Middle Colorado Watershed Council: Surface Water Quality Data Analysis

Prepared for:

The Middle Colorado Watershed Council

MIDDLE COLORADO WATERSHED COUNCIL

Prepared by:

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Acknowledgements

The Middle Colorado Watershed Council (MCWC) is a nonprofit organization established to protect and enhance the health of the Middle Colorado River Watershed (Watershed) in west central Colorado. The MCWC was established in late 2009 when the Colorado River Water Conservation District (River District), Colorado State University Extension (CSU Extension), Colorado Watershed Assembly, and the Sonoran Institute hosted a meeting to identify opportunities for collaboration in the Watershed. A Steering Committee, comprised of volunteers from the stakeholder group, was formed in 2010 to establish a long-term plan and secure funding for additional work. In July 2011, the MCWC's proposal to the Colorado Department of Public Health and Environment (CDPHE) for a Nonpoint Source Grant (NPS or 319 grant) was accepted. The grant has provided funds to support the development of this document and a Watershed Plan, in addition to other public education and outreach efforts.

The MCWC Technical Advisory Committee (TAC) was formed in late 2012 to provide technical expertise and oversight of the watershed assessment and planning efforts. This surface water quality data analysis (Analysis) is a fundamental component of the watershed planning process. Members of the TAC provided valuable input, balanced perspectives, and expertise to create the consensus-based approach for this Analysis. TAC members consistently provided practical and insightful comments at meetings and in draft versions of this document including technical expertise to improve the Analysis with respect to water quality, hydrology, and fisheries, along with substantial on-the-ground knowledge. Other TAC members shared their expertise in planning and local issues. MCWC's Executive Director was a vital resource for the oversight, review and development of this Analysis. The Executive Director organized meetings, gathered input from TAC and MCWC Board members, provided comments to improve the Analysis, and simultaneously began drafting the Watershed Plan, which has improved the efficiency of the planning process. CDPHE staff also supported the development of this Analysis and provided valuable feedback with respect to the grant requirements.

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1.0 Introduction

The Middle Colorado Watershed Council (MCWC) is a nonprofit organization established to protect and enhance the health of the Middle Colorado River Watershed (Watershed) in west central Colorado. The MCWC is currently developing a Watershed Plan to guide future activities in fulfillment of the organization's mission. This Surface Water Quality Data Analysis (Analysis) is an integral part of the watershed planning process in that it seeks to document, describe, and interpret existing surface water quality conditions throughout the Watershed. The approach for this Analysis was developed by the MCWC Technical Advisory Committee (TAC).

1.1 Report Purpose and Objectives

The overarching purpose of this Analysis is to inform the Watershed Plan. The key objectives of the Analysis are to:

1) Compile, analyze, and describe surface water quality in the Watershed;
2) Identify surface water quality data gaps;
3) Identify areas where surface water quality issues may be present.

Understanding the nature of data gaps in the Watershed is vital to improving existing monitoring efforts and should be considered when developing future monitoring programs. Monitoring efforts can be streamlined among partner agencies to increase the use and utility of data, while using money and other resources more efficiently when planned at a watershed scale.

Water quality data are an important tool for understanding of watershed health dynamics, identifying areas or sources for voluntary clean-up or restoration activities, and evaluating the outcomes of management activities. The data can also be used to develop a technical basis to support or refute water quality standards and impairment listings that can affect discharge permits, and to support funding for voluntary water quality improvements.

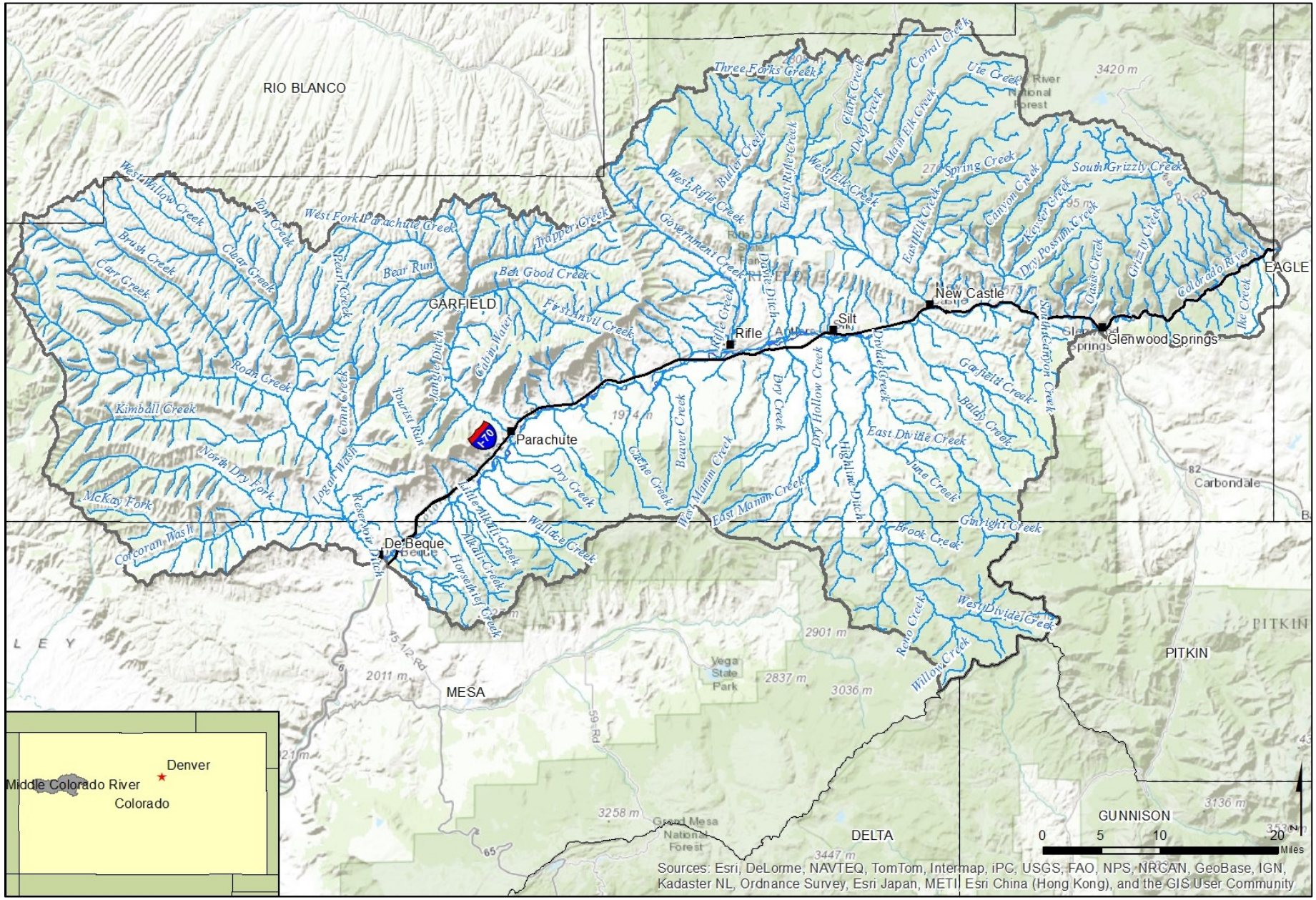
This report is intended for a technical audience; key information from this document will be summarized and incorporated into the Watershed Plan for use by the general public.

1.2 Study Area

The Watershed includes the mainstem of the Colorado River and its tributaries from the head of Glenwood Canyon in Garfield County to the Town of DeBeque in Mesa County, Colorado. The eastern boundary of the Watershed is located at the Eagle-Garfield County line. The Colorado River flows past the municipalities of Glenwood Springs, New Castle, Silt, Rifle, Parachute, Battlement Mesa, and DeBeque on a west, southwest trajectory to the terminus of the Watershed at the confluence of Roan Creek and the Colorado River near DeBeque (Figure 1). The Watershed is of vital importance locally and throughout the West. Numerous communities rely on the Colorado River and its tributaries for drinking water, agricultural, recreational, industrial, and environmental uses.

The Watershed drains approximately 2,022 square miles (1.3 million acres). The Watershed has 7,444 miles of perennial, intermittent, and ephemeral streams and rivers. The Roaring Fork River, which is not included in the Watershed, is addressed in the Roaring Fork Conservancy's *Roaring Fork Watershed Plan* (April 12, 2012). The Eagle River Watershed Council is active in the Eagle River and Upper Colorado River watersheds located east and upstream of the Watershed.

Figure 1. The Middle Colorado River Watershed in Western Colorado.



2.0 Factors that Affect Water Quality

Water quality conditions are the result of complex interacting factors that vary through time and throughout the Watershed. This section provides a brief overview of the natural and anthropogenic factors that can affect water quality. Site-specific water quality conditions are a result of multiple interactive factors.

2.1 Climate

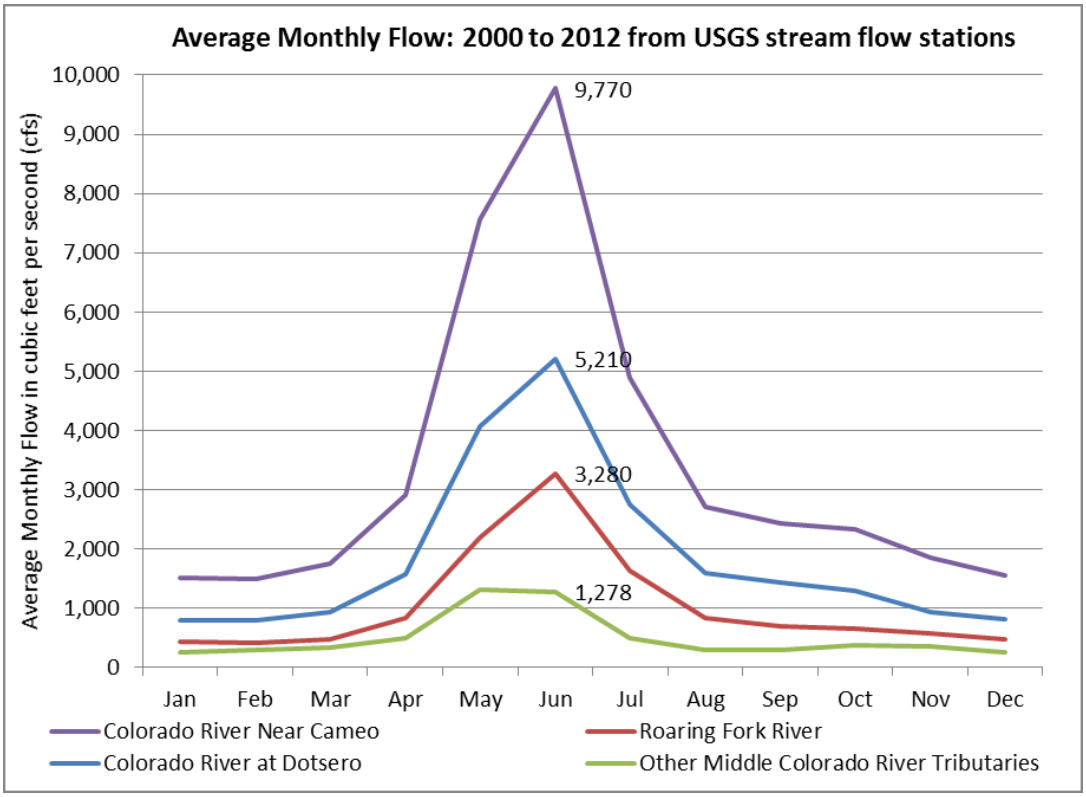
Colorado's variable climate is a function of the wide range in elevation and complex topography. Locally, the mountains, plateaus, and valley floors control the rate at which air masses pass through the Watershed and create orographic precipitation. The greatest average precipitation typically occurs in the winter months for most of western Colorado, while June is typically the driest month of the year (Doesken et al., 2003). The lowest annual average precipitation is about 12 inches per year in the Colorado River valley near Parachute (WRCC, 2013). Annual average precipitation is greatest in the higher elevations on the eastern and southern portions of the Watershed. In these mountainous areas, precipitation averages up to 42 inches per year and much of the precipitation accumulates as snow (NRCS, 2013). Snowpack, or layers of accumulated snow and the amount of stored water, is a vitally important water resource throughout the dry western United States. In the Watershed, the snowpack stores a large quantity of water, fuels spring runoff, and often moderates drought.

2.2 Hydrology

Stream flows in the Colorado River and its tributaries are typical of snowmelt driven mountain streams (Figure 2). Low flows generally occur from October to March. As spring approaches stream flow increases. Peak flows typically occur in May or June and taper quickly as the snowpack declines. Smaller tributaries in the watershed exhibit similar patterns, but flows are more readily increased by intense precipitation events (Hornberger et al., 1998).

Climate creates wet and dry periods, which are reflected in stream flows. In 2002, the Watershed experienced a drought and mean monthly stream flows were substantially lower than average (Table 1). Conversely, 2011 was relatively wet and mean monthly flows exceeded the 2000 to 2012 time period average. Monthly variations are also evident between wet and dry years.

Figure 2. Average monthly flows, in cubic feet per second (cfs) for the Colorado River, the Roaring Fork River and tributaries in the Middle Colorado River Watershed.



2.3 Water Management

Large scale water management practices also influence stream flows in the Watershed. The overall effect of water management, in general, is that peak flows are decreased due to water storage and low season flows are increased as stored water is released to satisfy downstream water rights. Because large-scale water management, such as reservoir storage and releases, occurs in the Watershed these fluxes have the ability to alter water quality. In addition there are approximately 52,000 irrigated acres in the Watershed and a significant portion of this water originates from smaller tributaries (CO BIP, 2014).

Table 1. Average monthly stream flow in cubic feet per second (cfs) for the Colorado River, Roaring Fork River and tributaries in the Middle Colorado River Watershed.

Hydrologic Condition[1]	Location	Average Monthly Stream Flow in Cubic Feet Per Second (cfs)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Low Water Year: 2002	Colorado River Near Dotsero	587	548	700	1,274	1,254	1,220	1,072	912	661	707	796	631
Average Conditions: 2000-2012		798	790	941	1,570	4,070	5,210	2,750	1,590	1,440	1,290	928	815
High Water Year: 2011		780	820	1,163	2,685	7,568	15,380	10,760	2,985	1,935	1,739	1,137	996
Low Water Year: 2002	Roaring Fork River at Glenwood Springs	389	332	355	617	913	1,100	497	454	465	448	424	348
Average Conditions: 2000-2012		442	413	474	846	2,190	3,280	1,640	840	707	651	575	482
High Water Year: 2011		450	436	505	847	2,004	6,418	4,513	1,025	931	814	658	558
Low Water Year: 2002	Other Middle Colorado River Tributaries	353	336	302	323	516	286	130	155	170	186	235	153
Average Conditions: 2000-2012		268	292	333	503	1,311	1,278	501	291	291	386	355	253
High Water Year: 2011		323	257	302	642	1,908	3,952	1,707	687	360	468	401	229
Low Water Year: 2002	Colorado River Near Cameo	1,329	1,215	1,357	2,214	2,683	2,606	1,699	1,520	1,296	1,341	1,455	1,132
Average Conditions: 2000-2012		1,510	1,500	1,750	2,920	7,570	9,770	4,880	2,720	2,440	2,330	1,860	1,550
High Water Year: 2011		1,552	1,513	1,969	4,174	11,480	25,750	16,980	4,697	3,226	3,021	2,196	1,782

Notes

1. Hydrologic Condition seeks to characterize recent low, high and average water years. The average stream flow for a given month may not represent the outcome for that particular year.

2.4 Geology

The majority of the Watershed is located in the eastern portion of the Piceance Basin. The Piceance Basin is a down-warped basin that is surrounded by uplifted regions (Thomas et al., 2013) and hosts a thick sequence of sedimentary rocks, the most common surficial geology in the Watershed. The prominent plateaus that rise above the Colorado River Valley, including the Roan and Battlement plateaus, expose thick sequences of sedimentary rocks. The Colorado River and its larger tributaries have sculpted deep alluvial valleys through these sedimentary rocks. Alluvium and gravel deposits, located in the river valleys, are comprised primarily of sedimentary clasts and are the result of on-going erosion in the basin. Erosion and weathering release minerals and other compounds that can affect water quality.

2.5 Land Use

The following paragraphs introduce common land uses in the Watershed and provide information on the potential impacts to water quality.

Urbanization. Most of the urban and suburban communities located along the mainstem of the Colorado River are also near the confluence of a tributary. Stormwater runoff from developed areas can be laden with sediment, heavy metals, hydrocarbons, bacteria, and other pollutants. This runoff may reach waterbodies through the stormwater drain system as well as through overland runoff. Runoff from residential lawns and public parks can contain fertilizers and pesticides, adding to the pollutant load. Municipal wastewater treatment plant discharges, while subject to extensive treatment processes and permitting, contain byproducts and untreated substances not currently regulated by federal or state laws that can have a cumulative effect on water quality as the discharged water mixes and flows downstream. Rural development, although dispersed, relies on individual sewage disposal systems to treat domestic wastewater. Unmaintained systems can have a cumulative effect on downstream waterbodies.

Irrigation. There are approximately 52,000 irrigated acres in the Watershed and a significant portion of this area is irrigated with water from smaller tributaries (CO BIP, 2014). Irrigation, water storage in unlined ponds, canals or other structures can allow excess water to infiltrate into soils. This condition, referred to as deep percolation, can accelerate the rate of natural weathering and groundwater return flows which can increase instream concentrations of certain pollutants including salts, selenium, iron, and others. Excess water application, regardless of the purpose (e.g., agricultural, industrial or residential uses), to soils derived from Mancos or Lewis shale is problematic throughout western Colorado due to the mobilization of selenium, which results in increased selenium concentrations in local waterways. Increased selenium concentrations have a detrimental and direct impact on endangered fish species in and downstream of the Watershed. Additionally, smaller tributaries in the Watershed are commonly dried up by irrigation diversions at one or more locations, for a substantial portion of the irrigation season.

Agriculture. Agricultural practices that occur in proximity to waterways can be a source of bacteria loading from livestock, particularly when allowed in or near riparian areas. Agricultural chemicals and fertilizers may also travel to waterways through surface water runoff or return flows, if not optimally managed.

Energy Development. Energy development has occurred from New Castle to DeBeque and is most concentrated in the Parachute, Mamm, Divide, and Battlement Creek drainages. As of December 2013, there were about 14,500 permitted natural gas wells in the Watershed (COGCC, 2013). Most wells produce natural gas along with limited quantities of crude oil and produced water. Water quality can be affected by spills or leaks, and surface disturbances, such as pads, pipelines, and roads that may increase erosion and deliver pollutants to streams. Water is used for drilling, well completion, and dust abatement, and increasingly recycled to support various energy development activities[1].

Industry. Other industrial activities, such as aggregate extraction, which occur along the mainstem of the Colorado River in the lower half of the Watershed, have the potential to introduce pollutants to the river through dewatering activities, erosion, and stormwater runoff. Infrastructure that supports industry, including Interstate 70, the railroad line, and the extensive network of roads, pipelines, and other utility corridors pose the potential for accidental spills, releases, and additional stormwater runoff.

In general, there is insufficient information regarding the above factors to attribute water quality conditions in the Watershed to any specific factor(s). Where possible, the existing data set is used to posit potential factors or source areas.

[1] Readers interested in learning more about natural gas development in the Watershed should consult the Community Guide: Understanding Natural Gas Development, prepared by the Garfield County Energy Advisory Board (2007).

3.0 Regulatory Framework

Water quality standards serve as the foundation of the water quality-based pollution control program mandated by the federal Clean Water Act (CWA). Water quality standards define the goals for a waterbody by designating its uses, setting criteria to protect those uses, and establishing provisions such as antidegradation policies, to protect waterbodies from pollutants. In Colorado, water quality standards are assigned to all waterbodies, including streams, rivers, lakes, and reservoirs. Standards are established through a public hearing process conducted by the Colorado Water Quality Control Commission (WQCC) within CDPHE. The Water Quality Control Division (WQCD), a department within CDPHE, is responsible for implementation of WQCC policies and regulations.

It is useful to know what the water quality standards are and whether or not those standards are being met in order to monitor, protect or enhance existing water quality. Comparing historical and current water quality data to the standards can provide an idea of whether a particular waterbody has historically or is currently experiencing water quality impairments.

This document introduces five key surface water quality regulations for purposes of comparison when evaluating existing water quality conditions in the Watershed. Each are described in more detail in the subsections that follow.

- Regulation 31 – The Basic Standards and Methodologies for Surface Water,
- Regulation 33 – Classifications and Numeric Standards for Upper Colorado River Basin and North Platte River,
- Regulation 37 – Classifications and Numeric Standards for Lower Colorado River Basin,
- Regulation 85 – Nutrients Management Control Regulation, and
- Regulation 93 – Section 303(d) List of Impaired Waters and Monitoring and Evaluation List.

3.1 Statewide and Basin-Specific Water Quality Regulations (Regulations 31, 33 and 37)

Regulation 31, the Basic Standards and Methodologies for Surface Water, describes a set of "beneficial uses" for Colorado's water and defines the water quality conditions generally necessary to maintain and attain identified beneficial uses. In addition, it establishes procedures for classifying the waters of the state, for assigning water quality standards, and for periodic review of and modification to the classifications and standards.

Regulations 33 and 37, Classifications and Numeric Standards for Upper and Lower Colorado River Basin, respectively, classify and assign numeric water quality standards to surface waters located in the upper and lower portions of the Colorado River Basin. In order to accomplish this in an organized fashion, all waterbodies are divided into segments, or discrete pieces, based upon similar characteristics, uses and other factors. These segments are assigned beneficial uses and specific water quality standards that must be met in order to protect the uses.

The Watershed contains thirty-seven segments regulated under both Regulation 33 and 37. Streams account for thirty-two of the segments and lakes, reservoirs, and ponds are grouped into five segments. Lake segments were established during the September 30, 2013 revision to Regulations 33 and 37. The new segments and standards address water quality criteria, such as temperature, dissolved oxygen and others, in a manner more specific to lakes, ponds, and reservoirs. Rifle Gap Reservoir, a part of Segment 20, is the only waterbody specifically named to a segment in the Watershed (Regulation 37). The remaining lake and ponds are assigned to a segment based on their location relative to other features. Appendix A summarizes the designated uses and numeric water quality standards for the segments in the Watershed. The segment descriptions presented in Appendix A are identical to the descriptions found in Regulations 33 and 37. Appendix A also includes a map of the water quality segments found in the Watershed. Note that the segment names are abbreviated (ex: Segment 1 rather than COLCLC01) and the segment descriptions are shortened in this document. The maps only show the portions of segments within the Watershed; parts of the segment may extend beyond the Watershed boundary.

Colorado recognizes several beneficial water uses. Aquatic life, recreation, agriculture, and water supply uses apply to some or all of the segments in the Watershed. Each of these use classifications has specific water quality standards for multiple parameters. The most conservative criteria (i.e., lowest value) among all beneficial uses for a waterbody is applied as the effective standard for each parameter (e.g., pH, temperature, lead, etc.). This approach assures the protection of all water uses because the beneficial use with the most conservative criteria is applied as the standard. In the Watershed, the numeric standards associated with aquatic life or water supply are typically the lowest (i.e., most conservative) and are therefore applied for many parameters.

The criteria to protect aquatic life generally have an acute and chronic standard for each parameter. Chronic standards represent those conditions that can cause stress in aquatic organisms during prolonged or repeated exposures and result in physical abnormalities, impaired growth, reduced survival, and lowered reproductive success. Acute standards represent those conditions that can cause extreme stress during instantaneous or brief exposures and result in sub-lethal and lethal effects on aquatic life. This approach requires an understanding of both the species expected in a given waterbody and the tolerance of those species to various water quality parameters. The chronic and acute standards are designed to protect 95 percent of the genera in a given waterbody (WQCC, 2013). Colorado relies on guidance from Federal, State and local scientists to establish these standards which are reviewed on a regular basis. Because chronic standards are designed to prevent problems associated with long term exposure to parameters, the concentration of a chronic standard is always lower than the concentration of the acute standard, which is designed to prevent lethal effects. If the concentration of a given parameter exceeds the applicable standard, the quality of the water is not protective of the given use. This condition is referred to as an “exceedance”.

3.2 Nutrient Regulations (Regulation 85)

Regulation 85 was adopted by the WQCC in 2012 as a statewide nutrient control regulation in an effort to reduce or avoid eutrophication (i.e., excess nutrients) in Colorado’s streams, rivers, lakes, and

reservoirs. Regulation 85 represents the first part of a comprehensive plan for phasing in nutrient controls over the next couple of decades to reduce phosphorus and nitrogen loadings to state waters. As part of the short- and long-term strategies to address current and potential future nutrient pollution of Colorado surface waters, this Regulation applies to both point and nonpoint sources of nutrients. Regulation 85 also requires point source entities to monitor instream water quality for specific forms of phosphorus and nitrogen and flow, and strongly encourages non-regulated entities to do the same in an effort to determine the location and magnitude of source contributions. Where nonpoint source contributions are significant, this regulation encourages voluntary approaches to nutrient control.

In concert with the adoption of Regulation 85, and as a second phase to nutrient controls, Regulation 31 was amended by the WQCC in 2012 to include "interim" science-based numeric water quality criteria for phosphorus, nitrogen and chlorophyll *a* (an indicator of aquatic plant and algae growth) for different waterbodies (Table 2). These concentrations represent a best estimate of what is required to protect the beneficial uses of the state's waters. These criteria are intended to be phased in as basic standards starting in 2022, and will likely be more restrictive than the first phase requirements in Regulation 85. As such, many regulated sources across the state will be faced with the need to install new or additional nutrient controls in order to meet the basic standards that will apply to streams, rivers, lakes, and reservoirs.

Table 2. Interim standards for total phosphorus, total nitrogen, and chlorophyll *a*.

Interim Nutrient Standards	Total Phosphorus	Total Nitrogen[6]	Chlorophyll a
Waterbody Characteristics	Concentration (mg/L)		Concentration (ug/L)
Lakes and Reservoirs, cold, > 25 acres[1, 3, 5]	0.025	0.426	8
Lakes and Reservoirs, warm, > 25 acres[1, 3, 5]	0.083	0.91	20
Lakes and Reservoirs, ≤ 25 acres	Reserved	Reserved	Reserved
Rivers and Streams- Cold[2, 4]	0.11	1.25	150 mg/m^2
Rivers and Streams- Warm[2, 4]	0.17	2.01	150 mg/m^2

Notes

1. Summer (July 1- September 30) average Total Phosphorus (mg/L) in the mixed layer of lakes (median of multiple depths), allowable exceedance frequency 1-in-5 years.
2. Annual median Total Phosphorus (mg/L), allowable exceedance frequency 1-in-5 years.
3. Summer (July 1- September 30) average chlorophyll a (ug/L) in the mixed layers of lakes (median of multiple depths), allowable exceedance frequency 1-in-5 years.
4. Summer (July 1- September 30) maximum attached algae, not to exceed.
5. Direct Use Water Supply (DUWS) lakes and reservoirs may not exceed 5 ug/L chlorophyll a.
6. Effective date 5/31/2017.

3.3 List of Impaired Waters (Regulation 93)

Section 303(d) of the CWA, requires that each state prepare a list of waters that do not meet water quality standards. Regulation 93 documents the Colorado List of Impaired Waters (303(d) List). The list must describe the waterbody and the parameter for which it is impaired. Typically, these lists are updated and reevaluated every two years; Colorado's next update will occur in 2016. The WQCD reviews readily available water quality data, typically collected within five years of the assessment

period, by segment relative to state water quality standards. When water quality data do not pass the evaluation, the waterbody is added to the 303(d) List. When impairment is in question because the available data are somehow insufficient (typically too few samples), the waterbody is added to Colorado's Monitoring and Evaluation (M&E) List. Table 3 presents the segments included on the 2012 303(d) List.

Segment 4a (tributaries to the Colorado River between the Roaring Fork River and Parachute Creek), Segment 10 (West and East Rifle Creek and Rifle Creek below Rifle Gap Reservoir), and Segment 14c (Dry Fork of Roan Creek) are impaired for selenium. The selenium standard is applied to prevent chronic exposure effects to aquatic life. Selenium concentrations are discussed in detail for each of these segments later in this report.

Rifle Gap and Harvey Gap Reservoirs are listed as impaired for elevated concentrations of mercury in fish tissue samples. Due to the mercury concentrations, fish caught in these reservoirs should not be consumed.

Table 3. 303(d) Listed segments in the Middle Colorado River Watershed.

Subwatershed	WQCD Segment	Stream Segment Description	Portion	303(d) Parameter	TMDL Priority
South Watershed	4a	All tributaries, including wetlands, to the **Colorado River from** the confluence with **the Roaring Fork River to** a point immediately below the confluence with **Parachute Creek** except for the specific listings in Segments 4b, 4c, 4d, 4e, 5, 6, 7a, 7b, 8, 9a, 9c, 10, 11a - h, and 12a.	All	Selenium	High
East Watershed	10	West Rifle Creek, including all tributaries and wetlands, from the source to Rifle Gap Reservoir. East Rifle Creek, including all tributaries and wetlands, from the White River National Forest boundary to Rifle Gap Reservoir. Rifle Creek, including all tributaries and wetlands, from Rifle Gap Reservoir to the confluence with the Colorado River.	All	Selenium	Low
West Watershed	14c	Mainstem of Roan Creek including all tributaries and wetlands, from a point immediately below the confluence with Kimball Creek to the confluence with the Colorado River.	Dry Fork	Selenium	Low
East Watershed	20	Rifle Gap Reservoir, Harvey Gap Reservoir and Vega Reservoir	Rifle Gap Reservoir	Aquatic Life (Mercury Fish Tissue)	High

3.4 Monitoring and Evaluation Segments (Regulation 93)

Several segments within the Watershed are on the M&E List where impairment is suspected but not adequately documented due to an insufficient amount of data, or other issues (Table 4). South Canyon Hot Springs (Segment 4b) is on the M&E List for dissolved oxygen which is an important parameter for the protection of aquatic life. Dissolved copper, lead, selenium, zinc, and total recoverable iron standards are also applied to prevent the effects of chronic exposure to aquatic life. These metals account for the majority of the M&E Listings in the Watershed (Table 4). The *Escherichia coli* (*E. coli*) standard is intended to protect recreational water use where direct human contact is possible. Three segments in the Watershed are on the M&E List due to a limited number of *E. coli* concentrations that have exceeded the standard. The mainstem of the Colorado River from the confluence with the Roaring Fork River to the western Watershed boundary, Segments 1 and 2a, is on the M&E List for sediment.

The purpose of the M&E List is to highlight where additional monitoring is needed to determine if an impairment(s) exists or whether the waterbody is in compliance with standard(s). Often, the WQCD will focus its resources on sampling these segments or, alternatively, encourage local management agencies to do the same. The Analysis evaluated data that initiated M&E Listings relative to additional data in the MCWC data set.

Table 4. Monitoring and Evaluation (M&E) segments in the Middle Colorado River Watershed.

Subwatershed	WQCD Segment	Stream Segment Description	Portion	M&E Parameters
East Watershed	4b	South Canyon Hot Springs.	All	Dissolved Oxygen, Lead
East Watershed	4c	The mainstem of South Canyon Creek from the South Canyon Hot Springs to the confluence with the Colorado River.	All	Copper, Selenium, *E. coli* (May-Oct)
East Watershed	10	West Rifle Creek, including all tributaries and wetlands, from the source to Rifle Gap Reservoir. East Rifle Creek, including all tributaries and wetlands, from the White River National Forest boundary to Rifle Gap Reservoir. Rifle Creek, including all tributaries and wetlands, from Rifle Gap Reservoir to the confluence with the Colorado River.	West Rifle Creek	Total Recoverable Iron
South Watershed	4a	All tributaries, including wetlands, to the Colorado River from the confluence with the Roaring Fork River to a point immediately below the confluence with Parachute Creek except for the specific listings in Segments 4b, 4c, 4d, 4e, 5, 6, 7a, 7b, 8, 9a, 9c, 10, 11a - h, and 12a.	Alkali Creek	*E.coli*, Copper, Total Recoverable Iron, Lead, Zinc
West Watershed	14b	Clear Creek, including all tributaries and wetlands, from a point immediately below the confluence with Tom Creek to the confluence with Roan Creek. Roan Creek, including all tributaries and wetlands, from a point immediately above the confluence with Clear Creek to a point immediately below the confluence with Kimball Creek.	All	Total Recoverable Iron, *E. coli*
Colorado River	1	Mainstem of the Colorado River from the confluence with the Roaring Fork River to immediately below the confluence with Rifle Creek.	All	Sediment
Colorado River	2a	Mainstem of the Colorado River from immediately below the confluence with Rifle Creek to immediately above the confluence of Rapid Creek.	All	Sediment

3.5 TMDL Development

Generally, after a segment is placed on the 303(d) List, an assessment of contaminant sources is completed. The assessment is referred to as a Total Maximum Daily Load (TMDL). TMDL assessments use water quality data and stream flow to determine the amount, or load, of a given parameter than can be in the stream without exceeding applicable water quality standards; plus a margin of safety. The TMDL documents contaminant loads that originate from point and nonpoint sources within the study area. Once this information is available, a plan is developed to address how each of the contributing sources can be reduced in order to meet the allowable load. To date, no TMDL assessments have been completed for impaired waterbodies in the Watershed. Note that an M&E Listing is not subject to the TMDL process.

Rifle Gap Reservoir has mercury-fish tissue impairments, also known as fish consumption advisories, which have been assigned a high priority for TDML development. However, because mercury is generally transported through the atmosphere, the TMDL will likely be addressed at a statewide rather than segment level.

The 303(d) Listings for selenium are attributed to exceedances of the chronic standard for aquatic life. The TMDL to address selenium pollution on Segment 4a, tributaries to the Colorado River between the confluences with the Roaring Fork River and Parachute Creek, is a high priority (Table 3). Preparing TMDLs to address selenium on Segment 10, Rifle Creek and its tributaries below Forest Service lands, and Segment 14c, the Dry Fork of Roan Creek, are considered a low priority at this time.

Other approaches, such as Use Attainability Analyses (UAA)[2], can also be used to address impairments. Such approaches may include changing the designated use applied to a segment, which may also change the standard and allow for compliance.

3.6 Outstanding Waters Designation

Waterbodies may be designated as Outstanding Waters (OW) if the WQCC determines that existing water quality is very good, that the waters have exceptional recreational or ecological significance and have not been impacted in any significant way, and if the waters warrant additional protection to prevent future degradation (Regulation 31).

Based on evidence that shows that water quality meets the requirements of the designation, combined with the requirements in Regulation 31.8(2)a, and the presence of Colorado River cutthroat trout, the OW designation was added to portions of the East Middle Fork of Parachute Creek (Segment 8) and portions of Battlement Creek (Segment 9c).

4.0 Description of the Data

This section describes the data sources used in this Analysis.

4.1 Data Sources

A literature review that emphasized surface water quality reports and data was completed as part of this Analysis. Various reports and studies are referenced throughout this report; however, the Piceance Basin Surface Water Study and the data collected as part of the WQCD data call are the basis of the surface water quality data set used in this Analysis.

[2] Use Attainability Analyses (UAA) are comprehensive assessments used to create segment specific standards to accommodate waterbodies with unique natural characteristics.

4.1.1 Piceance Basin Surface Water Study

The Characterization and Data-Gap Analysis of Surface-Water Quality in the Piceance Study Area report (USGS, 2013) was a central component of this Analysis. As part of the project, U.S. Geological Survey (USGS) compiled surface water quality data to create the Piceance Basin Water-Quality Data Repository. Background information on the Piceance Basin project can be found at http://rmgsc.cr.usgs.gov/cwqdr/Piceance/index.shtml. In order to query the water quality data, please link to the following Colorado Data Sharing Network (CDSN) site (http://maps.goldsystems.com/), review directions to access data, and select "Piceance_LDR" (http://rmgsc.cr.usgs.gov/cwqdr/Piceance/). The water quality data from the repository were incorporated into the data set used for this Analysis.

There are some important differences between this Analysis and the Piceance Basin study. First and foremost is the scale of the study areas; the Watershed is approximately one-fifth the size of the Piceance Basin study area. Due to the large study area and other factors in the Piceance Basin study, more restrictive data review criteria were used to screen the data set to allow for an effective and consistent assessment of surface water quality in the 9,500 square mile study area. This Analysis more specifically addresses the Watershed. Because the Watershed is a smaller study area, additional data not presented in the Piceance Basin study can be reviewed more closely, while focusing on different criteria. This Analysis includes all surface water quality data from the Piceance Basin Data Repository collected in the Watershed from 2000 to 2009 (after 2009 data were no longer added to the Repository).

The Piceance Basin report found that limited data were available for field properties, major ions, nutrients, and trace elements on the mainstem of the Colorado River between Glenwood Springs and Cameo, Colorado. Many of the tributaries to the Colorado River also lack water quality data. The report noted that although there are numerous monitoring sites in the Watershed, they lack spatial and temporal consistency and there is a lack of stream flow data needed to assess pollutant loads in both the tributaries and mainstem of the Colorado River.

Five sites from the Watershed were included in the trend analysis presented in the Piceance Basin Report. The sites and analysis parameters are: Colorado River at Devereux Bridge for field properties, and major ion and metal concentrations, Colorado River above South Canyon Creek for major ion and metal concentrations, West Divide Creek for field properties, Colorado River at Rifle Bridge for field properties, and Dry Creek for streamflow, field properties, and major ion and metal concentrations.

4.1.2 Water Quality Data from the WQCD Data Call

The WQCD hosts a data call every two years to support the development of the 303(d) and M&E Lists. Water quality data submitted to the WQCD during the 2014 data call were used in this Analysis. Many of the data were submitted to the WQCD via the Colorado Data Sharing Network (CDSN). The CDPHE data set added 1,220 samples collected from 95 stream locations. Seventy-eight of the locations

were new or not included in the Piceance Basin Study. New data, from 2009 to 2013, were added to seventeen existing locations. Where possible, additional data collected between 2009 and 2013 and stored in other repositories, such as USGS National Water Information System (NWIS), were added to the data set.

4.2 Compiled Water Quality Data Set

The compiled data set used in this Analysis included Piceance Basin surface water quality data, WQCD surface water quality data, and additional surface water quality data collected in the Watershed from 2000 to 2013. Water quality samples were collected from 393 locations in the Watershed (Table 5). Surface water quality data collected from locations in the Watershed south of the Colorado River (Figure 3) accounted for up to sixty-five percent of the samples; although it varied by parameter.

Table 5. Summary of locations by subwatershed and type.

Subwatershed	Area (mi^2)	Location Types[1]			Total Locations
		Stream	Lake	Spring	
East Watershed	621	21	2	1	24
South Watershed[2]	693	128	39	93	260
West Watershed	708	51	4	42	97
Colorado River Ribbon	13	12	0	0	12
MCWC Watershed Total:	**2,022**	**212**	**45**	**136**	**393**

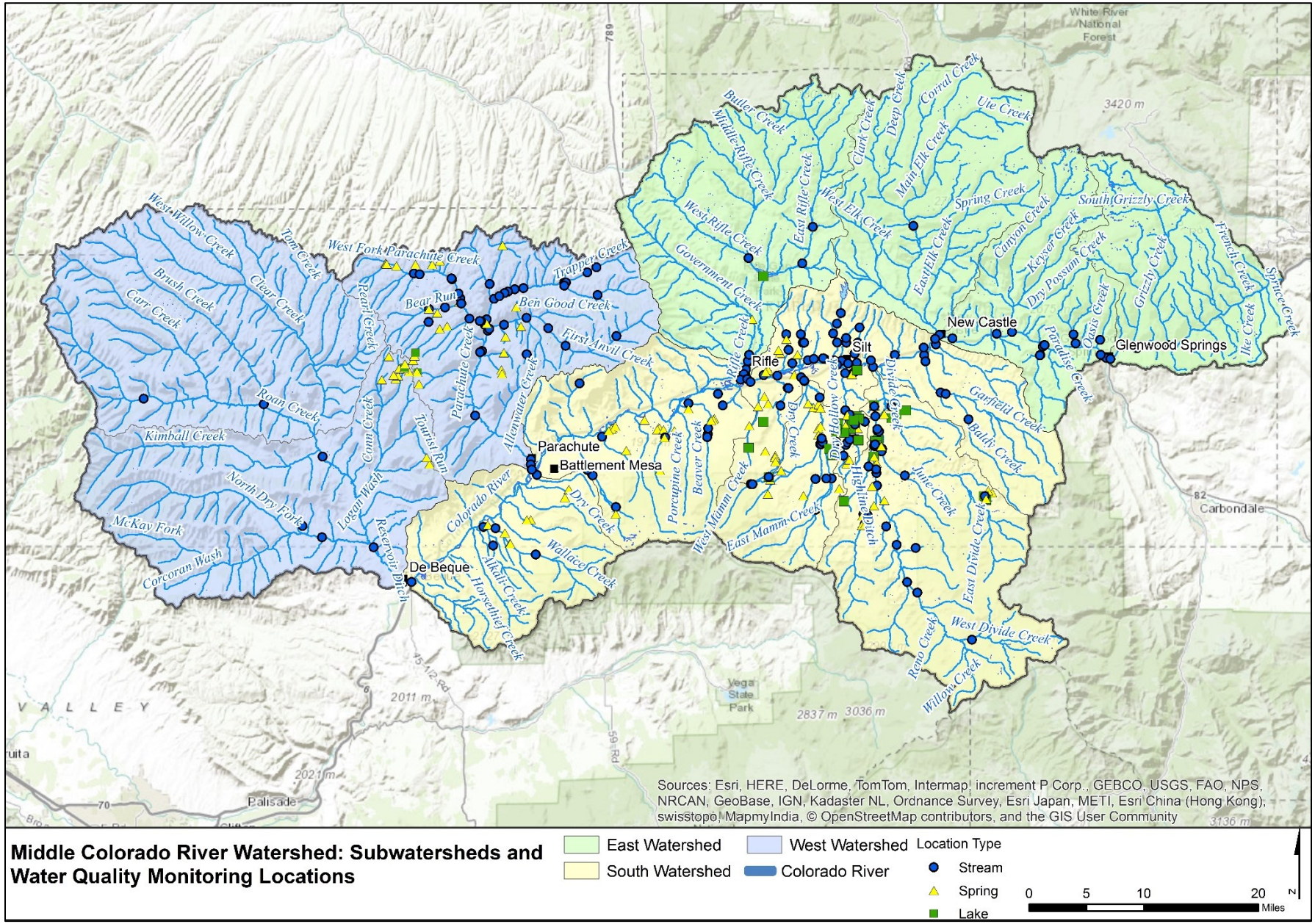
Notes
1. Does not include reference sites.
2. Site 704688 is a mine pit, but is included in the lake location type.

The data set best characterizes major metals and non-metals, minor metals and non-metals, and organics, including hydrocarbons. The data set lacks results for biological, nutrients, pesticides, radiochemical, sediment, and stable isotopes.

The number of sampling events at each location ranged from one to one hundred-thirty. Approximately eighty percent of the sites were sampled three times or less. Eight percent of the sites were sampled in twenty or more sampling events; sites where sampling occurred more than one hundred times accounted for less than two percent of the sites. Locations were not omitted from this Analysis based on the number of sampling events.

While many locations have been sampled, the data set is limited with respect to sampling frequency and spatial coverage. The size of the data set, which includes over one-hundred thousand records, required that the Analysis be carefully directed to assure the project remained within the scope of the assessment as a whole. The TAC established some guidelines which are outlined in the Analysis Methods (Section 5.0).

Figure 3. Water quality monitoring locations by site type in the Middle Colorado River Watershed.



4.3 Analysis Parameters

One objective of this Analysis was to better understand the water quality conditions in the Watershed. The 303(d) and M&E Lists provided a starting point to identify potentially problematic water quality parameters. Many other parameters, in addition to those included on the 303(d) and M&E Lists, were considered for inclusion in the Analysis. The following factors were used to help select the Analysis parameters:

- **Pollutant Origin:** The emphasis was on pollutants that may originate from nonpoint sources, since point source discharges are regulated by the State of Colorado.
- **Effect of Water Quantity:** How does the flow regime for intermittent, de-watered or managed systems affect the parameter? How does the parameter respond to various flow conditions? Can that response be managed effectively?
- **Adequate Metadata[3]:** Is there adequate Metadata associated with the results to provide context for the data? What was the purpose of sample collection? Was the sample collected in response to an event (large rainfall, spill, etc.) or to characterize normal conditions? This was especially important for data collected from energy production sites or at associated monitoring sites (such as residential springs or seeps). In general, this information is limited, which limits interpretation.
- **Actionable Outcomes:** Are issues attributed to the pollutant actionable on a local scale? Can education and outreach play a role in addressing nonpoint source pollution on private lands? For example, Rifle Gap Reservoir is impaired for mercury. However, it is not practical to address the problem on a local scale because mercury cycles globally and atmospheric deposition from remote sources plays a large role.
- **Funding Considerations:** What type of funding is available to implement projects to address the pollutant? The Colorado Nonpoint Source Program has identified selenium and metals, attributed to historic abandoned mines, as priority pollutants for funding. Several state and federal programs provide funding for salinity reduction efforts in the Colorado River Basin. Other agencies prioritize water quantity, supply, instream flows and habitat improvement when funding projects.

The list below introduces the parameters included in this Analysis and provides rationale for their inclusion.

4.3.1 Dissolved Selenium

Selenium is naturally found in sedimentary rocks in western Colorado. As water infiltrates through these rocks or soils derived from them, selenium can be transported to the nearest waterway, resulting in increased instream concentrations of selenium.

[3] Metadata refers to contextual information about the sample or measurement that answers the questions “who, what, where, how, and why”.

Selenium is a bio-accumulative metal; the degree to which it affects organisms varies by species and site-specific conditions (WQCC, 2013). Elevated selenium concentrations in the Watershed impact four endangered fish species found in the mainstem of the Colorado River downstream of the Watershed.

Water use practices play a large role in the amount of selenium mobilized due to human activities. Where excess water is applied to soils, regardless of the purpose, selenium can be mobilized. This condition, referred to as deep percolation, can accelerate the rate of natural weathering and groundwater return flows which, in turn, can increase instream concentrations of selenium. Additional pollutants including salts, iron, and others, can also be mobilized in this process. Agricultural, residential, and commercial irrigation, unlined ponds and canals, and other water uses can mobilize large quantities of selenium, particularly if they occur on soils derived from Mancos or Lewis shales (McMahon et al., 2011).

4.3.2 Nutrients

Several parameters were selected to evaluate the nutrient status of waterbodies including: total phosphorus, total nitrogen, dissolved nitrate, dissolved nitrite, dissolved ammonia, and chlorophyll *a*. Regulations 31 and 85 outline interim standards for nutrients. Since the standards are new, assessment and monitoring efforts can be used to assure more successful implementation of the new regulation and final standards.

Nutrients are required to support life. However, excess nutrients can cause eutrophication of waterbodies. Eutrophication is a process where a waterbody acquires excess phosphates and nitrates (Art, 1993), resulting in excessive plant and algae growth. As the organic materials are consumed by decomposers, dissolved oxygen concentrations can be severely depleted. Depletions in dissolved oxygen concentrations have the potential to disturb aquatic and riparian ecosystems. Eutrophication is most common in warm, slow moving rivers, and shallow lakes or ponds. Thus, nutrient control is a priority in supporting overall watershed health.

Common sources of nutrients can include runoff from fertilized areas, especially where fertilizer is over-applied, individual septic disposal systems, concentrated livestock feeding or grazing, and municipal or industrial wastewater treatment facilities.

4.3.3 Metals

Metals, including iron, lead, copper, and zinc have the ability to impair aquatic life if their concentrations exceed the applicable chronic standard and can be lethal or sub-lethal at concentrations greater than the acute standard.

Metals are bound in minerals in rock and soil throughout the earth's crust. As these materials weather, metals can be released. Weathering can be accelerated in areas where erosion is increased due to natural or anthropogenic factors. In some instances, natural conditions can result in elevated instream metal concentrations. Human activities that cause large scale ground disturbance, like mining

or road construction, expose soils and rock at the surface and can accelerate the weathering process and increase erosion. Over time these effects can also increase instream metal concentrations. Certain discharges also have the potential to increase instream metal concentrations.

The water supply standard for dissolved iron is a secondary standard. Secondary standards are applied to drinking water contaminants that can create issues associated with aesthetics, such as taste, odor or corrosion, but do not pose a risk to human health (EPA, 2013). Because it is a secondary standard, the WQCD does not typically address dissolved iron in TMDL assessments. Likewise, additional monitoring for streams with elevated dissolved iron concentrations is not necessary in most cases. Total iron concentrations (dissolved + total phases) are used to determine whether iron concentrations impair aquatic life.

4.3.4 Dissolved Oxygen

Dissolved oxygen is an important indicator of the health of a waterbody and sufficient concentrations are required to support healthy aquatic life. Undesirable conditions such as eutrophication are often characterized by low dissolved oxygen concentrations.

Water temperature influences dissolved oxygen concentrations. As water temperature increases, dissolved oxygen concentrations decrease. Water velocity and turbulence also effect dissolved oxygen concentrations. As water flows more quickly and along a more turbulent path, oxygen can be incorporated into the water, resulting in increased dissolved oxygen concentrations. In general, shallow, slow-moving, and warm waters have the lowest dissolved oxygen concentrations.

Large water discharges and water management practices such as diversions, can also influence water temperature. By keeping water in the channel, instream flow water rights tend to help moderate water temperatures, which is one of their key benefits. Geothermal features, which are found in the Watershed, may increase water temperature in certain areas.

4.3.5 *Escherichia coli*

E. coli is a coliform bacteria found in the intestines of humans and animals. Only certain strains of *E. coli* cause illness in humans. Potential sources of *E. coli* include individual sewage disposal systems, runoff from areas with intense grazing or where manure or other wastes are applied, and native wildlife.

E. coli is used as a proxy for other harmful microbes, such as Giardia, Cryptosporidium, and others. When *E. coli* concentrations exceed a certain threshold, it's likely that other harmful bacteria are also found in elevated concentrations. Contact with *E. coli* contaminated waters can cause minor illness, like nausea, diarrhea, and stomach cramps. The recreational use standards are intended to prevent these effects; and the standards for drinking water supplies are lower.

4.3.6 BTEX: Benzene, Toluene, Ethylene and Xylene

Benzene, Toluene, Ethylene and Xylene (BTEX) are the most soluble compounds associated with hydrocarbons. BTEX concentrations are often used to determine whether hydrocarbons are found in a waterbody; however, BTEX concentrations can decline rapidly as vapors are emitted from the water or sample. Locally, these compounds are important to monitor due to stormwater runoff and energy development in the Watershed.

4.3.7 Salinity

Salinity, or salts dissolved in water, is an issue throughout the Colorado River Basin. Excess salinity can limit the beneficial uses of water, particularly for agricultural and drinking water uses. In and upstream of the Watershed there are several geologic strata that deliver salts to the ground or surface waters.

The data set lacks real-time salinity data, especially outside of the mainstem of the Colorado River, and it is very difficult to draw conclusions from intermittent monitoring, especially without paired flow data, thus salinity was not addressed in detail in this Analysis. Other assessment and reports provide better data regarding trends in salinity (Tuttle and Grauch, 2009).

5.0 Analysis Methods

The methods used in this Analysis are outlined below.

5.1 Data Compilation

The goal of data compilation was to assemble all surface water quality data collected within the Watershed from 2000 to 2013 into a single format, link the data using accurate GIS data, and complete a data validation, and quality assurance-quality control (QA-QC) review. This process is summarized below:

1. Cropped the Piceance Basin Data Repository to include locations in the Watershed only.
2. Cropped the Piceance Basin Data Repository to include surface water samples collected from 2000 to 2009.
3. Removed other sample types, such as groundwater or sediment samples, from the data set. Other samples types were not included in the Analysis.
4. Added the WQCD Data Call data to the data set using a structure similar to the original USGS format. The time frame associated with the WQCD data was 2008 to 2013, but was longer for certain sites.
5. Queried other readily available data sources, such as USGS NWIS, to include additional water quality data collected from 2009 to 2013.
6. Verified sample Metadata, such as date, time, and location, to assure duplicate records were not created during the compilation.

7. Created a "common language" and units for each parameter. The original data sets included different names to document the same parameter (e.g., water temperature, temp-water or water, °C, etc.) and occasionally used different units. The parameter names and units were reviewed and made uniform across the data set while preserving the integrity of the original data.
8. Reviewed site coordinates and descriptions. The position of each location was verified for accuracy and the location description was clarified or improved, if needed.

5.2 Data Validation and QA-QC Review

1. Eliminated data with obvious QA-QC issues (e.g., pH values greater than 14). This effort was minimal due to the data review completed by USGS and WQCD during their respective compilation efforts.
2. Combined duplicate or adjacent locations. On occasion various agencies collected data at the same or very similar locations. Where this occurred, the locations were combined and named as recorded by the entity that sampled the site the most frequently. The Metadata was preserved as originally recorded and combined sites are clearly noted in the data set. This occurred at fewer than ten locations.
3. Eliminated duplicate water quality results. During the compilation process, it became obvious that either two entities had submitted the same data to USGS or WQCD during their respective data calls or that an entity had participated in both data calls. Where this occurred, the water quality data were reviewed and typically the data provided by the collecting entity was preserved.

5.3 Data Quality Considerations

The following sections present data quality considerations included in this Analysis.

5.3.1 Method Reporting Limit

The value of the method reporting limit (MRL) alters the utility of the data. MRL is defined as the lowest concentration of an analyte that can be accurately quantified with acceptable precision and accuracy, using standard methods and laboratory practices. A related term, the method detection limit (MDL) is defined as the minimum, non-zero concentration that can be measured with a high degree of confidence, but the exact concentration cannot be determined reliably. The MRL is typically set as three to five times the concentration of the MDL to assure that the concentration reported is known with a very high degree of accuracy and precision, regardless of any variation in the operating conditions at the laboratory. Analyte concentrations that range between the MDL and MRL are reported as estimated values. Estimated values were used in this Analysis; estimated values are not a large component of the data set.

All of the results indicate whether the analyte was detected in a given sample and typically include a value for the reporting limit (i.e., less than x). But in many cases, the type of reporting limit

was not provided. Because, several other terms exist to describe MDL and MRL, such as lower reporting limit (LRL), practical quantification limit (PQL), reporting limit (RL), and others, the term MDL was used during the data compilation and analysis process and is reported in many of the tables and the term MRL is used in text. In many cases the type of reporting limit is unknown. In general, the lowest MRL value for an analyte is presented as the lower value in a range of concentrations (i.e., less than x to y ug/L). Where the value of the MRL was not provided, the term less than the MRL was provided as the lower range of the concentrations (i.e., less than MRL).

During a water quality standard evaluation, results reported as less than the MRL are treated as a zero. When the MRL is greater than the standard it is not technically suitable to complete an evaluation. For example, a result of less than 10 ug/L (MDL = 10) indicates the sample has less than 10 ug/L of the parameter that was analyzed. If the standard for the parameter is 5 ug/L, this result is unusable; it lacks the precision to determine whether the sample concentration was greater than, less than, or equal to 5 ug/L. The suitability of the MDL was assessed in all of the standards evaluations. The suitability of the MRL does not affect evaluations where the sample had measureable concentrations of an analyte. In some cases, particularly in the West Watershed, the MRL used for selenium analyses exceeded the chronic standard. Water quality standards are not related to the MRL.

5.3.2 Dissolved Oxygen

Dissolved oxygen concentrations are dependent upon water temperature and stream flows. Cooler water temperatures and increased stream flow, especially water velocity and turbulence, tend to increase dissolved oxygen concentrations. Therefore, stream temperature and flow provide valuable context to interpret dissolved oxygen measurements. There is very limited flow data in the Watershed.

The 15th percentile dissolved oxygen concentration, measured under representative flow and temperature conditions, is used to determine attainment at individual monitoring sites (WQCD, 2013). Regulation 31 exempts dissolved oxygen criteria from surface waters of wetlands due to naturally occurring anoxic (low oxygen) conditions in some wetlands (WQCD, 2013). The sites classified as springs lack detailed site descriptions to determine whether the seep or spring supports a wetland (i.e., Metadata), where anoxic conditions may naturally occur. Similarly, lakes or ponds sampled may support wetlands or the water levels may fluctuate widely due to management practices. In general, flow or stage was not measured or estimated at spring and pond sites which, along with water temperature, provides valuable context for dissolved oxygen assessments.

Additionally, it is not possible to determine whether all dissolved oxygen measurements were made in-situ, or if sample vessels were used, and whether the probes were properly maintained (i.e., Metadata). Such factors make it difficult to infer whether some sites have insufficient dissolved oxygen concentrations. To be conservative, all of the dissolved oxygen data were included in the assessment. In some circumstances, temperature data were used to corroborate dissolved oxygen concentrations. The results should not be construed as impairment of the dissolved oxygen standard, especially for data collected from spring or lake sites because there is generally a lack of Metadata.

5.4 Subwatersheds

The Watershed is over two-thousand square miles and includes nearly four hundred water quality monitoring sites. To facilitate this Analysis the Watershed was divided into four subwatersheds based on common characteristics, including geology, climate, ecology, land use, and other factors. The subwatersheds, also referred to as watersheds, are introduced in their respective sections.

5.5 Use of Segments and Water Quality Standards

Water quality standards are established to protect beneficial uses. Because the standards relate to specific uses, such as agriculture or aquatic life, they are a useful tool to evaluate the status of a waterbody. Water quality standards are particularly useful where there is limited data for a given location. Eighty percent of the locations in the Watershed have been sampled three times or less. Each of the samples was an instantaneous characterization of the water quality. Without a larger record of data, it is difficult to interpret the results; this underscores the utility of water quality standards as a baseline for understanding historic and current conditions.

Regulations 33 and 37 establish segments, which group waterbodies according to shared characteristics, beneficial uses, and other factors. Because segments are grouped on a basin scale they often include several adjacent waterbodies that are tributary to a common waterbody (e.g., the East Fork, West Fork, and Middle Fork of a tributary may be grouped together as a single segment and the mainstem may be on a different segment). Alternatively, in a given waterbody, the character or uses may change from the headwaters to the confluence with another waterbody, so a single waterbody may be divided into several segments (e.g., the Colorado River is split into three separate segments within the Watershed). Because water quality standards protect beneficial uses which are assigned to segments, rather than individual waterbodies, standards assessments are typically performed on a segment by segment basis. This report follows that protocol; Sections 6.0 through 9.0 are organized to present the results of the Analysis by segment within each subwatershed. Specific waterbodies are discussed within the segment discussion, rather than individually.

Segment numbers are abbreviated in this Analysis. The prefix COLCLC or COUCUC that refers to either the Lower Colorado (Regulation 37) or Upper Colorado (Regulation 33) River Basin is omitted. Segments in the Upper Colorado River Basin are denoted with “UC” following the segment number to eliminate duplication between segments in the Upper and Lower Colorado River Basins. The East Watershed and the Colorado River include segments from both the Upper and Lower Colorado River Basins.

This Analysis deviates from a strict standards evaluation in the approach used on hardness-dependent water quality criteria; which are associated with the standards to protect aquatic life. Hardness-based numeric criteria, called table value standards (TVS), rely on hardness concentrations measured at the sample location to calculate the chronic or acute standard for several metals. A typical evaluation would use the lower value of the 95 percent confidence interval of the average hardness

value to calculate the TVS standard for that sample (i.e., hardness and metal concentrations are paired for by location).

For this Analysis, an average hardness value was calculated for each segment from stream samples on that segment. This deviation from the typical procedure was necessary due to the large size of the data set and some limitations within the data set (e.g., not all samples were analyzed for hardness, or calcium and magnesium concentrations). Further, a segment-wide average hardness value improves the characterization of water hardness in areas with low sample frequency. A confidence interval was not applied to the hardness values in this Analysis. This approach resulted in an estimated standard. Where an apparent exceedance occurred, the TVS standard was calculated using hardness data from the location in question. The result was evaluated against the location specific TVS standard, and results were only reported as exceedances where the TVS standard was exceeded using location specific hardness concentrations. Because the approach used to calculate hardness dependent TVS standards varies from the methods outlined in Regulation 31, exceedances reported in this Analysis should be considered preliminary in nature.

5.6 Data Summarization Methods

The sample size at a particular site for a given parameter affects the suitability of most analysis methods. In this Analysis the following guidelines were used for result statistics:

1. The range for a parameter is reported along with the number of samples regardless of the number of results. Where possible, the value of the MRL is reported.
2. Where there are less than five results for a parameter, the median may be a suitable summary statistic and may be reported where appropriate.
3. Where there are five to twenty results, an average may be a suitable summary statistic and may be reported, where appropriate.
4. Where there are more than twenty results, a percentile value may be a suitable summary statistic and may be reported along with the number of samples, where appropriate. On occasion fewer samples were used to calculate a percentile, where this occurred the number of samples is noted.
5. Two methods were used for percentile calculations. For percentiles associated with standards evaluations (85^{th} and 15^{th} percentiles), results less than the MRL were treated as zeroes, per the WQCD's methods. For percentiles not associated with standards evaluations (those reported in the summary tables for each watershed) the value of the MRL was used for the percentile calculation, rather than a zero, per the request of TAC members.
6. Results less than the MRL bias calculations because a value, either zero or the MRL, is assigned to represent an unknown concentration. To help clarify the effect of results less than the MRL, the percent of results less than the MRL was also reported. For percentiles calculations, where the percent less than the MRL is low, the bias attributed to the MRL is also low. Where the percent less than MRL was high, the bias attributed to the MRL is also high.

7. Estimated values, which are results reported by the laboratory that are between the MDL and MRL, were used in the analysis. This is preferable because it eliminates the bias associated with the MRL.

An initial assessment was completed for each subwatershed with all of the available data. The results were evaluated and additional detailed assessments were completed by subwatershed for each Analysis parameter where the following criteria were met:

1. At least twenty samples were collected for the Analysis parameter.
2. At least thirty percent of the results had concentrations greater than the MRL.
3. If the subwatershed included a 303(d) or M&E Listed segment, the listed parameter was analyzed in the subwatershed.

If a parameter was not selected for detailed analysis it was identified as a data gap, where appropriate. There are two types of data gaps, spatial and analytical. Spatial data gaps are areas that lack information for one or more parameters. Analytical data gaps represent a lack of information with respect to a specific parameter. Both types of data gaps are common in the Watershed.

Water quality parameters vary through time (temporally) in response to changes in flow, precipitation, water use, and other factors. Understanding the timing and extent of such variation provides valuable insights which may help identify pollutant sources and mitigation strategies. Qualitative temporal assessments were also completed if the following conditions were met in a subwatershed:

1. One hundred or more results were available for an Analysis parameter.
2. The results were distributed throughout the year, established by a relatively equal number of samples each month.
3. Approximately thirty percent of the results had concentrations greater than the MRL.

Many parameters lacked the number of results, even distributions, or detectable concentrations. Therefore it was not possible to complete temporal assessments for many parameters or the results were inconclusive and are not presented in the report. Where temporal analyses were used, the date was converted to a Julian day. Julian days, the day of the year (e.g. February 1 is day 32), can make patterns through time more apparent.

6.0 East Watershed Water Quality Analysis and Discussion

The East Watershed begins at the head of Glenwood Canyon and extends to the Grand Hogback just west of New Castle and includes the area drained by Rifle Creek (Figure 4). Portions of Glenwood Springs, New Castle, and Rifle are also located in the East Watershed.

The East Watershed is approximately 621 square miles in size and includes 2,535 miles of perennial, intermittent and ephemeral tributaries. There are twenty-four water quality monitoring sites in the East Watershed (Table 6). Streams account for twenty-one of the locations, the majority of which are in the Rifle Creek and Canyon Creek watersheds.

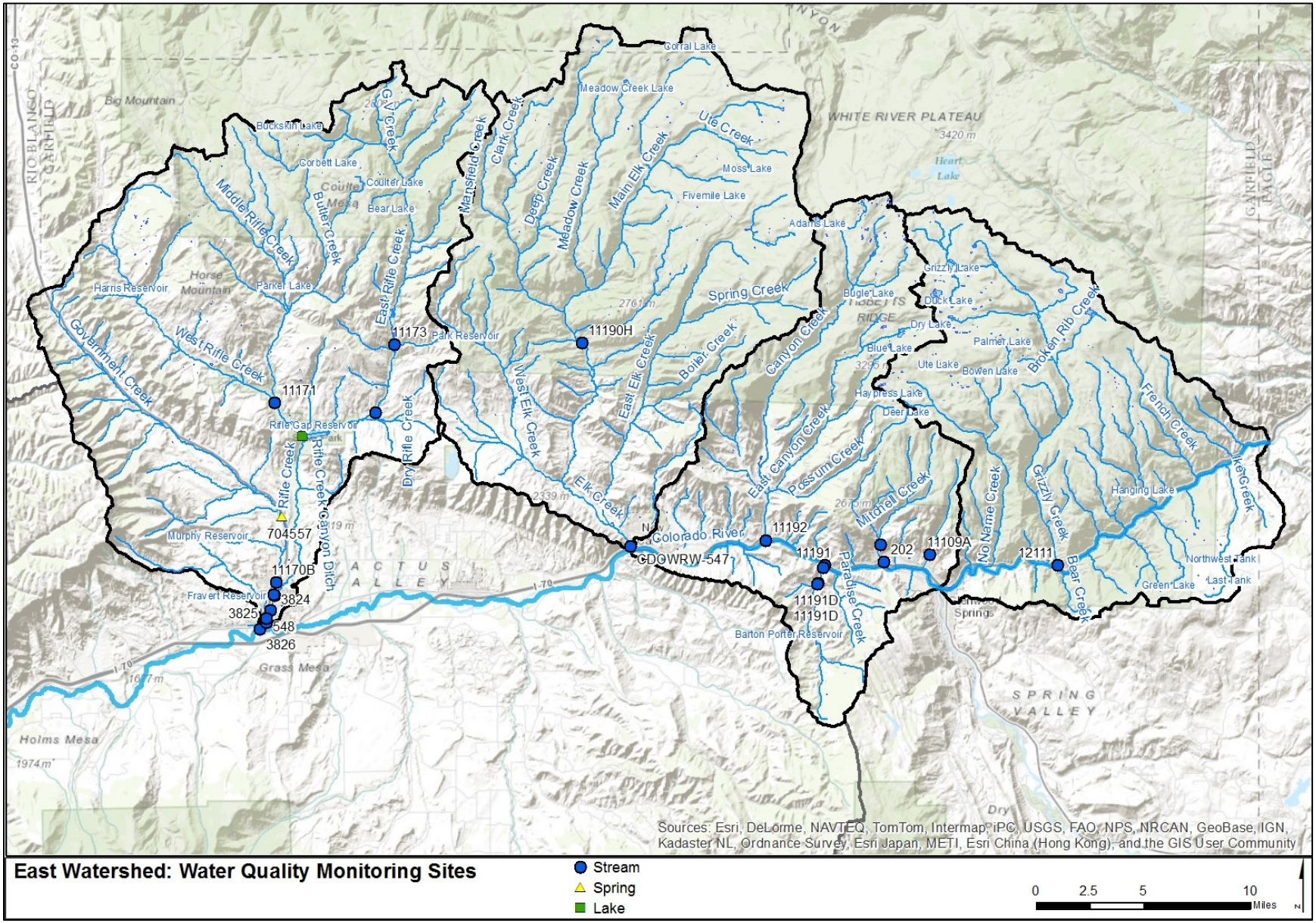
Table 6. Characteristics of the East Watershed.

HUC 10 Watershed	Area (mi^2)	Major Tributaries[1]	Length (mi)	Sample Location Type[2]			Towns
				Stream	Lake	Spring	
Glenwood Canyon-Colorado River	127.5	Grizzly Creek	17.3	1	0	0	Glenwood Springs, New Castle, Rifle
		No Name Creek	9.5				
		Ike Creek	6.2				
		West Fork Dead Horse Creek	6.2				
		French Creek	6.2				
Canyon Creek-Colorado River	114.3	Canyon Creek	15.8	8	0	0	
		East Canyon Creek	10.6				
		South Canyon Creek	6.9				
		Possum Creek	6.6				
		Mitchell Creek	6.3				
Elk Creek	179.3	Main Elk Creek	20.9	2	0	0	
		Government Creek	18.8				
		East Elk Creek	13.7				
		Deep Creek	12.5				
		West Elk Creek	10.2				
Rifle Creek	199.8	East Rifle Creek	18.9	10	2	1	
		Middle Rifle Creek	11.6				
		Rifle Creek	11.1				
		West Rifle Creek	10.8				
		Butler Creek	9.5				
East Watershed Total:	**620.8**	**All Tributaries[3]**	**2,535.6**	**21**	**2**	**1**	
				24			

Notes

1. The five longest named tributaries are presented for each HUC 10 Watershed.
2. Sample location type refers to the type of water feature the surface water quality sample was collected from.
3. All tributaries is a total of all named and unnamed tributaries in the East Watershed. The sum does not include the Colorado River.

Figure 4. Water quality monitoring sites in the East Watershed.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

The initial data compilation and analysis phase revealed a lack of data for several parameters, specifically dissolved nitrate, dissolved nitrite, and chlorophyll *a* data (Table 7). The existing data set has a limited number of total phosphorus and total nitrogen samples. These parameters are considered data gaps due to both limited baseline data and to support effective implementation of the numeric standards for total phosphorus and total nitrogen. To date, BTEX has been sampled on a very limited basis in the East Watershed. Unless energy development extends into the East Watershed, BTEX sampling may not be necessary; however, data collected at appropriate sites could characterize reference conditions.

Table 7. Summary statistics for analysis parameters in the East Watershed.

Parameter	Parameter Count	< MDL Count[1]	Percent <MDL[2]	Minimum	5th Percentile[3]	25th Percentile	Median	75th Percentile	95th Percentile	Maximum	Additional Analysis[4]	Data Gap	Regulatory Considerations
Dissolved Selenium (ug/L)	54	16	30%	1	1.00	1	1.4	3.9	6.18	13	Yes	Yes	303(d) listed
Total Phosphorus (mg/L)	40	15	38%	0.01	0.01	0.01	0.02	0.05	0.093	1.2	Yes	Yes	Reg. 85 (Nutrients)
Total Nitrogen (mg/L)	41	13	32%	0.1	0.2	0.29	0.41	0.5	0.52	2.3	Yes	Yes	Reg. 85 (Nutrients)
Dissolved Nitrate (mg/L)	2	1	50%	0	NA	NA	8	NA	NA	16	No, lack of data	Yes	
Dissolved Nitrite (mg/L)	1	1	100%	0	NA	NA	0	NA	NA	0	No, lack of data	Yes	
Dissolved Ammonia (mg/L)	52	29	56%	0.004	0.005	0.01	0.03	0.03	0.14	1	Yes	Yes	
Chlorophyll a (ug/L)	1	0	0	500	NA	NA	NA	NA	NA	500	No, lack of data	Yes	Reg. 85 (Nutrients)
Dissolved Iron (ug/L)	112	35	31%	2.6	4.74	10	17	36	106	3,200	Yes	No	
Total Iron (ug/L)	127	20	16%	0	10	18	110	991	8260	50,001	Yes	No	M&E list
Dissolved Lead (ug/L)	98	88	90%	0.37	1	1	1	1	5.085	12.3	Yes	Yes	M&E list
Dissolved Copper (ug/L)	100	87	87%	1	1.60	5	5	5	6.03	66	Yes	Yes	M&E list
Dissolved Zinc (ug/L)	109	56	51%	0.3	0.3	10	10	14	37.8	110	Yes	Yes	M&E list
Specific Conductance (uS/cm)	59	NA	NA	5.06	271	434	660.7	923	1591	2420	No		
Dissolved Oxygen (mg/L)	144	NA	NA	0.14	1.37	7.27	8.8	10	12.03	17.9	Yes	Yes	M&E list
E. coli (col/100 mL)	73	14	19%	0	0	1	28.5	179	627	1,986	Yes	Yes	M&E list
Benzene (ug/L)	1	1	100%	0	NA	NA	0	NA	NA	0	No, 100% < MDL	COGCC Monitoring Requirements	
Toluene (ug/L)	1	1	100%	0	NA	NA	0	NA	NA	0	No, 100% < MDL		
Ethylene (ug/L)	1	1	100%	0	NA	NA	0	NA	NA	0	No, 100% < MDL		
Xylene- all isomers (ug/L)	1	1	100%	0	NA	NA	0	NA	NA	0	No, 100% < MDL		

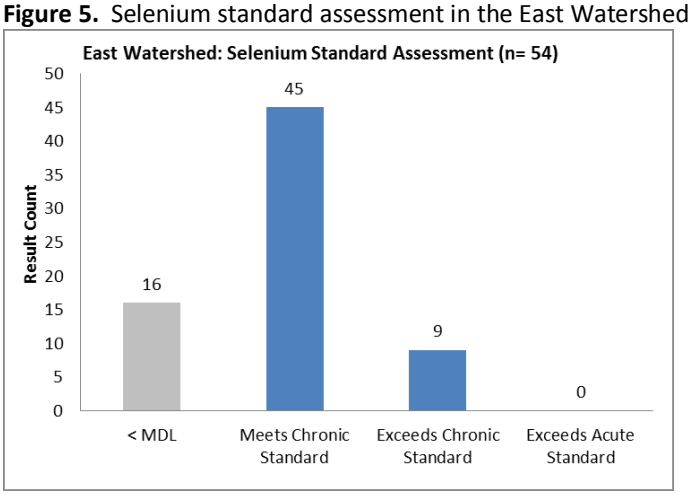
Notes

1. The count of results that were below the method detection limit (MDL).
2. The results below MDL expressed as a percent of all results (<MDL/total results).
3. Percentiles were not calculated unless there were 20 or more results for a given parameter.
4. This column identifies whether the parameter was selected for more detailed analysis.

6.1 Dissolved Selenium

Dissolved selenium concentrations ranged from less than 1 to 13 ug/L in 54 samples collected in the East Watershed (Table 7). Sixteen of the results were below the applicable MRL. All MRLs in the East Watershed were suitable to evaluate the chronic standard (i.e., MRL less than 4.6 ug/L). Nine of the dissolved selenium samples collected in the East Watershed exceeded the chronic dissolved selenium standard; the acute standard (18.6 ug/L) was not exceeded in any of the samples (Figure 5). The chronic standard was exceeded at five locations on three different segments (Table 8).

Figure 5. Selenium standard assessment in the East Watershed (n=54).



6.1.1 South Canyon Creek (Segment 4c)

Three of the sites where the chronic selenium standard was exceeded are located in South Canyon Creek on Segment 4c. The results are summarized from upstream to downstream in the following paragraphs.

In South Canyon Creek upstream of the South Canyon Hot Springs dissolved selenium concentrations ranged from 3.3 to 7.4 ug/L in four samples collected from August 2011 to May 2012 (Site 11191D; Figure 6). The chronic selenium standard was exceeded in two samples. South Canyon Creek below the hot springs was sampled once; the selenium concentration was 6 ug/L in March 2000, which is greater than the chronic selenium standard (Site 11191B; Figure 6).

Dissolved selenium concentration in South Canyon Creek at 134 Road, upstream of the Colorado River, ranged from 4.2 to 13 ug/L in four samples collected from July 2006 to April 2007 (Site 11191; Figure 6). Two samples exceeded the chronic selenium standard. Cumulatively, Segment 4c has been sampled nine times and five of the samples exceeded the chronic standard.

The South Canyon Hot Springs are individually characterized as Segment 4b. Dissolved selenium concentrations in the South Canyon Hot Springs ranged from less than 1 to 3.7 ug/L. Selenium concentrations were less than the chronic standard in all three samples and two of the samples were less than the MRL.

Samples collected from the Hot Springs and in South Canyon Creek downstream of the Hot Springs on the same day, on 10/17/2006 and 4/18/2007, did not exceed the chronic selenium standard. However, the selenium concentrations at the hot springs were below the MRL and the concentrations found in South Canyon Creek downstream of the hot springs were elevated relative to the hot springs at 4.1 and 4.2 ug/L for the 10/17/2006 and 4/18/2007 sampling events, respectively. South Canyon Creek above the Hot Springs was not sampled on these dates, however, selenium concentrations measured during 2011 and 2012 ranged from 3.3 to 7.4 ug/L. This suggests the upper portion of South Canyon Creek may be a source of selenium. The samples that exceeded the chronic selenium standard were collected during low flow conditions; however, there is not adequate data to correlate selenium concentrations to flow conditions in South Canyon Creek.

South Canyon Creek downstream of the hot springs, Segment 4c, is on the M&E List for selenium. Additional data should be collected along South Canyon Creek to better characterize selenium concentrations and determine the source of selenium. The existing data do not suggest the hot springs are a source of selenium. To date, sample collection efforts have not clearly isolated a selenium source. Potential sources above the hot springs include South Canyon Landfill, upper South Canyon Creek, and unnamed tributaries to South Canyon Creek.

6.1.2 Elk Creek (Segment 7a)

In Elk Creek near the mouth at the Highway 6 Bridge in New Castle, on Segment 7a, dissolved selenium concentrations ranged from 1.2 to 6.5 ug/L in thirteen samples collected from October 2002 to April 2007 (Site CDOWRW-547; Table 8). Three samples exceeded the chronic selenium standard on 10/23/2002, 11/24/2003, and 1/31/2003. These dates tend to characterize low flow conditions; however, there are insufficient data to characterize the relationship between selenium concentrations and stream flow in Elk Creek.

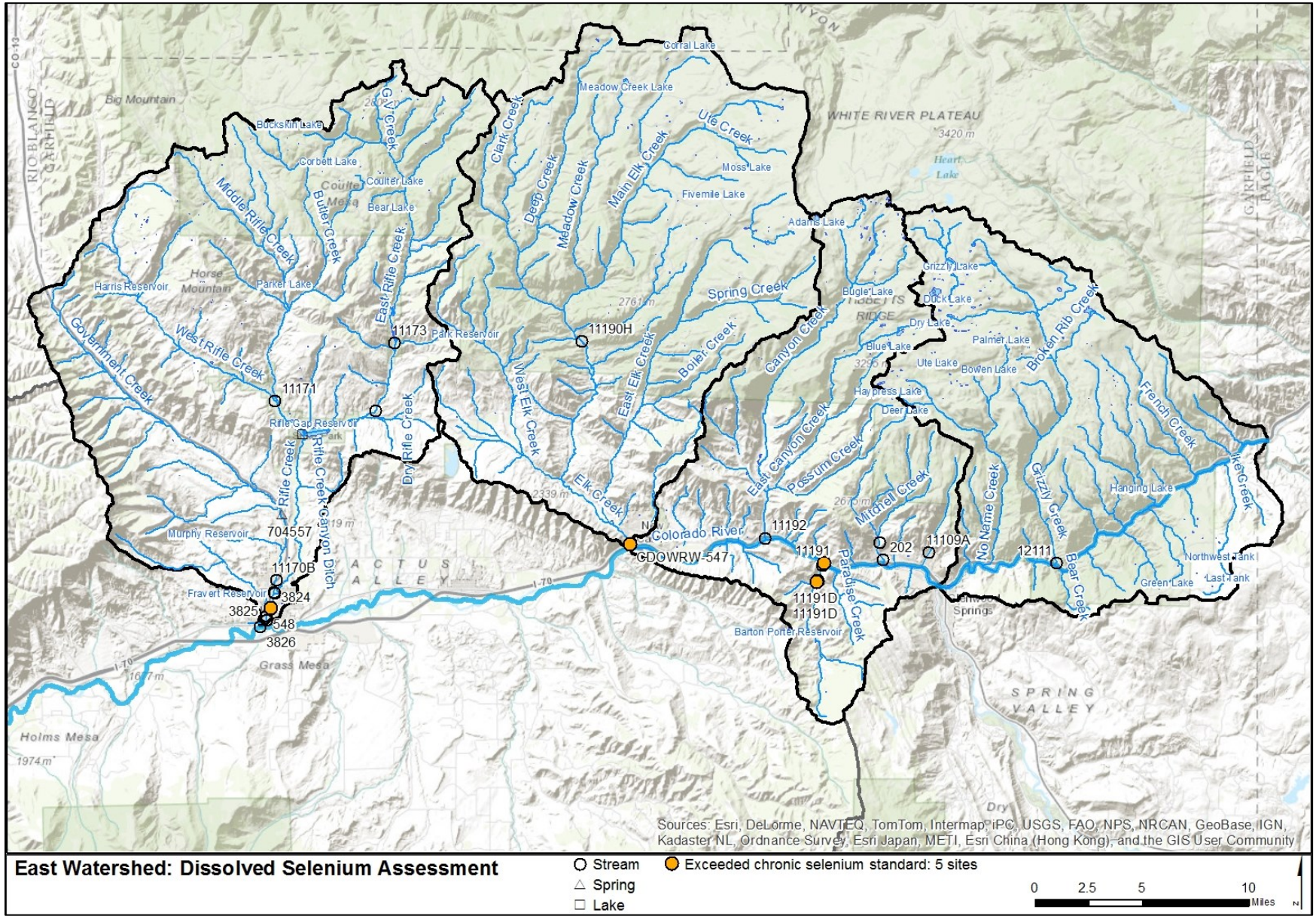
6.1.3 Rifle Creek and tributaries (Segment 10)

Dissolved selenium concentrations ranged from 1.4 to 4.8 ug/L in four samples collected from August 2006 to June 2007 in Rifle Creek at Railroad Avenue, about a mile upstream of the confluence with the Colorado River (Table 8 and Figure 6; site 11170). One sample exceeded the chronic standard for selenium. The selenium concentrations at other sample locations on Segment 10, Rifle Creek from its source and all tributaries, were below the chronic selenium standard. Segment 10 is on the 303(d) List for selenium. The TMDL priority for this segment is low. Additional data collection should occur to better characterize selenium concentrations and potential sources in Rifle Creek.

Table 8. Summary of locations where selenium concentrations exceeded the chronic standard (4.6 ug/L) in the East Watershed.

WQCC Segment	Site	Site Type	Number of Samples	Number of Exceedances	Minimum	Maximum
4c	11191	Stream	4	2	4.1	13
	11191B	Stream	1	1	6	
	11191D	Stream	4	2	3.3	7.4
7a	CDOWRW-547	Stream	13	3	1.2	6.5
10	11170	Stream	4	1	1.4	4.8

Figure 6. Water quality monitoring sites where dissolved selenium concentrations exceeded the chronic selenium standard.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

6.2 Total Phosphorus

Total phosphorus concentrations ranged from less than 0.01 to 1.2 mg/L in 40 samples from the East Watershed and 15 of the results were below the MRL (Table 7). One sample collected on Segment 4c from the mouth of South Canyon Creek (Figure 7; site 11191) exceeded the interim criteria for total phosphorus. The total phosphorus concentrations at the mouth of South Canyon Creek ranged from 0.02 to 1.2 mg/L. The sample that exceeded the interim criteria of 0.17 mg/L was collected on 10/17/2006, which typically characterizes low flow conditions.

All of the other total phosphorus samples were below the applicable interim criteria. This includes two samples collected from Rifle Gap Reservoir where total phosphorus concentrations were less than the MRL in both samples.

6.3 Total Nitrogen

Total nitrogen concentrations ranged from 0.1 to 2.3 mg/L in 41 samples collected in the East Watershed and total nitrogen was less than the MRL in 13 samples (Table 7). One sample collected in Rifle Creek at Railroad Avenue on 10/7/2008 exceeded the interim criteria for total nitrogen (Figure 7; site 11170). An additional 17 samples collected at this location were below the interim total nitrogen criterion (1.25 mg/L for Segment 10). The 85th percentile total nitrogen concentration for Rifle Creek at Railroad Avenue is 0.5 mg/L, which is below the interim criterion.

6.4 Dissolved Nitrate

Two dissolved nitrate samples were collected in the East Watershed (Table 7). One sample collected in East Rifle Creek above Rifle Gap Reservoir, on Segment 10, exceeded the applicable standard for dissolved nitrate (10 mg/L, Figure 7; site WCOP 99-0595). In the only sample collected to date, the dissolved nitrate concentration was 16 mg/L in East Rifle Creek above Rifle Gap Reservoir.

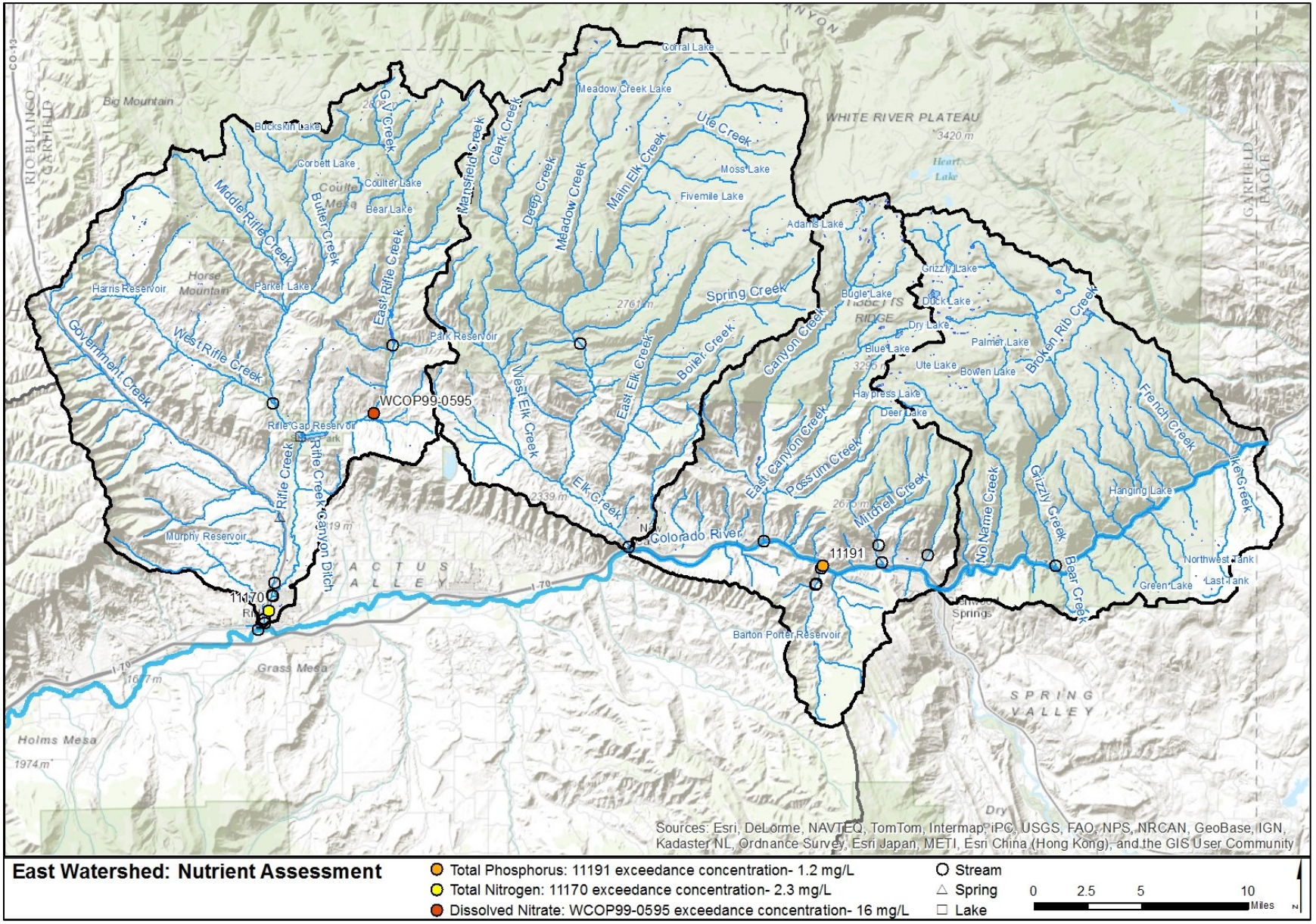
Table 9. Summary of locations where nutrient concentrations (mg/L) exceeded the applicable standard.

Site	Site Type	Parameter	Standard	Number of Samples	Percent < MDL	Minimum	Maximum
11191	Stream	Total Phosphorus	0.17, interim	4	0%	0.02	1.2
11170	Stream	Total Nitrogen	1.25, interim	18	39%	0.24	2.3
WCOP99-0595	Stream	Dissolved Nitrate	10	1	0%	NA	16

6.5 Dissolved Ammonia

Dissolved ammonia concentrations ranged from less than 0.005 to 1.0 mg/L in 52 samples (Table 7). The chronic standard for dissolved ammonia is both pH and temperature dependent. Even with the most restrictive temperature and pH values measured in the East Watershed, the chronic ammonia standard is greater than 1 mg/L which indicates all of the dissolved ammonia concentrations measured to date met applicable standards.

Figure 7. Water quality monitoring sites where nutrient concentrations exceeded the applicable standard.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

6.6 Dissolved Iron

Dissolved iron concentrations ranged from 2.6 to 32,000 ug/L in 112 samples where 35 samples had dissolved iron concentrations below the MRL (Table 7). Two samples collected at two locations exceeded the water supply criteria; all other samples had dissolved iron concentrations less than the water supply standard (300 ug/L).

6.6.1 South Canyon Creek (Segment 4c)

In South Canyon Creek near the mouth and below the hot springs, dissolved iron concentrations ranged from less than 10 to 3,200 ug/L in 13 samples. The water supply standard was exceeded on 10/17/2006, when the dissolved iron concentration was 3,200 ug/L (Figure 8; Site 11191). However, the other 12 samples collected near the mouth of South Canyon Creek had far lower dissolved iron concentrations and met the water supply standard.

6.6.2 Rifle Creek and Tributaries (Segment 10)

In Rifle Creek near Railroad Avenue dissolved iron concentrations ranged from 11 to 790 ug/L and one sample exceeded the water supply standard (Figure 8; site 11170). The sample that exceeded the water supply standard was collected on 4/22/2008, during spring runoff, and had a dissolved iron concentration of 790 ug/L. Dissolved iron concentrations in the other samples ranged from 11 to 56 ug/L which suggests that dissolved iron concentrations do not exceed the water supply standard (300 ug/L) on a regular basis. The water supply criterion for dissolved iron is a secondary standard. Secondary standards are not typically addressed in TMDLs; thus additional monitoring is not anticipated.

6.7 Total Iron

Total iron concentrations ranged from less than 3 to 50,000 ug/L in 127 samples collected from the East Watershed and 20 samples had total iron concentrations below the MRL (Table 7). The chronic total iron standard (1,000 ug/L) was exceeded in 31 samples collected at 11 locations (Table 10). The exceedances occurred on Segments 4c, 7a, and 10. The M&E List includes Segments 4c and 10.

Table 10. Summary of locations where total iron concentrations (ug/L) exceeded the chronic standard (1,000 ug/L)

WQCC Segment	Site	Site Type	Number of Samples	Exceedance Count	Percent < MDL	Minimum	Median	85th percentile	Maximum
4b	11191C	Stream	7	1	0%	32	110	NA	2,300
4c	11191	Stream	12	3	0%	48	412	1,310	2,700
	11191B	Stream	1	1	0%	NA	1,200	NA	NA
	11191D	Stream	4	3	0%	380	1,500	NA	2,700
7a	CDOWRW-547	Stream	25	2	4%	<10	76	463	1,673
10	548	Stream	6	5	0%	981	24,815	NA	50,001
	3826	Stream	1	1	0%	NA	1,251	NA	NA
	3827	Stream	1	1	0%	NA	1,732	NA	NA
	11170	Stream	22	9	0%	78	825	3,295	12,000
	11170B	Stream	4	2	0%	110	3,005	NA	11,000
	11171	Stream	4	3	0%	170	1,450	NA	1,900
East Watershed Total:				31					

6.7.1 South Canyon Creek (Segment 4c)

Four locations in South Canyon Creek, Segment 4c, exceeded the chronic total iron standard (1,000 ug/L) in eight samples. In South Canyon Creek, near the mouth downstream of the hot springs, dissolved iron concentrations ranged from 48 to 2,700 ug/L and four samples exceeded the chronic standard for total iron (Sites 11191 and 11191B; Table 10 and Figure 8). In South Canyon Creek upstream of the hot springs total iron concentrations ranged from 380 to 2,700 ug/L, with a median of 1,500 ug/L, and three of four samples exceeded the chronic total iron standard (Table 10; Site 11191D). Total iron concentrations at the hot springs in South Canyon Creek ranged from 32 to 2,300 ug/L; the maximum concentration was the only sample that exceeded the chronic standard in seven samples (Table 10; site 11191C). Based on four paired sample events, the hot springs do not appear to be a substantial source of total iron. During all four paired events the total iron concentration measured in South Canyon Creek upstream of the hot springs exceeded the concentrations measured in the hot springs.

6.7.2 Elk Creek (Segment 7a)

In Elk Creek, at Highway 6 in Newcastle, total iron ranged from less than 10 to 1,673 ug/L in 25 samples collected from November 2001 to January 2007 (Table 10; site CDOWRW-547). The samples collected in Elk Creek (Segment 7a) that exceeded the chronic standard were collected in 2003 and may have been omitted from the 2012 assessment because the samples are outside of the time frame, typically five years. Data collected from 2004 to 2007 did not exceed the chronic standard for total iron.

6.7.3 Rifle Creek and tributaries (Segment 10)

In Rifle Creek and its tributaries outside the boundary of the White River National Forest, Segment 10, six sites exceeded the chronic total iron standard in 21 samples. In Rifle Creek at Railroad Avenue Bridge, total iron concentrations ranged from 78 to 12,000 ug/L and the 85th percentile concentration is 3,295 ug/L. The chronic total iron standard was exceeded in 9 of 22 samples. Additional total iron data are available from Rifle Creek near the confluence with the Colorado River (Figure 8; sites 548 and 3826). Total iron concentrations in Rifle Creek near the confluence with the

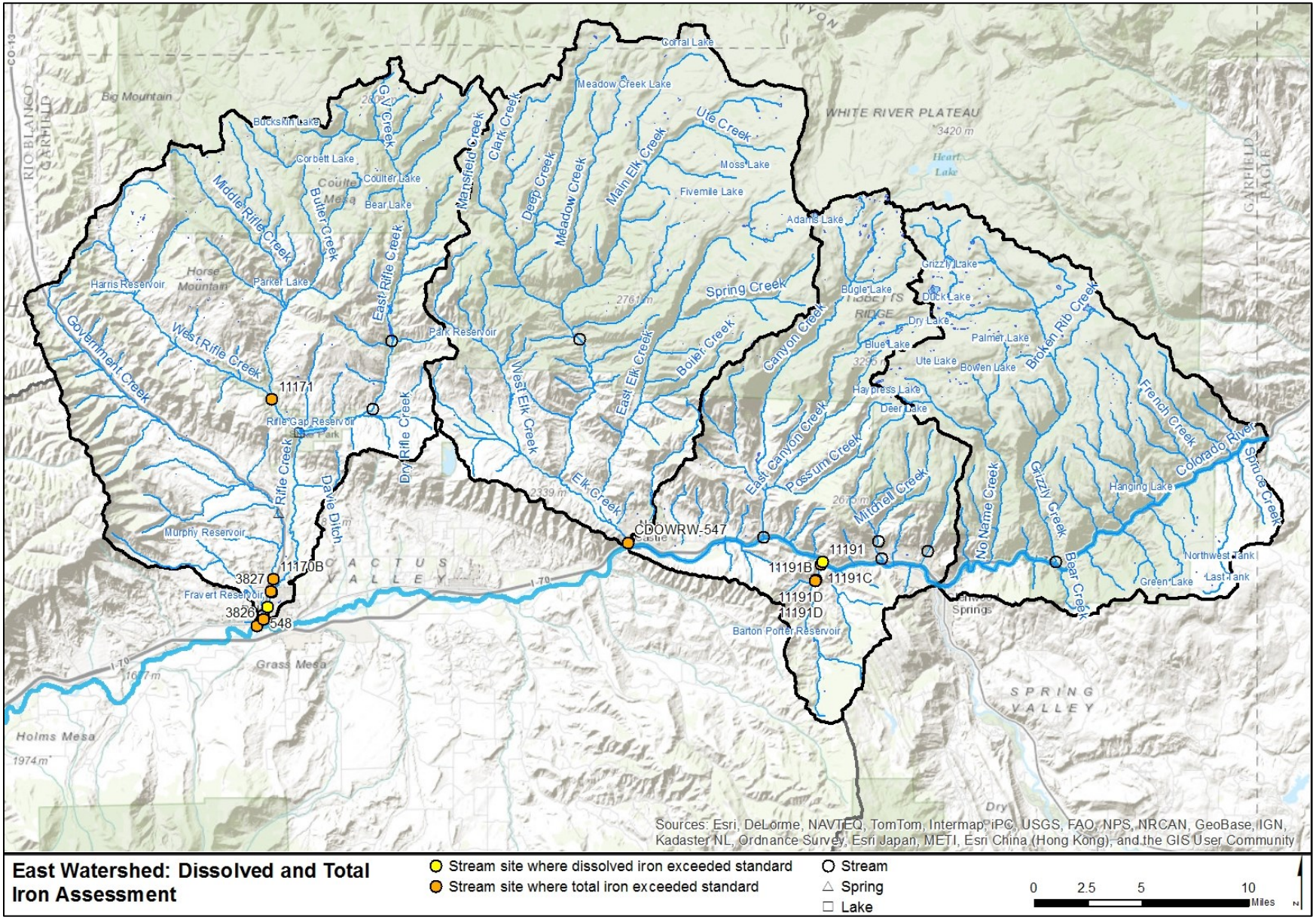
Colorado River ranged from 981 to 50,001 ug/L and six of seven concentrations exceeded the chronic standard (Table 10; sites 548 and 3826). The majority of the exceedances in Rifle Creek occurred between April and June when stream flow increases in response to snowmelt.

In Government Creek above the confluence with Rifle Creek total iron concentrations ranged from 110 to 11,000 ug/L in five samples and three samples exceeded the chronic total iron standard (Table 10 and Figure 8; sites 3827 and 11170B). The samples that exceeded the standard were collected during August, September and March; these months typically characterize low flow conditions.

In West Rifle Creek at Rifle Gap State Park total iron concentrations ranged from 170 to 1,900 ug/L in four samples (Table 10 and Figure 8, site 11171). Three samples exceeded the total iron standard. In East Rifle Creek at Rifle Falls State Park, total iron concentrations ranged from 10 to 22 ug/L in four samples. Middle Rifle Creek has not been sampled. Rifle Gap Reservoir near the dam was sampled at two depths in July 2006 and total iron concentrations were 42 and 50 ug/L in the only samples collected to date.

The existing data set suggests that total iron concentrations are elevated in West Rifle Creek, Government Creek, and Rifle Creek near the confluence with the Colorado River. However, the existing data do not clearly identify specific point or nonpoint sources. Additional data collection should occur to better delineate sources of iron.

Figure 8. Water quality monitoring sites where dissolved or total iron concentrations exceeded the applicable standard.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

6.8 Dissolved Lead

Dissolved lead concentrations ranged from 0.37 to 12.3 ug/L in 98 samples collected in the East Watershed and ninety percent of the dissolved lead concentrations were below the MRL (Table 7). None of the lead samples collected in the East Watershed exceeded the chronic or acute lead standards. Alkali Creek, a part of Segment 4a located in the South Watershed, is on the M&E List for dissolved lead. The East Watershed also includes portions of Segment 4a. However, the tributaries on Segment 4a in the East Watershed have not been sampled to date.

6.9 Dissolved Copper

In the East Watershed dissolved copper ranged from less than 1 to 66 ug/L in 100 samples and 87 percent of the dissolved copper concentrations were below the MRL (Table 7). The maximum concentration in the East Watershed of 66 ug/L was measured near the mouth of South Canyon Creek downstream of the hot springs on 10/17/2006. The concentration exceeded the chronic and acute standard and prompted the M&E Listing for Segment 4c. To date, three other samples were collected from the mouth of South Canyon Creek downstream of the hot springs and dissolved copper concentrations were below the MRL.

6.10 Dissolved Zinc

Dissolved zinc concentrations ranged from less than 0.3 to 110 ug/L in 109 samples; where 56 samples were below the MRL in (Table 7). All of the dissolved zinc concentrations in the East Watershed were below the chronic and acute criteria. Alkali Creek, a part of Segment 4a located in the South Watershed, is on the M&E List for dissolved zinc. The East Watershed also includes portions of Segment 4a; however, the tributaries on Segment 4a in the East Watershed have not been sampled to date.

6.11 Dissolved Oxygen

Dissolved oxygen concentrations ranged from 0.14 to 17.9 mg/L in 144 measurements in the East Watershed (Table 7). Nineteen dissolved oxygen measurements, collected from five locations, fell below the minimum acceptable concentration (6.0 mg/L). All other dissolved oxygen concentrations were greater than the applicable standard, 6.0 mg/L for cold waters and 5.0 mg/L for warm waters.

6.11.1 South Canyon Hot Springs (Segment 4b) and South Canyon Creek (Segment 4c)

Dissolved oxygen concentrations in South Canyon Hot Springs ranged from 0.48 to 5.28 mg/L and were less than the standard in six of seven samples (Table 11 and Figure 9; site 11191C). The hot springs increased the stream temperatures measured in South Canyon Creek downstream of the hot springs and water temperature ranged from 36.9 to 42.5 degrees Celsius.

In South Canyon Creek near the confluence with the Colorado River (site 11191), stream temperature ranged from 5.0 to 24.6 degrees Celsius and the increase in temperature due to the hot springs was less apparent. Due to cooler and more typical water temperatures, dissolved oxygen concentrations in South Canyon Creek downstream of the hot springs increased as the distance from the hot springs increased. Dissolved oxygen concentrations in South Canyon Creek above the confluence with Colorado River ranged from 5.16 mg/L to 11.49 mg/L (Table 11). Given the elevated temperatures attributed to the natural hot springs and the temperature dependence of dissolved oxygen concentrations, a site specific standard may be a suitable alternative to the current standard applied to Segment 4b. Currently, Segment 4b is on the M&E List for dissolved oxygen.

Table 11. Summary of monitoring sites where dissolved oxygen concentrations (mg/L) were below the standard (6.0 mg/L).

WQCC Segment	Site	Site Type	Number of Results	Count of < standard	Minimum	Median	Maximum
4b	11191C	Stream	7	6	0.48	3.91	5.28
6	11109A	Stream	5	1	5.73	9.70	14.02
10	704557	Spring	1	1	0.48		
20	11176A	Lake	17	9	0.14	5.52	7.01
	11176B	Lake	1	1	0.27		

6.11.2 Rifle Gap Reservoir (Segment 20)

In Rifle Gap Reservoir, approximately 100 feet from the dam, dissolved oxygen concentrations ranged from 0.14 to 7.01 mg/L on 7/26/2006 and accounted for ten of the dissolved oxygen samples that fell below the 6.0 mg/L threshold (Table 11 and Figure 9; sites 11176A and 11176B). It appears that dissolved oxygen concentrations were profiled by depth and 18 measurements were completed in succession. The water temperature was 23.25 and 23.2 degrees Celsius for the upper and lower depths respectively, which suggests the reservoir was not stratified. The temperature fell just above the current standard of 23.0 degrees Celsius (WQCD, 2013); however the current standard was not in effect during 2006. The data did not result in a 303(d) or M&E Listing for Rifle Gap Reservoir.

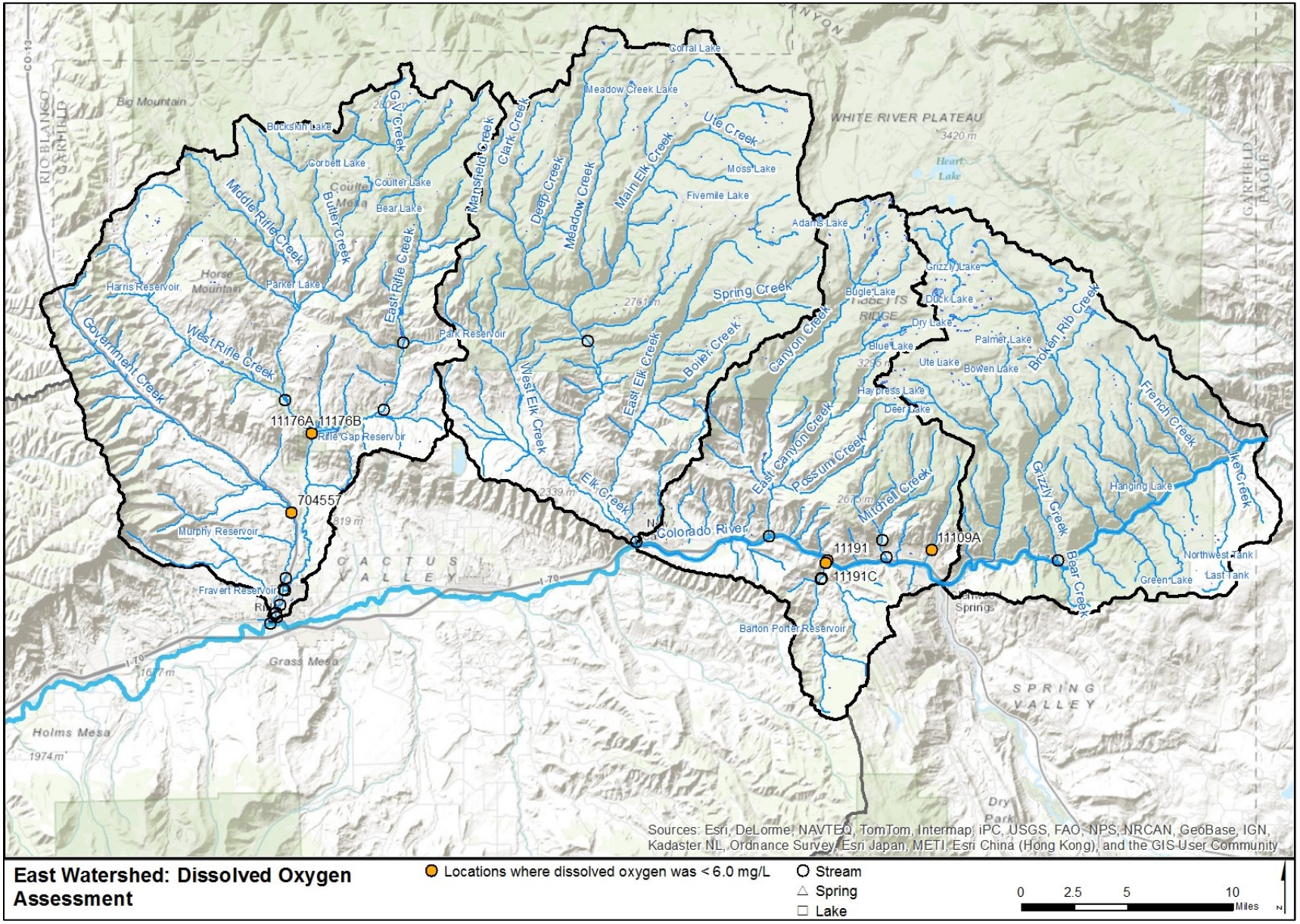
6.11.3 Oasis Creek (Segment 6)

In Oasis Creek above the diversion point at 600 Highlands Road, dissolved oxygen concentrations ranged from 5.73 to 14.02 mg/L in five measurements and one concentration was below the standard (Table 11 and Figure 9; site 11109A).

6.11.4 Government Creek (Segment 10)

On 9/21/2005, in the only sample collected to date, the dissolved oxygen concentration was 0.48 mg/L in a spring near Government Creek and Highway 13 (Table 11 and Figure 9; site 704557). The sample was collected in late summer and the water temperature was 44.8 degrees Celsius, which may indicate shallow standing water. The data set does not include additional information about the spring.

Figure 9. Water quality monitoring sites where dissolved oxygen concentrations were less than the standard (6.0 mg/L).



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

6.12 *Escherichia coli*

E. coli concentrations ranged from less than the MRL to 1986 colonies per 100 mL in 73 samples collected in the East Watershed (Table 7). Twenty-four samples collected from eight locations exceeded the applicable *E. coli* standard.

In the South Canyon Hot Springs *E. coli* concentrations ranged from less than 1 to 218 colonies per 100 mL and one of five samples exceeded the standard, 126 colonies per 100 mL (Table 12; site 11191C on Segment 4b). Downstream of the hot springs in South Canyon Creek, on Segment 4c, *E. coli* concentrations were elevated, perhaps due to warmer water temperatures. In South Canyon Creek below the hot springs *E. coli* concentrations ranged from 1 to 1106 colonies per 100 mL and exceeded the standard in four of thirteen samples (Table 12 and Figure 10; sites 11191 and 11191D). The exceedances occurred during low flow conditions in July, August, and October.

Table 12. Monitoring sites where *E. coli* concentrations (colonies per 100 mL) exceeded the standard (126 colonies per 100 mL).

WQCC Segment	Monitoring Site	Number of Results	Number < MDL	Minimum	Median	Maximum	Exceedance Count
4b	11191C	5	1	1	5.2	218.7	1
4c	11191	11	0	1	17.5	1106	3
	11191D	2	0	2	NA	304.4	1
7a	CDOWRW-547	4	1	0	31.15	435.2	1
	1192	4	1	0	101.4	260.2	2
10	11170	20	1	1	137.4	1986.3	10
	11170B	4	0	129.6	598.2	770.1	4
	11171	4	0	3.1	131.2	488.4	2
East Watershed Total Exceedance Count:							24

Samples collected from two sites on Segment 7a exceeded the *E. coli* standard. In Elk Creek at the Highway 6 Bridge *E. coli* concentrations ranged from 0 to 435 colonies per 100 mL and exceeded the *E. coli* standard in one sample (Table 12 and Figure 10; site CDOWRW-547). The exceedance occurred on 10/17/2006. In Canyon Creek near the mouth *E. coli* concentrations ranged from 0 to 260 colonies per 100 mL in four samples and two samples exceeded the standard (Table 12 and Figure 10; site 11192). The exceedances occurred on 10/17/2006 and 1/24/2007. Segment 7a is not on the 303(d) or M&E List for *E. coli*.

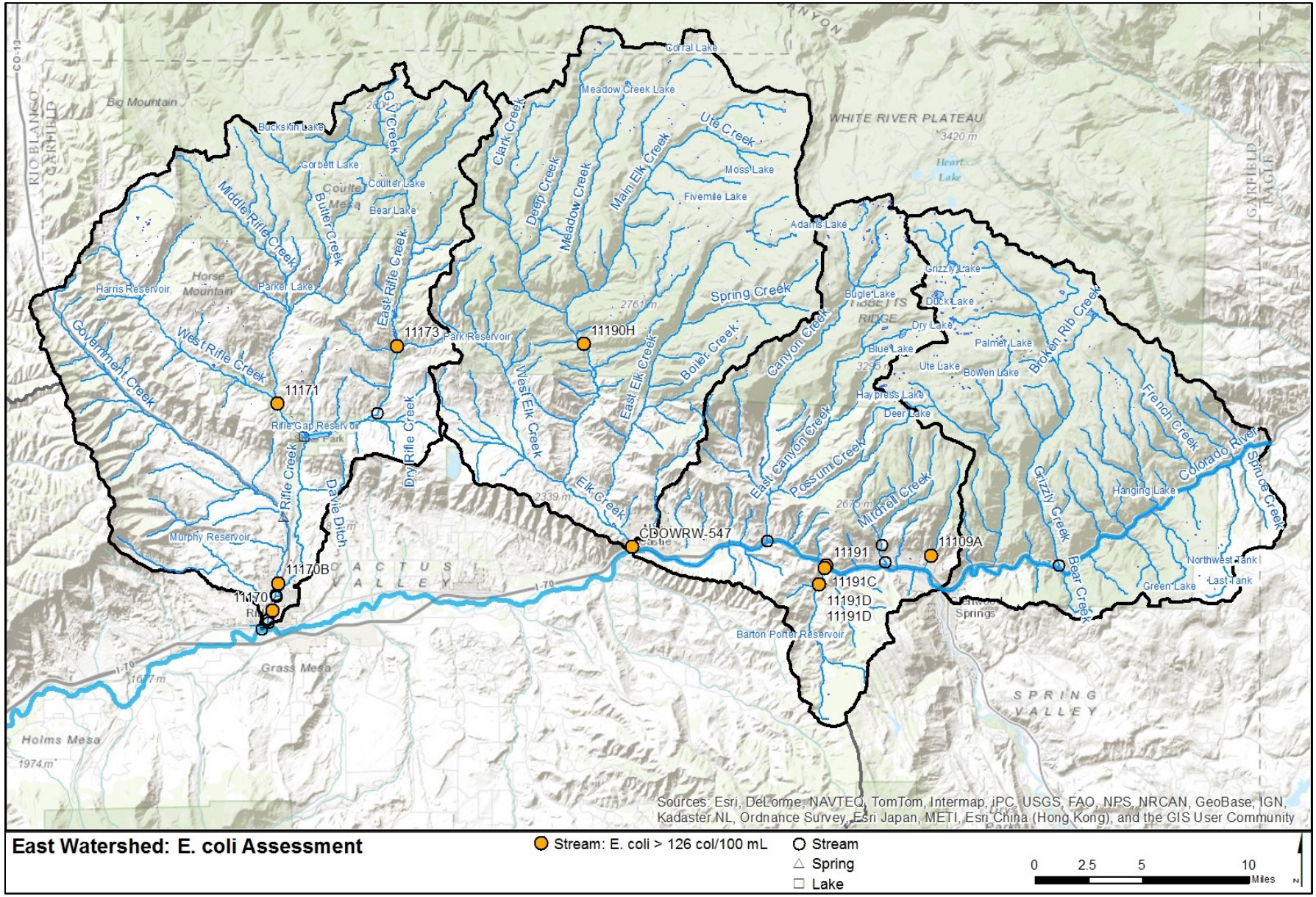
Three locations on Segment 10 had *E. coli* concentrations that exceeded the standard. In Rifle Creek at Railroad Avenue *E. coli* concentrations ranged from 1 to 1986 colonies per 100 mL in 20 samples and ten samples exceeded the *E. coli* standard (Table 12 and Figure 10; site 11170). The samples that exceed the standard were collected during the summer and early fall where low flow conditions and warm water temperatures may increase *E. coli* survival. The median concentration was 137.4 colonies per 100 mL which approaches the standard of 126 colonies per 100 mL for Segment 10 (Table 12).

In Government Creek at Highway 13 *E. coli* concentrations ranged from 129 to 770 colonies per 100 mL in four samples and all concentrations exceeded the standard (Table 12 and Figure 10; site

11170B). The samples were collected in August and October of 2011 and March and May of 2012 and tend to characterize a range of flow conditions which may suggest that elevated *E. coli* concentrations persist throughout the year in this portion of Government Creek.

In West Rifle Creek at Rifle Gap State Park *E. coli* concentrations ranged from 3 to 488 colonies per 100 mL and exceeded the standard in two of four samples (Table 12 and Figure 10; site 11171). The exceedances occurred in June and August. Samples collected from West Rifle Creek in October and April were less than the standard. *E. coli* samples have not been collected from Rifle Gap Reservoir. Segment 10 is not on the 303(d) or M&E List for *E. coli*.

Figure 10. Water quality monitoring sites where *E. coli* concentrations exceeded the standard (126 colonies per 100 mL).



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

6.13 Major Findings

The vast majority of water quality data in the East Watershed met applicable standards and supported existing water uses and overall watershed health. However, additional data collection could improve the vigor of the data set and allow for a more comprehensive evaluation.

Several tributaries in the East Watershed have not been sampled, including: Spruce Creek, French Creek, Ike Creek, Hanging Lake, and Dead Horse Creek, Cinnamon Creek, Devils Hole Creek, Deadmans Creek, Bear Creek, Grindstone Creek, No Name Creek, Cascade Creek, and Paradise Creek (Figure 4). The un-sampled creeks drain areas managed by the USFS and BLM with a limited number of privately held parcels. The headwaters of Elk and Rifle Creeks also lack water quality data. There are several popular recreation sites in this portion of the Watershed which may warrant a baseline characterization of water quality.

The Analysis has clearly identified South Canyon Creek, Rifle Creek, and to a lesser extent Elk Creek in the East Watershed as priorities for additional investigation. Current 303(d) and M&E Listings may help acquire funding and support for additional water quality monitoring in these areas. Additional water quality monitoring data will help determine whether these creeks support the designated uses for aquatic life and recreation, which based upon current data may be impaired. Paired flow measurements should be completed along with any additional sample collection to support load calculations which are a vital part of the TMDL assessment process.

Water quality in South Canyon Creek appears to be influenced by the effect of the South Canyon Hot Springs, particularly for stream temperature, dissolved oxygen, and *E. coli*. However, elevated selenium and iron concentrations near the mouth of South Canyon Creek may be attributed to other sources and warrants additional investigation. Sampling activities to date have isolated South Canyon Hot Springs and omitted other potential sources in the upper portion of the South Canyon Creek drainage.

The available data from Rifle Creek suggest that additional monitoring should occur to identify sources of selenium, iron, and *E. coli*. Dissolved oxygen concentrations should be characterized at Rifle Gap Reservoir to determine whether the 2006 measurements were representative of average summer conditions. Future characterization efforts should better evaluate tributaries to Rifle Creek including the east, middle, and west forks of Rifle Creek and Government Creek.

Existing data do not suggest that nutrient concentrations are a consistent issue in the East Watershed. However, only a limited number of nutrient samples have been collected to date. Additional data should be collected to support implementation of numeric standards for total phosphorous and total nitrogen and Regulation 85. Recent monitoring requirements associated with Regulation 85 may have increased the amount of data which should be incorporated into any future evaluations.

7.0 South Watershed Water Quality Analysis and Discussion

The South Watershed drains approximately 693 square miles and contains 2,846 miles of perennial, intermittent, and ephemeral tributaries (Table 13). Silt and portions of Rifle and Parachute are located in the South Watershed.

A small portion of the following HUC 10 watersheds are north of the Colorado River and are included in the South Watershed: Garfield Creek, Cache Creek, and Jerry Creek watersheds (Figure 11). The portions of the South Watershed that are north of the Colorado River are small relative to the total area and are more characteristic of conditions in the South Watershed than areas in the East or West Watersheds. The stream segments located in the area north of the Colorado River are grouped with tributaries to the south of the river.

The South Watershed has the most sample sites with a total of 260 (Table 13). Stream sites account for 128 of the sites, while lake and spring sites total 39 and 93 sites, respectively. Dry Hollow, Divide, and Mamm Creeks have the highest number of sites. The sample sites classified as lakes include ponds, reservoirs, and other small water features. The sample sites classified as springs include seeps and these sites may flow intermittently depending on season, drought conditions, water uses practices, and other factors. The west side of the South Watershed, near Debeque and Battlement Mesa, has fewer sample locations than the eastern portion of the South Watershed (Figure 11).

The data analysis revealed a lack of chlorophyll *a* data and a very limited number of total phosphorus, total nitrogen, and *E. coli* results (Table 14). These parameters are considered data gaps due the limited number of results and lack of spatial coverage. However, as components of total nitrogen dissolved nitrite and total ammonia concentrations provide some insight into nitrogen concentrations in the South Watershed. To date, 98 percent of the dissolved nitrite and 97 percent of the total ammonia concentrations were below the MRL in the South Watershed (Table 14). This may suggest that total nitrogen concentrations are not likely to be problematic at most locations in the South Watershed. To date, BTEX concentrations were measured in over 1,000 samples (Table 14). The vast majority of the BTEX results were below the MRL.

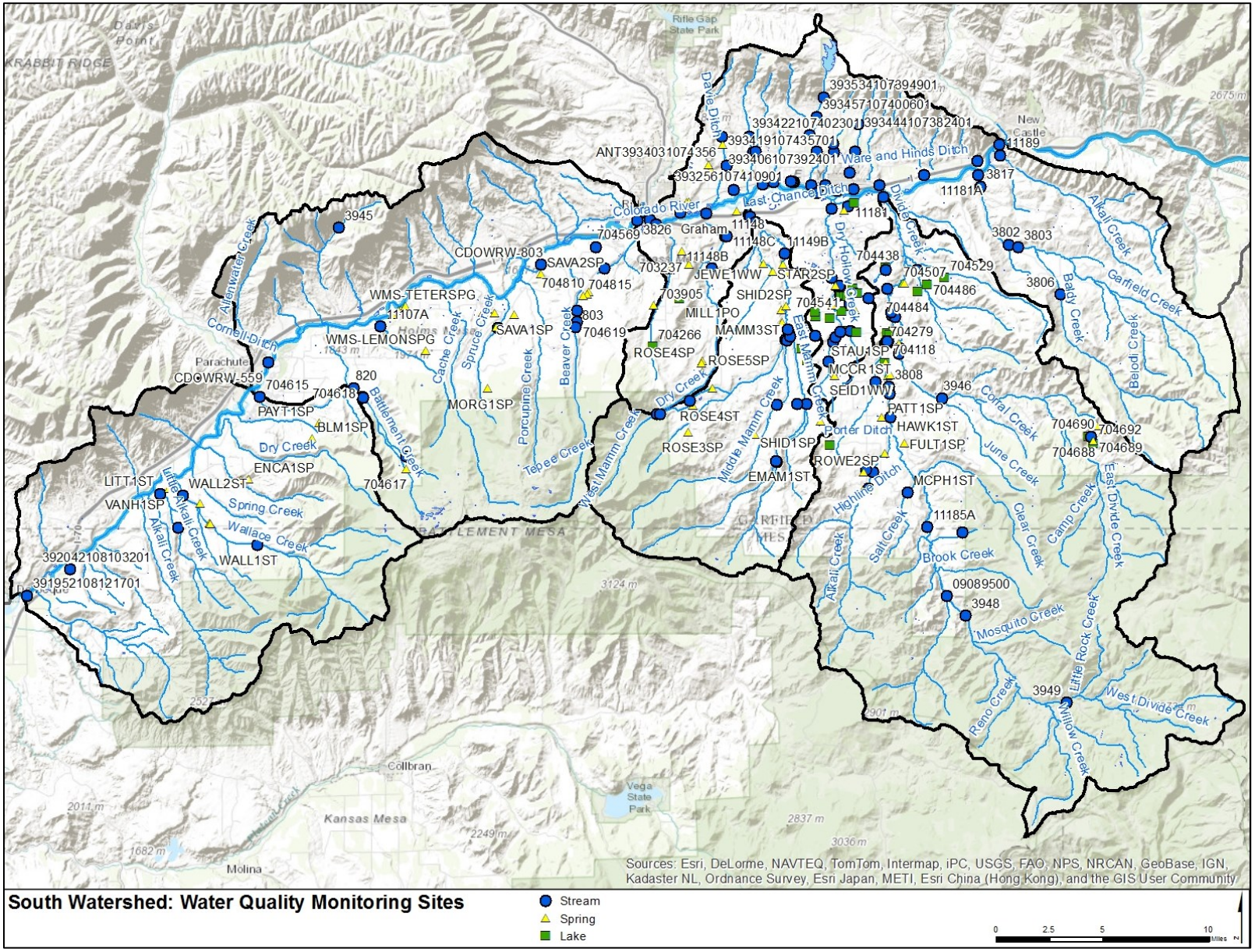
Table 13. Characteristics of the South Watershed.

HUC 10 Watershed	Area (mi^2)	Major Tributaries[1]	Length (mi)	Location Types			Towns
				Stream[2]	Lake	Spring	
Garfield Creek-Colorado River	155.2	Alkali Creek	31.2	52	20	27	Silt, Rifle, Battlement Mesa, Parachute and DeBeque
		Garfield Creek	15.7				
		Baldy Creek	11.6				
		Lower Cactus Valley Ditch	11.5				
		Dry Hollow Creek	9.2				
Divide Creek	201.1	West Divide Creek	28.7	34	16	21	
		East Divide Creek	19.7				
		Divide Creek	6.6				
		Willow Creek	8.6				
		Highline Ditch	12.1				
Mamm Creek	63.4	East Mamm Creek	12.6	22	3	17	
		Middle Mamm Creek	12.5				
		West Mamm Creek	10.6				
		Mamm Creek	7.5				
Cache Creek-Colorado River	148.9	Beaver Creek	12.8	13	0	19	
		Cache Creek	10.2				
		Battlement Creek	9.6				
		Porcupine Creek	8.5				
		Cottonwood Creek	6.3				
Jerry Creek-Colorado River	124.1	Dry Creek	19.6	7	0	9	
		Horsethief Creek	10.9				
		Wallace Creek	10.5				
		Pete and Bill Creek	7.2				
		Bluestone Valley Ditch	6.9				
South Watershed Total:	692.6	All Tributaries[3]	2,846.2	128	39	93	
				260			

Notes

1. The five longest named tributaries are presented for each HUC 10 Watershed.
2. Ditch sites were included along with stream sites.
3. All tributaries is a total of all named and unnamed tributaries in the South Watershed. The sum does not include the Colorado River.

Figure 11. Water quality monitoring sites in the South Watershed.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

Table 14. Summary statistics for analysis parameters in the South Watershed.

Parameter	Parameter Count	< MDL Count[1]	Percent <MDL[2]	Minimum	5th Percentile[3]	25th Percentile	Median	75th Percentile	95th Percentile	Maximum	Additional Analysis[4]	Data Gap	Regulatory Considerations
Dissolved Selenium (ug/L)	523	310	59%	0.28	1	1	1	5.5	15.8	55	Yes	Yes	303(d) listed
Total Phosphorus (mg/L)	33	7	21%	0.005	0.005	0.01	0.04	0.16	1.64	1.8	Yes	Yes	Reg. 85 (Nutrients)
Total Nitrogen (mg/L)	12	1	8%	0.39	NA	NA	1.02	NA	NA	3.6	Yes	Yes	Reg. 85 (Nutrients)
Total Nitrate (mg/L)	16	1	6%	0.11	NA	NA	0.83	NA	NA	1.72	Yes	Yes	
Dissolved Nitrite (mg/L)	467	458	98%	0	0.02	0.25	0.25	0.25	0.25	1.3	No, 98 % < MDL	No	
Dissolved Ammonia (mg/L)	27	15	56%	0.005	0.005	0.01	0.01	0.033	2.55	4	Yes	Yes	
Total Ammonia (mg/L)	455	439	96%	0.005	0.1	0.8	0.8	0.8	0.8	9.5	No, 97 % < MDL		
Chlorophyll a (ug/L)	0	0	0%	0	0	0	0	0	0	0	No	Yes	Reg. 85 (Nutrients)
Dissolved Iron (ug/L)	514	171	33%	3.2	13.65	70.85	335	817.5	3,675	37,000	Yes	No	
Total Iron (ug/L)	63	24	38%	3.2	10	57	200	404	10,810	68,500	Yes	Yes	M&E list
Dissolved Lead (ug/L)	74	51	69%	0.1	0.1	0.74	1	3	5.54	64	Yes	Yes	M&E list
Dissolved Copper (ug/L)	75	52	69%	0.5	0.976	1	2.4	5	63.7	112	Yes	Yes	M&E list
Dissolved Zinc (ug/L)	68	28	41%	0.3	2.74	3	7.9	16.125	84.1	14000	Yes	Yes	M&E list
Specific Conductance (uS/cm)	1,995	NA	NA	0.21	249	575	784	891	1,500	8620	No		
Dissolved Oxygen (mg/L)	1,189	NA	NA	0.3	2.3	7.2	9.6	11.5	13.3	20.2	Yes	No	
E. coli (col/100 mL)	7	0	0%	17.3	NA	NA	205	NA	NA	24192	Yes	Yes	M&E list
Benzene (ug/L)	1,216	1,124	92.4%	0.0008	0.5	1	1	1	1.825	360	Yes	COGCC Monitoring Requirements	
Toluene (ug/L)	2,056	2,032	98.8%	0.002	1	2	2	2	5	28	No, 99 % < MDL		
Ethylene (ug/L)	1,217	1,214	99.8%	0.004	0.5	2	2	2	2	16	No, 99 % < MDL		
Xylene- all isomers (ug/L)	1,148	1,147	99.9%	0.0	2	2	2	2	2	17	No, 99 % < MDL		

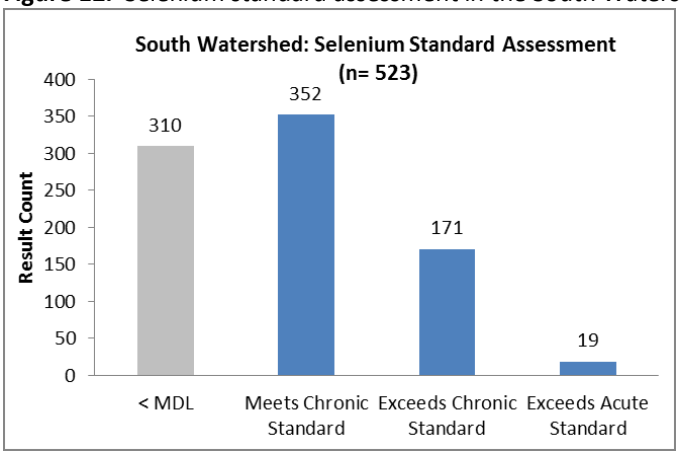
Notes

1. The count of results that were below the method detection limit (MDL).
2. The results below MDL expressed as a percent of all results (<MDL/total results).
3. Percentiles were not calculated unless there were 20 or more results for a given parameter.
4. Identifies whether a parameter was selected for additional analysis based on preliminary assessments.

7.1 Dissolved Selenium

Dissolved selenium concentrations ranged from 0.28 to 55 ug/L in 523 samples collected from the South Watershed. (Table 14). Dissolved selenium concentrations were below the MRL in 310 of the samples. Selenium concentrations in 352 of the samples were below the applicable chronic standard (Figure 12). However, the MRL associated with 22 samples was greater than the chronic selenium standard of 4.6 ug/L (e.g., MRL= 5 or 10 ug/L). The chronic standard was exceeded in 171 samples (Figure 12). The acute standard, which is 18.6 ug/L for segments where it is applied, was exceeded in 19 samples.

Figure 12. Selenium standard assessment in the South Watershed (n=523).



The chronic dissolved selenium standard was exceeded in 171 samples collected from 51 sites (Figure 13). Nineteen of these samples, collected from seven sites, also exceeded the acute standard. Stream sites exceeded the chronic standard in 136 samples and the acute standard in 16 samples. Dissolved selenium concentrations at spring sites exceeded the chronic standard in 23 samples and the acute standard in three samples. Lake sites accounted for 12 chronic exceedances; the acute standard was not exceeded. The monitoring sites are located on eight segments. The selenium discussion is grouped by segment rather than site, given the number of sites that exceeded the chronic standard.

7.1.1 Colorado River Tributaries between the Roaring Fork River and Parachute Creek (Segment 4a)

Segment 4a includes all tributaries to the Colorado River from the Roaring Fork River to Parachute Creek, except for tributaries listed in other segments. Currently the 303(d) List includes Segment 4a for selenium. The samples that prompted the 303(d) Listing were collected from the lower portion of Mamm Creek. Sixteen samples collected from eight locations exceeded the chronic standard; three of the locations were streams in the lower portion of Mamm Creek and five locations were springs.

In the lower portion of Mamm Creek adjacent to County Road 315, about 3.5 miles above the confluence with the Colorado River (Figure 13; site 11149B) dissolved selenium concentrations ranged

from 1.1 to 13 ug/L and four of six samples exceeded the chronic selenium standard. The acute standard was not exceeded. Dissolved selenium concentrations at two downstream sites (CDOWRW-4016 and 393136107423401) exceeded the chronic selenium standard in three of three samples. Collectively, the three surface water sites in the lower portion of Mamm Creek exceeded the chronic standard in seven of nine samples.

The chronic selenium standard was exceeded at five spring locations (Figure 13, site BRYN1SP, BRYN3SP, BRYN4SP, BRYN5SP, and BRYN6SP). The BRYN springs are located on the lower portion of Mamm Creek and an unnamed tributary that joins the mainstem of Mamm Creek from the west. The BRYN springs are up-gradient of site 11149B. A total of seven springs in this area were sampled by Encana between September 2004 and April 2005. Selenium concentrations were analyzed at five of seven springs. Dissolved selenium concentrations ranged from less than 5 to 14 ug/L. Based on the limited data available, it appears that dissolved selenium concentrations are highest in April. Nine of ten samples collected from the BRYN springs exceeded the chronic standard. The samples collected from the BRYN spring locations did not exceed the acute selenium standard.

In eight samples collected from an unnamed tributary (between Beaver and Rifle Creeks) about 2.6 miles above the Colorado River (Figure 13; site Beaver-Rifle) dissolved selenium concentrations ranged from less than 1 to 6.3 ug/L in samples collected twice monthly from January to April 2009. Two samples collected during winter low flows, on 1/11/2009 and 1/26/2009, exceeded the chronic standard. The remaining samples collected in late winter and early spring were below the MRL.

Dissolved selenium concentrations ranged from less than 1 to 6.5 ug/L in three samples collected from 12/20/2005 to 10/4/2007 where one sample exceeded the chronic standard along an unnamed tributary to the Colorado River near County Road 321 (Figure 13; site 704569). The exceedance occurred on 12/20/2005; the other samples were also collected during low flow conditions.

Dissolved selenium concentrations at a spring up-gradient of the Beaver Rifle site on an unnamed tributary to the Colorado River were less than 1 and 9.9 ug/L in January and April 2008, respectively (Figure 13; site 704570). The sample collected in April exceeded the chronic standard. At an adjacent spring dissolved selenium concentrations ranged from less than 1 to 24 ug/L in three samples (site 704810). The dissolved selenium concentration on 12/20/2005 was 24 ug/L which exceeded both the chronic and acute standards.

In a spring up-gradient of an unnamed tributary to the Colorado River (Figure 13; site GILE1SP) the dissolved selenium concentration was 5.2 ug/L in the only sample collected to date and exceeded the chronic selenium standard.

Dissolved selenium concentrations ranged from less than 1 to 16.4 ug/L at the mouth of Alkali Creek (Figure 13; site 11189). The chronic standard was exceeded in three of nine samples; the acute standard was not exceeded. The exceedances occurred in October and February.

In the only sample collected to date, the dissolved selenium was 9 ug/L and exceeded the chronic standard at a pond on the Colorado Oil and Gas Conservation Commission facility on Grass Mesa (Figure 13, Site 704266).

Several tributaries included on Segment 4a have not been sampled or selenium was not included in the analysis suite where samples were collected. This is most common for tributaries that drain the north side of the South Watershed and tributaries in the Holms Mesa area.

7.1.2 Dry Hollow Creek (Segment 4d)

In Dry Hollow Creek and its tributaries dissolved selenium concentrations ranged from less than 1 to 6.5 ug/L in 18 samples collected from ten locations. Seven samples collected from four locations exceeded the chronic selenium standard (Table 15). None of the samples collected in Dry Hollow Creek exceeded the acute standard. This data was not evaluated as part of the 303(d) Listing process. The samples were collected from fall 2003 to summer 2008 and may not be suitable due to the time frame associated with the standards evaluation process.

In the only sample collected to date, a spring below the Multa Trina Ditch, that is tributary to Dry Hollow Creek, had a dissolved selenium concentration of 6.5 ug/L on 6/8/2006 (Figure 13; site GUTH1SP). Dissolved selenium concentrations were less than 1 ug/L in four other springs that are also tributary to Dry Hollow Creek.

Dissolved selenium concentrations ranged from less than 1 to 6.1 ug/L in the mainstem of Dry Hollow Creek and the chronic standard was exceeded in six of eleven samples collected from three stream sites (Table 15). The acute selenium standard was not exceeded in any of the samples. Although the sample size is limited (n=11), selenium concentrations in Dry Hollow Creek may peak in late fall and early winter. Samples collected in October, November, December, and January had selenium concentrations that ranged from 5.2 to 6.1 ug/L. Samples collected from March, April and May were less than 1 ug/L. However, this sample set lacks data from the summer months.

7.1.3 Dry Creek (Segment 4e)

In Dry Creek and its tributaries dissolved selenium concentrations ranged from less than 1 to 6.3 ug/L in samples collected from one spring and four stream sites (Table 15). The dissolved selenium concentration in Dry Creek below the power plant at County Road 32 was 6.3 ug/L on 4/24/2012 and accounted for the only exceedance on Segment 4e (Figure 13; Site 11148C).

7.1.4 Mitchell, Canyon, Elk, Garfield, Beaver, Cache and Battlement Creeks (Segment 7a)

Segment 7a spans the East and South watersheds; Mitchell, Canyon, and Elk Creeks are in the East Watershed and Garfield, Beaver, Cache, and Battlement Creeks are in the South Watershed. Dissolved selenium was sampled at five locations in Garfield Creek and its tributaries and at six locations in Beaver Creek (Figure 13). Cache Creek and the portion of Battlement Creek included in Segment 7a

were not sampled for dissolved selenium. Battlement Creek has only been sampled in the portion of the stream included on Segment 9c.

The dissolved selenium concentration in Baldy Creek above the confluence with Garfield Creek was less than 5 mg/L on 7/8/2008, the only sample collected to date (Figure 13; site 3806). In Garfield Creek below the confluence with Baldy Creek the dissolved selenium concentration was 39.2 ug/L on 7/9/2008 which exceeded both the chronic and acute standard (Figure 13; site 3803). In a nearby downstream location, Garfield Creek immediately below the confluence with an unnamed tributary, the dissolved selenium concentration was less than 5 ug/L on 7/10/2008 (Figure 13; site 3802). Based on the July 2008 results, it appears that Garfield Creek above the confluence with Baldy Creek, which has not been sampled to date, may be a source of selenium. However, Garfield Creek below the confluence with Baldy Creek was sampled on 7/27/2011 and the dissolved selenium concentration was less than 5 ug/L and Garfield Creek above the confluence with Baldy Creek did not appear to be a source of selenium. In Garfield Creek near the confluence with the Colorado River dissolved selenium concentrations were less than the MRL in three of three samples, including a sample collected on 7/8/2008 when elevated concentrations were observed in the upper portion of Garfield Creek (Figure 13; sites 11181A and 3817).

There are three stream and two spring sites where dissolved selenium concentrations were measured six times in the Beaver Creek watershed. A spring up-gradient of Beaver Creek near the confluence with the Colorado River had a dissolved selenium concentration of 9.2 ug/L on 12/20/2005 which accounted for the only exceedance in the Beaver Creek watershed (Figure 13; site SAVA2SP).

7.1.5 Divide Creek (Segment 7b)

Dissolved selenium concentrations ranged from less than 1 to 55 ug/L in 356 samples collected from 27 stream and spring sites in Divide Creek on Segment 7b (Table 15). Dissolved selenium concentrations in 120 samples collected from six springs and eleven stream sites exceeded the chronic standard (Table 15 and Figure 13). Stream sites accounted for 112 of the chronic exceedances and spring sites accounted for eight exceedances. Fifteen stream samples and one spring sample also exceeded the acute selenium standard. The data were collected from 2004 to 2008. Standards evaluations typically use data from the preceding five years, which may explain why Segment 7b is not included on the 303(d) List for selenium.

Dissolved selenium concentrations were less than 5 ug/L in two samples collected during 2011 in the upper portion of Divide Creek and East Divide Creek. The results suggest that the selenium concentrations in the upper portions of Divide Creek are less than chronic water quality standard and concentrations tend to increase in Divide Creek below West Divide Creek near the Multa Trina Ditch and at other locations in the lower reaches of Divide Creek. Most of the stream sites where exceedances occurred are located in West Divide Creek above the confluence with East Divide Creek. Additional sample collection should occur to better understand selenium concentrations in Divide Creek.

7.1.6 Lakes, Reservoirs and Ponds between the Roaring Fork River and Parachute Creek (Segment 9b)

Segment 9b includes all of the lakes and ponds in the South Watershed. Dissolved selenium concentrations were measured in 35 samples collected from 18 lake, pond or reservoir sites and dissolved selenium concentrations ranged from less than 1 to 12 ug/L. The chronic standard was exceeded in 12 samples (Table 15). The acute standard was not exceeded in any of the lake samples collected in the South Watershed.

Dissolved selenium concentrations ranged from less than 1 to 12 ug/L in 35 samples collected from June 2004 to June 2006 in eleven ponds or lakes tributary to Dry Hollow Creek. Dissolved selenium concentrations at five of the ponds exceeded the chronic standard; none of the ponds exceeded the acute standard (Figure 13; sites 704455, 704501, SMIT1PO, ARBA1PO, and ELDE1PO).

In the Divide Creek watershed dissolved selenium concentrations ranged from less than 1 to 10 ug/L in 22 samples collected from six lake locations from June 2004 to June 2006. The chronic selenium standard was exceeded in six samples collected from three locations (Figure 13; sites 704484, LANG2PO, and LANG4PO).

7.1.7 Upper Battlement Creek (Segment 9c)

Segment 9c is classified as an Outstanding Water (Regulation 37) and includes the upper portion of Battlement Creek that is primarily on BLM land (the lower portion of Battlement Creek is a part of Segment 7a). There are four stream sites and a spring site on Upper Battlement Creek. The dissolved selenium concentration was 27 ug/L in Battlement Creek near the headwaters which exceeded both the chronic and acute standards in the only sample collected on 10/25/2005 (Table 15 and Figure 13; site 704617). Two samples collected from an unnamed tributary to Battlement Creek had dissolved selenium concentrations of 8.2 and less than 1 ug/L on 11/9/2005 and 10/17/2006, respectively (Figure 13; site 704616). The sample collected in November 2005 exceeded the chronic standard. Battlement Creek near the end of Segment 9c was sampled on 10/17/2005 and had a dissolved selenium concentration of 7.6 ug/L which exceeded the chronic selenium standard (Figure 13; Site 704618). The 2005 results suggest that dissolved selenium concentrations in Battlement Creek may be elevated in the late fall, but the data set is limited in scope.

In Battlement Creek near the end of Segment 9c dissolved selenium concentrations were less than the MRL, which ranged from 1 to 5 ug/L, in 13 samples collected from March 2008 to April 2010. These data may have been used to establish the Outstanding Water designation.

7.1.8 Colorado River Tributaries from Parachute Creek to Roan Creek (Segment 12b)

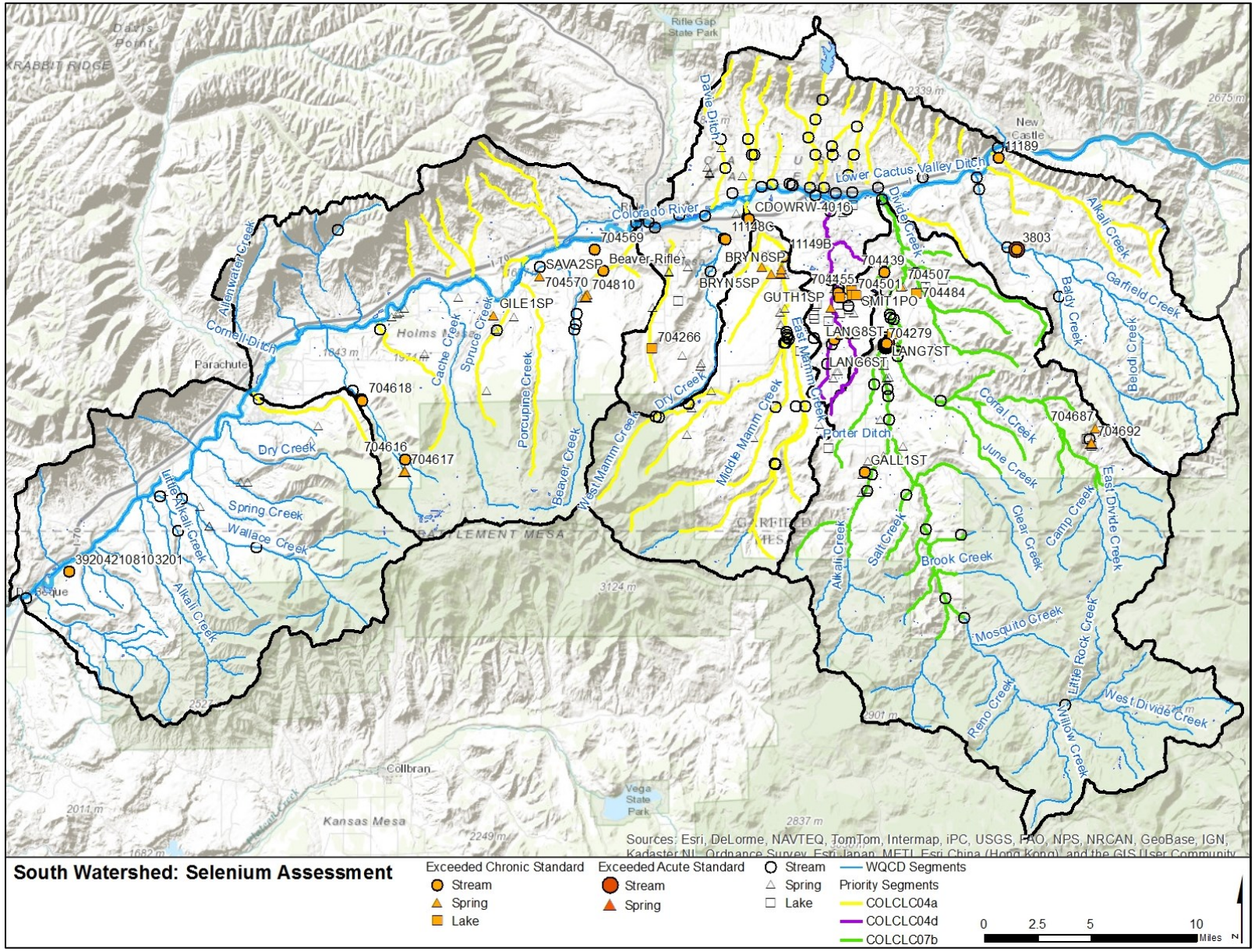
Dissolved selenium concentrations ranged from less than 1 to 1.9 ug/L in four spring sites tributary to Wallace Creek (Figure 13; sites KNOX2SP, KNOX3SP, KNOX4SP, and KNOX5SP). A spring site near High Mesa that drains to an unnamed tributary of the Colorado River had a dissolved selenium concentration of less than 1 ug/L in the only sample collected to date (Figure 13; site ENCA2SP).

On 10/21/2003 the dissolved selenium concentration in the Bluestone Valley Ditch at County Road 138 was 13.6 ug/L and exceeded the chronic selenium standard (Figure 13; Site 392042108103201).

Table 15. Dissolved selenium assessment summary by WQCC Segment in the South Watershed.

WQCC Segment	Segment Description	Site Type	Samples	Chronic Standard	Exceeded Chronic Standard	Percent of Samples	Acute Standard	Exceeded Acute Standard	Percent of Samples	Comments and Priority
4a	All tributaries, including wetlands, to the Colorado River from the Roaring Fork River to Parachute Creek except for listings in Segments 4b, 4c, 4d, 4e, 5, 6, 7a, 7b, 8, 9a, 9c, 10, 11a - h, and 12a.	Stream	42	4.6	13	31%	18.6	0	0%	15 locations: 8 in Mamm Creek Watershed, 5 in Cache Creek-Colorado River, 2 in Garfield Creek-Colorado River. High priority for TMDL development.
		Spring	24		12	50%		1	4%	
		Total	**66**		**25**	**38%**		**1**	**2%**	
4d	The mainstem of Dry Hollow Creek, including all tributaries and wetlands, from the source to the confluence with the Colorado River.	Stream	13	4.6	6	46%	18.6	0	0%	4 locations in Dry Hollow Creek exceeded the chronic standard (period of record: 2003-2008). Additional data should be collected to determine current status.
		Spring	5		1	20%		0	0%	
		Total	**18**		**7**	**39%**		**0**	**0%**	
4e	Mainstem of Dry Creek including all tributaries and wetlands from the source to immediately above the Last Chance Ditch.	Stream	4	4.6	1	25%	18.6	0	0%	No comments or priority assigned at this time.
		Spring	1		0	0%		0	0%	
		Total	**5**		**1**	**20%**		**0**	**0%**	
7a	Mitchell, Canyon, Elk, Garfield, Beaver and Cache Creeks, including all tributaries & wetlands, from boundary of the White River National Forest to the confluence with the Colorado River.	Stream	11	4.6	1	9%	18.6	1	9%	No comments or priority assigned at this time.
		Spring	5		1	20%		0	0%	
		Total	**16**		**2**	**13%**		**1**	**6%**	
7b	Mainstem of Divide Creek, including all tributaries and wetlands, from the boundary of the White River National Forest to the confluence with the Colorado River.	Stream	345	4.6	112	32%	18.6	15	4%	120 samples, collected from 2004 to 2008, exceeded chronic standard. Recently sampled locations were up gradient; additional sample collection recommended. High Priority.
		Spring	11		8	73%		1	9%	
		Total	**356**		**120**	**34%**		**16**	**4%**	
9b	All lakes and reservoirs tributary to the Colorado River from the Roaring Fork River to Parachute Creek, except for segment 20.	Lake, pond or reservoir	35	4.6	12	34%	18.6	0	0%	No comments or priority assigned at this time.
9c	Battlement Creek, including all tributaries and wetlands, from the source to the most downstream boundary of BLM lands. Outstanding waters designation.	Stream	18	4.6	2	11%	18.6	0	0%	No comments or priority assigned at this time.
		Spring	1		1	100%		1	100%	
		Total	**19**		**3**	**16%**		**1**	**5%**	
12b	All tributaries and wetlands to the Colorado River from a point immediately below the confluence of Parachute Creek to a point immediately below the confluence with Roan Creek.	Stream	1	4.6	1	100%	18.6	0	0%	No comments or priority assigned at this time.
		Spring	5		0	0%		0	0%	
		Total	**6**		**1**	**17%**		**0**	**0%**	

Figure 13. Water quality monitoring sites where dissolved selenium concentrations exceeded the chronic or acute selenium standard in the South Watershed.

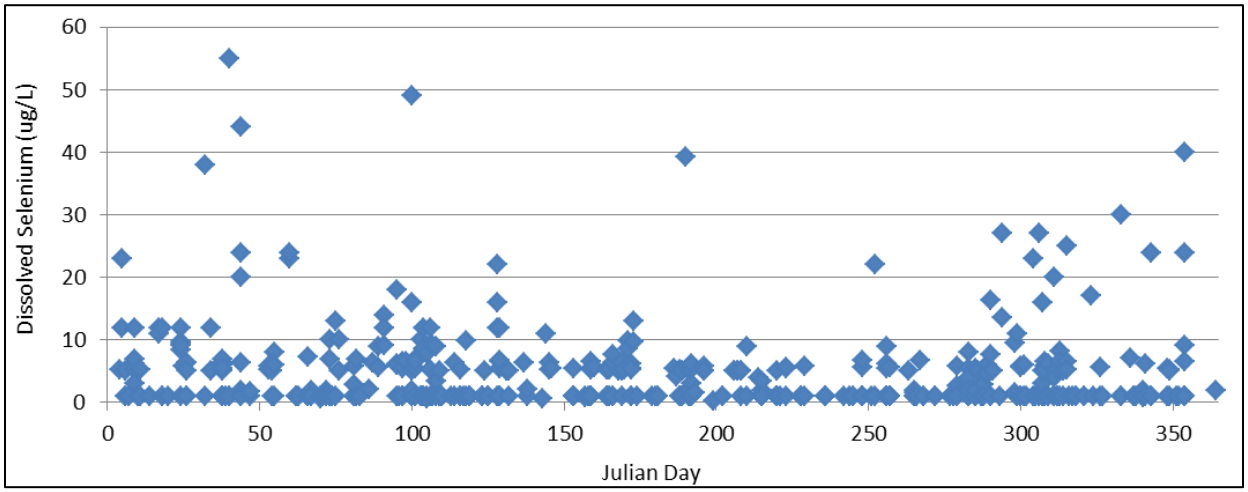


Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

7.1.9 Selenium Temporal Assessment

Selenium sample collection in the South Watershed is distributed on a somewhat even basis which allowed for a temporal assessment. In the South Watershed selenium concentrations appear to increase during two or three times of the year. The first peak occurs in mid-February around day 50 (Figure 14). The second peak occurs as spring snowmelt begins in early April (day 90) and continues until flow tapers off in mid-May (day 135). The third and most prominent peak occurs in late October (day 295) and continues through December during low flow conditions in the late fall and early winter. Elevated selenium concentrations may persist through the winter months.

Figure 14. Selenium concentrations (ug/L) in the South Watershed by Julian day.



7.2 Total Phosphorus

Total phosphorus concentrations ranged from 0.005 to 1.8 mg/L in 33 samples collected in the South Watershed where concentrations were below the MRL in seven of the samples (Table 16). Samples collected from five locations exceeded the interim criteria (0.11 mg/L) for total phosphorus in eight samples (Table 16). Segments 4d, 10, and 12b lack total phoshorus data

7.2.1 Dry Creek (Segment 4e)

Total phosphorus concentrations ranged from 0.5 to 1.8 mg/L in three samples collected in Dry Creek at County Road 352, which exceeded the interim standard of 0.11 mg/L.(Table 16 Segment 4e and Figure 15; sites 1148 and 11148C). The total phosphorus concentration was 0.37 mg/L in the only sample collected to date in Dry Creek at Site County Road 319 (approximately 1.5 miles upstream of the sites at County Road 352) The Dry Creek samples were collected in October, March, and April of 2011 and 2012.

7.2.2 Mamm Creek (Segment 4a)

Total phosphorus concentrations ranged from 0.02 to 1.7 mg/L in six samples from Mamm Creek approximately 3.2 miles above the confluence with the Colorado River (Table 16 and Figure 15; site 11149B). Three samples exceeded the interim standard for total phosphorus.

7.2.3 Alkali Creek (Segment 4a)

Total phosphorus concentrations ranged from 0.01 to 1.2 mg/L in six samples in Alkali Creek, near the confluence with the Colorado River (Table 16 and Figure 15; site 11189). One sample exceeded the interim standard for total phosphorus.

Table 16. Summary of locations where the interim standard for total phosphorus was exceeded; concentrations in mg/L.

WQCC Segment	Site	Site Type	Interim Standard	Samples	< MDL Count	Minimum	Median	Maximum
4a	11149B	Stream	0.11	6	0	0.02	0.22	1.7
	11189	Stream		6	0	0.01	0.04	1.2
4e	11148	Stream	0.11	2	0	0.5	NA	1.6
	11148B	Stream		1	0	0.37		
	11148C	Stream		1	0	1.8		

7.3 Total Nitrogen

Total nitrogen concentrations ranged from less than 0.5 to 3.6 mg/L in 12 samples collected from the South Watershed and exceeded the interim standard (1.25 mg/L) in three samples collected from three locations (Table 17). Total nitrogen concentrations ranged from 1.2 to 2.5 mg/L and one exceeded the interim standard in Dry Creek at County Road 352 (Table 17 and Figure 15; site 11148). In Dry Creek at County Road 319 the total nitrogen concentration was 1.8 mg/L (Table 17; site 11148B). The samples the exceeded the interim standard were collected from Dry Creek on 3/25/2012.

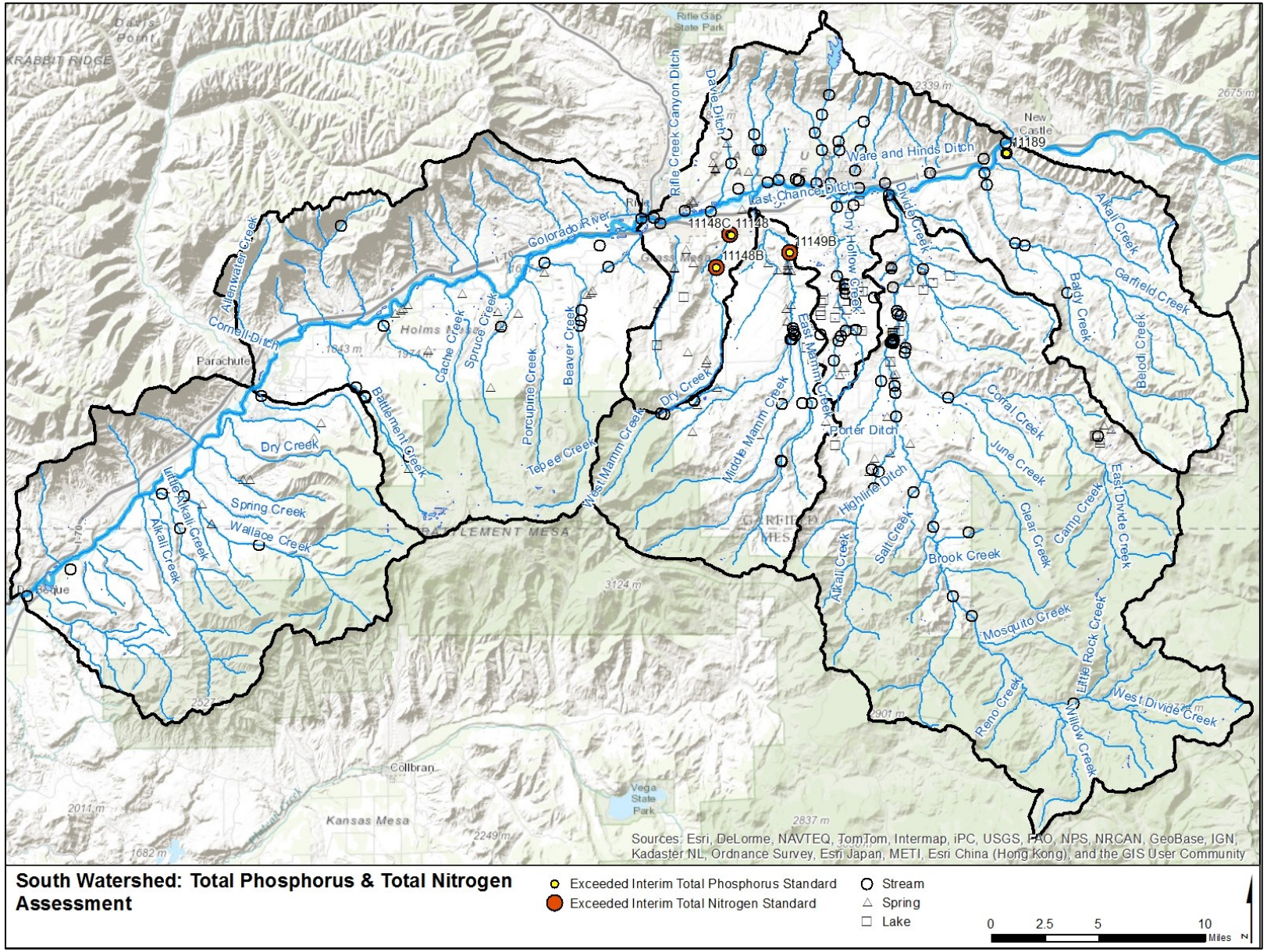
The third exceedance in the South Watershed occurred in Mamm Creek near the confluence with the Colorado River (Figure 15; site 11149B). The total nitrogen concentration was 3.6 mg/L on 8/2/2011 which is nearly three times the interim standard. However, the median concentration in Mamm Creek was less than the interim standard (Table 17).

Table 17. Summary of locations where the interim standard for total nitrogen was exceeded; concentrations in mg/L.

WQCC Segment	Site	Site Type	Interim Standard	Samples	< MDL Count	Minimum	Median	Maximum
4a	11149B	Stream	1.25	4	0	0.67	1.02	3.6
4e	11148	Stream	1.25	2	0	1.2	NA	2.5
	11148B	Stream		1	0	1.8		

Total nitrogen samples have not been collected from Segments 4d, 5, 7a, 7b, 10, 11g, and 12g.

Figure 15. Water quality monitoring sites where total phosphorus or total nitrogen concentrations exceeded the interim standard in the South Watershed.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

7.4 Dissolved Nitrite

Dissolved nitrite concentrations ranged from less than 0.001 to 1.3 mg/L in 467 samples and 98 percent of the dissolved nitrite concentrations were less than the MRL (Table 14). Dissolved nitrogen concentrations exceeded the applicable standard for the respective segment in seven samples. Dissolved nitrite concentrations were greater than the standard of 0.05 mg/L in two of 53 samples collected from Segment 4a. Sample concentrations were below the MRL in 49 of the samples from Segment 4a. Five of 364 samples exceeded the dissolved nitrite standard and 357 samples had concentrations below the MRL on Segment 7b. The dissolve nitrite exceedances appear to be anomalies when evaluated relative to other dissolved nitrite concentrations on each segment.

7.5 Dissolved Ammonia

Dissolved ammonia concentrations ranged from less than 0.005 to 4.0 mg/L in 27 samples and 15 of the results were less than the MRL (Table 14). One sample collected from Mamm Creek about 3.2 miles above the confluence with the Colorado River (Site 11149B) on Segment 4a exceeded both the chronic and acute standards with a dissolved ammonia concentration of 3.6 mg/L on 5/24/2012. The chronic and acute ammonia standards were 0.58 and 1.71 mg/L, respectively, based on paired pH and temperature data. Three other samples collected in Mamm Creek during 2011 and 2012 met the chronic and acute dissolved ammonia standards. It is likely that Mamm Creek will be added to the 2016 M&E List for dissolved ammonia (Sarah Wheeler, personal communication, 1/2/2014).

7.6 Dissolved Iron

Dissolved iron concentrations ranged from less than 3.2 to 37,000 ug/L in 514 samples collected from 103 sites in the South Watershed and were below the MRL in one-third of the samples (Table 14).

The dissolved iron standard is 300 ug/L for segments with a water supply designation. The water supply designation applies to eight segments in the South Watershed. The following segments do not have a water supply designation and are not included in the dissolved iron assessment: 4e (Dry Creek and tributaries), 11g (portions of the East Fork of Parachute Creek and selected unnamed tributaries north of the Colorado River) and 13a (Colorado River tributaries below confluence with Roan Creek, except those referenced in other segments).

In the South Watershed, 53 percent of the dissolved iron samples exceeded the dissolved iron standard at 61 sites (Figure 16). Stream sites (84 percent of the locations) accounted for 80 percent of the exceedances. Spring sites (9 percent of the locations) accounted for 9 percent of the exceedances. Lake sites (7 percent of the locations) accounted for 11 percent of the exceedances. Lakes in the South Watershed exceeded the standard with slightly higher frequency than stream or spring sites. It is difficult to deduce whether this is meaningful since there is limited information regarding the condition of the ponds. Based on the site descriptions many of the ponds are constructed for irrigation or energy production, so it is unlikely that the ponds support a direct use water supply or a significant fishery.

7.6.1 Divide Creek Watershed (Segments 5, 7a, 7b, and 9b)

The Divide Creek watershed (Segments 5, 7a, 7b, and 9b) was sampled the most frequently and accounted for 74 percent of the samples. Seventy-nine percent of the exceedances in the South Watershed occurred in the Divided Creek watershed. However, given the sample frequency this does not suggest a problem specific to the Divide Creek watershed.

7.6.2 Colorado River Tributaries between the Roaring Fork River and Parachute Creek (Segment 4a)

Segment 4a includes all the tributaries to the Colorado River from the Roaring Fork River to Parachute Creek except for tributaries included in other segments. Many of the tributaries are unnamed in this area. Local features were used to orient the reader to sample sites in this area.

In Segment 4a dissolved iron concentrations ranged from less than 4 to 12,000 ug/L in 60 samples collected from 2/24/2000 to 3/28/2012 (Table 18). The dissolved iron standard was exceeded in 45 percent of the samples collected from Segment 4a.

In the tributaries between New Castle and Rifle dissolved iron concentrations were sampled at 19 locations. The dissolved iron standard was exceeded in 13 samples collected from seven sites (Table 18; Figure 16). Springs near the Lower Cactus Valley Ditch, which are located north of the Colorado River and east of Rifle, accounted for five of the sites (Figure 16) and dissolved iron concentrations ranged from 640 to 3,000 ug/L. A pond in the vicinity (site 704266) also exceeded the water supply standard with a dissolved iron concentration of 480 ug/L.

The mouth of Alkali Creek exceeded the water supply standard in one of seven samples. Dissolved iron concentrations ranged from less than 4 to 1,700 ug/L. The only sample that exceeded the water supply standard was collected on 10/17/2006. Samples collected more recently, in 2011 and 2012, had lower dissolved iron concentrations; however, sample collection occurred in spring and summer when flows are typically higher.

Dissolved iron concentrations ranged from 21 to 2,200 ug/L in 27 samples collected from 15 locations in the Mamm Creek Watershed. Dissolved iron concentrations exceeded the water supply criterion in ten samples collected from nine locations (Table 18). With the exception of one site, each site was sampled only once. Spring sites accounted for five of the exceedances. Stream and lake sites accounted for four and one sites, respectively.

Dissolved iron concentrations ranged from 10 to 12,000 ug/L in 18 samples in the Cache Creek-Colorado River Watershed, which extends from Rifle to Parachute. The Beaver-Rifle site, located on an unnamed tributary to the Colorado River near County Road 320, was the most frequently sampled location in this portion of the South Watershed. Dissolved iron concentrations ranged from 70 to 12,000 ug/L in eight samples. Dissolved iron concentrations exceeded the water supply standard of 300 ug/L in six samples.

One of two samples exceeded the dissolved iron standard in the Jerry Creek-Colorado River Watershed, located on the west end of the South Watershed between Parachute and DeBeque.

7.6.3 Dry Hollow Creek and Tributaries (Segment 4d)

Dissolved iron concentrations ranged from less than 70 to 25,000 ug/L in 16 samples collected from eight locations in the Dry Hollow Creek watershed. Dissolved iron concentrations exceeded the water supply standard of 300 ug/L in 13 of the samples (Table 18). Stream sites accounted for nine exceedances and spring sites accounted for four exceedances. Sample collection in Dry Hollow Creek and its tributaries occurred from 2004 to 2006 and in 2008; most sites were sampled on one occasion. Samples collected during spring or early summer accounted for 8 of 13 exceedances, which may suggest dissolved iron concentrations tend to be elevated during periods of higher flow.

7.6.4 Mitchell, Canyon, Elk, Garfield, Beaver, Cache and Battlement Creeks (Segment 7a)

Segment 7a is comprised of several streams in both the East and South Watersheds. Garfield, Beaver, Cache, and Battlement Creeks are in the South Watershed. Dissolved iron concentrations ranged from less than 10 to 780 ug/L in 16 samples collected from ten locations. The dissolved iron standard was exceeded in one sample collected from a stream site and in one spring site for a total of two exceedances on Segment 7a (Table 18).

7.6.5 Divide Creek (Segment 7b)

Dissolved iron concentrations ranged from less than 10 to 37,000 ug/L in 358 samples collected from 26 locations in Divide Creek and its tributaries (Table 18). The water supply standard was exceeded in 195 of the evaluations (Table 18). Stream sites accounted for 97 percent of the exceedances (Table 18).

To date, five dissolved iron samples were collected from three sites near the headwaters of Divide Creek (Figure 16; sites ALKA1ST, CDOWRW-808 and GALL1ST). Dissolved iron concentrations exceeded the water supply standard of 300 ug/L in four samples.

Three sites located in unnamed tributaries to Divide Creek exceeded the dissolved iron standard in four of four samples (Figure 16; sites 704438, 704439 and 704390).

The dissolved iron standard was exceeded in 183 of 334 samples collected from several sites on West Divide Creek, about 1.3 miles above the confluence with East Divide Creek (Figure 16; sites LANG2ST to LANG10ST).

Dissolved iron concentrations ranged from less than 10 to 45 ug/L in three samples in Divide Creek near the confluence with the Colorado River (Figure 16; site 11181). Given the limited number of samples and elevated dissolved iron concentrations in the upper reaches of Divide Creek, particularly West Divide Creek, additional sample collection should occur at the mouth of Divide Creek.

The geology of Divide Creek is Quaternary alluvium in areas adjacent to the creek in the lower watershed. The alluvium is derived from materials in the upper portions of the watershed which are Tertiary sandstones and mudstones (Green et al., 1992). Weathering could be a natural source of iron in this portion of the watershed.

7.6.6 Lakes, Reservoirs and Ponds between the Roaring Fork River and Parachute Creek (Segment 9b)

Dissolved iron concentrations ranged from less than 70 to 15,000 ug/L in 17 lake or pond sites in 36 samples. The water supply standard 300 ug/L was exceeded 81 percent of the samples from ten ponds (Table 18). Six of the ponds are tributary to Dry Hollow Creek, three of the ponds are located in Divide Creek watershed (a part of the LANG study area) and one is tributary to Mamm Creek (Figure 16). Site descriptions indicate the ponds are used to water livestock, support irrigation, or for residential use. However, there is limited Metadata available to further describe each of the ponds (e.g., water levels, water source, etc.). When coupled with the limited number of samples, further interpretation is difficult.

7.6.7 Upper Battlement Creek (Segment 9c)

Dissolved iron concentrations ranged from less than 3.2 to 1,200 ug/L for 19 samples in the upper portion of Battlement Creek. The samples were collected from four stream sites and one spring site. The water supply standard 300 ug/L was exceeded in two samples collected from stream sites (Table 18).

7.6.8 Colorado River Tributaries from Parachute Creek to Roan Creek (Segment 12b)

Dissolved iron concentrations ranged from less than 70 to 890 ug/L in samples collected from five spring sites on Segment 12b and exceeded the water supply standard of 300 ug/L in two samples (Table 18). The sites are ENCA2SP, tributary to Pete and Bill Creek, and KNOX2SP, tributary to Wallace Creek (Figure 16).

The dissolved iron standard is a secondary water supply standard, so additional monitoring or 303(d) Listing is not anticipated. However, where dissolved iron concentrations exceeded 1,000 ug/L, total iron concentrations were likely in excess of the chronic aquatic life standard of 1,000 ug/L total iron (total = dissolved + suspended). Dissolved iron concentrations in excess of 1,000 ug/L were used to supplement the total iron discussion.

Table 18. Dissolved iron assessment summary for the South Watershed; the table includes only segments with a water supply designation.

WQCC Segment	Segment Description	Site Type	Samples	Water Supply Standard (ug/L)	Exceeded Water Supply Standard	Percent of Samples	Comments and Priority
4a	All tributaries, including wetlands, to the Colorado River from the Roaring Fork River to Parachute Creek except for the specific listings in Segments 4b, 4c, 4d, 4e, 5, 6, 7a, 7b, 8, 9a, 9c, 10, 11a - h, and 12a.	Stream	35	300	13	37%	No comments or priority assigned at this time. However, the segment is on the M&E list for total iron.
		Spring	23		13	57%	
		Total	**58**		**26**	**45%**	
4d	The mainstem of Dry Hollow Creek, including all tributaries and wetlands, from the source to the confluence with the Colorado River.	Stream	11	300	9	82%	The samples were collected from locations in Dry Hollow Creek in 2004-2006 and 2008.
		Spring	5		4	80%	
		Total	**16**		**13**	**81%**	
5	All tributaries to the Colorado River, including wetlands, which are within the boundaries of White River National Forest, except for the specific listing in Segments 9a and 9c.	Stream	1	300	0	0%	No comments or priority assigned at this time.
		Spring	0		0	0%	
		Total	**1**		**0**	**0%**	
7a	Mitchell, Canyon, Elk, Garfield, Beaver and Cache Creeks, including all tributaries & wetlands, from boundary of the White River National Forest to the confluence with the Colorado River.	Stream	11	300	1	9%	No comments or priority assigned at this time.
		Spring	5		1	20%	
		Total	**16**		**2**	**13%**	
7b	Mainstem of Divide Creek, including all tributaries and wetlands, from the boundary of the White River National Forest to the confluence with the Colorado River.	Stream	350	300	190	54%	Samples were collected from 2002-2008. Stream sites accounted for 97 percent of the exceedances.
		Spring	8		5	63%	
		Total	**358**		**195**	**54%**	
9b	All lakes and reservoirs tributary to the Colorado River from the Roaring Fork River to Parachute Creek, except for segment 20.	Lake, pond or	36	300	29	81%	No comments or priority assigned at this time.
9c	Battlement Creek, including all tributaries and wetlands, from the source to the most downstream boundary of BLM lands. Outstanding Waters designation	Stream	18	300	2	11%	No comments or priority assigned at this time.
		Spring	1		0	0%	
		Total	**19**		**2**	**11%**	
12b	All tributaries and wetlands to the Colorado River from a point immediately below the confluence of Parachute Creek to a point immediately below the confluence with Roan Creek.	Stream	0	300	0	0%	No comments or priority assigned at this time.
		Spring	5		2	40%	
		Total	**5**		**2**	**40%**	

7.7 Total Iron

Total iron concentrations ranged from less than 3.2 ug/L to 68,500 ug/L in 63 samples collected from 34 sites in the South Watershed (Table 14). The chronic standard was exceeded in seven samples collected from four sites in the South Watershed (Table 19).

Relative to the number of dissolved iron samples, the South Watershed lacks total iron samples. A total iron standard of 1,000 ug/L is applied to protect aquatic life uses. Total iron is the sum of the dissolved and suspended iron concentrations, so where dissolved iron concentrations exceeded 1,000 ug/L, total iron concentration were presumably greater than 1,000 ug/L. Dissolved iron concentrations, in excess of 1,000 ug/L were used to supplement the total iron assessment and are noted as such.

7.7.1 Mamm Creek (Segment 4a)

In Mamm Creek about 3.2 miles above the confluence with the Colorado River, total iron concentrations ranged from less than 200 to 68,500 ug/L in six samples collected from 3/16/2000 to 5/24/2012 (Figure 16; site 11149B). Total iron concentrations exceeded the chronic standard in three samples. Because the samples exceeded the chronic standard, Mamm Creek, but not other portions of Segment 4a, may be added to the M&E List or possibly the 303(d) List for total iron (Sarah Wheeler, personal communication, 1/2/2014). Other locations in Mamm Creek had dissolved iron concentrations that ranged from 21 to 2,200 ug/L in 26 samples and dissolved iron concentrations exceeded 1,000 ug/L in two samples. Additional sample collection should occur in Mamm Creek and its tributaries to better characterize total iron and identify potential sources.

7.7.2 Alkali Creek (Segment 4a)

In Alkali Creek near the mouth in New Castle total iron concentrations ranged from 95 to 68,000 ug/L in six samples collected from 2/24/2000 to 6/6/2012 (Figure 16; site 11189). The total iron concentration of 68,000 ug/L, measured on 10/17/2006, prompted the M&E Listing for Alkali Creek. In 2011 the total iron concentration was lower, 1,300 ug/L, but remained above the chronic standard of 1,000 ug/L. Due to relatively low dissolved iron concentrations in Alkali Creek, the data cannot be used to corroborate total iron concentrations. Additional data collection should occur to better characterize total iron concentrations and identify potential natural or anthropogenic sources.

7.7.3 East Divide Creek (Segment 7b)

In East Divide Creek below the confluence with June Creek the total iron concentration was 1,201 ug/L in the only sample collected to date (Figure 16; site 3946). The concentration exceeded the chronic standard but was far lower than the highest total iron concentrations found in the South Watershed. As discussed in the previous section, dissolved iron concentrations are elevated in the Divide Creek Watershed, particularly in West Divide Creek. Twenty-two percent of the dissolved iron concentrations collected from Divide Creek exceeded 1,000 ug/L; thus, total iron concentrations may exceed 1,000 ug/L more frequently than suggested by the total iron data.

7.7.4 Beaver Creek (Segment 7a)

In Beaver Creek, west of Flatiron Mesa, the total iron concentration was 1,271 ug/L in the only sample collected to date, which exceeded the chronic standard (Figure 16; site 803). Due to relatively low dissolved iron concentrations in Beaver Creek and other portions of Segment 7a, the data were not used to corroborate total iron concentrations.

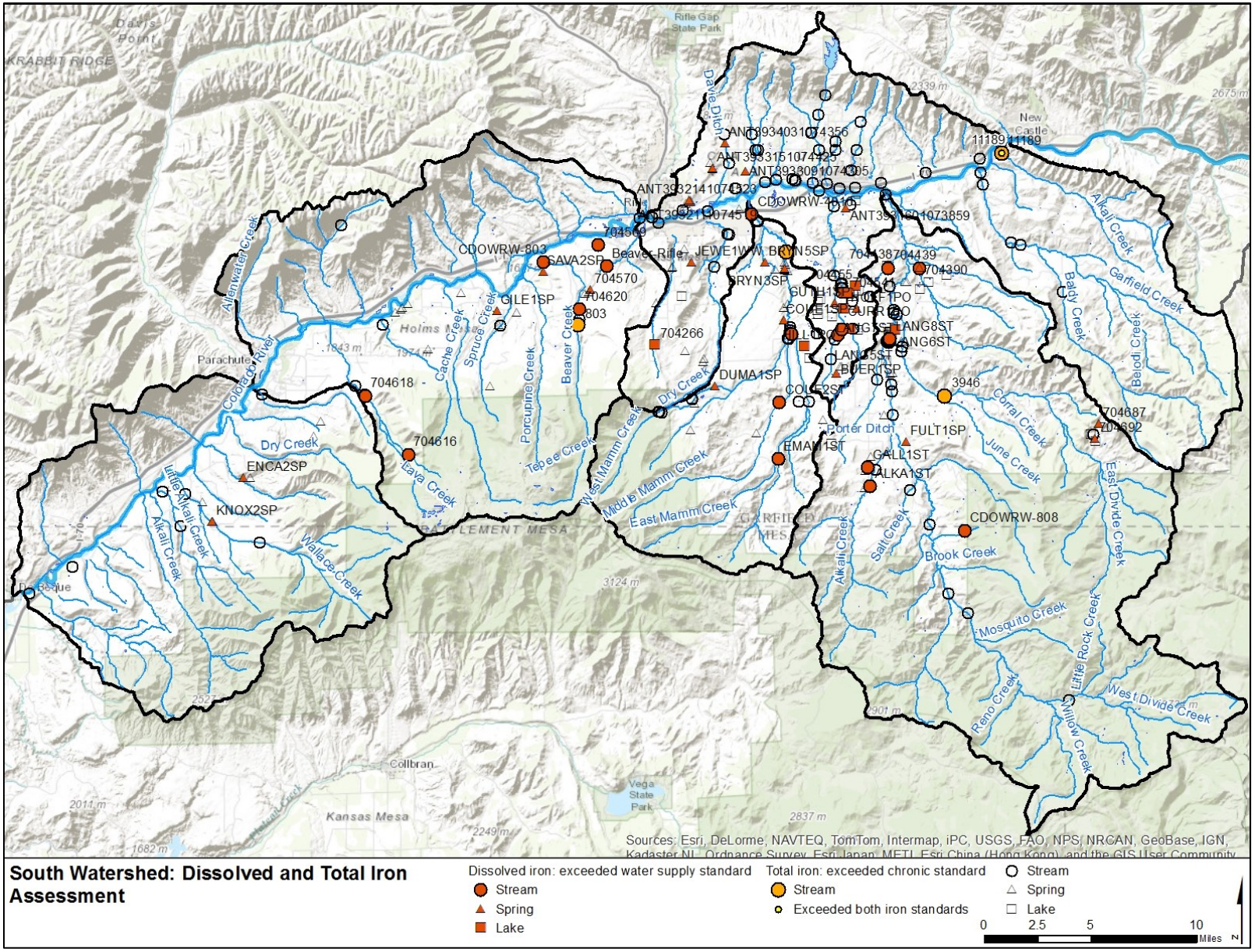
The chronic total iron standard of 1,000 ug/L was not exceeded on the following Segments: 4d, 4e (due to a temporary modification that expired on 12/31/2013 that allowed for existing conditions), 5, 9b, and 9c (Table 19). Segments 11g and 13a do not have total iron standards (WQCD, 2013). There are not total iron data for Segment 12b, Colorado River tributaries from Parachute to Roan Creek.

The geology of the South Watershed is Quaternary alluvium in areas adjacent to the creeks, generally in the lower portion of the watershed. The alluvium is derived from materials in the upper portions of the watershed which are primarily Tertiary sandstones and mudstones, with smaller areas of Cretaceous shale (Green et al., 1992). Weathering could be a natural source of iron in this portion of the Watershed.

Table 19. Total iron assessment summary for the South Watershed; the table only includes the segments with a total iron standard.

WQCC Segment	Segment Description	Site Type	Samples	Chronic Standard	Exceeded Chronic Standard	Percent of Samples	Comments and Priority
4a	All tributaries, including wetlands, to the Colorado River from the Roaring Fork River to Parachute Creek except for the specific listings in Segments 4b, 4c, 4d, 4e, 5, 6, 7a, 7b, 8, 9a, 9c, 10, 11a - h,	Stream	20	1,000	5	25%	Data from Alkali Creek prompted the 303(d) listing for total iron. Mamm Creek also had elevated concentrations. Additional sampling is recommended.
		Spring	3		0	0%	
		Total	**23**		**5**	**22%**	
4d	The mainstem of Dry Hollow Creek, including all tributaries and wetlands, from the source to the confluence with the Colorado River.	Stream	0	1,000	0	0%	No comments or priority assigned at this time.
		Spring	3		0	0%	
		Total	**3**		**0**	**0%**	
4e	Mainstem of Dry Creek including all tributaries and wetlands from the source to immediately above the Last Chance Ditch.	Stream	4	1,000	0	0%	COLCLC04e had a temporary modification, expired 12-31-2013, which allowed for existing quality for total recoverable iron.
		Spring	0		0	0%	
		Total	**4**		**0**	**0%**	
5	All tributaries to the Colorado River, including wetlands, which are within the boundaries of White River National Forest, except for the specific listing in Segments 9a and 9c.	Stream	1	1,000	0	0%	No comments or priority assigned at this time.
		Spring	0		0	0%	
		Total	**1**		**0**	**0%**	
7a	Mitchell, Canyon, Elk, Garfield, Beaver and Cache Creeks, including all tributaries & wetlands, from boundary of the White River National Forest to the confluence with the Colorado River.	Stream	10	1,000	1	10%	No comments or priority assigned at this time.
		Spring	0		0	0%	
		Total	**10**		**1**	10%	
7b	Mainstem of Divide Creek, including all tributaries and wetlands, from the boundary of the White River National Forest to the confluence with the Colorado River.	Stream	6	1,000	1	17%	Dissolved iron concentrations may suggest that elevated iron concentrations are more common than the total iron data indicates.
		Spring	1		0	0%	
		Total	**7**		**1**	**14%**	
9b	All lakes and reservoirs tributary to the Colorado River from the Roaring Fork River to Parachute Creek, except for segment 20.	Lake, pond or reservoi	1	1,000	0	0%	No comments or priority assigned at this time.
9c	Battlement Creek, including all tributaries and wetlands, from the source to the most downstream boundary of BLM lands. Outstanding waters designation	Stream	13	1,000	0	0%	No comments or priority assigned at this time.
		Spring	0		0	0%	
		Total	**13**		**0**	**0%**	

Figure 16. Water quality monitoring sites where dissolved or total iron concentrations exceeded the applicable standard.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

7.8 Dissolved Lead

Dissolved lead concentrations ranged from less than 0.1 to 64 ug/L in 74 samples collected from 27 locations and 69 percent of the results were below the MRL (Table 14). Twelve samples collected from two locations exceeded the chronic lead standard; the acute standard was not exceeded.

7.8.1 Alkali Creek (Segment 4a)

One in seven samples exceeded the chronic lead standard in Alkali Creek near the mouth in New Castle (Figure 17; site 11189). The sample that exceeded the chronic standard, which was approximately 11 ug/L based on the hardness, was collected on 10/17/2006 and had a concentration of 64 ug/L. Dissolved lead concentrations in the other six samples collected in Alkali Creek had concentrations less than 1 ug/L. Three of the samples were collected prior to the exceedance, in February and March 2000, and three samples were collected after, in July 2011 and March and June 2012. Alkali Creek, a part of Segment 4a, was added to the M&E List for dissolved lead based on the concentration measured during the 2006 sampling event. It's possible that the WQCD will remove the M&E Listing based on the dissolved lead concentrations measured in 2011 and 2012. The next 303(d) and M&E Lists will be released in April 2016. Additional sample collection should occur in Alkali Creek to determine whether the 2006 sample was characteristic of dissolved lead concentrations.

7.8.2 Battlement Creek (Segment 9c)

Dissolved lead concentrations ranged from less than 1.3 to 6.8 ug/L in 13 samples collected intermittently from 2008 to 2010 in Battlement Creek about 2.8 miles above the confluence with the Colorado River. Eleven samples exceeded the chronic lead standard, approximately 3.6 ug/L based on the hardness, measured in Battlement Creek. The acute lead standard was not exceeded in any samples (Figure 17; site 820). The remaining two samples, collected during March and April 2008, were below the MRL. Two upstream locations in Battlement Creek were sampled once each (Figure 11; sites 704614 and 704616) and the dissolved lead concentrations were less than 5 ug/L in both samples. Collectively, 11 of 15 dissolved lead samples from Battlement Creek exceeded the chronic lead standard; the acute standard was not exceeded. The data set lacks a sufficient number of samples to identify seasonal trends. Due to the number of chronic exceedances the health of aquatic life may be affected in this area. Additional data collection should occur to better characterize dissolved lead concentrations and potential natural or anthropogenic sources. The dissolved lead concentrations in Battlement Creek could result in a 303(d) or M&E Listing for Segment 9c in 2016.

7.9 Dissolved Copper

Dissolved copper concentrations ranged from less than 0.5 to 112 ug/L in 75 samples collected from 27 locations in the South Watershed and were below the MRL in 69 percent of the samples (Table 14). Six samples exceeded the chronic standard and four samples exceeded the acute standard. The exceedances occurred at three locations.

7.9.1 Alkali Creek (Segment 4a)

In Alkali Creek near the mouth in New Castle dissolved copper concentrations ranged from less than 4 to 30 ug/L in six samples (Figure 17; site 11189). One sample, collected on 10/17/2006, had a concentration of 30 ug/L and exceeded the chronic standard for dissolved copper. Four of six samples had copper concentrations below the MRL. Alkali Creek has not been sampled at other locations. Alkali Creek, a part of Segment 4a, was added to the M&E List for dissolved copper based on the concentration measured during the 2006 sampling event. It's possible that the WQCD will remove the M&E Listing based on the dissolved copper concentrations measured in 2011 and 2012. The next 303(d) and M&E Lists will be released in April 2016. Additional sample collection should occur on Alkali Creek to determine whether the 2006 sample was characteristic of dissolved copper concentrations.

7.9.2 West Divide Creek (Segment 7b)

Three adjacent stream locations in West Divide Creek upstream of the confluence with East Divide Creek sampled from December 2004 to March 2006 had dissolved copper concentrations ranging from less than 0.5 to 112 ug/L in 21 samples (Figure 11; sites LANG6ST, LANG7ST, and LANG8ST). Dissolved copper concentrations were below the MRL in nine samples and 16 samples met the dissolved copper criteria. Two adjacent sites in West Divide Creek near the confluence with East Divide Creek accounted for five chronic exceedances and four acute exceedances (Figure 17; sites LANG6ST and LANG8ST). At LANG6ST three of seven samples exceeded both the chronic and acute standards; the maximum concentration of 112 ug/L was measured in July 2005. At LANG8ST two of twelve samples exceeded the chronic standard and one sample exceeded the acute standard; the maximum concentration of 55 ug/L was measured in December 2005. The existing data set is not large enough to characterize trends or identify sources; additional data collection should occur in Divide Creek to better characterize copper concentrations.

7.9.3 Dry Creek (Segment 4e)

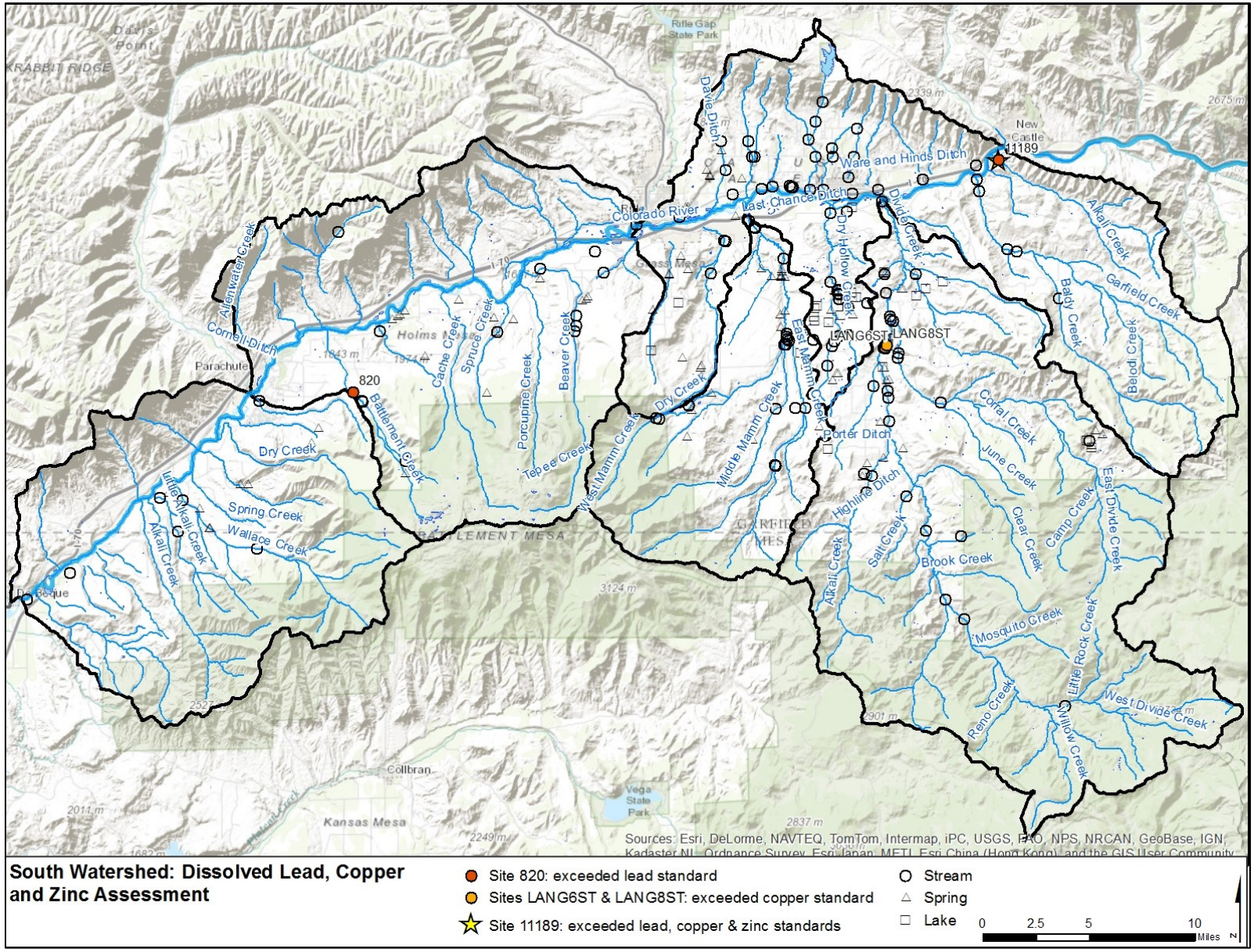
Dissolved copper concentrations ranged from less than 5 to 77 ug/L in three samples collected to date in Dry Creek at County Road 352, about 1.3 miles above the confluence with Last Chance Ditch (Figure 17; sites 11148 and 11148C). Dry Creek and its tributaries (Segment 4e) are use-protected and have a temporary modification that allows for existing quality. The temporary modification expires 12/31/2014; it is unknown whether the temporary modification will be extended.

7.10 Dissolved Zinc

Dissolved zinc concentrations ranged from less than 0.3 to 14,000 ug/L in 68 samples collected from 22 locations and were below the MRL in 41 percent of the samples (Table 14). One sample collected from the mouth of Alkali Creek, on 10/17/2006, had a dissolved zinc concentration of 14,000 ug/L, which exceeded the chronic and acute zinc standards (Site 11189). The 2006 result prompted the M&E Listing for Alkali Creek, a part of Segment 4a. Data collected more recently, in 2011 and 2012 (n=3), had zinc concentrations that ranged from less than 4 to 13 ug/L, and met the chronic standard.

The new data may be sufficient to resolve the M&E Listing. WQCD staff will assess the 2011 and 2012 data during the 2016 303(d) Listing process and determine whether Alkali Creek is in attainment. Additional sample collection should occur on Alkali Creek to determine whether the 2006 sample was characteristic of dissolved zinc concentrations.

Figure 17. Water quality monitoring sites where dissolved lead, copper or zinc concentrations exceeded the applicable standard.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

7.11 Dissolved Oxygen

Dissolved oxygen concentrations were measured 1,189 times at 50 stream, 52 spring, and 22 lake sites and ranged from 0.3 to 20.21 mg/L in the South Watershed (Table 14). Dissolved oxygen concentrations were less than the applicable criteria in 19, 21, and 22 percent of the measurements collected from stream, spring, and pond sites, respectively. Due to limited Metadata regarding the sample locations and the sample methods, dissolved oxygen concentrations may not necessarily be indicative of impairment.

The 15th percentile dissolved oxygen concentration for stream sites in the South Watershed was 5.08 mg/L. The target value for the 15th percentile dissolved oxygen concentration is 6.0 mg/L, which is applied as the standard at individual sites. The 19th percentile dissolved oxygen concentration was 6.05 mg/L, indicating that the vast majority of the dissolved oxygen concentrations measured at stream sites in the South Watershed were greater than 6.0 mg/L. Dissolved oxygen concentrations were less than 6.0 mg/L in 231 samples, collected from 44 locations (Table 20). Dissolved oxygen concentrations were less than the standard at 20, 16, and 6 stream, spring, and lake sites, respectively (Figure 18).

Dissolved oxygen concentrations were greater than 6.0 mg/L in all samples collected from Dry Creek and tributaries, tributaries in the White River National Forest, the portion of Parachute Creek on Segment 11g and tributaries to the Colorado River between Parachute and Roan Creeks.

7.11.1 Tributaries to the Colorado River between the Roaring Fork River and Parachute Creeks (Segment 4a)

Dissolved oxygen concentrations from stream sites on tributaries to the Colorado River between the Roaring Fork River and Parachute Creek (Segment 4a) were less than 6.0 mg/L in 16 samples collected from eight sites (Figure 18; Table 20). Three of the sites are located in the area north of the Colorado River near Farmers Ditch and Silt. Three sites are located in the Mamm Creek drainage. The remaining two sites are located west of Grass Mesa, south of Rifle.

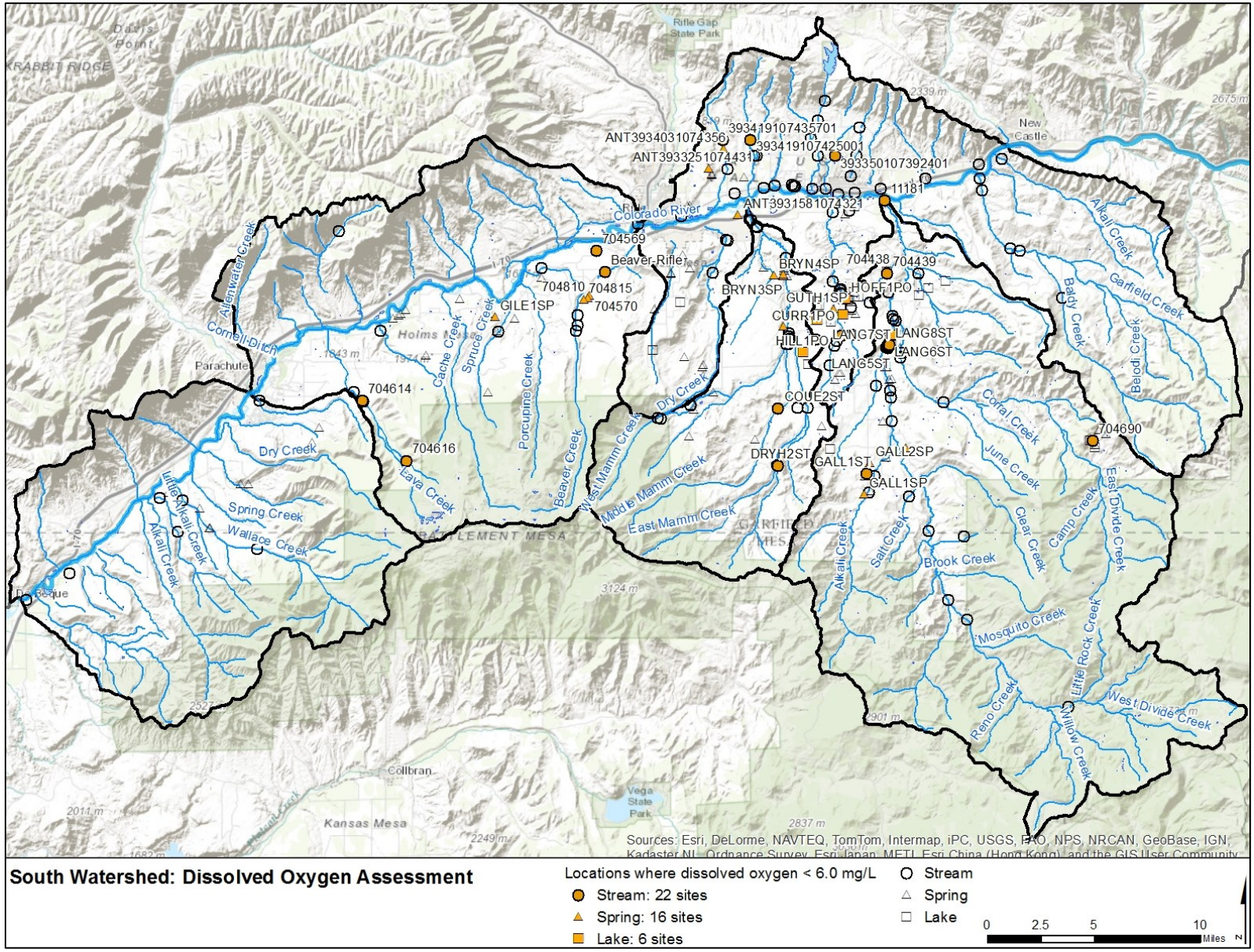
7.11.2 Divide Creek and Tributaries (Segment 7b)

Dissolved oxygen concentrations in Divide Creek and its tributaries (Segment 7b) were less than 6.0 mg/L in 155 samples collected from ten locations (Table 20). Seven of the sites were located on Divide Creek above the confluence with East Divide Creek (Figure 18). Those sites accounted for the vast majority of the dissolved oxygen concentrations that were below 6.0 mg/L. Upper East Divide Creek had one location and the lower portion of Divide Creek had two stream sites. Limited sample collection occurred at most of these locations.

Table 20. Dissolved oxygen summary by Segment and site type in the South Watershed.

WQCC Segment	Segment Description	Site Type	Dissolved Oxygen Results	< D.O. Standard	Percent < D.O. Standard
4a	All tributaries, including wetlands, to the Colorado River from the Roaring Fork River to Parachute Creek except for listings in Segments 4b, 4c, 4d, 4e, 5, 6, 7a, 7b, 8, 9a, 9c, 10, 11a - h, and 12a.	Stream	67	16	24%
		Spring	53	13	25%
		Total	120	29	24%
4d	The mainstem of Dry Hollow Creek, including all tributaries and wetlands, from the source to the confluence with the Colorado River.	Stream	55	3	5%
		Spring	7	1	14%
		Total	62	6	10%
4e	Mainstem of Dry Creek including all tributaries and wetlands from the source to immediately above the Last Chance Ditch.	Stream	4	0	0%
		Spring	4	0	0%
		Total	8	0	0%
5	All tributaries to the Colorado River, including wetlands, which are within the boundaries of White River National Forest, except for the specific listing in Segments 9a & 9c.	Stream	1	0	0%
		Spring	0	0	0%
		Total	1	0	0%
7a	Mitchell, Canyon, Elk, Garfield, Beaver and Cache Creeks, including all tributaries & wetlands, from boundary of the White River National Forest to the confluence with the Colorado River.	Stream	5	0	0%
		Spring	4	2	50%
		Total	9	2	22%
7b	Mainstem of Divide Creek, including all tributaries and wetlands, from the boundary of the White River National Forest to the confluence with the Colorado River.	Stream	798	155	19%
		Spring	16	7	44%
		Total	814	162	20%
9b	All lakes and reservoirs tributary to the Colorado River from the Roaring Fork River to Parachute Creek, except for segment 20.	Lake, pond or reservoi	130	29	22%
9c	Battlement Creek, including all tributaries and wetlands, from the source to the most downstream boundary of BLM lands. Outstanding waters designation	Stream	18	3	17%
		Spring	1	0	0%
		Total	19	3	16%
11g	Portions of Parachute Creek… and all tributaries to the Colorado River on the north side of the Colorado River from a point immediately below Cottonwood Creek to the confluence with Parachute Creek except for specific listings in segment 7a.	Stream	1	0	0%
		Spring	0	0	0%
		Total	1	0	0%
12b	All tributaries and wetlands to the Colorado River from a point immediately below the confluence of Parachute Creek to a point immediately below the confluence with Roan Creek.	Stream	0	0	0%
		Spring	25	0	0%
		Total	25	0	0%

Figure 18. Monitoring sites where dissolved oxygen concentrations were less than 6.0 mg/L in the South Watershed.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

7.12 *Escherichia coli*

E. coli concentrations ranged from 17.3 colonies per 100 mL to too numerous to count in seven samples collected from the South Watershed (Table 14). The standard of 630 colonies per 100 mL was exceeded in three samples collected from two locations. The South Watershed lacks *E. coli* data and additional sample collection should occur.

7.12.1 Alkali Creek (Segment 4a)

On 10/17/2006, the *E. coli* concentration in Alkali Creek near the confluence with the Colorado River was 24,192 colonies per 100 mL. Alkali Creek, a portion of Segment 4a, is currently on the M&E List for *E. coli*. The mouth of Alkali Creek was sampled on 7/12/2011 and the *E. coli* concentration was 92 colonies per 100 mL. The 2011 sample met the standard and may be sufficient to resolve the M&E Listing for Alkali Creek. WQCD will review the data as the 2016 303(d) and M&E Lists are created.

7.12.2 Mamm Creek (Segment 4a)

In four samples collected in Mamm Creek, about 3.2 miles above the confluence with the Colorado River, *E. coli* concentrations ranged from 43.2 to 2419.2 colonies per 100 mL. *E. coli* concentrations were greater than the standard in two of four samples; the exceedances occurred on 8/2/2011 and 3/28/2012. The samples that were below the *E. coli* criteria were collected on 10/25/2011 and 5/24/2012. Although the data are limited, *E. coli* concentrations appear to vary widely in the Mamm Creek Watershed. The data collected in 2011 and 2012 will likely result in an M&E Listing for Mamm Creek, a portion of Segment 4a (Wheeler, personal communication, 1/2/2014). However, the WQCD's assessment could change if additional data become available.

7.13 BTEX: Benzene, Toluene, Ethylene and Xylene

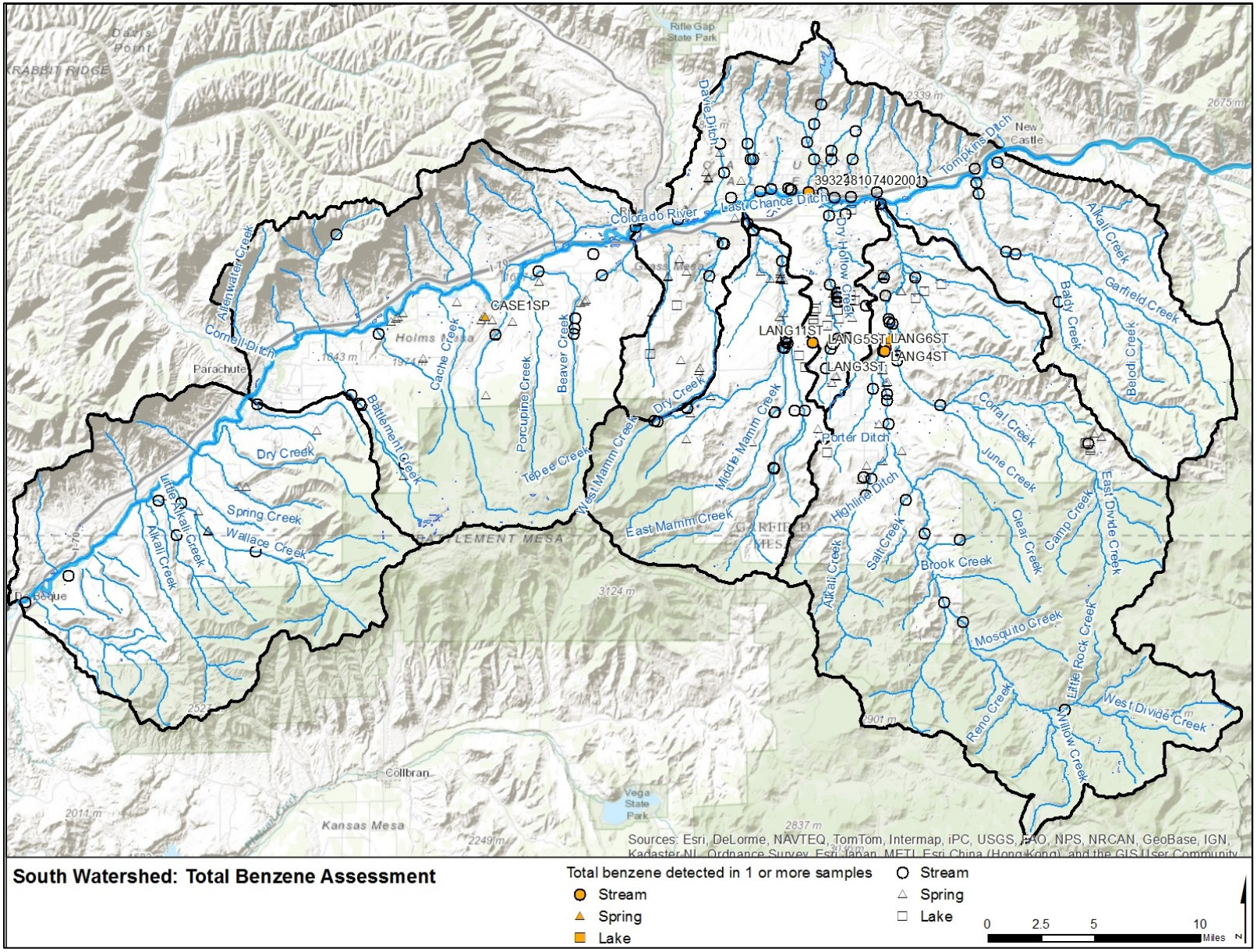
Total benzene concentrations were below the MRL in 92.5 percent of samples collected from the South Watershed (Table 14). Toluene, ethylene and xylene concentrations were below the MRL in 99 percent of samples collected in the South Watershed. Toluene, ethylene and xylene will not be discussed further.

In the South Watershed, total benzene was detected in 92 samples at 11 sites (Table 21; Figure 19). Stream sites accounted for seven of the locations, and springs and lakes accounted for two locations each. Total benzene concentrations ranged from 0.0008 to 360 ug/L in the South Watershed (Table 14). West Divide Creek, above the confluence with East Divide Creek, accounted for nine of the locations where total benzene was detected (Table 21 and Figure 19; LANG sites). At the most frequently sampled sites in West Divide Creek, total benzene concentrations were below the MRL in 71 to 99 percent of the evaluations (Table 21). A previous study in the Divide Creek area noted that fluctuations in benzene concentrations were likely due to natural variation and the origin was widespread, rather than localized, and was more than 600 feet below the ground surface (Tetra Tech, 2013).

Table 21. Summary of monitoring sites where total benzene was detected in one or more samples; concentrations in ug/L.

WQCC Segment	Site	Site Type	Number of Samples	Percent < MDL	Minimum Concentration	Maximum Concentration
4a	393248107402001	Stream	1	0%	1	NA
	CASE1SP	Spring	3	67%	0.3	28
	LANG11ST	Stream	3	0%	2.4	3.2
7b	LANG1ST	Stream	1	0%	5.9	NA
	LANG1PO	Lake	5	0%	1.3	4.4
	LANG2PO	Lake	52	77%	1	360
	LANG3ST	Stream	103	71%	0.5	12
	LANG4ST	Stream	182	79%	0.5	12
	LANG5ST	Stream	181	99%	0.5	1.5
	LANG6ST	Stream	128	99%	0.0008	1
	LANG10ST	Stream	63	86%	0.5	3.5

Figure 19. Monitoring sites where total benzene was detected in one or more samples in the South Watershed.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

7.14 Major Findings

Further data collection is recommended to better characterize selenium concentrations and identify potential sources in Mamm, Alkali, Dry Hollow, and Divide Creeks. Additional data could be used to identify natural or anthropogenic sources of selenium. Potential sources include the local geology, erosive soils, and various land uses.

Nutrient data are very limited in the South Watershed. The following areas lack total phoshorus data: Dry Hollow Creek (Segment 4d), Rifle Creek (Segment 10), and tributaries to the Colorado River between Parachute and Roan Creeks (Segment 12b). Total nitrogen samples have not been collected from the following areas: Dry Hollow Creek (Segment 4d), tributaries in the White River National Forest (Segment 5), Garfield, Beaver, and Cache Creeks (Segment 7a), Divide Creek and tributaries (Segment 7b), Rifle Creek (Segment 10), portions of Parachute Creek (Segment 11g and 12a). On-going and future sample efforts should assure that total phosphorus and total nitrogen are include in the analyses.

The dissolved lead assessment on Battlement Creek suggests that additional data collection should occur in this area to determine whether elevated lead concentrations persist and to identify potential sources. Given the extent of chronic exceedances, improved understanding of water quality is a priority.

Based on the existing data set, the mouths of Divide, Mamm, and Alkali Creeks are prime locations for long term monitoring efforts. Additional sites in tributaries to Divide, Mamm, and Alkali Creeks could also be identified. Energy producers collect a large volume of water quality data in the South Watershed. Those data should be incorporated into future monitoring efforts to increase efficiency and manage monitoring costs, if possible.

8.0 West Watershed Water Quality Analysis and Discussion

The West Watershed is 708 square miles and includes approximately 1,987 miles of perennial, intermittent and ephemeral streams (Table 22). Parachute and DeBeque are located at the outlets of Parachute Creek and Kimball Creek Watersheds, respectively.

The West Watershed has 98 sample sites, 72 of which are located in the Parachute Creek Watershed (Table 22). Stream sites account for 52 sites, while lake and spring sites total four and 42 sites, respectively (Figure 20). The headwaters of Kimball and Roan Creeks were sampled on a very limited basis. The West Watershed includes fourteen segments. The segments tend to be delineated in a more specific manner in this portion of the Watershed.

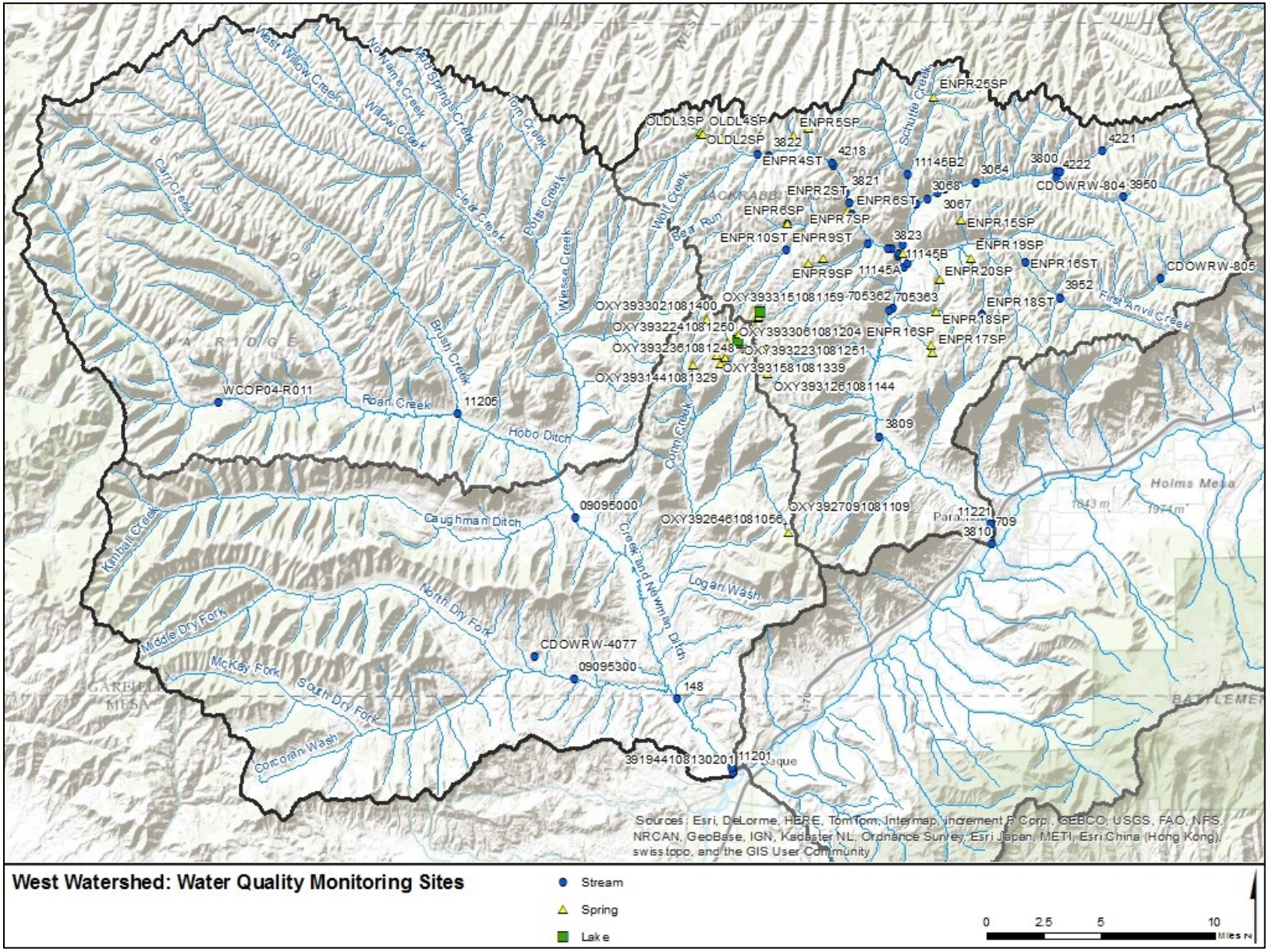
Table 22. Characteristics of the West Watershed.

HUC 10 Watershed	Area (mi^2)	Major Tributaries[1]	Length (mi)	Location Types			Towns
				Stream	Lake	Spring	
Parachute Creek	198.4	Parachute Creek	14.6	43	2	27	Parachute and DeBeque
		East Fork Parachute Creek	14.3				
		West Fork Parachute Creek	13.0				
		Northwater Creek	6.7				
		Willow Creek	6.6				
Clear Creek-Roan Creek	268.2	Roan Creek	29.4	3	0	0	
		Clear Creek	24.4				
		Brush Creek	18.8				
		Carr Creek	16.7				
		Tom Creek	7.7				
Kimball Creek-Roan Creek	241.6	Roan Creek	15.5	6	2	15	
		Kimball Creek	21.0				
		North Dry Fork	17.2				
		South Dry Fork	12.4				
		Conn Creek	12.3				
West Watershed Total:	708.2	All Tributaries[2]	1986.5	52	4	42	
				98			

Notes

1. The five longest named tributaries are presented for each HUC 10 Watershed.
2. All tributaries is a total of all named and unnamed tributaries in the West Watershed.

Figure 20. Water quality monitoring sites in the West Watershed.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

The data compilation and analysis revealed a lack of chlorophyll *a*, total phosphorus, total nitrogen, dissolved nitrate, dissolved nitrite and *E. coli* data (Table 23). These parameters are considered data gaps due the limited number of results and lack of spatial coverage in the West Watershed. The data gaps for phosphorus and nitrogen are particularly important as numeric criteria are adopted as part of Regulation 85. A unique and important fishery, extensive recreation, energy development, and agriculture occur in the West Watershed, which increases the need for water quality data.

Dissolved nitrate concentrations were less than 10 mg/L, the applicable standard, in all samples collected from the West Watershed.

Dissolved copper concentrations ranged from less than 1 to 28 ug/L in 218 samples and 210 of the results were less than the MRL (Table 23). All dissolved copper concentrations were less than the chronic and acute standards. Dissolved zinc concentrations ranged from less than the MRL to 79 ug/L in 107 samples and 47 percent of the results were less than the MRL (Table 23). All dissolved zinc samples were less than the chronic and acute standards. Additional analysis is not presented for these metals.

To date, BTEX concentrations were measured in 122 to 149 samples, depending on the individual parameter (Table 23). The vast majority, 99 to 100 percent, of the BTEX results were below the MRL. Additional analysis was not completed because very few of the samples had detectable concentrations of BTEX.

In a study of springs in the Parachute and Roan Creek drainages completed from 1981 to 1983, mean spring discharges were reported as approximately 5 gallons per minute (USGS, 1985). Spring discharges often increased sharply during or immediately after snowmelt (USGS, 1985). This indicates a short residence time for much of the infiltrated snowmelt in the upland regions (USGS, 1985). Shorter residence times may limit the extent to which surface waters can mix with groundwater or accumulate weathered constituents from the geologic strata it passes through, so the water discharged from some springs may remain more characteristics of meteoric waters (waters derived from the atmosphere-including precipitation, snowmelt, and condensation).

Table 23. Summary of analysis parameters in the West Watershed.

Parameter	Parameter Count	< MDL Count[1]	Percent <MDL[2]	Minimum	5th Percentile[3]	25th Percentile	Median	75th Percentile	95th Percentil	Maximum	Additional Analysis[4]	Data Gap	Regulatory Considerations
Dissolved Selenium (ug/L)	227	140	62%	0.3	1.76	3.25	10	20	22	94	Yes	Yes	303(d) listed
Total Phosphorus (mg/L)	55	22	40%	0.003	0.005	0.005	0.01	0.03	0.294	0.61	Yes	Yes	Reg. 85 (Nutrients)
Total Nitrogen (mg/L)	50	17	34%	0.1	0.36	0.5	0.57	1.30	2.05	2.22	Yes	Yes	Reg. 85 (Nutrients)
Dissolved Nitrate (mg/L)	18	6	33%	0.425	NA	NA	2.46	NA	NA	5.51	Yes	Yes	
Dissolved Nitrite (mg/L)	32	19	59%	0.004	0.005	0.007	0.008	0.009	0.015	0.05	Yes	Yes	
Dissolved Ammonia (mg/L)	88	77	88%	0	0.01	0.01	0.03	0.04	0.041	0.36	No	Yes	
Chlorophyll a (ug/L)	0	0	0%	NA	NA	NA	NA	NA	NA	NA	No	Yes	Reg. 85 (Nutrients)
Dissolved Iron (ug/L)	237	131	55%	5	10	15	50	100	3,620	19,000	Yes	Yes	M&E list
Total Iron (ug/L)	107	11	10%	10	20	50	140	580	8,740	32,000	Yes	Yes	M&E list
Dissolved Lead (ug/L)	191	171	90%	1	1	1	3	5	6.1	19	Yes	Yes	
Dissolved Copper (ug/L)	218	210	96%	1	1	5	20	20	20	28	No, 96% < MDL	No	
Dissolved Zinc (ug/L)	107	50	47%	0	3	5.90	10	25	56.4	79	Yes	No	
Specific Conductance (uS/cm)	211	NA	NA	205	451.5	578	791	1745	4280	86100	No	TBD	
Dissolved Oxygen (mg/L)	242	NA	NA	1.57	2.27	7.05	8.93	10.23	12.17	14.15	Yes	TBD	
E. coli (col/100 mL)	42	22	52%	0	1	2	46	150	680	2419	Yes	Yes	M&E list
Benzene (ug/L)	148	148	100%	0.16	0.16	0.5	0.5	0.5	0.5	1	No, 100% < MDL	COGCC Monitoring Requirements	
Toluene (ug/L)	122	122	100%	2	5	5	5	5	5	5	No, 100% < MDL		
Ethylene (ug/L)	149	147	99%	0.0005	NA	NA	0.5	NA	NA	2	No, 99% < MDL		
Xylene- all isomers (ug/L)	143	142	99%	0.5	0.5	1.5	1.5	1.5	1.5	34	No, 99% < MDL		

Notes

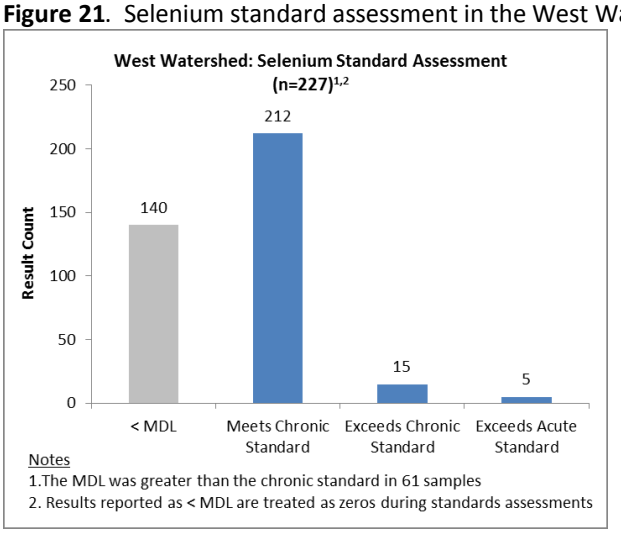
1. The count of results that were below the method detection limit (MDL).
2. The results below MDL expressed as a percent of all results (<MDL/total results).
3. Percentiles were not calculated unless there were 20 or more results for a given parameter.
4. Identifies whether a parameter was selected for additional analysis based on preliminary assessments.

8.1 Dissolved Selenium

Dissolved selenium concentrations ranged from less than 0.3 to 94 ug/L in 227 samples collected from the West Watershed and were below the MRL in 140 samples (Table 23). However, the MRL was greater than the chronic standard in 61 of the samples. The net effect of the unsuitable MRL in the West Watershed is that 61 samples appear to meet the applicable selenium standard, but it is not possible to make an actual determination because of the MRL associated with the result. This creates a data gap with respect to selenium concentrations in the West Watershed.

The unsuitable MRL do not affect the evaluations where the chronic or acute selenium standard was exceeded because the samples had measureable concentrations of selenium. In the West Watershed, 15 samples collected from 11 locations exceeded the chronic standard (Figures 21 and 22). The acute selenium standard was exceeded in five samples collected from four locations. Stream sites accounted for 15 of 16 chronic exceedances and all of the acute exceedances. One sample collected at a spring site exceeded the chronic selenium standard.

Figure 21. Selenium standard assessment in the West Watershed (n=227).



8.1.1 Northwater, Trapper, and East Middle Fork of Parachute Creeks and All Tributaries (Segment 8)

On Segment 8, two of twenty samples exceeded both the chronic and acute standards, which are 4.6 and 20 ug/L, respectively (Table 24). Dissolved selenium concentrations in the East Middle Fork of Parachute Creek above the confluence with the Middle Fork of Parachute Creek ranged from less than 10 to 67 ug/L (Figure 22; site ENPR13ST). The dissolved selenium concentrations that exceeded the standards were 26 and 67 ug/L in March 2003 and May 2005, respectively. Sample collection has occurred three times since May 2005 under low flow conditions in August 2005, 2006, and 2007. Dissolved selenium concentrations in these samples were less than the MRL, which ranged from 10 to 20 ug/L. Dissolved selenium concentrations have declined in samples collected since May 2005, but the extent of the decrease cannot be precisely defined due to the MRL used in the sample analyses. At a

downstream location in the Middle Fork of Parachute Creek above the confluences with the west and east forks (ENPR11ST), dissolved selenium concentrations were less than 10 ug/L in all the samples collected to date (n=5). Additional data collection should occur in Parachute Creek to resolve the uncertainty regarding selenium concentrations, which is attributed to inappropriate MRL and a limited number of samples.

8.1.2 Upper West Fork of Parachute Creek, a Portion of the East Fork of Parachute Creek and Tributaries (Segment 11a)

On Segment 11a dissolved selenium concentrations ranged from less than 5 to 30.8 ug/L in 20 samples and 19 results were below the MRL. In West Parachute Creek above the falls, the dissolved selenium concentration was 30.8 ug/L on 8/6/2008, exceeded the chronic and acute standards (Table 24). In the only other sample collected from this location, on 10/24/2011, the dissolved selenium concentrations was less than 5 ug/L. The dissolved selenium concentration measured downstream, in Parachute Creek below the falls, was less than 5 ug/L on 8/16/2011. Although the sample size is small, it does not appear that dissolved selenium concentrations are consistently problematic in this portion of Parachute Creek. The WQCD may opt to include Segment 11a on the 2016 M&E List, which indicates the need for additional data collection.

8.1.3 Lower West Fork of Parachute Creek and Upper Middle Fork of Parachute Creek (Segment 11b)

On Segment 11b dissolved selenium concentrations ranged from 1 to 94 ug/L in 63 samples collected from January 2000 to October 2011. The chronic standard was exceeded at two stream locations in the West Fork of Parachute Creek. Ten samples collected from spring sites met the chronic standard (Table 24). Segment 11b lacks an acute standard for dissolved selenium.

In the West Fork of Parachute Creek at the confluence with Bear Run Creek dissolved selenium concentrations ranged from less than 10 to 22 ug/L in five samples (Figure 22; ENPR6ST). The sample collected on 3/13/2008 had a dissolved selenium concentration of 22 ug/L which exceeded the chronic standard. At two other locations immediately upstream in the West Fork of Parachute Creek dissolved selenium concentrations were below the MRL in eight samples collected from 2004 to 2011; the MRL ranged from 5 to 20 ug/L. (Figure 20; sites 3821 and ENPR2ST). Based on existing data, it is not clear whether selenium is elevated on a consistent basis in this portion of Parachute Creek.

In the West Fork of Parachute Creek above the confluence with the Middle Fork of Parachute Creek dissolved selenium concentrations ranged from less than 10 to 94 ug/L in seven samples and the chronic standard was exceeded once (Figure 20; site ENPR3ST). From 2000 to 2011 dissolved selenium concentrations ranged from 1.1 to 5 ug/L in 13 samples collected from adjacent sites in the West Fork Parachute Creek above the confluence with the Middle Fork (Sites 3823 and 11145A). Based on limited data, it does not appear that selenium concentrations regularly exceeded the standard in this portion of West Parachute Creek.

Collectively 97 percent of the samples collected on Segment 11b met the chronic selenium standard. Samples collected from two locations exceeded the chronic standard; however, adjacent sites had selenium concentrations near or below the MRL. So, additional sample collection in this portion of Parachute Creek is not a priority at this time.

8.1.4 Mainstem of East Fork of Parachute Creek and Tributaries (Segment 11e)

Dissolved selenium concentrations were measured nine times at three stream and four times at two spring sites in the East Fork of Parachute Creek and its tributaries. Dissolved selenium concentrations were below the MRL in seven of the stream samples and in all four of the spring samples.

Two samples collected from the East Fork of Parachute Creek, roughly 1.25 miles upstream and downstream of Ben Good Creek, exceeded the chronic standard (20 ug/L) for dissolved selenium with concentrations of 60 and 62 ug/L, respectively (Figure 20; sites ENPR16ST and ENPR17ST). The East Fork of Parachute Creek upstream of Ben Good Creek was sampled on three other occasions and dissolved selenium concentrations were less than the MRL. Similarly, the East Fork of Parachute Creek below Ben Good Creek was sampled two other times and dissolved selenium concentrations were less than the MRL. With the existing data set it is not possible to determine whether selenium concentrations consistently exceeded the chronic standard of 20 ug/L.

Segment 11e flows into the lower portion of the East Fork of Parachute Creek and the mainstem of Parachute Creek where a lower chronic standard is applied to protect aquatic life. So although the lower standard of 4.6 ug/L is not applied to this segment, it is relevant because the segment is tributary to areas where the lower standard is applied. Any additional investigation in Parachute Creek should include an MRL suitable for the lower standard (i.e., MRL less than 4.6 ug/L).

8.1.5 Lower East Fork of Parachute Creek (Segment 11f)

Dissolved selenium concentrations were measured in 17 samples on the Lower East Fork of Parachute Creek (Table 24). In the East Fork of Parachute Creek, near County Road 215, dissolved selenium concentrations ranged from 2.5 to 27 ug/L in nine samples collected from October 2004 to April 2007. Three samples exceeded the chronic standard of 4.6 ug/L and two of the samples also exceeded the acute standard of 18.6 ug/L (Table 24). At a location about 1.4 miles upstream in the East Fork of Parachute Creek dissolved selenium concentrations were below the MRL in eight samples (Figure 20; site ENPR14ST).

Additional sample collection is recommended in the Lower East Fork of Parachute Creek, because selenium standards were exceeded on more than one occasion, and exceedances were observed at upstream and downstream locations in Segments 11e and 11h. Selenium sources in this area may include runoff from the produced water treatment facility, County Road 215, the East Fork of Parachute Creek or the local geology (Figure 22). Based on the existing data set, the East Fork of Parachute Creek may deliver selenium to the mainstem of Parachute Creek.

8.1.6 Lower South Side Tributaries to the East Fork Parachute Creek and East Side Tributaries to Parachute Creek (Segment 11g)

Dissolved selenium concentrations were sampled 33 times on Segment 11g. One of two samples collected in the East Fork of Parachute Creek upstream of the confluence with Second Anvil Creek exceeded the chronic selenium standard (Figure 22; site CDOWRW-805). On 6/25/2008, the dissolved selenium concentration was 28.3 ug/L, which exceeded the chronic standard of 20 ug/L. The other sample collected on 8/16/2011 had a concentration of less than 5 ug/L. This location is tributary to the Lower East Fork of Parachute Creek (Segments 11e and 11f) and may play a role in the elevated selenium concentrations measured downstream. However, additional data are needed to identify selenium sources in this portion of the Parachute Creek Watershed.

8.1.7 Mainstem of Parachute Creek and Tributaries below the Confluence with West and East Forks to the Colorado River (Segment 11h)

Dissolved selenium concentrations were measured 26 times on the lower mainstem of Parachute Creek and its tributaries. In six samples collected from 2004 to 2007 dissolved selenium concentrations ranged from less than 10 to 26 ug/L in Parachute Creek immediately below the confluence with the East Fork of Parachute Creek and accounted for one acute and two chronic exceedances (Figure 22; site ENPR11ST). The upstream portions of Parachute Creek, the East Fork of Parachute Creek, the produced water treatment facility, County Road 215, and the local geology are potential selenium sources in this area.

8.1.8 Roan Creek and Tributaries to Clear Creek, and Clear Creek and Tributaries to Tom Creek (Segment 14a)

Selenium concentrations ranged from 0.3 to 5 ug/L in seven samples collected from February 2000 to October 2006 in Segment 14a. The chronic selenium standard of 4.6 ug/L was exceeded in February 2000 in Roan Creek below the confluence with Brush Creek (Figure 22; site 11205). However, since February 2000 selenium concentrations were less than the chronic standard (n=6).

8.1.9 Roan Creek and Tributaries below Kimball Creek to the Colorado River (Segment 14c)

Selenium concentrations were measured twenty times in Roan Creek and its tributaries below Kimball Creek. Dissolved selenium ranged from 2 to 9 ug/L in twelve samples collected from 1998 to 2001 in the Dry Fork of Roan Creek about 4.5 miles upstream of the confluence with Roan Creek and one sample exceeded the chronic standard of 4.6 ug/L (Figure 22; site 09095300;). This exceedance established the 303(d) Listing for Segment 14c. In Roan Creek downstream of the confluence with the Dry Fork of Roan Creek dissolved selenium concentrations ranged from less than 1 to 4 ug/L in 17 samples collected from 2000 to 2011 (Figure 20; site 148). In Roan Creek near the mouth dissolved

selenium concentrations were below the chronic standard and ranged from 2 to 2.4 ug/L in two samples collected in 2007 and 2008 (Site 11201).

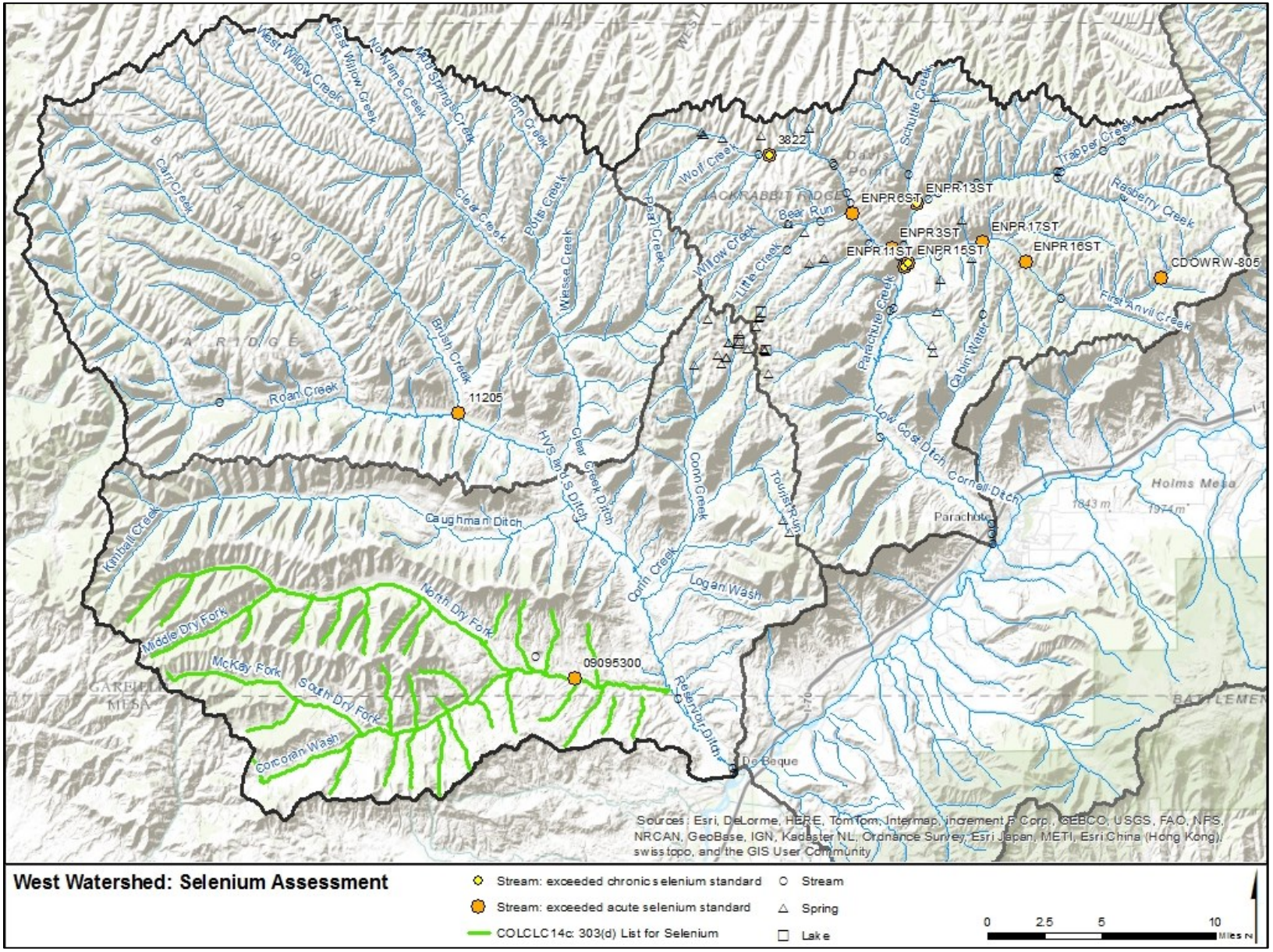
On Segment 14c elevated selenium concentrations appear to occur on an intermittent basis and may be restricted to the Dry Fork of Roan Creek. Dissolved selenium concentrations in the mainstem of Roan Creek do not appear problematic based on the existing data set (n=19). This is recognized, to some extent, by the low priority assigned to TMDL development for the Dry Fork of Roan Creek.

Dissolved selenium concentrations did not exceed the chronic or acute standards on Segments 11c and 11d (Table 24). Dissolved selenium concentrations have not been measured in the lakes, ponds and reservoirs located on Segments 9b and 19. There is a lack of water quality data in Kimball, Roan, and Clear Creeks (Figure 20).

Table 24. Summary of selenium assessment by Segment and site type.

WQCC Segment	Segment Description	Site Type	Samples	Chronic Standard	Exceeded Chronic Standard	Percent of Samples	Acute Standard	Exceeded Acute Standard	Percent of Samples	Comments and Priority
8	Mainstem of Northwater and Trapper Creeks, including all tributaries and wetlands, from their sources to the confluence with the East Middle Fork of Parachute Creek. East Middle Fork of Parachute Creek, including all tributaries and wetlands, from the source to the confluence with the Middle Fork of Parachute Creek.	Stream	20	4.6	2	10%	18.6	2	10%	No comments or priority assigned at this time.
		Spring	0		0	0%		0	0%	
		Total	**20**		**2**	**10%**		**2**	**10%**	
11a	Mainstem of West Fork of Parachute Creek, including all tributaries, from its source to West Fork Falls. Mainstem of East Fork of Parachute Creek, including all tributaries and wetlands, from a point immediately below the mouth of First Anvil Creek to the east boundary line of S27, T5S, R95W.	Stream	7	4.6	1	14%	18.6	1	14%	No comments or priority assigned at this time.
		Spring	13		0	0%		0	0%	
		Total	**20**		**1**	**5%**		**1**	**5%**	
11b	Mainstem of the West Fork of Parachute Creek from West Fork Falls to the confluence with Parachute Creek; mainstem of the Middle Fork of Parachute Creek from the north boundary line of S19, T5S, R95W to the confluence with East Middle Fork of Parachute Creek.	Stream	53	20	2	4%	NA			No comments or priority assigned at this time.
		Spring	10		0	0%				
		Total	**63**		**2**	**3%**				
11c	Mainstem of the Middle Fork of Parachute Creek including all tributaries (includes Davis Gulch and tributaries), from the source to the north boundary line of S19, T5S, R95W.	Stream	1	20	0	0%	NA			The standard was attained in all samples.
		Spring	2		0	0%				
		Total	**3**		**0**	**0%**				
11d	Mainstem of Middle Fork of Parachute Creek from the confluence with East Middle Fork to a point immediately above the confluence with the West Fork of Parachute Creek.	Stream	5	4.6	0	0%	18.6	0	0%	The standard was attained in all samples.
		Spring	0		0	0%		0	0%	
		Total	**5**		**0**	**0%**		**0**	**0%**	
11e	That portion of the mainstem of the East Fork of Parachute Creek, including all tributaries and wetlands, within Sections 27, 28, and 29, T5S, R95W.	Stream	9	20	2	22%	NA			
		Spring	4		0	0%				
		Total	**13**		**0**	**0%**				
11f	Mainstem of the East Fork of Parachute Creek from the west boundary line of S29, T5S, R95W to the confluence with Middle Fork of Parachute Creek.	Stream	17	4.6	3	18%	18.6	1	6%	Additional sample collection recommended.
		Spring	0		0	0%		0	0%	
		Total	**17**		**3**	**18%**		**1**	**6%**	
11g	All tributaries to East Fork Parachute Creek on the south side of the East Fork Parachute Creek from a point immediately below First Anvil Creek to the confluence with Parachute Creek; all tributaries to Parachute Creek on the east side of Parachute Creek from a point immediately below the East Fork of Parachute Creek to the confluence with the Colorado River; plus selected tributaries in the South Watershed.	Stream	11	20	1	9%	NA			No comments or priority assigned at this time.
		Spring	22		0	0%				
		Total	**33**		**1**	**3%**				
11h	Mainstem of Parachute Creek, including all tributaries and wetlands, from the confluence of the West and East Forks to the confluence with the Colorado River except for specific listings in segment 11g.	Stream	26	4.6	2	8%	18.6	1	4%	Additional sample collection recommended.
		Spring	0		0	0%		0	0%	
		Total	**26**		**0**	**0%**		**0**	**0%**	
14a	Mainstem of Roan Creek including all wetlands and tributaries, from its source to a point immediately above the confluence with Clear Creek, except for the specific listing in segment 14b. Clear Creek, including all tributaries and wetlands, from the source to a point immediately below the confluence with Tom Creek.	Stream	7	4.6	1	14%	18.6	0	0%	No comments or priority assigned at this time.
		Spring	0		0	0%		0	0%	
		Total	**7**		**1**	**14%**		**0**	**0%**	
14c	Mainstem of Roan Creek including all tributaries and wetlands, from a point immediately below the confluence with Kimball Creek to the confluence with the Colorado River.	Stream	20	4.6	1	5%	18.6	0	0%	The Dry Fork, part of 14c, is on the 303(d) list.
		Spring	0		0	0%		0	0%	
		Total	**20**		**1**	**5%**		**0**	**0%**	

Figure 22. Water quality monitoring sites where dissolved selenium concentrations exceeded the chronic or acute standard.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

8.2 Total Phosphorus

Total phosphorus concentrations ranged from 0.003 to 0.61 mg/L in 55 samples collected from 22 locations and were below the MRL in 40 percent of the samples (Table 23). Three sites in the West Watershed had concentrations that exceeded the interim total phosphorus standard (Table 25).

Table 25. Summary of total phosphorus concentrations, in mg/L, where the interim standard was exceeded.

WQCC Segment	Site	Site Type	Interim Standard	Samples	Minimum	Median	Maximum	< MDL Count
11h	11221	Stream	0.11	14	0.01	0.025	0.58	0
14c	148	Stream	0.17	9	0.01	0.03	0.35	0
	11201	Stream		2	0.03	NA	0.61	0

In Parachute Creek near the mouth in Parachute total phosphorus concentrations ranged from 0.01 to 0.58 mg/L in 14 samples collected from November 2007 to May 2012 and two samples had concentrations greater than the interim standard of 0.11 mg/L (Table 25 and Figure 23; site 11221).

In the Dry Fork of Roan Creek total phosphorus exceeded 0.1 mg/L, an EPA recommendation, 24 times from 1996 to 2004 (USGS, 2009). In Roan Creek near the confluence with the Dry Fork, northwest of Debeque, total phosphorus concentrations ranged from 0.01 to 0.35 mg/L in nine samples collected from August 2008 to June 2011 (Table 25; site 148;). In Roan Creek in Debeque at Road 44 total phosphorus concentrations were 0.03 and 0.61 mg/L in two samples and exceeded the interim standard on 4/22/2008 (Table 25; site 11201). On Segment 14c four exceedances occurred in April and June. This may be related to increased runoff and stream flow during and following snowmelt. However, it's more likely that the apparent "trend" is an artifact of limited sample collection. The data from Segments 11 h and 14c may result in an M&E Listing. Additional data collection is recommended for Parachute and Roan creeks.

8.3 Total Nitrogen

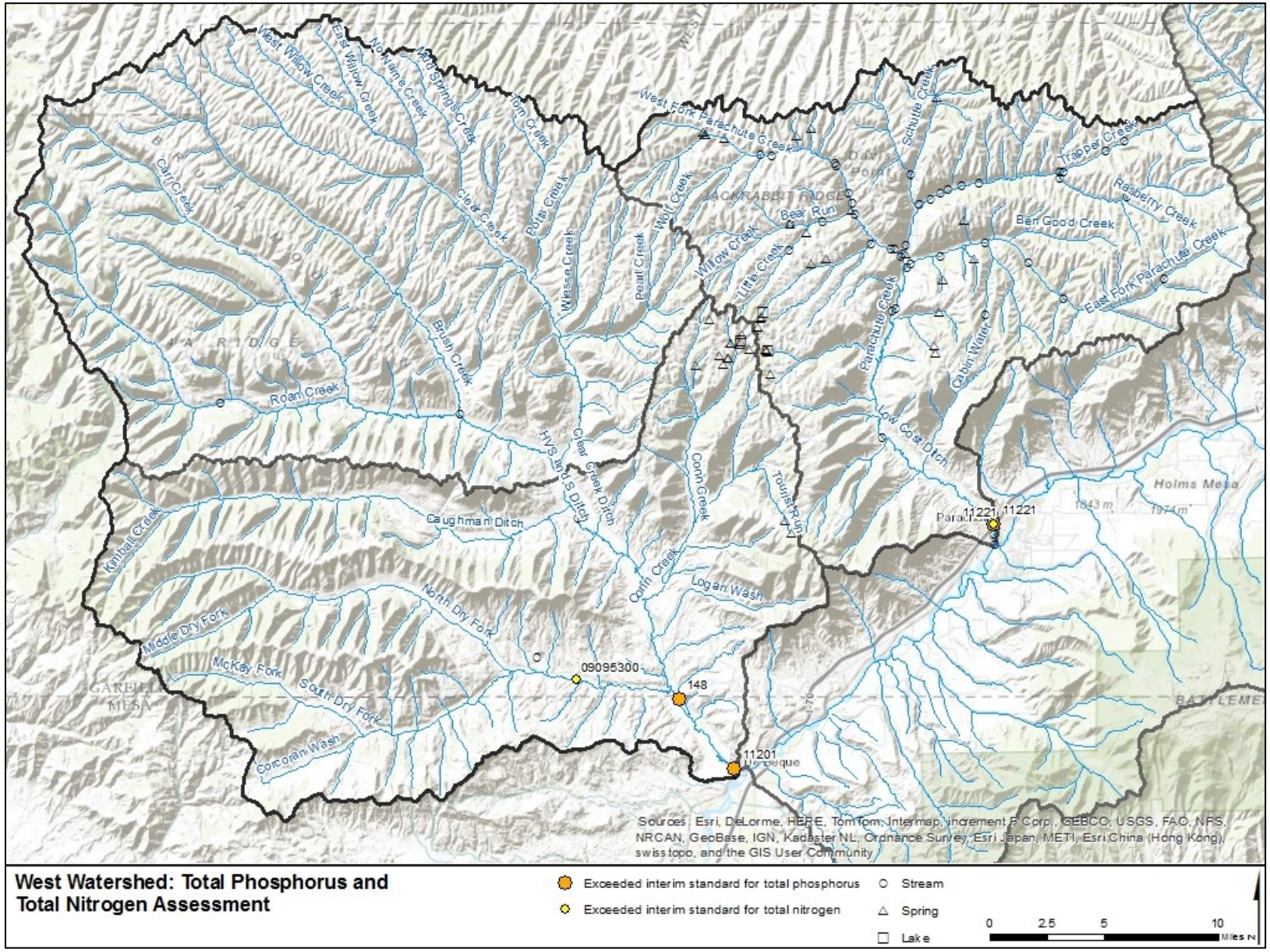
Total nitrogen concentrations ranged from less than 0.1 to 2.22 mg/L in 50 samples and were below the MRL in 17 of the samples in the West Watershed (Table 20). Total nitrogen concentrations collected from two locations exceeded the applicable interim standard on five occasions. In Parachute Creek near Parachute total nitrogen concentrations ranged from less than 0.10 to 1.4 mg/L in 14 samples and one sample exceeded the interim standard, 1.25 mg/L (Table 26 and Figure 24; site 11221).

Table 26. Summary of total nitrogen concentrations, in mg/L, where the interim standard was exceeded.

WQCC Segment	Site	Site Type	Interim Standard	Samples	Minimum	Median	Maximum	< MDL Count
11h	11221	Stream	1.25	14	< 0.10	0.5	1.4	10
14c	09095300	Stream	2.01	25	0.36	1.25	2.22	0

In 25 samples collected in the Dry Fork of Roan Creek, about 4.5 miles upstream of the confluence with Roan Creek, total nitrogen concentrations ranged from 0.36 to 2.22 mg/L (Table 26 and Figure 24; site 09095300). The interim standard of 2.01 mg/L was exceeded in four samples; however, the median concentration was 1.25 ug/L, which is less than the standard.

Figure 23. Monitoring sites where the interim standard for total phosphorus or total nitrogen was exceeded in the West Watershed.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

8.4 Dissolved Iron

Dissolved iron concentrations ranged from less than 5 ug/L to 19,000 ug/L in 237 samples and were below the MRL in 55 percent of the samples collected from the West Watershed (Table 20). The water supply standard for dissolved iron of 300 ug/L was exceeded in eleven samples collected from seven sites on five segments (Table 27).

8.4.1 Northwater, Trapper, East Middle Fork of Parachute Creeks and All Tributaries (Segment 8)

The East Middle Fork of Parachute Creek, Trapper Creek, and their tributaries are designated as Outstanding Waters. In the East Middle Fork of Parachute Creek above the confluence with Parachute Creek dissolved iron concentrations ranged from less than 50 to 1,000 ug/L in five samples (Table 27; Figure 24; site ENPR13ST). The water supply standard was exceeded in three samples collected from the East Middle Fork of Parachute Creek; however, the aquatic life standard was not exceeded.

8.4.2 Upper West Fork of Parachute Creek, a Portion of the East Fork of Parachute Creek and Tributaries (Segment 11a)

In the West Fork of Parachute Creek below the confluence with Wolf Creek dissolved iron concentrations ranged from less than 100 to 990 ug/L in four samples (Table 27 and Figure 24; site ENPR4ST). The water supply standard of 300 ug/L was exceeded in two samples and the median concentration 365 ug/L (n=4) exceeded the water supply standard.

8.4.3 Mainstem of East Fork of Parachute Creek and Tributaries (Segment 11e)

In the East Fork of Parachute Creek roughly 1.25 miles upstream of Ben Good Creek dissolved iron concentrations ranged from less than 100 to 3,700 ug/L in four samples collected from May 2005 to May 2006 (Figure 24, site ENPR16ST). In the East Fork of Parachute Creek roughly 1.25 miles downstream of Ben Good Creek dissolved iron concentrations ranged from less than 100 to 6,100 ug/L in three samples collected from May 2005 to May 2006 (Figure 24, site ENPR16ST). Dissolved iron concentrations exceeded the water supply standard in three samples; once at the upstream site and twice at the site downstream of Ben Good Creek. Although there are very limited data, concentrations increased at the downstream site, so Ben Good Creek may increase dissolved iron concentrations in the East Fork of Parachute Creek.

8.4.4 Lower East Fork of Parachute Creek (Segment 11f)

Dissolved iron concentrations collected from three sites in the Lower East Fork of Parachute Creek ranged from less than 10 to 10,000 ug/L and exceeded the water supply standard of 300 ug/L in two of eighteen samples collected from October 2004 to June 2008 (Table 27 and Figure 24). The exceedances occurred during spring runoff. Dissolved iron concentrations exceeded 1,000 ug/L, so

presumably the total iron concentration also exceeded 1,000 ug/L, and therefore the chronic standard for total iron in these samples.

8.4.5 Roan Creek and Tributaries below Kimball Creek to the Colorado River (Segment 14c)

In Roan Creek above the confluence with the Colorado River dissolved iron concentrations were 14 and 4,100 ug/L in two samples and the sample collected on 4/22/2008 exceeded the water supply standard of 300 ug/L (Table 27 and Figure 24; site 11201).

The following segments are not designated as water supplies so the dissolved iron standard is not applicable on Segments 11b, 11c, 11d, 11g, and 11h.

8.5 Total Iron

Total iron concentrations ranged from less than 10 to 32,000 ug/L in 107 samples collected in the West Watershed, where 22 samples exceeded the chronic standard of 1,000 ug/L and ten percent of the samples had concentrations below the MRL (Table 20). The chronic total iron standard is not applied to the following Segments 11b, 11c, and 11g.

8.5.1 Lower West Fork of Parachute Creek, Upper Middle Fork of Parachute Creek (Segment 11b)

In the West Fork of Parachute Creek immediately above the confluence with the Middle Fork of Parachute Creek total iron concentrations ranged from 18 to 2,600 ug/L in twelve samples collected from January 2000 to April 2007 (Figure 24; site 11145A). In the Middle Fork of Parachute Creek above the confluence with the West Fork of Parachute Creek total iron concentrations ranged from 10 to 13,000 ug/L in twelve samples collected during the same time (Figure 24; site 11145B). Each site exceeded the chronic standard in one sample (Table 28). The samples were not collected on the same date, but both exceedances occurred in April. Although the data set is very small, it appears that spring runoff may increase iron concentrations.

8.5.2 Lower East Fork of Parachute Creek (Segment 11f)

Total iron concentrations ranged from 27 to 2,300 ug/L in the East Fork of Parachute Creek immediately above the confluence with the Middle Fork in four samples collected from August 2006 to April 2007 and the chronic standard was exceeded in one sample (Table 28).

8.5.3 Roan Creek and Tributaries to Clear Creek, and Clear Creek and Tributaries to Tom Creek (Segment 14a)

In Roan Creek below Brush Creek total iron concentrations ranged from less than 40 to 1,100 ug/L in six samples (Table 28). The chronic standard of 1,000 ug/L was exceeded on 10/10/2006.

8.5.4 Roan Creek and Tributaries below Kimball Creek to the Colorado River (Segment 14c)

In Roan Creek near the mouth in DeBeque total iron concentrations were 750 and 14,000 ug/L in two samples and an exceedance occurred in April 2008 during spring runoff (Table 28 and Figure 24; site 11201).

In Roan Creek below the confluence with the Dry Fork of Roan Creek total iron concentrations ranged from 130 to 32,000 ug/L in 17 samples (Table 28 and Figure 24; site 148;). The chronic standard was exceeded in 11 samples.

The 2012 M&E List includes Segment 14b for total recoverable iron. Records supplied by the WQCD indicate that data have not been collected from Segment 14b. However, data from Roan Creek below the confluence with the Dry Fork are considered representative of the conditions in Segment 14b, which is immediately upstream of the Roan Creek site. The data were used to establish the M&E Listing.

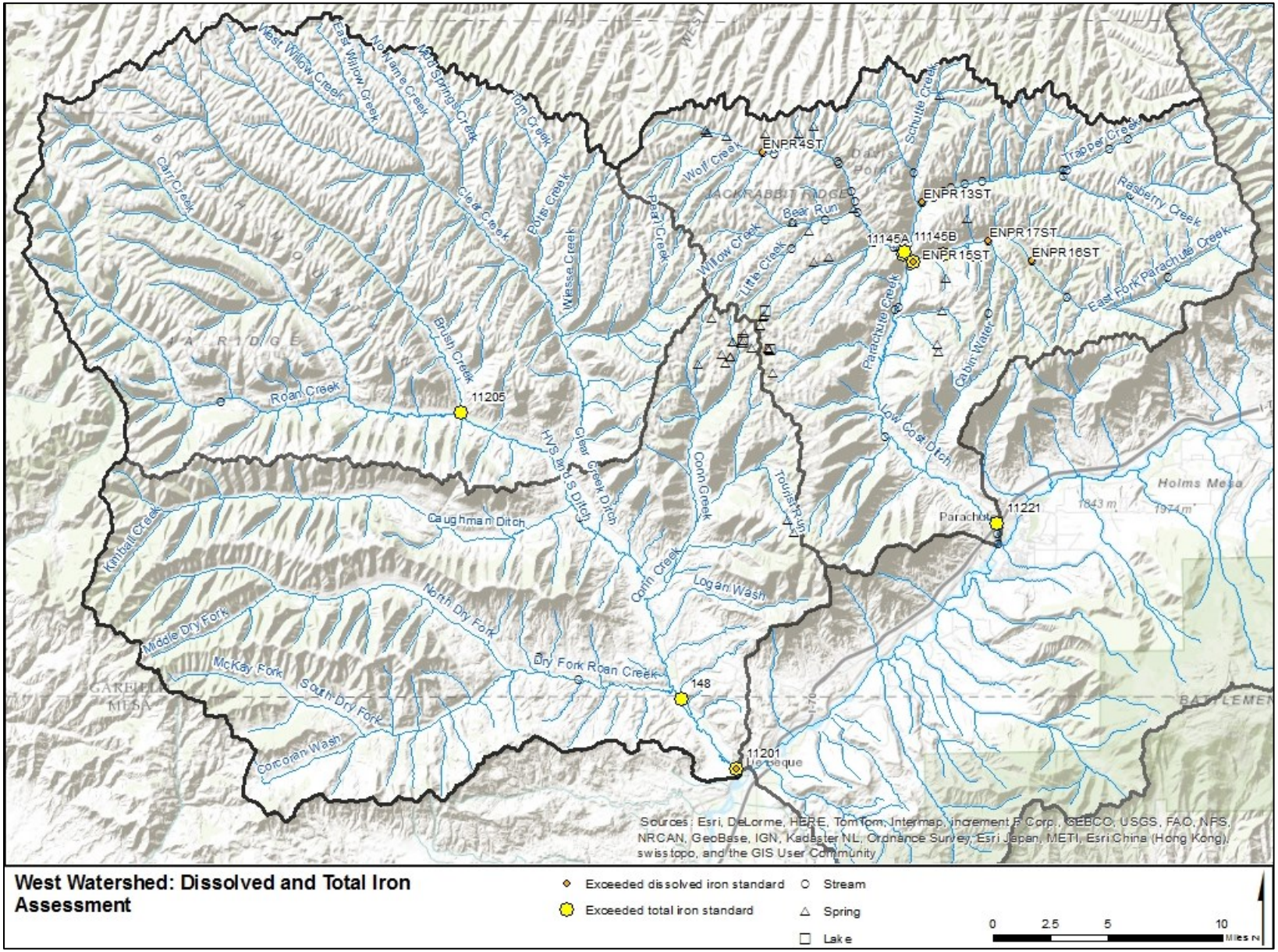
Table 27. Summary of sites where the water supply standard for dissolved iron was exceeded in one or more samples in the West Watershed; concentrations in ug/L.

WQCC Segment	Segment Description	Site	Site Type	Standard	Exceedances	Samples	Minimum	Median	Maximum	< MDL Count
8	Mainstem of Northwater and Trapper Creeks, including all tributaries and wetlands, from their sources to the confluence with the East Middle Fork of Parachute Creek. East Middle Fork of Parachute Creek, including all tributaries and wetlands, from the source to the confluence with the Middle Fork of Parachute Creek.	ENPR13ST	Stream	300	3	5	50	400	1,000	2
11a	Mainstem of West Fork of Parachute Creek, including all tributaries, from its source to West Fork Falls. Mainstem of East Fork of Parachute Creek, including all tributaries and wetlands, from a point immediately below the mouth of First Anvil Creek to the east boundary line of S27, T5S, R95W.	ENPR4ST	Stream	300	2	4	100	365	990	1
11e	That portion of the mainstem of the East Fork of Parachute Creek, including all tributaries and wetlands, within Sections 27, 28, and 29, T5S, R95W.	ENPR16ST	Stream	300	2	4	100	565	3,700	2
		ENPR17ST	Stream	300	1	3	100	230	6,100	1
11f	Mainstem of the East Fork of Parachute Creek from the west boundary line of S29, T5S, R95W to the confluence with Middle Fork of Parachute Creek.	ENPR14ST	Stream	300	1	9	50	100	10,000	6
		ENPR15ST	Stream	300	1	5	50	100	7,400	3
14c	Mainstem of Roan Creek including all tributaries and wetlands, from a point immediately below the confluence with Kimball Creek to the confluence with the Colorado River.	11201	Stream	300	1	2	14	NA	4,100	0

Table 28. Summary of sites where the chronic standard for total iron was exceeded in one or more samples in the West Watershed; concentrations in ug/L.

WQCC Segment	Segment Description	Site	Site Type	Standard	Exceedances	Samples	Minimum	Median	Maximum	< MDL Count
11b	Mainstem of the West Fork of Parachute Creek from West Fork Falls to the confluence with Parachute Creek; mainstem of the Middle Fork of Parachute Creek from the north boundary line of S19, T5S, R95W to the confluence with East Middle Fork of Parachute Creek.	11145A	Stream	1000	1	12	18	50	2,600	3
		11145B	Stream	1000	1	12	10	50	13,000	6
11f	Mainstem of the East Fork of Parachute Creek from the west boundary line of S29, T5S, R95W to the confluence with Middle Fork of Parachute Creek.	ENPR15ST	Stream	1000	1	4	27	195	2,300	0
11h	Mainstem of Parachute Creek, including all tributaries and wetlands, from the confluence of the West and East Forks to the confluence with the Colorado River except for specific listings in Segment 11g.	11221	Stream	1000	6	18	110	540	12,000	0
14a	Mainstem of Roan Creek including all wetlands and tributaries, from its source to a point immediately above the confluence with Clear Creek, except for the specific listing in segment 14b. Clear Creek, including all tributaries and wetlands, from the source to a point immediately below the confluence with Tom Creek.	11205	Stream	1000	1	6	40	110	1,100	1
14c	Mainstem of Roan Creek including all tributaries and wetlands, from a point immediately below the confluence with Kimball Creek to the confluence with the Colorado River.	148	Stream	1000	11	17	130	1,300	32,000	0
		11201	Stream	1000	1	2	750	NA	14,000	0

Figure 24. Monitoring sites where dissolved or total iron concentrations exceeded the applicable standard.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

8.6 Dissolved Lead

Dissolved lead concentrations ranged from less than 1 to 19 ug/L in 191 samples collected from 62 locations in the West Watershed and dissolved lead concentrations were below the MRL in 90 percent of the samples (Table 20). The chronic standard was exceeded in eight samples collected from five locations (Table 29). All five locations were in the Parachute Creek Watershed above the confluences of the east, west, and middle forks of Parachute Creek (Figure 25). The acute standard was not exceeded in any of the samples collected from the West Watershed.

8.6.1 West Fork of Parachute Creek Watershed (Segment 11g)

In the upper portion of the West Fork of Parachute Creek Watershed dissolved lead concentrations ranged from less than 5 to 19 ug/L in 14 samples collected from three adjacent sites from 2004 to 2008 (Table 29 and Figure 25; sites ENPR2ST, ENPR5ST, and ENPR6SP). The chronic standard of approximately 6.5 ug/L was exceeded in five samples.

8.6.2 Trapper Creek (Segment 8)

In Trapper Creek above the confluence with the East Fork of Parachute Creek dissolved lead concentrations ranged from less than 3 to 10.1 ug/L in four samples collected from June 2008 to August 2011 (Table 29 and Figure 25; site CDOWRW-804). The chronic standard of approximately 5.9 ug/L was exceeded in two samples.

8.6.3 East Fork of Parachute Creek

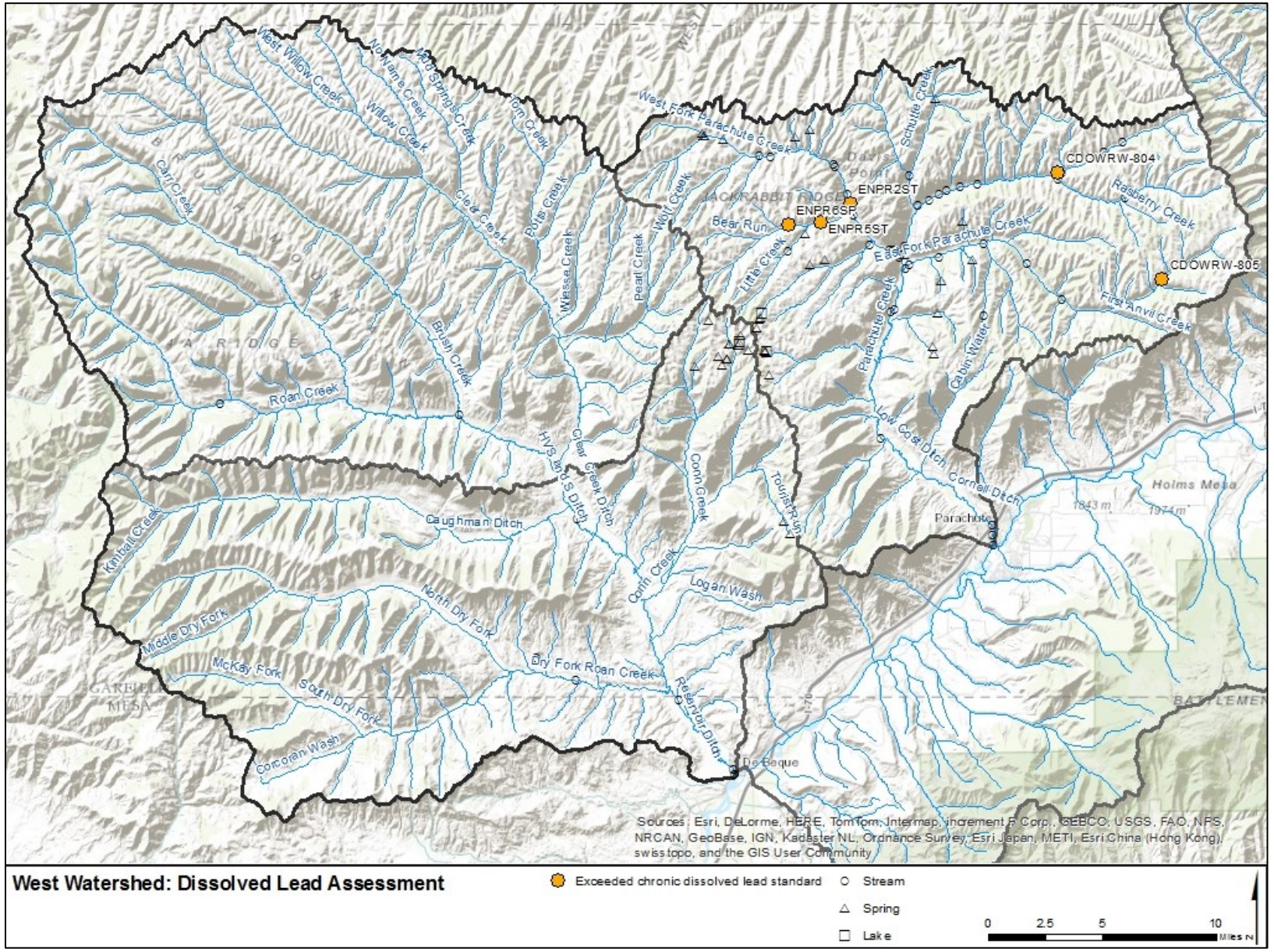
In the East Fork of Parachute Creek upstream of Second Anvil Creek dissolved lead concentrations ranged from less than 3 to 10.4 ug/L in three samples collected from June 2007 to August 2011 (Table 29 and Figure 25; site CDOWRW-805). The chronic standard of approximately 6.5 ug/L was exceeded in one sample.

Trapper Creek, the West Fork, and East Fork are tributary to Parachute Creek and accounted for all of the exceedances in the West Watershed. However, these sites do not appear to increase dissolved lead concentrations at downstream locations. Because of the timing associated with the data calls, the 2011 results were not evaluated during the evaluation period for the 2012 303(d) and M&E Lists. Therefore it's possible the 2011 data may result in an M&E Listing for Segment 8 and/or 11g.

Table 29. Monitoring sites where the chronic dissolved lead standard was exceeded; lead concentrations in ug/L.

WQCC Segment	Site	Site Type	Average Hardness (mg/L)	Chronic Standard	Chronic Exceedances	Samples	< MDL Count	Minimum	Median	Maximum
8	CDOWRW-804	Stream	221	5.9	2	4	1	<3	5.9	10.1
11b	ENPR2ST	Stream	257	6.9	2	7	4	<5	5	8.7
11g	CDOWRW-805	Stream	241	6.5	1	3	2	<3	3	10.4
	ENPR5ST	Stream	241	6.5	2	4	1	<5	6.6	19
	ENPR6SP	Spring	241	6.5	1	3	2	<5	5	7.5

Figure 25. Monitoring sites where the dissolved lead concentrations exceeded the chronic standard.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

8.7 Dissolved Oxygen

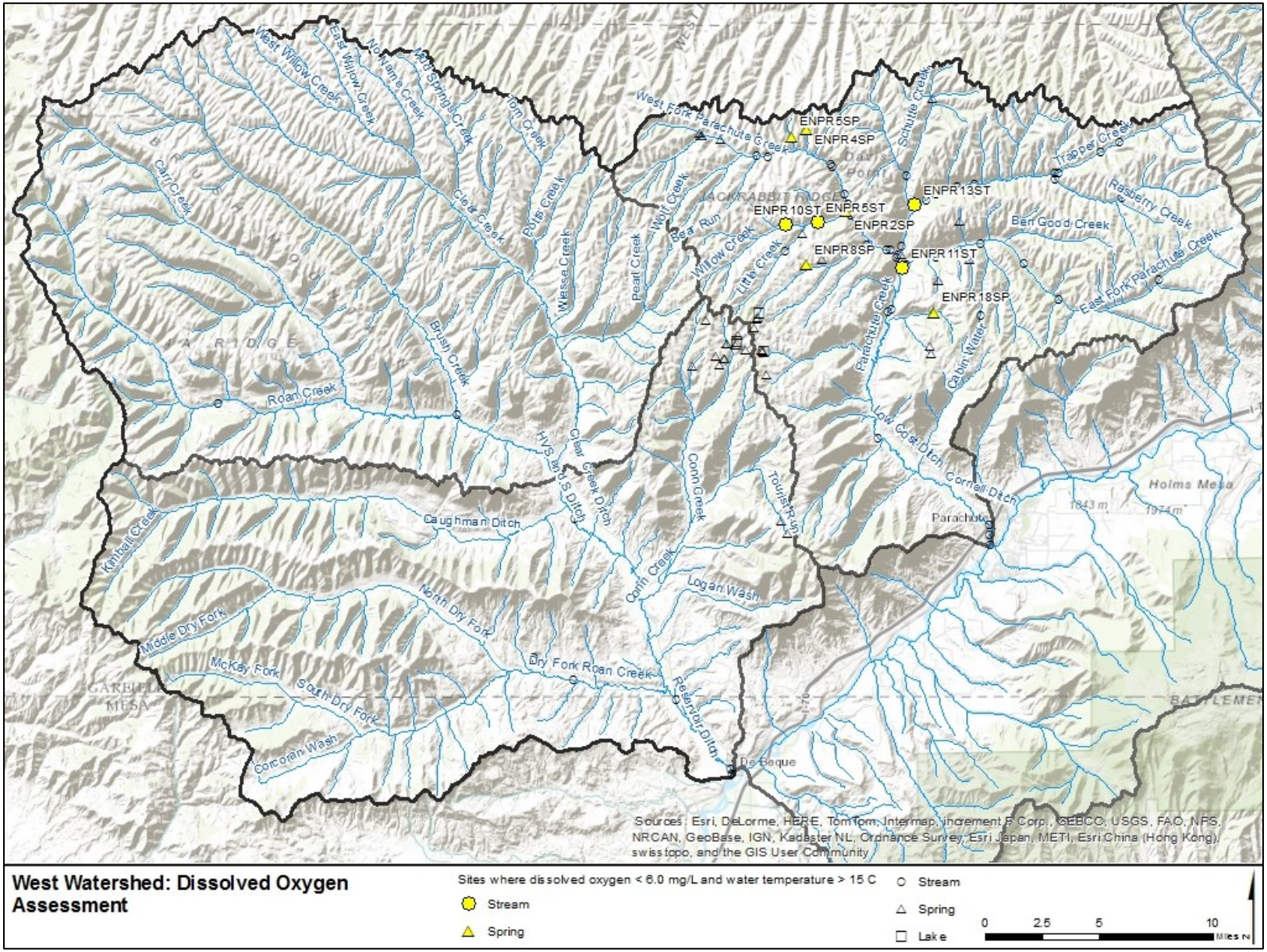
The 15th percentile dissolved oxygen concentration for the West Watershed was 5.35 mg/L based on 242 measurements from 59 sites in the West Watershed (Table 20). The standard for dissolved oxygen is a minimum concentration of 6.0 mg/L for most conditions and 7.0 mg/L during fish spawning for cold waters, and 5.0 mg/L throughout the year for warm waters. All segments in the West Watershed are cold waters, except for Segments 14c and 19 which are classified as warm waters.

The dissolved oxygen concentrations measured in the West Watershed are summarized in Table 30. Due to limited Metadata regarding the sample locations and the sample methods, dissolved oxygen concentrations may not necessarily be indicative of impairment. However, the proportion of dissolved oxygen concentrations lower than the standard in Parachute Creek on Segments 11a, 11e, and 11g suggest additional data collection may be needed to better understand potential deficiencies. Monitoring specifically for dissolved oxygen in the Parachute Creek drainage is unlikely, but if coupled with other monitoring efforts, such as rangeland or fisheries investigations, dissolved oxygen monitoring may become more realistic.

Table 30. Dissolved oxygen assessment summary by Segment in the West Watershed.

WQCC Segment	< D.O. Standard	Dissolved Oxygen	Percent < D.O.
8	2	18	11%
11a	8	18	44%
11b	4	56	7%
11c	1	3	33%
11d	0	4	0%
11e	4	13	31%
11f	6	23	26%
11h	0	18	0%
11g	15	32	47%
14a	0	7	0%
14b	0	0	0%
14c	0	50	0%
West Watershed	**40**	**242**	**17%**

Figure 26. Monitoring sites where the dissolved oxygen concentration was less than 6.0 mg/L and temperature was greater than 15 degrees Celsius.



Note: All sites on this map are located in streams tributary to the Colorado River. Colorado River sites are presented in Section 9.0.

8.8 *Escherichia coli*

E. coli concentrations ranged from less than 1 to 2,419 colonies per 100 mL in 42 samples collected from eight locations in the West Watershed and were below the MRL in 52 percent of the samples (Table 20). *E. coli* concentrations exceeded the applicable standard in eight samples collected from three locations.

E. coli concentrations ranged from less than 1 to 1,203 colonies per 100 mL in Parachute Creek downstream of the confluence with the Dry Fork of Roan Creek in ten samples collected from August 2006 to June 2010. *E. coli* concentrations exceeded the standard of 205 colonies per 100 mL in three samples. Near the mouth of Roan Creek *E. coli* concentrations were 155 and 325 colonies per 100 mL in two samples collected in November 2007 and April 2008, respectively. Collectively, four samples from the lower portion of Roan Creek exceeded the *E. coli* standard. The exceedances occurred from April to October, when surface waters are typically warmest and air temperatures generally remain above freezing. Although these locations are now on Segment 14c, they were originally on Segment 14b and were used to establish the M&E Listing. Additional data collection should occur to better characterize *E. coli* concentrations and identify potential sources.

E. coli concentrations were not measured on Segments: 8, 9b, 11a, 11c, 11g, and 14a.

8.9 Major Findings

Inappropriate MRL for dissolved selenium have created a data gap in the West Watershed. An initial remedy to address the data gap is to assure that all entities collecting data in the Watershed use an appropriate MRL for selenium analysis. A MRL of less than 4.6 ug/L is needed to evaluate the chronic selenium standard of 4.6 ug/L that is applied on most segments in the West Watershed. Given the way the segments are divided in the Watershed, many segments with a chronic standard of 20 ug/L flow directly into segments where the 4.6 ug/L standard is applied. Thus, using a lower MRL in these areas is also recommended due to the proximity. If possible, additional characterization efforts should focus on the upper portions of Parachute Creek and the Dry Fork of Roan Creek.

Total phosphorus and total nitrogen concentrations could be characterized further to identify potential sources, particularly in Parachute and Roan Creeks near Parachute and DeBeque.

Very limited data collection has occurred in the headwaters of the West Watershed, particularly in Kimball, Roan, and Clear Creeks. Given the ecological and economic value of these lands, water quality characterizations should occur to characterize current conditions. This is particularly important given the populations of Colorado River Cutthroat Trout identified in these areas and the high quality of the fisheries found on the Roan Plateau.

Dissolved nitrate concentrations were less than 10 mg/L, the applicable standard, in all samples collected from the West Watershed.

All dissolved copper concentrations were less than the chronic and acute standards. All dissolved zinc samples were less than the chronic and acute standards. The vast majority, 99 to 100 percent, of the BTEX results were below the MRL.

9.0 Colorado River Water Quality Analysis and Discussion

The Watershed includes 75 miles of the mainstem of the Colorado River. There are thirteen monitoring locations on the Colorado River in the Watershed (Table 31). Although the Colorado River passes through the East, South, and West Watersheds, water quality data from the Colorado River is presented in this section only. The monitoring locations are in the eastern half of the Watershed (Figure 27). The majority of the monitoring sites are located in the Colorado River near Glenwood Springs. The Colorado River at Parachute is the western most location but it is still fifteen miles east of the Watershed boundary (Figure 27; site CDOWRW-559). Currently, the Colorado River lacks an active water quality monitoring site west of Rifle. A large reach of the Colorado River is not monitored, resulting in a data gap.

The Colorado River is divided into three segments in the Watershed. Segment 3-UC includes the mainstem of the Colorado River above the confluence with the Roaring Fork River. Segment 1 is the mainstem of the Colorado River from the confluence with the Roaring Fork River to the confluence with Rifle Creek. Segment 2a is the mainstem of the Colorado River below Rifle Creek to the confluence with Rapid Creek, which is downstream of the western Watershed boundary.

Table 31. Characteristics of the Colorado River.

Waterbody	Length (mi)[1]	Location Types		
		Stream	Lake	Spring
Colorado River	75.3	13	NA	NA

Note
1. The length includes the Colorado River only, which flows through each of the other subwatersheds.

The data compilation and analysis revealed a lack of chlorophyll *a* data and a limited number of total nitrogen, dissolved nitrate, dissolved nitrite, *E. coli* and BTEX results (Table 32). All of these parameters are considered data gaps due the limited number of results, lack of spatial coverage, and the implementation of numeric criteria for total phosphorous and total nitrogen.

Dissolved zinc concentrations ranged from less than 1 to 200 ug/L in 188 samples collected from the Colorado River (Table 32). The maximum concentration was lower than the chronic standard, which is approximately 233 ug/L, based on the average hardness. USGS reported that dissolved zinc concentrations rose from 1991 to 1995 and fell from 1995 to 2007 in the mainstem of the Colorado River (2009). Because concentrations were below the chronic aquatic life standard in all samples and have declined through time, additional analysis in not presented.

Dissolved oxygen concentrations ranged from 5.0 to 17.1 mg/L in 428 measurements (Table 32). Dissolved oxygen concentrations trended downward from 1991 to 2007 (Thomas et al., 2013). The 15th percentile concentration was 8.0 mg/L which meets the applicable standards applied to each of the segments. Thus, additional analysis was not completed.

Figure 27. Water quality monitoring sites on the Colorado River in the Middle Colorado River Watershed.

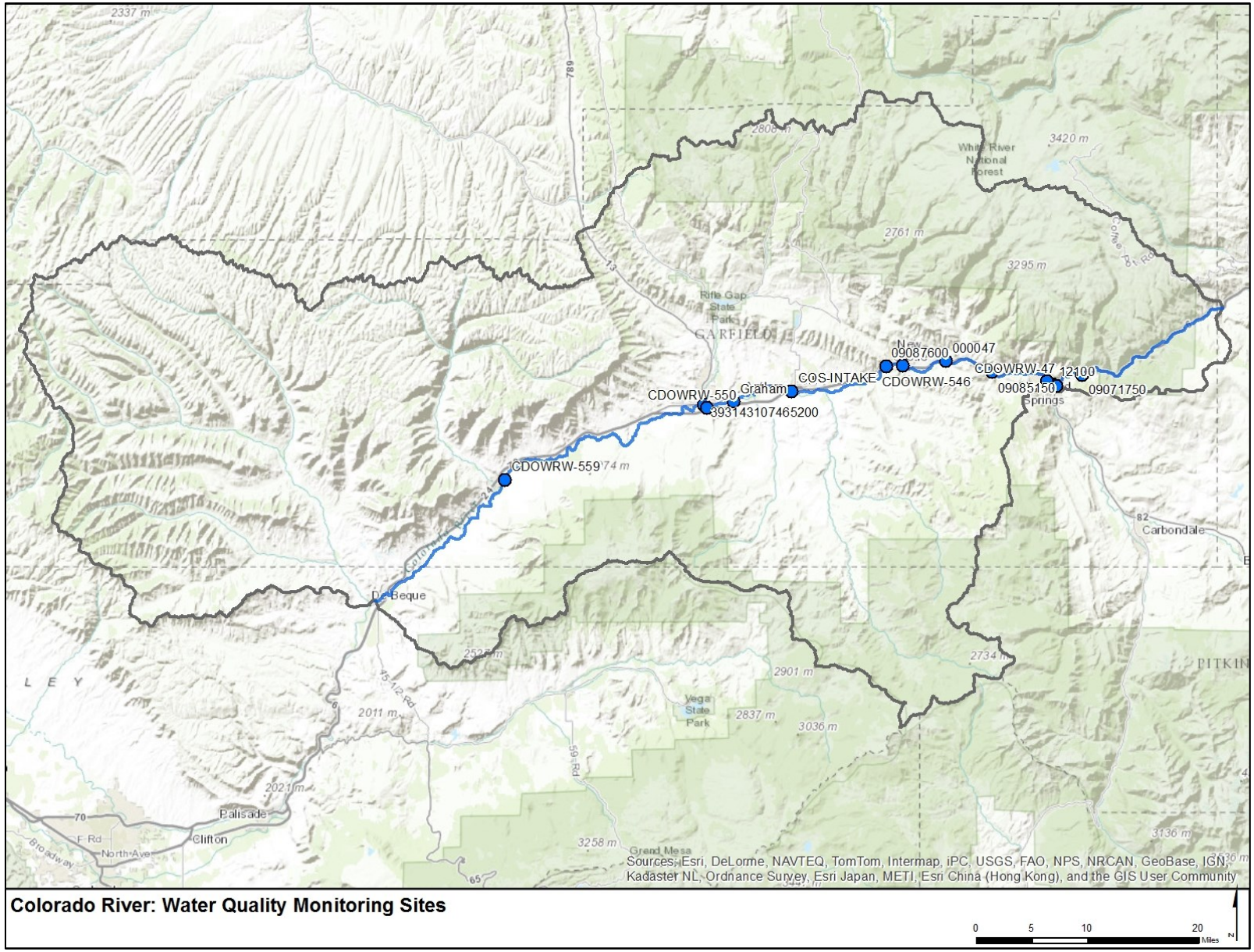


Table 32. Summary of analysis parameters in the Colorado River.

Parameter	Parameter Count	< MDL Count[1]	Percent <MDL[2]	Minimum	5th Percentile[3]	25th Percentile	Median	75th Percentile	95th Percentile	Maximum	Additional Analysis	Data Gap	Regulatory Considerations
Dissolved Selenium (ug/L)	199	121	61%	0.10	0.33	1	1	1.61	6.86	9.9	Yes	Yes	303(d) listed
Total Phosphorus (mg/L)	100	6	6%	0	0.01	0.02	0.033	0.06	0.174	0.615	Yes	Yes	Reg. 85 (Nutrients)
Total Nitrogen (mg/L)	17	13	76%	0.1	NA	NA	0.5	NA	NA	1.2	Yes	Yes	Reg. 85 (Nutrients)
Dissolved Nitrate (mg/L)	2	2	100%	0.058	NA	NA	0.093	NA	NA	0.128	No, lack of data	Yes	
Dissolved Nitrite (mg/L)	2	1	50%	0.007	NA	NA	NA	NA	NA	NA	No, lack of data	Yes	
Dissolved Ammonia (mg/L)	25	18	72%	0.01	0.019	0.03	0.03	0.03	0.0612	0.07	Yes	Yes	
Chlorophyll a (ug/L)	0	0	0	0	0	0	0	0	0	0	No, lack of data	Yes	Reg. 85 (Nutrients)
Dissolved Iron (ug/L)	248	11	4%	0	12	20	30	44	92	2,922	Yes	No	
Total Iron (ug/L)	287	3	1%	11	50	105	190	378	2,010	14,891	Yes	No	
Dissolved Lead (ug/L)	121	111	92%	0	1	1	1	1	3.5	13	Yes	No	
Dissolved Copper (ug/L)	152	91	60%	0	0	1.1	3	5	20	21.1	Yes	No	
Dissolved Zinc (ug/L)	188	65	35%	0	0	4.75	10	13.43	52.65	200	No	No	
Specific Conductance (uS/cm)	70	NA	NA	126	289.4	593.8	870.5	1089.8	1319.7	2299	Yes	No	
Dissolved Oxygen (mg/L)	428	NA	NA	5	7.24	8.6	9.8	11.34	12.78	17.1	No	No	
E. coli (col/100 mL)	42	30	71%	0	1	5	10	18	49	2419	Yes	Yes	
Benzene (ug/L)	18	18	100%	0	0	0	0	0	0	0	No, 100 % < MDL	Yes	COGCC Monitoring Requirements
Toluene (ug/L)	13	13	100%	0	0	0	0	0	0	0	No, 100 % < MDL	Yes	
Ethylene (ug/L)	18	18	100%	0	0	0	0	0	0	0	No, 100 % < MDL	Yes	
Xylene- all isomers (ug/L)	13	13	100%	0	0	0	0	0	0	0	No, 100 % < MDL	Yes	

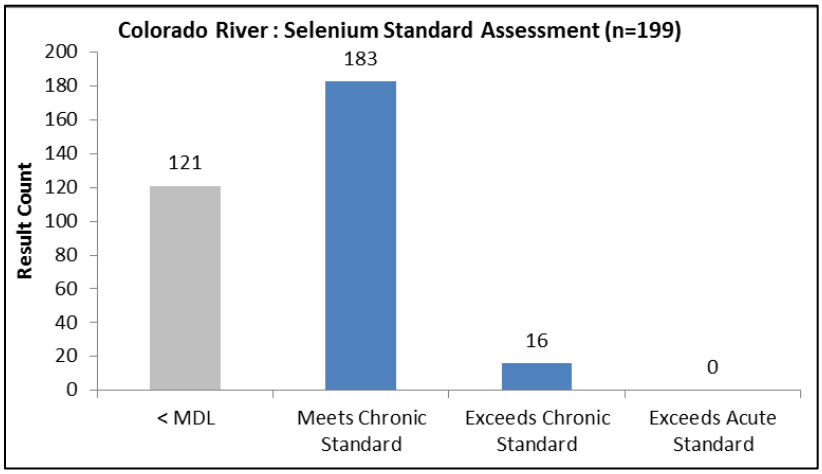
Notes

1. The count of results that were below the method detection limit (MDL).
2. The results below MDL expressed as a percent of all results (<MDL/total results).
3. Percentiles were not calculated unless there were 20 or more results for a given parameter.
4. This column identifies whether the parameter was selected for more detailed analysis.

9.1 Selenium

Dissolved selenium concentrations ranged from 0.1 to 9.9 ug/L in 199 samples and were below the MRL in 121 samples collected from the Colorado River (Table 32). The MRL was greater than the chronic standard in seven samples. Dissolved selenium concentrations were less than the chronic standard of 4.6 ug/L in 183 samples (Figure 28). The chronic standard was exceeded in sixteen samples collected from four locations (Figures 28 and 29). None of the concentrations exceeded the acute standard.

Figure 28. Selenium assessment summary for the Colorado River.



Dissolved selenium concentrations in the Colorado River at South Canyon Creek lacked a trend from 2006 to 2009 (Thomas et al., 2013). In the Colorado River at the Glenwood Springs Pedestrian Bridge above the confluence with the Roaring Fork River dissolved selenium concentrations ranged from less than 1 to 9.9 ug/L in fifty samples and dissolved selenium concentrations were below the MRL in 74 percent of the samples (Table 33; site CDOWRW-46). The chronic standard of 4.6 ug/L was exceeded in six samples.

In the Colorado River at Devereux Road Bridge dissolved selenium concentrations ranged from less than 0.6 to 7.5 ug/L in 17 samples (Table 33 and Figure 29; site CDOWRW-47). Six samples exceeded the chronic standard.

Table 33. Summary of monitoring sites where dissolved selenium concentrations exceeded the chronic standard, concentrations in ug/L.

WQCC Segment	Site	Number of Samples	Percent < MDL	Minimum	Median	Maximum	Exceedance Count
Upper Colorado 3	CDOWRW-46	50	74%	<1	<1	9.9	6
1	CDOWRW-47	17	18%	<0.6	2.9	7.5	6
	CDOWRW-546	13	62%	<0.6	5	6.9	1
	CDOWRW-550	10	50%	<MDL[1]	2.3	9.8	3

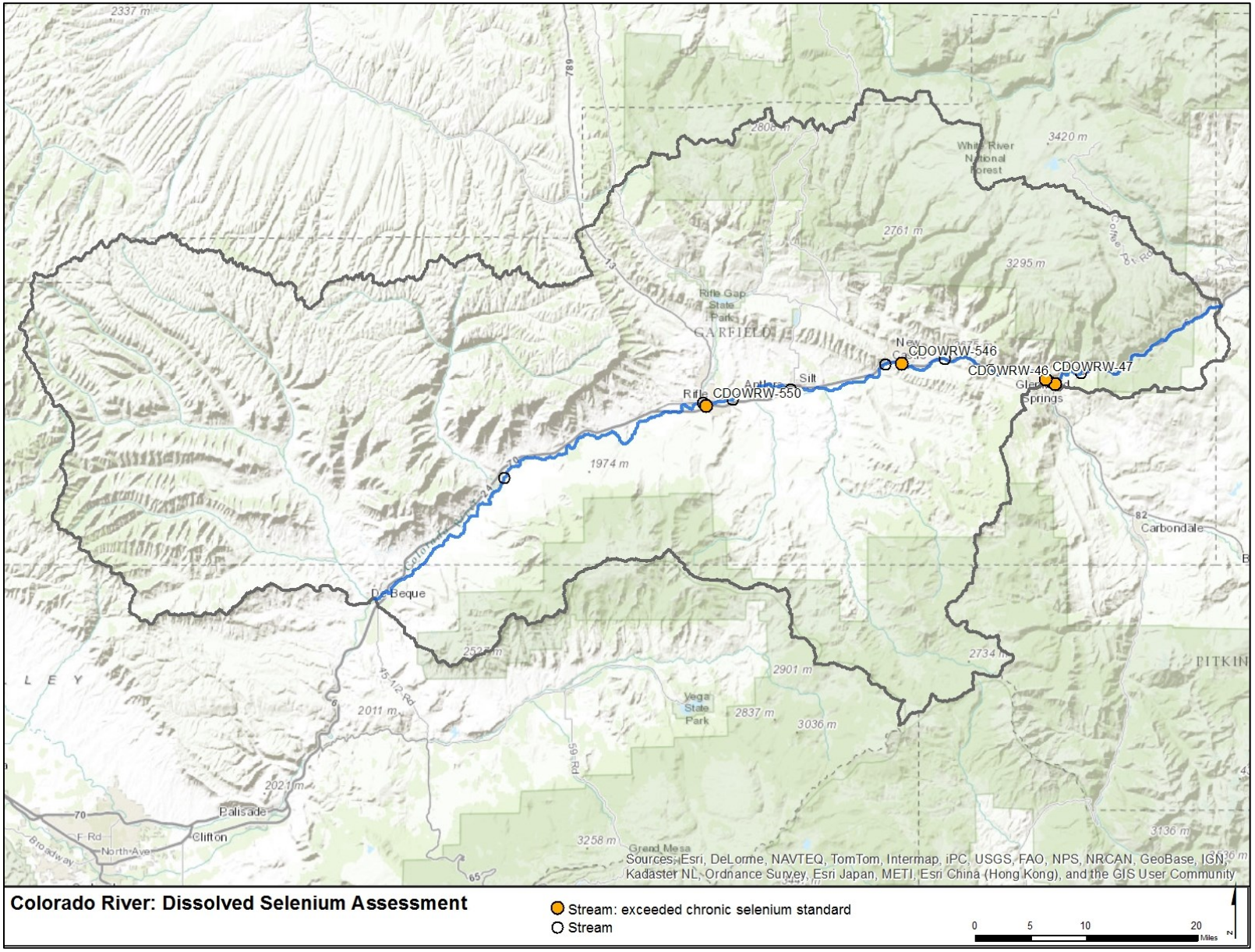
Note
The MDL was not reported at CDOWRW-550.

Dissolved selenium concentrations ranged from less than 0.6 to 6.9 ug/L and 62 percent of the results were below the MRL in 13 samples collected in the Colorado River near New Castle (Figure 29; site CDOWRW-546). Dissolved selenium concentrations exceeded the chronic standard in December 2003 with a concentration of 6.9 ug/L.

In the Colorado River at the Rifle Bridge dissolved selenium concentrations ranged from less than the MRL to 9.8 ug/L and were below the MRL in five of ten samples (Table 33 and Figure 29; site CDOWRW-550). The chronic standard was exceeded in three samples collected from the Colorado River at the Rifle Bridge.

All of the samples that exceeded the chronic standard were collected prior to 2006. Samples collected after 2006, as recently as 2012, met the chronic standard for selenium (n= 94). The Colorado River in the Watershed is not on the 2012 303(d) or M&E List for selenium. However, segments of the Colorado River downstream of the Watershed are included on the 303(d) or M&E Lists. This situation highlights the need for an active water quality monitoring site in the Colorado River west of Rifle to better understand the role of the Watershed in regional selenium concentrations.

Figure 29. Water quality monitoring sites in the Colorado River where dissolved selenium concentrations exceeded the chronic standard in one or more samples.



9.2 Total Phosphorus

Total phosphorus concentrations ranged from less than 0.01 to 0.62 mg/L in 100 samples collected from the Colorado River and six percent of the results were less than the MRL (Table 32). The interim total phosphorus standard was exceeded in ten samples collected from five sites (Table 34). All of the exceedances occurred in April, May or June, during peak flow, where increased surface runoff may deliver phosphorus to local waterbodies.

In the Colorado River at the Glenwood Springs Pedestrian Bridge, above the confluence with the Roaring Fork River, total phosphorus concentrations ranged from less than 0.01 to 0.59 mg/L in thirteen samples collected from February 2001 to November 2011 (Table 34 and Figure 30; site CDOWRW-46). The interim standard was exceeded four times. The median concentration of 0.05 mg/L was less than the interim standard of 0.11 mg/L.

Total phosphorus concentrations ranged from 0.01 to 0.62 mg/L in nine samples collected from February 2001 to December 2007 in the Colorado River at Devereux Road Bridge below the confluence with the Roaring Fork River (Table 34 and Figure 30; site CDOWRW-47). The only total phosphorus concentration that exceeded the interim standard was collected on 5/23/2005 and was the maximum concentration measured in the Colorado River to date.

Table 34. Monitoring sites in the Colorado River where the interim total phosphorus standard was exceeded; concentrations in mg/L.

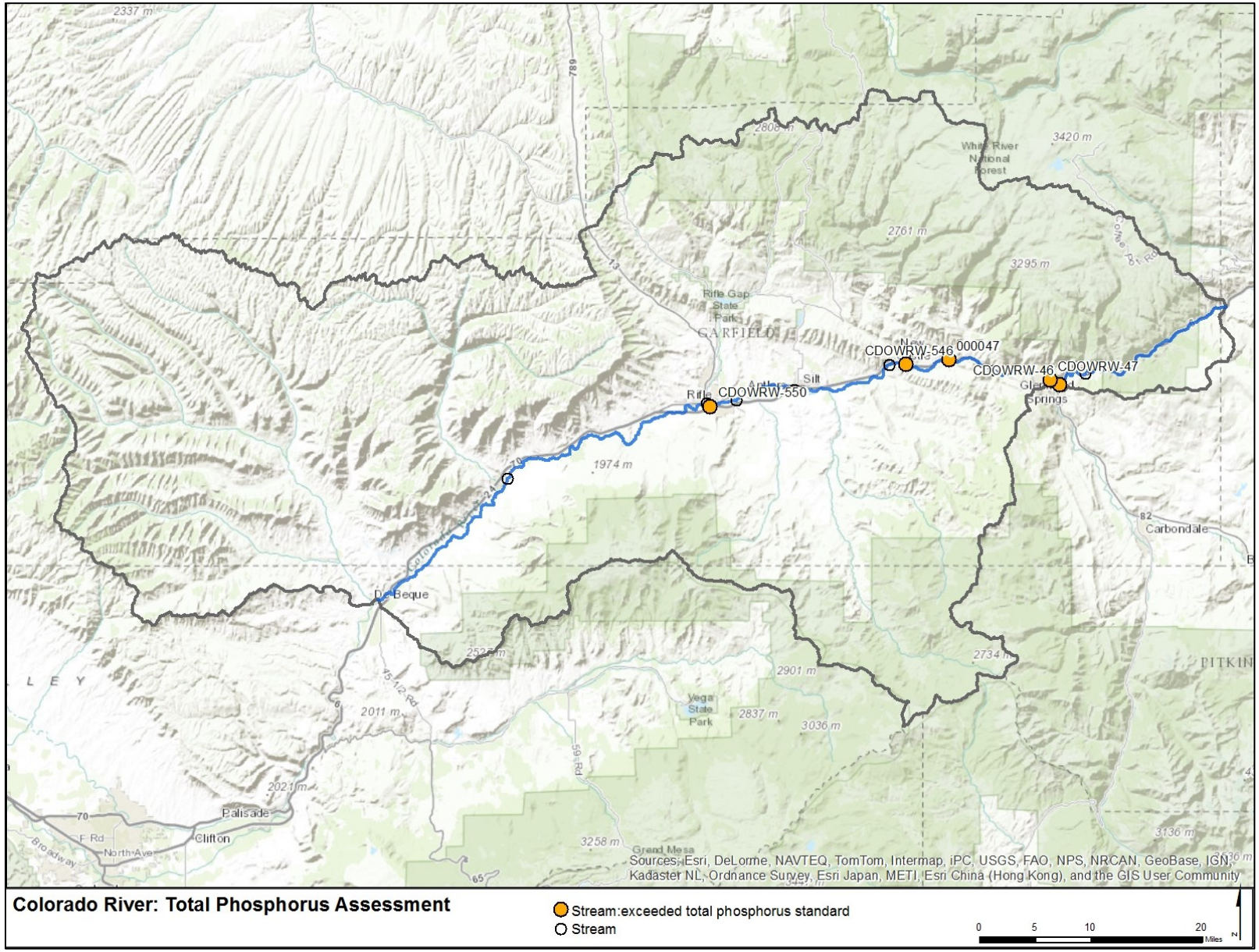
WQCC Segment	Site	Number of Samples	Percent < MDL	Minimum	Median	Maximum	Exceedance Count
Upper Colorado 3	CDOWRW-46	13	15%	<0.01	0.05	0.59	4
1	CDOWRW-47	9	0%	0.01	0.04	0.62	1
	000047	58	2%	<0.01	0.03	0.41	3
	CDOWRW-546	3	0%	0.05	0.08	0.17	1
	CDOWRW-550	3	0%	0.01	0.09	0.25	1

In the Colorado River east of New Castle, above the confluence with Elk Creek, total phosphorus ranged from less than 0.01 to 0.41 mg/L in 58 samples collected from February 2000 to June 2011 (Table 34 and Figure 30; site 000047). Three samples exceeded the interim standard; although the median concentration of 0.04 mg/L is less than the interim total phosphorus standard of 0.11 mg/L.

In the Colorado River near the New Castle Boat Ramp, total phosphorus concentrations ranged from 0.05 mg/L to 0.17 mg/L in three samples collected from March 2003 to May 2009 and one sample exceeded the interim standard (Table 34 and Figure 30; site CDOWRW-546). The median total phosphorus concentration of 0.08 mg/L was less than the interim standard total phosphorus standard of 0.11 mg/L.

In the Colorado River at the Rifle Bridge total phosphorus concentrations ranged from 0.01 to 0.25 mg/L in three samples collected from April 2003 to October 2004. The interim standard was exceeded in one sample but the median total phosphorus concentration of 0.09 mg/L did not exceed the interim standard (Table 34 and Figure 30; site CDOWRW-550).

Figure 30. Water quality monitoring sites in the Colorado River where total phosphorus concentrations exceeded the interim standard in one or more samples.



9.3 Dissolved Iron

Dissolved iron concentrations ranged from less than the MRL to 2,922 ug/L in 243 samples collected from thirteen sites in the Colorado River (Table 32). The dissolved iron water supply standard of 300 ug/L applies to all three segments of the Colorado River in the Watershed. Dissolved iron concentrations exceeded the water supply standard in seven samples collected from four locations (Table 35; Figure 31).

In the Colorado River at the Glenwood Springs Pedestrian Bridge, above the confluence with the Roaring Fork River, dissolved iron concentrations ranged from less than the MRL to 301 ug/L in 86 samples (Figure 31; site CDOWRW-46). One sample exceeded the water supply standard; however, the 85th percentile of 50 ug/L was less than the standard (Table 35).

Dissolved iron concentrations ranged from 10 to 399 ug/L in 51 samples collected from the Colorado River at Devereux Road Bridge below the confluence with the Roaring Fork River (Table 35 and Figure 31; site CDOWRW-47). One sample exceeded the water supply standard; however, the 85th percentile of 36 ug/L was well below the standard.

In the Colorado River at the Rifle Bridge dissolved iron concentrations ranged from 13 to 2,922 ug/L in 11 samples collected from January 2003 to April 2005 (Table 35 and Figure 31; site CDOWRW-550). The chronic standard was exceeded in one sample with a dissolved iron concentration of 2,922 ug/L on 5/23/2003. This was the highest dissolved iron concentration measured in the mainstem of the Colorado River and is roughly one-tenth of the highest concentrations measured in the South and West Watersheds, underscoring the dilution that can occur in the mainstem of the Colorado River.

Table 35. Monitoring sites where dissolved iron concentrations exceeded the water supply standard in the Colorado; concentrations in ug/L.

WQCC Segment	Site	Number of Samples	Percent < MDL	Minimum	Median	Maximum	Exceedance Count
Upper Colorado 3	CDOWRW-46	86	2%	< MDL	31	301	1
1	CDOWRW-47	51	0%	10	24	399	1
	CDOWRW-550	11	0%	13	23	2,922	1
2a	CDOWRW-559	5	0%	260	450	980	4

9.4 Total Iron

Total iron concentrations ranged from 11 to 14,891 ug/L in 287 samples collected at thirteen locations in the Colorado River. Total iron concentrations exceeded the chronic standard of 1,000 ug/L at five locations in 33 samples. Three sites (CDOWRW-46, CDOWRW-47, and CDOWRW-550) exceeded both the total and dissolved iron standards in a small portion of the samples (Tables 35 and 35; Figure 31).

Table 36. Monitoring sites where total iron concentrations exceeded the chronic standard in the Colorado; concentrations in ug/L.

WQCC Segment	Site	Number of Samples	Percent < MDL	Minimum	Median	Maximum	Exceedance Count
Upper Colorado 3	CDOWRW-46	92	0%	44	203	7,706	11
1	CDOWRW-47	91	0%	44	176	8,015	8
	000047	44	0%	32	180	2,000	2
	CDOWRW-546	27	0%	58	261	14,891	6
	CDOWRW-550	23	0%	11	119	4,172	6

Total iron concentrations ranged from 44 to 7,706 ug/L in 92 samples collected in the Colorado River at the Glenwood Springs Pedestrian Bridge (Table 36 and Figure 31; site CDOWRW-46). The chronic standard was exceeded in eleven samples; however, the 85th percentile total iron concentration of 645 ug/L was below the chronic standard of 1,000 ug/L.

Total iron concentrations ranged from 44 to 8,015 ug/L in 91 samples collected in the Colorado River at Devereux Road Bridge, below the confluence with the Roaring Fork River, from January 2000 to May 2007 (Table 36 and Figure 31; site CDOWRW-47). Total iron concentrations exceeded the chronic standard in eight samples. The 85th percentile total iron concentration was 656 ug/L, which is below the chronic standard of 1,000 ug/L. Total iron concentrations trended down from 1991 to 2000 and trended upward from 2000 to 2007 in the Colorado River at Devereux Road (Thomas et al., 2013).

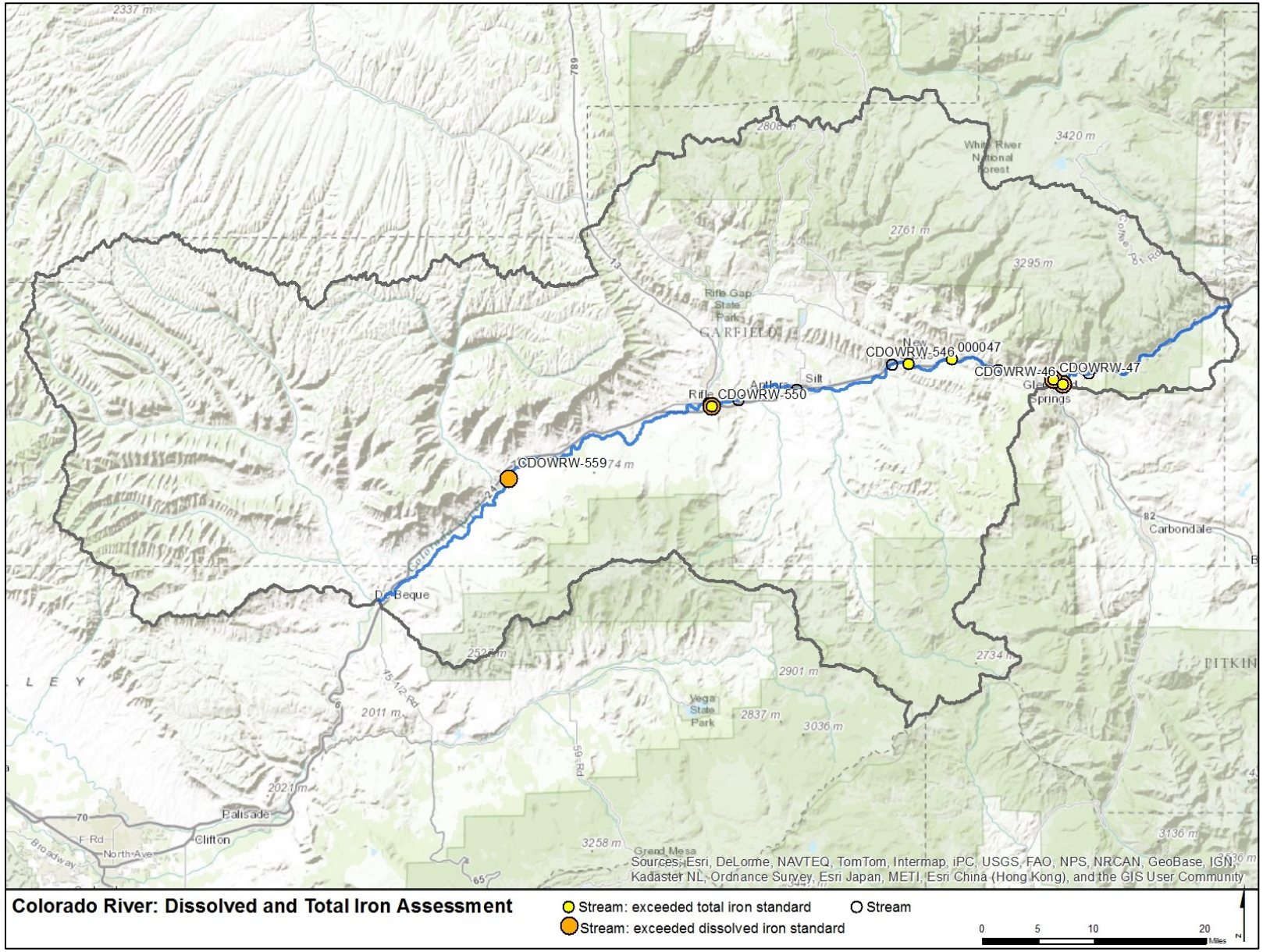
In the Colorado River upstream of New Castle, above the confluence with Elk Creek, total iron concentrations ranged from 32 to 2,000 ug/L in 44 samples collected from February 2000 to April 2007 (Table 36 and Figure 31; site 000047). The chronic standard was exceeded in two samples, but the 85th percentile concentration of 38 ug/L was well below the standard.

In the Colorado River near New Castle, total iron concentrations ranged from 58 to 14,981 ug/L in 27 samples collected from November 2000 to April 2005 (Table 36 and Figure 31; site CDOWRW-546). Six samples exceeded the chronic standard and the 85th percentile total iron concentration of 1,022 ug/L was greater than the chronic standard of 1,000 ug/L. The increase in total iron concentrations in the Colorado River near New Castles suggests that Elk Creek or other tributaries may be a source of iron.

In the Colorado River at the Rifle Bridge total iron concentrations ranged from 11 to 4,172 ug/L in 23 samples (Table 36 and Figure 31; site CDOWRW-550). The chronic standard was exceeded in six samples and the 85th percentile total iron concentration was 1,086 ug/L and exceeded the chronic

standard of 1,000 ug/L. The data suggest that total iron concentrations increase in the Colorado River from Glenwood Springs to Rifle; additional data are needed to identify potential sources.

Figure 31. Water quality monitoring sites in the Colorado River where dissolved and or total iron concentrations exceeded the applicable standard in one or more samples.



9.5 Dissolved Lead

Dissolved lead concentrations ranged from less than 1 to 13 ug/L in 121 samples and 92 percent of the results were less than the MRL (Table 32). Dissolved lead concentrations exceeded the chronic standard in three samples. The acute standard was not exceeded in any of the samples collected from the Colorado River.

In the Colorado River east of New Castle, above the confluence with Elk Creek, dissolved lead concentrations ranged from less than 1 to 13 ug/L in 58 samples collected from February 2000 to June 2001 (Figure 32; site 000047). Two samples exceeded the chronic standard, approximately 5.6 ug/L based on the average hardness, in September and December 2003. Ninety-seven percent of the samples were below the MRL, so the exceedances may not be representative of typical conditions.

In the Colorado River at Rifle Bridge dissolved lead concentrations ranged from 3.5 to 6.9 ug/L in three samples (Figure 32; site CDOWRW-550). The chronic standard, approximately 5.6 ug/L based on the average hardness, was exceeded in a sample collected in May 2003.

Since December 2003 dissolved lead concentrations in the Colorado River have not exceeded the chronic standard in 81 samples. This suggests that dissolved lead concentrations did not typically exceed the chronic standard and that aquatic life in the Colorado River is protected.

9.6 Dissolved Copper

Dissolved copper ranged from less than 1 to 21.1 ug/L in 152 samples collected in the Colorado River and dissolved copper concentrations were below the MRL in sixty percent of the samples (Table 32). From 1991 to 1999 dissolved copper concentrations trended upward and trended downward from 1999 to 2006 at Devereux Bridge (Thomas et al., 2013).

Dissolved copper concentrations ranged from 1.5 to 21.1 ug/L in three samples in the Colorado River at Rifle Bridge (Figure 32; site CDOWRW-550). One sample, collected in February 2003, exceeded both the chronic and acute standards for copper. Since February 2003 dissolved copper concentrations have not exceeded the chronic copper standard in 112 samples collected from the Colorado River. This suggests that dissolved copper concentrations did not typically exceed the chronic standard.

Figure 32. Water quality monitoring sites in the Colorado River where dissolved lead or copper concentrations exceeded the applicable standard in one or more samples.

9.7 *Escherichia coli*

E. coli concentrations ranged from less than the MRL to 2,419 colonies per 100 mL in 42 samples collected from the Colorado River and 30 results were less than the MRL (Table 32). The median *E. coli* concentration was 10 colonies per 100 mL (Table 32). In the Colorado River east of New Castle above the confluence with Elk Creek (Site 000047) one sample exceeded the *E. coli* standard of 126 colonies per 100 mL. In 34 other samples collected at this location *E. coli* concentrations were less than the standard.

9.8 BTEX: Benzene, Toluene, Ethylene and Xylene

From May 2006 to May 2009 BTEX concentrations were below the MRL in 13 samples collected in the Colorado River at the Town of Silt's drinking water supply intake. In the Colorado River at Parachute Bridge total benzene and ethylene concentrations were below the MRL in five samples (Table 32). The BTEX data set is limited in both size and spatial distribution. Additional data collection should occur in the Colorado River.

9.9 Major Findings

Sample collection in the Colorado River at Parachute Bridge ceased in 2007 (site CDOWRW-559). The Colorado River currently lacks monitoring locations west of Rifle. The Colorado River and several alluvial wells are critical drinking water supplies in the Watershed. A variety of land uses occur in the river corridor and efforts to improve riparian health and habitat are also underway. These factors coupled with the lack of monitoring locations create a significant data gap. At a minimum, a monitoring site should be established in the Colorado River near DeBeque. MCWC should coordinate with other stakeholders to assure that a monitoring plan is designed and implemented to address this data gap.

The mainstem of the Colorado River is on the M&E List for sediment. The WQCD does not currently have sediment criteria appropriate for rivers as large as the Colorado River. In the future, when sediment sample collection protocols and standards are established, sample collection should occur in the Colorado River to: 1) establish a baseline for the selected protocol, 2) evaluate results relative to corollary data such as total suspended sediment or specific conductance, 3) identify point and nonpoint sources, and 4) determine attainment status. Based on recent conversations with WQCD staff, the sediment protocol and standards for large rivers will not be established prior to 2017 (Hartenstine, personal communication, 8/13/2013).

Given that energy development is common in the South and West Watersheds, BTEX and other parameters are recommended to be sampled regularly in the mainstem of the Colorado River. Ideally, sample collection would bracket local energy development areas. The Colorado River near New Castle could provide an upstream reference site and the Colorado River near DeBeque could provide the downstream reference. Such an arrangement would help isolate the effect of energy development on the Colorado River, especially for parameters such as BTEX. However, energy development is not the only potential source of pollution to the Colorado River and careful data evaluation would be required.

Dissolved zinc concentrations were below the chronic aquatic life standard in all samples and have declined through time.

The 15th percentile dissolved oxygen concentration was 8.0 mg/L and readily meets the applicable standards for each segment of the Colorado River.

10.0 Conclusions

The overarching purpose of this Analysis is to inform the Watershed Plan. The key objectives of the Analysis are to:

1) Compile, analyze, and describe surface water quality in the Watershed;
2) Identify surface water quality data gaps;
3) Identify areas where surface water quality issues may be present.

The Analysis focused on areas where water quality standards were not met or where there is a lack of data. Overall, the vast majority of water quality data in the Watershed meets applicable standards and supports existing water uses and overall watershed health.

10.1 Spatial and Temporal Data Gaps

The Analysis identified several data gaps and monitoring needs for Watershed. The USGS noted that while the basin has many monitoring locations, they often lacked spatial and temporal consistency (Thomas et al., 2013). The water quality analysis corroborated these findings; eighty percent of the locations in the Watershed were sampled three times or fewer which limits the ability to identify patterns or trends.

In each of the subwatersheds the majority of the monitoring locations are in tributaries near the confluence with the Colorado River or concentrated in the mainstem of some larger drainages such as Divide, Mamm, or Parachute Creeks. The headwaters typically lack water quality data. There are a lack of data for tributaries in the eastern portion of the East Watershed. Although the South Watershed has the most monitoring locations, many of the locations have only been sampled once and this area in particular could benefit from a long-term monitoring plan. Very limited data collection has occurred in the headwaters of the West Watershed, particularly in Parachute, Kimball, Roan, and Clear Creeks. Given the ecological and economic value of these lands, water quality characterizations should be completed to establish baseline conditions. This is particularly important given the populations of Colorado River Cutthroat Trout and the high quality of the fisheries found on the Roan Plateau.

The Colorado River lacks an active monitoring location west of Rifle which constitutes a major data gap in the Watershed. Further it is not currently possible to evaluate the effect of major tributaries in the Watershed on the Colorado River due to a lack of monitoring locations that bracket the tributaries.

These factors further underscore the need for a long-term monitoring strategy in the Watershed. This information should be combined with the monitoring strategies proposed for the Piceance Basin in the regional water quality monitoring plan (USGS, 2013). Together, the resources can be used to design a water quality monitoring plan specific to the Watershed.

10.2 Information Data Gaps

The USGS identified trace elements and nutrients as the main analytical data gaps in the Watershed (Thomas et al., 2013). This Analysis confirmed those findings and identified data gaps for selenium, nutrients, *E. coli,* iron, lead, copper, and zinc. The following paragraphs summarize the most significant information data gaps.

Existing data do not suggest that nutrients are a particularly widespread or consistent issue in the Watershed. However, the data set is limited in both sample size and spatial distribution, thus any conclusions drawn from the current data set are considered tentative. Additional data collection is recommended on Elk, Alkali, Mamm, Parachute, and Roan Creeks as well as at selected Colorado River locations. Recent monitoring requirements associated with Regulation 85 may have increased the amount of data available, which should be incorporated into any future evaluations. On-going and future sample efforts should assure that total phosphorus and total nitrogen are include in the analysis suites.

The Analysis identified South Canyon Creek, Rifle Creek, and to a lesser extent Elk Creek as priorities for additional investigation in the East Watershed. Water quality in South Canyon Creek appears to be influenced by South Canyon Hot Springs, particularly for *E. coli* and stream temperature. However, selenium and iron concentrations near the mouth of South Canyon Creek may be attributed to sources aside from the hot springs and warrant additional investigation. The available data from Rifle Creek suggest that additional monitoring should occur to identify sources of selenium, iron, and *E. coli*. Dissolved oxygen concentrations should be characterized at Rifle Gap Reservoir to determine whether the 2006 measurements were representative of average summer conditions. Future sampling efforts should better characterize tributaries to Rifle Creek including the east, middle, and west forks of Rifle Creek and Government Creek.

In the South Watershed, additional data collection should occur to better understand selenium concentrations and identify potential sources. Based on the existing selenium data Mamm Creek, Alkali Creek, Dry Hollow Creek, and Divide Creek are priority areas for additional sample collection. In the South Watershed, further data collection should occur to better understand selenium concentrations and identify potential sources.

Inappropriate MRL for dissolved selenium have created a data gap in the West Watershed. An initial remedy to address the data gap is to assure that all entities collecting data in the Watershed use appropriate MRL for selenium analysis (i.e., MRL less than 4.6 ug/L).

There is a lack of stream flow data throughout the Watershed. Without stream flow data it is not possible to characterize pollutant loads in tributaries or in the mainstem of the Colorado River. A lack of flow data, along with limited chemical data, will make it difficult to develop TMDL reports.

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Appendix A: WQCC Segments

This appendix presents the Water Quality Control Commission (WQCC) Segments as presented in Regulations 33 and 37 (effective date 9-30-2013). The five lake segments presented below have yet to be incorporated into the WQCD shapefiles used to create the segmentation map because the rule-making was completed in late 2013.

Appendix A: Table 1 Water Quality Control Commission segments in the Middle Colorado River Watershed (1 of 8).

Segment Name	Segment Description	Designation	Use Classifications	Numeric Standards[1,2,3,4,5]						Temporary Modifications and Qualifiers
				Physical and Biological	Inorganic (mg/L)		Metals (ug/L)			
COUCUC03	Mainstem of the Colorado River from the outlet of Lake Granby to the confluence with Roaring Fork River.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-II)°C D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac)=TVS Zn(ch)=TVS(sc)	
COUCUC04	All tributaries to the Colorado River, including all wetlands, from the outlet of Lake Granby to the confluence with the Roaring Fork River, which are on National Forest lands, except for those tributaries included in Segments 1 and 2, and specific listings in Segments 8, 9 and 10a.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-I)°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COUCUC05	All lakes and reservoirs tributary to the Colorado River from the boundary of Rocky Mountain National Park and Arapahoe National Recreation Area to a point immediately below the confluence with the Roaring Fork River which are not on National Forest lands, except for specific listing in Segments 11 and 12.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CL,CLL)°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COUCUC07a	All tributaries to the Colorado River, including all wetlands, from a point immediately above the confluence with the Blue River and Muddy Creek to a point immediately below the confluence with the Roaring Fork River, which are not on National Forest lands, except for specific listings in Segment 7b, 7c and in the Blue		Aq Life Cold 1 Recreation N Water Supply Agriculture	T=TVS(CS-II)°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=630/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COLCLC01	Mainstem of the Colorado River from the confluence with the Roaring Fork River to immediately below the confluence with Rifle Creek.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-II)°C D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	

Appendix A Table 1. Water Quality Control Commission segments in the Middle Colorado River Watershed (2 of 8).

Segment Name	Segment Description	Designation	Use Classifications	Numeric Standards[1,2,3,4,5]						Temporary Modifications and Qualifiers
				Physical and Biological	Inorganic (mg/L)		Metals (ug/L)			
COLCLC02a	Mainstem of the Colorado River from immediately below the confluence with Rifle Creek to immediately above the confluence of Rapid Creek.		Aq Life Warm 1 Recreation E Water Supply Agriculture	T=TVS(WS-II) °C D.O. = 5.0 mg/l pH = 6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS	
COLCLC04a	All tributaries, including wetlands, to the Colorado River from the confluence with the Roaring Fork River to a point immediately below the confluence with Parachute Creek except for the specific listings in Segments 4b, 4c, 4d, 4e, 5, 6, 7a, 7b, 8, 9a, 9c, 10, 11a - h, and 12a.		Aq Life Cold 2 Recreation N Water Supply Agriculture	T=TVS(CS-II) °C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=630/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02-10(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS	
COLCLC04b	South Canyon Hot Springs.		Aq Life Warm 2 Recreation E	D.O.=5.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002	As(ac)=340 As(ch)=100(Trec) Cd(ac/ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS	
COLCLC04c	The mainstem of South Canyon Creek from the South Canyon Hot Springs to the confluence with the Colorado River.		Aq Life Warm 1 Recreation E Water Supply Agriculture	T=TVS(WS-IV)°C D.O.=5.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2 (ac)=0.019 Cl_2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS	
COLCLC04d	The mainstem of Dry Hollow Creek, including all tributaries and wetlands, from the source to the confluence with the Colorado River.		Aq Life Cold 2 Recreation N Water Supply Agriculture	T=TVS(CS-II)°C D.O.= 5.0 mg/l pH=6.5-9.0 E.Coli=630/100ml	NH_3(ac/ch)=TVS Cl_2 (ac)=0.019 Cl_2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02-10(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS	
COLCLC04e	Mainstem of Dry Creek including all tributaries and wetlands from the source to immediately above the Last Chance Ditch.	UP	Aq Life Cold 2 Recreation N Agriculture	T=TVS(CS-II) °C D.O.=5.0 mg/l pH=6.5-9.0 E.Coli=630/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=100	As(ac)=340 As(ch)=100(Trec) Cd(ac/ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS	Temporary Modifications: Cu(ac/ch)=existing quality Fe(ch)=existing quality(Trec) (Type iii) Expiration 12/31/2013

Appendix A Table 2. Water Quality Control Commission segments in the Middle Colorado River Watershed (3 of 8).

Segment Name	Segment Description	Designation	Use Classifications	Numeric Standards[1,2,3,4,5]						Temporary Modifications and Qualifiers
				Physical and Biological	Inorganic (mg/L)		Metals (ug/L)			
COLCLC04f	Mainstem of Dry Creek including all tributaries and wetlands from a point immediately above the Last Chance Ditch to the confluence with the Colorado River.		Aq Life Cold 1 Recreation N Agriculture	T=TVS(CS-II) °C D.O.=6.0 mg/l pH=6.5-9.0 E.Coli=630/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=100	As(ac)=340 As(ch)= 7.6(Trec) Cd(ac/ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS	
COLCLC05	All tributaries to the Colorado River, including wetlands, which are within the boundaries of White River National Forest, except for the specific listing in Segments 9a and 9c.		Aq Life Cold 1 Recreation P Water Supply Agriculture	T=TVS(CS-I) °C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=205/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COLCLC06	Mainstem of Oasis Creek including all tributaries and wetlands from the boundary of White River National Forest to the confluence with the Colorado River.		Aq Life Cold 2 Recreation P Water Supply Agriculture	T=TVS(CS-I) °C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=205/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02-10(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COLCLC07a	Mainstem of Mitchell, Canyon, Elk, Garfield, Beaver, and Cache Creeks, including all tributaries and wetlands, from the boundary of the White River National Forest to their confluences with the Colorado River. Battlement Creek from the most downstream boundary of BLM lands to the confluence with the Colorado River.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-I) °C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac)=TVS Zn(ch)=TVS(sc)	
COLCLC07b	Mainstem of Divide Creek, including all tributaries and wetlands, from the boundary of the White River National Forest to the confluence with the Colorado River.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-II) °C D.O.= 6.0 mg/l D.O.(sp)=7.0 mg/ pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	

Appendix A Table 3. Water Quality Control Commission segments in the Middle Colorado River Watershed (4 of 8).

Segment Name	Segment Description	Designation	Use Classifications	Numeric Standards[1,2,3,4,5]						Temporary Modifications and Qualifiers
				Physical and Biological	Inorganic (mg/L)		Metals (ug/L)			
COLCLC08	Mainstem of Northwater and Trapper Creeks, including all tributaries and wetlands, from their sources to the confluence with the East Middle Fork of Parachute Creek. East Middle Fork of Parachute Creek, including all tributaries and wetlands, from the source to the confluence with the Middle Fork of Parachute Creek.	OW	Aq Life Cold 1 Recreation N Water Supply Agriculture	T=TVS(CS-I) °C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=630/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COLCLC09a	Middle Rifle Creek, including all tributaries and wetlands, from its source to the confluence with West Rifle Creek. East Rifle Creek, including all tributaries and wetlands, from the source to the boundary of the White River National Forest.		Aq Life Cold 1 Recreation E Agriculture	T=TVS(CS-I) °C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=100	As(ac)=340 As(ch)=7.6(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COLCLC09b	All lakes and reservoirs tributary to the Colorado River from the confluence of the Colorado and the Roaring Fork River to a point immediately below the confluence of the Colorado River and Parachute Creek, and all lakes and reservoirs within the White River National Forest or the Grand Mesa National Forest, except for the specific listing in segment 20.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CL) °C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COLCLC09c	Battlement Creek, including all tributaries and wetlands, from the source to the most downstream boundary of BLM lands.	OW	Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-I) °C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COLCLC10	West Rifle Creek, including all tributaries and wetlands, from the source to Rifle Gap Reservoir. East Rifle Creek, including all tributaries and wetlands, from the White River National Forest boundary to Rifle Gap Reservoir. Rifle Creek, including all tributaries and wetlands, from Rifle Gap Reservoir to the confluence with the Colorado River.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-I) °C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	

Appendix A Table 4. Water Quality Control Commission segments in the Middle Colorado River Watershed (5 of 8).

Segment Name	Segment Description	Designation	Use Classifications	Numeric Standards[1,2,3,4,5]						Temporary Modifications and Qualifiers
				Physical and Biological	Inorganic (mg/L)		Metals (ug/L)			
COLCLC11a	Mainstem of West Fork of Parachute Creek, including all tributaries, from its source to West Fork Falls. Mainstem of East Fork of Parachute Creek, including all tributaries and wetlands, from a point immediately below the mouth of First Anvil Creek to the east boundary line of S27, T5S, R95W.		Aq Life Cold 1 Recreation N Water Supply Agriculture	T=TVS(CS-I) °C D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=630/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COLCLC11b	Mainstem of the West Fork of Parachute Creek from West Fork Falls to the confluence with Parachute Creek; mainstem of the Middle Fork of Parachute Creek from the north boundary line of S19, T5S, R95W to the confluence with East Middle Fork of Parachute Creek.		Aq Life Cold 2 Recreation N Agriculture	T=TVS(CS-I) °C D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 F.Coli=2000/100ml E.Coli=630/100ml	CN(ac)=0.2 NO_2=10 NO_3=100	B=0.75	As(ch)=100(Trec) Be(ch)=100(Trec) Cd(ch)=10(Trec) CrIII(ch)=100(Trec)	CrVI(ch)=100(Trec) Cu(ch)=200(Trec) Pb(ch)=100(Trec) Mn(ch)=200(Trec)	Ni(ch)=200(Trec) Se(ch)=20(Trec) Zn(ch)=2000(Trec)	
COLCLC11c	Mainstem of the Middle Fork of Parachute Creek including all tributaries (includes Davis Gulch and tributaries), from the source to the north boundary line of S19, T5S, R95W.		Aq Life Cold 2 Recreation N Agriculture	T=TVS(CS-I) °C D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=630/100ml	CN(ac)=0.2 NO_2=10 NO_3=100	B=0.75	As(ch)=100(Trec) Be(ch)=100(Trec) Cd(ch)=10(Trec) CrIII(ch)=100(Trec)	CrVI(ch)=100(Trec) Cu(ch)=200(Trec) Pb(ch)=100(Trec) Mn(ch)=200(Trec)	Ni(ch)=200(Trec) Se(ch)=20(Trec) Zn(ch)=2000(Trec)	
COLCLC11d	Mainstem of Middle Fork of Parachute Creek from the confluence with East Middle Fork to a point immediately above the confluence with the West Fork of Parachute Creek.		Aq Life Cold 1 Recreation N Agriculture	T=TVS(CS-I) °C D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 E.Coli=630/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10	As(ac)=340 As(ch)=7.6(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COLCLC11e	That portion of the mainstem of the East Fork of Parachute Creek, including all tributaries and wetlands, within Sections 27, 28, and 29, T5S, R95W.		Aq Life Cold 2 Recreation N Water Supply Agriculture	T=TVS(CS-I) °C D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 E.Coli=630/100ml	CN(ac)=0.2 NO_2=1.0 NO_3=10	S=0.002 B=0.75 Cl=250 SO_4=WS	As(ch)=0.02-10(Trec) Be(ch)=100(Trec) Cd(ch)=10(Trec) CrIII(ac)=50(Trec) CrIII(ch)=100(Trec)	CrVI(ch)=100(Trec) Cu(ch)=200(Trec) Fe(ch)=WS(dis) Pb(ch)=100(Trec) Mn(ch)=WS(dis) Mn(ch)=200(Trec) Hg(ch)=0.01(tot)	Ni(ch)=200(Trec) Se(ch)=20(Trec) Zn(ch)=2000(Trec)	

Appendix A Table 5. Water Quality Control Commission segments in the Middle Colorado River Watershed (6 of 8).

Segment Name	Segment Description	Designation	Use Classifications	Numeric Standards[1,2,3,4,5]						Temporary Modifications and Qualifiers
				Physical and Biological	Inorganic (mg/L)		Metals (ug/L)			
COLCLC11f	Mainstem of the East Fork of Parachute Creek from the west boundary line of S29, T5S, R95W to the confluence with Middle Fork of Parachute Creek.		Aq Life Cold 1 Recreation N Water Supply Agriculture	T=TVS(CS-I) °C D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 E.Coli=630/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COLCLC11g	All tributaries to East Fork Parachute Creek on the south side of the East Fork Parachute Creek from a point immediately below First Anvil Creek to the confluence with Parachute Creek; all tributaries to Parachute Creek on the east side of Parachute Creek from a point immediately below the East Fork of Parachute Creek to the confluence with the Colorado River; and all tributaries to the Colorado River on the north side of the Colorado River from a point immediately below Cottonwood Creek to the confluence with Parachute Creek except for specific listings in segment 7a.		Aq Life Cold 2 Recreation N Agriculture	T=TVS(CS-I) °C D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=630/100ml	CN(ac)=0.2 NO_2=10 NO_3=100	B=0.75	As(ch)=100(Trec) Be(ch)=100(Trec) Cd(ch)=10(Trec) CrIII(ch)=100(Trec)	CrVI(ch)=100(Trec) Cu(ch)=200(Trec) Pb(ch)=100(Trec) Mn(ch)=200(Trec)	Ni(ch)=200(Trec) Se(ch)=20(Trec) Zn(ch)=2000(Trec)	
COLCLC11h	Mainstem of Parachute Creek, including all tributaries and wetlands, from the confluence of the West and East Forks to the confluence with the Colorado River except for specific listings in segment 11g.		Aq Life Cold 2 Recreation P Agriculture	T=TVS(CS-II) °C D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=205/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=100	As(ac)=340 As(ch)=100(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COLCLC12a	All tributaries to East Fork Parachute Creek from its source to a point immediately below the mouth of First Anvil Creek.		Aq Life Cold 1 Recreation N Agriculture	T=TVS(CS-I) °C D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 E.Coli=630/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO2=0.05 NO3=100	As(ac)=340 As(ch)=7.6(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	

Appendix A Table 6. Water Quality Control Commission segments in the Middle Colorado River Watershed (7 of 8).

Segment Name	Segment Description	Designation	Use Classifications	Numeric Standards[1,2,3,4,5]						Temporary Modifications and Qualifiers
				Physical and Biological	Inorganic (mg/L)		Metals (ug/L)			
COLCLC12b	All tributaries and wetlands to the Colorado River from a point immediately below the confluence of Parachute Creek to a point immediately below the confluence with Roan Creek.		Aq Life Cold 2 Recreation P Water Supply Agriculture	T=TVS(CS-II) °C D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=205/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02-10 (Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COLCLC14a	Mainstem of Roan Creek including all wetlands and tributaries, from its source to a point immediately above the confluence with Clear Creek, except for the specific listing in segment 14b. Clear Creek, including all tributaries and wetlands, from the source to a point immediately below the confluence with Tom Creek.		Aq Life Cold 1 Recreation P Water Supply Agriculture	T=TVS(CS-I) °C D.O.=6.0 mg/l D.O.(sp)= 7.0 mg/l pH=6.5-9.0 E.Coli=205/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COLCLC14b	Clear Creek, including all tributaries and wetlands, from a point immediately below the confluence with Tom Creek to the confluence with Roan Creek. Roan Creek, including all tributaries and wetlands, from a point immediately above the confluence with Clear Creek to a point immediately below the confluence with Kimball Creek.		Aq Life Cold 1 Recreation P Water Supply Agriculture	T=TVS(CS-II) °C D.O.=6.0 mg/l D.O.(sp)= 7.0 mg/l pH=6.5-9.0 E.Coli=205/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COLCLC14c	Mainstem of Roan Creek including all tributaries and wetlands, from a point immediately below the confluence with Kimball Creek to the confluence with the Colorado River.		Aq Life Warm 1 Recreation P Water Supply Agriculture	T=TVS(WS-II) °C D.O.=5.0 mg/l pH=6.5-9.0 E.Coli=205/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS	
COLCLC19	All lakes and reservoirs tributary to the Colorado River from a point immediately below the confluence of the Colorado River and Parachute Creek to the Colorado-Utah border, except for specific listings in segments 9b, 13c, 20, and 21. This segment includes Highline Reservoir.		Aq Life Warm 1 Recreation E Agriculture	T=TVS(WL) °C D.O.=5.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=100	As(ac)=340 As(ch)=7.6(Trec) Cd(ac/ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS	

Appendix A Table 7. Water Quality Control Commission segments in the Middle Colorado River Watershed (8 of 8).

Segment Name	Segment Description	Designation	Use Classifications	Numeric Standards[1,2,3,4,5]						Temporary Modifications and Qualifiers
				Physical and Biological	Inorganic (mg/L)		Metals (ug/L)			
COLCLC20	Rifle Gap Reservoir, Harvey Gap Reservoir, and Vega Reservoir.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CLL) °C Rifle Gap Reservoir April-Dec T(WAT)=23.0 °C D.O.= 6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
COLCLC21	All lakes and reservoirs tributary to Roan Creek from the source to a point just below the confluence with Clear Creek. All lakes and reservoirs tributary to Rapid Creek from the source to the confluence with the Colorado River. All lakes and reservoirs tributary to the Little Dolores River from the source to a point immediately below the confluence with Hay Press Creek.		Aq Life Cold 1 Recreation U Water Supply Agriculture	T=TVS(CL) °C D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	

Notes

1. Segments and standards are from the Colorado Water Quality Control Comission Regulations 33 and 37: Effective Date 9-30-2013.
2. TVS= Table Value Standard. The value of these standards are hardness-dependent.
3. Ac= Acute, Ch= Chronic, Dis= Dissolved, OW= Outstanding Waters, Sp= Spawning, Tr= Trout, Trec= Total Recoverable, tot= total, WS= Water Supply.
4. Metal concentrations are dissolved, unless otherwise specified.
5. NH_3= Unionized ammonia. The standard relies on both water pH and temperature.

Appendix A- Figure 1. 1. Water Quality Control Commission segments in the Middle Colorado River Watershed.