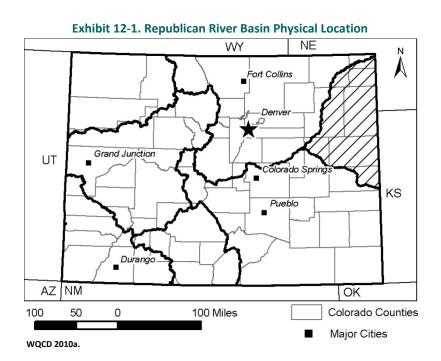
Chapter 12 Republican River Basin Plan (Regulation 38)



Ecoregions (Level IV): ¹	25. High Plains (b-d)	Surface Area: ²	9,404 square miles
	26. Southwestern Tablelands (e)	Stream Length: ³	5,618 miles
Threatened and Endangered	Threatened: 5	Major Land Cover: ²	Grassland and
Species (federal and state): ²	Endangered: 4		Planted/Cultivated
	State Species of Concern: 19		
Counties:	Cheyenne (portion), Elbert	No. of Assessed	2
	(portion), Kit Carson (portion),	Lakes/Reservoirs: ^{4,5}	7,667.83
	Lincoln (portion), Logan	Corresponding Acres:	
	(portion), Phillips, Sedgwick		
	(portion), Washington (portion),		
	Yuma		
Population: ⁶	33,934	No. of Groundwater Aquifers: ²	2
Major Population Centers: ³	Burlington, Holyoke, and Yuma	Approximate No. of Publicly	21
		Owned Treatment Works: ⁷	
Water Quality Planning Regions (in	1 and 5	Known Primary Water Quality	Escherichia coli and selenium
total or in part): ⁸		Stressors: ⁴	
	•	•	

¹ See appendix B for a description of key ecoregional characteristics.

² CWCB 2004 (34% of the South Platte Basin).

³ WQCD 2002.

⁴ WQCC 2010b, WQCD 2010a.

⁵ The number of lakes/reservoirs and the corresponding acres only include the lakes that have been assessed by the Water Quality Control Board and do not reflect all of the lakes/reservoirs present in the basin. ³ CWCB 2010.

⁶ CWCB 2010.

⁷ USEPA 2010a, 2010d; WQCD 2010b.

⁸See exhibit 2-2 in chapter 2 for the names of the Water Quality Planning Regions and counties covered.

This basin chapter and the SWQMP as a whole are primarily water quality documents. They are based on readily available, peer reviewed water quality information, particularly the 2010 Integrated Water Quality Monitoring and Assessment Report (2010 Integrated Report or Clean Water Act (CWA) section 305(b) report).¹ Both the Water Quality Control Commission (WQCC) and the Water Quality Control Division (WQCD) are aware of many other water quality data sources. Organizations and other parties with water quality data are encouraged to get involved in "calls for data" for the biennially completed CWA section 305(b) reports. The data sources that are used in forthcoming CWA section 305(b) reports will subsequently be used in future iterations of the SWQMP. Other key water quality regulations and policies used in the chapter are tabulated in Appendix A.

12.1 System Description

12.1.1 Location and Physical Setting

The Republican River Basin, which encompasses approximately 9,404 square miles, is on the eastern plains of Colorado. The Republican River flows eastward toward Colorado's borders with Nebraska and Kansas. The major tributaries to the Republican River are the Arikaree River, the North Fork of the Republican River, and the South Fork of the Republican River (WQCD 2002). The South Fork of the Republican River originates in Lincoln County and flows east and north, meeting Landsman Creek at Bonny Reservoir before exiting the state into Kansas. The Arikaree River also originates in Lincoln County and flows east and north parallel to the South Fork of the Republican River originates into Kansas south of the Nebraska state line. The North Fork of the Republican River originates in Yuma County and flows eastward, passing through Wray, Colorado, into Nebraska north of the Kansas state line. The Republican River Basin has the smallest population of all the river basins in Colorado. Wray, Burlington, and Holyoke are some of the larger cities in the basin. (CGS 2003, CWCB 2006).

The Republican River Basin is the only river basin in Colorado that does not have its headwaters in the mountains. As a result, elevations in the basin do not vary dramatically and stay between 5,000 and 3,500 feet where the Republican River leaves the state (CGS 2003). A map of the basin showing the Republican River and its major tributaries is provided as exhibit 12-3 (at end of chapter).

12.1.2 Ecology

The boundaries of the Republican River Basin fall within two distinct level III ecoregions (Chapman et al. 2006). Approximately 99.9% of the basin falls within the High Plains Ecoregion, and the remainder falls within the Southwestern Tablelands Ecoregion (exhibit 12-4 at end of chapter). Key characteristics of these and the more specific level IV ecoregions, such as physical characteristics, elevation, land cover, climate, geology, and soil types, are provided in appendix B.

¹ The Integrated Reports are prepared by the WQCD on a biennial basis and are approved by the WQCC as Regulation No. 93: *Colorado's Section 303(d) List of Impaired Waters and Monitoring and Evaluation List*, 5 CCR 1002-93 (WQCC 2010b; WQCD 2010a).

The Republican River Basin contains several endangered and threatened species and several species of state concern, as summarized in exhibit 12-5 (at end of chapter). There are four federally and/or state-listed endangered species (two fish and two bird species) and five federally and/or state-listed threatened species (one fish and four bird species). Finally, Colorado has 19 species of concern in the Republican River Basin (two fish, three amphibian, four reptile, seven birds, and three mammalian species) (CDOW 2010; CWCB 2004).

Exhibit 12-6 (at end of chapter) shows the locations of environmental and recreational uses (i.e., nonconsumptive uses) in the Republican River Basin.² The use categories include environmental focus areas, environmental and recreational focus areas, and recreational focus areas (CWCB 2009). The nonconsumptive uses shown are only meant to provide information on environmental and recreational uses in the basin and not to dictate future actions or impact any water rights (CWCB 2009).

12.1.3 Climate

The Republican River Basin is predominately made up of grasslands and plains that receive little precipitation, averaging 7 to 17 inches annually. Because the terrain is relatively flat and not protected by nearby mountain ranges, winters are often cold and summers can be extremely warm. Daily temperature ranges can also vary dramatically. Exhibit 12-7(at end of chapter) shows a contour (isohyetal) plot of the average annual precipitation throughout the basin (CWCB 2004).

12.1.4 Land Ownership and Land Cover/Use

Most of the land in the Republican River Basin is privately owned (92%). The state of Colorado owns seven percent of the land in the basin, and the federal government owns less than one percent. Exhibit 12-8 (at end of chapter) provides a map of land ownership by basin.

Land cover in the Republican River Basin is shown in exhibit 12-9 at end of chapter and summarized in exhibit 12-10. Grassland and planted/cultivated cropland are the predominant land cover types in the basin, covering approximately 51% and 31% of the basin, respectively.

Land Cover	Basin-wide		Statewide	
Land Cover	Area (sq. miles)	Percent of Total	Area (sq. miles)	Percent of Total
Grassland	4,745	50.5%	41,051	11.6%
Forest	1,146	12.2%	29,577	3.9%
Shrubland	294	3.1%	16,883	1.7%
Planted/cultivated	2,899	30.8%	13,737	21.1%

Exhibit 12-10. Republican River B	Basin ¹ Land Cover Data
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² In 2005, the Colorado legislature established the Water for the 21st Century Act, which established an Interbasin Compact Process that provides a permanent forum for broad-based water discussions in the state. The law created two new structures: the Interbasin Compact Committee (IBCC) and the Basin Roundtables. As part of the IBCC, the Basin Roundtables are required to complete basin-wide needs assessments; an assessment of consumptive water needs and an assessment of nonconsumptive water needs. In 2009, the Colorado Water Conservation Board released a draft report entitled, *Nonconsumptive Needs Assessment Focus Mapping*. The focus mapping described in the report is part of the Basin Roundtables' assessment of nonconsumptive water needs.

	Basin-wide		Statewide	
Land Cover	Area (sq. miles)	Percent of Total	Area (sq. miles)	Percent of Total
Barren	30	0.3%	1,219	2.5%
Wetland	6	0.1%	80	7.7%
Open water	84	0.9%	590	14.2%
Developed	199	2.1%	923	21.6%
TOTAL	9,403		104,067	

¹ Source: CWCB 2004. The CWCB South Platte River boundaries are different from the SWQMP boundaries. Land cover for the SWQMP Republican River Basin is equivalent to 34% of the CWCB South Platte River Basin.

12.1.5 Demographic and Socioeconomic Conditions

The population in the Republican River Basin is projected to increase by about 39 percent between 2009 and 2050 under medium economic growth assumptions, from 33,934 to 47,206. Logan County is projected to account for much of the population growth in the basin. Population will remain relatively flat in Yuma, Washington, Sedgewick, Pitkin, Lincoln, and Cheyenne counties during the same period. Exhibit 12-11 (at end of chapter) shows the population projections for the basin.

As shown in exhibit 12-12, regional and national service jobs constituted the largest portion of basic sector employment in 2007, followed by household basic jobs and government jobs. Household basic jobs are expected to grow more than jobs in any other sector between 2007 and 2050. Total jobs in the basin are expected to increase 65% between 2007 and 2050 (CWCB 2010).

Sector	2007	2050
Agribusiness Jobs	697	885
% of Total Jobs	3.3%	2.6%
Total % Growth	N/A	27.0%
Mining Jobs	155	184
% of Total Jobs	0.7%	0.5%
Total % Growth	N/A	18.7%
Manufacturing Jobs	748	1,013
% of Total Jobs	3.6%	2.9%
Total % Growth	N/A	35.4%
Government Jobs	1,237	1,491
% of Total Jobs	5.9%	4.3%
Total % Growth	N/A	20.5%
Regional/National Service Jobs	3,841	6,942
% of Total Jobs	18.4%	20.2%
Total % Growth	N/A	80.7%
Tourism Jobs	987	1,802
% of Total Jobs	4.7%	5.2%
Total % Growth	N/A	82.6%
Household Basic Jobs	1,605	4,405
% of Total Jobs	7.7%	12.8%
Total % Growth	N/A	174.5%

Exhibit 12-12. 2050 Employment Projections¹ for the Republican River Basin, Medium-Growth Scenario

Sector	2007	2050
Total Basic Jobs	9,280	16,722
% of Total Jobs	44.5%	48.6%
Total % Growth	N/A	80.2%
Resident Service Jobs	11,563	17,671
% of Total Jobs	55.5%	51.4%
Total % Growth	N/A	52.8%
Total Jobs	20,834	34,393
% of Total Jobs	100.00%	100.00%
Total % Growth	N/A	65.1%

¹The CWCB South Platte River Basin boundaries include the entirety of the SWQMP Republican River Basin boundaries. Employment data for the SWQMP Republican River Basin was estimated by using the CWCB population estimates for the Republican River Basin (approximately 1% of the CWCB South Platte Basin total population) to estimate Republican River Basin employment projections. Source: CWCB 2010.

12.1.6 Water Withdrawals

Water quantity and quality issues are intertwined, particularly in arid western states where water can be scarce (CFWE 2003). Water quantity issues tend to be more contentious than quality issues. Water rights are protected under Colorado's constitution and several state statutes, including the Colorado Water Quality Control Act. Colorado water law establishes water use rights for a variety of purposes including farming, drinking, manufacturing, recreation, protection of the environment, and all of the use categories listed in exhibit 12-13 below (CFWE 2003). Public and private entities involved in watershed protection in Colorado have grown to appreciate that the two worlds of water quality and quantity are inexplicably linked and are working together more frequently to combat water quality/quantity problems.

In 2005, the U.S. Geological Survey (USGS), in cooperation with the Colorado Water Conservation Board (CWCB), estimated total surface water and groundwater use in the Republican River Basin to be approximately 1,019.35 million gallons per day (Mgal/d). Use was estimated for the following categories: irrigation for crops, irrigation for golf courses, public supply, domestic, industrial, livestock, mining, and thermoelectric.³ Exhibit 12-13 shows the total water withdrawals in the basin and the state as a whole for these categories. The predominant uses of water in the basin were for agriculture at 1,008.29 Mgal/d (99%), followed by public supply at 6.92 Mgal/d (0.68%).

³ The term "public supply" refers to "community water systems" as that term is defined under the federal Safe Drinking Water Act. Community water systems (CWSs) are any water system that serves drinking water to at least 25 people for at least 60 days of the calendar year or has at least 15 service connections. In addition to providing water to domestic customers, CWSs also deliver water to commercial, industrial, and thermoelectric power users. The term "domestic" refers to the portion of the population not served by a "public supply" (USGS 2010).

	Withdrawals by Use Category		
Use Category	Withdrawals (Mgal/d) (percent of total basin withdrawals)	Total Withdrawals All of Colorado (Mgal/d)	Withdrawals in Republican River Basin as Percent of Total Withdrawals in State
Agriculture (crop irrigation & livestock)	1,008.29 (98.92%)	12,354.91	8.16%
Irrigation (golf course)	0.79 (0.08%)	40.64	1.93%
Public Supply ²	6.92 (0.68%)	864.17	0.80%
Domestic ³	2.22 (0.22%)	34.43	6.44%
Industrial	0.01 (0%)	142.44	0.01%
Mining	1.11 (0.11%)	21.42	5.18%
Thermoelectric	0.01 (0%)	123.21	0.01%
Totals	1,019.35 (or 1,142.68 thousand acre-feet per year)	13,581.22 (or 15,224.55 thousand acre-feet per year)	7.51%

Exhibit 12-13. Republican River Basin Total Water Withdrawals¹ in Colorado, 2005

¹ The CWCB South Platte River Basin boundaries include the entirety of the SWQMP Republican River Basin boundaries. Water withdrawal data for the SWQMP Republican River Basin was estimated assuming 34% of the CWCB South Platte River Basin water withdrawal is attributable to the Republican River.

² The term "public supply" is water supplied by a publicly or privately owned water system for public distribution, sometimes also known as a "municipal-supply system" or "community water system" (CWS). Any water system that serves drinking water to at least 25 people for at least 60 days of the calendar year or has at least 15 service connections is considered a public supply system. In addition to providing water to domestic customers, CWSs also deliver water to commercial, industrial, and thermoelectric power users (USGS 2010).

³ The term "domestic" refers to water used for household purposes, such as washing clothes, cleaning dishes, drinking, food preparation, bathing, flushing toilets, and watering lawns and gardens that are not served by public-supply systems (USGS 2010). Source: USGS 2010.

The CWCB recently completed a projection of municipal and industrial (M&I) surface water use needs to the year 2050 for the state.⁴ The projections will provide relevant parties in the state with a basis for discussing and addressing the state's future M&I water needs. In this report, the CWCB estimated M&I water demand in the Republican River Basin to be at 9,038 acre-feet per year (AFY) (8.1 Mgal/day) in 2008 and at 11,840 AFY (10.6 Mgal/day) for 2050 under medium economic growth assumptions. The water demands are projected to be 11,133 AFY (9.9 Mgal/day), under medium growth assumptions, if passive conservation is employed (CWCB 2010).⁵

M&I water needs in the Republican River Basin are expected to be nearly 0.3 times higher than 2008 levels by the year 2050. The counties with the highest forecasted M&I water demands in the Republican River Basin are Kit Carson, Phillips, and Yuma counties (CWCB 2010).

⁴ In 2003, the Colorado General Assembly authorized the CWCB to implement the Statewide Water Supply Initiative (SWSI), an 18-month basin-by-basin investigation of the state's existing and future water needs. As part of that effort, the CWCB assembled water users (farmers, ranchers, municipalities, industrial users, recreationalists, and environmentalists) to plan for the future. That effort resulted in the completion of the *Statewide Water Supply Initiative* Phase I Report in November 2004 and a Phase II report in November 2007. Both reports focus on all water uses, not just M&I. Since that time, the CWCB has undertaken another investigation to project M&I surface water use needs to the year 2050 for the state. The result of that investigation is reported in the document *State of Colorado 2050 Municipal and Industrial Water Use Projections*, dated July 2010. The report is part of the Basin Roundtables' assessment of consumptive water needs in the state as required by the Water for the 21st Century Act, which was passed by the Colorado legislature in 2005.

⁵ Passive conservation accounts for retrofits of existing housing and commercial construction with high-efficiency toilets, clothes washers, dishwashers, and the like as the baseline efficiency standards established under the 1992 National Energy Policy Act are implemented (CWCB 2010).

Self-supplied industrial (SSI) water uses is so minimal that self-supplied industrial water needs for the Republican River Basin have not been calculated (CWCB 2010).

12.1.7 Hydrography and Hydrology

12.1.7.1 Surface Geology

The majority of the Republican River Basin is located over the Ogallala Formation. The Ogallala Formation is made up of Miocene aged unconsolidated and semi-consolidated sands, gravels, clays, and silts. Deposits of sediment from Rocky Mountain alluvial fans are also present in the Republican River Basin. Calcium carbonate caliche (cementaceous calcium carbonate mortar) beds are common in the streams. Quaternary-age alluvial, valley-fill, dune sand, and loess also characterize the Ogallala Formation and the Republican Basin (CGS 2003). It should also be noted that soils derived from the various shallow geologies and deposited materials are a prime consideration in water quality planning.⁶

12.1.7.2 Surface Water

The Republican River Basin has some of the lowest annual flows leaving the state, with historical average annual flows at around 47,600 AFY, accounting for less than 5% of the flows leaving the state. A large portion of the Republican River Basin sits atop the Ogallala Formation and High Plains Aquifer. As a result, groundwater is an important water source for municipalities and agricultural facilities in the basin (WQCD 2002).

To monitor stream flow, numerous USGS stream flow gauges are maintained across the state of Colorado. The CWCB selected gauges to summarize historical flows in various basins across a broad spatial scale; however, no gauges were selected in the Republican River Basin. Exhibit 12-14 (at end of chapter) shows major surface water diversions and segments with decreased instream flow in the Republican River Basin.

In addition, it should be noted that snowpack can have significant impacts and can cause variations in surface water quality and quantity on an annual basis. The Natural Resources Conservation Service (NRCS) Snow Survey Program provides mountain snowpack data and streamflow forecasts for the western United States. Common applications of snow survey data include water supply management, flood control, climate modeling, recreation, and conservation planning. Additional information on the NRCS snow survey program can be found at http://www.co.nrcs.usda.gov/snow/.

12.1.7.3 Groundwater

Groundwater in the Republican River Basin is predominately located within the following three aquifers: (1) Alluvial, (2) Bedrock, and (3) Designated Basins. Exhibit 12-15 (at end of chapter)

⁶ Soil variations occur on a local and regional scale and should be taken into consideration when addressing water quality problems. Information on soil conditions can be found through the Natural Resources Conservation Service (NRCS) Web Soil Survey at <u>http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm</u>. The website can be used to access soil maps and soil descriptions, interpretations, and characteristics. The information can be used at a relatively broad scale as well as on a site-specific basis.

shows these aquifers. Also shown is the location of wells in the Republican River Basin with a permitted or decreed yield of 500 gallons per minute (gpm) or higher (CGS 2003).

Saturated alluvial deposits form the most productive aquifers, with yields ranging from less than 50 gpm to over 1,000 gpm. Most wells have yields between 250 and 950 gpm. Approximately 60% of the wells have productions less than 55 gpm, while 7% of the wells produce over 1,000 gpm. The highest yields occur over the Ogallala Aquifer. Most groundwater use in the basin is for agricultural application, but groundwater is also used for municipal supply, individual domestic supply, and livestock wells throughout the basin (CGS 2003).

12.2 Water Quality Classifications and Standards

12.2.1 Surface Water

12.2.1.1 Use Classifications

The Republican River Basin contains a total of eight waterbody segments covering approximately 5,655 stream miles, as shown in a map in exhibit 12-16 (at end of chapter). The WQCC has specified the classified uses for each of these segments in Regulation No. 38: *Classifications and Numeric Standards for the South Platte River Basin, Laramie River Basin, Republican River Basin, and Smoky Hill River Basin* (5 CCR 1002-38) (WQCC 2010a). The uses are summarized in exhibits 12-17 and 12-18 (at end of chapter). The WQCC has classified all the segments in the Republican River Basin as suitable for agriculture, followed by water supply and existing recreation (each at 63%), aquatic life warm 2 (50%), aquatic life warm water 1 (38%), not suitable for recreation (25%), aquatic life cold water 1 (13%), and undetermined recreation (13%). The stream miles associated with these uses are shown in exhibit 12-19.

Classified Uses	Number of Streams	Stream Miles	Percent of Total Stream Miles (n=5,655.10 miles)
Agriculture	8	5,655.10	100%
Aquatic Life Warm 2	4	5,501.20	97%
Not Suitable for Recreation	2	5,483.80	97%
Existing Recreational Uses	5	171.30	3%
Aquatic Life Warm 1	3	107.90	2%
Water Supply	5	83.70	1%
Aquatic Life Cold 1	1	46.00	1%
Undetermined Recreational Uses	1	01	
Aquatic Life Cold 2	0	0	
Potential Recreational Uses	0	0	
Total Streams	8	5,655.10	

Exhibit 12-19. Number of Streams and Stream Miles by Classified Use

¹ Lake-only segment is listed as having undetermined recreational uses. Source: WQCC 2010a. In its latest assessment cycle, the WQCD presented information for a total of two lakes in the Republican River Basin, covering 7,667.83 acres.⁷ Exhibit 12-20 shows the classified uses for each of these lakes/reservoirs and the corresponding lake acres.

Classified Uses	Number of Lakes	Lake Acres	Percent of Total Lake Acres (n=7,667.83 acres)
Agriculture	2	7,667.83	100%
Water Supply	2	7667.83	100%
Aquatic Life Warm 2	1	5,821.20	76%
Undetermined Recreational Uses	1	5,821.20	76%
Existing Recreational Uses	1	1,846.63	24%
Aquatic Life Warm 1	1	1,846.63	24%
Aquatic Life Cold 1	0	0	
Potential Recreational Uses	0	0	
Not Suitable for Recreation	0	0	
Aquatic Life Cold 2	0	0	
Total Lakes:	2	7,667.83	

Source: WQCC 2010a.

12.2.1.2 Designations

As further shown in exhibits 12-17 and 12-18 (at end of chapter), the WQCC has designated two waterbody segments in the Republican River Basin as *Use Protected*. It has not designated any waterbody segments in the basin as *Outstanding Waters*. The meaning of these two designations is provided in section 2.2.3.1 of chapter 2, "Water Quality Planning and Management in Colorado."

12.2.1.3 Standards

Numeric standards for the Republican River Basin are provided in the "Stream Classifications and Water Quality Standards" tables attached to Regulation No. 38. Because new standards are often developed and existing standards are periodically revised, the standards are not summarized here. Readers should consult the actual regulations for specific details; they are available at http://www.cdphe.state.co.us/regulations/wqccregs.

⁷ Lakes are presented in WQCC's surface water quality classifications and standards regulations in several ways. A lake may be present alone as its own segment, as a combination of several lakes grouped into a segment, or as part of a segment that includes streams, lakes, and wetlands. The WQCD presented only those lakes/reservoirs it assessed during its latest monitoring cycle in appendix B of the 2010 Integrated Report. The entire universe of lakes/reservoirs in the state is not explicitly denoted in the WQCC regulations, nor are the lakes/reservoirs fully denoted in WQCD's biennial Integrated Reports. Each biennial cycle, the WQCD assesses and presents information for only a subset of lakes/reservoirs in the state.

12.2.2 Lakes

12.2.2.1 Trophic Status

From July 2007 to July 2009 the WQCD monitored a total of 50 lakes and reservoirs across the state to evaluate their trophic status and to assess whether they were attaining their respective water quality standards. Of the 50 lakes and reservoirs assessed, none are in the Republican River Basin.

12.2.2.2 Fish Tissue Studies

As part of its overall monitoring efforts, the WQCD also investigates fish tissues for the presence of contaminants that can be harmful to humans if ingested. The WQCD uses the monitoring data to issue fish consumption advisories (FCAs) to the public as warranted. During the period July 2007 to July 2009, the WQCD evaluated fish tissues from more than 112 waterbodies for mercury, selenium and arsenic. None were assessed in the Republican River Basin. The WQCD has also not issued any FCAs for waterbodies in the Republican River Basin.

The WQCD chose to test for the presence of mercury, selenium, and arsenic in fish tissue because of the harmful human health effects that might occur if these parameters are ingested. In particular, mercury adversely impacts wildlife and humans, especially children and women of childbearing age. It is also the leading cause of impairment in the nation's estuaries and lakes. Mercury was cited in nearly 80% of FCAs reported by the states in the 2000 National Listing of Fish and Wildlife Advisories. Although arsenic generally bio-accumulates in fish in its less toxic organic form, human exposure is still harmful. The U.S. Department of Health and Human Services (DHHS) has determined that arsenic is a known carcinogen, and human exposure may occur by ingesting water, soil, or air contaminated by the substance. Selenium is an essential dietary element that prevents damage to tissues by oxygen. However, when consumed in amounts higher than the recommended daily allowance, it is toxic to both humans and animals, and excessive ingestion or exposure should be minimized (WQCD 2005).

Any waterbody that is issued an FCA is listed on the state's CWA section 303(d) list of impaired waters with aquatic life impairment. Total maximum daily loads (TMDLs) must be completed for all impairments.

12.2.3 Wetlands

A map of Republican River Basin wetlands is included as exhibit 12-21 (at end of chapter). The wetlands are those included in the U.S. Fish and Wildlife Service's (USFWS's) National Wetlands Inventory, the database the USFWS uses to periodically report to Congress on the status and trends of the nation's wetlands. Colorado's Natural Heritage Program and other entities are involved in more fully identifying and characterizing Colorado's wetlands. This information will be added when completed to future iterations of the SWQMP.

At the state level, the Republican River Basin lies within the northern portion of an area supported by the Colorado Division of Wildlife's (CDOW's) Prairie Focus Area Committee.⁸ The Committee has identified the wetland types within the Prairie Wetland Focus Area using the Colorado National Heritage Program's *Statewide Wetlands Classification and Characterization Final Report*. These wetland types, which are listed in exhibit 12-22, are generally distinguished by vegetation and soil types. The Committee's conservation concerns for the wetland types are also noted in the exhibit.

Wetland Type	Conservation Concerns
Submerged Aquatic Wetland	To be determined
Emergent Marsh	To be determined
Wet Meadow	To be determined
Riverine Wetlands/Riparian Areas	Loss or change of hydrology, fragmentation of corridors, invasion of exotic species, and lack of cottonwood regeneration
Warm Water Seeps, Springs, and Sloughs	Hydrologic alteration as a result of water development causing sloughs to become choked with silt and vegetation, thus diminishing habitat value
Playa Lakes	Sedimentation, pesticide and fertilizer runoff, excess nutrients and/or contaminants from feedlot effluent, oil field water dumping, altered grazing, hydrologic alterations, and water use regimes
Artificial Wetlands and Shallow-water Impoundments	Trampling of food plants desirable to birds and high water turbidity

Source: Prairie and Wetlands Focus Area Committee 2004.

12.2.4 Groundwater

12.2.4.1 Interim Narrative Standard

The Interim Narrative Standard found in section 41.5(C)(6)(b)(i) of Regulation No. 41: *The Basic Standards for Groundwater* (5 CCR 1002-41) (WQCC 2009) is applicable to all groundwater for which the WQCC has not already assigned standards, with the exception of those groundwaters where the total dissolved solids (TDS) are equal to or exceed 10,000 milligrams per liter (mg/L). The Interim Narrative Standard is independent of and in addition to the statewide groundwater standards for radioactive materials and organic pollutants.

Until such time as use classifications and numeric standards are adopted for groundwater on a site-specific basis, the following standards apply for each parameter at whichever of the following levels is the least restrictive:

• Existing ambient quality as of January 31, 1994, or

⁸ The CDOW created the Wetlands Wildlife Conservation Program (WWCP) to focus on preserving, restoring, enhancing, and creating wetlands throughout the state. This program focuses on (1) protecting the role of wetlands in Colorado as important feeding, breeding, migratory, and brooding habitat for water birds, and (2) providing recreational uses, such as hunting, fishing, and bird watching, through wetlands (CDOW 2008). The CDOW has created 11 focus area committees under the WWCP. The committees provide a mechanism through which conservationists can share information on local wetlands, discuss wetland needs, and generate ideas for wetland protection and restoration projects.

• That quality which meets the most stringent criteria set forth in tables 1 through 4 of Regulation No. 41: *The Basic Standards for Groundwater*.

The four tables from Regulation No. 41: *The Basic Standards for Groundwater* can be viewed online at <u>http://www.cdphe.state.co.us/regulations/wqccregs</u> for the following classified uses: Table 1: Domestic Water Supply - Human Health Standards; Table 2: Domestic Water Supply - Drinking Water Standards; Table 3: Agricultural Standards; and Table 4: Total Dissolved Solids Water Quality Standards.

12.2.4.2 Site-Specific Classifications and Standards

The WQCC has established six site-specific groundwater classifications for the Republican River Basin, as summarized in exhibit 12-23. Exhibits 12-24 through 12-30 (at end of chapter) illustrate the classified areas.⁹ These exhibits are cross-referenced in exhibit 12-23.

Site	Specified Area ^{1,2} Classifications for Confined and Unconfined Groundwater		Are Groundwater Quality Standards in Tables 1–4 Applicable? ³	
Republican River Basin				
City of Burlington Wellfield, Kit Carson County	See exhibit 12-24	Domestic Use Quality and Agricultural Use Quality	Yes	
City of Wray Wellfield, Yuma County	See exhibit 12-25	Domestic Use Quality and Agricultural Use Quality	Yes	
City of Yuma Wellfield, Yuma County	See exhibit 12-26	See exhibit 12-26 See exhibit 12-26 Agricultural Use Quality		
Southwest Protection Area, Kit Carson County	See exhibit 12-27	Domestic Use Quality and Agricultural Use Quality	Yes	
Town of Eckley Wellfield, Yuma County	See exhibit 12-28	Domestic Use Quality and Agricultural Use Quality	Yes	
Oil and Gas Field of Cheyenne County and Kit Carson County	See exhibits 12-29 and 12-30	Limited Use and Quality	No	

Exhibit 12-23. Site-Specific Groundwater Classifications and Standards in the Republican River Basin

¹Specified areas pertain to confined and unconfined groundwaters within the saturated zones.

² Maps displayed in these exhibits are pulled directly from Regulation No. 42: *Site-Specific Water Quality Classification and Standards for Ground Water* (WQCC 2006b).

³ The groundwater quality standards included in tables 1 to 4 of Regulation No. 41: *The Basic Standards for Groundwater* are assigned to all confined and unconfined groundwater in the specified area.

Source: WQCC 2006b.

12.2.4.3 Groundwater Quality

Aquifers located within the Republican and South Platte basins are shown on exhibit 12-15 (at end of chapter), which also shows wells with permitted or decreed capacities greater than or equal to 500 gpm. The Republican River Basin is separate and distinct from the South Platte Basin (CWCB 2004).

Alluvial Aquifers

Alluvial aquifers in the Republican River Basin include those associated with Frenchman Creek; the North Fork of the Republican River; the Arikaree River; and the South Fork of the Republican River and its tributary, Landsman Creek. The alluvial deposits consist of poorly

⁹ Maps displayed in these exhibits are pulled directly from Regulation No. 42: *Site-Specific Water Quality Classification and Standards for Ground Water* (WQCC 2006b).

sorted gravel, sand, and clay with caliche, Aeolian (wind-blown) sand deposits and silt cover much of the land surface outside the stream valleys and overlap the alluvial deposits. Near the state line, the alluvial aquifer of Frenchman Creek has a thickness of 65 feet and is hydraulically connected to the High Plains Aquifer (Ogallala Formation) (CGS 2003). See the exhibit at end of chapter 3 for map showing the distribution of alluvial deposits in Colorado.

Most of the alluvial wells are on the South Fork of the Republican River at depths greater than 40 feet. The overwhelming use of groundwater in the basin is for agricultural applications. Alluvial groundwater is also used for municipal supply. The City of Wray has used alluvial groundwater from the North Fork of the Republican River to supply a population of 2,083, while the City of Holyoke supplies a population of 2,900 from the alluvium of Frenchman Creek (CGS 2003).

High Plains Aquifer

The High Plains Aquifer, which includes the Ogallala Formation, is in the Republican River Basin along the eastern edge of Colorado. It is a major source of water for this agricultural region and other Great Plains states, extending from South Dakota on the north to Texas and New Mexico on the south, and occupying a total area of 174,000 square miles. The High Plains Aquifer supplies irrigation water for approximately 20% of the irrigated cropland in the United States (CGS 2003). See the exhibit at end of chapter 3 for map showing the Colorado's major sedimentary rock aquifers and aquifer systems.

The High Plains Aquifer is a *Designated Groundwater Basin*, subject to the jurisdiction of the Colorado Ground Water Commission. Designated Groundwater Basins are areas within the eastern plains with very little surface water, where users rely primarily on groundwater as their source of water supply. They are areas in which the use of groundwater is assumed not to impact the major surface water basin, to which the designated basin would otherwise be tributary. Designated groundwater basins are usually considered non-tributary, or at least not adjacent to major streams and rivers (CGS 2003).

The High Plains Aquifer is composed principally of the unconsolidated to semi-consolidated sands, gravels, clays and silts of the Ogallala Formation. Eastern Colorado contains the western edge of the Ogallala Formation. The Ogallala is the most significant hydrologic unit in the region, and it provides the bulk of the groundwater resource within the High Plains Aquifer. Streams that flowed eastward across the alluvial fans fronting the Rocky Mountains deposited the sediments of the Ogallala during the late Tertiary Period. Dune sand and windblown loess deposits of more recent origin are also considered part of the High Plains Aquifer where they are hydraulically connected to the Ogallala Formation (CGS 2003).

The primary source of recharge to the High Plains Aquifer is infiltration of precipitation in the form of rain and snow. Recharge is limited, however, by the low precipitation and high evaporation rates that are common on the eastern plains. Discharge exceeds recharge in the aquifer largely due to well pumping for agricultural purposes. Groundwater extraction for agriculture was approximately 1 million acre-feet in 1979 and is undoubtedly greater now. There were 15,600 wells of record in the Colorado portion of the High Plains Aquifer as of February 2001 (CGS 2003).

Water from the High Plains Aquifer is generally of good quality and is classified as a calcium bicarbonate type. The TDS concentrations range from 100 to 600 mg/L, except in localized hotspots where concentrations can exceed 1,000 mg/L. The TDS levels have been rising noticeably during the past 30 years. Prior to 1980, the bulk of the aquifer had TDS levels lower than 250 mg/L. Now there are no such areas. Most areas, however, still record concentrations lower than the state and federal secondary drinking water standard of 500 mg/L. The most significant increases in TDS concentration are associated with valley fill areas and might be the result of agricultural irrigation recharge and evaporative concentration (CGS 2003).

Hardness is moderate in the High Plains Aquifer, ranging from 100 to 350 mg/L. Ongoing water quality studies indicate that nitrate concentrations have also increased significantly since 1980 (CGS 2003).

The WQCD's groundwater protection program has carried out groundwater monitoring activities focused on agricultural chemicals such as fertilizers and pesticides over the past 18 years. This work is performed in conjunction with the Colorado Department of Agriculture and the Colorado State University Cooperative Extension Service. In 2008, the program contracted the services and expertise of the USGS to assist with the siting, installation, and sampling of 20 new monitoring wells within the center section of the Ogallala Formation. Only areas of irrigated agriculture were selected. The network of 20 wells was sampled in November 2008, and all samples were analyzed for over 100 pesticide active ingredients, nitrate- and nitrite-nitrogen, basic inorganic nutrients, and dissolved metals. Exhibit 12-31 (at end of chapter) shows the spatial distribution of the 20 monitoring wells (WQCD 2010a).

USGS is completing a thorough report, which will provide detailed data acquired during well development activities and sampling results and analysis. The last sampling event for the High Plains aquifer extended from 1997 to 1998 and was conducted primarily with domestic, irrigation, and municipal wells (WQCD 2010a).

12.3 Surface Water Quality Stressors and Sources

This section of the Republican River Basin Plan summarizes data provided in the 2010 Integrated Report developed by the WQCD and approved by the WQCC. It is important to note that the data on water quality impairments and pollutant sources, as well as segments listed for further monitoring and evaluation, are based on information that is available to WQCD today. Moreover, the data are limited to those parameters for which assessments are performed.

12.3.1 Impairments

As shown in exhibit 12-32 (at end of chapter), the WQCD identified one waterbody impairment for the Republican River Basin in the 2010 Integrated Report. The impaired segment is the mainstem of the Arikaree River from the confluence of the North and South Forks to the Kansas border (segment COSPRE04). *Escherichia coli* (*E. coli*) is the cause of the impairment. The impaired segment constitutes 13% of all stream segments in the basin and 2% of total stream miles. A map of the impairments is provided as exhibit 12-33 (at end of chapter).

12.3.2 Segments Listed for Further Monitoring and Evaluation

During each monitoring cycle, the WQCD typically identifies parameters with elevated concentrations in some segments within a basin. The sample results or other factors are such that the Division is unable to make a determination as to whether the classified use in question is being attained. These segments are subsequently placed on the state's Monitoring and Evaluation (M&E) List. In its latest monitoring cycle, the WQCD identified elevated concentrations of *E. coli* and selenium in one of the basin's eight segments (13%). The affected segment is from the mainstem of the Black Wolf Creek from the source to the confluence with the Arikaree River (COSPRE05). See exhibit 12-34 (at end of chapter) for details.

12.3.3 Known Sources of Stressors

Exhibit 12-35 provides a synopsis of the identified sources of stressors to the Republican River Basin based on parameters causing impairments per the 2010 Integrated Report. Note that similar but even more detailed information is provided in exhibits 12-32 (at end of chapter). The Republican River Basin has one impaired waterbody segment that requires the development of a TMDL. *E.coli* is the pollutant causing the impairment with the source category listed as "not assessed."

Exhibit 12-35. Republican River Basin, Summary of Stressors for Impaired Waterbodies¹

Sub-Basin and Watershed	Number of Impaired Segments	Impairment	Number of Affected Segments	Source of Pollutants	Number of Affected Segments	Segn Priorit	ber of Affo nents by T ty Develop Status	MDL oment
						Low	Med	High
Republican River Basin								
Republican River 1	E. coli	1	Not Assessed ²	1	0	0	1	
	1	Total	1	Total No. TMDLs	1	0	0	1

¹ The term "waterbodies" is used because the regulations identify some segments as containing streams, lakes, wetlands, or some combination thereof. In other instances, the regulations identify some segments as "lake-only." In this exhibit, all relevant segments are shown.

² Not Assessed" indicates that if a single designated use is not assessed within the segment, then the whole segment is entered into the EPA Assessment Database as not assessed.

12.4 TMDLs as Water Protection Strategies

12.4.1 TMDL Basics

As noted previously in chapter 2, "Water Quality Management and Planning in Colorado," CWA section 303(d) requires states to periodically submit to EPA a list of waterbodies that are impaired, meaning that the segment is not meeting the standards for its assigned use classification. The list of impaired waterbodies is referred to as the CWA section 303(d) list. The WQCD prepares the list in conjunction with its biennial Integrated Reports. The WQCC approves and adopts the list as Regulation No. 93: *Colorado's Section 303(d) List of Impaired Waters and Monitoring and Evaluation List* (5 CCR 1002-93) (WQCC 2010b).

TMDLs must be developed for waterbodies on the CWA section 303(d) list. A TMDL is the maximum amount of a pollutant that a waterbody can receive and still maintain water quality standards. The TMDL is the sum of the waste load allocation (WLA), which is the load from point source

TMDL Equation

TMDL = WLA + LA + MOS

discharges; the load allocation (LA), which is the load attributed to natural background and/or nonpoint sources; and a margin of safety (MOS).

An important aspect of the TMDL development process includes the identification of the sources of pollutants causing impairments in the waterbody. Both point sources and nonpoint sources are identified.

12.4.2 TMDLs Required To Be Developed

The WQCD has assigned a high priority to developing a TMDL for the *E. coli* impaired segment discussed above and presented in exhibit 12-32 (at end of chapter). The impaired portion of the segment is from the mainstem of the Arikaree River from the confluence of the North and South Forks to the Colorado/Kansas border (COSPRE04). The source of the impairment is listed as "Not Assessed."

12.4.3 TMDLs Completed To Date

During any given assessment cycle, segments for which a TMDL has already been developed are likely to be identified as impaired. This indicates that the TMDL has not yet been implemented or the benefits of TMDL implementation have yet to be realized. To date, the WQCD has not had to develop TMDLs for segments in the Republican River Basin.

12.4.4 TMDL Implementation Strategies

Although no TMDLs have been completed in the Republican River Basin to date, the WQCD recognizes that many other entities have undertaken or are planning activities that will contribute to improvements in water quality in the basin. In addition, WQCD appreciates that the development and implementation of strategies is best undertaken in partnership with local and other stakeholders in the watersheds and basins of issue. Readers interested in understanding the array of potential strategies that could be employed in a watershed should consult chapter 4 of this document, "*Strategies for Addressing Water Quality Problems*" and appendix E.

12.5 Planned Point Source Treatment Upgrades

As shown in exhibit 12-36, there are a total of 21 public and private point source dischargers in the Republican River Basin.¹⁰ The point source dischargers are located in seven counties. The counties with the greatest number of point source dischargers are Yuma with seven (33%); Washington with four (19%); and Kit Carson and Phillips with three each (14% each).

¹⁰ Point source dischargers only include those reported in the Clean Watershed Needs Survey 2008 database (USEPA 2010a), the USEPA ECHO database accessed June 24, 2010 (USEPA 2010d), and the Water Pollution Control Revolving Fund annual Intended Use Plan (WQCD 2010b).

Applicable Counties	Number of Point Sources by County	
Cheyenne	1	
Kit Carson	3	
Lincoln	2	
Logan	1	
Phillips	3	
Washington	4	
Yuma	7	
7	21	

Exhibit 12-36. Republican River Basin Summary of Point Sources by County

Sources: USEPA 2010a, 2010d; WQCD 2010b.

Congress authorized the Clean Water State Revolving Fund (CWSRF; called the Water Pollution Control Revolving Fund, or WPCRF, in Colorado) when amending the CWA in 1987. The purpose of the CWSRF is to help provide financial assistance to governmental agencies for the construction of projects that are listed in the state's annual Intended Use Plans (IUPs). The Project Eligibility List included in the IUPs is made up of projects for construction of publicly owned treatment works and projects/activities eligible for assistance under CWA sections 319 and 320. The Colorado IUP Project Eligibility List is comprised of the following six categories: (1) Category 1 includes those projects that improve or benefit public health or that will remediate a public health hazard; (2) Category 2 includes those projects that enable an entity to achieve permit compliance; (3) Category 3 includes those projects that contribute to the prevention of a public health hazard, enable an entity to maintain permit compliance, or enables an entity to address a possible future effluent limit or emerging issue; (4) Category 4 includes those projects that implement a watershed/nonpoint source management plan; (5) Category 5 includes those projects that implement a source water protection plan; and (6) Category 6 includes those projects that sought funding only under the American Recovery and Reinvestment Act of 2009 and that were not already on the state's Project Eligibility List as of January 1, 2009. For the purposes of the SWQMP, projects in categories 1 through 3 were labeled as wastewater treatment facility projects; projects in category 4 were labeled as nonpoint source projects or stormwater projects; and projects in category 5 were labeled as source water protection projects. Finally, projects in category 6 were labeled as wastewater treatment facility, nonpoint source, stormwater, or source water protection depending on the nature of the project (WQCD 2010b).

A total of 31 planned treatment projects were identified for point source facilities in the Republican River Basin.¹¹ Exhibit 12-37 provides a summary of the project types and includes the number of projects, the estimated costs of the project, and the population expected to benefit. The four project types are (1) wastewater treatment facility, (2) stormwater, (3) source water protection, and (4) nonpoint source. Wastewater treatment facility projects lead the list in terms of the greatest number of scheduled projects (21 of 31, or 68%). Source water protection projects follow with a total of five (16%). Exhibit 12-38 (at end of chapter) provides additional details.

¹¹ Projects identified include only those on the state's IUP. Therefore, the list is not likely inclusive of all projects that may be occurring in the basin.

Project Type	Number of Projects	Estimated Cost of Projects ¹	Population Expected to Benefit from Projects	Percent of Projects Reporting Population Data	
Wastewater Treatment Facility	21	\$24,356,100	26,567	100%	
Stormwater	3	\$4,115,041	5,427	100%	
Nonpoint Source	2	\$750,000	3,887	100%	
Source Water Protection	5	60,000	1,806	100%	
Total All Projects	31	\$29,281,141	37,687		

Exhibit 12-37. Summary of Scheduled Point Source Improvements in the Republican River Basin

¹ Dollar amounts listed are those reported in WPCRF project applications only, as reported in the IUP. They likely are not inclusive of all projects that may be occurring in the basin. Sources: USEPA 2010a, 2010d; WQCD 2010b.

Sources. USEFA 2010a, 2010a, WQCD 2010b.

The total estimated cost of the 31 projects in the Republican River Basin is approximately \$29.2 million. Wastewater treatment facility improvement projects constitute 83% of the total cost at approximately \$24.3 million. This is followed by stormwater projects at approximately \$4.1 million (14%), nonpoint source projects at about \$750,000 (3%), and source water protection projects at \$60,000 (0.2%). Exhibit 12-38 (at end of chapter) provides-additional details. In addition to project information, these exhibits also summarize NPDES permit information. It should be noted that funding gaps exist nationwide in the CWSRF for wastewater treatment projects.¹² Total funding has also not increased significantly under section 319 in spite of nonpoint sources being the leading source of water pollution nationwide.

12.6 Nonpoint Source Management

This section of the basin plans typically provides a summary of CWA section 319 projects identified as taking place in the basin over the past 5 years. No such projects were identified for the Republican River Basin.

¹² It is well recognized that the nation's infrastructure is aging and that the funds to replace this infrastructure are severely lacking. EPA recently completed its 2008 Report to Congress summarizing the results of its Clean Watersheds Needs Survey. The report presents a comprehensive analysis of capital investments necessary to meet the nation's wastewater and stormwater treatment and collection needs over the next 20 years. The report documents a total need of \$299.1 billion as of January 1, 2008. This total includes capital needs for publicly owned wastewater treatment pipes and treatment facilities (\$192.2 billion), combined sewer overflow correction (\$63.6 billion), and stormwater management (\$42.3 billion) (USEPA 2010b).

References

Text and Figure/Table References

- Chapman, S.S., G.E. Griffth, J.M. Omernik, A.B. Price, J. Freeouf, and D.L. Schrupp. 2006. Ecoregions of Colorado. Color poster with map, descriptive text, summary tables, and photographs (map scale 1:1,200,000). U.S. Geological Survey, Reston, Virginia.
- CDOW (Colorado Division of Wildlife). 2008. *Strategic Plan for the Wetland Wildlife Conservation Program*. Colorado Department of Natural Resources, Colorado Division of Wildlife, Denver, Colorado.
- CDOW. 2010. Species of Concern. < http://wildlife.state.co.us/WildlifeSpecies /SpeciesofConcern>. Accessed August 9, 2010.
- CFWE (Colorado Foundation for Water Education). 2003. *Citizen's Guide to Colorado Water Quality Protection*. Colorado Foundation for Water Education, Denver, Colorado.
- CGS (Colorado Geological Survey). 2003. *Ground Water Atlas of Colorado*. Special Publication 53. Colorado Department of Natural Resources, Division of Minerals and Geology, Colorado Geological Survey, Denver, Colorado.
- CWCB (Colorado Water Conservation Board). 2004. *Statewide Water Supply Initiative*. Colorado Department of Natural Resources, Colorado Water Conservation Board, Denver, Colorado.
- CWCB. 2006. *Statewide Water Supply Initiative Fact Sheet: South Platte Basin*. Colorado Department of Natural Resources, Colorado Water Conservation Board, Denver, Colorado.
- CWCB. 2009. *Nonconsumptive Needs Assessment Focus Mapping*. Colorado Department of Natural Resources, Colorado Water Conservation Board, Denver, Colorado.
- CWCB. 2010. *State of Colorado 2050 Municipal and Industrial Water Use Projections*. Colorado Department of Natural Resources, Colorado Water Conservation Board, Denver, Colorado.
- DOLA (Department of Local Affairs). Population Totals for Colorado Counties. http://dola.colorado.gov/dlg/demog/pop_cnty_estimates.html. Accessed on January 20, 2011. Colorado Department of Local Affairs, Division of Local Government, Denver, Colorado.
- Prairie and Wetlands Focus Area Committee and Rocky Mountain Bird Observatory. 2004. *Prairie and Wetlands Focus Area Strategic Area*. Prepared for Colorado Department of Natural Resources, Colorado Division of Wildlife, Denver, Colorado.

- USEPA (U.S. Environmental Protection Agency). 2010a. Clean Watershed Needs Survey 2008 Data. ">http://www.epa.gov/cwns>. Accessed June 28, 2010.
- USEPA. 2010b. *Clean Watershed Needs Survey: 2008 Report to Congress*. EPA-832-R-10-002. U.S. Environmental Protection Agency, Washington, D.C.
- USEPA. 2010c. *Grants Reporting Tracking System.* ">http://iaspub.epa.gov/pls/grts/f?p=110:199:1611870697608659::NO:::>. Accessed August 4, 2010.
- USEPA. 2010d. NPDES facility attribute information. http://www.epa.gov/echo/index.html. Accessed June 24, 2010.
- USGS (U.S. Geological Survey). 2010. *Estimated Withdrawals and Use of water in Colorado,* 2005. Scientific Investigations Report 2010–5002. U.S. Department of the Interior, U.S. Geological Survey, Reston, Virginia.
- WQCC (Water Quality Control Commission). 2006a. *Colorado Water Quality Management and Drinking Water Protection Handbook*. Policy 98-2. Colorado Department of Public Health and Environment, Water Quality Control Commission, Denver, Colorado.
- WQCC. 2006b. Regulation No. 42: *Site-Specific Water Quality Classifications and Standards for Ground Water*. 5 CCR 1002-42. Colorado Department of Public Health and Environment, Water Quality Control Commission, Denver, Colorado.
- WQCC. 2009. Regulation No. 41: *The Basic Standards for Groundwater*. 5 CCR 1002-41. Colorado Department of Public Health and Environment, Water Quality Control Commission, Denver, Colorado.
- WQCC. 2010a. Regulation No. 38: *Classifications and Numeric Standards for the South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin* 5 CCR 1002-38. Colorado Department of Public Health and Environment, Water Quality Control Commission, Denver, Colorado.
- WQCC. 2010b. Regulation No. 93: Colorado's Section 303(d) List of Impaired Waters and Monitoring and Evaluation List 5 CCR 1002-93. Colorado Department of Public Health and Environment, Water Quality Control Commission, Denver, Colorado.
- WQCD (Water Quality Control Division). 2002. *Integrated Water Quality Monitoring and Assessment Report*. Colorado Department of Public Health and Environment, Water Quality Control Division, Denver, Colorado.
- WQCD. 2005. *Quality Assurance Project Plan and Sampling Analysis and Assessment Plan for Fish Tissue Surveys for the State of Colorado*. Colorado Department of Public Health and Environment, Water Quality Control Division, Denver, Colorado.

- WQCD. 2008. Integrated Water Quality Monitoring and Assessment Report. Colorado Department of Public Health and Environment, Water Quality Control Division, Denver, Colorado.
- WQCD. 2010a. Integrated Water Quality Monitoring and Assessment Report. Colorado Department of Public Health and Environment, Water Quality Control Division, Denver, Colorado.
- WQCD. 2010b. State of Colorado Water Pollution Control Revolving Fund and State Domestic Wastewater Treatment Grant Intended Use Plan. Colorado Department of Public Health and Environment, Water Quality Control Division, Denver, Colorado.

Map References

Exhibit 12-1. Republican River Basin and Major Tributaries

WQCD (Water Quality Control Division). 2010a. CDPHE 2010 305(b) Basin Classifications. Shape\hucs\12digit\hydrologic_units\wbdhu12_a_co_Clip.shp. Acquired from Water Quality Control Division March 16, 2010.

Exhibit 12-3. Republican River Basin and Major Tributaries

- ESRI (Environmental Systems Research Institute, Inc.). 2008. U.S. and Canada City Points. \ESRI\cities.sdc. Accessed April 5, 2010.
- ESRI (Environmental Systems Research Institute, Inc.). 2008. U.S. and Canada Street Cartographic. \ESRI\streets.sdc. Accessed April 5, 2010.
- ESRI (Environmental Systems Research Institute, Inc.). 2008. U.S. Counties. \ESRI\counties.sdc. Accessed April 5, 2010.
- ESRI (Environmental Systems Research Institute, Inc.). 2008. U.S. National Atlas Water Feature Lines. \ESRI\hydroln_Clip_to_CO.shp. Accessed April 5, 2010.
- ESRI (Environmental Systems Research Institute, Inc.). 2008. U.S. States and Canada Provinces. \ESRI\states.sdc. Accessed April 5, 2010.
- USEPA (U.S. Environmental Protection Agency). 2010. 2010 EPA-approved National Hydrography Database (NHD) Stream Segmentation co_2010_305b_draft_str_021410.shp and 2010 EPA-approved National Hydrography Database (NHD) Waterbody Segmentation co_2010_305b_draft_wb_021410.shp. Acquired from Water Quality Control Division on March 16, 2010.
- WQCD (Water Quality Control Division). 2010a. CDPHE 2010 305(b) Basin Classifications. Shape\hucs\12digit\hydrologic_units\wbdhu12_a_co_Clip.shp. Acquired from Water Quality Control Division March 16, 2010.

Exhibit 12-4. Republican River Basin Level III Ecoregions

CEC (North American Commission for Environmental Cooperation). 2006. http://www.cec.org/Page.asp?PageID=122&ContentID=1329&SiteNodeID=498&BL_E xpandID>. Published by USEPA (U.S. Environmental Protection Agency). Accessed April 2, 2010.

Exhibit 12-6. Republican River Basin Nonconsumptive Needs Assessment

CWCB (Colorado Water Conservation Board). 2009a. *Nonconsumptive Needs Assessment Focus Mapping*. Colorado Department of Natural Resources, Colorado Water Conservation Board, Denver, Colorado.

Exhibit 12-7. Republican River Basin Precipitation

CWCB. 2004. *Statewide Water Supply Initiative*. Colorado Department of Natural Resources, Colorado Water Conservation Board, Denver, Colorado.

Exhibit 12-8. Republican River Basin Land Ownership

- CDOW (Colorado Division of Wildlife). 2003. Public Access Properties. NDIS_CDOW\CDOWPublicAccessProperties\CDOWPublicAccessProperties.shp. Accessed May 18, 2010.
- CSLB (Colorado State Land Board). 2009. Colorado State Land Ownership. CO State Land Board\slb_surface_ed_032210a.shp. Accessed May 11, 2010.
- USGS (U.S. Geological Survey). 2005. National Atlas of the United States (Federal Lands). NATIONALATLAS\lands\federal\fedlanp020.shp and NATIONALATLAS\lands\indian\indlanp020.shp. Accessed April 17, 2010.

Exhibit 12-9. Republican River Basin Land Cover

- USFWS (U.S. Fish and Wildlife Service). 2009. National Wetlands Inventory. http://www.fws.gov/wetlands/data/DataDownload.html Accessed June 14, 2010.
- USGS. 2001. National Land Cover Database. http://www.mrlc.gov/ >. Accessed April 2, 2010.

Exhibit 12-14. Republican River Basin Key Diversions and Streamflow Gauges

CWCB. 2004. *Statewide Water Supply Initiative*. Colorado Department of Natural Resources, Colorado Water Conservation Board, Denver, Colorado.

Exhibit 12-15. Republican River Basin Wells and Aquifers

CWCB. 2004. *Statewide Water Supply Initiative*. Colorado Department of Natural Resources, Colorado Water Conservation Board, Denver, Colorado.

Exhibit 12-16. Republican River Basin Classified Waterbody Segments

WQCD. 2010a. CDPHE 2010 305(b) Basin Classifications. Shape\hucs\12digit\hydrologic_units\wbdhu12_a_co_Clip.shp. Acquired from Water Quality Control Division March 16, 2010.

USEPA (U.S. Environmental Protection Agency). 2010. 2010 EPA-approved National Hydrography Database (NHD) Stream Segmentation co_2010_305b_draft_str_021410.shp and 2010 EPA-approved National Hydrography Database (NHD) Waterbody Segmentation co_2010_305b_draft_wb_021410.shp. Acquired from Water Quality Control Division on March 16, 2010.

Exhibit 12-21. Republican River Basin Wetlands

USFWS (U.S. Fish and Wildlife Service). 2009. National Wetlands Inventory. http://www.fws.gov/wetlands/data/DataDownload.html Accessed June 14, 2010.

Exhibit 12-33. Republican River Basin Impaired Waterbody Segments

WQCD. 2010a. CDPHE 2010 305(b) Basin Classifications. Shape\hucs\12digit\hydrologic_units\wbdhu12_a_co_Clip.shp. Acquired from Water Quality Control Division March 16, 2010.

WQCD. 2010b. CDPHE 2010 303(d) Listings By Regulation and Basin Shape\2010_303_ME\COSP\COSP_impaired_str.shp, Shape\2010_303_ME\COSP\lakes\COSP_impaired_lakes.shp. Acquired from Water Quality Control Division March 16, 2010.