Llano River Data Report

May 3, 2010

Prepared by:
Texas Stream Team
River Systems Institute
Texas State University – San Marcos

PREPARED IN COOPERATION WITH THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY AND U.S. ENVIRONMENTAL PROTECTION AGENCY

The preparation of this report was financed through grants from the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency

Introduction

The Llano River begins in central Kimble County, approximately 4 miles northwest of Junction, where the North and South Llano rivers meet and flows about 100 miles through Kimble, Mason, and Llano counties, draining about 4,466 mi^2 (11,568 km^2) of the Edwards Plateau before emptying into the Colorado River at Lake LBJ near Kingsland (see map below).[i,ii] The clay and sandy loams through which it flows support oak, juniper, pecan, mesquite, and a variety of grasses.[iii] The river has never stopped flowing due to the presence of several large springs, which contribute about 80% of the flow. After it flows into the Highland Lakes, it forms the primary water supply for the City of Austin and other downstream water users along the Colorado River.[iv] Land use includes agriculture, particularly livestock, pecan and hay production, recreation, natural gas production, and urban as it passes through Llano and Junction.[v] The Llano River Association and the South Llano River Watershed Alliance have formed to protect the quantity and quality of the river. Details can be found at http://llanoriverassociation.org/ or http://southllano.org/.

The Llano River has only been on the Texas 303(d) List of Impaired Water Bodies once in history. In 1996, the river was impaired for contact recreation because of bacteria. However, it was noted that there was limited data. The following data collected by volunteer water quality monitors between 1996 and 2008 show no occurrences when the water body exceeded standard established by the Texas Commission on Environmental Quality.

In alignment with Texas Stream Team's core mission, monitors attempt to collect data that can be used in decision-making processes, to promote a healthier and safer environment for people and aquatic inhabitants. While many assume it is the responsibility of Texas Stream Team to serve as the main advocate for volunteer monitor data use, it has become increasingly important for monitors to be accountable for their monitoring information and how it can be infused into the decision-making process, from "backyard" concerns to state or regional issues. To assist with this effort, Texas Stream Team coordinates with monitoring groups and government agencies to propagate numerous data use options.

Among these options, volunteer monitors can directly participate by communicating their data to various stakeholders. Some options include: participating in the Clean Rivers Program (CRP) Steering Committee Process; providing information during "public comment" periods; attending city council and advisory panel meetings; developing relations with local Texas Commission on Environmental Quality and river authority water specialists; and, if necessary, filing complaints with environmental agencies; contacting elected representatives and media; or starting organizing local efforts to address areas of concern.

The Texas Clean Rivers Act established a way for the citizens of Texas to participate in building the foundation for effective statewide watershed planning activities. Each CRP partner agency has established a steering committee to set priorities within its basin. These committees bring together the diverse interests in each basin and watershed. Steering committee participants include representatives from the public, government, industry, business, agriculture, and environmental groups. The steering committee is designed to allow local concerns to be addressed and regional solutions are recommended. For more information about participating in these steering committee meetings and to contribute your views about water quality, contact the appropriate CRP partner agency for your river basin at: http://www.tceq.state.tx.us/compliance/monitoring/crp/partners.html.

Currently, Texas Stream Team is working with various public and private organizations to facilitate data and information sharing. One component of this process includes interacting with watershed stakeholders at CRP steering committee meetings. A major function of these meetings is to discuss water quality issues and to obtain input from the general public. While participation in this process may not bring about instantaneous results, it is a great place to begin making institutional connections and to learn how to "work" the assessment and protection system that Texas agencies use to keep water resources healthy and sustainable.

In general, Texas Stream Team efforts to use volunteer data may include the following:

1. Assist monitors with data analysis and interpretation
2. Analyze watershed-level or site-by-site data for monitors and partners
3. Screen all data annually for values outside expected ranges
4. Network with monitors and pertinent agencies to communicate data
5. Attend meetings and conferences to communicate data
6. Participate in CRP stakeholder meetings
7. Provide a data viewing forum via the Texas Stream Team Data Viewer
8. Participate in professional coordinated monitoring processes to raise awareness of areas of concern

Information collected by Texas Stream Team volunteers utilizes a TCEQ and EPA approved quality assurance project plan (QAPP) to ensure data are correct and accurately reflects the environmental conditions being monitored. All data are screened for completeness, precision and accuracy where applicable, and scrutinized with data quality objective and data validation techniques. Sample results are intended to be used for education and research, baseline, local decision making, problem identification, and others uses deemed appropriate by the data user.

Water Quality Parameters

Water Temperature

Fish are cold-blooded and therefore depend on the temperature of water to be able to carry out processes such as metabolism and reproduction. Sources of warm water include powers plants' effluent after it has been used for cooling or hydroelectric plants which release warmer or cooler water (depending on the time of year) near the point of release. On a yearly scale, the amount of dissolved oxygen in the water decreases as temperatures increase, and vice versa, because warmer, less dense water can hold less oxygen molecules than cooler, more dense water. However, on a daily scale, the amount of dissolved oxygen in the water increases as temperatures increase, and vice versa, because of photosynthesis adding oxygen to the water body. Water temperature variations are most detrimental when they occur rapidly, leaving the biotic community no time to adjust. However, volunteer monitoring occurs at a particular time, so these variations are not covered in this report.

Dissolved Oxygen

Oxygen is necessary for the survival of most organisms. Too little oxygen will lead to asphyxiation of aquatic organisms. Too much oxygen (supersaturation) can cause bubbles to develop in cardiovascular systems, which could be fatal. Dissolved oxygen (DO) levels below 2 milligrams per liter (mg/L) can lead to asphyxiation, and levels above 20 mg/L can lead to supersaturation. The most suitable aquatic environment exhibits levels above 5 mg/L. High concentrations of nutrients can lead to excessive surface vegetation growth, which may starve subsurface vegetation of sunlight, and therefore limit the amount of dissolved oxygen in a water body due to limited photosynthesis. This process is enhanced when the subsurface vegetation dies and consumes oxygen when decomposing. Low dissolved oxygen levels may also result from high groundwater inflows as groundwater is typically low in dissolved oxygen due to minimal aeration or high temperatures which reduce oxygen solubility. Supersaturation typically only occurs underneath waterfalls or dams with water flowing over the top.

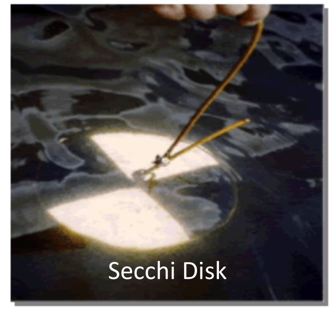
Specific Conductivity

Specific conductivity is a measure of the ability of a body of water to conduct electricity. It is measured in microSiemens per centimeter (µS/cm). A body of water is more conductive if it has more dissolved materials such as nutrients and salts, which indicate poor water quality if they are abundant. Nitrates and phosphates are specific nutrients for which tests are sometimes conducted. High concentrations of nutrients lower dissolved oxygen, the process of which was described in the previous section. High concentrations of salt can inhibit water absorption and limit root growth for vegetation, lead to an abundance of more drought tolerant plants, and cause dehydration of fish and amphibians. Sources of total dissolved solids (TDS) can include agricultural runoff, domestic runoff, or discharges from wastewater treatment plants.

pH

pH is a measure of acidity or alkalinity. The scale measures the concentration of hydrogen ions on a range of 0 to 14 and is reported in standard units (su). The range is logarithmic. Therefore, every 1 unit change means the acidity increased or decreased 10-fold. Sources of low pH (acidic) can include acid rain and runoff from acid-laden soils. Acid rain is mostly caused by coal power plants with minimal contributions from the burning of other fossil fuels and other processes such as volcanic emissions. Soil-acidity can be caused by excessive rainfall leaching alkaline materials out of soils, acidic parent material, crop decomposition creating hydrogen ions, or high-yielding fields which have drained the soil of all alkalinity. Sources of high pH (alkaline) include geologic composition as in the case of limestone increasing alkalinity and the dissolving of carbon dioxide in water. Carbon dioxide is water soluble, and as it dissolves it forms carbonic acid, an alkaline molecule. The most suitable range for healthy organisms is 6.5-9.

Secchi Depth and Total Depth



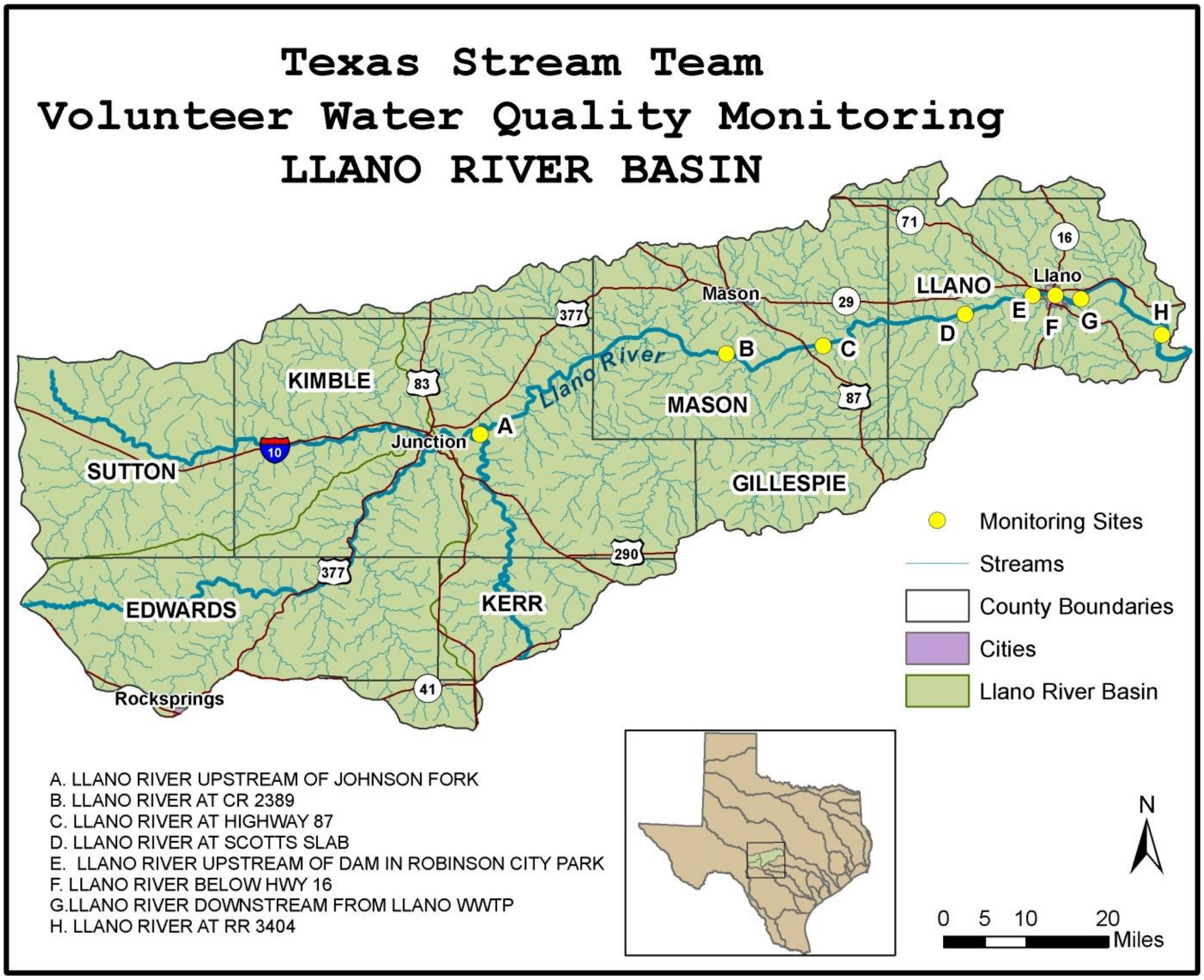
The Secchi Disk is used to determine the clarity of the water, a condition known as turbidity. The disk shown on the right is lowered into the water until it is no longer visible, and the depth is recorded. Highly turbid waters pose a risk to wildlife by clogging the gills of fish, reducing visibility, and carrying contaminants. Reduced visibility can harm predatory fish or birds that depend on good visibility to find their prey. Turbid waters allow very little light to penetrate deep into the water, which in turn decreases the density of phytoplankton, algae, and other aquatic plants. This reduces the dissolved oxygen in the water due to reduced photosynthesis. Contaminants are most commonly transported in sediment rather than in the water. Turbid waters can results from sediment washing away from construction sites, erosion of farms, or mining operations. Average Secchi Depth readings below Total Depth readings indicate highly turbid water. Readings that are equal to total depth indicate clear water. Low total depth observations have a potential to concentrate contaminants.

Data Analysis

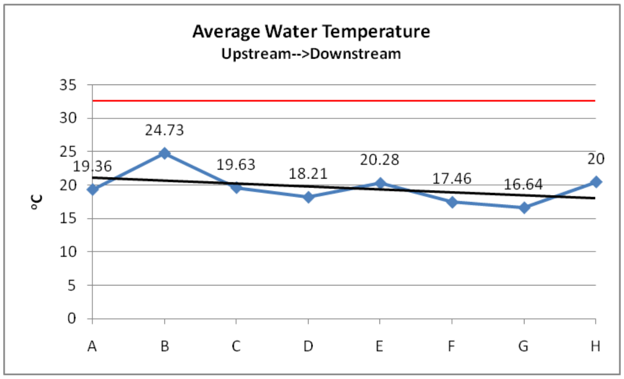
Texas Stream Team volunteer water quality monitor data indicates that the Llano River is a suitable ecosystem for aquatic life. Only 1 out of the 102 dissolved oxygen observations fell below the TCEQ standard for exceptional aquatic life use. All other parameters stayed within healthy limits. No data was collected for E. *coli* bacteria, so no conclusions can be drawn about how suitable it is for contact recreation.

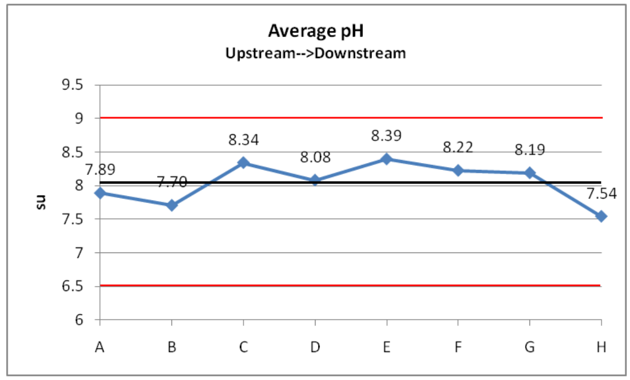
The standards shown in the tables and the red lines shown on the graphs are the standards according to the Texas Commission on Environmental Quality 2000 Texas Water Quality Standards for the watersheds which the sites fall within. At least ten samples from the last seven years with approximately the same interval between sampling events are required for a data set to be considered adequate. 10% of these samples must then exceed the standard for the water body to be considered impaired.[vi] The water temperature standard is a maximum amount. The conductivity standard is a maximum average amount. The dissolved oxygen standard is a minimum amount, and the pH standards are a range. It is important to note that the amount of exceedance is only for reference. Regulatory action by the TCEQ is based on more/different data than that of the Texas Stream Team.

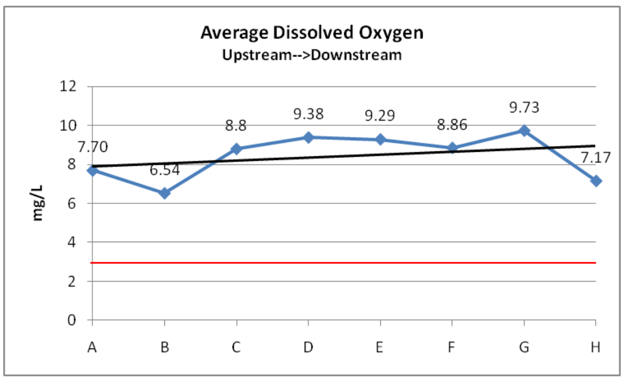
Llano River Summary Statistics (1996-2008)						
Parameter	**Range**	**Mean**	**Std. Dev.**	**Standard**	**% Exceedance**	**# Exceedance**
Water Temperature ($^{o}C/^{o}F$)	6-33/43-91	19.54	6.4	33 (max.)	0	0/134
Dissolved Oxygen (mg/L)	3.3-11.9	8.12	1.83	3 (min.)	0	0/102
pH (su)	7-9.5	8	0.46	6.5-9	0	0/142
Conductivity (µS/cm)	118-510	390.7	59.81	538.46 (max.)	0	0/115
Nitrate (mg/L)	0.25-1	0.48	0.61	1.95 (max.)	0	0/81
Orthophosphorus (mg/L)	0.085	0.085	0	0.37 (max.)	0	0/10

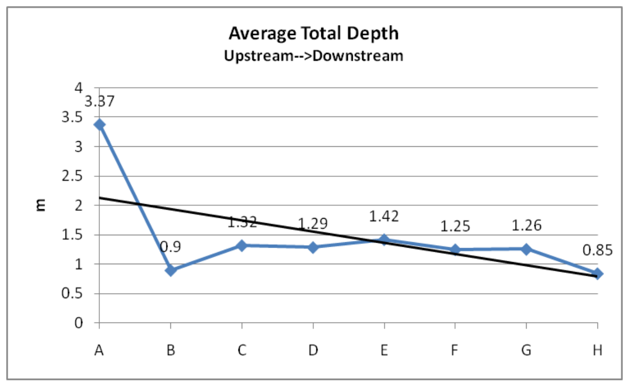

Texas Stream Team
Volunteer Water Quality Monitoring
LLANO RIVER BASIN
SUTTON
KIMBLE
EDWARDS
KERR
MASON
GILLESPIE
LLANO
Junction
Mason
Llano
Rockssprings
Llano River
10
83
377
290
41
87
29
71
16
A
B
C
D
E
F
G
H
Monitoring Sites
Streams
County Boundaries
Cities
Llano River Basin
A. LLANO RIVER UPSTREAM OF JOHNSON FORK
B. LLANO RIVER AT CR 2389
C. LLANO RIVER AT HIGHWAY 87
D. LLANO RIVER AT SCOTTS SLAB
E. LLANO RIVER UPSTREAM OF DAM IN ROBINSON CITY PARK
F. LLANO RIVER BELOW HWY 16
G.LLANO RIVER DOWNSTREAM FROM LLANO WWTP
H. LLANO RIVER AT RR 3404
N
0 5 10 20
Miles

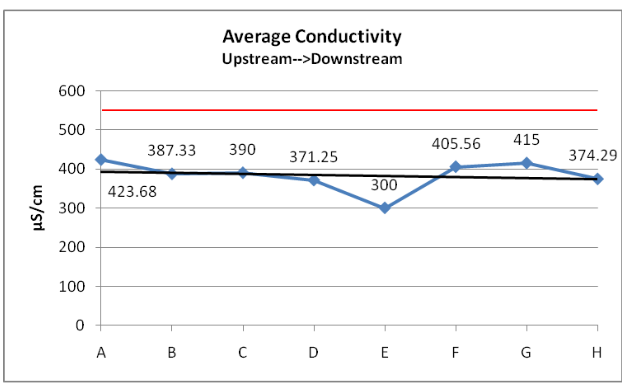
It can clearly be seen on these graphs displaying the upstream to downstream trends that all parameters except total depth do not vary much from upstream to downstream. The stream becomes shallower, but this does not appear to be affecting other conditions.

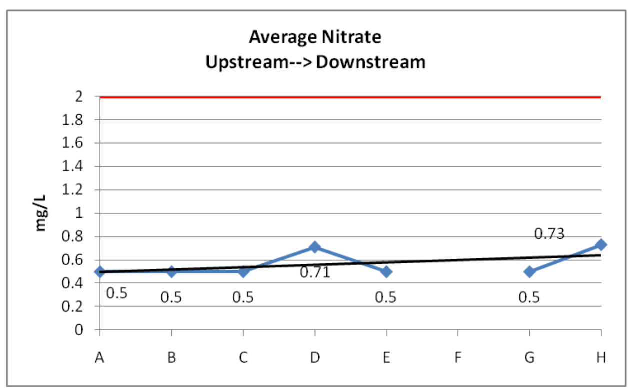




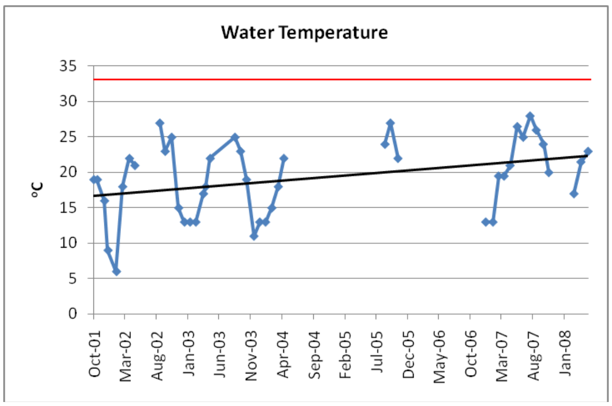


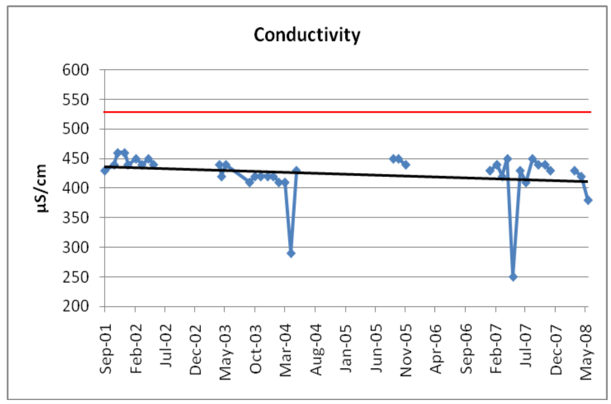


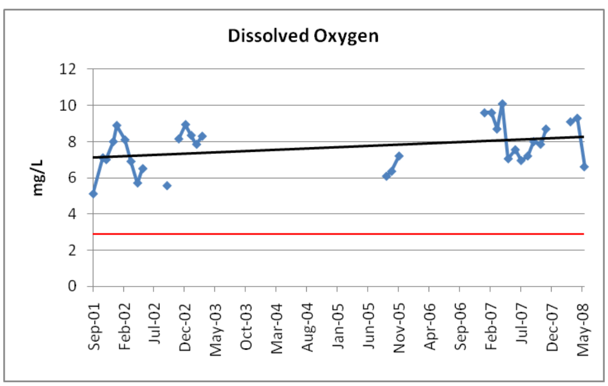


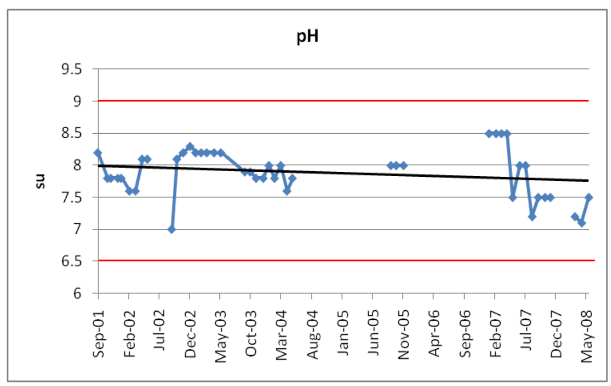


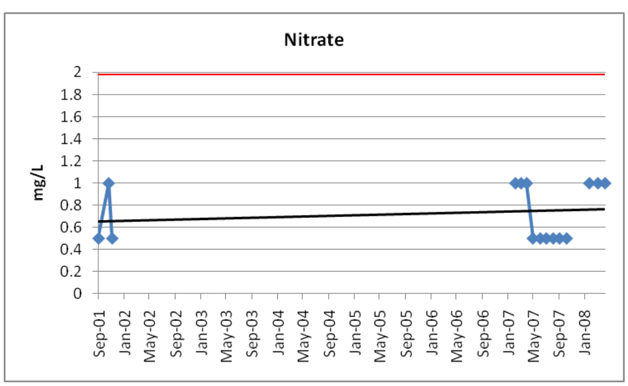
Llano River Upstream Of Johnson Fork						
Parameter	**#**	**% Complete**	**Min.**	**Mean.**	**Max.**	**Std. Dev.**
Sample Time	47	98	8:30	11:05	16:30	2:46
Total Depth (m)	36	75	1	3.32	8	1.57
Secchi Depth (m)	9	19	0.1	1.18	2	0.63
Water Temperature (^{o}C)	48	100	6	19	28	5.25
Specific Conductivity (μS/cm)	41	85	250	425.12	460	39.38
Dissolved Oxygen (mg/L)	35	73	5.1	7.59	10.1	1.29
pH (su)	47	98	7	9.38	78	10.23
Nitrate (mg/L)	15	31.25	0.5	0.73	1	0.26





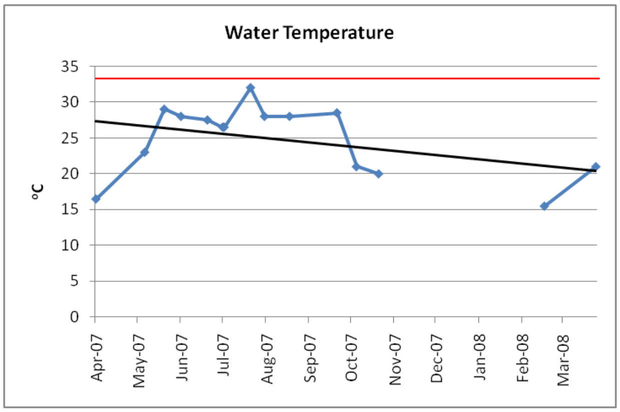


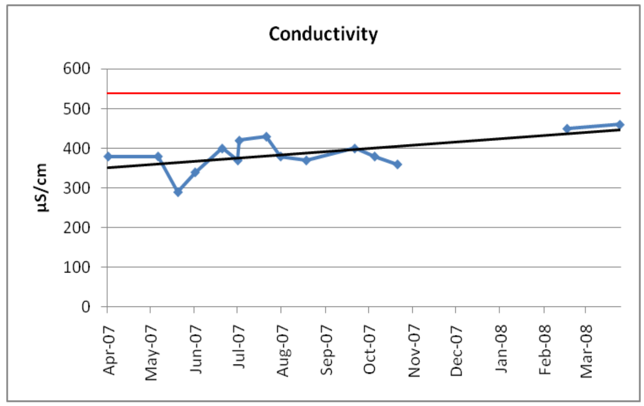


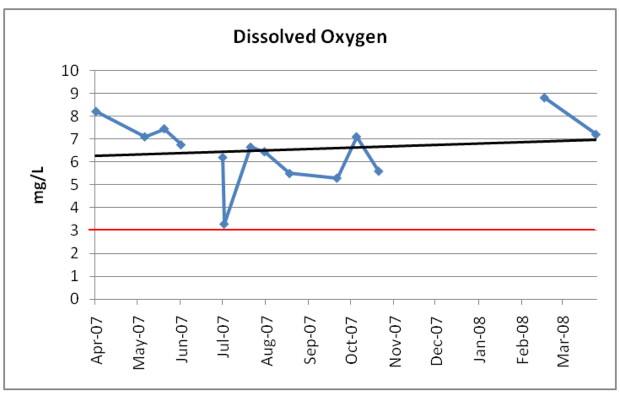


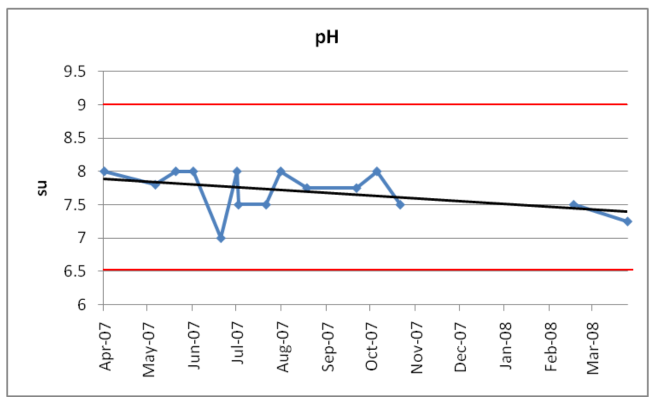
Data collected by: Bud Haasch and Jason May with the Lower Colorado River Authority

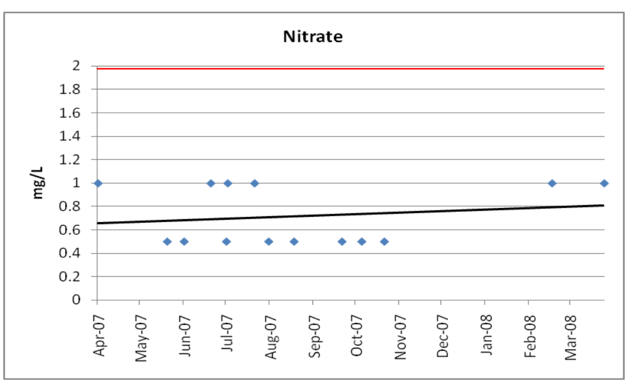
Llano River At CR 2389						
Parameter	#	% Complete	Min.	Mean.	Max.	Std. Dev.
Sample Time	15	100	8:15	12:29	16:30	2:32
Total Depth (m)	15	100	0.5	0.90	2.25	0.58
Secchi Depth (m)	6	40	1	1.18	1.8	0.32
Water Temperature (^{o}C)	15	100	15.5	25	32	4.91
Specific Conductivity (µS/cm)	15	100	290	387.33	460	42.84
Dissolved Oxygen (mg/L)	14	93	3.3	6.54	8.8	1.36
pH (su)	15	100	7	7.7	8	0.32
Nitrate (mg/L)	14	93	0.5	0.71	1	0.26





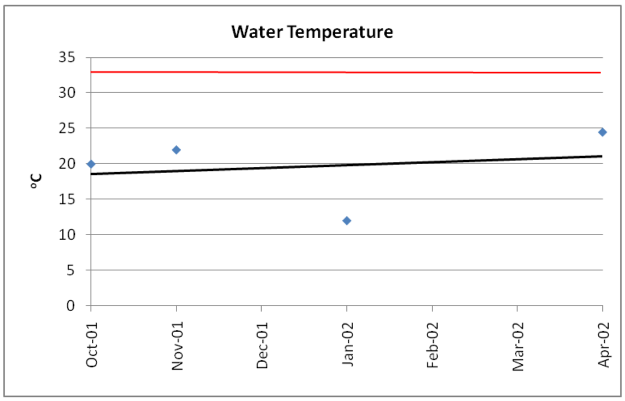


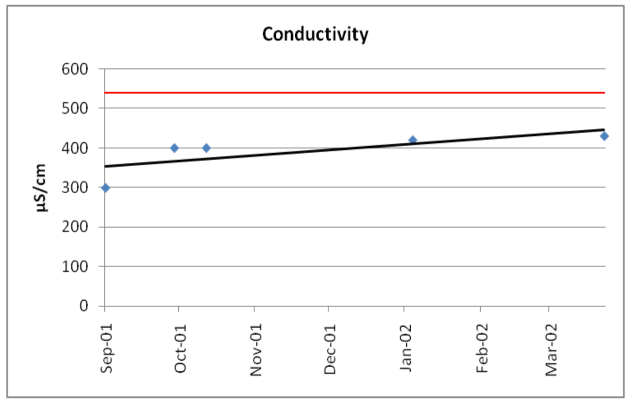


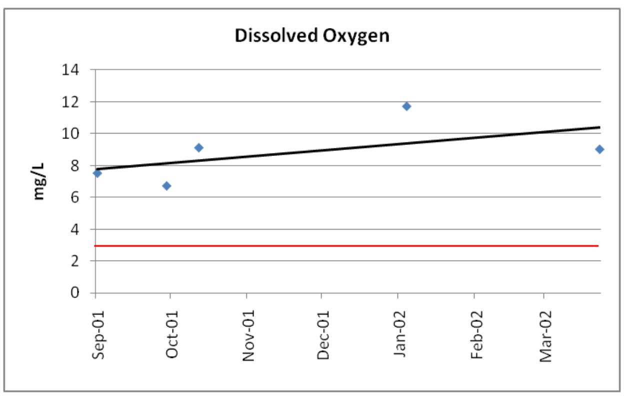


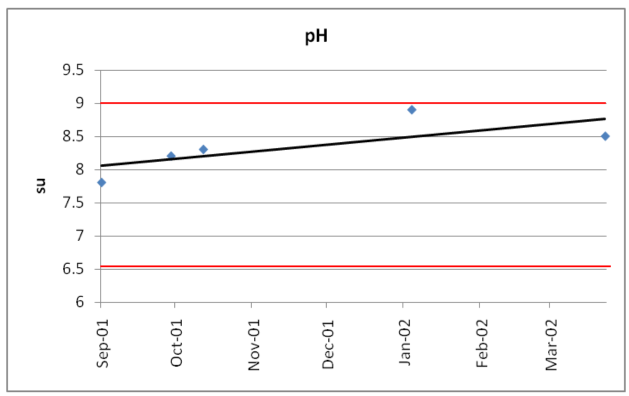
Data collected by: Cliff Stripling and Keith Kaan with the Lower Colorado River Authority

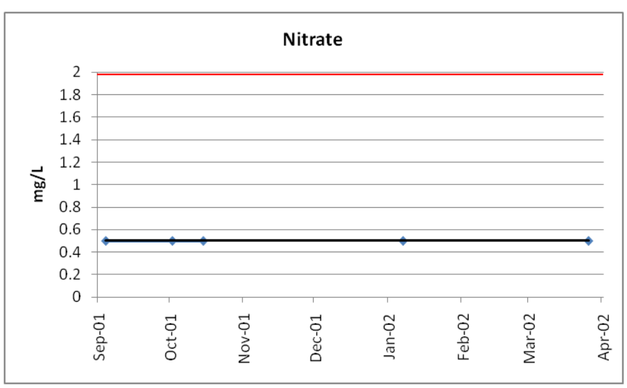
Llano River At Hwy 87						
Parameter	#	% Complete	Min.	Mean.	Max.	Std. Dev.
Sample Time	8	100	9:00	11:57	18:00	3:42
Total Depth (m)	8	100	1	1.36	1.7	0.23
Secchi Depth (m)	0	0				
Water Temperature (^oC)	6	75	12	20	24.5	4.29
Specific Conductivity (µS/cm)	8	100	300	381.25	430	51.39
Dissolved Oxygen (mg/L)	8	100	6.7	8.4125	11.7	1.67
pH (su)	8	100	7.8	8.25	8.9	0.36
Nitrate (mg/L)	5	62.5	0.5	0.5	0.5	0





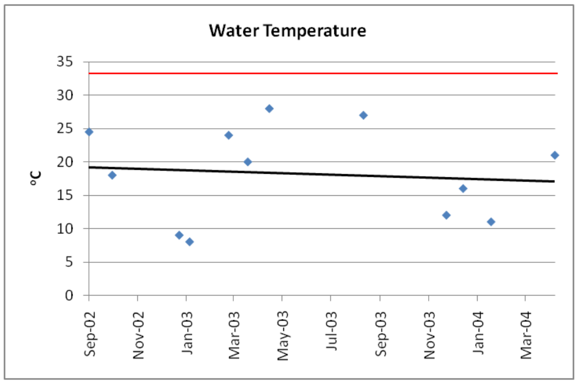


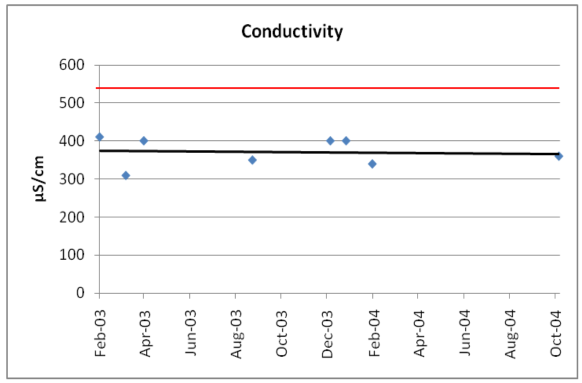


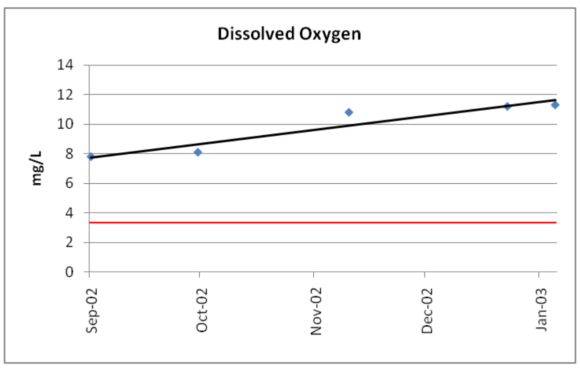


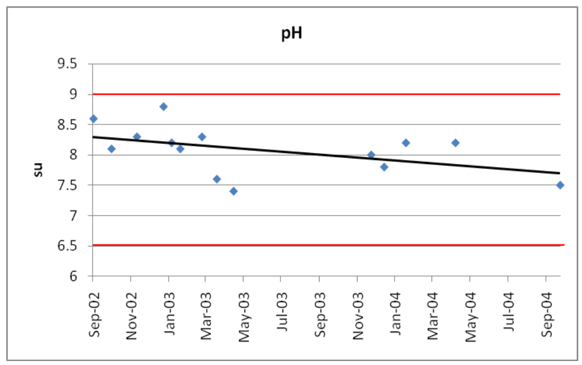
Data collected by : Unknown

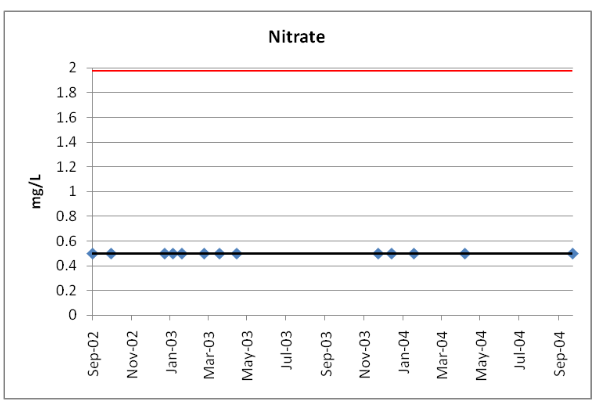
Llano River At Scotts Slab						
Parameter	#	% Complete	Min.	Mean.	Max.	Std. Dev.
Sample Time	14	93	12:50	16:24	19:00	1:58
Total Depth (m)	15	100	0.3	1.29	3.5	0.71
Secchi Depth (m)	0	0				
Water Temperature (°C)	12	80	8	18	28	7.02
Specific Conductivity (µS/cm)	8	53	310	371.25	410	36.43
Dissolved Oxygen (mg/L)	6	40	7.1	9.38	11.3	1.92
pH (su)	14	93	7.4	8.08	8.8	0.40
Nitrate (mg/L)	13	87	0.5	0.5	0.5	0





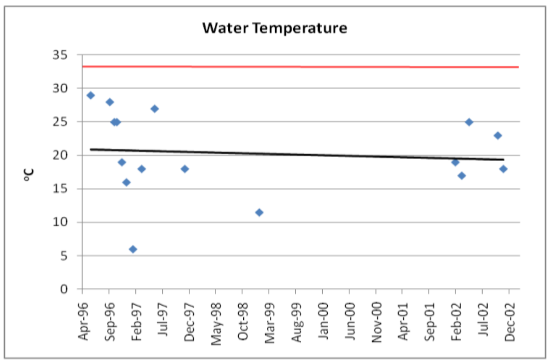


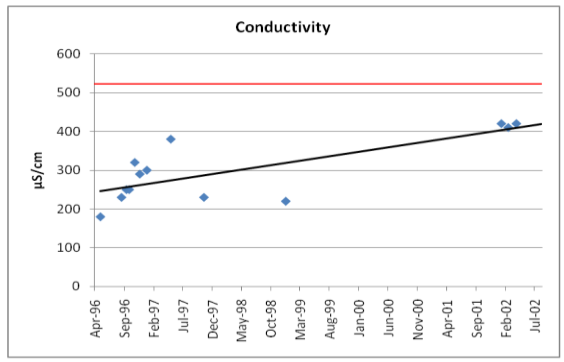


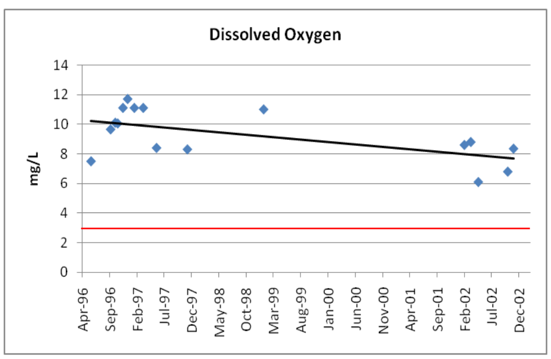


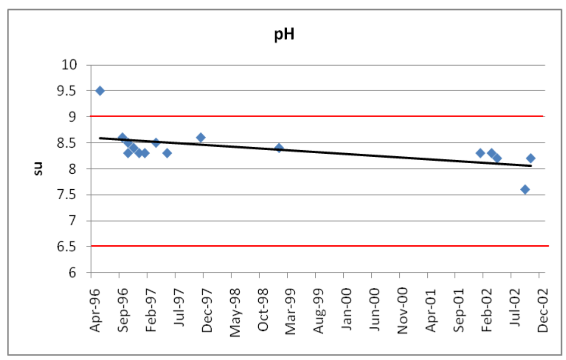
Data collected by: Thomas Pinckney and Dan Cone with the Lower Colorado River Authority

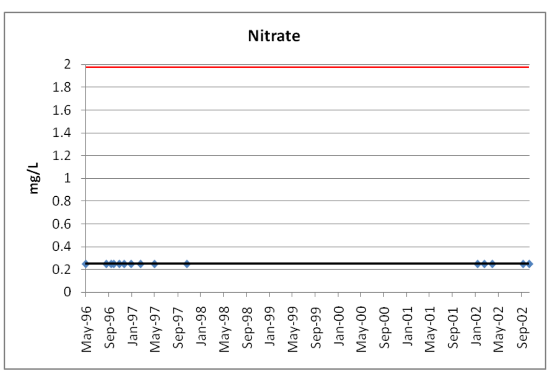
Llano River 3.2 km West Of Llano Upstream Of Dam In Robinson City Park						
Parameter	**#**	**% Complete**	**Min.**	**Mean.**	**Max.**	**Std. Dev.**
Sample Time	16	100	4:00	11:48	15:00	3:31
Total Depth (m)	14	88	0.3	1.42	4	1.57
Secchi Depth (m)	1	6	1	1	1	N/A
Water Temperature (°C)	16	100	6	20	29	6.24
Specific Conductivity (µS/cm)	13	81	180	300	420	83.37
Dissolved Oxygen (mg/L)	16	100	6.1	9.29	11.7	1.69
pH (su)	16	100	7.6	8.39	9.5	0.37
Nitrate	15	94	0.5	0.5	0.5	0
Orthophosphate	10	62.5	0.885	0.885	0.885	0

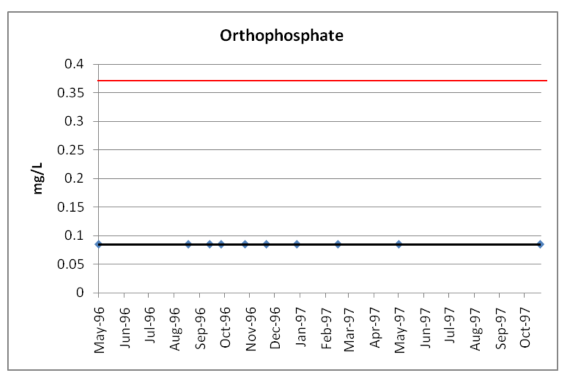






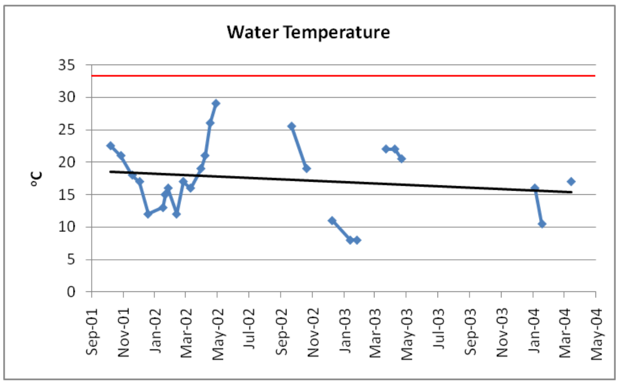


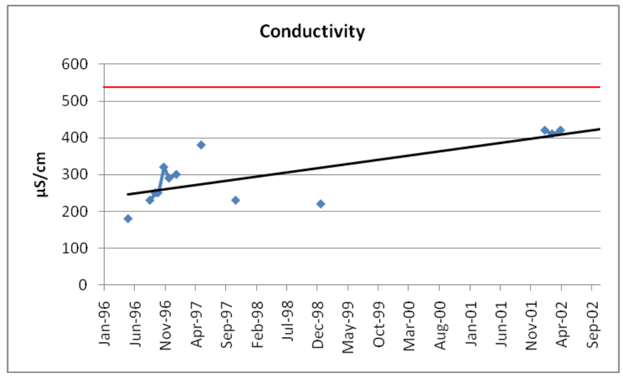


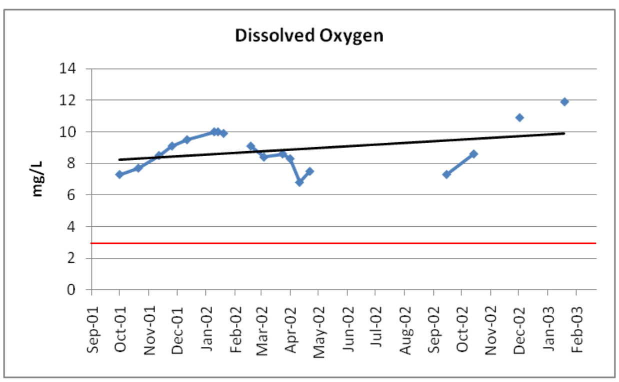


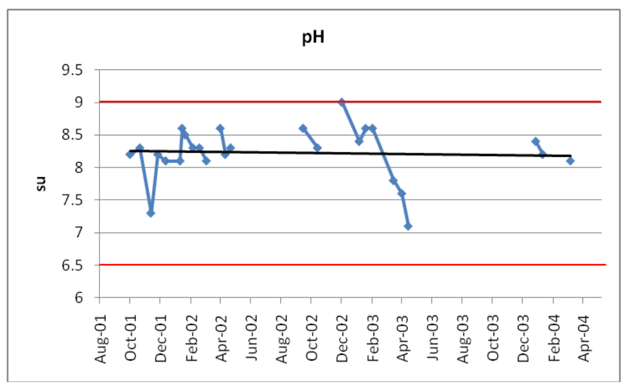
Data collected by: Thomas Pinckney and Dan Cone with the Lower Colorado River Authority

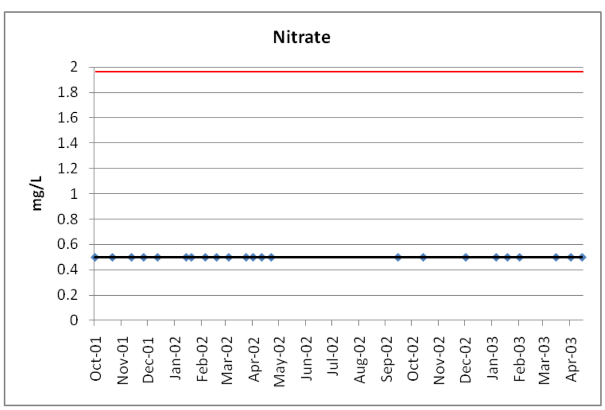
Llano River Below Hwy 16						
Parameter	#	% Complete	Min.	Mean.	Max.	Std. Dev.
Sample Time	26	96	11:00	15:58	18:55	1:40
Total Depth (m)	26	96	0.3	1.26	2	0.35
Secchi Depth (m)	0	0				
Water Temperature (°C)	26	96	8	18	29	5.35
Specific Conductivity (µS/cm)	18	67	340	400.5	510	40.45
Dissolved Oxygen (mg/L)	18	67	6.8	8.72	11.9	1.34
pH (su)	26	96	7.1	8.23	9	0.4
Nitrate	26	96	0.5	0.5	0.5	0





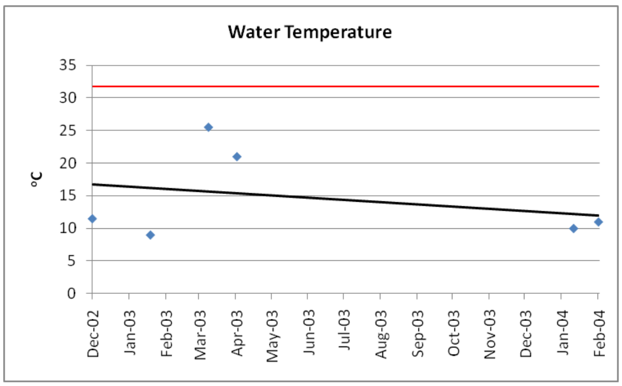


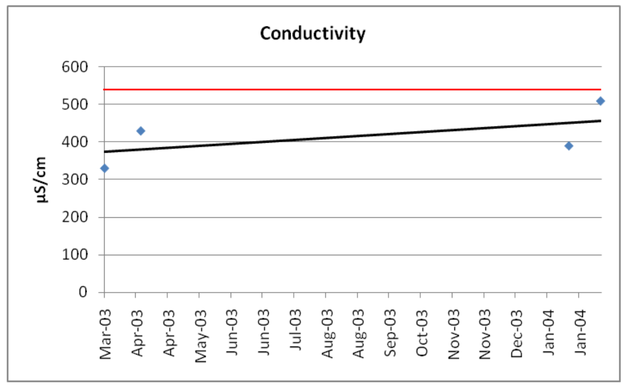


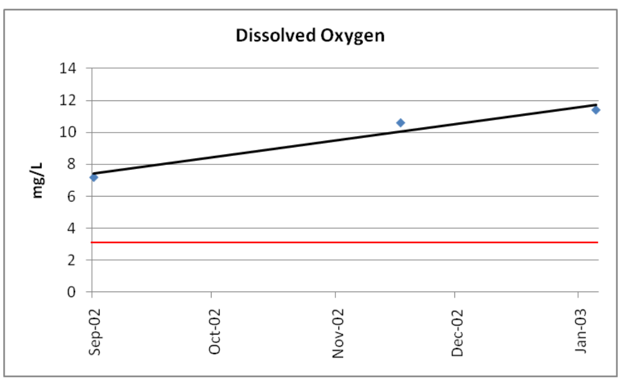


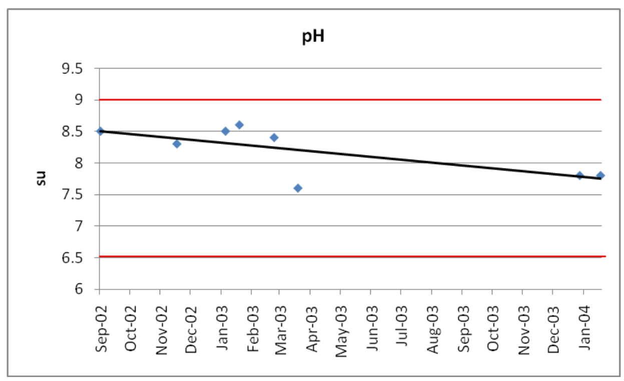
Data collected by: Steven Hubbell and Donna Thomas with the Lower Colorado River Authority

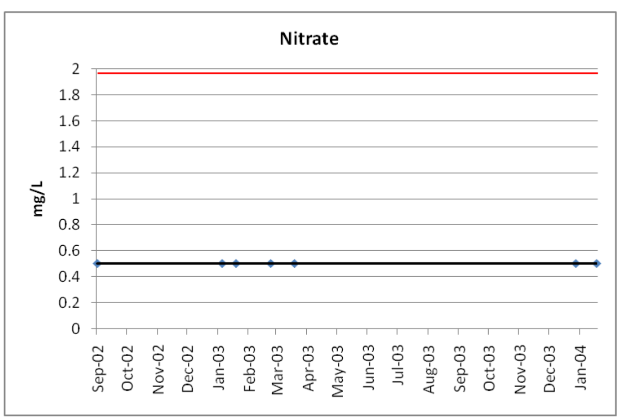
Llano River 3.2 km Downstream From Llano WWTP						
Parameter	**#**	**% Complete**	**Min.**	**Mean.**	**Max.**	**Std. Dev.**
Sample Time	8	100	13:37	16:38	19:50	1:57
Total Depth (m)	7	88	1	1.26	1.75	0.25
Secchi Depth (m)	0	0				
Water Temperature (^oC)	7	88	9	17	28.5	8.15
Specific Conductivity (µS/cm)	4	50	330	415	510	75.50
Dissolved Oxygen (mg/L)	3	38	7.2	9.73	11.4	2.23
pH (su)	8	100	7.6	8.19	8.6	0.39
Nitrate	7	88	0.5	0.5	0.5	0





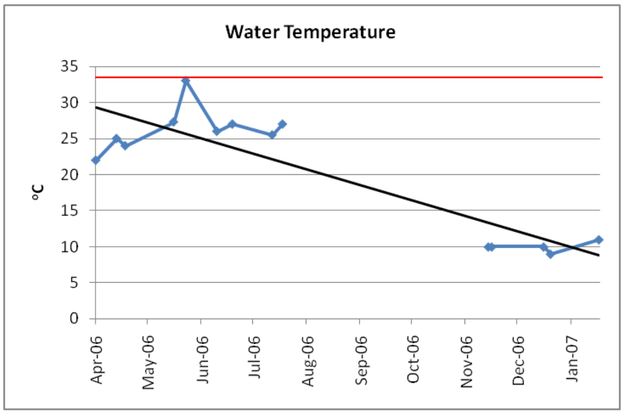


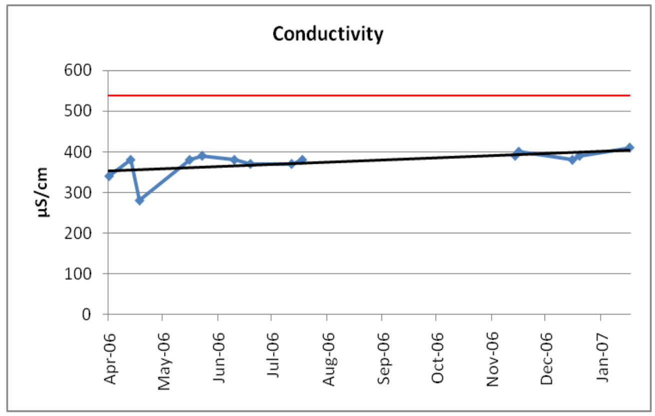


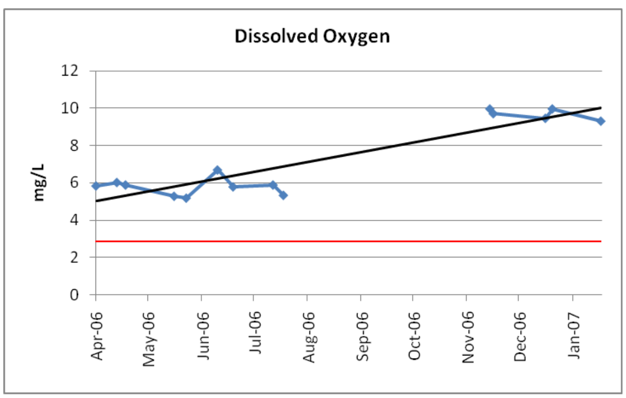


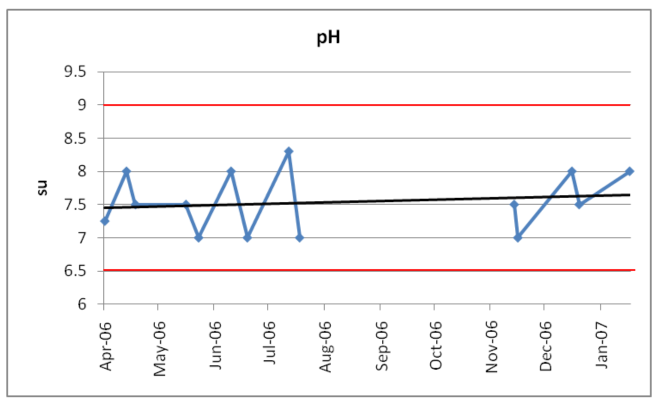
Data collected by: Thomas Pinckney and Dan Cone with the Lower Colorado River Authority

Llano River At RR 3404						
Parameter	#	% Complete	Min.	Mean.	Max.	Std. Dev.
Sample Time	15	100	7:30	9:37	13:25	1:40
Total Depth (m)	15	100	0.5	0.83	1.33	0.25
Secchi Depth (m)	2	13	0.9	1.25	1.6	0.49
Water Temperature (°C)	15	100	9	21	33	8.16
Specific Conductivity (µS/cm)	15	100	280	372	410	31.89
Dissolved Oxygen (mg/L)	15	100	5.2	7.08	9.95	1.94
pH (su)	15	100	7	7.52	8.3	0.45









Data collected by: Elisabeth Welsh with the Colorado River Foundation, Judy McCoy with the Lower Colorado River Authority, Leo Slaton, David Ferry, and Linda Lowenthal

[i] Llano River Association, *The Llano River,* n.d., available from http://llanoriverassociation.org/the-llano-river/; accessed 15 April 2010.

[ii] Heitmuller, Franklin T., *Lithologic And Hydrologic Controls Of Downstream Sedimentary Characteristics In The Llano River Watershed, Central Texas*, USA, 16 March 2010, available from http://gsa.confex.com/gsa/2010NE/finalprogram/abstract_169152.htm; accessed 15 April 2010.

[iii] Texas State Historical Association, *The Llano River,* 22 February 2010, available from http://www.tshaonline.org/handbook/online/articles/LL/rnl11.html; accessed 15 April 2010.

[iv] Broad, Tyson, *Land of the Living Waters: A Characterization of South Llano River, Its Springs, and Its Watershed,* 2008, available from http://llanoriverassociation.org/downloads/South_Llano_River_Report.pdf; accessed 15 April 2010.

[v] Heitmuller, Franklin T., *Lithologic And Hydrologic Controls Of Downstream Sedimentary Characteristics In The Llano River Watershed, Central Texas*, USA, 16 March 2010, available from http://gsa.confex.com/gsa/2010NE/finalprogram/abstract_169152.htm; accessed 15 April 2010.

[vi] Texas Commission on Environmental Quality, *2008 Guidance for Assessing and Reporting Surface Water Quality in Texas*, 19 March 2009, available from http://www.tceq.state.tx.us/assets/public/compliance/monops/water/08twqi/2008_guidance.pdf; accessed 30 March 2010.