Rio Grande Stream Management Plan

Prepared for:

Rio Grande Basin Roundtable and the
Stream Management Plan Technical Advisory Team

With support from:

Colorado Water Conservation Board
San Luis Valley Conservation and Connection Initiative
Bureau of Reclamation WaterSMART Program
American Whitewater
San Luis Valley Water Conservancy District
Conejos Water Conservancy District

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Executive Summary

The purpose of the Rio Grande, Conejos River, and Saguache Creek Stream Management Plans (SMPs) is to assess stream conditions to enable local stakeholders to develop informed and data-driven management actions with the goal of preserving and enhancing water uses and community values. Following the release of the 2015 Colorado Water Plan, the Rio Grande Basin Roundtable (Roundtable) recognized the need for comprehensive assessments and management plans for locally prioritized streams in the Rio Grande Basin. Streams in the Rio Grande Basin were prioritized by a SMP Subcommittee of the Roundtable. The SMP Subcommittee prioritized the following stream segments: 1) The Rio Grande from Stony Pass to the Colorado state line, 2) Conejos River from Platoro Reservoir to the Rio Grande confluence, and 3) Saguache Creek from the South Fork Saguache Creek confluence to Braun Bridge. To support the project, a SMP Technical Advisory Team (TAT) was formed and composed of state and federal agency officials, local water managers, nonprofit organizations, private landowners, and interested stakeholders. The TAT was instrumental in guiding data collection and the overall direction of the SMPs.

The SMPs are built on and guided by stakeholder input and values. Stakeholder engagement, through public meetings, landowner outreach, surveys, and email and social media updates, was critically important throughout the planning process. The SMP goals and priority projects were developed with significant stakeholder input and are aligned with stakeholder values.

To characterize stream condition and function, a *conditions assessment* was conducted for each stream. Each stream was divided into reaches based on similarities in geomorphology and reach breaks influenced by infrastructure, such as diversion dams. Assessments of recreational and aquatic habitat streamflow needs, diversion infrastructure, geomorphology, riparian vegetation, water quality, and aquatic life were completed. Conditions assessment results are organized by reach and include a list of impacts, or stressors, affecting each reach as well as a discussion of the likely cause(s) of stressors. The SMPs define management goals as well as priority projects and actions stakeholders may take to further each goal. Rough cost estimates are included, where appropriate.

The Rio Grande, Conejos River, and Saguache Creek SMPs are intended to be used as science-based guides for stream management through collaborative and multi-benefit projects. They provide an implementation strategy to support healthy streams and protect the ecosystem services they provide for fish, wildlife, and communities that rely on them.

Acknowledgements

Technical Advisory Team

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Bird Conservancy of the Rockies
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Colorado Parks and Wildlife
Colorado Water Conservation Board
Conejos Water Conservancy District
Conejos Water Users Association
Headwaters Alliance
Natural Resources Conservation Service
Rio Grande Basin Roundtable
Rio Grande Headwaters Land Trust
Rio Grande Headwaters Restoration Project
United States Forest Service
Rio Grande Water Conservation District
Rio Grande Water Users Association
Saguache Creek Water Users Association
San Luis Valley Irrigation District
San Luis Valley Water Conservancy District
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Glossary

Alluvial aquifer – An aquifer comprising unconsolidated material deposited by water, typically occurring adjacent to rivers.

Armoring (bed or channel) – The application of resistant materials on a river bed or banks to reduce scour and erosion.

Augmentation (of flow) – The addition of water to a system. In the case of water rights, this typically refers to augmentation plans used to replace depletions to streams caused by well pumping.

Avulsion – The sudden change of river's location or path.

Base flow – The portion of streamflow occurring outside of runoff, typically lasting from mid- to late-summer through early spring.

Benthic macroinvertebrates – Aquatic insects and other invertebrate (lacking a backbone) organisms living on the stream channel bed, often within interstitial spaces of channel substrate anywhere from sand to large boulders. Although some aquatic invertebrates may be quite small, "macro" refers to their visibility without magnification.

Channelization – Mechanical alteration of a river or stream that confines flow within a single course. Often times these actions can be combined with straightening.

Channel migration – The natural process by which stream channels move laterally over time.

Compact – The interstate Rio Grande Compact signed in 1938 between the states of Colorado, New Mexico, and Texas.

C-value – A value ranging from 0 to 10 and representing an estimated probability that a plant is likely to occur in a landscape relatively unaltered from pre-European settlement conditions. Also known as the coefficient of conservatism.

Depletion (of flow) – Removal of water from a system.

Flow duration curve – A graph representing the percent of time a specified discharge is equaled or exceeded.

Geomorphic – Relating to the form of the land or topography. In the context of streams, geomorphic characteristics include the physical shapes of streams, their water and sediment transport processes, and the landforms they create.

Hyporheic zone – Delineates a volume of saturated sediment that surrounds a river, where mixing of surface water and shallow groundwater occurs, and constitutes a transitional area (ecotone) between the surface and groundwater hydrologic systems and between aquatic and terrestrial habitats in the riparian zone. Referred to in this document in the context of hyporheic exchange.

Peak flow – Highest streamflow of the year, typically during spring snowmelt runoff.

Reach – A stream segment along which similar hydrologic conditions exist, such as discharge, depth, area, and slope.

River miles – River miles represent the distance of a stream channel across a landscape. In this report, river miles were calculated using the Source Water Route Framework dataset, which is extracted from the National Hydrography Dataset. Note: river miles are synonymous with stream miles.

Roundtable – The Rio Grande Basin Roundtable

San Luis Valley Closed Basin – A basin in the northern San Luis Valley where surface water outflow is prevented by a hydrologic divide and therefore surface waters are not tributary to the Rio Grande.

Sediment transport – The ability of a stream or river to transport an equal amount of sediment out of a reach as the amount entering the reach.

Subdistrict – A groundwater management subdistrict of the Rio Grande Water Conservation District or the Trinchera Water Conservancy District.

Turbidity – The measure of relative clarity of a liquid.

Wet meadow – A type of wetland characterized by soils that are saturated for part or all of the growing season.

Acronyms

303(d)	The 303(d) list of impaired waters in Colorado (defined by the Colorado Department of Public Health and Environment)
AA	Targeted Assessment Area (see Riparian Vegetation Assessment)
AF	Acre-feet
AW	American Whitewater
Basin	Rio Grande Basin
BLM	Bureau of Land Management
BMI	Benthic Macroinvertebrates
CDPHE	Colorado Department of Public Health and Environment
CFS	Cubic feet per second
CNHP	Colorado Natural Heritage Program
CPW	Colorado Parks and Wildlife
CWCB	Colorado Water Conservation Board
DEM	Digital Elevation Model
EIA	Ecological Integrity Assessment
FQA	Floristic Quality Assessment
GIS	Geographic Information System
ISF	Instream Flow
M&E	Monitoring and Evaluation List
MMI	Multi-Metric Index (see Aquatic Life Assessment)
NRCS	Natural Resources Conservation Service
RGDSS	Rio Grande Decision Support System
RGHRP	Rio Grande Headwaters Restoration Project
SLV	San Luis Valley
SMP	Stream Management Plan
SWE	Snow Water Equivalent
SWRF	Source Water Route Framework
TAT	Technical Advisory Team
TMDL	Total maximum daily load
URGWA	Upper Rio Grande Watershed Assessment
USFS	United States Forest Service
USGS	United States Geological Survey

Contents

1. Introduction

1.1 Purpose and Scope

The 2015 Colorado Water Plan set a goal that 80 percent of locally prioritized rivers be covered by stream management plans (SMPs) by 2030. Following publication of the Water Plan, the Rio Grande Basin Roundtable (Roundtable) recognized the need for comprehensive assessments and management plans for locally prioritized streams in the Rio Grande Basin. To help meet this need, a subcommittee of the Roundtable selected three priority stream segments for an initial round of SMPs. The SMP subcommittee prioritized the following stream segments: 1) The Rio Grande from Stony Pass to the Colorado state line (191.3 river miles), 2) Conejos River from Platoro Reservoir to the Rio Grande confluence (84.4 river miles), and 3) Saguache Creek from the South Fork Saguache Creek confluence to Braun Bridge (65.7 river miles). A map of the prioritized streams is shown in Figure 1.1.

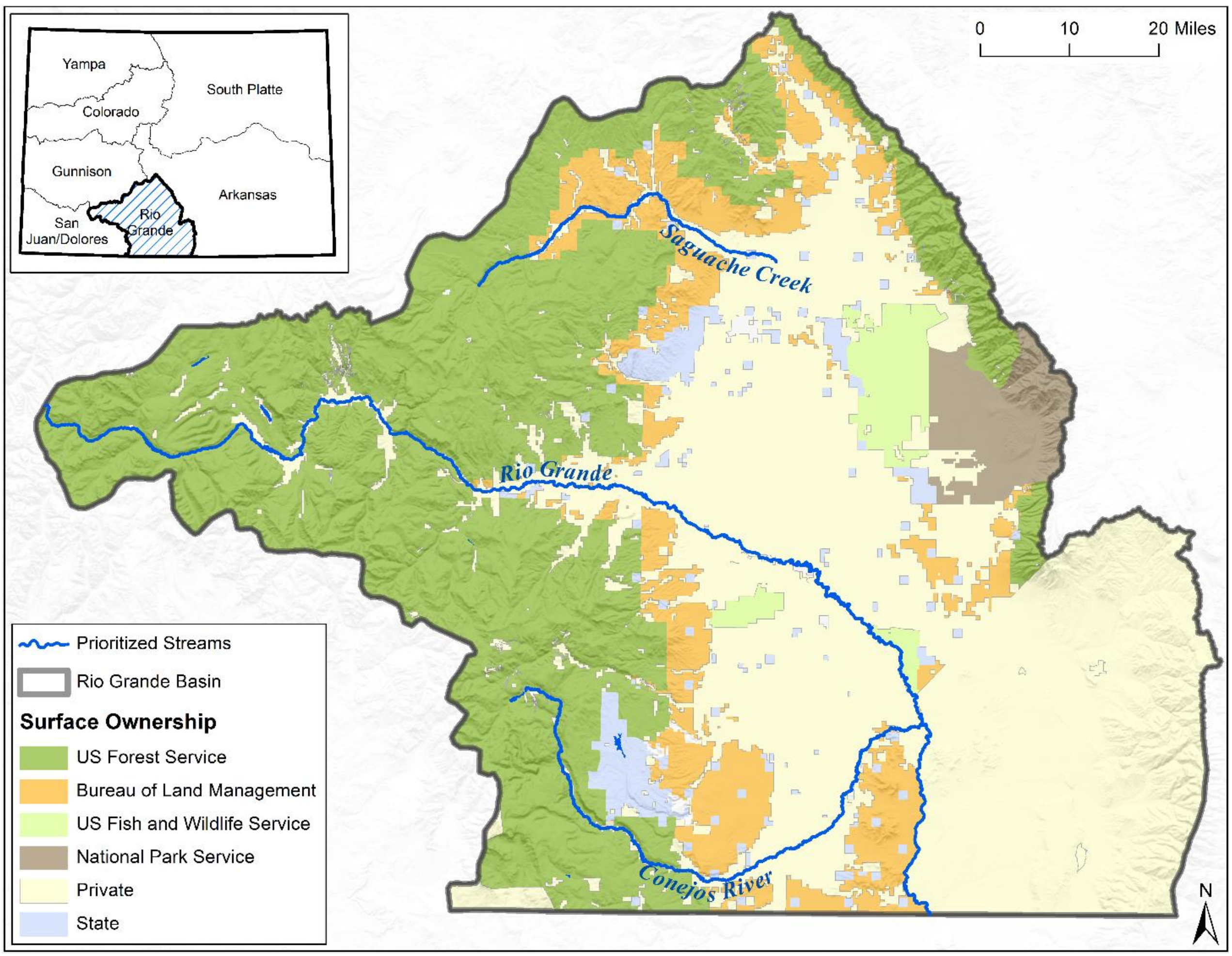


Figure 1.1: SMP prioritized streams with land ownership overlaid and delineation of Rio Grande Basin boundary.

To support the project, a SMP Technical Advisory Team (TAT) was formed and composed of state and federal agency officials, local water managers, nonprofit organizations, private landowners, and interested stakeholders. The TAT was instrumental in guiding data collection and the overall direction of the SMPs. The purpose of the Rio Grande, Conejos River, and Saguache Creek SMPs is to assess stream conditions to enable local stakeholders to develop informed and data-driven management actions with the goal of preserving and enhancing water uses and community values. The SMPs are intended to be used as guides for effective and multi-benefit restoration and stream management projects.

Although multiple studies have been conducted on the Rio Grande in Colorado, the Roundtable and TAT recognized a need to better understand the condition and function of streams in the Rio Grande Basin. Previous studies documenting the condition of the Rio Grande include the 2001 Rio Grande Headwater Restoration Project, the 2016 Rio Grande Natural Area River Condition Assessment, and the 2018 Upper Rio Grande Watershed Assessment (MWH, 2001; Riverbend Engineering, 2016; SGM & Lotic Hydrological, 2018). However, a study covering the entire Rio Grande in Colorado with consistent methodology had not been completed, and data for the Conejos River and Saguache Creek was particularly limited. The Roundtable recognized that a comprehensive study of these three prioritized streams was needed. The Rio Grande, Conejos River, and Saguache Creek SMPs address that need.

1.2 Project Objectives

The objectives of the Rio Grande, Conejos River, and Saguache Creek SMPs were to:

- Maintain and build on the coalition of community partners engaged in stream management planning through frequent and robust stakeholder engagement throughout the project.
- Summarize and obtain information regarding the biological, hydrological, and geomorphological condition of identified stream reaches in the Rio Grande watershed.
- Define and prioritize environmental, recreational, and community values.
- Develop goals to improve flows and physical conditions needed to support values.
- Outline actions to achieve measurable progress toward maintaining or improving goals.
- Identify opportunities and constraints for implementation of projects, and additional data needed to inform project development.

1.3 Why are Stream Management Plans Important?

SMPs offer a valuable opportunity for communities to address issues related to stream functions in an effort to better support diverse groups of water users. They provide the opportunity to assess stream conditions and function, identify likely stressors adversely affecting these conditions, and develop multi-objective solutions to mitigate stressors and improve conditions. Because SMPs are stakeholder-driven, diverse community values are represented in decision making and the development of goals and priority actions. Strong stakeholder interest and support provided the impetus for the Rio Grande, Conejos River, and Saguache Creek SMPs and contributed significantly to the success of each SMP.

1.4 Stakeholder Engagement

A diverse group of stakeholders utilize and are intimately connected to the Rio Grande, Conejos River, and Saguache Creek. Irrigated agriculture has a rich history on the basin, having utilized surface water from the Rio Grande for over 150 years. Agricultural producers depend on surface water to irrigate crops during the growing season, and many farms and ranches are now operated by the fourth and fifth generation producers. Anglers have access to exceptional Rio Grande, Conejos River, and Saguache Creek sport fisheries. Recreational boating opportunities are also plentiful, with commercial and private boaters floating the Rio Grande and Conejos River. Not least, San Luis Valley residents enjoy and take pride in the aesthetic value of the streams and rivers flowing through the region.

To engage stakeholders and gather input, significant outreach was conducted throughout the SMP process. Regular email updates were sent to a SMP stakeholder listserv, individual and group meetings were held, and the SMP Project Coordinator presented regularly to the Roundtable and several other stakeholder groups. A summary of stakeholder engagement activities is detailed below:

- Provided regular project updates via the SMP email listserv.
- Held six TAT meetings to discuss stream conditions assessment methodology, assessment results, and project goals/priority projects. Resources from TAT and public meetings including minutes, handouts, and presentations were published on the Rio Grande Headwaters Restoration Project website.
- Held five public community meetings in summer 2019. Each meeting was specific to one of the three SMPs. Public meetings were advertised in the Valley Courier, Saguache Crescent, Conejos County Citizen, Del Norte Prospector, Monte Vista Journal, and through the SMP listserv and several Facebook groups. Meetings were also advertised on KSLV and KRZA radio stations.
- Provided regular updates for the following groups: Rio Grande Basin Roundtable, Rio Grande Water Users Association, Conejos Water Users Association, Saguache Creek Water Users Association, San Luis Valley Wetland Focus Area Committee, and the boards of the Rio Grande Headwaters Restoration Project, San Luis Valley Water Conservancy District, Rio Grande Water Conservation District, and the Conejos Water Conservancy District.
- Presented to several other interested groups including the Colorado Agricultural Water Alliance and the San Luis Valley Cattlemen’s Association.
- Published an online ArcGIS “Story Map” outlining the Stream Management Plans.
- Distributed three public SMP stakeholder surveys, one for each SMP.
- Coordinated with American Whitewater to distribute a “boatable days” survey, which informed the recreational use assessment study on the Rio Grande and Conejos River.
- Completed significant outreach to and held meetings with many individual landowners.
- Held meetings with water commissioners for each SMP.

- Held special meetings with state and federal agencies including Colorado Parks and Wildlife (CPW), U.S. Fish and Wildlife Service (USFWS), Bureau of Land Management (BLM), and U.S. Forest Service (USFS).

Individual responses and themes resulting from the surveys, as well as feedback and input from formal and informal meetings, were incorporated into the planning process. The community values identified during this process include:

- Diversion infrastructure improvements to increase efficiency, reduce maintenance, and promote stream health.
- Maintaining and enhancing riparian areas.
- Maintaining adequate streamflows for aquatic habitat, overall stream health, agriculture, and recreation. This includes coordinated reservoir releases and consistent flows for fishing and boating on the Rio Grande to support recreation and the local economy.
- Increased storage to augment flows and increase flexibility during dry years (e.g., reservoirs)
- Removal or mitigation of boating hazards (fencing, diversions, bridges, etc.).
- Improved infrastructure for sustainable recreational access to the river (e.g., boat ramps in Alamosa, South Fork, etc.)
- Riparian and aquatic habitat connectivity and agriculture viability through conservation easements and other strategies.
- Protecting and restoring floodplain connection and wet meadows and other wetlands for increased alluvial aquifer storage.
- Improving overall stream health for imperiled species, including fish and riparian habitat restoration.
- Additional monitoring data on water quality, irrigation infrastructure, and streamflows.
- Mitigating effects of flooding and debris flows (i.e., addressing severe bank erosion, particularly near key infrastructure).

1.5 Physiographic and Geologic Setting

Regional geologic and climatic history play important roles in fluvial geomorphology, which largely shapes the streams and rivers we see today. For the purposes of the SMPs, the physiographic context of a study area is defined by the dominant geologic and climatic conditions that define the modern landscape, which influence the study streams' form and associated physical processes.

The Upper Rio Grande Basin (Basin) in south-central Colorado covers 7,630 square miles and is bordered to the south by New Mexico. Within the Basin lies the San Luis Valley (SLV), a high elevation intermountain valley situated between two major mountain ranges. The SLV is a large rift valley in the Southern Rocky Mountains Province (Figure 1.2) and is part of the larger Rio Grande rift which extends from north of the SLV near Leadville, Colorado to southern Mexico (Bachman & Mehnert, 1978).

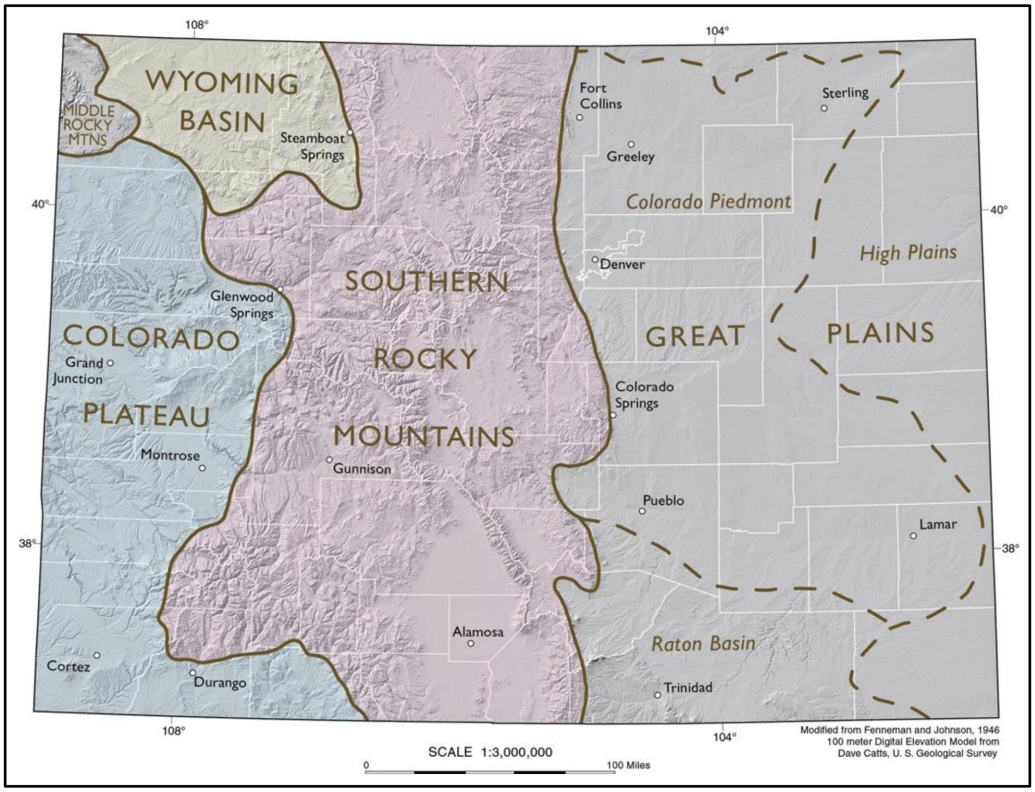


Figure 1.2: Physio-geographic regions of Colorado (source: Colorado Geological Survey website).

The geology of the Southern Rocky Mountains Province is dominated by Precambrian igneous and metamorphic rocks uplifted and exposed during mountain building events. The last major event, the Laramide orogeny, ended approximately 70 million years ago and was largely responsible for building the San Juan Mountains. The Sangre de Cristo Mountains bound the SLV on the east, while the eastern San Juan Mountains form the western edge of the valley. The La Garita Range, which lies on the northwest edge of the valley and on the north end of the San Juan Mountains, was formed from volcanism and tectonics. The La Garita Range forms the headwaters of Saguache Creek, which also drains the Cochetopa Hills to the north. The La Garitas and eastern San Juans contribute to the Upper Rio Grande Watershed while the south-eastern San Juans make up the headwaters of Conejos River. Much of this area was influenced during the Paleocene (approximately 60 million years ago) by the La Garita super-caldera eruption, one of the largest known volcanic eruptions in Earth's history.

Generally speaking, the La Garitas are less steep than the San Juans and drain lower elevations. Significant glaciation was not noted to have occurred in the headwaters of Saguache Creek. The valley in which Saguache Creek lies is bound by lava and ash deposits. Near the town of Saguache, the Creek escapes onto the broad Alamosa Basin, an alluvial basin which makes up the north end of the Rio Grande Rift Valley (Figure 1.3). Alternating layers of sand, gravel and clay compromise the Alamosa alluvial basin. This material was transported and deposited by fluvial processes that fan material out onto the valley floor as well as by shallow water bodies where clay layers would have formed.

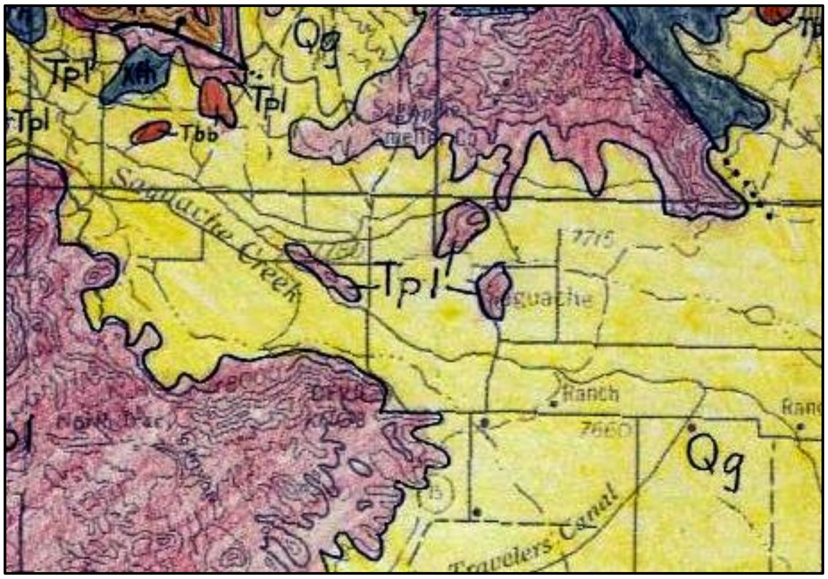
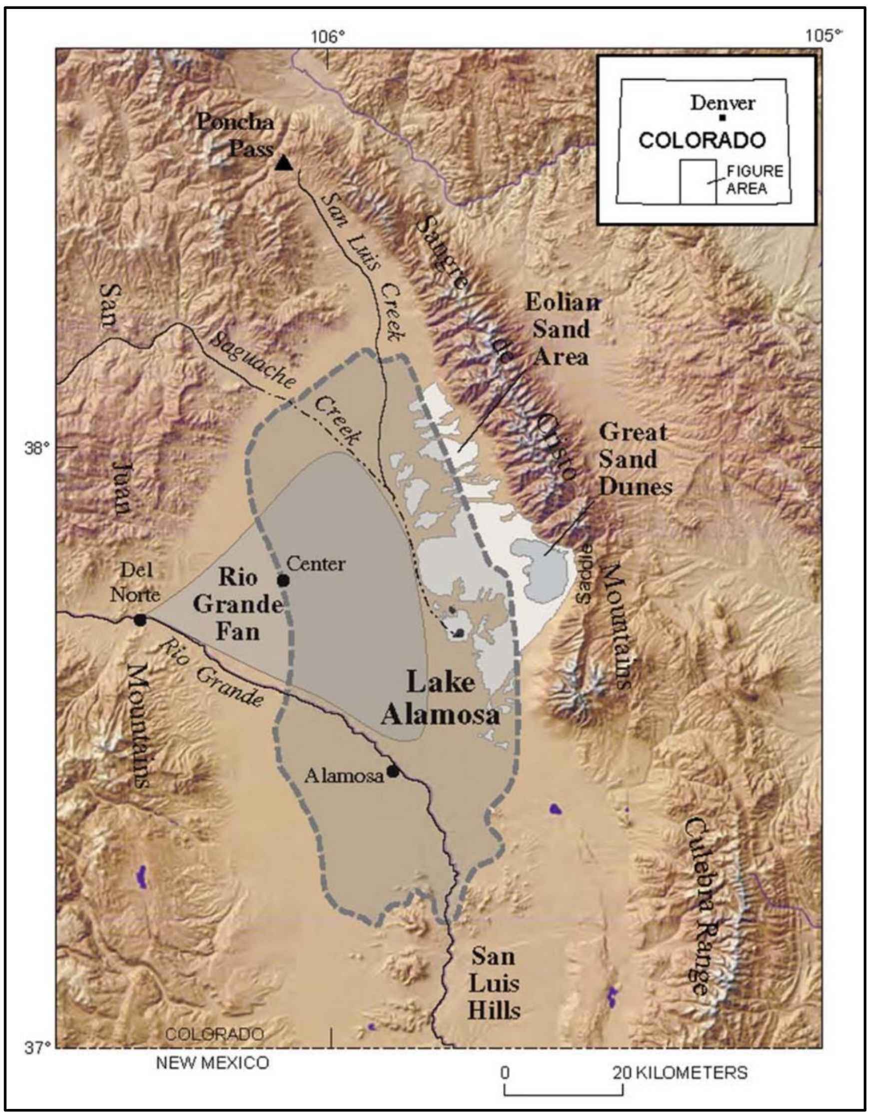


Figure 1.3: Simplified geologic map of the lower portion of the Saguache Creek study area. Qg (yellow) indicates alluvium; Tpl (light purple) indicates pre-ash flow andesitic lavas and breccias (volcanic origin).



Conversely, both the Rio Grande and Conejos River headwaters were heavily glaciated. Sediment excavated and deposited by glacial movement and melt as recently as 10,000 years ago still exists throughout the canyons and within the floodplains of the Rio Grande and Conejos River. Sediment and runoff contributions from glacial meltwater contributed to large alluvial fan formations where the streams break free from the San Juan foothills and spill onto the Rio Grande rift valley floor (Figure 1.4).

Figure 1.4: Map showing the generalized location of the Rio Grande Fan which covered over the ancient lakebed sediments of Lake Alamosa (Madole et al., 2008).

The Rio Grande, Conejos River, and Saguache Creek drain east out of the mountains and into the SLV. On the northern end of the SLV, Saguache Creek and other streams drain into a high altitude subbasin known as the San Luis Valley Closed Basin (Closed Basin), also referred to as the Alamosa Basin (Upson, 1939). The Closed Basin is endorheic, meaning its surface waters do not flow outside its boundaries and therefore are not tributary to the Rio Grande. Within the Closed Basin, streams draining the La Garita and Sangre de Cristo Ranges on the west and east sides of the valley, respectively, terminate in low points, or sump areas, forming numerous Inter-Mountain Basin Playas. The lowest elevation playa complex in the Closed Basin is San Luis Lakes, located just west of the Great Sand Dunes. The southern boundary of the San Luis Valley Closed Basin is thought to be formed by a low hydrologic divide resulting from the Rio Grande alluvial fan on the west and alluvial material from the Sangre de Cristo Mountain on the east (Alstine & Simon, 1982). The Closed Basin covers approximately 2,940 mi^2, making up about 39% of the Rio Grande Basin, shown in Figure 1.5.

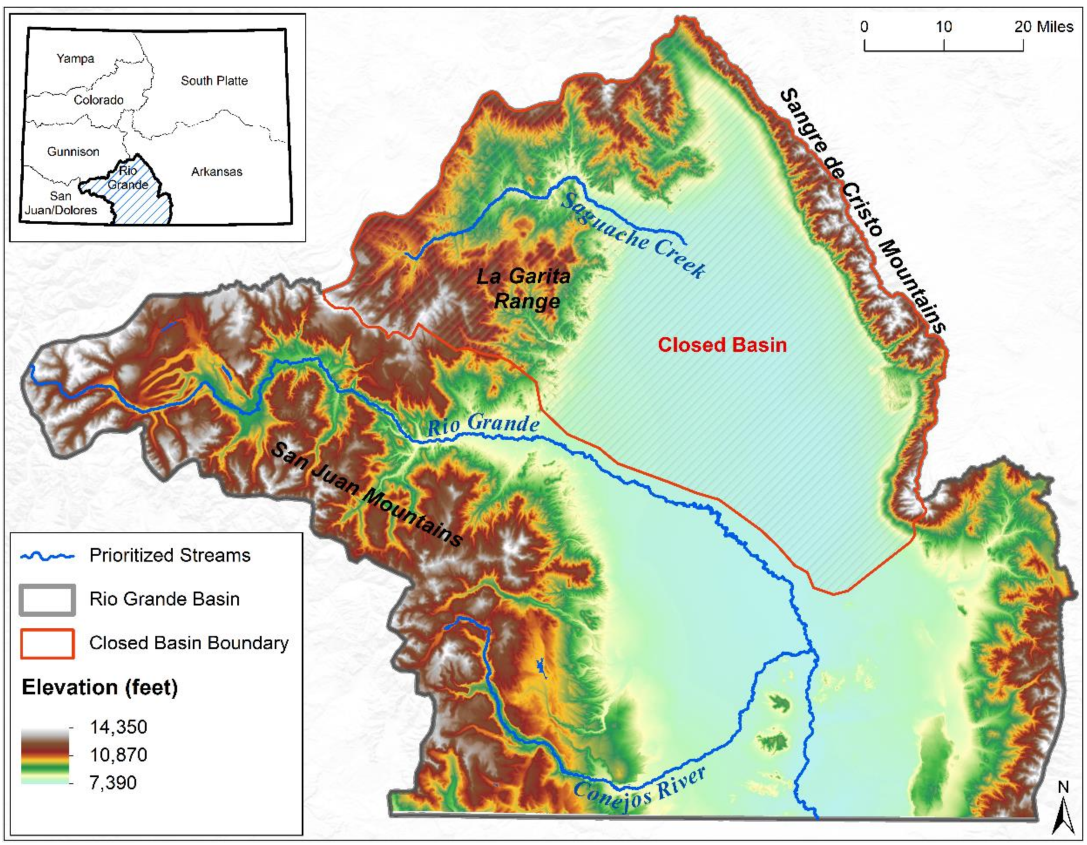


Figure 1.5. Prioritized streams in the Rio Grande Basin with elevation, major mountain ranges, and delineation of the Closed Basin boundary.

The Rio Grande is the largest river in the Rio Grande Basin in Colorado, both in terms of annual flow and river miles. It is a diverse river, starting in once-glaciated mountain valleys, spilling out onto a broad and ancient alluvial fan, and then following a rift in volcanic rock as it turns south into New Mexico. The river flows from its headwaters at Stony Pass, a high alpine mountain pass in the San Juan

Mountains (37°47'42.72"N, 107°32'55.12"W), downstream to the Colorado - New Mexico state line (36°59'43.84"N, 105°43'4.59"W). This entire segment, totaling 191.3 miles, is included in the Rio Grande SMP.

From its high alpine headwaters on the Continental Divide (approximately 12,600 ft), the Rio Grande flows east to Rio Grande Reservoir. From the reservoir, the river continues flowing east through narrow alluvial valleys of the San Juan Mountains, bounded by rock of volcanic origin. Near the Town of South Fork, the river passes through foothills toward the San Luis Valley. At the Town of Del Norte, it spreads out onto a broad alluvial fan and continues east, meandering through the SLV. At the City of Alamosa, the river reaches the Rio Grande rift and turns south toward New Mexico. It eventually crosses the Colorado state line at approximately 7,390 ft where it follows a fault through a box canyon. The total watershed area of the Rio Grande at the downstream end of the study area is 7630 mi^2.

The Conejos River begins near the Continental Divide at Lake Ann. The river flows northeast before reaching Platoro Reservoir and the town of Platoro (approximately 11,925 ft). From the reservoir, it flows southeast through the San Juan Mountains, meeting the San Luis Valley near the Town of Mogote. From Mogote, the river flows northeast to its confluence with the Rio Grande near Lasauses, CO. Saguache Creek is located in the northwest corner of the San Luis Valley floor. The Creek begins at a series of small lakes in the La Garita Wilderness. It flows northeast before reaching a wide alluvial fan upstream of the Town of Saguache, where it turns southeast. The Creek then flows past Saguache and into the Closed Basin on the northern end of the SLV, where it terminates in wetlands and playa lakes.

1.6 Hydrologic Context

Hydrology plays a fundamental role in channel form, riparian areas, water quality, and aquatic life. The timing and magnitude of streamflow is a driver of geomorphic "work" in stream channels (i.e., more water in the system means more work being done to mobilize and transport sediment in the system, affecting stream channel and floodplain morphology). These hydrologic processes also affect the establishment and maintenance of riparian vegetation, water quality parameters, and the type and abundance of aquatic life. Surface hydrology in Colorado's Rio Grande Basin is characterized by high flows during spring runoff lasting into early summer, and significantly lower (base) flows in late summer, early fall, and winter. The SMP study streams are snowmelt-driven, with the vast majority of water production occurring in the form of snow. These characteristics are illustrated by the hydrograph in Figure 1.6, showing average daily flows at the Rio Grande near Del Norte gage from 1890 to 2017.

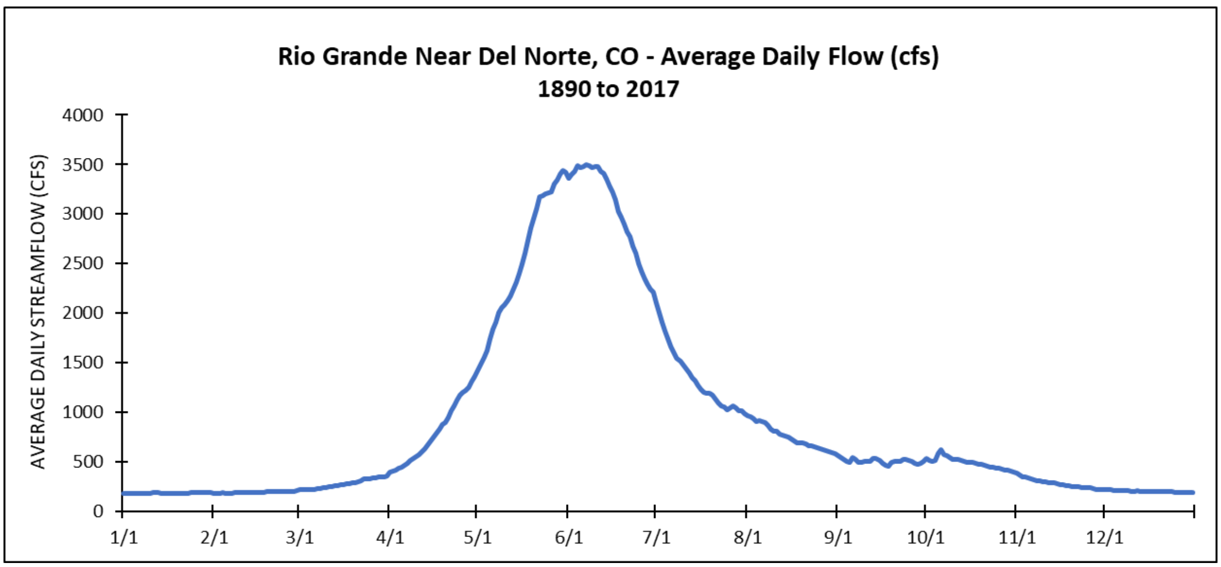


Figure 1.6: Average daily streamflow at the Rio Grande Near Del Norte, CO (RIODELCO) gage – 1890 to 2017.

Monsoon season typically results in sufficient precipitation to increase flows again in mid- to late-summer. Flooding from both snowmelt runoff and small-scale convective rainfall events during the monsoon are common mechanisms for high water events in the SMP study streams (Figure 1.7). Though rare in the period of record, extreme events have been observed to occur on streams draining into the SLV from the San Juan Mountains. Localized flash floods are likely to occur on tributary streams, which may cause the mainstems to swell, but more likely influence the streams by bringing fresh sediment down to the valley bottom and supplying the channels with material (Figure 1.7).

Saguache Creek does not have considerable upstream water storage facilities (dams and reservoirs) or flow regulation, so flows are more likely to fluctuate depending on available runoff in the watershed. The Rio Grande and Conejos River both have water storage reservoirs in their headwaters, which have reduced peak flows and thus the frequency with which geomorphically significant flows pass through the channels and floodplains. In all the study streams, numerous diversion structures influence flows by withdrawing water, but not typically enough to significantly alter the geomorphic condition or trajectory of the study reaches. However, these diversions change the frequency in which floodplains are inundated and bed sediments are mobilized.

Figure 1.7: Left: Snowmelt runoff doing geomorphic work on the Rio Grande floodplain, June 2019. Right: Sediment washed down from a small watershed that feeds a tributary to Saguache Creek (Photo: Round River Design, LLC).

In the “plains” reaches of the San Luis Valley, relatively impermeable clay layers connect the contributing streams to the relatively shallow aquifer that sits on top of these clay layers. Until as recent as the 1970s, the Alamosa Basin in the northern part of the San Luis Valley was naturally endorheic with water only escaping through evapo-transpiration of which the endpoint was a playa adjacent to the Great Sand Dunes. Modern water engineering projects have created some transfer of water out of the basin and into the Rio Grande watershed. In any event, the shallow depth to clay creates a situation where flooding can occur from water percolating up from below when the shallow aquifer is saturated (as opposed to flooding only occurring from over-topping of streambanks). The shallow depth to water in portions of the study area creates naturally abundant wetlands (Figure 1.8).

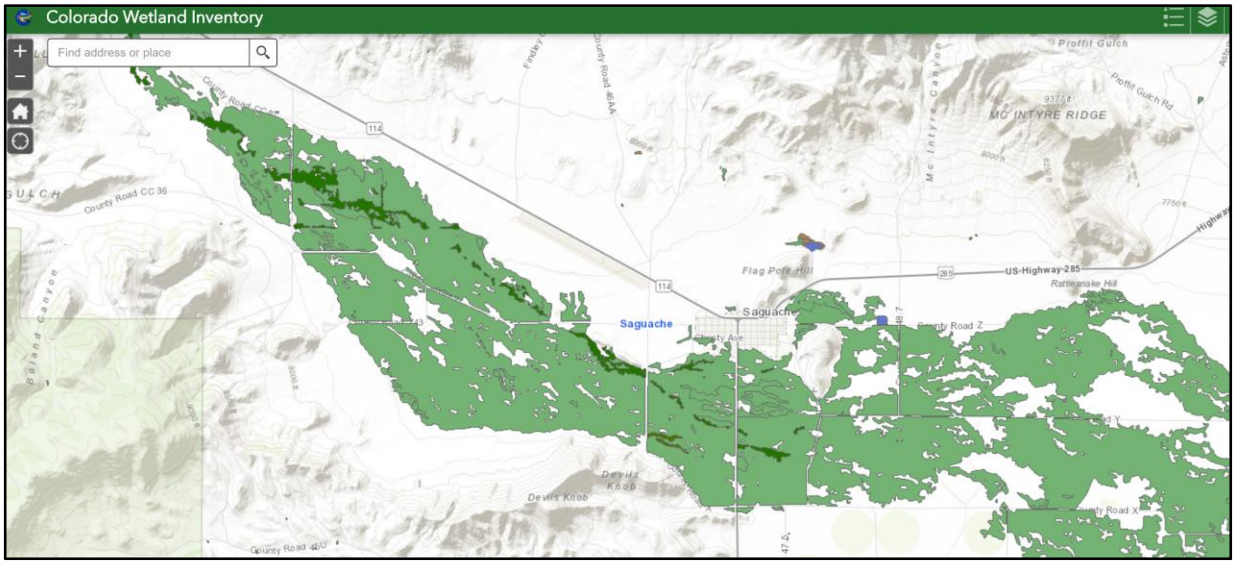


Figure 1.8: Wetlands map showing that much of the valley floor of Saguache Creek is sub-irrigated. Source: Colorado Wetland Inventory Mapping Tool (CNHP, 2019).

Temporal Trends in Rio Grande Hydrology

Generally speaking, average annual streamflow of the SMP study streams has been in decline since the 1930s (Figure 1.9) and winter and spring season temperatures have increased in the Rio Grande Basin (Chavarria & Gutzler, 2018). Recent climate modeling suggests this trend of decreasing annual precipitation and streamflow in the Rio Grande Basin will continue in the future (Lukas et al., 2014).

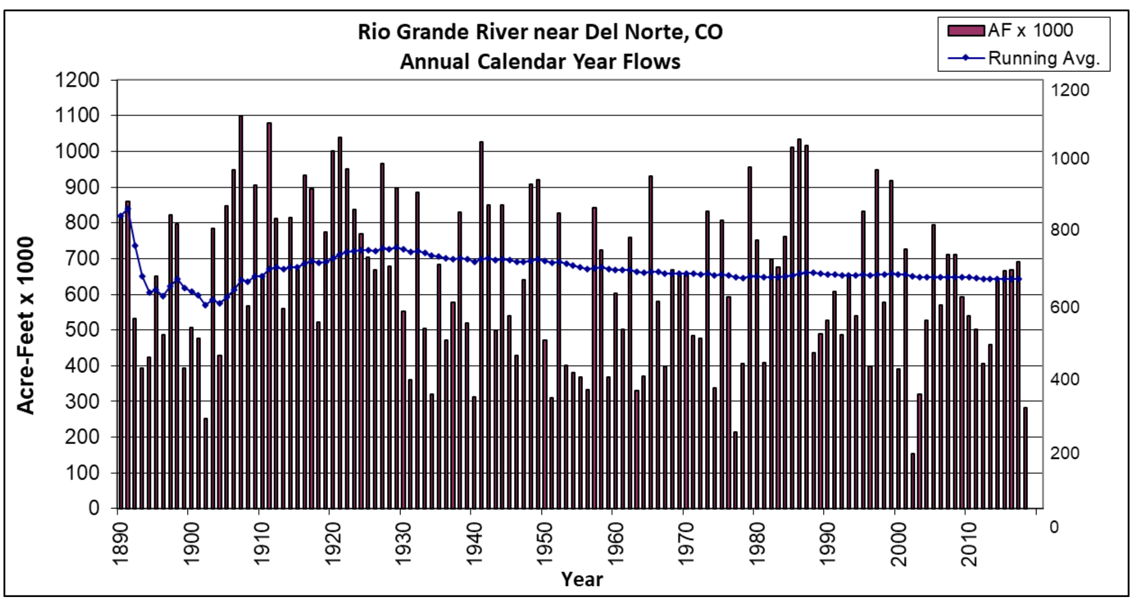


Figure 1.9: Annual flows (acre-feet x 1000) at the Rio Grande Near Del Norte, CO gage, illustrating downward trend in average annual flow (Source: Colorado Division of Water Resources).

In addition, compared to historic hydrology (viewed here as 1950 to 1997), the timing and peak of spring snowmelt and runoff has shifted in the last 20 years. Rio Grande peak runoff has, on average, decreased 5.7% and shifted ten days earlier, from June 4th to May 25th. To help illustrate this shift, Figure 1.10 compares average daily streamflow at the Rio Grande Near Del Norte gage from 1950 to 1997 to the average daily flow from 1998 to 2018.

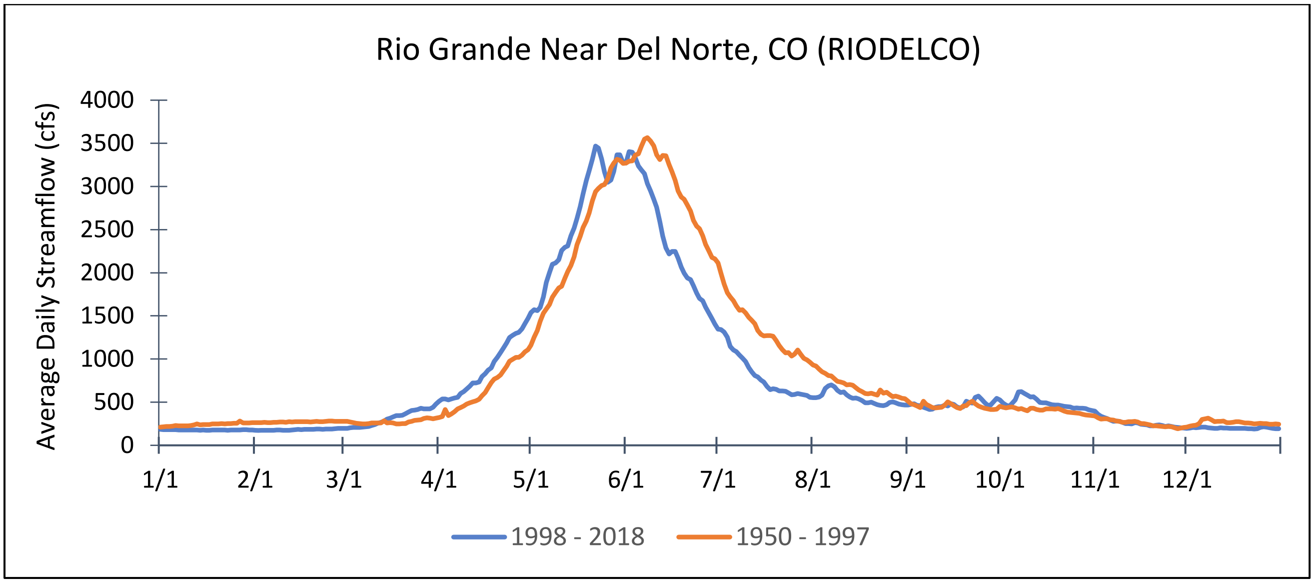


Figure 1.10: Comparison of average daily flows at the (RIODELCO) stream gage.

Studies suggest these changes in peak runoff can be attributed to a combination of lower Snow Water Equivalent (SWE), a warming trend in spring temperature, and increased solar absorption caused by dust-on-snow events (Clow, 2010; Stewart et al., 2004; Lukas et al., 2014). Research by Chavarria and Gutzler (2018) showed April 1 SWE decreased approximately 25% across the Rio Grande Basin between 1958 and 2015. Although average peak runoff has decreased, recent increases in dust-on-snow events can result in significantly earlier and *higher* peak runoff. Figure 1.11 illustrates this phenomenon at the Rio Grande Near Del Norte gage following a 2009 dust-on-snow event in the San Juan Mountains.

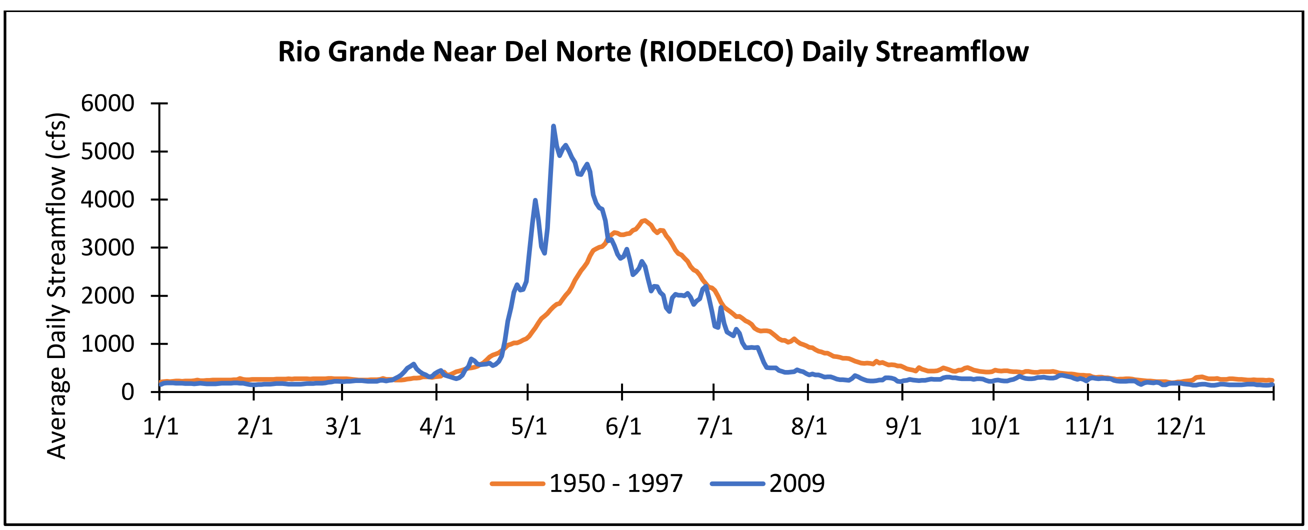


Figure 1.11: 2009 average daily flow at the RIODELCO gage following a dust-on-snow event plotted with 1950 to 1997 average daily flow.

As peak runoff continues to occur earlier in the spring, late summer flows are also predicted to decrease, as seen in the Figure 1.11. Furthermore, climate projections indicate that more precipitation will likely shift from snow to rain. One study showed the extent of snow-dominated land area within the upper Rio Grande Basin could decrease from 65% to 36% by the mid-21st century (Klos et al., 2017). Because the Basin's hydrology is primarily snowmelt-driven, this shift from snow to rain will have significant impacts on natural flow regimes. For example, increased precipitation in the form of rain paired with higher air temperature will increase the rate of evapotranspiration, resulting in less water reaching streams and contributing to streamflow. Studies also suggest this shift will cause less predictable, "flashier" streamflow and a reduction in the natural snowpack reservoir will accelerate the trends of decreasing annual streamflow, earlier peak flow, and lower late summer flow. Additionally, wildfires, tree mortality due to insects, and other forest health impacts will exacerbate these impacts. For example, vegetation loss decreases snowpack shading and increases snowmelt rates, creating a positive feedback loop (Lukas et al., 2020).

These projected changes in precipitation and hydrology may have a variety of impacts for water managers, water users, and aquatic life. Changes in the timing and amount of available water will affect agriculture, boating, fishing, and aquatic species. With less predictable flows, water managers, including reservoir operators, will be challenged to store and deliver water effectively using current infrastructure and may need to invest in additional or altered infrastructure. Farmers and ranchers are likely to have significantly less surface water available for agricultural use and groundwater recharge may decline. Aquatic species, including insects and fish, may be stressed by lower and warmer streamflow as well as a lack of adequate flows to maintain aquatic habitat. In turn, anglers and boaters are likely to have fewer recreational opportunities when flows are ideal. Many aspects of stream function, and the ecosystem services provided by those functions, may also be affected. For example, the geomorphic work performed by historic hydrology will be altered, riparian areas and flood-dependent species such as cottonwoods may no longer receive overbank flows at the same time or frequency, and water quality will almost certainly be affected. Adaptation to these effects and creative solutions to water management are critical to maintaining adequate surface water for water users and the environment.

1.7 Groundwater–Surface Water Interactions and Aquifer Storage

Groundwater-surface water interactions have been well documented across the western U.S., including in Colorado (Arnold et al., 2016; Hatch et al., 2006; Winter et al., 1998). In Colorado's Rio Grande Basin, groundwater-surface water dynamics have been extensively studied, especially as part of the Rio Grande Decision Support System (RGDSS) Groundwater Model. Although aquifer dynamics and groundwater-surface water interactions are not fully understood, RGDSS utilizes the best available data to model these dynamics, including calculations of streamflow depletions due to groundwater pumping. This section discusses the history of groundwater development in the Basin, the modeled impact of groundwater pumping on streamflows, and the conservation efforts underway to reduce groundwater withdrawals, replace injurious streamflow depletions resulting from pumping, and ultimately reach sustainable aquifer conditions.

There are two aquifers in the Basin: the confined and unconfined aquifers. The shallow, expansive unconfined aquifer is made up of sands and gravels and occupies the entire Alamosa Basin. The relatively deep confined aquifer lies beneath the unconfined and the two aquifer systems are separated by a series of blue clay layers.

The Rio Grande, Conejos River, and Saguache Creek are located within the jurisdiction of Colorado Department of Natural Resources – Division of Water Resources, Division 3 which manages all water well permits for the Rio Grande Basin. Well permit appropriations within the Rio Grande Basin withdraw unconfined and confined aquifer groundwater. Well withdrawals cause depletions to streams from which surface water right holders obtain their water supplies; the depletions to surface water rights result from the consumptive use of water withdrawn from the wells. Well development in the Basin began in the 1920s with scattered development across the Basin. Figure 1.12 shows Division 3 wells in 1930.

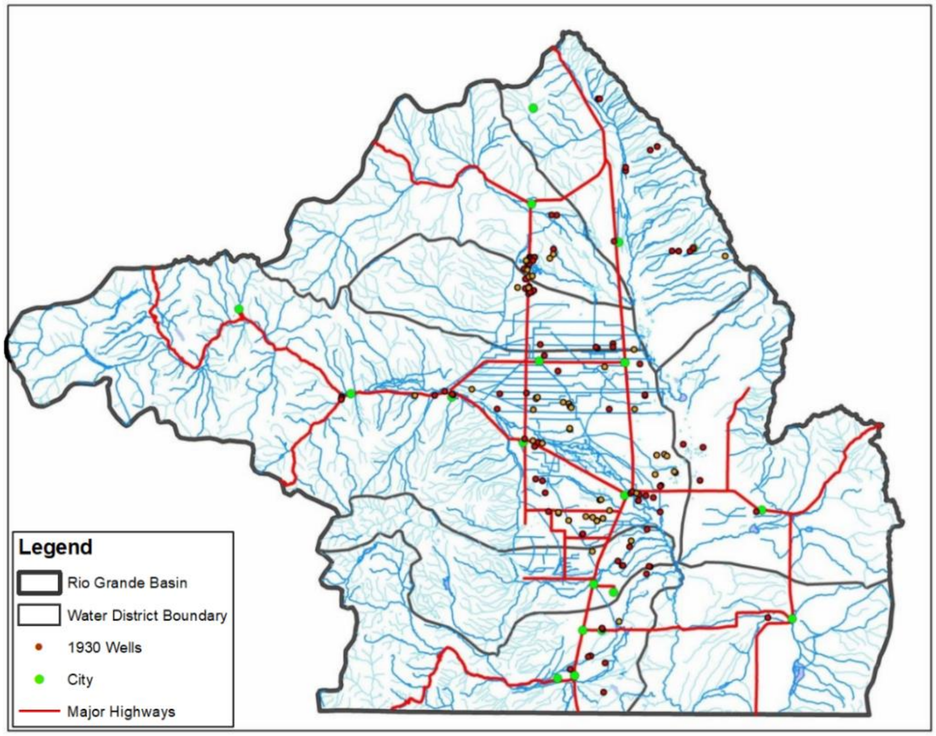


Figure 1.12: Division 3 well locations in 1930.

In the late 1930s, new well development increased significantly and by 1952 there were 1,300 wells in the Basin. By 1980, there were more than 2,300 wells. There are currently over 6,000 irrigation, commercial, and municipal wells in Division 3. Figure 1.13 shows current Division 3 wells.

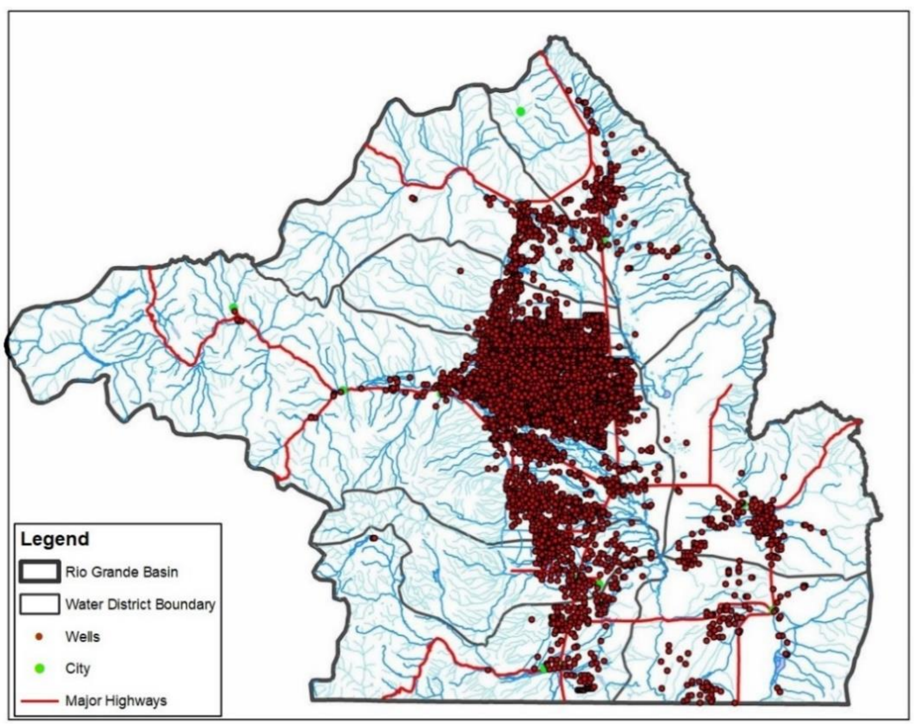


Figure 1.13: Current Division 3 well locations.

Groundwater development led to extensive groundwater use and over appropriation, eventually resulting in the need for groundwater withdrawal rules and regulations. To help inform and develop the rules, the RGDSS Groundwater Model (Model) was developed. The Model calculates flows through the confined and unconfined aquifer systems and can be used to predict stream gains/losses as a result of pumping stresses.

Surface Water Depletions

The Model shows that groundwater withdrawal can cause surface water (stream) depletions. To quantify depletions for a given stream reach, the San Luis Valley floor was divided into geographic subdivisions called Response Areas (RAs) which share broad hydrologic commonalities. The Model was then used to generate Response Functions (RFs), which describe the relationships between groundwater withdrawals and stream depletions, within each RA. RFs can be used within the Model to evaluate current and/or hypothetical changes in groundwater withdrawals such as switching off select wells. Using these spatial and temporal inputs, stream depletions caused by groundwater withdrawals can be calculated under varying conditions. Each stream with modeled depletions resulting from groundwater withdrawals in a given RA was divided into administrative reaches, shown in Table 1.1.

Table 1.1: Administrative stream reaches RGDSS Groundwater Model Response Area stream reaches.

Stream	Stream Reaches
Rio Grande	1. Rio Grande Del Norte to Excelsior Ditch 2. Excelsior Ditch to Chicago Ditch 3. Chicago Ditch to the State Line
Conejos River	1. Conejos Above Seledonia/Garcia Ditches 2. Conejos Below Seledonia/Garcia Ditches
Saguache Creek	1. Malone Ditch to Braun Bros Ditch

Modeled stream depletions from the groundwater withdrawals extend well into the future. A portion of the depletions in most RAs extend ±20 years past the current year's groundwater withdrawals. Over time, gradual refinements have been applied to the Model, typically when one or more of the modeled stresses are changed or new data is available and Model calibration refinement is applied.

Division 3 Well Rules

In 2015, the State Engineer submitted new Well Rules through the Division 3 water court system (DWR, 2015) to mitigate stream depletions, which injure senior surface water rights, and to attain sustainable groundwater levels within each RA. The Well Rules were approved by water court decree on March 15, 2019 and require all non-exempt wells to replace their calculated depletions to Rio Grande Basin streams through following a formal water augmentation plan or joining a groundwater management subdistrict (Subdistrict). Under a water augmentation plan, a water district or other entity mitigates a well's injury to senior water rights by physically replacing depletions in time, place, and quantity.

Beginning in 2006, the Rio Grande Water Conservation District began forming Subdistricts, whose boundaries are based on geologic and hydrologic characteristics of the Basin. Subdistricts are responsible for replacing the injurious stream depletions caused by groundwater withdrawal by well owners within a given Subdistrict. Each Subdistrict operates under an annual replacement plans (ARP) to replace their injurious stream depletions. They also strive to reduce well pumping in an effort to regain sustainable aquifer levels. Wells not in compliance with the Well Rules after March 15, 2021 will be curtailed by the State Engineer.

For planning purposes, the Model was run using the RFs for Subdistricts located on the Rio Grande, Conejos River, and Saguache Creek. This example was completed to estimate the amount of water that will be replaced on these streams when all Subdistricts are operating. The example included streamflow and groundwater withdrawal data from 2017 and results are shown in Table 1.2.

Table 1.2: Total depletions on each stream system in 2017.

Stream	Total Depletions - May through April (acre-feet)
Rio Grande	10,316
Conejos River	6,923
Saguache Creek	912

The 2017 example illustrates the measurable effect of well pumping on streamflows in the Rio Grande Basin. Within each Subdistrict, participating well owners are making considerable efforts to reduce overall well pumping. Through these efforts, Subdistricts are working toward aquifer sustainability and reductions in surface water depletions resulting from well pumping. As a result of groundwater users replacing depletions to streams and rivers throughout the Rio Grande Basin, streamflows are expected to increase and result in healthier, more resilient systems.

There is also potential to mitigate streamflow depletions and the associated water quality impacts through conservation and restoration activities throughout the watershed. For example, streams with active and connected floodplains support groundwater-surface water exchange within hyporheic zones, thereby buffering water temperature. Additionally, alluvial aquifer and wet meadow restoration efforts have been shown to attenuate flood flows and enhance late summer streamflow in the arid West (Hammersmark et al., 2008 & Loheide et al., 2009). These restoration techniques mitigate the risk of flooding and the damage it may cause by enabling high flows, most commonly experienced during spring runoff, to spread out onto floodplains and soak into alluvial systems. This water, stored in wet meadows and alluvial systems, is slowly released throughout the summer irrigation season, augmenting late summer and fall base flow in streams. Finally, conserving existing surface water use and protecting wet meadows, wetlands, and riparian areas also has the potential to mitigate stream depletions and aide in groundwater recharge and aquifer sustainability.

1.8 Major Reservoirs on the Rio Grande and Conejos River Systems

Reservoirs provide water storage on both the Rio Grande and Conejos River. Major reservoirs affecting the Rio Grande are "pre-Compact," which, under the terms of the Compact, means they were built before 1929, while the two reservoirs on the Conejos River are "post-Compact." Operations of post-Compact reservoirs are limited by Article VII of the Compact. Under Article VII, post-Compact reservoirs are not permitted to store water when total Rio Grande Project (downstream Compact reservoirs) storage is less than 400,000 acre-feet (Compact, 1938). This significantly limits post-Compact reservoir operations in the Basin.

Rio Grande Reservoirs

Four major reservoirs provide storage for the Rio Grande: Rio Grande Reservoir, Santa Maria Reservoir, Continental Reservoir, and Beaver Creek Reservoir. Figure 1.14 shows the locations of these reservoirs.

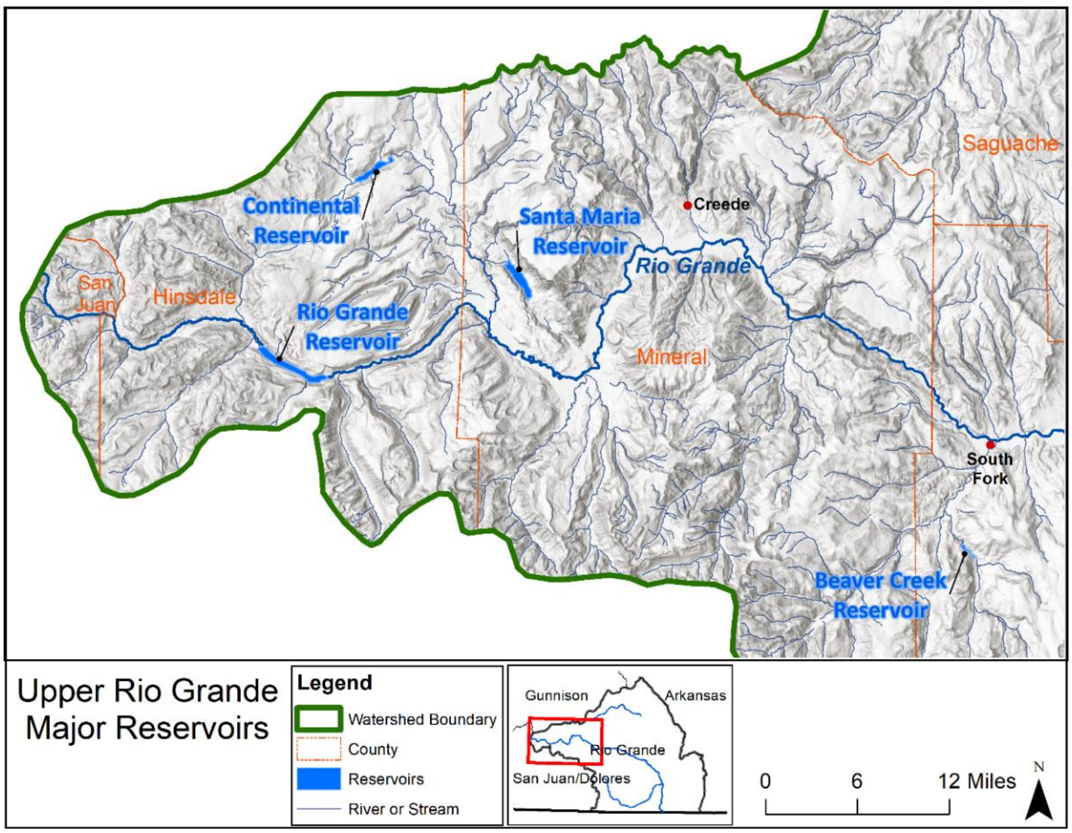


Figure 1.14: Major reservoirs in the Rio Grande watershed upstream of South Fork.

Rio Grande Reservoir is an on-channel reservoir on the Rio Grande just upstream of the Rio Grande Box Canyon. It was built in 1912 to provide water storage for farmers in the San Luis Valley Irrigation District and has a capacity of 51,113 AF. It is owned and operated by the San Luis Valley Irrigation District. Between 2012 and 2020, significant improvements were made to the dam and its outlet works to address seepage and dam safety concerns. Improvements included resurfacing the dam to prevent seepage as well as updating the outlet tunnel and adding new valves to the outlet works, which will allow the reservoir to pass high flows and eliminate leakage from the outlet. The improvements were made as part of the Rio Grande Cooperative Project and the Rio Grande Reservoir Rehabilitation Project, completed in 2020.

Continental Reservoir is an on-channel reservoir on North Clear Creek. It was built in 1928 and has a capacity of 26,716 AF. Santa Maria Reservoir is an off-channel reservoir built in 1911 with a capacity of 43,826 AF. Santa Maria Reservoir flows are released into Boulder Creek, a tributary to Clear Creek downstream of Continental Reservoir. Clear Creek joins the Rio Grande approximately 2.1 miles downstream of the Rio Grande Box Canyon. Santa Maria Reservoir and Continental Reservoir are owned and operated by the Santa Maria Reservoir Company.

Beaver Creek Reservoir is an on-channel reservoir on Beaver Creek. It was built in 1914 and has a capacity of 4,758 AF. It is owned and managed by CPW. Along with Rio Grande Reservoir, improvements were also made to Beaver Creek Reservoir as part of the Rio Grande Cooperative Project. The reservoir's spillway was rebuilt, a new abutment was constructed, and the outlet tunnel was improved to enhance outlet control and downstream flow management. Additionally, seepage issues on the dam were addressed.

All four major Rio Grande reservoirs are pre-Compact, allowing them to store during the non-irrigation season and operate with more flexibility than post-Compact reservoirs. Rio Grande, Santa Maria, and Continental reservoirs store water primarily for irrigation, Rio Grande Compact deliveries, augmentation plans, and instream replacements for Subdistricts. Beaver Creek Reservoir is primarily managed for wildlife and recreation.

Conejos River Reservoirs

Platoro Reservoir and Trujillo Meadows Reservoir, both of which are post-Compact reservoirs, provide the only significant storage in the Conejos River watershed. The Platoro dam was completed in 1951 by the Bureau of Reclamation (BOR), making it a post-Compact reservoir. The dam is an earthfill structure consisting of a main embankment and a dike section, separated by a rock knoll in which the spillway is excavated. The reservoir formed by the dam has a capacity of 59,570 AF, 6,060 AF of which are for flood control and 53,510 AF for joint use. While BOR retains ownership of the dam, operations are managed by the Conejos Water Conservancy District. The dam is situated at 10,000 ft, relatively high in the watershed.

Upper portion of Platoro Reservoir during winter (Photo: Christi Bode).

Trujillo Meadows Reservoir is located on the mainstem Rio De Los Pinos, a tributary to the Rio San Antonio, and was completed in 1957. It has a capacity of 913 AF and is managed by CPW for recreation.

1.9 Inter-State Legal Context and Surface Water Rights

History of Surface Water Rights

On the Rio Grande, the Silva Ditch holds the most senior water right and was appropriated in 1866. By the late 1800s, surface water rights from the Rio Grande (Water District 20) were fully appropriated. Water rights continued to be issued through the early 1900s, leading to an over-appropriation surface water rights. Figure 1.15 shows the relationship between cumulative absolute surface water rights versus dry, average, and wet streamflow hydrographs, as measured at the Rio Grande Near Del Norte gage. Average daily flow from the year 1985 is also shown on the graph below to illustrate an exceptionally wet year in which all water rights were in priority.

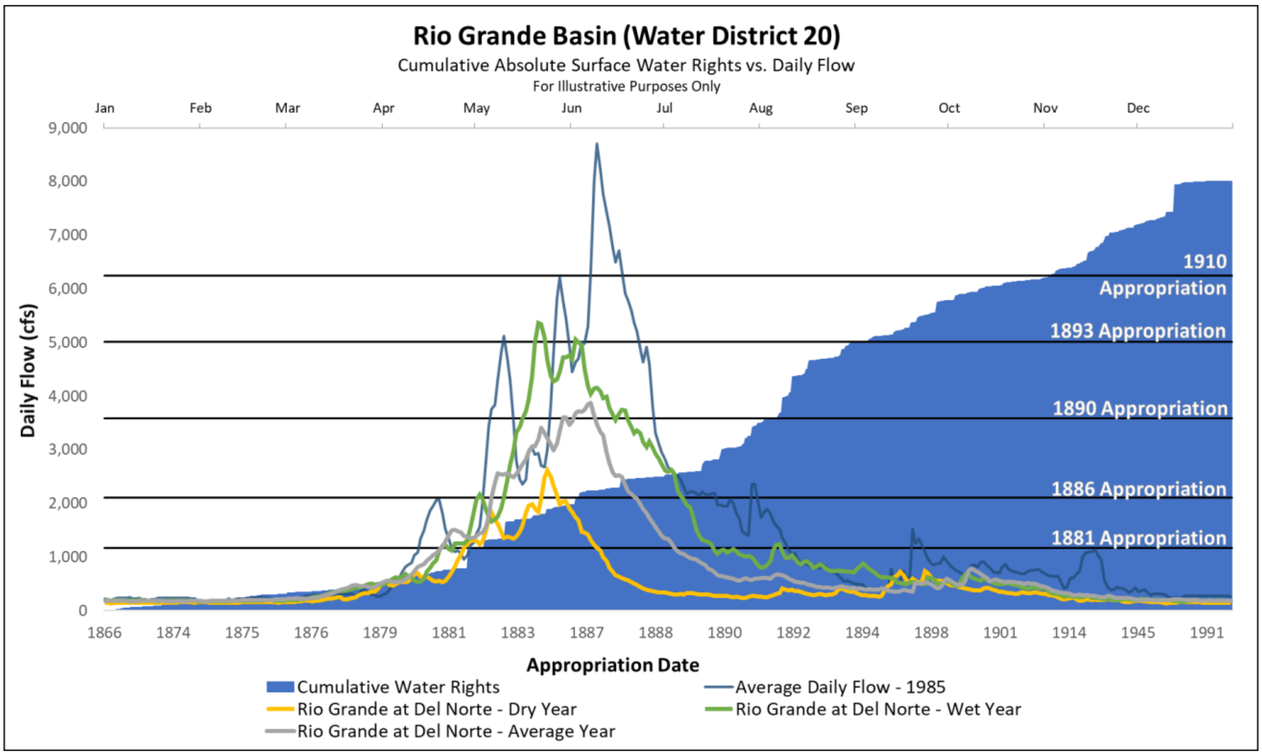


Figure 1.15: Water District 20 cumulative absolute surface water rights versus dry, average, and wet streamflow hydrographs measured at the Rio Grande Near Del Norte, CO (RIODELCO) stream gage.

Rio Grande Compact

The equitable distribution of Rio Grande waters between the United States and Mexico was established in the 1906 Convention between the two countries (Convention, 1906). In 1938, the states of Colorado, New Mexico, and Texas entered into the Rio Grande Compact (Compact). The Compact equitably apportions the waters of the Rio Grande in the U.S. and defines Colorado's delivery requirement to New Mexico along with many other aspects of management of the river. To determine baseline water supply and use, inflows at upstream gaging stations (index stations) were compared to outflows at downstream gaging stations during a study period from 1928 to 1937. Under the Compact, Colorado agreed to deliver a predetermined amount of water to New Mexico based on flows at index stream gage stations (Compact, 1938). On the Rio Grande, index flows are determined by measurements at the Rio Grande Near Del Norte, CO (RIODELCO) stream gage. On the Conejos River, index supply is measured as the sum of the Conejos River Near Mogote, CO (CONMOGCO) stream gage during the calendar year, plus the measured flows of Rio San Antonio and Rio de Los Pinos (SANORTCO and LOSORTCO, respectively) during the months of April to October. Conejos River Compact deliveries to the Rio Grande are measured as the sum of two gages, the North Channel Conejos River Near La Sauces (NORLASCO) and South Channel Conejos River Near La Sauces (SOULASCO). Saguache Creek does not have a delivery requirement under the Rio Grande Compact because it drains into the Closed Basin and therefore is not considered a tributary to the Rio Grande.

The Rio Grande Near Lobatos, CO (RIOLOBCO) stream gage is located downstream of the confluence of the Rio Grande and Conejos River as well as all surface water diversions. Therefore, it measures the combined flows of the Rio Grande and Conejos River being delivered to New Mexico (Compact, 1938). Figure 1.16 shows locations of stream gages used to measure Rio Grande Compact index and delivery flows in Colorado, while figure 1.15 shows the larger spatial extent of the international Compact.

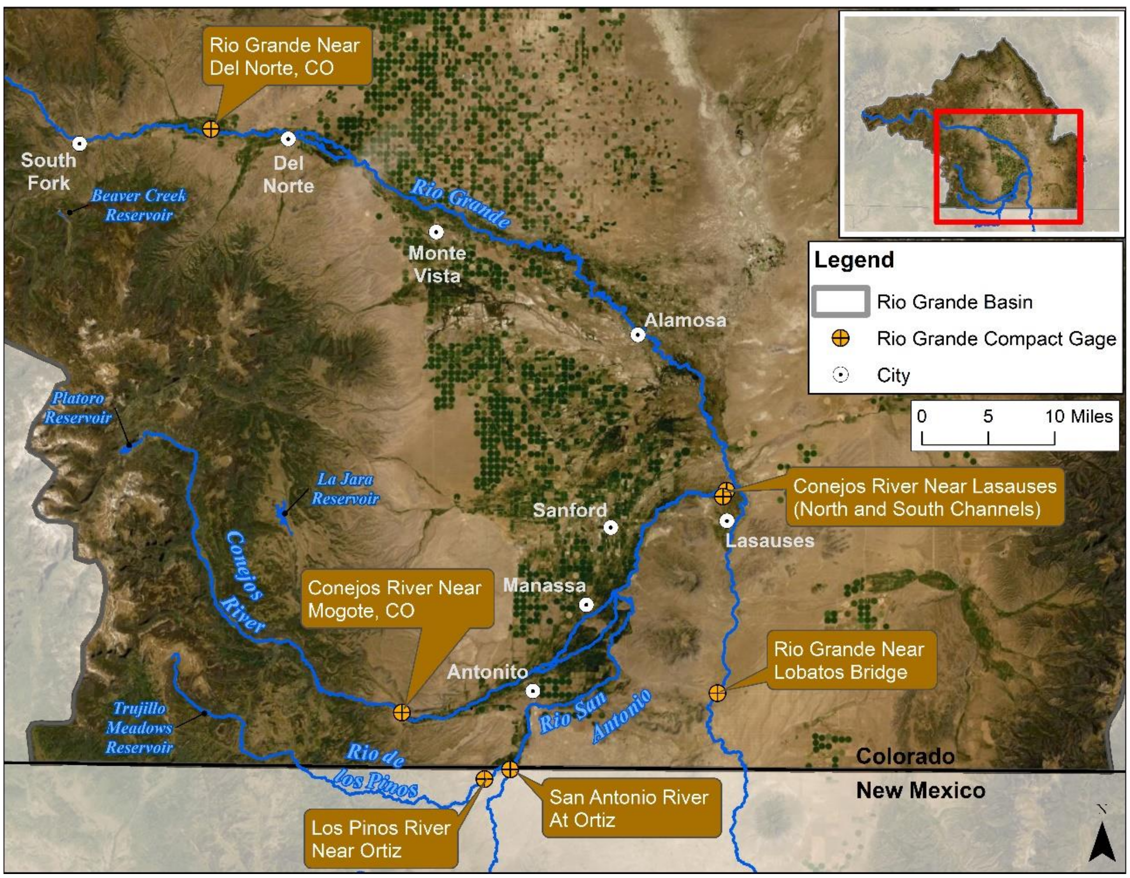


Figure 1.16: Stream gage locations used to measure Rio Grande Compact index and delivery flows.

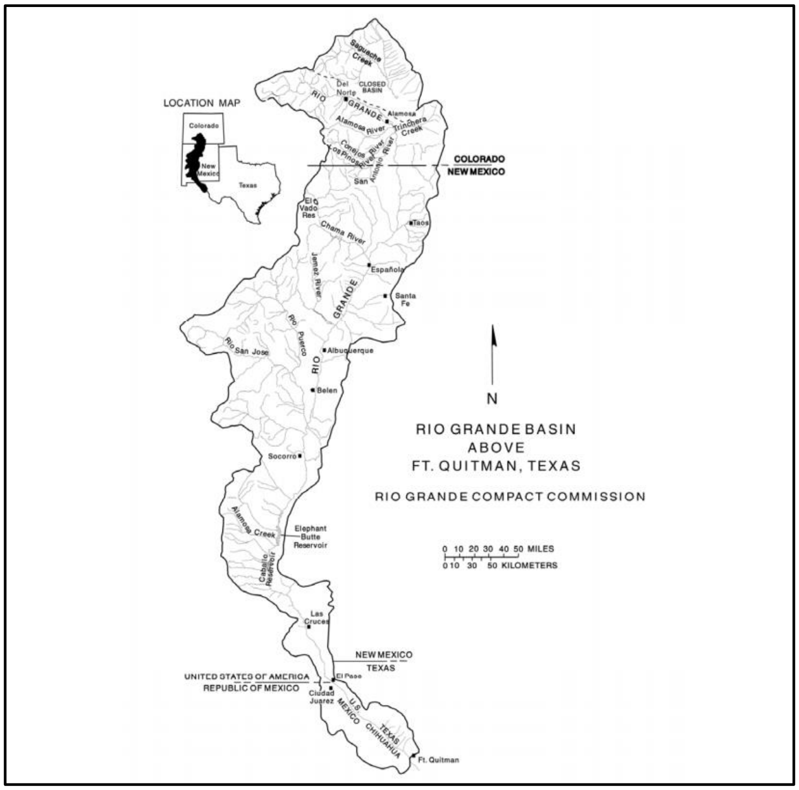


Figure 1.17: Spatial extent of the Rio Grande Compact (Rio Grande Compact Commission, 2015).

Figure 1.18 shows Rio Grande and Conejos River delivery obligations as a function of each river's annual measured index flows.

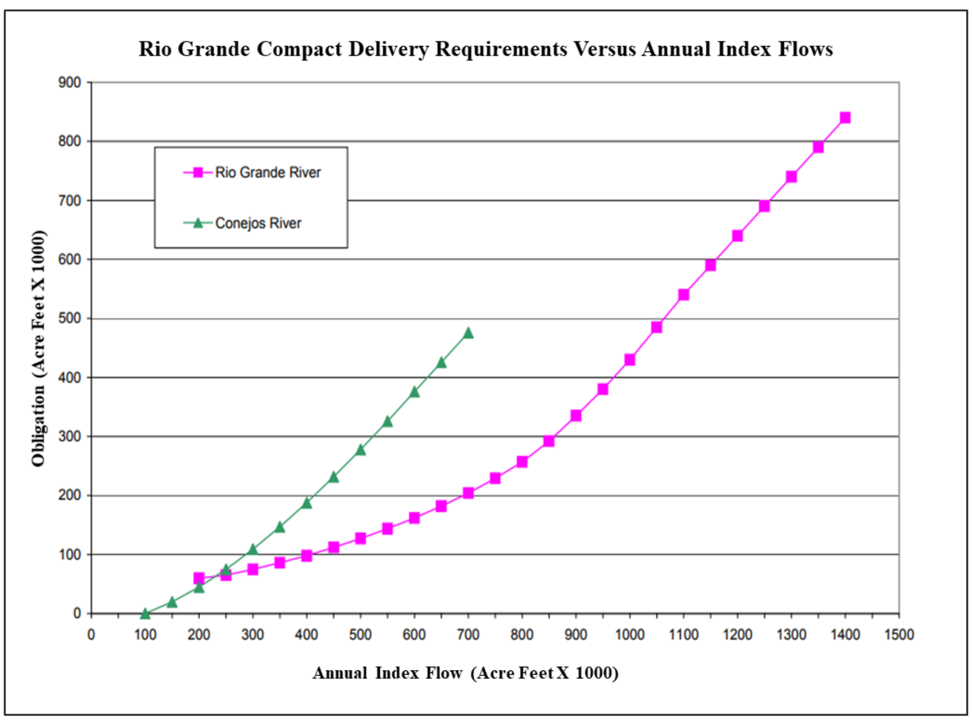


Figure 1.18: Rio Grande and Conejos River delivery obligations as a function of annual index flows under the Rio Grande Compact.

Water Rights Curtailment

Because water rights in Division 3 are over-appropriated, the Division 3 Engineer is required to curtail surface water diversions on the Rio Grande and Conejos River during the irrigation season (typically April 1 to October 31) in order to meet Compact delivery obligations (DWR, 2015). During the irrigation season, the Division Engineer estimates annual flow at the index gages using snowpack measurements, weather forecasts, and streamflow models. The Division Engineer uses the flow estimates and models to calculate total anticipated annual streamflow and flow within the winter months and the irrigation season. Because all winter flows are delivered to the state line, the Division Engineer subtracts these flows from the total anticipated delivery requirement. The remaining obligation must be met with flows produced in the irrigation season and therefore, is curtailed from irrigators. The curtailment is applied to surface water rights on a daily basis, which results in some water rights not being served. Annual index flow estimates and curtailment are updated every 10 days to reflect the most recent data. As noted above, Saguache Creek does not have a delivery requirement under the Compact. Saguache Creek water rights are administered based on prior appropriation.

2. Conditions Assessment Methods

The Rio Grande, Conejos River, and Saguache Creek SMPs utilized a reach-scale conditions assessment to assess current stream condition and function. The conditions assessment considered seven indicators of stream health and function: diversion infrastructure, recreational flow needs, aquatic habitat flow needs, geomorphology, riparian vegetation, aquatic life, and water quality. With the exception of recreational and aquatic habitat flow needs, each indicator was rated by reach using an academic rating scale. Recreational and aquatic habitat flow needs were quantified by reach but were not rated. Each indicator was assessed using two or more metrics, or subvariables, to determine an overall rating. The conditions assessment focused on identifying stressors affecting stream condition as well as opportunities to improve those conditions for environmental, recreational, agricultural, and other stakeholder uses. The assessment provides benchmark data that can be used for management decisions and can be incorporated into long-term monitoring programs. In addition, assessment findings provide an opportunity to approach restoration, conservation, and stream management planning using an interdisciplinary and multi-benefit approach.

Where appropriate, a modified version of the Functional Assessment of Colorado Streams (FACStream) 1.0 framework was utilized to rate stream health indicators by reach (Beardsley et al., 2015). FACStream is an organizational framework that uses an academic grading scale (A-F) to assess a stream condition and its degree of functional impairment as compared to reference condition. Table 2.1 shows the FACStream grading system. Each grade represents a condition class defined by the degree of functional impairment. Pristine streams having no impact score 100 (A+). A score of 50 (F-) indicates the lowest level of functioning for a reach that is profoundly impaired, but still recognizable as a feature that conveys water.

The water quality and aquatic life assessments utilized modified FACStream while other stream condition variables included in the assessment utilized slightly different methodology. Methodology for each variable is described in sections 2.3 through 2.10.

Table 2.1: FACStream functional condition rating criteria.

(blue)	A	**Reference standard**
(green)	B	**Highly functional**
(yellow)	C	**Functional**
(pink)	D	**Functionally impaired**
(red)	F	**Nonfunctional**

2.1 Reach Delineation

Each prioritized stream was divided into relatively homogenous reaches with start/end points based on significant changes in geomorphology, land use, tributary streams, and major diversion structures. The intention of reach delineation is to provide discrete spatial units for analysis. Due to the large geographic extent of the study area, some reaches include subtle changes in geomorphology that are not captured. Conditions assessment results are organized by reach within each SMP for ease of use. Reach descriptions, overview maps, photos, associated river miles, and assessment results are provided in each SMP.

River miles for each reach were calculated using the Colorado Decision Support System (CDSS) Source Water Route Framework (SWRF). The SWRF is a GIS dataset extracted from the National Hydrography Dataset and specifically developed for Colorado. The SWRF dataset contains measured route data for all named streams and rivers in Colorado. Measurements on each stream begin at its most downstream location and progress upstream to the headwaters of the stream. River mile 0 may be located at the Colorado state line (e.g., Rio Grande), at a confluence with a larger river (e.g., Conejos River), or at a stream's terminus (e.g., Saguache Creek). For example, river mile 0 on the Conejos River is defined as its confluence with the Rio Grande and the outlet of Platoro Reservoir is located at river mile 84.4. River miles represent the distance of a stream channel across a landscape. This is important to note because river miles are based on a stream or river's centerline, and therefore the calculated lengths over-represent the distance geographically of the valleys from start to endpoint.

2.2 Review of Relevant Existing Information

Existing reports, studies, datasets, and other information on stream condition were compiled for each SMP. A significant amount of existing information was gathered, particularly related to the Rio Grande, including the Upper Rio Grande Watershed Assessment, the Rio Grande Headwaters Restoration Project, and the Rio Grande Natural Area River Condition Assessment (MWH, 2001; Riverbend Engineering, 2016; SGM & Lotic Hydrological, 2018). Table 2.2 lists existing information used in the condition assessment as well as the primary information types.

Table 2.2: Summary of existing information.

Summary of Existing Information		Applicable SMP Assessments					
Report or Data Source	**Description**	**Diversion Infrastructure**	**Hydrology and Flow Needs**	**Geomorphology**	**Riparian Vegetation**	**Water Quality**	**Aquatic Life**
Rio Grande Headwaters Restoration Project (2001)	Planning document for mainstem Rio Grande	X		X	X		
Rio Grande Basin Implementation Plan (2015)	Planning document supporting Colorado Water Plan and Rio Grande Basin needs		X				
Rio Grande Natural Area River Condition Assessment (2016)	Assessment of stream conditions within Rio Grande Natural Area			X	X	X	X
Upper Rio Grande Watershed Assessment (2018)	Physical and biological stream assessment driven by stakeholders and technical advisory team			X	X	X	X
Feasibility Study: River Corridor Improvements Rio Grande in Alamosa, CO (2017)	Planning document for Rio Grande in Alamosa						
Colorado Water Conservation Board Diversion Infrastructure Inventory (2006)	Inventory and maps of diversion structures, including condition	X					
Rio Grande Decision Support System (RGDSS)	Irrigation statistics for all decreed water rights	X	X				
Measurable Results Program and Phase II Monitoring (2015)	SVAP, macroinvertebrates, water quality, bank stability						X
Bureau of Land Management Aquatic Assessment, Inventory, and Monitoring (AIM) program (2017)	Detailed reach-level assessment of stream condition					X	X
Integrated Water Quality Monitoring and Assessment Report, Colorado Department of Public Health and Environment (CDPHE) (2018)	Water quality parameters (e.g. pH, conductivity, dissolved oxygen) National Water Quality Assessment Program, United States Geological Survey, and EPA					X	X
Wildfire Impacts on Water Quality, Macroinvertebrate, and Trout Populations in the Upper Rio Grande (Rust, 2019)	Study of post-wildfire impacts on water quality and aquatic life.					X	X
Colorado Parks and Wildlife (Nehring and Anderson, 1993)	PHABSIM surveys and IFIM		X				
CPW Fish Survey and Stocking Data (2006 - 2018)	Fish population surveys and stocking data	X	X				X
CPW Rio Grande Fisheries Management Plan (2016)	An overview for collaborative efforts in river restoration efforts	X	X				X
Colorado State Wildlife Action Plan (2015)	Planning document						X
Instream Flows (ISF) Water Rights - Held by the Colorado Water Conservation Board (CWCB)	Decreed instream flows		X				
Division of Water Resources Division 3 Streamflow Monitoring Network	Stream gage data		X				
Rio Grande Basin LiDAR survey (2012)	SLV-wide LiDAR dataset (bare earth)	X		X			
Colorado Natural Heritage Program (CNHP) Vegetation Surveys	Vegetation surveys, including wetlands				X		
Rio Grande National Forest Vegetation Mapping	GIS data containing vegetation communities				X		

2.3 Diversion Infrastructure Inventory and Assessment

The Rio Grande Headwaters Restoration Project (RGHRP) completed an inventory and functional assessment of instream diversion infrastructure. Diversion structures located on the mainstems of each prioritized SMP stream were included in the inventory. The inventories include assessments of diversion structure headgates, diversion dams, measurement devices, and nearby channel conditions affecting each structure. Each structure's impact on stream function was also included.

Figure 2.1: Prairie Ditch diversion on the Rio Grande.

Each structure's condition was rated using the A-F scale defined by FACStream. Two ratings were determined for each structure. One rating was assigned to the structure's headgate and a separate rating was assigned to the cumulative condition of the structure's diversion dam, measurement structure, and nearby channel conditions. Ratings were based on the structure's ability to effectively divert water as well as its impact on channel conditions, stream function, fish passage, and recreational boating. Grades were averaged for an overall rating. The overall rating scale is described in Table 2.3.

Table 2.3: Rating scale used for diversion infrastructure assessment.

Rating Scale	Impairment	Description
A ≥ 90	Negligible	The structure functions very well and no stream health impacts were detected. Improvements are not currently needed.
B ≥ 80	Mild	The structure functions well, however minor repair needs were noted and/or stream health impacts were detected. Minor improvements are recommended.
C ≥ 70	Significant	The structure functions, however significant repair needs were noted and/or significant stream impacts were detected. Improvements are recommended.
D ≥ 60	Severe	The structure functions poorly and/or severely impacts stream health. Extensive repairs or replacement of structural elements is recommended.
F ≥ 50	Profound	The structure is nonfunctional and/or profoundly impacts stream health. Full structure replacement is recommended.
N/A	N/A	The structure does not exist or was not rated.

To determine diversion structure condition and function, three kickoff meetings were held with the water commissioners for Water Districts 20 (Rio Grande), 22 (Conejos River), and 26 (Saguache Creek). During meetings, concerns, needed improvements, and other functional considerations were noted. Following kickoff meetings, each structure was visited and photographed to document its condition and to highlight repairs and/or improvements needed. Individual landowners and ditch companies were also consulted and field visits were arranged.

Channel Migration Analysis

Channel margins along the Rio Grande and the Conejos River were delineated using available aerial photography for the years 1960, 1975, 1998 and 2017. These delineations identify an approximated, but not exact, location of the channel margin at the time the image was taken (further information regarding their accuracy and known error is described in **Appendix B**). These delineations (example in Figure 2.2) were used to investigate significant channel migration since 1960 at the reach level in order to identify potential threats to a given structure. For example, although channel avulsion is a naturally occurring process, it can cause the river to bypass diversion structures.

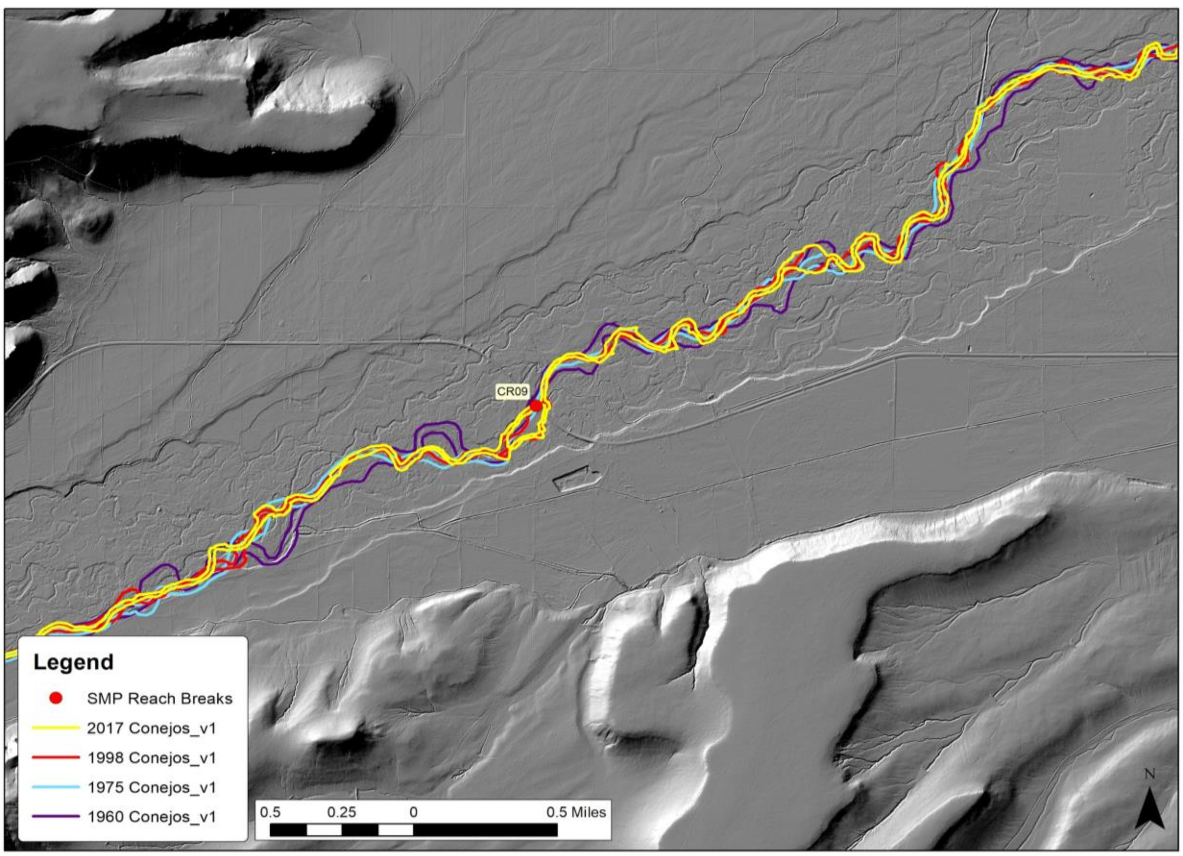


Figure 2.2: Example of bankline identification to delineate the very recent historic location of the Conejos River in the vicinity of the Mogote Bridge utilizing aerial photography from 1960, 1975, 1998 and 2017.

Using the information described above, a “report card” containing descriptive statistics, photographs, location, and channel migration maps, and recommended improvements was created for each structure. An example report card for the Westside Ditch is shown in Figures 2.3 and 2.4.

Each structure’s report card was saved as a PDF. Links to each structure’s report card, as well as a map showing diversion structure locations, are available on Rio Grande Headwaters Restoration Project’s “Stream Management Plans” webpage at the following url: https://riograndeheadwaters.org/stream-management-plans. The report cards are intended to be used by water commissioners, landowners, ditch companies, and other water users to monitor structure conditions over time. A summary of each structure, including recommended improvements, can be found in section 3.2.

Example Report Card

RIO GRANDE
DIVERSION INFRASTRUCTURE INVENTORY

Structure Name: WESTSIDE D

Reported By: Daniel Boyes

Date: April 11, 2019

Headgate Location:	**Latitude**	**Longitude**
	37.46663333	-106.85586667

Headgate Type: Manually operated 3' wide steel slide gates (3)

Headgate Condition:	**Diversion and other Condition:**	**River Miles From New Mexico State Line (Point of Diversion):**	**Structure Submerged:**
A ☐	A ☐	49.95 mi	Yes ☐
B ☐	B ☐		No ☒
C ☐	C ☐		
D ☒	D ☒		
F ☐	F ☐		

Repair(s) or Improvement(s) Completed Since 2006: Ditch maintenance, including debris removal.

Repair(s) or Improvement(s) Currently Needed: The headgates do not function well and could be repaired or replaced. The flume is often submerged and does not measure accurately. It should also be repaired or replaced. The diversion dam functions for water rights holders, but it could function significantly better if it was replaced. During spring runoff in 2019, the levee forming the bank north of the diversion dam washed out (see photo below). This has occurred in the past, and an updated diversion dam with higher flow and sediment transport capacity is recommended. If the diversion dam is improved, boat and fish passage should be included, especially considering the increasing popularity of recreational boating in the Alamosa area. Diversion structure improvements were also identified in the 2017 Rio Grande River Corridor Feasibility Study. If improvements are made that allow for boat passage, a safe takeout location adjacent to or downstream of the diversion is also recommended. Any required Army Corps of Engineers permitting also needs to be considered. Improvements should carefully consider riparian area restoration near the structure. Additionally, ~1 mile below the headgate, the ditch crosses the Alamosa Ditch, where a portion of water is diverted from the Westside to the Alamosa. See map below. The water rights holders in both ditches would like to improve the diversion at this junction, diverting more water to the Alamosa Ditch.

Structure Description: There is a corrugated sheet metal diversion dam with a 20' steel weir and 20' radial gate that spans the river and directs river flow to a short feeder channel that services the headgate. There is a log trash boom across the entrance of the feeder channel. At the headgate, the ditch enters a culvert before passing through the flume. Upstream of the diversion dam, the channel has migrated south (see 1975 and 1960 channel margin maps), although significant migration is limited by the levees and thus the migration has not affected the diversion's ability to function. The diversion dam gates do not have sufficient capacity to pass flood flows. For this reason, during high flow events (e.g. spring 2019), the river bank north of the structure can fail, leading to significant flows bypassing the structure via the failed bank. High flow scenarios could also potentially lead to flooding upstream of the diversion dam or in East Alamosa due to a backwater effect. Significant debris and sediment are deposited upstream of this diversion due to the structure's limited sediment transport capacity along with regularly low river velocities. This structure impacts the sediment transport regime and channel capacity of the river upstream of the diversion dam.

Comments: This ditch includes priorities 165, 234, 259, 274, 280, 304, 322, 346, and 363.

Estimated Range of Cost: High

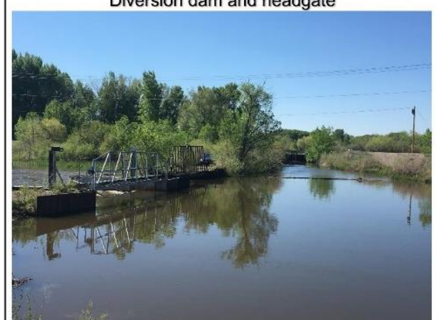
Headgate looking downstream

Headgate outlet

Diversion dam looking downstream

Diversion dam looking upstream

Diversion dam and headgate



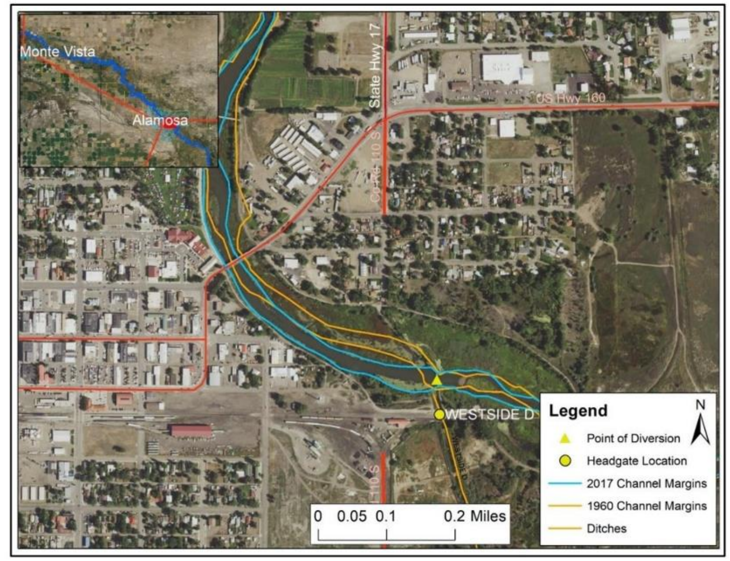
Measurement Structure

RIO GRANDE DIVERSION INFRASTRUCTURE INVENTORY	Rio Grande Stream Management Plan
WESTSIDE DITCH	
PHOTO LOG	

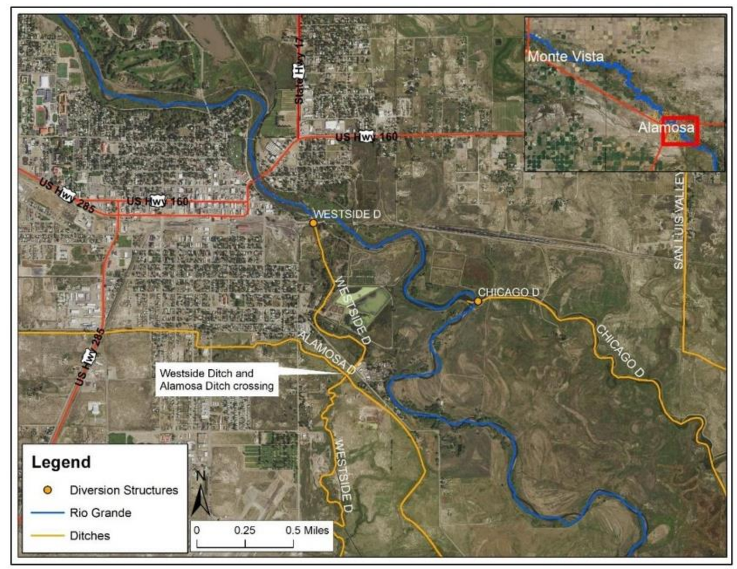
Figure 2.3: Example report card developed for diversion infrastructure inventory (pages 1-2).

Failed levee north of diversion dam during Spring 2019 runoff.

Flooded diversion dam during Spring 2019 runoff.



Headgate location with 1960 and 2017 channel margins overlaid.



Westside Ditch and Alamosa Ditch junction, ~1 mile beyond of the headgate.

Figure 2.4: Example report card developed for diversion infrastructure inventory (pages 3-4).

2.4 Hydrology Assessment

The hydrology assessment characterized flow regimes and assessed flow targets for the Rio Grande, Conejos River, and Saguache Creek SMPs. Daily point flow models (PFMs) were developed by Wilson Water Group, LLC, for each stream using a combination of gaged streamflow data, diversion records, stream gains/losses, USGS Stream Stats, and local knowledge from water commissioners and hydrographers. Within each PFM, daily streamflows were generated for both gaged and ungaged locations of interest (i.e., hydrology nodes). Locations of hydrologic interest within each SMP were selected with input from the TAT. At ungaged locations, the tools described above were used to simulate daily historical streamflow conditions.

The Conejos River and Rio Grande PFMs were calibrated by comparing simulated streamflow to recorded values and anecdotal information from the Water Commissioner and water users. The Saguache Creek PFM was calibrated assuming no flow after the last diversion on the Creek, per discussions with the Water Commissioner. A study period of 1998 to 2017 was used for all point flow models and reflects current administration over variable hydrology including the critically dry period during 2002. Gains and losses were distributed along the river based on irrigated acreage, tributary inflows, and on-the-ground observations by the Water Commissioners. Flows were estimated at all ungaged hydrology nodes, using the closest gages, diversions, and gains and losses. It should be noted that the level of calibration at each node varied depending on several external factors including frozen streams, irrigation return flows, ungaged tributaries, springs and seeps, etc.

The results from each PFM were summarized both graphically and tabularly and used in the recreational flow needs assessment as well as the aquatic habitat flow needs assessment. Using the PFM, wet, dry, and average daily hydrographs for the 1998 to 2017 period of record were calculated based on average annual streamflow. Wet years were classified as the 75th percentile and above, average was the 25th to the 75th percentile, and dry was the 25th percentile and below. Figure 2.5 illustrates a typical hydrograph resulting from the PFM.

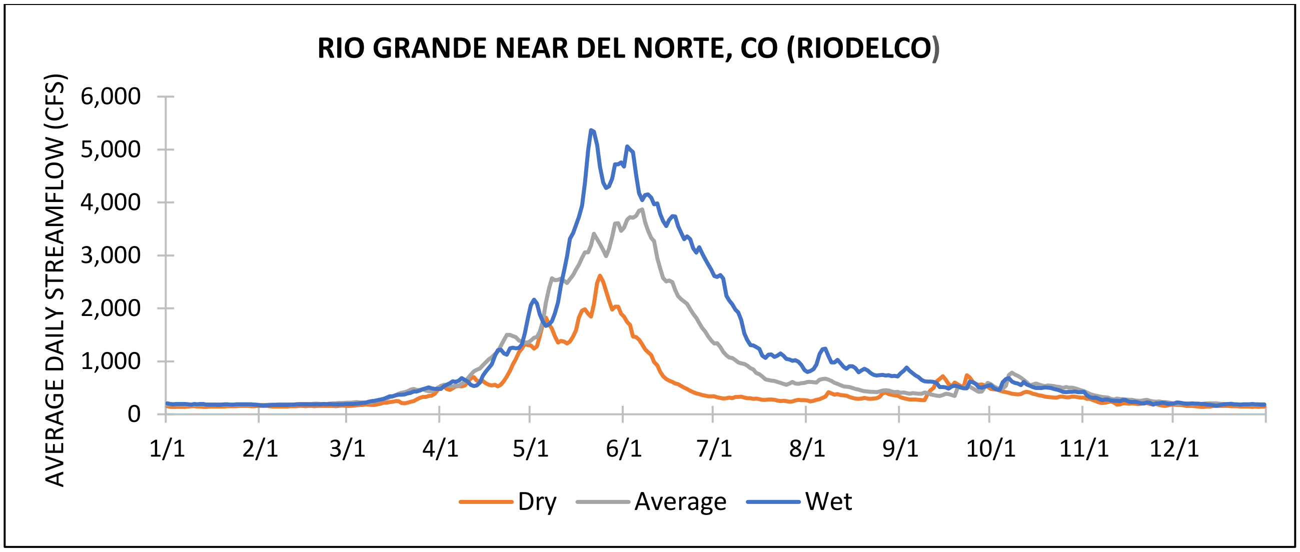


Figure 2.5: Typical hydrograph developed as part of the hydrology assessment.

Application of Hydrology Data and Point Flow Models

In addition to characterizing general hydrology and flow regimes, the hydrology data described above was used in the geomorphology, the recreational use and streamflow needs, and aquatic habitat needs assessments. Specifically, flow duration curves for each hydrology node were utilized in the geomorphology assessment to calculate bed mobility thresholds and frequency of overbanking events. Additionally, daily PFMs were utilized to calculate boatable days as part of the Recreational Use and Streamflow Needs assessment and to determine frequency of flow target attainment as part of the Aquatic Habitat Streamflow Needs assessment. Each of these assessments is described in detail below.

2.5 Recreational Use and Streamflow Needs Assessment

With input from the TAT, local stakeholders, and the RGHRP, American Whitewater (AW) completed a recreational use and streamflow needs assessment on the Rio Grande and Conejos River. Eight Rio Grande reaches and three Conejos River reaches were identified as priorities for recreational use and were included in the assessment.

To determine flow preferences for each reach, an online recreational use survey was distributed. Four types of questions were presented to survey respondents, three of which quantified flow preferences by reach, collectively, while another was directly related to water management and stream management planning. SMP-related questions allowed for comments on recreation constraints caused by infrastructure, navigational hazards, and opportunities to improve streamflow and overall recreational opportunities. Responses to SMP-related questions were incorporated into Rio Grande and Conejos River SMP stakeholder values.

Survey results were analyzed to determine streamflow preferences as well as acceptable and optimal flow thresholds for each reach. Having identified flow preferences and thresholds, AW's Boatable Days tool was run using daily streamflow data for dry, average, and wet year types (described above) to capture flow variations over the period of record. The tool applied flow preferences as inputs to calculate the number of boatable days by flow year type and reach. The Boatable Days tool has been employed in previous recreational use assessments, including the Colorado and San Miguel rivers, and is an accepted methodology for assessing and defining recreational flow needs (Stafford et al., 2016). Assessment results defined the range of flows supporting recreational use and illustrated how flows affect recreational opportunities for each reach.

This assessment played a critical role in the SMP process by quantifying baseline recreational use on the Rio Grande and Conejos River. Although some information existed previously, this assessment provided quantitative information needed to develop goals to maintain and enhance streamflows for recreational use on these two rivers. The TAT and local stakeholders used this information to develop a variety of action items to maintain and enhance recreational streamflows on the Rio Grande and Conejos River. The assessment will be available to inform water management operations in the future. Additionally, the TAT used the results to identify additional river access needs and infrastructure hazards currently limiting recreational use. Priority projects and action items resulting from this assessment are described in Section 4, *Rio Grande SMP Implementation Strategy*.

Detailed assessment methodology, results by assessment reach, and a copy of the survey questions, are available in the full report, *Assessment of Streamflow Needs for Supporting Recreational Water Uses on the Rio Grande and Conejos River* (**Appendix A**).

2.6 Aquatic Habitat Streamflow Needs Assessment

The RGHRP used a combination of data and models to determine aquatic habitat flow needs for each SMP assessment reach. The R2-Cross protocol was used to determine minimum flow targets for aquatic species habitat (CWCB, 1996). This protocol includes detailed site-level data collection, including a cross section, discharge measurement, and pebble count. This field data is run using the R2Cross model and results in two minimum flow recommendations: a winter recommendation and a summer recommendation. For the purposes of aquatic habitat flow targets, *winter* is defined as October 1 through April 30 while *summer* is defined as May 1 through September 30 (see Figure 2.6). This is the time period used for existing decreed instream flows (ISFs). Summer and winter flows are applied as recommended minimum flows for each reach.

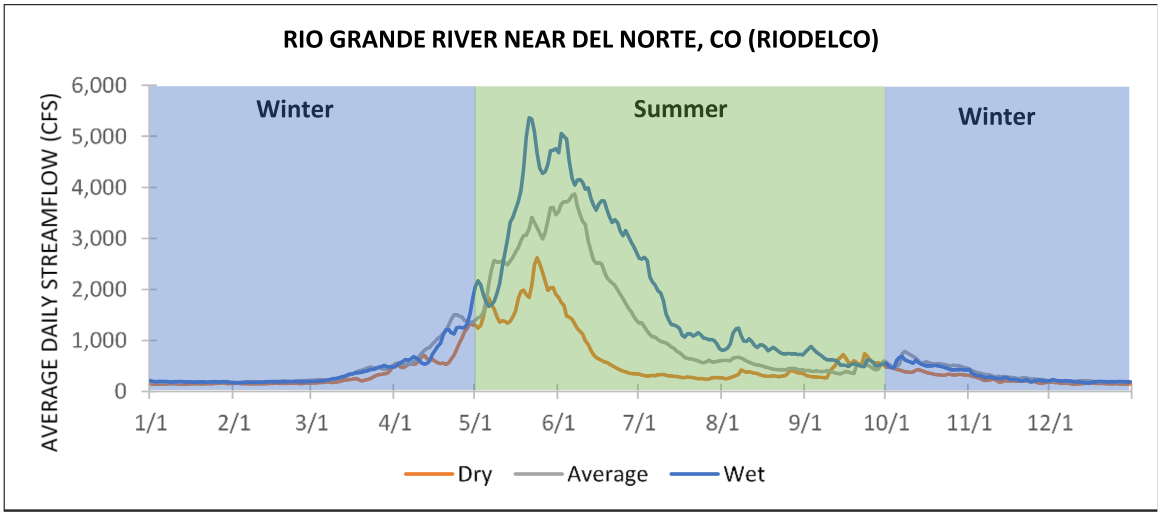


Figure 2.6: Winter versus summer time periods used in aquatic habitat flow needs assessment.

Final minimum flow determinations from R2Cross were also compared to existing aquatic habitat assessments completed on the Conejos River. Specifically, results from Physical Habitat Simulation Model (PHABSIM) and Instream Flow Incremental Methodology (IFIM) assessments previously conducted on the Conejos River were used to verify the accuracy of R2Cross results within reaches CR01 through CR04. R2Cross site locations for each reach were selected based on two primary criteria, which are standard for R2Cross: 1) Located within the lower third of the reach, and 2) located at a critical, habitat-limiting riffle.

Similar to the recreational needs assessment, results from the aquatic habitat flow needs assessment were paired with hydrographs created as part of the hydrology assessment. As described above in section 2.5, hydrographs for low, average, and high flows were applied to each priority reach. By overlaying these three hydrographs with aquatic habitat flow targets, the frequency of flow target attainment was determined. This information will be available to inform existing and potential voluntary programs and opportunities aimed at better meeting aquatic habitat flow recommendations.

Important Caveats Regarding Aquatic Habitat Flow Targets

It is important to note the following caveats regarding aquatic habitat flow recommendations:

- R2Cross was developed using habitat criteria for lower order streams and cold-water fisheries, with a focus on supporting salmonid species. Some sites within the SMP study area occurred outside these typical parameters, including in reaches classified as warm-water fisheries.
- The time period defined for winter and summer flow recommendations does not align with the Rio Grande Basin irrigation season, which to a large degree dictates reservoir releases and surface water diversions. Specifically, the summer period, as defined for aquatic habitat, begins May 1 and ends September 30 while the irrigation season is two months longer, beginning April 1 and ending October 31. The seasonal periods used in the aquatic habitat needs assessment

are intended to best protect critical life stages of salmonid species and were determined using the best available data.

- It is likely that flow targets for some reaches would not have been met even under unaltered hydrologic conditions. For example, natural, unaltered inflows to Platoro Reservoir rarely meet the calculated winter flow targets below Platoro Reservoir (reaches CR01 and CR02). There may be external factors contributing to the relatively high flow targets calculated for those reaches.
- The effects of climate change on the timing and amount of precipitation and snowmelt runoff have exacerbated existing challenges with regard to water storage and delivery.
- The timing and/or amount of legal water delivery requirements, including decreed water rights as well as those required under the Rio Grande Compact, can result in very limited flexibility in reservoir releases. In some cases, often due to below-average snowpack or other hydrologic factors, existing legal delivery requirements may prohibit reservoirs from shifting releases in an effort to meet flow targets.
- Some reservoirs affecting the Rio Grande and Conejos River are privately owned and are operated at the discretion of the reservoir company.

2.7 Geomorphology Assessment

The geomorphology assessment, conducted by Round River Design, Inc and Watershed Science and Design, LLC, utilized GIS and field data to assess the reach-scale geomorphic condition for each SMP study stream. Geomorphic characterization begins with identifying the fundamental processes of river change. Eventually, additional factors, both natural and human-caused, may create circumstances that increase the uncertainty of how a channel will react when energized.

In order to individually and collectively tell the story of a stream's geomorphic condition and attempt to decipher its expected future trajectory, both the examination of existing data and development of new remote-sensed data layers were completed. The assessment focused on documenting the geomorphic characteristics and constraints of each reach using GIS data. Additionally, site-level data was used, and, where vehicle access exists, field observations were conducted. An overall assessment of existing geomorphic condition in relation to an assumed natural reference condition was completed. Using assessment results, a qualitative rating was assigned to each reach. Table 2.4 defines the rating scale used for geomorphic condition.

Table 2.4: Rating scale used for geomorphology assessment.

Rating Scale	Impairment	Description
A	Very Low	Reach geomorphology is at or near reference condition with very little or no impact due to stressors. Few stressors may exist, however their impact on the geomorphology is minimal.
B	Low	Geomorphic condition is mildly impaired, with mild impacts resulting from a few stressors.
C	Moderate	Geomorphic condition is significantly impaired, with measurable impacts exist resulting from several stressors.
D	High	Geomorphic condition is severely impaired, with impacts resulting from numerous stressors. The reach is considered geomorphically impaired.
F	Very High	Geomorphic condition is profoundly impaired, with extreme impacts resulting from numerous stressors. The reach is considered nonfunctional in terms of geomorphic processes.

Several subvariables were included in the geomorphology assessment and are described in Tables 2.5 and 2.6. Among other subvariables, assessments of floodplain connectivity, sediment transport, and flow regime in terms of bankfull flow were included.

Table 2.5: Geomorphic reach information sheets explanation.

Reach	Determined by the RGHRP
Confinement	A reach averaged ratio comparing the average channel width over the average valley width.
D50	Median bed surface grain size (as determined through a pebble count conducted by RGHRP staff).
Bed composition	Descriptive categorization of the D50 grain (e.g., sand, fine gravel, large gravel, cobble).
Stream form	Generalized qualitative categorization of the existing and reference morphology of the stream bed based on categories developed by Montgomery and Buffington (1997). See **Appendix D**.
SEM stage	A qualitative assessment of existing and idealized/undisturbed stream evolution stage based on guidance developed by Cluer and Thorne (2014). See **Appendix D**.
Sediment regime	A qualitative assessment of current and idealized sediment regime based on guidance developed by Vermont's River Management Program (see **Appendix D**).
Valley slope	A measurement of the change in elevation between the top of the reach and the bottom of the reach divided by the length of the valley within which the stream has the opportunity to pass through (note this is not always a straight line as large terraces or bedrock outcrops might force "bends" into the valley length measurement.
Stream Power △	Qualitative assessment of change in stream power based on changes in valley slope and confinement.
Mobility Threshold Flows	A calculation of the flow or range of flows as described below in **Section 2.7.1**.
Frequency of Occurrence	How often the mobility threshold flow is exceeded as described below in **Section 2.7.1**.
Overbank Flow Estimate	The flow that is estimated to overtop the channel and initiates floodplain activation based on HEC-RAS modeling using surveyed cross-sections.
Overbank Flow Frequency	How often the overbank flow estimate is exceeded as described below in **Section 2.7.1**.
Watershed setting	"Landscape units" broadly defined by their position within a watershed and the prevailing sediment transport processes of net erosion, transfer, or accumulation as described by Fryirs et al. (2005).
River Style	River styles were identified in the 2018 Upper Rio Grande Watershed Assessment (Lotic, 2018). In the interest of continuity, this assessment has largely kept those same River Style names and descriptions while adding a few new ones for the reaches that were not described in that report (Table 2.6).
Stressors	A qualitative summary of the stressors to the geomorphic condition of the reach. These may include anthropomorphic-induced changes to the watershed or stream corridor including alterations to the hydrologic, biotic and/or geomorphic controls that determine the quality of the geomorphic condition of the reach and lend to an evaluation of its departure from an unadulterated assumed reference condition (i.e., degree of geomorphic impairment).
Degree of Geomorphic Impairment	Overall assessment of existing geomorphic condition in relation to an assumed natural reference condition.

Table 2.6: River Styles (adapted from the Upper Rio Grande Watershed Assessment, 2018).

<table>
<tr><th colspan="4"></th></tr>
<tr><th>Watershed Setting</th><th>Watershed Setting</th><th>Modifiers</th><th>River Style</th></tr>
<tr><td>Headwaters</td><td>Source</td><td rowspan="11">Valley Slope
Floodplain Presence or Absence
Planform (Existing and Potential)
Floodplain Geomorphology
Channel Geomorphology
Bed/Bank Material
Structural Elements</td><td>Alpine Headwaters</td></tr>
<tr><td rowspan="3">Canyon
(Confined and Partially Confined)</td><td rowspan="3">Transport</td><td>Step Cascade</td></tr>
<tr><td>Confined Valley</td></tr>
<tr><td>Confined Valley Occasional Floodplain Pockets</td></tr>
<tr><td rowspan="3">Mountain Valley
(Partially Confined and Unconfined Reaches)</td><td rowspan="3">Response</td><td>Elongated Discontinuous Floodplain, Bedrock and/or terrace confined</td></tr>
<tr><td>Low-Moderate Sinuosity Planform-Controlled Discontinuous Floodplain</td></tr>
<tr><td>Meandering Planform Controlled Discontinuous Floodplain</td></tr>
<tr><td rowspan="3">Alluvial Fans, Plains and San Luis Valley Floor
(Unconfined)</td><td rowspan="3">Accumulation</td><td>Low-Moderate Sinuosity Unconfined</td></tr>
<tr><td>Meandering Coarse Grain Bed</td></tr>
<tr><td>Meandering Fine Grain Bed</td></tr>
<tr><td>Altered</td><td>Altered</td><td>Altered</td></tr>
</table>

2.7.1 Geomorphic Condition – Floodplain Activation and Bed Mobility

Geomorphic condition was assessed through the lens of a traditional bankfull flow. This bankfull flow has two components to its definition: 1) it is the flow at which water begins to spill out of the channel and onto the adjacent floodplain and 2) it is the flow that transports the greatest amount of sediment over time. Both components of this definition were assessed by calculating the flow at which the adjacent floodplain is activated and by calculating the flow that can mobilize the channel bed. Generally speaking, the floodplain activation flow and the bed mobility flow should be similar at any given location in an alluvial stream system.

The bankfull flow in an unimpaired system has a recurrence interval of approximately 1.5 years, on average. This means that in any given year there is a 67% chance that the river will rise to or overtop the channel banks and activate the floodplain. There is a small amount of variability in the frequency of bankfull flows but typically they are always smaller than the 2 to 3-year peak flow if there is not a prevalence of biotic factors in the stream system, which is the case for all three streams in this study.

Floodplain Activation Flows

A channel is said to be at bankfull stage when it is just about to flood the active floodplain. Thus, the active floodplain defines the limits of the bankfull channel. The active floodplain is the flat portion of the valley adjacent to the channel that is constructed by the present river in the present climate. The phrase “present river in the present climate” is especially important because if the river degrades or incises, what was formerly the floodplain is abandoned and becomes a terrace or abandoned floodplain. It is therefore important to distinguish the active floodplain from abandoned terraces.

HEC-RAS, a tool developed by the U.S. Army Corps of Engineers, was used to perform cross-sectional hydraulic calculations for floodplain activation flow (i.e., the flow that fills the channel and begins to spill onto the floodplain immediately adjacent to the channel). This analysis is only applicable to alluvial channels; reaches in confined bedrock canyons or whose shape is defined by geologic factors were not assessed through this method. Additionally, the analysis was limited to the surveyed channel and not tied to any floodplain modeling. To assess hydrologic geomorphic impairment, the calculated floodplain activation flow for each reach was compared to streamflow data from the hydrology assessment. For a given reach, the calculated floodplain activation flow should be roughly equal to the peak flow from the hydrology assessment’s *average year* hydrograph and should be greater than the 2-year peak flow. If this standard was not met, the reach was considered impaired. The degree of impairment is linked to the deviation in the frequency of floodplain inundation.

Function and Benefits of Floodplain Connectivity

Floodplain connectivity refers to a stream’s ability to spread out on its floodplain during overbanking events. The floodplain activation analysis described above is important because functional, well-connected floodplains play a critical role in overall stream function, providing a multitude of benefits to stream health as well as water users. Floodplain inundation recharges alluvial aquifer systems, a process sometimes referred to as "wetting the sponge." Alluvial water storage results in sustained streamflow during baseflow periods in late summer and fall. These sustained flows not only benefit aquatic species but also surface irrigators, who receive more consistent late season flows. For this reason, alluvial aquifers are often referred to as "natural reservoirs."

Figure 2.7: Floodplain activation and resulting alluvial aquifer recharge, June 2019 (Photo: Christi Bode).

Floodplain activation and overbanking events are also critical to cottonwood and other riparian vegetation establishment. In some cases, an elevated groundwater table may be supporting riparian vegetation. Elevated groundwater tables are naturally common throughout the SLV with flood irrigation contributing. Conversely, poor floodplain connectivity reduces groundwater-surface water exchange in the hyporheic zone, can negatively impact stream temperature and dissolved oxygen levels, and reduces alluvial aquifer storage potential.

Figure 2.8: Flooded riparian area along the Rio Grande, June 2019.

Function and Benefits of Wet Meadows

Functional floodplains also exist as both natural and managed wetlands. Many wetland types are found in the Basin and one type of particular importance is wet meadows. Natural wet meadows are common at higher elevations and headwaters of the Rio Grande Basin, including tributaries to mainstem streams and rivers. Managed, or "working," wet meadows are abundant on the floor of the SLV in the form of irrigated lands. Wet meadows provide valuable ecosystem services including attenuation of flood flows, augmentation of baseflow, mitigation of post-wildfire sediment production, streambank stability, buffering of surface water temperature, nutrient filtering, and wildlife habitat (Findlay, 1995). Wet meadows are typically seasonally saturated. During high flows resulting from spring runoff or monsoon rains, wet meadows become saturated and act as a sponge in alluvial aquifer systems. In late summer, water stored in these sponges is slowly released, resulting in baseflow augmentation. Additionally, wet meadows have been shown to increase streambank stability and resiliency. One study indicated that streambanks colonized by wet meadow vegetation were, on average, five times stronger than banks with xeric vegetation (Micheli & Kirchner, 2002). This suggests that instability caused by loss of riparian vegetation can be mitigated by meadow vegetation.

Figure 2.9: Wet meadow in Rio Grande State Wildlife Area.

In the event of high severity wildfires and other disturbance events, wet meadows, particularly those at high- to mid-elevations, play an important role in mitigating potential downstream fluvial hazards. Post-wildfire precipitation can lead to significant soil erosion and an increased risk of flooding, debris flows, and other flow-related impacts. For example, following the 2013 West Fork Complex Fire, the upper Rio Grande watershed exhibited resiliency to wildfire impacts. Elevated turbidity and total suspended solids concentrations was observed and a fish kill of brown and rainbow trout on Trout Creek was attributed to sediment loading resulting from wildfire impacts (Rust et al., 2019). However, outside of these short-term impacts, the watershed as a whole was shown to be very resilient to wildfire. This resiliency is likely due in part to intact wet meadows and other wetland types. In functional wetlands and wet meadows, flood flows spread out, dissipate their energy, and allow for sediment deposition. In this way, wet meadows can act as sediment banks, thereby significantly mitigating downstream flooding and sedimentation caused by wildfire and other impacts. Although the SMPs focus on the Rio Grande, Conejos River, and Saguache Creek mainstems, maintaining the condition and resiliency of wet meadows on tributary streams, in alpine and subalpine basins, and in adjacent uplands is crucial to protecting water quality and mitigating the risk of fluvial hazards downstream and in the mainstems.

In addition to the benefits listed above, working wet meadows maintained by annual flood irrigation have been shown to be important habitat for migratory bird species. Among other species, iconic sandhill cranes, which migrate through the SLV twice a year, rely upon working wet meadows (Wetland Dynamics LLC, 2019).

Bed Mobility Flows

Long-term bed load and flow measurements have shown that the bankfull flow transports the greatest amount of material over time. While larger flow events transport greater quantities per event and smaller flow events occur more frequently, the bankfull flow is effective and sufficiently frequent to perform the greatest amount of work in establishing and maintaining channel shape.

Bankfull flows should mobilize the bed material in alluvial channels, though this assessment can become more complex in areas where the streams are working through glacial outwash alluvium rather than contemporary alluvium. Similar to the floodplain activation flows, the bed mobility flows should occur during the peak flows in the *average year* hydrographs and if peak flow data is available, the floodplain activating flow should be greater than the 2-year peak flow. If this standard was not met, the reach was considered impaired. Again, the degree of impairment is linked to the deviation in the frequency of floodplain inundation. Bed mobility flows were calculated using Critical Shear Stress and Shields Analysis, which are further described in **Appendix C**, and were reported as a range.

Function and Benefits of Bed Mobilization

At larger scales, the mobilization and deposition of bed sediments creates and maintains bedform features that provide in-channel habitat such as riffles and pools to support aquatic species at various stages of their life-cycle. At smaller scales, flows that flush fine particles such as sand and silt from the interstitial spaces between more coarse material are important for food web building blocks such as algae, zooplankton, phytoplankton, and macroinvertebrates. Flows that evacuate fine sediment from pools and deposit coarse sediment on bars are important to maintain the quality and quantity of habitat used for many species of cold-water fish to spawn and rear their young. Conversely, a lack of flows that trigger bed mobility will tend to cause either long-term scour or aggradation (site specific) of the channel bed and tend to simplify the channel, reduce bedform variability, and homogenize aquatic and riparian habitat. On the floodplain, riparian vegetation establishment and succession is often dependent upon the mobilization and deposition of sediment (and seed) within the stream corridor. Mobilizing sediments may also result in the erosion of banks (and therefore the recruitment of wood) and the deposition of new bars (and therefore places for early successional species to colonize).

2.8 Riparian Vegetation Assessment

Riparian vegetation was assessed using site-level surveys as well as larger scale remote sensing methods. A site-level botany survey, conducted by McBride BioTracking, LLC, assessed the current ecological integrity of selected assessment areas (AAs) along the Rio Grande, Conejos River, and Saguache Creek riparian areas. Additionally, the RGHRP used a GIS tool to characterize riparian condition at a reach scale. Each assessment yielded a rating and the two ratings were averaged for an overall reach rating. The overall riparian vegetation rating scale is outlined in Table 2.7.

Table 2.7: Rating scale used for riparian vegetation assessment.

Rating Scale	Impairment	Description
A ≥ 90	Negligible	Riparian area is unaltered, at or near reference condition, and supports stream health. Native vegetation diversity is self-sustaining and there is no evidence of exotic or noxious species.
B ≥ 80	Mild	Riparian area is in good condition with only minor alterations. Native species predominate and if nonnative species are present, their impact on diversity and native species cover is insignificant. The riparian area's ability to support stream health may be slightly reduced.
C ≥ 70	Significant	Riparian area exhibits decreased plant diversity, loss of structural complexity, and may be hydrologically disconnected from the river. Nonnative species may be widespread and small populations of noxious species may be present. Riparian area degradation is a significant stream health stressor.
D ≥ 60	Severe	Riparian area has severely decreased species diversity, loss of structural complexity, hydrologic alteration, and is disconnected from the river. Lack of riparian function is a main stream health stressor. Noxious species are prevalent or dominant, leading to very low native species cover. Bare ground may be a substantial proportion of land cover.
F ≥ 50	Profound	Riparian area is dominated by noxious species and/or has been converted to bare ground or other impervious surfaces. Riparian habitat is essentially nonfunctional and poor riparian condition is a primary stream health stressor.

2.8.1 Site-Level Assessment (Ecological Integrity Assessment)

A site-level riparian vegetation assessment was completed for most, but not all, SMP reaches. The sampling methodology was based on the Ecological Integrity Assessment (EIA) for Colorado Wetlands, Version 2.1 (Lemly et al., 2016). This protocol has itself been adapted from the U.S. Environmental Protection Agency's (EPA) National Wetlands Condition Assessment (NWCA) flexible-plot method (U.S. EPA, 2011). The EIA framework was designed by the EPA and NatureServe in response to the need to assess the effectiveness of biological and functional indicators of wetlands nationwide. In its entirety, this method collects data to evaluate the following range of Major Ecological Factors for each assessment area (AA), or site: 1) Landscape, 2) Buffer, 3) Vegetation, 4) Hydrology, 5) Physiochemistry, and 6) Size (Table 2.8). Because the focus of the assessment was riparian vegetation, field data collection only included Major Ecological Factors 1 – 3.

Table 2.8: Hierarchical structure of the Colorado EIA method (Lemly et al., 2016).

Rank Factor	*Major Ecological Factor*	*Metrics*[1]	*Metric Variants*
Landscape Context	Landscape	L1. Contiguous Natural Land Cover L2. Land Use Index	
	Buffer	B1. Perimeter with Natural Buffer B2. Width of Natural Buffer B3. Condition of Natural Buffer	
Condition	Vegetation	V1. Native Plant Species Cover V2. Invasive Nonnative Plant Species Cover V3. Native Plant Species Composition V4. Vegetation Structure V5. Regeneration of Native Woody Species **[opt.]** V6. Coarse and Fine Woody Debris **[opt.]**	V3 and V4 vary by wetland type. V5 and V6 are for woody systems.
	Hydrology	H1. Water Source H2. Hydroperiod H3. Hydrologic Connectivity	H1, H2, and H3 vary by wetland type.
	Physiochemistry	S1. Soil Condition S2. Surface Water Turbidity / Pollutants **[opt.]** S3. Algal Growth **[opt.]**	S2 and S3 are for sites with surface water.
Size	Size	Z1. Comparative Size **[opt.]** Z2. Change in Size **[opt.]**	Z1 and Z2 are for assessments of entire wetlands.

[1] Optional metrics noted as **[opt.]** can be used depending on study design and wetland type.

A modified version of the CNHP (2015) Colorado EIA Scorecard was used to determine individual metric and overall ratings for each AA. The modified scorecard includes the following rating weights:

Modified EIA Scorecard

- Rank Factor: Landscape Context (overall rating weight of 0.3)
    1) Landscape metrics (rating sub-weight 0.33)
    2) Buffer metrics (rating sub-weight 0.67)
- Rank Factor: Condition (overall rating weight of 0.7)
    3) Vegetation metrics (rating sub-weight 1)

Each metric is rated according to deviation from its natural state, or the best current understanding of how the particular ecological system is expected to look and function under reference conditions (Lemly & Rocchio, 2009). The further a metric moves away from its natural range of structure and function, the lower the rating it receives. The ratings for each category are collectively applied to produce an overall Ecological Integrity Score (EIS) for each site. General EIS score definitions are shown in Table 2.9.

Table 2.9: Definition of Ecological Integrity Assessment ratings (Lemly et al., 2016).

Rank Value	Description
A	**Reference Condition (No or Minimal Human Impact):** Wetland functions within the bounds of natural disturbance regimes. The surrounding landscape contains natural habitats that are essentially unfragmented with little to no stressors; vegetation structure and composition are within the natural range of variation, nonnative species are essentially absent, and a comprehensive set of key species are present; soil properties and hydrological functions are intact. Management should focus on preservation and protection.
B	**Slight Deviation from Reference:** Wetland predominantly functions within the bounds of natural disturbance regimes. The surrounding landscape contains largely natural habitats that are minimally fragmented with few stressors; vegetation structure and composition deviate slightly from the natural range of variation, nonnative species and noxious weeds are present in minor amounts, and most key species are present; soils properties and hydrology are only slightly altered. Management should focus on the prevention of further alteration.
C	**Moderate Deviation from Reference:** Wetland has a number of unfavorable characteristics. The surrounding landscape is moderately fragmented with several stressors; the vegetation structure and composition is somewhat outside the natural range of variation, nonnative species and noxious weeds may have a sizeable presence or moderately negative impacts, and many key species are absent; soil properties and hydrology are altered. Management would be needed to maintain or restore certain ecological attributes.
D	**Significant Deviation from Reference:** Wetland has severely altered characteristics. The surrounding landscape contains little natural habitat and is very fragmented; the vegetation structure and composition are well beyond their natural range of variation, nonnative species and noxious weeds exert a strong negative impact, and most key species are absent; soil properties and hydrology are severely altered. There may be little long term conservation value without restoration, and such restoration may be difficult or uncertain.

According to Lemly and Rocchio (2009), there are two important thresholds which indicate degradation to the point where action is needed within the assigned ranks:

- The B-C threshold (i.e., transition from a rating of B to a rating of C) indicates the level below which conditions are not considered acceptable for sustaining ecological integrity.
- The C-D threshold indicates a level below which system integrity has been drastically compromised and is unlikely to be restorable.

EIA metrics and associated ratings are specific to the particular ecological system being sampled. The Ecological System definitions and descriptions are components of the International Vegetation Classification System and have been developed by NatureServe and the Natural Heritage Network (Lemly et al., 2016). The EIA for an assessment area helps clarify the minimum performance standards for a wetland system, identifies the current ecological integrity of a system, and specifies the particular ecological components that must be repaired in order to restore a wetland to a desired level of ecological integrity (Lemly & Rocchio, 2009).

NatureServe has begun development of descriptions for specific wetland and riparian ecological systems found in the Southern Rocky Mountain Ecoregion (Lemly & Rocchio, 2009):

- Subalpine-Montane Riparian Shrublands
- Subalpine-Montane Riparian Woodlands
- Lower Montane Riparian Woodlands and Shrublands
- Subalpine-Montane Fen
- Alpine-Montane Wet Meadow
- North American Arid Freshwater Marsh
- Intermountain Basin Playas

As part of the EIA assessment, CNHP's Floristic Quality Assessment (FQA) tool was also used to assess native riparian vegetation (Lemly et al., 2016). The FQA method uses "coefficients of conservatism" (C-values), which are assigned to all native species in Colorado. C-values range from 0 to 10 and represent an estimated probability that a species is likely to occur in unaltered, pre-European settlement conditions. Species which are intolerant of habitat degradation and are obligate to reference condition landscapes have high C-values while those more tolerant of habitat degradation have low C-values. Most nonnative species have C-values of 0. For the SMP, the basic FQA index called mean C (i.e., average C-value for a given site) was calculated at each SMP site.

See **Appendix E** for a detailed description of the site-level EIA survey methods.

2.8.2 GIS Remote Sensing Vegetation Assessment

To assess riparian vegetation condition at a larger scale, the RGHRP employed a set of GIS tools. The tools are collectively known as the Riparian Condition Assessment Tool (RCAT), which includes the Valley Bottom Extraction Tool (VBET), Riparian Vegetation Departure (RVD) tool, and the Riparian Condition Assessment (RCA) tool (Macfarlane et al., 2018). These GIS tools consist of ArcPython scripts that use nationally available digital elevation models (DEMs) and 30-meter LANDFIRE imagery to assess the current condition of riparian vegetation. Because the RCAT tools and analysis are based upon watershed boundaries, the analysis was completed for all perennial streams within the Rio Grande Basin. First, VBET was used to delineate the maximum possible extent of riparian vegetation along each study stream using a DEM and average slope and valley width thresholds. Note: the riparian extent does not include wetlands that are not associated with the perennial stream network. Where available, a 2-meter DEM, derived from LiDAR data, was used. For the remainder of the Basin, the nationally available 10-meter DEM was used.

The RVD assessment tool divides each stream into discrete 500-meter assessment units. Within each assessment unit, the tools overlay the VBET output and LANDFIRE imagery. To compare current and reference vegetation, two LANDFIRE datasets are used. Current riparian vegetation cover is modeled using the Existing Vegetation Type (EVT) layer, while historic (pre-European settlement) vegetation is modeled using the LANDFIRE Bio-physical Setting (BpS) layer. Imagery falling within the VBET boundary is included in each assessment. RVD calculates the degree to which each unit has “departed” or been converted from pre-European, or “reference,” condition. This is expressed as a percentage. Additionally, the tool analyzes the LANDFIRE imagery to determine what primary type of land conversion, if any, has occurred within each unit.

The more comprehensive RCA tool assesses riparian area condition using three inputs: riparian vegetation departure (modeled by the RVD tool), land use intensity, and floodplain connectivity. Each assessment unit is attributed with values on continuous scales for each of the three inputs. To determine floodplain connectivity, roads, railroads, development, and other types of land conversion were used to assess overall riparian conditions for each spatial unit. The overall RCA score is calculated using all three inputs and is expressed as a value between 0 and 1. An example of the RCA output is shown in Figure 2.10.

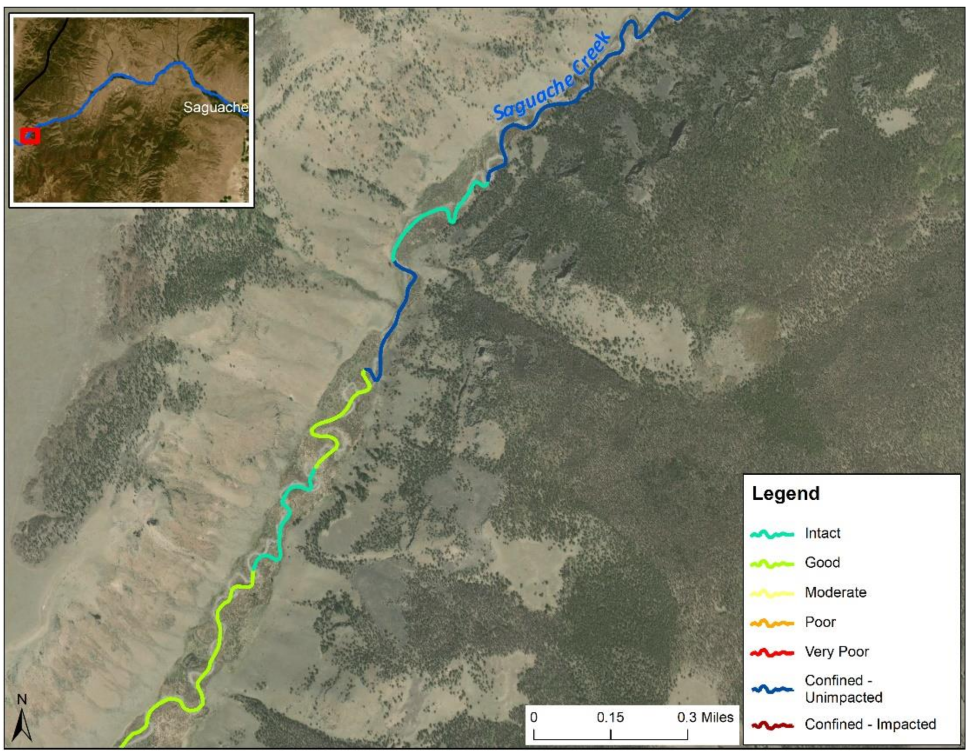


Figure 2.10: Example of GIS riparian vegetation assessment results.

The RCA rating scale, including RCA score thresholds, is shown in Table 2.10.

Table 2.10: Rating scale used GIS remote sensing vegetation assessment

Rating Scale	Impairment	RCA Score	Description
A ≥ 90	Negligible	≥ 0.9	Riparian vegetation is considered to be in reference condition. Few, if any, nonnative species are present, land use intensity is negligible, and floodplain connectivity is intact.
B ≥ 80	Mild	0.6 - 0.89	Riparian vegetation is in good condition with few nonnative species present. Land use intensity is low and river-floodplain connectivity is mostly intact.
C ≥ 70	Significant	0.3 - 0.59	Riparian vegetation is in moderate condition and small populations of noxious species may be present. Land use intensity is moderate and there is some loss of river-floodplain connectivity.
D ≥ 60	Severe	0.1 - .29	Riparian vegetation is in poor condition. Noxious plant species are prevalent. Land use intensity is high and, in many areas, the river lacks floodplain access.
F ≥ 50	Profound	< 0.1	Riparian vegetation is in very poor condition. Noxious plant species are dominant. Land use intensity is extreme and the majority of the reach lacks floodplain access.

The RCAT tools were developed by a team of researchers at Utah State University. Additional information and documentation of these tools is available at this url: http://rcat.riverscapes.xyz/. As noted above, both the site-level and GIS assessments were used in assessing overall riparian vegetation condition. The EIA rating and RCA ratings were averaged to calculate a final grade for each SMP reach.

2.9 Water Quality Assessment

A modified version of the FACStream framework was used for the water quality assessment. The assessment primarily utilized existing data collected by the Colorado Water Quality Control Division (CWQCD), CPW's River Watch program, and the U.S. Geological Survey's National Water Quality Assessment (NAWQA) program. Recent data (i.e., post-2010) was prioritized to best capture current water quality conditions. Existing data was supplemented with targeted water quality data collection during summer 2018 and spring 2019. Three water quality parameters (subvariables) were assessed: 1) temperature, 2) nutrients, and 3) chemical conditions (including pH and metal concentrations). Each of these parameters is an important indicator of water quality and, collectively, provide a detailed assessment of overall water quality. Where available, sediment data was also analyzed but was not included in the overall water quality reach ratings. Subvariables were rated according to the rating scales in Tables 2.11 to 2.13.

Table 2.11: Rating scale used for water temperature subvariable

Rating Scale		Impairment	Description
A	≥ 90	Negligible	The temperature regime is natural and appropriate for a pristine, high-functioning river in reference condition.
B	≥ 80	Mild	The temperature regime is within the range of natural variability and standards are not exceeded. However, natural aquatic biota may be minimally impaired.
C	≥ 70	Significant	The temperature regime is altered to a degree that could potentially limit natural aquatic biota and/or regulatory standards are occasionally exceeded. This rating applies to **303(d) Monitoring and Evaluation (M&E)** reaches.
D	≥ 60	Severe	The temperature regime is altered to a degree that is known to be lethal or limiting to natural aquatic biota and/or regulatory standards are *frequently* exceeded. This rating applies to **303(d) listed** reaches.
F	≥ 50	Profound	The temperature regime is severely altered. Natural biota may be severely impaired and/or regulatory standards are *chronically* exceeded. This rating also applies to **303(d) listed** reaches.

Table 2.12: Rating scale used for nutrients subvariable

Rating Scale		Impairment	Description
A	≥ 90	Negligible	Nutrient levels are natural and appropriate for a pristine, high-functioning river in reference condition.
B	≥ 80	Mild	Nutrient levels are within the range of natural variability and standards are not exceeded. However, natural aquatic biota may be minimally impaired.
C	≥ 70	Significant	Nutrient levels are altered to a degree that could potentially limit natural aquatic biota and/or regulatory standards are occasionally exceeded. This rating applies to **303(d) Monitoring and Evaluation (M&E)** reaches.
D	≥ 60	Severe	Nutrient levels are altered to a degree that is known to be lethal or limiting to natural aquatic biota and/or regulatory standards are *frequently* exceeded. This rating applies to **303(d) listed** reaches.
F	≥ 50	Profound	Nutrient levels are severely altered. Natural biota may be severely impaired and/or regulatory standards are *chronically* exceeded. This rating also applies to **303(d) listed** reaches.

Table 2.13: Rating scale used for chemical conditions subvariable

Rating Scale		Impairment	Description
A	≥ 90	Negligible	Chemical conditions are natural and appropriate for a pristine, high-functioning river in reference condition.
B	≥ 80	Mild	Chemical conditions are within the range of natural variability and standards are not exceeded. However, natural aquatic biota may be minimally impaired.
C	≥ 70	Significant	Chemical conditions are altered to a degree that could potentially limit natural aquatic biota and/or regulatory standards are occasionally exceeded. This rating applies to **303(d) Monitoring and Evaluation (M&E)** reaches.
D	≥ 60	Severe	Chemical conditions are altered to a degree that is known to be lethal or limiting to natural aquatic biota and/or regulatory standards are *frequently* exceeded. This rating applies to **303(d) listed** reaches.
F	≥ 50	Profound	Chemical conditions are severely altered. Natural biota may be severely impaired and/or regulatory standards are *chronically* exceeded. This rating also applies to **303(d) listed** reaches.

The overall water quality score was calculated as the mean of the subvariable scores. In some reaches, there was insufficient data to assess one or more subvariables. Any subvariables lacking sufficient data for a given reach were not included in the calculation of that reach's overall water quality score. An exception to the chemical conditions subvariable (Table 2.13) was made for reaches having only a chronic arsenic impairment. Many SMP reaches as well as pristine headwater streams exceed the chronic water supply standard for total arsenic of 0.02. The impairments do not appear to affect aquatic life. Because the impact is negligible and because it is likely that these exceedances are likely attributable to naturally occurring arsenic, any such reaches were assigned a chemical condition rating of B. A summary of water quality data and impairments is included in **Appendix F**.

2.10 Aquatic Life Assessment

The aquatic life assessment included an assessment of benthic macroinvertebrates and trout species' abundance and health. These two subvariables were rated using a modified version of the FACStream framework, described in Tables 2.14 through 2.16. The overall aquatic life rating was calculated as the mean of the subvariable scores. In some reaches, there was insufficient data to assess one or more subvariables. Any subvariables lacking sufficient data for a given reach were not included in the calculation of that reach's overall water quality score. Table 2.14 describes the aquatic life rating scale. The two subvariables are described below.

Table 2.14: Rating scale used for aquatic life assessment

Rating Scale	Impairment	Description
A ≥ 90	Negligible	Aquatic biota indicate a high-functioning reach that is representative of an unaltered, reference condition reach.
B ≥ 80	Mild	Aquatic biota are mildly impaired, indicating a functioning reach near reference condition. Macroinvertebrate and/or fish species presence or abundance may be slightly altered.
C ≥ 70	Significant	Aquatic biota are altered. Exotic species may be common, diversity lacking, and/or species distributions skewed. Important functional groups are appropriately represented even when nonnative species are present.
D ≥ 60	Severe	Aquatic biota are severely altered and may include abundant exotic species, major loss of diversity, or lacking keystone species. One or more important functional groups is unfilled or poorly represented.
F ≥ 50	Profound	Aquatic biota are fundamentally altered. Examples include communities dominated by exotic species and communities with multiple important functional groups that are vacant or severely diminished.

Benthic Macroinvertebrates

Benthic macroinvertebrates (BMI) are excellent indicators of water quality, aquatic habitat, and overall river health. BMI assemblages are sensitive to many stressors including altered habitat, changes in sediment input, hydrologic regimes, and water quality. Different macroinvertebrates groups respond differently to these stressors. For example, species of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), often referred to as EPT, are intolerant of pollution and poor water quality while other aquatic invertebrate groups are relatively tolerant. Macroinvertebrates are also a significant food source for fish and play a critical role in the transfer of energy to higher trophic levels. Changes in BMI communities can result in changes to fish communities.

Figure 2.11: Stoneflies, an indicator of good water quality.

BMI data was obtained from previously collected samples and was supplemented with targeted sampling during the summer of 2018. BMI samples were assessed using multi-metric index (MMI) scores. The MMI uses multiple equally weighted metrics to score the macroinvertebrate population diversity and density on a scale from 0-100 (CDPHE, 2020). The MMI is calibrated to one of three "biotypes," where biotypes are defined as regions that would have similar macroinvertebrate assemblages based on the elevation, slope, and ecoregion. The biotypes group macroinvertebrate assemblages into mountain streams, plains streams, and the transition streams in between the mountains and plains. The sampling locations within the SMP study area include Biotype 1 (transition) and Biotype 2 (mountain) sites. The state of Colorado sets different MMI attainment and impairment thresholds for each Biotype, which are described in Table 2.15.

Table 2.15: Thresholds for Biotype 1 and Biotype 2.

MMI	Biotype 1	Biotype 2
Attainment	45.2	47.5
Impairment	33.7	39.8

If a site's MMI score is between the impairment and attainment threshold, further investigation is warranted and other metrics are considered. To determine impairment, two additional indices, the Shannon-Wiener Diversity Index (SDI) and Hilsenhoff Biotic Index (HBI), are considered. The SDI is a measure of relative species abundance, on a scale from zero to five, with higher values indicating higher species diversity (MacArthur, 1965). HBI is a measure of the relative abundance of pollution-tolerant species and ranges from zero to ten, where a higher value indicates more pollution tolerant species are present (Hilsenhoff, 1987).

The rating scale for the benthic macroinvertebrates subvariable is described in Table 2.16.

Table 2.16: Rating scale used for MMI aquatic life subvariable

Rating Scale	Impairment	Description
A	Negligible	The reach sustains and supports reference conditions for macroinvertebrate communities and aquatic life use. No management is needed other than protection of existing conditions. MMI score is 80–100.
B	Mild	Some detectable stressors are likely with minor alterations to macroinvertebrate communities. The ecological system retains essential qualities and supports a high level of function. Some management may be required to sustain or improve this condition. MMI score is 65 – <80.
C	Significant	The reach supports and maintains essential components of macroinvertebrate communities, but exhibits measurable signs of degradation and less than optimal community parameters. The reach meets the attainment threshold, with an MMI score >45.2 (Biotype 1) or >47.5 (Biotype 2) and <65.
D	Severe	There are detectable alterations or degradation of aquatic life use, but the system still supports a fundamental community structure and function. Active management is recommended to maintain and improve characteristic functional support. MMI score is >33.8 – 45.2 (Biotype 1) or 39.9 – 47.5 (Biotype 2).
F	Profound	There is clear impairment to macroinvertebrate communities and aquatic life. This level of alteration generally results in an inability to support characteristic benthic organisms, or makes the stream segment biologically unsuitable. The reach has a "below impairment" threshold. MMI score of <33.7 (Biotype 1) or <39.8 (Biotype 2).

Trout

Trout biomass was also included as a subvariable in the aquatic life assessment. Because trout species depend on abundant food sources and high-quality habitat, their presence is an indicator of good water quality and aquatic habitat. Within the SMP study area, several native fishes are present, however due to limited data on native fish habitat requirements and abundance, native species were not assessed in this subavariable. The subvariable was measured as total pounds of trout species per acre, as shown in Table 2.17.

Table 2.17: Rating scale used for trout aquatic life metric

Rating Scale	Impairment	Description
A ≥ 90	Negligible	High total biomass (≥60 lbs/acre-gold medal standard); overall average relative weight is average or higher than average; viable recreational fishery.
B ≥ 80	Mild	Medium total biomass (40-59 lbs/acre); overall average relative weight is average; mediocre fishery with moderate numbers of adult fish.
C ≥ 70	Significant	Low total biomass (20-39 lbs/acre); overall average relative weight is below average; inconsistent recreational fishery with low numbers of adult fish.
D ≥ 60	Severe	Very low total biomass (0-19 lbs/acre); overall average relative weight is substantially below average; minimal recreational fishery potential with very low numbers of adult fish.
F ≥ 50	Profound	No trout present; no natural reproduction; no biomass; no recreational fishery.

A summary of macroinvertebrate and trout data is included in **Appendix F**.

2.11 Stream Condition Stressors

For the purposes of the SMP, stream condition stressors are considered to be past or present anthropogenic impacts affecting stream conditions. To understand the likely causes of impairment for each condition assessment, stream condition stressors were investigated for each SMP study reach. Stressors are often manifested and can be observed through their impact on stream condition. For example, degraded water quality may be the measurable result of a historic mining stressor. This section lists the most common stressors affecting the SMP study streams, many of which are interrelated and affect multiple stream health variables.

Crossings and Diversions

Structures such as bridges, culverts, diversion dams, and weirs may exacerbate channel migration or erosion. These structures can direct and concentrate flows into a streambank or embankment resulting in damage to infrastructure. Structures that are undersized, located near tight bends, or located where slopes change are more likely to have trouble passing sediment and debris being transported by a stream (Figure 2.12). This can result in upstream deposition of this material and subsequent channel movement while on the downstream side the sediment-deprived water becomes erosive. It is important to understand that this is often a structure problem, not a sediment or debris problem. As such, negative impacts can often be ameliorated through improved design or structure retrofits. Sediment and debris transport disruption is common at diversion structures within the SMP study area.

Prediction of geomorphic instability as a result of crossing structures or the most likely location of new channels should a crossing become blocked or fail is beyond the scope of this SMP. It is recommended, however, that road crossing designs allow for appropriate sediment transport at low, medium, and high flows (including the overflow areas), as well as the capability to pass debris. Crossings or crossing approaches might even be designed to fail (e.g., break-away designs) should they become plugged during a flood so as to encourage flood waters to stay in the channel. Similarly, diversion dams may create instability in a system partially due to their attempt to lock a laterally dynamic channel into a fixed location.

Disruption of natural sediment and/or debris transport regimes also degrades aquatic habitat. Sediment accumulation upstream of structures decreases fish as well as aquatic insect habitat complexity by eliminating interstitial spaces. Sediment and/or woody debris deprivation downstream of structures also decreases habitat complexity and limits nutrient inputs. Additionally, in-channel structures such as diversion dams can create barriers to fish passage, thereby fragmenting aquatic habitats. Habitat fragmentation can negatively affect fish populations and communities in a variety of ways including preventing fish from reaching spawning areas, isolating breeding populations and decreasing genetic diversity, and increasing the risk of disease.

Figure 2.12: (Left) Bridge over Saguache Creek with a pier in the middle of the bridge that may collect debris during a flood. (Right) Undersized culverts failing to transport sediment in a dry wash in Saguache County.

Roads and Railways

Roads oriented so they constrict the active river corridor can increase flow depths, shear stresses, and sediment transport capacities of streams. These constrictions can affect reaches upstream and downstream. Road and railroad bed encroachment does not appear to be significantly affecting the geomorphic stability of any of the streams in the SMP study area (Figure 2.13).

Figure 2.13: Railroad lines and bridges crossing the Rio Grande near flood stage, June 2019.

Channelization, Armoring, and Disconnection of Floodplains

Channelization (i.e., straightening of channel meanders; removal of large wood and/or beavers; filling of side channels to force a stream into a single-thread) and stream bank armoring (i.e., placement of rock riprap, concrete barriers, or other materials to prevent channel migration or widening) has occurred on the SMP study streams and adversely affects natural channel processes and stream health. Figure 2.14 shows a channelized portion of the Rio Grande.

Figure 2.14: Channelization of the Rio Grande at the Soldiers Home Road (County Road 3E).

These features can cause river-floodplain disconnection (i.e., the river is unable to access its floodplain at high flows where it otherwise would have). Stream response to floodplain disconnection and/or bank armoring typically results in the transfer of erosive energy to the opposite bank, a downstream reach, or toward the channel bed.

Figure 2.15: River-floodplain disconnection on the Rio Grande upstream of Alamosa.

Generally speaking, these changes lead to a fluvial response (i.e., instability seen as increased erosion, sedimentation, and/or channel movement). Disconnecting features such as berms or levees are not uncommon in the SMP study area, typically as a result of land conversion or road and railroad construction that now occupies former river floodplain.

Fill and Floodplain/Riparian Area Conversion

Land conversion can alter or eliminate floodplain complexity, side channels, wetlands, riparian vegetation, overflow relief channels, and other important geomorphic and ecological components of streams. Riparian vegetation and wetlands along some SMP reaches are impacted by fill and/or floodplain/riparian area conversion resulting from development, overgrazing, and nonnative species dominance. Riparian vegetation throughout the floodplain and river corridor, not just along the main channel, is critical to energy dissipation, stream shading, bank stability, wildlife habitat, and many other natural stream processes. Overgrazing and/or development fill brought into the corridor erases the evidence of past channel migration, possibly creating a false sense of protection from fluvial erosion to those that occupy the land. Furthermore, development creates the expectation (e.g., stable banks) that these rivers will remain in their current location indefinitely and therefore current and future generations will be willing and able to invest in the costs (both monetary and ecological) that will be required to resist natural channel processes (e.g., bank erosion and channel migration) (Figure 2.16).


Figure 2.16: Development in the active river corridor of the Rio Grande in the Town of Del Norte.

Flow Alteration: Impoundments

While Saguache Creek is a free-flowing stream, large dams affect both the Rio Grande and Conejos River. Dams affect these rivers both by reducing sediment transport, by trapping sediment behind them (Figure 2.17), as well as by reducing the peak flows that might otherwise provide channel-forming flows to flush fines, mobilize sediments, and do other geomorphic work. The Rio Grande is controlled by the earthen dam of the Rio Grande Reservoir which sits approximately 20 miles west of Creede. To a lesser degree, flows are also affected by Continental and Santa Maria reservoirs, which flow into Clear Creek. The Platoro dam on Conejos River is located roughly 1 mile above the town of Platoro, Colorado. Because these reservoirs are required to pass inflows during spring runoff, peak runoff is only altered when reservoir inflows surpass reservoir outlet capacity.

Figure 2.17: Sediment trapped behind the Rio Grande Reservoir (seen during dam repairs which had the reservoir drained during the fall of 2018).

Flow Alteration: Diversions

Diversion structures can affect stream health in two main ways: they act as small dams, trapping sediment behind them and they can act as barriers to aquatic habitat connectivity. The disruption of sediment transport can create localized channel and bank instability. As water is diverted out of the stream system, it can create conditions where channel flow is below optimal to perform geomorphic work. Without channel-maintaining flows, channels may narrow as vegetation creeps into the channel where scouring flows once kept the channel open. This process is particularly evident in Rio Grande SMP reach RG14, within the Alamosa levee system. Diversions can act as fish barriers, thereby reducing aquatic habitat connectivity and limiting species movement. Although very little is known regarding the habitat requirements of native species inhabiting the SMP study streams, fish species thrive when they are able to move between a variety of habitat types.

Hillslope/Channel Erosion

Streams receive sediment of varying sizes from naturally-occurring hillslope and channel erosion processes. However, unusually high or low sediment inputs can adversely affect stream health. Among other impacts, unusually high sediment loads decrease fish and macroinvertebrate habitat complexity by eliminating interstitial spaces, while low sediment loads can also decrease habitat complexity and limit key nutrient inputs. High sediment input often occurs as a result of hillslope, bank, and channel instability. Instability often results from a loss of riparian vegetation that would otherwise stabilize banks and can be exacerbated by floodplain disconnection. In areas lacking floodplain connectivity, high flows cannot dissipate energy by spreading out, leading to accelerated bank erosion and downstream sedimentation. Low sediment supply can also be caused by bank stabilization efforts which have resulted in less erosion than would have occurred under natural conditions.

Abandoned Mine Lands

Historic mining operations, or Abandoned Mine Lands (AML) continue to affect water quality in the SMP study area. For example, historic mining near Creede is known to be the primary source of elevated heavy metal concentrations in Willow Creek, which has led to elevated concentrations in the Rio Grande downstream of Willow Creek. State water quality standard exceedances of both cadmium and zinc resulted in a 303(d) listing and subsequent Total Maximum Daily Load (TMDL) requirement for these metals from the Willow Creek confluence to the Rio Grande/Alamosa County line. Mild AML water quality impacts were noted in the Conejos River but were not noted in Saguache Creek. Elevated metal concentrations can have toxic effects on aquatic life.

Exotic/Naturalized Plant Species

It is worth briefly exploring the difference between nonnative invasive (including noxious) plant species and nonnative naturalized species. Native plant species occurred in the U.S. before European settlement, while a nonnative species is thought to have been introduced as a result of European settlement. An invasive plant is nonnative, able to establish itself at a variety of sites, grows quickly, and spreads to the point of disrupting the local plant community and associated ecosystem. A naturalized plant species is also nonnative, but doesn’t take over the existing native plant community or associated ecosystem dynamics (USDA NRCS, 2019).

Dense stands of invasive species can negatively affect hydrologic processes and ecological function of an area, particularly in riparian zones (Gebauer, 2013). A key trait of invasive plant species is their potential to outcompete the native plant community, sometimes resulting in a monoculture of vegetation. The presence of naturalized species, however, may have minimal impacts on the native biological integrity, species or functional group diversity, or productivity of a given site (Spyreas et al., 2010).

Buffer width is one important factor in riparian health. A buffer of sufficient size and quality improves water quality by trapping sediments and filtering pollutants before they reach the river or stream. When the buffer includes a variety of canopy layers, it also provides stream shading and helps control water temperature. Finally, the presence of woody debris helps shape the riparian channel and provides habitat for a variety of species (Gebauer, 2013). These pivotal ecosystem services provided by a diverse and structurally complex plant community are often diminished when invasive species spread through and area. Naturalized species however, have been observed to exist within a community without having strong adverse impacts to these ecological functions. Therefore, while the presence of naturalized plant species may not be as desirable as that of native plants, naturalized species should not be managed in the same aggressive manner used to control populations of invasive species.

For the purpose of the SMPs, the following plant species encountered during surveys were considered to be naturalized rather than invasive: *Dactylis gomerata* (Orchardgrass), *Phleum pratense* (Timothy grass), *Poa compressa* (Canada bluegrass), *Poa pratensis* (Kentucky bluegrass)*, Taraxacum officinale* (Dandelion)*, Trifolium pratense* (Red clover)*,* and *Trifolium repens* (White clover)*.* It is important to note that these species may be considered to be invasive in some locations and under certain ecological conditions. However, during SMP surveys, these species were neither observed to establish monocultures, nor to have obvious harmful impacts on the biological integrity of any given assessment area.

Additionally, all noxious plants encountered in addition to the species, *Phalaris arundinaea* (Reed canarygrass), were considered to be invasive. Noxious plants were identified using the state of Colorado's Noxious Weed List (CDA, 2018). While not classified as a noxious species, *P. arundinacea* is thought to have both native and nonnative types within the U.S. It has been promoted and intentionally spread in the past as a forage grass for livestock. For the purpose of the Colorado EIA Scorecard, this species is considered to be an increaser species with a '0' rating for its C-value. Spyreas et al. (2008) suggested that when *P. arundinacea* becomes invasive, it decreases community level diversity and biological integrity of sampled sites across Illinois. This species has also been implicated in contributing to low streamflow during the growing season in semi-arid riparian zones in eastern Washington. The recommendation for assessment areas with a presence by noxious plant species is to actively control these populations to minimize spread and prevent further disruption to the site's ecological integrity.

Exotic Aquatic Species

Nonnative aquatic species such as common carp and northern pike, both of which are present in the SMP study streams, may indicate degraded stream health. Exotic species are more likely to survive in areas where water quality or habitat degradation has led to unsuitable conditions for native species.

Removal or Lack of Woody Material

Large and small woody material, both alive and dead, is an important driver of river function and the creation and maintenance of aquatic species habitat. Woody material within the main channel, secondary channels, and floodplain influences the transport of water, sediment, and debris as well as the geomorphic form and stability of streams. It also creates valuable aquatic habitat including pools, which provide refuge for fish and other aquatic species during high and low flows and buffer water temperature. Lack of woody material in some SMP study reaches has resulted in reduced floodplain connectivity, less diverse aquatic habitat, and lower overall system resiliency.

Unknown Stressors

In some cases, causes of impairment are unknown. Most often, unknown stressors are related to water chemistry impairment. For example, elevated arsenic concentrations measured in the headwaters of the Rio Grande, Conejos River, and Saguache Creek have no readily apparent source. Likely, the impairment can be attributed to high concentrations of naturally occurring arsenic in geologic formations. However, the point source is unknown and warrants further research.

3. Rio Grande SMP Conditions Assessment Results

3.1 Summary of Rio Grande SMP Conditions Assessment Findings

This section provides a summary of the conditions assessment results for all Rio Grande reaches. Table 3.1 and the corresponding map in Figure 3.1 outline the Rio Grande Stream Management Plan assessment reaches, including each reach's length in river miles.

Table 3.1: Description of Rio Grande SMP assessment reaches.

Reach ID	Reach Description	Length (River Miles)*
RG01	Stony Pass to Bear Creek Confluence	7.1
RG02	Bear Creek Confluence to Rio Grande Reservoir Inlet	8.6
RG03	Rio Grande Reservoir Outlet to Mouth of Box Canyon	9.1
RG04	Mouth of Box Canyon to Hogback Mountain	11.0
RG05	Hogback Mountain to Marshall Park Campground	6.1
RG06	Marshall Park Campground to Wagon Wheel Gap	13.8
RG07	Wagon Wheel Gap to Forest Road 430A Bridge	7.1
RG08	Forest Road 430A Bridge to Highway 149 Bridge in South Fork	7.0
RG09	Highway 149 Bridge in South Fork to Rio Grande Splitter	21.3
RG10	Rio Grande Splitter to Prairie Ditch	9.5
RG11	Prairie Ditch to Gunbarrel Road (Highway 285)	6.9
RG12	Gunbarrel Road (Highway 285) to Rio Grande/Alamosa County Line	8.8
RG13	Rio Grande/Alamosa County Line to City of Alamosa Near Lakewood Drive	22.0
RG14	City of Alamosa Near Lakewood Drive to Chicago Ditch	4.5
RG15	Chicago Ditch to Conejos River Confluence	19.2
RG16	Conejos River Confluence to Rio Grande Canyon Entrance	7.1
RG17	Rio Grande Canyon Entrance to Colorado/New Mexico State Line	22.2
	Total Stream Miles	**191.3**

*River miles were calculated using SWRF (see section 2.1). Diversion structures were also assessed on the North Channel Rio Grande, a 6.9-mile reach. Other stream conditions were not assessed for the North Channel Rio Grande.

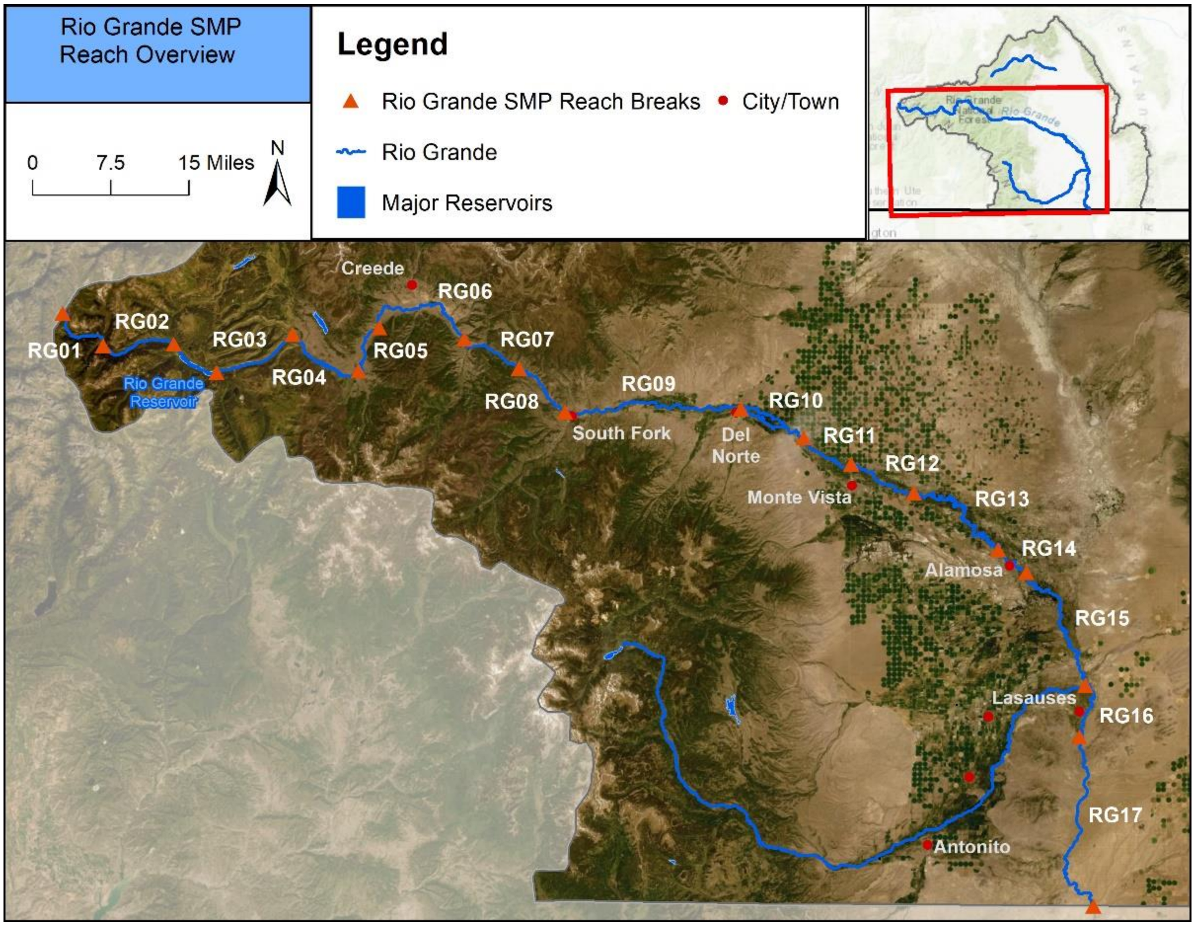


Figure 3.1: Overview of Rio Grande SMP assessment reaches.

The transition from Reach RG11 to RG12, at the Highway 285 bridge, marks the river's transition from a classification of *aquatic life cold 1* to *aquatic life warm 1*. Classifications refer to the stream segment's *aquatic life use* and are designated by the Colorado Department of Public Health and Environment (CDPHE). This location (Gunbarrel Rd/Hwy 285 Bridge) also marks the transition from the steeper upstream channel slopes to the flatter downstream channel slopes, causing the channel to transition from being erosional to depositional (MWH, 2001). Water temperature standards, designated by CDPHE, are as follows: Reaches RG01 to halfway through RG06 have a *cold stream tier I (CS-I)* standard. Roughly halfway through RG06, at the Willow Creek confluence, the river transitions to a *cold stream tier II (CS-II)* standard. Downstream, reaches RG07 through RG11 have a *cold stream tier II (CS-II)* standard and reaches RG12 through RG17 have a *warm stream tier II (WS-II)* standard (CDPHE, 2018a).

Figure 3.2 shows reach condition by assessment as well as the overall reach condition. Overall reach condition was calculated as the mean assessment rating for each reach.

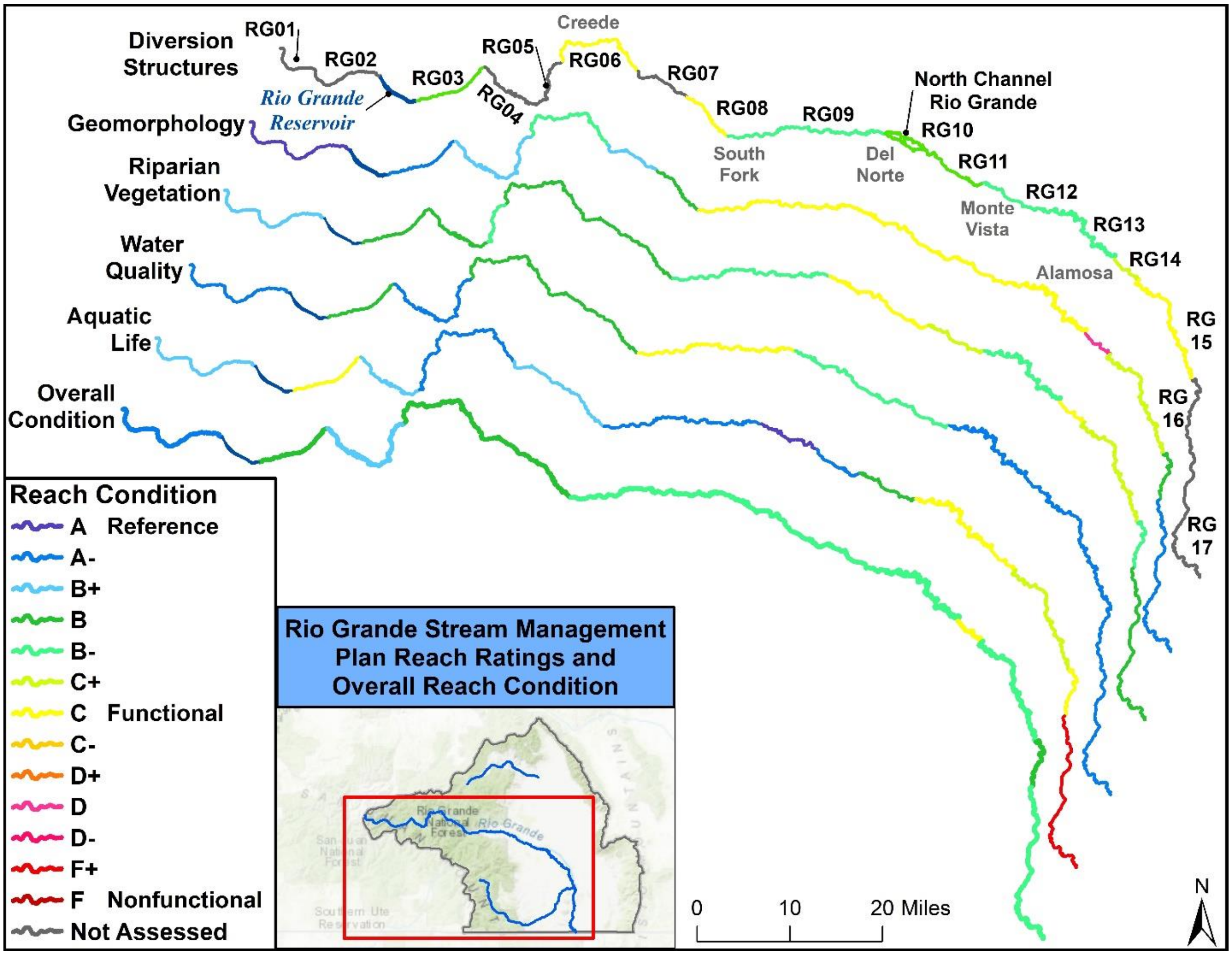


Figure 3.2: Conditions Assessment results presented by reach. Overall reach condition is also shown.

3.1.1 Rio Grande Diversion Infrastructure Inventory

All diversion structures located on the mainstem Rio Grande were included in this assessment.

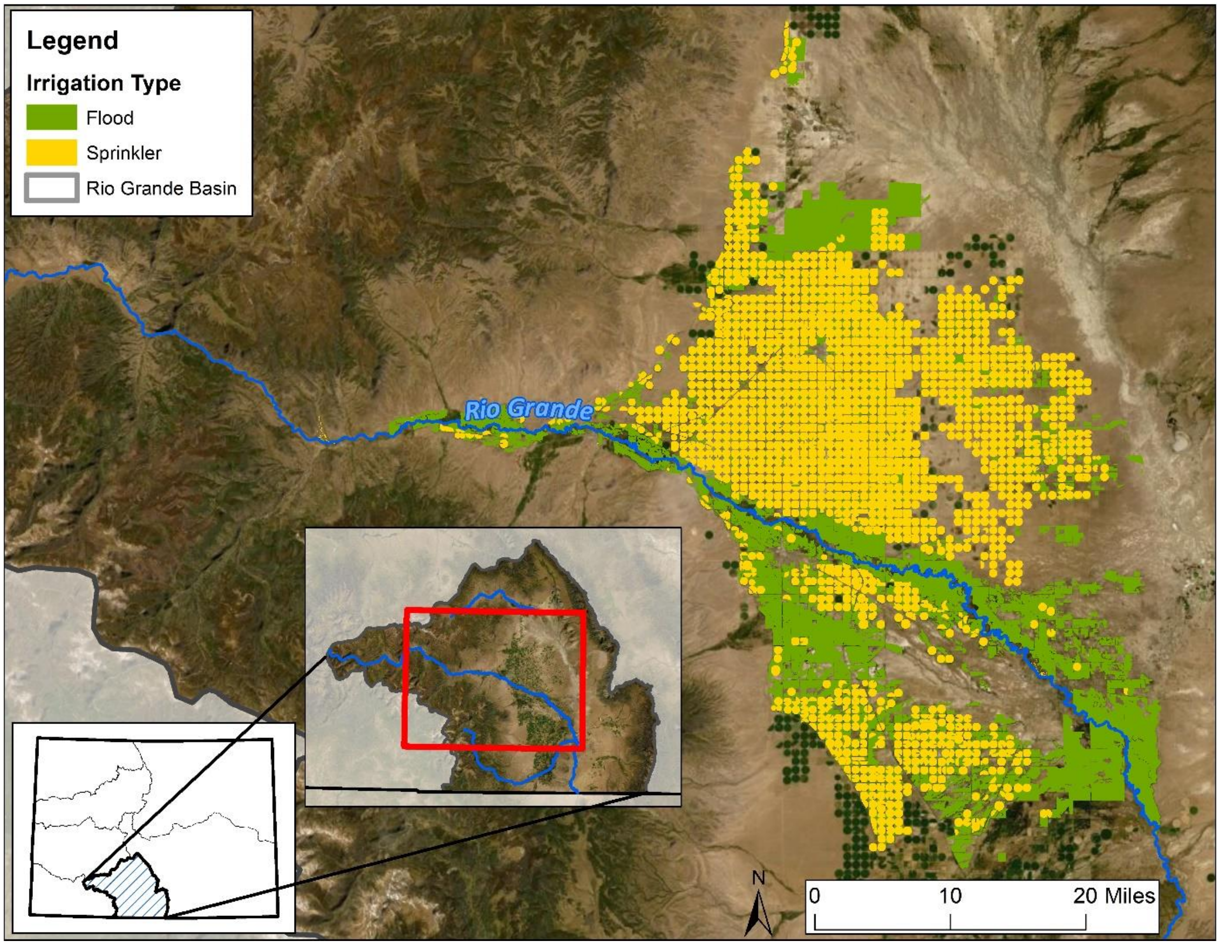


Figure 3.3: Land irrigated partially or entirely by Rio Grande surface water rights.

The diversion infrastructure inventory revealed several issues affecting the function of diversion infrastructure (e.g., headworks, diversion dams, measurement devices, and other diversion infrastructure) as well as adjacent riparian and stream conditions. Issues identified included aging and inefficient infrastructure requiring significant maintenance, bank and hillslope erosion resulting in increased sediment accumulation at diversions, headgates, and in ditch systems, sediment transport disruption at diversion dams, which exacerbates erosion, channel migration, and/or incision, and barriers to fish and/or boat passage at some diversions. Technical Advisory Team (TAT) recommendations for improving Rio Grande diversion infrastructure include: 1) Diversion dam improvements for enhanced sediment transport, fish passage, and/or boat passage, 2) Floodplain reconnection and channel stabilization through reshaping and riparian revegetation, and 3) Repair or replacement of structural components including headgates, headwalls, and measurement devices. Additionally, the TAT recommends consolidating the points of diversion for several structures to improve ditch efficiencies and reduce maintenance and sediment transport impacts. Consolidation of the following structures is recommended: the Independent and Ehrowitz ditches; the Brey and Weiss ditches and the Excelsior, Costilla, and Independent ditches (using Excelsior Ditch as the point of diversion). McIntosh Arroya Ditch could also be relocated to allow for restoration and other projects on the South Channel Rio Grande such as a low-flow channel. Additionally, combining the headgates and feeder channels servicing the Monte Vista Canal and Rio Grande Valley Piedra ditches, which share a diversion, would reduce maintenance for both ditch companies. However, it should be noted that consolidation of some structures may not be possible due to legal or water rights-related obstacles.

With the exception of two specific diversion structures, CPW recommends maintaining existing and creating new fish passage at diversions within the entire SMP study area to maintain and improve aquatic habitat connectivity. The Prairie Ditch diversion and the Rio Grande Canal currently act as barriers to the upstream movement of nonnative predatory fish found downstream. CPW recommends maintaining these existing barriers to prevent predation on or competition with native small-bodied species as well as trout fisheries found upstream.

Table 3.2 summarizes several attributes of each diversion structure, including its location and current condition. Additionally, each structure's annual irrigated acres and amount diverted are listed based on data from 2017 diversion records. The 2001 Rio Grande Headwaters Restoration Project study assessed structures from the upstream limit of the Town of South Fork downstream to the Alamosa-Conejos County line (MWH, 2001). Additionally, an inventory and assessment funded by the Colorado Water Conservation Board (CWCB) was completed in 2006 and included diversions on the mainstem of the Rio Grande. Structure condition from this assessment is also included in Table 3.2.

Table 3.2: Diversion infrastructure statistics and condition listed by structure.

SMP Assessment Reach	Structure Name	Priority	Total Decreed Rate (cfs)	Water District ID (WDID)	2001 Rating	2006 Rating	Current Structure Rating	Headgate Automation (Y/N)	River Miles from Colorado State Line	Acres Irrigated (acres)	Amount Diverted (acre-feet)	Flood, Sprinkler, Both	% Flood/ % Sprinkler	Notes
RG03	San Juan Ditch	1903-49K	10	2000827	N/A	N/A	B	N	167.0	N/A	N/A	Flood	100/0	Irrigated acres data not available. Amt. diverted in 2016: 31.74 AF
RG06	Antlers Park Ditch	1903-51	1.06	2000514	N/A	N/A	D	N	148.2	N/A	N/A	Flood	100/0	Irrigated acres data not available. Amt. diverted in 2016: 8.73 AF
	Spring Ranch Ditch	329	1	2000861	N/A	N/A	B	N	140.1	N/A	222.95	Flood	100/0	This structure also services Wason Ditch. No irrigated lands data available.
RG08	Jessup Ditch 1	1903-1	1.72	2000692	N/A	N/A	C	N	126.8	5.07	87.33	Flood	100/0	2017 irrigation data not available; 2016 data used.
RG09	South Fork Highline Ditch	106	16.96	2000854	N/A	Good	C	N	0.9	87.01	960.01	Flood	100/0	River miles from confluence of South Fork Rio Grande and mainstem Rio Grande.

SMP Assessment Reach	Structure Name	Priority	Total Decreed Rate (cfs)	Water District ID (WDID)	2001 Rating	2006 Rating	Current Structure Rating	Headgate Automation (Y/N)	River Miles from Colorado State Line	Acres Irrigated (acres)	Amount Diverted (acre-feet)	Flood, Sprinkler, Both	% Flood/ % Sprinkler	Notes
RG09	South Side Diversion	This structure operates under augmentation plan 2007053	0.5	2002027	N/A	N/A	A	N	120.3	8.63	15.55	Sprinkler	0/100	
RG09	North Side Diversion	This structure operates under augmentation plan 2007053	2.5	2002026	N/A	N/A	A	N	120.3	79.39	192.34	Sprinkler	0/100	
RG09	Riviere Estates Augmentation Plan	This structure operates under augmentation plan 2002037	N/A	2007022	Good	Fair	B	N	119.6	N/A	N/A	N/A	N/A	This structure diverts surface water from the Rio Grande, but does not irrigate agricultural land. 2017 data not available; amt diverted in 2010: 0.70 AF.
RG09	Anaconda Ditch	105	38.76	2000511	Fair	Fair	B	N	118.0	147.02	1852.79	Flood	100/0	
RG09	Minor Ditch	105	39.48	2000752	Fair	Fair	C+	N	114.8	1006.26	6581.09	Flood & Sprinkler	71/29	
RG09	Meadow Glen Ditch	105	46.86	2000742	Good	Good	B-	N	114.3	475.87	2653.51	Flood	84/16	
RG09	Pfeiffer Ditch	164	10.67	2000787	Fair	Fair	A-	N	113.8	150.14	353.86	Flood	100/0	
RG09	Independent Ditch 2	105	67.23	2000681	Fair	Fair	C+	N	111.2	1408.38	6789.12	Flood & Sprinkler	87/13	

SMP Assessment Reach	Structure Name	Priority	Total Decreed Rate (cfs)	Water District ID (WDID)	2001 Rating	2006 Rating	Current Structure Rating	Headgate Automation (Y/N)	River Miles from Colorado State Line	Acres Irrigated (acres)	Amount Diverted (acre-feet)	Flood, Sprinkler, Both	% Flood/ % Sprinkler	Notes
RG09	**Knoblauch Ditch**	**258**	**7.36**	**2001130**	**N/A**	**N/A**	**B-**	**N**	**111.2**	**80.00**	**695.02**	**Flood**	**100/0**	This ditch services Knoblauch Ditch 1 and Knoblauch Ditch 2. Irrigation records listed include those structures.
RG09	**Ehrowitz Ditch**	**175**	**12.35**	**2000614**	**Fair**	**Good**	**C**	**N**	**110.9**	**287.48**	**1054.43**	**Flood & Sprinkler**	**78/22**	
RG09	**Bauer Ditch**	**187**	**15.25**	**2000528**	**Fair**	**Good/ Fair**	**B-**	**N**	**109.4**	**309.25**	**1031.22**	**Flood & Sprinkler**	**81/19**	
RG09	**Atkins Ditch**	**57**	**1.05**	**2000965**	**Poor**	**Fair**	**A-**	**N**	**106.8**	**298.55**	**294.35**	**Flood**	**15/85**	Irrigated acres reported under Atkins/Voss Seepage Pump, ID#1705.
RG09	**Park Green Ditch**	**184**	**5.2**	**2000782**	**Poor**	**Poor**	**B+**	**N**	**105.1**	**230.89**	**879.48**	**Flood & Sprinkler**	**70/30**	
RG09	**Dyer Ditch**	**15**	**4**	**2000611**	**Fair**	**Fair**	**C-**	**N**	**103.1**	**56.35**	**223.34**	**Flood**	**100/0**	
RG09	**Del Norte Town Ditch**	**126**	**3.3**	**2000595**	**N/A**	**Fair**	**D**	**N**	**103.1**	**45.41**	**7.74**	**Flood & Sprinkler**	**95/5**	

SMP Assessment Reach	Structure Name	Priority	Total Decreed Rate (cfs)	Water District ID (WDID)	2001 Rating	2006 Rating	Current Structure Rating	Headgate Automation (Y/N)	River Miles from Colorado State Line	Acres Irrigated (acres)	Amount Diverted (acre-feet)	Flood, Sprinkler, Both	% Flood/ % Sprinkler	Notes
RG09	Rio Grande Canal	28	1699.4	2000812	Good	Good	B	Y	101.7	69408.42	186014.93	Flood & Sprinkler	5/95	This ditch holds a winter recharge water right (Case No 79CW91). The total decreed rate accounts for 50.9 cfs transferred to Rio Grande Canal (priorities 28 and 176)
RG09	Schuch Schmidt Ditch	179	4.4	2000833	Good	Good	C	N	101.7	209.71	1284.71	Flood & Sprinkler	6/94	
RG09	Midland Ditch	1916-18	60	2000747	Poor	Good	B-	N	101.7	N/A	N/A	Flood	100/0	Not in priority in 2017.
RG09	Rio Grande Ditch 4	13	1.2	2000815	Fair	Good	B-	N	101.0	48.21	152.53	Flood	100/0	
RG09	Rio Grande Ditch 1	8	36	2000810	Fair	Good	C	N	100.3	736.91	4883.08	Flood	100/0	
RG09	Rio Grande Splitter	N/A	N/A	N/A	Good	N/A	C	N	100.2	N/A	N/A	Flood	N/A	This structure services all ditches on the North Channel Rio Grande.
North Channel Rio Grande	Weiss Ditch	1903-44	1.34	2000901	Good	Fair	F	N	6.5	80.01	N/A	Flood	100/0	
North Channel Rio Grande	Brey Ditch	341	4.8	2000552	Good	Poor	A-	N	6.5	85.19	300.30	Flood	100/0	

SMP Assessment Reach	Structure Name	Priority	Total Decreed Rate (cfs)	Water District ID (WDID)	2001 Rating	2006 Rating	Current Structure Rating	Headgate Automation (Y/N)	River Miles from Colorado State Line	Acres Irrigated (acres)	Amount Diverted (acre-feet)	Flood, Sprinkler, Both	% Flood/ % Sprinkler	Notes
North Channel Rio Grande	Rio Grande Ditch 2	83	4.2	2000814	Good	Good/ Fair	A	N	6.3	412.97	1676.26	Flood & Sprinkler	77/23	
North Channel Rio Grande	Kane Callan Ditch	36	24	2000699	Good	Good/ Fair	A-	N	5.6	296.47	2692.40	Flood	100/0	
North Channel Rio Grande	Anna Raber Ditch	73	3.8	2000513	Good	Good	C+	N	5.5	150.78	600.60	Flood	100/0	
North Channel Rio Grande	Off Ditch	81	5	2000777	Good	Good/ Fair	A-	N	4.2	411.10	1450.53	Flood	100/0	
North Channel Rio Grande	Raber Ditch	73	3.8	2000801	Good	Poor	A-	N	2.0	128.13	464.14	Flood	100/0	
North Channel Rio Grande	Hall-Voss Ditch	244	1.95	2000966	Good	Poor	B-	N	1.5	82.74	264.30	Flood	100/0	
North Channel Rio Grande	Cochran Pioneer Ditch	13	3	2000582	Good	Good	A-	N	0.6	246.88	862.03	Flood & Sprinkler	58/42	
North Channel Rio Grande	Farmers Union Canal	308	801.36	2000631	Good	Good	B	N	0.6	41085.81	47371.47	Flood & Sprinkler	0.1/99.9	This ditch holds a winter recharge water right (Case No 79CW91).
RG10	Mcintosh Arroya Ditch	83	4	2000737	Poor	Good	C+	N	95.1	186.48	569.26	Flood	100/0	
RG10	Silva Ditch	1	18.86	2000846	Good	Good	B-	N	92.6	625.66	7236.60	Flood & Sprinkler	64/36	
RG10	Atencio Ditch 2	144	4	2000518	Fair	Good	B-	N	92.6	129.32	1613.97	Flood	100/0	

SMP Assessment Reach	Structure Name	Priority	Total Decreed Rate (cfs)	Water District ID (WDID)	2001 Rating	2006 Rating	Current Structure Rating	Headgate Automation (Y/N)	River Miles from Colorado State Line	Acres Irrigated (acres)	Amount Diverted (acre-feet)	Flood, Sprinkler, Both	% Flood/ % Sprinkler	Notes
RG10	McDonald Ditch	11	14.4	2000736	Fair	Good	A	Y	91.3	647.81	6155.20	Flood & Sprinkler	71/29	
RG10	Prairie Ditch	11	367.02	2000798	Good	Good	A	Y	90.8	14494.37	21998.68	Flood & Sprinkler	1.5/98.5	This ditch holds a winter recharge water right (Case No 79CW91).
RG11	Monte Vista Canal	224	340.77	2000753	Good	Good	B	Y	90.0	22708.74	45923.12	Flood & Sprinkler	30/70	This ditch holds a winter recharge water right (Case No 79CW91).
RG11	Rio Grande Piedra Valley Ditch	146	94.48	2000811	Fair	Fair	B+	N	89.9	6959.06	21580.08	Flood & Sprinkler	79/21	
RG11	San Jose or Lucero Ditch	3	5.4	2000826	N/A	N/A	B	N	89.9	222.80	1156.78	Flood & Sprinkler	49/51	
RG11	Consolidated Ditch	See priorities for Marajo, John Anderson, Star, Rio Grande San Luis, Rio Grande Lariat, Anderson, Atencio, and Horner Ydren Ditches	See Marajo, John Anderson, Star, Rio Grande San Luis, Rio Grande Lariat, Anderson, Atencio, Horner Ydren Ditches		Poor	Fair	A	Y	89.4	N/A	N/A	Flood	N/A	This structure services Marajo, John Anderson, Star, Rio Grande San Luis, Rio Grande Lariat, Anderson, Atencio, and Horner Ydren Ditches. See below.

SMP Assessment Reach	Structure Name	Priority	Total Decreed Rate (cfs)	Water District ID (WDID)	2001 Rating	2006 Rating	Current Structure Rating	Headgate Automation (Y/N)	River Miles from Colorado State Line	Acres Irrigated (acres)	Amount Diverted (acre-feet)	Flood, Sprinkler, Both	% Flood/ % Sprinkler	Notes
RG11	Pace Ditch	18	1.4	2000781	Poor	Fair	B	N	89.4	91.73	569.46	Flood	100/0	
RG11	Marajo Ditch	231	5	2000731	N/A	Fair	C	N	89.4	170.01	594.26	Flood	100/0	Serviced by Consolidated Ditch
RG11	John Anderson Ditch	193	3.2	2000694	N/A	Poor	B-	N	89.4	105.05	1183.36	Flood	100/0	Serviced by Consolidated Ditch
RG11	Star Ditch	263	13.61	2000865	N/A	Fair	B	N	89.4	468.90	1224.61	Flood	100/0	Serviced by Consolidated Ditch
RG11	Rio Grande San Luis Ditch	156	53.24	2000817	N/A	Good/ Fair	B-	N	89.4	2939.20	9215.74	Flood & Sprinkler	47/53	Serviced by Consolidated Ditch
RG11	Rio Grande Lariat Ditch	217	106.8	2000816	N/A	Fair	B	N	89.4	3641.66	12432.58	Flood & Sprinkler	42/58	Serviced by Consolidated Ditch
RG11	Anderson Ditch	57	16.15	2000512	N/A	Fair	B	N	89.4	710.49	5474.46	Flood	100/0	Serviced by Consolidated Ditch
RG11	Atencio Ditch	2	6.18	2000517	N/A	Fair	B	N	89.4	351.66	2111.04	Flood	100/0	Serviced by Consolidated Ditch
RG11	Horner Ydren Ditch	14	12.7	2000671	N/A	Poor	B	N	89.4	575.68	3903.73	Flood & Sprinkler	90/10	Serviced by Consolidated Ditch
RG11	Butler Irrigation Ditch	30	6.8	2000556	Poor	Good	B-	N	88.3	307.45	2090.81	Flood & Sprinkler	45/55	
RG11	Hubbard Ditch	31	1	2000677	N/A	Good	B	N	87.1	107.66	374.29	Flood	100/0	
RG11	Fish Ditch	34	9.3	2000636	Poor	Fair	A-	N	85.3	1688.27	2662.45	Flood	100/0	
RG11	Nichol Ditch	138	11.2	2000775	Poor	Fair	B	N	85.0	475.74	2481.56	Flood	100/0	

SMP Assessment Reach	Structure Name	Priority	Total Decreed Rate (cfs)	Water District ID (WDID)	2001 Rating	2006 Rating	Current Structure Rating	Headgate Automation (Y/N)	River Miles from Colorado State Line	Acres Irrigated (acres)	Amount Diverted (acre-feet)	Flood, Sprinkler, Both	% Flood/ % Sprinkler	Notes
RG12	**Empire Canal**	**71**	**512**	**2000623**	**Fair**	**Good**	**B**	**Y**	**82.2**	**35526.92**	**77484.00**	**Flood & Sprinkler**	**55/45**	This ditch holds a winter recharge water right (Case No 79CW91). 6.08 cfs belonging to priorities 71 and 211 is delivered via this ditch and is accounted for in the total decreed rate.
RG12	**Billings Ditch**	**34**	**34.94**	**2000546**	**Poor**	**Good**	**D-**	**N**	**81.1**	**3402.92**	**5709.52**	**Flood & Sprinkler**	**25/75**	
RG12	**San Luis Valley Canal**	**270**	**500.98**	**2000829**	**Poor**	**Poor**	**B+**	**Y**	**78.0**	**14704.63**	**25153.68**	**Flood & Sprinkler**	**21/79**	This ditch holds a winter recharge water right (Case No 01CW20).
RG12	**Centennial Ditch**	**32**	**82.4**	**2000566**	**Fair**	**Good**	**A-**	**Y**	**77.4**	**5448.00**	**21398.00**	**Flood & Sprinkler**	**68/32**	This ditch holds a winter recharge water right (Case No 79CW91).

SMP Assessment Reach	Structure Name	Priority	Total Decreed Rate (cfs)	Water District ID (WDID)	2001 Rating	2006 Rating	Current Structure Rating	Headgate Automation (Y/N)	River Miles from Colorado State Line	Acres Irrigated (acres)	Amount Diverted (acre-feet)	Flood, Sprinkler, Both	% Flood/ % Sprinkler	Notes
RG13	Excelsior Ditch	74	179.4	2000627	Fair	Good	C	N	74.6	5158.44	24974.67	Flood & Sprinkler	95/5	This ditch holds a winter recharge water right (Case No 01CW20).
RG13	Costilla Ditch	293	103.3	2000587	Poor	Good	B	Y	65.0	9420.78	12310.85	Flood & Sprinkler	97/3	
RG13	Independent Ditch	166	11.2	2000680	Fair	Good	B	N	56.2	363.48	3187.48	Flood & Sprinkler	82/18	This structure is owned by the City of Alamosa. The measurement structure is a rated steel box. This structure can sweep the river during low flows.
RG14	Westside Ditch	165	35.8	2000903	Poor	Poor	D	N	50.0	1897.81	4769.52	Flood	100/0	
RG14	Chicago Ditch	174	66.4	2000575	Good	Good	A-	Y	48.5	6025.64	10974.11	Flood	100/0	
RG15	Meadow Overflow	68	67	2000743	N/A	N/A	B-	N	43.0	N/A	126.94	Flood	100/0	Irrigated acres data not available.
RG15	New Ditch	1903-22	30.43	2000773	Fair	Poor	C-	N	41.9	1795.40	141.00	Flood	100/0	

*Note: Acres irrigated, amount diverted, and percent flood/sprinkler are based on 2017 records. River miles for structures located on North Channel Rio Grande are from the confluence of the North Channel Rio Grande and mainstem Rio Grande. Amounts are rounded to the nearest tenth.

3.1.2 Aquatic Habitat Flow Needs Assessment Summary

***For a description of R2Cross methodology and caveats, refer to section 2.6**

Twenty-two R2 Cross sites were completed between Rio Grande Reservoir and the Colorado/New Mexico state line. The hydrology nodes used in the aquatic habitat flow needs assessment, summer/winter flow targets, and corresponding instream flow water rights for each reach are shown in Table 3.3.

Table 3.3: Hydrology nodes, summer and winter flow targets, and corresponding instream flows by reach.

SMP Reach(es)	Gage/Location Name	Gaged/ Ungaged	Summer Flow Target (cfs)	Winter Flow Target (cfs)	Latitude	Longitude	Corresponding Instream Flow Case No. and Flow Rates (summer/winter) in cfs
RG03	Rio Grande at Thirty Mile Bridge Near Creede (RIOMILCO)	Gaged	85	31	37.72492	-107.25579	N/A
RG03	Rio Grande at Mouth of Box Canyon	Ungaged	89	64	37.77458	-107.14128	3-83CW040 (55/20)
RG04	Rio Grande Upstream of Trout Creek	Ungaged	182	81	37.72095	-107.02973	3-83CW049 (90/45)
RG05	Rio Grande at Marshall Park Campground	Ungaged	179	90	37.79317	-106.98192	3-83CW039 (150/65)
RG06	Rio Grande at Wagon Wheel Gap (RIOWAGCO)	Gaged	179	90	37.76642	-106.83065	3-83CW039 (150/65)
RG07, RG08	Rio Grande Upstream of South Fork Confluence	Ungaged	182	84	37.67603	-106.65436	3-83CW042 (160/80)
RG09	Rio Grande Near Del Norte (RIODELCO)	Gaged	330	82	37.68861	-106.45981	N/A
RG10, RG11	Rio Grande at Monte Vista (RIOMONCO)	Gaged	220	78	37.60951	-106.14902	N/A
RG12	Rio Grande Upstream of San Luis Valley Canal	Ungaged	177	83	37.58003	-106.07515	N/A
RG13	Rio Grande at Alamosa (RIOALACO)	Gaged	209	77	37.48081	-105.87796	N/A
RG14	N/A	N/A	N/A	N/A	N/A	N/A	N/A
RG15, RG16	Rio Grande Above Trinchera Creek Near Lasauses (RIOTRICO)	Gaged	216	90	37.3165	-105.74279	N/A
RG17	Rio Grande Near Lobatos (RIOLOBCO)	Gaged	312	92	37.07869	-105.75697	N/A

Based on data from two sites, the mean summer minimum flow recommendation (three of three Habitat Criteria met), referenced at the Thirty Mile Bridge gage is 85 cfs. The winter minimum (two of three Habitat Criteria met) is 31 cfs. Based on data from two separate sites, the mean summer minimum flow recommendation, referenced at the Wagon Wheel Gap gage is 179 cfs. The winter minimum is 90 cfs. Notably, minimum flow recommendations increased from RG03 through RG09, decreased from RG09 to RG14, and increased again from RG15 to RG17. It is assumed that the decrease from RG09 to RG14 is due to diversions from the river, which, over the last 150 years, have reduced channel capacity and resulted in other geomorphic changes.

In an attempt to estimate flows between gages, a regression analysis was performed at downstream gages (Del Norte, Monte Vista, and Lobatos) relative to measured flow at the Wagon Wheel Gap gage. Although a reasonable correlation and precision to the Del Norte gage was achieved, particularly at higher flows, a poor relationship was found further downstream to the Monte Vista and Lobatos gages.

For the purposes of the SMP, it is assumed that if the recommended minimum flow is delivered at both the Thirty Mile Bridge gage (85 cfs summer and 31 cfs winter) and Wagon Wheel Gap gage (179 cfs summer and 90 cfs winter), habitat values for trout would be protected elsewhere on the river. When possible, it may be beneficial to augment Rio Grande Reservoir releases if the measured minimum flow at Thirty Mile Bridge does not meet or exceed the minimum flow recommendation at Wagon Wheel Gap. Instream Flow Incremental Methodology (IFIM) and Physical Habitat Simulation (PHABSIM) studies were conducted by CPW. Habitat Suitability curves from these studies are not available, however, so comparison is not possible.

Fish species life history information is important when considering opportunities to operate reservoirs to maximize aquatic habitat. Rio Grande brown trout (the dominant resident salmonid) life history was used to determine critical aquatic habitat time periods. Using findings from Nehring & Anderson (1993) for the Rio Grande, critical life history is as follows: Adult Spawning 10/15-11/15; Egg Incubation 10/15-5/1; Egg Hatching 4/1-6/1; Fry Emergence 5/15-6/15. Based on this information, the following actions are recommended, when possible:

- Keep flows consistent during the winter period (October 1 through April 30) for brown trout spawning, egg incubation, and hatching. When possible, a minimum flow of 31 and 90 cfs measured at the Thirty Mile bridge and Wagon Wheel Gap Gages, respectively, is recommended. Fish are sensitive to flow changes during the spawn. Even subtle changes can affect spawning behavior with possible effects on egg deposition, hatching, and subsequent fry production. Spawning flows should be maintained through the winter to protect incubating eggs. Flows can increase early in the incubation period but care must be taken not to scour eggs from the gravel. Newly emerged fry are very vulnerable to “blowout” from elevated flow. It is critical to not artificially increase the winter flow prior to runoff whenever possible.
- Natural runoff aside, it is recommended that flows be gradually ramped (see ramping recommendations below) to the summer minimum criteria (May 1 through September 30 – 85 and 179 cfs measured at the Thirty Mile bridge and Wagon Wheel Gap Gages, respectively) to

protect further hatching and fry emergence. Allow river flow to return to base flow prior to October 1, if possible.

- An abrupt and large change in flow can be very detrimental to aquatic biota and their habitat. If possible, ramping should be conducted in a manner that allows water managers to meet downstream obligations while protecting aquatic life and their habitat. To this end, it is recommended that flow changes not exceed 25% per day. This pertains to any anthropogenic flow change, either up or down, throughout the year.
- A site-specific recommendation is to maintain the above flow recommendations to protect an aboriginal population of Rio Grande chub (a Tier 1 Species of Concern in Colorado) upstream of the Prairie Ditch diversion near Sevenmile Plaza (reach RG10).

Discharge and Temperature Regression Analysis

A linear regression analysis of water temperature and discharge was completed to determine the effect of Rio Grande Reservoir releases on downstream water temperature. The analysis revealed that a weak negative correlation existed between discharge and water temperature (increased discharge results in lower water temperature), however the relationship did not extend more than approximately 10 miles downstream of the reservoir. Based on these findings, it is assumed that reservoir releases will have a mild but spatially limited effect on lowering water temperature in the Rio Grande outside of natural variations in temperature.

3.1.3 Rio Grande Riparian Vegetation Summary

In total, 10 AAs were surveyed along the Rio Grande, which spanned five counties: Hinsdale, Mineral, Rio Grande, Alamosa, and Costilla (Figure 3.4). The highest elevation site was RGVeg02 at 3,030 meters (9,940 ft); the lowest elevation site was RGVeg17 at 2,280 meters (7,480 ft). Seven of the sites were located on federally managed land (BLM, U.S. Fish & Wildlife Service, and U.S. Forest Service), one occurred on a CPW parcel, and three were located on privately owned properties.

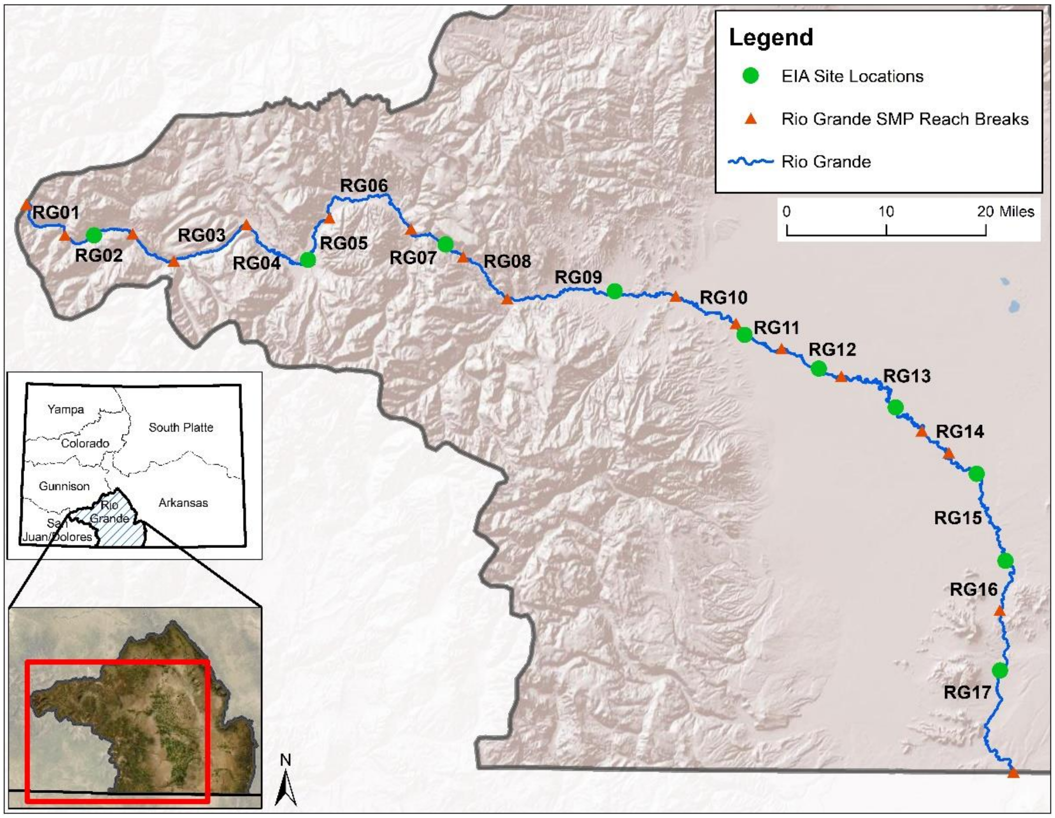


Figure 3.4: Rio Grande SMP EIA AA locations.

Generally, the highest elevation AAs received the highest overall Ecological Integrity Assessment ratings while the lowest elevation sites reflected more intensive disturbance with overall lower overall ratings. The two highest elevation sites (RGVeg02 and RGVeg04) along the Rio Grande received a B+ for their overall EIA ratings. Seven of the sites sampled received a B- rating (RGVeg07 – RGVeg16). The lowest rating was a C+ for the lowest elevation location, RGVeg17 (Tables 3.4 and 3.5).

Table 3.4: EIA – Overall scores for all Rio Grande AAs

Assessment Area	Calc Points	Calc Rating
RGVeg02	3.36	B+
RGVeg04	3.15	B+
RGVeg07	2.88	B-
RGVeg09	2.71	B-
RGVeg11	2.71	B-
RGVeg12	2.62	B-
RGVeg13	2.70	B-
RGVeg15	2.69	B-
RGVeg16	2.63	B-
RGVeg17	2.15	C+

Table 3.5: EIA – Individual metric scores for all Rio Grande AAs

	RGVeg02	RGVeg04	RGVeg07	RGVeg09	RGVeg11	RGVeg12	RGVeg13	RGVeg15	RGVeg16	RGVeg17
Overall Ecological Integrity Points	3.36	3.15	2.88	2.71	2.71	2.62	2.70	2.69	2.63	2.15
Overall Ecological Integrity Rank	B+	B+	B-	B-	B-	B-	B-	B-	B-	C+
LANDSCAPE METRICS										
L1. Contiguous Natural Land Cover	B	A	C	C	C	B	B	B	B	C
L2. Land Use Index	A	B	B	C	C	B	C	B	C	C
BUFFER METRICS										
B1. Perimeter with Natural Buffer	A	A	C	C	A	A	A	A	A	B
B2. Width of Natural Buffer	C	B	C	C	B	A	C	B	A	C
B3.1. Condition of Natural Buffer - Veg	A	B	A	B	B	C	B	B	B	C
B3.2. Condition of Natural Buffer - Soils	A	B	B	A	B	B	B	B	C	B
VEGETATION METRICS										
V1. Native Plant Species Cover	C	C-	B	C	C	C-	C	C	C	C-
V2. Invasive Nonnative Plant Species Cover	A	A	B	A	B	B	B	B	B	B
V3. Native Plant Species Composition	B	B	B	B	B	C	C	C	B	D
V4. Vegetation Structure	B	B	B	C	B	C	B	B	C	C
V5. Regen. of Native Woody Species **(opt.)**	A	A	B	B	B	B	B	N/A	C	B
V65. Coarse and Fine Woody Debris **(opt.)**	A	B	B	B	C	B	B	N/A	B	C

According to Lemly et al. (2016), the ecological integrity for a riparian area with an overall EIA score of B is considered to be a slight deviation from reference conditions. The wetland is expected to generally function within the range of natural disturbance regimes. While management to improve these conditions is desirable, a central focus should at least be to maintain these conditions. Special attention should be given to areas with a B- rating, which implies that the ecological integrity occurs near the threshold of degrading to less desirable (or functional) conditions. Management of riparian areas receiving an overall EIA rating of C should focus on improving the ecological integrity and preventing further alteration from reference conditions (Table 2.8). For these areas, adapted management is necessary to restore the ecological attributes that have been significantly altered from natural conditions.

A total of 181 plant taxa were encountered, including 170 unique species. The total number of plant taxa encountered at each site ranged from 28 to 48, with an average of 38 plant taxa per site. The most taxa were observed at the highest elevation sites (RGVeg02 and RGVeg04). The fewest taxa were encountered at RGVeg12 and RGVeg15. There was no obvious elevation trend in the number of taxa found at each site (Table 3.6).

Table 3.6: Total taxa encountered by AA

Assessment Area	# Taxa Observed
RGVeg02	48
RGVeg04	48
RGVeg07	35
RGVeg09	38
RGVeg11	40
RGVeg12	28
RGVeg13	47
RGVeg15	28
RGVeg16	31
RGVeg17	40
Average	**38**

Average relative cover of native species ranged from 62% at RGVeg17 to 98.8% at RGVeg07. Noxious species were present in the following locations: RGVeg07 (0.1% average cover), RGVeg11 (0.1% average cover), RGVeg12 (2.9% average cover), RGVeg13 (2.5% average cover), RGVeg15 (3.1% average cover), RGVeg16 (1.4% average cover), and RGVeg17 (1.6% average cover). Average mean C-values for native species ranged from 3.8 (RGVeg17) to 5.3 (RGVeg02, RGVeg04, and RGVeg07). Average cover weighted mean C-values for native species ranged from 3.3 (RGVeg17) to 5.7 (RGVeg02) (Table 3.7).

Reach-level RCA scores derived from the GIS remote sensing vegetation assessment closely matched and helped validate overall EIA scores. In general, RCA scores were very similar to site-level EIA scores through the SMP study area. For more detailed findings from the GIS assessment, see **Appendix E**.

Table 3.7: Floristic Quality Assessment (FQA) indices by AA

FQA Indices	RGVeg02	RGVeg04	RGVeg07	RGVeg09	RGVeg11	RGVeg12	RGVeg13	RGVeg15	RGVeg16	RGVeg17
Mean C-Value (All species)	4.8	4.7	5.0	4.3	3.9	3.2	2.7	3.1	3.2	2.0
Mean C-Value (Native species)	5.3	5.3	5.3	5.3	4.5	4.7	4.0	4.5	4.6	3.8
Cover-weighted Mean C-Value (All species)	4.8	4.2	5.1	4.6	4.4	3.1	3.0	1.3	3.9	2.0
Cover-weighted Mean C-Value (Native species)	5.7	5.1	5.2	5.6	4.6	4.3	3.4	3.8	4.3	3.3
FQI (All species)	22.9	25.3	21.1	16.5	13.2	12.3	11.8	12.3	12.0	8.2
FQI (Native species)	24.3	27.0	21.8	18.4	14.5	14.9	14.5	14.8	14.3	11.4
Cover Weighted FQI (All species)	23.2	22.8	21.9	17.7	15.3	12.4	13.3	5.1	14.4	8.0
Cover Weighted FQI (Native species)	26.0	26.1	21.5	19.3	14.9	13.6	12.1	12.4	13.2	9.6
Adjusted FQI	50.4	49.9	51.1	47.8	41.5	38.5	33.0	37.4	38.4	27.6
Adjusted Cover Weighted FQI	54.1	48.2	50.3	50.1	42.9	35.3	27.6	31.3	35.6	23.5

The highest elevation sites (RGVeg02 and RGVeg04) were identified as Rocky Mountain Subalpine-Montane Riparian Shrubland Ecological System. RGVeg07 was the only Rocky Mountain Subalpine-Montane Riparian Woodland Ecological System surveyed. RGVeg09, RGVeg11, RGVeg12, RGVeg13, RGVeg15, RGVeg16, RGVeg17 were all identified as Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland Ecological System.

The following Physiognomic Groups represented all sites surveyed along the Rio Grande: Tall Willow Shrubland (57.5% of plots), Deciduous Dominated Forest/Woodland (17.5% of plots), Evergreen Riparian Forest (10% of plots), Herbaceous Vegetation (10% of plots), and Non-Willow Shrubland (5% of plots).

3.1.4 Rio Grande Water Quality Summary

Overall, the Rio Grande, from its headwaters to the state line, exhibits excellent water quality and aquatic life. The headwaters of the Rio Grande above Rio Grande Reservoir have exceptional water quality, with several tributary streams listed as "outstanding waters" (CDPHE, 2018b). Water quality in the headwaters of the Rio Grande is well documented by the Upper Rio Grande Watershed Assessment (URGWA [SGM & Lotic Hydrological, 2018]).

Despite mostly excellent water quality, some SMP reaches exceed state standards for heavy metals and RG09 is on the 303(d) list for water temperature (CDPHE, 2018c). While other metals exceedances are fairly limited in geographic scope, total arsenic exceedances have been detected from Stony Pass to the Rio Grande/Alamosa county line. Data shows that both dissolved and total arsenic concentrations are consistently above the chronic water quality standard of 0.02 µg/L in RG01 through RG12. The URGWA suggested two possible explanations for elevated arsenic above Rio Grande Reservoir: 1) It is the result of naturally occurring arsenic-rich local geology, and 2) A known abandoned mine with tailings in direct contact with Kite Lake contributes arsenic and other metals to the watershed (SGM & Lotic Hydrological, 2018). In either case, arsenic concentrations are elevated in other relatively pristine tributaries and segments of the mainstem Rio Grande. Due to the uncertainty regarding the source of arsenic, as well as the lack of long-term data within this reach, the URGWA recommended more frequent and higher spatial resolution water quality monitoring. If the source of arsenic cannot be identified or mitigated, the URGWA suggested reviewing and potentially adjusting chronic standard for specific segments of the Upper Rio Grande.

Finally, a study conducted by Rust et al. (2019) investigated the impact of the West Fork Complex Fire on water quality in the upper Rio Grande. The study showed that turbidity and total suspended solids concentrations were temporarily elevated following the fire. However, other water quality parameters were not significantly different than control sites, suggesting water quality in the Rio Grande and its tributaries was relatively resilient to the acute effects of wildfire.

3.1.5 Rio Grande Aquatic Life Summary

Overall, the diverse aquatic habitats within the SMP study area support healthy aquatic life. Many macroinvertebrate samples had diverse species assemblages including sensitive taxa. Fish surveys indicate healthy trout fisheries in multiple SMP study reaches. Further, river otter observations in the Rio Grande in northern New Mexico and upstream as far as Creede also suggest intact aquatic habitat and food webs. However, some loss of functional groups within macroinvertebrate assemblages exists, particularly within reaches RG16 and RG17. In addition, native cold- and warm-water fish populations have declined within the SMP study area and nonnative fish species are impacting reaches RG10 through RG17.

In 2018, CPW developed a Fish Management Plan for the Rio Grande from its headwaters to the state line (CPW, 2018). The plan divides the river into four management sections: the headwaters section (SMP reaches RG01 – RG02), upper management section (SMP reaches RG03 – RG09), middle management section (SMP reach RG10), and lower management section (SMP reaches RG11 – RG17). Management sections were established based on fish habitat and populations as well as existing barriers. The headwaters section is managed as a cold-water trout fishery with a focus on Rio Grande cutthroat trout. Species include native longnose dace and Rio Grande cutthroat trout as well as nonnative brook trout, rainbow trout, and white sucker. This section is stocked with Rio Grande cutthroat trout and nonnative fish are no longer stocked. The upper management section is also a cold-water fishery inhabited by trout, suckers, and dace. Native Rio Grande cutthroat trout have been replaced in the mainstem by brown trout, brook trout, and nonnative cutthroat trout. White sucker has replaced native Rio Grande sucker and longnose dace is the only remaining native species in the upper management section. The middle management section holds healthy trout and an aboriginal Rio Grande chub population near Sevenmile Plaza. This section is managed with the goal of preserving and protecting the chub population. The up- and downstream boundaries are marked by two diversion dams which form barriers to upstream movement of fish. Management includes maintaining the existing barriers to prevent upstream movement by nonnative predators. In the lower management section, the river transitions from a cold-water to a warm-water stream. The fishery reflects this transition, with brown trout, northern pike, largemouth bass, yellow perch, common carp, and white sucker. Native species such as green sunfish, black bullhead, red shiner, and longnose dace also inhabit this section. Native Rio Grande sucker and Rio Grande chub have been replaced by nonnative species. The presence of white sucker prevents the establishment of a Rio Grande sucker population because the species are known to hybridize.

Native Species Distribution

In general, the distribution and abundance of native fish species has declined significantly, with most species retreating from their historic ranges into more isolated and small populations. Species of particular interest within the SMP study area include Rio Grande sucker, chub, and cutthroat trout. The current basin-wide distribution of these species is described below.

The Rio Grande sucker is a small herbivorous fish considered State Endangered in Colorado. The sucker is endemic to the Rio Grande watershed in Colorado and New Mexico. In Colorado, it was historically found in the Rio Grande, Conejos River, Hot Creek, and at McIntire Springs. It now only exists in a few small populations, including where it has been reintroduced to lower-elevation streams on the Rio Grande National Forest. Rio Grande sucker have been stocked in tributaries to the Conejos River as well as the mainstem of Saguache Creek near the Town of Saguache.

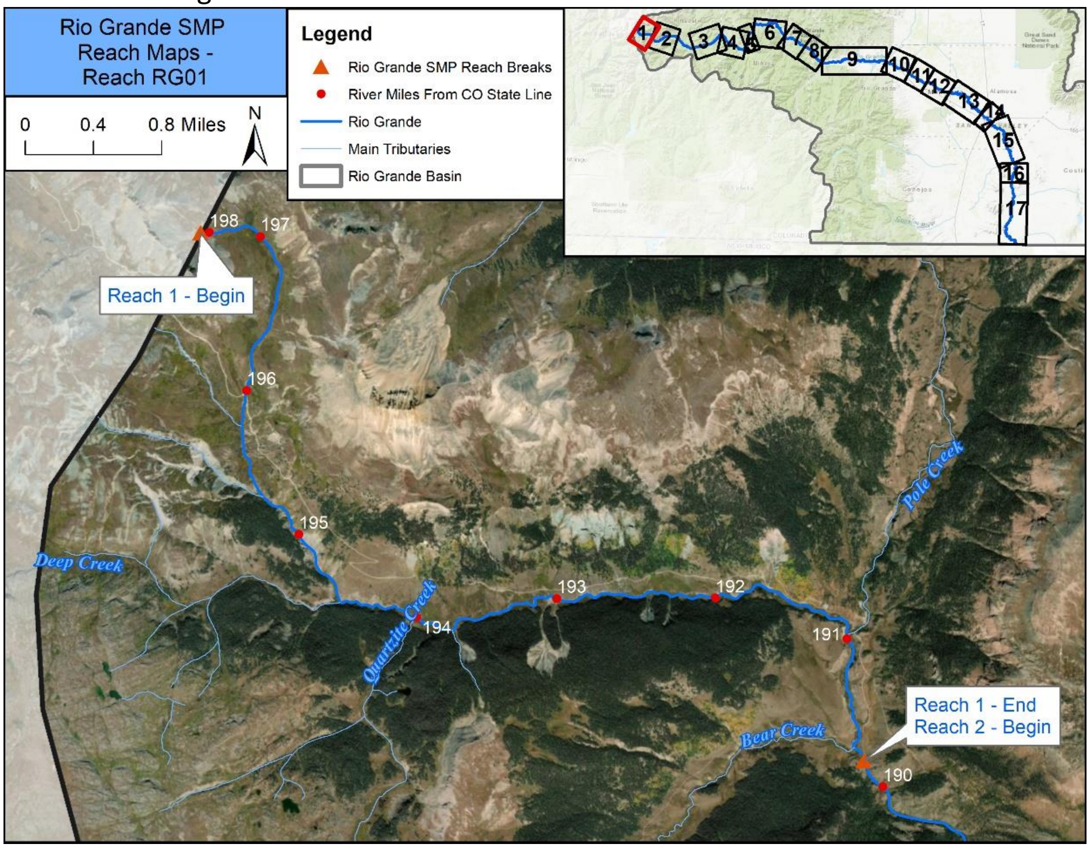
The Rio Grande chub, a Tier 1 Species of Concern in Colorado, is a small insectivore species endemic to the Rio Grande Basin in Colorado and New Mexico, including the SLV Closed Basin. Historically, the species is known to have been present in the Rio Grande, Conejos River, Saguache Creek, and San Luis Creek. Currently, three known aboriginal populations exist – in Baca National Wildlife Refuge, Hot Creek State Wildlife Area, and the Rio Grande between the Rio Grande Canal and the Prairie Ditch diversion. A 2003 study showed Rio Grande chub to be declining and limited to select streams in the Rio Grande Basin (Bestgen et al., 2003). The only large and relatively stable populations at that time were in Hot Creek and Saguache Creek. More recent surveys, however, revealed that a small population of Rio Grande chub are present in the mainstem of the Rio Grande (CPW, 2018). CPW also stocks chub in the mainstem Rio Grande downstream of Monte Vista.

The Rio Grande cutthroat trout is a native salmonid species listed as a Tier 1 Species of Concern in Colorado. Numerous populations exist in the Rio Grande Basin, mostly in lower order, high elevation streams on the Rio Grande National Forest. The historic range of Rio Grande cutthroat trout (RGCT) has dramatically decreased (RGCT, 2013). Significant efforts are underway to maintain and enhance RGCT populations. The Rio Grande Cutthroat Conservation Team, made up of regional aquatic ecologists from state and federal agencies, has conducted and supported population surveys, genetic analyses, fish stocking efforts, and habitat improvements to promote the long-term protection of RGCT. Similar efforts are focused on Rio Grande chub and sucker conservation.

3.2 Conditions Assessment Results by Reach

3.2.1 RG01 – Stony Pass to Bear Creek Confluence

This reach extends from Stony Pass to just downstream of the confluence with Bear Creek where the river's confinement changes.



Representative Reach Photo

RG01 Conditions Assessment Overview

Reach: RG01		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	A													
Riparian Vegetation	B+		X											
Water Quality	A-													X
Aquatic Life	B+													
Diversion Structures	N/A													

A	B	C	D	F	Not Assessed

*For an explanation of reach ratings, see Section 2.

RG01 Geomorphology

<table>
<tr><td>Reach</td><td colspan="8">Location Description</td></tr>
<tr><td>RG01</td><td colspan="8">Stony Pass to Bear Creek Confluence</td></tr>
<tr><td>Confine-ment</td><td>D50</td><td>Bed Comp.</td><td>Existing Stream Form</td><td>Reference Stream Form</td><td>SEM Stage Existing</td><td>SEM Stage Ref.</td><td>Existing Sediment Regime</td><td>Reference Sediment Regime</td></tr>
<tr><td>Varies</td><td>No Data</td><td>No Data</td><td>Multiple</td><td>Multiple</td><td>Multiple</td><td>Multiple</td><td>Multiple</td><td>Multiple</td></tr>
<tr><td>Valley Slope</td><td>Stream Power △</td><td>Bed Mobility Threshold Flows</td><td>Bed Mobility Frequency</td><td colspan="2">Overbank Flow Estimate</td><td colspan="3">Overbank Flow Frequency</td></tr>
<tr><td>5.7%</td><td>N/A</td><td>No Data</td><td>No Data</td><td colspan="2">No Data</td><td colspan="3">No Data</td></tr>
<tr><td colspan="2">Watershed setting</td><td>River Style</td><td colspan="4">Characteristics</td><td colspan="2">Representative Photo</td></tr>
<tr><td colspan="2">Source</td><td>Alpine headwaters

And

Elongated discontinuous floodplain, bedrock confined</td><td colspan="4">High gradient, low-order streams exhibiting waterfalls, cascades, no floodplain, and substrate ranging from bedrock and boulders to sand and gravel; interspersed with small zones of alluvium and valley fills.

Low to moderate sinuosity reaches in partially confined valleys; channel bed in predominantly alluvial materials; various bar types, run and pool complexes, well developed floodplain typically on one side of the river; lateral channel movements occur but are largely confined by valley margins for a majority but not all of linear channel distance. Confining margins variously include bedrock, terraces, alluvial fans, and extensive colluvium stretches.</td><td colspan="2"></td></tr>
<tr><td colspan="9">Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity</td></tr>
<tr><td colspan="9">High alpine headwaters valley that had been glaciated. The reach gathers headwater and material including inputs from Pole Creek, Quartzite Creek and Bear Creek. Near the top the reach appears to be dominated by step-pools and cascades in a confined corridor. In the middle of the reach, it finds some sediment contributions from fans and slope failures creating alluvial pockets in a semi-confinement valley in a more moderate sloped riffle-pool and plane bedded system. The reach is moderately sensitive and is likely to make adjustments with small scale changes but maintain meta-stability.</td></tr>
<tr><td colspan="7">Stressors</td><td colspan="2">Degree of Geomorphic Impairment</td></tr>
<tr><td colspan="7">Stressors to reach are natural. Frequent wood and sediment inputs from avalanche and debris paths.</td><td colspan="2">A</td></tr>
</table>

RG01 Riparian Vegetation

An EIA site was not completed within this reach. Results from the reach-scale RCA assessment indicated healthy riparian areas with an overall rating of B+. The only mild stressor identified was road crossings.

RG01 Water Quality and Aquatic Life

Water Quality		
Temperature	Chemical Conditions	Nutrients
N/A	B	A
Overall Rating		A-

Aquatic Life			
Average MMI Score	Overall MMI Rating	Trout (lbs/acre)	Trout Rating
74.3	B+	N/A	N/A
Overall Rating			B+

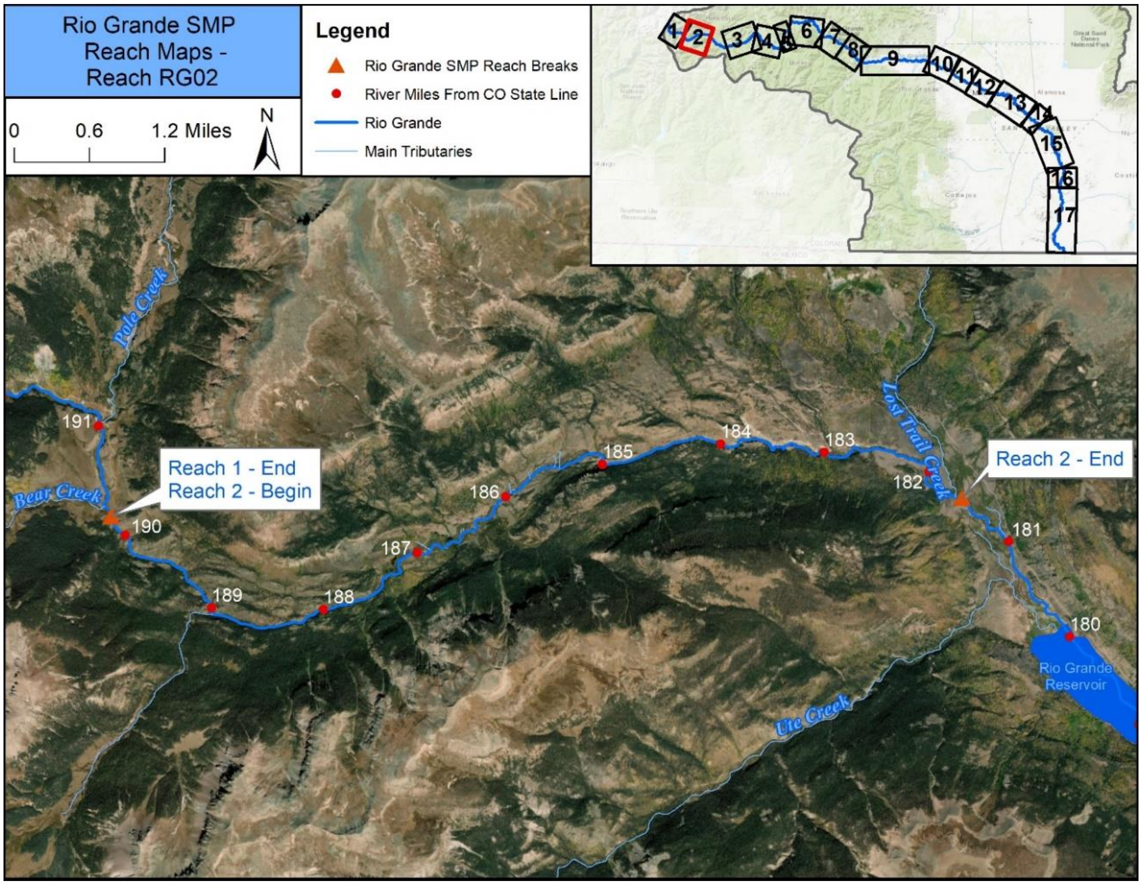
The headwaters of the Rio Grande above Rio Grande Reservoir exhibit exceptional water quality, with several tributary streams in RG01 listed as "outstanding waters," including Quartzite Creek and Bear Creek (CDPHE, 2018b). Water quality in this reach of the Rio Grande is well documented by the URGWA (SGM & Lotic Hydrological, 2018). The URGWA includes water quality data from 2013 through 2018, including monitoring water quality parameters following the West Fork Complex Fire. The study found detectable changes in water quality and aquatic life immediately following the fires. However, within four years following the fire event, water quality parameters, including turbidity, as well as macroinvertebrate assemblages, had returned to pre-fire conditions.

The URGWA found most physical and chemical water quality parameters, including pH, temperature, and specific conductivity, were all within normal ranges for a cold-water river and were within state water quality standards from Stony Pass to Hannah Lane (reach RG01 through RG09) (SGM & Lotic Hydrological, 2018). Despite mostly excellent water quality, the Rio Grande from Stony Pass to Rio Grande Reservoir is listed as 303(d) impaired for total arsenic (CDPHE, 2018c). The URGWA found arsenic concentrations were consistently above the chronic water quality standard of 0.02 µg/L. The URGWA suggested two possible explanations for elevated arsenic above Rio Grande Reservoir: 1) It is the result of naturally occurring arsenic-rich local geology, and 2) A known abandoned mine with tailings in direct contact with Kite Lake contributes arsenic and other metals to the watershed. In either case, arsenic concentrations are elevated in other relatively pristine tributaries and segments of the mainstem Rio Grande. Due to the uncertainty regarding the source of arsenic, as well as the lack of long-term data within this reach, the URGWA recommended more frequent and higher spatial resolution water quality monitoring. Additionally, if the source of arsenic cannot be identified or mitigated, the URGWA suggested reviewing and potentially adjusting chronic standard for specific segments of the Upper Rio Grande.

This reach supports a healthy benthic macroinvertebrate community with an average MMI score of 74.3. Trout data was not available, however Rio Grande cutthroat trout are present in tributaries and the mainstem Rio Grande upstream of Rio Grande Reservoir. Additional fish species include brook trout, longnose dace, brown trout, rainbow trout, and white sucker, with rainbow trout being the most abundant. Trout biomass data was not available.

3.2.2 RG02 – Bear Creek Confluence to Rio Grande Reservoir Inlet

Where the confinement changes downstream of Bear Creek confluence to the western end of the Rio Grande Reservoir.



Representative Reach Photo

RG02 Conditions Assessment Overview

Reach: RG02		Major Stream Condition Stressors												
Parameter	**Condition Rating**	**Crossings and diversions**	**Roads and railways**	**Floodplain disconnection**	**Channelization and armoring**	**Fill and floodplain conversion**	**Flow alteration: impoundments**	**Flow alteration: diversions**	**Abandoned mine lands**	**Exotic/naturalized plant species**	**Exotic aquatic species**	**Lack of woody material**	**Hillslope/channel erosion**	**Unknown source**
Geomorphology	A													
Riparian Vegetation	B+		X											
Water Quality	A-													X
Aquatic Life	B+													
Diversion Structures	N/A													

A	B	C	D	F	Not Assessed

*For an explanation of reach ratings, see Section 2.

RG02 Geomorphology

Reach	Location Description
RG02	Bear Creek Confluence to Rio Grande Reservoir Inlet

Confine-ment	D50	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Variable	No Data	No Data	Multiple	Multiple	Multiple	Multiple	Multiple	Multiple

Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate	Overbank Flow Frequency
2.2%	↓	No Data	No Data	No Data	No Data

Watershed setting	River Style	Characteristics	Representative Photo
Source, Transport, and Response	Confined valley And Confined valley occasional floodplain pockets And Meandering planform-Controlled dis-continuous floodplain	Confined channel geometry with very little or no floodplain present throughout reach. Instream features derive from lower gradients than step cascades reaches; with plane bed and riffle-run sequences dominant rather than cascades and step pools, although the latter may still occur. Planform remains fully margin-controlled. Small and discontinuous floodplain pockets, controlled largely by margin structures. Riffles, runs and rapids with occasional larger wood-generated or step pools. Median substrate decreasing in size compared to headwaters; fewer boulders and more sands and gravels. Occasional but irregular instream bar formations. Active channel abuts confining margins for a minority of linear valley distance but is not fully unconfined. Floodplain and instream geomorphic features characteristic of meandering and lateral migration including multiple bar forms, especially point bars, cutoffs, and cutbanks.	

Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity
High alpine headwaters reach that works through a variety of valley settings. Discrepancies in the extent of glacial scour and influence of bedrock outcroppings likely dictate the valley confinement and slope giving this long reach numerous stream forms, trajectories, and sensitivities. In some places, the river is a steep transport reach through step-pools and cascades in a confined corridor. In others, it passes through a bedrock gorge-type setting. In other sections, the reach has alluvial pockets in an unconfined valley with evidence of numerous former channels and active lateral shifting. And yet others there are small pockets of alluvium but fluvial signatures are largely absent. The reach becomes aggradational before the reach break in the vicinity of the average high water level of the Rio Grande Reservoir.

Stressors	Degree of Geomorphic Impairment
Stressors to reach are natural. Frequent wood and sediment inputs from avalanche and debris paths.	A

RG02 Riparian Vegetation

Overall, this site (RGVeg02) appears to be in very good condition, receiving an overall EIA rating of B+ (3.36). The lowest individual metric ratings it received were for Natural Buffer Width (C) and Native Plant Species Cover (C) (Table 3.7).

Table 3.7: EIA Scorecard – RGVeg02

RGVeg02 Observer: W. McBride	Wt	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				**3.36**	**B+**
Rank Factor: LANDSCAPE CONTEXT	0.30			**3.41**	**B+**
LANDSCAPE METRICS	0.33			**3.50**	**A-**
L1. Contiguous Natural Land Cover	1	B	3		
L2. Land Use Index	1	A	4		
BUFFER METRICS	0.67			**3.36**	**B+**
B1. Perimeter with Natural Buffer	n/a	A	4		
B2. Width of Natural Buffer	n/a	C	2		
B3.1. Condition of Natural Buffer - Veg	n/a	A	4		
B3.2. Condition of Natural Buffer - Soils	n/a	A	4		
Rank Factor: CONDITION	0.70			**3.33**	**B+**
VEGETATION METRICS	1			**3.33**	**B+**
V1. Native Plant Species Cover	1	C	2		
V2. Invasive Nonnative Plant Species Cover	1	A	4		
V3. Native Plant Species Composition	1	B	3		
V4. Vegetation Structure	1	B	3		
V5. Regen. of Native Woody Species **(opt.)**	1	A	4		
V65. Coarse and Fine Woody Debris **(opt.)**	1	A	4		

Both Contiguous Natural Land Cover and Natural Buffer Width were disrupted by Forest Service Road 520 that runs parallel to the river to the north. According to Lemly et al. (2016), fragmentation of natural land cover can be detrimental to natural ecological processes such as seed dispersal, animal movement, and genetic diversity. Without re-routing FS Road 520, these metric scores cannot be easily improved as they are currently assessed.

Regarding Native Plant Species cover, the average relative cover of native species for this site was 85%. The nonnative species with the highest absolute cover included *Poa compressa* with 17%, 7.5%, 3.5%, and 0% cover in plots 1, 2, 3, and 4, respectively. *Poa pratensis* and *Taraxacum officinale* also occurred consistently across plots, but neither had greater than 3.5% absolute cover in any one plot (Tables 30 and 31). While it is desirable to have higher cover of native species, the most common nonnative species at this site are essentially naturalized in this region. These nonnatives did not result in monocultures and overall plant species diversity was relatively high compared to the other Rio Grande AAs. Further, no noxious species were observed at this site.

The averaged mean C-value for native species was 5.3 and the averaged cover-weighted mean C-value for native species was 5.7 (Table 3.7). This suggests that the majority of native species present are equally found in natural and non-natural areas. Current land uses observed and approximate cover within the 500 m buffer include livestock grazing at light intensity (33%), management for native vegetation (66%), and unpaved roads (1%). Recent sign from deer and elk were also observed.

Results from the reach-scale RCA assessment indicated healthy riparian areas with a B+ rating. The only mild stressor identified was road crossings. The average of the EIA and RCA ratings is B+.

RG02 Water Quality and Aquatic Life

Water Quality		
Temperature	Chemical Conditions	Nutrients
N/A	B	A
Overall Rating		**A-**

Aquatic Life			
Average MMI Score	Overall MMI Rating	Trout (lbs/acre)	Trout Rating
74.3	B+	N/A	N/A
Overall Rating			**B+**

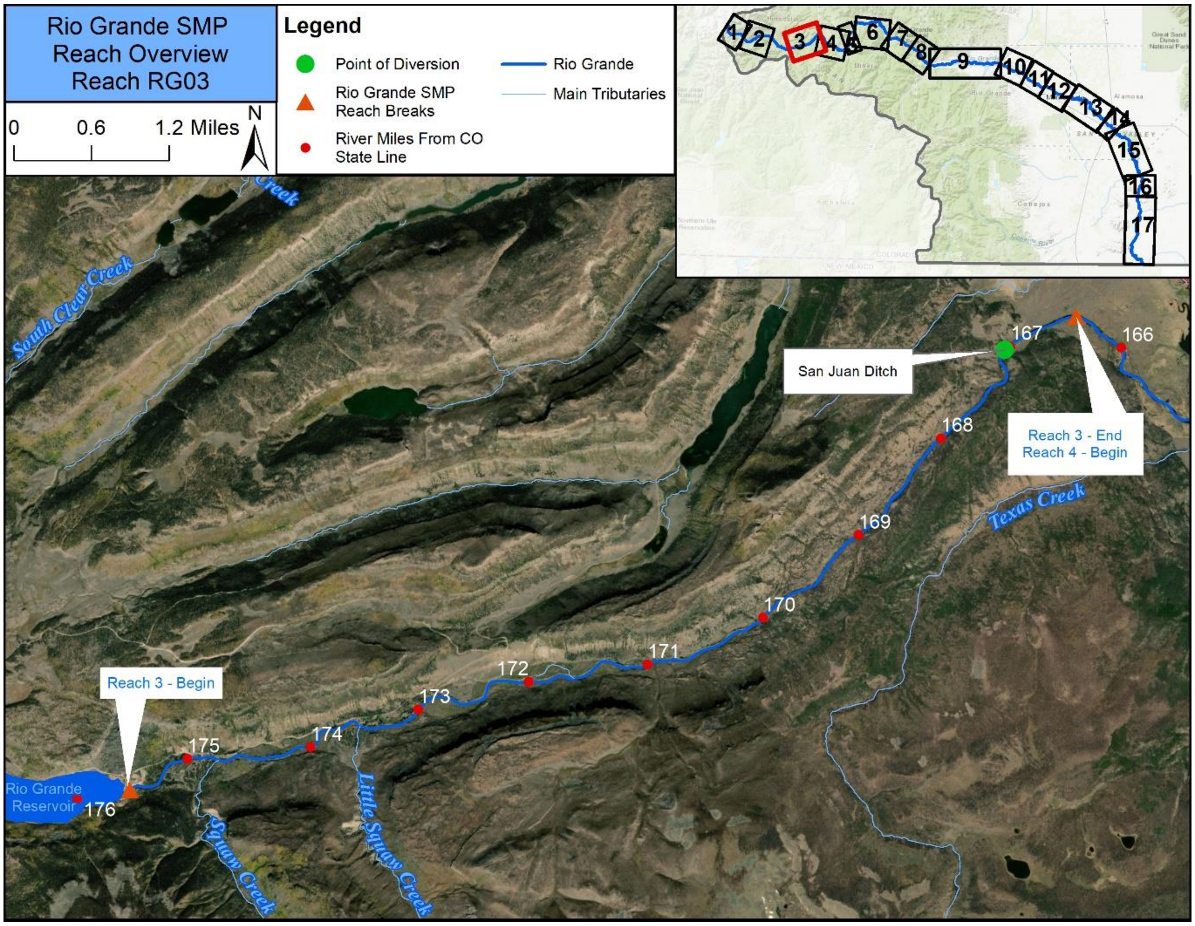
As described in RG01, the headwaters of the Rio Grande above Rio Grande Reservoir exhibit exceptional water quality. Some tributary streams in RG02, such as Ute Creek, are listed as "outstanding waters," (CDPHE, 2018b). Water quality in this reach of the Rio Grande is well documented by the Upper Rio Grande Watershed Assessment (SGM & Lotic Hydrological, 2018). The URGWA includes water quality data from 2013 through 2018, including monitoring water quality parameters following the West Fork Complex Fire. The study found detectable changes in water quality and aquatic life immediately following the fires. However, within four years following the fire event, water quality parameters, including turbidity, as well as macroinvertebrate assemblages, had returned to pre-fire conditions.

The URGWA found most physical and chemical water quality parameters, including pH, temperature, and specific conductivity, were all within normal ranges for a cold-water river and were within state water quality standards from Stony Pass to Hannah Lane (reach RG01 through RG09) (SGM & Lotic Hydrological, 2018). Despite mostly excellent water quality, the Rio Grande from Stony Pass to Rio Grande Reservoir is listed as 303(d) impaired for arsenic (CDPHE, 2018c). The URGWA found arsenic concentrations were consistently above the chronic water quality standard of 0.02 µg/L. The URGWA suggested two possible explanations for elevated arsenic above Rio Grande Reservoir: 1) It is the result of naturally occurring arsenic-rich local geology, and 2) A known abandoned mine with tailings in direct contact with Kite Lake contributes arsenic and other metals to the watershed (SGM & Lotic Hydrological, 2018). In either case, arsenic concentrations are elevated in other relatively pristine tributaries and segments of the mainstem Rio Grande. Due to the uncertainty regarding the source of arsenic, as well as the lack of long-term data within this reach, the URGWA recommended more frequent and higher spatial resolution water quality monitoring. Additionally, if the source of arsenic cannot be identified or mitigated, the URGWA suggested reviewing and potentially adjusting chronic standard for specific segments of the Upper Rio Grande.

This reach supports a healthy benthic macroinvertebrate community with an average MMI score of 74.3. Trout data was not available however Rio Grande cutthroat trout are present in several tributaries and the mainstem Rio Grande upstream of Rio Grande Reservoir. Additional fish species include brook trout, longnose dace, brown trout, rainbow trout, and white sucker, with rainbow trout being the most abundant.

3.2.3 RG03 – Rio Grande Reservoir Outlet to Mouth of Box Canyon

The Rio Grande Reservoir outlet downstream to the mouth of the Rio Grande Box Canyon, just downstream of Forest Road 520.21.



Representative Reach Photo

RG03 Conditions Assessment Overview

Reach: RG03		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	A-	X					X							
Riparian Vegetation	B		X											
Water Quality	B													X
Aquatic Life	C						X							
Diversion Structures	B													

A	B	C	D	F	Not Assessed

*For an explanation of reach ratings, see Section 2.

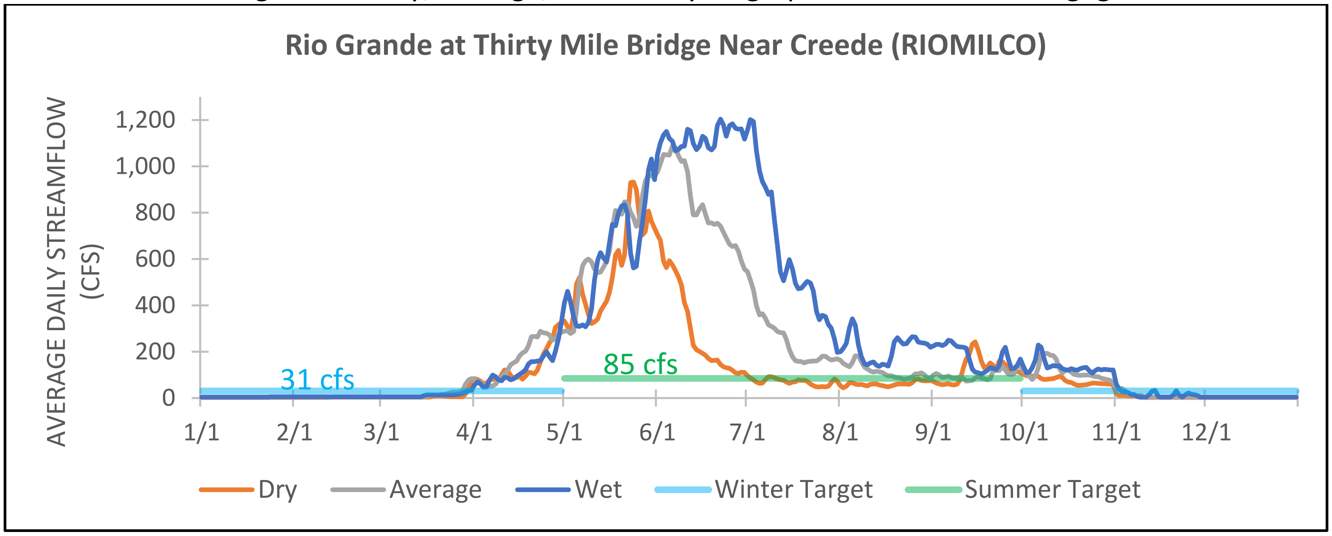
Approximately 0.8 miles downstream of Rio Grande Reservoir, the first tributary, Squaw Creek, meets the Rio Grande. Squaw Creek contributes significantly more flow to the river than the only other tributary in this reach, Little Squaw Creek. Downstream of River Hill Campground, the river enters a narrow box canyon and remains very confined for approximately 3.7 miles until Forest Road 520.21. In the 1996 Rio Grande National Forest Plan, the Rio Grande (Box Canyon) was identified as eligible for inclusion in the National Wild and Scenic River System as a scenic river (USDA Forest Service, 2017).

RG03 Geomorphology

Reach	Location Description							
RG03	Rio Grande Reservoir Outlet to Mouth of Box Canyon							
Confine-ment	D50 (mm)	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Partially-confined	98-148	Cobble	Riffle-pool	Riffle-pool	I	0	Transport	Transport
Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate		Overbank Flow Frequency		
0.8%	N/A	Upstream: Not mobile Downstream: 2600 cfs	Varies	Upstream: 1400 cfs Downstream: 4000 cfs		Upstream: 2-year flows Downstream: Extreme Events Only		
Watershed setting		River Style	Characteristics				Representative Photo	
Transport		Low/moderate sinuosity planform controlled discontinuous floodplain	Similar to elongated discontinuous floodplain but with slightly increased sinuosity and tendency to exhibit active meandering activity and channel features in planform. Channel still abuts confining valley margins frequently. Increased presence of meander-related geomorphic floodplain and channel features including paleo channels, meander cutoffs, cutbanks; multiple instream bar types.					
Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity								
Partially-confined valley at the outlet of the Rio Grande Reservoir Dam with pockets of discontinuous floodplain with some wetland features turns into a more confined reach through bedrock in a "box canyon." Lateral adjustments are more likely at the upstream end but with consistent flow and very little sediment supply from the reservoir the reach stable, though not necessarily healthy. At the end of the bedrock gorge the reach empties onto a broad alluvial valley.								
Stressors							Degree of Geomorphic Impairment	
Valley walls on both sides burned during the West Fork Complex Fire in 2013. Valley side slopes appear to be bedrock dominated. No evidence of slope failures or significant sediment inputs. Camping spots and forest access roads start to encroach with at least one undersized crossing. The reach is sediment supply limited. The natural hydrologic regime is altered by Rio Grande Reservoir.							A-	

RG03 Aquatic Habitat Flow Targets

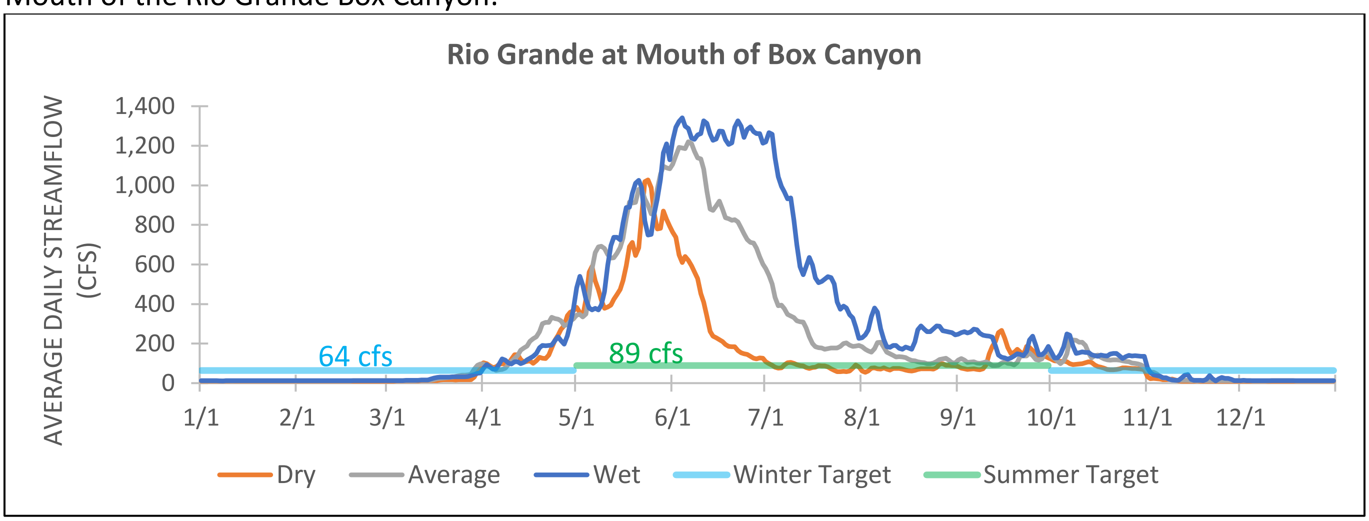
Two aquatic habitat assessment sites were completed within RG03. The graph below shows summer and winter flow targets with dry, average, and wet hydrographs at the RIOMILCO gage.



This table shows percent of days the reach's summer and winter flow targets are met in each year type at the RIOMILCO gage:

RG03a	DRY	AVERAGE	WET
Winter	30%	33%	31%
Summer	56%	94%	100%

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs at the Mouth of the Rio Grande Box Canyon.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type at the Mouth of the Rio Grande Box Canyon:

RG03b	DRY	AVERAGE	WET
Winter	30%	30%	29%
Summer	63%	99%	100%

*See section 2.6 for a detailed explanation of aquatic habitat methodology and caveats.

RG03 Riparian Vegetation

An EIA site was not completed within this reach. Results from the reach-scale RCA assessment indicated healthy riparian areas with an overall rating of B rating. The only mild stressor identified was road crossings and encroachment. There are localized impacts from roads in the area immediately downstream of Rio Grande Reservoir and around Thirty Mile Campground.

RG03 Water Quality and Aquatic Life

Water Quality		
Temperature	Chemical Conditions	Nutrients
A	D	A
Overall Rating		B

Aquatic Life			
Average MMI Score	Overall MMI Rating	Trout (lbs/acre)	Trout Rating
50.8	C	N/A	N/A
Overall Rating			C

The 303(d) listing for chronic arsenic persists in this reach (CDPHE, 2018c). Although not on the 303(d) list, aluminum exceeds chronic standards (SGM & Lotic Hydrological, 2018). Highest mean aluminum concentrations were measured at the Mouth of Box Canyon site in the URGWA.

In summer 2019, a water temperature instrument was installed at the Rio Grande at Thirty Mile Bridge (RIOMILCO) gage. The new instrument was integrated into the existing Division of Water Resources stream gage data logger, which is remotely uploaded to the DWR's surface water website, along with streamflow and any other data collected at a given gage. Although water temperature data from the URGWA was available and used for the SMP, this new temperature dataset will be useful for future temperature monitoring.

Sampling results show significant impairment to macroinvertebrate communities (average MMI score of 50.8), however key functional groups remain intact. Trout data was not available. It should be noted that Rio Grande Reservoir was recently repaired to address leaks in the dam. These repairs will ensure no water leaks when the reservoir is storing all its inflows, especially during winter months. The first significant tributary, Squaw Creek, typically contributes enough water to re-wet the channel when there are no reservoir releases.

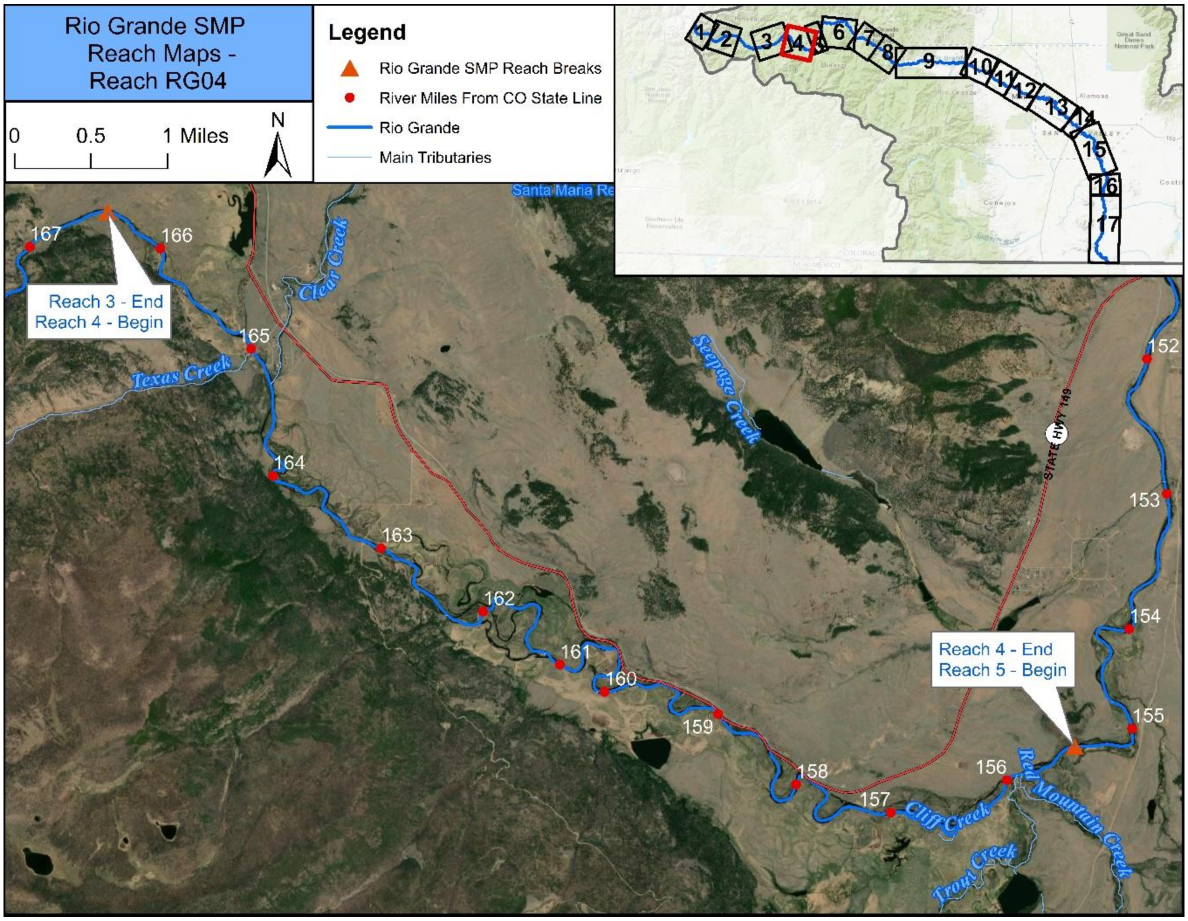
RG03 Diversion Infrastructure

***Refer to reach overview map above for diversion structure locations.**

San Juan Ditch: This structure is located at the mouth of the Rio Grande Box Canyon. There is no formal diversion dam for this structure. The entrance to the approximately 750 ft long feeder channel is located on a riffle in the river and receives its full decree when the ditch is in priority. No major issues were identified at this structure, however the flume is tilted and could be reset or replaced to improve measurement accuracy.

3.2.4 RG04 – Mouth of Box Canyon to Hogback Mountain

The mouth of the Rio Grande Box Canyon downstream to where the river passes Hogback Mountain, west of Creede and just downstream of Trout Creek.



Representative Reach Photo

RG04 Conditions Assessment Overview

Reach: RG04		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	B+	X	X				X						X	
Riparian Vegetation	B					X							X	
Water Quality	A-													X
Aquatic Life	B+						X					X		
Diversion Structures	N/A													

A	B	C	D	F	Not Assessed

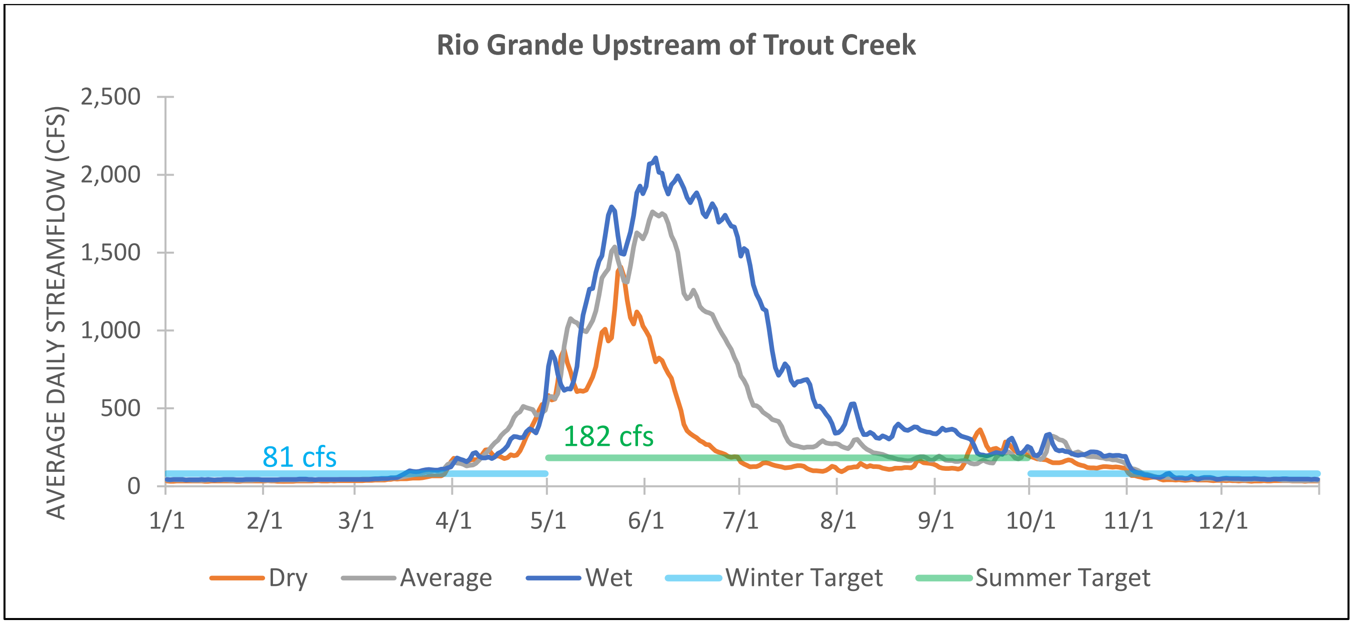
*For an explanation of reach ratings, see Section 2.

RG04 Geomorphology

Reach	Location Description							
RG04	Mouth of Box Canyon to Hogback Mountain							
Confine-ment	D50 (mm)	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Unconfined	50-57	Coarse Gravel	Riffle-pool	Riffle-pool	I	0	Deposition	Deposition
Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate		Overbank Flow Frequency		
0.4%	↓	2200-2600 cfs	Wet years for 3 days	2400 cfs		Wet years for 3 days		
Watershed setting		River Style	Characteristics				Representative Photo	
Response		Meandering planform-controlled discontinuous floodplain	Active channel abuts confining margins for a minority of linear valley distance (weak but present connection to valley margins). Floodplain and instream geomorphic features characteristic of meandering and lateral migration including multiple bar forms, especially point bars, cutoffs, and cutbanks.					
Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity								
Middle watershed reach in an unconfined alluvial valley downstream of a transport reach. Grade of the reach appears to be controlled by a bedrock outcrop and confining valley at the downstream end which is keeping the slope of the reach naturally mild and aggradational. Reach is sensitive and adjusting actively. Evidence of numerous former channels and active lateral shifting.								
Stressors							Degree of Geomorphic Impairment	
Valley walls on southern side burned during the West Fork Complex Fire in 2013 otherwise stressors to the reach are all natural and limited. Largely the reach is reacting to sediment inputs and flows from the upper watershed, which are still limited by the reservoir. The major drivers of hydrology and biotic inputs that would otherwise have significant influence on the geomorphology of this reach are altered and therefore degree of impairment listed as B+.							B+	

RG04 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type:

RG04	DRY	AVERAGE	WET
Winter	30%	36%	39%
Summer	53%	82%	100%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.

RG04 Riparian Vegetation

Overall, this site (RGVeg04) appears to be in very good condition, receiving an overall EIA rating of B+ (3.15). The lowest individual metric ratings it received were for Native Plant Species Cover (C-) (Table 3.8).

Table 3.8: EIA Scorecard – RGVeg04

RGVeg04 Observer: W. McBride	Wt	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				**3.15**	**B+**
Rank Factor: LANDSCAPE CONTEXT	0.30			**3.32**	**B+**
LANDSCAPE METRICS	0.33			**3.50**	**A-**
L1. Contiguous Natural Land Cover	1	A	4		
L2. Land Use Index	1	B	3		
BUFFER METRICS	0.67			**3.22**	**B+**
B1. Perimeter with Natural Buffer	n/a	A	4		
B2. Width of Natural Buffer	n/a	B	3		
B3.1. Condition of Natural Buffer - Veg	n/a	B	3		
B3.2. Condition of Natural Buffer - Soils	n/a	B	3		
Rank Factor: CONDITION	0.70			**3.08**	**B+**
VEGETATION METRICS	1			**3.08**	**B+**
V1. Native Plant Species Cover	1	C-	1.5		
V2. Invasive Nonnative Plant Species Cover	1	A	4		
V3. Native Plant Species Composition	1	B	3		
V4. Vegetation Structure	1	B	3		
V5. Regen. of Native Woody Species **(opt.)**	1	A	4		
V65. Coarse and Fine Woody Debris **(opt.)**	1	B	3		

Regarding Native Plant Species Cover, average relative cover of native species for this site was 82%. The nonnative species with the highest absolute cover include the following species with cover values for plots 1, 2, 3, and 4, respectively: *Poa pratensis* (1.5%, 17.5%, 3.5%, and 7.5%), *Poa compressa* (3.5%, 1.5%, 3.5%, and 7.5%), and *Taraxacum officinale* (0.5%, 7.5%, 17.5%, and 3.5%). While it is desirable to have higher cover of native species, the most common nonnative species at this site are essentially naturalized in this region. These nonnatives did not result in monocultures and overall plant species diversity was relatively high compared to the other Rio Grande AAs. Further, no noxious species were observed at this site.

The averaged mean C-value for native species was 5.3 and the averaged cover-weighted mean C-value for native species was 5.1 (Table 3.7). This suggests that the majority of native species present are equally found in natural and non-natural areas.

Current land uses observed and approximate cover within the 500 m buffer include management for native vegetation (83%), light fishing recreation (10%), unpaved roads (5%), and commercial structures as powerlines (2%). Traffic along the unpaved roads for recreation and power line access appear to be the main sources of disturbance. There is a private property located to the east of the AA; however, based on aerial imagery, much of the area within the buffer appears to be in an overall natural state with relatively intact ecosystem processes.

Results from the reach-scale RCA assessment indicated significant riparian area impairment with a C+ rating. Identified stressors include floodplain conversion and bank/hillslope erosion. The average of the EIA and RCA ratings is B.

RG04 Water Quality and Aquatic Life

Water Quality		
Temperature	**Chemical Conditions**	**Nutrients**
A	B	A
Overall Rating		**A-**

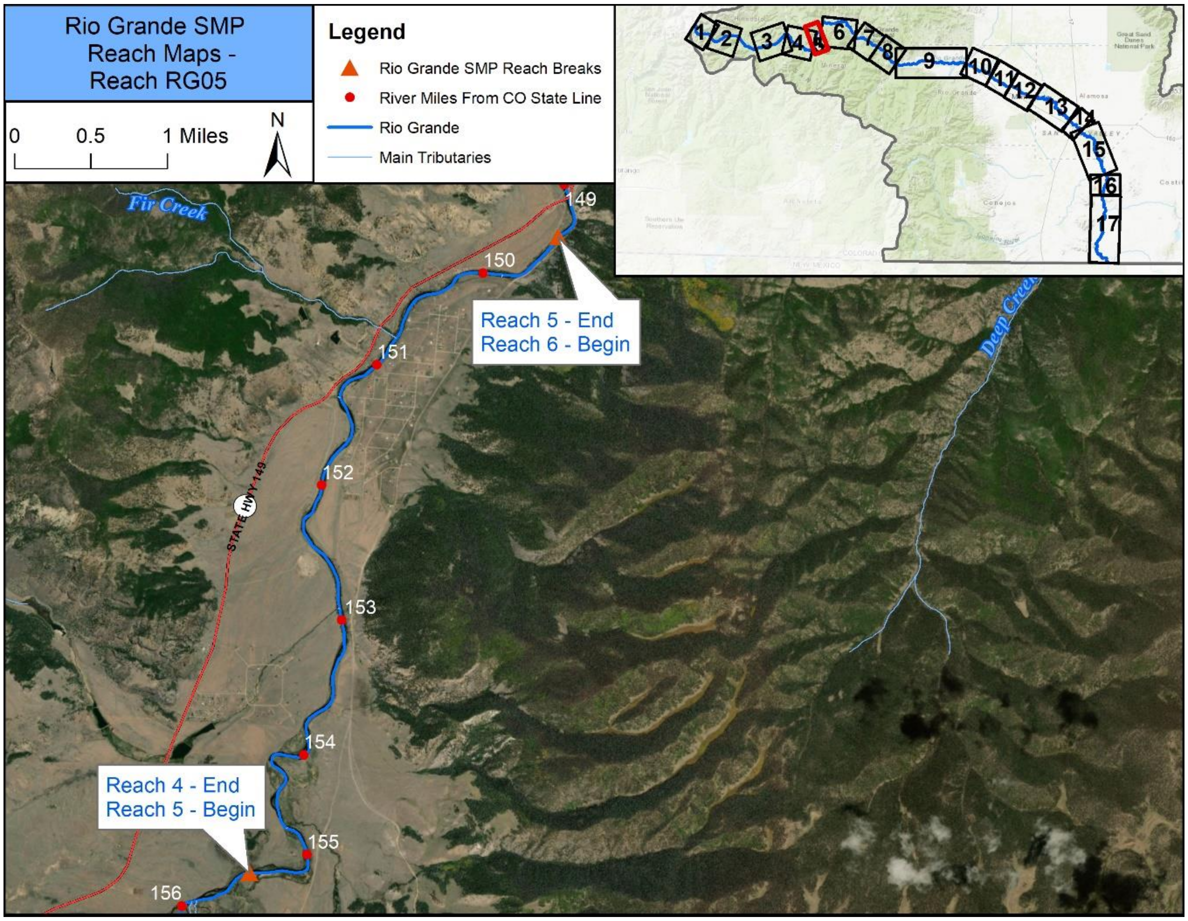
Aquatic Life			
Average MMI Score	**Overall MMI Rating**	**Trout (lbs/acre)**	**Trout Rating**
78	B+	N/A	N/A
Overall Rating			**B+**

The 303(d) listing for chronic arsenic persists in this reach (CDPHE, 2018c). In addition, dissolved Aluminum exceeds chronic standards (SGM & Lotic Hydrological, 2018). Highest mean aluminum concentrations were measured at the Mouth of Box Canyon site in the URGWA.

This reach supports a healthy BMI community with high diversity and an average MMI score of 78. Trout data was not available.

3.2.5 RG05 – Hogback Mountain to Marshall Park Campground

From where the river passes Hogback Mountain west of Creede downstream to where the valley confines at the upstream end of Sixmile Flats (near Marshall Park campground).



Representative Reach Photo

RG05 Conditions Assessment Overview

Reach: RG05		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	B+		X			X	X					X	X	
Riparian Vegetation	B-					X								
Water Quality	A-													X
Aquatic Life	A-													
Diversion Structures	N/A													

A	B	C	D	F	Not Assessed

*For an explanation of reach ratings, see Section 2.

RG05 Geomorphology

Reach	Location Description
RG05	Hogback Mountain to Marshall Park Campground

Confine-ment	D50	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Partially-confined	No Data	No Data	Riffle-pool	Riffle-pool	I	0	Confined source and transport	Confined source and transport

Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate	Overbank Flow Frequency
0.3%	↑	No Data	No Data	No Data	No Data

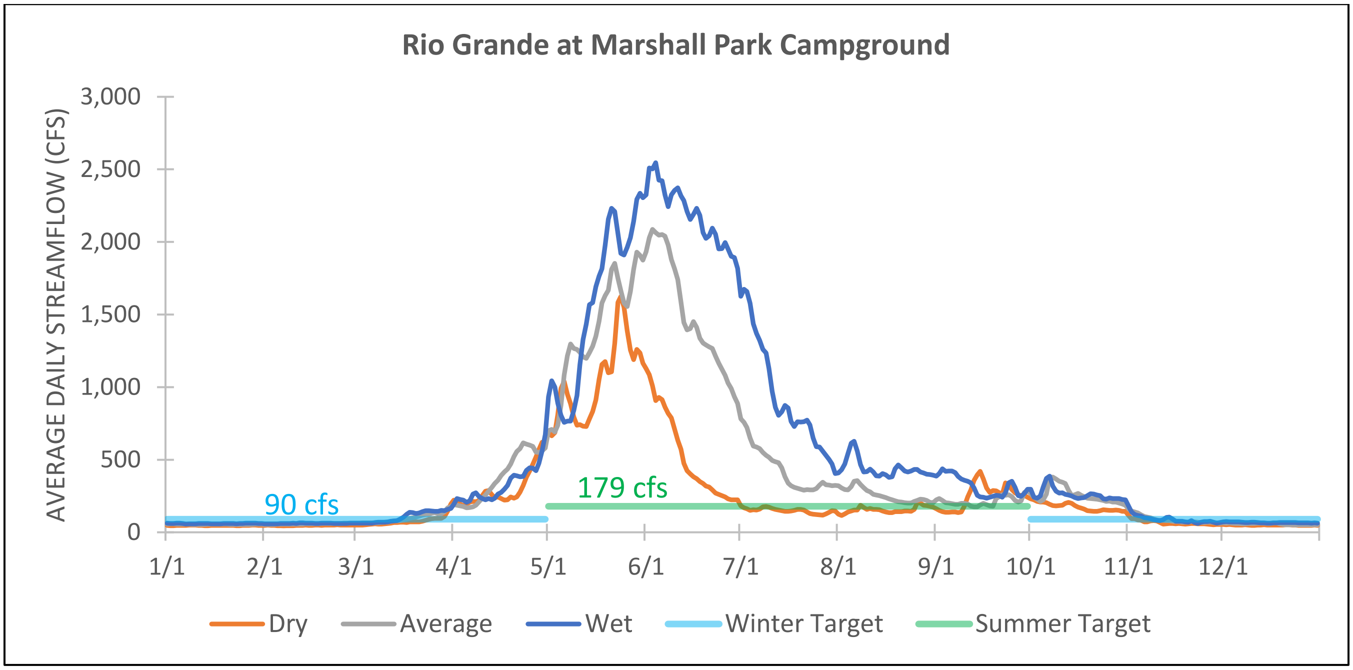
Watershed setting	River Style	Characteristics	Representative Photo
Transport	Elongated discontinuous floodplain	Low to moderate sinuosity reaches in partially confined valleys; channel bed in predominantly alluvial materials; various bar types, run and pool complexes, well developed floodplain typically on one side of the river; lateral channel movements occur but are largely confined by valley margins for a majority but not all of linear channel distance. Confining margins include terraces and fans.	

Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity
Middle watershed reach in a partially-confined alluvial valley formed by a volcanic caldera (the center of the caldera rebounded – a resurgent dome – and the river has run a course around the northern half circle of the caldera). The river has incised through glacial lake sediments of the Ancient Lake Creede. The modern river is partially-confined within these large abandoned terraces. Reach is relatively stable. Evidence of abandoned terraces. Grade of the reach controlled by a bedrock outcrop at Wagon Wheel Gap.

Stressors	Degree of Geomorphic Impairment
Stressors to reach included a lack of large wood; some development that is or may encroach upon natural channel adjustment. Reach may have seen limited temporary impacts from West Fork Complex Fire burning in the reaches upstream in 2013.	B+

RG05 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type:

RG05	DRY	AVERAGE	WET
Winter	33%	40%	42%
Summer	58%	99%	100%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.

RG05 Riparian Vegetation

An EIA site was not completed within this reach. Results from the reach-scale RCA assessment indicated relatively healthy riparian areas with an overall rating of B-. The only stressor identified was floodplain conversion from housing development.

RG05 Water Quality and Aquatic Life

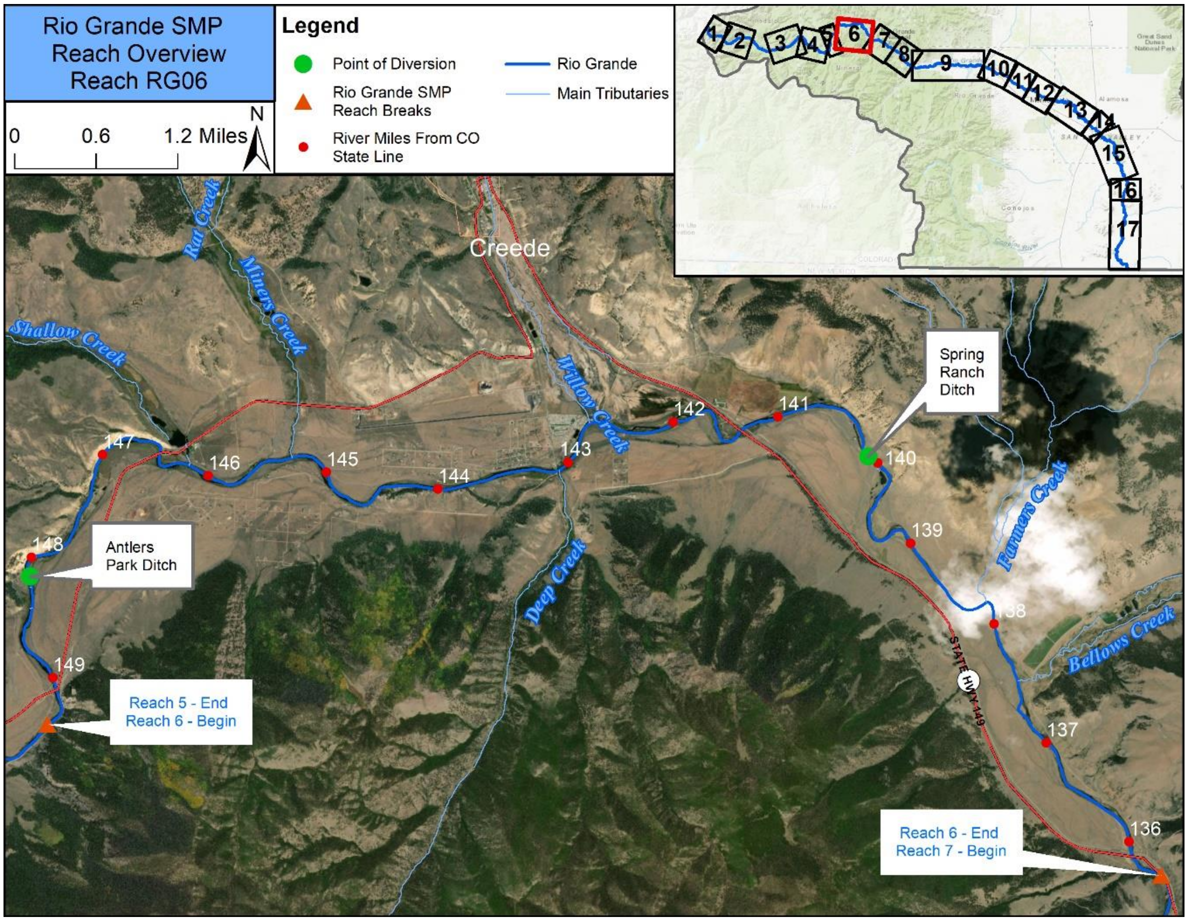
Water Quality		
Temperature	Chemical Conditions	Nutrients
A	B	A
Overall Rating		**A-**

Aquatic Life			
Average MMI Score	Overall MMI Rating	Trout (lbs/acre)	Trout Rating
84.4	A-	N/A	N/A
Overall Rating			**A-**

The 303(d) listing for chronic arsenic persists in this reach (CDPHE, 2018c). No other water quality concerns were identified. Macroinvertebrate data was not available and the average MMI score from RG06 was extrapolated to this reach given their similarities. This MMI score indicates a very healthy BMI community near reference condition. Trout data was not available.

3.2.6 RG06 – Marshall Park Campground to Wagon Wheel Gap

From where the valley confines at the upstream end of Sixmile Flats (near the Marshall Park campground) downstream to just below the Highway 149 bridge at Wagon Wheel Gap.



Representative Reach Photo

RG06 Conditions Assessment Overview

Reach: RG06		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	B-	X			X	X	X					X		
Riparian Vegetation	B		X			X								
Water Quality	B								X					X
Aquatic Life	A-													
Diversion Structures	C													

A	B	C	D	F	Not Assessed

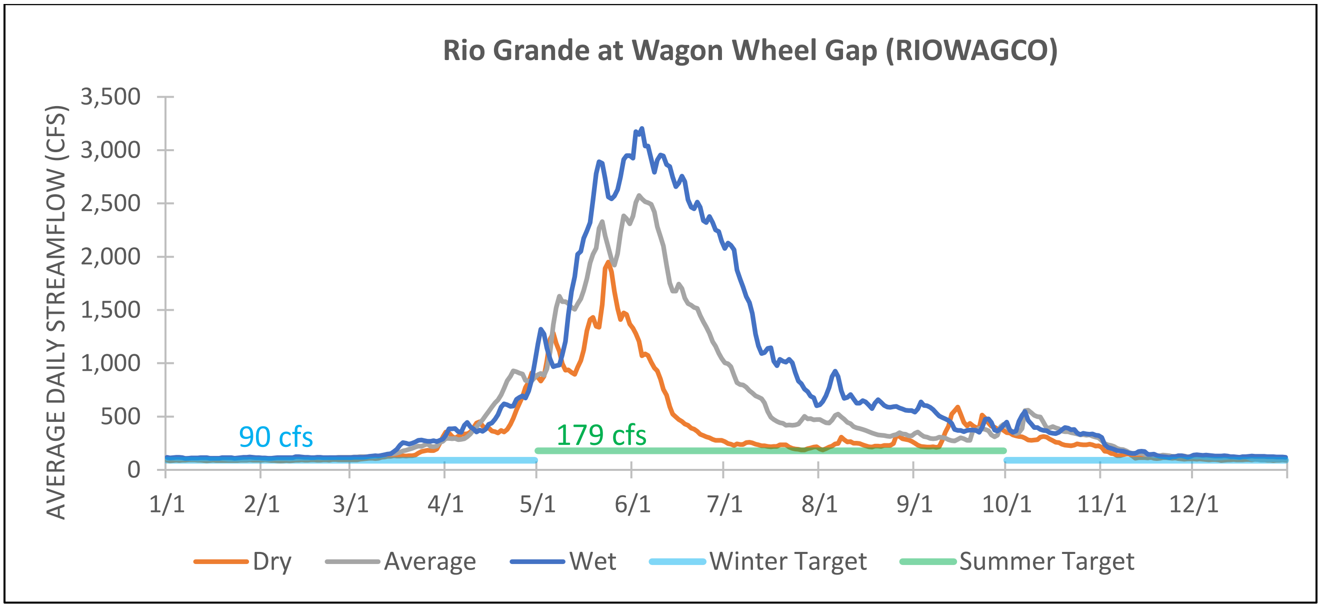
*For an explanation of reach ratings, see Section 2.

RG06 Geomorphology

<table>
<tr><td>Reach</td><td colspan="8">Location Description</td></tr>
<tr><td>RG06</td><td colspan="8">Marshall Park Campground to Wagon Wheel Gap.</td></tr>
<tr><td>Confine-ment</td><td>D50 (mm)</td><td>Bed Comp.</td><td>Existing Stream Form</td><td>Reference Stream Form</td><td>SEM Stage Existing</td><td>SEM Stage Ref.</td><td>Existing Sediment Regime</td><td>Reference Sediment Regime</td></tr>
<tr><td>Partially confined</td><td>119</td><td>Large Cobble</td><td>Riffle-pool</td><td>Riffle-pool</td><td>I</td><td>0</td><td>Confined source & transport</td><td>Confined source & transport</td></tr>
<tr><td>Valley Slope</td><td>Stream Power △</td><td>Bed Mobility Threshold Flows</td><td>Bed Mob. Frequency</td><td colspan="2">Overbank Flow Estimate</td><td colspan="3">Overbank Flow Frequency</td></tr>
<tr><td>0.4%</td><td>↔</td><td>In-channel flows do not move avg. material</td><td>Extreme Events Only</td><td colspan="2">2000-2200 cfs</td><td colspan="3">Wet years for 45 days; average years for 10 days.</td></tr>
<tr><td colspan="2">Watershed Setting</td><td>River Style</td><td colspan="4">Characteristics</td><td colspan="2">Representative Photo</td></tr>
<tr><td colspan="2">Transport</td><td>Elongated discontinuous floodplain</td><td colspan="4">Low-moderate sinuosity in partially confined valleys; channel bed in predominantly alluvial materials; various bar types, run and pool complexes, well developed floodplain typically on one side of river; lateral channel movements occur but largely confined by valley margins for a majority but not all of linear channel distance. Confining margins include terraces and fans.</td><td colspan="2"></td></tr>
<tr><td colspan="9">Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity</td></tr>
<tr><td colspan="9">Middle watershed reach in a partially-confined alluvial valley formed by a volcanic caldera (the center of the caldera rebounded - a resurgent dome - and the river has run a course around the northern half circle of the caldera). The river has incised through glacial lake sediments of the Ancient Lake Creede. The modern river is partially-confined within these large abandoned terraces. Reach is relatively stable. Grade of the reach controlled by underlying bedrock at Wagon Wheel Gap.</td></tr>
<tr><td colspan="7">Stressors</td><td colspan="2">Degree of Geo. Impairment</td></tr>
<tr><td colspan="7">Stressors to reach included a lack of large wood, numerous in-channel structures, bank armoring, and development that is or may encroach upon natural channel adjustment.</td><td colspan="2">B-</td></tr>
</table>

RG06 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type:

RG06	DRY	AVERAGE	WET
Winter	86%	100%	100%
Summer	100%	100%	100%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.

RG06 Riparian Vegetation

An EIA site was not completed within this reach. Results from the reach-scale RCA assessment indicated healthy riparian areas with an overall rating of B. Identified stressors include roads and floodplain conversion from housing development.

RG06 Water Quality and Aquatic Life

Water Quality		
Temperature	Chemical Conditions	Nutrients
A	D	A
Overall Rating		B

Aquatic Life			
Average MMI Score	Overall MMI Rating	Trout (lbs/acre)	Trout Rating
84.4	A-	N/A	N/A
Overall Rating			A-

Water quality in this reach is impacted by historic mining, mineral milling, smelting, and mineral prospecting. Historic mining operations north of Creede discharge heavy metals into Willow Creek. As a result, elevated heavy metal concentrations have been measured in the Rio Grande downstream of the river's confluence with Willow Creek. Downstream of the confluence, the Rio Grande has a 303(d) listing for lead and previous cadmium and zinc exceedances resulted in the current Total Maximum Daily Load (TMDL) for both cadmium and zinc extending from Willow Creek to the Rio Grande/Alamosa county line. Progress has been made in recent years to mitigate the mine waste discharge. Currently, the only metal impairment is dissolved zinc, which exceeds the chronic aquatic life standard. The 303(d) listing for lead was from a previous CDPHE listing cycle however it remains on the list because the number of samples collected recently is not adequate to remove it from the list. Although not on the 303(d) list, data from the URGWA showed arsenic also currently exceeds the water supply standard in this reach (SGM & Lotic Hydrological, 2018).

In summer 2019, a water temperature instrument was installed at the Rio Grande Near Wagon Wheel Gap, CO (RIOWAGCO) gage. The new instrument was integrated into the existing Division of Water Resources stream gage data logger, which is remotely uploaded to the DWR's surface water website, along with streamflow and any other data collected at a given gage. Although water temperature data from the URGWA was available and used for the SMP, this new temperature dataset will be useful for future temperature monitoring. Despite the presence of heavy metals, this reach supports a healthy, near-reference benthic macroinvertebrate community with an average MMI score of 84.4.

RG06 Diversion Infrastructure

***Refer to reach overview map above for diversion structure locations.**

Antlers Park Ditch: This structure is located roughly 1 mile downstream of Marshall Park campground and has no diversion dam. The structure cannot access its full decree due to the ditch's location on the river and the poor condition of the headgate. Given these issues, the TAT recommends installing a new headgate and improving or relocating the diversion dam to effectively divert water at all flows.

Spring Ranch Ditch: A rock weir diversion dam services the river headgate, located on the south bank. The river headgate includes a steel wing wall, return flow gate, and a log trash boom to keep debris out. A roughly 550 ft feeder channel delivers water to main headgate. Another return flow headgate is adjacent to the main headgate. No immediate repair needs were noted at this structure.

3.2.7 RG07 – Wagon Wheel Gap to Forest Road 430A Bridge

The upstream end of this reach is just below the Highway 149 bridge at Wagon Wheel Gap. The downstream boundary of this reach is located at the bridge from Highway 149 onto Forest Road 430A. The majority of this reach falls within the Rio Grande National Forest.

Representative Reach Photo

RG07 Conditions Assessment Overview

Reach: RG07		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	B+	X	X	X		X						X		
Riparian Vegetation	B		X	X		X								
Water Quality	B								X					X
Aquatic Life	B+													
Diversion Structures	N/A													

A	B	C	D	F	Not Assessed

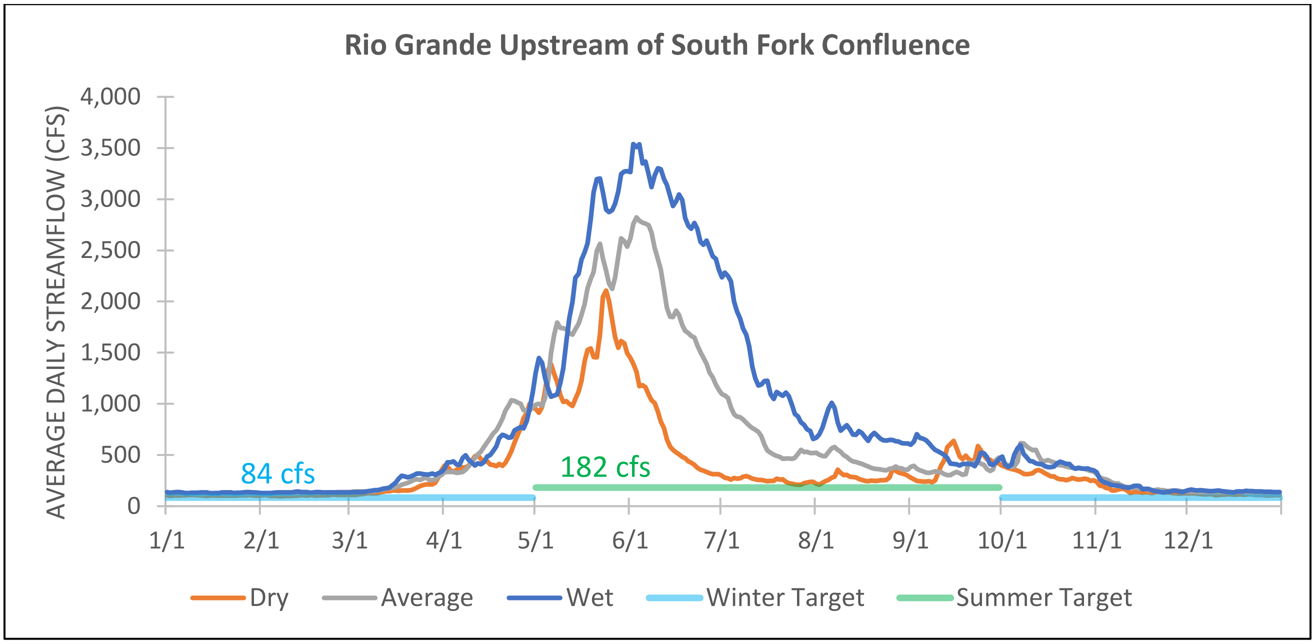
*For an explanation of reach ratings, see Section 2.

RG07 Geomorphology

Reach	Location Description							
RG07	Wagon Wheel Gap to Forest Road 430A Bridge							
Confine-ment	D50	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Confined	No Data	No Data	Plane bed	Plane bed	1	1	Transport	Transport
Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate		Overbank Flow Frequency		
0.45%	↑	No Data	No Data	No Data		No Data		
Watershed setting		River Style	Characteristics				Representative Photo	
Transport		Confined valley	Confined channel geometry with very little or no floodplain present throughout reach. Instream features derive from lower gradients than step cascade reaches; with plane bed and riffle-run sequences dominant rather than cascades and step pools, although the latter may still occur. Planform remains fully margin-controlled.					
Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity								
Middle watershed reach in a naturally confined valley. Reach appears to be geomorphically stable. Evidence of abandoned terraces.								
Stressors							Degree of Geomorphic Impairment	
Some encroachment from railroad/roads as well as some development sited within the corridor. Undersized crossings. Lack of large wood.							B+	

RG07 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type:

RG07	DRY	AVERAGE	WET
Winter	100%	100%	100%
Summer	100%	100%	100%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.

RG07 Riparian Vegetation

Overall, this site (RGVeg07) appears to be in good condition, receiving an overall EIA rating of B- (2.88). However, this score suggests that this site has the potential to degrade to a rating of C if further alteration from natural conditions occurs. The lowest individual metric ratings it received were for Contiguous Natural Land Cover (C), Perimeter with Natural Buffer (C), and Width of Natural Buffer (C) (Table 3.9).

Table 3.9: EIA Scorecard – RGVeg07

RGVeg07 Observer: W. McBride	Wt	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				**2.88**	**B-**
Rank Factor: LANDSCAPE CONTEXT	0.30			**2.60**	**B-**
LANDSCAPE METRICS	0.33			**2.50**	**B-**
L1. Contiguous Natural Land Cover	1	C	2		
L2. Land Use Index	1	B	3		
BUFFER METRICS	0.67			**2.65**	**B-**
B1. Perimeter with Natural Buffer	n/a	C	2		
B2. Width of Natural Buffer	n/a	C	2		
B3.1. Condition of Natural Buffer - Veg	n/a	A	4		
B3.2. Condition of Natural Buffer - Soils	n/a	B	3		
Rank Factor: CONDITION	0.70			**3.00**	**B+**
VEGETATION METRICS	1			**3.00**	**B+**
V1. Native Plant Species Cover	1	B	3		
V2. Invasive Nonnative Plant Species Cover	1	B	3		
V3. Native Plant Species Composition	1	B	3		
V4. Vegetation Structure	1	B	3		
V5. Regen. of Native Woody Species **(opt.)**	1	B	3		
V65. Coarse and Fine Woody Debris **(opt.)**	1	B	3		

Both Contiguous Natural Land Cover, Perimeter with Natural Buffer, and Width of Natural Buffer were disrupted by a combination of railroad tracks and State Highway 149 that runs parallel to the river to the northeast. Due to the location of these semi-permanent structures, these metric scores cannot be easily improved as they are currently assessed.

Average relative cover of native species for this site was 99%. The averaged mean C-value for native species was 5.3 and the averaged cover-weighted mean C-value for native species was 5.2 (Table 3.7). This suggests that the majority of native species present are equally found in natural and non-natural areas. The only noxious species encountered was *Verbascum thapsus* in plot 3 with a cover of 0.2% (average noxious cover across all plots was 0.05%). Current land uses observed and approximate cover within the 500 m buffer include management for native vegetation (83%), light grazing (10%), light recreation via fishing (2%), paved roads (2%), railroad tracks (2%), and commercial buildings (1%). Traffic along the highway and recreational use at the nearby campground likely cause the highest disturbance impacts at this site.

Results from the reach-scale RCA assessment indicated healthy riparian vegetation with a B rating. Stressors include roads and railways and mild floodplain conversion and disconnection from housing development. The average of the EIA and RCA ratings is B.

RG07 Water Quality and Aquatic Life

Water Quality		
Temperature	Chemical Conditions	Nutrients
A	D	A
Overall Rating		**B**

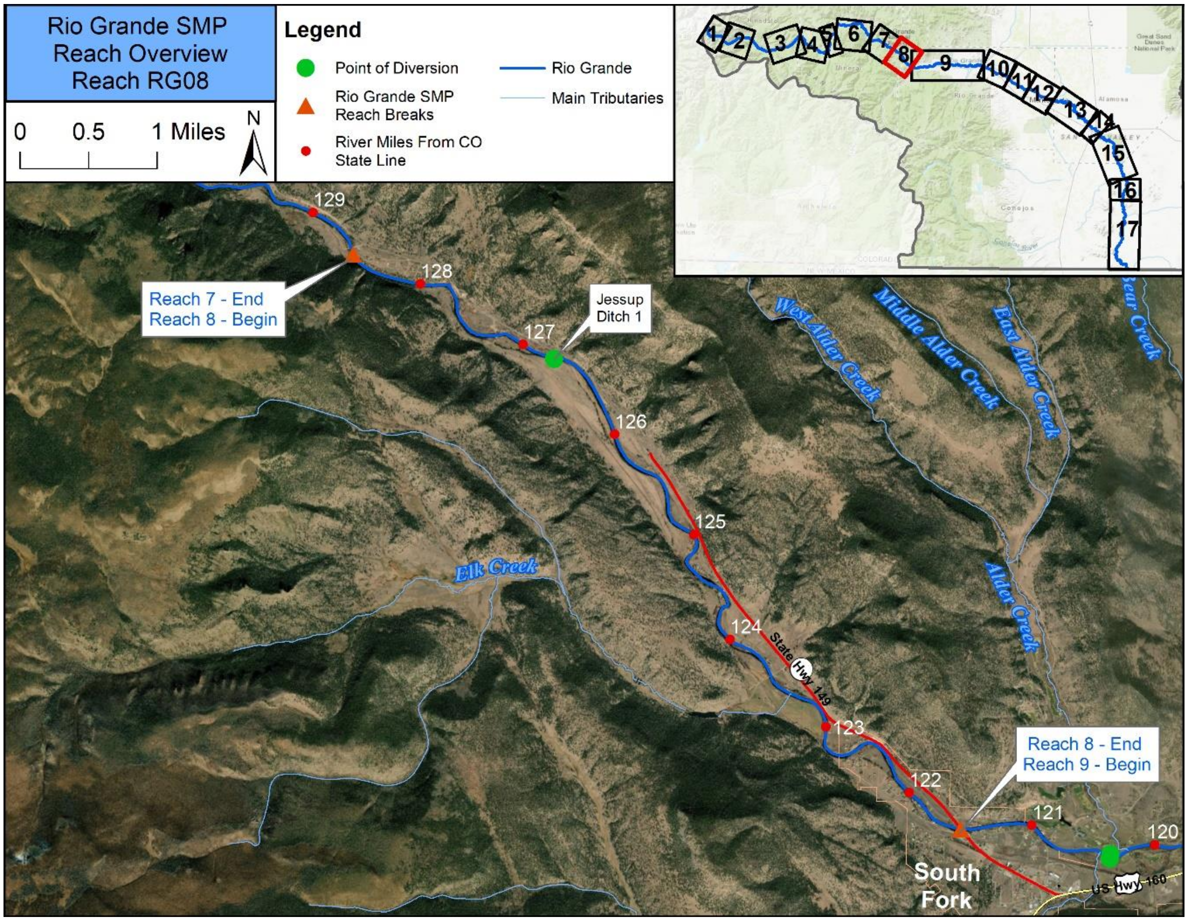
Aquatic Life			
Average MMI Score	Overall MMI Rating	Trout (lbs/acre)	Trout Rating
67	B-	62.8	A
Overall Rating			**B+**

Water quality in this reach is impacted by historic mining, mineral milling, smelting, and mineral prospecting. Historic mining operations north of Creede discharge heavy metals into Willow Creek. As a result, elevated heavy metal concentrations have been measured in the Rio Grande downstream of the river's confluence with Willow Creek. Downstream of the confluence, the Rio Grande has a 303(d) listing for lead and previous cadmium and zinc exceedances resulted in the current TMDL for both cadmium and zinc. Progress has been made in recent years to mitigate the mine waste discharge. Currently, the only metal impairment is dissolved zinc, which exceeds the chronic aquatic life standard. The 303(d) listing for lead was from a previous CDPHE listing cycle however it remains on the list because the number of samples collected recently is not adequate to remove it from the list. Although not on the 303(d) list, data from the URGWA showed arsenic also currently exceeds the water supply standard in this reach (SGM & Lotic Hydrological, 2018).

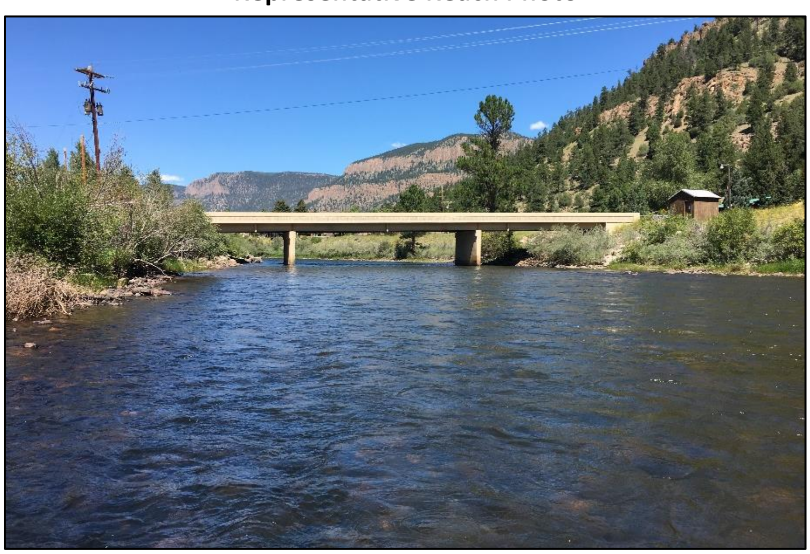
Similar to RG06, this reach supports a near-reference condition healthy BMI community with an average MMI score of 67. Trout biomass is also high and brown trout are very abundant in this reach with population surveys showing over 2000 fish per mile. Other fish species in this reach include longnose dace, brown trout, rainbow trout, and white sucker.

3.2.8 RG08 – Forest Road 430A Bridge to Highway 149 Bridge in South Fork

The upstream boundary of this reach is located at the bridge from Highway 149 onto Forest Road 430A (near the Rio Grande National Forest boundary). The downstream end of this reach occurs at the Highway 149 bridge over the Rio Grande just upstream of South Fork.



Representative Reach Photo



RG08 Conditions Assessment Overview

Reach: RG08		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	B	X	X	X		X						X		
Riparian Vegetation	B		X	X		X								
Water Quality	B								X					X
Aquatic Life	B+													
Diversion Structures	C													

A	B	C	D	F	Not Assessed

*For an explanation of reach ratings, see Section 2.

RG08 Geomorphology

Reach	Location Description
RG08	Forest Road 430A Bridge to Highway 149 Bridge in South Fork

Confine-ment	D50 (mm)	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Partially-confined	111	Small Cobble	Plane bed	Plane bed	1	1	Transport	Transport

Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate	Overbank Flow Frequency
0.37%	↔	In channels flows do not move average bed material	Extreme Events Only	Confined Reach; no floodplain.	Extreme Events Only

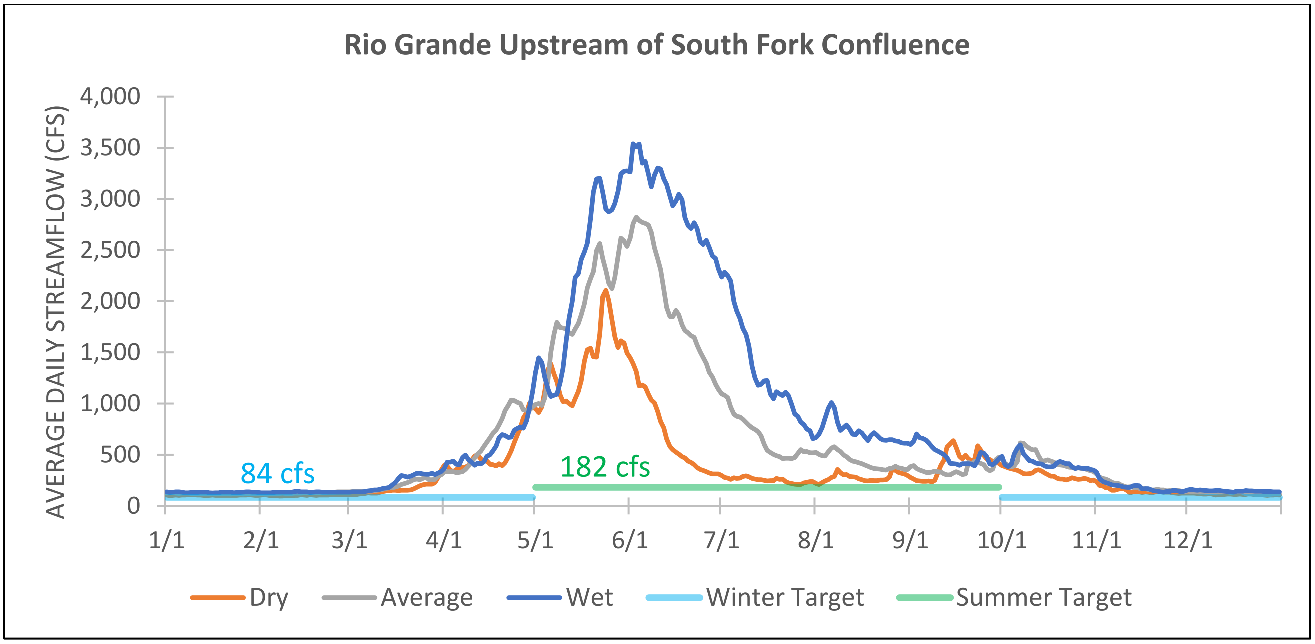
Watershed setting	River Style	Characteristics	Representative Photo
Transport	Elongated discontinuous floodplain	Low to moderate sinuosity reaches in partially confined valleys; channel bed in predominantly alluvial materials; various bar types, run and pool complexes, well developed floodplain typically on one side of the river; lateral channel movements occur but are largely confined by valley margins for a majority but not all of linear channel distance. Confining margins include terraces and fans.	

Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity
Middle watershed reach in a partially-confined valley. Channel itself inset into high terraces the highest of which are likely related to glacial outwash events and the lower ones perhaps slightly disconnected due to modern stressors which reduce floodplain connectivity and geomorphic flows. Reach is stable.

Stressors	Degree of Geomorphic Impairment
Some encroachment from railroad/roads as well as some development sited within the corridor. Undersized crossings exist. Lack of large wood.	B

RG08 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type:

RG08	DRY	AVERAGE	WET
Winter	100%	100%	100%
Summer	100%	100%	100%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.

RG08 Riparian Vegetation

An EIA site was not completed within this reach. Results from the reach-scale RCA assessment indicated healthy riparian vegetation with a B rating. Stressors include roads and railways and mild floodplain conversion and disconnection from housing development.

RG08 Water Quality and Aquatic Life

Water Quality		
Temperature	Chemical Conditions	Nutrients
A	D	A
Overall Rating		B

Aquatic Life			
Average MMI Score	Overall MMI Rating	Trout (lbs/acre)	Trout Rating
67	B-	62.8	A
Overall Rating			B+

Water quality in this reach is impacted by historic mining, mineral milling, smelting, and mineral prospecting. Historic mining operations north of Creede discharge heavy metals into Willow Creek. As a result, elevated heavy metal concentrations have been measured in the Rio Grande downstream of the river's confluence with Willow Creek. Downstream of the confluence, the Rio Grande has a 303(d) listing for lead and previous cadmium and zinc exceedances resulted in the current TMDL for both cadmium and zinc. Progress has been made in recent years to mitigate the mine waste discharge. Currently, the only metal impairment is dissolved zinc, which exceeds the chronic aquatic life standard. The 303(d) listing for lead was from a previous CDPHE listing cycle however it remains on the list because the number of samples collected recently is not adequate to remove it from the list. Although not on the 303(d) list, data from the URGWA showed arsenic also currently exceeds the water supply standard in this reach (SGM & Lotic Hydrological, 2018).

Macroinvertebrate data was not available and the average MMI score from RG07 was extrapolated to this reach given their similarities. This MMI score indicates a healthy benthic macroinvertebrate community. Fish surveys have revealed abundant and healthy brown and rainbow trout. Brown trout are exceptionally abundant in this reach, with population surveys showing over 2000 fish per mile. Other fish species in this reach include longnose dace, brown trout, rainbow trout, and white sucker.

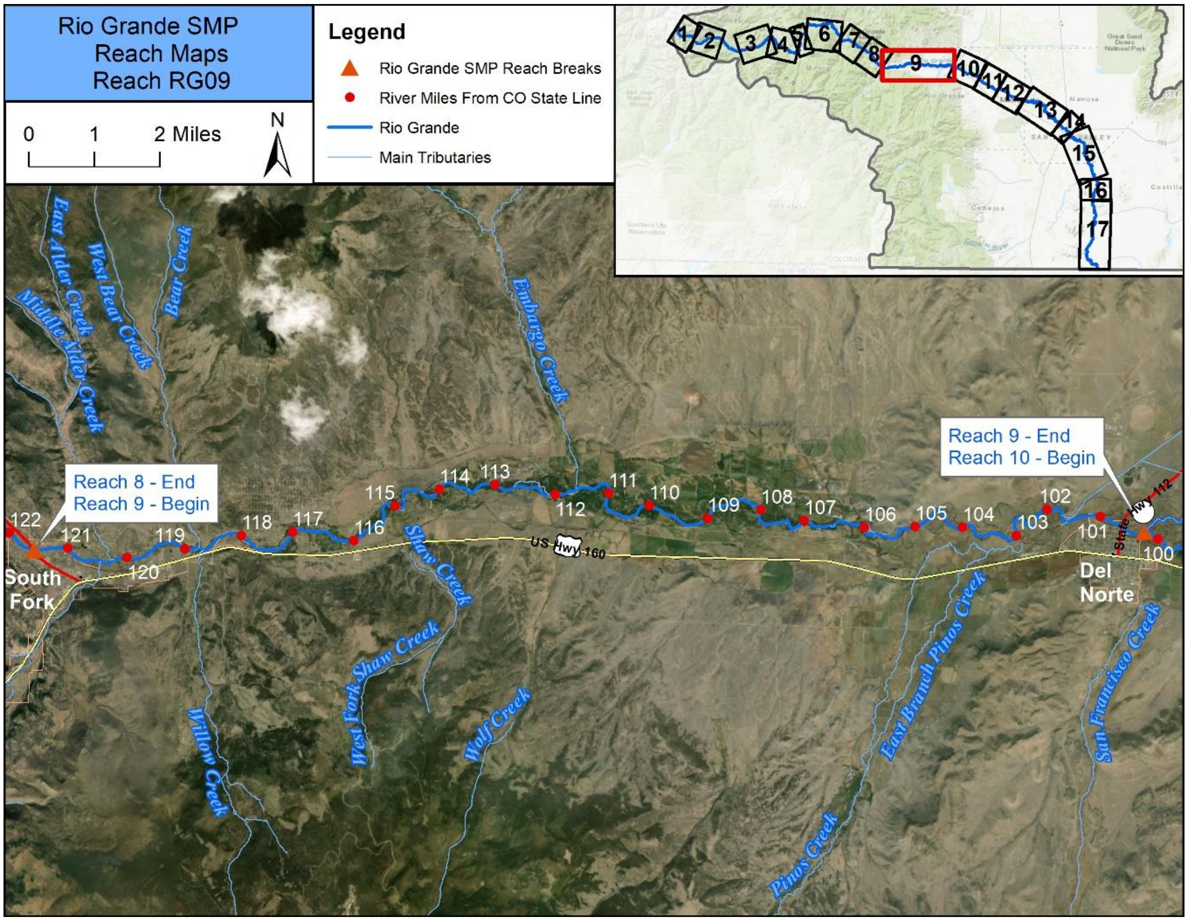
RG08 Diversion Infrastructure

***Refer to reach overview map above for diversion structure locations.**

Jessup Ditch 1: This structure is located on the south bank of the Rio Grande approximately 0.5 mile downstream of the Upper Coller Bridge in the Coller State Wildlife Area. A stacked rock diversion dam, installed in 2007 as part of a fish habitat improvement project, diverts water into a short feeder channel to the headgate. The headgate is housed inside a pump house, which is currently non-functional. The diversion dam and feeder channel function well. The water right holder uses a portable pump at a settling pond approximately 730 ft downstream of the headgate. Water is pumped upstream from the diversion. Given the challenge of using a portable pump to irrigate, the TAT recommends repair or replacement of the pump house.

3.2.9 RG09 – Highway 149 Bridge in South Fork to Rio Grande Splitter

The Highway 149 Bridge over the Rio Grande just upstream of South Fork downstream to the Rio Grande Splitter just east of Del Norte.



Representative Reach Photo

RG09 Conditions Assessment Overview

Reach: RG09		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	C	X	X	X	X	X		X				X		
Riparian Vegetation	B-			X		X								
Water Quality	C								X					X
Aquatic Life	A-	X						X						
Diversion Structures	B-													

A	B	C	D	F	Not Assessed

*For an explanation of reach ratings, see Section 2.

RG09 Geomorphology

Reach	Location Description
RG09	Highway 149 Bridge in South Fork to Rio Grande Splitter

Confine-ment	D50 (mm)	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Partially- to unconfined	96-108	Small Cobble	Riffle-pool	Riffle-pool	1	0	Coarse Equilibrium & Fine Deposition	Coarse Equilibrium & Fine Deposition

Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate	Overbank Flow Frequency
0.25%	↓	4200-5600	1 in every 2-4 years.	5600-6000 cfs	1 in every 3-4 years.

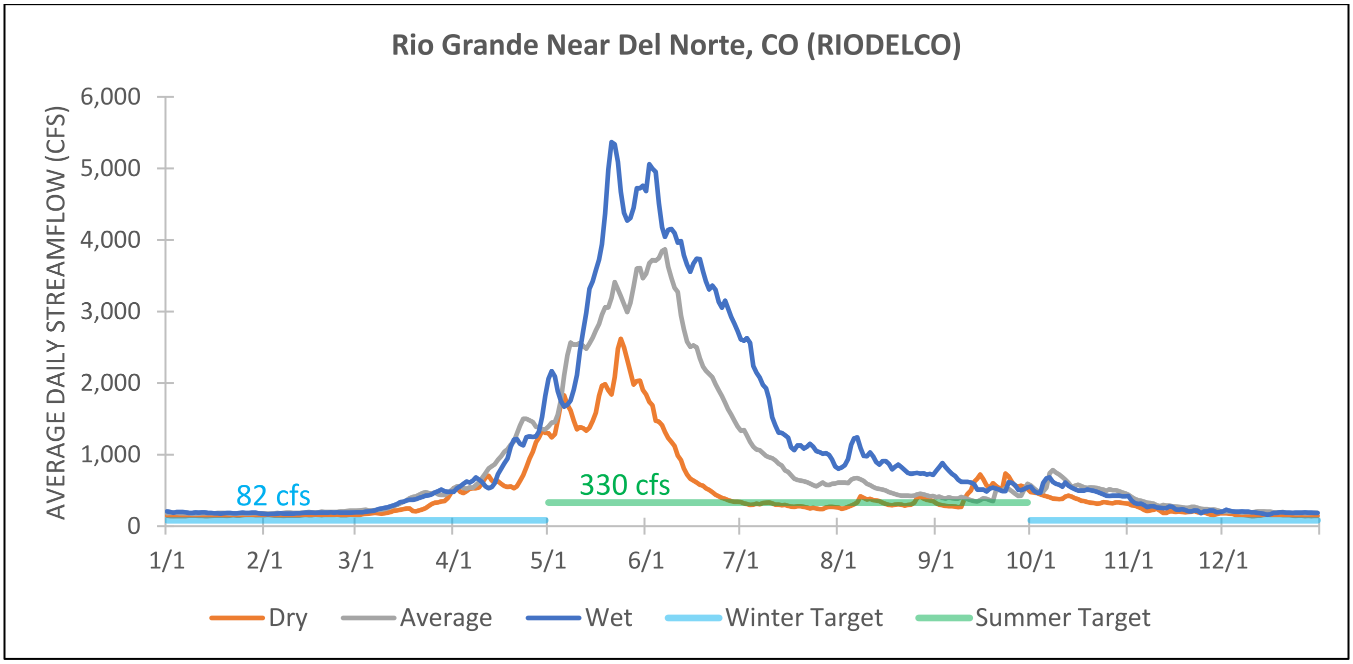
Watershed setting	River Style	Characteristics	Representative Photo
Response	Meandering planform-controlled discontinuous floodplain And Meandering Coarse Grained Bed	Active channel abuts confining margins for a minority of linear valley distance (weak but present connection to valley margins). Floodplain and instream geomorphic features characteristic of meandering and lateral migration including multiple bar forms, especially point bars, cutoffs, and cutbanks. Unconfined channel with moderate to high sinuosity, well developed meandering and associated channel and floodplain geomorphic forms. Range of bar types, floodplain features and floodplain textures; substrate sizes tending toward cobbles and large gravels; substrate variability depends on habitat-scale geomorphic features such as location in bend, pool, or riffle.	

Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity
Partially confined valley turning into unconfined; Reach is more active in planform adjustment than reach upstream as the valley slope becomes flatter and valley opens. The South Fork Rio Grande contributes to sediment load at top of reach.

Stressors	Degree of Geomorphic Impairment
Settlement of the town of South Fork has come with the need to control the river using in-channel structures and armoring. Roads are found on both the north and south banks. Numerous instances of channel straightening. Limited large woody material.	C

RG09 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type:

RG09	DRY	AVERAGE	WET
Winter	100%	100%	100%
Summer	64%	100%	100%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.

RG09 Riparian Vegetation

Overall, this site (RGVeg09) appears to be in good condition, receiving an overall EIA rating of B- (2.71). However, this score suggests that this site has the potential to degrade to a C rating if further alteration from natural conditions occurs. The lowest individual metric ratings it received were for Contiguous Natural Land Cover (C), Land Use Index (C), Perimeter with Natural Buffer (C), Width of Natural Buffer (C), Native Plant Species Cover (C), and Vegetation Structure (C) (Table 3.10).

Table 3.10: EIA Scorecard – RGVeg09

RGVeg09 Observer: W. McBride	Wt	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				**2.71**	**B-**
Rank Factor: LANDSCAPE CONTEXT	0.30			**2.43**	**C+**
LANDSCAPE METRICS	0.33			**2.00**	**C+**
L1. Contiguous Natural Land Cover	1	C	2		
L2. Land Use Index	1	C	2		
BUFFER METRICS	0.67			**2.65**	**B-**
B1. Perimeter with Natural Buffer	n/a	C	2		
B2. Width of Natural Buffer	n/a	C	2		
B3.1. Condition of Natural Buffer - Veg	n/a	B	3		
B3.2. Condition of Natural Buffer - Soils	n/a	A	4		
Rank Factor: CONDITION	0.70			**2.83**	**B-**
VEGETATION METRICS	1			**2.83**	**B-**
V1. Native Plant Species Cover	1	C	2		
V2. Invasive Nonnative Plant Species Cover	1	A	4		
V3. Native Plant Species Composition	1	B	3		
V4. Vegetation Structure	1	C	2		
V5. Regen. of Native Woody Species **(opt.)**	1	B	3		
V65. Coarse and Fine Woody Debris **(opt.)**	1	B	3		

Contiguous Natural Land Cover, Land Use Index, Perimeter with Natural Buffer, and Width of Natural Buffer were all impacted by livestock grazing. Moderate to heavy grazing activity was the central factor that impacted the ratings for these metrics. Grazing pressure often results in reduced species diversity in combination with an increase in both native and nonnative plant species that are more tolerant of stressors such as higher intensity grazing pressure. As the plant community becomes stressed, there is also greater chance for noxious species to invade and thrive, which further disrupts the ecological processes. A reduction in grazing pressure within a minimum of 100 m from both sides of the river corridor would improve the condition of the buffer by reducing the potential for invasion by nonnative species and pollutant loading.

Regarding Native Plant Species Cover, the average relative native species cover was 86%. The nonnative species with the highest absolute cover include the following species with cover values for plots 1, 2, 3, and 4, respectively: *Phalaris arundinacea* (1.5%, 17.5%, 0%, and 0%), and *Poa pratensis* (0.5%, 1.5%, 7.5%, and 17.5%). There were no noxious species observed within the AA.

Regarding Native Plant Species Composition, the average mean C-value for native species at this site was 5.4, and the average cover-weighted mean C-value for native species was 4.5 (Table 3.7). These values suggest that most native species present are equally likely to be found in natural and non-natural areas. The impacts from anthropogenic disturbance are sub-optimal for the occurrence of species sensitive to habitat degradation and/or disturbance.

Current land uses observed and approximate cover within the 500 m buffer include heavy livestock grazing (30%), moderate grazing (30%), management for native vegetation (26%), light recreation (10%), unpaved roads (2%), and paved roads (2%). A reduction of grazing pressure and minimizing the use of two-tracks within 100 m of the river would alleviate stressors adjacent to this riparian area.

Results from the reach-scale RCA assessment indicated mostly healthy riparian vegetation with a B-rating. Stressors include floodplain conversion and disconnection from housing development. The average of the EIA and RCA ratings is B-.

RG09 Water Quality and Aquatic Life

Water Quality		
Temperature	**Chemical Conditions**	**Nutrients**
D	D	A
Overall Rating		**C**

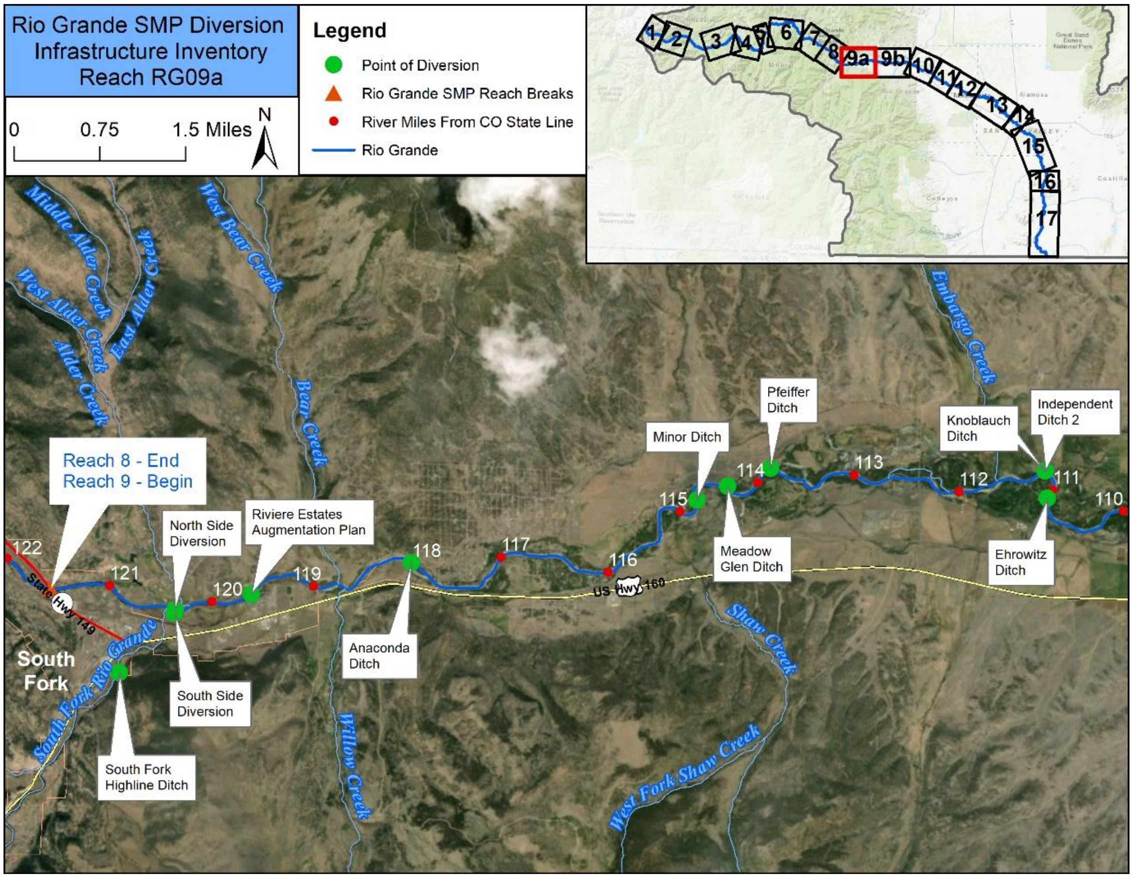
Aquatic Life			
Average MMI Score	**Overall MMI Rating**	**Trout (lbs/acre)**	**Trout Rating**
74.9	B+	>60	N/A
Overall Rating			**A-**

Total arsenic and dissolved manganese are on the 303(d) list for this reach. Manganese concentrations are greater than the year 2000 ambient level of 38 µg/l and greater than the table value standard of 50 µg/l (CDPHE, 2018a). Lead exceeds the aquatic life use standards and is on the 303(d) M&E List. The TMDL for cadmium and zinc beginning in RG06 persist through this reach with both metals currently exceeding standards. Copper had previously exceeded standards however recent data shows attainment. This reach is also on the 303(d) list for water temperature. Between May 2013 and June 2019, the Del Norte stream gage recorded 1 Daily Maximum (DM) exceedances and 9 Maximum Weekly Average Temperature (MWAT) exceedances. Additionally, data from the URGWA showed arsenic and aluminum both exceed the chronic water supply standard (SGM & Lotic Hydrological, 2018).

Diversion structures form multiple barriers to fish passage in this reach and reduce aquatic habitat connectivity. Despite fish barriers and heavy metal exceedances, aquatic life remains healthy. This reach supports a healthy benthic macroinvertebrate community with an average MMI score of 74.9. Also, the portion of this reach from its starting point to the Rio Grande Canal (nearly the entire reach) is designated as a Gold Medal Waters due to abundant brown and rainbow trout fisheries.

RG09a Diversion Infrastructure

*Due to the relatively high number of diversion structures located within this reach, structures are displayed in two separate maps (RG09a and b), each of which show roughly half of the reach's structures.



South Fork Highline Ditch: This structure is located on the South Fork Rio Grande and functions effectively overall. A concrete diversion dam spans the river and has semi-permanent metal posts which support stop boards and increase head pressure during low flows. The headgate is located on the east side of the river. The headgate is set in concrete. The flume currently measures accurately, but may need to be replaced in the near future due to rust damage.

South Side Diversion: A small rock diversion dam on the south side of the river submerses the structure's point of diversion. Water is pumped directly from the river. The pump is housed in a small building and is metered. It is located just downstream of a pedestrian bridge serving the Rio Grande Club & Resort golf course. The channel is relatively stable in this reach and is not expected to migrate significantly in the future. There were no major issues identified at this structure.

North Side Diversion: No headgate exists, instead a submersible pump installed below the water surface is utilized. A small rock diversion dam on the north side of the river submerses the structure's point of diversion. Water is pumped directly from the river via a metered submersible pump. It is located just downstream of a pedestrian bridge serving the Rio Grande Club & Resort golf course. The channel is relatively stable in this reach and is not expected to migrate significantly in the future. There were no major issues identified at this structure.

Riviere Estates: A stacked rock diversion dam directs water to a short feeder channel and to the headgate. A log trash boom across the feeder channel prevents debris from accumulating in front of the headgate. The boom appears to be functioning well. Historic aerial photographs used to assess channel migration indicate the channel has remained relatively stable since 1960 (see report card). The headgate enters a culvert, which delivers water to two ponds inside the RV park. There were no major issues identified at this structure.

Anaconda Ditch: Water is diverted from the Rio Grande into a feeder channel located on the north bank of the river. A stacked rock diversion dam diverts water to the feeder channel, which delivers water to the headgate, which is approximately 30 ft below an old headgate. At low flows, the diversion can be difficult to navigate in rafts and dories. The channel has remained stable in this location for at least the last 45 years and is not expected to experience significant migration in the near future. Woody debris accumulation is an issue in the feeder channel and at the headgate, particularly because of the ditch's location on the outside of a meander. Additionally, significant erosion is occurring on the south bank of the river upstream of the diversion. Given the issues at this structure, the TAT recommends removing the old headgate and installing a trash rack in front of the new headgate as well as stabilizing the south bank. Additionally, if any future improvements are made to the diversion dam, the TAT recommends maintaining fish passage and also creating safe boat passage at the diversion.

Minor Ditch: The Rio Grande splits around an island upstream of the structure's river headgate. The river headgate is located on the south bank of the channel. A roughly 0.5 mile feeder channel delivers water to the main headgates. An overflow channel directs unused water from the ditch back to the Rio Grande. This structure suffers from the poor condition of the river headgate, the potential for the structure to be cut off from the river in the event of a rerouting of the main channel to the north, and sediment and debris accumulation in the ditch. The concrete wingwalls on either side of the river headgate are heaving and falling in towards the river. The river channel is unstable and there is potential for the upstream meander to be cut off, causing the full capacity of the river to flow through the north channel. During spring 2019 runoff, significant flow entered the channel north of the island. If this continues to develop, the river will abandon the south channel, making the diversion nonfunctional. Additionally, debris accumulation occurs at the main headgate and in the feeder channel. Finally, there is a point on the feeder channel roughly halfway between the river headgate and main headgate where the ditch is dangerously close to the river and could fail at high flow (see report card). Given the current and potential issues at this structure, the TAT recommends bank stabilization upstream of the island and on the feeder channel and headworks repair. Bank stabilization upstream of the diversion would help prevent potential channel avulsion, stabilization or feeder channel rerouting would prevent ditch failure, and new wingwalls adjacent to the headgate ensure the headworks are stable.

Meadow Glen Ditch: There is no formal diversion dam for this structure. Water naturally flows into the feeder channel, located on the north bank of the channel. A 4 ft galvanized metal fence serves as a trash rack. The feeder channel delivers water to the headgate, which is approximately 200 ft down the ditch. A steel divider (diversion dam) along the feeder channel directs water to the headgate, which functions poorly due to leakage. The river channel at this structure is relatively stable (see channel migration maps in diversion inventory). There is some gravel bar formation downstream of the diversion, but it is not expected to affect this structure. Woody debris is able to bypass the trash rack at the mouth of the feeder channel because of a large gap between it and the bank. Given these issues, the TAT recommends extending the trash rack and repairing the headgate. An improved trash rack would prevent woody debris from entering the feeder channel and reduce maintenance, while headgate repairs would eliminate the leak and improve ditch efficiency.

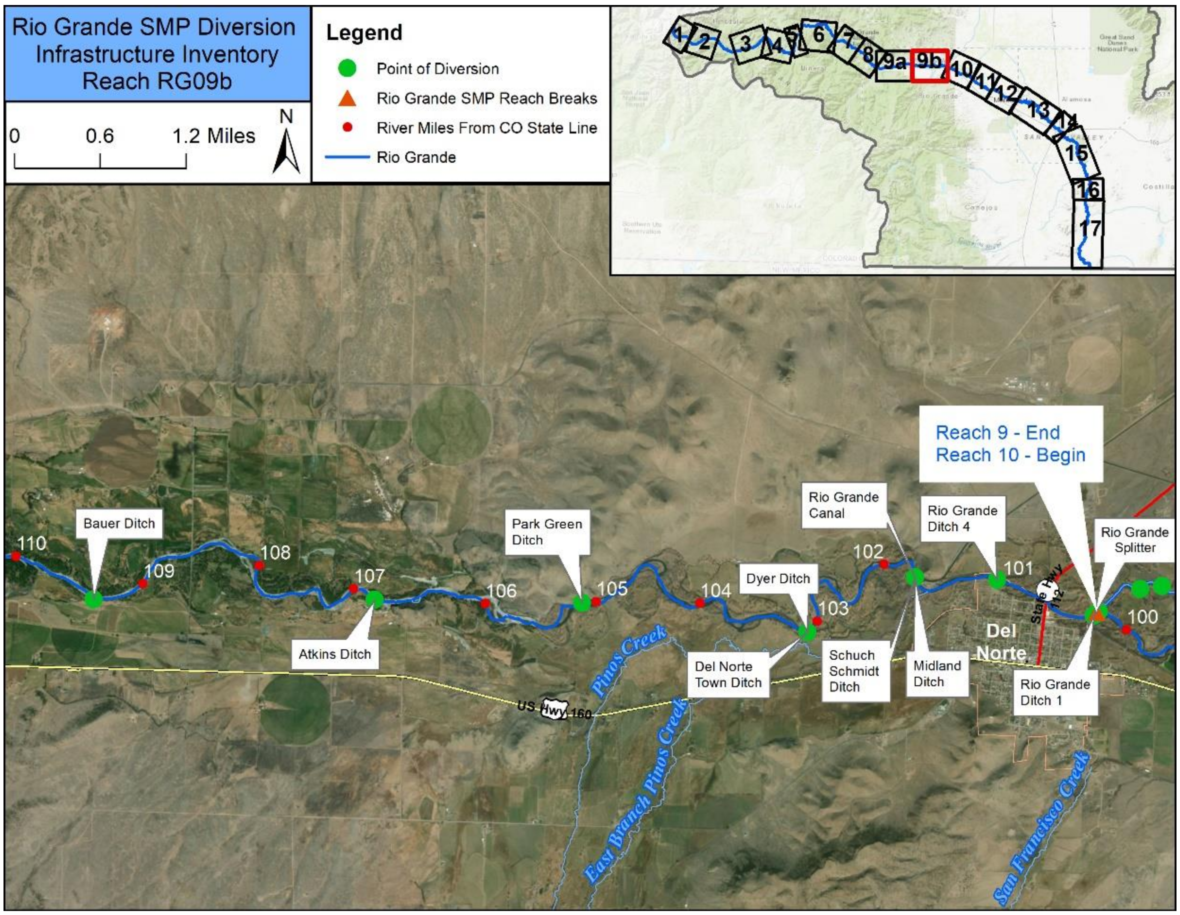
Pfeiffer Ditch: There is no formal diversion dam for this structure. A headgate located on the north bank of the channel directs water to a feeder channel, and is dependent upon streamflow. The feeder channel is an abandoned river channel which, according to the 2001 Rio Grande Headwaters Restoration Project, was part of the Rio Grande in 1941 but was probably cut off sometime between 1948 and 1949. The feeder channel directs water from the river to the headgate, located approximately 0.4 miles from the diversion. The main issues facing this structure are sedimentation in the feeder channel, woody debris in the feeder channel and at the main headgate, and, to a lesser degree, difficulty diverting the ditch's water rights during low flow conditions. The TAT recommends mitigating sedimentation, installing a trash rack at the headgate, and considering the installation of a diversion dam. A sluice gate at the river headgate would reduce sedimentation and a trash rack at the main headgate would prevent debris accumulation. Although the ditch only has difficult diverting at extremely low flows, the construction of a small diversion would allow the ditch to divert at all flows.

Independent Ditch 2: A W-shaped diversion dam made of boulders directs water to the headgate, which is on the north bank of the river. Recent high flow events have shifted some of the boulders which make up the diversion, resulting in a boating hazard and making water diversion at low flows very challenging. A trash rack made of 4 ft galvanized metal fence sits in front of the headgate, which does not seal properly. There are various materials stabilizing the banks upstream of the structure and around the headwall. However, the banks that are not reinforced are largely unstable and subject to erosion. This structure is located on the outside of a bend just upstream of the apex. According to the 2001 Rio Grande Headwaters Restoration Project, this meander bend is tightening and there is potential for the entire meander to be cut off during a high flow event, making this structure unusable. Given these issues, the TAT recommends improving the diversion dam, repairing or replacing the headgate, and revegetating and stabilizing the adjacent streambanks. An improved diversion could be designed to be easily passable by boats while also effectively diverting water at all flows. Streambank stabilization and riparian revegetation would mitigate erosion and reduce the risk of bank failure and future impacts to the structure.

Knoblauch Ditch: This structure shares a diversion dam and headwall with the Independent Ditch 2 (see above). The ditch's headgate functions well. The Independent Ditch 2 recommendations described above for diversion dam improvements and streambank restoration also apply to this structure.

Ehrowitz Ditch: The original diversion dam was damaged, and currently there is no formal diversion dam for this structure. Instead, an informal sand and gravel push-up diversion dam is formed each year in an effort to divert the ditch's water rights during low flow conditions. It is typically reconfigured and/or adjusted multiple times throughout the irrigation season. Depending on its configuration, it can be difficult to navigate via boat, especially during low flows. The river is migrating east upstream of the point of diversion, which is exacerbating these challenges. The roughly 0.5 mile feeder channel directs water to the headgate and an overflow channel directs return flows back to the river. Sedimentation in the feeder channel requires regular maintenance. Additionally, the return flow structure has sunken and makes headgate control challenging. Based on the assessment of this structure, the TAT recommends either the installation of a new diversion dam at this location or relocating the diversion upstream, with the possibility of using the existing Independent Ditch 2 diversion. A new diversion dam, either in its current location or moved upstream, would effectively divert water and reduce maintenance. Repair or replacement of the return flow structure is also recommended to improve control of flows to the headgate.

RG09b Diversion Infrastructure



Bauer Ditch: There is no diversion dam, but this ditch functions on grade with the river. Occasionally, this ditch has difficulty diverting its full decree due to the lack of a diversion dam. The point of diversion is located on the outside bend of the river, just downstream of the apex. The river channel has migrated very little in the last 45 years, although localized bank erosion has occurred. Bank stabilization structures were installed upstream and downstream of this structure in 2009 to mitigate bank erosion. Flows are directed into a feeder channel located on the south bank. The feeder channel is approximately 1,200 ft long and delivers water to the headgate. A 2 ft culvert (see report card) returns overflow water to the Rio Grande. The feeder channel and a significant portion below the headgate are within the floodplain. This is problematic due to constant erosion by the river as well as sediment deposition in the feeder channel. The TAT recommends raising the elevation of the feeder channel and/or installing a sluice gate to mitigate sediment accumulation. Additionally, a small diversion dam would enable the ditch to operate at all flow levels.

Atkins Ditch: This structure's diversion was improved in 2009 and is now a stacked rock structure with boulders anchored on the south bank of the river, similar to a J-Hook. The diversion directs water from the Rio Grande to a short feeder channel located on the north bank of the river. The feeder channel, a small rock diversion dam, directs flow to the headgate. The headgate was replaced about six years ago and functions well. The feeder channel returns to the river just downstream of the headgate. As the channel has migrated away from the point of diversion, a gravel bar has been forming at the mouth of the feeder channel and gravel material continually needs to be removed for the structure to access its full decree. See photo in report card labeled, "diversion dam and feeder channel on Rio Grande." The south bank has also experience erosion as a result of channel migration. The channel migration away from the point of diversion may cause the diversion dam to function less effectively and/or require repairs in the future. Given these current and potential future challenges, the TAT recommends bank stabilization on the south bank and possible diversion dam improvements or diversion relocation if channel migration accelerates. Bank stabilization would mitigate lateral channel migration and if migration accelerates, a modified diversion dam and/or relocating the diversion upstream may be necessary for this structure to function properly.

Park Green Ditch: A small feeder channel on the north bank of the Rio Grande diverts water to the headgate. The feeder channel is approximately 0.2 miles long. There is no formal diversion dam, but the point of diversion is located at the apex of a meander and flows naturally enter the feeder channel. The feeder channel flows between a gravel bar to the south and a bedrock feature to the north. Due to its location, this structure experiences debris and sediment accumulation which has resulted in significantly reduced capacity. This ditch has difficulty diverting during low flows due to the lack of a diversion and during high flows due to limited feeder channel capacity. The TAT recommends installing a small but improved diversion dam and, because diversion relocation would be difficult, continued maintenance to remove debris and sediment in the feeder channel. A new diversion would allow the ditch to access water during low flows and sediment removal from the feeder channel would allow this structure to function at its full capacity.

Dyer Ditch: The Rio Grande has remained relatively stable in this area since at least 1960, however erosion on the south bank downstream of the diversion appears to have increased in recent years. A headwall with a culvert along the south bank of the Rio Grande directs water to a high flow channel that services this ditch and the Del Norte Town Ditch. A diversion dam on the feeder channel directs water to the headgate and functions well. The headgate, however, jams and does not seal properly. Water not diverted by the Dyer Ditch remains in the overflow channel, which merges with Pinos Creek and returns to the Rio Grande just downstream of the Rio Grande Canal. There is a depressed area along the bank of the Rio Grande just downstream of this structure's diversion which will allow river flows of greater than 5000 cfs to overtop the bank and flow along a high flow channel. This channel flows back to the river downstream of the Rio Grande Canal headgate. This is an emergency overflow measure to prevent the Rio Grande Canal headgate from being washed out during high flows. The TAT recommends repairing or replacing the headgate, including lifting it, as it is typically underwater. Additionally, bank stabilization near the diversion is recommended to mitigate erosion and prevent future channel avulsion.

Del Norte Town Ditch: This structure shares a diversion with the Dyer Ditch. After passing the Dyer headgate, the channel merges with Pinos Creek and passes two overflow channels before reaching the Del Norte Town Ditch headgate (see aerial image in report card). During high flows, this ditch can also receive water from Pinos Creek. Water not diverted by the Dyer Ditch remains in the overflow channel, which merges with Pinos Creek. Both the diversion dam and headgate are aging and function poorly. At low flows, the ditch is unable to divert its full decree. The TAT recommends replacing the existing diversion and headgate and removing an old headgate, which is located just downstream of the main headgate. These improvements would enhance the overall function of this ditch. See Dyer Ditch, above, for a description of the emergency overflow channel near this structure.

Rio Grande Canal: The channel is very stable in the area immediately surrounding this structure's diversion, in part due to the bedrock control on the north bank of the river. However, approximately 1.5 miles upstream of the Rio Grande Canal diversion, near the Dyer Ditch diversion, there is potential for the river to jump the south bank and form a new channel, following Dyer Ditch and the Pinos Creek channel (see map below). If this occurs, the Rio Grande Canal would be bypassed and could pose a serious flooding risk to the Town of Del Norte. The canal's diversion is a concrete dam that spans the entire river, directing water to the canal headgates. The headgates and canal are located on the north side of the river. A pair of sluice gates enables sediment to be flushed downstream. An additional set of adjustment gates (3) are located just downstream of the headgate. The diversion dam functions well for water users, but poses significant risks for recreational boaters. The diversion dam creates a roughly 10-foot change in the river's water surface elevation. At some flows, this forms a hydraulic jump, which is very dangerous and can entrain, or trap, objects for long periods of time. To make this structure safe for recreational boaters, the diversion dam would need to be modified for safe boat passage. However, as noted in the 2018 *Rio Grande Fish Management Plan,* this channel-wide diversion serves a critical role as a barrier to nonnative fish species movement upstream. The only designated Gold Medal fishery in the Rio Grande Basin spans approximately 17 miles from South Fork downstream to this structure. If the structure is ever modified, it is critically important that it remains a fish barrier to prevent nonnative predators found downstream from moving upstream into the high-quality trout fisheries. The TAT does not recommend any immediate improvements, however if the diversion is modified in the future, the TAT recommends incorporating boat passage, if possible, and maintain the existing fish barrier.

Schuch Schmidt Ditch: This structure shares a diversion with the Rio Grande Canal. The structure utilizes the same diversion dam and the headgate is located on the headwall of the Rio Grande Canal diversion structure. Water drains through a corrugated metal pipe underneath the hill to the north, and reaches the ditch approximately 0.25 miles northeast. The diversion dam functions well for this ditch, but the headgate leaks. The flume measures well but is aging and is beginning to show signs of rust damage. The TAT recommends headgate repair and replacement of the measurement flume to improve the structure's efficiency and function.

Midland Ditch: A 0.5 mile feeder channel on the north bank of the Rio Grande directs water to this ditch's headgate. A concrete headwall with check board capabilities sits adjacent to the headgate and returns undiverted flows to an overflow channel and back to the river. The river is very stable in this reach, and significant shifts are not expected to occur. This ditch's headgate functions well. The diversion dam should be repaired. However, it is a relatively junior priority and is very seldom in priority. There is a minor sedimentation issue, especially downstream of the headgate, that requires regular maintenance. No major improvements are currently needed.

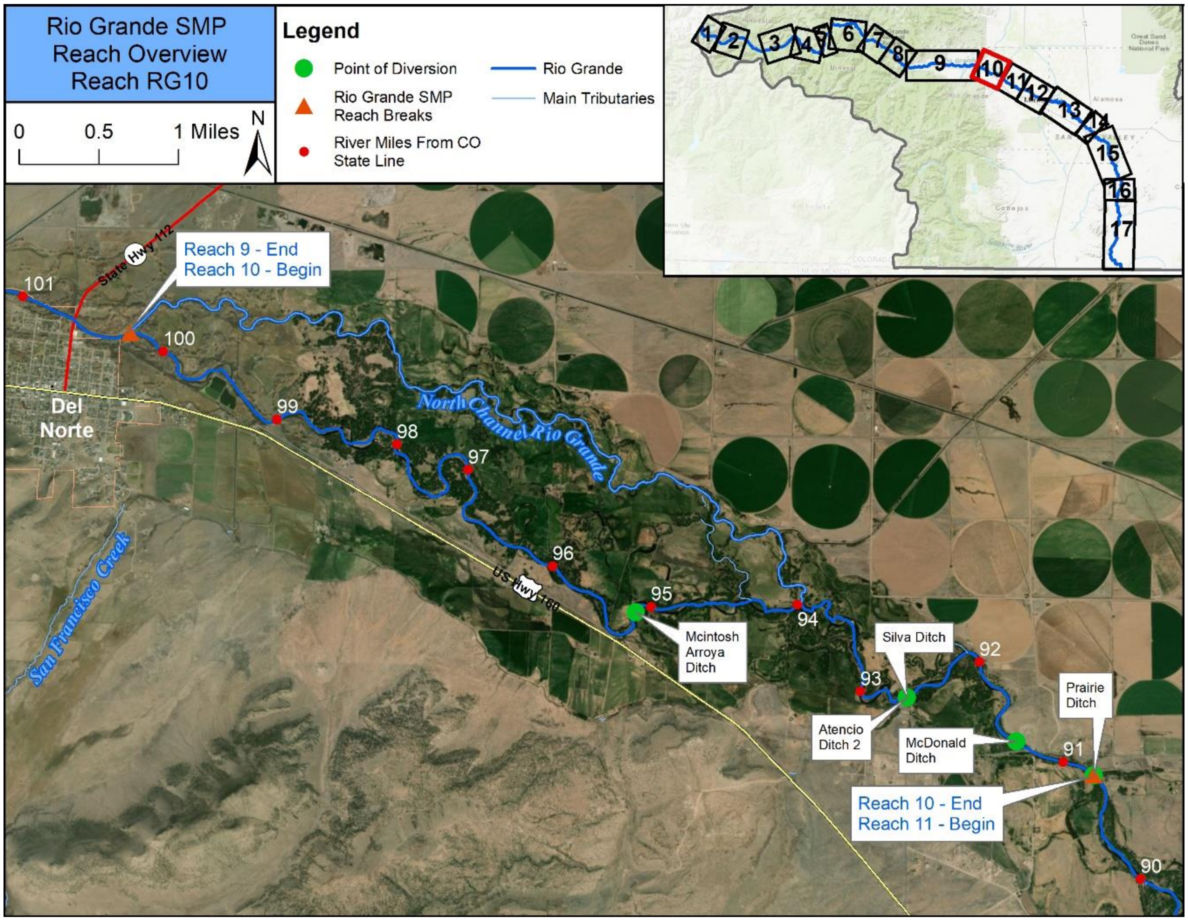
Rio Grande Ditch 4: There is a long feeder channel, with the point of diversion located on the south bank of the Rio Grande. The feeder channel travels past the Woods & River RV Park, past the Del Norte Town Park, and under State Hwy 112, before it reaches the headgate. A small vertical corrugated metal pipe with check boards and a concrete headwall, located just upstream of the headgate, directs unused water into the return flow channel back to the river. The headgate leaks slightly. Water entering the headgate is carried in a corrugated metal pipe underneath the adjacent property to the east, where it becomes a 12 ft plastic corrugated pipe. The plastic pipe travels under the Rio Grande and irrigates the island formed by the North and South Channels of the Rio Grande. Just downstream of the flume, the ditch goes into a siphon and is carried under the Rio Grande. The diversion dam, which is upstream of the Hwy 112 bridge, functions well except at low flows, when the ditch has difficulty accessing water. During 2019 spring runoff, significant sediment and woody debris became lodged at the diversion dam entrance, including a large cottonwood. Given the issues facing this structure, the TAT recommends headgate repair, minor improvements to the diversion for effective low flow diversion, and the installation of a trash rack to prevent woody debris from entering the feeder channel. Continual maintenance and feeder ditch clearing will be necessary if a trash rack or other debris mitigation system is not employed.

Rio Grande Ditch 1: This structure is just upstream of where the Rio Grande bifurcates into the North and South Channels of the Rio Grande. Flows to the North Channel are controlled by the Rio Grande Splitter (see below). This structure's headgate is located on the south bank of the Rio Grande. A small push-up diversion dam directs water to the headgate and the ditch runs southeast from the river. During low flows, this ditch has difficulty diverting water effectively. This structure's headgate functions well, but is aging. The flume functions moderately well but could be reset. The TAT recommends replacing the diversion dam with a structure that effectively diverts water at all flow levels. Additionally, headgate and flume repairs are recommended in the near future.

Rio Grande Splitter: The Rio Grande Splitter is the river structure that controls flow to the North and South Channels of the Rio Grande. A concrete headwall with eight 3 ft wide wooden headgates controls flows to the North Channel. A diversion dam made up of boulders and woody debris controls flows to the South Channel. Although the headworks controlling flow to the North Channel functions well, the push-up diversion dam on the South Channel functions poorly, collects woody debris, and heavy equipment is regularly used to maintain the structure. Downstream of the diversion dam, the south bank of the South Channel is eroding and lacks riparian vegetation. The diversion dam also poses a significant obstacle to recreational boat passage and fish passage to the South Channel. Given the challenges faced by water users and the risk to recreational boating, the TAT recommends replacing the current diversion with a more functional and lower maintenance structure. CPW recommends fish passage at this location. The TAT recommends also creating safe boat passage and allowing for debris and sediment transport at the diversion. As part of the diversion dam replacement, bank and vegetation revegetation is recommended.

3.2.10 RG10 – Rio Grande Splitter to Prairie Ditch

The Rio Grande Splitter just east of Del Norte downstream to the Prairie Ditch diversion near Sevenmile Plaza. Note this reach is bifurcated into the North and South Channel Rio Grande.



Representative Reach Photo

RG10 Conditions Assessment Overview

Reach: RG10		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	C	X	X		X	X		X				X		
Riparian Vegetation	C					X								
Water Quality	B-								X					X
Aquatic Life	A	X						X						
Diversion Structures	B													

A	B	C	D	F	Not Assessed

*For an explanation of reach ratings, see Section 2.

RG10 Geomorphology

Reach	Location Description
RG10	Rio Grande Splitter to Prairie Ditch

Confine-ment	D50	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Unconfined	No Data	No Data	Riffle-pool	Riffle-pool	1	0	Coarse Equilibrium & Fine Deposition	Coarse Equilibrium & Fine Deposition

Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate	Overbank Flow Frequency
0.36%	↔	No Data	No Data	No Data	No Data

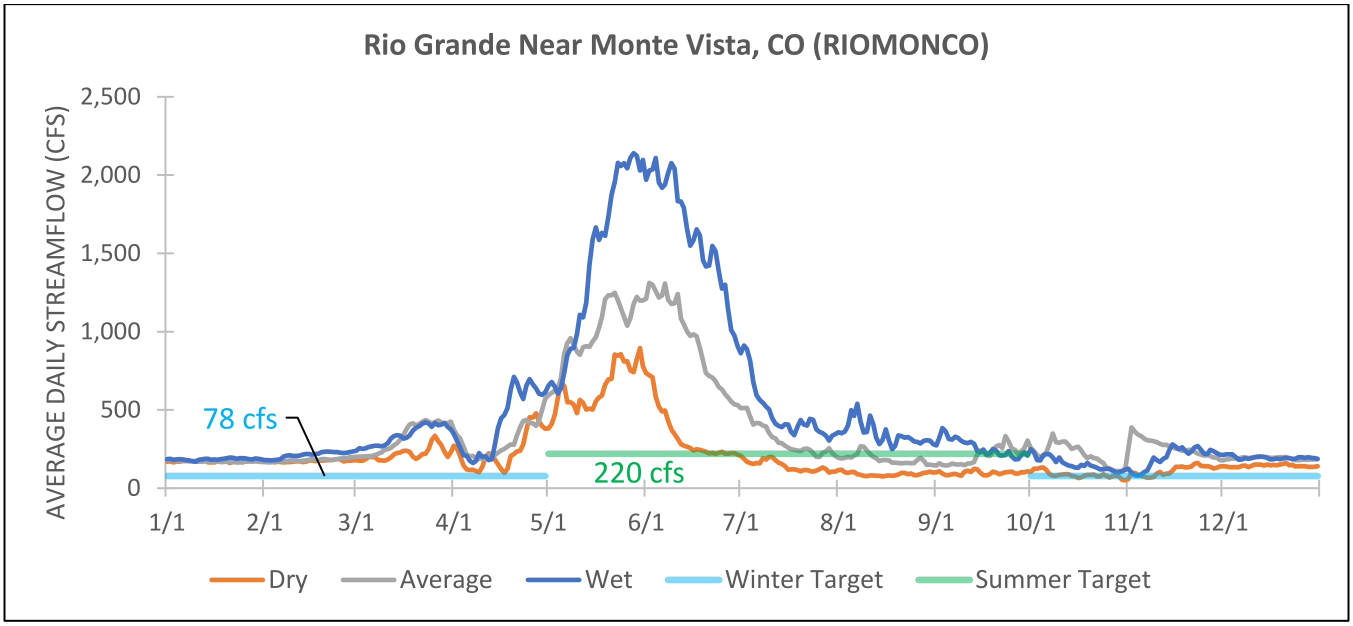
Watershed setting	River Style	Characteristics	Representative Photo
Response	Meandering Coarse Grained Bed	Unconfined channel with moderate to high sinuosity, well developed meandering and associated channel and floodplain geomorphic forms. Range of bar types, floodplain features and floodplain textures; substrate sizes tending toward cobbles and large gravels; substrate variability depends on habitat-scale geomorphic features such as location in bend, pool, or riffle.	

Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity
When the Rio Grande of glacial times exited the mountains, it spread onto the floor of the San Luis Valley forming an enormous low gradient alluvial fan known locally as the Rio Grande Fan. The Rio Grande of modern times has eroded into the southern portion of the fan as it makes its way eastward toward Alamosa. The modern river corridor is incised into terraces of this fan material. Within this river corridor, the channel's sinuosity becomes very high and fluvial signatures of past channel migration abound across the corridor. Alterations to the hydrology, biotic drivers, and sediment/floodplain activation are at work influencing the river corridor. Barring significant changes, the reach is likely to remain moderately sensitive to stressors and the channel is likely to slowly push meanders down-valley and laterally migrate within a somewhat predictable meander belt.

Stressors	Degree of Geomorphic Impairment
Channelization, land use, undersized crossings, diversions, loss of biotic drivers and woody material, hydrologic and floodplain alterations.	C

RG10 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type:

RG10	DRY	AVERAGE	WET
Winter	93%	100%	100%
Summer	39%	69%	94%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.

RG10 Riparian Vegetation
An EIA site was not completed within this reach. Results from the reach-scale RCA assessment indicated significant riparian vegetation impairment with an overall rating of C. The primary stressors identified was floodplain conversion.

RG10 Water Quality and Aquatic Life

Water Quality		
Temperature	**Chemical Conditions**	**Nutrients**
N/A	D	A
Overall Rating		**B-**

Aquatic Life			
Average MMI Score	**Overall MMI Rating**	**Trout (lbs/acre)**	**Trout Rating**
N/A	N/A	133.6	A
Overall Rating			**A**

Water quality is fair in this reach, with impairments limited to metal exceedances. Total arsenic and dissolved copper are on the 303(d) list for this reach, with copper having two acute exceedances between September 2015 and January 2016. Arsenic does not currently show standards exceedance however the analytical detection limits were too high to make a new attainment determination and thus total arsenic remains on the 303(d) list. Lead exceeds the aquatic life use standards and is on the 303(d) M&E List. The TMDL for cadmium and zinc beginning in RG06 persist through this reach with both metals currently exceeding standards.

Diversion structures form multiple barriers to fish passage in this reach and reduce aquatic habitat connectivity. Despite barriers and heavy metal exceedances, aquatic life remains healthy. This reach supports a brown trout population with a recent population survey showing 133 pounds per acre. Other fish species in this reach include longnose dace, brown trout, rainbow trout, and white sucker. Macroinvertebrate data was not available.

RG10 Diversion Infrastructure

***Refer to reach overview map above for diversion structure locations.**

McIntosh Arroya Ditch: This is the only structure located on the South Channel of the Rio Grande. There is no formal diversion dam, but an island and a small riffle helps divert water from the river to a feeder channel on the south bank of the river. The channel in this part of the river is unstable. The meander on which the diversion is located has been moving north and has tightened over time. In the future, this may result in the river reclaiming its historic channel, which would create challenges for the ditch, as it currently follows portions of the historic river channel. The feeder channel is approximately 0.5 miles long and delivers water to the headgate. The feeder channel then meanders back to the river, serving as the return flow channel. The headgate leaks and, according to the 2006 inventory, the headwall was replaced approximately 23 years ago. Woody debris accumulation, especially in the feeder channel and near the headgate, is also an issue. The flume is functional, however the channel is beginning to erode at its downstream end. Given these issues, the TAT recommends headgate repair or full replacement, installation of a trash rack or relocation of the headgate closer to the point of diversion, and flume repairs. Alternatively, the entire structure could be relocated to a more desirable point of diversion, which would reduce maintenance and allow for other restoration efforts on the South Channel.

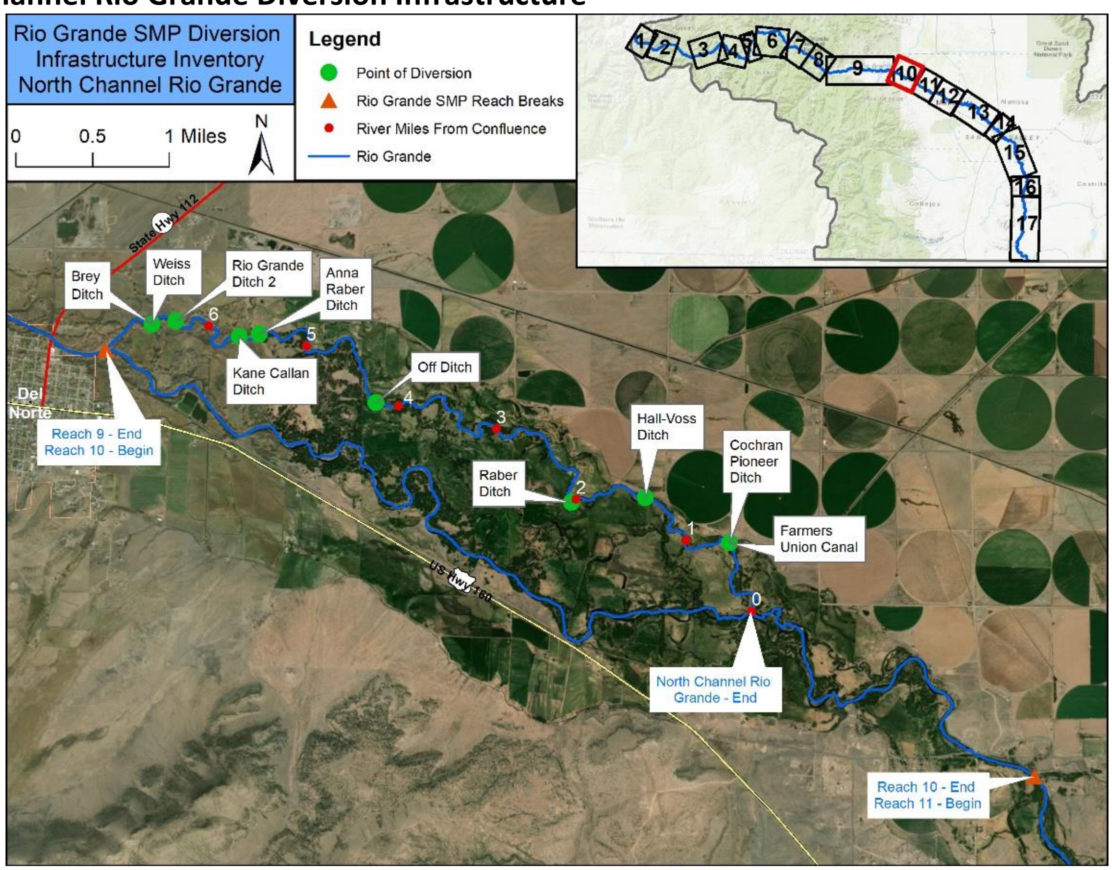
Silva Ditch: This structure holds the #1 priority on the Rio Grande. The ditch shares a diversion dam and short feeder channel with the Atencio Ditch 2. The diversion dam is a stacked rock structure, which was recently supplemented with additional rock. Despite recent improvements, this diversion accumulates woody debris and sediment and is a significant maintenance challenge for water users. It is a hazard for recreational boaters and can also form a barrier to fish passage during low flow conditions. Water is directed to the headgate, located down a short feeder channel off the south bank of the Rio Grande. The headgate functions well and is well maintained. The flume was replaced in 2018 and also functions well. The channel both upstream and downstream of the diversion experiences lateral migration. Meanders have continued to grow over the last 40 years (see map in report card). However, migration at the diversion dam is limited due to bedrock control. A secondary channel begins approximately 0.9 miles upstream of the diversion and flows around the structure. Given the issues identified, the TAT recommends replacing the diversion dam. A new diversion could be designed to increase diversion and irrigation efficiencies, reduce maintenance, create fish and boat passage, and improve sediment and debris transport.

Atencio Ditch 2: For a description of the diversion dam and associated recommendations, see the Silva Ditch, as the two ditches shares a diversion dam and feeder channel. This ditch's headgate and measurement flume were recently replaced and function well.

McDonald Ditch: The channel in this area is partially controlled by bedrock and has migrated very little over the last 40 years. A concrete diversion directs water to an automated headgate, located on the north bank of the river. The headgate delivers water to an approximately 1,000 ft pipeline that passes under County Rd 5 N and delivers water to the ditch. In order to address an aging headgate and diversion dam, this structure was fully reconstructed as part of the *McDonald Ditch Implementation Project*, completed in 2016. The project was undertaken as a partnership between the RGHRP, NRCS, and the ditch company and included the construction of a new diversion dam, headgate, and pipeline as well as the reclamation of a 2-acre wetland and stabilization of 1,000 ft of streambank. The structure was moved upstream and a new diversion dam, headgate, and extended canal were constructed. The old diversion dam, made up of concrete blocks and debris, is in very poor condition, poses a significant hazard to boats and anglers, and creates a barrier to fish passage at low flows. The new diversion dam is approximately 780 ft upstream of the old diversion dam and includes a fish ladder for trout passage which also allows for boat passage. These improvements have significantly increased this diversion’s efficiency.

Prairie Ditch: A recently installed grouted rock diversion dam diverts water to a short feeder channel with a trash rack at its entrance. The feeder channel delivers water to the headgates, three of which are manually operated and one of which is automated. Adjacent to the headgates is a sluice gate that returns water to the river. The channel is relatively stable in this area, with very little migration occurring. The new trash rack, headgate, sluice gate, and diversion dam were installed in partnership with the RGHRP, NRCS, and the ditch company as part of the *Prairie Ditch Implementation Project*. The diversion dam is now a grouted rock structure and streambank stabilization structures were also installed near the diversion. The diversion dam structure was completed in Fall/Winter 2015, and the headgate and trash rack were completed Spring 2016. The diversion dam forms an important fish barrier between reaches RG10 and RG11. As noted in the 2018 *Rio Grande Fish Management Plan*, it serves as the upstream fish passage barrier to protect an aboriginal population of Rio Grande chub near Sevenmile Plaza. No immediate repair needs were noted at this structure.

North Channel Rio Grande Diversion Infrastructure



Weiss Ditch: This structure is located on the south bank of the North Channel Rio Grande just upstream of Brey Ditch. The channel has remained very stable in this reach and is not expected to migrate significantly in the near future. The headgate is located on the outside of a meander and has no trash rack. It is difficult to operate and functions poorly. A very minimal rock diversion dam, shared with the Brey Ditch, is located just downstream of this structure and does not appear to significantly benefit this ditch. When this ditch is in priority, flows are high enough that a diversion dam is not necessary. The diversion dam is unstable and in poor condition. The flume for this structure could not be located. Given the issues identified, the TAT recommends headgate improvement and the installation of a functional measurement device. To reduce maintenance and improve efficiency of both this ditch and the Brey Ditch, consolidation of the two structures is also an option. If consolidation was pursued, the TAT recommends replacing or improving the diversion dam.

Brey Ditch: This structure is located on the North Channel of the Rio Grande just downstream of Weiss Ditch. The channel has remained very stable in this reach and is not expected to migrate significantly in the near future. This structure's diversion dam is shared with the Weiss Ditch, directing water into a short feeder channel and to this ditch's headgate. The diversion has difficulty diverting water at low flows and the ditch has insufficient capacity to convey its full decree during high flows due to debris and sediment accumulation. Given these challenges facing water users, the TAT recommends replacing or improving the diversion and possible consolidation with the Weiss Ditch to reduce overall maintenance for both ditches. Whether or not consolidation occurs, ditch enlargement is also recommended to allow for to conveyance of higher flow.

Rio Grande Ditch 2: This structure is located on the north bank of the river in the transition zone between two meanders. The river has migrated very little in the last 40 years and is not expected to migrate significantly in the future. A rock cross vane diversion dam diverts water to the headgate, which is located on the north bank of the river. The old headgate still exists downstream of the main headgate (see report card). As part of the *Five Ditches Project*, a full structure replacement was completed in 2018. The project included a new diversion dam, new headgate, and bank stabilization near the structure. The diversion dam is now a rock cross vane that is passable by both fish and boats. The surrounding banks were reinforced with boulders and riparian vegetation. No immediate repair needs were noted.

Kane Callan Ditch: Channel migration analysis shows the river is stable in the area near this structure. A short feeder channel, located on the north bank of the river, leads to the headgate. A boulder diversion across the river directs water into the feeder channel. A return flow structure adjacent to the headgate is controlled by a 5 ft steel slide gate. Regular diversion dam maintenance is required due to debris accumulation. The TAT recommends installation of a sluice gate to mitigate debris or, alternatively, continued maintenance to ensure proper function.

Anna Raber Ditch: Channel migration analysis shows the river is stable in the area near this structure. A rock boulder diversion dam directs water to a short feeder channel, located on the south bank of the Rio Grande. The headgate is located on the inside of a bend. The diversion is just upstream of a river bridge. The feeder channel travels underneath the bridge to the headgate. The headgate leaks and is difficult to operate. The diversion dam collects some woody debris, but otherwise functions well. The

TAT recommends headgate repair or replacement to increase efficiency and reduce maintenance. Debris mitigation, either through installation of a sluice gate or continued maintenance, is also recommended.

Off Ditch: Channel migration analysis shows the river is stable in the area immediately surrounding this structure. A concrete and rock diversion dam spans the river channel just downstream of the structure, directing water to a short feeder channel and the headgate, which sits along the south bank of the Rio Grande. The diversion functions moderately well but has washed out during previous high flow events and is a maintenance need for water users. A wire fence serves as a trash rack at the entrance of the feeder channel. Given the diversion dam maintenance need, the TAT recommends improving or replacing the diversion with a new stacked rock structure that is more resilient during high flow events.

Raber Ditch: Channel migration analysis shows the river is stable in the area immediately surrounding this structure. A stacked rock diversion dam directs water to the headgate, which is located on the south bank of the river. The diversion dam functions well and no immediate need for improvement was identified. The flume is aging and the TAT recommends replacing it in the near future.

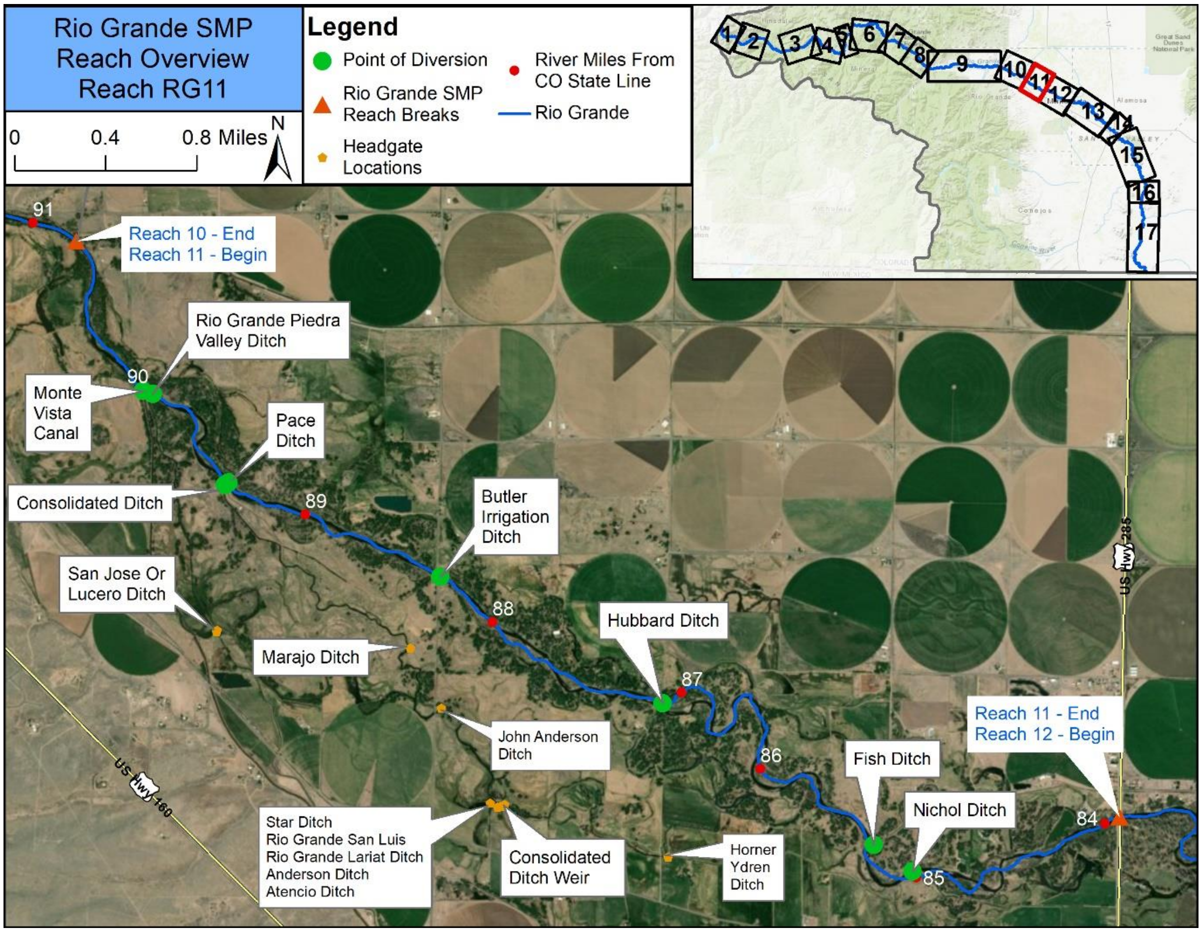
Hall-Voss Ditch: The river both upstream and downstream of this structure has remained stable in the recent past. A small stacked rock diversion dam directs water to the headgate, which is located on the south bank of the river. The diversion dam functions moderately well, but the ditch has difficulty conveying high flows. The headgate is wired to a fence post for support. The headgate lacks a supporting headwall and it leaks and is difficult to operate. The TAT recommends headgate replacement, installation of a headgate support structure, and ditch enlargement and/or cleaning to increase conveyance capacity.

Cochran Pioneer Ditch: The river both upstream and downstream of this structure has undergone very little lateral migration in the recent past. A concrete diversion dam just downstream directs water to the Farmers Union Canal headgate, which is located on the north bank of the river. The diversion structure includes a manually operated radial gate and the capability to install check boards. The Cochran Pioneer Ditch headgate is built into the headwall of the Farmers Union Canal. No significant issues or repair needs were noted at this structure.

Farmers Union Canal: The river both upstream and downstream of this structure has undergone very little lateral migration in the recent past. A concrete diversion dam just downstream directs water to the Farmers Union Canal headgate, which is located on the north bank of the river. The diversion structure includes a manually operated radial gate and the capability to install check boards. The headgates function moderately well but leaks were noted. Given the headgate leak and the volume of water delivered via this ditch, the TAT recommends headgate repair or replacement, ideally with automated gates, to reduce maintenance and increase efficiency.

3.2.11 RG11 – Prairie Ditch to Gunbarrel Road (Highway 285)

Where the Prairie Ditch breaks off the Rio Grande near Sevenmile Plaza downstream to Gunbarrel Road (Highway 285) north of Monte Vista.



Representative Reach Photo

RG11 Conditions Assessment Overview

Reach: RG11		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	C	X	X	X	X	X		X				X		
Riparian Vegetation	C					X				X				
Water Quality	B-								X				X	X
Aquatic Life	A-	X						X					X	
Diversion Structures	B													

A	B	C	D	F	Not Assessed

*For an explanation of reach ratings, see Section 2.

RG11 Geomorphology

Reach	Location Description
RG11	Prairie Ditch to Gunbarrel Road (Highway 285)

Confine-ment	D50	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Unconfined	No Data	No Data	Riffle-pool	Riffle-pool	1	0	Coarse Equilibrium & Fine Deposition	Coarse Equilibrium & Fine Deposition

Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate	Overbank Flow Frequency
0.21%	↓	No Data	No Data	No Data	No Data

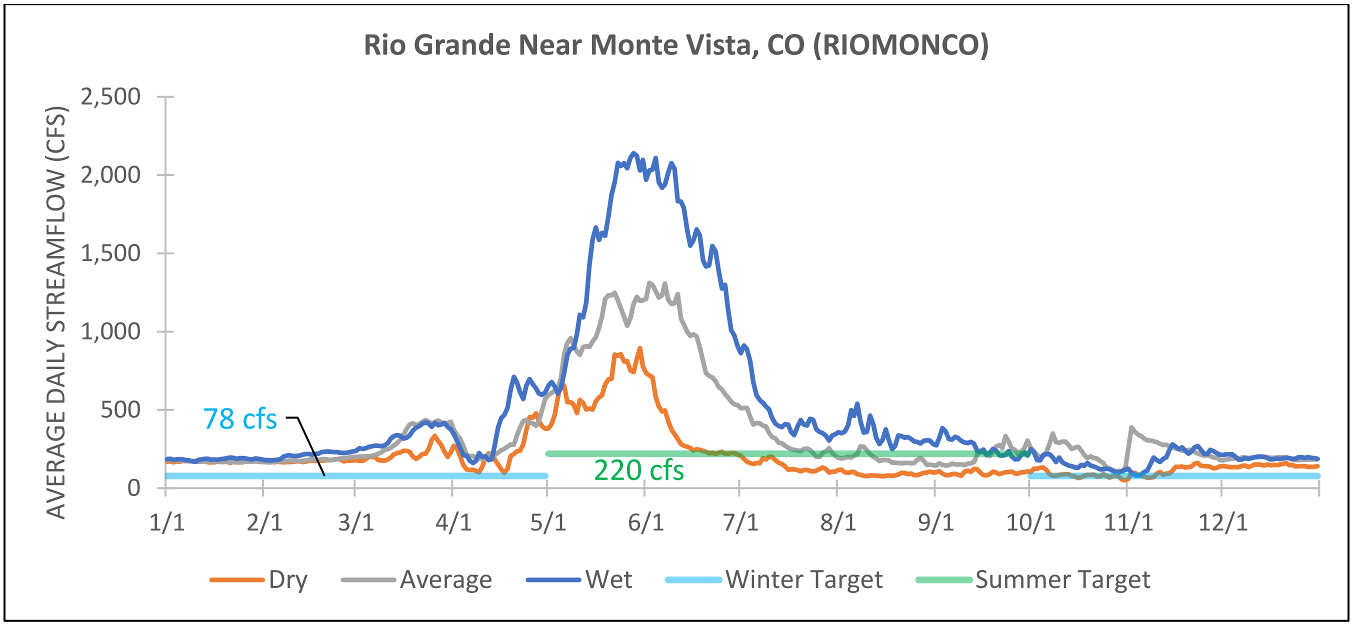
Watershed setting	River Style	Characteristics	Representative Photo
Response	Meandering Coarse Grained Bed	Unconfined channel with moderate to high sinuosity, well developed meandering and associated channel and floodplain geomorphic forms. Range of bar types, floodplain features and floodplain textures; substrate sizes tending toward large gravels; substrate variability depends on habitat-scale geomorphic features such as location in bend, pool, or riffle.	

Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity
When the Rio Grande of glacial times exited the mountains, it spread onto the floor of the San Luis Valley forming an enormous low gradient alluvial fan known locally as the Rio Grande Fan. The Rio Grande of modern times has eroded into the southern portion of the fan as it makes its way eastward toward Alamosa. The modern river corridor is incised into terraces of this fan material. Within this river corridor, the channel's sinuosity becomes very high and fluvial signatures of past channel migration abound across the corridor. Alterations to the hydrology, biotic drivers, and sediment/floodplain activation are at work influencing the river corridor. Barring significant changes, the reach is likely to remain moderately sensitive to stressors and the channel is likely to slowly push meanders down valley and laterally migrate within a somewhat predictable meander belt.

Stressors	Degree of Geomorphic Impairment
Channelization, land use, diversions, loss of biotic drivers and woody material, hydrologic and floodplain alterations.	C

RG11 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type:

RG11	DRY	AVERAGE	WET
Winter	93%	100%	100%
Summer	39%	69%	94%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.

RG11 Riparian Vegetation

Overall, this site (RGVeg11) appears to be in good condition, receiving an overall EIA rating of B- (2.71). However, this score suggests that this site has the potential to degrade to a C rating if further alteration from natural conditions occurs. The lowest individual metric ratings it received were for Contiguous Natural Land Cover (C), Land Use Index (C), Native Plant Species Cover (C), and Coarse and Fine Woody Debris (C) (Table 3.11).

Table 3.11: EIA Scorecard – RGVeg11

RGVeg11 Observer: W. McBride	Wt	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				**2.71**	**B-**
Rank Factor: LANDSCAPE CONTEXT	0.30			**2.82**	**B-**
LANDSCAPE METRICS	0.33			**2.00**	**C+**
L1. Contiguous Natural Land Cover	1	C	2		
L2. Land Use Index	1	C	2		
BUFFER METRICS	0.67			**3.22**	**B+**
B1. Perimeter with Natural Buffer	n/a	A	4		
B2. Width of Natural Buffer	n/a	B	3		
B3.1. Condition of Natural Buffer - Veg	n/a	B	3		
B3.2. Condition of Natural Buffer - Soils	n/a	B	3		
Rank Factor: CONDITION	0.70			**2.67**	**B-**
VEGETATION METRICS	1			**2.67**	**B-**
V1. Native Plant Species Cover	1	C	2		
V2. Invasive Nonnative Plant Species Cover	1	B	3		
V3. Native Plant Species Composition	1	B	3		
V4. Vegetation Structure	1	B	3		
V5. Regen. of Native Woody Species **(opt.)**	1	B	3		
V65. Coarse and Fine Woody Debris **(opt.)**	1	C	2		

Contiguous Natural Land Cover within a 500 m buffer was disrupted by two-tracks located both north and south of the river that appear to be well traveled. These access routes fragment the natural landscape, leaving less than 60% of the buffered area around the AA within a contiguous natural landscape. These metrics could be improved by consolidating the main access traffic to routes located a minimum of 100 m from the river.

The average relative cover of native plants was 94%. While no single nonnative species was clearly dominant across plots, there were several nonnative species with low to moderate cover occurring in the highest diversity plots (1 and 2). While plots 3 and 4 included few to no nonnative species, there was relatively low overall plot diversity with only 12 and 6 total plant species recorded, respectively. The noxious species *Cirsium arvense* (Canada thistle) was only found in plot 1 with a total cover of 0.2%.

According to the landowner, (Pers. Comm.), the riparian area on the south side of the river has been closed to grazing for about 10 years. Previously, there were no *Salix* individuals present, but since excluding cattle, the willow community has returned. A portion of the riparian area on the north side of the river, which includes part of the AA, has recently been excluded from grazing. A fence now parallels the riparian corridor approximately 20 m from the north edge of the riverbank. Plots 1-3 were placed within the grazing exclosure, while plot 4 was situated outside the exclosure. There was a noticeable difference in plant diversity between plots inside and outside of the exclosure, with an average of 16 species per plot for those located inside the exclosure and only six species encountered in plot 4. Given more time to recover, the condition of the plant community within the exclosure has potential to improve. Extending the distance of the exclosure fence line further outward from the riparian corridor (up to 100 m) would further enhance restoration potential.

Regarding Native Plant Species Composition, the average mean C-value for native species was 4.5, while the average cover-weighted mean C-value for native species was 4.6 (Table 3.7). These values suggest that most native species present are equally likely to be found in natural and non-natural areas. However, with continued relief from grazing pressure it is possible that plant species more sensitive to disturbance will eventually reestablish and overall species diversity will increase.

Outside of the grazing exclosure there was little woody debris distributed throughout the area. There were slash piles scattered across the terrain from recent management activities. Inside the exclosure, woody debris was also limited, however was beginning to accumulate. The presence of both coarse and fine woody debris plays a critical role in riparian systems by enhancing habitat, retaining organic matter and nutrients, and contributing to stream channel architecture (Lemly et al., 2016). Given additional time, the area within the exclosure will continue to develop its woody debris. Current land uses observed and approximate cover within the 500 m buffer include moderate grazing (76%), management for native vegetation (20%), and unpaved roads (4%). There was evidence at this site of past beaver activity, however no recent sign was observed.

Results from the reach-scale RCA assessment indicated significant riparian vegetation impairment with a C- rating. Stressors include floodplain conversion and nonnative species competition. The average of the EIA and RCA ratings is C.

RG11 Water Quality and Aquatic Life

Water Quality		
Temperature	Chemical Conditions	Nutrients
N/A	D	A
Overall Rating		**B-**

Aquatic Life			
Average MMI Score	Overall MMI Rating	Trout (lbs/acre)	Trout Rating
84.2	A-	N/A	N/A
Overall Rating			**A-**

Water quality is fair in this reach, with metals impairments. Total arsenic and dissolved copper are on the 303(d) list for this reach, with copper having two acute exceedances between September 2015 and January 2016. Arsenic does not currently show standards exceedance however the analytical detection limits were too high to make a new attainment determination and thus total arsenic remains on the 303(d) list. Lead exceeds the aquatic life use standards and is on the 303(d) M&E List. The TMDL for cadmium and zinc beginning in RG06 persist through this reach.

Despite heavy metal exceedances, this reach supports a healthy benthic macroinvertebrate community with an average MMI score of 84.2. However, diversion structures form multiple barriers to fish passage in this reach and reduce aquatic habitat connectivity. Trout data was not available.

RG11 Diversion Infrastructure

***Refer to reach overview map above for diversion structure locations.**

Monte Vista Canal: The river headgate for this structure is on the south bank of the river just upstream of the Rio Grande Piedra Valley Ditch headgate. The diversion dam for this structure is a rock structure with check boards and is shared with the Rio Grande Piedra Valley Ditch (see maps in report card). The diversion dam directs water to a short feeder channel that comes off of the river and delivers water to the river headgate. A catwalk with a trash boom serves as the trash rack at the entrance of the feeder channel. From the river headgate, a long feeder channel (approximately 1.2 miles long) delivers water to the main headgate. An overflow structure from this feeder channel runs approximately 550 ft to the feeder channel for the Rio Grande Piedra Valley Ditch/*San Jose or Lucero Ditch*. An overflow channel runs approximately 1.5 miles from this feeder channel to the Consolidated Ditch Slough, where it enters between Marajo Ditch and John Anderson Ditch. The concrete around the river headgate is spalling and sediment accumulation is an issue. Given the issues identified, the TAT recommends installing a sluice gate or other sediment transport structure, such as an Obermeyer, at the river headgate or on the diversion dam. Additionally, to increase efficiency and decrease maintenance, this ditch's headgate could be combined with that of the Rio Grande Piedra Valley Ditch.

Rio Grande Piedra Valley Ditch: For a description and recommendations related to the diversion dam, refer to the Monte Vista Canal as the diversion point is the same for both ditches. The river headgate for this structure is on the south bank of the river just downstream of the Monte Vista Canal headgate. From the river headgate, a long feeder channel (approximately 1.1 miles long) delivers water to the main headgate. This feeder channel also services the *San Jose or Lucero Ditch*; this structure's main headgate serves as the diversion dam for the *San Jose or Lucero Ditch*. An overflow channel runs approximately 1.5 miles to the Consolidated Ditch Slough, where it enters between the Marajo Ditch and the John Anderson Ditch. The main headgate currently functions well but is aging and may require significant repairs in the near future. To mitigate these issues, the TAT recommends installation of an improved trash rack and, as noted above, this ditch's headgate could be combined with that of the Monte Vista Canal to increase efficiency and decrease maintenance.

San Jose or Lucero Ditch: For a description and recommendations related to the diversion, refer to the Monte Vista Canal as they share a diversion. The Rio Grande Piedra Valley Ditch main headgate serves as the diversion dam for this structure, located approximately 1.1 miles down the feeder channel. The main headgate functions well. The flume has heaved and downstream erosion is occurring. The TAT recommends flume replacement to maintain long-term measurement accuracy and efficiency.

Consolidated Ditch: Within the last 35 years, the river has migrated significantly in this area, especially upstream of the diversion dam. The two meanders upstream of the diversion have been growing and changing the orientation of the river where it meets the diversion dam. A brand new large concrete diversion dam spans the river and directs water to the headgate. On the south bank of the river, a radial sluice gate was installed that can be adjusted using an air bladder. On the north side of the diversion, a large fish ladder was installed. In the center of the diversion sits an additional adjustable Obermeyer gate. A substantial trash rack is at the entrance to the ditch, with the headgates located just below. All of the infrastructure is concrete. As part of the *Five Ditches Project*, the headgate and diversion dam were replaced in partnership with the NRCS, RGHRP, and the ditch company. The headgate and trash rack were completed Spring 2018, and the diversion dam structure was completed Spring 2019. They now function well. This structure allows for boat and fish passage and, after construction was completed, bank and riparian habitat was restored using rock structures and riparian vegetation plantings. This structure serves 8 ditches, including Marajo Ditch, John Anderson Ditch, Star Ditch, Rio Grande San Luis Ditch, Rio Grande Lariat Ditch, Anderson Ditch, Atencio Ditch, and Horner Ydren Ditch. No issues or needs for improvement were noted at this structure.

Pace Ditch: This ditch shares a diversion dam and headworks with the Consolidated Ditch. Refer to Consolidated Ditch for a description of the diversion. The channel conditions described under the Consolidated Ditch also apply to this ditch. The ditch's flume can get submerged during high flow. The TAT recommends lifting and resetting the flume. Although this may not be possible, if the ditch upstream of flume had more elevation change, the flume would function significantly better.

Consolidated Slough Weir: Water is diverted off the Rio Grande via the Consolidated Ditch diversion located on the south bank of the river. The Consolidated Ditch transports water approximately 3.12 miles to this structure, the Consolidated Slough Weir. The Consolidated Slough Weir diverts water from the Consolidated Ditch to four separate headgates, each with a short feeder channel. The structure uses check boards to raise the upstream water level and head pressure for the following headgates: Atencio Ditch, Anderson Ditch, Rio Grande Lariat Ditch, and Rio Grande San Luis Ditch (in order from east to west). This structure is in good condition and no repair needs were identified.

Marajo Ditch: This structure is serviced by the Consolidated Slough Ditch and is located 1.3 miles down the Slough. There is a corrugated steel sheet pile diversion dam along the Slough that diverts water to the headgate, which sits along the bank of the east bank of the slough. The headgate is aging and the diversion dam on the feeder channel does not function well. In addition, the corrugated steel sheet pile along the side of the headgate is heaving and no longer supporting the headgate properly. The flume can be submerged during high flows. Based on the issues identified at this structure, the TAT recommends replacing the diversion dam and associated materials, resetting or replacing the flume, and considering headgate replacement in the future. These improvements would increase water delivery efficiency and reduce maintenance needs.

John Anderson Ditch: This structure is located approximately 1.8 miles downstream of the Consolidated Ditch diversion. A short feeder channel just downstream of County Rd 3W branches off of the Consolidated Slough, which directs water to the headgate, which is aging and difficult to operate. The downstream adjustment and return flow structure are approximately 0.5 mile downstream. The flume could not be located at the time of inspection but the water commissioners confirmed that it measures accurately. The TAT recommends headgate replacement for ease of use and efficient water delivery.

Star Ditch: Water is diverted off the Rio Grande via the Consolidated Slough Ditch diversion located on the south bank of the river. The Consolidated Slough delivers water to the feeder channel, which transports water approximately 3.1 miles to the Star Ditch headgate. The headgate is just upstream of the Atencio Ditch, Anderson Ditch, Rio Grande Lariat Ditch, and Rio Grande San Luis Ditch. The Consolidated Slough Weir creates enough head pressure in the Consolidated Slough to deliver water to a short feeder channel and the Star Ditch headgate. The headgate functions well and does not leak.

The Parshall flume is slightly tilted and eroding on its downstream side. The TAT recommends resetting the flume to maintain long-term measurement accuracy.

Rio Grande San Luis Ditch: Water is diverted off the Rio Grande via the Consolidated Slough Ditch diversion located on the south bank of the river. The Consolidated Slough Ditch headgate delivers water to the feeder channel, which transports water approximately 3.12 miles to the Rio Grande San Luis Ditch headgate. The headgate is adjacent to the Anderson Ditch, Rio Grande Lariat Ditch, and Atencio Ditch. The Consolidated Slough Weir diverts water to a short feeder channel and to the Rio Grande San Luis Ditch headgate. The headgate leaks badly, however the headwall is sound. The TAT recommends headgate replacement to increase water delivery efficiency and reduce maintenance.

Anderson Ditch: Water is diverted off the Rio Grande via the Consolidated Ditch diversion located on the south bank of the river. The Consolidated headgate delivers water to the feeder channel, which transports water approximately 3.12 miles to the Anderson headgate. The headgate is adjacent to the Atencio Ditch, Rio Grande Lariat Ditch, and Rio Grande San Luis Ditch. The Consolidated Ditch Weir diverts water to a short feeder channel and to the headgate. Erosion is occurring downstream of the flume and the TAT recommends addressing this erosion to maintain measurement accuracy.

Rio Grande Lariat Ditch: Water is diverted off the Rio Grande via the Consolidated Ditch diversion located on the south bank of the river. The Consolidated Ditch headgate delivers water to the feeder channel, which transports water approximately 3.12 miles to the Rio Grande Lariat Ditch headgate. The headgate is adjacent to the Atencio Ditch, Anderson Ditch, and Rio Grande San Luis Ditch. The Consolidated Slough Weir diverts water to a short feeder channel and to the headgate. No major repairs were noted, but the headgates leak slightly and the TAT recommends repairs or improvements to eliminate the leak.

Atencio Ditch: Water is diverted off the Rio Grande via the Consolidated Ditch diversion located on the south bank of the river. The Consolidated Ditch headgate delivers water to the feeder channel, which transports water approximately 3.12 miles to the Atencio Ditch headgate. The headgate is adjacent to the Anderson Ditch, Rio Grande Lariat Ditch, and Rio Grande San Luis Ditch. The Consolidated Slough Weir diverts water to a short feeder channel and to the Atencio Ditch. The flume gets submerged at high flows. The TAT recommends resetting or replacing the flume, which would increase water delivery efficiency and reduce maintenance.

Horner Ydren Ditch: This structure is located approximately 1.8 miles downstream of the Consolidated Ditch diversion. There is a short feeder channel just downstream of County Rd 3 W that comes off of the Consolidated Ditch that directs water to this headgate. The downstream adjustment and return flow structure are approximately 0.5 mile downstream. The headgate, wing walls, and overflow structure were recently replaced and function well. The diversion dam is steel with check boards. Aside from regular sediment clearing, no immediate repair needs were noted.

Butler Irrigation Ditch: The channel in this area has shown signs of past avulsion. A rock weir diversion, just downstream of County Rd 3 W, directs river flow to the feeder channel. Boulders making up the diversion have shifted in recent years and the diversion does not function optimally. A small diversion on the feeder channel directs water to the first headgate, a 3 ft wide steel slide gate. Any flow not diverted returns to the river approximately 500 ft downstream. The ditch travels approximately 0.3 miles to the main headgate. Sediment accumulation at the feeder channel and up to the headgate is an issue. The TAT recommends repairing and improving the diversion dam at this location and addressing sediment accumulation at the headgate and in the feeder channel. CPW recommends fish passage in this reach and the TAT recommends also creating safe boat passage. Diversion dam repairs would improve the ditch's ability to effectively divert its water rights at all water Levels. Sediment removal in the feeder channel and near the headgate would also improve ditch efficiency and function.

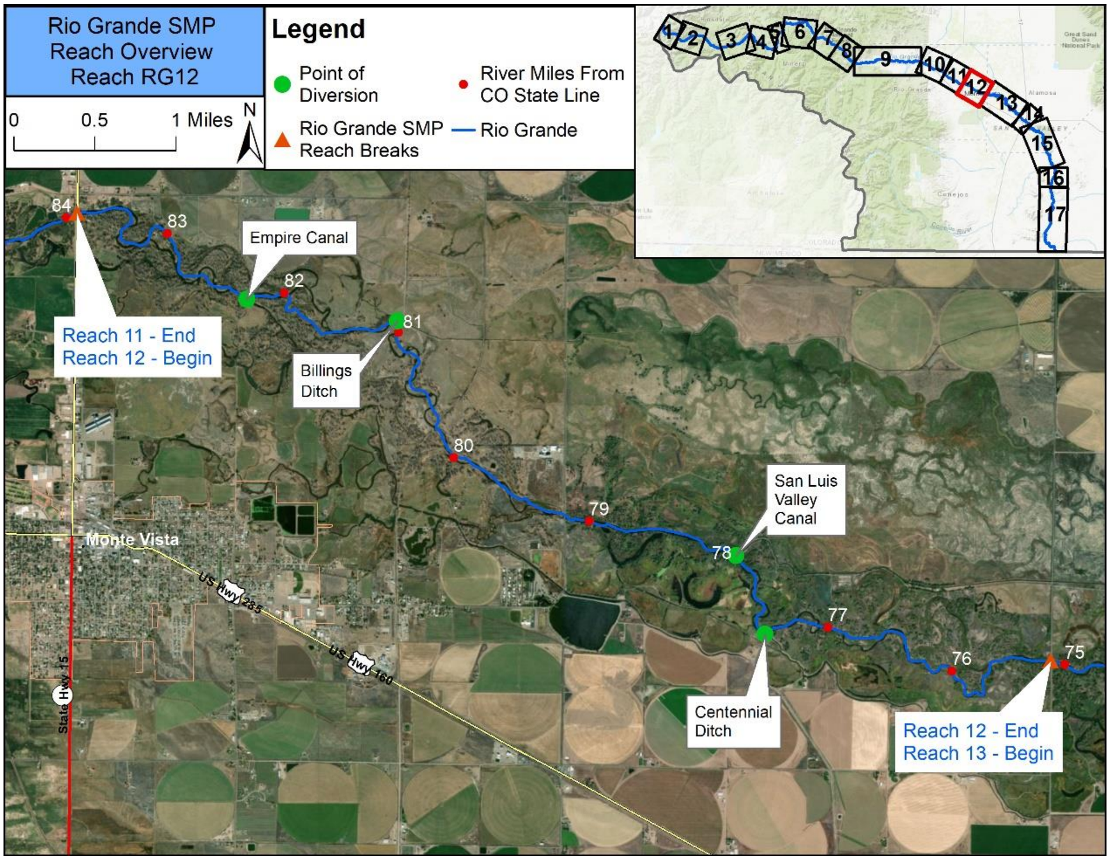
Hubbard Ditch: The channel in this area has shown signs of past avulsion. For example, a meander was cut off between 1975 and 1998. The existing feeder channel follows this historic channel (see map in report card). A small stacked rock diversion dam on the Rio Grande directs water to a long feeder channel. Approximately 0.25 miles down the feeder channel is a primary headgate and return flow structure. An additional 0.45 miles downstream (a total of approximately 0.7 miles from the diversion dam) is the main headgate. A culvert return flow structure with check boards also serves as a diversion dam for the main headgate. The flume was replaced in 2018 and functions well. Sediment and debris accumulation in the feeder channel and headgate are major issues for this ditch. Because a trash rack is not likely to ameliorate this issue, the TAT recommends regular debris clearing in the feeder channel and culvert upstream of the headgate. Alternatively, the point of diversion could be relocated downstream to reduce maintenance needs in the feeder channel.

Fish Ditch: A stacked rock diversion dam directs water from the Rio Grande to the headgate and a long feeder channel, located on the north bank of the river. Adjacent to the headgate is a relatively new sluice gate designed to mitigate sediment and debris issues. The feeder channel carries water approximately 1.2 miles to the adjustment headgate. An overflow structure directs any excess water into a historic oxbow and ultimately back to the Rio Grande. Severe cut banks exist both upstream and downstream of the diversion dam. During 2019 spring runoff, the north bank upstream of the diversion experienced significant erosion (see report card). Significant channel migration has occurred both upstream and downstream of this structure. At the point of diversion, the river has been migrating northeast toward the diversion. If this migration continues, there is a chance the river may capture its historic channel and form a new main channel. Despite recent improvements, sediment and debris accumulation remains an issue at the diversion dam and headgate. The TAT recommends installing an improved trash rack at the river headgate and implementing bank stabilization and riparian revegetation upstream of the diversion to prevent possible channel avulsion.

Nichol Ditch: There is no formal diversion dam for this structure. Water flows into a feeder channel located on the south bank of the Rio Grande. The feeder channel travels approximately 0.25 mile to the headgate. The headgate and flume function well. At the point of diversion, the river is migrating northeast, away from the feeder channel entrance. As a result, a small point bar is forming at the point of diversion, resulting in access and maintenance issues for the ditch. To reduce maintenance and ensure long-term function, the TAT recommends installing an improved diversion dam. A small stacked rock structure would likely function well for water diversion and could also be used to restore the cut bank on the north bank of the river and create additional fish habitat.

3.2.12 RG12 – Gunbarrel Road (Highway 285) to Rio Grande/Alamosa County Line

From Gunbarrel Road (Highway 285) north of Monte Vista downstream to the border of Rio Grande and Alamosa Counties.



Representative Reach Photo

RG12 Conditions Assessment Overview

Reach: RG12		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	C	X	X	X	X	X		X						
Riparian Vegetation	C+					X				X				
Water Quality	B-								X				X	X
Aquatic Life	B	X						X			X		X	X
Diversion Structures	B-													

A	B	C	D	F	Not Assessed

*For an explanation of reach ratings, see Section 2.

RG12 Geomorphology

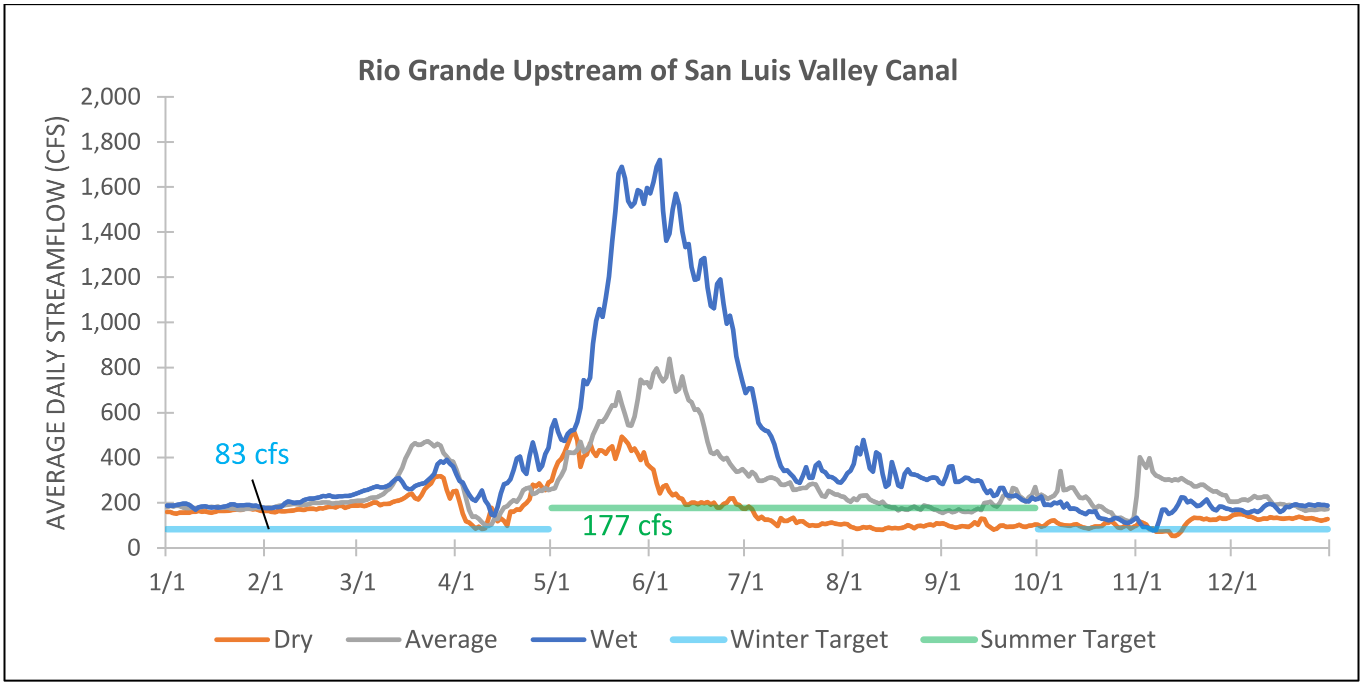
<table>
<tr><td>Reach</td><td colspan="8">Location Description</td></tr>
<tr><td>RG12</td><td colspan="8">Gunbarrel Road (Highway 285) to Rio Grande - Alamosa County Line</td></tr>
<tr><td>Confine-ment</td><td>D50 (mm)</td><td>Bed Comp.</td><td>Existing Stream Form</td><td>Reference Stream Form</td><td>SEM Stage Existing</td><td>SEM Stage Ref.</td><td>Existing Sediment Regime</td><td>Reference Sediment Regime</td></tr>
<tr><td>Unconfined</td><td>29-38</td><td>Coarse Gravel</td><td>Riffle-pool</td><td>Riffle-pool</td><td>1</td><td>0</td><td>Deposition</td><td>Deposition</td></tr>
<tr><td>Valley Slope</td><td>Stream Power △</td><td>Bed Mobility Threshold Flows</td><td>Bed Mobility Frequency</td><td colspan="2">Overbank Flow Estimate</td><td colspan="3">Overbank Flow Frequency</td></tr>
<tr><td>0.21%</td><td>↓</td><td>900-1200 cfs</td><td>30 days during Average years and for 55 days during Wet years</td><td colspan="2">Upstream of the County Road 6 E bridge: 1800 cfs

Downstream of the bridge: 3400 cfs</td><td colspan="3">Upstream of the County Road 6 E bridge: wet years for approximately 10-15 days

Downstream of the bridge: extreme events only.</td></tr>
<tr><td colspan="2">Watershed setting</td><td>River Style</td><td colspan="4">Characteristics</td><td colspan="2">Representative Photo</td></tr>
<tr><td colspan="2">Accumulation</td><td>Meandering Coarse Grain Bed</td><td colspan="4">Unconfined channel with moderate to high sinuosity, well developed meandering and associated channel and floodplain geomorphic forms. Range of bar types, floodplain features and floodplain textures; substrate sizes tending toward coarse gravel; substrate variability depends on habitat-scale geomorphic features such as location in bend, pool, or riffle.</td><td colspan="2"></td></tr>
<tr><td colspan="9">Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity</td></tr>
<tr><td colspan="9">When the Rio Grande of glacial times exited the mountains, it spread onto the floor of the San Luis Valley forming an enormous low gradient alluvial fan known locally as the Rio Grande Fan. The Rio Grande of modern times has eroded into the southern portion of the fan as it makes its way eastward toward Alamosa. The modern river corridor is incised into terraces of this fan material. Within this river corridor, the channel’s sinuosity becomes very high and fluvial signatures of past channel migration abound across the corridor. Alterations to the hydrology, biotic drivers, and sediment/floodplain activation are at work influencing the river corridor. Barring significant changes, the reach is likely to remain moderately sensitive to stressors and the channel is likely to slowly push meanders down valley and laterally migrate within a somewhat predictable meander belt.</td></tr>
<tr><td colspan="7">Stressors</td><td colspan="2">Degree of Geomorphic Impairment</td></tr>
<tr><td colspan="7">Channelization, undersized crossings, diversions, land use, loss of biotic drivers, hydrologic and floodplain alterations.</td><td colspan="2">C</td></tr>
</table>

RG12 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type:

RG12	DRY	AVERAGE	WET
Winter	95%	100%	100%
Summer	40%	86%	100%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.

RG12 Riparian Vegetation

Overall, this site (RGVeg12) appears to be in good condition, receiving an overall EIA rating of B- (2.62). However, this score suggests that this site has the potential to degrade to a C rating if further alteration from natural conditions occurs. The lowest individual metric ratings it received were for Condition of Natural Buffer – Vegetation (C), Native Plant Species Cover (C-), Native Plant Species Composition (C), and Vegetation Structure (C) (Table 3.12).

Table 3.12: EIA Scorecard – RGVeg12

RGVeg12 Observer: W. McBride	Wt	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				2.62	B-
Rank Factor: LANDSCAPE CONTEXT	0.30			3.11	B+
LANDSCAPE METRICS	0.33			3.00	B+
L1. Contiguous Natural Land Cover	1	B	3		
L2. Land Use Index	1	B	3		
BUFFER METRICS	0.67			3.16	B+
B1. Perimeter with Natural Buffer	n/a	A	4		
B2. Width of Natural Buffer	n/a	A	4		
B3.1. Condition of Natural Buffer - Veg	n/a	C	2		
B3.2. Condition of Natural Buffer - Soils	n/a	B	3		
Rank Factor: CONDITION	0.70			2.42	C+
VEGETATION METRICS	1			2.42	C+
V1. Native Plant Species Cover	1	C-	1.5		
V2. Invasive Nonnative Plant Species Cover	1	B	3		
V3. Native Plant Species Composition	1	C	2		
V4. Vegetation Structure	1	C	2		
V5. Regen. of Native Woody Species **(opt.)**	1	B	3		
V65. Coarse and Fine Woody Debris **(opt.)**	1	B	3		

Condition of Natural Buffer – Vegetation and Native Plant Species Cover were both impacted by the low average relative cover of native species at this site (60%). The nonnative species with the highest absolute cover include the following species with cover values for plots 1, 2, 3, and 4, respectively: *Bromus inermis* (17.5%, 1.5%, 1.5%, and 17.5%), *Elymus repens* (7.5%, 17.5%, 17.5%, and 3.5%), and *Poa pratensis* (7.5%, 0.5%, 3.5%, and 3.5%). The noxious species *Cirsium arvense* was encountered in all four plots (0.2%, 3.5%, 7.5%, and 0.5% cover) and had an average cover of 3%.

Regarding Native Plant Species Composition, the average mean C-value for native species was 4.7, while the average cover-weighted mean C-value for native species was 4.3 (Table 3.7). These values suggest that most native species present are equally likely to be found in natural and non-natural areas.

This site received a C-rank for Vegetation Structure because the vertical strata and presence of woody debris were moderately less complex than natural conditions. Simultaneously, herbaceous litter cover appeared to be excessive relative to expected natural conditions. The plant associations at this site are *Salix exigua/*Mesic Graminoid Shrubland (Carsey et al., 2003) and mature *Populus angustifolia* with an herbaceous understory (undescribed) reflect plant communities of early seral stages. While *Salix exigua* is an excellent soil stabilizer, this species can dominate a stand and reduce overall diversity. This site may benefit from weed removal and introduction of additional native species (via seed, cuttings, and/or transplants) to facilitate transition to a more mature seral state.

Current land uses observed and approximate cover within the 500 m buffer include light recreation (75%), non-tilled hayfields (22%), and unpaved roads (3%). The two tracks primarily occur > 100 m from the river, however a prominent two-track running east/west on the south side of the river approaches the riparian corridor to within a few meters. It would be beneficial to re-route this track further from the river, if possible. There was evidence at this site of past beaver activity, however no recent sign was observed.

Results from the reach-scale RCA assessment indicated significant riparian vegetation impairment with a C rating. Stressors include floodplain conversion and nonnative species competition. The average of the EIA and RCA ratings is C+.

RG12 Water Quality and Aquatic Life

Water Quality		
Temperature	Chemical Conditions	Nutrients
N/A	D	A
Overall Rating		B-

Aquatic Life			
Average MMI Score	Overall MMI Rating	Trout (lbs/acre)	Trout Rating
72.7	B	N/A	N/A
Overall Rating			B

Dissolved cadmium, lead, and zinc exceed water quality standards and are on the 303(d) list for this reach. Total arsenic does not currently show standards exceedance however the analytical detection limits were too high to make an attainment determination during the last state listing cycle and thus it remains on the 303(d) list. The TMDL for cadmium and zinc beginning in RG06 persists through this reach. Dissolved manganese exceeds the water supply standard however it does not exceed the year 2000 ambient of 157 µg/l and was removed from the M&E List in the last listing cycle. The segment was previously listed for copper but now shows attainment of the aquatic life standard.

Despite heavy metal exceedances, this reach supports a healthy benthic macroinvertebrate community with an average MMI score of 72.7. However, diversion structures form multiple barriers to fish passage in this reach and reduce aquatic habitat connectivity. Trout data was not available.

RG12 Diversion Infrastructure

***Refer to reach overview map above for diversion structure locations.**

Empire Canal: The headgate sits along the south bank of the river. The concrete is spalling on the river headgate, also noted in 2006 inventory. There is no formal diversion dam, but water is diverted effectively because the headgate is located on the outside of a meander. There is a trash rack along the south bank of the river just upstream of the headgate that does not appear to be functional. There are slots in the headgate upstream of the radial gates to place stop boards. The feeder canal transports water approximately 3.3 miles from the river headgate to the main headgate. At the main headgate, a return flow structure returns any unused water to the river upstream of County Rd 3. The channel is unstable and has migrated significantly both upstream and downstream of the structure. Upstream of the river headgate, meanders are developing due to lateral migration of the river downstream. As the meanders upstream continue to develop, there is a small chance the river will intercept a historic channel, which would cut off this structure. Riprap has been placed on the north bank of the river immediately upstream of the structure. Two bank stabilization projects were installed between this structure and Hwy 285 - one in 2009 and a second in 2010. During low flows, water administration between this structure and the Billings Ditch is difficult. In addition, the flume has difficulty measuring accurately at low flows. The TAT recommends river headgate repairs to address aging concrete, removal of riprap and installation of enhanced bank stabilization structures and riparian revegetation, channel migration monitoring, and repair or replacement of the flume. Improved bank stabilization would reduce annual maintenance and eliminate the need for heavy equipment operation in the channel and headgate and flume repairs would reduce future infrastructure risks and maintenance.

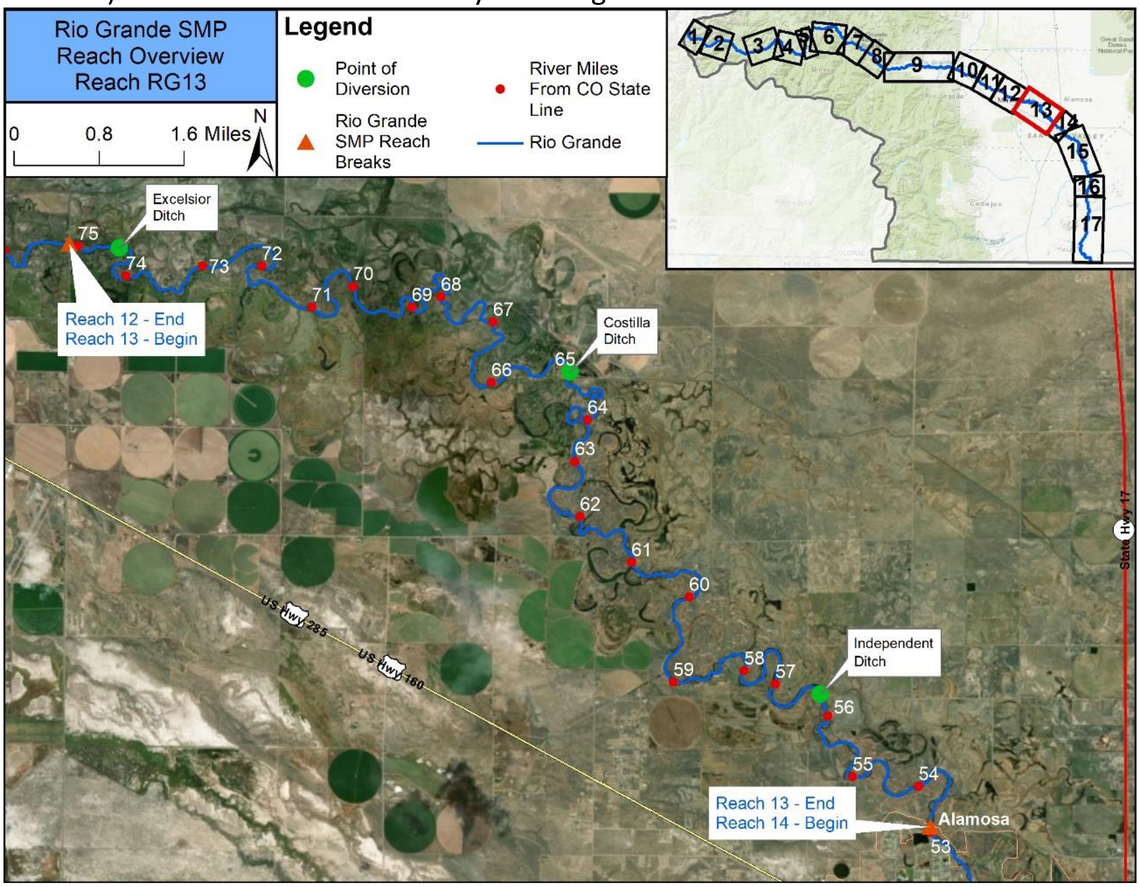
Billings Ditch: This structure is located near the apex of a meander. Channel migration analysis shows the meander is tightening and may be cut off in the future (see map in report card). If this occurs, the ditch will no longer be functional. A diversion dam composed of rocks and debris directs flow to a short feeder channel with a log trash boom at its entrance. At the end of the feeder channel is a welded steel plate headwall and attached headgate. The headgate does not seal properly. Debris accumulates on the diversion dam and, despite the trash boom, is especially an issue at the headgate. Sediment accumulation is also an issue at this structure. The ditch company also has difficulty diverting water during low flow conditions. Additionally, the flume is too large for the volume of the ditch and does not measure accurately at low flows. Given the issues identified at this structure, the TAT recommends installing a new diversion dam, headgate (with an adjacent sluice), and flume at this location. The TAT also recommends implementing bank stabilization and riparian revegetation, especially upstream of the diversion. CPW recommends fish passage in this reach and the TAT recommends also creating safe boat passage and allowing for adequate sediment transport. A new diversion dam and headgate would improve sediment transport and debris-passing capabilities. Bank stabilization and riparian revegetation would reduce erosion, help prevent the meander from being cut off, and maintain ditch and river function. As an alternative solution, the TAT recommends the ditch company consider moving the point of diversion and headgate upstream to avoid the potential impact of channel avulsion.

San Luis Valley Canal: This structure is located in the transition zone between two broad meanders in the river. Since 1975, the channel has migrated both upstream and downstream of this structure. The meander immediately upstream of the diversion has been tightening and migrating to the northwest. Just downstream of the diversion, the river is migrating to the southwest, away from the diversion, and the next downstream meander is also tightening. Channel capacity is limited in this part of the river, which has caused the bank upstream of the structure to breach during past high flow events. This structure's headgate was replaced in Spring 2019 in partnership with the RGHRP, and the ditch company as part of the *Five Ditches Project*. The headgate was moved about 120 ft closer to the river, and the concrete wing walls from the old headgate were saved. The old headgate will serve as the new measurement device for this structure. In addition, bank stabilization structures were installed and riparian vegetation was planted downstream of the diversion to address erosion on the south bank. During the spring 2019 runoff, the bank downstream of the newly installed headgate breached, allowing water to enter the ditch around the headgate (see report card). Although the headgate has been repaired, the TAT recommends regular monitoring given the potential risk of breaching.

Centennial Ditch: A new grouted rock diversion dam was installed in 2018 in partnership with the RGHRP, and the ditch company as part of the *Five Ditches Project*. The diversion dam was designed to be a partial barrier to nonnative fish movement upstream. It allows for boat passage while also creating adequate head pressure during low flows as well as adjustment capabilities for a range of higher flows. It includes an adjustable gate controlled by an air bladder. A rock weir was installed downstream of the diversion to prevent scour downstream of the diversion and to stabilize the adjacent streambanks. Native riparian vegetation was also planted as part of this project. The diversion dam directs water to the headgates which function very well. One of the two headgates is automated. The measurement weir was also recently improved and functions well. Despite recent improvements, the channel is unstable both upstream and downstream of the diversion dam. Immediately upstream of the diversion, the meanders are tightening and, during a high flow event, the meander could be cut off. If this occurs, it would cause the diversion to also be cut off. The TAT recommends monitoring the risk of meander cutoff given its potential impact on this structure.

3.2.13 RG13 – Rio Grande/Alamosa County Line to City of Alamosa Near Lakewood Drive

The Rio Grande/Alamosa County line downstream to the western edge of the City of Alamosa (near Lakewood Drive) where the Alamosa levee system begins.



Representative Reach Photo

RG13 Conditions Assessment Overview

Reach: RG13		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	C	X	X	X	X	X		X				X		
Riparian Vegetation	B-					X				X				
Water Quality	A-												X	X
Aquatic Life	C	X						X			X	X	X	X
Diversion Structures	B-													

A	B	C	D	F	Not Assessed

*For an explanation of reach ratings, see Section 2.

RG13 Geomorphology

Reach	Location Description
RG13	Rio Grande – Alamosa County Line to City of Alamosa near Lakewood Drive

Confine-ment	D50 (mm)	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Unconfin ed	29	Coarse Gravel	Riffle-pool	Riffle-pool	1	0	Deposition	Deposition

Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate	Overbank Flow Frequency
0.04%	↔	In channel flows do not mobilize the D50.	Extreme Events Only	1400 cfs	Extreme Events Only

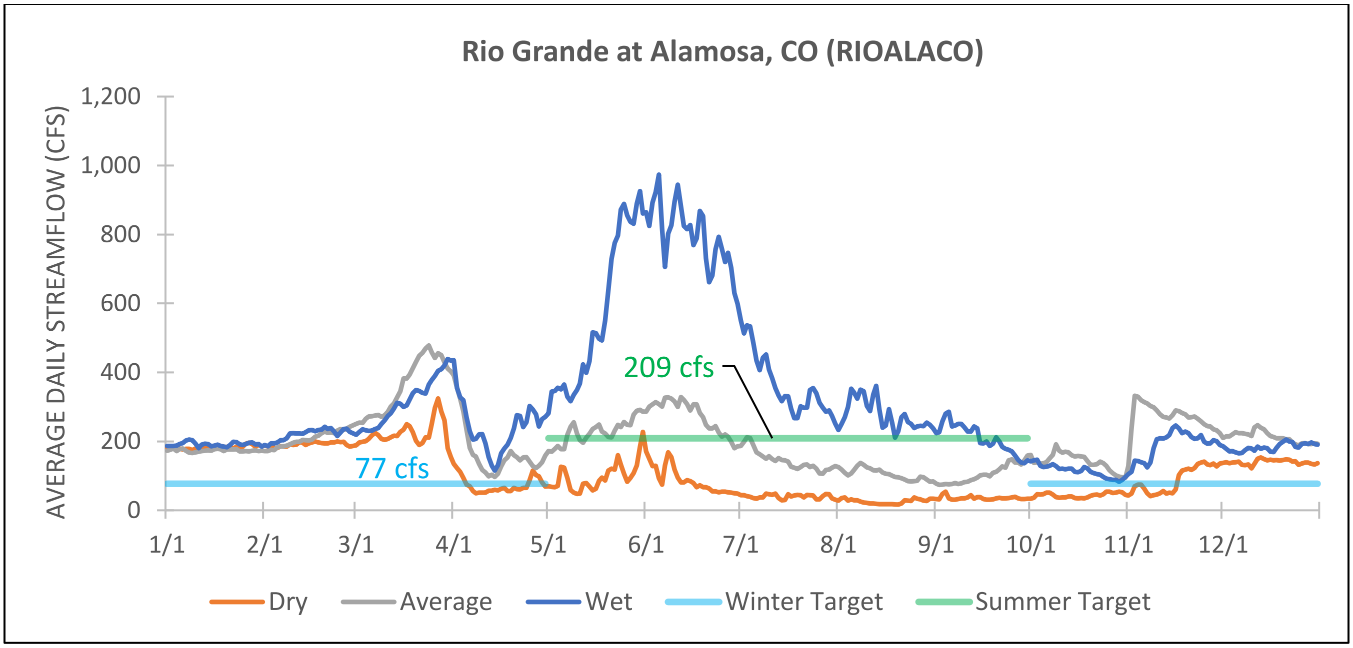
Watershed setting	River Style	Characteristics	Representative Photo
Accumulation	Meandering Coarse Grain Bed	Unconfined channel with moderate to high sinuosity, well developed meandering and associated channel and floodplain geomorphic forms. Range of bar types, floodplain features and floodplain textures; substrate sizes tending toward coarse gravel; substrate variability depends on habitat-scale geomorphic features such as location in bend, pool, or riffle.	

Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity
When the Rio Grande of glacial times exited the mountains, it spread onto the floor of the San Luis Valley forming an enormous low gradient alluvial fan known locally as the Rio Grande Fan. The Rio Grande of modern times has eroded into the southern portion of the fan as it makes its way eastward toward Alamosa. The modern river corridor is incised into terraces of this fan material. Within this river corridor, the channel's sinuosity becomes very high and fluvial signatures of past channel migration abound across the corridor. Alterations to the hydrology, biotic drivers, and sediment/floodplain activation are at work influencing the river corridor. Barring significant changes, the reach is likely to remain moderately sensitive to stressors and the channel is likely to slowly push meanders down valley and laterally migrate within a somewhat predictable meander belt.

Stressors	Degree of Geomorphic Impairment
Channelization, land use, loss of biotic drivers, lack of large woody material, hydrologic and floodplain alterations.	C

RG13 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type:

RG13	DRY	AVERAGE	WET
Winter	68%	100%	100%
Summer	0%	29%	89%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.

RG13 Riparian Vegetation

Overall, this site (RGVeg13) appears to be in good condition, receiving an overall EIA rating of B- (2.70). However, this score suggests that this site has the potential to degrade to a C rating if further alteration from natural conditions occurs. The lowest individual metric ratings it received were for Land Use Index (C), Width of Natural Buffer (C), Native Plant Species Cover (C), and Native Plant Species Composition (C) (Table 3.13).

Table 3.13: EIA Scorecard – RGVeg13

RGVeg13 Observer: W. McBride	Wt	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				**2.70**	**B-**
Rank Factor: LANDSCAPE CONTEXT	0.30			**2.78**	**B-**
LANDSCAPE METRICS	0.33			**2.50**	**B-**
L1. Contiguous Natural Land Cover	1	B	3		
L2. Land Use Index	1	C	2		
BUFFER METRICS	0.67			**2.91**	**B-**
B1. Perimeter with Natural Buffer	n/a	A	4		
B2. Width of Natural Buffer	n/a	C	2		
B3.1. Condition of Natural Buffer - Veg	n/a	B	3		
B3.2. Condition of Natural Buffer - Soils	n/a	B	3		
Rank Factor: CONDITION	0.70			**2.67**	**B-**
VEGETATION METRICS	1			**2.67**	**B-**
V1. Native Plant Species Cover	1	C	2		
V2. Invasive Nonnative Plant Species Cover	1	B	3		
V3. Native Plant Species Composition	1	C	2		
V4. Vegetation Structure	1	B	3		
V5. Regen. of Native Woody Species **(opt.)**	1	B	3		
V65. Coarse and Fine Woody Debris **(opt.)**	1	B	3		

The Land Use Index and Width of Natural Buffer were both impacted by moderate grazing occurring south of the river. Grazing at this level of intensity fragments the cover or natural land use surrounding the AA. The grazing pasture covers an estimated 50% of the 500 m buffer and occurs within the 100 m buffer area immediately adjacent to the AA.

The average relative cover of native species was 92%, which ranks as a C for Native Plant Species Composition. *Phalaris arundinacea* was the nonnative species with the highest absolute cover, however it only occurred in plot 1 (7.5%). On average, there were 21 species per plot, seven of which were classified as nonnative. *Cirsium arvense* was present in all plots (3.5%, 3.5%, 1.5%, and 1.5% cover per plot) with an average cover of 2.5%. Regarding Native Plant Species Composition, the average mean C-value for native species was 4.0, while the average cover-weighted mean C-value for native species was 3.4 (Table 3.7). This suggests high cover by increaser native species that are tolerant of disturbance and habitat degradation. These species are commonly found in non-natural areas significantly impacted by anthropogenic disturbance.

Current land uses observed and approximate cover within the 500 m buffer include moderate grazing (50% cover of the buffered area), non-tilled hay fields (40%), management for native vegetation (9%) and two-track access roads (1%).

Results from the reach-scale RCA assessment indicated significant riparian vegetation impairment with a C+ rating. Stressors include floodplain conversion and nonnative species competition. The average of the EIA and RCA ratings is B-.

RG13 Water Quality and Aquatic Life

Water Quality		
Temperature	Chemical Conditions	Nutrients
N/A	A	B
Overall Rating		A-

Aquatic Life			
Average MMI Score	Overall MMI Rating	Trout (lbs/acre)	Trout Rating
53.3	C	N/A	N/A
Overall Rating			C

No state water quality standard exceedances were identified in this reach however total phosphorous is nearing the aquatic life standard and is therefore rated a B.

Diversion structures form multiple barriers to fish passage. An average MMI score of 53.5 shows impairment to macroinvertebrate communities however key functional groups remain intact. Trout data was not available. Fish species in this reach include black bullhead, brook stickleback, common carp, fathead minnow, plains topminnow, red shiner, white sucker, rainbow x cutthroat, longnose dace, northern pike, and Rio Grande chub. A total of five Rio Grande chub were observed in 2015. CPW plans to establish additional long-term monitoring sites within this reach.

RG13 Diversion Infrastructure

***Refer to reach overview map above for diversion structure locations.**

Excelsior Ditch: The diversion structure is an adjustable steel weir with hand cranks that spans the river and diverts river flow to the river headgate, located on the north bank of the river. There is a log trash boom in front of the headgate where woody debris accumulates. This structure does not function well during both high and low flow conditions. The ditch is not able to divert its full decree during low river flows and water users have difficulty adjusting diversion rates based on streamflow fluctuations. Silt has accumulated upstream of the diversion and the river is occasionally dredged. During previous high flow events, the ditch bank downstream of the headgate has washed out due to the river overtopping its banks upstream and draining toward the downstream ditch berm. Flow from the river also backs up in the downstream return flow ditch and enters the ditch through the return flow slide gate. The gradient on the return flow ditch is very low, and silt accumulates along the downstream side of the gate. Channel migration has previously and is currently occurring both upstream and downstream of the structure (see maps in report card). An emergency overflow channel on the south bank is intended to mitigate damage by increasing channel capacity during high flows. Bank stabilization structures were installed upstream of the structure on the north bank or river.

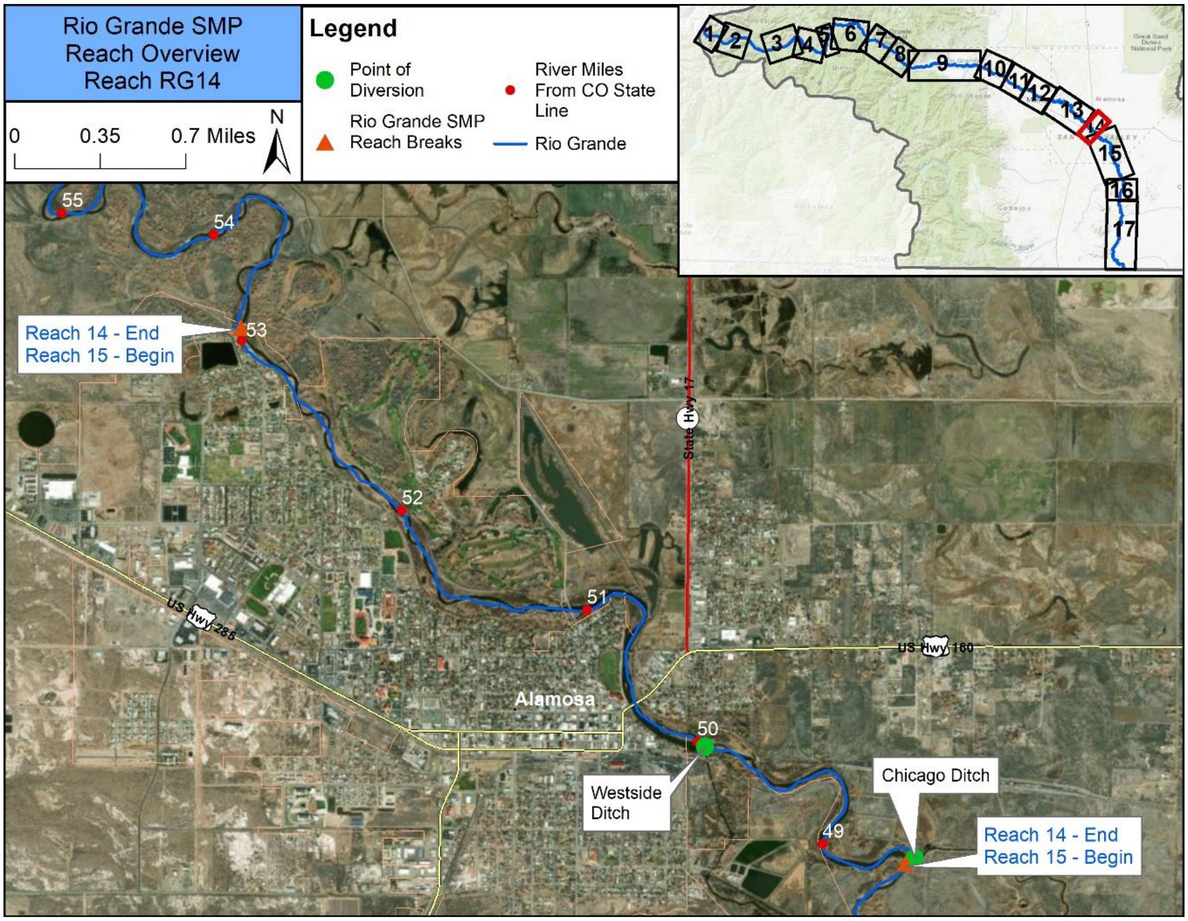
Given these issues, the TAT recommends installing a new automated headgate and diversion dam at this location, improving the return flow structure, and upstream bank stabilization. CPW recommends fish passage and the TAT recommends creating safe boat passage and increasing sediment transport capacity. A new headgate, especially one with automation, would allow for increased water control, diurnal flow adjustments, and lower maintenance. A new diversion dam would improve the ability of the ditch to effectively divert its water rights at all water levels. Additionally, raising the elevation of the return flow gate and return flow ditch dredging would improve water control and reduce maintenance needs. Finally, stabilization of upstream banks (in addition to bank stabilization structures installed in 2014) would help prevent this structure from being washed out during high flow events.

Costilla Ditch: This structure is located on the outside of a meander and just downstream of its apex. A trapezoidal concrete diversion dam diverts river flow into the feeder channel on the east bank of the river. The diversion dam effectively diverts water, however it significantly reduces channel capacity at this location. The feeder channel is approximately 1,000 ft long and directs river flow to the headgate. There is a steel trash rack at the entrance of the feeder channel. There are several historic channels near the current channel, suggesting channel avulsion was historically prevalent here. For this reason, it is assumed that channel avulsion from the current channel to a historic channel during a flood event is possible. Immediately upstream of the structure, the river has not migrated significantly since the 1960s (see report card). This is due in part to riprap and concrete blocks that were placed upstream of the diversion on the east bank of the river for stabilization. Downstream of the diversion, channel avulsion has occurred historically and there is potential for meander cutoffs. This ditch's slope is very low and backs up when the ditch is in priority, resulting in a significant issue for water users. Based on these issues, the TAT recommends removing the concrete upstream of the diversion and replacing it with bank stabilization structures and riparian vegetation. This restoration would improve river function and reduce hazards for boaters and livestock. Additionally, if the diversion is reconstructed in the future, the TAT recommends increasing its capacity to improve river function and reduce the likelihood of the river reclaiming a historic channel during a high flow event.

Independent Ditch: A large concrete diversion dam consisting of a pair of radial gates and a concrete weir diverts river flow to the headgate. The headgate sits along a short feeder channel on the east bank of the Rio Grande that comes off of the river just upstream of the diversion dam. There is a steel trash rack just upstream of the headgate. The measurement structure is a rated steel box and functions moderately well. This structure is owned by the City of Alamosa. There is potential for a meander to be cut off approximately 0.25 miles upstream of the diversion dam. This would cause the diversion to become dysfunctional. Significant sedimentation and debris accumulation occurs at this structure. Despite debris accumulation, the headgate itself functions well. Although the channel has remained fairly stable in the last 45 years, bank erosion has occurred both upstream and downstream of the structure, particularly upstream on the east bank. The TAT recommends installing a new trash rack in front of the structure's headgate. CPW recommends fish passage in this reach and the TAT also recommends creating safe boat passage and increasing sediment transport capacity at the diversion. Additionally, the TAT recommends bank stabilization upstream of the diversion. An improved trash rack in front of the headgate would mitigate debris accumulation and reduce ditch maintenance. If the diversion is replaced in the future, increasing its sediment transport capacity and creating boat passage would improve ditch function, enhance river health, and provide new recreational opportunities. Riparian revegetation and/or bank stabilization structures would increase bank stability and mitigate erosion and sediment input.

3.2.14 RG14 – City of Alamosa Near Lakewood Drive to Chicago Ditch

The western edge of the City of Alamosa (near Lakewood Drive) where the levee system begins downstream to the Chicago Ditch diversion east of Alamosa.



Representative Reach Photo

RG14 Conditions Assessment Overview

Reach: RG14		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	D	X	X	X	X	X		X				X		
Riparian Vegetation	C					X				X				
Water Quality	A-												X	X
Aquatic Life	C	X						X			X	X	X	X
Diversion Structures	C+													

A	B	C	D	F	Not Assessed

*For an explanation of reach ratings, see Section 2.

RG14 Geomorphology

Reach	Location Description
RG14	City of Alamosa Near Lakewood Drive to Chicago Ditch

Confine-ment	D50	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Unconfined	No Data	No Data	Plane bed	Plane bed	2	0	Transport	Deposition

Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate	Overbank Flow Frequency
0.08%	↑	No Data	No Data	No Data	No Data

Watershed setting	River Style	Characteristics	Representative Photo
Altered	Urban	Highly altered reach with extensive channelization.	

Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity
Highly altered channel through the City of Alamosa. Numerous meander bends were straightened. Levees on both sides of the river.

Stressors	Degree of Geomorphic Impairment
Reach stressors are predominantly due to manipulation of the corridor for development including roads, levees, and a golf course, altered hydrology, and the loss of biotic factors and large wood within the river corridor.	D

RG14 Riparian Vegetation

An EIA site was not completed within this reach. Results from the reach-scale RCA assessment indicated significant riparian vegetation impairment with a C rating. Stressors include floodplain conversion and disconnection as well as nonnative species competition.

RG14 Water Quality and Aquatic Life

Water Quality		
Temperature	Chemical Conditions	Nutrients
N/A	A	B
Overall Rating		**A-**

Aquatic Life			
Average MMI Score	Overall MMI Rating	Trout (lbs/acre)	Trout Rating
53.3	C	N/A	N/A
Overall Rating			**C**

No state water quality standard exceedances were identified in this reach however total phosphorous is nearing the aquatic life standard and is therefore rated a B. Macroinvertebrates were not collected within this reach, however given the similarities to RG13, the MMI score is assumed to be the same in this reach. Diversion structures form multiple barriers to fish passage in this reach and reduce aquatic habitat connectivity.

RG14 Diversion Infrastructure

***Refer to reach overview map above for diversion structure locations.**

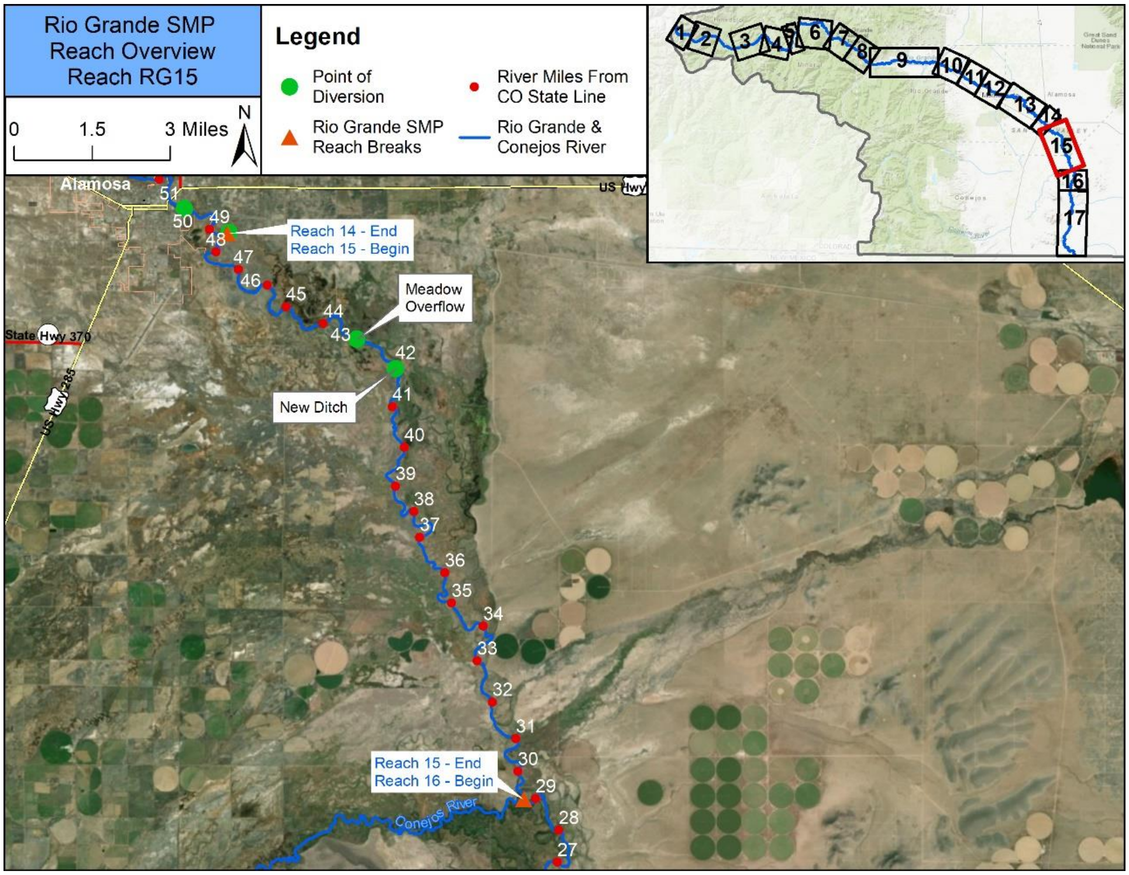
Westside Ditch: A corrugated sheet metal diversion with a 20 ft steel weir and a 20 ft radial gate spanning the river directs river flow to a short feeder channel and services the headgates. There is a log trash boom across the entrance of the feeder channel. At the headgates, which are aging and difficult to operate, the ditch enters a culvert before passing through the flume. Upstream of the diversion, the channel has migrated south (see 1975 and 1960 channel margin maps), although significant migration is limited by the levees and thus lateral migration has not affected the diversion's ability to function. The diversion gates do not have sufficient capacity to pass flood flows. For this reason, during high flow events, the river bank north of the structure can fail, leading to significant flows bypassing the structure via the failed bank. High flow scenarios could also potentially lead to flooding upstream of the diversion or in East Alamosa due to a backwater effect. Significant debris and sediment are deposited upstream of this diversion due to the structure's limited sediment transport capacity along with regularly low river velocities. This structure impacts the sediment transport regime and channel capacity of the river upstream of the diversion. The diversion effectively diverts water, however it is difficult and time consuming to operate. During 2019 spring runoff, the levee forming the bank north of the diversion washed out (see report card) and has occurred in the past.

Given the poor condition of the infrastructure and its impact on river function, the TAT recommends replacing the diversion and headgate with new structures. CPW recommends fish passage at this location and the TAT recommends boat passage and increased sediment transport capacity, especially considering the increasing popularity of recreational boating in the Alamosa area. A new headgate would reduce water user maintenance needs and increase ditch efficiency. A new diversion would allow for fish and boat passage, reduce the risk of flooding in East Alamosa, and would reestablish natural sediment transport processes in this location. Diversion structure improvements were also identified in the 2017 Rio Grande River Corridor Feasibility Study. If improvements are made that allow for boat passage, a safe takeout location adjacent to or downstream of the diversion is also recommended.

Chicago Ditch: This structure is located approximately 1.3 miles downstream of the Westside Ditch. Historic channel avulsion is evident both upstream and downstream of the diversion. The concrete diversion dam creates head pressure for the headgate, located approximately 230 ft upstream. Woody debris accumulates in front of the headgate, but it is not a significant issue for water users. There is a radial adjustment/overflow gate on the east side of the diversion dam. The diversion functions well for water rights holders, but forms a barrier to boating and fish passage, especially at low flows. At two locations downstream of the headgate (approximately 3.4 miles and 4 miles, respectively), the ditch is very close to the Rio Grande, in part due to channel migration. If channel migration continues, the ditch could be washed out in these locations (see map in report card). Based on the issues identified, the TAT recommends bank stabilization or relocating the path of the ditch to avoid potential ditch failure. The TAT also recommends stabilization, floodplain reconnection, and riparian revegetation downstream of the diversion to reduce erosion. CPW recommends fish passage in this reach and the TAT also recommends creating safe boat passage at the diversion. If implemented, these recommendations would improve ditch function, enhance river health, and provide new recreational opportunities.

3.2.15 RG15 – Chicago Ditch to Conejos River Confluence

The Chicago Ditch diversion just east of Alamosa downstream to the confluence of the Conejos River.



Representative Reach Photo

RG15 Conditions Assessment Overview

Reach: RG15		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	C+	X		X				X				X	X	
Riparian Vegetation	C+			X		X				X				
Water Quality	A-												X	X
Aquatic Life	C+	X						X			X	X	X	X
Diversion Structures	C													

A	B	C	D	F	Not Assessed

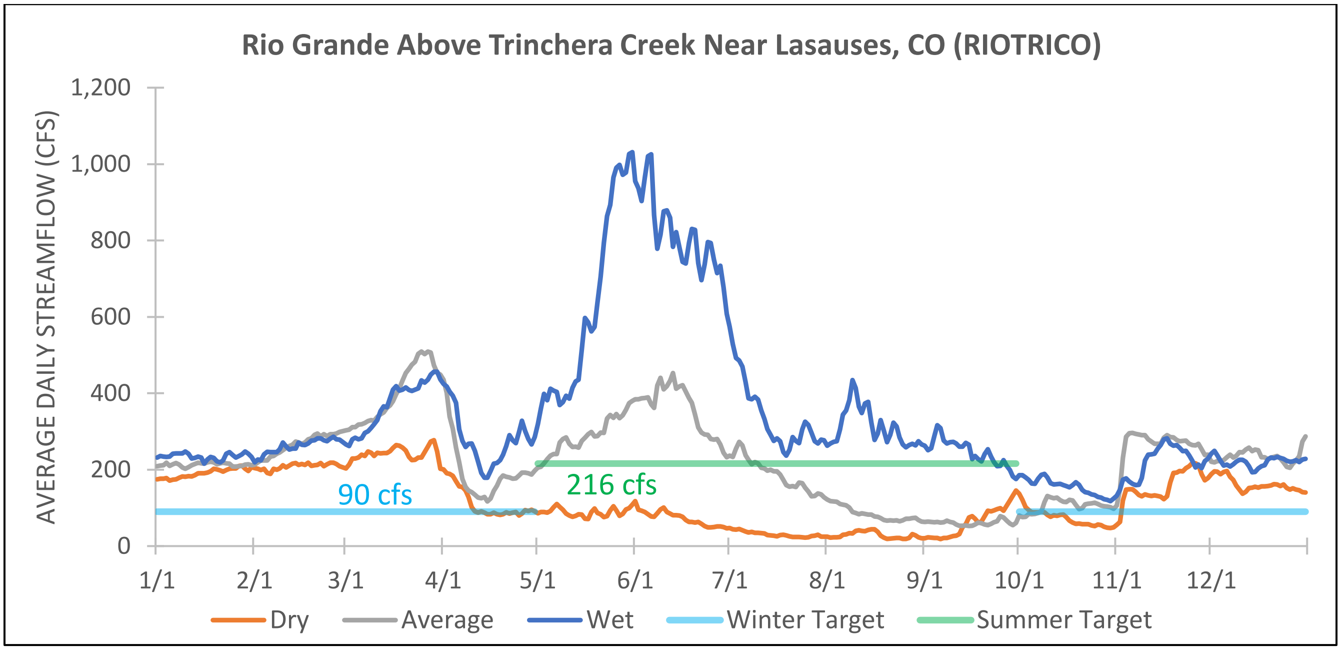
*For an explanation of reach ratings, see Section 2.

RG15 Geomorphology

<table>
<tr><td>Reach</td><td colspan="8">Location Description</td></tr>
<tr><td>RG15</td><td colspan="8">Chicago Ditch to Conejos River Confluence</td></tr>
<tr><td>Confine-ment</td><td>D50 (mm)</td><td>Bed Comp.</td><td>Existing Stream Form</td><td>Reference Stream Form</td><td>SEM Stage Existing</td><td>SEM Stage Ref.</td><td>Existing Sediment Regime</td><td>Reference Sediment Regime</td></tr>
<tr><td>Unconfined</td><td><2</td><td>Sand and Silts</td><td>Riffle-pool</td><td>Riffle-pool</td><td>1</td><td>0</td><td>Deposition</td><td>Deposition</td></tr>
<tr><td>Valley Slope</td><td>Stream Power △</td><td>Bed Mobility Threshold Flows</td><td>Bed Mobility Frequency</td><td colspan="2">Overbank Flow Estimate</td><td colspan="3">Overbank Flow Frequency</td></tr>
<tr><td>0.05%</td><td>↓</td><td>Not Calculated</td><td>Not Calculated</td><td colspan="2">Not Calculated</td><td colspan="3">Not Calculated</td></tr>
<tr><td colspan="2">Watershed setting</td><td>River Style</td><td colspan="4">Characteristics</td><td colspan="2">Representative Photo</td></tr>
<tr><td colspan="2">Accumulation</td><td>Meandering Fine Grain Bed</td><td colspan="4">Unconfined channel with moderate to high sinuosity, well developed meandering and associated channel and floodplain geomorphic forms. Range of bar types, floodplain features and floodplain textures; substrate sizes tending toward sand; substrate variability depends on habitat-scale geomorphic features such as location in bend, pool, or riffle.</td><td colspan="2"></td></tr>
<tr><td colspan="9">Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity</td></tr>
<tr><td colspan="9">This reach runs through the Alamosa National Wildlife Refuge (NWR) and the Rio Grande Natural Area (RGNA). Sinuosity becomes very high and fluvial signatures of past channel migration abound across the valley floor. Alterations to the hydrology, biotic drivers, and sediment/floodplain activation are at work influencing the river corridor but its condition is improved merely as part of the location within the Alamosa NWR. Barring significant changes, the reach is likely to remain sensitive and mobile.</td></tr>
<tr><td colspan="7">Stressors</td><td colspan="2">Degree of Geomorphic Impairment</td></tr>
<tr><td colspan="7">Stressors include alterations to the hydrologic regime and biotic drivers, limited large wood, bank erosion, and floodplain disconnection.</td><td colspan="2">C+</td></tr>
</table>

RG15 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type:

RG15	DRY	AVERAGE	WET
Winter	80%	96%	100%
Summer	0%	44%	96%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.

RG15 Riparian Vegetation

Overall, this site (RGVeg15) appears to be in good condition, receiving an overall EIA rating of B- (2.69). However, this score suggests that this site has the potential to degrade to a C rating if further alteration from natural conditions occurs. The lowest individual metric ratings it received were for Native Plant Species Cover (C) and Native Plant Species Composition (C) (Table 3.14).

Table 3.14: EIA Scorecard – RGVeg15

RGVeg15 Observer: W. McBride	Wt	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				**2.69**	**B-**
Rank Factor: LANDSCAPE CONTEXT	0.30			**3.15**	**B+**
LANDSCAPE METRICS	0.33			**3.00**	**B+**
L1. Contiguous Natural Land Cover	1	B	3		
L2. Land Use Index	1	B	3		
BUFFER METRICS	0.67			**3.22**	**B+**
B1. Perimeter with Natural Buffer	n/a	A	4		
B2. Width of Natural Buffer	n/a	B	3		
B3.1. Condition of Natural Buffer - Veg	n/a	B	3		
B3.2. Condition of Natural Buffer - Soils	n/a	B	3		
Rank Factor: CONDITION	0.70			**2.50**	**B-**
VEGETATION METRICS	1			**2.50**	**B-**
V1. Native Plant Species Cover	1	C	2		
V2. Invasive Nonnative Plant Species Cover	1	B	3		
V3. Native Plant Species Composition	1	C	2		
V4. Vegetation Structure	1	B	3		
V5. Regen. of Native Woody Species (opt.)	1	N/A	NULL		
V65. Coarse and Fine Woody Debris (opt.)	1	N/A	NULL		

The average relative cover of native species was 91%, which ranks as a C for Native Plant Species Composition. No single nonnative species was clearly dominant across sampled plots, however multiple nonnative species with low to moderate cover occurred in all plots.

Additionally, *Phalaris arundinacea* is considered to be an increaser species by CNHP and had consistently high cover across plots 1, 2, 3, and 4 with values of 62.5%, 37.5%, 17.5%, and 17.5%, respectively. The noxious species *Cirsium arvense* was present in plots 1, 2, 3, and 4 with cover values of 0.5%, 0.5%, 3.5%, and 7.5%, respectively (average cover 3%). *Cardaria draba* occurred in plot 4 only with a cover of 0.5%. The average mean C-value for native species was 4.5, while the average cover-weighted mean C-value was only 3.8 (Table 3.7).

Current land uses observed and approximate cover within the 500 m buffer include non-tilled hayfields (60%), management for native vegetation (20%), light recreation (e.g., birding) (15%), and unpaved roads (5%). A few willows showed evidence of having been recently browsed by beaver.

Results from the reach-scale RCA assessment indicated significant riparian vegetation impairment with a C rating. Stressors include floodplain conversion and nonnative species competition. The average of the EIA and RCA ratings is C+.

RG15 Water Quality and Aquatic Life

Water Quality		
Temperature	Chemical Conditions	Nutrients
N/A	A	B
Overall Rating		**A-**

Aquatic Life			
Average MMI Score	Overall MMI Rating	Trout (lbs/acre)	Trout Rating
58.3	C+	N/A	N/A
Overall Rating			**C+**

No state water quality standard exceedances were identified in this reach however total phosphorous is nearing the aquatic life standard and is therefore rated a B. Water quality data is limited for this reach. One diversion structure can form a barrier to fish passage during low flow conditions. An average MMI score of 58.3 indicates significant impairment to macroinvertebrate communities however key functional groups remain intact.

RG15 Diversion Infrastructure

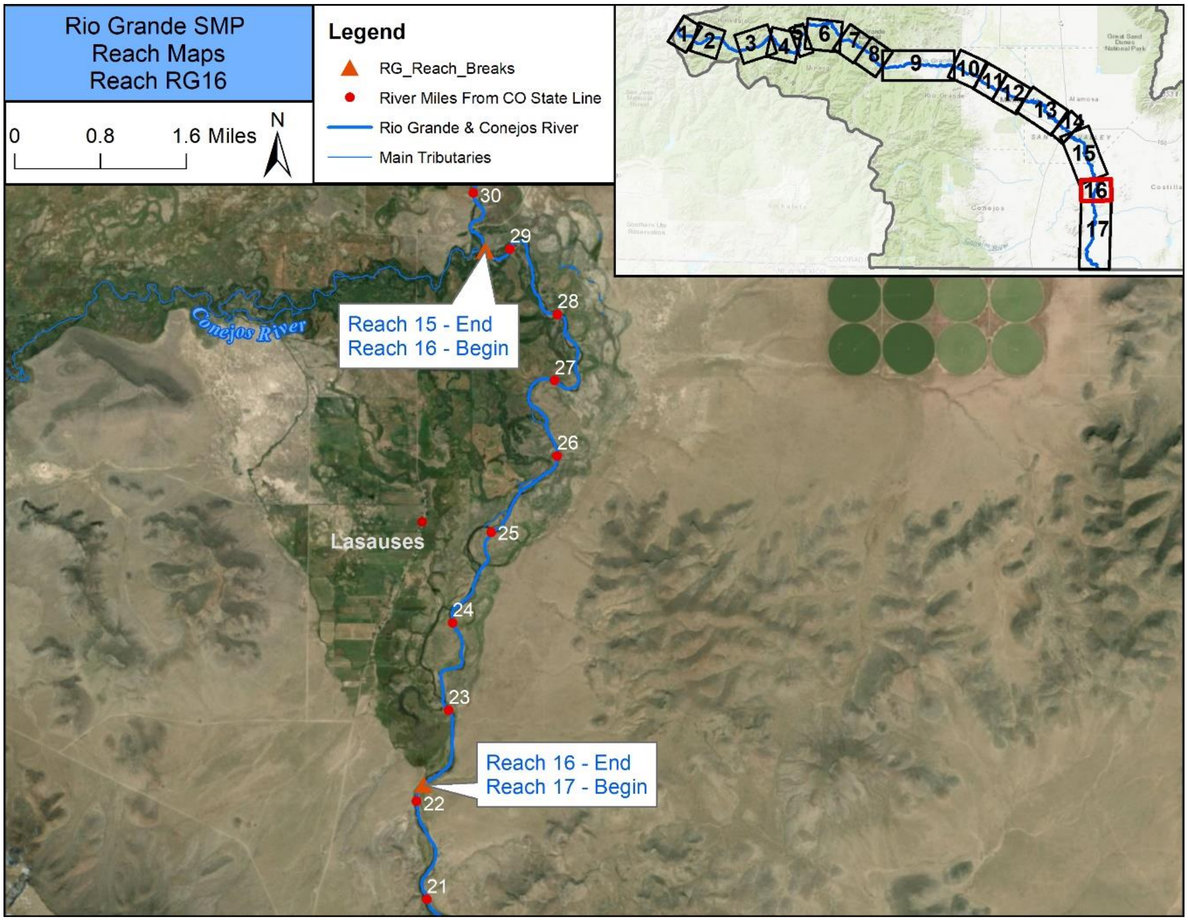
***Refer to reach overview map above for diversion structure locations.**

Meadow Overflow: A U-shaped rock weir diversion dam directs water to a feeder channel, approximately 550 ft long, located on the south bank of the river. A sluice gate at the entrance to the feeder channel helps transport sediment downstream. The diversion dam functions well. At the end of the feeder channel, water is pumped out of the river via a permanently installed, metered lift pump. Alternatively, water can be delivered to the ditch via the original headgate, which is adjacent to the lift pump. There is a cutthroat flume just below the headgate which is in poor condition. Any flow not pumped or diverted returns to the river via two small culverts leading to a return flow channel. The lift pump does not function well for the water user. The TAT recommends repairing the existing headgate or improving the lift pump, replacing the flume, and implementing channel and bank restoration near the diversion to reconnect the river with its floodplain and to restore native riparian vegetation. Headgate replacement or an improved pump would improve ditch function and efficiency and adjacent restoration would improve river function by slowing and dispersing water during high flow events. Channel and bank restoration would enhance riparian vegetation recruitment and reduce erosion.

New Ditch: This is the last diversion structure on the Rio Grande before the New Mexico state line. The channel in this reach is entrenched and is not connected with the floodplain in many locations. The diversion dam was recently repaired but is still not functioning optimally. During 2019 spring runoff, the river flooded around the dam. There are plans to raise the elevation of the diversion for improved function. The flume is on the east side of Closed Basin Canal and does not measure very accurately. The headgate and diversion dam were replaced in 2019. The culvert where the New Ditch crosses under Chicago Ditch was also replaced. Given the issues identified at this structure, the TAT recommends diversion dam replacement, resetting or replacing the flume, and implementing channel and bank restoration. The TAT recommends fish and boat passage in this reach as well as adequate sediment transport. A new diversion could be designed to effectively divert the ditch’s water rights while also allowing for sediment transport and fish and boat passage. River restoration would reconnect the river with its floodplain and restore native riparian vegetation. Restoration would also improve the function of this structure by slowing and dispersing water during high flow events, thereby protecting diversion infrastructure. Flume improvements would reduce maintenance and improve measurement accuracy.

3.2.16 RG16 – Conejos River Confluence to Rio Grande Canyon Entrance

From the confluence of the Conejos River downstream to the entrance of the lower Rio Grande canyon, just downstream of Lasauses, Co. Beginning at the downstream end of this reach, the western side of the river channel is owned by BLM.



Representative Reach Photo

RG16 Conditions Assessment Overview

Reach: RG16		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	B			X				X					X	
Riparian Vegetation	B-					X				X				
Water Quality	A-												X	X
Aquatic Life	C							X			X	X	X	X
Diversion Structures	N/A													

A	B	C	D	F	Not Assessed

*For an explanation of reach ratings, see Section 2.

RG16 Geomorphology

Reach	Location Description
RG16	Conejos River Confluence to Rio Grande Canyon Entrance.

Confine-ment	D50	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Unconfined	No Data	No Data	Riffle-pool	Riffle-pool	1	0	Deposition	Deposition

Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate	Overbank Flow Frequency
0.17%	↔	No Data	No Data	No Data	No Data

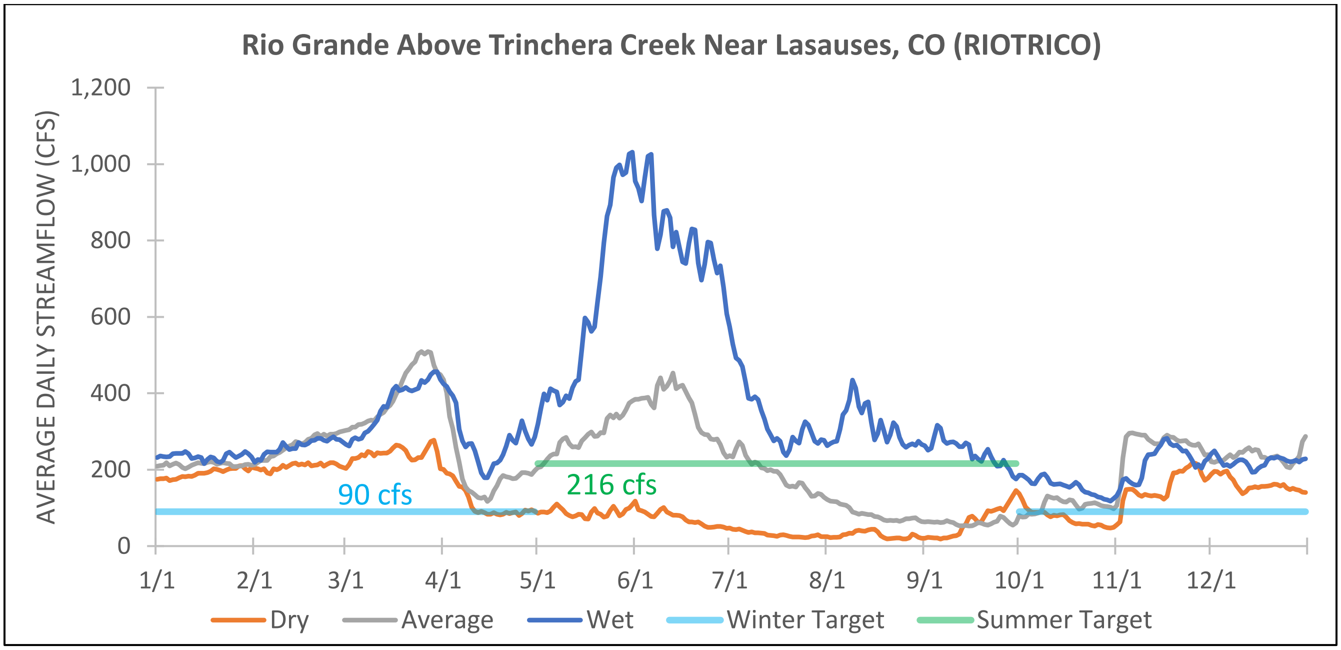
Watershed setting	River Style	Characteristics	Representative Photo
Accumulation	Meandering Fine Grain Bed	Unconfined channel with moderate to high sinuosity, well developed meandering and associated channel and floodplain geomorphic forms. Range of bar types, floodplain features and floodplain textures; substrate sizes tending toward fine gravel and sand; substrate variability depends on habitat-scale geomorphic features such as location in bend, pool, or riffle.	

Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity
"Both sides have experienced bank erosion, unstable banks and tributary head-cutting. This reach has a relatively flat slope and evidence of aggradation and recent abandoned channels/channel migration is visible. Near the bottom of this reach the river is split into two similarly sized channels which persist, creating an island, nearly a mile long. The river transitions from being flat and wide (over-wide in many places), to more canyon-like and incised, especially on river left." (Riverbend Engineering, 2016).

Stressors	Degree of Geomorphic Impairment
"This reach is located entirely within the Rio Grande Natural Area (RGNA) established in 2006 by the U.S. Congress through Public Law 109-337, the Rio Grande Natural Area Act 1. The RGNA extends 1/4 mile on either side of the bank of the river. The reach has significant agriculture on river right, however it is fed from irrigation diversions on the Conejos [River], benefitting the Rio Grande with a moderately healthy wetland and riparian zone, mostly on river right. A high desert ecosystem dominates river left in this reach. There was also evidence of beaver activity in the area." (Riverbend Engineering, 2016).	B

RG16 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type:

RG15	DRY	AVERAGE	WET
Winter	80%	96%	100%
Summer	0%	44%	96%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.

RG16 Riparian Vegetation

Overall, this site (RGVeg16) appears to be in good condition, receiving an overall EIA rating of B- (2.63). This score suggests that this site has the potential to degrade to a C rating if further alteration from natural conditions occurs. The lowest individual metric ratings it received were for Land Use Index (C), Condition of Natural Buffer – Soils (C), Native Plant Species Cover (C), Vegetation Structure (C), and Regeneration of Native Woody Species (C) (Table 3.15).

Table 3.15: EIA Scorecard – RGVeg16

RGVeg16 Observer: W. McBride	Wt	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				**2.63**	**B-**
Rank Factor: LANDSCAPE CONTEXT	0.30			**2.94**	**B-**
LANDSCAPE METRICS	0.33			**2.50**	**B-**
L1. Contiguous Natural Land Cover	1	B	3		
L2. Land Use Index	1	C	2		
BUFFER METRICS	0.67			**3.16**	**B+**
B1. Perimeter with Natural Buffer	n/a	A	4		
B2. Width of Natural Buffer	n/a	A	4		
B3.1. Condition of Natural Buffer - Veg	n/a	B	3		
B3.2. Condition of Natural Buffer - Soils	n/a	C	2		
Rank Factor: CONDITION	0.70			**2.50**	**B-**
VEGETATION METRICS	1			**2.50**	**B-**
V1. Native Plant Species Cover	1	C	2		
V2. Invasive Nonnative Plant Species Cover	1	B	3		
V3. Native Plant Species Composition	1	B	3		
V4. Vegetation Structure	1	C	2		
V5. Regen. of Native Woody Species **(opt.)**	1	C	2		
V65. Coarse and Fine Woody Debris **(opt.)**	1	B	3		

Signs of moderate grazing occur north of the confluence of the Conejos and Rio Grandes. This level of grazing intensity disrupts the extent of continuous natural land cover within the 500 m buffer zone of the AA. Perhaps due to its proximity to County Road Z, this site also shows a range of light to moderate signs of recreational activity, which includes fishing access along the riparian corridor.

The average relative cover of native species was 92%, which ranks as a C for Native Plant Species Composition. No single nonnative species was clearly dominant across sampled plots, however multiple nonnative species with low to moderate cover occurred in all plots. The noxious species *Cirsium arvense* and *Cardaria draba* were observed at this site. *Cirsium arvense* occurred in all four plots (0.5%, 1.5%, 3.5%, and 0.2%) and had an average cover of 1.4%. *Cardaria draba* occurred in three plots (0.5%, 0.5%, 1.5%, and 0%), with an average cover of 0.8% (Tables 30 and 31). The average mean C-value for native species was 4.6, while the average cover-weighted mean C-value was only 4.3 (Table 3.7). These C-values suggest plants that are tolerant of disturbance and are as likely to occur in non-natural areas as they are in natural areas.

The Condition of Natural Buffer – Soils rank reflects a combination of signs of moderate intensity of human use at the site and erosion observed along the north river bank. The Vegetation Structure was impacted by patches of vegetation that appeared to be denser than expected of natural conditions.

These patches were mainly comprised of *Salix exigua* and other native increaser species. Regeneration of Native Woody Species was impacted by the lack of mature *Populus angustifolia* individuals at the site. There were several seedlings scattered throughout the AA, but the only mature individuals observed occurred in a small stand south of the AA.

Current land uses observed and approximate cover within the 500 m buffer include moderate grazing (50%), light recreation (28%), non-tilled hay fields (20%), unpaved roads (1%), and paved roads/parking lots (1%). Both *Populus angustifolia* and *Salix exigua* individuals within the AA showed evidence of having been recently felled by beaver.

Results from the reach-scale RCA assessment indicated significant riparian vegetation impairment with a C+ rating. Stressors include floodplain conversion and nonnative species competition. The average of the EIA and RCA ratings is B-.

RG16 Water Quality and Aquatic Life

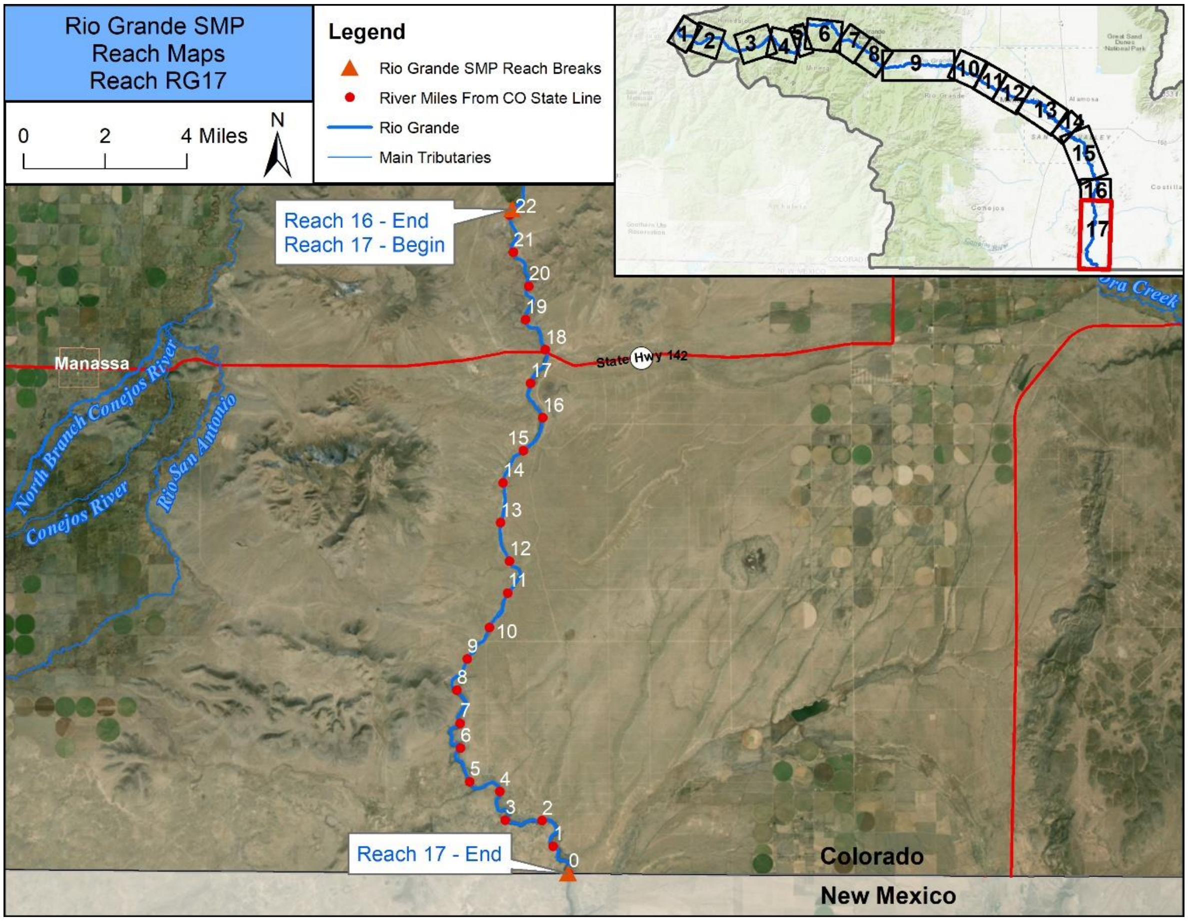
Water Quality		
Temperature	**Chemical Conditions**	**Nutrients**
N/A	A	B
Overall Rating		**A-**

Aquatic Life			
Average MMI Score	**Overall MMI Rating**	**Trout (lbs/acre)**	**Trout Rating**
56.3	C	N/A	N/A
Overall Rating			**C**

No state water quality standard exceedances were identified in this reach however total phosphorous is nearing the aquatic life standard and is therefore rated a B. An average MMI score of 56.3 indicates significant impairment to macroinvertebrate communities however key functional groups remain intact.

3.2.17 RG17 – Rio Grande Canyon Entrance to Colorado/New Mexico State Line

The upstream boundary of this reach is at the entrance to the lower Rio Grande canyon. The downstream end is where the Rio Grande crosses the Colorado/New Mexico line.



Representative Reach Photo

RG17 Conditions Assessment Overview

Reach: RG17		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	A-							X					X	
Riparian Vegetation	B					X				X				
Water Quality	A-												X	X
Aquatic Life	F+							X			X	X	X	X
Diversion Structures	N/A													

A	B	C	D	F	Not Assessed

*For an explanation of reach ratings, see Section 2.

RG17 Geomorphology

Reach	Location Description
RG17	Rio Grande Canyon Entrance to Colorado - New Mexico State Line

Confine-ment	D50 (mm)	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Confined	34-40	Very coarse gravel	Plane bed	Plane bed	1	1	Transport	Transport

Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate	Overbank Flow Frequency
0.03%	↑	1600-1800 cfs	Wet years for 15 days	4000-4800 cfs	Confined Reach

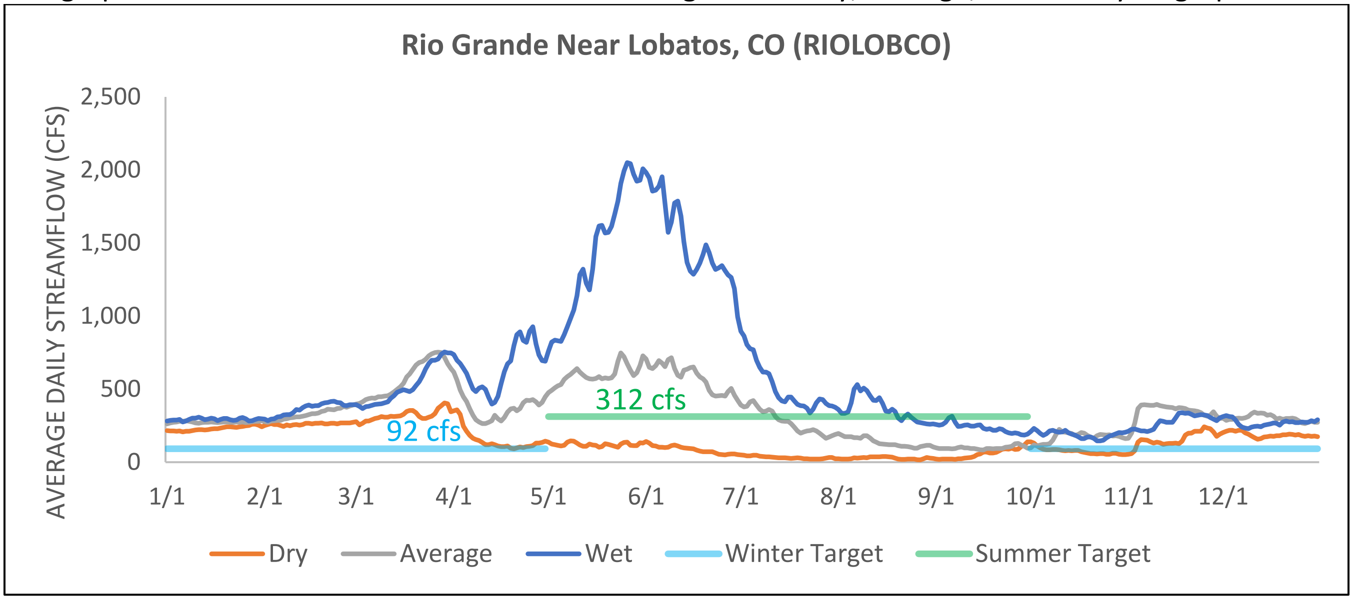
Watershed setting	River Style	Characteristics	Representative Photo
Transport	Confined valley	Confined channel geometry with very little or no floodplain present throughout reach. Instream features derive from lower gradients than step cascade reaches; with plane bed and riffle-run sequences dominant rather than cascades and step pools, although the latter may still occur. Planform remains fully margin-controlled.	

Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity
Natural box canyon. Channel is in stage 1, its reference condition. Occasional island and bar formation causing channel splits. Low sensitivity. The river begins to pick up hillslope and valley margin sediments as they become more closely connected and the bed coarsens as stream power increases and the transport ability of the river increases.

Stressors	Degree of Geomorphic Impairment
"This reach is located entirely within the Rio Grande Natural Area (RGNA)... One pocket of fill noticeable at a crossing. This reach is characterized by a predominant high desert ecosystem, consisting of rabbit brush and sage with minimal plant material that can stabilize the banks such as grasses, sedges, willows, cottonwoods, etc. and is influenced by erosion, especially on river right where several alluvial fans constrict the already low flow. There has been overgrazing and heavy anthropogenic activity where the river is accessible (in the non-canyon stretches), leaving an over-wide and shallow channel." (Riverbend Engineering, 2016).	A-

RG17 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



This table shows percent of days the reach's summer and winter flow targets are met in each year type:

RG17	DRY	AVERAGE	WET
Winter	86%	100%	100%
Summer	0%	47%	75%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.
Note: Boating is not permitted from Lobatos Bridge to Lee Trail (New Mexico) from April 1st to May 31st to protect sensitive wildlife breeding areas, including nesting raptors (BLM, 2000).

RG17 Riparian Vegetation

Overall, this site (RGVeg17) appears to be in fair condition, receiving an overall EIA rating of C+ (2.15). A C rating suggests the riparian area has several unfavorable characteristics and management is required to maintain or restore certain ecological attributes. At the time of sampling, the site was being actively grazed at moderate to high intensity. The lowest individual metric ratings it received were for Contiguous Natural Land Cover (C), Land Use Index (C), Width of Natural Buffer (C), Condition of Natural Buffer – Vegetation (C), Native Plant Species Cover (C-), Native Plant Species Composition (D), Vegetation Structure (C), and Coarse and Fine Woody Debris (C) (Table 3.16).

Table 3.16: EIA Scorecard – RGVeg17

RGVeg17 Observer: W. McBride	Wt	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				**2.15**	**C+**
Rank Factor: LANDSCAPE CONTEXT	0.30			**2.32**	**C+**
LANDSCAPE METRICS	0.33			**2.00**	**C+**
L1. Contiguous Natural Land Cover	1	C	2		
L2. Land Use Index	1	C	2		
BUFFER METRICS	0.67			**2.47**	**C+**
B1. Perimeter with Natural Buffer	n/a	B	3		
B2. Width of Natural Buffer	n/a	C	2		
B3.1. Condition of Natural Buffer - Veg	n/a	C	2		
B3.2. Condition of Natural Buffer - Soils	n/a	B	3		
Rank Factor: CONDITION	0.70			**2.08**	**C+**
VEGETATION METRICS	1			**2.08**	**C+**
V1. Native Plant Species Cover	1	C-	1.5		
V2. Invasive Nonnative Plant Species Cover	1	B	3		
V3. Native Plant Species Composition	1	D	1		
V4. Vegetation Structure	1	C	2		
V5. Regen. of Native Woody Species **(opt.)**	1	B	3		
V65. Coarse and Fine Woody Debris **(opt.)**	1	C	2		

Contiguous Natural Land Cover and Width of the Natural Buffer were both impacted by two-tracks that bound the river on both sides. This leaves only approximately 30% of the total 500 m buffer area that is considered to be both natural land cover and contiguous with the AA itself. The active grazing at moderate to heavy intensity on both sides of the AA impacted the Land Use Index rank. The areas immediately adjacent to the riverbanks on both sides were heavily impacted, while rangelands approximately 50 m away from the banks were moderately grazed.

The average relative cover of native species was only 62%, leading to low scores for both Condition of Natural Buffer – Vegetation and Native Plant Species Cover. The nonnative species *Plantago major* had consistently high cover with values of 37.5%, 3.5%, 17.5%, and 7.5% cover for plots 1, 2, 3, and 4, respectively. While no other single nonnative species had consistently high cover, each plot had between 29% to 64% relative cover by nonnative species. The noxious species *Cirsium arvense* was present in plots 2, 3, and 4 (1.5%, 1.5%, and 3.5% cover) with an average cover of 1.6%.

The average mean C-value for native species was 3.8, while the average cover-weighted mean C-value was only 3.3 (Table 3.7). This reveals overall dominance by native species that are highly tolerant of disturbance and commonly found in non-natural areas.

Finally, although *Salix exigua* was present with relatively high cover across three of the plots, the expected cover of fine woody debris was lacking from this site. This appears to be the result of heavy browsing by livestock and native wildlife. Signs of beaver activity were also observed in the area, with a beaver lodge situated approximately 50 m downstream of the AA along the west bank.

Current land uses observed and approximate cover within the 500 m buffer include moderate livestock grazing (83%), heavy livestock grazing (15%), and unpaved roads (2%). A beaver lodge was observed just downstream of the AA. No active beaver observed, but the lodge appears to be in good condition.

Results from the reach-scale RCA assessment indicated mildly impaired riparian areas with a B+ rating. Stressors include floodplain conversion, and nonnative plant species. The average of the EIA and RCA ratings is B.

RG17 Water Quality and Aquatic Life

Water Quality		
Temperature	**Chemical Conditions**	**Nutrients**
A	A	B
Overall Rating		**A-**

Aquatic Life			
Average MMI Score	**Overall MMI Rating**	**Trout (lbs/acre)**	**Trout Rating**
30.6	F+	N/A	N/A
Overall Rating			**F+**

No water quality impairments were identified in this reach however the CDPHE segment from Lobatos Bridge to the New Mexico state line (CORGRG13) is on the M&E list for sediment. Specific sediment standards are not available for the state of Colorado however sediment has and may still be an issue in this reach. Field observations suggest ephemeral tributaries to the mainstem may contribute significant sediment. Water temperature data from the Lobatos Bridge gage showed no daily maximum nor maximum weekly average temperature exceedances from May 2013 to June 2019.

An average MMI score of 30.6 indicated severe impairment to macroinvertebrate communities with an MMI score below the impairment threshold. However, macroinvertebrate and fish data is limited, especially considering the length of this reach.

4. Rio Grande SMP Implementation Strategy

4.1 Rio Grande SMP Goals and Priority Action Items

The vision for implementation of the Rio Grande Stream Management Plan is *to balance diverse ecological, agricultural, cultural, and recreational needs to support a healthy watershed and its sustainable use*. The goals and associated action items and projects listed below are based on community values identified during stakeholder engagement activities and stream condition assessment results. Action items and projects are organized under the primary goal which they will help meet. This implementation strategy was developed with input and support from the Technical Advisory Team (TAT). The TAT recognizes that the projects list below is dynamic. As conditions change, project details may change and new projects will be identified in the future.

*Note: Refer to Table 4.1 for relative costs of priority projects. For action items that may include multiple projects, cost estimates are per site.

Table 4.1: Range of project costs.

Relative Cost	Range
Low	<$10,000
Medium	$10,000 – $100,000
Medium-High	$100,000 – $250,000
High	$250,000 – $1,000,000
Very High	>$1,000,000

Goal A. Improve function and reduce maintenance of irrigation infrastructure, both for water users and river health.	
Target – Fully functioning, low maintenance diversion structures with little or no impairment to river function. Riparian restoration and fish habitat improvements should be considered as part of any improvements.	**Performance Indicators** – Continued monitoring and documentation of infrastructure function.
Justification – The diversion infrastructure assessment identified significant infrastructure improvements needs. Some structures do not function well for water users, and, in some cases, negatively affect stream health and function through sediment transport disruption and/or limiting boat and/or fish passage.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Minor Ditch Improvement Project	Address channel migration and improve the Minor Ditch headgate while maintaining fish and boat passage.	Reach 9	B, C, D, G, and H	Enhanced aquatic habitat and recreational boating opportunities; improved riparian vegetation condition and water quality; bank stabilization.	Medium-High
Ehrowitz Ditch Improvement Project	Install an improved diversion dam capable of delivering water at all flows while maintaining fish and boat passage.	Reach 9	B, C, D, G, and H	Enhanced aquatic habitat and recreational boating opportunities; improved riparian vegetation condition and water quality; improved recreational opportunities; increased sediment transport capacity; bank stabilization.	Medium-High
Rio Grande Splitter Improvement Project	Install an improved diversion structure to divert water effectively and allow for sediment transport. Additionally, the new structure will incorporate fish and boat passage.	Reach 10	B, C, D, F, G, and H	Enhanced aquatic habitat and recreational boating opportunities; improved riparian vegetation condition and water quality; improved recreational opportunities; increased sediment transport capacity; bank stabilization.	Very High

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Monte Vista Canal Improvement Project	Improve the Monte Vista Canal headgate and diversion structure while maintaining existing fish and boat passage.	Reach 11	B, C, D, G, and H	Enhanced aquatic habitat and recreational boating opportunities; improved riparian vegetation condition and water quality; bank stabilization.	High
Billings Ditch Improvement Project	Replace the entire ditch infrastructure, including the headgate and diversion. Implement bank stabilization and riparian revegetation.	Reach 12	B, C, D, F, G, and H	Enhanced aquatic habitat and recreational boating opportunities; improved riparian vegetation condition and water quality; bank stabilization.	Medium-High
Excelsior Ditch Improvement Project	Install an improved diversion dam and automated headgate and implement bank stabilization, floodplain reconnection, riparian revegetation.	Reach 13	B, C, D, F, G, and H	Enhanced aquatic habitat and recreational boating opportunities; improved riparian vegetation condition and water quality; increased sediment transport capacity; bank stabilization.	High
Westside Ditch Improvement Project	Replace the existing diversion dam and create fish and boat passage at this location.	Reach 14	B, C, D, F, G, and H	Enhanced aquatic habitat and recreational boating opportunities; improved riparian vegetation condition and water quality; increased sediment transport capacity; bank stabilization.	High
New Ditch Improvement Project	Implement diversion dam improvements, floodplain reconnection, and riparian revegetation.	Reach 15	B, C, D, F, G, and H	Enhanced aquatic habitat and recreational boating opportunities; improved riparian vegetation condition and water quality; increased sediment transport capacity; bank stabilization.	Medium-High

*Although diversion structures are listed individually, infrastructure improvement projects may be grouped and completed in phases. Irrigation infrastructure projects listed here are top priorities, however improvement needs exist on other structures as well. For a detailed assessment of each diversion structure and its condition, visit this webpage: https://riograndeheadwaters.org/stream-management-plans.

Figure 4.1: Aerial view of the Centennial Ditch diversion (photo: Stuart Penny).

Goal B. Maintain or improve bank and channel stability, especially near important wildlife habitat and critical infrastructure such as homes, diversion structures, roads, and bridges.	
Target – Improved stream function through localized bank stabilization, riparian vegetation reestablishment, sediment transport, and floodplain connection.	**Performance Indicators** – Monitoring of geomorphic condition indicators, including channel morphology, bank stability, and sediment balance.
Justification – Results from the conditions assessment and historic imagery analysis show accelerated erosion and channel instability with impacts on critical infrastructure.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Middle Rio Grande Streambank Stabilization and Riparian Restoration Project	Implement targeted bank stabilization on private riverfront parcels located between South Fork and Monte Vista.	Reaches 9 through 11	A, C, D, E, F, and G	Reduced risk to irrigation infrastructure; improved floodplain connectivity, natural channel processes, riparian vegetation condition, and water quality; enhanced aquatic habitat.	Medium-High
Bank Stabilization Near Dyer Ditch	Bank stabilization and restoration project approximately 1.5 miles upstream of the Rio Grande Canal near the Dyer Ditch point of diversion and Pinos Creek. This project will include bank stabilization structures and riparian restoration to reduce the risk of flooding and damage in the Town of Del Norte and to reduce the risk of channel avulsion, which could result in the river bypassing the Rio Grande Canal diversion.	Reach 9	A, C, D, E, F, and G	Reduced risk to irrigation infrastructure; improved floodplain connectivity, natural channel processes, riparian vegetation condition, and water quality; enhanced aquatic habitat.	Medium
Rio Grande Riparian Stabilization Project – Phase 6	Targeted restoration including channel shaping and the installation of rock barbs and woody root wads to improve aquatic habitat, stabilize streambanks, and reconnect the river to the floodplain and riparian areas. This work will build upon previous phases with the overall goal of the project is to improve the health and resilience of the Rio Grande in Alamosa County.	Reach 13	A, C, D, E, F, and G	Reduced risk to irrigation infrastructure; improved floodplain connectivity and alluvial storage during drought years, natural channel processes, riparian vegetation condition, and water quality; enhanced aquatic habitat.	High

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Lower Rio Grande Streambank Stabilization and Riparian Restoration Project	Targeted bank stabilization and riparian revegetation on the lower Rio Grande downstream of Alamosa. Priority restoration locations were identified in the Rio Grande Natural Area River Condition Assessment (2016).	Reaches 15 through 17	A, C, D, E, F, and G	Reduced risk to irrigation infrastructure; improved floodplain connectivity, natural channel processes, riparian vegetation condition, and water quality; enhanced aquatic habitat.	High
Rio Grande Fish Habitat Improvements	Aquatic habitat restoration, focusing on fish habitat enhancements.	Reaches 9 through 13	A, C, D, E, F, and G	Reduced risk to irrigation infrastructure; improved floodplain connectivity, natural channel processes, riparian vegetation condition, and water quality; enhanced aquatic habitat.	High
Rio Grande Floodplain Restoration	Bank stabilization and floodplain reconnection with a focus on sediment reduction.	Reaches 9 through 15	A, C, D, E, F, and G	Reduced risk to irrigation infrastructure; improved floodplain connectivity and increased alluvial aquifer storage; natural channel processes, riparian vegetation condition, and water quality; enhanced aquatic habitat.	Medium-High
Rio Grande Bank Stabilization Rehabilitation	Repair or replace bank stabilization structures in areas still experiencing erosion.	Reaches 9 through 11	A, C, D, E, F, and G	Reduced risk to irrigation infrastructure; improved floodplain connectivity, natural channel processes, riparian vegetation condition, and water quality; enhanced aquatic habitat.	Medium-High

Goal C. Maintain and improve the function of floodplains, associated alluvial aquifers, and natural channel processes.	
Target – Improved floodplain connection where appropriate. Allow for channel migration where possible.	**Performance Indicators** – Floodplain function allowing for mitigation of flood flows and augmentation of baseflows. Improved riparian areas and geomorphic condition indicators.
Justification – Functional floodplains maintain connection between uplands and river corridors and contribute to alluvial aquifer storage.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Rio Grande Wet Meadow Restoration	Implement targeted wet meadow restoration using temporary wood grade structures (TWGS) and other restoration techniques upstream of Rio Grande Reservoir and on tributaries to the Rio Grande.	Reaches 1 and 2	D, E, and F	Improved riparian vegetation condition and water quality; enhanced aquatic habitat.	Medium
Lower Rio Grande Wetland Restoration	Implement targeted wetland restoration on the lower Rio Grande downstream of Alamosa. Priority restoration locations were identified in the Rio Grande Natural Area River Condition Assessment (2016).	Reaches 15 through 17	D, E, and F	Improved riparian vegetation condition and water quality; enhanced aquatic habitat.	Medium
Rio Grande Wild and Scenic Management	Maintain current Rio Grande National Forest management of Reaches 3 and 7 (Rio Grande Box Canyon and Wagon Wheel Gap to FS Rd 430A) for wild and recreational values. This may include projects to enhance recreational opportunities.	Reaches 3 and 7	H	Improved recreational boating opportunities.	Low (annually)

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Rio Grande Corridor Conservation Easements	Build upon existing efforts to continue acquiring conservation easements on private lands within the active river corridor. Easements can help preserve the ecological integrity of working lands which provide valuable ecosystem services and support stream health.	All	B, D, and E	Easements can help preserve the ecological integrity of working lands which provide valuable ecosystem services and support stream health. As new easements are secured, river corridor protection is expanded, providing substantial natural resources and river health benefits. Benefits may include increased streambank and channel stability, improved riparian vegetation condition, and enhanced alluvial aquifer storage, thereby mitigating impacts of groundwater withdrawal on streamflow depletion.	Variable

Figure 4.2: The Rio Grande overtopping its banks near Creede (reach RG06) and accessing its floodplain, spring 2019.

Goal D. Maintain and improve the extent and condition of riparian areas.	
Target – Riparian areas with diverse species and age classes that contribute to overall stream health and wildlife habitat, including imperiled species.	**Performance Indicators** – Colorado Natural Heritage Program Ecological Integrity Assessment (EIA) score; SLV HCP, riparian area function, in conjunction with floodplain and river channel function.
Justification – Healthy and highly functioning riparian areas are critical to overall stream health. Importantly, intact riparian vegetation provides stream shading and provides a buffer against changes in water temperature. The riparian vegetation assessment noted degraded riparian areas in multiple SMP reaches. Maintaining and improving riparian vegetation will support overall stream health and complements other objectives.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Middle Rio Grande Riparian Revegetation	Implement targeted riparian and floodplain restoration and reconnection projects within Rio Grande and Higel State Wildlife Areas.	Reaches 12 and 13	B, C, and E	Improved floodplain connectivity and bank stability; enhanced alluvial aquifer storage, thereby mitigating impacts of groundwater withdrawal on streamflow depletion.	Medium
Alamosa National Wildlife Refuge River and Riparian Restoration	Implement targeted floodplain reconnection, riparian revegetation, riparian fencing, and water infrastructure improvements to improve riparian and aquatic habitat within the Alamosa National Wildlife Refuge's Rio Grande riparian corridor.	Reach 15	B, C, E, F, and G	Improved water quality, floodplain connectivity and bank stability; enhanced aquatic habitat and alluvial aquifer storage, thereby mitigating impacts of groundwater withdrawal on streamflow depletion.	Medium
Lower Rio Grande Riparian Revegetation	Implement targeted riparian revegetation projects within Rio Grande Natural Area in conjunction with livestock exclosures to protect vegetation from herbivory.	Reaches 15 through 17	B, C, and E	Improved floodplain connectivity and bank stability; enhanced alluvial aquifer storage, thereby mitigating impacts of groundwater withdrawal on streamflow depletion.	Medium

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Rio Grande Riparian Fencing	Promote off-channel water developments (e.g., stock tanks), in conjunction with riparian fencing, to protect riparian areas while still providing adequate water for livestock.	All	B, C, E, F, and G	Improved water quality, floodplain connectivity and bank stability; enhanced aquatic habitat and alluvial aquifer storage, thereby mitigating impacts of groundwater withdrawal on streamflow depletion.	Low
Rio Grande Riparian Habitat Restoration	Implement riparian revegetation, ideally in conjunction with bank stabilization and floodplain reconnection projects. The focus should be on native riparian species restoration, particularly within reaches 15 to 17, and species/habitat protection in reaches 1 through 8.	All	B, C, and E	Improved floodplain connectivity and bank stability; enhanced alluvial aquifer storage, thereby mitigating impacts of groundwater withdrawal on streamflow depletion.	High

Figure 4.3: Riparian vegetation in Coller State Wildlife Area (reach RG08).

Goal E. Work toward aquifer sustainability and mitigate impact of groundwater withdrawal on streamflow depletion.	
Target – Improvements in aquifer sustainability and implementation of projects to minimize impacts of groundwater withdrawal on streamflow.	**Performance Indicators** – Aquifer level monitoring, as required by Division 3 groundwater rules and regulations.
Justification – Groundwater withdrawal has a modeled impact on streamflow, as shown by the Rio Grande Decision Support System model.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Groundwater Management Subdistricts	Continue to support groundwater conservation efforts underway through groundwater management Subdistricts. For the purposes of the Rio Grande SMP, the focus is on the Subdistricts that have modeled impacts on Rio Grande streamflow.	Reaches 8 through 17	C, D, and J	Potentially improved floodplain connectivity and riparian vegetation condition; enhanced aquatic habitat through streamflow augmentation; increased streambank and channel stability; enhanced alluvial aquifer storage, thereby mitigating impacts of groundwater withdrawal on streamflow depletion.	N/A
Groundwater Conservation Easements	Explore and implement additional groundwater conservation strategies, including groundwater conservation easements.	All	C, D, and J	Groundwater conservation easements would help reach sustainable aquifer levels and may improve riparian vegetation condition and water quality.	Variable

Goal F. Maintain or improve water quality, with a focus on mine reclamation projects and compliance with State water quality standards.	
Target – Improve water quality, particularly reducing heavy metal concentrations and temperature exceedance, where feasible.	**Performance Indicators** – Heavy metal concentrations, water temperature, and other standard water quality parameters.
Justification – Excellent water quality is crucial to the health of the Rio Grande. Although there are few water quality concerns, it is recognized that maintaining excellent water quality is critically important for supporting aquatic and river health for all water users.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Rio Grande Heavy Metal Mitigation	Continue and build upon recent efforts to mitigate water quality impairments from the Willow Creek confluence near Creede to the Rio Grande/Alamosa County line. Impairments within this segment include elevated concentrations of arsenic, cadmium, zinc, lead, copper, and manganese. Efforts to reduce the source inputs of these metals, especially within the Willow Creek drainage, will improve water quality.	Reaches 6 through 13	D, and G	Improved riparian vegetation condition; enhanced aquatic habitat conditions.	Medium (annually)
Middle Rio Grande Water Quality Improvement	Implement targeted riparian revegetation and bank restoration to improve water quality, especially temperature and turbidity, through stream shading and sediment reduction.	Reaches 11 through 16	D, and G	Improved riparian vegetation condition; enhanced aquatic habitat conditions.	Medium
Lower Rio Grande Sediment Reduction	Sediment reduction on the Lower Rio Grande within the Rio Grande Natural Area, particularly intermittent tributaries. This may include bank stabilization and small rock check structures, and other low-tech process-based restoration techniques.	Reaches 15 through 17	D, and G	Improved riparian vegetation condition; enhanced aquatic habitat conditions.	Medium

Goal G. Maintain or improve long-term sustainability of Rio Grande fisheries and associated aquatic habitat.	
Target – Protect and build upon Rio Grande fisheries by continuing current management and prioritizing projects that enhance both cold- and warm-water fisheries, including imperiled species.	**Performance Indicators** – Colorado Parks and Wildlife fish surveys, macroinvertebrate MMI scores, water quality monitoring.
Justification – The Rio Grande supports remarkable recreational fisheries, which supports local anglers and outfitters, and bolsters the local economy.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Rio Grande Fall Fish Surveys	Conduct fry shocking in fall to better understand species life stage information.	Reaches 3 through 10	J	This information would improve the life history data for key sport fish species, thereby allowing water managers to more effectively deliver flows to support fisheries.	Low (annually)
Alamosa Levee System Channel Shaping	Implement channel shaping within the Alamosa levee system. Channel shaping will result in the creation of a low-flow channel within the levee system, which will improve fish habitat and extend the recreational boating season by creating a smaller and deeper cross section with pool habitat during low flow conditions. The project would ideally be conducted in conjunction with channel dredging to reduce flood risk and increase channel capacity.	Reach 14	F, H, and K	Improved sediment transport, enhanced sport fishing opportunities, and lower water temperatures and a lengthened recreational boating season as a result of the narrowed, deeper low flow-channel. Potential project benefits are further described in the 2017 Feasibility Study for the Rio Grande Corridor in Alamosa (Riverbend Engineering, 2017).	High
Rio Grande Fish Passage Improvements	Maintain and improve fish passage, particularly at diversion structures, throughout the Rio Grande, with the exception of important nonnative species barriers (as outlined in the diversion infrastructure inventory).	Reaches 8 through 15	A and J	Improved fish passage will allow fish to travel greater distances at lower flows. Additionally, fish passage designs can often include sediment passage capabilities which reduces infrastructure maintenance.	Medium-High

Goal H. Improve infrastructure to support recreational access and use on the Rio Grande.	
Target – Improve current access locations and construct new infrastructure, where appropriate, to enhance recreational opportunities, with a focus on sustainable infrastructure.	**Performance Indicators** – Number of new or improved river access locations; number of people utilizing the river for recreation.
Justification – Recreational access and safety improvements were identified as high priorities for community stakeholders. Opportunities exist to better support recreational activities on the Rio Grande, including fishing access, boat launches/take-outs, signage, and removal of navigational hazards.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Rio Grande Recreational Signage Improvement Project	Install signage to indicate river access locations (for boating and general access) as well as river hazards. If possible, local organizations and state and federal agencies should coordinate to ensure consistency in signage formatting.	Reaches 3 through 17	K	Improved signage will increase recreational use and safety of the Rio Grande, helping to support the local economy and improve recreational opportunities in general.	Low
Rio Grande Recreational Hazards Rectification	Rectify hazards, including low head diversion structures and low bridges, where possible. Antlers Bridge and the Wagon Wheel Gap Railroad Trestle are top priorities.	Reaches 3 through 17	K	Hazard rectification will increase the number of boatable days on the Rio Grande by allowing for boat passage within a wider range of flows. It will also improve safety.	Medium-High
Rio Grande Infrastructural Flow Threshold Identification	Conduct a study to refine existing flow thresholds at major recreational hazards such as low bridges and low head diversion structures. This will involve water height measurements at each hazard location at several discharge levels during spring runoff.	Reaches 3 through 17	K	This study will increase the accuracy of flow thresholds associated with recreational hazards. This information is invaluable to the recreational boating community's understanding of recreational opportunities, including boatable days, on the Rio Grande.	Low
Middle Rio Grande Recreational Infrastructure Improvements	Improve river access in the Town of South Fork. An improved river access point and/or play wave has been considered immediately downstream of the Hwy 149 bridge.	Reach 9	N/A	Improved river access and recreation opportunities.	High

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Revitalize the Rio – Phase 1	A collaborative effort to enhance water-based recreation opportunities for Alamosa residents and visitors. Phase 1 will include the construction of boat ramps and/or river access sites within City of Alamosa reach, creating a contiguous 2.74 mile boatable stretch in the City of Alamosa. Completion of this project in conjunction with the Alamosa Levee Channel Shaping (above) is recommended.	Reach 14	N/A	Improved river access and recreation opportunities.	Medium-High
Lower Rio Grande Recreational Infrastructure Improvements	Recreational access improvements on the Lower Rio Grande downstream of Alamosa. Access points in need of improvement were identified in the Rio Grande Natural Area River Condition Assessment (2016) and include the following locations: County Road Z, Lasauses, Highway 142 Bridge, Lobatos Bridge, and the Colorado state line.	Reach 15 through 17	N/A	Improved river access and recreation opportunities.	Medium-High

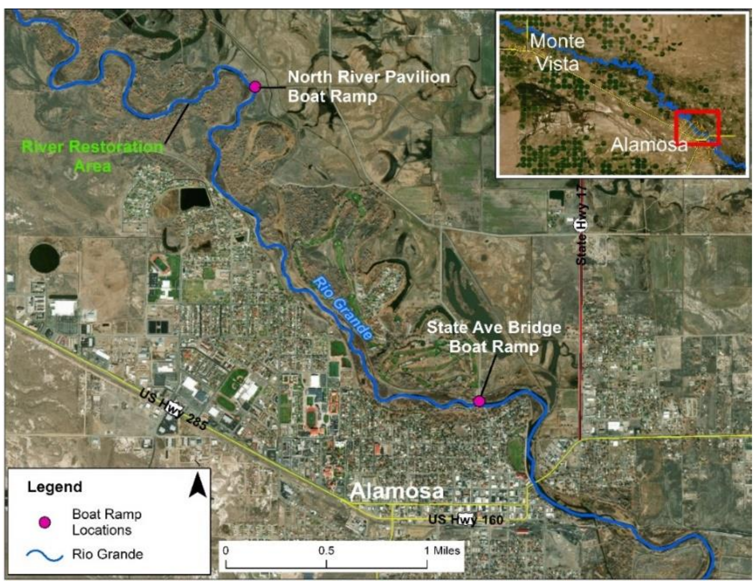


Figure 4.4: Proposed boating and recreational access points included in Revitalize the Rio – Phase 1.

Goal I. Collect additional streamflow data and continue snowpack monitoring to better characterize Rio Grande hydrology and improve streamflow forecasting.	
Target – Strategically install instrumentation and collect additional data to improve available streamflow and snowpack information.	**Performance Indicators** – Additional high-quality streamflow and snowpack data.
Justification – A lack of streamflow data, particularly on tributaries to the Rio Grande, was identified. Additional streamflow data will aid in understanding current hydrology and water management.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Rio Grande Streamflow Data Collection	Install temporary and/or permanent stream gages on the mainstem and select tributaries, including, but not limited to, the Rio Grande at the Mouth of Box Canyon, Rio Grande at Marshall Park, and Clear Creek (tributary to the Rio Grande).	Reaches 3 through 5	G, J, and K	Additional streamflow data will improve water managers' ability to optimize flows to support aquatic habitat and recreational uses.	Medium
Rio Grande Streamflow Forecasting Improvement Project	This project will build upon snowpack and climate measurement tools to improve streamflow forecasting. While forecasting capabilities have greatly improved in recent years, opportunities for improvement remain. In particular, consistent Airborne Snow Observatory snowpack data collection and assimilation into models such as WRF-Hydro will continue to enhance forecasting accuracy. Identification and planning for potential climate impacts such as dust-on-snow events is also recommended.	All	G, J, and K	Streamflow and forecasting information will improve water managers' ability to optimize flows to support aquatic habitat and recreational uses. Improved forecasting will also aid in Rio Grande Compact administration.	Medium (annually)

Figure 4.5: Doppler radar station in Alamosa, CO.

Goal J. Consider flow targets identified in the Aquatic Habitat Needs Assessment in the context of reservoir operations.	
Target – Utilize partnerships and flexible, voluntary agreements among water managers to meet aquatic habitat flow targets, when possible, to improve aquatic habitat.	**Performance Indicators** – Stream gage data to track progress toward aquatic habitat flow targets.
Justification – Meeting aquatic habitat flow targets, where possible, will improve aquatic species habitat while also supporting the local economy.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Rio Grande Aquatic Habitat Flow Restoration	Maintain and build upon efforts of the Rio Grande Cooperative Project (San Luis Valley Irrigation District, Trout Unlimited, SLV Water Conservancy District) and other partnerships in an effort to meet aquatic habitat flow targets.	Reaches 3 through 17	G	This project will support fisheries by providing additional habitat.	Medium (annually)

Goal K. Using guidance from the recreational needs assessment, consider opportunities to maintain or enhance boatable days for recreational uses, especially in the context of reservoir operations and infrastructure updates.	
Target – Utilize partnerships and flexible, voluntary agreements among water managers to meet recreational flow targets, when possible, to enhance river-based recreational opportunities.	**Performance Indicators** – Stream gage data to determine opportunities to meet recreational flow targets in a given water year.
Justification – The quality and opportunity of river-based recreation on the Rio Grande were identified as community values that bolster the local economy.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Relative Cost
Rio Grande Recreational Flow Program	Utilize existing partnerships (e.g., Rio Grande Cooperative Project) to develop a dynamic, flexible, and voluntary program aimed at enhancing boatable days on the Rio Grande.	Reaches 3 through 9; 14 through 17	H	This project will improve recreational use opportunities on the Rio Grande.	Medium (annually)
Climate Change and Rio Grande Recreational Flows	Use the existing Boatable Days tool to determine how climate change may impact recreational use opportunities on the Rio Grande and Conejos River.	Reaches 3 through 9; 14 through 17	H	This project will improve recreational use opportunities on the Rio Grande.	Low
The Rio Grande "Flowcast" Initiative	Develop a consistent communication pathway between reservoir operators, DWR, and water users, especially private and commercial boaters and anglers during the irrigation season. This may be a daily email during the irrigation season.	All	H and I	This communication will improve recreational use opportunities on the Rio Grande. It will also increase awareness and understanding of Rio Grande streamflow regimes by a broader group of stakeholders.	Low (annually)

5. Potential Funding Sources for SMP Implementation

A list of potential funding sources was developed to support implementation of the Rio Grande SMP. This list is intended to be used as a reference and starting point for funding priority projects. It should be noted that there are likely numerous other applicable sources of funding. Table 5.1 lists funding sources and the types of projects expected to be eligible under each source.

Table 5.1: Potential funding sources for priority SMP projects and action items.

Funder	Description of Grant Program(s)	Eligible SMP-Related Projects/Action Items
Bureau of Reclamation (BOR)	BOR administers the WaterSMART program, which houses several grant programs including planning, research, and water efficiency projects.	This program primarily funds infrastructure-related projects to improve water efficiency. Other programs support baseline data collection, basin studies, and watershed planning.
Colorado Department of Public Health and Environment (CDPHE)	CDPHE administers grant funds to address water quality issues, especially projects that address water quality impairments on the 303(d) list.	Restoration or mitigation projects related to water quality. In the event of a Compliance on Consent (COC) order, funds are available for Supplemental Environmental Projects (SEP) that mitigate water quality issues, especially those associated with the COC order.
Colorado Healthy Rivers Fund	This grant program is administered through Colorado Water Conservation Board in association with the Water Quality Control Division and the Colorado Watershed Assembly.	On-the-ground projects "that contribute to cleaner water, healthier wildlife habitat, and improved recreation," including river restoration and riparian re-vegetation.
Colorado Parks and Wildlife (CPW)	CPW's Wetlands and Wildlife Program	Wetlands restoration, including streambank restoration and floodplain reconnection projects. Infrastructure projects that support wetland and/or wildlife habitat.
Colorado Water Conservation Board (CWCB)	There are numerous grant and loan programs administered by the CWCB. Among others, these include the Watershed Restoration, Colorado Water Plan (CWP) grants, and the Water Supply Reserve Fund (WSRF) program.	CWCB grant programs cover a wide range of potential projects, from stream restoration to water infrastructure. Loans are also available for entities such as ditch companies.
Great Outdoors Colorado (GOCO)	GOCO grants fund habitat restoration, land conservation, recreation and outdoor planning, and stewardship.	Boat ramps and other recreation infrastructure. River and wetland restoration and conservation activities, including conservation easements.
National Fish and Wildlife Foundation (NFWF)	NFWF primarily funds wildlife-related projects. The Foundation also has a significant restoration focus.	Stream corridor restoration, especially wildlife-related projects.
Natural Resource Conservation Service (NRCS)	NRCS has several funding programs including the Environmental Quality Incentive Program (EQIP), Targeted Conservation Plan (TCP), National Water Quality Initiative (NWQI), and Regional Conservation Partnership Program (RCPP).	Bank stabilization, diversion and ditch infrastructure improvements, and wildlife habitat enhancement.
RESTORE Colorado Program (Restoration and Stewardship of Outdoor Resources and the Environment)	RESTORE Colorado is a strategic funding partnership between GOCO, NFWF, CWCB, CPW, Gates Family Foundation, and Colorado Department of Natural Resources.	Enhancement and restoration of hydrology and connectivity for native species including aquatic habitat restoration and fish barrier installation/removal. Enhancement and restoration of riparian and wetland habitats, including managing grazing in riparian areas, invasive species removal, and wet meadow restoration.

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7. List of Appendices

The following is a list of SMP appendices. The appendices, which include the recreational use and flow needs assessment conducted by American Whitewater and other background reports used to develop the SMP are available as PDFs at: https://riograndeheadwaters.org/stream-management-plans. The full riparian vegetation and geomorphology reports are also available at this site.

A. **Assessment of Streamflow Needs for Supporting Recreational Water Uses on the Rio Grande and Conejos River**
B. **Channel Migration Analysis**
C. **SMP Tracer Gravel Study**
D. **Stream Classification System Summaries**
E. **Botany Survey and Analysis**
F. **Water Quality and Aquatic Life Data**