INTENSIVE SURVEYS OF WATERSHEDS CONTRIBUTING TO McKINNEY FALLS SPRING 1993

Environmental Resources Management Division
City of Austin - Environmental and Conservation Services Department

INTRODUCTION

Natural watercourses running through McKinney Falls State Park were closed to swimming in 1981 due to periodic episodes of bacterial contamination. At that time, a suspected source of contamination was urban runoff from the highly developed watersheds which drain to Onion Creek within the Park. Furthermore, public perception was that the City of Austin's Williamson Creek Wastewater Treatment Plant, immediately upstream of the Park, was polluting the water. Since that time, twelve years of water quality data have been collected by various State and local agencies and the Williamson Creek Wastewater Treatment Plant has been decommissioned (in 1986). Texas Parks and Wildlife Department (TPWD) has therefore proposed reopening a segment of Onion Creek within McKinney Falls State Park to swimming in May, 1993.

To assist the State in the evaluation of this proposal, the City of Austin's Environmental and Conservation Services Department (ECSD) proposed to review historical water quality data collected from within the Park since the closing of the Williamson Creek Treatment Plant in 1986 and to conduct intensive surveys to further verify conclusions drawn from the data review. Water quality and bacteriological samples have been collected and analyzed for various parameters from sites within the Park by several agencies, including the Texas Department of Health (TDH), the Austin/Travis County Health Department (ATCHD), and the City of Austin Water and Wastewater Department (W&WW). ECSD's review and investigations focused primarily on those water quality parameters most closely associated with swimmer health and safety - fecal coliform and turbidity.

Historical data indicate that high levels of fecal coliform contamination are relatively rare, and such occurrences appear to be related to high flows after storm events. Exhibit 1 shows the number of samples analyzed for fecal coliform concentrations from 1987 to 1992 by all agencies collectively and the number of times in which levels exceeded 200 colonies/100 ml sample. (The TWC surface water quality standard for contact recreation is a geometric mean of five or more samples of less than 200 colonies of fecal coliform per 100 ml over a thirty day period.)

To verify the observed relationship between fecal coliform concentrations and high flows, and to further investigate the instream relationship between fecal coliform concentration, high flows, and turbidity, ECSD proposed additional studies of McKinney Falls and its contributing creeks - Onion, Williamson, Slaughter, South Boggy, Rinard, Marble, and Bear - prior to the proposed park opening in May, 1993. The regional assessment conducted by ECSD included two intensive surveys: one in March, 1993 during typical baseflow (dry weather) conditions and one in April, 1993 following a local rainstorm event.

ECSD WATER QUALITY INVESTIGATIONS

Baseflow Conditions

On March 16 and 17, 1993, ECSD monitored 17 sites (Exhibit 2, site map) during baseflow conditions, in creeks contributing to McKinney Falls as well as in the Falls area itself. Dry weather conditions had prevailed for two weeks prior to this sampling. The only measurable precipitation which occurred was 0.39" on March 12. Grab samples at each site were collected and delivered to the City's Walnut Creek Laboratory for analysis on the day of collection. Samples were analyzed for the following parameters: fecal coliform, fecal streptococcus, total suspended solids, volatile suspended solids, chemical oxygen demand, biochemical oxygen demand, total organic carbon, nitrate, nitrite, total Kjeldahl nitrogen, total phosphorus, ortho phosphorus, dissolved oxygen, conductivity, turbidity, pH, and temperature. Both fecal coliform and fecal streptococcus were analyzed in order to determine the likely source of bacterial contamination - animal versus human. If the observed fecal coliform to fecal streptococcus ratio is 4:1 or greater, human contamination sources are indicated (i.e. raw or inadequately treated wastewater); however, if the ratio is 0.7:1 or less, sources of animal bacterial contamination are indicated. Observed relationships between 0.7 and 4.1 are inconclusive in terms of a predominant origin for the bacteria present.

Stormflow Conditions

On April 7, a storm event large enough to generate stream runoff began around 8 am and ended approximately three hours later, totaling 0.55" of precipitation as measured at the City Flood Early Warning System (FEWS) raingauge #4900. Fecal coliform, fecal streptococcus, pH, temperature, conductivity, temperature, and turbidity were taken at the lower falls (On1) at 12:45 pm and again at 3:35 pm. The same suite of 17 parameters examined during baseflow was examined between 12:45 pm and 3:10 pm at eight stream sites (On1, W1, M1, R1, Bo1, Br1, On5, S1). On April 8th (7:15 am, 10:30 am, and 2 pm) fecal coliform, fecal streptococcus, pH, temperature, conductivity, dissolved oxygen and turbidity were tracked over time at the lower falls. The spatial and temporal nature of these samples was selected to compare baseflow to stormflow at sites of stream confluence and to examine the relationships between bacterial concentrations, turbidity and time following the storm event.

RESULTS AND DISCUSSION

All data collected during baseflow and stormflow conditions are shown in Exhibits 3 and 4, respectively. The full suite of parameters was designed to provide an overview of general water quality; however, for the purposes of this report - an evaluation of water quality as it relates to swimmer health and safety - the discussion focuses on fecal coliform, fecal streptococcus, and turbidity. A brief discussion of nitrates is also included due to the tendency for high nitrates to increase algae growth. Algae growth could render the creekbed in the swimming area slippery and visually unappealing.

Bacteria

During baseflow conditions, water from all test sites contained less than 200 colonies/100ml of fecal coliform. The highest coliform count was recorded at the South Boggy Creek station at S. 1st St. (130 colonies/100 ml). The lowest fecal coliform count found during the entire survey was recorded at Onion Creek below the lower falls (13 colonies/100ml). Such counts indicate excellent sanitary quality for streams, either urban or nonurban. Most urbanized streams in Austin, such as Shoal and Waller Creek, reveal well over 200 colonies/100ml during dry weather conditions; for instance, ATCHD's long-term data show an arithmetic mean of 1,866 and 2,187 colonies/100ml respectively for these two creeks from 1984-1990. The fecal coliform to fecal streptococcus ratios for the 17 sites of this study are below the 4:1 ratio; such ratios typically do not indicate a human source of fecal contamination during normal baseflow conditions.

Two days before the stormflow intensive survey (April 5), ATCHD recorded 130 colonies/100ml of fecal coliform at McKinney Falls during baseflow conditions. During the stormflow survey, fecal coliform counts at that site were predictably high (108,000 colonies/100ml) immediately following the storm event at 12:45 pm; however, fecal coliform counts dropped quickly to 12,000 colonies/100ml by 3:35 pm on the same afternoon and were down further to 290 colonies/100ml by the following day, April 8 (2:15 pm). Routine ATCHD sampling in the next week recorded < 9 colonies/100ml on April 12. These variations are graphically presented in Exhibit 5. Although fecal coliform were not tracked continually to see when levels dropped below the 200 colonies/100ml standard, the data indicate that this criteria would be satisfied after approximately 48 hours. Reduction in bacteria levels will vary depending on the duration of the runoff-affected flows which is itself dependent upon the intensity, duration, and distribution of the storm event.

Fecal streptococcus counts dropped from 23,000 colonies/100ml at 12:45 pm, April 7 to 580 col./100ml at 2:15 pm, April 8th. While the observed ratio of fecal coliform to fecal streptococcus was 4.7:1 immediately following the storm event (12:45 pm), the ratio had changed to 0.24:1 within a few hours (3:35 pm). A ratio of greater than 4:1 immediately following the storm may indicate some human fecal contamination or reflect some concentration distortion during the first flush of pollution, because the observed ratios for subsequent samples indicated animal sources within a few hours and the next day as well. In order to explain if the observed ratio of >4:1 involves any overflow of sanitary sewers due to stormwater infiltration, more stormwater sampling would be necessary.

Following the measured storm event, the major sources of bacteria to McKinney Falls State Park were inflows from Williamson Creek (45,000 colonies/100ml) and South Boggy Creek (18,714 colonies/100ml) tributaries. These creeks are also in the most highly developed watersheds of all contributing creeks upstream of McKinney Falls State Park. Bacteria levels will vary somewhat with storm characteristics; therefore a single sampling event does not necessarily represent the actual variations in sources by watershed.

Turbidity and Solids

During the baseflow sampling, turbidity and solids were low at the lower falls site in McKinney Falls State Park and relatively low in all contributing watersheds except for the station on Marble Creek at Thaxton Road (M2). Higher turbidity and solids at Marble Creek during low flow can be explained by a muddy channel substrate combined with agricultural land uses, especially cattle grazing.

During the stormflow survey, turbidity was high (39 NTUs) at the lower falls site immediately following the storm event, but tracked the downward bacteria trend by dropping to 2.3 NTUs by 2:15 pm the next day (Exhibit 6). However, like the bacteria, turbidity did not return to baseflow levels (0.44 NTUs) until sometime after the last sample was taken at 2:15 pm on April 8, indicating some persistence of runoff impacts. Williamson and South Boggy Creeks were the major contributors to both high turbidity, TSS, and VSS loads (Exhibit 4).

Nitrates and Other Water Quality Parameters

During the baseflow sampling, relatively high NO3-N concentrations (1.65 mg/l) were observed at the lower falls site within McKinney Falls State Park. This is consistent with the average nitrate concentration of 1.87 mg/l recorded by W&WW at the same site between 1986 and 1992. (For comparative purposes, the average nitrate concentration of Shoal Creek sampled by ATCHD from 1984 to 1990 was 0.46 mg/l.) Even higher NO3-N levels (2.66 mg/l) were seen during this baseflow study in Williamson Creek at its confluence with Onion Creek. However, the high nitrate levels at the lower falls cannot be attributed to Williamson Creek alone, because high nitrates (1.45 mg/l) were also found in Onion Creek above the Park's upper falls (On2) which is upstream of the Williamson Creek confluence. The nitrates become elevated on Onion Creek downstream of Onion Creek at William Cannon (On3) and become elevated on Williamson Creek somewhere below Williamson at Pleasant Valley (W2) and its confluence with Onion Creek.

There are several potential sources of nitrates in this area, including: seepage of nitrates from the decommissioned Williamson Creek Wastewater Treatment site grounds (old holding ponds), or Jimmy Clay golf course. However, preliminary sampling conducted by golf course staff above and below the golf course indicated that nitrate concentrations upstream of the course (> 5.0 mg/l) were actually higher than concentrations below the course (< 3.0 mg/l). Further investigations of these two potential sources are planned.

During the stormflow survey, NO3-N levels at the lower falls were predictably higher (2.16 mg/l) following the storm event than baseflow levels (1.65 mg/l). Higher nitrates are measured at On1 than On5, demonstrating the same spatial difference in nitrates as was seen during baseflow conditions. The highest contributions to nitrate levels occur from Onion Creek downstream of I-35, Marble Creek (1.54 mg/l), Slaughter Creek (1.09 mg/l), and Williamson Creek (0.8 mg/l).

Exhibit 7 shows the variations in specific conductivity during and after the storm. The conductivity variations are a mirror image of turbidity and bacteria because the conductivity of runoff is lower than baseflow. This graph is provided to further verify the time required for storm-affected runoff to pass.

Other nutrients and water quality parameters were within the normal range for urban/suburban stream systems during baseflow and storm conditions.

CONCLUSIONS AND RECOMMENDATIONS

- With respect to indicator bacteria, McKinney Falls State Park appears to be safe for swimming during baseflow conditions and 48 hours following a storm event. We recommend that TPWD conduct additional post-storm monitoring to verify the 48 hour minimum closure time since this increment is based on sampling of only one storm.

- The return of turbidity and/or conductivity to pre-storm levels might be considered by TPWD as an indicator that swimming is safe again after a storm event, since turbidity decreases appear to accompany decreases in bacteria counts.

- We recommend that TPWD also monitor bacteria levels closely during extreme low flow events for possible population increase due to heavy human use and higher temperatures.

- The source of nitrate loading to the McKinney Falls State Park area cannot be determined precisely without further study. An investigation of the suspected source area in the vicinity of the holding ponds of the closed Williamson Creek Wastewater Plant is currently underway by ECSD and the City Parks and Recreation Department.

- Additional dry weather storm sewer screening and further wastewater package plant inspections do not appear to be warranted at this time. However, we recommend continued monitoring by TPWD at the swimming areas of the park, at least weekly, and request that any increase in parameters of concern be reported immediately to the City.

- The City should consider structural quality retrofit projects for nonpoint source control on Williamson and South Boggy Creeks, because these watersheds are the most urbanized and appear to be the greatest contributors of pollutants to the McKinney Falls State Park area after storm runoff events.

Exhibit 1

Fecal Coliform Levels at McKinney Falls

(1987-1992)

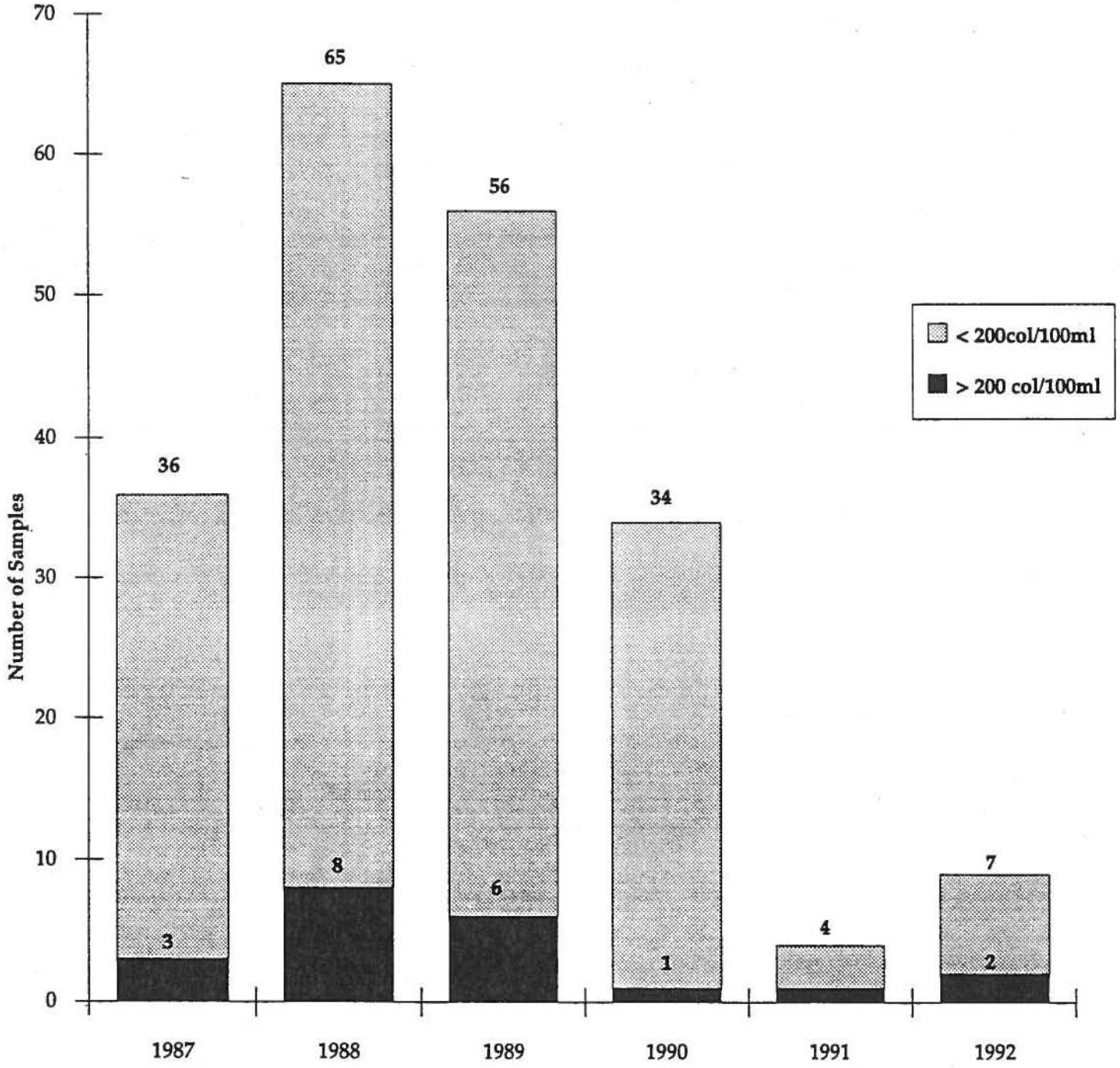
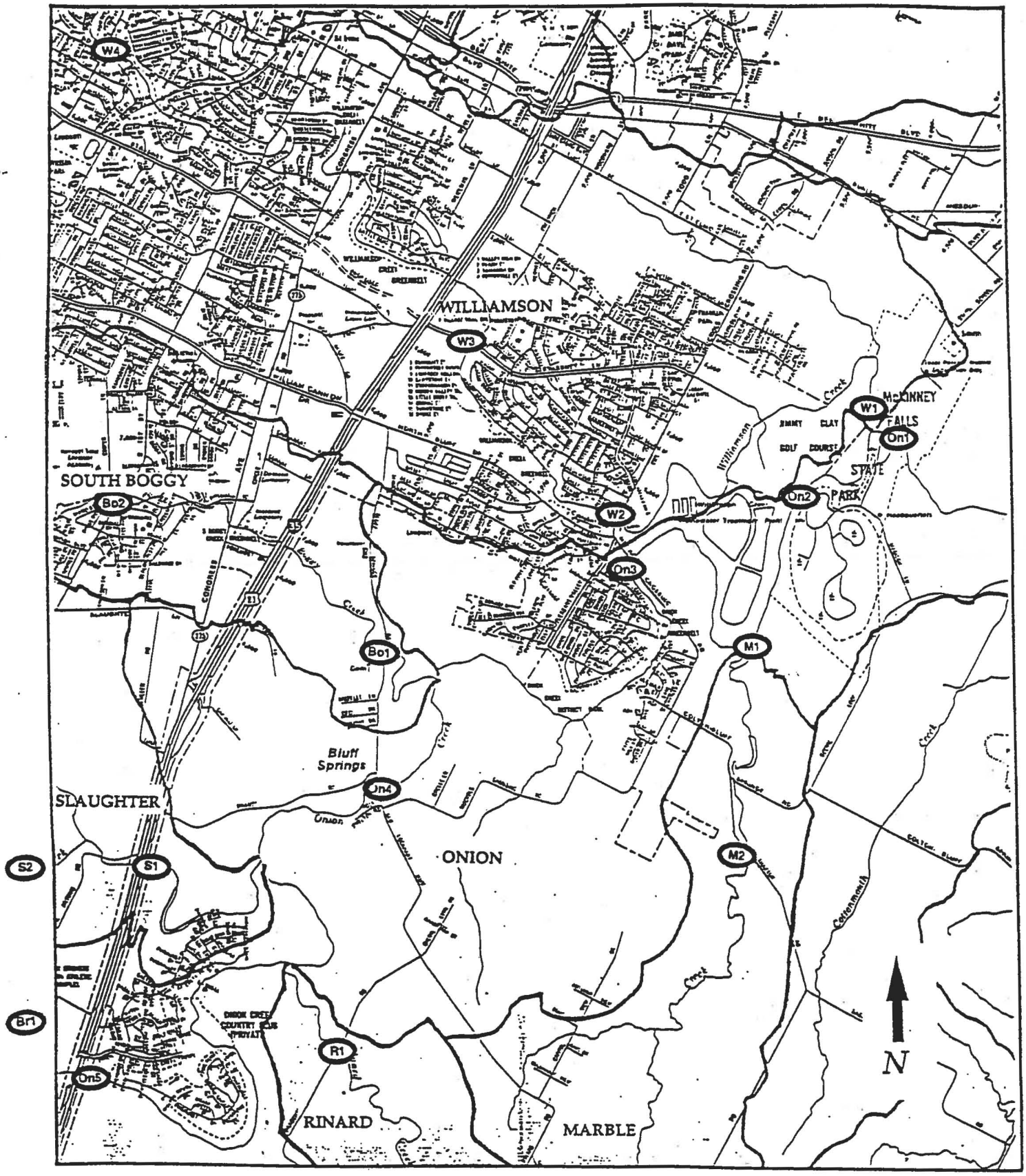


Exhibit 2
Intensive Survey Monitoring Sites Above McKinney Falls



Source: COA ECSD, 1993.

Exhibit 3
ECSD Intensive Survey Results
Baseflow Conditions
(March 16-17, 1993)

Code	Site	Temp °C	pH	DO MG/L	Cond.	Turbidity NTUs	TSS MG/L	VSS MG/L	COD MG/L	BOD MG/L	TOC MG/L	NH3-N MG/L	NO3-N MG/L	TKN MG/L	TP MG/L	ORTHO-P MG/L	F COLI col/100ml	F STREP col/100ml
On1	Onion below lower falls	17.02	8.29	10.40	611	0.49	1.1	0.5	9.0	0.4	7.8	0.06	1.65	0.24	<.02	<.02	13	19
On2	Onion above upper falls	15.17	8.40	11.76	615	0.39	0.3	0.5	5.2	0.2	4.53	0.06	1.45	0.22	<.02	<.02	23	22
On3	Onion at William Cannon	15.37	8.22	10.09	587	0.51	1.0	0.2	2.4	1.4	3.55	0.04	0.44	0.19	<.02	<.02	63	76
On4	Onion at Old Lockhart Hwy	15.28	8.20	9.59	591	0.38	0.7	0.5	5.6	1.2	3.58	0.06	0.25	0.16	<.02	<.02	55	74
On5	Onion at I-35	14.50	8.28	10.70	590	0.44	0.4	0.4	4.0	1.3	4.36	0.34	0.33	0.18	0.02	<.02	19	9
Br1	Bear at FM 1626	16.65	8.20	10.02	580	0.7	1.9	0.6	19.4	2.6	9.21	0.08	0.24	0.45	0.02	0.02	19	31
W1	Williamson at Pleasant Valley	15.42	8.18	9.04	704	0.42	0.5	0.3	<.4	1.1	5.37	0.06	0.32	0.22	<.02	<.02	88	88
W2	Williamson above lower falls	20.03	8.37	14.77	646	0.48	0.8	0.6	10.6	0.3	3.84	0.06	2.66	0.21	<.02	<.02	45	21
W3	Williamson at Stassney	15.77	7.86	8.73	668	0.7	1.1	0.4	6.0	1.2	5.2	0.06	0.09	0.23	0.03	0.02	45	37
W4	Williamson at Manchaca	16.56	8.20	10.76	483	3.2	5.0	1.8	15.6	3.2	7.84	0.06	0.22	0.39	0.06	0.02	93	68
Bo1	S. Boggy at Bluff Springs[1]	14.82	8.15	10.39	682	0.7	0.5	0.3	<.4	0.9	4.65	0.08	0.22	0.12	<.02	<.02	73	46
Bo2	S. Boggy at S. 1st St.	16.83	7.93	9.58	787	1.6	3.1	0.8	9.0	1.0	3.6	0.06	0.45	<.12	0.07	0.05	130	278
S1	Slaughter at I-35	15.18	8.30	10.79	582	1.9	2.4	0.7	9.8	1.4	5.13	0.06	0.11	0.21	<.02	<.02	100	74
S2	Slaughter at Manchaca	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry
M1	Marble above Onion	18.41	7.99	14.59	677	3.4	4.8	1.0	10.6	1.3	6	0.06	1.76	0.29	0.02	<.02	66	64
M2	Marble at Thaxton	15.84	8.18	9.08	675	13	28.0	3.8	23.5	1.4	8.58	0.1	<.06	0.23	<.02	0.02	22	120
R1	Rinard at Bradshaw	14.90	8.17	9.85	617	3.4	3.7	0.9	19.0	1.5	10.4	0.08	<.06	0.31	0.05	0.02	23	78
	Minimum	**14.50**	**7.86**	**8.73**	**483**	**0.38**	**0.3**	**0.2**	**2.4**	**0.2**	**3.55**	**0.04**	**0.09**	**0.12**	**<.02**	**<.02**	**13**	**9**
	Average	**16.11**	**8.18**	**10.63**	**631**	**1.98**	**3.5**	**0.8**	**10.7**	**1.3**	**5.85**	**0.08**	**0.73**	**0.24**	**0.04**	**0.03**	**55**	**69**
	Maximum	**20.03**	**8.40**	**14.77**	**787**	**13**	**28.0**	**3.8**	**23.5**	**3.2**	**10.4**	**0.34**	**2.66**	**0.45**	**0.07**	**0.05**	**130**	**278**

Exhibit 4
ECSD Intensive Survey Results
Stormflow Conditions
(April 7-8, 1993)

Code	Sites	Date	Time	Temp ° C	pH	DO MG/L	Cond.	Turbidity NTUs	TSS MG/L	VSS MG/L	VSS MG/L	COD MG/L	BOD MG/L	TOC MG/L	NH3-N MG/L	N-NO3 MG/L	Fecal Coli col/100ml	Fecal Strep col/100ml
On1	Onion below lower falls	4/7/93	12:45	16.93	8.44	8.8	519	39	297	30	30	47	8.6	6.03	0.2	2.16	108000	23167
On1		4/7/93	15:35	17.14	8.2	9.11	428	36									12000	50000
On5	Onion at IH-35	4/7/93	14:40	18.5	8.13	8.54	588	0.79	0.8	0.5	0.5	2	1.7	3.51	0.05	0.39	25	74
Br1	Bear at FM 1626	4/7/93	14:20	17.53	8.32	8.11	902	1.4	5	0.5	0.5	15.4	2.9	7.54	0.04	0.45	14	47
W1	Williamson above lower falls	4/7/93	13:00	16.73	8.64	8.18	421	47	410	50	50	53	8.2	5.84	0.13	0.8	45000	100000
Bo1	S. Boggy at Bluff Springs	4/7/93	14:00	16.71	8.49	8.91	296	25	100	8	8	21	5	14.6	0.07	0.46	18714	17000
S1	Slaughter at IH-35	4/7/93	15:10	17.56	8.2	8.5	616	14	30	3	3	5.2	2.5	5.84	0.04	1.09	530	590
M1	Marble above Onion	4/7/93	13:20	17.48	8.42	7.7	687	5.9	12	0.5	0.5	9.8	1.4	5.64	0.04	1.54	2500	930
R1	Rinard at Bradshaw	4/7/93	13:40	17.59	8.41	8.83	664	2.3	14	1	1	5.6	2.3	5.35	0.02	0.23	2800	2200
On1	Onion below lower falls	4/8/93	7:15	16.71	8.42	9.26	544	2.8									600	214
On1		4/8/93	10:30	17.46	8.44	9.5	564	2.4									420	820
On1		4/8/93	14:15	19.08	8.3	9.05	564	2.3									290	580
	Onion (On1 Duplicate)	4/7/93							402	42	42	66	8.5	5.86	0.22	2.42	76000	20167
	Minimum			16.71	8.13	7.7	296	0.79	0.8	0.5	0.5	2	1.4	3.51	0.02	0.23	14	47
	Average			17.45	8.37	8.71	566.08	14.91	141.20	15.06	15.06	25.00	4.57	6.69	0.09	1.06	20,530	16,599
	Maximum			19.08	8.64	9.5	902	47	410	50	50	66	8.6	14.6	0.22	2.42	108,000	100,000

Exhibit 5

Changes in Fecal Coliform Concentrations Following a Significant Rainfall Event

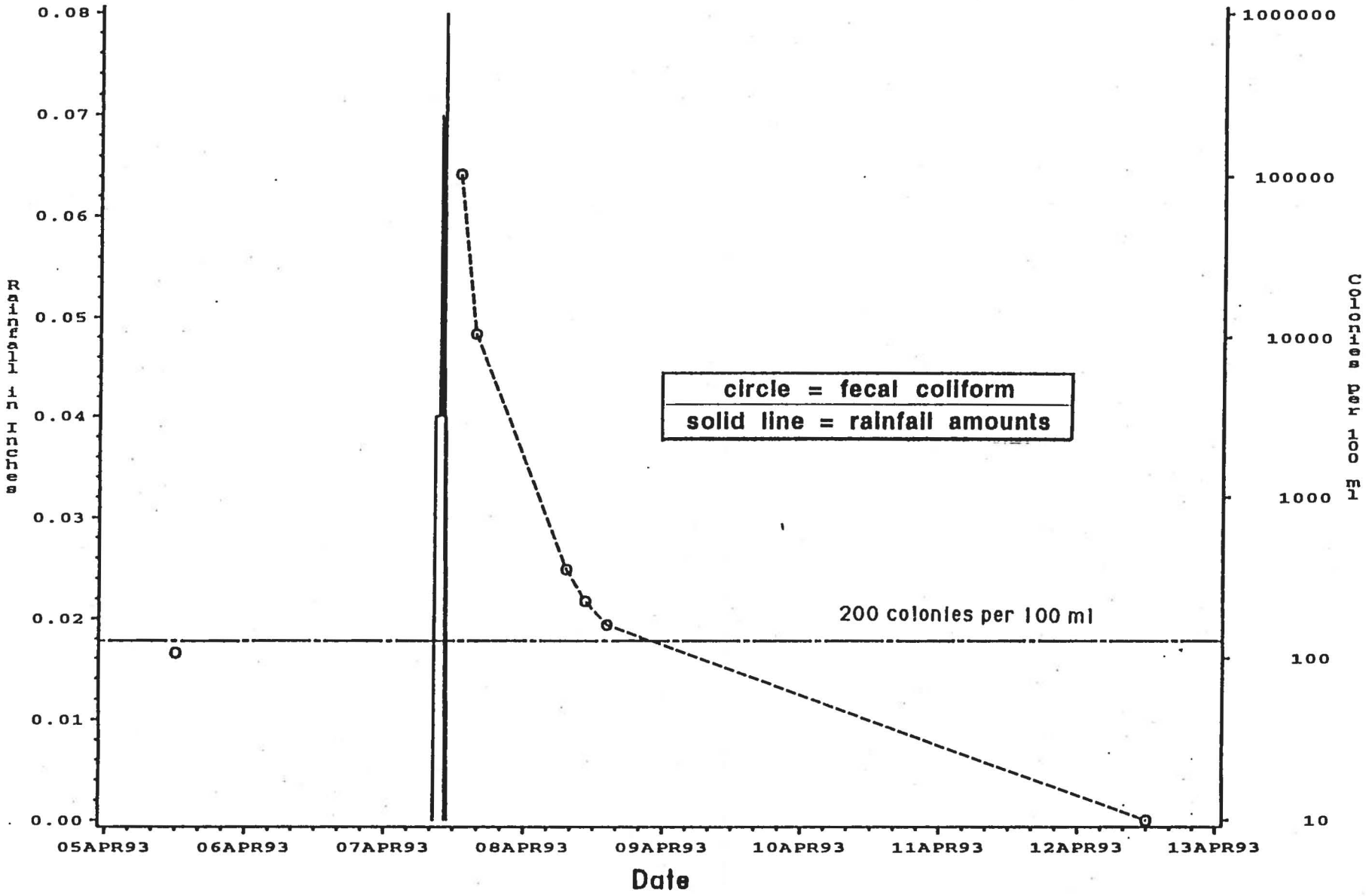


Exhibit 6

Changes in Stream Turbidity Following a Significant Rainfall Event

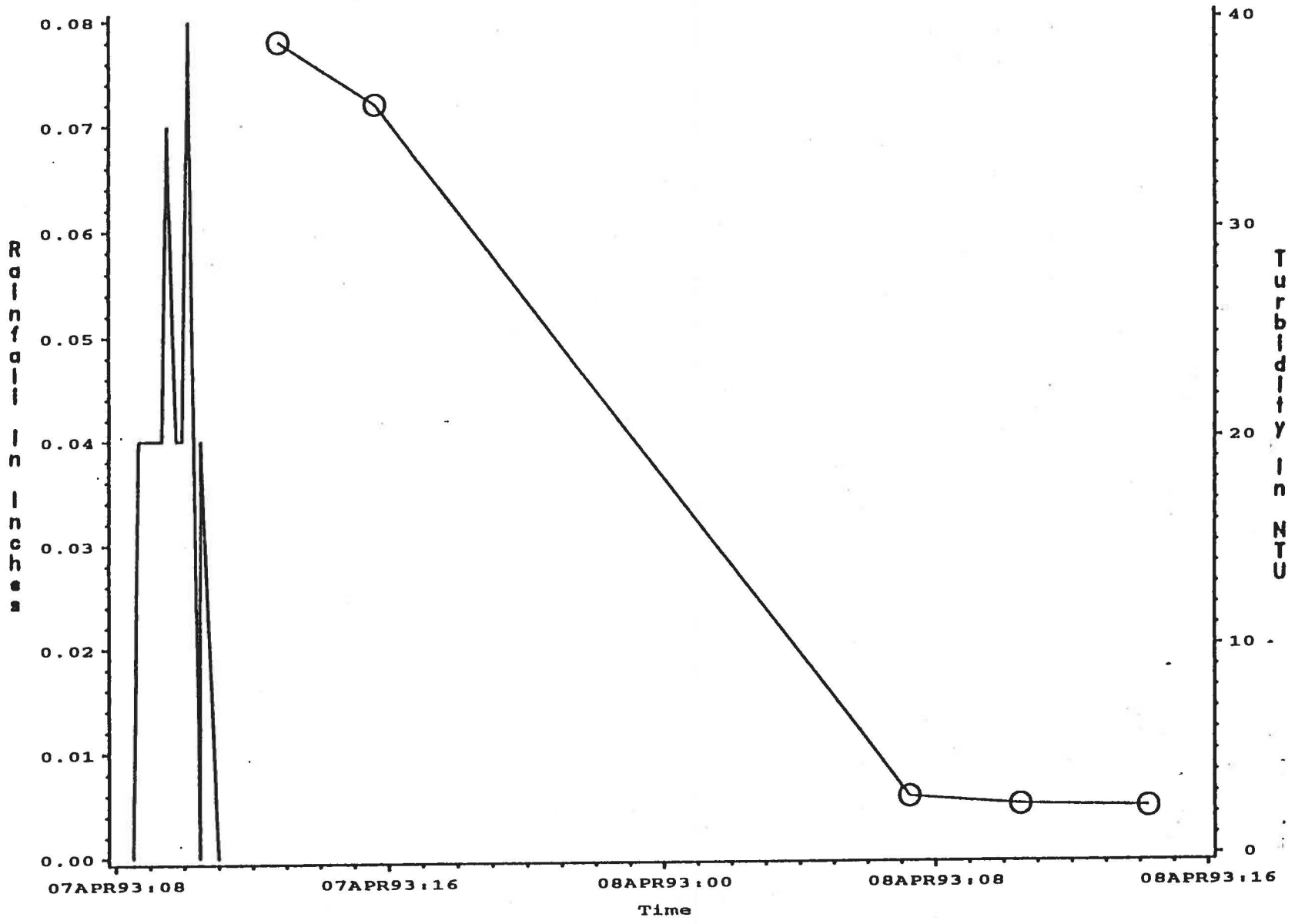


Exhibit 7

Changes in Ambient Stream Conductivity Following a Significant Rainfall Event