BENEFICIAL USE RECONNAISSANCE
MONITORING AND ASSESSMENT REPORT

Waterbody: Bear River Watershed: Bear River

Hydrologic Unit Code: WYBR16010101 Segments: 006-3, 007-3, 008-3 & 058-3

Investigators: Tavis Eddy, Glen Garton, Jack Smith (WDEQ/WQD); Mike Dukart, Jules Feck (WQD Interns); and, Benita Gustafson (Uinta Co. Conservation District).

INTRODUCTION

The segments in this assessment reach go from the Utah / Wyoming state line to the inlet of Woodruff Narrows Reservoir. This entire reach of the Bear River is classified by Chapter 1, Appendix A of the Water Quality Rules and Regulations as a Class 2, coldwater stream (WDEQ/WQD, 2000). Designated uses for the Bear River include: agriculture, protection and propagation of fish (coldwater game fish) and wildlife, industry, human consumption, recreation, and scenic value. The Bear River originates on the northern side of the Uinta Range in northeastern Utah. The river flows north out of the Uinta Range and enters Wyoming. The northward flow of the river continues, past the City of Evanston, Wyoming, to Woodruff Narrows Reservoir. Upon exiting the reservoir, the river swings to the west and reenters the state of Utah.

The five segments that comprise the reach from the Utah / Wyoming state line to Woodruff Narrows were included in a single assessment report to facilitate a single, complete assessment of this portion of the river. Table 1 gives the specific use support, causes, and sources of impairment as identified for those segments in the 1996 Wyoming Water Quality Assessment Report (WDEQ/WQD, 1996). Those support information were determined in 1998 to be old or inconclusive data, and the segments were then included in the monitoring program for a complete assessment.

Five bioassessment stations (WB-42, WB-43, WB-44, WBI-01, and WB-45) were established on the reach on October 20 and 21, 1998. The pre-monitoring evaluation suggested that these five bioassessment stations; one above Mill Creek, one between Mill and Sulphur Creeks, one between Sulphur Creek and above the City of Evanston, one below the City of Evanston, and one above the inlet to Woodruff Narrows Reservoir would adequately provide a use assessment of this waterbody. Two stations (WB-42 and WB-43 were located in close proximity to historic bioassessment stations (WBI-16 and WBI-17, respectively). One station (WBI-01) was the relocation of a historic bioassessment station. In addition, bioassessment stations have been established on Mill Creek, Pleasant Valley Creek, and Sulphur Creek. Separate assessment reports will be written for these three Bear River tributaries. Water chemistry, biological (macroinvertebrates), and physical (habitat quality) data were collected at this site in accordance with the department's bioassessment sampling and analysis plan (King, 1993a), Nonpoint Source Program Quality Assurance Project Plan (WDEQ/WQD, 1993), and Surface Water Quality Assurance Project Plan (WDEQ/WQD, 1989).

Table 1. Use Support, Causes, and Sources of upper Bear River Segments, 1996 Wyoming Water Quality Assessment Report.

Segment	Length	Degree of Use Support	Cause of Impairment	Souces of Impairment
008. Utah stateline to Mill Cr.	13.96 mi.	Aquatic Life - Partial	Siltation, Habitat	Pastureland, Streambank, Removal of Riparian.
007. Mill Cr. to Sulphur Cr.	9.20 mi.	Aquatic Life - Partial	Siltation, Habitat	Pastureland, Rangeland, Irrigated Crop, Streambank, Removal of Riparian
006. Sulphur Cr. to Yellow Cr.	12.10 mi.	Cold Water Fish - Threatened	Siltation	Unknown
059. Yellow Cr. to Whitney Canyon Cr.	~16 mi.	Full Support	None	None
058. Whitney Canyon Cr. to Woodruff Narrows Resv.	~1 mi.	Fish Consumption - Not Supported Cold Water Fish - Not Supported	Siltation, Nutrients, Flow Alteration, Organic, Metals	Pastureland, Irrigated Crop, Channelization, Flow Problems, Streambank, Removal of Riparian, Unknown

The samplers noted a precipitation event occurring in the watershed approximately 5 days prior to sampling. Any runoff associated with that event was not felt to be a factor in the data collection. The weather during the bioassessments was clear and cool.

DESCRIPTION OF BIOASSESSMENT STATIONS

The Bear River "Burton" bioassessment station (WB-42) was established in the NE¼SE¼ Sec. 03, T.12N., R.120W., Uinta County, Wyoming. Locational coordinates for this station are 41° 02' 36.38" north latitude and -110° 55' 56.48" west longitude. These coordinates were determined from a corrected global positioning system reading at the base of the sample riffle. This station was located upstream of the Chalk Creek Road crossing, approximately 3.5 miles north of the Utah stateline at an elevation of approximately 7,380 feet. The station is found on the *Myers Reservoir* USGS 7½' Quadrangle and the *Evanston* 1:100,000 BLM Surface Management Status map. This station was located approximately 1/4 mile downstream of the location of historic Bioassessment Station WBI-16, established in 1994 and sampled in 1994, 1995, and 1996.

The Bear River "Field" bioassessment station (WB-43) was established in the NE¼NW¼ Sec. 30, T.14N., R.119W., Uinta County, Wyoming. Locational coordinates for this station are 41° 09' 57.61" north latitude and -110° 52' 50.26" west longitude. These coordinates were determined from a corrected global positioning system reading at the base of the sample riffle.

This station was located upstream of the Highway 150 crossing, approximately 4 miles upstream of the Sulphur Creek confluence, at an elevation of approximately 7,069 feet. The station is found on the *Millis* USGS 7½' Quadrangle and the *Evanston* 1:100,000 BLM Surface Management Status map. This station was located approximately 1/8 mile upstream of the location of historic Bioassessment Station WBI-17, established and sampled in 1994.

The Bear River "State Park" bioassessment station (WB-44) was established in the SW¼SE¼ Sec. 22, T.15N., R.120W., Uinta County, Wyoming. Locational coordinates for this station are 41° 15' 37.33" north latitude and -110° 56' 06.88" west longitude. These coordinates were determined from a corrected global positioning system reading at the base of each sample riffle. This station was located in Bear River State Park, approximately 1 mile upstream of the Interstate 90 crossing, at an elevation of approximately 6,800 feet. The station is found on the *Evanston* USGS 7½' Quadrangle and the *Evanston* 1:100,000 BLM Surface Management Status map.

The Bear River "Nixon" bioassessment station (WBI-01) was re-established in the SE¼SE¼ Sec. 36, T.16N., R.121W., Uinta County, Wyoming. Locational coordinates for this station are 41° 18' 53.31" north latitude and -111° 00' 33.11" west longitude. These coordinates were determined from a corrected global positioning system reading at the base of the sample riffle. This station was located downstream of the County Road 105 crossing, approximately 3.5 miles north of the City of Evanston, at an elevation of approximately 6,600 feet. The station is found on the *Murphy Ridge* USGS 7½' Quadrangle and the *Evanston* 1:100,000 BLM Surface Management Status map. This bioassessment station was originally established and sampled in 1994. The "Nixon" station is also located approximately 1 mile upstream of the historic bioassessment station WBI-08, established and sampled in 1994.

The Bear River "Martin Ranch" bioassessment station (WB-45) was established in the SW¼NW¼ Sec. 32, T.17N., R.120W., Uinta County, Wyoming. Locational coordinates for this station are 41° 24' 56.75" north latitude and -111° 00' 59.42" west longitude. These coordinates were determined from a corrected global positioning system reading at the base of the sample riffle. This station was located approximately 3.5 miles upstream of Woodruff Narrows Reservoir at an elevation of approximately 6,400 feet. The station is found on the *Neponset Reservoir NE* USGS 7½' Quadrangle and the *Evanston* 1:100,000 BLM Surface Management Status map.

RESULTS AND DISCUSSION

PHYSICAL SETTING

The five stations are located in the foothills and plains landform areas of the Wyoming Basins Ecoregion. The predominate geologies in the immediate area of the five sample stations are presented in Table 2. Detailed soil survey mapping has not been completed in this area and the

predominant soil type (series or association) at the stations could not be determined. The general soil taxonomy (order/suborder/great group/subgroup) at the five stations (Munn and Arneson, 1998) are presented in Table 2. Land use and additional watershed characteristics are also presented in Table 2.

Table 2. Watershed characteristics of the upper Bear River bioassessment stations.

	Burton	**Field**	**State Park**	**Nixon**	**Martin Ranch**
Elev. (ft.)	7380	7069	6800	6600	6400
Predominant Geology	Quaternary Alluvium (Qa)	Quaternary Alluvium (Qa)	Quarternary Alluvium (Qa)	Quarternary Alluvium (Qa)	Quarternary Alluvium (Qa)
General Soils	Typic Torriorthents	Typic Torrifluvents	Typic Torrifluvents	Typic Torrifluvents	Typic Torrifluvents
Primary Land Use	Recreation and Wildlife Habitat	Recreation and Wildlife Habitat	Recreation and Wildlife Habitat	Livestock Grazing	Irrigated Hayland
Secondary Land Use	Livestock Grazing	Rural Home Development	Urban	Recreation and Wildlife Habitat	Livestock Grazing
Discharge (cfs)	110.2	129.3	205.7	259.3	95.9
Drainage Area ($mi.^2$)	201	296	438	665	770
Stream Order	4	5	5	5	5
Stream Type	C3	F3	C3	C3	C3

Several reservoirs on Bear River tributaries are located along this reach. These include: Meyers, Austin, Martin, Sulphur Creek, Crompton, and Painter. These reservoirs were constructed primarily for irrigation with some domestic supply being provided by Sulphur Creek Reservoir. Numerous irrigation and water supply withdraws, including the Crown Ditch, Hilliard Westside Canal, Hilliard East Fork Canal, Bear Canal, Cottonwood (Meyers Reservoir) Diversion, Evanston Aqueduct, Booth Ditch, City Ditch, Old City Ditch, Rocky Mountain Ditch, Adin Brown Ditch, Morris Ditch, Tunnel Ditch, and Christensen Ditch are located with this reach of the watershed. Historic channelization and/or bank rip-rap were noted at all but the uppermost (Burton) stations and were quite extensive at the two stations above the City of Evanston ("State Park" and "Field").

Discharges at the Bear River bioassessment stations were measured by the mid-section method using a Global Flowprobe®. Discharges increase downstream with the addition of tributary water. That trend was reversed between the "Nixon" and "Martin Ranch" stations where discharge decreased dramatically, presumably due to irrigation withdraws.

With the exception of the “Field” station, the upper Bear River bioassessment stations were determined to be Rosgen C3 stream type. The “C3” stream type is a slightly entrenched, meandering stream that is dominated by cobble, and has riffle-pool channels with a well developed floodplain. This stream type is very susceptible to shifts in both lateral and vertical stability caused by channel disturbance and changes in flow and sediment regimes of the contributing watershed. Rates of lateral adjustment are influenced by the presence and condition of riparian vegetation (Rosgen, 1996). The “Field” station was determined to be a Rosgen F3 stream type. The “F3" stream type is a cobble dominated, entrenched, and meandering channel (Rosgen, 1996). Intensive channelization and rip-rap at this location resulted in the entrenchment ratio that placed this site in the “F” type. The investigators felt that the stream would have been a “C3" if the intensive channelization had not occurred.

Several permitted NPDES discharge points are located within the upper Bear River watershed. These include one large municipal wastewater treatment facility (City of Evanston), three smaller wastewater treatment plants, two industrial facilities, and one oil treater facility. These permitted dischargers are all located either in the City of Evanston area or downstream of the city. These permits get inspected by WDEQ/WQD staff on a scheduled basis and the permit holders are required to comply with a self-monitoring program. In addition, several industrial and construction stormwater discharge permits have been issued for gravel mines, industrial areas, and construction activities in the watershed. These permits are inspected by WDEQ/WQD staff and the permit holders are required to develop and follow a stormwater pollution prevention plan.

There has been extensive oil and gas development in this part of the upper Bear River watershed, including the Anschutz Ranch East, Chicken Creek, Yellow Creek, Painter Reservoir East, and Whitney Canyon gas fields and the Thomas Canyon, Painter Reservoir West, and Woodruff Narrows oil and gas fields (De Bruin, 1996). The *Metallic and Industrial Minerals Map of Wyoming* map (Harris et al., 1985) identifies several construction and aggregrate pits along the Bear River along with brick and refractory clay deposits and surface mines on the east side of the river, north of Almy, Wyoming.

Portions of the upper Bear River watershed are within the Hams Fork coal field (Glass et. al, 1975). There are currently no active coal mines in this watershed, however, several small, historic underground coal mines are located along the Bear River in the Almy, Wyoming area.

Photographs taken at the sampling stations include: upstream, downstream, and panoramic views. Additional photographs of shoreline rip-rap and bank condition were taken. These photographs can be found in the Bear River (Utah Stateline to Woodruff Narrows Resv.) assessment file.

WATER QUALITY

Water quality samples were taken at all five stations on October 20, 1998. Grab samples were collected, preserved, transported and analyzed in accordance with procedures outlined in the department's Surface Water Quality Assurance Project Plan (WDEQ/WQD, 1989). All water quality data were evaluated for quality assurance and quality control and met data quality objectives. Water quality parameters and results for the 1998 Bear River stations are found in Table 3.

Table 3. Water Quality Parameters and Results, upper Bear River, October 20, 1998.

Parameter (units)	Burton	Field	State Park	Nixon	Martin Ranch
Day (mo/day/yr)	10/20/98	10/20/98	10/20/98	10/20/98	10/20/98
Time (hours)	08:30	10:30	11:00	09:45	12:00
Temperature (°C)	1.8	3.4	5.0	4.0	6.0
pH (Standard Units)	8.66	8.53	8.80	7.67	8.14
Conductivity (µS/cm)	210	274	366	374	404
Dissolved Oxygen (mg/l)	9.70	9.88	9.46	9.86	10.03
Turbidity (NTU)	0.98	1.42	5.79	4.90	4.21
TSS (mg/l)	<2	<2	6	4	2
Alkalinity (mg/l)	120	150	180	190	200
Chlorides (mg/l)	<5	<5	8	15	19
Sulfate (mg/l)	<10	<10	13	15	20
Total Hardness (mg/l)	119	155	207	213	221
Total Phosphorus (mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate Nitrogen (mg/l)	0.1	<0.1	<0.1	0.1	<0.1
Fecal Coliform Bacteria (# colonies / 100 ml.)	No data	No data	No data	10	Non - Detection (<10)

The water temperatures observed at the five upper Bear River stations were well below the WDEQ/WQD (1998) maximum allowable stream temperature of 25.6° C for cold water fisheries. These samples were taken toward the end of October, and do not accurately reflect the maximum stream temperatures that would be observed in July or August. Variation in temperature between sites most likely reflect different sample times during the day.

The pH values observed at the upper Bear River stations were basic (greater than 7 standard units) but below the WDEQ/WQD (1998) upper limit standard of 9.0 standard units. There appears to be a slight (although most likely not significant) increase in pH from upstream to downstream (with the exception of the "Nixon" station). This possible increase in pH can be due to the addition of dissolved constituent in the system, as substantiated by increasing conductivity and alkalinity values, or due to increased photosynthesis and respiration of aquatic plants (increased aquatic plant cover being directly related to increasing nutrients). The slightly lower, morning pH at the "Nixon" station may represent the diurnal pH fluctuation in the river below the City of Evanston.

Conductivity is a field measurement used to evaluate the level of dissolved constituents in the water. The more dissolved substances present, the higher the conductivity measurement. There are no WDEQ/WQD surface water quality standards for conductivity, however King (1990) reported aquatic organism negative response when conductivities were greater than 6,900 µS/cm. The conductivity at the upper Bear River stations are well below such a level. There is a consistent increase in conductivity from the most upstream station (210 µS/cm) to the most downstream station (404 µS/cm). This constant increase is most likely reflects the addition of dissolved constituents to the watershed from various tributaries that headwater in the sedimentary rock watersheds.

Dissolved oxygen is the amount of free oxygen available to aquatic organisms. Temperature and dissolved oxygen are inversely related in that as the temperature rises, the DO concentration decreases. However, dissolved oxygen depletion rarely occurs in shallow, well-mixed, aerated streams (King, 1993a). However, dissolved oxygen is also sensitive to increased algal productivity and biomass from nutrient enrichment. High algal biomass often produces large diurnal fluctuations in dissolved oxygen. Deoxygenation can also occur as a result of organic pollution loading to a stream. Oxygen is required to break down complex organic molecules into simple inorganic molecules. The degree of deoxygenation depends on a number of factors such as dilution, temperature, the in-stream biological oxygen demand (BOD), the degree of re-aeration, and the bacteria composition of the water. Because of these variables, the point of maximum deoxygenation may occur considerably downstream of the point of loading (Mason, 1996). Dissolved oxygen levels observed at the upper Bear River stations (9.46 - 10.03 mg/l) are greater than the 4.0 mg/l one day minimum coldwater criteria for non-early life stages (WDEQ/WQD, 1998). Several of the dissolved oxygen readings were taken early in the morning when levels are commonly depressed. These early morning readings were still significantly greater than the minimum coldwater standard, however, cold water temperatures at these times may also be restricting aquatic plant growth and transpiration; minimizing the early morning dissolved oxygen depression.

Turbidity is an optical property of water where total suspended solids (TSS) and some dissolved material cause light to be scattered. An increase in turbidity and TSS has been shown to decrease the production and abundance of plant material, decrease abundance of fish food organisms, and decrease production and abundance of fish (Lloyd, 1987; Newcombe and Jensen, 1996). The

WDEQ/WQD (1998) numeric standard for turbidity deals with turbidity increases attributable to the activities of man. The WDEQ/WQD (1998) narrative standard for floating and suspended solids states that activities attributable to man shall not cause significant degradation of habitat for aquatic life or adversely affect plant life or wildlife. Lloyd's (1987) literature review of the effects of turbidity on salmonids suggested that turbidity in the 10-25 NTU range and TSS concentrations near 35 mg/l can have deleterious effects on fish. Newcombe and Jensen's (1996) literature review suggest TSS values between 18 and 35 mg/l can result in reduced feeding and abundance, and TSS values in the range of 50 to 66 mg/l can result in reduced rates of weight gain and avoidance behavior in adult rainbow and cutthroat trout. The instantaneous turbidity (0.98 - 4.90 NTU) and TSS (<2 - 6 mg/l) readings at the upper Bear River stations are very low and do not suggest stress on the coldwater game fish during base flow conditions. Both turbidity and TSS peak at the "State Park" station. This is likely due to sediment contributions from Sulphur Creek, a tributary where the assessment report "weight-of-evidence" evaluation identifies an impairment to this system due to sediment and nutrients.

Alkalinity refers to the capacity of water to neutralize the addition of acid. Alkalinity is also important for primary production (bacteria and algae) in streams which directly affects the macroinvertebrate community. Generally, as alkalinity increases, stream production increases (King, 1993a). There is no numeric alkalinity standard in Wyoming, but a minimum limit of 20 mg/l has been suggested by the U.S. Environmental Protection Agency (1986). The upper Bear River alkalinity levels are all greater than this minimum threshold. The upper Bear River alkalinity levels show a constant increase from the upstream to downstream locations. As was suggested with electrical conductivity, this is most likely the result of the addition of tributary waters that flow from sedimentary rock watersheds.

Chlorides and sulfates are the two principal dissolved components in water. Increased chloride or sulfate levels can have a negative effect on benthic macroinvertebrates. WDEQ/WQD (1998) water quality standards set aquatic life acute and chronic chloride standards of 860 mg/l and 230 mg/l, respectively. There is no surface water numeric standard for sulfates in Wyoming, however, King's (1993a) review suggests sulfate levels below 150 mg/l were optimal for macroinvertebrates. Chloride levels at the upper Bear River stations ranged from <5 to 19 mg/l. These levels are all well below the state's chronic standard. Sulfate levels in the upper Bear River stations ranged from <10 to 20 mg/l. These levels were all well below the recommended upper threshold for benthic organisms. There was a measurable increase in both sulfates and chlorides between the "Field" and "State Park" stations. This is likely due to contributions from Sulphur Creek (sulfate and chloride levels commonly in the 20 - 30 mg/l range). However, the levels observed in the Bear River do not suggest any negative impact to the aquatic life in the upper Bear River under base flow conditions. As was the case with electrical conductivity and alkalinity, both chloride and sulfate levels increased with downstream sampling.

Total hardness in stream water is related to the concentration of metals (metallic ions). Common metallic ions that contribute to hardness include calcium and magnesium. When the hardness is numerically greater than the sum of carbonate and bicarbonate alkalinity, the excess is called noncarbonate hardness. Other metallic ions included in the noncarbonated hardness fraction may

include aluminum, iron, strontium, zinc, and manganese. There is no total hardness water quality standard in Wyoming, however, if a large disparity between total hardness concentrations are observed between reference streams and the stream being assessed, sampling for specific metal should be conducted (King, 1993a). The total hardness in the upper Bear River ranged from 119 - 221 mg/l and indicate "moderately hard" to "hard" water. These hardness values observed in at the upstream sites do not differ significantly from the carbonate alkalinity. The difference between total hardness and carbonate alkalinity starts to increase slightly at the lower two sites suggesting the possible addition of small amounts of metallic ions such as iron or manganese.

Phosphorus is an essential element for plant growth and is considered one of two primary nutrients associated with human induced pollution. Even low levels of phosphorus (>0.2 mg/l) can stimulate growth of algae, periphyton, and bacteria. Naturally occurring phosphorus enters the stream primarily by soil erosion and sediment transport. Additional sources of phosphorus can include municipal and industrial effluents, and runoff from animal feeding areas and fertilized lands (King, 1993a). Wyoming has not established water quality standards for phosphorus, however, King's (1993a) literature review suggests total phosphorus levels should not exceed 0.05 mg/l in a stream that enters a lake or reservoir and suggests a target total phosphorus concentration of $\leq$1.0 mg/l for streams that do not directly enter lakes. The total phosphorus levels in the upper Bear River were all below the 0.1 mg/l detection limit. These data do not suggest that the Bear River is a significant contributor to total phosphorus loading to Woodruff Narrows Reservoir during fall, base flow conditions.

Several forms of nitrate nitrogen are present in nature. WDEQ bioassessments sample and analyze nitrate → nitrite nitrogen. Nitrate is considered the other of the two primary nutrients associated with human induced pollution. Sources of human induced nitrate concentrations can be from municipal and industrial effluents, animal feeding operations, fertilizer use, and other human and animal waste runoff (King, 1993a). Wyoming does not have a nitrate standard for aquatic life, however, the human health standard for nitrate nitrogen is 10 mg/l (WDEQ/WQD, 1998). Nitrate nitrogen levels in the upper Bear River were generally less than the detection limit of 0.1 mg/l with the exception of the "Burton" and "Nixon" stations (0.1 mg/l). The "Nixon" station reading most likely reflects some nitrate additions to the City of Evanston's wastewater treatment plant on Yellow Creek and the "Burton" station reading may be reflecting wildlife, livestock, or recreational use in the vicinity of the the Utah/Wyoming stateline.

Fecal coliform bacteria counts were made at the lowest two stations in the upper Bear River reach ("Nixon" and "Martin Ranch"). Each sample consisted of 6 dilutions (0.001 - 10ml.). Only one colony forming unit was observed in the 10 ml. dilution at the "Nixon" site (10 cfu/100 ml.). No colonies were observed in the "Martin Ranch" sample. These samples were taken outside of the May 1 - September 30 recreation period, but suggest overall low bacteria levels in the upper Bear River during the fall, base flow period.

Water quality observations made during the bioassessments are presented in Table 4.

Table 4. Water Quality Observations, upper Bear River. October 20, 1998.

Station	Surface Sheen	Water Color	Water Odor	Surface Foam
Burton	None	None	None	None
Field	Slight sheen on water in backwater pools.	None	None	None
State Park	None	Light Green	None	None
Nixon	None	Light Brown	None	Foam in some Pools
Martin Ranch	None	Light Brown	Sulfur	Foam in some Pools

In general, there appeared to be a slight increase in water color from upstream to downstream stations. This color change may correspond to the slight increase in turbidity and dissolved constituents from upstream to downstream locations. The slight water sheen observed in backwater pools at the "Field " station may reflect natural organic compounds as a result of plant and leaf decompostion. The foam observed at the lower two is probably the cumulative result of nutrients added to the system fromthe wastewater treatment plants, livestock grazing, and rural residential areas in the watershed. The slight sulfur odor detected at the lowest station may be the result of organic decay in the exposed muds because of reduced flows in response to irrigation withdraws or possibly background odor from gas development facilities to the east.

Additional water chemisty monitoring data (less than 5 years old) have been collected by the United States Geological Survey at Station 10020100. This station is located upstream of Woodruff Narrows Reservoir and is approximately 1 mile downstream of the WDEQ "Martin Ranch" bioassessment station. Data for this 5-year period are presented in Table 5. Older data are presented in the "Historical and Ancillary Data" section of this assessment report.

U.S.G.S. data results on those parameters collected as part of the Beneficial Use Reconnaissance protocols are quite similar to those WDEQ bioassessment data. Nutrient data collected by the U.S.G.S. (Nitrate plus Nitrite Nitrogen, Ammonia Nitrogen, and Ortho Phosphorus) indicate nutrient transport in the river above the reservoir. U.S.G.S. data also show highly variable sediment transport in the river, ranging from 10 to 3,600 tons per day. Elevated sediment transport (> 1,000 tons/day) occurred during spring runoff (April or May) when discharge was approximately 1,200 cfs. The highest level of sediment transport during this period was observed on May 24, 1999 when 3,600 tons of sediment per day were recorded.

PHYSICAL HABITAT

Habitat Assessment

Physical (habitat quality) data were collected and analyzed according to WDEQ/WQD bioassessment protocols (King, 1993a). All data were evaluated for quality assurance and quality

control and met data quality objectives.

Table 5. Water Quality Monitoring Data (1996 - 2000), U.S.G.S. Station 10020100.

Date	Discharge (cfs)	E. Cond. (uS/cm)	pH (su)	Temp. (°C)	Sulfate (mg/l)	Chloride (mg/l)	$NO_3 + NO_2$ - N (mg/l)	NH_4 (mg/l)	Phos. Ortho (mg/l)	TSS (mg/l)	TSS (t / day)
04/16/95	76	455	8.6	8.0	24.0	22.0	ND	ND	ND	51	10
05/19/95	300	336	8.4	11.0	13.0	12.0	ND	ND	ND	165	134
06/27/95	2,000	145	8.2	15.0	3.1	2.6	ND	ND	ND	180	972
12/05/95	75	460	8.5	3.0	17.0	19.0	< 0.05	<0.02	0.03	71	14
04/10/96	1,200	411	8.3	9.0	18.0	16.0	0.06	0.03	0.02	581	1,880
05/01/96	402	462	8.6	9.0	24.0	21.0	<0.05	0.02	0.02	56	61
06/18/96	712	171	8.6	16.0	27.0	2.8	<0.05	0.03	<0.01	100	192
11/13/96	60	435	8.6	5.0	16.0	17.0	<0.05	0.02	<0.01	16	2.6
04/23/97	678	508	8.4	4.0	28.0	27.0	<0.05	0.05	0.01	190	348
05/15/97	1,190	213	8.3	11.0	7.2	7.6	0.08	0.02	<0.01	385	1,240
06/11/97	1,960	224	8.1	13.0	5.5	7.2	0.05	<0.01	<0.01	169	894
11/01/97	248	457	8.6	0.0	19.0	20.0	0.12	<0.02	0.03	145	97
04/22/98	335	585	8.7	11.5	32.0	34.0	<0.05	0.03	0.01	149	135
05/26/98	828	251	7.7	12.0	7.5	7.2	<0.05	<0.02	<0.01	153	341
06/25/98	1,390	234	8.3	13.0	9.1	7.0	<0.05	0.05	<0.01	154	576
11/24/98	198	474	8.3	3.0	19.0	20.0	<0.05	0.03	0.01	56	30
03/23/99	477	531	8.4	4.0	26.0	36.0	0.06	<0.02	0.02	363	468
05/24/99	1,300	259	8.1	13.0	10.0	7.4	0.10	0.04	0.01	1,030	3,600
06/17/99	1,080	180	8.3	12.0	3.8	4.7	<0.05	<0.02	0.02	174	509
11/17/99	47	490	8.7	5.0	20.0	25.5	<0.05	<0.02	<0.01	57	7.3
03/29/00	319	545	8.2	8.0	31.2	29.0	<0.05	0.032	0.018	252	217
05/24/00	618	159	8.1	15.0	4.2	3.4	<0.05	<0.02	<0.01	476	794
06/27/00	12	576	8.3	16.0	31.5	38.9	<0.05	<0.02	<0.01	43	1.4

ND = No Data

Substrate composition and silt cover (embeddedness) were recorded at eight, one square foot sample points within the riffle where macroinvertebrates were collected. Water velocity was also recorded at each of these points. A summary of these data are presented in Table 6.

Table 6. Mean Substrate Composition, Weighted Embeddedness, and Water Velocity at Five Bear River Sample Riffles, 1998.

Mean Percent Substrate (Eight 1 ft.^{2} Quadrats)								
Station Name	Cobble (2.5-10")	Coarse Gravel (1 - 2.5")	Fine Gravel (0.3 - 1")	Sand (<0.3", gritty)	Silt* (<0.3", fine)	Clay (Hard Pack)	Organic (fine, black)	Precipitate (Oil, WWTF)
"Burton"	48.1	24.4	26.3	1.3	0.0	0.0	0.0	0.0
"Field"	71.3	26.3	2.5	0.0	0.0	0.0	0.0	0.0
"State Park"	71.3	24.4	4.4	0.0	0.0	0.0	0.0	0.0
"Nixon"	85.0	10.3	2.0	1.5	1.3	0.0	0.0	0.0
"Martin Ranch"	0.6	90.9	8.1	0.4	0.0	0.0	0.0	0.0

Station Name	**Weighted Embeddedness - Silt Coverage (Range 20 to 100)** Eight 1 ft.^{2} Quadrats	**Mean Water Velocity (ft./sec.)** Eight Quadrat Locations
"Burton"	70.25	1.49 (Mean at 7 locations, No data for Quad. 8).
"Field"	71.50	2.38
"State Park"	26.25	2.15
"Nixon"	26.75	2.10
"Martin Ranch"	35.60	1.29

* Silt substrate is where the silt covering is greater than 1/4 inch deep

The most common substrate component in the Bear River sample riffles from the Utah / Wyoming stateline to below Evanston was cobble, followed by coarse gravel. The dominant substrate at the lowest station ("Martin Ranch") was coarse gravel. The presence of rock and gravel in flowing streams is generally considered the most desirable habitat (Plafkin et al., 1989). Substrate, such as found in the Bear River sample riffles, should reflect a diverse and balanced macroinvertebrate community. These substrate data suggest that macroinvertebrate data discussed later are affected by water quality stressors and not the selection of an inferior substrate riffle for sample collection.

Weighted embeddedness (silt covering) in the sample riffle can range from 20 (complete silt cover) to 100 (void of silt cover). The weighted embeddedness at the upper Bear River sample riffles ("Burton" and "Field") was relatively high at 70.25 and 71.50, respectively. These data indicate a riffle substrate relatively free of fine, silt covering. The weighted embeddedness drops

considerable at the "State Park", "Nixon", and "Martin Ranch" stations; values of 26.25, 26.75, and 35.60, respectively. These data indicate that riffle substrate approaches complete silt cover at these sites. Mean current velocities observed in these sample riffles suggest that these silt covering conditions are a function of fines in the system and not a result of reduced flow velocity. The Sulphur Creek Assessment Report identifies sediment issues below Sulphur Creek Reservoir. The Bear River weighted embeddedness data shows the lowest silt covering immediately above the confluence with Sulphur Creek ("Field") and the highest silt covering at the first station below Sulphur Creek ("State Park"). Silt covering decreases slightly from the "State Park" station to the "Nixon" and then the "Martin Ranch" stations. These data suggest Sulphur Creek is a major source of the sediment in this reach of the Bear River.
The condition of upland, riparian, and instream habitat influences water quality and macroinvertebrate community structure. Habitat quality is strongly related to biological condition and may also limit biological potential (King, 1993a). The qualitative habitat quality assessments for the Bear River covered sample reaches that ranged from 1,600 to 3,300 feet, depending upon wetted width. Thirteen habitat assessment parameters were evaluated within each of these reaches. Evaluation of these parameters allow for a total habitat score ranging from zero to 200 points. High total point scores equate to high quality habitat. Specifics of the individual habitat parameters are contained in King (1993a) and the department's procedures paper *Beneficial Use Reconnaissance Project - Wadable Stream Monitoring Methodology* (WDEQ/WQD, 1998).

Habitat Scores for Bear River stations and the mean and standard deviation of eleven Wyoming Basins reference streams are contained in Table 7. The upstream Bear River "Burton" site had the highest total habitat score, very comparable to Wyoming Basins Reference Condition. The total habitat score at the Bear River "Field" site had the lowest total habitat score. Factors

Table 7. Habitat Scores for the Smiths Fork as Compared with Eleven Wyoming Basins Reference Streams.

Station	Total Habitat Score
"Burton" (WB-42)	154
"Field" (WB-43)	96
"State Park" (WB-44)	117
"Nixon" (WBI-01)	123.5
"Martin Ranch" (WB-45)	119 *
11 Wyoming Basin Reference Conditions Stations (Mean and Standard Deviation)	144 (20.6)

* Evaluated as a Low Gradient Stream

resulting in the low score were associated with the extensive channelization and bank rip-rap work observed in this reach. The total habitat score increased at the Bear River "State Park" site; the extent of channelization was less at this station, however, the degree of silt covering in the sample riffle increased dramatically at this station. The total habitat score increased slightly at the Bear River "Nixon" site; primarily a result of attributes associated with slightly less channelization. The total habitat score at the Bear River "Martin Ranch" station again dropped slightly. This score can not be directly compared with the upstream station scores because of the use of Low Gradient assessment at the site. However, this score is relatively depressed as result of a predominance of fines in the substrate, limited high-quality pool substrate, and bank stability and bank cover conditions on the left (facing downstream) bank.

Pool Quality

Pool quality data, as related to fish habitat, were collected at four consecutive pool habitats above the sample riffles at each assessment station. These data were collected in accordance with the department's procedures paper *Beneficial Use Reconnaissance Project - Wadable Stream Monitoring Methodology* (WDEQ/WQD, 1998). Pool quality scores can range from 0 to 10, with the higher point values representing higher quality pools for fish habitat. Pool quality scores for the four pools at each station are presented in Table 8.

Table 8. Pool Quality Scores, Bear River, 1998.

Station	Pool 1	Pool 2	Pool 3	Pool 4	Mean Score
"Burton"	3	5	6	4	4.5
"Field"	6	NA*	NA*	NA*	6
"State Park"	6	6	5	9	6.5
"Nixon"	5	6	6	2	4.75
"Martin Ranch"	1	6	4	5	4.0

* Only one pool in 2,360-foot assessment reach

In general the moderate scores observed (4 to 6 point range) were the result of good residual pool depths but somewhat limited overhead cover, subsurface cover, and less than desirable substrate composition. Low pool scores (1 to 3 point range) were less than desirable in all qualities. The poor pool substrate in the downstream stations reflects the elevated sediment transport during high flows.

Of note is the fact that only one pool was evaluated in the "Field" sample reach. This was primarily due to the extensive channelization that occurred in this section of river.

Additional Habitat Observations

Observers began noting sedimentation, braiding, point bars, and mid-channel bars beginning at the "State Park" station. These observations support the embeddedness (silt cover) data collected in the sample riffles.

MACROINVERTEBRATE AND BIOLOGICAL CONDITION

Macroinvertebrate samples were taken from riffles at each of the five stations. Eight surber samples were randomly located at each riffle and a composite sample was obtained at each site. Samples were collected and preserved according to WDEQ/WQD bioassessment protocols (King, 1993a).

Macroinvertebrate samples were sent to WDEQ/WQD's contract laboratory (Aquatic Biology Associates, Corvallis, OR) where they were processed and subsampled according to WDEQ/WQD protocol and standard taxonomic effort (King, 1993a). All biological data were evaluated for quality assurance and quality control and met data quality objectives.

Core Metrics

Wyoming Department of Environmental Quality biological, water quality, and physical habitat data from 1992 to 1997 were analyzed to construct a regionally-calibrated multi-metric biotic index (Stribling et al., 2000). This analysis resulted in the delineation of four separate bioregions (areas with similar biological attributes). The Bear River sites fall into the "Basins" Bioregion. Eight core metrics with pronounced discrimination efficiency (degree of separation between metric value distributions of reference and degraded sites) were used to construct the multi-metric biological index (Wyoming Stream Integrity Index). These core metrics for the Bear River stations and the resulting index scorings are presented in Table 9. Total scores above the 25th Percentile of the Basins Bioregion "reference" index data were rated as "good" (61.8 - 80.9) or "very good" (> 80.9). Index score values below the 25th Percentile are rated as "fair" (41.1 - 61.7), "poor" (20.6 - 41.0), or "very poor" (< 20.6). A "good" or "very good" multi-metric rating suggests full support of aquatic life use. A "fair" multi-metric rating suggests partial support and "poor" and "very poor" ratings suggest non-support of aquatic life.

The upstream Bear River bioassessment stations ("Burton" and "Field") scored out under the Wyoming Stream Integrity Index with "good" ratings, suggesting full support of aquatic life use. The three bioassessment stations downstream of Sulphur Creek ("State Park", "Nixon", and "Martin Ranch") scored out with "fair" ratings, suggesting partial support of aquatic life. A detailed analysis of each metric in the index is given after Table 9.

Table 9. Core Metrics. Basins bioregion reference condition metric values; Bear River metric values, metric scores, index scores, and ratings.

Core Metric											
Total Taxa	45	30	66.7	37	82.2	38	84.4	31	68.9	36	80
Ephemeroptera Taxa	9	7	77.8	8	88.9	8	88.9	6	66.7	7	77.8
Plecoptera Taxa	7	7	100	4	57.1	3	42.9	3	42.9	1	14.3
Trichoptera Taxa	10	6	60	9	90	7	70	5	50	5	50
% Plecoptera	16.5	3.58	21.7	4.21	25.5	0.93	5.6	0.54	3.3	0.55	3.3
% Non-insects*	0.04	5	85.2	16.64	69.6	18.55	67.6	27.11	59.4	11.8	75.1
% 10 Dominant*	71	92.67	25.3	84.9	52.1	80.71	66.5	85.7	49.3	88.34	40.2
BCI CTQa*	62.5	57.23	100	73.14	76.6	77	68.1	78.58	64.7	89.47	40.7
Scraper Taxa	8	6	75	8	100	4	50	5	62.5	5	62.5
% Collector - Gatherers*	13	25.36	85.8	39.76	69.2	62.72	42.9	67.8	37	60.4	45.5
Index Score ($\sum$ /10)			69.7		71.1		58.7		50.5		48.9
Rating			Good		Good		Fair		Fair		Fair

* Metric where the trend increases with increasing stress (positive TwI). Higher values indicate a negative response. Reference Condition 5th percentile is utilized to calculate the score for positive TwI metrics.

The total number of taxa generally increases with increasing water quality. An exception are high quality, low productivity mountain streams with naturally low concentrations of dissolved constituents and correspondently low total taxa (and total insect taxa) richness (King, 1993b). The number of taxa in the Bear River increases from the "Burton" to the "Field" sites. The "Burton" site is the closest station to the Uinta Mountains and the increase in taxa numbers may be due to an increase in dissolved constituents as reported in King (1993b). The total number of taxa remains fairly constant between the "Field" and "State Park" stations then drops at the "Nixon" station before recovering at the "Martin Ranch" station. The drop observed at the "Nixon" station may be a result of point source and stormwater contributions to the Bear River in the vicinity of the City of Evanston.

The Order Ephemeroptera (mayflies) contains approximately 700 species in North America. Because of the large number of species, mayflies will normally be found in most samples collected in stream riffles habitats during any time of the year. Their presence in riffle habitats is generally associated with good to excellent water quality while their absence from riffle habitats is a strong indicator of poor water quality (King, 1993b). The functional feeding groupings of mayflies are primarily scrapers, collector gatherers, or shredders. The number of Ephemerotera taxa in the Bear River remain fairly constant at 6 to 8 taxa, slightly less than the reference condition expected number of 9 taxa.

Taxa in the Order Plecoptera (stoneflies) are found in cool, well-oxygenated streams with good to excellent water quality. These taxa are the most sensitive of all aquatic macroinvertebrates to water pollutants and their presence is considered a barometer of good water quality. Because of this, the presence of numerous stonefly taxa and a significant percentage of stonefly density are good indicators of good to excellent water quality (King, 1993b). The number of Plecoptera taxa were greatest at the upper "Burton" station (7 taxa) and decreased consistently down the watershed to the "Martin Ranch" station (1 taxa). These data suggest decreasing water quality (possibly a direct response to sediment increases) as one moves down the Bear River. The percentage of Plecoptera taxa was fairly consistent at the upper two stations ("Burton" and "Field" at 3.58% and 4.21%, respectively) before dropping to below 1% at the "State Park" station and slightly above 0.5% at the lower two stations ("Nixon" and "Martin Ranch"). This metric also suggests a decrease in water quality below the "Field" station.

Taxa of the Order Trichoptera (caddisflies) are commonly found in most aquatic habitats. These taxa should be found in all riffle samples with the exception of streams with very poor water quality. Caddisflies either live in cases or are free-living (without cases). It is not unusual to find from 5 to 10 different types of caddisflies in stream riffles with good water quality (King, 1993b). The number of caddisflies in the Bear River samples ranges from 5 to 9, with the highest number at the "Field" station and the lowest number at both the "Nixon" and "Martin Ranch" locations. These taxa follow a similar pattern as was seen in the Order Plecoptera where numbers first increase (possibly due to increased dissolved constituents as the water moves from the mountains); and then exhibits a steady decline below the confluence with Sulphur Creek, possibly due to degrading water quality.

Non-insect taxa are commonly pollutant tolerant members of the Phyla Annelida (segmented worms) and Platyhelminthes (flatworms), and generally indicate poor water quality. Other non-insect taxa include members of the Phylum Mollusca (Class Gastropoda - snails; and Class Pelecypoda - clams), Phylum Aschelminthes (nematodes), and Class Arachnida (water mites). Nematodes are generally pollutant tolerant taxa while the mollusks and water mites are more moderately pollutant tolerant species. Generally the percentage of non-insects increases with decreasing water quality. The percentage of non-insects in the Bear River consistently increases from a low of 5% at the "Burton" site to a high of 27.11% at the "Nixon" site downstream of the City of Evanston. Between the "Nixon" and the "Martin Ranch" stations, the percentage decreases to 11.8%. The most common non-insect at the "Burton" and "Field" sites was the water mite *Acari* (2.68 of the total 5.0%), a pollution intolerant taxa that is generally an indication of moderate to good water quality (King, 1993b). *Acari* was again the most common non-insect at the "State Park" station with 5.75%; followed closely by moderately pollution tolerant Oligochaeta worm *Specaria josinae* , at 5.01%. The most common non-insect at the "Nixon" station was the pollution-tolerant Oligochaeta worm *Pristina jenkinae*, comprising a significant 20.61% of the sample. Acari was again the most common of 11 non-insect taxa at the "Martin Ranch" station with 5.36%. This lowest site had the most non-insect taxa of any station, including 6 Oligochaeta worm taxa. Again, these non-insect community data indicate decreasing water quality below the "Field" station (above Sulphur Creek). These data suggest the poorest water quality appears to be immediately downstream of the City of Evanston.

The percent contribution of the dominant taxa is an indication of community balance. A community dominated by a single taxon or by relatively few taxa indicates environmental stress due to poor water quality or habitat quality (King, 1993a). The ten dominant taxa in the Bear River goes from a high of 92.67% at the "Burton" station and decrease to the "State Line" station with 80.71%. The percent 10 dominants again increases downstream to the "Martin Ranch" where they comprised 88.94%. The single dominant taxa ranges from a pollution intolerant taxa at the most upstream station, to a pollution tolerant worm at the station immediately downstream of the City of Evanston. The dominant taxa at the "Burton" site was the pollution-intolerant caddisfly *Brachycentrus occidentallis* , a scraper organism comprising 25.18% of the total sample. Again, the dominance by a few, pollution intolerant taxa at this station suggests this metric has a lower score not because of poor water quality, but more likely because very good water quality provides a minimal amount of dissolved constituents and nutrients to the benthic community. The most common taxa at the "Nixon" site was the pollution tolerant Oligochaeta worm *Pristina jenkinae* (20.61%), a taxa in the collector/gatherer functional feeding group.

The Biotic Condition Index (BCI), Actual Community Tolerance Quotient (CTQ a) is the product of values derived from the taxon's tolerance levels to alkalinity and sulfate plus selectivity for or against fine texture substrate materials and low stream gradients. Values range from 2 to slightly greater than 100 with the larger values indicating greater taxon tolerance to pollution (Winget and Mangum, 1979; Platts et. al, 1983). BCI - CTQa values for the Bear River were lowest at the "Burton" station (Value of 57.23 and corresponding metric score of 100) and increased steadily to the "Martin Ranch" station (Value of 89.47 and corresponding metric score of 40.7).

These data suggest the pollution tolerance of the overall benthic community increases steadily from the upstream station to the downstream station.

Scrapers are the functional feeding group of macroinvertebrate taxa that scrape rock, twig, and leaf surfaces for food such as periphyton (King, 1993b). Taxa in this function feeding group tend to be relatively intolerant to stressors such as sediment that reduce or eliminate their feeding areas. The number of scraper taxa observed at the upstream Bear River station ("Burton") was slightly less than observed in reference condition. The low amount of silt covering on the substrate at this station (discussed in the Physical Data section of this report) does not suggest a siltation problem but may be a factor of reduced periphyton at this station due to high quality water naturally low in dissolved contituents coming off the Uinta Mountains. The number of scraper taxa at the "Field" station matched reference condition while the number of scraper taxa below Sulphur Creek dropped significantly. The pattern observed with scraper taxa, with the exception of the "Burton" station discussed above, follows closely what was observed in the weighted embeddedness (silt covering) data discussed in the Physical Data section of this report.

Collector - Gatherers are a functional feeding group of macroinvertebrate taxa that eat decomposing fine organic matter such as decayed plants, leaves and materials in stream bottom sediments. A high percentage of collector - gatherer taxa can be indicative of organic enrichment from vegetative material, manure, or sewage. An increase in this functional feeding group may also indicate increased stream sedimentation (King, 1993b). The percentage of collector - gatherer taxa in the Bear River was lowest at the "Burton" site (25.36 %). The percentage of Collector-gatherers increased to 39.76% at the "Field" site; dramatically increased to 62.72% at the "State Park" site; continued to increase at the "Nixon" station (67.8%, highest percentage observed); and, decreased slightly to 60.4% at the "Martin" The high percentage of collector - gatherer taxa in the Bear River below Sulphur Creek suggests organic enrichment and/or sedimentation in this system. The highest percentage of Collector-gatherers observed below the City of Evanston corresponds with many of the other metric examined.

Additional Metrics

Additional macroinvertebrate metrics, although not shown to have as high a discrimination efficiency as those contained in the core metrics, are useful in explaining the biological conditions of the Bear River. These additional metrics are summarized in Table 10.

The modified Hilsenhoff Biotic Index (HBI) involves summation of the pollution tolerances of organisms into a single value. Tolerance values ranging from 0 to 10 are assigned to each organism contained in the sample. Organisms assigned higher values are more tolerant to organic and possibly nutrient and sediment pollutants. A high HBI value indicates that the macroinvertebrate community is comprised of organisms with greater tolerance to pollutants.

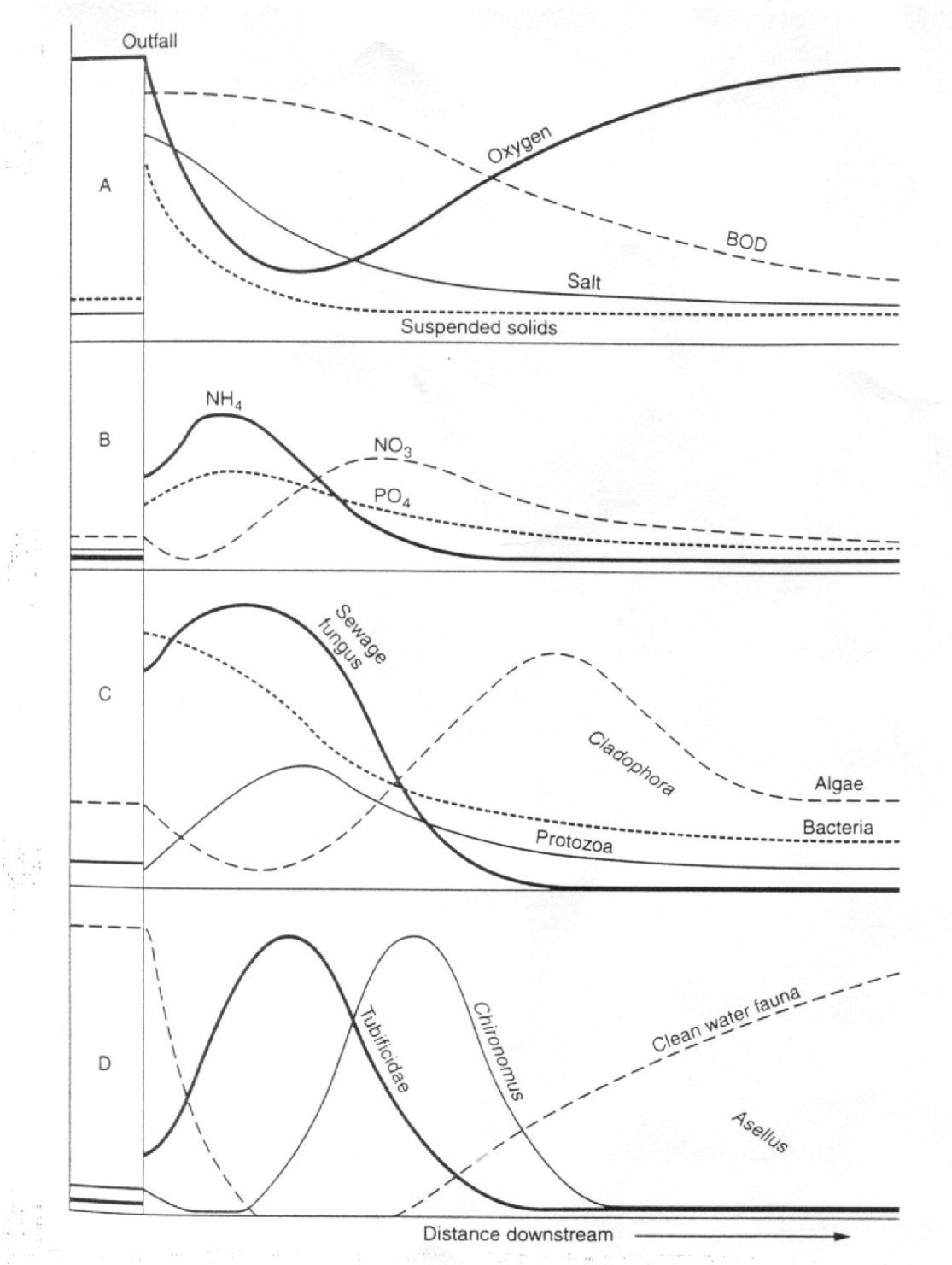
Table 10. Supplemental Metric Values at five upper Bear River stations.

Supplemental Metrics	Metric Value				
	Burton	Field	State Park	Nixon	Martin Ranch
Modified HBI	2.37	3.06	3.34	5.13	3.45
Ratio EPT Taxa / Chironomidae Abundance	125.26	36.91	27.27	2.08	7.72
% Collector - Filterer + % Collector - Gatherers	43.75	60.03	77.01	84.25	86.27
% Hydropsychidae / Total Trichoptera	0.34	0.63	0.60	0.72	0.92
No. Non-Insect Taxa	3	5	7	5	11
Community Loss Index (Lower Stns. to Burton)	NA	0.297	0.368	0.581	0.460
% Multivoltine	15.94	20.41	18.09	35.53	24.17
% Univoltine	54.24	63.15	81.45	63.74	74.91
% Semivoltine	29.82	16.44	0.46	0.72	0.92

King (1993a) provides references and additional discussion on this index. The modified HBI value at the "Burton" station (2.37) is quite low and represents a fairly pollution intolerant community. The HBI values steadily increase downstream and exhibit a dramatic increase between the "State Park" and the "Nixon" stations. This correlates with information presented in the core metrics and suggests a the biological response to gradual decreases in water quality to the City of Evanston followed by a dramatic decreases in water quality below the City of Evanston. The HBI values decrease again between the "Nixon" and "Martin Ranch" stations, and approach the value observed at the "State Park" station. This suggests a possible increase in water quality, most likely in pollutants that show a positive response with increased distance from an organic effluent (ammonia- nitrogen, biological oxygen demand, total suspended solids) (Figure 1)

The ratio of EPT (Ephemeroptera, Plecoptera, and Trichoptera) to Chironomidae abundance is an assessment of community balance. EPT taxa are relatively sensitive to water pollution while Chironomidae (midges) are generally less sensitive and increase in abundance due to increases in organic matter and sediment. A balanced community will have a fairly even distribution of each of the four groups with a substantial representation of EPT taxa (King, 1993a). A greater

Figure 1. Schematic representation of the physical (A), chemical (B), and Biological (C) changes in water quality in a river below a discharge of an organic effluent (*IN:* Mason, 1996 as adopted from Haynes, 1960).



indicates impacts due to water pollution. This ratio for the Bear River "Burton" station was 125.26, indicating more far more EPT taxa than Chironomidae taxa. This ratio drops dramatically to 36.91 and 27.27 at the "Field" and "State Park" stations, respectively. However, these ratios continue to show a dominance of EPT taxa. The ratio takes another significant drop to 2.08 at the "Nixon" station, suggesting an imbalance in the community. The ratio rebounds somewhat to 7.72 at the Martin Ranch. This may be the result of a possible decrease in organic matter at this site. This ratio, although quite balanced with respect to the four Orders examined, remains considerably lower than that observed at the three upstream stations.

The Collector - Filterer functional feeding group consists of those taxa that eat fine particulate material suspended in the water by filtering the food from the water. Examples of Collector - Filterer feeding group taxa are mosquitoes and blackflies. Like Collector - Gatherer taxa, a high percentage of Collector - Filterer taxa is an indicator of organic enrichment from manure and/or sewage and increased sedimentation (King, 1993b). The combined percentage of Collector-Filterers plus Collector-Gatherers When combined with the Collector - Gatherer functional feeding group, these two function feeding groups comprise 43.75 % of the organisms at the "Burton" site to an extremely high 86.27 % of all the organisms collected at the downstream-most "Martin Ranch" station. Again, these data suggest organic matter contributions increase in the system from upstream to downstream.

Percent Hydropsychidae to total Trichoptera is a metric that measures the density of the generally mild pollution tolerant Hydropsychidae family (primarily filtering collectors) to the density of total Trichoptera (relatively sensitive to water pollution)(King, 1993a). King (1993a) assigns the highest biological score to samples where density of Hydropsychidae is less than 20% of the total Trichoptera. Hydropsychidae comprise 34% of the Tricoptera at the "Burton" station. The percentage increase to 63% at the "Field" station, drops slightly to 60% at the "State Park" station, increases up to 72% at the "Nixon" station, and takes a dramatic increase to 92% at the "Martin Ranch" station. These data indicate that the composition of the Order Tricoptera in being dominated by the more pollution-tolerant Hydropsychidae at the lower stations.

As discussed earlier, non-insect taxa are commonly pollutant tolerant members of the Phyla Annelida (segmented worms) and Platyhelminthes (flatworms), and generally indicate poor water quality. Other non-insect taxa include members of the Phylum Mollusca (Class Gastropoda - snails; and Class Pelecypoda - clams), Phylum Aschelminthes (nematodes), and Class Arachnida (water mites). Nematodes are generally pollutant tolerant taxa while the mollusks and water mites are more moderately pollutant tolerant species. Generally the number of non-insect taxa increases with decreasing water quality. The number of non-insect taxa was 3 at the "Burton" station. The number of non-insect taxa increases slightly downstream to the "Nixon" station (5 taxa), before increasing dramatically to 11 at the "Martin Ranch" station. Again, this increasing trend suggests a decrease in water quality through the system.

The Community Loss Index compares macroinvertebrate communities at two locations where at least one location represents a reference or control. The index measures the loss of taxa between

the reference location and the comparison location with index values increasing as the degree of dissimilarity with the reference location increases. Low community loss index score values indicate little taxa loss between stations. King (1993a) provides additional discussion on the

specifics of this index. The macroinvertebrate community in the lower four Bear River stations was compared with the community in the upper-most "Burton" station. The Community Loss Index increases from the "Field" to the "Nixon" stations and then decreases slightly at the "Martin Ranch" station. Although these values show a trend that is supported by other metrics data, the actual values show a slight (<0.5) to moderate (0.5 - 1.5) community loss (King, 1993a).

Community voltinism is a measure of the distribution of taxa with various life cycle requirements. Multivoltine taxa are those that exhibit several life cycles during a single year. Univoltine taxa are those requiring a year to complete a single life cycle, while semivoltine taxa are those that require several years to complete a life cycle. An even distribution of these three assemblages suggests a stable community. The dominance of multivoltine taxa suggest possible seasonal degradation of water quality or periodic pulses of pollutants through the system have limited the survival of univoltine and semivoltine taxa. The percentage of multivoltine organisms in the Bear River increases from between the "Burton" to the "Nixon" stations, where the highest percentage (35.53%) was observed. Contrasting to those values, the percentage of semivoltine taxa drops dramatically to less than 1% at the "State Park", "Nixon", and "Martin Ranch" stations. These data do not suggest a stable community with respect to life cycle assemblages below the "Field" station, above Sulphur Creek. The low percentage of semivoltine taxa below Sulphur Creek suggest that some environmental condition(s) in the Bear River are not suitable for survival of long-lived organisms.

ANCILLARY AND HISTORICAL DATA

Chemical Data.

The Wyoming Department of Environmental Quality conducted bioassessments at four Bear River locations between 1994 and 1996. Water chemistry data were collected at station WBI-06 (located immediately downstream of the 1998 "Burton" station) in 1994, 1995, and 1995. Bioassessment stations WBI-07 (immediately downstream of 1998 "Field" station), WBI-01 ("Nixon" station), and WBI-18 (1.5 miles downstream of "Nixon" station) were all sampled in 1994. Results of these samples are presented in Table 11.

These historic WDEQ water quality data are very comparable to the results obtained during the 1998 assessment. Of particular interest are the downstream increase in chlorides and sulfates and the occasional measurable levels of nitrate nitrogen.

Table 11. WDEQ Water Quality Parameters and Results*, Bear River, 1994 - 1996.

Parameter (units)	WBI-06	WBI-06	WBI-06	WBI-07	WBI-01	WBI-18
Day (mo/day/yr)	10/11/94	10/05/95	09/24/96	10/11/94	10/11/94	10/13/93
Time (hours)	1,122	1,015	1,105	1,415	1,622	1,555
Temperature (°C)	7.3	2.0	10.7	10.6	9.4	10.4
pH (Standard Units)	8.1	8.3	8.3	8.1	8.6	8.1
Conductivity (µS/cm)	195	262	213	223	363	421
Dissolved Oxygen (mg/l)	8.1	9.0	8.3	8.0	9.4	8.2
Turbidity (NTU)	1.0	1.8	1.5	0.7	1.6	1.4
TSS (mg/l)	1.0	1.0	1.2	3.0	3.0	4.0
Alkalinity (mg/l)	82	104	108	100	146	167
Chlorides (mg/l)	< 5	< 5	< 5	< 5	13	18
Sulfate (mg/l)	<10	< 10	< 10	< 10	13	18
Total Hardness (mg/l)	70	108	108	88	142	161
Total Phosphorus (mg/l)	< 0.1	<0.1	<0.1	< 0.1	0.1	< 0.1
Nitrate Nitrogen (mg/l)	< 0.1	0.12	< 0.1	< 0.1	0.2	0.1

* 1994 Data are characterized as "historical" because of being collected more than 5 years prior to this assessment report.

Water chemistry data have historically been collected at numerous United States Geological Survey gaging stations, Wyoming DEQ locations, and Wyoming Water Resources Center locations on the Bear River. Stations (from south to north) include: Station 411526110554701 - Bear River at Hospital Bridge (1988 - 1989); Station 1199 - Bear River below Sewage Outfall (1977); Station 10016900 - Bear River at Evanston (1986 - 1989); Station 30 - Bear River at Wyoming 89 Bridge (1967 - 1972); Station 411826111002001 - Bear River above Yellow Creek (1988 - 1989); Station 10018900 - Yellow Creek at Mouth (1983 - 1989); Station WRDS-03309 - Bear River 13.5 Miles North of Evanston; and, Station 10020100 - Bear River above Woodruff Narrows Reservoir (1985 - 1997).

A synopsis of some of the historic water quality data from seven of those gaging stations is found in Table 12.

Table 12. Historical water quality chemistry data collected at various Bear River locations. 1967 - 1989.

Parameter							
pH (s.u.)							
Mean	7.96	8.21	7.95		8.40	8.30	
Max.	8.42		8.40		8.50	8.80	
Min.	7.50		7.50		8.30	7.90	
No.	2	1	2		2	41	
EC (uS/cm)							
Mean	205.5	310	257.5		250.0	700.12	
Max.	259.0		355.0		350.0	900.0	
Min.	152.0		160.0		150.0	400.0	
No.	2	1	2		2	41	
Temperature (°C)							
Mean	6.25		7.42		10.33	8.44	
Max.	10.0		11.0		13.0	23.0	
Min.	0.5		0.5		4.0	0.0	
No.	6		6		6	41	
NH_4 (mg/l)							
Mean	0.03	0.08	0.04		0.02	0.12	0.15
Max.	0.03		0.09		0.02	0.87	0.44
Min.	0.02		0.02		0.01	0.01	0.02
No.	2	1	3		2	41	4
$NO_2 + NO_3$ (mg/l)							
Mean	0.1	< 0.1	0.1		0.10	0.65	0.02
Max.	0.1		0.29		0.10	4.80	0.03
Min.	0.1		<0.1		0.10	0.10	<0.01
No.	2	1	3		2	41	
Total Phos. (mg/l)							
Mean	0.01		0.10		0.01	0.56	0.12
Max.	0.01		0.29		0.01	0.04	0.32
Min.	0.01		<0.01		0.01	3.40	0.02
No.	2		3		2	41	4
Fecal Coliform Bact. (cfu/100ml)							
Mean		500		3299.37		103.78	
Max.				16000		360.0	
Min.				11		9.0	
No.		1		46		41	

Table 12 (cont.). Historical water quality chemistry data collected at various Bear River locations. 1967 - 1989.

Parameter							
Chloride (disslv.) (mg/l)							
Mean	2.95		4.15		4.50		
Max.	3.8		6.0		6.50		
Min.	2.1		2.3		2.50		
No.	2		2		2		
Sulfate (disslv.) (mg/l)							
Mean	10.5	18.52	11.0		11.0		
Max.	15.0		16.0		16.0		
Min.	6.0		6.0		6.0		
No.	2	1	2		2		
TSS (mg/l)							
Mean	108.14	32.0	90.43		148.85		
Max.	286.0		240.0		410.0		
Min.	10.0		9.0		12.0		
No.	14	1	14		13		
TSS (tons/dayl)							
Mean	181.17		156.38		262.69		
Max.	691		622		794.0		
Min.	3.3		3		4.0		
No.	14		14		13		

Several of these historical water quality data sets (pH, temperature, electrical conductivity, and total suspended solids) are quite similar to monitoring data observed on the Bear River. Nutrients data (nitrogen compounds and total phosphorus) in this historical data set suggest that Yellow Creek was a significant nutrient contributor to the Bear River system. Historical fecal coliform bacteria data show a significant bacteria load in the Bear River below the City of Evanston sewer outfall. Waste water treatment during that period likely consisted on primary treatment only, and these data illustrate the significant improvements in waste water treatment in the past 30 years.

More recent water quality data (1985 to present) have been collected at the USGS Bear River Above Reservoir gaging station (Station 10020100). The most recent data (1996 - 2000) have already been discussed in the Chemical data section of this report. Historic water quality data (1985 - 1995) are presented in Table 13.

Table 13. Historic water chemistry data, USGS Station 10020100. Bear River Above Woodruff. 1985 - 1995.

Parameter	No. of Samples (Dates)	Mean	Maximum (Date) Discharge	Minimum (Date) Discharge
pH (s.u.)	30 (1985-95)	8.28	8.8 (03/22/94) 262 cfs	7.6 (08/24/88) 1.0 cfs
EC (uS/cm)	42 (1985-95)	422.8	730 (11/01/88) 7.2 cfs	145 (06/27/95) 2000 cfs
Temp. (°C)	46 (1985-95)	9.51	23 (07/18/92) 84 cfs	0.0 (numerous, winter) 6.5 - 140 cfs
Total Ammonia (mg/l)	21 (1985-89)	0.06	0.22 (02/01/89) 6.50 cfs	< 0.01 (08/24/88) 1.0 cfs
Total $NO_2 + NO_3$ (mg/l)	21 (1985-89)	0.31	2.60 (11/01/88) 7.2 cfs	< 0.1 (numerous)
Total Nitrogen (mg/l)	2 (1985-86)	1.05	1.10 (11/20/85) 140 cfs	1.00 (01/07/86) 130 cfs
Total Phosphorus. (mg/l)	34 (1985-92)	0.17	2.30 (11/01/88) 7.2 cfs	< 0.03 (6 observations) 5.1 - 870 cfs
Fecal Coliform Bacteria (cfu/100ml.)	21 (1985-89)	55.76	120 (05/06/86) 1726 cfs	8 (01/08/87) no data for discharge
Chloride (mg/l)	32 (1985-95)	19.6	41.0 (10/27/92) 5.1 cfs	2.6 (06/27/95) 2000 cfs
Sulfate (mg/l)	32 (1985-95)	22.9	42.0 (04/03/90) 138 cfs	2.5 (06/27/90) 244 cfs
TSS (mg/l)	25 (1989-95)	116.2	490.0 (06/15/93) 1030 cfs	1.0 (09/12/90) 7.1 cfs

These historical water quality data from the Bear River above Woodruff Narrows Reservoir are typical of what would be expected in this system. Dissolved constituents (as measured by electrical conductivity, total chloride, and total sulfate) are highest during low flows in the summer and fall.

Fecal coliform bacteria and total suspended solids were both highest during high flows observed in the spring. This suggests that these two pollutants are related to overland flow contributions into the system, transport of sediment from the streambanks (TSS), re-suspension of sediment and bacteria from the channel bottom, or a combination of all three scenarios.

The Wyoming Game and Fish (Miller, no date) provides some information on the historic water quality in Woodruff Narrows Reservoir. That report states: "*The water is usually turbid because of wind action and inflowing silt. Secchi disk readings vary from 1.3 to 4.3 feet*."

The highest water temperatures were observed in the summer months. However, maximum water temperatures were relatively moderate with only 3 of the 46 observations being greater than 20 °C.

Total ammonia values were highest in winter (November through March) when water temperatures were at 0.0 ° C. Total ammonia is comprised of the un-ionized (NH_3) and ionized (NH_4^+) forms. Toxicity is related to the un-ionized component, and is both temperature and pH related (with a high temperature coupled with a high pH resulting in the most toxic conditions). The low temperature and slightly elevated pH values (around 8.2 standard units) results in a moderate ammonia toxicity during these periods.

Nitrate →nitrite nitrogen values were highest (>0.4 mg/l) between the months of November and February. In 5 of 6 observations, the water temperature was 0.0 ° C. The elevated nitrate →nitrite nitrogen and total ammonia levels observed at cold water temperatures are likely due to reduced nitrification via the bacteria *Nitrosomonas* and less nitrate update by aquatic vegetation.

Eighteen of the 34 total phosphorus samples (53%) exceeded the 0.05 mg/l threshold recommended by King (1993a) for waters entering a lake or reservoir. Five of those samples exceeded 0.20 mg/l. Two of those five highest total phosphorus levels occurred during the winter during very low flows (6.5 and 7.2 cfs). These suggest an upstream phosphorus loading not associated with sediment transport. The fact that these observations were made during winter may be the result of decreased aquatic plant activity that normally would be using this nutrient for growth. The remaining three elevated phosphorus observations occurred during moderate to high stream flows, suggesting phosphorus loading associated with sediment transport.

These elevated phosphorus values have been described as a factor in the water quality in Woodruff Narrows Reservoir. The Wyoming Game and Fish (Miller, no date) reports: *"Blooms of Aphanizomenon and Anabaena have occurred in the reservoir. Oxygen sags have occurred, but no fish kills have been reported. The National Eutrophication Survey indicates the reservoir*

is eutrophic because of excessive amounts of phosphorus in the inflowing water." *Aphanizomenon* and *Anabaena* are cyanobacterial plankton. Large populations of cyanobacteria can produce sufficient toxins to kill fish, especially when phosphorus becomes limited (Mason, 1996).

Biological Data.

Four WDEQ historic bioassessment stations were established on the Bear River as part of the Reference Stream Project in 1994. The upper-most 1994 station (WBI-16) was established immediately upstream of the "Burton" station. This station was again sampled in 1995 and 1996. A comparison of the 1994 - 1996 data for Station WBI-16, along with the 1998 data for the "Burton" station provide a temporal analysis of the changes and variability of the benthic community at a single bioassessment station over a period of 5 years.

In general, all years' data at this upper-most station in Wyoming's portion of the Bear River watershed show a "good" condition. WSII total scores range from 62.2 (1995) to 72.3 (1996). The variability is scores could be attributed to a lesser number of Ephemeroptera and scraper organisms observed in 1995. This could be a result of natural life cycle variability of this order, or possibly the random sample locations in 1995 were located in slightly more less-desirable habitats. Overall, these data support the notion that the upper-most station in the Bear River assessment is in a WSII "good" category, and supports designated uses.

Four WDEQ historic bioassessment stations were established spatially along the Bear River as part of the Reference Stream Project in 1994. These stations were: WBI-16 (immediately upstream of the 1998 "Burton" station), WBI-17 (immediately downstream of the 1998 "Field" station, above Sulphur Creek confluence), WBI-01 (the same location as the 1998 "Nixon" station), and WBI-18 (approximately 1 mile downstream of the "Nixon" station). The results of the 1994 sampling are summarized in Table 15.

In general, the 1994 data show the same biological trends as was observed during the 1998 assessment of the Bear River. The two stations above Sulphur Creek had WSII ratings of "good" (scores of 70.5 and 72.1). WSII ratings dropped to "fair" below the City of Evanston, where scores of 48.1 and 45.9 were observed). Similar to the 1998 data, the downstream stations showed a loss of Plecoptera taxa, an increase of the non-insect component, and an increase of the collector-gatherer function feeding group. These characteristics were discussed earlier in this document, but indicate a loss of "clean water" taxa and a corresponding increase in taxa that are stimulated by sediment and nutrient enhancement.

Table 14. Core Metrics. Basins bioregion reference condition metric values; Upper Bear River Station metric values, metric scores, index scores, and ratings. 1994 - 1996, 1998.

Core Metric									
Total Taxa	45	37	82.2	33	73.3	42	93.3	30	66.7
Ephemeroptera Taxa	9	6	66.7	5	55.6	7	77.8	7	77.8
Plecoptera Taxa	7	4	57.1	5	71.4	4	57.1	7	100.0
Trichoptera Taxa	10	9	90.0	7	70.0	11	100.0	6	60.0
% Plecoptera	16.5	3.33	20.2	2.93	17.8	3.15	19.1	3.58	21.7
% Non-insects*	0.04	7.97	80.3	6.04	83.3	8.87	79.0	5.0	85.2
% 10 Dominant*	71	85.83	48.9	89.41	36.5	85.84	48.8	92.67	25.3
BCI CTQa*	62.5	69.49	84.6	72.97	77.0	74.68	73.2	57.23	100.0
Scraper Taxa	8	6	75.0	3	37.5	6	75.0	6	75.0
% Collector - Gatherers*	13	12.97	100.0	13.54	99.4	13.19	99.8	25.36	85.8
Index Score ($\sum$/10)			70.5		62.2		72.3		69.7
Rating			Good		Good		Good		Good

* Metric where the trend increases with increasing stress (positive TwI). Higher values indicate a negative response. Reference Condition 5th percentile is utilized to calculate the score for positive TwI metrics.

Table 15. Core Metrics. Basins bioregion reference condition metric values; Historic Bear River Stations metric values, metric scores, index scores, and ratings. 1994.

Core Metric	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total Taxa	45	37	82.2	55	100.0	42	93.3	38	84.4
Ephemeroptera Taxa	9	6	66.7	9	100.0	6	66.7	5	55.6
Plecoptera Taxa	7	4	57.1	3	42.9	0	0.0	0	0.0
Trichoptera Taxa	10	9	90.0	8	80.0	6	60.0	6	60.0
% Plecoptera	16.5	3.33	20.2	1.28	7.8	0	0.0	0	0.0
% Non-insects*	0.04	7.97	80.3	35.73	51.9	61.09	31.4	22.08	64.1
% 10 Dominant*	71	85.83	48.9	60.84	100.0	78.22	75.1	89.04	37.8
BCI CTQa*	62.5	69.49	84.6	83.05	54.8	85.52	49.4	91.03	37.3
Scraper Taxa	8	6	75.0	10	100.0	5	62.5	7	87.5
% Collector - Gatherers*	13	12.97	100.0	27.02	83.9	63.1	42.4	72	32.2
Index Score (∑/10)			70.5		72.1		48.1		45.9
Rating			Good		Good		Fair		Fair

-18, 1994

* Metric where the trend increases with increasing stress (positive TwI). Higher values indicate a negative response. Reference Condition 5th percentile is utilized to calculate the score for positive TwI metrics.

Physical Data.

The historical WDEQ 1994 bioassessment data were also reviewed for percent fines (sand, silt, and clay) in the substrate. Those data are summarized in Table 16. In general, the percent fines observed in the substate in 1994 increased from upstream to downstream. The upstream-most station had 0% fines, while the lower-most site (Station WBI-18, near Almy) had the most fines at 12%. These data support the historic benthic macroinvertebrate data that indicate a shift from "clean water" taxa to those that tolerate sediment enhancement.

Table 16. Historic (1994) Bear River Physical Data (Percent Fines).

	WBI-16 (Above Mill Creek)	WBI-17 (Above Sulphur Creek)	WBI-01 (Below Evanston)	WBI-08 (Near Almy)
Percent Fines	0	2	4	12

Other Historical Information.

Dorn (1986) provides a collection of historical accounts of the Wyoming landscape in the period (1805 - 1878) prior to significant settlement by humans of European descent. This collection includes several accounts of the Bear River in the vicinity and upstream of present-day Evanston, Wyoming.

1. In July, 1850, Madison Moorman passed through the area enroute to the California gold fields and observed that along the Bear River "*the grass was pretty good*... [and] *a narrow strip on the bank of the river is heavily timbered with cottonwood*." This account suggests cottonwood tree dominated riparian zone common to what is observed on the Bear River in the vicinity of Evanston, Wyoming today.

2. In August, 1856, J. Robert Brown also passed through the area near present-day Evanston enroute to California and reported the "*Bear River is about 2 rods* [33 feet] *wide, and excellent water; the grass luxuriant ... I brought in two small trout*." The two small trout caught by Brown would be Bonneville cutthroat trout (*Oncorhynchus clarki utah*).

3. James Simpson, an army topographical engineer, was in this area from August to October, 1859. At a location somewhere in between the WDEQ "Burton" and "Field" stations, Simpson made the following observations: "*My party caught some fine trout in it* [Bear River]. *A grove of cottonwood and willows, interspersed with some fir trees and pines, characterizes it at the crossing. An abundance of grass is to be found on this stream*..." Again, the trout caught by the Simpson party would be Bonneville cutthroat trout.

4. In 1873 a party was surveying the southern boundary of the Wyoming Territory. W.A. Richards, a member of that party, made the following observations of the Bear River and Mill Creek in the vicinity of the state's southwest corner. "*The bottoms bordering each stream* [Mill Creek and the Bear River] *are about 30 chains* [1,980 feet] *wide, and covered with a heavy growth of willow, but a present are not marshy. The streams are clear, swift running with gravel bottom*..." Again, this description suggests a wide valley bottom with a well-developed riparian zone. The stream type and channel bottom in 1873 appear to be similar to what was seen at the upper Bear River and the Mill Creek assessment stations in 1998.

The Wyoming Game and Fish Department comprehensive survey of the Bear River drainage (initiated in 1966 and completed in the late 1970's) describes the reaches of the Bear River covered by this assessment report. That survey (Miller, no date) describes the reach from the Utah / Wyoming state line downstream to slightly upstream of the confluence with Sulphur Creek:

> *"The flows are regulated only slightly by Whitnery Reservoir in Utah. Water is diverted from this section of the river for irrigation and for domestic use by the City of Evanston. The river has been channelized in several areas, and the fisheries has deteriorated because of it. Water temperatures approach 70°F (20°C) during the summer... Non-game fish are present in moderate numbers and include Utah suckers, mountain suckers, bluehead suckers, Utah chubs, red-side shiners, leatherside chubs, dace, and sculpins... Trout present include mostly native Bonneville cutthroat trout even though Snake River cutthroat trout have been planted in the past along with some rainbow and brown trout."*

Miller's report (no date) goes on to describe the reach from above Sulphur Creek confluence to Woodruff Narrows Reservoir:

> *"This section of the river suffers from high flows during the spring runoff, and then very low flows during late summer and fall... Riparian vegetation includes grasses, shrubs, willows, and some cottonwoods. Bottom material is mostly gravel, with silt present in pool areas... The stream has been channelized, straightened, and dammed in order to obtain irrigation water, and "protect" private property... Non-game fish dominate the fish populations. Species present include Utah chubs, Utah suckers, bluehead suckers, mountain suckers, dace, sculpins, redside shiners, and leatherside chubs... Trout are found in low numbers and include mostly Bonneville cutthroat and brown trout. Whitefish are also present in low to moderate numbers. Past stocking records show that Snake River cutthroat, brown, rainbow, and brook trout have all been stocked..."*

Appendix 3 of Miller's report (no date) provides electrofishing results in the Bear River. Several stations were sampled in August, 1972 and provide a synopsis of fish composition in the assessment reach covered by this report. Those data are reproduced in Table 14. Fish diversity appears to increase from the upper-most station (near the WDEQ "Burton" station) to below the confluence with Sulphur Creek. This is due primarily to an increased number of non-game fish

species being collected. The species diversity then shows signs of decrease to the station immediately above Woodruff Narrows Reservoir. Trout abundance increases from the upper location (immediately below the WDEQ "Burton" Station) to the next downstream location (immediately below the WDEQ "Field" Station). Trout abundance then shows a dramatic decrease below Sulphur Creek confluence followed by another dramatic decrease below the City of Evanston, before finally losing presence immediately above Woodruff Narrows Reservoir.

Table 14. Wyoming Game and Fish Electofishing Data, Bear River, August, 1972 (Miller, no date).

Location	Date	Distance Sampled	Estimated Trout/Mile	Species and Number or Frequency
0.5 Mile Below Chalk Creek Crossing (Below WDEQ "Burton" Station.)	08/02/72	500 ft.	85	Bonneville Cutthroat - 3 Snake River Cutthroat - 5 Utah Chub - Present Bluehead Sucker - Present Redside Shiner - Present Sculpins - Present
Myers Hwy. Bridge (Below WDEQ "Field" Station)	08/23/72	300 ft.	106	Bonneville Cutthroat - 6 Mountain Whitefish - Numerous Utah Chub - 1 Redside Shiner - Numerous Dace - Present Sculpins - Present Mountain Sucker - Numerous Leatherside Shiner - Present
Below Sulphur Creek	08/22/72	1200 ft.	48	Bonneville Cutthroat - 11 Mountain Whitefish - Numerous Utah Sucker - Numerous Utah Chub - Numerous Bluehead Sucker - Present Redside Shiner - Numerous Dace - Present Sculpins - Present Mountain Sucker - Present
2 Miles Below Evanston (Above WDEQ "Nixon" Station)	08/23/72	500 ft.	21	Bonneville Cutthroat - 2 Utah Sucker - Numerous Utah Chub - Present Bluehead Sucker - Present Redside Shiner - Present Dace - Present Sculpins - Present
Above Woodruff Narrows Reservoir (Below WDEQ "Martin Ranch" Station)	08/04/72	500 ft.	None	Utah Sucker - 4 Utah Chub - Common Redside Shiner - Numerous

SUMMARY AND CONCLUSIONS

Classification

The Bear River from Woodruff Narrows upstream to the Utah / Wyoming state line is correctly classified as a Class 2, Coldwater game fish waterbody. This conclusion is based on Wyoming Game and Fish Department fisheries data collected in August, 1972. These data indicate the presence of Bonneville cutthroat trout, Snake River cutthroat trout, and mountain whitefish in this reach of the Bear River. Historical accounts for the Bear River prior to major settlement by people of European descent report the presence of trout in the Bear River. This reach is properly classified as a Class 2AB under the definitions provided in the 2001 Chapter 1, Rules and Regulations.

Water Quality

Water quality data collected on the Bear River by the WDEQ during this assessment (October 20, 1998) did not identify the exceedence of any numeric water quality standard. These data did indicate that concentrations of various parameters (electrical conductivity, alkalinity, chloride, sulfate, and total hardness) increase from upstream to downstream in this system. Overall, suspended sediment (as measured by turbidity and total suspended solids) increases from upstream to downstream. The exception to this general trend is at the "State Park" station where both EC and TSS are highest, presumably due to influences attributed to Sulphur Creek (see WDEQ/WQD assessment report on Sulphur Creek for details on this tributary).

U.S.G.S. water quality monitoring data (less than 5-years old) has been collected at the gaging station above Woodruff Narrows Reservoir. These data indicate that nutrients (ammonia, nitrate nitrogen, and ortho phosphorus) transport is occurring in the system. The U.S.G.S monitoring data also indicate a considerable amount of sediment is transported by the river during high, spring flows.

Foam was observed on the water surface in pool areas at the "Nixon" and "Martin Ranch" stations, supporting the notion of nutrient enhancement.

Physical Habitat

Weighted embeddedness (silt cover on gravels and cobble) data indicated that the two upper stations ("Burton" and "Field") were relatively free of a silt covering. Silt cover increased dramatically at the "State Park" station (downstream of Sulphur Creek confluence). Silt cover remained high at the lower two stations ("Nixon" and "Martin Ranch").

Habitat scores at the upper "Burton" station were very comparable with reference condition. Habitat scores drop significantly at the "Field" station, primarily due to extensive, historic channelization at this location. Habitat scores rebound slightly at the "State Park", "Nixon", and

"Martin Ranch" stations, primarily due to a lesser amount of historic channelization activity. Habitat scores at these three lower stations were lower than reference condition, primarily due to sediment in the sample riffles and pools, bank stability conditions, and disruptive pressures adjacent to the channel.

Moderate pool quality scores were observed in the Bear River. Residual pool depths were generally good, and factored into bringing the scores up. Pools generally had less than desirable substrate, with the amount of fines (silt) in the pools being much more pronounced in the lower stations. Limited overhead cover and subsurface cover were also observed in the Bear River pool habitats.

Macroinvertebrates and Biological Condition

Wyoming Stream Integrity Index (WSII) scores for the two upstream stations ("Burton" and "Field") indicate that these two stations do not differ significantly from reference condition. WSII scores at the three lower stations ("State Park", "Nixon", and "Martin Ranch") decrease dramatically from the upstream stations, and show a definite deviation from reference condition.

Core metrics that exhibited a defined scoring decrease from upstream to downstream were: Plecoptera Taxa, Trichoptera Taxa, Percent Plecoptera, BCI CTQ $_a$, Scraper Taxa, and Percent Collector - Gatherer. The pattern observed in these core metrics is reflective of a system where clean-water taxa and functional feeding group are replaced by taxa and functional feeding groups that are sediment tolerant and respond to nutrient enrichment. These biological data support the water quality and physical habitat evidence discussed above.

Supplemental metrics such as: Ratio EPT Taxa / Chrionomidae Abundance, Percent Collector Filterer plus Percent Collector Gatherer, Percent Hydropsychidae to Total Trichoptera, Number of non-insect taxa, Percent Multivoltine Taxa, and Percent Semivoltine Taxa all support the conclusion of sediment and nutrient enrichment represented in the Core Metrics.

Historical and Ancillary Information

Historical water quality data indicate that the Bear River exhibits elevated sediment transport during high spring flows. Additionally, nutrient transport (ammonia, nitrate nitrogen, and total phosphorus) has historically been observed both during high and low flow periods. This suggests that nutrients have been added to the system not only through runoff, overland flow, and the erosional process; but also via some type of "constant supply" mechanism (point and/or non-point sources). Historical information for Woodruff Narrows Reservoir discuss algae blooms and oxygen sags in the reservoir indicating a eutrophic condition. The source of this reservoir eutrophication was suggested to be excessive phosphorus delivery from inflowing waters.

Historical macroinvertebrate data collected by the WDEQ as part of the reference stream project (1994-1996) allow a historical analysis of biological data from both temporal and spatial aspect.

Four year's data at the upper-most station define the extent of natural variability at a specific location. The WSII scores at this location were all in the "good" category for these four years. Spatially, four stations along the reach were established in 1994. The biological data from these stations followed the same trends that were observed in the 1998 assessment data. Stations above Sulphur Creek rated out as "good", while the two stations located below the City of Evanston rated as "fair." The relationships observed in the 1998 were also observed in the 1994 data; those being the decrease of "clean water" taxa and functional feeding groups and the increase of non-insect and pollution-tolerant taxa and function feeding groups from upstream to downstream.

Historical observations indicate that the Bear River supported native trout prior to significant settlement by people of European descent. Wyoming Game and Fish data indicate that the Bear River supported coldwater game fish in 1972.

FINAL ASSESSMENT AND SIGNATURES

Review of the chemical, biological, and physical data collected on the Bear River on October 20 and 21, 1998 indicate that the Bear River is a Class 2 (cold water) waterbody under current WDEQ/WQD Rules and Regulations (WDEQ, 2000).

These data suggest that the Bear River is fully supporting all designated uses from the Utah / Wyoming state line downstream to confluence with Sulphur Creek. These data also suggest that the Bear River is only partially supporting the designated use of "Protection and Propagation of Fish and Wildlife", specifically coldwater game fish from the confluence of Sulphur Creek downstream to Woodruff Narrows Reservoir. The stressors that result in this partial support recommendation include sediment and nutrients. The causes of these stressors are Sulphur Creek contributions and undetermined land uses between Sulphur Creek and Woodruff Narrows Reservoir. A weight-of-evidence review of the chemical, biological, physical, and historical data was used to make this decision. This decision is based on the following items:

Bear River Above Sulphur Creek Confluence

Items identifying full support of designated uses (in order of significance):

1. Quantitative biological data that do not show a significant departure from reference condition;
2. Supplemental quantitative biological data that support the conclusions brought forth in the core metrics;
3. Semi-Quantitative physical data (weighted embeddedness) that do not indicate a sedimentation problem on riffle substrate;
4. Quantitative water chemistry data that do not indicate a water quality stressor at base flow conditions; and,
5. Historical information indicating the support of a cold water game fish population.

Items contrary to full support of designated uses (in order of significance):

1. Qualitative habitat data that indicate a depressed habitat score immediately upstream of Sulphur Creek, due primarily to historic channelization.

The single item that is contrary to the evidence suggesting full support is not of sufficient weight to alter this recommendation.

Bear River From Sulphur Creek to Woodruff Narrows Reservoir

Items identifying partial support of "Protection and Propagation of Fish and Wildlife" designated use (in order of significance):

1. Quantitative biological data that show a significant departure from reference condition;
2. Supplement quantitative biological data that support the conclusions brought forth in the core metrics;
3. Semi-Quantitative physical data (weighted embeddedness) that show increased sedimentation on sample riffles;
4. Quantitative water quality monitoring data (U.S.G.S.) that show significant sediment transport in the system during high flows;
5. Historic quantitative biological data that show similar trends in metric response as seen in the 1998 sampling;
6. Historic quantitative water quality data that show nutrient and sediment loading in the system;
7. Historic quantitative fisheries data that show declining cold water game fish density and composition from upstream to downstream; and,
8. Historic algae blooms and oxygen sags observed in Woodruff Narrows Reservoir as a result of phosphorus inputs to that reservoir.

Items contrary to the Partial Support of "Protection and Propagation of Fish and Wildlife" designated use recommendation (in order of significance):

1. Quantitative water quality data that do not identify water quality stressors under base flow conditions.

The single item that is contrary to the evidence suggesting partial support is not of sufficient weight to alter this recommendation.

SIGNATURES

Sampler (signature and printed name)	Date
Sampler (signature and printed name)	Date
Sampler (signature and printed name)	Date
Monitoring Supervisor (signature and printed name)	Date

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