BLACKFOOT WATERSHED WATER QUALITY STATUS AND TRENDS MONITORING PROJECT

2004 SUMMARY REPORT

Prepared for:

BLACKFOOT CHALLENGE
P.O. Box 103
Ovando, MT 59854

Prepared by:

PBS&J
801 N. Last Chance Gulch
P.O. Box 239
Helena, MT 59624

January 2006

Project # B41070.00

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

In 2004, the Blackfoot Challenge and its partners implemented the Blackfoot Watershed Water Quality Status and Trends Monitoring Program. This basin-wide monitoring program was designed and implemented to track overall health and water quality of the Blackfoot watershed over time. The data generated from this monitoring program will be used to characterize current conditions, to identify trends, and to identify restoration needs. This program combined with ongoing restoration monitoring efforts will also help partners understand the cumulative effects of restoration throughout the watershed. This interim report summarizes data collected in 2004 and describes the general status of water quality and biological indicators in the Blackfoot basin, but is not intended to make water quality impairment calls for the purposes of 303(d) listing under the Clean Water Act. The physical and chemical monitoring parameters were collected again in 2005. Future reports will focus on comparing sampling results with other available datasets.

The *Blackfoot Watershed Water Quality Status and Trends Monitoring Program* consists of a network of 12 fixed location "index" stations spread throughout the Blackfoot Basin and at which various physical, chemical, and biological data are gathered on a periodic basis. The monitoring variables, which are described in more detail in **Section 2.0** of this report, have been carefully selected to provide a comprehensive measure of water quality, biological integrity, and overall watershed health. Monitoring locations, representing distinct segments of the main stem Blackfoot River as well as key tributaries, have been selected to provide a "big picture" view of water quality throughout the watershed.

The intent is to maintain the operation of the program in a consistent fashion for a period of years, following which time trends (i.e. improving, static, or declining patterns) can be evaluated. In the meantime, the program will be used to gage the year-to-year status of the river, and to detect spatial (i.e. upstream to downstream) patterns.

2.0 MONITORING FRAMEWORK AND RATIONALE

Monitoring Locations

The Blackfoot Watershed Water Quality Status and Trends Monitoring Network consists of six monitoring sites on the main stem Blackfoot River, and six stations on the river's major tributaries, including the Landers Fork, Nevada Creek (2 stations), North Fork, Monture Creek, and the Clearwater River (**Figure 2-1** and **Table 2-1**). The six main stem stations reflect water quality at the upstream and downstream ends of each of three distinct segments of the river: the Blackfoot Headwaters – from the confluence of Beartrap and Anaconda creeks to Nevada Creek, 2) the Middle Blackfoot – from Nevada Creek to the Clearwater River, and 3) the Lower Blackfoot – from the Clearwater River to the Clark Fork. Rationale for selection of the stations included the presence of active streamflow gaging stations, representative geographical spacing along the river, inclusion of major tributaries, known or suspected pollution sources, and past monitoring activities (**Table 2-1**).

The overall goal of the station network design is to provide representative coverage of the entire watershed at a broad geographical scale, which can be integrated with more site- or area-specific monitoring programs to evaluate cause-and-effect relationships and cumulative responses. In other words, this program is intended to take a broad view of watershed health and basin-wide water quality, whereas other monitoring efforts may address more site-specific problems and improvements throughout the basin. It is not the intent for this project to make Clean Water Act impairment calls, but rather to provide information and analysis to the Montana Department of Environmental Quality (MDEQ) to support the agency's efforts to identify and restore impaired waters.

Monitoring Variables

The *Blackfoot Watershed Water Quality Status and Trends Monitoring Program* relies on a suite of physical, chemical, and biological measurements to evaluate water quality and watershed health as influenced by a variety of possible impairment causes. These include undesirable changes in streamflow, water temperature increases, excessive amounts of sediment, toxic metals, or algae-stimulating nutrients, and degradation of aquatic and riparian habitat. Each of these impacts can negatively affect designated uses of the Blackfoot Basin's waters, including aquatic life, cold water fisheries, drinking water, primary contact recreation (swimming), and agricultural and industrial uses. The selected monitoring variables, rationale, and relationships to designated water uses are summarized in **Table 2-2**.

In the past, many water quality monitoring programs relied only on measuring individual chemical pollutants in the water or in bottom sediments. These programs were not effective at measuring the ecological health of streams, which is best achieved through monitoring of a combination of chemical, physical (including habitat), and biological attributes.

Biological monitoring using aquatic insects (macroinvertebrates) and algae (periphtyon) provides additional benefits over conventional chemical monitoring. Where water column measurements reflect conditions only at the time of sampling, biological monitoring reflects both current conditions and temporal changes that may result from the cumulative effects of successive disturbances or episodic events. The long-term effects of drought, floods, spills, process changes, and illegal dumping are monitored continuously by organisms. Biological monitoring also allows the assessment of a wide range of stressors, including physical, chemical, biological, point, non-point, toxic, and non-toxic agents.

Maintaining water quality for fish and aquatic life is public policy of the State of Montana (MCA 75-5-101). Fish and aquatic life are specifically designated uses of the Blackfoot River and its tributaries (ARM 17.30.607 (1) (a) and 17.30.623 (1)), and "pollution" is defined in Montana statute in part as "contamination, or other alteration of the physical, chemical, or biological properties of any state waters…" (MCA 75-5-103(25) (a)). Therefore, biological monitoring provides a direct measure of aquatic life use-support and compliance with Montana water quality policies.

Monitoring Frequency

Physical and chemical data collection activities are performed six times each year by staff of the U.S. Geological Survey at each of the 12 stations in the network. Specific sampling times are determined on the basis of streamflow levels, which can be monitored remotely from the U.S. Geological Survey's real-time streamflow gaging network. The six sampling events are selected to coincide with: 1) the spring rising limb of the hydrograph (April-May), 2) at or near the peak of spring runoff (May-June), 3) the falling limb of the spring runoff hydrograph (June), 4) the summer base flow period (August), 5) late fall (November-December), and 6) an additional unscheduled high flow/runoff event that can occur any time of the year. Water quality can be expected to vary under each of these sets of conditions and times of the year.

Biological monitoring variables integrate conditions over a longer period of time (days, months, or years). Therefore, biological monitoring is conducted only once each year, in mid- to late-August. Actual field sampling methods are described in detail in the separate technical reports that are included as appendices to this report.

Sample Analysis

Water samples for chemical analysis are analyzed by the U.S. Geological Survey's National Water Quality Laboratory in Denver, Colorado. Algae and aquatic insect samples are processed by independent contractors (organisms are counted and identified to species) in Missoula and Helena. The algae samples for chlorophyll analysis are processed by the Montana Department of Public Health and Human Services Chemistry Laboratory in Helena.

Figure 2-1. ***Blackfoot watershed water quality status and trends monitoring network station locations.***

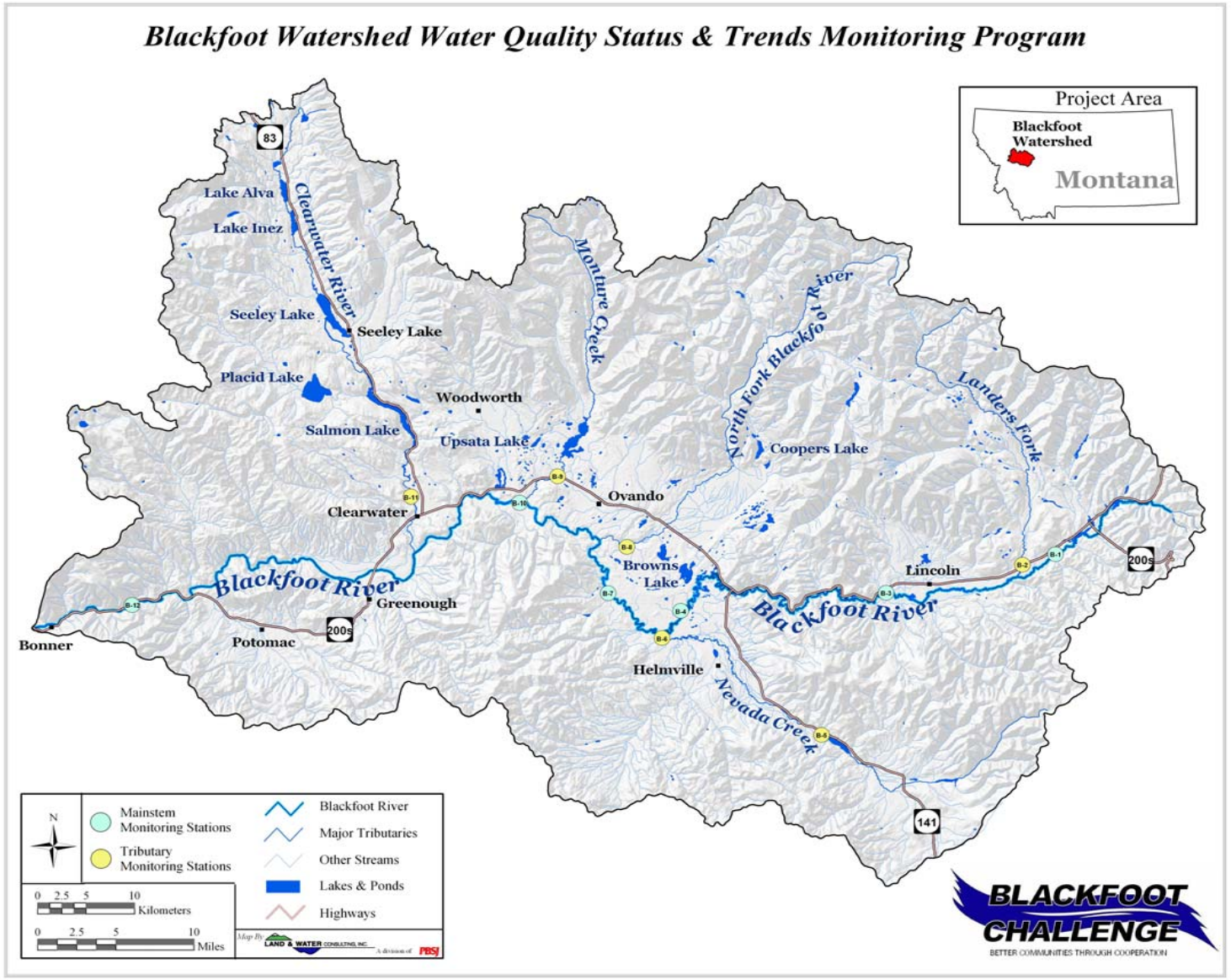


Table 2-1. ***Blackfoot watershed water quality status and trends monitoring network station descriptions and rationale.***

Station Number	River Mile[1]	Station Description	Rationale
B-1	119.4	Blackfoot River below Alice Creek, near Lincoln	Metals recovery area located below wetlands depositional zone and a significant headwaters tributary. Control site above Landers Fork. Previous water quality and streamflow monitoring site operated by USGS. Chemical, physical and biological monitoring performed at a nearby site by DHES and MFWP.
B-2	116.1	Landers Fork near Lincoln	Major tributary to upper Blackfoot River with strong influence on water quality. Major fisheries importance. Downstream of former McDonald Gold Project proposal. Previous water quality, streamflow and/or fisheries monitoring by USGS, DHES, MFWP, and others.
B-3	104.0	Blackfoot River at Dalton Mountain Road Bridge, near Lincoln	Downstream of Landers Fork, Poorman Creek, and Lincoln area development activities. Former USGS, DHES, and MFWP monitoring site.
B-4	72.0	Blackfoot River above Nevada Creek, near Helmville	Downstream integrator station for Blackfoot Headwaters TMDL planning unit, control site above Nevada Creek confluence, and active USGS flow gaging station. Former USGS water quality monitoring station.
B-5	-31.1	Nevada Creek below Nevada Creek Reservoir	Upper Nevada Creek watershed control site and active DNRC streamflow and former water quality monitoring station. Monitors water quality issues associated with dam operation, and 303(d) water quality issues in headwaters area.
B-6	67.8	Nevada Creek near mouth, near Helmville	Major (negative) impact on Blackfoot main stem water quality. Downstream integrator station for Nevada Creek TMDL planning unit and upstream TMDL restoration activities. Active USGS flow gaging and water quality station.
B-7	60.2	Blackfoot River at Raymond Bridge	Downstream of Nevada Creek confluence and upstream control station for North Fork Blackfoot River.
B-8	54.1	North Fork Blackfoot River above Dry Gulch, near Ovando	Major (positive) impact on Blackfoot main stem water quality. High fisheries importance and provides reference information. Active USGS gaging station and former water quality monitoring station operated by USGS, DHES, and MFWP. Active fisheries monitoring by MFWP.
B-9	45.9	Monture Creek near Ovando	Major tributary to middle Blackfoot with positive influence on main stem water quality. High fisheries importance and reference stream. Active fisheries monitoring by MFWP, former streamflow gaging by USGS, and former water quality monitoring by DHES and others.
B-10	45.8	Blackfoot River at Scotty Brown Bridge	Downstream integrator station for Middle Blackfoot TMDL planning unit. Control site above Clearwater River and mid-basin evaluation station. Previous water quality monitoring by USGS, DHES, and others.
B-11	34.7	Clearwater River near Clearwater	Major tributary with major land use activities and water quality influence on main stem Blackfoot River. Former USGS streamflow and water quality monitoring station.
B-12	7.9	Blackfoot River near Bonner	Existing long-term water quality/biology status and trends monitoring station with long-term historical record (Tri-State Council, DHES, DEQ), active USGS streamflow and water quality monitoring station. Integrator station for Lower Blackfoot TMDL planning area, and cumulative water quality of entire watershed.

[1] River miles from mouth on the Clark Fork River, from *River Mile Index of the Columbia River Basin* (MDNRC 1984).

Table 2-2. ***Blackfoot watershed water quality monitoring variables, rationale, and relationships to beneficial water uses.***

Monitoring Parameter	Rationale and Relationship to Designated Uses
I. Physical Parameters	
• Streamflow	Streamflow levels influence water chemistry and many physical variables, such as temperature, and affect the ability of a stream to transport sediment and other pollutants. Extremes in flow (drought, floods) can cause long lasting damage to fish and aquatic life populations by altering habitat.
• Water temperature	Temperature patterns and extremes influence a water body's ability to support fish and associated aquatic life. Montana's water quality standards for temperature are expressed in terms of allowable increases above "naturally occurring" temperatures to protect the existing temperature regime for fish and aquatic life. For waters of the Blackfoot drainage (B-1 class waters), the maximum allowable increase over naturally occurring temperature is 1° F, when the naturally occurring temperature is less than 67 º F. If the temperature is greater than 67º F, the maximum allowable increase is 0.5º F (ARM 17.30.623(e)).
• pH	pH levels outside of normal ranges can negatively affect aquatic life and increase the solubility of metals. Montana's water quality standards set restrictions on induced changes in pH in order to protect fish and aquatic life as well as other beneficial uses. For waters of the Blackfoot River drainage (B-1 waters), the maximum allowable change in pH within the range of 6.5 to 8.5 must be less than 0.5 pH units. Natural pH outside this range must be maintained without change. Natural pH above 7.0 must be maintained above 7.0 (ARM 17.30.623(c)).
• Specific conductivity	Conductivity provides an indirect measure of the amount of dissolved chemical constituents in water, and is useful for quickly assessing the suitability of a water for drinking water of water supply uses. There is no recommended criterion for conductivity. However, most beneficial water uses are fully supported at levels below 1500 µs/cm.
• Dissolved oxygen	Cold water aquatic life requires high levels of dissolved oxygen. Oxygen demanding wastes and elevated water temperatures reduce dissolved oxygen levels in surface waters. Minimum dissolved oxygen levels to protect aquatic life in streams of the Blackfoot watershed have been established in the MT water quality standards. The 1-day minimum water column concentration of dissolved oxygen for streams containing early life stages of fish is 8.0 mg/L, while for other life stages the 1-day minimum concentration is 4.0 mg/L (MDEQ 2004).
• Turbidity	High levels of turbidity (or cloudiness) can negatively affect most water uses, from aquatic life to drinking water to recreation. The MT water quality standards set a limit of a 5 unit increase over natural background turbidity levels for streams of the Blackfoot watershed (ARM 17.30.623(2) (d)).
• Suspended sediment	High levels of suspended sediment may indicate unnatural erosion problems in a watershed and can negatively affect most beneficial uses. In the Blackfoot River headwaters, heavy metals are transported in association with suspended sediment. The MT water quality standards do not establish numeric criteria for sediment, but restrict increases above naturally occurring levels or from discharges to state surface waters (ARM 17.30.623(1) (f)).

Table 2-2 (continued). ***Blackfoot watershed water quality monitoring variables, rationale, and relationships to beneficial water uses.***

<table>
<tr><th>Monitoring Parameter</th><th>Rationale and Relationship to Designated Uses</th></tr>
<tr><td>II. Water Chemistry</td><td></td></tr>
<tr><td>• Metals</td><td>Heavy metals, including cadmium, copper, lead, zinc, and others, are toxic to aquatic life and can affect human health. The toxicity of cadmium, copper, lead and zinc is inversely proportional to the hardness of the water. MT water quality standards for metals in the Blackfoot watershed are summarized below (MDEQ 2004).
<table>
<tr><th rowspan="2">Parameter</th><th colspan="2">Aquatic Life</th><th>Human Health</th></tr>
<tr><th>Acute Toxicity (µg/L) (1)</th><th>Chronic Toxicity (µg/L) (2)</th><th>Surface Water (µg/L) (1)</th></tr>
<tr><td>Cadmium, TR</td><td>1.05 @ 50 mg/l hardness</td><td>0.16 @ 50 mg/l hardness</td><td>5</td></tr>
<tr><td>Copper, TR</td><td>7.3 @ 50 mg/l hardness</td><td>5.2 @ 50 mg/l hardness</td><td>1,300</td></tr>
<tr><td>Lead, TR</td><td>34 @ 50 mg/l hardness</td><td>1.3 @ 50 mg/l hardness</td><td>15</td></tr>
<tr><td>Zinc, TR</td><td>67 @ 50 mg/l hardness</td><td>67 @ 50 mg/l hardness</td><td>2,000</td></tr>
</table>
(1) Maximum allowable concentration.
(2) No four-day (96-hour) or longer period average concentration may exceed these values.
Note: TR = Total Recoverable</td></tr>
<tr><td>• Nutrients</td><td>The nutrients nitrogen and phosphorus stimulate the growth of aquatic plants (algae) which can impair aquatic life and recreational uses of streams through oxygen depression, food chain effects, and reduced aesthetics. Most waters of Montana are protected from excessive nutrient concentrations by narrative standards which prohibit the creation of "conditions which produce undesirable aquatic life" (ARM 17.30.637(e)). The exception is the Clark Fork River above the confluence with the Flathead River, where numeric water quality standards have been adopted. These standards are 0.300mg/l for total nitrogen, and 0.020 mg/l (upstream of the Blackfoot River) and 0.039 mg/l (downstream of the Blackfoot River) for total phosphorus (ARM 17.30.631). The State of Montana is presently in the process of developing statewide numerical nutrient criteria.</td></tr>
<tr><td>III. Biological Indicators</td><td></td></tr>
<tr><td>• Aquatic macro-invertebrates</td><td>Aquatic macroinvertebrates (aquatic insects) are good indicators of the effects of multiple stressors (chemical as well as physical) on aquatic systems because they are differentially sensitive to pollution and habitat alterations and some species have long life spans. The MT water quality standards specify that the Blackfoot River and its tributaries shall be maintained as suitable for fish and associated aquatic life (i.e. aquatic insects). The State of Montana has adopted specific protocols and criteria for assessing the biological integrity of streams based on the makeup of resident aquatic macroinvertebrate communities and the quality of the available habitat for these life forms (MDEQ 2005).</td></tr>
<tr><td>• Periphyton</td><td>The species composition and relative abundances of periphyton (algae) in a stream provide an indication of water and habitat quality, as influenced by nutrients, sediment, metals, temperature, streamflow, and other variables. When coupled with macroinvertebrate surveys, they provide a well rounded appraisal of the overall biological integrity of a stream. The State of Montana has adopted specific protocols and criteria for assessing the biological integrity of streams based on periphyton communities (MDEQ 1999, presently under revision).</td></tr>
<tr><td>• Chlorophyll a</td><td>Algal densities, measured as chlorophyll a, may provide a measure of nutrient enrichment in a stream. The State of Montana has not adopted numeric criteria for algae or chlorophyll a in the Blackfoot River. However, standards have been adopted for the Clark Fork River from its headwaters to the Flathead River confluence. These standards are 100 mg/M^2 chlorophyll a as a summer mean concentration, and 150 mg/M^2 as a summer peak concentration (ARM 17.30.631). Other scientific literature suggests that 100 mg/M^2 for chlorophyll a is indicative of moderately enriched conditions, whereas non-enriched, light-limited, or scour-dominated stream systems typically have benthic chlorophyll a values much less than 50 mg/M^2 (USEPA 2000).</td></tr>
</table>

3.0 2004 MONITORING RESULTS

The 2004 monitoring results are summarized in the following sections on a parameter by parameter basis. Spatial (upstream to downstream) patterns are discussed, as well as central tendencies and extremes observed at individual stations. The various monitoring data are collectively interpreted in **Section 4.0** of this summary report. Separate interpretive reports describing the physical/chemical and various biological data (macroinvertebrates, periphyton, chlorophyll *a*) are included in **Appendices A-D**. Field forms, field notes, and site photos which can help explain some of the results are included in **Appendices E and F**.

3.1 Physical Parameters

The physical properties of water have traditionally served as on e of the primary means of monitoring water quality. Parameters such as pH, dissolved oxygen, conductivity, turbidity, and water temperature are sensitive to municipal, industrial, and non-point source pollution and are important to aquatic ecosystems. Monitoring results for physical parameters are summarized below. A detailed interpretive report of physical and chemical monitoring variables in included in **Appendix A** of this report.

Streamflow

Figure 3-1 provides a comparison of streamflow levels in the Blackfoot River near Bonner during calendar year 2004 to the long-term average flow recorded by the U.S. Geological Survey at the same location since 1898. It can be concluded based on these hydrographs that streamflows in the Blackfoot watershed during 2004 were below normal, on average. Additionally, the spring snowmelt runoff peak occurred about one month earlier, and was substantially lower, than the long-term average.

On a more site-specific basis, streamflows were lowest at the upper Blackfoot monitoring stations and in the smaller tributary streams, and were highest at the lower-most Blackfoot River station near Bonner. The hydrographs indicated that peak flows occurred during May and June at most sampling locations, although an extreme runoff event occurred in March in Nevada Creek below the Nevada Creek Reservoir. Individual water quality sampling events represented various points on the hydrograph, including rising and falling limb, near peak flow, and during baseflow conditions in November. Overall, lower streamflows in 2004 may have somewhat increased late-summer water temperatures and chlorophyll *a* concentrations. They may have also reduced suspended sediment and heavy metals concentrations during spring runoff, when compared to a more normal runoff year.

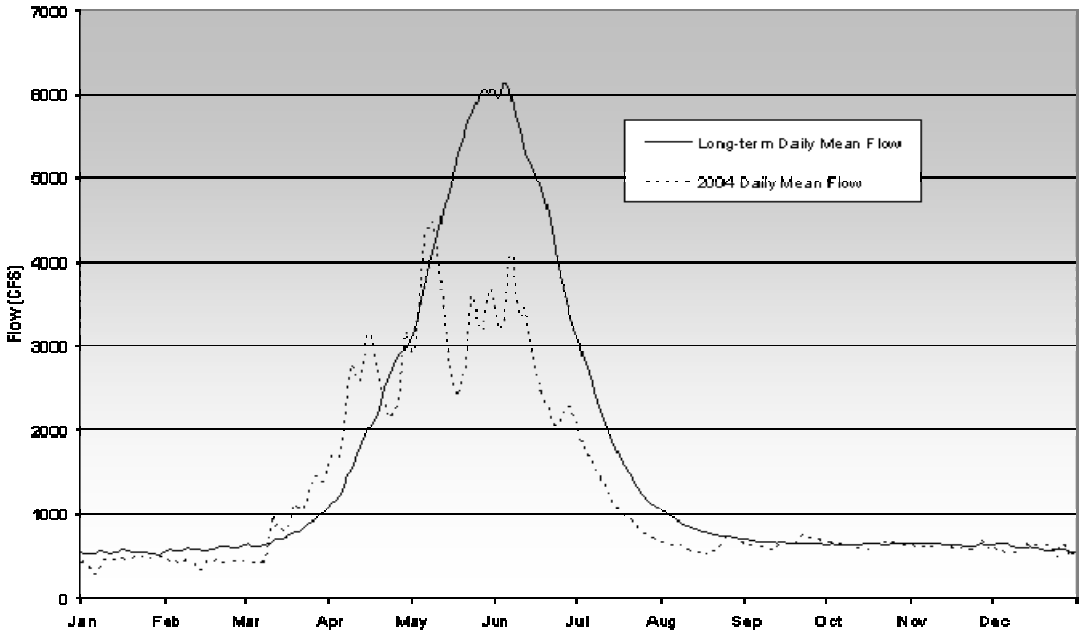
Water Temperature

Stream temperatures at Blackfoot monitoring stations fluctuated greatly depending on time of year and time of day. In general, stream temperatures were lowest in the upper watershed and in the tributary streams. Median stream temperatures in the Blackfoot River main stem were similar to those in most tributary streams (10.0 ^{o}C). Stream temperatures tended to increase in a downstream direction in the main stem Blackfoot River from below Alice Creek (4.5 ^{o}C) to the

Raymond Bridge (10.5 ^{o}C). Median stream temperatures tended to remain relatively constant from the Raymond Bridge to the station near Bonner. Median temperatures in tributary streams were lowest in the Landers Fork (5.2 ^{o}C) and highest in the Clearwater River (13.0 ^{o}C) and in Nevada Creek near its mouth (12.5 ^{o}C). The highest instantaneous water temperature was also recorded in the Clearwater River (22.5 ^{o}C).

Apparent differences in water temperature between stations should be interpreted with some caution because they reflect instantaneous measurements taken at different times of the day.

Figure 3-1. ***Daily mean streamflow in the Blackfoot River near Bonner during 2004 in comparison to the long-term daily mean streamflow (from USGS 2005).***



pH

Median pH in the main stem of the Blackfoot River increased downstream from below Alice Creek (8.1) to the Raymond Bridge (8.5). Downstream of the Raymond Bridge, median pH in the Blackfoot River remained relatively constant to the Bonner station. Median pH in tributary streams was lowest in Nevada Creek below Nevada Creek Reservoir (8.0) and highest in Nevada Creek near its mouth (8.4). In general, median pH increased from the upper watershed downstream to the mouth. Median pH in tributary streams was comparable to the main stem river. None of the pH values were cause for concern.

Like the water temperature measurements, apparent differences in pH between stations should be interpreted with some caution because they reflect instantaneous measurements taken at different times of the day. In general, pH tends to increase during the day and decline during hours of darkness.

Specific Conductivity

Specific conductivity, an indirect measure of dissolved ion concentrations, was highest in the Blackfoot main stem at Raymond Bridge (280 µs/cm median) and lowest near Bonner (184 µs/cm median). Among tributary streams, median specific conductance was lowest in the Clearwater River near Clearwater (145 µs/cm) and highest in Nevada Creek near its mouth (401 µs/cm). In general, tributary streams had a lower median specific conductance than main stem sites (229 and 249 µs/cm, respectively). Conductance values reflected generally low concentrations of dissolved solids and good water quality.

Dissolved Oxygen

Median dissolved oxygen concentrations in the main stem Blackfoot River were highest at the Raymond Bridge site (10.6 mg/L) and lowest above Nevada Creek (8.6 mg/L). Median dissolved oxygen concentrations in tributary streams were highest in the Landers Fork near mouth (10.5 mg/L) and lowest in Nevada Creek below Nevada Creek Reservoir (9.0 mg/L). Differences in dissolved oxygen concentrations between sites were likely affected by time of sampling and diurnal fluctuations. Lowest concentrations of dissolved oxygen tend to occur at pre-dawn and highest concentrations can be expected in late-afternoon. None of the measured values reflected standards violations or problems for resident aquatic life.

Turbidity and Suspended Sediment

Turbidity readings in the Blackfoot watershed were generally low during 2004, except for the Nevada Creek sites below Nevada Creek Reservoir and near the mouth, where median values of 16.0 NTU and 14.0 NTU, respectively, reflected moderately turbid conditions on most occasions. Median turbidity was lower in tributary streams (2.3 NTU) than in the main stem Blackfoot River sites (2.7 NTU). Several sites throughout the watershed had very low (below detection) median turbidity values reflecting very clear water. These included Blackfoot River sites below Alice Creek and at the Dalton Mountain Road, Landers Fork near mouth, North Fork Blackfoot above Dry Gulch, Monture Creek near Ovando and Clearwater River near Clearwater. With some exceptions, maximum turbidity readings at most stations were recorded during the highest flow event of the sampling year.

Median concentrations of suspended sediment at Blackfoot River stations were lowest in the upper watershed below Alice Creek (2.5 mg/L) and highest at Raymond Bridge (14 mg/L). Median suspended sediment concentrations in the tributary streams were lowest in the Clearwater River (2.0 mg/L) and highest in Nevada Creek near its mouth (30 mg/L).

Highest instantaneous turbidity and suspended sediment readings were recorded in the Landers Fork on August 23, 2004 (190 NTU and 298 mg/L, respectively) and in Nevada Creek near its mouth on March 10, 2004 (99 NTU and 292 mg/L, respectively). Both of these events represented snowmelt or rainfall runoff events. These values can be considered to be problematic to beneficial water uses, depending on their duration, and certainly reflect sediment sources in the respective watersheds.

3.2 Water Chemistry

Chemical constituents of concern in the Blackfoot watershed primarily include heavy metals associated with past mining activities, and algal nutrients (forms of nitrogen and phosphorus) associated with agricultural land uses and urban development. Monitoring results for water chemistry parameters are summarized below. A more detailed interpretive report describing the water chemistry monitoring results is in included in **Appendix A** of this report.

Nutrients

Nutrient variables measured included total nitrogen (TN), nitrate + nitrite-nitrogen (NO_2+NO_3), ammonia-nitrogen (NH_3-N), total phosphorus (TP), and orthophosphate (OP). Nutrient concentrations in 2004 were generally low throughout the Blackfoot watershed, with several notable exceptions. Total phosphorus concentrations were significantly higher in Nevada Creek below Nevada Creek Reservoir and near the mouth when compared to the other stations in the network. Total nitrogen concentrations were also much higher in the two Nevada Creek sites, and slightly elevated in the Landers Fork near mouth. Several tributary streams had elevated concentrations of nitrate + nitrite in 2004, including Landers Fork near mouth, Nevada Creek below Nevada Creek Reservoir, North Fork Blackfoot above Dry Gulch, and Monture Creek near Ovando. Concentrations of ammonia were generally below the analytical detection limit at most sites in 2004 except at the Nevada Creek site below Nevada Creek Reservoir. Ammonia concentrations at this station were significantly higher than at any other sampling location. Concentrations of orthophosphate were also significantly higher at the two Nevada Creek sites than at any of the other sampling locations. Overall, the Nevada Creek sites had significantly higher nutrient concentrations than any other monitoring location in the Blackfoot network.

Median total phosphorus concentrations were generally low in the upper watershed and increased downstream to Nevada Creek near its mouth, where concentrations (0.301 mg/L) were ten-fold greater than the standards established for the Clark Fork River (0.20, 0.39 mg/L, see Table 2-2). The highest median concentration among Blackfoot River main stem sites was at the Raymond Bridge (0.191 mg/L) located below Nevada Creek. The lowest median TP concentration among tributary streams was measured in the North Fork Blackfoot above Dry Gulch (0.005 mg/L). The lowest median TP concentration among main stem sites was in the Blackfoot River near Bonner (0.010 mg/L).

Median total nitrogen (TN) concentrations in the Blackfoot River main stem were generally low in 2004, ranging from 0.080 mg/L at sites below Alice Creek, at Dalton Mountain Road and above Nevada Creek, to a high of 0.150 mg/L at Raymond Bridge. Median TN concentrations were much higher in tributary streams, ranging from 0.120 mg/L at Monture Creek near Ovando to 0.690 in Nevada Creek below Nevada Creek Reservoir. By comparison, the total nitrogen standard established for the Clark Fork River is 0.300 mg/L.

Median nitrate + nitrite concentrations in the main stem Blackfoot River were below the analytical detection limit (<0.016 mg/L) at all stations except Dalton Mountain Road (0.023 mg/L). Among tributary streams, median nitrate + nitrite concentrations were below the analytical detection limit (<0.016 mg/L) in the Clearwater River near Clearwater. The highest

median NO_2+NO_3 concentrations were found in the North Fork Blackfoot above Dry Gulch (0.069 mg/L) and Landers Fork near mouth (0.058 mg/L).

Median concentrations of ammonia-nitrogen within the Blackfoot watershed were below the analytical detection limit (<0.010 mg/L) at all monitoring locations except Nevada Creek below Nevada Creek Reservoir (0.105 mg/L). High concentrations of ammonia were experienced during March at Nevada Creek near mouth (0.868 mg/L) and in the Blackfoot River at Raymond Bridge (1.14 mg/L). These samples were collected following a major runoff event on Nevada Creek suggesting the presence of non-point source runoff.

Median orthophosphate (OP) concentrations within the Blackfoot watershed were highest in Nevada Creek near its mouth (0.089 mg/L) and below the reservoir (0.029 mg/L). Median OP concentrations at all other monitoring sites were below the analytical detection limit (<0.006 mg/L), although Blackfoot River at Raymond Bridge did experience a high concentration of OP during the March sampling event (0.648 mg/L).

The nutrient data pointed to Nevada Creek as having consistently problematic concentrations of both nitrogen and phosphorus. Landers Fork and the North Fork Blackfoot had moderately elevated concentrations of nitrate + nitrite when compared to other stations in the watershed.

Metals

Metals concentrations throughout the Blackfoot watershed were quite variable in 2004. In general, metal concentrations tended to be closely related to streamflow levels, with highest concentrations occurring during high flow periods. Cadmium concentrations were below the analytical detection limit at all sites except at the uppermost station, Blackfoot River below Alice Creek, the Landers Fork, and Nevada Creek near the mouth. The Blackfoot River below Alice Creek had measurable cadmium concentrations throughout most of the sampling year. The chronic toxicity aquatic life criterion for cadmium was exceeded at this station during May 2004 (0.25 µg/L) and in the Landers Fork near Lincoln during August (0.32 µg/L). Drinking water standards excursions for cadmium were not noted as occurring in 2004.

Median copper (Cu) concentrations were quite variable throughout the Blackfoot watershed in 2004. The highest median concentration among main stem Blackfoot River sites was at Scotty Brown Bridge (2.10 µg/L), while the lowest median concentration was at the site near Bonner (0.850 µg/L). Among tributary sites, the highest median Cu concentration was found in Nevada Creek near mouth (2.20 µg/L), while the lowest was at North Fork Blackfoot above Dry Gulch (0.700 µg/L). The chronic toxicity aquatic life criterion for copper was exceeded in the Landers Fork during August 2004 (13.6 µg/L), and in Nevada Creek near its mouth during March 2004 (7.8 µg/L). Drinking water standards excursions for copper were not noted as occurring in 2004.

Among main stem Blackfoot River sites, median lead (Pb) concentrations were generally low in the upper watershed below Alice Creek (0.145 µg/L) and increased downstream to Scotty Brown Bridge (0.450 µg/L). Below Scotty Brown Bridge, median Pb concentrations decreased to the site near Bonner (0.090 µg/L). Among tributary sites, the highest median Pb concentrations were measured in Nevada Creek below Nevada Creek Reservoir (0.450 µg/L) and near its mouth

(0.460 µg/L). Several sites had median concentrations that were below the analytical detection limit (<0.060 µg/L), including the North Fork Blackfoot above Dry Gulch, Monture Creek near Ovando and the Clearwater River near Clearwater. Lead concentrations exceeded the chronic toxicity aquatic life criterion in the Landers Fork during August 2004 (18.6 µg/L), and in Nevada Creek near its mouth during March 2004 (3.2 µg/L). Drinking water standards excursions for lead were detected in the Landers Fork during the August 2004 sampling event.
Median zinc (Zn) concentrations were exceptionally high at one location during 2004, the Blackfoot River below Alice Creek (22.5 µg/L). The Blackfoot River at Dalton Mountain Road (3.0 µg/L) had a median Zn concentration above the analytical detection limit, otherwise all sites throughout the watershed had median Zn concentrations below the analytical detection limit (<2.0 µg/L). Acute and chronic toxicity aquatic life criteria were exceeded in the Blackfoot River below Alice Creek during May 2004 (118 µg/L). Drinking water standards excursions for zinc were not observed at Blackfoot watershed monitoring locations in 2004.

The 2004 metals data pointed to the Blackfoot River below Alice Creek, Landers Fork, and Nevada Creek as having intermittent metals water quality standards excursions of variable magnitude. Abandoned mine/wet weather related sources were likely responsible for then observed problems. Cadmium and zinc were problematic in the Blackfoot River below Alice Creek during a May 2004 high flow event. Cadmium, copper, and lead exceeded water quality standards in the Landers Fork during an August 2004 rainfall runoff event, while copper and lead exceeded standards in Nevada Creek near its mouth during a March 2004 runoff event.

3.3 Biological Indicators

Aquatic Macroinvertebrates

Aquatic macroinvertebrate communities are suitable for use in bioassessments because they are known to be important indicators of stream ecosystem health. Long lives, complex life cycles, and limited mobility mean that there is ample time for the community to respond to the cumulative effects of environmental perturbations. In general, the macroinvertebrate assessments rely on an array of individual measures, or metrics, that collectively provide an indication of biological condition as well as habitat and water quality. Community attributes that contribute to the interpretations include individual sensitivity of species to stress or pollution, functional roles of species within the community, and the overall makeup of the community in terms of species present and their relative abundances compared to others. The assessment of macroinvertebrate habitat quality provides additional information that can be used to evaluate the relationship between habitat integrity and water quality. Both factors contribute to the functional integrity of aquatic invertebrate communities. Where habitat quality is high, but bioassessment results indicate impairment, it can be assumed that water quality is a limiting factor. Where habitat quality is limiting, bioassessment scores can be expected to be diminished even if water quality remains high. The State of Montana has adopted specific protocols and criteria for assessing the biological integrity of streams and the levels of beneficial use support based on resident aquatic insect communities and the quality of the available habitat, and these are described in detail in **Appendix B**.

Figure 3-2 summarizes biological assessment scores for aquatic macroinvertebrate communities sampled from sites in the Blackfoot River watershed during 2004. **Table 3-1** summarizes macroinvertebrate metric summary values, scores, and bioassessments for the Blackfoot monitoring sites. **Table 3-2** summarizes the results of the macroinvertebrate habitat quality assessment for each the Blackfoot monitoring sites. Conclusions pertaining to water quality conditions and the level of beneficial water use support derived from the macroinvertebrate data are summarized below. The full text of the macroinvertebrate bioassessment report and associated data are included in **Appendix B** of this summary report.

A sparse mayfly assemblage suggested slight impairment of water quality in the Blackfoot River below Alice Creek. Heptageniid mayflies were apparently not present at the site, and metals contamination was suggested based on the sensitivity of this group to metals. The bioassessment score for this site suggested slight impairment and partial support of designated uses. The habitat assessment indicated that poor water quality, not habitat limitations, were the primary cause of biological impairment.

Landers Fork near Lincoln supported a diverse, sensitive, and functional invertebrate assemblage characteristic of minimally impaired montane sites. The bioassessment score for the Landers Fork near Lincoln indicated non-impairment and full support of designated uses. The habitat evaluation showed only a slight degree of impairment that did not appear to influence the bioassessment results.

Fine organic particles in suspension were a major energy source at the Blackfoot River at the Dalton Mountain Road Bridge. Otherwise, water quality was probably reasonably good here, and in-stream habitats may have been relatively undisturbed. The bioassessment scores suggested slight impairment and partial support of uses. The habitat assessment indicated optimal habitat suggesting that water quality was a potentially greater limiting factor to overall biointegrity at this site than the quality of the available habitat.

Warmer water temperatures and slight nutrient enrichment may have influenced the aquatic assemblages at the Blackfoot River above Nevada Creek. This site produced bioassessment scores suggesting slight impairment and partial support of uses. The habitat assessment indicated sub-optimal conditions, but water quality was probably a greater limiting factor than the quality of the available habitat.

The dam at the Nevada Creek Reservoir profoundly affected invertebrate assemblages resident in Nevada Creek below the outflow. Filter-feeders overwhelmed the functional composition of these communities, and thermal stress and nutrient enrichment were suggested. Severe impairment and non-support of uses was indicated for this site. Habitat quality was sub-optimal but water quality was the primary limiting factor contributing to a low level of biological integrity.

Abundant filter-feeders, warm water-tolerant taxa, and near-absent stonefly fauna characterized the benthic assemblage collected from Nevada Creek near its mouth. Nutrient enrichment and thermal stress likely affected the benthic assemblage here. This site was rated as moderately

impaired and partially supportive of uses. Habitat quality was rated as sub-optimal but water quality was a more important limiting factor contributing to the impairment rating.
Very slight nutrient enrichment may have affected the composition of benthic assemblages at the Blackfoot River at Raymond Bridge in summer 2004. This site produced bioassessment scores suggesting slight impairment and partial support of uses. Habitat quality was rated as only slightly optimal, therefore water quality was the primary determinant contributing to the slight impairment rating.

Mild-to-moderate nutrient enrichment but appropriate water temperatures appeared to influence the composition of aquatic communities on the North Fork of the Blackfoot above Dry Gulch (Site B8). Slight impairment but full use support was indicated. Habitat quality was rated as optimal, therefore water quality was the primary determinant contributing to the slight impairment rating.

Slight impairment of water quality by thermal stress and/or nutrient enrichment seemed to be implicit in the composition of the benthic assemblages collected at Monture Creek near Ovando. The site produced scores suggesting slight impairment and partial support of designated uses. Habitat quality was rated as sub-optimal but water quality was a more important limiting factor contributing to the slightly impaired rating.

The Blackfoot River at Scotty Brown Bridge supported a benthic assemblage characteristic of a minimally disturbed, large montane river. Good water quality and excellent in-stream habitats were suggested. The site yielded a bioassessmejnt score suggesting slight impairment and partial support of designated water uses. Habitat quality was rated as slightly sub-optimal but water quality was a more important limiting factor contributing to the slightly impaired rating.

Warm water temperatures and habitat disruptions were suggested by the benthic fauna collected at the Clearwater River. The site was rated as moderately impaired and partially supportive of uses. Habitat quality was rated as optimal, therefore water quality was the primary determinant contributing to the moderate impairment rating.

The Blackfoot River at Bonner supported a benthic macroinvertebrate assemblage that seemed appropriate for a large montane river in its lower reaches. Good water quality and habitats were indicated. The site's bioassessment scores suggested slight impairment and partial support of uses. Habitat quality was rated as optimal, therefore water quality was the primary determinant contributing to the slight impairment rating.

Figure 3-2. ***Comparison of aquatic macroinvertebrate bioassessment scores (reported as percent of maximum score) for Blackfoot watershed monitoring stations during August 2004 (reproduced from Bollman 2005).***

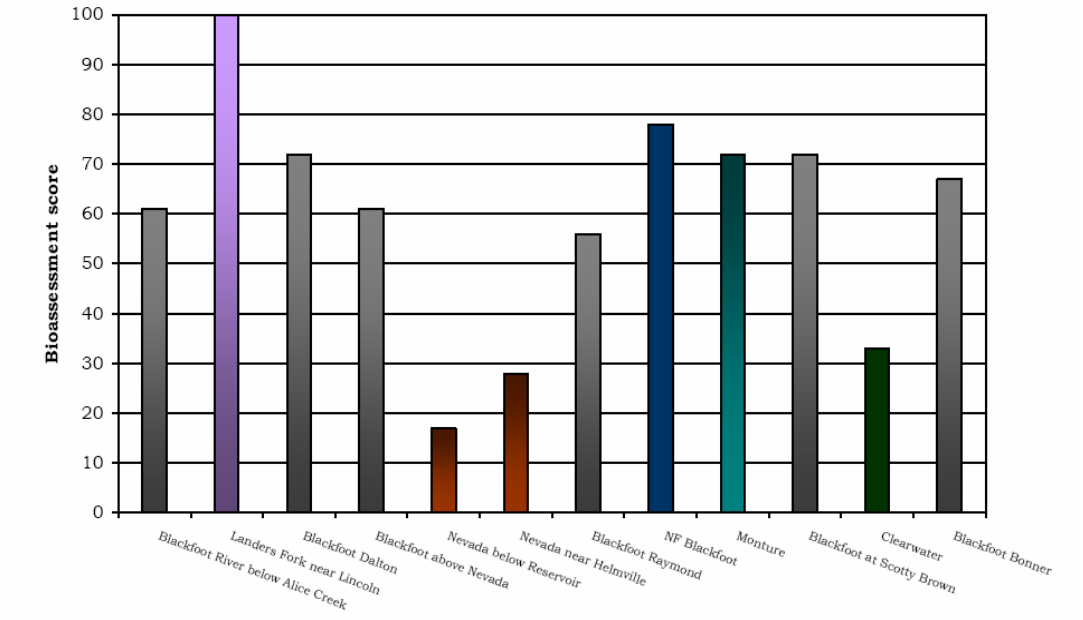


Table 3-1. ***Macroinvertebrate metric summary values (averaged for 4 replicates at each site), scores, and bioassessments for Blackfoot watershed monitoring stations during August 2004 (reproduced from Bollman 2005).***

	SITES											
	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
METRICS	**METRIC VALUES**											
Ephemeroptera richness	2.75	7.75	5.5	4.5	1	3	3.75	5.75	4.25	5.75	2.25	4.75
Plecoptera richness	4	3.25	3	5.25	0	0.25	2	3.25	2	5.5	1.75	3.75
Trichoptera richness	9	5.25	4.5	8.5	4	6.25	6.75	5	9.5	7.75	6	7
Number of sensitive taxa	3	5	2.75	2	0	0.25	2	2	2	2.75	.75	1.25
% filterers	16.58	4.48	54.37	30.74	87.57	70.80	11.03	18.25	18.45	16.76	25.40	17.01
% tolerant taxa	12.63	0.00	1.97	27.17	34.82	23.02	16.04	5.1	2.82	16.36	30.48	11.54
	METRIC SCORES											
Ephemeroptera richness	1	3	3	2	0	1	1	3	2	3	1	2
Plecoptera richness	3	3	2	3	0	0	2	3	2	3	1	3
Trichoptera richness	3	3	3	3	2	3	3	3	3	3	3	3
Number of sensitive taxa	2	3	2	2	0	0	2	2	2	2	0	1
% filterers	1	3	0	0	0	0	1	1	1	1	0	1
% tolerant taxa	1	3	3	1	1	1	1	2	3	1	1	2
TOTAL SCORE (max.=18)	11	18	13	11	3	5	10	14	13	13	6	12
PERCENT OF MAX.	**61%**	**100%**	**72%**	**61%**	**17%**	**28%**	**56%**	**78%**	**72%**	**72%**	**33%**	**67%**
Impairment classification*	**SLI**	**NON**	**SLI**	**SLI**	**SEV**	**MOD**	**SLI**	**SLI**	**SLI**	**SLI**	**MOD**	**SLI**
USE SUPPORT †	**PART**	**FULL**	**PART**	**PART**	**NON**	**PART**	**PART**	**FULL**	**PART**	**PART**	**PART**	**PART**

* Impairment classifications: (NON) non-impaired, (SLI) slightly impaired, (MOD) moderately impaired, (SEV) severely impaired. See Table 3b.
† Use support designations: See Table 3a.

Table 3-2. ***Macroinvertebrate habitat assessment scores* for Blackfoot watershed monitoring stations during August 2004 (reproduced from Bollman 2005).***

		B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
Max. possible score	Parameter												
10	Riffle development	9	10	5	4	3	9	10	10	10	10	10	10
10	Benthic substrate	9	9	8	9	4	6	9	10	10	9	10	10
20	Embeddedness	18	16	16	16	11	16	16	19	18	15	20	18
20	Channel alteration	16	15	18	15	13	16	18	20	20	16	20	16
20	Sediment deposition	13	8	14	11	11	10	16	19	15	16	20	16
20	Channel flow status	18	16	16	18	18	16	18	18	18	18	15	18
20	Bank stability	9/9	6/5	9/9	7/7	9/9	5/9	8/8	9/9	5/5	7/7	10/10	9/9
20	Bank vegetation	8/8	5/5	9/9	7/7	9/9	6/8	7/7	10/10	3/3	8/8	10/10	9/9
20	Vegetated zone	7/7	6/6	8/8	6/6	5/5	3/3	5/5	9/9	3/3	5/5	5/5	7/7
160	Total	131	107	129	113	106	107	127	152	113	124	145	138
	Percent of maximum	**82%**	**67%**	**81%**	**71%**	**66%**	**67%**	**79%**	**95%**	**71%**	**78%**	**91%**	**86%**
	CONDITION*	Optimal	Sub-optimal	Optimal	Sub-optimal	Sub-optimal	Sub-optimal	Optimal	Optimal	Sub-optimal	Sub-optimal	Optimal	Optimal

Condition categories: Optimal > 80% of maximum score; Sub-optimal 75 - 56%; Marginal 49 - 29%; Poor <23%. (Plafkin et al. 1989).

* Scores are based on criteria developed by Montana DEQ for streams with riffle/run prevalence.

Periphyton Community Structure

Periphyton is the assemblage of small, often microscopic organisms (bacteria, fungi, and algae) that occur in aquatic habitats as a biofilm of varying thickness attached to the surfaces of submerged substrates such as rocks and logs. Benthic algae typically dominate the periphyton community in freshwater streams. These algae can be divided into two major groups: the diatom algae which possess a rigid silica cell wall called a "frustule," and the non-diatom or soft-bodied algae. Algae, and particularly the diatoms, are useful as water quality biomonitors because they occur in very large numbers, are highly sensitive to physical and chemical factors, and have known environmental requirements and pollution tolerances unique to individual species. The State of Montana has adopted specific protocols and criteria for assessing the biological integrity of streams and the levels of beneficial use support based on periphyton communities, and these are described in detail in **Appendix C**.

Table 3-3 summarizes metric scores and bioassessment results for periphyton communities in the Blackfoot River watershed during 2004. Conclusions pertaining to water quality conditions and the level of beneficial water use support that were derived independently from the algae are summarized below. The full text of the periphyton bioassessment report and associated data are included in **Appendix C** of this summary report.

Minor impairment of the biological community was indicated at the Blackfoot River below Alice Creek, probably due to sediment and metals impacts. A very diverse assemblage of soft-bodied and diatom algae suggested elevated levels of algal nutrients. Landers Fork near Lincoln was moderately impaired due to environmental stress related to substrate disturbance, although sediment impacts were not indicated. Both soft-bodied and diatom algae were much less diverse than in the Blackfoot main stem due to relatively nutrient-poor conditions at this site.

Sediment impacts were responsible for minor impairment at Blackfoot River at Dalton Mountain Road near Lincoln. Biological integrity was good, and a diverse assemblage of soft-bodied and diatom algae indicated abundant inorganic nutrients. Minor impairment of the biota related to sediment was indicated at the Blackfoot River above Nevada Creek. A highly diverse community of soft-bodied and diatom algae was present, apparently in response to low levels of environmental stress and nutrient-rich conditions.

Nevada Creek below Nevada Creek Reservoir had only minor impairment indicated by diatom metrics that apparently was due to sediment impacts. The very low number of soft-bodied genera and the predominance of diatoms with a strong affinity for elevated nutrients suggest site B-5 was adversely impacted by the upstream impoundment. Elevated sediment was responsible for minor impairment at Nevada Creek near its mouth, and highly productive conditions were indicated by the predominance of diatom species preferring elevated levels of inorganic nutrients.

Sediment was indicated as the cause of minor impairment of the Blackfoot River at Raymond Bridge. Elevated inorganic nutrients influenced the diverse assemblage of soft-bodied and diatom algae at this site, which strongly mirrored the flora of lower Nevada Creek.
At the North Fork Blackfoot River above Dry Gulch biological integrity was good with only minor impairment, apparently related to substrate disturbance. Moderately low levels of inorganic nutrients were indicated, based on the lower diversity of soft-bodied genera and diatom species at this site. Minor impairment was indicated by a slightly depressed pollution index value at Monture Creek near Ovando, although a cause was not apparent. Soft-bodied algae and the diatom assemblage suggested at least slight enrichment by inorganic nutrients at this site.

Biological integrity was good at the Blackfoot River at Scotty Brown Bridge, with only minor impairment due substrate disturbance. Monture Creek and the North Fork likely had significant positive impacts on the Blackfoot River at Scotty Brown Bridge, as suggested by diatom nutrient preferences.

The Clearwater River at Clearwater was rated as unimpaired with excellent biological integrity. The diatom flora, which had relatively little in common with the Blackfoot River, indicated moderately high levels of inorganic nutrient enrichment at this site.

Excellent biological integrity with no impairment of aquatic life was indicated at the Blackfoot River near Bonner, the only main stem Blackfoot River site so rated in August 2004. The very diverse algal assemblage indicated highly productive, nutrient-rich conditions at this site.

Table 3-3. ***Attached algae (diatom) metric scores and bioassessment results for Blackfoot watershed monitoring stations during August 2004 (mod.= moderate; part.= partial; excel.= excellent)(reproduced from Weber 2005).***

SITE:	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B-11	B-12
DIATOM METRICS	**METRIC SCORES**											
Species Richness	3	3	3	3	3	3	3	3	3	3	3	3
Shannon Diversity Index	3	2	3	3	3	3	3	3	3	3	3	3
Pollution Index	2	3	3	3	3	3	3	3	2	3	3	3
Siltation Index	2	3	2	2	2	2	2	3	3	3	3	3
Disturbance Index	3	1	3	3	3	3	3	2	3	2	3	3
Percent Dominant Species	3	1	3	3	3	2	3	2	2	2	3	3
	BIOASSESSMENT											
MINIMUM SCORE	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**
BIOLOGICAL INTEGRITY	**Good**	**fair**	**good**	**good**	**good**	**good**	**good**	**good**	**Good**	**Good**	**excel.**	**excel.**
IMPAIRMENT	**minor**	**mod.**	**minor**	**minor**	**minor**	**minor**	**minor**	**minor**	**Minor**	**Minor**	**none**	**none**
USE SUPPORT	**Full**	**part.**	**full**	**full**	**full**	**full**	**full**	**full**	**Full**	**Full**	**full**	**full**

Chlorophyll a

The 2004 Blackfoot watershed chlorophyll *a* monitoring program provided insight into basin-wide conditions, spatial patterns, impairment problems, and pollution sources. Key findings are discussed in the following paragraphs. Chlorophyll *a* concentrations measured at the 12 Blackfoot watershed monitoring stations are shown in **Figure 3-3**. The full text of the chlorophyll *a* data assessment report and associated data are included in **Appendix D** of this summary report.

Algal densities, measured as chlorophyll *a*, may provide a measure of nutrient enrichment in a stream. Chlorophyll *a* concentrations measured in the Blackfoot watershed during 2004 showed considerable variability between stations, and between replicate samples collected at the same station. This was due to the naturally patchy distribution of algae across the available substrate. However, the sample size of ten replicates per site provided a sound basis for evaluating central tendencies as well as differences between sites.

Within the 12 monitoring stations that were sampled, chlorophyll *a* concentrations ranged from very low in the North Fork Blackfoot River, to very high in lower Nevada Creek and in the Blackfoot River below Nevada Creek, relative to the potential for negative impacts on beneficial water uses. The Landers Fork, the Blackfoot River above Nevada Creek and at the Scotty Brown Bridge, and the Clearwater River, also contained elevated levels of chlorophyll *a*. The Blackfoot River below Alice Creek, at the Dalton Mountain Road and near Bonner, Nevada Creek below Nevada Creek Reservoir, the North Fork, and Monture Creek had very low to relatively low levels of chlorophyll.

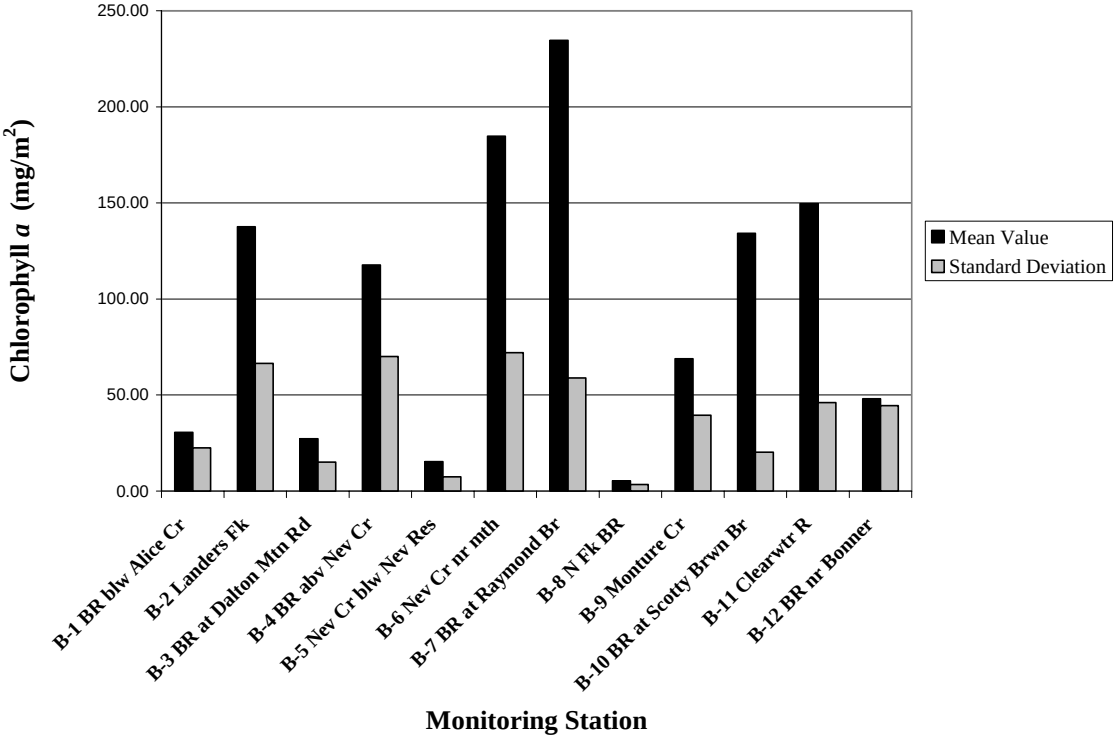
Mean chlorophyll *a* concentrations measured in the Landers Fork, lower Nevada Creek, Clearwater River, and in the Blackfoot River above Nevada Creek, at Raymond Bridge, and at Scotty Brown Bridge exceeded the state water quality standard set for the Clark Fork River. The Clark Fork standard is 100 mg/m^2 for summer mean chlorophyll *a* concentrations. Mean chlorophyll *a* concentrations at two Blackfoot basin stations – Nevada Creek near mouth and the Blackfoot River at Raymond Bridge -- surpassed the state water quality standard of 150 mg/m^2 for summer peak chlorophyll *a* concentrations in the Clark Fork River. Only the Blackfoot River below Alice Creek (B-1), the Blackfoot River at Dalton Mountain Road Bridge (B-3), Nevada Creek below Nevada Creek Reservoir (B-5), and the North Fork Blackfoot River (B-8) were consistently below the Clark Fork threshold limits in all 10 replicate samples.

Field observations suggested that chlorophyll levels in the Blackfoot River at the Dalton Mountain Road and in Nevada Creek below Nevada Creek Reservoir may have been artificially limited by an absence of suitable (stable) substrate for algal colonization. In other words, the measured chlorophyll levels at those sites may not have been representative of the actual level of nutrient enrichment.

The spatial pattern for chlorophyll concentrations in the main stem Blackfoot River showed a gradually increasing trend downstream to the Raymond Bridge, concurrent with suspected sources of nutrient inputs (see next section). This increasing trend was followed by declining concentrations downstream to the lower most monitoring station near Bonner. Declining

chlorophyll *a* concentrations appeared to be associated with inflows from cleaner tributaries, notably the North Fork and Monture Creek.

Figure 3-3. ***Algal standing crops in the Blackfoot watershed (measured as chlorophyll a) during 2004.***



4.0 CONCLUSIONS

Basin-Wide Water Quality Status

Table 4-1 summarizes the assessment results presented in the previous sections of this report by monitoring station and parameter. The table shows the degree of water quality and/or biological impairment, based on the criteria and standards presented in Table 2-2 and other sections of this report as well as best professional judgment, that were suggested as being present at each monitoring station based on each of the separate monitoring variables. The assessment results reflect conditions documented during the 2004 calendar year. The assigned ratings include three categories of impairment: "severe", "moderate", and "slight or none". Assignment of these ratings was somewhat subjective because they had to consider the frequency and magnitude of problems based on multiple observations (in the case of the water quality data), and because in some cases there were no specific criteria available for evaluating the monitoring results. Adding to the subjectivity of these ratings are the inherent differences in the physical characteristics of the different monitoring locations, which may influence some of the monitoring results. Overall, the impairment ratings are intended to provide a summary view of water quality conditions at each station and some insight into the impairment causes, but are not intended to be 303(d) listing impairment ratings, such as is done by MDEQ.

Collectively, the data present a fairly complete picture of conditions and spatial patterns in the Blackfoot drainage. Streamflows were generally below normal in the Blackfoot watershed during 2004. Spring runoff occurred about a month earlier than normal and peaks flows were substantially below normal peak levels. Continuing drought conditions and chronic low flows may be a source of impairment to aquatic life uses throughout the Blackfoot watershed. A high intensity runoff event in March 2004 in the Nevada Creek drainage contributed to poor water quality due to elevated turbidity, sediment, and metals concentrations.

Despite lower than average flows, instantaneous water temperatures recorded at Blackfoot monitoring stations during 2004 were generally below thresholds that are considered injurious to fish and cold water aquatic life. One exception was the Clearwater River during the mid-July 2004 sampling event where the recorded temperature was well above the recommended limit for growth and propagation of trout (67 ^{o}F or 19.4 ^{o}C) .

Measurements for pH, specific conductivity, and dissolved oxygen during the six sampling events in 2004 were consistently within desired ranges at all monitoring stations.

Turbidity and/or suspended sediment levels were considered to be moderate problems in the Landers Fork and in Nevada Creek below Nevada Creek Reservoir and near the mouth, and slight problems in the Blackfoot River below their respective confluences (Dalton Mountain Road, above Nevada Creek, Raymond Bridge, Scotty Brown Bridge).

The nutrient data pointed to Nevada Creek as having consistently problematic concentrations of both nitrogen and phosphorus. Landers Fork and the North Fork Blackfoot had moderately elevated concentrations of nitrate + nitrite when compared to other stations in the watershed.

The headwaters area of the Blackfoot River, including the main stem below Alice Creek and the Landers Fork, showed moderate impacts due to heavy metals. Metals concentrations were generally streamflow dependent and may have been greater in a year of more normal streamflows. Lower Nevada Creek also sustained isolated impacts from metals during a March 2004 runoff event.

Collectively, the biological assessments based on macroinvertebrates and/or periphyton, suggested severe impairment in Nevada Creek below the Nevada Creek Reservoir, moderate impairment in the Landers Fork, lower Nevada Creek, and the Clearwater River, and slight or no impairment at all of the remaining eight monitoring stations. The macroinvertebrate and periphyton assessments produced contradictory conclusions in several instances, which may not be surprising considering the different trophic levels they represent and the stressors that were implicated.

Chlorophyll *a* concentrations suggested severe problems stemming from excessive benthic algae in lower Nevada Creek and in the Blackfoot downstream from Nevada Creek (Raymond Bridge), moderate problems in Landers Fork, the Blackfoot above Nevada Creek, the Blackfoot at Scotty Brown Bridge, and the Clearwater River, and slight problems in Monture Creek and the Blackfoot River near Bonner. No problems stemming from excessive attached algae were found in the upper Blackfoot main stem below Alice Creek and at Dalton Mountain Road, and in upper

Nevada Creek and the North Fork Blackfoot. Visual observations suggested that algae growth in upper Nevada Creek and in the Blackfoot at Dalton Mountain Road may have been limited by an unstable stream bottom regardless of nutrient levels.

Spatial Patterns

In general, water quality and biological integrity were highest in the upper and lower Blackfoot watershed, with impairments ranging from slight to severe in various intermediate segments and some tributaries. One exception was metals impacts which were detected in the uppermost portion of the Blackfoot and in Landers Fork. Among the tributaries, Nevada Creek sustained significant sediment, nutrients, and metals impacts, and appeared to have a negative impact on water quality in the Blackfoot River downstream from its confluence. Conditions were generally good in Monture Creek and especially the North Fork, and their inflows provided positive benefits to downstream segments of the Blackfoot River.

Possible Impairment Causes and Sources

The following discussion of possible causes and sources of water quality impairments is based on existing knowledge of land uses and natural features in the Blackfoot watershed but is somewhat speculative.

Elevated water temperatures in the Clearwater River during July 2004 were probably attributable to upstream lake effects and prevailing drought conditions. Sediment problems in the Landers Fork may have been due to natural sources and 2003 wildfire effects, among others. Sediment problems in Nevada Creek were likely associated with irrigation water management practices (fluctuating flows below the reservoir), eroding stream banks, and various agricultural land uses in the Nevada Creek drainage. Sediment sources associated with these two tributaries may have contributed, at least in part, to the slight sediment problems found in the Blackfoot River below their confluences.

Slightly elevated nutrient and chlorophyll *a* levels in Landers Fork could have been associated with post-fire nutrient releases, as well as other diffuse non-point sources. It will be interesting to monitor time trends at this station as the watershed recovers. Severe to moderate nutrient enrichment and excessive algae growth in Nevada Creek and in the Blackfoot downstream of Nevada Creek in 2004 were probably a result of the predominantly agricultural land uses in the Nevada Creek drainage. Sources of slight nutrient enrichment in the Blackfoot River above Nevada Creek, at Scotty Brown Bridge, and in Monture Creek are unknown but probably stemmed from multiple diffuse sources. Elevated nutrients in the North Fork suggest the possibility of livestock or groundwater derived sources.

Apparent sources of nutrient enrichment in the Blackfoot River between the Dalton Mountain Road Bridge and the Nevada Creek confluence, indicated by a large in-stream increase in chlorophyll a concentrations, are unknown. One factor may have been that upstream concentrations were under-represented due to the possible substrate limitations that were described earlier.

Table 4-1. ***Degree of impairment at Blackfoot watershed monitoring stations during 2004 as indicated by various monitoring parameters.***

Monitoring Station	Physical Parameters							Chemical Parameters		Biological Parameters		
	Streamflow	Water Temperature	pH	Specific Conductivity	Dissolved Oxygen	Turbidity	Suspended Sediment	Nutrients	Metals	Macro-invertebrates	Periphyton	Chlorophyll *a*
B-1 Blackfoot River below Alice Creek, near Lincoln	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Moderate	Slight or None	Slight or None	Slight or None
B-2 Landers Fork near Lincoln	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Moderate*	Moderate*	Slight or None *	Moderate	Slight or None	Moderate	Moderate
B-3 Blackfoot River at Dalton Mountain Road Bridge, near Lincoln	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None
B-4 Blackfoot River above Nevada Creek, near Helmville	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Moderate
B-5 Nevada Creek below Nevada Creek Reservoir	Moderate	Slight or None	Slight or None	Slight or None	Slight or None	Moderate	Moderate	Severe	Slight or None	Severe	Slight or None	Slight or None
B-6 Nevada Creek near mouth, near Helmville	Moderate	Slight or None	Slight or None	Slight or None	Slight or None	Moderate	Moderate	Severe	Slight or None	Moderate	Slight or None	Severe
B-7 Blackfoot River at Raymond Bridge	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Moderate	Slight or None	Slight or None	Slight or None	Severe
B-8 North Fork Blackfoot River above Dry Gulch, near Ovando	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None
B-9 Monture Creek near Ovando	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None
B-10 Blackfoot River at Scotty Brown Bridge	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Moderate
B-11 Clearwater River near Clearwater	Slight or None	Moderate	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Moderate	Slight or None	Moderate
B-12 Blackfoot River near Bonner	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None	Slight or None

*Reflects one extreme event in August 2004.

Agricultural land use activities, including intensive irrigation, may have been additional contributing factors to the observed spatial trends in this reach of the river. Elevated chlorophyll levels in the Clearwater River may have been stimulated by warm water releases from the Clearwater chain of lakes, as well as residential development and heavy recreational use in the lakes.

Metals problems in the upper Blackfoot River main stem and Landers Fork were attributed to the effects of historical mining activities that seemed most apparent during runoff conditions. Sources of metals in Nevada Creek during the March 2004 high runoff event appeared to be located between the reservoir and the mouth but are not specifically known.

5.0 REFERENCES

ARM 17.30.607 (1) (a). Administrative Rules of Montana. Water-use Classifications – Clark Fork of the Columbia River Drainage. Montana Department of Environmental Quality. Helena, MT.

ARM 17.30.623 (1). Administrative Rules of Montana. B-1 Classification Standards – Designated Uses. Montana Department of Environmental Quality. Helena, MT.

ARM 17.30.623(2) (c)). Administrative Rules of Montana. B-1 Classification Standards – pH. Montana Department of Environmental Quality. Helena, MT.

ARM 17.30.623(2) (d)). Administrative Rules of Montana. B-1 Classification Standards – Turbidity. Montana Department of Environmental Quality. Helena, MT.

ARM 17.30.623(e), ARM 17.30.623(e)). Administrative Rules of Montana. B-1 Classification Standards – Temperature. Montana Department of Environmental Quality. Helena, MT.

ARM 17.30.623(f). Administrative Rules of Montana. B-1 Classification Standards – Sediment. Montana Department of Environmental Quality. Helena, MT.

ARM 17.30.631. Administrative Rules of Montana. Numeric Algal Biomass and Nutrient Standards for the Clark Fork River. Montana Department of Environmental Quality. Helena, MT.

ARM 17.30.637(e). Administrative Rules of Montana. General Prohibitions – Narrative Nutrient Standards. Montana Department of Environmental Quality. Helena, MT.

Bollman, Wease. 2005. A Biological Assessment of Sites in the Blackfoot River Watershed, Montana. Rhithron Associates, Inc. Missoula, MT. January 2005.

MCA 75-5-101. Montana Codes Annotated. Water Quality, General Provisions, Policy. Montana Department of Environmental Quality. Helena, MT.

MCA 75-5-103(25) (a)). Montana Codes Annotated. Water Quality, Definition of Pollution. Montana Department of Environmental Quality. Helena, MT.

MDEQ. 1999. Non-Point Source Standard Operating Procedures for Periphyton. Section 12.1.2.4. Montana Department of Environmental Quality. Helena, MT. March 1999.

MDEQ. 2005. Sample Collection, Sorting, and Taxonomic Identification of Benthic Macroinvertebrates. Water Quality Planning Bureau Standard Operating Procedures. WQPBWQM-009. Montana Department of Environmental Quality. Helena, MT. March 2005.

MDEQ. 2004. Circular WQB-7, Montana Numeric Water Quality Standards. Montana Department of Environmental Quality, Helena, MT. January 2004.

MDNRC. 1984. River Mile Index of the Columbia River Basin. Montana Department of Natural Resources and Conservation. July 1984. Helena, MT.

USEPA. 2000. Nutrient Criteria Technical Guidance Manual – Rivers and Streams. U.S. Environmental Protection Agency. Office of Water, Office of Science and Technology, Washington, DC 20460. EPA-822-B-00-002. July 2000

USGS. 2005. USGS National Water Information System Data for Montana at: http://nwis.waterdata.usgs.gov/mt/nwis/nwis

Weber, Erich E. 2005. Blackfoot Watershed Water Quality Status and Trends Periphyton Monitoring. PhycoLogic. East Helena, MT. March 2005.

6.0 APPENDICES

Appendix A

Blackfoot Watershed Water Quality Status and Trends Monitoring Project – 2004 Water Quality Data Evaluation

.

Appendix B

Blackfoot Watershed Water Quality Status and Trends Monitoring Project – 2004 Macroinvertebrate Data Evaluation

Appendix C

Blackfoot Watershed Water Quality Status and Trends Monitoring Project – 2004 Periphyton Data Evaluation

Appendix D

Blackfoot Watershed Water Quality Status and Trends Monitoring Project – 2004 Chlorophyll *a* Data Evaluation

Appendix E

USGS Field Forms and Field Notes

Appendix F

PBS&J Field Forms, Field Notes and Site Photos