Water Quality Status Report

Georgetown Creek, Bear Lake County

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Idaho Department of Health & Welfare
Division of Environment
Statehouse, Boise, Idaho 83720

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ABSTRACT

Georgetown Creek drains a small watershed in Bear Lake County. A phosphate fertilizer plant operated in Georgetown Canyon until 1964. This study was conducted to assess water quality of Georgetown Creek as a background for future monitoring. Twenty parameters were sampled bi-monthly at six stations for a one year period. Ortho-phosphate phosphorus was significantly higher (P .05) below the Georgetown Mill site than it was above the site. Every day 45.7 pounds of ortho-phosphate were being added to the creek by the Georgetown mill property. Magnesium and sulphate were significantly increased near the National Forest boundary. The source of these increases was not apparent, and the increases did not appear to be detrimental to the creek.

INTRODUCTION

Georgetown Creek drains a small, mountainous watershed in Bear Lake County, Idaho. It has a mean annual discharge of 0.879 cms (31.4 cubic feet per second) near its confluence with the Bear River. Central Farmers Phosphate Company operated a phosphate mine on Snowdrift Mountain and a processing mill at the head of Georgetown Creek for several years. Other companies have owned and/or operated the plant since Central Farmers left. The plant ceased operation in 1964 and has not operated since. The present owner of the plant is Beker Industries in Soda Springs.

During the time of plant operation, wastes from the plant were collected and piped along the creek to a waste facility near Georgetown. A number of spills and pipe breaks occurred. One occurrence involved a rail car of phosphorus which overturned, releasing its contents into the creek. Releases of toxic materials such as this were not uncommon. Preliminary observations indicate that the Georgetown Creek hydrology, water chemistry, flora, and fauna have recovered from these disturbances.

Beker Industries has applied for permits to begin operations again at the Georgetown mill site. This study was undertaken to provide a measure of recovery from past disturbance and to provide base-line data for future water quality measurement.

METHODS AND MATERIALS

Six stations were selected on Georgetown Creek (Table 1, Figure 1). Samples were collected bi-monthly for 13 months, beginning in October, 1975. Water quality samples were grab samples collected at each station. Benthos samples were collected with a kick net. Discharge was obtained from Mr. W. Jeppsen, USGS., Logan, Utah.

Table 1. Station locations for Georgetown Creek Study.

Number	River		Location
	Kilometer	Mile	
1	17.6	11.0	1.6 km, 1.0 miles above the boundary of the Georgetown mill site.
2	16.0	10.0	On the upstream boundary of the Georgetown mill site.
3	15.5	9.7	On the downstream boundary of the Georgetown mill site.
4	12.3	7.7	3.2 km downstream from Station 3, and 2.4 km upstream from the Caribou National Forest boundary.
5	8.0	5.0	At Slugg Creek Rd. Bridge, 1.9 km downstream from the USFS boundary.
6	0.32	0.2	Near the Confluence of Georgetown Creek and the Bear River, 3.2 km downstream from Georgetown.

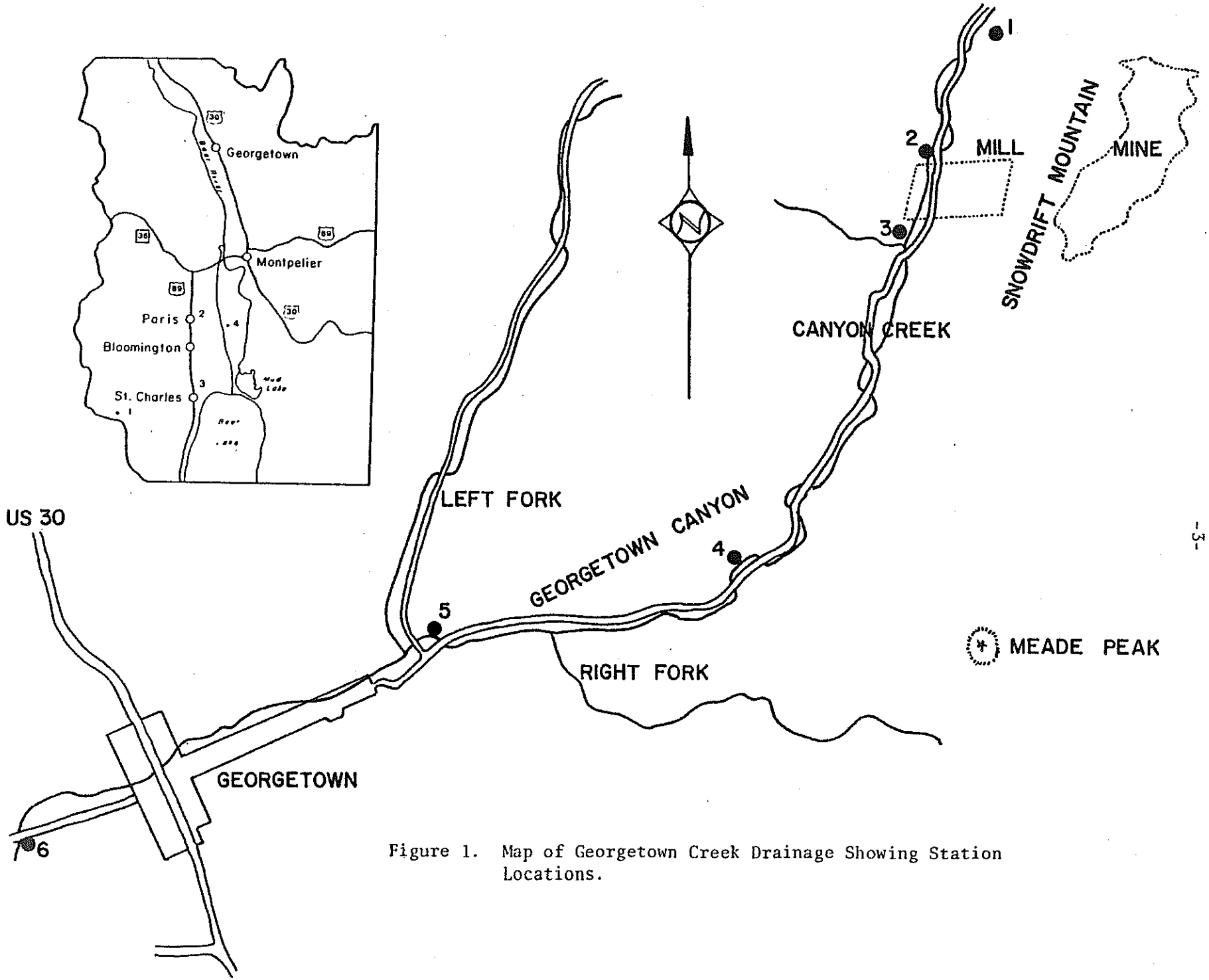

Figure 1. Map of Georgetown Creek Drainage Showing Station Locations.

RESULTS

Mean annual discharge for Georgetown Creek is 0.879 cubic meters per second (31.4 cfs) (Personal Communications, W. Jeppson, USGS, Logan, Utah). Statistics relating to annual loadings in Georgetown Creek are presented in Table 2. Table 3 summarizes data that do not lend themselves to loading presentation. Statistical differences between water quality stations are summarized in Table 4.

Benthic macroinvertebrates from the Georgetown collections have been identified and enumerated. A species list of the insects collected at each station is presented in Table 5. Species diversities have been calculated for the individual collections, and those results averaged. All data for each station have also been pooled to obtain a pooled species diversity. Diversity results from Georgetown Creek are presented in Table 6.

Table 2. Annual Water Quality data at the Georgetown Creek Stations, 10/75 - 10/76. All data are in pounds per day.

Parameter	Statistic	1	2	3	4	5	6
Ortho-Phosphate (asP)	N	3	5	6	6	6	2
	$\bar{X}$	11.85	6.77	52.47	20.31	10.15	22.00
	S.D.	5.08	1.69	11.85	13.54	8.46	22.00
Total Inorganic Phosphate (as P)	N	3	4	6	6	6	2
	$\bar{X}$	32.16	45.70	104.93	37.23	71.08	96.47
	S.D.	1.69	44.00	42.31	33.85	37.23	11.85
Total-Phosphorus (as P)	N	3	4	6	6	6	2
	$\bar{X}$	11.85	15.23	37.23	13.54	25.39	32.16
	S.D.	1.69	14.23	16.92	10.15	13.54	1.69
Nitrate (as N)	N	3	5	6	6	6	2
	$\bar{X}$	5.08	20.31	15.23	148.93	125.24	242.02
	S.D.	3.38	22.00	22.00	74.47	49.08	165.86
Ammonia (as N)	N	3	5	6	6	6	2
	$\bar{X}$	1.69	5.08	6.77	5.08	5.08	6.77
	S.D.	1.69	5.08	6.77	3.38	3.38	1.69
Total Kjeldahl Nitrogen	N	3	4	6	6	6	2
	$\bar{X}$	130.32	154.01	186.17	186.17	203.09	126.93
	S.D.	8.46	86.31	52.47	101.55	103.24	36.23
Hardness (as $CaCo_3$)	N	3	5	6	6	6	2
	$\bar{X}$	29956	28602	31141	28941	31987	41634
	S.D.	4891	5551	4603	4925	7616	2369
Magnesium	N	3	5	6	6	6	2
	$\bar{X}$	1777	2149	2234	2403	2623	1896
	S.D.	117	222	193	200	64	982
Total Dissolved Solids	N	3	5	6	6	6	2
	$\bar{X}$	55173	53819	57373	53988	62112	79713
	S.D.	9647	7108	6939	8124	10324	1912
Total Alkalinity (as Co_3)	N	3	5	6	6	6	2
	$\bar{X}$	28941	25225	27756	26910	24879	32495
	S.D.	4502	5895	3926	4756	5856	965
Fluoride	N	3	5	6	6	6	2
	$\bar{X}$	18.62	15.23	28.77	22.00	27.08	40.62
	S.D.	15.23	11.85	15.23	10.15	10.15	0
Sulphate	N	3	5	6	6	6	2
	$\bar{X}$	2014	2843	3351	2082	6804	9054
	S.D.	152	660	1032	609	1650	1076
Silica	N	3	4	6	6	6	2
	$\bar{X}$	1405	1423	1515	1317	1376	1757
	S.D.	157	122	127	120	103	149
Chemical Oxygen Demand	N	3	5	6	6	6	6
	$\bar{X}$	1405	745	795	778	694	1912
	S.D.	626	355	372	1100	575	389
Biochemical Oxygen Demand	N	1	3	3	3	3	
	$\bar{X}$	135	135	152	118	96	
	S.D.		51	61	61	25	

Table 3. Annual means of selected parameters from Georgetown Creek, 10/75-10/76. $\bar{x}_g$ represents a geometric mean.

Parameter	Statistic (all $\bar{x}$ in mg/l)	1	2	3	4	4a	5	6
Dissolved Oxygen (in mg/l)	N	1	2	4	4	1	4	1
	$\bar{X}$	8.9	9.8	8.8	8.3	8.6	7.8	8.7
	S.D.		1.4	1.1	.7		1.5	
	minimum		8.8	8.0	7.8		5.4	
Turbidity (in JTU)	N	3	5	6	6	1	6	2
	$\bar{X}$	9.3	17.1	9.9	11.7	.26	16.2	4.8
	S.D.	13.6	14.4	8.6	13.0		13.8	1.8
Temperature (in °C)	N	1	3	4	4	1	4	1
	$\bar{X}$	11.5	5.7	4.9	6.2	9	6.8	16
	S.D.		5.7	4.6	2.1		3.9	
Fecal Coliform (geometric mean of #/100 ml)	N	1	3	3	3		3	
	$\bar{X}g$	2	2	2	2		2	
	S.D.		0	0	0		2.62	
Fecal Strep (geometric mean of #/100 ml)	N	1	3	3	3		3	
	$\bar{X}g$	8	2	2.6	3.7		4.2	
	S.D.		0	.92	4.70		5.84	

Table 4. Statistically significant differences ($P < .05$) among Georgetown Creek Water Quality data based on a one way analysis of variance and a Duncan's multiple range test.

Parameter	Significant differences noted
Ortho-Phosphate	1 & 2 vs 3, 4, 5, & 6
Magnesium	1, 2, 3, 4, and 6 vs Station 5
Sulphate	1, 2, 3, 4, vs 5 and 6

Table 5. Benthic Insect Species Distribution in Georgetown Creek, September 1975 to October 1976.

Species	Station					
	1	2	3	4	5	6
EPHENEROPTERA						
Baetis bicaudatus				X	X	
B. intermedius					X	
B. tricaudatus				X		
Baetis sp.	X	X	X	X	X	X
Cynmigula sp.			X		X	
Ephenerella Coloradensis	X	X	X	X	X	X
E. doddsi	X	X	X	X	X	
E. flavilinea					X	
E. grandis	X				X	
E. inermis	X			X		
E. infrequens					X	
Heptagenia sp.	X	X	X	X	X	
PLECOPTERA						
Acroneuria pacifica		X		X		
Alloperla sp.					X	
Arcyropteryx parallela	X	X		X	X	
Isocapnia sp.					X	
Isoperla sp.		X				
Nemoura sp.	X	X	X	X	X	X
TRICHOPTERA						
Arctopsyche sp.				X		
Athripsodes sp.	X	X	X	X	X	
Brachycentrus sp.					X	X
Glossossoma sp.			X		X	
Hesperophylax sp.		X		X	X	X
Hydropsyche sp						X
Leptocella sp.					X	
Limnephilidae				X	X	
Nesperophylax sp.						X
Rhyacophila acropedes	X	X	X	X	X	X
R. angelita		X				
R. oreta				X		
R. vagrita				X		
R. verrula				X		
COLEOPTERA						
Optioservus sp.	X	X	X	X	X	X
Other Coleoptera						

Species	Station					
	1	2	3	4	5	6
DIPTERA						
Atherix sp.					X	
Chironomus sp.	X	X	X	X	X	X
Limnophora sp.					X	
Pericoma sp.		X			X	
Simulium sp.			X	X	X	X
Tipula sp.		X			X	X
MOLLUSCA						
Physa sp.	X				X	
Pisidium sp.					X	

Table 6. Benthic species diversity information from Georgetown Creek. Pooled diversity $\bar{d}p$ represents the total diversity from all collections at one station. Mean diversity $\bar{d}_{\bar{x}}$ represents the mean of the individual diversity values at that station.

	Station					
Index	1	2	3	4	5	6
$\bar{d}p$	2.75	3.52	3.16	3.46	4.01	2.52
$\bar{d}_{\bar{x}}$	2.31	2.48	2.39	2.52	2.46	2.52
$\bar{d}_s$	0.43	0.12	0.21	0.37	0.45	N/A
N	3	3	3	4	6	1

Table 7. Water quality statistics from Georgetown Creek: 1970 and 1976. All data are in pounds per day unless otherwise noted.

	1970 Study (Sum of all Data)			1976 Study (Sum of all Data)		
Parameter	N	$\bar{x}$	S.D.	N	$\bar{x}$	S.D.
Dissolved Solids	26	34695	3453	26	37064	6262
Total Solids	25	39095	3656	-	No data	-
Hardness	21	27925	3503	28	30972	6093
Iron	26	76.2	238.6	-	No data	-
Total Phosphorus	26	30.5	27.1	26	22.0	15.2
Total Nitrogen	26	76.2	47.4	26	174.3	84.6
Copper	14	10.2	23.4	-	No data	-
Fluoride	14	1.7	0	26	23.7	11.8
Chloride	20	863	469	-	No data	-
Mercury	5	0.5	0.8	-	No data	-
Nitrate (as N)	5	3.4	0	27	16.9	16.9
Turbidity (JTU)	5	60.4	12.0	27	3537.2	6431.2

DISCUSSION

There are few significant differences ($P < .05$) (Table 4) among the data in Table 2. Ortho-phosphate is increased 45.7 pounds per day (675%) between stations 2 and 3. This increased phosphorus loading appears to come from the Georgetown mill site. The ortho-phosphate loadings are high throughout the lower portion of the creek. These lower creek loadings are significantly higher than those at stations 1 and 2, but are much lower than those at 3. This indicates the source is at the mill site, and loadings generally decrease downstream as the phosphate is used by aquatic plants.

The other significant differences are not regarded as ecologically important in Georgetown Creek. Those differences are: magnesium at Stations 1-4 and 6 vs. 5; and sulphate at Stations 1-4 vs. 5-6. It does not appear that these increased loadings are harming the creek.

No significant differences in mean species diversity (Table 6) were noted. Pooled diversity was higher at Station 5 than at other stations. This is probably due to the increased number of collections at Station 5. The more rare species would have been collected by repetetive sampling, and the diversity would have been increased. The apparently low diversity at Station 1 is probably not an actual reflection of lowered diversity. Instead it is probably a result of sampling error. Discontinuities in the species list (Table 5) are also primarily the result of insufficient collections. The diversity levels and species lists are indicative of a healthy stream insect population and a high quality environment.

These data do not show a discernible difference in water quality of Georgetown Creek between 1970 and 1976. Parameters which are comparable have statistically similar ($P < .05$) mean levels.

Temperatures of Georgetown Creek vary seasonally and do not exceed the accepted criteria for the type of aquatic life found in the creek. Dissolved oxygen fell below the state standard of 6.0 mg/l once during the study (5.4 mg/l in November at Station 5). This was simply a result of diel respiration in the stream. No data are available on pH; but the levels of fecal coliform bacteria were always well below the state maximum of 50 colonies/100 ml.

Although ortho and total phosphorus levels are several times the suggested maximum (.01 mg/l PO_4 as P and .05 mg/l total P) these nutrients do not cause nuisance algal growths in Georgetown Creek. No data were collected on pesticides, dissolved gases, or radioactivity. There are no aesthetic problems that interfere with beneficial uses of Georgetown Creek.

CONCLUSIONS

1. The Georgetown mill site was significantly ($P < .05$) affecting the water quality of Georgetown Creek at the time of this study. The annual mean ortho-phosphate phosphorus loading was 6.8 pounds per day above the mill site and 52.5 ppd below the site. This represents a 675% increase, and a contribution of 45.7 pounds of phosphorus per day.

2. The benthic insect community is diverse and healthy. Most of the species collected are indicative of clean water, and are intolerant of stress.

3. The data reported here will make an acceptable base-line against which to measure future disturbances in Georgetown Creek.

4. Georgetown Creek meets all specific water quality standards on a routine basis. One sample from Station 5 failed to meet the minimum dissolved oxygen level. That was the only detected violation of Idaho water quality standards.

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

6. The stream is adversely affected by non-point sources in two locations. One is the Georgetown mill site as discussed in Number 1 above. The second is the area near the U.S. Forest Service boundary (Station 5). In this lower area, magnesium and sulphate are significantly increased. However, these latter increases do not reach toxic levels, and do not appear to be detrimental. The increases probably stem from minor tributaries or local changes in geology.

7. The yearly contributions of phosphate-phosphorus, magnesium, and sulphate in the three critical areas are detailed in Table 8. Percentage increase is also shown.

8. The likely cause or derivation of the source of these increased loadings is the Georgetown mill site in the upper creek. The source is not apparent in the lower creek.

Table 8. Annual contribution of ortho-phosphate phosphorus, magnesium and sulphate in Georgetown Creek. Data are in pounds per day, annual average. Percentage increase is calculated as percent of upstream loadings.

	Annual Loading (in pounds per day)			
Parameter	Station 2	Station 3	Contribution	Percentage Increase
Ortho-phosphate Phosphorus (as P)	6.8	52.5	45.7	675%

Parameter	Station 4	Station 5	Contribution	Percentage Increase
Magnesium	2403	2623	220	9.2%
Sulphate	2082	6804	4722	227%

LITERATURE CITED

Idaho Department of Health & Welfare. 1973. Water Quality Standards and Waste Water Treatment Requirements, Idaho Board of Health. Statehouse, 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: STUDY PLAN

SPECIAL STUDY - GEORGETOWN CREEK, BEAR LAKE COUNTY

Georgetown Creek drains a small, mountainous watershed. It has a discharge of approximately 20 cfs at its mouth. Central Farmers operated a phosphate processing mill at the head of Georgetown Canyon for several years. Other companies have operated and/or owned the plant since that time. The plant closed down in 1964 and has not operated since. The present owner of the plant is Beker Industries of Soda Springs.

During the time of operation of the plant, a number of spills and pipe breaks occurred. These occurrences released large amounts of toxic materials down Georgetown Creek. Preliminary observations indicate that the fauna and flora of the creek have largely recovered from these perturbations. Beker Industries has applied for permits to begin operations again at the Georgetown mill site.

This special study will provide a base-line against which to monitor future changes in water quality. The study will also allow an assessment of the recovery of damaged portions of the creek and may provide additional data needed by the Water Planning Section for stream segment classification. The creek represents stream segment BB-210 of the Bear River Basin in the Idaho Stream Segment numbering program.

Five stations will be chosen on the creek at locations designed to allow the assessment of the factors mentioned above. These stations will be sampled monthly for several chemical and physical parameters, as well as for benthic invertebrate populations. Sampling will begin in September 1975 and will continue for approximately 13 months.

The sampling stations will be located as follows:

Station 1: Approximately 1.0 miles (1.6 kilometers) above the present Georgetown Canyon mill site. Access to this station is via Diamond Creek Road. Since this road is closed in winter, access will be via foot, snow-shoe, and ski. Thus, a reduced sampling schedule may be required. This station is at River Mile 11.0 (17.6 kilometers).

Station 2: At the upper end of the new sixty inch culvert on the eastern (upstream) end of the Georgetown mill site. This station is at River Mile 10.0 (16.0 kilometers).

Station 3: At the bridge of Diamond Creek Road, just below the Georgetown Mill property. This station is at River Mile 9.7 (15.5 kilometers).

Station 4: At the point where the stream crosses under the road and into a large canyon. This point is 2.0 miles (3.2 kilometers) below Station 3, 1.5 miles (2.4 kilometers) above the Caribou National Forest Boundary, and 1.8 miles (2.9 kilometers) above a large irrigation diversion. This station is at river mile 7.7 (12.3 kilometers).

Station 4a: Across the canyon (north) from Station 4, a large number of Springs form a tributary to Georgetown Creek. This station has a luxuriant algal growth and appears to be radically different in water quality. This station will be sampled bi-monthly; i.e., on alternate sampling trips. It will be sampled for the monthly parameters each time and the "Quarterly" parameters on the first, last, and "Sixth-month" trips.

Station 5: At the bridge 0.2 miles (0.3 kilometers) above the road to Slugg Creek. This station is 2.7 miles (4.3 kilometers) below Station 4, 1.2 miles (1.9 kilometers) below the Caribou National Forest Boundary, and 0.9 miles (1.4 kilometers) below the irrigation diversion. This station is at River Mile 5.0 (8.0 kilometers).

Station 6: At the bridge 0.2 miles (0.3 kilometers) above the confluence of Georgetown Creek and the Bear River. This station is at River Mile 0.2 (0.3 kilometers).

Water samples will be taken with a DH-59 suspended sediment sampler. They will be analyzed for several chemical parameters, as listed below. Temperatures will be taken with a hand-held thermometer, held 2" below the water surface. Benthic samples will be taken with a kick net.

Monthly Samples

Turbidity
Ammonia
Nitrate
Ortho-phosphate
Hardness
Magnesium
Sulphate
Specific Conductance
Alkalinity
Chloride
Total Kjeldahl Nitrogen
Total Phosphorus
Total Inorganic Phosphorus
COD
Fluoride
Dissolved Oxygen
Temperature
Silica
Sodium
Fecal Colifrom bacteria
Fecal Streptococci bacteria