WATER QUALITY STATUS REPORT • REPORT NO. 62

PINE CREEK
NEZPERCE COUNTY
1986

Agricultural Non-point Source Pollution Abatement Program

Prepared by

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Division of Environment
Boise, Idaho

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ABSTRACT

A water quality study was conducted on Pine Creek from February 20, 1985 to February 23, 1986. The objectives of that study were to: 1) determine baseline water quality of Pine Creek and its tributaries; and 2) document the effects of storm event runoff on water quality.

Pine Creek is a third order tributary to the Clearwater River. Current beneficial uses are as an agricultural water supply and for secondary contact recreation. Some spring steelhead spawning occurs in the drainage and cold water biota are present. Both are limited by water quality.

Water quality in Pine Creek was most severely impacted by two periods, runoff and low flows. Periods of minimal discharge normally occur from mid-April to the advent of the fall rains in September or October. The upper reaches usually go completely dry except for freshets created by summer storms. Peak runoff events on Pine Creek typically occur when chinook rainstorms melt the snow-packs or deliver driving rains to unprotected soils.

Water quality during the dry summer months in the canyon is characterized by temperatures over 20°C, and elevated pH values greater than 8.5 S.U. Given the current habitat conditions it is possible that the water quality criteria of a productive cold water biotic system may not be met.

Three events in 1985 produced peak discharges of approximately 100 cfs each, at the mouth. Three storms in early 1986 exceeded the 1985 peaks by 2 to 10 times. A ten year storm event for a drainage of that size is around 1,000 cfs based upon precipitation over 24 hours. A storm on February 23, 1986 approached this figure.

Suspended sediment exported from Pine Creek into the Clearwater River exceeded 12,300 tons during the period of study. Most of that suspended sediment, 93 percent, occurred during the storms on February 16 and 23, 1986. The one day total from the upper watershed accounted for 65 percent or 8,100 tons.

An interesting correlation was noted between the contribution of suspended sediment from the upper watershed to total suspended sediment load from the entire watershed as recorded at the mouth. As the load at the mouth increased, the percentage contributed by the upper watershed increased at a greater rate. A decrease in the concentration of suspended sediment at the mouth indicates that either substantial deposition of sediment occurred during peak events, or the upper watershed contributed the majority of sediment and the rest of the watershed provided the majority of water. It is unlikely that significant deposition of sediment occured because of the steep, confined channel of Pine Creek in the canyon.

There was a notable difference in the concentrations of suspended sediment exhibited at the two upper stations only during peak runoff events. The eastern drainage sampled at Leland consistently showed concentrations of suspended sediment 50 to 90 percent greater than the northern sub-watershed. Factors that may cause such a disparity in concentrations include sediment delivery rates, land use, discharge, channel stability, and soil types.

The influx of nutrients, notably nitrite + nitrate, and total phosphorus were seasonally related. At least 35 tons of nitrite and nitrate were exported from Pine Creek in this manner. Twenty-two tons can be attributed to the upper two stations, 12 tons from the north subwatershed and the other 10 tons from Leland.

The phosphorus loading was event-related. The concentrations of orthophosphate and hydrolyzable phosphate increased along with the suspended sediment concentrations due to the affinity of the phosphate ion for positively charged soil particles, particularly the clays. An estimated 16 tons of total phosphate were lost from the drainage, including 6 tons from the northern watershed and 4 tons from east of Leland.

Pine Creek delivered enormous quantities of sediment and nutrients to the Clearwater River. Most of that occured during the peak runoff events. Successful implementation of an Agricultural Non-point Source Pollution Abatement Project will mitigate some of the water quality problems associated with agricultural and land use practices.

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INTRODUCTION

The NezPerce Soil & Water Conservation District (SWCD) signed an Idaho Agriculture Nonpoint Source Pollution Abatement planning grant agreement with the Idaho Division of Environment on January 21, 1985. The planning grant process is used to determine the suitability of the Pine Creek watershed for implementation of cost-shared Best Management Practices (BMPs) to reduce water pollution caused by agricultural practices. Part of this planning process included a water quality monitoring study conducted for a period of one year. This study determined the condition of Pine Creek as defined by water quality.

The Pine Creek watershed is in the northeast corner of NezPerce County. The rolling plateau, at an elevation of 2200-2800 feet, has slopes of 4 to 30 percent of highly erodable silt-loam soils. The canyon has slopes of 30-60% (Figure 1). There are 30 operators farming the 13,000 acres of dryland crops of peas and winter wheat. Most of the remaining 3800 acres is range and timber. Some Best Management Practices, such as sediment basins, grassed waterways, and tile drains are in use.

Pine Creek is a third order tributary to the Clearwater River. There are 13 first and second order streams, one to three miles long, that drain the 16,850 acres in the watershed. Most of the 5000 acres in the upper watershed drain seven miles to the southwest. The last five miles is in a canyon, where it drops 1000 feet to the Clearwater River at 875 feet elevation.

Current usages of the stream are as an agricultural water supply, and for secondary contact recreation. Salmonid spawning habitat and cold water biota are present but are limited by water quality.

Study Objectives

The objectives of the planning study were to: (1) determine water quality in various reaches and sub-watersheds; (2) determine baseline water quality; and (3) document the effects of storm event runoff on water quality in Pine Creek.

METHODS AND MATERIALS

Methods of sample collection, preservation and analysis followed Standard Methods (APHA ,1985), or EPA guidelines (EPA,1979). Water samples were drawn with a DH-48 sampler at 0.6 times the stream depth and collected in a churn splitter from which separate samples were drawn. Grab samples were taken from turbulent stream reaches to provide mixing of laminar flows during minimal discharge.

SAMPLING SITES

Three monitoring stations were chosen on Pine Creek to divide the watershed. This method allowed the separate watersheds to be evaluated for their contributions to the sediment and nutrient loads. Station #1 was a mile above the community of Leland. There are 2633 acres in the subwatershed. Station #2 characterized the east fork of Pine Creek that enters Pine Creek at Leland. There are 1930 acres in this drainage. The third station was at the mouth of Pine Creek and portrayed the whole watershed (Table 1).

FREQUENCY

This study was designed to monitor water quality during spring and storm runoff events when the maximum influx of nutrients and suspended sediment were contributed. It has been shown that the majority of the loading of nutrients and sediment are delivered during a few peak runoff events. These peak events usually occur in the spring when warm southwesterly winds deliver driving rains.

A schedule was established that provided flexibility to respond to storm events as they occurred. Intermediate data points were gathered every two weeks to provide information on water quality during "normal" spring flows. Two additional samples were taken in the late spring to characterize ambient conditions at low flows.

VOLUNTEER ASSISTANCE

It became evident after the first season that valuable data were being lost due to the flashy nature of the stream. Storm events occurred with such rapidity that little time was available to respond. A network of four SWCD cooperators volunteered to monitor the stream during storm events to which DOE was unable to respond quickly enough. The volunteers were provided with sampling equipment and trained in the techniques and methods of taking grab samples. They also recorded precipitation and temperature data along with crest and staff gauge readings. Their data points were averaged with DOE "same day" data for quality control checks.

PARAMETERS

Agricultural practices may contribute substantially to the sedimentation and nutrient loading of Pine Creek and subsequently to the Clearwater River. The parameters were chosen to monitor the nutrients normally leached from fields. Other parameters were general indicators of water quality which highlight changes in designated beneficial uses of a particular stream segment. A listing of the physical, chemical and bacterial parameters is provided in Table 2.

The determination of total amounts of solutes contributed during a one day period, or loads, were deduced by assuming that an individual sample was a "typical" sample for the whole day. Selected dates were chosen for the purpose of comparing different subwatersheds on the same date.

Discharge

The methods used to determine discharge in this study were as outlined by the U.S. Geological Survey (U.S.G.S., 1977). Instantaneous discharge at a given point was calculated from the cross-sectional area of the stream and the stream velocity.

Evidence of peak discharges was gathered by use of crest gauges anchored in the stream bed (Figure 2). The use of a crest gauge at Station #1 above Leland, and in 1986 at Station #2, east of Leland, provided details on peak discharges that would have been missed otherwise. The crest gauges provided a means for volunteers to monitor fluctuations in stream depths. This information was compared with data collected from actual discharge measurements to estimate flows.

Direct measurement of velocity and area were made with a Marsh McBirney Model 201 current meter. Determination of these two parameters was not always possible. During extreme flows the "orange peel" method was used to determine velocity. This method involves timing a floating object over a known length of the stream. Measurements from the top of the water to bridge railings compared with previous bottom profile data and crest gauge readings allowed estimation of depths.

A regression equation for peak discharges of ten year frequency was adopted from Thomas (1973). The Manning equation was also used to determine discharges of storm events (U.S.G.S., 1977).

pH

The pH of water is a measure of its hydrogen ion concentration. Many chemical reactions are affected by the pH. On-site pH measurements were conducted using a Corning, Model #103, pH meter. Samples submitted by volunteers were analyzed by the State laboratory.

Conductivity and Temperature

Conductivity is a numerical expression of the ability of a water sample to carry an electrical current. This number is dependent on the total concentration of the total dissolved solids and salts in the water (APHA, 1985). Conductivity and temperature measurements were taken with a YSI, Model 33, S-C-T meter, on site, and by the State lab on volunteers samples.

Suspended Sediment

Suspended sediment (S.S.) concentrations are one of the prime indicators of non-point pollution. Suspended sediment consists of soil particles that are entrained in the water column from three inches above the stream bottom to the top of the water column (Clark, 1985).

Nitrogen

The method of determination for the total organic nitrogen concentrations is called the Total Kjeldahl Nitrogen (TKN) process. This process does not distinguish between organic nitrogen and ammonia. An estimate of just the organic fraction may be made by subtracting the ammonia concentration from the TKN concentration.

Samples taken by volunteers were analyzed for total Kjeldahl nitrogen, nitrite + nitrate and ammonia. Samples were preserved with 2 ml of concentrated sulfuric acid.

Phosphorus

The three major forms of phosphorus that were monitored during the length of this study were total phosphorus (T.P.), orthosphosphate (O'PO_4), and hydrolyzable phosphate (H'PO_4). Only total phosphorus was monitored on samples taken by SWCD volunteers. Samples were preserved with 2 ml of concentrated sulfuric acid.

Bacteria

Samples for bacterial analysis were collected in sterile, 250 ml bottles. The samples were refrigerated until analyzed by the Lewiston Central District Health Laboratory.

RESULTS

Discharge

The flows in the Pine Creek drainage are subject to extreme fluctuations. Periods of minimal discharge occur from mid-April until the fall rains in September or October and during the coldest part of the winter when the stream freezes. Typical flows during these periods are less than five cubic feet per second (cfs) at the mouth. The upper drainage dries up completely.

Peak runoff events normally occur when chinook rain storms from the southwest rapidly melt the snowpack. The combination of low percent of forest cover, frozen soils that prevent percolation, steep slopes that allow little time for absorption, and the sudden onslaught of warm west winds with heavy rain, all contribute to the "flashy" nature of the watershed. This pattern is typical in the numerous drainages of the Palouse region.

In 1985 the snowmelt runoff occurred over a mild and dry period in early March. Three rainy periods in late March and early April, and one in late May, produced the peak flows. The greatest flow was approximately 100 cfs on March 15th at the mouth. By comparison, the 1986 sampling season started on January 30th with a rainstorm on snow cover that produced flows of at least 175 cfs at the mouth. An intense thunderstorm, of ten year frequency, on February 23, resulted in a recorded 674 cfs at the mouth (Figure 3). Evidence indicated that the peak may have been 1.4 feet higher. An estimate of 1,000 cfs was calculated by assuming the same velocity for the increased depth.

Suspended Sediment

Comparison of suspended sediment concentrations reveal only slight differences between the mean concentrations of the two upper drainages. Samples from east of Leland showed a mean concentration of 1,710 mg/L while the mean concentration for samples from the northern drainage was 1,370 mg/L. Differences in loadings may be attributed to greater flows from the north of Leland.

There is a notable difference in the suspended sediment concentrations of the two upper drainages during runoff events. While the background levels of suspended sediment remained approximately equal, if not slightly higher for the northern watershed, the big difference came with the peak events. The eastern drainage consistently had concentrations of 50 percent to 90 percent greater than that of the northern drainage.

Volunteers took samples on February 16th after a particularly heavy rainstorm. Concentrations of suspended sediment of 7,300 mg/L at Station #1, east of Leland, and 8100 mg/L at Station #2, above Leland, were the greatest recorded for the study. The only monitored peak storm event that comes close to these concentrations were from the February 23rd, 1986 storm which had suspended sediment concentrations of 2730 mg/L and 3620 mg/L for the two stations respectively.

The influence of peak events during the rainy period extending from January 27, 1986 for a week, and then later from February 13th to the 25th, overwhelmed all other fluctuations in concentrations and flows (Figure 4). The load of any one of these sample dates exceeded the total load for 1985, based upon samples collected by the DOE (Table 4).

An estimated 2,262 tons of suspended sediment from above Leland and 1,855 tons of suspended sediment from east of Leland were recorded at these stations for February 16th, 1986. No data are available from Station *3, at the mouth, for this date. One week later, during the February 23rd storm, another 1804 tons of sediment from north of Leland, and 1340 tons from east of Leland were carried away (Table 4). The drainage as a whole lost 7335 tons of sediment for that one day.

An estimated of 11,850 tons of suspended sediment were discharged from the mouth of Pine Creek (Table 4). The upper part of the drainage contributed 68 percent or 8,100 ton of the total. This was split into 4,446 tons from the north of Leland and 3,656 tons from the eastern drainage.

Nitrogen

Concentrations of nitrite + nitrate were greatest in the early spring and slowly decreased throughout the season to about a third of the peak level (Figure 5). This is consistent with the soluble characteristic of the ions which allows them to be leached from the soil. The inorganic nitrogen criterion of 0.3 mg/L was exceeded for every sample taken, mean = 12.3 mg/L (Table 4).

Average ammonia (NH_3) concentrations for the various reaches differed only slightly. The mean concentrations for ammonia coming from above Leland was 0.09 mg/L, that from the drainage east of Leland was slightly higher for the same days at 0.13 mg/L. Mean concentrations for nitrite + nitrate, follow the trend set by ammonia. The concentration from the northern drainage was slightly less than that from east of Leland (10.4 mg/L vs 12.6 mg/L).

The total inorganic nitrogen (NO_2+NO3 and NH_3) load lost from the whole drainage exceeded thirty-six tons during the length of the study (Table 4). Nine and a half tons were lost during the January 30th storm, but the greatest amount,14 tons, was lost during the February 23 storm. The upper part of the drainage exhibited some slightly different characteristics. A slightly greater load of total inorganic nitrogen was lost on January 30, 1986 (7 tons) than on February 23 (6.5 tons).

Total Kjeldahl nitrogen (TKN) concentrations during this study ranged from 0.56 to 18.8 mg/L. No limiting criteria have been set for TKN concentrations. Samples taken by the volunteers on February 16, 1986 displayed the single largest concentrations at 17.5 mg/L at the upper station and 18.8 mg/L from east of Leland. No other single day concentration exceeded 8.5 mg/L.

Phosphorus

The main components of total phosphorus are hydrolyzable phosphate and orthophosphate. Together they account for 73 percent of the total phosphorus from above Leland, 71 percent from the drainage east of Leland, and 82 percent at the mouth. The hydrolyzable phosphate was the greater portion of this fraction. Because of the affinity of phosphorus for sediment, hydrolyzable phosphate concentrations fluctuated with the suspended sediment concentrations (Figure 6).

Total phosphorus concentrations exceeded the recommended criterion of 0.1 mg/L for each sample during the period monitored. The mean concentration of total phosphorus for samples at the mouth was 1.14 mg/L (Table 3).

A total of 33,200 pounds of phosphorus were discharged from the Pine Creek drainage. Most of this load, 64 percent, can be accounted for in the February 23 storm. Another 26 percent was delivered on February 16, 1986. Sixty percent of the total phosphorus which was lost was evidently attributable tothe two upper stations (Table 4).

Bacteria

Waters designated as usable for secondary contact recreation, i.e. wading and fishing, are not to exceed fecal coliform colonies greater than 800/100 ml at any time or a geometric mean of 200/100 ml based on five samples/30 days (IDHW-DOE, 1985). The single day criterion was exceeded on one sample date, June 7, 1985, at the mouth of Pine Creek (Table 4). The average ratios of fecal coliform to fecal streptococcus were 2.8, 1.4, and 1.7 for Stations 1,2, and 3 respectively.

Quality Assurance

This project served as part of a series of quality assurance checks by the DOE on precision and accuracy of sampling procedures. Duplicate and spiked samples were collected from various stations and on different dates. The data were pooled for several projects and results were compiled (Bauer, 1985).

Precision estimates from duplicate samples gathered in March 1985 are given in Table 6. Precision estimates for suspended sediment, total phosphorus,total nitrite plus nitrate, total Kjeldahl nitrogen and turbidity were good to excellent. Orthophosphate, total hydrolyzable phosphate and total ammonia exhibit poorer precision (Bauer,1985).

Percent recovery for suspended sediment, orthophosphate, total nitrate, and total Kjeldahl nitrogen were within five percent of the absolute value. Methods used to determine hydrolyzable phosphate tended to underestimate concentrations by 20 percent. Total phosphorus was overestimated by 12 percent and total ammonia overestimated by 20 percent.

DISCUSSION

Discharge

The 1985 water year was abnormal in a couple of respects. First, the mild warm weather that melted the snow pack slowly and the second was the lack of any significant rain events (Table 5). That was an abrupt contrast with the first few sampling dates of 1986. Closer coordination with SWCD members, the establishment of a volunteer sampling network, and different hydrologic conditions enabled characterization of the effects of chinook storms on water quality.

Pine Creek discharges were very erratic. The small size of the watershed, and the proximity of the stations to the head of the watershed provided little time for the sampler to react to storm events. The crest gauges provided a means of recording the transitory peak flows. They were also valuable in providing a means for volunteers to contribute to the data base in a standardized manner. These estimates were used in loading rates only when actual flow measurements were not available. Some peak discharges at each station were estimated from information gathered from the crest gauges and from comments by individuals as to the height of the water and debris left behind. A case in point was the February 23, 1986 storm. The crest gauge at Station #2 was destroyed by the storm, but there was evidence that water had overtopped a bridge at Leland indicating flows of at least 200 cfs. The peak discharge at the mouth may have been as great as approximately 1,000 cfs on February 23rd. That would have been comparable to a 10 year storm event (Thomas,1973).

Most of this report has been geared to discussing what occurs during the peak discharges. The other end of the spectrum also imposes limitations on beneficial uses. Periods of minimal discharges typically occur in Pine Creek from mid-April until September or October when the fall rains start. The upper reaches usually go completely dry except for freshets created by summer storms. The surface water freezes solid in winter, thereby reducing the contribution of discharge from the upper watershed. The discharge at the lower end of Pine Creek is reduced to less than five cfs during these periods of low flows.

A report issued by the Soil Conservation Service stated that an average of 1 cfs per square mile may be yielded from drainages in the Clearwater Basin (U.S.D.A,1986). That guideline provides an estimate of 22 cfs as an average daily discharge. Of course, seasonal trends cause Pine Creek flows to fluctuate wildly. A peak discharge of 1,000 cfs occurred at the mouth of Pine Creek on February 23, 1986 while flows for most of the dry summer months were less than 5 cfs.

Suspended Sediment

Suspended sediment concentrations were positively correlated with greater flows (Figure 7). One exception was noted on the February 16, 1986 when the single greatest concentrations were recorded at the two upper stations. This may have been due to the particularly heavy, driving rains that preceded the sampling.

Overall, 66 percent of the total suspended sediment load exported at the mouth of Pine Creek may have its origin in the upper reaches. This figure varied from 14 percent during lower flows to 101 percent during the heaviest flows. The figure of 101 percent may be due to sediment settling before reaching the mouth, or the concentrations of solutes had not reached the mouth by the time of sampling.

As the loads at the mouth increased, the upper stations contributed a greater percentage of the load (Table 4). Lands on the upper watershed, which comprise 27 percent of the total watershed, evidently contributed a disproportionate amount of suspended sediments during peak events.

The 50 to 90 percent difference in concentrations seen in the upper watersheds during runoff events may have been due to a reach of 150-200 feet of denuded streambank directly upstream of the sampling station for the eastern watershed. No protective cover or stabilizing features prevent the wasting of the bank into the stream.

Nutrients

Pine Creek delivered large amounts of nitrogen and phosphorus to the Clearwater River. The stream is recharged with each influx of nutrients from each storm event. Every sample analyzed exhibited concentrations of nitrite and nitrate, and total phosphorus that exceeded recommendations to prevent eutrophication in lakes and impoundments. Reserves of nutrients are stored as organic sediments deposited on the stream bottom.

There were only slight differences exhibited in the chemical concentrations between the northern-most drainage and the eastern drainage at Leland. Some of these differences in concentrations may be due to a dilution effect caused by the higher flows registered at Station #1, above Leland. If this is the case, then the per acre yield of nutrients will decrease.

Nitrogen is an essential element for maximum potential plant growth. There are three major interconvertible fractions of nitrogen in soil and water; total organic nitrogen, ammonia (NH_3), and the nitrite plus nitrate complex (NO_2 + NO_3). Nitrogen may be applied to cultivated fields as a fertilizer in the form of anhydrous ammonia and nitrate compounds.

The total organic fraction consists of a wide variety of organically bound nitrogen usually found in plant and animal tissue. It also includes the byproducts of those organic complexes and synthetic organic molecules, e.g. pesticides and herbicides. This represents a reservoir of nitrogen that will be available for plant utilization once it has been broken down by oxidation and nitrifying bacteria.

The nitrate ion (NO_3) is soluble in water and may be readily leached from soils to be carried to streams. When samples are analyzed for nitrates it is a common practice to analyze both the nitrite and nitrate fraction (NO_2 + NO_3). The reasoning for this is due to the interconvertibility of nitrite and nitrate.

Ammonia (NH_3) is converted by microbial action into nitrate, which is more soluble and therefore more readily available to plants. This reaction is sensitive to several environmental factors such as temperature, moisture, aeration, pH, and the ratio between ammonia and nitrate.

The influx of nitrite + nitrate was a seasonal trend. High concentrations of nitrite + nitrate in the early spring tapered off later in the year (Figure 5). This is consistent with the water soluble characteristic of the ion which allows it to be leached from the soil. This may be the reason that the same amount of inorganic nitrogen was lost from the January 30, 1986 storm, which had much lower flows than the one on February 23, 1986. Most of the nitrite + nitrate had already been leached out.

The presence of excess nitrogen in aquatic systems may lead to accelerated eutrophication in lakes and reservoirs. In extreme cases it may be harmful to aquatic life. It is the inorganic nitrogen (NH_3 and NO_2 + NO_3) concentration that is detrimental and has an established criterion. A concentration of total inorganic nitrogen of 0.3 mg/L is considered the maximum limit for preventing the development of biological nuisance and accelerated eutrophication of impoundments (Mackenthun,1973).

Natural waters exhibit a range of values of TKN from 0.05 to 2.0 mg/L. The unusually high concentrations of organic nitrogen may be due to the influence of animal wastes, which are high in organic nitrogen. Several cattle feedlots, barnyards and pastures border the stream.

Phosphorus

Total phosphorus analysis includes all the phosphorus present in the sample regardless of form. Included are organically bound phosphates, condensed phosphates, and orthophosphates. Filterable orthophosphate refers to a water soluble form of phosphate available for biological uptake. Hydrolyzable phosphates are the fraction of other phosphates convertible to orthophosphate.

Phosphorus (P) is an essential element to plant growth, and, if not present in sufficient quantities, is a limiting factor to maximum plant production. Therefore, it may be applied as a supplement to fields to increase crop yields.

The phosphorus concentrations and loading are event related. The phosphate ion has an affinity for the positively charged soil particles, particularly the clays. The erosion of the soil then transports the phosphorus to the stream. The concentrations of orthophosphate and hydrolyzable phosphate increase with the suspended sediment concentration (Figure 6). Clay particles tend to stay in suspension due to their small size. The phosphate associated with the particles are tightly bound to the clay and will be carried along by the stream.

A goal of 0.1 mg/L total phosphorus has been suggested to prevent nuisance growth in flowing waters not discharging directly to lakes or impoundments (Mackenthun, 1973).

Bacteria

Monitoring for bacterial contamination has been a standard water quality procedure to indicate potential contamination and possible presence of other disease-causing organisms. A ratio of colonies of fecal coliform : fecal streptococcus greater than 0.7 is an indicator of contamination by warm-blooded animals.

The ratio of fecal coliform: fecal streptococcus indicates fecal contamination by warm-blooded animals in Pine Creek. The most probable cause would be the numerous feedlots, pastures and barnyards bordering the stream. The constituents of feedlot runoff include raw manure, and urea, both are rich in organic nitrogenous compounds, ammonia, organic solids and total phosphorus and bacteria.

Two factors that may elevate the number of colonies present in samples are, heavy runoff off of areas where livestock are contained, and warm weather that will accelerate the growth rate of bacteria. Both factors probably affected the observed counts in Pine Creek. Most of the sampling was done during or after storm events, and temperatures of the water on the day when counts exceeded the single day criteria were approaching 20° C.

Quality Assurance

Precision is a measure of mutual agreement (or measure of the dispersion) among individual analysis of the same property. Sources of error may occur at any time from sample collection to analysis. Potential errors include the sampling techniques, contamination, interference or inherent analytical errors.

Accuracy is a measure of agreement between the measured value and the absolute value expressed as percent recovery. The absolute value is determined from a sample "spiked" with a known quantity of a given parameter. The optimum is to have an average percent recovery of 100 percent with a narrow confidence interval (Table 7).

CONCLUSIONS

1) Pine Creek is a relatively small drainage of approximately 22 square miles of rolling prairie croplands and a steep canyon of forested slopes and rangeland.

2) Substantial quantities of nutrients and sediments are contributed to the Clearwater River from Pine Creek. During spring runoff the increased turbidity of Pine Creek may be seen as a plume in the Clearwater River for a mile downstream. Current beneficial uses of Pine Creek are as an agricultural water supply, secondary contact recreation, salmonid spawning habitat, and for cold water biota.

3) Water quality in the canyon during the dry summer months was characterized by flows less than five cubic feet per second, temperatures over 20°C, and pH values greater than 8.5 S.U. These conditions are near the upper criteria limits set for cold water biota.

4) A total of 12,300 tons of suspended sediment was exported to Pine Creek during the length of the study. Ninty-three percent of the total load came during two storm events.

5) The contribution of suspended sediment by the upper watershed increased disproportionately with the total loads from the mouth.

6) There was a notable difference of solute concentrations recorded at the two upper stations only during peak runoff events. The east fork at Leland consistently had suspended sediment concentrations 50 to 90 percent greater than the north fork.

7) An estimate of 35 tons of nitrite + nitrate was lost from the drainage. Twelve tons came from the northern watershed and 10 tons came from the east of Leland.

8) Phosphorus concentrations fluctuated with suspended sediment concentrations. Sixteen tons of total phosphorus were lost from the whole drainage, 6 tons from the north fork and 4 tons from the east.

RECOMMENDATIONS

1. An Agricultural Nonpoint Source Pollution Abatement Program targeted to implementing Best Management Practices should mitigate some of the impacts of agriculture on water quality. Benefits of a successful campaign to the watershed may be: 2) a reduction in soil erosion from dryland crop acreages; 3) a decrease in the rate of sediment delivered to the stream; 4) enhancement of potential fish habitat; 5) a decrease in the sediment and nutrient loads delivered to the Clearwater River.

2. An implementation plan submitted by the Nez Perce SWCD should emphasize soil erosion reduction from critical acreages; target the upper watershed for riparian enhancement, including bank stabilization on the lower end of the east fork of Pine Creek; reduce nutrient losses from cultivated fields, specifically inorganic nitrogen, in the early spring; and control of animal wastes from feedlots, barnyards and pastures.

3. Classification of the existing designated uses of Pine Creek into the Idaho Water Quality Standards may further protect these uses by providing specific standards of water quality. Current usages of the stream are as an agricultural water supply, and for secondary contact recreation, salmonid spawning habitat and cold water biota.

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Table 1

Pine Creek Project

Water Quality Monitoring Stations

Station #	Description	Latitude/Longitude	River Mile	Elevation	STORET
1	NF Pine Cr 1 mi N of Leland	46°35'30"/116°35'35"	324.30/139.30/23.60/ 7.80	2,302'	2020259
2	EF Pine Cr @ Leland	46°34'47"/116°36'15"	324.30/139.30/23.60/ 6.50/.10	2,215'	2020260
3	Pine Cr. 4 mi from mouth	46°31'25"/116°38'43"	324.30/139.30/23.60/ .70	925'	2020261

Table 2. Pine Creek Project Water Quality Parameters

STORET	Parameter	Units
Field Measurements		
00061	Flow	CFS
00010	Water Temperature	°C
00094	Conductivity	µmhos/cm
00400	pH	S.U.
Laboratory Analysis		
00076	Turbidity	NTU
00530	Suspended Sediment (S.S.)	mg/L
00625	Total Kjeldahl Nitrogen (TKN)	mg/L
00610	Total Ammonia (NH_3)	mg/L
00630	Total Nitrite + Nitrate (NO_2+NO_3)	mg/L
00665	Total Phosphorus (T.P.)	mg/L
00669	Total Hydrolyzable Phosphorus (H'PO_4)	mg/L
70507	Dissolved Orthophosphate (O'PO_4)	mg/L
31679	Fecal Streptococcus	#/100 ml
31616	Fecal Coliform	#/100 ml

TABLE 3a. WATER QUALITY DATA FOR PINE CREEK

STATION #1, THE NORTH FORK OF PINE CREEK ABOVE LELAND

DATE	FLOW CFS	T °C	COND. @ 25°	pH S.U.	NH3 mg/L	NO2+ NO3 mg/L	TKN mg/L	T.P. mg/L	H'PO4 mg/L	O'PO4 mg/L	S.S. mg/L	TURB. NTU	FECAL STREP #/.1L	FECAL COLI #/.1L
02/20/85	0.1	1.0	273	7.1	0.06	14.50	0.57	0.09	0.02	0.05	3	4	201	29
03/07/85	3.3	4.0	254	6.9	0.07	16.60	0.74	0.13	0.02	0.03	16	17	23	20
03/15/85	22.5	6.8	192	7.0	0.13	7.64	2.68	1.05	0.64	0.05	706	280	250	60
03/27/85	10.9	5.8	251	7.0	0.07	9.34	0.89	0.24	0.19	0.02	47	68	55	114
04/16/85	0.5	12.0	181	7.3	0.03	5.19	0.66	0.08	0.07	0.01	5	8	39	650
06/07/85	9.2	14.8	169	7.0	0.16	7.54	2.11	0.61	0.34	0.08	45	222	500	500
01/30/86	84.2	1.0	143	7.8	0.14	16.50	3.79	2.2	1.21	0.26	1570	AAA	1700	200
V01/30/86	84.2	1.0	AAA	AAA	AAA	17.90	3.65	2.0	AAA	AAA	1220	AAA	AAA	AAA
V01/30/86	84.2	1.0	AAA	AAA	AAA	16.50	3.86	2.1	AAA	AAA	1620	AAA	AAA	AAA
*01/30/86	84.2	1.0	143	7.8	0.14	17.00	3.76	2.1	1.21	0.26	1470	AAA	1700	200
02/16/86	115.0	AAA	149	5.9	AAA	11.30	17.5	8.0	AAA	AAA	7300	AAA	AAA	AAA
02/23/86	245.0	2.0	86	6.1	0.14	5.34	6.47	4.1	3.22	0.16	2730	AAA	2700	100
AVERAGE	54.5	5.6	204	◊7.0	0.09	10.40	3.93	1.82	0.71	0.08	1369	100	◊221	◊112
MAXIMUM	245.0	14.8	273	7.3	0.16	17.90	17.5	1.05	3.22	.26	7300	280	1700	650
MINIMUM	0.1	1.0	86	5.9	0.03	5.19	0.57	0.08	0.02	0.01	3	4	23	20

AAA UNREPORTED DATA
◊ LOGARITHMIC MEANN
V01/30/86 SAMPLES COLLECTED BY SWCD VOLUNTEERS, ONLY THE MEAN FOR DATE WAS AVERAGED WITH ALL THE DATA
*01/30/86 MEAN FOR ALL DATA COLLECTED ON THIS DATE

TABLE 3b. WATER QUALITY DATA FOR PINE CREEK

STATION #2, THE EAST FORK OF PINE CREEK AT LELAND

DATE	FLOW CFS	T °C	COND. @ 25°	pH S.U.	NH3 mg/L	NO2+ NO3 mg/L	TKN mg/L	T.P. mg/L	H'PO4 mg/L	O'PO4 mg/L	S.S. mg/L	TURB. NTU	FECAL STREP #/.1L	FECAL COLI #/.1L
02/20/85	0.1	03.0	281	7.1	0.05	15.70	0.78	0.11	0.02	0.06	3	2	25	44
03/07/85	1.8	04.8	329	6.9	0.41	21.00	1.34	0.23	0.01	0.11	7	12	99	76
03/15/85	24.7	05.0	210	7.0	0.21	12.40	4.15	1.96	1.20	0.05	1410	400	260	40
03/27/85	6.5	05.4	352	7.0	0.08	11.70	0.91	0.29	0.21	0.03	32	72	AAA	AAA
04/16/85	0.4	11.2	236	6.8	0.06	8.25	0.80	0.15	0.08	0.06	7	13	47	248
06/07/85	2.8	16.8	178	6.8	0.11	6.54	2.45	0.72	0.30	0.21	70	280	1000	400
01/30/86	64.4	0.5	211	6.1	0.28	18.40	5.09	2.60	1.34	0.30	2250	AAA	900	600
V01/30/86	64.4	0.5	AAA	AAA	AAA	19.70	4.61	2.20	AAA	AAA	1820	AAA	AAA	AAA
V01/30/86	64.4	0.5	AAA	AAA	AAA	15.60	5.37	2.60	AAA	AAA	2270	AAA	AAA	AAA
*01/30/86	64.4	0.5	211	6.1	0.28	17.90	5.02	2.50	1.34	0.30	2113	AAA	900	600
√01/30/86	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	1430	AAA	AAA	AAA
02/16/86	85.0	AAA	166	5.9	AAA	12.90	18.80	7.90	AAA	AAA	8100	AAA	AAA	AAA
02/23/86	137.3	2.2	129	6.9	AAA	7.73	8.48	4.30	AAA	AAA	3620	AAA	AAA	AAA
AVERAGE	35.9	5.9	232	◊6.9	0.13	12.59	1.73	2.02	0.45	0.11	254.8	130	◊141	◊173
MAXIMUM	24.7	16.8	352	7.1	0.41	21.00	18.80	7.90	1.34	0.30	1410	400	1000	600
MINIMUM	0.1	3.0	129	5.9	0.05	6.54	0.78	0.11	0.01	0.03	3	2	25	40

AAA UNREPORTED DATA

V01/30/86 SAMPLES COLLECTED BY SWCD VOLUNTEERS, ONLY THE MEAN FOR DATE WAS AVERAGED WITH ALL THE DATA

*01/30/86 MEAN FOR ALL DATA COLLECTED ON THIS DATE

√01/30/86 DUPLICATE SAMPLE COLLECTED 150 FT. ABOVE REGULAR SAMPLING SITE, NOT INCLUDED IN MEAN FOR DATE

◊ LOGARITHMIC MEAN

TABLE 3c. WATER QUALITY DATA FOR PINE CREEK

STATION #3, PINE CREEK NEAR THE MOUTH

DATE	FLOW CFS	T °C	COND. @ 25°	pH S.U.	NH3 mg/L	NO2+ NO3 mg/L	TKN mg/L	T.P. mg/L	H'PO4 mg/L	O'PO4 mg/L	S.S. mg/L	TURB. NTU	FECAL STREP #/.1L	FECAL COLI #/.1L
02/20/85	6.3	0.5	250	7.3	0.03	05.55	0.61	0.20	0.06	0.13	24	11	58	76
03/07/85	15.6	02.2	494	6.8	0.08	17.70	0.56	0.15	0.02	0.07	16	11	15	12
03/15/85	101.7	07.0	274	7.2	0.13	13.30	2.65	1.01	0.64	0.06	686	240	160	60
03/27/85	29.2	06.0	396	7.7	0.05	12.70	0.88	0.27	0.23	0.02	43	56	AAA	AAA
04/04/85	15.4	09.0	245	7.7	0.06	16.10	0.77	0.23	0.22	0.03	39	32	10	14
04/16/85	2.6	14.4	276	7.4	0.04	09.66	0.66	0.19	0.07	0.09	15	10	23	139
04/19/85	8.5	10.0	258	8.2	AAA	AAA	AAA	AAA	AAA	AAA	29	27	AAA	AAA
04/30/85	3.7	19.6	158	8.7	0.18	07.20	0.66	0.18	0.03	0.12	11	5	16	72
06/07/85	21.1	15.2	199	7.6	0.89	05.48	2.03	0.70	0.24	0.25	123	210	1600	1000
01/30/86	178.0	3.0	238	7.0	0.22	19.60	4.64	2.60	1.55	0.20	1440	AAA	2200	600
02/23/86	673.5	3.2	184	7.6	0.27	7.52	8.02	5.90	5.16	0.24	4040	AAA	3000	300
AVERAGE	96.0	8.14	270	◊7.6	0.20	10.96	2.15	1.14	0.82	0.12	588	67	◊121	◊104
MAXIMUM	101.7	19.6	494	8.7	0.89	17.70	8.02	5.90	5.16	0.25	4040	240	3000	1000
MINIMUM	2.6	0.5	158	6.8	0.03	5.48	0.56	0.15	0.02	0.02	11	5	10	12

AAA UNREPORTED DATA

◊ LOGARITHMIC MEAN

TABLE 4a. NUTRIENT LOADS FOR PINE CREEK*

STATION #1 , AT THE NORTH FORK OF PINE CREEK ABOVE LELAND

DATE	FLOW CFS	S.S. LOAD TONS/DAY	NH3 LOAD LB/DAY	NO2+NO3 LOAD LB/DAY	INORGANIC N LOAD LB/DAY	T.P. LOAD LB/DAY	O'PO4 LOAD LB/DAY	H'PO4 LOAD LB/DAY	TOTAL PO4 LOAD LB/DAY
02/20/85	0.1	<0.1	<1	8	8	<1	<1	<1	<1
03/07/85	3.3	0.1	1	300	300	2	<1	<1	<1
03/15/85	22.5	43.0	16	930	940	130	6	78	84
03/27/85	10.9	1.4	4	550	550	14	1	11	12
04/16/85	0.5	<0.1	<1	14	14	<1	<1	<1	<1
06/07/85	9.2	1.1	8	370	380	30	4	17	21
◊01/30/86	84.2	333.5	64	7700	7800	950	120	550	670
02/16/86	115.0	2262.5	AAA	7000	7000	5000	AAA	AAA	AAA
02/23/86	245.0	1804.0	180	7100	7300	5400	210	4300	4500
TOTAL *		4445.6	280	24000	24000	12000	340	5000	5300

* ROUNDED TO SIGNIFICANT DIGITS
AAA UNREPORTED DATA
◊ MEAN FOR ALL DATA COLLECTED ON 01/30/85

TABLE 4b. NUTRIENT LOADS FOR PINE CREEK*

STATION #2 , AT THE EAST FORK OF PINE CREEK AT LELAND

DATE	FLOW CFS	S.S. LOAD TONS/DAY	NH3 LOAD LB/DAY	NO2+NO3 LOAD LB/DAY	INORGANIC N LOAD LB/DAY	T.P. LOAD LB/DAY	O'PO4 LOAD LB/DAY	H'PO4 LOAD LB/DAY	TOTAL PO4 LOAD LB/DAY
02/20/85	0.1	<0.1	<1	8	8	<1	<1	<1	<1
03/07/85	1.8	<0.1	4	200	200	2	1	<1	1
03/15/85	24.7	94.0	28	1700	1700	260	7	160	170
03/27/85	6.5	0.6	3	400	400	10	1	7	8
04/16/85	0.4	<0.1	<1	18	18	<1	<1	<1	<1
06/07/85	2.8	0.6	2	99	100	11	3	4	7
◊01/30/86	64.4	366.5	97	6200	6300	870	100	460	570
02/16/86	85.0	1855.0	AAA	5900	5900	3600	AAA	AAA	AAA
02/23/86	137.3	1339.5	AAA	5700	5700	3200	AAA	AAA	AAA
TOTAL *		3655.0	130	20000	20000	8000	100	630	760

* ROUNDED TO SIGNIFICANT DIGITS
AAA UNREPORTED DATA
◊ MEAN FOR ALL DATA COLLECTED ON 01/30/85

TABLE 4c. NUTRIENT LOADS FOR PINE CREEK*

STATION #3 , AT PINE CREEK NEAR THE MOUTH

DATE	FLOW CFS	S.S. LOAD TONS/DAY	NH3 LOAD LB/DAY	NO2+NO3 LOAD LB/DAY	INORGANIC N LOAD LB/DAY	T.P. LOAD LB/DAY	O'PO4 LOAD LB/DAY	H'PO4 LOAD LB/DAY	TOTAL PO4 LOAD LB/DAY
02/20/85	6.3	0.4	1	190	190	7	4	2	6
03/07/85	15.6	0.6	7	1500	1500	13	6	2	8
03/15/85	101.7	188.0	71	7300	7400	550	33	350	380
03/27/85	29.2	3.4	8	2000	2000	42	3	36	39
04/04/85	15.4	1.6	5	1300	1300	19	2	18	20
04/16/85	2.6	0.1	<1	140	140	3	1	1	2
04/19/85	8.5	0.7	AAA	AAA	AAA	AAA	AAA	AAA	AAA
04/30/85	3.7	0.1	4	140	150	4	2	<1	3
06/07/85	21.1	7.0	100	620	720	80	28	27	55
01/30/86	178.0	690.0	210	19000	19000	2500	190	1500	1700
▵02/16/86	AAA	3620.0	AAA	13000	13000	8600	AAA	AAA	AAA
02/23/86	673.5	7335.0	980	27000	28000	21400	870	19000	20000
TOTAL *		11850.0	1400	71000	73000	33200	1100	21000	22000

* ROUNDED TO SIGNIFICANT DIGITS
AAA UNREPORTED DATA
▵ SUM OF LOADS RECORDED AT THE TWO UPPER STATIONS

Table 5. Summary of Precipitation Data for the Pine Creek Project (inches of precipitation)

Month	Dwórshak *	Leland Δ	Normal *
1985			
January	0.50	AAA	3.03
February	1.60	AAA	2.65
March	1.59	AAA	2.99
April	2.42	1.64	2.08
May	3.15	2.14	2.25
June	1.27	2.05	1.97
1986			
January	3.38	1.94	3.03
February	4.67	5.14	2.65
March	2.69	AAA	2.99

* Dworshak National Fish Hatchery Climatology Center

Δ Average of data compiled by SCD volunteers on Pine Creek Watershed

AAA Unreported Data

Table 6. Precision Estimates of Monitored Parameters*

STORET	Parameter	n	Average Relative Range
80154	Suspended Sediment	6	4.4
00665	Total Phosphorus	6	6.6
70507	Orthophosphate	6	16.6
00669	Total Hydrolyzable Phosphorus	6	70.2
00630	Total Nitrite + Nitrate	6	9.7
00610	Total Ammonia	6	89.7
00625	Total Kjeldahl Nitrogen	6	8.5
00076	Turbidity	6	3.2

* From Bauer (1985)
n = number of samples

Table 7. Accuracy Estimates of Monitored Parameters*

STORET	Parameter	n	Average % Recovery	95% CI
80154	Suspended Sediment	13	95.4	1.2
00665	Total Phosphorus	13	112.8	2.9
70507	Orthophosphate	13	99.0	6.3
00669	Total Hydrolyzable Phosphorus	13	80.0	4.5
00620	Total Nitrate	13	103.9	3.8
00610	Total Ammonia	13	120.1	11.8
00625	Total Kjeldahl Nitrogen	13	104.0	9.0

* From Bauer (1985)
n= number of samples

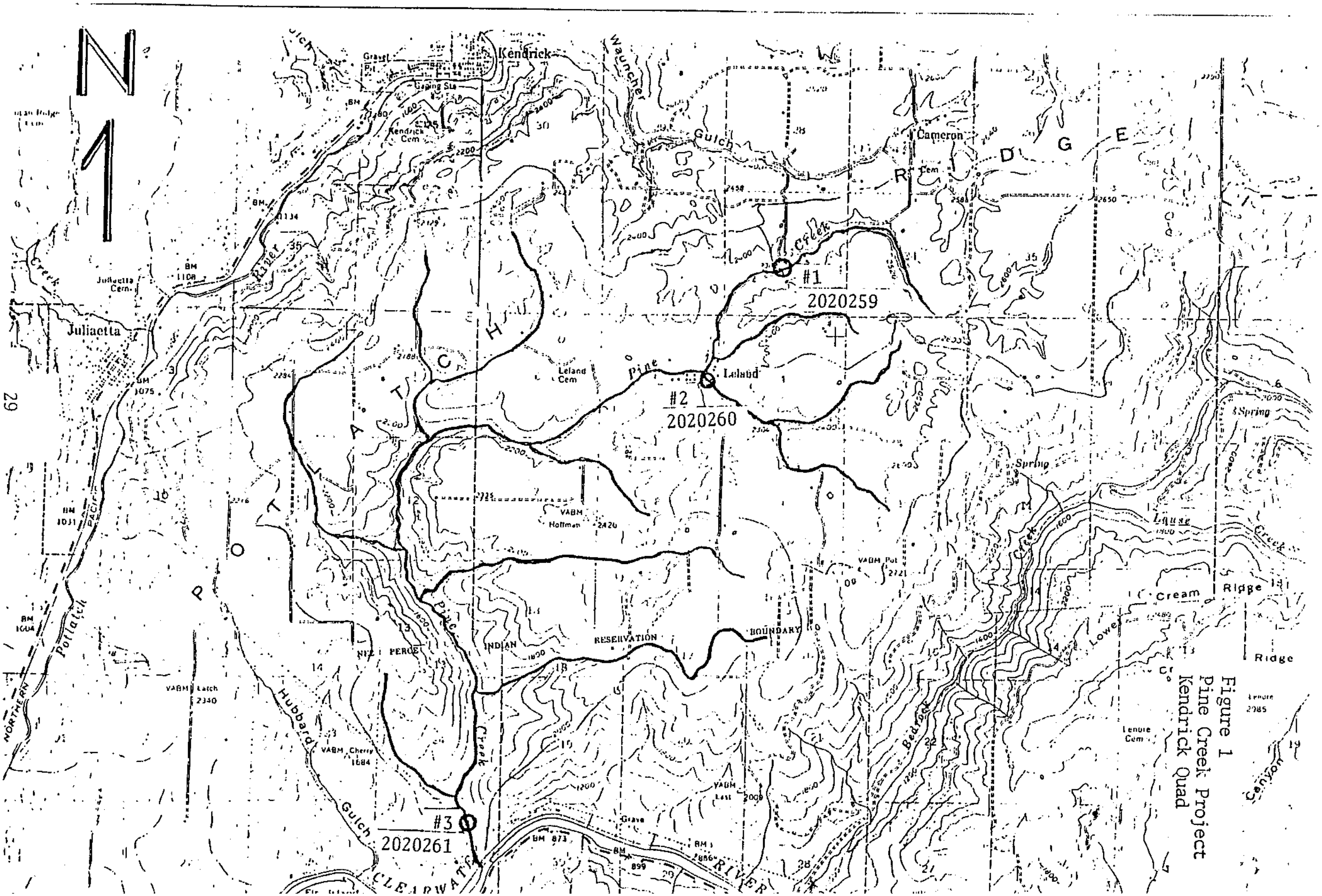


Figure 1
Pine Creek Project
Kendrick Quad

FIGURE 2. STREAM CREST GAUGE

NOTE: GROUND CORK IS PLACED IN THE GAUGE. AS THE WATER RECEDES THE CORK ADHERES TO THE MEASURING ROD.

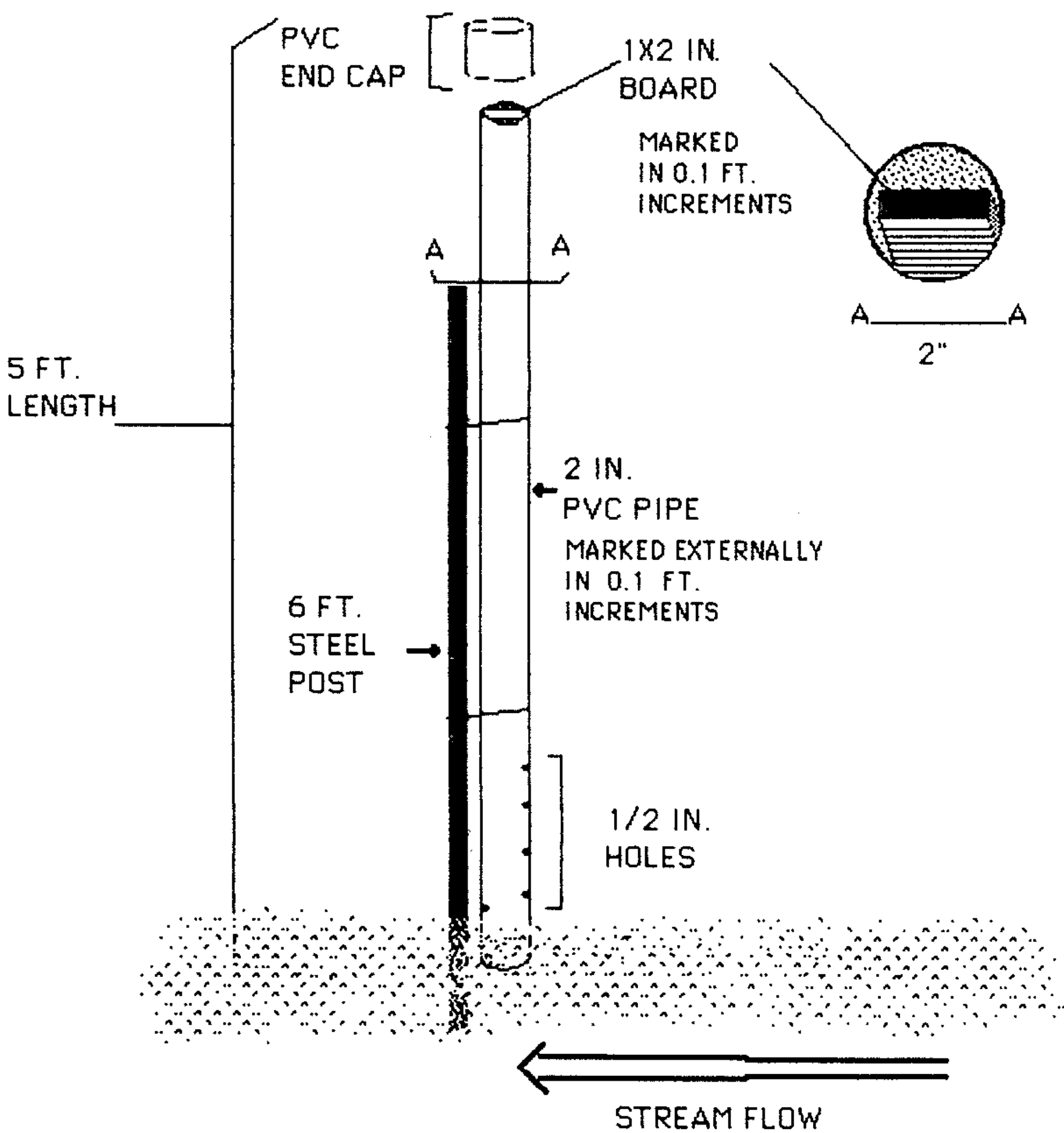


FIGURE 3. DISCHARGE MEASUREMENTS OF THE PINE CREEK DRAINAGE FOR SELECTED DATES.

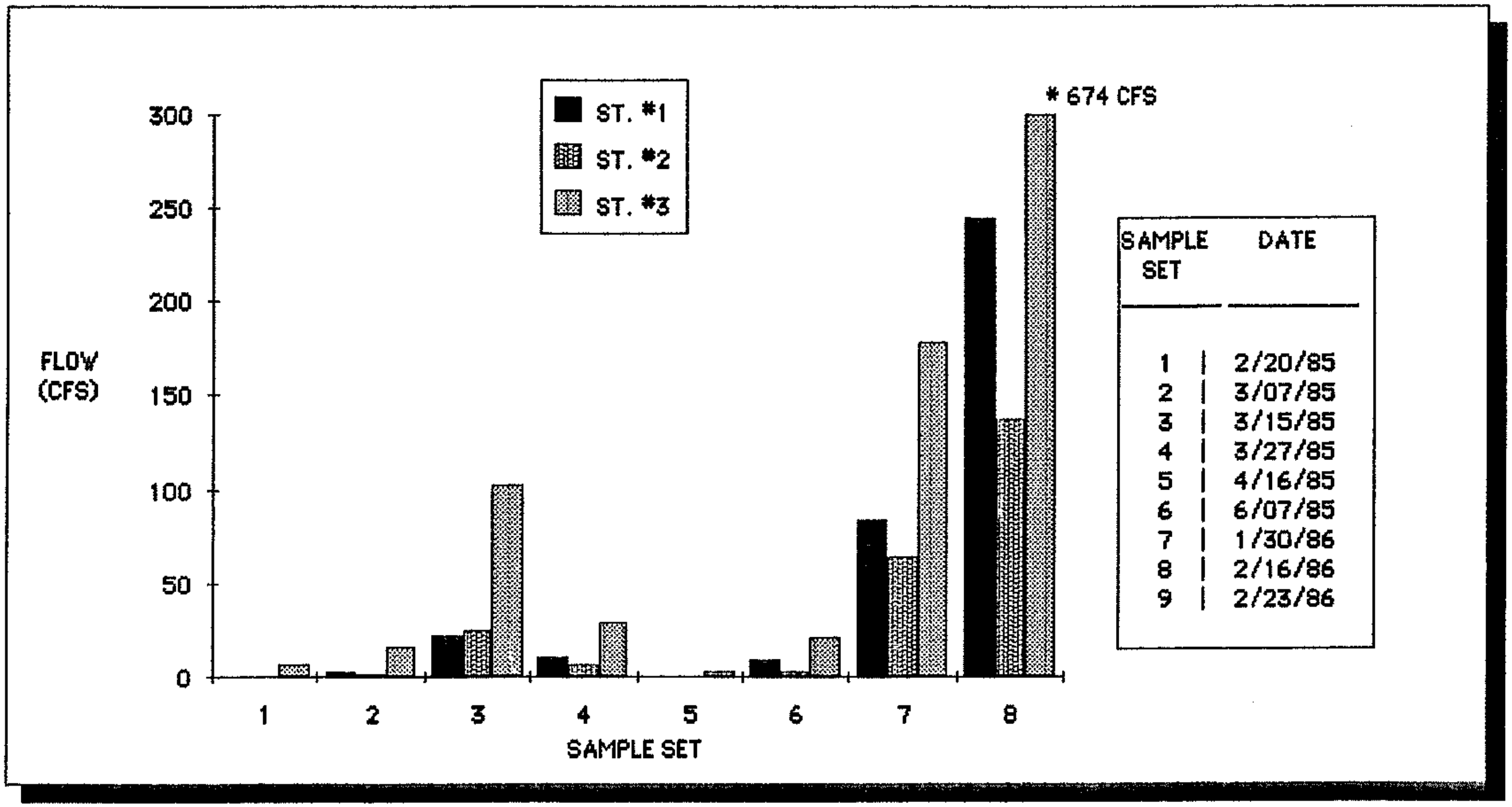


FIGURE 4. SUSPENDED SEDIMENT LOADS OF PINE CREEK FOR SELECTED DATES

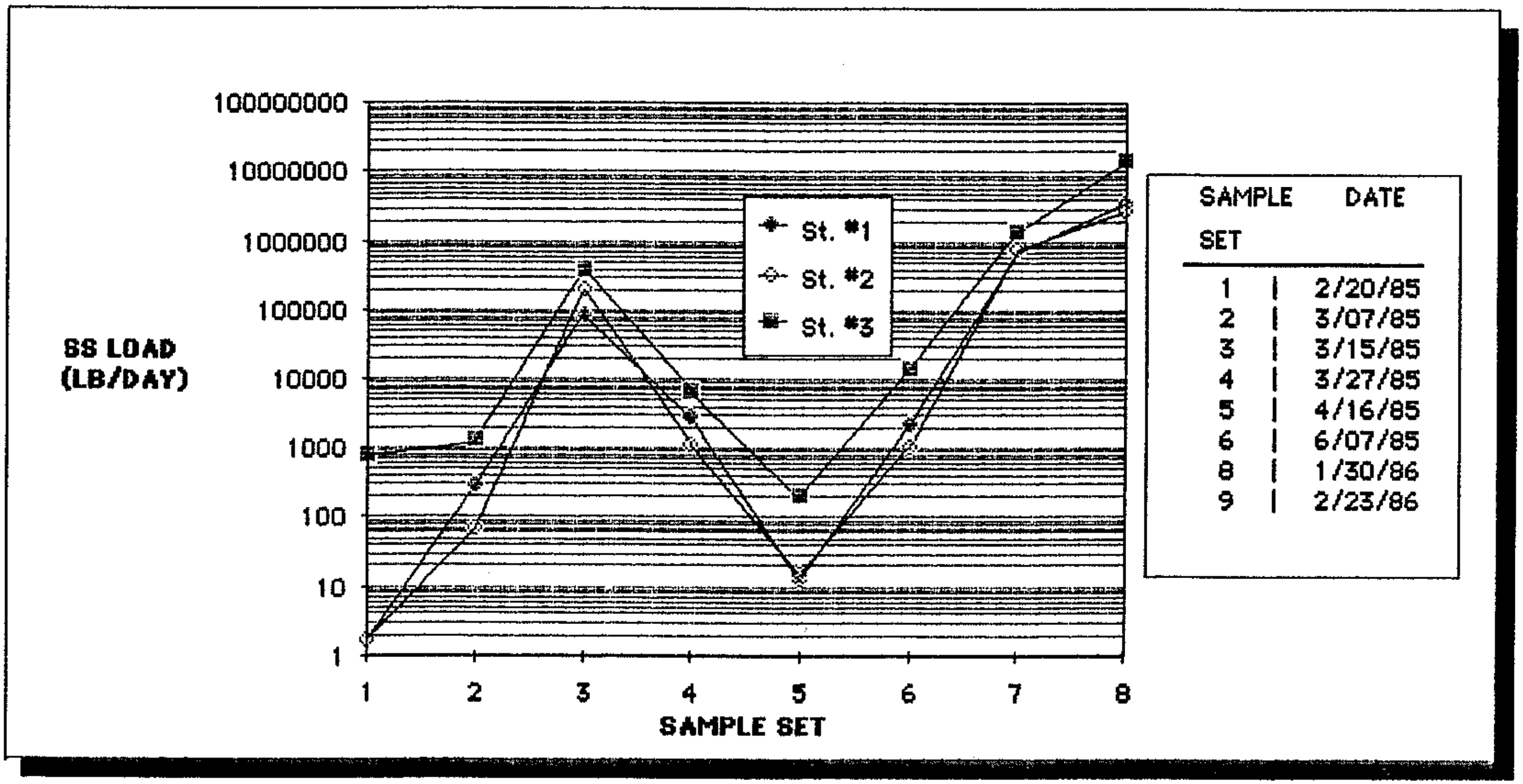


FIGURE 5. NITRITE + NITRATE CONCENTRATIONS IN PINE CREEK FOR THE SPRING OF 1985.

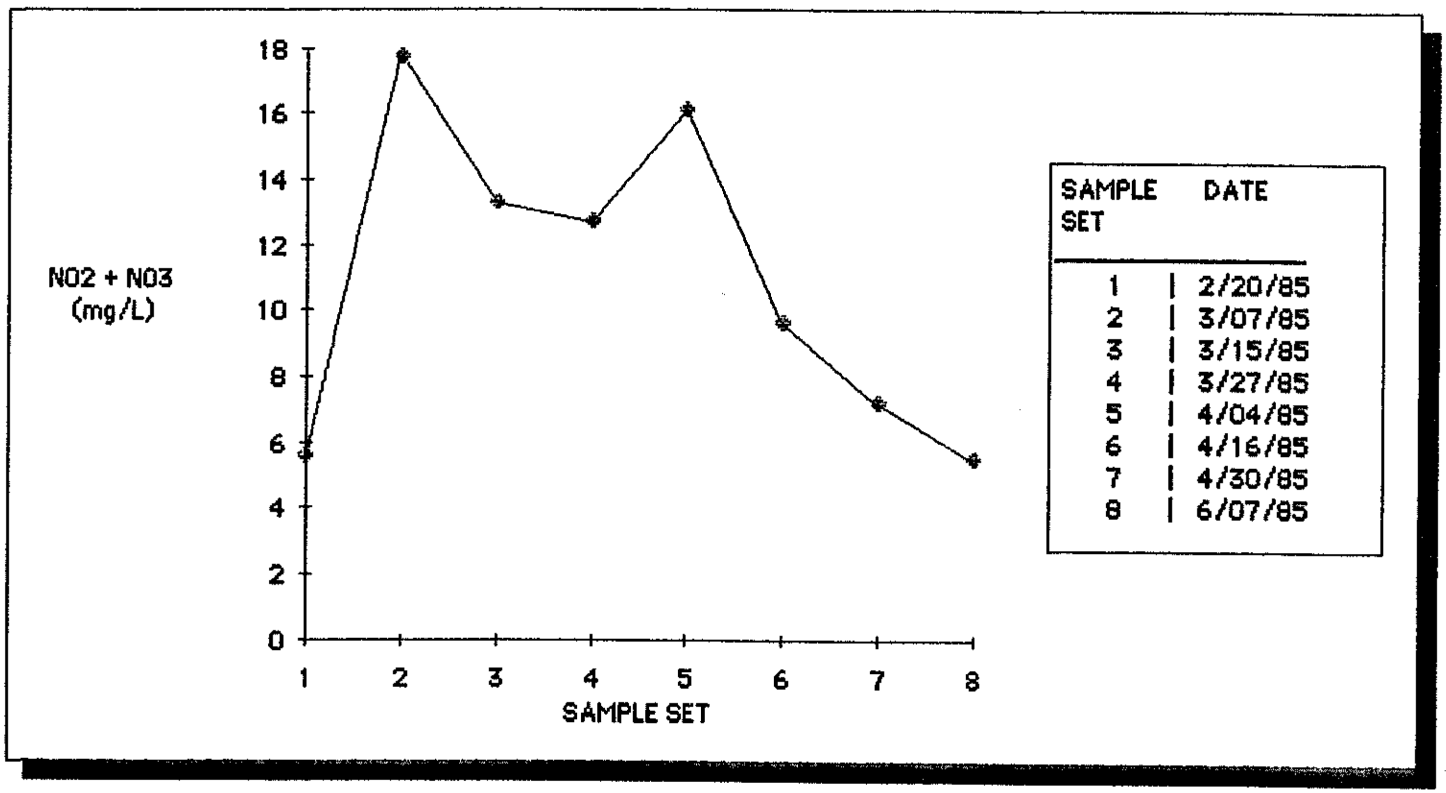
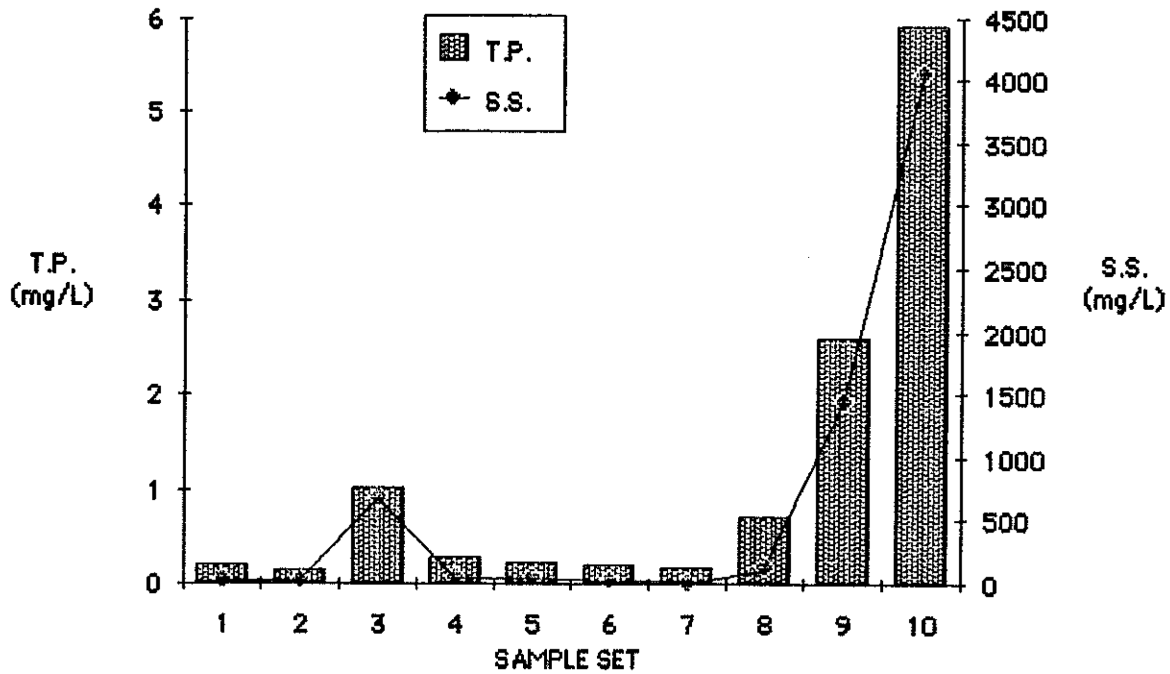


FIGURE 6. TOTAL PHOSPHORUS CONCENTRATIONS IN RESPONSE TO SUSPENDED SEDIMENT CONCENTRATIONS FOR ST. #3 AT PINE CREEK.



SAMPLE SET	DATE
1	2/20/85
2	3/07/85
3	3/15/85
4	3/27/85
5	4/16/85
6	6/07/85
7	4/30/85
8	6/07/85
9	1/30/86
10	2/23/86

FIGURE 7. SUSPENDED SEDIMENT CONCENTRATIONS IN RESPONSE TO DISCHARGE ON PINE CREEK.