Cowleech Fork Special Study – Subwatershed 7.07

Sabine River Authority of Texas

August 31, 1999

Prepared in Cooperation with the Texas Natural Resource Conservation Commission

Under the Authorization of the Texas Clean Rivers Act.

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Introduction

Subwatershed 7.07 includes the Cowleech Fork of the Sabine River and covers 177 square miles in the upper Sabine Basin. The waterbody is not designated as a segment in the Texas Surface Water Quality Standards (TSWQS) and the general standards for surface water are applicable. Cowleech Fork is one of seven subwatersheds in the Lake Tawakoni watershed and represents 23% of the 756 square-mile total drainage area of the reservoir. Lake Tawakoni is listed as Segment 0507 in the TSWQS. Cowleech Fork is intermittent from its origin at the Sabine Basin Divide, north of Celeste, downstream to the confluence of Long Branch, receiving stream for the City of Greenville wastewater treatment plant in south Greenville. Due to effluent from the city, Cowleech Fork is perennial downstream of Long Branch. During high stream flow, Greenville may divert water from Cowleech Fork into city lakes near the northern city limits.

The 1996 Sabine River Authority Assessment of Water Quality identified the Cowleech Fork Subwatershed as an area of concern due to poor water quality. Water quality concerns and possible concerns in this subwatershed include dissolved oxygen, chlorides, sulfates, total dissolved solids, nutrients, fecal coliform and ambient toxicity. Preliminary results indicate the cause of toxicity to be organic chemicals (possibly pesticides).

Background

Subwatershed 7.07 contains the City of Greenville, Celeste, and agricultural land, which presently is used for cropland, livestock grazing or hay meadows but historically has been farmed more extensively with row crops including cotton, corn, wheat and sorghum. The Subwatershed has approximately 25,000 people with about 11,000 housing units. The City of Greenville utilizes surface water in this subwatershed for drinking water supply. There are three domestic discharges and one industrial discharge. The area also has three landfills.
In addition to water quality concerns and possible concerns for routine water quality parameters, ambient toxicity was detected at two sites. Ambient toxicity was observed at one site upstream of the city of Greenville and another site downstream of Greenville showed lethality in seven out of sixteen tests conducted in 1996. Additional ambient toxicity testing at a new site, added farther upstream of Greenville in 1997, had lethality to the test organisms three out of seven times.

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Due to the extensive use of Lake Tawakoni for recreation and as a water supply reservoir, a special study was initiated in the spring of 1998 in the Cowleech Fork Subwatershed to identify the sources of water quality impairments. Since 1998 was an unusually dry year, the study was extended into 1999. The lethal and sublethal results seen in the ambient toxicity tests were the primary concern of the study. Sampling was conducted to substantiate non-compliance with Texas Surface Water Quality Standards for oxygen, chlorides, sulfates, and total dissolved solids. Additional water quality parameters typically collected by SRA included fecal coliform bacteria, nutrients, total organic carbon, pH, conductivity, temperature, rainfall, and weather conditions. Atrazine has been detected in low levels in drinking water supplies using Lake Tawakoni as their raw water source, prompting the TNRCC to place Lake Tawakoni on the State of Texas 1998 Clean Water Act 303(d) List. Lake Tawakoni still meets all designated uses and is listed as "threatened-medium" because the low levels detected in finished water are well below maximum contaminant levels for drinking water. Atrazine screening was included in the present study to gather some data on levels of atrazine entering Lake Tawakoni during rainfall events.

Study Design

Quarterly sampling included dissolved oxygen, chlorides, sulfates, total dissolved solids, nutrients, fecal coliform bacteria, total organic carbon, pH, conductivity, temperature, and stream flow. A sample for ambient toxicity was collected at nine locations on Cowleech Fork and selected tributary streams in an effort to clarify the source and identity of toxicity seen in previous samples.

In addition to regular quarterly sampling, two sampling events were timed to collect samples within 12 hours of a rainfall with significant runoff. Samples from each site were submitted for a priority pollutant scan in an effort to identify the toxic element indicated by biomonitoring. This sample was collected after a significant rainfall runoff event since prior sampling indicated toxicity was more likely after rainfall.

An assessment of the fish and benthic communities was conducted at each site. Data from RBA's performed previously in the Cowleech Fork watershed has been incorporated in this report.

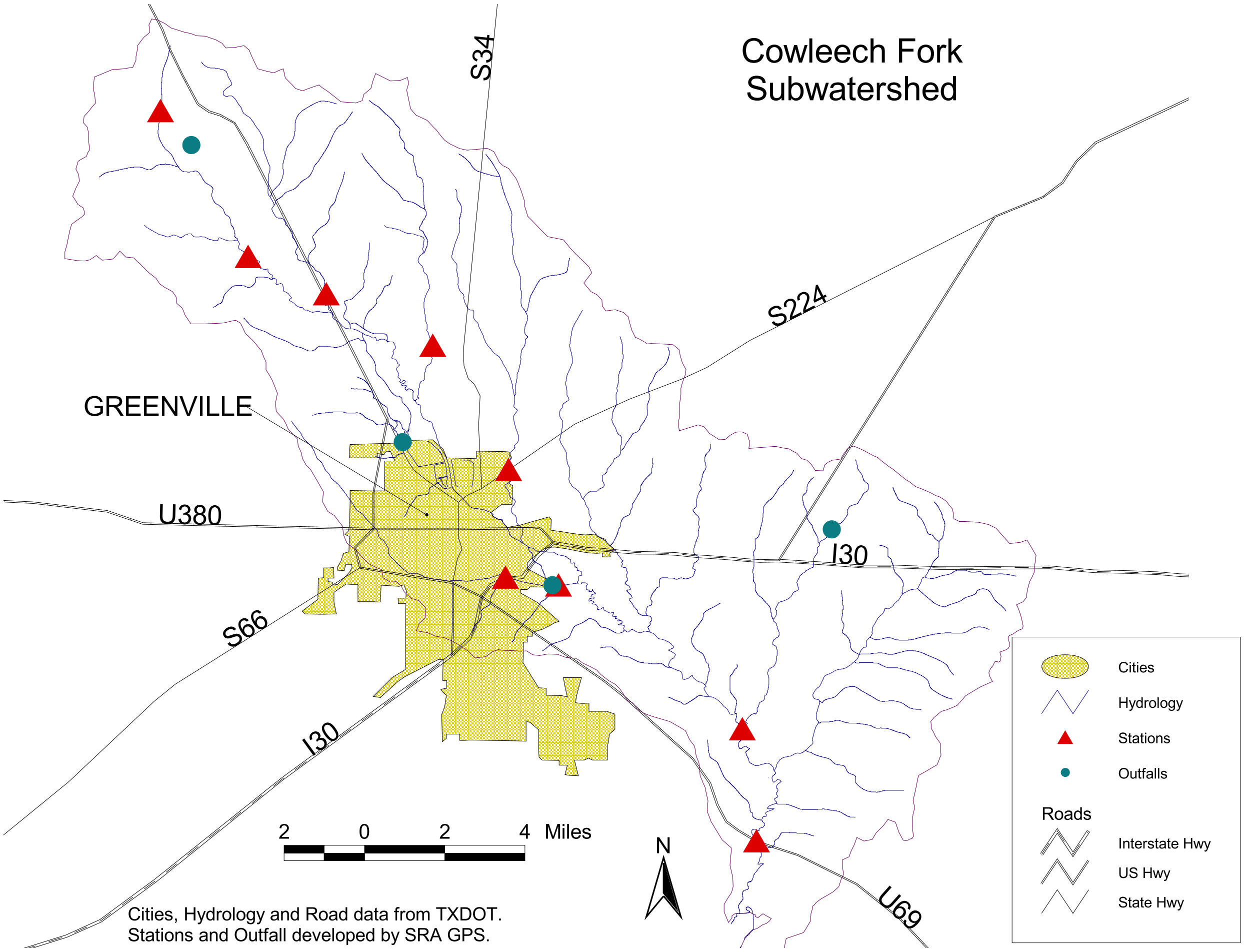
Cowleech Fork Sampling Sites

These sites have been chosen to give areal coverage and to provide more information as to the source of toxicity and non-compliance with stream standards seen in previous sampling efforts.

SRA ID	Description	TNRCC #	Parameter Set
CLF1562	Cowleech Fork at FM1562	15989	Q, RF, AT, RBA
CLF1083	Cowleech Fork at CR1083	15661	Q, RF, AT, RBA
HK1035	Hickory Creek at CR1035	15992	Q, RF, AT, RBA
TD1001	Tidwell Creek at CR1001	15991	Q, RF, AT, RBA
HRC224	Horse Creek at SH224	15990	Q, RF, AT, RBA
LB2	Long Branch upstream of Greenville effluent	15993	Q, RF, AT, RBA
LB1	Long Branch downstream of Greenville effluent	15983	Q, RF, AT, RBA
LT25	Cowleech Fork at CR 3128 (Dixon Co. Rd.)	10344	Q, RF, AT, RBA
LT24	Cowleech Fork Sabine River at US69 NW of Lone Oak	10343	Q, RF, AT

Parameter Set Codes: Q = Quarterly, RF = Rainfall Event Sampling, AT = Ambient Toxicity, RBA = Rapid Biological Assessment

Figure 1. Sample Locations in the Cowleech Fork Subwatershed



<u>Cowleech Fork at FM1562</u>: This site is about two miles downstream from the Sabine Basin Divide and is upstream of Celeste and any other known impacts other than agricultural.

<u>Cowleech Fork at CR1083</u>: This site was used to assess water quality upstream of Greenville but downstream of the City of Celeste. This watershed contains the Celeste wastewater outfall, an abandoned railroad, and an abandoned landfill.

<u>Hickory Creek at CR1035</u>: The Hickory Creek site was used as a comparison for the site on Cowleech Fork at CR1083. The watersheds above these two sites are similar. There is one landfill, an abandoned railroad and a small portion of runoff from the City of Celeste in this watershed.

<u>Tidwell Creek at CR1001</u>: This site was chosen to identify the areal extent of water quality impairment in the watershed.

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Horse Creek at SH224: This site was chosen to identify the areal extent of toxicity in the watershed. The watershed is very rural and impairment is expected to exist here if the source of impairment on Cowleech Fork is agricultural.

Long Branch at IH30 access road upstream of WWTP (LB2): This site receives runoff from the western portion of Greenville but is upstream of the wastewater treatment plant outfall and was selected to assess potential urban non-point impacts.

Long Branch 100m downstream of Greenville WWTP (LB1): This site receives runoff from the western portion of Greenville as well as the city's wastewater treatment plant and was selected to assess potential point and non-point impacts.

Cowleech Fork at CR3128: This site was used to indicate cumulative effects from the majority of the subwatershed and possible impact to Lake Tawakoni.

Cowleech Fork Sabine River at US69 NW of Lone Oak: This site is the most downstream site on the Cowleech Fork watershed before it enters Lake Tawakoni and was sampled to assess the water quality of the watershed as a unit and the potential impacts to Lake Tawakoni. Lake Tawakoni is a water supply reservoir as well as a popular recreation site. Flow is often very sluggish at this site which contains backwater from Lake Tawakoni at normal and near-normal pool level.

Figure 2. Land Use in the Cowleech Fork Subwatershed

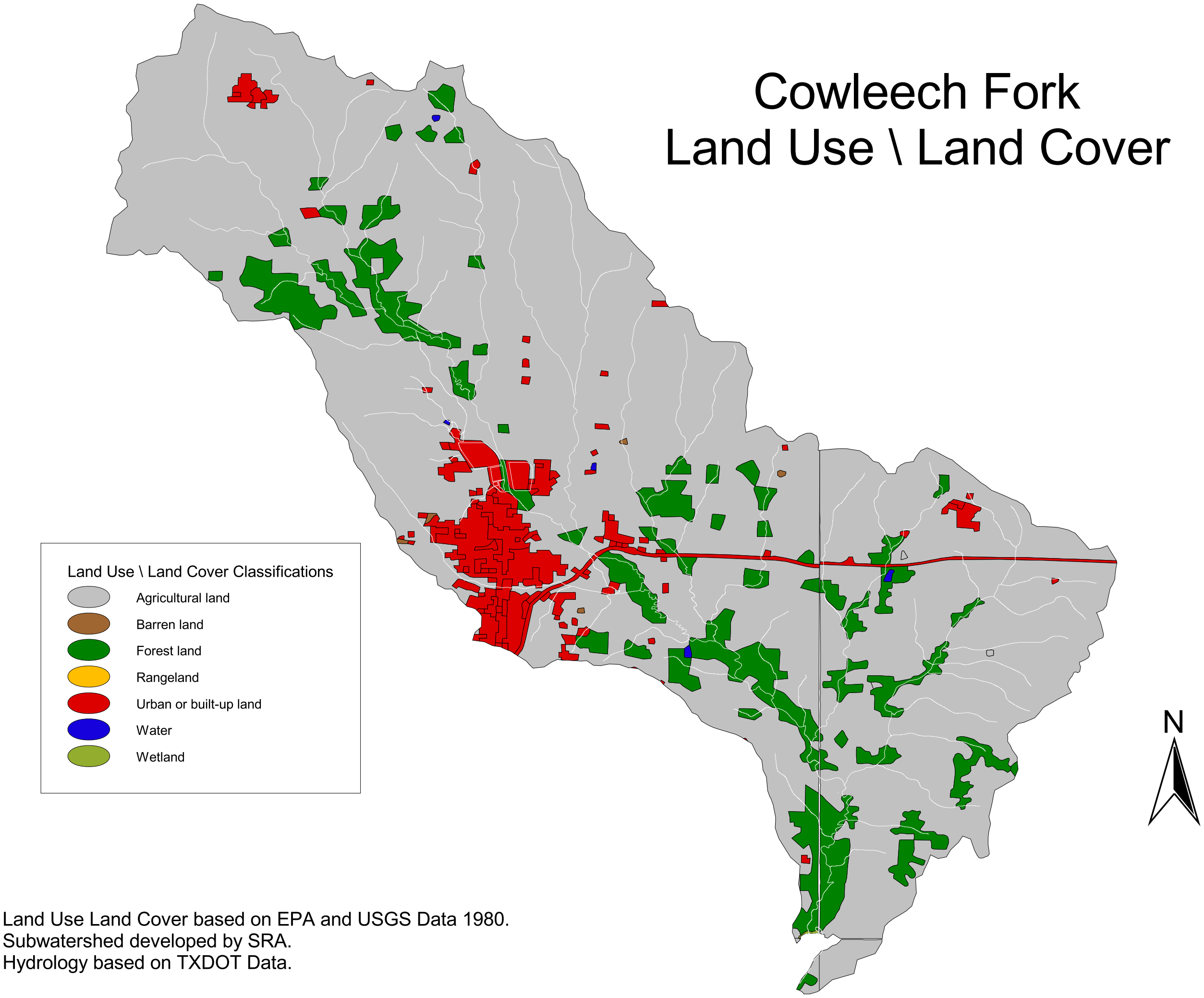
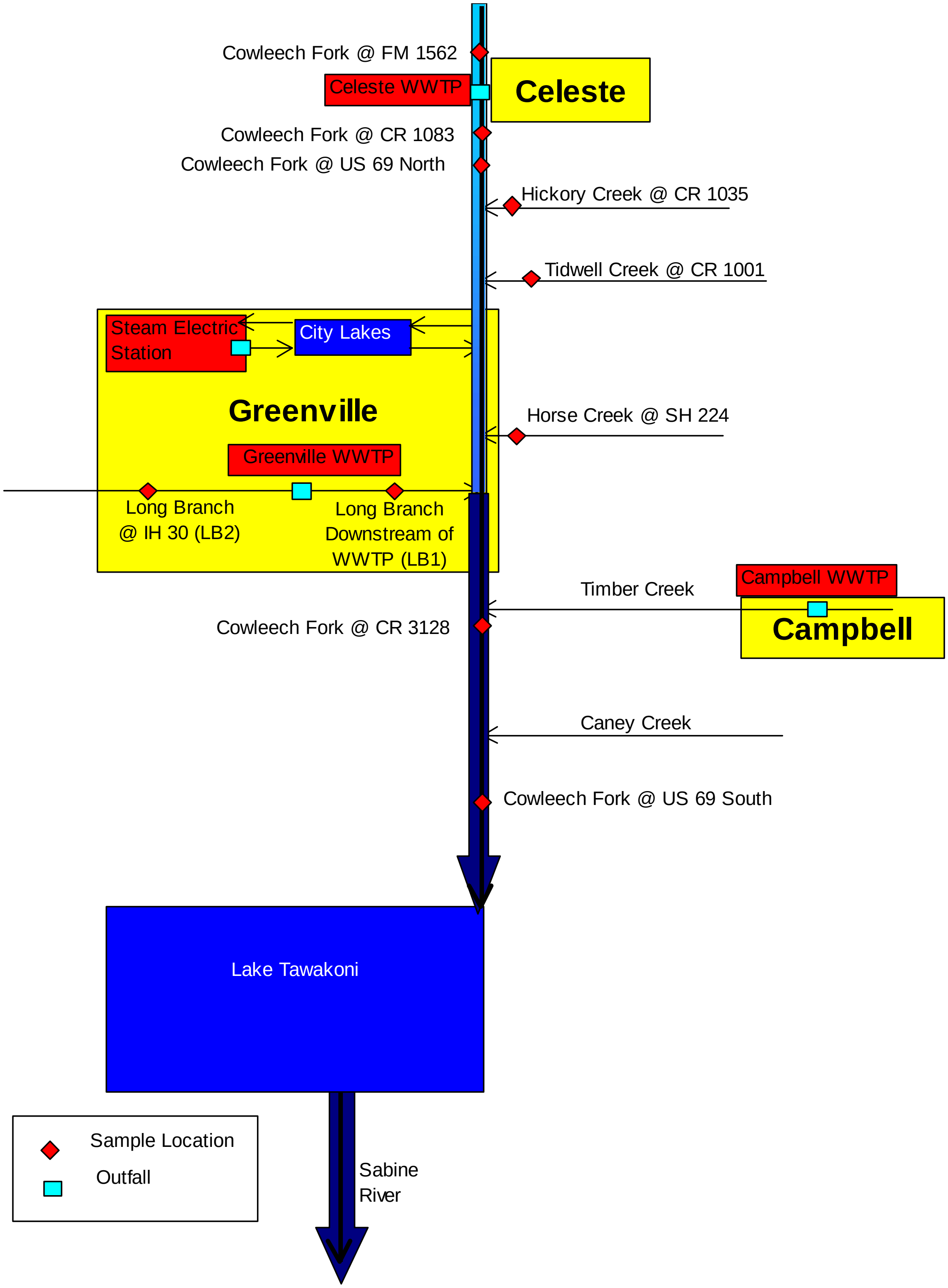
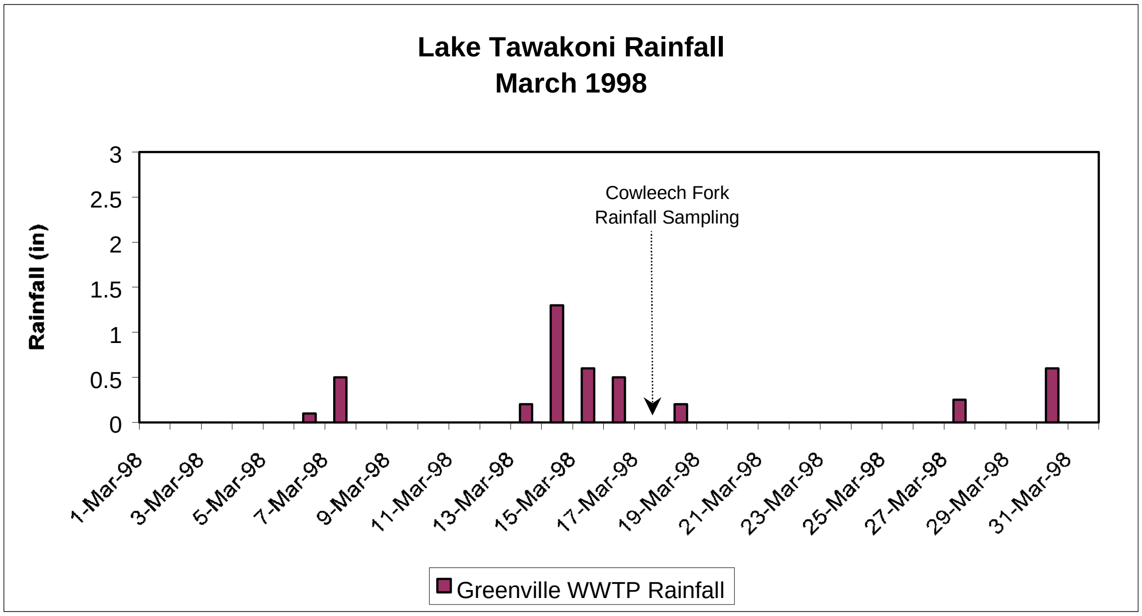


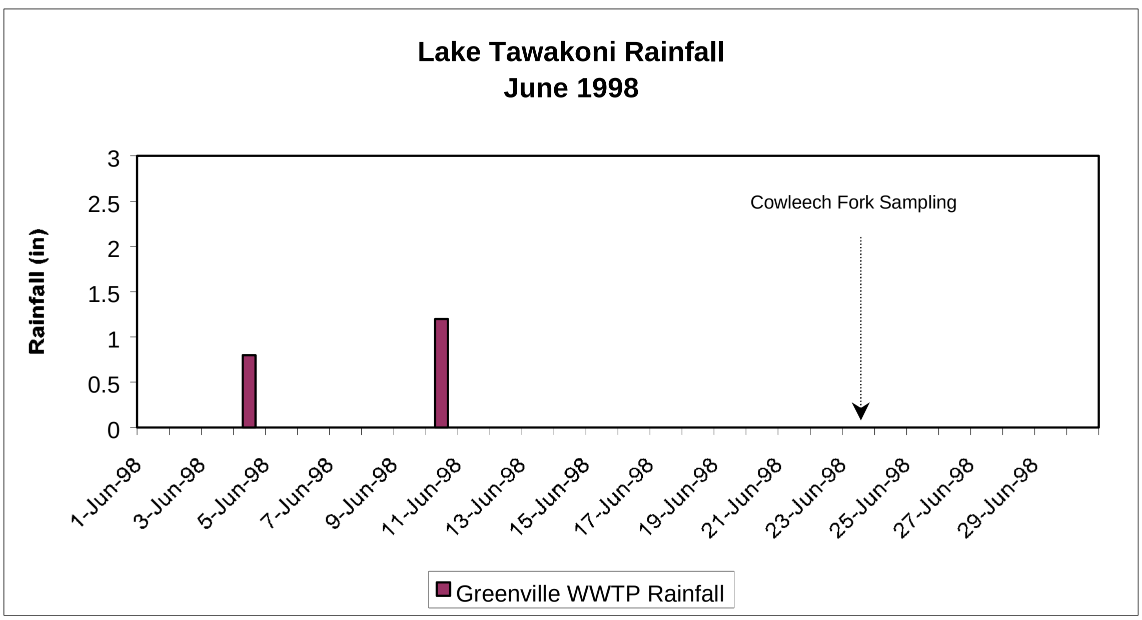
Figure 3. Schematic Diagram of Cowleech Fork Subwatershed

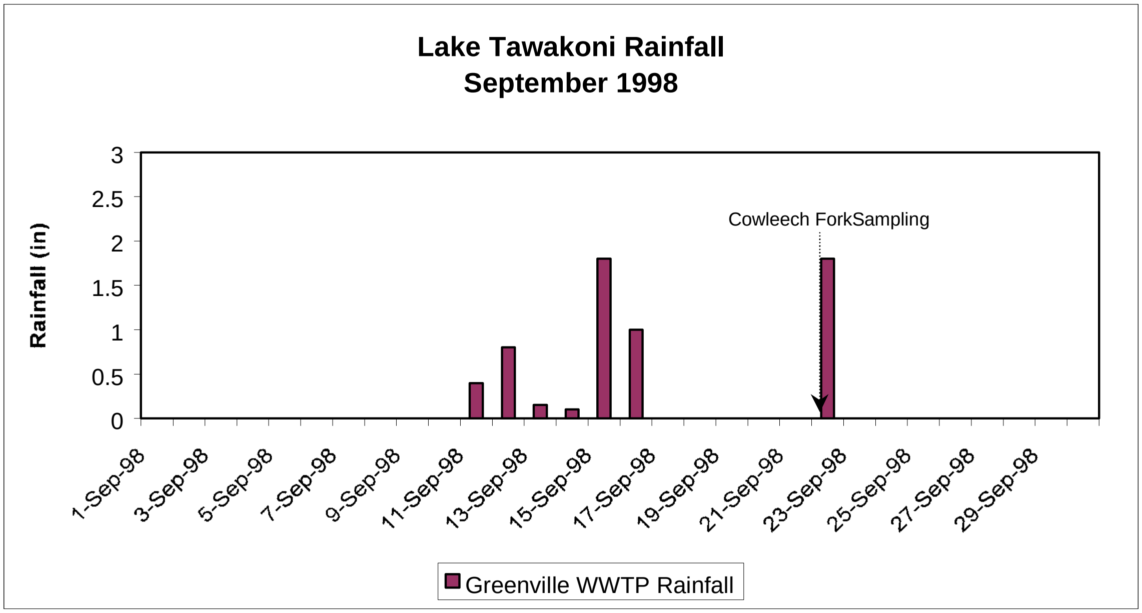


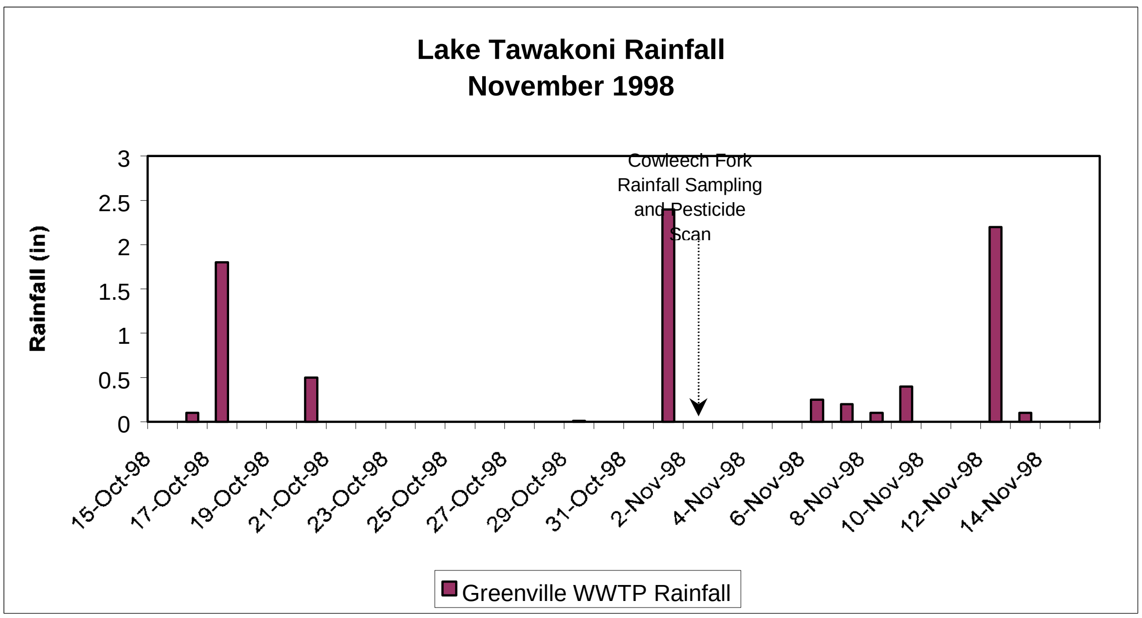
Sampling Events and Rainfall

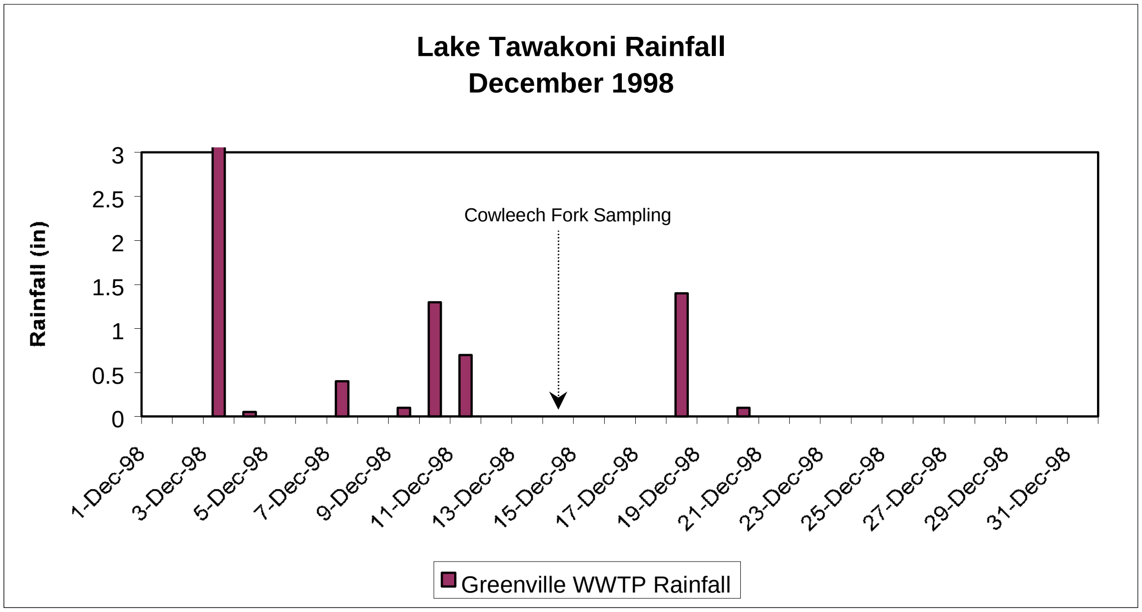
Rainfall is measured at the SRA Iron Bridge Division Office located at Lake Tawakoni and the City of Greenville measures rainfall at the wastewater treatment facility near the LB1 study site in South Greenville. Variations did occur between the two rainfall gage stations since the rainfall was not evenly distributed but both gauges generally recorded rainfall during significant rainfall events. The following graphs are based on Greenville's rain gauge since it is centrally located within the study area. Sampling events are denoted as arrows on the graphs.

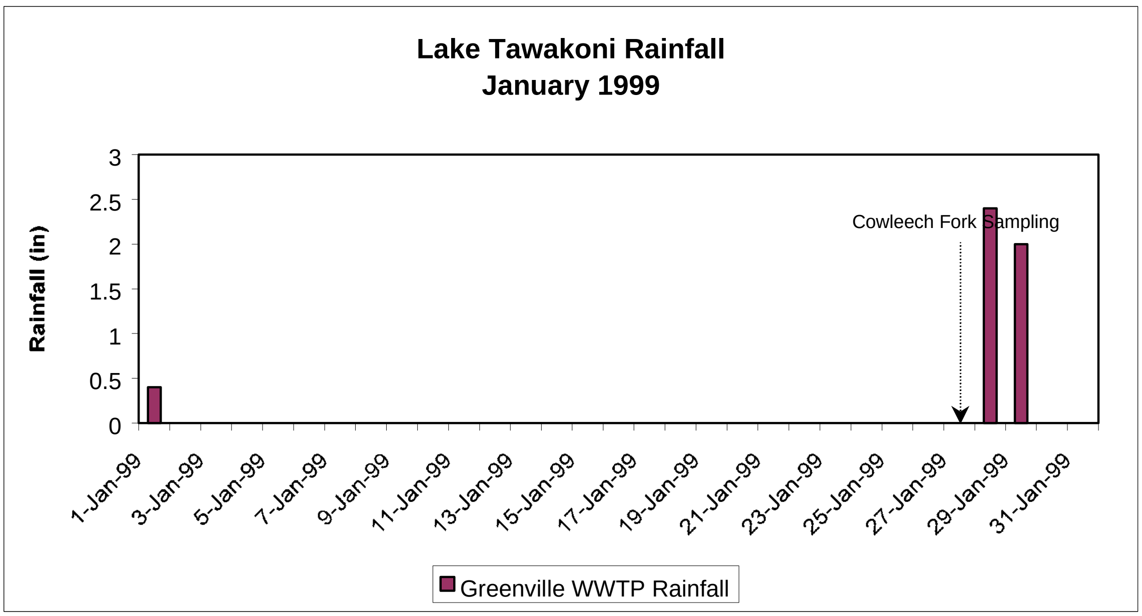


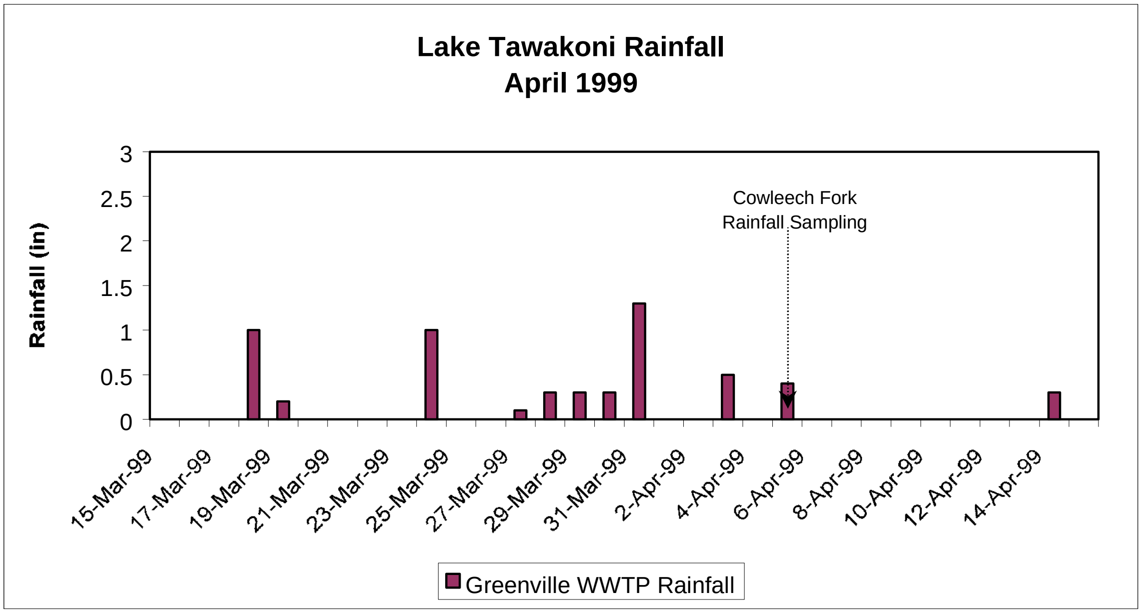


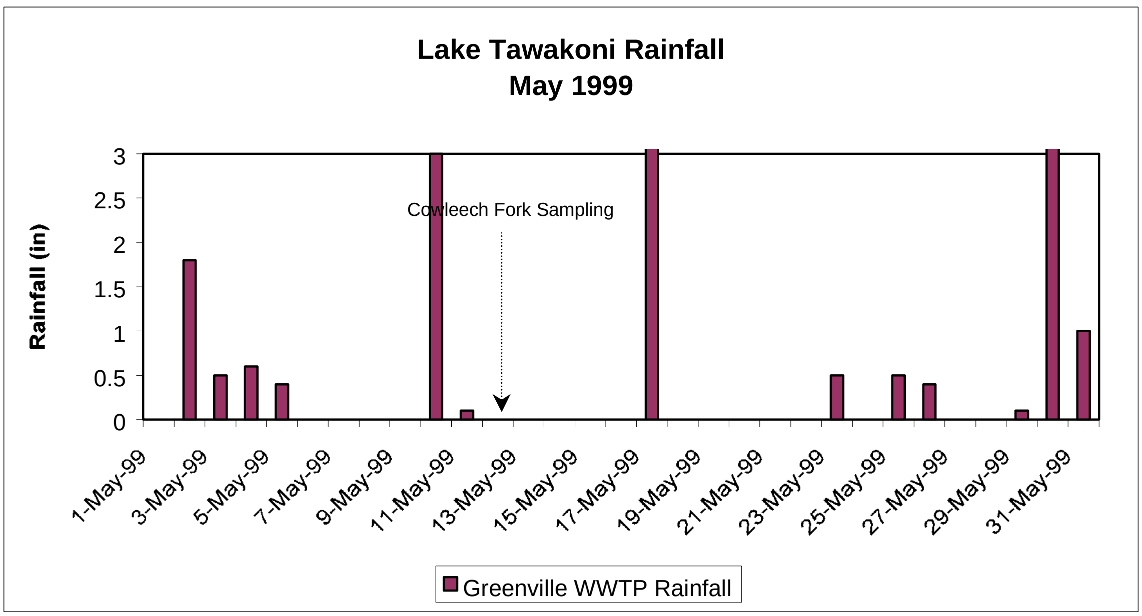

Lake Tawakoni Rainfall
September 1998
Rainfall (in)
3
2.5
2
1.5
1
0.5
0
Cowleech ForkSampling
1-Sep-98
3-Sep-98
5-Sep-98
7-Sep-98
9-Sep-98
11-Sep-98
13-Sep-98
15-Sep-98
17-Sep-98
19-Sep-98
21-Sep-98
23-Sep-98
25-Sep-98
27-Sep-98
29-Sep-98
Greenville WWTP Rainfall


Lake Tawakoni Rainfall
November 1998
Rainfall (in)
3
2.5
2
1.5
1
0.5
0
Cowleech Fork
Rainfall Sampling
and Pesticide
Scan
15-Oct-98
17-Oct-98
19-Oct-98
21-Oct-98
23-Oct-98
25-Oct-98
27-Oct-98
29-Oct-98
31-Oct-98
2-Nov-98
4-Nov-98
6-Nov-98
8-Nov-98
10-Nov-98
12-Nov-98
14-Nov-98
Greenville WWTP Rainfall


Lake Tawakoni Rainfall
December 1998
Rainfall (in)
3
2.5
2
1.5
1
0.5
0
Cowleech Fork Sampling
1-Dec-98
3-Dec-98
5-Dec-98
7-Dec-98
9-Dec-98
11-Dec-98
13-Dec-98
15-Dec-98
17-Dec-98
19-Dec-98
21-Dec-98
23-Dec-98
25-Dec-98
27-Dec-98
29-Dec-98
31-Dec-98
Greenville WWTP Rainfall


Lake Tawakoni Rainfall
January 1999
Rainfall (in)
3
2.5
2
1.5
1
0.5
0
Cowleech Fork Sampling
1-Jan-99
3-Jan-99
5-Jan-99
7-Jan-99
9-Jan-99
11-Jan-99
13-Jan-99
15-Jan-99
17-Jan-99
19-Jan-99
21-Jan-99
23-Jan-99
25-Jan-99
27-Jan-99
29-Jan-99
31-Jan-99
Greenville WWTP Rainfall


Lake Tawakoni Rainfall
April 1999
Rainfall (in)
3
2.5
2
1.5
1
0.5
0
Cowleech Fork
Rainfall Sampling
15-Mar-99
17-Mar-99
19-Mar-99
21-Mar-99
23-Mar-99
25-Mar-99
27-Mar-99
29-Mar-99
31-Mar-99
2-Apr-99
4-Apr-99
6-Apr-99
8-Apr-99
10-Apr-99
12-Apr-99
14-Apr-99
Greenville WWTP Rainfall


Lake Tawakoni Rainfall
May 1999
Rainfall (in)
3
2.5
2
1.5
1
0.5
0
Cowleech Fork Sampling
1-May-99
3-May-99
5-May-99
7-May-99
9-May-99
11-May-99
13-May-99
15-May-99
17-May-99
19-May-99
21-May-99
23-May-99
25-May-99
27-May-99
29-May-99
31-May-99
Greenville WWTP Rainfall

Results

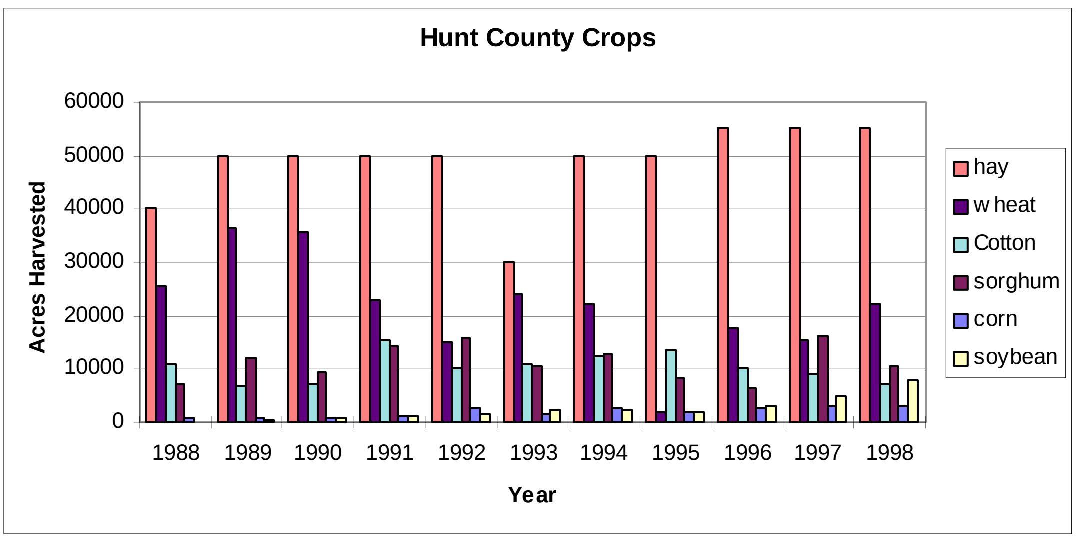
Agricultural Land Use and Pesticide Screening

As a part of this study, research was conducted to determine what pesticides have been applied in the watershed and when they were applied and at what levels they were applied. A recent Internet publication (http://www.texascenter.org) highlights the difficulties in obtaining this type of data. The Texas Pesticide Information Network (Texas PIN) states that the "lack of information on pesticide use impairs the effective and efficient implementation of existing laws for the protection of drinking water quality, human health, food safety and fish and wildlife habitat from pesticide contamination." The site also recommended that "Texas needs a pesticide use reporting system, such as those available in other states, to provide the type of information essential for full and effective implementation of laws designed to protect human health and the environment from pesticide contamination." The difficulties this study encountered were that written records exist for the purchase of only certain pesticides and even these records don't provide application information necessary to calculate cumulative loading to certain watersheds. All of the various agencies that keep pesticides-related records were helpful, in as much as was possible for this study. The only accurate way to predict water quality impact from pesticides is through inference from crops harvested and recommended dosages for pesticides generally recommended for those crops. Application of pesticides to yards in urban areas is even more difficult to quantify and applicators are generally less educated in the proper application and dosage. The study area contains sites expected to be impacted from urban as well as rural land use.

Total acres of the major crops planted in Hunt County are recorded by the county extension offices and the USDA and is compiled and published by TXU Electric, Economic Development. This data is shown below to illustrate historical and current agricultural land use. Most of the crops planted in 1997 and 1998 are hay, wheat, sorghum, and cotton, in that order.
A lot of research is being conducted in agricultural watersheds in response to the discovery of atrazine in drinking water supplies across the US. The pre-emergent herbicide atrazine, is commonly used with corn and sorghum crops. It is typically applied at a dosage of one pound per acre while planting corn in February and March and while planting sorghum in March and

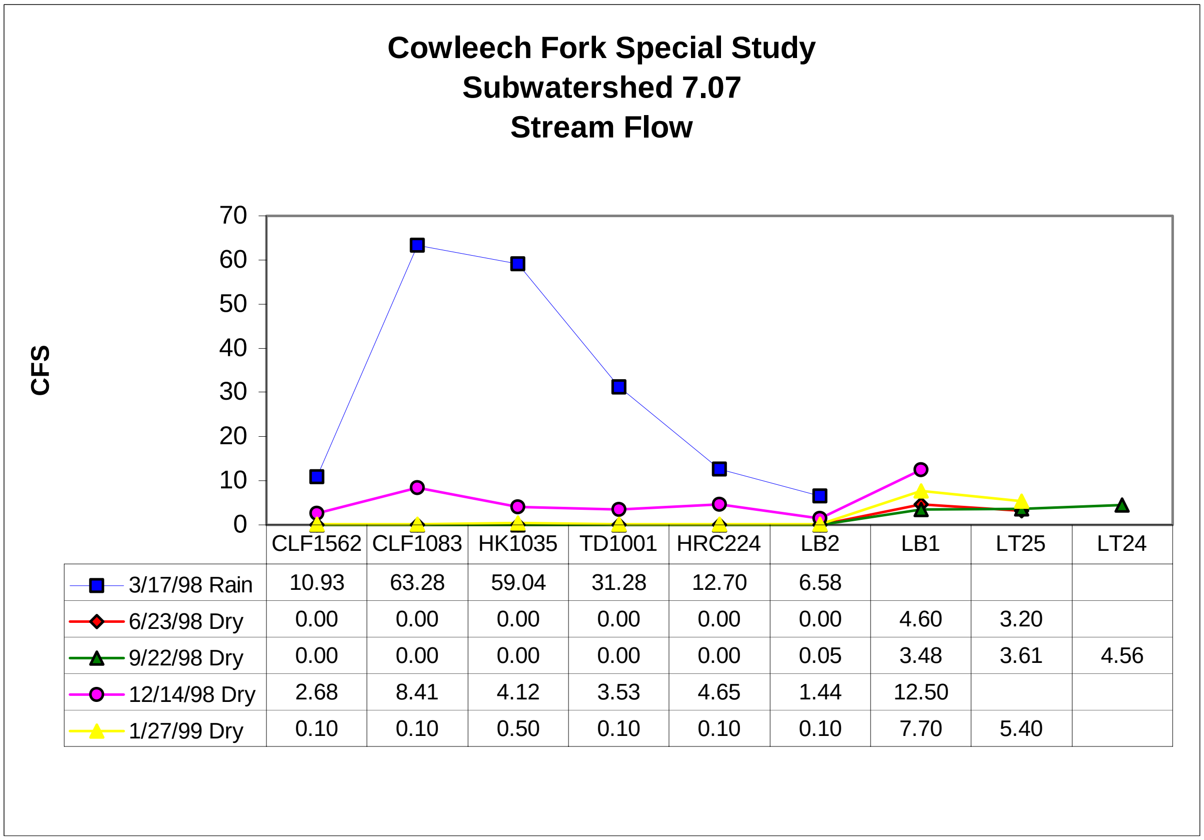
April. Sometimes an additional application is made in October or November to keep land clear during the winter. Atrazine, often formulated with a fertilizer, can also be purchased by individuals for private application weed control on lawns.

Immunoassay technology screening kits from Beacon Analytical Systems, Inc. (InSite Atrazine Tube Kit) were used to sample CLF69 during two rainfall events. The 4/5/99 sample assayed 0.26ppb and the other on 5/12/99 assayed 5.8ppb. These data should be used discriminately since some positive interferences from other pesticides may be encountered using this type of kit. Additionally, water samples were taken at all nine study sites on 11/3/98 and submitted for chlorinated and organophosphorus pesticide scans using EPA Methods 8081 and 8141A respectively. No detectable amounts of pesticides were found in any of these samples.



Flow

Water chemistry was more a function of flow status and rainfall than sample site or temporal parameters. Stream flow was near zero, or non-flowing with isolated pools, at most of the upstream sites during the non-rainfall event samples. As the following graph indicates, the City of Greenville's WWTP outfall at LB1 contributes almost all of the dry weather flow to downstream Cowleech Fork sites. The only USGS gauging station in the study area is at IH30 and Cowleech Fork on the east side of Greenville. This site was contacted routinely via internet to verify changes in flow status, but flows at the study sites had to be quantified with transects and a Price AA flow meter. Flow was measured at LT24 only twice due to its tendency to flood during significant rainfall and the stream is very sluggish during dry weather. LT24 is located in the riverine headwaters of Lake Tawakoni and reflects impounded waters during non-rainfall runoff periods and normal reservoir pool levels. Flow measured at LT24 not shown on this graph was 248cfs during the 4/5/99 rainfall sampling event. Only LT24 was sampled on 4/5/99, primarily as a check for biomonitoring toxicity and atrazine screening after a significant rain event. Samples were not collected at LT25 on 3/17/98 due to inaccessibility from flooding.



	CLF1562	CLF1083	HK1035	TD1001	HRC224	LB2	LB1	LT25	LT24
3/17/98 Rain	10.93	63.28	59.04	31.28	12.70	6.58			
6/23/98 Dry	0.00	0.00	0.00	0.00	0.00	0.00	4.60	3.20	
9/22/98 Dry	0.00	0.00	0.00	0.00	0.00	0.05	3.48	3.61	4.56
12/14/98 Dry	2.68	8.41	4.12	3.53	4.65	1.44	12.50		
1/27/99 Dry	0.10	0.10	0.50	0.10	0.10	0.10	7.70	5.40	

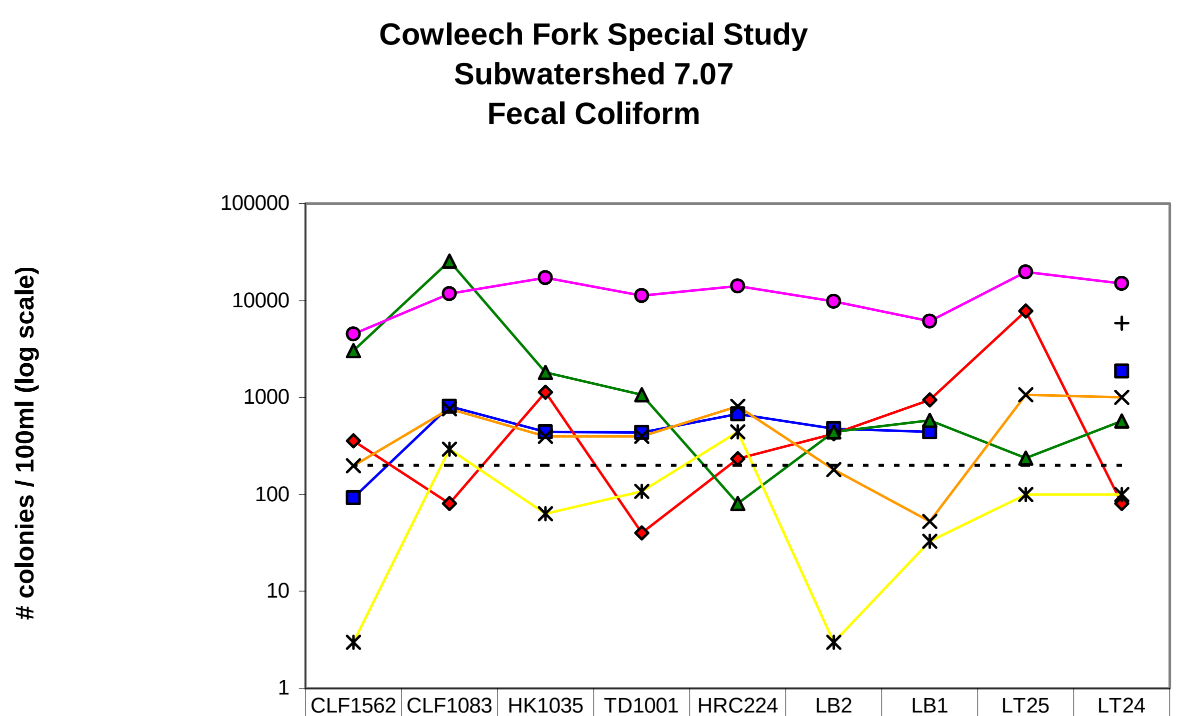
Fecal Coliform Bacteria

Coliform bacteria are a collection of relatively harmless microorganisms that live in large numbers in the intestines of man and warm- and cold-blooded animals. Their normal function is to aid in the digestion of food. Fecal coliform bacteria are a specific subgroup of this collection and the most common member is *Escherichia coli*. These organisms may be separated from the total coliform group by their ability to grow at elevated temperatures and are associated only with the fecal material of warm-blooded animals.

The presence of fecal coliform bacteria in aquatic environments indicates contamination with the fecal material of man or other animals. The water may also be contaminated by pathogens or disease producing bacteria or viruses, which can exist in fecal material. Some waterborne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis and hepatitis A. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Fecal coliform bacteria may occur in ambient water due to the overflow of domestic sewage or nonpoint sources of human and animal waste.

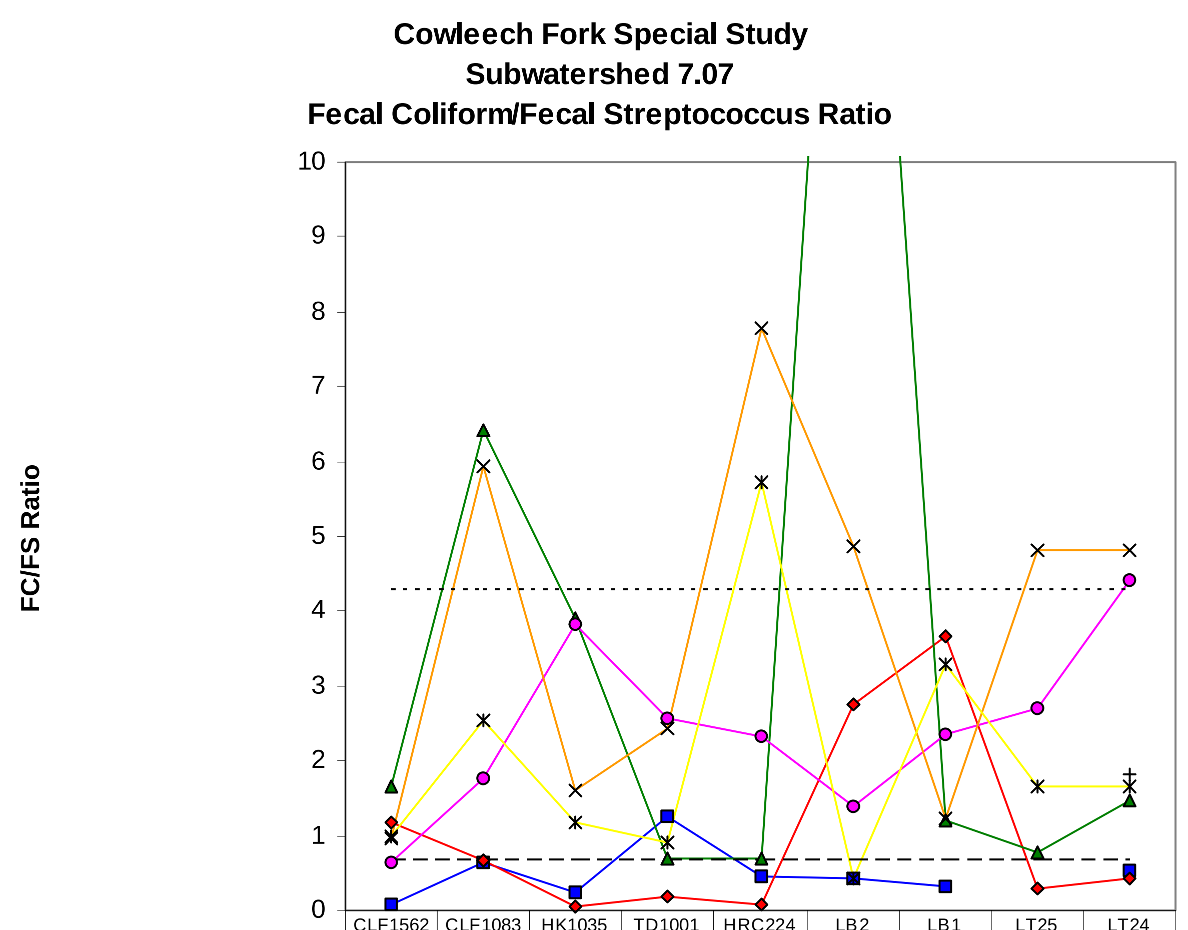
The TSWQS fecal coliform limit in water used for contact recreation is 200 colonies per 100 mL of water. Levels of fecal coliform bacteria exceeded the numerical criteria in stream standards in most samples at all sites. The levels tended to be higher during rainfall events, but even samples collected during extended dry periods showed levels well above the 200 colony limit. These results indicate contamination from both point and nonpoint sources. Fecal coliform to fecal streptococcus ratios were measured to help determine the source of fecal contamination. Contamination due to human sources should show ratios at 4.3 or higher and animal sources would have a ratio of 0.7 or less. Although all sites showed ratios less than 0.7 at least once, every site also showed ratios above the maximum level for animal waste. These results indicate some of the contamination is from non-human sources.

Special Study on Subwatershed 7.07 – Cowleech Fork



	CLF1562	CLF1083	HK1035	TD1001	HRC224	LB2	LB1	LT25	LT24
3/17/98 Rain	92	810	440	437	680	480	440		1880
6/23/98 Dry	357	80	1140	40	232	420	940	7790	80
9/22/98 Dry	3020	25500	1820	1060	80	440	580	236	570
11/2/98 Rain	4500	11800	17200	11300	14000	9800	6100	19750	15000
12/14/98 Dry	196	760	400	400	810	180	53	1060	1000
1/27/99 Dry	3	295	63	108	440	3	33	100	100
4/5/99 Rain									5800
Stream Standard	200	200	200	200	200	200	200	200	200

Special Study on Subwatershed 7.07 – Cowleech Fork



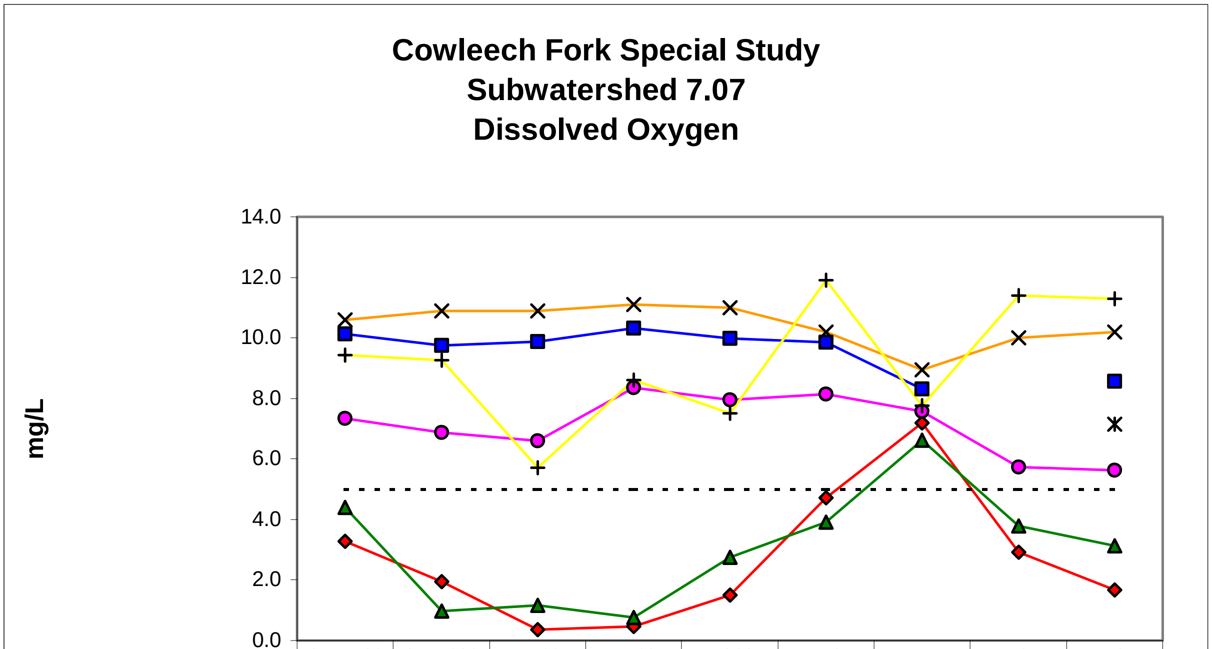
	CLF1562	CLF1083	HK1035	TD1001	HRC224	LB2	LB1	LT25	LT24
3/17/98 Rain	0.1	0.6	0.2	1.2	0.5	0.4	0.3		0.5
6/23/98 Dry	1.2	0.7	0.1	0.2	0.1	2.8	3.7	0.3	0.4
9/22/98 Dry	1.7	6.4	3.9	0.7	0.7	19.1	1.2	0.8	1.5
11/2/98 Rain	0.6	1.8	3.8	2.6	2.3	1.4	2.3	2.7	4.4
12/14/98 Dry	1.0	5.9	1.6	2.4	7.8	4.9	1.2	4.8	4.8
1/27/99 Dry	1.0	2.5	1.2	0.9	5.7	0.4	3.3	1.7	1.7
4/5/99 Rain									1.8
Ratio for Humans	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Max. Ratio for Animals	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7

Dissolved Oxygen

Adequate dissolved oxygen is necessary for a healthy aquatic community and to provide for aerobic life forms that carry on natural stream purification processes. As dissolved oxygen levels in water drop below 5.0 mg/L, aquatic life is put under stress. The lower the concentration, the greater the stress. Oxygen levels that remain below 1-2 mg/L for a few hours can result in large fish kills. Stream standards for dissolved oxygen are set as the minimum average value for a 24-hour period. The daily average set in TSWQS is 5.0 mg/L with a minimum instantaneous value of 3.0 mg/L.

Station LB1 was the only site that was consistently above the minimum standard for dissolved oxygen. Although oxygen levels were adequate during most sampling events at all of the sites, there were two sampling events where the levels were well below the minimum standard at most sites. Both of these sampling events occurred during warm weather. Saturation of oxygen was over 100% at LB2, LT25, and LT24 on 1/27/99 indicating high algal photosynthetic activity. These results indicate a stressed environment for the aquatic community.

Special Study on Subwatershed 7.07 – Cowleech Fork



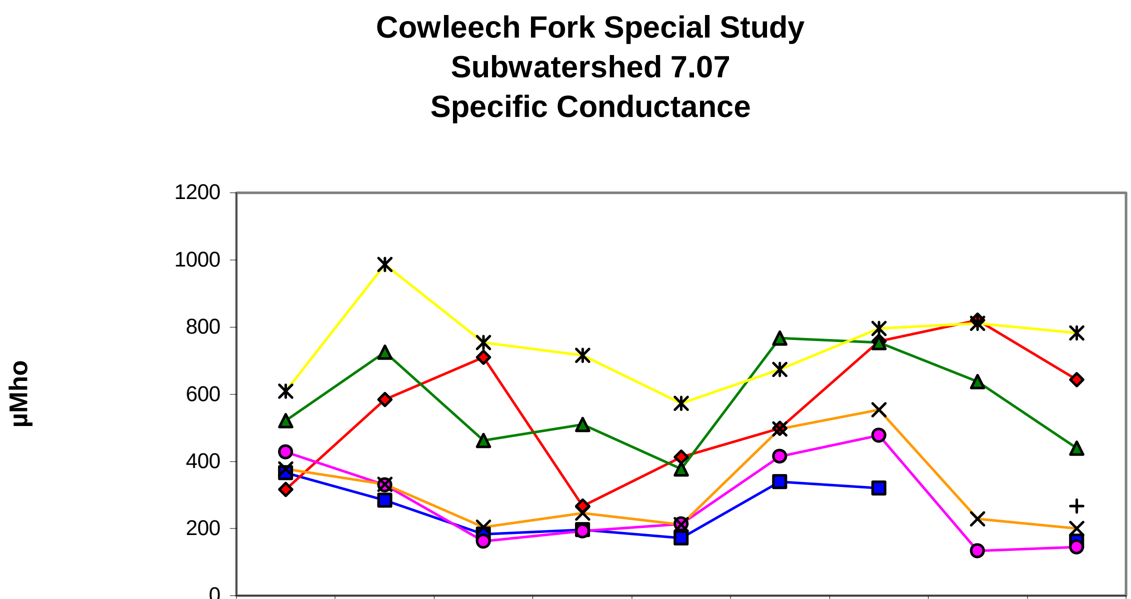
	CLF1562	CLF1083	HK1035	TD1001	HRC224	LB2	LB1	LT25	LT24
3/17/98 Rain	10.1	9.7	9.9	10.3	10.0	9.9	8.3		8.6
6/23/98 Dry	3.3	2.0	0.3	0.5	1.5	4.7	7.2	2.9	1.7
9/22/98 Dry	4.4	1.0	1.2	0.8	2.8	3.9	6.6	3.8	3.1
11/2/98 Rain	7.3	6.9	6.6	8.4	8.0	8.1	7.6	5.7	5.6
12/14/98 Dry	10.6	10.9	10.9	11.1	11.0	10.2	8.9	10.0	10.2
1/27/99 Dry	9.4	9.3	5.7	8.6	7.5	11.9	7.8	11.4	11.3
4/5/99 Rain									7.1
Stream Standard	5	5	5	5	5	5	5	5	5

Specific Conductance

Specific conductance is a measurement of the ability of water to carry an electrical current. Many of the chemicals commonly found in water exist as dissolved salts. The salts are present as ions and allow the water to conduct electricity. The specific conductance or conductivity measurement is related to ionic strength, but does not indicate what specific ions are present. Resistance, which is an electrical measurement expressed in ohms, is the opposite of conductivity. Conductivity is then expressed in reciprocal ohms. A more convenient unit of measurement in the chemical analysis of water is µmhos. The specific conductance can be used to estimate the amount of total dissolved solids present. Elevated dissolved solids can cause "mineral tastes" in drinking water. Corrosion or encrustation of metallic surfaces by waters high in dissolved solids causes problems with industrial equipment and boilers as well as domestic plumbing, hot water heaters, toilet flushing mechanisms, faucets, and washing machines and dishwashers. There are no limits listed in TSWQS for specific conductance.

Specific conductance ranged from a low of 133 at LT25 to a high of 986 µmhos/cm at CLF1083. Dry weather samples generally ranged from 400-800 µmhos/cm and rainfall events were usually below 400 µmhos /cm. CLF1562, CLF1083, and the two Long Branch sites were generally higher than the other sites, but the levels were not excessively high. This would indicate impact from both point and nonpoint sources.

Special Study on Subwatershed 7.07 – Cowleech Fork



	CLF1562	CLF1083	HK1035	TD1001	HRC224	LB2	LB1	LT25	LT24
3/17/98 Rain	366	283	182	197	172	340	320		161
6/23/98 Dry	317	585	710	266	413	500	758	821	643
9/22/98 Dry	522	726	462	511	377	768	755	639	440
11/2/98 Rain	428	329	162	192	213	415	479	133	144
12/14/98 Dry	378	331	203	245	211	497	555	229	200
1/27/99 Dry	609	986	755	717	574	675	797	812	783
4/5/99 Rain									266

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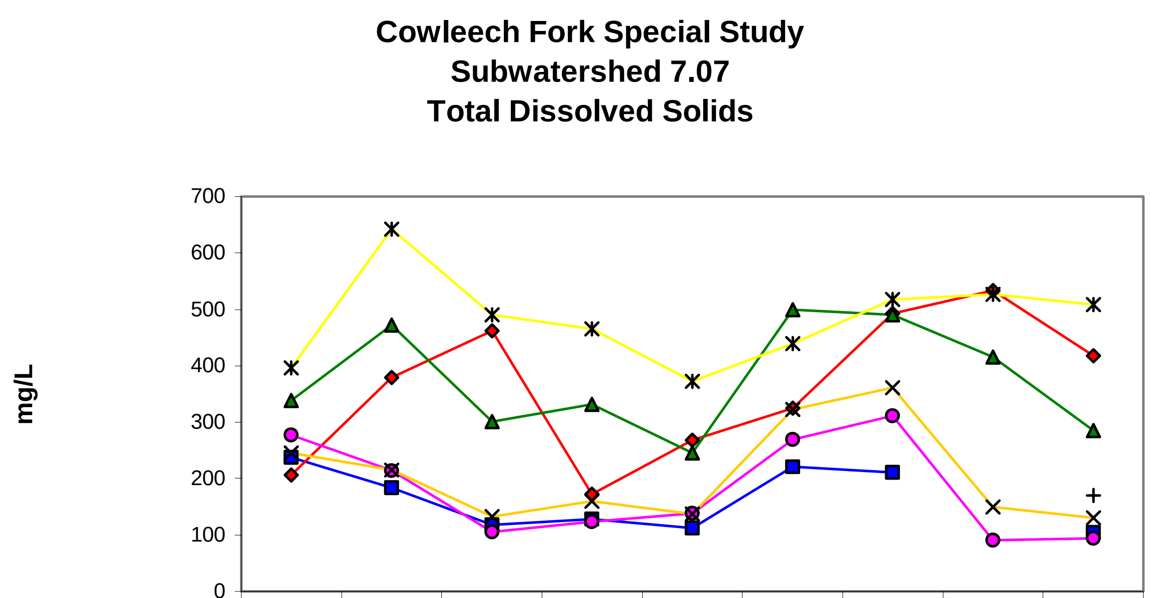
Total Dissolved Solids (TDS):

Total Dissolved Solids (TDS) is a measure of the amount of material dissolved in water (mostly inorganic salts). Excessive amounts of dissolved solids can impact the aquatic community by creating a habitat unsuitable to some sensitive species of both plants and animals. Total dissolved solids are calculated as a percentage of specific conductance, so the same trends are followed. Stream standards have not been established for Cowleech Fork upstream of Lake Tawakoni, but a limit of 200 mg/l has been set for Lake Tawakoni and 500 mg/l in the river downstream. TDS was usually above 200 mg/l and over 500 mg/l in a few dry weather samples. The TDS values appear to be related more to weather than to point sources. TDS levels are generally elevated during extreme dry conditions due to the concentration effect of evaporation.



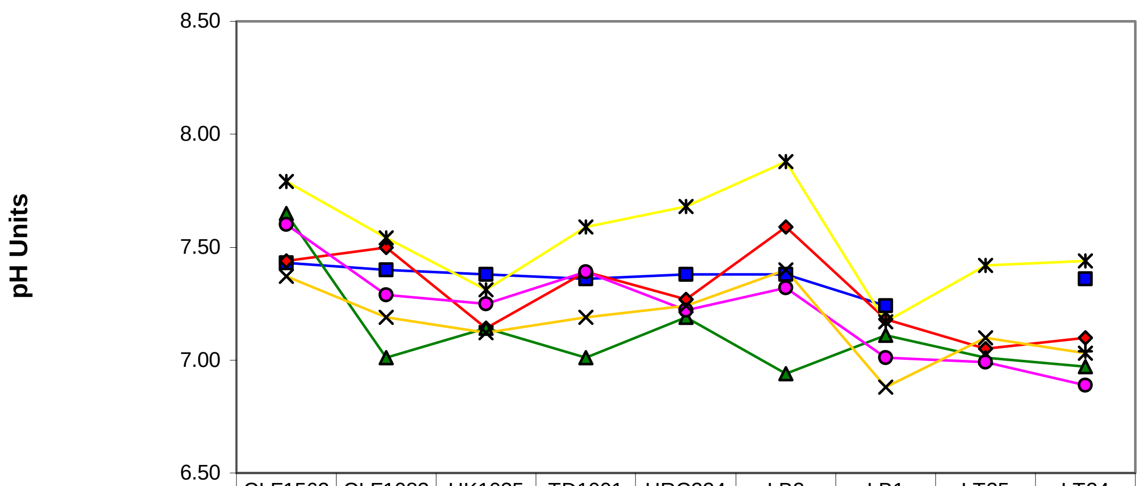
	CLF1562	CLF1083	HK1035	TD1001	HRC224	LB2	LB1	LT25	LT24
3/17/98 Rain	238	184	118	128	112	221	211		104
6/23/98 Dry	206	380	462	172	269	325	493	534	418
9/22/98 Dry	339	472	301	332	246	499	491	416	286
11/2/98 Rain	278	214	105	124	138	270	311	91	94
12/14/98 Dry	246	215	132	160	137	323	361	149	130
1/27/99 Dry	396	642	491	466	373	439	518	527	509
4/5/99 Rain									170

pH

The acidity or alkalinity of water is expressed as the pH. The pH is determined by the concentration of the hydrogen ion [H+] in a solution. In general, a pH of 7 is neutral and water with a pH < 7 is considered acidic and water with a pH > 7 is considered basic or alkaline. Each change in pH unit represents a tenfold change in acidity. One of the most significant environmental impacts of pH is the affect that it has on the solubility and thus the bioavailability of other substances.

The range of pH designated in TSWQS for Lake Tawakoni is from 6.0 to 8.5, but no standards have been set for the Cowleech Fork Subwatershed. The pH ranged from 6.88 to 7.88 at all sites and no impacts were observed from any sources.

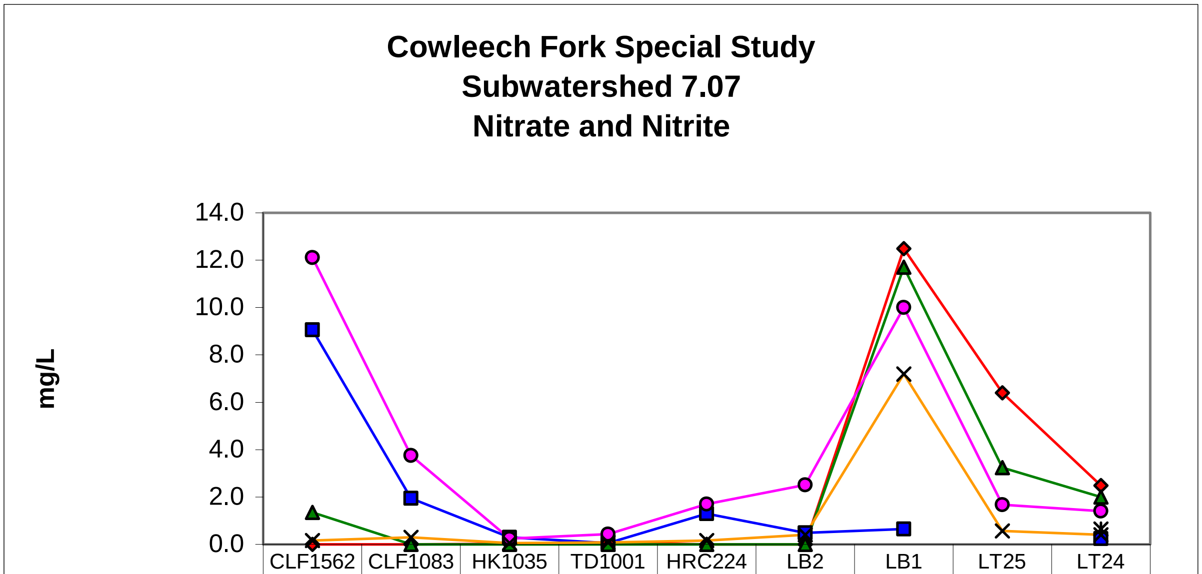
Cowleech Fork Special Study
Subwatershed 7.07
pH



	CLF1562	CLF1083	HK1035	TD1001	HRC224	LB2	LB1	LT25	LT24
3/17/98 Rain	7.43	7.40	7.38	7.36	7.38	7.38	7.24		7.36
6/23/98 Dry	7.44	7.50	7.14	7.39	7.27	7.59	7.18	7.05	7.10
9/22/98 Dry	7.65	7.01	7.14	7.01	7.19	6.94	7.11	7.01	6.97
11/2/98 Rain	7.60	7.29	7.25	7.39	7.22	7.32	7.01	6.99	6.89
12/14/98 Dry	7.37	7.19	7.12	7.19	7.24	7.40	6.88	7.10	7.03
1/27/99 Dry	7.79	7.54	7.31	7.59	7.68	7.88	7.17	7.42	7.44
4/5/99 Rain									7.04

Nitrate and Nitrite

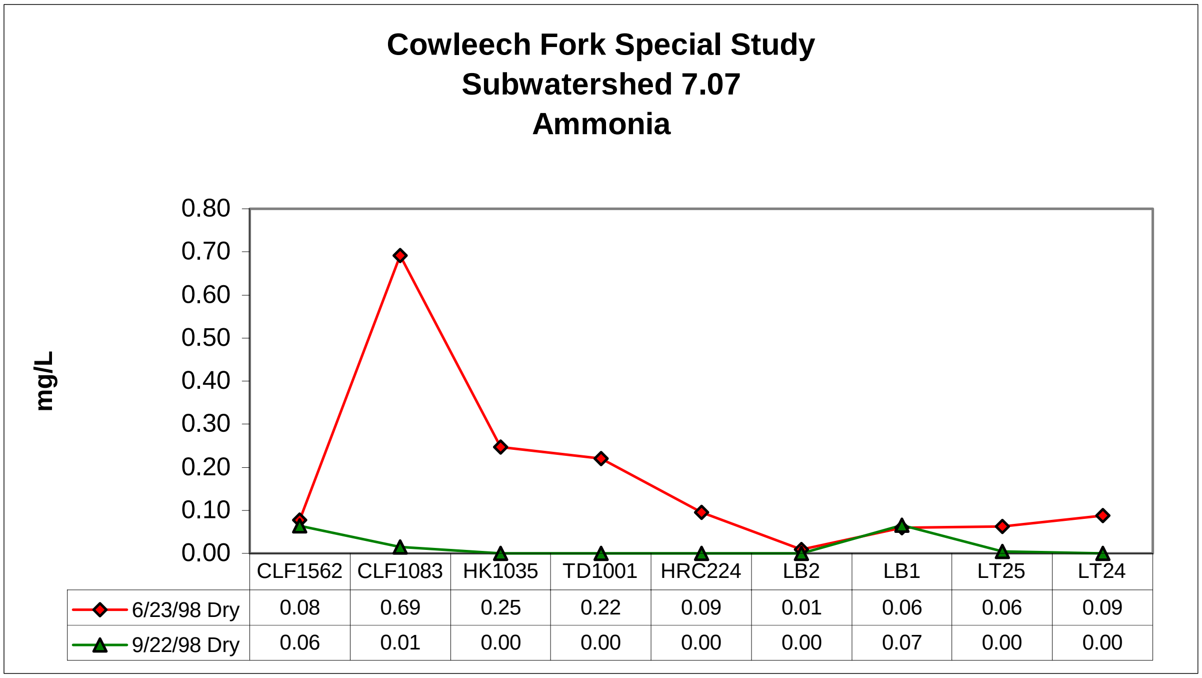
Nitrogen-containing compounds act as nutrients in streams, rivers, and reservoirs. The major routes of entry of nitrogen into bodies of water are municipal and industrial wastewater, septic tanks, feed lot discharges, animal wastes (including birds and fish), runoff from fertilized agricultural field and lawns and discharges from car exhausts. Bacteria in water quickly convert nitrites [NO2-] to nitrates [NO 3 -] and this process uses up oxygen. High nitrates in drinking water can cause digestive disturbances in people and high nitrites can cause toxicity in fish. Levels of nitrate and nitrite in streams should not exceed 10 mg/L, although no limits are listed in TSWQS. Nitrite and nitrate are analyzed together and reported as a combined value.
The median nitrate & nitrite level observed in Cowleech Fork was 0.4 mg/L. Peaks were observed at CLF1562 twice, once with a recent rainfall event and the other without. Elevated levels were shown at Station LB1 in all samples except on 3/17/98 during high flow from heavy rains. These results indicate stressed conditions in the Cowleech Fork Subwatershed due to nutrient enrichment from nonpoint sources and the wastewater treatment plant. The results also indicate the nutrients are being assimilated into the stream to some extent.



	CLF1562	CLF1083	HK1035	TD1001	HRC224	LB2	LB1	LT25	LT24
3/17/98 Rain	9.05	1.94	0.29	0.05	1.29	0.48	0.66		0.24
6/23/98 Dry	0.01	0.01	0.02	0.08	0.01	0.01	12.50	6.40	2.49
9/22/98 Dry	1.34	0.01	0.01	0.01	0.01	0.01	11.70	3.25	2.00
11/2/98 Rain	12.10	3.76	0.23	0.44	1.70	2.51	10.00	1.68	1.40
12/14/98 Dry	0.17	0.30	0.05	0.07	0.16	0.41	7.18	0.56	0.40
4/5/99 Rain									0.65

Ammonia

Although there are no stream standards for ammonia, it can be toxic to fish in very small amounts. The toxicity is dependent on pH and increases as pH increases. Stream values from natural sources of ammonia are rarely above 1 mg/L. The median value for ammonia was 0.09 mg/l for all sites. Although higher levels were detected at CLF1083, HK1035, and TD1001 in June 1998, the levels were well within safe limits. Ammonia was reported for only two sample events due to laboratory equipment failure.

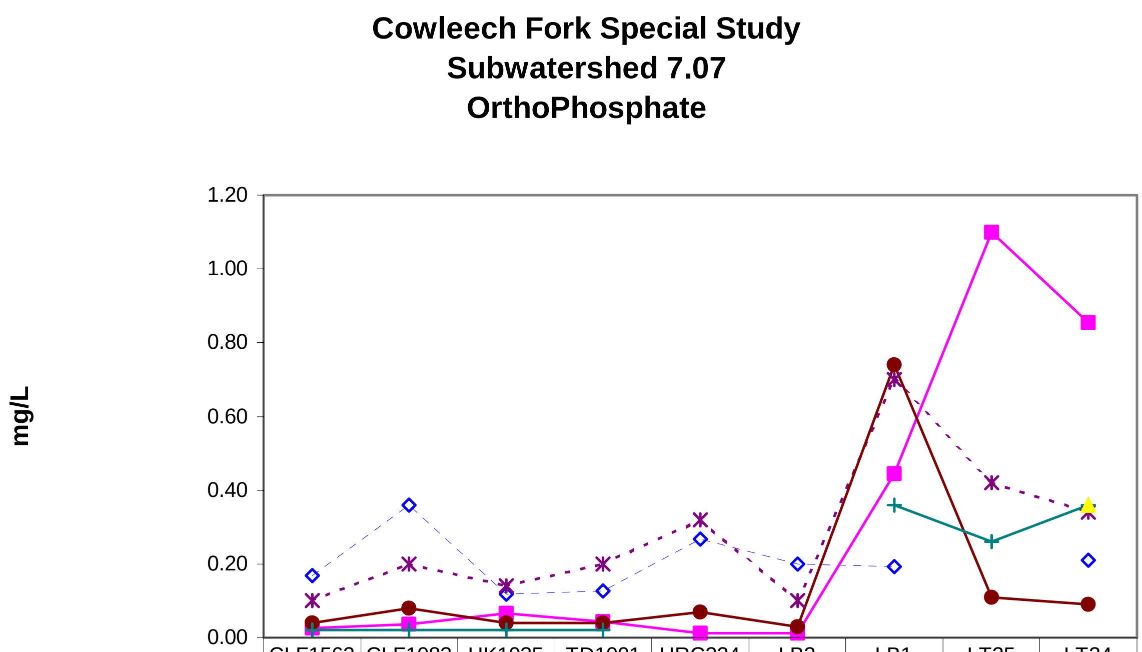


	CLF1562	CLF1083	HK1035	TD1001	HRC224	LB2	LB1	LT25	LT24
6/23/98 Dry	0.08	0.69	0.25	0.22	0.09	0.01	0.06	0.06	0.09
9/22/98 Dry	0.06	0.01	0.00	0.00	0.00	0.00	0.07	0.00	0.00

Orthophosphate

There are no stream standards for orthophosphate and the greatest threat it poses for waterbodies is nutrient enrichment. The presence of even small amounts (1 mg/L) in water can lead to excessive growth of aquatic weeds and algae.

Orthophosphate values were generally low at most sample sites and the median value was 0.13 mg/L. The only elevated levels were detected downstream from the City of Greenville's wastewater treatment at LB1 and LT25. The highest value was 1.1mg/l at LT25. These results indicate nutrient enrichment from the wastewater treatment plant.

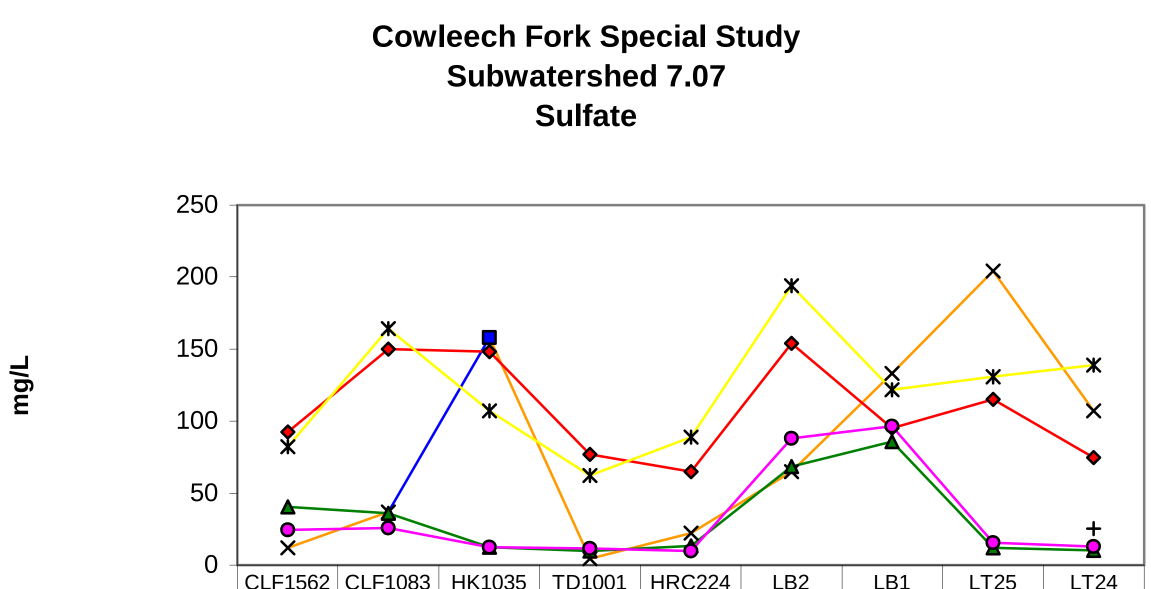


	CLF1562	CLF1083	HK1035	TD1001	HRC224	LB2	LB1	LT25	LT24
3/17/98 Rain	0.17	0.36	0.12	0.13	0.27	0.20	0.19		0.21
6/23/98 Dry									
9/22/98 Dry	0.03	0.04	0.07	0.04	0.01	0.01	0.44	1.10	0.85
11/2/98 Rain	0.10	0.20	0.14	0.20	0.32	0.10	0.70	0.42	0.34
12/14/98 Dry	0.04	0.08	0.04	0.04	0.07	0.03	0.74	0.11	0.09
1/27/99 Dry	0.02	0.02	0.02	0.02			0.36	0.26	0.36
4/5/99 Rain									0.36

Special Study on Subwatershed 7.07 – Cowleech Fork

Sulfates

Sulfates are not considered toxic to plants or animals at normal concentrations. Levels of sulfate in Sabine Basin streams are generally well below 100 mg/L. Higher levels in streams can result from the breakdown of detritus washed into the stream. Cowleech Fork is not a designated segment; therefore, stream standards for sulfates have not been established. The standard for Lake Tawakoni is an annual average not to exceed 35mg/l and an annual average not to exceed 100mg/l below Lake Tawakoni. Normal and low flow samples were usually below these values but rainfall event samples were usually higher. The value at both Long Branch sites was never observed below 65mg/l. Long Branch upstream of the wastewater treatment plant has a mixed urban and rural watershed. The elevated levels of sulfate appear to be from nonpoint source pollution.

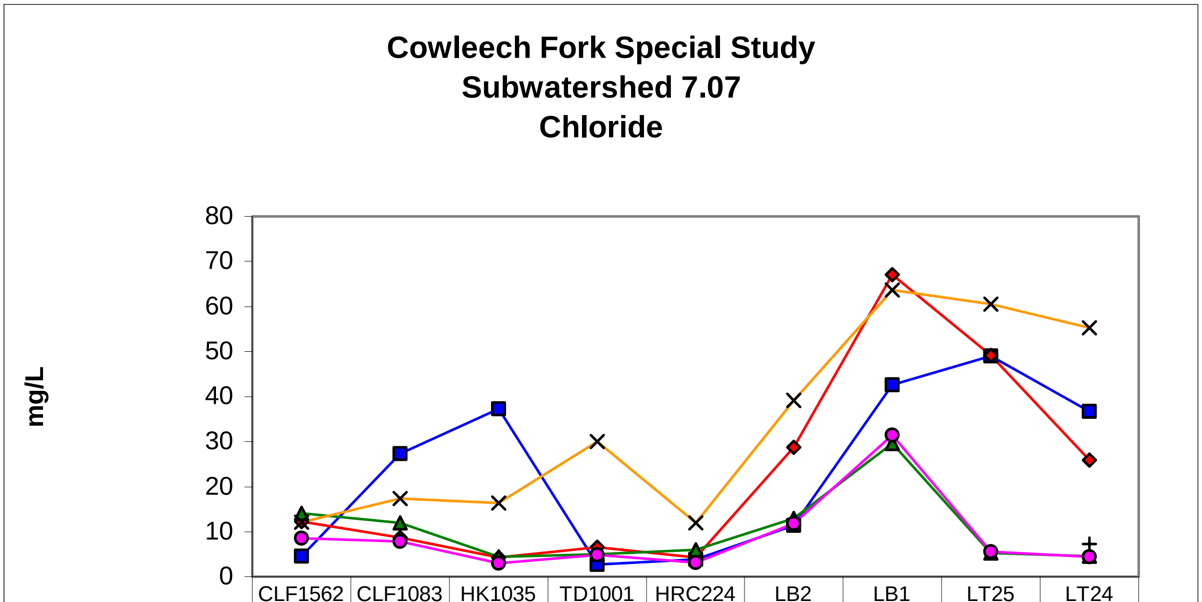


	CLF1562	CLF1083	HK1035	TD1001	HRC224	LB2	LB1	LT25	LT24
6/23/98 Dry	12	37	158	5	22	65	133	204	107
9/22/98 Dry	93	150	148	77	65	154	95	115	75
11/2/98 Rain	41	36	13	10	14	69	86	12	10
12/14/98 Dry	24	26	12	12	10	88	97	16	13
1/27/99 Dry	82	164	107	62	89	194	122	131	139
4/5/99 Rain									25

Special Study on Subwatershed 7.07 – Cowleech Fork

Chlorides

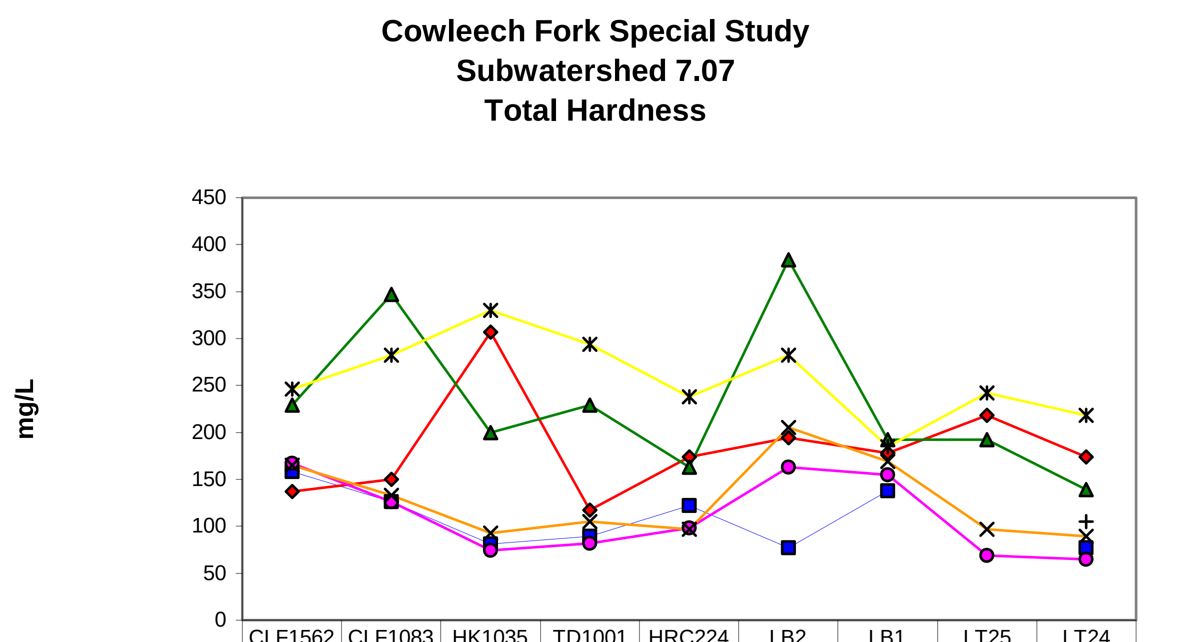
Although chloride stream standards have not been established for Cowleech Fork, the standard for Lake Tawakoni is an annual average not to exceed 35mg/l and an annual average not to exceed 100mg/l below Lake Tawakoni. High levels of chlorides (600 mg/L) can negatively impact freshwater streams and higher levels (1200 mg/L) can be toxic to fish. Chloride in the Cowleech Fork Subwatershed was less than 35mg/l in most samples. The dry weather samples were generally higher apparently due to natural conditions. Although slightly elevated values were observed at Station LB1, the levels were not high enough to indicate water quality problems. The higher values appear to be from the impact of treated wastewater.



	CLF1562	CLF1083	HK1035	TD1001	HRC224	LB2	LB1	LT25	LT24
6/23/98 Dry	5	27	37	3	4	11	43	49	37
9/22/98 Dry	12	9	4	7	4	29	67	49	26
11/2/98 Rain	14	12	4	5	6	13	30	5	5
12/14/98 Dry	9	8	3	5	3	12	31	6	4
1/27/99 Dry	12	17	16	30	12	39	64	61	55
4/5/99 Rain									7

Hardness

Water hardness is a measure of the minerals dissolved in the water, but primarily it is equivalent to the calcium and magnesium concentration of the water. Hardness is typically reported as mg /L as CaCO3 (calcium carbonate). The most important impact of hardness on fish and other aquatic life appears to be the affect the presence of these ions has on the other more toxic metals such as lead, cadmium, chromium and zinc. Generally, the harder the water, the lower the toxicity of other metals to aquatic life. If a stream or river is a drinking water source, hardness can present problems in the water treatment process. Hardness must also be removed before certain industries can use the water. Total hardness in the Cowleech Fork Subwatershed usually ranged between 75 and 250mg/l. Dry weather samples were usually higher than wet weather samples and was apparently due to natural conditions rather than impact from point or nonpoint sources.



	CLF1562	CLF1083	HK1035	TD1001	HRC224	LB2	LB1	LT25	LT24
3/17/98 Rain	158	126	81	89	122	77	138		77
6/23/98 Dry	137	150	307	117	174	194	178	218	174
9/22/98 Dry	229	347	200	229	163	384	192	192	139
11/2/98 Rain	167	126	74	82	98	163	155	69	65
12/14/98 Dry	165	133	93	105	97	205	169	97	89
1/27/99 Dry	246	282	330	294	238	282	185	242	218
4/5/99 Rain									105

Alkalinity

Alkalinity refers to the capability of water to neutralize acid. This is really an expression of buffering capacity. A buffer is a solution to which an acid can be added without appreciably changing the pH. Alkalinity varied between sites and sample events, but was usually between 50 and 175mg/l. The highest values were observed during dry weather sampling and were probably the result of concentration through evaporation. No impacts from point or nonpoint sources were observed.

Cowleech Fork Special Study
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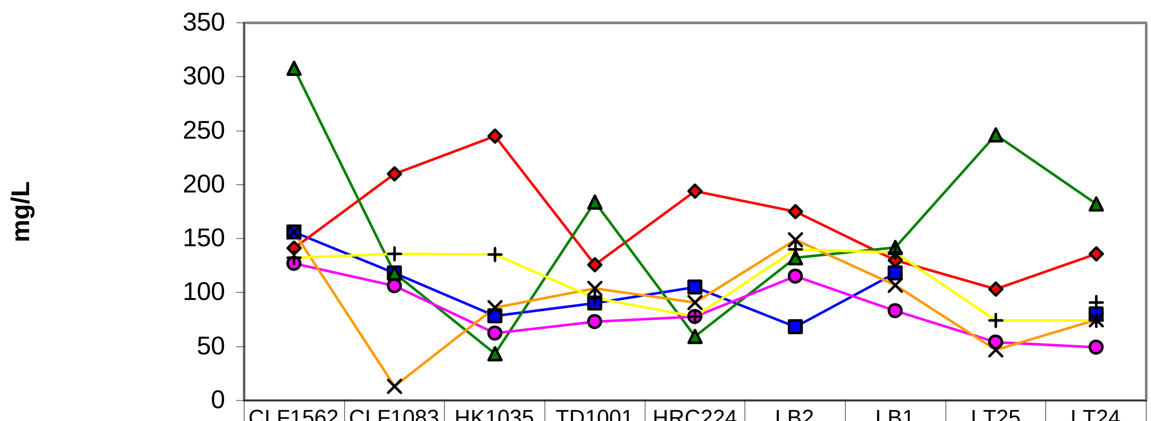
Total Alkalinity



	CLF1562	CLF1083	HK1035	TD1001	HRC224	LB2	LB1	LT25	LT24
3/17/98 Rain	156	118	78	90	105	68	118		80
6/23/98 Dry	141	210	245	126	194	175	130	103	136
9/22/98 Dry	308	118	44	184	59	132	142	246	182
11/2/98 Rain	127	106	62	73	78	115	83	54	49
12/14/98 Dry	156	13	86	104	91	149	107	47	75
1/27/99 Dry	132	136	135	95	78	140	137	74	74
4/5/99 Rain									91

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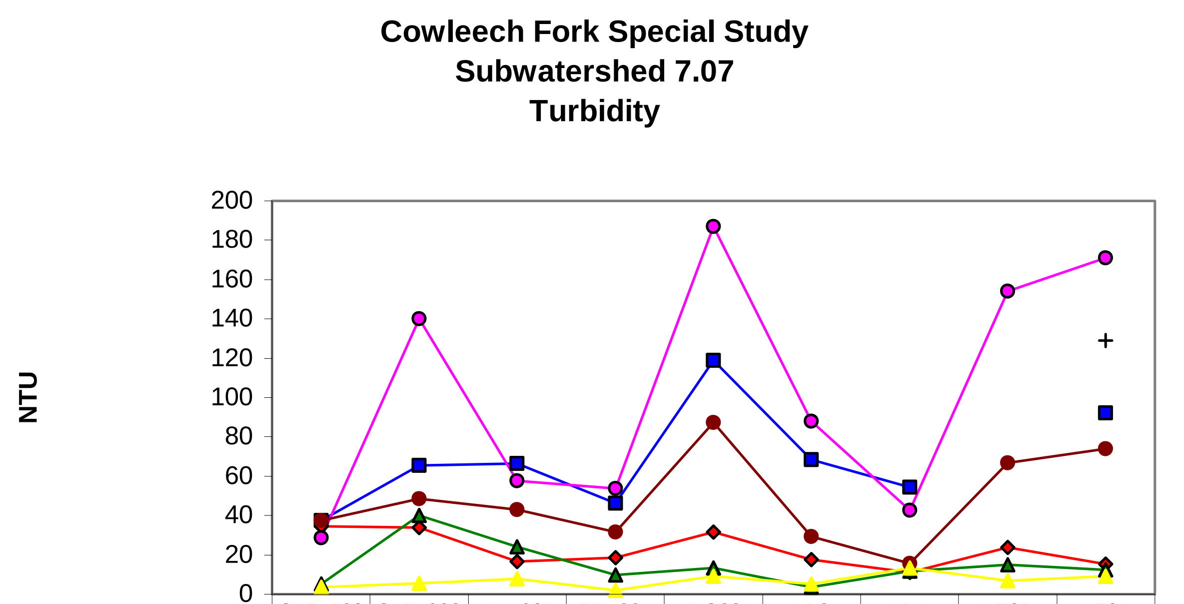
Turbidity

Turbidity refers to the suspended matter in water that interferes with the passage of light through the water. The turbidity may be caused by a variety of suspended materials, such as clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, plankton and other microscopic organisms and similar substances. Turbidity in water has public health implications due to the possibilities of pathogenic bacteria encased in the particles and thus escaping disinfection processes. Turbidity interferes with water treatment (filtration), and affects aquatic life. Excessive amounts of turbidity also make water aesthetically objectionable. Turbidity was less than 40 NTU in most dry weather samples and due to runoff, most rainfall event samples were higher and ranged from 40 to 187 NTU. Stations HRC224 and LT24 consistently peaked higher than the other sites during rainfall events. The elevated values were apparently due to nonpoint sources.

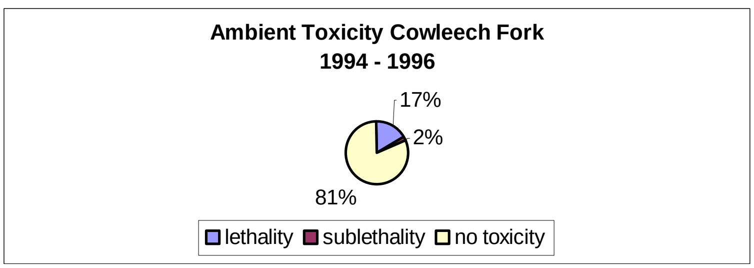


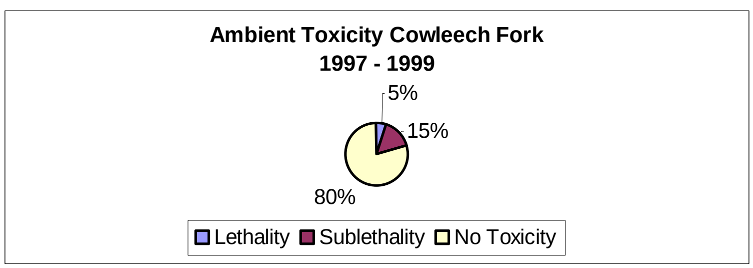
	CLF1562	CLF1083	HK1035	TD1001	HRC224	LB2	LB1	LT25	LT24
3/17/98 Rain	38	66	66	46	119	68	55		92
6/23/98 Dry	35	34	17	19	32	18	11	24	15
9/22/98 Dry	5	40	24	10	14	4	12	15	12
11/2/98 Rain	29	140	58	54	187	88	43	154	171
12/14/98 Dry	37	49	43	32	87	29	16	67	74
1/27/99 Dry	3	5	8	2	9	5	13	7	9
4/5/99 Rain									129

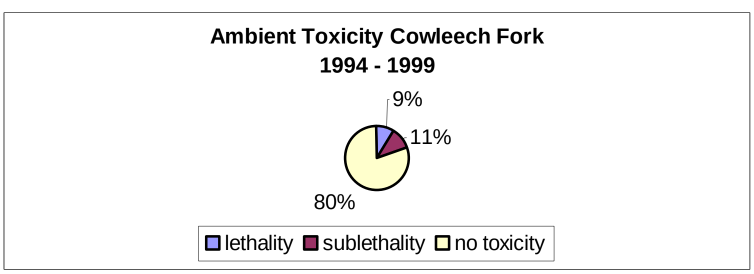
Special Study on Subwatershed 7.07 – Cowleech Fork

Ambient Toxicity Data

Ambient toxicity tests performed in the Cowleech Fork Subwatershed since 1994 have shown no toxicity in 80% of the samples. Ambient toxicity samples taken during this two year study provided results for two rainfall events and three normal or low flow events. The toxicity tests showed no toxicity in any of the samples taken during this study to *Pimephales promelas.* Vertebrates, such as *Pimephales*, are generally more tolerant to toxicants than invertebrates such as *Ceriodaphnia*. Vertebrates, through more complex liver functions, are better able to metabolize toxins. *Ceriodaphnia dubia* exhibited sublethality in 30% of the samples and lethality in 11% of the samples. The overall lethality for both species in the 1997-1999 study period was 5% lethality and 15% sublethality. This indicates that while conditions are not always favorable for some sensitive species, the stream should support a healthy aquatic community.

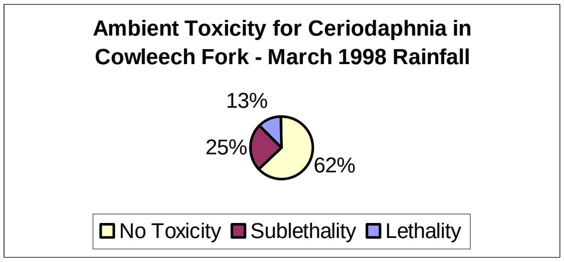


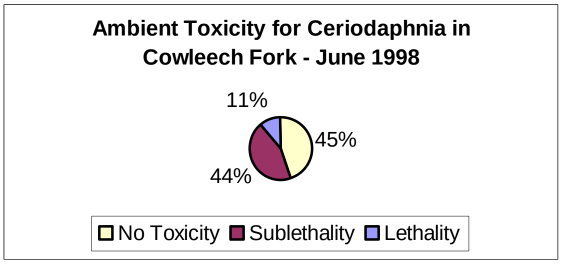


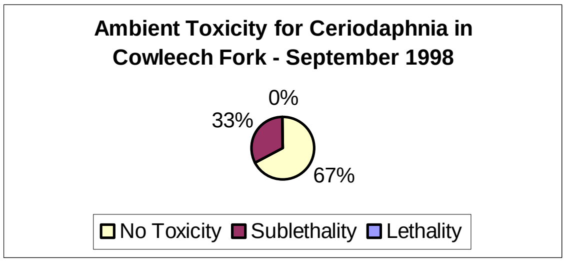


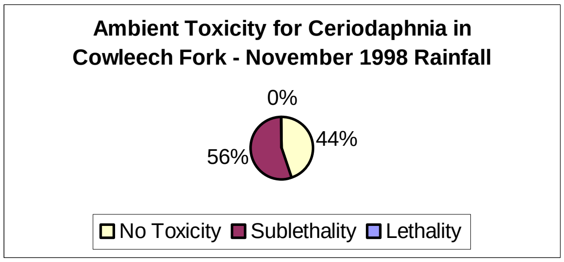
Special Study on Subwatershed 7.07 – Cowleech Fork

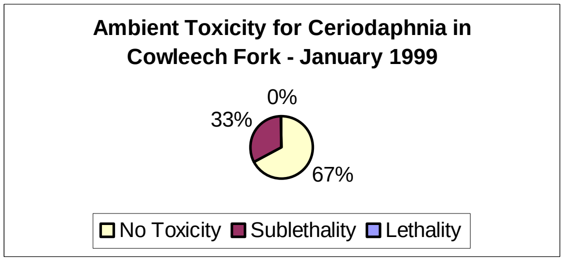
Lethality to *Ceriodaphnia dubia* was 13% in March 1998 during a rainfall event and sublethality was 25%. Sublethality was 56% to *Ceriodaphnia dubia* during the November rainfall event, but no lethality was observed. In June 1998, lethality was 11% and sublethality was 44%. Toxicity appeared to be lower in other months during dry weather. Historically, biomonitoring toxicity in this subwatershed has been strongly related to season, with most toxicity appearing in April, May, and June. In this study, toxicity was usually sublethal and was not strongly correlated to season or rainfall. This may be attributed to the unusually dry study year and more time for biodegradation of any toxicants in the soil between rainfall events. Also, the second quarter sample event fell in June after a long dry period so rainfall events fell in March and November of 1998. Since 1998 was unusually dry, an additional biomonitoring sample was collected in January 1999 after a rainfall event.





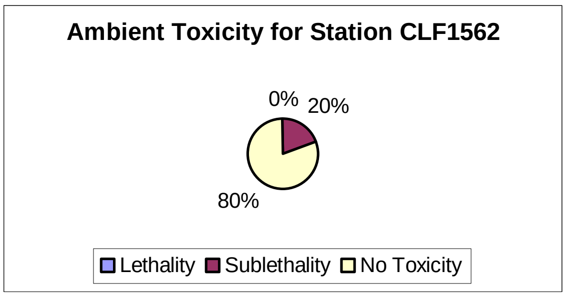


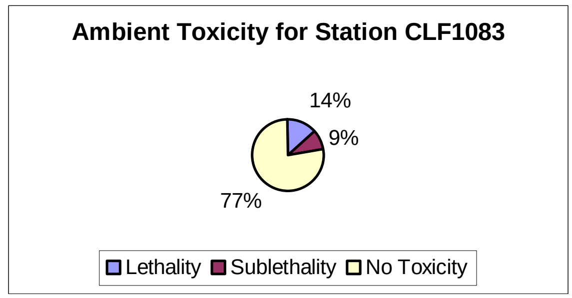


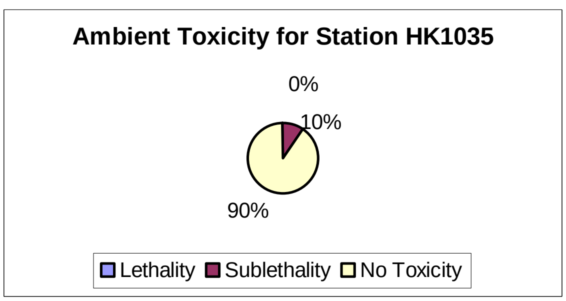


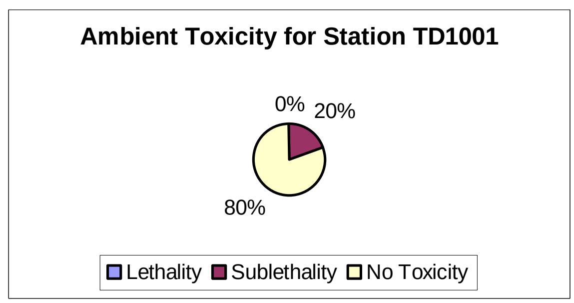
Special Study on Subwatershed 7.07 – Cowleech Fork

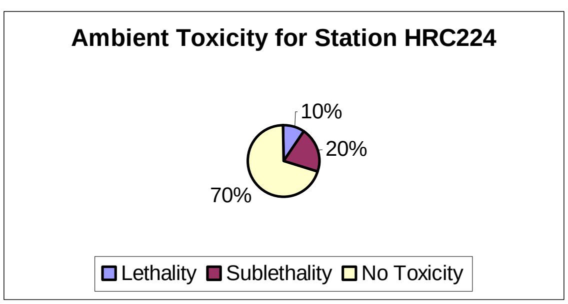
Sublethality was observed at all sites during at least one sampling event. Station LB1 showed sublethality in 40% of the sampling events. The highest lethality was 23% seen at Station CLF69N, a historical station, sampled from 1994 to 1996. Almost all of the stations showed no toxicity in 75% or more of the sampling events. No site had consistent toxicity and toxicity was never observed at all sites during the same sampling event. This would indicate the toxicity problems probably come from a variety non-point of sources.

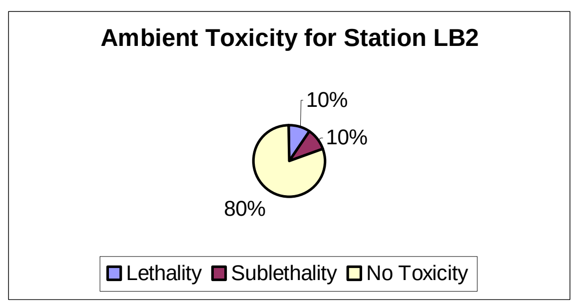




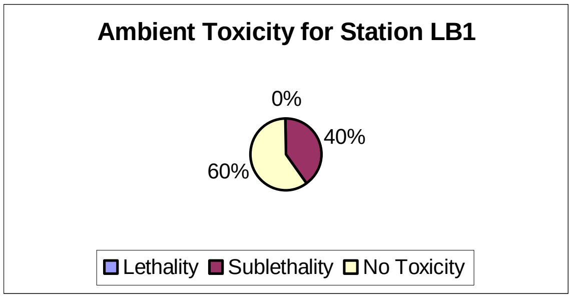


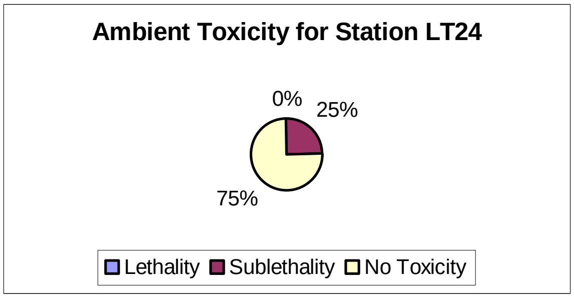


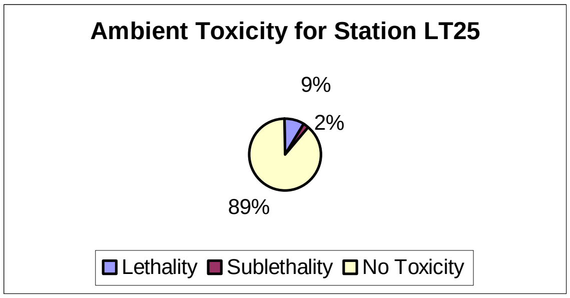


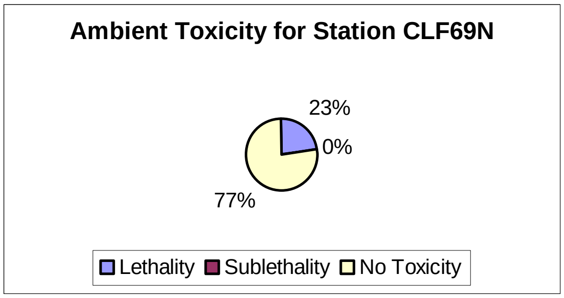


Special Study on Subwatershed 7.07 – Cowleech Fork









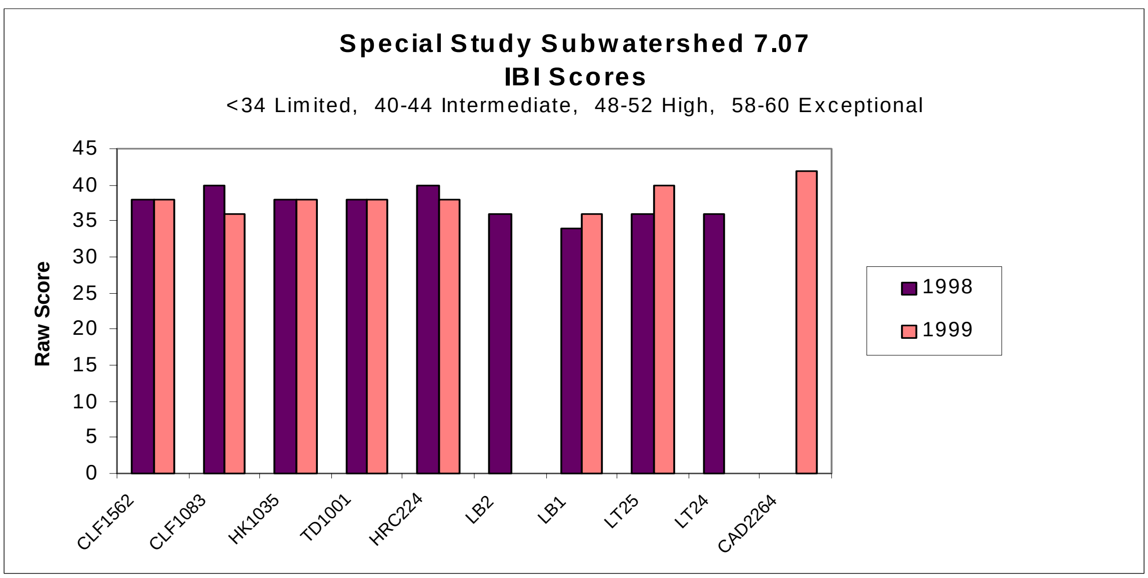
Special Study on Subwatershed 7.07 – Cowleech Fork

Benthic Macroinvertebrate and Fish Data

Fish and benthic macroinvertebrates (benthics) were collected at each site and the index of biological integrity (IBI) and the USEPA Rapid Bioassessment (RBA) Protocol II were applied to assess the health of each population. The IBI was used to analyze fish data and assign an aquatic life use for each stream. A reference site was added in 1999 on Caddo Creek. Fish and benthic macroinvertebrates were collected twice at each of these sites, once in 1998 during a drought year and again in 1999 during more normal conditions. Two sites sampled in 1998 were not re-sampled in 1999, LB2 because it was dry, and LT24 because it was too deep to wade. Benthics were collected at LT24 along the bank but no riffle-type habitat was present.

Index of Biological Integrity (IBI)

All of the sampled streams scored "Limited/Intermediate" or "Intermediate" using the IBI. These scores are typical for most Upper Sabine Basin streams sampled by SRA. Caddo Creek was added during the study as a biological reference site and had a slightly better benthic and fish population than any of the study sites. LB1 in 1998 scored the lowest. Since there is little or no flow from upstream in the summer, this site is often 100% treated effluent.

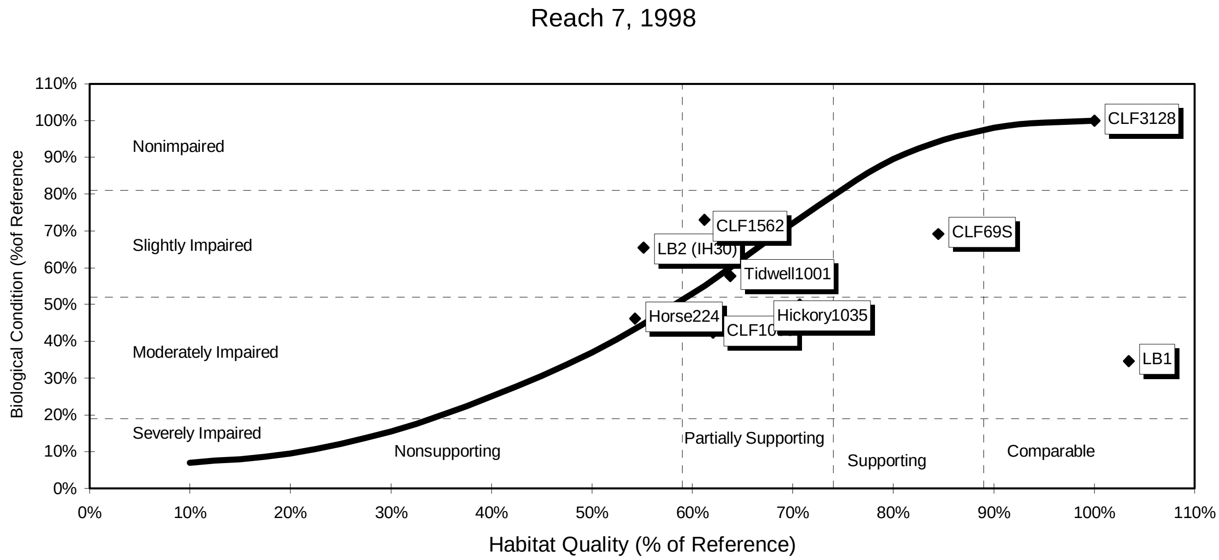


Special Study on Subwatershed 7.07 – Cowleech Fork

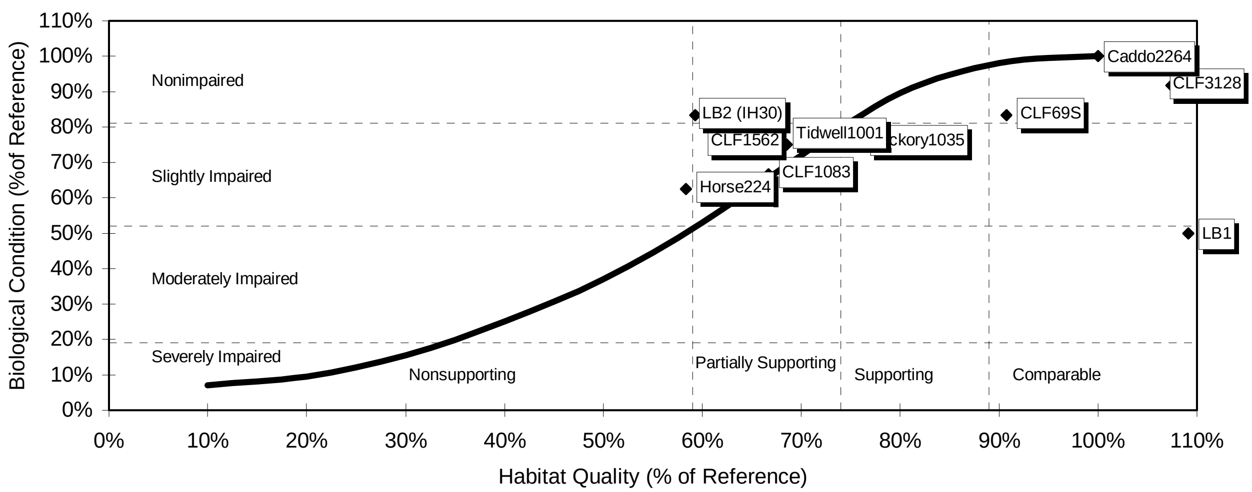
Rapid Bioassessment (RBA)

The RBA is used to evaluate the benthic macroinvertebrate community and stream habitat and compare study sites against a relatively non-impacted reference site. The sites in Reach 7 were sampled in 1998 between 6/30/98 and 8/18/98 during an unusually dry year. Many of these sites were nonflowing and collections were made in isolated pools. The sites were resampled in 1999 during more normal conditions. Rapid bioassessment protocols require a relatively nonimpacted reference stream as a standard for comparison with the study sites. In 1998, one of the study sites was used as the reference since it scored high in habitat and biological quality. In 1999, a new reference site was chosen on Caddo Creek which is adjacent to the Cowleech Fork watershed. The Caddo Creek site has a very similar habitat and watershed land-use but, unlike the Cowleech Fork watershed, toxicity has not been observed in historical biomonitoring sampling of Caddo Creek.

All of the nonflowing sites grouped closely in both habitat and biological quality and contained the biota expected in the limited habitat of a nonflowing stream. Of the three flowing sites, LB1 scored “moderately impaired”, Cowleech Fork at US69 scored “slightly impaired”, and Cowleech Fork at CR3128 (used as a reference site in 1998) had the healthiest community. In 1999, using Caddo Creek as a reference LB1, Hickory and Cowleech Fork at CR1083 rated “slightly impaired”. Cowleech Fork at CR3128 scored very close to Caddo Creek. LB2 was not resampled in 1999 because it was dry.



Reach 7, 1998 Sites Compared with Caddo (1999) Reference



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Summary and Recommendations

Toxicity in the Cowleech Fork Subwatershed was shown to be less severe than in previous sampling. Ambient toxicity does appear occasionally in this Subwatershed, but it is transient and does not appear to be from a single source or to originate from any specific stream. A higher percentage of the samples have shown some toxicity during April, May, and June.

Impairments to the aquatic life appear to be minimal. Benthic diversity was highest at CLF3128 (LT25), which is the first Cowleech Fork site downstream from Long Branch. The effluent dominated site, LB1 showed only an intermediate score for biological integrity. Habitat differences between sites appear to account for most of the differences in fish and benthic data, especially intermittent vs. perennial sites.

The impact of the effluent from the City of Greenville does appear to restrict biological diversity in the receiving stream, Long Branch. However, the effluent is the only flow in the stream much of the summer and perhaps even for the Cowleech Fork main stem. The overall impact of the effluent appears to be positive for the environment, since the absence of water in the stream would be detrimental to the maintenance of aquatic life. Improvements could be made with the addition of an artificial wetland to further treat wastewater from the City of Greenville. This would improve the water quality at the point of discharge.

Impacts from nonpoint sources can only be dealt with as the particular sources of the pollutants can be identified. It appears that the sources are mostly related to agricultural activities in the watershed. Best management practices should be implemented to reduce the impact to the aquatic environment. Consideration should be given to the implementation of a steering committee to shepherd a source protection plan for Lake Tawakoni and it’s watershed. This committee should establish positive steps and set feasible goals for reducing man’s impacts from point and non-point sources of pollutants in the 756 square mile watershed of Lake Tawakoni.

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It is unknown whether the source for atrazine is primarily from agriculture or private use. It is uncertain whether the levels will remain below the current safe levels or increase. The Sabine River Authority will be participating in a cooperative sampling effort with the TNRCC. The sampling will include analysis for atrazine at three sites on Lake Tawakoni and will be analyzed using the approved EPA Method 525.2 for drinking water analysis. The sampling will establish seasonal trends for the future and be used as baseline data to determine the effectiveness of best management practices.