APPENDIX H

LCCD Hawk Creek Monitoring Study Conducted 1995-1996

Available Summary Data

For

Surface Water Monitoring

From

Hawk Creek Water Quality Monitoring Grant

1995 – 1996

Compiled by Dean White
Water & Soil Resources Technician
Lincoln County Conservation District

July 2009

HAWK CREEK WATER QUALITY MONITORING

FOR

LINCOLN COUNTY CONSERVATION DISTRICT

INTRODUCTION

Selection of potential sampling sites was conducted on November 22, 1994. The process commenced with a review of maps and aerial photographs of the watershed. David Lundgren of SCS provided first hand knowledge of the watershed to supplement that provided by Conservation District personnel. Since the intent of the grant is to characterize current water quality conditions in Hawk Creek, it was determined at this time that sampling sites would be established on the creek and not on tributary streams. Important factors considered at each potential site included:

- sampling access - due to the potential for large flow volumes in Hawk Creek during the high flow period, sites would be selected that allowed for obtaining flow measurements from bridges or other structures that would eliminate the need for wading;

- tributary contribution - sites should be able to provide a general indication of changes in water quality in Hawk Creek due to the contribution of flow from tributary streams; and

- land uses - sites should be able to provide a general indication of the effects of various land uses on the water quality of Hawk Creek.

Field observation of potential sites commenced with a trip to the mouth of the watershed and continued back upstream toward Highway 2.

POTENTIAL SAMPLING SITES

Five potential sampling sites were selected along Hawk Creek. These sites will be numbered from the mouth to the farthest upstream location using a combination of letters and numbers. This numbering system will aid in the identification of sites for reports and at a future time when the results of the sampling may be reviewed. A brief description of the sites follows.

Site HC1 (section 30, township 27 north, range 36 east)

This site will be located on Hawk Creek at the bridge on the Miles-Creston Road. This is the last bridge on the creek before it goes over Hawk Creek falls and flows into a reach

that will be effected by the water levels in Lake Roosevelt. The sampling site is approximately 1/4 mile upstream of the falls and should provide a good indication of what the creek is contributing to Lake Roosevelt. Snook Canyon and Olsen Canyon contribute flow to the creek upstream of this point. The contribution of Bean Canyon may also be identifiable depending upon the exact location of sample collection. Sampling will be conducted on the downstream side of the bridge due to large woody debris in the channel on the upstream side.

Site HC2 (section 32, township 27 north, range 36 east)

This site will be located at the bridge on Hawk Creek Road just south of the junction with Indian Creek Road. Indian Creek, Dodd Canyon and Trinkle Canyon all contribute flow to Hawk Creek upstream of this point. The area adjacent to the creek upstream of this point appears to have a mixture of rural residential and agricultural land uses.

Site HC3 (section 16, township 26 north, range 36 east)

This site will be located adjacent to the large culvert that runs under Hawk Creek Road at the junction with Hawk Creek Ranch Road. Stock Creek contributes flow to Hawk Creek upstream of this sampling point as do the many streams draining the Bachelor Prairie area. This sampling point will provide an indication of the effect of activities occurring on both sides of the valley upstream of this point.

Site HC4 (section 17, township 26 north, range 36 east)

This site will be located at the second bridge on Hawk Creek Ranch Road upstream of the junction with Hawk Creek Road. The area adjacent to the stream immediately upstream of this point is rural residential in land use. There is also agricultural activity farther upstream that could influence the water quality of Hawk Creek at this point. The main channel approximately 1 mile upstream of this point was dry on November 22 and a local resident stated that the creek goes under ground during certain times of the year and resurfaces prior to reaching the designated sampling point.

Site HC5 (section 15, township 25 north, range 36 east)

This site is located downstream of the confluence of Cottonwood Creek and Hawk Creek. Access is either from Highway 2 just west of the Department of Transportation's constructed wetlands or by way of the road that follows Cottonwood Creek out of Davenport. This site will provide information on the quality of the water flowing from the Tanner Lake area south of Highway 2 as well as the large area upstream of Davenport.

The sampling sites were selected so that the watershed could be broken into segments upstream of each point and water quality within each segment characterized. Since the scope of the grant is to identify water quality concerns within the watershed and not to

pinpoint specific sources, the proposed sampling scheme should fulfill the grant requirements.

WATER QUALITY PARAMETERS

The following is a brief description of the water quality data that will be collected at each site.

In the field monitoring:

- **Dissolved oxygen** - important to aquatic life, solubility of atmospheric oxygen in fresh water ranges from 14.6 milligrams per liter at 0 degrees Celsius to approximately 7 milligrams per liter at 35 degrees Celsius under 1 atmosphere pressure. The Washington State standard for Class A waters is 8 milligrams per liter or higher.

- **pH** - is a measure of the intensity of the acid or basic conditions of the water. It is important because different substances become available at different pH ranges. Aquatic organisms have optimum pH ranges and can exist only under certain conditions.

- **Conductivity** - is the measure of a solutions ability to carry an electrical current. Only ions in solution carry an electrical current. Conductivity varies with the number and type of ions present. Electrolytic conductivity increases with temperature.

- **Temperature** - effects all aquatic life. Temperature that is too high effects metabolic rates. High temperatures can be lethal to organisms. The Washington State standard for Class A waters is 18 degrees Celsius or less.

- **Flow** - the amount of water passing a point in a given period of time. This is measured in cubic feet per second and is obtained by obtaining a series of velocity readings along a cross-section of the stream channel. Flow measurements are used to determine the loading rates, in pounds per day, of nutrients and total suspended solids.

Laboratory analysis:

- **Ammonia - nitrogen** - may be used by plants directly to produce plant protein. Sources of nitrogen include human and animal wastes, fertilizers, and decaying organic matter. Organic nitrogen is broken down by bacteria to form ammonia. Ammonia in excess of plant needs is oxidized by bacteria to form nitrite. Higher ammonia values in water indicate that the sample was obtained near the source of the nitrogen or that the contamination was fairly recent. Ammonia may be toxic to aquatic life, but it is generally not a problem at a pH of less than 8 and ammonia - N concentrations below 1 milligram per liter.

- **Nitrate plus nitrite - nitrogen** - are formed as a part of the nitrification process. This process proceeds from ammonia to nitrite to nitrate. Nitrites generally have low concentrations in ground and surface waters. Nitrate has a drinking water standard of 10 milligrams per liter or less. Nitrate is converted to nitrite in the intestines of humans and reduces the oxygen carrying capacity of the blood. It leads to methemoglobinemia, blue babies, in infants.

- **Total phosphorus** - is the measure of all the phosphorus in solution, both organic and inorganic forms. Phosphorus, along with nitrogen, promotes the growth of aquatic plants that can destroy fish habitat. Sources of phosphorus include human and animal wastes, soil erosion, fertilizers and decaying organic matter.

- **Total suspended solids** - is a measure of the suspended material being carried by a stream. It is often used as an estimate of the suspended sediment load being carried by a stream.

- **Turbidity** - a measure of the clarity of the water. Turbid waters contain suspended matter that interferes with the passage of light through the water. The suspended material may range from colloidal to coarse dispersions depending upon the degree of turbulence. May be another indicator of suspended sediment load.

- **Fecal Coliform** - used as an indicator of the presence of other pathogens that may cause human health problems. It is an indicator of the presence of contamination by human or animal wastes.

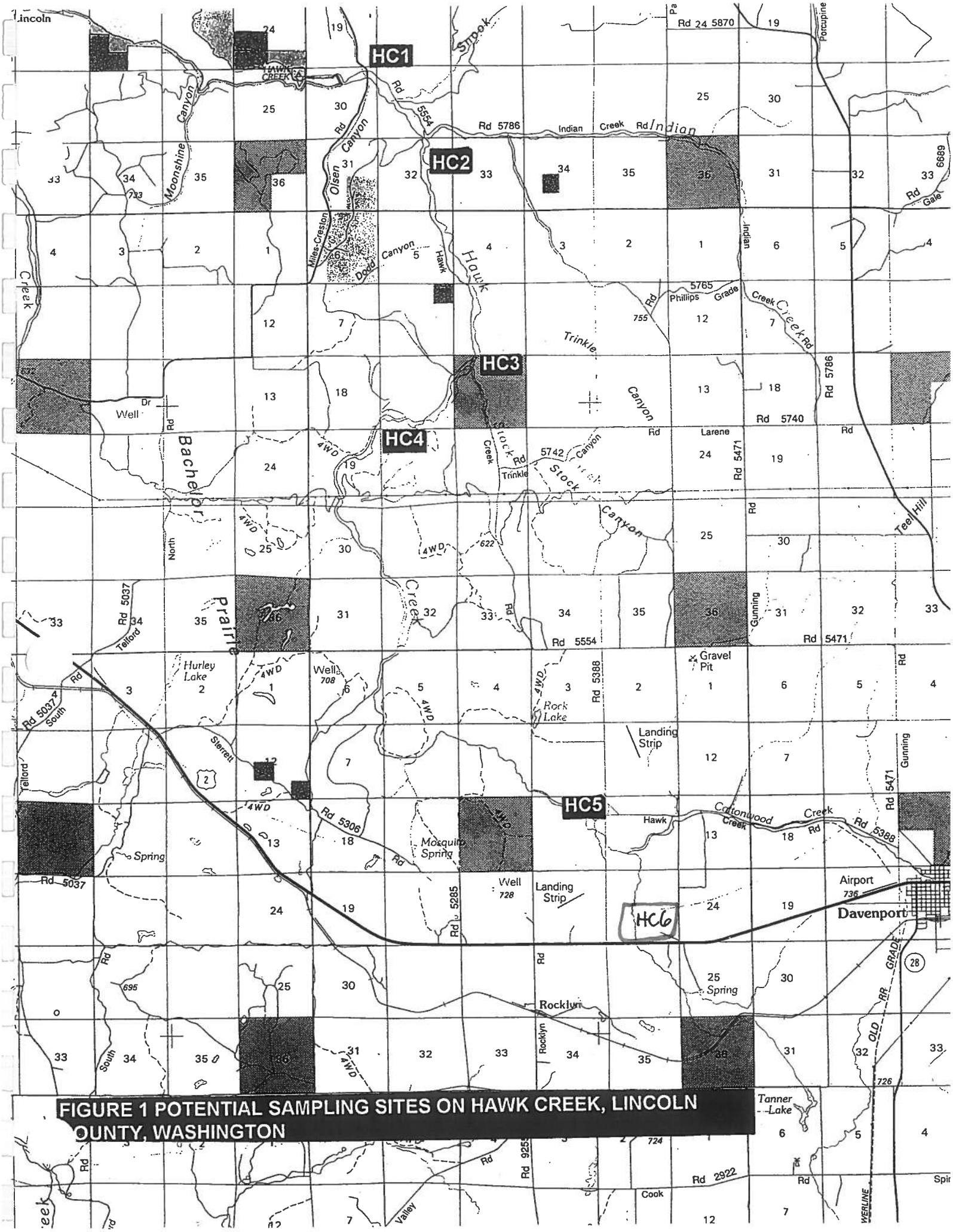


FIGURE 1 POTENTIAL SAMPLING SITES ON HAWK CREEK, LINCOLN COUNTY, WASHINGTON

Dear Sherry,

Here is the data from the first sampling period. I have enclosed some material on water quality parameters that might be helpful. In addition:

Time - recorded because the conditions can change through the day depending upon temperature and the presence of aquatic vegetation. Parameters that will change with time of sampling include temperature, dissolved oxygen, and pH.

Temperature - State standard for class A waters is 18 degrees C or less. High temperature can affect aquatic life by stressing them.

Dissolved oxygen - important for aquatic organisms. State standard for class A waters is 8 milligrams per liter

Conductivity - a measure of the dissolved salts in the solution, no State standard

pH - State standard of less than 9, I believe for class A waters

Nitrate+nitrite - no State standard for surface waters, drinking water standard for nitrate (NO3) is less than 10 milligrams per liter

Ammonia - no State standard

Turbidity - State standard is no increase of more than 5 NTU above background, must somehow define background

Fecal Coliform - for class A waters the geometric mean must be below 100 colonies per 100 milliliters and not more than 20% of the samples can exceed 200 colonies per 100 milliliters

I hope all the information helps. If you have questions please call me and we can talk things over. Looks like the nitrate-nitrite levels are higher than the nitrate levels found by WSU in Lake Roosevelt but there is a dilution factor to figure into things.

Hope all goes well for you.

Charlie

DATE: November 1, 1996

TO: Sherry Ledgerwood, Lincoln County Conservation District

FROM: Charlie Kessler, Stevens County Conservation District

SUBJECT: Hawk Creek Water Quality Data

I have received the results of the September 24, 1996 Hawk Creek sampling from the Eastern Washington University laboratory. The data for the entire project is summarized in the enclosed spreadsheets. I have conducted some additional analysis of the data that will hopefully prove useful to you when you present the results to your Board of Supervisors and when you write your final report. I was not sure of the level of detail you desire for Stevens County to perform on the data analysis. If you want or need more assistance on the analysis, please let me know.

TABLE 1: A comparison of Hawk Creek Data with Washington State Water Quality Standards; were Standards violated during the project sampling

STATION	DISSOLVED OXYGEN	TEMP.	pH	FECAL COLIFORM
HC1	NO	NO	NO	YES, 17% > 100
HC2	NO	NO	NO	YES, geometric mean > 50; 33% > 100
HC3	NO	NO	NO	YES, 17 % > 100
HC4	NO	NO	NO	NO
HC5	YES, 3 times	NO	NO	YES, geometric mean > 50; 17% > 100
HC6	YES, 1 time	NO	NO	YES, 20% > 100

The fecal coliform data are definitely affected by the small number of samples that were taken. A large sample population provides for a better estimate of actual conditions and also dampens out the affect of a single reading above the 100 colony per 100 milliliter level.

The chronic standard for ammonia-N is based upon temperature and pH and is therefore not one set number for all conditions. I used the maximum NH_3-N levels recorded for the individual stations on Hawk Creek and compared them to the chronic levels for the actual temperature and pH recorded on the date these levels were reported. All stations had maximum NH_3-N concentrations on October 17, 1995 during low flow sampling.

TABLE 2: A comparison of Hawk Creek Data with Washington State Water Quality Standards; maximum NH_3-N concentrations compared to chronic standards

STATION	MAXIMUM NH3 - N mg/L	TEMP. degrees C	pH	CHRONIC mg/L	MEASURED / CHRONIC
HC1	0.07	10.4	7.9	1.365	0.05
HC2	0.08	10.3	7.7	1.742	0.05
HC3	0.09	9.9	7.7	1.747	0.05
HC4	0.07	10.2	7.5	1.81	0.04
HC5	0.09	8.9	7.6	1.785	0.05
HC6	0.10	8.1	7.4	1.834	0.05

Even at the maximum concentration, the samples from Hawk Creek did not exceed 5 % of the chronic criteria for the associated pH and temperature conditions. The source for making this comparison is the Environmental Protections Agency's *Quality Criteria for Water 1986.*

The nitrate - nitrite - nitrogen (NO3+NO2 - N) results are higher than what we have found in the sampling we have conducted on other tributaries to Lake Roosevelt. The following table provides a comparison of Hawk Creek data with data from the Colville River at Chewelah, Washington and 10 tributaries to Lake Roosevelt / Columbia River in northern Stevens County.

TABLE 3: Comparison of Hawk Creek nitrate + nitrite - Nitrogen data with data from the Colville River and Columbia River tributary watersheds in Stevens County

LOCATION	MAXIMUM (mg/L)	AVERAGE (mg/L)
HAWK CREEK		
HC1	1.46	0.98
HC2	1.50	0.88
HC3	2.47	1.43
HC4	1.73	1.43
HC5	2.62	2.10
HC6	1.16	0.80
UPPER COLUMBIA		
SHEEP / GOODEVE	0.19	0.08
CEDAR	0.17	0.12
ONION	0.36	0.15
DEEP	0.21	0.08
PINGSTON	0.84	0.44
WESTSIDE	0.48	0.14
COLVILLE RIVER	1.44	0.47

The total phosphorus readings for Hawk Creek are all in excess of the levels EPA recommends for surface waters flowing into a lake or reservoir. This is not a standard but a recommendation. For water not flowing into a lake or reservoir, not more than 100 micrograms per liter is recommended, for waters flowing into a lake or reservoir, not more than 50 micrograms per liter is recommended and for the lake itself, not more than 25 micrograms per liter. The Hawk Creek data are summarized in the following table.

TABLE 4: Hawk Creek total phosphorus data; all values are in micrograms per liter

STATION	MAXIMUM	MINIMUM	AVERAGE
HC1	236	66	147
HC2	242	64	132
HC3	282	79	148
HC4	274	90	161
HC5	366	68	176
HC6	212	65	144

I have also created a table, Table 5 on a separate page, of loading data for both average and maximum conditions for each of the sampling stations. In the case of ammonia, the maximum concentration at each site occurred during low flow periods and so the loading at this time is less than the loading calculated for the average conditions.

I hope that this information will be helpful to you in preparing a project report. If you want Stevens County Conservation District to conduct further analysis, please let me know. If you are going to conduct more analysis yourself and need assistance, please feel free to call.

It has been very enjoyable working with you, Tom, David and Celine on this project. Thank you for giving me the opportunity to learn more about Lincoln County.

TA[illegible]E 5: Loading rates for average and maximum cond[illegible]s, in pounds per day or number of colonies per s[illegible]nd for fecal coliform, for the Hawk Creek Water Quality Monitoring Project, 1995 - 96

STATION	NO3+NO2-N		NH3 - N		T. PHOSPHORUS		T. SUS. SOLIDS		FECAL COLIFORM	
	AVE.	MAX.	AVE.	MAX.	AVE.	MAX.	AVE.	MAX.	AVE.	MAX.
HC1	222	423	9.1	3.9	33	143	4039	25,981	516,591	1,887,561
HC2	183	391	6.2	3.9	27	135	2905	26,296	1,118,017	2,542,940
HC3	210	1027	7.3	2.7	22	46	2053	14,960	129,322	619,507
HC4	182	240	5.1	2.1	21	99	1679	11,900	126,988	325,241
HC5	152	34	3.6	1.0	13	72	1286	10,286	201,431	1,147,056
HC6	7	27	0.4	0.1	1.2	1.6	128	31	7880	398,580

Average loading rates are calculated using average concentrations or numbers and average flow values

Maximum loading rates are calculated using the maximum concentration or number and the flow measured on the date corresponding to the maximum concentration or number

FIELD SAMPLING RESULTS FOR WATER QUALITY MONITORING ON HAWK CREEK, LINCOLN COUNTY, WASHINGTON

STATION: HAWK CREEK 1, BRIDGE ON MILES - CRESTON ROAD						
	TIME	TEMP	D.O.	COND.	pH	FLOW
		DEG. C	mg/l	µS/cm		CFS
1/16/95	1:05PM	4.7	11.8	232	7.9	53.8
6/5/95	11:35AM	13	10	276	8.1	22.1
10/17/95	12:42PM	10.4	11.1	280	7.9	10.3
3/12/96	3:20PM	9.2	11	255	8.1	112.1
9/24/96	3:35PM	11.1	11.87	283	8.3	12.3
MAXIMUM		13	11.87	283	8.3	112.1
MINIMUM		4.7	10	232	7.9	10.3
AVERAGE		9.7	11.2	265	8.1	42.1

STATION: HAWK CREEK 2, BRIDGE ON HAWK CREEK ROAD NEAR JUNCTION WITH INDIAN CREEK ROAD						
	TIME	TEMP	D.O.	COND.	pH	FLOW
		DEG. C	mg/l	µS/cm		CFS
1/16/95	11:50AM	4.5	11.6	229	7.8	48.3
6/5/95	10:50AM	12.5	9.6	274	7.8	20.3
10/17/95	11:45AM	10.3	10.5	279	7.7	9.1
3/12/96	2:30PM	9.2	11.0	253	8.0	103.8
9/24/96	2:45PM	11.5	11.6	278	8.2	11.2
MAXIMUM		12.5	11.6	279	8.2	103.8
MINIMUM		4.5	9.6	229	7.7	9.1
AVERAGE		9.6	10.9	263	7.9	38.5

FIELD SAMPLING RESULTS FOR WATER QUALITY MONITORING ON HAWK CREEK, LINCOLN COUNTY, WASHINGTON

STATION: HAWK CREEK 3, JUNCTION OF HAWK CREEK ROAD AND HAWK CREEK RANCH ROAD						
	TIME	TEMP	D.O.	COND.	pH	FLOW
		DEG. C	mg/l	µS/cm		CFS
1/16/95	10:45AM	4.3	11.8	230	7.8	30.5
6/5/95	10:15AM	11.7	9.9	266	7.9	13.6
10/17/95	10:54AM	9.9	10	266	7.7	5.6
3/12/96	1:22PM	8.3	11.2	267	8.0	77.1
9/24/96	1:50PM	9.9	11.2	263	8.0	9.0
MAXIMUM		11.7	11.8	267	8	77.1
MINIMUM		4.3	9.9	230	7.7	5.6
AVERAGE		8.8	10.8	258.4	7.9	27.2

STATION 4: SECOND BRIDGE ON HAWK CREEK RANCH ROAD						
	TIME	TEMP	D.O.	COND.	pH	FLOW
		DEG. C	mg/l	µS/cm		CFS
1/16/95	9:50AM	4.2	11.5	232	7.8	25.7
6/5/95	9:45AM	11.4	9.6	274	7.7	11.9
10/17/95	10:11AM	10.2	9.7	272	7.5	5.6
3/12/96	12:48PM	8.0	10.7	274	8.0	66.9
9/24/96	12:48PM	10.2	10.0	274	7.7	7.8
MAXIMUM		11.4	11.5	274	8	66.9
MINIMUM		4.2	9.6	232	7.5	5.6
AVERAGE		8.8	10.3	265	7.7	23.6

FIELD SAMPLING RESULTS FOR WATER QUALITY MONITORING ON HAWK CREEK, LINCOLN COUNTY, WASHINGTON

STATION 5: DOWNSTREAM OF CONFLUENCE OF HAWK CREEK & COTTONWOOD CREEK						
	TIME	TEMP	D.O.	COND.	pH	FLOW
		DEG. C	mg/l	µS/cm		CFS
1/16/95	8:30AM	3	10.8	272	7.7	20.7
6/5/95	8:45AM	13.5	7	392	7.5	5.1
10/17/95	9:20AM	8.9	8	412	7.6	2.0
3/12/96	11:52AM	6.2	10.5	317	7.9	36.7
9/24/96	11:45AM	9.3	7.2	416	7.6	2.4
MAXIMUM		13.5	10.8	416	7.9	36.7
MINIMUM		3	7	272	7.5	2
AVERAGE		8.2	8.7	362	7.7	13.4

STATION 6: HAWK CREEK DOWNSTREAM OF DOT WETLANDS NORTH OF HIGHWAY 2						
	TIME	TEMP	D.O.	COND.	pH	FLOW
		DEG. C	mg/l	µS/cm		CFS
1/16/95	NS	NS	NS	NS	NS	NS
6/5/95	7:55AM	13.1	6.8	313	7.3	1.4
10/17/95	8:30AM	8.1	7.9	338	7.4	0.2
3/12/96	10:35AM	5.6	9.0	331	7.5	4.3
9/24/96	10:45AM	6.3	9.5	322	7.5	0.5
MAXIMUM		13.1	9.5	338	7.5	4.3
MINIMUM		5.6	6.8	313	7.3	0.2
AVERAGE		8.3	8.3	326	7.4	1.6

TIME: TIME OF DAY AT WHICH THE SAMPLE WAS TAKEN
TEMP.: WATER TEMPERATURE
DEG. C: DEGREES CELSIUS (CENTIGRADE)
D.O.: DISSOLVED OXYGEN
COND: CONDUCTIVITY
mg/L: MILLIGRAMS PER LITER
µS/cm: MICROSIEMENS PER CENTIMETER
CFS: CUBIC FEET PER SECOND

LABORATORY RESULTS FOR WATER QUALITY MONITORING ON HAWK CREEK, LINCOLN COUNTY, WASHINGTON

	NO3+NO2-N	NH3-N	TP	TURBIDITY	TSS	FECAL COLIFORM
	mg / L	mg / L	µg / L	NTU	mg / L	# colonies / 100 ml
STATION: HAWK CREEK 1, BRIDGE ON MILES - CRESTON ROAD						
1/16/95	1.46	0.06	201	27	28	30
1/16/95D	1.46	0.05	216	26	27	30
6/5/95	0.75	0.01	94	1.3	5	300
10/17/95	0.41	0.07	66	1.0	**2**	27
3/12/96	1.33	0.02	236	32	43	40
9/24/96	0.48	0.01	69	1.0	**2**	22
MAXIMUM	1.46	0.07	236	32	43	300
MINIMUM	0.41	0.01	66	1	2	22
AVERAGE	0.98	0.04	147.0	14.7	17.8	NA
GEO.MEAN	NA	NA	NA	NA	NA	43.1
STATION: HAWK CREEK 2, BRIDGE ON HAWK CREEK ROAD NEAR JUNCTION NEAR JUNCTION WITH INDIAN CREEK ROAD						
1/16/95	1.5	0.04	220	28	27	40
6/5/95	0.72	**0.01**	93	1.2	3	440
6/5/95D	0.69	0.01	95	1.2	3	390
10/17/95	0.47	0.08	64	0.7	**2**	74
3/12/96	1.33	0.05	242	34	47	90
9/24/96	0.57	0.01	78	1.1	2	24
MAXIMUM	1.5	0.08	242	34	47	440
MINIMUM	0.47	0.01	64	0.7	2	24
AVERAGE	0.88	0.03	132	11.0	14	NA
GEO. MEAN	NA	NA	NA	NA	NA	102
STATION: HAWK CREEK 3, JUNCTION OF HAWK CREEK ROAD AND HAWK CREEK RANCH ROAD						
1/16/95	1.66	0.03	282	38	35	40
6/5/95	1.15	0.01	97	1.6	7	160
10/17/95	1.02	0.09	79	0.9	**2**	7
10/17/95D	1.03	0.08	80	0.9	2	8
3/12/96	2.47	0.04	263	40	36	20
9/24/96	1.25	0.02	87	0.4	**2**	3
MAXIMUM	2.47	0.09	282	40	36	160
MINIMUM	1.02	0.01	79	0.4	2	3
AVERAGE	1.43	0.05	148	13.6	14	NA
GEO. MEAN	NA	NA	NA	NA	NA	16.7

LABORATORY RESULTS FOR WATER QUALITY MONITORING ON HAWK CREEK, LINCOLN COUNTY, WASHINGTON

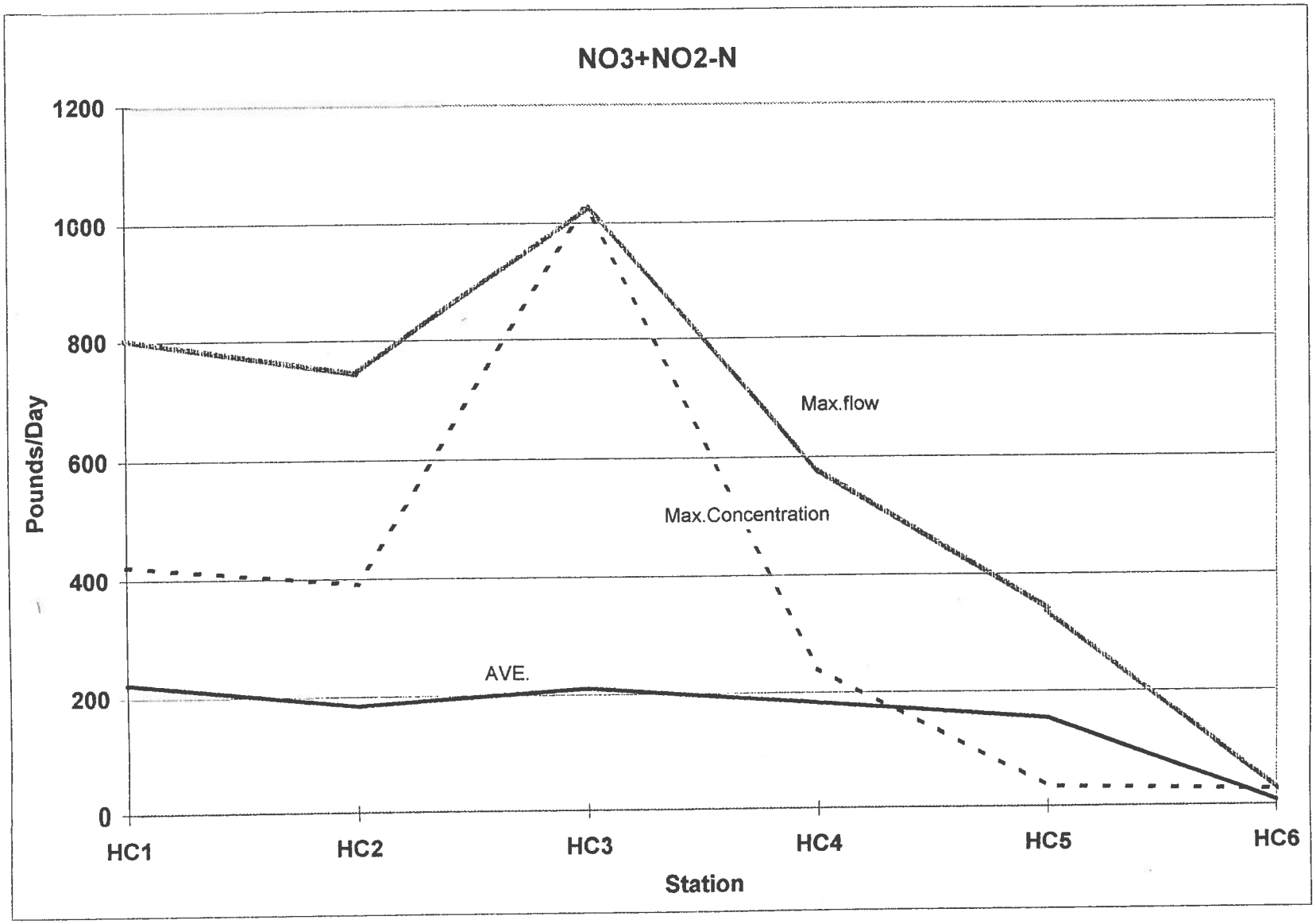
	NO3+NO2-N	NH3-N	TP	TURBIDITY	TSS	FECAL COLIFORM
	mg / L	mg / L	µg / L	NTU	mg / L	# colonies / 100 ml
STATION 4: SECOND BRIDGE ON HAWK CREEK RANCH ROAD						
1/16/95	1.73	0.04	250	41	26	60
6/5/95	1.16	0.04	94	1.2	3	96
10/17/95	1.18	0.07	90	0.5	**2**	8
3/12/96	1.61	0.04	274	43	33	26
9/24/96	1.47	0.01	98	0.5	**2**	2
MAXIMUM	1.73	0.07	274	43	33	96
MINIMUM	1.16	0.01	90	0.5	2	2
AVERAGE	1.43	0.04	161	17.2	13.2	NA
GEO. MEAN	NA	NA	NA	NA	NA	18.9
STATION 5: DOWNSTREAM OF CONFLUENCE OF HAWK CREEK & COTTONWOOD CREEK						
1/16/95	2.26	0.06	301	39	39	20
6/5/95	1.49	0.01	134	3.8	10	790
10/17/95	1.91	0.09	68	1.7	2	14
3/12/96	1.72	0.08	366	58	52	37
9/24/96	2.59	0.01	91	1.6	**2**	50
9/24/96D	2.62	0.02	94	1.5	**2**	53
MAXIMUM	2.62	0.09	366	58	52	790
MINIMUM	1.49	0.01	68	1.5	2	14
AVERAGE	2.10	0.05	176	17.6	17.8	NA
GEO. MEAN	NA	NA	NA	NA	NA	52.8
STATION 6: DOWNSTREAM OF THE DOT WETLANDS NORTH OF HIGHWAY 2						
1/16/95	NS	NS	NS	NS	NS	NS
6/5/95	0.6	0.04	215	5.2	16	1000
10/17/95	0.43	0.1	148	4.2	29	31
3/12/96	1.16	0.04	146	23	14	1
3/12/96D	1.16	0.05	145	23	13	2
9/24/96	0.63	0.02	65	1.6	**2**	25
MAXIMUM	1.16	0.1	215	23	29	1000
MINIMUM	0.43	0.02	65	1.6	2	1
AVERAGE	0.80	0.05	144	11.4	14.8	NA
GEO. MEAN	NA	NA	NA	NA	NA	17.3
NO3+NO2-N: NITRATE PLUS NITRITE - NITROGEN						
NH3-N: AMMONIA - NITROGEN						
TP: TOTAL PHOSPHORUS						
TSS: TOTAL SUSPENDED SOLIDS						
mg/L: MILLIGRAMS PER LITER						
µg/L: MICROGRAMS PER LITER						
ml: MILLILITERS		**BOLD** numbers denote measurements below detection limit				

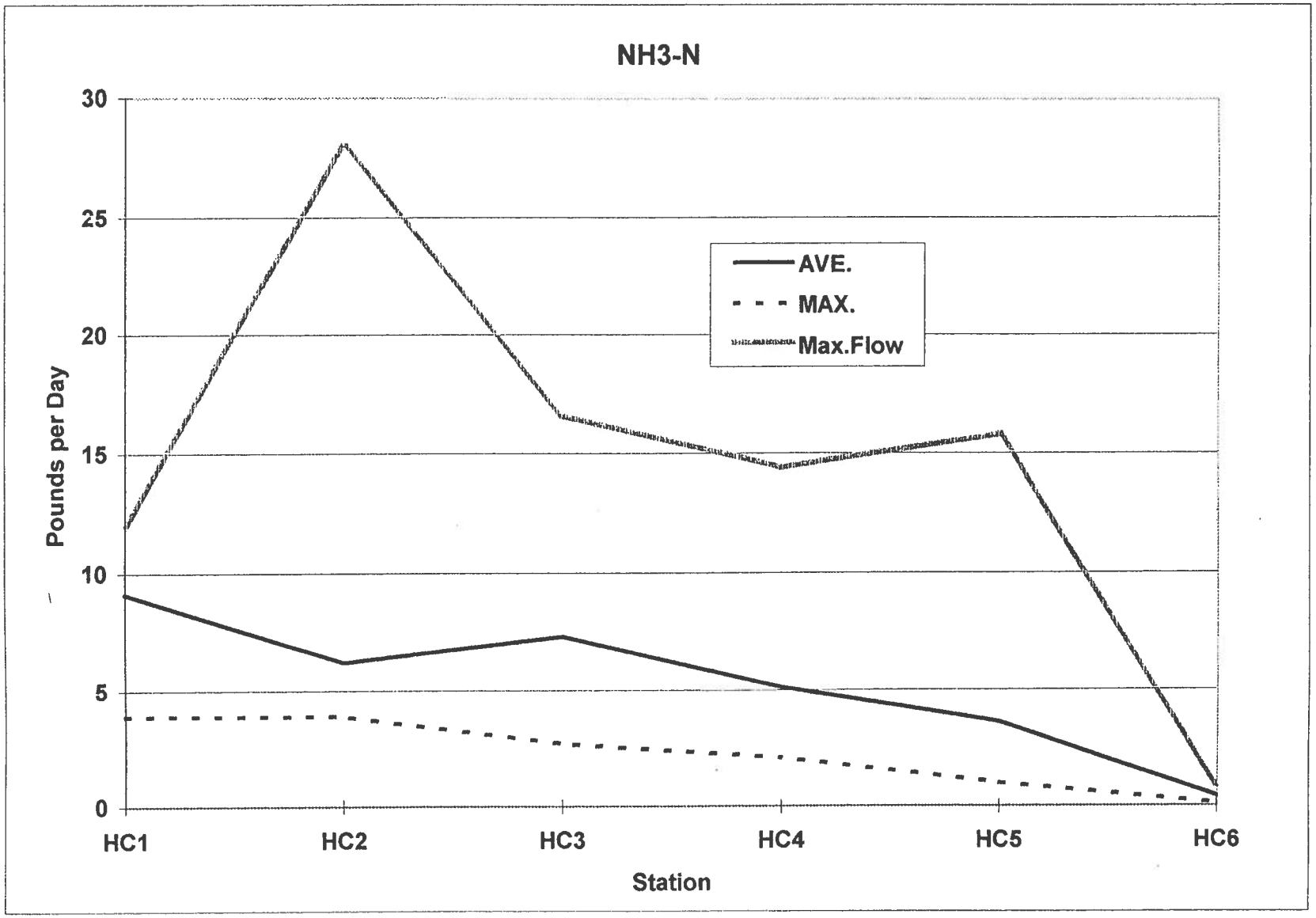
Table 5: Loading rates for average , maximum concentration, and maximum flows; in pounds per day or number of colonies per second for fecal coliform, for the Hawk Creek Water Quality Monitoring Project, 1995-96

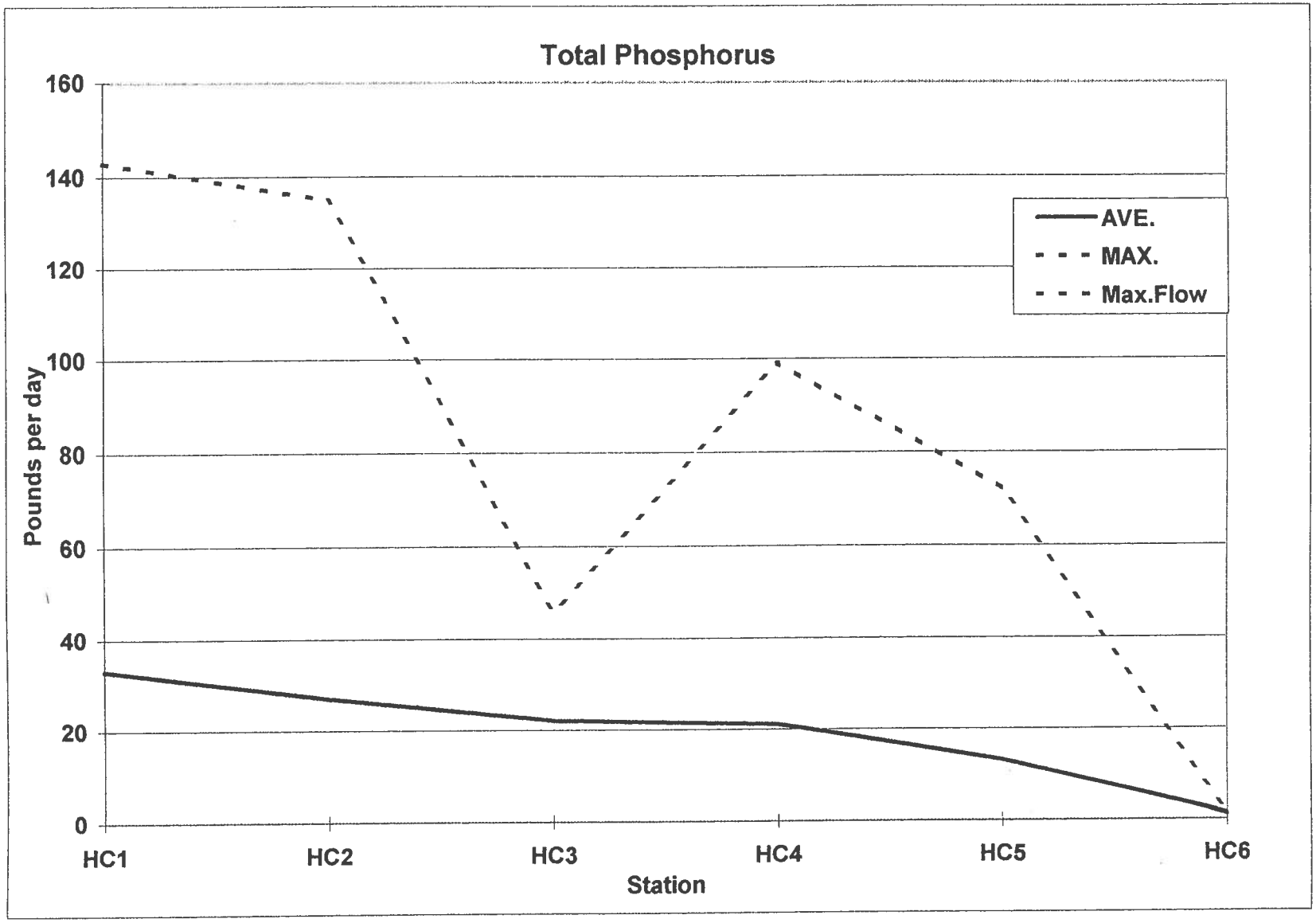
STATION	NO3+NO2-N			NH3 - N			T. PHOSPHORUS		
	AVE.	MAX.	Max.Flow	AVE.	MAX.	Max.Flow	AVE.	MAX.	Max.Flow
HC1	222	423	804	9.1	3.9	12.1	33	143	143
HC2	183	391	744	6.2	3.9	28	27	135	135
HC3	210	1,027	1,026	7.3	2.7	16.6	22	46	46
HC4	182	240	581	5.1	2.1	14.4	21	99	99
HC5	152	34	340	3.6	1.0	15.8	13	72	72
HC6	7	27	27	0.4	0.1	0.9	1.2	1.6	1.6

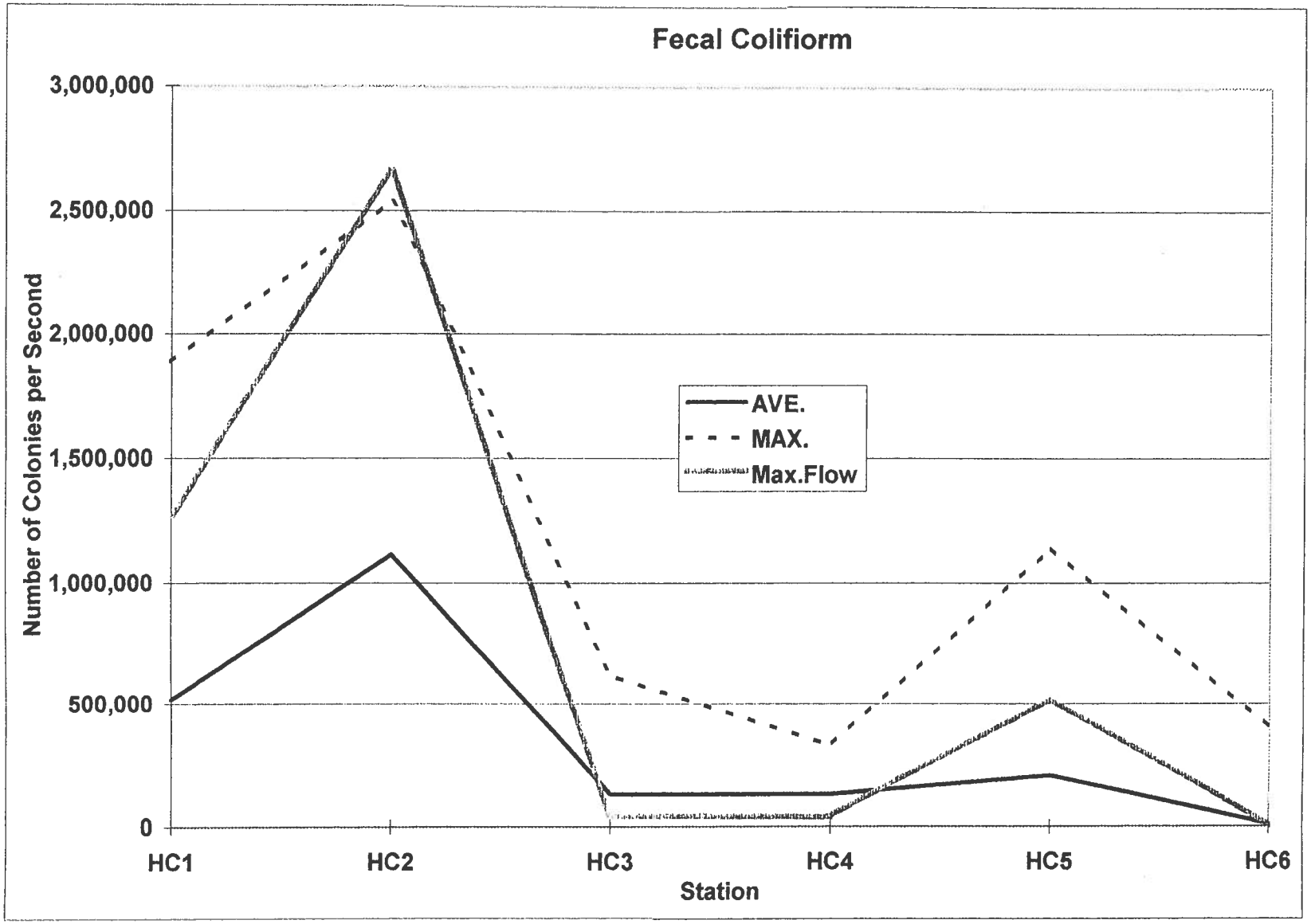
STATION	T. SUS. SOLIDS			FECAL COLIFORM		
	AVE.	MAX.	Max.Flow	AVE.	MAX.	Max.Flow
HC1	4,039	25,981	25,981	516,591	1,887,561	1,276,595
HC2	2,905	26,296	26,296	1,118,017	2,542,940	2,659,667
HC3	2,053	14,960	14,960	129,322	619,507	43,901
HC4	1,679	11,900	11,900	126,988	325,241	38,093
HC5	1,286	10,286	10,286	201,431	1,147,056	522,425
HC6	128	31	324	7880	398,580	2,448

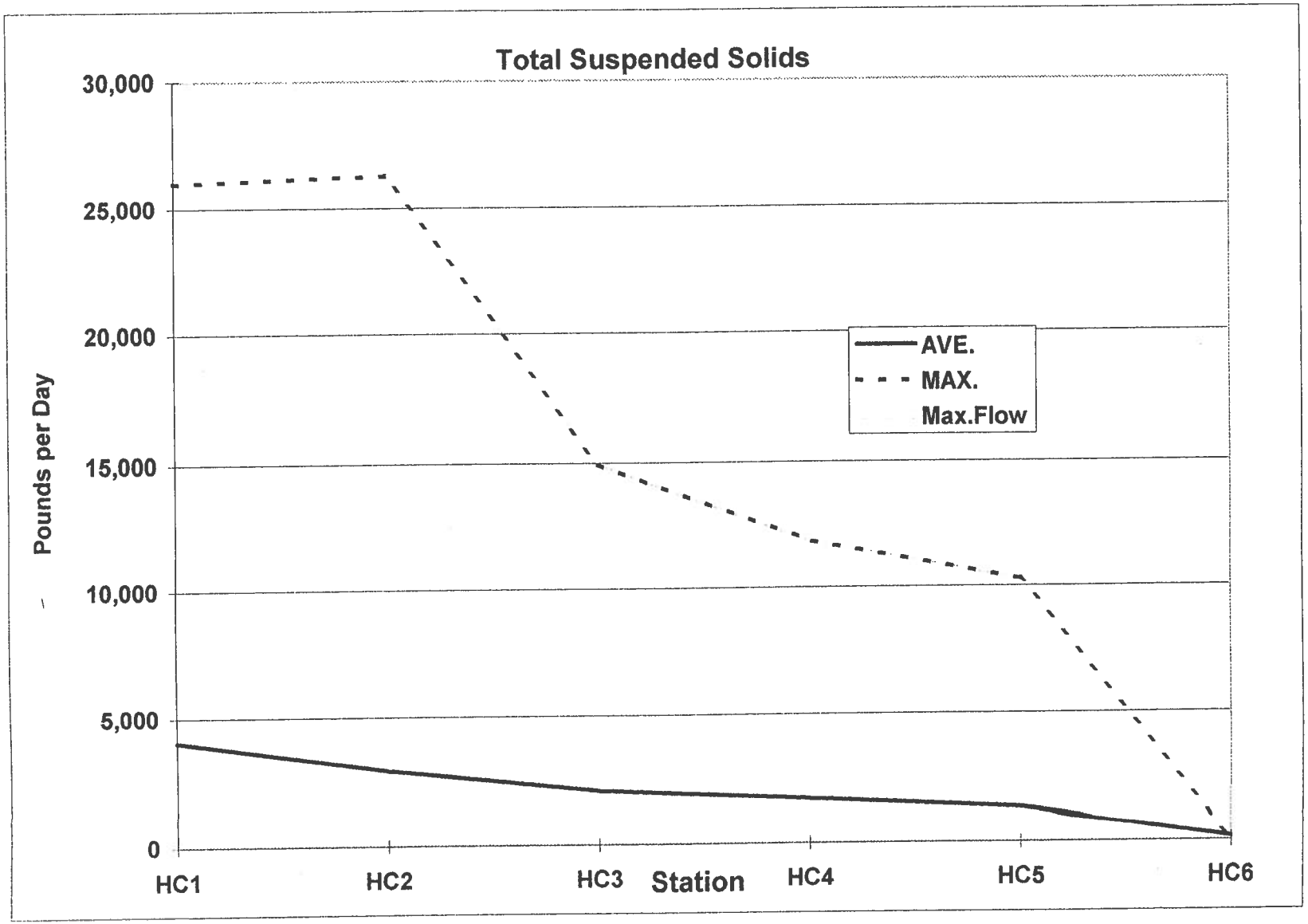
Maximum loading rates are calculated using the maximum concentration or number and the flow measured on the date corresponding to the maximum concentration or number


NO3+NO2-N
1200
1000
800
600
400
200
0
Pounds/Day
Max.flow
Max.Concentration
AVE.
HC1
HC2
HC3
HC4
HC5
HC6
Station


NH3-N
30
25
20
15
10
5
0
Pounds per Day
AVE.
MAX.
Max.Flow
HC1
HC2
HC3
HC4
HC5
HC6
Station


Total Phosphorus
160
140
120
100
80
60
40
20
0
Pounds per day
AVE.
MAX.
Max.Flow
HC1
HC2
HC3
HC4
HC5
HC6
Station


Fecal Colifiorm
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Number of Colonies per Second
AVE.
MAX.
Max.Flow
HC1
HC2
HC3
HC4
HC5
HC6
Station

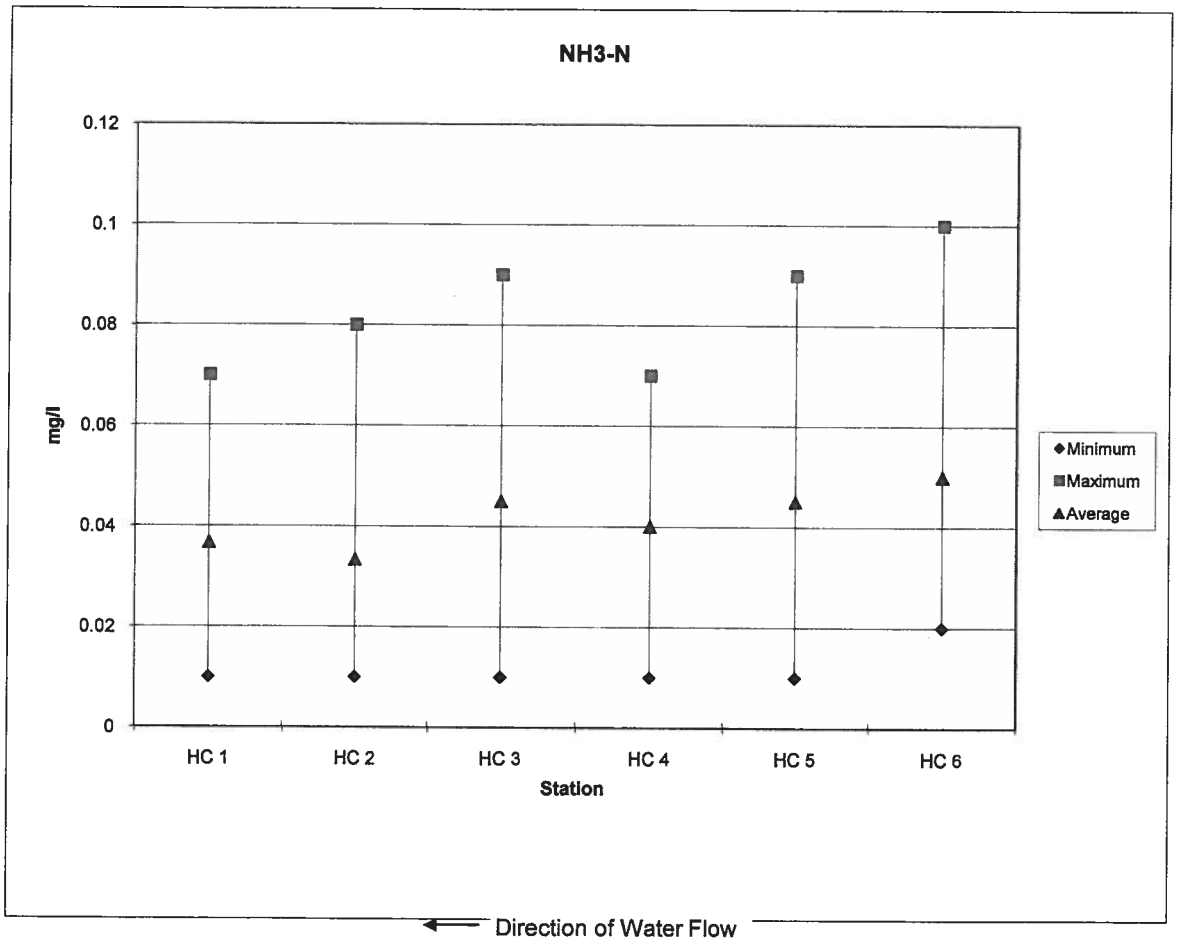

Total Suspended Solids
30,000
25,000
20,000
15,000
10,000
5,000
0
Pounds per Day
AVE.
MAX.
Max.Flow
HC1
HC2
HC3
Station
HC4
HC5
HC6

Hawk Creek Project

Centeninal Clean Water Funds

	1/16/1995	6/5/1995	#######	3/12/1996	9/24/1996	Dup.	Minimum	Maximum	Average	#/day max flow
HC 1	0.06	0.01	0.07	0.02	0.01	0.05	0.01	0.07	0.04	12.1
HC 2	0.04	0.01	0.08	0.05	0.01	0.01	0.01	0.08	0.03	28.0
HC 3	0.03	0.01	0.09	0.04	0.02	0.08	0.01	0.09	0.05	16.6
HC 4	0.04	0.04	0.07	0.04	0.01		0.01	0.07	0.04	14.4
HC 5	0.06	0.01	0.09	0.08	0.01	0.02	0.01	0.09	0.05	15.8
HC 6	NS	0.04	0.1	0.04	0.02	0.05	0.02	0.1	0.05	0.9

Ammonia in mg/l
NS = not sampled

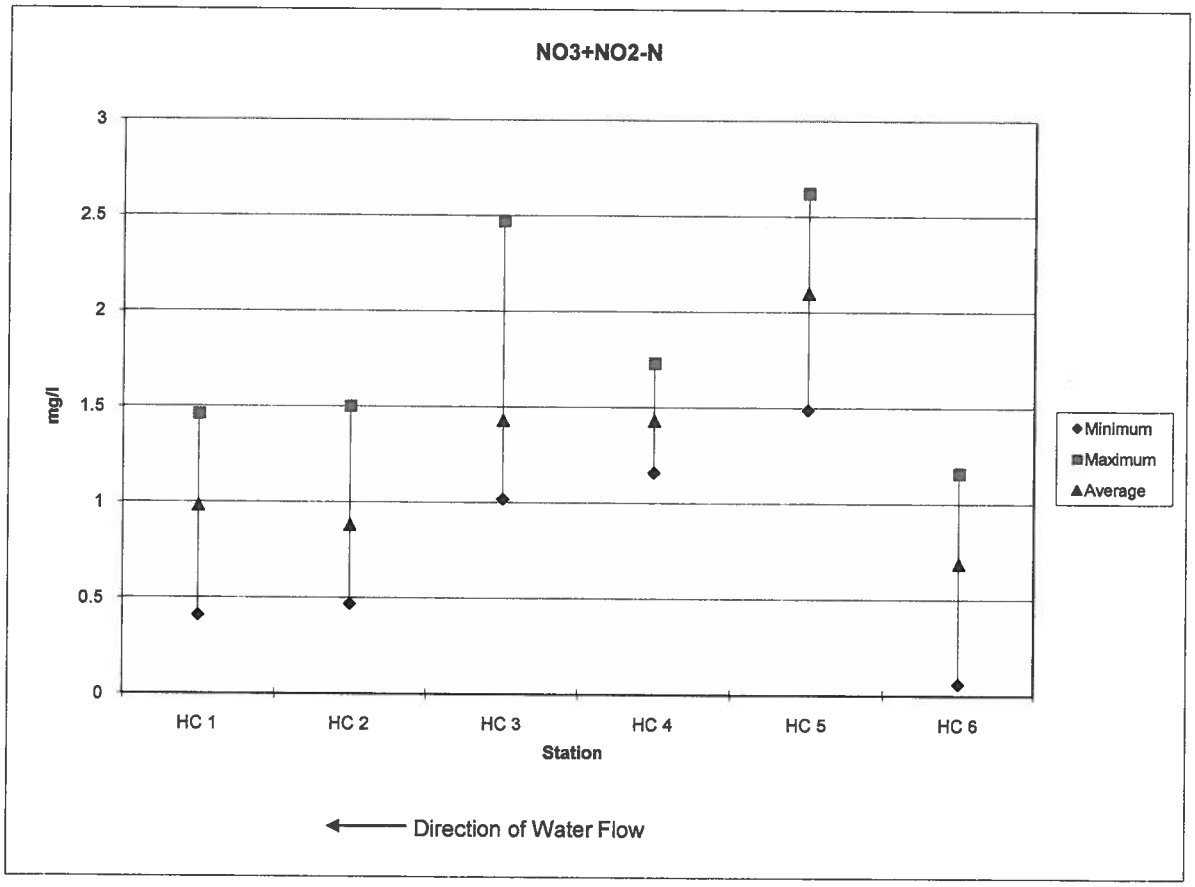


Hawk Creek Project

Centeninal Clean Water Funds

	1/16/1995	6/5/1995	10/17/1995	3/12/1996	9/24/1996	Dup.	Minimum	Maximum	Average	#/day max flow
HC 1	1.46	0.75	0.41	1.33	0.48	1.46	0.41	1.46	0.98	804
HC 2	1.5	0.72	0.47	1.33	0.57	0.69	0.47	1.5	0.88	744
HC 3	1.66	1.15	1.02	2.47	1.25	1.03	1.02	2.47	1.43	1026
HC 4	1.73	1.16	1.18	1.61	1.47		1.16	1.73	1.43	581
HC 5	2.26	1.49	1.91	1.72	2.59	2.62	1.49	2.62	2.10	340
HC 6	NS	0.06	0.43	1.16	0.63	1.16	0.06	1.16	0.69	27

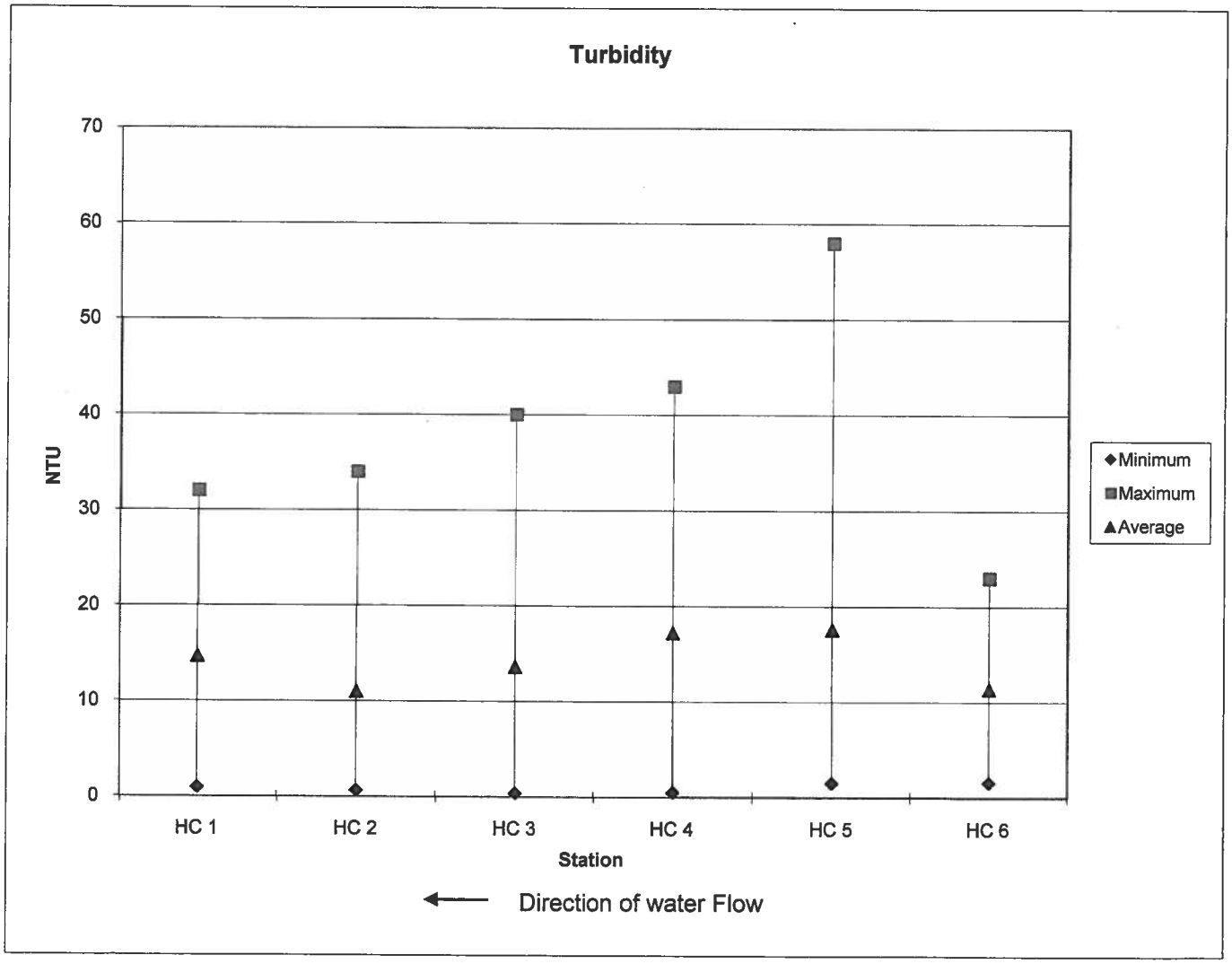
Nitrate+ Nirite in mg/l
NS = not sampled



Hawk Creek Project
Centeninal Clean Water Funds

	1/16/1995	6/5/1995	10/17/1995	3/12/1996	9/24/1996	Dup.	Minimum	Maximum	Average
HC 1	27	1.3	1	32	1	26	1	32	14.7
HC 2	28	1.2	0.7	34	1.1	1.2	0.7	34	11.0
HC 3	38	1.6	0.9	40	0.4	0.9	0.4	40	13.6
HC 4	41	1.2	0.5	43	0.5		0.5	43	17.2
HC 5	39	3.8	1.7	58	1.6	1.5	1.5	58	17.6
HC 6	NS	5.2	4.2	23	1.6	23	1.6	23	11.4

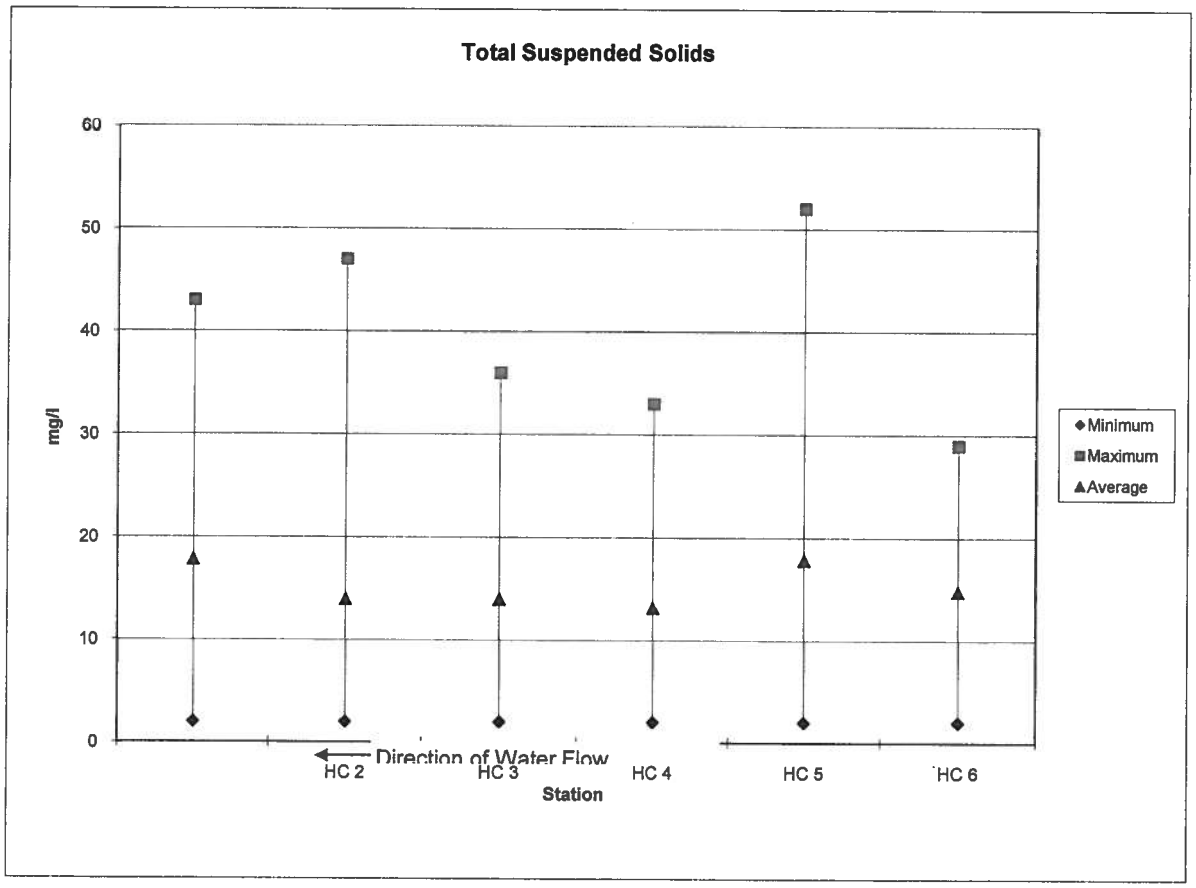
Turbidity in NTU
NS = not sampled



Hawk Creek Project
Centeninal Clean Water Funds

	1/16/1995	6/5/1995	10/17/1995	3/12/1996	9/24/1996	Dup.	Minimum	Maximum	Average	#/day max flow
	28	5	2	43	2	27	2	43	17.83	25981
HC 2	27	3	2	47	2	3	2	47	14.00	26296
HC 3	35	7	2	36	2	2	2	36	14.00	14960
HC 4	26	3	2	33	2		2	33	13.20	11900
HC 5	39	10	2	52	2	2	2	52	17.83	10286
HC 6	NS	16	29	14	2	13	2	29	14.80	324

Total Suspended Solids in mg/l
NS = not sampled



HC 1

	Flow	Phos.	TSS	Turb.	NH3-N	NO3+NO2-N	Fecal C	DO
1/16/1995	53.8	201	28.00	27.00	0.06	1.46	30	11.8
6/5/1995	22.1	94	5.00	1.30	0.01	0.75	300	10
10/17/1995	10.3	66	2.00	1.00	0.07	0.41	27	11.1
3/12/1996	112.1	236	43.00	32.00	0.02	1.33	40	11
9/24/1996	12.3	69	2.00	1.00	0.01	0.48	22	11.87
Correlation with flow		**0.94**	**0.98**	**0.92**	**24.95**	**0.82**	**-0.21**	**0.002**

HC2

	Flow	Phos.	TSS	Turb.	NH3-N	NO3+NO2-N	Fecal C	DO
1/16/1995	48.3	220	27	28	0.04	1.5	40	11.6
6/5/1995	20.3	93	3	1.2	0.01	0.72	440	9.6
10/17/1995	9.1	64	2	0.7	0.08	0.47	74	10.5
3/12/1996	103.8	242	47	34	0.05	1.33	90	11
9/24/1996	11.2	78	2	1.1	0.01	0.57	24	11.6
Correlation with flow		**0.91**	**0.98**	**0.92**	**0.18**	**0.80**	**-0.17**	**0.22**

HC 3

	Flow	Phos.	TSS	Turb.	NH3-N	NO3+NO2-N	Fecal C	DO
1/16/1995	30.5	282	35	38	0.03	1.66	40	11.8
6/5/1995	13.6	97	7	1.6	0.01	1.15	160	9.9
10/17/1995	5..6	79	2	0.9	0.09	1.02	7	10
3/12/1996	77.1	263	36	40	0.04	2.47	20	11.2
9/24/1996	9.0	87	2	0.4	0.02	1.25	3	11.2
Correlation with flow		**0.74**	**0.80**	**0.81**	**0.88**	**0.99**	**-0.35**	**0.31**

HC 4

	Flow	Phos.	TSS	Turb.	NH3-N	NO3+NO2-N	Fecal C	DO
1/16/1995	25.7	250	26	41	0.04	1.73	60	11.5
6/5/1995	11.9	94	3	1.2	0.04	1.16	95	9.6
10/17/1995	5.6	90	2	0.5	0.07	1.18	8	9.7
3/12/1996	66.9	274	33	43	0.04	1.61	26	10.7
9/24/1996	7.8	98	2	0.5	0.01	1.47	2	10
Correlation with flow		0.86	0.90	0.83	-0.03	0.60	-0.01	0.54

HC 5

	Flow	Phos.	TSS	Turb.	NH3-N	NO3+NO2-N	Fecal C	DO
1/16/1995	20.7	301	39	39	0.06	2.26	20	10.8
6/5/1995	5.1	134	10	3.8	0.01	1.49	790	7
10/17/1995	2	68	2	1.7	0.09	1.91	14	8
3/12/1996	36.7	366	52	58	0.08	1.72	37	10.5
9/24/1996	2.4	91	2	1.6	0.01	2.59	50	7.2
Correlation with flow		**0.97**	**0.98**	**0.99**	**0.47**	**-0.22**	**-0.30**	**0.87**

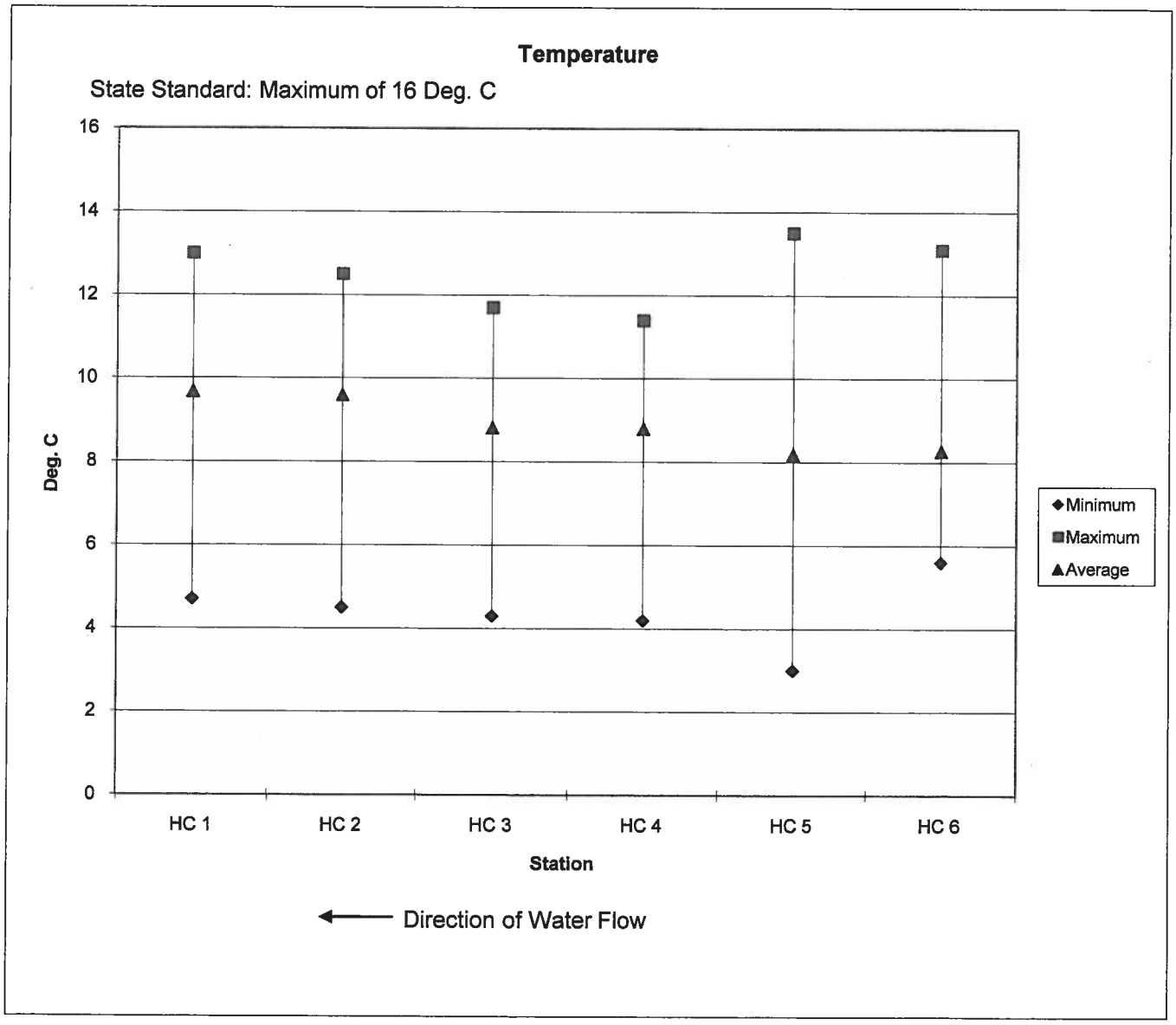
HC 6

	Flow	Phos.	TSS	Turb.	NH3-N	NO3+NO2-N	Fecal C	DO
1/16/1995	NS	NS	NS	NS	NS	NS	NS	NS
6/5/1995	1.4	215	16	5.2	0.04	0.06	1000	6.8
10/17/1995	0.2	148	29	4.2	0.1	0.43	31	7.9
3/12/1996	4.3	146	14	23	0.04	1.16	1	9
9/24/1996	0.5	65	2	1.6	0.02	0.63	25	9.5
Correlation with flow		**0.21**	**-0.13**	**0.97**	**-0.32**	**0.71**	**-0.10**	**0.21**

Hawk Creek Project
Centeninal Clean Water Funds

	1/16/1995	6/5/1995	10/17/1995	3/12/1996	9/24/1996	Minimum	Maximum	Average
HC 1	4.7	13	10.4	9.2	11.1	4.7	13	9.68
HC 2	4.5	12.5	10.3	9.2	11.5	4.5	12.5	9.60
HC 3	4.3	11.7	9.9	8.3	9.9	4.3	11.7	8.82
HC 4	4.2	11.4	10.2	8	10.2	4.2	11.4	8.80
HC 5	3	13.5	8.9	6.2	9.3	3	13.5	8.18
HC 6	NS	13.1	8.1	5.6	6.3	5.6	13.1	8.28

Temperature in Deg. C
NS = not sampled

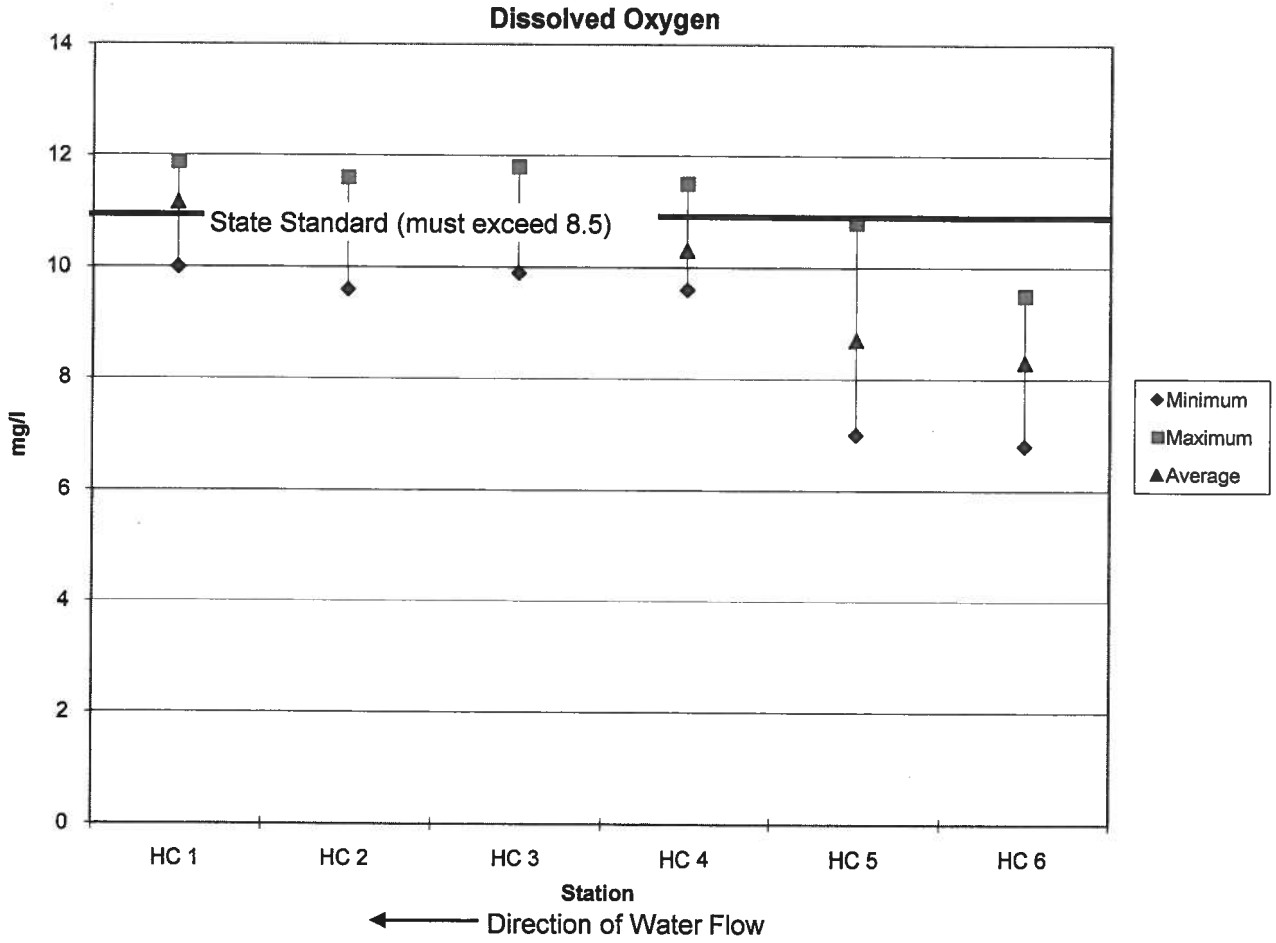


Hawk Creek Project

Centeninal Clean Water Funds

	1/16/1995	6/5/1995	10/17/1995	3/12/1996	9/24/1996	Minimum	Maximum	Average
HC 1	11.8	10	11.1	11	11.87	10	11.87	11.15
HC 2	11.6	9.6	10.5	11	11.6	9.6	11.6	10.86
HC 3	11.8	9.9	10	11.2	11.2	9.9	11.8	10.82
HC 4	11.5	9.6	9.7	10.7	10	9.6	11.5	10.30
HC 5	10.8	7	8	10.5	7.2	7	10.8	8.70
HC 6	NS	6.8	7.9	9	9.5	6.8	9.5	8.30

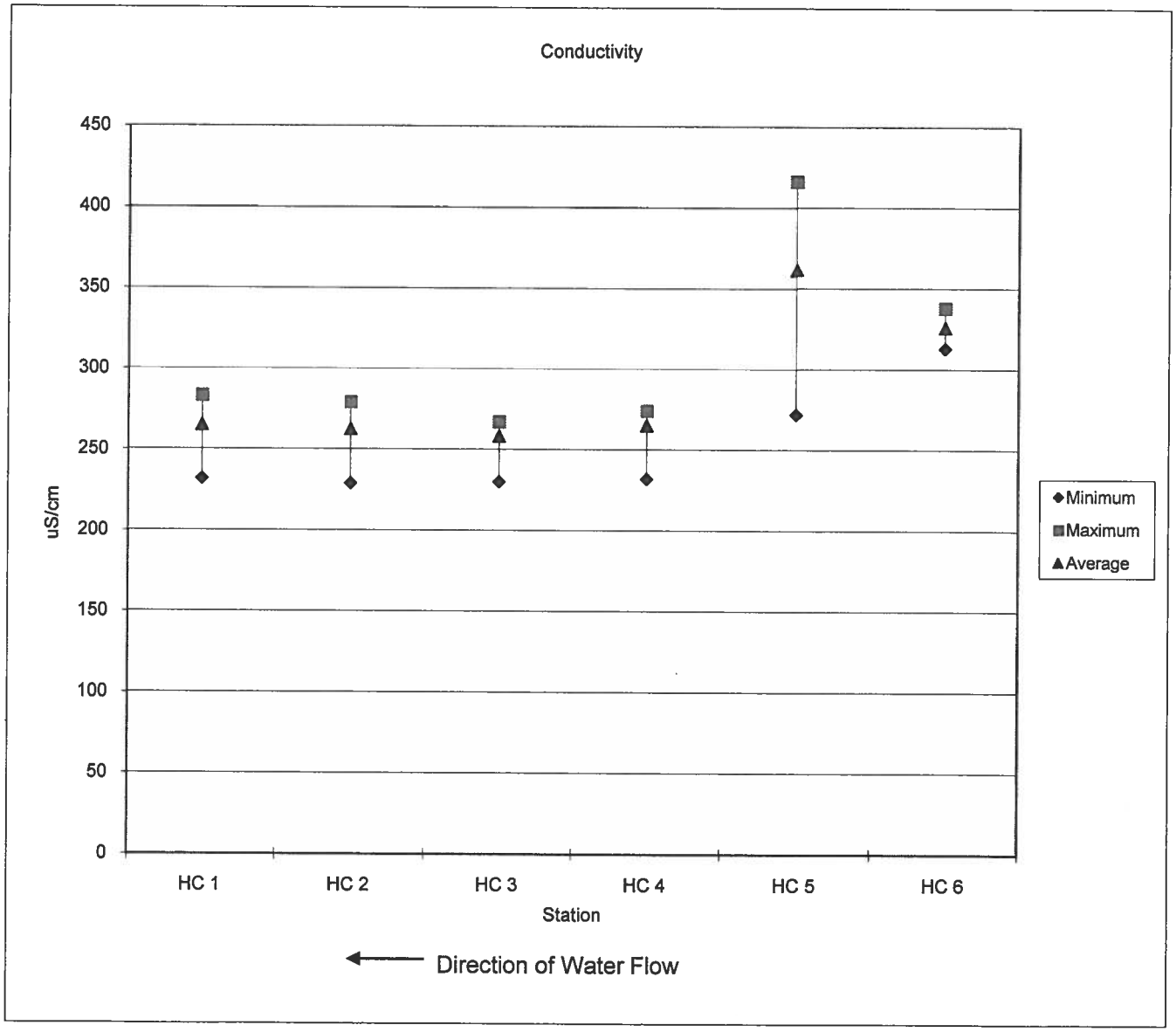
Dissolved Oxygen in mg/l
NS= not sampled



Hawk Creek Project
Centeninal Clean Water Funds

	1/16/1995	6/5/1995	10/17/1995	3/12/1996	9/24/1996	Minimum	Maximum	Average
HC 1	232	276	280	255	283	232	283	265.2
HC 2	229	274	279	253	278	229	279	262.6
HC 3	230	266	266	267	263	230	267	258.4
HC 4	232	274	272	274	274	232	274	265.2
HC 5	272	392	412	317	416	272	416	361.8
HC 6	NS	313	338	331	322	313	338	326.0

Conductivity in µS/cm
NS=not sampled

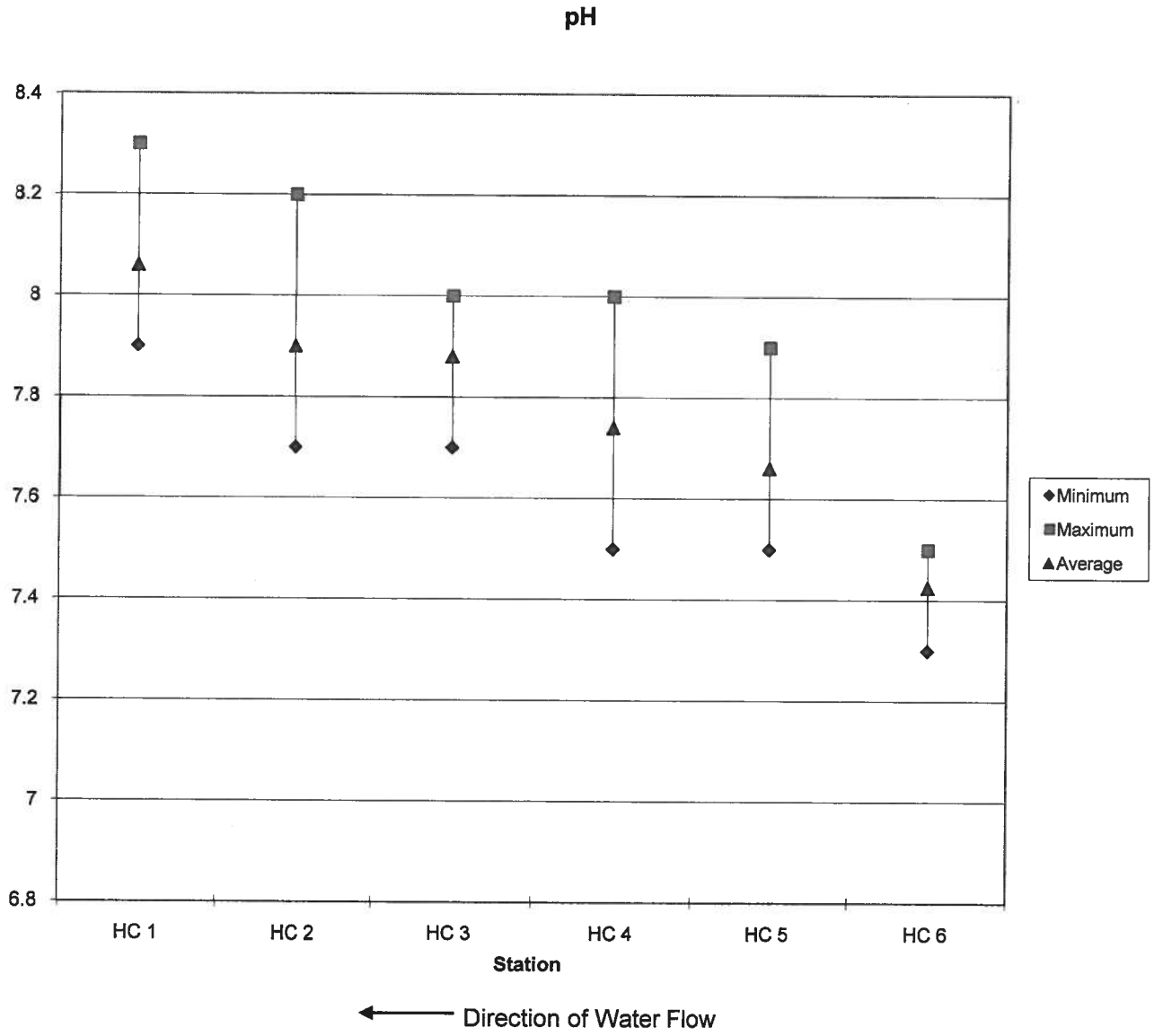


Hawk Creek Project
Centeninal Clean Water Funds

	1/16/1995	6/5/1995	10/17/1995	3/12/1996	9/24/1996	Minimum	Maximum	Average
HC 1	7.9	8.1	7.9	8.1	8.3	7.9	8.3	8.1
HC 2	7.8	7.8	7.7	8	8.2	7.7	8.2	7.9
HC 3	7.8	7.9	7.7	8	8	7.7	8	7.9
HC 4	7.8	7.7	7.5	8	7.7	7.5	8	7.7
HC 5	7.7	7.5	7.6	7.9	7.6	7.5	7.9	7.7
HC 6	NS	7.3	7.4	7.5	7.5	7.3	7.5	7.4

NS = not sampled

State Standard pH (6.5-8.5)

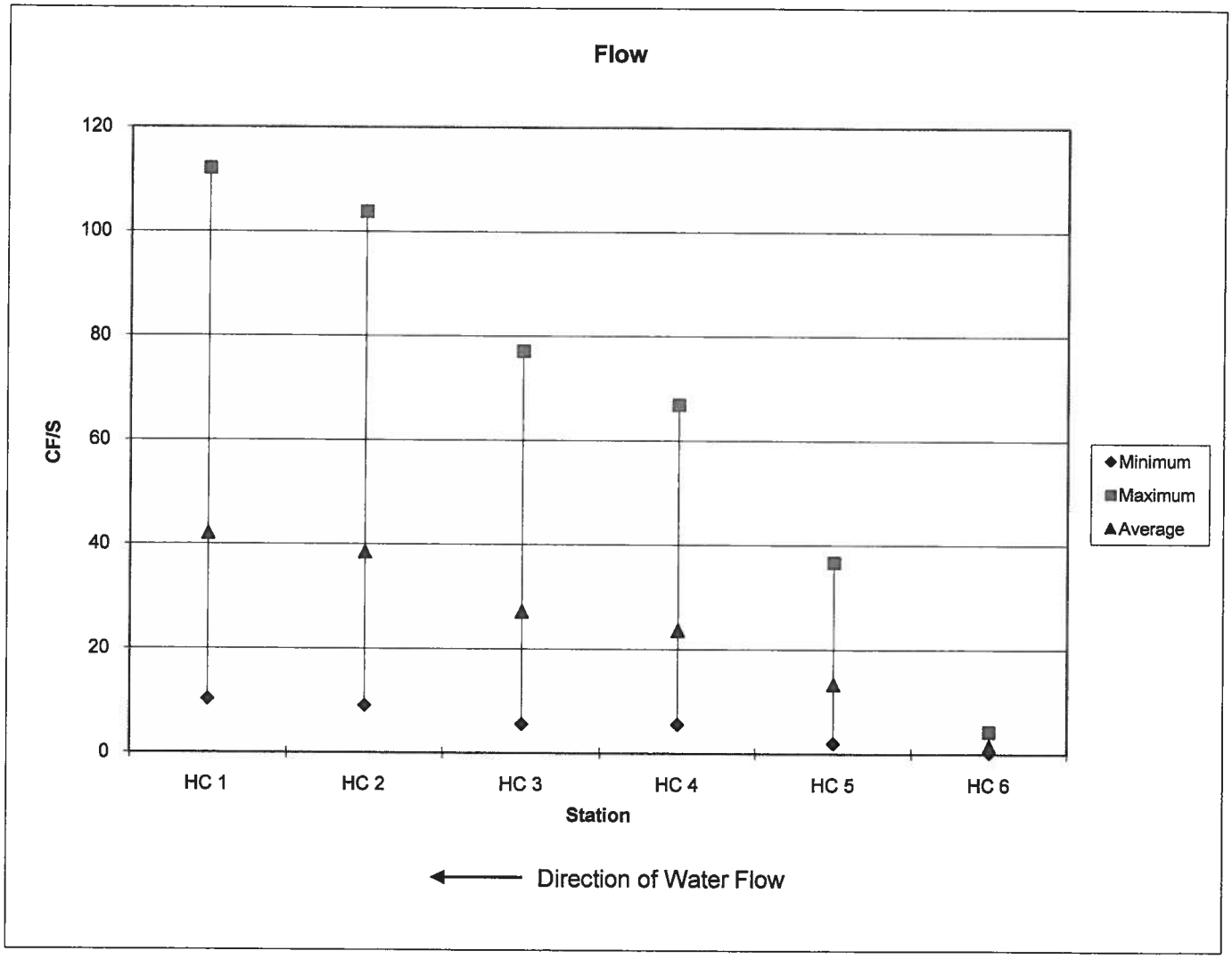


Hawk Creek Project

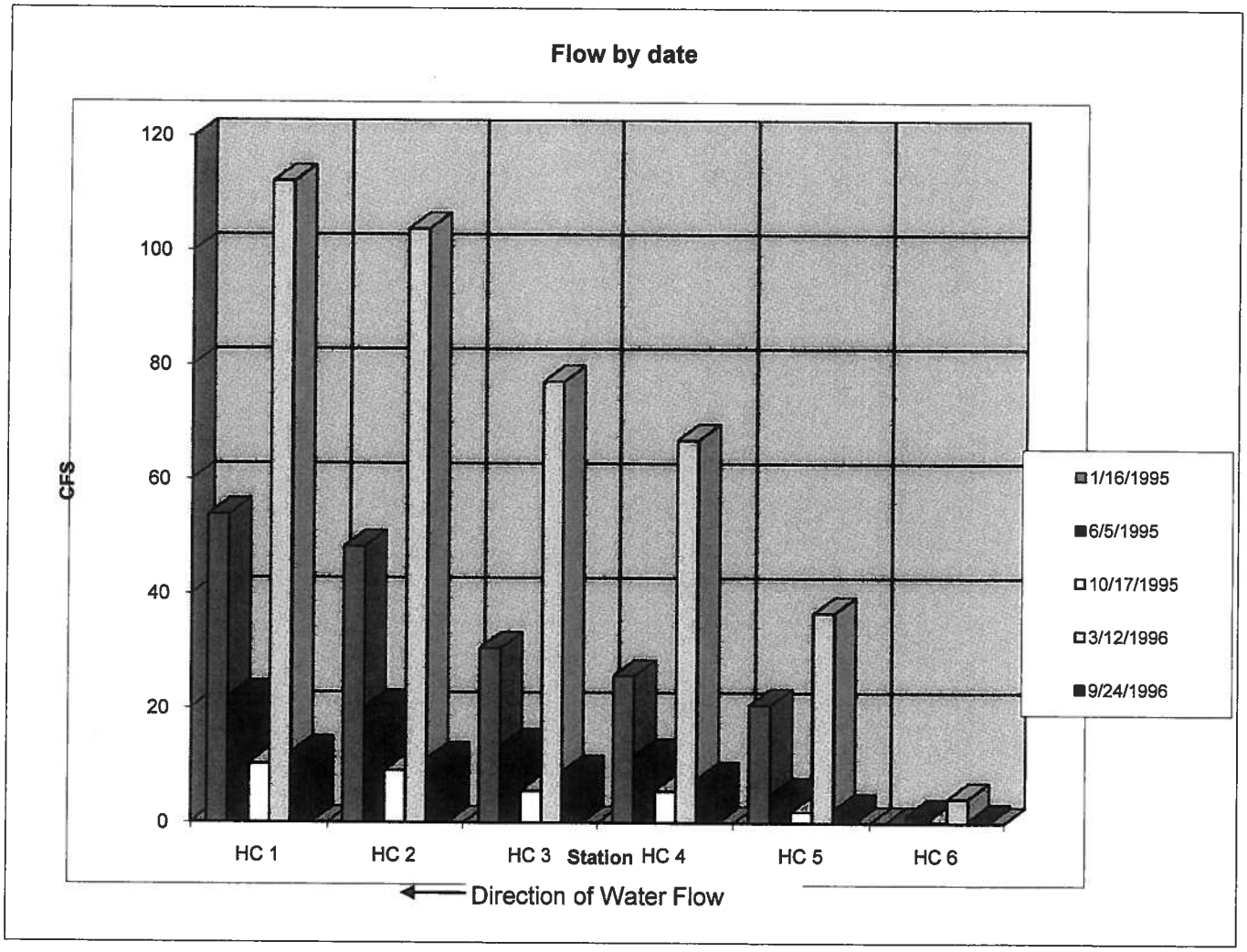
Centeninal Clean Water Funds

	1/16/1995	6/5/1995	10/17/1995	3/12/1996	9/24/1996	Minimum	Maximum	Average
HC 1	53.8	22.1	10.3	112.1	12.3	10.3	112.1	42.12
HC 2	48.3	20.3	9.1	103.8	11.2	9.1	103.8	38.54
HC 3	30.5	13.6	5.6	77.1	9	5.6	77.1	27.16
HC 4	25.7	11.9	5.6	66.9	7.8	5.6	66.9	23.58
HC 5	20.7	5.1	2	36.7	2.4	2	36.7	13.38
HC 6	NS	1.4	0.2	4.3	0.5	0.2	4.3	1.6

Water Flow in Cubic Feet per Second
NS = not sampled



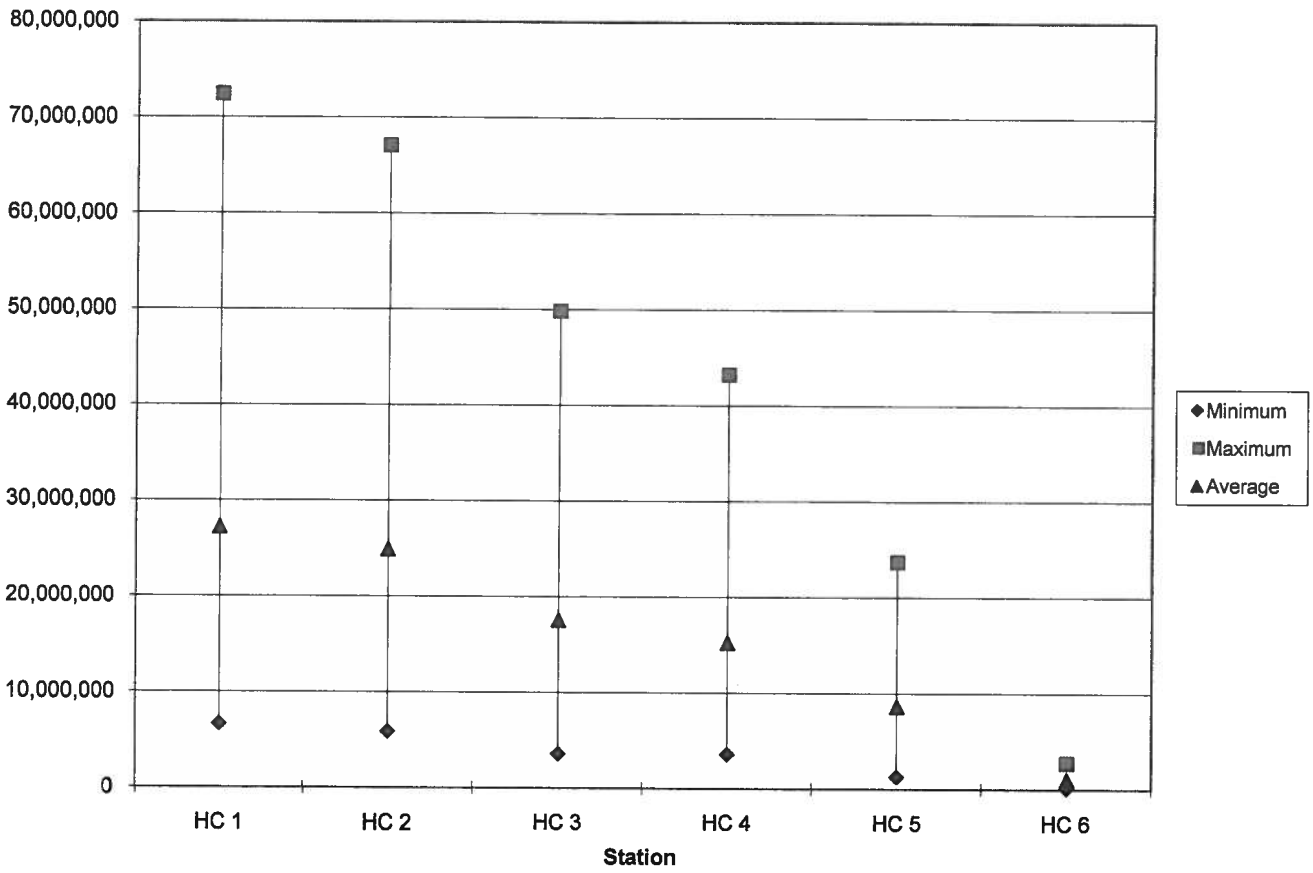
Hawk Creek Project
Centeninal Clean Water Funds



Hawk Creek Project
Centeninal Clean Water Funds

	Minimum	Maximum	Average
HC 1	6,657,492	72,456,777	27,224,616
HC 2	5,881,861	67,092,002	24,910,653
HC 3	3,619,607	49,834,233	17,555,094
HC 4	3,619,607	43,241,377	15,241,131
HC 5	1,292,717	23,721,353	8,648,275
HC 6	129,272	2,779,341	1,034,173

Flow in Gallons per Day



← Direction of Water Flow

Hawk Creek Project

Centeninal Clean Water Funds

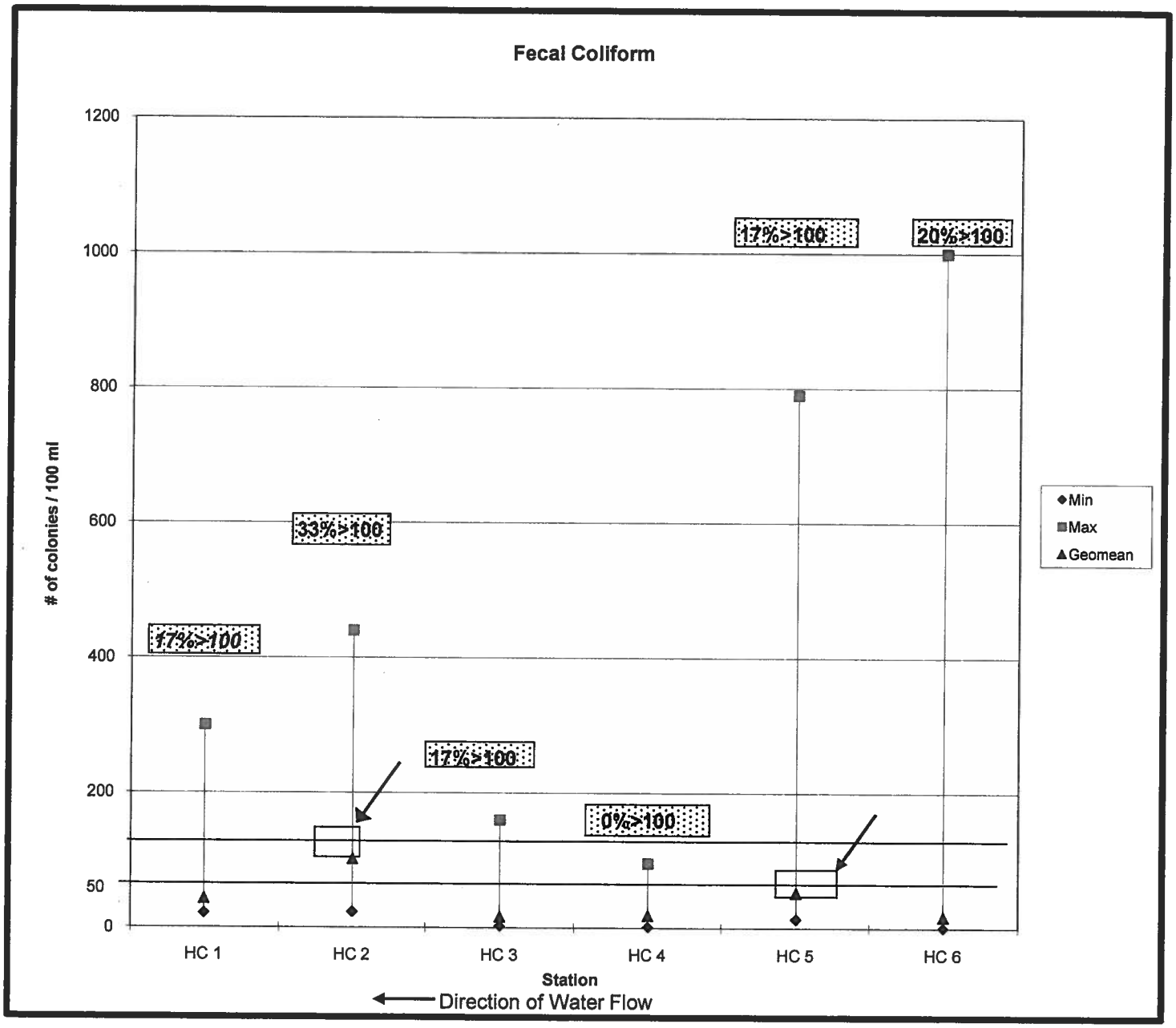
HC 1	1/16/1995 30	1/16/1995 D 30	6/5/1995 300	10/17/1995 27	3/12/1996 40	9/24/1996 22	Minimum 22	Maximum 300	Geomean 43.1
HC 2	1/16/1995 40	6/5/1995 440	6/5/95 D 390	10/17/1995 74	3/12/1996 90	9/24/1996 24	24	440	101.6
HC 3	1/16/1995 40	6/5/1995 160	10/17/1995 7	10/17/95 D 8	3/12/1996 20	9/24/1996 3	3	160	16.7
HC 4	1/16/1995 60	6/5/1995 95	10/17/1995 8	3/12/1996 26	9/24/1996 2		2	95	18.8
HC 5	1/16/1995 20	6/5/1995 790	10/17/1995 14	3/12/1996 37	9/24/1996 50	9/24/96 D 53	14	790	52.8
HC 6	1/16/1995 NS	6/5/1995 1000	10/17/1995 31	3/12/1996 1	3/12/96 D 2	9/24/1996 25	1	1000	17.3

Fecal Coliform Bacteria

	Min	Max	Geomean	% X's>100
HC 1	22	300	43.1	17%
HC 2	24	440	102	33%
HC 3	3	160	16.7	17%
HC 4	2	96	18.9	0%
HC 5	14	790	52.8	17%
HC 6	1	1000	17.3	20%

Hawk Creek Project

Centeninal Clean Water Funds

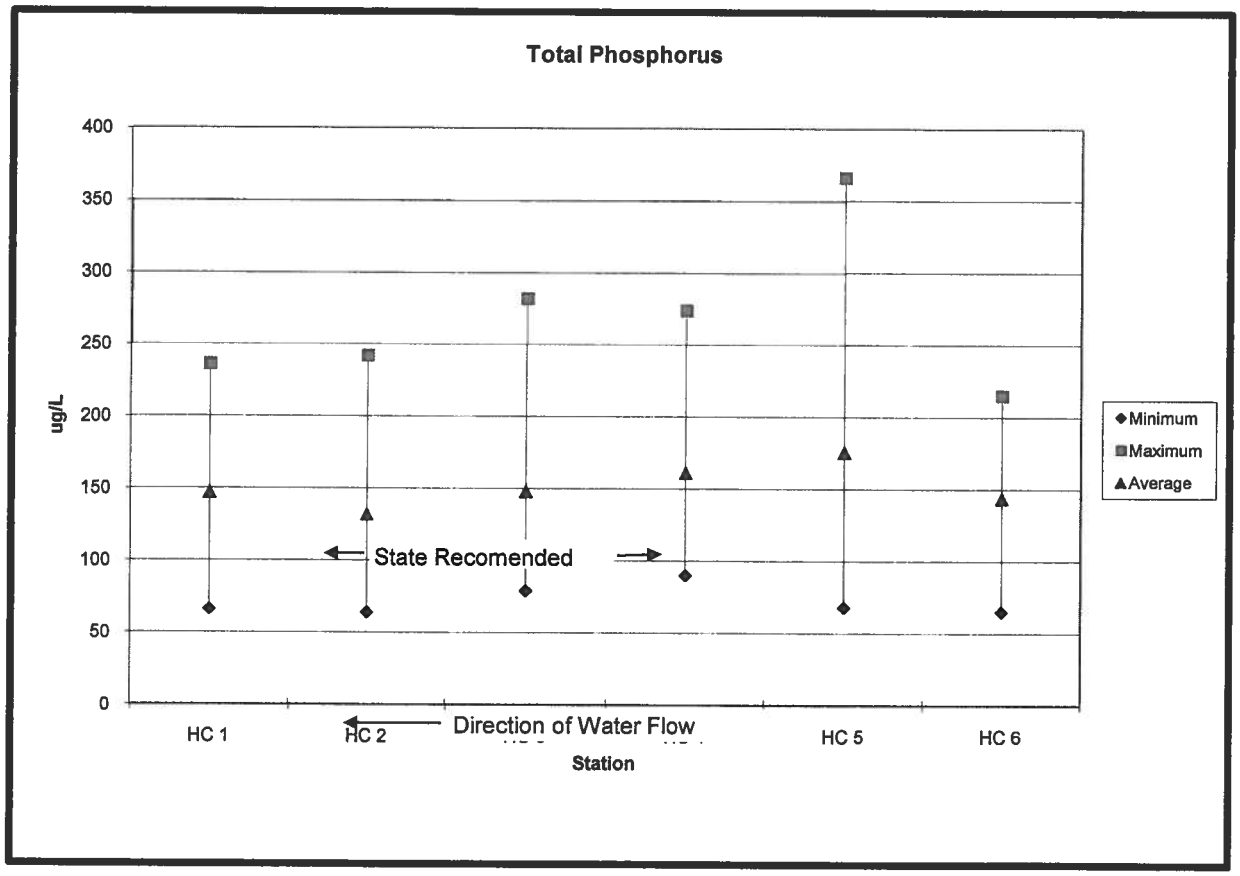


State Standards:

1) Geomean can't excede 50 →

2) 10% of samples can't excede 100

Hawk Creek Project
Centeninal Clean Water Fund

	1/16/1995	6/5/1995	10/17/1995	3/12/1996	9/24/1996	Dup.	Minimum	Maximum	Average	#/day max flow
HC 1	201	94	66	236	69	216	66	236	147	143
HC 2	220	93	64	242	78	95	64	242	132	135
HC 3	282	97	79	263	87	80	79	282	148	109
HC 4	250	94	90	274	98	NS	90	274	161	99
HC 5	301	134	68	366	91	94	68	366	176	72
HC 6	NS	215	148	146	65	145	65	215	144	3

Phosphorus in mg/l
NS = not sampled