Geotechnical
Water Resources
Environmental and
Ecological Services

YAMPA RIVER 2008 Habitat, Benthic Invertebrate, and Water Quality Sampling

Submitted to:
City of Steamboat Springs

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Executive Summary

The Yampa River Management Plan, finalized by the City of Steamboat Springs in 2003, includes a monitoring program for stream habitat, macroinvertebrate communities, and water quality. As a result, data were collected in 2004, 2005, 2007, and 2008 to measure these characteristics. The purpose of this report is to present the results of the 2008 sampling effort and to compare these results with those from earlier years to determine whether changes have occurred over time. Habitat, macroinvertebrate, and water quality data were also examined for spatial and seasonal trends to determine whether City of Steamboat Springs management of recreational activities were adequately protecting the Yampa River.

Rapid Bioassessment Protocol (RBP) habitat scores remained fairly stable, but a very slight decrease in scores was observed in a downstream direction. The habitat-limiting factors were typical of those observed in urban and suburban setting, and the same factors have been affecting physical stream habitat since the beginning of habitat surveys in 2004. Sediment deposition affects overall scores near the upstream end of the study reach, and channel alteration scores become more important near the downstream end of the study reach. Habitat was rated “suboptimal” at all sites, and the effects of urbanization on the Yampa River appear to be relatively mild. Minor bank damage was likely a result of high flows in spring 2008, but its occurrence was limited.

Benthic macroinvertebrate communities varied throughout the study reach; density was highest at the downstream-most site, but average diversity was highest at sites YMP-2 and YMP-3a. Site YMP-7 supported more tolerant organisms such as oligochaetes and chironomids and a lower relative abundance of EPT organisms than the other three sites. These changes and a slight increase in the Hilsenhoff Biotic Index throughout the study site suggest that mild impacts are affecting the macroinvertebrate community in the Yampa River. However, most of the macroinvertebrates collected within the study reach were fairly common and able to thrive in diverse environmental conditions. Because few clear temporal trends were observed and because many of the metrics displayed a similar pattern of change throughout the study sites, this suggests large-scale environmental factors or upstream effects are driving changes in the macroinvertebrates in the Yampa River.

Few temporal trends were observed in the macroinvertebrate populations. Decreases in density and diversity and increases in the percentage of oligochaetes, occurred between 2005 and 2007, but density and diversity increased again between 2007 and 2008. Likewise, increases in the percentage of chironomids and the Hilsenhoff Biotic Index between 2005 and 2007 were offset by decreases in these metrics between 2007 and 2008. These changes were seen at most or all of the sampling sites, which suggests that large-scale environmental factors or upstream effects are driving changes in the macroinvertebrate community.

Overall, water quality in the Yampa River appears to be good, and exceedances of Colorado Department of Public Health and Environment (CDPHE) standards did not occur in 2008. However, U.S. Environmental Protection Agency standards for total nitrogen and total phosphorus standards were exceeded in most years at most sites. Concentrations of these nutrients were similar at all measured sites, suggesting that city management of recreational activities are not affecting water quality in the Yampa River. Total nitrogen concentrations showed little change or slight decreases over time, depending upon the sampling site, and total phosphorus increased from 2004 to 2007 but decreased again in 2008.

1.0 Introduction

In 2003, the City of Steamboat Springs finalized the Yampa River Management Plan to protect environmental resources associated with the river and its tributaries, manage recreational use of the river, and direct policy. The management plan included a monitoring program for stream habitat, macroinvertebrate communities, and water quality to assess its effectiveness. GEI Consultants, Ecological Division (GEI) collected habitat and macroinvertebrate data in 2004, 2005, 2007, and 2008. Water quality data were collected by Hydro-Environmental Solutions in 2004 and 2005, and GEI Consultants collected these data in 2007 and 2008.

The purpose of this report is twofold. First, the results of the 2008 sampling effort are presented. Then, these results are examined to detect spatial or temporal changes in habitat, macroinvertebrate communities, or water quality as the stream flows through the City of Steamboat Springs. The 2008 data are also compared with data from previous years to determine whether changes have occurred over time. These results can be used to determine whether the Yampa River Management Plan continues to protect the Yampa River and its tributaries in the vicinity of Steamboat Springs.

Eight monitoring sites have been established: four sites are on the mainstem of the Yampa River, and the other four are located on the tributaries that enter the river in the vicinity of Steamboat Springs (Figure 1). Water quality samples are taken at all eight sites. Macroinvertebrates are collected only at the four mainstem Yampa River sites. The sites are as follows, from upstream to downstream:

Site YMP-1: Located on the Yampa River approximately 200 m upstream of its confluence with Walton Creek. This site is characterized by large, vegetated islands and some channelization that resulted from the construction of Weiss Pond. GPS coordinates at this site are N40º26.954’ W106º49.215’. Minor damage to this bank is likely a result of high spring runoff in 2008.

Site WALT: Located on Walton Creek approximately 10 m upstream of the U.S. Highway 40 Bridge.

Site YMP-2: Located on the Yampa River approximately 35 m upstream of its confluence with Fish Creek. GPS coordinates at this site are N40º27.961’ W106º49.802’.

Site FISH: Located on Fish Creek downstream of Highway 40 and approximately 10 m upstream of the pedestrian bridge.

Site YMP-3A: Located on the Yampa River approximately 70 m upstream of the pedestrian bridge and the Steamboat Springs Health and Recreation Center’s hot spring outflow in Dr. Rich Weiss Park. The river is channelized at this site, and the riffle used for sampling is close to gate #8 on the kayak course. GPS coordinates at this site are N40º28.831’ W106º49.658’.

Site BTKN-DWN: Located on Butcherknife Creek approximately 15 m upstream of Yampa Street in the riparian demonstration area.

Site SODA: Located on Soda Creek upstream of the second pedestrian bridge from the confluence with the Yampa River in Little Toots Park.

Site YMP-7: Located on the Yampa River approximately 100 m upstream of the James Brown Bridge. The south bank of the river is channelized by the railroad grade. GPS Coordinates for this site are N40º29.750’ W106º51.393’. Large amounts of filamentous green algae were observed on the cobbles at this site in 2008.

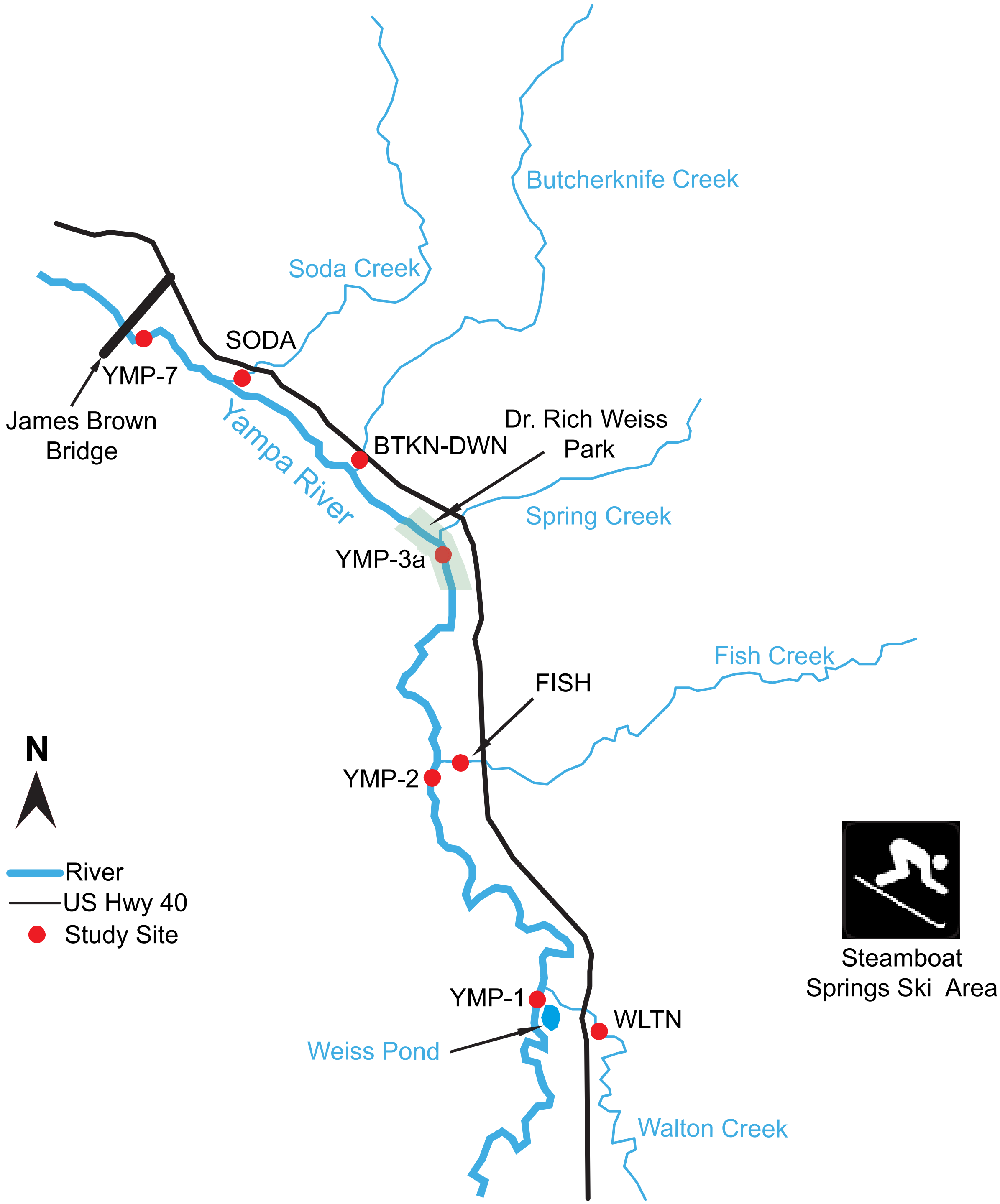


Figure 1: Sampling sites for the Yampa River and its tributaries in the vicinity of Steamboat Springs.

2.0 Methods

2.1 Habitat

The Rapid Bioassessment Protocol for Use in Wadeable Streams and Rivers (RBP, Barbour et al. 1999) was used to assess habitat and riparian condition at all four main stem sampling sites. Under this protocol, 10 instream and riparian characteristics are visually evaluated and given a score of 0-20, with 20 being optimal. Metrics are separated into primary, secondary, and tertiary categories. Primary metrics affect aquatic communities the most and include measures such as substrate embeddedness, current velocity, and depth. Secondary metrics rate channel morphology and include measures of sediment deposition, consistency of flow, channel alterations, and the frequency of riffles and meanders. Tertiary metrics focus on riparian zone condition and include bank stability, bank vegetation, and riparian zone width. Summation of all of the metrics provides a number that corresponds to a qualitative stream habitat rating. Scores from 200-160 are rated as “optimal”, those from 150-110 are rated as “suboptimal”, those from 100-60 are rated as “marginal”, and scores of 50 or lower are rated as “poor”.

Each site was evaluated with the RBP, and the habitat was classified as poor, marginal, suboptimal, or optimal. The 2008 habitat data for all four sites were compared to determine whether there were any spatial trends in assigned RBP scores. Habitat data from 2008 were also compared to data from previous years to identify any changes in stream habitat over time.

2.2 Benthic Macroinvertebrates

2.2.1 Sampling Methods

Benthic macroinvertebrates were sampled at all four Yampa River sites on September 26, 2008. GEI personnel used a modified Hess sampler with an area of 0.086 m^2 and 500 μm mesh (Canton and Chadwick 1984) to collect three samples from a riffle at each site. Three samples are sufficient for reliable quantitative estimates of invertebrate populations (Canton and Chadwick 1988). Qualitative community composition in non-riffle habitats such as pools, pool margins, and backwaters was assessed by sampling with a kick net with 500 μm mesh (Hauer and Resh 1996, Carter and Resh 2001).

Collected samples were transferred to individual containers and preserved with denatured alcohol. Each labeled container was submitted to the GEI laboratory for processing. Organisms were sorted from debris, identified, and enumerated. Samples with large numbers of organisms (more than 300) were subsampled; 300 organisms were removed from a portion of the sample for identification and enumeration, and the remainder of the sample was searched for rare taxa (Vinson and Hawkins 1996, Carter and Resh 2001). A minimum of

350 organisms was sorted from the sweep samples, and one specimen of each identifiable taxon was kept. Quality assurance procedures indicated ≥99 percent efficiency for sorting.

Sorted organisms were identified to the lowest practical taxonomic level (Lenat and Resh 2001) and counted by taxon. Quality assurance procedures indicated ≥99 percent agreement for taxonomic and count accuracy (Whitaker 1975, Stribling et al. 2003).

Chironomid larvae and oligochaetes were mounted on glass microscope slides and cleared prior to identification and counting. If the number of chironomids or oligochaetes was excessive (i.e., > 30 per sample), they were subsampled so that 10 percent of the individuals was mounted. Identification of oligochaetes was conducted by GEI, and chironomids were identified by Dr. Leonard Ferrington, Jr., University of Minnesota.

2.2.2 Data Analysis

Twelve metrics were calculated from the macroinvertebrate data. These metrics allow inferences to be made about environmental conditions in the Yampa River because taxa differ in their ecological needs and relative sensitivities to environmental stressors.

1. **Total density**: the average density of organisms calculated from the three Hess samples.

2. **Taxa richness**: the total number of taxa from the Hess and kick samples at each site.

3. **Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa richness**: the average number of EPT organisms calculated from the three Hess samples. Because EPT organisms are considered to be sensitive to a wide range of stressors (Hynes 1970, Rosenberg and Resh 1993, Barbour et al. 1999, Lydy et al. 2000), decreases in the abundance of these taxa may indicate impacts. The total number from the Hess and kick samples is also reported for each site, but the average number is used in statistical analyses.

4. **Percent density of EPT organisms**: the average percentage of EPT organisms calculated from the three Hess samples. Both diversity and abundance of EPT organisms provide information about aquatic habitat quality.

5. **Percent density of Chironomidae and Oligochaeta**: average percentage of these two taxa calculated from the three Hess samples. Because chironomids and oligochaetes are considered tolerant to poor water quality and degraded habitats (Barbour et al. 1999), an increase their relative abundance may indicate changes to water quality or physical habitat.

6. **Ratio of EPT/Chironomidae density (EPT/C)**: relative abundance of EPT organisms compared to chironomids.

7. **Ratio of EPT/Chironomidae + Oligochaeta density (EPT/C&O)**: relative abundance of EPT organisms compared to the summed abundance of chironomids and oligochaetes.

8. **The Hilsenhoff Biotic Index (HBI)**: The HBI (Hilsenhoff 1982) is an abundance-weighted measure of the pollution tolerance of the taxa present in the system. Tolerance values for individual taxa range from 0 (pollution-intolerant) to 10 (pollution-tolerant), and were developed from information presented in Barbour et al. (1999). Taxa without assigned tolerance values were given the tolerance value for the next highest taxonomic level.

9. **Percent density of dominant taxon**: The percent density of the dominant taxon is also useful for determining stream impact because disturbed or impacted streams often contain large numbers of a single, dominant taxon (Ward and Kondratieff 1992).

10. **Percent density of "shredder", "scraper", and "filterer" organisms**: The relative contribution to overall density of each of these functional feeding groups (FFG's) is calculated from the three Hess samples. Functional feeding group classifications (i.e. shredder, scraper, filterer) help determine nutrient loads in a stream. For example, shredders, which consume leaf litter, are more common in low-nutrient streams, and collector-gatherers such as chironomids are more common in streams with naturally or artificially high nutrient levels (Vannote et al. 1980). FFG classifications were assigned to each taxon based on Merritt and Cummins (1996) and Barbour et al. (1999). If a FFG classification was not available for a taxon, the FFG value for the next highest taxonomic level was used.

Statistical analyses were used to test for differences between sites with respect to density, total number of taxa, number of EPT taxa, and percentage of EPT individuals. Only quantitative data from the replicate Hess samples, not qualitative data from kick samples, were used in the analyses. Analysis of variance (ANOVA) and the Tukey-Kramer multiple comparison procedure were used to test for differences between sites. Statistical analyses were run in NCSS (Hintze 2000), and results were considered significant at the 0.05 level. Assumptions of normality and equal variance were tested to ensure validity of the analyses. .

Qualitative analyses of multiple years of Yampa River macroinvertebrate data were also performed to identify temporal changes both within and between sites. Available data included historical preliminary benthic macroinvertebrate population estimates from June, July, and September 2001 (Aquatic Wetland Company 2002), and September 2004, 2005, and 2007 (CEC 2005, CEC 2006, GEI 2007). Collection methods, taxonomic resolution, and study site locations were different between 2001 and the other years, but they were identical in 2004, 2005, and 2007. Although they were collected at different sites and analyzed with different methods, the 2001 data were useful in identifying general macroinvertebrate population characteristics of the Yampa River study reach.

2.3 Water Quality

2.3.1 Sampling Methods

Water quality samples were collected at all eight monitoring sites on July 7th and September 15th, 2008. Pre-packaged bottles were obtained from ACZ Laboratories, Steamboat Springs, Colorado, on the morning of the sampling date. Water samples at each site were placed in bottles with site-specific labels and preserved in a cooler until the end of the sampling effort. Filled bottles were promptly returned to ACZ Laboratories for analysis. Testing was performed to determine the levels of the following parameters:

- Dissolved metals: calcium, chromium, iron, magnesium, manganese, and zinc
- Total organic carbon
- Fecal coliforms
- Conductivity and hardness
- Nitrogen: nitrate, nitrate and nitrite, nitrite, ammonia, and total nitrogen
- Total phosphorus

2.3.2 Data Analysis

Water quality data from 2008 were compared to Colorado Department of Public Health and Environment standards for Class I streams (CDPHE 2007) when they were available. However, ecoregional nutrient criteria were obtained from U.S. Environmental Protection Agency standards. Because the use and application of water quality criteria is complex, reasons for using the selected criteria are explained below. If multiple standards were available (i.e. from CDPHE and USEPA), we generally selected the most stringent ones. We also used chronic (long-term toxicity) standards instead of acute (short-term toxicity) when both were both available. Chronic standards are generallly lower than acute standards The use of more stringent criteria allows for earlier detection of potential water quality problems.

Chromium is present in the environment in two forms: trivalent (Cr III) and hexavalent (Cr VI), but the water quality reports from ACZ Laboratories contain data for total chromium. Total chromium levels were compared to the standard for the more toxic Cr VI because the allowable environmental concentrations are lower than they are for Cr III.

Bioavailability and environmental concentrations of certain metals depend upon environmental concentrations of other compounds, so allowable concentrations depend upon local water chemistry. Mean chloride ion concentrations were obtained from U.S. Geological Survey water quality data for the Yampa River and used to calculate locally relevant standards. Also, there is a positive relationship between water hardness and maximum allowable concentrations of many metals. As a result, the lowest hardness observed at any of the Yampa River sites was used to calculate standards for these metals.

The state of Colorado adopted the EPA standard for ammonia. However, because ammonia becomes more toxic with increasing pH and temperature, it was necessary to use temperature and pH data from U.S. Geological Survey data on the Yampa River. Because of the concern about the impacts of summer recreational use of the river, the mean value of the highest 25 percent of temperatures was used. Average pH over the period of record was also used. This resulted in the selection of a conservative ammonia standard for Yampa River management.

Although no state standards currently exist for nutrients such as nitrogen and phosphorus, the EPA has developed recommendations. The criteria for nitrogen and phosphorus were obtained from Ecoregion II standards for forested mountain streams (USEPA 2000).

To determine whether there were seasonal changes in water quality, data from July 2008 and September 2008 were compared. Interannual trends were also examined. Water quality data were not collected in 2006, but the 2008 data were compared to the data from previous years to determine whether an interannual trend was apparent.

3.0 Results

3.1 Habitat

3.1.1 Spatial Trends

Habitat ratings did not vary substantially between the upstream and downstream-most sites (Table 1). This implies that current management practices largely prevent additional impacts to the physical habitat of the Yampa River through the town of Steamboat Springs. However, slightly lower values were observed in the lower sites in 2007 and 2008 compared to the upstream sites. Limitations to physical habitat were similar at all four sites: mild sedimentation, channelization, limited riffle habitat, mild bank erosion and/or limited riparian vegetation on the banks, and narrow riparian zones. These attributes are typical in streams flowing through urban and suburban areas. Although embeddedness tends to decrease in a downstream direction, measures of channel alteration (such as channelization) increase. The increased velocity at these sites would tend to flush out fine sediments, thereby decreasing embeddedness and sediment deposition. However, channelization lowers channel alteration scores and is often associated with low vegetative cover and low riparian width. The extent of channel alteration was the only habitat metric that was consistently rated as suboptimal throughout the reach. Sites YMP-1 and YMP-2 were characterized by mild to moderate sediment deposition again in 2008. Site YMP-1 received low scores for bank stability due to bank damage from high stream flows in spring 2008. Bank damage was commonplace in this section of the river during spring runoff. However, aside from a lower bank stability score, habitat scores were not affected by local or upstream bank erosion. These factors led to an overall rating of “suboptimal” for Yampa River physical habitat at each of the sites (Table 1).

3.1.2 Temporal Trends

Habitat assessment scores changed little in all three survey years (Table 1). Site YMP-7 was the only site that exhibited a possible trend in habitat quality between years. This site has consistently scored low with respect to channel alteration and riparian zone metrics. It appears that modifications have been made to the right bank of the river just upstream of the condominium complex in order to protect it from high stream flows. This led to slightly lower scores for channel and riparian condition in 2008. There were no consistent changes in overall scores or individual parameter scores over time for the remaining monitoring sites. The scores at all four sites were rated as “suboptimal”. This reflects the fact that urbanization in the Yampa Valley has affected the Yampa River to some extent throughout the study reach.

Table 1: Habitat ratings for sites on the Yampa River, Steamboat Springs, Colorado, September 15, 2008. L/R indicates scores for Left and Right Banks.

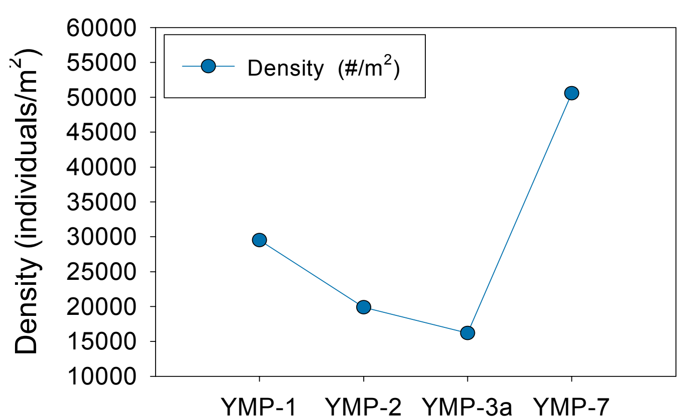
Variable Category	Parameter	Site			
		YMP-1	**YMP-2**	**YMP-3a**	**YMP-7**
Primary	Epifaunal Substrate/Available Cover	15	17	16	15
	Embeddedness	14	12	13	17
	Velocity/Depth Regime	16	18	17	16
Secondary	Sediment Deposition	14	12	16	17
	Channel Flow Status	18	16	16	17
	Channel Alteration	14	12	7	8
	Frequency of Riffles	11	16	11	15
Tertiary	Bank Stability (L/R)	5/8	8/9	8/8	7/7
	Vegetative Protection (L/R)	9/9	9/9	8/8	6/6
	Riparian Vegetative Zone (L/R)	9/6	7/5	9/8	6/7
	Total Score	**148**	**150**	**145**	**144**
	Condition	Suboptimal	Suboptimal	Suboptimal	Suboptimal
	2007 Total Score	151	151	145	146
	2006 Total Score	145	147	146	150
	2005 Total Score	143	150	144	149

3.2 Benthic Macroinvertebrates

3.2.1 Spatial Trends

Mean total density ranged from 16,192 individuals/m^2 at YMP-3a to 50,555 individuals/m^2 at Site YMP-7 (Table 2). Trends were similar to 2007, with densities highest at the most downstream site and lowest at Site YMP-3a at Rich Weiss Park (Figure 2). Statistical tests revealed a significant difference between the high densities observed at Site YMP-7 and the lower densities observed at sites YMP-2 and YMP-3a. Densities at Site YMP-1 were intermediate and not statistically different from the other sites.

Figure 2:
Mean density of macroinvertebrates collected from each of four sampling sites on the Yampa River in fall 2008.

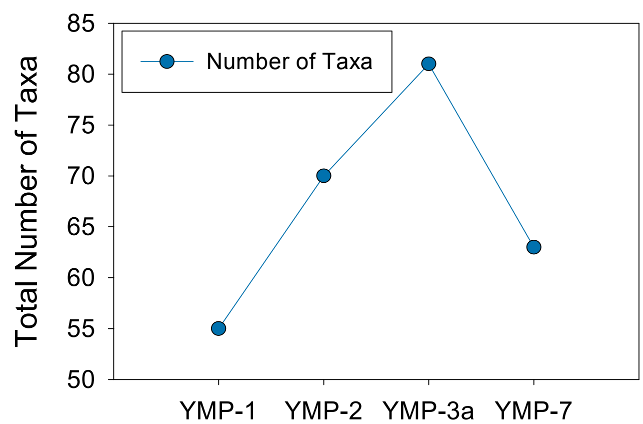


Most of the collected taxa were insects, but Hydracarina (water mites), Crustacea (crustaceans), and Mollusca (snails and clams) were present in small numbers throughout the reach (Appendix A). Annelids (segmented worms) increased in density in a downstream direction and represented a significant component of the aquatic community at Site YMP-7. The mean number of taxa was lowest at Site YMP-1 and highest at YMP-3a (Table 2 and Figure 3). ANOVA indicated that the total number of taxa was significantly higher at Site YMP-3a than at Site YMP-1 and that YMP-2 and YMP-7 had intermediate numbers of taxa (Figure 3).

Table 2: Macroinvertebrate metrics for Yampa River sites in fall 2008.

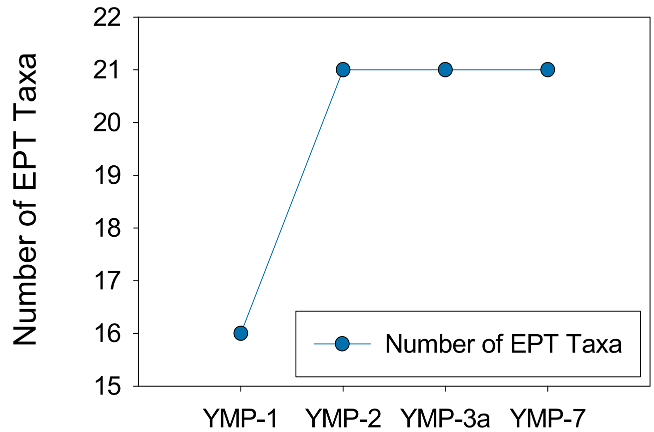
Metric	YMP-1	YMP-2	YMP-3a	YMP-7
Mean Density (individuals/m^2)	29,500	19,907	16,192	50,555
Total # Taxa	55	70	81	63
Total # EPT Taxa	16	21	21	21
% EPT Density	55.6	56.3	39.1	31.6
% Oligochaete and Chironomid Density	10.3	19.7	37.1	56.9
Ratio: EPT/C	6.5:1	4.2:1	4.3:1	2.4:1
Ratio: EPT/C&O	5.4:1	2.9:1	1.1:1	0.6:1
Hilsenhoff Biotic Index	3.03	3.66	4.00	4.48
% Dominant Taxon	26.1	26.0	27.5	42.6
% Shredders	0.4	0.9	1.7	6.2
% Scrapers	7.3	3.7	8.0	1.5
% Filterers	22.0	28.3	19.8	14.6

Figure 3:
Total number of taxa collected at each of four sampling sites on the Yampa River, fall 2008.



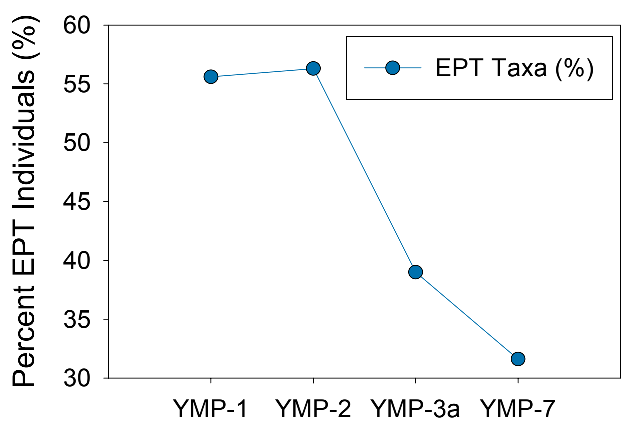
The mean number of EPT taxa was lowest at site YMP-1 and the same at all other sites (Figure 4). There was no statistical difference between the mean number of taxa at any of the sites ($p > 0.05$).

Figure 4:
Total number of EPT taxa collected at each of four sampling sites on the Yampa River, fall 2008.



The percent contribution of EPT taxa to total density ranged from 32 percent at Site YMP-7 to 56 percent at Site YMP-2 (Table 2 and Figure 5). The average percentage of EPT individuals decreased markedly between sites YMP-2 and YMP-3a. However, statistical analysis revealed no significant differences between sites. This trend is reversed for oligochaetes and chironomids whose densities increase markedly downstream of Site YMP-2 (Table 2). This spatial trend is seen in the EPT/C&O ratio (Table 2). There is a weaker spatial trend in the EPT/C ratio, indicating that macroinvertebrate community changes in the study reach in 2008 were largely a function of oligochaete abundance.

Figure 5:
The mean percent EPT contribution to total macroinvertebrate density at each of four sampling sites on the Yampa River, fall 2008.



The percent contribution of the dominant taxon ranged from 26 percent at sites YMP-1 and YMP-2 to 43 percent at Site YMP-7 (Table 2). The dominant taxon differed between sites: at Site YMP-1 it was a riffle beetle (*Zaitzevia parvula*), at Site YMP-2 it was a caddisfly (*Hydropsyche sp.*), and at sites YMP-3 and YMP-7 it was an oligochaete worm (Family Naididae). These three taxa are relatively ubiquitous and tolerant of varying environmental conditions (Ward and Kondratieff 1992, Vieira et al. 2006). Still, there appears to be a slight spatial trend in the pollution tolerance of the macroinvertebrate community throughout the study reach. Naid worms are far more tolerant of organic pollution than the other three taxa (Barbour et al. 1999), and they increase in abundance in a downstream direction. Also, the sensitive mayfly *Paraleptophlebia sp*. (Barbour et al. 1999), one of the five most abundant taxa at Site YMP-1, was only collected at this upstream-most site.

Pollution tolerance values assigned to individual taxa were variable within sites; they ranged from 0 to 8 at sites YMP-1 and YMP-2 and from 0 to 10 at sites YMP-3a and YMP-7. However, an increase in the Hilsenhoff Biotic Index indicated that the macroinvertebrate community at the downstream end of the study reach is more tolerant of poor water quality than the communities from upstream sites. The HBI ranged from 3.03 at Site YMP-1 to 4.48 at Site YMP-7 and increased consistently in a downstream direction through the study reach.

Percent density of shredders increased between Sites YMP-1 and YMP-7, and spatial trends were absent from the other two functional feeding groups. Percent scrapers and filterers were variable between reaches but appeared to decline at the downstream end of the reach (Table 2).

Site YMP-7 varied with respect to the other sites within the study reach in that it was characterized by the highest density but had the lowest percentage of EPT taxa in terms of total density. The slight community shift towards more pollution-tolerant organisms suggests that water quality may be affecting the macroinvertebrates in the Yampa River, but high species richness, including EPT richness, does not indicate a problem and may also be related to physical habitat.

3.2.2 Temporal Trends

All of the macroinvertebrate metrics varied over time, but not all metrics varied consistently throughout the study reach. For example, density decreased between 2004 and 2008 at Site YMP-1, decreased between 2004 and 2007 and increased between 2007 and 2008 at the middle sites, and exhibited no temporal trend at Site YMP-7. The total number of taxa and the total number of EPT taxa appeared to decrease over time at all sites except Site YMP-7, where an increase was observed between 2007 and 2008. The percentage of EPT individuals decreased at all sites between 2004 and 2007 and increased between 2007 and 2008. On the other hand, oligochaetes and chironomids both increased in relative abundance at sites YMP-3a and YMP-7 but showed no temporal trend at the two upstream sites. As a result, the EPT/C and EPT/C&O ratios were variable in time and throughout the study reach. The Hilsenhoff Biotic Index changed similarly through time at all sites; numbers were higher in 2005 and 2007 than they were in 2004 or 2008. The variations over time in percent dominant taxa and percent of all functional feeding groups varied by site, and few temporal trends were detectable.

Many of the changes in metrics appear to have occurred throughout the study site, and no negative temporal trends appear to be unique to the sites downstream of the City of Steamboat Springs. Therefore, current management practices appear to be preventing further negative effects to the macroinvertebrate community. Increases in the number of taxa, number of EPT taxa, and percent density of EPT organisms at Site YMP-7 offset the decreases observed between 2004 and 2007 and indicate that these metrics may be changing as a result of natural variation, not anthropogenic effects.

3.3 Water Quality

3.3.1 Spatial Trends

The water in the Yampa River has met CDPHE standards for most of the measured analytes for the entire study period, suggesting that the overall water quality in the Yampa River is good. Metal exceedances were limited to iron and zinc in Fish Creek in July 2007, and ammonia standards were only exceeded in 2005 (Table 3). However, the nutrient (nitrogen and phosphorus) load in the system is apparently elevated. Total nitrogen concentrations exceeded the EPA criterion of 0.12 mg/L at most sites and on most dates. The phosphorus standard of 0.010 mg/L was exceeded at most sites in 2004 and 2007, no sites in 2005 and primarily main stem sites in 2008.

Table 3: Exceedances of water quality standards on the Yampa River and its tributaries in 2004, 2005, 2007, and 2008. Analytes were omitted if no EPA or state standards existed or if no exceedances were observed.

Analyte/Site	YMP-1	WLTN	YMP-2	Fish	YMP-3a	BTKN	SODA	YMP-7
Iron				Jul 07				
Zinc				Jul 07				
N_2 as Ammonia	2005	2005		2005	2005	2005	2005	2005
Total Nitrogen	2004-2008	2004-2008	2004, Sep 07, 2008	2004-2008	2004-2008	2004-2008	2004-2008	2004-2008
Total Phosphorus	2004, 2007, 2008	2004, 2007, Sep 08	2004, 2007, 2008		2004, 2007, 2008	2004, Jul 07, Jul 08	2007	2007, 2008

Total nitrogen levels exceeded the standard at all sites in 2008, but there was no spatial pattern in nitrogen concentrations within the study reach. Total nitrogen levels were relatively constant throughout the study reach, and tributary inputs did not increase the levels in the main stem of the stream.

Phosphorus levels in the Yampa River and its tributaries ranged from 0 mg/L to 0.050 mg/L. This maximum concentration of 0.050 mg/L was measured in the spring at Site BTKN. However, no phosphorus was detected in the fall sample collected at the same site. The phosphorus input at this site could have been a function of high runoff, but it appears to have been temporary. U.S. Geological Survey phosphorus measurements were available from 1975 to 2008 for the Yampa River below Stagecoach Reservoir, upstream of the study reach. Total phosphorus levels ranged from 0.01 to 0.20 mg/L, so the Yampa River has high phosphorus levels as it flows into the town of Steamboat Springs. Measured levels of total phosphorus within the study reach in 2004, 2005, 2007, and 2008 were often above the range of values observed at Stagecoach. However, total phosphorus levels in the main stem of the Yampa River did not change appreciably through the study reach, suggesting that the nutrient loads largely originate upstream of city limits.

3.3.2 Temporal Trends

Seasonal trends were apparent with respect to some analytes in 2008. Hardness and conductivity were higher at all sites in the fall, probably because of seasonal low flows. There was also a seasonal pattern in nitrate concentrations. Although instream nitrate concentrations were well below the permissible limit, they tended to be higher in July than in September.

Because this study encompasses a limited time scale, it is difficult to make inferences about temporal changes in water quality. Although total phosphorus increased throughout the study site between 2004 and 2007, phosphorus levels at all sites were lower in 2008 than in 2007. Total nitrogen levels have varied between sites with respect to direction and magnitude of temporal changes. However, total nitrogen levels were often lower in 2008 than in 2007. Historic nutrient data for the Yampa River between 1978 and 1993 were between 0.18 and 1.0 mg/L for total organic nitrogen, between 0.05 and 0.10 mg/L for nitrate and nitrite, and between 0.02 and 0.20 mg/L for phosphorus (Tobin 1996). Total nitrogen and nitrate/nitrite nitrogen values within the study reach currently fall within this range. Although phosphorus levels have been higher than this historic range in the past, the 2008 values were within the observed range. It is possible that phosphorus concentrations in the Yampa River are inversely related to the volume of spring runoff. However, this has not been tested.

4.0 Conclusions

The segment of the Yampa River in the vicinity of Steamboat Springs is in good condition, and the effects of urbanization appear to be relatively mild. RBP scores and physical habitat ratings were similar to those observed in previous years and did not change appreciably throughout the study reach. Even though a downward trend in habitat scores is possible at Site YMP-7, the scores changed very little. Benthic macroinvertebrate communities varied throughout the study reach; density was highest at the downstream-most site, but average diversity was highest at sites YMP-2 and YMP-3a. Site YMP-7 supported more tolerant organisms such as oligochaetes and chironomids and a lower relative abundance of EPT organisms than the other three sites. These changes and a slight increase in the Hilsenhoff Biotic Index throughout the study site suggest that mild impacts are affecting the macroinvertebrate community in the Yampa River. However, most of the macroinvertebrates collected within the study reach were fairly common and able to thrive in diverse environmental conditions. Because few clear temporal trends were observed and because many of the metrics displayed a similar pattern of change throughout the study site, upstream or large-scale effects are probably affecting the macroinvertebrate community in the Yampa River. The current Yampa River Management Plan appears to be protective of the macroinvertebrate community within the study reach.

In 2008, there were no exceedances of CDPHE standards for ammonia, metals, or *E. coli*, but exceedance of total nitrogen and total phosphorus standards were present. However, total nitrogen and nitrate/nitrite nitrogen concentrations were similar to historic values measured at the outlet of Stagecoach Reservoir. Although phosphorus levels in the study reach are higher than those observed near the outlet of Stagecoach Reservoir, they are consistent throughout the study reach. This implies that phosphorus input to the Yampa River is largely a function of activities upstream of city limits. Given that the study reach is characterized by similar habitat scores, a diverse macroinvertebrate community, and good water quality, it appears that the Yampa River Management Plan is effective in protecting the natural resources of the stream and its tributaries.

5.0 Sources Cited

Aquatic and Wetland Company. 2002. *Yampa River Studies*, Draft 2001 Summary Report.

Barbour M. T., Gerritsen, J., Snyder, B. D., and J. B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

Canton, S. P., and J. W. Chadwick. 1984. A new modified Hess sampler. *Progressive Fish-Culturalist* 46:57-59.

Canton, S. P., and J. W. Chadwick. 1988. Variability in benthic invertebrate density estimates from stream samples. *Journal of Freshwater Ecology* 4:291-298.

Carter, J. L., and V. H. Resh. 2001. After site selection and before data analysis: sampling, sorting, and laboratory procedures used in stream benthic macroinvertebrate monitoring programs by USA state agencies. *Journal of the North American Benthological Society* 20:658-682.

Chadwick Ecological Consultants, Inc. 2005. *Yampa River 2004 Benthic Invertebrate Sampling*. Technical Memorandum prepared for the City of Steamboat Springs.

Chadwick Ecological Consultants, Inc. 2006. *Yampa River 2005 Benthic Invertebrate Sampling*. Technical Memorandum prepared for the City of Steamboat Springs.

Colorado Department of Public Health and Environment (CDPHE). 2007. Regulation 31: *The Basic Standards and Methodologies for Surface Water* (5 CCR 1002-31). Water Quality Control Commission, Denver, CO.

GEI Consultants, Inc. 2007. Yampa River Benthic Macroinvertebrate and Water Quality Monitoring, 2007. Prepared for the City of Steamboat Springs.

Hauer, F. R., and V. H. Resh. 1996. Benthic Macroinvertebrates. Pages 339-369 In: Hauer, F. R., and G. A. Lamberti (eds). *Methods in Stream Ecology*. Academic Press, Inc., San Diego, CA.

Hilsenhoff, W. L. 1982. *Using a Biotic Index to Evaluate Water Quality in Streams*. Technical Bulletin No. 132, Wisconsin Department of Natural Resources.

Hintze, J.L. 2000. *NCSS 2001 Statistical System for Windows*. Number Cruncher Statistical Systems, Kaysville, UT.

Hynes, H. B. N. 1970. *The Ecology of Running Waters*. University of Toronto Press, Toronto.

Lenat, D. R., and V. H. Resh. 2001. Taxonomy and stream ecology – the benefits of genus- and species-level identifications. *Journal of the North American Benthological Society* 20:287-298.

Lydy, M. J., Crawford, C. G., and J. W. Frey. 2000. A comparison of selected diversity, similarity, and biotic indices for detecting changes in benthic-invertebrate community structure and stream quality. *Archives of Environmental Contamination and Toxicology* 39:469-479.

Merritt, R. W., and K. W. Cummins (eds.). 1996. An Introduction to the Aquatic Insects of North America, 3rd edition. Kendall/Hunt Publishing Co., Dubuque, IA.

Rosenberg, D. M., and V. H. Resh (eds). 1993. Freshwater Biomonitoring and Benthic Macroinvertebrates. Chapman and Hall, New York. 488 pp.

Stribling, J. B., Moulton, S. R. II, and G. T. Lester. 2003. Determining the quality of taxonomic data. *Journal of the North American Benthological Society* 22:621-631.

Tobin, R. L. 1996. Initial Effects of Stagecoach Reservoir on Discharge, Water-Quality Characteristics, and Suspended-Sediment Loads in the Yampa River, Northwestern Colorado. U.S. Geological Survey Water-Resources Investigations Report 95-4101.

U.S. Environmental Protection Agency (USEPA). 2000. Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria, Rivers and Streams in Nutrient Ecoregion II. EPA 822-00-015. Office of Water, Washington, D.C.

Vannote, R. L., Minshall, G. W., Cummins, K. W., Sedell, J. R., and C. E. Cushing. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences 37:130-137.

Viera, N.K.M., N.L. Poff, D.M. Carlisle, S.R. Moulton II, M.L. Koski, and B.C. Kondratieff. 2006. A database of lotic invertebrate traits for North America: U.S. Geological Survey Data Series 187. U.S. Geological Survey, Reston, VA.

Vinson, M. R., and C. P. Hawkins. 1996. Effects of sampling area and subsampling procedure on comparisons of taxa richness among streams. Journal of the North American Benthological Society 15:392-399.

Ward, J. V., Kondratieff, B. C., and R. E. Zuellig. 2002. An Illustrated Guide to the Mountain Stream Insects of Colorado, 2nd edition. University Press of Colorado, Niwot, CO.

Whitaker, R. H. 1975. *Communities and Ecosystems*, 2nd Edition. Macmillan Publishing Company, New York.

Appendix A

Macroinvertebrate Data

MACROINVERTEBRATE DENSITY
CLIENT: STEAMBOAT SPRINGS
SITE: YMP-1
SAMPLED: 09/26/08

TAXA	REP 1	REP 2	REP 3	COMPOSITE	SWEEP
INSECTA					
EPHEMEROPTERA	**5932**	**15945**	**9433**	**10437**	
Baetis bicaudatus	116		233	116	X
Baetis tricaudatus	198	233	233	221	X
Ephemera simulans					X
Ephemerella dorothea/excrucians	2675	3256	3954	3295	
Nixe sp.	35			12	
Paraleptophlebia sp.	1710	10944	2687	5114	X
Rhithrogena undulata	1198	1512	2326	1679	X
Tricorythodes minutus					X
ODONATA					
Coenagrionidae					X
PLECOPTERA	**337**	**489**	**152**	**326**	
Chloroperlidae	35			12	
Claassenia sabulosa	209	244	140	198	X
Isogenoides sp.	58	12	12	27	X
Isoperla sp.	35	233		89	
HEMIPTERA					
Ambrysus mormon					X
Callicorixa sp.					X
Rhagovelia rivale					X
Sigara sp.					X
COLEOPTERA	**5117**	**11746**	**7327**	**8063**	
Dubiraphia quadrinotata					X
Microcylloepus pusillus		116	116	77	
Optioservus castanipennis	81	116	698	298	X
Zaitzevia parvula	5036	11514	6513	7688	X
TRICHOPTERA	**1337**	**6885**	**8734**	**5652**	
Anagapetus debilis	116	349		155	
Cheumatopsyche sp.	151	465	465	360	X
Hydropsyche sp.	1035	6071	8269	5125	X
Oecetis sp.	35			12	X
DIPTERA	**2186**	**3395**	**7477**	**4351**	
Atherix pachypus	12		12	8	
Chironomus sp.					X
Conchapelopia/Thienemannimyia gr. sp.	81		174	85	X
Cricotopus bicinctus			174	58	
Cricotopus trifascia	81		174	85	X
Dicrotendipes sp.					X
Eukiefferiella sp.		116	326	147	
Hemerodromia sp.		465	349	271	
Heterotrissocladius sp.	35			12	
Hexatoma sp.	709	605	372	562	X
Labrundinia sp.					X
Lopescladius sp.			174	58	
Microtendipes sp.					X
Orthocladius/Cricotopus gr.			174	58	X
Unid. Orthocladiinae		116		39	

MACROINVERTEBRATE DENSITY
CLIENT: STEAMBOAT SPRINGS
SITE: YMP-1
SAMPLED: 09/26/08

TAXA	REP 1	REP 2	REP 3	COMPOSITE	SWEEP
DIPTERA (cont.)					
Parametriocnemus sp.	35	116		50	X
Polypedilum sp.	35	116		50	X
Prosimulium sp.	500	698	1047	748	X
Psectrocladius sp.					X
Rheocricotopus sp.					X
Simulium sp.	35		698	244	X
Tvetenia sp.	663	1163	3803	1876	X
HYDRACARINA	**70**		**349**	**139**	
Hygrobates sp.	35		233	89	
Sperchonopsis sp.	35		116	50	
CRUSTACEA					
ISOPODA					
Caecidotea communis					X
AMPHIPODA	**35**			**12**	
Gammarus lacustris					X
Hyalella azteca cx.	35			12	X
DECAPODA		**12**		**4**	
Cambaridae		12		4	X
ANNELIDA					
OLIGOCHAETA	**349**	**116**	**1047**	**504**	
Naididae	349	116	1047	504	
MOLLUSCA					
GASTROPODA	**35**			**12**	
Physa sp.	35			12	X
TOTAL (#/sq. meter)	15398	38588	34519	29500	
NUMBER OF TAXA	31	23	27	55 *	39
SHANNON-WEAVER (H')				3.32	
TOTAL EPT TAXA	14	10	9	16 *	
EPT INDEX (% of Total Taxa)	45	43	33	29 *	
EPHEMEROPTERA ABUNDANCE (% of Total Density)	39	41	27	35	

*Includes taxa from the sweep sample

MACROINVERTEBRATE DENSITY
CLIENT: STEAMBOAT SPRINGS
SITE: YMP-2
SAMPLED: 09/26/08

TAXA	REP 1	REP 2	REP 3	COMPOSITE	SWEEP
INSECTA					
EPHEMEROPTERA	**5709**	**4652**	**3837**	**4732**	
Baetidae	58	58	174	97	X
Baetis tricaudatus		349		116	X
Epeorus longimanus			58	19	
Ephemera simulans					X
Ephemerella dorothea/excrucians	2791	2384	1686	2287	X
Fallceon quilleri	58	58		39	
Paraleptophlebia sp.	2035	1221	1512	1589	X
Rhithrogena robusta	116	349	291	252	X
Tricorythodes minutus	651	233	116	333	X
PLECOPTERA	**406**	**198**	**464**	**355**	
Claassenia sabulosa	116	58	58	77	X
Cultus aestivalis			58	19	
Perlodidae			174	58	X
Skwala americana	174	140	116	143	X
Suwallia sp.	116		58	58	
HEMIPTERA					
Rhagovelia rivale					X
Sigara sp.					X
COLEOPTERA	**5408**	**2965**	**3140**	**3837**	
Dubiraphia quadrinotata			58	19	X
Heterlimnius corpulentus			58	19	
Microcylloepus pusillus		58		19	
Narpus concolor					X
Optioservus castanipennis	349	58	291	233	X
Zaitzevia parvula	5059	2849	2733	3547	X
TRICHOPTERA	**6547**	**4489**	**7326**	**6120**	
Cheumatopsyche sp.	407		58	155	
Glossosomatidae	233	291	465	330	X
Helicopsyche borealis	116		116	77	X
Hydropsyche sp.	5268	3733	6513	5171	X
Hydroptila sp.					X
Oecetis sp.	523	465	174	387	
Polycentropus sp.					X
DIPTERA	**3885**	**2304**	**3663**	**3282**	
Atherix pachypus	70	12		27	X
Ceratopogoninae	58			19	
Chironomus sp.					X
Conchapelopia/Thienemannimyia gr. sp.	1070	326	756	717	X
Cricotopus (N.) nostocicola	209		93	101	
Cricotopus trifascia	105		93	66	
Cryptochironomus					X
Dixa sp.					X
Eukiefferiella sp.	105		93	66	
Hemerodromia sp.	116	116	116	116	

MACROINVERTEBRATE DENSITY
CLIENT: STEAMBOAT SPRINGS
SITE: YMP-2
SAMPLED: 09/26/08

TAXA	REP 1	REP 2	REP 3	COMPOSITE	SWEEP
DIPTERA (cont.)					
Hexatoma sp.	267	198	349	271	X
Labrundinia sp.			186	62	
Lopescladius sp.		256	186	147	X
Microtendipes sp.					X
Orthocladius (Euorthocladius) sp.		70		23	
Orthocladius/Cricotopus gr.	105	128		78	
Parametriocnemus sp.					X
Pentaneura sp.		70		23	
Phaenopsectra sp.					X
Polypedilum sp.					X
Potthastia sp.	105			35	
Procladius sp.					X
Prosimulium sp.	174	58	349	194	X
Rheocricotopus sp.	105			35	
Rheotanytarsus sp.		70	291	120	
Simulium sp.					X
Tvetenia sp.	1396	1000	1151	1182	X
HYDRACARINA	**116**	**58**	**174**	**116**	
Hygrobates sp.	58	58	58	58	
Sperchonopsis sp.	58		58	39	X
Torrenticola sp.			58	19	
CRUSTACEA					
ISOPODA					
Caecidotea communis					X
AMPHIPODA	**128**	**186**		**105**	
Gammarus lacustris					X
Hyalella azteca cx.	128	186		105	X
DECAPODA					
Cambaridae					X
ANNELIDA					
OLIGOCHAETA	**1059**	**1919**	**872**	**1283**	
Lumbriculidae	12			4	
Naididae	1047	1919	872	1279	X
HIRUDINEA					
Dina parva					X
Mooreobdella microstoma					X
MOLLUSCA					
GASTROPODA	**58**	**174**		**77**	
Laevapex sp.		58		19	
Physa sp.	58	116		58	

MACROINVERTEBRATE DENSITY
CLIENT: STEAMBOAT SPRINGS
SITE: YMP-2
SAMPLED: 09/26/08

TAXA	REP 1	REP 2	REP 3	COMPOSITE	SWEEP
PELECYPODA					
Pisidium sp.					X
TOTAL (#/sq. meter)	23316	16945	19476	19907	
NUMBER OF TAXA	35	31	35	70 *	45
SHANNON-WEAVER (H')				3.74	
TOTAL EPT TAXA	14	12	16	21 *	
EPT INDEX (% of Total Taxa)	40	39	46	30 *	
EPHEMEROPTERA ABUNDANCE (% of Total Density)	24	27	20	24	

*Includes taxa from the sweep sample

MACROINVERTEBRATE DENSITY
CLIENT: STEAMBOAT SPRINGS
SITE: YMP-3A
SAMPLED: 09/26/08

TAXA	REP 1	REP 2	REP 3	COMPOSITE	SWEEP
INSECTA					
COLLEMBOLA					
Entomobryidae					X
EPHEMEROPTERA	**2675**	**3035**	**3290**	**3002**	
Baetis bicaudatus	116	116	151	128	
Baetis tricaudatus	35	93	81	70	X
Drunella doddsi			35	12	
Epeorus sp.		35	116	50	
Ephemerella dorothea/excrucians	814	465	965	748	X
Fallceon quilleri	35	81		39	
Paraleptophlebia bicornuta/packi					X
Paraleptophlebia sp.	1279	1547	1244	1357	X
Rhithrogena undulata	198	35	384	206	
Tricorythodes minutus	198	663	314	392	X
PLECOPTERA	**35**	**209**	**302**	**182**	
Chloroperlidae		35	35	23	
Claassenia sabulosa	35	81	81	66	
Isoperla sp.		93	151	81	X
Sweltsa sp.			35	12	
HEMIPTERA					
Sigara sp.					X
COLEOPTERA	**1547**	**2826**	**3024**	**2466**	
Dubiraphia quadrinotata					X
Hygrotus sp.					X
Liodessus obscurellus					X
Microcylloepus pusillus			35	12	
Narpus concolor	35	35		23	
Optioservus castanipennis	430	384	814	543	X
Zaitzevia parvula	1082	2407	2175	1888	X
LEPIDOPTERA			**35**	**12**	
Crambidae			35	12	X
TRICHOPTERA	**2558**	**3140**	**3721**	**3140**	
Anagapetus debilis	116	151	151	139	
Cheumatopsyche sp.		198	209	136	
Helicopsyche borealis		35	35	23	
Helicopsyche borealis	116	349	500	322	
Hydropsyche sp.	2245	2407	2826	2493	X
Hydroptila sp.	81			27	
Micrasema bactro					X

MACROINVERTEBRATE DENSITY
CLIENT: STEAMBOAT SPRINGS
SITE: YMP-3A
SAMPLED: 09/26/08

TAXA	REP 1	REP 2	REP 3	COMPOSITE	SWEEP
DIPTERA	**2243**	**1769**	**3442**	**2481**	
Atherix pachypus	35	58		31	X
Cardiocladius sp.					X
Ceratopogoninae					X
Cladotanytarsus sp.			58	19	
Conchapelopia/Thienemannimyia gr. sp.	814	279	570	554	X
Cricotopus (N.) nostocicola	116	291	221	209	
Cricotopus trifascia	116	233	395	248	X
Cryptochironomus			58	19	
Diamesa sp.	58			19	
Dixa sp.					X
Eukiefferiella sp.			58	19	X
Hemerodromia sp.	81	35	198	105	
Hexatoma sp.	233	233	384	283	
Limnophyes sp.					X
Lopescladius sp.	58	35		31	
Micropsectra sp.					X
Neoplasta sp.					X
Orthocladius (Euorthocladius) sp.	58			19	
Orthocladius/Cricotopus gr.			58	19	
Unid. Orthocladiinae		81		27	X
Paralauterborniella sp.					X
Parametriocnemus sp.					X
Pentaneura sp.	58			19	
Phaenopsectra sp.					X
Polypedilum sp.	58	35		31	
Potthastia sp.	116	35		50	
Procladius sp.					X
Prosimulium sp.	151	384	1047	527	X
Protanyderus margarita			35	12	
Rheotanytarsus sp.		35		12	
Simulium sp.		35	81	39	X
Synorthocladius sp.			58	19	
Tanytarsus sp.					X
Thienemanniella sp.	58			19	
Tipula sp.					X
Tvetenia sp.	233		221	151	
HYDRACARINA	**116**	**186**	**512**	**272**	
Hygrobates sp.		35	198	78	
Lebertia sp.		35		12	
Sperchonopsis sp.		81	116	66	
Torrenticola sp.	116	35	198	116	
CRUSTACEA					
ISOPODA					
Caecidotea communis					X

MACROINVERTEBRATE DENSITY
CLIENT: STEAMBOAT SPRINGS
SITE: YMP-3A
SAMPLED: 09/26/08

TAXA	REP 1	REP 2	REP 3	COMPOSITE	SWEEP
AMPHIPODA					
Gammarus lacustris					X
Hyalella azteca cx.					X
DECAPODA					
Cambaridae					X
TURBELLARIA	**116**	**81**		**66**	
Girardia sp.	116	81		66	
ANNELIDA					
OLIGOCHAETA	**5431**	**2757**	**5385**	**4524**	
Enchytraeidae		198		66	
Naididae	5431	2559	5385	4458	X
HIRUDINEA					
Dina parva					X
MOLLUSCA					
GASTROPODA		**128**	**12**	**47**	
Laevapex sp.		35		12	
Physa sp.		93	12	35	X
TOTAL (#/sq. meter)	14721	14131	19723	16192	
NUMBER OF TAXA	33	41	40	81 *	42
SHANNON-WEAVER (H')				3.86	
TOTAL EPT TAXA	12	16	17	21 *	
EPT INDEX (% of Total Taxa)	36	39	43	26 *	
EPHEMEROPTERA ABUNDANCE (% of Total Density)	18	21	17	19	

*Includes taxa from the sweep sample

MACROINVERTEBRATE DENSITY
CLIENT: STEAMBOAT SPRINGS
SITE: YMP-7
SAMPLED: 09/26/08

TAXA	REP 1	REP 2	REP 3	COMPOSITE	SWEEP
INSECTA					
EPHEMEROPTERA	**8955**	**13376**	**6629**	**9653**	
Acentrella insignificans		116		39	
Asioplax edmundsi		233	233	155	
Baetidae	2093	1745	814	1551	X
Baetis tricaudatus	349	233		194	X
Epeorus sp.	233		116	116	
Ephemerella dorothea/excrucians	5699	9304	4303	6435	X
Fallceon quilleri		465		155	X
Paraleptophlebia bicornuta/packi			116	39	
Paraleptophlebia sp.	116	582	233	310	X
Rhithrogena undulata		116		39	
Tricorythodes minutus	465	582	814	620	X
PLECOPTERA	**24**	**116**	**116**	**86**	
Capniidae			116	39	
Claassenia sabulosa	12			4	
Isoperla sp.	12	116		43	X
HEMIPTERA					
Sigara sp.					X
COLEOPTERA	**2325**	**1861**	**7094**	**3760**	
Dubiraphia quadrinotata	116			39	
Microcylloepus pusillus	116			39	
Optioservus castanipennis	930	465	814	736	
Zaitzevia parvula	1163	1396	6280	2946	X
LEPIDOPTERA		**116**		**39**	
Crambidae		116		39	X
TRICHOPTERA	**11048**	**3977**	**3721**	**6249**	
Amiocentrus aspilus	116			39	
Cheumatopsyche sp.		116	116	77	X
Glossosoma sp.					X
Hydropsyche sp.	10351	3396	3140	5629	X
Lepidostoma sp.	116			39	
Oecetis avara/disjuncta	465	465	349	426	X
Polycentropus sp.			116	39	
DIPTERA	**4919**	**10582**	**8953**	**8155**	
Atherix pachypus	12			4	
Ceratopogoninae			116	39	
Conchapelopia/Thienemannimyia gr. sp.		302	1093	465	X
Cricotopus (N.) nostocicola		605		202	
Cricotopus bicinctus	116			39	
Cricotopus trifascia	465	1814	2814	1698	X
Eukiefferiella sp.	465	302		256	
Hemerodromia sp.			349	116	
Labrundinia sp.	116			39	X
Microtendipes sp.		302		101	X
Nanocladius sp.	116			39	X
Orthocladius/Cricotopus gr.	721	4838	2814	2791	X
Unid. Orthocladiinae	233		430	221	X

MACROINVERTEBRATE DENSITY
CLIENT: STEAMBOAT SPRINGS
SITE: YMP-7
SAMPLED: 09/26/08

TAXA	REP 1	REP 2	REP 3	COMPOSITE	SWEEP
DIPTERA (cont.)					
Parametriocnemus sp.					X
Pentaneura sp.	116			39	
Polypedilum sp.					X
Prosimulium sp.	1279	1163	349	930	X
Rheocricotopus sp.		302		101	X
Rheotanytarsus sp.	116		651	256	X
Simulium sp.	582	233	116	310	X
Synorthocladius sp.					X
Tanytarsus sp.	233			78	X
Tvetenia sp.	349	605	221	392	
Wiedemannia sp.		116		39	
HYDRACARINA	**582**	**116**	**116**	**271**	
Hygrobates sp.	349			116	X
Sperchonopsis sp.		116		39	
Torrenticola sp.	233		116	116	
CRUSTACEA					
AMPHIPODA					
Gammarus lacustris					X
Hyalella azteca cx.					X
DECAPODA					
Cambaridae					X
TURBELLARIA	**233**	**361**	**116**	**237**	
Girardia sp.	233	361	116	237	
ANNELIDA					
OLIGOCHAETA	**3256**	**27935**	**34889**	**22027**	
Eiseniella tetraedra		23	116	46	
Enchytraeidae			1151	384	
Lumbriculidae			116	39	
Naididae	3256	27912	33506	21558	X
HIRUDINEA			**233**	**78**	
Nephelopsis obscura			233	78	X
TOTAL (#/sq. meter)	31342	58440	61867	50555	
NUMBER OF TAXA	34	31	31	63 *	35
SHANNON-WEAVER (H')				3.22	
TOTAL EPT TAXA	12	13	12	21 *	
EPT INDEX (% of Total Taxa)	35	42	39	33 *	
EPHEMEROPTERA ABUNDANCE (% of Total Density)	29	23	11	19	

*Includes taxa from the sweep sample

Appendix B

Water Quality Data

Table B-1: Water quality parameters for Yampa River Site YMP-1 in 2004, 2005, 2007, and 2008. ND = analyte was not detected. n/a = no accepted criterion exists for a given analyte. n/s = no data were taken for a particular metric on the given sampling occasion.

Analyte	Units	Standard	2004	2005	July 2007	Sept. 2008	July 2008	Sept. 2008
Calcium	mg/L	n/a	32.5	15.6	27.1	33.1	14.1	32.6
Chromium	mg/L	0.011[1]	ND	ND	ND	ND	ND	ND
Iron	mg/L	1.0	0.04	0.21	0.07	0.04	0.15	0.04
Magnesium	mg/L	n/a	11.5	9.3	8.6	13.1	4.3	12.0
Manganese	mg/L	1.65	0.024	0.005	0.013	0.014	0.022	0.0042
Zinc	mg/L	0.118	ND	ND	0.003	ND	ND	0.006
Total Organic Carbon	mg/L	n/a	7	ND	7	6	8	8
Fecal Coliforms	#/100 ml	200[2]	n/s	2	36	0	0	2
Conductivity (@ 25º C)	µmhos/cm	n/a	n/s	n/s	224	311	126	296
Hardness ($CaCO_3$)	mg/L	n/a	129	77.24	103	137	53	131
Nitrogen as Nitrate	mg/L	10[3]	ND	0.08	ND	ND	0.4	ND
Nitrogen as Nitrite	mg/L	0.145[4]	0.01	0.018	ND	ND	ND	ND
Nitrogen as NO_3 & NO_2	mg/L	10[3]	0.02	0.1	ND	ND	0.4	ND
Nitrogen as Ammonia	mg/L	0.02[5]	ND	0.052	ND	ND	ND	ND
Total Nitrogen	mg/L	0.12[6]	0.6	0.145	0.8	0.8	0.5	0.6
Total Phosphorus	mg/L	0.01[6]	0.06	ND	0.09	0.09	0.04	0.03

1 Criterion is for the more toxic Cr VI, but total Cr is listed in the table.
2 Derived from CDPHE standards for primary recreational contact.
3 Drinking water standards for combined nitrate and nitrite (no standard for nitrate).
4 Nitrite standard based on average chloride ion concentrations from USGS water quality data for the Yampa River 1950-present.
5 Ammonia standard based on a pH of 8.2 and a temperature of 18º C.
6 Nutrient criteria based on EPA Ecoregion II standards for forested mountain streams – Colorado state standards have not been developed.

Table B-2: Water quality parameters for Walton Creek in 2004, 2005, 2007, and 2008. ND = analyte was not detected. n/a = no accepted criterion exists for a given analyte. n/s = no data were taken for a particular metric on the given sampling occasion.

Analyte	Units	Standard	2004	2005	July 2007	Sept. 2007	July 2008	Sept. 2008
Calcium	mg/L	n/a	17.8	2.41	21.8	42.7	3.8	22.2
Chromium	mg/L	0.011[1]	ND	ND	ND	ND	ND	ND
Iron	mg/L	1.0	0.28	0.18	0.07	0.12	0.12	0.07
Magnesium	mg/L	n/a	3.4	1.44	4.1	10.4	0.8	4.4
Manganese	mg/L	1.65	0.072	0.003	0.133	0.023	0.013	0.0121
Zinc	mg/L	0.118	0.01	ND	0.014	ND	0.005	0.003
Total Organic Carbon	mg/L	n/a	5	ND	6	6	7	5
Fecal Coliforms	#/100 ml	200[2]	n/s	92	168	ND	0	14
Conductivity (@ 25º C)	µmhos/cm	n/a	n/s	n/s	185	394	32	187
Hardness ($CaCO_3$)	mg/L	n/a	59	11.93	71	149	13	74
Nitrogen as Nitrate	mg/L	10[3]	0.03	0.068	0.03	ND	0.04	ND
Nitrogen as Nitrite	mg/L	0.145[4]	ND	0.026	ND	ND	ND	ND
Nitrogen as NO_3 & NO_2	mg/L	10[3]	0.03	0.09	0.03	ND	0.04	ND
Nitrogen as Ammonia	mg/L	0.02[5]	ND	0.058	ND	ND	ND	ND
Total Nitrogen	mg/L	0.12[6]	0.4	0.151	1.9	0.4	0.6	0.3
Total Phosphorus	mg/L	0.01[6]	0.03	ND	0.05	0.02	0.01	0.02

1 Criterion is for the more toxic Cr VI, but total Cr is listed in the table.

2 Derived from CDPHE standards for primary recreational contact.

3 Drinking water standards for combined nitrate and nitrite (no standard for nitrate).

4 Nitrite standard based on average chloride ion concentrations from USGS water quality data for the Yampa River 1950-present.

5 Ammonia standard based on a pH of 8.2 and a temperature of 18º C.

6 Nutrient criteria based on EPA Ecoregion II standards for forested mountain streams – Colorado state standards have not been developed.

Table B-3: Water quality parameters for Yampa River Site YMP-2 in 2004, 2005, 2007, and 2008. ND = analyte was not detected. n/a = no accepted criterion exists for a given analyte. n/s = no data were taken for a particular metric on the given sampling occasion.

Analyte	Units	Standard	2004	2005	July 2007	Sept. 2007	July 2008	Sept. 2008
Calcium	mg/L	n/a	31.1	21.4	26.6	29.9	11.5	33.0
Chromium	mg/L	0.011[1]	ND	ND	ND	ND	ND	ND
Iron	mg/L	1.0	0.07	0.38	0.06	0.06	0.13	0.03
Magnesium	mg/L	n/a	11	10.3	8.4	11.6	3.4	12.0
Manganese	mg/L	1.65	0.019	0.039	0.014	0.009	0.020	0.0038
Zinc	mg/L	0.118	ND	ND	0.007	ND	0.006	0.003
Total Organic Carbon	mg/L	n/a	6	ND	7	7	8	7
Fecal Coliforms	#/100 ml	200[2]	n/s	n/s	30	ND	0	4
Conductivity (@ 25º C)	µmhos/cm	n/a	n/s	n/s	220	284	102	305
Hardness ($CaCO_3$)	mg/L	n/a	123	95.8	101	122	43	132
Nitrogen as Nitrate	mg/L	10[3]	ND	ND	ND	ND	0.09	ND
Nitrogen as Nitrite	mg/L	0.145[4]	ND	ND	ND	ND	ND	ND
Nitrogen as NO_3 & NO_2	mg/L	10[3]	ND	ND	ND	ND	0.09	ND
Nitrogen as Ammonia	mg/L	0.02[5]	ND	ND	ND	ND	ND	ND
Total Nitrogen	mg/L	0.12[6]	0.6	ND	ND	0.6	0.6	0.6
Total Phosphorus	mg/L	0.01[6]	0.05	ND	0.08	0.09	0.04	0.04

[1] Criterion is for the more toxic Cr VI, but total Cr is listed in the table.

[2] Derived from CDPHE standards for primary recreational contact.

[3] Drinking water standards for combined nitrate and nitrite (no standard for nitrate).

[4] Nitrite standard based on average chloride ion concentrations from USGS water quality data for the Yampa River 1950-present.

[5] Ammonia standard based on a pH of 8.2 and a temperature of 18º C.

[6] Nutrient criteria based on EPA Ecoregion II standards for forested mountain streams – Colorado state standards have not been developed.

Table B-4: Water quality parameters for Fish Creek in 2004, 2005, 2007, and 2008. ND = analyte was not detected. n/a = no accepted criterion exists for a given analyte. n/s = no data were taken for a particular metric on the given sampling occasion.

Analyte	Units	Standard	2004	2005	July 2007	Sept. 2007	July 2008	Sept. 2008
Calcium	mg/L	n/a	3.7	1.1	4.7	3.1	2.0	2.9
Chromium	mg/L	0.011[1]	ND	ND	0.0002	ND	ND	ND
Iron	mg/L	1.0	0.03	0.13	6.02	ND	0.05	0.06
Magnesium	mg/L	n/a	0.7	0.53	0.7	0.6	0.4	0.6
Manganese	mg/L	1.65	ND	ND	0.0219	0.0014	0.008	0.0013
Zinc	mg/L	0.118	0.01	ND	0.587	ND	0.004	ND
Total Organic Carbon	mg/L	n/a	4	ND	4	3	5	4
Fecal Coliforms	#/100 ml	200[2]	n/s	14	86	ND	0	0
Conductivity (@ 25º C)	µmhos/cm	n/a	n/s	n/s	27	29	18	27
Hardness ($CaCO_3$)	mg/L	n/a	12	4.88	15	10	7	10
Nitrogen as Nitrate	mg/L	10[3]	0.04	0.035	ND	ND	0.06	ND
Nitrogen as Nitrite	mg/L	0.145[4]	ND	ND	ND	ND	ND	ND
Nitrogen as NO_3 & NO_2	mg/L	10[3]	0.04	0.035	ND	ND	0.06	ND
Nitrogen as Ammonia	mg/L	0.02[5]	ND	0.152	ND	ND	ND	ND
Total Nitrogen	mg/L	0.12[6]	0.3	0.157	ND	0.2	0.3	0.2
Total Phosphorus	mg/L	0.01[6]	ND	ND	0.01	ND	0.01	ND

[1] Criterion is for the more toxic Cr VI, but total Cr is listed in the table.

[2] Derived from CDPHE standards for primary recreational contact.

[3] Drinking water standards for combined nitrate and nitrite (no standard for nitrate).

[4] Nitrite standard based on average chloride ion concentrations from USGS water quality data for the Yampa River 1950-present.

[5] Ammonia standard based on a pH of 8.2 and a temperature of 18º C.

[6] Nutrient criteria based on EPA Ecoregion II standards for forested mountain streams – Colorado state standards have not been developed.

Table B-5: Water quality parameters for Yampa River Site YMP-3a in 2004, 2005, 2007, and 2008. ND = analyte was not detected. n/a = no accepted criterion exists for a given analyte. n/s = no data were taken for a particular metric on the given sampling occasion.

Analyte	Units	Standard	2004	2005	July 2007	Sept. 2007	July 2008	Sept. 2008
Calcium	mg/L	n/a	30.7	7.76	24.7	28.5	8.6	30.0
Chromium	mg/L	0.011[1]	ND	ND	ND	ND	ND	ND
Iron	mg/L	1.0	0.09	0.3	0.09	0.03	0.14	0.03
Magnesium	mg/L	n/a	10.9	5.1	7.8	11.1	2.5	11.2
Manganese	mg/L	1.65	0.046	0.015	0.0057	0.0069	0.0127	0.0033
Zinc	mg/L	0.118	ND	ND	0.003	ND	0.002	ND
Total Organic Carbon	mg/L	n/a	6	ND	7	6	7	7
Fecal Coliforms	#/100 ml	200[2]	n/s	37	14	ND	0	100
Conductivity (@ 25º C)	µmhos/cm	n/a	n/s	n/s	204	273	79	288
Hardness ($CaCO_3$)	mg/L	n/a	122	40.3	94	117	32	121
Nitrogen as Nitrate	mg/L	10[3]	ND	0.09	ND	ND	0.03	ND
Nitrogen as Nitrite	mg/L	0.145[4]	ND	0.02	ND	ND	ND	ND
Nitrogen as NO_3 & NO_2	mg/L	10[3]	ND	0.11	ND	ND	0.03	ND
Nitrogen as Ammonia	mg/L	0.02[5]	ND	0.252	ND	ND	ND	ND
Total Nitrogen	mg/L	0.12[6]	0.5	0.36	0.3	0.4	0.5	0.5
Total Phosphorus	mg/L	0.01[6]	0.05	ND	0.07	0.09	0.03	0.04

[1] Criterion is for the more toxic Cr VI, but total Cr is listed in the table.

[2] Derived from CDPHE standards for primary recreational contact.

[3] Drinking water standards for combined nitrate and nitrite (no standard for nitrate).

[4] Nitrite standard based on average chloride ion concentrations from USGS water quality data for the Yampa River 1950-present.

[5] Ammonia standard based on a pH of 8.2 and a temperature of 18º C.

[6] Nutrient criteria based on EPA Ecoregion II standards for forested mountain streams – Colorado state standards have not been developed.

Table B-6: Water quality parameters for Butcherknife Creek in 2004, 2005, 2007, and 2008. ND = analyte was not detected. n/a = no accepted criterion exists for a given analyte. n/s = no data were taken for a particular metric on the given sampling occasion.

Analyte	Units	Standard	2004	2005	July 2007	Sept. 2007	July 2008	Sept. 2008
Calcium	mg/L	n/a	10.4	5.35	9.6	11.9	11.0	11.9
Chromium	mg/L	0.011[1]	ND	ND	ND	ND	ND	ND
Iron	mg/L	1.0	0.04	0.58	0.07	0.07	0.23	0.14
Magnesium	mg/L	n/a	2.2	2.43	1.9	2.4	2.3	2.3
Manganese	mg/L	1.65	ND	0.029	0.0077	0.0015	0.0045	0.0020
Zinc	mg/L	0.118	ND	ND	0.009	0.002	0.003	0.002
Total Organic Carbon	mg/L	n/a	4	ND	4	3	7	4
Fecal Coliforms	#/100 ml	200[2]	n/s	19	12	180	0	100
Conductivity (@ 25º C)	µmhos/cm	n/a	n/s	n/s	78	113	83	104
Hardness ($CaCO_3$)	mg/L	n/a	35	23.3	32	40	37	39
Nitrogen as Nitrate	mg/L	10[3]	0.03	0.067	0.04	0.1	0.08	0.05
Nitrogen as Nitrite	mg/L	0.145[4]	ND	0.018	ND	ND	ND	ND
Nitrogen as NO_3 & NO_2	mg/L	10[3]	0.03	0.085	0.04	0.1	0.08	0.05
Nitrogen as Ammonia	mg/L	0.02[5]	ND	0.173	ND	ND	ND	ND
Total Nitrogen	mg/L	0.12[6]	0.4	0.25	0.2	0.2	0.5	0.3
Total Phosphorus	mg/L	0.01[6]	0.03	ND	0.04	ND	0.05	ND

[1] Criterion is for the more toxic Cr VI, but total Cr is listed in the table.

[2] Derived from CDPHE standards for primary recreational contact.

[3] Drinking water standards for combined nitrate and nitrite (no standard for nitrate)

[4] Nitrite standard based on average chloride ion concentrations from USGS water quality data for the Yampa River 1950-present.

[5] Ammonia standard based on a pH of 8.2 and a temperature of 18º C.

[6] Nutrient criteria based on EPA Ecoregion II standards for forested mountain streams – Colorado state standards have not been developed.

Table B-7: Water quality parameters for Soda Creek in 2004, 2005, 2007, and 2008. ND = analyte was not detected. n/a = no accepted criterion exists for a given analyte. n/s = no data were taken for a particular metric on the given sampling occasion.

Analyte	Units	Standard	2004	2005	July 2007	Sept. 2007	July 2008	Sept. 2008
Calcium	mg/L	n/a	12.1	1.77	12.1	33.1	2.7	12.3
Chromium	mg/L	0.011[1]	ND	ND	ND	ND	ND	ND
Iron	mg/L	1.0	0.07	0.12	0.07	0.04	0.04	0.02
Magnesium	mg/L	n/a	1.8	0.77	1.8	13.1	0.5	1.8
Manganese	mg/L	1.65	ND	ND	0.0026	0.01	0.0025	0.0017
Zinc	mg/L	0.118	ND	ND	0.04	ND	ND	ND
Total Organic Carbon	mg/L	n/a	4	ND	5	6	3	3
Fecal Coliforms	#/100 ml	200[2]	n/s	44	152	ND	0	44
Conductivity (@ 25º C)	µmhos/cm	n/a	n/s	n/s	124	311	25	127
Hardness ($CaCO_3$)	mg/L	n/a	38	7.58	38	137	9	38
Nitrogen as Nitrate	mg/L	10[3]	ND	0.049	0.02	ND	0.04	0.02
Nitrogen as Nitrite	mg/L	0.145[4]	ND	0.01	ND	ND	ND	ND
Nitrogen as NO_3 & NO_2	mg/L	10[3]	ND	0.05	0.02	ND	0.04	0.02
Nitrogen as Ammonia	mg/L	0.02[5]	ND	0.213	ND	ND	ND	ND
Total Nitrogen	mg/L	0.12[6]	0.3	0.25	0.2	0.8	0.3	0.2
Total Phosphorus	mg/L	0.01[6]	ND	ND	0.02	0.09	ND	ND

[1] Criterion is for the more toxic Cr VI, but total Cr is listed in the table.

[2] Derived from CDPHE standards for primary recreational contact.

[3] Drinking water standards for combined nitrate and nitrite (no standard for nitrate)

[4] Nitrite standard based on average chloride ion concentrations from USGS water quality data for the Yampa River 1950-present.

[5] Ammonia standard based on a pH of 8.2 and a temperature of 18º C.

[6] Nutrient criteria based on EPA Ecoregion II standards for forested mountain streams – Colorado state standards have not been developed.

Table B-8: Water quality parameters for Yampa River Site YMP-7 in 2004, 2005, 2007, and 2008. ND = analyte was not detected. n/a = no accepted criterion exists for a given analyte. n/s = no data were taken for a particular metric on the given sampling occasion.

Analyte	Units	Standard	2004	2005	July 2007	Sept. 2007	July 2008	Sept. 2008
Calcium	mg/L	n/a	27.4	7.03	26.1	29.7	8.7	30.0
Chromium	mg/L	0.011[1]	ND	ND	ND	ND	ND	ND
Iron	mg/L	1.0	0.06	0.26	0.11	0.05	0.12	0.05
Magnesium	mg/L	n/a	9.6	4.69	8.1	11.1	2.5	10.7
Manganese	mg/L	1.65	0.013	0.006	0.0105	0.0089	0.0125	0.0039
Zinc	mg/L	0.118	ND	ND	0.047	ND	ND	0.004
Total Organic Carbon	mg/L	n/a	6	ND	7	8	7	7
Fecal Coliforms	#/100 ml	200[2]	n/s	5	18	ND	0	8
Conductivity (@ 25º C)	µmhos/cm	n/a	n/s	n/s	292	409	88	381
Hardness ($CaCO_3$)	mg/L	n/a	108	36.8	98	120	32	119
Nitrogen as Nitrate	mg/L	10[3]	ND	0.07	ND	ND	0.05	ND
Nitrogen as Nitrite	mg/L	0.145[4]	ND	0.012	ND	ND	ND	ND
Nitrogen as NO_3 & NO_2	mg/L	10[3]	ND	0.08	ND	ND	0.05	ND
Nitrogen as Ammonia	mg/L	0.02[5]	ND	0.116	ND	ND	ND	ND
Total Nitrogen	mg/L	0.12[6]	0.5	0.241	0.3	0.4	0.5	0.5
Total Phosphorus	mg/L	0.01[6]	0.05	ND	0.07	0.09	0.02	0.03

[1] Criterion is for the more toxic Cr VI, but total Cr is listed in the table.
[2] Derived from CDPHE standards for primary recreational contact.
[3] Drinking water standards for combined nitrate and nitrite (no standard for nitrate).
[4] Nitrite standard based on average chloride ion concentrations from USGS water quality data for the Yampa River 1950-present.
[5] Ammonia standard based on a pH of 8.2 and a temperature of 18º C.
[6] Nutrient criteria based on EPA Ecoregion II standards for forested mountain streams – Colorado state standards have not been developed.