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DEPARTMENT OF NATURAL RESOURCES

DIVISION OF GEOLOGICAL AND GEOPHYSICAL SURVEYS

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Report of Investigations 88-2

USING TURBIDITY TO PREDICT TOTAL SUSPENDED SOLIDS IN MINED STREAMS IN INTERIOR ALASKA

By
Stephen F. Mack

STATE OF ALASKA
Department of Natural Resources
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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USING TURBIDITY TO PREDICT TOTAL SUSPENDED SOLIDS IN MINED STREAMS IN INTERIOR ALASKA

by
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ABSTRACT

Data from mined streams in interior Alaska were used to determine the extent to which data from different locations can be combined to predict total suspended solids (TSS) from turbidity measurements. Data were transformed into logarithms with log TSS regressed on log turbidity using linear regression. Coefficients of determination (r^2) for equations derived from measurements in seven basins, 15 streams and 18 sites ranged from 0.261 to 0.996 with standard errors of estimate (SEE) ranging from +155 percent (-61 percent) to +14 (-13 percent). Covariance analysis indicated relationships between TSS and turbidity data collected from different basins to be statistically different; turbidity-TSS relationships of data from different streams within a basin may also differ, and relationships of data from different sites within a stream may differ. Also, data collected in separate years may have statistically different relationships. Model validation confirmed the uncertainty of using previous years' data. At one site, multiple regression with turbidity and average velocity used as predictors for TSS improved the r^2 from 0.20 of a simple turbidity-TSS model to 0.68 and reduced SEE from +98 percent (-49 percent) to +49 percent (-33 percent).

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INTRODUCTION

This report presents the results of an investigation of the statistical relationship between turbidity and total suspended solids (TSS) in free-flowing, placer-mined streams in interior Alaska. Because of high levels of sediment discharge, increasing scrutiny is being directed at the placer mining industry. To determine the impact of discharged sediment, samples

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from mined streams are collected and analyzed, both for turbidity and for TSS. The turbidity parameter is easier, less time consuming, and less expensive to measure. If a good statistical relationship between turbidity and TSS can be established, turbidity analysis would serve for most purposes. A good statistical relationship is defined as one which has an acceptable coefficient of determination (r^2) and standard error of estimate.

Several government agencies and consulting firms have collected a considerable amount of paired turbidity and TSS data from placer-mined streams in interior Alaska during the past 3 yr. I have organized these observations on a basin-stream-site basis and applied statistical techniques to determine the feasibility of predicting TSS from turbidity, using existing data.

BACKGROUND

Placer mining entails locating free gold in alluvial (placer) deposits near bedrock, uncovering the gold-bearing layer (stripping), and separating gold from sand and gravels (sluicing). Stripping and sluicing, as practiced in Alaska, often results in the discharge of noticeable amounts of sediment into many bodies of water that otherwise would be virtually sediment free. This is contrary to state and federal laws by which the placer mining industry is more and more being governed.

Two parameters by which the impact of placer mining on water bodies is measured are turbidity (which relates to the muddiness or cloudiness of the water), and TSS (which describes the physical amount of sediment in the water column).

Turbidity is defined by APHA (1985) as 'the expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample.' Such scattering and absorption is caused by particles--clays or silts, algae, organic detritus, and other fine insoluble sediments--suspended in the water (Hach and others, 1984). In Alaska, turbidity is measured by turbidimeter, in nephelometric turbidity units (NTU). Nephelometry is the measurement of light scattered at right angles to the incident light beam passing through a sample (Hach and others, 1984). The deleterious effects of turbidity include, but are not limited to, aesthetic and functional impairment of recreational use, impaired productivity and adverse impacts on the food chain because of reduced light penetration, avoidance by fish populations, and impaired treatment of drinking water (Peterson and others, 1985).

Turbidity measurement requires a properly calibrated turbidimeter and appropriate glassware. Portable turbidimeters are available which can accurately measure turbidity in the field. Nephelometric turbidimeters can measure values to 100 NTUs; however, the standard method requires dilutions to below 40 NTU (APHA, 1985). Placer-mined streams are often above 100 NTU and may require several dilutions.

TSS is defined by APHA (1985) as 'the portion of total solids retained by a glass-fiber filter.' TSS is reported in concentrations (usually milligrams per liter) and represents the mass of non-dissolved solids contained in the water column. TSS is not to be confused with settleable solids, which is the volumetric quantity of solids that will settle in an Imhoff cone in 1 hr (APHA, 1985) and are reported in milliliters per liter. This project did not investigate any relationship between turbidity and settleable solids.

Recent research connects high TSS concentrations to biota damage, including impacts on fish at various life stages and impacts on invertebrates (Peterson and others, 1985). TSS, combined with discharge, gives an estimate of sediment load, which is the total amount of sediment carried by a stream.

TSS measurement requires ovens, analytical balances, and glassware for filtering samples, and is not practical outside a properly equipped laboratory. TSS analysis requires more time than turbidity measurements. Samples must be filtered (which can take hours with silt-laden samples) and dried in an oven. Turbidity measurements can be done in the field and require only time for the turbidimeter readout to stabilize and, for highly turbid samples, time for dilutions.

Extensive literature exists on the relationship of turbidity to TSS. Measurement of turbidity was developed as an index of suspended material concentrations, but it has been long recognized that no single, universal relationship is applicable (Lloyd, 1985); turbidity is an optical measurement of reflected light, whereas TSS is measured by the actual mass of particles retained on filter paper. Investigators have found that particles with very little mass can cause turbidity; in fact, much of the variation in turbidity is attributed to particles 10 microns or smaller (Nichols, 1986). Samples with identical TSS measurements but differing particle sizes can have very different turbidity measurements. Conversely, of two samples with similar turbidity measurements, the sample with coarser material can measure substantially higher in TSS (Nichols, 1986). Particle size may vary less in streams affected by placer mining because of effluent treatment, which is usually in the form of settling ponds. Settling ponds do a poor job of removing particles smaller than 25 microns (Dames and Moore, 1986), and because finer particles are also most responsible for turbidity, placer-mined streams may exhibit less variability from differences in particle size.

A consideration of the sources of error in turbidity and TSS measurements is necessary for developing a relationship between turbidity and TSS. Nichols (1986) identified four sources of error: (1) error in sample collection; (2) subsample error; (3) error in turbidity analyses; and (4) error in TSS analyses.

The first source, 'error in sample collection,' refers to whether the sample collected is representative of the whole stream cross section; this category is not applicable to the project reported here. Development of regression equations require only that TSS and turbidity samples be taken at the same time and at the same location, regardless of whether samples are representative of an entire cross section.

The second source, 'subsample error,' however, is important to the project reported here. TSS and turbidity samples are commonly collected in bottles with a capacity in excess of what is needed for analysis, and subsamples are then taken from these bottles for the actual analysis. The subsample error factor becomes most critical when samples contain coarse particles, because these start settling immediately after a thorough shaking, and the subsample may not contain a representative proportion of the coarser particles.

The third source, 'error in turbidity analyses,' has received the most attention. Pickering (1976) recommended that the U.S. Geological Survey stop reporting turbidity because of measurement error. Nichols (1986) extensively studied this type of error. In the past, turbidity was measured by various methods which reported in similar, but not identical, units. Nephelometry is now the standard method and is used in Alaska for measuring turbidity in placer-mined streams. Although nephelometry is the only method used, several brands--and models within brands--of nephelometric turbidimeters are used, and there is concern that these instruments do not report identical results. Nichols (1986) tested three turbidimeters on replicate samples from a placer-mined stream and found the results varied from 6 to 20 percent between instruments. For each set of replicates, the coefficients of variation for the instruments ranged from 1 to 15 percent. Rounding data according to standard methods (APHA, 1985) may help reduce error due to variation in turbidimeter brand or model (Peterson and others, 1985).

The fourth source, 'error in TSS analyses,' appears to be attributable mainly to subsample error (Nichols 1986). Paralleling turbidity variability trials cited above, Nichols also tested TSS variability of replicate samples and found higher coefficients of variation for TSS replicates (10 to 33 percent) than for turbidity (2 to 10 percent) between corresponding replicate sets.

In spite of problems in relating TSS to turbidity, numerous attempts have been and continue to be made to relate the two parameters. Lloyd (1985), Peterson and others (1985), and Nichols (1986) have summarized the attempts of others, and Lloyd and Nichols have added their own equations. It is apparent from viewing the equations and their graphical representations that no one equation best describes the TSS-turbidity relationship (Peterson and others, 1985). Nichols found a statistical rationale for the common practice of using a logarithmic transformation of the data and commented that although all authors report the coefficient of determination (r^2), few give an estimate of the equation error. Both Nichols (1986) and Peterson and others (1985) caution that although turbidity-TSS equations can be useful, the error associated with the correlation must be known. Scatterplots of the data must be analyzed to determine if data are clustered into discrete groups, and the relationship should be periodically updated. The regression model must consider drainage, season, and discharge and is best based on data from similar sources, such as glacial streams or placer-mined streams (Peterson and others, 1985).

Nichols (1986) tested these recommendations on a placer-mined stream near Fairbanks. Collecting samples above mining, directly below sluicing, and below settling ponds, he found the data clustered in distinct groups. Regression equations for the clusters predicted TSS with average errors of 25 to 30 percent, a result which compares well with those of other investigators. The error associated with predicting individual TSS concentrations from turbidity was much higher---600 to 1,700 percent.

The investigation reported here follows the work of Lloyd, Peterson and others, and Nichols. A quantity of data exists, collected by several investigators from several sites in interior Alaska, and, although the experience of other investigators indicates that equations from different areas differ statistically, it was hypothesized that because placer mining is essentially similar throughout interior Alaska, equations predicting TSS from turbidity might be similar enough to formulate one equation for the entire area or for the area within a single basin. By organizing data on a geographic basis, using the computer to generate site, stream and basin-specific equations, and applying appropriate statistical techniques, one might determine to what extent historical data can be used and whether the concept of one predictive equation has merit.

In natural streams with no large point source of sediment such as placer mining, a positive relationship exists between sediment concentration and discharge or velocity (Leopold and Maddock, 1953). In streams affected by placer mining, the point source input from sluicing operations overwhelms this balance to the extent that dilution from extreme events may result in a negative relationship. However, in such streams, sediment settles from the water column onto stream bottom during low flows and resuspends during high flows, which affects the turbidity-TSS relationship. All other things being equal, particle size distributions in the water column will vary with flow, and coarser particles will be suspended at higher velocities. Because turbidity-TSS relationship is affected by changes in particle size distributions within the water column, variation in particle size distributions over a wide range of flows may introduce considerable error into a simple regression which uses turbidity as the predictor variable. To investigate this, I constructed a multiple regression model using turbidity and velocity variables to predict TSS.

Discharge data containing information needed to estimate velocity were available for many observations from the Crooked Creek basin, but investigators have not routinely measured discharge during water quality sampling, so multiple regression could not be applied to the entire database. Velocity was used as a variable in order to combine observations from different sites and construct a basin model.

METHODS

Sources of Data

Eight data sources were used in the development of the project database:

1. Alaska Division of Geological and Geophysical Surveys (DGGS) placer mining research program (Mack and Moorman 1986);

2. United States Environmental Protection Agency (EPA) STORET database (USEPA 1985);

3. Alaska Department of Environmental Conservation (DEC), Environmental Quality Monitoring and Laboratory Operations data from 1983-85 (ADEC 1984, ADEC 1985, Hock 1986);

4. Alaska Department of Fish and Game (ADF&G), Habitat Division miscellaneous data from 1983-5 (Weber 1985);

5. 'Fairbanks Area Ambient Water Quality Study, Placer Related Basins, 1984,' (draft), Jerry Hilgert, Institute of Northern Forestry (INF), USDA;

6. 'Placer Mining Wastewater Settling Pond Demonstration Project Report,' R&M Consultants, Inc., 1982;

7. 'Placer Mining Wastewater Treatment Technology Project,' Phase 2 Report, Shannon & Wilson, Inc., 1985; and

8. data collected by the Alaska Cooperative Fishery Research Unit (ACFRU) investigators for several projects during 1982-83 (Wagener 1984).

The total database of over 1,100 observations does not contain all available data. Data collected directly below a sluice or pond outlet was not included, because particle size distributions affect the turbidity-TSS relationship as larger particles settle out in settling ponds and in the stream channel. By avoiding data so directly affected by mining, the effect of particle size distributions was minimized. No data from R&M Consultants (1982) were used, and other data sources---particularly Shannon and Wilson (1985)---were scrutinized to make certain that only data from sites 500 ft or farther from mining operation outlets were included in the database.

The EPA STORET database contains sample replication where, in some instances, an investigator collected multiple samples within a short time span. Because of concern that replicates might bias the results toward the replicated samples, only data from the first sample was included when samples were taken less than 30 min apart by the same investigator at the same site. Even with this restriction, the database is not temporally homogeneous. Much of the data came from intensive, short studies at sites where, for example, samples might be collected on a 3-hr basis for 3 days. Because of the diurnal change in turbidity and TSS below a mining operation due to starting and stopping of work, a range of values will be included; but it must be assumed that the relationship present for this short time did not vary throughout the operating season. These types of data are mixed with observations taken on a daily or weekly basis, or miscellaneous samples that were not part of a systematic monitoring program.

Paired turbidity-TSS data not determined from weighing a dried filter were not used in development of the equations. TSS data reported by Wagener (1984) were calculated from total solids, using a conversion developed from conductivity. Although this is a standard method, I felt that inclusion of these data might introduce additional error to the equations. Wagener's data were used later to check the predictive value of the equations.

Considerable scatter can exist in the reported data at lower levels of turbidity and TSS. Figure 1, a plot of turbidity and TSS from Eagle Creek above and below mining, is a vivid demonstration. It shows well the clustering described by Nichols (1986). When these data are combined, the sample coefficient of determination (r^2) value (0.952) is high; however, a correlation based only on data from sites above mining operations results in a poor r^2 value (0.031). A correlation analysis based on data from sites downstream from mining operations results in a poorer r^2 (0.837) than the combined data, but the equation is more descriptive of the turbidity-TSS relationship within placer-mining areas, and the equation error is less. In this instance, the standard error of estimate (SEE) for combined data is 0.412 (+158, -61 percent), and for data from sites below mining activity SEE = 0.115 (+30,-23 percent).

A problem arose in using data from different sources, because of differing TSS reporting procedures among laboratories. Various labs reported low TSS values to within one to three significant figures; thus, for different labs, 1 could be equivalent to 0.6 or 1.4, which, in turn, could be equivalent to 0.56 or 1.44. This was further complicated by varied lower detection or reporting limits. Detection limits for data used in this study ranged from 0.01 mg/L to 4 mg/L. Because 4 mg/L is a high detection limit for clear streams, considerable scatter can be introduced when paired with turbidity data reported to the nearest hundredth, down to 0.01 NTU. Less variability was noticed in the reporting procedures for turbidity. These reporting problems may not greatly affect the sample coefficient of determination, but may affect the equation error.

Because of the reporting and clustering problems with lower value observations, the database used for regression analyses included only those observations with turbidity greater than 5 NTUs. Although admittedly arbitrary for the purposes of this project, 5 NTUs is a justifiable limit, because it is the background turbidity drinking water supply standard for the State of Alaska (ADEC, 1979). Deletion of observations with turbidity less than 5 NTUs reduced the database to 885 observations.

Geographical Organization

Investigations were conducted mainly in placer-mining areas accessible by road, near Fairbanks and along the Steese, Elliot, and Dalton Highways. Streams in these areas eventually drain into the Yukon River via the Tanana and Koyukuk Rivers and Birch Creek. Major drainage basins used in the study are described in the draft U.S. Geological Survey Hydrological Unit Map of Alaska (USGS, 1985); smaller basins were delineated where data were available. Seven basins were selected: Birch Creek, Crooked Creek, Chena River, Chatanika River, Goldstream Creek, Upper Tolovana River, and Koyukuk River (fig. 2). Analysis was broken down further to creeks and rivers within the basins, and to sites on those creeks.

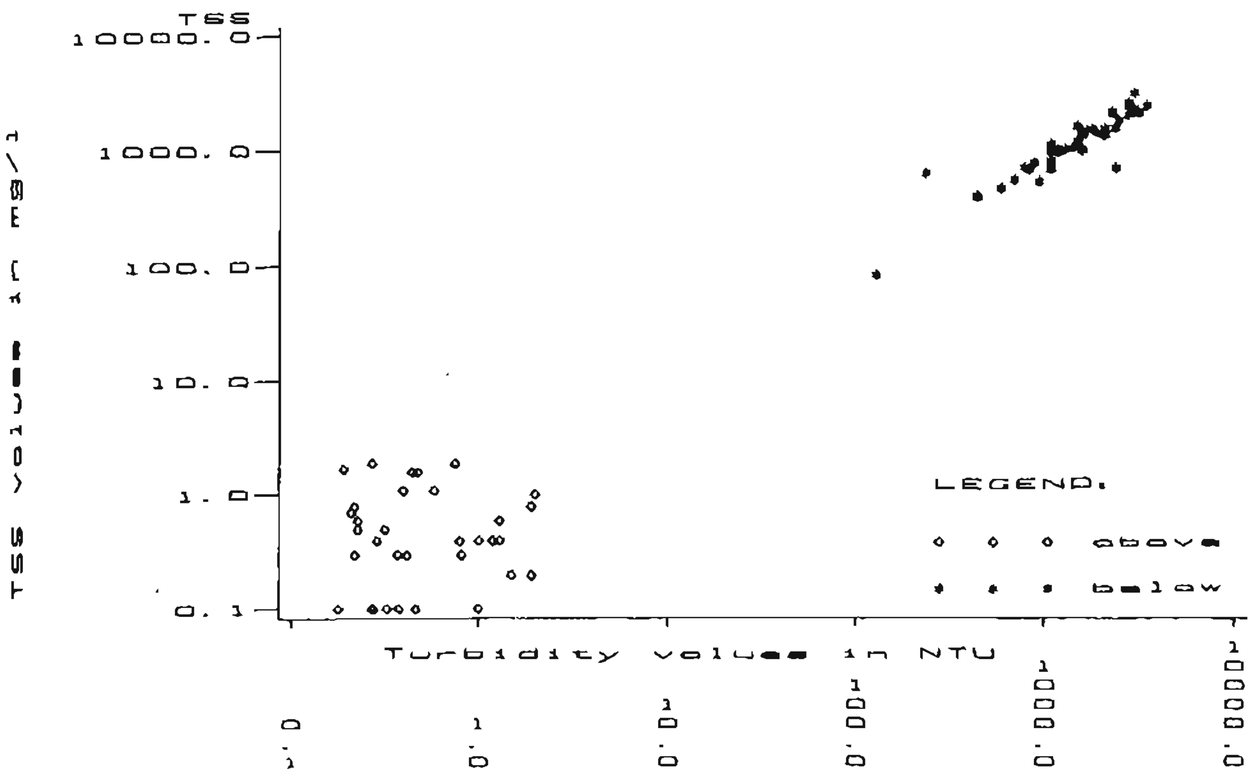

Figure 1. Plot of turbidity and TSS above and below mining, Eagle Creek in Birch Creek basin.

Statistical Methods

Statistical methods employed for this project included logarithmic transformation of data, simple and multiple linear regression, coefficient of determination, standard error of estimate, and analysis of covariance models. Turbidity and TSS values were transformed to logarithms for regression analyses. The wide range of values displayed well on a logarithmic scale, and an initial plot of the data on linear scale showed a power curve that appeared straight on a logarithmic scale. Nichols (1986) investigated the rationale behind logarithmic transformation of data in the development of turbidity-TSS relationships, and his residual analysis indicated that a logarithmic transformation of both turbidity and TSS best fit the data.

Linear regression uses the relation between two or more variables to predict one from the other(s) (Neter, Wasserman, and Kutner, 1985). A simple linear regression model is expressed in the equation $y = a + b(x)$, where x is the predictor variable (in this case, turbidity), y is the response variable (TSS), b is the slope of the line, and a is the y axis intercept. Because the analyses were performed on log transformed data, the regression equations

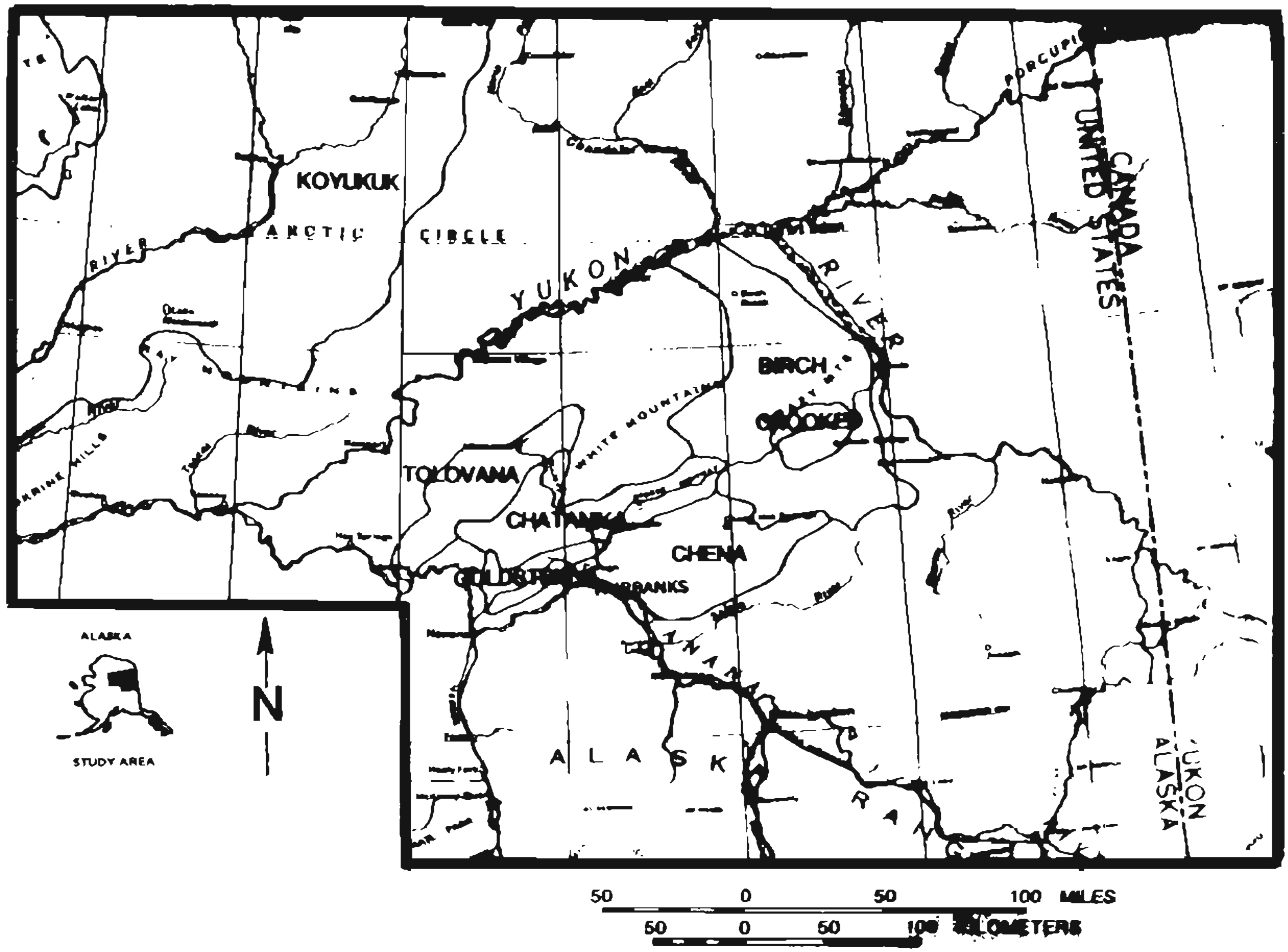

Figure 2. Interior Alaska Basins with placer mining data.

can be expressed as power functions in the form of $\underline{y} = \underline{a}*(\underline{x}^b)$, where the terms are defined as above.

The coefficient of determination (r^2) and standard error of estimate (SEE) indicate how well the regression equation fits; r^2 can be interpreted as the proportionate reduction of variation in the response variable associated with the predictor variable. It always lies between 0 and 1; the closer to 1, the greater the linear association between the two variables (Neter, Wasserman, and Kutner, 1985).

The r^2 indicates how well two variables are linearly associated but does not show how much error would be involved if the model were used for predictive purposes. Since the predictive value of the turbidity-TSS relationship is of primary importance to this project, error analysis is crucial. Standard error of estimate (SEE) is one way of reporting error. SEE, the positive square root of the regression model mean square error, is an estimator of regression model standard deviation (Neter, Wasserman, and Kutner, 1985). For this project, SEE, reported in percent, was used as an estimator of standard deviation for the predicted TSS for any turbidity value. Appendix B describes calculation method and contains sample calculations.

In order to determine to what extent data from different areas can be combined to develop useful predictive equations, it was first necessary to determine whether the predictive regression equations for different groups of data (for example, data from different basins) were similar at a specified confidence level. To determine the similarity of data from different groups, a covariance model was developed by adding qualitative indicator variables for each data group, and tested to determine if indicator variables improve the model. The assumption was that if indicator variables do not improve the model, they are not needed, and the data can be combined to develop one equation. Covariance analysis assumes (1) independence of observations, (2) normality of residuals, and (3) common variability of the points around the individual regression lines. Data used for this project were independent observations. The latter two assumptions were not studied but were assumed to hold. Appendix B contains a more detailed description of covariance analysis.

The calculations were performed on the University of Alaska-Fairbanks VAX computer using the GLM (general linear model) procedure of the SAS statistical package (SAS, 1985a,b). Both turbidity and TSS were transformed into base-10 logarithms, and all analyses were performed on transformed data. All pairs had site, stream, basin, collection date, and source descriptors to enable analysis on any of these. Geographical descriptors were based on the USGS hydrologic unit map and hierarchical in nature, which allowed analysis of subbasins or streams within larger basins.

Model Validation

Following the statistical practice of Neter, Wasserman, and Kutner (1985) to measure the predictive value of a model with data not used in the model development, paired data from placer-mined streams in interior Alaska which had not been included in the principal database were used to measure the predictive ability of the equations. DEC fiscal year 1986 placer-mining data from the 1985 summer (DEC, 1986) and Alaska Cooperative Fishery Research Unit data from the 1983 summer (Wagener, 1984) were used. TSS was estimated from turbidity values reported by those researchers, by using the most appropriate regression equation indicated from analysis of covariance. Results were compared with reported TSS, and a Z score was calculated by dividing the difference between the reported and predicted TSS by the regression equation SEE. The Z score gives a relative measure of how close, in multiples of SEE, the predicted value is to the reported value. A negative Z score means the model overpredicted.

Velocity-turbidity Multiple Regression Model

Velocity estimates were available for 76 paired turbidity-TSS observations from the Crooked Creek basin, including 16 observations on Crooked Creek at Central. These estimates were developed from staff gage readings by using velocity rating curves. Multiple regression models and accompanying statistics were developed using the GLM procedure of the SAS statistical package (SAS, 1985b).

RESULTS

Summary Statistics

The complete database used for this project contains 1,100 observations from approximately 140 sites in seven basins: Birch Creek (excluding Crooked Creek), Crooked Creek, Chena River, Chatanika River, Goldstream Creek, Upper Tolovana River, and Koyukuk River (app. A).

Regression equations used only those observations where turbidity was greater than 5 NTU. Of these 885 observations, 552 observations (62 percent) came from 18 individual sites which had 15 or more observations, and 766 observations (87 percent) came from 15 streams with 15 or more observations. Summary statistics for these sites and streams are presented in table 1. On 7 of the 15 streeams (Eagle, Gold Dust, Deadwood, Ketchem, Mammoth, Gilmore, and Goldstream Creeks), 70 percent of the observations came from one of the 18 individual sites (above), and on 4 (Crooked and Fish Creeks, and Chatanika and Tolovana Rivers) over 70 percent came from 2 or 3 sites with 15 or more observations. Even though the observations came from a large geographic area, most data came from relatively few sites on a few streams. Investigators from other agencies and consulting firms also use these road-accessible sites.

The Koyukuk River basin was an exception---probably because of its distance from Fairbanks. No stream in this basin had even 10 observations. Existing data were mainly from sites along the Dalton Highway.

Figures 3 through 10 present plots of paired observations grouped according to stream or site location. None of the stream data exhibit the definite cluster pattern demonstrated by figure 1, but the site data do show a more clustered pattern. Figure 9 points up the problem with using data from different sources. The data from Fish Creek below Lucky 7 were

Table 1. Summary statistics for streams and sites with 15 or more observations.

Location		Turbidity (in NTUs)				Total suspended solids (mg/L)			
	N[a]	Mean	SD[b]	Max	Min	Mean	SD[b]	Max	Min
A. Birch Creek Basin									
1. Lower Birch Cr	44	39.2	46.6	240	6.4	75.1	138	770	12.7
a. Birch ab Crooked Cr	16	15.08	9.48	32	6.4	71.6	187	770	14.8
2. Eagle Cr	47	1770	1150	7000	130	1450	1440	10000	85
a. Eagle b GHD	46	1654	860	3500	130	1312	695	3190	85
3. Gold Dust Cr	18	1590	1220	5000	100	1180	947	3040	52
a. Gold Dust b GDM	18	1590	1220	5000	100	1180	947	3040	52
4. Upper Birch Cr	16	739	542	2100	270	872	688	2640	244
B. Crooked Creek Basin									
1. Crooked Cr	96	459	412	1900	33	392	361	1530	37
a. Crooked Cr at Central	38	663	482	1900	33	564	417	1532	37
b. Crooked Cr ab mouth	19	134	68.1	310	60	110	55.9	250	55.2
2. Deadwood Cr	36	875	991	3500	45	1540	1540	5980	23
a. Deadwood Cr at CHSR	32	866	995	3500	45	1559	1569	5980	23
3. Ketchem Cr	22	1640	1700	5100	110	2600	3200	9300	97.6
a. Ketchem Cr at CHSR	20	1737	1750	5100	210	2800	3290	9300	97.6
4. Mammoth Cr	32	383	324	1300	16	493	457	1810	88
a. Mammoth Cr at Steese	27	380	286	1200	50	496	459	1810	88
5. Porcupine Cr	34	167	162	750	23	186	270	1470	16.5

[a] Number of observations.
[b] Standard deviation.

Table 1. Continued.

Location	N[a]	Turbidity (in NTUs) Mean	SD[b]	Max	Min	Total suspended solids (mg/L) Mean	SD[b]	Max	Min
C. Chena River Basin									
1. Fish Cr	67	214	225	1100	6.9	192	225	950	15
a. Fish Cr b Gold Dredge	22	16.5	7.18	36	6.9	51	78.4	396	15
b. Fish Cr b Lucky 7	43	623	212	1100	45	271	242	950	20
D. Chatanika River Basin									
1. Chatanika R	151	40.2	51	310	5.1	52.2	82.2	500	2
a. Chatanika R at 39 mile	15	12.7	14.9	65	5.1	10.5	10.2	32	2
b. Chatanika R at Long Cr	53	21.4	20	95	6.2	20	22.8	100	3
c. Chatanika R b Faith Cr	56	74.6	68.1	310	6.2	102	113	500	6
2. Faith Cr	27	215	498	2600	6.7	233	375	1890	14
a. Faith Cr at Steese	17	75.1	43.1	140	14	120	112	416	14
E. Goldstream Creek Basin									
1. Goldstream Cr	50	269	123	800	30	323	241	1400	30
a. Goldstream Cr b Fox	36	284	105	800	65	335	239	1400	140
2. Gilmore Cr	50	1650	1100	5300	60	479	271	1300	20
a. Gilmore Cr b BD Mining	44	1810	1070	5300	280	506	273	1300	20
F. Tolovana River Basin									
1. Tolovana R	76	20.8	23.8	180	5.4	61.6	176	1400	7.2
a. Tolovana R at TAPS	30	18.1	10.1	40	6.1	39.1	43.6	238	11
b. Tolovana R ab West Fork	36	18	9.16	38	5.4	33.9	19.2	83	13

collected by a consulting firm (R&M) for a summer-long project and reflect a variety of seasonal conditions. The data from Fish Creek below Gold Dredge were collected by EPA researchers during a 3-day span and have a much tighter cluster pattern.

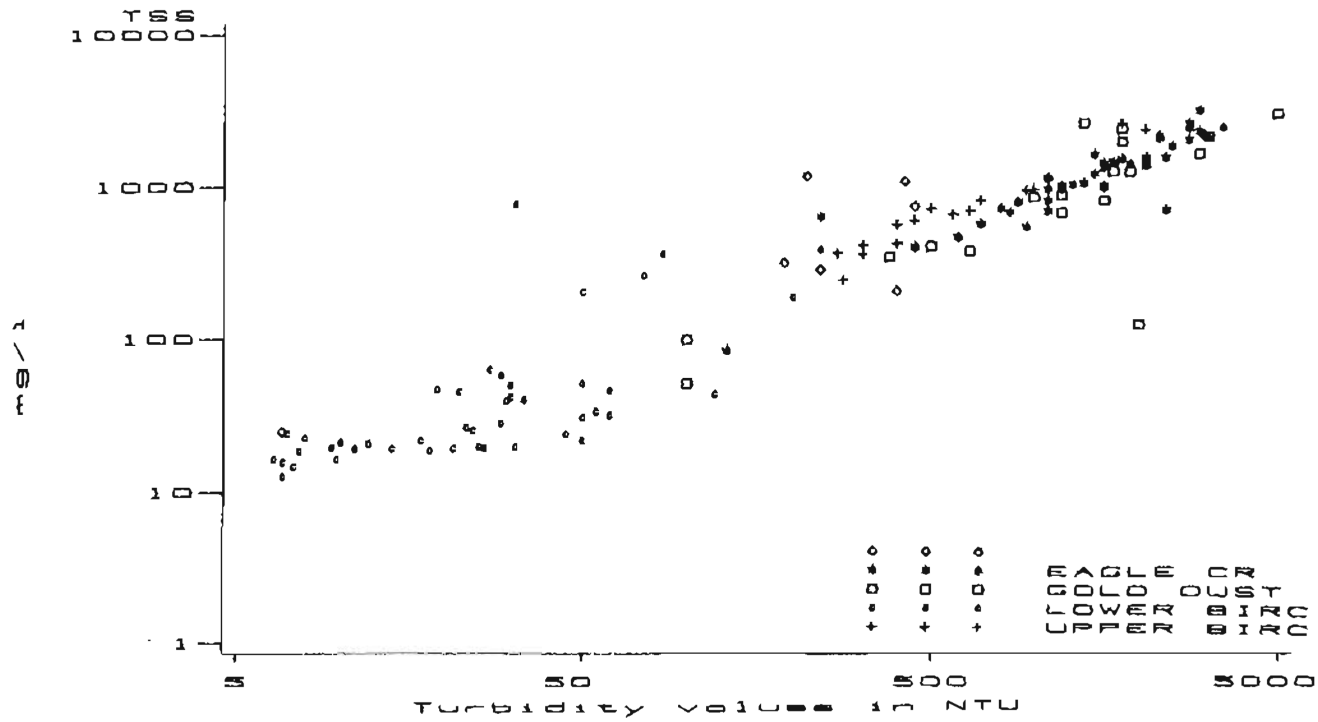

Figure 3. Plot of turbidity and TSS for streams in Birch Creek Basin.

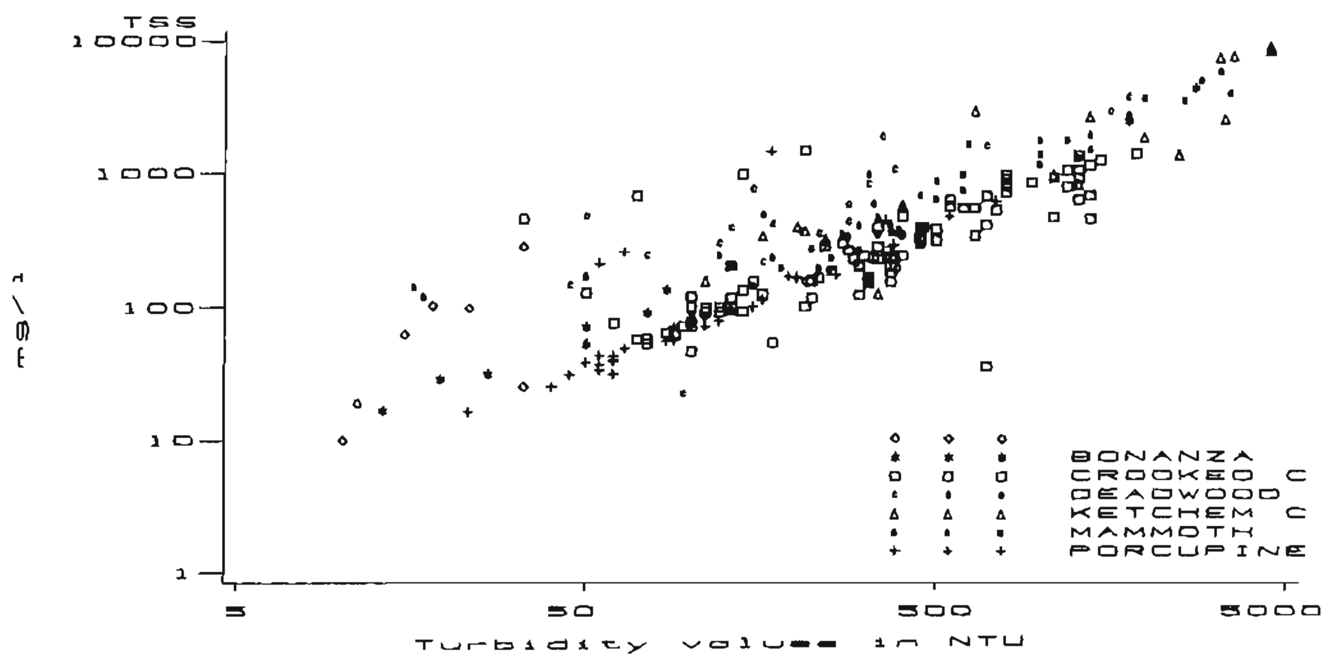

Figure 4. Plot of turbidity and TSS for streams in Crooked Creek basin.

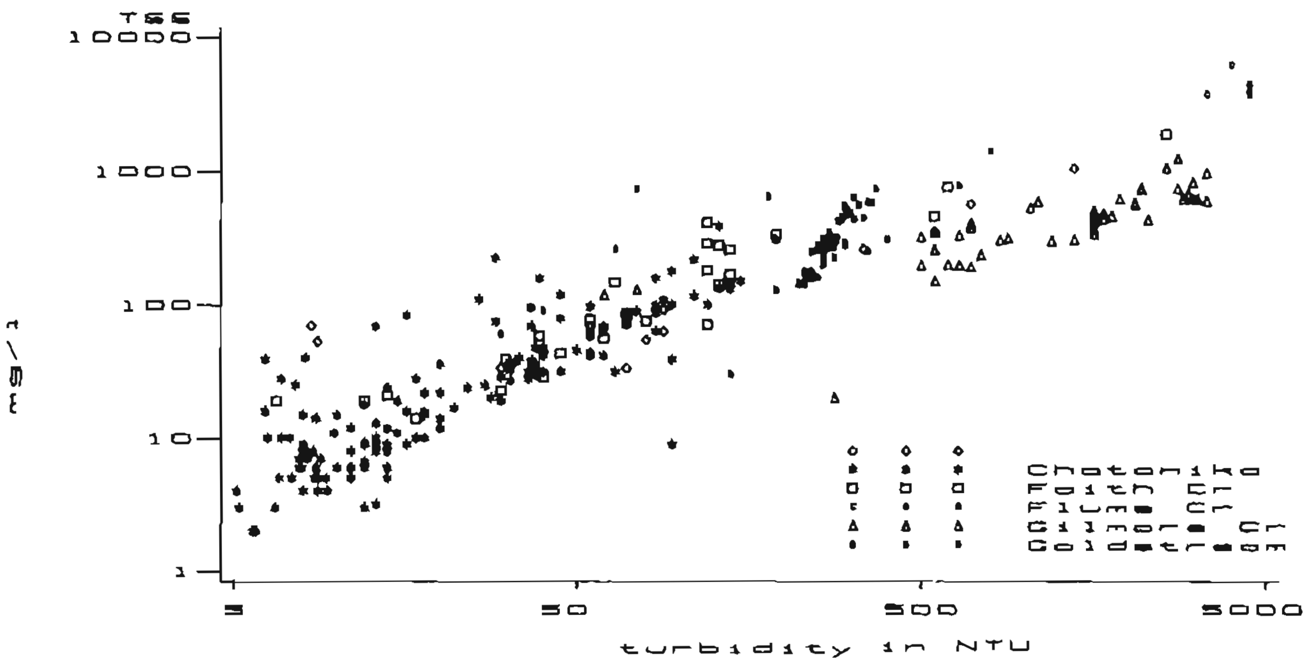

Figure 5. Plot of turbidity and TSS for streams in the Chatanika and Goldstream basins.

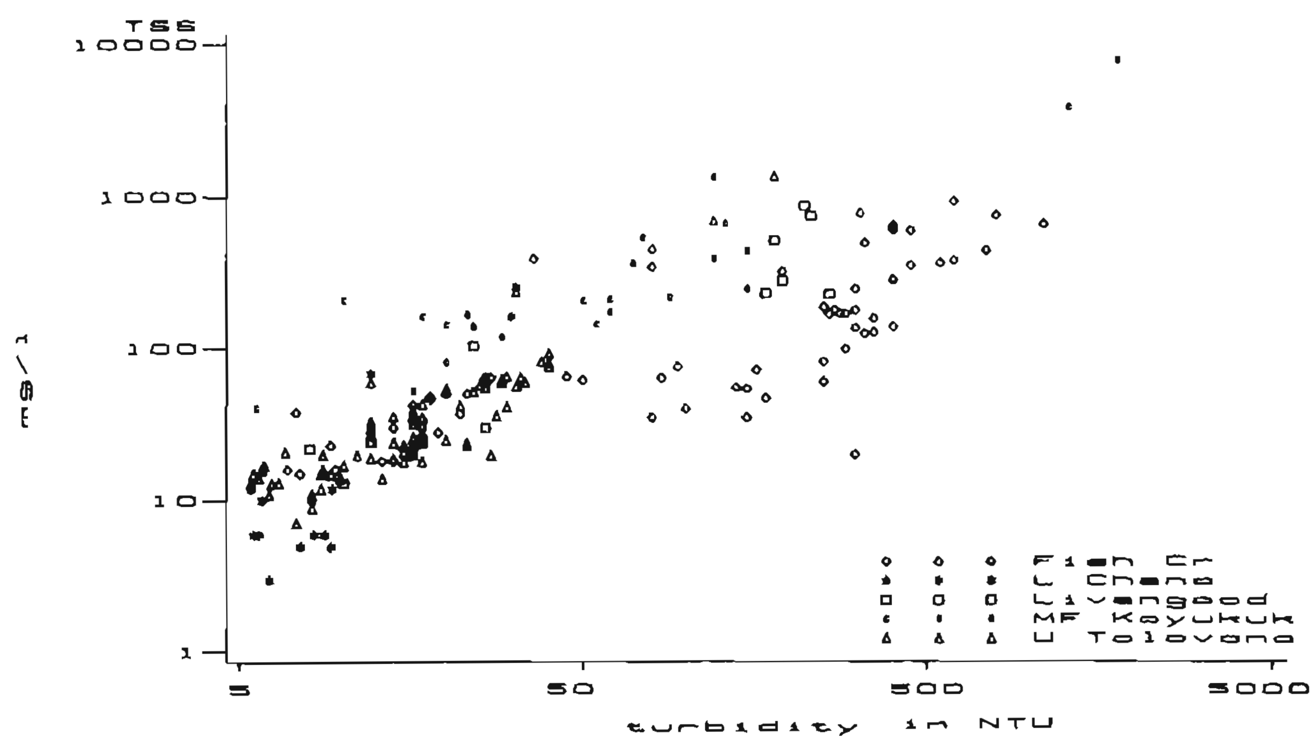

Figure 6. Plot of turbidity and TSS for streams in the Upper Tolovana, Chena and Koyukuk basins.

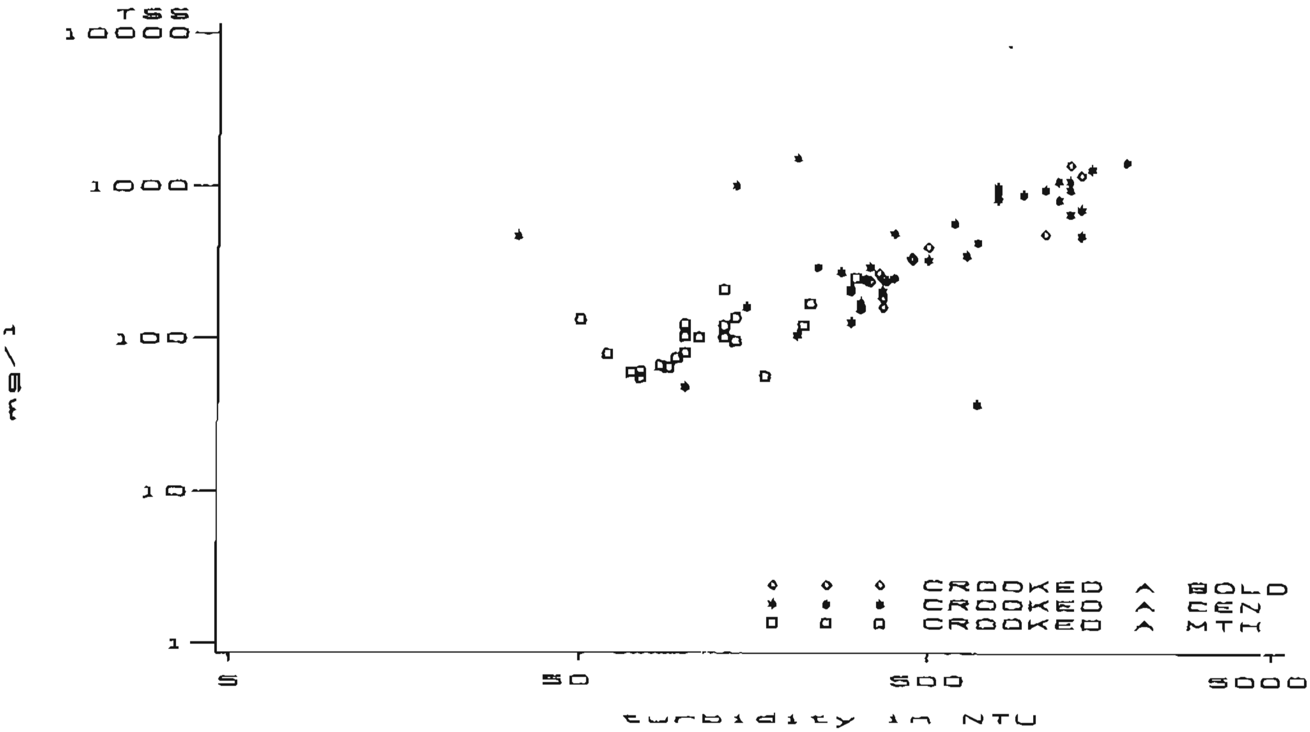

Figure 7. Plot of turbidity and TSS for sites on Crooked Creek.

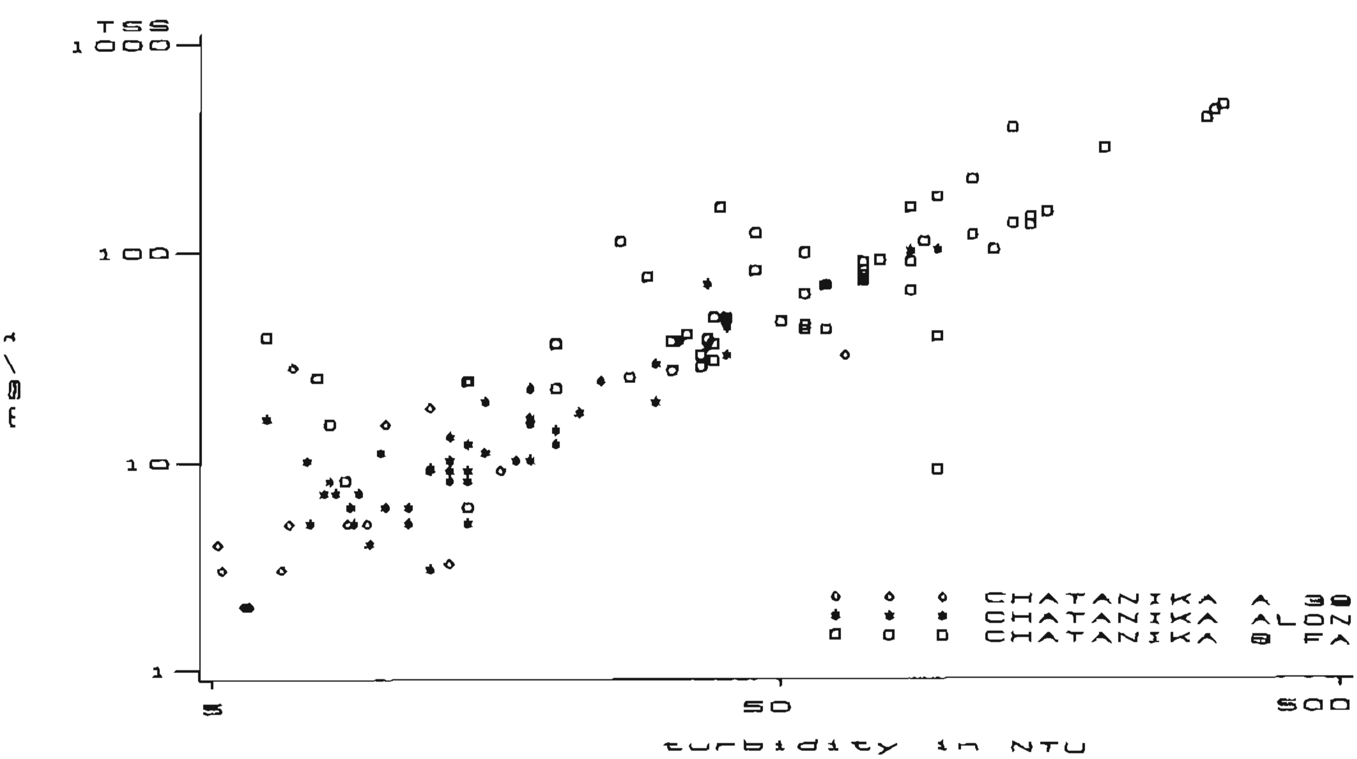

Figure 8. Plot of turbidity and TSS for sites on Chatanika River.

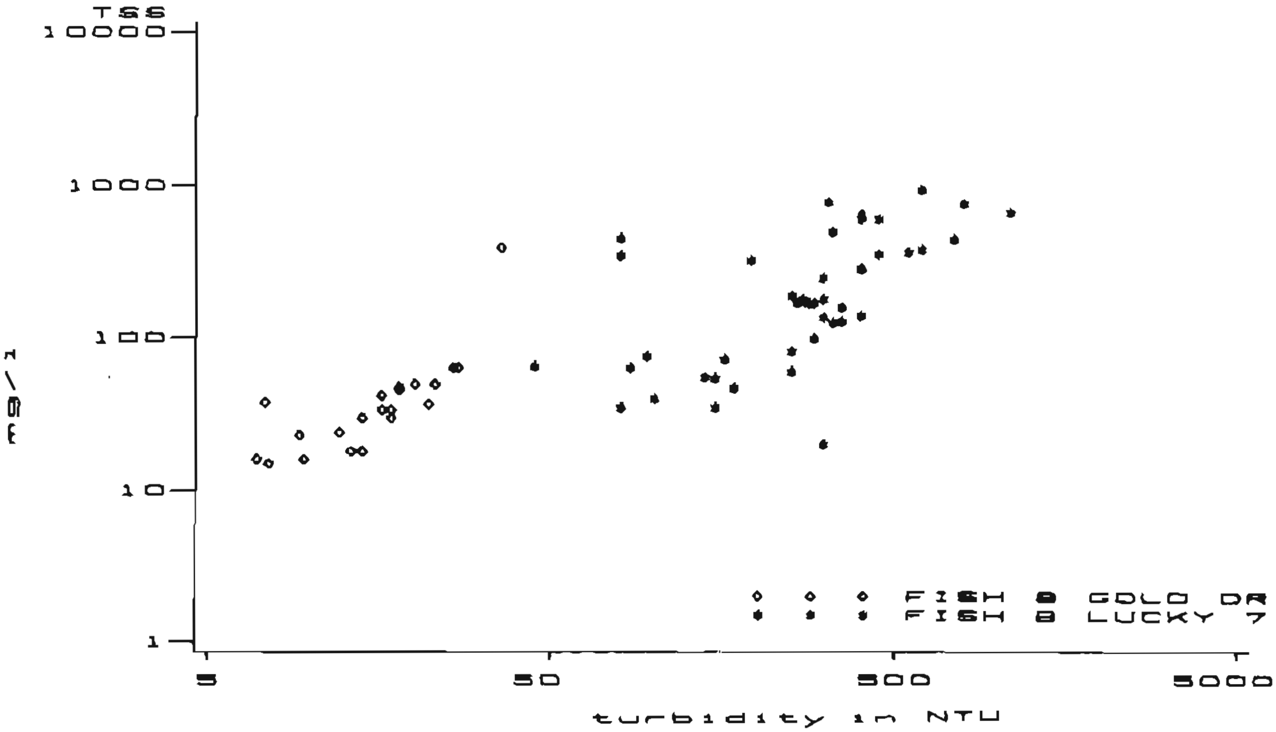

Figure 9. Plot of turbidity and TSS for sites on Fish Creek.

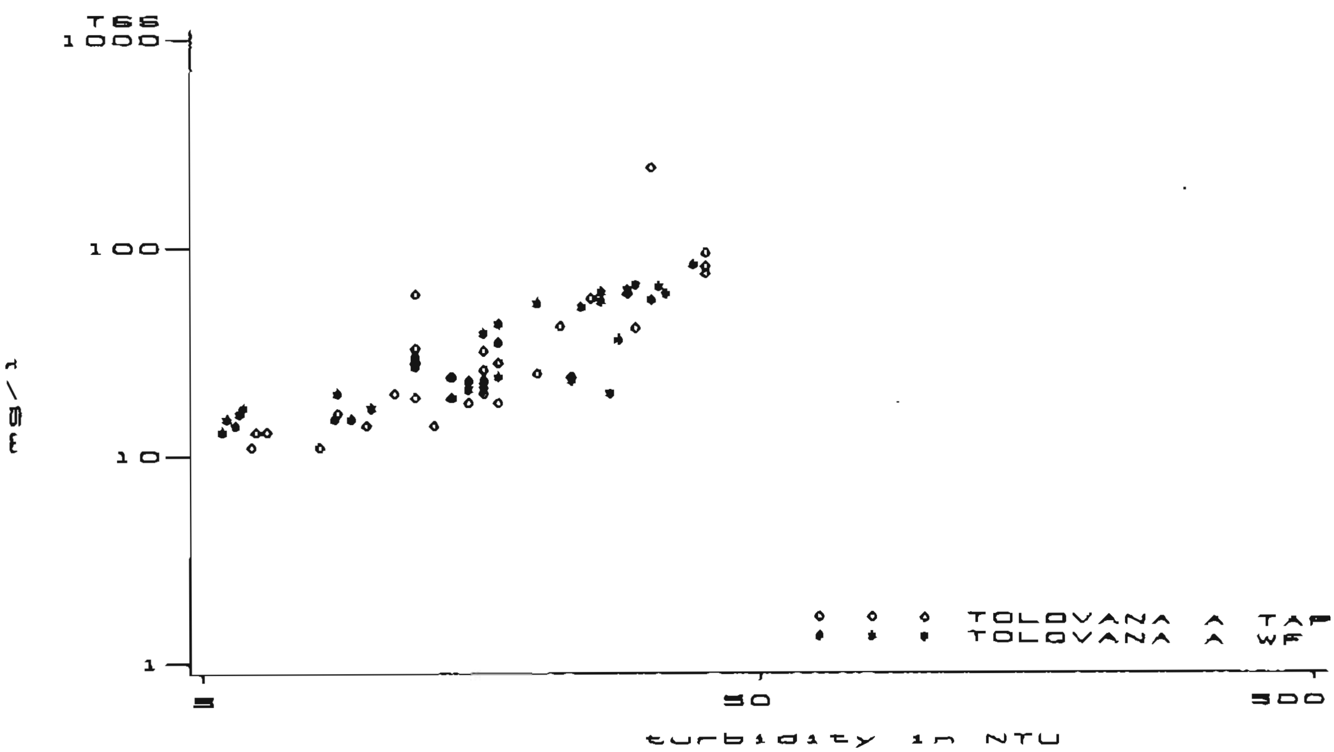

Figure 10. Plot of turbidity and TSS for sites on Tolovana River.

Regression Equations

Table 2 presents regression equation coefficients with descriptive parameters for all sites and streams with 15 or more observations, for the seven basins, and for the combined interior Alaska database along with the results of the analysis of covariance.

Table 2. Summary of regression equations and covariance analysis for basins, streams, and sites in interior Alaska.

[Equations in the form $y = a*(x^b)$, where y = TSS, x = turbidity, a = y axis intercept, and b = slope. N = number of observations.]

Location	N	a	b	r^2	+SEE(%)	-SEE(%)	F*<F?[1]
Interior Alaska	885	2.317	0.851	0.813	112	53	no
Birch Cr Basin	133	2.630	0.840	0.899	75	43	yes
1. Lower Birch Cr	44	3.540	0.731	0.468	104	51	
Birch Cr ab CC	16	2.158	1.014	0.372	119	54	
2. Eagle Cr	47	1.416	0.924	0.847	33	25	
Eagle Cr b GHD	46	2.046	0.871	0.837	30	23	
3. Gold Dust Cr	18	1.259	0.911	0.671	102	51	
Gold Dust Cr b GDM	18	1.259	0.911	0.671	102	51	
4. Upper Birch Cr	16	1.249	0.989	0.944	17	15	
Crooked Cr Basin	239	2.000	0.900	0.730	103	51	no
1. Crooked Cr	96	3.589	0.748	0.553	73	42	yes
Crooked Cr ab Boulder	9	0.032	1.504	0.549	23	19	
Crooked Cr at Central	38	14.655	0.535	0.261	123	55	
Crooked Cr ab mouth	19	2.178	0.821	0.256	97	49	
2. Deadwood Cr	36	5.012	0.859	0.767	82	45	
Deadwood Cr at CHSR	32	4.656	0.863	0.769	86	46	
3. Ketchem Cr	22	1.982	1.028	0.839	82	45	
Ketchem Cr at CHSR	20	1.406	0.999	0.863	74	43	
4. Mammoth Cr	32	10.328	0.638	0.711	52	34	
Mammoth Cr at Steese	27	1.858	0.928	0.808	40	28	
5. Porcupine Cr	34	0.713	1.044	0.696	81	45	

[1] A 'no' in this column indicates that the equations which, when combined, would make up this geographical unit are statistically different at the 95 percent confidence level. For example, the 'no' for the interior Alaska equation indicates that the basin equations within interior Alaska are statistically different from each other. A 'yes' indicates the equations are statistically similar.

Table 2. Continued.

Location	N	a	b	r^2	+SEE(%)	-SEE(%)	F*<F?[1]
Chena River Basin	96	3.311	0.771	0.648	155	61	no
1. Fish Cr	67	5.598	0.630	0.629	107	52	no
Fish Cr b Gold Dredge	22	1.153	1.261	0.627	55	35	
Fish Cr b Lucky 7	43	1.315	0.879	0.370	124	55	
2. Little Chena	14	0.124	2.108	0.782	95	49	
Chatanika R Basin	186	0.932	1.034	0.789	90	47	yes
1. Chatanika R	151	0.729	1.098	0.743	88	47	no
Chatanika R at 39m	15	0.771	0.965	0.418	115	54	
Chatanika R at Long	53	0.473	1.179	0.803	47	32	
Chatanika R b Faith	56	2.280	0.844	0.610	85	46	
2. Faith Cr	27	1.770	0.930	0.881	56	36	
Faith Cr at Steese	17	0.611	1.186	0.787	57	36	
Goldstream Cr Basin	112	5.808	0.651	0.602	97	49	no
1. Goldstream Cr	50	5.781	0.694	0.320	76	43	
Goldstream Cr b Fox	36	1.274	0.967	0.385	52	34	
2. Gilmore Cr	50	4.560	0.627	0.657	51	34	
Gilmore Cr b BD Mining	44	0.848	0.852	0.719	44	31	
Upper Tolovana River Basin	88	1.500	1.083	0.841	53	35	yes
1. Tolovana R	76	1.233	1.157	0.778	50	33	yes
Tolovana R at TAPS	30	1.419	1.088	0.673	53	35	
Tolovana R ab West Fork	36	3.126	0.814	0.722	34	25	
2. Livengood Cr	12	1.871	1.015	0.882	74	43	
Koyukuk R Basin	31	5.768	0.867	0.635	140	58	

Figures 11 through 18 show regression lines plotted by basin and stream location. The regression which included all 885 observations had a coefficient of determination of 0.813 but a standard error of estimate of +112 percent (-53 percent). Coefficients of determination for the basin equations ranged from 0.602 (Goldstream Creek basin) to 0.899 (Birch Creek basin). Four of seven equations had standard errors of estimate less than +100 percent.

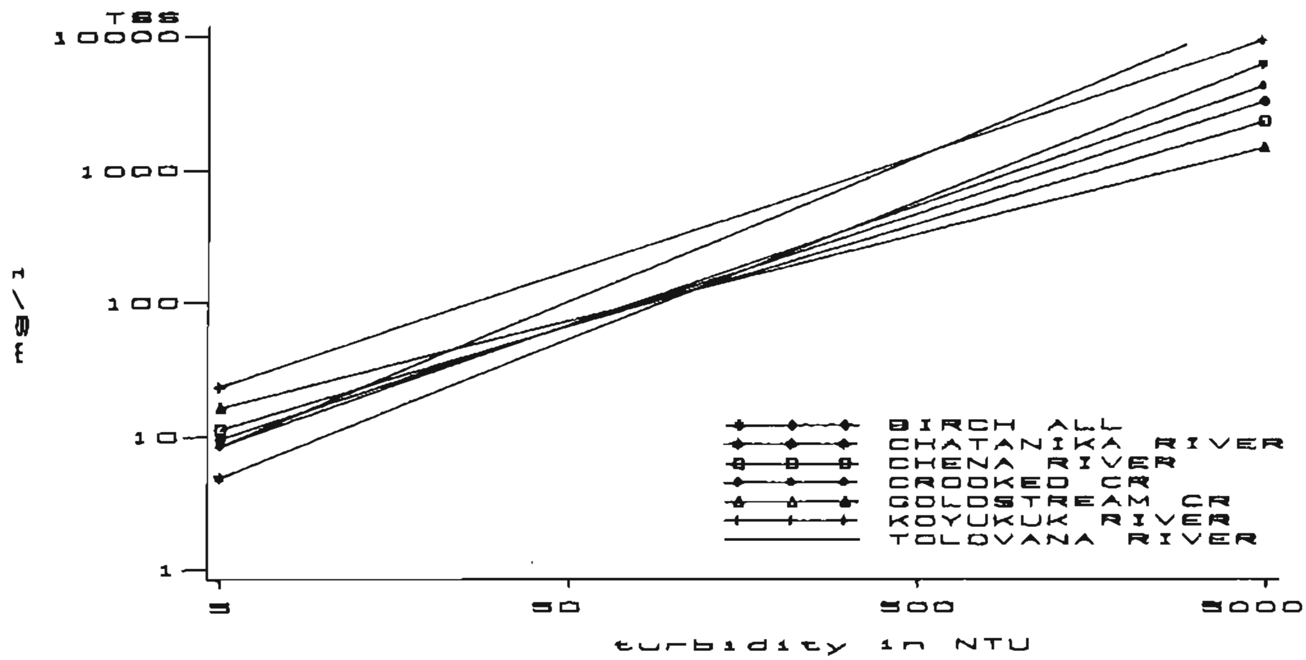

Figure 11. Plot of turbidity-TSS regression lines for seven basins in interior Alaska.

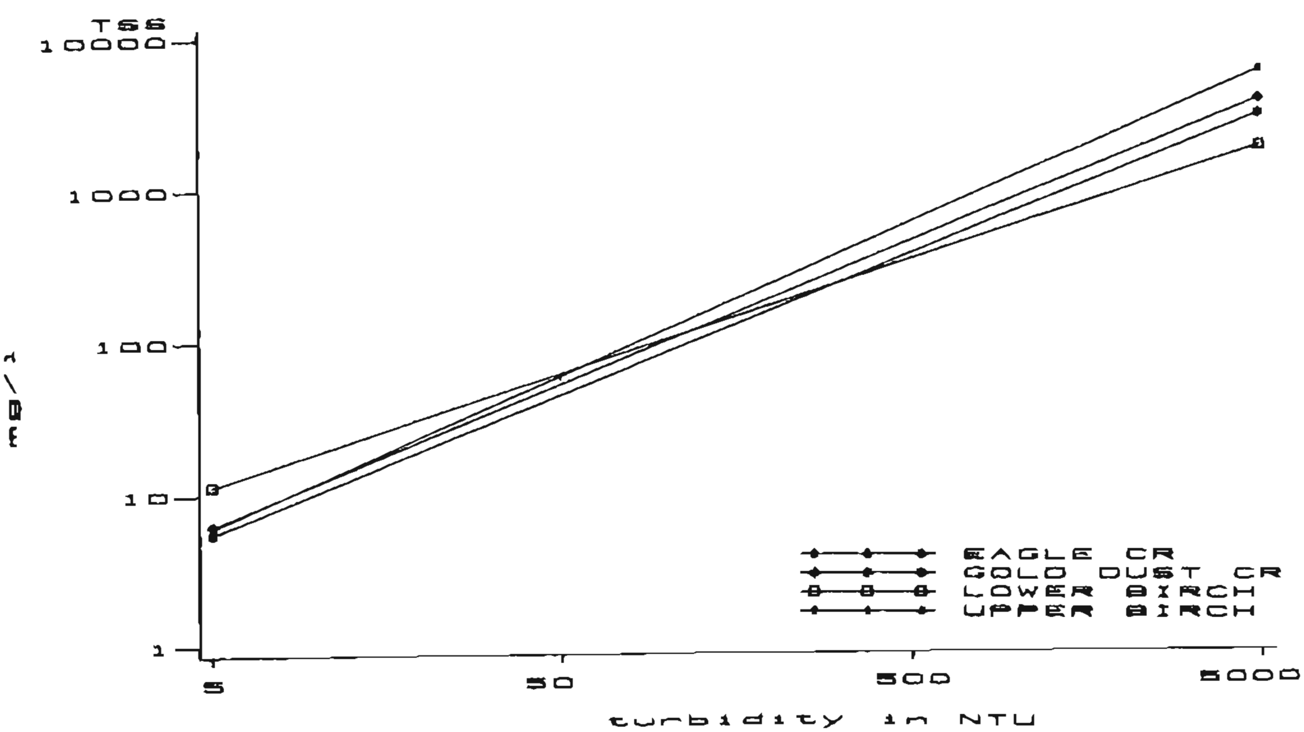

Figure 12. Plot of turbidity-TSS regression lines for streams in Birch Creek basin.

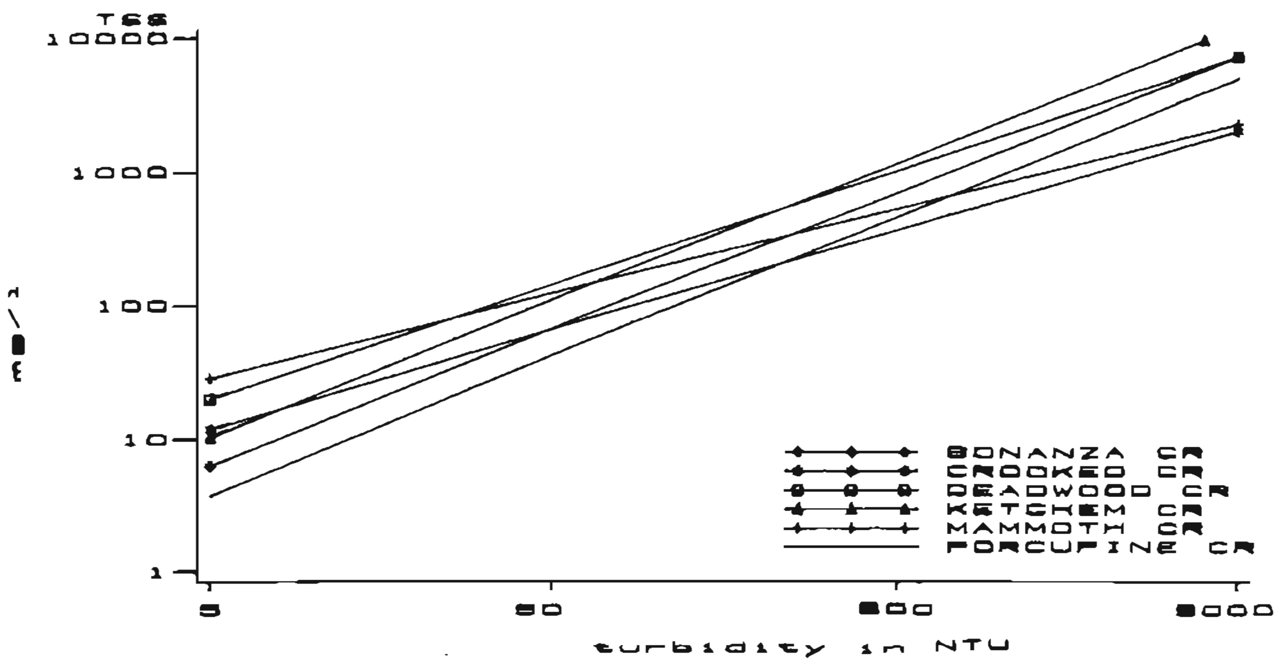

Figure 13. Plot of turbidity-TSS regression lines for streams in Crooked Creek basin.

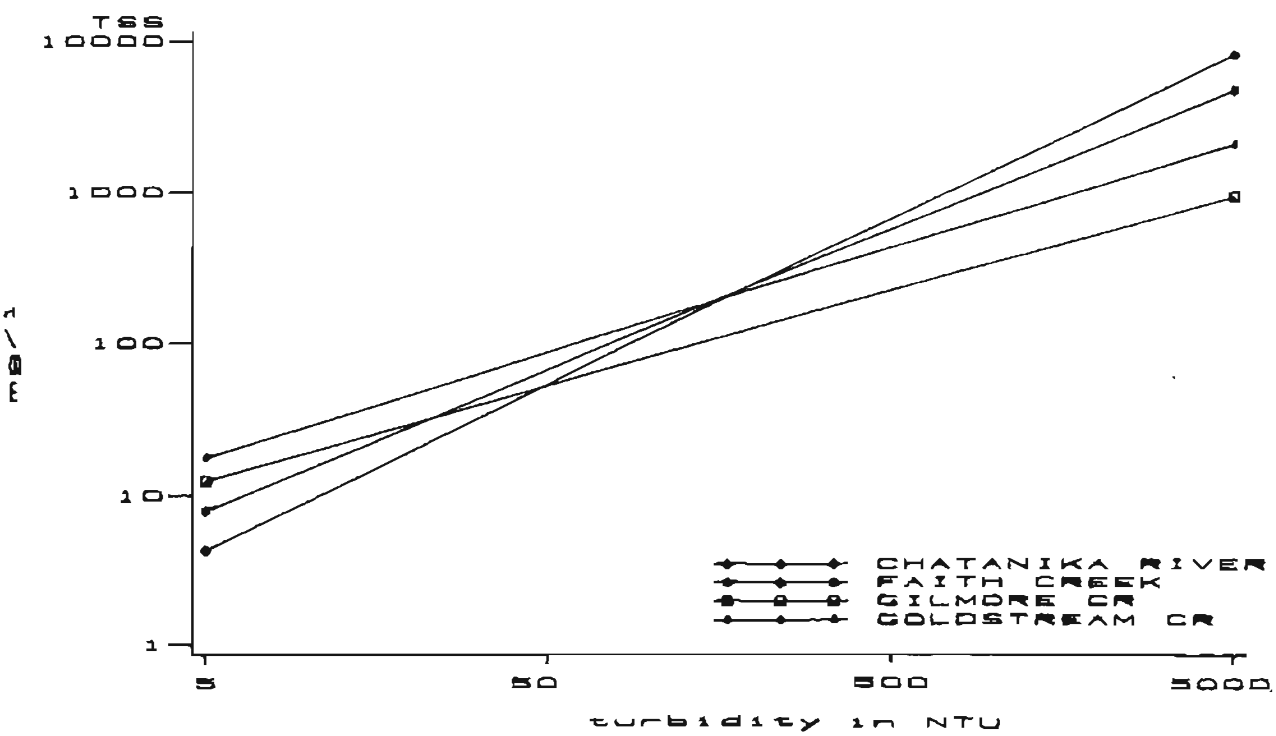

Figure 14. Plot of turbidity-TSS regression lines for streams in Chatanika and Goldstream basins.

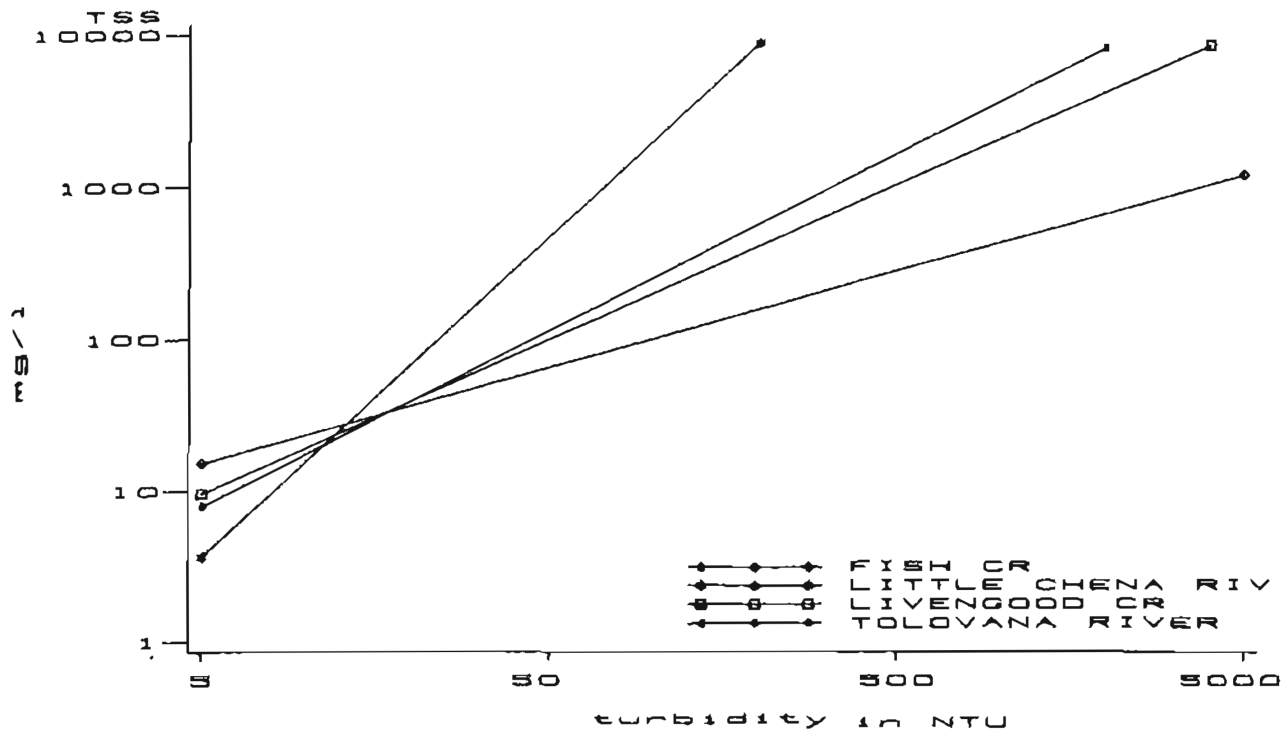

Figure 15. Plot of turbidity-TSS regression lines for streams in the Upper Tolovana and Chena basins.

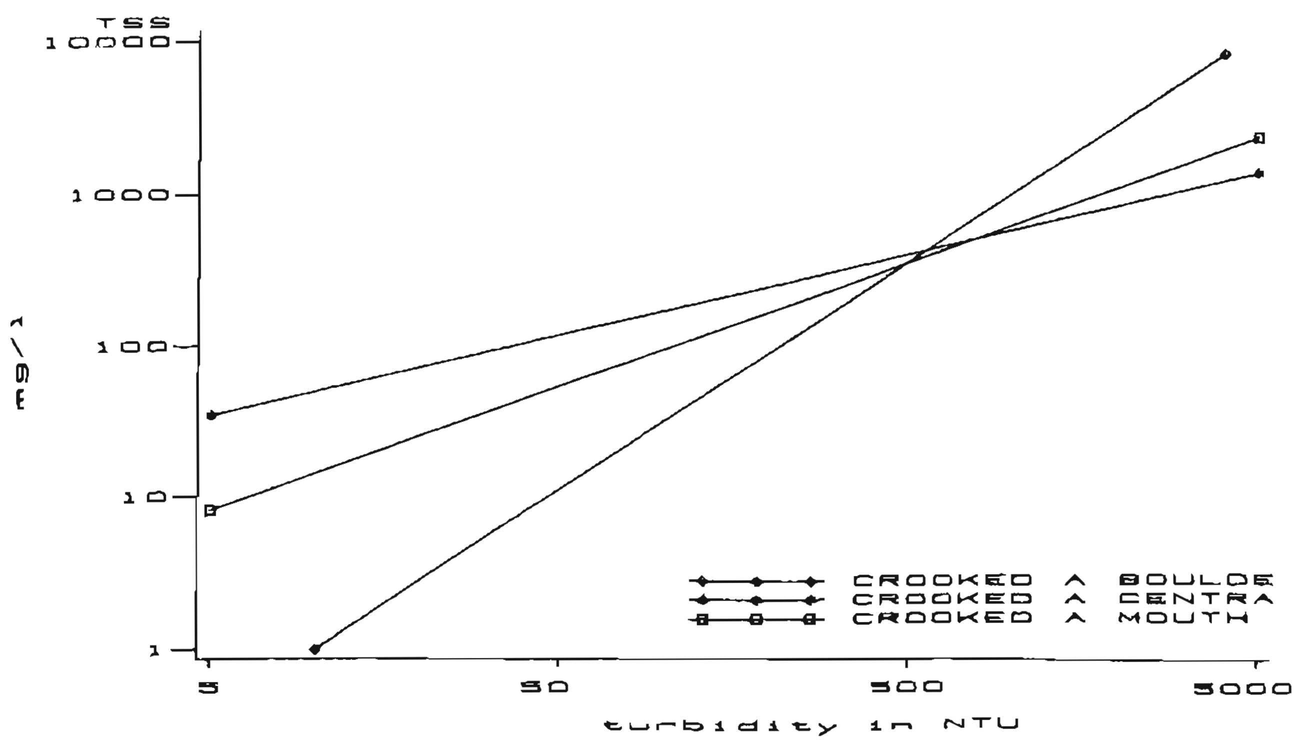

Figure 16. Plot of turbidity-TSS regression lines for sites on Crooked Creek.

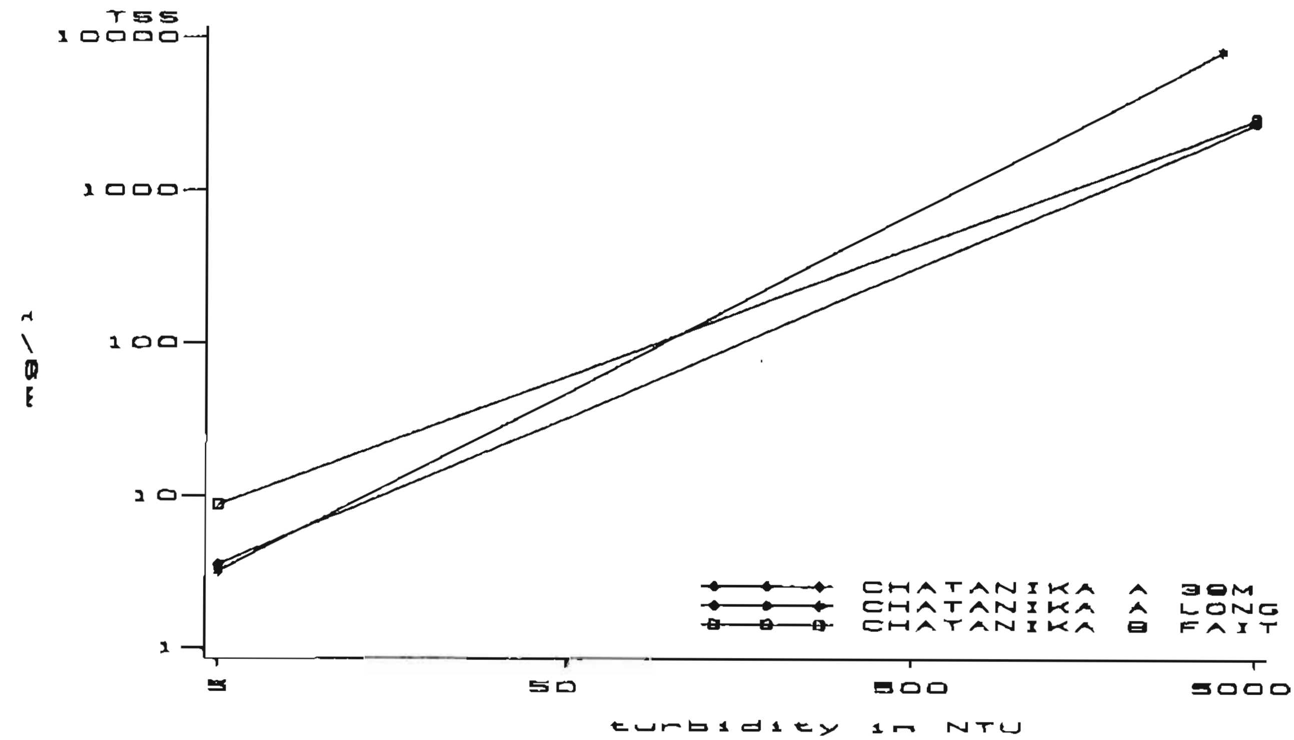

Figure 17. Plot of turbidity-TSS regression lines for sites on Chatanika River.

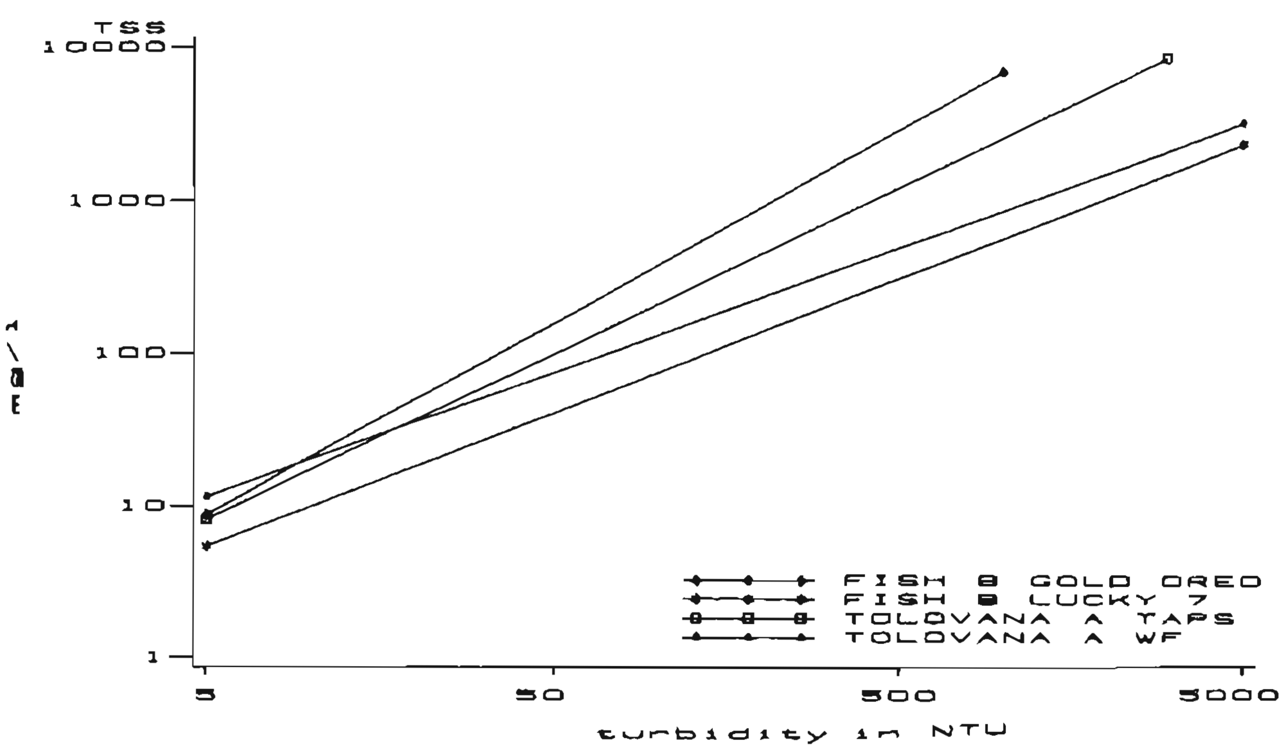

Figure 18. Plot of turbidity-TSS regression lines for sites in the Upper Tolovana River and Chena basins.

For the stream data equations, the equation coefficients and regression parameters---coefficient of determination (r^2) and standard error of estimate (SEE) varied considerably; r^2 ranged from 0.320 (Goldstream Creek) to 0.996 (Upper Birch Creek), and r^2 in 13 of 15 equations was over 0.50. SEE varied from +107 percent (-52 percent) with Fish Creek data to +17 percent (-15 percent) for Upper Birch Creek, and +SEE value was less than 100 percent in 12 of 15 equations.

The variation of equation descriptors (r^2, SEE) for site equations was similar to that of stream equations; r^2 ranged from 0.262 at Crooked Creek at the bridge to 0.863 at Ketchem Creek at the Circle Hot Springs Road. In 13 of 18 equations, r^2 was over 0.50. Other sites with relatively poor r^2 values were Birch above Crooked Creek (0.372), Fish Creek below Lucky 7 (0.370), Chatanika at 39 mile Steese (0.418), and Goldstream below Fox (0.389).

SEE for site equations ranged from +30 percent (-23 percent) to +124 percent (-55 percent) and 13 of 18 were less than +100 percent. An inverse relationship generally existed between SEE and r^2 for the site equations; that is, equations with the lowest r^2 had the highest SEE. Figure 19, a plot of coefficients of determination and corresponding standard errors of estimate for site and stream equations, demonstrates the scatter that occurred with these equations. No general conclusion can be drawn about whether combination of data into stream equations improved, reduced, or averaged the regression parameters.

Analysis of Covariance

For streams with two or more sites, for basins with two or more streams, and for all interior Alaska data, analysis of covariance was performed. The results of this work are presented in column 8 ($F^* < F$?) of table 2. A 'yes' in this column indicates that the equations describing the data groups included in the covariance analysis were statistically similar at the 95 percent level, and that the equation describing the combined data would therefore be the most appropriate.

The analysis of covariance results were mixed; the seven basin equations for interior Alaska were statistically different, which indicated that these data should not be combined to develop one equation. At the basin level, the four streams in Birch Creek, the two streams in the Chatanika River basin, and the two streams in the Upper Tolovana River basin had statistically similar equations for each basin. The six streams in the Crooked Creek basin, the two streams in the Chena River basin, the two streams in the Goldstream Creek basin, were statistically different for each basin. At the stream level, the F value comparison indicated that the three sites on Crooked Creek and the two sites on the Upper Tolovana River had statistically similar regression equations. The three sites on the Chatanika River and the two sites on Fish Creek were statistically different.

Of note is the reversal in the Chatanika River basin. One might expect sites on one stream to have similar regression equations if the total stream equation were similar to that of a tributary stream. That was not the case

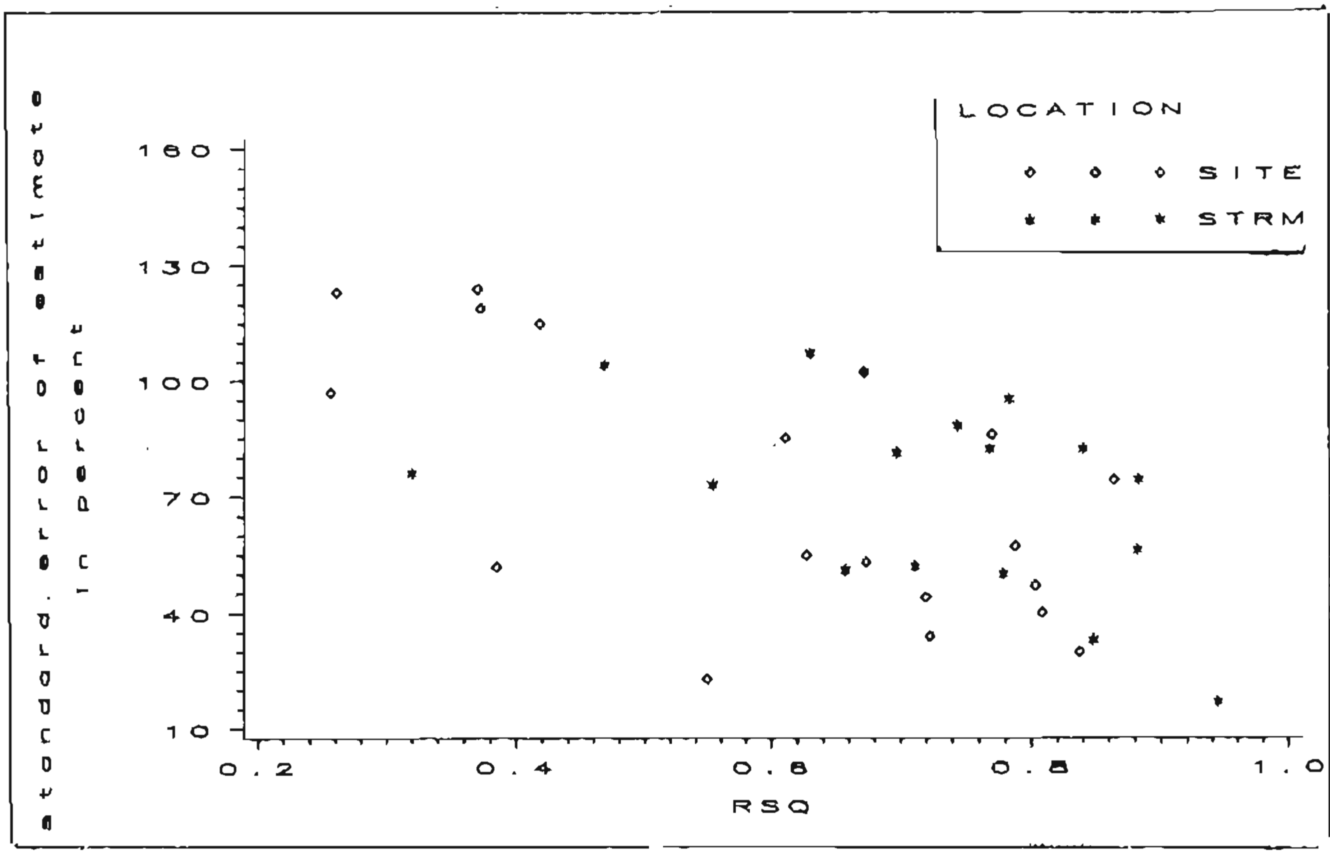

Figure 19. Plot of regression equation coefficients of determination and standard errors of estimate.

with the Chatanika River. Covariance analysis indicated that the regression equations for the sites on the Chatanika River were different, yet the equation for the combined data from the Chatanika River was not significantly different from the equation for Faith Creek. When only 1984 data were used, regressions for the Chatanika River sites were statistically similar, but when the 1983 data were included the difference occurred.

Whether regression equations are similar between sites, streams and basins was a central question for this project. Also of interest was whether regression equations are similar between years. Does the equation developed from data collected in 1983 and 1984 accurately predict in 1985? Covariance analysis was used to investigate whether the equations for the combined database and equations for site data from Crooked Creek at Central, Chatanika River below Faith Creek, and Chatanika River above Long Creek differed between years. The results, presented in table 3, show that regression equations can differ statistically from year to year. When all data were combined, the regression equations for each year (1983-85) were different. However, earlier analysis demonstrated that one should not combine data from different basins. To rule out the possibility that the difference by year of the combined data might be a function of basin differences, three individual sites--Crooked Creek at Central, Chatanika below Faith Creek, and Chatanika at Long Creek---were investigated. Covariance analysis based on year showed

Table 3. Summary of covariance analysis by year.

[Equations in the form $\underline{y} = \underline{a}*(\underline{x}^b)$, where $\underline{y}$ = TSS, $\underline{x}$ = turbidity, $\underline{a}$ = $\underline{y}$ axis intercept, and $\underline{b}$ = slope.]

Location (yr)	N	a	b	r^2	+SEE(%)	-SEE(%)	F*<F%?
Int. Alaska (all)	885	2.317	0.851	0.81	112	53	no
Int. Alaska (83)	158	0.689	1.082	0.92	56	36	
Int. Alaska (84)	543	3.236	0.799	0.80	119	54	
Int. Alaska (85)	184	2.871	0.820	0.74	101	50	
Crooked Cen (all)	38	14.655	0.535	0.26	123	55	no
Crooked Cen (84)	19	234.423	0.156	0.04	121	55	
Crooked Cen (85)	19	2.009	0.831	0.41	87	47	
Chat b Faith (all)	56	2.280	0.844	0.61	85	48	yes
Chat b Faith (83)	32	1.611	0.894	0.77	34	25	
Chat b Faith (84)	24	2.553	0.865	0.62	137	58	
Chat a Long (all)	53	0.473	1.179	0.80	47	32	no
Chat a Long (83)	28	0.514	1.092	0.55	33	25	
Chat a Long (84)	25	0.813	1.055	0.82	52	34	

that the regression equations for Chatanika at Long Creek and Crooked Creek at Central were different, whereas regression equations for Chatanika below Faith were similar (figs. 20 and 21).

Model Validation

Model validation was done with 1985 data from the Chatanika and Tolovana Rivers and Goldstream Creek (DEC, 1986) and 1983 data from Upper Birch Creek, Crooked Creek, and Chatanika River (Wagener, 1984). Appendix C presents the results of these comparisons. Figure 22 is a histogram of Z scores for 1985 Chatanika and Tolovana DEC data and 1983 data reported by Wagener (1984). The Chatanika data had an average Z score of -1.07; 55 percent of the observations were within one standard error of estimate and 98 percent were within two standard errors of estimate of the reported values. The Tolovana data had an average Z score of -0.20, with 89 percent within one standard error of estimate and 95 percent within two standard errors of estimate of reported values. The 1983 data had an average Z score of 0.56, with 58 percent within one standard error of estimate and 88 percent within two standard errors of estimate of the reported values.

The disparity between the 1985 Tolovana and Chatanika results was noteworthy. These data were collected by the same people using the same methods during a 2-wk period. Results from the 1983 data were underpredicted, on average, and distribution was spread out more than in the other two groups of data.

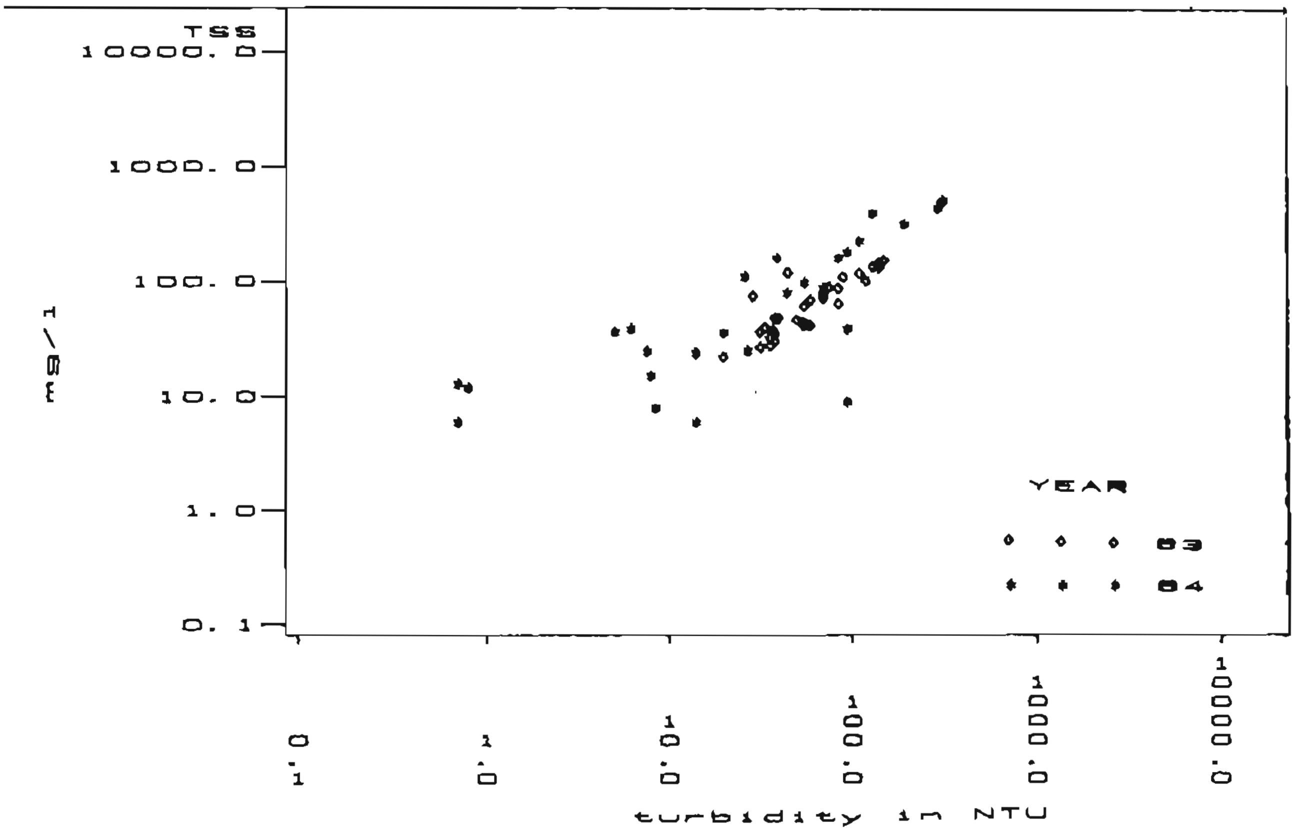

Figure 20. Plot of turbidity and TSS by year, Chatanika River below Faith Creek, 1983-84.

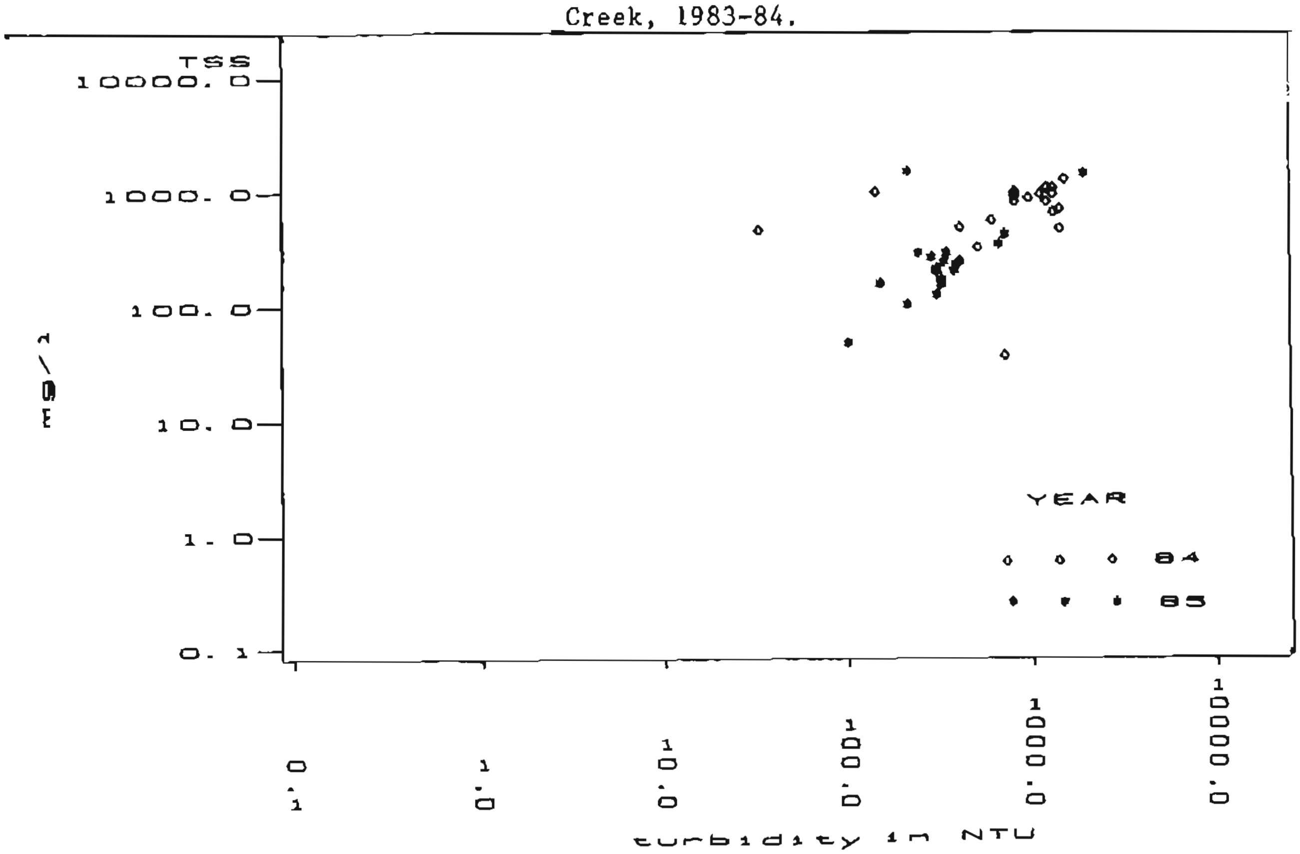

Figure 21. Plot of turbidity and TSS by year, Crooked Creek at Central, 1984-85.

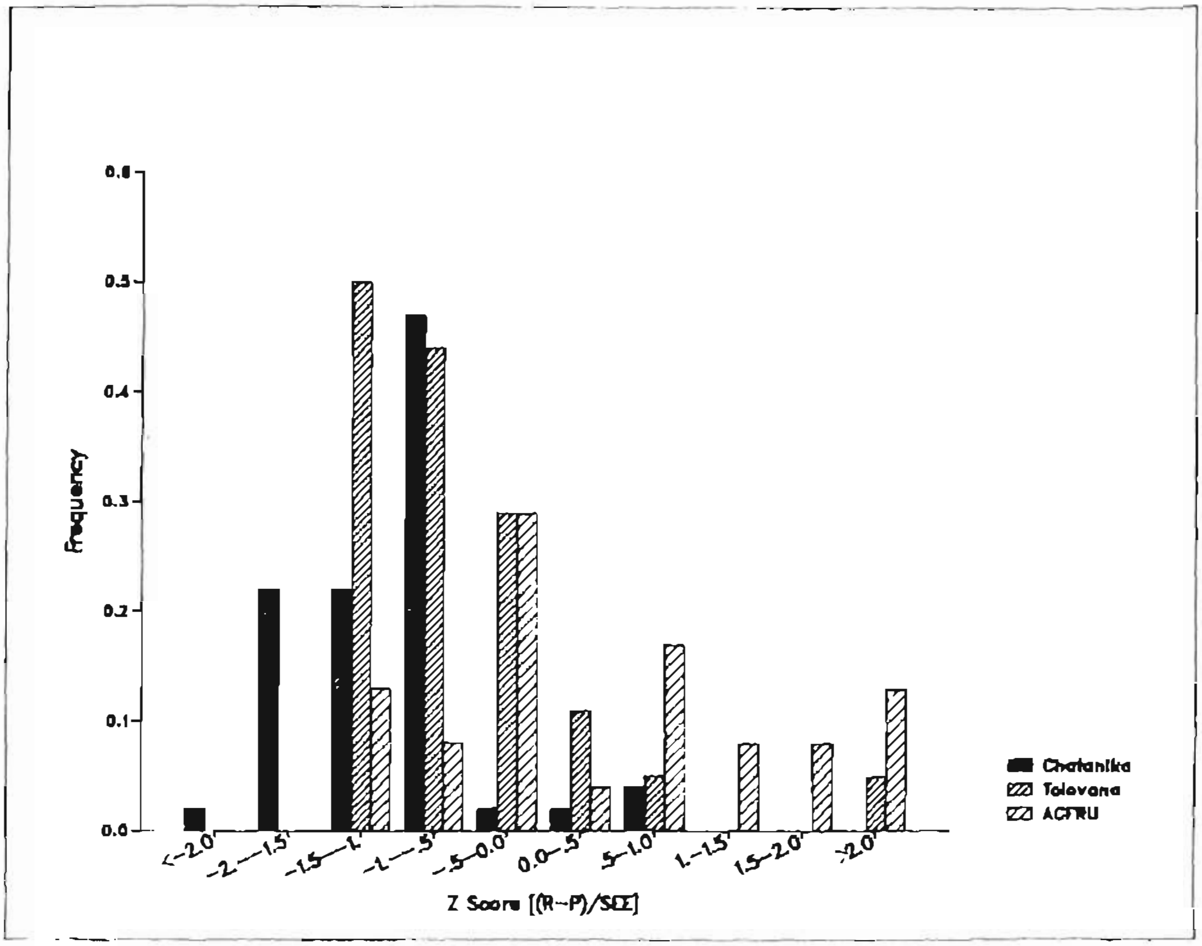

Figure 22. Z score distributions for 1985 Chatanika and Tolovana and 1983 ACFRU data.

The Chatanika data came mostly from two sites---Chatanika below Faith Creek and Chatanika at Long Creek---which had different Z score distributions. At the site on Chatanika below Faith Creek, 92 percent of the Z scores (22 of 24) fell within the greater than -1.0 and less than -0.5 interval and at the site on Chatanika at Long Creek, 81 percent of the Z scores were less than -1.0. In particular, the predicting equation for the site on Chatanika below Faith Creek may not be accurate for this set of data, but the precision---92 percent within one Z score interval---was good.

Velocity-Turbidity Multiple Regression

Velocity estimates were available for 76 observations within the Crooked Creek basin. Simple regression of the log transformed turbidity and TSS data produced an r^2 of 0.82 with an SEE of 0.296 (+98,-49 percent). Velocity by itself does not have significant relationship with total suspended solids. The multiple regression model with log velocity as the second predictor variable produced an r^2 of 0.85 and an SEE of 0.271 (+87,-46 percent). These are not substantial improvements, but the added velocity variable is statistically significant at the 95-percent confidence level.

When only data from Crooked Creek at Central were considered, there was marked improvement. Multiple regression (log turbidity and log velocity) improved the simple regression (log turbidity) r^2 of 0.207 to 0.686 and reduced the SEE from +98 (-49 percent) to +56 (-36 percent). Table 4 presents a comparison of the multiple regression analyses.

DISCUSSION

The underlying premise of this project was that, because placer mining methods are similar throughout interior Alaska, the turbidity-TSS relationship in placer-mined streams in interior Alaska also may be similar and may allow the use of one equation to define that relationship. This was not borne out by the analysis. Regression equations for the seven basins were statistically different. Of six basins that had two or more streams with 15 or more observations, only three produced statistically similar regression equations and, in one of those, equations for the individual sites are not similar. Of four streams that had two or more sites with 15 or more observations, two had statistically different regressions.

Covariance analysis also indicated that one should be careful using equations developed from data of previous years to predict TSS. The equations using all data from interior Alaska were different for 1983, 1984, and 1985. Covariance analysis of three sites indicated that at two of those sites the equations differed between years. Model validation supported this uncertainty. Estimates from 1985 Chatanika River site data averaged more than one standard error of estimate from reported TSS.

Error as indicated by the standard error of estimate is reasonable for most equations. Considerable variation may occur among individual observations. Inspection of the data from the site equations with the worst error terms showed that these sites were close to sluice operations or included

Table 4. Comparison of multiple and simple linear regression equations from Crooked Creek basin.

[Equations in the form $\underline{y} = \underline{a} * (\underline{x}_1 b_1) * (\underline{x}_2 b_2)$, where $\underline{x}_1$ = turbidity, $\underline{x}_2$ = velocity, and $\underline{b}_1$, $\underline{b}_2$, and $\underline{a}$ are coefficients.]

Location	N	$\underline{a}$	$\underline{b}_1$	$\underline{b}_2$	$\underline{r}^2$	+SEE	-SEE
Crooked Creek Basin							
Simple regression (turb)	72	1.211	0.985		0.788	91	48
Simple regression (vel)	72	134.896		0.165	0.005	305	75
Multiple regression	72	0.851	1.016	0.456	0.828	79	44
Crooked Creek at Central							
Simple regression (turb)	16	7.447	0.622		0.207	98	49
Simple regression (vel)	16	210.863		0.073	0.002	114	53
Multiple regression	16	0.001	1.919	2.127	0.686	56	36

data from a variety of flow conditions. It is important to note that these equations cannot be used to estimate TSS outside the range of values in the data sets used to develop the equations, particularly turbidity values less than 5 NTU. Also, these equations cannot be used to predict TSS in non-placer-mined streams.

Stream flow levels---discharge or velocity---can affect the turbidity-TSS relationship over a wide range of flows. When velocity was added to the poor relationship at Crooked Creek at Central, the r^2 improved remarkably and the error was reduced equally well. Inspection of the data showed much different turbidity-TSS relationships at high flows. Observations in May and early June showed TSS values much higher than the accompanying turbidity values. Observations from Crooked Creek basin in late June and mid-August, 1985---times of high flows---revealed similar relationships. Low flows in early August may partly explain the poor prediction performance of the Chatanika site equations on 1985 DEC data. Lack of measured or estimated discharge and velocity data limits a more thorough exploration of this. Addition of a discharge or velocity variable is essential for adequate prediction of TSS from turbidity over a wide range of flows, although a simple regression may be acceptable for average-level summer flows.

The research conducted here indicated that the most appropriate use of regression models to predict TSS from turbidity in mined streams is on a single site basis. Analyses indicated that regression equations should be used with care if developed for more that one site, if used on sites that did not contribute data to the model development, or if used for years that did not contribute data to the model development. A simple regression equation developed with data collected during normal flows will underestimate TSS at high flows and overestimate TSS at low flows. Analysis of covariance indicated that the relationship may stay the same between years, sites, or streams, but this constancy of relationship requires verification and cannot be assumed.

A strong, if not perfect, relationship exists between TSS and turbidity; turbidity, as well as being much less expensive to collect, has a more enforceable standard. Excess amounts of sediment which cause ecological and aesthetic damage can be accurately monitored or estimated by either parameter, and this report has demonstrated a way to estimate sediment loads with a minimum amount of TSS analysis.

As state and federal funding declines and interest remains constant in solutions to the issue of water quality in placer-mining areas, funds to do all desired analyses may not be available. If water-quality monitoring in placer-mined streams requires both turbidity and suspended sediment information, then the turbidity-TSS models recommended here can help stretch the analysis dollar.

CONCLUSION

The results of the analyses conducted in this report support the conclusion that equations are most useful in predicting TSS values from turbidity measurements when developed on a site basis. Combining all data from interior Alaska into one equation is not supported by the analysis, nor is combining data within a basin or stream. The turbidity-TSS relationship may change from one year to the next. Multiple regression models using turbidity and velocity to predict TSS give improved results over a wide range of flows.

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OBS	LOCATION	HYUNIT	SOURCE	DATE	TIME	TURB	TSS
54	PTARMIGAN A STE	4040203	4	84-08-22	1800	4.60	2.80
55	PTARMIGAN A STE	4040203	5	84-08-30	1220	1.00	22.00
56	TWELVEMILE A MT	4040203	3	84-08-07	1916	0.40	4.00
57	TWELVEMILE A MT	4040203	3	84-08-07	1938	0.20	4.00
58	TWELVEMILE A MT	4040203	3	84-08-10	1253	0.30	4.00
59	TWELVEMILE A MT	4040203	3	84-08-21	1035	0.30	0.40
60	TWELVEMILE B NF	4040203	4	84-08-15	1815	0.30	2.00
61	TWELVEMILE B RC	4040203	4	84-08-15	1635	0.55	0.27
62	TWELVEMILE NF	4040203	4	84-08-15	1315	0.35	0.40
63	CLUMS A MTH	4040204	4	85-06-12	955	0.40	1.70
64	CLUMS A VOLCANO	4040204	4	85-06-12	1120	1.20	3.10
65	CROOKED A HARNG	4040204	4	85-06-10	1506	0.65	1.20
66	HARRINGTON A MT	4040204	4	85-06-10	1048	0.60	1.20
67	EAGLE A GHD	4040205	2	84-06-20	1545	0.48	1.60
68	EAGLE A GHD	4040205	2	84-06-21	855	1.30	0.40
69	EAGLE A GHD	4040205	2	84-06-21	1140	1.90	0.80
70	EAGLE A GHD	4040205	2	84-06-21	1510	1.90	0.20
71	EAGLE A GHD	4040205	2	84-06-21	2115	2.00	1.00
72	EAGLE A GHD	4040205	2	84-06-22	830	1.20	0.40
73	EAGLE A GHD	4040205	2	84-06-22	1330	1.00	0.40
74	EAGLE A GHD	4040205	2	84-06-22	1630	1.00	0.10
75	EAGLE A GHD	4040205	2	84-06-22	2030	1.50	0.20
76	EAGLE A GHD	4040205	2	84-06-23	910	0.50	0.05
77	EAGLE A GHD	4040205	2	84-06-23	1440	1.10	0.05
78	EAGLE A GHD	4040205	2	84-06-23	1840	1.20	0.40
79	EAGLE A GHD	4040205	2	84-06-24	850	1.00	0.05
80	EAGLE A GHD	4040205	2	84-06-24	1130	1.30	0.60
81	EAGLE A GHD	4040205	2	84-06-24	1355	0.80	0.40
82	EAGLE A GHD	4040205	2	84-07-17	1100	0.29	0.40
83	EAGLE A GHD	4040205	2	84-07-17	1520	0.19	1.70
84	EAGLE A GHD	4040205	2	84-07-17	1930	0.22	0.80
85	EAGLE A GHD	4040205	2	84-07-18	930	0.40	1.10
86	EAGLE A GHD	4040205	2	84-07-18	1205	0.27	1.90
87	EAGLE A GHD	4040205	2	84-07-18	1640	0.45	1.60
88	EAGLE A GHD	4040205	2	84-07-19	820	0.18	0.05
89	EAGLE A GHD	4040205	2	84-07-19	1200	0.27	0.10
90	EAGLE A GHD	4040205	2	84-07-19	1455	0.37	0.30
91	EAGLE A GHD	4040205	2	84-07-20	835	0.19	0.05
92	EAGLE A GHD	4040205	2	84-07-20	1115	0.42	0.30
93	EAGLE A GHD	4040205	2	84-07-20	1600	0.23	0.50
94	EAGLE A GHD	4040205	2	84-07-21	700	0.23	0.05
95	EAGLE A GHD	4040205	2	84-07-21	1030	0.27	0.05
96	EAGLE A GHD	4040205	2	84-07-21	1300	0.23	0.60
97	EAGLE A GHD	4040205	2	84-08-09	1200	0.59	1.10
98	EAGLE A GHD	4040205	2	84-08-09	1630	0.21	0.70
99	EAGLE A GHD	4040205	2	84-08-09	1945	0.75	1.90
100	EAGLE A GHD	4040205	2	84-08-10	830	0.28	0.10
101	EAGLE A GHD	4040205	2	84-08-10	1200	0.42	0.30
102	EAGLE A GHD	4040205	2	84-08-10	1425	0.82	0.30
103	EAGLE A GHD	4040205	2	84-08-11	1255	0.45	0.05
104	EAGLE A GHD	4040205	2	84-08-11	1555	0.47	0.10
105	EAGLE A GHD	4040205	2	84-08-11	2020	0.32	0.50
106	EAGLE A GHD	4040205	2	84-08-12	925	0.38	0.10

OBS	LOCATION	HYUNIT	SOURCE	DATE	TIME	TURB	TSS
160	GOLD DUST B GDM	4040206	2	84-06-21	1715	2000.0	125
161	GOLD DUST B GDM	4040206	2	84-06-22	1300	380.0	350
162	GOLD DUST B GDM	4040206	2	84-06-22	1600	1200.0	890
163	GOLD DUST B GDM	4040206	2	84-06-22	1720	1700.0	1280
164	GOLD DUST B GDM	4040206	2	84-06-23	1340	3200.0	2180
165	GOLD DUST B GDM	4040206	2	84-06-23	1835	1600.0	820
166	GOLD DUST B GDM	4040206	2	84-06-24	1240	3000.0	1670
167	GOLD DUST B GDM	4040206	2	84-06-24	1410	5000.0	3040
168	GOLD DUST B GDM	4040206	2	84-08-20	1830	1200.0	680
169	GOLD DUST B GDM	4040206	2	84-08-20	2015	1900.0	1270
170	GOLD DUST B GDM	4040206	2	84-08-21	1630	650.0	380
171	GOLD DUST B GDM	4040206	2	84-08-21	1800	1000.0	865
172	GOLD DUST B GDM	4040206	2	84-08-22	1300	1800.0	2440
173	GOLD DUST B GDM	4040206	2	84-08-22	1740	1800.0	2000
174	GOLD DUST B GDM	4040206	2	84-08-23	1815	100.0	52
175	GOLD DUST B GDM	4040206	2	84-08-24	1115	100.0	100
176	GOLD DUST B GDM	4040206	2	84-08-24	1340	500.0	408
177	HARRISON A BIRC	4040207	1	83-08-08	1500	240.0	290
178	HARRISON A BIRC	4040207	3	84-08-08	1500	240.0	290
179	HARRISON A BIRC	4040207	3	84-08-08	1540	190.0	320
180	HARRISON A MTH	4040207	4	84-08-29	1415	450.0	745
181	HARRISON A MTH	4040207	4	85-06-13	930	6.8	25
182	HARRISON A SQUA	4040207	3	84-08-08	1635	400.0	210
183	HARRISON B SQUA	4040207	3	84-08-08	1625	420.0	1100
184	SQUAW A HARRISO	4040207	3	84-08-08	1625	220.0	1200
185	BIRCH A 12 MILE	4040208	4	84-09-06	1438	1000.0	970
186	BIRCH A 12 MILE	4040208	4	84-09-23	1220	400.0	420
187	BIRCH A 12 MILE	4040208	4	85-06-12	1615	450.0	603
188	BIRCH A 12MILE	4040208	3	84-08-10	1258	400.0	560
189	BIRCH A 12MILE	4040208	3	84-08-21	1045	270.0	368
190	BIRCH A BUTTE C	4040208	4	84-09-06	1215	1800.0	2640
191	BIRCH A GOLD DS	4040208	4	85-06-12	1648	650.0	694
192	BIRCH AB NF CON	4040208	1	83-08-09	1845	320.0	360
193	BIRCH B 12 MILE	4040208	4	84-09-06	1422	700.0	820
194	BIRCH B 12MILE	4040208	3	84-08-07	1915	580.0	660
195	BIRCH B 12MILE	4040208	3	84-08-07	1930	500.0	720
196	BIRCH B 12MILE	4040208	3	84-08-10	1301	320.0	410
197	BIRCH B BEAR C	4040208	4	84-09-06	1300	950.0	960
198	BIRCH B NF CON	4040208	1	83-08-09	1850	280.0	244
199	BIRCH B PTARMIG	4040208	4	84-09-06	1150	2100.0	2380
200	BIRCH B WILLOW	4040208	4	84-09-06	1345	1100.0	1150
201	CROOKED A ALBER	4040210	1	84-08-09	1550	460.0	410
202	CROOKED A BLDRI	4040210	5	85-07-24	1325	380.0	205
203	CROOKED A BOLDR	4040210	3	84-08-08	1743	1100.0	490
204	CROOKED A BOLDR	4040210	3	84-08-09	1030	1400.0	1200
205	CROOKED A BOLDR	4040210	3	84-08-09	1612	1300.0	1400
206	CROOKED A BOLDR	4040210	5	85-07-24	114	360.0	269
207	CROOKED A BOLDR	4040210	5	85-07-24	714	330.0	241
208	CROOKED A BOLDR	4040210	5	85-07-24	1314	340.0	236
209	CROOKED A BOLDR	4040210	5	85-07-24	1914	370.0	248
210	CROOKED A BOLDR	4040210	5	85-07-25	1014	370.0	161
211	CROOKED A BOLDR	4040210	5	85-07-26	114	500.0	398
212	CROOKED A BOLDR	4040210	5	85-07-26	714	450.0	327

OBS	LOCATION	HYUNIT	SOURCE	DATE	TIME	TURB	TSS
266	CROOKED A MTH	4040210	5	85-07-25	1630	110.00	101.00
267	CROOKED A MTH	4040210	5	85-07-25	2230	100.00	80.30
268	CROOKED A MTH	4040210	5	85-07-26	430	85.00	66.40
269	CROOKED A MTH	4040210	5	85-07-26	1930	95.00	73.90
270	CROOKED A MTH	4040210	5	85-07-27	1030	70.00	59.80
271	CROOKED A MTH	4040210	5	85-07-27	1630	90.00	64.80
272	CROOKED A MTH	4040210	5	85-07-27	2230	140.00	95.90
273	CROOKED A MTH	4040210	5	85-07-28	430	75.00	55.20
274	CROOKED A MTH	4040210	5	85-08-07	1338	220.00	122.00
275	CROOKED A MTH	4040210	5	85-08-13	1515	230.00	170.00
276	CROOKED A MTH	4040210	5	85-08-22	1300	140.00	137.00
277	CROOKED A MTH	4040210	5	85-09-05	1700	100.00	124.00
278	CROOKED A MTH I	4040210	5	85-07-03	1830	50.00	132.00
279	CROOKED A MTH I	4040210	5	85-07-25	1215	130.00	101.00
280	CROOKED A MTH I	4040210	5	85-07-25	1218	100.00	103.00
281	CROOKED A WBALB	4040210	3	84-08-08	1050	160.00	130.00
282	CROOKED A WBALB	4040210	3	84-08-09	1220	290.00	240.00
283	CROOKED B ALBER	4040210	1	84-08-09	1545	270.00	310.00
284	CROOKED B BEDRK	4040210	5	85-07-23	1930	120.00	95.10
285	CROOKED B BEDRK	4040210	5	85-07-24	1930	120.00	103.00
286	CROOKED B BEDRK	4040210	5	85-07-25	1030	100.00	74.00
287	CROOKED B BEDRK	4040210	5	85-07-25	1630	110.00	94.80
288	CROOKED B BEDRK	4040210	5	85-07-25	2230	220.00	162.00
289	CROOKED B BEDRK	4040210	5	85-07-26	430	220.00	166.00
290	CROOKED B DEADW	4040210	3	84-08-08	1244	750.00	550.00
291	CROOKED B DEADW	4040210	1	84-08-08	1750	700.00	700.00
292	CROOKED B DEADW	4040210	3	84-08-09	1305	550.00	660.00
293	CROOKED B EBALB	4040210	3	84-08-09	1545	270.00	310.00
294	CROOKED B PORC	4040210	3	84-08-09	1006	340.00	410.00
295	CROOKED B WBALB	4040210	3	84-08-09	1230	250.00	190.00
296	CROOKED N KETCH	4040210	3	84-08-08	1000	500.00	330.00
297	ALBERT A BRDG	4040211	4	85-06-16	1610	15.00	64.00
298	ALBERT A BRDG	4040211	4	85-06-17	1008	33.00	293.00
299	ALBERT A MTH	4040211	4	85-06-16	952	18.00	105.00
300	ALBERT A STEESE	4040211	4	84-08-23	1630	11.00	19.00
301	ALBERT EB A CC	4040211	3	84-08-09	1540	10.00	10.00
302	ALBERT EB A CRK	4040211	1	84-08-09	1540	3.30	6.00
303	ALBERT WB A CC	4040211	3	84-08-09	1235	3.30	6.00
304	ALBERT WB A CRK	4040211	1	84-08-09	1540	10.00	10.00
305	BEDROCK A STEES	4040211	5	84-07-25	1220	1.00	4.00
306	BEDROCK A STEES	4040211	4	84-07-26	1450	4.50	7.60
307	BEDROCK A STEES	4040211	5	85-07-23	1130	0.29	0.46
308	BEDROCK A STEES	4040211	5	85-07-25	1055	0.41	2.67
309	BEDROCK A STEES	4040211	5	85-08-22	1440	3.60	27.90
310	BOULDER A CC	4040211	5	85-07-24	1314	0.66	1.70
311	BOULDER A CC	4040211	5	85-07-24	1914	0.37	1.91
312	BOULDER A CC	4040211	5	85-07-25	1014	0.38	7.67
313	BOULDER A CC	4040211	5	85-07-26	1014	0.48	1.29
314	BOULDER A GRNHR	4040211	5	84-07-25	1220	33.00	26.00
315	BOULDER A GRNHR	4040211	4	84-07-25	1700	23.00	101.00
316	BOULDER A GRNHR	4040211	4	84-07-26	1738	2.80	4.60
317	BOULDER A STEES	4040211	5	84-07-24	1220	1.00	2.00
318	BOULDER A STEES	4040211	4	84-07-26	1022	1.40	1.80

OBS	LOCATION	HYUNIT	SOURCE	DATE	TIME	TURB	TSS
372	KETCHEM A CHSR	4040214	1	84-08-08	1550	4600.00	9300.0
373	KETCHEM A CHSR	4040214	3	84-08-08	2210	2500.00	1400.0
374	KETCHEM A CHSR	4040214	3	84-08-09	100	110.00	160.0
375	KETCHEM A CHSR	4040214	3	84-08-09	410	160.00	350.0
376	KETCHEM A CHSR	4040214	3	84-08-09	728	210.00	380.0
377	KETCHEM A CHSR	4040214	3	84-08-09	959	200.00	410.0
378	KETCHEM A CHSR	4040214	3	84-08-09	1545	3600.00	7900.0
379	KETCHEM A CHSR	4040214	3	84-08-09	1842	650.00	3000.0
380	KETCHEM A CHSR	4040214	3	84-08-09	2048	1400.00	2700.0
381	KETCHEM A CHSR	4040214	3	84-08-10	124	5100.00	7100.0
382	KETCHEM A CHSR	4040214	3	84-08-10	656	390.00	380.0
383	KETCHEM A CHSR	4040214	3	84-08-10	953	240.00	330.0
384	KETCHEM A CHSR	4040214	3	84-08-10	1124	450.00	310.0
385	KETCHEM A CHSR	4040214	5	84-08-27	1220	3300.00	7600.0
386	KETCHEM A CHSR	4040214	4	85-06-16	1638	400.00	594.0
387	KETCHEM A CHSR	4040214	5	85-08-22	915	1300.00	868.0
388	KETCHEM A MININ	4040214	4	84-08-29	1030	0.75	0.4
389	KETCHEM A CHSR	4040214	4	84-08-21	1338	2000.00	1910.0
390	KETCHEM A CHSR	4040214	4	84-08-23	1820	3400.00	2610.0
391	KETCHEM N CC	4040214	3	84-08-08	955	1100.00	1000.0
392	KETCHEM N CC	4040214	3	84-08-09	1505	340.00	130.0
393	MAMMOTH A MTH	4040215	3	84-08-09	1004	280.00	350.0
394	MAMMOTH A STEES	4040215	5	84-08-01	1220	1200.00	1812.0
395	MAMMOTH A STEES	4040215	4	84-08-01	1620	1000.00	1810.0
396	MAMMOTH A STEES	4040215	3	84-08-08	1150	300.00	270.0
397	MAMMOTH A STEES	4040215	3	84-08-08	1505	340.00	480.0
398	MAMMOTH A STEES	4040215	3	84-08-08	1752	600.00	990.0
399	MAMMOTH A STEES	4040215	3	84-08-08	2115	170.00	240.0
400	MAMMOTH A STEES	4040215	3	84-08-09	1	500.00	660.0
401	MAMMOTH A STEES	4040215	3	84-08-09	300	370.00	370.0
402	MAMMOTH A STEES	4040215	3	84-08-09	615	300.00	420.0
403	MAMMOTH A STEES	4040215	3	84-08-09	900	50.00	173.0
404	MAMMOTH A STEES	4040215	3	84-08-09	1157	210.00	160.0
405	MAMMOTH A STEES	4040215	3	84-08-09	1504	130.00	210.0
406	MAMMOTH A STEES	4040215	3	84-08-09	1800	120.00	250.0
407	MAMMOTH A STEES	4040215	3	84-08-09	2057	220.00	280.0
408	MAMMOTH A STEES	4040215	3	84-08-10	10	600.00	770.0
409	MAMMOTH A STEES	4040215	3	84-08-10	556	340.00	360.0
410	MAMMOTH A STEES	4040215	3	84-08-10	903	400.00	560.0
411	MAMMOTH A STEES	4040215	3	84-08-10	1208	370.00	400.0
412	MAMMOTH A STEES	4040215	4	84-08-21	850	110.00	88.0
413	MAMMOTH A STEES	4040215	4	85-06-17	1155	270.00	358.0
414	MAMMOTH A STEES	4040215	5	85-06-20	1440	1000.00	1205.0
415	MAMMOTH A STEES	4040215	5	85-07-23	1515	180.00	199.0
416	MAMMOTH A STEES	4040215	5	85-07-24	1515	250.00	239.0
417	MAMMOTH A STEES	4040215	5	85-07-25	615	230.00	199.0
418	MAMMOTH A STEES	4040215	5	85-07-25	1215	150.00	146.0
419	MAMMOTH A STEES	4040215	5	85-07-25	1815	450.00	394.0
420	MAMMOTH A STEES	4040215	5	85-07-26	15	400.00	349.0
421	MASTODON A MINE	4040215	4	84-08-01	1100	0.50	4.4
422	MASTODON A MTH	4040215	5	84-08-02	1220	370.00	430.0
423	MASTODON B WILK	4040215	4	84-08-01	1300	1300.00	1340.0
424	MILLER A MINING	4040215	4	84-07-31	1000	1.10	0.8

OBS	LOCATION	HYUNIT	SOURCE	DATE	TIME	TURB	TSS
478	CHENA A NORDALE	4050601	3	84-08-13	1837	2.1	12.00
479	CHENA A NORDALE	4050601	3	84-08-20	2140	0.7	5.60
480	CHENA A NORDALE	4050601	4	85-05-15	1200	15.0	86.00
481	CHENA A SM TRAC	4050601	4	85-05-15	1200	13.0	47.00
482	CHENA A WENDELL	4050601	1	83-08-09	1210	2.7	5.00
483	CHENA A WENDELL	4050601	1	83-08-10	1755	3.0	7.00
484	CHENA A WENDELL	4050601	1	83-08-15	1250	5.2	4.00
485	CHENA A WENDELL	4050601	1	83-08-15	2100	3.0	4.00
486	CHENA A WENDELL	4050601	3	84-08-13	1120	2.5	4.00
487	CHENA A WENDELL	4050601	3	84-08-13	2058	2.5	11.00
488	CHENA MF A MINE	4050601	3	84-08-13	1150	0.5	1.00
489	CHENA MF B POND	4050601	3	84-08-13	1210	3.5	18.00
490	CHENA MF B POND	4050601	3	84-08-13	1211	3.8	22.00
491	CHENA MF B POND	4050601	3	84-08-13	1212	4.9	26.00
492	CHENA MF B POND	4050601	3	84-08-13	1300	3.5	17.00
493	CHENA NF A EF	4050601	3	84-08-13	1405	0.2	4.00
494	CHENA NR 2 RI	4050601	3	84-08-13	1305	3.0	4.00
495	CHENA NR 2 RI	4050601	3	84-08-13	1745	0.5	13.00
496	CHENA NR TWO RI	4050601	1	83-08-05	1800	3.4	4.00
497	CHENA NR TWO RI	4050601	1	83-08-10	1345	1.3	1.30
498	CHENA NR TWO RI	4050601	1	83-08-15	1430	2.2	1.00
499	CHENA,EF AB MTH	4050601	1	83-08-05	1620	2.5	8.00
500	CHENA,EF AB MTH	4050601	1	83-08-05	1625	2.7	5.00
501	CHENA,EF AB MTH	4050601	1	83-08-15	1615	9.5	5.00
502	CHENA,NF AB EF	4050601	1	83-08-05	1725	0.3	1.00
503	CHENA,NF AB EF	4050601	1	83-08-10	1530	0.7	2.00
504	CHENA,NF AB EF	4050601	1	83-08-10	1550	0.4	2.00
505	CRIPPLE A CHENA	4050602	4	84-05-09	1200	45.0	235.00
506	CRIPPLE A CHENA	4050602	4	84-05-15	1200	250.0	2060.00
507	CRIPPLE A CHENA	4050602	4	85-05-15	1200	26.0	226.00
508	FAIRBANKS A MTH	4050603	1	84-08-10	1910	0.8	0.05
509	FAIRBANKS A MTH	4050603	1	84-08-13	2030	0.6	0.20
510	FAIRBANKS A MTH	4050603	1	84-08-16	1925	0.5	0.80
511	FAIRBANKS A MTH	4050603	1	84-08-20	1815	0.5	0.80
512	FAIRBANKS A PAX	4050603	1	84-08-16	2100	120.0	118.00
513	FAIRBANKS A SAT	4050603	1	84-08-10	2020	60.0	40.00
514	FAIRBANKS A SAT	4050603	1	84-08-13	1645	360.0	3368.00
515	FAIRBANKS A SAT	4050603	1	84-08-16	2040	1800.0	7580.00
516	FAIRBANKS A SAT	4050603	1	84-08-20	1950	27.0	280.00
517	FISH AT GOLD DR	4050604	1	84-08-10	1905	50.0	62.00
518	FISH AT GOLD DR	4050604	1	84-08-20	1830	19.0	28.00
519	FISH B GOLD DRG	4050604	1	84-08-13	2000	7.3	38.00
520	FISH B GOLD DRG	4050604	1	84-08-13	2300	6.9	16.00
521	FISH B GOLD DRG	4050604	1	84-08-14	200	7.5	15.00
522	FISH B GOLD DRG	4050604	1	84-08-14	500	9.5	16.00
523	FISH B GOLD DRG	4050604	1	84-08-14	800	9.2	23.00
524	FISH B GOLD DRG	4050604	1	84-08-14	1100	13.0	18.00
525	FISH B GOLD DRG	4050604	1	84-08-14	1400	12.0	24.00
526	FISH B GOLD DRG	4050604	1	84-08-14	1700	14.0	18.00
527	FISH B GOLD DRG	4050604	1	84-08-15	200	17.0	30.00
528	FISH B GOLD DRG	4050604	1	84-08-15	500	14.0	30.00
529	FISH B GOLD DRG	4050604	1	84-08-15	1100	18.0	48.00
530	FISH B GOLD DRG	4050604	1	84-08-15	1400	18.0	46.00

OBS	LOCATION	HYUNIT	SOURCE	DATE	TIME	TURB	TSS
584	LCHENA A CHRS	4050605	3	84-08-11	1905	5.8	10.0
585	LCHENA A CHRS	4050605	3	84-08-11	1915	5.4	12.0
586	LCHENA A CHRS	4050605	3	84-08-13	1819	3.5	15.0
587	LCHENA A CHRS	4050605	3	84-08-16	2200	2.2	5.0
588	LCHENA A CHRS	4050605	3	84-08-20	2100	1.9	6.4
589	LCHENA A CHSR	4050605	1	83-08-04	2020	3.8	6.0
590	LCHENA A CHSR	4050605	1	83-08-04	2200	6.1	3.0
591	LCHENA A CHSR	4050605	1	83-08-05	300	9.2	5.0
592	LCHENA A CHSR	4050605	1	83-08-05	700	8.8	6.0
593	LCHENA A CHSR	4050605	1	83-08-05	1200	5.5	6.0
594	LCHENA A CHSR	4050605	1	83-08-05	1300	4.3	4.0
595	LCHENA A CHSR	4050605	1	83-08-05	1340	5.7	6.0
596	LCHENA A CHSR	4050605	1	83-08-05	1900	3.9	6.0
597	LCHENA A CHSR	4050605	1	83-08-10	1305	8.1	10.0
598	LCHENA A CHSR	4050605	1	83-08-10	1710	9.3	12.0
599	LCHENA A CHSR	4050605	1	83-08-15	1335	8.2	6.0
600	LCHENA A CHSR	4050605	1	83-08-15	1730	7.5	5.0
601	LCHENA A NORDAL	4050605	4	84-05-09	1200	12.0	68.0
602	LCHENA A NORDAL	4050605	4	84-05-15	1200	31.0	164.0
603	LCHENA A NORDAL	4050605	4	85-05-15	1200	32.0	258.0
604	CHATANIKA A 39M	4050901	1	83-08-06	1345	9.3	5.0
605	CHATANIKA A 39M	4050901	1	83-08-06	2000	6.6	3.0
606	CHATANIKA A 39M	4050901	1	83-08-09	1030	5.8	2.0
607	CHATANIKA A 39M	4050901	1	83-08-09	1150	6.8	5.0
608	CHATANIKA A 39M	4050901	1	83-08-09	2140	5.2	3.0
609	CHATANIKA A 39M	4050901	1	83-08-12	1250	4.8	1.0
610	CHATANIKA A 39M	4050901	1	83-08-12	1430	5.7	2.0
611	CHATANIKA A 39M	4050901	1	83-08-12	2255	8.6	5.0
612	CHATANIKA A 39M	4050901	1	83-08-16	1315	12.0	18.0
613	CHATANIKA A 39M	4050901	1	83-08-16	1435	10.0	15.0
614	CHATANIKA A 39M	4050901	3	84-08-07	1255	6.9	28.0
615	CHATANIKA A 39M	4050901	3	84-08-07	1256	16.0	9.0
616	CHATANIKA A 39M	4050901	3	84-08-10	1723	65.0	32.0
617	CHATANIKA A 39M	4050901	3	84-08-14	1530	5.1	4.0
618	CHATANIKA A 39M	4050901	3	84-08-14	1540	2.2	4.0
619	CHATANIKA A 39M	4050901	3	84-08-15	705	2.3	4.4
620	CHATANIKA A 39M	4050901	3	84-08-15	1955	14.0	24.0
621	CHATANIKA A 39M	4050901	3	84-08-21	745	3.9	6.4
622	CHATANIKA A 39M	4050901	4	84-09-23	1630	13.0	3.2
623	CHATANIKA A 59M	4050901	4	84-09-23	1510	12.0	6.7
624	CHATANIKA A DOT	4050901	3	84-08-18	1605	8.0	9.0
625	CHATANIKA A ELL	4050901	1	83-08-07	1110	3.2	2.0
626	CHATANIKA A ELL	4050901	1	83-08-07	2010	8.0	4.0
627	CHATANIKA A ELL	4050901	1	83-08-11	1115	4.5	3.0
628	CHATANIKA A ELL	4050901	1	83-08-11	2145	3.3	2.0
629	CHATANIKA A ELL	4050901	1	83-08-13	1130	4.9	2.0
630	CHATANIKA A ELL	4050901	1	83-08-14	210	4.6	3.0
631	CHATANIKA A ELL	4050901	4	84-05-09	1200	13.0	69.0
632	CHATANIKA A ELL	4050901	4	84-05-15	1200	16.0	84.0
633	CHATANIKA A ELL	4050901	3	84-08-12	1122	11.0	8.0
634	CHATANIKA A ELL	4050901	3	84-08-16	2118	4.2	4.0
635	CHATANIKA A ELL	4050901	3	84-08-19	1410	6.3	10.0
636	CHATANIKA A ELL	4050901	4	85-05-15	1200	29.0	227.0

OBS	LOCATION	HYUNIT	SOURCE	DATE	TIME	TURB	TSS
690	CHATANIKA ALONG	4050901	3	84-08-09	220	3.9	6.0
691	CHATANIKA ALONG	4050901	3	84-08-09	520	7.8	7.0
692	CHATANIKA ALONG	4050901	3	84-08-09	820	70.0	71.0
693	CHATANIKA ALONG	4050901	3	84-08-09	1120	95.0	100.0
694	CHATANIKA ALONG	4050901	3	84-08-09	1420	40.0	43.0
695	CHATANIKA ALONG	4050901	3	84-08-09	1720	18.0	22.0
696	CHATANIKA ALONG	4050901	3	84-08-09	2020	8.2	7.0
697	CHATANIKA ALONG	4050901	3	84-08-09	2320	4.1	11.0
698	CHATANIKA ALONG	4050901	3	84-08-10	220	3.6	4.0
699	CHATANIKA ALONG	4050901	3	84-08-10	520	30.0	29.0
700	CHATANIKA ALONG	4050901	3	84-08-10	725	3.7	6.0
701	CHATANIKA ALONG	4050901	3	84-08-10	820	60.0	69.0
702	CHATANIKA ALONG	4050901	3	84-08-10	1120	85.0	99.0
703	CHATANIKA ALONG	4050901	3	84-08-10	1420	37.0	69.0
704	CHATANIKA ALONG	4050901	3	84-08-10	1620	24.0	24.0
705	CHATANIKA ALONG	4050901	3	84-08-10	1706	15.0	19.0
706	CHATANIKA ALONG	4050901	3	84-08-14	1554	9.4	4.0
707	CHATANIKA ALONG	4050901	3	84-08-14	1600	4.7	7.2
708	CHATANIKA ALONG	4050901	3	84-08-15	1930	7.3	10.0
709	CHATANIKA ALONG	4050901	3	84-08-21	805	4.1	3.6
710	CHATANIKA ALONG	4050901	4	84-09-23	1610	14.0	5.0
711	CHATANIKA B FAI	4050901	1	83-08-06	1725	45.0	120.0
712	CHATANIKA B FAI	4050901	1	83-08-09	1510	37.0	38.0
713	CHATANIKA B FAI	4050901	1	83-08-09	1730	32.0	27.0
714	CHATANIKA B FAI	4050901	1	83-08-09	2030	29.0	75.0
715	CHATANIKA B FAI	4050901	1	83-08-09	2330	38.0	30.0
716	CHATANIKA B FAI	4050901	1	83-08-10	230	70.0	80.0
717	CHATANIKA B FAI	4050901	1	83-08-10	530	75.0	90.0
718	CHATANIKA B FAI	4050901	1	83-08-10	830	70.0	76.0
719	CHATANIKA B FAI	4050901	1	83-08-10	1130	55.0	62.0
720	CHATANIKA B FAI	4050901	1	83-08-10	1430	38.0	48.0
721	CHATANIKA B FAI	4050901	1	83-08-10	1730	50.0	46.0
722	CHATANIKA B FAI	4050901	1	83-08-10	2030	34.0	40.0
723	CHATANIKA B FAI	4050901	1	83-08-10	2330	60.0	68.0
724	CHATANIKA B FAI	4050901	1	83-08-11	230	90.0	110.0
725	CHATANIKA B FAI	4050901	1	83-08-11	530	140.0	144.0
726	CHATANIKA B FAI	4050901	1	83-08-11	830	110.0	118.0
727	CHATANIKA B FAI	4050901	1	83-08-11	1130	85.0	88.0
728	CHATANIKA B FAI	4050901	1	83-08-11	1430	60.0	42.0
729	CHATANIKA B FAI	4050901	1	83-08-11	1730	36.0	32.0
730	CHATANIKA B FAI	4050901	1	83-08-11	1855	38.0	36.0
731	CHATANIKA B FAI	4050901	1	83-08-11	2030	36.0	28.0
732	CHATANIKA B FAI	4050901	1	83-08-11	2330	70.0	72.0
733	CHATANIKA B FAI	4050901	1	83-08-12	230	140.0	132.0
734	CHATANIKA B FAI	4050901	1	83-08-12	530	150.0	152.0
735	CHATANIKA B FAI	4050901	1	83-08-12	830	130.0	134.0
736	CHATANIKA B FAI	4050901	1	83-08-12	1130	120.0	100.0
737	CHATANIKA B FAI	4050901	1	83-08-12	1430	85.0	64.0
738	CHATANIKA B FAI	4050901	1	83-08-12	1730	55.0	44.0
739	CHATANIKA B FAI	4050901	1	83-08-12	1930	55.0	42.0
740	CHATANIKA B FAI	4050901	1	83-08-12	2010	40.0	48.0
741	CHATANIKA B FAI	4050901	1	83-08-16	1930	20.0	22.0
742	CHATANIKA B FAI	4050901	1	83-08-16	2025	32.0	37.0

OBS	LOCATION	HYUNIT	SOURCE	DATE	TIME	TURB	TSS
796	FAITH A STEESE	4050904	1	83-08-06	1645	45.0	44.0
797	FAITH A STEESE	4050904	1	83-08-06	1740	120.0	182.0
798	FAITH A STEESE	4050904	1	83-08-09	1500	120.0	71.0
799	FAITH A STEESE	4050904	1	83-08-09	1730	60.0	56.0
800	FAITH A STEESE	4050904	1	83-08-12	1805	80.0	76.0
801	FAITH A STEESE	4050904	1	83-08-12	2000	70.0	86.0
802	FAITH A STEESE	4050904	1	83-08-16	1910	31.0	39.0
803	FAITH A STEESE	4050904	1	83-08-16	2005	55.0	78.0
804	FAITH A STEESE	4050904	3	84-08-07	1715	140.0	260.0
805	FAITH A STEESE	4050904	3	84-08-07	1722	120.0	290.0
806	FAITH A STEESE	4050904	1	84-08-10	1516	39.0	59.0
807	FAITH A STEESE	4050904	3	84-08-14	1555	140.0	170.0
808	FAITH A STEESE	4050904	3	84-08-15	805	14.0	21.0
809	FAITH A STEESE	4050904	3	84-08-15	1825	120.0	416.0
810	FAITH A STEESE	4050904	3	84-08-21	900	17.0	14.0
811	FAITH A STEESE	4050904	3	84-08-21	2230	65.0	148.0
812	FAITH A STEESE	4050904	4	84-09-23	1445	40.0	29.0
813	FAITH AB MCCLAI	4050904	3	84-08-21	950	12.0	19.0
814	FAITH B MCINTSH	4050904	2	84-08-01	1300	2600.0	1890.0
815	FAITH B MCINTSH	4050904	2	84-08-02	1515	190.0	339.0
816	FAITH B MCINTSH	4050904	2	84-08-16	1525	550.0	465.0
817	FAITH B MCINTSH	4050904	2	84-08-17	1310	600.0	767.0
818	FAITH B MCINTSH	4050904	2	84-08-29	1555	280.0	315.0
819	FAITH B MCINTSH	4050904	2	84-08-30	1450	130.0	142.0
820	FAITH B MINE	4050904	4	85-06-09	1653	130.0	278.0
821	MCMANUS A FAITH	4050905	1	83-08-06	1655	0.3	1.0
822	MCMANUS A FAITH	4050905	1	83-08-09	1505	0.3	1.0
823	MCMANUS A FAITH	4050905	1	83-08-12	1940	0.2	1.0
824	MCMANUS A FAITH	4050905	1	83-08-16	1950	0.4	2.0
825	MCMANUS A FAITH	4050905	3	84-08-07	1615	0.2	4.0
826	MCMANUS A FAITH	4050905	3	84-08-07	1652	0.1	4.0
827	MCMANUS A FAITH	4050905	3	84-08-10	1515	0.3	4.0
828	MCMANUS A FAITH	4050905	3	84-08-14	1550	1.0	4.0
829	MCMANUS A FAITH	4050905	3	84-08-15	810	0.4	0.4
830	MCMANUS A FAITH	4050905	3	84-08-15	1830	0.5	0.5
831	MCMANUS A FAITH	4050905	3	84-08-21	910	0.3	3.2
832	MCMANUS A FAITH	4050905	4	84-09-23	1415	0.1	0.5
833	TATALINA A BRDG	4050906	4	84-05-09	1200	3.8	16.0
834	TATALINA A BRDG	4050906	4	84-05-15	1200	8.4	70.0
835	TATALINA A BRDG	4050906	3	84-08-16	1530	1.2	7.0
836	TATALINA A BRDG	4050906	4	85-05-15	1200	8.8	53.0
837	TATALINA A CHT	4050906	3	84-08-15	1326	2.3	4.0
838	GOLDSTREAM A FX	4050910	4	84-05-09	1200	40.0	90.0
839	GOLDSTREAM A FX	4050910	4	84-05-15	1200	180.0	645.0
840	GOLDSTREAM A FX	4050910	4	85-05-15	1200	75.0	726.0
841	GOLDSTREAM A LR	4050910	3	84-08-15	1200	190.0	128.0
842	GOLDSTREAM A MT	4050910	3	84-08-15	1240	30.0	60.0
843	GOLDSTREAM ALOG	4050910	1	84-08-15	1200	190.0	128.0
844	GOLDSTREAM B FX	4050910	1	83-08-06	1225	330.0	556.0
845	GOLDSTREAM B FX	4050910	1	83-08-08	1050	300.0	292.0
846	GOLDSTREAM B FX	4050910	1	83-08-08	1130	300.0	272.0
847	GOLDSTREAM B FX	4050910	1	83-08-14	1455	260.0	250.0
848	GOLDSTREAM B FX	4050910	1	83-08-14	1540	270.0	282.0

OBS	LOCATION	HYUNIT	SOURCE	DATE	TIME	TURB	TSS
902	GILMORE B BDMIN	4050912	2	84-06-13	1155	280.00	20.0
903	GILMORE B BDMIN	4050912	2	84-06-13	1825	1100.00	595.0
904	GILMORE B BDMIN	4050912	2	84-06-14	940	500.00	195.0
905	GILMORE B BDMIN	4050912	2	84-06-14	1430	550.00	256.0
906	GILMORE B BDMIN	4050912	2	84-06-14	1830	600.00	198.0
907	GILMORE B BDMIN	4050912	2	84-06-15	1155	500.00	324.0
908	GILMORE B BDMIN	4050912	2	84-06-15	1355	550.00	256.0
909	GILMORE B BDMIN	4050912	2	84-06-15	1510	650.00	332.0
910	GILMORE B BDMIN	4050912	2	84-06-16	955	700.00	190.0
911	GILMORE B BDMIN	4050912	2	84-06-16	1140	650.00	195.0
912	GILMORE B BDMIN	4050912	2	84-06-16	1430	850.00	305.0
913	GILMORE B BDMIN	4050912	2	84-06-17	1120	750.00	235.0
914	GILMORE B BDMIN	4050912	2	84-06-17	1250	700.00	374.0
915	GILMORE B BDMIN	4050912	2	84-06-17	1515	900.00	315.0
916	GILMORE B BDMIN	4050912	2	84-07-09	1415	5300.00	1300.0
917	GILMORE B BDMIN	4050912	2	84-07-09	1610	3400.00	600.0
918	GILMORE B BDMIN	4050912	2	84-07-09	1700	2900.00	620.0
919	GILMORE B BDMIN	4050912	2	84-07-10	1300	3000.00	660.0
920	GILMORE B BDMIN	4050912	2	84-07-10	1610	3200.00	620.0
921	GILMORE B BDMIN	4050912	2	84-07-10	1715	3100.00	620.0
922	GILMORE B BDMIN	4050912	2	84-07-11	940	3000.00	670.0
923	GILMORE B BDMIN	4050912	2	84-07-11	1310	2800.00	730.0
924	GILMORE B BDMIN	4050912	2	84-07-11	1525	2600.00	1050.0
925	GILMORE B BDMIN	4050912	2	84-07-12	1000	3400.00	960.0
926	GILMORE B BDMIN	4050912	2	84-07-12	1230	3100.00	820.0
927	GILMORE B BDMIN	4050912	2	84-07-12	1540	2300.00	430.0
928	GILMORE B BDMIN	4050912	2	84-07-13	930	1600.00	365.0
929	GILMORE B BDMIN	4050912	2	84-07-13	1245	1200.00	300.0
930	GILMORE B BDMIN	4050912	2	84-07-13	1510	1600.00	337.0
931	GILMORE B BDMIN	4050912	2	84-08-25	1210	1400.00	305.0
932	GILMORE B BDMIN	4050912	2	84-08-25	1515	1600.00	445.0
933	GILMORE B BDMIN	4050912	2	84-08-25	1755	2200.00	740.0
934	GILMORE B BDMIN	4050912	2	84-08-26	1135	1700.00	480.0
935	GILMORE B BDMIN	4050912	2	84-08-26	1440	2200.00	720.0
936	GILMORE B BDMIN	4050912	2	84-08-26	1630	2800.00	1240.0
937	GILMORE B BDMIN	4050912	2	84-08-27	1130	2100.00	560.0
938	GILMORE B BDMIN	4050912	2	84-08-27	1525	1900.00	620.0
939	GILMORE B BDMIN	4050912	2	84-08-27	1725	1800.00	460.0
940	GILMORE B BDMIN	4050912	2	84-08-28	1130	2100.00	580.0
941	GILMORE B BDMIN	4050912	2	84-08-28	1440	1600.00	460.0
942	GILMORE B BDMIN	4050912	2	84-08-28	1625	1600.00	420.0
943	GILMORE B BDMIN	4050912	2	84-08-29	1135	1600.00	500.0
944	GILMORE B BDMIN	4050912	2	84-08-29	1630	1600.00	420.0
945	GILMORE B BDMIN	4050912	2	84-08-29	1800	1700.00	440.0
946	PEDRO A MTH	4050913	1	83-08-14	1445	70.00	34.0
947	PEDRO A MTH	4050913	1	83-08-16	1235	55.00	70.0
948	PEDRO A MTH	4050913	3	84-08-10	1812	90.00	93.0
949	PEDRO A MTH	4050913	3	84-08-13	1900	30.00	34.0
950	TOLOVANA A BRDG	4050920	4	84-05-09	1200	2.40	10.0
951	TOLOVANA A BRDG	4050920	4	84-05-15	1200	3.80	30.0
952	TOLOVANA A BRDG	4050920	3	84-08-12	1255	1.60	1.0
953	TOLOVANA A BRDG	4050920	4	85-05-15	1200	4.20	24.0
954	TOLOVANA A BRDG	4050920	4	85-08-07	1440	1.02	1.2

OBS	LOCATION	HYUNIT	SOURCE	DATE	TIME	TURB	TSS
1008	TOLOVANA A WF	4050920	3	84-08-13	1020	12.0	27.0
1009	TOLOVANA A WF	4050920	3	84-08-13	1320	8.6	15.0
1010	TOLOVANA A WF	4050920	3	84-08-13	1620	5.4	13.0
1011	TOLOVANA A WF	4050920	3	84-08-13	1920	24.0	52.0
1012	TOLOVANA A WF	4050920	3	84-08-13	2220	12.0	30.0
1013	TOLOVANA A WF	4050920	3	84-08-14	120	16.0	23.0
1014	TOLOVANA A WF	4050920	3	84-08-14	420	10.0	17.0
1015	TOLOVANA A WF	4050920	3	84-08-14	720	23.0	23.0
1016	TOLOVANA A WF	4050920	3	84-08-14	1020	15.0	23.0
1017	TOLOVANA A WF	4050920	3	84-08-14	1320	33.0	65.0
1018	TOLOVANA A WF	4050920	3	84-08-14	1620	38.0	83.0
1019	TOLOVANA A WF	4050920	3	84-08-14	1920	26.0	55.0
1020	TOLOVANA A WF	4050920	3	84-08-14	2220	8.7	20.0
1021	TOLOVANA A WF	4050920	3	84-08-15	120	5.7	14.0
1022	TOLOVANA A WF	4050920	3	84-08-15	420	5.9	17.0
1023	TOLOVANA A WF	4050920	3	84-08-15	720	14.0	19.0
1024	TOLOVANA A WF	4050920	3	84-08-15	1020	9.2	15.0
1025	TOLOVANA A WF	4050920	3	84-08-15	1320	14.0	24.0
1026	TOLOVANA A WF	4050920	3	84-08-15	1620	16.0	21.0
1027	TOLOVANA A WF	4050920	3	84-08-15	1920	16.0	39.0
1028	TOLOVANA A WF	4050920	3	84-08-15	2220	34.0	60.0
1029	TOLOVANA A WF	4050920	3	84-08-16	120	32.0	56.0
1030	TOLOVANA A WF	4050920	3	84-08-16	1415	28.0	36.0
1031	TOLOVANA A WF	4050920	3	84-08-16	1415	17.0	43.0
1032	TOLOVANA A WILB	4050920	3	84-08-16	1900	1.2	5.0
1033	TOLOVANA A WILB	4050920	3	84-08-16	1907	2.3	4.0
1034	TOLOVANA B WF	4050920	1	83-08-07	1430	8.6	12.0
1035	TOLOVANA B WF	4050920	1	83-08-07	1520	8.1	9.0
1036	TOLOVANA B WF	4050920	1	83-08-11	1540	14.0	36.0
1037	TOLOVANA B WF	4050920	1	83-08-11	1605	12.0	30.0
1038	TOLOVANA B WF	4050920	3	84-08-12	1658	16.0	35.0
1039	TOLOVANA B WF	4050920	3	84-08-16	1356	15.0	23.0
1040	TOLOVANA B WILB	4050920	1	84-08-12	2012	6.8	21.0
1041	TOLOVANA B WILB	4050920	1	84-08-12	2125	120.0	710.0
1042	TOLOVANA B WILB	4050920	1	84-08-16	1910	180.0	1400.0
1043	TOLOVANA WF	4050920	3	84-08-12	1642	1.6	4.0
1044	TOLOVANA WF	4050920	3	84-08-12	1747	0.7	14.0
1045	TOLOVANA WF	4050920	3	84-08-16	1602	0.7	4.0
1046	TOLOVANA WF	4050920	3	84-08-16	1602	0.7	3.0
1047	TOLOVANA WF ACG	4050920	1	83-08-07	1335	0.6	0.5
1048	TOLOVANA WF ACG	4050920	1	83-08-11	1420	1.9	1.0
1049	TOLOVANA WF ACG	4050920	1	83-08-11	1850	1.3	2.0
1050	LIVENGOOD A BRD	4050921	4	84-05-09	1200	180.0	525.0
1051	LIVENGOOD A BRD	4050921	4	84-05-15	1200	220.0	890.0
1052	LIVENGOOD A BRD	4050921	3	84-08-12	1330	190.0	284.0
1053	LIVENGOOD A BRD	4050921	3	84-08-12	1815	260.0	230.0
1054	LIVENGOOD A BRD	4050921	3	84-08-16	1750	17.0	25.0
1055	LIVENGOOD A BRD	4050921	3	84-08-16	1750	12.0	24.0
1056	LIVENGOOD A BRD	4050921	4	85-05-15	1200	230.0	757.0
1057	LIVENGOOD A BRG	4050921	1	83-08-07	1740	10.0	13.0
1058	LIVENGOOD A BRG	4050921	1	83-08-11	1300	170.0	234.0
1059	LIVENGOOD A BRG	4050921	1	83-08-11	1925	26.0	30.0
1060	LIVENGOOD A ELL	4050921	4	85-08-07	1425	24.0	105.0

OBS	LOCATION	HYUNIT	SOURCE	DATE	TIME	TURB	TSS
1114	WISEMAN A NOLAN	4060101	1	84-08-08	1735	3.70	14.0
1115	MASCOT B MINE	4060102	4	85-06-11	2200	4.00	7.7
1116	KOYUKUK SF A DA	4060201	1	84-08-03	1615	5.20	6.0
1117	KOYUKUK SF A DA	4060201	1	84-08-09	1500	0.70	3.2
1118	KOYUKUK SF A DA	4060201	4	85-08-16	1150	0.30	0.8
1119	KOYUKUK SF AHWY	4060201	1	83-08-13	2100	0.90	1.0
1120	PROSPECT A DALT	4060201	3	84-08-09	1550	2.90	8.0
1121	PROSPECT A MINE	4060201	4	85-07-30	1200	0.34	0.3
1122	PROSPECT A MING	4060201	4	85-08-13	1030	2.80	6.3
1123	PROSPECT A PIPE	4060201	4	85-08-16	1050	55.00	294.0
1124	PROSPECT B MING	4060201	4	85-08-13	1940	280.00	194.0
1125	PROSPECT B MING	4060201	4	85-08-15	140	65.00	48.0
1126	PROSPECT B MING	4060201	4	85-08-15	2240	85.00	73.0
1127	PROSPECT B MING	4060201	4	85-08-16	740	50.00	180.0
1128	PROSPECT B PIPE	4060201	4	85-08-01	1010	25.00	9.4

A. Standard Error of Estimate.

Because the linear regression uses logarithmic transformation of the data, the calculated standard error of estimate is a logarithm. In this report it is reported as a percentage which is calculated by adding (and substracting) the SEE to the logarithm of a base linear value, back transforming the result to a linear value, subtracting the base linear value from this result and dividing by the base linear value. Below is a sample calculation:

The standard error of estimate for the log-log equation for the combined data from Birch Creek basin is 0.243. Assume a linear value of 200 milligrams per liter.

$$+SEE(\%)=[(10^{(\log(200)+.243)})-200]/200 = .75 \text{ or } 75 \text{ percent}$$

$$-SEE(\%)=[200-10^{(\log(200)-.243)}]/200$$

$$= .43 \text{ or } 43 \text{ percent}$$

different basins, streams or sites are similar, indicator variables for the different locations are added to the basic turbidity-TSS model. An F test is performed to see if the slope and y intercept coefficients of the full model (with indicator variables) are statistically different from those of a reduced model (without indicator variables) at a specified confidence level. The equation for this relationship is:

$$F^* = [(SSE_R - SSE_F)/(df_R - df_F)]/(SSE_F/df_F),$$

where:

SSE_F is the error sum of squares for the full model,
SSE_R is the error sum of squares for the reduced model,
df_F is the degrees of freedom for the full model, and
df_R is the degrees of freedom for the reduced model.

If the calculated F^* is less than F at a specified confidence level (F values are from an F value table), the inference is that the two groups of data are not statistically different at that level (Neter, Wasserman, and Kutner 1985). This type of analysis can also be used to see if data from different years or sources can be combined.

SAMPLE LOCATION	DATE & TIME	TURB lab (NTU)	TURB field (NTU)	TSS reprtd (mg/l)	TSS calcltd (mg/l)	Diff Rpt-Calc	Z VALUE (R-P)/SEE

A. Data collected by DEC at various location in interior Alaska in 1985.

SAMPLE LOCATION	DATE & TIME	TURB lab (NTU)	TURB field (NTU)	TSS reprtd (mg/l)	TSS calcltd (mg/l)	Diff Rpt-Calc	Z VALUE (R-P)/SEE
CHATANIKA A POK	85081605		4.2	1.0	3.5	-2.5	-0.79
" " "	85081676		6.5	8.0	5.7	2.3	0.45
CHATANIKA A 39 M	85081606		4.4	1.0	3.0	-2.0	-0.58
CHATANIKA A LONG	85081607		115.0	15.0	127.2	-112.2	-1.88
" " "	85081650		30.0	7.0	26.1	-19.1	-1.56
" " "	85081651		12.0	12.0	8.9	3.1	0.76
" " "	85081652		7.0	6.0	4.7	1.3	0.59
" " "	85081653		6.5	3.0	4.3	-1.3	-0.64
" " "	85081654		8.5	2.0	5.9	-3.9	-1.41
" " "	85081655		18.0	4.0	14.3	-10.3	-1.53
" " "	85081656		28.0	21.0	24.0	-3.0	-0.27
" " "	85081657		44.0	14.0	41.0	-27.0	-1.40
" " "	85081658		37.0	12.0	33.4	-21.4	-1.36
" " "	85081659		34.0	1.0	30.2	-29.2	-2.06
" " "	85081661		22.0	4.0	18.1	-14.1	-1.66
" " "	85081662		20.0	5.0	16.2	-11.2	-1.47
" " "	85081663		33.0	4.0	29.2	-25.2	-1.84
" " "	85081664		22.0	11.0	18.1	-7.1	-0.83
" " "	85081665		38.0	12.0	34.5	-22.5	-1.39
" " "	85081666		30.0	8.0	26.1	-18.1	-1.48
" " "	85081667		33.0	8.0	29.2	-21.2	-1.54
" " "	85081668		24.0	6.0	20.1	-14.1	-1.49
" " "	85081669		22.0	5.0	18.1	-13.1	-1.54
" " "	85081670		21.0	5.0	17.1	-12.1	-1.51
" " "	85081671		32.0	5.0	28.1	-23.1	-1.75
" " "	85081672		44.0	13.0	41.0	-28.0	-1.45
" " "	85081673		39.0	10.0	35.5	-25.5	-1.53
" " "	85081674		38.0	4.0	34.5	-30.5	-1.88
" " "	85081675		40.0	8.0	36.6	-28.6	-1.66
			Average for Chatanika at Long Cr				-1.30
FAITH ABOVE MCMAN	85081609		290.0	76.0	345.1	-269.1	-1.39
" " "	85081623		93.0	31.0	119.9	-88.9	-1.32
CHATANIKA B F&M	85081625		62.0	11.0	87.6	-76.6	-1.03
" " "	85081626		164.0	36.0	206.9	-170.9	-0.97
" " "	85081627		104.0	28.0	138.4	-110.4	-0.94
" " "	85081629		264.0	97.0	315.2	-218.2	-0.82
" " "	85081630		310.0	110.0	363.3	-253.3	-0.82
" " "	85081631		240.0	80.0	289.8	-209.8	-0.85
" " "	85081632		276.0	100.0	327.9	-227.9	-0.82
" " "	85081633		200.0	54.0	246.6	-192.6	-0.92

Appendix C. (Continued)

SAMPLE LOCATION	DATE & TIME	TURB lab (NTU)	TURB field (NTU)	TSS reprtd (mg/l)	TSS calcltd (mg/l)	Diff Rpt-Calc	Z VALUE (R-P)/SEE
EAST F TOLOVANA	85081954	5.50		6.0	9.5	-3.5	-0.69
" " "	85081955	5.90		13.0	10.3	2.7	0.50
" " "	85081956	5.50		3.0	9.5	-6.5	-1.29
" " "	85081957	4.90		6.0	8.4	-2.4	-0.54
" " "	85081958	4.70		7.0	8.0	-1.0	-0.24
" " "	85081959	6.80		12.0	12.0	0.0	0.01
" " "	85081960	6.50		10.0	11.4	-1.4	-0.23
" " "	85081961	12.00		58.0	22.1	35.9	3.05
" " "	85081962	6.80		12.0	12.0	0.0	0.01
" " "	85081963	5.50		6.0	9.5	-3.5	-0.69
" " "	85081964	4.90		6.0	8.4	-2.4	-0.54
" " "	85081965	5.00		6.0	8.6	-2.6	-0.56
" " "	85081966	5.50		6.0	9.5	-3.5	-0.69
" " "	85081967	5.60		7.0	9.7	-2.7	-0.52
" " "	85081968	6.20		8.0	10.8	-2.8	-0.49
" " "	85081969	6.10		8.0	10.6	-2.6	-0.47
" " "	85081970	6.40		7.0	11.2	-4.2	-0.71
" " "	85081971	5.10		6.0	8.8	-2.8	-0.59
" " "	85081972	4.70		5.0	8.0	-3.0	-0.71
			Average for Tolovana ab West For				-0.25
TOLOVANA A TAPS	85081973	5.80		4.0	10.1	-6.1	-1.13
" " "	85081974	5.70		5.0	9.9	-4.9	-0.93
" " "	85081975	5.40		5.0	9.3	-4.3	-0.87
" " "	85081976	5.60		6.0	9.7	-3.7	-0.72
" " "	85081977	6.20		8.0	10.8	-2.8	-0.49
" " "	85081978	6.40		10.0	11.2	-1.2	-0.20
" " "	85081979	5.00		11.0	8.6	2.4	0.53
" " "	85081980	5.50		6.0	9.5	-3.5	-0.69
" " "	85081981	5.70		11.0	9.9	1.1	0.21
" " "	85081982	5.40		9.0	9.3	-0.3	-0.06
" " "	85081983	5.70		9.0	9.9	-0.9	-0.17
" " "	85081984	6.00		7.0	10.4	-3.4	-0.62
" " "	85081985	6.20		9.0	10.8	-1.8	-0.32
" " "	85081986	5.70		5.0	9.9	-4.9	-0.93
" " "	85081987	5.60		9.0	9.7	-0.7	-0.13
" " "	85081988	5.30		6.0	9.1	-3.1	-0.65
" " "	85081989	5.10		3.0	8.8	-5.8	-1.24
" " "	85081990	5.10		6.0	8.8	-2.8	-0.59
" " "	85081991	4.90		5.0	8.4	-3.4	-0.76
" " "	85081992	5.00		6.0	8.6	-2.6	-0.56
" " "	85081993	4.70		6.0	8.0	-2.0	-0.47
" " "	85081994	4.80		9.0	8.2	0.8	0.18
" " "	85081995	4.40		10.0	7.5	2.5	0.64
" " "	85081996	5.30		6.0	9.1	-3.1	-0.65