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MEMORANDUM
February 3, 1986

To: Jon Neel

From: Pat Crawford PMC

Subject: Weaver Creek Low-Flow, Point-Source Reconnaissance

ABSTRACT

A reconnaissance survey was conducted on Weaver Creek during the last two weeks of October 1985 in order to identify sources of pollution other than the Battle Ground sewage treatment plant (STP). The few significant point sources observed individually had no major effect on Weaver Creek's water quality during low flow, but collectively they caused a general increase in pollutant levels.

INTRODUCTION

On October 22, 23, and 29, 1985, a reconnaissance survey was conducted on the Weaver Creek drainage. The survey included a drive-through ascertaining land use and drainage characteristics; stream-walks from river mile (r.m.) 0.1 to 3.7; sampling of various points along the creek; and investigating point sources entering the creek. This survey was to be the initial phase of a low-flow receiving water study in the vicinity of the Battle Ground STP. A low-flow study had been requested by the Southwest Regional Office (SWRO) of the Department of Ecology (Ecology) as a result of data and conclusions from previous surveys (Heffner, 1984; Kiernan, 1983; and Moore, 1978). The primary objectives were to, first, quantify the impact of the Battle Ground STP effluent on Weaver Creek's water quality at low flow; second, quantify the impact of other sources of pollutants on the drainage; and third, verify that the STP is meeting its National Pollutant Discharge Elimination System (NPDES) permit requirements. A reconnaissance was to precede the intensive receiving water survey, but this study was cancelled because of increased flows. However, information gathered during the reconnaissance is presented in this report to help SWRO personnel in future actions concerning Weaver Creek.

The purposes of the reconnaissance survey were to:

1. Identify and evaluate impacts of pollutant sources other than Battle Ground STP.
2. Gather information for planning a receiving water survey.
3. Determine if low flow conditions were present.

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Site Description and Background

Weaver Creek has a drainage area of 6.47 square miles and is about 4.3 miles long (Figure 1). The change in elevation from its origin to its confluence with Salmon Creek is approximately 110 feet. Battle Ground (population 3,260) is located about 3 r.m. up Weaver Creek.

The Battle Ground STP effluent enters Weaver Creek at approximately r.m. 2.1. In 1978, water quality in Weaver Creek failed to meet Class A standards downstream from the STP (Moore and Anderson, 1978) (Table 1). In 1980, the STP was upgraded to extended secondary treatment with dechlorination. Previous data (Heffner, 1984; Kiernan, 1983; and Moore, 1978) indicated that the STP failed to meet the dilution requirements as designated in the guidelines (Ecology, 1980). This had contributed to the poor water quality observed in Weaver Creek in the past. However, data collected before and after the STP upgrades indicated that the STP was not the only source of pollution to the creek. For example, upstream fecal coliform (FC) bacteria concentrations have never met Class A standards. Heffner (1984) indicated that effluent oxygen demand did not appear to be sufficient to cause the drop in dissolved oxygen (D.O.) downstream from the STP during low flow.

METHODS

On October 22, a drive-through survey was performed, main-channel stations were sampled, and flows were measured. The stream was walked from r.m. 1 to r.m. 1.9 on October 23, and from r.m. 1.9 to 3.7 on October 29 (Figure 1; Table 2). Weaver Creek main-channel stations were designated WC; discharges were designated D; and Jewel Creek stations were designated JC.

Flow measurements were made at selected sites with a Marsh-McBirney magnetic flow meter. When possible, flows from small discharges were measured by recording the time required to fill a container of known volume (a 500 mL pH bottle or a 4-liter bucket). Temperature, conductivity, and pH measurements were taken in the field. Samples for D.O. were fixed in the field and subsequently analyzed in the Tumwater field laboratory, along with a sample for chlorine residual collected at Jewel Creek (station JC-2). All other samples were stored in the dark on ice and returned to Olympia. The samples were transported to the Manchester laboratory the day following collection.

Battle Ground STP operator Bob Jones furnished instantaneous flow measurements and information on current plant operations.

RESULTS AND DISCUSSION

Land-Use Characteristics

A plywood plant and a dairy product processor are located in Battle Ground. Most of the drainage outside the Battle Ground city limits appears to be

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Rainfall on days preceding and during the survey is listed in Table 4. It appears that even a relatively small amount of rainfall has a substantial impact on the stream flow. The time lapse between rain events and flow response was relatively short at the time of the survey.

Coliform

Main-stream FC bacteria levels indicate that there is a problem throughout the drainage (Figure 2). No main-channel sample collected upstream from the Battle Ground STP outfall met Class A FC standards (Table 1). The geometric mean for all samples upstream and downstream from the STP was 192 and 125 organisms/100 mL, respectively. Upstream FC levels were consistently higher than those downstream of the STP. Seven of the 15 samples collected upstream of the STP for FC bacteria exceeded the 200 organisms/100 mL standard. Previous samples taken here have shown similar FC results.

All FC bacteria levels were greater than 200 organisms/100 mL on Day 1 of the survey. With the exception of samples taken at station WC-6, these were the highest FC levels of the three-day survey. Flow measured at station WC-17 also was highest on Day 1, and rain had fallen in the 24-hour period preceding Day 1 of the survey. Runoff from this rainfall was partially responsible for the elevated FC concentrations. On individual days, FC levels did not vary substantially throughout the drainage except at WC-9 and WC-6 (Figure 2). High concentrations at WC-9 could be due to the STP discharge. The STP was not analyzed; however, estimates using upstream and downstream data indicate the effluent concentration had to average 470 organisms/100 mL to account for downstream increases. This concentration would exceed both the maximum monthly and weekly NPDES permit limits of 200 and 400 organisms/100 mL, respectively. High concentrations at WC-6 could be the result of waterfowl in the stream. The <1 value for FC at JC-2 was due to a very high residual chlorine concentration (see Chlorine Discharge).

No source other than the STP effluent seems to have any major effect on FC levels. Several small discharges flow into Weaver Creek. The FC levels in several of these discharges were substantially elevated. At the time of this survey, however, flows from these discharges were 1 percent or less of the total stream flow. Therefore, individual impacts were almost negligible (Table 3). The reason for the high FC concentrations near the origin of Weaver creek is unknown. Access to points above WC-1 were not found. The low FC concentrations at D-5 suggest the source to be from the city's water system. Both D-3A and D-7 had elevated FC levels, but the sources of each of these discharges could not be determined. The high FC concentration in D-7 suggests it might be a leaking sewer line or septic system. Elevated FC concentrations from D-11 were expected because the drainage passed through an operating dairy farm. Calculations of FC for discharges into Weaver Creek indicate that there should have been a measurable increase on main-channel stations downstream, but none were observed. For example, on Day 3, the impact of D-7 should have resulted in a 26 percent increase in FC levels and D-11 should have raised FC levels by 72 percent if the flow is assumed to be

rural-residential. Below the town, several large farms were observed. Hobby farms having two to six farm animals were common. Three farms had a larger number of animals. Several farms engaged in hay or crop production were adjacent to the creek (Figure 3).

Farm animals had access to Weaver Creek between Battle Ground and station WC-17. One farm adjacent to the STP appeared to be a dairy farm which was no longer being used for that purpose. Several whitefaced cattle were seen grazing in the pastures. Active dairy farms were observed at Scotton Corner and near the intersection of Northeast 199th Street and Northeast 117th Avenue (Figure 3). Several farms engaged in hay or crop production also were observed. Plowed fields were observed at several points on the east side of Weaver Creek between stations WC-10 and D-14.

Above Battle Ground, Weaver Creek flows through areas of heavy brush. Within the town, about 50 percent of the creek is bounded by lawn. The rest of the creek has brush along its banks. Below Battle Ground, the creek flows through unoccupied pasture and hay fields up to a point about 200 yards upstream from the STP outfall. Between this location and station WC-17 (Figure 3), Weaver Creek was primarily bounded by very heavy brush, extending approximately 50 feet from each bank. Several impassible areas had to be omitted during the stream-walk. Heavy accumulations of aquatic vegetation also were found from below the STP discharge to station WC-17.

There was a substantial quantity of trash in the creek--two boat motors, a pressure cooker, and considerable lumber and plywood. There also was a large amount of other garbage such as cans, bottles, and grass clippings in and along the creek.

Flow

Flow measurements were made at selected main-channel stations and at point discharges (Table 3). Except for the section of Weaver Creek between WC-2 and WC-6, flow measurements showed no unexplainable increases. On October 29, flow between these two stations increased by about 50 percent, but no major surface discharge was observed. Minor discharges at D-3A and D-5 amounted to less than 2 percent of the total flow. The flow at D-7 also was negligible at the time of this survey. Ground-water intrusion could be responsible for this increase.

Jewel Creek, the major tributary, flows into Weaver Creek about 200 yards downstream from WC-6. Its flow was only about one-tenth that of Weaver Creek.

At the time of sampling, the dilution ratio of Weaver Creek to STP effluent was only 2:1. This fell far short of the 20:1 ratio required for the construction of new treatment plants (Ecology, 1980). Stream flows were greater than three times those which were encountered during the Kiernan study (Kiernan, 1983), indicating that the low-flow period was past.

(Table 1). On Day 3, the temperature change met the standards by only 0.3°C. Other point discharges did not individually cause measurable change in the temperature of Weaver Creek, but there was a measurable increase within the Battle Ground city limits. These temperature changes imply the criterion for temperature could be violated in warmer weather.

The pH levels tended to be on the low side throughout the drainage when compared to Class A standards. It also was low compared to historical data of other drainages in the vicinity such as Salmon Creek, Burnt Bridge Creek, and the east fork of the Lewis River (Ecology, 1985). The pH data compared reasonably well with that taken during the December Class II survey (Heffner, 1984), but it was slightly lower than the August 1983 reconnaissance survey (Kiernan, 1983). No discharge was seen to have any major impact on Weaver Creek drainage system's pH.

CONCLUSIONS

Weaver Creek above and below the Battle Ground discharge does not meet Class A FC standards. Except the STP, none of the numerous point discharges identified during this low-flow reconnaissance individually caused major impacts on FC levels. Collectively they, along with waterfowl and livestock, sustained the unacceptable FC levels in the Weaver Creek drainage. During this survey, the ratio of stream flow to STP effluent was found to be 2:1 instead of the recommended 20:1 (Ecology, 1980). Temperature variations caused by the STP may violate water quality standards in warmer weather.

PC:cp

Attachments

0.03 cfs. No notable increase was observed in either case. A series of beaver dams lie between D-11 and WC-12. This could have enhanced die-off rates by increasing time of travel. D-13 was a holding pond which probably was used for irrigation. Its FC concentration was not substantially different than that of Weaver Creek.

Dissolved Oxygen

D.O. measurements indicate that Weaver Creek barely met the 8.0 mg/L minimum criterion for Class A water during the time of the survey. On Day 1, the D.O. level at station WC-10 was below Class A standard. D.O. levels appear low at station WC-1 near the origin, then increase within Battle Ground, and finally decrease slightly at station WC-8 (Figure 2). This trend seems to be consistent for all three days. No obvious external influences were causing this pattern. Ground-water intrusion can cause low D.O. levels near the origin (Hynes, 1970). D.O. levels in Jewel Creek were nearly identical to those of WC-6, and the flow at D-7 was insufficient to be part of the cause of the D.O. sag at WC-10. The D.O. sag was most pronounced at WC-10. This was caused by the STP effluent. The D.O. saturation levels had recovered at WC-12 to the same level as at WC-8, just above the STP outfall. This recovery might be due partly to the reaeration caused by water flowing over a series of beaver dams located between WC-10 and WC-12.

At several points downstream of the STP, there seemed to be a strong odor of effluent emanating from the creek. This was especially evident when one stirred the bottom sediment. A hydrogen sulfide odor also was quite pronounced at several downstream locations.

Chlorine Discharge

On the first day of the survey, a chlorine odor was detected at JC-2. The level of free chlorine was 0.3 ppm, and the total residual chorine level was 0.6 ppm. The free chlorine level exceeded the acute toxicity level by a factor of 16 (USEPA, 1984). Both pH and nutrient results indicate that the chlorine probably is not from laundry drainage (note: both household bleach and laundry detergents are alkaline). Since Jewel Creek is culverted under much of Battle Ground, it was impossible to determine the source of the chlorine. Possible sources include school district activities, swimming pool water, or Andersen Dairy's disinfection water. The chlorine problem was not encountered on the other days of the survey.

Temperature and pH

The STP effluent was the only point-source discharge to cause significant change in the creek temperature. On Day 1 of the survey, the temperature change between WC-8 and WC-10 was 2.3°C. Acceptable temperature change for this day according to Class A criterion was calculated to be only 1.6°C

REFERENCES

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Table 1. Class A (excellent) water quality standards (WAC 173-201-045) and characteristic uses.

Characteristic uses:	Water supply, wildlife habitat; livestock watering; general recreation and aesthetic enjoyment; commerce and navigation; fish reproduction, migration, rearing, and harvesting.
Water Quality Criteria	
Fecal coliform:	Geometric mean not to exceed 100 organisms/100 mLs with not more than 10 percent of samples exceeding 200 organisms/100 mLs.
Dissolved oxygen:	Shall exceed 8 mg/L.
Total dissolved gas:	Shall not exceed 110 percent saturation.
Temperature:	Shall not exceed 18°C due to human activity. Increases shall not, at any time, exceed $t = 28/(T+7)$; or where temperature exceeds 18°C naturally, no increase greater than 0.3°C. t = allowable temperature increase across dilution zone, and T = highest temperature outside the dilution zone. Increases from non-point sources shall not exceed 2.8°C.
pH:	Shall be within the range of 6.5 to 8.5, with man-caused variation within a range of less than 0.5 unit.
Toxic, radioactive, or deleterious materials:	Shall be below concentrations of public health significance, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect any water use.
Aesthetic values:	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

Table 2. Station descriptions for the October 22, 23, and 29 reconnaissance surveys of the Weaver Creek drainage.

Station Number	River Mile	Description
WC-1	4.3	Weaver Creek - upstream side of the culvert on Northeast 152nd Avenue
WC-2	3.7	Weaver Creek - upstream side of the culvert on 5th Street
WC-3	3.6	Weaver Creek - downstream side of the Clark Street culvert
D-3A		Discharge - six-inch pipe on north side of Station WC-3
WC-4	3.4	Weaver Creek - downstream side of 1st Street culvert
D-5	3.3	Discharge - 12-inch pipe draining into west culvert under main street about 100 feet from downstream opening (bring a flashlight)
WC-6	3.2	Weaver Creek - 100 feet upstream from "B" Street culvert
D-/	3.1	Discharge - small seep 100 feet downstream from "B" Street out of east bank
WC-8	2.1	Weaver Creek - ten feet upstream from STP outfall
WC-9	2.0	Weaver Creek - 250 feet downsream from STP outfall
WC-10	1.9	Weaver Creek - 50 feet downstream from Northeast 199th Street culvert
D-11	1.7	Discharge - small drainage on west side of the first culvert south of Northeast 199th Street under Northeast 132nd Avenue
WC-12	1.2	Weaver Creek - ten feet upstream from culvert at end of Northeast 132nd Street
D-13	1.1	Drainage - from pond 50 feet east of Weaver Creek
D-14	0.9	Small drainage on north side of private road on east side of Weaver Creek
D-15	0.6	Small drainage on east side of Weaver Creek
D-16	0.3	Small drainage on west side of Weaver Creek near a one-inch iron pipe
WC-17	0.1	Weaver Creek - 100 feet downstream from the Easy Street culvert
JC-1		Jewel Creek - north side of Granite Street culvert
JC-2	2.5	Jewel Creek - southeast side of Nowak Lane culvert

Table 3. Field data and laboratory analytical results for samples from Weaver Creek and its tributaries, October 1985 (mg/L unless otherwise stated).

Station Number	River Mile	Date	Time	Flow (cfs)	Temp. (°C)	pH (S.U.)	Sp. Cond. (umhos/cm)	D.O.	D.O. (% sat.)	F. Coli. (#/100 mL)	NH_3-N	NO_2-N	NO_3-N	O-PO_4-P	T-PO_4-P	Chlorine (free)	Chlorine (total)
WC-1	4.3	10/22	1000	1.6	9.3	6.3	150	8.7	76	210	--	--	--	--	--	--	--
		10/23	1800	--	10.3	--	140	8.8	78	130	--	--	--	--	--	--	--
		10/29	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WC-2	3.7	10/22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/23	1750	--	10.2	--	145	9.4	83	150	--	--	--	--	--	--	--
		10/29	1320	1.9	6.8	6.4	110	10.8	88	110	--	--	--	--	--	--	--
WC-3	3.6	10/22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/29	1420	--	--	--	--	--	--	300	--	--	--	--	--	--	--
D-3A	3.6	10/22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/29	1415	0.03	14.2	--	90	--	--	460	--	--	--	--	--	--	--
WC-4	3.4	10/22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/29	1425	--	7.8	--	110	10.5	88	140	--	--	--	--	--	--	--
D-5	3.3	10/22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/29	1440	--	13.2	6.8	240	--	--	4*	--	--	--	--	--	--	--
WC-6	3.2	10/22	1025	2.9	10.2	6.6	165	9.5	84	520	--	--	--	--	--	--	--
		10/23	1740	--	10.6	--	150	9.4	84	600	--	--	--	--	--	--	--
		10/29	1200	2.9	7.7	6.3	115	10.8	90	150	--	--	--	--	--	--	--
D-7	3.1	10/22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/29	1100	--	--	--	--	--	--	3700	--	--	--	--	--	--	--
WC-8	2.1	10/22	1340	3.0	10.2	6.6	155	8.8	80	220	--	--	--	--	--	--	--
		10/23	1620	2.4	11.1	7.0	150	9.3	84	110	--	--	--	--	--	--	--
		10/29	0950	3.4	7.3	7.3	--	10.6	88	120	--	--	--	--	--	--	--
STP Effluent	2.1	10/22	1350	1.5	--	--	--	--	--	460**	--	--	--	--	--	--	--
		10/23	1600	1.3	--	--	--	--	--	480**	--	--	--	--	--	--	--
		10/29	0935	1.5	--	--	--	--	--	--	--	--	--	--	--	--	--
WC-9	2.0	10/22	1315	4.4	12.5	6.7	200	8.4	78	300	--	--	--	--	--	--	--
		10/23	1620	--	13.0	7.0	220	8.3	78	240	--	--	--	--	--	--	--
		10/29	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WC-10	1.9	10/22	1240	4.8	12.3	6.7	200	7.6	71	200	--	--	--	--			
		10/23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/29	0910	--	9.0	6.7	195	9.1	79	66	--	--	--	--	--	--	--
D-11	1.7	10/22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/23	1540	0.03	12.1	6.9	110	8.1	75	4400	--	--	--	--	--	--	--
		10/29	0900	--	--	--	--	--	--	7700	--	--	--	--	--	--	--
WC-12	1.2	10/22	1215	4.9	11.4	6.8	165	8.6	78	230	--	--	--	--	--	--	--
		10/23	1420	--	12.2	7.0	215	8.4	78	60	--	--	--	--	--	--	--
		10/29	0850	--	8.3	6.7	170	9.5	81	63	--	--	--	--	--	--	--
D-13	1.1	10/22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/23	1250	0.035	12.0	6.8	165	8.1	75	48*	--	--	--	--	--	--	--
		10/29	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
D-14	0.9	10/22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/23	1200	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/29	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
D-15	0.6	10/22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/23	1110	0.027	10.6	--	--	--	--	--	--	--	--	--	--	--	--
		10/29	--	--	--	--	--	--	--	--	--	--	--	--	--		
D-16	0.3	10/22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/23	1100	0.003	10.1	--	--	--	--	--	--	--	--	--	--	--	--
		10/29	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WC-17	0.1	10/22	1140	5.3	11.2	6.9	195	9.0	82	240	--	--	--	--	--	--	--
		10/23	1000	3.8	11.4	7.2	200	8.6	78	100	--	--	--	--	--	--	--
		10/29	0820	4.1	6.1	6.6	170	10.2	85	50	--	--	--	--	--	--	--
JC-1		10/22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/29	1230	--	9.2	6.1	103	9.0	78	770	--	--	--	--	--	--	--
JC-2	2.5	10/22	1430	0.25	13.4	6.7	157	9.0	85	<1	0.07	0.01	1.40	0.11	0.16	0.3	0.6
		10/23	1730	--	13.4	--	165	8.6	82	680	--	--	--	--	--	--	--
		10/29	1250	0.33	12.7	6.5	160	9.7	91	250	--	--	--	--	--	--	--

*Estimate.
**Estimate based on upstream and downstream data.
-- = Sample not collected.

Table 4. Rainfall at Battle Ground sewage treatment plant, October 1985.

From 0800	To 0800	Inches of Precipitation
10/20	10/21	0.32
10/21	10/22	0.47
10/22	10/23	0.02
10/27	10/28	0.66
10/28	10/29	none

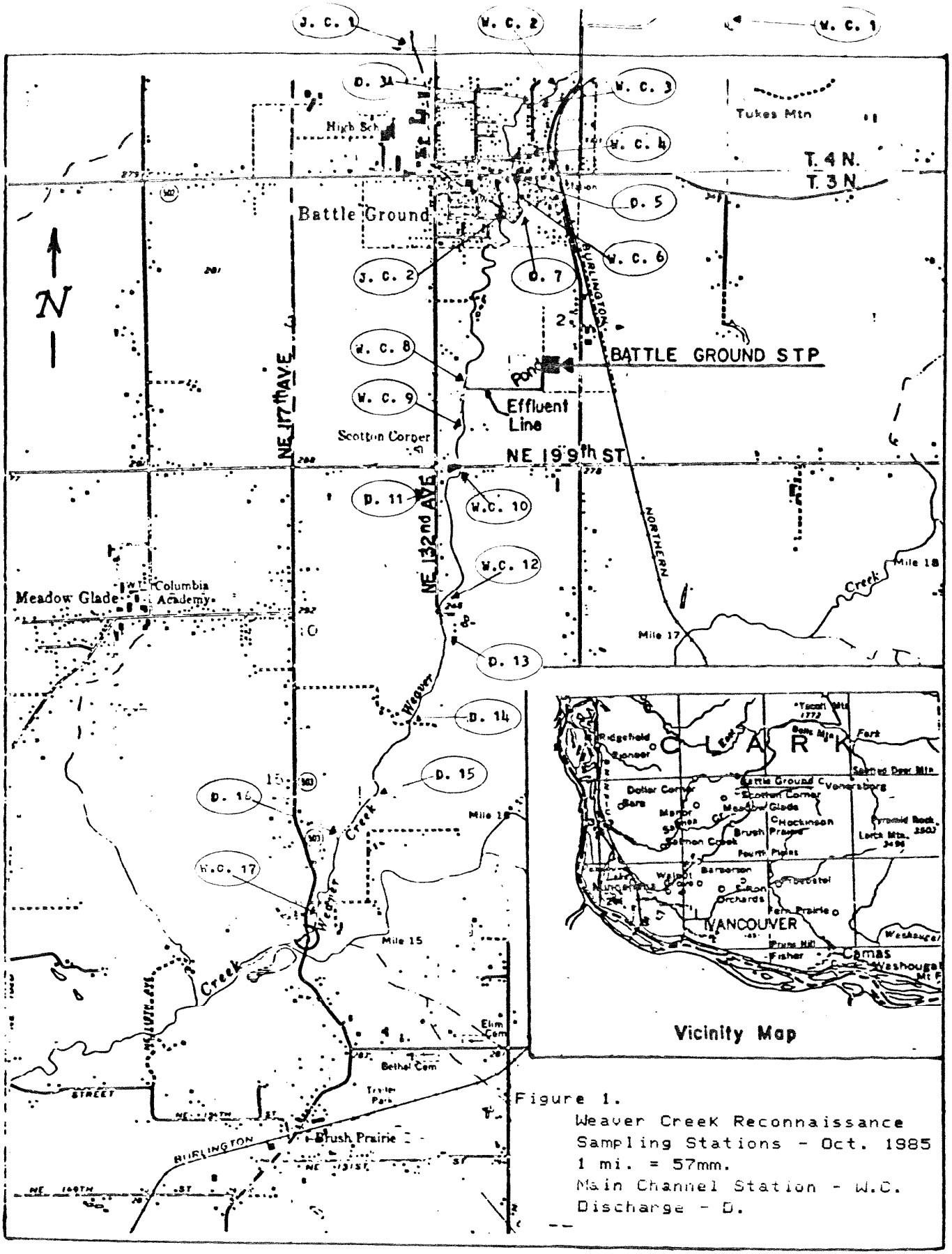

Figure 1.
Weaver Creek Reconnaissance Sampling Stations - Oct. 1985
1 mi. = 57mm.
Main Channel Station - W.C.
Discharge - D.