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COPPER RIVER HIGHWAY ENVIRONMENTAL IMPACT STUDIES: WATER QUALITY OF SURFACE WATERS

BY

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in cooperation with
Alaska Department of Transportation and Public Facilities

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WATER QUALITY OF SURFACE WATERS

by Mary A. Maurer[1] and Scott R. Ray[2]

EXECUTIVE SUMMARY

Water quality data were collected by the Alaska Division of Water in July, September, and October 1992 on the Uranatina River, Tiekel River, Cleave Creek, Tasnuna River, and Nels Miller Slough to provide information for the Environmental Impact Statement on the proposed Copper River Highway.

All five streams are characterized by low temperatures, high oxygen concentrations, relatively low total dissolved solids, and calcium-bicarbonate water. Trace metal concentrations are low in all streams. The glacial Tiekel River, Cleave Creek, and Tasnuna River have high suspended-sediment concentrations and turbidity in July. The Uranatina River and Nels Miller Slough have comparatively low sediment concentrations and turbidity in both summer and autumn. Fecal coliform bacteria densities are very low.

Historical water-quality data on the Copper River, Tiekel River, Tsina River, Boulder Creek, Stuart Creek, and O'Brien Creek show that all streams are similarly classified as calcium-bicarbonate water. Historical data indicate the Copper River carries a heavy suspended-sediment load and has high turbidity during the summer. The glacial Tsina River increases turbidity of the Tiekel River during the summer.

The most probable primary and secondary impact associated with Copper River Highway construction is an increase in the suspended-sediment load and turbidity of affected streams. It is anticipated that mitigating measures will be applied to reduce primary and secondary water-quality impacts associated with each of the proposed routes. A definitive statement on which route will have the most water-quality impacts to tributary streams and the Copper River is not possible without an examination of detailed route-alignment design plans and route-specific erosion control plans. However, general conclusions on each proposed route are as follows:

The Wood Canyon Route appears to have the lowest potential for water-quality impacts to tributary streams of the Copper River. Mitigation measures will still be required to reduce runoff and prevent accidental spills into the Copper River.

The potential for sediment runoff along the Tiekel Route is high because of the relatively deep valley, steep slopes and shallow soils in the lower drainage. The Tiekel River will be most impacted by sediment in spring and autumn when the river is free of glacial silt.

The potential for sediment runoff along the Tasnuna Route is high because numerous stream crossings will be required along the route. Sediment loading and turbidity impacts during the summer are expected to be low because of the river's naturally high glacial silt content. The potential for the Tasnuna River's water-quality to be impacted by contaminants other than sediment is high if the proposed highway is aligned within the river's active floodplain.

Water-quality impacts to the Copper River for each of the proposed routes are expected to be similar to impacts on tributary streams, but less because of dilution effects.

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INTRODUCTION

The Alaska Department of Transportation and Public Facilities (ADOT&PF) requested the Alaska Division of Water (DOW) Hydrologic Survey to collect the stream water-quality data that are necessary to evaluate various alternatives in a Draft Environmental Impact Statement on a proposed Copper River Highway. The DOW focused on Copper River tributary streams west of the mainstem Copper River between Chitina, Alaska and the Allen Glacier.

Site selections were based on the following objectives: (1) fill data gaps to augment the historical water-quality database, and (2) obtain water-quality data for streams having documented anadromous or resident fish populations. We relied primarily on the U.S. Geological Survey (USGS) water-quality database to identify data gaps. In addition, we contacted fishery biologists at the Alaska Department of Fish and Game, Habitat Division in Anchorage who indicated several streams within the project area having salmon spawning, salmon rearing, and resident fish populations.

Based on the data search and inquiries, the following six sampling sites were selected: Uranatina River, lower Tiekel River, Cleave Creek, upper Tasnuna River, lower Tasnuna River, and Nels Miller Slough (fig. 1). Stream characteristics are shown in Table 1. The sampling sites on the Uranatina River, Cleave Creek, lower Tiekel River, and lower Tasnuna River were at DOW's streamflow gage sites because these streams were unwadable in July 1992. Estimated late July streamflow in these streams is based on comparison with measured discharge in October and observed stage differences.

This report presents the water-quality data collected in 1992 under two distinct streamflow conditions, summer high streamflow and autumn intermediate flow; a summary of historical water-quality data in the project area; and a listing of potential primary and secondary water quality impacts to streams associated with the proposed Copper River Highway.

ACKNOWLEDGMENTS

Funding for this project was provided by ADOT&PF to DOW under Reimbursable Services Agreement No. 2532022. The authors thank Roy Glass, U.S. Geological Survey, Water Resources Division, Anchorage for providing computer printouts of historical USGS streamflow and water-quality data within the project area.

FIELD MEASUREMENTS

On-site water quality measurements were made at the six stream sites. Water temperature, dissolved oxygen concentration, and specific conductance were measured with a Model 4041 Hydrolab that was pre- and post-calibrated according to the instrument's operation and maintenance instructions (Hydrolab, 1981). The stream pH was measured with a Beckman Φ 11 pH meter that was calibrated on-site with standard buffers. Total alkalinity was determined by potentiometric titration. An untreated water sample was titrated to approximately pH 3.0, using 0.16 N sulfuric acid in a HACH digital titrator and a Beckman Φ 11 pH meter. The titration endpoint was calculated using Gran's graphical methods described in Stumm and Morgan, 1981. Total hardness was measured with a HACH total hardness test kit, Model HA-DT. Imhoff cones were used to measure settleable solids.

Stream velocities used in the discharge calculations were measured with a standard pygmy or Price AA meter. Velocities were measured at six-tenths depth, with sufficient numbers of sections such that no one section contained over ten percent of the flow. Discharge was calculated using the standard midpoint method (USDI, 1981).

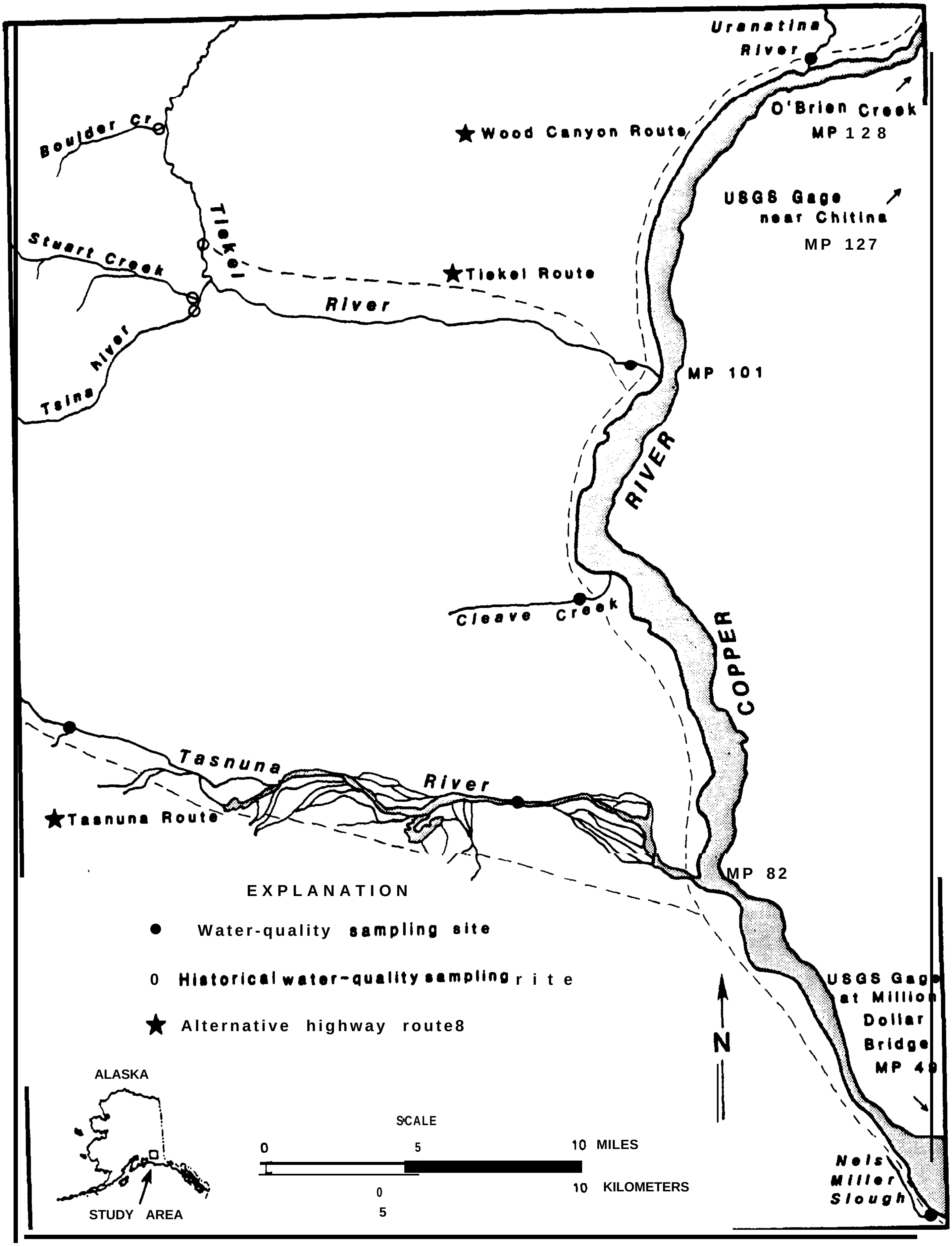


Figure 1. Locatlon map of water-quality sampling ● itoe, Copper River project area.

Table 1. Stream characteristics at water-quality sites in Copper River project area (see fig. 1 for site locations).

STREAM	DRAINAGE AREA (SQ MI)	STREAM TYPE
Uranatina River	74	Non-glacial
upper Tiekel River	122	Non-glacial
Tiekel River	457	Glacial
Cleave Creek	50	Glacial
upper Tasnuna River	23	Glacial
Tasnuna River	348	Glacial
Nets Miller Slough	5.5	Non-glacial

SAMPLING PROCEDURES

Generally, water samples were collected according to the methods of the U.S. Geological Survey (1977). Water samples for sediment and inorganic constituent analyses were collected from the stream by dip sampling, and then cornposited in and split from a churn splitter. Depth-integrated sampling was not attempted in July because five of six streams were unwadable. Field personnel decided to maintain consistency in sampling technique and conduct dip sampling at all six sites during the summer (July) and autumn (September-October) sampling periods. Water was collected by dipping a one-liter plastic bottle below the water surface. The bottle contents were then poured into a eight-liter capacity churn splitter. About six liters of water were obtained using this technique. Water collection was restricted from 5 to 15 feet from the stream's edge at five of six stream sites due to high streamflow. Water was obtained from mid-channel at Nels Miller Slough, which was wadable in July and October.

The cornposited water sample in the churn splitter was split into a set of five water samples per site in the following order: total suspended sediment (unfiltered), total metals (unfiltered), dissolved metals and cations (filtered), anions (filtered), and nutrients (filtered). The sample bottles for total suspended sediment and total metal samples were filled at the churn splitter's spigot while operating the churn, to ensure the water samples were well-mixed. The filtered samples were split from the churn splitter with an in-line filtration system. Water was drawn from the churn splitter with a MASTERFLEX hand pump equipped with silicone tubing. The water was forced through the tubing into a 142mm GEOTECH filter assembly containing a 0.45μm membrane filter. The filtrate from the filter assembly was collected in the sample bottles. The filter assembly was flushed with approximately 500 mL of filtrate prior to bottle filling.

Water samples requiring on-site acidification (total metals, dissolved metals, and nutrients) were collected in bottles that were pre-charged with acid at the DOW Water Quality Laboratory at the University of Alaska Fairbanks campus. Each total and dissolved metal bottle held approximately 2 mL of ULTREX-grade nitric acid. Each nutrient bottle held approximately 2 mL of sulfuric acid.

A water sample for fecal coliform bacteria analysis was obtained by dip sampling with a sterile, plastic 125 mL bottle. The sample was not cornposited, filtered, or treated.

All samples were immediately placed in a cooler and chilled with blue ice packs.

LABORATORY ANALYSES

Inoraanic Analvses

Water-quality analyses were conducted at the DOW Water Quality Laboratory. The laboratory is a participant in the U.S. Environmental Protection Agency (USEPA) Performance Evaluation program as well as the USGS Standard Reference Water Quality Assurance program. Analytical methods and detection limits are outlined in Table 2. For all parameters, calibrations were performed using National Bureau of Standards traceable standards where applicable. General data reduction procedures are described in Standard Methods (APHA, 1989).

Table 2. Analytical methods and detection limits for water-quality constituents and properties.

Constituent or property	Method	Detection Limit
Barium	AES 0029	0.01 mg/L
Cadmium	EPA 213.2	0.001 mg/L
Aluminum	AES 0023	0.01 mg/L
Arsenic	EPA 206.2	0.001 mg/L
Calcium	AES 0029	0.01 mg/L
Chloride	EPA 300.0	0.01 mg/L
Chromium	EPA 218.2	0.001 mg/L
Copper	EPA 220.2	0.001 mg/L
Fecal Coliform	SM 909C	2 or 10 colonies/l00 ml
Fluoride	EPA 340.2	0.01 mg/L
Iron	AES 0029	0.03 mg/L
Lead	EPA 239.2	0.001 mg/L
Magnesium	AES 0029	0.02 mg/L
Manganese	AES 0029	0.01 mg/L
Nickel	AES 0029	0.01 mg/L
Nitrate + Nitrite	EPA 353.2	0.1 mg/L
Potassium	EPA 258.1	0.01 mg/L
Total Suspended Solids	EPA 160.2	0.1 mg/L
Turbidity	EPA 180.1	0.1 NTU
Silicon	AES 0029	0.01 mg/L
Sodium	AES 0029	0.1 mg/L
Sulfate	EPA 300.0	0.01 mg/L
Zinc	AES 0029	0.02 mg/L

EPA = U.S. Environmental Protection Agency (EPA, 1983)
AES = Atomic emission spectroscopy (Federal Register, Part V, 40 CFR Part 136, Sept. 3, 1987)
SM = Standard Methods (APHA, 1989)

Samples were stored at 4°C until analyzed. Holding times, as described by the USEPA (EPA, 1983) and Standard Methods (APHA, 1989), were not exceeded for any of the samples.

Digestions for total metals were carried out using USEPA methods (EPA, 1983). Samples for total metals are reduced and refluxed with several additions of acid before returning the sample to its original volume, which results in a thorough and complete digestion of the sample.

Bacteriological Analvses

Fecal coliform bacteria analyses were conducted by Northern Testing Laboratory (NTL) in Anchorage, Alaska. The laboratory's quality control program is presented in a document entitled "Quality Assurance Quality Control Program General Information" (NTL, 1991). Sample bottles, blue ice, and coolers were provided by the laboratory. Fecal coliform bacteria densities were determined by the membrane filter technique, according to Standard Method 909C (APHA, 1989).

RESULTS AND DISCUSSION

Present Investiaation

Streamflow at all sites was noticeably greater in July than in late September. The estimated July streamflow was five to ten times greater than the September flow in all streams, excluding Nels Miller Slough. Generally, streams have low water temperatures, high dissolved oxygen concentrations, slightly basic pH, and few settleable solids. Turbidity, specific conductance, total hardness, and alkalinity are inversely related to discharge. Field measurements are shown in Table 3.

Although all streams appeared to be well-mixed, the lower Tasnuna River site was examined because of its wide channel and nearby upstream tributaries (fig 1). A Hydrolab was used to make cross-sectional measurements of specific water-quality parameters (Table 4). The data show that water temperature and pH did not change appreciably across the cross-section. There is a slight increase in specific conductance and decrease in dissolved oxygen concentration on the river's south side (right side facing downstream), indicating minor differences in the cross-sectional water-quality profile at this site.

Water quality analyses by DOW are shown in Appendix A. A key to the sample bottle numbers precedes the analytical reports. Dissolved constituent concentrations are listed unless otherwise noted. All streams are characterized by low mineralization, with total dissolved solids less than 75 mg/L and total hardness ranging from 25 to 70 mg/L (Table 3). Dissolved nitrate + nitrite concentrations were measurable in September only. No analyzed dissolved constituent concentration, except 0.37 mg/L for iron at Cleave Creek, exceeds the maximum contaminant concentration level in the Alaska Drinking Water Regulations, Title 18, Chapter 80.070 of the Alaska Administrative Code (Alaska Department of Environmental Conservation, 1991).

A trilinear diagram shows water-type classification, based on major ion compositions, for five streams with July 1992 data (fig. 2). The upper and lower Tasnuna River sites are combined because there was no measurable difference in major ion composition between sites. The diagram indicates that all streams are similarly classified as calcium-bicarbonate water. Likewise, the trilinear diagram showing September-October 1992 data indicates similar water type among streams and little change from July 1992 (fig 3). Although streams have lower specific conductance and higher streamflow and suspended sediment concentrations in July, the water type in all five streams remains relatively constant.

Table 3. Copper River area water-quality field measurements made by Alaska Division of Water during 1992.

Stream	Date/Time	Water Temperature (°C)	Air Temperature (°C)	Barometric Pressure (mm)	Discharge (ft^3/sec)	Turbidity (NTU)	Settleable Solids (ml/L)
Lower Tiekel River	07/28/92-1215 10/02/92-1330	5.2 3.0	12.5 8.0	762.0 751.8	NM[1] 530	160 2.5	0.1 NM[1]
Uranatina River	07/28/92-1512 10/02/92-1430	77 2.1	17.5 10.0	760.5 749.3	NM[1] 76.1[2]	8.4 0.50	<0.1 NM[1]
Cleave Creek	07/28/92-1745 10/02/92-1230	3.3 2.6	12.0 4.5	761.0 751.8	NM' 80.6[2]	180 12	0.1 NM'
Upper Tasnuna River	07/29/92-0930 09/30/92-1945	4.4 0.7	15.0 -1.0	761.5 740.2	NM' 51.6	85 3.5	0.1 NM
Lower Tasnuna River	07129192-I 230 09/30/92-I 215	2.5 1.1	15.5 2.5	761.5 755.9	NM' 568[2]	280 75	0.1 NM'
Nels Miller Slough	07/29/92-1720 10/02/92-1100	6.0 2.9	15.5 4.0	770.6 756.4	41.9 30.2	6.6 5.1	NM' NM'

Stream	Date	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)	pH	Total Alkalinity (mg/L as $CaCO_3$)	Total Hardness (mg/L as $CaCO_3$)	Total Dissolved Solids (mg/L)[3]
Lower Tiekel River	07/28/92 10/02/92	42 133	12.8 14.2	100 107	7.8 7.5	26.0 46.5	36 70	35 67
Uranatina River	07/28/92 10/02/92	48 123	11.8 14.5	98 106	7.8 7.5	30.9 52.7	32 64	41 68
Cleave Creek	07/28/92 10/02/92	38 140	12.9 14.4	96 106	7.8 7.6	19.6 46.3	28 66	32 75
Upper Tasnuna River	07/29/92 09/30/92	35 96	12.6 14.9	97 107	7.5 7.6	19.2 28.3	25 46	30 46
Lower Tasnuna River	07129192 09/30/92	35 113	13.6 14.3	100 101	7.4 7.7	19.3 34.0	27 46	30 57
Nels Miller Slough	07/29/92 10/02/92	50 77	11.9 14.1	94 105	7.3 7.8	22.7 20.9	33 38	41 35

[1] NM = not measured
[2] Measurement made on 9/30/92
[3] Computed value, based on the sum of dissolved-constituent concentrations

Table 4. Cross-sectional measurements at lower Tasnuna River site (see fig. 1), September 10, 1992.

Tape Reading (ft)	Time (hours)	Water Depth (ft)	pH	Water Temperature (°C)	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/l)
71[1]						
80	1510	1-2	5.8	2.2	77	14.0
100	1513	1-2	6.0	2.2	77	13.7
120	1515	1-2	6.0	2.1	76	13.7
140	1516	1-2	6.1	1.9	76	13.7
160	1517	1-2	6.2	2.1	77	13.6
180	1518	1-2	6.2	2.1	76	13.6
200	1519	1-2	6.2	2.1	78	13.6
220	1520	1-2	6.2	2.2	79	13.5
240	1521	1-2	6.2	2.2	81	13.4
260[2]	1522	1-2	6.1	2.3	96	12.8

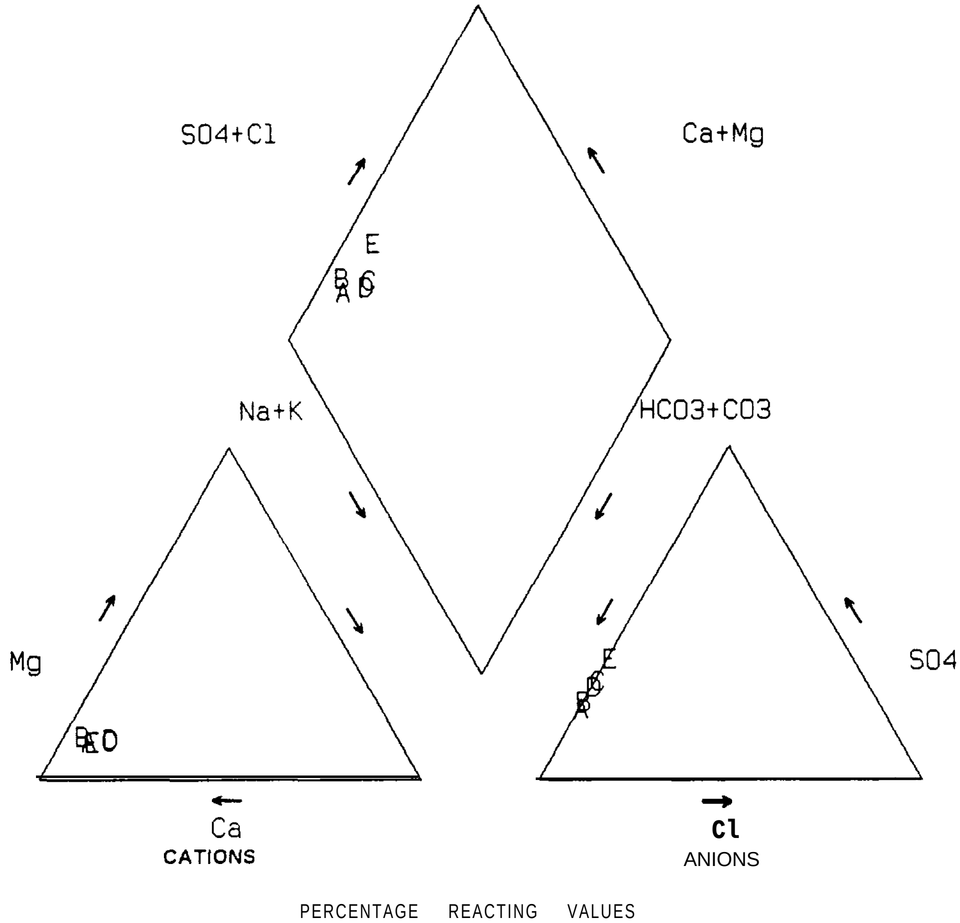
Note: Falling stage, dry and cool (freezing above -2000') last 72 hrs.

[1] Left edge of water, facing downstream.
[2] Right edge of water, facing downstream.

Generally, most trace-metal concentrations in the streams were either undetected or detected in minute amounts. Total and dissolved trace-metal concentrations were usually the same order of magnitude. Total iron and aluminum concentrations, however, were relatively high in July in the glacial streams: Tasnuna River, lower Tiekel River, and Cleave Creek. Total silicon was also higher in glacial streams in July.

There was a noticeable seasonal difference in trace-metal concentrations as well. The three glacial streams had higher trace-metal concentrations in July than September due to high suspended-sediment load during the summer. Except for arsenic, dissolved metal concentrations in all streams were slightly lower in September-October than in July.

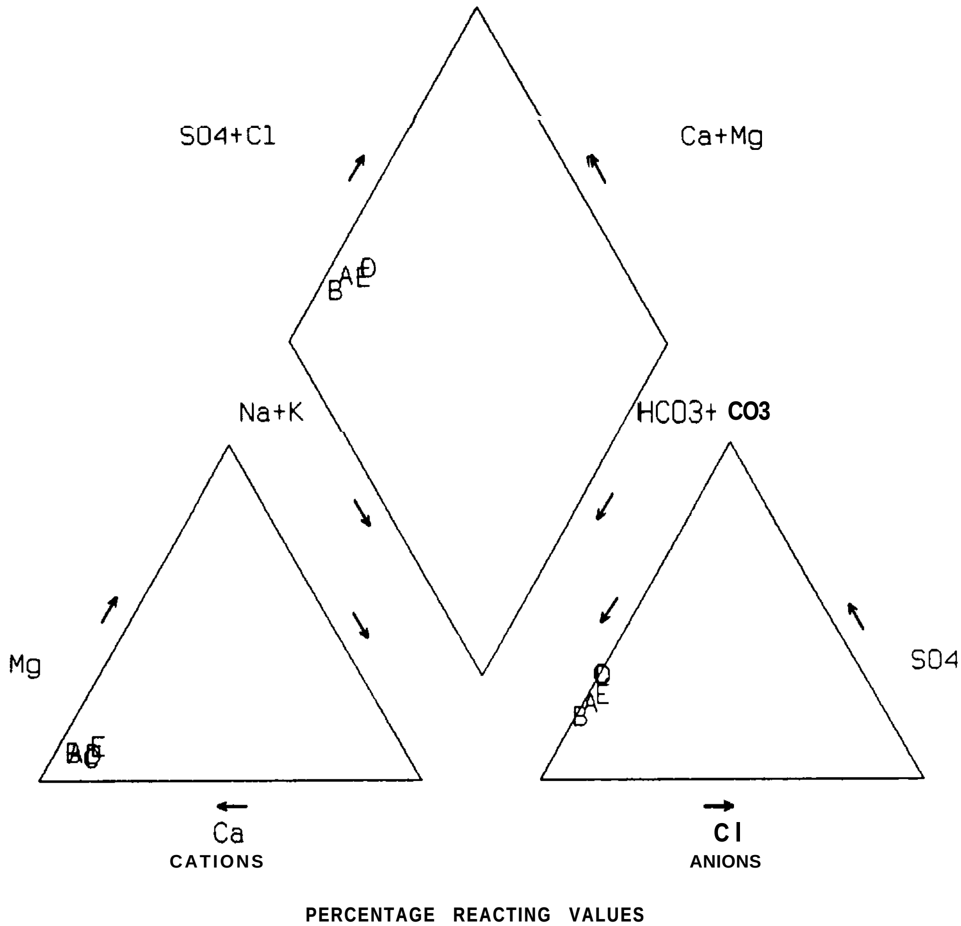
The lower Tasnuna River had the highest suspended-sediment concentrations and turbidity. The glacial streams had much lower turbidity and total suspended-sediment concentrations in the autumn, except the lower Tasnuna River which was still relatively turbid (74 NTU) in late September. The Uranatina River and Nels Miller Slough had relatively low turbidity and suspended-sediment concentrations in both July and October.



EXPLANATION

Svmbol	Site
A	lower Tiekel River
B	Uranatina River
C	Cleave Creek
D	Tasnuna River (mean of two sites)
E	Nels Miller Slough

Figure 2. Water-type classification of streams sampled by Alaska Division of Water, July 1992.



EXPLANATION

Symbol	Site
A	lower Tiekel River
B	Uranatina River
C	Cleave Creek
D	Tasnuna River (mean of two sites)
E	Nels Miller Slough

Figure 3. Water-type classification of streams sampled by Alaska Division of Water, September and October 1992.

Sample collection time, holding time, analysis time and results for fecal coliform bacteria are shown in Table 5. Analytical reports are shown in Appendix B. The holding time of six hours was exceeded in 10 of 12 samples owing to the logistic difficulty of transporting samples from remote collection sites to the Anchorage laboratory. Nine of twelve samples had fecal coliform bacteria densities less than the stated method detection limits of 2 colonies/l 00 ml, or 10 colonies/l 00 ml, depending on the date of analysis. Cleave Creek, lower Tasnuna River, and Nels Miller Slough had a fecal coliform bacteria density of 2 colonies/l 00 ml. These results indicate that the densities of fecal coliform bacteria from warm-blooded animals were very low in the streams at the time of sampling.

Table 5. Summary of fecal coliform bacteria data for sampled streams in Copper River project area.

Stream	Date Collected	Time Collected (hours)	Date Analyzed	Time Analyzed (hours)	Holding Time’ (hours)	No. Colonies per 100 ml
Uranatina River	07/28/92 10/02/92	1512 1500	07/29/92 10/02/92	1500 2000	24 5	<2 <2
Tiekel River	07/28/92 10/02/92	1215 1340	07/29/92 10/02/92	1500 2000	27 6	c 2 <2
Cleave Creek	07/28/92 10/02/92	1745 1245	07/29/92 10/02/92	1500 2000	21 7	2 <2
Upper Tasnuna River	07/29/92 09/30/92	1125 1110	07/30/92 10/01/92	1300 1000	26 23	<2 <10
Lower Tasnuna River	07/29/92 09/30/92	1605 1230	07/30/92 10/01/92	1300 1000	21 21	2 <10
Nels Miller Slough	07/29/92 10/02/92	1700 1107	07/30/92 10/02/92	1300 2000	20 9	<2 2

[1] Holding time between sampling and analysis is not to exceed 6 hours, according to USGS, 1977.

Historical Data

A literature search was conducted at the Bureau of Land Management Alaska Resource Library in Anchorage Alaska to acquire available historical water-quality data. Two on-line computer databases, LASERCAT - a catalog of books and journals held by libraries throughout Alaska and the Pacific Northwest, and GEOREF- a geological database, were searched.

Historical U.S. Geological Survey water-resource data for the Copper River basin are summarized in Emery and others, 1985. The only additional historical water-quality data that were found near the project area are geochemical data on a glacial meltwater stream from the Worthington Glacier (Slatt, 1972).

Water-quality samples have been periodically collected in the region by the USGS from 1949 to the present. Appendix C summarized the data collected from two sites on the Copper River, the Tiekel

River, two sites on the Tsina River, Stuart Creek, Boulder Creek, and O'Brien Creek. The summary includes the total number of analyses for each analyte, number of results below the method detection limit, mean, median and range of the analyses.

Since some of the data are reported as "below detection limits", the calculation of the mean becomes more complicated. The most common method for estimating summary statistics of data which include censored values (values reported as "below the detection limit") is simple substitution. This method substitutes a single value for the censored value. The substitution of zero produces estimates which are biased low, while substitution of the detection limit produces estimates which are biased high (Helsel, 1990). The means reported in Appendix C were derived using one-half the detection limit. Although this method is relatively poor, alternative methods which provide better estimates are more time consuming. Since these results are not used for enforcement, the estimates of the means using the simple substitution are adequate.

The median is also reported in the summary statistics. When censored data are present, the median can be an important statistic. If less than 50 percent of the data are censored, then the median can be calculated without any effect from the censored data.

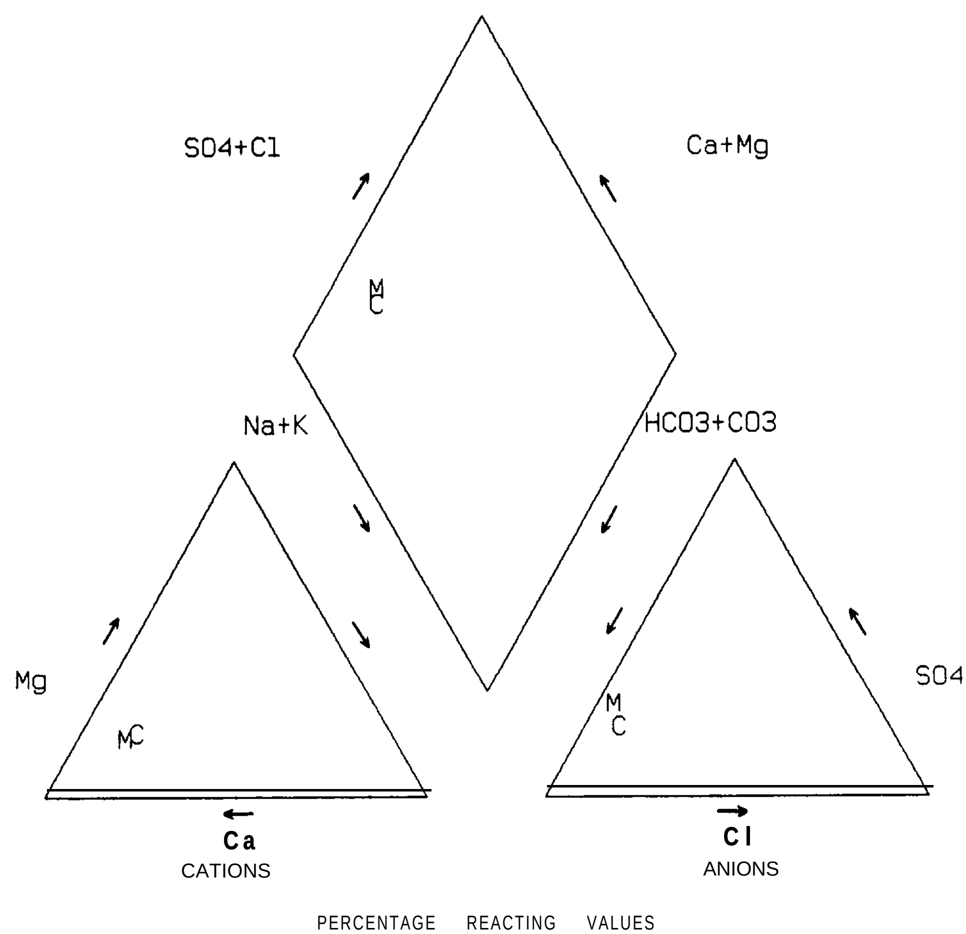
The majority of USGS water-quality samples have been collected from the Copper River near Chitina. Since 1990 water-quality samples have been collected from the Copper River at the Million Dollar Bridge. A trilinear diagram shows that water at both Copper River sites is classified as calcium-bicarbonate water (fig.4). A trilinear diagram of the five tributary streams shows that the water type is similarly classified as calcium-bicarbonate water (fig. 5).

Water-Oualitv Imoacts

The proposed highway has the potential for primary as well as secondary water-quality impacts to Copper River tributary streams. These potential impacts are summarized as a cause and effect relationship in Table 6. Primary impacts are those that are directly related to highway construction, operation, and maintenance. Secondary impacts are those that are "caused by an action and are later in time or farther removed in distance but are still reasonably foreseeable" (40 CFR 1508.8). For example, roadside gas stations and campgrounds would be considered secondary impacts.

The most probable primary water-quality impact resulting from the proposed highway is an increase in the suspended-sediment load and turbidity of affected streams. These impacts will be greatest during road construction. Turbidity and suspended sediment are also the most probable secondary impacts because of potential natural resource and land development within the project area. The mitigating measures listed in Table 6 can be applied to reduce both primary and secondary impacts.

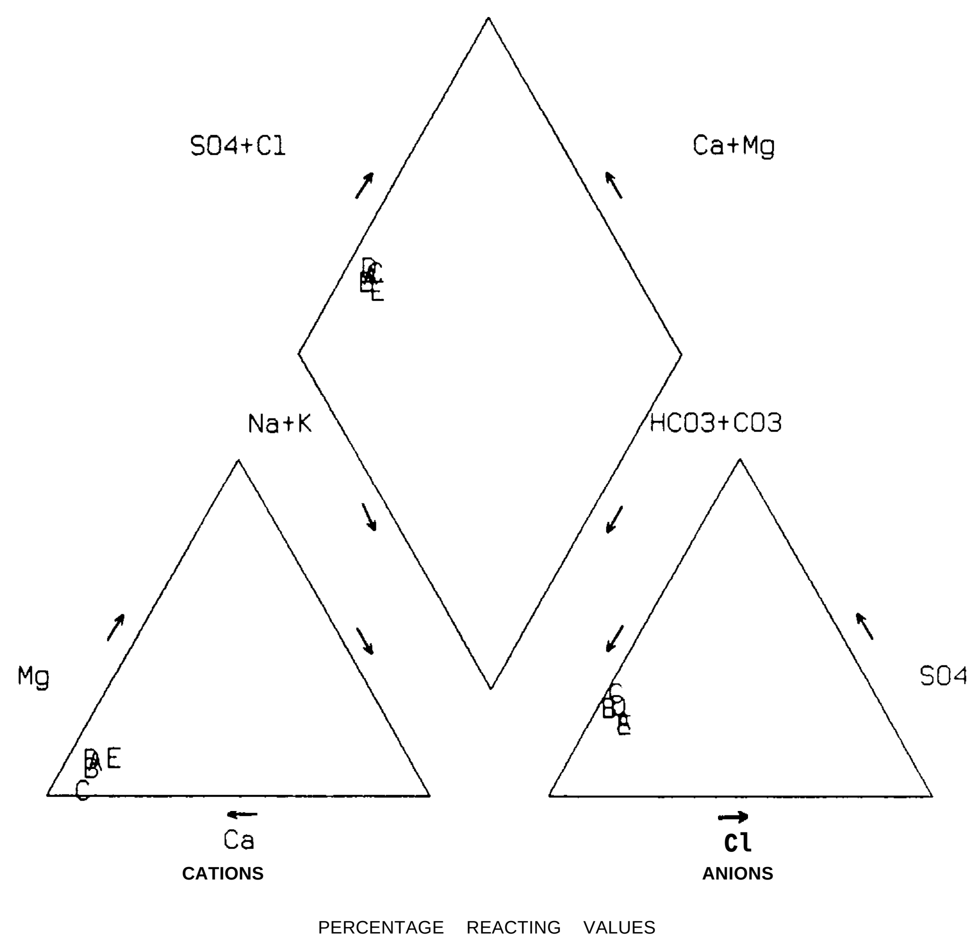
The magnitude of potential impacts will depend on climate, traffic characteristics, highway drainage design, maintenance activities, accidental spills, and surrounding land use (Federal Highway Administration, 1984). Climatic and hydrologic factors that lead to erosion and sedimentation are discussed in the Division of Water's companion publication, Public-Data File 92-24 entitled *Copper River Highways, Environmental Impact Studies: Hydrologic Aspects* (Carrick and others, 1992). Some of the secondary impacts associated with highway design maintenance care are expected to be negligible. For instance, ADOT&PF does not presently use herbicides and much of the asphalt runoff associated with road surface paving will not occur initially because the proposed road is to be unpaved (Degerlund, ADOT&PF, written commun., 19921. The surrounding land along each proposed route is presently undeveloped and infrastructure is non-existent. Consequently, future land development associated with and made possible by the proposed highway is expected to be the most important factor in determining the type and magnitude of secondary water-quality impacts.



EXPLANATION

Symbol	Site
M	Copper River at Million Dollar Bridge
C	Copper River near Chitina

Figure 4. Water-type classification of Copper River using U.S. Geological Survey historical data.



EXPLANATION

Symbol	Site
A	upper Tiekel River
B	Tsina River (mean of two sites)
C	Stuart Creek
D	Boulder Creek
E	O'Brien Creek

Figure 5. Water-type classification of five streams, using U.S. Geological Survey historical data.

Table 6. Potential primary and secondary water-quality impacts to Copper River tributary streams and mitigating measures associated with each of the proposed Copper River Highway routes.

PRIMARY WATER-QUALITY IMPACTS

	Potential Cause	Potential Effect	Mitiaatina Measures[1]
1.	instream road construction activities; sand & gravel removal from streams & flood plains; dredge & fill operations within stream channels; borrow bit evacuation; instream riprap & training structure placement; sediment pond discharge; streambank erosion due to groundcover & riparian vegetation removal; increased runoff from disturbed slopes; blasting; bridge construction & culvert installation; stripping of topsoil; road sanding	increase in stream turbidity & total suspended-sediment concentrations	time construction & maintenance activity to minimize sediment loading; develop route-specific erosion control plans; perform soils & slope stability analysis; use erosion control structures and practices (eg. sediment traps, silt fences, water bars, diversion ditches, sediment screens, slope drains, sedimentation basins, rip rap, revetments, gabions, shoulder dikes, berms, rock or gravel blankets, sodding, seeding, planting, mulch, mat binders, soil binders); revegetate streambanks
2.	sediment pond discharge; groundcover & riparian vegetation removal	increase in water temperature	maintain vegetative buffer along streams; revegetate cover along streambanks and around sediment ponds
3.	fertilizer runoff (used for borrow pit & road shoulder revegetation); blasting	increase in nitrogen & phosphorus compounds	use runoff control measures (same as erosion control measures in 1. above); avoid blasting near water courses
4.	road salting	change in water chemistry & pH	sweep sands and gravel from road surface in early spring; line and cover salt stock piles
5.	snow dump meltwater; road surface runoff	increase in trace metal concentrations	use runoff control measures (same as erosion control measures in 1. above)

[1] Reference sources: Lotspeich (1971); Lotspeich and Holmes (1974); Federal Highway Administration (1985a; 1985b; 1985c)

Table 6. (continued) Potential primary and secondary water-quality impacts to Copper River tributary streams and mitigating measures associated with each of the proposed Copper River Highway routes.

SECONDARY WATER-QUALITY IMPACTS

	Potential Cause	Potential Effect	Mitioatina Measures[1]
6.	runoff from roadside rest areas, picnic areas, campgrounds	increase in bacteria colonies; increase in biochemical oxygen demand	use sealed portable toilet units
7.	runoff from solid-waste sites	increase in biochemical oxygen demand; change in water chemistry	perform soil analysis at prospective sites; use impervious protective liner at solid-waste sites
8.	herbicide runoff	introduction of biocides	use runoff control measures (same as erosion control measures in 1. above)
9.	asphalt paving plant & road surface runoff; fuel, oil, grease & solvent runoff from roadside gas stations & heavy equipment facilities; accidental fuel spills	introduction of petroleum hydrocarbons	use runoff control measures (same as erosion measures in 1. above); site equipment facilities in areas with low erosion potential; install oil/water separators at equipment facilities; stockpile spill cleanup equipment at maintenance facilities along the route
10	runoff from natural resource development (e.g. water, timber, minerals, timber); runoff from commerical & residential development	physical, chemical and biological effects listed in 1. - 9. above	address cumulative water-quality impacts in natural resource management plans; develop land-use guidelines & ordinances

[1] Reference sources: Lotspeich (1971); Lotspeich and Holmes (1974); Federal Highway Administration (1985a; 1985b; 1985c)

Route Comoarisons

The three alternative highway routes along the Copper River are referred to as the (1) Wood Canyon Route, (2) Tiekel Route, and (3) Tasnuna Route (fig. 1). The impacts of each alternative highway route to the water quality of affected streams is discussed. General water-quality impacts to the Copper River are also addressed.

Wood Canyon Route

The Wood Canyon route will have the lowest water-quality impacts to tributary streams because each stream will be crossed once, near the stream's mouth. Thus, the amount of sediment loading into tributary streams is expected to be low. Erosion mitigation will still be required at these stream crossings to prevent sedimentation of braided channels on each stream's alluvial fan. There is a potential for runoff and accidental spills to reach the Copper River, given the river's close proximity to the proposed highway alignment. Mitigation measures, such as timing construction activity during summer when the Copper River has high streamflow and high sediment load, will reduce water-quality impacts to the Copper River.

Tiekel Route

The incised nature of the Tiekel River channel will require the highway alignment to be located on upland benches rather than adjacent to the stream. Such an alignment will probably reduce the number of stream crossings. Therefore, the potential for physical disturbance to the streambed and sediment loading from instream or near-stream highway construction is low.

Nevertheless, the lower Tiekel River drainage has relatively steep slopes, numerous rivulets, and shallow soils. Both temporary and permanent mitigating measures to control erosion and runoff will be required. During the summer any increase in suspended sediment and turbidity will not be noticeable because the stream carries glacial silt (Table 7), which is contributed by tributary streams such as the Tsina River (Table 8). An increase in suspended sediment and turbidity will be most visible during the autumn when the stream has a very light suspended sediment load and low turbidity (Table 7).

Tasnuna Route

The magnitude of water-quality impacts associated with the Tasnuna Route will depend upon the exact alignment of the highway. The potential for instream disturbance and associated sediment loading is high if the highway alignment is set within the Tasnuna River's floodplain. Such an alignment will require the placement of numerous culverts and bridges, thereby increasing the potential for direct sediment and pollutant runoff into the Tasnuna River.

Although the increase in sediment and turbidity will not be visible in the upper Tasnuna River in the summer because of the heavy sediment load from glaciers, mitigating measures to reduce sediment loading will be required during autumn when the upper river is virtually sediment-free (Table 7). In contrast, the lower Tasnuna River has a comparatively high sediment load in summer and autumn (Table 7) due to numerous glaciers and glacial lakes along its course. Therefore, potential sediment loading in the lower Tasnuna River during the autumn will not have as great a visible impact to water clarity as it would in the Tiekel River.

Coooer River Impacts

The water-quality impacts to the Copper River as a result of any of the three proposed highway routes are expected to be similar to those on tributary streams (see Table 6), but less because of dilution effects. Water-quality impacts resulting from highway construction and maintenance during the summer are expected to be masked by the Copper River's high streamflow and heavy suspended-sediment loading (Table 8). Water-quality impacts on the Copper River during winter are expected to be low.

Table 7. Summary of Alaska Division of Water's 1992 turbidity and total suspended sediment data for Copper River project area.

Site	Turbidity (NTU)		Total Suspended Solids (mg/L)	
	July	Sep-Ott	July	Sep-Ott
lower Tiekel River	160	2.5	274	2.37
Uranatina River	8.4	0.50	9.50	0.40
Cleave Creek	180	12	329	12.9
upper Tasnuna River	85	3.5	300	3.19
lower Tasnuna River	280	75	357	48.1
Nels Miller Slough	6.6	5.1	36.0	22.4

Table 8. Summary of turbidity and total suspended sediment data from historical U. S. Geological Survey data for Copper River project area.

Site	Turbidity (NTU)			Total Suspended Solids (mg/L)		
	No. of samples	Maximum value	Minimum value	No. of samples	Maximum value	Minimum value
Copper River near Chitina	53	1300	4.5	4	620	12
Copper River at Million Dollar Bridge	10	800	98	6	1370	678
Tiekel River near Tiekel	3	8	1	ND'	ND'	ND'
Tsina River above Stuart Creek	5	90	<2	ND'	ND'	ND'

[1] No data available

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APPENDIX A

Key to DOW Sample Bottle Numbers

and DOW Analytical Reports

Key to sample bottle numbers for inorganic constituent samples analyzed by DOW Water Quality Laboratory.

Stream	Date	Constituent Group				
		Anions’	Nitrate + Nitrite	Cations & Dissolved Metals[2]	Total Metals[3]	Turbidity & Total Suspended Sediment
Tiekel River	07/28/92 10/02/92 10/02/92	199 489 491[4]	238 479 481[4]	225 469 471"	212 459 461[4]	251 499 501[4]
Uranatina River	07/28/92 10/02/92	200 490	239 480	226 470	213 460	252 500
Cleave Creek	07/28/92 10/02/92	201 488	240 478	227 468	214 458	253 498
Upper Tasnuna River	07/28/92 09/30/92	202 485	241 475	228 465	215 455	254 495
Lower Tasnuna River	07/29/92 07/29/92 09/30/92	203 204" 486	242 243[4] 476	229 230[4] 466	216 217[4] 456	255 256[4] 496
Nels Miller Slough	07/29/92 10/02/92	205 487	244 477	231 467	218 457	257 497
		206[5]	245[5]	232[5]	219[5]	

[1] Anions include fluoride, chloride, and sulfate.

[2] Cations include calcium, magnesium, sodium, and potassium; dissolved metals include aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc; silicon also measured.

[3] Total metals include aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc. Total silicon also measured.

[4] Field duplicate sample.

[5] Field equipment-blank sample.

State of Alaska
Department of Natural Resources / Division of Water
WATER QUALITY LABORATORY
209 O'Neill University of Alaska Fairbanks Fairbanks, Alaska 99775 (907)474-7713

Client: **DNR/DOW** Copper River Project

Submitted By: Mary **Maurer**

Date Submitted: 6-August 1992

Sample	Fluoride	Chloride	Sulfate
199	0.04	0.23	6.30
200	0.03	0.10	8.56
201	0.02	0.18	7.58
202	0.02	0.16	6.87
203	0.02	0.21	6.76
204	0.02	0.20	6.77
205	0.02	0.31	11.9
206	**<DL**	**<DL**	**<DL**
Units	**mg/L**	**mg/L**	**mg/L**
EPA Method	340.2	300.0	300.0
Detection Limit	0.01	0.01	0.01
Date of Analysis	21-Aug-92	21 Aug 92	21-Aug-92
RPD	2.1	3.2	0.1
% Recovery	104	96	98

Approved By Jim Vohden **Date** 8 OCT 92

Jim Vohden, Chemist

State of Alaska
Department of Natural Resources / 'Division of Water
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Client: **DNR/DOW** Copper River Project

submitted By: Mary **Maurer**

Date Submitted: **6-August** 1992

Sample	Nitrate + Nitrite
238	**<DL**
239	**<DL**
240	**<DL**
241	**<DL**
242	**<DL**
243	**<DL**
244	**<DL**
245	**<DL**
Units	**mg/L as N**
EPA Method	353.2
Detection Limit	0.1
Date of Analysis	**20-Aug-92**
RPD	1.2
% Recovery	97

Approved **By** Jim Vohden

Date 8 OCT 92

Jim Vohden, Chemist

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'Department of Natural Resources / Division of Water
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Client: **DNR/DOW** Copper River Project

Submitted By: Mary Maurer

Date Submitted: **6-August** 1992

Sample	Calcium	Magnesium	Sodium	Potassium
225	10.1	0.77	0.89	0.37
226	11.0	0.96	0.76	0.09
227	8.6	0.73	0.83	1.42
228	7.5	0.65	0.66	1.30
229	7.8	0.68	0.82	1.18
230	8.2	0.76	0.89	1.26
231	11.1	0.88	0.92	0.69
232	<DL	<DL	<DL	<DL
Units	mg/L	mg/L	mg/L	mg/L
EPA Method	AES 0029	AES 0029	AES 0029	258.1
Detection Limit	0.01	0.02	0.1	0.01
Date of Analysis	1-Sept-92	1-Sept-92	1 -Sept-92	1-Sept-92
RPD	1.9	0.1	4.0	1.0
% Recovery	99	98	108	98

Approved By ______________ **Date** 8 Oct 92

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Client: **DNR/DOW** Copper River Project

Submitted By: Mary **Maurer**

Date Submitted: **6-August** 1992

Sample	Iron	Manganese	Aluminum	Barium	Nickel
225	0.16	0.02	0.20	0.02	0.01
226	0.03	0.01	0.08	0.02	0.02
227	0.37	0.02	0.34	0.03	0.02
228	0.23	0.02	0.22	0.03	0.03
229	0.14	0.01	0.11	0.02	0.02
230	0.12	0.01	0.13	0.02	0.02
231	<DL	<DL	0.05	0.02	0.04
232	<DL	<DL	<DL	<DL	<DL
Units	mg/L	mg/L	mg/L	mg/L	mg/L
EPA Method	AES 0029	AES 0029	AES 0029	AES 0029	AES 0029
Detection Limit	0.03	0.01	0.01	0.01	0.01
Date of Analysis	21-Sept-92	21-Sept-92	21-Sept-92	21-Sept-92	21-Sept-92
RPD	1.3	0.1	6.3	2.4	2.0
% Recovery	92	103	97	97	%

Approved By [signature] Date 8OCT92.

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Client: **DNR/DOW** Copper River Project

Submitted By: Mary Maurer

Date Submitted: **6-August** 1992

Sample	Silicon	Zinc	Arsenic	Cadmium	Chromium
225	1.02	0.08	0.004	<DL	<DL
226	1.07	0.08	0.003	<DL	<DL
227	0.99	0.09	0.005	<DL	<DL
228	0.82	0.09	0.005	<DL	<DL
229	0.51	0.07	0.004	<DL	<DL
230	0.60	0.08	0.004	<DL	<DL
231	1.13	0.09	0.004	<DL	<DL
232	<DL	<DL	<DL	<DL	<DL
Units	mg/L	mg/L	mg/L	mg/L	mg/L
EPA Method	AES 0029	AES 0029	206.2	213.2	218.2
Detection Limit	0.01	0.02	0.001	0.001	0.001
Date of Analysis	21-Sept-92	21-Sept-92	22-Sept-92	22-Sept-92	22-Sept-92
RPD	5.7	2.2	4.6	2.3	1.7
% Recovery	103	90	89	108	110

Approved By ____________ Date 8OCT92

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Client: **DNR/DOW** Copper River Project

Submitted By: Mary Maurer

Date Submitted: **6-August** 1992

Sample	copper	Lead
225	0.010	<DL
226	0.010	<DL
227	0.012	<DL
228	<DL	<DL
229	<DL	<DL
230	<DL	<DL
231	<DL	<DL
232	<DL	<DL
Units	**mg/L**	**mg/L**
EPA Method	220.2	239.2
Detection Limit	0.001	0.001
Date of Analysis	**22-Sept-92**	**22-Sept-92**
RPD	1.0	8.3
% Recovery	97	85

Approved By ______________________ Date 8OCT92

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Client: DNR/DOW Copper River Project

Submitted By: Mary Maurer

Date Submitted: 6-August 1992

Sample	Iron(total)	Manganese(total)	Aluminum(total)	Barium(total)	Nickel(total)
212	2.46	0.10	1.60	0.04	0.04
213	0.16	0.01	0.14	0.02	0.02
214	5.88	0.14	3.07	0.07	0.04
215	5.23	0.13	2.76	0.08	0.04
216	4.40	0.12	2.15	0.05	0.07
217	4.52	0.13	2.52	0.05	0.06
218	0.30	0.02	0.22	0.03	0.07
219	<DL	<DL	<DL	<DL	<DL
Units	mg/L	mg/L	mg/L	mg/L	mg/L
EPA Method	AES 0029	AES 0029	AES 0029	AES 0029	AES 0029
Detection Limit	0.03	0.01	0.01	0.01	0.01
Date of Analysis	21-Sept-92	21-Sept-92	21-Sept-92	21-Sept-92	21-Sept-92
RPD	1.4	9.3	2.2	9.8	8.2
% Recovery	93	92	85	89	109

Approved By Jim Vohden Date 8 OCT 92

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Client: **DNR/DOW** Copper River Project

Submitted By: Mary Maurer

Date Submitted: **6-August** 1992

Sample	Silicon(total)	Zinc(total)	Arsenic(total)	Cadmium(total)	Chromium(total)
212	2.88	0.15	0.010	<DL	0.012
213	1.14	0.12	0.004	<DL	0.005
214	5.79	0.12	0.015	<DL	0.014
215	4.78	0.12	0.013	<DL	0.013
216	4.43	0.14	0,011	<DL	0.012
217	4.91	0.13	0.012	<DL	0.012
218	1.48	0.11	0.005	<DL	<DL
219	<DL	<DL	<DL	<DL	<DL
Units	mg/L	mg/L	mg/L	mg/L	mg/L
EPA Method	AES 0029	AES 0029	206.2	213.2	218.2
Detection Limit	0.01	0.02	0.001	0.001	0.001
Date of Analysis	21-Sept-92	21-Sept-92	22"Sept-92	22-Sept-92	22-Sept-92
RPD	7.6	5.3	4.9	2.3	2.6
% Recovery	105	89	90	109	103

Approved By Jim Vohden

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Client: **DNR/DOW** Copper River Project

Submitted **By**: Mary **Maurer**

Date Submitted: **6-August** 1992

Sample	Copper(total)	Lead(total)
212	0.016	0.004
213	0.012	<DL
214	0.014	0.003
215	0.011	0.002
216	0.028	0.003
217	0.029	0.003
218	0.009	cDL
219	<DL	<DL
Units	**mg/L**	**mg/L**
EPA Method	220.2	239.2
Detection Limit	0.001	0.001
Date of Analysis	22-Sept-92	22-Sept-92
RPD	6.3	9.3
% Recovery	98	87

Approved By Jim Vohden Date 8 OCT 92

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submitted By: Mary **Maurer**

Date Submitted: **6-August** 1992

Sample	Turbidity	Total Suspended Solids
251	90	274
252	4.0	9.50
253	110	329
254	70	300
255	180	354
256	190	357
257	4.9	36.0
Units	**NTU**	**mg/L**
EPA Method	180.1	160.2
Detection Limit	0.1	0.1
Date of Analysis	12-Aug-92	12-Aug-92
RPD		
% Recovery		

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Client: DNR/DOW Copper River Project

Submitted By: Mary Maurer

Date Submitted: 5 October 1992

Sample	Fluoride	Chloride	Sulfate
485	0.05	0.39	11.1
486	0.05	0.29	15.4
487	0.04	0.53	6.94
488	0.04	0.13	19.8
489	0.02	0.51	13.0
490	0.03	0.27	11.4
491	0.02	0.52	13.0
Units	mg/L	mg/L	mg/L
EPA Method	340.2	300.0	300.0
Detection Limit	0.01	0.01	0.01
Date of Analysis	26 Oct 92	6 Oct 92	6 Oct 92
RPD	3.7	0.1	0.1
% Recovery	92	98	94

Approved By Jim Vohden Date 28OCT92

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Client: **DNR/DOW** Copper River Project

Submitted By: Mary Maurer

Date Submitted: 5 October 1992

Sample	Nitrate + Nitrite
475	0.15
476	0.11
477	0.65
478	0.30
479	0.80
480	0.80
481	0.75
Units	mg/L as N
EPA Method	353.2
Detection Limit	0.1
Date of Analysis	14 Oct 92
RPD	4.4
% Recovery	91

Approved By Jim Vohden Date 28 OCT 92

Jim Vohden, Chemist

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Client: **DNR/DOW** Copper River Project

Submitted By: **Mary Maurer**

Date Submitted: 5 October 1992

Sample	calcium	Magnesium	Sodium	Potassium
465	13.1	0.59	0.94	1.84
466	15.6	0.95	0.83	2.48
467	10.3	0.76	1.03	0.94
468	20.7	0.91	1.22	2.98
469	20.3	1.08	1.16	0.49
470	19.7	1.04	1.10	0.43
471	20.7	1.09	1.34	0.48
Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**
EPA Method	AES 0029	AES 0029	AES 0029	258.1
Detection Limit	0.01	0.02	0.1	0.01
Date of Analysis	26 Oct 92	26 Ckt 92	26 Oct 92	26 Ckt 92
RPD	0.7	0.5	16.4	4.9
% Recovery	101	99	102	109

Approved By Jim Vohden Date 28OCT92

Jim Vohden, Chemist

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Department of Natural Resources / Division of Water
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Client: **DNR/DOW** Copper River Project

submitted **By:** Mary **Maurer**

Date Submitted: 5 **October** 1992

Sample	Iron	Manganese	Aluminum	Barium	Nickel
465	<DL	CDL	<DL	<DL	<DL
466	0.09	0.02	<DL	<DL	<DL
467	<DL	<DL	<DL	<DL	<DL
468	<DL	<DL	<DL	<DL	<DL
469	<DL	<DL	<DL	<DL	<DL
470	<DL	<DL	<DL	<DL	<DL
471	<DL	<DL	<DL	<DL	<DL
Units	mg/L	mg/L	mg/L	mg/L	mg/L
EPA Method	AES 0029	AES 0029	AES 0029	AES 0029	AES 0029
Detection Limit	0.03	0.01	0.01	0.01	0.01
Date of Analysis	23 Oct 92	23 Oct 92	23 Oct 92	23 Oct 92	23 Oct 92
RPD	0.0	2.0	5.3	6.3	4.7
% Recovery	97	101	104	90	92

Approved **By** [signature] Date 28 OCT 92

Jim **Vohden,** Chemist

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209 O'Neill University of Alaska Fairbanks Fairbanks, Alaska 99775 (907)474-7713

Client: DNR/DOW Copper River Project

Submitted By: Mary Maurer

Date Submitted: 5 October 1992

Sample	Silicon	Zinc	Arsenic	Cadmium	Chromium
465	1.03	<DL	0.006	<DL	<DL
466	1.20	<DL	0.005	<DL	<DL
467	1.20	<DL	0.004	<DL	<DL
468	1.08	<DL	0.006	<DL	<DL
469	1.05	<DL	0.005	<DL	<DL
470	1.33	<DL	0.005	<DL	<DL
471	1.02	CDL	0.005	<DL	<DL
Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
EPA Method	AES 0029	AES 0029	206.2	213.2	218.2
Detection Limit	0.01	0.02	0.001	0.001	0.001
Date of Analysis	23 Oct 92	23 Oct 92	22 Oct 92	22 Oct 92	22 Oct 92
RPD	2.0	3.5	1.8	3.7	2.2
% Recovery	101	105	%	91	91

Approved By [signature] Date 28OCT92

Jim Vohden, Chemist

State .-of Alaska
Department of Natural Resources / Division of Water
WATER QUALITY LABORATORY
209 O'Neill University of Alaska Fairbanks Fairbanks, Alaska 99775 (907)474-77 13

Client: **DNR/DOW** Copper River Project

submitted By: Mary **Maurer**

Date Submitted: 5 October 1992

Sample	Copper	Lead
465	<DL	<DL
466	<DL	CDL
467	<DL	<DL
468	0.006	<DL
469	<DL	<DL
470	<DL	<DL
471	<DL	<DL
Units	mg/L	mg/L
EPA Method	220.2	239.2
Detection Limit	0.001	0.001
Date of Analysis	22 Oct 92	22 Oct 92
RPD	5.6	6.2
% Recovery	107	94

Approved By ____________ **Date** 28 OCT 92

Jim Vohden, Chemist

State of Alaska
Department of Natural Resources / Division of Water
WATER QUALITY LABORATORY
209 O'Neill University of Alaska Fairbanks Fairbanks, Alaska 99775 (907)474-7713

Client: **DNR/DOW** Copper River Project

Submitted By: **Mary Maurer**

Date Submitted: 5 October 1992

Sample	Iron(total)	Manganese(total)	Aluminum(total)	Barium(total)	Nickel(total)
455	0.21	<DL	0.09	<DL	<DL
456	3.34	0.07	1.30	<DL	<DL
457	0.36	<DL	0.19	<DL	<DL
458	0.67	<DL	0.36	<DL	<DL
459	0.09	<DL	0.03	<DL	<DL
460	0.09	<DL	<DL	<DL	<DL
461	0.10	<DL	0.02	<DL	<DL
Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
EPA Method	AES 0029	AES 0029	AES 0029	AES 0029	AES 0029
Detection Limit	0.03	0.01	0.01	0.01	0.01
Date of Analysis	23 Oct 92	23 Oct 92	23 Oct 92	23 Oct 92	23 Oct 92
RPD	3.7	2.2	6.5	1.1	5.7
% Recovery	99	91	103	106	90

Approved By Jim Vohden

Jim Vohden, Chemist

Date 28 OCT 92

State of Alaska
Department of Natural Resources / Division of Water
WATER QUALITY LABORATORY
209 O'Neill University of Alaska Fairbanks Fairbanks, Alaska 99775 (907)474-7713

Client: DNR/DOW Copper River Project

Submitted By: Mary Maurer

Date Submitted: 5 October 1992

Sample	Silicon(total)	Zinc(total)	Arsenic(total)	Cadmium(total)	Chromium(total)
455	1.45	<DL	0.006	<DL	<DL
456	2.31	<DL	0.011	<DL	0.006
457	1.46	<DL	0.005	<DL	<DL
458	1.17	<DL	0.008	<DL	<DL
459	1.20	<DL	0.005	<DL	<DL
460	1.52	<DL	0.005	<DL	<DL
461	1.06	<DL	0.005	<DL	<DL
Units	mg/L	mg/L	mg/L	mg/L	mg/L
EPA Method	AES 0029	AES 0029	206.2	213.2	218.2
Detection Limit	0.01	0.02	0.001	0.001	0.001
Date of Analysis	23 Oct 92	23 Oct 92	22 Oct 92	22 Oct 92	22 Oct 92
RPD	3.3	8.5	3.4	3.7	9.8
% Recovery	92	103	94	91	95

Approved By Jim Vohden Date 28 OCT 92

Jim Vohden, Chemist

State of Alaska
Department of Natural Resources / Division of Water
WATER QUALITY LABORATORY
209 O'Neill University of Alaska Fairbanks Fairbanks, Alaska 99775 (907)474-7713

Client: **DNR/DOW** Copper River Project

Submitted **By**: Mary **Maurer**

Date Submitted: 5 **October** 1992

Sample	Copper(total)	Lead(total)
455	0.019	<DL
456	0.051	0.002
457	0.019	<DL
458	0.019	<DL
459	0.016	<DL
460	0.018	<DL
461	0.017	<DL
Units	mg/L	mg/L
EPA Method	220.2	239.2
Detection Limit	0.001	0.001
Date of Analysis	22 Oct 92	22 Oct 92
RPD	1.0	6.8
% Recovery	104	94

Approved By Jim Vohden

Date 28 OCT 92

Jim Vohden, Chemist

State of Alaska
'Department of Natural Resources / Division of Water
WATER QUALITY LABORATORY
209 O'Neill University of Alaska Fairbanks Fairbanks, Alaska 99775 (907)47-77 13

Client: **DNR/DOW** Copper River Project

submitted By: Mary Maurer

Date Submitted: 5 October 1992

Sample	Turbidity	Total Suspended Solids
495	1.6	3.19
4%	180	48.1
497	1.7	22.4
498	6.9	12.9
499	1.1	2.37
500	0.55	0.40
501	0.90	2.35
Units	**NTU**	**mg/L**
EPA Method	180.1	160.2
Detection Limit	0.1	0.1
Date of Analysis	8 Oct 92	8 Oct 92
RPD		
% Recovery		

Approved By ____ **Date** 28 OCT 92

Jim Vohden, Chemist

APPENDIX B

Northern Testing Laboratory Analytical Reports

NORTHERN TESTING LABORATORIES, INC.

3330 INDUSTRIAL AVENUE — FAIRBANKS. ALASKA 99701 — (907) 456.3116 • FAX 456.3125
2505 FAIRBANKS STREET — ANCHORAGE. ALASKA 99503 — (907) 277.8378 • FAX 274.9645

State of Alaska Dept. of Natural Resources
Division of Water
PO Box 772116
Eagle River AR 99577-2116

Attn: Mary Mauer

RECEIVED
OCT 27 1992
ALASKA DNR/DIV Of WATER
EAGLE RIVER ALASKA

Report Date: 07/31/92

Date Arrived: 07/29/92
Date Sampled: 07/28/92
Time Sampled: 1215 ← typo. Should read 1512 hrs. MAM 10/27/92
Collected By: MAM

MDL = Method Detection Limit

Flag Definitions
B = Below Regulatory Min.
H = Above Regulatory Max.
E = Below Detection Limit Estimated Value

Our Lab #: All9282
Location/Project: Copper River Sampling
your Sample ID: Uranatina River
Sample Matrix: Water
Comments: Time Analyzed: 1500

Method	Parameter	Unit8	Result	Flag	MDL	Date Analyze
SM 909C	Fecal Coliform	#/100 ml	<MDL		2	07/29/92

Julie Schafer for
Reported By: Susan C. Tifental
Microbiology Supervisor

NORTHERN TESTING LABORATORIES, INC.

3330 INDUSTRIAL AVENUE FAIRBANKS. ALASKA 99701 (907) 456.3116 . FAX 456.3125
2505 FAIRBANKS STREET ANCHORAGE. ALASKA 99503 (907) 277-8378 . FAX 274.9645

State of Alaska Dept. of Natural Resources
Divieion of Water
PO Box 772116
Eagle River AK 99577-2116

Attn: Mary Mauer

RECEIVED
OCT 27 1992
ALASKA DNR/DIV OF WATER
EAGLE RIVER ALASKA

Report Date: 07/31/92

Date Arrived: 07/29/92
Date Sampled: 07/28/92
Time Sampled: 1215
Collected By: MAM

MDL = Method Detection Limit
Flag Definitions
B = Below Regulatory Min.
H = Above Regulatory Max.
E = Below Detection Limit Estimated Value

Our Lab #: A119281
Location/Project: Copper River Sampling
Your Sample ID: L. Tiekel R.
Sample Matrix: Water
Comments: Time Analyzed: 1500

Method	Parameter	Units	Result	Flag	MDL	Date Analyzed
SM 909C	Fecal Coliform	#/100 ml	<MDL		2	07/29/92

Julie Schaefer for
Reported By: Susan C. Tifental
Microbiology Supervisor

NORTHERN TESTING LABORATORIES, INC.

3330 INDUSTRIAL AVENUE FAIRBANKS. ALASKA 99701 (907) 456-3116 • FAX 456.3125
2505 FAIRBANKS STREET ANCHORAGE. ALASKA 99503 (907) 277-8378 • FAX 274.9645

State of Alaska Dept. of Natural Resources
Division of Water
PO Box 772116
Eagle River AK 99577-2116

Attn: Mary Mauer

RECEIVED
OCT 27 1992
ALASKA DNR/DIV OF WATER
EAGLE RIVER ALASKA

Report Date: 07/31/92

Date Arrived: 07/29/92
Date Sampled: 07/28/92
Time Sampled: 1215 ← typo. should read 1745 hrs.
Collected By: MAM

MAY 10/27/92

MDL = Method Detection Limit

Flag Definitions
B = Below Regulatory Min.
H = Above Regulatory Max.
E = Below Detection Limit Eetimated Value

Our Lab #: A119283
Location/Project: Copper River Sampling
Your Sample ID: ~~Glove~~ Greave Creek
Sample Matrix: Water MAM 10/27/92
Comments: Time Analyzed: 1500

Method	Parameter	Units	Result	Flag	MDL	Date Analyze
SM 909C	Fecal Coliform	#/100 ml	2		2	07/29/92

Julie Schaefer for
Reported By: Susan C. Tifental
Microbiology Supervisor

NORTHERN TESTING LABORATORIES, INC.

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State of Alaska Dept. of Natural Resources
Division of Water
P.O. Box 772116
Eagle River AK 99577-2116

Attn: Mary Maurer

RECEIVED
OCT 27 1992
ALASKA DNR/DIV OF WATER
EAGLE RIVER ALASKA

Report Date: 07/31/92

Date Arrived: 07/30/92
Date Sampled: 07/29/92
Time Sampled: 1125
Collected By: MAM

MDL = Method Detection Limit

Flag Definition5
B = Below Regulatory Min.
H = Above Regulatory Max.
E = Below Detection Limit Estimated Value

Our Lab #: A119303
Location/Project: Copper River Drainage
Your Sample ID: U. ~~Tashuna~~ Tasnuna R.
Sample Matrix: Water
Comments: Time Analyzed: 1300

MAM 10/27/92

Method	Parameter	Units	Result	Flag	MDL	Date Analyzed
SM 909C	Fecal Coliform	#/100 ml	<MDL		2	07/30/92

Julie Schaefer for
Reported By: Susan C. Tifental
Microbiology Supervisor

NORTHERN TESTING LABORATORIES, INC.

3330 INDUSTRIAL AVENUE FAIRBANKS. ALASKA 99701 (907) 456.3116 . FAX 456-3125
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Division of Water
P.O. Box 772116
Eagle River AK 99577-2116

Attn: Mary Maurer

RECEIVED
OCT 27 1992
ALASKA DNR/DIV OF WATER
EAGLE RIVER ALASKA

Report Date: 07/31/92

Date Arrived: 07/30/92
Date Sampled: 07/29/92
Time Sampled: 1605
Collected By: MAM

MDL = Method Detection Limit
Flag Definitions
B = Below Regulatory Min.
H = Above Regulatory Max.
E = Below Detection Limit Estimated Value

Our Lab #: A119305
Location/Project: Copper River Drainage
Your Sample ID: L. ~~Tashuna~~ Tasnuna R.
Sample Matrix: Water
Comments: Time Analyzed: 1300

MAM 10/27/92

Method	Parameter	Units	Result	Flag	MDL	Date Analyze
SM 909C	Fecal Coliform	#/100 ml	2		2	07/30/92

Julie Schaefer for
Reported By: Susan C. Tifental
Microbiology Supervisor-

NORTHERN TESTING LABORATORIES, INC.

3330 INDUSTRIAL AVENUE FAIRBANKS. ALASKA 99701 (907) 456.3116 • FAX 456.3125
2505 FAIRBANKS STREET ANCHORAGE. ALASKA 99503 (907) 277.6378 • FAX 274.9645

State of Alaska Dept. of Natural Resources
Division of Water
P.O. Box 772116
Eagle River AK 99577-2116

Attn: Mary Maurer

RECEIVED
OCT 2 7 1992
ALASKA DNR/DIV Of WATER
EAGLE RIVER ALASKA

Report Date: 07/31/92

Date Arrived: 07/30/92
Date sampled: 07/29/92
Time Sampled: 1700
Collected By: MAM

MDL = Method Detection Limit
Flag Definitions
B = Below Regulatory Min.
H = Above Regulatory Max.
E = Below Detection Limit Estimated Value

Our Lab #: A119306
Location/Project: Copper River Drainage
Your Sample ID: Nels Miller
Sample Matrix: Water
Comments: Time Analyzed: 1300

Method	Parameter	Unit5	Result	Flag	MDL	'Date Analyzec
	Fecal Coliform	#/100 ml	<MDL		2	07/30/92

Julie Schaefer for
Reported By: Susan C. Tifental
Microbiology Supervieor

NORTHERN TESTING LABORATORIES, INC.

3330 INDUSTRIAL AVENUE — FAIRBANKS, ALASKA 99701 — (907) 456.3116 . FAX 456.3125
2505 FAIRBANKS STREET — ANCHORAGE, ALASKA 99503 — (907) 277-8378 • FAX 274.9645

State of Alaska **DNR/DOW**
P.O. Box 772116
Eagle River AK 99577-2116

Attn: Mary Maurer

RECEIVED
OCT 27 1992
ALASKA DNR/DIV OF WATER
EAGLE RIVER ALASKA

Report Date: **10/14/92**

Date Arrived: **10/05/92**
Date Sampled: **10/02/92**
Time Sampled: 1500
Collected By: MM

MDL = Method Detection Limit
Flag Definitions
B = Below Regulatory Min.
H = Above Regulatory Max.
E = Below Detection Limit Estimated Value

Our Lab #: A120840
Location/Project: -
Your Sample ID: Uranatina River
Sample Matrix: Water
Comments: Time Analyzed: 2000

Method	Parameter	Units	Result	Flag	MDL	Date Analyze
SM 909C	Fecal Coliform	#/100 ml	<MDL		2	10/02/92

Julie Schaefer for
Reported By: Susan C. Tifental
Microbiology Supervisor

NORTHERN TESTING LABORATORIES, INC.

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2505 FAIRBANKS STREET — ANCHORAGE, ALASKA 99503 — (907) 277-8378 • FAX 274.9645

State of Alaska DNR/DOW
P.O. Box 772116
Eagle River AK 99577-2116

Attn: Mary Maurer

RECEIVED
OCT 27 1992
ALASKA DNR/DIV OF WATER
EAGLE RIVER ALASKA

Report Date: 10/14/92

Date Arrived: 10/05/92
Date Sampled: 10/02/92
Time Sampled: 1340
Collected By: MM

MDL = Method Detection Limit
Flag Definitions
B = Below Regulatory Min.
H = Above Regulatory Max.
E = Below Detection Limit Estimated Value

Our Lab #: A120839
Location/Project: -
Your Sample ID: Tiekel River
Sample Matrix: Water
Comments: Time Analyzed: 2000

Method	Parameter	Units	Result	Flag	MDL	Date Analyzed
SM 909C	Fecal Coliform	#/100 ml	<MDL		2	10/02/92

Julie Schaefer for

Reported By: Susan C. Tifental
Microbiology Supervisor

NORTHERN TESTING LABORATORIES, INC.

3330 INDUSTRIAL AVENUE FAIRBANKS ALASKA 99701 (907) 456.3116 • FAX 456.3125
2505 FAIRBANKS STREET ANCHORAGE. ALASKA 99503 (907) 277.8378 • FAX 274.9645

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Eagle River AK 99577-2116

Attn: Mary Maurer

RECEIVED
OCT 27 1992
ALASKA DNR/DIV OF WATER
EAGLE RIVER ALASKA

Report Date: 10/14/92

Date Arrived: 10/05/92
Date Sampled: 10/02/92
Time Sampled: 1245
Collected By: MM

MDL = Method Detection Limit
Flag Definitions
B = Below Regulatory Min.
H = Above Regulatory Max.
E = Below Detection Limit Estimated Value

Our Lab #: A120838
Location/Project: -
Your Sample ID: Cleave Creek
Sample Matrix: Water
Comments : Time Analyzed: 2000

Method	Parameter	Units	Result	Flag	MDL	Date Analyzed
SM 909C	Fecal Coliform	#/100 ml	<MDL		2	10/02/92

Julie Schaefer for
Reported By: Susan C. Tifental
Microbiology Supervisor

NORTHERN TESTING LABORATORIES, INC.

3330 INDUSTRIAL AVENUE — FAIRBANKS, ALASKA 99701 — (907) 456.3116 • FAX 456.3125
2505 FAIRBANKS STREET — ANCHORAGE, ALASKA 99503 — (907) 277.8378 • FAX 274.9645

State of Alaska DNR/DOW
P.O. Box 772116
Eagle River AK 99577-2116

Attn: Mary Maurer

RECEIVED
OCT 27 1992
ALASKA DNR/DIV OF WATER
EAGLE RIVER ALASKA

Report Date: 10/06/92

Date Arrived: 10/01/92
Date Sampled: 09/30/92
Time Sampled: 1110
Collected By: -

MDL = Method Detection Limit
Flag Definitions
B = Below Regulatory Min.
H = Above Regulatory Max.
E = Below Detection Limit Estimated Value

Our Lab #: A120753
Location/Project: -
Your Sample ID: Upper Tasnuna
Sample Matrix: Water
Comments : Time Analyzed: 1000

Method	Parameter	Units	Result	Flag	MDL	Date Analyzed
SM 909C	Fecal Coliform	#/100 ml	<MDL.		10	10/01/92

Julie Schrufer for
Reported By: Susan C. Tifental
Microbiology Supervisor

NORTHERN TESTING LABORATORIES, INC.

3330 INDUSTRIAL AVENUE FAIRBANKS. ALASKA 99701 (907) 456.3116 • FAX 456.3125
2505 FAIRBANKS STREET ANCHORAGE. ALASKA 99503 (907) 277.8378 • FAX 274.9645

State of Alaska DNR/DOW
P.O. Box 772116
Eagle River AK 99577-2116

Attn: Mary Maurer

RECEIVED
OCT 27 1992
ALASKA DNR/DIV OF WATER
EAGLE RIVER ALASKA

Report Date: 10/06/92

Date Arrived: 10/01/92
Date Sampled: 09/30/92
Time Sampled: 1230
Collected By: -

MDL = Method Detection Limit
Flag Definition6
B = Below Regulatory Min.
H = Above Regulatory Max.
E = Below Detection Limit Estimated Value

Our Lab #: A120752
Location/Project: -
Your Sample ID: Lower Tasnuna
Sample Matrix: Water
Comments: Time Analyzed: 1000

Method	Parameter	Units	Result	Flag	MDL	Date Analyzed
SM 909C	Fecal Coliform	#/100 ml	<MDL		10	10/01/92

Julie Schafer for
Reported By: Susan C. Tifental
Microbiology Supervisor

NORTHERN TESTING LABORATORIES, INC.

3330 INDUSTRIAL AVENUE FAIRBANKS. ALASKA 99701 (907) 456.3116 . FAX 456.3125
2505 FAIRBANKS STREET ANCHORAGE. ALASKA 99503 (907) 277.8378 . FAX 274.9645

State of Alaska DNR/DOW
P.O. Box 772116
Eagle River AK 99577-2116

Attn: Mary Maurer

RECEIVED
OCT 27 1992
ALASKA DNR/DIV OF WATER
EAGLE RIVER ALASKA

Report Date: 10/14/92

Date Arrived: 10/05/92
Date Sampled: 10/02/92
Time Sampled: 1107
Collected By: MM

MDL = Method Detection Limit

Flag Definitions
B = Below Regulatory Min.
H = Above Regulatory Max.
E = Below Detection Limit Estimated Value

Our Lab #: A120837
Location/Project: -
Your Sample ID: Nels Miller Slough
Sample Matrix: Water
Comments : Time Analyzed: 2000

Method	Parameter	Units	Result	Flag	MDL	Date Analyze'
SM 909C	Fecal Coliform	#/100 ml	2		2	10/02/92

Julie Schaefer for
Reported By: Susan C. Tifental
Microbiology Supervisor

APPENDIX C

Historical USGS Data

Copper River near Chitina

Period of Record: 1951-58; 1963-72; 1974-75; 1978-89; 1991
(all constituent values are dissolved unless otherwise noted)

Propertv or constituent	Total samples	# of samples C detection limit	Mean	Median	Max	Min
Total Alkalinity (mg/L as $CaCO_3$)	107	0	66	64	105	45
Aluminum (µg/L)	'24	0	114	110	290	71.6
Arsenic (µg/L)	41	1	1.9	2	4	<1.0
Barium (µg/L)	41	3	34	24	200	17
Cadmium (µg/L)	39	31	Cl .0	<1.0	4	cl.0
Calcium (mg/L)	125	0	25	24	42	19
Chloride (mg/L)	125	0	6.0	4	24	1.2
Chromium (µg/L)	39	27	1.9	Cl.0	20	<1.0
Copper (µg/L)	41	3	5.3	4	23	< 1.0
Dissolved Oxygen (mg/L)	45	0	11.39	11.44	14	7.97
Fecal Coliform (# colonies/100 ml)	45	17	K7[1]	K3[1]	K43[1]	<1
Fluoride (mg/L)	119	10	0.2	0.1	0.8	<0.1
Total Hardness (mg/L)	126	0	79.9	74.0	139	58.6
Iron (µg/L)	43	1	88	70	350	< 3.0
Lead (µg/L)	36	16	2.5	5	13	<1.0
Magnesium (mg/L)	125	0	4.1	3.6	9.3	2.1
Manganese (µg/L)	43	5	6.8	6	23	cl.0
Nickel (µg/L)	36	11	2.0	1	6	<1.0
Nitrite + Nitrate (mg/L)	50	33	<0.10	<0.10	0.21	<0.10
Orthophosphate (mg/L)	40	16	0.02	0.01	0.16	<0.01
pH	124	0	7.74	7.8	8.67	6.5
Potassium (mg/L)	114	0	1.7	1.6	4.3	0.8
Total Dissolved Solids (mg/L)[2]	123	0	108	99.5	195	74.1
Total Suspended Solids (mg/L)	4	0	255	193	620	12
Turbidity (NTU)	53	0	349	260	1300	4.5
Silica (mg/L)	124	0	7.6	6.7	19	1.9
Sodium (mg/L)	115	0	5.3	4.6	14	3
Specific Conductance (µS/cm)	134	0	181	168	334	122
Sulfate (mg/L)	125	0	18	17	31	6
Temperature (°C)	111	0	7.4	7.9	13	0.5
Zinc (µg/L)	40	11	13	9	79	<3.0
Discharge' (cfs)			3821 0[4]		380000	2000

[1] K indicates a non-ideal count.
[2] Sum of constituents.
[3] Period of record = 35 years.
[4] Annual Mean.

Copper River at Million Dollar Bridge near Cordova, Alaska

Period of Record: 1990-92
(all constituent values are dissolved unless otherwise noted)

Property or constituent	Total samoles	# of samples C detection limit	Mean	Median	Max	Min
Total Alkalinity (mg/L as $CaCO_3$)	11	0	48	47	68	38
Aluminum (µg/L)	9	0	163	130	410	90
Arsenic (µg/L)	6	1	1.6	2	2	<1.0
Barium (µg/L)	9	0	20	20	25	17
Cadmium (µg/L)	6	6	c l	<1	C l	c l
Calcium (mg/L)	10	0	19	19	22	17
Chloride (mg/L)	10	0	2.1	2.2	3.1	0.9
Chromium (µg/L)	6	2	1	1	2	<1
Copper (µg/L)	6	1	1.8	2	3	<1
Dissolved Oxygen (mg/L)	11	0	11.6	11.6	14.1	10.5
Fecal Coliform (# colonies/100 ml)	11	1	K7[1]	K5[1]	K31[1]	<3
Fluoride (mg/L)	10	7	<0.1	<0.1	0.2	<0.1
Total Hardness (mg/L)	7	0	59	58	68	52
Iron (µg/L)	9	0	139	92	400	59
Lead (µg/L)	6	5	<1	<1	4	C l
Magnesium (mg/L)	10	0	2.7	2.7	3.1	2.2
Manganese (µg/L)	9	0	5.6	5	10	3
Nickel (µg/L)	9	4	1.3	1	4	c l
Nitrite + Nitrate (mg/L as N)	10	3	0.16	0.08	0.55	<0.1
Orthophosphate (mg/L)	10	8	co.01	<0.01	0.03	c 0.01
pH	11	0	8.5	8.4	8.7	8.3
Potassium (mg/L)	10	0	1.8	1.8	1.9	1.6
Total Dissolved Solids (mg/L)[2]	9	0	79	81	88	68
Total Suspended Solids (mg/L)	6	0	1100	1150	1370	678
Turbidity (NTU)	10	0	430	465	800	98
Silica (mg/L)	10	0	4.1	4.1	4.9	3.3
Sodium (mg/L)	10	0	2.8	2.8	3.4	2.2
Specific Conductance (µS/cm)	11	0	135	129	196	112
Sulfate (mg/L)	10	0	18	19	23	13
Temperature (°C)	11	0	6.6	7.5	10.5	0.5
Zinc (µg/L)	6	5	<3	<3	3	<3
Discharge[3] (cfs)			63400[4]		273000	6700

[1] K indicates a non-ideal count.
[2] Residue, at 1 80°C.
[3] Water years 1990-l 991.
[4] Annual Mean.

Tiekel River near Tiekel, Alaska

Period of Record: 1952-54; 1956; 1972-73; 1975; 1977
(all constituent values are dissolved unless otherwise noted)

Prooertv or constituent	Total samples	# of samples C detection limit	Mean	Median	Max	Min
Total Alkalinity (mg/L as $CaCO_3$)	13	0	34	36	45	21
Calcium (mg/L)	11	0	16	16	19	8.6
Chloride (mg/L)	11	0	2.6	1.8	6.8	0.5
Dissolved Oxygen (mg/L)	4	0	12.2	12.1	13.4	11.3
Fecal Coliform (# colonies/100 ml)	1	0	K7[1]	K7[1]	K7[1]	K7[1]
Fluoride (mg/L)	10	3	0.1	0.1	0.40	co.1
Total Hardness (mg/L)	11	0	44	45	52	24
Iron (µg/L)	1	0	40	40	40	40
Magnesium (mg/L)	11	0	1.1	1.0	1.7	0.6
Manganese (µg/L)	1	0	20	20	20	20
Nitrate (mg/L as N)	11	0	0.9	0.7	1.9	0.3
Orthophosphate (mg/L)	1	1	co.01	<0.01	<0.01	co.01
pH	14	0	7.1	7.0	8.2	6.3
Potassium (mg/L)	9	0	0.4	0.4	1.1	0.1
Total Dissolved Solids (mg/L)[2]	11	0	58	61	74	39
Turbidity (NTU)	3	0	3	1	8	1
Silica (mg/L)	11	0	5.4	5.3	7.8	3.7
Sodium (mg/L)	10	0	1.5	1.7	3.0	1.0
Specific Conductance (µS/cm)	15	0	97	100	133	60
Sulfate (mg/L)	11	0	10	10	14	6.4
Temperature (°C)	11	0	3.6	4.0	9.0	0.0
Instantaneous Discharge[3] (cfs)	3	-			835	E23[3]

[1] K indicates a non-ideal count.
[2] Sum of constituents.
[3] E = Estimate.

Tsina River above Stuart Creek near Tiekel, Alaska

Period of Record: 1970; 1972-73; 1975
(all constituent values are dissolved unless otherwise noted)

Property or constituent	Total samples	# of samples c detection limit	Mean	Median	Max	Min
Total Alkalinity (mg/L as $CaCO_3$)	6	0	50	50	71	27
Calcium (mg/L)	4	0	23	22	29	19
Chloride (mg/L)	4	0	0.8	0.7	1.5	0.4
Copper (µg/L)	1	0	10	10	10	10
Dissolved Oxygen (mg/L)	6	0	12.6	12.6	14.2	11.6
Fecal Coliform (# colonies/100 ml)	1	0	K10[1]	K10[1]	K10[1]	K10[1]
Fluoride (mg/L)	4	1	0.1	0.2	0.2	<0.1
Total Hardness (mg/L)	4	0	61	59	77	51
Iron (µg/L)	3	1	67	20	170	<20
Magnesium (mg/L)	4	0	1.1	1.2	1.2	0.9
Manganese (µg/L)	3	2	10	<10	20	<10
Nitrate (mg/L as N)	4	0	1.5	1.3	2.9	0.6
Orthophosphate (mg/L)	3	2	<0.01	<0.01	0.01	co.01
pH	7	0	7.8	7.6	8.2	6.9
Potassium (mg/L)	4	0	1.0	0.9	1.2	0.8
Total Dissolved Solids (mg/L)[2]	3	0	76.7	68	98	64
Turbidity (NTU)	5	2	19	2	90	<2
Silica (mg/L)	4	0	3.7	3.7	4.3	3.0
Sodium (mg/L)	4	0	1.7	1.6	1.9	1.0
Specific Conductance (µS/cm)	7	0	132	130	170	74
Sulfate (mg/L)	4	0	17	16	24	13
Temperature (°C)	8	0	1.8	1.3	5	0
Instantaneous Discharge[3] (cfs)	3				E3000[3]	32

[1] K indicates a non-ideal count.
[2] Sum of constituents.
[3] E = Estimate.

Tsina River near Valdez, Alaska

Period of Record: 1949; 1951-54; 1956
(all constituent values are dissolved unless otherwise noted)

Property or constituent	Total samples	# of samples <detection limit	Mean	Median	Max	Min
Total Alkalinity (mg/L as $CaCO_3$)	12	0	33	34	53	17
Calcium (mg/L)	11	0	16	16	25	7.3
Chloride (mg/L)	12	0	0.9	0.9	1.8	0.2
Fluoride (mg/L)	8	4	co.1	<0.1	0.2	co.1
Total Hardness (mg/L)	12	0	42	42	63	20
Iron (µg/L)	11	3	29	10	100	<10
Magnesium (mg/L)	11	1	0.9	1.0	2.0	co.1
Manganese (µg/L)	4	4	<0.1	<0.1	<0.1	co.1
Nitrate (mg/L as N)	12	0	0.26	0.14	0.73	0.02
pH	12	0	7.0	7.1	7.9	6.3
Potassium (mg/L)	6	0	1.1	1.0	3.0	0.1
Total Dissolved Solids (mg/L)[1]	11	0	53	56	83	29
Silica (mg/L)	12	0	3.6	3.3	5.0	1.6
Sodium (mg/L)	6	0	1.2	1.1	2.2	0.5
Specific Conductance (µS/cm)	12	0	94	96	139	46
Sulfate (mg/L)	12	0	11	13	16	4.5
Temperature (°C)	7	0	3.6	4.0	5.5	0.0
Instantaneous Discharge’ (cfs)	1[2]					

[1] Sum of constituents.
[2] Discharge was 1930 cfs on June 22, 1949.

Stuart Creek near Tiekel, Alaska

Period of Record: 1951-53; 1956; 1970; 1972-73
(all constituent values are dissolved unless otherwise noted)

Propertv or constituent	Total samples	# of samples C detection limit	Mean	Median	Max	Min
Total Alkalinity (mg/L as $CaCO_3$)	10	0	29	29	41	14
Calcium (mg/L)	9	0	14	13	la	a.3
Chloride (mg/L)	9	2	0.7	1.0	1.8	<0.1
Copper (µg/L)	1	0	10	10	10	10
Dissolved Oxygen (mg/L)	4	0	12.6	12.3	14.1	11.6
Fecal Coliform (# colonies/100 ml)	1	1	<1	<1	cl	<1
Fluoride (mg/L)	7	3	0.1	0.1	0.2	<0.1
Total Hardness (mg/L)	9	0	38	37	49	23
Iron (µg/L)	a	0	29	30	40	10
Magnesium (mg/L)	9	0	0.9	0.8	1.3	0.2
Manganese (µg/L)	4	1	24	15	60	<10
Nitrate (mg/L as N)	a	0	0.3	0.2	1.2	0.2
Orthophosphate (mg/L)	2	2	<0.01	co.01	<0.01	<0.01
pH	10	0	7.1	7.1	a.0	6.2
Potassium (mg/L)	7	0	0.29	0.20	0.60	0.10
Total Dissolved Solids (mg/L)[1]	8	0	49	50	68	29
Silica (mg/L)	a	0	4.4	4.2	7.0	2.2
Sodium (mg/L)	7	0	1.4	1.4	1.9	0.8
Specific Conductance (µS/cm)	10	0	76	a7	107	38
Sulfate (mg/L)	9	0	12	9.9	31	6.1
Temperature (°C)	7	0	2.7	0.0	a.0	0.0
Instantaneous Discharge (cfs)	2	•			416	33

[1] Sum of constituents.

Boulder Creek near Tiekel, Alaska

Period of Record: 1971-73
(all constituent values are dissolved unless otherwise noted)

Property or constituent	Total samples	# of samples <detection limit	Mean	Median	Max	Min
Total Alkalinity (mg/L as $CaCO_3$)	5	0	22	25	27	15
Calcium (mg/L)	4	0	11	12	12	9.4
Chloride (mg/L)	4	0	1.2	1.0	2.5	0.5
Dissolved Oxygen (mg/L)	2	0	12.2	12.2	12.4	12.0
Fecal Coliform (# colonies/100 ml)	1	1	<1	<1	<1	<1
Fluoride (mg/L)	4	1	0.2	0.2	0.3	<0.1
Total Hardness (mg/L)	4	0	30	32	33	26
Iron (µg/L)	3	0	50	30	110	10
Magnesium (mg/L)	4	0	0.8	0.8	0.90	0.60
Manganese (µg/L)	3	2	<10	<10	10	<10
Nitrate (mg/L as N)	3	0	0.05	0.05	0.07	0.02
Orthophosphate (mg/L)	2	2	<0.01	<0.01	<0.01	<0.01
pH	5	0	7.4	7.5	7.7	7.1
Potassium (mg/L)	4	1	0.1	0.1	0.2	<0.1
Total Dissolved Solids (mg/L)[1]	4	0	40	41	44	34
Silica (mg/L)	4	0	3.3	3.6	3.9	2.2
Sodium (mg/L)	4	0	0.9	1.0	1.1	0.40
Specific Conductance (µS/cm)	5	0	59	60	72	42
Sulfate (mg/L)	4	0	7.9	8.0	9.0	6.6
Temperature (°C)	5	0	4.0	5.5	7.0	0.0
Instantaneous Discharge (cfs)	5	-			72	E5.0[2]

[1] Sum of constituents.
[2] E = Estimate.

0' Brien Creek near Chitina, Alaska

Period of Record: 1972; 1982
(all constituent **values** are dissolved unless otherwise noted)

Property or constituent	Total samples	# of samples < detection limit	Mean	Median	Max	Min
Total Alkalinity (mg/L as $CaCO_3$)	2	0	40	40	49	30
Calcium (mg/L)	2	0	17	17	22	12
Chloride (mg/L)	2	0	3.9	3.9	5.6	2.2
Fluoride (mg/L)	2	0	0.3	0.3	0.5	0.1
Total Hardness (mg/L)	2	0	49	49	62	35
Magnesium (mg/L)	2	0	1.4	1.4	1.7	1.1
Manganese (µg/L)	2	0	15	15	20	10
Nitrate (mg/L as N)	1	0	0.09	0.09	0.09	0.09
Orthophosphate (mg/L)	1	1	co.01	<0.01	<0.01	<0.01
pH	3	0	7.5	7.6	7.6	7.3
Potassium (mg/L)	2	0	0.6	0.6	0.6	0.6
Total Dissolved Solids (mg/L)[1]	2	0	65	65	84	46
Silica (mg/L)	2	0	4.2	4.2	5.0	3.3
Sodium (mg/L)	2	0	2.7	2.7	3.8	1.5
Specific Conductance (µS/cm)	5	0	140	115	253	74
Sulfate (mg/L)	2	0	11	11	15	6.3
Temperature (°C)	4	0	4.6	4.8	9.0	0.0
Instantaneous Discharge (cfs)	5				192	5.8

[1] Sum of constituents.