



**Matthew Rodriquez**  
*Secretary for  
Environmental Protection*

# California Regional Water Quality Control Board North Coast Region

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5550 Skylane Boulevard, Suite A, Santa Rosa, California 95403  
(707) 576-2220 • FAX (707) 523-0135  
<http://www.waterboards.ca.gov/northcoast>



**Edmund G. Brown Jr.**  
*Governor*

TO: File: Laguna de Santa Rosa; TMDL Development and Planning

FROM: Steve Butkus

DATE: October 25, 2011

SUBJECT: Diel Water Quality within the Laguna de Santa Rosa Watershed during 2001-2002

The water quality of the Laguna de Santa Rosa (Laguna) has been studied for over 20 years (CH<sub>2</sub>M Hill, 1994). The State Water Board adopted the Section 303(d) listings of the Laguna in 1976 for high nutrients and low dissolved oxygen (DO) concentrations. A TMDL was completed for the Laguna in 1995 in the form of a Waste Reduction Strategy (Morris, 1995) which addressed the reduction of nitrogen loading from point and non-point sources. Low DO concentrations were the result of inputs of excessive nutrients which stimulate photosynthetic growth and subsequently cause depressed DO levels when the algae dies and decays. The TMDL assumed that reductions in nitrogen and ammonia would also result in attainment of the dissolved oxygen water quality objective. Goals for nitrogen, ammonia and dissolved oxygen were established for four attainment locations in the Laguna: (1) Stony Point Road, (2) Occidental Road, (3) Guerneville Road, and (4) Trenton-Healdsburg Road.

The Sonoma County Water Agency (SCWA) and State Water Resources Control Board (SWRCB) on behalf of the North Coast Regional Water Quality Control Board (NCRWQCB) entered into an agreement which provided, in part, a " ... review of NCRWQCB's water quality control plan for the Russian River Watershed to determine whether existing NCRWQCB water quality standards, objectives, and procedures provide adequate protection to listed and unlisted species ... " As part of this effort, continuous DO concentration, pH and temperature data were collected during 2001-2002 at the four Laguna attainment locations to assess the effectiveness of the TMDL.

This memorandum serves to document the results of this monitoring.

## Data Analysis Methods

Data Sondes were deployed at each of the TMDL attainment locations approximately monthly for twelve monitoring events (Table 1). Data collected on Data Sonde deployment and retrieval dates were not included in the analysis of diel conditions (i.e., only data collected for a 24-hour period beginning at 00:00 were used for comparisons). Tables were developed presenting several statistical metrics (i.e., mean, maximum, minimum, range) that represent the median value during the measurement period for each month. The continuous DO concentration, pH and temperature data collected were also compared using data plots. The visual comparisons of these data are described for each monitoring location.

Table 1. Laguna Monitoring Survey Dates

Survey No.	Start Date	End Date	Diel Days
1	8/1/2001	8/3/2001	1
2	8/29/2001	9/2/2001	2
3	10/22/2001	10/27/2001	3
4	11/9/2001	11/16/2001	6
5	4/12/2002	4/19/2002	6
6	5/10/2002	5/21/2002	9
7	6/14/2002	6/25/2002	9
8	7/12/2002	7/23/2002	9
9	8/9/2002	8/20/2002	9
10	9/13/2002	9/25/2002	10
11	10/11/2002	10/21/2002	9
12	11/15/2002	11/25/2002	9

## Results

Data Sonde measurements of dissolved oxygen concentrations and percent saturation, water temperatures and pH are shown for each location and survey in Figures 1 – 48. Dissolved oxygen saturation was derived from water temperature assuming zero salinity and one atmosphere barometric pressure (USGS, 2011).

Visual comparisons of the measurements show larger diel variation during summer and early fall due to increased productivity and solar heating. Diel patterns of dissolved oxygen appear to closely follow water temperature. These patterns indicate that productivity is largely influence by temperature dependence. Many of the dissolved concentrations measured are well below the 7.0 mg/L water quality objective specified in the Basin Plan (NCRWQCB, 2007). Diel patterns measured at Trenton-Healdsburg road are not as erratic as the other stations likely due to more complete mixing in this reach of the Laguna, which is more lotic in nature.

Diel variation measured in November does not exhibit a definitive diel pattern (Figures 13-16 and 45-48). The observed variations are likely driven by stream flow. Stream flow was measured by the U.S. Geological Survey at 2 locations: Stony Point Road (USGS stream gage #11465680) and Occidental Road (USGS stream gage #11465750). The diel water quality patterns observed are similar to daily mean stream flows during November 2001 (Figure 76), but not during November 2002 (Figure 77).

Dissolved oxygen concentrations were visually compared for each measurement survey between attainment locations in Figures 49-60. Diel patterns tend to be generally similar between attainment locations. However, instrument drift is suspected for the dissolved oxygen concentrations measurements collected during June 2002 (Figure 55) and November 2002 (Figure 60). Dissolved oxygen measurements were collected with a Data Sonde instrument with a membrane sensor that could foul in the environment. These data may be considered suspect.

Descriptive statistics were derived for the diel measurements to better compare the data between attainment locations. Daily mean, maximum, minimum and diel range were derived from the median value for each measurement survey and are presented in Tables 2-17 and Figures 61-75. In general, dissolved oxygen concentrations and saturation levels increase as the water moves downstream (i.e., from Stony Point Road to Trenton-Healdsburg Road). The pH also rises as the water moves downstream, which is indicative of productivity (i.e., photosynthetic activity increases the pH by removing carbon dioxide from water).

Water temperature shows a slight increase in the slower flowing lentic locations (i.e., Occidental Road and Guerneville Road), likely due to less riparian shading in the wide reaches. Much larger diel ranges are observed in dissolved oxygen and pH at Occidental Road location representing the difference between the lentic (lake-like) and lotic (stream-like) environments.

Table 2. Daily Mean Dissolved Oxygen Concentrations by Month

Survey	Month	Daily Mean Dissolved Oxygen Concentration (mg/L)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	1.8	2.7	6.1	6.7
2	Sep-2001	1.4	3.5	4.9	7.3
3	Oct-2001	4.8	14.1	6.0	8.6
4	Nov-2001	1.0	4.8	5.6	6.7
5	Apr-2002	0.6	10.6	5.3	6.3
6	May-2002	1.7	10.2	8.6	6.4
7	Jun-2002	0.4	2.4	4.6	7.1
8	Jul-2002	0.5	1.3	5.6	6.8
9	Aug-2002	0.4	3.0	5.4	7.2
10	Sep-2002	0.2	3.5	5.6	7.3
11	Oct-2002	0.2	4.9	8.2	8.9
12	Nov-2002	0.0	0.3	0.5	2.2

Table 3. Daily Maximum Dissolved Oxygen Concentrations by Month

Survey	Month	Daily Maximum Dissolved Oxygen Concentration (mg/L)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	3.6	5.5	8.4	7.6
2	Sep-2001	3.3	7.3	6.1	8.4
3	Oct-2001	7.6	19.1	6.5	9.0
4	Nov-2001	1.6	6.8	7.2	7.8
5	Apr-2002	1.2	13.6	8.5	7.2
6	May-2002	2.5	14.9	10.5	7.1
7	Jun-2002	1.0	5.1	5.9	7.9
8	Jul-2002	1.0	3.6	6.7	8.1
9	Aug-2002	0.5	7.1	6.3	8.4
10	Sep-2002	0.5	7.1	6.1	8.3
11	Oct-2002	0.7	7.9	9.2	9.6
12	Nov-2002	0.1	0.6	0.6	2.3

Table 4. Daily Minimum Dissolved Oxygen Concentrations by Month

Survey	Month	Daily Minimum Dissolved Oxygen Concentration (mg/L)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	0.8	0.7	5.4	6.2
2	Sep-2001	0.4	1.1	4.2	6.7
3	Oct-2001	3.2	9.7	5.7	8.3
4	Nov-2001	0.4	3.4	4.7	5.9
5	Apr-2002	0.2	7.6	4.0	5.5
6	May-2002	1.0	6.2	7.4	6.0
7	Jun-2002	0.4	0.3	3.4	6.3
8	Jul-2002	0.4	0.3	4.8	6.1
9	Aug-2002	0.4	0.6	4.8	6.6
10	Sep-2002	0.1	0.8	5.0	6.8
11	Oct-2002	0.1	2.8	7.2	8.6
12	Nov-2002	0.0	0.1	0.4	2.1

Table 5. Diel Range of Dissolved Oxygen Concentrations by Month

Survey	Month	Diel Range Dissolved Oxygen Concentration(mg/L)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	2.9	4.8	3.0	1.3
2	Sep-2001	3.0	6.3	1.9	1.7
3	Oct-2001	4.2	9.7	1.0	0.7
4	Nov-2001	1.3	2.8	1.9	1.7
5	Apr-2002	1.0	7.7	4.2	1.6
6	May-2002	1.2	6.9	3.2	1.2
7	Jun-2002	0.6	4.6	2.6	1.7
8	Jul-2002	0.5	3.3	1.9	2.0
9	Aug-2002	0.2	6.6	1.5	2.0
10	Sep-2002	0.4	6.5	1.3	1.5
11	Oct-2002	0.5	5.6	2.6	1.1
12	Nov-2002	0.1	0.4	0.2	0.2

Table 6. Daily Mean Dissolved Oxygen Percent Saturation by Month

Survey	Month	Daily Mean Dissolved Oxygen Saturation (%)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	20.7	30.5	70.0	73.4
2	Sep-2001	15.0	39.5	55.5	79.0
3	Oct-2001	47.3	140.9	58.5	82.9
4	Nov-2001	10.2	47.2	52.8	65.0
5	Apr-2002	5.9	108.8	55.6	66.7
6	May-2002	17.5	117.8	92.7	68.7
7	Jun-2002	4.3	28.7	53.7	77.8
8	Jul-2002	5.2	14.3	66.4	76.6
9	Aug-2002	4.2	34.0	61.7	79.3
10	Sep-2002	1.6	38.6	61.5	77.3
11	Oct-2002	2.0	49.1	80.2	85.7
12	Nov-2002	0.3	2.7	4.8	20.2

Table 7. Daily Maximum Dissolved Oxygen Percent Saturation by Month

Survey	Month	Daily Maximum Dissolved Oxygen Saturation (%)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	40.9	63.1	96.0	86.3
2	Sep-2001	37.2	83.4	69.3	93.8
3	Oct-2001	75.4	193.0	64.2	88.9
4	Nov-2001	15.3	66.6	69.6	75.8
5	Apr-2002	12.2	145.8	86.5	77.3
6	May-2002	25.5	177.0	115.0	77.9
7	Jun-2002	10.5	62.0	70.7	89.8
8	Jul-2002	10.2	41.2	79.2	95.4
9	Aug-2002	5.1	82.3	70.8	98.3
10	Sep-2002	5.6	81.5	67.0	89.9
11	Oct-2002	6.4	82.6	93.5	94.7
12	Nov-2002	1.0	5.2	5.9	20.8

Table 8. Daily Minimum Dissolved Oxygen Percent Saturation by Month

Survey	Month	Daily Minimum Dissolved Oxygen Saturation (%)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	8.9	7.7	60.8	68.6
2	Sep-2001	4.2	11.7	47.6	72.0
3	Oct-2001	30.6	91.7	55.8	80.9
4	Nov-2001	3.5	33.4	44.5	57.4
5	Apr-2002	2.0	75.8	42.1	58.2
6	May-2002	10.2	64.4	78.7	62.7
7	Jun-2002	3.7	3.7	37.6	69.0
8	Jul-2002	4.2	3.1	55.0	68.0
9	Aug-2002	4.0	6.1	53.9	71.6
10	Sep-2002	1.2	8.4	53.9	71.8
11	Oct-2002	1.3	26.4	70.0	82.2
12	Nov-2002	0.0	1.1	3.9	19.0

Table 9. Diel Range of Dissolved Oxygen Percent Saturation by Month

Survey	Month	Diel Range Dissolved Oxygen Saturation (%)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	32.0	55.3	35.2	17.7
2	Sep-2001	33.0	71.7	21.7	21.8
3	Oct-2001	41.6	107.9	10.4	8.2
4	Nov-2001	12.4	28.6	18.3	16.2
5	Apr-2002	9.9	85.3	44.0	17.4
6	May-2002	12.1	91.3	36.3	15.5
7	Jun-2002	6.8	57.7	34.1	22.7
8	Jul-2002	5.7	38.2	24.6	27.6
9	Aug-2002	1.8	77.2	16.9	26.3
10	Sep-2002	4.5	74.9	17.1	18.0
11	Oct-2002	4.8	58.3	26.6	12.9
12	Nov-2002	1.0	4.0	1.7	1.7

Table 10. Daily Mean Water Temperature by Month

Survey	Month	Daily Mean Water Temperature (°C)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	20.8	20.8	22.0	20.1
2	Sep-2001	20.1	20.5	21.2	19.4
3	Oct-2001	14.3	15.7	14.7	13.7
4	Nov-2001	14.3	14.6	14.6	14.2
5	Apr-2002	15.7	16.5	16.9	16.8
6	May-2002	15.9	21.3	19.3	18.4
7	Jun-2002	18.4	23.4	22.5	20.9
8	Jul-2002	19.1	21.8	22.5	21.1
9	Aug-2002	18.7	21.5	21.8	20.0
10	Sep-2002	16.1	19.8	19.5	18.0
11	Oct-2002	12.8	15.1	14.9	13.6
12	Nov-2002	11.0	13.0	11.8	12.0

Table 11. Daily Maximum Water Temperature by Month

Survey	Month	Daily Maximum Water Temperature (°C)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	22.1	22.4	23.3	22.5
2	Sep-2001	21.4	21.7	21.9	20.9
3	Oct-2001	15.4	17.1	15.3	14.9
4	Nov-2001	14.8	15.0	15.0	15.0
5	Apr-2002	16.4	17.9	18.7	18.2
6	May-2002	17.0	23.8	20.6	19.7
7	Jun-2002	20.1	25.6	24.8	23.1
8	Jul-2002	20.8	23.3	24.2	23.2
9	Aug-2002	20.5	23.1	23.2	22.3
10	Sep-2002	17.2	22.4	21.5	19.9
11	Oct-2002	13.6	16.6	15.8	14.7
12	Nov-2002	11.5	13.6	12.1	12.3

Table 12. Daily Minimum Water Temperature by Month

Survey	Month	Daily Minimum Water Temperature (°C)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	19.7	19.5	21.2	18.5
2	Sep-2001	19.3	19.4	20.7	18.2
3	Oct-2001	13.5	13.8	14.1	12.6
4	Nov-2001	14.1	14.1	14.1	13.9
5	Apr-2002	15.1	15.6	15.8	16.0
6	May-2002	14.8	19.4	17.9	16.7
7	Jun-2002	16.8	21.9	21.2	19.1
8	Jul-2002	17.6	20.7	21.8	19.2
9	Aug-2002	17.4	20.3	20.7	18.5
10	Sep-2002	15.2	18.0	18.3	16.3
11	Oct-2002	12.3	14.1	14.4	12.8
12	Nov-2002	10.7	12.6	11.6	11.7

Table 13. Diel range of Water Temperature by Month

Survey	Month	Diel Range Water Temperature (°C)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	2.4	2.9	2.1	4.0
2	Sep-2001	2.1	2.3	1.3	2.8
3	Oct-2001	2.0	3.3	1.3	2.3
4	Nov-2001	0.8	0.7	1.2	0.9
5	Apr-2002	1.4	2.7	2.5	2.5
6	May-2002	2.2	4.0	2.8	3.0
7	Jun-2002	3.2	3.8	4.2	3.9
8	Jul-2002	3.0	2.6	2.4	4.3
9	Aug-2002	2.9	2.8	2.5	3.8
10	Sep-2002	2.0	4.6	2.9	3.7
11	Oct-2002	1.3	2.7	1.7	1.8
12	Nov-2002	0.8	0.9	0.8	0.8

Table 14. Daily Mean pH by Month

Survey	Month	Daily Mean pH (s.u.)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	7.31	7.46	7.93	7.79
2	Sep-2001	7.30	7.54	7.79	7.86
3	Oct-2001	7.37	8.16	7.76	7.84
4	Nov-2001	6.78	7.39	7.21	7.05
5	Apr-2002	7.08	7.81	7.27	7.45
6	May-2002	7.25	8.26	7.19	7.52
7	Jun-2002	6.92	7.25	7.53	7.85
8	Jul-2002	6.88	7.20	7.76	7.72
9	Aug-2002	7.11	7.38	7.77	7.76
10	Sep-2002	7.25	7.40	7.78	7.80
11	Oct-2002	7.23	7.39	7.79	7.77
12	Nov-2002	6.67	6.81	6.66	6.92

Table 15. Daily Maximum pH by Month

Survey	Month	Daily Maximum pH (s.u.)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	7.38	7.58	8.09	7.87
2	Sep-2001	7.36	7.73	7.88	7.95
3	Oct-2001	7.47	8.60	7.82	7.88
4	Nov-2001	6.84	7.67	7.36	7.14
5	Apr-2002	7.11	8.19	7.55	7.53
6	May-2002	7.30	8.78	7.33	7.57
7	Jun-2002	6.97	7.43	7.71	7.95
8	Jul-2002	6.94	7.28	7.84	7.83
9	Aug-2002	7.20	7.60	7.84	7.88
10	Sep-2002	7.33	7.55	7.84	7.88
11	Oct-2002	7.26	7.59	7.85	7.83
12	Nov-2002	6.69	6.84	6.69	6.93

Table 16. Daily Minimum pH by Month

Survey	Month	Daily Minimum pH (s.u.)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	7.26	7.36	7.89	7.76
2	Sep-2001	7.28	7.43	7.74	7.82
3	Oct-2001	7.31	7.82	7.67	7.82
4	Nov-2001	6.68	7.16	7.09	7.01
5	Apr-2002	7.05	7.53	7.18	7.41
6	May-2002	7.23	7.91	7.08	7.49
7	Jun-2002	6.88	7.14	7.38	7.77
8	Jul-2002	6.86	7.16	7.72	7.66
9	Aug-2002	7.07	7.28	7.71	7.66
10	Sep-2002	7.21	7.29	7.70	7.77
11	Oct-2002	7.20	7.30	7.72	7.74
12	Nov-2002	6.65	6.80	6.65	6.90

Table 17. Diel Range of pH by Month

Survey	Month	Diel Range pH (s.u.)			
		Stony Point Road	Occidental Road	Guerneville Road	Trenton-Healdsburg Road
1	Aug-2001	0.12	0.22	0.20	0.11
2	Sep-2001	0.09	0.30	0.15	0.13
3	Oct-2001	0.16	0.83	0.15	0.06
4	Nov-2001	0.14	0.25	0.27	0.08
5	Apr-2002	0.06	0.74	0.32	0.12
6	May-2002	0.07	0.69	0.29	0.08
7	Jun-2002	0.10	0.28	0.31	0.16
8	Jul-2002	0.10	0.13	0.14	0.18
9	Aug-2002	0.14	0.32	0.13	0.23
10	Sep-2002	0.12	0.25	0.14	0.11
11	Oct-2002	0.07	0.31	0.09	0.10
12	Nov-2002	0.04	0.03	0.06	0.03

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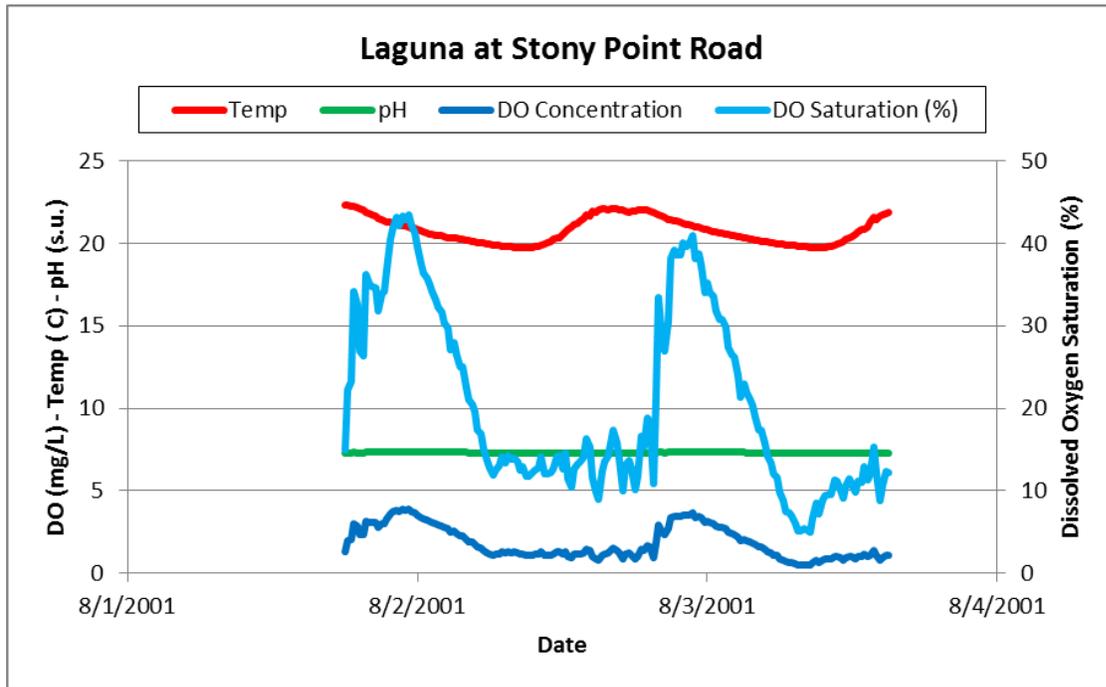


Figure 1. Diel Data Sonde Measurements from the Laguna at Stony Point Road during August 2001

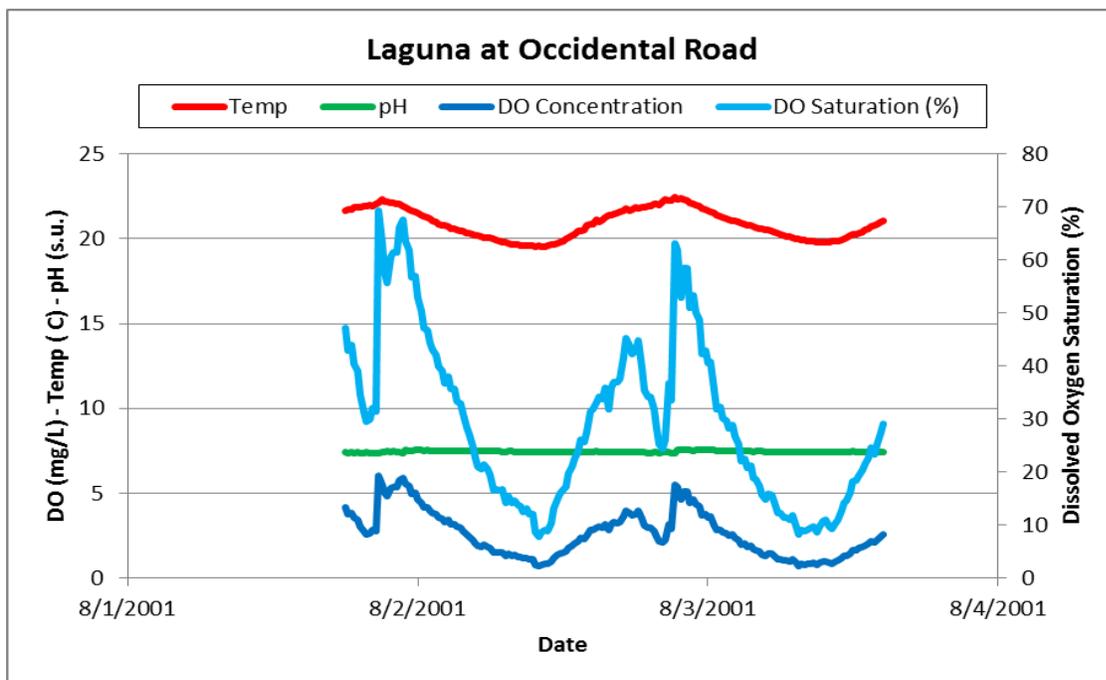


Figure 2. Diel Data Sonde Measurements from the Laguna at Occidental Road during August 2001

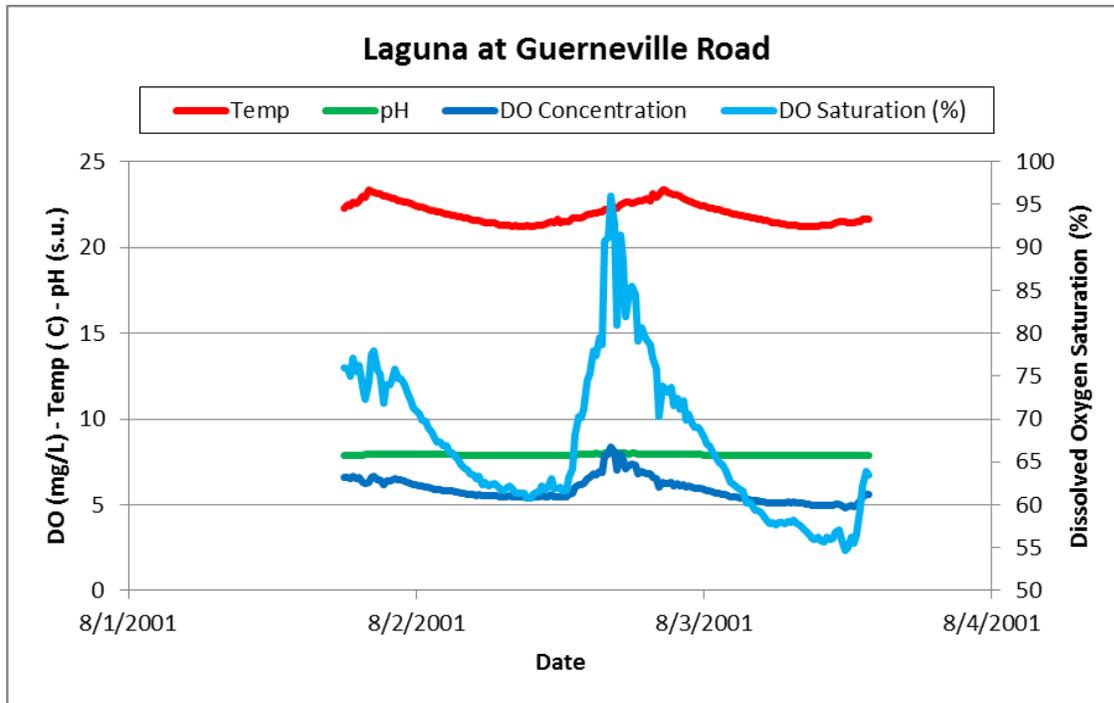


Figure 3. Diel Data Sonde Measurements from the Laguna at Guerneville Road during August 2001

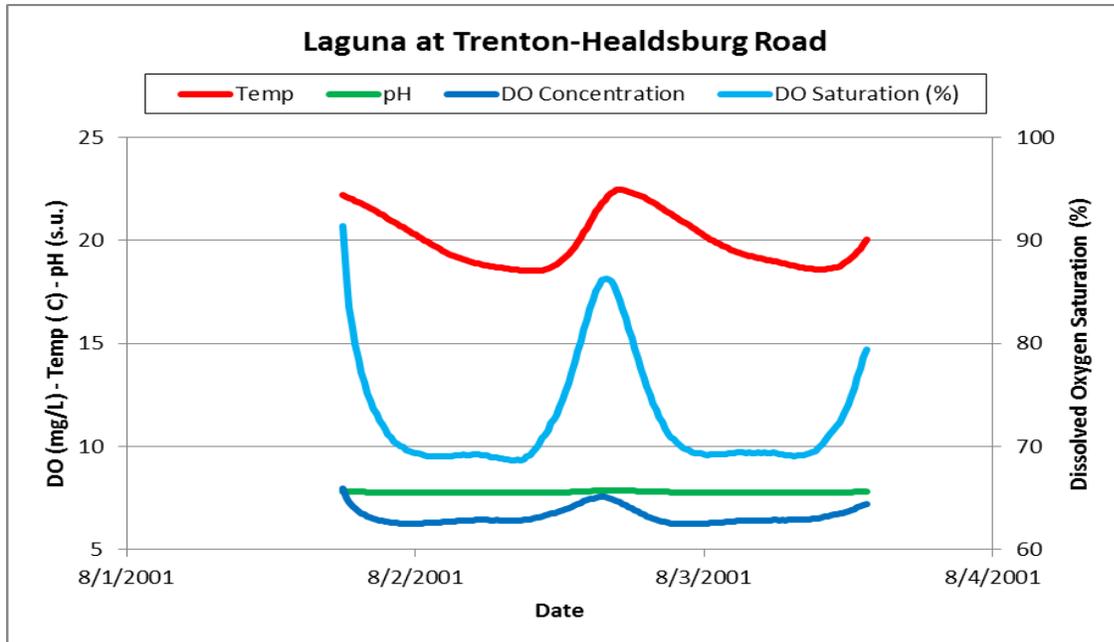


Figure 4. Diel Data Sonde Measurements from the Laguna at Trenton-Healdsburg Road during August 2001

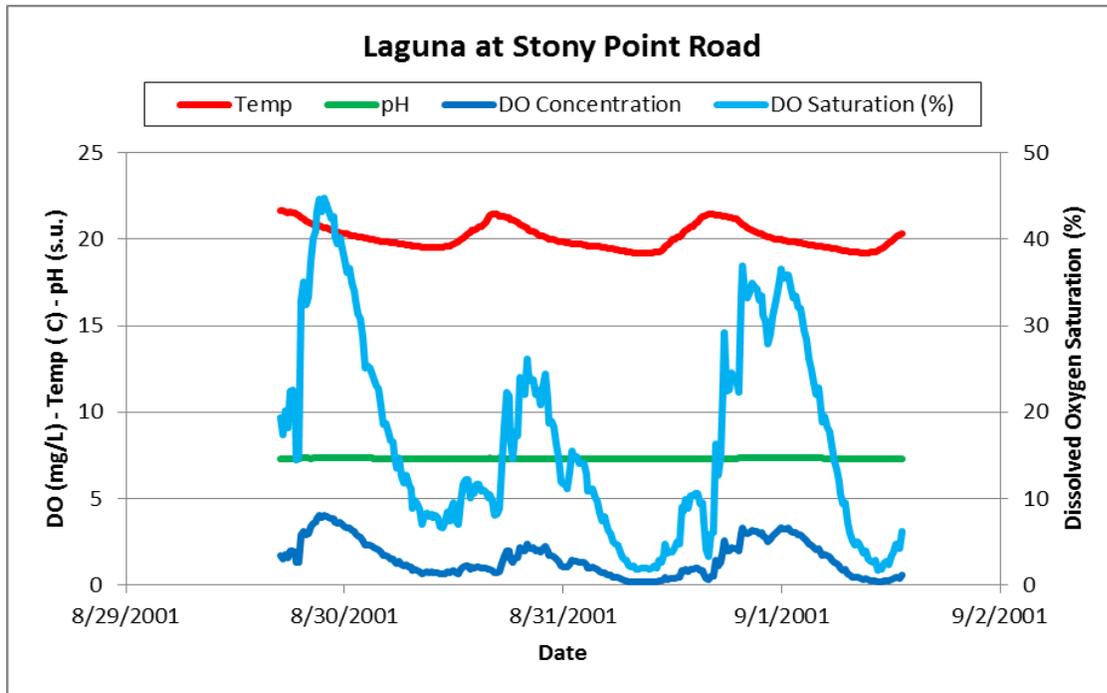


Figure 5. Diel Data Sonde Measurements from the Laguna at Stony Point Road during September 2001

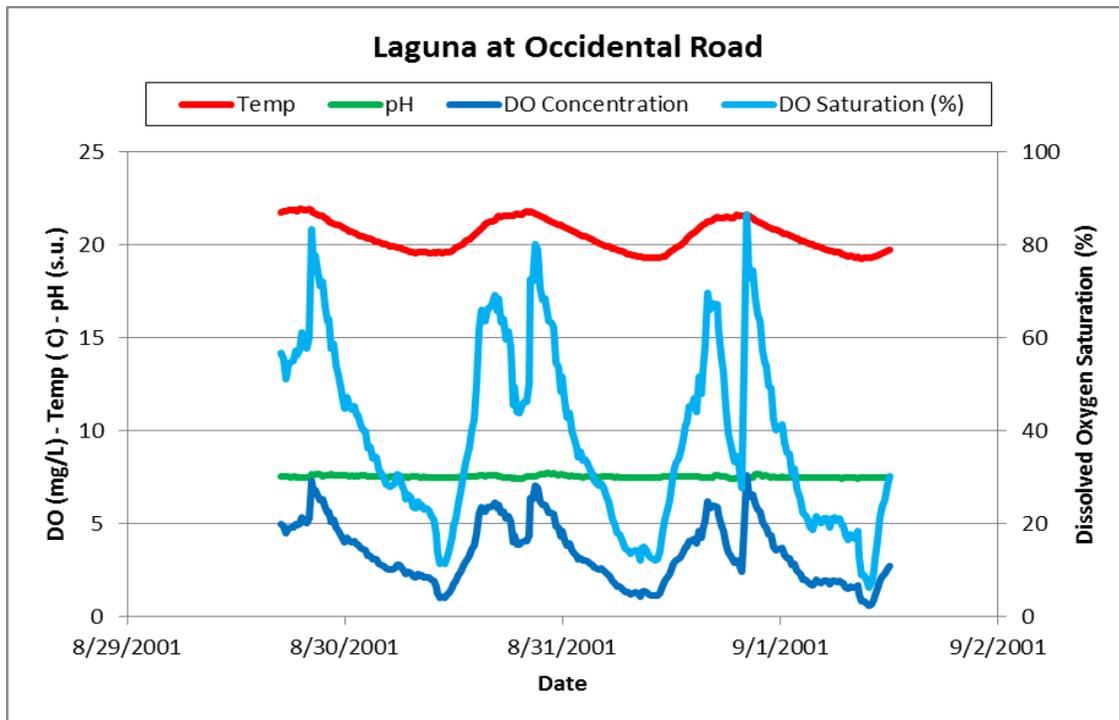


Figure 6. Diel Data Sonde Measurements from the Laguna at Occidental Road during September 2001

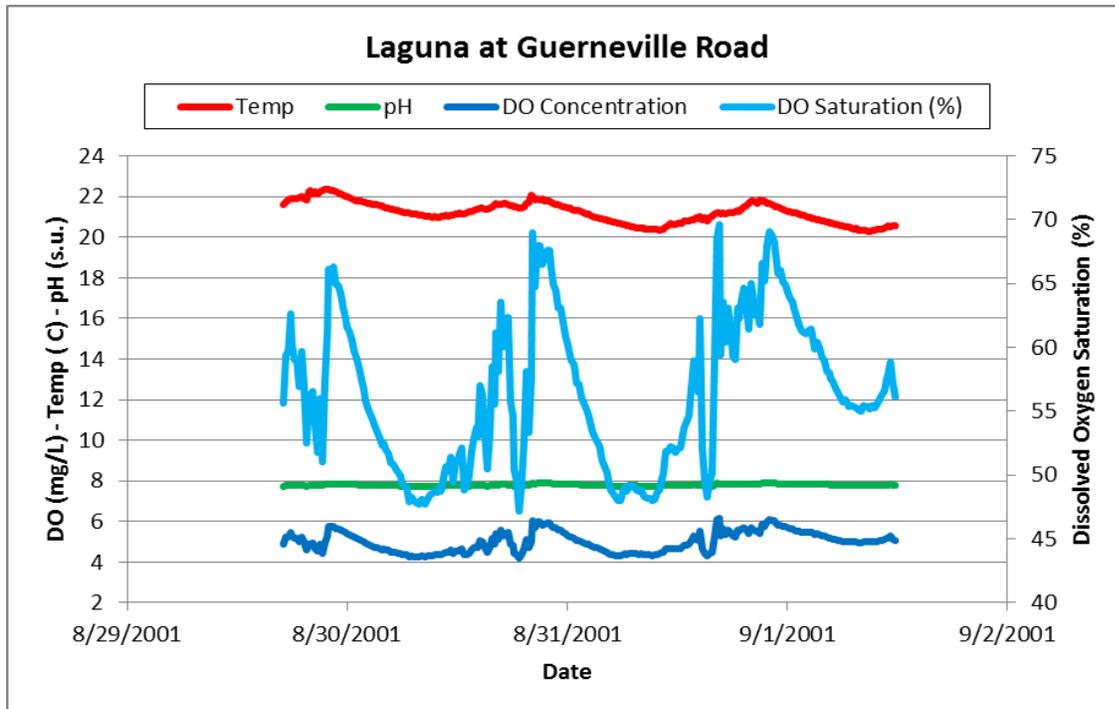


Figure 7. Diel Data Sonde Measurements from the Laguna at Guerneville Road during September 2001

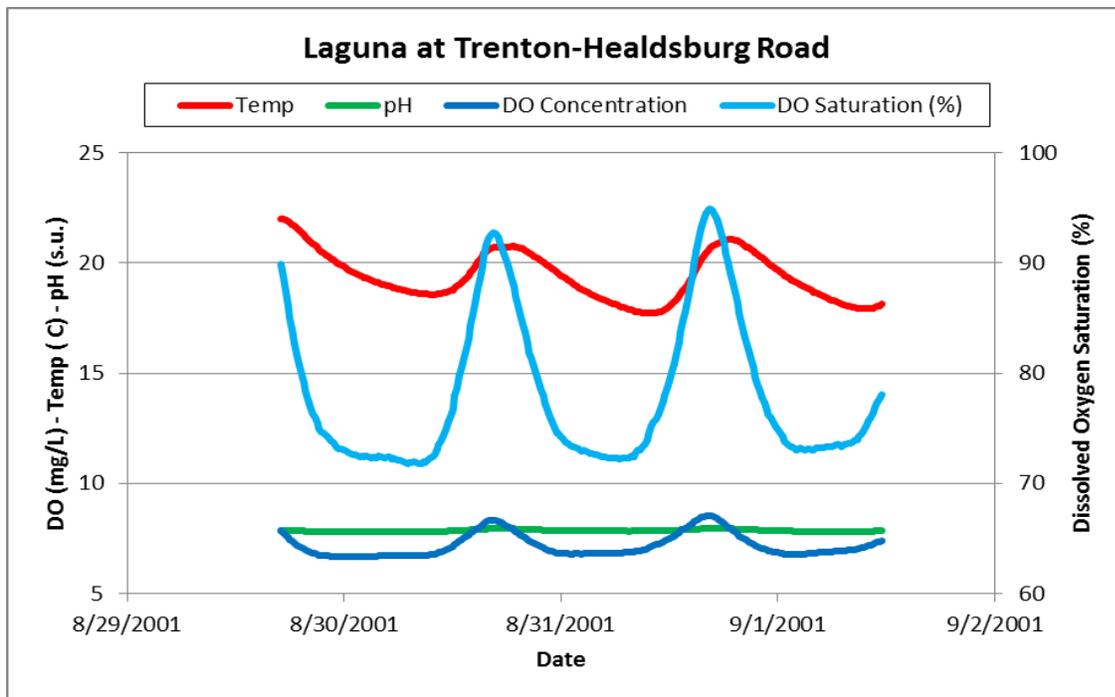


Figure 8. Diel Data Sonde Measurements from the Laguna at Trenton-Healdsburg Road during September 2001

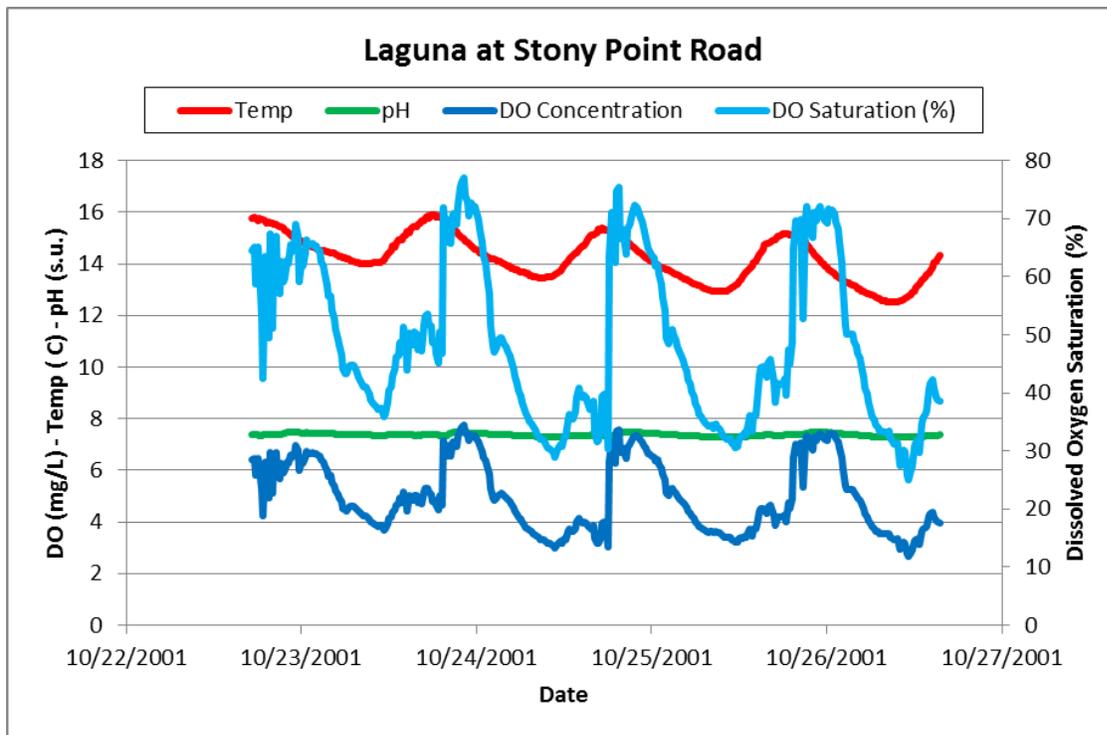


Figure 9. Diel Data Sonde Measurements from the Laguna at Stony Point Road during October 2001

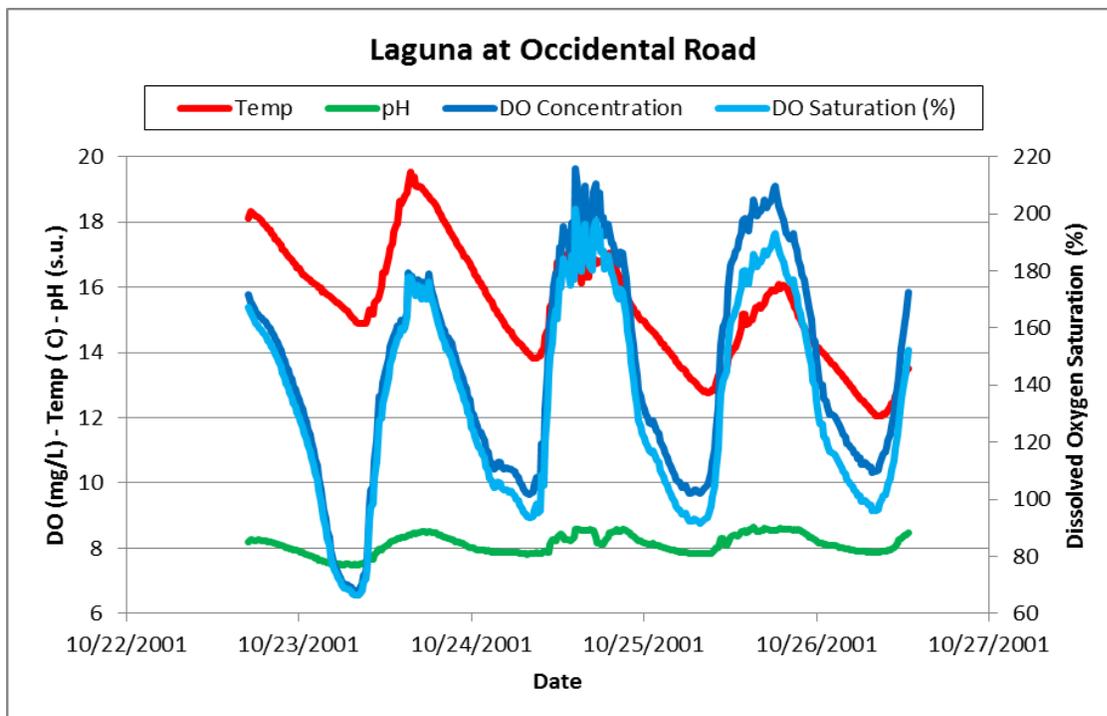


Figure 10. Diel Data Sonde Measurements from the Laguna at Occidental Road during October 2001

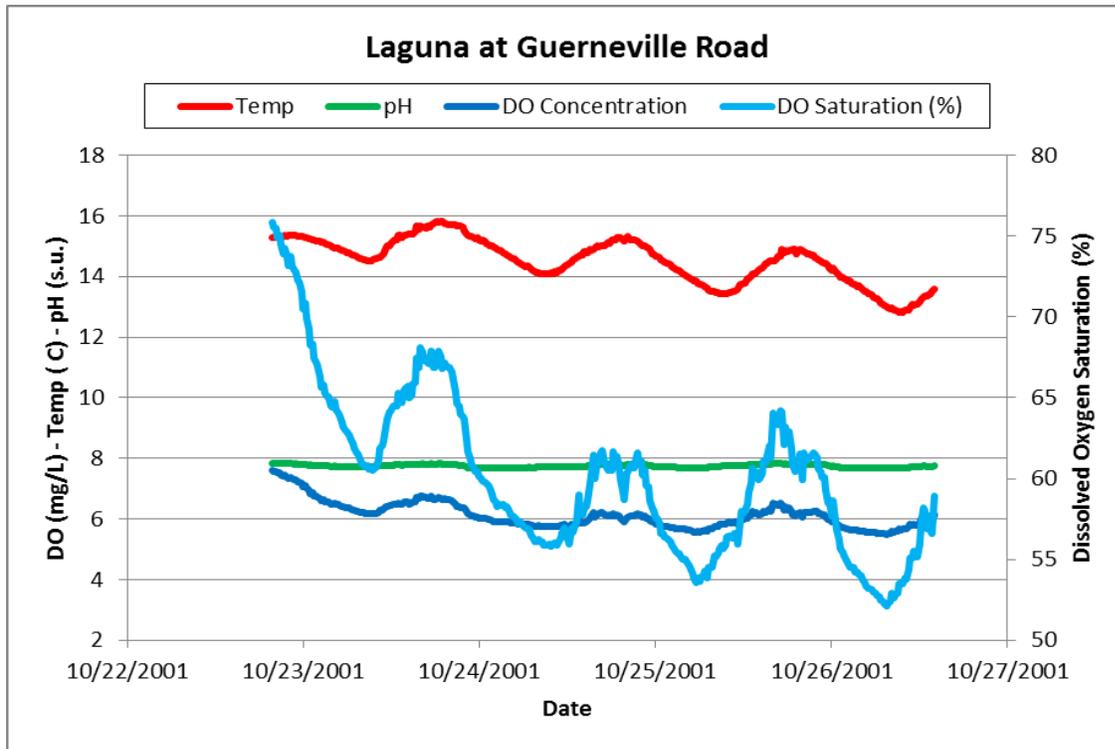


Figure 11. Diel Data Sonde Measurements from the Laguna at Guerneville Road during October 2001

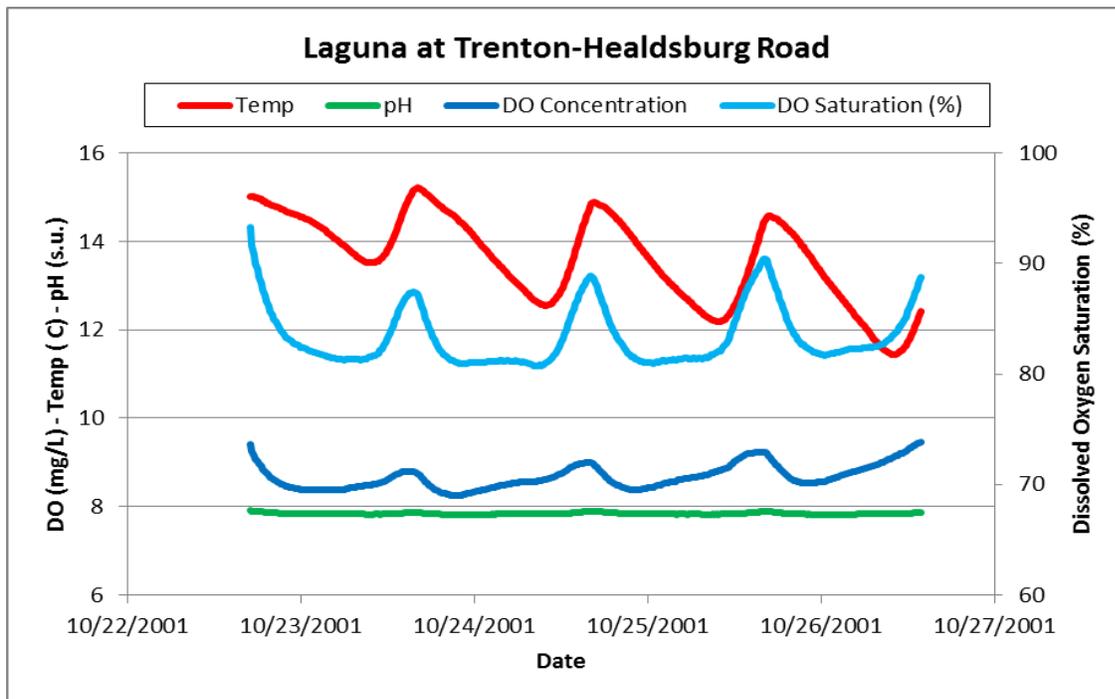


Figure 12. Diel Data Sonde Measurements from the Laguna at Trenton-Healdsburg Road during October 2001

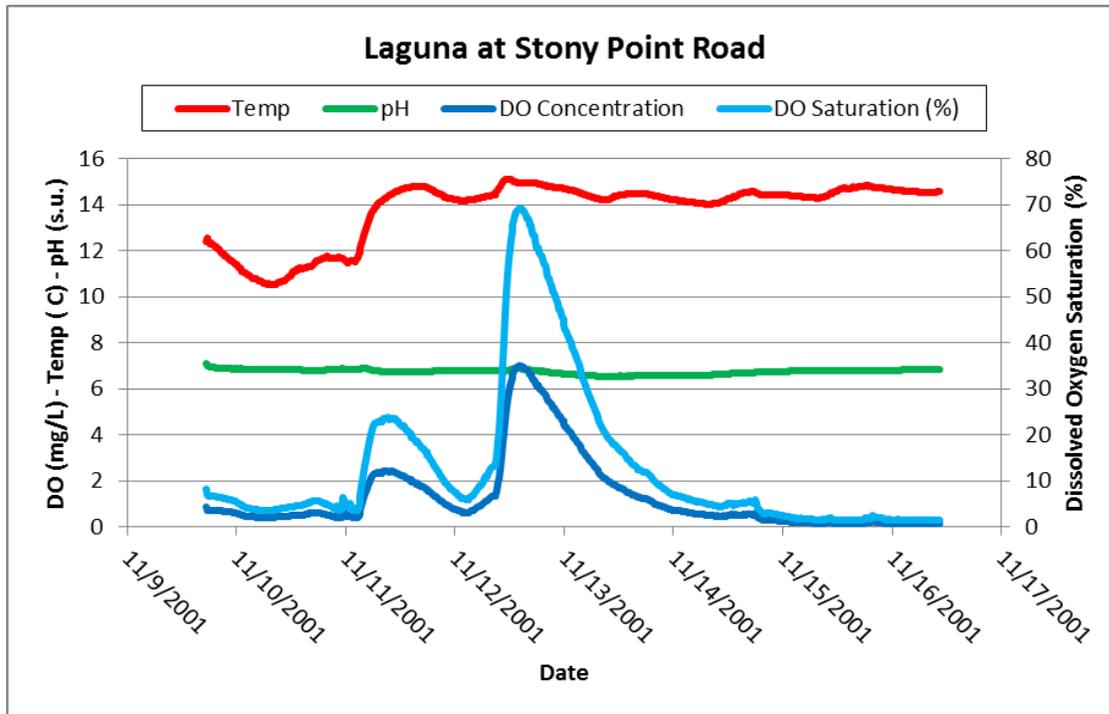


Figure 13. Diel Data Sonde Measurements from the Laguna at Stony Point Road during November 2001

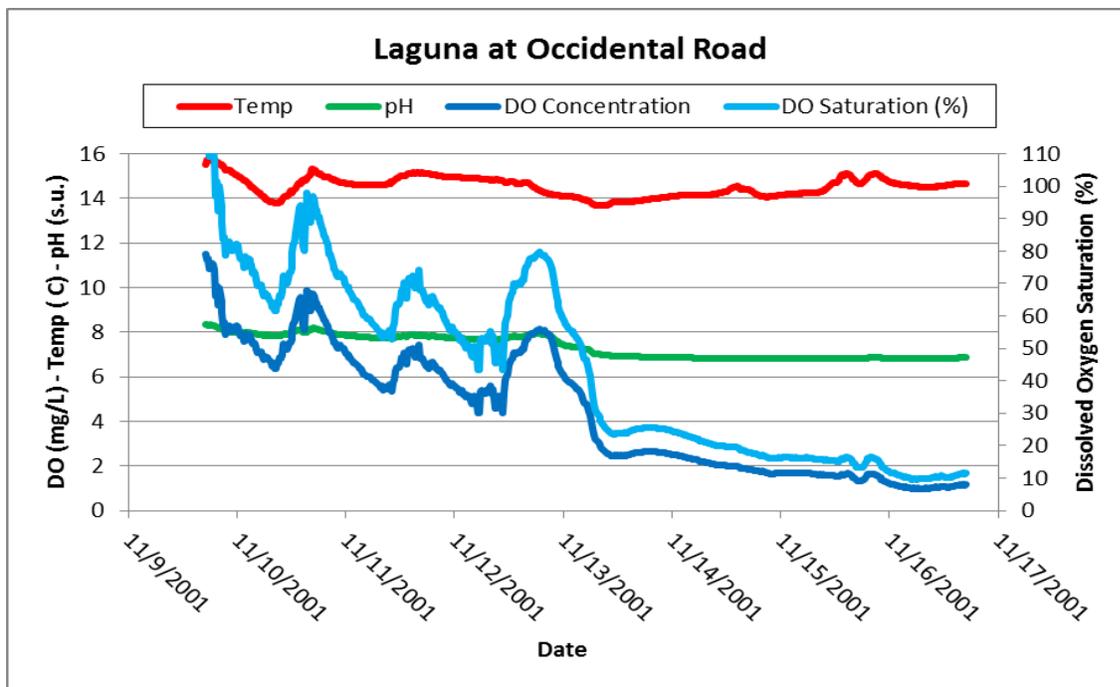


Figure 14. Diel Data Sonde Measurements from the Laguna at Occidental Road during November 2001

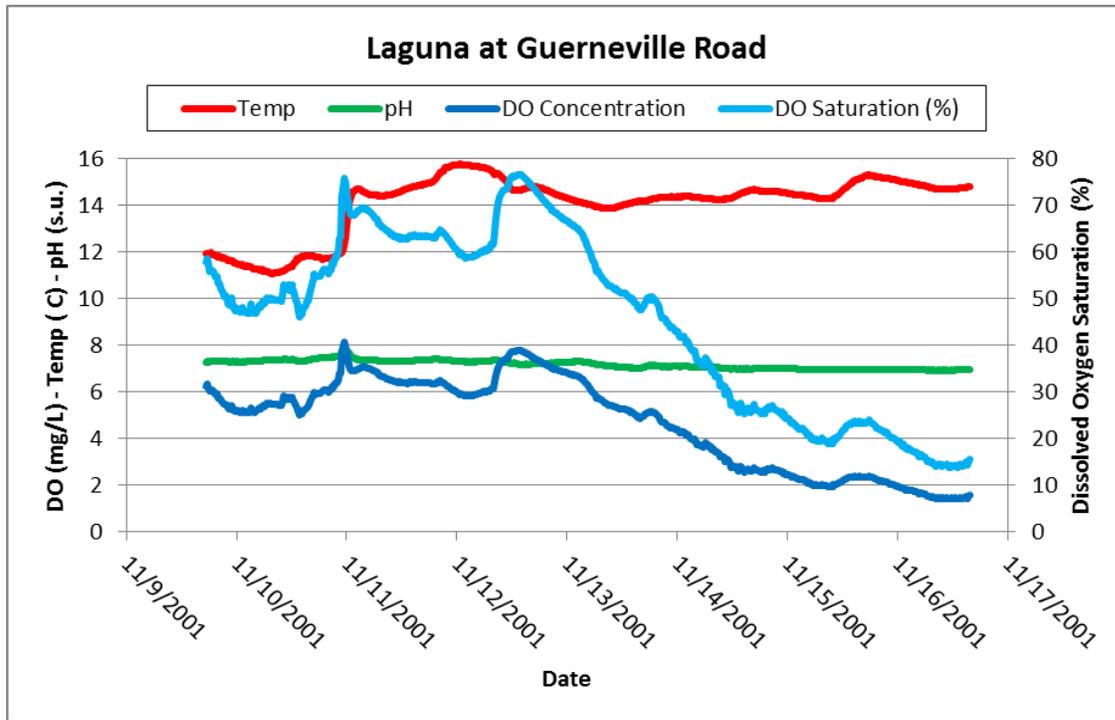


Figure 15. Diel Data Sonde Measurements from the Laguna at Guerneville Road during November 2001

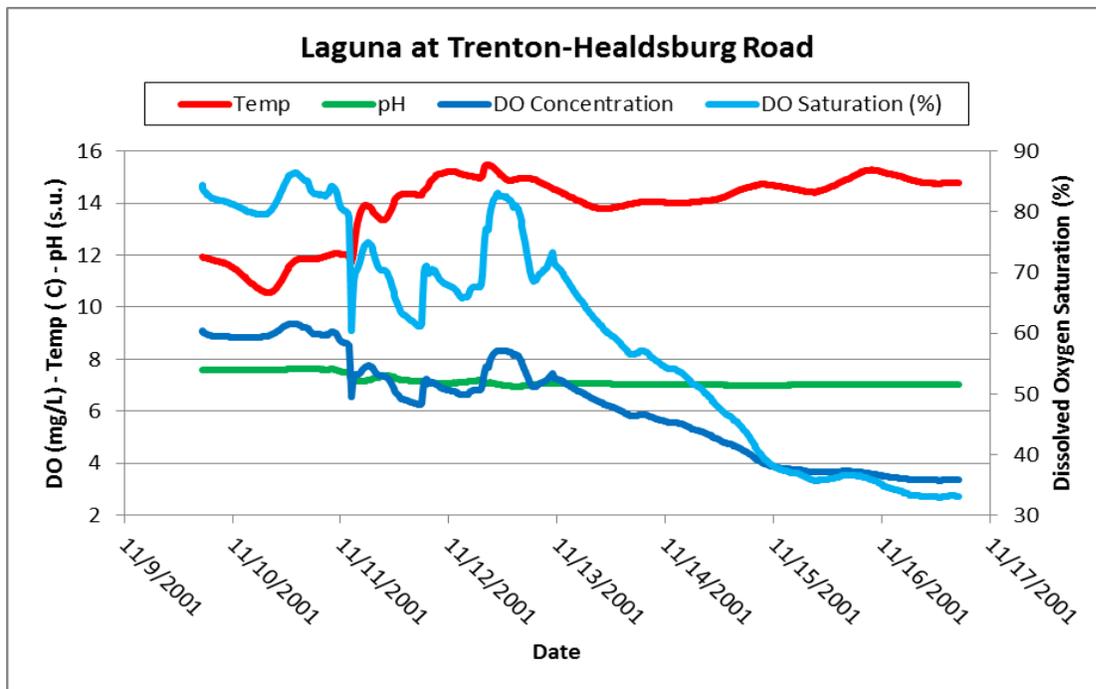


Figure 16. Diel Data Sonde Measurements from the Laguna at Trenton-Healdsburg Road during November 2001

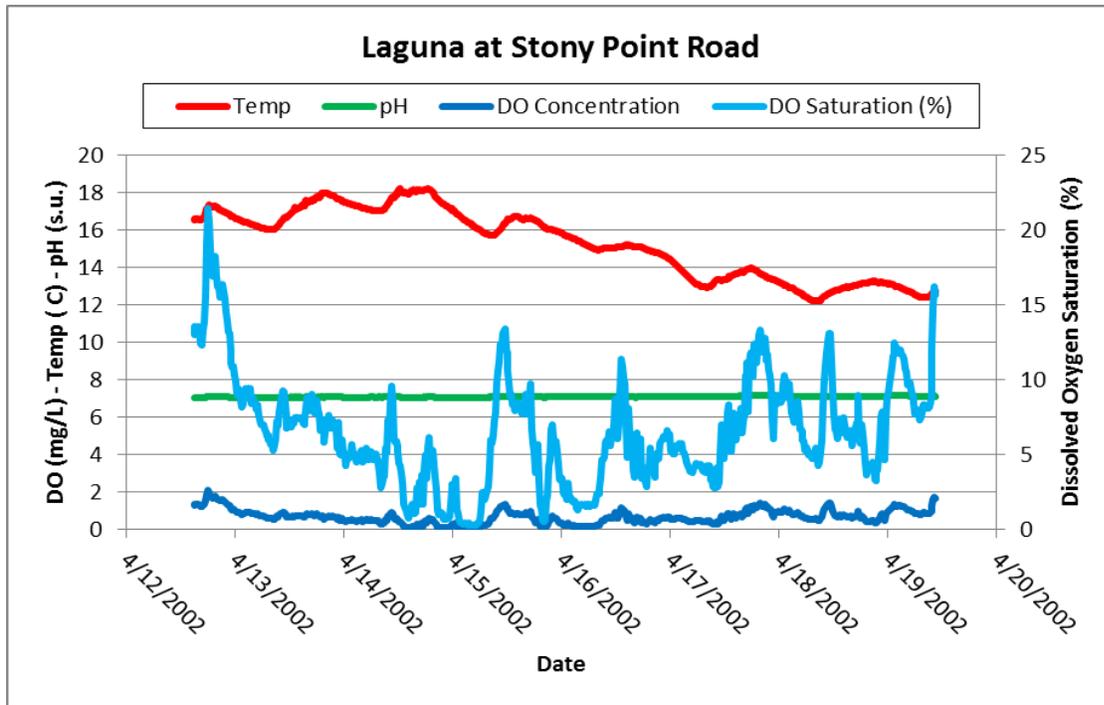


Figure 17. Diel Data Sonde Measurements from the Laguna at Stony Point Road during April 2002.

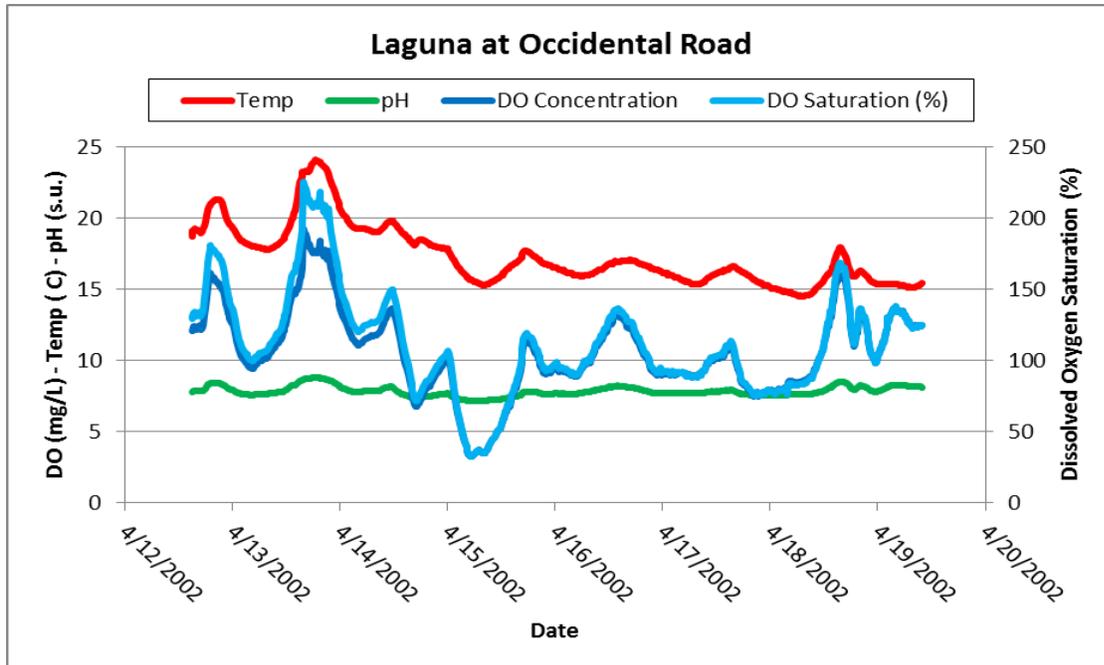


Figure 18. Diel Data Sonde Measurements from the Laguna at Occidental Road during April 2002

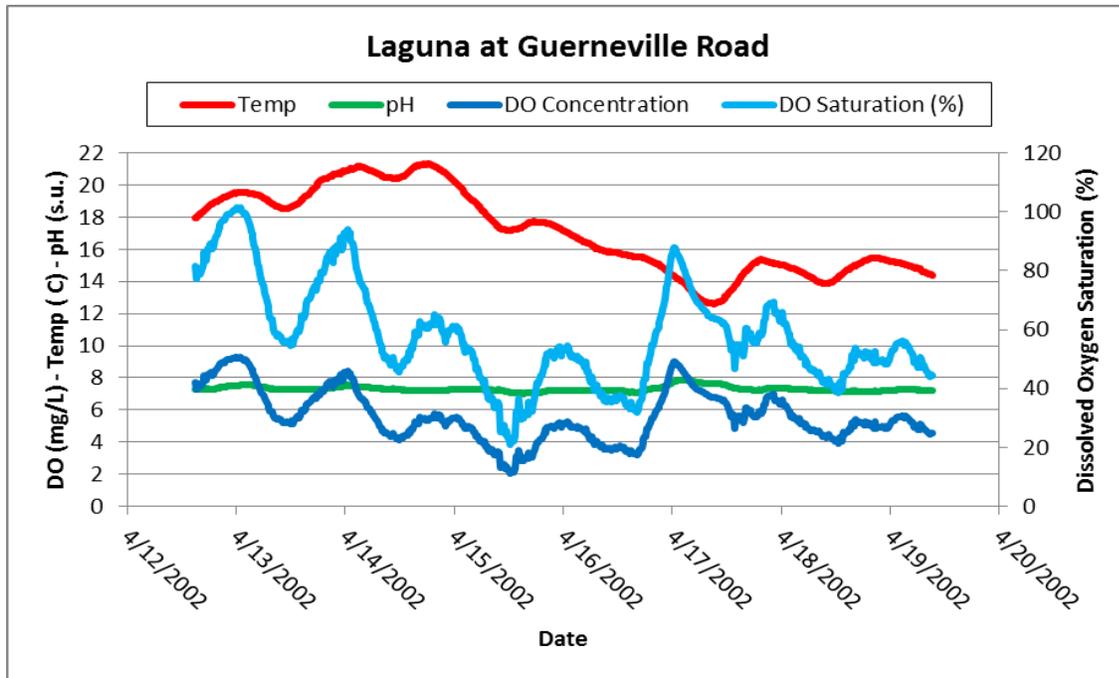


Figure 19. Diel Data Sonde Measurements from the Laguna at Guerneville Road during April 2002

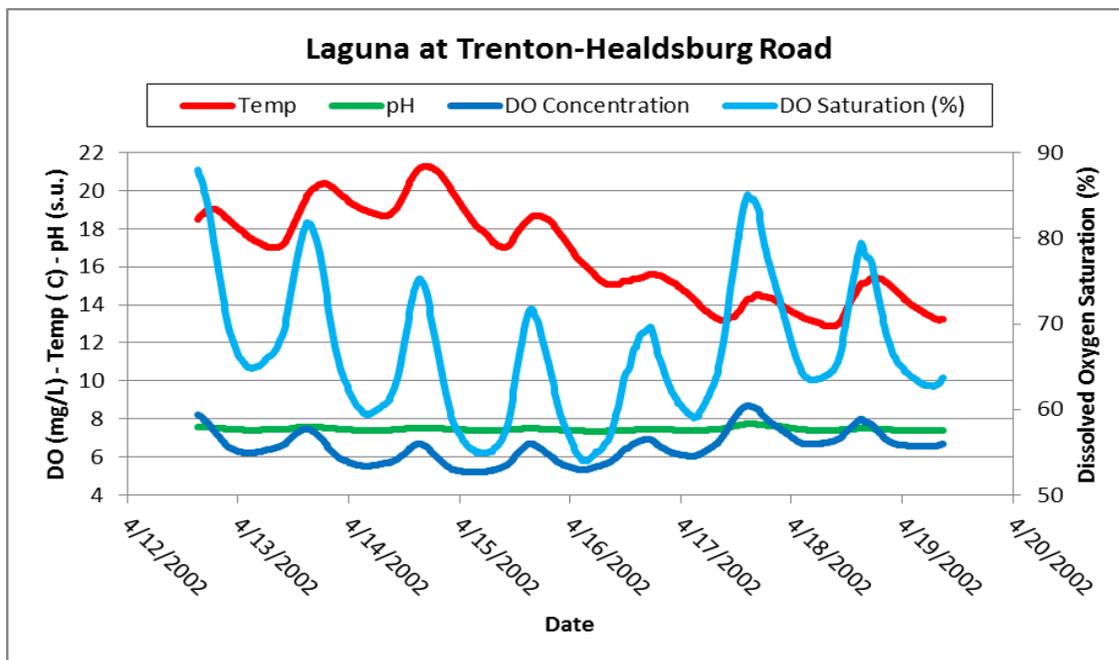


Figure 20. Diel Data Sonde Measurements from the Laguna at Trenton-Healdsburg Road during April 2002

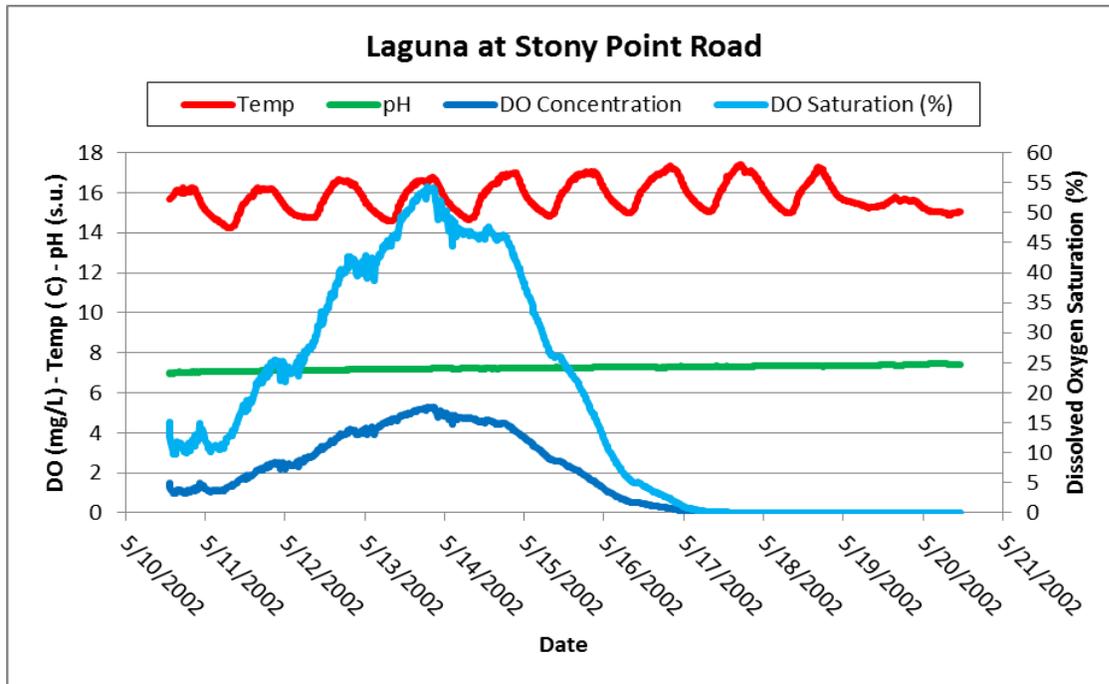


Figure 21. Diel Data Sonde Measurements from the Laguna at Stony Point Road during May 2002

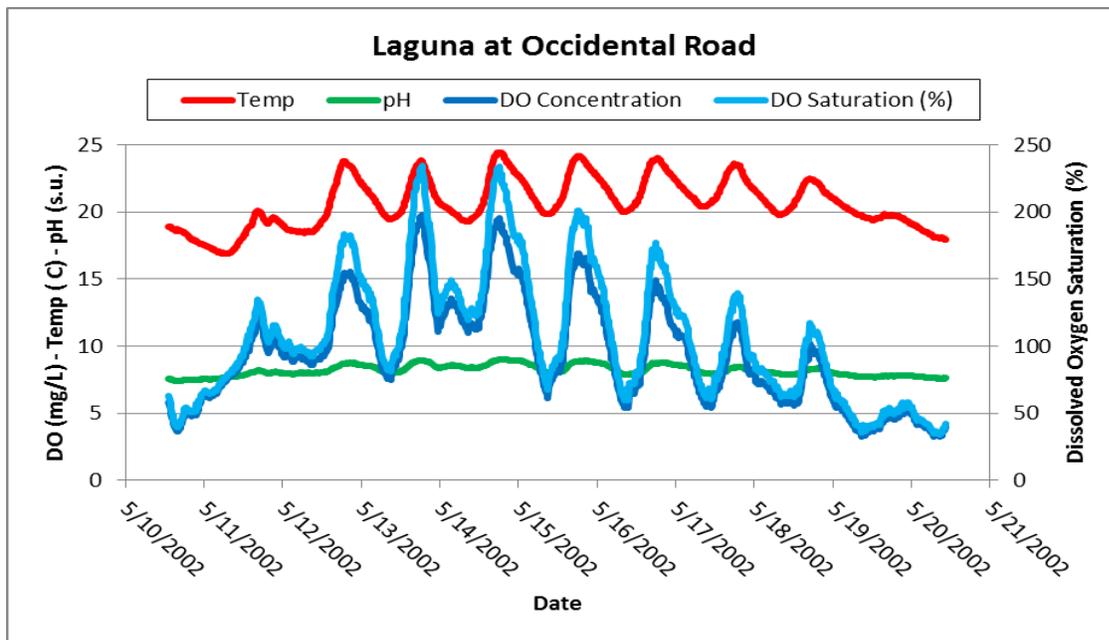


Figure 22. Diel Data Sonde Measurements from the Laguna at Occidental Road during May 2002

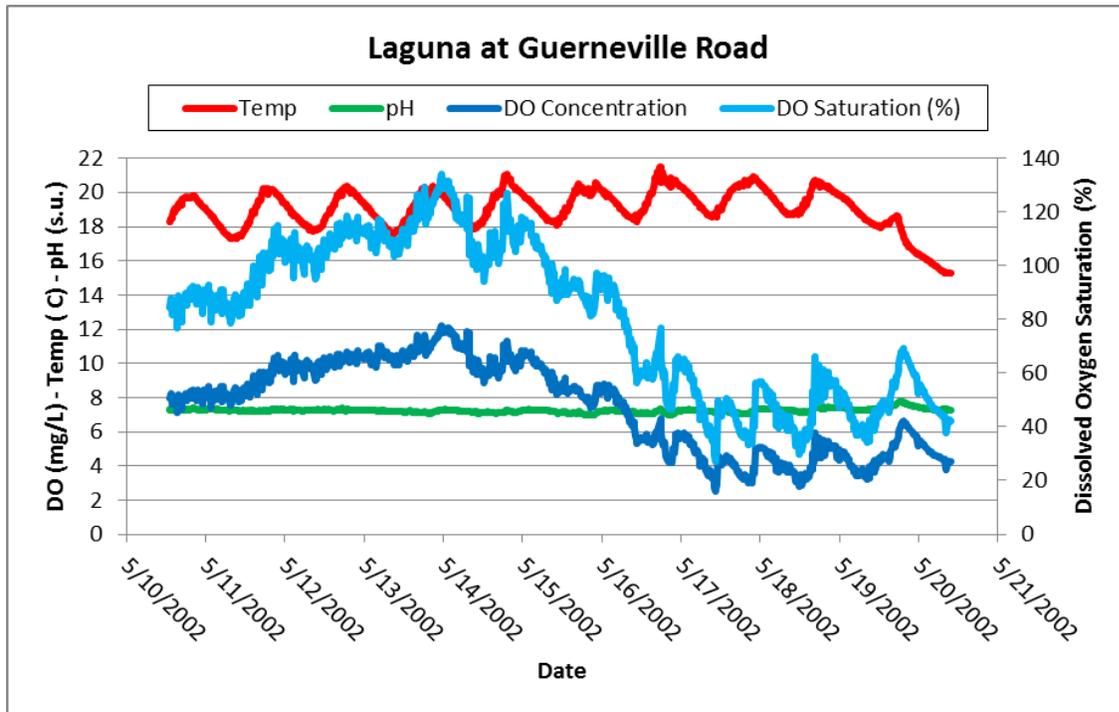


Figure 23. Diel Data Sonde Measurements from the Laguna at Guerneville Road during May 2002

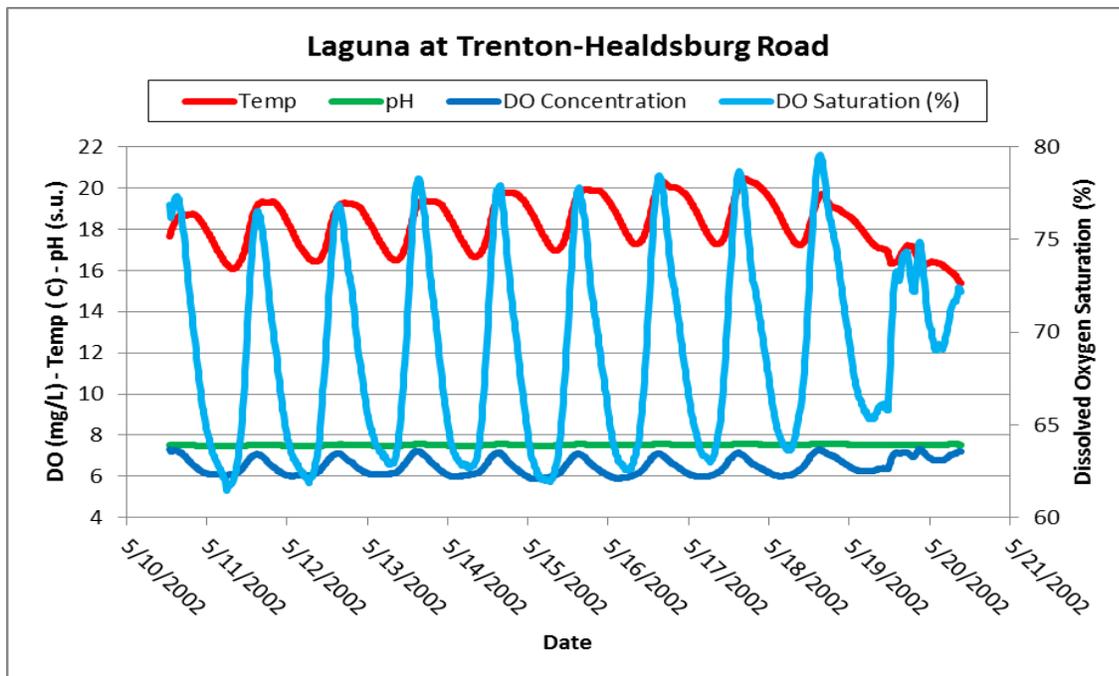


Figure 24. Diel Data Sonde Measurements from the Laguna at Trenton-Healdsburg Road during May 2002

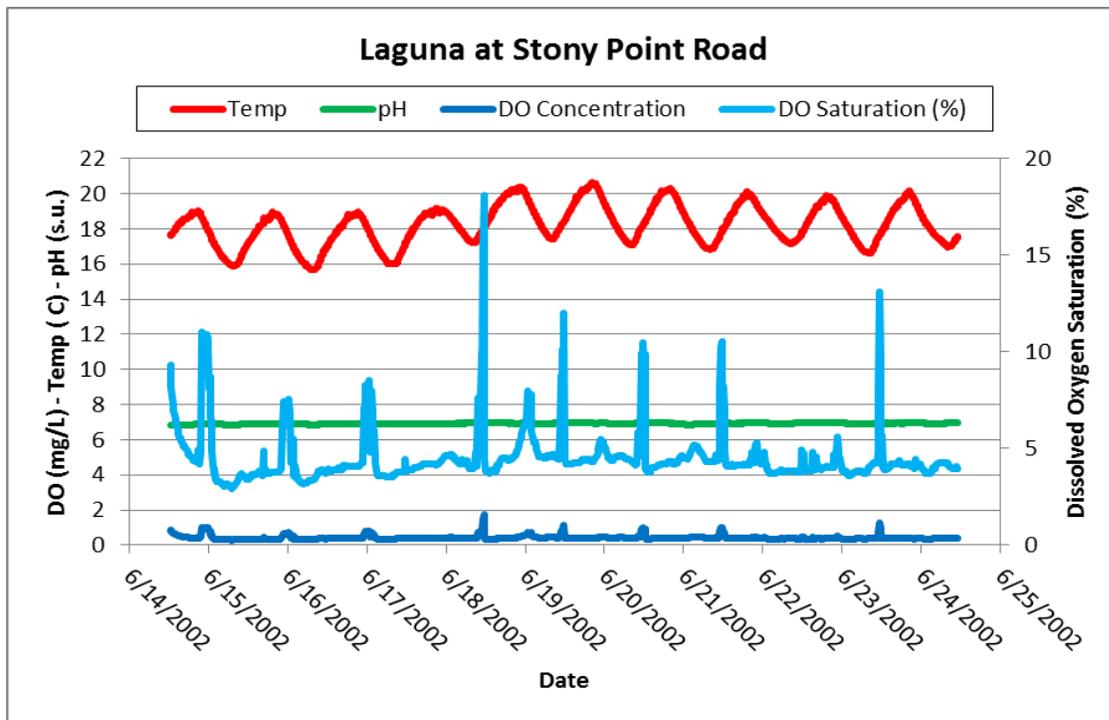


Figure 25. Diel Data Sonde Measurements from the Laguna at Stony Point Road during June 2002

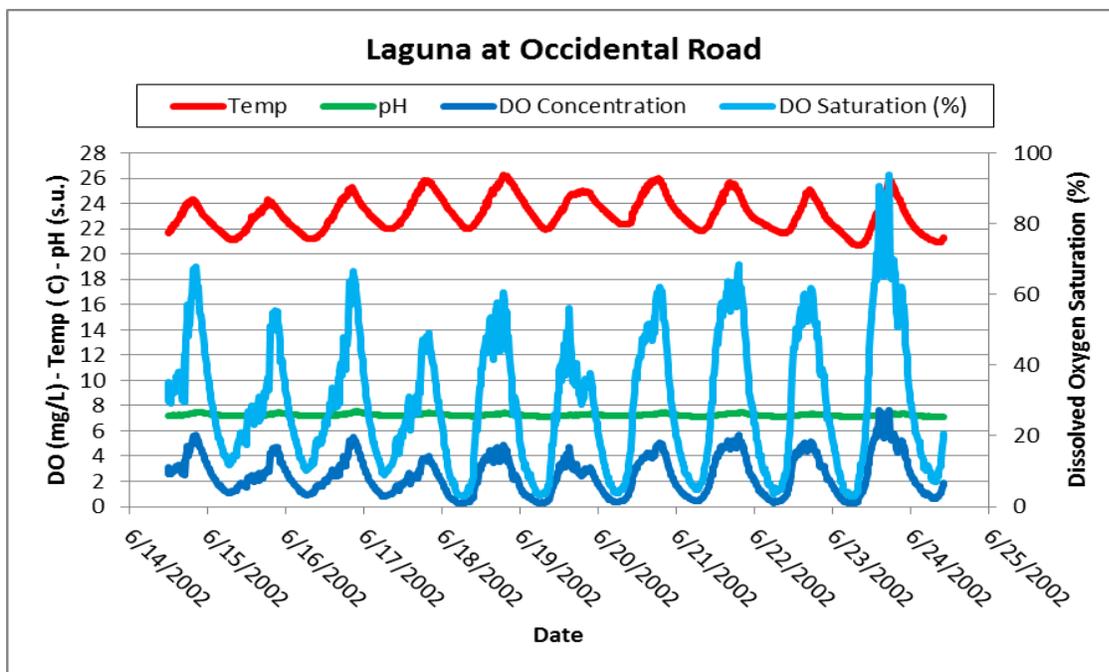


Figure 26. Diel Data Sonde Measurements from the Laguna at Occidental Road during June 2002

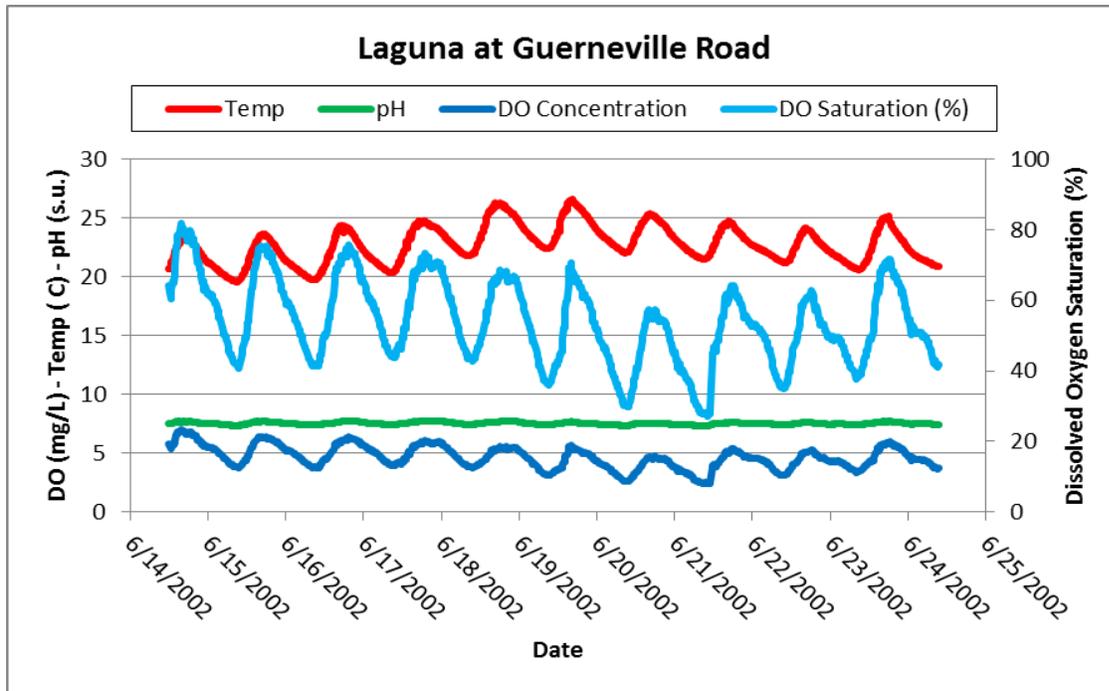


Figure 27. Diel Data Sonde Measurements from the Laguna at Guerneville Road during June 2002

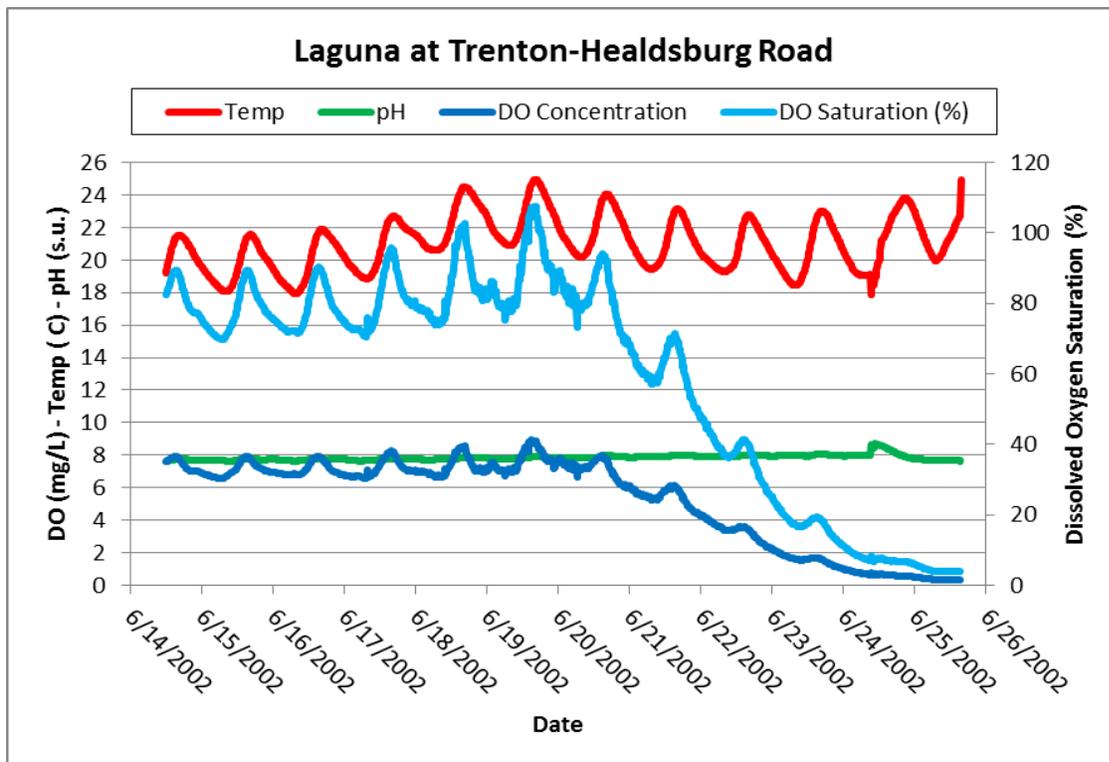


Figure 28. Diel Data Sonde Measurements from the Laguna at Trenton-Healdsburg Road during June 2002

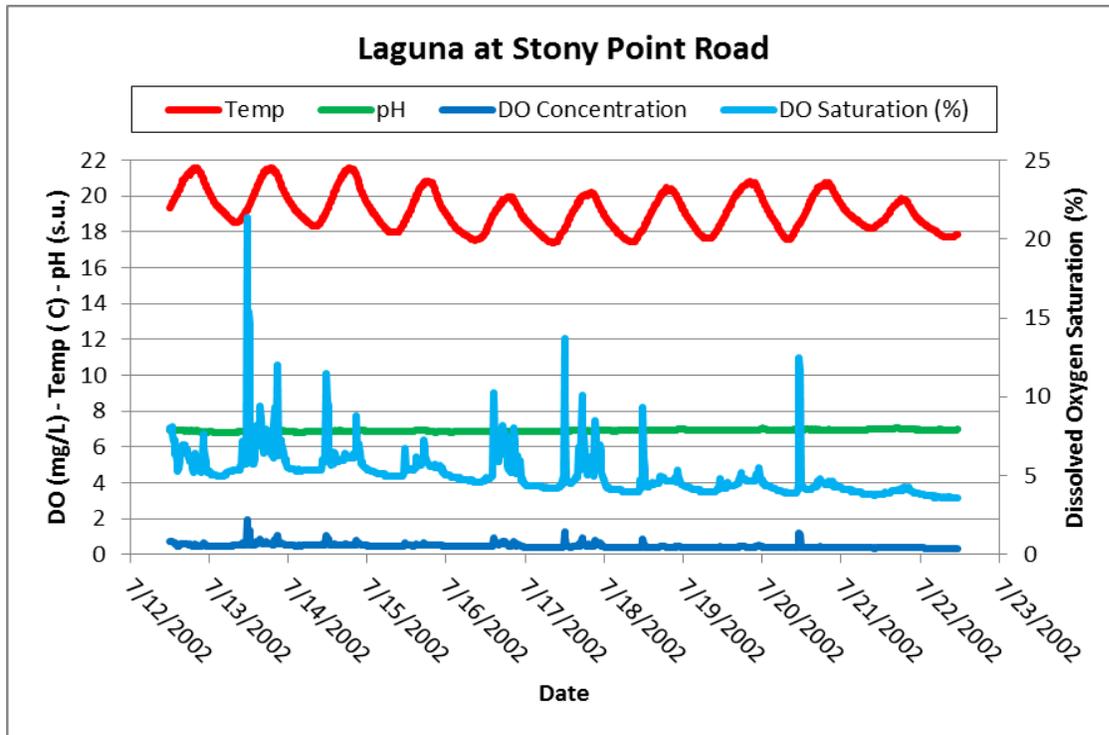


Figure 29. Diel Data Sonde Measurements from the Laguna at Stony Point Road during July 2002

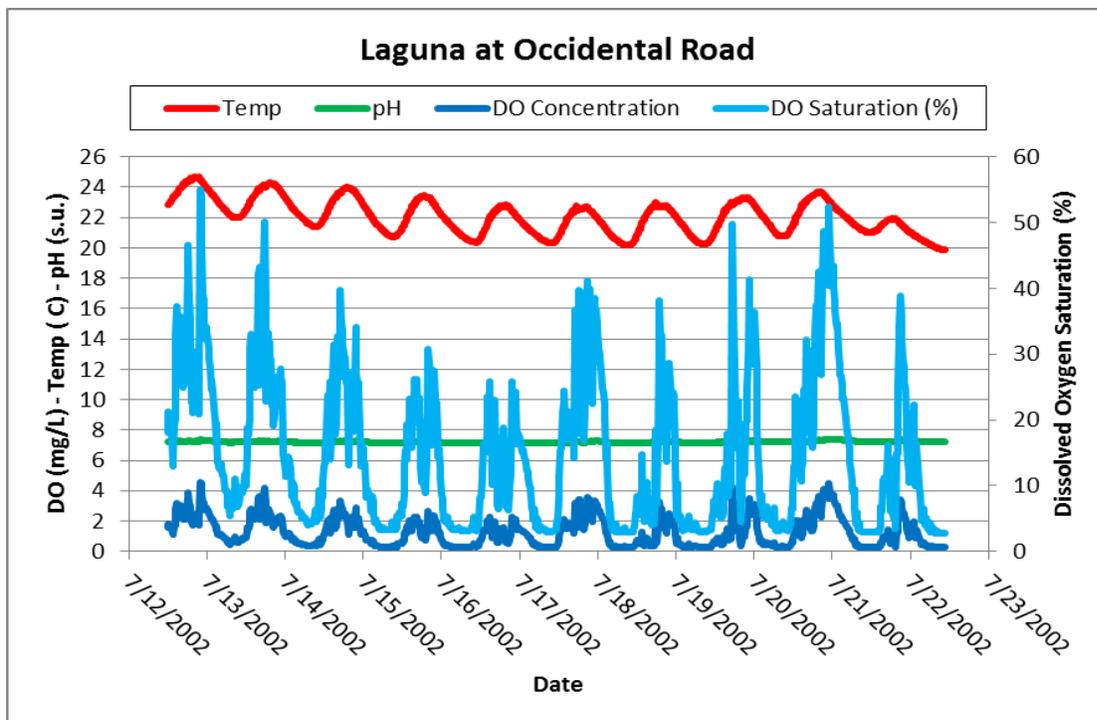


Figure 30. Diel Data Sonde Measurements from the Laguna at Occidental Road during July 2002

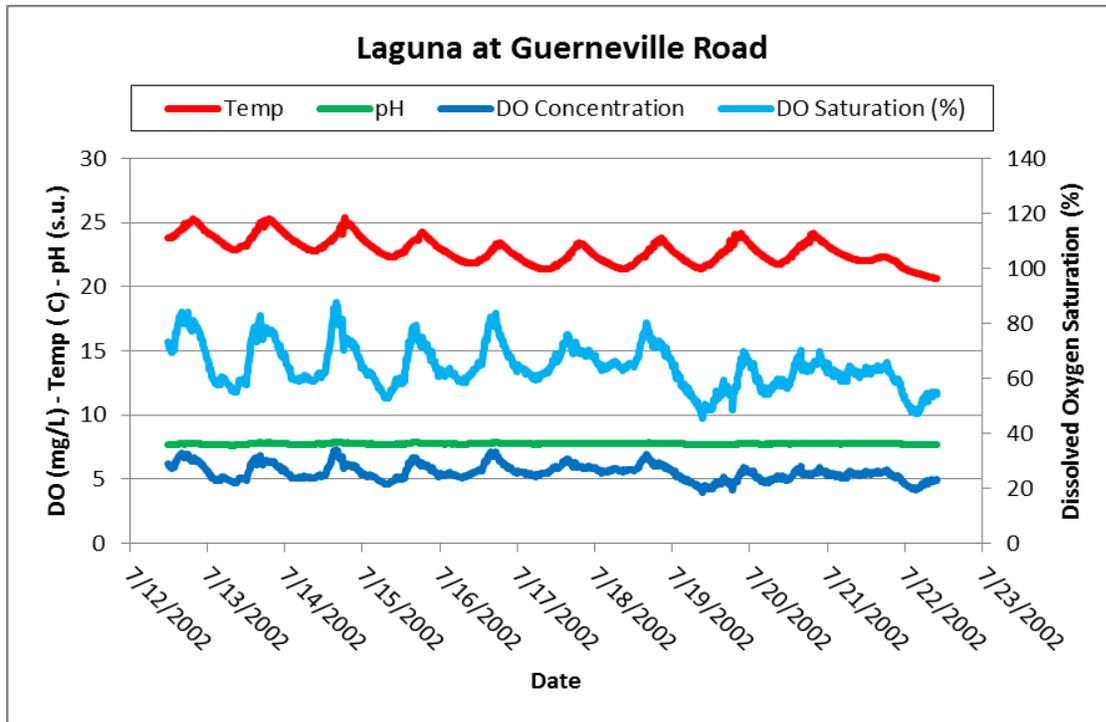


Figure 31. Diel Data Sonde Measurements from the Laguna at Guerneville Road during July 2002

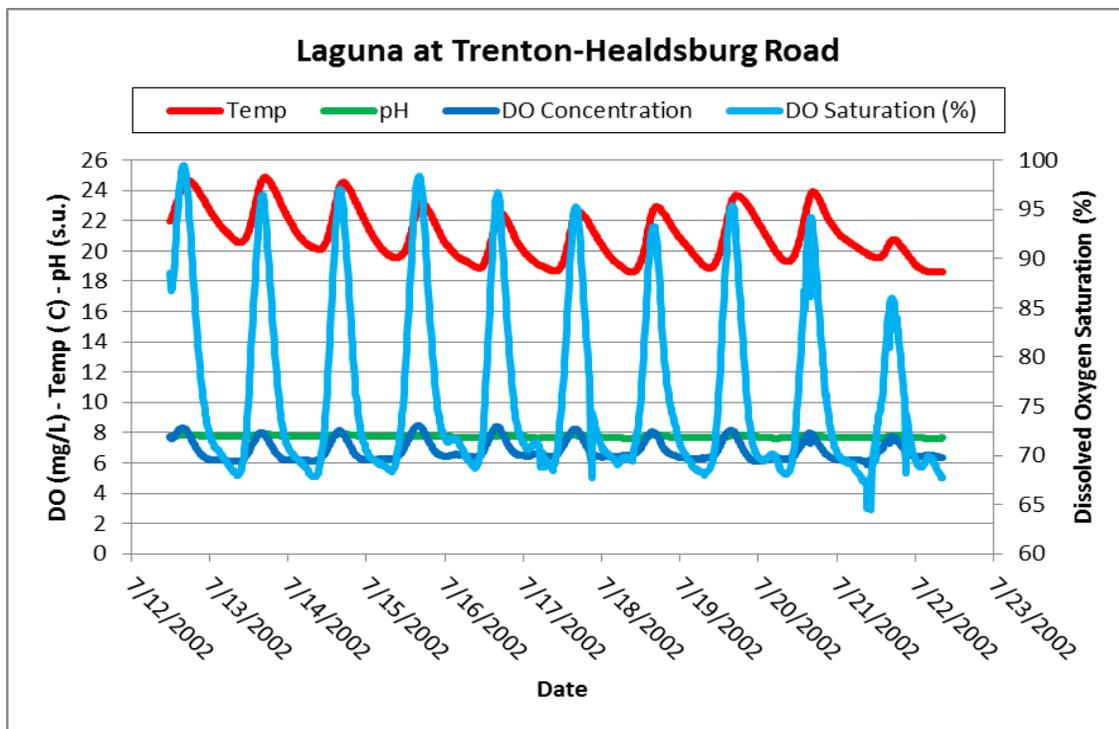


Figure 32. Diel Data Sonde Measurements from the Laguna at Trenton-Healdsburg Road during July 2002

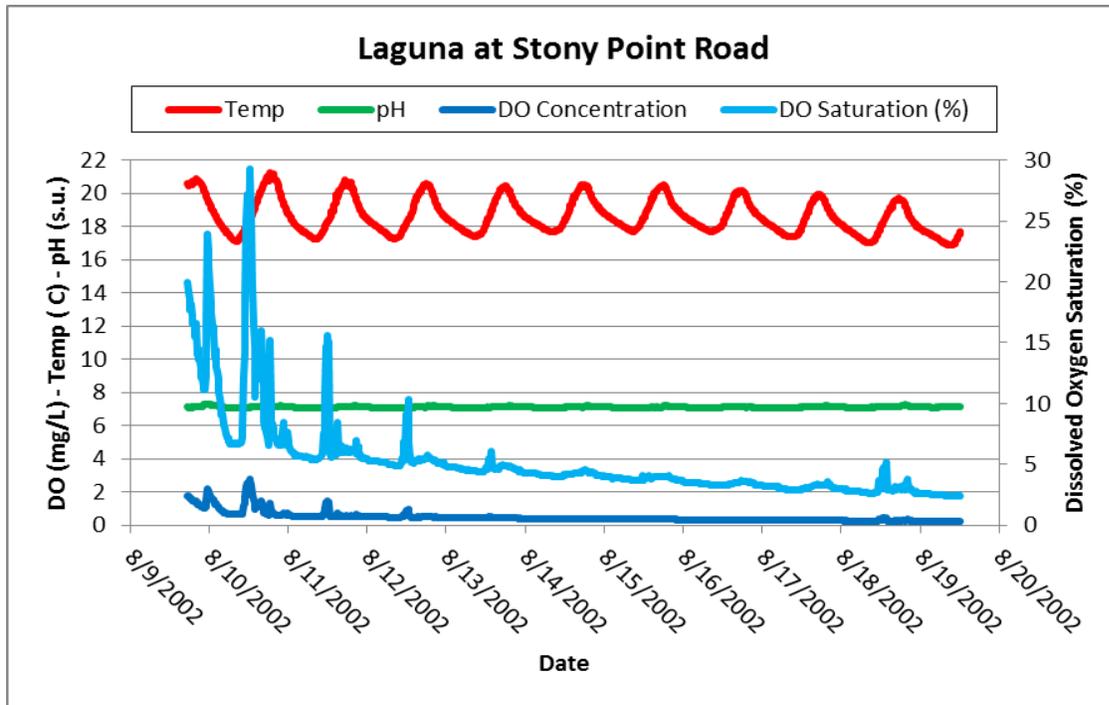


Figure 33. Diel Data Sonde Measurements from the Laguna at Stony Point Road during August 2002

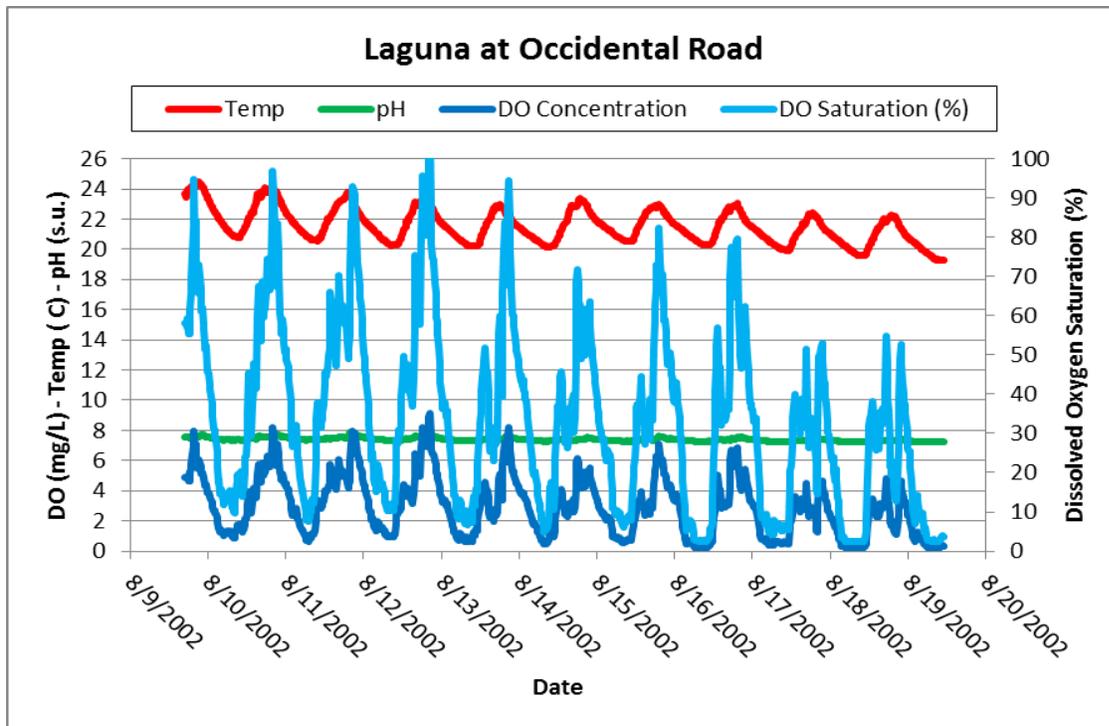


Figure 34. Diel Data Sonde Measurements from the Laguna at Occidental Road during August 2002

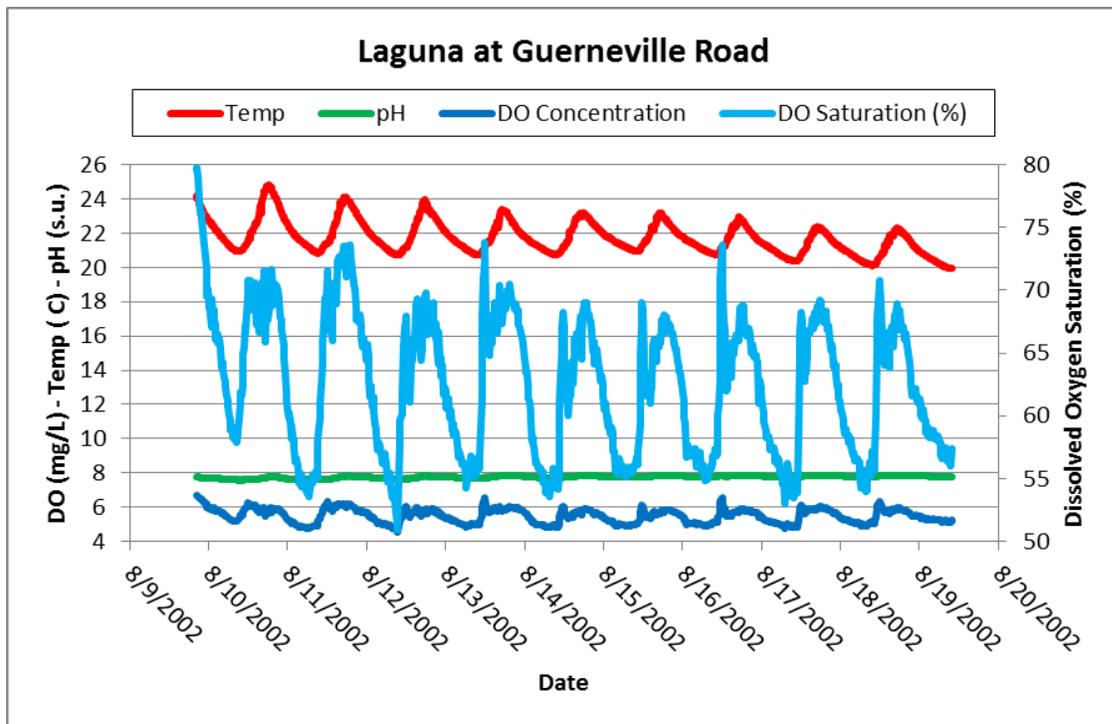


Figure 35. Diel Data Sonde Measurements from the Laguna at Guerneville Road during August 2002

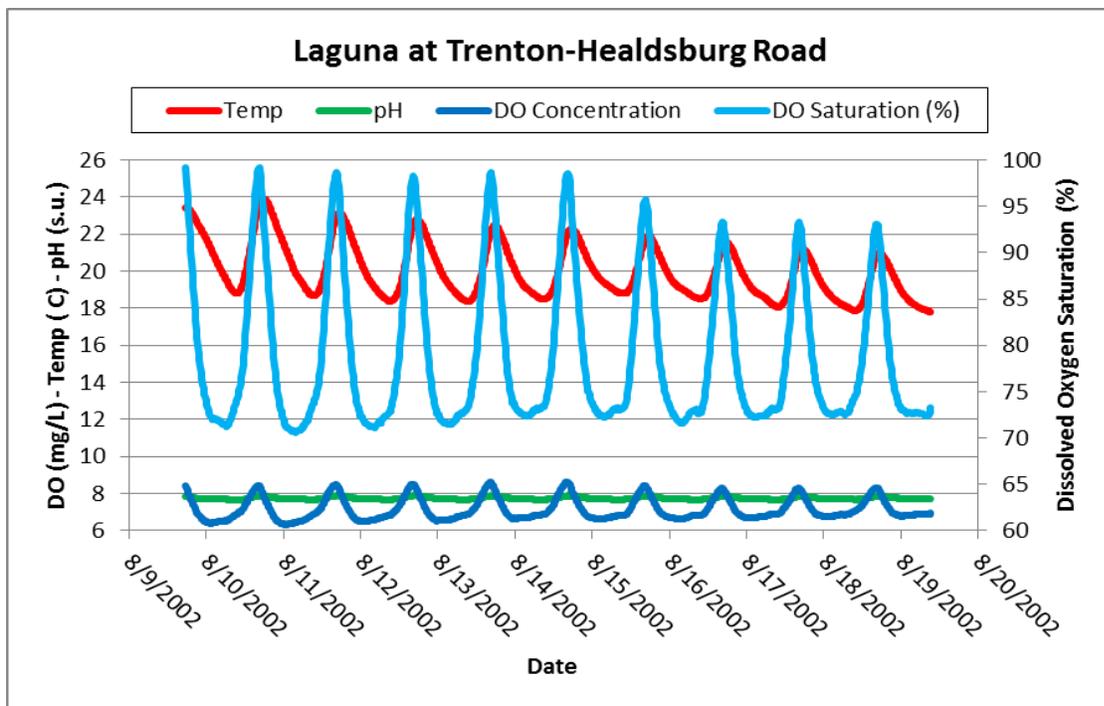


Figure 36. Diel Data Sonde Measurements from the Laguna at Trenton-Healdsburg Road during August 2002

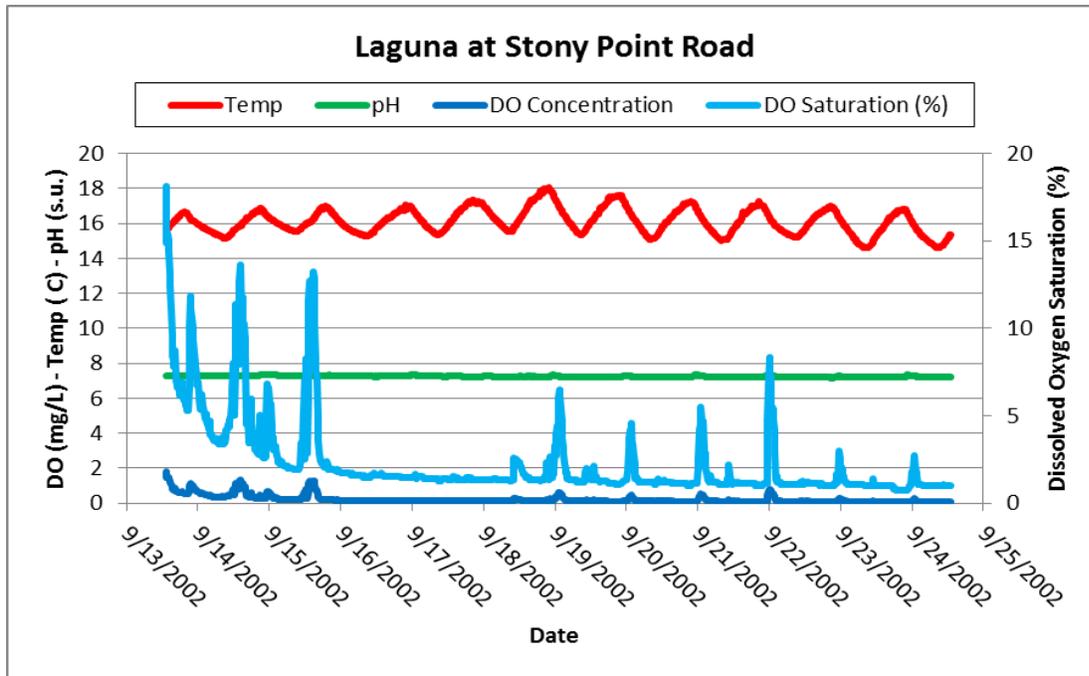


Figure 37. Diel Data Sonde Measurements from the Laguna at Stony Point Road during September 2002

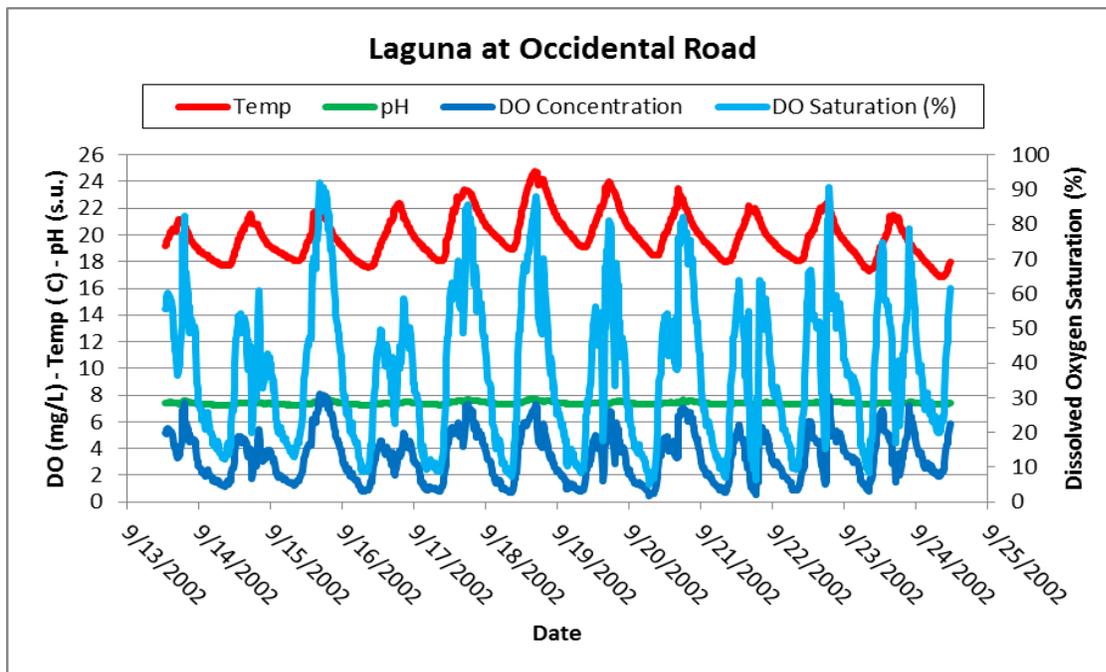


Figure 38. Diel Data Sonde Measurements from the Laguna at Occidental Road during September 2002

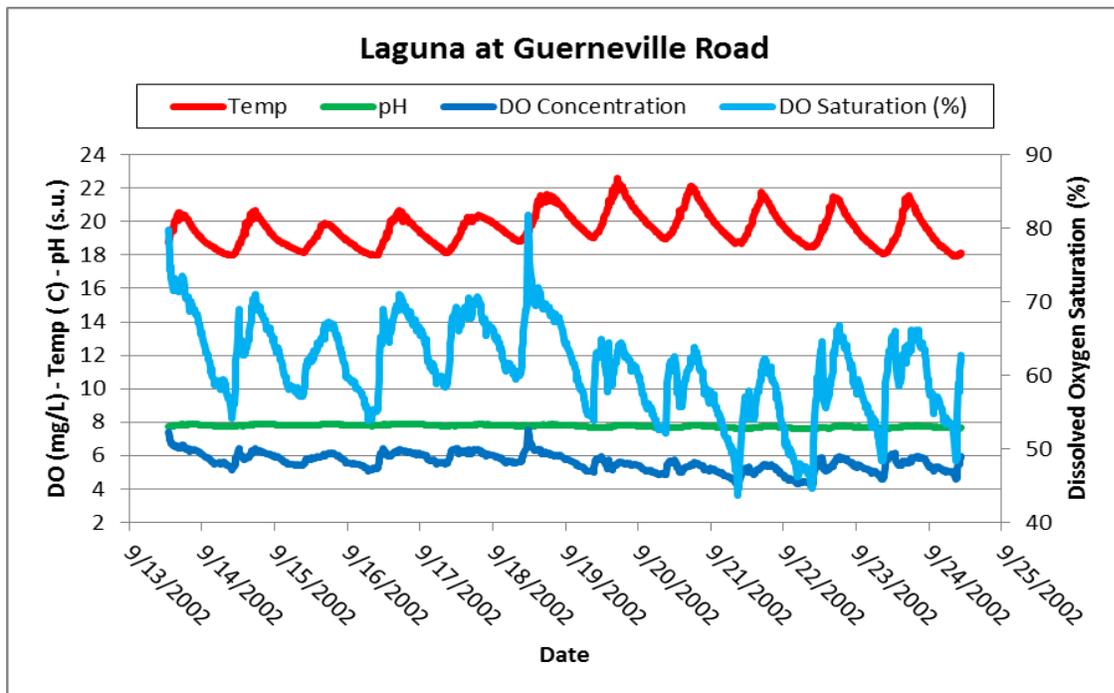


Figure 39. Diel Data Sonde Measurements from the Laguna at Guerneville Road during September 2002

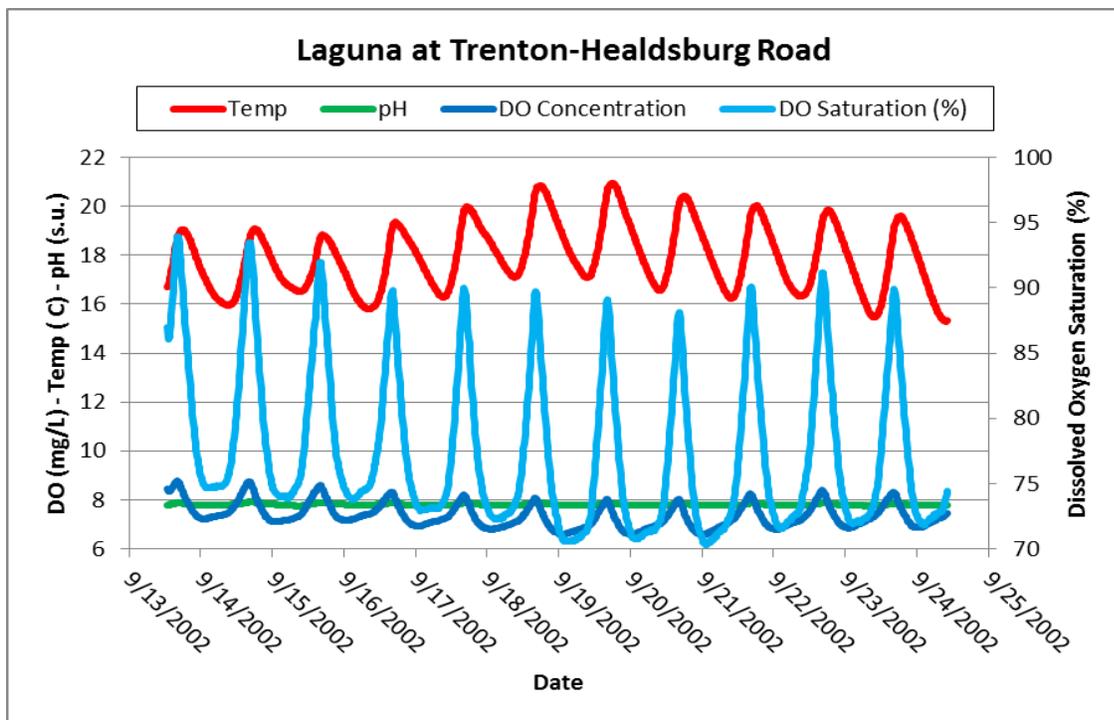


Figure 40. Diel Data Sonde Measurements from the Laguna at Trenton-Healdsburg Road during September 2002

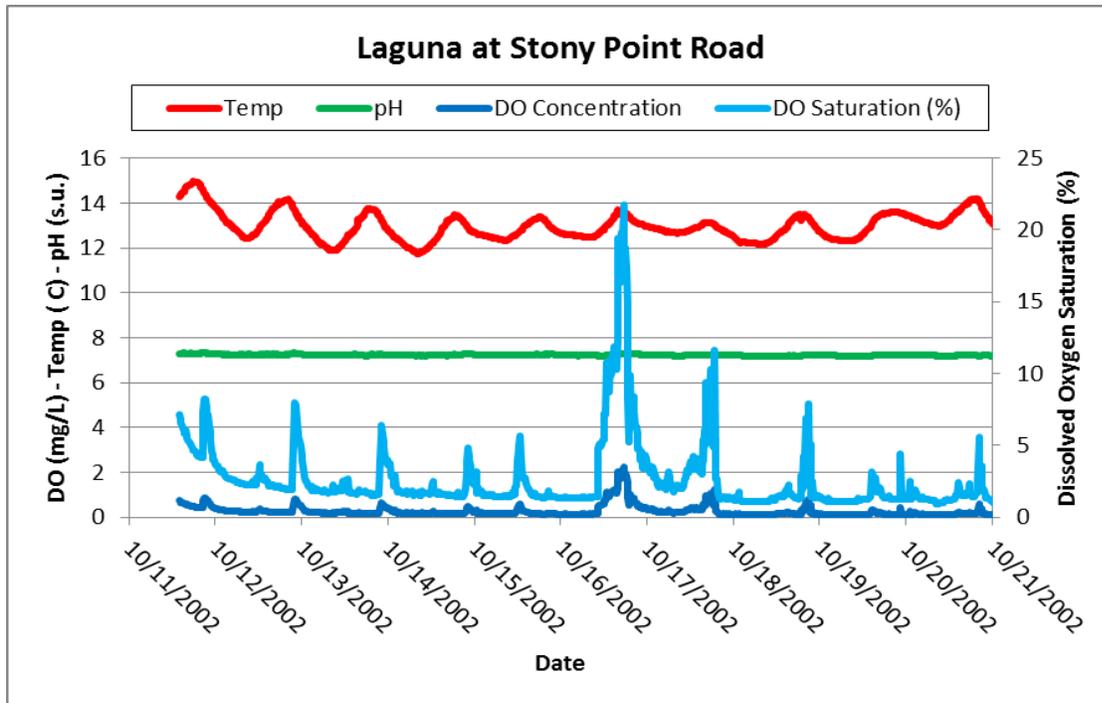


Figure 41. Diel Data Sonde Measurements from the Laguna at Stony Point Road during October 2002

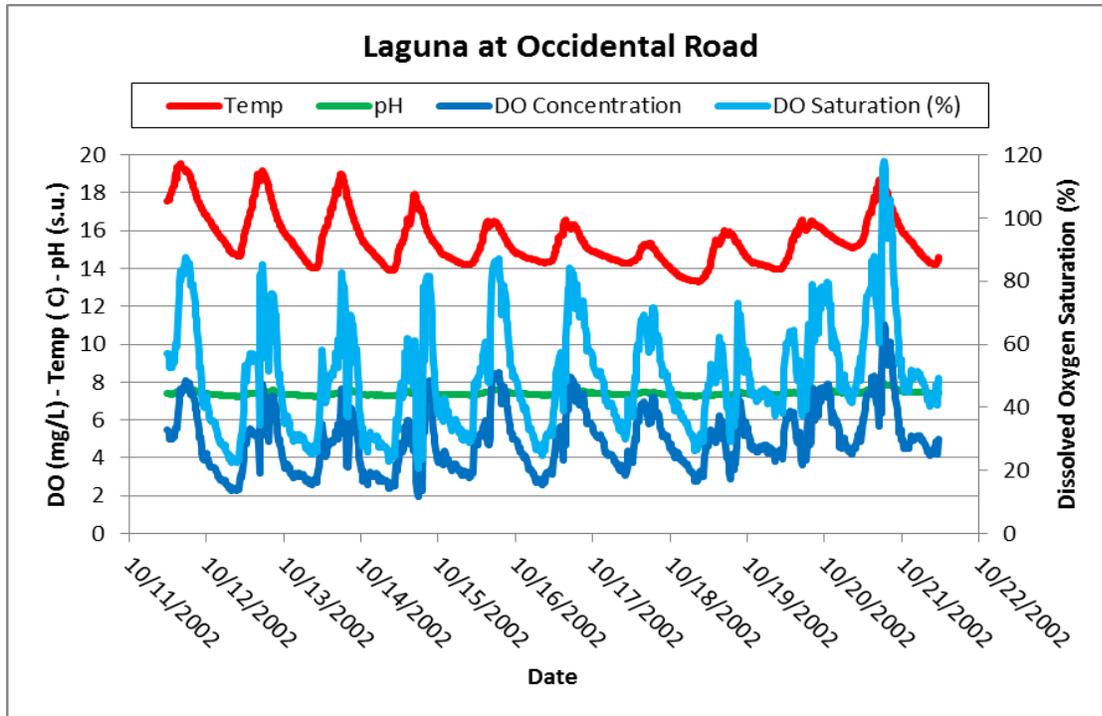


Figure 42. Diel Data Sonde Measurements from the Laguna at Occidental Road during October 2002

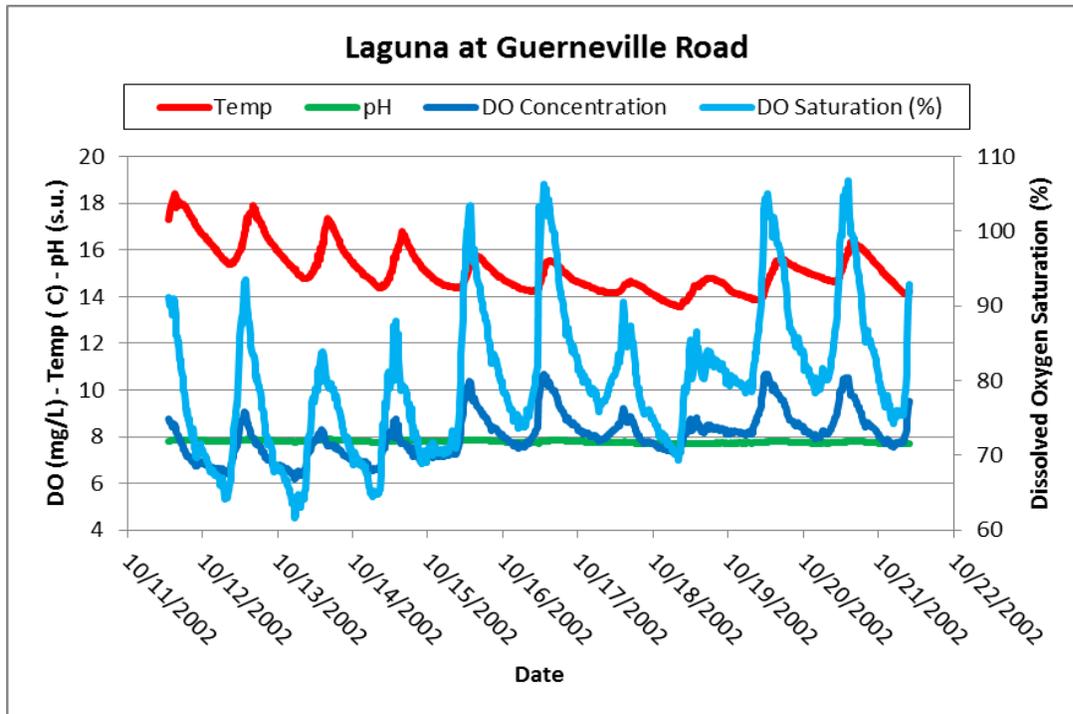


Figure 43. Diel Data Sonde Measurements from the Laguna at Guerneville Road during October 2002

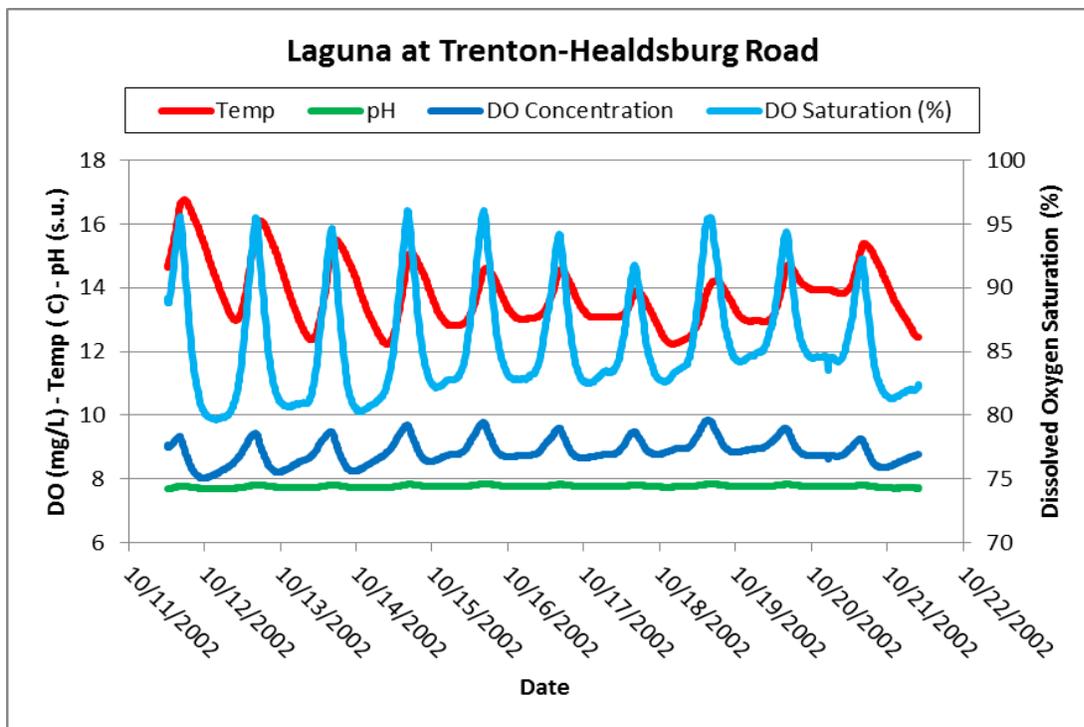


Figure 44. Diel Data Sonde Measurements from the Laguna at Trenton-Healdsburg Road during October 2002

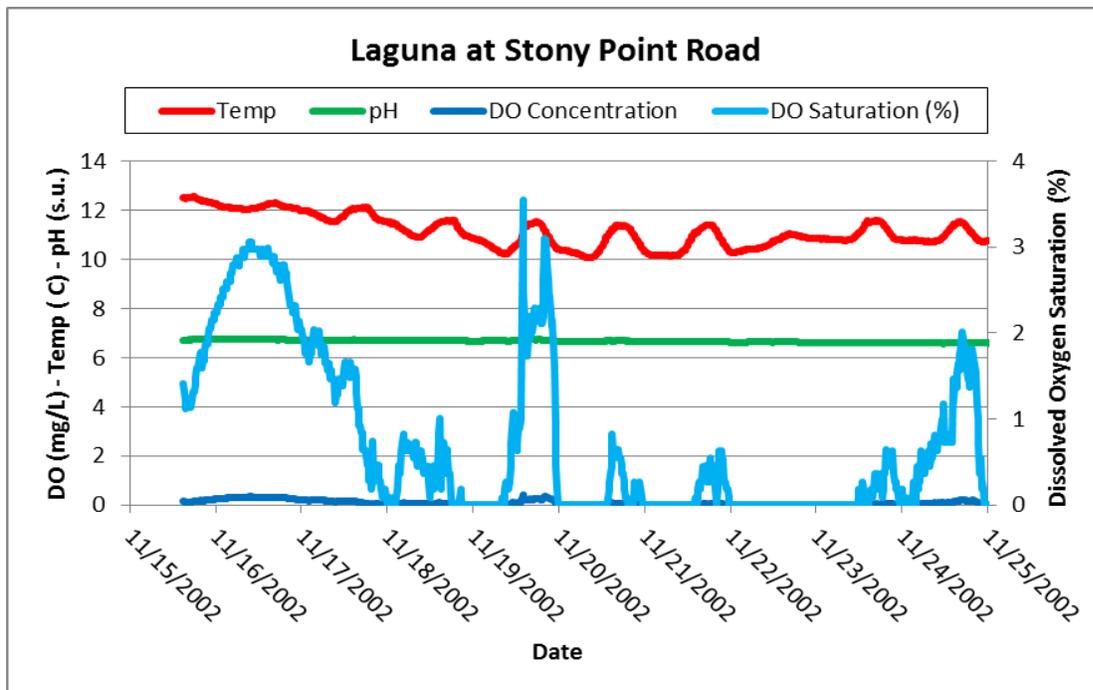


Figure 45. Diel Data Sonde Measurements from the Laguna at Stony Point Road during November 2002

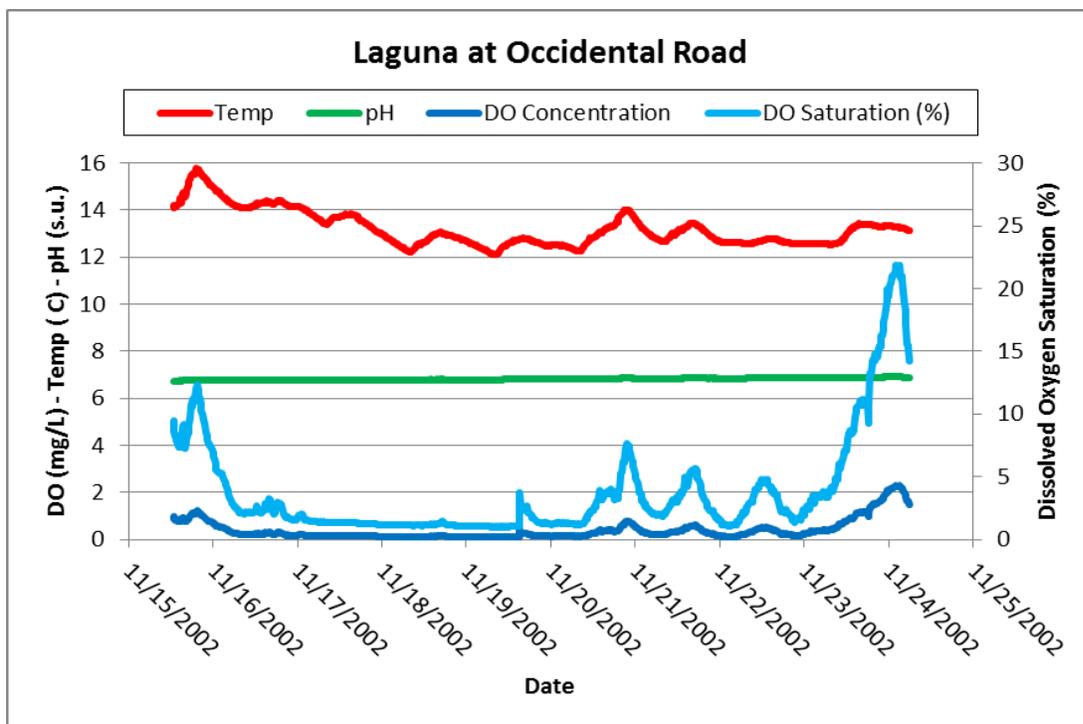


Figure 46. Diel Data Sonde Measurements from the Laguna at Occidental Road during November 2002

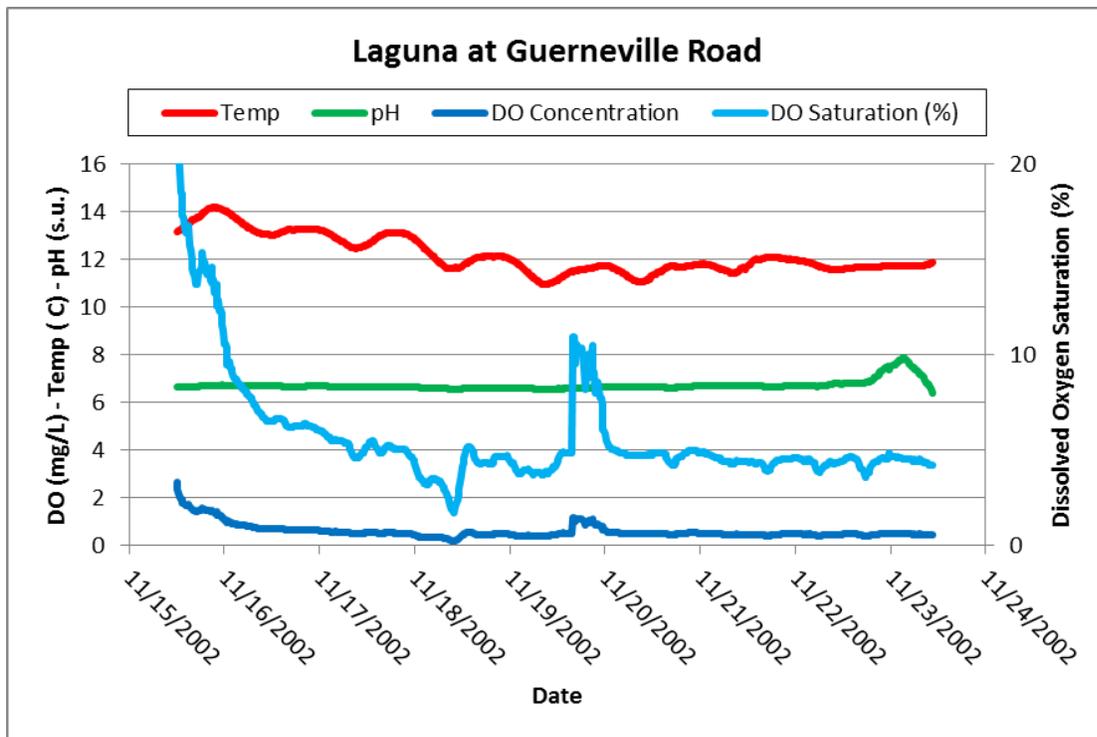


Figure 47. Diel Data Sonde Measurements from the Laguna at Guerneville Road during November 2002

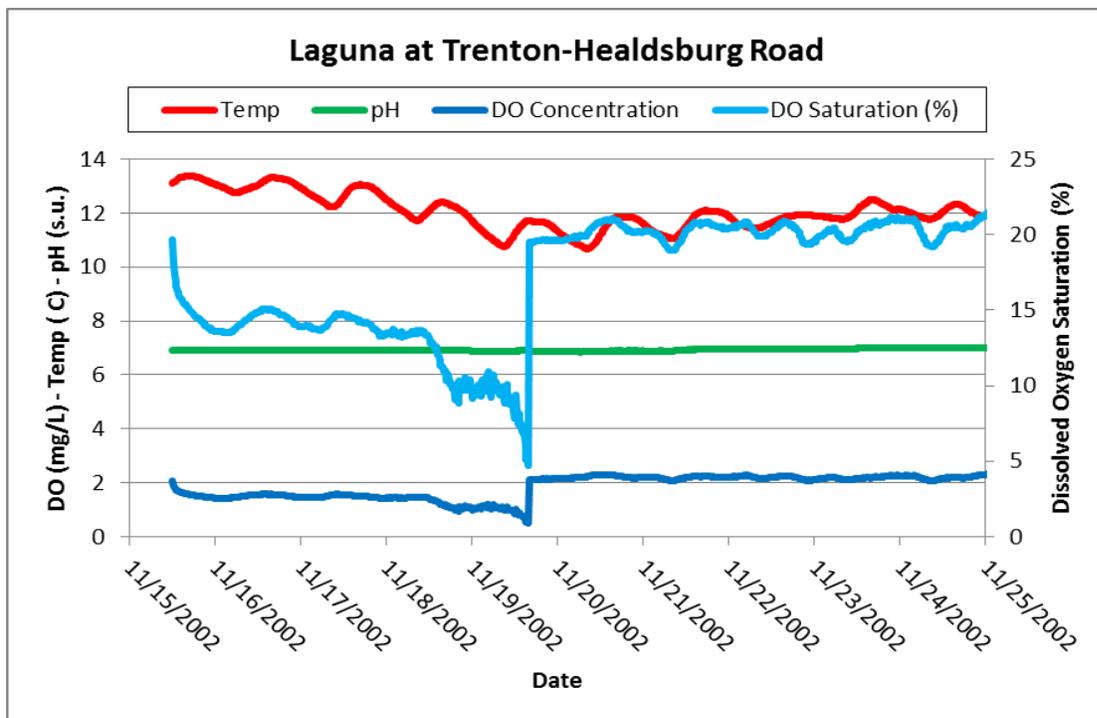


Figure 48. Diel Data Sonde Measurements from the Laguna at Trenton-Healdsburg Road during November 2002

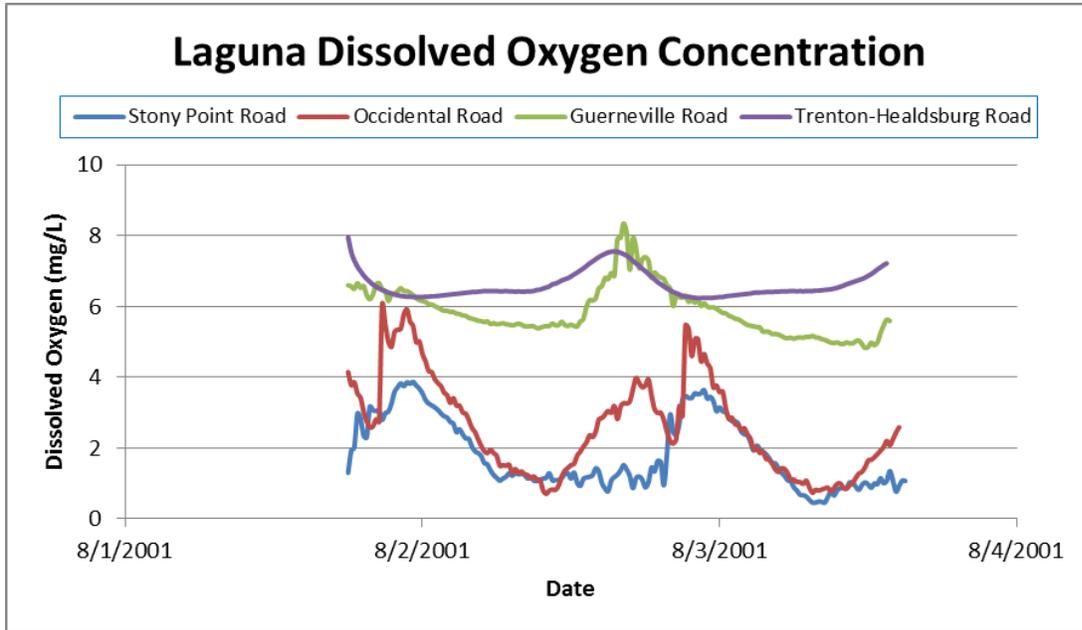


Figure 49. Comparison of Diel Dissolved Oxygen Concentrations for August 2001

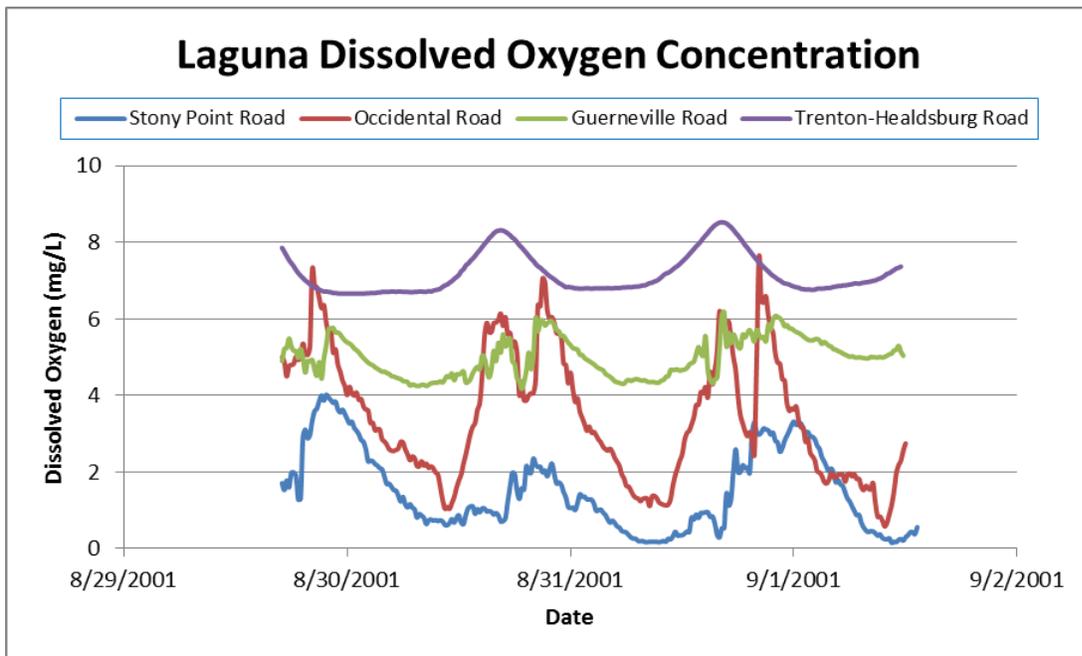


Figure 50. Comparison of Diel Dissolved Oxygen Concentrations for September 2001

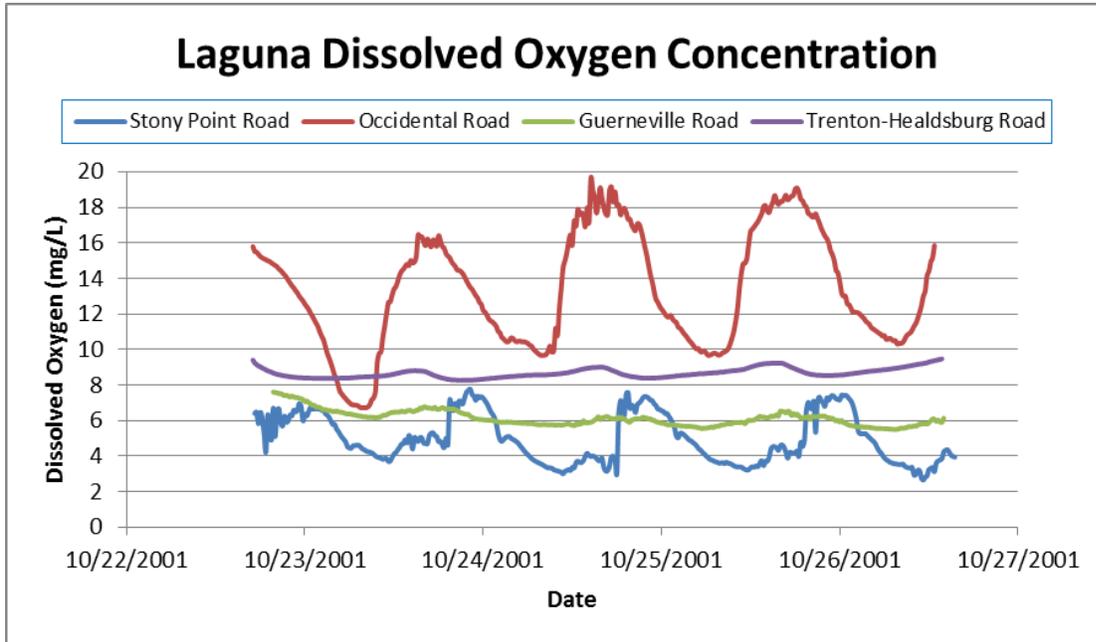


Figure 51. Comparison of Diel Dissolved Oxygen Concentrations for October 2001

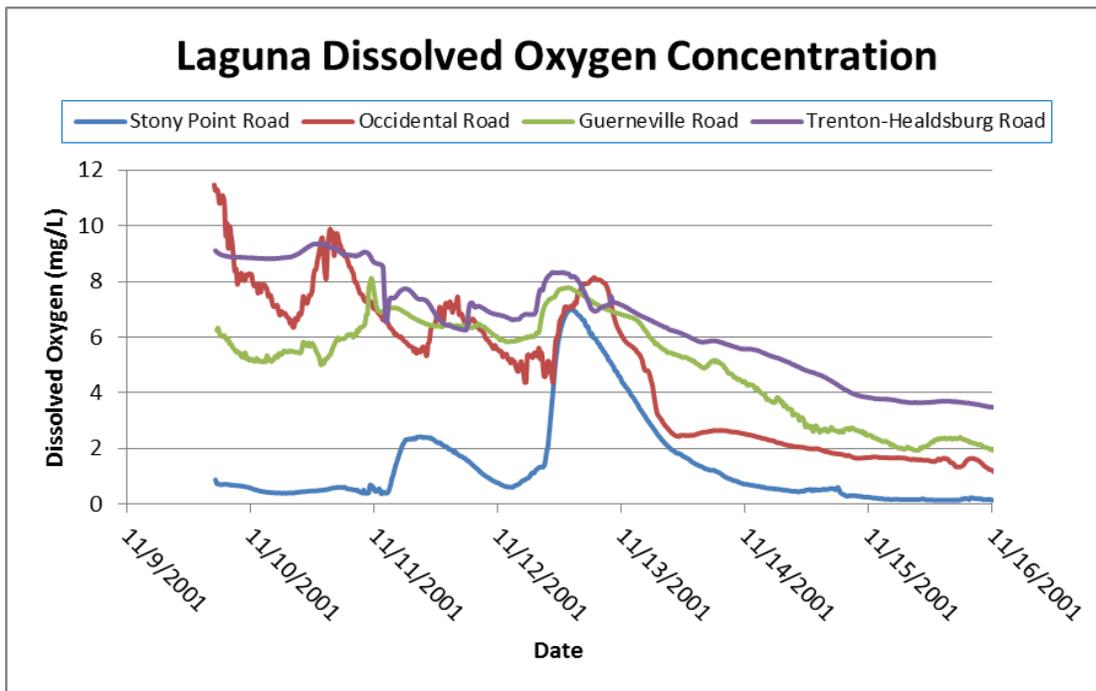


Figure 52. Comparison of Diel Dissolved Oxygen Concentrations for November 2001

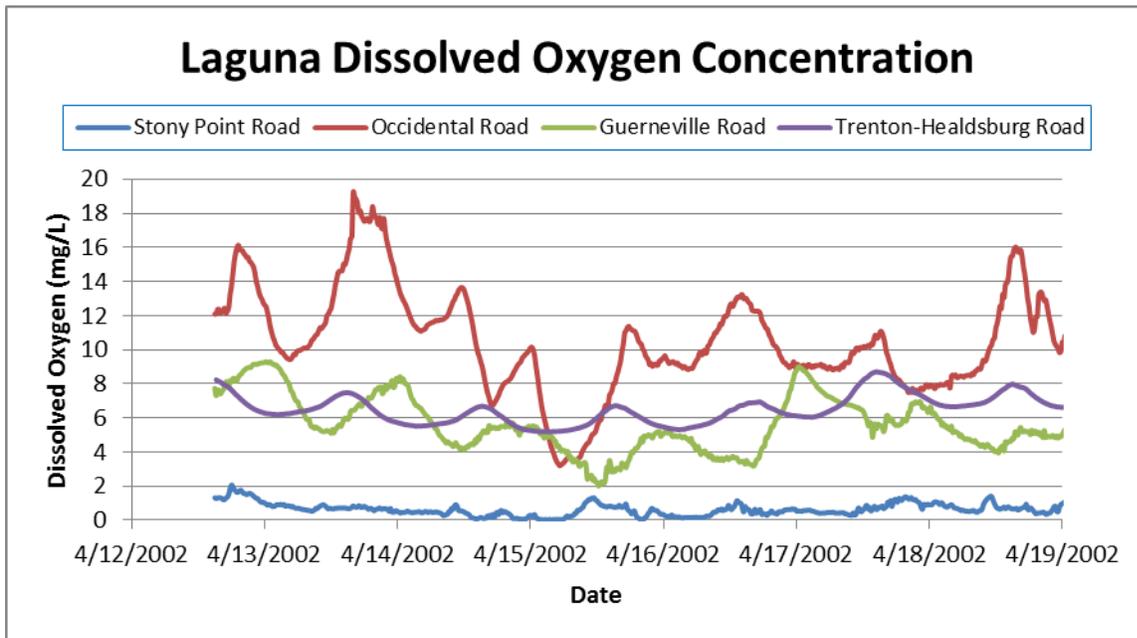


Figure 53. Comparison of Diel Dissolved Oxygen Concentrations for April 2002

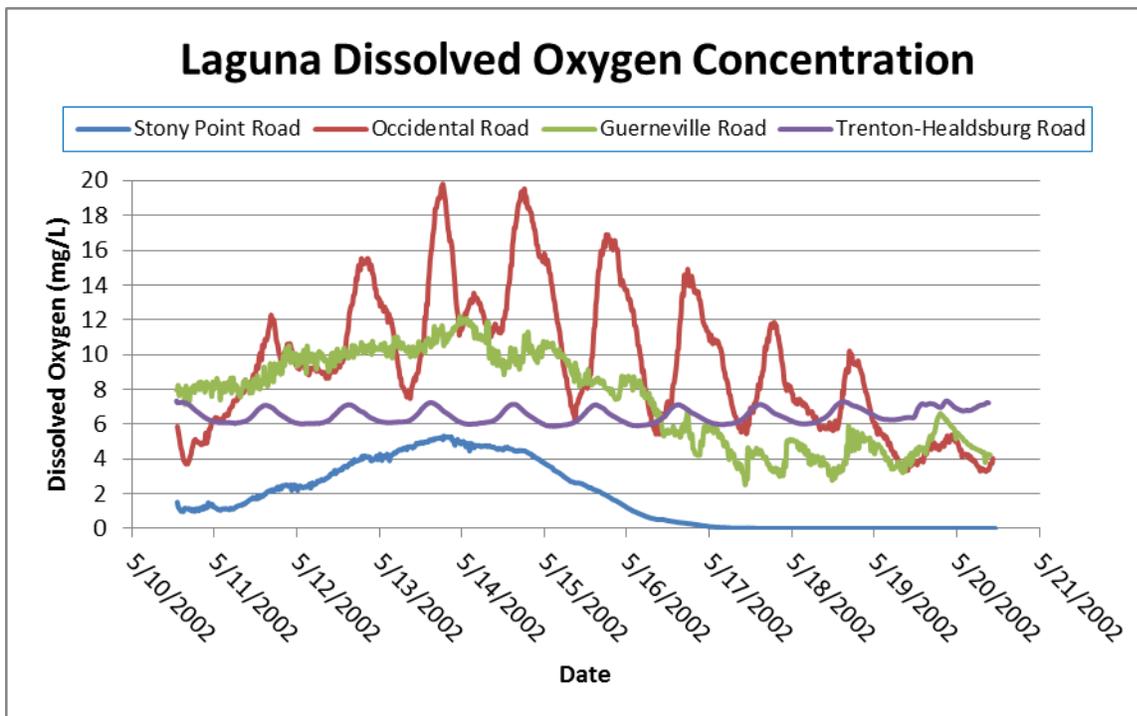


Figure 54. Comparison of Diel Dissolved Oxygen Concentrations for May 2002

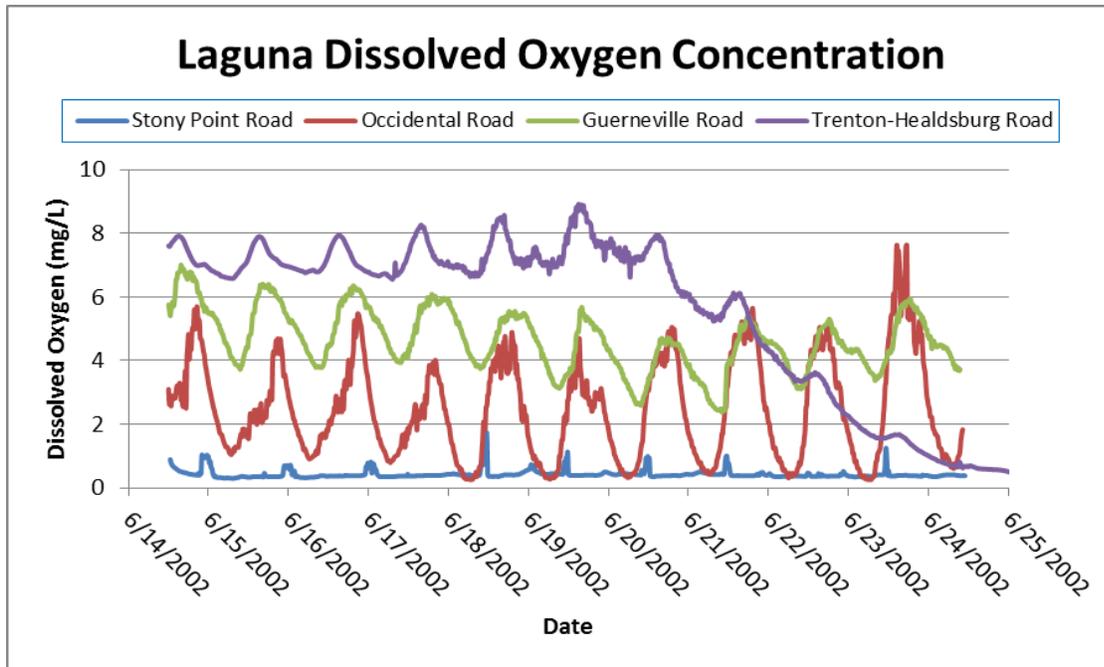


Figure 55. Comparison of Diel Dissolved Oxygen Concentrations for June 2002. Note that instrument drift is suspected in the dissolved oxygen concentration measurements.

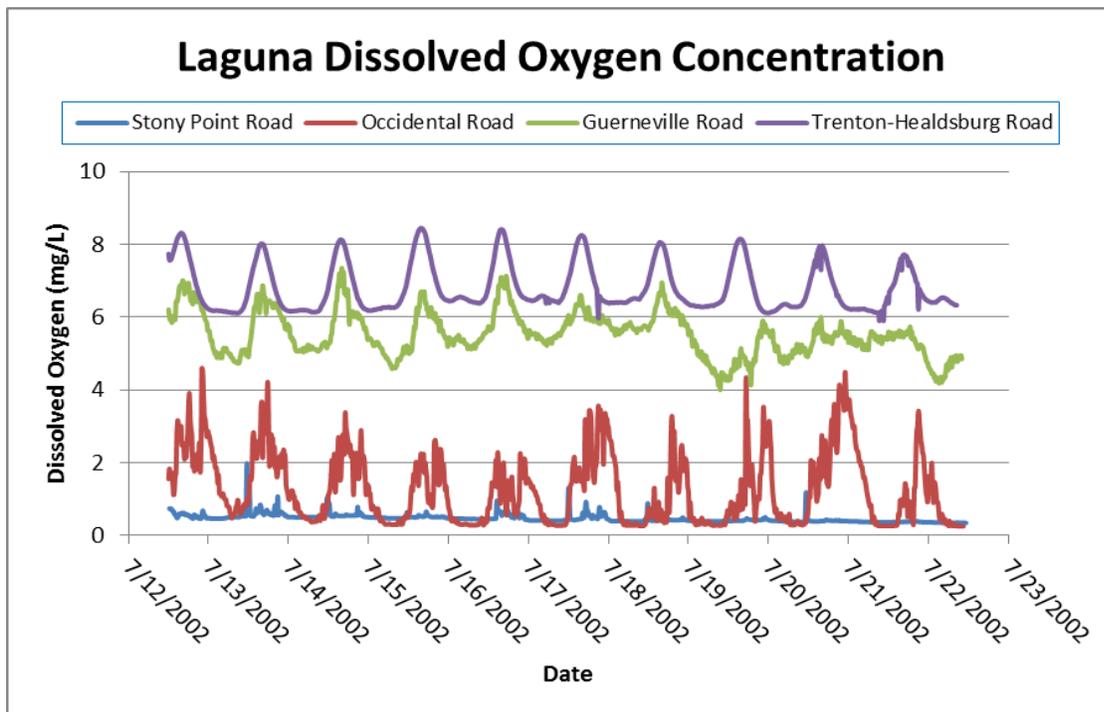


Figure 56. Comparison of Diel Dissolved Oxygen Concentrations for July 2002

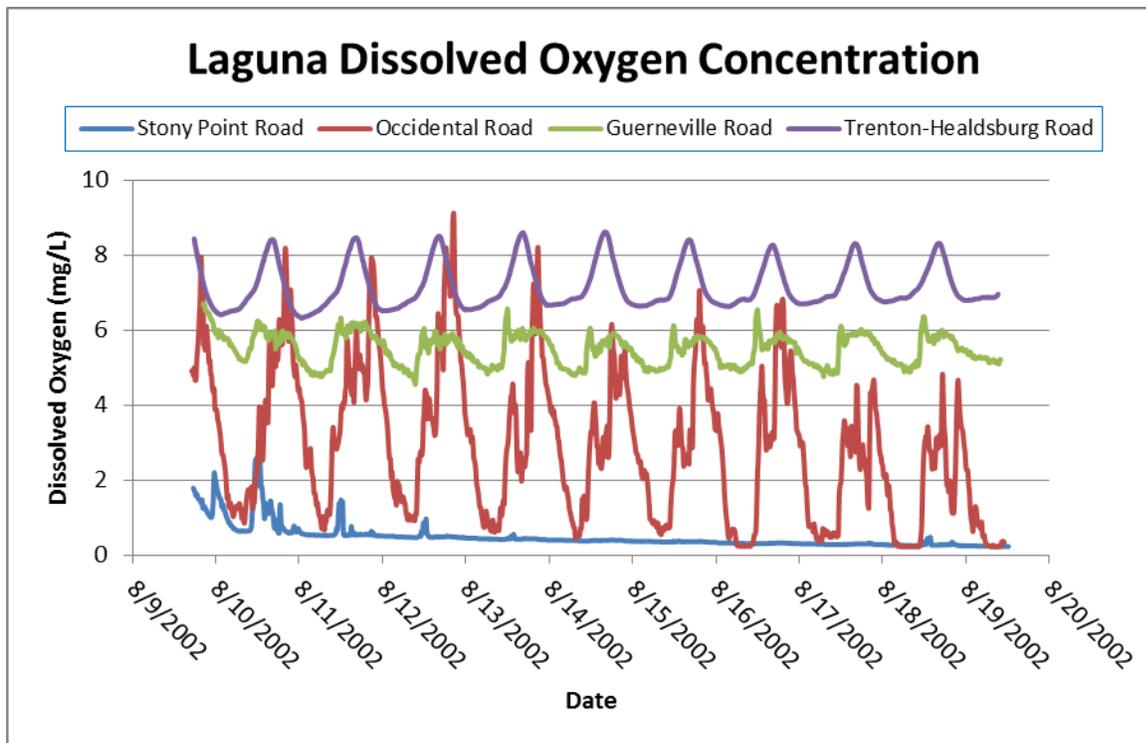


Figure 57. Comparison of Diel Dissolved Oxygen Concentrations for August 2002

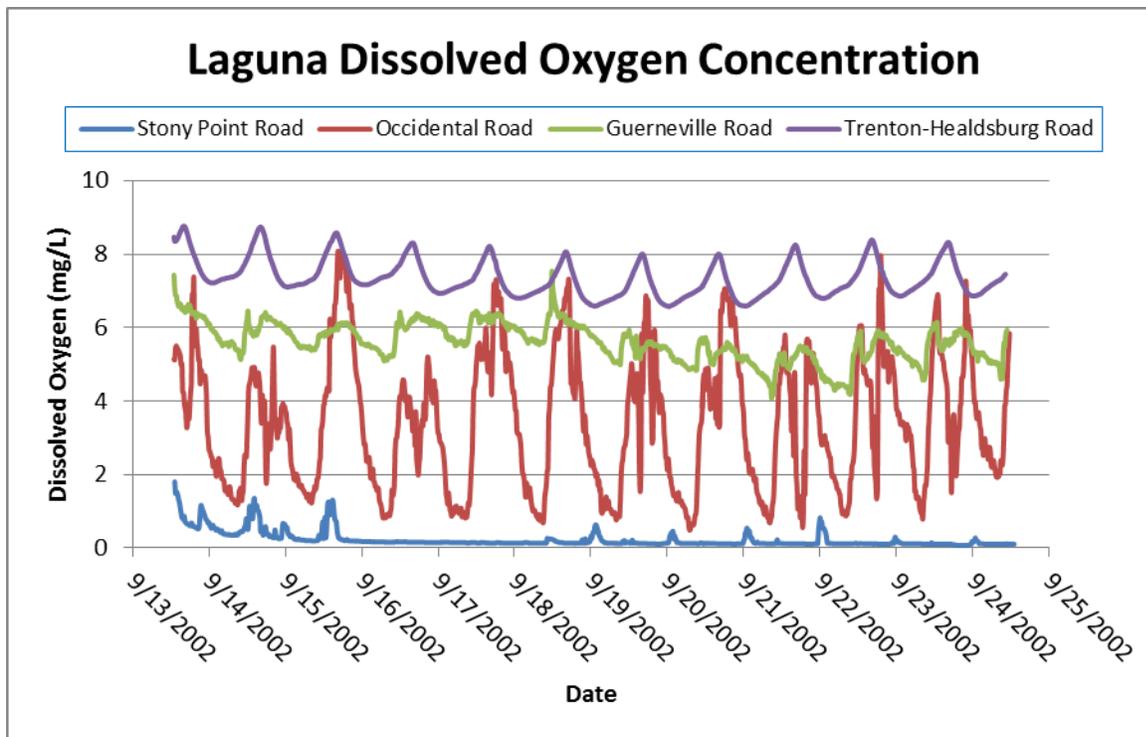


Figure 58. Comparison of Diel Dissolved Oxygen Concentrations for September 2002

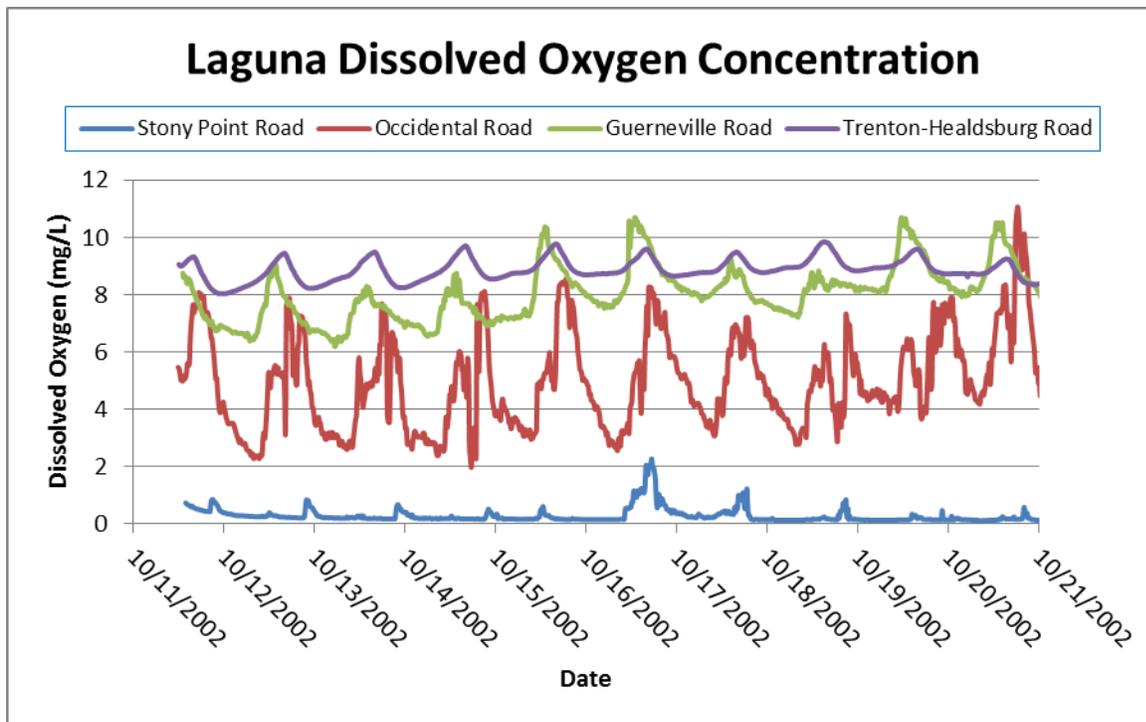


Figure 59. Comparison of Diel Dissolved Oxygen Concentrations for October 2002

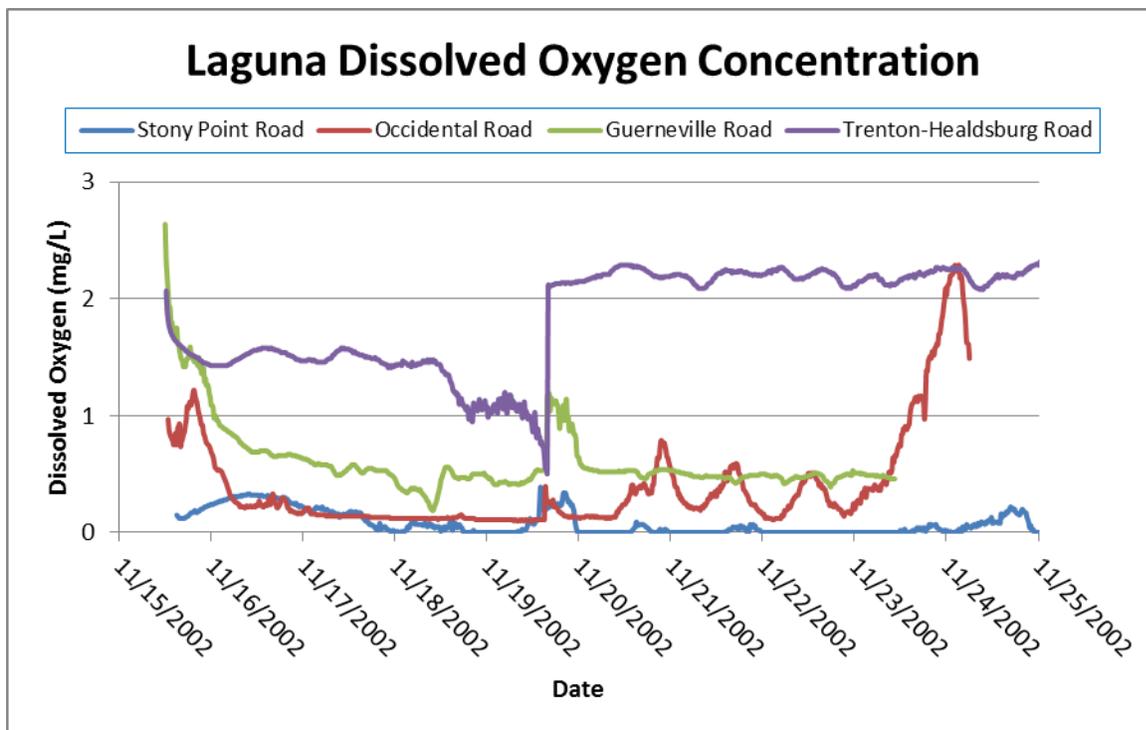


Figure 60. Comparison of Diel Dissolved Oxygen Concentrations for November 2002. Note that instrument drift is suspected in the dissolved oxygen concentration measurements.

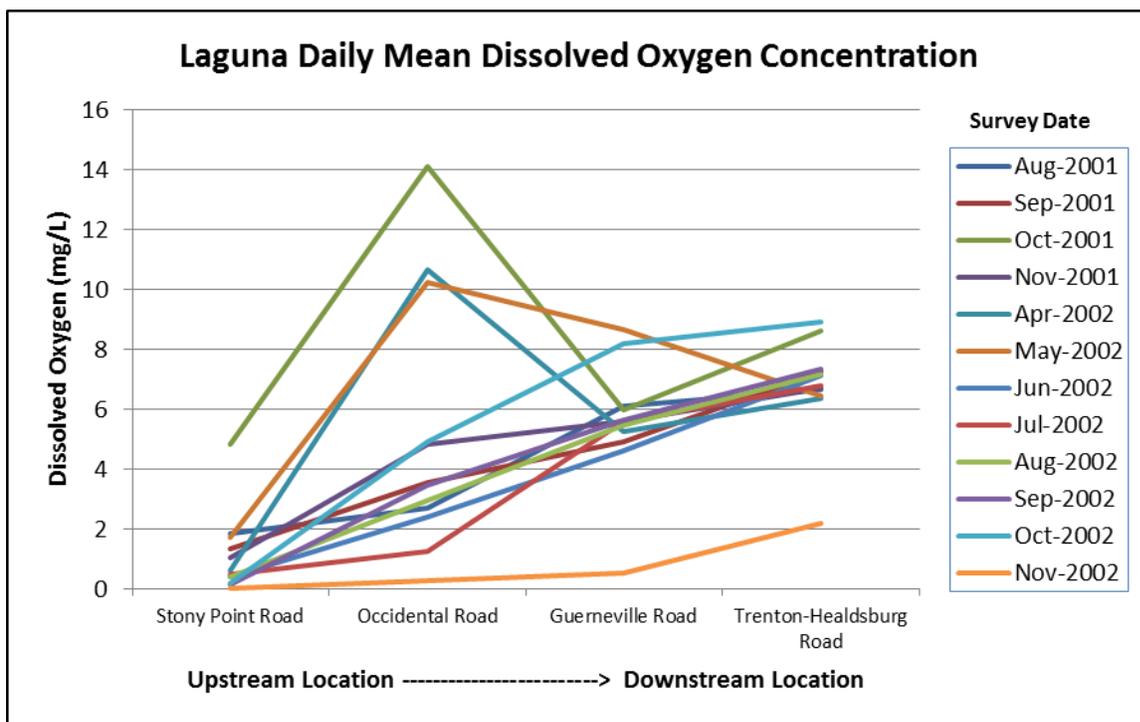


Figure 61. Comparison of Mean Dissolved Oxygen Concentrations between Locations

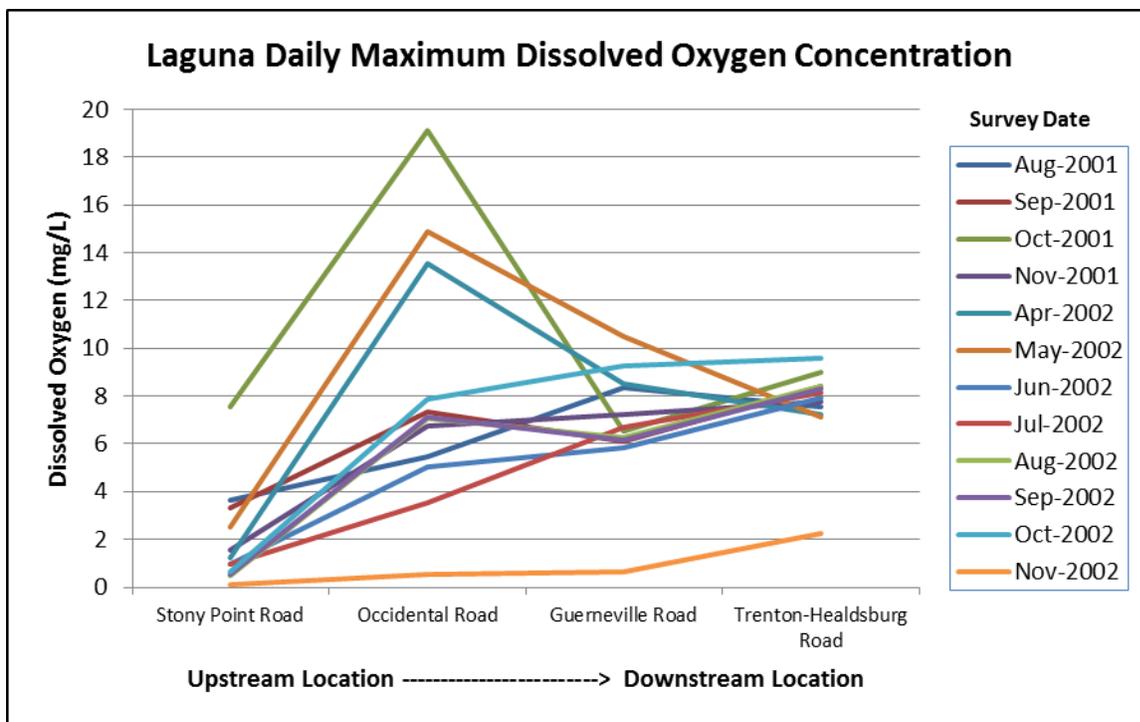


Figure 62. Comparison of Maximum Dissolved Oxygen Concentrations between Locations

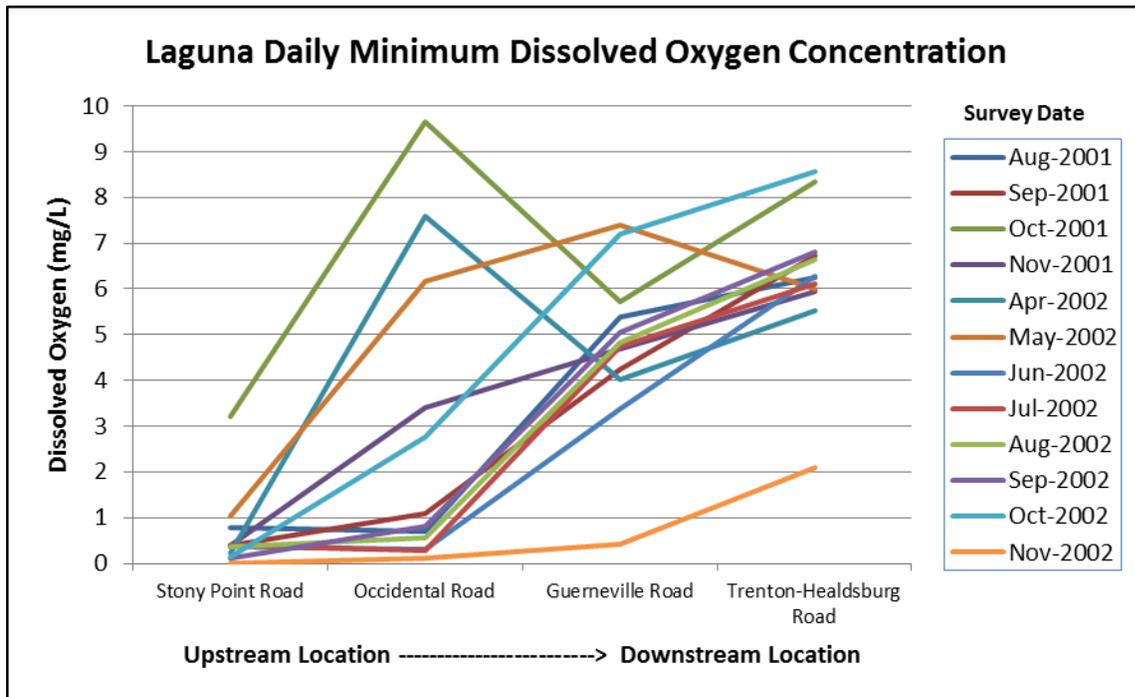


Figure 63. Comparison of Minimum Dissolved Oxygen Concentrations between Locations

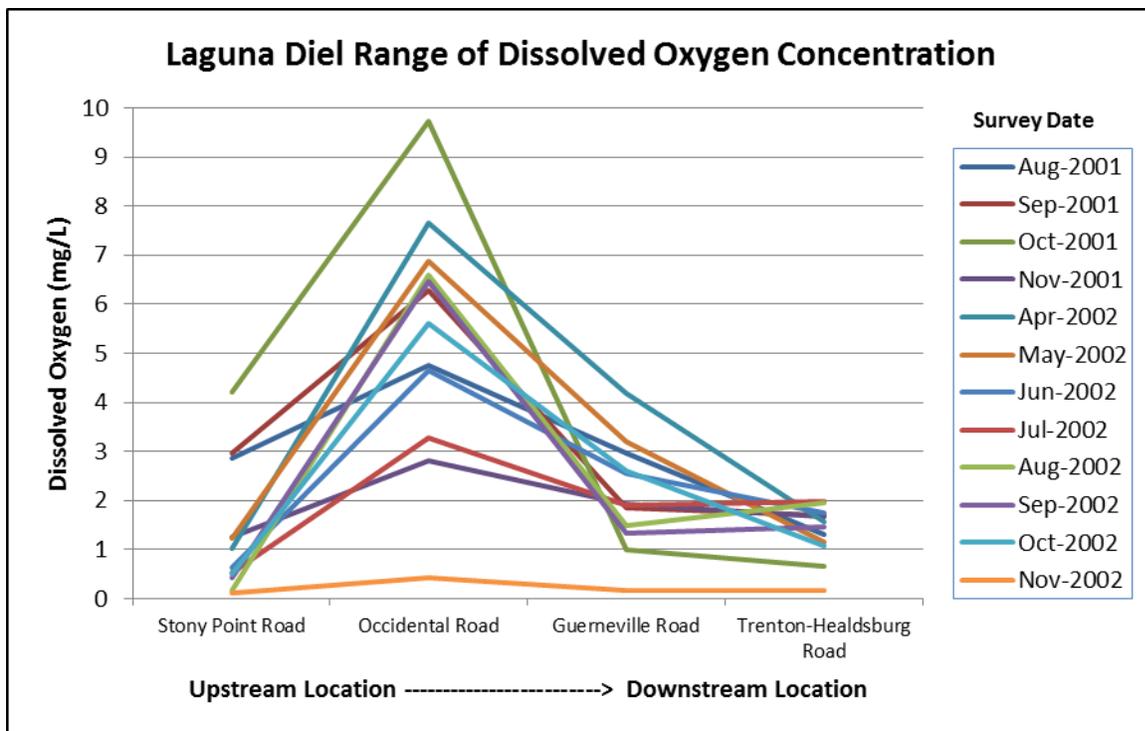


Figure 64. Comparison of the Diel Range Dissolved Oxygen Concentrations between Locations

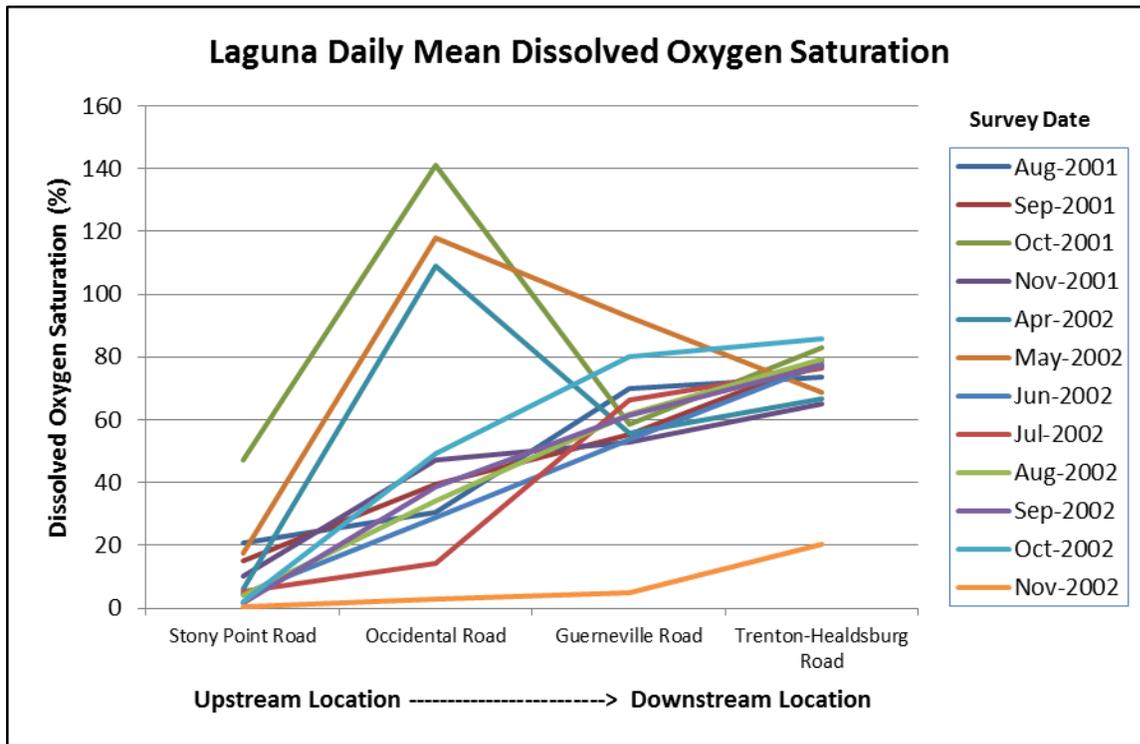


Figure 65. Comparison of the Mean Dissolved Oxygen Saturation between Locations

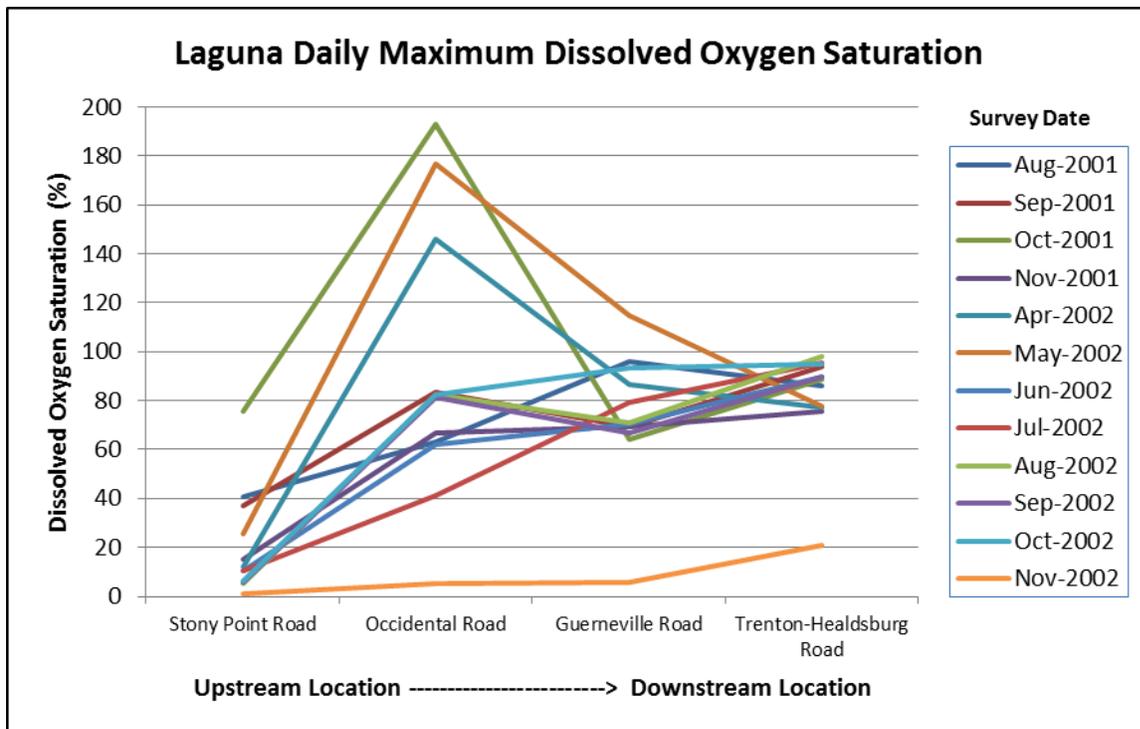


Figure 66. Comparison of the Maximum Dissolved Oxygen Saturation between Locations

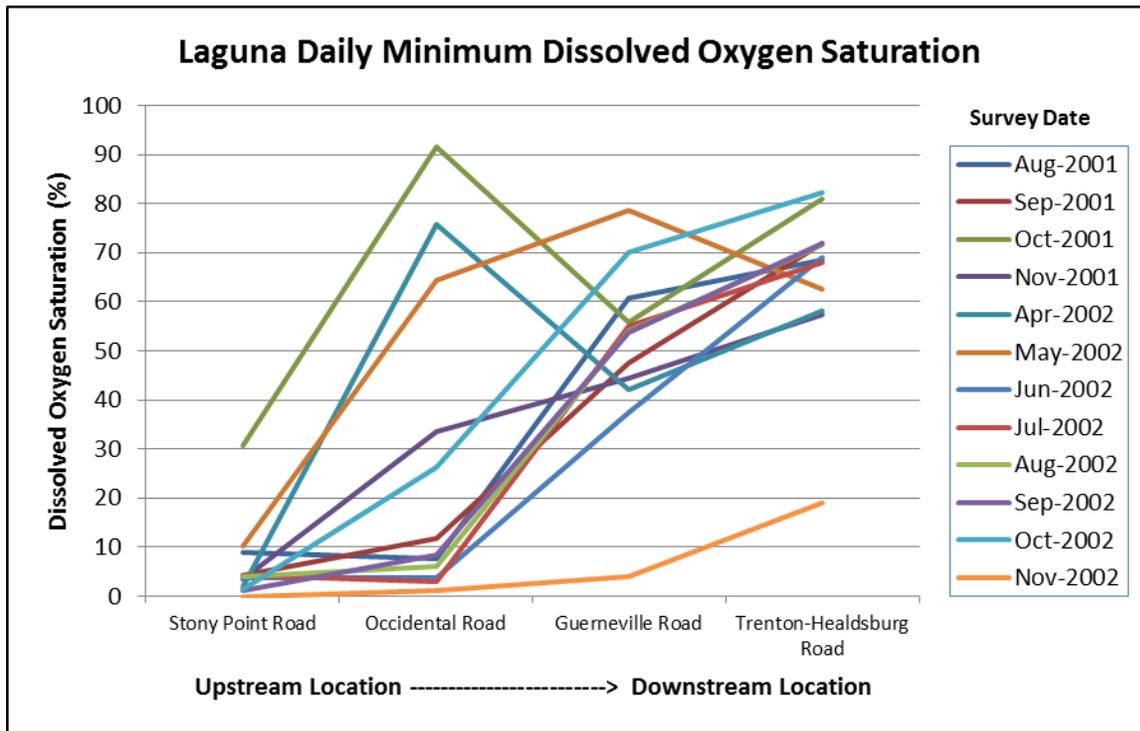


Figure 67. Comparison of the Minimum Dissolved Oxygen Saturation between Locations

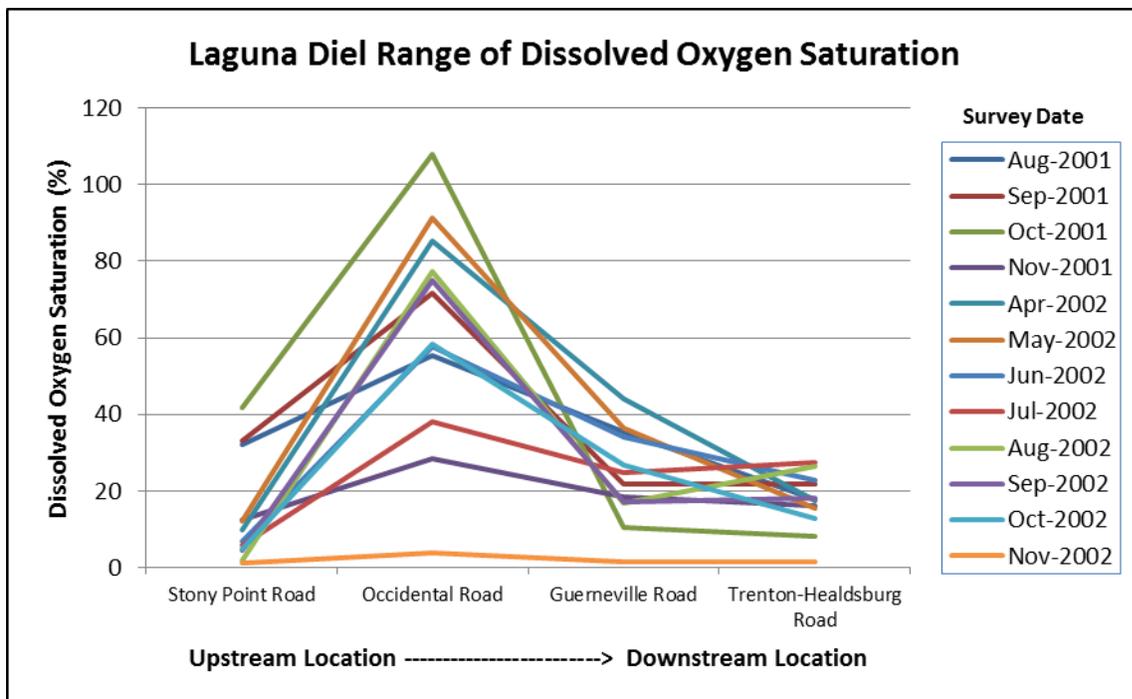


Figure 68. Comparison of the Diel Range of Dissolved Oxygen Saturation between Locations

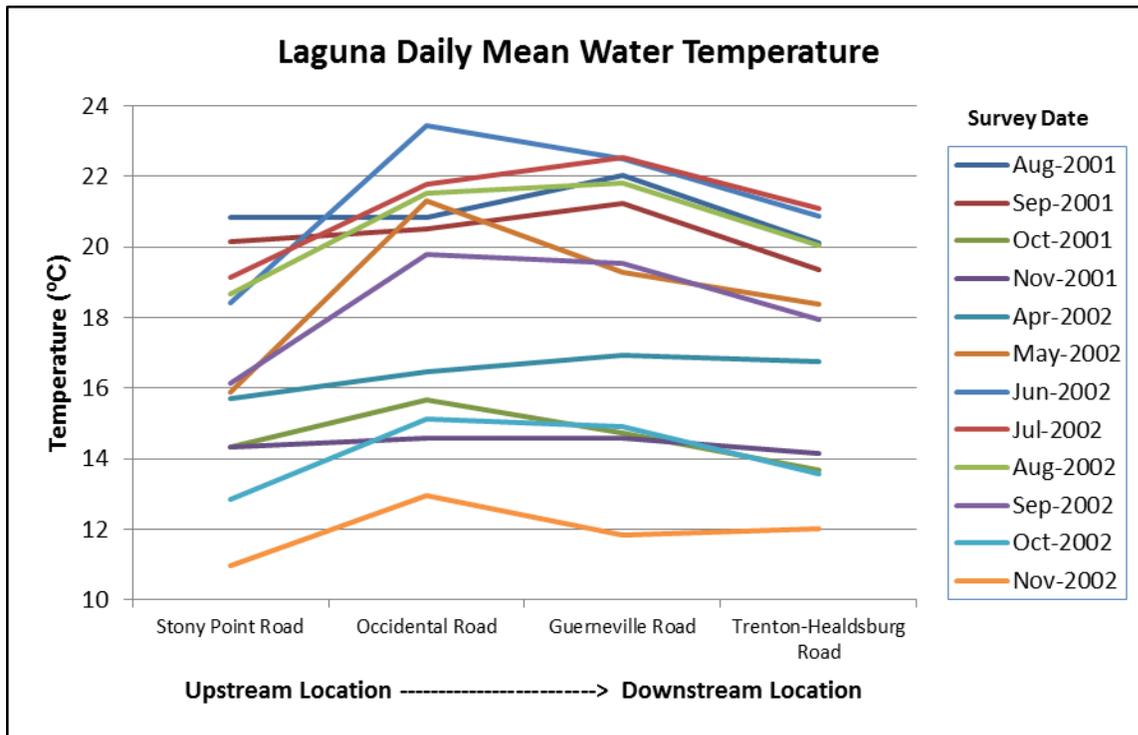


Figure 68. Comparison of the Mean Water Temperature between Locations

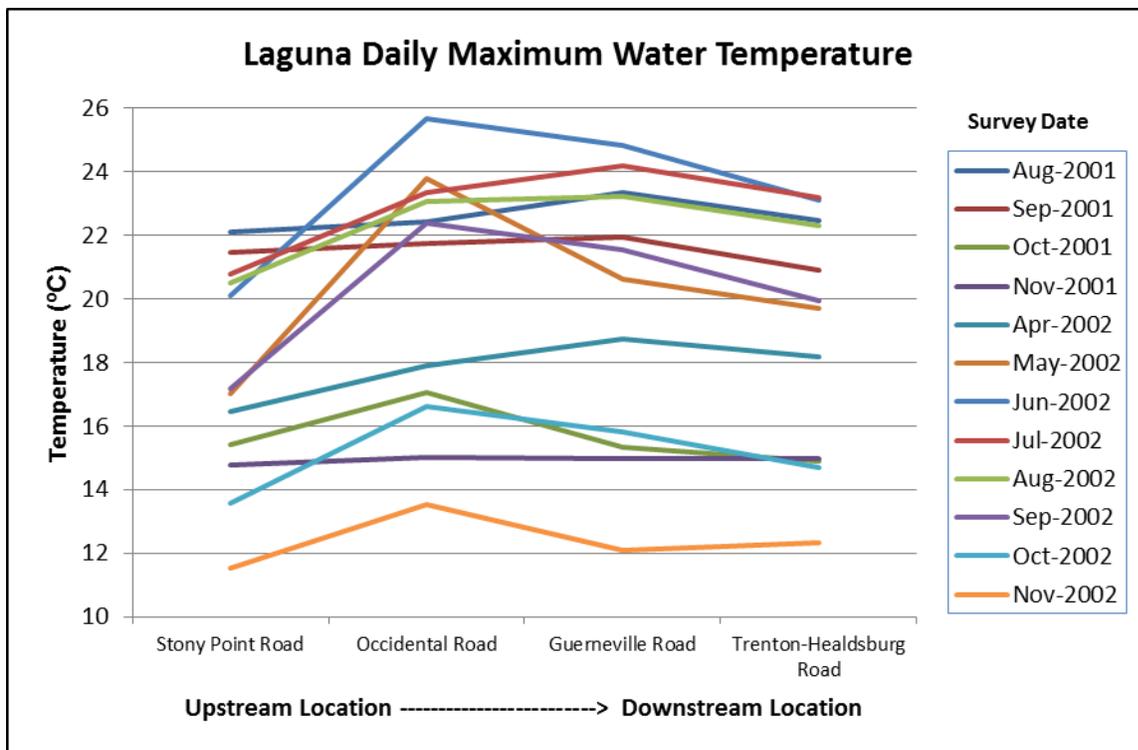


Figure 69. Comparison of the Maximum Water Temperature between Locations

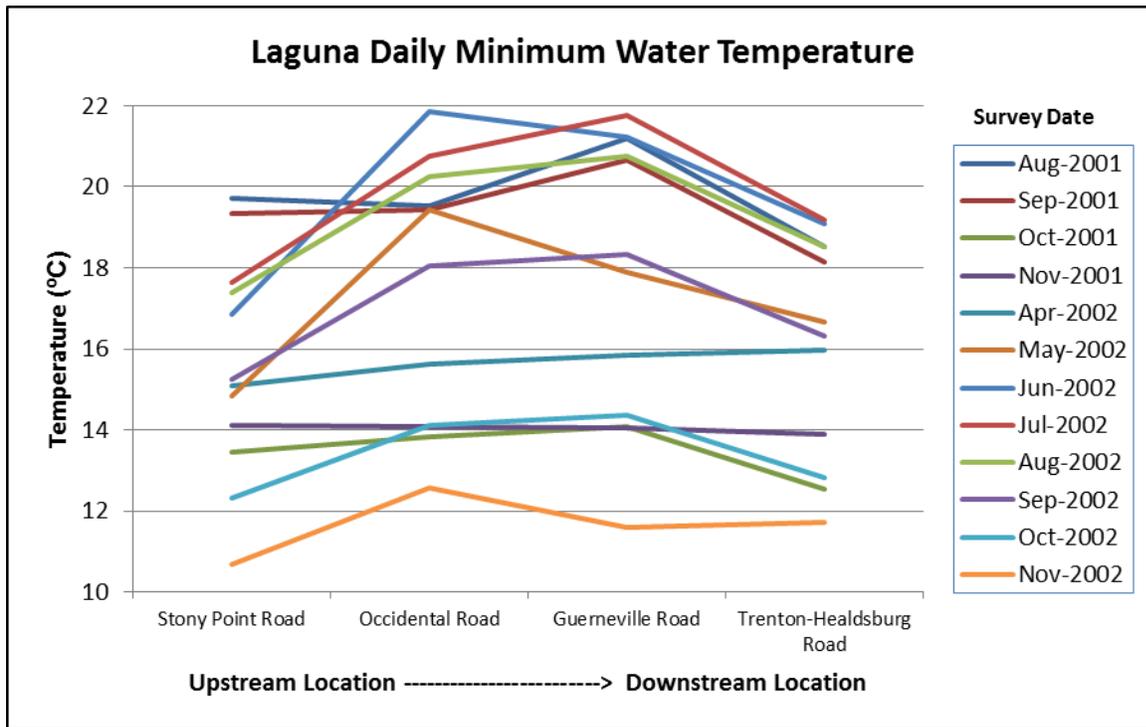


Figure 70. Comparison of the Minimum Water Temperature between Locations

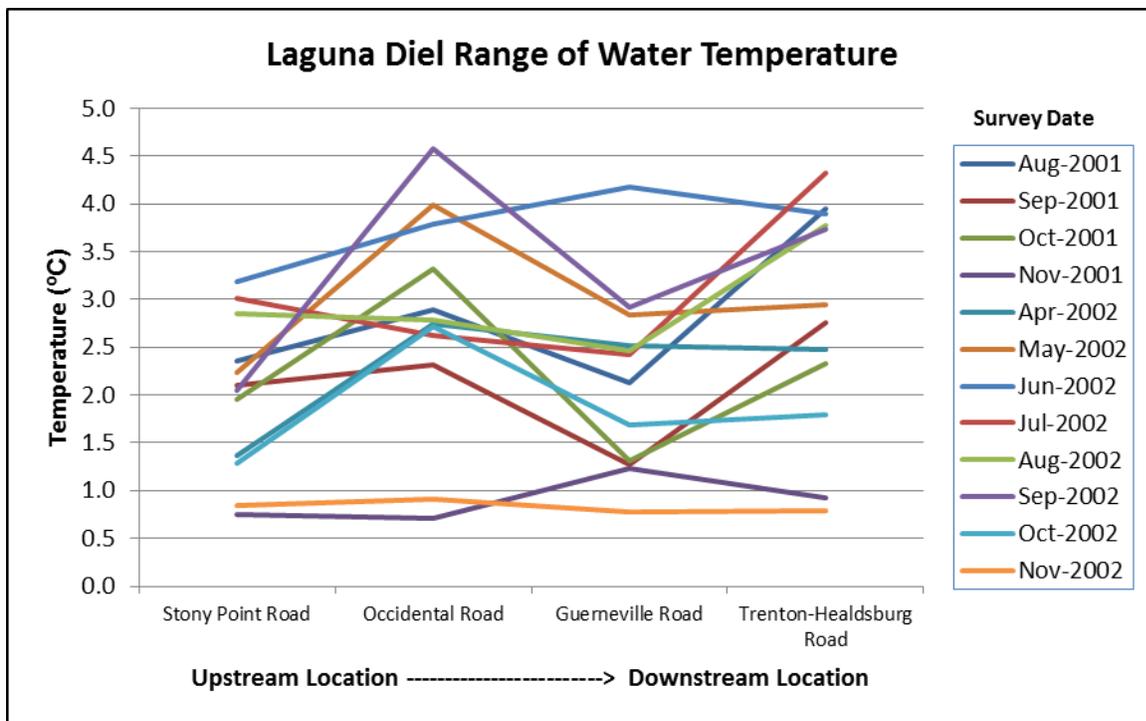


Figure 71. Comparison of the Diel Range of Water Temperature between Locations

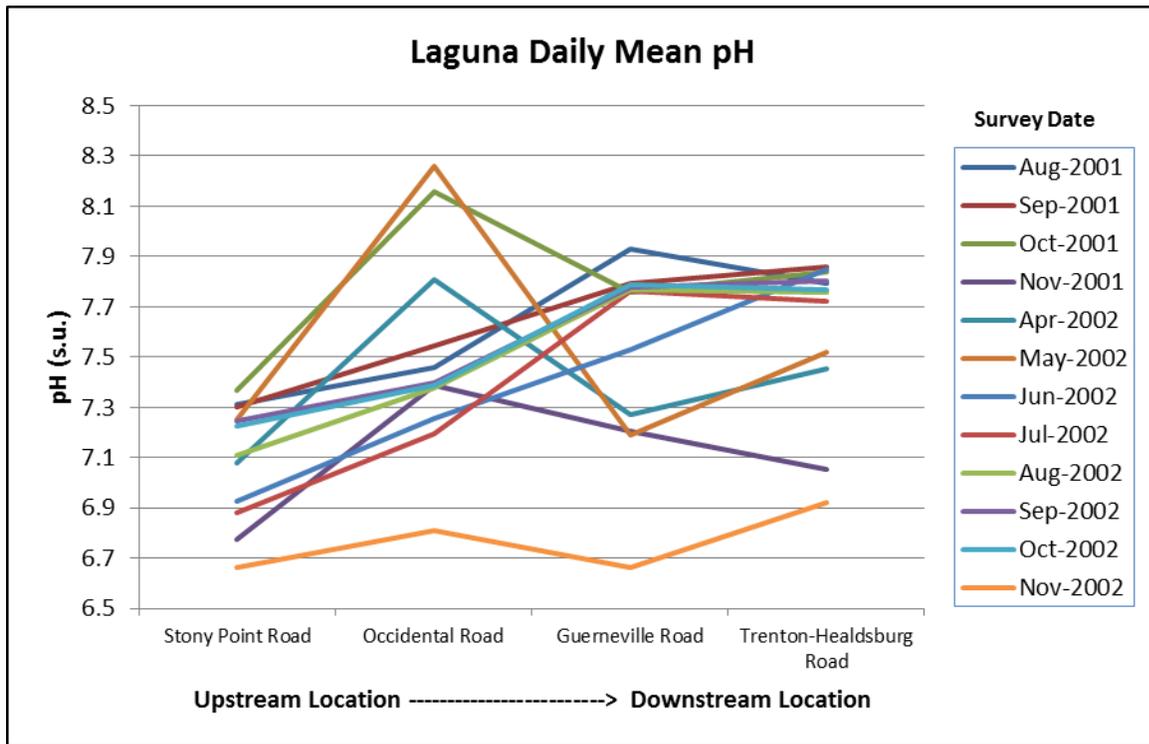


Figure 72. Comparison of the Mean pH between Locations

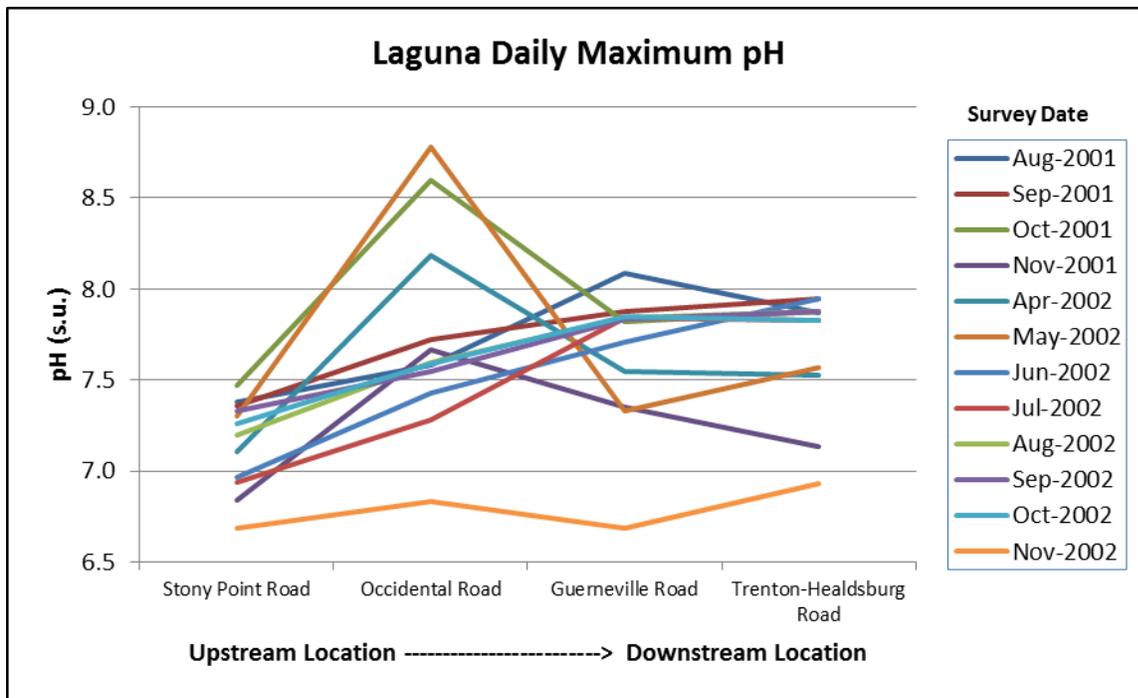


Figure 73. Comparison of the Maximum pH between Locations

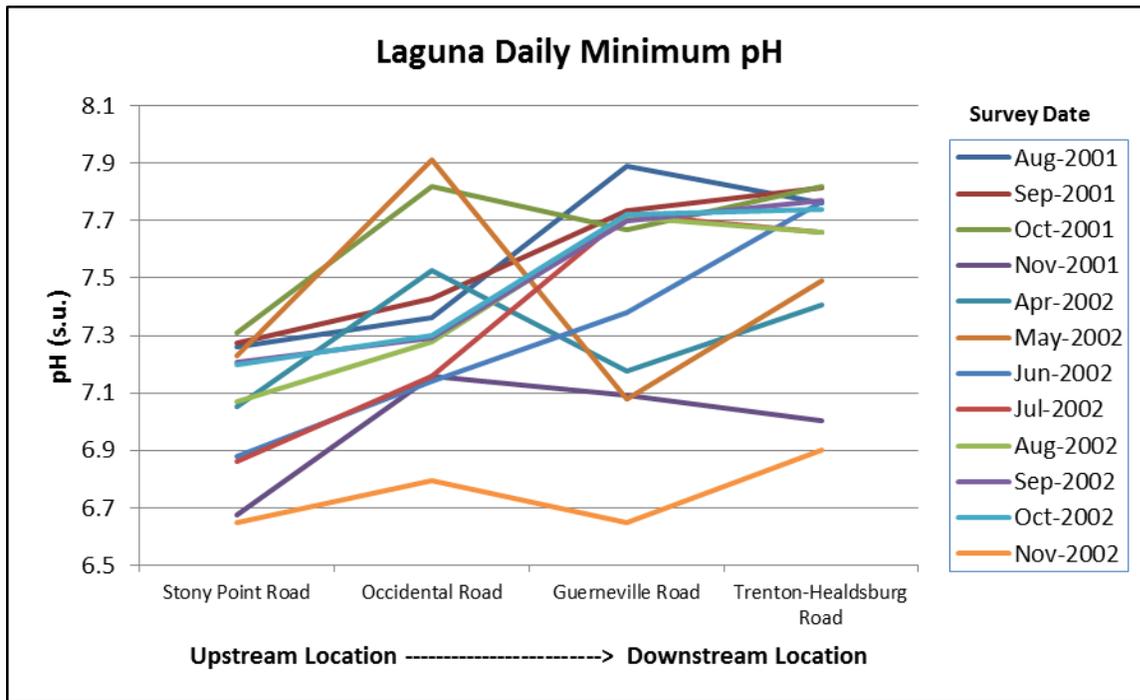


Figure 74. Comparison of the Minimum pH between Locations

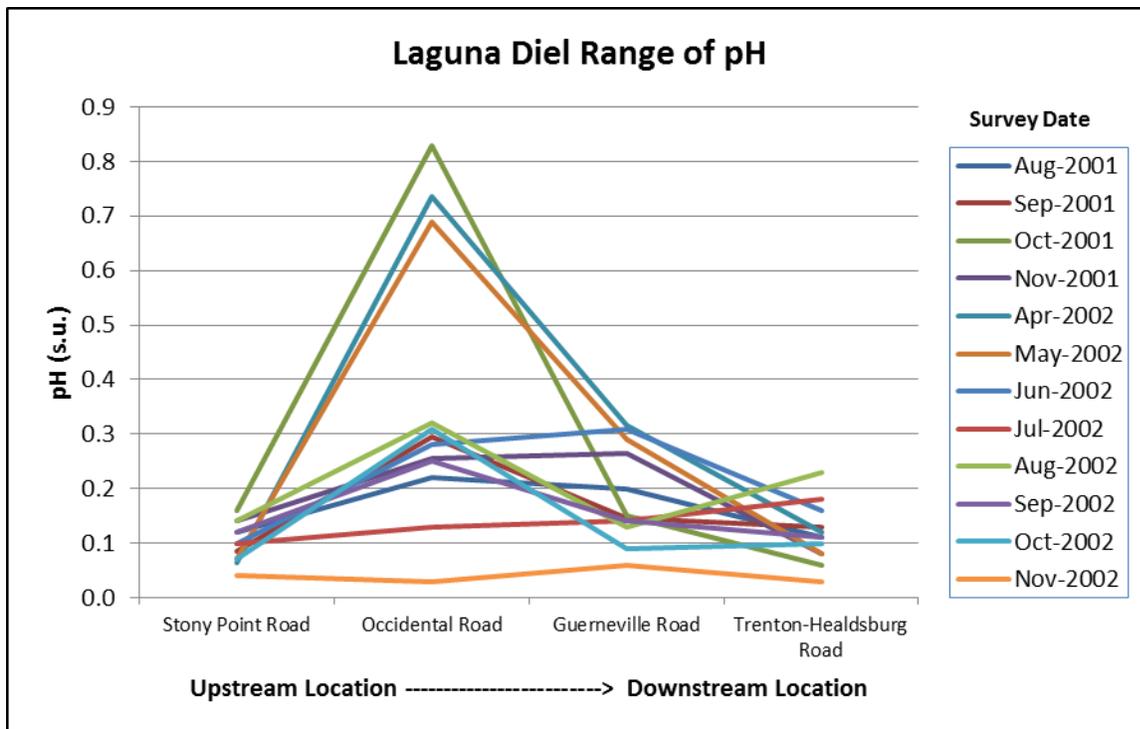


Figure 75. Comparison of the Diel Range pH between Locations

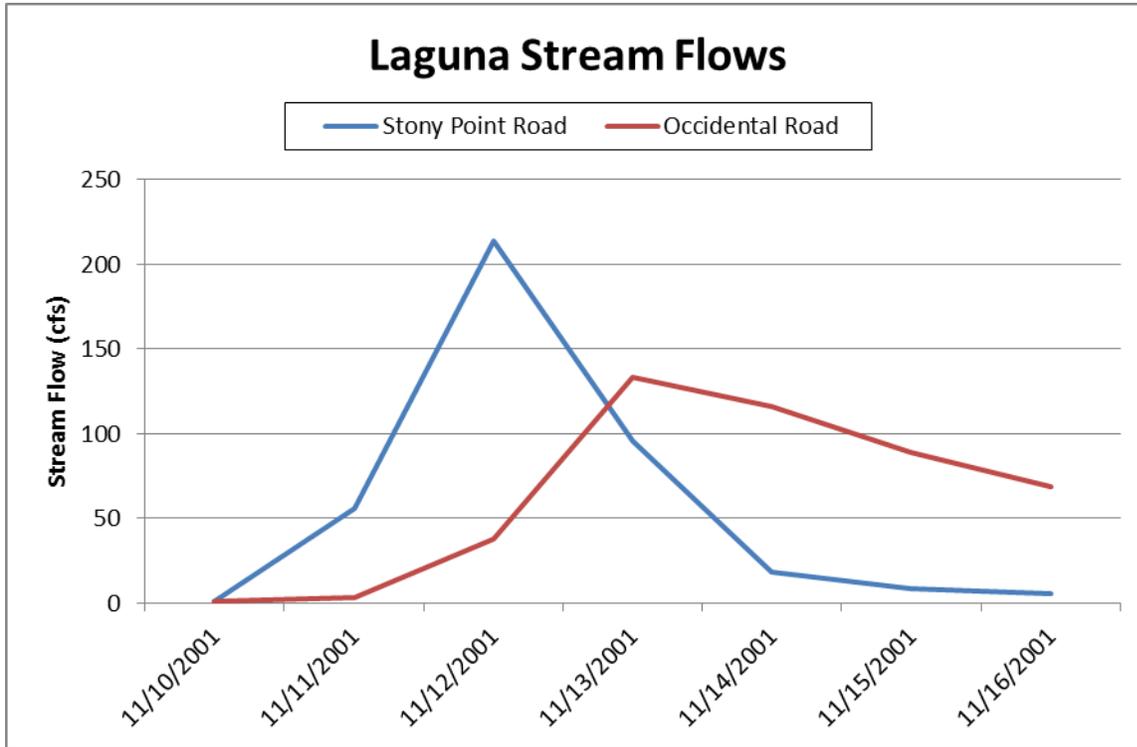


Figure 76. Stream Flows measured during November 2001

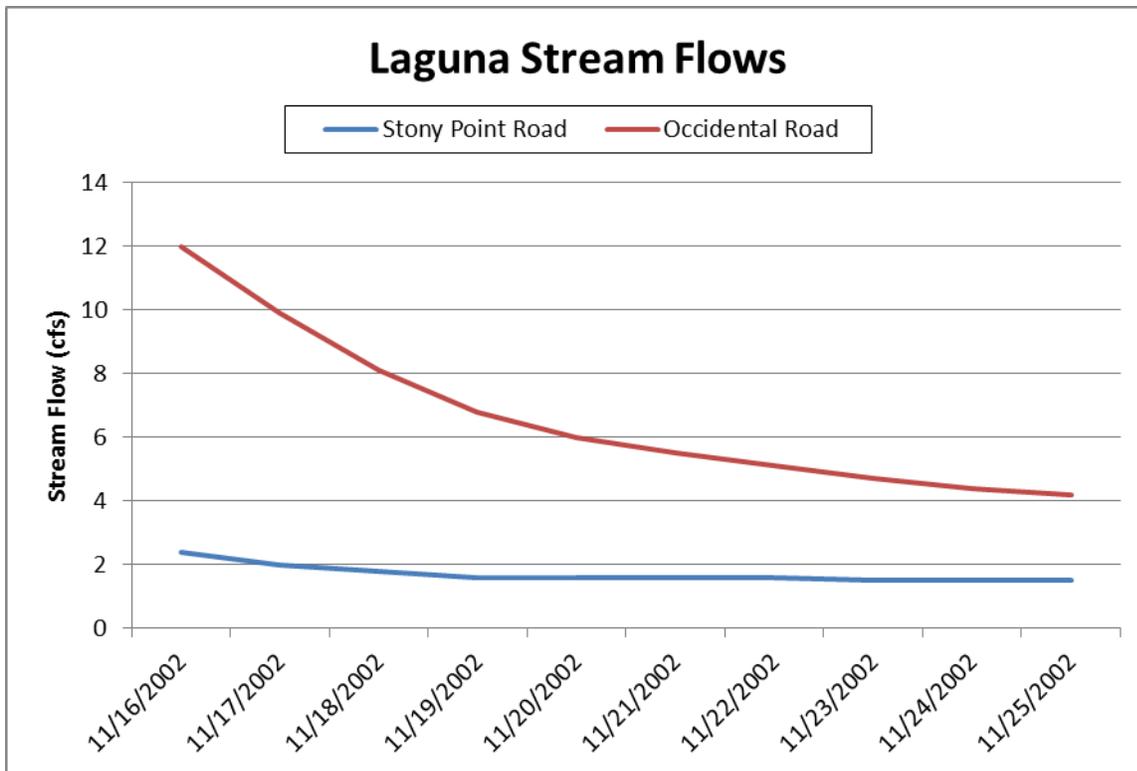


Figure 77. Stream Flows measured during November 2002