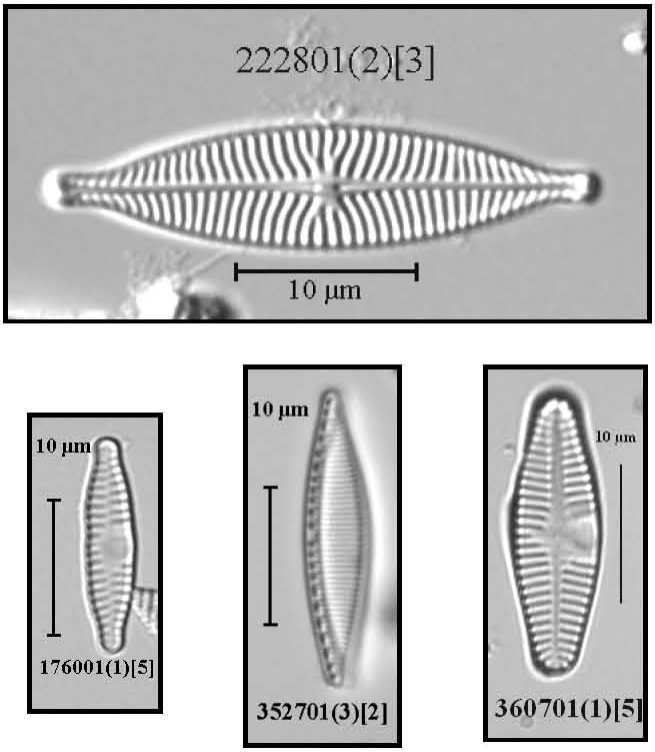
INTERPRETATION OF PERIPHYTON SAMPLES FOR MONTANA STREAMS - MIDDLE ROCKIES ECOREGION 2006



Prepared By:
Mark Teply
Larix Systems, Inc.

Loren Bahls
Hannaea

Prepared For:

The Montana Department of Environmental Quality.
Water Quality Monitoring Section. Rosie Sada. Project Manager.
1520 E 6th Avenue. Helena, MT 59620.

October 5, 2006

Cover. Examples of common diatom species in streams of the Middle Rockies ecoregion of Montana whose populations increase in response to sediment impairment. Top: *Navicula capitatoradiata.* Bottom (l to r): *Fragilaria vaucheriae, Nitzschia fonticola, Planothidium lanceolatum*.

Interpretation of Periphyton Samples for Montana Streams - Middle Rockies Ecoregion

Prepared by

Mark Teply[1] and Loren Bahls[2]

October 2006

[1] Larix Systems, Inc., 44 No. Last Chance Gulch, No. 4, Helena, MT 59601. (406) 458-0045.

[2] Hannaea, 1032 12th Street, Helena, MT 59601. (406) 443-2196.

Table of Contents

List of Tables

Introduction

This paper provides guidance for interpretation of periphtyon sample results from wadeable streams within or heavily influenced by the Middle Rockies Ecoregion (USEPA 2000). It incorporates biocriteria recently developed by Teply and Bahls (2006) and those originally presented by Bahls (1993). Biocriteria developed by Teply and Bahls (2006) use statistical models to predict, with known reliability, the probability of impairment under 303(d) guidelines due to sedimentation. Biocriteria developed by Bahls (1993) use thresholds to assign ratings for impairment due to sediment, nutrients, and/or metals. The thresholds used by Bahls (1993) are not statistically-based, but independent validation by Teply and Bahls (2005) yields several empirically-based rules for their qualified use in impairment determinations. In both instances, of specific interest to the Montana Department of Environmental Quality is the level of impairment where aquatic life use support is partial or none.

Sediment Increaser Taxa

Biocriteria presented by Teply and Bahls (2006) use Sediment Increaser Taxa – common diatom taxa whose relative abundance increases in response to impairment due to sediment (see **Table 1**). While many diatoms can be cited to either be sensitive or be tolerant to sediment, the empirical approach employed by Teply and Bahls (2006) indicates that these taxa are most likely to take advantage of sediment stress in streams within or heavily influenced by the Middle Rockies Ecoregion. Furthermore, as a group, these Sediment Increaser Taxa are not prone to indicate impairment for any other reason than sediment. Given the lack of numeric State standards for sediment impairment, this model can offer an important piece of evidence in water quality assessments. Specific interpretations of Sediment Increaser Taxa follow below.

Those in the genera *Navicula* and *Nitzschia*, plus *Eolimna minima* and *Sellaphora pupula*, are motile and capable of maintaining their position on aggrading substrates composed of fine sediment. Two species — *Amphora pediculus* and *Planothidium*

lanceolatum — are adapted to live attached to sand grains. Several others — *Fragilaria vaucheriae, Staurosira construens, Staurosirella leptostauron, Staurosirella pinnata, and Stephanocyclus meneghiniana* — are nonmotile and unattached. These species prosper only in slower current velocities where sediments are prone to accumulate. The two remaining species on the list — *Cocconeis pediculus* and *Gomphonema parvulum* — are attached species that serve as secondary indicators of sedimentation. *Cocconeis pediculus* is primarily an epiphyte on *Cladophora*, which prospers mainly in nutrient-rich waters with slow to moderate current velocities where sedimentation is an issue. *Gomphonema parvulum* indicates organic enrichment, which is usually associated with sedimentation, both organic and inorganic sediment (e.g., see Beaver 1981, Lange-Bertalot 1979, Lowe 1974, van Dam et al. 1994, and others).

Table 1. Sediment Increaser Taxa screened for streams in the Middle Rockies ecoregion.

Sediment Increaser Taxa
Amphora pediculus
Cocconeis pediculus
Eolimna minima
Fragilaria vaucheriae
Gomphonema parvulum
Navicula capitatoradiata
Navicula reichardtiana
Navicula tripunctata
Nitzschia fonticola
Nitzschia heufleriana
Nitzschia linearis
Planothidium lanceolatum
Sellaphora pupula
Staurosira construens
Staurosirella leptostauron
Staurosirella pinnata
Stephanocyclus meneghiniana

For water quality assessments, the following guidance is offered for interpretation of periphyton samples from wadeable streams within or heavily influenced by the Middle Rockies Ecoregion using Sediment Increaser Taxa. **Appendix A** provides example

interpretations following this guidance for both unimpaired and impaired streams.

Statement of Biocriterion

All interpretations using Sediment Increaser Taxa should begin with the following statement, clarifying the basis for the interpretation to follow:

> *"Sample diatom taxa counts were evaluated to determine the probability of sediment impairment using the Sediment Increaser Taxa List for the Middle Rockies Ecoregion (Teply and Bahls 2006)."*

This statement can be made on a sample-by-sample basis or to cover an entire group of samples evaluated using this biocriterion.

Sediment Increaser Taxa

The investigator would then summarize Sediment Increaser Taxa appearing in the sample, and qualify their autecological importance as indicators of stress due to sedimentation, as follows:

> *"[Number of Sediment Increaser Taxa] diatom taxa on the Sediment Increaser Taxa List were counted, representing a total percent relative abundance of [PRA of Sediment Increaser Taxa]. These taxa have autecological affinities that make them suitable indicators of sedimentation (see Teply and Bahls 2006)."*

The percent relative abundance stated would simply be calculated as the sum of percent relative abundance values for all Sediment Increaser Taxa occurring in the sample. Optionally, the investigator, with the assistance of a qualified periphyton ecologist, can expand on autecological affinities if they are of particular relevance in interpreting the sample results. Statements can be derived from the taxa-specific interpretations provided above.

Probability of Sediment Impairment

The probability of the sample representing a stream impaired due to sediment can be determined via **Table 2**. This table translates the model developed by Teply and Bahls (2006) into a simplified rating scale. Recognizing the many uncertainties that underlay any predictive model, it is adequate for the investigator to state a range of probabilities in practical application. For instance, if the percent relative abundance of taxa on the Sediment Increaser Taxa list is 35 percent, the probability that the sample represents a stream impaired by sediment can be stated to be about 80 to 90%. For very low (<5%) or very high (>45%) percent relative abundance values, it is adequate to state that the probability of impairment is less than 5% or greater than 95%, respectively.

Table 2. Probability of sediment impairment in streams in the Middle Rockies Ecoregion based on the percent relative abundance of Sediment Increaser Taxa (Table 1).

Percent Relative Abundance	Approx. Probability of Sediment Impairment
4.65	5%
8.99	10%
14.25	20%
18.04	30%
21.28	40%
24.31	50%
27.33	60%
30.57	70%
34.36	80%
39.62	90%
43.95	95%

Using this guidance, the following statement should be made:

> *"This indicates that the sample represents a stream that has about a [Probability of Sediment Impairment] percent probability of being impaired due to sediment under 303(d) guidelines. This model does not consider other causes of impairment and this result does not indicate whether the stream may or may not be impaired due to other causes."*

Statement of Reliability

Finally, the interpretation of Sediment Increaser Taxa should conclude with a statement of reliability about the biocriterion, as follows:

> *"The model used to make this determination was statistically significant ($p<0.01$) and overall classification accuracy was independently verified to be 68%."*

This statement can be made on a sample-by-sample basis or to cover an entire group of samples evaluated using this biocriterion.

Original Diatom Metrics

While not reliable in discriminating impaired streams from unimpaired streams, there are selected instances where the original metrics used by Bahls (1993) are still useful. These interpretations are informed by the universality of knowledge about specific taxa and are beyond the realm of statistical modeling. This can lead to an interpretation of impairment due to sediment, nutrients, and/or metals; but it requires review by a qualified periphyton ecologist and consideration of the entirety of sample results. Furthermore, reliability of the interpretation cannot be asserted statistically. Nevertheless, the biocriteria presented by Bahls (1993) still prove useful.

Therefore, the following guidance is offered for interpretation of periphyton samples from wadeable streams within or heavily influenced by the Middle Rockies Ecoregion using biocriteria presented by Bahls (1993). **Appendix A** provides example interpretations following this guidance for both unimpaired and impaired streams.

Statement of Biocriteria

All interpretations using biocriteria by Bahls (1993) should begin with the following statement, clarifying the basis for the interpretations that follow:

> *"Using the original metrics described by Bahls (1993) and autecology of the dominant species, additional interpretations can be made as follows."*

This statement can be made on a sample-by-sample basis or to cover an entire group of samples evaluated using these biocriteria.

General Rules for Interpretation

Teply and Bahls (2005) demonstrated that biocriteria presented in Bahls (1993) can be best used to indicate stressors (naturally occurring or human-caused), but cannot be reliably used to indicate unimpaired conditions. Understanding this, the following rules can be stated for using biocriteria presented by Bahls (1993) (restated in **Appendix B**) in judging levels and diagnosing causes of impairment:

1. Metric Impairment Rating is "Minor", "Moderate", or "Severe" – The following statement may be presented for each instance where a resulting metric value yields an impairment rating of "Minor", "Moderate", or "Severe" per Bahls (1993):

   "The [Metric Name] of [Metric Value] indicates [Impairment Rating] due to [Probable Cause of Impairment]."

   Cause of impairment may be human-caused (anthropogenic) or natural. Recognizing that these impairment ratings can be attributable to naturally occurring stress as well as human-caused influences, the investigator must consider the entirety of taxa results to discern the origin of the cause. In most instances, this is supported by interpretation of dominant taxa used as indicator taxa. In others, community metrics (e.g., richness or diversity) can indicate naturally occurring enrichment or other stressors. In any case, interpretation requires review by a qualified periphyton ecologist. Where an impairment rating is determined to be attributable to naturally occurring stress, the rating should be

qualified by the following statement:

"[Impairment Rating] indicated by [Metric Name] is likely due to natural stress resulting from [Reasons, e.g., fast current velocity, cold water, low nutrients]."

With the assistance of a qualified periphyton ecologist, causes of stress – naturally occurring or human-caused – can be further substantiated. For example, diagnostic autecological metrics (e.g., percent eutraphentic diatoms, percent acidophilic diatoms) may be used to identify specific environmental influences on the periphyton community.

2. Metric Impairment Rating is "None" – Teply and Bahls (2005) demonstrated that the original six metrics too often indicate unimpaired conditions when, in fact, impaired conditions are known to exist. Impairment ratings of "None" per Bahls (1993) should therefore be considered unreliable and so noted as follows:

   "Interpretations of other metric results are considered indeterminate."

   Recognizing that results are indeterminate, the investigator may consider the entirety of results to discern potential impairment. This interpretation requires review by a qualified periphyton ecologist.

Note: There may be instances where interpretation of Sediment Increaser Taxa can conflict with interpretation of Siltation Index via Bahls (1993). Siltation Index **can** indicate impairment due to sediment ("Minor", "Moderate", or "Severe") regardless of interpretation provided by the Sediment Increaser Taxa; in this case, Siltation Index would confirm or override the Sediment Increaser Taxa. Siltation Index **cannot** indicate non-impaired conditions for sediment regardless of interpretation provided by the Sediment Increaser Taxa; in this instance, Siltation Index would neither confirm nor override. In either instance, the interpretation is specific to sediment impairment and does not indicate whether the sample may or may not be impaired due to other causes.

References

Bahls, L.L. 1993. Periphyton Bioassessment Protocols for Montana Streams. Montana Department of Health and Environmental Sciences; Water Quality Bureau; Helena, Montana. Revised January 1993.

Beaver, J. 1981. Apparent Ecological Characteristics of Some Common Freshwater Diatoms. Ontario Ministry of The Environment, Technical Support Section, Don Mills, Ontario.

Lange-Bertalot, H. 1979. Pollution tolerance of diatoms as a criterion for water quality estimation. Nova Hedwigia 64:285-304.

Lowe, R.L. 1974. Environmental Requirements and Pollution Tolerance of Freshwater Diatoms. EPA-670/4-74-005. U.S. Environmental Protection Agency, National Environmental Research Center, Office of Research and Development, Cincinnati, OH.

Teply, M. and L. Bahls. 2005. Diatom Biocriteria for Montana Streams. Prepared for the Montana Department of Environmental Quality by Larix Systems, Inc. of Helena, Montana. September 2005.

Teply, M. and L. Bahls. 2006. Diatom Biocriteria for Montana Streams – Middle Rockies Ecoregion. Prepared for the Montana Department of Environmental Quality by Larix Systems, Inc. of Helena, Montana. February 2006.

US EPA. 2000. Level III Ecoregions of the Continental United States (Map). National Health and Environmental Effects Research Laboratory. Corvallis, Oregon.

van Dam, H., A. Mertens, and J. Sinkeldam. 1994. A coded checklist and ecological indicator values of freshwater diatoms from The Netherlands. Netherlands Journal of Aquatic Ecology 28(1):117-133.

Appendix A

Example Interpretations of Periphyton Samples

Stream Name: South Fork Spanish Creek, Spanish Peaks Wilderness
Segment ID: SFSpanis_407_C
ALU Support: Fully Supporting
Causes: N/A

Sample	Taxa	Count	PRA
048601	Achnanthes sp.	2	0.23
048601	Achnanthidium minutissimum	661	74.69
048601	Aulacoseira distans	1	0.11
048601	Cavinula pseudoscutiformis	1	0.11
048601	Cocconeis placentula	19	2.15
048601	Diatoma mesodon	16	1.81
048601	Diatoma tenuis	1	0.11
048601	Encyonema minutum	5	0.56
048601	Encyonema silesiacum	2	0.23
048601	Epithemia sorex	1	0.11
048601	Eunotia implicata	2	0.23
048601	Eunotia minor	1	0.11
048601	Fragilaria vaucheriae	14	1.58
048601	Frustulia crassinervia	3	0.34
048601	Gomphonema kobayasii	8	0.9
048601	Gomphonema olivaceum	2	0.23
048601	Gomphonema sp.	4	0.45
048601	Hannaea arcus	86	9.72
048601	Meridion circulare	2	0.23
048601	Navicula cryptocephala	2	0.23
048601	Nitzschia perminuta	4	0.45
048601	Nitzschia sp.	2	0.23
048601	Planothidium lanceolatum	3	0.34
048601	Reimeria sinuata	29	3.28
048601	Rossithidium pusillum	5	0.56
048601	Staurosira construens	3	0.34
048601	Synedra rumpens	4	0.45
048601	Synedra ulna	2	0.23

Sample	Metric	Value	Impairment
048601	Total Number of Species Counted	28	Minor
048601	Shannon's Diversity Index	1.67	Moderate
048601	Percent Dominant Species	74.69	Moderate
048601	Siltation Index	1.02	Indeterminate
048601	Pollution Index	2.96	Indeterminate
048601	Disturbance Index	74.69	Moderate
048601	Percent Sediment Increaser Taxa	2.26	< 5% Probability

Interpretation:

Sample diatom taxa were evaluated to determine the probability of sediment impairment using the Sediment Increaser Taxa List for the Middle Rockies Ecoregion (Teply and Bahls 2006). Three (3) diatom taxa on the Sediment Increaser Taxa List were counted, representing a total percent relative abundance of 2.26%. These taxa have autecological affinities that make them suitable indicators of sedimentation (see Teply and Bahls 2006). This indicates that the sample represents a stream that has less than a 5% probability of being impaired due to sediment under 303(d) guidelines. This model does not consider other causes of impairment and this result does not indicate whether the stream may or may not be impaired due to other causes. The model used to make this determination was statistically significant ($p<0.01$) and overall classification accuracy was independently verified to be 68%.

Using the original metrics described by Bahls (1993) and autecology of the dominant species, additional independent interpretations can be made as follows. Species Richness of 28 indicates minor impairment. The minor impairment indicated by this metric is likely due to natural stress; the relatively small number of species is typical of cold mountain streams with steep gradients and low concentrations of nutrients and dissolved solids. Similarly, moderate impairment is indicated by Shannon diversity, percent dominant species, and disturbance index. These impairment ratings are also likely due to natural stress, as expressed by the dominance of *Achnanthidium minutissimum*. *Achnanthidium minutissimum* is an adnate pioneer species that achieves high numbers in response to natural physical stress (high current velocity and substrate scour). Interpretations of other metric results are considered indeterminate.

Stream Name: Sage Creek, Headwaters to Laird Cr.
Segment ID: MT40G001_020
ALU Support: Fully Supporting
Causes: N/A

Sample	Taxa	Count	PRA
156901	Achnanthes deflexa	17	2.12
156901	Achnanthes lanceolata	6	0.75
156901	Achnanthes minutissima	57	7.12
156901	Amphora pediculus	2	0.25
156901	Cocconeis placentula	9	1.12
156901	Cymbella affinis	8	1
156901	Cymbella mexicana	2	0.25
156901	Cymbella minuta	470	58.75
156901	Cymbella sinuata	4	0.5
156901	Diatoma mesodon	19	2.38
156901	Fragilaria leptostauron	2	0.25
156901	Fragilaria pinnata	2	0.25
156901	Fragilaria vaucheriae	9	1.12
156901	Gomphonema angustatum	16	2
156901	Gomphonema subclavatum	2	0.25
156901	Hannaea arcus	133	16.62
156901	Meridion circulare	4	0.5
156901	Navicula gregaria	2	0.25
156901	Navicula minima	4	0.5
156901	Navicula reichardtiana	2	0.25
156901	Navicula tripunctata	18	2.25
156901	Nitzschia frustulum	2	0.25
156901	Stephanodiscus hantzschii	10	1.25

Sample	Metric	Value	Impairment
156901	Total Number of Species Counted	23	Minor
156901	Shannon's Diversity Index	2.27	Minor
156901	Percent Dominant Species	58.75	Moderate
156901	Siltation Index	3.5	Indeterminate
156901	Pollution Index	2.34	Minor
156901	Disturbance Index	7.12	Indeterminate
156901	Percent Sediment Increaser Taxa	5.62	~ 5% Probability

Interpretation:

Sample diatom taxa were evaluated to determine the probability of sediment impairment using the Sediment Increaser Taxa List for the Middle Rockies Ecoregion (Teply and Bahls 2006). Four (4) diatom taxa on the Sediment Increaser Taxa List were counted, representing a total percent relative abundance of 5.62%. These taxa have autecological affinities that make them suitable indicators of sedimentation (see Teply and Bahls 2006). This indicates that the sample represents a stream that has about a 5-10% probability of being impaired due to sediment under 303(d) guidelines. This model does not consider other causes of impairment and this result does not indicate whether the stream may or may not be impaired due to other causes. The model used to make this determination was statistically significant ($p<0.01$) and overall classification accuracy was independently verified to be 68%.

Using the original metrics described by Bahls (1993) and autecology of the dominant species, additional independent interpretations can be made as follows. Several metrics indicate minor or moderate impairment for various causes. The impairment ratings indicated by these metrics are likely due to natural stress. The dominant species was *Cymbella minuta,* which is a eurytopic species that prefers fresh, circumneutral waters. The next most abundant species was *Hannaea arcus*, which indicates cold waters, high levels of dissolved oxygen and low concentrations of organic and inorganic nutrients. Given the high quality waters required by these species, the stress indicated is probably natural in origin and related to cold waters and low nutrient concentrations. Interpretations of other metric results are considered indeterminate.

Stream Name: Black Bear Creek
Segment ID: MT76F003_060
ALU Support: Not Supporting
Causes: Other than Sediment, Nutrients, and Metals

Sample	Taxa	Count	PRA
331601	Achnanthidium minutissimum	11	1.3
331601	Amphora copulata	2	0.24
331601	Cocconeis placentula	30	3.55
331601	Cyclotella meneghiniana	1	0.12
331601	Cymatopleura solea	5	0.59
331601	Diatoma mesodon	1	0.12
331601	Diploneis oblongella	1	0.12
331601	Encyonema silesiacum	2	0.24
331601	Fragilaria capucina	4	0.47
331601	Frustulia vulgaris	3	0.36
331601	Gomphonema angustatum	4	0.47
331601	Gomphonema kobayasii	10	1.18
331601	Gomphonema micropus	8	0.95
331601	Gomphonema minutum	6	0.71
331601	Gomphonema parvulum	6	0.71
331601	Gomphonema subclavatum	1	0.12
331601	Hantzschia amphioxys	2	0.24
331601	Hippodonta hungarica	2	0.24
331601	Mayamaea atomus	1	0.12
331601	Melosira varians	5	0.59
331601	Meridion circulare	9	1.07
331601	Navicula antonii	2	0.24
331601	Navicula capitatoradiata	41	4.86
331601	Navicula cryptotenella	8	0.95
331601	Navicula gregaria	1	0.12
331601	Navicula lanceolata	45	5.33
331601	Navicula libonensis	13	1.54
331601	Navicula minima	32	3.79
331601	Navicula soehrensis	2	0.24
331601	Navicula subminuscula	6	0.71
331601	Navicula tenelloides	1	0.12
331601	Navicula tridentula	2	0.24
331601	Navicula tripunctata	4	0.47
331601	Navicula trivialis	6	0.71
331601	Nitzschia acicularis	4	0.47
331601	Nitzschia amphibia	8	0.95
331601	Nitzschia archibaldii	2	0.24
331601	Nitzschia dissipata	82	9.72
331601	Nitzschia frustulum	4	0.47
331601	Nitzschia incognita	2	0.24
331601	Nitzschia linearis	46	5.45
331601	Nitzschia palea	167	19.79
331601	Nitzschia paleacea	24	2.84
331601	Nitzschia perminuta	8	0.95
331601	Nitzschia pusilla	6	0.71
331601	Nitzschia recta	2	0.24
331601	Nitzschia sigmoidea	6	0.71
331601	Nitzschia sociabilis	3	0.36
331601	Nitzschia solita	13	1.54
331601	Pinnularia borealis	3	0.36
331601	Pinnularia viridis	4	0.47
331601	Planothidium frequentissimum	31	3.67
331601	Planothidium lanceolatum	9	1.07
331601	Reimeria sinuata	1	0.12
331601	Rhoicosphenia abbreviata	2	0.24
331601	Rhopalodia gibba	20	2.37
331601	Sellaphora laevissima	1	0.12
331601	Sellaphora pupula	2	0.24
331601	Simonsenia delognei	2	0.24
331601	Stauroneis kriegeri	1	0.12
331601	Stauroneis sp.	2	0.24

331601	Surirella angusta	16	1.9
331601	Surirella minuta	72	8.53
331601	Synedra acus	16	1.9
331601	Synedra ulna	6	0.71
331601	Tryblionella hungarica	2	0.24

Sample	Metric	Value	Impairment
331601	Total Number of Species Counted	66	Indeterminate
331601	Shannon's Diversity Index	4.69	Indeterminate
331601	Percent Dominant Species	19.79	Indeterminate
331601	Siltation Index	75.59	Severe
331601	Pollution Index	1.92	Moderate
331601	Disturbance Index	1.3	Indeterminate
331601	Percent Sediment Increaser Taxa	16.71	20-30% Probability

Interpretation:

Sample diatom taxa were evaluated to determine the probability of sediment impairment using the Sediment Increaser Taxa List for the Middle Rockies Ecoregion (Teply and Bahls 2006). Six (6) diatom taxa on the Sediment Increaser Taxa List were counted, representing a total percent relative abundance of 16.71%. These taxa have autecological affinities that make them suitable indicators of sedimentation (see Teply and Bahls 2006). This indicates that the sample represents a stream that has about a 20-30% probability of being impaired due to sediment under 303(d) guidelines. This model does not consider other causes of impairment and this result does not indicate whether the stream may or may not be impaired due to other causes. The model used to make this determination was statistically significant ($p<0.01$) and overall classification accuracy was independently verified to be 68%.

Using the original metrics described by Bahls (1993) and autecology of the dominant species, additional independent interpretations can be made as follows. The Siltation Index of 75.59 indicates severe impairment due to sedimentation. The Pollution Index of 1.92 indicates moderate impairment due to nutrients. The sediment impairment rating is likely due to causes other than sediment. The dominant species was *Nitzschia palea,* which is an obligate nitrogen heterotroph and hypereutrophic species that tolerates low levels of dissolved oxygen and prefers large concentrations of organic and inorganic nutrients. *Nitzschia dissipata* was the next most common species. This species requires higher levels of dissolved oxygen and indicates lower but still moderate concentrations of organic and inorganic nutrients. Together with the pollution index, they suggest elevated concentrations of organic nutrients. The dominant species (*Nitzschia palea*) also suggests that the sediment impairment indicated here may be organic and not inorganic in nature. Interpretations of other metric results are considered indeterminate.

Stream Name: Casino Creek, Headwaters to Mouth
Segment ID: MT41S004_040
ALU Support: Partially Supporting
Causes: Nutrients

Sample	Taxa	Count	PRA
200201	Achnanthes lanceolata	9	1.09
200201	Achnanthes minutissima	125	15.17
200201	Amphora inariensis	1	0.12
200201	Amphora libyca	1	0.12
200201	Amphora pediculus	5	0.61
200201	Caloneis bacillum	11	1.33
200201	Cocconeis placentula	40	4.85
200201	Cymbella silesiaca	1	0.12
200201	Fragilaria leptostauron	1	0.12
200201	Fragilaria vaucheriae	1	0.12
200201	Gomphonema dichotomum	4	0.49
200201	Gomphonema kobayasii	67	8.13
200201	Gomphonema mexicanum	4	0.49
200201	Gomphonema minutum	5	0.61
200201	Gomphonema olivaceum	3	0.36
200201	Gomphonema parvulum	51	6.19
200201	Gyrosigma spencerii	1	0.12
200201	Melosira varians	6	0.73
200201	Navicula capitatoradiata	5	0.61
200201	Navicula cryptocephala	1	0.12
200201	Navicula cryptotenella	230	27.91
200201	Navicula exilis	2	0.24
200201	Navicula gregaria	9	1.09
200201	Navicula lanceolata	8	0.97
200201	Navicula lenzii	2	0.24
200201	Navicula menisculus	14	1.7
200201	Navicula minima	4	0.49
200201	Navicula reichardtiana	2	0.24
200201	Navicula tripunctata	62	7.52
200201	Navicula trivialis	2	0.24
200201	Nitzschia alpina	2	0.24
200201	Nitzschia dissipata	125	15.17
200201	Nitzschia fonticola	1	0.12
200201	Nitzschia frustulum	1	0.12
200201	Nitzschia gracilis	2	0.24
200201	Nitzschia heufleriana	1	0.12
200201	Nitzschia inconspicua	2	0.24
200201	Nitzschia palea	4	0.49
200201	Nitzschia sociabilis	7	0.85
200201	Rhoicosphenia curvata	1	0.12
200201	Surirella minuta	1	0.12

Sample	Metric	Value	Impairment
200201	Total Number of Species Counted	41	Indeterminate
200201	Shannon's Diversity Index	3.48	Indeterminate
200201	Percent Dominant Species	27.91	Minor
200201	Siltation Index	59.1	Moderate
200201	Pollution Index	2.47	Minor
200201	Disturbance Index	15.17	Indeterminate
200201	Percent Sediment Increaser Taxa	17.23	20-30% Probability

Interpretation:

Sample diatom taxa were evaluated to determine the probability of sediment impairment using the Sediment Increaser Taxa List for the Middle Rockies Ecoregion (Teply and Bahls 2006). Eight (8) diatom taxa on the Sediment Increaser Taxa List were counted, representing a total percent relative abundance of 17.23%. These taxa have autecological affinities that make them suitable indicators of sedimentation (see Teply and Bahls 2006). This indicates that the sample represents a stream that has about a 20-30% probability of being impaired due to sediment under 303(d) guidelines. This model does not consider other causes of

impairment and this result does not indicate whether the stream may or may not be impaired due to other causes. The model used to make this determination was statistically significant ($p<0.01$) and overall classification accuracy was independently verified to be 68%.

Using the original metrics described by Bahls (1993) and autecology of the dominant species, additional independent independent interpretations can be made as follows. The Silitation Index of 59.1 indicates moderate impairment due to sediment. The Pollution Index of 2.47 indicates minor impairment due to nutrients. The dominant species in the sample was *Navicula cryptotenella,* which can tolerate a wide range of nutrient conditions ranging from oligotrophic to eutrophic or even hypereutrophic. The next most abundant species—*Achnanthes minutissima* and *Nitzschia dissipata*—have similar ecological requirements. The somewhat depressed pollution index and the somewhat elevated percent dominant species suggest that this site has elevated concentrations of organic and inorganic nutrients. Interpretations of other metric results are considered indeterminate.

Stream Name: Blackfoot River, Headwaters to Landers Fork
Segment ID: MT76F001_010
ALU Support: Not Supporting
Causes: Metals

Sample	Taxa	Count	PRA
215701	Achnanthes lanceolata	10	1.25
215701	Achnanthidium biasolettianum	2	0.25
215701	Achnanthidium minutissimum	81	10.12
215701	Aulacoseira distans	6	0.75
215701	Aulacoseira italica	1	0.12
215701	Caloneis silicula	2	0.25
215701	Cocconeis placentula	8	1
215701	Cymbella sp.	4	0.5
215701	Diatoma mesodon	6	0.75
215701	Encyonema auerswaldii	4	0.5
215701	Encyonema minutum	13	1.62
215701	Encyonema silesiacum	43	5.38
215701	Epithemia sorex	4	0.5
215701	Epithemia turgida	6	0.75
215701	Fragilaria capucina	10	1.25
215701	Fragilaria vaucheriae	22	2.75
215701	Fragilariforma bicapitata	2	0.25
215701	Gomphonema acuminatum	2	0.25
215701	Gomphonema angustatum	2	0.25
215701	Gomphonema kobayasii	2	0.25
215701	Gomphonema olivaceoides	53	6.62
215701	Gomphonema parvulum	2	0.25
215701	Hannaea arcus	81	10.12
215701	Meridion circulare	32	4
215701	Navicula arvensis	5	0.62
215701	Navicula cryptotenella	4	0.5
215701	Navicula minima	10	1.25
215701	Navicula minuscula	24	3
215701	Navicula tripunctata	4	0.5
215701	Nitzschia amphibia	2	0.25
215701	Nitzschia archibaldii	22	2.75
215701	Nitzschia dissipata	7	0.88
215701	Nitzschia fonticola	33	4.12
215701	Nitzschia linearis	1	0.12
215701	Nitzschia palea	6	0.75
215701	Nitzschia pumila	2	0.25
215701	Nitzschia pura	6	0.75
215701	Psammothidium helveticum	5	0.62
215701	Reimeria sinuata	1	0.12
215701	Rhoicosphenia curvata	2	0.25
215701	Rhopalodia gibba	1	0.12
215701	Staurosira construens	96	12
215701	Staurosirella leptostauron	27	3.38
215701	Staurosirella pinnata	38	4.75
215701	Synedra rumpens	81	10.12
215701	Synedra ulna	25	3.12

Sample	Metric	Value	Impairment
215701	Total Number of Species Counted	46	Indeterminate
215701	Shannon's Diversity Index	4.47	Indeterminate
215701	Percent Dominant Species	12	Indeterminate
215701	Siltation Index	15.75	Indeterminate
215701	Pollution Index	2.6	Indeterminate
215701	Disturbance Index	10.12	Indeterminate
215701	Percent Sediment Increaser Taxa	30.37	60-70% Probability

Interpretation:

Sample diatom taxa were evaluated to determine the probability of sediment impairment using the Sediment Increaser Taxa List for the Middle Rockies Ecoregion (Teply and Bahls 2006). Eight (8) diatom taxa on the Sediment Increaser Taxa List were counted,

representing a total percent relative abundance of 30.37%. These taxa have autecological affinities that make them suitable indicators of sedimentation (see Teply and Bahls 2006). This indicates that the sample represents a stream that has about a 20-60-70% probability of being impaired due to sediment under 303(d) guidelines. This model does not consider other causes of impairment and this result does not indicate whether the stream may or may not be impaired due to other causes. The model used to make this determination was statistically significant ($p<0.01$) and overall classification accuracy was independently verified to be 68%.

Using the original metrics described by Bahls (1993) and autecology of the dominant species, additional independent independent interpretations can be made; however, metric values indicate that interpretations of the six original are considered indeterminate. The dominant diatom species was *Staurosira construens,* which requires low to medium concentrations of inorganic nutrients, low levels of organic nutrients, and high concentrations of dissolved oxygen. It is also indicative of slower current velocities where sediment is likely to accumulate. Three other species—*Achnanthes minutissima, Hannaea arcus*, and *Synedra rumpens*—were nearly as abundant as *Staurosira construens*. These species also require high concentrations of dissolved oxygen, low levels of organic nutrients, and variable concentrations of inorganic nutrients.

Stream Name: Shields River, Headwaters to Cottonwood Creek
Segment ID: MT43A001_012
ALU Support: Partially Supporting
Causes: Sediment

Sample	Taxa	Count	PRA
201301	Achnanthes biasolettiana	2	0.22
201301	Achnanthes lanceolata	29	3.21
201301	Achnanthes minutissima	44	4.87
201301	Amphipleura pellucida	9	1
201301	Amphora pediculus	8	0.88
201301	Aulacoseira distans	3	0.33
201301	Aulacoseira granulata	1	0.11
201301	Aulacoseira italica	1	0.11
201301	Cocconeis placentula	75	8.3
201301	Cyclotella meneghiniana	5	0.55
201301	Cymbella affinis	52	5.75
201301	Cymbella minuta	2	0.22
201301	Cymbella naviculiformis	2	0.22
201301	Cymbella silesiaca	16	1.77
201301	Diatoma mesodon	1	0.11
201301	Diatoma vulgaris	6	0.66
201301	Fragilaria capucina	6	0.66
201301	Fragilaria construens	7	0.77
201301	Fragilaria leptostauron	2	0.22
201301	Fragilaria vaucheriae	4	0.44
201301	Gomphoneis eriense	2	0.22
201301	Gomphonema angustatum	4	0.44
201301	Gomphonema dichotomum	14	1.55
201301	Gomphonema minutum	1	0.11
201301	Gomphonema olivaceum	4	0.44
201301	Gomphonema pumilum	13	1.44
201301	Gomphonema subtile	8	0.88
201301	Melosira varians	48	5.31
201301	Meridion circulare	6	0.66
201301	Navicula atomus	1	0.11
201301	Navicula capitatoradiata	71	7.85
201301	Navicula cryptotenella	13	1.44
201301	Navicula gregaria	6	0.66
201301	Navicula lanceolata	5	0.55
201301	Navicula minima	2	0.22
201301	Navicula pelliculosa	4	0.44
201301	Navicula reichardtiana	51	5.64
201301	Navicula sp.	2	0.22
201301	Navicula tripunctata	124	13.72
201301	Navicula trivialis	4	0.44
201301	Navicula viridula	7	0.77
201301	Nitzschia acicularis	8	0.88
201301	Nitzschia dissipata	95	10.51
201301	Nitzschia fonticola	2	0.22
201301	Nitzschia gracilis	5	0.55
201301	Nitzschia heufleriana	5	0.55
201301	Nitzschia inconspicua	5	0.55
201301	Nitzschia linearis	11	1.22
201301	Nitzschia palea	28	3.1
201301	Nitzschia paleacea	4	0.44
201301	Nitzschia pura	4	0.44
201301	Nitzschia sigmoidea	1	0.11
201301	Nitzschia sociabilis	2	0.22
201301	Nitzschia vermicularis	2	0.22
201301	Reimeria sinuata	36	3.98
201301	Rhoicosphenia curvata	19	2.1
201301	Surirella angusta	2	0.22
201301	Surirella minuta	7	0.77
201301	Synedra ulna	3	0.33

Sample	Metric	Value	Impairment
201301	Total Number of Species Counted	59	Indeterminate
201301	Shannon's Diversity Index	4.68	Indeterminate
201301	Percent Dominant Species	13.72	Indeterminate
201301	Siltation Index	52.1	Moderate
201301	Pollution Index	2.55	Indeterminate
201301	Disturbance Index	4.87	Indeterminate
201301	Percent Sediment Increaser Taxa	35.49	80-90% Probability

Interpretation:

Sample diatom taxa were evaluated to determine the probability of sediment impairment using the Sediment Increaser Taxa List for the Middle Rockies Ecoregion (Teply and Bahls 2006). Eight (8) diatom taxa on the Sediment Increaser Taxa List were counted, representing a total percent relative abundance of 35.49%. These taxa have autecological affinities that make them suitable indicators of sedimentation (see Teply and Bahls 2006). This indicates that the sample represents a stream that has about a 80-90% probability of being impaired due to sediment under 303(d) guidelines. This model does not consider other causes of impairment and this result does not indicate whether the stream may or may not be impaired due to other causes. The model used to make this determination was statistically significant ($p<0.01$) and overall classification accuracy was independently verified to be 68%.

Using the original metrics described by Bahls (1993) and autecology of the dominant species, additional independent interpretations can be made as follows. The Silitation Index of 52.1 indicates moderate impairment due to sediment. There is a large percent abundance of motile species in the genera *Navicula, Nitzschia*, and *Surirella*. The dominant species is *Navicula tripunctata,* which is an autotrophic, alkaliphilic and eutraphentic species that requires relatively high concentrations of dissolved oxygen and inorganic nutrients and low levels of organic loading. *Nitzschia dissipata*, the next most common species, has similar ecological requirements. Interpretations of other metric results are considered indeterminate.

Stream Name: Smith River, Hound Creek to Mouth
Segment ID: MT41J001_020
ALU Support: Partially Supporting
Causes: Sediment, Nutrients

Sample	Taxa	Count	PRA
184001	Achnanthes lanceolata	1	0.12
184001	Achnanthes minutissima	33	4.07
184001	Amphipleura pellucida	9	1.11
184001	Amphora inariensis	2	0.25
184001	Amphora libyca	2	0.25
184001	Amphora pediculus	8	0.99
184001	Cocconeis pediculus	89	10.99
184001	Cocconeis placentula	12	1.48
184001	Cyclotella meneghiniana	1	0.12
184001	Cymatopleura solea	1	0.12
184001	Cymbella affinis	8	0.99
184001	Cymbella caespitosa	1	0.12
184001	Cymbella microcephala	49	6.05
184001	Cymbella minuta	4	0.49
184001	Cymbella silesiaca	7	0.86
184001	Cymbella sinuata	5	0.62
184001	Diatoma mesodon	2	0.25
184001	Diatoma moniliformis	20	2.47
184001	Diatoma vulgaris	6	0.74
184001	Epithemia adnata	30	3.7
184001	Epithemia sorex	121	14.94
184001	Epithemia turgida	7	0.86
184001	Fragilaria construens	21	2.59
184001	Fragilaria leptostauron	2	0.25
184001	Fragilaria pinnata	4	0.49
184001	Fragilaria vaucheriae	80	9.88
184001	Gomphonema olivaceum	29	3.58
184001	Gomphonema parvulum	2	0.25
184001	Gomphonema pumilum	11	1.36
184001	Hantzschia amphioxys	1	0.12
184001	Navicula capitatoradiata	37	4.57
184001	Navicula cryptotenella	19	2.35
184001	Navicula gregaria	2	0.25
184001	Navicula lanceolata	1	0.12
184001	Navicula libonensis	2	0.25
184001	Navicula menisculus	1	0.12
184001	Navicula minima	2	0.25
184001	Navicula reichardtiana	13	1.6
184001	Navicula tripunctata	21	2.59
184001	Neidium binodeformis	2	0.25
184001	Nitzschia alpina	2	0.25
184001	Nitzschia amphibia	1	0.12
184001	Nitzschia angustata	2	0.25
184001	Nitzschia dissipata	27	3.33
184001	Nitzschia fonticola	8	0.99
184001	Nitzschia gracilis	2	0.25
184001	Nitzschia heufleriana	8	0.99
184001	Nitzschia intermedia	1	0.12
184001	Nitzschia linearis	9	1.11
184001	Nitzschia palea	2	0.25
184001	Nitzschia paleacea	4	0.49
184001	Nitzschia perminuta	2	0.25
184001	Nitzschia recta	3	0.37
184001	Nitzschia sigmoidea	1	0.12
184001	Nitzschia sociabilis	5	0.62
184001	Nitzschia vermicularis	1	0.12
184001	Rhoicosphenia curvata	31	3.83
184001	Rhopalodia gibba	1	0.12
184001	Surirella angusta	2	0.25
184001	Surirella minuta	2	0.25
184001	Synedra parasitica	2	0.25

184001	Synedra ulna	26	3.21

Sample	Metric	Value	Impairment
184001	Total Number of Species Counted	62	Indeterminate
184001	Shannon's Diversity Index	4.7	Indeterminate
184001	Percent Dominant Species	14.94	Indeterminate
184001	Siltation Index	22.22	Minor
184001	Pollution Index	2.57	Indeterminate
184001	Disturbance Index	4.07	Indeterminate
184001	Percent Sediment Increaser Taxa	37.78	80-90% Probability

Interpretation:

Sample diatom taxa were evaluated to determine the probability of sediment impairment using the Sediment Increaser Taxa List for the Middle Rockies Ecoregion (Teply and Bahls 2006). Ten (10) diatom taxa on the Sediment Increaser Taxa List were counted, representing a total percent relative abundance of 37.78%. These taxa have autecological affinities that make them suitable indicators of sedimentation (see Teply and Bahls 2006). This indicates that the sample represents a stream that has about a 80-90% probability of being impaired due to sediment under 303(d) guidelines. This model does not consider other causes of impairment and this result does not indicate whether the stream may or may not be impaired due to other causes. The model used to make this determination was statistically significant ($p<0.01$) and overall classification accuracy was independently verified to be 68%.

Using the original metrics described by Bahls (1993) and autecology of the dominant species, additional independent interpretations can be made as follows. The Silitation Index of 52.1 indicates moderate impairment due to sediment. The majority of cell counts are represented by *Epithemia sorex,* which is an eutraphentic species that requires fairly high levels of dissolved oxygen. The next most abundant species—*Cocconeis pediculus* and *Fragilaria vaucheriae*—are also eutraphentic species that require moderate to fairly high concentrations of dissolved oxygen. These taxa suggest impairment by inorganic nutrients but probably little or no impairment by organic nutrients. Interpretations of other metric results are considered indeterminate.

Stream Name: Madison River, Ennis Dam to Mouth
Segment ID: MT41F001_010
ALU Support: Partially Supporting
Causes: Sediment, Metals

Sample	Taxa	Count	PRA
149909	Achnanthidium minutissimum	20	2.36
149909	Amphora libyca	8	0.94
149909	Amphora pediculus	2	0.24
149909	Aulacoseira granulata	5	0.59
149909	Cocconeis pediculus	49	5.77
149909	Cocconeis placentula	10	1.18
149909	Cymatopleura solea	2	0.24
149909	Cymbella excisa	7	0.82
149909	Cymbella mexicana	7	0.82
149909	Diatoma vulgaris	148	17.43
149909	Encyonema auerswaldii	2	0.24
149909	Encyonema silesiacum	4	0.47
149909	Epithemia sorex	17	2
149909	Fragilaria crotonensis	6	0.71
149909	Fragilaria vaucheriae	37	4.36
149909	Gomphoneis eriense	8	0.94
149909	Gomphoneis herculeana	24	2.83
149909	Gomphonema minutum	43	5.06
149909	Gomphonema olivaceum	46	5.42
149909	Gomphonema parvulum	20	2.36
149909	Melosira varians	36	4.24
149909	Navicula antonii	1	0.12
149909	Navicula capitatoradiata	15	1.77
149909	Navicula cryptotenella	23	2.71
149909	Navicula minima	1	0.12
149909	Navicula tripunctata	17	2
149909	Neidium affine	2	0.24
149909	Nitzschia dissipata	6	0.71
149909	Nitzschia fonticola	21	2.47
149909	Nitzschia inconspicua	2	0.24
149909	Nitzschia paleacea	4	0.47
149909	Nitzschia recta	1	0.12
149909	Nitzschia subacicularis	4	0.47
149909	Rhoicosphenia curvata	104	12.25
149909	Staurosira construens	104	12.25
149909	Staurosirella pinnata	20	2.36
149909	Stephanodiscus hantzschii	8	0.94
149909	Synedra acus	2	0.24
149909	Synedra ulna	11	1.3
149909	Tryblionella apiculata	2	0.24

Sample	Metric	Value	Impairment
149909	Total Number of Species Counted	40	Indeterminate
149909	Shannon's Diversity Index	4.28	Indeterminate
149909	Percent Dominant Species	17.43	Indeterminate
149909	Siltation Index	11.43	Indeterminate
149909	Pollution Index	2.76	Indeterminate
149909	Disturbance Index	2.36	Indeterminate
149909	Percent Sediment Increaser Taxa	33.7	70-80% Probability

Interpretation:

Sample diatom taxa were evaluated to determine the probability of sediment impairment using the Sediment Increaser Taxa List for the Middle Rockies Ecoregion (Teply and Bahls 2006). Nine (9) diatom taxa on the Sediment Increaser Taxa List were counted, representing a total percent relative abundance of 33.7%. These taxa have autecological affinities that make them suitable indicators of sedimentation (see Teply and Bahls 2006). This indicates that the sample represents a stream that has about a 70-80% probability of being impaired due to sediment under 303(d) guidelines. This model does not consider other causes of

impairment and this result does not indicate whether the stream may or may not be impaired due to other causes. The model used to make this determination was statistically significant ($p<0.01$) and overall classification accuracy was independently verified to be 68%.

Using the original metrics described by Bahls (1993) and autecology of the dominant species, additional independent independent interpretations can be made; however, metric values indicate that interpretations of the six original are considered indeterminate. The dominant species is *Diatoma vulgaris,* which is a meso-eutrophic species that requires relatively high concentrations of dissolved oxygen. The next most common species—*Rhoicosphenia curvata* and *Staurosira construens*—are also meso-eutrophic to eutrophic species that require fairly high to very high concentrations of dissolved oxygen. Dominance by these taxa suggests elevated concentrations of inorganic, but not organic, nutrients.

Stream Name: Little Blackfoot River, Dog Creek to Mouth
Segment ID: MT76G004_010
ALU Support: Partially Supporting
Causes: Sediment, Nutrients, and Metals

Sample	Taxa	Count	PRA
012302	Achnanthes lanceolata	7	0.85
012302	Achnanthidium minutissimum	2	0.24
012302	Amphora pediculus	7	0.85
012302	Cocconeis pediculus	178	21.71
012302	Cocconeis placentula	435	53.05
012302	Diatoma vulgaris	2	0.24
012302	Encyonema silesiacum	4	0.49
012302	Epithemia adnata	1	0.12
012302	Epithemia sorex	56	6.83
012302	Fragilaria tenera	1	0.12
012302	Fragilaria vaucheriae	1	0.12
012302	Gomphonema minutum	6	0.73
012302	Gomphonema olivaceum	4	0.49
012302	Gomphonema parvulum	4	0.49
012302	Gomphonema rhombicum	2	0.24
012302	Hannaea arcus	2	0.24
012302	Navicula capitatoradiata	4	0.49
012302	Navicula cryptotenella	1	0.12
012302	Navicula reichardtiana	4	0.49
012302	Nitzschia archibaldii	2	0.24
012302	Nitzschia dissipata	1	0.12
012302	Nitzschia fonticola	2	0.24
012302	Nitzschia hantzschiana	4	0.49
012302	Nitzschia inconspicua	4	0.49
012302	Nitzschia linearis	2	0.24
012302	Pseudostaurosira brevistriata	24	2.93
012302	Reimeria sinuata	4	0.49
012302	Rhoicosphenia curvata	4	0.49
012302	Rhopalodia gibba	2	0.24
012302	Sellaphora bacillum	2	0.24
012302	Sellaphora pupula	2	0.24
012302	Staurosira construens	34	4.15
012302	Staurosirella leptostauron	10	1.22
012302	Staurosirella pinnata	2	0.24

Sample	Metric	Value	Impairment
012302	Total Number of Species Counted	34	Indeterminate
012302	Shannon's Diversity Index	2.44	Minor
012302	Percent Dominant Species	53.05	Moderate
012302	Siltation Index	3.41	Indeterminate
012302	Pollution Index	2.95	Indeterminate
012302	Disturbance Index	0.24	Indeterminate
012302	Percent Sediment Increaser Taxa	31.33	70-80% Probability

Interpretation:

Sample diatom taxa were evaluated to determine the probability of sediment impairment using the Sediment Increaser Taxa List for the Middle Rockies Ecoregion (Teply and Bahls 2006). Twelve (12) diatom taxa on the Sediment Increaser Taxa List were counted, representing a total percent relative abundance of 31.33%. These taxa have autecological affinities that make them suitable indicators of sedimentation (see Teply and Bahls 2006). This indicates that the sample represents a stream that has about a 70-80% probability of being impaired due to sediment under 303(d) guidelines. This model does not consider other causes of impairment and this result does not indicate whether the stream may or may not be impaired due to other causes. The model used to make this determination was statistically significant ($p<0.01$) and overall classification accuracy was independently verified to be 68%.

Using the original metrics described by Bahls (1993) and autecology of the dominant species, additional independent interpretations can be made as follows. Shannon's Diversity Index of 2.44 indicates minor impairment. Percent Dominant Species of 53.05 indicates moderate impairment. The dominant diatom species is *Cocconeis placentula,* which is a eutraphentic species. *Cocconeis pediculus*, the next most abundant species, is also eutraphentic, which suggests that this site has elevated concentrations of inorganic nutrients but not organic nutrients. It is primarily an epiphyte on *Cladaphora* which prospers in nutrient rich waters with slow to moderate current velocities where sedimentation is an issue.

Stream Name: Prickly Pear Creek, Helena WWTP to Lake Helena
Segment ID: MT41I006_020
ALU Support: Not Supporting
Causes: Sediment, Nutrients, and Metals

Sample	Taxa	Count	PRA
325901	Achnanthidium minutissimum	9	1.08
325901	Caloneis molaris	4	0.48
325901	Cocconeis pediculus	7	0.84
325901	Cocconeis placentula	19	2.27
325901	Cyclotella meneghiniana	5	0.6
325901	Diatoma vulgaris	11	1.32
325901	Encyonema silesiacum	4	0.48
325901	Fragilaria capucina	2	0.24
325901	Geissleria decussis	7	0.84
325901	Gomphonema clavatum	3	0.36
325901	Gomphonema mexicanum	1	0.12
325901	Gomphonema minutum	10	1.2
325901	Gomphonema parvulum	65	7.78
325901	Gomphonema truncatum	3	0.36
325901	Hippodonta hungarica	6	0.72
325901	Lemnicola hungarica	4	0.48
325901	Melosira varians	30	3.59
325901	Navicula cryptocephala	5	0.6
325901	Navicula cryptotenella	2	0.24
325901	Navicula erifuga	2	0.24
325901	Navicula gregaria	7	0.84
325901	Navicula lanceolata	1	0.12
325901	Navicula minima	6	0.72
325901	Navicula oligotraphenta	13	1.56
325901	Navicula protracta	2	0.24
325901	Navicula subminuscula	2	0.24
325901	Navicula tripunctata	2	0.24
325901	Navicula trivialis	5	0.6
325901	Navicula veneta	3	0.36
325901	Neidium ampliatum	2	0.24
325901	Nitzschia amphibia	316	37.8
325901	Nitzschia capitellata	3	0.36
325901	Nitzschia desertorum	4	0.48
325901	Nitzschia dissipata	3	0.36
325901	Nitzschia fonticola	2	0.24
325901	Nitzschia inconspicua	3	0.36
325901	Nitzschia linearis	7	0.84
325901	Nitzschia palea	16	1.91
325901	Nitzschia paleacea	6	0.72
325901	Nitzschia pusilla	2	0.24
325901	Nitzschia sigmoidea	1	0.12
325901	Nitzschia supralitorea	5	0.6
325901	Pinnularia microstauron	1	0.12
325901	Planothidium frequentissimum	10	1.2
325901	Planothidium lanceolatum	10	1.2
325901	Rhoicosphenia abbreviata	31	3.71
325901	Sellaphora pupula	54	6.46
325901	Stauroneis smithii	2	0.24
325901	Surirella brebissonii	1	0.12
325901	Surirella minuta	2	0.24
325901	Synedra acus	11	1.32
325901	Synedra ulna	104	12.44

Sample	Metric	Value	Impairment
325901	Total Number of Species Counted	52	Indeterminate
325901	Shannon's Diversity Index	3.76	Indeterminate
325901	Percent Dominant Species	37.8	Minor
325901	Siltation Index	58.7	Moderate
325901	Pollution Index	2.02	Minor
325901	Disturbance Index	1.08	Indeterminate
325901	Percent Sediment Increaser Taxa	18.92	30-40% Probability

Interpretation:

Sample diatom taxa were evaluated to determine the probability of sediment impairment using the Sediment Increaser Taxa List for the Middle Rockies Ecoregion (Teply and Bahls 2006). Six (6) diatom taxa are on the Sediment Increaser Taxa List were counted, representing a total percent relative abundance of 18.92%. These taxa have autecological affinities that make them suitable indicators of sedimentation (see Teply and Bahls 2006). This indicates that the sample represents a stream that has about a 30-40% probability of being impaired due to sediment under 303(d) guidelines. This model does not consider other causes of impairment and this result does not indicate whether the stream may or may not be impaired due to other causes. The model used to make this determination was statistically significant ($p<0.01$) and overall classification accuracy was independently verified to be 68%.

Using the original metrics described by Bahls (1993) and autecology of the dominant species, additional independent interpretations can be made as follows. The Siltation Index of 58.7 indicates moderate impairment due to sediment. The Pollution Index of 2.02 indicates minor impairment due to nutrients. The dominant species was *Nitzschia amphibia*, which contributed 37.8% of the cells counted. *Nitzschia amphibia* is an alkaliphilous, eutraphentic species that tolerates somewhat depressed levels of dissolved oxygen and is capable of using organic nitrogen. Other common eutraphentic nitrogen heterotrophs in this sample include *Gomphonema parvulum* and *Melosira varians*. These species and *Sellaphora pupula* and *Synedra ulna*, which were also common, can tolerate low to moderate levels of dissolved oxygen. In summary, diatom metrics and dominant species suggest that this site is impaired by organic loading, depressed dissolved oxygen, elevated concentrations of inorganic nutrients, and excessive sedimentation.

Appendix B

Montana Rapid Bioassessment Protocols

Appendix B. Diatom association metrics used by the State of Montana to evaluate biological integrity in mountain streams: references, range of values, expected response to increasing impairment or natural stress, and criteria for rating levels of biological integrity. The lowest rating for any one metric is the rating for that site.

Biological Integrity/ Impairment or Stress/ Use Support	No. of Species Counted[1]	Diversity Index[2] (Shannon)	Pollution Index[3]	Siltation Index[4]	Disturbance Index[5]	% Dominant Species[6]	% Abnormal Cells[7]
Excellent/None Full Support	>29	>2.99	>2.50	<20.0	<25.0	<25.0	0
Good/Minor Full Support	20-29	2.00-2.99	2.01-2.50	20.0-39.9	25.0-49.9	25.0-49.9	>0.0, <3.0
Fair/Moderate Partial Support	19-10	1.00-1.99	1.50-2.00	40.0-59.9	50.0-74.9	50.0-74.9	3.0-9.9
Poor/Severe Nonsupport	<10	<1.00	<1.50	>59.9	>74.9	>74.9	>9.9
References	Bahls 1979 Bahls 1993	Bahls 1979	Bahls 1993	Bahls 1993	Barbour et al. 1999	Barbour et al. 1999	McFarland et al. 1997
Range of Values	0-100+	0.00-5.00+	1.00-3.00	0.0-90.0+	0.0-100.0	~5.0-100.0	0.0-30.0+
Expected Response	Decrease[8]	Decrease[8]	Decrease	Increase	Increase	Increase	Increase

[1]Based on a proportional count of 400 cells (800 valves)

[2]Base 2 [bits] (Weber 1973)

[3]Composite numeric expression of the pollution tolerances assigned by Lange-Bertalot (1979) to the common diatom species

[4]Sum of the percent abundances of all species in the genera *Navicula, Nitzschia* and *Surirella*

[5]Percent abundance of Achnanthidium minutissimum (synonym: *Achnanthes minutissima*)

[6]Percent abundance of the species with the largest number of cells in the proportional count

[7]Cells with an irregular outline or with abnormal ornamentation, or both

[8]Species richness and diversity may increase somewhat in mountain streams in response to slight to moderate increases in nutrients or sediment