Water Quality Status Report

Bloomington Creek, Bear Lake County

Study conducted by:

Jim Perry
Bob Campbell

Idaho Department of Health & Welfare
Division of Environment
Statehouse, Boise Idaho 83220

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TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

ABSTRACT

Bloomington Creek drains a small watershed in Bear Lake County, Idaho. A phosphate mine and mill have been proposed for the Bloomington area. This study was conducted to provide background water quality data on Bloomington Creek. Twenty-one parameters were sampled bi-weekly for one year at four water quality stations. Fecal and total coliform bacteria were significantly higher below the town of Bloomington than at the three upstream stations. These were the only significant ($P < 0.05$) differences among the data.

INTRODUCTION

Bloomington Creek drains a small watershed (6,320 hectares, 24.4 square miles) in Bear Lake County, Idaho. This area is part of the Bear River Range which drains into Bear Lake and the Bear River. The area is one of extensive faulting, high earthquake potential, and high geologic interest. The Bloomington phosphate beds underlie part of the area. The majority of the area is comprised of sedimentary rocks. The Phosphoria, of Permian age, lies at an east-west strike. This bed is 2.0 to 7.0 meters thick (6½ to 23 feet). It is overlain by 51.5 m (170 feet) of shale, then a 3.3 m (11 foot) vanadium bed, and then an additional 4.5 m (15 foot) phosphate bed. These phosphate and vanadium beds are the ones of economic potential in the area. Surface geology consists of the exposed faces of the dip and strike of these beds with quartzite boulders strewn over the surface (Earth Sciences, 1974).

Bloomington Creek originates in a pair of cirque lakes (Bloomington Lakes) at an elevation of 2,636 meters (8,700 feet). The creek is approximately 29 km long (18 miles) from its headwaters to its mouth in Dingle Swamp. The town of Bloomington is adjacent to river kilometers 4.8 to 6.4 (river miles 3.0 to 4.0). Bloomington is at approximately 1,818 meters (6,000 feet) above sea level. The Bloomington phosphate mine is proposed to be in Bloomington Canyon, west of the town, at river kilometers 10.4 to 13.3 (river miles 6.5 to 8.3).

Earth Sciences Incorporated (1974) has prepared an Environmental Impact Statement for the Bloomington phosphate mine. That report is notably short of water quality information. This study was designed to provide background data on the water quality of Bloomington Creek. The impact of future disturbances along the creek valley will be measured against this background.

METHODS AND MATERIALS

Four stations were chosen for water quality monitoring (Table 1) (Figure 1). Samples were collected bi-weekly for a year, beginning in April, 1975. Grab samples for water quality were taken at each station. Benthos samples were collected with a Surber sampler and with kick samples. Discharge was taken from the USGS gauging station at Station 2.

Table 1. Station locations for Bloomington Creek Study

Number	River km	River mile	Comments
1	13.6	8.5	Upstream of all proposed mining and milling activity
2	11.2	7.0	Below mill site, but above mine tailings and workings
3	9.6	6.0	Below all proposed mining and milling activity
4	4.8	3.0	At U.S. Highway 89 bridge, below the town of Bloomington

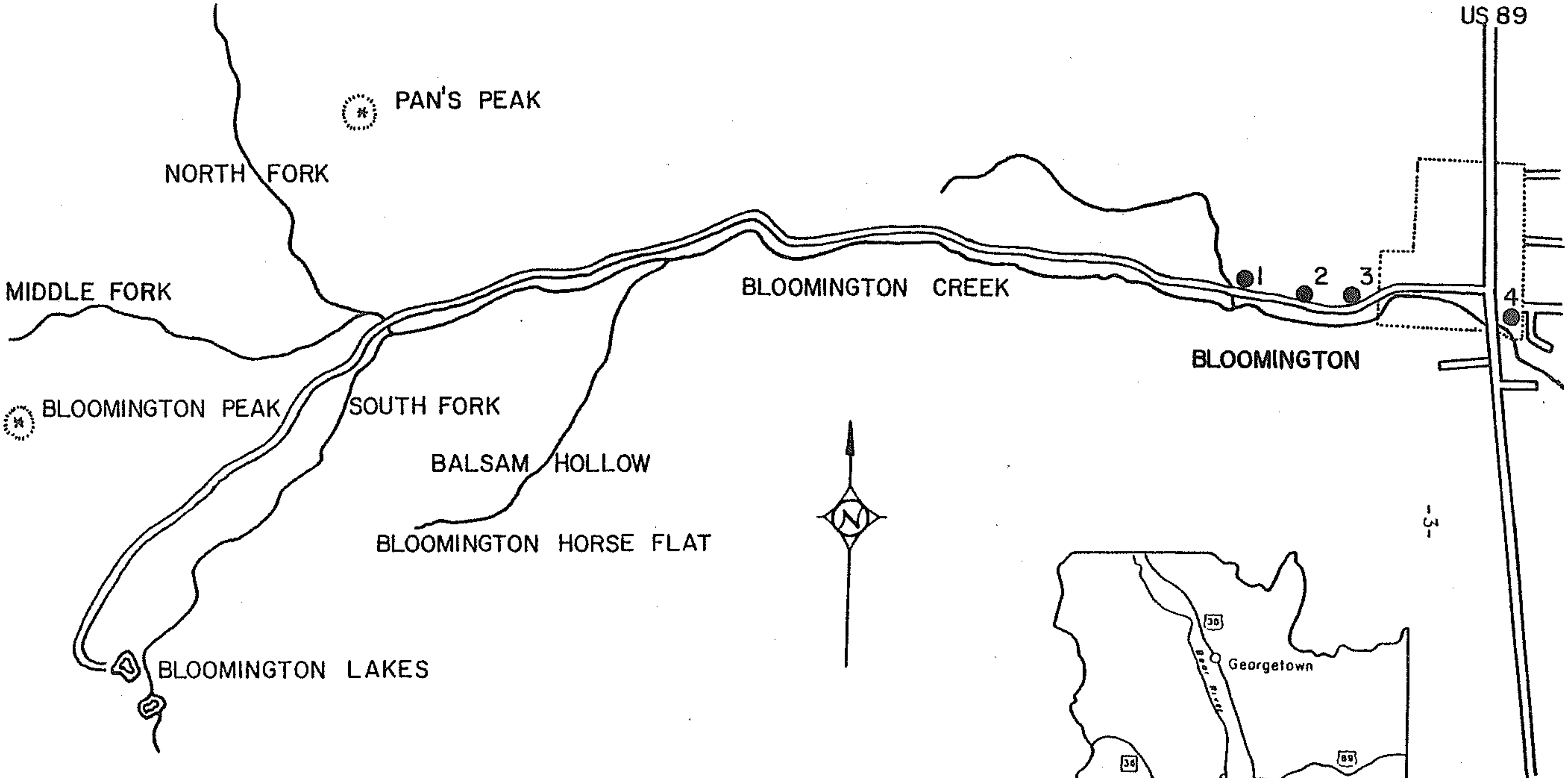
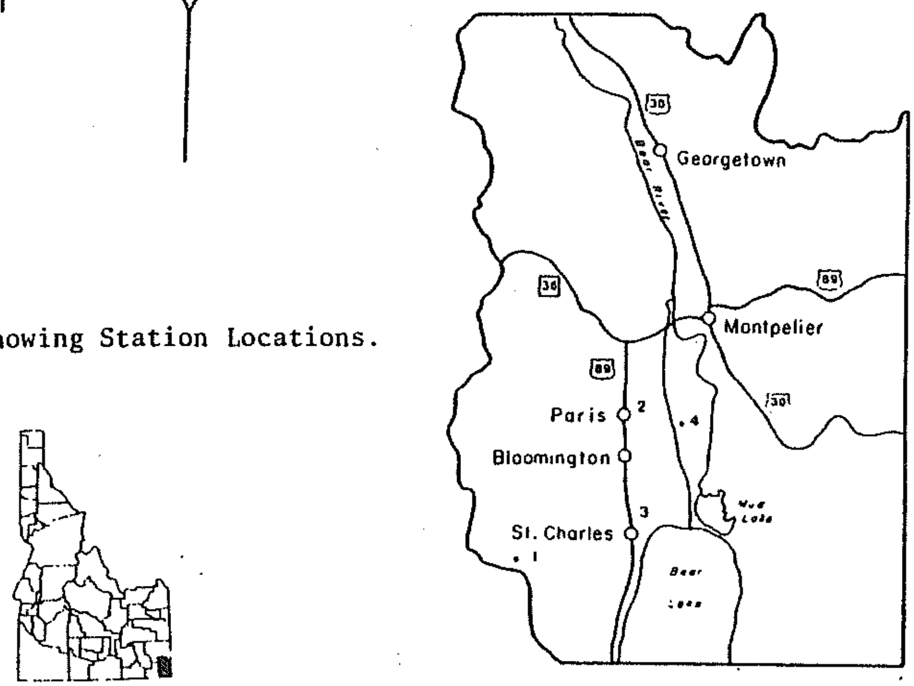


Figure 1. Map of Bloomington Drainage Showing Station Locations.



RESULTS

Daily discharge records from Station 2 are available from the USGS. When discharge was measured at all four stations, no discernible difference was noted along the 8.8 kilometers (5.5 miles) involved. Discharge for Bloomington Creek on the sample dates of this study are presented in Table 2.

Table 2. Discharge data for Bloomington Creek on the sample dates reported in this paper.

	Discharge			Discharge	
Date	cfs*	cms**	Date	cfs	cms
4/03/75	16	0.45	1/21/76	17	0.48
4/16/75	18	0.51	2/11/76	17	0.48
5/01/75	22	0.62	2/25/76	16	0.45
5/22/75	38	1.08	3/10/76	16	0.45
6/16/75	146	4.13	4/14/76	33	0.93
7/09/75	83	2.35	4/21/76	30	0.85
7/24/75	51	1.44	5/04/76	36	1.02
8/13/75	35	0.99	5/19/76	108	3.06
9/11/75	27	0.76			
10/09/75	23	0.65			
10/23/75	21	0.59	Annual Mean	35.21	1.00
11/06/75	21	0.59			
11/20/75	18	0.51			
12/16/75	19	0.54			
1/07/76	17	0.48			
1/14/76	17	0.48			

*Cubic feet per second
**Cubic meters per second

Statistics relating to annual loadings in Bloomington Creek are presented in Table 3. Table 4 summarizes data that do not lend themselves to loading presentation.

Table 3. Loadings of various parameters in Bloomington Creek, April 1975 to May 1976. (All values represent pounds per day.)

Parameter	Station 1 Mean	Station 1 Standard Deviation	Station 1 N	Station 1 Range	Station 2 Mean	Station 2 Standard Deviation	Station 2 N	Station 2 Range	Station 3 Mean	Station 3 Standard Deviation	Station 3 N	Station 3 Range	Station 4 Mean	Station 4 Standard Deviation	Station 4 N	Station 4 Range
Biochemical Oxygen Demand	247	237	14	92-1023	213	123	14	79-537	197	114	14	68-403	209	173	13	79-472
Chemical Oxygen Demand	1445	1829	19	193-7870	1047	1159	19	37-4722	1344	1792	19	110-7870	1742	1961	18	396-8657
Nitrate (as N)	18.1	23.1	20	.27-88.8	17.9	24.2	20	.34-91.1	14.7	20.3	20	0.27-81.8	19.21	23.0	20	.25-94.2
Total Kjeldahl Nitrogen (as N)	246	280.6	20	60-1338	321.7	382.8	20	43-1419	263.5	300	20	26-1259	240	193	20	76-866
Ortho-Phosphate (as P)	5.2	10.1	20	0.28-46.3	3.9	6.2	19	0.28-28.4	3.9	5.6	20	0.29-25.7	6.1	10.2	19	0.6-43.7
Total Phosphorus (as P)	14.9	25.8	20	0.9-118	7.2	8.5	20	0.9-39	12.9	17.1	20	0.9-62	14.4	16.9	20	3-36
Total Inorganic Phosphorus (as P)	15.6	29.8	12	0.36-108	7.4	8.2	11	0.75-28.0	12.3	12.5	11	0.36-26.5	16.8	23.5	11	3.0-82.1
Total Solids	36223	25640	21	15092-111748	34480	25477	22	16041-115683	34211	25507	22	14316-117257	36421	24433	22	15954-106240
Total Dissolved Solids	28316	20189	20	10131-82454	28125	19429	20	9036-82454	28166	19504	20	9036-82454	30116	21164	19	9583-84952
Suspended Solids (obtained by difference)	7907				6355				6045				6305			
Manganese	4.0	7.1	24	8.6-34.9	3.0	4.7	24	0.86-233	3.0	3.8	21	0.86-17.5	3.5	5.9	24	0.86-34.9
Iron	26.6	49.9	23	1.13-168.8	22.8	49.1	24	1.13-197.9	23.6	47.0	22	1.0-157.1	35.2	93.3	24	1.13-442.3
Potassium	65	77	23	15-394	89	137	24	8.6-582	70	96	22	4-472	151	120	22	39-472
Sodium	347	263	23	23.7-1259	340	205	24	124-1023	360	241	22	174-1180	364	226	24	52-1102
Fluoride	6.8	6.2	10	1.9-19	8.9	12.0	10	1.1-19	7.95	7.5	10	1.2-24	7.1	6.6	9	1.2-21
Bicarbonate Alkalinity (as $CaCO_3$)	25275	17828	24	10004-53544	44959	98276	24	8624-50200	26543	17633	22	10476-60528	26971	19269	23	8279-62856

Table 4. Annual means of selected parameters from Bloomington Creek. (Data were collected between April 3, 1975 and May 19, 1976).

	Station															
	1				2				3				4			
Parameter	Mean	Standard Deviation	N	Range	Mean	Standard Deviation	N	Range	Mean	Standard Deviation	N	Range	Mean	Standard Deviation	N	Range
Temperature (°C)	6.5	3.5	17	2-14	6.6	3.5	17	2-14	6.7	3.9	16	1.3-14	6.9	4.8	15	0.0-15
Dissolved Oxygen (in mg/l)	10.1	3.7	12	5.4-18.6	9.7	2.8	12	4.5-14.4	9.6	3.0	12	5.3-16.4	9.4	2.8	11	4.6-14.2
Fecal Coliform bacteria, geometric mean of #/100 ml	3.91	3.91	20	2-120	4.93	3.91	19	2-60	4.11	3.49	18	2-54	82.26	6.84	18	2-3600
Total Coliform bacteria, geometric mean of #/100 ml	42.3	10.4	22	2-4000	43.2	7.4	22	2-770	24.9	9.4	22	2-1400	265.1	542	22	32-7200
Fecal Streptococci bacteria, geometric mean of #/100 ml	5.6	3.4	15	2-90	6.5	4.6	15	2-130	8.4	4.4	14	2-88	13	5.0	13	2-2400

Benthic insect species distributions from the Bloomington Creek study are presented in Table 5.

Table 5. Benthic Insect Species Distribution in Bloomington Creek; May 1975 to May 1976.

Species	Stations 1	2	3	4
EPHEMEROPTERA				
Baetis bicaudatus	X	X	X	X
B. parvus				X
Cynmigula sp.	X	X	X	
Epeorus deceptivus	X			
E. gradnis	X	X		
E. longimanus	X	X	X	X
Ephemerella coloradensis	X	X		X
E. doddsi	X	X		X
E. flavilinea		X	X	X
E. grandis	X		X	X
E. inermis	X	X	X	X
Heptagenia sp.				X
Leptophlebia sp.	X			
Rhithrogena robusta	X		X	
Tricorythodes minutus	X	X	X	X
PLECOPTERA				
Acroneuria pacifica	X	X	X	X
Alloperla sp.	X	X	X	X
Arcynopteryx parallela	X			
Capnia sp.				X
Claassenia sabulosa	X	X	X	X
Diura sp.	X			
Isocapnia sp.				X
Isogenus sp.	X			
Isoperla sp.	X	X	X	X
Nemoura sp.	X	X	X	
Paraperla sp.	X			
TRICHOPTERA				
Arctopsyche sp.	X			X
Athripsodes sp.	X	X	X	X
Brachycentrus sp.	X	X	X	X
Dolophiloides sp.	X			
Glossossoma sp.				X
Hesperophylax sp.				X
Hydropsyche sp.	X	X	X	X
Leptocella sp.	X	X	X	X
Limnephilidae	X			
Micrasaema sp.	X	X		
Nesperophylax sp.	X			
Oecetis sp.	X	X	X	

Species	Stations 1	2	3	4
TRICHOPTERA (Continued)				
Parapsyche sp.	X	X		X
Phyranganeidae	X			
Psychomiidae	X	X		
Rhyacophila acropedes	X	X	X	X
COLEOPTERA				
Optioservus sp.	X	X	X	X
Other Coleoptera	X	X	X	X
DIPTERA				
Antocha sp.	X		X	X
Atherix sp.	X	X	X	X
Chironomus sp.	X	X	X	X
Pericoma sp.	X	X	X	X
Simulium sp.	X	X	X	X
Tipula sp.				X
Other Diptera	X	X	X	X
MOLLUSCA				
Gyraulus sp.	X	X		
Lymnaea sp.				X
Physa sp.	X	X	X	X
Pisidium sp.	X	X	X	X
Nematomorpha	X	X	X	
HIRUDINEA				X
AMPHIPODA				
Asellus sp.				X
Hyalella sp.				X
PISCES				
Cottus sp.				X

Table 6. presents statistics concerning the species diversity calculations for Benthic invertebrates at the four stations. Diversities of 1.0 - 2.0 indicate moderate pollution and diversities of 2.0 - 3.0 indicate clean water.

Table 6. Species diversity information from kick samples from Bloomington Creek.

Mean Diversity

Station 1			Station 2			Station 3			Station 4		
Mean	Standard Deviation	N	Mean	Standard Deviation	N	Mean	Standard Deviation	N	Mean	Standard Deviation	N
2.13	0.54	14	2.09	0.33	15	2.01	0.33	12	1.42	0.47	12

Pooled Diversity*

*All data in the study, from a particular station, pooled for calculations.

Station 1			Station 2			Station 3			Station 4		
$\bar{d}p$	No. Species	No. Ind.	$\bar{d}p$	No. Species	No. Ind.	$\bar{d}p$	No. Species	No. Ind.	$\bar{d}p$	No. Species	No. Ind.
2.58	49	3513	2.57	34	3986	2.55	29	3917	2.18	31	3969

DISCUSSION

There are no significant ($P < 0.05$) differences among the means presented in Table 3. Thus there are no stresses upon the water quality of Bloomington Creek that can be demonstrated from these loading data. Annual geometric means of fecal and total coliform bacteria show significant differences. Bacteria levels at Station 4 (below Bloomington) are significantly ($P < 0.05$) higher than levels at the upstream stations. This indicates that a coliform loading is being generated in the area of the farms and homes of Bloomington and this loading is increasing coliform concentrations in Bloomington Creek.

Benthic species diversity is the most demonstrative parameter measured. Mean diversity decreases slightly from Stations 1 through 3. This difference is not significant. However, Station 4 has a diversity which is significantly lower than that of the other stations. That lowered diversity is a reflection of disturbance caused by the town of Bloomington and by the removal of the riparian vegetation. This latter is regarded as a much more severe limitation. The removal of this vegetation allows more light to penetrate and removes the food source supplied by the leaves from the vegetation. Thus a smaller number of species can survive and a few of those species survive in large numbers. This lowers diversity and lowers stability; that is, the system is much more vulnerable to stress and is therefore in a less desirable condition.

Pooled species diversity indicates a similar trend; the upper three stations are similar; the lowest has a lower diversity. It is of more interest to examine the numbers of species and numbers of individuals collected over the year. Number of species decreases rapidly from Station 1 to 3. Stations 3 and 4 are similar. Numbers of individuals, however, are nearly constant among the stations. This indicates that the energy being used for production in each location is very similar. However, the upper two stations have more diverse food and habitat, thus allowing more species to survive.

The Bloomington Creek hydrograph is presented in tabular form in Table 1. Flow peaks in late May to early June and quickly returns to base flow. There do not appear to be other flow variations in the creek.

The major influence on water quality of these flow variations is primarily an increase in the solid material loadings. Solids produced from the watershed, in tons per year, are shown in Table 7.

Table 7. Solids production in tons per year at the four Bloomington Creek Stations.

Solid Type	Station 1	2	3	4
Total	6611	6293	6244	6647
Dissolved	5168	5133	5140	5496
Suspended	1443	1160	1104	1151

The annual mean is greatly influenced by runoff conditions when loadings are as high as 117,257 pounds of total solids per day. The standard deviation of the solids statistical means (Table 3) also gives an indication of the great variation in solids loadings seen over the year.

There do not appear to be differences in flow conditions or in their influence among the four stations.

CONCLUSIONS

1. The Earth Sciences' exploratory operation was not placing discernible stress upon Bloomington Creek at the time of this study.

2. No water quality parameters other than coliform bacteria were significantly different among the four stations, based on annual means. Fecal and total coliform bacteria were significantly higher at the station at U.S. Highway 89 (below Bloomington) than at the more upstream stations. In fact, both parameters showed violations of Idaho Water Quality Standards (based on annual geometric means) at the U.S. Highway 89 stations.

3. The benthic insect community at the upstream stations is diverse and healthy. Insect populations at the lowermost station showed considerable stress, a major part of which is attributable to the removal of riparian vegetation and organic inputs from the area adjacent to Bloomington.

4. Data reported in this study will make an acceptable base-line against which to measure future disturbances to Bloomington Creek.

5. Bloomington Creek meets all specific water quality standards on a routine basis. One sample from each of the four stations failed to meet the minimum dissolved oxygen level. Two samples from Station 4 exceeded the allowable level for fecal coliform bacteria. These latter samples caused the annual geometric mean to exceed the 50 colonies allowed in Class A_2 water.

6. Bloomington Creek also meets the general water quality criteria for toxic substances, trophic status, and other areas of concern.

7. The stream is not adversely affected by non-point sources above the town of Bloomington. Between Stations 3 and 4, bacterial levels are increased.

8. The yearly contribution of fecal and total coliform bacteria in Bloomington is shown in Table 8. Percentage increase is also shown.

9. The likely cause or derivation of the source of these increased loadings is dairy farms near the town of Bloomington.

Table 8. Annual contribution of fecal and total coliform bacteria from the town of Bloomington. Data are based on annual geometric mean of 18 samples. Percentage increase is calculated as percent of upstream loading.

	Annual Loading (in billions of colonies per day)			
	Station 3	Station 4	Contribution	Percentage Increase
Fecal Coliform	3.54	70.85	67.31	1901%
Total Coliform	21.45	228.33	206.88	965%

RECOMMENDATIONS

Bloomington Creek should be monitored on a regular basis starting with the initiation of mining activity. Results from that monitoring would be compared with this study as a measure of disturbance and of compliance with Idaho Water Quality Standards.

LITERATURE CITED

Earth Sciences Inc., 1974. Preliminary Environmental Impact Assessment. Bloomington Phosphate Project. ESI, Golden, Colorado.

Idaho Department of Health and Welfare, 1973. Water Quality Standards and Waste Water Treatment Requirements. Idaho Department of Health and Welfare, Boise, Idaho.

APPENDIX 1: GLOSSARY OF TERMS

Benthos: Organisms living on the bottom of a stream.

Bi-Weekly: Once every two weeks.

cfs: See "Cubic Feet Per Second."

Cubic Feet Per Second (cfs): An expression of discharge water passing a given point in one second. Also called "second-feet."

Cubic Meters Per Second (cms): A metric expression of discharge measurement. One cms equals 35.31 cubic feet per second (cfs).

Geometric Mean: The Nth root of the product of N numbers. Used as a way of calculating the mean of a series of numbers where the extremes vary widely from the mean. Also used for mean population levels of animals.

Hydrograph: A graph of the discharge of a river at several points over time.

Loadings: The weight of a concentration of a dissolved or suspended substance in water. Use of a loading calculation allows one to express the relative importance of water quality parameters in streams of various sizes.

m^3/sec. (cms): See "Cubic Meters Per Second."

mg/l: See "Milligrams Per Liter."

Milligrams Per Liter (mg/l): The number of milligrams (thousandths of a gram) of a substance in one liter of water, equivalent to parts per million (ppm).

Macro-Benthos: See "Benthos."

Non-point Source: Pollutants entering a stream from a broad, poorly defined area. The contrast of a "Point Source" in which pollutants are discharged to a water body directly; e.g., through a pipe.

Point Source Discharge: A direct, discrete effluent to a water body. Also see "Non-point Source."

SAR: See "Sodium Absorption Ratio."

Sodium Absorption Ratio: The relation between sodium, calcium, and magnesium in a water body. Abnormally high sodium concentrations may be detrimental to plant growth. SAR's of less than 4.00 are not considered harmful.

Water Quality Limiting: A designation given a stream segment indicating that the segment will not meet water quality standards after implementation of "secondary treatment" for publicly-owned treatment works and "Best Available Treatment" for all other point source dischargers.

APPENDIX 2: FINAL STUDY PLAN OF BLOOMINGTON CREEK SURVEY

Bloomington Creek is a small tributary to the Bear River in Bear Lake County. The stream represents valuable irrigation water supply and trout spawning water. The area near the creek is part of the Idaho Phosphate Belt. Earth Sciences Corporation is currently conducting an exploratory phosphate drilling program in Bloomington Canyon.

The exploratory drill site is above the road along Bloomington Creek. Waste material from the drill site is being deposited between the drill site and the road. Runoff from the mine location and the adjacent hillside will pass over, under, or through the waste material and may enter the creek. This runoff water may carry nutrients such as phosphates, it may carry heavy metals from the tailings, and most critically, it may carry sediment into Bloomington Creek.

This proposed survey will monitor the creek above and below the drill site. Sampling stations will be selected which will reflect input into the creek from the exploratory site. The stations to be sampled will be as follows:

Station 1: This station is located approximately 50 meters above the entrance to the Earth Sciences Corporation parking lot at the exploratory drill site. Additional stations will be selected above this point and will be sampled infrequently. Access to the creek above this point is impractical in the winter and spring. Therefore, the stations above this will be regarded as supplemental.

Station 2: This station will sample water influent to Bloomington Creek from the drainage system and culvert below the mine wastes. A drain system is located below the waste pile and a culvert passes under the road and connects the drain ditch with the creek. The sample will be taken from the mouth of the culvert. This station will be sampled for water quality only.

Station 3: This station will be on Bloomington Creek at the first stock fence below the exploratory drill site. This station will be about 30 meters below the point where the Earth Sciences Corporation takes their culinary water from the creek.

Station 4: A station on Bloomington Creek just above the U.S. Highway 89 Bridge.

These four stations will be sampled bi-weekly beginning about April 1, 1975, and extending approximately one year. At Station 2, samples will be taken for water quality and benthos. Water quality samples will be analyzed for the following parameters:

Temperature, Dissolved Oxygen, Turbidity, Total Solids, Nitrate, Ortho-phosphate, Specific Conductance, Alkalinity, Iron, Manganese, Sodium, Potassium, Chloride, Suspended Solids. Settleable Solids, Total Kjeldahl Nitrogen, Total Phosphorus, and Fecal Coliform Bacteria.

In addition, the following heavy metals will be analyzed bi-monthly: Cadmium, Chromium, Copper, Lead, Mercury, Silver, and Zinc. All water quality samples will be grab samples from the center of the stream. Samples for the analysis of benthic populations will be taken bi-weekly with a standard Surber square-foot bottom sampler.