.70	2.22	2.22
3	01-Nov-05	11:19	11:56	U1 - 80%, U5 - 37%	Unit 1 Closed	3.98	3.31	3.16	2.70	1.46	1.46
4	01-Nov-05	11:58	12:35	U1 - 50%, U5 - 74%	Unit 1 Closed	4.20	3.47	3.39	3.60	2.32	2.32
5	01-Nov-05	12:39	13:18	U2 - 50%, U5 - 74%	Unit 2 Closed	4.11	3.51	3.22	3.60	1.99	1.99
6	01-Nov-05	13:20	13:59	U5 - 74%	Open	4.55	4.37	4.31	4.40	4.14	4.14
7	01-Nov-05	14:02	14:43	U2 - 80%, U5 - 39%	Unit 2 Closed	4.20	3.61	2.71	3.00	1.15	1.15
8	01-Nov-05	14:44	15:11	U2 - 50%, U5 - 39%	Unit 2 Closed	4.35	3.75	2.97	3.00	1.81	1.81
9	01-Nov-05	15:19	15:57	U1, U3 - 50%, U5 - 39%	Unit 1 Open Unit 3 Closed	4.45	3.61	3.89	3.50	2.46	3.60
10	03-Nov-05	7:57	8:53	U1 - 2200 cfs, 70%	Open	3.84	3.57	3.84	3.50	3.24	3.36
11	03-Nov-05	8:53	9:27	U1, U2 -2200 cfs each, 70%	Open	2.30	2.26	2.75	1.80	1.41	2.08
12	03-Nov-05	9:32	9:58	J1, U2, U3 - 2200 cfs each, 70%	U3 Closed	1.43	1.23	1.56	0.60	0.35	0.60
13	03-Nov-05	11:02	11:33	U1,U3 - 2200 cfs each, 70% U5 - 6000 cfs, 76%	U3 Closed	3.77	3.15	3.15	2.50	1.76	1.76
14	03-Nov-05	9:59	10:36	U1, U2, U3 - 2200 cfs each U5 - 6000 cfs	U3 Closed	2.76	2.55	3.48	1.60	1.01	2.22
15	03-Nov-05	10:37	11:00	U1, U2, U3 - 3200 cfs each, 96% U5 - 6000 cfs, 76%	U3 Closed	3.10	2.52	3.32	1.90	1.18	1.78

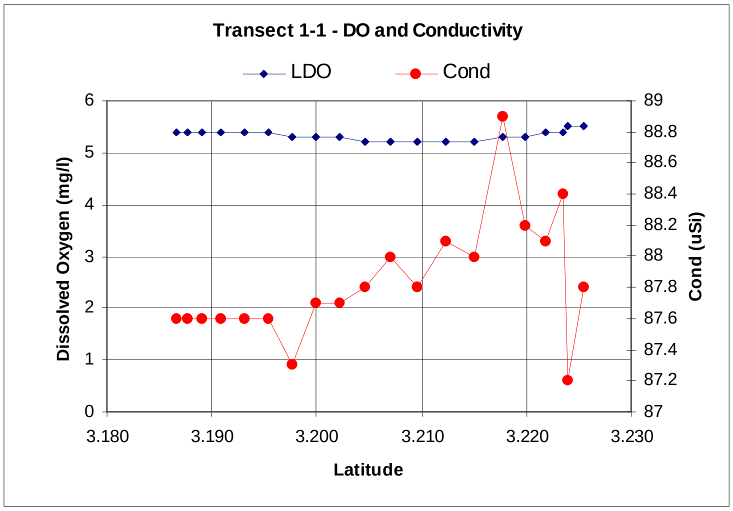
Summary of DO Monitoring Results during Recorded Operating Conditions during the Monitor Location Study

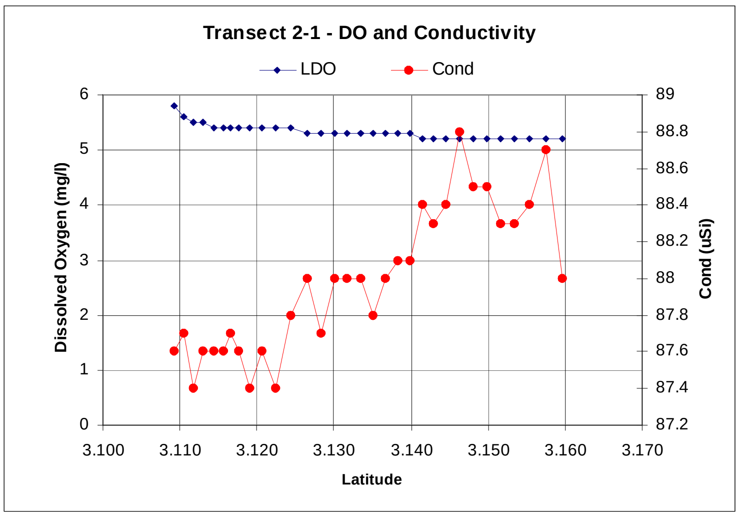
						Transect 2					
Run #	**Day**	**Level Logger Time (Beginning of Flow)**	**Level Logger Time (End of Flow)**	**Operating Conditions and Gate Settings**	**Aeration Bypass Valves**	**T2-Mean DO-boat monitor, mg/L**	**Mean DO-Deployed Monitors, mg/L**	**Mean DO-LDB and RDB monitors, mg/L**	**Minimum DO-boat monitor, mg/L**	**Minimum DO-Deployed Monitors, mg/L**	**Minimum DO-LDB and RDB monitors, mg/L**
1	01-Nov-05	9:33	10:36	U5 - 37%	Open	5.33	5.12	5.06	5.20	4.91	4.91
2	01-Nov-05	10:38	11:17	U1 - 50%, U5 - 37%	Unit 1 Closed	4.47	4.10	4.04	3.30	3.85	3.85
3	01-Nov-05	11:19	11:56	U1 - 80%, U5 - 37%	Unit 1 Closed	3.89	3.60	3.47	2.80	2.93	2.93
4	01-Nov-05	11:58	12:35	U1 - 50%, U5 - 74%	Unit 1 Closed	4.19	4.08	4.00	3.60	3.77	3.77
5	01-Nov-05	12:39	13:18	U2 - 50%, U5 - 74%	Unit 2 Closed	4.23	3.92	3.77	3.40	3.35	3.35
6	01-Nov-05	13:20	13:59	U5 - 74%	Open	4.60	4.51	4.45	4.50	4.27	4.27
7	01-Nov-05	14:02	14:43	U2 - 80%, U5 - 39%	Unit 2 Closed	4.05	3.63	3.47	2.60	2.95	2.95
8	01-Nov-05	14:44	15:11	U2 - 50%, U5 - 39%	Unit 2 Closed	4.29	3.85	3.69	4.10	3.64	3.64
9	01-Nov-05	15:19	15:57	U1, U3 - 50%, U5 - 39%	Unit 1 Open Unit 3 Closed	3.99	3.87	3.93	3.70	3.75	3.87
10	03-Nov-05	7:57	8:53	U1 - 2200 cfs, 70%	Open	3.86	3.82	na	3.60	3.08	na
11	03-Nov-05	8:53	9:27	U1, U2 -2200 cfs each, 70%	Open	2.44	2.23	na	1.70	1.34	na
12	03-Nov-05	9:32	9:58	J1, U2, U3 - 2200 cfs each, 70%	U3 Closed	1.31	1.43	na	0.70	0.44	na
13	03-Nov-05	11:02	11:33	U1,U3 - 2200 cfs each, 70% U5 - 6000 cfs, 76%	U3 Closed	3.83	4.64	na	2.80	4.16	na
14	03-Nov-05	9:59	10:36	U1, U2, U3 - 2200 cfs each U5 - 6000 cfs	U3 Closed	3.26	3.77	na	2.00	3.58	na
15	03-Nov-05	10:37	11:00	U1, U2, U3 - 3200 cfs each, 96% U5 - 6000 cfs, 76%	U3 Closed	3.39	4.13	na	1.90	4.08	na

Summary of DO Monitoring Results during Recorded Operating Conditions during the Monitor Location Study											
						Transect 3					
Run #	Day	Level Logger Time (Beginning of Flow)	Level Logger Time (End of Flow)	Operating Conditions and Gate Settings	Aeration Bypass Valves	T3-Mean DO boat monitor, mg/L	Mean DO-Deployed Monitors, mg/L	Mean DO-LDB and RDB monitors, mg/L	Minimum DO-boat monitor, mg/L	Minimum DO-Deployed Monitors, mg/L	Minimum DO-LDB and RDB monitors, mg/L
1	01-Nov-05	9:33	10:36	U5 - 37%	Open	5.24	5.30	5.27	5.20	5.02	5.02
2	01-Nov-05	10:38	11:17	U1 - 50%, U5 - 37%	Unit 1 Closed	4.50	4.09	4.03	3.70	3.87	3.87
3	01-Nov-05	11:19	11:56	U1 - 80%, U5 - 37%	Unit 1 Closed	4.20	3.50	3.36	3.20	2.92	2.92
4	01-Nov-05	11:58	12:35	U1 - 50%, U5 - 74%	Unit 1 Closed	4.10	3.95	3.80	3.60	3.43	3.43
5	01-Nov-05	12:39	13:18	U2 - 50%, U5 - 74%	Unit 2 Closed	4.12	3.78	3.70	3.40	3.34	3.34
6	01-Nov-05	13:20	13:59	U5 - 74%	Open	4.59	4.59	4.44	4.50	4.43	4.43
7	01-Nov-05	14:02	14:43	U2 - 80%, U5 - 39%	Unit 2 Closed	4.00	3.27	3.18	2.60	2.67	2.67
8	01-Nov-05	14:44	15:11	U2 - 50%, U5 - 39%	Unit 2 Closed	4.20	3.82	3.72	3.70	3.42	3.42
9	01-Nov-05	15:19	15:57	U1, U3 - 50%, U5 - 39%	Unit 1 Open Unit 3 Closed	3.98	3.80	3.83	3.90	3.63	3.79
10	03-Nov-05	7:57	8:53	U1 - 2200 cfs, 70%	Open	3.87	3.78	3.85	3.70	3.27	3.27
11	03-Nov-05	8:53	9:27	U1, U2 -2200 cfs each, 70%	Open	2.68	2.45	2.61	2.10	1.79	1.79
12	03-Nov-05	9:32	9:58	U1, U2, U3 - 2200 cfs each, 70%	U3 Closed	1.57	1.55	1.76	1.00	0.70	0.70
13	03-Nov-05	11:02	11:33	U1,U3 - 2200 cfs each, 70% U5 - 6000 cfs, 76%	U3 Closed	3.84	3.07	2.90	2.90	2.06	2.06
14	03-Nov-05	9:59	10:36	U1, U2, U3 - 2200 cfs each U5 - 6000 cfs	U3 Closed	2.57	2.76	2.75	0.50	2.06	2.06
15	03-Nov-05	10:37	11:00	U1, U2, U3 - 3200 cfs each, 96% U5 - 6000 cfs, 76%	U3 Closed	3.37	2.65	2.56	2.10	1.60	1.60

APPENDIX T

RESULTS OF TRANSECTS – PLOTTED





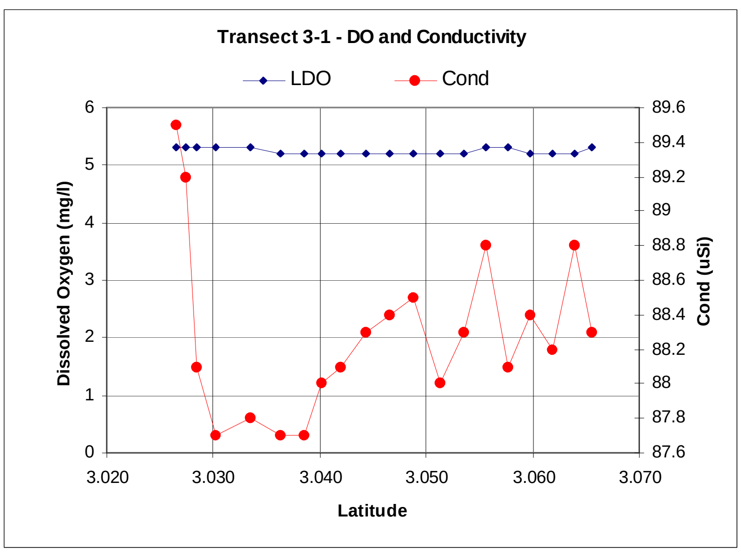
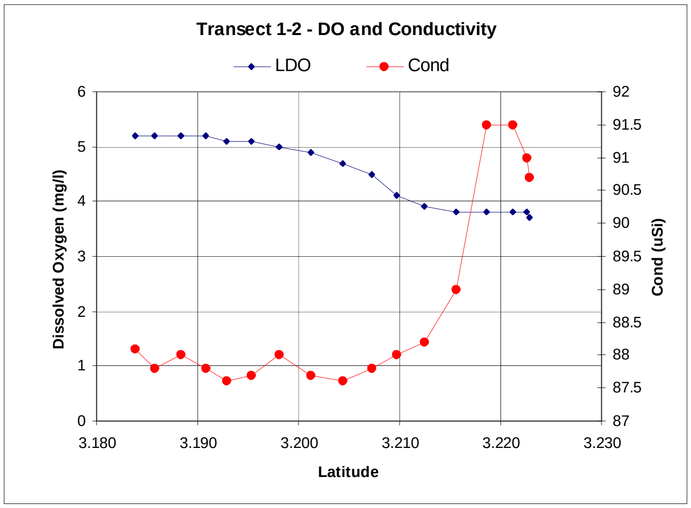
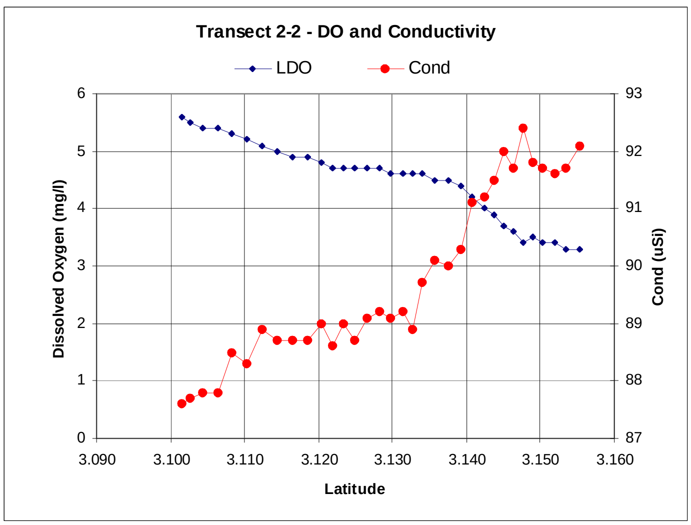


Figure T-1: Run 1 – Unit 5 at 37% Gate





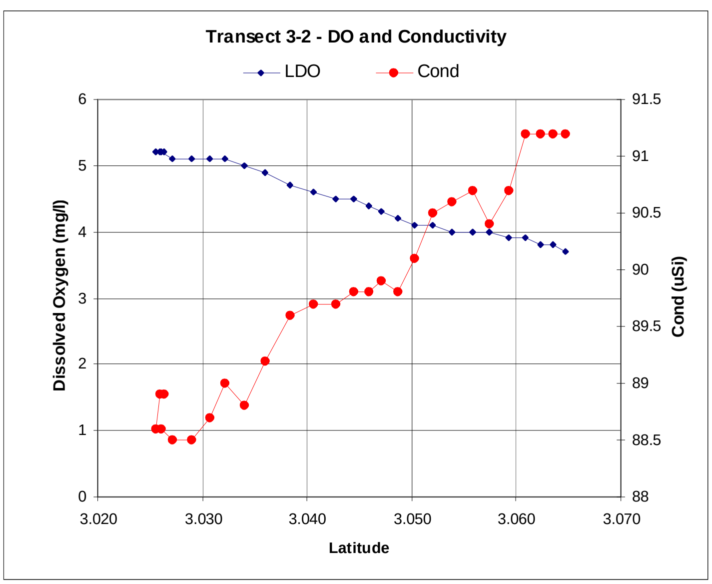
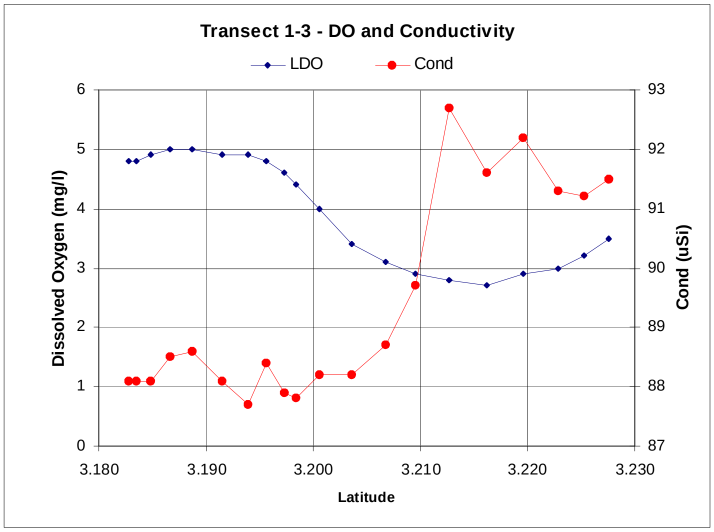
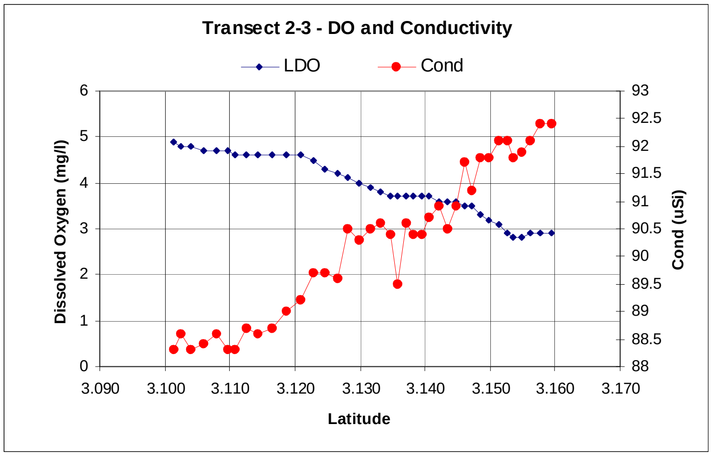


Figure T-2: Run 2 – Unit 1 at 50% Gate (ABV, Closed) and Unit 5 at 37% Gate





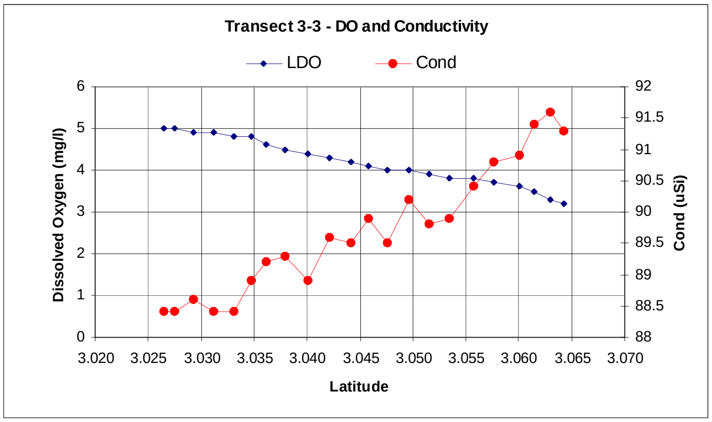
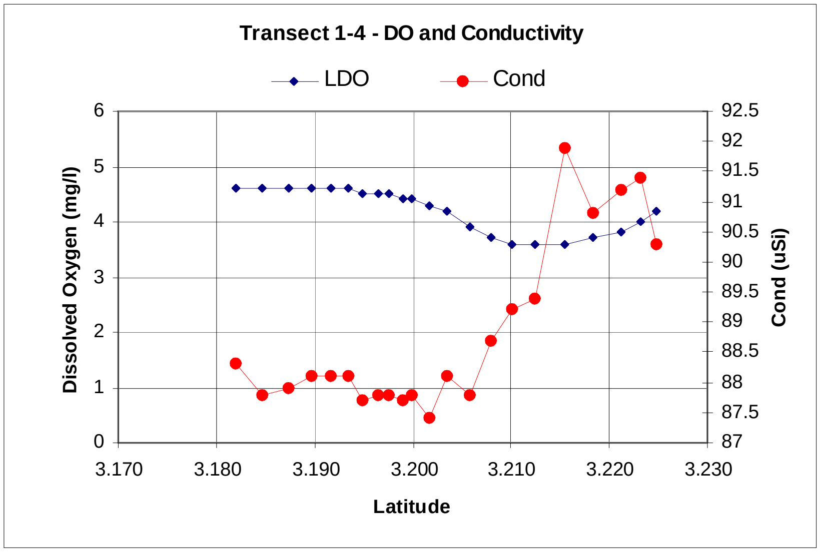
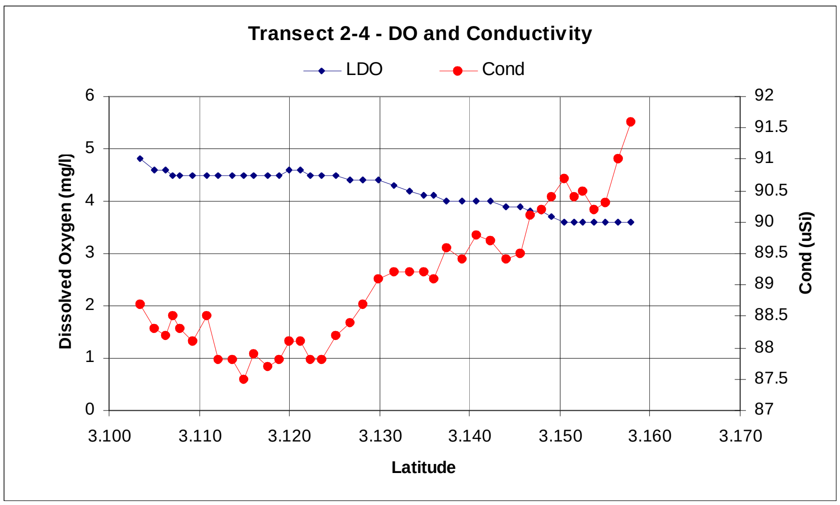


Figure T-3: Run 3 – Unit 1 at 80% Gate (ABV, Closed) and Unit 5 at 37% Gate





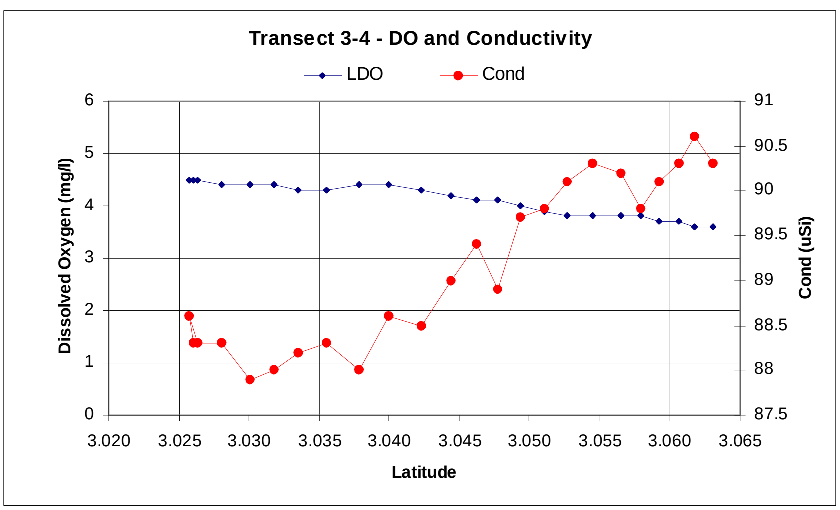
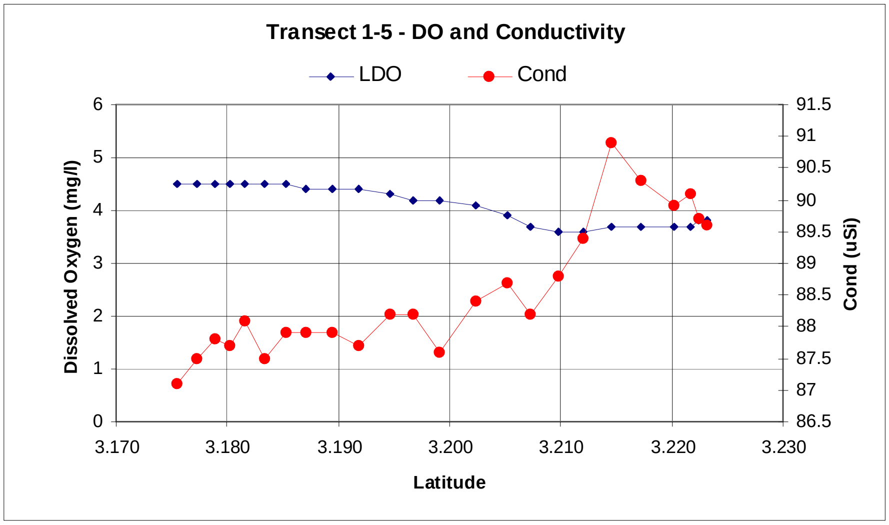
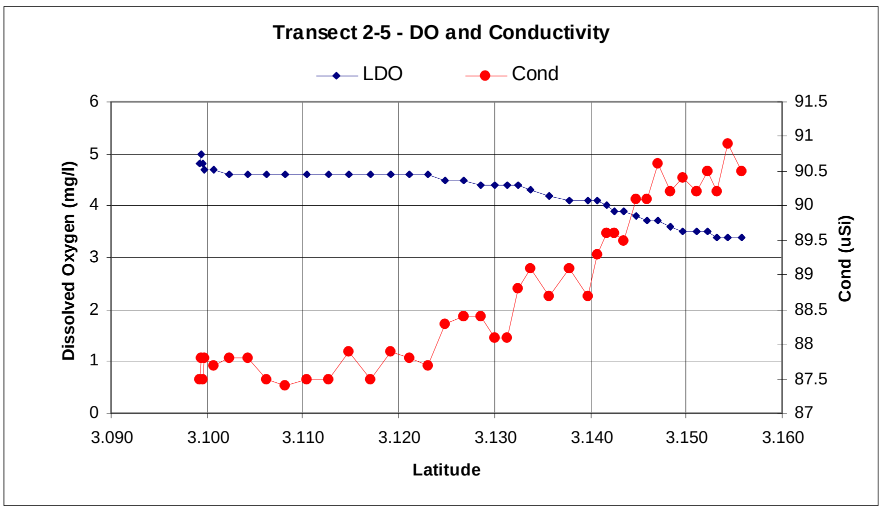


Figure T- 4: Run 4 – Unit 1 at 50% Gate (ABV, Closed) and Unit 5 at 74% Gate





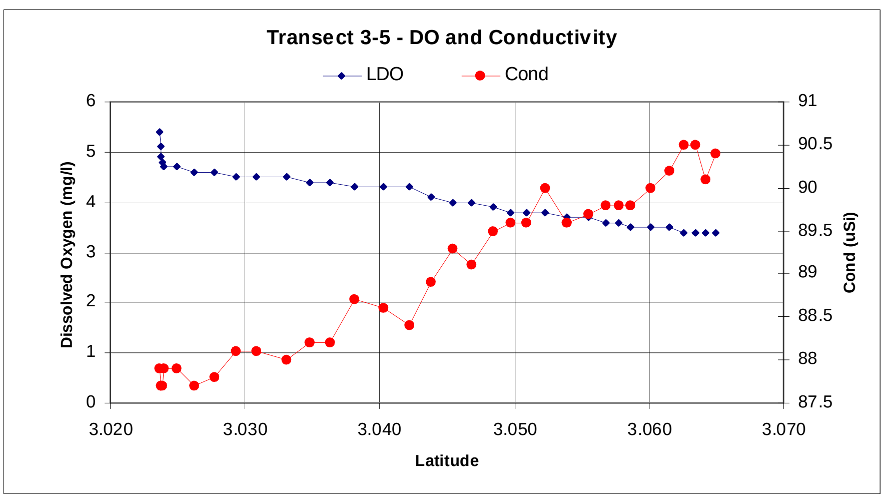
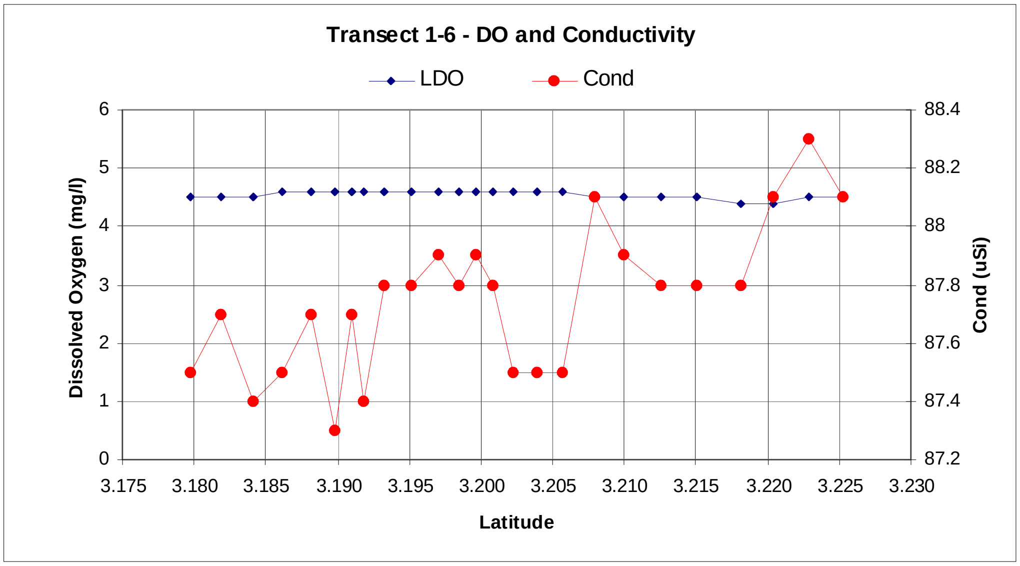
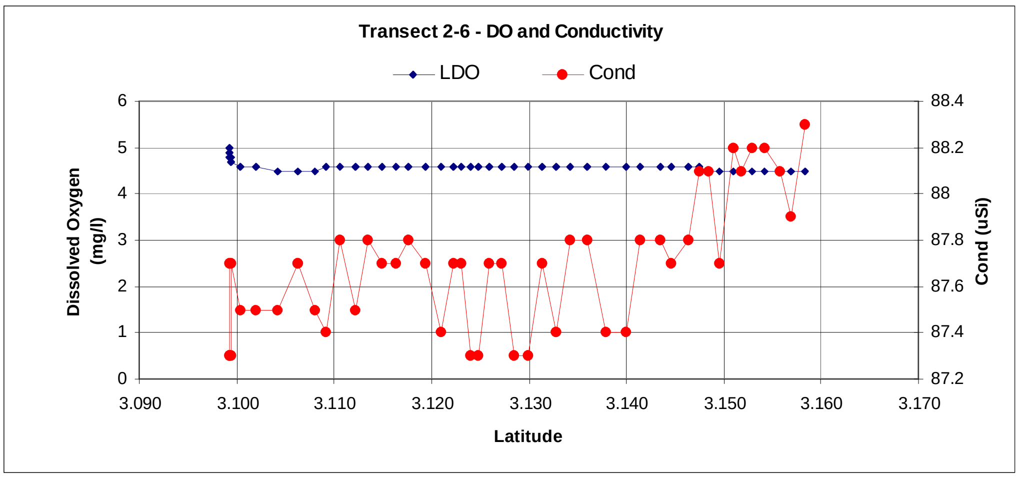


Figure T- 5: Run 5 – Unit 2 at 50% Gate (ABV, Closed) and Unit 5 at 74% Gate





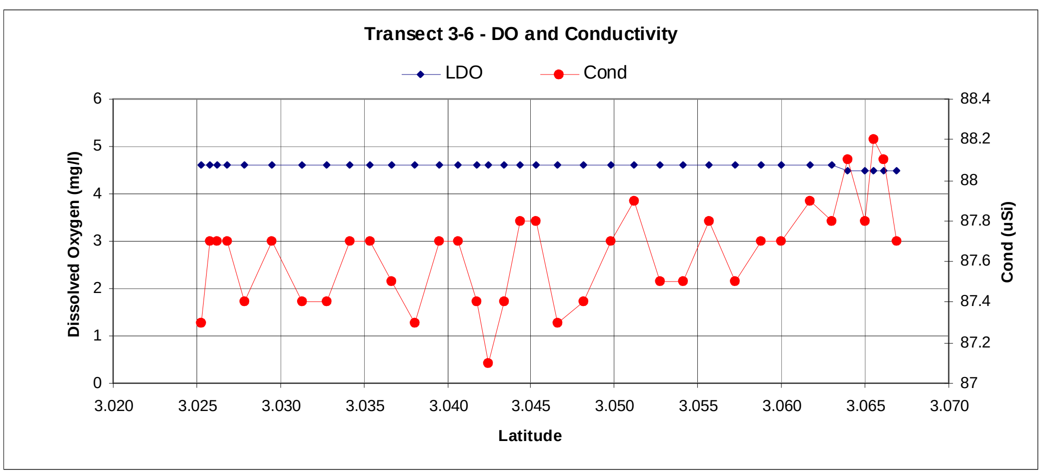
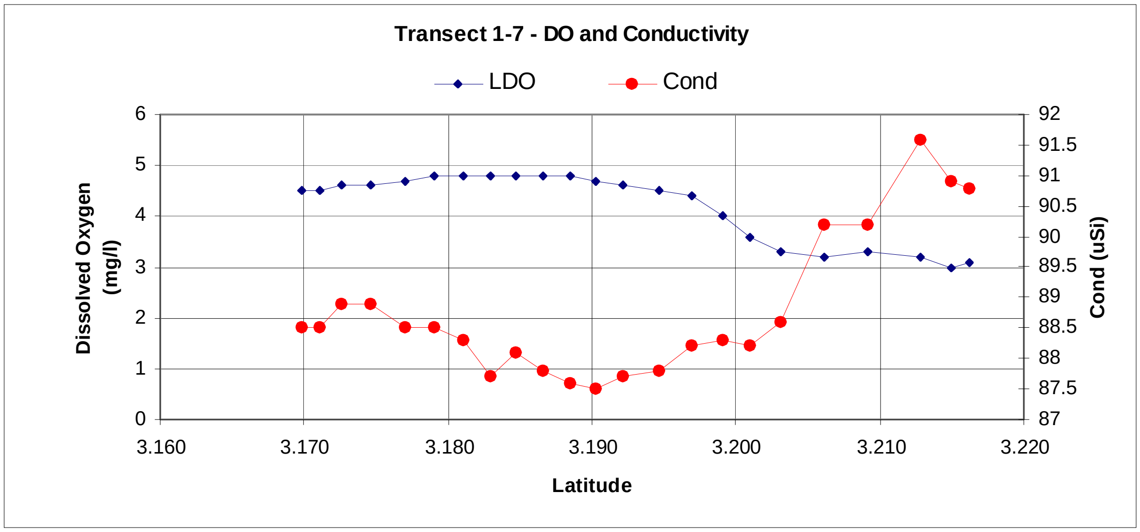
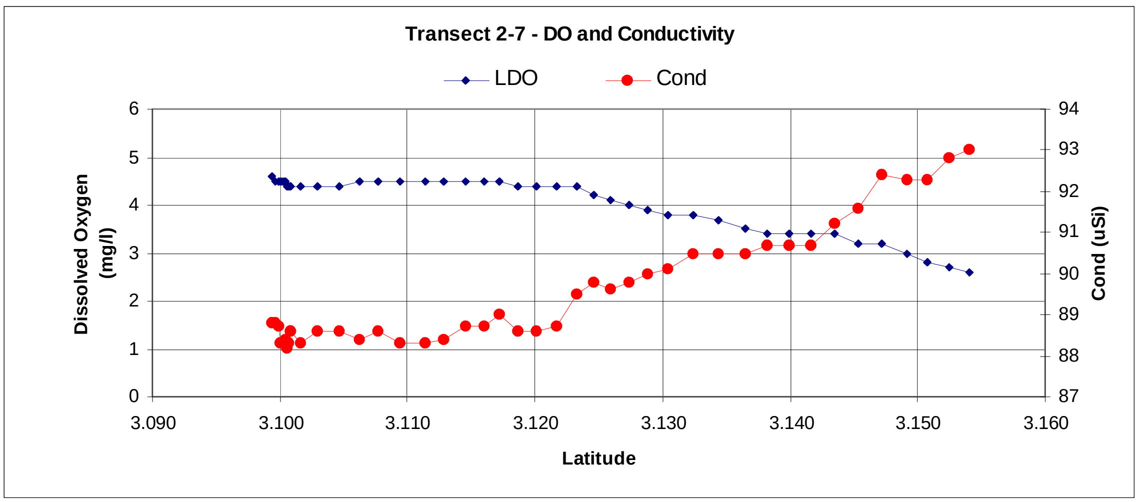


Figure T- 6: Run 6 – Unit 5 at 74% Gate





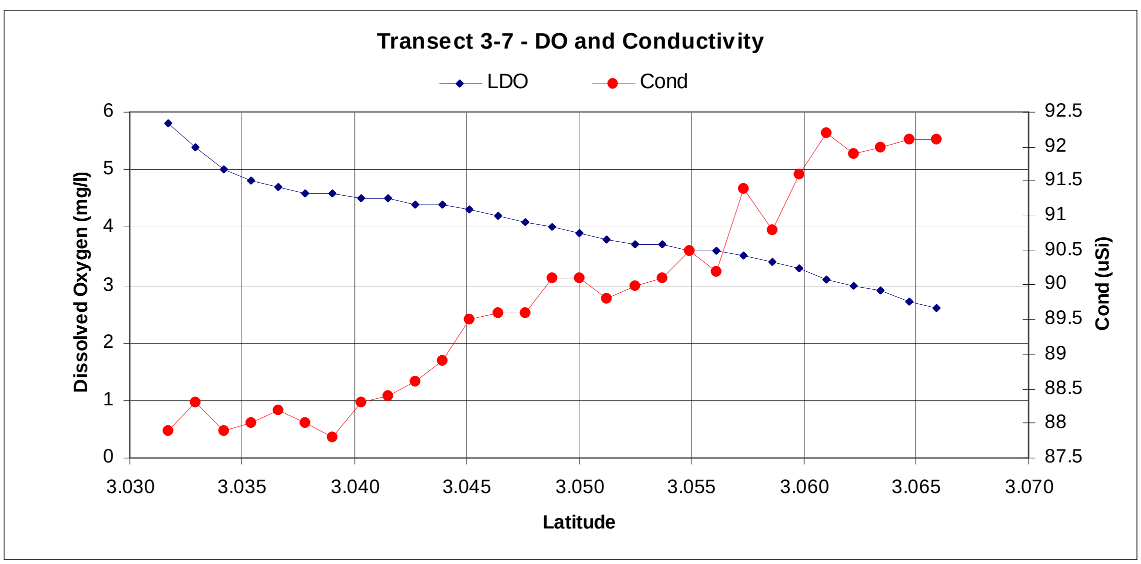
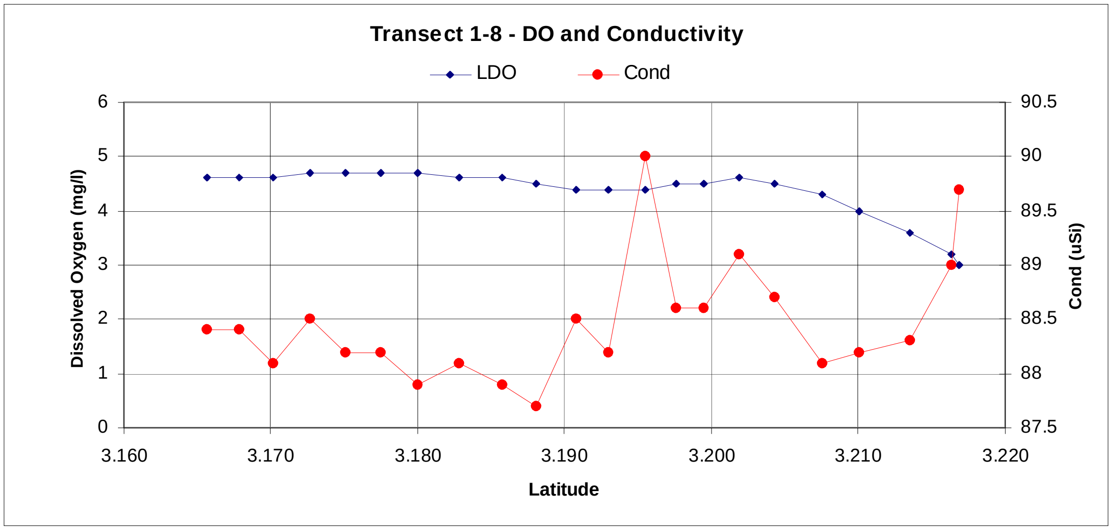
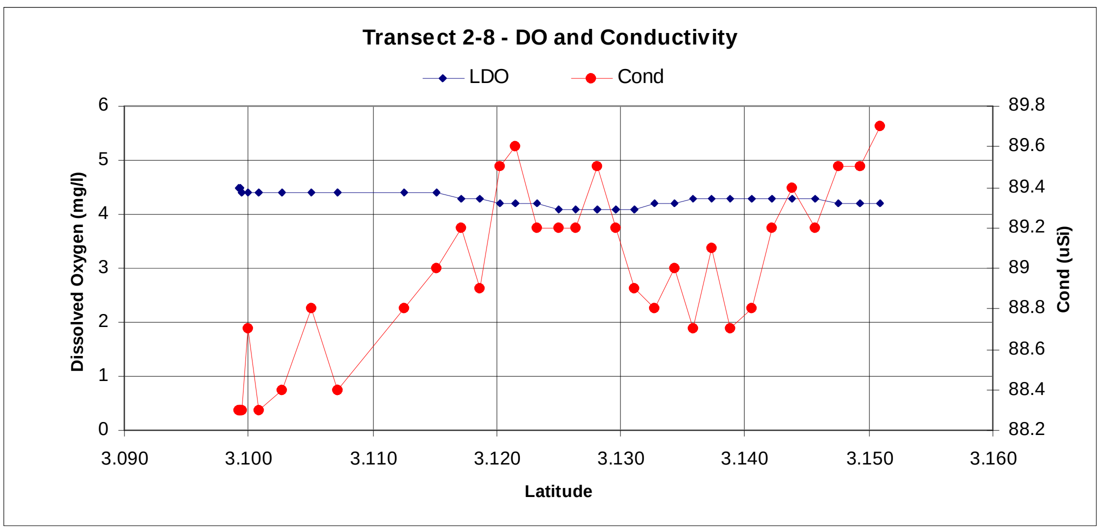


Figure T- 7: Run 7 – Unit 2 at 80% Gate (ABV, Closed) and Unit 5 at 39% Gate





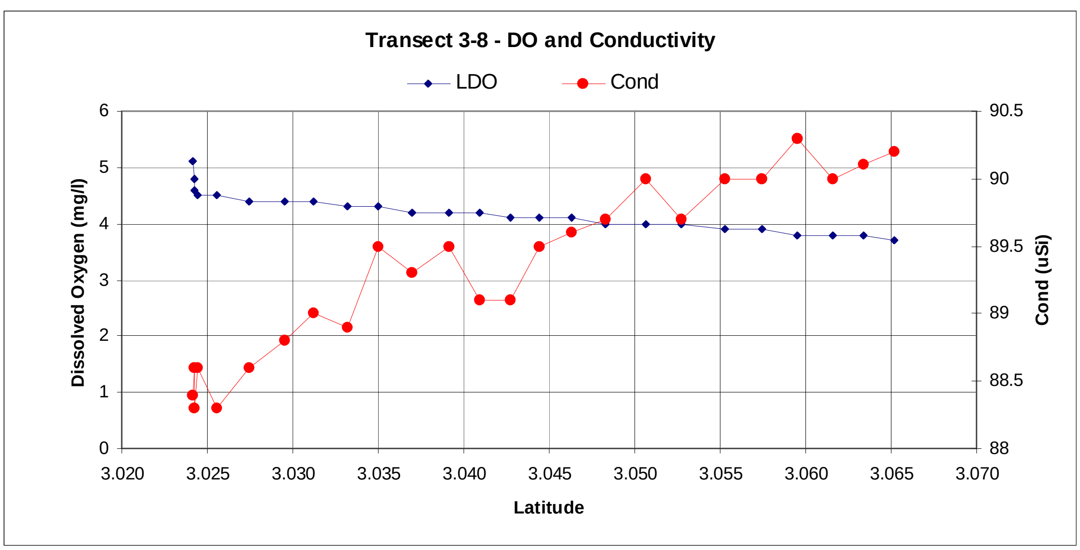
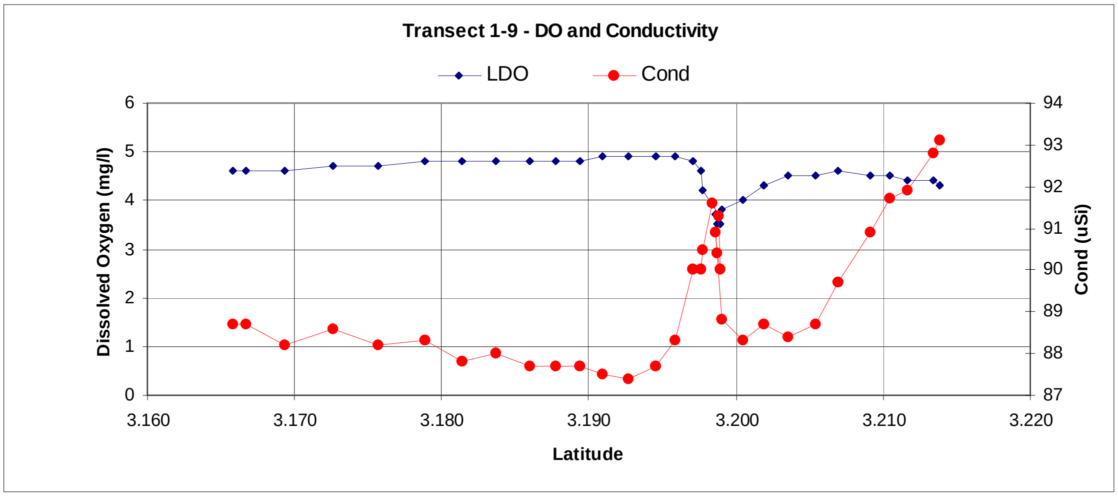
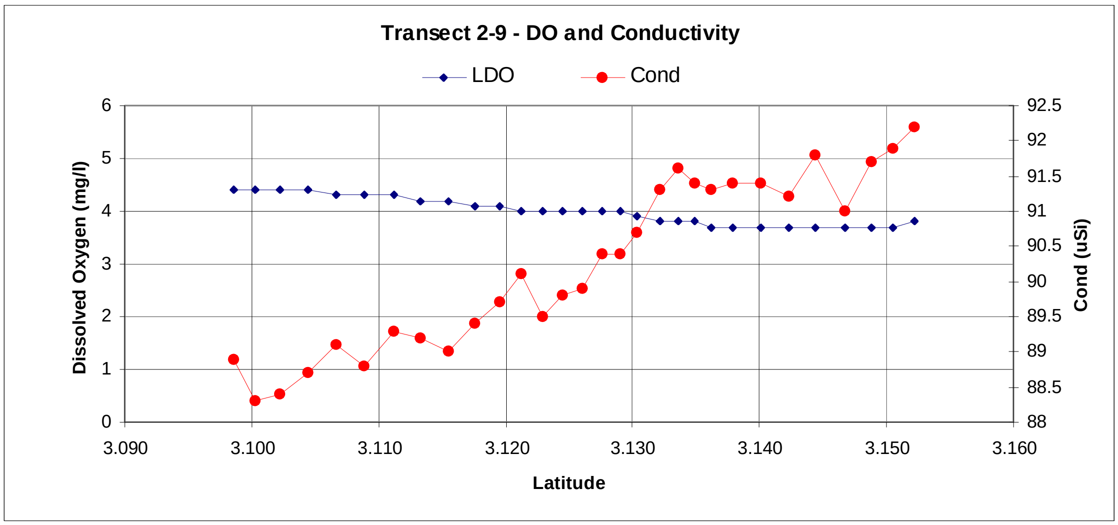


Figure T- 8: Run 8 – Unit 2 at 50% Gate (ABV, Closed); Unit 5 at 39% Gate





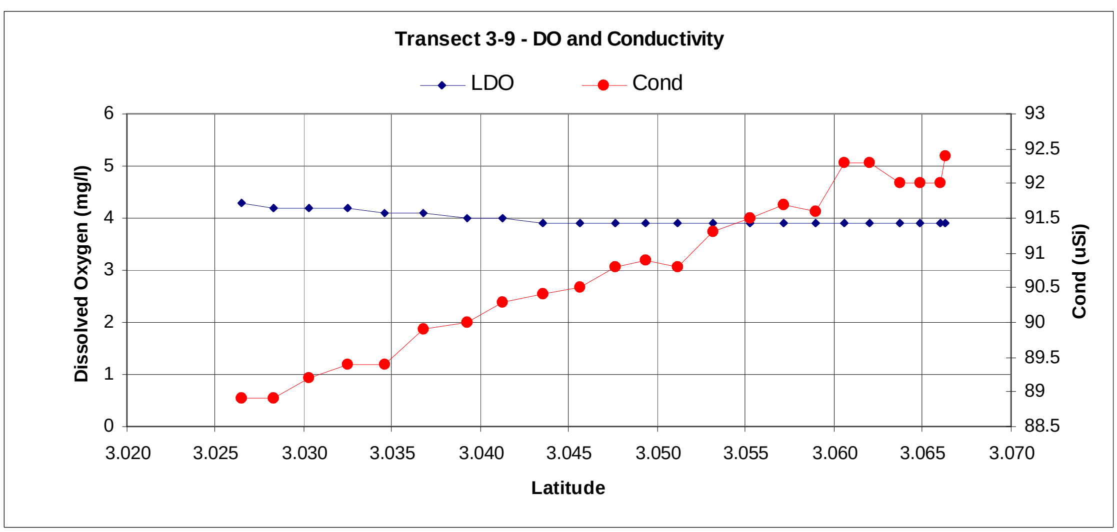
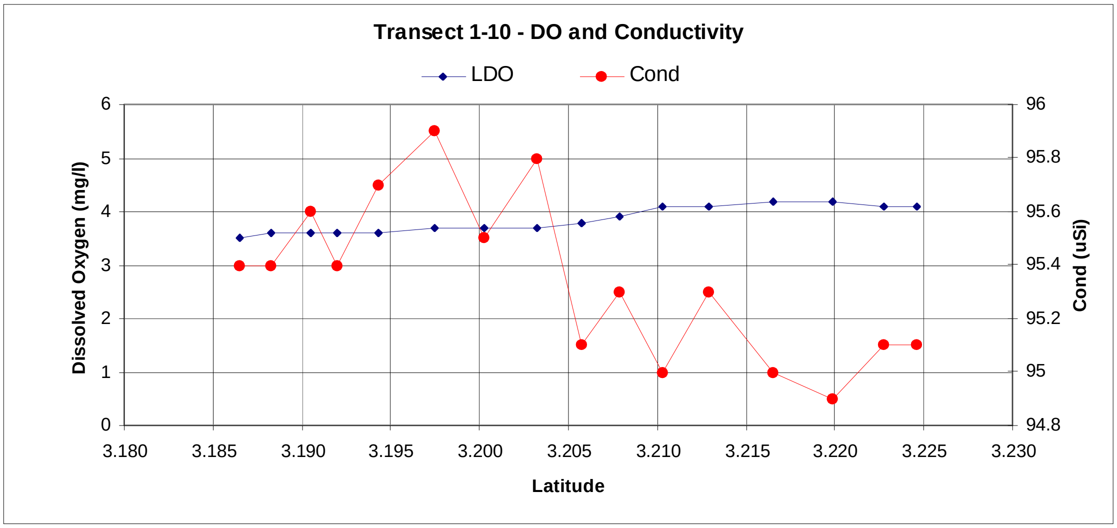
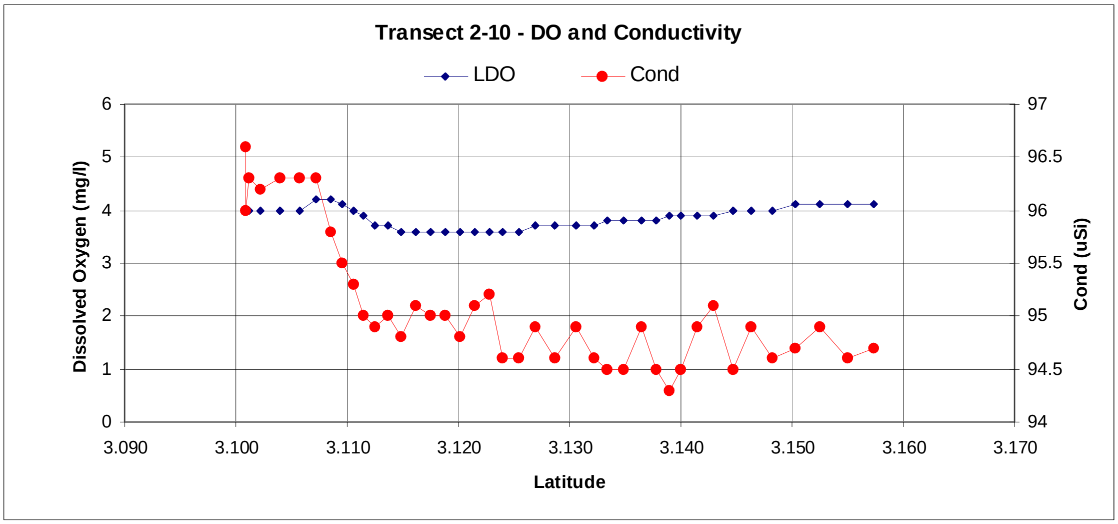


Figure T- 9: Run 9 – Unit 1 at 50% Gate (ABV, Open); Unit 3 at 50% Gate (ABV, Closed); Unit 5 at 39% Gate





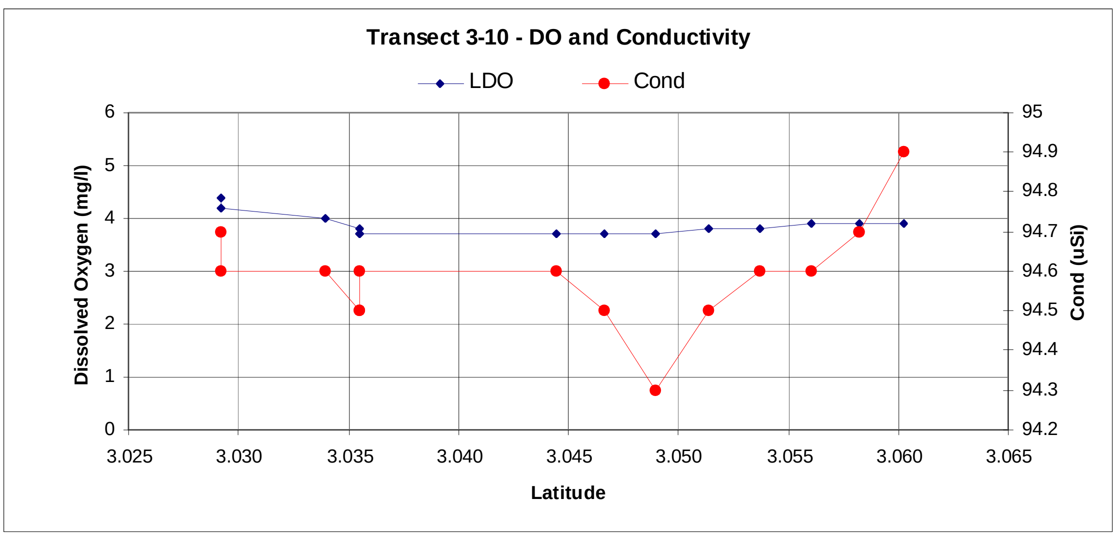
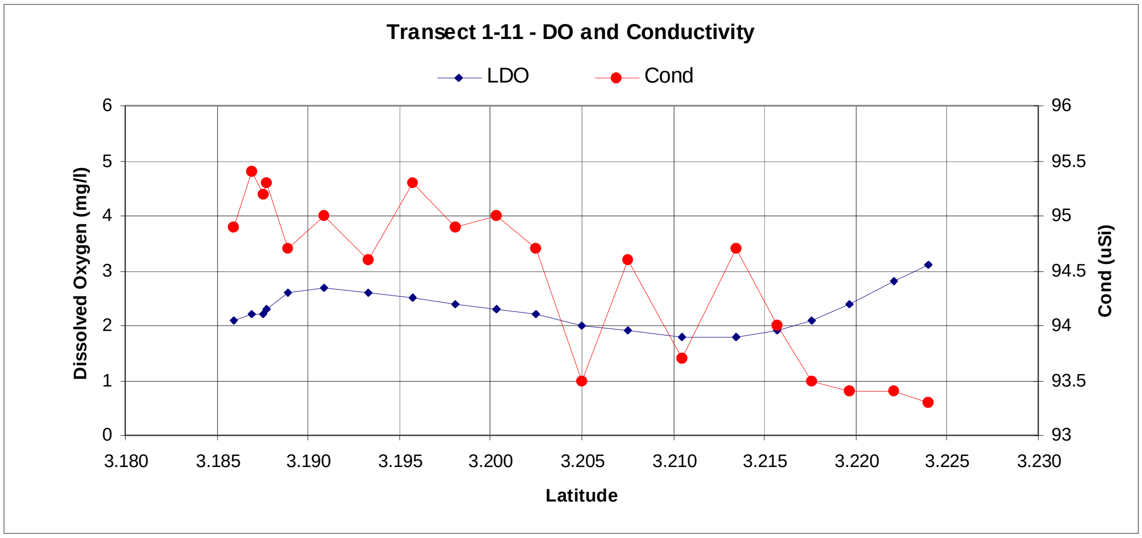
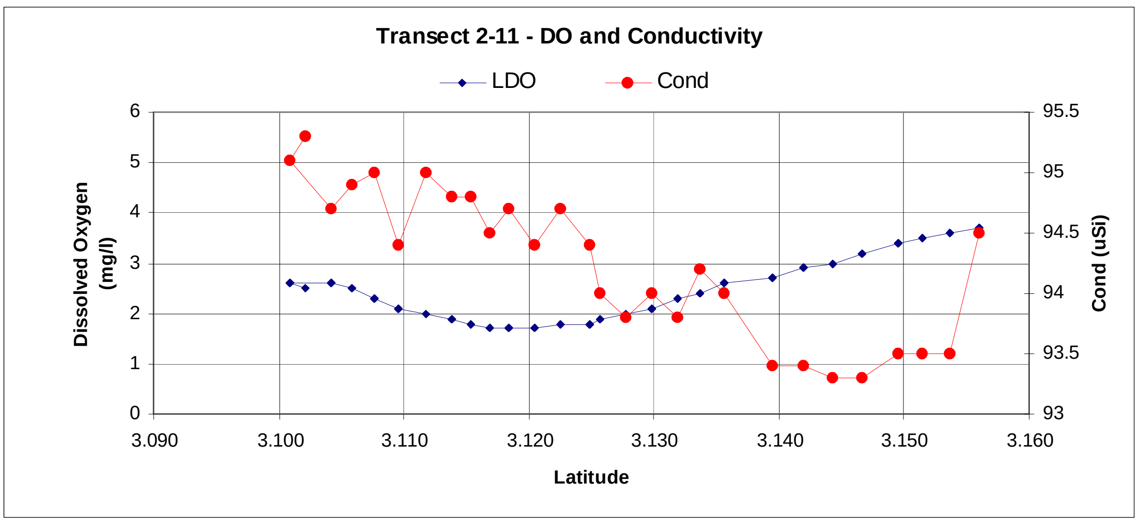


Figure T- 10: Run 10 – Unit 1 at 70% Gate (ABV, Open)





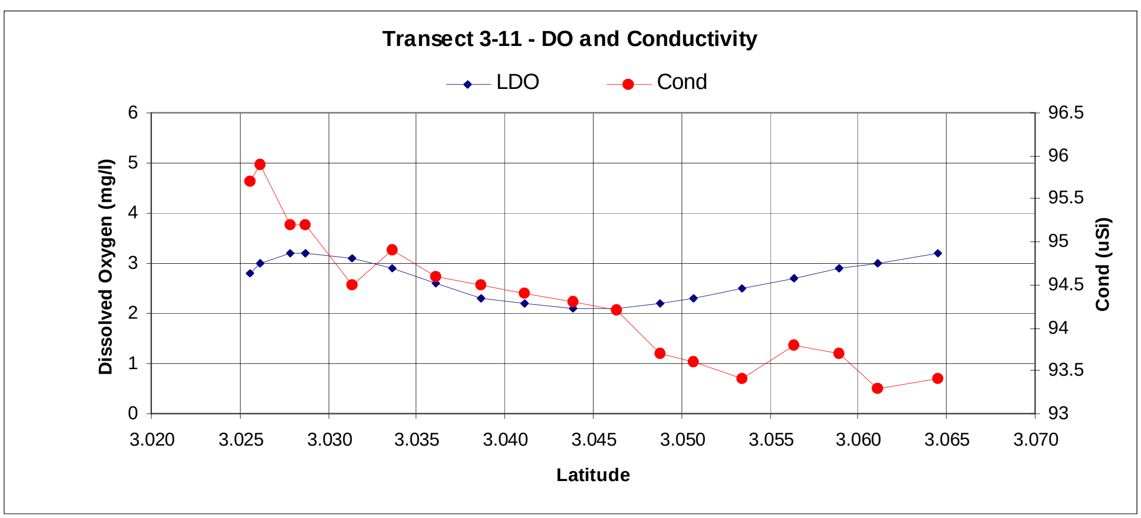
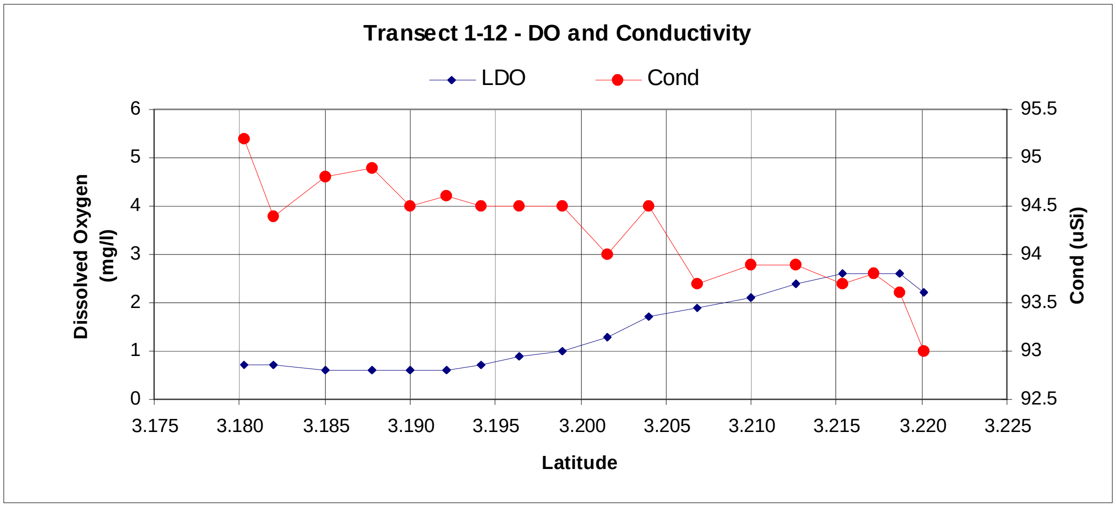
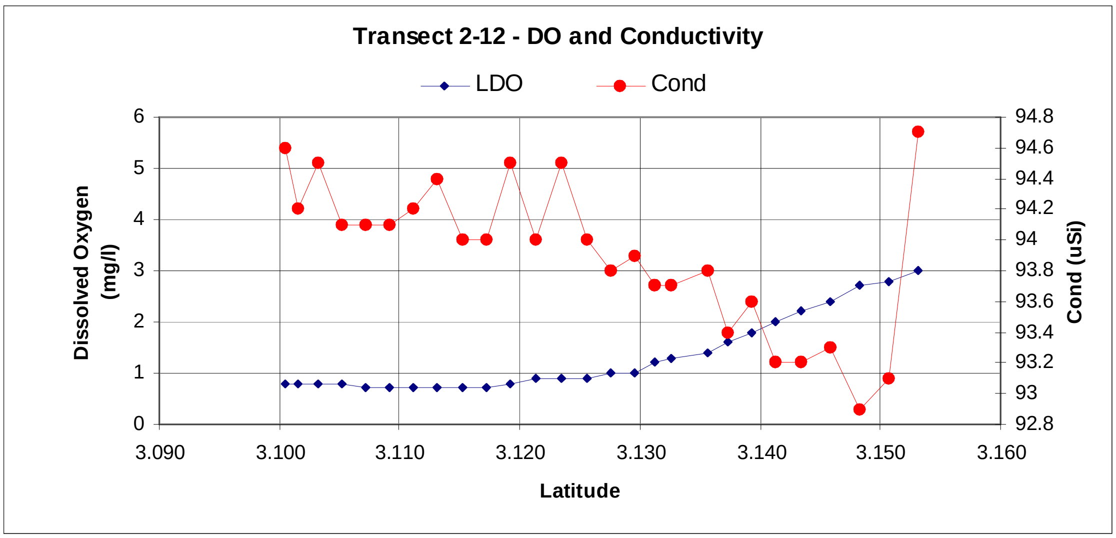


Figure T- 11: Run 11 – Units 1 and 2 at 70% Gate (ABV, Open)





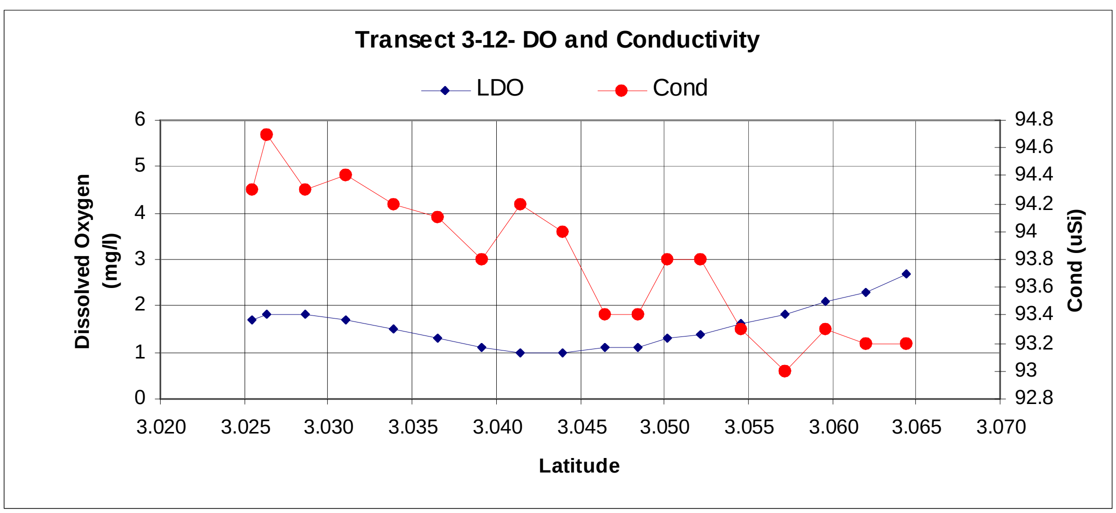
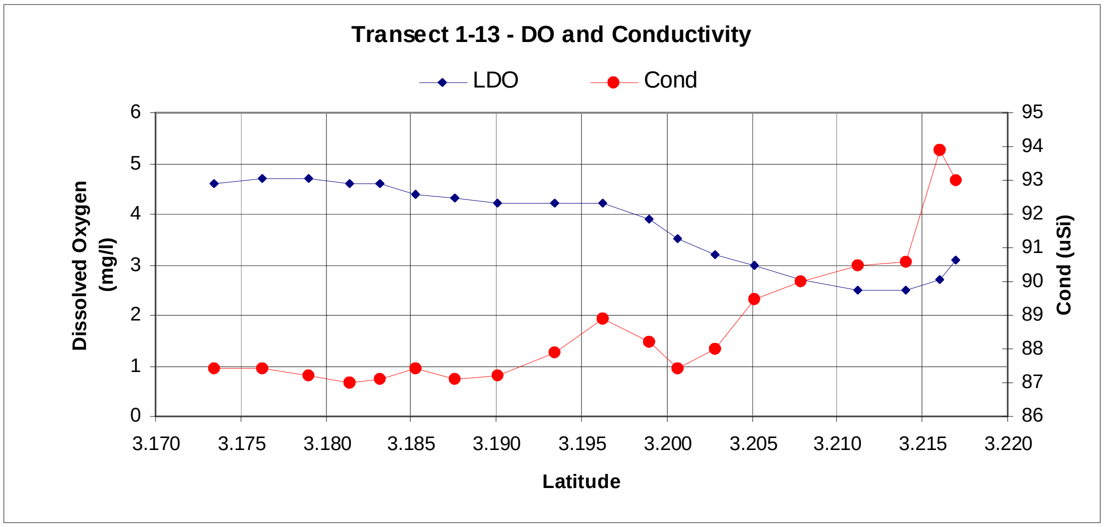
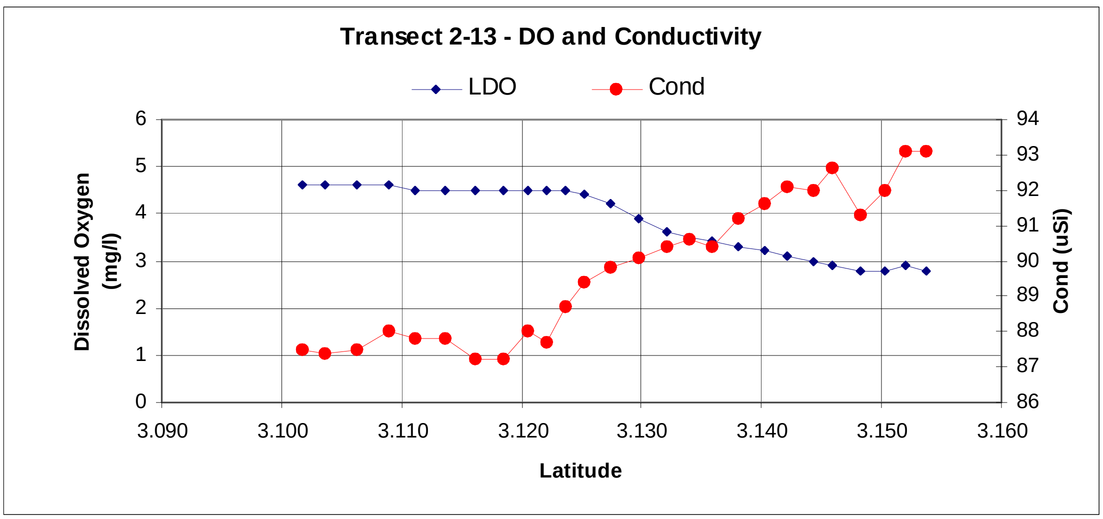


Figure T- 12: Run 12 – Units 1 and 2 at 70% Gate (ABV, Open); Unit 3 at 70% Gate (ABV, Closed)





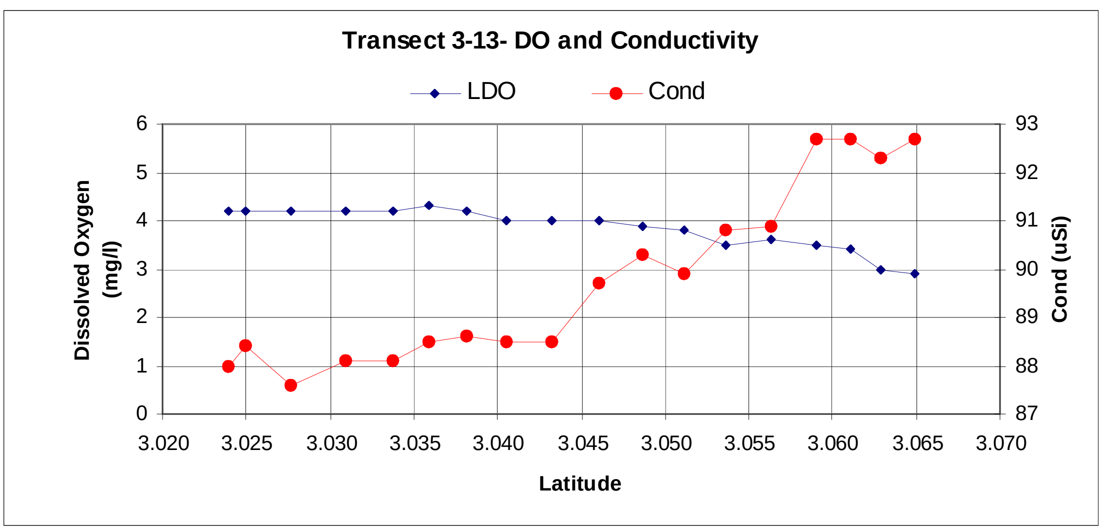
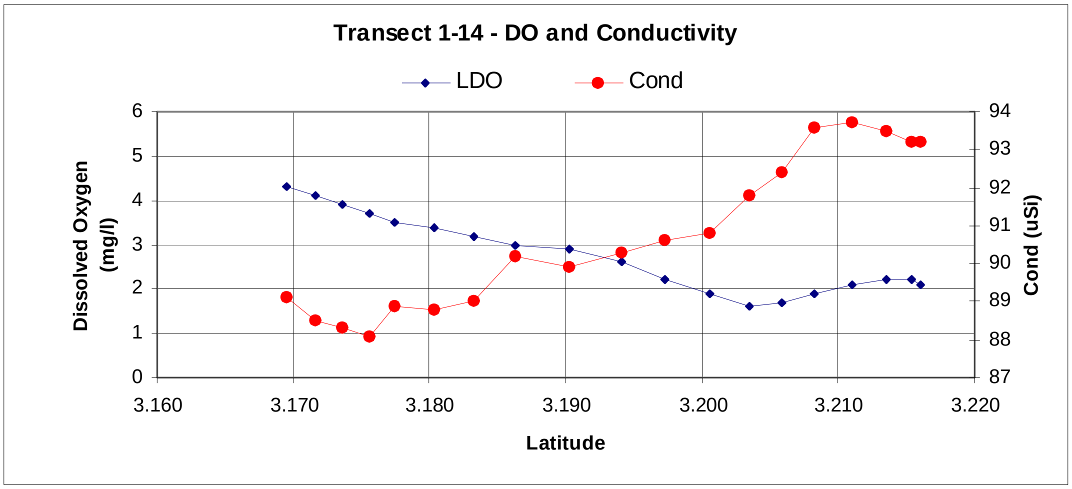
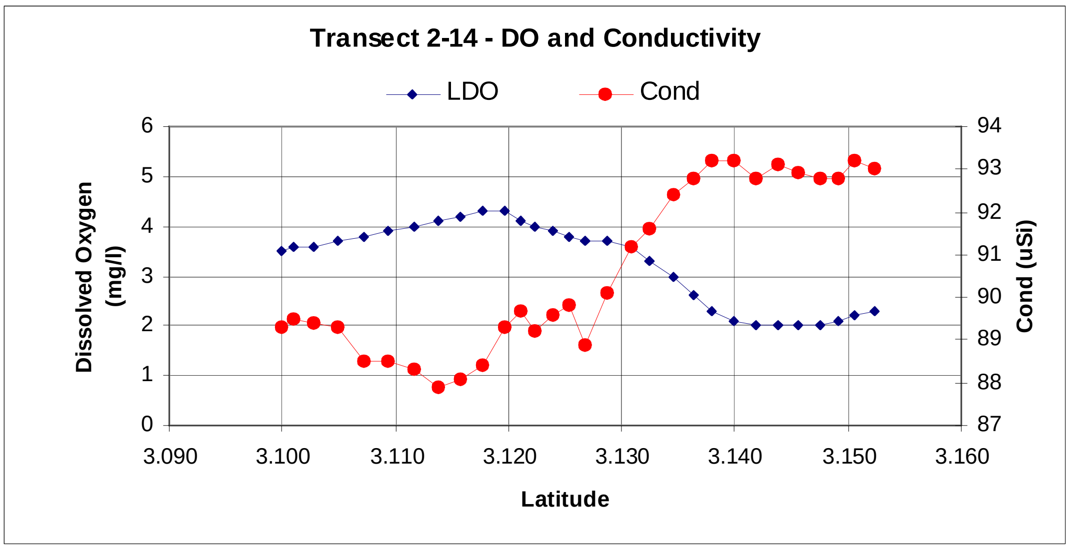


Figure T- 13: Run 13 – Units 1 and 3 at 70% Gate (ABV Closed on U3); Unit 5 at 76% Gate





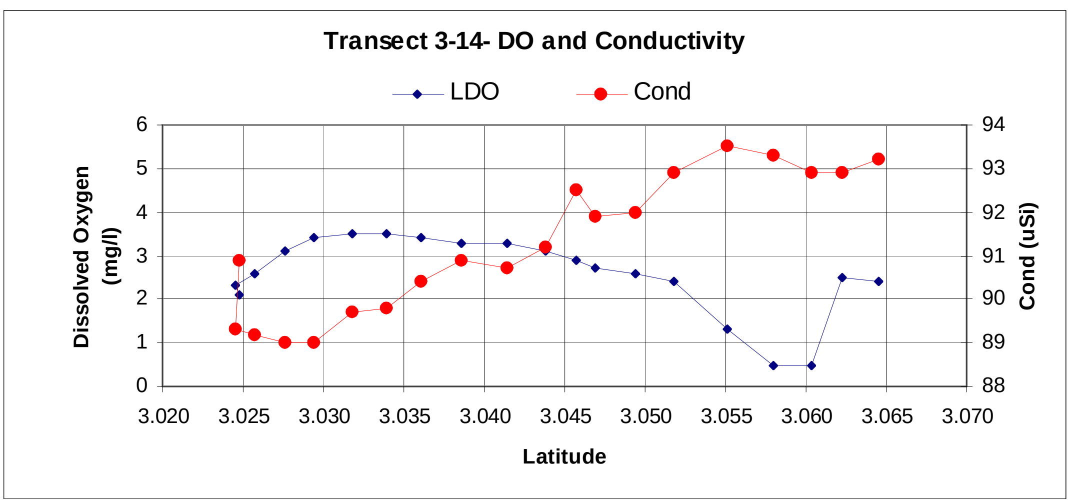
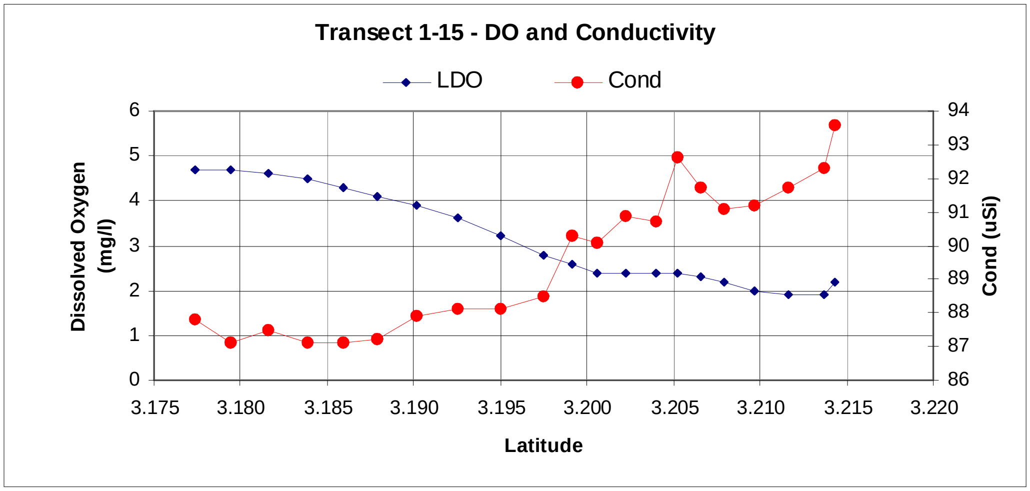
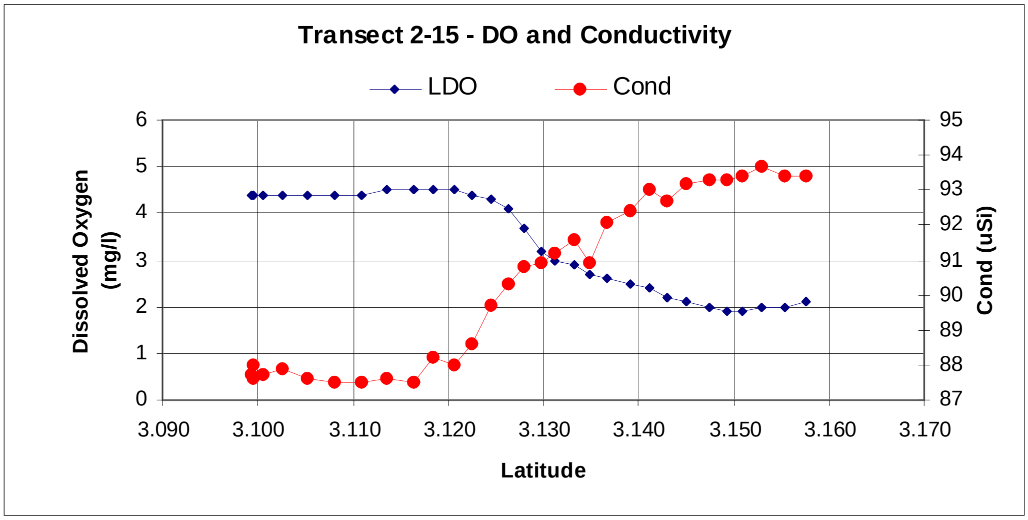


Figure T- 14: Run 14 – Units 1, 2, and 3 at 70% Gate (ABV Closed on U3); Unit 5 at 76% Gate





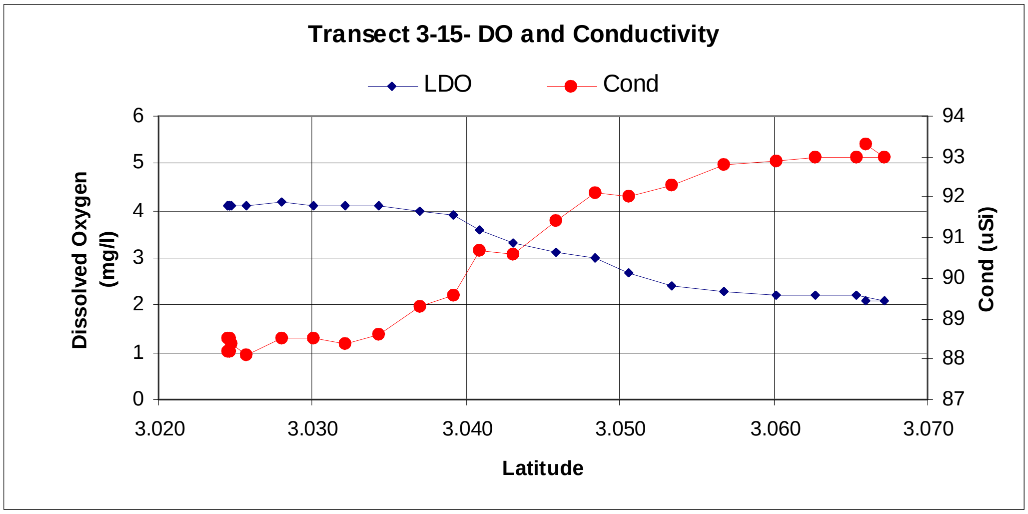


Figure T- 15: Run 15 – Units 1, 2, and 3 at 96% Gate (ABV Closed on U3); Unit 5 at 76% Gate

Kacie Jensen

From: Alan Stuart
Sent: Monday, May 01, 2006 3:32 PM
To: 'Amanda Hill (Amanda_Hill@fws.gov)'; 'Dick Christie (dchristie@infoave.net)'; 'Hal Beard'; 'Prescott Brownell (Prescott.Brownell@noaa.gov)'; 'gjobsis@americanrivers.org'; 'Patrick Moore'; 'Gina Kirkland - DHEC'; 'cdwood@usgs.gov'; 'Sarah W Ellisor'; 'Richard Roos-Collins'; 'Julie Gantenbein'; Alan Stuart
Cc: BARGENTIERI@scana.com; 'Jim Ruane'; RMAHAN@scana.com; 'Ray Ammarell (RAmmarell@scana.com)'; 'Steve Summer'; 'Tom Eppink'; 'Brian J. McManus'; 'BOWLES, THOMAS M'; Alison Guth; 'EPPINK, THOMAS G'
Subject: Final Monitor Relocation Report

Good afternoon,

Attached for your records is the Final Monitor Relocation Report for Saluda Hydro. I received no comments on the Second Draft of the report issued on April 10, 2006. The attached report did not change from that version, the only exception of being this version is marked as FINAL as opposed to DRAFT.

Thank you for all of your efforts and if you have questions please give me a call.

Final Report on Monitor Locati...

Alan

SALUDA HYDROELECTRIC PROJECT

2006 USGS MONITOR RELOCATION ASSESSMENT

FINAL REPORT

MAY 2006

SALUDA HYDROELECTRIC PROJECT

2006 USGS MONITOR RELOCATION ASSESSMENT

FINAL REPORT

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SALUDA HYDROELECTRIC PROJECT

2006 USGS MONITOR RELOCATION ASSESSMENT

FINAL

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Revised 4/8/06

SALUDA HYDROELECTRIC PROJECT

2006 USGS MONITOR RELOCATION ASSESSMENT

FINAL REPORT

May 1, 2006

1.0 INTRODUCTION

Prior to and during the low DO period of 2005, SCE&G undertook the following tasks:

1. Installed hub baffles on Units 1 through 4 to increase the effectiveness of the turbine venting system at higher gate settings;
2. Conducted turbine venting tests so that the effectiveness of the hub baffles on aeration in Units 1 and 5 could be determined; and
3. Evaluated various locations in the tailrace to install long-term water quality monitor(s) for DO and temperature.

This document describes the results of the field study conducted for evaluating the best location(s) for a water quality monitor(s), i.e., the above Task 3.

2.0 BACKGROUND

The report on 2004 operations included some of the following observations on the current monitoring system:

1. The monitor readings have been rated good in the past by USGS, ± 0.3-0.5 mg/L;
2. The location is not considered to be representative for all conditions in the tailwater, i.e., it’s biased towards the DO in the discharge from the unit that’s operating that is on the left descending bank (LDB);
3. The objectives for the current USGS monitor do not include the purpose of providing monitoring for compliance-type comparisons to State instream water quality standards;
4. Photosynthesis and respiration by aquatic plants in the tailwater can affect in some years the DO level at the location of the monitor;

5. The USGS gage occasionally malfunctions for several days;
6. Fouling is a significant issue that affects the reliability of the data; and
7. SCE&G spot measurements during the 2004 study period were usually higher than the USGS monitor (see annual aeration report for the 2004 low DO period.).

The monitor location study conducted in 2005 was designed considering the site-specific characteristics of the Saluda Hydroelectric Project, approaches used at other projects, and guidance from the SC USGS office as well as national guidelines (USGS, 2000).

3.0 EVALUATION OF ALTERNATIVE MONITOR LOCATIONS

This section identifies and outlines the scope of work, procedures, and methods of work used for evaluating monitor locations in the tailrace at the Saluda Project. This test plan used for the study specified the Saluda plant operating conditions and identified measurements used to evaluate alternative monitor locations.

Eleven water quality monitors were deployed across three transects in the tailrace to collect information needed to evaluate alternative monitoring locations (Figure 1.) During two testing periods (November 1 and 3, 2005), there were a wide range of pre-defined operating conditions. November was selected for the monitor evaluation study because it is during this time that water quality in the releases from Unit 5 is likely to be different than in the releases from the other units. It was best to conduct this latter evaluation after DO and conductivity at the intake of Unit 5 was different than at the intakes for Units 1 through 4 so that mixing characteristics between the unit discharges could be measured. As described in the annual aeration reports for 2004 and 2005, the DO at the intake of Unit 5 increases several weeks before the DO at the intakes of Units 1 through 4. Also, since conductivity in the water column of the lake is greater near the bottom of the lake (due to releases of anoxic products from the lake sediments) where the Unit 1 through 4 intakes are located, the conductivity in the releases from Unit 5 is lower.

The operating conditions are presented in Table 1. The operating conditions used for testing took into account the units that experienced outages, and the units were operated over a range of gate settings. These gate settings allowed the monitor locations to be evaluated for generation operating conditions at the Saluda Project. It should be noted that some of the runs were conducted with the air valves closed on one of the units to allow a more thorough evaluation of mixing in the tailrace, however, under normal operations when SCE&G would be aerating the discharges from the plant, none of the air valves would be closed and there would not be as much difference in DO in the tailrace as indicated by these test results.

For the purpose of this study, it was assumed that there were three potential monitoring schemes that could be used at a selected location in Saluda tailrace:

1. Two monitors could be used, one each on the LDB and RDB;
2. A multi-port intake pipe or a multi-pipe intake system could be installed across the tailrace and water could be pumped to one monitor on the stream bank; and
3. Multiple monitoring points could be used across the tailrace.

As the review of the draft report developed, it was suggested that a single mid-point location also be considered.

4.0 PLANT OPERATING MEASUREMENTS

During the two tests, the following information was recorded frequently enough to track conditions for each run:

- Wicket gate position for each unit operating;
- The settings on the air supply valves; and
- Discharge for each unit operating (for selected runs).

Water depth at the transects also was recorded at one-minute intervals using level loggers.

5.0 WATER QUALITY MEASUREMENTS

During the monitor location study, 24 hours per day, the following information was recorded in the tailwater at one-minute intervals:

- DO
- Conductivity
- Temperature

These data were collected using autologging water quality monitors that were placed in the tailrace for the duration of the study. The water quality monitors were placed in line with three transects across the tailrace (Figure 1):

1. One transect immediately downstream from the turbulent upwelling areas of the turbine discharges where the water flows downstream away from the powerhouse—one monitor each approximately below Units 1, 2, 3, and 5;
2. One transect across from the current USGS water quality monitor location—one monitor each at approximately one-third points across the channel, plus another monitor located next to the USGS monitor about 5% of the width of the river from the descending left bank (LDB); and
3. An intermediate transect between the above two transects—with two monitors located about 25% of the width from the RDB and LDB and another monitor located at the midpoint.

In addition to the deployed monitors, transects of DO, conductivity, and temperature were collected across the tailrace during each run using a rapid-measuring DO instrument after flow and water quality stabilized. Transect data provided information on how DO and conductivity varied across the entire tailwater including the areas where the water quality monitors were not deployed. These transect profiles provided the ability to determine the average DO for the transect using about 20-40 measurements for each transect profile.

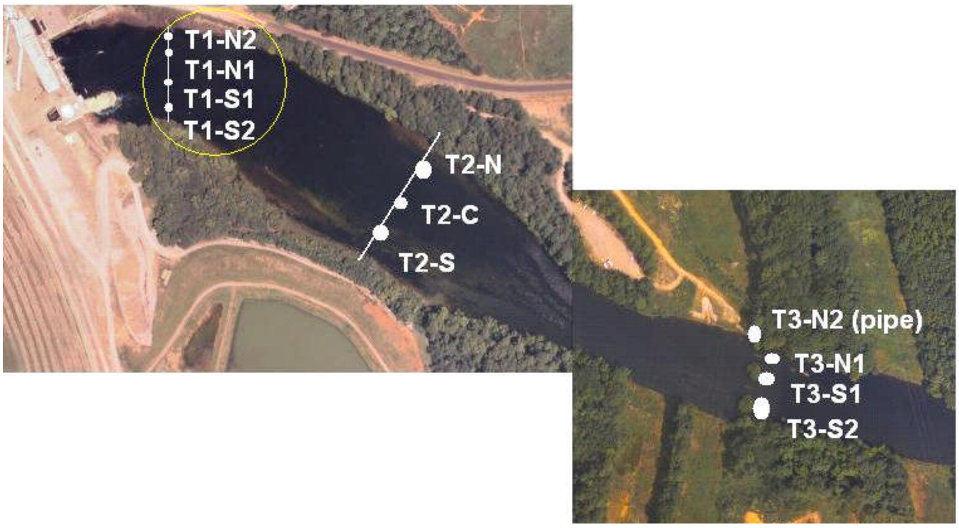


Figure 1: Aerial View of Tailrace with Locations of Transects and Deployed Monitors

6.0 DATA ANALYSES

The results of the tests are summarized in Figures 2 through 13 (also see Table 1 and Figures T1-T15 in appendices). Figures 2 through 7 present the results of the deployed monitors at each transect, for each run, and for each day that tests were conducted. Figures 8 through 13 present comparisons of results between transects for three monitoring approaches (the means of boat measured transects, 3 to 4 deployed monitors at each transect, the LDB-RDB monitors at each transect) and comparisons of results at each transect using these same three monitoring approaches. Table 2 presents a summary of the responsiveness of measurements at transects 2 and 3 to changes in operations at the powerhouse.

Graphical observations are as follows:

1. At transect 1 on November 1 (see Figure 2), the DO recorded by the two T-N1, N2 monitors varied significantly when more than one unit was operating (see runs 2, 3, 5, 7, 9), probably due to high turbulence in the tailrace and the mixing of different unit discharges—single monitors and single port intake pipes would not be advised in this area.

2. The minimum DO values recorded by the two T-N1,N2 monitors were as low as 1 to 2 mg/L during runs 3, 5, 7, and 8 but the minimum DO values recorded by the boat monitor were near 3 mg/L during these runs (see Figures 2 and 11 and T-3,5,7,8, and Table 1). A review of the minimum recorded DO levels at transects 2 and 3 do not indicate a systematic difference between results the boat monitor and the deployed monitors. These results indicate that vertical mixing was incomplete at the location of transect 1.
3. At transect 3 (see Figures 4 and 7) the variability in recorded DO measurements by all monitors dampened significantly indicating that vertical, lateral, and longitudinal diffusion resulted in mixing of the turbulent waters noted at transect 1, even though complete lateral mixing had not yet occurred.
4. The monitor at T3-pipe (adjacent to the USGS monitor) was consistently the last monitor to respond (see Figures 4 and 7) to changes in operations at the powerhouse (see runs 1,2,3,6,7,8,9,10,11,12,14,15.) For several of these runs, this monitor had not even stabilized by the time the run was terminated. One reason for this slow response might be that the monitor is incased in a pipe where water exchange rate is much less than for monitors placed in-situ. Another reason for this slow response can be seen by reviewing the aerial photograph of the tailwater and tracing the predominant water currents that would occur in a system like this. As the turbine discharges leave the powerhouse, the flow goes straight in the direction of the LDB, passes downstream along the LDB, passes through the narrow passage between transects 2 and 3, and then flows predominantly towards the RDB as it passes transect 3. Streamflow lines in this depiction of predominant flow patterns would indicate slower water currents at the location of the USGS monitor, thus the slower response time to changes in operations at the powerhouse.
5. Figure 8 presents the mean values of all the DO monitors used in the boat transects for each run. These results show that the mean values from all three monitor locations studied for all the runs were similar without any systematic deviations. These results indicate that the values of low DO measured by some of the deployed monitors at T1 apparently did not represent significant masses of water.

6. Figure 9 presents the mean values of all the deployed DO monitors used at the transects for each run. These results show that the mean values from T1 demonstrated systematic lower values compared to the other locations. As discussed above some of the monitors at T1 indicated that this location was not completely mixed vertically. Complete vertical mixing likely occurred a short distance downstream, i.e., within a few hundred feet.
7. Figures 8, 9, 12, and 13 show that there was a predominant pattern of the boat measured DO values being slightly greater than DO values recorded by the deployed monitors (i.e., the difference in mean DO values for all runs at T3 between the boat measurements and the measurements by the deployed monitors was 0.3 mg/L.) The reason for this difference is not known, but might have been caused by less fouling of the monitor used in the boat. Another reason might have been that the boat monitor measurements were more accurate since this approach involved 4 to 5 times as many measurements as the deployed monitors and represented more of the cross-sectional area of the transect.
8. Figures 10, 11, 12, and 13 present the results of using the mean values of the LDB and RDB monitors compared to the other monitoring approaches. It appears that results at T3 were acceptable, but that results at T1 indicated that monitors at LDB-RDB differed from the means of all deployed monitors greater than 0.5 mg/L on four occasions (i.e., runs 7,8,14, 15).
9. Minimum DO values recorded within transect measurements at T3 varied within the cross-section depending on operations at the powerhouse, i.e., sometimes minimum DO values were near the LDB, sometimes near RDB, and sometimes near the middle of the channel (see Figures 2 through 7 and T-1 through T-15). When aeration capability is fully implemented in the future, these same minimum DO patterns might occur but variations in DO would be much less in magnitude. Operational procedures and operational monitoring would eliminate or significantly reduce the occurrence of minimum DO values within the cross-section.

10. The response times for DO monitors to reach a steady reading after changes in operations at the powerhouse are shown in Table 2. On average the monitors at T2 responded in about 8 minutes whereas those at T3 (not including T3-pipe) responded in about 18 minutes. The maximum response times were 12 minutes at T2 and 25 minutes at T3. The minimum response times were 4 minutes at T2 and 12 minutes at T3 The average, maximum, and minimum response times at T3-pipe were 45, 60, and 20 minutes, respectively. An examination of the gate settings for the runs in Table 1 and corresponding response times in Table 2 shows that the amount of flow through the powerhouse is a major factor affecting response times at T2 and T3. Due to the variability in flow and unit operations at the Saluda Project, more responsive and frequent operational monitoring would likely be needed to help maximize water quality so that the standards would be attained.

Table 1: Operating Conditions During Runs

Operating Conditions during the Monitor Location Study								
Run #	**Day**	**Recorded Time (Beginning of Flow)**	**Recorded Time (End of Flow)**	**Level Logger Time (Beginning of Flow)**	**Level Logger Time (End of Flow)**	**Operating Conditions**	**Actual Gate Settings**	**Aeration Bypass Valves**
1	01-Nov-05		10:25 AM	9:33 AM	10:36 AM	U5 - 40%	37	Open
2	01-Nov-05	10:40 AM	11:13 AM	10:38 AM	11:17 AM	U1 - 50%, U5 - 40%	50 / 37	Unit 1 Closed
3	01-Nov-05	11:20 AM	11:46 AM	11:19 AM	11:56 AM	U1 - 80%, U5 - 40%	80 / 37	Unit 1 Closed
4	01-Nov-05	11:58 AM	12:22 PM	11:58 AM	12:35 PM	U1 - 50%, U5 - 80%	50 / 74	Unit 1 Closed
5	01-Nov-05	12:39 PM	1:08 PM	12:39 PM	1:18 PM	U2 - 50%, U5 - 80%	na	Unit 2 Closed
6	01-Nov-05	1:19 PM	1:55 PM	1:20 PM	1:59 PM	U5 - 80%	na	Open
7	01-Nov-05	2:10 PM	2:40 PM	2:02 PM	2:43 PM	U2 - 80%, U5 - 40%	80 / 39	Unit 2 Closed
8	01-Nov-05	2:41 PM	3:08 PM	2:44 PM	3:11 PM	U2 - 50%, U5 - 40%	na	Unit 2 Closed
9	01-Nov-05	3:08 PM		3:19 PM	3:57 PM	U1, U3 - 50%, U5 - 40%	na	Unit 1 Open Unit 3 Closed
10	03-Nov-05	8:01 AM	8:50 AM	7:57 AM	8:53 AM	U1 - 2200 cfs	70	Open
11	03-Nov-05	8:57 AM	9:22 AM	8:53 AM	9:27 AM	U1, U2 -2200 cfs each	70 / 70	Open
12	03-Nov-05	9:35 AM	9:56 AM	9:32 AM	9:58 AM	U1, U2, U3 - 2200 cfs each	70 / 70 / 70	U3 Closed
13	03-Nov-05	11:06 AM	11:30 AM	11:02 AM	11:33 AM	U1,U3 - 2200 cfs each U5 - 6000 cfs	70 / 70 / 76	U3 Closed
14	03-Nov-05	10:05 AM	10:25 AM	9:59 AM	10:36 AM	U1, U2, U3 - 2200 cfs each U5 - 6000 cfs	70 / 70 / 70 / 76	U3 Closed
15	03-Nov-05	10:41 AM	10:57 AM	10:37 AM	11:00 AM	U1, U2, U3 - 3200 cfs each U5 - 6000 cfs	95 / 97 / 95 / 76	U3 Closed

Table 2: Responsiveness of Monitor Locations to Operations at Saluda Powerhouse

RUN NUMBER	TRANSECT 2 MINUTES	TRANSECT 3 (Excluding T3-Pipe) MINUTES	T3-PIPE MINUTES
1	6	20	60
2	9	25	60
3	8	18	45+
4	8	15	35
5	10	15	45
6	10	20	37
7	9	16	38
8	7	15	45
9	11	19	na
10	8	22	65
11	10	20	na
12	12	17	na
13	5	12	20
14	4	13	na
15	na	na	na
Averages	**8**	**18**	**45**
Maximum	**12**	**25**	**60**
Minimum	**4**	**12**	**20**

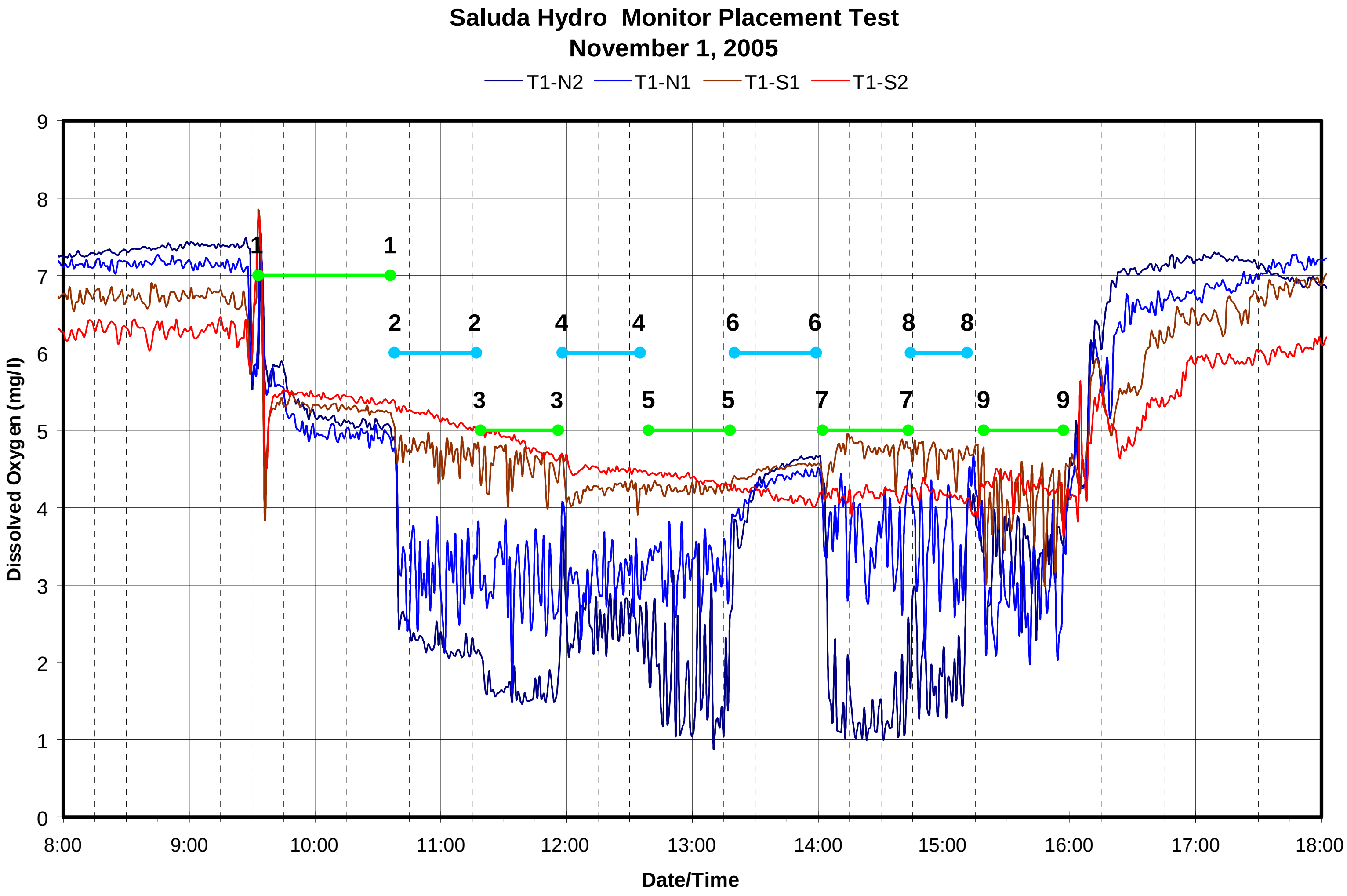


Figure 2: Results of Deployed DO Monitors at Transect 1 for Runs 1-9, November 1

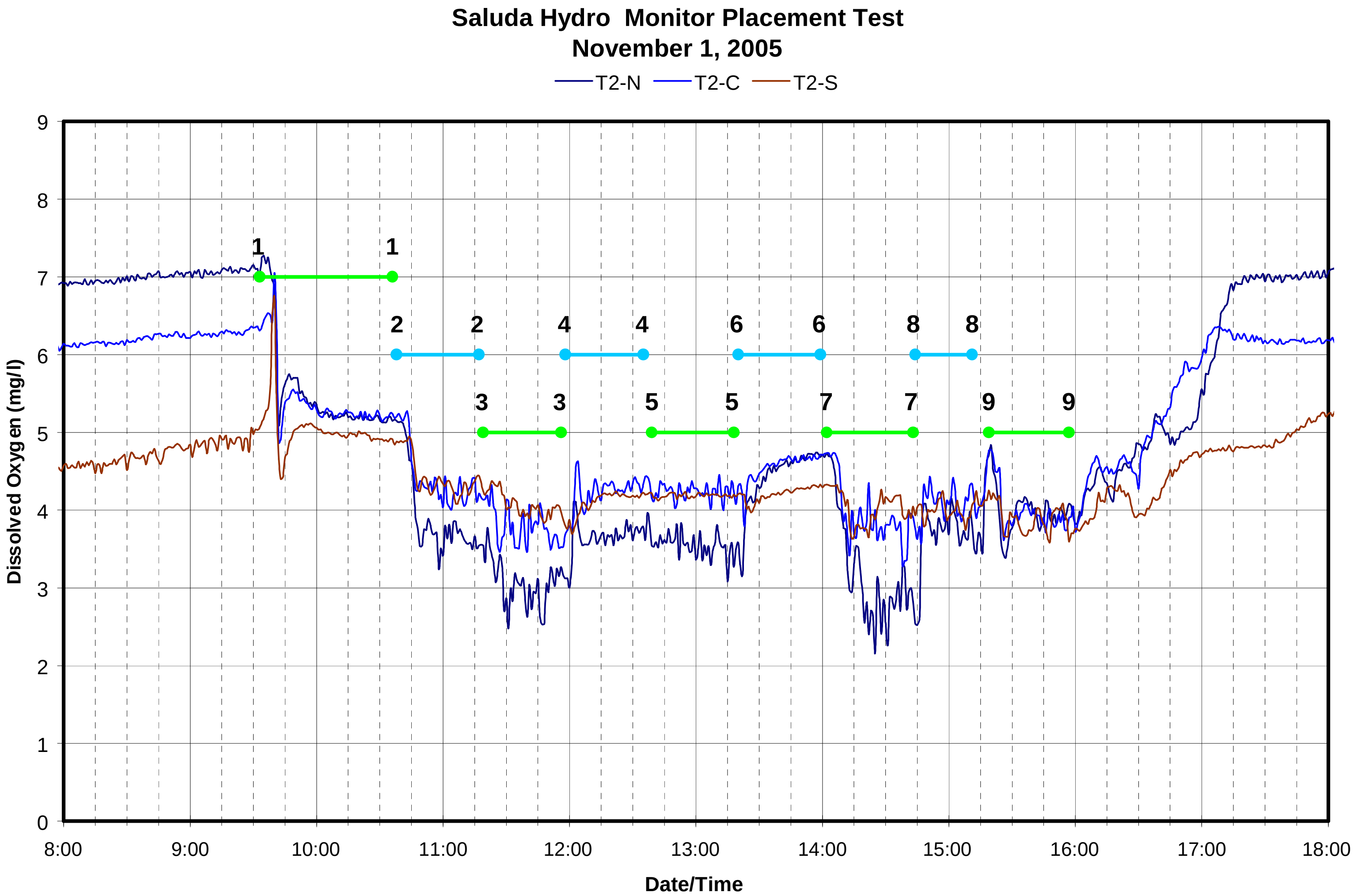


Figure 3: Results of Deployed DO Monitors at Transect 2 for Runs 1-9, November 1

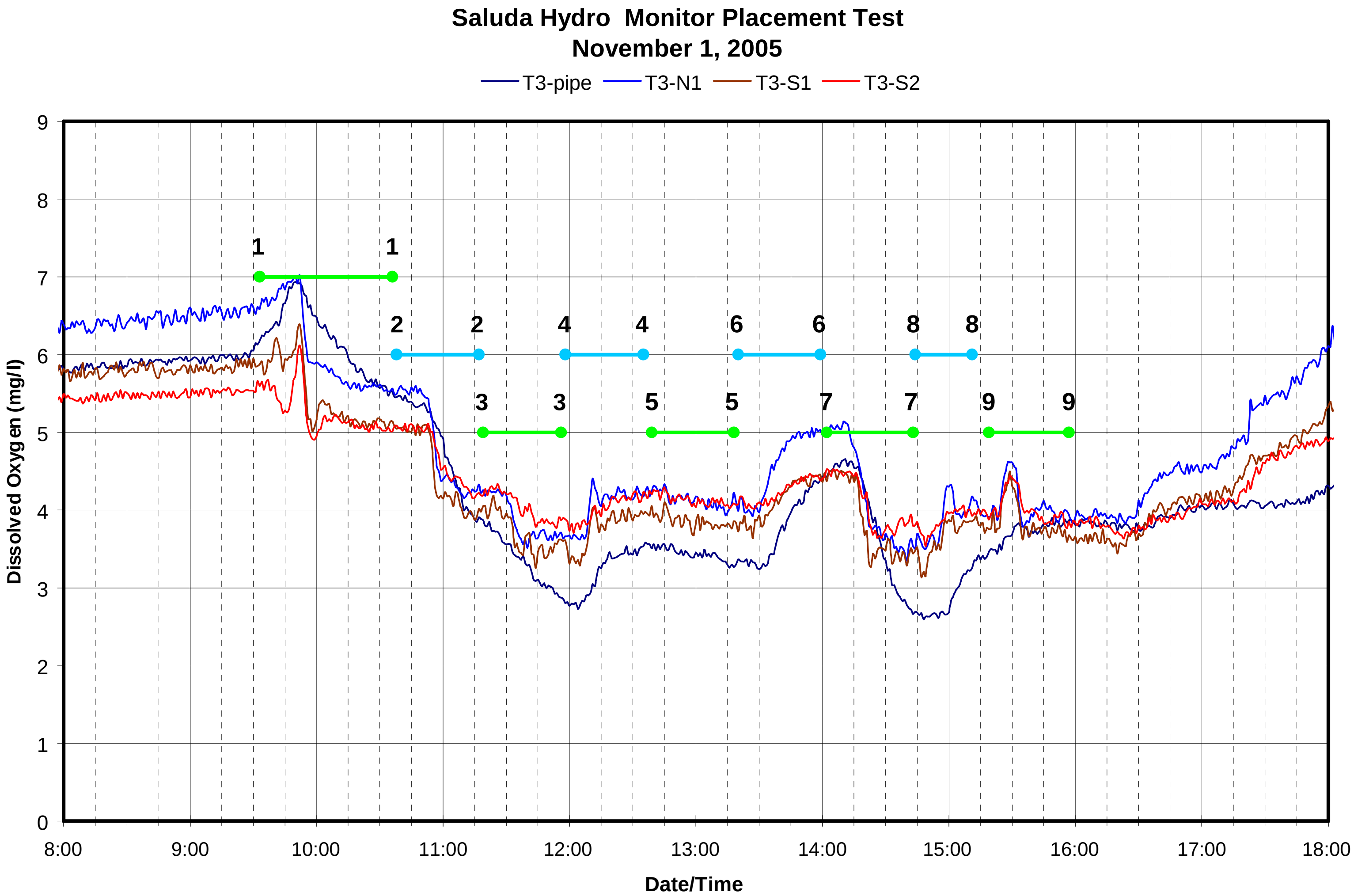


Figure 4: Results of Deployed DO Monitors at Transect 3 for Runs 1-9, November 1

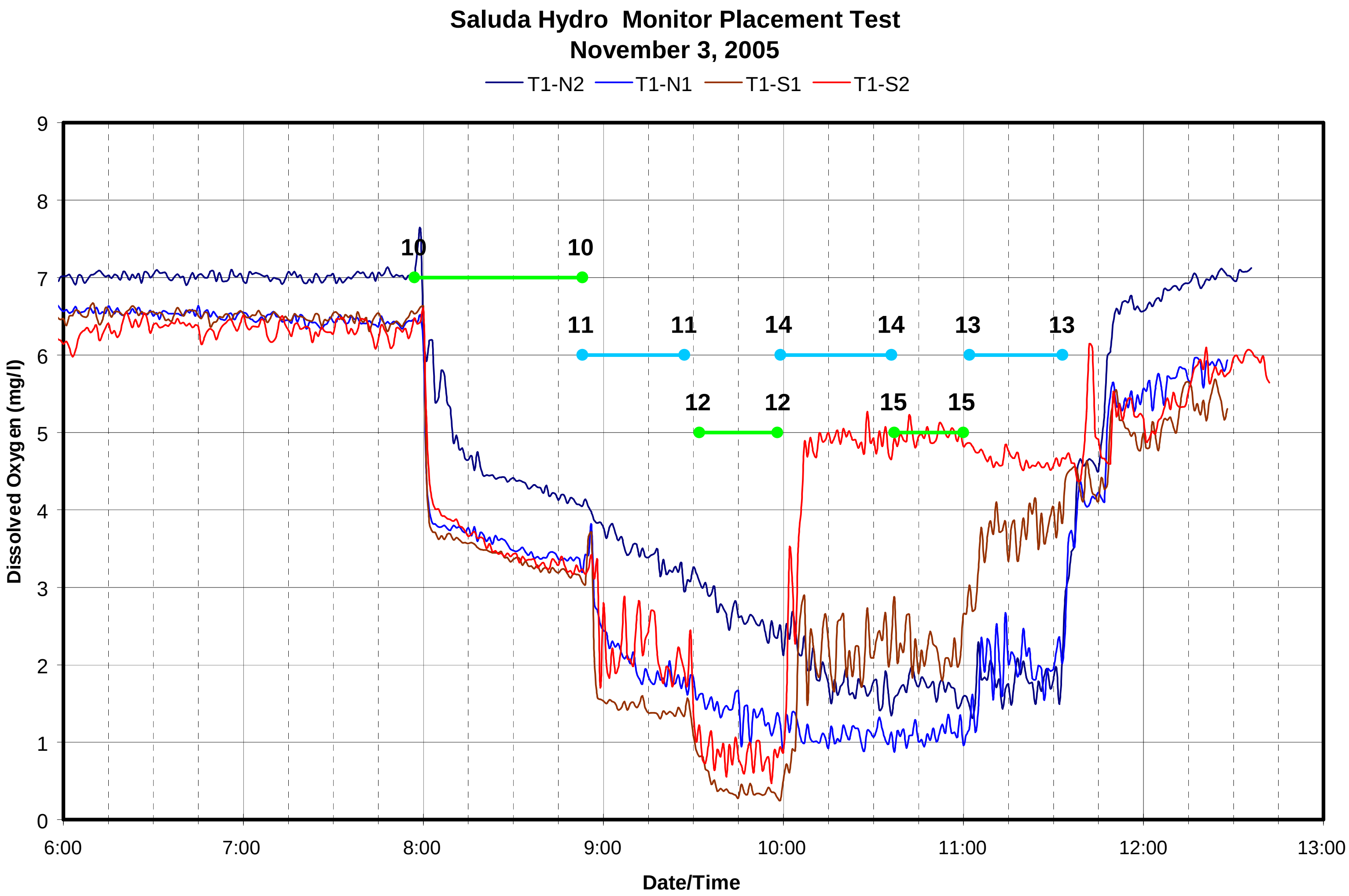


Figure 5: Results of Deployed DO Monitors at Transect 1 for Runs 10-15, November 3

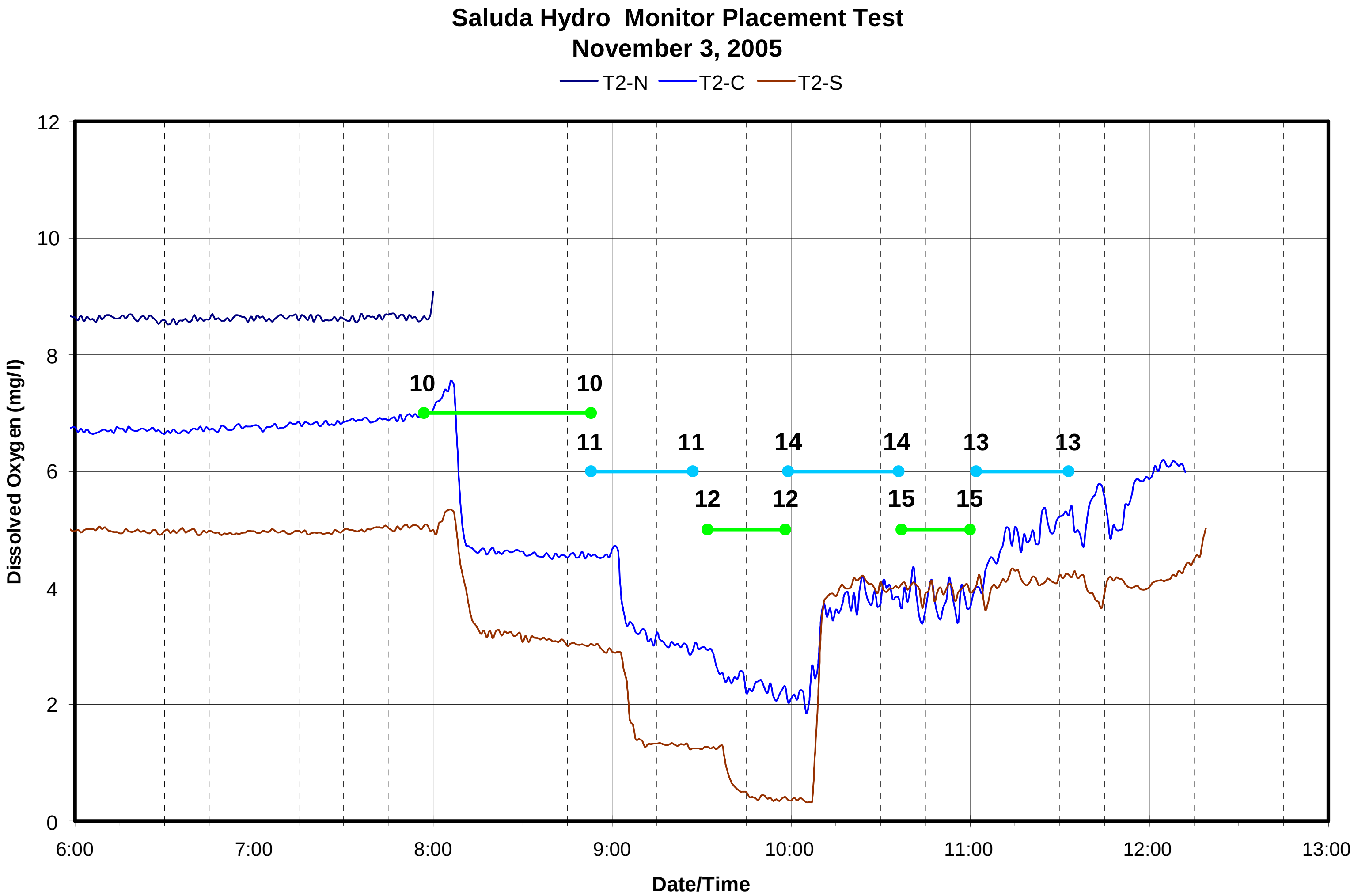


Figure 6: Results of Deployed DO Monitors at Transect 2 for Runs 10-15, November 3

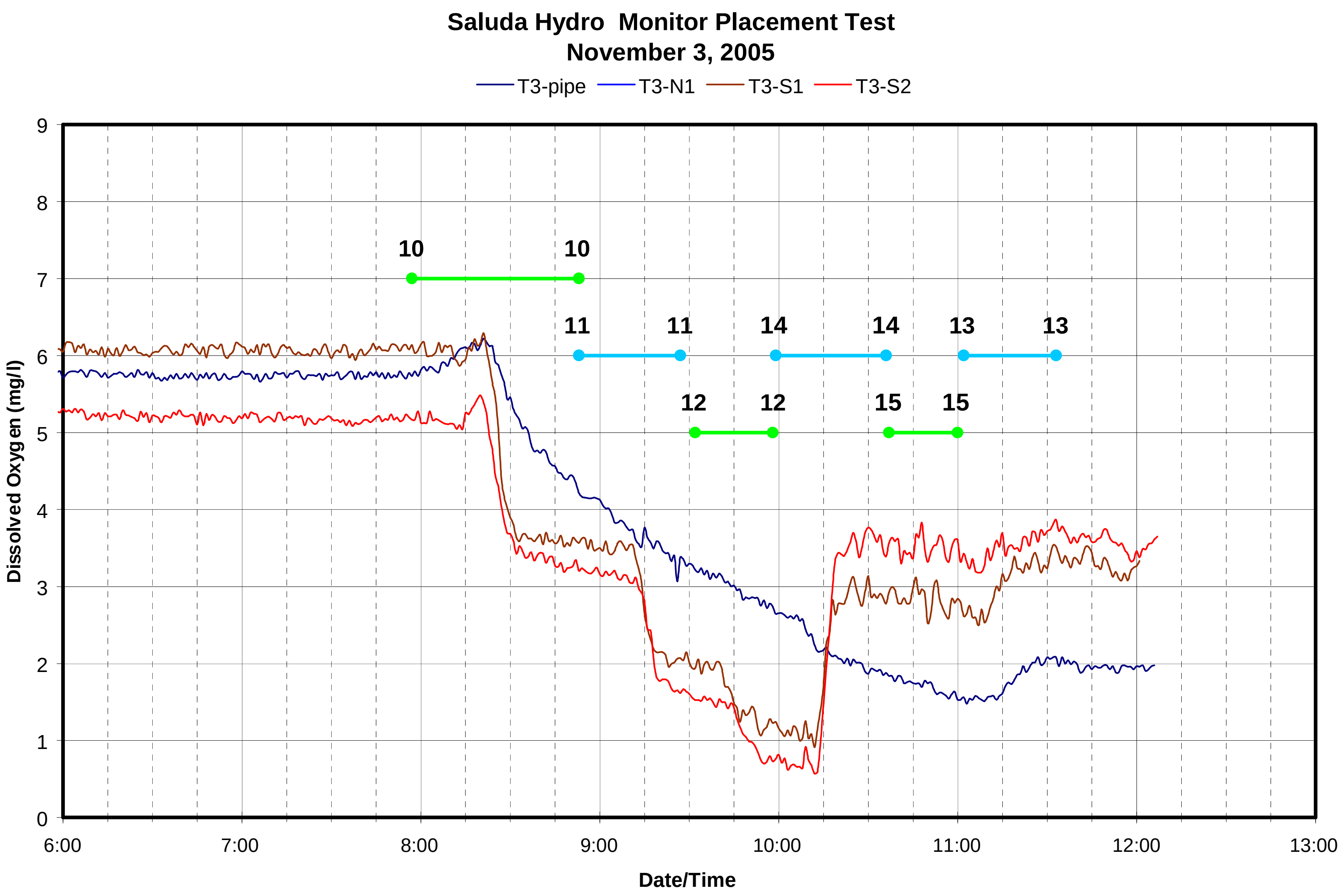


Figure 7: Results of deployed DO monitors at transect 3 for Runs 10-15, November 3 (note: N1 was not monitoring)

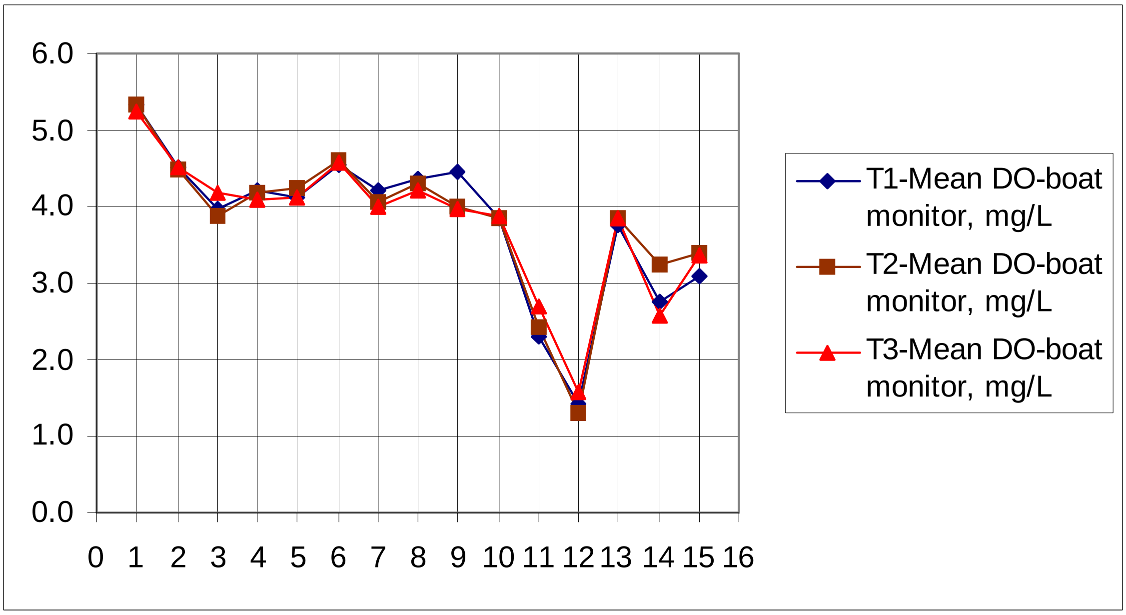


Figure 8: Mean Values of DO Monitors Used in Boat Transects for Each Run

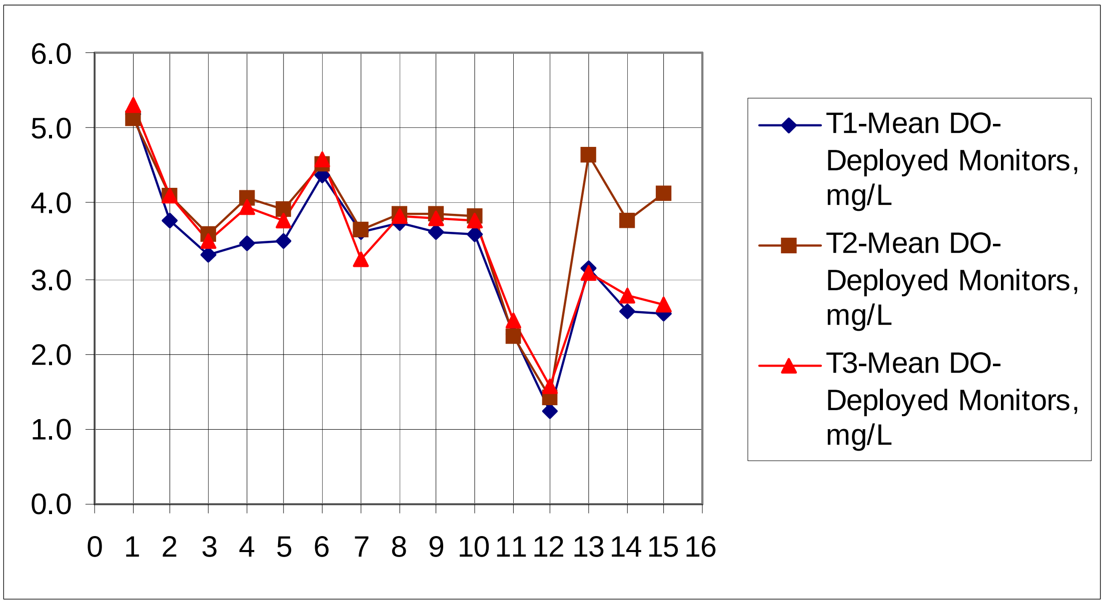


Figure 9: Mean Values of Deployed DO Monitors at Each Transect for Each Run (note that one of the deployed monitors at T2 was not operating for runs 10-15 so results for runs 13,14,15 should not be compared to the results for T1 and T3)

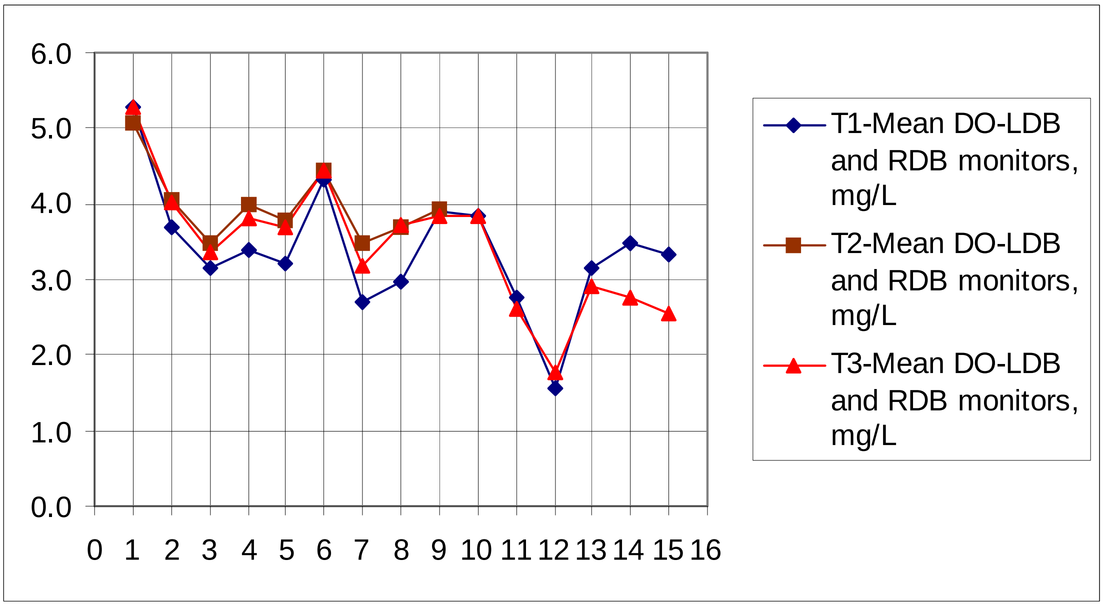


Figure 10: **Mean Values of Deployed DO Monitors on the LDB and RDB at Each Transect for Each Run (note that values were not available for T2 for runs 10-15)**

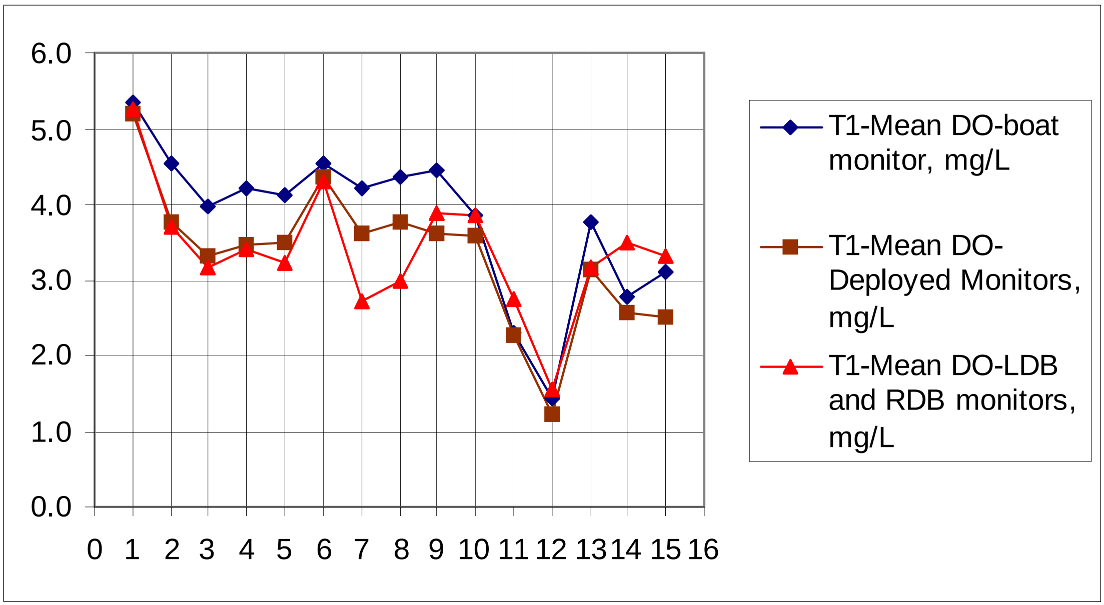


Figure 11: **Mean Values of DO Monitors Used in Boat Transects, All Deployed DO Monitors, and Deployed DO Monitors on LDB and RDB at Transect one for Each Run**

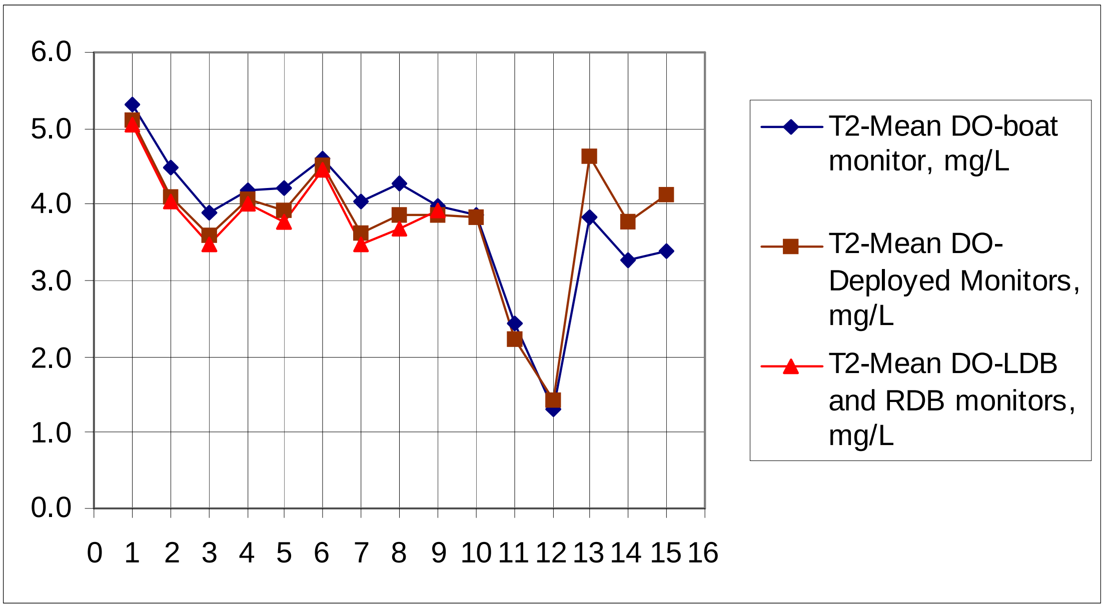


Figure 12: **Mean Values of DO Monitors Used in Boat Transects, All Deployed DO Monitors, and Deployed DO Monitors on LDB and RDB at Transect Two for Each Run**

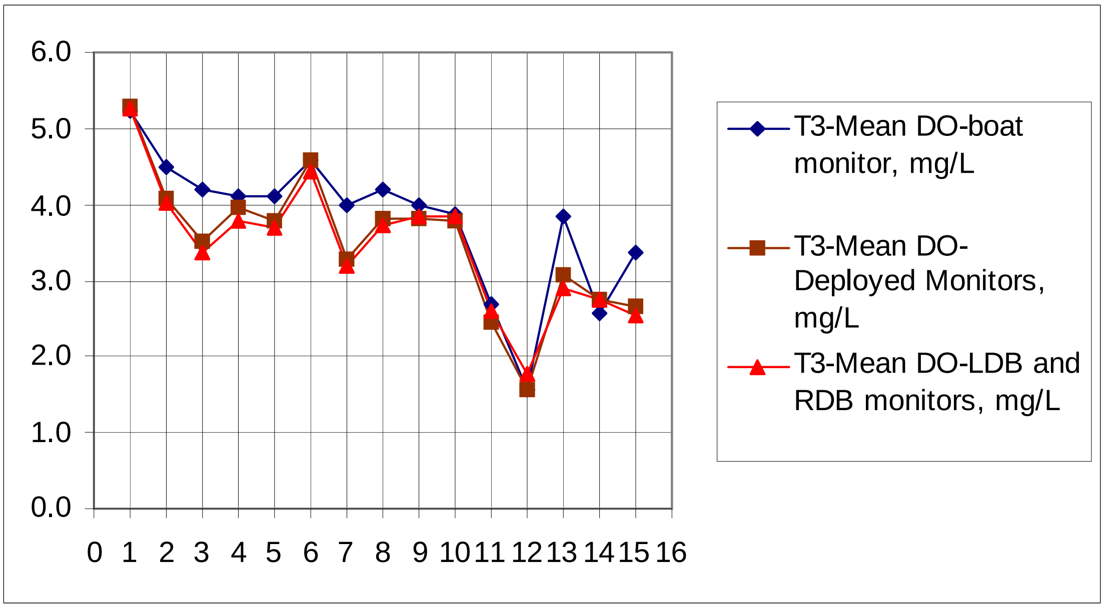


Figure 13: **Mean Values of DO Monitors Used in Boat Transects, All Deployed DO Monitors, and Deployed DO Monitors on LDB and RDB at Transect Three for Each Run**
(note monitor T3-N1 did not record data during runs 10-15)

6.1 Effects of Aquatic Plants on DO Monitoring

Studies conducted in 2003 revealed the effects of aquatic plants on DO monitoring results at the current monitor. Figure 14 shows the effects that respiration by plants had on DO in the early morning hours. The effects of respiration by plants on DO should be minimized in designing a system for instream water quality monitoring. At some locations around the country, the effects of plant respiration have been documented to have caused the minimum DO to decrease to less than 4 mg/L (e.g., Holston River in Tennessee, Catawba River in NC and SC, North Platte River in NE).

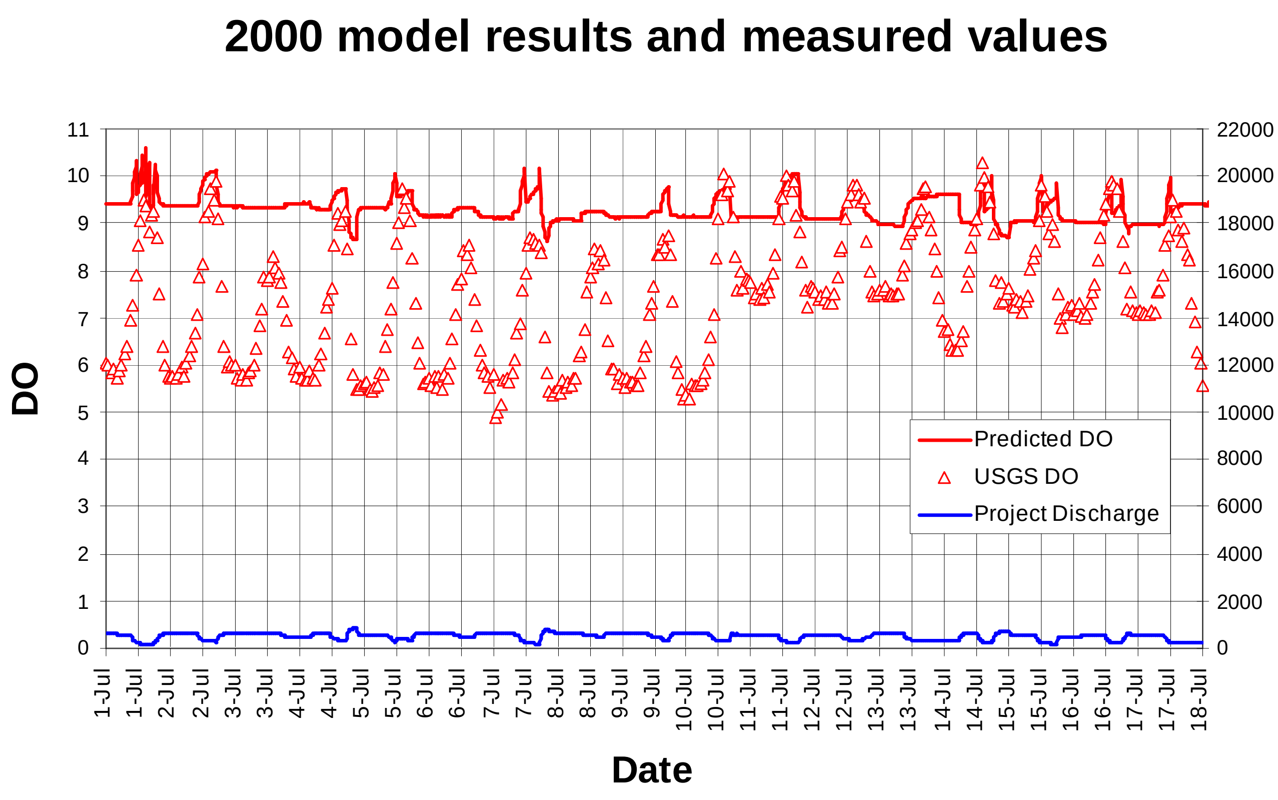


Figure 14: (Figure C-21 in 2003 Report on the Site-Specific DO Standard) Turbine Aeration Model Predictions for Discharges from Saluda Hydro Compared to Data from the USGS Monitor Downstream from the Dam – Showing the Effects of Respiration of the Aquatic Weeds on Measured DO During Early Morning Hours and Low Flow Conditions

6.2 <u>Considerations for Selecting a Monitoring Location and Approach</u>

There are a number of considerations when selecting a monitoring approach:

1. Instream water quality monitoring versus operational monitoring—each monitoring purpose has its own needs.
2. Instream water quality monitoring is for evaluating consistency with the water quality standards, that are linked to the protection of the aquatic life in the river.
3. Operational monitoring is for operating aeration systems and plant operations to enhance the probability that the instream water quality will conform to all elements of the water quality standard.
4. What is the most important variable to monitor protection of aquatic life, the mean DO at the instream water quality determination point (i.e., the location of a transect) or the minimum DO within the cross-section? The answer is the mean DO at the instream water quality determination point. The mean represents the mass of water moving downstream from the instream water quality determination point, whereas the minimum value represents only a small portion of the cross-section and a transient condition that occurs only periodically and continues only a short distance before mixing with water having higher DO and attaining the mean DO as measured at the instream water quality determination point. Minimum DO can occur at any location within a cross-section depending on unit operations and aeration of individual units. There is not a single-point location where a monitor can be placed to ensure accurate measurement of overall water quality vs. water quality criteria under all operations. For example, a LDB monitor at T3, only, would not always monitor the lowest DO.
5. The best location to monitor DO from an operational standpoint would be the first location downstream from the powerhouse where DO is mixed vertically in the water column, especially before aquatic plants can affect DO in the tailwater. However, even with the most commonly used aeration method (i.e., turbine venting), there is still mixing and aeration in the tailrace even if only one unit is operating.

6. Under current operating conditions, response time is not too important since Saluda is not equipped with remote operating monitors and controls for the aeration systems now in place. However, when future aeration control systems may be in place, response time would be more important so that the systems could enhance the probability that the instream water quality will conform to the DO standard.
7. Due to the variability in flow and unit operations at the Saluda Project, more responsive and frequent operational monitoring would likely be needed to help maximize water quality so that the DO standard substantially would be attained.
8. Cost—initial installation and long-term maintenance. These considerations are important, but were not considered in this study.

The above considerations were discussed at the Annual Saluda Hydro Operations Meeting on March 23, 2006, and a number of attendees suggested that a midpoint location be considered at Transect 3, the current location of the USGS monitor. Following is a portion of the minutes of the meeting:

> The group began to discuss which area would be best for the monitor relocation. Jim noted that his observations have shown that a spot in transect 3 looks promising. Steve Summer explained that he has hopes of the group agreeing on one location rather than pulling water samples from multiple locations.
>
> …. Gerrit Jobsis expressed concern that there was the possibility that one gage location may not pick up dissolved oxygen (DO) variation across the river if one unit was not working correctly. Jim noted that situation may still be found even if there were two monitors or even three. Gina Kirkland explained that they typically give some relief for a mixing area, however, that they would need to determine what defined compliance and how far downstream mixing would be allowed to occur. She also expressed her concern about the installment of two or more monitoring stations. She explained that if there is a large difference in readings you have to determine which monitor is reading correctly and if compliance is being met.
>
> Alan explained to the group how the units were currently venting. He noted that Jim Carter had just performed tests on unit 4 and it was shown to vent very well, similarly to unit one. It was also explained that Units 2 and 3 are in the initial stages of having their seals repaired and should be ready for the testing in October. Gina asked if for future maintenance SCE&G would periodically test the intake air to make sure it is operating well over time. Steve Summer noted that he thought that it may be something to consider. He added that normally if they run a unit and it is not venting correctly it is apparent.

Bill Argentieri began to explain to the group what research has been done on the USGS monitor relocation. He noted that SCE&G has had discussions with USGS on a flow through design monitor, however, USGS has had serious maintenance and piping issues with this model in the past. Bill also noted they have had Jim Ruane look into a better single location for a USGS monitor as well. The group began to discuss the monitor relocation issue in a little more detail and asked Carlton Wood to give a little feedback on this issue.

Carlton explained that USGS attempts to locate a continuous monitor in a location that is representative of the mean as shown by transects. He noted that he was certain that the present location of the monitor is extremely biased towards the negative regarding DO values and that he has personally observed large masses of aquatic vegetation hanging on the housing and suffocating the monitor. Steve Summer added that aerial inspections have shown longitudinal beds of Elodea near the bank. Carlton then continued to explain that he believes that bank erosion or run-off is causing an orange film on the membrane that you would not typically observe out towards the middle of the river. Carlton pointed out that if it was decided that a single location would be used, he would suggest a location towards the middle of the channel. He noted that they can also increase the inspections at necessary times of the year as well.

Gina Kirkland noted that she was comfortable having a single location. She explained that part of the reason why she was comfortable with the single location is because there are margins of safety built into the standard and an occasional exceedence from the standard would not cause a huge problem with the stream. Gerrit noted that he was still concerned with an average condition obtained from one monitor location, however, he did noted that an average condition may be acceptable if there was a commitment from SCE&G not to operate a unit when it is not running properly and if there was some kind of routine maintenance agreement. Gina then asked Gerrit if there was a percentage that could be acceptable because operating at 90 percent was still good. Gerrit noted that there may be a particular number that he could agree to.

In response to Gerrit's previous concern, Steve Summer explained that there were some instances under which SCE&G would have to run the units, even if they were not venting fully. He gave an example of a high rainfall event, and noted that if a hurricane was immanent that they would have to run the units to prepare. Steve also noted that they would need to maintain their reserve capabilities if a unit went down elsewhere.

Considering these comments, a midpoint location was evaluated using the data collected during the monitor location study and considering future aeration capabilities and operational monitoring approaches for the aeration systems.

Table 3 summarizes the results of the monitor evaluations at Transect 3, including the results of the boat transects, the four deployed monitors, the LDB and RDB monitors, and the monitor at the mid-point location. The comparisons between the four monitoring approaches show that the midpoint location is about as representative as the other approaches. Considering

Table 3: Comparison of the performance of the DO monitor at the midpoint of Transect 3 to the other monitoring approaches

Run #	Day	Operating Conditions and Gate Settings	Aeration Bypass Valves	Avg time of transect	T3-Mean DO-boat monitor, mg/L	Mean DO-Deployed Monitors, mg/L	Mean DO-LDB and RDB monitors, mg/L	Minimum DO-boat monitor, mg/L	Minimum DO-Deployed Monitors, mg/L	Minimum DO-LDB and RDB monitors, mg/L	Midpoint, location T3-S1
1	01-Nov-05	U5 - 37%	Open	10:35	5.24	5.30	5.27	5.20	5.02	5.02	5.14
2	01-Nov-05	U1 - 50%, U5 - 37%	Unit 1 Closed	11:19	4.50	4.09	4.03	3.70	3.87	3.87	4.05
3	01-Nov-05	U1 - 80%, U5 - 37%	Unit 1 Closed	11:53	4.20	3.50	3.36	3.20	2.92	2.92	3.57
4	01-Nov-05	U1 - 50%, U5 - 74%	Unit 1 Closed	12:28	4.10	3.95	3.80	3.60	3.43	3.43	4.03
5	01-Nov-05	U2 - 50%, U5 - 74%	Unit 2 Closed	13:14	4.12	3.78	3.70	3.40	3.34	3.34	3.79
6	01-Nov-05	U5 - 74%	Open	14:01	4.59	4.59	4.44	4.50	4.43	4.43	4.48
7	01-Nov-05	U2 - 80%, U5 - 39%	Unit 2 Closed	14:47	4.00	3.27	3.18	2.60	2.67	2.67	3.13
8	01-Nov-05	U2 - 50%, U5 - 39%	Unit 2 Closed	15:14	4.20	3.82	3.72	3.70	3.42	3.42	3.81
9	01-Nov-05	U1, U3 - 50%, U5 - 39%	Unit 1 Open Unit 3 Closed	16:02	3.98	3.80	3.83	3.90	3.63	3.79	3.63
10	03-Nov-05	U1 - 2200 cfs, 70%	Open	8:51	3.87	3.78	3.85	3.70	3.27	3.27	3.63
11	03-Nov-05	U1, U2 -2200 cfs each, 70%	Open	9:22	2.68	2.45	2.61	2.10	1.79	1.79	2.11
12	03-Nov-05	J1, U2, U3 - 2200 cfs each, 70%	U3 Closed	9:55	1.57	1.55	1.76	1.00	0.70	0.70	1.14
13	03-Nov-05	U1,U3 - 2200 cfs each, 70% U5 - 6000 cfs, 76%	U3 Closed	11:31	3.84	3.07	2.90	2.90	2.06	2.06	3.40
14	03-Nov-05	U1, U2, U3 - 2200 cfs each U5 - 6000 cfs	U3 Closed	10:20	2.57	2.76	2.75	na	2.06	2.06	2.78
15	03-Nov-05	U1, U2, U3 - 3200 cfs each, 96% U5 - 6000 cfs, 76%	U3 Closed	10:58	3.37	2.65	2.56	2.10	1.60	1.60	2.84

the **mean** DO concentrations at Transect 3, the monitor results at the midpoint location were about the same as for the other approaches for 11 runs and was marginally (i.e., 0.2 to 0.4 mg/L) less than the means of the other approaches for 4 runs (i.e., runs 9-12). Therefore, with respect to the mean concentrations determined for the four approaches, the midpoint location was marginally conservative towards exceeding the mean values determined by the other approaches. It is also interesting to note that the mean values of DO for all the deployed monitors for the duration of the monitor location study was essentially the same as the mean value obtained using the monitor at the midpoint location, i.e., 5.50 mg/L for all four monitors and 5.53 mg/L for the midpoint location.

Considering the **minimum** DO concentrations at Transect 3, the monitor results at the midpoint location were greater than the minimum concentrations determined using the other approaches for 11 runs, but this difference was caused to some extent by the monitor that was located adjacent to the current USGS monitor near the LDB. The other cause for the difference between the midpoint location and the minimum observed DO in the transect was that aeration was zero or very low on one or two of the original units during the various runs. However, it is significant to note that even considering that aeration was not occurring on one or two of the units during these 11 runs, the minimum recorded DO was usually only 0.4-0.7 mg/L less than the midpoint location. Also, the greatest differences measured between the midpoint location and the minimum observed DO were 1.2 and 1.3 mg/L, and these occurred when two of the original units were not aerating (U3 valves were closed and U2 was not drawing much airflow since the tailwater elevation was high and it was not drawing much air anyway since the headcover seals were leaking.)

Hence, when the aeration systems are in place for all the units, the midpoint location at Transect 3 should provide representative monitoring results. Based on the aeration studies conducted in 2005 on Unit 1, headcover measurements in 2006 on Unit 4, and the design approach to placing hub baffles on Units 2 and 3, it is now anticipated that the original four units are likely to have similar aeration characteristics. To address the concern about knowing whether individual units are being aerated, operational procedures and monitoring of the aeration systems for each unit would be best. Operational procedures can be developed and implemented using handbooks, training, and QA/QC practices. Operational monitoring, as needed, can be used to track the performance of aeration systems. Turbine aeration systems can be monitored using airflow monitors or periodic spot measurements to confirm that sufficient airflow is being drawn into the units. A similar approach could be used to monitor headcover pressures. These approaches are much more reliable and less expensive than DO monitors. Such devices do not require frequent calibration and maintenance, and they have a long life span (i.e., decades). Also, airflow or headcover measurements would provide the best "early warning" information regarding the performance of the turbine aeration systems. If oxygen was to be used to supplement turbine aeration, there are similar measurements that could be used to monitor operational performance.

It should also be noted that even if Unit 5 is aerated differently than the original units and possibly aerated to a lower level of DO, it is likely that this will not impact tailwater aquatic life. Unit 5 is likely to continue to be operated using a preferential procedure of "last on, first off" during the low DO period until temperature in the surface layer of Lake Murray is sufficiently cool for striped bass and the DO at the intake of Unit 5 is sufficient to provide the desired DO target in the tailrace. Under this operating procedure, Unit 5 would be operated very infrequently.

6.3 Conclusions and Recommendations

- A DO monitoring system supplied with water from the river using a multi-port intake pipe or a multi-pipe intake system would provide the best measure of representative DO in the river. This approach is much less subject to bias than considering any one location in a cross-section, and it represents a more robust measurement of DO in the system than any other approach. This approach would produce a mean of 10-20 "measurements" in the cross-section and would be more accurate for mean DO measurements at a cross-section than a limited number (three or four) of monitors. However, USGS experience has indicated that this approach is not practical. Also, preliminary considerations for the design of such a system indicates that intake ports in the pipe would need to be very small likely resulting in plugging.
- A desired location for an operational monitor is a short distance downstream from Transect 1. This location would be more responsive and minimize the effects of respiration by aquatic plants. However, the study indicated that mixing may not be complete at this location. Also, velocities in the region are high.

- The best overall location and monitoring approach appears to be a midpoint monitor setup at the site of the USGS gage (i.e., Transect 3). The study showed that this location is representative of conditions at this location. This location would be more desirable than the current LDB location that is less responsive, experiences more problems with fouling due to the accumulation of weeds, is less representative of DO in the transect, and experiences impacts from runoff events.
- River DO monitoring could be supplemented by powerhouse operational monitoring of airflows to or headcovers of the units. These measurements would allow operators to monitor aeration performance of individual units and to take appropriate steps to maintain aeration systems at their desired levels of operation.

APPENDIX A

SUMMARY RESULTS OF TRANSECTS – TABULATED

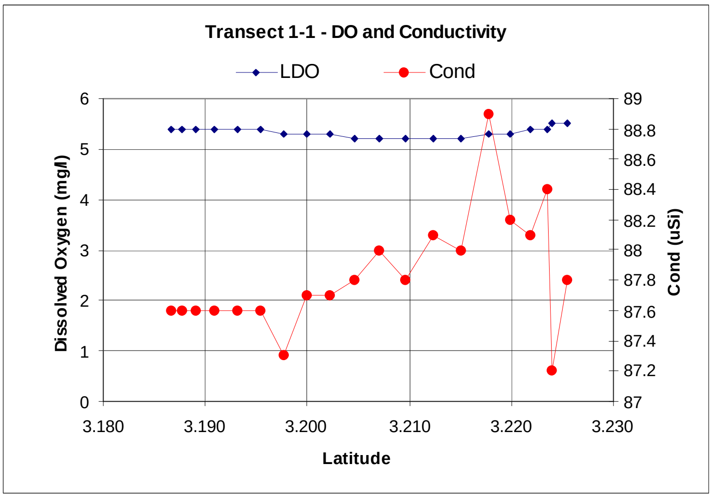
Summary of DO Monitoring Results during Recorded Operating Conditions during the Monitor Location Study											
						Transect 1					
Run #	Day	Level Logger Time (Beginning of Flow)	Level Logger Time (End of Flow)	Operating Conditions and Gate Settings	Aeration Bypass Valves	T1-Mean DO-boat monitor, mg/L	Mean DO-Deployed Monitors, mg/L	Mean DO-LDB and RDB monitors, mg/L	Minimum DO-boat monitor, mg/L	Minimum DO-Deployed Monitors, mg/L	Minimum DO-LDB and RDB monitors, mg/L
1	01-Nov-05	9:33	10:36	U5 - 37%	Open	5.34	5.19	5.27	5.20	4.96	5.15
2	01-Nov-05	10:38	11:17	U1 - 50%, U5 - 37%	Unit 1 Closed	4.53	3.77	3.69	3.70	2.22	2.22
3	01-Nov-05	11:19	11:56	U1 - 80%, U5 - 37%	Unit 1 Closed	3.98	3.31	3.16	2.70	1.46	1.46
4	01-Nov-05	11:58	12:35	U1 - 50%, U5 - 74%	Unit 1 Closed	4.20	3.47	3.39	3.60	2.32	2.32
5	01-Nov-05	12:39	13:18	U2 - 50%, U5 - 74%	Unit 2 Closed	4.11	3.51	3.22	3.60	1.99	1.99
6	01-Nov-05	13:20	13:59	U5 - 74%	Open	4.55	4.37	4.31	4.40	4.14	4.14
7	01-Nov-05	14:02	14:43	U2 - 80%, U5 - 39%	Unit 2 Closed	4.20	3.61	2.71	3.00	1.15	1.15
8	01-Nov-05	14:44	15:11	U2 - 50%, U5 - 39%	Unit 2 Closed	4.35	3.75	2.97	3.00	1.81	1.81
9	01-Nov-05	15:19	15:57	U1, U3 - 50%, U5 - 39%	Unit 1 Open Unit 3 Closed	4.45	3.61	3.89	3.50	2.46	3.60
10	03-Nov-05	7:57	8:53	U1 - 2200 cfs, 70%	Open	3.84	3.57	3.84	3.50	3.24	3.36
11	03-Nov-05	8:53	9:27	U1, U2 -2200 cfs each, 70%	Open	2.30	2.26	2.75	1.80	1.41	2.08
12	03-Nov-05	9:32	9:58	U1, U2, U3 - 2200 cfs each, 70%	U3 Closed	1.43	1.23	1.56	0.60	0.35	0.60
13	03-Nov-05	11:02	11:33	U1,U3 - 2200 cfs each, 70% U5 - 6000 cfs, 76%	U3 Closed	3.77	3.15	3.15	2.50	1.76	1.76
14	03-Nov-05	9:59	10:36	U1, U2, U3 - 2200 cfs each U5 - 6000 cfs	U3 Closed	2.76	2.55	3.48	1.60	1.01	2.22
15	03-Nov-05	10:37	11:00	U1, U2, U3 - 3200 cfs each, 96% U5 - 6000 cfs, 76%	U3 Closed	3.10	2.52	3.32	1.90	1.18	1.78

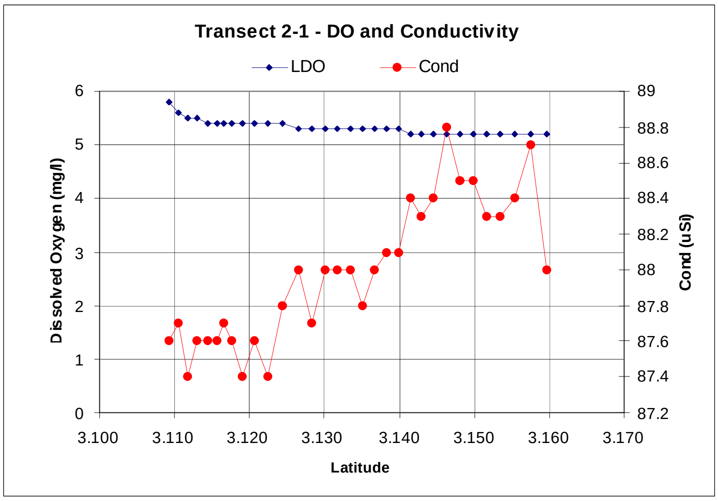
Summary of DO Monitoring Results during Recorded Operating Conditions during the Monitor Location Study											
						Transect 2					
Run #	Day	Level Logger Time (Beginning of Flow)	Level Logger Time (End of Flow)	Operating Conditions and Gate Settings	Aeration Bypass Valves	T2-Mean DO-boat monitor, mg/L	Mean DO-Deployed Monitors, mg/L	Mean DO-LDB and RDB monitors, mg/L	Minimum DO-boat monitor, mg/L	Minimum DO-Deployed Monitors, mg/L	Minimum DO-LDB and RDB monitors, mg/L
1	01-Nov-05	9:33	10:36	U5 - 37%	Open	5.33	5.12	5.06	5.20	4.91	4.91
2	01-Nov-05	10:38	11:17	U1 - 50%, U5 - 37%	Unit 1 Closed	4.47	4.10	4.04	3.30	3.85	3.85
3	01-Nov-05	11:19	11:56	U1 - 80%, U5 - 37%	Unit 1 Closed	3.89	3.60	3.47	2.80	2.93	2.93
4	01-Nov-05	11:58	12:35	U1 - 50%, U5 - 74%	Unit 1 Closed	4.19	4.08	4.00	3.60	3.77	3.77
5	01-Nov-05	12:39	13:18	U2 - 50%, U5 - 74%	Unit 2 Closed	4.23	3.92	3.77	3.40	3.35	3.35
6	01-Nov-05	13:20	13:59	U5 - 74%	Open	4.60	4.51	4.45	4.50	4.27	4.27
7	01-Nov-05	14:02	14:43	U2 - 80%, U5 - 39%	Unit 2 Closed	4.05	3.63	3.47	2.60	2.95	2.95
8	01-Nov-05	14:44	15:11	U2 - 50%, U5 - 39%	Unit 2 Closed	4.29	3.85	3.69	4.10	3.64	3.64
9	01-Nov-05	15:19	15:57	U1, U3 - 50%, U5 - 39%	Unit 1 Open Unit 3 Closed	3.99	3.87	3.93	3.70	3.75	3.87
10	03-Nov-05	7:57	8:53	U1 - 2200 cfs, 70%	Open	3.86	3.82	na	3.60	3.08	na
11	03-Nov-05	8:53	9:27	U1, U2 -2200 cfs each, 70%	Open	2.44	2.23	na	1.70	1.34	na
12	03-Nov-05	9:32	9:58	U1, U2, U3 - 2200 cfs each, 70%	U3 Closed	1.31	1.43	na	0.70	0.44	na
13	03-Nov-05	11:02	11:33	U1,U3 - 2200 cfs each, 70% U5 - 6000 cfs, 76%	U3 Closed	3.83	4.64	na	2.80	4.16	na
14	03-Nov-05	9:59	10:36	U1, U2, U3 - 2200 cfs each U5 - 6000 cfs	U3 Closed	3.26	3.77	na	2.00	3.58	na
15	03-Nov-05	10:37	11:00	U1, U2, U3 - 3200 cfs each, 96% U5 - 6000 cfs, 76%	U3 Closed	3.39	4.13	na	1.90	4.08	na

Summary of DO Monitoring Results during Recorded Operating Conditions during the Monitor Location Study											
						Transect 3					
Run #	Day	Level Logger Time (Beginning of Flow)	Level Logger Time (End of Flow)	Operating Conditions and Gate Settings	Aeration Bypass Valves	T3-Mean DO-boat monitor, mg/L	Mean DO-Deployed Monitors, mg/L	Mean DO-LDB and RDB monitors, mg/L	Minimum DO-boat monitor, mg/L	Minimum DO-Deployed Monitors, mg/L	Minimum DO-LDB and RDB monitors, mg/L
1	01-Nov-05	9:33	10:36	U5 - 37%	Open	5.24	5.30	5.27	5.20	5.02	5.02
2	01-Nov-05	10:38	11:17	U1 - 50%, U5 - 37%	Unit 1 Closed	4.50	4.09	4.03	3.70	3.87	3.87
3	01-Nov-05	11:19	11:56	U1 - 80%, U5 - 37%	Unit 1 Closed	4.20	3.50	3.36	3.20	2.92	2.92
4	01-Nov-05	11:58	12:35	U1 - 50%, U5 - 74%	Unit 1 Closed	4.10	3.95	3.80	3.60	3.43	3.43
5	01-Nov-05	12:39	13:18	U2 - 50%, U5 - 74%	Unit 2 Closed	4.12	3.78	3.70	3.40	3.34	3.34
6	01-Nov-05	13:20	13:59	U5 - 74%	Open	4.59	4.59	4.44	4.50	4.43	4.43
7	01-Nov-05	14:02	14:43	U2 - 80%, U5 - 39%	Unit 2 Closed	4.00	3.27	3.18	2.60	2.67	2.67
8	01-Nov-05	14:44	15:11	U2 - 50%, U5 - 39%	Unit 2 Closed	4.20	3.82	3.72	3.70	3.42	3.42
9	01-Nov-05	15:19	15:57	U1, U3 - 50%, U5 - 39%	Unit 1 Open Unit 3 Closed	3.98	3.80	3.83	3.90	3.63	3.79
10	03-Nov-05	7:57	8:53	U1 - 2200 cfs, 70%	Open	3.87	3.78	3.85	3.70	3.27	3.27
11	03-Nov-05	8:53	9:27	U1, U2 -2200 cfs each, 70%	Open	2.68	2.45	2.61	2.10	1.79	1.79
12	03-Nov-05	9:32	9:58	J1, U2, U3 - 2200 cfs each, 70%	U3 Closed	1.57	1.55	1.76	1.00	0.70	0.70
13	03-Nov-05	11:02	11:33	U1,U3 - 2200 cfs each, 70% U5 - 6000 cfs, 76%	U3 Closed	3.84	3.07	2.90	2.90	2.06	2.06
14	03-Nov-05	9:59	10:36	U1, U2, U3 - 2200 cfs each U5 - 6000 cfs	U3 Closed	2.57	2.76	2.75	0.50	2.06	2.06
15	03-Nov-05	10:37	11:00	U1, U2, U3 - 3200 cfs each, 96% U5 - 6000 cfs, 76%	U3 Closed	3.37	2.65	2.56	2.10	1.60	1.60

APPENDIX T

RESULTS OF TRANSECTS – PLOTTED





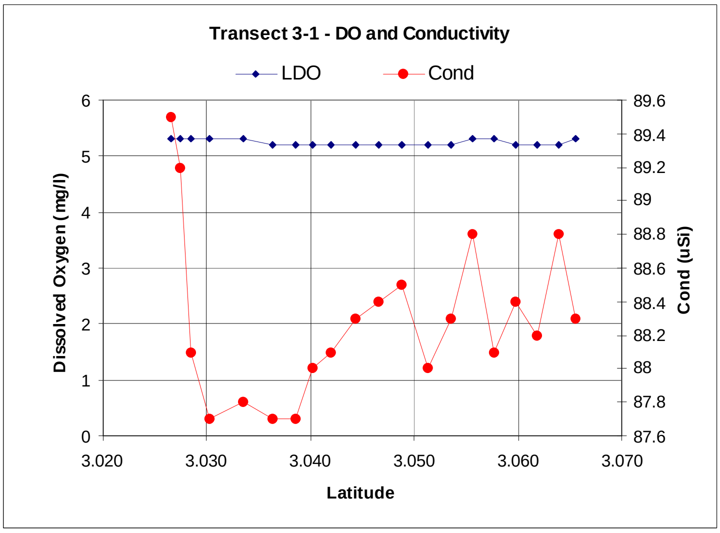
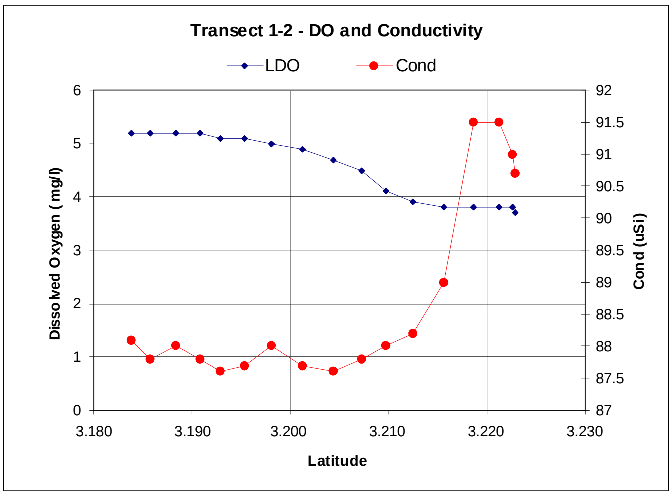
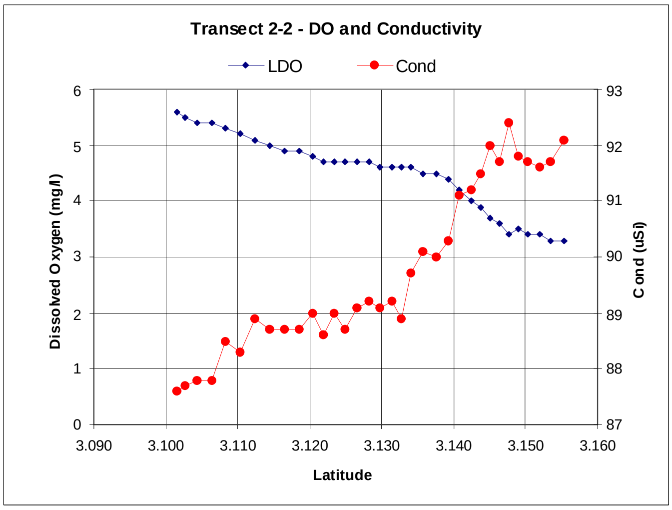


Figure T-1: Run 1 – Unit 5 at 37% Gate





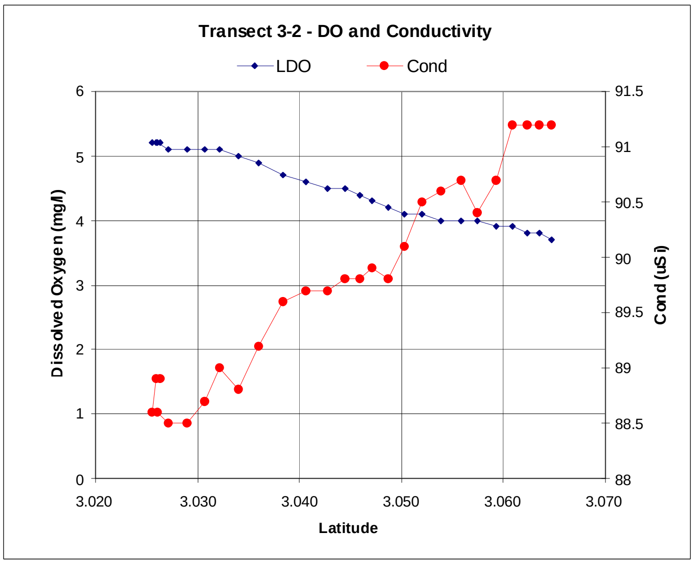
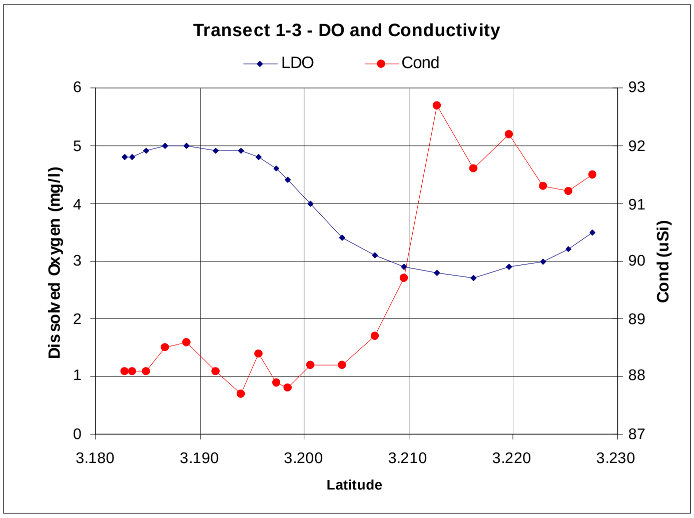
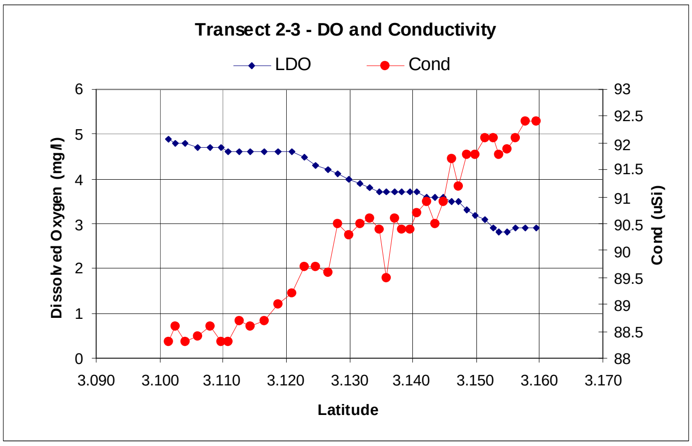


Figure T-2: Run 2 – Unit 1 at 50% Gate (ABV, Closed) and Unit 5 at 37% Gate





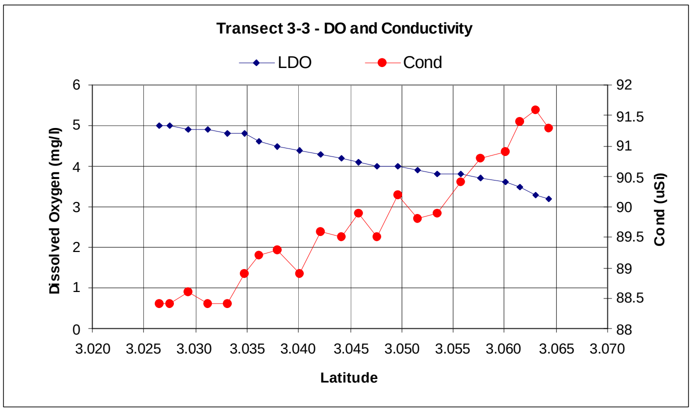
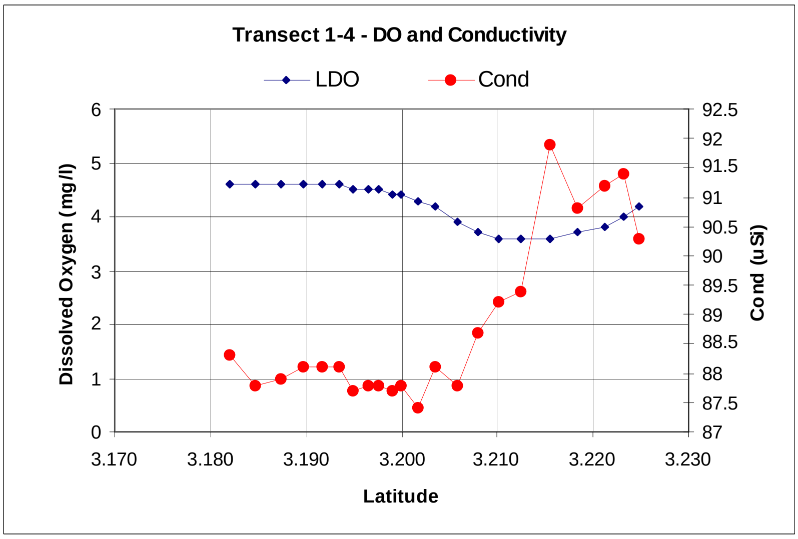
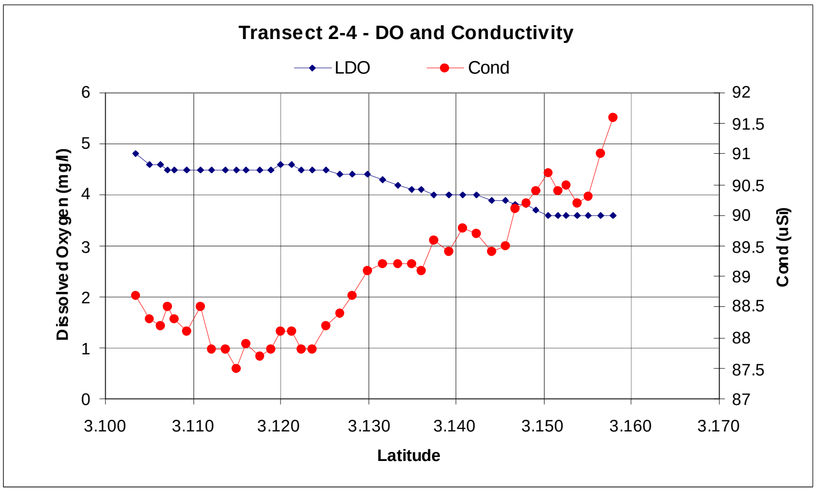


Figure T-3: Run 3 – Unit 1 at 80% Gate (ABV, Closed) and Unit 5 at 37% Gate





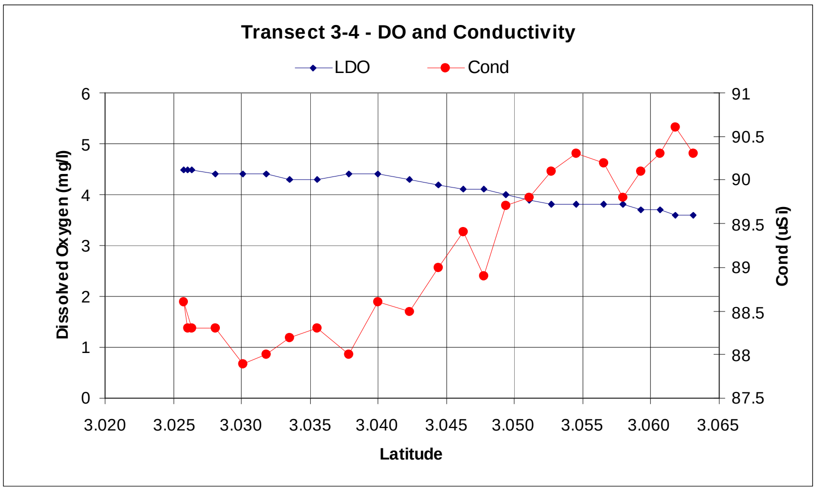
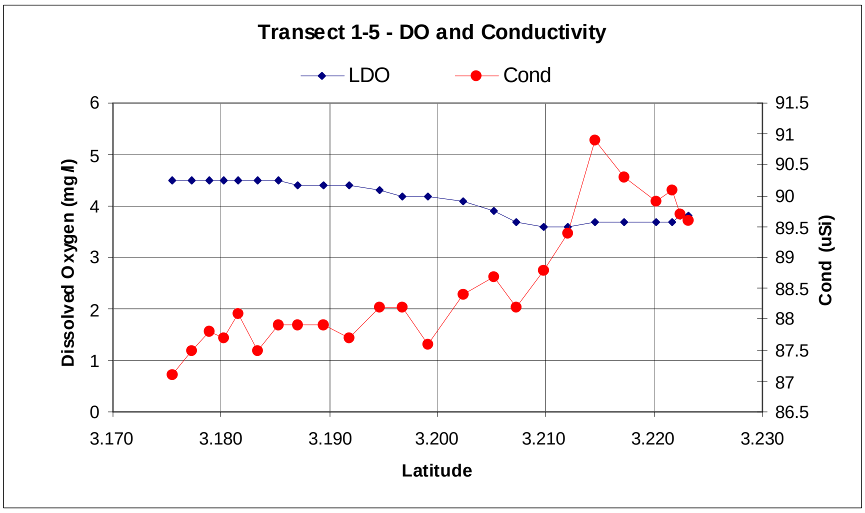
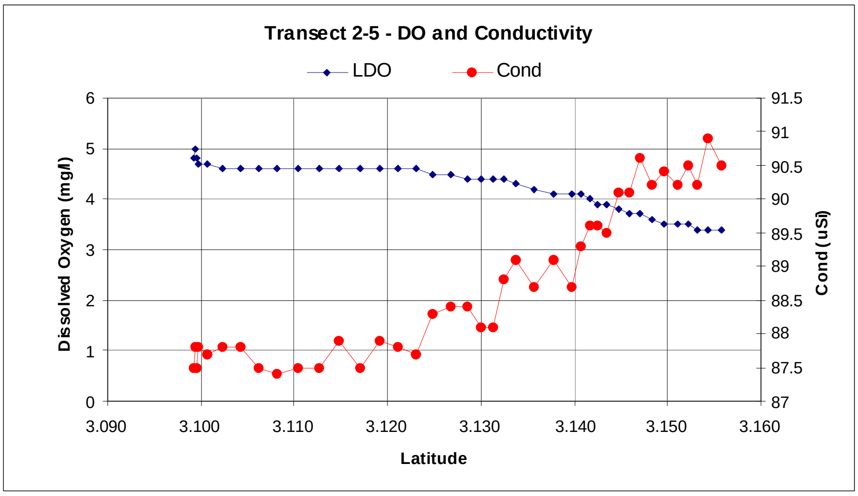


Figure T- 4: Run 4 – Unit 1 at 50% Gate (ABV, Closed) and Unit 5 at 74% Gate





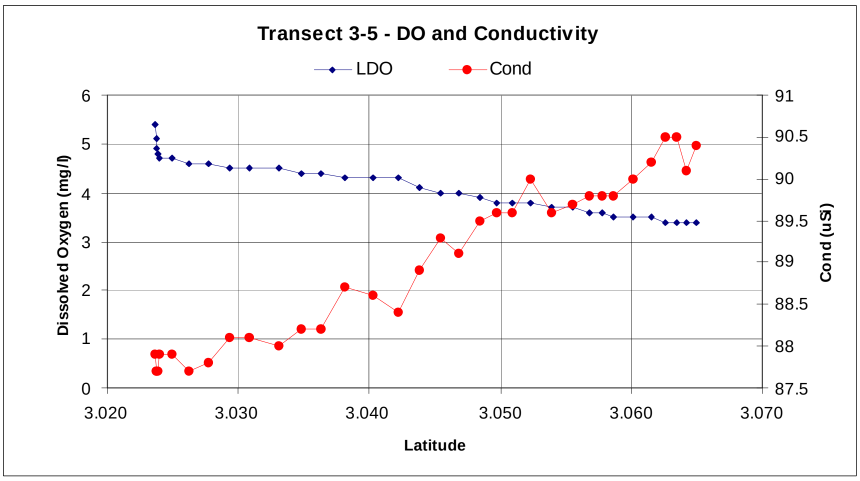
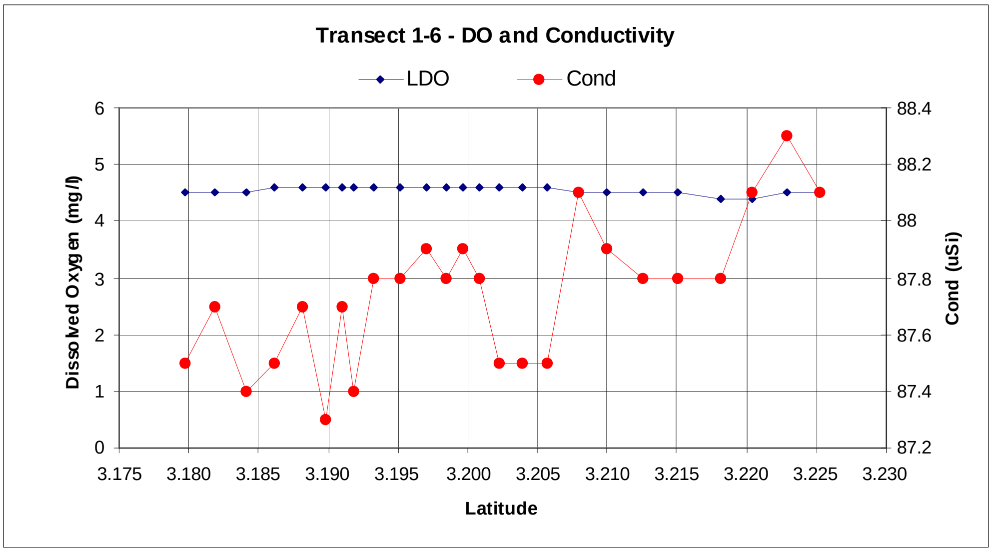
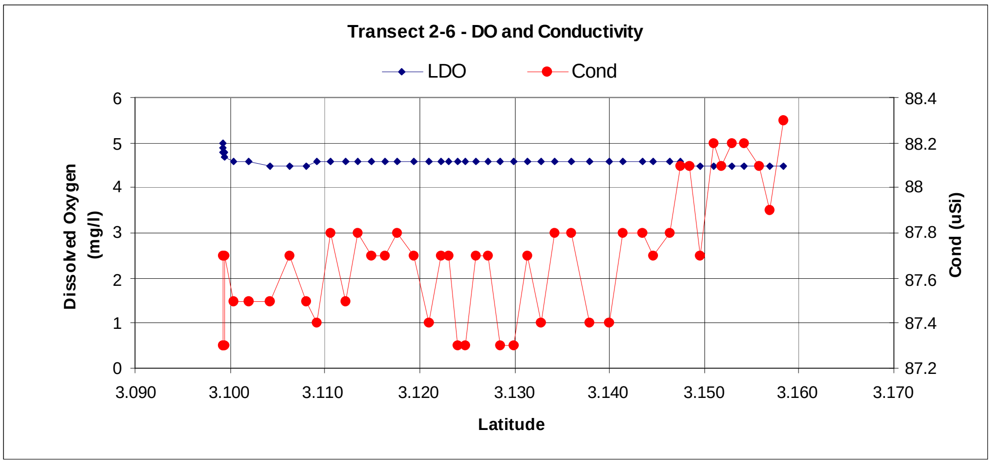


Figure T- 5: Run 5 – Unit 2 at 50% Gate (ABV, Closed) and Unit 5 at 74% Gate





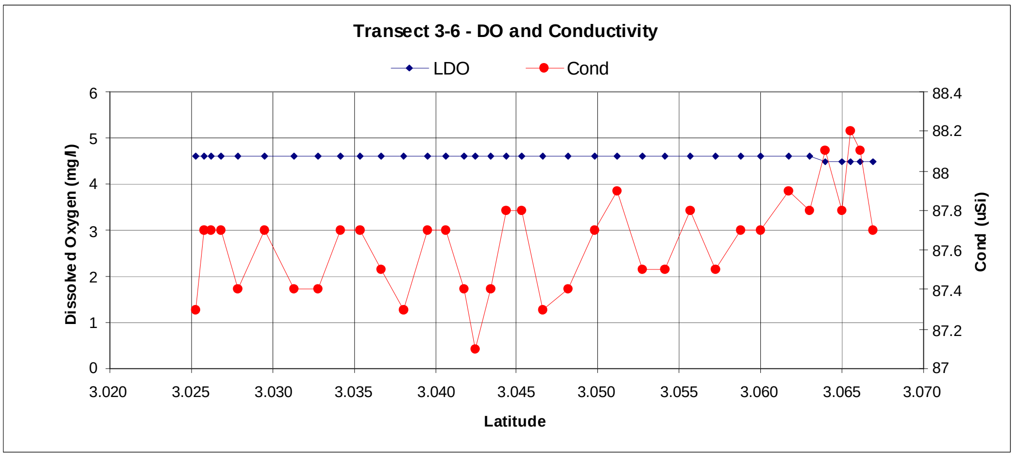
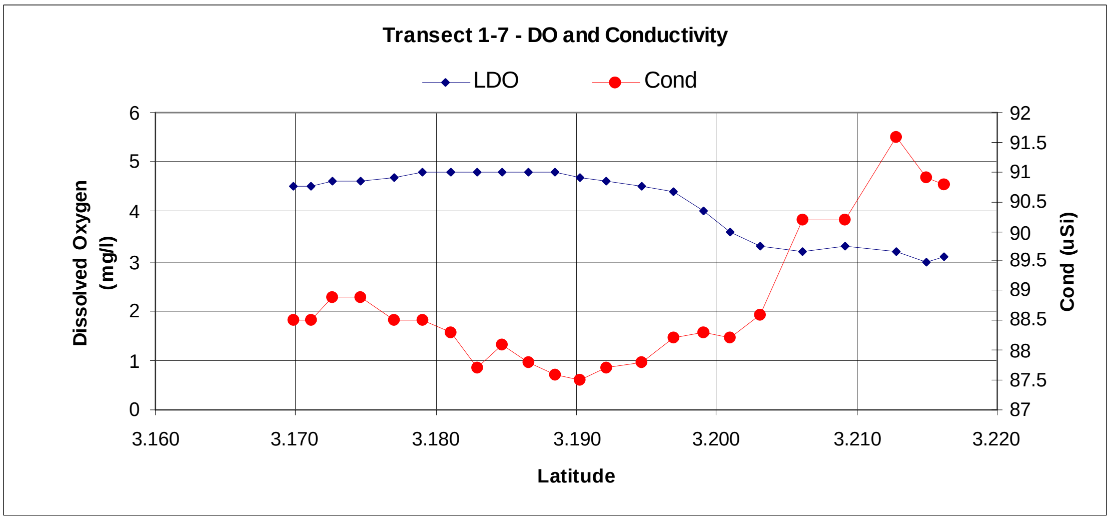
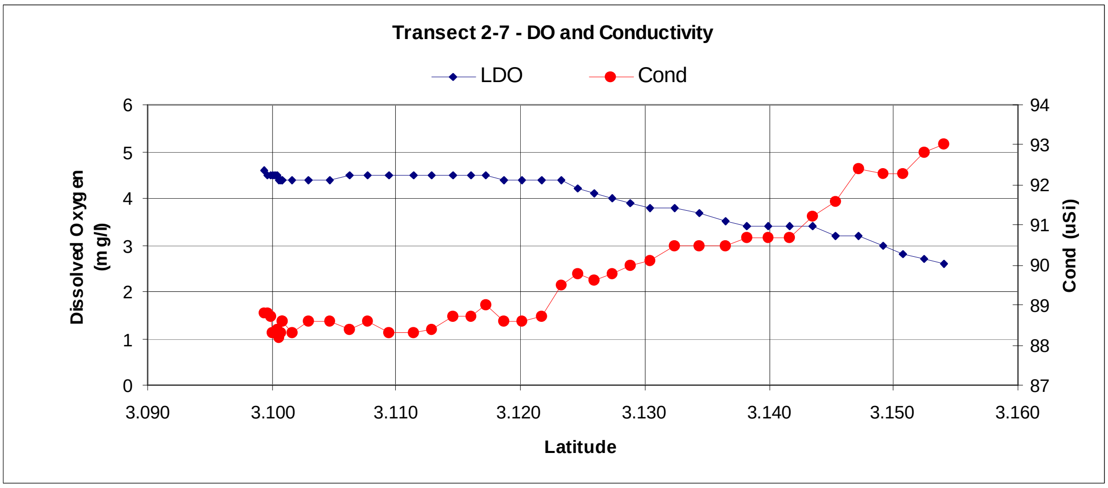


Figure T-6: Run 6 – Unit 5 at 74% Gate





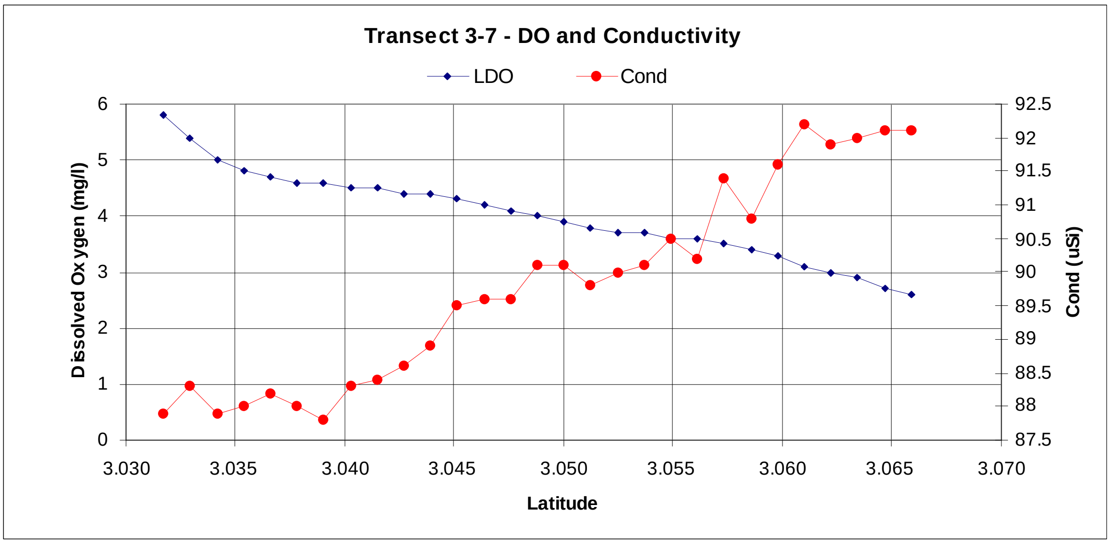
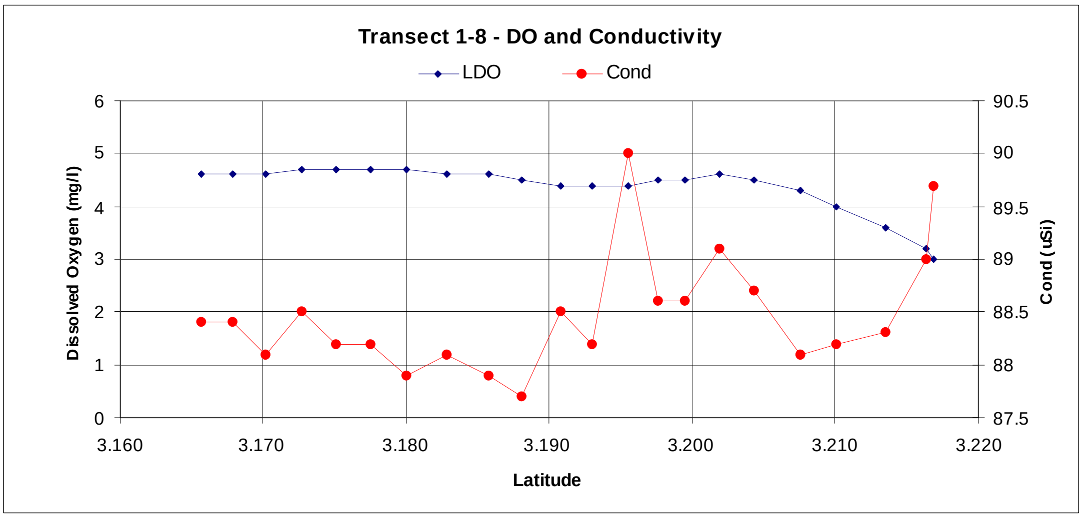
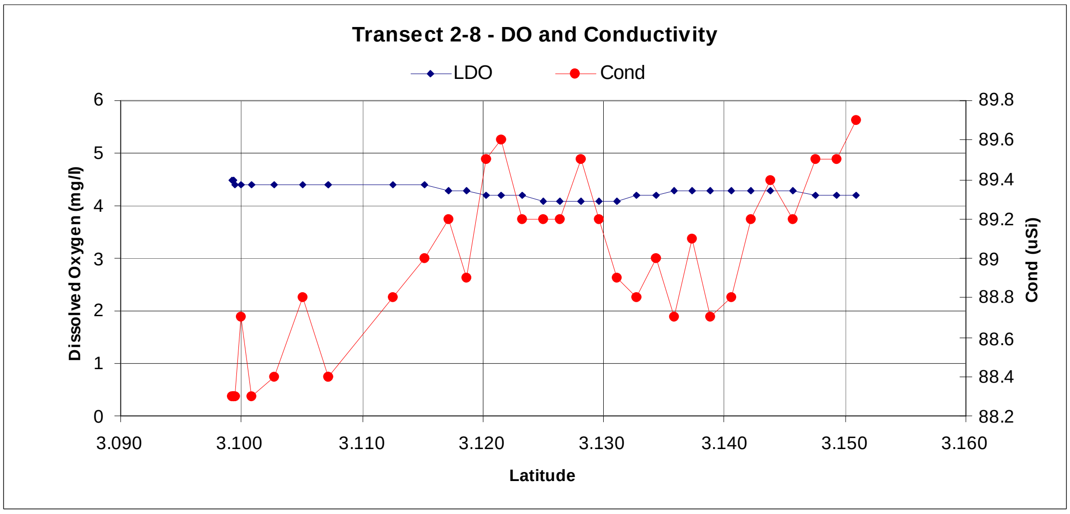


Figure T- 7: Run 7 – Unit 2 at 80% Gate (ABV, Closed) and Unit 5 at 39% Gate





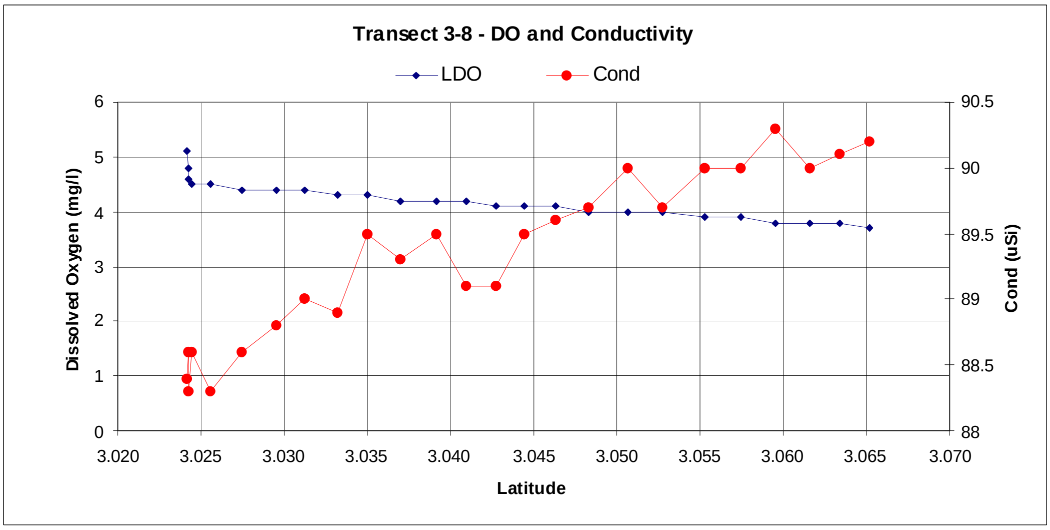
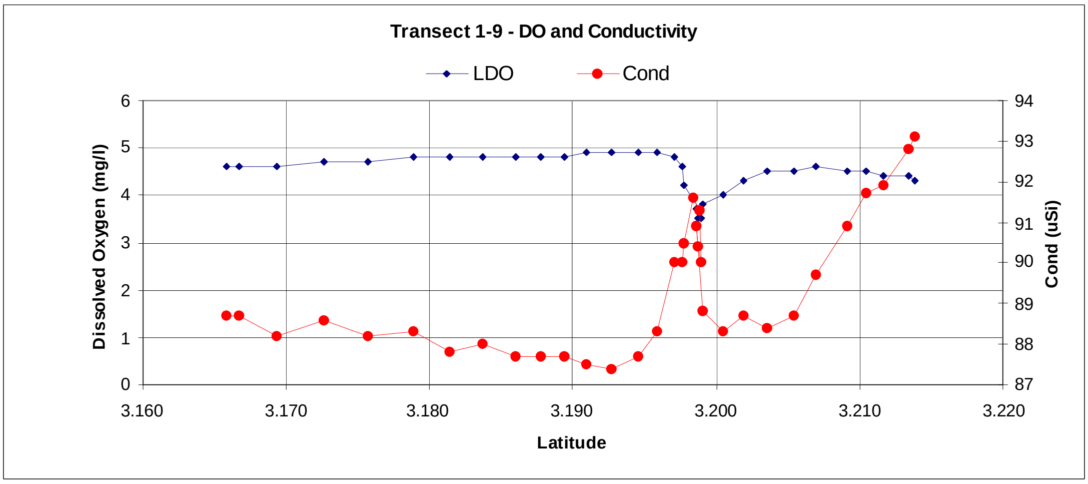
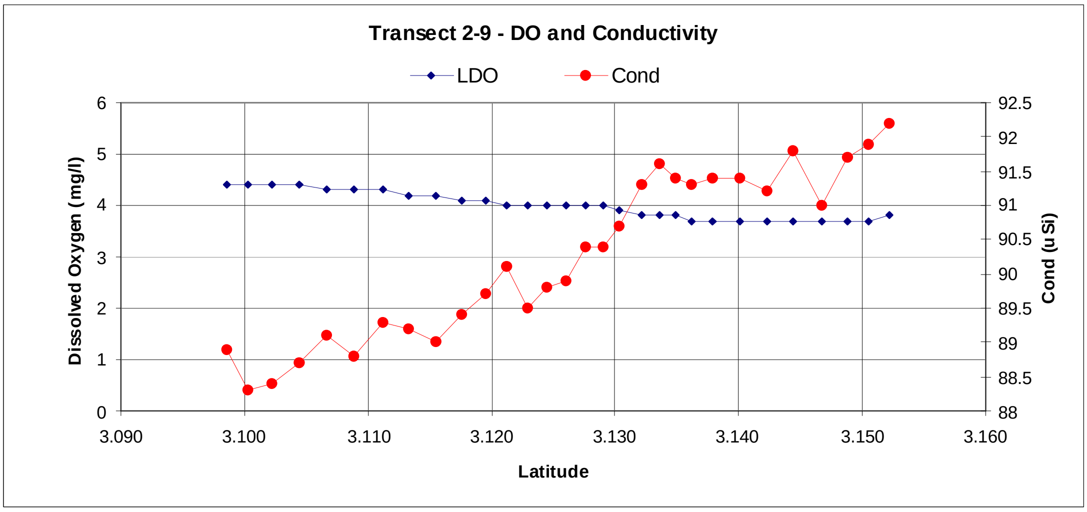


Figure T- 8: Run 8 – Unit 2 at 50% Gate (ABV, Closed); Unit 5 at 39% Gate





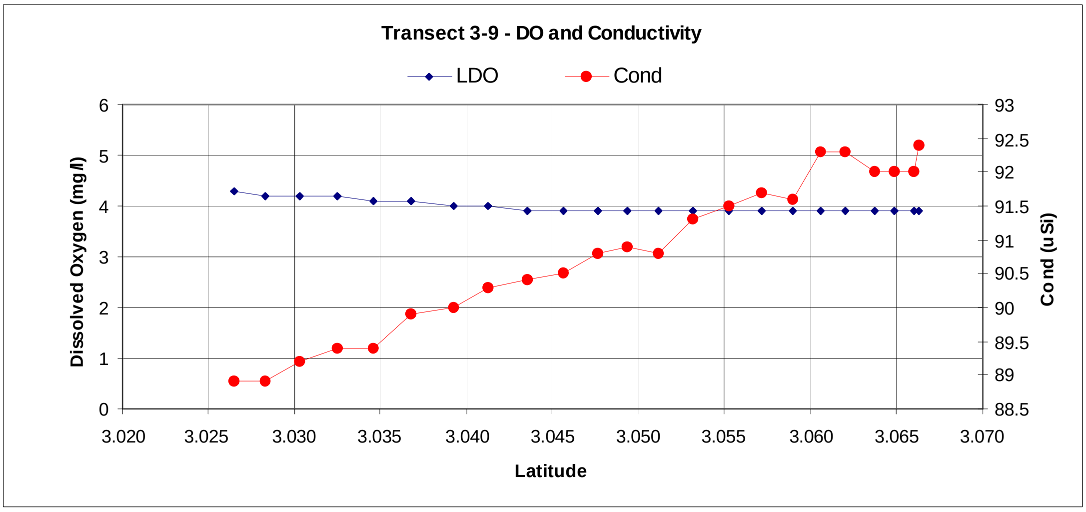
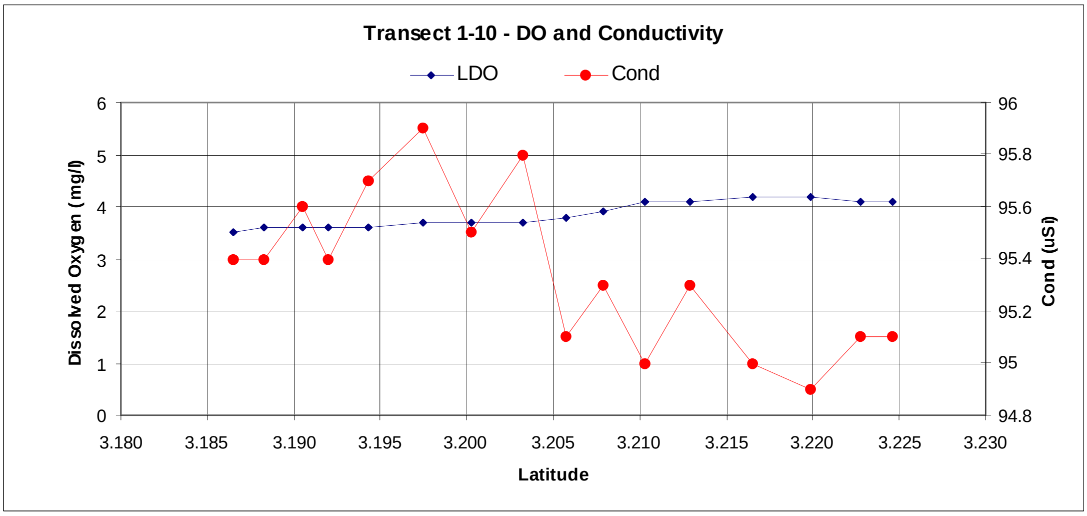
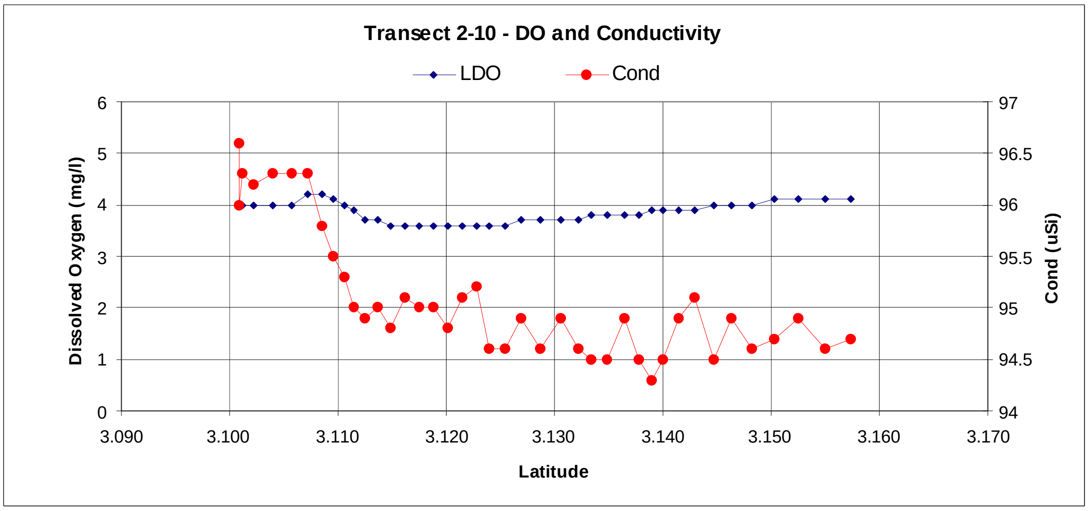


Figure T- 9: Run 9 – Unit 1 at 50% Gate (ABV, Open); Unit 3 at 50% Gate (ABV, Closed); Unit 5 at 39% Gate





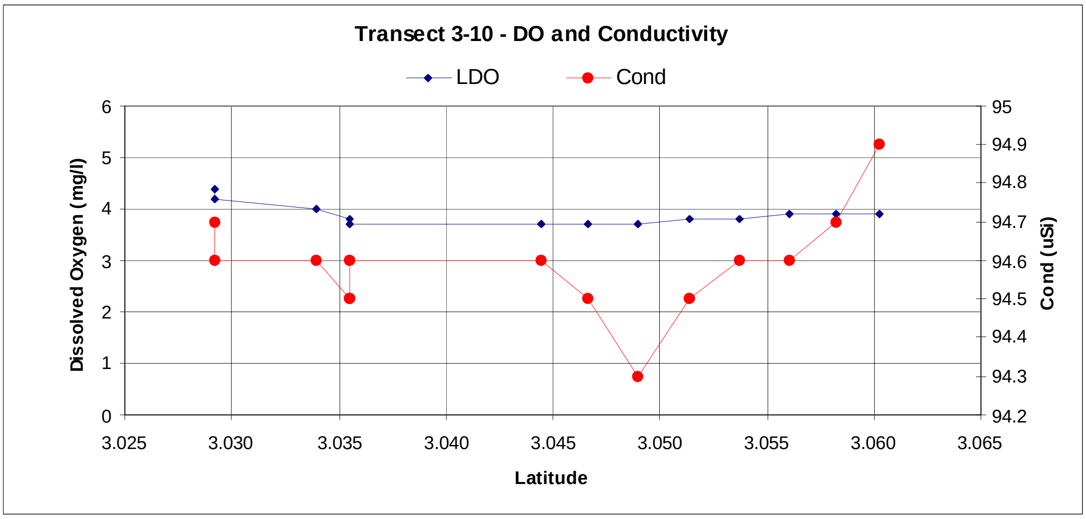
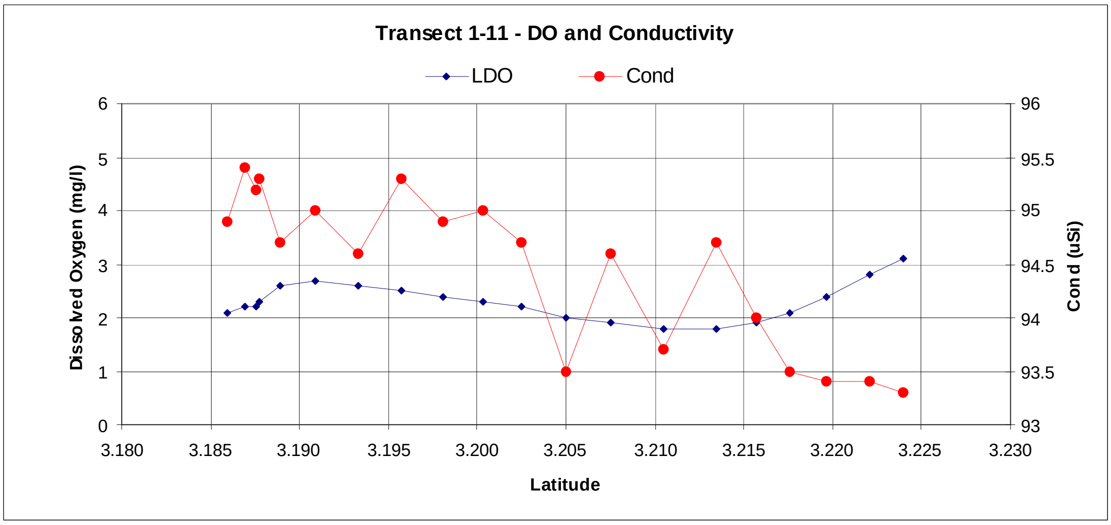
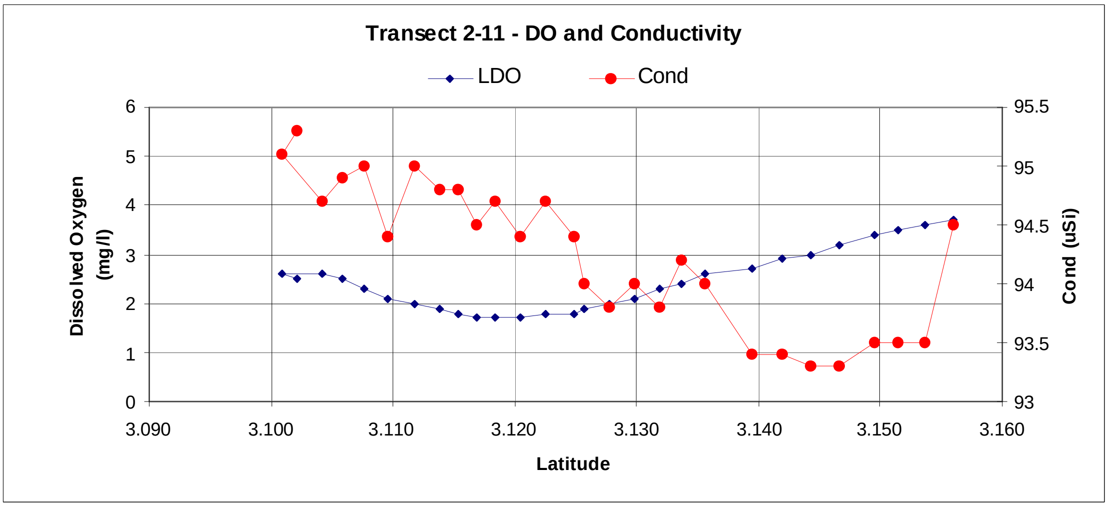


Figure T-10: Run 10 – Unit 1 at 70% Gate (ABV, Open)





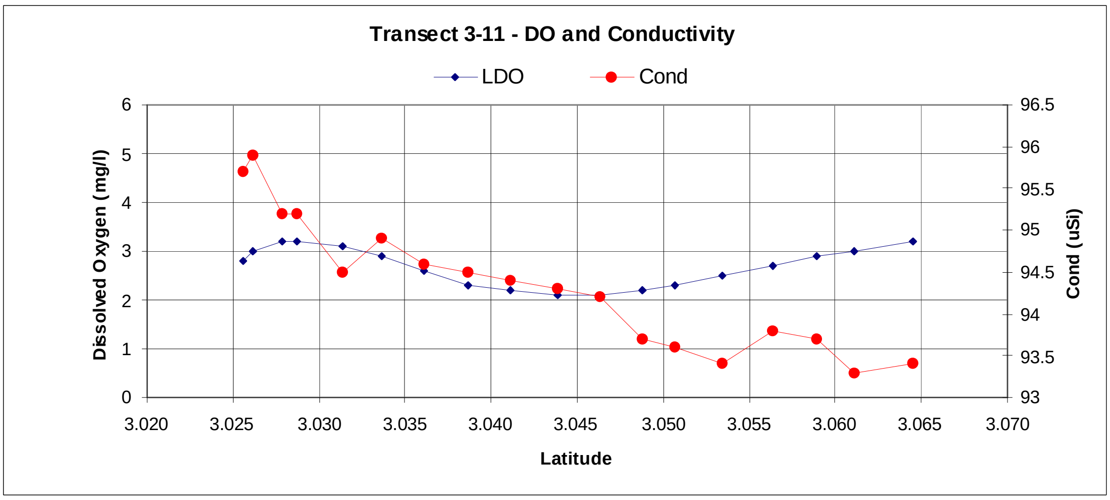
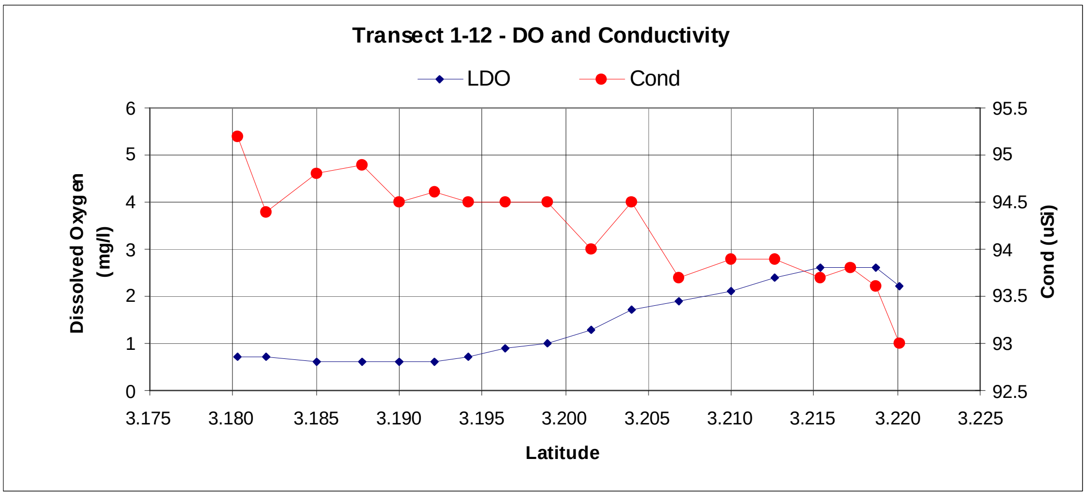
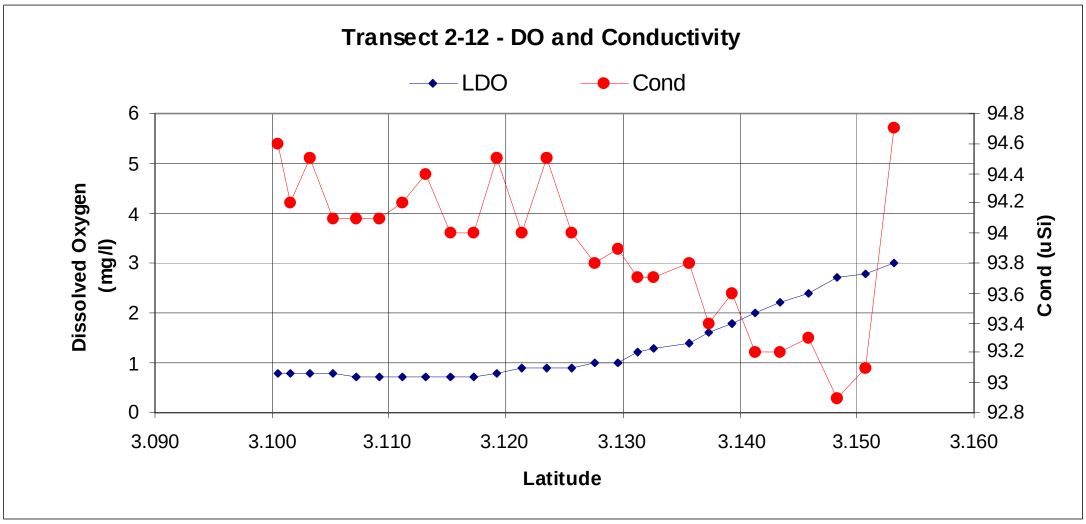


Figure T- 11: Run 11 – Units 1 and 2 at 70% Gate (ABV, Open)





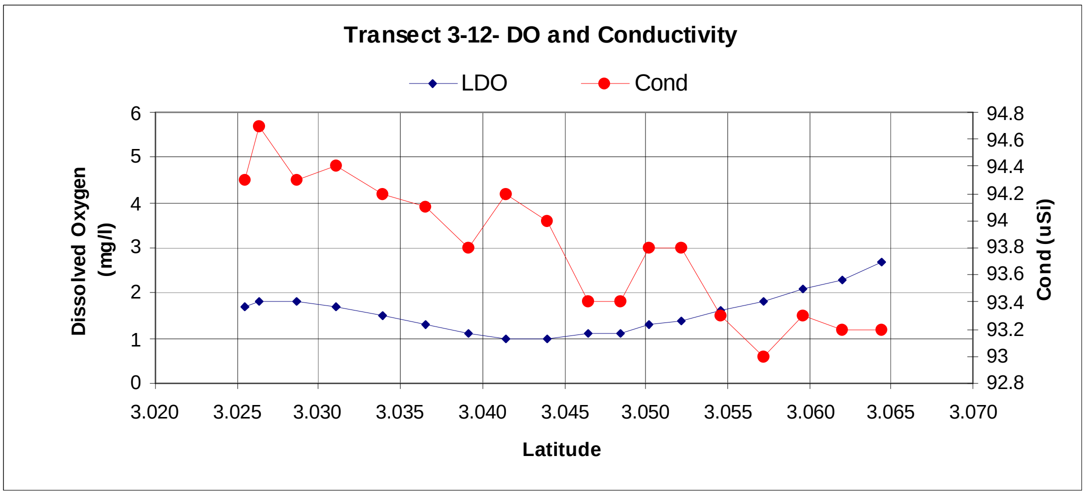
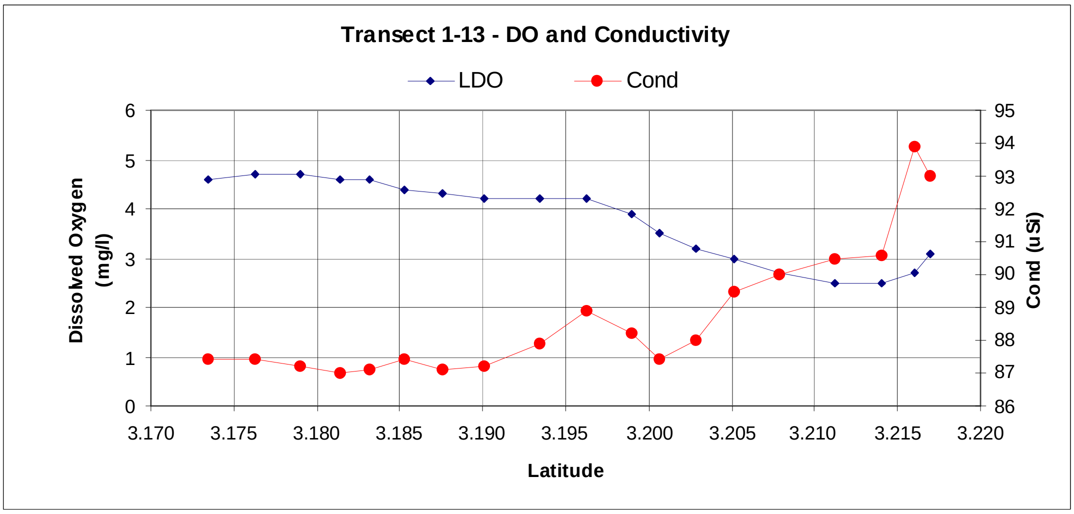
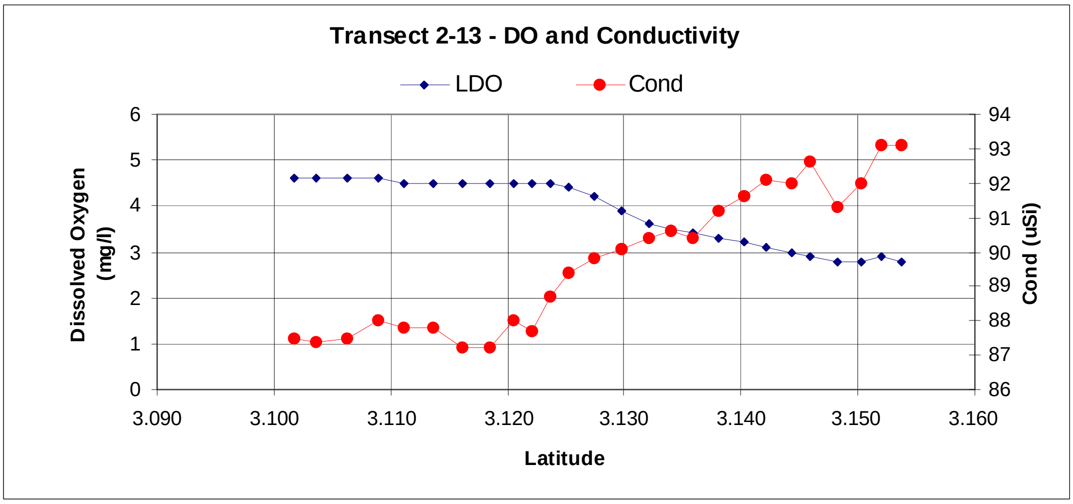


Figure T- 12: Run 12 – Units 1 and 2 at 70% Gate (ABV, Open); Unit 3 at 70% Gate (ABV, Closed)





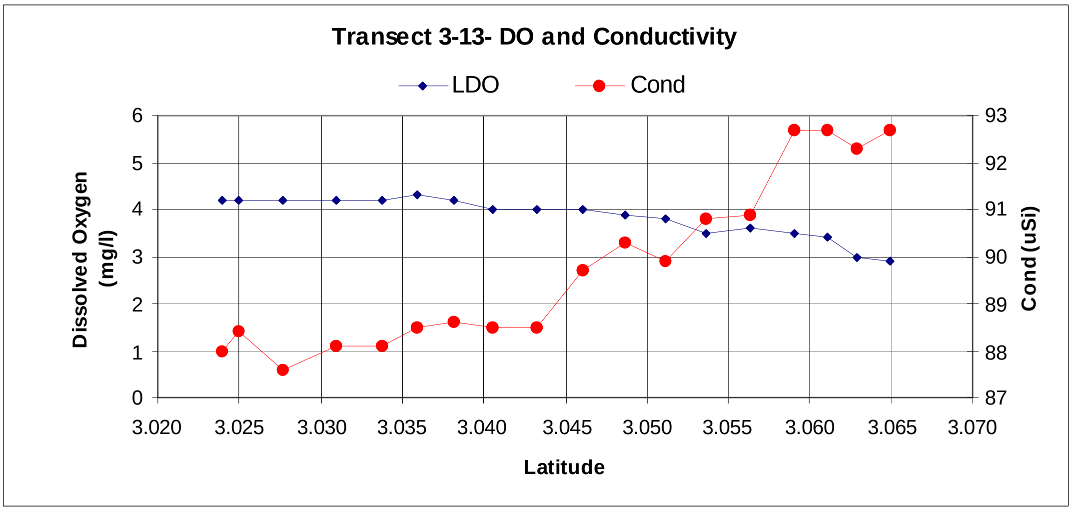
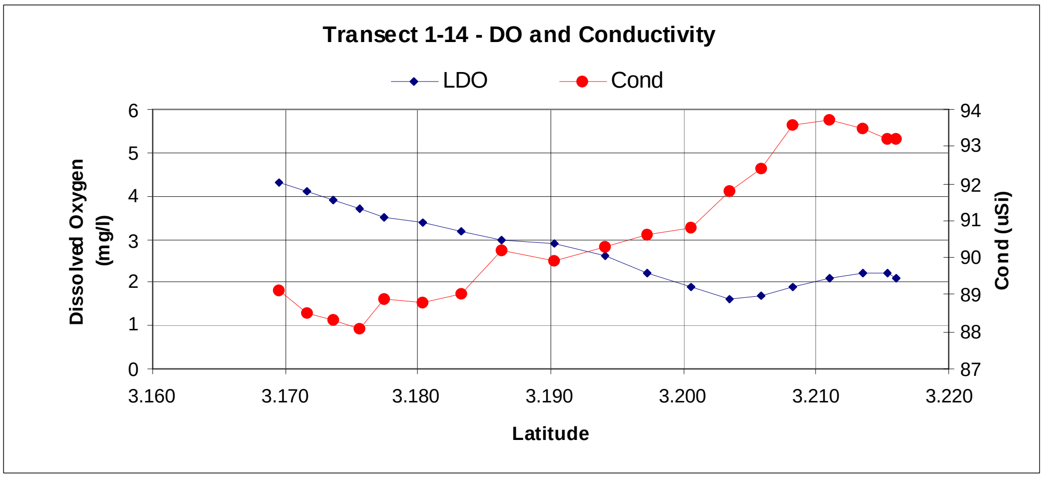
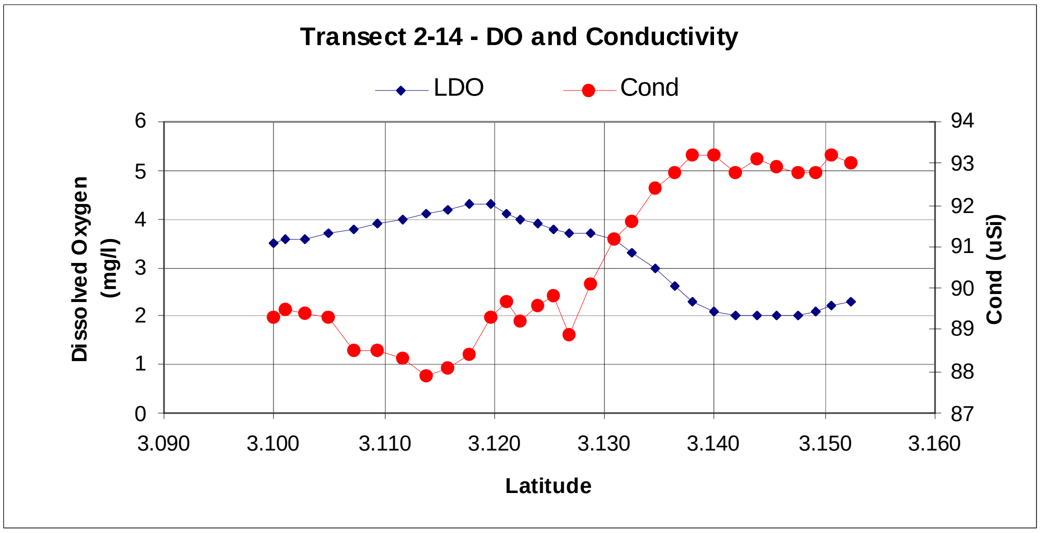


Figure T- 13: Run 13 – Units 1 and 3 at 70% Gate (ABV Closed on U3); Unit 5 at 76% Gate





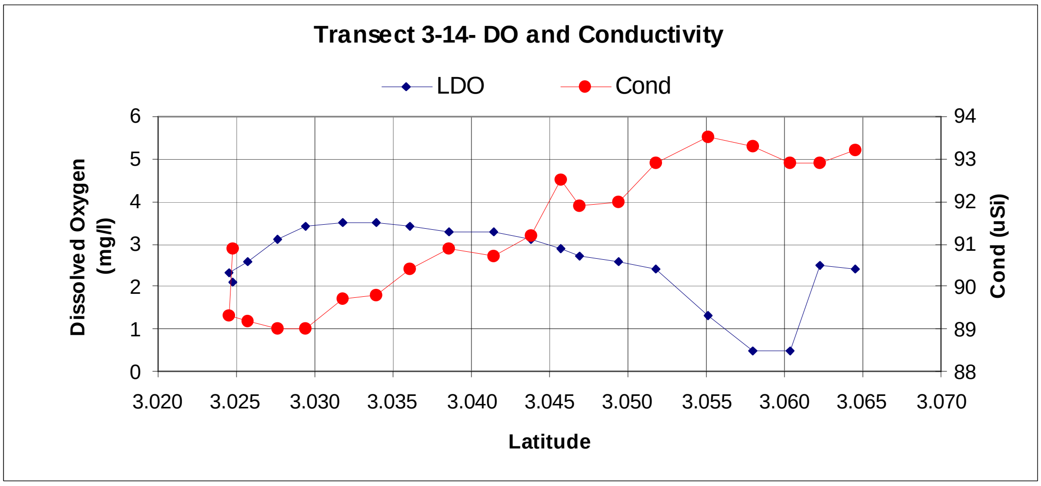
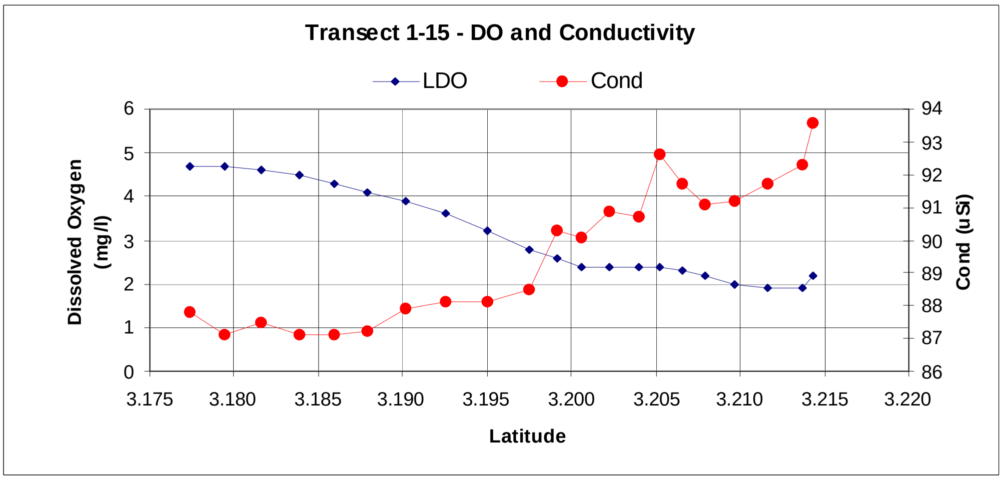
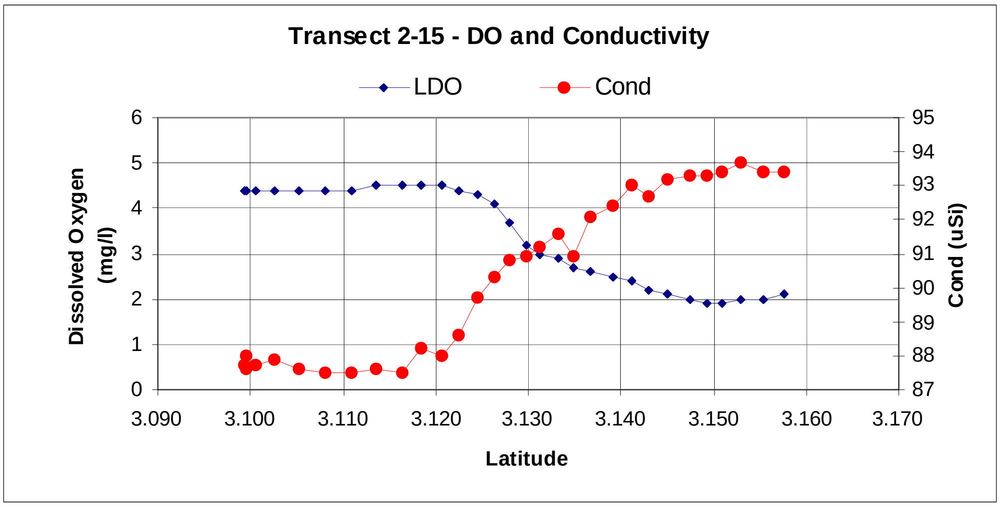


Figure T- 14: Run 14 – Units 1, 2, and 3 at 70% Gate (ABV Closed on U3); Unit 5 at 76% Gate





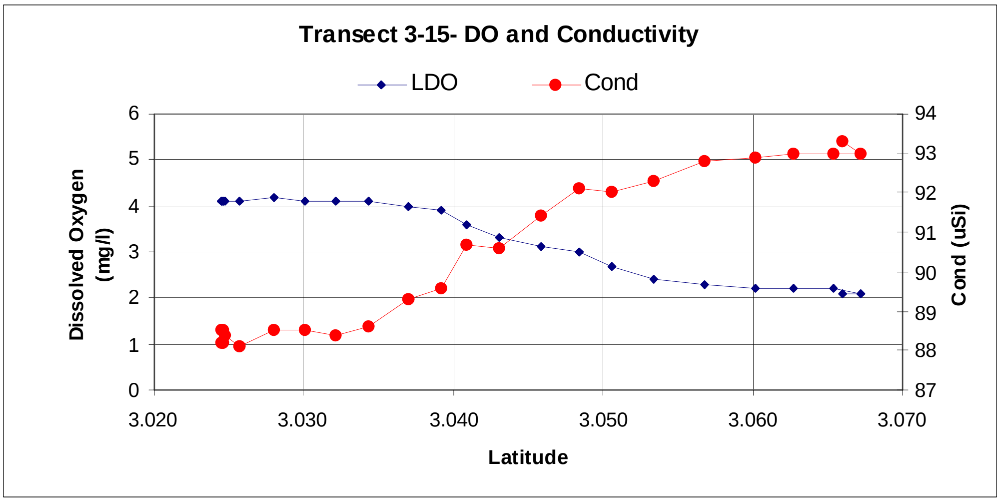


Figure T- 15: Run 15 – Units 1, 2, and 3 at 96% Gate (ABV Closed on U3); Unit 5 at 76% Gate

Kacie Jensen

From: Jennifer Summerlin
Sent: Wednesday, April 12, 2006 11:20 AM
To: 'Tom Stonecypher'; Alan Stuart; Alison Guth; 'Amanda Hill'; 'Andy Miller'; BARGENTIERI@scana.com; 'Bill Hulslander'; 'Bill Marshall'; 'Brett Bursey'; 'Cam Littlejohn'; 'Charlene Coleman'; 'Charles Floyd'; 'Craig Stow'; 'Daniel Tufford'; 'Dick Christie'; 'Don Tyler'; 'Donald Eng'; 'Ed Diebold'; 'George Duke'; 'Gerrit Jobsis (American Rivers)'; 'Gina Kirkland'; 'Hank McKellar'; 'Jeff Duncan'; 'Jennifer O'Rourke'; 'Jim Glover'; 'Jim Ruane '; 'John Davis (johned44@bellsouth.net)'; 'Joy Downs'; 'Karen Kustafik'; 'Keith Ganz-Sarto'; 'Kim Westbury'; 'Larry Turner (turnerle@dhec.sc.gov)'; 'Malcolm Leaphart'; 'Mark Leao'; 'Mike Sloan'; 'Norman Ferris'; 'Patrick Moore'; 'Prescott Brownell'; 'Ralph Crafton'; 'Reed Bull (rbull@davisfloyd.com)'; 'Richard Kidder'; 'Robert Keener (SKEENER@sc.rr.com)'; 'Ron Ahle'; 'Roy Parker'; Shane Boring; 'Steve Bell'; 'Steve Summer'; 'Suzanne Rhodes'; 'Tom Bowles (tbowles@scana.com)'
Cc: Shane Boring
Subject: Saluda relicensing: LMA Water Quality study plan

Dear Saluda Water Quality RCG Member:

As discussed in our February 21st RCG meeting, Roy Parker has provided information on Lake Murray Association cove water quality studies. Attached is the study plan, which was found in the Lake~Link Newsletter. Thanks for your continued interest in the process.

LMA WQ study plan.pdf (300 KB)...

Jennifer Summerlin
Scientist Technician
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

(Osprey Nests continued) The wooden platforms that the Lake Murray Association constructed in the past used 2 x 6 boards enclosing an area of nine square feet. This type of construction allows the birds to have a large flat enclosed area in which to drop their nest building materials and results in use of almost 100% of the materials collected. The new metal platforms will have similar features.

LAKE MURRAY WATER QUALITY MONITORING PLAN

By Roy Parker

The Lake Murray Association Board of Directors approved a plan to monitor water quality in Lake Murray during the last board meeting.

Water quality monitoring will begin in May 2006.

The focus of our efforts will be to monitor water quality in five different type coves, with each cove type meeting specific identifying criteria.

REASONS FOR DECIDING TO MONITOR WATER QUALITY

- Current water quality monitoring that is being carried out by The Department of Health and Environmental Control (DHEC) and by SCE&G is mostly confined to large, open water sampling sites.
- During the past few years, many new houses have been built around the lake. We want to be assured that the resulting increase in shoreline population density is not deteriorating water quality.
- We want to assure ourselves and all lake users that we do not have a water quality problem in Lake Murray.
- This plan is not being implemented because we know of a problem. We hope water quality is fine, but we want to determine that freshwater quality standards are currently being met and will continue to be met in all areas of the lake.

TYPES OF COVES TO BE MONITORED

- Type I - A densely populated cove on a septic system with drain fields.
- Type II - An undeveloped cove with low population density to be considered as a standard or reference cove.
- Type III - A cove where one or more marinas are located.
- Type IV - A cove where an agricultural watershed empties into the cove.
- Type V - A cove where multi unit housing and accompanying dock and marina are planned.

WHAT WILL WE MONITOR FOR

- We plan to monitor four densely populated coves that are on septic systems with drain fields once each month for fecal coliform and phosphorus. If we find freshwater standards are out of compliance at a particular sampling site, four follow-up samples will be taken during a 30 day period from that site.
- The standard or reference cove will be monitored once each month to compare the results from it to the results in other coves being monitored.
- We will monitor two coves where there is a marina once each month for petroleum hydrocarbons, Benzene, Toluene, Ethyl benzene and Xylene.
- We will monitor one cove that drains an agricultural watershed once each month for fecal coliform and phosphorus.
- In order to establish a baseline, we will monitor a cove where multi unit housing, docks and marina are planned, so we can get pre and post development water quality results.

ANALYTICAL LABORATORY, NUMBER OF SAMPLES and COSTS

- Data Resources Inc. located in Columbia, a SC State certified laboratory, will be analyzing our samples. Either the laboratory or the appropriate State agency will train people who will be taking and transporting samples to the laboratory.

- During the period of May 1st to the end of October, we expect to collect and have analyzed about 130 water samples. This could increase, if we find water quality standards out of compliance at more sites than expected. Needed follow-up sampling could increase the numbers of samples required.

- Our estimated cost to carry out the water quality monitoring plan, as described for the 6 month period May through October, is a little over $2,000. This will require that many hours of time be contributed by volunteers to collect and transport samples for analysis.

We encourage Lake Murray Association members to volunteer to monitor water quality on our lake. We need people to help collect and transport water samples to the laboratory. The Environmental Committee will make the final decisions regarding coves selected to monitor, but we are open to recommendations from association members of coves to monitor. Please contact Roy Parker at 118 Beechcreek Court, Lexington, SC 29072, or royparker38@earthlink.net if you wish to assist in collecting water samples or make suggestions of coves to monitor.

Kacie Jensen

From: Jim Ruane [jimruane@comcast.net]
Sent: Wednesday, April 05, 2006 3:44 PM
To: Dan Tufford; 'Andy Miller'
Cc: Alan Stuart; Alison Guth
Subject: Re: W2 agreement

tech reviews of models--agreem...

Hi Dan and Andy

we looked over the agreement again and came up with revisions that might address some of your concerns, but we believe this revised version is what we need.

If it still causes you concern, please use the Word revision tool, make the revisions you need, and return it.

You may have already considered this but perhaps the presentation we made on Dec 7 would be sufficient for your needs. It pretty much includes a lot of the info that is in the draft report. This presentation is available on the Saluda relicensing web site.

Thanks, Jim

Richard J. Ruane, Reservoir Environmental Mgt., Inc.
900 Vine Street   Suite 5
Chattanooga, TN 37403
423-265-5820; cell: 423-605-5820; Fax: 423-266-5217; jim@chatt.net

----- Original Message -----
From: "Dan Tufford" <tufford@sc.edu>
To: "Alison Guth" <Alison.Guth@KleinschmidtUSA.com>
Cc: "'Andy Miller'" <millerca@dhec.sc.gov>; "Alan Stuart" <Alan.Stuart@KleinschmidtUSA.com>; "'Jim Ruane'" <jimruane@comcast.net>
Sent: Monday, April 03, 2006 1:17 PM
Subject: Re: W2 agreement

> Hello All,
>
> Thanks for sending the agreement, unfortunately it is unsatisfactory
> in its current form. The first paragraph states that the protocol is
> only for the temporary model review, but the rest of the text goes
> well beyond that scope. We need to reword it so the provisions of the
> protocol cover only issues that are of concern at this stage.
>
> During the TWC meeting there were two concerns raised about releasing
> the report: 1) confidentiality and 2) that discussions about the
> technical aspects of the model would include the developers. The
> agreement as it is written covers many more issues and will, in fact,
> constrain the very discussion it is intended to facilitate.
>
> If there is a sound reason for me to accept that the disclaimer in the
> first paragraph is sufficient let me know what it is. For now I
> believe the text should only cover what we talked about during the
> meeting, in whatever detail is needed to protect REMI and SCE&G. I
> will be glad to discuss my concerns in more detail if necessary.
>
> The model meeting with Ruane, Miller, an SCDHEC modeler, and me still
> needs to be firmed up. The two possible dates we agreed to in the TWC
> meeting were April 25 and 26. I may have a conflict on April 25 so if

> April 26 is still OK for others can we make that our definite date?
>
> Getting the model documentation well in advance of that meeting is
> essential for the meeting to be productive.
>
> Regards,
> Daniel L. Tufford, Ph.D.
> Research Assistant Professor
> University of South Carolina
> Department of Biological Sciences
> Sumwalt 209A   (office)
> 701 Sumter Street, Room 401   (mail)
> Columbia, SC 29208
> e-mail: tufford@sc.edu
> web: http://www.biol.sc.edu/~tufford
> Ph: 803.777.3292 Fx: 803.777.3292
>
>
> Alison Guth wrote:
>
> > Andy and Dan
> >
> > I have attached a copy of Jim Ruane's agreement for the W2 Model.
> > Please sign and send back to me. Thanks, Alison
> >
> > <<tech reviews of models--agreement.pdf>>
> >
> > Alison Guth
> > Licensing Coordinator
> > Kleinschmidt Associates
> > 101 Trade Zone Drive
> > Suite 21A
> > West Columbia, SC 29170
> > P: (803) 822-3177
> > F: (803) 822-3183
>

TECHNICAL REVIEWS OF THE LAKE MURRAY CE-QUAL-W2 WATER QUALITY MODEL

Protocol Agreement for Technical Reviews

Revision 1: 4/4/06

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Approach for Technical Reviews under the QA/QC Program

This agreement was developed to allow stakeholders temporary access to the draft Lake Murray model report in order to review the current model that will be upgraded during the FERC relicensing process for the Saluda Project. This temporary access is being provided by SCE&G to meet the technical needs of stakeholders for planning future modeling efforts. This temporary access does not constitute any part of an agreement for Section 401 certification or other relicensing processes. Rather, the intent of this release is to enable technical review of the current calibration of the model that will be upgraded. This protocol does not limit any future agreement that might be reached concerning long-term access to or ownership of the model. This protocol outlines only the process that will be followed during this temporary technical model review. This protocol must be agreed to by stakeholders prior to their temporary access to the draft model report.

To help meet the needs of the stakeholders and SCE&G, this protocol for temporary model access was developed with the following specific objectives:

- to provide an opportunity for technical experts to review the draft model report;
- to provide a mechanism for interaction between the stakeholders, SCE&G, and the REMI modelers to answer questions, provide feedback, and utilize results of the exchange to improve the quality of the model upgrades by REMI;
- to protect SCE&G's investment in the draft model report and the relicensing process;
- to protect the modeling consultants' proprietary information;
- to enable SCDHEC, USEPA and SCDNR to respond to potential FOIA requests and record-keeping requirements.

During their review, technical reviewers should bear in mind the modeling objectives for which this model was developed. The model for which access is being provided was developed with these objectives:

1. to predict temperature and DO in the forebay and discharges from Lake Murray;
2. to predict effects of hydro operations on reservoir and release temperature and DO;
3. to predict the effects of phosphorus reductions in selected watersheds on algal levels and DO in the forebay of the reservoir and its discharges.

The scope for these predictions is for planning and policy level considerations, e.g., to examine the cause/effect relationships between operations or inflow loadings and the resulting temperature and DO in the reservoir and its releases. These predictions are intended to be helpful in exploring alternative management strategies for improving water quality in the reservoir and its releases.

This provision for release of the draft model report is subject to the expectations and agreements below.

Background Considerations about the CE-QUAL-W2 Water Quality Model Developed for Lake Murray

Site-specific models like that developed for Lake Murray are intended for specific, limited uses, and by their nature, they are intended for use by Andy Sawyer and Jim Ruane, both working under Reservoir Environmental Management, Inc (REMI). Model calibration involved an intensive reconciliation process that is fully understood primarily by the model developers. The challenge to the model developer is to develop the best possible model to meet the intended objectives considering the available data and other pertinent information, the model being used, and settings for the coefficients, rates, and processes in the model. In the process of developing the best possible model, many decisions are made by the model developers that have implications for model calibration choices and, therefore, applications. It is technically important, therefore, that simulations to explore alternatives for the relicensing study be performed by the model developers and not by someone with little or no knowledge of the reconciliation process described above.

Deleted: Running and reviewing these models takes a lot of time, and the initial learning curve is steep, especially if the reviewers are not familiar with CE-QUAL-W2. Reviewers should expect difficulties, especially at first. It will take a significant time commitment by the stakeholders. It will be difficult for technical reviewers to review the model and become as familiar with it as are the model developers. However, Sawyer and Ruane will be available to assist the stakeholders in their reviews and it is recommended that the reviewers take advantage of this service. ¶

SCE&G and their consultants view the models themselves as being the most useful avenue for "conflict reconciliation" between model developers and reviewers. With this background in mind, the following expectations and agreements are provided as guidelines for this process.

SCE&G, Stakeholder, KA, and REMI Expectations

The stakeholders expect the opportunity to review the draft modeling report and to discuss how the model was developed. They want to use this information for developing plans for future modeling of water quality associated with Lake Murray.

SCE&G, KA, and REMI expect the reviews to increase stakeholder awareness of the capabilities and limitations of the model and lead to realistic expectations of what the model can and cannot do. They want the technical reviews to help build confidence in the integrity of the model and planned upgrades by the agencies and other stakeholders who look to the agencies for their approval. They want the model to be useful for the modeling objectives stated above, with due consideration to the caveats and qualifications provided by the modelers. They want stakeholders to understand that models cannot perfectly represent actual conditions in waterways, but that models are the best way to predict effects of operational and certain other changes to support decisions that need to be made regarding the Saluda Project. They have strived to do the best they can based on

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the data and model that was used, and they want the upgraded calibrated model to be the best tool available for the stated objectives.

Agreements Regarding Release of the Draft Model Report for Lake Murray

The model developers welcome discussion regarding the model and are available to assist reviewers. This model review is envisioned as an opportunity for enhanced cooperation and teamwork with stakeholders. To this end, the following agreements are necessary to provide structure for the reviews.

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1. It is understood that during the relicensing process calibration is the responsibility of SCE&G and their consultants, and any agency suggestions for calibration arising from their review should be directed to the model developers, Sawyer and Ruane, for further discussion. For QA/QC reasons, simulations of alternatives related to the relicensing effort will be performed by the REMI model leader who is intimately familiar with the model calibration and model limitations. It is understood that the reviewers will not possess the models to develop independent calibrations or simulations of alternatives, but that they will discuss and, if needed, request that these be made by Ruane or Sawyer.
2. Interpretation of results of model calibrations and model runs should involve Ruane and/or Sawyer. The expectation is that consensus on interpretation will be reached between the reviewer and Ruane or Sawyer, and that this consensus will be based on technical reasoning using the literature and experience from other projects, considerations for robustness, sensitivity analyses, etc.
3. Reviewer comments, if provided, should be relevant to the stated objectives for the models, and should be based on sound, proven principles that are consistent with the models being used, the available data, literature, and the objectives for the models. Considering the stage of model development for Lake Murray and that the CE-QUAL-W2 model was selected over two years ago, reviewer comments regarding selection of the models being used or comparing this model to other models would not be useful in this review process.
4. The stakeholders agree not to release the draft model report, inputs, or results to other organizations or individuals without express written permission by SCE&G. FOIA requests can be an exception but SCE&G must be notified within 48 hours of such a request. The model report and inputs and other information provided should be treated as proprietary SCE&G property. However, it is the stakeholder responsibility that any copy that is printed or copied onto other media by the agencies for FOIA or internal purposes must also clearly indicate that it is "SCE&G Proprietary Property".
5. Conflicts, if any, arising from this model review are expected to be resolved via sincere attempts at technical consensus in a spirit of constructiveness and cooperation with model developers Ruane and Sawyer. It is expected that all avenues to reconcile conflicts will be exhausted before commenting to others outside the reviewers and Ruane and Sawyer. If consensus cannot be reached, both parties agree to include comments and responses by the other party with any comments released unilaterally.

6. Some technical revisions will be made to the CE-QUAL-W2 source code to develop the upgraded calibrations. This version of CE-QUAL-W2 will not be released outside of the REMI team, KA, and SCE&G. Although the full source code will not be provided to the stakeholders as part of this review, relevant code excerpts will be provided to show how alterations were implemented. These revisions have been discussed in model review meetings and will have been reviewed by Tom Cole or Merlynn Bender. The Cole/Bender review information will be provided to the stakeholders upon receipt.

I agree and promise to abide with this agreement.

___________________________________ _______________
Signed Name Date

____
Organization

Questions or comments? Contact:

Jim Ruane
Reservoir Environmental Management, Inc.
jimruane@comcast.net
423-265-5820

Kacie Jensen

From: Alison Guth
Sent: Friday, March 31, 2006 3:20 PM
To: 'Dan Tufford'; 'Andy Miller'
Cc: Alan Stuart; 'Jim Ruane'
Subject: W2 agreement

Andy and Dan

I have attached a copy of Jim Ruane's agreement for the W2 Model. Please sign and send back to me. Thanks, Alison

tech reviews of models--agreem...

Alison Guth
Licensing Coordinator
Kleinschmidt Associates
101 Trade Zone Drive
Suite 21A
West Columbia, SC 29170
P: (803) 822-3177
F: (803) 822-3183

TECHNICAL REVIEWS OF THE LAKE MURRAY CE-QUAL-W2 WATER QUALITY MODEL

Protocol Agreement for Technical Reviews

Revision 0: 3/30/06

Approach for Technical Reviews under the QA/QC Program

This agreement was developed to allow stakeholders temporary access to the draft Lake Murray model report in order to review the current model that will be upgraded during the FERC relicensing process for the Saluda Project. This temporary access is being provided by SCE&G to meet the technical needs of stakeholders for planning future modeling efforts. This temporary access does not constitute any part of an agreement for Section 401 certification or other relicensing processes. Rather, the intent of this release is to enable technical review of the current calibration of the model that will be upgraded. This protocol does not limit any future agreement that might be reached concerning long-term access to or ownership of the model. This protocol outlines only the process that will be followed during this temporary technical model review. This protocol must be agreed to by stakeholders prior to their temporary access to the draft model report.

To help meet the needs of the stakeholders and SCE&G, this protocol for temporary model access was developed with the following specific objectives:

- to provide an opportunity for technical experts to review the draft model report;
- to provide a mechanism for interaction between the stakeholders, SCE&G, and the REMI modelers to answer questions, provide feedback, and utilize results of the exchange to improve the quality of the model upgrades by REMI;
- to protect SCE&G's investment in the draft model report and the relicensing process;
- to protect the modeling consultants' proprietary information;
- to enable SCDHEC, USEPA and SCDNR to respond to potential FOIA requests and record-keeping requirements.

During their review, technical reviewers should bear in mind the modeling objectives for which this model was developed. The model for which access is being provided was developed with these objectives:

1. to predict temperature and DO in the forebay and discharges from Lake Murray;
2. to predict effects of hydro operations on reservoir and release temperature and DO;
3. to predict the effects of phosphorus reductions in selected watersheds on algal levels and DO in the forebay of the reservoir and its discharges.

The scope for these predictions is for planning and policy level considerations, e.g., to examine the cause/effect relationships between operations or inflow loadings and the resulting temperature and DO in the reservoir and its releases. These predictions are intended to be helpful in exploring alternative management strategies for improving water quality in the reservoir and its releases.

This provision for release of the draft model report is subject to the expectations and agreements below.

Background Considerations about the CE-QUAL-W2 Water Quality Model Developed for Lake Murray

Site-specific models like that developed for Lake Murray are intended for specific, limited uses, and by their nature, they are intended for use by Andy Sawyer and Jim Ruane, both working under Reservoir Environmental Management, Inc (REMI). Model calibration involved an intensive reconciliation process that is fully understood primarily by the model developers. The challenge to the model developer is to develop the best possible model to meet the intended objectives considering the available data and other pertinent information, the model being used, and settings for the coefficients, rates, and processes in the model. In the process of developing the best possible model, many decisions are made by the model developers that have implications for model calibration choices and, therefore, applications. It is technically important, therefore, that simulations to explore alternatives for the relicensing study be performed by the model developers and not by someone with little or no knowledge of the reconciliation process described above.

Running and reviewing these models takes a lot of time, and the initial learning curve is steep, especially if the reviewers are not familiar with CE-QUAL-W2. Reviewers should expect difficulties, especially at first. It will take a significant time commitment by the stakeholders. It will be difficult for technical reviewers to review the model and become as familiar with it as are the model developers. However, Sawyer and Ruane will be available to assist the stakeholders in their reviews and it is recommended that the reviewers take advantage of this service.

SCE&G and their consultants view the models themselves as being the most useful avenue for "conflict reconciliation" between model developers and reviewers. With this background in mind, the following expectations and agreements are provided as guidelines for this process.

SCE&G, Stakeholder, KA, and REMI Expectations

The stakeholders expect the opportunity to review the draft modeling report and to discuss how the model was developed. They want to use this information for developing plans for future modeling of water quality associated with Lake Murray.

SCE&G, KA, and REMI expect the reviews to increase stakeholder awareness of the capabilities and limitations of the model and lead to realistic expectations of what the model can and cannot do. They want the technical reviews to help build confidence in the integrity of the model and planned upgrades by the agencies and other stakeholders who look to the agencies for their approval. They want the models to be useful for the modeling objectives stated above, with due consideration to the caveats and qualifications provided by the modelers. They want stakeholders to understand that models cannot perfectly represent actual conditions in waterways, but that models are the best way to predict effects of operational and certain other changes to support decisions that need to be made regarding the Saluda Project. They have strived to do the best they can based on the data and model that was used, and they want the upgraded calibrated model to be the best tool available for the stated objectives.

Agreements Regarding Release of the Draft Model Report for Lake Murray

The model developers welcome discussion regarding the model and is available to assist reviewers. This model review is envisioned as an opportunity for enhanced cooperation and teamwork with stakeholders. To this end, the following agreements are necessary to provide structure for the reviews.

1. It is understood that calibration is the responsibility of SCE&G and their consultants, and any agency suggestions for calibration arising from their review should be directed to the model developers, Sawyer and Ruane, for further discussion. For QA/QC reasons, simulations of alternatives related to the relicensing effort will be performed by the REMI model leader who is intimately familiar with the model calibration and model limitations. It is understood that the reviewers will not possess the models to develop independent calibrations or simulations of alternatives, but that they will discuss and, if needed, request that these be made by Ruane or Sawyer.
2. Interpretation of results of model calibrations and model runs should involve Ruane and/or Sawyer. The expectation is that consensus on interpretation will be reached between the reviewer and Ruane or Sawyer, and that this consensus will be based on technical reasoning using the literature and experience from other projects, considerations for robustness, sensitivity analyses, etc.
3. Reviewer comments, if provided, should be relevant to the stated objectives for the models, and should be based on sound, proven principles that are consistent with the models being used, the available data, literature, and the objectives for the models. Considering the stage of model development for Lake Murray and that the CE-QUAL-W2 model was selected over two years ago, reviewer comments regarding selection of the models being used or comparing this model to other models would not be useful in this review process.
4. The stakeholders agree not to release draft model report, inputs, or results to other organizations or individuals without express written permission by SCE&G. FOIA requests can be an exception but SCE&G must be notified within 48 hours of such a request. The model report and inputs and other information provided should be treated as proprietary SCE&G property. However, it is the stakeholder responsibility that any copy that is printed or copied onto other media by the agencies for FOIA or internal purposes must also clearly indicate that it is "SCE&G Proprietary Property".

5. Conflicts, if any, arising from this model review are expected to be resolved via sincere attempts at technical consensus in a spirit of constructiveness and cooperation with model developers Ruane and Sawyer. It is expected that all avenues to reconcile conflicts will be exhausted before commenting to others outside the reviewers and Ruane and Sawyer. If consensus cannot be reached, both parties agree to include comments and responses by the other party with any comments released unilaterally.
6. Some technical revisions will be made to the CE-QUAL-W2 source code to develop the upgraded calibrations. This version of CE-QUAL-W2 will not be released outside of the REMI team, KA, and SCE&G. Although the full source code will not be provided to the stakeholders as part of this review, relevant code excerpts will be provided to show how alterations were implemented. These revisions have been discussed in model review meetings and will have been reviewed by Tom Cole or Merlynn Bender. The Cole/Bender review information will be provided to the stakeholders upon receipt.

I agree and promise to abide with this agreement.

________________________________ ______________
Signed Name Date

____
Organization

Questions or comments? Contact:

Jim Ruane
Reservoir Environmental Management, Inc.
jimruane@comcast.net
423-265-5820

Kacie Jensen

From: Alan Stuart

Sent: Wednesday, May 02, 2007 7:09 PM

To: Alan Stuart; 'LEAPHART,JR., MALCOLML'; Dave Anderson; Van Hoffman; Alan Axson; Alison Guth; Amanda Hill; BARGENTIERI@scana.com; Bill Brebner ; Bill Marshall; Charlene Coleman; Charlie Rentz; David Hancock; Dick Christie; George Duke; Gerrit Jobsis (American Rivers); Guy Jones; ipitts@scprt.com; Jeff Duncan; Jennifer O'Rourke; Jennifer Hand; Jim Devereaux; JoAnn Butler; Joy Downs; Karen Kustafik; Keith Ganz-Sarto; Kelly Maloney; turnerle@dhec.sc.gov; Lee Barber; Mark Leao; Marty Phillips; Mike Waddell; Miriam Atria; Norman Ferris; Patricia Wendling; Patrick Moore; Ralph Crafton; RMAHAN@scana.com; rparsons12@alltel.net; Richard Mikell; sjones@imichotels.net; Steve Bell; Suzanne Rhodes; Tim Vinson; Tom Brooks; Tommy Boozer; Tony Bebber

Cc: keithcloud@yahoo.com

Subject: RE: Recreation Assessment Study Report...Clarification

Good evening all,

I need to make a point of clarification in my preceding mail. I inadvertently omitted an important part from the last paragraph which I have revised and included the omissions (bold) in the modified paragraph below...

"On last item that requires attention, the focus group is limited to the chapter meeting and does not include the flow evaluation exercise that Mike (representing the TU organization) will be attending in your absence **and those additional other TU individuals recruited to participate as part of the "expert panel" by Marty/Kelly (flow demo coordinators)** . In the message on the TU website advertising the meeting (which I think is a great idea) the flow evaluation is referenced and it may be interpreted by your members this is open to everyone. Please make sure the message reflects that this flow exercise is limited to the "expert panel" assembled through the TWC and not an open invitation to attend or participate. If your **non-recruited** members would like to personally evaluate on their own during those days that is completely up to them and a purely personal decision on their part."

What I was attempting to point out is I did not want your TU membership to misunderstand that the flow evaluation exercise was just a "show up and participate event". It needs to be coordinated through the TWC and comprised of manageable numbers and comprised of a good cross section of various user groups and interests.

My apologies for the omissions....thanks, Alan

From: Alan Stuart
Sent: Wed 5/2/2007 4:29 PM
To: 'LEAPHART,JR., MALCOLML'; Dave Anderson; Van Hoffman; Alan Axson; Alison Guth; Amanda Hill; BARGENTIERI@scana.com; Bill Brebner ; Bill Marshall; Charlene Coleman; Charlie Rentz; David Hancock; Dick Christie; George Duke; Gerrit Jobsis (American Rivers); Guy Jones; ipitts@scprt.com; Jeff Duncan; Jennifer O'Rourke; Jennifer Summerlin; Jim Devereaux; JoAnn Butler; Joy Downs; Karen Kustafik; Keith Ganz-Sarto; Kelly Maloney; turnerle@dhec.sc.gov; Lee Barber; Mark Leao; Marty Phillips; Mike Waddell; Miriam Atria; Norman Ferris; Patricia Wendling; Patrick Moore; Ralph Crafton; RMAHAN@scana.com; rparsons12@alltel.net; Richard Mikell; sjones@imichotels.net; Steve Bell; Suzanne Rhodes; Tim Vinson; Tom Brooks; Tommy Boozer; Tony Bebber
Cc: keithcloud@yahoo.com
Subject: RE: Recreation Assessment Study Report

Hi Malcolm,

I feel the need to provide some input. The point of the focus group is to get opinions from a cross section of river users (i.e *wading* fishermen) you feel were somehow missed. Further the questions in the survey which will be distributed to TU chapter members will be consistent with those administered during the field study. The purpose is quite simply to obtain information consistent with those other users of the river. The questionnaire will address areas of access, safety use etc just as it did for those folks using the river at the time of the survey. If we were to administer a different survey then the information would bias against the other users. In the FERC relicensing process all user groups should have the opportunity to provide input and that is what we are trying to do. Our job is not to tip the balance of power in any one direction but to ensure all groups are represented and this will be accomplished by the focus group process.

Additionally, you have said on numerous occasions that TU's recommendations contained in your comment ICD letter continue to be the organizations position. I believe this to be the case and believe it to be widely accepted by all of the other stakeholders active in the relicensing process. Therefore, I don't understand your comment regarding "focus meeting with Trout Unlimited leaders for organizational positions". Again, the point of the focus group is not to obtain positions as they have already been clearly defined. We will not be soliciting positions from anyone, simply opinions. We are not looking for positions during the focus group nor will it become a confrontational or adversarial activity (i.e complaint session). We want to implement the survey as outlined in the study plan and continue to refine the recreational use study.

On last item that requires attention, the focus group is limited to the chapter meeting and does not include the flow evaluation exercise that Mike (representing the TU organization) will be attending in your absence. In the message on the TU website advertising the meeting (which I think is a great idea) the flow evaluation is referenced and it may be interpreted by your members this is open to everyone. Please make sure the message reflects that this flow exercise is limited to the "expert panel" assembled through the TWC and not an open invitation to attend or participate. If your members would like to personally evaluate on their own during those days that is completely up to them and a purely personal decision on their part.

I hope this clarifies a few things I perceive as being misconstrued.

Thanks....Alan

-----Original Message-----
From: LEAPHART,JR., MALCOLML [mailto:MALCOLML@mailbox.sc.edu]
Sent: Wednesday, May 02, 2007 2:29 PM
To: Dave Anderson; Van Hoffman; Alan Axson; Alan Stuart; Alison Guth; Amanda Hill; BARGENTIERI@scana.com; Bill Brebner ; Bill Marshall; Charlene Coleman; Charlie Rentz; David Hancock; Dick Christie; George Duke; Gerrit Jobsis (American Rivers); Guy Jones; ipitts@scprt.com; Jeff Duncan; Jennifer O'Rourke; Jennifer Summerlin; Jim Devereaux; JoAnn Butler; Joy Downs; Karen Kustafik; Keith Ganz-Sarto; Kelly Maloney; turnerle@dhec.sc.gov; Lee Barber; Mark Leao; Marty Phillips; Mike Waddell; Miriam Atria; Norman Ferris; Patricia Wendling; Patrick Moore; Ralph Crafton; RMAHAN@scana.com; rparsons12@alltel.net; Richard Mikell; sjones@imichotels.net; Steve Bell; Suzanne Rhodes; Tim Vinson; Tom Brooks; Tommy Boozer; Tony Bebber
Cc: keithcloud@yahoo.com
Subject: RE: Recreation Assessment Study Report

Dave,
We are glad that you will be soliciting member preferences from Trout Unlimited members at their May 14 meeting as that input will supplement the initial survey results where most of those were not included. Mike is working with the Saluda River Chapter President, Keith Cloud, to help coordinate your visit, including an announcement on their website to encourage members to attend. We are assuming that you will have each complete a membership survey after reviewing those with them for maximum input - but that is not clear from the addendum guideline??

And we are glad that you will have a focus meeting with planned in May. Mike Waddell will represent TU at the focus meeting since you have scheduled while I am out of town. The TU position statement that I filed as comments to the ICD in August, 2005 still provides our written organizational requests and recommendations and should provide the framework for the meeting. Mike will be glad to discuss the various issues further, including any new ones raised to help facilitate understanding on both sides. We will develop any additional responses as needed in writing quickly after the meeting and followup reviews with chapter, state council, and national TU leaders.

From: Dave Anderson [mailto:Dave.Anderson@KleinschmidtUSA.com]
Sent: Wed 5/2/2007 1:47 PM
To: Van Hoffman; Alan Axson; Alan Stuart; Alison Guth; Amanda Hill; Bill Argentieri; Bill Brebner ; Bill Marshall; Charlene Coleman; Charlie Rentz; Dave Anderson; David Hancock; Dick Christie; George Duke; Gerrit Jobsis (American Rivers); Guy Jones; ipitts@scprt.com; Jeff Duncan; Jennifer O'Rourke; Jennifer Summerlin; Jim Devereaux; JoAnn Butler; Joy Downs; Karen Kustafik; Keith Ganz-Sarto; Kelly Maloney; turnerle@dhec.sc.gov; Lee Barber; LEAPHART,JR., MALCOLML; Mark Leao; Marty Phillips; Mike Waddell; Miriam Atria; Norman Ferris; Patricia Wendling; Patrick Moore; Ralph Crafton; Randy Mahan; rparsons12@alltel.net; Richard Mikell; sjones@imichotels.net; Steve Bell; Suzanne Rhodes; Tim Vinson; Tom Brooks; Tommy Boozer; Tony Bebber
Subject: Recreation Assessment Study Report

Recreation RCG Members:

For those of you that are not aware (either by being a member of the Recreation Management TWC or by seeing the presentation a couple of weeks ago), the Recreation Assessment Study Report has been finalized and is posted on the Saluda Hydro Relicensing website. The presentation is also on the website at this time. I have attached an executive summary of the report for you use as well.

The RCG should be aware that, based on comments received from RMTWC members, we will be completing a "spring addendum" to this report to capture spring use at the Project as well as solicit preferences from a couple of groups that TWC members felt were missed either because of temporal reasons (their activity participation typically occurs outside of our sampling period) or because they use private access. I have attached the final study plan for this addendum so you will be aware of what's going on in this TWC.

Other than that, things are progressing smoothly. The RMTWC is currently reviewing the Boat Density Study Report (comments are due by Friday) and the Downstream Flows TWC has scheduled the dates of the recreational flow assessment. All three of these studies should be complete by the end of the summer.

From here, the Recreation Management TWC will be looking at all the information we have and begin to draft a Recreation Plan for the Saluda Project. Once a draft is completed in the TWC, we will distribute to the RCG for their input.

As always, let me know if you have any questions.

Dave

<<Saluda Recreation Assessment Study Report Executive Summary (FINAL).pdf>> <<Spring Use Addendum Study Plan (2007-04-13;FINAL).pdf>>

Kacie Jensen

From: Shane Boring
Sent: Wednesday, April 04, 2007 12:58 PM
To: Tom Bowles (tbowles@scana.com); Alan Stuart; Alison Guth; Amanda Hill; Amy Bennett; Andy Miller; Bill Argentieri; Daniel Tufford; Gerrit Jobsis (American Rivers); Gina Kirkland; Jennifer Summerlin; Jim Glover; Jim Ruane ; Larry Turner (turnerle@dhec.sc.gov); Malcolm Leaphart; Randy Mahan; Reed Bull (rbull@davisfloyd.com); Richard Kidder; Ron Ahle; Roy Parker; Shane Boring
Subject: Lower Saluda/Upper Congaree Temperature Study: 6-Month Update

Dear Water Quality TWC Members:

I wanted to take a few minutes to update everyone on the status of the ongoing temperature study being conducted on the lower Saluda and Congaree rivers. As you may remember from past updates, paired temperature sensors (TidBits) were deployed at 7 locations at approximately 10 mi interval beginning in the vicinity of Riverbanks Zoo on the Saluda and extending to the Highway 601 Bridge on the Congaree, near the confluence of the Congaree and Wateree rivers. In addition, TidBits were also deployed on the Broad River at Interstate-20 (to allow comparison to the Broad) and at the USGS gage below Saluda Dam (to verify data from the USGS gage). We have been downloading data monthly and will continue to collect data through October of this year.

Due to the large volume and complexity of the data, we are in discussions with Dr. John Grego (USC - Dept. of Statistics) to have he and his graduate student(s) perform the final data analysis. Although a complete analysis has not been completed, a preliminary look at the data collected thus far suggests the following:

- No differences in cross-sectional temperature in lower Saluda River;
- Cross-sectional temperature in the upper Congaree River appear to differ, with the "Saluda side" of the Congaree being cooler than the "Broad side";
- Difference in temperature between the Saluda and Broad sides of the Congaree appear to extend at least as far downstream as the Interstate-77 Bridge; and
- Mixing appears to be complete by the time water reaches Congaree National Park, with no differences in cross-sectional temperature evident at this time.

Again, these are preliminary observations of the data collected thus far and should not be interpreted as final study conclusions.

Finally, a presentation summarizing the project status, which was given at the March 26th Water Quality TWC meeting is also attached.

Thanks and please feel free to give me a call with any questions.

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
101 trade Zone Dr., Suite 21A
West Columbia, SC 29170
Phone: (803) 822-3177
E-mail: Shane.Boring@KleinschmidtUSA.com

Lower Saluda and Congaree Riv...