

### 3.2 Water Quality

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As already discussed in Section 3.1, in the watershed there are many uses of water. And these uses, while they require adequate water quantity, most often also require good water quality. Drinking and domestic water supplies, irrigation water, and water that provides habitat for wildlife are all dependent on good water quality. In addition, water quality is valued for water-based recreation activities, and overall quality of life – which translates into healthy water resources for the people that live in and visit the watershed, as well as its biotic communities. Water quality in the Roaring Fork Watershed has been monitored for over five decades and many studies have been conducted looking at water quality and related issues. Organizations like the Roaring Fork Conservancy, Colorado Department of Natural Resources, Colorado Department of Public Health and Environment (CDPHE), Colorado Division of Wildlife’s River Watch Program (Colorado River Watch), U.S. Environmental Protection Agency (USEPA), U.S. Forest Service, and U.S. Geological Survey (USGS) have spent considerable time and resources monitoring water quality in the watershed. Water quality data summaries and limited data analysis have been periodically performed and used to help inform water quality management decisions (Roaring Fork Conservancy, 2006a; O’Keefe and Hoffman, 2005; Hempel and Crandall, 2001; Britton, 1979). The Northwest Colorado Council of Governments (NWCCOG) developed a watershed plan in 2002 as part of Section 208 of the Clean Water Act. This plan provided guidance with respect to water quality monitoring needs and various watershed improvement projects (Northwest Colorado Council of Governments, 2007). The Safe Drinking Water Act requires that all of the municipalities in the watershed monitor their drinking water (see Section 3.2.6 for more information). The consumer confidence reports of some of the municipalities can be found online (Table 3.2.1).

Table 3.2.1. Location of drinking water consumer confidence reports for various municipalities in the Roaring Fork Watershed.

MUNICIPALITY	DRINKING WATER CONSUMER CONFIDENCE REPORT
Aspen	<a href="http://www.aspenpitkin.com/pdfs/depts/58/ccr2006final.pdf">www.aspenpitkin.com/pdfs/depts/58/ccr2006final.pdf</a>
Snowmass Village	<a href="http://www.swsd.org/2006-monitoring-results">www.swsd.org/2006-monitoring-results</a>
Basalt	Available at 200 Fiou Lane, Basalt (970-927-4723)
Carbondale	<a href="http://www.carbondalegov.org/vertical/Sites/{E239F6F5-CCA3-4F3A-8B27-95E8145FD79A}/uploads/{CCBABC55-C8F6-460C-9DC3-7B4970FAF3E3}.PDF">www.carbondalegov.org/vertical/Sites/{E239F6F5-CCA3-4F3A-8B27-95E8145FD79A}/uploads/{CCBABC55-C8F6-460C-9DC3-7B4970FAF3E3}.PDF</a>
Glenwood Springs	<a href="http://www.ci.glenwood-springs.co.us/departments/publicworks/water/files/ccfinal07.pdf">www.ci.glenwood-springs.co.us/departments/publicworks/water/files/ccfinal07.pdf</a>

#### 3.2.1 Data Sources and Assessments

Water quality data from six agencies at 301 sites have been compiled into a relational database. This web-accessible common data repository provides all interested parties equal access to the latest water quality information. Using this common data repository, water quality data were

evaluated for uniformity and then used to establish the baseline of available water resources data for the watershed (<http://co.water.usgs.gov/cf/roaringforkcf/default.cfm>).

Approximately 70 percent of water quality sites in the watershed are streams, 21 percent are groundwater (wells and springs), and the rest are lake/reservoir, effluent, or mine sites. Table 3.2.2 provides a summary description of these data by responsible agency stored in the common data repository. The primary purpose of the water quality data analysis and summaries included in this report is to describe and explain recent water quality conditions. For that purpose, a subset of all available water quality data was created that consisted of data from 1995 to the present. This subset was retrieved from the common data repository for detailed summary and analysis (appendix 3.2.1). The analysis focused on water quality locations with adequate data to describe existing water quality conditions; therefore, only sites with five or more water quality samples were retained. It was possible that while 5 samples were collected, not all constituents were collected during each of those 5 samples; therefore, data can be summarized based on less than 5 values. Where appropriate, multiple water quality sampling sites that generally represent the same geographic location were combined into a single site. This was done so that all available data for a given location could be evaluated as a single more comprehensive water quality data set.

Table 3.2.2. All data information for water quality data compiled in the Roaring Fork Watershed and stored in the web-accessible common data repository.

AGENCY	NUMBER OF SITES	NUMBER OF SAMPLES	DATE RANGE
Colorado Department of Natural Resources	10	251	1966-1968
Colorado Department of Public Health and Environment	48	1,934	1968-2003
Colorado River Watch	41	4,710	1990-2007
U.S. Environmental Protection Agency	12	59	1969-2000
U.S. Forest Service	35	350	1973-1980
U.S. Geological Survey	174	12,500	1949-2007

As part of various water quality monitoring programs, 500 distinct water quality constituents have been analyzed for in the Roaring Fork Watershed. This large number of constituents represents a combination of changing techniques, different agencies collecting similar constituents, and the collection of organic samples (pesticides and volatile organics) that have numerous constituents analyzed in a single sample. Water quality monitoring efforts have provided information for a particular time period, area, site type (streams, groundwater, mines, effluent, lakes or reservoirs), and/or sampling medium (water, sediment, tissue). Constituents were selected that have been recently and regularly collected at a large number of sites to describe recent water quality conditions in the watershed and to compare sub-watersheds.

The existence of an applicable water quality standard was another factor used to prioritize which constituents to use in this report. The following constituent groups were selected for water quality analysis in this report: field parameters, major ions, nutrients, trace elements, and on a

more limited basis, microorganisms and total suspended solids/suspended sediment. While many other constituent groups have been collected in the watershed, these constituent groups were chosen because they are effective measures of existing water quality conditions, and help in understanding common factors that effect water quality.

Constituents like nutrients and trace elements are not typically found in high concentrations in the environment unless there is some source (continuous, episodic, etc.). Therefore, the detection or lack of detection of a constituent is as important as their concentration when they are detected. When a constituent is not detected in a sample, there are a variety of ways of handling reporting this. One approach is to report the concentration as zero; however, this approach is somewhat misleading. By reporting the concentration as zero, this implies that the concentration is zero, however, this is not known. What is known is that the constituent was not able to be detected in the sample using a particular method. For every constituent, there can be multiple methods of analysis that have varying abilities to detect that constituent in a sample. Therefore, the more appropriate approach to reporting a constituent as “not detected” is to report it as less than the method reporting limit (MRL) of the given method. An MRL for a particular method is the concentration at which a constituent can accurately be reported. When a constituent is reported as less than the MRL, we call this constituent value a censored value (Helsel, 2005). For example, a censored cadmium concentration could be reported as less than 5 micrograms per liter (<5 µg/L). The actual measured concentration of cadmium may be 4.1 µg/L; however, that concentration cannot be reported with any certainty because the particular method is only accurate for concentrations greater than 5 µg/L.

CDPHE has developed acute and chronic water quality standards for several different constituents. An acute standard quantifies a higher constituent concentration for which, during a short exposure (1 day), an aquatic organism would die. A chronic standard is a lower constituent concentration that would, during extended exposure, cause adverse effects including increased mortality and decreased biologic integrity. As such, chronic standards are meant to be compared to 30-day average concentrations; however, very few sites have monthly data let alone more than one sample in a month. Therefore, for the purposes of this analysis, it was necessary to assume that constituent concentrations were representative of a 30 day average. It is important to note that when a sample exceeds an acute or chronic standard that it is an indication of elevated concentrations, but does not indicate that the site is out of compliance with the standard. These standards are often based in part on the relative hardness of the stream and can be referred to as table value standards (TVS). (Colorado Department of Public Health and Environment, 2007b).



Figure 3.2.1. Cattle Creek Stream Team February 17, 2007( Photo Credit: Chad Rudow)

### Previous work

A number of site- and issue-specific studies have been undertaken within the watershed pertaining to water quality. These are summarized within this sub-section. For detailed results, the reader should refer to the particular study of interest.

Evaluations of current and suggested stormwater best management practices were conducted for Basalt and Glenwood Springs. These evaluations identify possible water quality issues and suggest future water quality monitoring (Matrix Design Group, 2001 and 2003). An evaluation of various structural and non-structural best management practices appropriate for golf course design, construction, and maintenance was conducted using Maroon Creek Golf Club as a case study. The evaluation recommended water quality monitoring for both surface water and groundwater for chemical, physical, and biological parameters in receiving waters (Wright Water Engineers, 1996).

Specific conductance and total dissolved solids have been the focus of several studies in the watershed because they are a robust measure of the dissolved solids content. In a literature review to evaluate the effect of deicers in Colorado, USGS and Roaring Fork Conservancy data were analyzed to look at trends in chloride, specific conductance, and streamflow. A non-linear relationship was observed between chloride and specific conductance, while a linear relationship was found between streamflow and both chloride and specific conductance (Fischel, 2001). Specific conductance, salinity, temperature and pH were monitored at 112 study sites during October 1997 to establish a relationship between the geology of the Carbondale area with increases in salinity observed in streams during base flow conditions (Kirkham et al., 1999). This study was based, in part, on a groundwater contribution study of the Upper Colorado River Basin

that used dissolved-solids concentrations and streamflow to determine the salt load that the Roaring Fork is contributing to the Colorado River (Warner et al., 1985).

Other studies within the watershed have endeavored to understand specific processes and factors that influence water quality. A study of the geologic and hydrologic factors governing development impacts on the Crystal River near Marble was used to provide a suitable basis for establishing appropriate land use and environmental policies for future development in the area (Rold and Wright, 1996). Stream sediment data were sampled for heavy mineral concentrations in the Maroon Bells/Snowmass Wilderness (McHugh et al., 1987).

Stream restoration efforts on Brush Creek are ongoing to improve stream stability, function, aquatic habitat, and associated riparian areas. These efforts have been underway since 1992 and the Greenway Plan is intended to provide a comprehensive view of the stream and context for community investment and future improvements (Town of Snowmass Village, 2007). The Roaring Fork Conservancy initiated a targeted study on Brush Creek to establish baseline data, evaluate pH and phosphorus levels, and identify appropriate management strategies for open space parcels (Roaring Fork Conservancy, 2007). High pH values were found to coincide with low streamflow, therefore, the study recommended that streamflow be monitored on Brush Creek to better understand this relationship.

### **3.2.2 Data and Knowledge Gaps**

The process of evaluating and assessing the available water quality data has served to partially identify spatial, analytical, and temporal data gaps. In order to provide a more in-depth analysis of all existing water quality data, completion of the USGS water quality retrospective will include a more comprehensive assessment of historical data. This assessment is intended to provide a more complete understanding of baseline conditions, seasonal and spatial trends, analysis of other water quality constituents, similarities and differences across the watershed, and the influence of upstream water quality conditions on downstream reaches.

Because recent groundwater quality data for the Roaring Fork Watershed does not exist, it is difficult to determine site-specific groundwater issues and data gaps. However, there are some areas where baseline groundwater quality monitoring might be of use. As an example, Basalt and Carbondale use groundwater (springs or wells) as a municipal water supply (O'Keefe and Hoffman, 2005). Source water assessments have been conducted for these municipalities and have identified the potential for contamination of these municipal water supplies (Colorado Department of Public Health and Environment, 2004a and b). As population growth continues in the watershed, land use will change from natural and more rural settings to residential and urban types of land use. Local governments need information to help them evaluate the most suitable locations for domestic wells and light industry such as auto repair shops, cemeteries, and dry cleaners. It is also not known what effects onsite wastewater disposal (septic) systems have on the groundwater quality.

Tools are needed to identify areas with the highest predisposition to groundwater contamination and areas of surface and groundwater interaction so that wise land-use decisions can be made. In the Eagle River Watershed, a neighboring watershed, a groundwater susceptibility assessment study is being conducted by the USGS to address this need. The overall goal of this project is to

develop maps that show the predisposition of the primary alluvial aquifer in the Eagle River Watershed to groundwater contamination. These maps will assist stakeholders in Eagle County to make land-use decisions using scientifically defensible information to aid in long-term water-resource protection and management. The results of this project will also help determine groundwater/surface-water interactions, sources of recharge to the groundwater, and the age and flow directions of the groundwater. As development continues, local organizations need tools to evaluate potential land development effects on ground- and surface-water resources. For instance, it is not known what the recharge sources are for the alluvial aquifer; some portions of the aquifer may be recharged through upwelling of groundwater from the surrounding bedrock, and other areas may be recharged by infiltration from the Eagle River.

Measuring streamflow during water quality data collection is an extremely valuable addition to Colorado River Watch because it provides the ability to track changes in constituent loads and load sources. In addition to instantaneous streamflow data collection, continuous water quality monitors that can measure parameters such as temperature, specific conductance, and/or dissolved oxygen would enhance the ability to observe daily, seasonal, and annual water quality conditions, and would provide a more detailed context for understanding how streamflow, land use, climate, and other natural factors influence water quality.

Additional collection of microorganism data would aid in understanding their occurrence. Water-based recreation is a major attraction to the watershed and increasing microorganism sample collection would help to inform regulators and users alike to the potential threat of water-borne diseases.

The addition of wastewater compounds (or emerging contaminants) to water quality data collection would provide a baseline of data to describe the existence of these compounds in the watershed. Wastewater compounds are organic compounds of natural or synthetic origin typically found in domestic and industrial wastewaters. These compounds include flame retardants, industrial solvents, domestic pesticides, pharmaceutical, and personal-care products (Zaugg et al., 2002). Wastewater treatment processes are not designed to remove all of these compounds from water, resulting in many of these compounds being expelled into streams as treated water (Lee et al., 2004). Several wastewater compounds were detected in samples collected downstream from the discharge of treated wastewater on Boulder Creek during a study conducted in 2000 indicating that these compounds were not removed during secondary treatment (Murphy et al., 2003).

A subset of wastewater compounds includes substances that are known or suspected to disrupt endocrine function in vertebrate organisms. Termed endocrine-disrupting chemicals (EDCs), these compounds are defined by the USEPA (U.S. Environmental Protection Agency, 1997) as: “. . . an exogenous agent that interferes with the synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body that are responsible for the maintenance of homeostasis, reproduction, development, and (or) behavior.”

Initial studies of EDCs and their effect on vertebrates demonstrated adverse effects on test organisms in controlled laboratory settings (Taylor and Harrison, 1999; Kaiser, 2000). More recently, causal relations have been established linking environmentally relevant concentrations of EDCs and adverse effects in aquatic organisms (Schoenfuss et al., 2008; Bistodeau et al.,

2006). In contrast to many toxic chemicals, effects from EDCs on test organisms have been observed at very low concentrations, well below concentrations typically considered “safe” (Kaiser, 2000). To date, most studies have focused on the effects of a single compound; toxic effects of chemical mixtures are not known (Sullivan et al., 2005). It is thought that long-term, continual exposure to EDCs may have subtle effects on vertebrate populations over time through adverse effects on reproduction (Daughton and Ternes, 1999).

### 3.2.3 Water Quality Constituents: Significance and Standards

The following descriptions are for the various water quality constituents that have been tracked within the watershed.

#### Field Parameters

Field parameters are physical properties measured to establish the environmental conditions at the time that the water quality sample is collected, and they help in understanding water-chemical and biological data. These parameters include pH, temperature, dissolved oxygen, specific conductance, and total dissolved solids.

pH, is the negative logarithm of hydrogen ion concentration and relates to the health of aquatic organisms because it is a key determinate for the overall water chemistry. CDPHE has established an instream standard for pH in the range of 6.5 to 9.0 units (Colorado Department of Public Health and Environment, 2007b). Some portions of the watershed have naturally elevated pH values because of the geology of the area, so occasional exceedances of the standard would not be of high concern. However, pH values consistently above the standard at a given site could be considered a water quality concern.

Water temperature can influence the metabolic rates of stream organisms. Consistently elevated stream temperatures are a water quality concern. The CDPHE maximum instream standard for water temperature is 20°C (68°F) (Colorado Department of Public Health and Environment, 2007b). Exceptions to this standard are the Fryingpan River from Ruedi Reservoir Dam to the confluence with the Roaring Fork River and the Roaring Fork River from the confluence with the Fryingpan River to the confluence with the Colorado River. These two segments are designated as Gold Medal fisheries by the Colorado Wildlife Commission and have a chronic temperature standard of 18.2°C (64.8°F) (Colorado Department of Public Health and Environment, 2007b). The interim temperature standards for rivers and streams above 7,000 feet that have cutthroat or brook trout populations is not to exceed an average weekly temperature of 17.22°C (63°F).

Adequate dissolved oxygen concentrations in surface water are an important factor to maintaining a healthy stream ecosystem because many aquatic organisms depend on dissolved oxygen for respiration. CDPHE’s minimum instream standard for dissolved oxygen is 6.0 milligrams per litre (mg/L) except during spawning periods for cold water fish when the standard is 7.0 mg/L (Colorado Department of Public Health and Environment, 2007b).

Specific conductance is a measure of the ability of water to conduct an electrical current (Hem, 1992). Specific conductance is often used as an indication of the mineral content (total dissolved

solids) of water. It can be monitored on a continuous basis in streams, which provides an opportunity to understand the relationships between constituent concentrations and their relationship to streamflow. No water quality standard exists for specific conductance.

## Major Ions

The relative percentages of the major ion concentrations in a water sample may indicate the water type and can help identify the water source (Freeze and Cherry, 1979). Understanding the source of a water sample will aid in interpreting the water quality findings. The major ions dissolved in most natural waters typically include calcium, magnesium, potassium, sodium, carbonate, bicarbonate, chloride, fluoride, sulfate, and silica. Complete major-ion data have not been routinely collected at all sites throughout the watershed. Five sites had sufficient data to characterize water type (Appendix 3.2.2, figures 1-5):

- Roaring Fork River above Difficult Creek near Aspen (Site 2),
- Roaring Fork River near Emma (Site 18),
- Roaring Fork River at Glenwood Springs (Site 24),
- Crystal River above Avalanche Creek near Redstone (Site 42),
- Crystal River below Carbondale (Site 46).

Because chloride and sulfate have a 250 mg/L standard, these major ion constituents were evaluated and summarized for most sites (Colorado Department of Public Health and Environment, 2007b).

Hardness is defined in terms of the presence of calcium and magnesium cations in water and cannot be attributed to a single constituent, but is reported in terms of an equivalent concentration of calcium carbonate. Hardness in the range of 0 - 60 mg/L is considered soft while hardness greater than 180 mg/L is considered very hard (Hem, 1992). Soft waters (low hardness) are associated with rocks that are resistant to weathering like igneous rocks. Hard water (high hardness) could indicate that the water was in contact with calcite-rich rocks like limestone. Higher hardness concentrations buffer the effects of some trace elements, which is why the Table Value Standards (TVS) for trace elements are computed based on hardness.

Total dissolved solids (TDS) is a measure of the concentration of dissolved ions (mostly major ions) in water and is commonly referred to as salinity. CDPHE does not currently have a TDS standard; however, TDS concentrations above 1,000 mg/L are considered slightly saline (Hem, 1992).

## Nutrients

Nutrients (nitrogen and phosphorus) are essential for plant and animal nutrition but excessive concentrations in water can have adverse ecological and human health effects. Nitrogen and phosphorus occur in different chemical forms, including ammonia, nitrate, nitrite, orthophosphate, and in organic compounds. Natural sources of nutrients to streams include the erosion and dissolution of phosphorus minerals from geologic formations, soils, and the decomposition of organic material. Anthropogenic sources of nitrogen and phosphorus include the use of fertilizers in agricultural and urban areas, effluent from wastewater treatment plants, seepage from combined-animal feedlots, and septic systems, and use of detergents containing

phosphates. Atmospheric deposition of nitrogen can result from naturally occurring nitrogen compounds in the atmosphere or from nitrogen compounds created through fossil fuel combustion.

Excessive concentrations of nitrogen and phosphorus in a waterbody can cause eutrophication, possibly resulting in excessive algal growth or blooms, low dissolved oxygen concentrations, fish kills, and a decline in the health and diversity of aquatic communities such as invertebrates and fish. Elevated concentrations of un-ionized ammonia ( $\text{NH}_3$ ) in a stream can be toxic to fish.

Nitrite is an intermediate form of nitrogen and is typically found in high concentrations in association with untreated sewage or other organic waste. Outside of these circumstances, nitrate is the more stable nitrogen species found in natural waters and can exist in a wide range of environmental conditions (Mueller et al., 1995). In water sample analysis, nitrogen is most commonly reported as nitrite plus nitrate, but can be assumed to consist almost entirely of nitrate unless an obvious source of nitrite is present. Phosphate is the only significant form of dissolved phosphorus in natural water (Hem, 1992) and is only moderately soluble. Compared to nitrate, phosphate is not very mobile in a groundwater setting. Instead, phosphorus is often found in sediment and organic particulates, therefore, erosion can transport considerable amounts of suspended phosphorus to surface waters (Mueller et al., 1995).

Instream State water quality standards have been established for nitrite (0.05 mg/L), nitrate (10 mg/L), and un-ionized ammonia (has a TVS) by CDPHE for selected stream segments in the watershed (Colorado Department of Public Health and Environment, 2007b). A nitrate standard has not been established for Brush Creek. CDPHE has not established an instream standard for total phosphorus. As an approach to developing an actual nutrient criteria for streams, the State of Colorado Water Quality control Division is currently working to understand the link between nutrient criteria for streams and their designates uses, aquatic life, and recreation (Colorado Water Quality Forum, 2008). As a general water quality recommendation, the USEPA recommends that total phosphorus concentrations be less than 0.1 mg/L for streams and less than 0.05 mg/L for streams flowing directly into lakes and reservoirs in order to control eutrophication of the water bodies (USEPA, 1986). The USEPA developed a national strategy for developing regional nutrient criteria for regions that are aggregates of USEPA's level III ecoregions. In each region, naturally occurring conditions for nutrients are similar. The total phosphorus regional nutrient criteria were developed and represent reference conditions (conditions that reflect minimal impact to waterbodies by human activities). These criteria represent a starting point for States and Tribes in developing water quality standards to protect aquatic life and water uses. Reference conditions for the Roaring Fork River Basin (part of level III ecoregion 21, Southern Rocky Mountains) is 0.01 mg/L for total phosphorus (U.S. Environmental Protection Agency, 2000). For this analysis, the 0.1 mg/L was used as a "standard" for comparison instead of the 0.01 mg/L concentration for several reasons. As with both of these concentrations, they are recommendations and not actual standards. In addition, it was beyond the scope of this effort to apply the 0.01 mg/L concentration as many of the sample's method report limits (MRLs) are equal to or exceeded the 0.01 mg/L standard. Adding to this complexity, many sites had multiple MRLs.

## Trace Elements

Many trace elements in natural waters are vitally important to human health, plant nutrition, and aquatic life. For example, fluoride concentration in drinking water and its relation to prevention of tooth decay was discovered in the 1930s (Hem, 1992). However, in larger concentrations, trace elements can be toxic to plants and animals and, in sufficient concentrations, to humans. Trace elements are often defined as those elements that generally occur in concentrations less than 1,000 microns per litre ( $\mu\text{g/L}$ ) (Hem, 1992). Unless stated otherwise, trace element concentrations refer to dissolved concentrations.

There are natural (geology) and anthropogenic sources of trace elements in streams. Anthropogenic sources can include mining activity and urban land uses that act to increase trace element contributions to streams. Mining (both active and historical) in the watershed has provided conduits for water and air to come in contact with the underlying geologic material, where both physical and chemical weathering can dissolve and transport trace elements. Waste streams from human activities in urban areas also can mobilize trace elements in the environment. Arsenic, cadmium, copper, total recoverable iron, lead, manganese, selenium, and zinc concentrations were all evaluated for this report with respect to TVS exceedances (Colorado Department of Public Health and Environment, 2007b).

## Microorganism Data

Microorganism data were summarized where available and compared to standards for two indicator organisms, fecal coliform and *E. coli*. USEPA recommends fecal coliform testing for recreational waters (U.S. Environmental Protection Agency, 2007b). CDPHE has set a numeric standard of 200 colony forming units per 100 milliliters (CFU/100 mL), which is also the suggested USEPA guideline. Studies comparing fecal coliform to *E. coli* indicate that illnesses attributed to swimming in water contaminated by fecal matter correlate more strongly with *E. coli* colony counts (Dufour and Cabelli, 1984). Based on this information, the USEPA has recommended the use of *E. coli* as a fecal indicator. There is a standard of 126 CFU/100 mL for *E. coli* in the Roaring Fork Watershed.

## Suspended Solids

High levels of suspended solids can impair aquatic ecosystems by increasing the temperature of the water, abrading and clogging fish gills, and smothering plants, insects, and fish spawning beds. Two types of suspended solid-phase material data were available within the watershed: total suspended solids (TSS) and suspended sediment (SS). Studies by Gray et al. (2000) have concluded that SS and TSS are not comparable and that SS is the more reliable and reproducible measure of suspended matter in natural waters. SS in streams and rivers is compositionally identical to TSS with the exception that SS includes sand-sized (and larger) particles that TSS may not include. Where available, SS data are used to describe suspended solid-phase material, and in its absence, TSS data are used.

### 3.2.4 Influences on Water Quality

Water quality can be influenced by natural and anthropogenic sources, which originate from either point or nonpoint sources. A point source is a single localized source of pollution, while a nonpoint source is a diffuse source. Various point and nonpoint sources were identified for the

Roaring Fork Watershed in the 208 plan developed by Northwest Colorado Council of Governments (NWCCOG) in 2002. These include wastewater treatment plant discharges, population growth, and industrial discharges. The water quality section for each sub-watershed in Chapter 4 has a map that shows the location and size of wastewater treatment plants and sanitation districts. Nonpoint sources included runoff from urban land use, hydrologic modifications, mining, recreational activities, and agricultural activities (Northwest Colorado Council of Governments, 2007). As urban and residential land uses increase in the watershed, changes in water quality will likely be observed in streams and groundwater. Increases in impervious surfaces can act to create chemical runoff, increase stream temperatures, and decrease the amount of infiltration that occurs during precipitation and snowmelt events. Low stream flows intensify the concentration of chemicals and can adversely affect water quality. For example, the allowable concentrations of constituents in wastewater effluent are calculated based upon the quantity of the receiving water. If the use of independent septic drainage systems increased in the watershed, the potential for groundwater contamination from nutrients and microorganisms could also increase.

### 3.2.5 Water Quality Regulations

This section focuses on federal and State regulations (some of which were briefly mentioned in Section 3.2.1) that determine how water quality is evaluated and protected generally and within the Roaring Fork Watershed.

#### Federal

The Clean Water Act (CWA), 33 U.S.C. Secs. 1251, et seq., is the cornerstone of surface water quality protection in the United States (the act does not deal directly with groundwater or water quantity issues). It is administered by the USEPA, and employs a variety of regulatory and non-regulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water." An introduction to the CWA can be found at: <http://www.epa.gov/watertrain/cwa/>.

For many years following the passage of the CWA in 1972, the USEPA, States, and Indian tribes focused mainly on the chemical aspects of the "integrity" goal. During the last decade, however, more attention has been given to physical and biological integrity. Also, in the early decades of the CWA's implementation, efforts focused on regulating discharges from traditional point source facilities, such as wastewater treatment plants and industrial facilities, with little attention paid to runoff from streets, construction sites, farms, and other "wet-weather" sources.

Starting in the late 1980s, efforts to address polluted runoff have increased significantly. For nonpoint source runoff issues, voluntary programs, including cost-sharing with landowners, are often used. For wet weather point sources like urban storm sewer systems and construction sites, a regulatory approach is being employed.

Evolution of CWA programs over the last decade also has included a shift from a program-by-program, source-by-source, pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach, equal emphasis is placed on protecting healthy waters and restoring impaired ones. A full array of issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining State water quality and other environmental goals is another hallmark of this approach

One of the key issues in the CWA relevant to the State of Colorado and the Roaring Fork Watershed is the extent to which it can address the water quality effects of water withdrawals and diversions under the Colorado water law system. In this regard, the Colorado General Assembly enacted H.B. 1132 in 2007. This new law provides that, when a water judge issues a decree for a change of type of use of irrigation water rights that transfers more than 1,000 acre-feet of consumptive use of water per year, the water judge may include a term or condition that addresses decreases in water quality caused by the change. This new law only applies to water rights applications filed after the effective date of the legislation (Feb. 28, 2007).

The Safe Drinking Water Act (SDWA) 42 U.S.C. Secs. 300f to 300j-9 was originally passed by Congress in 1974 and amended in 1986 and 1996. The law protects public health by regulating the nation's public drinking water and its sources, which include rivers, lakes, reservoirs, springs, and groundwater wells (SDWA does not regulate private wells that serve fewer than 25 individuals). SDWA authorizes the USEPA to set national health-based standards for drinking water to protect against both naturally-occurring and man-made contaminants that may be found in drinking water. The USEPA, States, and private or public water systems then work together to make sure that these standards are met.

There are a number of threats to drinking water, including improper disposal of chemicals, animal wastes, pesticides, human wastes, wastes injected deep underground, and naturally-occurring substances. Drinking water that is not properly treated or disinfected, or that travels through an improperly maintained distribution system, also can pose a health risk. Originally, SDWA focused primarily on treatment as the means of providing safe drinking water at the tap. The 1996 amendments greatly enhanced the existing law by recognizing source water protection, operator training, funding for water system improvements, and public information as important components of safe drinking water. This approach ensures the quality of drinking water by protecting it from source to tap. For additional information about the SDWA, go to: <http://www.epa.gov/safewater/sdwa/30th/factsheets/understand.html>.

## State

The following information was taken from “The Citizen’s Guide to Water Quality Protection” (Colorado Foundation for Water Education, 2003), which can be referred to for more detailed information.

The CDPHE is the State agency in charge of water quality protection. The Water Quality Control Commission (WQCC), Water Quality Control Division (WQCD), Operators Certification Board, and the Board of Health are all part of CDPHE. The WQCC develops the rules for water quality management while the WQCD implements management policies established by the Commission

and Board of Health. CDPHE is Colorado's lead agency for surface and groundwater monitoring, protection, and restoration. It regulates the discharge of pollutants into the State's surface and groundwater and enforces the Colorado Primary Drinking Water Regulations. The Colorado Board of Health sets State drinking water standards, minimum standards for individual sewage disposal systems, and land application of water treatment plant sludges. The Colorado Water and Wastewater Facility Operators Certification Board licenses operators of facilities that treat and manage drinking water and sewage. Additionally the Colorado Division of Wildlife provides input to the WQCC/WQCD regarding the health of the State's aquatic life. Colorado's water quality protection framework has three main components:

- Use classifications
- Water quality standards
- Anti-degradation provisions

The WQCC adopts use classifications for each current or future use to be protected, based on how the water is currently used and what beneficial uses are desired in the future. To protect these uses, the State sets numerical and narrative standards. The primary purpose of anti-degradation provisions is to protect current water quality, especially where that quality is better than necessary to protect a water body's classified uses. More detail about these standards is provided above in Section 3.2.3.

The WQCD coordinates the State's stormwater permitting program. All construction that disturbs more than one acre of land is required to develop a Stormwater Management Plan and apply for a Stormwater Discharge Permit. This program does not set numerical standards or require sampling, but rather puts the onus on the permittee to implement a series of best management practices to assure that no pollutants will enter a water of the State via stormwater runoff.

Within the stormwater program, local communities are encouraged by CDPHE to contract with the WQCD to conduct inspections on permitted and non-permitted construction sites. The municipalities and counties within the Roaring Fork Watershed are small and have not yet entered the USEPA-mandated phase of implementation of stormwater programs. As a result, most jurisdictions in the watershed have not yet begun to develop criteria or programs to manage those discharges associated with storm events.