Carson River Special Monitoring Project - 2001

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Carson River Special Monitoring Project – 2001

Introduction

Segments of the Carson River and tributaries (along with other waterbodies in Nevada) are listed as impaired due to exceedances of the total phosphorus water quality standard. The total phosphorus standard of 0.1 mg/l applies to the Carson River and across much of the state, and is based upon recommendations in EPA's Gold Book. These recommendations are not identified as criteria, but rather as a "desired goal for the prevention of plant nuisances." Given the native soil conditions in Nevada, the suitability of TP standard must be questioned. Studies performed on the Truckee River and Pyramid Lake have shown that nitrogen rather than phosphorus is the limiting nutrient. The same may be true of the Carson River.

During the Summer of 2001, BWQP staff performed a special monitoring effort on the Carson River to collect detailed dissolved oxygen (DO), temperature and other data to begin evaluating the TP standard and assessing whether or not total phosphorus standard exceedances are causing eutrophication problems on the Carson River. Before a large amount of resources are devoted to developing TMDLs and control strategies, it is advisable to evaluate the suitability of the TP standard

Summary of Monitoring Sites and Related Efforts

During the period July 6, 2001 through September 24, 2001, the BWQP performed intensive monitoring for a portion of the Carson River system in Carson Valley. Figure 1 and Table 1 present the main monitoring sites used during this project. On July 6, 2001, BWQP installed a Hydrolab DataSonde in the Carson River at the Genoa Lake Golf Course. The Hydrolab was used to collect hourly DO, temperature and pH values over the course of the study. Each week, data were retrieved from the Hydrolab and the unit was recalibrated. At that time, a water grab sample was taken and sent to the laboratory for analysis. Also, streamflows at the site were estimated by staff.

In addition to the Hydrolab data collection effort, BWQP also weekly monitored early morning (usually between 6 and 8 AM) and late afternoon (usually between 2 and 4 pm) DO and temperature at eight other locations upstream and downstream from the Hydrolab site. Over the course of the field work, staff monitored additional parameters such as weather provided by National Weather Service, and streamflow at USGS gaging stations.

Conditions during the Monitoring Project

Conditions during this project were extreme in terms of streamflow and weather. The 2001 Water Year was the driest and hottest on record. During the study period, streamflows at Carson River at Carson City were significantly lower than the historic median flows at this station, especially during the early part of the monitoring (Figure 2). Flows were approximately at the

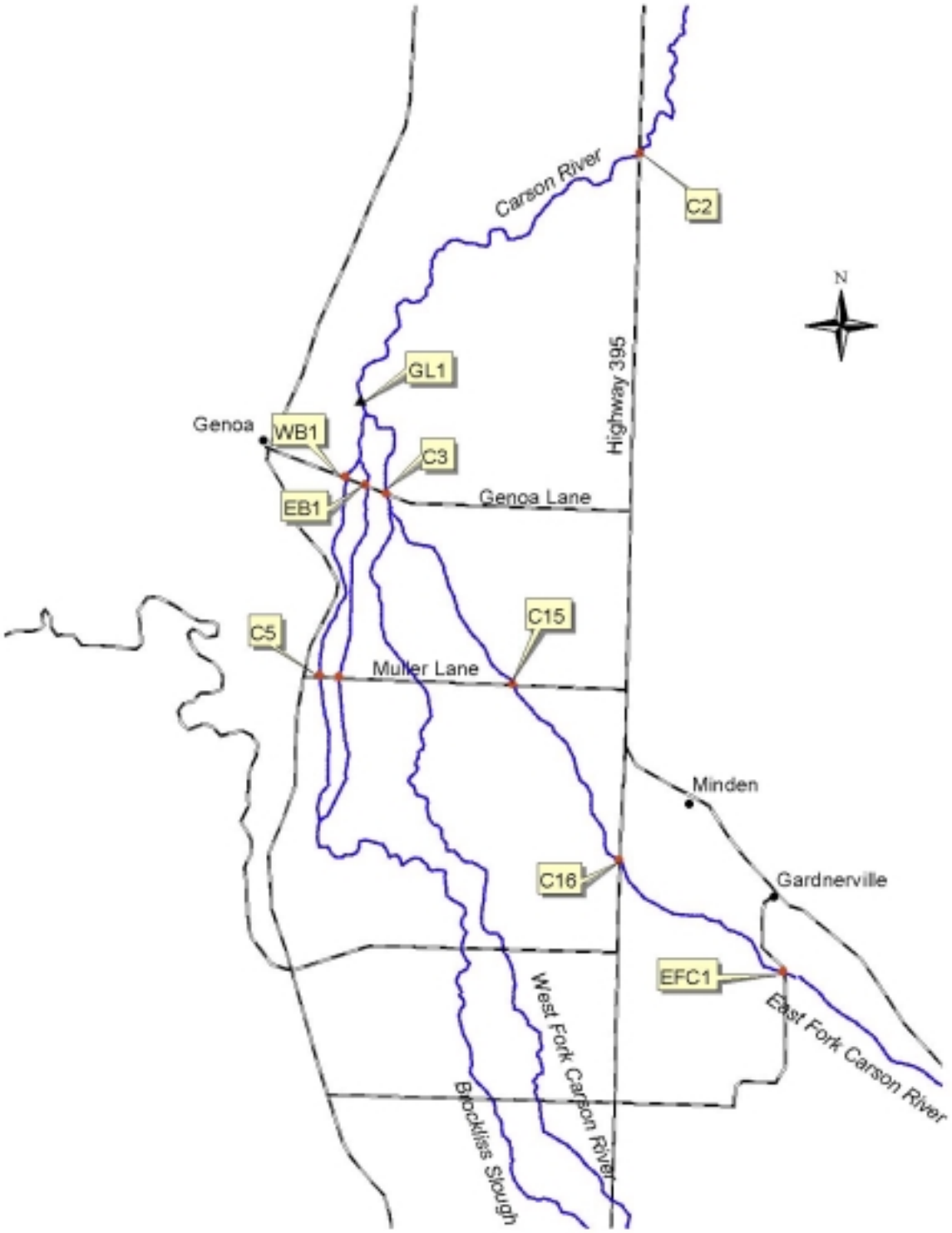


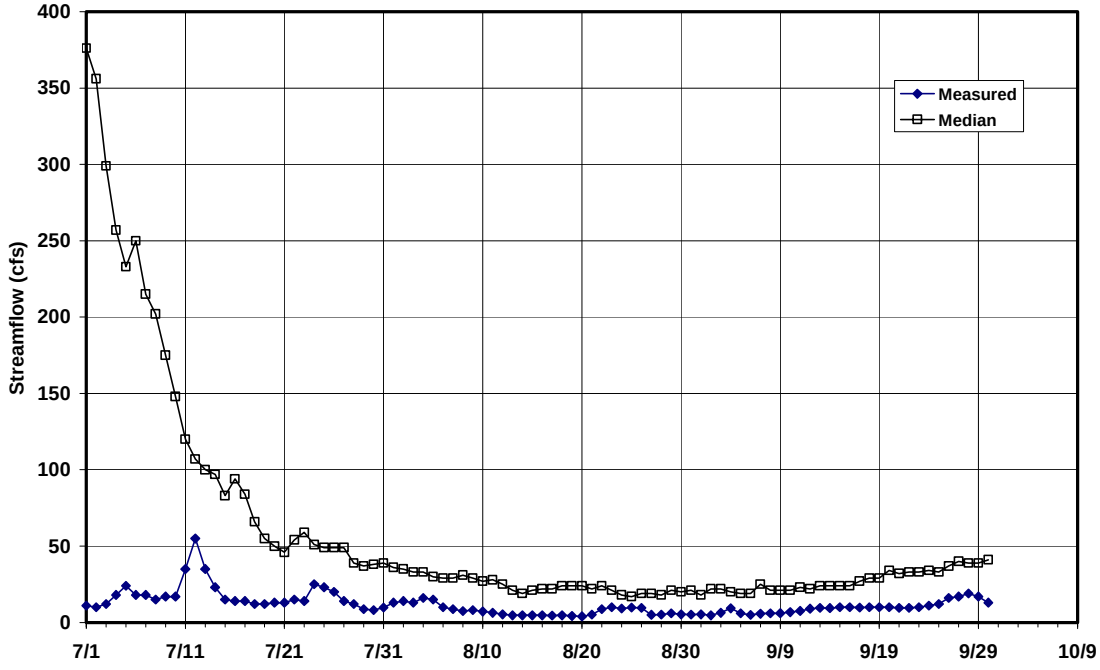
Figure 1. Water Quality Monitoring Sites

Table 1. Summary of Water Quality Monitoring Stations Used in the Project

Station ID	Description
Hydrolab Station	
GL1	Carson River at Genoa Lake Golf Course
Spot DO and Temperature Stations	
C2*	Carson River at Cradlebaugh Bridge (Highway 395)
C3*	Carson River at Genoa Lane
C15*	East Fork Carson River at Muller Lane
C16*	East Fork Carson River at Highway 88
EFC1	East Fork Carson River at Lutheran Bridge
WB1	West Brockliss Slough at Genoa Lane
EB1	East Brockliss Slough at Genoa Lane
C5*	West Brockliss Slough at Muller Lane

* Stations are part of NDEP ongoing ambient water quality monitoring network

Figure 2. 10311000 - Carson River at Carson City, NV - Measured and Median Flows



historic 10th percentile level (Figure 3). In otherwords, historic flows have been at these levels (or lower) for these days about 1 out of 10 years. Further exacerbating the low flow conditions, air temperatures were frequently hotter than normal (Figure 4).

Figure 3. 10311000 - Carson River at Carson City, NV - Measured and 10th Percentile Flows

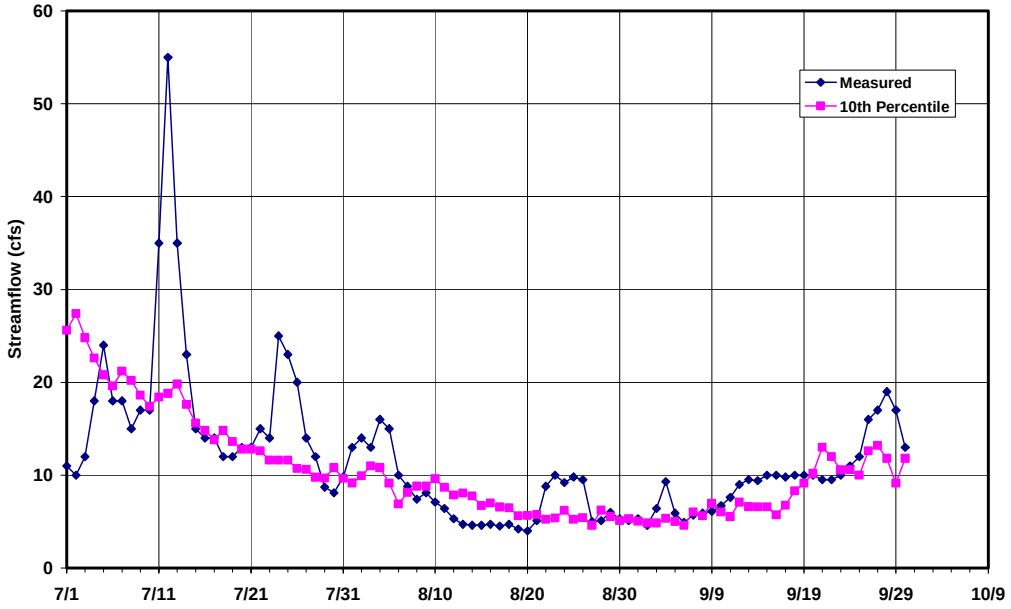
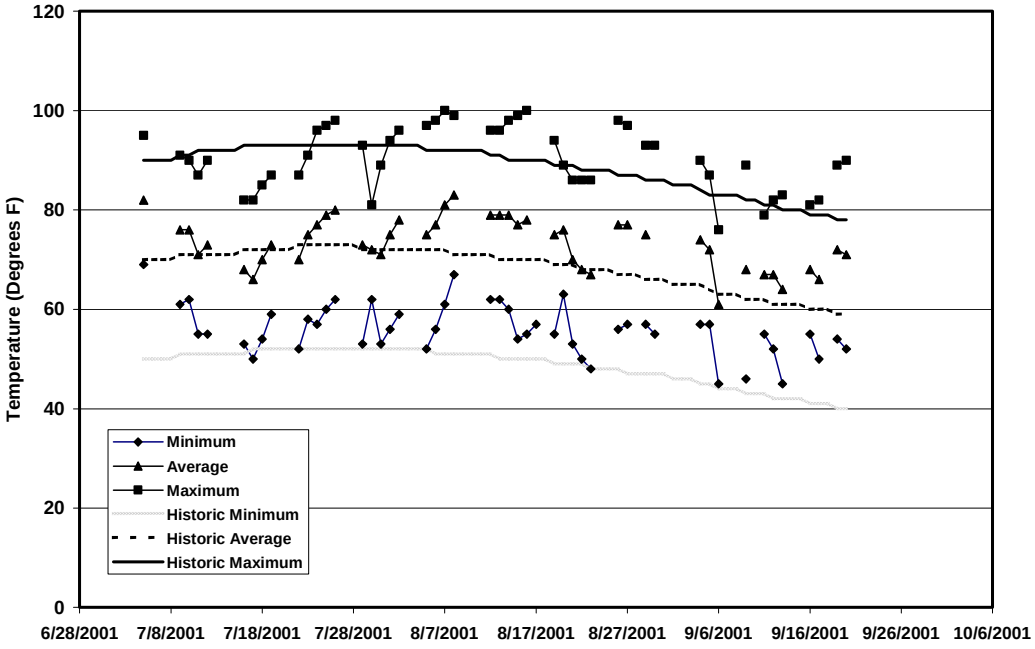


Figure 4. Reno Airport Temperatures



Water Quality Standards and Their Applicability

Dissolved Oxygen

The water quality standard for dissolved oxygen for June through October is 5 mg/l (single value) at this location on the Carson River (See NAC 445A.153) based upon EPA's "Quality Criteria for Water 1976 (Red Book)" for fisheries. The NAC does not provide any guidance for applying this standard It is unknown if the 5 mg/l value is intended to represent a daily mean or maximum limit, or a 7-day (or other duration) average limit. Also, the Red Book is a little unclear on what the 5 mg/l value represents. However, it appears that the Red Book intends the 5 mg/l standard to represent an instantaneous minimum as measured at any time. In otherwords, DO levels would need to be 5 mg/l or higher through out the entire day for compliance with standards.

More recent studies suggest that this standard may not be adequate. The Gold Book (1986) provides a more detailed DO standard, depending upon life stage of the fish, and the period of time being examined.

Temperature

This reach of the river is classified as a coldwater fishery with a temperature standard for July through October is 23 degrees C for this reach of the Carson River (NAC 445A.153). According to previous standards review rationale documents, this standard was generally based upon recommendations by the Nevada Division of Wildlife (NDOW) for coldwater fisheries protection. However, a September 8, 1984 letter from NDOW to NDEP recommended that the July to October temperature standard be set at 20 degrees C instead of 23 degrees C.

The NAC does not provide any guidance for applying this standard. It is unknown if the 23 degrees C value is intended to represent a daily mean or maximum limit, or a 7-day (or other duration) average limit.

Nutrients

The total phosphorus standard for this reach is set at 0.1 mg/l as an annual average. A total phosphorus standard of 0.1 mg/l applies across much of the state, including the Carson River, and is based upon recommendations in EPA's Gold Book. These recommendations are not identified as criteria, but rather as a "desired goal for the prevention of plant nuisances." Given the native soil conditions in Nevada, the suitability of TP standard must be questioned. Studies performed on the Truckee River and Pyramid Lake have shown that nitrogen rather than phosphorus is the limiting nutrient. The same may be true of the Carson River.

The nitrogen beneficial use standards for this portion of the Carson River are divided into 3 species: nitrate (10 mg/l), nitrite (0.06 mg/l) and un-ionized ammonia (0.02 mg/l). None of the standards were set for the control of algal growth. The nitrate standard is based upon drinking

water requirements while the nitrite and un-ionized ammonia standards are based upon toxicity to aquatic life concerns.

Applicability of Water Quality Standards during Low Flows

Data collected during extreme flow events (drought or flood) may not always be useful for evaluating water quality standard compliance. Nevada Administrative Code 445A.121(8) states,

> *"The specified standards are not considered violated when the natural conditions of the receiving water are outside the established limits, including periods of extreme high or low flow ...." Therefore, water chemistry data associated with samples collected during extreme high and low flows should not be considered in determining standards compliance.*

Typically, $7Q10_{high}$ and $7Q10_{low}$ may be used to establish the extreme flow condition thresholds. 7Q10 flows are developed from historic streamflow data and are defined as a predicted high or low flow for a consecutive seven day period with an expected recurrence interval of ten years. An analysis of the Carson River at Carson City, NV station indicates a $7Q10_{low}$ value of about 4 cfs. During the monitoring period, flows at Carson City were near or greater than this threshold. The same holds true for the other upstream gaging stations (10309000 – EF Carson River near Gardnerville, NV and 10310000 – WF Carson River at Woodfords, CA). While the overall flow conditions during 2001 were extreme, flow conditions at the Carson City gage for the monitoring period were not that unusual, but some days experienced flows that were borderline in terms of meeting the $7Q10_{low}$ threshold.

Though Water Year 2001 was the driest on record, flows during the monitoring period were not the lowest on record. As shown on Figure 3, flows at Carson City have been lower than the July 7, 2001 through September 24, 2001 flows about 10 percent of the time. These lower flows have occurred during previous drought years such as 1977 and 1988. Based upon this information, it would appear that the data collected as part of this study are close to the $7Q10_{low}$ threshold and are borderline for evaluating water quality standards compliance.

Summary of Monitoring Results

Following is a summary of the data collected as part of this project. The original data sheets and information are in the project file at the office of BWQP.

Hydrolab

At the Carson River at Genoa Lakes Golf Course, a variety of data were collected. With the Hydrolab, hourly dissolved oxygen and temperature were primary parameters that were monitored. Operation of the Hydrolab required staff to weekly visit the site to download data and recalibrate the unit. During each weekly visit, BWQP collected grab samples for laboratory analysis and estimated streamflows.

Figure 5. Carson River at Genoa Lakes Golf Course - Dissolved Oxygen

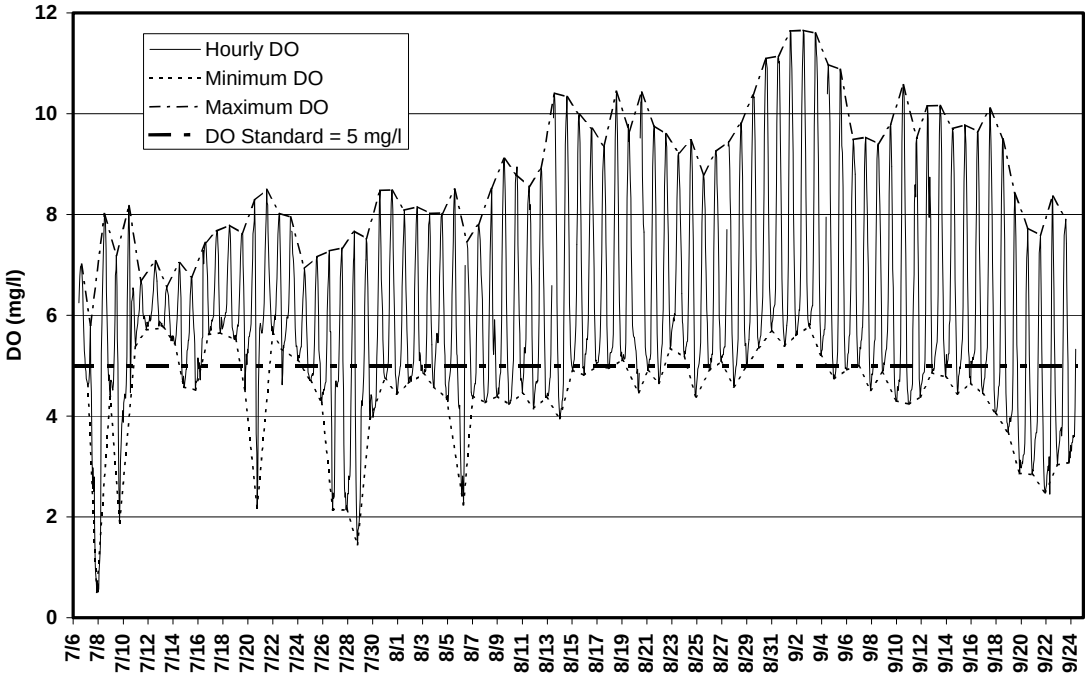
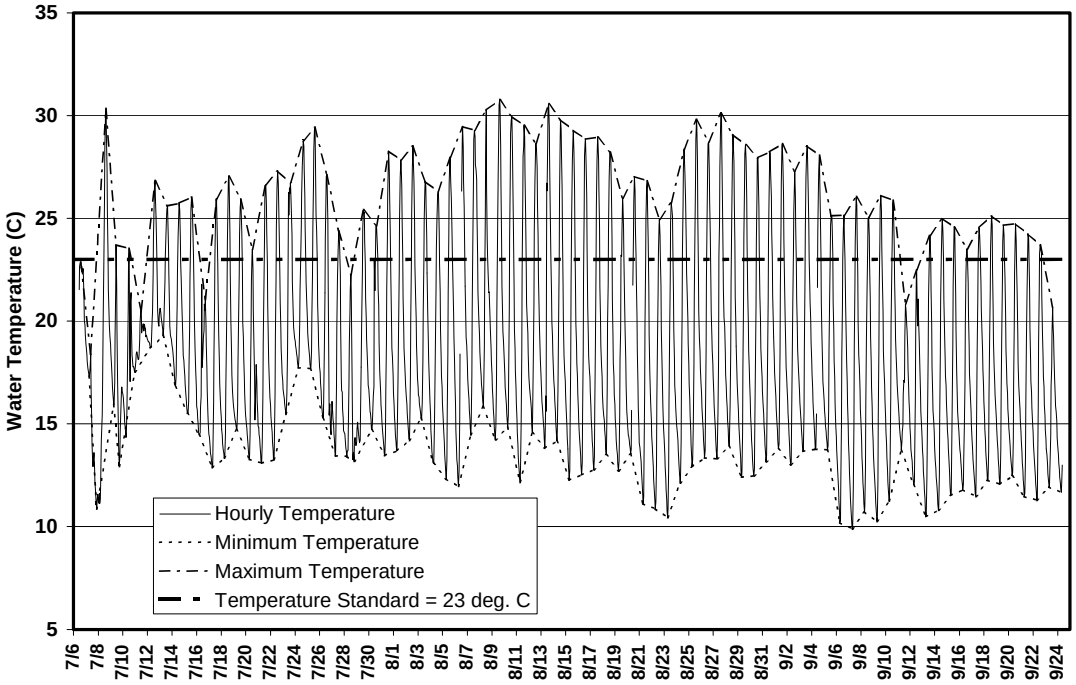


Figure 6. Carson River at Genoa Lakes Golf Course - Water Temperature



Hourly DO and water temperature data collected at the Carson River at Genoa Lake Golf Course site are summarized in Figures 5 and 6. When the Hydrolab was installed on July 7th, streamflows at the site were estimated to be approximately 44 cfs. At that time, the Hydrolab had been installed near the left bank. By August 6, flows had decreased to about 10 cfs and the Hydrolab was in a section of the river that was getting little to no flow. As a result, the Hydrolab was moved about 100 feet downstream (near the left bank) to better flow conditions.

As stated earlier, the water quality standard for dissolved oxygen for June through October is 5 mg/l (single value) at this location on the Carson River (See NAC 445A.153). During the 80-day monitoring period, most of the days (75%) experienced DO levels below the 5 mg/l standard for some period during the day (Table 2). However in many instances, the lower DO levels were of limited duration with only 29% of the hourly readings having DO levels below 5 mg/l. Exceedances of the standard were even less (14%) when the data were examined on an average daily basis.

The temperature standard for July through October is 23 degrees C for this reach of the Carson River (NAC 445A.153). Over 90% of the monitored days experienced water temperatures higher than the 23 degree C standard. Only 22% of the hourly readings had temperature levels higher than the standard. When the temperature data were averaged for each day, none of the daily average values were over the 23 degree C standard.

Table 2. Water Quality Standard Exceedances at Carson River at Genoa Lakes Golf Course

Parameter	Percentage of Time Standard Exceeded by Data Groupings		
	Percent of Hourly Values	Percent of Daily Averages	Percent of Days
Dissolved Oxygen	29	14	75
Temperature	22	0	90

There appears to have been quite a lot of instability in the diurnal DO patterns during the first two weeks of the monitoring. It is believed that some of these erratic fluctuations in the DO and temperature occurred as the result of weather systems passing through the region. As discussed above, the initial Hydrolab site was experiencing limited flow movement in the days prior to August 6. Some of the erratic fluctuations in the data may have been caused by this condition. It may be that the data collected after August 6 are more reliable and indicative of conditions in the main stream. However it must be noted that the Hydrolab was installed near the river bank and the data may not be representative of conditions across the channel cross section.

An examination of the water chemistry data shows that total nitrogen concentrations were rather variable during the first two weeks of the monitoring, as was the TN:TP ratios. This may have also been a factor resulting in the erratic DO levels.

It is interesting to note that after August 6th most of the minimum DO levels were near the 5 mg/l level. However during the last week of the monitoring, the minimum DO levels dropped to below 3 mg/l. This drop seems to coincide with an increase in total nitrogen, nitrate and phosphorus levels on 9/24/01 (see Table 3).

Grab Samples and Laboratory Analyses

Table 3 provides a summary of the nutrient concentrations in the weekly grab samples. Note that all of the TP levels exceeded the TP standard of 0.1 mg/l.

As stated earlier, one purpose of this study was to begin evaluating the TP standard and assessing whether or not total phosphorus standard exceedances are causing eutrophication problems on the Carson River. One approach is to examine N:P ratios as a first cut at determining which nutrients are limiting algal growth. Table 4 summarizes both the Total Nitrogen:Total Phosphorus ratios and the Dissolved Inorganic Nitrogen:Orthophosphate ratios. Generally, N:P ratios greater than seven indicate that phosphorus may be the limiting nutrient (*Surface Water-Quality Modeling*, S. Chapra, 1997). The data in Table 4 with values less than seven suggest that nitrogen was the limiting nutrient during this study.

Table 3. Nutrient Concentrations in Weekly Grab Samples

Date/Time	OP as P (mg/l)	TP as P (mg/l)	Total N as N (mg/l)	Kjeldahl as N (mg/l)	Nitrite as N (mg/l)	Ammonia as N (mg/l)	Nitrate as N (mg/l)
7/16/02 11:00	0.19	0.27	0.83	0.79	< 0.01	< 0.1	0.03
7/23/01 12:30	0.16	0.24	1.31	1.30	< 0.01	< 0.1	0.00
7/30/01 11:45	0.22	0.31	0.68	0.66	< 0.01	< 0.1	0.01
8/6/01 11:45	0.28	0.33	0.46	0.44	< 0.01	0.11	0.01
8/13/01 11:45	0.14	0.19	0.43	0.40	< 0.01	< 0.1	0.02
8/20/01 11:30	0.12	0.18	0.58	0.53	< 0.01	< 0.1	0.04
8/27/01 11:30	0.10	0.16	0.46	0.43	< 0.01	< 0.1	0.02
9/4/01 11:00	0.08	0.16	0.51	0.49	< 0.01	< 0.1	0.01
9/10/01 11:15	0.08	0.16	0.47	0.46	< 0.01	< 0.1	0
9/17/01 11:15	0.06	0.16	0.43	0.41	< 0.01	< 0.1	0.01
9/24/01 11:30	0.13	0.25	0.60	0.49	0.03	< 0.1	0.08

Table 4. Summary of Nitrogen to Phosphorus Ratios

Date/Time	TN:TP Ratios	DIN:OP
7/16/02 11:00	3.07	0.42
7/23/01 12:30	5.46	0.31
7/30/01 11:45	2.19	0.27
8/6/01 11:45	1.39	0.43
8/13/01 11:45	2.26	0.86
8/20/01 11:30	3.22	0.75
8/27/01 11:30	2.88	0.70
9/4/01 11:00	3.19	0.75
9/10/01 11:15	2.94	0.63
9/17/01 11:15	2.69	1.00
9/24/01 11:30	2.40	1.00

Streamflow

Streamflows at the site were estimated weekly by BWQP using the float technique. Velocity was first estimated by floating objects on the river and noting the time required for the objects to travel a measured distance. The flow rate was then determined by multiplying the average flow velocity by an estimated cross sectional area of the channel. Results are summarized in Table 5.

Table 5. Estimated Streamflow

Date	Estimated Streamflow (cfs)
7/6/2001	44
7/16/2001	48
7/23/2001	24
7/30/2001	21
8/6/2001	10
8/13/2001	7
8/20/2001	12
8/27/2001	5
9/4/2001	7
9/10/2001	8
9/17/2002	8
9/24/2001	11

Spot DO and Temperature Readings

As mentioned earlier, BWQP staff monitored early morning and late afternoon DO and temperature at eight other locations upstream and downstream from the Hydrolab site. Of particular interest are the early morning DO (typically the lowest of the day) and the afternoon temperature (typically the highest) readings. Figures 7 and 8 summarize the early morning DO data collected at these sites. In general, more frequent violations of the DO standard occurred at: East Fork Carson River at Muller Lane and at all of the West Brockliss Slough sites.

Figures 9 and 10 present the afternoon temperature data collected at the spot reading sites. The most frequent exceedances of the temperature standard occurred during the first part of the monitoring period at the East Fork Carson and Carson River sites.

There are some limitations with this approach. The intent is to monitor at the appropriate time in order to capture the minimum DO levels in the morning and maximum water temperatures in the afternoon, however it can become difficult to time the spot readings to coincide with the DO and temperature extremes. The Hydrolab data collected at Carson River at Genoa Lakes Golf Course indicate that the daily minimum DO levels generally occurred before 6 AM and the maximum temperatures occurred between 2 and 3 PM. Based upon this information, it is probable that the morning DO spot readings taken between 6 to 8 AM are higher than the actual minimums experienced at those locations. However, the afternoon temperature readings taken between 2 and 4 PM are good indicators of the daily maximum temperatures for those locations.

Figure 7. Early Morning DO at Spot Reading Sites - EF Carson and Carson River

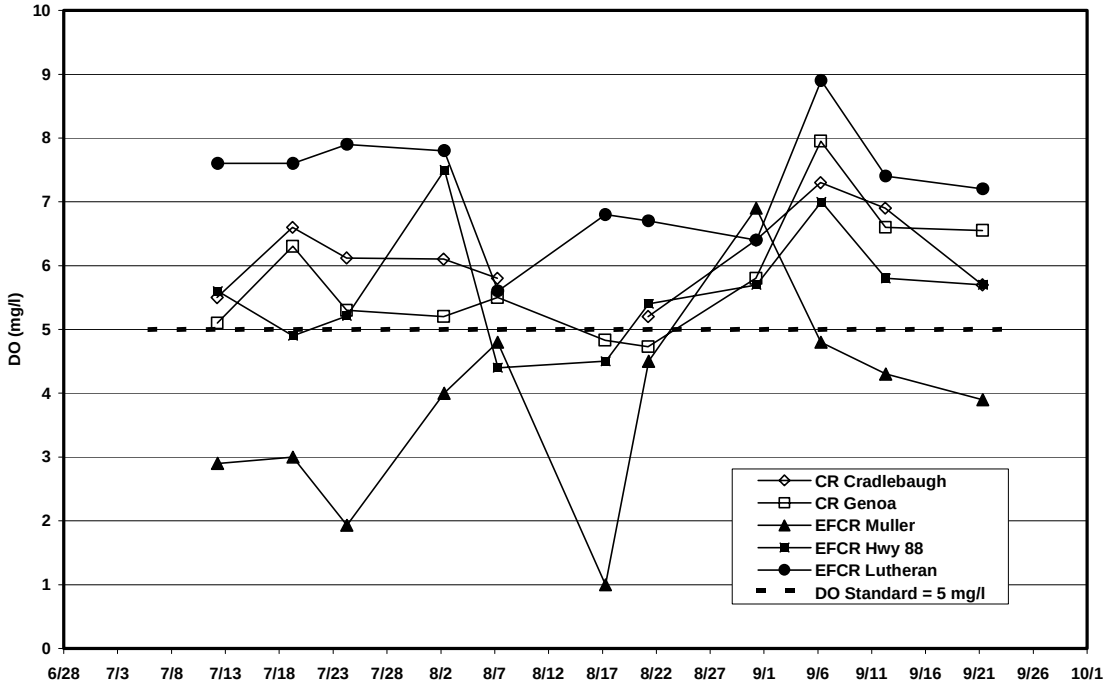


Figure 8. Early Morning DO at Spot Reading Sites - Brockliss Slough

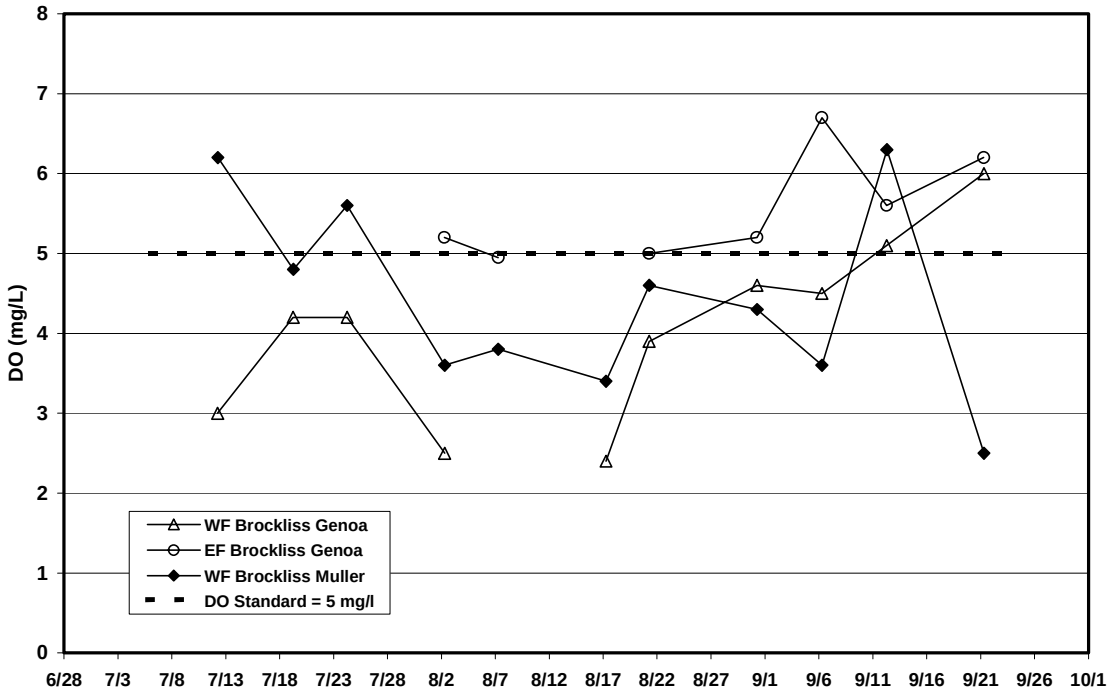


Figure 9. Afternoon Temperature at Spot Reading Sites - EF Carson and Carson River

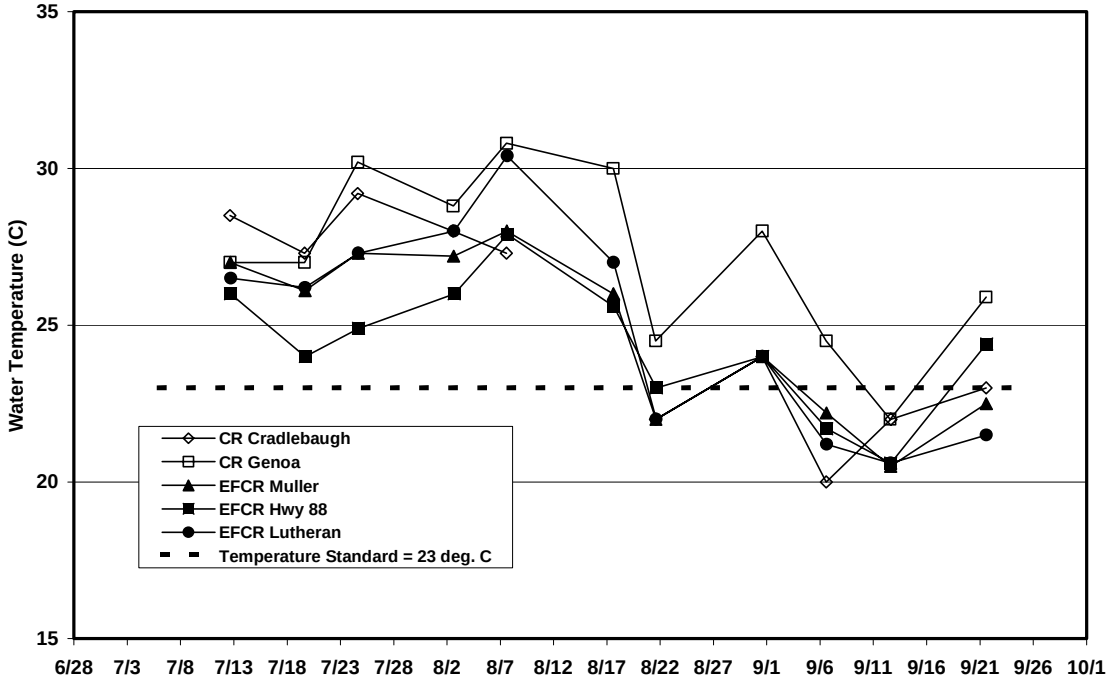
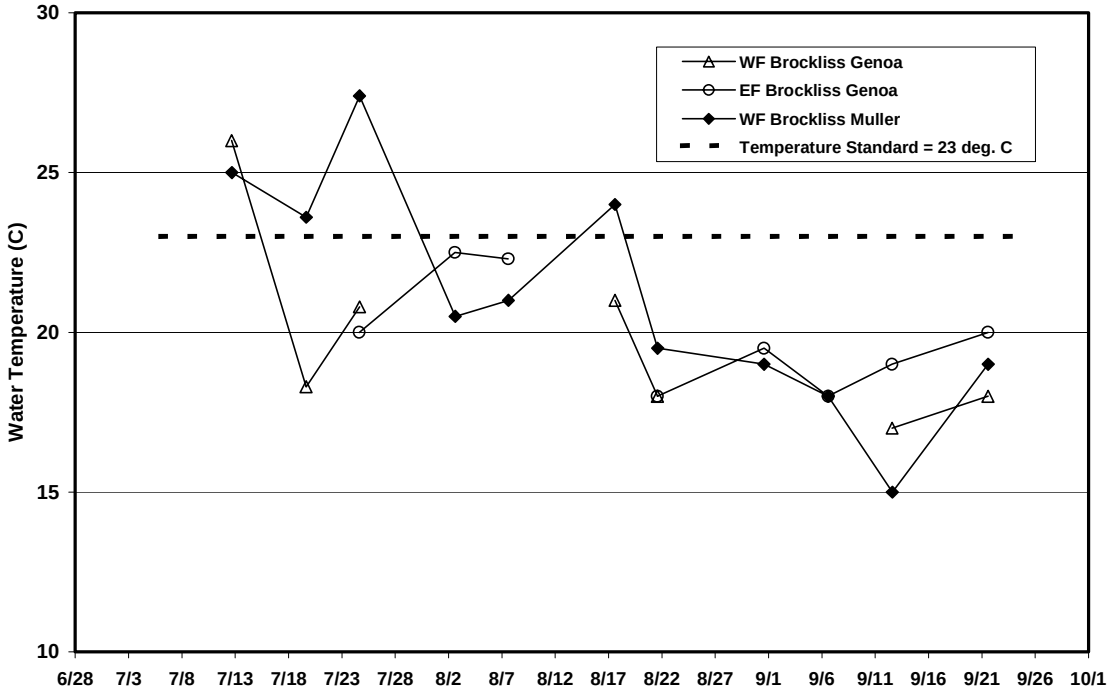


Figure 10. Afternoon Temperature at Spot Reading Sites - Brockliss Slough



Conclusions and Recommendations

The following conclusions and recommendations are offered:

- The data collected from July 6, 2001 through September 24, 2001 show that areas of the EF Carson and Carson River experienced DO and temperature problems during this period.
- Every grab sample showed TP standard (0.1 mg/l) exceedances but dissolved oxygen did not drop below 5 mg/l every week. Considering the N:P ratios, nitrogen was probably the limiting nutrient. The TN and nitrate standards were never exceeded during this project, but these standards were not set to control eutrophication.
- All DO and temperature data collected represent conditions only at the particular monitoring location. DO and temperature could be quite different upstream or downstream of these location, or even in different portions of the channel, or at different depths. While standards were frequently violated, the impacts to the aquatic life is unknown. Fish may seek out other riffle/pool areas of the river with higher DO and lower temperatures.
- Additional monitoring and research is needed to further quantify the occurrence of DO problems in the Carson River and evaluate the appropriateness of the TP standard (0.1 mg/l). Future Hydrolab installations should be located near the center of the flow and within different riffle and pool areas if possible.