BIOLOGICAL INTEGRITY
OF THE JUDITH RIVER, FERGUS COUNTY, MONTANA
BASED ON THE COMPOSITION AND STRUCTURE
OF THE BENTHIC ALGAE COMMUNITY

Prepared for:

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SUMMARY

On August 9, 2000, periphyton samples were collected from two stations on the middle Judith River near Lewistown, Montana for the purpose of assessing whether this segment of the river is water-quality limited and in need of TMDLs. The samples were collected following DEQ standard operating procedures, processed and analyzed using standard methods for periphyton, and evaluated following modified USEPA rapid bioassessment protocols for wadeable streams.

The Judith River heads in the Rocky Mountain Ecoregion, flows through the Valley and Foothill Prairie Ecoregion, and ends in the Northern Great Plains Ecoregion, where the study reach is located. For this reason, Judith River metrics were compared to criteria for both mountain streams and prairie streams.

When compared to biocriteria for both mountain streams and prairie streams, the large percentage of *Achnanthes minutissima* and the large number of abnormal diatom frustules indicated moderate impairment and **partial support of aquatic life uses** at both sampling sites. The stress that caused this impairment may be either natural or cultural in origin.

The periphyton communities at both sites were represented by the usual groups of algae with healthy genus richness. Although a shift in abundance from cyanobacteria at J 1 to green algae at J 3 may indicate some nutrient enrichment, values for the diatom pollution index, which were nearly identical, indicated no significant increase in organic loading between the two sites.

The relatively large similarity index indicated that sites J 1 and J 3 had very similar diatom floras and that little or no environmental change had occurred between the two sites.

INTRODUCTION

This report evaluates the biological integrity, support of aquatic life uses, and probable causes of impairment to those uses, in a section of the Judith River near Lewistown, Montana. The purpose of this report is to provide information that will help the State of Montana determine whether the Judith River is water-quality limited and in need of TMDLs.

The federal Clean Water Act directs states to develop water pollution control plans (Total Maximum Daily Loads or TMDLs) that set limits on pollution loading to water-quality limited waters. Water-quality limited waters are lakes and stream segments that do not meet water-quality standards, that is, that do not fully support their beneficial uses. The Clean Water Act and USEPA regulations require each state to (1) identify waters that are water-quality limited, (2) prioritize and target waters for TMDLs, and (3) develop TMDL plans to attain and maintain water-quality standards for all water-quality limited waters.

Evaluation of use support in this report is based on the species composition and structure of the periphyton (benthic algae, phytobenthos) community at two stream sites that were sampled on August 9, 2000. The periphyton community is a basic biological component of all aquatic ecosystems. Periphyton accounts for much of the primary production and biological diversity in Montana streams (Bahls et al. 1992).

Plafkin et al. (1989) and Stevenson and Bahls (1999) list several advantages of using periphyton in biological assessments:

- Algae are universally present in large numbers in all streams and unimpaired periphyton assemblages typically support a large number (>30) of species;
- Algae have rapid reproduction rates and short life cycles, making them useful indicators of short-term impacts;

- As primary producers, algae are most directly affected by physical and chemical factors, such as temperature, nutrients, dissolved salts, and toxins;
- Sampling is quick, easy and inexpensive, and causes minimal damage to resident biota and their habitat;
- Standard methods and criteria exist for evaluating the composition, structure, and biomass of algal associations;
- Identification to species is straightforward for the diatoms, for which there is a large body of taxonomic and ecological literature;
- Excessive algae growth in streams is often correctly perceived as a problem by the public.
- Periphyton and other biological communities reflect the *biological integrity*¹ of waterbodies; restoring and maintaining the biological integrity of waterbodies is a goal of the federal Clean Water Act;
- Periphyton and other biological communities integrate the effects of different stressors and provide a measure of their aggregate impact; and
- Periphyton and other biological communities may be the only practical means of evaluating impacts from non-point sources of pollution where specific ambient criteria do not exist (e.g., impacts that degrade habitat or increase nutrients).

Periphyton is a diverse assortment of simple photosynthetic organisms, called algae, and other microorganisms that live attached to or in close proximity of the stream bottom. Most algae, such as the diatoms, are microscopic. Diatoms are distinguished by having a cell wall composed of opaline glass: hydrated amorphous silica. Diatoms often carpet a stream bottom with a slippery brown film.

¹ *Biological integrity* is defined as "the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a region" (Karr and Dudley 1981).

Some algae, such as the filamentous greens, are conspicuous and their excessive growth may be aesthetically displeasing, deplete dissolved oxygen, interfere with fishing and fish spawning, clog water filters and irrigation intakes, create tastes and odors in drinking water, and cause other problems.

PROJECT AREA AND SAMPLING SITES

The project area is located in Fergus County near the city of Lewistown, Montana (pop. 6,368). The Judith River heads in the Little Belt Mountains (maximum elevation 9,175 feet) and flows northeast for about 100 miles to where it enters the Missouri River near the town of Winifred (pop. 162). The two sampling sites addressed in this report bracket a 10-mile-long segment of the Judith River located between Ross Fork and Ware northwest of Lewistown.

The upper watershed of the Judith River lies within the Northern Rockies Ecoregion (Woods et al. 1999). The river then traverses a band of the Montana Valley and Foothill Prairies Ecoregion. The lower (and the longest) segment of the river--a portion of which is addressed in this report--flows through the Northwestern Great Plains Ecoregion.

The surface geology of the watershed is composed of Madison Limestone in the mountainous headwaters and Colorado Shale overlain by Quaternary gravel deposits at lower elevations (Renfro and Feray 1972). Vegetation is mixed forest in the headwaters and mixed grassland at lower elevations (USDA 1976).

Periphyton samples were collected at two sites on August 9, 2000 (Table 1). The upper site (J 1) is located west of Ross Fork at an elevation of about 3,750 feet (Map 1). The lower site (J 3) is located east of Ware at an elevation of 3,450 feet (Map

2). Ross Fork and Ware are sidings on the Burlington Northern and Santa Fe Railroad.

Land use in the Judith River watershed is mostly silviculture and recreation in the mountains and livestock grazing and hay production with some dryland farming at lower elevations. Fish, wildlife, and watershed values are also important. The Judith River is classified B-1 in the Montana Surface Water Quality Standards above Big Spring Creek, and B-2 below Big Spring Creek. The section of river addressed in this report is located just above the mouth of Big Spring Creek and is classified B-1.

METHODS

Periphyton samples were collected by Darrin Kron (Water Monitoring Section, MDEQ Monitoring and Data Management Bureau) following standard operating procedures of the MDEQ Planning, Prevention, and Assistance Division.

Using appropriate tools, microalgae were scraped, brushed, or sucked from natural substrates in proportion to the rank of those substrates at the study site. Macroalgae were picked by hand in proportion to their abundance at the site. All collections of microalgae and macroalgae were pooled into a common container and preserved with Lugol's solution.

The samples were examined to estimate the relative abundance and rank by biovolume of diatoms and genera of soft (non-diatom) algae according to the method described by Bahls (1993). Soft algae were identified using Dillard (1999), Prescott (1978), Smith (1950), and Whitford and Schumacher (1984). These books also served as references on the ecology of the soft algae, along with Palmer (1977).

After the identification of soft algae, the raw periphyton samples were cleaned of organic matter using sulfuric acid, and permanent diatom slides were prepared using Naphrax, a high refractive index mounting medium, following *Standard Methods for the Examination of Water and Wastewater* (APHA 1998). Between 407 and 408 diatom cells (814 to 816 valves) were counted at random and identified to species. The following were used as the main taxonomic and autecological references for the diatoms: Krammer and Lange-Bertalot 1986, 1988, 1991a, 1991b; Patrick and Reimer 1966, 1975. Lowe (1974) was also used as an ecological reference for the diatoms.

The diatom proportional counts were used to generate an array of diatom association metrics (Table 2). A metric is a characteristic of the biota that changes in some predictable way with increased human influence (Barbour et al. 1999).

Metric values from the Judith River were compared to numeric biocriteria or threshold values developed for streams in the Rocky Mountain and Great Plains Ecoregions of Montana (Tables 3 and 4). These criteria are based on metric values measured in least-impaired reference streams (Bahls et al. 1992) and on metric values measured in streams that are known to be impaired by various sources and causes of pollution (Bahls 1993). Because metrics from both sites indicated impairment (see Table 6), Protocol II (Bahls 1993) could not be used.

The criteria in Tables 3 and 4 distinguish among four levels of impairment and three levels of aquatic life use support: no impairment or only minor impairment (full support); moderate impairment (partial support); and severe impairment (nonsupport). These impairment levels correspond to excellent, good, fair, and poor *biological integrity*, respectively.

Quality Assurance. Several steps were taken to assure that

the study results are accurate and reproducible.

Upon receipt of the samples, station and sample information were recorded in a laboratory notebook and the samples were assigned a unique number compatible with the Montana Diatom Database, e.g., 2004-01. The first part of this number (2004) designates the sampling site (Judith River west of Ross Fork); the second part of this number (01) designates the number of periphyton samples that have been collected at this site to date for which data have been entered into the Montana Diatom Database.

Sample observations and analyses of soft (non-diatom) algae were recorded in a lab notebook along with station and sample information provided by MDEQ. A portion of the raw sample was used to make duplicate diatom slides. After completing the diatom proportional count, the slide used for the count will be deposited in the University of Montana Herbarium in Missoula. The other slide will be retained by *Hannaea* in Helena.

On completion of the project, station information, sample information, and diatom proportional count data will be entered into the Montana Diatom Database.

RESULTS AND DISCUSSION

Results are presented in Tables 5 and 6, which are located near the end of this report following the Literature Cited section. Spreadsheets containing completed diatom proportional counts, with species' pollution tolerance classes (PTC) and percent abundances, are attached as Appendix A.

SAMPLE NOTES

J 1. Some filaments of *Audouinella* had terminal setae. Specimens of *Synedra* were particularly evident among the diatoms.

J 3. No observations were recorded for this sample.

NON-DIATOM ALGAE

The periphyton samples from both sites contained a healthy mix of green algae, diatoms, red algae, and cyanobacteria (Table 5). Non-diatom genus richness was good, with 10 genera observed at J 1 and 11 genera at J 3. Cyanobacteria (*Gloeotheca*) were most abundant at J 1, while green algae (*Cladophora*) ranked first in biovolume at J 3. Diatoms were intermediate in abundance and biovolume at both sites.

The decline in nitrogen-fixing cyanobacteria and the increase in green algae from J 1 to J 3 may indicate an increase in nutrient concentrations between these sites. Certain cyanobacteria (blue-green algae) are typical of mountain streams with lower nutrient levels in Montana (Bahls et al. 1992). They cannot compete with diatoms and green algae under moderate to heavy nutrient loading.

Cladophora, which was occasional at J 1 but frequent at J 3, is a widespread alga that often becomes a nuisance in waters that are enriched with nutrients. *Ankistrodesmus* and *Scenedesmus* are planktonic algae that are common in larger and nutrient-enriched hardwater streams and rivers.

Red algae are generally more sensitive to pollution than other types. *Audouinella*, a red alga found in the Judith River and in many other Montana streams, was common at J 1 and rare at J 3 (Table 5).

DIATOMS

The major diatom species in the Judith River were either sensitive to or only somewhat tolerant of organic pollution (Table 6). The percent abundance of tolerant and sensitive species was about the same at the two sites, resulting in almost identical pollution indexes. The pollution indexes indicated no

impairment for either a mountain stream or a prairie stream.

However, diatom species diversity at both sites indicated minor impairment for a mountain stream and moderate impairment for a prairie stream (Table 6). Species richness also indicated minor to moderate impairment at J 3. Diatom diversity and species richness were significantly higher at J 1 than at J 3; values at J 1 were very near the threshold for no impairment of a mountain stream and for minor impairment of a prairie stream.

The low diversity at both sites was due, in part, to the large percent abundance of *Achnanthes minutissima*. This is an opportunistic "weed" species that colonizes recently disturbed habitats. Its large abundance at both sites indicated that moderate biological, chemical, or physical disturbance had occurred before the samples were collected. It is not known whether this disturbance was natural or cultural in origin.

The relatively small number of cells in the motile genera *Navicula* and *Nitzschia* indicated no impairment from siltation at either site (Table 6).

Fifteen diatom valves (7.5 cells) exhibiting physical abnormalities were observed at each site, indicating moderate impairment. The percentage of teratological cells has been correlated with ambient concentrations of heavy metals in certain Colorado streams (McFarland et al. 1997). Teratological cells may also result from other forms of pollution and environmental stress.

Only a few cells of diatom species in the family Epithemiaceae were counted, indicating that nitrogen was probably not limiting to algal growth at either site. Diatoms in this family often harbor nitrogen-fixing cyanobacteria within their cells and are most abundant in waters where nitrogen is the

limiting nutrient.

The relatively large similarity index (72.94) indicated that the two sites had very similar diatom floras and that little or no change in environmental conditions had occurred between the two sites. Adjacent reaches on the same stream, without intervening tributaries or pollution sources, can expect to have at least 60% of their diatom floras in common (Bahls 1993).

In summary, dominance by *Achnanthes minutissima* and a relatively large number of abnormal frustules indicated moderate impairment at both sites when compared to biocriteria for both mountain streams and prairie streams. Moreover, low diatom diversity values at both sites indicated moderate impairment when compared to diversity biocriteria for prairie streams. It is not known whether the stress that resulted in the large populations of *A. minutissima*, the low diversity, and the larger than normal number of teratological cells was natural or cultural in origin.

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MAP 1

MAP 2

Table 1. Location of periphyton stations on the Judith River sampled August 9, 2000: Station codes, sample numbers in the Montana Diatom Database, and latitudes and longitudes. Stations are listed in order from upstream to downstream.

Location	Station Code	Sample Number	Latitude/ Longitude
Judith River west of Ross Fork	J 1	2004-01	47 04 48 109 42 44
Judith River east of Ware	J 3	2005-01	47 10 20 109 38 56

Table 2. Diatom association metrics used to evaluate biological integrity in Montana streams: reference, range of values in Montana streams, and expected direction of metric response to increasing anthropogenic perturbation or natural stress.

Metric	Reference	Range of Values	Expected Response
Shannon Species Diversity	Bahls 1979	0.00-5.00+	Decrease ¹
Pollution Index ²	Bahls 1993	1.00-3.00	Decrease
Siltation Index ³	Bahls 1993	0.00-90.0+	Increase
Disturbance Index ⁴	Barbour et al. 1999	0.00-100.0	Increase
No. Species Counted	Bahls 1979, 1993	0-100+	Decrease ¹
Percent Dominant Species	Barbour et al. 1999	5.0-100.0	Increase
Percent Abnormal Cells	McFarland et al. 1997	0.0-20.0+	Increase
Similarity Index	Whittaker 1952	0.0-80.0+	Decrease
Percent Epithemiaceae	Stevenson & Pan 1999	0.0-80.0+	Decrease
Percent Aerophiles	Johansen 1999	0.0-100	Increase

¹ Shannon diversity and species richness may increase somewhat in naturally nutrient-poor mountain streams in response to slight to moderate increases in nutrients or sediment.

² Composite numeric expression of the pollution tolerances assigned by Lange-Bertalot (1979) to the common diatom species.

³ Sum of the percent abundances of all species in the genera *Navicula*, *Nitzschia*, and *Surirella*, plus the species *Cymbella sinuata*.

⁴ Percent abundance of *Achnanthes minutissima*.

Table 3. Criteria for rating levels of biological integrity, environmental impairment or natural stress, and aquatic life use support in wadeable **mountain** streams of Montana using selected metrics for benthic diatom associations. The lowest rating for any one metric is the overall rating for the study site.

Biological Integrity/ Impairment or Natural Stress/Use Support	Diversity Index (Shannon)	Pollution Index	Siltation Index	Disturbance Index	Number of Species Counted	Percent Dominant Species	Percent Abnormal Cells	Percent Similarity Index ¹
Excellent None/Full Support	>2.99	>2.50	<20.0	<25.0	>29	<25.0	0.0	>59.9
Good/Minor Full Support	2.00- 2.99	2.01- 2.50	20.0- 39.9	25.0- 49.9	20- 29	25.0- 49.9	>0.0- <1.0	40.0- 59.9
Fair/Moderate Partial Support	1.00- 1.99	1.50- 2.00	40.0- 59.9	50.0- 74.9	10- 19	50.0- 74.9	1.0- 9.9	20.0- 39.9
Poor/Severe Nonsupport	<1.00	<1.50	>59.9	>74.9	<10	>74.9	>9.9	<20.0

¹ The Similarity Index or Percent Community Similarity (Whittaker 1952) may be used to compare a study site to an unimpaired upstream control site on the same stream. This metric measures the degree of floristic similarity between diatom associations at the two sites and is the sum of the smaller of the two percent abundance values for each species that is common to both sites. Adjacent riffles on the same stream, without intervening tributaries or environmental perturbations, will generally have at least 60% of their diatom floras in common (Bahls 1993). PCS may also be used to gauge the relative amount of impairment or recovery that occurs between adjacent study sites: >59.9% = very similar floras, no change; 40.0-59.9% = somewhat similar floras, minor change; 20.0-39.9% = somewhat dissimilar floras, moderate change; <20.0% = very dissimilar floras, major change.

Table 4. Criteria for rating levels of biological integrity, environmental impairment or natural stress, and aquatic life use support in Wadeable Plains streams of Montana using selected metrics for benthic diatom associations. The lowest rating for any one metric is the overall rating for the study site.

Biological Integrity/ Impairment or Natural Stress/Use Support	Diversity Index (Shannon)	Pollution Index	Siltation Index	Disturbance Index	Number of Species Counted	Percent Dominant Species	Percent Abnormal Cells	Percent Similarity Index ¹
Excellent None/Full Support	>3.99	>2.25	<50.0	<25.0	>39	<25.0	0.0	>59.9
Good/Minor Full Support	3.00- 3.99	1.76- 2.25	50.0- 69.9	25.0- 49.9	30- 39	25.0 49.9	>0.0- <1.0	40.0- 59.9
Fair/Moderate Partial Support	2.00- 2.99	1.25- 1.75	70.0- 89.9	50.0- 74.9	20- 29	50.0- 74.9	1.0- 9.9	20.0- 39.9
Poor/Severe Nonsupport	<2.00	<1.25	>89.9	>74.9	<20	>74.9	>9.9	<20.0

¹ The Similarity Index or Percent Community Similarity (Whittaker 1952) may be used to compare a study site to an unimpaired upstream control site on the same stream. This metric measures the degree of floristic similarity between diatom associations at the two sites and is the sum of the smaller of the two percent abundance values for each species that is common to both sites. Adjacent riffles on the same stream, without intervening tributaries or environmental perturbations, will generally have at least 60% of their diatom floras in common (Bahls 1993). PCS may also be used to gauge the relative amount of impairment or recovery that occurs between adjacent study sites: >59.9% = very similar floras, no change; 40.0-59.9% = somewhat similar floras, minor change; 20.0-39.9% = somewhat dissimilar floras, moderate change; <20.0% = very dissimilar floras, major change.

Table 5. Relative abundance of cells and rank by biovolume of diatoms and genera of non-diatom algae in periphyton samples collected from the Judith River near Lewistown, Montana on August 9, 2000.

Taxa	<u>Relative Abundance and (Rank)</u>	
	J 1	J 3
Chlorophyta (green algae)		
<i>Ankistrodesmus</i>	occasional (9)	occasional (10)
<i>Cladophora</i>	occasional (4)	frequent (1)
<i>Cosmarium</i>	rare (11)	occasional (7)
<i>Oedogonium</i>		common (5)
<i>Scenedesmus</i>	occasional (10)	occasional (9)
<i>Spirogyra</i>		frequent (3)
Chrysophyta (golden algae)		
Bacillariophyceae	frequent (2)	frequent (4)
Rhodophyta		
<i>Audouinella</i>	common (5)	rare (11)
Cyanophyta (cyanobacteria)¹		
<i>Calothrix</i>	common (3)	occasional (8)
<i>Gloeotheca</i>	abundant (1)	abundant (2)
<i>Hydrocoleum</i>	occasional (8)	
<i>Merismopedia</i>		occasional (12)
<i>Oscillatoria</i>	occasional (7)	
<i>Phormidium</i>	common (6)	frequent (6)

¹ Formerly known as blue-green algae.

Table 6. Percent abundance of major diatom species¹ and values of selected diatom association metrics for periphyton samples collected from the Judith River near Lewistown, Montana on August 9, 2000.

Species/Metric (Pollution Tolerance Class) ³	Percent Abundance/Metric Values ²			
	Mountain Criteria		Plains Criteria ⁴	
	J 1	J 3	J 1	J 3
<i>Achnanthes biasolettiana</i> (3)	8.09	2.46		
<i>Achnanthes minutissima</i> (3)	55.76	68.92		
<i>Cymbella laevis</i> (3)	5.27	1.23		
<i>Cymbella microcephala</i> (2)	4.90	9.46		
Cells Counted	408	407		
Total Species	69	44		
Species Counted	52	<u>29</u>		29
Species Diversity	<u>2.99</u>	<u>2.08</u>	2.99	2.08
Percent Dominant Species	55.76	68.92	55.76	68.92
Disturbance Index	55.76	68.92	55.76	68.92
Pollution Index	2.75	2.76		
Siltation Index	9.07	2.46		
Percent Abnormal Cells	1.84	1.84	1.84	1.84
Percent Epithemiaceae	0.61	0.49		
Similarity Index		72.94		

¹ A major diatom species is here considered to be one that accounts for 5% or more of the cells in one or more samples of a sample set.

² Underlined values indicate good biological integrity, minor impairment, and full support of aquatic life uses; **bold values** indicate fair biological integrity, moderate impairment, and partial support of aquatic life uses; all other values indicate excellent biological integrity, no impairment, and full support of aquatic life uses when compared to diatom criteria for mountain and plains streams in Tables 3 and 4.

³ 3 = sensitive to pollution; 2 = tolerant of pollution; 1 = most tolerant of pollution.

⁴ Only metric values that exceed diatom biocriteria for plains streams are shown.

APPENDIX A: DIATOM PROPORTIONAL COUNTS

Sample	Genus/Species/Variety	Pollution Tolerance Class	Count	Percent
200401	Achnanthes biasolettiana	3	66	8.09
200401	Achnanthes minutissima	3	455	55.76
200401	Amphora inariensis	3	0	0.00
200401	Amphora libyca	3	1	0.12
200401	Amphora pediculus	3	3	0.37
200401	Aulacoseira distans	3	0	0.00
200401	Caloneis bacillum	2	0	0.00
200401	Cocconeis placentula	3	3	0.37
200401	Cymbella affinis	3	1	0.12
200401	Cymbella amphicephala	3	3	0.37
200401	Cymbella delicatula	3	1	0.12
200401	Cymbella laevis	3	43	5.27
200401	Cymbella microcephala	2	40	4.90
200401	Cymbella minuta	2	2	0.25
200401	Cymbella perpusilla v. striatior	3	11	1.35
200401	Cymbella silesiaca	2	24	2.94
200401	Cymbella sinuata	3	2	0.25
200401	Denticula kuetzingii	3	5	0.61
200401	Diatoma moniliformis	2	3	0.37
200401	Diploneis oblongella	3	1	0.12
200401	Fragilaria construens	3	4	0.49
200401	Fragilaria pinnata	3	0	0.00
200401	Fragilaria vaucheriae v. capitellata	2	10	1.23
200401	Frustulia vulgaris	2	1	0.12
200401	Gomphonema dichotomum	3	7	0.86
200401	Gomphonema intricatum v. vibrio	3	4	0.49
200401	Gomphonema mexicanum	2	2	0.25
200401	Gomphonema minutum	3	2	0.25
200401	Gomphonema olivaceum	3	2	0.25
200401	Gomphonema parvulum	1	5	0.61
200401	Gomphonema pumilum	3	0	0.00
200401	Gomphonema sp.	3	0	0.00
200401	Gomphonema subtile	3	0	0.00
200401	Navicula capitata	2	1	0.12
200401	Navicula capitatoradiata	2	3	0.37
200401	Navicula cryptocephala	3	2	0.25
200401	Navicula cryptotenella	2	0	0.00
200401	Navicula gregaria	2	0	0.00
200401	Navicula kotschy	2	6	0.74
200401	Navicula lenzii	2	1	0.12
200401	Navicula menisculus	2	2	0.25
200401	Navicula pupula	2	3	0.37
200401	Navicula pygmaea	2	2	0.25
200401	Navicula reichardtiana	2	4	0.49
200401	Navicula stroemii	2	2	0.25
200401	Navicula tripunctata	3	1	0.12
200401	Navicula trivialis	2	0	0.00

Sample	Genus/Species/Variety	Pollution Tolerance Class	Count	Percent
200401	Navicula veneta	1	9	1.10
200401	Nitzschia amphibia	2	2	0.25
200401	Nitzschia angustata	2	0	0.00
200401	Nitzschia angustatula	2	0	0.00
200401	Nitzschia apiculata	2	2	0.25
200401	Nitzschia desertorum	2	10	1.23
200401	Nitzschia fonticola	3	2	0.25
200401	Nitzschia frustulum	2	1	0.12
200401	Nitzschia gracilis	2	0	0.00
200401	Nitzschia lacuum	3	2	0.25
200401	Nitzschia liebetruthii	2	2	0.25
200401	Nitzschia palea	1	11	1.35
200401	Nitzschia paleacea	2	4	0.49
200401	Nitzschia solita	1	2	0.25
200401	Stauroneis smithii	3	0	0.00
200401	Surirella angusta	1	0	0.00
200401	Synedra acus	2	4	0.49
200401	Synedra delicatissima	2	0	0.00
200401	Synedra nana	3	20	2.45
200401	Synedra rumpens	2	14	1.72
200401	Synedra tenera	2	0	0.00
200401	Synedra ulna	2	2	0.25

Sample	Genus/Species/Variety	Pollution Tolerance Class	Count	Percent
200501	<i>Achnanthes biasolettiana</i>	3	20	2.46
200501	<i>Achnanthes minutissima</i>	3	561	68.92
200501	<i>Amphora libyca</i>	3	0	0.00
200501	<i>Cocconeis pediculus</i>	3	2	0.25
200501	<i>Cocconeis placentula</i>	3	1	0.12
200501	<i>Cyclotella meneghiniana</i>	2	0	0.00
200501	<i>Cymbella affinis</i>	3	3	0.37
200501	<i>Cymbella delicatula</i>	3	2	0.25
200501	<i>Cymbella laevis</i>	3	10	1.23
200501	<i>Cymbella microcephala</i>	2	77	9.46
200501	<i>Cymbella perpusilla</i> v. <i>striator</i>	3	3	0.37
200501	<i>Cymbella silesiaca</i>	2	7	0.86
200501	<i>Denticula kuetzingii</i>	3	4	0.49
200501	<i>Diatoma moniliformis</i>	2	9	1.11
200501	<i>Diatoma vulgare</i>	3	0	0.00
200501	<i>Fragilaria leptostauron</i>	3	0	0.00
200501	<i>Fragilaria pinnata</i>	3	0	0.00
200501	<i>Fragilaria vaucheriae</i> v. <i>capitellata</i>	2	24	2.95
200501	<i>Gomphonema kobayasii</i>	3	2	0.25
200501	<i>Gomphonema minutum</i>	3	2	0.25
200501	<i>Gomphonema olivaceum</i>	3	0	0.00
200501	<i>Gomphonema parvulum</i>	1	8	0.98
200501	<i>Gomphonema pumilum</i>	3	4	0.49
200501	<i>Gomphonema subtile</i>	3	0	0.00
200501	<i>Navicula cryptotenella</i>	2	4	0.49
200501	<i>Navicula gregaria</i>	2	1	0.12
200501	<i>Navicula kotschy</i>	2	4	0.49
200501	<i>Navicula pupula</i>	2	0	0.00
200501	<i>Navicula stroemii</i>	2	1	0.12
200501	<i>Navicula trivialis</i>	2	0	0.00
200501	<i>Navicula veneta</i>	1	0	0.00
200501	<i>Nitzschia amphibia</i>	2	0	0.00
200501	<i>Nitzschia angustata</i>	2	0	0.00
200501	<i>Nitzschia fonticola</i>	3	0	0.00
200501	<i>Nitzschia palea</i>	1	5	0.61
200501	<i>Nitzschia perminuta</i>	3	5	0.61
200501	<i>Nitzschia solita</i>	1	0	0.00
200501	<i>Stauroneis smithii</i>	3	0	0.00
200501	<i>Synedra acus</i>	2	12	1.47
200501	<i>Synedra delicatissima</i>	2	1	0.12
200501	<i>Synedra nana</i>	3	13	1.60
200501	<i>Synedra rumpens</i>	2	4	0.49
200501	<i>Synedra tenera</i>	2	21	2.58
200501	<i>Synedra ulna</i>	2	3	0.37