RECLAMATION

Managing Water in the West

Arkansas Valley Conduit and Long-Term Excess Capacity Master Contract

FINAL ENVIRONMENTAL IMPACT STATEMENT

APPENDIXES: VOLUME 2

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United States Department of the Interior
Bureau of Reclamation
Great Plains Region
Eastern Colorado Area Office

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

August 2013

MISSION STATEMENTS

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Appendix E.1 - Alluvial Groundwater Effects

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Introduction

Appendix E.1 supplements Chapter 4 – *Groundwater Hydrology* in the EIS. This appendix contains further information on methodology and quantitative effects of alternatives on alluvial aquifers in the Upper Arkansas River and Fountain Creek basins. Groundwater levels could be affected by changes in groundwater pumping and changes in river stage. Methodology and effects for the Lower Arkansas River Basin are in Appendix F.3.

Groundwater Effects Related to Pumping

Methods and groundwater effects related to alluvial pumping changes are described in this section. Alluvial groundwater pumping effects analyses were completed for four aquifers in the Upper Arkansas River and Fountain Creek basins: the Upper Arkansas River Aquifer, Fountain Creek Aquifer, Widefield Aquifer, and Windmill Gulch Aquifer (Figure 1).

Methods

The analysis used a steady state (i.e., groundwater effects reach an equilibrium and do not change with time) equation for groundwater flow to a well. Average annual groundwater pumping rates, as well as rates for normal, dry, and wet years, were used in the equation to evaluate annual groundwater levels. The alluvial aquifers were assumed to remain hydraulically connected with the river to provide a constant water supply, consistent with studies done in the region (Survey 2003). Equation 1 (Dietz 1943) was used to simulate steady state drawdown:

Equation 1

$$s = \frac{Q}{2\pi Kb} G(x, y)$$

Where,

s = drawdown at a point (x,y)
Q = volumetric pumping rate (gpd)
K is the aquifer hydraulic conductivity (ft/d)
b = saturated thickness of the aquifer (ft)
G(x,y) = Green's function for the aquifers boundary conditions.

The river was represented as a single linear boundary condition for the analysis, yielding the following form of Green's function (Equation 2):

Equation 2

$$G(x, y) = \frac{1}{2} \ln \frac{(x_1 + x_w)^2 + (y_1 - y_w)^2}{(x_1 - x_w)^2 + (y_1 - y_w)^2}$$

Where,

x_1 and y_1 = coordinates of the observation point in the aquifer

x_w and y_w = coordinates of the pumping well.

The aquifer was assumed to be homogeneous (aquifer hydraulic conductivity and thickness was assumed to be constant throughout) because of data limitations. This approach is consistent with previous studies of the region (Reclamation 2008). The assumed hydraulic conductivity and thickness for the aquifers are summarized in Table 1.

Table 1. Assumed Homogeneous Aquifer Properties

Aquifer	Saturated Thickness (feet)	Hydraulic Conductivity (feet/day)
Upper Arkansas River Aquifer	100[1]	280[4]
Fountain Creek Aquifer	50[2]	480[3]
Widefield Aquifer	25[3]	830[3]
Windmill Gulch Aquifer	25[3]	830[3]

Notes: Above parameters were found at the following sources:
[1] Survey 2003
[2] Reclamation 2008
[3] Steve Smith 2006
[4] Watts 2005

Since the number and location of pumping wells in each aquifer was unknown, a single hypothetical well 400 feet from the river was assumed to pump the water for each region. By assuming a single pumping well, the worst case scenario (i.e. greatest possible change in drawdown) for groundwater pumping from each region was assessed, and the assumption is consistent with previous studies (Reclamation 2008). An aptly designed well field with multiple, properly spaced wells would have less drawdown than those shown in this analysis.

A pumping rate was estimated for a typical dry, wet, and normal year within the study period, as well as an overall average pumping rate for the years 1982-2009. Total pumping per year was calculated for each alternative using the Daily Model results. The total pumping for each aquifer under each alternative is summarized in Table 2 and Table 3. Pumping becomes greater during dry years than during wet years. This is because demand can be met with surface water supplies during wet years, and groundwater pumping is not needed. During dry and normal years, groundwater pumping is needed to meet water demands in these regions (see Appendix D.4).

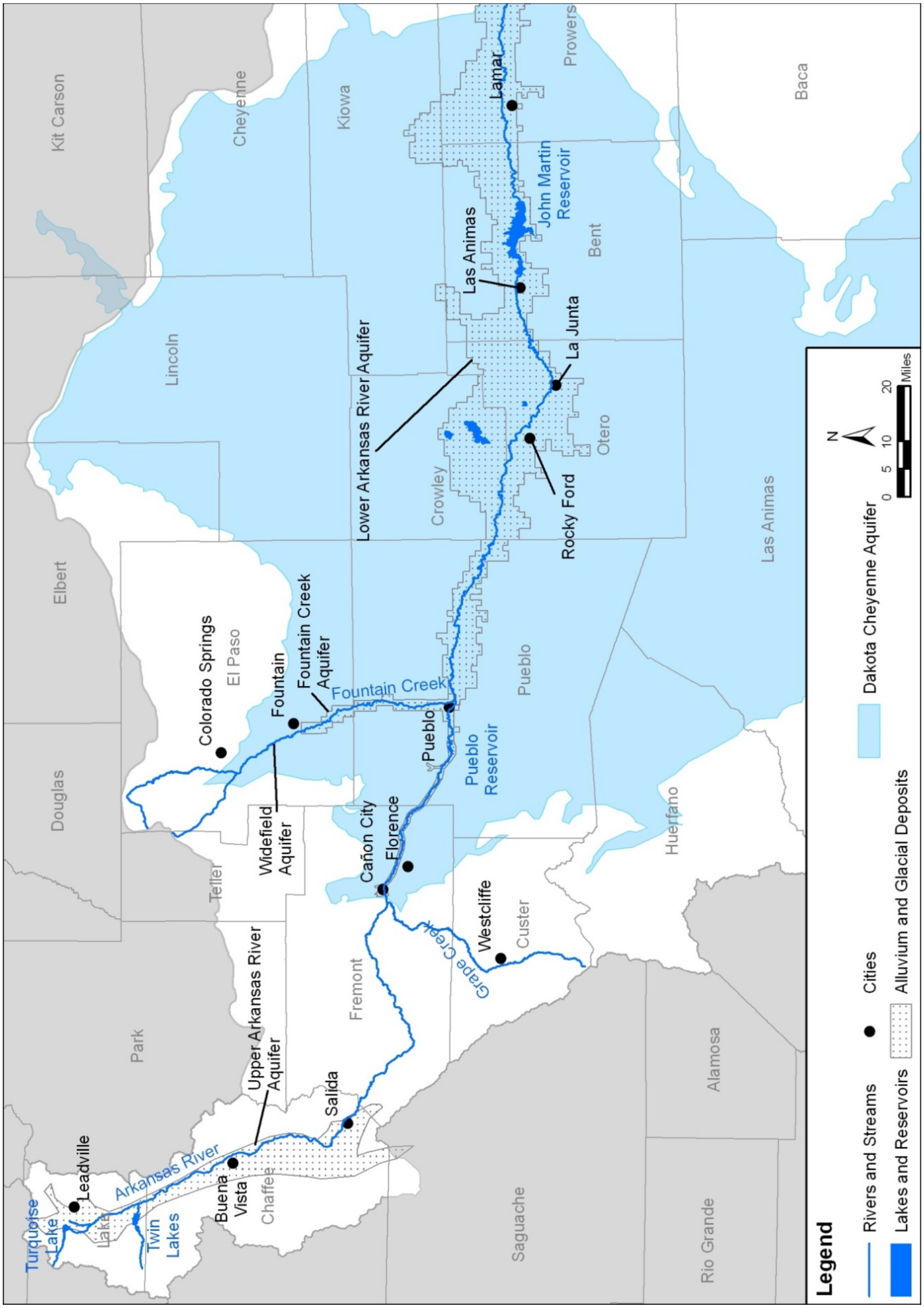

Figure 1. Groundwater Study Area

Effects were reported based on the highest drawdown, which occurs next to the assumed well, 400 feet from the river. Farther from the well, effects to the aquifer from pumping diminish. An example of such a drawdown cone is in Figure 2.

Water table level changes can increase risk of basement flooding in residential homes, especially in residential areas with water table depths less than 10 feet. Additional analysis of the Fountain Creek Alluvial Aquifer quantified homes that could be at risk from rising groundwater conditions.

Data from current water well applications received by the state engineer was obtained from the Colorado Division of Water Resources. From these records water levels were interpolated by finding the closest subset of wells with static water level data to a point and applying a weight based on proportionate areas.

Table 2. Annual Alluvial Pumping – Direct Effects

Aquifer	Existing Condition	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Overall Average Alluvial Pumping (ac-ft/year)[1]								
Upper Arkansas River Aquifer	2,144	4,279	4,279	4,279	4,279	4,279	4,279	4,279
Fountain Creek Aquifer	0	1,718	259	241	1,372	264	295	344
Widefield Aquifer	0	534	169	153	424	169	179	225
Windmill Gulch Aquifer	0	117	51	51	96	52	60	60
Dry Year Alluvial Pumping (ac-ft/year) [1]								
Upper Arkansas River Aquifer	2,160	4,314	4,314	4,314	4,314	4,314	4,314	4,314
Fountain Creek Aquifer	0	7,316	3,658	3,113	7,316	3,663	3,669	3,706
Widefield Aquifer	0	2,602	1,410	951	2,603	1,411	1,584	1,938
Windmill Gulch Aquifer	0	240	240	240	240	240	240	240
Normal Year Alluvial Pumping (ac-ft/year) [1]								
Upper Arkansas River Aquifer	2,155	4,303	4,303	4,303	4,303	4,303	4,303	4,303
Fountain Creek Aquifer	0	4,006	927	904	3,882	971	929	1,066
Widefield Aquifer	0	1,291	746	742	1,241	736	738	778
Windmill Gulch Aquifer	0	240	240	240	240	240	240	240
Wet Year Alluvial Pumping (ac-ft/year) [1]								
Upper Arkansas River Aquifer	2,155	4,303	4,303	4,303	4,303	4,303	4,303	4,303
Fountain Creek Aquifer	0	0	0	0	0	0	0	0
Widefield Aquifer	0	0	0	0	0	0	0	0
Windmill Gulch Aquifer	0	0	0	0	0	0	0	0

Notes:
(1) Data is from the Daily Model analysis (Appendix D.4).

Table 3. Annual Alluvial Pumping – Cumulative Effects

Aquifer	Existing Condition	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Overall Average Alluvial Pumping (ac-ft/year) [(1)]								
Upper Arkansas River Aquifer	2,144	4,279	4,279	4,279	4,279	4,279	4,279	4,279
Fountain Creek Aquifer	0	2,399	1,831	1,817	2,415	1,835	1,874	1,815
Widefield Aquifer	0	1,087	810	797	1,078	810	830	809
Windmill Gulch Aquifer	0	157	154	150	154	154	154	154
Dry Year Alluvial Pumping (ac-ft/year) [(1)]								
Upper Arkansas River Aquifer	2,160	4,314	4,314	4,314	4,314	4,314	4,314	4,314
Fountain Creek Aquifer	0	6,216	4,928	4,928	6,217	4,928	5,045	4,958
Widefield Aquifer	0	2,879	2,252	2,252	2,872	2,252	2,276	2,255
Windmill Gulch Aquifer	0	240	240	240	240	240	240	240
Normal Year Alluvial Pumping (ac-ft/year) [(1)]								
Upper Arkansas River Aquifer	2,155	4,303	4,303	4,303	4,303	4,303	4,303	4,303
Fountain Creek Aquifer	0	4,094	3,202	3,179	4,041	3,166	3,206	3,200
Widefield Aquifer	0	2,001	1,498	1,476	1,977	1,475	1,496	1,497
Windmill Gulch Aquifer	0	240	240	240	240	240	240	240
Wet Year Alluvial Pumping (ac-ft/year) [(1)]								
Upper Arkansas River Aquifer	2,155	4,303	4,303	4,303	4,303	4,303	4,303	4,303
Fountain Creek Aquifer	0	0	0	0	0	0	0	0
Widefield Aquifer	0	0	0	0	0	0	0	0
Windmill Gulch Aquifer	0	0	0	0	0	0	0	0

Notes:
[(1)] Data is from the Daily Model analysis (Appendix D.4).

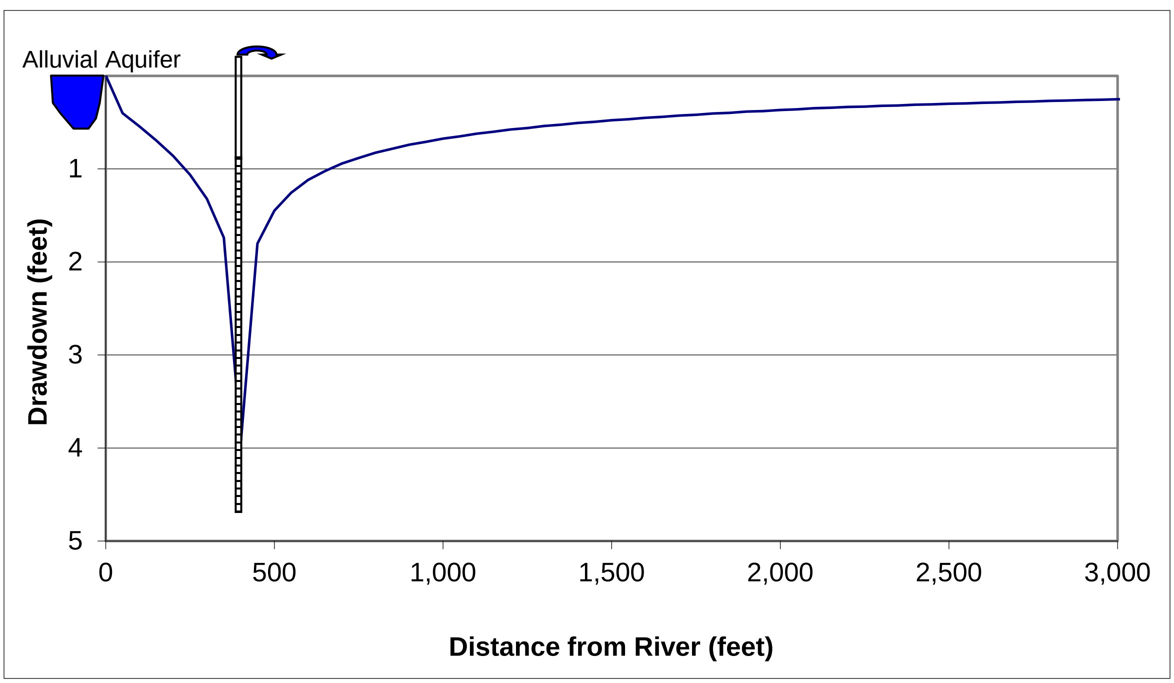

Figure 2. Example Drawdown Cone in an Alluvial Aquifer

Results

Groundwater effects are presented in tabular format for an overall average, dry, wet, and normal years for each aquifer in the study area (Table 4 to Table 11). Effects were calculated for both direct and cumulative effects.

Groundwater pumping in all alternatives would not affect Upper Arkansas River Aquifer groundwater levels for direct and cumulative effects, compared to the No Action. The No Action Alternative would decrease water table levels, compared to existing conditions, because of additional groundwater pumping to meet future municipal demand by Master Contract participants.

Groundwater pumping in all alternatives would generally increase groundwater levels (decrease drawdown) in the Fountain Creek Basin alluvial aquifers (Fountain Creek Aquifer, Widefield Aquifer, and Windmill Gulch Aquifer) for direct and cumulative effects, compared to the No Action. During a typical wet year pumping would not be needed in all alternatives, including the No Action, since demand would be met from other sources, and would not affect groundwater levels. During normal and dry years there would be a greater need for groundwater pumping for most action alternatives when compared with wet years, with the exception of the JUP North Alternative. The No Action Alternative would decrease water table levels, compared to existing conditions, because of additional groundwater pumping demand.

All alternatives would not affect basement flooding in the Fountain Creek Basin. Regions that have the possibility of being affected by rising groundwater levels have water table levels within 10 feet of the surface. A map of water table levels for the Fountain Creek Basin was constructed from well data (Figure 3). As can be seen from the map, only 6 percent of the Fountain Creek Alluvial Aquifer has a water table within 10 feet of ground surface. Of this 6 percent, approximately 46 percent lies below municipal areas. Despite the shallow water level in these locations, the results show that while the action alternatives would increase water table levels, compared to the No Action, levels would still be at or below existing conditions and would not increase basement flooding risk in existing residential areas.

Table 4. Overall Average Groundwater Pumping Effects on Groundwater Levels – Direct Effects

Aquifer	Existing Condition [1]	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Drawdown [2] (feet)								
Upper Arkansas River Aquifer	9.72	19.41	19.41	19.41	19.41	19.41	19.41	19.41
Fountain Creek Aquifer	0.00	9.09	1.37	1.27	7.26	1.40	1.56	1.82
Widefield Aquifer	0.00	3.27	1.04	0.93	2.60	1.04	1.09	1.37
Windmill Gulch Aquifer	0.00	0.71	0.31	0.31	0.59	0.32	0.37	0.37
Effects – Change in Drawdown [3] [feet (%)] (No Action Baseline)								
Upper Arkansas River Aquifer	---	---	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Fountain Creek Aquifer	---	---	-7.72 (-84.9%)	-7.82 (-86%)	-1.83 (-20.2%)	-7.69 (-84.6%)	-7.53 (-82.8%)	-7.27 (-80%)
Widefield Aquifer	---	---	-2.23 (-68.3%)	-2.33 (-71.4%)	-0.67 (-20.6%)	-2.23 (-68.3%)	-2.17 (-66.5%)	-1.89 (-58%)
Windmill Gulch Aquifer	---	---	-0.4 (-55.9%)	-0.4 (-55.9%)	-0.13 (-18%)	-0.4 (-55.7%)	-0.35 (-48.6%)	-0.35 (-48.6%)
Effects – Change in Drawdown [feet (%)] (Existing Conditions Baseline)								
Upper Arkansas River Aquifer	---	9.68 (99.6%)	9.68 (99.6%)	9.68 (99.6%)	9.68 (99.6%)	9.68 (99.6%)	9.68 (99.6%)	9.68 (99.6%)
Fountain Creek Aquifer	---	---	---	---	---	---	---	---
Widefield Aquifer	---	---	---	---	---	---	---	---
Windmill Gulch Aquifer	---	---	---	---	---	---	---	---

Notes:
(1) Fountain Creek Aquifer, Widefield Aquifer, and Windmill Gulch Aquifer do not have Existing Conditions effects because simulated Existing Conditions drawdown is 0 ft.
(2) Drawdown is shown at the well 400 ft. from the river.
(3) Negative effects are to be interpreted as a decrease in drawdown, or an increase in groundwater levels.

Table 5. Normal Year Groundwater Pumping Effects on Groundwater Levels – Direct Effects

Aquifer	Existing Condition [1]	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Drawdown [2] (feet)								
Upper Arkansas River Aquifer	9.77	19.52	19.52	19.52	19.52	19.52	19.52	19.52
Fountain Creek Aquifer	0.00	21.20	4.91	4.78	20.54	5.14	4.91	5.64
Widefield Aquifer	0.00	7.90	4.57	4.54	7.60	4.50	4.51	4.76
Windmill Gulch Aquifer	0.00	1.47	1.47	1.47	1.47	1.47	1.47	1.47
Effects – Change in Drawdown [3] [feet (%)] (No Action Baseline)								
Upper Arkansas River Aquifer	---	---	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Fountain Creek Aquifer	---	---	-16.29 (-76.8%)	-16.41 (-77.4%)	-0.66 (-3.1%)	-16.06 (-75.8%)	-16.28 (-76.8%)	-15.55 (-73.4%)
Widefield Aquifer	---	---	-3.33 (-42.2%)	-3.36 (-42.5%)	-0.3 (-3.8%)	-3.4 (-43%)	-3.38 (-42.9%)	-3.14 (-39.7%)
Windmill Gulch Aquifer	---	---	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Effects – Change in Drawdown [feet (%)] (Existing Conditions Baseline)								
Upper Arkansas River Aquifer	---	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)
Fountain Creek Aquifer	---	---	---	---	---	---	---	---
Widefield Aquifer	---	---	---	---	---	---	---	---
Windmill Gulch Aquifer	---	---	---	---	---	---	---	---

Notes:
(1) Fountain Creek Aquifer, Widefield Aquifer, and Windmill Gulch Aquifer do not have Existing Conditions effects because simulated Existing Conditions drawdown is 0 ft.
(2) Drawdown is shown at the well 400 ft. from the river.
(3) Negative effects are to be interpreted as a decrease in drawdown, or an increase in groundwater levels.

Table 6. Dry Year Groundwater Pumping Effects on Groundwater Levels – Direct Effects

Aquifer	Existing Condition [1]	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Drawdown [2] (feet)								
Upper Arkansas River Aquifer	9.80	19.57	19.57	19.57	19.57	19.57	19.57	19.57
Fountain Creek Aquifer	0.00	33.33	19.36	16.47	33.33	19.38	19.41	19.61
Widefield Aquifer	0.00	15.93	8.63	5.82	15.93	8.63	9.70	11.86
Windmill Gulch Aquifer	0.00	1.47	1.47	1.47	1.47	1.47	1.47	1.47
Effects – Change in Drawdown [3] [feet (%)] (No Action Baseline)								
Upper Arkansas River Aquifer	---	---	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Fountain Creek Aquifer	---	---	-13.98 (-41.9%)	-16.86 (-50.6%)	0 (0%)	-13.95 (-41.8%)	-13.92 (-41.8%)	-13.73 (-41.2%)
Widefield Aquifer	---	---	-7.3 (-45.8%)	-10.11 (-63.5%)	0 (0%)	-7.29 (-45.8%)	-6.23 (-39.1%)	-4.06 (-25.5%)
Windmill Gulch Aquifer	---	---	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Effects – Change in Drawdown [feet (%)] (Existing Conditions Baseline)								
Upper Arkansas River Aquifer	---	9.77 (99.7%)	9.77 (99.7%)	9.77 (99.7%)	9.77 (99.7%)	9.77 (99.7%)	9.77 (99.7%)	9.77 (99.7%)
Fountain Creek Aquifer	---	---	---	---	---	---	---	---
Widefield Aquifer	---	---	---	---	---	---	---	---
Windmill Gulch Aquifer	---	---	---	---	---	---	---	---

Notes:

(1) Fountain Creek Aquifer, Widefield Aquifer, and Windmill Gulch Aquifer do not have Existing Conditions effects because simulated Existing Conditions drawdown is 0 ft.

(2) Drawdown is shown at the well 400 ft. from the river.

(3) Negative effects are to be interpreted as a decrease in drawdown, or an increase in groundwater levels.

Table 7. Wet Year Groundwater Pumping Effects on Groundwater Levels – Direct Effects

Aquifer	Existing Condition (1)	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Drawdown (2) (feet)								
Upper Arkansas River Aquifer	9.77	19.52	19.52	19.52	19.52	19.52	19.52	19.52
Fountain Creek Aquifer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Widefield Aquifer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Windmill Gulch Aquifer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Effects – Change in Drawdown (3) [feet (%)] (No Action Baseline)								
Upper Arkansas River Aquifer	---	---	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Fountain Creek Aquifer	---	---	---	---	---	---	---	---
Widefield Aquifer	---	---	---	---	---	---	---	---
Windmill Gulch Aquifer	---	---	---	---	---	---	---	---
Effects – Change in Drawdown [feet) (%)] (Existing Conditions Baseline)								
Upper Arkansas River Aquifer	---	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)
Fountain Creek Aquifer	---	---	---	---	---	---	---	---
Widefield Aquifer	---	---	---	---	---	---	---	---
Windmill Gulch Aquifer	---	---	---	---	---	---	---	---

Notes:
(1) Fountain Creek Aquifer, Widefield Aquifer, and Windmill Gulch Aquifer do not have Existing Conditions effects because simulated Existing Conditions drawdown is 0 ft.
(2) Drawdown is shown at the well 400 ft. from the river.
(3) Negative effects are to be interpreted as a decrease in drawdown, or an increase in groundwater levels.

Table 8. Overall Average Groundwater Pumping Effects on Groundwater Levels – Cumulative Effects

Aquifer	Existing Condition [1]	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Drawdown [2] (feet)								
Upper Arkansas River Aquifer	9.72	19.41	19.41	19.41	19.41	19.41	19.41	19.41
Fountain Creek Aquifer	0.00	12.70	9.69	9.61	12.78	9.71	9.91	9.60
Widefield Aquifer	0.00	6.66	4.95	4.88	6.60	4.96	5.08	4.95
Windmill Gulch Aquifer	0.00	0.96	0.94	0.92	0.94	0.94	0.94	0.94
Effects – Change in Drawdown [3] [feet (%)] (No Action Baseline)								
Upper Arkansas River Aquifer	---	---	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Fountain Creek Aquifer	---	---	-3.01 (-23.7%)	-3.08 (-24.3%)	0.08 (0.6%)	-2.99 (-23.5%)	-2.78 (-21.9%)	-3.09 (-24.4%)
Widefield Aquifer	---	---	-1.7 (-25.6%)	-1.78 (-26.7%)	-0.06 (-0.9%)	-1.7 (-25.5%)	-1.58 (-23.7%)	-1.7 (-25.6%)
Windmill Gulch Aquifer	---	---	-0.02 (-1.6%)	-0.04 (-4.3%)	-0.02 (-1.6%)	-0.02 (-1.6%)	-0.02 (-1.6%)	-0.02 (-1.6%)
Effects – Change in Drawdown [feet (%)] (Existing Conditions Baseline)								
Upper Arkansas River Aquifer	---	9.68 (99.6%)	9.68 (99.6%)	9.68 (99.6%)	9.68 (99.6%)	9.68 (99.6%)	9.68 (99.6%)	9.68 (99.6%)
Fountain Creek Aquifer	---	---	---	---	---	---	---	---
Widefield Aquifer	---	---	---	---	---	---	---	---
Windmill Gulch Aquifer	---	---	---	---	---	---	---	---

Notes:
(1) Fountain Creek Aquifer, Widefield Aquifer, and Windmill Gulch Aquifer do not have Existing Conditions effects because simulated Existing Conditions drawdown is 0 ft.
(2) Drawdown is shown at the well 400 ft. from the river.
(3) Negative effects are to be interpreted as a decrease in drawdown, or an increase in groundwater levels.

Table 9. Normal Year Groundwater Pumping Effects on Groundwater Levels – Cumulative Effects

Aquifer	Existing Condition (1)	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Drawdown (2) (feet)								
Upper Arkansas River Aquifer	9.77	19.52	19.52	19.52	19.52	19.52	19.52	19.52
Fountain Creek Aquifer	0.00	21.66	16.94	16.82	21.38	16.75	16.96	16.93
Widefield Aquifer	0.00	12.25	9.17	9.03	12.10	9.03	9.15	9.16
Windmill Gulch Aquifer	0.00	1.47	1.47	1.47	1.47	1.47	1.47	1.47
Effects – Change in Drawdown (3) [feet (%)] (No Action Baseline)								
Upper Arkansas River Aquifer	---	---	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Fountain Creek Aquifer	---	---	-4.72 (-21.8%)	-4.84 (-22.3%)	-0.28 (-1.3%)	-4.91 (-22.7%)	-4.7 (-21.7%)	-4.73 (-21.8%)
Widefield Aquifer	---	---	-3.08 (-25.2%)	-3.22 (-26.3%)	-0.15 (-1.2%)	-3.22 (-26.3%)	-3.09 (-25.3%)	-3.08 (-25.2%)
Windmill Gulch Aquifer	---	---	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Effects – Change in Drawdown [feet (%)] (Existing Conditions Baseline)								
Upper Arkansas River Aquifer	---	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)
Fountain Creek Aquifer	---	---	---	---	---	---	---	---
Widefield Aquifer	---	---	---	---	---	---	---	---
Windmill Gulch Aquifer	---	---	---	---	---	---	---	---

Notes:

(1) Fountain Creek Aquifer, Widefield Aquifer, and Windmill Gulch Aquifer do not have Existing Conditions effects because simulated Existing Conditions drawdown is 0 ft.

(2) Drawdown is shown at the well 400 ft. from the river.

(3) Negative effects are to be interpreted as a decrease in drawdown, or an increase in groundwater levels.

Table 10. Dry Year Groundwater Pumping Effects on Groundwater Levels – Cumulative Effects

Aquifer	Existing Condition (1)	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Drawdown (2) (feet)								
Upper Arkansas River Aquifer	9.80	19.57	19.57	19.57	19.57	19.57	19.57	19.57
Fountain Creek Aquifer	0.00	32.89	26.08	26.07	32.90	26.07	26.70	26.23
Widefield Aquifer	0.00	16.67	13.78	13.78	16.67	13.78	13.93	13.80
Windmill Gulch Aquifer	0.00	1.47	1.47	1.47	1.47	1.47	1.47	1.47
Effects – Change in Drawdown (3) [feet (%)] (No Action Baseline)								
Upper Arkansas River Aquifer	---	---	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Fountain Creek Aquifer	---	---	-6.81 (-20.7%)	-6.81 (-20.7%)	0.01 (0%)	-6.81 (-20.7%)	-6.19 (-18.8%)	-6.65 (-20.2%)
Widefield Aquifer	---	---	-2.88 (-17.3%)	-2.89 (-17.3%)	0 (0%)	-2.89 (-17.3%)	-2.73 (-16.4%)	-2.87 (-17.2%)
Windmill Gulch Aquifer	---	---	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Effects – Change in Drawdown [feet (%)] (Existing Conditions Baseline)								
Upper Arkansas River Aquifer	---	9.77 (99.7%)	9.77 (99.7%)	9.77 (99.7%)	9.77 (99.7%)	9.77 (99.7%)	9.77 (99.7%)	9.77 (99.7%)
Fountain Creek Aquifer	---	---	---	---	---	---	---	---
Widefield Aquifer	---	---	---	---	---	---	---	---
Windmill Gulch Aquifer	---	---	---	---	---	---	---	---

Notes:

(1) Fountain Creek Aquifer, Widefield Aquifer, and Windmill Gulch Aquifer do not have Existing Conditions effects because simulated Existing Conditions drawdown is 0 ft.

(2) Drawdown is shown at the well 400 ft. from the river.

(3) Negative effects are to be interpreted as a decrease in drawdown, or an increase in groundwater levels.

Table 11. Wet Year Groundwater Pumping Effects on Groundwater Levels – Cumulative Effects

Aquifer	Existing Condition (1)	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Drawdown (2) (feet)								
Upper Arkansas River Aquifer	9.77	19.52	19.52	19.52	19.52	19.52	19.52	19.52
Fountain Creek Aquifer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Widefield Aquifer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Windmill Gulch Aquifer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Effects – Change in Drawdown (3) [feet (%)] (No Action Baseline)								
Upper Arkansas River Aquifer	---	---	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Fountain Creek Aquifer	---	---	---	---	---	---	---	---
Widefield Aquifer	---	---	---	---	---	---	---	---
Windmill Gulch Aquifer	---	---	---	---	---	---	---	---
Effects – Change in Drawdown [feet (%)] (Existing Conditions Baseline)								
Upper Arkansas River Aquifer	---	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)	9.74 (99.7%)
Fountain Creek Aquifer	---	---	---	---	---	---	---	---
Widefield Aquifer	---	---	---	---	---	---	---	---
Windmill Gulch Aquifer	---	---	---	---	---	---	---	---

Notes:
(1) Fountain Creek Aquifer, Widefield Aquifer, and Windmill Gulch Aquifer do not have Existing Conditions effects because simulated Existing Conditions drawdown is 0 ft.
(2) Drawdown is shown at the well 400 ft. from the river.
(3) Negative effects are to be interpreted as a decrease in drawdown, or an increase in groundwater levels.

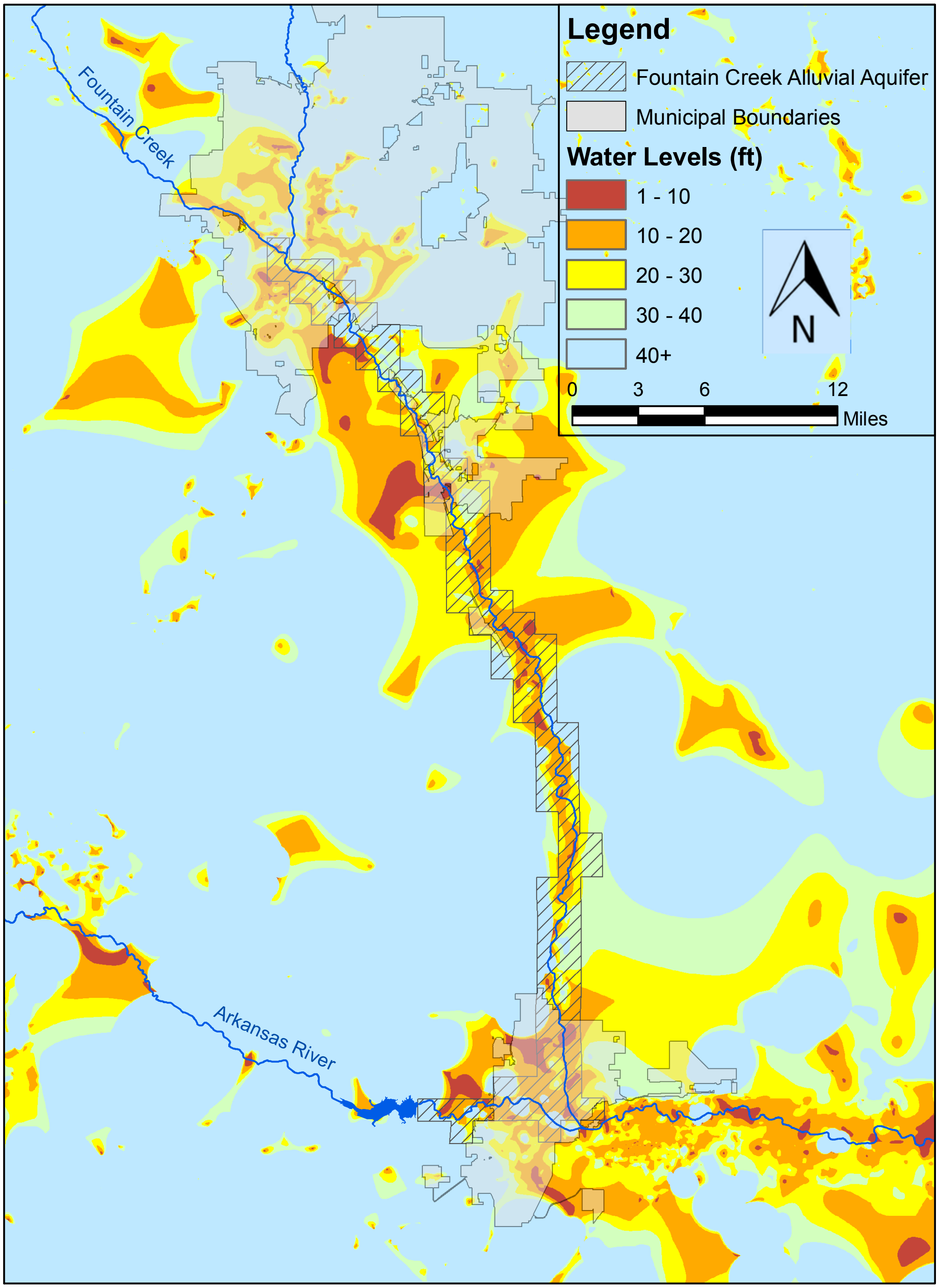

Figure 3. Map of Groundwater Depths in the Fountain Creek Alluvial Aquifer

Groundwater Effects Related to Changes in River Stage

Methods and groundwater effects related to river stage (elevation) changes are described in this section. Effects analyses were completed for four aquifers in the Upper Arkansas River and Fountain Creek basins: the Upper Arkansas River Aquifer, Fountain Creek Aquifer, Widefield Aquifer, and Windmill Gulch Aquifer.

Methods

Effects of changes in river levels on alluvial groundwater levels were calculated at several streamflow gage locations on the Upper Arkansas River and Fountain Creek basins, including the Arkansas River near Wellsville (07093700), Arkansas River above Pueblo (07099400), Fountain Creek at Security (07105800), and Fountain Creek at Pueblo (07106500).

Groundwater levels at each location were calculated assuming steady flow (does not change with time) in an unconfined aquifer. An equation for head in an unconfined aquifer was derived using Darcy's Law for groundwater and the Dupuit assumptions (the change in head is equal to the slope of the water table and for small changes in head the aquifer is horizontal). Applying Darcy's Law to a section of unconfined aquifer with steady one-dimensional groundwater flow in a direction perpendicular to the surface yields the following steady state equation (Fetter 1988):

Equation 3

$$h^2 = h_1^2 - \frac{(h_1^2 - h_2^2)x}{L} + \frac{W}{K}(L - x)x$$

Where,

h = head in the aquifer at a distance x from the river (ft)
h_1 and h_2 = head in the aquifer at a distance of 0 and L from the river (ft)
W = net volumetric rate of addition or withdrawal of water from the aquifer (e.g. infiltration, evaporation, or alluvial groundwater pumping (gpd)
K = hydraulic conductivity of the alluvial aquifer material. (ft/d)

Head in the aquifer at the river (distance of 0) was calculated by adding the aquifer's saturated thickness to the average monthly river stage. The average monthly river stage was calculated from Daily Model output. At distance L the head in the aquifer was assumed to be equal to the saturated thickness of the aquifer.

Evapotranspiration, groundwater recharge, and groundwater discharge from the alluvial aquifer were assumed to remain the same throughout the analysis. In addition, since pumping was considered separately in the previous analysis, W was set equal to 0 at all locations. These assumptions allow effects to be assessed for just river level changes, as the second term in the equation drops out. The aquifer was assumed to be isotropic (uniform in all orientations), have a uniform thickness, and homogeneous (same properties throughout), consistent with prior studies (Reclamation 2008). The assumed hydraulic conductivity and aquifer thickness, and aquifer width at each location are summarized in Table 12.

Table 12. Aquifer Properties at Gage Locations

Gage Location	Aquifer Width (feet)	Saturated Thickness (feet)	Hydraulic Conductivity (feet/day)
Arkansas River Near Wellsville (07093700)	5092[1]	100[3]	280[2]
Arkansas River Above Pueblo (07099400)	6427[4]	250[4]	530[3]
Fountain Creek At Security (07105800)	8054[4]	25[4]	830[4]
Fountain Creek At Pueblo (07106500)	11275[4]	40[4]	1000[4]

Notes: Above Parameters were found at the following sources:
(1) CDSS Map Viewer
(2) Watts 2005
(3) Survey 2003
(4) Steve Smith 2006

Results

Groundwater effects caused by changes in river levels are presented in tabular format for an overall monthly average simulated head for each gage (Table 13 to Table 20). Effects were calculated for both direct and cumulative effects. In general, changes in river stage would not affect groundwater levels for all alternatives, compared to No Action. Changes would also be negligible in dry, wet, and normal years. The No Action Alternative, compared to the existing conditions, would not significantly change groundwater levels.

Table 13. Overall Average Effects of River Levels on Groundwater at the Fountain Creek At Security Gage – Direct Effects

Month	Existing Conditions	No Action		Comanche North		Pueblo Dam South		JUP North		Pueblo Dam North		River South		Master Contract Only	
Simulated Head in Aquifer (feet)															
Jan	25.7	25.8		25.8		25.8		25.8		25.8		25.8		25.8	
Feb	25.8	25.8		25.8		25.8		25.8		25.8		25.8		25.8	
Mar	25.9	25.9		25.9		25.9		25.9		25.9		25.9		25.9	
Apr	26.0	26.0		26.0		26.0		26.0		26.0		26.0		26.0	
May	26.2	26.2		26.2		26.2		26.2		26.2		26.2		26.2	
Jun	26.1	26.1		26.1		26.1		26.1		26.1		26.1		26.1	
Jul	26.0	26.0		26.0		26.0		26.0		26.0		26.0		26.0	
Aug	26.1	26.1		26.1		26.1		26.1		26.1		26.1		26.1	
Sep	25.8	25.8		25.8		25.8		25.8		25.8		25.8		25.8	
Oct	25.8	25.8		25.8		25.8		25.8		25.8		25.8		25.8	
Nov	25.8	25.8		25.8		25.8		25.8		25.8		25.8		25.8	
Dec	25.7	25.7		25.7		25.7		25.7		25.7		25.7		25.7	
Average	25.9	25.9		25.9		25.9		25.9		25.9		25.9		25.9	
Effects - Simulated Drawdown (feet) (%) (No Action Alternative Baseline)															
No Measureable Effects															
Effects - Simulated Drawdown (feet) (%) (Existing Conditions Baseline)															
Jan	---	0.0	(0.0)	0.0	(0.1)	0.0	(0.1)	0.0	(0.0)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)
Feb	---	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Mar	---	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Apr	---	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
May	---	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Jun	---	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)
Jul	---	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)
Aug	---	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Sep	---	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Oct	---	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)
Nov	---	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)
Dec	---	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)
Average	---	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)

Table 14. Overall Average Effects of River Levels on Groundwater at the Fountain Creek At Pueblo Gage – Direct Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Head in Aquifer (feet)								
Jan	41.8	41.9	41.9	41.9	41.9	41.9	41.9	41.9
Feb	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9
Mar	41.9	41.9	42.0	42.0	41.9	42.0	42.0	42.0
Apr	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9
May	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0
Jun	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9
Jul	41.6	41.7	41.7	41.7	41.7	41.7	41.7	41.7
Aug	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9
Sep	41.6	41.6	41.6	41.6	41.6	41.6	41.6	41.6
Oct	41.8	41.9	41.9	41.9	41.9	41.9	41.9	41.9
Nov	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9
Dec	41.8	41.9	41.9	41.9	41.9	41.9	41.9	41.9
Average	41.8	41.9	41.9	41.9	41.9	41.9	41.9	41.9
Effects - Simulated Drawdown (feet) (%) (No Action Alternative Baseline)								
Jan	---	---	0.0 (0.1)	0.0 (0.1)	0.0 (0.0)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)
Feb	---	---	0.0 (0.1)	0.0 (0.1)	0.0 (0.0)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)
Mar	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Apr	---	---	0.0 (0.1)	0.0 (0.1)	0.0 (0.0)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)
May	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Jun	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Jul	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Aug	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Sep	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Oct	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Nov	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Dec	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Average	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Effects - Simulated Drawdown (feet) (%) (Existing Conditions Baseline)								
Jan	---	0.0 (0.1)	0.1 (0.2)	0.1 (0.2)	0.0 (0.1)	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)
Feb	---	0.0 (0.0)	0.0 (0.1)	0.0 (0.1)	0.0 (0.0)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)
Mar	---	0.0 (0.0)	0.0 (0.1)	0.0 (0.1)	0.0 (0.0)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)
Apr	---	0.0 (0.1)	0.1 (0.2)	0.1 (0.2)	0.0 (0.1)	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)
May	---	0.0 (0.1)	0.1 (0.1)	0.1 (0.1)	0.0 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)
Jun	---	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)
Jul	---	0.0 (0.1)	0.1 (0.1)	0.1 (0.1)	0.0 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)
Aug	---	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)
Sep	---	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)
Oct	---	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)
Nov	---	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)
Dec	---	0.1 (0.1)	0.1 (0.2)	0.1 (0.2)	0.1 (0.1)	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)
Average	---	0.0 (0.1)	0.1 (0.1)	0.1 (0.1)	0.0 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)

Table 15. Overall Average Effects of River Levels on Groundwater at the Arkansas River Near Wellsville Gage – Direct Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Head in Aquifer (feet)								
Jan	103.4	103.4	103.4	103.4	103.4	103.4	103.4	103.4
Feb	103.3	103.3	103.2	103.2	103.3	103.2	103.2	103.2
Mar	103.2	103.2	103.2	103.2	103.2	103.2	103.2	103.2
Apr	103.2	103.2	103.2	103.2	103.3	103.2	103.2	103.2
May	104.4	104.4	104.4	104.4	104.4	104.4	104.4	104.4
Jun	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7
Jul	104.8	104.8	104.8	104.8	104.8	104.8	104.8	104.8
Aug	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1
Sep	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5
Oct	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5
Nov	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5
Dec	103.4	103.4	103.4	103.4	103.4	103.4	103.4	103.4
Average	103.8	103.8	103.8	103.8	103.8	103.8	103.8	103.8
Effects - Simulated Drawdown (feet) (%) (No Action Alternative Baseline)								
No Measureable Effects								
Effects - Simulated Drawdown (feet) (%) (Existing Conditions Baseline)								
No Measureable Effects								

Table 16. Overall Average Effects of River Levels on Groundwater at the Arkansas River Above Pueblo Gage – Direct Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Head in Aquifer (feet)								
Jan	252.0	252.0	252.0	252.0	252.0	252.0	252.0	252.0
Feb	252.1	252.1	252.0	252.0	252.0	252.0	252.1	252.0
Mar	252.3	252.3	252.2	252.2	252.2	252.2	252.3	252.2
Apr	253.0	252.9	252.9	252.9	252.9	252.9	252.9	252.9
May	253.9	253.9	253.8	253.8	253.8	253.8	253.9	253.9
Jun	255.1	255.0	255.0	255.0	255.0	255.0	255.1	255.1
Jul	254.2	254.2	254.1	254.1	254.1	254.1	254.2	254.2
Aug	253.4	253.3	253.3	253.3	253.3	253.3	253.3	253.3
Sep	252.5	252.5	252.4	252.4	252.4	252.4	252.5	252.4
Oct	252.4	252.4	252.3	252.3	252.4	252.3	252.3	252.3
Nov	252.3	252.2	252.2	252.2	252.2	252.2	252.2	252.2
Dec	252.0	252.0	252.0	252.0	252.0	252.0	252.0	252.0
Average	252.9	252.9	252.9	252.9	252.9	252.9	252.9	252.9
Effects - Simulated Drawdown (feet) (%) (No Action Alternative Baseline)								
Jan	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Feb	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Mar	---	---	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	0.0 (0.0)	0.0 (0.0)
Apr	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
May	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Jun	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Jul	---	---	0.0 (0.0)	0.0 (0.0)	-0.1 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Aug	---	---	-0.1 (0.0)	0.0 (0.0)	0.0 (0.0)	-0.1 (0.0)	0.0 (0.0)	0.0 (0.0)
Sep	---	---	-0.1 (0.0)	-0.1 (0.0)	0.0 (0.0)	-0.1 (0.0)	0.0 (0.0)	0.0 (0.0)
Oct	---	---	-0.1 (0.0)	-0.1 (0.0)	0.0 (0.0)	-0.1 (0.0)	0.0 (0.0)	0.0 (0.0)
Nov	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Dec	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Average	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Effects - Simulated Drawdown (feet) (%) (Existing Conditions Baseline)								
Jan	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Feb	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Mar	---	0.0 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)
Apr	---	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)
May	---	0.0 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	0.0 (0.0)	0.0 (0.0)
Jun	---	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	0.0 (0.0)	0.0 (0.0)
Jul	---	0.0 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	0.0 (0.0)	-0.1 (0.0)
Aug	---	0.0 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)
Sep	---	0.0 (0.0)	-0.1 (0.0)	-0.1 (0.0)	0.0 (0.0)	-0.1 (0.0)	0.0 (0.0)	0.0 (0.0)
Oct	---	-0.1 (0.0)	-0.1 (-0.1)	-0.1 (-0.1)	-0.1 (0.0)	-0.1 (-0.1)	-0.1 (0.0)	-0.1 (0.0)
Nov	---	0.0 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	0.0 (0.0)	0.0 (0.0)
Dec	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Average	---	0.0 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	0.0 (0.0)	-0.1 (0.0)

Table 17. Overall Average Effects of River Levels on Groundwater at the Fountain Creek At Security Gage – Cumulative Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Head in Aquifer (feet)								
Jan	25.7	26.2	26.2	26.2	26.2	26.2	26.2	26.2
Feb	25.8	26.3	26.3	26.3	26.3	26.3	26.3	26.3
Mar	25.9	26.3	26.3	26.3	26.3	26.3	26.3	26.3
Apr	26.0	26.4	26.4	26.4	26.4	26.4	26.4	26.4
May	26.2	26.5	26.5	26.5	26.5	26.5	26.5	26.5
Jun	26.1	26.5	26.5	26.5	26.5	26.5	26.5	26.5
Jul	26.0	26.4	26.4	26.4	26.4	26.4	26.4	26.4
Aug	26.1	26.5	26.5	26.5	26.5	26.5	26.5	26.5
Sep	25.8	26.3	26.3	26.3	26.3	26.3	26.3	26.3
Oct	25.8	26.3	26.3	26.3	26.3	26.3	26.3	26.3
Nov	25.8	26.3	26.3	26.3	26.3	26.3	26.3	26.3
Dec	25.7	26.2	26.2	26.2	26.2	26.2	26.2	26.2
Average	25.9	26.3	26.3	26.3	26.3	26.3	26.3	26.3
Effects - Simulated Drawdown (feet) (%) (No Action Alternative Baseline)								
No Measureable Effects								
Effects - Simulated Drawdown (feet) (%) (Existing Conditions Baseline)								
Jan	---	0.5 (1.9)	0.5 (1.9)	0.5 (1.9)	0.5 (1.9)	0.5 (1.9)	0.5 (1.9)	0.5 (1.9)
Feb	---	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)
Mar	---	0.4 (1.7)	0.4 (1.7)	0.4 (1.7)	0.4 (1.7)	0.4 (1.7)	0.4 (1.7)	0.4 (1.7)
Apr	---	0.4 (1.6)	0.4 (1.6)	0.4 (1.6)	0.4 (1.6)	0.4 (1.6)	0.4 (1.6)	0.4 (1.6)
May	---	0.4 (1.4)	0.4 (1.4)	0.4 (1.4)	0.4 (1.4)	0.4 (1.4)	0.4 (1.4)	0.4 (1.4)
Jun	---	0.4 (1.5)	0.4 (1.5)	0.4 (1.5)	0.4 (1.5)	0.4 (1.5)	0.4 (1.5)	0.4 (1.5)
Jul	---	0.4 (1.7)	0.4 (1.7)	0.4 (1.7)	0.4 (1.7)	0.4 (1.7)	0.4 (1.7)	0.4 (1.7)
Aug	---	0.4 (1.5)	0.4 (1.5)	0.4 (1.5)	0.4 (1.5)	0.4 (1.5)	0.4 (1.5)	0.4 (1.5)
Sep	---	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)
Oct	---	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)	0.5 (1.9)	0.5 (1.8)
Nov	---	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)	0.5 (1.8)
Dec	---	0.5 (2.0)	0.5 (2.0)	0.5 (2.0)	0.5 (2.0)	0.5 (2.0)	0.5 (2.0)	0.5 (2.0)
Average	---	0.4 (1.7)	0.4 (1.7)	0.4 (1.7)	0.4 (1.7)	0.4 (1.7)	0.4 (1.7)	0.4 (1.7)

Table 18. Overall Average Effects of River Levels on Groundwater at the Fountain Creek At Pueblo Gage – Cumulative Effects

Month	Existing Conditions	No Action		Comanche North		Pueblo Dam South		JUP North		Pueblo Dam North		River South		Master Contract Only	
Simulated Head in Aquifer (feet)															
Jan	41.8	42.1		42.1		42.1		42.1		42.1		42.1		42.1	
Feb	41.9	42.1		42.1		42.1		42.1		42.1		42.1		42.1	
Mar	41.9	42.2		42.1		42.1		42.2		42.1		42.1		42.1	
Apr	41.9	42.3		42.3		42.3		42.3		42.3		42.3		42.3	
May	42.0	42.6		42.6		42.6		42.6		42.6		42.6		42.6	
Jun	41.9	42.5		42.5		42.5		42.5		42.5		42.5		42.5	
Jul	41.6	42.2		42.2		42.2		42.2		42.2		42.2		42.2	
Aug	41.9	42.2		42.2		42.2		42.2		42.2		42.3		42.2	
Sep	41.6	41.9		41.9		41.9		41.9		41.9		41.9		41.9	
Oct	41.8	42.1		42.0		42.1		42.1		42.0		42.1		42.1	
Nov	41.9	42.1		42.1		42.1		42.1		42.1		42.1		42.1	
Dec	41.8	42.0		42.0		42.0		42.0		42.0		42.0		42.0	
Average	41.8	42.2		42.2		42.2		42.2		42.2		42.2		42.2	
Effects - Simulated Drawdown (feet) (%) (No Action Alternative Baseline)															
Jan	---	---		0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Feb	---	---		0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Mar	---	---		0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Apr	---	---		0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
May	---	---		0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Jun	---	---		0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Jul	---	---		0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Aug	---	---		0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Sep	---	---		0.0	(0.0)	0.0	(0.0)	0.0	(-0.1)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Oct	---	---		0.0	(-0.1)	0.0	(0.0)	0.0	(0.0)	0.0	(-0.1)	0.0	(0.0)	0.0	(0.0)
Nov	---	---		0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Dec	---	---		0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Average	---	---		0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Effects - Simulated Drawdown (feet) (%) (Existing Conditions Baseline)															
Jan	---	0.3	(0.6)	0.3	(0.6)	0.3	(0.6)	0.2	(0.6)	0.3	(0.6)	0.3	(0.6)	0.3	(0.6)
Feb	---	0.2	(0.4)	0.2	(0.5)	0.2	(0.5)	0.2	(0.4)	0.2	(0.5)	0.2	(0.5)	0.2	(0.5)
Mar	---	0.2	(0.5)	0.2	(0.5)	0.2	(0.5)	0.2	(0.5)	0.2	(0.5)	0.2	(0.5)	0.2	(0.5)
Apr	---	0.4	(1.1)	0.4	(1.1)	0.4	(1.1)	0.5	(1.1)	0.4	(1.1)	0.5	(1.1)	0.4	(1.1)
May	---	0.6	(1.5)	0.6	(1.5)	0.6	(1.5)	0.6	(1.5)	0.6	(1.5)	0.6	(1.5)	0.6	(1.5)
Jun	---	0.6	(1.5)	0.7	(1.6)	0.7	(1.6)	0.6	(1.5)	0.7	(1.6)	0.6	(1.5)	0.6	(1.6)
Jul	---	0.6	(1.4)	0.6	(1.4)	0.6	(1.4)	0.6	(1.3)	0.6	(1.4)	0.6	(1.4)	0.6	(1.4)
Aug	---	0.4	(0.9)	0.4	(0.9)	0.4	(0.9)	0.4	(0.9)	0.4	(0.9)	0.4	(1.0)	0.4	(0.9)
Sep	---	0.3	(0.8)	0.3	(0.8)	0.3	(0.8)	0.3	(0.8)	0.3	(0.8)	0.4	(0.9)	0.3	(0.8)
Oct	---	0.3	(0.7)	0.3	(0.6)	0.3	(0.7)	0.3	(0.7)	0.3	(0.6)	0.3	(0.7)	0.3	(0.7)
Nov	---	0.3	(0.6)	0.3	(0.6)	0.2	(0.6)	0.2	(0.6)	0.3	(0.6)	0.3	(0.6)	0.3	(0.6)
Dec	---	0.2	(0.5)	0.2	(0.5)	0.2	(0.5)	0.2	(0.5)	0.2	(0.5)	0.2	(0.6)	0.2	(0.6)
Average	---	0.4	(0.9)	0.4	(0.9)	0.4	(0.9)	0.4	(0.9)	0.4	(0.9)	0.4	(0.9)	0.4	(0.9)

Table 19. Overall Average Effects of River Levels on Groundwater at the Arkansas River Near Wellsville Gage – Cumulative Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Head in Aquifer (feet)								
Jan	103.4	103.4	103.5	103.5	103.4	103.5	103.4	103.4
Feb	103.3	103.2	103.2	103.2	103.2	103.2	103.2	103.2
Mar	103.2	103.2	103.2	103.2	103.2	103.2	103.2	103.2
Apr	103.2	103.3	103.3	103.3	103.3	103.3	103.3	103.3
May	104.4	104.2	104.2	104.2	104.2	104.2	104.2	104.2
Jun	105.7	105.5	105.5	105.5	105.5	105.5	105.5	105.5
Jul	104.8	104.7	104.7	104.7	104.7	104.7	104.7	104.7
Aug	104.1	104.1	104.1	104.1	104.0	104.1	104.1	104.1
Sep	103.5	103.4	103.4	103.4	103.4	103.4	103.4	103.4
Oct	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5
Nov	103.5	103.6	103.6	103.6	103.6	103.6	103.6	103.6
Dec	103.4	103.5	103.5	103.5	103.5	103.5	103.5	103.5
Average	103.8	103.8	103.8	103.8	103.8	103.8	103.8	103.8
Effects - Simulated Drawdown (feet) (%) (No Action Alternative Baseline)								
No Measurable Effects								
Effects - Simulated Drawdown (feet) (%) (Existing Conditions Baseline)								
Jan	---	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)
Feb	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Mar	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Apr	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
May	---	-0.1 (-0.1)	-0.2 (-0.1)	-0.2 (-0.1)	-0.1 (-0.1)	-0.2 (-0.1)	-0.1 (-0.1)	-0.1 (-0.1)
Jun	---	-0.2 (-0.2)	-0.2 (-0.2)	-0.2 (-0.2)	-0.2 (-0.2)	-0.2 (-0.2)	-0.2 (-0.2)	-0.2 (-0.2)
Jul	---	-0.1 (-0.1)	-0.1 (-0.1)	-0.1 (-0.1)	-0.1 (-0.1)	-0.1 (-0.1)	-0.1 (-0.1)	-0.1 (-0.1)
Aug	---	-0.1 (-0.1)	0.0 (0.0)	0.0 (0.0)	-0.1 (-0.1)	0.0 (0.0)	0.0 (0.0)	-0.1 (-0.1)
Sep	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Oct	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Nov	---	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)
Dec	---	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)
Average	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)

Table 20. Overall Average Effects of River Levels on Groundwater at the Arkansas River Above Pueblo Gage – Cumulative Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Head in Aquifer (feet)								
Jan	252.0	251.9	251.9	251.9	251.9	251.9	251.9	251.9
Feb	252.1	252.0	252.0	252.0	252.0	252.0	252.0	252.0
Mar	252.3	252.0	252.0	252.0	252.0	252.0	252.0	252.0
Apr	253.0	252.4	252.4	252.4	252.4	252.4	252.4	252.4
May	253.9	253.3	253.3	253.3	253.3	253.3	253.3	253.3
Jun	255.1	254.7	254.6	254.6	254.7	254.6	254.7	254.7
Jul	254.2	253.9	253.9	253.9	253.8	253.9	253.9	253.9
Aug	253.4	253.1	253.0	253.0	253.0	253.0	253.1	253.1
Sep	252.5	252.1	252.1	252.1	252.1	252.1	252.1	252.1
Oct	252.4	252.0	252.0	252.0	252.0	252.0	252.0	252.0
Nov	252.3	252.0	252.0	252.0	252.0	252.0	252.0	252.0
Dec	252.0	251.9	251.9	251.9	251.9	251.9	251.9	251.9
Average	252.9	252.6	252.6	252.6	252.6	252.6	252.6	252.6
Effects - Simulated Drawdown (feet) (%) (No Action Alternative Baseline)								
Jan	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Feb	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Mar	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Apr	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
May	---	---	-0.1 (0.0)	-0.1 (0.0)	0.0 (0.0)	-0.1 (0.0)	0.0 (0.0)	0.0 (0.0)
Jun	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Jul	---	---	0.0 (0.0)	-0.1 (0.0)	-0.1 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Aug	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Sep	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Oct	---	---	0.0 (0.0)	-0.1 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Nov	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Dec	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Average	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Effects - Simulated Drawdown (feet) (%) (Existing Conditions Baseline)								
Jan	---	-0.1 (-0.1)	-0.2 (-0.1)	-0.2 (-0.1)	-0.2 (-0.1)	-0.2 (-0.1)	-0.1 (-0.1)	-0.1 (-0.1)
Feb	---	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)	-0.1 (0.0)
Mar	---	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)
Apr	---	-0.6 (-0.2)	-0.6 (-0.2)	-0.6 (-0.2)	-0.6 (-0.2)	-0.6 (-0.2)	-0.6 (-0.2)	-0.6 (-0.2)
May	---	-0.6 (-0.2)	-0.6 (-0.3)	-0.6 (-0.3)	-0.6 (-0.2)	-0.6 (-0.3)	-0.6 (-0.2)	-0.6 (-0.2)
Jun	---	-0.4 (-0.2)	-0.5 (-0.2)	-0.5 (-0.2)	-0.4 (-0.2)	-0.5 (-0.2)	-0.4 (-0.2)	-0.4 (-0.2)
Jul	---	-0.3 (-0.1)	-0.3 (-0.1)	-0.4 (-0.1)	-0.4 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)
Aug	---	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)
Sep	---	-0.4 (-0.1)	-0.4 (-0.2)	-0.4 (-0.2)	-0.4 (-0.2)	-0.4 (-0.2)	-0.4 (-0.1)	-0.4 (-0.2)
Oct	---	-0.4 (-0.2)	-0.5 (-0.2)	-0.5 (-0.2)	-0.4 (-0.2)	-0.5 (-0.2)	-0.4 (-0.2)	-0.4 (-0.2)
Nov	---	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)
Dec	---	-0.1 (0.0)	-0.1 (-0.1)	-0.1 (-0.1)	-0.1 (-0.1)	-0.1 (-0.1)	-0.1 (0.0)	-0.1 (0.0)
Average	---	-0.3 (-0.1)	-0.4 (-0.1)	-0.4 (-0.1)	-0.4 (-0.1)	-0.4 (-0.1)	-0.3 (-0.1)	-0.3 (-0.1)

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Appendix F.1 – Water Quality Affected Environment Supplemental Information

Contents

Tables

Figures

Attachment

Appendix F.1 supplements the Water Quality portion of Chapter 3 - *Affected Environment* in the EIS. This appendix contains additional information about water quality resources that could be affected by implementing the proposed AVC, Master Contract, and Interconnect alternatives.

Water Quality Standards and Thresholds

The Colorado Department of Public Health and Environment (Health Department) is responsible for: 1) assigning use classifications to state water segments, 2) establishing water quality standards for each water segment, and 3) reporting on attainment of water quality standards. Water use classifications for streams, lakes, and reservoirs identify protected uses for stream segments, lakes, and reservoirs, using numerical standards for specific pollutants to protect these uses. Nonattainment of water quality standards is reported every two years via the State's 303(d) list (Attachment F.1-1). The list gets its name from section 303(d) of the federal Clean Water Act, which requires states to periodically submit a list of impaired waters to EPA.

The Safe Drinking Water Act was adopted by Congress in 1974 to protect public health by regulating the quality of public drinking water supplies. It controls the quality of water "at the tap" rather than addressing water quality in-stream or regulating pollution sources. The EPA developed national drinking water standards known as maximum contaminant levels. These standards set numerical limitations for many of the most significant contaminants in public water system drinking water. Secondary drinking water standards set limits on chemicals that cause aesthetic problems with drinking water, such as taste and odor problems.

Colorado has adopted state drinking water standards identical to the maximum contaminant levels established by the EPA (Colorado Foundation for Water Education 2003). The Health Department has also adopted several site-specific numeric standards, including acute and chronic table value standards and ambient quality-based standards. Following Health Department guidelines, in most cases, the 85th percentile of the available surface water data was compared to the numeric water quality standard to determine attainment of water quality standards (Health Department 2012a).

Several published studies from U.S. Geological Survey, Health Department, EPA, Colorado State University, and others were reviewed for water quality information in the study area. To evaluate water quality in this EIS, existing data from the U.S. Geological Survey and Health Department were reviewed and compared to the water quality thresholds shown in Table 1. For some constituents, standards were not available, and other values were used for comparison.

Table Value Standards are site specific standards that may apply to a river segment based on research-based criteria, and are appropriate to protect applicable classified uses.

Ambient Quality-Based Standards are site specific standards where evidence has been presented that the natural or irreversible man-induced ambient water quality levels are higher than table value standards, but are determined adequate to protect classified uses.

Acute water quality standards protect beneficial uses under short-term, high concentration events.

Chronic water quality standards protect uses for longer periods of time, generally for 30 days.

Table 1. Standards and Thresholds Used in Water Quality Analysis

Parameter[1]	Drinking Water Quality Standards and Thresholds (5 CCR 1003-1)	Site Specific or Other Water Quality Standards and Thresholds
Dissolved Selenium	Drinking Water Primary MCL = 50 µg/L.	Chronic = 4.6 µg/L; Acute = 18.4 µg/L Site-specific ambient- and attainability-based underlying standards[2]
Salinity	Drinking Water Secondary MCL[3] = 500 mg/L total dissolved solids.	Agricultural High Salinity Hazard[3] = 750 µS/cm specific conductance (Richards 1954).
Radio-nuclides	Adjusted Gross Alpha Activity Drinking Water Primary MCL = 15 pCi/L. Combined Radium 226/228 Drinking Water Primary MCL= 5 pCi/L. Uranium Drinking Water Primary MCL = 30 µg/L.	Uranium Standard for Arkansas River Basin = Lowest practicable level (Health Department 2012a).
Bacteria	Total Coliforms Drinking Water Primary MCL = No more than 5.0 percent of the samples collected during a month are total coliform-positive	Escherichia coli (E. coli) = 126 colonies / 100 milliliter (recreation class E) (Health Department 2012a).
Sulfate	Drinking Water Secondary MCL[3] = 250 mg/L.	250 mg/L or quality as of Nov. 30, 2010 for waters with an actual water supply use.[4]
Total Recoverable Iron	Iron Drinking Water Secondary MCL[3] = 0.3 mg/L.	1,000 µg/L in Arkansas River between Lake Fork and Lake Creek. Regulated as the least restrictive level (300 µg/L) or existing water quality (1-1-2000) in of study area
Copper	Drinking Water Primary Action Level = 1.3 mg/L. Drinking Water Secondary MCL[3] = 1 mg/L.	Standards are site-specific (Health Department 2012a).
Zinc	Drinking Water Secondary MCL[3] = 5 mg/L.	Site-specific standards (Health Department 2012a).
Cadmium	Drinking Water Primary MCL = 5 µg/L.	Site-specific standards (Health Department 2012a).
Suspended Sediment	N/A	N/A
Temperature	N/A	Maximum weekly average temperature (in ^{o}C) varies by water body type, use classification, expected fish species, and season (Health Department 2012a).
Nutrients	Nitrite Drinking Water Primary MCL: 1 mg/L as nitrogen. Nitrate Drinking Water Primary MCL: 10 mg/L as nitrogen.	Total Phosphorus: 110 µg/L (cold streams); 170 µg/L (warm stream); 25 µg/L (Lakes and Reservoirs >25 acres, cold, summer); 83 µg/L (Lakes and Reservoirs >25 acres, warm, summer) Total Nitrogen: 1,250 µg/L (cold streams); 2,010 µg/L (warm stream); 426 µg/L (Lakes and Reservoirs >25 acres, cold, summer); 910 µg/L (Lakes and Reservoirs >25 acres, warm, summer) Chlorophyll a: 150 mg/m^2 (streams, summer) ; 8 µg/L (Lakes and Reservoirs >25 acres, cold, summer); 20 µg/L (Lakes and Reservoirs >25 acres, warm, summer) (Health Department 2012b) [5]
Emerging Contaminants	N/A	N/A

Notes:

(1) Not all water quality standards are summarized; only those used in this water quality assessment.

(2) Site-specific ambient- and attainability-based underlying standards for selenium have been adopted for several segments in the study area based on data of natural selenium sources not exacerbated by human activity. In other segments, temporary modifications are in place as underlying standards are not being met because of correctable human-induced conditions or significant uncertainty regarding the appropriate long-term underlying standard (Health Department 2012a).

(3) Guideline is not an enforceable standard, but provides information on water quality levels above which there may be negative effects.

(4) Site-specific ambient-based underlying standards for sulfate have been adopted for several segments in the study area (Health Department 2012a).

(5) Interim nutrient standards currently apply in headwaters above permitted discharges. Standards will be used after May 31, 2022 to apply numeric standards to other individual segments.

Water Quality Constituents

Water bodies and stream segments are evaluated in this EIS to assess how the proposed alternatives would affect water quality. The following sections supplement Chapter 3 affected environment information by providing additional background technical material and data related to streamflow water quality, reservoir water quality, and other water quality concerns.

Selenium

Marine shale rock formations and soil derived of marine shales underlie much of the Fountain Creek basin between Colorado Springs and the Arkansas River, and the Arkansas River basin between Pueblo Reservoir and John Martin Reservoir (U.S. Geological Survey 1992). Surface and sub-surface water from lawn watering, irrigation, and precipitation contacts and dissolves selenium-containing rock and soils in the study area. Ortiz et al. (1998) found that over 90 percent of selenium measured in Arkansas River downstream from Pueblo Reservoir was in the dissolved phase.

The Arkansas River between Fountain Creek and the Kansas state line are impaired for selenium; total maximum daily loads (TMDLs) have not been completed. The instream table value standard for selenium is lower than the primary drinking water standard of 50 µg/L because of aquatic life stream classifications. Table 2 shows dissolved selenium concentrations and water quality standards in Fountain Creek and the Lower Arkansas River.

Table 2. Dissolved Selenium in Fountain Creek and the Lower Arkansas River

Stream Segment	Dissolved Selenium Concentration			Hardness (mg/L as $CaCO_3$)	Chronic Water Quality Standard (µg/L)	Acute Water Quality Standard (µg/L)	Sample Period (# of Samples)
	Median (µg/L)	85th Percentile (µg/L) [1][2]	Maximum (µg/L) [2]				
Fountain Creek, Hwy 47 to Arkansas River (WBID COARFO02b)	10.9 [3], 5.4 [4]	16.5 [3], 7.7 [4]	26.3 [3], 12.3 [4]	338.94	28.1	42.3	2005-2010 (28) [3], 2008-2011 (64) [4]
Arkansas River, Wildhorse Creek to Fountain Creek (WBID COARMA03)	8.0 [3], 9.7 [4]	17.4 [3], 18.0 [4]	93.4 [3], 26.5 [4]	371.36	17.4	50.9	2001-2006 (14) [3], 2008-2011 (67) [4]
Arkansas River, Fountain Creek to Colorado Canal (WBID COARLA01a)	11.2 [3], 9.3 [4]	**16.4** [3], 12.7 [4]	34.0 [3], 16.0 [4]	320.26	14.1	19.1	2003-2009 (13) [3], 2008-2011 (70) [4]
Arkansas River, Colorado Canal head gate to John Martin Reservoir (WBID COARLA01b)	9.6	**13.0**	31.0	400.00	4.6	18.4	2003-2009 (37)
Arkansas River, below John Martin Reservoir (WBID COARLA01c)	11.0	**27.1**	34.0	400.00	4.6	18.4	2003-2009 (27)

Source: Health Department 2012a, 2012b, Pueblo 2012
Notes:
(1) 303(d) list exceedences are indicated in **bold**.
(2) The maximum measured value is compared to the acute water quality standard. The 85th percentile value is compared to the chronic water quality standard.
(3) Health Department values used for the 2012 303(d) list.
(4) Values provided by the City of Pueblo.

Salinity

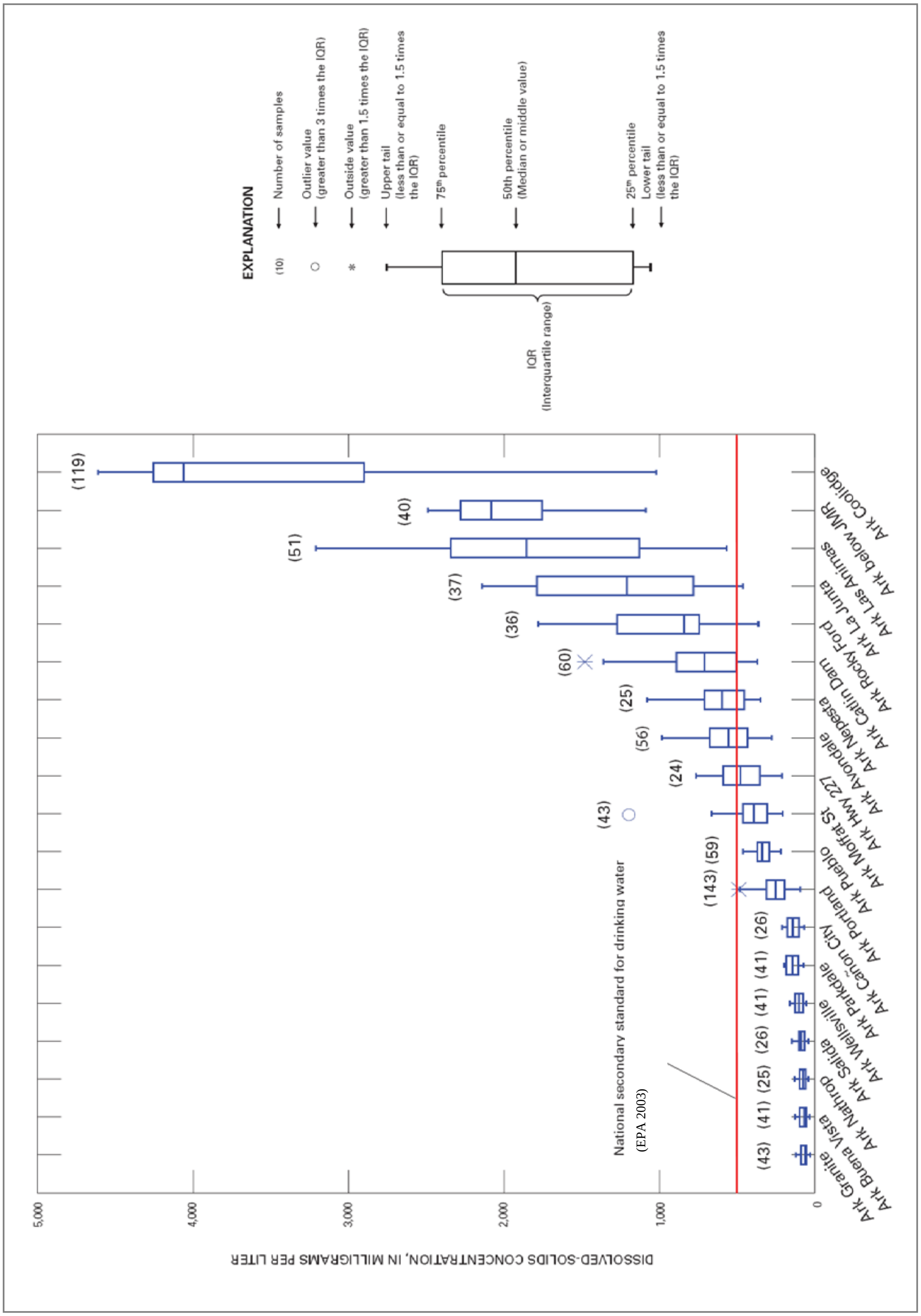
The secondary drinking water standard (5 CCR 1003-1) for salinity is 500 mg/L total dissolved solids. Salinity levels above this standard affect the taste and odor of drinking water, and can have deleterious effects on treatment processes. The total dissolved solids concentrations in the Arkansas River and tributaries are in Table 3. The spatial distribution of total dissolved solids concentrations in the Arkansas River Basin is in Figure 1. Diversions from the Arkansas River below the City of Pueblo could exceed the secondary drinking water standard.

The term **"total solids"** is matter suspended or dissolved in water, and is related to both specific conductance and turbidity. Total solids is the term used for material left in a container after evaporation and drying of a water sample. Total Solids includes both **total suspended solids**, the portion of total solids retained by a filter, and **total dissolved solids**, the portion that passes a filter.

Table 3. Historical Total Dissolved Solids Concentrations at selected sites in the Arkansas River Basin, 1976–2007

Source Agency	Site Number	Site Name	Number of Samples	Total Dissolved Solids (milligrams per liter)			
				Minimum	Mean	Median	Maximum
USGS	07081200	Ark Leadville	27	28	110	116	174
USGS	07083700	Ark Malta	3	77	96	94	116
USGS	07086000	Ark Granite	43	33	74	64	122
USGS	07087200	Ark Buena Vista	41	34	77	68	126
USGS	07091200	Ark Nathrop	25	44	81	76	131
USGS	07091500	Ark Salida	26	45	91	90	147
USGS	07093700	Ark Wellsville	41	57	105	102	163
USGS	07094500	Ark Parkdale	41	72	143	146	201
USGS	07096000	Ark Canon City	26	69	140	143	214
USGS	07097000	Ark Portland	143	95	252	254	489
USGS	07099400	Ark Pueblo	59	220	333	340	464
USGS	381628104381700	Wild Horse Creek	20	2,330	3,075	3,070	3,530
USGS	07099970	Ark Moffat St	43	210	405	390	1,190
USGS	07106500	Fnt Pueblo	42	332	846	834	1,070
USGS	381510104350601	Ark Hwy 227	24	213	468	447	766
USGS	381530104333200	Salt Creek	20	364	436	444	486
USGS	07108900	St. Charles River	21	242	1,521	1,800	2,450
USGS	07109500	Ark Avondale	56	279	565	553	983
USGS	07116500	Huerfano River	12	774	3,159	2,770	5,640
USGS	07117000	Ark Nepesta	25	348	599	590	1,080
USGS	07117600	Chicosa Creek	1	2,360	2,360	2,360	2,360
USGS	380715103564701	Apishapa River	13	586	1,385	1,280	2,190
USGS	07119700	Ark Catlin Dam	60	371	726	691	1,480
USGS	07120500	Ark Rocky Ford	36	365	952	830	1,780
USGS	380111103382101	Timpas Creek	18	692	1,473	1,400	2,890
USGS	07123000	Ark La Junta	37	465	1,335	1,210	2,140
USGS	380421103193101	Horse Creek	13	2,110	3,247	3,390	4,130
USGS	07124000	Ark Las Animas	51	567	1,797	1,850	3,210
USGS	07128500	Purgatoire River	39	774	3,074	3,340	5,010
USGS	07130500	Ark Below JMR	40	1,090	1,969	2,080	2,490
USGS	07137500	Ark Coolidge	119	1,020	3,570	4,060	4,610

Source: Miller et al. 2010



Source: Miller et al. 2010

Figure 1. Spatial Distribution of Dissolved-solids Concentrations in the Arkansas River from Granite, Colorado, to Coolidge, Kansas, 1976–2007

Radionuclides

Naturally occurring radionuclides are caused by erosion and chemical weathering of naturally occurring mineral deposits. Radionuclides concentrations are a known problem in groundwater sources for drinking water, such as the Dakota-Cheyenne aquifer (Malcolm Pirnie 2009). Several AVC participants currently have wells that withdraw water from this aquifer.

Radium is produced when other radioactive substances, such as uranium and thorium, break down over time. Radium is commonly found in two forms, as Radium 226 and Radium 228. Radium 226 is an alpha emitter and decays to radon. Radium 228 is a beta emitter and decays to Radium 224. The primary drinking water standard for combined radium (Radium 226 and Radium 228) is 5 pCi/L.

Gross alpha particle activity is a measurement of all alpha activity present. It is an indication for overall level of radioactivity. As uranium and radium degrade, alpha particles may be emitted, adding to the total gross alpha particle activity count. Alpha particles are typically blocked by the skin and do not pose a risk if a person is exposed from external sources. Showering and bathing do not pose a significant risk. If these particles are inhaled or consumed by eating or drinking, the emissions may directly contact sensitive tissues and increase the risk of cancer (Malcolm Pirnie 2009). The primary drinking water standard for gross alpha particle activity is 15 pCi/L.

Uranium is notably present in several areas of the Arkansas River Basin. The largest increase in median dissolved-uranium concentrations occurs between Rocky Ford and La Junta, where it more than doubles. This large change likely results from groundwater and surface water interactions and changes in geology. Concentrations of dissolved uranium in groundwater vary over about five orders of magnitude in the Arkansas River Basin and typically increase downstream along the Arkansas River (Miller et al. 2010). The Arkansas River from John Martin Reservoir to Kansas is impaired by uranium; a TMDL has not been completed (Table 4).

Table 4. Dissolved Uranium in Fountain Creek and the Lower Arkansas River

Stream Segment	Dissolved Uranium Concentration Median (µg/L)	Dissolved Uranium Concentration 85th Percentile (µg/L) (1)(2)	Dissolved Uranium Concentration Maximum (µg/L) (2)	Hardness (mg/L as $CaCO_3$)	Chronic Water Quality Standard (µg/L) (3)	Acute Water Quality Standard (µg/L) (3)	Sample Period (# of Samples)
Fountain Creek, Hwy 47 to Arkansas River (WBID COARFO02b)	8.00	11.30	12.00	338.94	30	9,223	2003-2009 (19)
Arkansas River, Wildhorse Creek to Fountain Creek (WBID COARMA03)	6.00	8.31	24.50	371.36	30	10,200	2005-2006 (8)
Arkansas River, Fountain Creek to Colorado Canal (WBID COARLA01a)	8.00	9.82	12.20	320.26	30	8,851	1998-2006 (9)
Arkansas River, Colorado Canal to John Martin Reservoir (WBID COARLA01b)	10.00	12.97	79.00	400.00	30	11,070	2003-2009 (30)
Arkansas River, below John Martin Reservoir (WBID COARLA01c)	40.50	**74.65**	78.00	400.00	30	11,070	2003-2009 (8)

Source: Health Department 2012a, 2012b

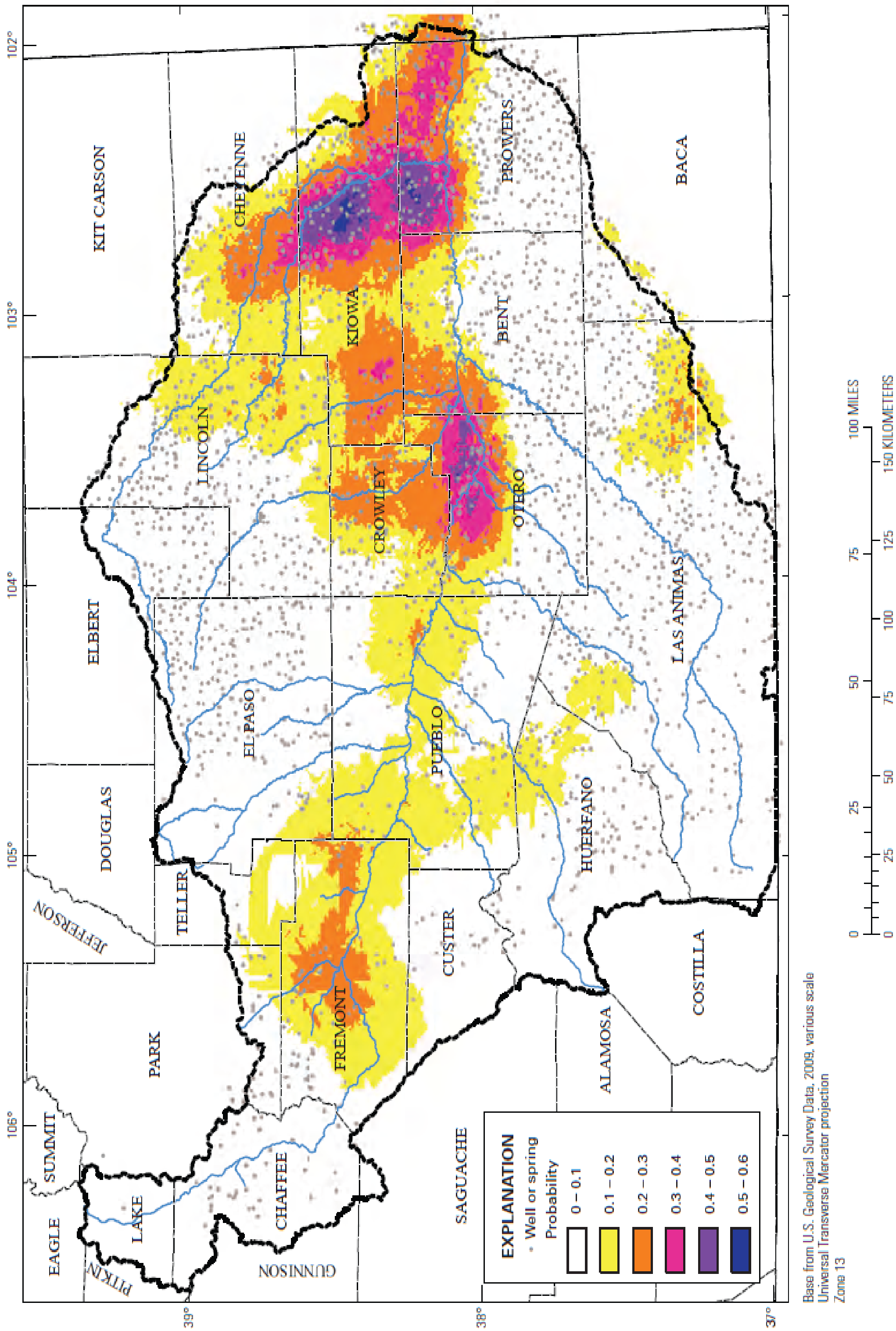
Notes:

(1) 303(d) list exceedences are indicated in **bold**.

(2) The maximum measured value is compared to the acute water quality standard. The 85th percentile value is compared to the chronic water quality standard.

(3) From Basic Standards Regulation Section 31.16, "When applying the table value standards for uranium to individual segments, the Commission shall consider the need to maintain radioactive materials at the lowest practical level as required by Section 31.11(2) of the Basic Standards regulation".

As shown in Figure 2, probabilities of exceeding the primary drinking water standard for uranium (30 µg/L) in groundwater are greatest in Otero, Kiowa, Cheyenne, and Prowers counties, where probabilities commonly range from 30 to 60. These areas coincide with those where bedrock formations (suspected sources of uranium) are present at the surface or are directly overlain by alluvial deposits (Miller et al. 2010).



Source: Miller et al. 2010

Figure 2. Probability of Exceeding Primary Drinking Water Standards for Dissolved Uranium in Groundwater

Bacteria

Most segments of Fountain Creek are impaired by *E. coli*; TMDLs have not been completed (Table 5). Birds are the suspected dominant source of *E. coli* in Upper Fountain Creek (upstream from Monument Creek), although human sources were sporadically found to contribute to *E. coli* concentrations (U.S. Geological Survey 2009). Although raw sewage spills have contaminated Fountain Creek for short periods in the past, wastewater treatment facility effluent data show that average bacteria concentrations in wastewater effluent are well below bacteria water quality standards (EPA 2007) and that effluent discharged to Fountain Creek likely dilutes bacterial densities during storm flows when bacterial densities are typically highest. In comparison, *E. coli* concentrations in the Lower Arkansas River meet standards (Health Department 2012c).

Table 5. *E. coli* Concentrations in Fountain Creek and the Lower Arkansas River

Stream Segment	Geometric Mean (count per 100 mL)(1)	Seasonal (count per 100 mL)(1)(2)	Water Quality Standard (per 100 mL)	Sample Period (# of Samples)
Fountain Creek, Hwy 47 to Arkansas River (WBID COARFO02b)	N/A	**240** (3)	126	2005-2009 (15)
Arkansas River, Wildhorse Creek to Fountain Creek (WBID COARMA03)	48	N/A	126	2002-2006 (12)
Arkansas River, Fountain Creek to Colorado Canal (WBID COARLA01a)	48	N/A	126	1998-2006 (12)
Arkansas River, Colorado Canal to John Martin Reservoir (WBID COARLA01b)	20	82(3)	126	2003-2009 (27)
Arkansas River, John Martin Reservoir to the Stateline (WBID COARLA01c)	14	39(4)	126	2003-2009 (23)

Source: Health Department 2012a, 2012b
Notes:
(1) 303(d) list exceedences are indicated in **bold**.
(2) Seasonal values correspond to months with recreational or biological concern.
(3) Season is May through October.
(4) Season is April through October.

Sulfate

The Arkansas River is sulfate impaired from Fountain Creek to the Colorado Canal; a TMDL has not been completed (Table 6). A temporary modification to the sulfate water quality standard is in place for this river segment because the Health Department and the City of Pueblo believe that some sulfate reduction is possible by implementing best management practices (Health Department 2010a).

Table 6. Sulfate Concentrations in Fountain Creek and the Lower Arkansas River

Stream Segment	85th Percentile (milligrams per liter)(1)	Water Quality Standard (milligrams per liter)	Sample Period (# of Samples)
Fountain Creek, Hwy 47 to Arkansas River (WBID COARFO02b)	440	485	2005-2009 (16)
Arkansas River, Wildhorse Creek to Fountain Creek (WBID COARMA03)	152	250	2005-2006 (4)
Arkansas River, Fountain Creek to Colorado Canal (WBID COARLA01a)	**331**	329	2003-2009 (23)
Arkansas River, Colorado Canal to John Martin Reservoir (WBID COARLA01b)	417	902	2003-2009 (23)
Arkansas River, John Martin Reservoir to the Stateline (WBID COARLA01c)	2,110	250	2003-2009 (27)

Source: Health Department 2012a, 2012b
Notes:
(1) 303(d) list exceedences are indicated in **bold**. The 85th percentile measured value is compared to the water quality standard.

Total Recoverable Iron and Other Metals

Total recoverable iron is a measure of iron in a waterbody. Alluvial groundwater from Fountain Creek to the Colorado Canal head gate is impaired for total recoverable iron (Health Department 2006). Tributaries to the Arkansas River from Pueblo Reservoir to John Martin Reservoir, such as Timpas Creek and Horse Creek, are included in the 2010 impaired streams list for total recoverable iron. Concentrations of total recoverable iron tend to be higher in lower Fountain Creek and other tributaries than in the Arkansas River (Ortiz et al. 1998).

The likely source of iron is erosion in tributaries, which contribute sediment and associated particulate iron to the Arkansas River. Particulate contaminants such as metals (e.g., iron) can be associated with suspended sediments. Total recoverable iron tends to adsorb to sediments and is transported at high levels during storm events (Edelmann et al. 2002). Ortiz et al. (1998) also noted elevated concentrations of total recoverable iron in the Arkansas River between Pueblo Reservoir and John Martin Reservoir. Edelmann and Ortiz found that between Avondale and Las Animas, concentrations were substantially higher during snowmelt runoff and post-snowmelt runoff seasons, probably due to the resuspension of settled material during high flows and tributary inflow. Additionally, the Apishapa and Purgatoire Rivers had stormflow total iron concentrations 200 to 300 times higher than any measurements in the main stem, on the order of 200,000 µg/L. Table 7 summarizes total recoverable iron data in Fountain Creek and the Lower Arkansas River.

Table 7. Total Recoverable Iron Concentrations in Fountain Creek and the Lower Arkansas River

Stream Segment	Median (µg/L)[1]	Hardness (mg/L as $CaCO_3$)	Water Quality Standard (µg/L)	Sample Period (# of Samples)
Fountain Creek, Hwy 47 to Arkansas River (WBID COARFO02b)	3,450	338.94	5,280	2005-2010 (28)
Arkansas River, Wildhorse Creek to Fountain Creek (WBID COARMA03)	112	371.36	1,000	2005-2006 (4)
Arkansas River, Fountain Creek to Colorado Canal (WBID COARLA01a)	2,765	320.26	2,765	1998- 2006 (18)
Arkansas River, Colorado Canal head gate to John Martin Reservoir (WBID COARLA01b)	1,200	400.00	1,950	2003- 2009 (23)
Arkansas River, John Martin Reservoir to the Stateline (WBID COARLA01c)	230	400.00	1,000	2003- 2009 (27)

Source: U.S. Geological Survey 2011; Health Department 2012a, 2012b
Notes:
(1) The median measured value is compared to the water quality standard.

Lake Creek exceeded water quality standards for copper (Table 8), and was listed on the 2010 impaired waters list, but has been removed from the 2012 impaired list. A TMDL for copper was recently completed for Lake Creek to address impairment of Aquatic Life Cold 1 designated use (Health Department 2010b). There are no permitted dischargers in this stream segment, and hydrothermally altered natural background copper supplies most of the pollutant. The TMDL consists of a load allocation (i.e. non-point source load) and a 10 percent margin of safety (Table 9). Improvements in the Lake Creek watershed were not identified in the TMDL.

Hydrothermal alteration is a change of rocks or minerals caused by hydrothermal processes, such as fluids accompanying or heated by magma. Ore deposits, such as lead, zinc, and copper, can occur in areas of hydrothermal alteration.

The Upper Arkansas River is not on the 2012 impaired waters list, although several TMDLs have been completed for this river segment, in response to previous years' impaired waters listings, for managing cadmium, zinc, and lead from mine drainage. Table 10 lists the dissolved metals ambient levels and targets assessed in the TMDL. Table 11 through Table 15 list the load allocations for these stream segments. The Upper Arkansas River could be relisted on the impaired waters list if load allocations and water quality standards are exceeded.

Table 8. Dissolved Copper Concentrations on Lake Creek

Stream Segment	Dissolved Copper Concentration Median (µg/L)	85th Percentile (µg/L) [(1)(2)]	Maximum (µg/L) [(2)]	Hardness (mg/L as $CaCO_3$)	Chronic Water Quality Standard (µg/L)	Acute Water Quality Standard (µg/L)	Sample Period (# of Samples)
Mainstem of Lake Creek and all Tributaries and Wetlands (WBID COARUA10)	7.00	**12.65**	44.00	44.52	4.49	6.27	2000-2004 (30)

Source: Health Department 2012a, 2012b
Notes:
(1) 303(d) list exceedences are indicated in **bold**.
(2) The maximum measured value is compared to the acute water quality standard. The 85th percentile value is compared to the chronic water quality standard.

Table 9. Total Maximum Daily Load Allocations for Copper in Lake Creek

Month	Dissolved Copper Loading: Ambient Stream Concentration (lbs/day)	TMDL Allowable Load (lbs/day)	10% Margin of Safety (lbs/day)	TMDL with 10% Margin of Safety (lbs/day)	Waste Load Allocation (lbs/day)[(1)]	Load Allocation (lbs/day)	Percent Reduction Needed to Attain Chronic Copper Table Value Standard
Jan	1.05	0.70	0.07	0.63	0.00	0.86	40
Feb	1.68	0.55	0.05	0.49	0.00	0.68	71
Mar	3.35	0.73	0.07	0.66	0.00	0.90	80
Apr	2.50	1.58	0.16	1.42	0.00	1.47	43
May	16.97	19.40	1.94	17.46	0.00	9.38	0
Jun	46.59	32.70	3.27	29.43	0.00	19.53	37
Jul	11.77	10.02	1.00	9.02	0.00	9.64	23
Aug	5.52	5.35	0.54	4.82	0.00	5.51	13
Sep	2.17	2.49	0.25	2.24	0.00	2.84	0
Oct	1.31	1.74	0.17	1.57	0.00	2.12	0
Nov	2.90	1.62	0.16	1.45	0.00	1.40	50
Dec	0.88	1.00	0.10	0.90	0.00	1.18	0

Source: Health Department 2010b
Notes:
(1) Waste load allocation is zero because there are no permitted dischargers in this reach.

Table 10. Dissolved Metals Ambient Levels and Targets Used in the Arkansas River between Lake Fork Creek and Pueblo Reservoir TMDLs

Stream Segment	Pollutant	85th Percentile (µg/L)	Chronic Water Quality Standard (µg/L)	Sample Period (# of Samples)
Mainstem of the Arkansas River between Lake Fork Creek and Lake Creek (WBID COARUA02c)	Dissolved Cadmium	0.70	1.2	2000-2005 (320)
	Dissolved Zinc	149	284	
Mainstem of the Arkansas River between Lake Creek and Pueblo Reservoir (WBID COARUA03)	Dissolved Cadmium	0.41	0.33	1999-2005 (218)
	Dissolved Zinc	98	95	
	Dissolved Lead	0.00	1.78	

Source: Health Department 2009a

Table 11. Total Maximum Daily Load Allocations for Dissolved Cadmium in the Arkansas River between Lake Fork Creek and Lake Creek

	Dissolved Cadmium Loading			
Month	Total Maximum Daily Limit (lbs/day)	Total Discharger Waste Load Allocation (lbs/day)	Abandoned Mine Waste Load Allocation (lbs/day)	Total Load Allocation (lbs/day)
Jan	0.113	0.002	0.100	0.011
Feb	0.106	0.002	0.093	0.010
Mar	0.109	0.002	0.096	0.011
Apr	0.158	0.002	0.140	0.016
May	0.583	0.002	0.522	0.058
Jun	1.406	0.002	1.264	0.140
Jul	0.695	0.002	0.623	0.069
Aug	0.336	0.002	0.301	0.033
Sep	0.235	0.002	0.210	0.023
Oct	0.181	0.002	0.161	0.018
Nov	0.147	0.002	0.131	0.015
Dec	0.138	0.002	0.122	0.014

Source: Health Department 2009a

Table 12. Total Maximum Daily Load Allocations for Dissolved Zinc in the Arkansas River between Lake Fork Creek and Lake Creek

	Dissolved Zinc Loading			
Month	Total Maximum Daily Limit (lbs/day)	Total Discharger Waste Load Allocation (lbs/day)	Abandoned Mine Waste Load Allocation (lbs/day)	Total Load Allocation (lbs/day)
Jan	28.5	0.78	25.0	2.78
Feb	26.9	0.78	23.5	2.61
Mar	27.4	0.78	24.0	2.67
Apr	39.2	0.78	34.6	3.85
May	139.3	0.78	124.7	13.85
Jun	340.4	0.78	305.6	33.96
Jul	173.1	0.78	155.1	17.23
Aug	84.2	0.78	75.1	8.34
Sep	59.7	0.78	53.1	5.89
Oct	45.7	0.78	40.4	4.49
Nov	37.3	0.78	32.8	3.65
Dec	35.4	0.78	31.2	3.47

Source: Health Department 2009a

Table 13. Total Maximum Daily Load Allocations for Dissolved Cadmium in the Arkansas River between Lake Creek and Pueblo Reservoir

Month	Dissolved Cadmium Loading: Total Maximum Daily Limit (lbs/day)	Total Waste Load Allocation (lbs/day)	Total Load Allocation (lbs/day)
Jan	0.83	0.027	0.80
Feb	0.75	0.027	0.73
Mar	0.68	0.027	0.65
Apr	0.61	0.027	0.58
May	1.07	0.027	1.04
Jun	2.13	0.027	2.10
Jul	1.26	0.027	1.24
Aug	1.25	0.027	1.23
Sep	0.80	0.027	0.77
Oct	0.79	0.027	0.76
Nov	0.85	0.027	0.82
Dec	0.91	0.027	0.88

Source: Health Department 2009a

Table 14. Total Maximum Daily Load Allocations for Dissolved Zinc in the Arkansas River between Lake Creek and Pueblo Reservoir

Month	Dissolved Zinc Loading: Total Maximum Daily Limit (lbs/day)	Total Waste Load Allocation (lbs/day)	Total Load Allocation (lbs/day)
Jan	238	7.55	231
Feb	219	7.55	211
Mar	198	7.55	191
Apr	176	7.55	169
May	295	7.55	287
Jun	589	7.55	581
Jul	344	7.55	337
Aug	356	7.55	349
Sep	232	7.55	225
Oct	233	7.55	225
Nov	245	7.55	237
Dec	265	7.55	258

Source: Health Department 2009a

Table 15. Total Maximum Daily Load Allocations for Dissolved Lead in the Arkansas River between Lake Creek and Pueblo Reservoir

Month	Dissolved Lead Loading		
	Total Maximum Daily Limit (lbs/day)	Total Waste Load Allocation (lbs/day)	Total Load Allocation (lbs/day)
Jan	4.7	0.244	4.5
Feb	4.3	0.244	4.0
Mar	3.9	0.244	3.7
Apr	3.4	0.244	3.2
May	5.2	0.244	4.9
Jun	9.9	0.244	9.7
Jul	6.0	0.244	5.8
Aug	6.8	0.244	6.5
Sep	4.7	0.244	4.4
Oct	4.7	0.244	4.4
Nov	4.8	0.244	4.6
Dec	5.4	0.244	5.1

Source: Health Department 2009a

Suspended Sediment

Suspended sediments in surface water bodies are influence by climate (i.e. rainfall) and properties of exposed rock and soil (e.g. construction sites, logging areas). Suspended sediments reduce the stream clarity, affect its visual appeal, affect benthic invertebrates, and can reduce the river channel conveyance capacity once deposited. There are no quantitative in-stream water quality guidelines for suspended sediment, sediment discharge, or sediment yield, and there is no threshold above which suspended sediment concentrations are considered a water quality concern in this analysis.

There are limited sediment data for the Arkansas River main stem. Between 1990 and 1993, United States Geological Survey collected 24 to 28 sediment samples at various gages in the Arkansas River Basin (Figure 3). Concentrations upstream from Pueblo Reservoir tended to be lower than in the Arkansas River between Pueblo Reservoir and John Martin Reservoir. Increases in concentration at the Arkansas River at Portland gage are likely caused by changing geology and agricultural land use (Ortiz et al. 1998). Pueblo Reservoir causes sediment to settle so concentrations decrease downstream from Pueblo Reservoir. Ortiz et al. (1998) found that thunderstorms can generate large sediment loads in the Arkansas River between the Fountain Creek confluence and John Martin Reservoir.

Fountain Creek is a sand-bed stream characterized by high rates of erosion and deposition, and the water tends to be cloudy. Suspended sediment concentrations in Fountain Creek have been linked to urban development (Von Guerard 1989). The median suspended sediment concentration in Fountain Creek from 2000 through 2009 was 290 mg/L, although concentrations tend to be at least 10 times greater during storm events (Figure 4). Several tributaries to Fountain Creek, such as Sand Creek and Cottonwood Creek, contribute substantial amounts of sediment to Fountain Creek. Sand Creek contributes 23 to 37 percent of the sediment load at the Fountain Creek at Security gage (Mau et al. 2007). This sediment transport eventually contributes to sediment loads entering the Arkansas River.

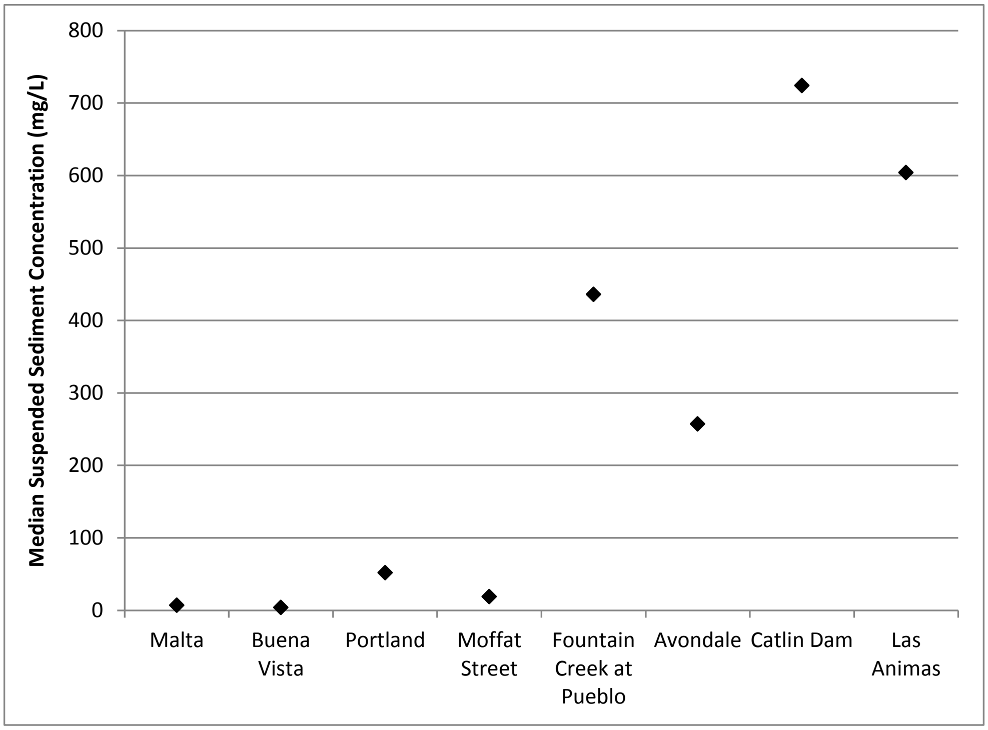


Figure 3. Median Suspended Sediment Concentrations at U.S. Geological Survey Gages, 1990 to 1993

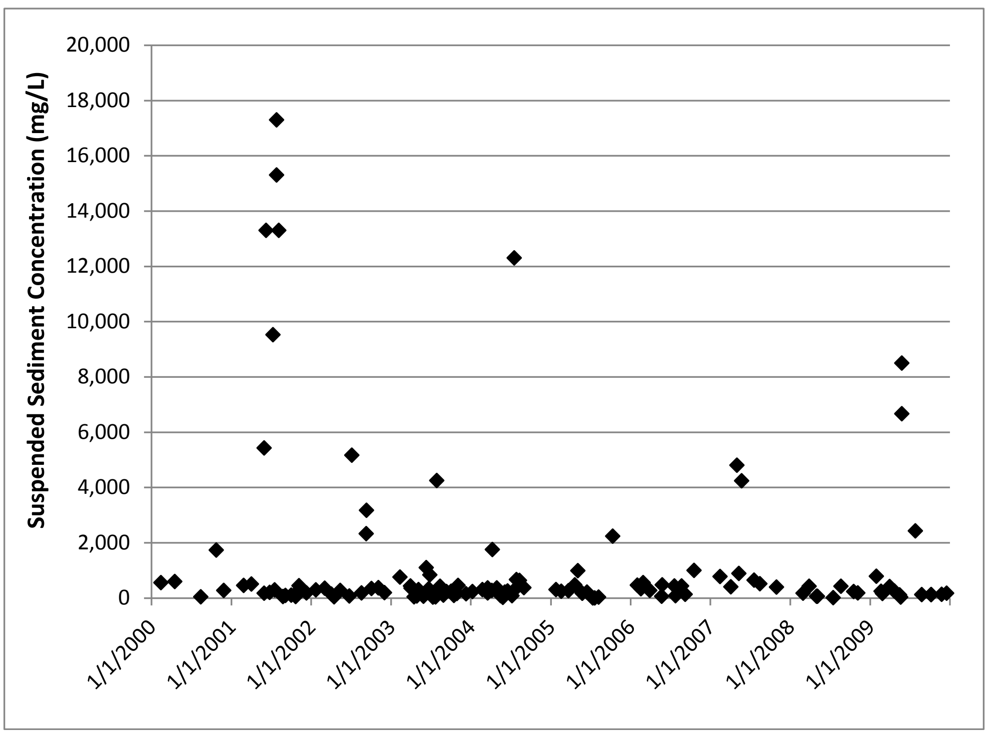
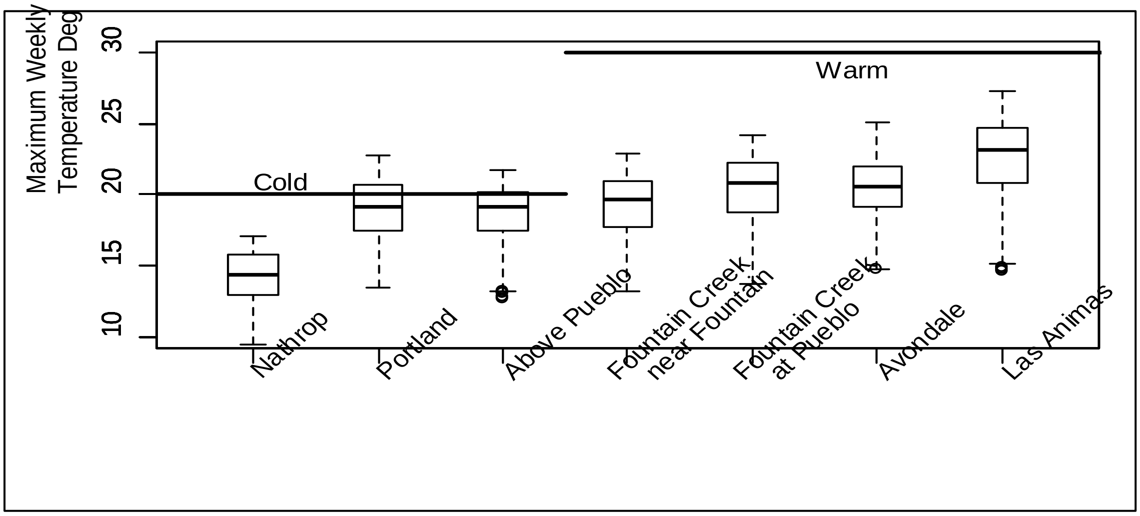


Figure 4. Suspended Sediment Concentrations for Fountain Creek at Pueblo Gage, 2000-2009

Temperature

The Arkansas River from the headwaters to the Wildhorse Creek confluence is classified (Aquatic Life use) as cold water Class I, with the remaining river classified as warm water Class I or Class II (see Chapter 3 and Appendix H). A boxplot showing maximum weekly average temperature statistics at Arkansas River and Fountain Creek gages and interim warm and cold water fishery standards is presented in Figure 5. These interim standards will soon be replaced by new numeric standards and temperature tiers (Table 16). It should be noted that proposed temperature tier numbers are not the same as Aquatic Life use classifications.



Source: USGS 2011

Figure 5. Boxplot of Summertime Maximum Weekly Average Temperatures at Arkansas River and Fountain Creek U.S. Geological Survey Gages

Table 16. Regulation No. 31 Numeric Temperature Standards

Water Body/Tier	Class 1 Cold Water Biota Standards (°C) [(1)]	Class 1 Warm Water Biota Standards (°C) [(1)]
Rivers and Streams: Tier I	Jun-Sep = 17.0 (chronic), 21.7 (acute) Oct-May = 9.0 (chronic), 13.0 (acute)	Mar-Nov = 24.2 (chronic), 29.0 (acute) Dec-Feb = 12.1 (chronic), 15.4 (acute)
Rivers and Streams: Tier II	Apr-Oct = 18.3 (chronic), 23.9 (acute) Nov-Mar = 9.0 (chronic), 13.0 (acute)	Mar-Nov = 27.5 (chronic), 28.6 (acute) Dec-Feb = 13.8 (chronic), 14.3 (acute)
Rivers and Streams: Tier III	Not applicable	Mar-Nov = 28.7 (chronic), 31.8 (acute) Dec-Feb = 14.3 (chronic), 15.9 (acute)
Lakes and Reservoir	Apr-Dec = 17.0 (chronic), 21.2 (acute) Jan-Mar = 9.0 (chronic), 13.0 (acute)	Apr-Dec = 26.3 (chronic), 29.5 (acute) Jan-Mar = 13.2 (chronic), 14.8 (acute)
Large Lakes and Reservoirs	Apr-Dec = 18.3 (chronic), 23.8 (acute) Jan-Mar = 9.0 (chronic), 13.0 (acute)	Not applicable

Note:
(1) These standards were adopted in Regulation No. 31-*The Basic Standards and Methodologies for Surface Water* in 2007. These standards will likely replace the interim temperature standards in Regulation No. 32-*Classifications and Numeric Standards for Arkansas River Basin* at the next basin triennial hearing.

Nutrients

Regulated nutrients in the study area include total phosphorus, total nitrogen, and chlorophyll *a*. Typical historical concentrations are in Table 17 and Table 18. Chlorophyll *a* data is unavailable. Nutrients and trophic state in reservoirs are discussed in the Reservoir Water Quality section below.

Table 17. Total Nitrogen Concentrations in Fountain Creek and the Lower Arkansas River

Stream Gage	Total Nitrogen (micrograms per liter)[1]	Water Quality Standard (micrograms per liter)	Sample Period (# of Samples)
Fountain Creek at Pueblo	3,210	[2]	1998-2007 (67)
Arkansas River above Pueblo	407	[2]	1998-2011 (36)
Arkansas River at Moffat St.	737	[2]	1998-2011 (5)
Arkansas River near Avondale	1,640	[2]	1988-2011 (48)
Arkansas River at La Junta	2,845	[2]	1998-2010 (24)
Arkansas River at Las Animas	1,750	[2]	1998-2007 (27)
Arkansas River below John Martin Reservoir	1,015	[2]	1998-2007 (28)

Source: USGS 2013

Notes:

(1) The measured median value is compared to the water quality standard.

(2) Water quality standard will not be in effect until after May 31, 2022. At that time, interim standards (1,250 µg/L cold streams, 2,010 µg/L warm streams) will be considered when applying numeric standards to individual stream segments.

Table 18. Total Phosphorus Concentrations in Fountain Creek and the Lower Arkansas River

Stream Gage	Total Phosphorus (micrograms per liter)[1]	Water Quality Standard (micrograms per liter)	Sample Period (# of Samples)
Fountain Creek at Pueblo	460	[2]	1998-2007 (67)
Arkansas River above Pueblo	29	[2]	1998-2011 (60)
Arkansas River at Moffat St.	22	[2]	1998-2011 (14)
Arkansas River near Avondale	310	[2]	1988-2011 (25)
Arkansas River at La Junta	119	[2]	1998-2010 (17)
Arkansas River at Las Animas	54	[2]	1998-2007 (24)
Arkansas River below John Martin Reservoir	30	[2]	1998-2007 (27)

Source: USGS 2013

Notes:

(1) The measured median value is compared to the water quality standard.

(2) Water quality standard will not be in effect until after May 31, 2022. At that time, interim standards (110 µg/L cold streams, 170 µg/L warm streams) will be considered when applying numeric standards to individual stream segments.

Reservoir Water Quality

Reservoir water quality is generally determined by the water quality of inflows; by a number of physical reservoir characteristics such as depth, temperature, evaporation rates, and circulation patterns; by residence time (i.e. the time a unit volume of water is in the reservoir); and by activity of aquatic organisms. Changes in magnitude and timing of inflows and outflows can alter reservoir stratification characteristics, which can in turn affect water quality. Reservoir water quality and trophic state (i.e. biological condition) is greatly affected by nutrient levels in reservoir inflows as well as temperature and solar intensity. High temperatures and high nutrient levels lead to algae growth and reduced dissolved oxygen, which can inhibit beneficial uses of a reservoir.

Upper Arkansas River Basin Reservoirs

Turquoise Lake and Twin Lakes water quality is generally good (Table 19 and Table 20), although Twin Lakes is listed on the 2012 impairment list for copper. Historical dissolved copper concentration data for Twin Lakes Reservoir is in Table 21.

Table 19. Summary of Historical Water Quality Data for Turquoise Lake

Parameter	Turquoise Lake Ambient Water Quality [1] (Site Number 7144a)	Turquoise Lake Ambient Water Quality [1] (Site Number 7144b)	Standard
Temperature, C	[2]	[2]	18.3º C (Apr-Dec chronic); 9.0º C (Jan-Mar chronic)
Dissolved Oxygen , mg/L	6.4	5.2	6.0 mg/L
pH, standard units	5.9-7.6	4.7-6.9	6.5 to 9.0
E. coli, #/100 mL	< 1.0	[2]	126/100 mL
Sulfate, mg/L	3.0	3.0	250 mg/L
Iron (total recoverable), 1,000 µg/L	51	184	1,000 µg/L
Copper, µg/L	< 5.0	< 5.0	[3
Lead, µg/L	< 1.0	< 1.0	[3]
Manganese, µg/L	< 2.0	3.0	[3]
Selenium, µg/L	< 1.0	< 1.0	[3]
Zinc, µg/L	< 10.0	< 10.0	[3]
Total Nitrogen, µg/L	< 800	< 800	[4]
Total Phosphorus, µg/L	8.0	10.0	[4]
Chlorophyll *a*	1,100	[2]	[4]

Source: USGS 2013

Notes:

(1) 2005-2006 period of record, n = 5 (7144a), n = 4 (7144b)

(2) Data not available.

(3) Data not available to calculate table value standard.

(4) Water quality standard will not be in effect until after May 31, 2022. At that time, interim standards (426 µg/L total nitrogen, 25 µg/L total phosphorus, 8 µg/L chlorophyll *a*) will be considered when applying numeric standards to individual stream segments.

Table 20. Summary of Historical Water Quality Data for Twin Lakes

Parameter	Twin Lakes Ambient Water Quality (1) (Site Number 7173a)	(Site Number 7173b)	(Site Number 7174a)	(Site Number 7174b)	Standard
Temperature, C	(2)	(2)	(2)	(2)	18.3º C (Apr-Dec chronic); 9.0º C (Jan-Mar chronic)
Dissolved Oxygen , mg/L	6.9	5.1	7.0	6.5	6.0 mg/L
pH, standard units	7.4-7.8	7.0-7.3	7.4-7.9	7.0-7.6	6.5 to 9.0
E. coli, #/100 mL	1.0	(2)	2.0	(2)	126/100 mL
Sulfate, mg/L	12.0	12.0	16.8	13.0	250 mg/L
Iron (total recoverable), 1,000 µg/L	66.8	65.6	155.5	180.0	1,000 µg/L
Lead, µg/L	< 1.0	< 1.0	< 1.0	< 1.0	0.51-0.71 µg/L (chronic), varies by site
Manganese, µg/L	< 2.0	5.0	3.9	5.4	1,022-1,128 µg/L (chronic), varies by site
Selenium, µg/L	1.2	< 1.0	1.3	1.0	4.6 µg/L (chronic)
Zinc, µg/L	< 10.0	< 10.0	< 10.0	< 10.0	36-47 µg/L (chronic), varies by site
Total Nitrogen, µg/L	< 800	< 800	< 800	890	(4)
Total Phosphorus, µg/L	4.0	4.0	6.0	6.0	(4)
Chlorophyll *a*	1,100	(2)	900	(2)	(4)

Source: USGS 2013
Notes:
(1) 2005-2006 period of record, n = 5 (7174a), n = 4 (7173a, 7173b, 7174b)
(2) Data not available.
(3) Water quality standard will not be in effect until after May 31, 2022. At that time, interim standards (426 µg/L total nitrogen, 25 µg/L total phosphorus, 8 µg/L chlorophyll *a*) will be considered when applying numeric standards to individual stream segments.

Table 21. Dissolved Copper Concentration in Twin Lakes Reservoir

Reservoir Site	Dissolved Copper Concentration: Median (µg/L)	85th Percentile (µg/L)(1)(2)	Maximum (µg/L)(2)	Hardness (mg/L as $CaCO_3$)	Chronic Water Quality Standard (µg/L)	Acute Water Quality Standard (µg/L)	Sample Period (# of Samples)
Twin Lakes Reservoir (Site Number 7174a)	3.0	7.6	10.0	27.8	8.0	4.0	2005-2010 (6)
Twin Lakes Reservoir (Site Number 7174b)	8.0	9.0	9.0	23.8	8.0	3.5	2006-2010 (5)

Source: Health Department 2012a, 2012b
Notes:
(1) 303(d) list exceedences are indicated in bold.
(2) The maximum measured value is compared to the acute water quality standard. The 85th percentile value is compared to the chronic water quality standard.

Pueblo Reservoir

The quality of inflows to Pueblo Reservoir from the Upper Arkansas River tends to be good with no impairments listed for streamflow into the reservoir in the 2012 303(d) list. Table 22 provides a summary of historical water quality values for Pueblo Reservoir releases. Historical uranium concentrations at the Arkansas River above Pueblo gage (indicative of Pueblo Reservoir release concentrations) are in Figure 6.

Table 22. Summary of Historical Water Quality Data for Pueblo Reservoir Releases

Parameter	Average Annual Water Quality[1]				Standard[2][3]
	1st Quarter (Jan-Mar)	2nd Quarter (Apr-Jun)	3rd Quarter (Jul-Sep)	4th Quarter (Oct-Nov)	
Temperature, C	8.6	13.4	20.5	13.0	N/A
Dissolved Oxygen , mg/L	11.5	10.0	8.5	9.3	6.0 mg/L
Turbidity, NTU	1.7	3.4	6.3	5.1	Treatment technique[4]
pH, standard units	8.4	8.3	8.0	8.3	6.5 to 9.0[3]
Alkalinity, mg/L as $CaCO_3$	127	120	98	121	N/A
Hardness, mg/L as $CaCO_3$	208	199	156	201	N/A
Total Dissolved Solids, mg/L	337	321	253	311	500[3]
Total Organic Carbon, mg/L	2.0	2.2	2.3	2.2	Treatment technique[5]
Sodium, mg/L	23.3	24.0	16.0	21.4	N/A
Nitrate, mg/L as N	0.27	0.22	0.22	0.15	10[2]
Chloride, mg/L	9.2	8.9	8.0	9.4	250[3]
Bromide[6], mg/L	0.027	0.026	0.024	0.028	N/A
Fluoride, mg/L	0.59	0.50	0.46	0.51	4.0[2]/2.0[3]
Sulfate, mg/L	130	123	97	123	250[3]
Silica, mg/L as SiO_2	12	9.6	10	12	N/A
Iron, mg/L	0.008	0.016	0.010	0.009	0.3[3]
Manganese, mg/L	0.004	0.007	0.010	0.020	0.05[3]
Arsenic, mg/L	< 0.001	< 0.001	< 0.001	< 0.001	0.01[2]
Selenium, mg/L	0.004	0.004	0.003	0.004	0.05[2]

Source: USGS 2010; BWWP 2011

Key: N/A – not applicable, NTU – nephelometric turbidity units

Notes:

(1) Samples collected at varying frequencies from 1986 to 2010. Not all parameters measured in each sample.

(2) Enforceable primary drinking water maximum contaminant level.

(3) Non-enforceable secondary drinking water maximum contaminant level.

(4) Less than 0.3 NTU in 95 percent of monthly filter effluent samples and less than 1 NTU in all filter effluent samples.

(5) Removal of constituent for conventional treatment facilities varies with source water total organic carbon and alkalinity concentrations (per Stage 1 Disinfectants and Disinfection Byproducts Rule).

(6) Bromide calculated based on correlation with chloride concentration (Magazinovic, 2004).

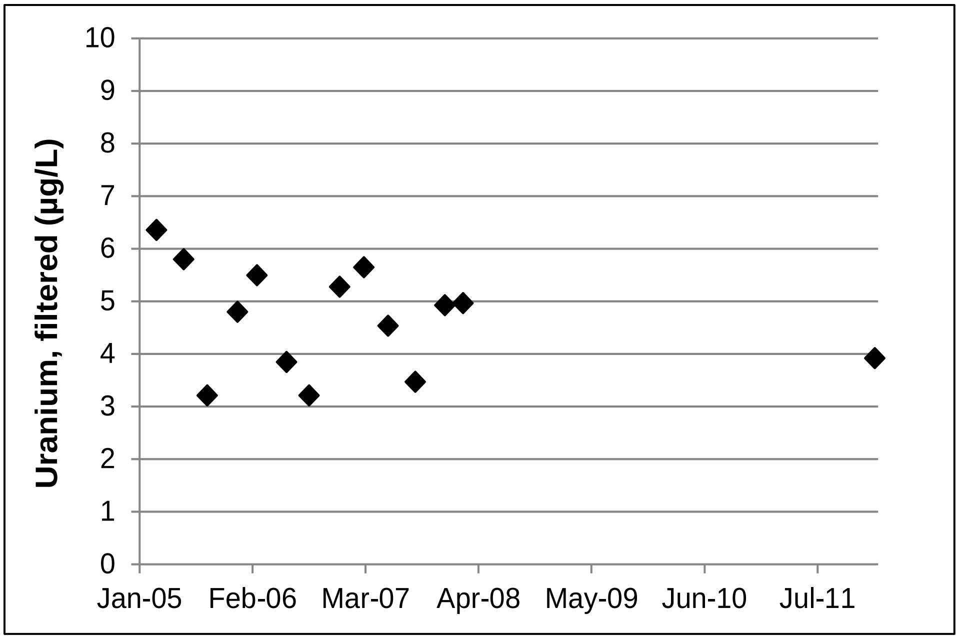


Figure 6. Historical Uranium Concentrations at the Arkansas River Above Pueblo Gage

Lower Arkansas River Basin Reservoirs

Salinity levels in Lake Henry and Lake Meredith typically exceed agricultural tolerances and secondary drinking water guidelines in Lake Henry and Lake Meredith (Table 23). Lake Henry, Lake Meredith, and John Martin Reservoir are on the 2012 impaired list for selenium. Other Lake Henry, Lake Meredith, and John Martin Reservoir water quality parameters are in Table 24, Table 25, and Table 26.

Table 23. Lower Arkansas River Basin Reservoir Water Quality

Parameter	Lake Henry 85th Percentile (1)	Lake Meredith 85th Percentile (1)	John Martin Reservoir 85th Percentile (1)
Total Dissolved Solids, mg /L	1,007	2,955	2,225
Selenium, µg /L	**13.6**	**5.4**	**9.7**

Source: Health Department 2012a, 2012b
Notes:
(1) 303(d) list exceedences are indicated in **bold**. The 85th percentile measured value is compared to the water quality standard.

Table 24. Summary of Historical Water Quality Data for Lake Henry

Parameter	Lake Henry Ambient Water Quality (1) (Site Number 7830a1)	Lake Henry Ambient Water Quality (1) (Site Number 7830b1)	Standard
Temperature, C	(2)	(2)	26.3º C (Apr-Dec chronic); 13.2º C (Jan-Mar chronic)
Dissolved Oxygen , mg/L	6.5	6.9	5.0 mg/L
pH, standard units	8.1-8.3	8.2-8.3	6.5 to 9.0
E. coli, #/100 mL	1	2	126/100 mL
Iron (total recoverable), 1,000 µg/L	1,120	336	1,000 µg/L
Copper, µg/L	< 5.0	< 5.0	(3
Lead, µg/L	< 1.0	< 1.0	(3)
Manganese, µg/L	10.0	6.7	(3)
Zinc, µg/L	11.0	11.0	(3)
Total Nitrogen, µg/L	< 1,000	< 1,400	(4)
Total Phosphorus, µg/L	80.0	22.0	(4)
Chlorophyll *a*	14,100	3,200	(4)

Source: USGS 2013
Notes:
(1) 2005-2006 period of record, n = 5 (7830a1), n = 3 (7830b1)
(2) Data not available.
(3) Data not available to calculate table value standard.
(4) Water quality standard will not be in effect until after May 31, 2022. At that time, interim standards (910 µg/L total nitrogen, 83 µg/L total phosphorus, 20 µg/L chlorophyll *a*) will be considered when applying numeric standards to individual stream segments.

Table 25. Summary of Historical Water Quality Data for Lake Meredith

Parameter	Lake Meredith Outlet Ambient Water Quality (1)	Standard
Temperature, C	(2)	26.3º C (Apr-Dec chronic); 13.2º C (Jan-Mar chronic)
Dissolved Oxygen , mg/L	6.4	5.0 mg/L
pH, standard units	7.4-8.0	6.5 to 9.0
E. coli, #/100 mL	(2)	126/100 mL
Iron (total recoverable), 1,000 µg/L	(2)	1,000 µg/L
Copper, µg/L	(2)	(3
Lead, µg/L	(2)	(3)
Manganese, µg/L	350.7	(3)
Zinc, µg/L	(2)	(3)
Total Nitrogen, µg/L	< 6,000	(4)
Total Phosphorus, µg/L	639	(4)
Chlorophyll *a*	(2)	(4)

Source: USGS 2013
Notes:
(1) 2002-2003 period of record, n = 8
(2) Data not available.
(3) Data not available to calculate table value standard.
(4) Water quality standard will not be in effect until after May 31, 2022. At that time, interim standards (910 µg/L total nitrogen, 83 µg/L total phosphorus, 20 µg/L chlorophyll *a*) will be considered when applying numeric standards to individual stream segments.

Table 26. Summary of Historical Water Quality Data for John Martin Reservoir

Parameter	John Martin Reservoir Ambient Water Quality [(1)] (Site Number 7524a)	(Site Number 7521a)	Standard
Temperature, C	[(2)]	[(2)]	26.3º C (Apr-Dec chronic); 13.2º C (Jan-Mar chronic)
Dissolved Oxygen , mg/L	6.6	6.2	5.0 mg/L
pH, standard units	7.9-8.3	7.8-8.4	6.5 to 9.0
E. coli, #/100 mL	[(2)]	6	126/100 mL
Iron (total recoverable), 1,000 µg/L	1,521	842	1,000 µg/L
Copper, µg/L	< 5.0	< 5.0	[(3)]
Lead, µg/L	< 1.0	< 1.0	[(3)]
Manganese, µg/L	11.0	21.8	90 µg/L chronic
Zinc, µg/L	11.0	< 10.0	[(3)]
Total Nitrogen, µg/L	< 800	< 800	[(4)]
Total Phosphorus, µg/L	13.0	40.0	[(4)]
Chlorophyll *a*	31,150	18,650	[(4)]

Source: USGS 2013
Notes:
[(1)] 2005-2006 period of record, n = 3 (7524a), n = 6 (7521a)
[(2)] Data not available.
[(3)] Data not available to calculate table value standard.
[(4)] Water quality standard will not be in effect until after May 31, 2022. At that time, interim standards (910 µg/L total nitrogen, 83 µg/L total phosphorus, 20 µg/L chlorophyll *a*) will be considered when applying numeric standards to individual stream segments.

Reverse Osmosis Brine Reject Concentrate

La Junta and Las Animas use reverse osmosis in their water treatment process and discharge brine reject concentrate to the Arkansas River. The quality of reverse osmosis brine reject concentrate for Las Animas is in Table 27, respectively. No data is readily available on La Junta's reverse osmosis process waste stream characteristics. Both entities release the reverse osmosis rejection concentrate to the Arkansas River under permits issued by the Health Department.

Table 27. Las Animas RO Rejection Concentrate Water Quality

Parameter	Unit	Measured Value
Uranium	µg /L	87
Alpha emitting Radium	pCi/L	0.36
Gross Alpha	pCi/L	36
Gross Beta	pCi/L	17
Radium 228	pCi/L	14

Source: Health Department 2009b

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Attachment A

Colorado’s 2012 Section 303(D) List of Impaired Waters and Monitoring and Evaluation List (Arkansas River Basin)

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

WATER QUALITY CONTROL COMMISSION

5 CCR 1002-93

REGULATION #93

COLORADO'S SECTION 303(D) LIST OF IMPAIRED WATERS AND MONITORING AND EVALUATION LIST

ADOPTED:	**MARCH 17, 2004**
EFFECTIVE:	**MAY 3, 2004**
ADOPTED:	**MARCH 14, 2006**
EFFECTIVE:	**APRIL 30, 2006**
ADOPTED:	**MARCH 11, 2008**
EFFECTIVE:	**APRIL 30, 2008**
ADOPTED:	**MARCH 9, 2010**
EFFECTIVE:	**APRIL 30, 2010**
ADOPTED:	**FEBRUARY 13, 2012**
EFFECTIVE:	**MARCH 30, 2012**

DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

WATER QUALITY CONTROL COMMISSION

5 CCR 1002-93

REGULATION #93

COLORADO'S SECTION 303(D) LIST OF IMPAIRED WATERS AND MONITORING AND EVALUATION LIST

93.1 Authority

These regulations are promulgated pursuant to section 25-8-101 et seq C.R.S. as amended, and in particular, 25-8-202 (1) (a), (b), (i), (2) and (6); 25-8-203 and 25-8-204.

93.2 Purpose

This regulation establishes Colorado's List of Water-Quality-Limited Segments Requiring Total Maximum Daily Loads ("TMDLs") and Colorado's Monitoring and Evaluation List.

(1) The list of Water-Quality-Limited Segments Requiring TMDLs fulfills requirements of section 303(d) of the federal Clean Water Act which requires that states submit to the U.S. Environmental Protection Agency a list of those waters for which technology-based effluent limitations and other required controls are not stringent enough to implement water quality standards.

(2) Colorado's Monitoring and Evaluation List identifies water bodies where there is reason to suspect water quality problems, but there is also uncertainty regarding one or more factors, such as the representative nature of the data. Water bodies that are impaired, but it is unclear whether the cause of impairment is attributable to pollutants as opposed to pollution, are also placed on the Monitoring and Evaluation List. This Monitoring and Evaluation list is a state-only document that is not subject to EPA approval.

93.3 Water Bodies Requiring TMDLs or Identified for Monitoring and Evaluation

Only those segments where a Clean Water Section 303(d) Impairment has been determined require TMDLs. For these segments, TMDLs are only required for those parameters that are identified as impairments. Listings marked with an asterisk (*) are carryover from the 1998 303(d) List. Consequently they are all high priority.

WBID	Segment Description	Portion	Colorado's Monitoring & Evaluation Parameter(s)	Clean Water Act Section 303(d) Impairment	303(d) Priority
COAR	**Arkansas River Basin**				

WBID	Segment Description	Portion	Colorado's Monitoring & Evaluation Parameter(s)	Clean Water Act Section 303(d) Impairment	303(d) Priority
COARFO01a	Fountain Creek and tributaries above Monument Creek	all		*E. coli*	H
COARFO02a	Fountain Creek, Monument Creek to Hwy 47	all	Fe(Trec)	*E. coli*	H
COARFO02b	Fountain Creek from Hwy 47 to the Arkansas River	all		*E.coli* (May-October)	H
COARFO04	All tribs to Fountain Creek, which are not on National Forest or Air Force Academy Land	all		*E.coli*	H
COARFO04	All tribs to Fountain Creek, which are not on National Forest or Air Force Academy Land	Sand Creek	Aquatic Life		
COARFO06	Monument Creek from National Forest to Fountain Creek	All (for *E. coli*)		*E.coli* (May-October)	H
COARFO07a	Pikeview Reservoir, Willow Springs Ponds #1 and #2	Willow Springs Ponds #1 & #2		Aquatic Life Use (PCE FCA)	M
COARLA01a	Arkansas River, Fountain Creek to Colorado Canal headgate	all		Se, SO_4	L
COARLA01b	Arkansas River, Colorado Canal headgate to John Martin Reservoir	all		Se	L
COARLA01c	Arkansas River, John Martin Reservoir to stateline	all		Se, U	L
COARLA04	Apishapa River, Timpas Creek, Lorencito Canyon	Apishapa River, Timpas Creek		Se	L
COARLA04	Apishapa River, Timpas Creek, Lorencito Canyon	Timpas Creek		Fe(Trec)	H

WBID	Segment Description	Portion	Colorado's Monitoring & Evaluation Parameter(s)	Clean Water Act Section 303(d) Impairment	303(d) Priority
COARLA05b	Trinidad Reservoir, Long Canyon Reservoir, and Lake Dorothey	Trinidad Reservoir		Aquatic Life Use (Hg Fish Tissue), D.O. (Temperature)	H
COARLA07	Purgatoire River, I-25 to Arkansas River	all	Sediment	Se	L
COARLA09a	Mainstem of Adobe Creek and Gageby Creek…	all		Se	L
COARLA09a	Mainstem of Adobe Creek and Gageby Creek…	Horse Creek		Fe(Trec)	H
COARLA09a	Mainstem of Adobe Creek and Gageby Creek…	Adobe Creek		*E. coli*	H
COARLA09b	Apache Creek, Breckenridge Creek, Little Horse Creek, Bob Creek, Wildhorse Creek, Wolf Creek, Big Sandy Creek	all		Se	L
COARLA09c	Rule Creek, Muddy Creek, Caddoa Creek, Clay Creek, Cat Creek…	As specified to right	Zn (Rule Creek)	Fe(Trec), Se (Chicosa Creek)	L
COARLA10	Two Buttes Res., Two Buttes Pond, Hasty Lake, Holbrook Res., Burchfield Lake, Nee-Skah (Queens) Res., Adobe Creek Res., Neeso Pah Res., Nee Nosha Res., Nee Gronda Res.	Adobe Creek Res., Nee Gronda Res		Se	L
COARLA11	John Martin Reservoir	all		Se	L
COARLA12	Lake Henry, Lake Meredith	all		Se	L
COARMA04a	Wildhorse Creek	all	NO_2	*E. coli*, Se	H/L

WBID	Segment Description	Portion	Colorado's Monitoring & Evaluation Parameter(s)	Clean Water Act Section 303(d) Impairment	303(d) Priority
COARMA06	St. Charles River and tributaries, CF&I diversion to Arkansas River	all	U	Se	L
COARMA07	Greenhorn Creek, including all tributiaries, from source to Greenhorn Highline Diversion Dam; Graneros Creek; North Muddy Creek	all	Cu, Zn		
COARMA09	Greenhorn Creek, including tributaries, from Greenhorn Highline Diversion Dam to the St. Charles River	all	Se		
COARMA10	Sixmile Creek	all		Fe(Trec), Se	L
COARMA12	Huerfano River, from Muddy Creek to the Arkansas River	all		Se	L
COARMA14	Cucharas River, from Walsenburg PWS diversion to the outlet of Cucharas Reservoir	all		Se	L
COARMA16	Huajatolla Reservoir, Diagre Reservoir, Walsenburg Lower Town Lake, Horseshoe Lake and Martin Lake (Ohem Lake)	Horseshoe Lake		Aquatic Life Use (Hg Fish Tissue)	H
COARMA18a	Boggs Creek	all		Se, Zn, U	H
COARUA05	All tributaries to the Arkansas River from the source to immediately below the confluence with Browns Creek	Lake Fork below Sugarloaf Dam to the confluence with the Arkansas River	Aquatic Life		
COARUA08b	Iowa Gulch from ASARCO water supply intake to Paddock #1 Ditch (Iowa Ditch)	all		Cd, Pb, Zn	M

WBID	Segment Description	Portion	Colorado's Monitoring & Evaluation Parameter(s)	Clean Water Act Section 303(d) Impairment	303(d) Priority
COARUA10	Mainstem of Lake Creek and all tributaries, lakes and reservoirs from source to Arkansas River (including Twin Lakes Reservoir)	all, excluding Twin Lakes Reservoir		pH, D.O.	H
COARUA10	Mainstem of Lake Creek and all tributaries, lakes and reservoirs from source to Arkansas River (including Twin Lakes Reservoir)	Twin Lake West		Cu	H
COARUA14b	Tributaries to the Arkansas River, from Pueblo Reservoir to Colorado Canal headgate	Teller Reservoir	Aquatic Life Use (Hg Fish Tissue)		
COARUA15	Grape Creek including De Weese Res., Texas, Badger, Hayden, Hamilton, Stout and Big Cottonwood Creeks, Newland Creek	De Weese Reservoir		D.O.	H
COARUA20	Fourmile Creek and tributaries, Cripple Creek to Arkansas River	North Fork Wilson Creek below Independence Mine		As	
COARUA21a	Mainstem of Cripple Creek from the source to a point 1.5 miles upstream of the confluence with Fourmile Creek.	all		Aquatic Life (provisional)	L
COARUA27	Mainstem of Eightmile Creek, including all tributaries, wetlands, lake and reservoirs, from the source to the mouth of Phantom Canyon; Brush Hollow Reservoir	Brush Hollow Reservoir		Aquatic Life Use (Hg Fish Tissue), D.O.	H
COGU	**Gunnison River Basin**				

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Appendix F.2 – Water Quality Analyses

Contents

Tables

Figures

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This appendix presents the water quality effects analyses for different constituents and areas of concern within the study area.

Salinity Analysis

This section describes how the AVC EIS alternatives effects on salinity were evaluated by developing, calibrating, and applying a model that simulates changes in salinity due to physical and operational changes in river flow.

Methods

Triana et al. (2010) developed the GeoDSS, a geo-referenced Decision Support System for Agro-environmental enhancement of Colorado's Lower Arkansas River Basin. The GeoDSS features tools for calibrating and simulating flows and water quality in river basins. The GeoDSS flow modeling is based on MODSIM, a generalized River Basin Management Decision Support System (Labadie 2006). GeoDSS includes a water quality module for conservative constituent simulation that allows estimating unmeasured concentration of inflows based on the simulated concentrations and the measured concentration at control points (i.e., gage stations with measured concentration).

As discussed in Chapter 3 of the EIS, salinity is a concern in the Lower Arkansas River and Fountain Creek, particularly in the Arkansas River downstream from the Avondale gage, as well as in Fountain Creek from Jimmy Camp Creek to the Arkansas River. The salinity model encompasses the area of concern and also extends far enough upstream to simulate physical and operational changes associated with the alternatives. The model includes the Arkansas River from Pueblo Reservoir to the Arkansas River at Las Animas gage and Fountain Creek downstream from Colorado Springs.

Figure 1 depicts the salinity model study area, United States Geological Survey (USGS) and Colorado Division of Water Resources gages with salinity measurements used in model development, and approximate locations of the wastewater treatment facilities (WWTFs) accounted for in the model. Although some stream gages are operated by the Colorado Division of Water Resources, all of the data were obtained from the USGS, and therefore, the USGS gage names and numbers are referenced.

Salinity is the amount of mineral salts dissolved in water. It can be measured directly by determining the total dissolved solids (TDS) concentration. An indirect measurement of salinity is specific conductance, or how well water can conduct electricity. Salinity is directly correlated with specific conductance; however, the relationship between specific conductance and TDS changes with location and concentration levels. Specific conductance is easily measured with a probe and is the most common measure of salinity in the study area. Therefore, these relationships were used to estimate TDS at the controls points. The unit of measure of salinity used in this model is TDS in milligrams per liter (mg/L).

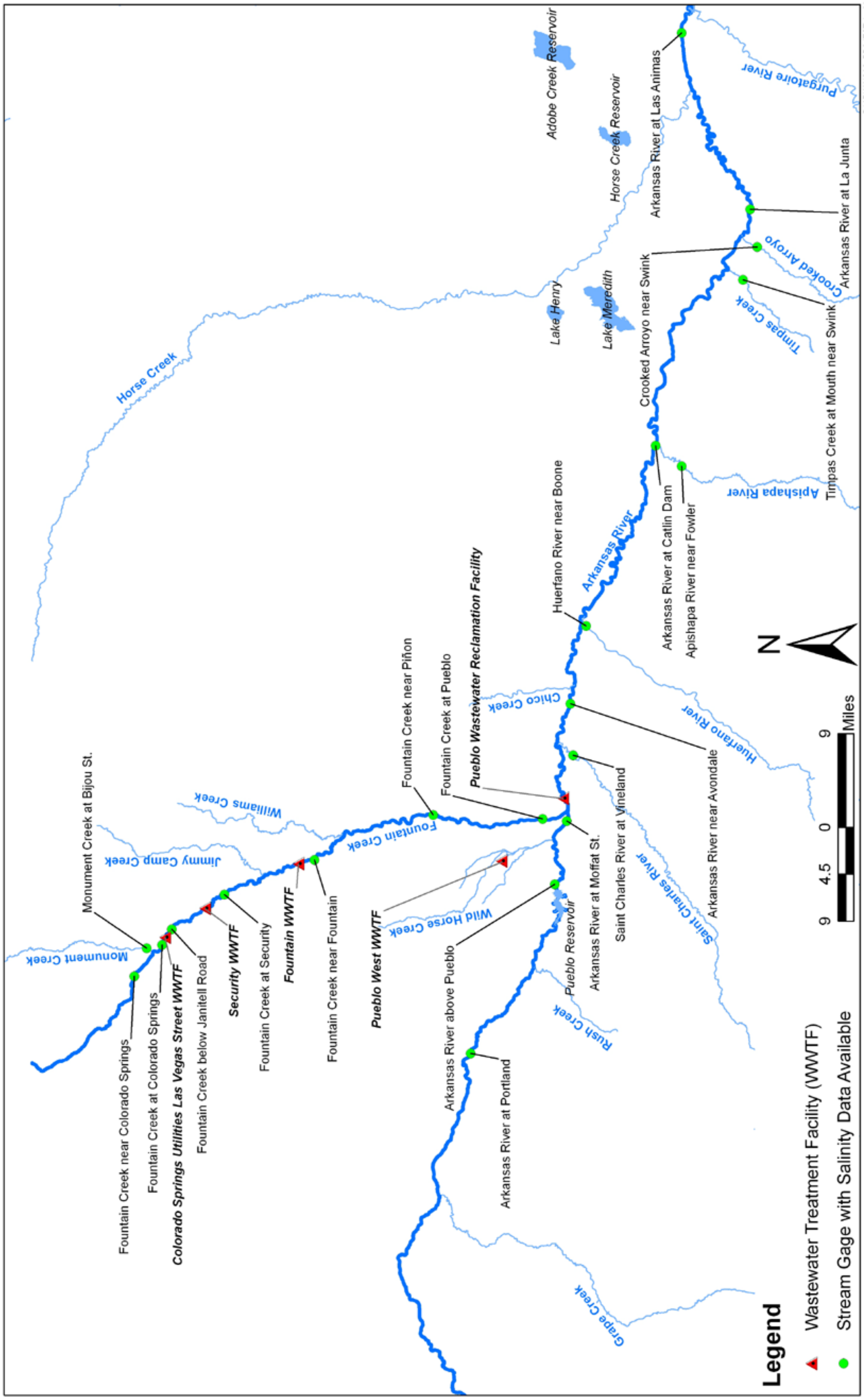


Figure 1. Salinity Model Study Area and Control Point/Gage Locations

A mass balance approach was selected to model salinity in the Lower Arkansas River Basin. The GeoDSS was coupled with the MODSIM Daily Model to evaluate effects of the alternatives on salinity concentrations based on simulated changes in flow conditions from the Daily Model. The salinity model, implemented in the GeoDSS water quality module, was calibrated to match measured concentrations at control points, estimating the concentration of measured and unmeasured inflows without defined/measured concentration. The salinity model was used to compare salinity among alternatives. It should not be used as an absolute prediction of future water quality, but as an indication of relative water quality effect among alternatives.

Model Study Period

Changes in salinity were analyzed using a 10-year model study period, from 1999 through 2009, based on the original GeoDSS study period extended through the Daily Model study period. Weekly time steps were selected as the model interval to reasonably capture the concentration variability based on the limited data availability throughout the study area.

Table 1summarizes the period of record for stream gages salinity measurements available at the time of model construction at regular and irregular measurement intervals. *Regular* measurements refer to data taken at constant intervals of time and *irregular* measurement refers to samples taken during field visits at variable intervals. Table 1 lists number of measurements available for each station, data type and abbreviations used in this appendix.

Table 1. Daily Salinity Data Period of Record for Stream Gages

Gage Name	Abbreviation	Measurement Interval	Number of Measurements	Daily Salinity Data Period of Record
Arkansas River at Portland	7097000	Irregular	6,659	Oct/1990 - Sep/2009
Arkansas River above Pueblo	ARKPUECO	Irregular	651	Oct/1965 - Dec/2010
Arkansas River above Pueblo	ARKPUECO	Regular	8,480	Apr/1986 - Sep/2009
Arkansas River at Moffat St.	ARKMOFCO	Irregular	287	Oct/1988 - Dec/2010
Arkansas River at Moffat St.	ARKMOFCO	Regular	7,572	Oct/1988 - Sep/2009
Fountain Creek near Colorado Springs	07103700	Regular	6,940	Oct/1990 - Sep/2009
Fountain Creek near Colorado Springs	07103700	Irregular	841	Oct/1971 - Dec/2010
Monument Creek at Bijou St.	07104905	Regular	6,940	Oct/1990 - Sep/2009
Fountain Creek at Colorado Springs	07105500	Irregular	997	Nov/1970 - Dec/2010
Fountain Creek below Janitell Road	07105530	Regular	6,940	Oct/1990 - Sep/2009
Fountain Creek at Security	07105800	Irregular	715	Nov/1970 - Dec/2010
Fountain Creek near Fountain	07106000	Irregular	236	Jun/1905 - Oct/2010
Fountain Creek near Fountain	07106000	Regular	6,940	Oct/1990 - Sep/2009
Fountain Creek near Piñon	FOUPINCO	Irregular	1,419	Apr/1973 - Nov/2011
Fountain Creek at Pueblo	FOUPUECO	Irregular	1,458	Nov/1963 - Dec/2010
Fountain Creek at Pueblo	FOUPUECO	Regular	6,940	Oct/1990 - Sep/2009
Saint Charles River at Vineland St.	STCHARCO	Regular	6,940	Oct/1990 - Sep/2009
Arkansas River near Avondale	ARKAVOCO	Irregular	1,866	Feb/1969 - Dec/2010
Arkansas River near Avondale	ARKAVOCO	Regular	8,837	Jul/1979 - Sep/2009
Huerfano River near Boone	HUEBOOCO	Irregular	386	Apr/1976 - Nov/2011
Arkansas River at Catlin Dam	ARKCATCO	Irregular	6,609	Oct/1990 - Sep/2009
Apishapa River near Fowler	APIFOWCO	Irregular	520	Nov/1963 - Nov/2011
Timpas Creek at Mouth	TIMSWICO	Irregular	525	Mar/1967 - Nov/2011
Crooked Arroyo near Swink	CANSWKCO	Irregular	289	Dec/1968-Sep/1993
Arkansas River at La Junta	ARKLAJCO	Irregular	131	Oct/1961 - Nov/2009
Arkansas River at Las Animas	ARKLASCO	Irregular	9,400	Nov/1945 - Sep/2009
Arkansas River at Las Animas	ARKLASCO	Regular	6,422	Dec/1985 - Sep/2005

Historical salinity data for gages with missing data were simulated using flow and salinity relationships derived from available data. This was done so that the baseline salinity model could be calibrated to evaluate changes in concentration for the alternatives for the selected study period.

General Model Organization

The model was designed for a relative comparison of the effects of the alternatives on the salinity of the system. The approach established a baseline salinity condition based on historical measurements of specific conductance and relationships between flow and specific conductance at control points (gages with measured concentrations). Unknown sources of salinity were estimated based on mass balance computations in river segments between control points.

The main assumption of the salinity modeling was that the changes in salt loads in the system would be driven mainly by changes in flows, and the underlying physical processes that are the source of the salinity loading to the system would remain relatively unchanged for the alternatives. For example, groundwater return flows were assumed to have the same historical concentration and salt load changes were a function of return flow changes.

Regression equations to represent the relationship between specific conductance and flow were used at control points to fill in missing data. The locations in the main rivers where regression equations were used include: the Monument Creek at Bijou St. gage, Fountain Creek near Colorado Springs gage, Fountain Creek below Janitell Road gage, Fountain Creek at Pueblo gage, Arkansas River at Portland gage, Arkansas River at Moffat St. gage, Arkansas River above Pueblo gage, Arkansas River near Avondale gage, Arkansas River at Catlin Dam gage, and Arkansas River at Las Animas gage. Historical regression equations were also used to predict salinity in large tributaries, including the St. Charles River, Timpas Creek, Huerfano River, Crooked Arroyo and Apishapa River. Figure 2 shows a schematic of the model under existing conditions with the control points used to calibrate the different segments.

For most upstream nodes where proposed operations are unlikely to affect historical conditions, the filled historical concentrations were used as a starting point to estimate specific conductance in the study area. In other places in the model, the filled historical concentrations were used to estimate the unmeasured inflows concentration including groundwater returns and surface runoff. Full mix of the salinity loadings was assumed at each point in the GeoDSS modeling network, generating a node outflow concentration that was carried out to the next downstream node. Outflows were assigned with the full-mixed concentration computed at the location where they are taken out of the system.

Some WWTFs were explicitly modeled with a specified salinity concentration assigned to return flow. Other WWTF simulated in the Daily Model were simulated with a calibrated concentration based on the mass balance of the segment where they are located. The WWTFs modeled explicitly were Colorado Springs Utilities at Las Vegas Street, Security, Fountain and Pueblo West.

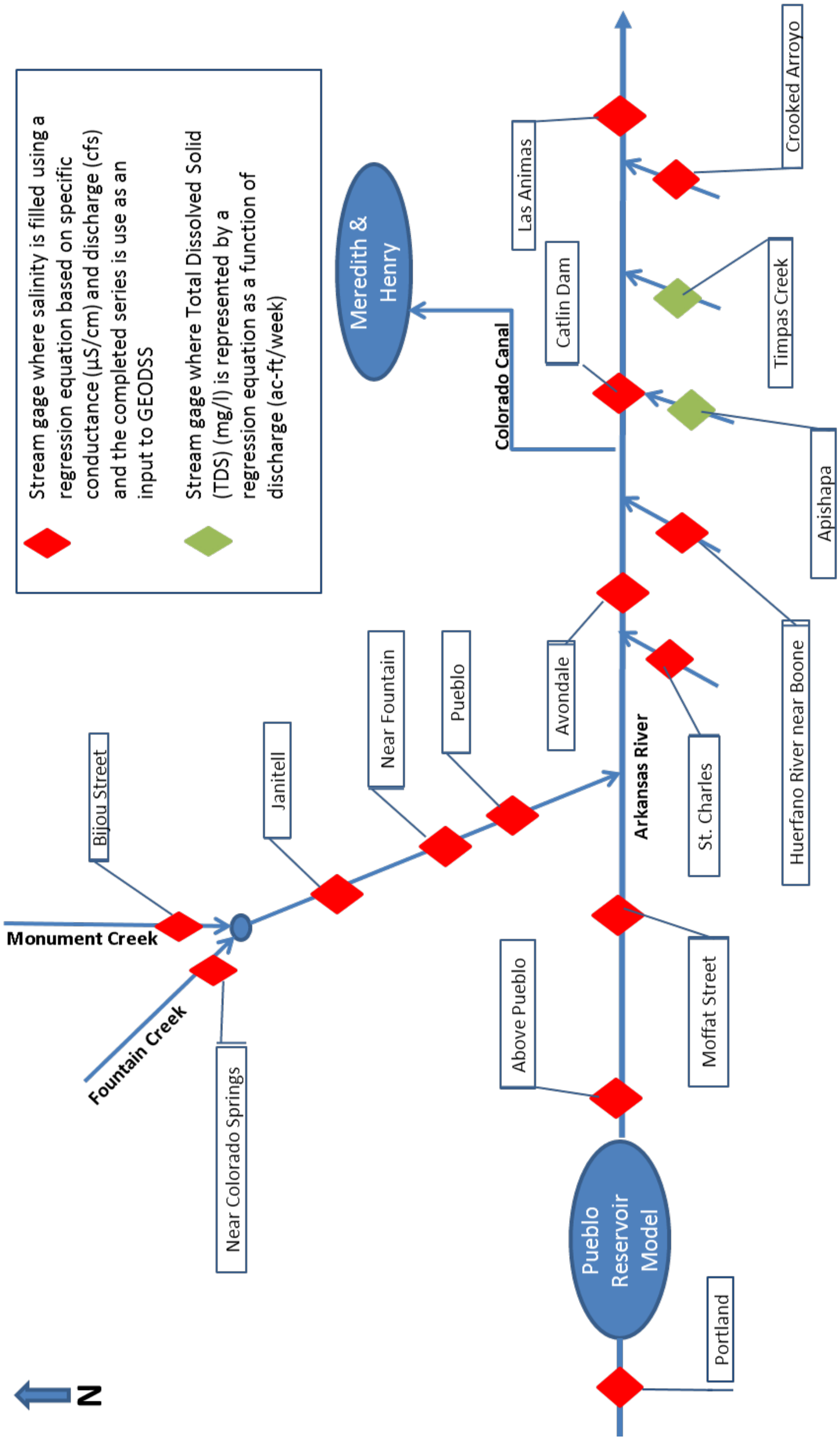


Figure 2. Salinity Model Schematic for Existing Conditions

Specific Conductance and Total Dissolved Solids The benefit of using specific conductance is the quantity of available historical data. However, specific conductance is not actually a unit based on mass. Specific conductance measures how well water conducts electricity, which is related to ions associated with the breakdown of dissolved solids. Thus, relationships are used to relate measurements of specific conductance to dissolved solids, which vary at different locations in the study area. Recent representations of TDS based on specific conductance (USGS 2010) were used to estimate the TDS at the different locations in the study area. For locations without defined relationships, a nearby gage with similar drainage characteristics was selected. Table 2 shows the selection of relationship for the modeled control points used to estimate TDS.

Table 2. Summary of Relationship to Estimate Total Dissolved Solids at the Modeled Gages

Gage	USGS Equation
Fountain Creek near Colorado Springs	TDS = 0.7186 * SC - 56.053
Monument Creek at Bijou St.	TDS = 0.7186 * SC - 56.053
Fountain Creek below Janitell	TDS = 0.7186 * SC - 56.053
Fountain Creek near Fountain	TDS = 0.7186 * SC - 56.053
Fountain Creek at Pueblo	TDS = 0.7701 * SC - 98.323
Arkansas River at Portland	TDS = 0.6426 * SC - 6.7052
Arkansas River above Pueblo	TDS = 0.7213 * SC - 38.816
Arkansas River at Moffat St.	TDS = 0.7213 * SC - 38.816
Saint Charles River at Vineland	TDS = 0.9717 * SC - 174.3
Arkansas River near Avondale	TDS = 0.793 * SC - 89.256
Huerfano River near Boone	TDS = 0.9371 * SC +167.89
Apishapa River near Fowler	TDS = 0.9609 * SC - 259.69
Arkansas River at Catlin Dam	TDS = 0.8652 * SC - 145.43
Arkansas River near Rocky Ford	TDS = 0.8652 * SC - 145.43
Timpas Creek at Mouth	TDS = 0.9527 * SC - 280.28
Crooked Arroyo near Swink	TDS = 0.9527 * SC - 280.28
Arkansas River at Las Animas	TDS = 0.9126 * SC - 230.95

Key: TDS = total dissolved solid in mg/l, SC = specific conductance in µS/cm
Notes:

(1) Relationship between specific conductance and TDS from a nearby gage was used for the locations where no relationship was available from the report.

(2) Regression between the two variables at the Fountain Creek near Fountain gage was used for all the other stations upstream from the gage, regression at the Arkansas River above Pueblo was used for the Arkansas River at Moffat St. gage, regression at the Arkansas River at Catlin Dam gage was used for the Arkansas river at Rocky ford gage, and regression at the Timpas Creek near Swink gage was used for the Crooked Arroyo near Swink gage.

The relationship between the two variables at the Fountain Creek at Pueblo gage was used for the Arkansas River at Moffat St. gage, while the relationship at Timpas Creek near Swink gage was used for the Crooked Arroyo near Swink.

Salinity and Flow Relationships for Missing Salinity Data Missing specific conductance data were estimated for model development using the regression equation producing the highest correlation and smallest mean absolute error (MAE) between measured flow and specific conductance. Seven-parameter relationship between flow and concentration developed by Cohn et al. (1992) was used as a regression equation alternative. If there was no regression equation with an R^2 greater than 0.5, the missing data were computed via interpolation.

The seven-parameter regression equation includes two flow terms, two sinusoidal terms to account for seasonality, and two time terms to account for any temporal trends. The regression equation (Equation 1) takes the following form:

Equation 1

$$\ln(SC) = \beta_0 + \beta_1 \ln(Q/Qc) + \beta_2 [\ln(Q/Qc)]^2 + \beta_3(T-Tc) + \beta_4(T-Tc)^2 + \beta_5\sin(2\Pi T) + \beta_6\cos(2\Pi T) + E$$

where SC = specific conductance (µS/cm)
β_x = constants
Q = streamflow (cfs)
T = time (years), note, initial time equal to 10/1/1980 for all equations in this study
Qc, Tc = centering terms for flow and time, defined in Cohn et al. (1992)
Π = constant, pi
E = independent, random error

The seven-term equation methodology was successfully used by USGS (2004) to study dissolved concentrations in the vicinity of Pueblo. In the current study, this seven-term regression model was implemented to represent missing specific conductance for: Fountain Creek near Colorado Springs and Fountain Creek below Janitell Road gages; Monument Creek at Bijou St gage; Arkansas River at Portland and Arkansas River near Rocky Ford gages; as well as Crooked Arroyo near Swink gage and Huerfano near Boone gage.

Table 3 summarizes the methods used to fill model control point missing data. Table 4 summarizes the seven term regression coefficients for the gages that use this equation type.

In cases where interpolation was used, each interpolated data point was verified for integration with the surrounding specific conductance and flow data. When interpolation resulted in data outside of the historical range, the mean of the two closest recorded specific conductance measurements was used for the missing day.

The performance of the regression equations was evaluated using the coefficient of determination between the predicted and measured values. Plots were used to visually illustrate the comparison between estimated and measured concentration and the performance of the equations over the period of measured data. Since these equations were used to fill-in missing data, the correlation and mean absolute error give insight on the expected level of error during the fill-in process.

Table 3. Summary of Method Used to Estimate Missing Daily Specific Conductance Data

Gage	Curve Type	Missing Data (%)	Equation	Method	R^2	MAE (mg/L)
Fountain Creek near Colorado Springs	-	93	7 Term Regression	Regression	0.77	23.46
Monument Creek at Bijou St.	-	97	7 Term Regression	Regression	0.67	49.12
Fountain Creek below Janitell Road	*	59	7 Term Regression	Regression	0.60	47.07
Fountain Creek near Fountain	-	7	None	Interpolation	-	-
Fountain Creek at Pueblo	Log	3	SC = -207.3Ln(Q) + 2147.9	Regression	0.62	58.87
Arkansas River at Portland	-	4	7 Term Regression	Regression	0.63	26.37
Arkansas River above Pueblo	-	3	None	Interpolation	-	-
Arkansas River at Moffat St.	Power	14	$SC = 1851.1(Q)^{-0.215}$	Regression	0.58	67.61
Saint Charles River at Vineland	Power	97	$SC = 5525.7(Q)^{-0.416}$	Regression	0.81	228.30
Arkansas River near Avondale	Log	6	SC=-249.4Ln(Q)+2421.6	Regression	0.68	65.55
Huerfano River near Boone	-	92	7 Term Regression	Regression	0.79	467.47
Apishapa River near Fowler	Log	99	TDS = = -518.3Ln(Q*) + 3777.5	Regression	0.72	262.35
Arkansas River at Catlin Dam	-	7	None	Interpolation	-	-
Arkansas River near Rocky Ford	-	98	7 Term Regression	Regression	0.83	116.11
Timpas Creek at Mouth	Power	88	$TDS = 19140(Q^*)^{-0.393}$	Regression	0.62	251.70
Crooked Arroyo near Swink	-	94	7 Term Regression	Regression	0.75	248.34
Arkansas River at Las Animas	-	-	None	Interpolation	-	-

Key: SC = specific conductance in µS/cm, TDS = Total Dissolved Solids in mg/L, Q = streamflow in cfs,
R^2 = coefficient of determination of estimated Vs. measured concentration,
MAE = Mean Absolute Error = average(abs(Yobs-Yexp))

Table 4. Summary of Coefficients for the Seven Term Regression Equation Between Flow and TDS

Gage	β_0	β_1	β_2	β_3	β_4	β_5	β_6
Arkansas River at Portland	5.488	-0.474	-0.037	-0.007	-0.003	-0.018	0.050
Fountain Creek near Colorado Springs	5.029	-0.003	0.066	0.006	0.000 NS	0.044	-0.065
Monument Creek at Bijou St.	6.124	-0.286	-0.024	0.017	-0.001	0.111	0.052
Fountain Creek below Janitell Road	5.639	-0.423	-0.033	0.007	-0.001	0.175	0.023
Huerfano near Boone	6.300	-0.580	-0.036	0.000 NS	0.000 NS	-0.084	0.171
Arkansas River near Rocky Ford	6.885	-0.235	-0.017	-0.004	0.001	0.005	0.074
Crooked Arroyo near Swink	7.143	-0.424	-0.055	0.002	0.000 NS	0.072	0.063

Key: NS = not significant

Regression equations for Timpas Creek and Apishapa River gages were used directly in GeoDSS to estimate salinity for all the simulated time steps. Figure 3 and Figure 4 show the flow and salinity (total dissolved solids) relationship for gages using simple regressions. The black solid line represents the selected regression equation.

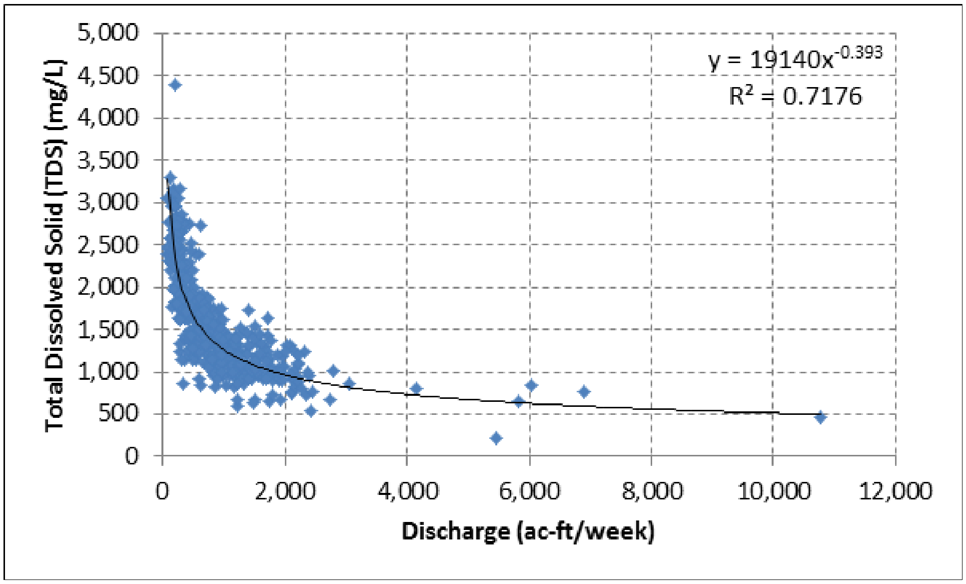


Figure 3. Timpas Creek Near Swink Salinity and Flow Relationship

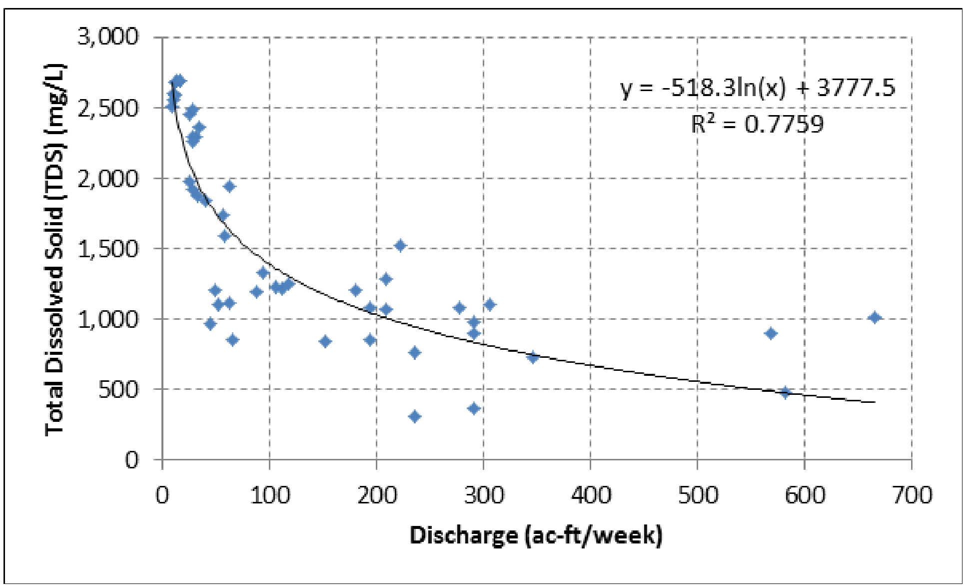


Figure 4. Apishapa River Near Fowler Salinity and Flow Relationship

Figure 5 through Figure 8 show the performance of regression equations used to estimate missing salinity data for the Fountain Creek and Monument Creek gages graphically comparing the estimated and measured TDS values. Red line on these plots represents the best linear fit with zero intercept to the estimated and predicted values.

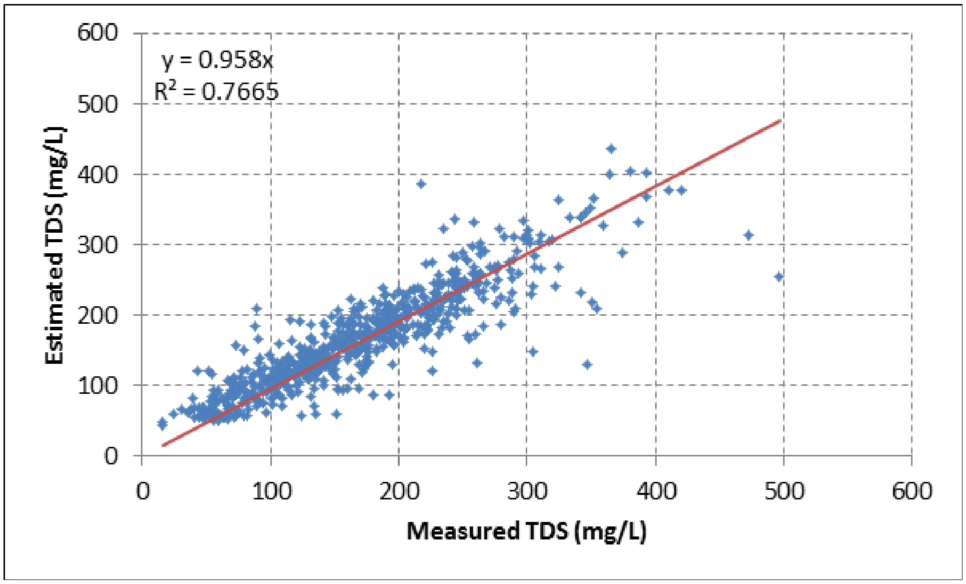


Figure 5. Fountain Creek Near Colorado Springs Estimated TDS Performance

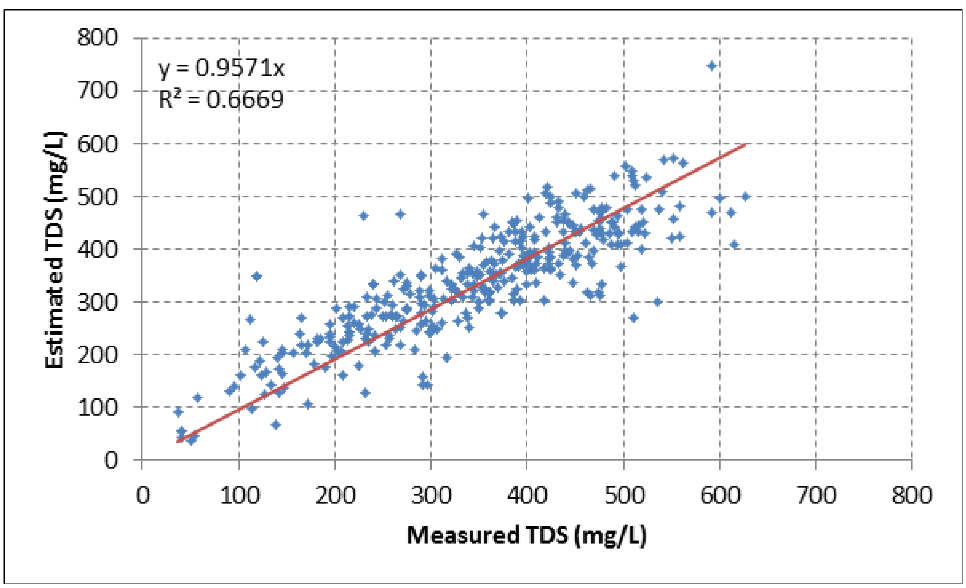


Figure 6. Monument Creek At Bijou St. Estimated TDS Performance

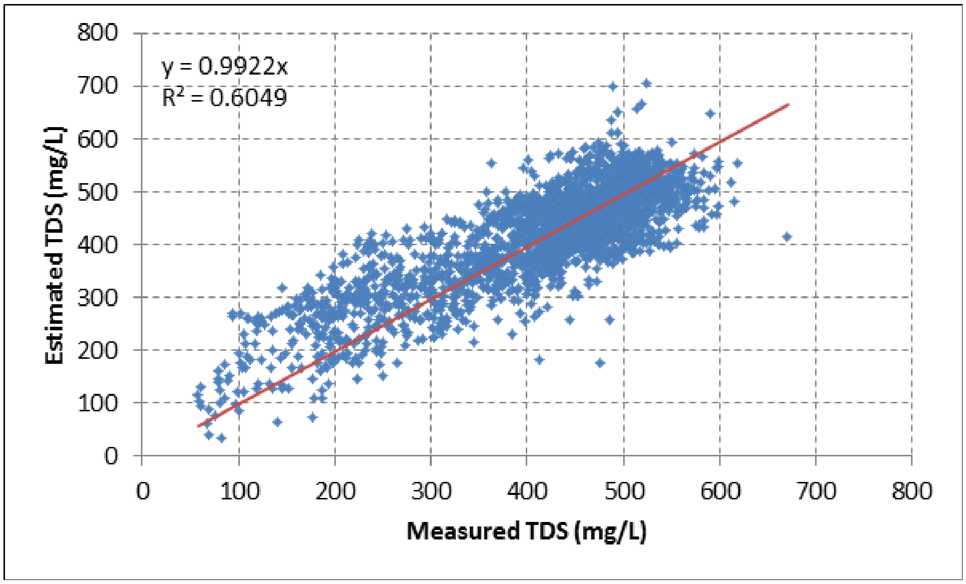


Figure 7. Fountain Creek Below Janitell Road Estimated TDS Performance

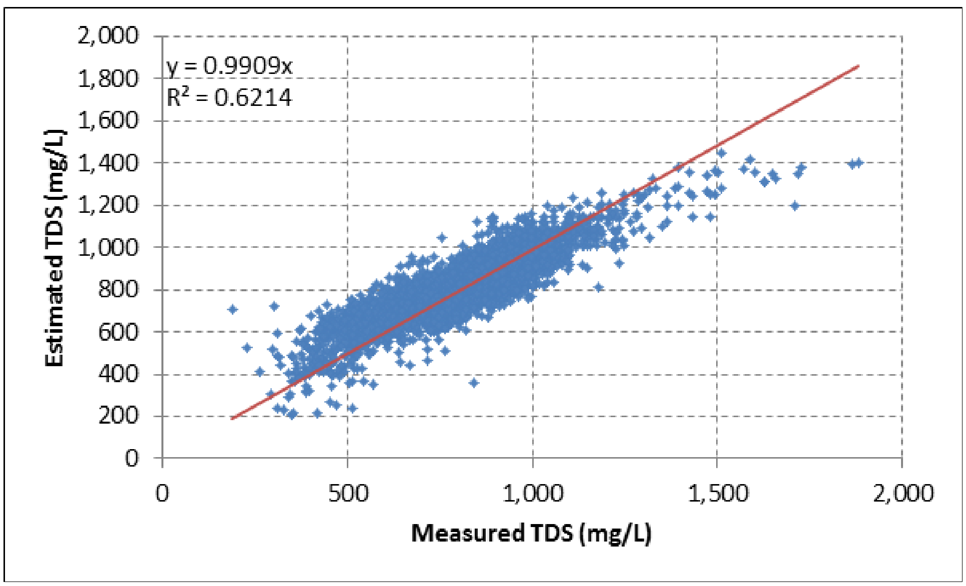


Figure 8. Fountain Creek At Pueblo Estimated TDS Performance

Figure 9 through Figure 12 show the performance of regression equations used to estimate missing salinity data for the Arkansas River gages, graphically comparing the estimated and measured values with the best linear fit with zero intercept and the corresponding correlation coefficient.

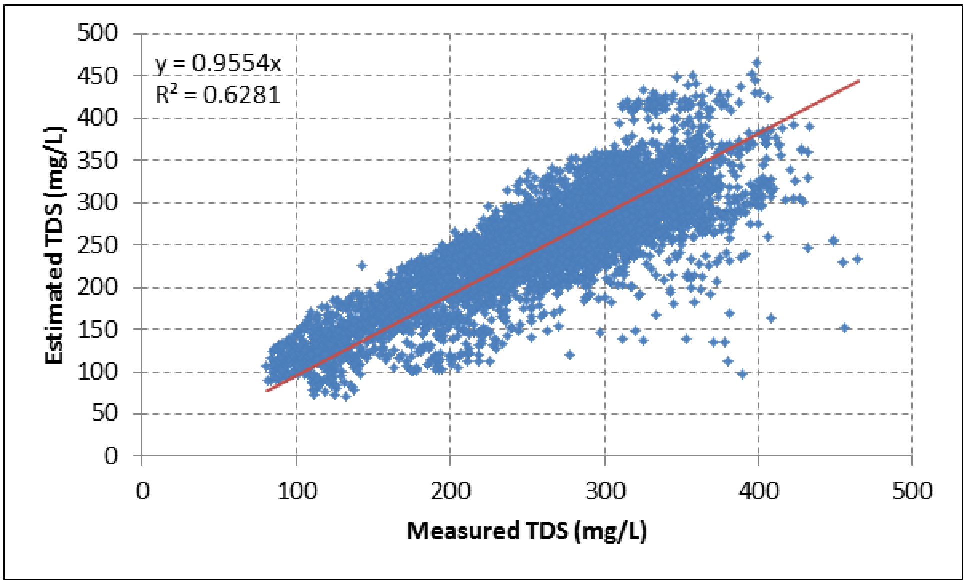


Figure 9. Arkansas River At Portland Estimated TDS Performance

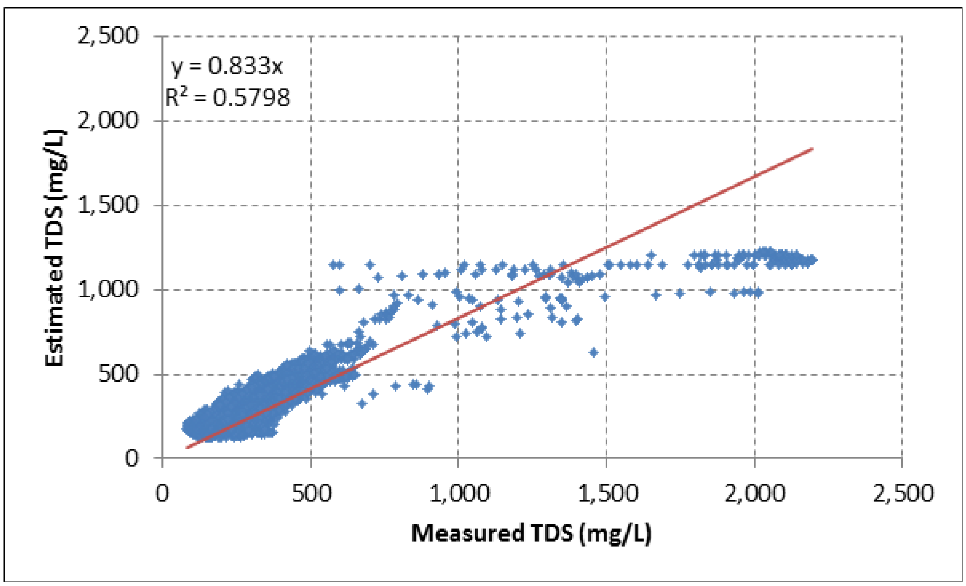


Figure 10. Arkansas River At Moffat St. Estimated TDS Performance

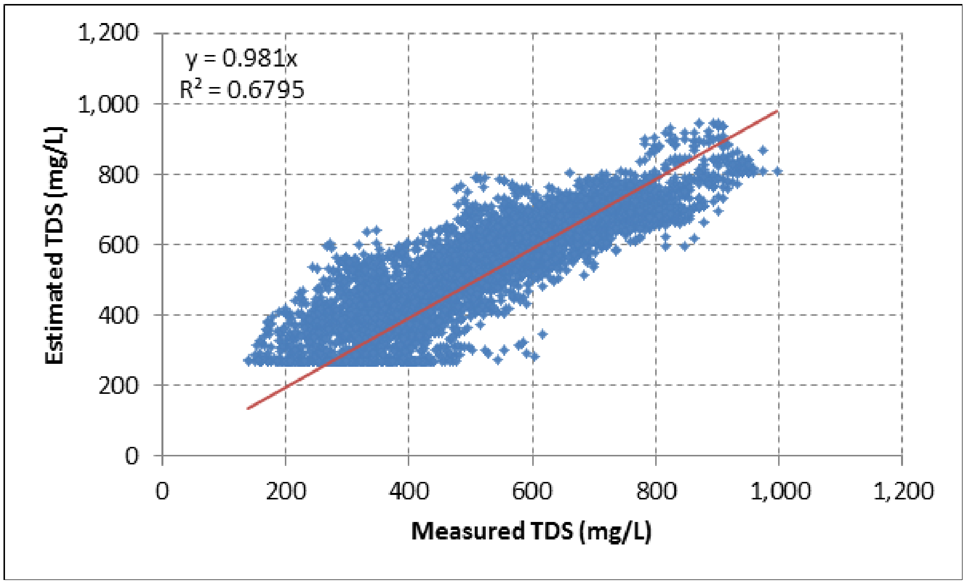


Figure 11. Arkansas River Near Avondale Estimated TDS Performance

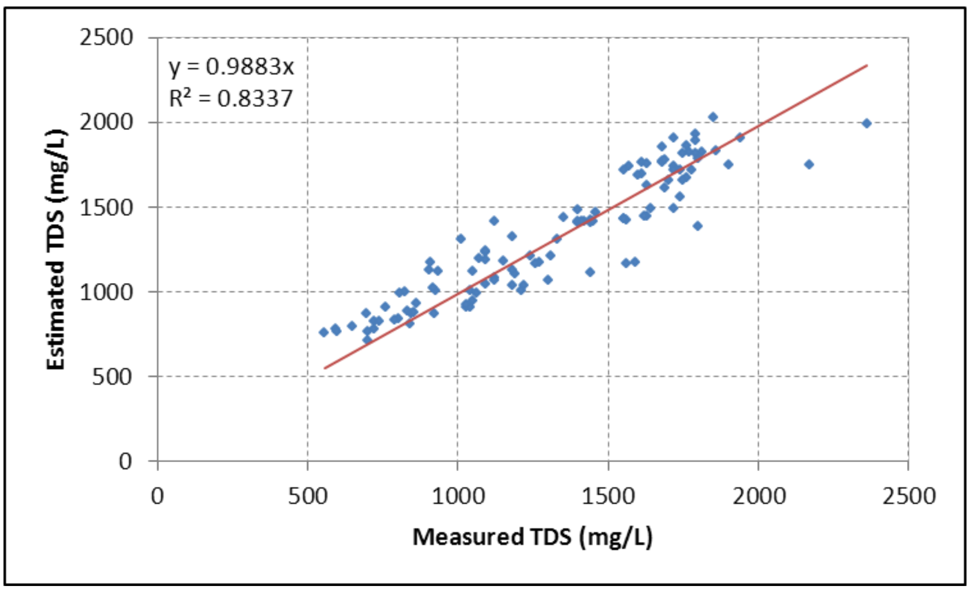


Figure 12. Arkansas River Near Rocky Ford Estimated TDS Performance

The performance of the regression equations for Saint Charles River, Huerfano River and Crooked Arroyo are in Figure 13 through Figure 15. These regression equations were used to estimate missing salinity data for the corresponding tributaries to the Arkansas River. These figures graphically compare the measured and estimated concentration, showing the best linear fit between the estimated and measured data and the corresponding coefficient of correlation.

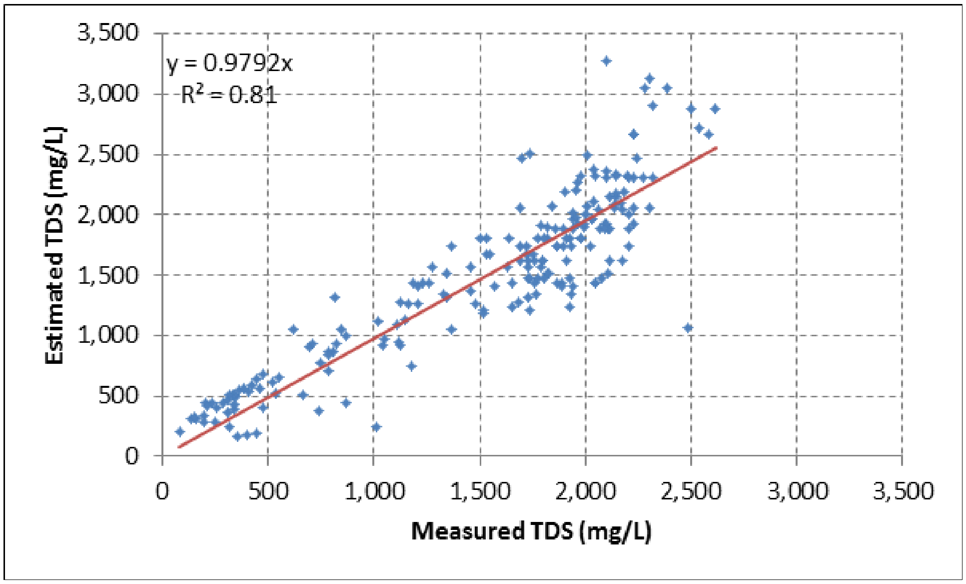


Figure 13. Saint Charles River Estimated TDS Performance

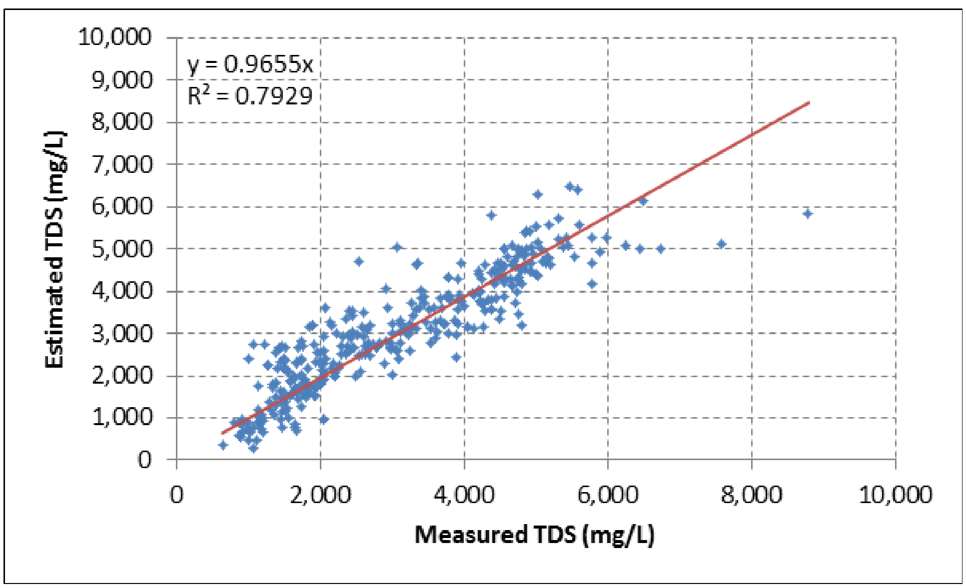


Figure 14. Huerfano River Near Boone Estimated TDS Performance

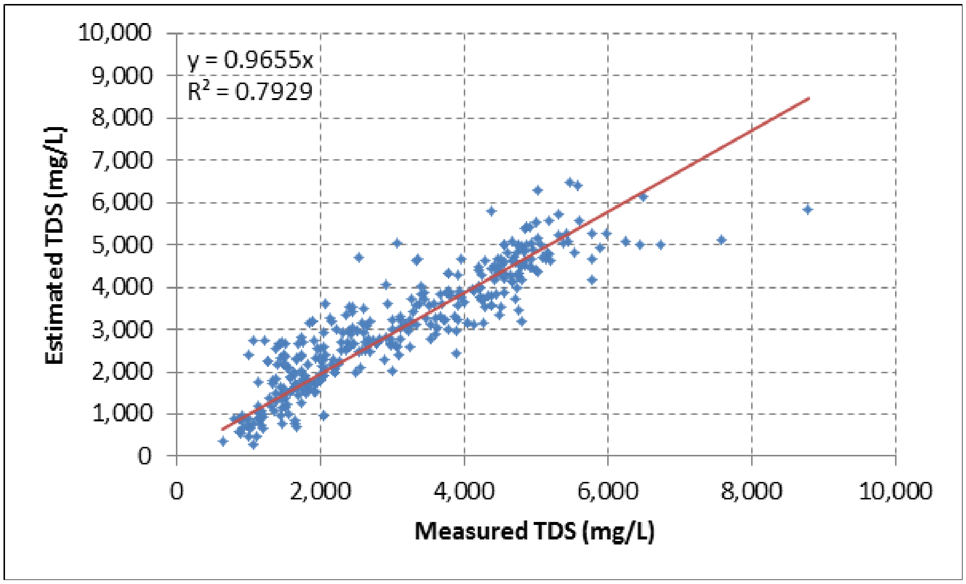
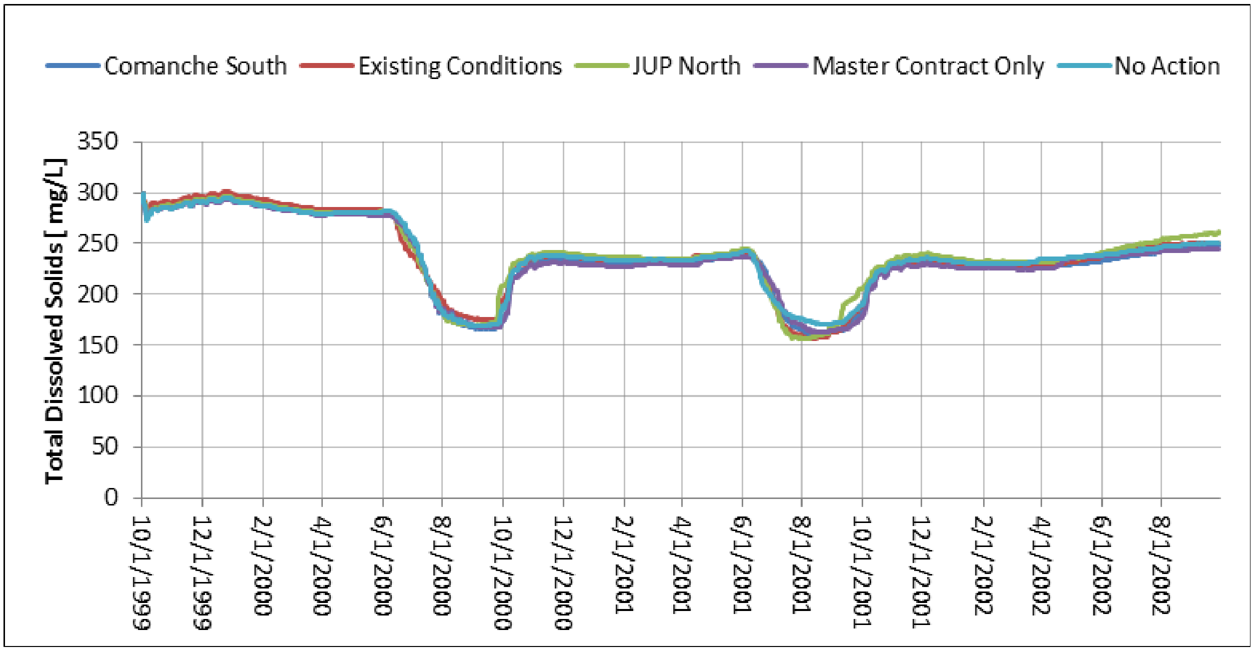


Figure 15. Crooked Arroyo Near Swink Estimated TDS Performance

Pueblo Reservoir Salinity Transport Salinity at the Portland gage was assumed to remain unchanged under the different alternatives, since the changes in flows and drainage conditions upstream from Pueblo Reservoir under the different alternatives would be negligible (see Appendix D.4). Although salinity contributions between the Arkansas River at Portland gage and the reservoir would not be expected to change significantly, changes in storage volumes, releases, chemical and physical processes in the reservoir could change the salinity concentration of reservoir outflows, which are inflows to the salinity model. The USGS developed a model to simulate the transit of different water quality constituents through Pueblo Reservoir (Ortiz 2012), with a model study period of water year 2000 to water year 2002 using a daily time step.

The USGS model outflow TDS results were analyzed to estimate the expected changes in reservoir outflow concentration for each alternative. The model predicted relatively small changes in the daily concentration among the alternatives (Figure 16). Table 5 summarizes simulated monthly average change in Pueblo Reservoir outflow concentration for the different alternatives with respect to the No Action.

The expected changes in concentration for the different alternatives is considered negligible (see Chapter 4 – *Water Quality*). For that reason and the uncertainty associated with estimating weekly Pueblo Reservoir outflow concentrations outside the USGS modeled period, the concentration for the Pueblo Reservoir releases for all the alternatives is assumed constant for the comparative analysis of salinity effects. The historical observed concentrations at the Arkansas River above Pueblo gage are assumed to represent Pueblo Reservoir releases for this analysis.



Note: Comanche South has been replaced by Comanche North in the Final EIS. Results remain the same.
Figure 16. USGS Daily Modeled Concentration for Pueblo Reservoir Outflow (Ortiz 2012)

Table 5. Summary of Relative Weekly Changes in Modeled TDS at the Arkansas River above Pueblo Gage with respect to the No Action from USGS Model (Ortiz 2012)

Month	Comanche North (%)	Pueblo Dam South	JUP North (%)	Pueblo Dam North (%)	River South (%)	Master Contract Only (%)
Jan	0.97	0.97	-0.94	0.97	0.97	1.78
Feb	0.85	0.85	-0.76	0.85	0.85	1.55
Mar	0.86	0.86	-0.31	0.86	0.86	1.67
Apr	1.37	1.37	0.02	1.37	1.37	1.73
May	1.12	1.12	-0.35	1.12	1.12	0.79
Jun	-0.10	-0.10	-0.61	-0.10	-0.10	0.19
Jul	1.61	1.61	2.27	1.61	1.61	0.38
Aug	2.99	2.99	1.84	2.99	2.99	1.86
Sep	2.52	2.52	-3.88	2.52	2.52	2.98
Oct	1.63	1.63	-2.43	1.63	1.63	2.51
Nov	1.10	1.10	-1.17	1.10	1.10	1.89
Dec	1.07	1.07	-1.10	1.07	1.07	1.90
Average	**1.34**	**1.34**	**-0.61**	**1.34**	**1.34**	**1.60**

General Segment Mass Balance Format The salinity model used mass balance principles over discrete segments. Stream gages located at either end of a segment have average daily historical streamflow and specific conductance records. When multiplied, the flow and concentration represent a salinity load. The salinity load at the upstream gage plus the salinity load into the segment minus the salinity load diverted out of the segment is equal to the salinity load at the downstream end of the segment. The concentration at the downstream end of the segment is equal to the salinity load at that point divided by the streamflow.

Model calibration included estimating unknown concentrations of inflows, such that the resulting difference between calibration and measured salinity loads at the downstream point of the segment did not improve. The model uses only inflows with unmeasured or non-estimated concentration to adjust the mass balance in the segment; therefore, these calibrated concentrations are not strictly tied to a physical salinity source. In some cases the calibrated concentration requires higher concentration values, larger than the river observed concentrations, to correct deficient salinity loading estimates or to compensate for low unmeasured inflows in relation with the missing salt loading in the segment. In this analysis, the unknown concentration upper limit was assumed as 4,500 mg/L to keep the calibration process realistic. The exception is inflow concentration to the segment upstream from the Fountain Creek at Pueblo gage for which the calibration concentration upper limit was assumed as 6,000 mg/L due to indication of large salinity loads reported at the downstream gage.

Equation 2 is describes the mass balance analysis in an individual node. This equation was applied in the model for each node sequentially from the upstream end of the segment to the downstream end of the segment, using the node outflow concentration results sequentially from the upstream nodes to the downstream nodes.

Equation 2

$$[Q_{in}*C_{in}] + [Q_{unmeasured\ in}*C_{unmeasured\ in}] = [Q_{unmesured\ out}*C_{out}] + [Q_{out}*C_{out}]$$

Where:

Q_{in} = inflow with measured concentration
C_{in} = Measured/Estimated Concentration of inflows
$Q_{unmeasured\ in}$ = inflow with unmeasured concentration, includes unmeasured gains to the segment – solved for by balancing flows at bottom gage
$C_{unmeasured\ in}$ = Estimated/Calibrated Concentration of inflows – generally unknown
$Q_{unmeasured\ out}$ = unmeasured losses outflow, solved for by balancing flows at bottom gage
Q_{out} = measured outflow, includes measured diversions – from hydrologic model
C_{out} = concentration of outflows – computed by the model at each point based on the salt load entering the node and the total outflow.

Measured outflows are typically measured diversions for agriculture, municipalities and industry, as well as diversion for storage. Note that the GeoDSS internally assumes salinity loadings associated with unmeasured inflows in a segment at the upstream end of the segment and salinity loadings associated with unmeasured outflows in the segment at the downstream end of the segment.

Due to the expected variability of transit losses and wetted stream widths along the river reaches in the study area, those quantities were assumed to be part of unmeasured segment losses, which are quantified during the calibration process. Concentrations of the unmeasured segment losses are simulated by the model based on the upstream mass balance.

Some measured inflows have measured concentrations, other measured inflows use regression equations based on historical streamflow and specific conductance to estimate salt loadings and some measured inflows such as the WWTF assume an effluent concentration based on typical source-effluent data. Measured inflows without measured/estimated concentration are assigned with a concentration during the calibration process using Equation 2. Figure 17 shows a schematic of a typical segment in the model.

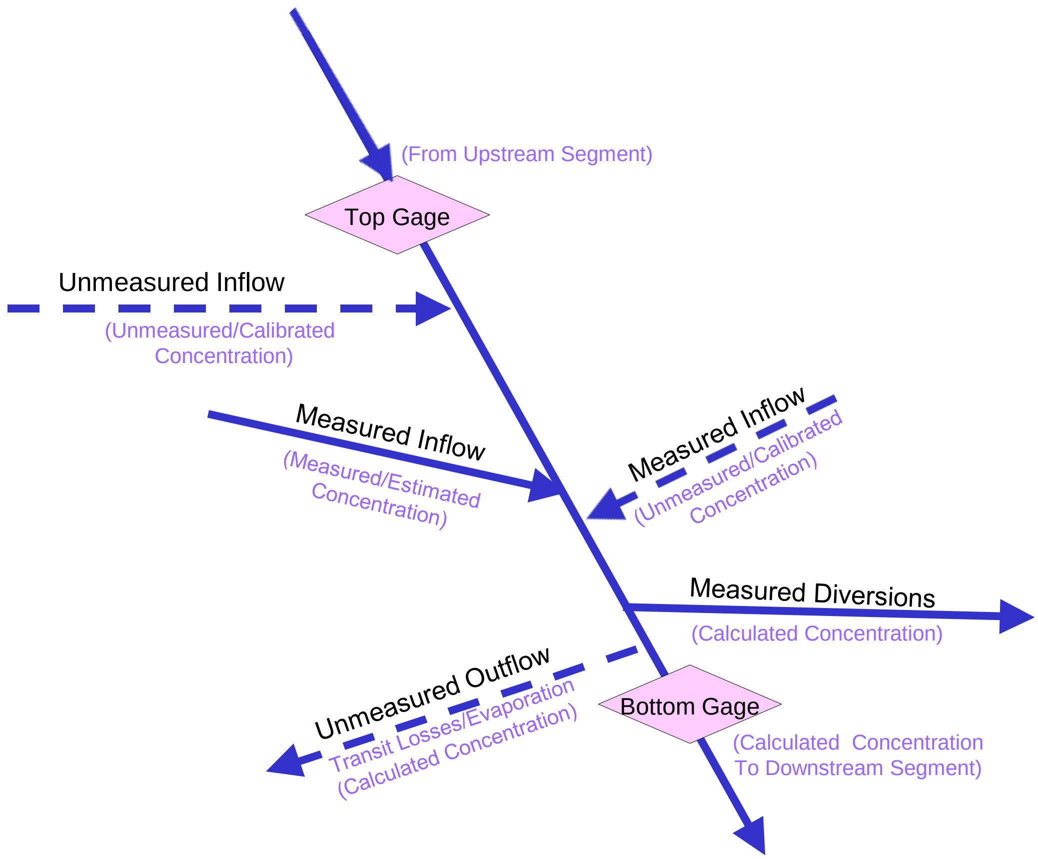


Figure 17. Example Salinity Model Segment

GeoDSS Calibration and Simulation For this study, the salinity model calibration includes two stages: (1) flow replication and (2) salinity calibration. The objective of the first calibration stage is to duplicate in GeoDSS, by segments between gauges, the simulated flows in the Daily Model. The flow replication is performed for the historical conditions and all the simulated alternatives. The objective of the second state of calibration is to estimate unmeasured concentrations to match as close as possible measured concentrations at the control points (i.e., gages with measured concentration).

The original GeoDSS network (Triana, Labadie and Gates 2010) was extended to mimic the major inflows and outflow from the network as modeled in the Daily Model. Due to the Daily Model's complexity, only the major inflows and outflows were explicitly represented in the GeoDSS network. During the flow replication stage, Daily Model simulated flows at the gages are used to quantify inflows and outflows not explicitly modeled in the GeoDSS, lumping those inflows and outflows into the unmeasured gains and losses of the segment, respectively.

During the salinity calibration, historical flows, inflows with measured TDS and measured TDS at the control points are used to solve for unmeasured concentrations on a weekly basis until the resulting difference between calibration and measured salinity loads at the downstream point of the segment could not be improved. Since the computation is performed from the upstream end to the downstream end of the network carrying over the resulting outflow concentration from one segment to the next, an iterative procedure is used in GeoDSS to adjust unmeasured concentrations within the specified bounds to closely match the measured concentrations at the control points.

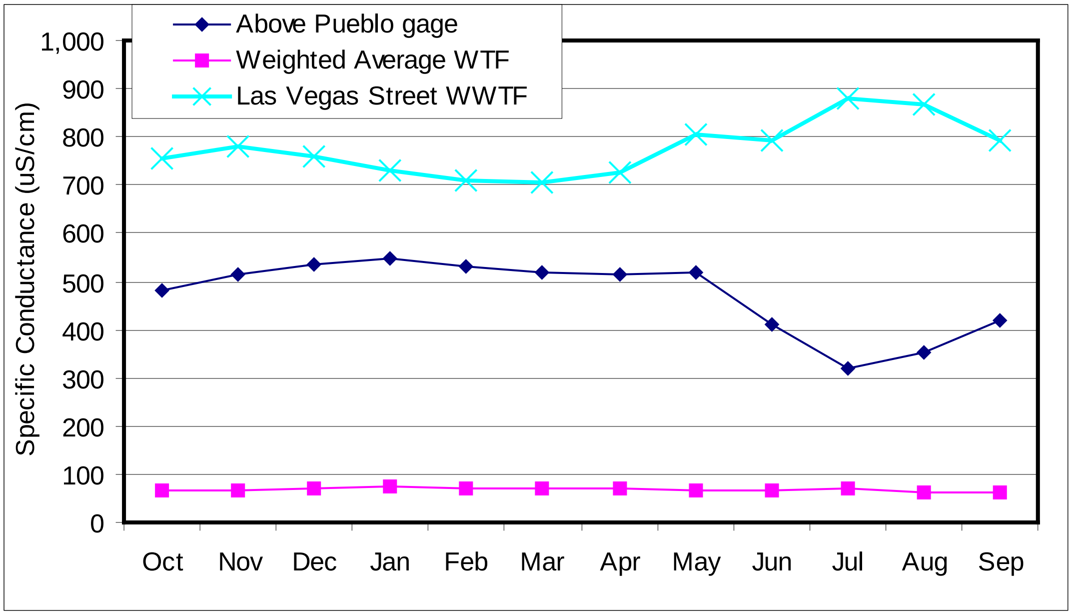
The salinity simulation run type is used for alternatives salinity modeling and effects analysis; the calibrated weekly inflow concentrations from the Salinity Calibration are used in combination with the corresponding Daily Model replicated inflows for each alternative to estimate the alternatives salinity loadings and resulting concentrations throughout the network. Table 6 shows a summary of run types with the known and unknown (i.e., solved for) variables in each case.

Table 6. Summary of Salinity Modeling Steps with Known and Unknown Variables

Modeling Step	Known Variables	Unknown Variables (solved for)
Flow Replication (historical and all alternatives)	Daily Model Simulated • Gage Flows • Diversion • Explicit Returns	Unmeasured gains and losses and other Daily Model inflows/outflows not explicitly modeled in GeoDSS
Salinity Calibration (only historical calibration)	All flows throughout the network including unmeasured flows (Flow Calibration) Concentration at the measured/estimated nodes	Unmeasured Concentrations Calibrated to match the downstream control point concentration
Salinity Simulation (all alternatives)	All flow including unmeasured gains and losses (Flow Calibration) All Concentrations including calibrated concentration at unmeasured points (Salinity Calibration)	Simulated Concentrations at all nodes in the network

Waste Water Treatment Facilities Discharges The concentration for the WWTF effluents were modeled based on assumptions from the Southern Delivery Systems Final EIS (Reclamation 2008), because it covered part of the same study area on the Arkansas River. The Southern Delivery System EIS (Reclamation 2008) derived an increase in TDS between the weighted average of raw water specific conductance and the WWTF effluent of 707 µS/cm (452 mg/L), based on data from Las Vegas Street WWTF effluent.

Figure 18 depicts the monthly mean specific conductance in the Las Vegas WWTF effluent, as well as a weighted average for the Colorado Springs water treatment facilities and the Arkansas River Above Pueblo gage (represents Pueblo Reservoir outflow salinity, Pueblo Reservoir would be the source of AVC water). This monthly mean specific conductance was used to model historical conditions.



Source: Reclamation (2008)
Figure 18. Colorado Springs Source Water and WWTF Effluent Salinity

Criteria for Determining Significance of Effects

Table 7 lists significance criteria used to describe the intensity of salinity effects. Potential effects on water quality were evaluated for each action alternative compared to the No Action Alternative. Effects were analyzed assuming best management practices and resource protection measures described in Chapter 2 and Appendix B.5 would be incorporated.

Table 7. Water Quality Effect and Intensity Description

Effect Intensity	Intensity Description
Negligible	Chemical, physical, or biological effects on water quality would be below or near detectable limits, and would be within historical or desired water quality conditions.
Minor	Chemical, physical, or biological effects on water quality would be detectable, but would be within 10% of historical water quality conditions for parameters and stream segments meeting water quality standards. The alternative would not cause a water quality violation, but existing violations would continue. Water and wastewater treatment facilities would continue to meet water quality standards without changes to treatment processes.
Moderate	Chemical, physical, or biological effects on water quality would be detectable and the historical baseline would be exceeded by 10 – 20% for parameters and stream segments meeting water quality standards. A new water quality violation would not result, but existing violations would continue and increase by less than 5%. Slight modifications to water and wastewater treatment facility processes could be needed to meet water quality standards.
Major	Chemical, physical, or biological effects on water quality would exceed the historical baseline by more than 20% for parameters and stream segments meeting water quality standards (more than 5% for stream segments violating water quality standards). A new violation in a water quality standard is likely. Substantial modifications to existing water and wastewater treatment facility processes could be needed to meet water quality standards.

Notes:
(1) Short-term effect – recovers in three years or less after alternative implementation.
(2) Long-term effect – takes more than three years to recover after alternative implementation.

Results

The salinity model segment assumptions, inflow concentrations, and alternatives' simulation results are presented in this section.

Calibration

This section presents modeling assumptions and the calibrated concentration for the different modeled segments. Segments are named by the downstream gage.

The calibrated concentration corresponds to representative values assigned to the unknown salinity inflows to the segment. In segments with multiple calibrated concentrations the weighted concentration is presented as representative for these segments. These values were calculated during the salinity calibration process to simulate a concentration at the downstream control point as close as possible to the measured concentration. Note that in GeoDSS the values of calibrated concentration are only calculated for inflows greater than zero with unmeasured concentration. Outflow concentrations, including the unmeasured losses, correspond to the simulated concentration at the diversion point, computed mixing the salt loads throughout the segment.

The flow replication step uses all the gages in the network independently of the existence of measured salinity. This creates *intermediate gages* in the salinity calibration that provide additional sources of unmeasured inflows and outflows to the segment, but are not used for salinity calibration purposes because they do not have a complete record of measured/estimated concentration. The GeoDSS treats unmeasured inflows at the intermediate gages in the calibration process independently of other unmeasured inflows in the corresponding segment, resulting in potentially different calibrated concentrations at the unmeasured inflows in the segment. When the intermediate gage has some salinity measurements (i.e., discrete data), those time steps with salinity data are used to calibrate inflows upstream from the intermediate gage. In time steps with no salinity data at the intermediate gages, the GeoDSS iterative process adjusts the inflows upstream from the intermediate gage to match the segment downstream measured concentration.

The average monthly measured/estimated salinity concentration for the most upstream nodes in both Arkansas River and Fountain Creek are summarized in Table 8.

Table 8. Monthly Simulated Salinity Concentration for Upstream Boundary Gages

Month	Arkansas River above Pueblo	Fountain Creek near Colorado Springs	Monument Creek at Bijou St.
Jan	341.5	246.3	472.4
Feb	344.4	248.4	438.8
Mar	337.4	227.0	397.5
Apr	336.6	180.0	319.8
May	344.1	161.3	309.3
Jun	268.4	184.3	358.4
Jul	230.5	185.5	375.7
Aug	265.9	174.4	404.0
Sep	308.2	185.1	460.4
Oct	312.3	172.2	467.1
Nov	329.9	212.4	487.4
Dec	340.9	232.1	494.9

Fountain Creek below Janitell Road Segment This segment is the most upstream segment in Fountain Creek and used measured concentration at the Fountain Creek below Janitell Road gage to calibrate the segment concentrations. It is bounded upstream by four gages (i.e., Fountain Creek near Colorado Springs gage, Monument Creek at Bijou St. gage, and Cheyenne Creek at Evans Ave. gage) and includes Fountain Creek at Colorado Springs gage as an intermediate gage.

Assumptions Las Vegas Street WWTF effluent monthly concentrations were assumed from the Southern Delivery System Final EIS (Reclamation 2008) as shown in Figure 18. Since no Southern Delivery System alternative will affect the future potential increase in effluent concentration from Colorado Springs when Southern Delivery System is fully operational, the same monthly concentrations are used in the direct and cumulative effects analysis. This results in having a lower concentration for the cumulative effects no action alternative than what may be expected given increased Arkansas Basin water delivered to Southern Delivery System participants, but it will not affect relative comparison of alternatives.

Calibrated Concentration The Fountain Creek at Colorado Springs gage was included as a salinity source to this segment. This gage has only discrete salinity data; no continuous monitoring is performed at the gage. In the modeling approach for this gage, discrete data was used in the model to estimate salt load to nodes upstream in the segment in weeks with available data. For weeks when concentration was not measured, the resulting concentration at the gage was a function of upstream mass loads and the next downstream measured concentration. This approach allowed using the measured discrete data in the model without the need to develop a relationship for all the simulated weeks. The results were checked for reasonableness, since an iterative process takes place in using this modeling approach. Figure 19 shows the calibration results for both periods with and without measured concentration at the Fountain Creek at Colorado Springs gage.

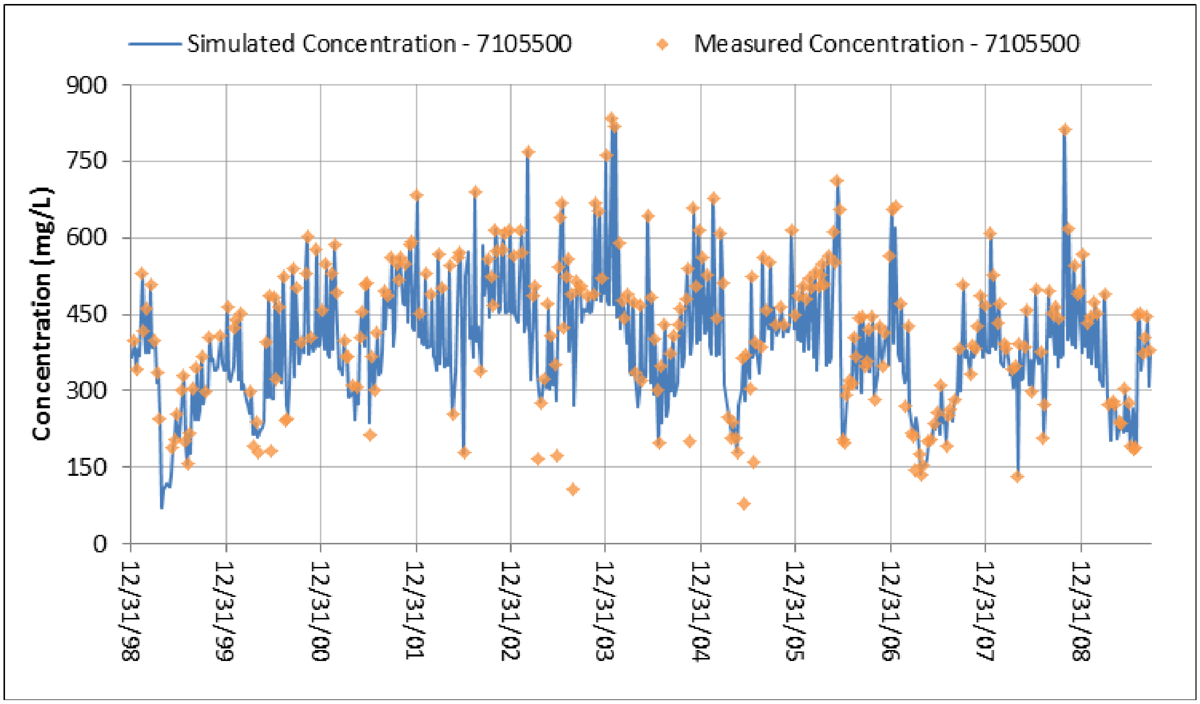


Figure 19. Modeled and Measured Salinity Concentration for Fountain Creek at Colorado Springs Gage Calibration

The specific conductance of Las Vegas Street WWTF effluent was specified in the mass balance as discussed above. Figure 20 depicts the weekly average calculated salinity concentration for inflows between the three gages with unmeasured concentration. Note that the unmeasured losses are assigned with the in-stream concentrations, which are typically much lower than the inflow concentrations.

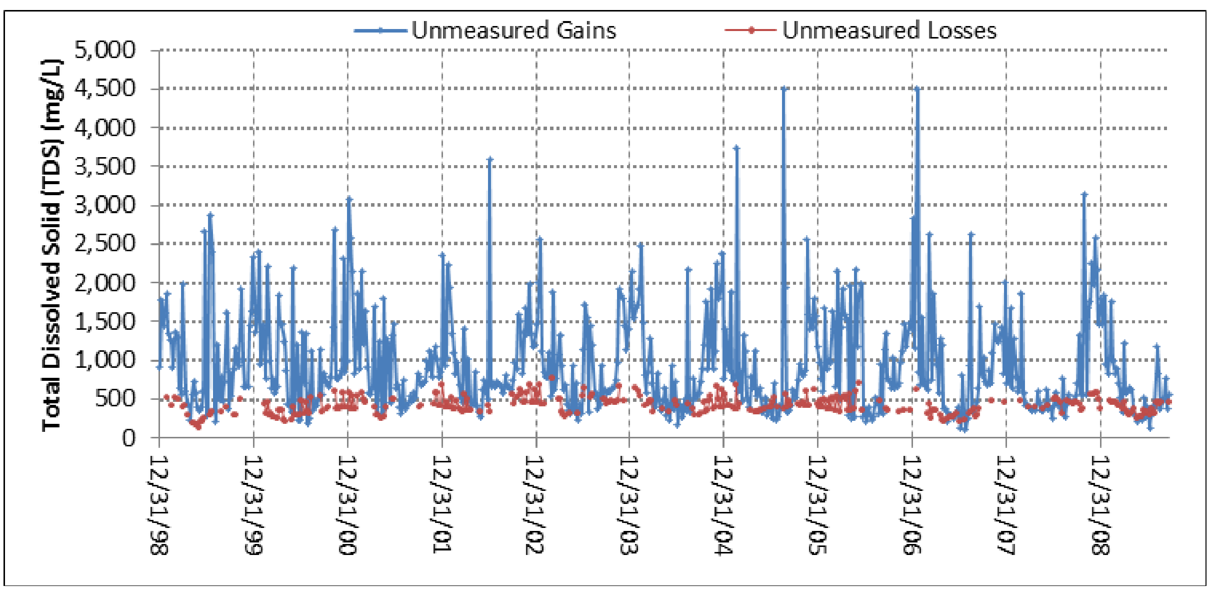


Figure 20. Weekly Calibrated and Simulated Salinity Concentration to Janitell Segment for Unmeasured Inflows and Outflows

Fountain Creek near Fountain Segment This segment used measured concentration at the Fountain Creek near Fountain gage to calibrate unknown concentrations. The segment includes the Fountain Creek at Security gage as an intermediate gage, with discrete salinity concentration data. The upstream gages include Fountain Creek below Janitell Road gage, Jimmy Camp Creek at Fountain gage and Little Fountain Creek near Fountain gage.

Assumptions The effluent concentration for Fountain and Security WWTFs was assumed based on weighted blend of source water (Reclamation 2008). The assumed effluent salinity for Fountain and Security is in Table 9.

Table 9. Estimated Fountain and Security Water Supply and Wastewater Salinity

Month	Estimated Wastewater (µS/cm)	Estimated Wastewater (mg/L)
Jan	1,429	971
Feb	1,433	974
Mar	1,435	975
Apr	1,437	977
May	1,443	981
Jun	1,444	982
Jul	1,384	938
Aug	1,382	937
Sep	1,394	946
Oct	1,411	958
Nov	1,423	967
Dec	1,431	972
Mean	**1,420**	**965**

In the future, Fountain and Security may change alluvial groundwater pumping rates or locations. However, the model assumes that the effluent salinity concentration for these WWTF will remain the same, because no alternative is expected to affect this concentration and historical combined average effluent release to Fountain Creek is less than 5 cfs. This represents a small percentage of flow in Fountain Creek, which averages about 150 cfs between the Janitell and Fountain gages.

Calibrated Concentration Figure 21 depicts the weekly average calculated salinity concentration for inflows and between Fountain Creek below Janitell Road and Fountain Creek near Fountain gages.

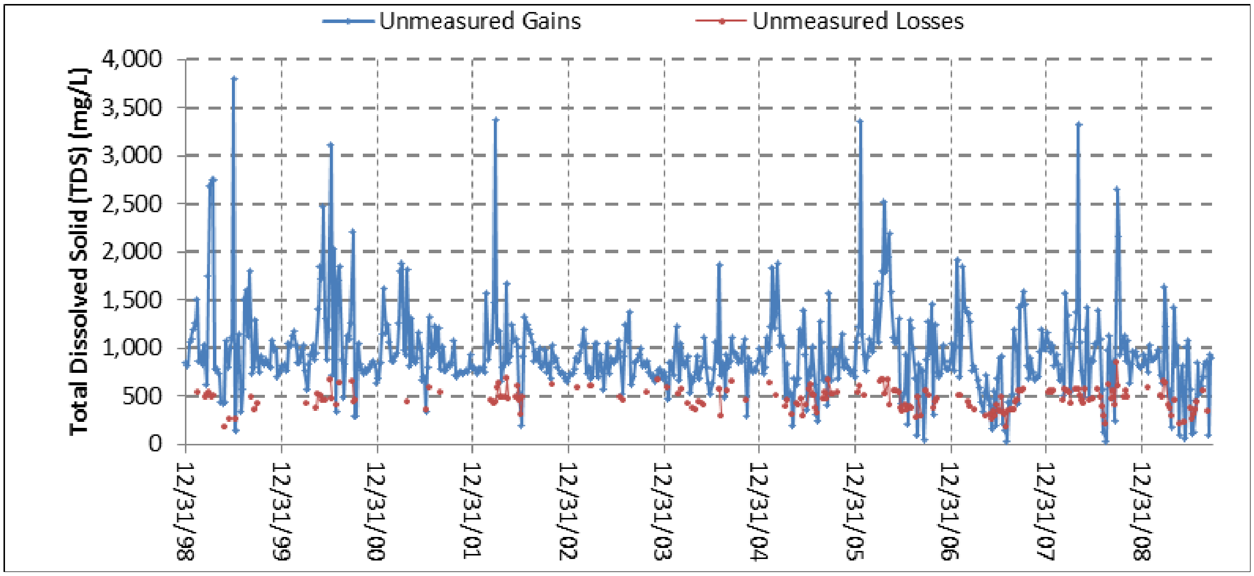


Figure 21. Weekly Calibrated and Simulated Salinity Concentration for Fountain Creek near Fountain Segment Unmeasured Inflows and Outflows

Figure 22 compares the measured and simulated concentration for the Fountain Creek near Fountain gage.

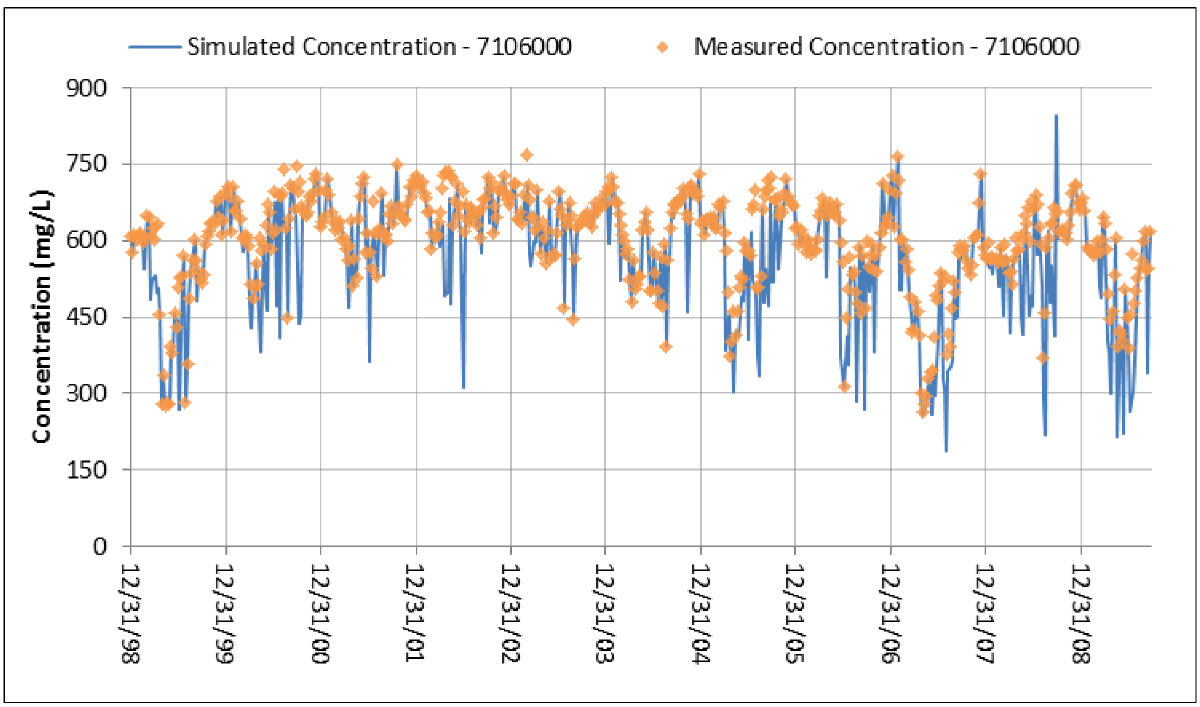


Figure 22. Weekly Comparison of Measured and Simulated Salinity Concentration for Fountain Creek near Fountain Gage Calibration

Fountain Creek at Pueblo Segment This segment used measured concentration at the Fountain Creek at Pueblo gage to calibrate unknown concentrations. The segment upstream gage is Fountain Creek near Fountain and includes Fountain Creek near Piñon gage as intermediate gage with discrete salinity data. The only inflow with unmeasured concentration in this segment is the inflow simulated at Williams Creek.

Calibrated Concentration Figure 23 depicts the weekly average calculated salinity concentration for inflows with unmeasured concentration between Fountain Creek near Fountain and Fountain Creek at Pueblo gages.

This segment has numerous weeks (i.e., about 60 percent of modeled weeks) where a net loss were calculated in the calibration process between Fountain Creek near Piñon and Fountain Creek at Pueblo gages, which makes the salinity calibration difficult. The upper bound of the calibrated concentration was set larger than other segments (6,000 mg/L) to try to accommodate for this situation. GeoDSS is unable to better calibrate weeks with net losses in the segment because it only adjusts the inflows unmeasured concentrations while the outflow are assigned with the in-stream calculated concentration, under predicting the concentration in this segment. Figure 24 shows the comparison of calibrated and the measured concentration for this segment.

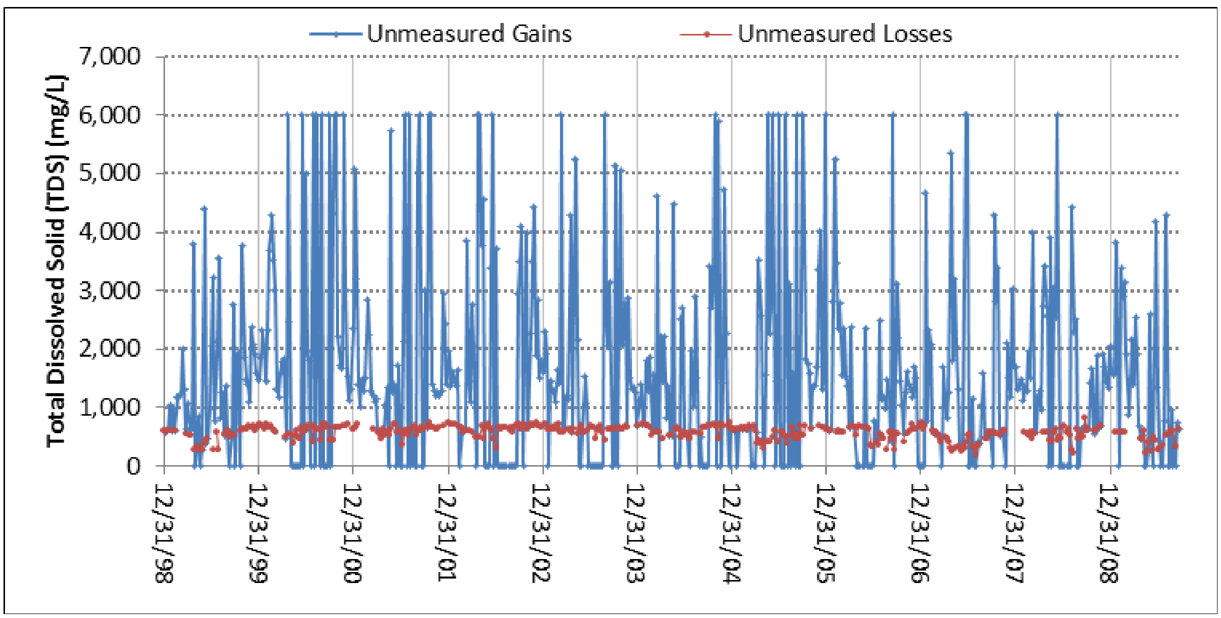


Figure 23. Weekly Calibrated and Simulated Salinity Concentration to Fountain Creek at Pueblo Segment for Unmeasured Inflows and Outflows

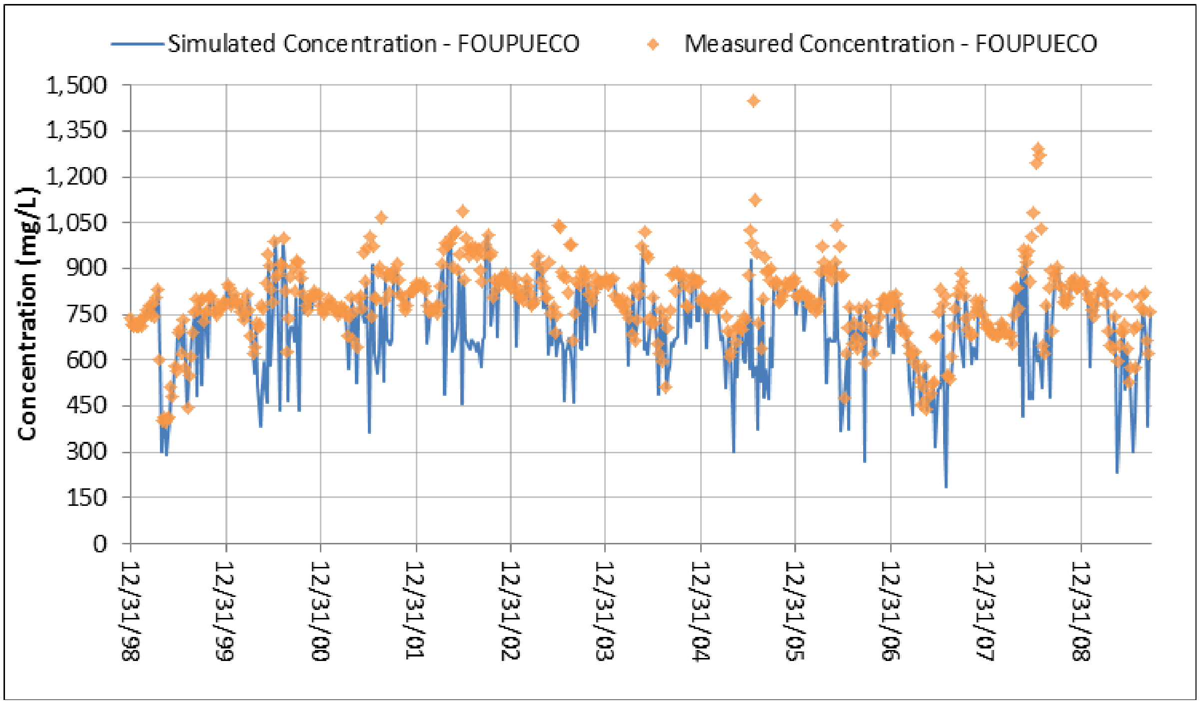


Figure 24. Weekly Comparison of Measured and Simulated Salinity Concentration for Fountain Creek at Pueblo Gage Calibration

Since the calibrated concentration is used as the baseline for the existing conditions, the relative comparison of alternatives is not going to be significantly affected by the concentration under prediction simulated at the Fountain Creek at Pueblo gage.

Arkansas River at Moffat St. Segment This segment used measured concentration at the Arkansas River at Moffat St. gage to calibrate unknown concentrations. The concentration measured at the Arkansas River above Pueblo gage, was assumed as the concentration of Pueblo Reservoir releases, is the upstream gage for this segment. Figure 25 depicts the weekly average calculated salinity concentration for inflows between Pueblo Reservoir and Arkansas River above Pueblo gage.

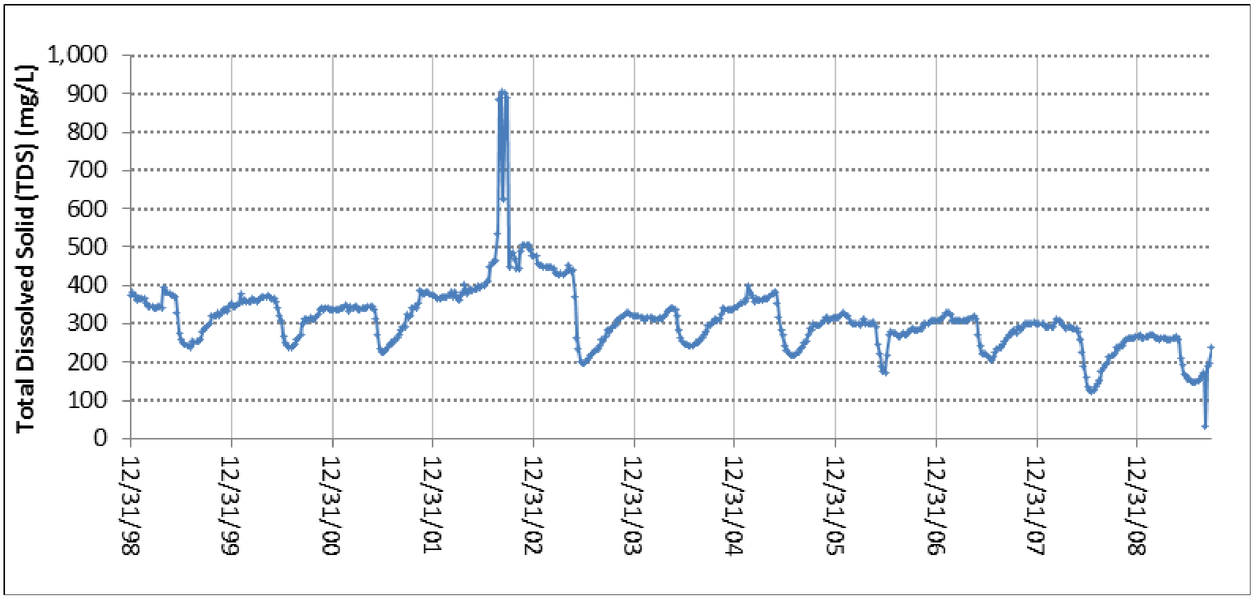


Figure 25. Weekly Measured Salinity Concentration at the Arkansas River above Pueblo Gage

Assumptions This segment includes the Pueblo West WWTF effluent discharged through Wildhorse Creek. It is assumed that effluent concentration remains the same as it flows down Wildhorse Creek. The assumed effluent salinity for Pueblo West WWTF, based on Reclamation (2008), is in Table 10.

Table 10. Pueblo West Raw Water and Estimated Wastewater Specific Conductance

Month	Raw Water from Pueblo Reservoir (µS/cm)	Wastewater (µS/cm)	Wastewater (mg/L)
Jan	461	1,168	804
Feb	473	1,180	812
Mar	480	1,187	817
Apr	485	1,192	821
May	504	1,211	835
Jun	508	1,215	838
Jul	325	1,032	706
Aug	319	1,026	701
Sep	355	1,062	727
Oct	407	1,114	765
Nov	443	1,150	791
Dec	468	1,175	809
Mean	**435**	**1,143**	**785**

Source: Reclamation (2008)

Calibrated Concentration. Figure 26 depicts the weekly average calculated salinity concentration for inflows between Arkansas River above Pueblo and Arkansas River at Moffat St. gages. This segment includes changes in salinity concentrations from a portion of the City of Pueblo.

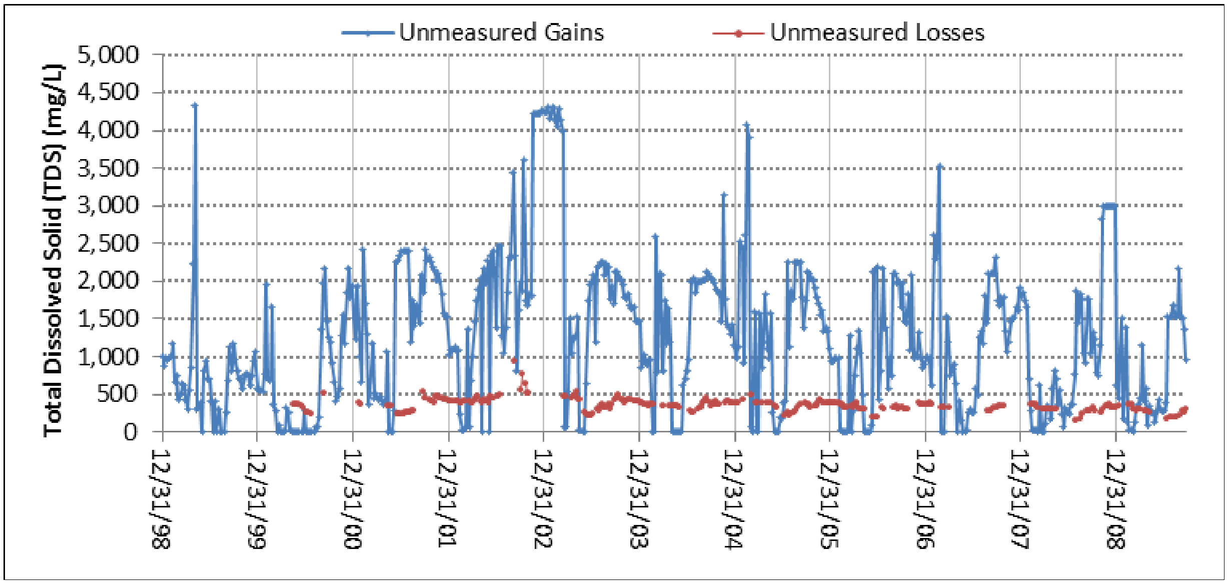


Figure 26. Weekly Calibrated and Simulated Salinity Concentration to Arkansas River at Moffat St. Segment for Unmeasured Inflows and Outflows

Comparison of simulated and historical measured concentration at the Arkansas River at Moffat St. gage is in Figure 27. Simulated concentration agreed with the measured concentration for most of the simulated period with larger errors shown at the end of 2002 and beginning of 2003. This period recorded unusual high salinity and extremely low flows values at the Arkansas River at Moffat St. gage. The period where the calibrated concentration is lower than the recorded values has flow lower than 2 cfs. Since the high salinity concentration at the end of 2002 are not observed at the Arkansas River above Pueblo gage, water reported to the Moffat St. gage is most likely only return flows within this reach. Note that with the extremely low flows in the river the salt loadings to the system in this period are extremely low; therefore, the under prediction of concentration in this period will have no significant effect in the comparative analysis of salinity values in the comparative analysis of alternatives. The low salinity loading to the system is corroborated by the observed concentration at the Arkansas River near Avondale gage, where concentrations at the end of 2002 and beginning of 2003 do not show extreme values (see next section Figure 29).

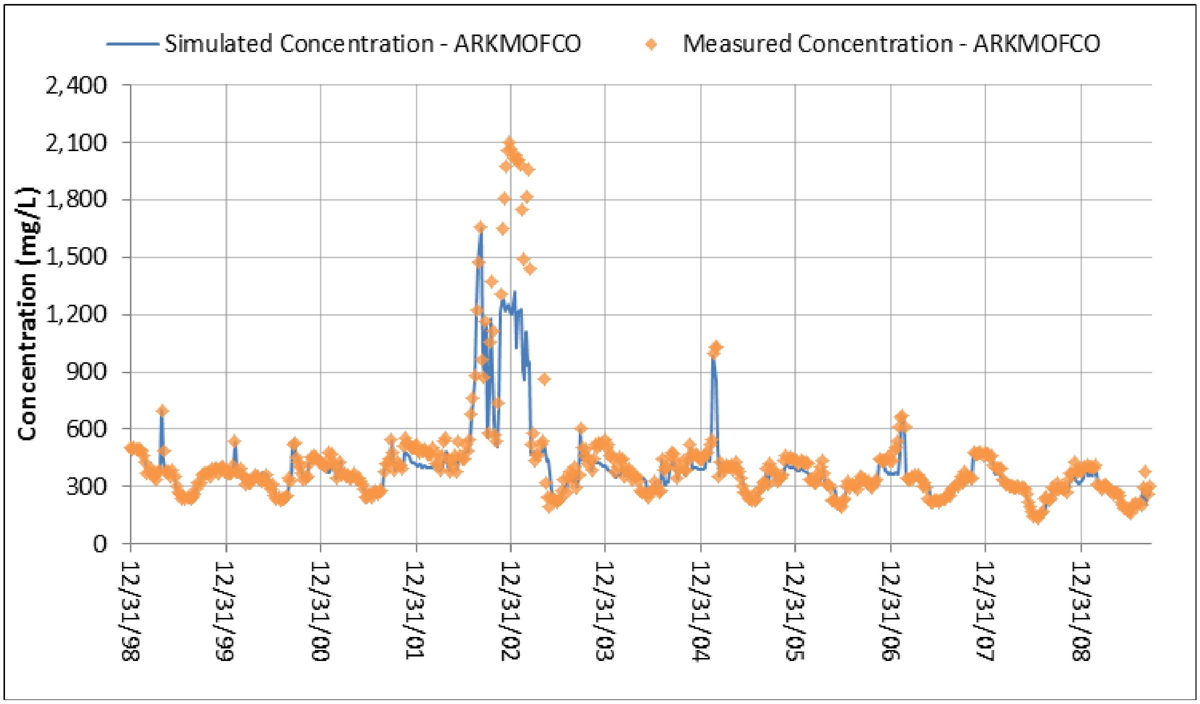


Figure 27. Weekly Comparison of Measured and Simulated Salinity Concentration for Arkansas River at Moffat Gage Calibration

Arkansas River near Avondale Segment This segment used measured concentration at the Arkansas River near Avondale gage to calibrate unknown concentrations. The segment combines inflows from Fountain Creek and the Arkansas River and receives tributary inflows from the Saint Charles River. This segment also receives the effluent from the Pueblo WWTF.

Calibrated Concentration Figure 28 depicts the weekly average calculated salinity concentration for inflows with unmeasured concentration between Arkansas River at Moffat St. and Arkansas River near Avondale gages. With exception of few points, the calibrated concentration has values in the same range throughout the simulation indicating a relative uniform source of salinity in this segment, downstream from the Fountain at Pueblo gage and Arkansas River at Moffat St. gage.

Measured concentration matches simulated concentration well, in part due to the number of simulated inflows with unmeasured concentration that allows flexibility in the calibration. Figure 29 compares the calibrated and simulated concentration at the Arkansas River near Avondale gage.

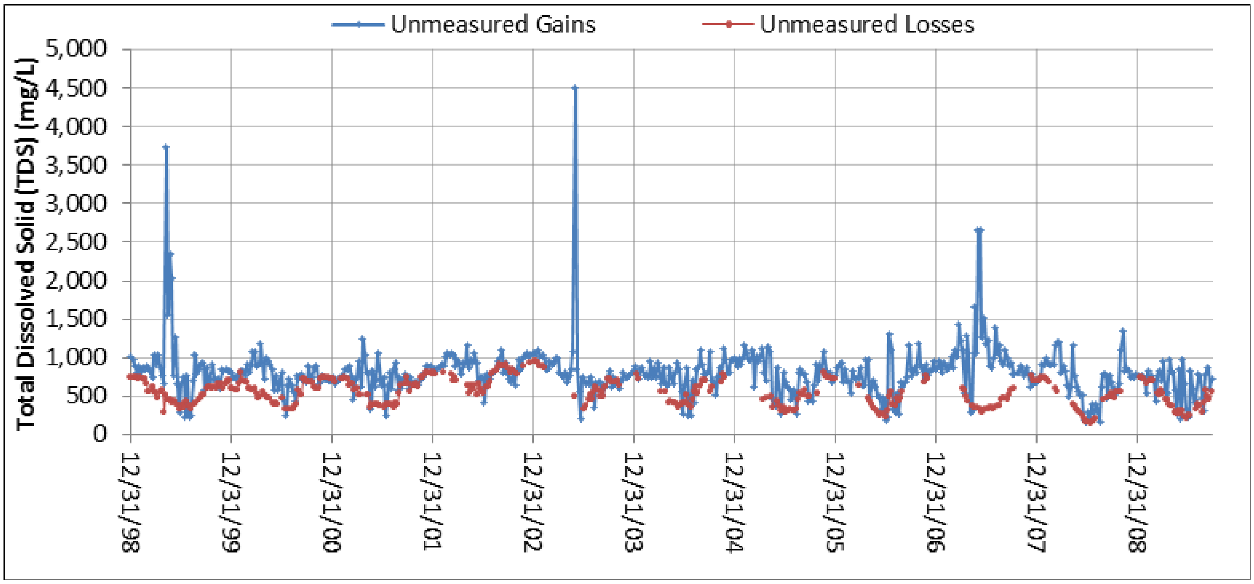


Figure 28. Weekly Calibrated and Simulated Salinity Concentration to Arkansas River near Avondale Segment for Unmeasured Inflows and Outflows

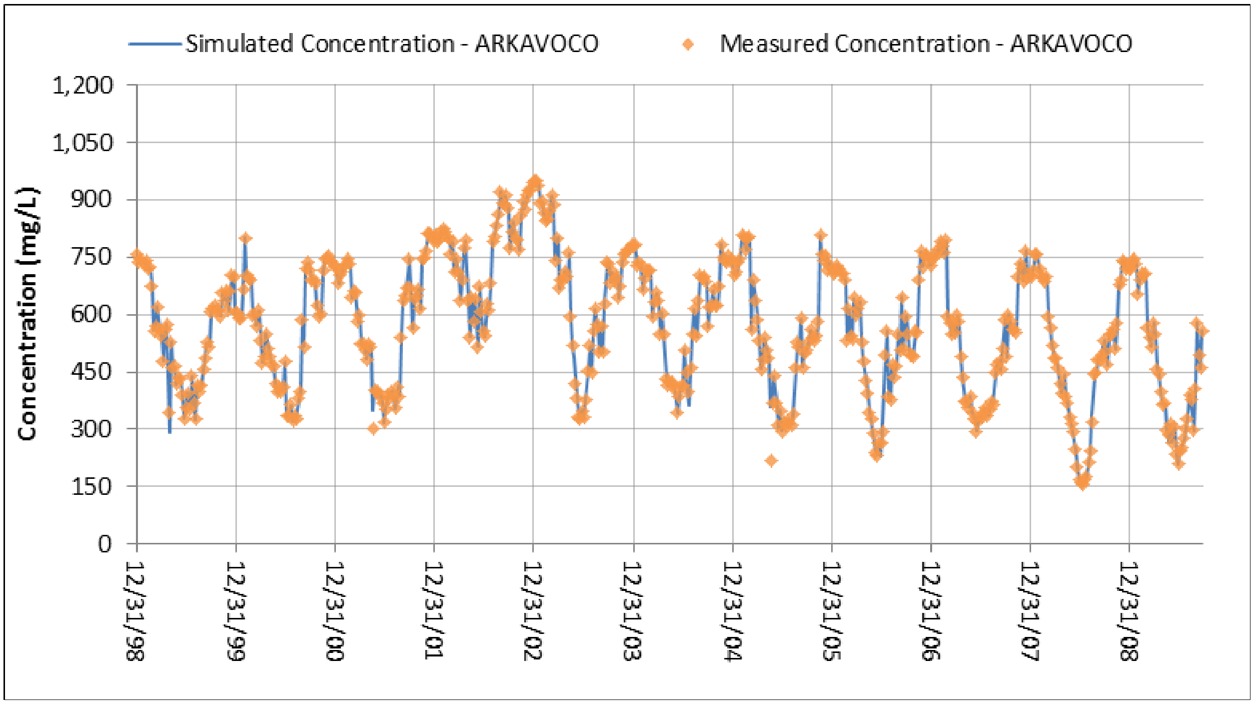


Figure 29. Weekly Comparison of Measured and Simulated Salinity Concentration for Arkansas River near Avondale Gage Calibration

Arkansas River at Catlin Dam Segment This segment used measured concentration at the Arkansas River at Catlin Dam gage to calibrate unknown concentrations. This segment receives contributions from the Huerfano River and Apishapa River.

Calibrated Concentration Figure 30 depicts the representative weekly average salinity concentration for inflows between Arkansas River near Avondale and Arkansas River at Catlin Dam gages. The representative concentration is the flow weighted concentration entering the segment. The results indicate a large source of salinity added to the Arkansas River in this segment. The average concentration of unmeasured gains to this segment is about 1,700 mg/L.

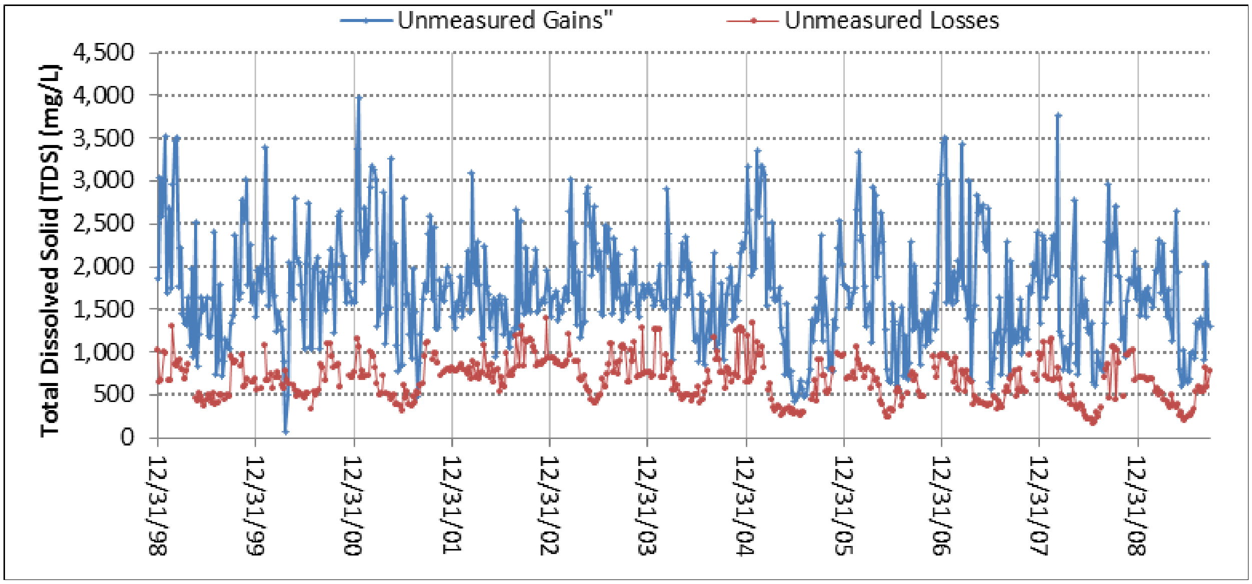


Figure 30. Weekly Calibrated and Simulated Salinity Concentration to Arkansas River at Catlin Dam Segment for Unmeasured Inflows and Outflows

The calibration of inflow unmeasured concentrations was able to adequately reproduce the measured concentration at the Arkansas River at Catlin Dam gage. Figure 31 compares simulated and measured concentrations for the Arkansas River at Catlin Dam gage.

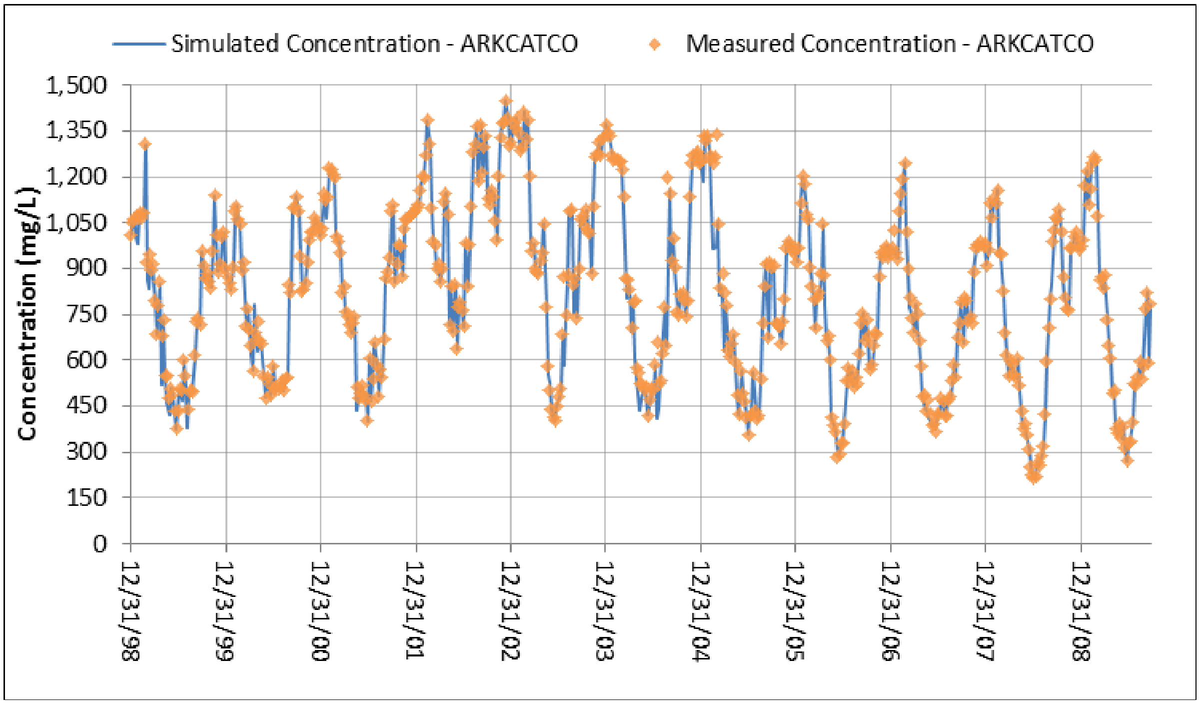


Figure 31. Weekly Comparison of Measured and Simulated Salinity Concentration for Arkansas River at Catlin Gage Calibration

Arkansas River near Rocky Ford Segment This segment used measured/estimated concentration at the Arkansas River near Rocky Ford gage to calibrate unknown concentrations. Although this segment simulates several return flow nodes, it does not receive major measured tributaries. Calibration to the estimated historical concentration at this gage helps as an intermediate control point to calibrate the next downstream segment to the Arkansas River at Las Animas gage.

Calibrated Concentration Figure 32 depicts the weekly average calculated salinity concentration for inflows between Arkansas River at Catlin Dam and Arkansas River near Rocky Ford gages. Large variability is shown in the calibrated concentration, indicating what could be intermittent sources of salinity loads to the river in this segment. Trends of low and high calibrated concentrations apparent between the first two thirds and the last third of the simulation and the end of the simulation, are likely due to effects of missing data and the fill-in process.

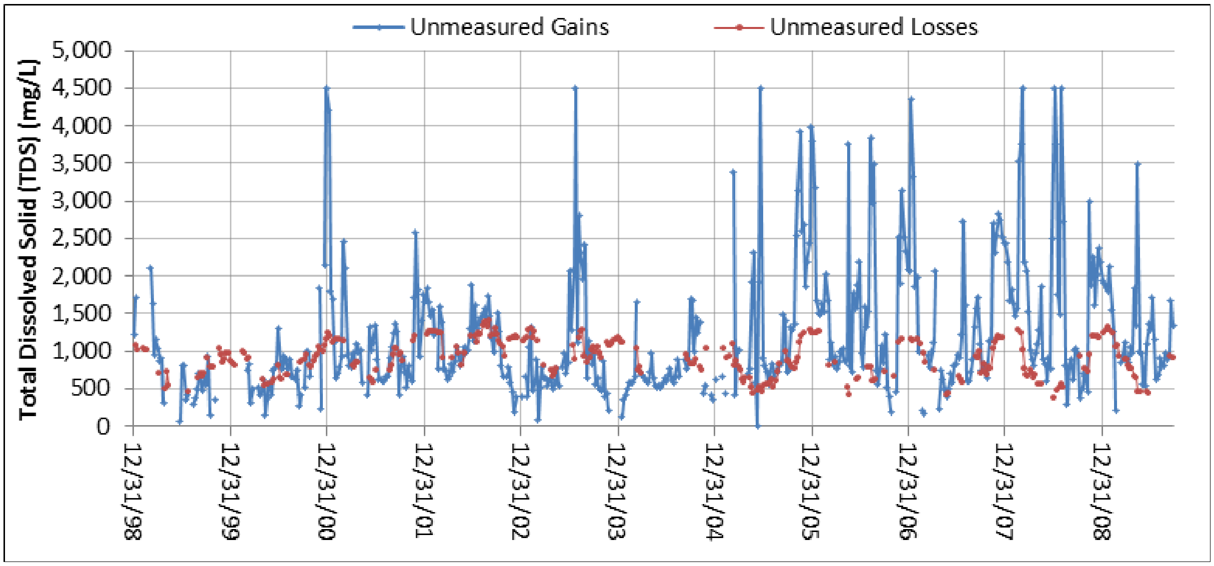


Figure 32. Weekly Calibrated and Simulated Salinity Concentration to Arkansas River near Rocky Ford Segment for Unmeasured Inflows and Outflows

Figure 33 shows the result of this section calibration, comparing the measured/estimated and simulated concentration at the Arkansas River near Rocky Ford gage. Simulated concentration matches historical estimated concentration for most of the simulation period. The larger calibration errors in the beginning of the simulation correspond with periods of net losses in the segment and corresponding low calibrated salt loadings to the segment.

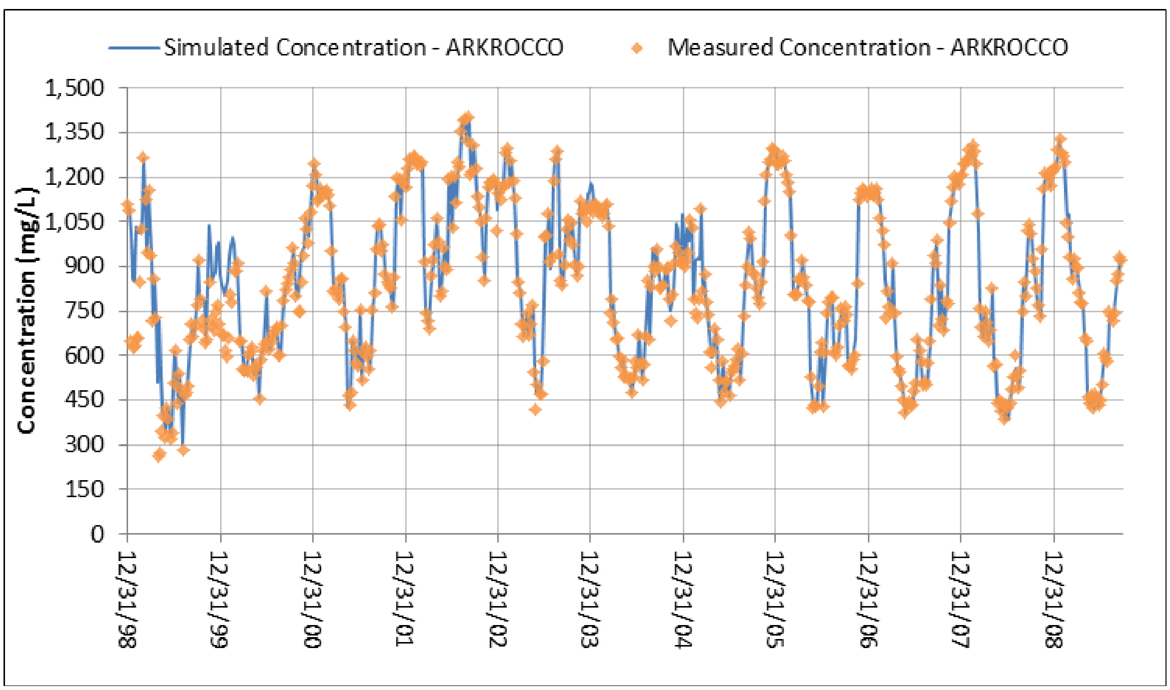


Figure 33. Weekly Comparison of Measured and Simulated Salinity Concentration for Arkansas River near Rocky Ford Gage Calibration

Arkansas River at Las Animas Segment This segment uses measured concentrations at the Arkansas River at Las Animas gage to calibrate unknown concentrations. This segment receives Timpas Creek, Crooked Arroyo, and several unmeasured tributaries. This is the most downstream segment simulated by the model and is located just upstream from the confluence of the Purgatory River with the Arkansas River.

Assumptions Flows in Horse Creek were neglected since they were not modeled in the Daily Model, and were assumed to be blended with the other unmeasured inflows in the segment.

Calibrated Concentration Figure 34 depicts the weekly average calculated salinity concentration for inflows between Arkansas River near Rocky Ford and Arkansas River at Las Animas gages. Results show a relative uniform unmeasured salinity load in this segment, with exception of the first year of simulation where larger values were present. The overall average salinity load concentration was 1,178 mg/L.

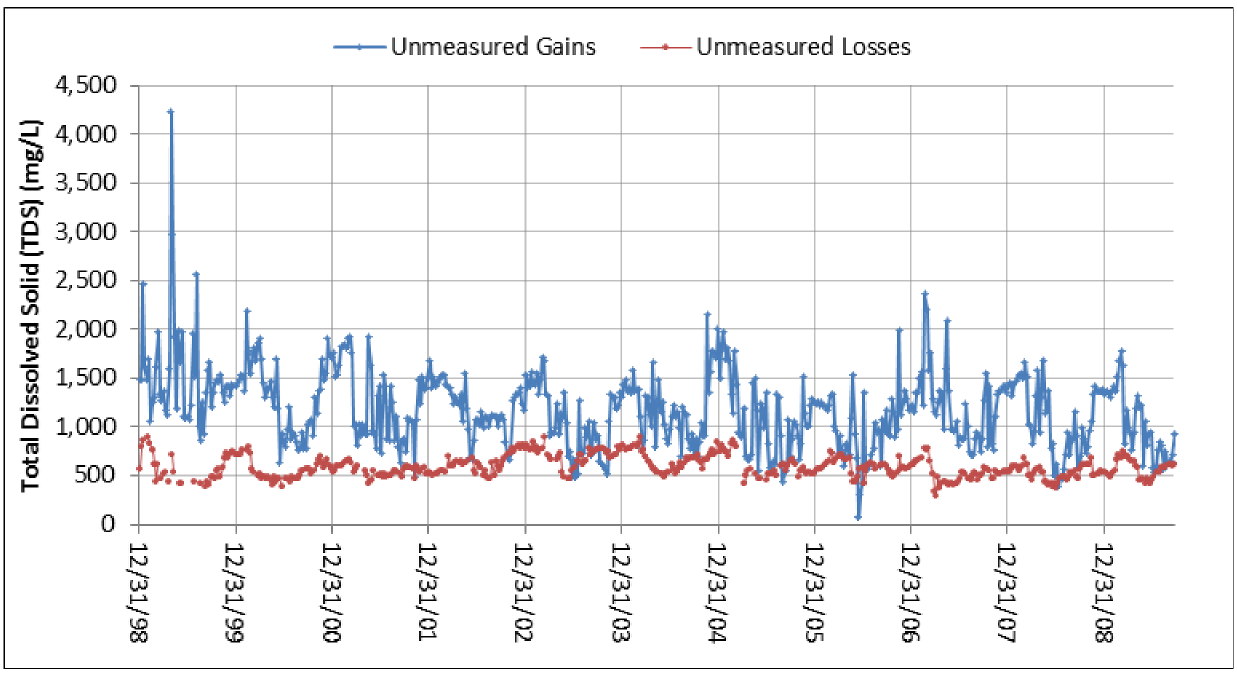


Figure 34. Weekly Calibrated and Simulated Salinity Concentration to Arkansas River at Las Animas Segment for Unmeasured Inflows and Outflows

Simulated concentration at this segment included the accumulated effect of calibrated salinity load that cascades from the upstream end of the model to this segment. Figure 35 compares the simulated and measured concentration at the Arkansas River at Las Animas. The results show a good overall model performance in mimicking the concentration at the intermediate control points and at the downstream end of the simulated area.

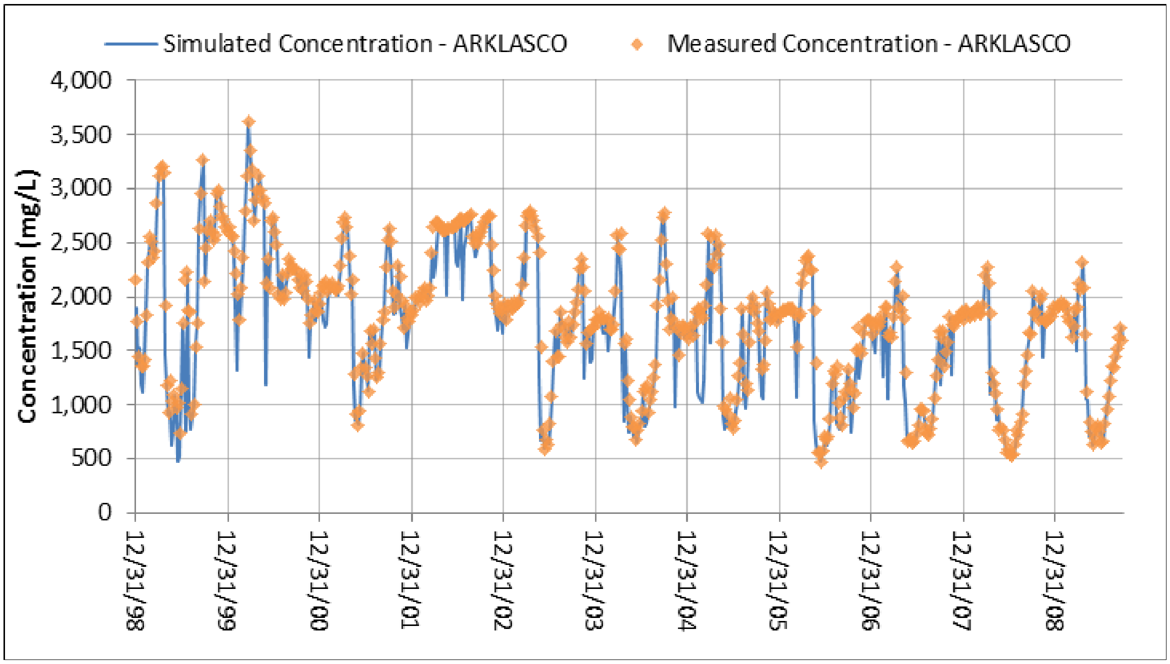


Figure 35. Weekly Comparison of Measured and Simulated Salinity Concentration for Arkansas River at Las Animas Gage Calibration

Calibration Summary

The calibration of the GeoDSS water quality model to represent salinity loading and transport in the study area was evaluated comparing the mean and selected percentiles of simulated and measured concentrations at the gages that serve as control points. Table 11 shows the statistics per control point of simulated and measured concentrations, including percent change of each statistic and the average mean error.

Table 11. Summary Statistics – Salinity Concentration Calibration Performance for Control Points in the Study Area

Gage	Mean (mg/L)	Percentile [mg/L] 15	25	50	75	85	Average Mean Error (mg/L)
715530- Fountain Creek below Janitell Road							
Simulated	449.4	349.4	382.7	454.0	509.3	555.9	*±6.1 (1%)*
Measured	443.9	344.1	374.3	441.0	509.9	556.2	
Percent Difference	-1%	-2%	-2%	-3%	0%	0%	
7106000-Fountain Creek near Fountain							
Simulated	574.0	454.2	518.5	604.5	656.3	678.3	*±30.6 (5%)*
Measured	603.8	515.5	564.3	621.7	668.8	688.2	
Percent Difference	5%	12%	8%	3%	2%	1%	
FOUPUECO-Fountain Creek at Pueblo							
Simulated	711.7	576.3	638.5	739.3	807.0	845.6	*±82.1 (10%)*
Measured	793.8	689.3	736.7	799.4	857.7	890.7	
Percent Difference	15%	23%	21%	14%	8%	6%	
ARKPUECO-Arkansas River above Pueblo							
Simulated	312.8	241.2	263.4	309.5	348.9	373.0	*±0 (0%)*
Measured	312.8	241.2	263.4	309.5	348.9	373.0	
Percent Difference	0%	0%	0%	0%	0%	0%	
ARKMOFCO-Arkansas River at Moffat St.							
Simulated	392.3	265.1	299.0	359.7	413.5	457.5	*±43.7 (10%)*
Measured	430.5	257.2	297.6	370.7	448.7	494.1	
Percent Difference	9%	-3%	0%	3%	8%	7%	
ARKAVOCO-Arkansas River near Avondale							
Simulated	576.8	371.0	442.7	587.8	718.2	751.2	*±1.2 (0%)*
Measured	576.8	374.0	442.7	588.0	718.5	751.3	
Percent Difference	0%	1%	0%	0%	0%	0%	
ARKCATCO-Arkansas River at Catlin Dam							
Simulated	819.3	487.8	566.2	831.9	1041.1	1132.8	*±10.2 (1%)*
Measured	828.4	500.0	575.7	843.4	1058.4	1143.7	
Percent Difference	1%	2%	2%	1%	2%	1%	
ARKROCCO-Arkansas River near Rocky Ford							
Simulated	852.0	552.1	634.5	849.1	1077.2	1166.0	*±16.3 (2%)*
Measured	838.3	549.6	619.2	816.7	1064.0	1165.5	
Percent Difference	-2%	0%	-2%	-4%	-1%	0%	
ARKLASCO-Arkansas River at Las Animas							
Simulated	1732.9	908.0	1236.3	1792.3	2122.1	2483.4	*±82 (5%)*
Measured	1814.2	1050.6	1422.8	1848.5	2206.0	2558.7	
Percent Difference	4%	14%	13%	3%	4%	3%	

Notes:

Average mean error: AME = $\frac{\sum |SimVal - ObsVal|}{N}$

Where: SimVal = simulated value, ObsVal = observed value, N = number of observations, From Galloway and Green (2002).

In general, results show good representation of measured concentration at the control points, with larger errors at the downstream Fountain Creek and Arkansas River gages. The largest percent difference (around 20 percent under prediction) is at the 15th and 25th percentiles for the Fountain at Pueblo gage, where low unmeasured inflows to the model limit performance. The Las Animas gage shows the largest percent difference in the Arkansas River, with around 14 percent under prediction at the 15th and 25th percentiles.

The model results reflect the cascading effect of calibration errors because the GeoDSS uses the simulated concentration at the gages to represent salt loading to the next downstream segment. In many cases calibration self-corrects those errors in the next downstream segment, adjusting that downstream segment unmeasured concentrations to try to match the downstream gage concentration. For example, this is the case in the Arkansas River at Avondale where discrepancies between measured and simulated at the Fountain Creek at Pueblo gage are adjusted.

The average mean error for all the control points is less than 10 percent. The average percent difference of the mean shows slight under prediction of concentration in the simulation, except the Fountain Creek below Janitell Road and Arkansas River near Rocky Ford gages, which show a slight over prediction of concentrations. The calibrated salinity model provides a reasonable baseline to compare the relative effects on salinity for the alternatives.

Simulation of Alternatives Changes in salinity loadings and concentrations for the direct and cumulative effects were analyzed for the each alternative. The calibrated salinity model was used as the base to simulate alternatives. Calibrated concentrations of unmeasured inflows were assumed constant for all scenarios, while the unmeasured flow gains and losses to each scenario were based on the Daily Model simulated flows.

Changes in salinity loads to the system under each alternative were simulated according to the changes of flow simulated in the Daily Model and the calibrated concentrations. Salt loads were routed and mixed with other simulated salt loads from upstream to downstream, allowing simulation of salinity concentration at all the diversion and control points (gages). Table 12 shows the assumed concentration at the Arkansas River above Pueblo, Fountain Creek near Colorado Springs and Monument Creek at Bijou St. gages, which are the most upstream gages in the simulated area

Table 12. Simulated Salinity Concentration for Upstream Model Boundary Gages

Gage	Mean	Concentration Statistics (mg/L)				
		15th	25th	50th	75th	85th
Arkansas River above Pueblo	313	241	263	310	349	373
Fountain Creek near Colorado Springs	200	128	154	197	242	278
Monument Creek at Bijou St.	414	313	352	427	476	516

Direct and Indirect Effects A comparative analysis with the No Action Alternative and existing conditions was performed to estimate the changes in salinity under each alternative for the direct effects analysis. For each control point, statistics of simulated concentration and relative changes with respect to the No Action Alternative and the existing conditions are presented, as well as the monthly statistics of simulated concentration for the different alternatives and their percent change with respect to No Action and existing conditions for the direct effect analysis. Table 13 and Table 14 summarize direct and indirect salinity effects in the Arkansas River and Fountain Creek.

Table 13. Summary of Mean Direct and Indirect Salinity Effects

Gage	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Mean Concentration (mg/L)								
Arkansas River at Moffat St.	391	406	420	420	418	420	389	407
Arkansas River near Avondale	564	582	591	591	587	591	584	586
Arkansas River at Catlin Dam	780	791	804	804	804	804	799	792
Arkansas River at Las Animas	1,684	1,624	1,623	1,625	1,632	1,623	1,621	1,616
Fountain Creek near Fountain	596	658	662	662	658	662	661	663
Fountain Creek at Pueblo	698	746	746	746	746	746	746	747
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Arkansas River at Moffat St.	---	---	14 (3.4)	14 (3.5)	13 (3.1)	14 (3.4)	-17 (-4.2)	1 (0.4)
Arkansas River near Avondale	---	---	8.6 (1.5)	8.6 (1.5)	4.5 (0.8)	8.5 (1.5)	1.7 (0.3)	4 (0.7)
Arkansas River at Catlin Dam	---	---	13 (1.6)	13 (1.7)	13 (1.7)	13 (1.7)	8 (1.0)	2 (0.2)
Arkansas River at Las Animas	---	---	-1 (-0.1)	1 (0.1)	8 (0.5)	-1 (-0.1)	-3 (-0.2)	-8 (-0.5)
Fountain Creek near Fountain	---	---	4 (0.6)	4 (0.6)	0 (0.0)	4 (0.6)	3 (0.5)	5 (0.8)
Fountain Creek at Pueblo	---	---	0 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Arkansas River at Moffat St.	---	14 (3.7)	28 (7.3)	29 (7.3)	27 (6.9)	28 (7.3)	-3 (-0.7)	16 (4.1)
Arkansas River near Avondale	---	19 (3.3)	27 (4.8)	27 (4.8)	23 (4.1)	27 (4.8)	20 (3.6)	23 (4.0)
Arkansas River at Catlin Dam	---	11 (1.4)	24 (3.0)	24 (3.1)	24 (3.0)	24 (3.1)	19 (2.4)	12 (1.6)
Arkansas River at Las Animas	---	-61 (-3.6)	-62 (-3.7)	-59 (-3.5)	-52 (-3.1)	-62 (-3.7)	-63 (-3.8)	-68 (-4.0)
Fountain Creek near Fountain	---	62 (10.4)	66 (11.1)	66 (11.0)	62 (10.4)	66 (11.0)	65 (10.9)	67 (11.2)
Fountain Creek at Pueblo	---	48 (6.8)	48 (6.9)	48 (6.9)	48 (6.8)	48 (6.8)	47 (6.8)	49 (7.0)

Table 14. Summary of 85th Percentile Direct and Indirect Salinity Effects

Gage	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
85th Percentile Concentration (mg/L)								
Arkansas River at Moffat St.	446	478	504	506	498	501	473	479
Arkansas River near Avondale	733	753	764	764	758	764	760	760
Arkansas River at Catlin Dam	1,062	1,056	1,094	1,087	1,078	1,092	1,083	1,060
Arkansas River at Las Animas	2,323	2,170	2,185	2,186	2,206	2,175	2,185	2,172
Fountain Creek near Fountain	733	801	802	802	799	802	802	802
Fountain Creek at Pueblo	870	906	905	905	905	905	905	905
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Arkansas River at Moffat St.	---	---	26 (5.5)	28 (5.9)	21 (4.3)	24 (5.0)	-5 (-1.1)	1 (0.2)
Arkansas River near Avondale	---	---	11.3 (1.5)	11.6 (1.5)	5.5 (0.7)	11.5 (1.5)	7.8 (1.0)	7.5 (1.0)
Arkansas River at Catlin Dam	---	---	38 (3.6)	31 (2.9)	22 (2.1)	36 (3.4)	27 (2.5)	4 (0.4)
Arkansas River at Las Animas	---	---	15 (0.7)	15 (0.7)	36 (1.7)	5 (0.2)	15 (0.7)	2 (0.1)
Fountain Creek near Fountain	---	---	1 (0.1)	1 (0.1)	-2 (-0.2)	1 (0.1)	1 (0.1)	1 (0.1)
Fountain Creek at Pueblo	---	---	-1 (-0.1)	-1 (-0.1)	-1 (-0.1)	-1 (-0.1)	-1 (-0.1)	-1 (-0.1)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Arkansas River at Moffat St.	---	31 (7.0)	58 (12.9)	60 (13.4)	52 (11.6)	55 (12.3)	26 (5.9)	32 (7.3)
Arkansas River near Avondale	---	19 (2.6)	31 (4.2)	31 (4.2)	25 (3.4)	31 (4.2)	27 (3.7)	27 (3.7)
Arkansas River at Catlin Dam	---	-6 (-0.6)	32 (3.0)	25 (2.4)	16 (1.5)	30 (2.8)	21 (2.0)	-2 (-0.1)
Arkansas River at Las Animas	---	-153 (-6.6)	-138 (-6.0)	-138 (-5.9)	-117 (-5.0)	-148 (-6.4)	-138 (-5.9)	-151 (-6.5)
Fountain Creek near Fountain	---	68 (9.3)	69 (9.4)	69 (9.4)	66 (9.1)	69 (9.4)	69 (9.4)	69 (9.4)
Fountain Creek at Pueblo	---	36 (4.1)	35 (4.0)	35 (4.0)	35 (4.0)	35 (4.0)	34 (4.0)	35 (4.0)

Table 15 and Table 16 show the statistics and relative change with respect to the No Action Alternative and the existing conditions for the Arkansas River at Moffat St. gage. All alternatives, except River South and Master Contract Only, would have negligible to minor adverse effects on river salinity when compared with the No Action Alternative. Occasional moderate increases in salinity would occur in dry years. The largest percent changes occur in January, February, March, September and October. All alternatives increase salinity during various months, compared to existing conditions, although changes are of similar magnitude as effects compared to the No Action.

Table 15. Direct Effects Simulated Salinity Concentration Comparison for Arkansas River at Moffat St. Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	391	406	420	420	418	420	389	407
15th percentile	264	267	267	267	267	267	262	267
25th percentile	299	303	304	304	304	304	303	303
50th percentile	365	375	385	385	381	385	367	379
75th percentile	419	438	452	452	451	452	432	439
85th percentile	446	478	504	506	498	501	473	479
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	14 (3.4)	14 (3.5)	13 (3.1)	14 (3.4)	-17 (-4.2)	1 (0.4)
15th percentile	---	---	0 (0.1)	0 (0.1)	0 (0.1)	0 (0.1)	-5 (-1.7)	0 (0.1)
25th percentile	---	---	1 (0.3)	1 (0.3)	1 (0.3)	1 (0.3)	-1 (-0.3)	0 (0.0)
50th percentile	---	---	10 (2.6)	10 (2.7)	6 (1.7)	10 (2.6)	-7 (-1.9)	4 (1.1)
75th percentile	---	---	14 (3.3)	14 (3.3)	13 (3.0)	14 (3.2)	-5 (-1.2)	1 (0.3)
85th percentile	---	---	26 (5.5)	28 (5.9)	21 (4.3)	24 (5.0)	-5 (-1.1)	1 (0.2)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	14 (3.7)	28 (7.3)	29 (7.3)	27 (6.9)	28 (7.3)	-3 (-0.7)	16 (4.1)
15th percentile	---	2 (0.9)	3 (1.0)	3 (1.0)	3 (1.0)	3 (1.0)	-2 (-0.8)	3 (1.0)
25th percentile	---	4 (1.4)	5 (1.7)	5 (1.7)	5 (1.7)	5 (1.7)	3 (1.1)	4 (1.4)
50th percentile	---	10 (2.8)	20 (5.5)	20 (5.5)	17 (4.5)	20 (5.5)	3 (0.8)	14 (3.9)
75th percentile	---	19 (4.5)	33 (7.9)	33 (7.9)	32 (7.7)	33 (7.8)	13 (3.2)	20 (4.8)
85th percentile	---	31 (7.0)	58 (12.9)	60 (13.4)	52 (11.6)	55 (12.3)	26 (5.9)	32 (7.3)

Table 16. Direct Effects Monthly Simulated Salinity Concentration for Arkansas River at Moffat St. Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	472	483	508	508	503	508	463	488
Feb	516	537	566	566	567	566	485	537
Mar	393	406	426	427	425	426	389	411
Apr	367	379	387	387	388	387	376	379
May	351	354	356	356	355	356	354	355
Jun	277	279	280	280	280	280	278	279
Jul	265	271	275	274	274	275	265	271
Aug	333	345	356	356	356	356	320	346
Sep	407	425	446	447	443	446	401	425
Oct	404	433	454	454	445	454	426	440
Nov	452	473	485	485	486	485	448	470
Dec	484	511	527	528	525	527	486	512
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	25 (5.2)	25 (5.3)	20 (4.2)	25 (5.2)	-20 (-4.0)	5 (1.0)
Feb	---	---	29 (5.4)	29 (5.6)	30 (5.7)	29 (5.4)	-52 (-9.7)	0 (0.1)
Mar	---	---	20 (4.8)	21 (5.1)	19 (4.5)	20 (4.8)	-17 (-4.2)	5 (1.1)
Apr	---	---	8 (2.2)	8 (2.3)	9 (2.6)	8 (2.2)	-3 (-0.8)	0 (0.1)
May	---	---	2 (0.5)	2 (0.5)	1 (0.4)	2 (0.5)	0 (-0.1)	1 (0.3)
Jun	---	---	1 (0.3)	1 (0.3)	1 (0.3)	1 (0.3)	-1 (-0.4)	0 (0.0)
Jul	---	---	4 (1.2)	3 (1.1)	3 (0.9)	4 (1.2)	-6 (-2.4)	0 (0.0)
Aug	---	---	11 (3.1)	11 (3.0)	11 (3.2)	11 (3.0)	-25 (-7.3)	1 (0.3)
Sep	---	---	21 (4.8)	22 (5.1)	18 (4.2)	21 (5.0)	-24 (-5.6)	0 (-0.1)
Oct	---	---	21 (5.0)	21 (4.9)	12 (2.8)	21 (5.0)	-7 (-1.6)	7 (1.8)
Nov	---	---	12 (2.5)	12 (2.4)	13 (2.6)	12 (2.5)	-25 (-5.3)	-3 (-0.7)
Dec	---	---	16 (3.3)	17 (3.4)	14 (2.9)	16 (3.3)	-25 (-4.9)	1 (0.3)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	11 (2.2)	36 (7.6)	36 (7.6)	31 (6.6)	36 (7.6)	-9 (-1.9)	16 (3.2)
Feb	---	21 (3.9)	50 (9.6)	50 (9.7)	51 (9.9)	50 (9.6)	-31 (-6.1)	21 (4.0)
Mar	---	13 (3.5)	33 (8.5)	34 (8.8)	32 (8.2)	33 (8.4)	-4 (-0.8)	18 (4.7)
Apr	---	12 (3.0)	20 (5.3)	20 (5.4)	21 (5.7)	20 (5.2)	9 (2.2)	12 (3.1)
May	---	3 (1.0)	5 (1.5)	5 (1.4)	4 (1.3)	5 (1.5)	3 (0.9)	4 (1.2)
Jun	---	2 (0.7)	3 (1.1)	3 (1.1)	3 (1.1)	3 (1.1)	1 (0.3)	2 (0.8)
Jul	---	6 (2.3)	10 (3.5)	9 (3.4)	9 (3.3)	10 (3.5)	0 (-0.2)	6 (2.3)
Aug	---	12 (3.6)	23 (6.8)	23 (6.8)	23 (7.0)	23 (6.7)	-13 (-4.0)	13 (3.9)
Sep	---	18 (4.4)	39 (9.5)	40 (9.7)	36 (8.9)	39 (9.6)	-6 (-1.4)	18 (4.4)
Oct	---	29 (7.1)	50 (12.5)	50 (12.4)	41 (10.1)	50 (12.5)	22 (5.5)	36 (9.0)
Nov	---	21 (4.7)	33 (7.3)	33 (7.3)	34 (7.4)	33 (7.3)	-4 (-0.9)	18 (3.9)
Dec	---	27 (5.6)	43 (9.0)	44 (9.1)	41 (8.6)	43 (9.0)	2 (0.4)	28 (5.9)

Table 17 and Table 18 show the statistics and relative change for the Arkansas River near Avondale gage. All alternatives would have predominantly negligible adverse effects on Arkansas River near Avondale gage salinity concentrations, with occasion minor effects occurring in various months, compared to the No Action. All alternatives increase salinity levels at the Arkansas River near Avondale gage, compared to existing conditions, caused by additional municipal discharges and streamflow changes.

Table 17. Direct Effects Simulated Salinity Concentration Comparison for Arkansas River near Avondale Gage

Statistic	Existing Conditions	No Action		Comanche North		Pueblo Dam South		JUP North		Pueblo Dam North		River South		Master Contract Only	
Simulated Concentration (mg/L)															
Mean	564	582		591		591		587		591		584		586	
15th percentile	371	378		382		382		381		382		379		380	
25th percentile	437	445		451		451		447		451		447		448	
50th percentile	576	597		607		605		601		607		598		600	
75th percentile	687	713		724		723		718		724		721		720	
85th percentile	733	753		764		764		758		764		760		760	
Change in Concentration Compared to No Action Alternative [mg/L (%)]															
Mean	---	---		8.6	(1.5)	8.6	(1.5)	4.5	(0.8)	8.5	(1.5)	1.7	(0.3)	4	(0.7)
15th percentile	---	---		3.6	(1.0)	3.6	(0.9)	3.2	(0.8)	4	(1.1)	0.6	(0.2)	2	(0.5)
25th percentile	---	---		5.6	(1.2)	5.3	(1.2)	1.8	(0.4)	5.5	(1.2)	2.2	(0.5)	2.3	(0.5)
50th percentile	---	---		9.7	(1.6)	7.8	(1.3)	4.2	(0.7)	9.6	(1.6)	1.2	(0.2)	2.6	(0.4)
75th percentile	---	---		11.5	(1.6)	10.4	(1.5)	4.8	(0.7)	11.5	(1.6)	8.1	(1.1)	7.2	(1.0)
85th percentile	---	---		11.3	(1.5)	11.6	(1.5)	5.5	(0.7)	11.5	(1.5)	7.8	(1.0)	7.5	(1.0)
Change in Concentration Compared to Existing Conditions [mg/L (%)]															
Mean	---	19	(3.3)	27	(4.8)	27	(4.8)	23	(4.1)	27	(4.8)	20	(3.6)	23	(4.0)
15th percentile	---	7	(1.8)	10	(2.8)	10	(2.8)	10	(2.7)	11	(2.9)	7	(2.0)	9	(2.4)
25th percentile	---	8	(1.9)	14	(3.2)	14	(3.1)	10	(2.3)	14	(3.2)	10	(2.4)	11	(2.4)
50th percentile	---	21	(3.7)	31	(5.4)	29	(5.1)	26	(4.4)	31	(5.4)	23	(3.9)	24	(4.2)
75th percentile	---	26	(3.8)	37	(5.4)	36	(5.3)	31	(4.5)	37	(5.4)	34	(5.0)	33	(4.8)
85th percentile	---	19	(2.6)	31	(4.2)	31	(4.2)	25	(3.4)	31	(4.2)	27	(3.7)	27	(3.7)

Table 18. Direct Effects Monthly Simulated Salinity Concentration for Arkansas River near Avondale Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	707	728	743	744	735	743	732	737
Feb	744	767	777	777	774	777	766	771
Mar	627	650	670	670	659	668	661	662
Apr	525	552	561	561	555	561	560	559
May	430	438	442	442	439	442	441	440
Jun	347	352	354	355	354	354	353	353
Jul	368	382	387	386	385	387	382	384
Aug	477	488	494	494	490	494	486	490
Sep	579	609	616	616	614	616	603	608
Oct	621	645	660	660	652	660	657	655
Nov	667	687	691	691	692	691	681	684
Dec	715	733	739	739	738	739	730	733
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	15 (2.0)	16 (2.1)	7 (0.9)	15 (2.0)	4 (0.4)	9 (1.2)
Feb	---	---	10 (1.2)	10 (1.2)	7 (0.9)	10 (1.2)	-1 (-0.1)	4 (0.5)
Mar	---	---	20 (3.0)	20 (3.0)	9 (1.4)	18 (2.8)	11 (1.6)	12 (1.9)
Apr	---	---	9 (1.7)	9 (1.7)	3 (0.6)	9 (1.7)	8 (1.4)	7 (1.4)
May	---	---	4 (0.8)	4 (0.8)	1 (0.3)	4 (0.8)	3 (0.7)	2 (0.5)
Jun	---	---	2 (0.5)	3 (0.6)	2 (0.4)	2 (0.5)	1 (0.1)	1 (0.2)
Jul	---	---	5 (1.3)	4 (1.1)	3 (0.7)	5 (1.3)	0 (0.0)	2 (0.6)
Aug	---	---	6 (1.2)	6 (1.3)	2 (0.4)	6 (1.3)	-2 (-0.4)	2 (0.3)
Sep	---	---	7 (1.2)	7 (1.2)	5 (0.8)	7 (1.2)	-6 (-0.9)	-1 (-0.1)
Oct	---	---	15 (2.3)	15 (2.2)	7 (1.0)	15 (2.3)	12 (1.8)	10 (1.6)
Nov	---	---	4 (0.7)	4 (0.7)	5 (0.8)	4 (0.7)	-6 (-0.8)	-3 (-0.3)
Dec	---	---	6 (0.9)	6 (0.9)	5 (0.7)	6 (0.9)	-3 (-0.4)	0 (0.0)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	21 (3.0)	36 (5.1)	37 (5.2)	28 (4.0)	36 (5.1)	25 (3.5)	30 (4.2)
Feb	---	23 (3.1)	33 (4.4)	33 (4.4)	30 (4.1)	33 (4.4)	22 (3.0)	27 (3.7)
Mar	---	23 (3.7)	43 (6.9)	43 (6.9)	32 (5.2)	41 (6.6)	34 (5.4)	35 (5.7)
Apr	---	27 (5.1)	36 (6.9)	36 (6.9)	30 (5.7)	36 (6.9)	35 (6.6)	34 (6.6)
May	---	8 (1.8)	12 (2.7)	12 (2.7)	9 (2.2)	12 (2.7)	11 (2.5)	10 (2.4)
Jun	---	5 (1.5)	7 (2.1)	8 (2.1)	7 (1.9)	7 (2.1)	6 (1.6)	6 (1.7)
Jul	---	14 (3.9)	19 (5.3)	18 (5.0)	17 (4.7)	19 (5.3)	14 (3.9)	16 (4.5)
Aug	---	11 (2.4)	17 (3.6)	17 (3.7)	13 (2.7)	17 (3.7)	9 (2.0)	13 (2.7)
Sep	---	30 (5.1)	37 (6.4)	37 (6.4)	35 (5.9)	37 (6.4)	24 (4.2)	29 (5.0)
Oct	---	24 (3.9)	39 (6.3)	39 (6.2)	31 (4.9)	39 (6.3)	36 (5.7)	34 (5.6)
Nov	---	20 (3.0)	24 (3.7)	24 (3.7)	25 (3.8)	24 (3.7)	14 (2.1)	17 (2.6)
Dec	---	18 (2.5)	24 (3.3)	24 (3.4)	23 (3.2)	24 (3.3)	15 (2.0)	18 (2.5)

The monthly concentration statistics at the Arkansas River at Catlin Dam and Arkansas River near Rocky Ford gages show smaller percent changes with respect to the No Action alternative than the Arkansas River near Avondale gage concentrations (Table 19 through Table 22). Effects for both gages would be predominantly negligible, with occasional minor increases in concentration. The Arkansas River at Catlin Dam concentrations would slightly decrease with respect to the No Action Alternative in November, except for the JUP North Alternative. The Master Contract Only Alternative would decrease the average concentration in months after August. All alternatives would slightly increase salinity concentrations in most months, compared to existing conditions.

Table 19. Direct Effects Simulated Salinity Concentration Comparison for Arkansas River at Catlin Dam Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	780	791	804	804	804	804	799	792
15th percentile	468	469	473	473	473	473	471	470
25th percentile	538	557	568	568	567	568	567	564
50th percentile	795	818	828	830	828	828	823	820
75th percentile	968	975	992	988	987	991	988	974
85th percentile	1,062	1,056	1,094	1,087	1,078	1,092	1,083	1,060
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	13 (1.6)	13 (1.7)	13 (1.7)	13 (1.7)	8 (1.0)	2 (0.2)
15th percentile	---	---	4 (0.8)	4 (0.8)	4 (0.9)	4 (0.8)	2 (0.4)	1 (0.1)
25th percentile	---	---	11 (2.0)	11 (2.0)	9 (1.6)	11 (1.9)	10 (1.7)	7 (1.3)
50th percentile	---	---	10 (1.2)	12 (1.4)	10 (1.2)	10 (1.2)	5 (0.6)	2 (0.3)
75th percentile	---	---	17 (1.8)	13 (1.3)	12 (1.2)	16 (1.6)	13 (1.3)	-1 (-0.1)
85th percentile	---	---	38 (3.6)	31 (2.9)	22 (2.1)	36 (3.4)	27 (2.5)	4 (0.4)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	11 (1.4)	24 (3.0)	24 (3.1)	24 (3.0)	24 (3.1)	19 (2.4)	12 (1.6)
15th percentile	---	1 (0.2)	5 (1.1)	5 (1.1)	6 (1.2)	5 (1.1)	3 (0.6)	2 (0.4)
25th percentile	---	19 (3.6)	30 (5.6)	30 (5.6)	29 (5.3)	30 (5.6)	29 (5.4)	26 (4.9)
50th percentile	---	23 (2.9)	33 (4.1)	34 (4.3)	33 (4.1)	32 (4.1)	27 (3.4)	25 (3.2)
75th percentile	---	7 (0.8)	25 (2.6)	20 (2.1)	19 (2.0)	23 (2.4)	20 (2.1)	6 (0.7)
85th percentile	---	-6 (-0.6)	32 (3.0)	25 (2.4)	16 (1.5)	30 (2.8)	21 (2.0)	-2 (-0.1)

Table 20. Direct Effects Monthly Simulated Salinity Concentration for Arkansas River at Catlin Dam Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	1,010	1,019	1,044	1,046	1,044	1,044	1,037	1,023
Feb	1,081	1,072	1,105	1,106	1,091	1,105	1,097	1,083
Mar	899	915	934	933	926	935	933	927
Apr	716	734	747	749	749	747	748	741
May	540	550	556	556	555	556	555	553
Jun	431	438	441	441	441	441	439	437
Jul	496	510	518	515	514	518	514	517
Aug	631	637	643	643	643	643	638	635
Sep	836	856	869	870	872	870	862	853
Oct	863	892	902	902	905	902	899	891
Nov	918	925	923	924	942	924	915	907
Dec	996	995	1,016	1,018	1,020	1,017	1,003	996
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	25 (2.5)	27 (2.7)	25 (2.5)	25 (2.5)	18 (1.8)	4 (0.4)
Feb	---	---	33 (3.1)	34 (3.2)	19 (1.8)	33 (3.1)	25 (2.3)	11 (1.0)
Mar	---	---	19 (2.1)	18 (2.0)	11 (1.2)	20 (2.1)	18 (1.9)	12 (1.3)
Apr	---	---	13 (1.8)	15 (2.1)	15 (2.1)	13 (1.8)	14 (2.0)	7 (1.0)
May	---	---	6 (1.0)	6 (0.9)	5 (0.9)	6 (1.1)	5 (0.8)	3 (0.5)
Jun	---	---	3 (0.6)	3 (0.7)	3 (0.7)	3 (0.6)	1 (0.3)	-1 (-0.2)
Jul	---	---	8 (1.6)	5 (1.1)	4 (0.9)	8 (1.7)	4 (0.9)	7 (1.5)
Aug	---	---	6 (0.8)	6 (0.9)	6 (0.8)	6 (0.8)	1 (0.0)	-2 (-0.4)
Sep	---	---	13 (1.5)	14 (1.6)	16 (1.8)	14 (1.5)	6 (0.7)	-3 (-0.4)
Oct	---	---	10 (1.1)	10 (1.1)	13 (1.4)	10 (1.1)	7 (0.8)	-1 (-0.1)
Nov	---	---	-2 (-0.2)	-1 (-0.1)	17 (1.9)	-1 (-0.1)	-10 (-1.1)	-18 (-1.9)
Dec	---	---	21 (2.1)	23 (2.2)	25 (2.4)	22 (2.1)	8 (0.8)	1 (0.1)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	9 (0.9)	34 (3.4)	36 (3.5)	34 (3.3)	34 (3.4)	27 (2.6)	13 (1.3)
Feb	---	-9 (-0.9)	24 (2.2)	25 (2.3)	10 (0.9)	24 (2.2)	16 (1.4)	2 (0.1)
Mar	---	16 (1.8)	35 (3.9)	34 (3.8)	27 (3.0)	36 (3.9)	34 (3.7)	28 (3.1)
Apr	---	18 (2.4)	31 (4.3)	33 (4.6)	33 (4.6)	31 (4.3)	32 (4.5)	25 (3.4)
May	---	10 (2.0)	16 (3.0)	16 (2.9)	15 (2.9)	16 (3.1)	15 (2.8)	13 (2.5)
Jun	---	7 (1.6)	10 (2.2)	10 (2.3)	10 (2.3)	10 (2.2)	8 (1.9)	6 (1.4)
Jul	---	14 (2.7)	22 (4.3)	19 (3.8)	18 (3.6)	22 (4.4)	18 (3.6)	21 (4.2)
Aug	---	6 (1.0)	12 (1.8)	12 (2.0)	12 (1.8)	12 (1.9)	7 (1.1)	4 (0.7)
Sep	---	20 (2.5)	33 (4.0)	34 (4.1)	36 (4.3)	34 (4.0)	26 (3.2)	17 (2.1)
Oct	---	29 (3.3)	39 (4.4)	39 (4.4)	42 (4.8)	39 (4.4)	36 (4.1)	28 (3.2)
Nov	---	7 (0.7)	5 (0.6)	6 (0.6)	24 (2.6)	6 (0.7)	-3 (-0.4)	-11 (-1.2)
Dec	---	-1 (-0.1)	20 (2.0)	22 (2.1)	24 (2.3)	21 (2.0)	7 (0.7)	0 (0.0)

Table 21. Direct Effects Simulated Salinity Concentration Comparison for Arkansas River near Rocky Ford Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	823	830	839	839	838	839	835	831
15th percentile	530	531	539	540	536	539	540	536
25th percentile	617	616	636	631	631	631	635	628
50th percentile	824	831	838	839	839	837	831	830
75th percentile	1,012	1,012	1,029	1,029	1,035	1,028	1,023	1,013
85th percentile	1,120	1,125	1,135	1,139	1,137	1,137	1,132	1,123
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	9 (1.1)	10 (1.2)	9 (1.0)	10 (1.1)	6 (0.7)	1 (0.1)
15th percentile	---	---	7 (1.4)	8 (1.6)	5 (1.0)	8 (1.5)	9 (1.7)	5 (0.9)
25th percentile	---	---	20 (3.3)	15 (2.4)	15 (2.4)	15 (2.4)	18 (3.0)	12 (2.0)
50th percentile	---	---	6 (0.8)	8 (0.9)	8 (1.0)	6 (0.7)	0 (0.0)	-1 (-0.1)
75th percentile	---	---	17 (1.7)	17 (1.7)	23 (2.3)	16 (1.6)	11 (1.1)	1 (0.1)
85th percentile	---	---	11 (0.9)	14 (1.3)	13 (1.1)	12 (1.1)	7 (0.6)	-2 (-0.1)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	7 (0.9)	16 (2.0)	17 (2.0)	16 (1.9)	17 (2.0)	13 (1.6)	8 (1.0)
15th percentile	---	1 (0.2)	8 (1.6)	9 (1.8)	6 (1.2)	9 (1.7)	10 (1.9)	6 (1.1)
25th percentile	---	-1 (-0.2)	19 (3.1)	14 (2.3)	14 (2.3)	14 (2.2)	18 (2.8)	11 (1.8)
50th percentile	---	7 (0.9)	14 (1.6)	15 (1.8)	15 (1.8)	13 (1.6)	7 (0.8)	6 (0.7)
75th percentile	---	0 (0.0)	17 (1.7)	17 (1.7)	23 (2.3)	16 (1.6)	11 (1.0)	1 (0.1)
85th percentile	---	5 (0.4)	16 (1.4)	19 (1.7)	18 (1.6)	17 (1.5)	12 (1.1)	3 (0.3)

Table 22. Direct Effects Monthly Simulated Salinity Concentration for Arkansas River near Rocky Ford Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	1,040	1,039	1,061	1,063	1,062	1,062	1,056	1,044
Feb	1,034	1,018	1,046	1,047	1,029	1,047	1,040	1,027
Mar	929	942	955	953	940	955	953	949
Apr	715	727	735	737	738	735	735	730
May	575	582	587	586	585	587	586	586
Jun	542	547	549	549	549	549	548	547
Jul	642	661	662	660	661	663	660	665
Aug	727	728	729	730	730	730	729	727
Sep	873	887	896	897	898	896	890	880
Oct	849	875	880	880	883	880	877	873
Nov	935	940	941	942	954	942	936	928
Dec	1,049	1,050	1,065	1,066	1,070	1,066	1,055	1,051
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	22 (2.2)	24 (2.4)	23 (2.2)	23 (2.2)	17 (1.6)	5 (0.5)
Feb	---	---	28 (2.7)	29 (2.8)	11 (1.0)	29 (2.8)	22 (2.2)	9 (0.9)
Mar	---	---	13 (1.4)	11 (1.2)	-2 (-0.1)	13 (1.4)	11 (1.2)	7 (0.8)
Apr	---	---	8 (1.1)	10 (1.3)	11 (1.5)	8 (1.1)	8 (1.1)	3 (0.4)
May	---	---	5 (0.8)	4 (0.7)	3 (0.5)	5 (0.9)	4 (0.7)	4 (0.7)
Jun	---	---	2 (0.2)	2 (0.2)	2 (0.3)	2 (0.2)	1 (0.1)	0 (-0.1)
Jul	---	---	1 (0.1)	-1 (-0.1)	0 (0.0)	2 (0.3)	-1 (-0.1)	4 (0.6)
Aug	---	---	1 (0.2)	2 (0.3)	2 (0.3)	2 (0.3)	1 (0.1)	-1 (-0.2)
Sep	---	---	9 (1.0)	10 (1.1)	11 (1.3)	9 (1.1)	3 (0.4)	-7 (-0.7)
Oct	---	---	5 (0.6)	5 (0.6)	8 (1.0)	5 (0.6)	2 (0.3)	-2 (-0.2)
Nov	---	---	1 (0.1)	2 (0.2)	14 (1.5)	2 (0.2)	-4 (-0.5)	-12 (-1.2)
Dec	---	---	15 (1.4)	16 (1.5)	20 (1.9)	16 (1.5)	5 (0.4)	1 (0.0)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	-1 (-0.1)	21 (2.0)	23 (2.2)	22 (2.1)	22 (2.1)	16 (1.5)	4 (0.4)
Feb	---	-16 (-1.6)	12 (1.1)	13 (1.2)	-5 (-0.5)	13 (1.2)	6 (0.6)	-7 (-0.7)
Mar	---	13 (1.3)	26 (2.7)	24 (2.6)	11 (1.2)	26 (2.8)	24 (2.5)	20 (2.2)
Apr	---	12 (1.6)	20 (2.7)	22 (3.0)	23 (3.2)	20 (2.7)	20 (2.7)	15 (2.1)
May	---	7 (1.3)	12 (2.1)	11 (1.9)	10 (1.8)	12 (2.1)	11 (2.0)	11 (1.9)
Jun	---	5 (0.9)	7 (1.1)	7 (1.2)	7 (1.2)	7 (1.2)	6 (1.0)	5 (0.9)
Jul	---	19 (2.9)	20 (3.1)	18 (2.9)	19 (2.9)	21 (3.2)	18 (2.8)	23 (3.5)
Aug	---	1 (0.1)	2 (0.3)	3 (0.4)	3 (0.3)	3 (0.4)	2 (0.2)	0 (-0.1)
Sep	---	14 (1.5)	23 (2.6)	24 (2.6)	25 (2.8)	23 (2.6)	17 (1.9)	7 (0.8)
Oct	---	26 (3.0)	31 (3.7)	31 (3.7)	34 (4.1)	31 (3.7)	28 (3.4)	24 (2.9)
Nov	---	5 (0.5)	6 (0.7)	7 (0.8)	19 (2.0)	7 (0.8)	1 (0.1)	-7 (-0.7)
Dec	---	1 (0.1)	16 (1.5)	17 (1.6)	21 (2.0)	17 (1.5)	6 (0.5)	2 (0.1)

Table 23 and Table 24 show statistics and relative change with respect to the No Action Alternative and the existing conditions for the Arkansas River at Las Animas gage. Effects would be predominantly negligible, with occasional minor increases in concentration. Comparison of monthly concentrations at the Arkansas River at Las Animas gage shows a mixed tendency, where March and April show the largest percent of reduction in concentration, and October shows the largest percent of increase in concentration compared with the No Action Alternative. Concentrations of all alternatives would decrease slightly compared to existing conditions.

Table 23. Direct Effects Simulated Salinity Concentration Comparison for Arkansas River at Las Animas Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	1,684	1,624	1,623	1,625	1,632	1,623	1,621	1,616
15th percentile	875	867	873	873	864	874	865	859
25th percentile	1,181	1,157	1,152	1,156	1,162	1,152	1,154	1,150
50th percentile	1,753	1,707	1,712	1,717	1,730	1,712	1,714	1,709
75th percentile	2,038	1,959	1,954	1,963	1,965	1,952	1,961	1,954
85th percentile	2,323	2,170	2,185	2,186	2,206	2,175	2,185	2,172
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	-1 (-0.1)	1 (0.1)	8 (0.5)	-1 (-0.1)	-3 (-0.2)	-8 (-0.5)
15th percentile	---	---	6 (0.7)	5 (0.6)	-4 (-0.4)	7 (0.8)	-2 (-0.2)	-9 (-1.0)
25th percentile	---	---	-5 (-0.4)	-1 (-0.1)	5 (0.4)	-5 (-0.4)	-3 (-0.2)	-7 (-0.6)
50th percentile	---	---	5 (0.3)	10 (0.6)	23 (1.4)	5 (0.3)	7 (0.4)	2 (0.1)
75th percentile	---	---	-5 (-0.2)	4 (0.2)	6 (0.3)	-7 (-0.4)	2 (0.1)	-5 (-0.2)
85th percentile	---	---	15 (0.7)	15 (0.7)	36 (1.7)	5 (0.2)	15 (0.7)	2 (0.1)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	-61 (-3.6)	-62 (-3.7)	-59 (-3.5)	-52 (-3.1)	-62 (-3.7)	-63 (-3.8)	-68 (-4.0)
15th percentile	---	-8 (-0.9)	-2 (-0.2)	-2 (-0.3)	-12 (-1.3)	-1 (-0.1)	-10 (-1.1)	-17 (-1.9)
25th percentile	---	-24 (-2.0)	-29 (-2.4)	-25 (-2.1)	-19 (-1.6)	-29 (-2.4)	-26 (-2.2)	-31 (-2.6)
50th percentile	---	-46 (-2.6)	-42 (-2.4)	-37 (-2.1)	-23 (-1.3)	-41 (-2.3)	-39 (-2.2)	-45 (-2.6)
75th percentile	---	-79 (-3.9)	-83 (-4.1)	-74 (-3.6)	-73 (-3.6)	-86 (-4.2)	-77 (-3.8)	-83 (-4.1)
85th percentile	---	-153 (-6.6)	-138 (-6.0)	-138 (-5.9)	-117 (-5.0)	-148 (-6.4)	-138 (-5.9)	-151 (-6.5)

Table 24. Direct Effects Monthly Simulated Salinity Concentration for Arkansas River at Las Animas Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	1,801	1,798	1,824	1,825	1,815	1,824	1,822	1,808
Feb	1,732	1,707	1,733	1,733	1,699	1,734	1,734	1,724
Mar	1,994	1,860	1,775	1,781	1,854	1,776	1,781	1,763
Apr	2,215	2,086	2,033	2,045	2,105	2,028	2,024	2,032
May	1,376	1,296	1,307	1,308	1,306	1,307	1,309	1,309
Jun	1,043	1,003	1,006	1,006	1,008	1,006	1,006	1,002
Jul	1,252	1,181	1,195	1,197	1,192	1,194	1,191	1,182
Aug	1,389	1,304	1,315	1,319	1,320	1,320	1,307	1,304
Sep	1,869	1,811	1,799	1,797	1,806	1,792	1,803	1,815
Oct	1,901	1,829	1,884	1,885	1,838	1,887	1,881	1,866
Nov	1,832	1,818	1,786	1,789	1,826	1,788	1,779	1,791
Dec	1,847	1,842	1,857	1,857	1,860	1,857	1,853	1,843
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	26 (1.4)	27 (1.5)	17 (1.0)	26 (1.5)	24 (1.4)	10 (0.6)
Feb	---	---	26 (1.5)	26 (1.5)	-8 (-0.5)	27 (1.6)	27 (1.6)	17 (1.0)
Mar	---	---	-85 (-4.6)	-79 (-4.3)	-6 (-0.3)	-84 (-4.5)	-79 (-4.3)	-97 (-5.2)
Apr	---	---	-53 (-2.6)	-41 (-2.0)	19 (0.9)	-58 (-2.8)	-62 (-3.0)	-54 (-2.6)
May	---	---	11 (0.9)	12 (0.9)	10 (0.8)	11 (0.9)	13 (1.0)	13 (1.1)
Jun	---	---	3 (0.2)	3 (0.3)	5 (0.4)	3 (0.2)	3 (0.3)	-1 (-0.1)
Jul	---	---	14 (1.2)	16 (1.3)	11 (0.9)	13 (1.0)	10 (0.9)	1 (0.0)
Aug	---	---	11 (0.8)	15 (1.2)	16 (1.2)	16 (1.2)	3 (0.2)	0 (0.0)
Sep	---	---	-12 (-0.7)	-14 (-0.8)	-5 (-0.3)	-19 (-1.0)	-8 (-0.4)	4 (0.2)
Oct	---	---	55 (3.0)	56 (3.1)	9 (0.5)	58 (3.2)	52 (2.9)	37 (2.1)
Nov	---	---	-32 (-1.7)	-29 (-1.6)	8 (0.4)	-30 (-1.6)	-39 (-2.2)	-27 (-1.5)
Dec	---	---	15 (0.8)	15 (0.8)	18 (1.0)	15 (0.8)	11 (0.6)	1 (0.0)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	-3 (-0.2)	23 (1.3)	24 (1.4)	14 (0.8)	23 (1.3)	21 (1.2)	7 (0.4)
Feb	---	-25 (-1.4)	1 (0.1)	1 (0.1)	-33 (-1.9)	2 (0.2)	2 (0.1)	-8 (-0.4)
Mar	---	-134 (-6.7)	-219 (-11.0)	-21 (-10.7)	-140 (-7.0)	-218 (-11.0)	-213 (-10.7)	-231 (-11.6)
Apr	---	-129 (-5.8)	-182 (-8.2)	-170 (-7.7)	-110 (-5.0)	-187 (-8.5)	-191 (-8.7)	-183 (-8.3)
May	---	-80 (-5.9)	-69 (-5.0)	-68 (-5.0)	-70 (-5.1)	-69 (-5.0)	-67 (-4.9)	-67 (-4.9)
Jun	---	-40 (-3.8)	-37 (-3.6)	-37 (-3.5)	-35 (-3.4)	-37 (-3.6)	-37 (-3.6)	-41 (-3.9)
Jul	---	-71 (-5.6)	-57 (-4.5)	-55 (-4.4)	-60 (-4.7)	-58 (-4.7)	-61 (-4.8)	-70 (-5.6)
Aug	---	-85 (-6.1)	-74 (-5.3)	-70 (-5.0)	-69 (-4.9)	-69 (-5.0)	-82 (-5.9)	-85 (-6.1)
Sep	---	-58 (-3.1)	-70 (-3.8)	-72 (-3.9)	-63 (-3.4)	-77 (-4.1)	-66 (-3.5)	-54 (-2.9)
Oct	---	-72 (-3.8)	-17 (-0.9)	-16 (-0.9)	-63 (-3.3)	-14 (-0.7)	-20 (-1.1)	-35 (-1.9)
Nov	---	-14 (-0.7)	-46 (-2.5)	-43 (-2.3)	-6 (-0.3)	-44 (-2.4)	-53 (-2.9)	-41 (-2.2)
Dec	---	-5 (-0.3)	10 (0.5)	10 (0.5)	13 (0.7)	10 (0.5)	6 (0.3)	-4 (-0.3)

Table 25 through Table 23 show statistics and relative change with respect to the No Action Alternative and existing conditions of simulated salinity for Fountain Creek gages. All alternatives would have mostly negligible effects on Fountain Creek salinity, compared to the No Action, although occasional minor increases would occur. On Fountain Creek, compared with the No Action Alternative, simulated concentration would increase the most in February, March and October, with smaller differences during the summer months especially in September. The alternatives would increase salinity concentrations compared to existing conditions because of additional municipal discharge.

Table 25. Direct Effects Simulated Salinity Concentration Comparison for Fountain Creek near Fountain Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	596	658	662	662	658	662	661	663
15th percentile	427	513	517	517	513	517	513	517
25th percentile	497	571	572	571	572	571	567	572
50th percentile	615	665	668	668	661	668	668	668
75th percentile	698	742	756	756	742	756	756	756
85th percentile	733	801	802	802	799	802	802	802
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	4 (0.6)	4 (0.6)	0 (0.0)	4 (0.6)	3 (0.5)	5 (0.8)
15th percentile	---	---	4 (0.8)	3 (0.6)	0 (0.0)	3 (0.7)	0 (0.0)	4 (0.8)
25th percentile	---	---	1 (0.1)	0 (0.0)	1 (0.2)	0 (0.0)	-4 (-0.7)	1 (0.3)
50th percentile	---	---	3 (0.4)	3 (0.4)	-4 (-0.6)	3 (0.4)	3 (0.4)	3 (0.4)
75th percentile	---	---	14 (1.8)	14 (1.8)	0 (0.0)	14 (1.8)	14 (1.8)	14 (1.9)
85th percentile	---	---	1 (0.1)	1 (0.1)	-2 (-0.2)	1 (0.1)	1 (0.1)	1 (0.1)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	62 (10.4)	66 (11.1)	66 (11.0)	62 (10.4)	66 (11.0)	65 (10.9)	67 (11.2)
15th percentile	---	86 (20.2)	91 (21.2)	90 (21.0)	86 (20.2)	90 (21.0)	86 (20.2)	91 (21.2)
25th percentile	---	74 (14.9)	75 (15.0)	74 (14.8)	75 (15.0)	74 (14.8)	70 (14.0)	75 (15.2)
50th percentile	---	50 (8.1)	52 (8.5)	52 (8.5)	46 (7.4)	52 (8.5)	52 (8.5)	53 (8.5)
75th percentile	---	44 (6.4)	58 (8.3)	58 (8.3)	44 (6.4)	58 (8.3)	58 (8.3)	59 (8.4)
85th percentile	---	68 (9.3)	69 (9.4)	69 (9.4)	66 (9.1)	69 (9.4)	69 (9.4)	69 (9.4)

Table 26. Direct Effects Monthly Simulated Salinity Concentration for Fountain Creek near Fountain Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	637	703	712	712	701	711	703	713
Feb	630	687	699	700	688	700	700	701
Mar	609	661	678	674	664	674	676	677
Apr	538	650	651	651	649	651	658	658
May	509	586	596	596	590	596	596	593
Jun	532	596	598	598	596	598	598	598
Jul	522	611	611	612	611	611	611	611
Aug	551	573	572	572	571	572	572	572
Sep	607	709	702	702	703	702	695	707
Oct	695	727	734	734	734	734	734	734
Nov	665	700	700	701	700	700	700	700
Dec	678	706	703	703	703	703	703	703
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	9 (1.2)	9 (1.2)	-2 (-0.2)	8 (1.2)	0 (0.0)	10 (1.4)
Feb	---	---	12 (1.8)	13 (1.8)	1 (0.2)	13 (1.8)	13 (1.8)	14 (2.0)
Mar	---	---	17 (2.5)	13 (1.9)	3 (0.4)	13 (1.9)	15 (2.2)	16 (2.3)
Apr	---	---	1 (0.2)	1 (0.1)	-1 (-0.2)	1 (0.1)	8 (1.3)	8 (1.3)
May	---	---	10 (1.6)	10 (1.6)	4 (0.6)	10 (1.6)	10 (1.6)	7 (1.1)
Jun	---	---	2 (0.3)	2 (0.3)	0 (0.0)	2 (0.3)	2 (0.3)	2 (0.3)
Jul	---	---	0 (0.1)	1 (0.1)	0 (0.0)	0 (0.1)	0 (0.1)	0 (0.1)
Aug	---	---	-1 (-0.2)	-1 (-0.2)	-2 (-0.3)	-1 (-0.2)	-1 (-0.2)	-1 (0.0)
Sep	---	---	-7 (-1.0)	-7 (-1.0)	-6 (-0.9)	-7 (-1.0)	-14 (-2.0)	-2 (-0.2)
Oct	---	---	7 (1.0)	7 (1.0)	7 (1.0)	7 (1.0)	7 (1.0)	7 (1.0)
Nov	---	---	0 (0.0)	1 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Dec	---	---	-3 (-0.3)	-3 (-0.3)	-3 (-0.4)	-3 (-0.3)	-3 (-0.3)	-3 (-0.3)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	66 (10.3)	75 (11.6)	75 (11.6)	64 (10.1)	74 (11.6)	66 (10.3)	76 (11.8)
Feb	---	57 (9.2)	69 (11.1)	70 (11.1)	58 (9.3)	70 (11.1)	70 (11.1)	71 (11.3)
Mar	---	52 (8.6)	69 (11.2)	65 (10.6)	55 (9.0)	65 (10.6)	67 (10.9)	68 (11.1)
Apr	---	112 (20.9)	113 (21.1)	113 (21.0)	111 (20.6)	113 (21.0)	120 (22.4)	120 (22.4)
May	---	77 (15.2)	87 (17.0)	87 (17.0)	81 (15.9)	87 (17.0)	87 (17.0)	84 (16.4)
Jun	---	64 (12.0)	66 (12.3)	66 (12.4)	64 (12.0)	66 (12.3)	66 (12.4)	66 (12.3)
Jul	---	89 (17.1)	89 (17.2)	90 (17.2)	89 (17.1)	89 (17.2)	89 (17.2)	89 (17.2)
Aug	---	22 (4.0)	21 (3.8)	21 (3.8)	20 (3.6)	21 (3.7)	21 (3.8)	21 (3.9)
Sep	---	102 (16.8)	95 (15.6)	95 (15.6)	96 (15.7)	95 (15.6)	88 (14.5)	100 (16.5)
Oct	---	32 (4.6)	39 (5.6)	39 (5.6)	39 (5.6)	39 (5.6)	39 (5.6)	39 (5.6)
Nov	---	35 (5.3)	35 (5.3)	36 (5.3)	35 (5.3)	35 (5.3)	35 (5.3)	35 (5.3)
Dec	---	28 (4.2)	25 (3.8)	25 (3.8)	25 (3.7)	25 (3.8)	25 (3.8)	25 (3.8)

Table 27. Direct Effects Simulated Salinity Concentration Comparison for Fountain Creek at Pueblo Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	698	746	746	746	746	746	746	747
15th percentile	522	565	563	563	571	563	563	564
25th percentile	582	632	641	638	632	638	635	643
50th percentile	706	757	762	760	757	760	757	763
75th percentile	822	857	855	855	855	855	854	857
85th percentile	870	906	905	905	905	905	905	905
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	0 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)
15th percentile	---	---	-2 (-0.3)	-2 (-0.4)	6 (1.0)	-2 (-0.4)	-2 (-0.3)	-1 (-0.2)
25th percentile	---	---	9 (1.4)	6 (0.9)	-1 (-0.1)	6 (0.9)	3 (0.5)	11 (1.7)
50th percentile	---	---	5 (0.6)	3 (0.4)	0 (0.0)	3 (0.4)	0 (0.0)	6 (0.7)
75th percentile	---	---	-2 (-0.2)	-2 (-0.2)	-2 (-0.2)	-2 (-0.2)	-3 (-0.4)	0 (0.0)
85th percentile	---	---	-1 (-0.1)	-1 (-0.1)	-1 (-0.1)	-1 (-0.1)	-1 (-0.1)	-1 (-0.1)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	48 (6.8)	48 (6.9)	48 (6.9)	48 (6.8)	48 (6.8)	47 (6.8)	49 (7.0)
15th percentile	---	43 (8.2)	41 (7.8)	40 (7.8)	48 (9.3)	41 (7.8)	41 (7.9)	42 (8.0)
25th percentile	---	50 (8.6)	59 (10.2)	56 (9.6)	50 (8.5)	56 (9.6)	53 (9.1)	61 (10.5)
50th percentile	---	51 (7.2)	55 (7.8)	54 (7.6)	50 (7.1)	53 (7.6)	50 (7.1)	56 (8.0)
75th percentile	---	35 (4.2)	33 (4.0)	33 (4.0)	33 (4.0)	33 (4.0)	31 (3.8)	35 (4.3)
85th percentile	---	36 (4.1)	35 (4.0)	35 (4.0)	35 (4.0)	35 (4.0)	34 (4.0)	35 (4.0)

Table 28. Direct Effects Monthly Simulated Salinity Concentration for Fountain Creek at Pueblo Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	738	789	789	788	787	788	780	789
Feb	749	794	797	797	794	797	797	798
Mar	711	751	761	758	754	758	760	761
Apr	669	760	753	752	759	753	757	758
May	601	666	671	671	670	671	672	669
Jun	620	677	679	679	677	679	679	679
Jul	609	686	686	686	686	686	686	686
Aug	640	655	653	653	653	653	653	654
Sep	652	745	737	737	739	737	731	742
Oct	827	833	840	840	840	839	840	840
Nov	770	789	789	789	789	789	789	789
Dec	805	813	807	807	810	807	807	807
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	0 (0.0)	-1 (-0.1)	-2 (-0.2)	-1 (-0.1)	-9 (-1.1)	0 (0.1)
Feb	---	---	3 (0.4)	3 (0.4)	0 (0.1)	3 (0.4)	3 (0.4)	4 (0.5)
Mar	---	---	10 (1.3)	7 (0.9)	3 (0.4)	7 (0.9)	9 (1.2)	10 (1.4)
Apr	---	---	-7 (-0.9)	-8 (-1.0)	-1 (-0.2)	-7 (-0.9)	-3 (-0.3)	-2 (-0.3)
May	---	---	5 (0.7)	5 (0.7)	4 (0.6)	5 (0.7)	6 (0.9)	3 (0.5)
Jun	---	---	2 (0.2)	2 (0.2)	0 (0.0)	2 (0.2)	2 (0.3)	2 (0.3)
Jul	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Aug	---	---	-2 (-0.2)	-2 (-0.2)	-2 (-0.3)	-2 (-0.2)	-2 (-0.2)	-1 (-0.1)
Sep	---	---	-8 (-1.0)	-8 (-1.0)	-6 (-0.8)	-8 (-1.0)	-14 (-1.9)	-3 (-0.3)
Oct	---	---	7 (0.8)	7 (0.8)	7 (0.8)	6 (0.8)	7 (0.8)	7 (0.8)
Nov	---	---	0 (-0.1)	0 (-0.1)	0 (0.0)	0 (-0.1)	0 (-0.1)	0 (-0.1)
Dec	---	---	-6 (-0.8)	-6 (-0.8)	-3 (-0.4)	-6 (-0.8)	-6 (-0.8)	-6 (-0.8)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	51 (6.9)	51 (6.8)	50 (6.8)	49 (6.7)	50 (6.8)	42 (5.7)	51 (6.9)
Feb	---	45 (6.0)	48 (6.4)	48 (6.4)	45 (6.1)	48 (6.4)	48 (6.4)	49 (6.6)
Mar	---	40 (5.7)	50 (7.1)	47 (6.7)	43 (6.1)	47 (6.7)	49 (7.0)	50 (7.2)
Apr	---	91 (13.5)	84 (12.5)	83 (12.4)	90 (13.4)	84 (12.5)	88 (13.2)	89 (13.2)
May	---	65 (10.9)	70 (11.7)	70 (11.7)	69 (11.6)	70 (11.7)	71 (11.9)	68 (11.4)
Jun	---	57 (9.2)	59 (9.4)	59 (9.4)	57 (9.2)	59 (9.4)	59 (9.5)	59 (9.5)
Jul	---	77 (12.6)	77 (12.6)	77 (12.6)	77 (12.6)	77 (12.6)	77 (12.6)	77 (12.6)
Aug	---	15 (2.3)	13 (2.1)	13 (2.1)	13 (2.0)	13 (2.1)	13 (2.1)	14 (2.2)
Sep	---	93 (14.3)	85 (13.2)	85 (13.2)	87 (13.4)	85 (13.2)	79 (12.1)	90 (13.9)
Oct	---	6 (0.7)	13 (1.5)	13 (1.5)	13 (1.6)	12 (1.5)	13 (1.6)	13 (1.5)
Nov	---	19 (2.4)	19 (2.4)	19 (2.4)	19 (2.4)	19 (2.4)	19 (2.4)	19 (2.4)
Dec	---	8 (1.0)	2 (0.2)	2 (0.3)	5 (0.7)	2 (0.3)	2 (0.3)	2 (0.3)

Cumulative Effects Analysis A comparative analysis contrasting the No Action Alternative and existing condition scenarios was performed to estimate changes in salinity under each alternative for the cumulative effects analysis. Cumulative effects simulation uses the results of the Daily Model, which reflects all the simulated operations under these conditions in the streamflows. Since it is assumed that the concentration of WWTF effluent is the same for all alternatives, changes in salt loadings from the WWTFs are based only on the estimated changes in effluent flow.

Table 29 and Table 30 show statistics and relative change with respect to the No Action Alternative and the existing conditions for the Arkansas River at Moffat St. gage. All alternatives, except River South and Master Contract Only, would have negligible to minor adverse effects on river salinity when compared with the No Action Alternative. Monthly changes in concentration in the Arkansas River upstream from the confluence with Fountain Creek would have the greatest percent changes in January, February and August to October. All alternatives increase salinity, compared to existing conditions, because of streamflow changes caused by exchanges in this reach.

Table 29. Cumulative Effects Simulated Salinity Concentration Comparison for Arkansas River at Moffat St. Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	391	439	454	454	453	454	419	440
15th percentile	264	275	280	280	280	280	272	276
25th percentile	299	324	328	327	327	328	322	324
50th percentile	365	411	423	423	422	423	393	409
75th percentile	419	476	493	495	494	495	464	478
85th percentile	446	525	541	541	538	540	513	527
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	15 (3.3)	15 (3.4)	14 (3.1)	15 (3.4)	-20 (-4.6)	1 (0.2)
15th percentile	---	---	5 (1.8)	4 (1.5)	4 (1.6)	4 (1.6)	-3 (-1.2)	0 (0.1)
25th percentile	---	---	4 (1.3)	4 (1.1)	3 (1.0)	4 (1.3)	-2 (-0.5)	0 (0.2)
50th percentile	---	---	12 (3.0)	12 (2.9)	12 (2.8)	12 (3.0)	-18 (-4.3)	-1 (-0.3)
75th percentile	---	---	17 (3.6)	18 (3.9)	17 (3.7)	18 (3.9)	-13 (-2.7)	1 (0.3)
85th percentile	---	---	16 (3.0)	16 (3.1)	13 (2.5)	15 (2.9)	-12 (-2.4)	2 (0.3)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	48 (12.3)	63 (16.0)	63 (16.0)	62 (15.8)	63 (16.1)	28 (7.1)	49 (12.5)
15th percentile	---	11 (4.2)	16 (6.1)	15 (5.8)	16 (5.9)	16 (5.9)	8 (2.9)	11 (4.3)
25th percentile	---	25 (8.2)	29 (9.6)	28 (9.4)	28 (9.3)	29 (9.7)	23 (7.7)	25 (8.4)
50th percentile	---	46 (12.6)	58 (16.0)	58 (15.9)	58 (15.8)	58 (16.0)	28 (7.8)	45 (12.3)
75th percentile	---	57 (13.6)	74 (17.7)	76 (18.0)	75 (17.8)	76 (18.0)	44 (10.6)	58 (14.0)
85th percentile	---	79 (17.6)	94 (21.1)	95 (21.2)	92 (20.5)	94 (21.1)	66 (14.8)	80 (18.0)

Table 30. Cumulative Effects Monthly Simulated Salinity Concentration for Arkansas River at Moffat Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	472	503	525	525	523	525	478	504
Feb	516	523	554	554	553	554	475	524
Mar	393	426	441	442	442	441	400	425
Apr	367	409	419	419	418	419	402	410
May	351	394	399	398	401	399	388	397
Jun	277	291	292	293	293	293	289	290
Jul	265	290	295	295	297	296	283	292
Aug	333	392	406	407	405	407	363	392
Sep	407	502	526	525	524	526	475	503
Oct	404	513	540	540	530	540	499	518
Nov	452	516	528	527	530	528	491	516
Dec	484	541	555	555	555	555	513	541
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	22 (4.2)	22 (4.3)	20 (4.0)	22 (4.3)	-25 (-5.1)	1 (0.1)
Feb	---	---	31 (6.0)	31 (6.0)	30 (5.7)	31 (5.9)	-48 (-9.1)	1 (0.2)
Mar	---	---	15 (3.4)	16 (3.6)	16 (3.6)	15 (3.5)	-26 (-6.1)	-1 (-0.3)
Apr	---	---	10 (2.4)	10 (2.3)	9 (2.1)	10 (2.4)	-7 (-1.7)	1 (0.2)
May	---	---	5 (1.1)	4 (1.1)	7 (1.7)	5 (1.2)	-6 (-1.6)	3 (0.7)
Jun	---	---	1 (0.4)	2 (0.6)	2 (0.6)	2 (0.6)	-2 (-0.6)	-1 (-0.2)
Jul	---	---	5 (1.8)	5 (1.8)	7 (2.3)	6 (2.0)	-7 (-2.6)	2 (0.6)
Aug	---	---	14 (3.6)	15 (3.8)	13 (3.3)	15 (3.9)	-29 (-7.3)	0 (0.1)
Sep	---	---	24 (4.6)	23 (4.6)	22 (4.2)	24 (4.6)	-27 (-5.4)	1 (0.1)
Oct	---	---	27 (5.2)	27 (5.2)	17 (3.3)	27 (5.4)	-14 (-2.8)	5 (1.0)
Nov	---	---	12 (2.2)	11 (2.2)	14 (2.7)	12 (2.2)	-25 (-4.8)	0 (0.0)
Dec	---	---	14 (2.6)	14 (2.6)	14 (2.6)	14 (2.6)	-28 (-5.2)	0 (-0.1)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	31 (6.6)	53 (11.0)	53 (11.1)	51 (10.8)	53 (11.1)	6 (1.2)	32 (6.7)
Feb	---	7 (1.3)	38 (7.3)	38 (7.3)	37 (7.1)	38 (7.3)	-41 (-8.0)	8 (1.4)
Mar	---	33 (8.6)	48 (12.3)	49 (12.5)	49 (12.5)	48 (12.4)	7 (2.0)	32 (8.3)
Apr	---	42 (11.3)	52 (14.0)	52 (13.9)	51 (13.7)	52 (14.0)	35 (9.5)	43 (11.6)
May	---	43 (12.4)	48 (13.7)	47 (13.7)	50 (14.3)	48 (13.8)	37 (10.6)	46 (13.3)
Jun	---	14 (5.1)	15 (5.5)	16 (5.7)	16 (5.7)	16 (5.7)	12 (4.4)	13 (4.8)
Jul	---	25 (9.3)	30 (11.4)	30 (11.3)	32 (11.9)	31 (11.5)	18 (6.5)	27 (10.0)
Aug	---	59 (17.6)	73 (21.9)	74 (22.1)	72 (21.4)	74 (22.2)	30 (9.0)	59 (17.8)
Sep	---	95 (23.4)	119 (29.1)	118 (29.1)	117 (28.6)	119 (29.1)	68 (16.7)	96 (23.5)
Oct	---	109 (27.0)	136 (33.6)	136 (33.6)	126 (31.2)	136 (33.8)	95 (23.4)	114 (28.2)
Nov	---	64 (14.1)	76 (16.7)	75 (16.6)	78 (17.3)	76 (16.7)	39 (8.7)	64 (14.1)
Dec	---	57 (11.9)	71 (14.8)	71 (14.8)	71 (14.8)	71 (14.8)	29 (6.1)	57 (11.8)

All alternatives would negligibly affect salinity concentrations at the Arkansas River near Avondale gage, compared to the No Action (Table 31 and Table 32). Concentrations increase and decrease for all alternatives compared to existing conditions, depending on month and year.

Table 31. Cumulative Effects Simulated Salinity Concentration Comparison for Arkansas River near Avondale Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	564	606	610	609	610	609	606	607
15th percentile	371	425	431	430	431	430	424	424
25th percentile	437	513	514	513	511	514	515	519
50th percentile	576	633	639	637	638	637	631	635
75th percentile	687	707	711	709	711	709	711	707
85th percentile	733	745	748	745	746	744	743	741
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	4 (0.7)	3 (0.4)	3 (0.6)	2 (0.4)	-1 (-0.1)	0 (0.0)
15th percentile	---	---	6 (1.5)	5 (1.1)	5 (1.3)	5 (1.1)	-1 (-0.3)	-1 (-0.3)
25th percentile	---	---	1 (0.3)	0 (0.1)	-1 (-0.3)	2 (0.3)	2 (0.4)	6 (1.3)
50th percentile	---	---	6 (1.0)	4 (0.7)	5 (0.8)	4 (0.6)	-1 (-0.2)	2 (0.4)
75th percentile	---	---	4 (0.6)	2 (0.3)	4 (0.5)	2 (0.3)	4 (0.6)	0 (0.0)
85th percentile	---	---	3 (0.4)	0 (0.0)	2 (0.2)	-1 (-0.1)	-2 (-0.2)	-4 (-0.5)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	43 (7.6)	47 (8.3)	45 (8.1)	46 (8.2)	45 (8.0)	42 (7.5)	43 (7.6)
15th percentile	---	54 (14.5)	60 (16.2)	59 (15.8)	59 (16.0)	59 (15.8)	53 (14.2)	53 (14.2)
25th percentile	---	76 (17.3)	77 (17.6)	76 (17.4)	74 (17.0)	77 (17.7)	78 (17.8)	82 (18.8)
50th percentile	---	57 (9.9)	63 (10.9)	61 (10.6)	62 (10.8)	61 (10.6)	55 (9.6)	59 (10.3)
75th percentile	---	20 (3.0)	24 (3.5)	23 (3.3)	24 (3.5)	22 (3.2)	24 (3.5)	20 (2.9)
85th percentile	---	12 (1.6)	14 (2.0)	11 (1.6)	13 (1.8)	11 (1.5)	10 (1.3)	8 (1.1)

Table 32. Cumulative Effects Monthly Simulated Salinity Concentration for Arkansas River near Avondale Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	707	708	712	712	712	712	705	707
Feb	744	712	717	717	718	717	709	712
Mar	627	664	661	661	665	661	659	659
Apr	525	598	601	601	599	605	600	602
May	430	525	527	514	525	515	524	522
Jun	347	441	444	443	440	442	443	442
Jul	368	420	428	427	426	428	416	424
Aug	477	526	540	540	542	530	524	528
Sep	579	649	652	651	650	651	657	649
Oct	621	661	666	666	663	666	665	664
Nov	667	685	688	688	689	689	684	685
Dec	715	716	717	717	719	717	713	715
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	4 (0.6)	4 (0.6)	4 (0.5)	4 (0.6)	-3 (-0.4)	-1 (-0.1)
Feb	---	---	5 (0.6)	5 (0.7)	6 (0.8)	5 (0.7)	-3 (-0.5)	0 (0.0)
Mar	---	---	-3 (-0.4)	-3 (-0.4)	1 (0.2)	-3 (-0.4)	-5 (-0.7)	-5 (-0.7)
Apr	---	---	3 (0.4)	3 (0.4)	1 (0.1)	7 (1.1)	2 (0.3)	4 (0.7)
May	---	---	2 (0.3)	-11 (-2.0)	0 (-0.1)	-10 (-2.0)	-1 (-0.2)	-3 (-0.7)
Jun	---	---	3 (0.6)	2 (0.6)	-1 (-0.1)	1 (0.3)	2 (0.5)	1 (0.3)
Jul	---	---	8 (1.9)	7 (1.8)	6 (1.6)	8 (1.9)	-4 (-0.8)	4 (1.0)
Aug	---	---	14 (2.8)	14 (2.7)	16 (3.2)	4 (0.8)	-2 (-0.3)	2 (0.4)
Sep	---	---	3 (0.5)	2 (0.4)	1 (0.3)	2 (0.4)	8 (1.3)	0 (0.0)
Oct	---	---	5 (0.7)	5 (0.7)	2 (0.3)	5 (0.7)	4 (0.5)	3 (0.3)
Nov	---	---	3 (0.5)	3 (0.4)	4 (0.5)	4 (0.5)	-1 (-0.2)	0 (0.0)
Dec	---	---	1 (0.3)	1 (0.2)	3 (0.4)	1 (0.3)	-3 (-0.4)	-1 (-0.1)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	1 (0.1)	5 (0.8)	5 (0.8)	5 (0.7)	5 (0.7)	-2 (-0.2)	0 (0.0)
Feb	---	-32 (-4.2)	-27 (-3.6)	-27 (-3.6)	-26 (-3.5)	-27 (-3.6)	-35 (-4.7)	-32 (-4.3)
Mar	---	37 (5.9)	34 (5.5)	34 (5.5)	38 (6.1)	34 (5.5)	32 (5.2)	32 (5.2)
Apr	---	73 (14.0)	76 (14.4)	76 (14.5)	74 (14.1)	80 (15.2)	75 (14.4)	77 (14.7)
May	---	95 (22.1)	97 (22.5)	84 (19.6)	95 (21.9)	85 (19.7)	94 (21.9)	92 (21.3)
Jun	---	94 (26.9)	97 (27.7)	96 (27.7)	93 (26.8)	95 (27.3)	96 (27.6)	95 (27.3)
Jul	---	52 (14.2)	60 (16.3)	59 (16.2)	58 (16.0)	60 (16.3)	48 (13.3)	56 (15.3)
Aug	---	49 (10.2)	63 (13.3)	63 (13.2)	65 (13.7)	53 (11.2)	47 (9.9)	51 (10.7)
Sep	---	70 (12.0)	73 (12.5)	72 (12.4)	71 (12.3)	72 (12.4)	78 (13.4)	70 (12.0)
Oct	---	40 (6.5)	45 (7.3)	45 (7.3)	42 (6.8)	45 (7.2)	44 (7.1)	43 (6.9)
Nov	---	18 (2.8)	21 (3.2)	21 (3.2)	22 (3.3)	22 (3.3)	17 (2.5)	18 (2.8)
Dec	---	1 (0.1)	2 (0.3)	2 (0.3)	4 (0.5)	2 (0.3)	-2 (-0.3)	0 (0.0)

Table 33 and Table 34 show statistics and relative comparison with respect to the No Action Alternative and existing conditions for cumulative effects at the Arkansas River at Catlin Dam gage. Concentrations changes would be predominately negligible. All alternatives would increase salinity concentrations compared to existing conditions because of additional municipal discharge.

Table 33. Cumulative Effects Simulated Salinity Concentration Comparison for Arkansas River at Catlin Dam Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	780	820	828	827	827	826	829	819
15th percentile	468	518	536	540	532	533	523	527
25th percentile	538	632	642	634	649	643	637	646
50th percentile	795	873	873	869	871	868	871	870
75th percentile	968	977	981	986	983	982	992	976
85th percentile	1,062	1,059	1,069	1,069	1,069	1,068	1,081	1,050
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	8 (0.9)	7 (0.8)	7 (0.9)	6 (0.7)	9 (1.1)	-1 (-0.1)
15th percentile	---	---	18 (3.4)	22 (4.2)	14 (2.6)	15 (2.9)	4 (0.9)	9 (1.7)
25th percentile	---	---	11 (1.7)	3 (0.4)	17 (2.7)	12 (1.8)	5 (0.8)	14 (2.2)
50th percentile	---	---	0 (0.0)	-4 (-0.5)	-2 (-0.2)	-5 (-0.6)	-2 (-0.2)	-3 (-0.3)
75th percentile	---	---	5 (0.5)	9 (0.9)	7 (0.7)	5 (0.5)	15 (1.6)	-1 (-0.1)
85th percentile	---	---	10 (0.9)	10 (1.0)	10 (0.9)	9 (0.8)	22 (2.1)	-9 (-0.9)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	40 (5.1)	48 (6.1)	46 (6.0)	47 (6.0)	46 (5.9)	49 (6.3)	39 (5.1)
15th percentile	---	50 (10.7)	68 (14.5)	72 (15.4)	64 (13.6)	65 (13.9)	55 (11.7)	59 (12.6)
25th percentile	---	94 (17.4)	104 (19.4)	96 (17.9)	111 (20.6)	105 (19.5)	99 (18.3)	108 (20.0)
50th percentile	---	78 (9.8)	78 (9.8)	73 (9.2)	76 (9.6)	72 (9.1)	76 (9.5)	75 (9.4)
75th percentile	---	9 (0.9)	14 (1.4)	18 (1.8)	16 (1.6)	14 (1.4)	24 (2.5)	8 (0.9)
85th percentile	---	-3 (-0.3)	7 (0.6)	8 (0.7)	7 (0.7)	6 (0.6)	19 (1.8)	-12 (-1.1)

Table 34. Cumulative Effects Monthly Simulated Salinity Concentration for Arkansas River at Catlin Dam Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	1,010	1,020	1,029	1,031	1,028	1,030	1,031	1,017
Feb	1,081	976	967	967	970	969	999	977
Mar	899	906	906	903	907	903	906	905
Apr	716	826	831	831	828	832	832	823
May	540	650	666	655	653	650	666	650
Jun	431	520	522	523	519	522	522	521
Jul	496	539	553	550	554	554	543	547
Aug	631	677	692	691	695	687	684	677
Sep	836	891	907	907	901	904	924	897
Oct	863	948	959	959	959	960	951	944
Nov	918	938	945	945	950	945	941	932
Dec	996	980	988	989	992	988	990	976
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	9 (0.8)	11 (1.0)	8 (0.7)	10 (1.0)	11 (1.0)	-3 (-0.3)
Feb	---	---	-9 (-0.9)	-9 (-0.9)	-6 (-0.6)	-7 (-0.8)	23 (2.4)	1 (0.1)
Mar	---	---	0 (0.0)	-3 (-0.3)	1 (0.1)	-3 (-0.4)	0 (-0.1)	-1 (-0.1)
Apr	---	---	5 (0.5)	5 (0.6)	2 (0.2)	6 (0.7)	6 (0.7)	-3 (-0.4)
May	---	---	16 (2.4)	5 (0.9)	3 (0.4)	0 (0.0)	16 (2.5)	0 (0.1)
Jun	---	---	2 (0.6)	3 (0.6)	-1 (-0.1)	2 (0.4)	2 (0.5)	1 (0.4)
Jul	---	---	14 (2.6)	11 (2.1)	15 (2.9)	15 (2.8)	4 (0.7)	8 (1.6)
Aug	---	---	15 (2.2)	14 (2.0)	18 (2.6)	10 (1.5)	7 (1.0)	0 (0.0)
Sep	---	---	16 (1.8)	16 (1.8)	10 (1.1)	13 (1.5)	33 (3.7)	6 (0.6)
Oct	---	---	11 (1.2)	11 (1.1)	11 (1.1)	12 (1.3)	3 (0.3)	-4 (-0.4)
Nov	---	---	7 (0.7)	7 (0.7)	12 (1.3)	7 (0.7)	3 (0.3)	-6 (-0.7)
Dec	---	---	8 (0.8)	9 (0.9)	12 (1.1)	8 (0.8)	10 (1.0)	-4 (-0.4)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	10 (1.0)	19 (1.9)	21 (2.1)	18 (1.7)	20 (2.0)	21 (2.1)	7 (0.7)
Feb	---	-105 (-9.7)	-114 (-10.6)	-114 (-10.6)	-111 (-10.3)	-112 (-10.4)	-82 (-7.6)	-104 (-9.6)
Mar	---	7 (0.8)	7 (0.8)	4 (0.4)	8 (0.9)	4 (0.4)	7 (0.7)	6 (0.7)
Apr	---	110 (15.4)	115 (16.0)	115 (16.1)	112 (15.6)	116 (16.2)	116 (16.2)	107 (14.9)
May	---	110 (20.4)	126 (23.3)	115 (21.4)	113 (20.9)	110 (20.4)	126 (23.3)	110 (20.5)
Jun	---	89 (20.5)	91 (21.2)	92 (21.3)	88 (20.5)	91 (21.0)	91 (21.1)	90 (21.0)
Jul	---	43 (8.5)	57 (11.3)	54 (10.9)	58 (11.6)	58 (11.5)	47 (9.4)	51 (10.3)
Aug	---	46 (7.3)	61 (9.7)	60 (9.5)	64 (10.1)	56 (8.9)	53 (8.4)	46 (7.3)
Sep	---	55 (6.6)	71 (8.5)	71 (8.6)	65 (7.9)	68 (8.2)	88 (10.6)	61 (7.3)
Oct	---	85 (9.8)	96 (11.1)	96 (11.1)	96 (11.1)	97 (11.2)	88 (10.2)	81 (9.3)
Nov	---	20 (2.2)	27 (2.9)	27 (3.0)	32 (3.5)	27 (2.9)	23 (2.5)	14 (1.5)
Dec	---	-16 (-1.6)	-8 (-0.8)	-7 (-0.7)	-4 (-0.5)	-8 (-0.8)	-6 (-0.6)	-20 (-2.0)

Table 35 and Table 36 show statistics and relative comparison with the No Action Alternative and existing conditions for the Arkansas River near Rocky Ford gage. Concentrations changes would be predominately negligible for all alternatives, compared to the No Action. All alternatives would increase salinity concentrations compared to existing conditions because of additional municipal discharge

Table 35. Cumulative Effects Simulated Salinity Concentration Comparison for Arkansas River near Rocky Ford Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	823	854	858	857	860	857	862	852
15th percentile	530	577	581	578	578	576	584	587
25th percentile	617	666	669	670	672	671	673	664
50th percentile	824	864	864	862	861	861	867	856
75th percentile	1,012	1,021	1,029	1,029	1,034	1,025	1,039	1,016
85th percentile	1,120	1,117	1,127	1,127	1,128	1,127	1,134	1,119
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	4 (0.4)	3 (0.3)	5 (0.6)	3 (0.3)	8 (0.9)	-2 (-0.2)
15th percentile	---	---	4 (0.8)	1 (0.2)	1 (0.2)	-1 (-0.1)	7 (1.3)	10 (1.7)
25th percentile	---	---	3 (0.4)	4 (0.6)	5 (0.8)	5 (0.7)	6 (0.9)	-2 (-0.4)
50th percentile	---	---	-1 (-0.1)	-2 (-0.2)	-3 (-0.3)	-3 (-0.4)	3 (0.4)	-9 (-1.0)
75th percentile	---	---	8 (0.8)	7 (0.7)	12 (1.2)	4 (0.4)	18 (1.7)	-6 (-0.6)
85th percentile	---	---	9 (0.8)	10 (0.9)	11 (0.9)	9 (0.8)	16 (1.4)	2 (0.1)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	32 (3.9)	35 (4.3)	35 (4.2)	37 (4.5)	35 (4.2)	39 (4.8)	30 (3.6)
15th percentile	---	47 (8.8)	51 (9.6)	48 (9.0)	48 (9.0)	46 (8.7)	54 (10.2)	57 (10.7)
25th percentile	---	49 (8.0)	52 (8.4)	53 (8.7)	55 (8.9)	54 (8.8)	56 (9.0)	47 (7.6)
50th percentile	---	40 (4.8)	39 (4.8)	38 (4.6)	37 (4.5)	37 (4.5)	43 (5.2)	31 (3.8)
75th percentile	---	9 (0.9)	17 (1.7)	17 (1.6)	22 (2.1)	13 (1.3)	27 (2.7)	4 (0.4)
85th percentile	---	-2 (-0.2)	7 (0.6)	7 (0.7)	8 (0.7)	7 (0.6)	14 (1.2)	-1 (-0.1)

Table 36. Cumulative Effects Monthly Simulated Salinity Concentration for Arkansas River near Rocky Ford Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	1,040	1,057	1,066	1,068	1,064	1,067	1,067	1,056
Feb	1,034	914	891	891	892	894	945	912
Mar	929	914	911	910	913	910	914	912
Apr	715	800	804	804	802	806	803	799
May	575	691	696	692	694	690	695	686
Jun	542	615	623	622	623	621	620	616
Jul	642	687	697	696	702	696	690	694
Aug	727	754	759	758	767	757	761	754
Sep	873	928	935	935	933	934	948	924
Oct	849	900	909	908	910	907	904	895
Nov	935	962	969	969	974	969	966	960
Dec	1,049	1,048	1,053	1,054	1,057	1,053	1,054	1,043
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	9 (0.8)	11 (1.0)	7 (0.7)	10 (0.9)	10 (0.9)	-1 (-0.1)
Feb	---	---	-23 (-2.5)	-23 (-2.5)	-22 (-2.4)	-20 (-2.2)	31 (3.3)	-2 (-0.2)
Mar	---	---	-3 (-0.3)	-4 (-0.5)	-1 (-0.2)	-4 (-0.5)	0 (-0.1)	-2 (-0.3)
Apr	---	---	4 (0.5)	4 (0.5)	2 (0.3)	6 (0.6)	3 (0.4)	-1 (-0.2)
May	---	---	5 (0.7)	1 (0.2)	3 (0.5)	-1 (0.0)	4 (0.6)	-5 (-0.7)
Jun	---	---	8 (1.3)	7 (1.2)	8 (1.4)	6 (1.1)	5 (0.9)	1 (0.2)
Jul	---	---	10 (1.5)	9 (1.2)	15 (2.2)	9 (1.3)	3 (0.5)	7 (0.9)
Aug	---	---	5 (0.7)	4 (0.6)	13 (1.7)	3 (0.4)	7 (0.9)	0 (0.0)
Sep	---	---	7 (0.8)	7 (0.8)	5 (0.6)	6 (0.6)	20 (2.1)	-4 (-0.4)
Oct	---	---	9 (1.0)	8 (0.9)	10 (1.1)	7 (0.8)	4 (0.5)	-5 (-0.6)
Nov	---	---	7 (0.7)	7 (0.7)	12 (1.2)	7 (0.7)	4 (0.4)	-2 (-0.3)
Dec	---	---	5 (0.5)	6 (0.5)	9 (0.8)	5 (0.5)	6 (0.6)	-5 (-0.5)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	17 (1.6)	26 (2.5)	28 (2.7)	24 (2.3)	27 (2.5)	27 (2.6)	16 (1.5)
Feb	---	-120 (-11.6)	-143 (-13.8)	-143 (-13.8)	-142 (-13.7)	-140 (-13.5)	-89 (-8.7)	-122 (-11.8)
Mar	---	-15 (-1.6)	-18 (-1.9)	-19 (-2.1)	-16 (-1.8)	-19 (-2.1)	-15 (-1.7)	-17 (-1.8)
Apr	---	85 (11.9)	89 (12.4)	89 (12.5)	87 (12.2)	91 (12.6)	88 (12.3)	84 (11.6)
May	---	116 (20.1)	121 (21.0)	117 (20.4)	119 (20.7)	115 (20.1)	120 (20.9)	111 (19.3)
Jun	---	73 (13.3)	81 (14.8)	80 (14.7)	81 (14.9)	79 (14.6)	78 (14.4)	74 (13.6)
Jul	---	45 (7.0)	55 (8.6)	54 (8.3)	60 (9.3)	54 (8.4)	48 (7.5)	52 (8.0)
Aug	---	27 (3.6)	32 (4.4)	31 (4.2)	40 (5.4)	30 (4.0)	34 (4.6)	27 (3.6)
Sep	---	55 (6.2)	62 (7.1)	62 (7.1)	60 (6.9)	61 (6.9)	75 (8.5)	51 (5.8)
Oct	---	51 (6.0)	60 (7.1)	59 (7.0)	61 (7.2)	58 (6.9)	55 (6.6)	46 (5.4)
Nov	---	27 (2.9)	34 (3.7)	34 (3.7)	39 (4.2)	34 (3.7)	31 (3.4)	25 (2.6)
Dec	---	-1 (-0.1)	4 (0.4)	5 (0.4)	8 (0.7)	4 (0.4)	5 (0.5)	-6 (-0.6)

Table 37 and Table 38 show the statistics and relative comparison with the No Action Alternative and existing conditions for the Arkansas River at Las Animas gage. Concentration changes would be predominately negligible for all alternatives, compared to the No Action. All alternatives would decrease salinity concentrations compared to existing conditions.

Table 37. Cumulative Effects Simulated Salinity Concentration Comparison for Arkansas River at Las Animas Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	1,684	1,604	1,603	1,601	1,601	1,603	1,602	1,601
15th percentile	875	891	870	871	885	870	885	883
25th percentile	1,181	1,150	1,147	1,146	1,153	1,147	1,162	1,154
50th percentile	1,753	1,690	1,668	1,664	1,681	1,663	1,684	1,683
75th percentile	2,038	1,926	1,921	1,921	1,924	1,921	1,926	1,919
85th percentile	2,323	2,152	2,153	2,153	2,152	2,164	2,139	2,142
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	-1 (-0.1)	-3 (-0.2)	-3 (-0.2)	-1 (0.0)	-2 (-0.1)	-3 (-0.2)
15th percentile	---	---	-21 (-2.4)	-20 (-2.3)	-6 (-0.7)	-21 (-2.3)	-6 (-0.6)	-8 (-0.9)
25th percentile	---	---	-3 (-0.3)	-4 (-0.4)	3 (0.3)	-4 (-0.3)	12 (1.0)	4 (0.4)
50th percentile	---	---	-22 (-1.3)	-26 (-1.6)	-9 (-0.5)	-26 (-1.6)	-6 (-0.3)	-7 (-0.4)
75th percentile	---	---	-5 (-0.2)	-5 (-0.3)	-2 (-0.1)	-5 (-0.2)	0 (0.0)	-7 (-0.4)
85th percentile	---	---	1 (0.0)	1 (0.0)	0 (0.0)	11 (0.5)	-13 (-0.6)	-11 (-0.5)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	-80 (-4.8)	-82 (-4.9)	-83 (-4.9)	-84 (-5.0)	-81 (-4.8)	-83 (-4.9)	-83 (-5.0)
15th percentile	---	16 (1.8)	-6 (-0.6)	-5 (-0.5)	9 (1.1)	-5 (-0.6)	10 (1.1)	8 (0.9)
25th percentile	---	-31 (-2.6)	-34 (-2.9)	-35 (-2.9)	-28 (-2.4)	-34 (-2.9)	-19 (-1.6)	-27 (-2.3)
50th percentile	---	-64 (-3.6)	-86 (-4.9)	-90 (-5.1)	-73 (-4.1)	-90 (-5.1)	-69 (-3.9)	-70 (-4.0)
75th percentile	---	-112 (-5.5)	-116 (-5.7)	-117 (-5.7)	-114 (-5.6)	-116 (-5.7)	-112 (-5.5)	-119 (-5.8)
85th percentile	---	-171 (-7.4)	-170 (-7.3)	-170 (-7.3)	-171 (-7.4)	-160 (-6.9)	-184 (-7.9)	-182 (-7.8)

Table 38. Cumulative Effects Monthly Simulated Salinity Concentration for Arkansas River at Las Animas Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	1,801	1,792	1,805	1,803	1,804	1,804	1,804	1,791
Feb	1,732	1,580	1,528	1,527	1,534	1,531	1,615	1,581
Mar	1,994	1,761	1,744	1,750	1,775	1,749	1,741	1,741
Apr	2,215	2,007	2,017	2,002	2,003	2,009	1,978	1,981
May	1,376	1,266	1,275	1,270	1,280	1,275	1,266	1,263
Jun	1,043	970	962	961	966	960	965	973
Jul	1,252	1,239	1,239	1,242	1,225	1,252	1,214	1,255
Aug	1,389	1,332	1,337	1,337	1,338	1,336	1,338	1,334
Sep	1,869	1,811	1,801	1,802	1,802	1,801	1,784	1,807
Oct	1,901	1,893	1,909	1,909	1,885	1,910	1,902	1,899
Nov	1,832	1,822	1,832	1,832	1,808	1,831	1,829	1,817
Dec	1,847	1,826	1,835	1,835	1,836	1,834	1,837	1,825
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	13 (0.7)	11 (0.6)	12 (0.6)	12 (0.7)	12 (0.7)	-1 (-0.1)
Feb	---	---	-52 (-3.3)	-53 (-3.3)	-46 (-2.9)	-49 (-3.1)	35 (2.2)	1 (0.0)
Mar	---	---	-17 (-1.0)	-11 (-0.6)	14 (0.8)	-12 (-0.7)	-20 (-1.2)	-20 (-1.1)
Apr	---	---	10 (0.5)	-5 (-0.3)	-4 (-0.2)	2 (0.1)	-29 (-1.4)	-26 (-1.3)
May	---	---	9 (0.8)	4 (0.4)	14 (1.2)	9 (0.7)	0 (0.0)	-3 (-0.2)
Jun	---	---	-8 (-0.8)	-9 (-0.9)	-4 (-0.4)	-10 (-1.0)	-5 (-0.5)	3 (0.3)
Jul	---	---	0 (0.0)	3 (0.2)	-14 (-1.1)	13 (1.0)	-25 (-2.0)	16 (1.2)
Aug	---	---	5 (0.4)	5 (0.4)	6 (0.5)	4 (0.3)	6 (0.4)	2 (0.2)
Sep	---	---	-10 (-0.6)	-9 (-0.5)	-9 (-0.5)	-10 (-0.6)	-27 (-1.5)	-4 (-0.2)
Oct	---	---	16 (0.8)	16 (0.8)	-8 (-0.4)	17 (0.9)	9 (0.5)	6 (0.3)
Nov	---	---	10 (0.6)	10 (0.5)	-14 (-0.8)	9 (0.5)	7 (0.4)	-5 (-0.2)
Dec	---	---	9 (0.5)	9 (0.5)	10 (0.6)	8 (0.5)	11 (0.6)	-1 (0.0)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	-9 (-0.5)	4 (0.2)	2 (0.1)	3 (0.2)	3 (0.2)	3 (0.2)	-10 (-0.5)
Feb	---	-152 (-8.8)	-204 (-11.8)	-205 (-11.8)	-198 (-11.4)	-201 (-11.6)	-117 (-6.7)	-151 (-8.7)
Mar	---	-233 (-11.7)	-250 (-12.6)	-244 (-12.3)	-219 (-11.0)	-245 (-12.3)	-253 (-12.7)	-253 (-12.7)
Apr	---	-208 (-9.4)	-198 (-9.0)	-213 (-9.7)	-212 (-9.6)	-206 (-9.3)	-237 (-10.7)	-234 (-10.6)
May	---	-110 (-8.0)	-101 (-7.3)	-106 (-7.7)	-96 (-7.0)	-101 (-7.4)	-110 (-8.0)	-113 (-8.2)
Jun	---	-73 (-7.1)	-81 (-7.8)	-82 (-7.9)	-77 (-7.4)	-83 (-8.0)	-78 (-7.5)	-70 (-6.7)
Jul	---	-13 (-1.0)	-13 (-1.0)	-10 (-0.8)	-27 (-2.1)	0 (0.0)	-38 (-3.0)	3 (0.2)
Aug	---	-57 (-4.1)	-52 (-3.7)	-52 (-3.8)	-51 (-3.6)	-53 (-3.8)	-51 (-3.7)	-55 (-3.9)
Sep	---	-58 (-3.1)	-68 (-3.7)	-67 (-3.6)	-67 (-3.6)	-68 (-3.7)	-85 (-4.6)	-62 (-3.3)
Oct	---	-8 (-0.4)	8 (0.4)	8 (0.4)	-16 (-0.9)	9 (0.4)	1 (0.0)	-2 (-0.1)
Nov	---	-10 (-0.5)	0 (0.0)	0 (0.0)	-24 (-1.3)	-1 (0.0)	-3 (-0.1)	-15 (-0.8)
Dec	---	-21 (-1.2)	-12 (-0.7)	-12 (-0.7)	-11 (-0.6)	-13 (-0.7)	-10 (-0.6)	-22 (-1.2)

Table 39 to Table 42 shows statistics and relative comparison with respect to the No Action Alternative and existing conditions for gages on Fountain Creek. Fountain Creek, with respect to the No Action Alternative, would have negligible percent changes in simulated concentration. The alternatives would increase salinity concentrations in the drier summer months, compared to existing conditions, because of the influence of higher municipal discharges.

Table 39. Cumulative Effects Simulated Salinity Concentration Comparison for Fountain Creek near Fountain Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	596	609	610	607	608	606	608	609
15th percentile	427	493	485	485	487	484	487	493
25th percentile	497	530	530	528	529	528	531	532
50th percentile	615	585	587	586	586	586	587	587
75th percentile	698	642	644	643	642	643	647	644
85th percentile	733	683	683	680	683	681	686	683
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	1 (0.2)	-2 (-0.3)	-1 (-0.1)	-3 (-0.5)	-1 (-0.1)	0 (0.0)
15th percentile	---	---	-8 (-1.6)	-8 (-1.6)	-5 (-1.1)	-9 (-1.7)	-5 (-1.1)	0 (0.0)
25th percentile	---	---	0 (0.1)	-2 (-0.3)	-1 (-0.1)	-2 (-0.3)	2 (0.3)	2 (0.3)
50th percentile	---	---	2 (0.3)	1 (0.2)	1 (0.1)	1 (0.2)	2 (0.3)	2 (0.3)
75th percentile	---	---	2 (0.3)	1 (0.1)	0 (0.0)	1 (0.2)	5 (0.8)	2 (0.3)
85th percentile	---	---	0 (0.0)	-2 (-0.3)	0 (0.0)	-2 (-0.3)	3 (0.4)	0 (0.0)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	13 (2.1)	14 (2.3)	11 (1.8)	12 (2.0)	10 (1.6)	12 (2.0)	13 (2.2)
15th percentile	---	66 (15.4)	58 (13.5)	58 (13.5)	60 (14.1)	57 (13.4)	60 (14.1)	66 (15.4)
25th percentile	---	33 (6.6)	33 (6.6)	31 (6.3)	32 (6.4)	31 (6.3)	34 (6.9)	34 (6.9)
50th percentile	---	-30 (-4.9)	-28 (-4.6)	-29 (-4.7)	-30 (-4.8)	-29 (-4.7)	-28 (-4.6)	-29 (-4.7)
75th percentile	---	-55 (-7.9)	-54 (-7.7)	-55 (-7.8)	-55 (-7.9)	-54 (-7.8)	-50 (-7.2)	-53 (-7.6)
85th percentile	---	-50 (-6.8)	-50 (-6.9)	-52 (-7.2)	-50 (-6.8)	-52 (-7.1)	-47 (-6.4)	-50 (-6.9)

Table 40. Cumulative Effects Monthly Simulated Salinity Concentration for Fountain Creek near Fountain Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	637	611	612	611	611	611	609	609
Feb	630	587	592	592	590	592	588	588
Mar	609	606	602	600	602	600	603	604
Apr	538	585	585	586	585	598	587	597
May	509	650	641	610	641	611	637	634
Jun	532	680	681	681	676	678	684	684
Jul	522	579	584	584	574	584	570	582
Aug	551	550	574	574	575	550	554	553
Sep	607	610	611	611	609	610	619	615
Oct	695	606	598	597	600	595	608	604
Nov	665	604	603	603	603	605	606	605
Dec	678	621	620	620	620	620	620	621
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	1 (0.2)	0 (0.1)	0 (0.1)	0 (0.0)	-2 (-0.2)	-2 (-0.3)
Feb	---	---	5 (0.9)	5 (0.8)	3 (0.4)	5 (0.8)	1 (0.2)	1 (0.2)
Mar	---	---	-4 (-0.8)	-6 (-1.1)	-4 (-0.8)	-6 (-1.0)	-3 (-0.5)	-2 (-0.4)
Apr	---	---	0 (0.0)	1 (0.1)	0 (0.0)	13 (2.2)	2 (0.4)	12 (2.1)
May	---	---	-9 (-1.4)	-40 (-6.1)	-9 (-1.4)	-39 (-6.0)	-13 (-2.0)	-16 (-2.4)
Jun	---	---	1 (0.1)	1 (0.1)	-4 (-0.6)	-2 (-0.3)	4 (0.7)	4 (0.6)
Jul	---	---	5 (0.9)	5 (1.0)	-5 (-0.8)	5 (1.0)	-9 (-1.5)	3 (0.6)
Aug	---	---	24 (4.2)	24 (4.2)	25 (4.5)	0 (0.0)	4 (0.6)	3 (0.5)
Sep	---	---	1 (0.2)	1 (0.2)	-1 (-0.1)	0 (0.0)	9 (1.4)	5 (0.8)
Oct	---	---	-8 (-1.3)	-9 (-1.4)	-6 (-0.9)	-11 (-1.7)	2 (0.4)	-2 (-0.2)
Nov	---	---	-1 (-0.1)	-1 (-0.2)	-1 (-0.1)	1 (0.1)	2 (0.2)	1 (0.1)
Dec	---	---	-1 (0.0)	-1 (0.0)	-1 (-0.1)	-1 (0.0)	-1 (-0.1)	0 (0.0)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	-26 (-4.2)	-25 (-4.0)	-26 (-4.1)	-26 (-4.1)	-26 (-4.2)	-28 (-4.4)	-28 (-4.4)
Feb	---	-43 (-6.8)	-38 (-6.0)	-38 (-6.0)	-40 (-6.4)	-38 (-6.0)	-42 (-6.6)	-42 (-6.6)
Mar	---	-3 (-0.5)	-7 (-1.3)	-9 (-1.6)	-7 (-1.3)	-9 (-1.5)	-6 (-1.1)	-5 (-0.9)
Apr	---	47 (8.8)	47 (8.9)	48 (9.0)	47 (8.8)	60 (11.3)	49 (9.2)	59 (11.1)
May	---	141 (27.6)	132 (25.8)	101 (19.8)	132 (25.8)	102 (19.9)	128 (25.1)	125 (24.5)
Jun	---	148 (27.8)	149 (27.9)	149 (27.9)	144 (27.0)	146 (27.5)	152 (28.6)	152 (28.5)
Jul	---	57 (10.9)	62 (12.0)	62 (12.0)	52 (10.1)	62 (12.0)	48 (9.3)	60 (11.6)
Aug	---	-1 (-0.1)	23 (4.1)	23 (4.1)	24 (4.4)	-1 (-0.1)	3 (0.5)	2 (0.4)
Sep	---	3 (0.5)	4 (0.7)	4 (0.7)	2 (0.3)	3 (0.5)	12 (1.9)	8 (1.3)
Oct	---	-89 (-12.9)	-97 (-14.1)	-98 (-14.1)	-95 (-13.7)	-100 (-14.4)	-87 (-12.6)	-91 (-13.1)
Nov	---	-61 (-9.1)	-62 (-9.2)	-62 (-9.3)	-62 (-9.2)	-60 (-9.0)	-59 (-8.9)	-60 (-9.1)
Dec	---	-57 (-8.4)	-58 (-8.4)	-58 (-8.4)	-58 (-8.5)	-58 (-8.4)	-58 (-8.4)	-57 (-8.4)

Table 41. Cumulative Effects Simulated Salinity Concentration Comparison for Fountain Creek at Pueblo Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	698	662	663	660	662	659	661	662
15th percentile	522	513	513	511	513	513	517	517
25th percentile	582	560	560	560	560	559	561	563
50th percentile	706	644	647	647	641	647	647	646
75th percentile	822	718	720	717	718	717	722	718
85th percentile	870	764	768	766	769	764	761	766
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	1 (0.2)	-1 (-0.2)	0 (0.0)	-3 (-0.4)	-1 (-0.1)	0 (0.0)
15th percentile	---	---	0 (0.0)	-2 (-0.4)	0 (-0.1)	0 (-0.1)	3 (0.7)	3 (0.7)
25th percentile	---	---	0 (-0.1)	-1 (-0.1)	0 (0.0)	-1 (-0.2)	1 (0.1)	2 (0.4)
50th percentile	---	---	3 (0.4)	2 (0.4)	-3 (-0.5)	3 (0.4)	3 (0.4)	2 (0.3)
75th percentile	---	---	1 (0.2)	-1 (-0.1)	0 (0.0)	-1 (-0.1)	4 (0.6)	0 (0.0)
85th percentile	---	---	4 (0.6)	2 (0.2)	5 (0.6)	0 (0.0)	-3 (-0.4)	2 (0.2)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	-36 (-5.2)	-35 (-5.0)	-38 (-5.4)	-36 (-5.2)	-39 (-5.6)	-37 (-5.3)	-36 (-5.2)
15th percentile	---	-9 (-1.7)	-9 (-1.7)	-11 (-2.1)	-9 (-1.8)	-9 (-1.8)	-5 (-1.1)	-5 (-1.1)
25th percentile	---	-22 (-3.7)	-22 (-3.8)	-22 (-3.8)	-22 (-3.7)	-23 (-3.9)	-21 (-3.6)	-19 (-3.3)
50th percentile	---	-62 (-8.8)	-59 (-8.4)	-60 (-8.5)	-65 (-9.2)	-59 (-8.4)	-60 (-8.4)	-60 (-8.5)
75th percentile	---	-104 (-12.7)	-103 (-12.5)	-105 (-12.8)	-104 (-12.6)	-105 (-12.8)	-100 (-12.2)	-104 (-12.7)
85th percentile	---	-106 (-12.2)	-102 (-11.7)	-105 (-12.0)	-101 (-11.7)	-106 (-12.2)	-109 (-12.6)	-104 (-12.0)

Table 42. Cumulative Effects Monthly Simulated Salinity Concentration for Fountain Creek at Pueblo Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	738	675	676	675	676	674	671	672
Feb	749	660	662	662	662	662	660	659
Mar	711	659	654	653	654	653	656	657
Apr	669	641	638	639	638	650	642	649
May	601	665	657	626	656	627	653	650
Jun	620	700	701	700	697	698	703	704
Jul	609	618	625	625	614	624	610	623
Aug	640	600	623	623	624	601	602	602
Sep	652	635	640	640	636	639	646	641
Oct	827	685	684	683	683	681	688	686
Nov	770	681	683	683	682	684	682	682
Dec	805	708	706	706	710	706	707	707
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	1 (0.1)	0 (0.1)	1 (0.2)	-1 (-0.1)	-4 (-0.6)	-3 (-0.5)
Feb	---	---	2 (0.2)	2 (0.3)	2 (0.3)	2 (0.2)	0 (0.0)	-1 (-0.2)
Mar	---	---	-5 (-0.8)	-6 (-1.0)	-5 (-0.8)	-6 (-0.9)	-3 (-0.6)	-2 (-0.4)
Apr	---	---	-3 (-0.5)	-2 (-0.4)	-3 (-0.5)	9 (1.4)	1 (0.1)	8 (1.3)
May	---	---	-8 (-1.3)	-39 (-5.9)	-9 (-1.3)	-38 (-5.8)	-12 (-1.8)	-15 (-2.3)
Jun	---	---	1 (0.2)	0 (0.1)	-3 (-0.4)	-2 (-0.2)	3 (0.5)	4 (0.5)
Jul	---	---	7 (1.1)	7 (1.1)	-4 (-0.6)	6 (1.0)	-8 (-1.3)	5 (0.9)
Aug	---	---	23 (3.9)	23 (3.8)	24 (4.0)	1 (0.2)	2 (0.4)	2 (0.4)
Sep	---	---	5 (0.7)	5 (0.7)	1 (0.1)	4 (0.6)	11 (1.7)	6 (0.8)
Oct	---	---	-1 (-0.2)	-2 (-0.3)	-2 (-0.4)	-4 (-0.6)	3 (0.4)	1 (0.1)
Nov	---	---	2 (0.4)	2 (0.3)	1 (0.2)	3 (0.5)	1 (0.1)	1 (0.1)
Dec	---	---	-2 (-0.3)	-2 (-0.3)	2 (0.2)	-2 (-0.3)	-1 (-0.1)	-1 (-0.2)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	-63 (-8.6)	-62 (-8.5)	-63 (-8.5)	-62 (-8.4)	-64 (-8.6)	-67 (-9.1)	-66 (-9.0)
Feb	---	-89 (-11.9)	-87 (-11.7)	-87 (-11.6)	-87 (-11.6)	-87 (-11.7)	-89 (-11.9)	-90 (-12.1)
Mar	---	-52 (-7.2)	-57 (-7.9)	-58 (-8.2)	-57 (-7.9)	-58 (-8.1)	-55 (-7.7)	-54 (-7.5)
Apr	---	-28 (-4.2)	-31 (-4.7)	-30 (-4.6)	-31 (-4.7)	-19 (-2.9)	-27 (-4.1)	-20 (-3.0)
May	---	64 (10.7)	56 (9.3)	25 (4.2)	55 (9.3)	26 (4.3)	52 (8.7)	49 (8.2)
Jun	---	80 (12.8)	81 (13.0)	80 (12.9)	77 (12.4)	78 (12.6)	83 (13.4)	84 (13.4)
Jul	---	9 (1.4)	16 (2.6)	16 (2.5)	5 (0.8)	15 (2.4)	1 (0.1)	14 (2.3)
Aug	---	-40 (-6.3)	-17 (-2.6)	-17 (-2.7)	-16 (-2.6)	-39 (-6.2)	-38 (-6.0)	-38 (-5.9)
Sep	---	-17 (-2.5)	-12 (-1.7)	-12 (-1.8)	-16 (-2.3)	-13 (-1.9)	-6 (-0.8)	-11 (-1.7)
Oct	---	-142 (-17.1)	-143 (-17.3)	-144 (-17.4)	-144 (-17.4)	-146 (-17.6)	-139 (-16.7)	-141 (-17.0)
Nov	---	-89 (-11.6)	-87 (-11.3)	-87 (-11.3)	-88 (-11.5)	-86 (-11.2)	-88 (-11.5)	-88 (-11.5)
Dec	---	-97 (-12.0)	-99 (-12.2)	-99 (-12.3)	-95 (-11.8)	-99 (-12.3)	-98 (-12.1)	-98 (-12.2)

Selenium Analysis

This section describes methods and results of the selenium analysis. All references in this appendix to selenium are to the dissolved form, because it is the regulated and most commonly monitored form of selenium.

Methods

Selenium data are not frequently collected in the study area. Despite limited data, selenium in the study area was evaluated using a conservative constituent mass balance approach. Historical data was reconstructed using relationships between salinity and selenium. Results from the detailed salinity model were used to support the estimation of selenium for missing data periods.

The mass balance approach to simulate selenium concentrations throughout the study area was carried out using the GeoDSS for the Lower Arkansas River. Methods for modeling selenium are the same as used to model salinity (see this Appendix F.2 – *Salinity Analysis*). Due to simplified modeling assumptions, the results of the selenium analysis are more appropriate to gain an understanding of the relative direction and magnitude of effects between the alternatives than to describe absolute future selenium conditions.

The results of the selenium analysis followed the same pattern as the salinity analysis because the historical relationships between salinity and selenium are all monotonically increasing (i.e., when salinity increases, selenium increases). Results are presented by percentile and as monthly averages. The 85th percentile of available samples is the statistic used by Health Department to evaluate exceedences of the chronic dissolved selenium Water Quality Standard (WQS) (Health Department 2005).

The significance criteria in Table 7 were used to evaluate selenium effects.

Model Study Period

Similar to salinity, the selenium study period is a 10-year model study period, from 1999 through 2009, based on the original GeoDSS study period extended through the Daily Model study period. Weekly time steps were selected as the model interval to reasonably capture the concentration variability based on the limited data availability throughout the studied area.

Table 43 summarizes the period of record for stream gages where selenium measurements were available. *Irregular* measurement refers to samples taken at field visits at irregular intervals. Table 43 also provides the number of measurements available for each station, data type and the abbreviation used in this report.

Table 43. Daily Selenium Data Period of Record for Stream Gages

Gage Name	Abbreviation	Measurement Interval	Number of Measurements	Daily Selenium Data Period of Record
Fountain Creek at Colorado Springs	7105500	Irregular	134	Apr/1981 - Oct/2010
Fountain Creek at Security	7105800	Irregular	89	Nov/1998- Oct/2010
Fountain Creek at Pueblo	FOUPUECO	Irregular	139	Apr/1981 - Oct/2010
Arkansas River above Pueblo	ARKPUECO	Irregular	52	Apr/1982 - Feb/2008
Arkansas River at Moffat St.	ARKMOFCO	Irregular	72	Apr/1990 - Feb/2008
Arkansas River near Avondale	ARKAVOCO	Irregular	63	June/1976 - Aug/2010
Arkansas River at Catlin Dam	ARKCATCO	Irregular	85	Apr/1990 - Aug/2010
Arkansas River at Las Animas	ARKLASCO	Irregular	57	Apr/1990 - Aug/2010

Figure 36 shows a schematic of the selenium model control points used for GeoDSS calibration. Weekly selenium concentration of unmeasured inflows was estimated to match, as close as possible, the estimated concentration at the control points.

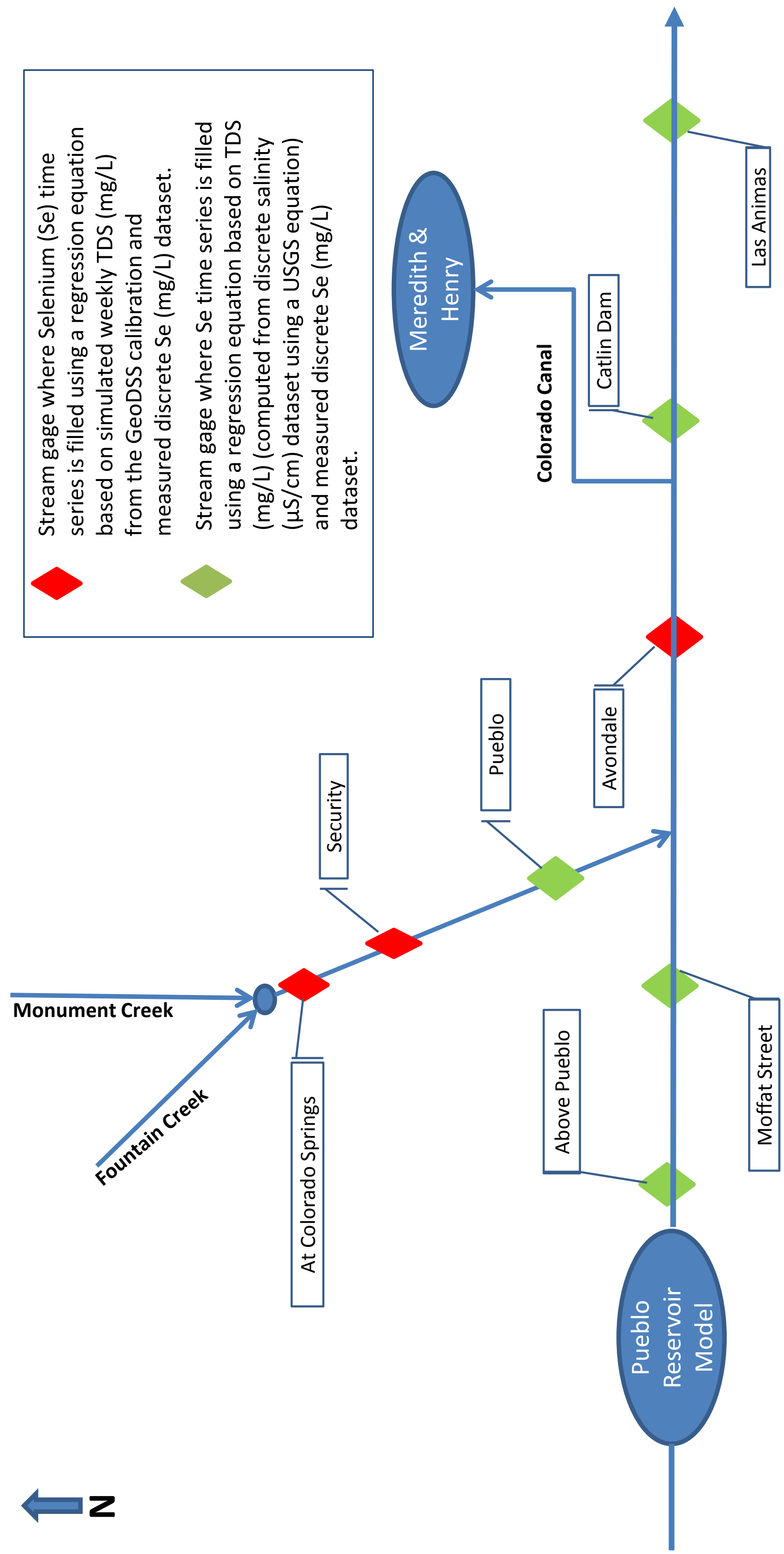


Figure 36 Selenium Model Control Points Schematic for Existing Conditions

Selenium and Salinity Relationships

Dissolved selenium and salinity (measured as specific conductance) are historically related in surface water in the lower Arkansas River, and many of the factors that affect salinity concentrations would likely affect selenium concentrations. Bossong (2001) studied the correlation between salinity and dissolved selenium at locations within the Fountain Creek Basin. Bossong (2001) found strong positive correlations between dissolved selenium at the Fountain Creek below Janitell Road, Fountain Creek near Fountain, and Fountain Creek at Pueblo gages. Correlations between salinity and selenium concentrations have been found throughout the arid Western United States (Seiler et al. 2003).

Based on those findings, in this analysis, specific relationships for the study area were derived to perform the analysis of dissolved selenium building on the detailed salinity modeling presented in the previous section of this appendix. Historical relationships between measured and simulated salinity (as TDS) and selenium were evaluated to select the relationship with stronger correlation to represent the selenium concentration at the different control points in the study area.

Measured salinity was obtained from the USGS published data using the specific conductance to TDS conversion equations shown in Table 2. The simulated TDS dataset was obtained from the historical calibration in GeoDSS. It was assumed that average weekly simulated TDS concentration obtained from the historical calibration in GeoDSS was representative of TDS concentration at a USGS gage and therefore could be used to derive the relationship with measured selenium concentration. Measured selenium corresponds to the USGS published discrete sampling of filtered selenium in µg/L.

The development of selenium and TDS relationships usually has limited number of data points available, making this process challenging and requiring professional judgment to find relationships expected to perform better for the historical range of TDS values. A logarithmic transformation of the data was performed to develop the relationships.

Figure 37 through Figure 39 present the selenium and TDS relationships for modeled gages in Fountain Creek. The relationship for Fountain Creek at Colorado Springs gage, shown in Figure 37, was derived using the average weekly simulated TDS concentration dataset obtained from the GeoDSS historical calibration and the discrete measured selenium concentration. Figure 37 shows the relationship and the selected equation to estimate selenium at Fountain Creek at Colorado Springs gage. The coefficient of determination (R^2) for this case is 0.73.

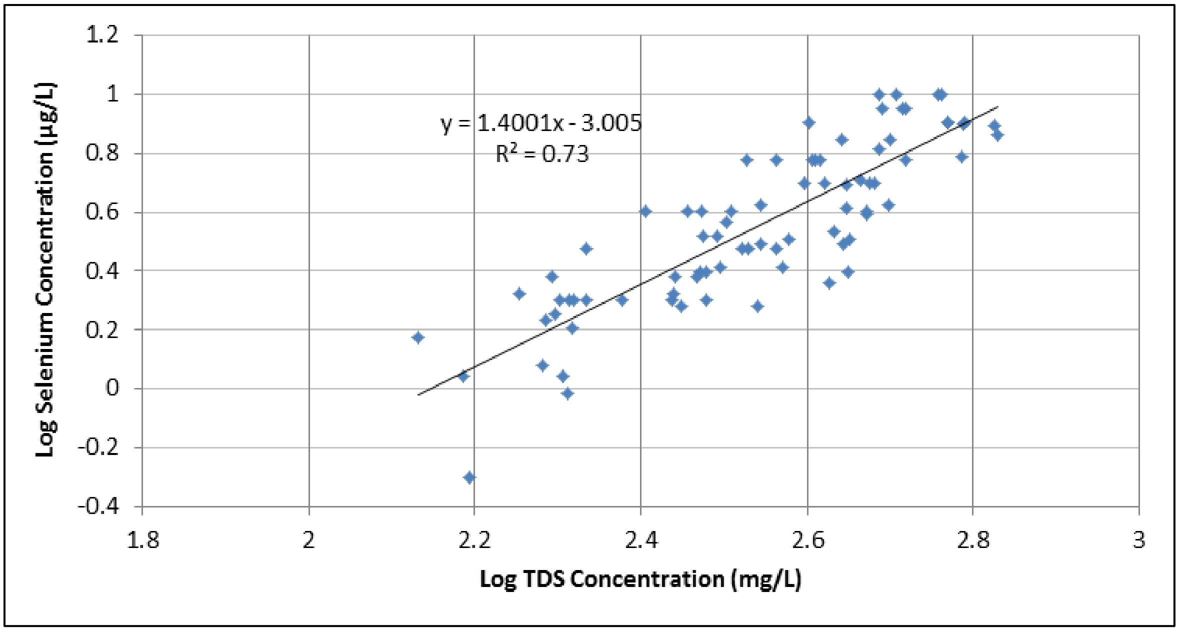


Figure 37. TDS and Selenium Concentration Relationship for Fountain Creek at Colorado Springs Gage

TDS and selenium relationship for Fountain Creek at Security was based on the average weekly simulated TDS concentration from the GeoDSS historical calibration and the available selenium measured concentration. Figure 38 shows the relationship between the two variables, the regression equation and corresponding R^2. Although there is not a strong correlation between TDS and selenium at this gage, due to the limited selenium data between the Security gage and Fountain Creek at Pueblo gage this relationship was used to represent the selenium concentration change at the upstream end of the Security to Pueblo segment of Fountain Creek.

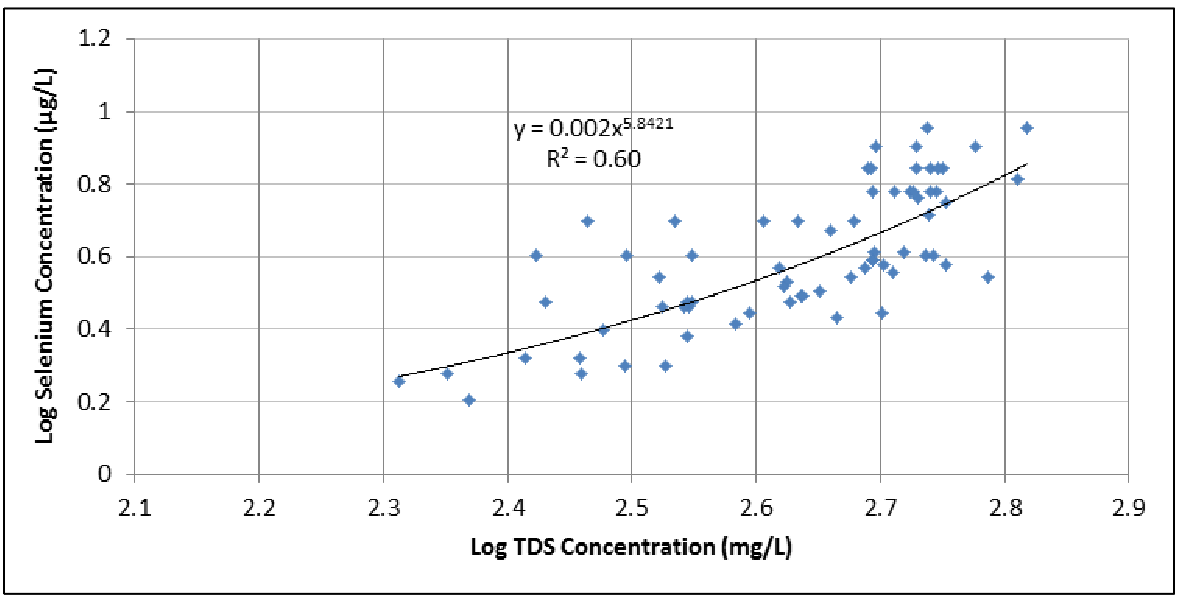


Figure 38. TDS and Selenium Concentration Relationship for Fountain Creek at Security Gage

The TDS and selenium relationship for the Fountain Creek at Pueblo gage was based on the average USGS measured TDS and selenium. Figure 39 shows the selected relationship, the regression equations and corresponding R^2.

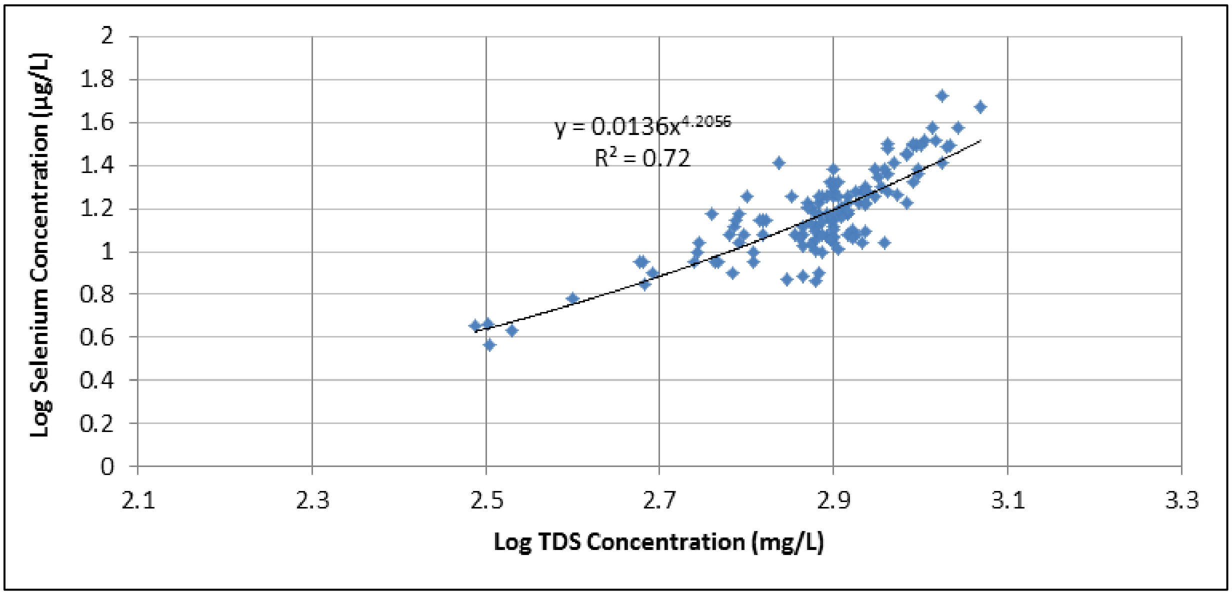


Figure 39. TDS and Selenium Concentration Relationship for Fountain Creek at Pueblo Gage

Figure 40 through Figure 44 show the relationships between TDS and selenium for the Arkansas River gages. The TDS and selenium relationship for the Arkansas River above Pueblo gage was derived from average USGS measured TDS and measured selenium samples. A linear relationship was selected to be conservative in prediction of selenium values outside the observed range, especially for high TDS values observed in 2002 for which there is no measured selenium data. Although the prediction error outside the range of observed values used to develop the relationships is higher, the error in selenium load estimates in those high concentration periods is small due to the extremely low flows (less than 2 cfs) that occurred in that period. Figure 40 shows relationship for the corresponding TDS and selenium measured points and the selected regression equation and coefficient of determination.

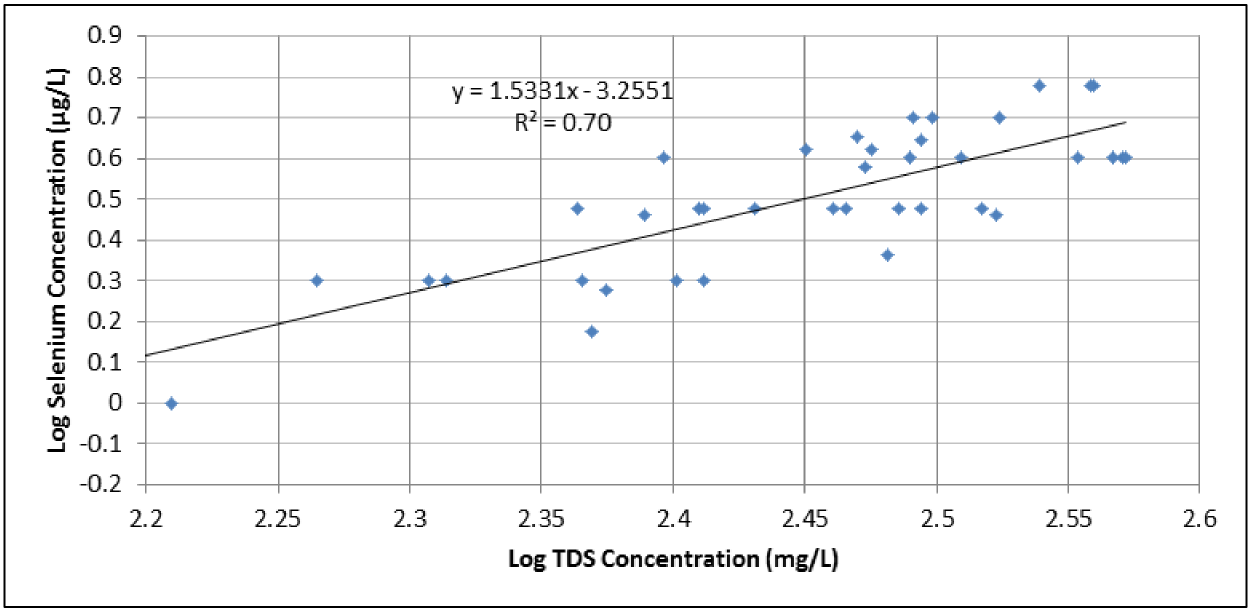


Figure 40. TDS and Selenium Concentration Relationship for Arkansas River above Pueblo Gage

TDS and selenium relationship for the Arkansas River at Moffat St. gage was derived from the average USGS measured TDS and selenium samples. Figure 41 shows the relationship between the two variables and corresponding R^2.

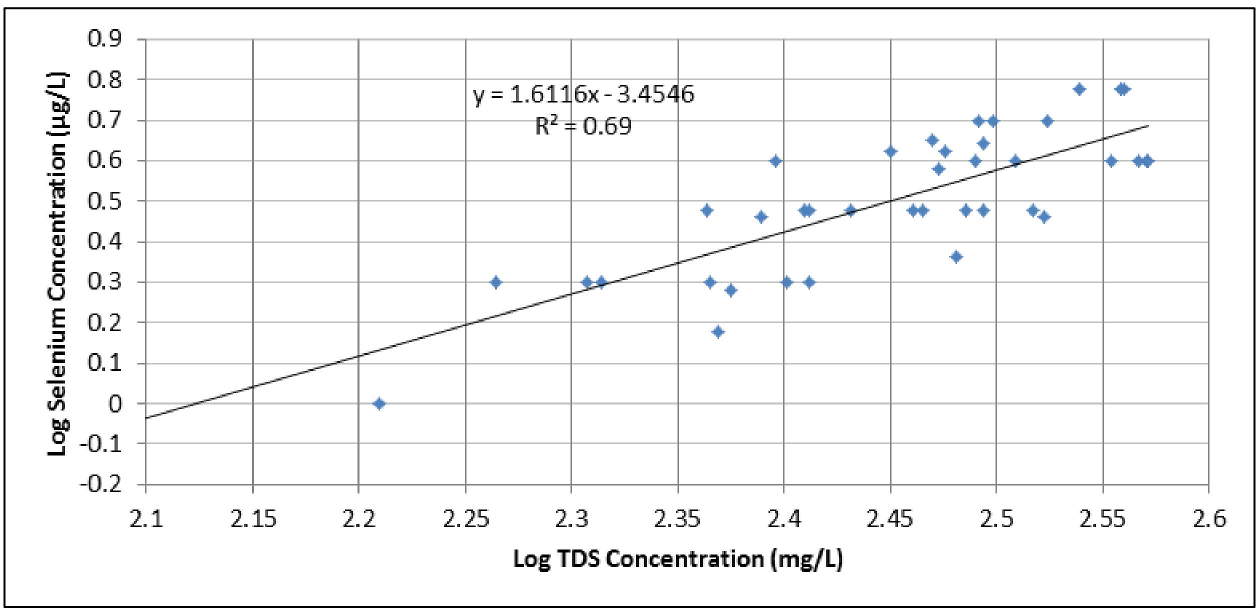


Figure 41. TDS and Selenium Concentration Relationship for the Arkansas River at Moffat St. Gage

The relationship between TDS and selenium at the Arkansas River near Avondale gage was based on the average weekly simulated TDS concentration from the GeoDSS historical calibration run and discrete measured Selenium concentration. Figure 42 shows the relationship between the two variables and corresponding regression equation and R^2.

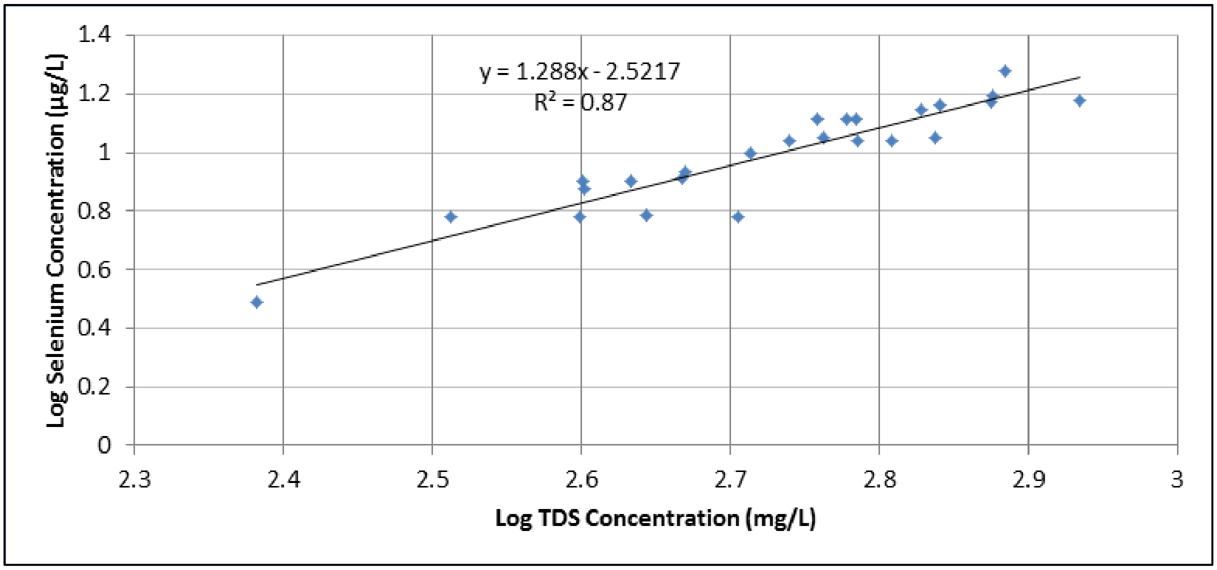


Figure 42. TDS and Selenium Concentration Relationship for Arkansas River near Avondale Gage

The TDS and selenium relationship for the Arkansas River at Catlin Dam gage was based on the average USGS measured TDS and selenium samples. Figure 43 shows the corresponding relationship between the two variables and corresponding R^2.

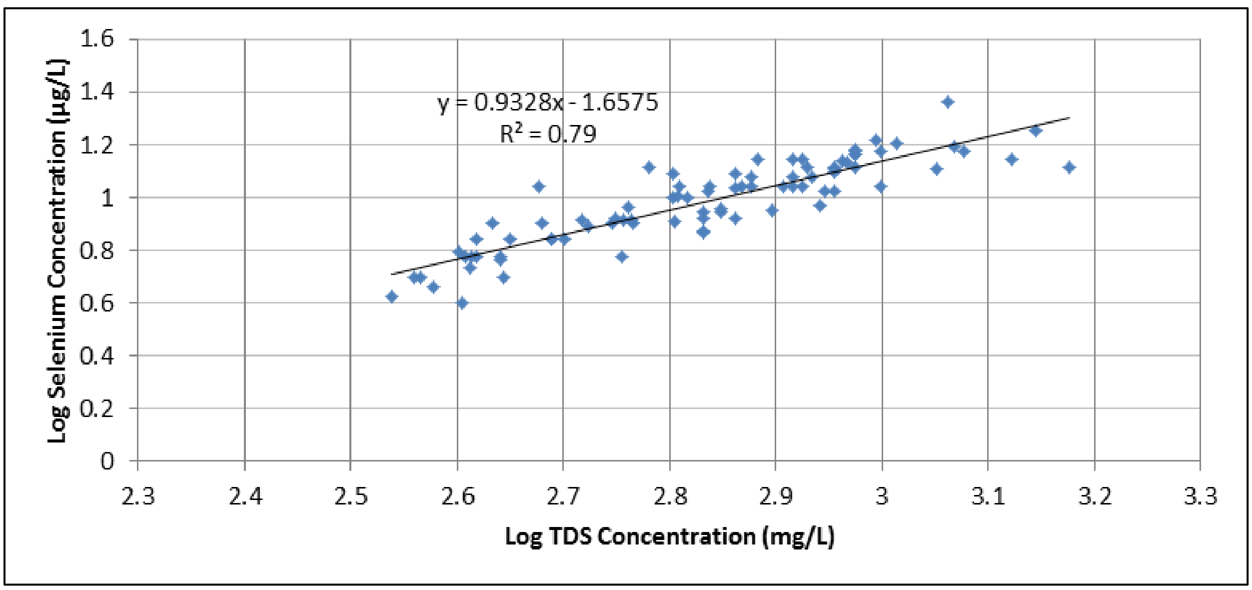


Figure 43. TDS and Selenium Concentration Relationship for Arkansas River at Catlin Dam Gage

The TDS and selenium relationship for the Arkansas River at Las Animas gage was based on the average USGS measured TDS and the selenium samples. Figure 44 shows the relationship between the two variables and corresponding R^2.

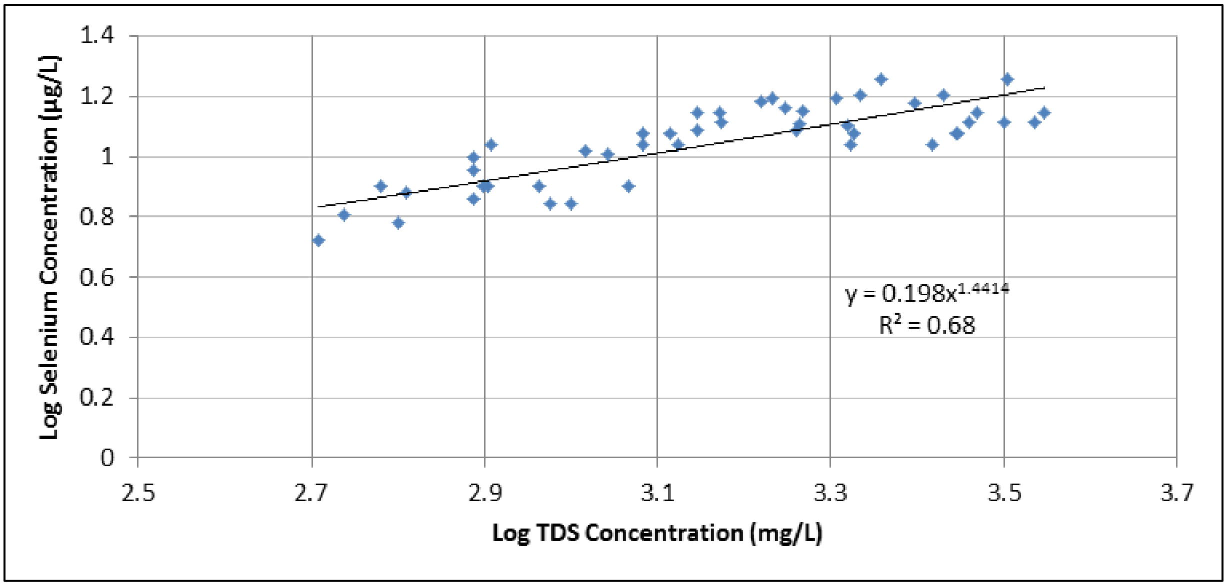


Figure 44. TDS and Selenium Concentration Relationship for Arkansas River at Las Animas Gage

Boundary Conditions

Selenium concentration at the Arkansas River above Pueblo gage was assumed as the upstream boundary condition for the AVC selenium analysis on the Arkansas River. Based on the Pueblo Reservoir total dissolved solids modeling by USGS (Ortiz 2012) and the relationship between selenium and salinity, the expected change of selenium concentrations among the alternatives is relatively small. Historical reconstructed selenium concentration at the Arkansas River above Pueblo gage was assumed to be the same for the comparative analysis of the alternatives with the selenium mass loading changing based only on the changes in reservoir releases volumes. Figure 45 shows the weekly historical reconstructed selenium concentration for the Arkansas River above Pueblo gage in this analysis.

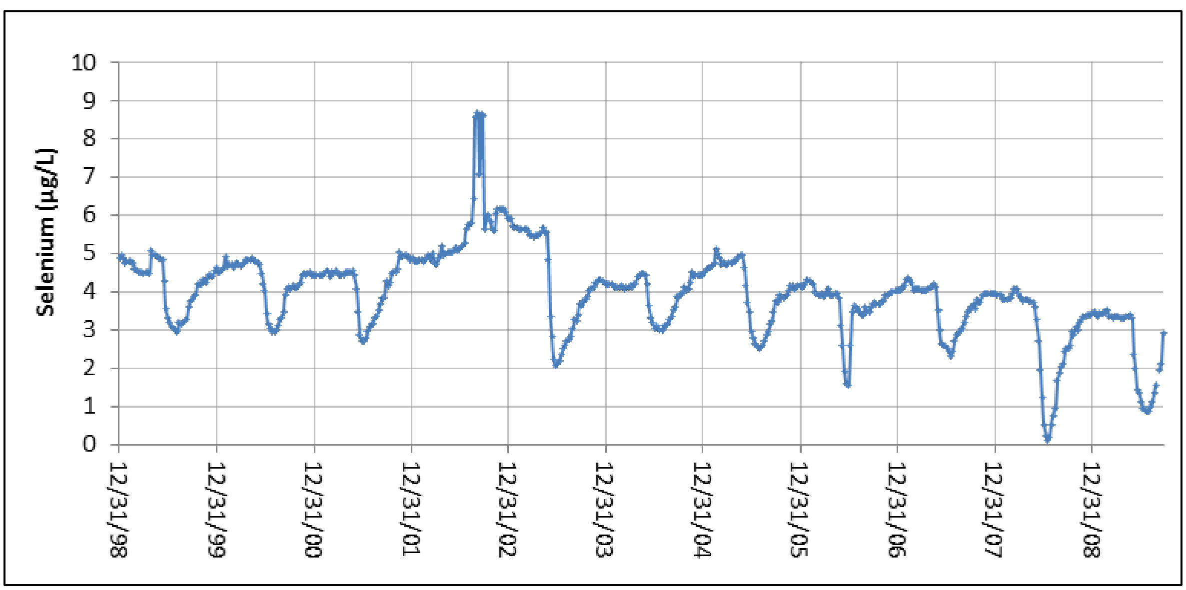


Figure 45. Historical Reconstructed Selenium Concentration for the Arkansas River above Pueblo Gage

The Fountain Creek at Colorado Springs gage is the upstream boundary in Fountain Creek. It is assumed that historical reconstructed concentration represents the selenium concentration at this location for all the alternatives because none of the alternatives would affect selenium concentration upstream from this point. The selenium loadings to the system at the Fountain Creek at Colorado Springs gage will change based on the predicted changes in flows for each alternative. Figure 46 show the reconstructed historical concentration for the Fountain Creek at Colorado Springs gage.

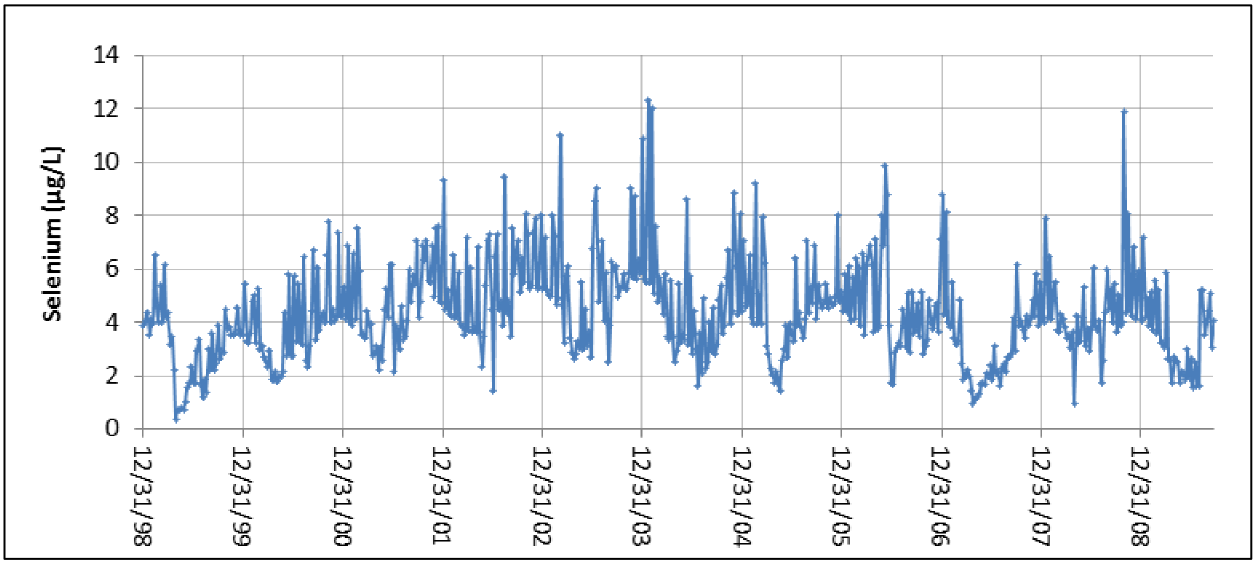


Figure 46. Historical Reconstructed Selenium Concentration for the Fountain Creek at Colorado Springs Gage

Larger variability of concentration was observed at the upstream boundary in Fountain Creek than in the Arkansas River. The larger variability is potentially caused by the city of Colorado Springs diverse return flows compared with the smoothing action of Pueblo Reservoir on this constituent. The monthly average selenium concentration for the most upstream nodes in Arkansas River and Fountain Creek are summarized in Table 44.

Table 44. Historical Reconstructed Selenium Concentration for Upstream Boundary Gages

Month	Selenium Concentration (µg/L)	
	Arkansas River above Pueblo	Fountain Creek at Colorado Springs
Jan	4.4	5.4
Feb	4.5	5.2
Mar	4.4	4.4
Apr	4.4	3.3
May	4.5	2.9
Jun	3.3	4.0
Jul	2.6	3.7
Aug	3.1	3.8
Sep	3.7	4.5
Oct	4.0	4.9
Nov	4.3	5.1
Dec	4.4	5.5

Table 45 shows the reconstructed historical concentration statistics at the upstream boundaries of the model corresponding to the Arkansas River above Pueblo gage and Fountain Creek at Colorado Springs gage.

Table 45. Simulated Selenium Concentration for Upstream Model Boundary Gages

Gage	Mean (µg/L)	Concentration Statistic (µg/L)				
		15	25	50	75	85
Arkansas River above Pueblo	4.0	3.0	3.4	4.1	4.6	4.9
Fountain Creek near Colorado Springs	4.4	2.6	3.1	4.1	5.4	6.2

Results

This section presents modeling assumptions and the calibrated concentration for the different modeled segments. The segments are named by the downstream gage.

As in salinity modeling, the calibrated concentration corresponds to a value assigned to the unknown selenium inflows to the segment. These values were calculated during the calibration process to simulate a concentration at the downstream station as close as possible to the measured concentration. Note that the values of calibrated concentration were only calculated for periods with net unmeasured gains to the segment; therefore, there were periods with no calibrated concentration that correspond to period with net unmeasured losses in the segment. Concentration of the unmeasured losses corresponds to the simulated concentration at the downstream end of the segment that was computed by mixing the salt loads to the segment.

Calibration and Baseline Conditions

This section shows calibration results for selenium modeling of the study area. These results include calibrated concentrations by segment, computed for unmeasured concentrations to match as close as possible downstream concentration at the control point of the segment. Calibration results are summarized and presented as the flow-weighted concentration for the segment's inflows and the concentration computed for the unmeasured losses of the segment. The simulated and reconstructed historical concentrations per segment are compared to observe the result of the calibration mimicking historical concentration at the segment control point. The calibrated concentrations for historical inflows and outflows with unmeasured concentration are assumed to remain unchanged.

Calibrated concentrations are not necessarily associated with a physical selenium source because they are uniformly assigned to all the net inflows with unmeasured concentration in the segment and those inflows are not necessarily correlated with the missing selenium loads between the upstream end and the downstream end of the segment. The calibrated concentrations are constrained by an upper bound to keep the calibration from selecting unreasonable values to exactly match the segment downstream concentration. For this analysis, it was assumed that the calibration upper bound is 60 µg/L, which is about four times higher than the observed selenium concentration in the study area.

Selenium loadings from the WWTF in the study area were not explicitly estimated for this analysis. Selenium loading from the WWTF was estimated using the same methodology for segment inflows with unmeasured concentrations, assigning the segment calibrated concentration to the simulated WWTF effluent. Changes in selenium loadings from the WWTF for the alternatives were simulated based on changes in the WWTF effluent flow rate.

Arkansas River at Moffat St. Segment This segment covers the Arkansas River from the Arkansas River above Pueblo gage, which is the boundary condition for the selenium analysis, to the Arkansas River at Moffat St. gage. This segment collects return flows from the west and central section of the City of Pueblo and the Pueblo West WWTF. Increases in selenium by transit in the segment streams are accounted for in the calibration of unmeasured concentrations. Figure 47 shows the weighted selenium concentration for the inflows with unmeasured concentration and the unmeasured losses at the Arkansas River at Moffat St. segment. Note that concentrations of unmeasured losses and inflows calibrated concentration are only computed for cases where flows are greater than zero, creating discontinuities in the plots.

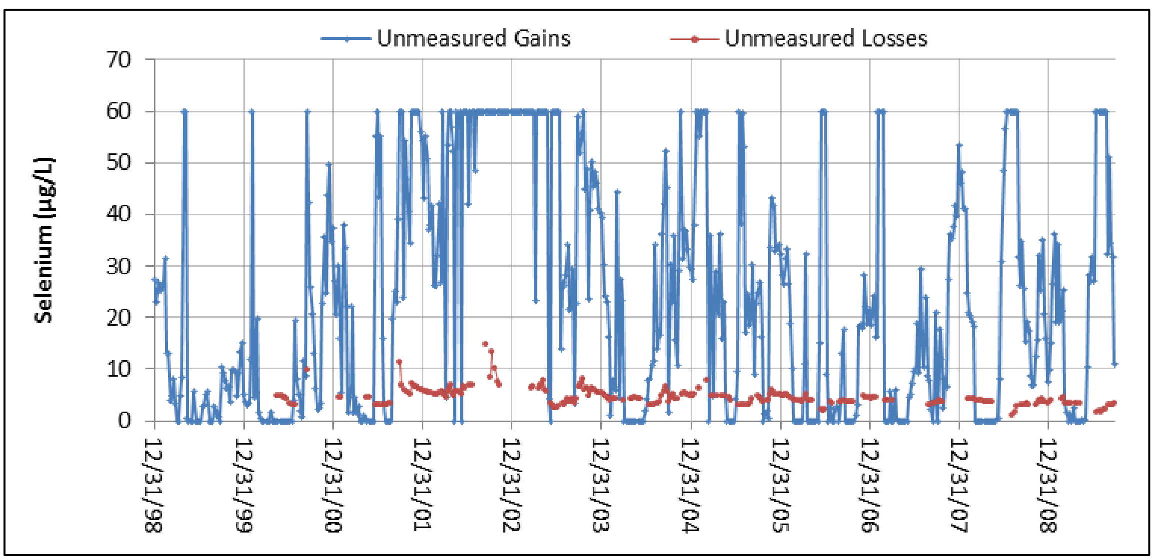


Figure 47. Selenium Calibrated Concentration for the Arkansas River at Moffat St. Segment

Results show an irregular selenium concentration of the unmeasured inflows, with several occasions resulting at the calibration upper bound for the segment (60 µg/L), especially during the extremely high concentrations recorded during extremely low flows in 2002 and 2003. Figure 48 compares weekly calibrated and measured concentration at the Arkansas River at Moffat St. gage.

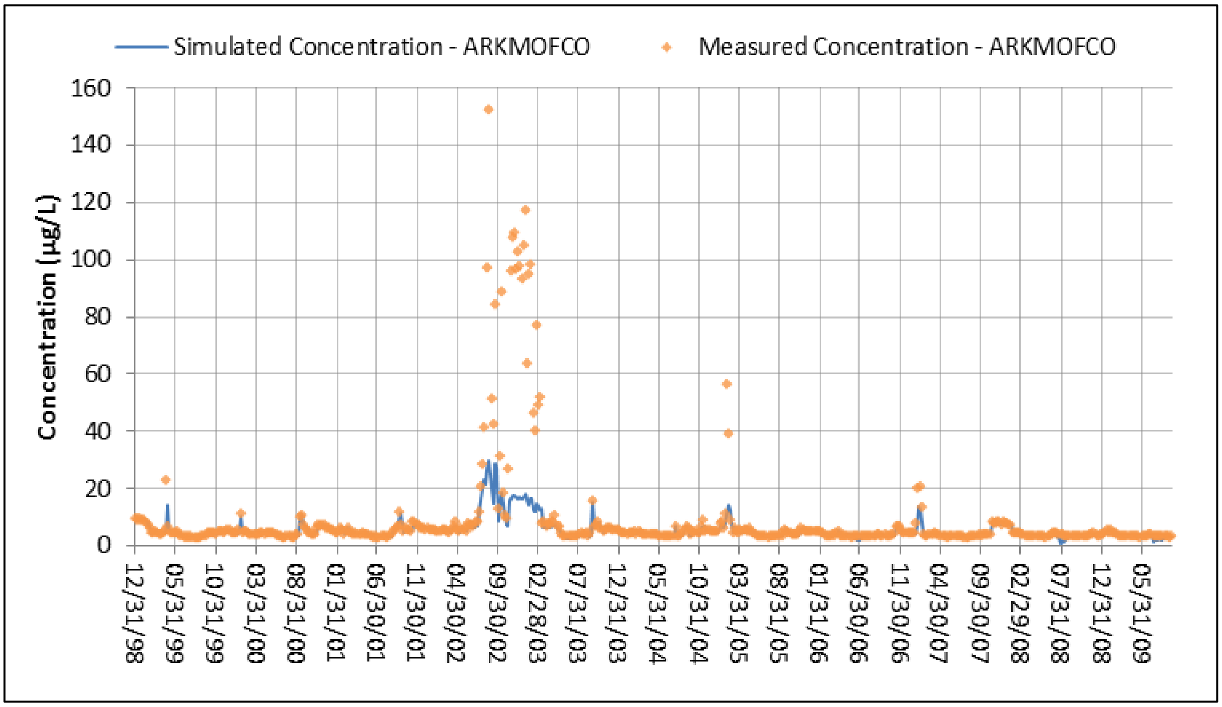


Figure 48. Comparison of Historical and Simulated Selenium Concentration for Arkansas River at Moffat St. Gage

In general, calibration results show a good match of the lower estimated selenium concentration with under prediction of the high peaks in 2002 and 2003. In this case the calibrated concentration upper bound is constraining the calibrate concentration to match closely high peaks from 2002 and 2003. These results are considered appropriate for this analysis because (1) the calibrated concentration upper bound is sufficient to represent the majority of the processes in the segment; (2) the frequency of the high peaks is low such that they do not affect the calculation of the 85 percent percentile (7.4 µg/L) that is used in the selenium effects analysis; and (3) there is a large uncertainty about the magnitude of the selenium at the 2002 and 2003 peaks because they are outside of the observed data value range. For these reasons, the use of the calibrated concentrations for the comparative analysis of the alternatives is considered a valid approach for analyzing the selenium relative effects.

Fountain Creek at Security Segment This is the first segment modeled on Fountain Creek, and includes the estimated concentration at Fountain Creek at Colorado Springs gage, which is the model upstream boundary in Fountain Creek. Selenium concentration for unmeasured contributors was estimated to match the segment downstream estimated concentration. Figure 49 shows the weekly calibrated and simulated concentration for the segment unmeasured gains and losses, respectively.

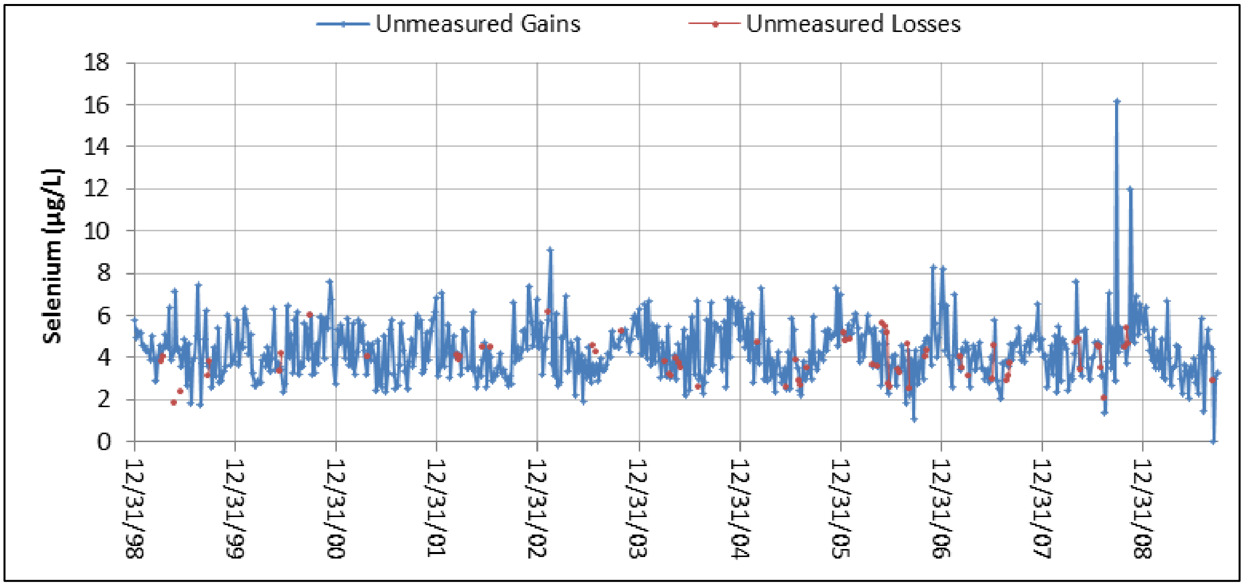


Figure 49. Selenium Calibrated Concentration for the Fountain Creek at Security Segment

Results show relative small variability on the unmeasured gains concentration throughout the modeled period and about the same range of concentration for the gains and losses, indicating a small increase in selenium concentration from the upstream end to the downstream end of the segment. Figure 50 shows the calibration results for the Fountain Creek at Security gage.

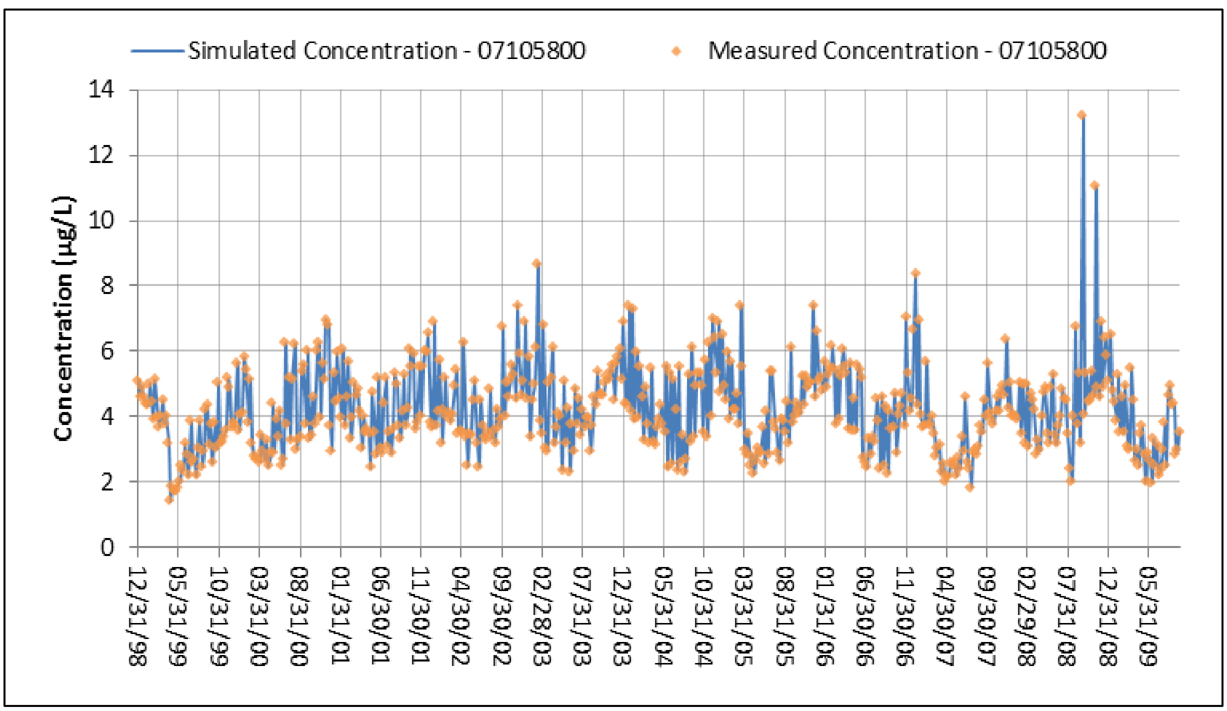


Figure 50. Comparison of Historical and Simulated Selenium Concentration for Fountain Creek at Security Gage

The flow amount and number of inflows with unmeasured concentration allow having an excellent match of the selenium concentration at this control point.

Fountain Creek at Pueblo Segment This is the most downstream segment on Fountain Creek before it flows into the Arkansas River. This segment includes limited number of inflows with unmeasured concentrations and the assumed calibration concentration upper bound limits the ability to match closer the reconstructed historical concentration at the downstream control point of the segment. Figure 51 shows the calibrated selenium concentration for the inflows with unmeasured concentrations and the calculated concentration for the unmeasured losses only for periods with net unmeasured losses in the Fountain Creek at Pueblo segment.

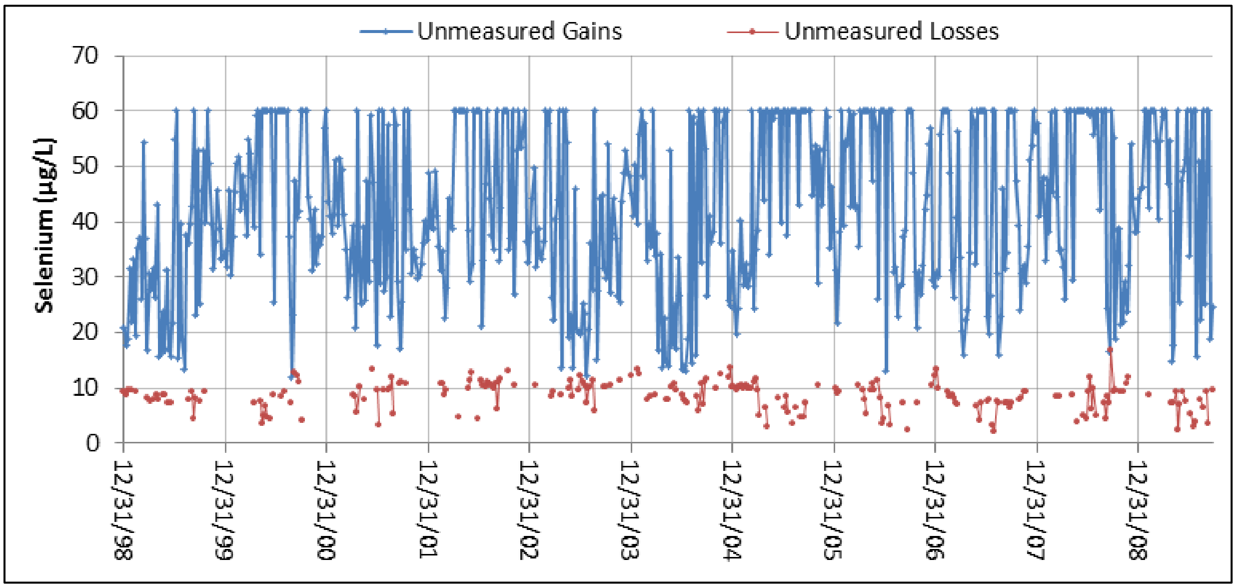


Figure 51. Selenium Calibrated Concentration for the Fountain Creek at Pueblo Segment

Figure 52 compares the calibrated selenium concentration and the historical estimated concentration at Fountain Creek at Pueblo gage. Although high historical estimated concentration values at the control point of this segment were underestimated during the calibration, the majority of these peaks are above the 85th percentile (18.7 µg/L); thus, the calibration is considered appropriate to perform the comparative selenium effects for the alternatives.

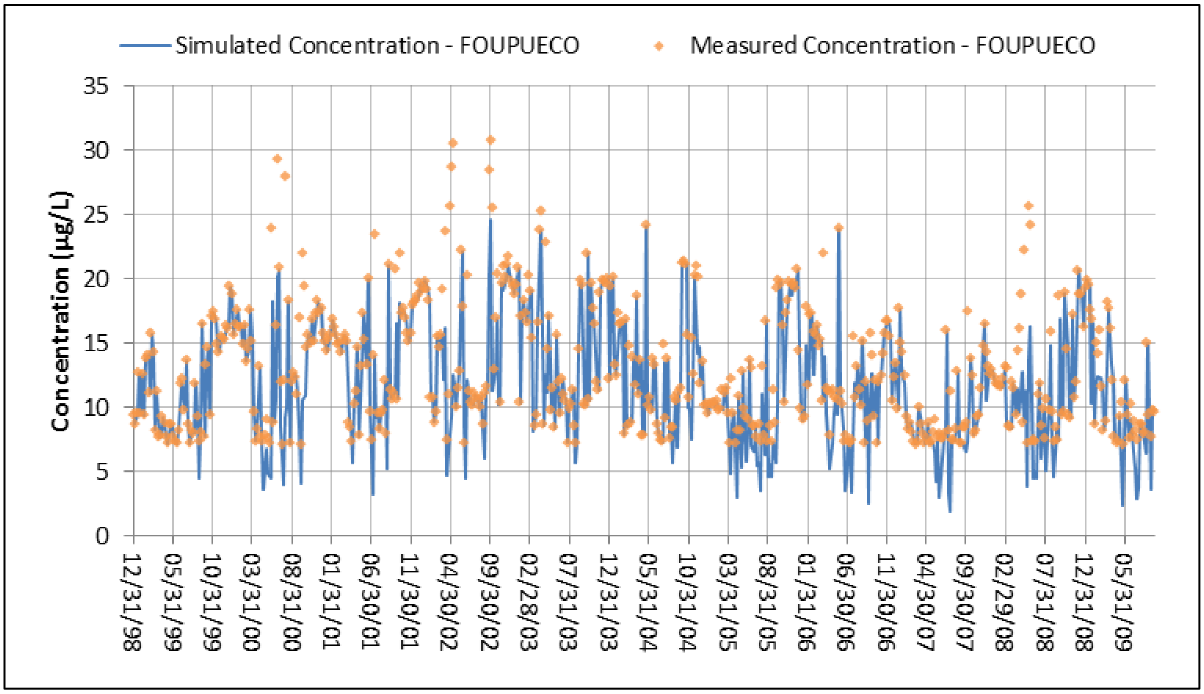


Figure 52. Comparison of Historical and Simulated Selenium Concentration for Fountain Creek at Pueblo Gage

Arkansas River at Avondale Segment This segment contains the confluence of Fountain Creek and the Arkansas River. The calibration of the segment took into account the mixing of the simulated selenium loads at Fountain Creek at Pueblo gage and the Arkansas River at Moffat St. gage with the historical estimated concentrations from the Saint Charles River. Figure 53 shows the calibrated concentration for inflows with unmeasured concentrations to the segment, as well as the calculated concentration of the unmeasured losses only for periods with net unmeasured losses in the segment.

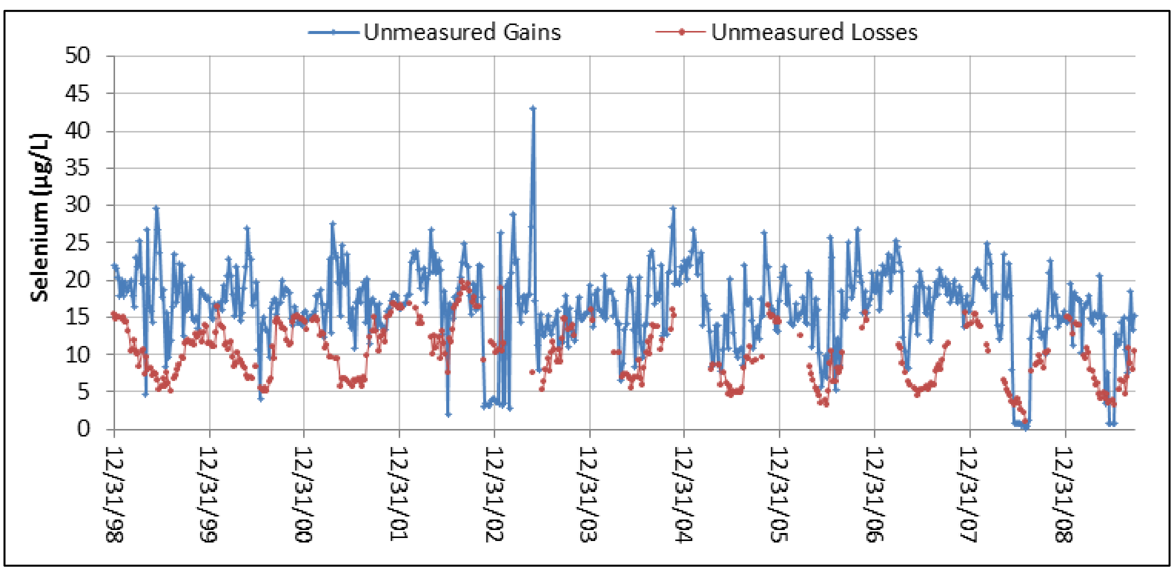


Figure 53. Selenium Calibrated Concentration for the Arkansas River near Avondale Segment

The segment contains seven return flow points with unmeasured concentration, allowing flexibility in the calibration process to provide a good match of the historical downstream concentration. Note that the calibration process self corrects the underestimation of concentration observed at the Fountain Creek at Pueblo gage. Figure 54 shows the comparison between the calibrated and reconstructed historical selenium concentration for the Arkansas River near Avondale control point. Results show a tight fit between the historical and calibrated concentration, with the exception of the dry period of 2002 and 2003.

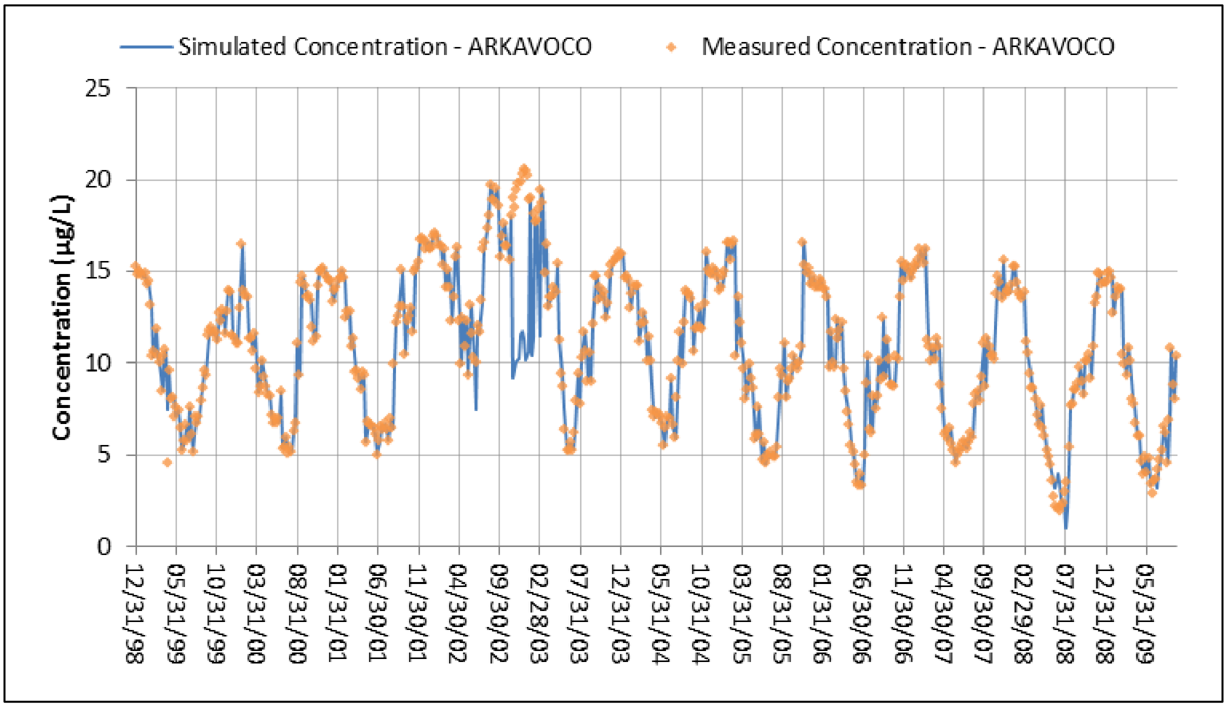


Figure 54. Comparison of Historical and Simulated Selenium Concentration for Arkansas River near Avondale Gage

Arkansas River at Catlin Dam Segment This segment collects the Apishapa River and Huerfano River contributions. Selenium concentrations on these tributaries were estimated as part of the calibration process. The representative selenium concentrations of the segment inflows without measured concentration has large variability but similar magnitude with the in-segment computed concentration for the unmeasured losses, indicating selenium loads in this segment with similar concentration to the stream concentration. Zero calibrated concentration for unmeasured gains indicates cases in which the simulated balance of selenium in the segment has a lower concentration than the historical concentration at the downstream gage. Figure 55 shows the representative selenium concentration for the inflows with unmeasured concentrations and simulated concentration of unmeasured losses of this segment.

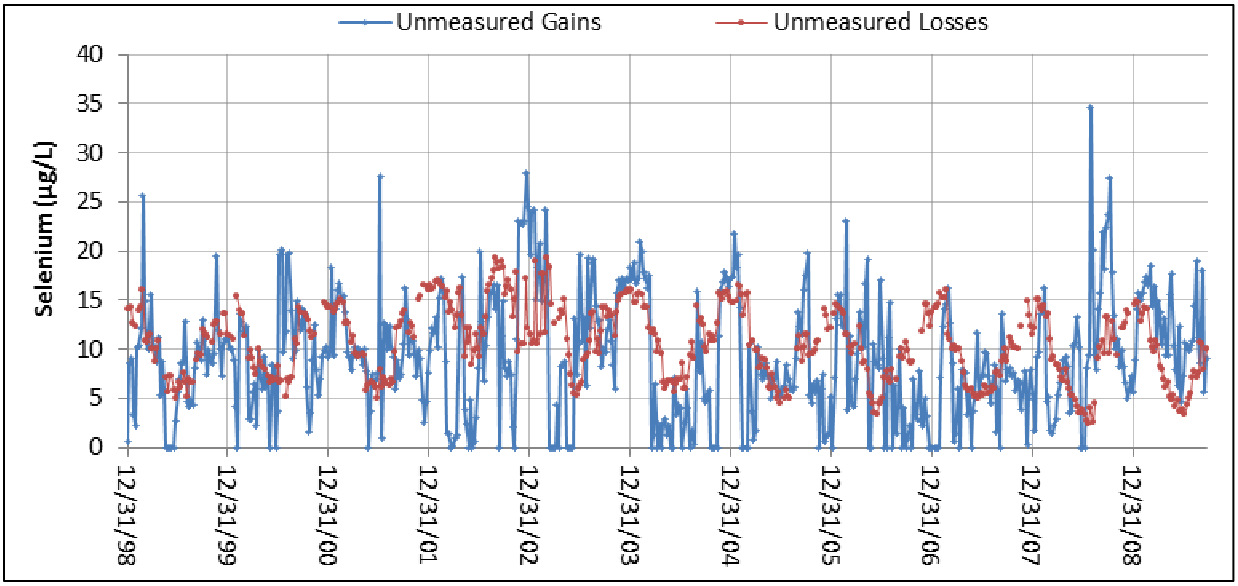


Figure 55. Selenium Calibrated Concentration for the Arkansas River at Catlin Dam Segment

The number of inflows without measured/estimated concentration to this segment allowed flexibility in the calibration procedure to match closely the downstream concentration, further offsetting errors observed at the Arkansas River near Avondale gage during the 2002 and 2003 periods. Figure 56 compares calibrated concentration and the historical estimated concentration for the Arkansas River at Catlin Dams gage.

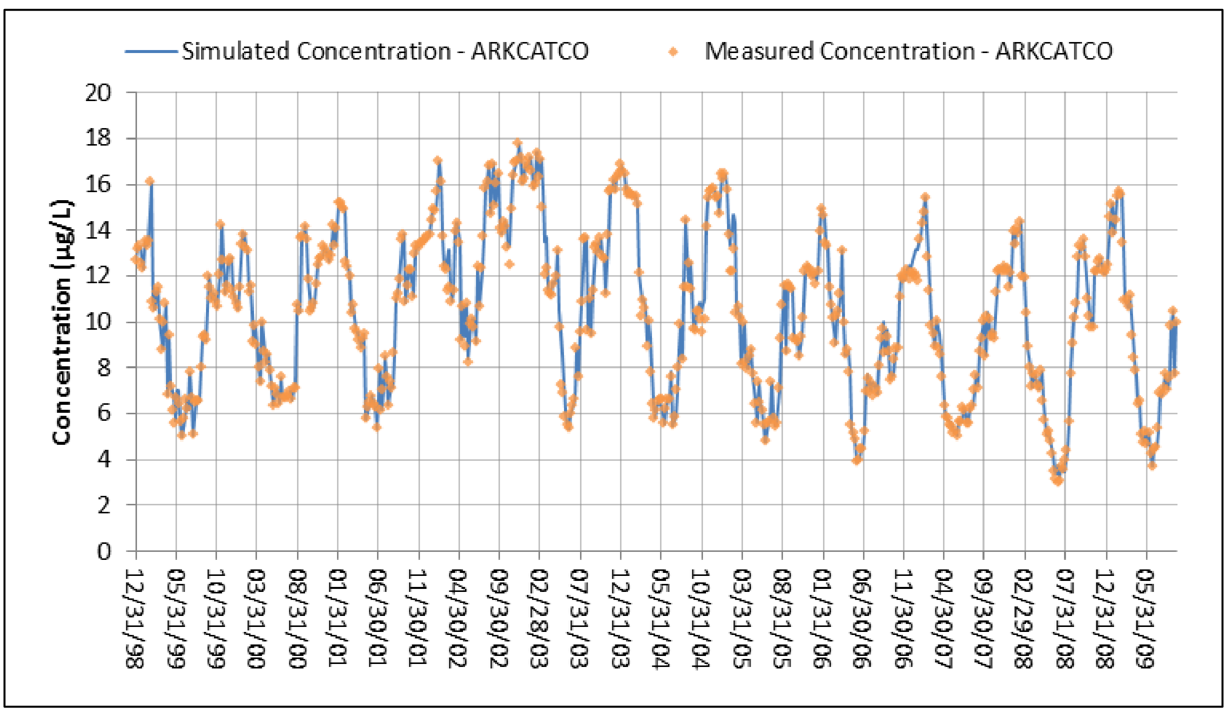


Figure 56. Comparison of Historical and Simulated Selenium Concentration for the Arkansas River at Catlin Dam Gage

Arkansas River at Las Animas Segment This segment receives loads from the flow-measured tributaries Timpas Creek and Crooked Arroyo, which in this case, do not have selenium measurements. Intermediate gages on the Arkansas River in this segment allowed estimating unmeasured flow gains and losses between those gages, gains which are a source of unmeasured selenium loadings. Figure 57 shows the weekly calibrated concentration for the segment based on the concentrations for each segment inflow with unmeasured selenium, and the computed concentration for unmeasured losses for periods with net losses in this segment.

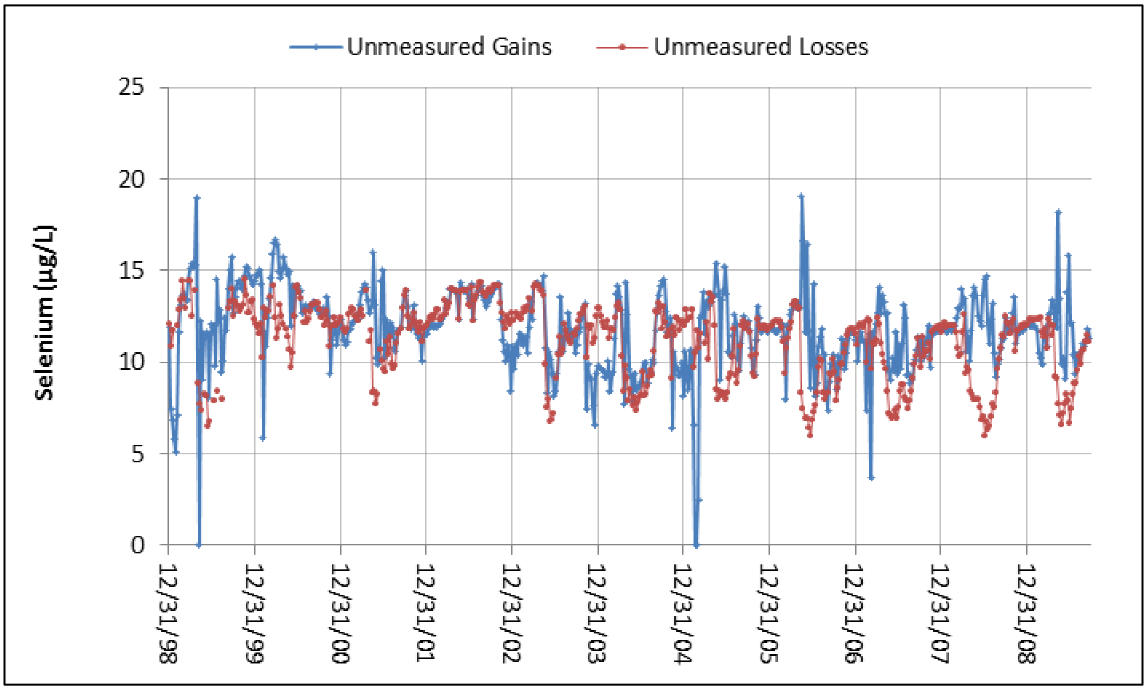


Figure 57. Selenium Calibrated Concentration for the Arkansas River at Las Animas Segment

The unmeasured concentration assigned in the calibration process allowed a close match of the historical reconstructed concentration at the Arkansas River at Las Animas gage. Figure 58 shows the comparison between the simulated and the historical concentration for the Arkansas River at Las Animas gage.

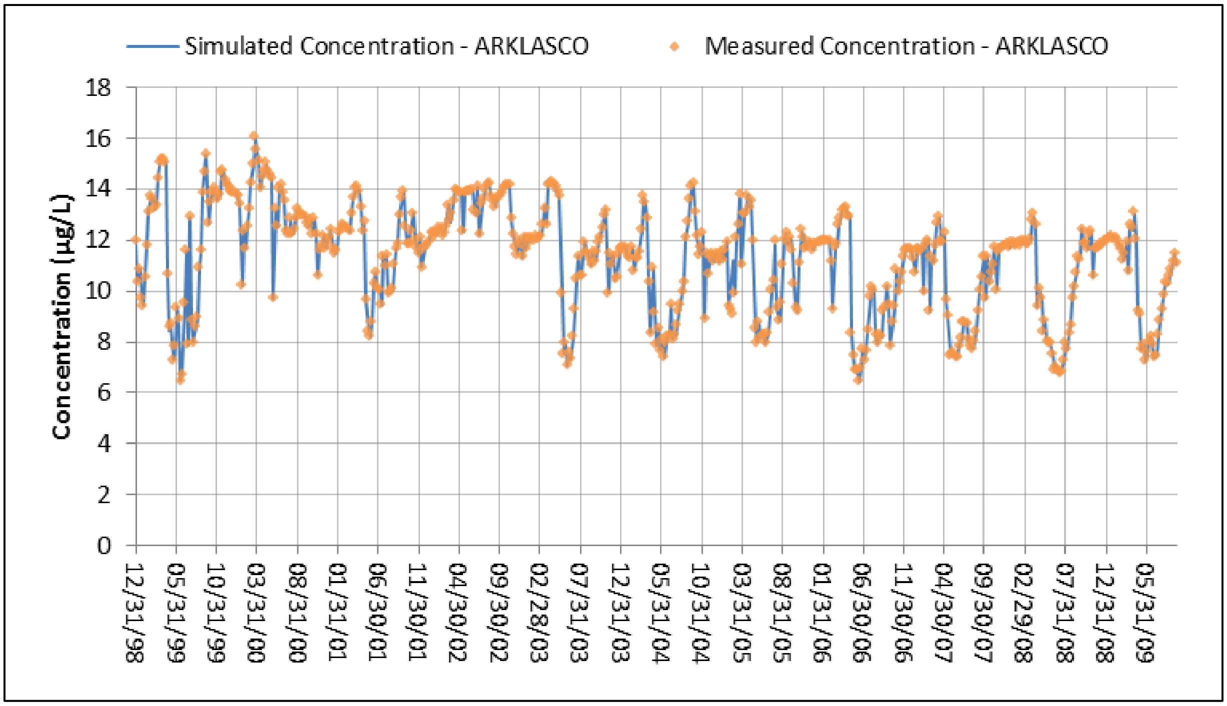


Figure 58. Comparison of Historical and Simulated Selenium Concentration for the Arkansas River at Las Animas Gage

Simulation of Alternatives

Changes in selenium loadings for the direct and cumulative effects scenarios were analyzed for the alternatives. The calibrated selenium model was used as the base for the simulation of the alternatives. Following a methodology similar to salinity, calibrated selenium concentrations of inflows without measured selenium were assumed to be representative of the sources of selenium while the inflows and outflows to each alternative for the direct and cumulative effects are based on the Daily Model simulated flows.

Changes in selenium loads to the system under each alternative were simulated according to the changes of flow simulated in the Daily Model and the calibrated concentrations (e.g., WWTF and agricultural return flows). Selenium loads were routed and mixed with other simulated selenium loads from upstream to downstream, allowing simulation of selenium concentration at the diversion and control points (gages).

According to the methodology adopted, changes in selenium loads from the WWTFs were assumed to change only due to changes in effluent flows and using calibrated concentrations at these locations for all cases. Based on the assumption that WWTF concentrations are the same in future conditions as historical, only effluent flow changes affect the simulated changes in selenium loadings from the WWTF. None of the alternatives is expected to significantly affect the selenium concentration of the WWTFs effluent relative to other alternatives; therefore, it is believed that this approach is appropriate to evaluate the selenium effects in this study.

Similarly, changes in selenium loadings from agricultural return flows in this analysis are based on the simulated changes in flows due to changes in agricultural irrigation in the analysis area.

The underlying assumption in this methodology is that the calibrated concentration of this selenium source remains unchanged for the different alternatives, which is considered an appropriate assumption for the relative comparison of alternatives performed in this section.

Direct Effects Analysis A comparative analysis with the No Action Alternative and Existing Condition was performed to estimate the changes in selenium concentration under each alternative. The results are summarized comparing the statistics of the simulated concentration and the relative changes of the statistics for the control points in the study area. Monthly statistics of the simulated concentration for the different alternatives and their percent change with respect to No Action and existing conditions for the direct effect analysis is also presented to observe the temporal changes in selenium under each alternative. Table 46 shows a summary of direct and indirect selenium effects in the Arkansas River and Fountain Creek.

Table 46. Summary of Direct and Indirect Selenium Effects

Gage	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Mean Concentration (µg/L)								
Arkansas River at Moffat St.	5.4	5.6	5.8	5.8	5.8	5.8	5.3	5.6
Arkansas River near Avondale	10.3	10.2	10.4	10.4	10.3	10.4	10.3	10.3
Arkansas River at Catlin Dam	10.0	10.0	10.1	10.1	10.0	10.1	10.0	10.0
Arkansas River at Las Animas	11.2	11.1	11.1	11.1	11.1	11.2	11.1	11.1
Fountain Creek at Pueblo	12.4	11.6	11.7	11.7	11.6	11.7	11.7	11.7
85th Percentile Concentration (µg/L)								
Arkansas River at Moffat St.	6.8	7.2	7.5	7.6	7.5	7.5	7.1	7.3
Arkansas River near Avondale	14.2	14.0	14.4	14.4	14.2	14.3	14.2	14.1
Arkansas River at Catlin Dam	13.9	13.8	14.0	14.0	14.0	14.1	14.0	14.0
Arkansas River at Las Animas	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
Fountain Creek at Pueblo	18.4	16.4	16.6	16.6	16.3	16.6	16.6	16.7

Table 47 and Table 48 show the statistics and relative change with respect to the No Action Alternative and the existing conditions for the Arkansas River at Moffat St. gage. All alternatives, except River South and Master Contract Only, would have minor adverse effects on selenium, compared to the No Action. Monthly changes in concentration would have the largest percent changes in January to March, August and September. The River South and Master Contract Only alternatives would have negligible effects because AVC participant supplies would not bypass this gage for these alternatives. All alternatives would increase selenium concentrations, compared to existing conditions.

Table 47. Simulated Selenium Concentration Comparison for Arkansas River at Moffat St. Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	5.4	5.6	5.8	5.8	5.8	5.8	5.3	5.6
15th percentile	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
25th percentile	3.5	3.5	3.6	3.6	3.5	3.5	3.5	3.5
50th percentile	4.4	4.5	4.5	4.5	4.5	4.5	4.4	4.5
75th percentile	5.8	6.1	6.5	6.5	6.4	6.5	5.9	6.2
85th percentile	6.8	7.2	7.5	7.6	7.5	7.5	7.1	7.3
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0.2 (3.6)	0.2 (3.6)	0.2 (3.6)	0.2 (3.6)	-0.3 (-5.4)	0.0 (0.0)
15th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
25th percentile	---	---	0.1 (2.9)	0.1 (2.9)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
50th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	-0.1 (-2.2)	0.0 (0.0)
75th percentile	---	---	0.4 (6.6)	0.4 (6.6)	0.3 (4.9)	0.4 (6.6)	-0.2 (-3.3)	0.1 (1.6)
85th percentile	---	---	0.3 (4.2)	0.4 (5.6)	0.3 (4.2)	0.3 (4.2)	-0.1 (-1.4)	0.1 (1.4)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	0.2 (3.7)	0.4 (7.4)	0.4 (7.4)	0.4 (7.4)	0.4 (7.4)	-0.1 (-1.9)	0.2 (3.7)
15th percentile	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
25th percentile	---	0.0 (0.0)	0.1 (2.9)	0.1 (2.9)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
50th percentile	---	0.1 (2.3)	0.1 (2.3)	0.1 (2.3)	0.1 (2.3)	0.1 (2.3)	0.0 (0.0)	0.1 (2.3)
75th percentile	---	0.3 (5.2)	0.7 (12.1)	0.7 (12.1)	0.6 (10.3)	0.7 (12.1)	0.1 (1.7)	0.4 (6.9)
85th percentile	---	0.4 (5.9)	0.7 (10.3)	0.8 (11.8)	0.7 (10.3)	0.7 (10.3)	0.3 (4.4)	0.5 (7.4)

Table 48. Direct Effects Monthly Simulated Selenium Concentration for Arkansas River at Moffat St. Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	6.5	6.7	7.1	7.1	7.0	7.1	6.4	6.8
Feb	7.4	7.7	8.1	8.1	8.1	8.1	6.9	7.7
Mar	5.0	5.1	5.3	5.3	5.3	5.3	5.0	5.2
Apr	4.7	4.9	4.9	5.0	5.0	4.9	4.8	4.8
May	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Jun	3.7	3.8	3.8	3.8	3.8	3.8	3.7	3.8
Jul	3.6	3.7	3.8	3.8	3.8	3.8	3.5	3.7
Aug	4.8	5.1	5.4	5.4	5.4	5.4	4.4	5.1
Sep	6.0	6.3	6.7	6.7	6.7	6.7	5.6	6.3
Oct	5.4	5.8	6.1	6.1	6.0	6.1	5.7	5.9
Nov	6.3	6.6	6.8	6.8	6.8	6.8	6.2	6.6
Dec	6.9	7.3	7.5	7.6	7.5	7.5	6.9	7.3
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.4 (5.5)	0.4 (5.6)	0.3 (4.4)	0.4 (5.5)	-0.3 (-4.3)	0.1 (1.1)
Feb	---	---	0.4 (4.9)	0.4 (5.2)	0.4 (5.4)	0.4 (4.9)	-0.8 (-10.2)	0 (0.1)
Mar	---	---	0.2 (3.5)	0.2 (3.7)	0.2 (3.6)	0.2 (3.4)	-0.1 (-3.4)	0.1 (0.7)
Apr	---	---	0 (1.6)	0.1 (1.8)	0.1 (3.7)	0 (1.5)	-0.1 (-0.7)	-0.1 (-0.7)
May	---	---	0 (0.7)	0 (0.7)	0 (0.5)	0 (0.7)	0 (0.2)	0 (0.4)
Jun	---	---	0 (0.6)	0 (0.6)	0 (0.5)	0 (0.5)	-0.1 (-1.2)	0 (0.0)
Jul	---	---	0.1 (2.4)	0.1 (2.3)	0.1 (2.0)	0.1 (2.4)	-0.2 (-6.1)	0 (0.0)
Aug	---	---	0.3 (5.6)	0.3 (5.5)	0.3 (5.4)	0.3 (5.2)	-0.7 (-14.4)	0 (0.8)
Sep	---	---	0.4 (6.9)	0.4 (7.2)	0.4 (6.2)	0.4 (7.1)	-0.7 (-10.8)	0 (-0.3)
Oct	---	---	0.3 (5.1)	0.3 (5.1)	0.2 (2.6)	0.3 (5.1)	-0.1 (-1.8)	0.1 (1.9)
Nov	---	---	0.2 (2.9)	0.2 (2.9)	0.2 (2.9)	0.2 (2.9)	-0.4 (-6.0)	0 (-0.8)
Dec	---	---	0.2 (3.9)	0.3 (4.0)	0.2 (3.5)	0.2 (3.9)	-0.4 (-5.5)	0 (0.3)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	0.2 (3.0)	0.6 (8.7)	0.6 (8.7)	0.5 (7.6)	0.6 (8.7)	-0.1 (-1.4)	0.3 (4.1)
Feb	---	0.3 (4.2)	0.7 (9.3)	0.7 (9.6)	0.7 (9.8)	0.7 (9.3)	-0.5 (-6.5)	0.3 (4.2)
Mar	---	0.1 (3.3)	0.3 (6.9)	0.3 (7.1)	0.3 (7.0)	0.3 (6.8)	0 (-0.2)	0.2 (4.0)
Apr	---	0.2 (2.5)	0.2 (4.2)	0.3 (4.3)	0.3 (6.3)	0.2 (4.1)	0.1 (1.8)	0.1 (1.8)
May	---	0 (1.3)	0 (2.0)	0 (2.0)	0 (1.8)	0 (2.0)	0 (1.4)	0 (1.7)
Jun	---	0.1 (1.2)	0.1 (1.8)	0.1 (1.8)	0.1 (1.8)	0.1 (1.8)	0 (0.0)	0.1 (1.3)
Jul	---	0.1 (2.8)	0.2 (5.2)	0.2 (5.2)	0.2 (4.8)	0.2 (5.2)	-0.1 (-3.4)	0.1 (2.8)
Aug	---	0.3 (5.2)	0.6 (11.0)	0.6 (10.9)	0.6 (10.9)	0.6 (10.7)	-0.4 (-10.0)	0.3 (6.0)
Sep	---	0.3 (5.6)	0.7 (12.8)	0.7 (13.2)	0.7 (12.1)	0.7 (13.1)	-0.4 (-5.8)	0.3 (5.2)
Oct	---	0.4 (7.9)	0.7 (13.4)	0.7 (13.4)	0.6 (10.8)	0.7 (13.4)	0.3 (5.9)	0.5 (10.0)
Nov	---	0.3 (5.4)	0.5 (8.4)	0.5 (8.4)	0.5 (8.5)	0.5 (8.4)	-0.1 (-1.0)	0.3 (4.5)
Dec	---	0.4 (5.4)	0.6 (9.5)	0.7 (9.6)	0.6 (9.1)	0.6 (9.5)	0 (-0.4)	0.4 (5.8)

Table 49 and Table 50 show the statistics summary for the simulated selenium concentrations at Arkansas River near Avondale gage. All alternatives would have negligible effects on selenium, compared to the No Action, as effects are around 2 percent or less. Monthly simulated concentration effects have the greatest percent changes in January, March, and October. All alternatives would not substantially change selenium concentrations, compared to existing conditions.

Table 49. Simulated Selenium Concentration Comparison for Arkansas River near Avondale Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	10.3	10.2	10.4	10.4	10.3	10.4	10.3	10.3
15th percentile	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
25th percentile	7.3	7.4	7.4	7.4	7.4	7.4	7.4	7.4
50th percentile	10.1	10.4	10.5	10.5	10.4	10.5	10.4	10.4
75th percentile	13.3	13.1	13.4	13.4	13.3	13.4	13.3	13.3
85th percentile	14.2	14.0	14.4	14.4	14.2	14.3	14.2	14.1
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0.2 (2.0)	0.2 (2.0)	0.1 (1.0)	0.2 (2.0)	0.1 (1.0)	0.1 (1.0)
15th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
25th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
50th percentile	---	---	0.1 (1.0)	0.1 (1.0)	0.0 (0.0)	0.1 (1.0)	0.0 (0.0)	0.0 (0.0)
75th percentile	---	---	0.3 (2.3)	0.3 (2.3)	0.2 (1.5)	0.3 (2.3)	0.2 (1.5)	0.2 (1.5)
85th percentile	---	---	0.4 (2.9)	0.4 (2.9)	0.2 (1.4)	0.3 (2.1)	0.2 (1.4)	0.1 (0.7)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	-0.1 (-1.0)	0.1 (1.0)	0.1 (1.0)	0.0 (0.0)	0.1 (1.0)	0.0 (0.0)	0.0 (0.0)
15th percentile	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
25th percentile	---	0.1 (1.4)	0.1 (1.4)	0.1 (1.4)	0.1 (1.4)	0.1 (1.4)	0.1 (1.4)	0.1 (1.4)
50th percentile	---	0.3 (3.0)	0.4 (4.0)	0.4 (4.0)	0.3 (3.0)	0.4 (4.0)	0.3 (3.0)	0.3 (3.0)
75th percentile	---	-0.2 (-1.5)	0.1 (0.8)	0.1 (0.8)	0.0 (0.0)	0.1 (0.8)	0.0 (0.0)	0.0 (0.0)
85th percentile	---	-0.2 (-1.4)	0.2 (1.4)	0.2 (1.4)	0.0 (0.0)	0.1 (0.7)	0.0 (0.0)	-0.1 (-0.7)

Table 50. Direct Effects Monthly Simulated Selenium Concentration for Arkansas River near Avondale Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	13.2	12.9	13.3	13.3	13.1	13.3	13.1	13.2
Feb	14.6	14.3	14.5	14.5	14.4	14.5	14.4	14.4
Mar	11.8	11.8	12.1	12.1	12.0	12.1	12.0	12.0
Apr	9.4	9.6	9.8	9.8	9.7	9.8	9.8	9.8
May	7.3	7.3	7.4	7.4	7.4	7.4	7.4	7.4
Jun	5.6	5.6	5.7	5.7	5.7	5.7	5.6	5.6
Jul	5.9	6.1	6.2	6.2	6.1	6.2	6.0	6.1
Aug	8.3	8.2	8.3	8.3	8.2	8.3	8.2	8.2
Sep	10.6	10.7	10.8	10.8	10.7	10.8	10.5	10.6
Oct	11.7	11.8	12.1	12.1	11.9	12.1	12.1	12.0
Nov	12.4	12.4	12.5	12.5	12.5	12.5	12.4	12.4
Dec	13.5	13.2	13.3	13.4	13.2	13.3	13.2	13.2
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.4 (2.9)	0.4 (3.0)	0.2 (1.0)	0.4 (2.9)	0.2 (1.1)	0.3 (2.2)
Feb	---	---	0.2 (1.0)	0.2 (1.0)	0.1 (0.7)	0.2 (1.0)	0.1 (0.2)	0.1 (0.5)
Mar	---	---	0.3 (3.1)	0.3 (3.3)	0.2 (1.6)	0.3 (2.9)	0.2 (2.3)	0.2 (2.1)
Apr	---	---	0.2 (1.7)	0.2 (1.7)	0.1 (0.6)	0.2 (1.7)	0.2 (2.0)	0.2 (1.5)
May	---	---	0.1 (1.1)	0.1 (1.1)	0.1 (0.5)	0.1 (1.1)	0.1 (1.1)	0.1 (0.7)
Jun	---	---	0.1 (0.9)	0.1 (0.9)	0.1 (0.7)	0.1 (0.9)	0 (-0.1)	0 (0.2)
Jul	---	---	0.1 (2.0)	0.1 (1.6)	0 (1.2)	0.1 (2.0)	-0.1 (-0.9)	0 (0.8)
Aug	---	---	0.1 (1.4)	0.1 (1.5)	0 (0.2)	0.1 (1.5)	0 (-0.5)	0 (0.4)
Sep	---	---	0.1 (1.3)	0.1 (1.3)	0 (0.8)	0.1 (1.3)	-0.2 (-1.1)	-0.1 (-0.1)
Oct	---	---	0.3 (2.7)	0.3 (2.6)	0.1 (1.1)	0.3 (2.7)	0.3 (2.6)	0.2 (2.0)
Nov	---	---	0.1 (0.8)	0.1 (0.8)	0.1 (0.9)	0.1 (0.8)	0 (-0.5)	0 (-0.4)
Dec	---	---	0.1 (1.4)	0.2 (1.4)	0 (0.6)	0.1 (1.4)	0 (0.2)	0 (0.4)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	-0.3 (-1.8)	0.1 (1.1)	0.1 (1.2)	-0.1 (-0.8)	0.1 (1.1)	-0.1 (-0.7)	0 (0.3)
Feb	---	-0.3 (-1.7)	-0.1 (-0.8)	-0.1 (-0.7)	-0.2 (-1.0)	-0.1 (-0.8)	-0.2 (-1.5)	-0.2 (-1.2)
Mar	---	0 (0.0)	0.3 (3.1)	0.3 (3.3)	0.2 (1.6)	0.3 (2.9)	0.2 (2.3)	0.2 (2.1)
Apr	---	0.2 (2.4)	0.4 (4.1)	0.4 (4.1)	0.3 (2.9)	0.4 (4.1)	0.4 (4.5)	0.4 (3.9)
May	---	0 (0.3)	0.1 (1.4)	0.1 (1.4)	0.1 (0.8)	0.1 (1.4)	0.1 (1.4)	0.1 (1.0)
Jun	---	0 (-0.2)	0.1 (0.7)	0.1 (0.8)	0.1 (0.5)	0.1 (0.7)	0 (-0.3)	0 (0.0)
Jul	---	0.2 (2.2)	0.3 (4.2)	0.3 (3.8)	0.2 (3.4)	0.3 (4.2)	0.1 (1.3)	0.2 (3.0)
Aug	---	-0.1 (-0.6)	0 (0.8)	0 (0.8)	-0.1 (-0.4)	0 (0.8)	-0.1 (-1.1)	-0.1 (-0.2)
Sep	---	0.1 (0.7)	0.2 (2.0)	0.2 (2.0)	0.1 (1.5)	0.2 (2.0)	-0.1 (-0.4)	0 (0.6)
Oct	---	0.1 (0.4)	0.4 (3.1)	0.4 (3.0)	0.2 (1.5)	0.4 (3.1)	0.4 (3.1)	0.3 (2.5)
Nov	---	0 (0.1)	0.1 (0.8)	0.1 (0.8)	0.1 (0.9)	0.1 (0.8)	0 (-0.5)	0 (-0.3)
Dec	---	-0.3 (-2.2)	-0.2 (-0.8)	-0.1 (-0.8)	-0.3 (-1.6)	-0.2 (-0.8)	-0.3 (-2.0)	-0.3 (-1.8)

Table 51 and Table 52 show the statistics summary for the simulated selenium concentrations at Arkansas River at Catlin Dam gage. All alternatives would have negligible effects on selenium, compared to the No Action, as changes are around 2 percent or less. The Arkansas River at Catlin Dam gage concentrations in August and September would slightly increase with respect to the No Action Alternative, except for the River South, which would decrease. All alternatives would not substantially change selenium concentrations, compared to existing conditions.

Table 51. Simulated Selenium Concentration Comparison for Arkansas River at Catlin Dam Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	10.0	10.0	10.1	10.1	10.0	10.1	10.0	10.0
15th percentile	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
25th percentile	7.1	7.2	7.2	7.2	7.1	7.2	7.2	7.2
50th percentile	9.8	9.8	10.0	10.0	9.9	10.0	9.9	10.0
75th percentile	12.5	12.4	12.6	12.7	12.6	12.7	12.5	12.6
85th percentile	13.9	13.8	14.0	14.0	14.0	14.1	14.0	14.0
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0.1 (1.0)	0.1 (1.0)	0.0 (0.0)	0.1 (1.0)	0.0 (0.0)	0.0 (0.0)
15th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
25th percentile	---	---	0.0 (0.0)	0.0 (0.0)	-0.1 (-1.4)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
50th percentile	---	---	0.2 (2.0)	0.2 (2.0)	0.1 (1.0)	0.2 (2.0)	0.1 (1.0)	0.2 (2.0)
75th percentile	---	---	0.2 (1.6)	0.3 (2.4)	0.2 (1.6)	0.3 (2.4)	0.1 (0.8)	0.2 (1.6)
85th percentile	---	---	0.2 (1.4)	0.2 (1.4)	0.2 (1.4)	0.3 (2.2)	0.2 (1.4)	0.2 (1.4)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	0.0 (0.0)	0.1 (1.0)	0.1 (1.0)	0.0 (0.0)	0.1 (1.0)	0.0 (0.0)	0.0 (0.0)
15th percentile	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
25th percentile	---	0.1 (1.4)	0.1 (1.4)	0.1 (1.4)	0.0 (0.0)	0.1 (1.4)	0.1 (1.4)	0.1 (1.4)
50th percentile	---	0.0 (0.0)	0.2 (2.0)	0.2 (2.0)	0.1 (1.0)	0.2 (2.0)	0.1 (1.0)	0.2 (2.0)
75th percentile	---	-0.1 (-0.8)	0.1 (0.8)	0.2 (1.6)	0.1 (0.8)	0.2 (1.6)	0.0 (0.0)	0.1 (0.8)
85th percentile	---	-0.1 (-0.7)	0.1 (0.7)	0.1 (0.7)	0.1 (0.7)	0.2 (1.4)	0.1 (0.7)	0.1 (0.7)

Table 52. Direct Effects Monthly Simulated Selenium Concentration for Arkansas River at Catlin Dam Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	13.1	13.0	13.3	13.3	13.1	13.3	13.1	13.2
Feb	14.6	14.4	14.6	14.6	14.5	14.6	14.5	14.5
Mar	10.8	10.6	10.7	10.7	10.8	10.7	10.7	10.7
Apr	9.0	9.1	9.2	9.2	9.1	9.2	9.2	9.2
May	7.0	7.0	7.1	7.1	7.0	7.1	7.0	7.0
Jun	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
Jul	6.4	6.5	6.6	6.5	6.5	6.6	6.4	6.6
Aug	8.3	8.2	8.3	8.3	8.2	8.3	8.2	8.2
Sep	10.6	10.6	10.7	10.7	10.7	10.7	10.5	10.6
Oct	11.0	11.0	11.3	11.3	11.1	11.3	11.3	11.3
Nov	11.6	11.6	11.7	11.7	11.7	11.7	11.6	11.6
Dec	12.8	12.6	12.8	12.8	12.7	12.8	12.6	12.7
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.3 (2.4)	0.3 (2.4)	0.1 (1.1)	0.3 (2.3)	0.1 (1.0)	0.2 (1.6)
Feb	---	---	0.2 (1.6)	0.2 (1.4)	0.1 (0.8)	0.2 (1.6)	0.1 (0.6)	0.1 (0.9)
Mar	---	---	0.1 (1.6)	0.1 (1.7)	0.2 (2.2)	0.1 (1.5)	0.1 (1.1)	0.1 (1.2)
Apr	---	---	0.1 (1.1)	0.1 (1.1)	0 (0.3)	0.1 (1.1)	0.1 (1.5)	0.1 (1.3)
May	---	---	0.1 (0.9)	0.1 (0.8)	0 (0.2)	0.1 (0.9)	0 (0.8)	0 (0.6)
Jun	---	---	0 (0.7)	0 (0.7)	0 (0.5)	0 (0.7)	0 (-0.1)	0 (0.3)
Jul	---	---	0.1 (1.6)	0 (1.1)	0 (0.7)	0.1 (1.8)	-0.1 (-0.5)	0.1 (1.2)
Aug	---	---	0.1 (0.4)	0.1 (0.4)	0 (-0.1)	0.1 (0.4)	0 (-0.9)	0 (-0.2)
Sep	---	---	0.1 (0.5)	0.1 (0.5)	0.1 (0.4)	0.1 (0.6)	-0.1 (-1.2)	0 (0.0)
Oct	---	---	0.3 (2.4)	0.3 (2.3)	0.1 (0.6)	0.3 (2.4)	0.3 (2.2)	0.3 (1.9)
Nov	---	---	0.1 (0.6)	0.1 (0.6)	0.1 (0.6)	0.1 (0.6)	0 (-0.3)	0 (0.0)
Dec	---	---	0.2 (1.1)	0.2 (1.1)	0.1 (0.5)	0.2 (1.1)	0 (0.1)	0.1 (0.3)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	-0.1 (-1.1)	0.2 (1.2)	0.2 (1.3)	0 (-0.1)	0.2 (1.2)	0 (-0.2)	0.1 (0.4)
Feb	---	-0.2 (-1.3)	0 (0.3)	0 (0.1)	-0.1 (-0.5)	0 (0.3)	-0.1 (-0.7)	-0.1 (-0.4)
Mar	---	-0.2 (-2.1)	-0.1 (-0.5)	-0.1 (-0.4)	0 (0.1)	-0.1 (-0.6)	-0.1 (-1.0)	-0.1 (-0.8)
Apr	---	0.1 (0.9)	0.2 (1.9)	0.2 (2.0)	0.1 (1.2)	0.2 (2.0)	0.2 (2.4)	0.2 (2.2)
May	---	0 (0.1)	0.1 (1.0)	0.1 (0.9)	0 (0.3)	0.1 (1.0)	0 (0.9)	0 (0.7)
Jun	---	0 (-0.2)	0 (0.5)	0 (0.5)	0 (0.3)	0 (0.5)	0 (-0.3)	0 (0.0)
Jul	---	0.1 (1.7)	0.2 (3.4)	0.1 (2.8)	0.1 (2.4)	0.2 (3.5)	0 (1.3)	0.2 (3.0)
Aug	---	-0.1 (-0.2)	0 (0.1)	0 (0.2)	-0.1 (-0.3)	0 (0.1)	-0.1 (-1.1)	-0.1 (-0.4)
Sep	---	0 (0.6)	0.1 (1.1)	0.1 (1.1)	0.1 (1.0)	0.1 (1.1)	-0.1 (-0.6)	0 (0.6)
Oct	---	0 (0.4)	0.3 (2.8)	0.3 (2.7)	0.1 (0.9)	0.3 (2.7)	0.3 (2.6)	0.3 (2.3)
Nov	---	0 (0.1)	0.1 (0.8)	0.1 (0.8)	0.1 (0.8)	0.1 (0.8)	0 (-0.2)	0 (0.1)
Dec	---	-0.2 (-1.7)	0 (-0.6)	0 (-0.6)	-0.1 (-1.2)	0 (-0.7)	-0.2 (-1.6)	-0.1 (-1.4)

Table 53 and Table 54 show the statistics summary for the simulated selenium concentrations at Arkansas River at Las Animas gage. All alternatives would have negligible effects on selenium, compared to the No Action. All alternatives would not substantially change selenium concentrations, compared to existing conditions.

Table 53. Simulated Selenium Concentration Comparison for Arkansas River at Las Animas Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (μg/L)								
Mean	11.2	11.1	11.1	11.1	11.1	11.2	11.1	11.1
15^{th} percentile	8.4	8.3	8.4	8.4	8.3	8.4	8.3	8.3
25^{th} percentile	9.7	9.7	9.6	9.6	9.7	9.6	9.6	9.6
50^{th} percentile	11.7	11.6	11.7	11.7	11.6	11.7	11.6	11.7
75^{th} percentile	12.6	12.5	12.5	12.5	12.5	12.5	12.5	12.5
85^{th} percentile	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
Change in Concentration Compared to No Action Alternative [μg/L (%)]								
Mean	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (0.9)	0.0 (0.0)	0.0 (0.0)
15^{th} percentile	---	---	0.1 (1.2)	0.1 (1.2)	0.0 (0.0)	0.1 (1.2)	0.0 (0.0)	0.0 (0.0)
25^{th} percentile	---	---	-0.1 (-1.0)	-0.1 (-1.0)	0.0 (0.0)	-0.1 (-1.0)	-0.1 (-1.0)	-0.1 (-1.0)
50^{th} percentile	---	---	0.1 (0.9)	0.1 (0.9)	0.0 (0.0)	0.1 (0.9)	0.0 (0.0)	0.1 (0.9)
75^{th} percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
85^{th} percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Change in Concentration Compared to Existing Conditions [μg/L (%)]								
Mean	---	-0.1 (-0.9)	-0.1 (-0.9)	-0.1 (-0.9)	-0.1 (-0.9)	0.0 (0.0)	-0.1 (-0.9)	-0.1 (-0.9)
15^{th} percentile	---	-0.1 (-1.2)	0.0 (0.0)	0.0 (0.0)	-0.1 (-1.2)	0.0 (0.0)	-0.1 (-1.2)	-0.1 (-1.2)
25^{th} percentile	---	0.0 (0.0)	-0.1 (-1.0)	-0.1 (-1.0)	0.0 (0.0)	-0.1 (-1.0)	-0.1 (-1.0)	-0.1 (-1.0)
50^{th} percentile	---	-0.1 (-0.9)	0.0 (0.0)	0.0 (0.0)	-0.1 (-0.9)	0.0 (0.0)	-0.1 (-0.9)	0.0 (0.0)
75^{th} percentile	---	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)
85^{th} percentile	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)

Table 54. Direct Effects Monthly Simulated Selenium Concentration for Arkansas River at Las Animas Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	11.7	11.6	11.7	11.7	11.7	11.7	11.7	11.7
Feb	11.8	11.8	11.9	11.8	11.7	11.9	11.8	11.8
Mar	12.3	12.1	12.0	12.0	12.2	12.0	12.0	12.0
Apr	12.9	12.8	12.8	12.8	12.8	12.8	12.8	12.8
May	10.1	10.0	10.0	10.0	10.0	10.1	10.0	10.0
Jun	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
Jul	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
Aug	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1
Sep	11.8	11.7	11.7	11.7	11.7	11.7	11.7	11.7
Oct	11.8	11.8	11.9	11.9	11.9	11.9	11.9	11.9
Nov	11.7	11.7	11.8	11.8	11.8	11.8	11.7	11.7
Dec	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.1 (0.7)	0.1 (0.8)	0.1 (0.3)	0.1 (0.7)	0.1 (0.3)	0.1 (0.5)
Feb	---	---	0.1 (0.8)	0 (0.7)	-0.1 (-0.2)	0.1 (0.9)	0 (0.2)	0 (0.6)
Mar	---	---	-0.1 (-1.0)	-0.1 (-1.0)	0.1 (0.2)	-0.1 (-1.1)	-0.1 (-1.3)	-0.1 (-1.1)
Apr	---	---	0 (0.1)	0 (0.1)	0 (0.2)	0 (0.1)	0 (0.1)	0 (0.0)
May	---	---	0 (0.4)	0 (0.4)	0 (0.1)	0.1 (0.5)	0 (0.2)	0 (0.3)
Jun	---	---	0 (0.2)	0 (0.2)	0 (0.2)	0 (0.2)	0 (0.0)	0 (0.0)
Jul	---	---	0 (0.4)	0 (0.3)	0 (0.3)	0 (0.4)	0 (-0.2)	0 (0.2)
Aug	---	---	0 (0.2)	0 (0.3)	0 (0.1)	0 (0.2)	0 (0.0)	0 (0.0)
Sep	---	---	0 (-0.1)	0 (-0.1)	0 (-0.1)	0 (-0.1)	0 (-0.4)	0 (-0.1)
Oct	---	---	0.1 (0.5)	0.1 (0.4)	0.1 (0.1)	0.1 (0.5)	0.1 (0.4)	0.1 (0.2)
Nov	---	---	0.1 (0.0)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0 (-0.2)	0 (-0.1)
Dec	---	---	0 (0.4)	0 (0.3)	0 (0.2)	0 (0.3)	0 (0.1)	0 (0.2)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	-0.1 (-0.4)	0 (0.4)	0 (0.4)	0 (-0.1)	0 (0.4)	0 (0.0)	0 (0.2)
Feb	---	0 (-0.4)	0.1 (0.4)	0 (0.3)	-0.1 (-0.6)	0.1 (0.5)	0 (-0.2)	0 (0.2)
Mar	---	-0.2 (-1.5)	-0.3 (-2.6)	-0.3 (-2.6)	-0.1 (-1.4)	-0.3 (-2.6)	-0.3 (-2.8)	-0.3 (-2.6)
Apr	---	-0.1 (-0.9)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.9)
May	---	-0.1 (-1.2)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-1.1)	0 (-0.8)	-0.1 (-1.0)	-0.1 (-0.9)
Jun	---	0 (-0.7)	0 (-0.5)	0 (-0.5)	0 (-0.5)	0 (-0.5)	0 (-0.7)	0 (-0.7)
Jul	---	0 (-0.4)	0 (0.0)	0 (-0.1)	0 (-0.1)	0 (0.0)	0 (-0.6)	0 (-0.2)
Aug	---	0 (-0.5)	0 (-0.2)	0 (-0.2)	0 (-0.4)	0 (-0.2)	0 (-0.4)	0 (-0.5)
Sep	---	-0.1 (-0.1)	-0.1 (-0.2)	-0.1 (-0.2)	-0.1 (-0.2)	-0.1 (-0.2)	-0.1 (-0.5)	-0.1 (-0.2)
Oct	---	0 (0.0)	0.1 (0.4)	0.1 (0.4)	0.1 (0.0)	0.1 (0.4)	0.1 (0.3)	0.1 (0.2)
Nov	---	0 (0.4)	0.1 (0.5)	0.1 (0.5)	0.1 (0.5)	0.1 (0.5)	0 (0.2)	0 (0.3)
Dec	---	0 (-0.3)	0 (0.0)	0 (0.0)	0 (-0.1)	0 (0.0)	0 (-0.2)	0 (-0.1)

Table 55 and Table 56 show the statistics summary for the simulated selenium concentrations at Fountain Creek at Pueblo gage. All alternatives would have predominantly negligible effects on selenium, compared to the No Action, as effects are around 2 percent or less. The late winter and early spring months would have the largest percent changes in concentration. All alternatives would decrease selenium concentrations, compared to existing conditions.

Table 55. Simulated Selenium Concentration Comparison for Fountain Creek at Pueblo Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	12.4	11.6	11.7	11.7	11.6	11.7	11.7	11.7
15th percentile	7.3	7.5	7.5	7.5	7.5	7.5	7.5	7.5
25th percentile	8.4	8.3	8.4	8.4	8.3	8.4	8.4	8.5
50th percentile	11.5	10.6	10.7	10.7	10.6	10.7	10.7	10.7
75th percentile	16.1	14.8	14.7	14.8	14.8	14.7	14.6	14.8
85th percentile	18.4	16.4	16.6	16.6	16.3	16.6	16.6	16.7
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0.1 (0.9)	0.1 (0.9)	0.0 (0.0)	0.1 (0.9)	0.1 (0.9)	0.1 (0.9)
15th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
25th percentile	---	---	0.1 (1.2)	0.1 (1.2)	0.0 (0.0)	0.1 (1.2)	0.1 (1.2)	0.2 (2.4)
50th percentile	---	---	0.1 (0.9)	0.1 (0.9)	0.0 (0.0)	0.1 (0.9)	0.1 (0.9)	0.1 (0.9)
75th percentile	---	---	-0.1 (-0.7)	0.0 (0.0)	0.0 (0.0)	-0.1 (-0.7)	-0.2 (-1.4)	0.0 (0.0)
85th percentile	---	---	0.2 (1.2)	0.2 (1.2)	-0.1 (-0.6)	0.2 (1.2)	0.2 (1.2)	0.3 (1.8)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	-0.8 (-6.5)	-0.7 (-5.6)	-0.7 (-5.6)	-0.8 (-6.5)	-0.7 (-5.6)	-0.7 (-5.6)	-0.7 (-5.6)
15th percentile	---	0.2 (2.7)	0.2 (2.7)	0.2 (2.7)	0.2 (2.7)	0.2 (2.7)	0.2 (2.7)	0.2 (2.7)
25th percentile	---	-0.1 (-1.2)	0.0 (0.0)	0.0 (0.0)	-0.1 (-1.2)	0.0 (0.0)	0.0 (0.0)	0.1 (1.2)
50th percentile	---	-0.9 (-7.8)	-0.8 (-7.0)	-0.8 (-7.0)	-0.9 (-7.8)	-0.8 (-7.0)	-0.8 (-7.0)	-0.8 (-7.0)
75th percentile	---	-1.3 (-8.1)	-1.4 (-8.7)	-1.3 (-8.1)	-1.3 (-8.1)	-1.4 (-8.7)	-1.5 (-9.3)	-1.3 (-8.1)
85th percentile	---	-2.0 (-10.9)	-1.8 (-9.8)	-1.8 (-9.8)	-2.1 (-11.4)	-1.8 (-9.8)	-1.8 (-9.8)	-1.7 (-9.2)

Table 56. Direct Effects Monthly Simulated Selenium Concentration for Fountain Creek at Pueblo Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	14.2	13.3	13.6	13.5	13.2	13.5	13.2	13.6
Feb	14.2	13.3	13.5	13.5	13.3	13.5	13.5	13.5
Mar	12.5	11.6	11.8	11.8	11.7	11.8	11.8	11.9
Apr	10.8	11.0	10.8	10.8	10.9	10.8	11.0	11.0
May	9.4	9.1	9.4	9.4	9.2	9.4	9.4	9.3
Jun	10.1	9.6	9.7	9.7	9.6	9.7	9.7	9.7
Jul	9.3	9.4	9.4	9.4	9.4	9.4	9.4	9.4
Aug	10.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
Sep	10.3	9.9	9.7	9.7	9.8	9.7	9.5	9.9
Oct	16.0	14.5	14.7	14.7	14.7	14.7	14.7	14.7
Nov	15.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
Dec	17.1	15.0	15.1	15.1	14.9	15.1	15.1	15.1
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.3 (2.2)	0.2 (2.1)	-0.1 (-0.1)	0.2 (2.1)	-0.1 (-0.4)	0.3 (2.5)
Feb	---	---	0.2 (1.0)	0.2 (1.0)	0 (-0.1)	0.2 (1.0)	0.2 (1.0)	0.2 (1.3)
Mar	---	---	0.2 (1.6)	0.2 (1.4)	0.1 (0.6)	0.2 (1.2)	0.2 (1.7)	0.3 (2.1)
Apr	---	---	-0.2 (-1.3)	-0.2 (-1.5)	-0.1 (-0.4)	-0.2 (-1.4)	0 (-0.1)	0 (-0.1)
May	---	---	0.3 (2.7)	0.3 (2.7)	0.1 (1.1)	0.3 (2.7)	0.3 (2.8)	0.2 (2.0)
Jun	---	---	0.1 (0.5)	0.1 (0.5)	0 (0.0)	0.1 (0.5)	0.1 (0.6)	0.1 (0.5)
Jul	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.1)
Aug	---	---	0 (-0.2)	0 (-0.2)	0 (-0.3)	0 (-0.2)	0 (-0.2)	0 (0.1)
Sep	---	---	-0.2 (-2.0)	-0.2 (-2.0)	-0.1 (-1.7)	-0.2 (-2.0)	-0.4 (-4.2)	0 (-0.2)
Oct	---	---	0.2 (1.3)	0.2 (1.3)	0.2 (1.3)	0.2 (1.3)	0.2 (1.3)	0.2 (1.3)
Nov	---	---	0 (0.1)	0 (0.1)	0 (0.0)	0 (0.1)	0 (0.1)	0 (0.0)
Dec	---	---	0.1 (0.0)	0.1 (0.1)	-0.1 (-1.0)	0.1 (0.0)	0.1 (0.0)	0.1 (0.1)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	-0.9 (-6.5)	-0.6 (-4.5)	-0.7 (-4.5)	-1 (-6.7)	-0.7 (-4.5)	-1 (-6.9)	-0.6 (-4.2)
Feb	---	-0.9 (-6.5)	-0.7 (-5.5)	-0.7 (-5.6)	-0.9 (-6.6)	-0.7 (-5.5)	-0.7 (-5.5)	-0.7 (-5.3)
Mar	---	-0.9 (-6.5)	-0.7 (-5.0)	-0.7 (-5.2)	-0.8 (-5.9)	-0.7 (-5.4)	-0.7 (-5.0)	-0.6 (-4.5)
Apr	---	0.2 (1.3)	0 (0.0)	0 (-0.2)	0.1 (0.9)	0 (-0.1)	0.2 (1.2)	0.2 (1.2)
May	---	-0.3 (-2.7)	0 (-0.1)	0 (-0.1)	-0.2 (-1.7)	0 (-0.1)	0 (0.0)	-0.1 (-0.8)
Jun	---	-0.5 (-4.6)	-0.4 (-4.1)	-0.4 (-4.1)	-0.5 (-4.6)	-0.4 (-4.1)	-0.4 (-4.1)	-0.4 (-4.1)
Jul	---	0.1 (0.6)	0.1 (0.7)	0.1 (0.7)	0.1 (0.6)	0.1 (0.7)	0.1 (0.7)	0.1 (0.7)
Aug	---	-1 (-9.6)	-1 (-9.8)	-1 (-9.8)	-1 (-9.9)	-1 (-9.8)	-1 (-9.8)	-1 (-9.5)
Sep	---	-0.4 (-2.9)	-0.6 (-4.9)	-0.6 (-4.9)	-0.5 (-4.6)	-0.6 (-4.9)	-0.8 (-7.0)	-0.4 (-3.1)
Oct	---	-1.5 (-9.1)	-1.3 (-7.9)	-1.3 (-7.9)	-1.3 (-7.9)	-1.3 (-7.9)	-1.3 (-7.9)	-1.3 (-7.9)
Nov	---	-1 (-6.4)	-1 (-6.4)	-1 (-6.3)	-1 (-6.4)	-1 (-6.4)	-1 (-6.4)	-1 (-6.4)
Dec	---	-2.1 (-11.8)	-2 (-11.8)	-2 (-11.7)	-2.2 (-12.6)	-2 (-11.8)	-2 (-11.8)	-2 (-11.7)

Cumulative Effects Analysis A comparative analysis with the No Action Alternative and existing conditions was performed to estimate the changes in selenium under each alternative for the cumulative effects analysis. Cumulative effects simulation uses the results of the Daily Model, which reflects all the simulated operations under these conditions in the streamflows.

Selenium simulation results are summarized using the statistics of the simulated concentration and relative change between each alternative and the No Action and existing conditions for the control points in the study area. Additionally, results are also summarized in monthly statistics of the simulated concentration for the different alternatives, indicating the percent changes for the alternatives under the cumulative effects analysis.

Table 57 and Table 58 summarize results for the Arkansas River at Moffat St. gage. The Comanche North, Pueblo Dam South, and JUP North, and Pueblo Dan North alternatives would have mostly minor adverse effects. Monthly changes in selenium would have the largest percent changes in the months of January, February and July to October. The Pueblo Dam South Alternative would have a moderate adverse increase in the 85th percentile, compared to No Action. All alternatives would increase selenium concentrations in late summer and fall months, compared to existing conditions, because of decreases in streamflow.

Table 57. Cumulative Effects Simulated Selenium Concentration Comparison for Arkansas River at Moffat St. Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	5.4	6.1	6.3	6.3	6.3	6.3	5.7	6.1
15th percentile	3.2	3.3	3.3	3.3	3.3	3.3	3.3	3.3
25th percentile	3.5	3.6	3.6	3.6	3.6	3.6	3.6	3.6
50th percentile	4.4	4.5	4.5	4.5	4.5	4.5	4.5	4.5
75th percentile	5.8	6.8	7.1	7.1	7.1	7.1	6.4	6.8
85th percentile	6.8	8.1	8.9	9.0	8.7	8.9	7.9	8.2
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0.2 (3.3)	0.2 (3.3)	0.2 (3.3)	0.2 (3.3)	-0.4 (-6.6)	0.0 (0.0)
15th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
25th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
50th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
75th percentile	---	---	0.3 (4.4)	0.3 (4.4)	0.3 (4.4)	0.3 (4.4)	-0.4 (-5.9)	0.0 (0.0)
85th percentile	---	---	0.8 (9.9)	0.9 (11.1)	0.6 (7.4)	0.8 (9.9)	-0.2 (-2.5)	0.1 (1.2)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	0.7 (13.0)	0.9 (16.7)	0.9 (16.7)	0.9 (16.7)	0.9 (16.7)	0.3 (5.6)	0.7 (13.0)
15th percentile	---	0.1 (3.1)	0.1 (3.1)	0.1 (3.1)	0.1 (3.1)	0.1 (3.1)	0.1 (3.1)	0.1 (3.1)
25th percentile	---	0.1 (2.9)	0.1 (2.9)	0.1 (2.9)	0.1 (2.9)	0.1 (2.9)	0.1 (2.9)	0.1 (2.9)
50th percentile	---	0.1 (2.3)	0.1 (2.3)	0.1 (2.3)	0.1 (2.3)	0.1 (2.3)	0.1 (2.3)	0.1 (2.3)
75th percentile	---	1.0 (17.2)	1.3 (22.4)	1.3 (22.4)	1.3 (22.4)	1.3 (22.4)	0.6 (10.3)	1.0 (17.2)
85th percentile	---	1.3 (19.1)	2.1 (30.9)	2.2 (32.4)	1.9 (27.9)	2.1 (30.9)	1.1 (16.2)	1.4 (20.6)

Table 58. Cumulative Effects Monthly Simulated Selenium Concentration for Arkansas River at Moffat St. Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	6.5	7.0	7.3	7.3	7.3	7.3	6.6	7.0
Feb	7.4	7.4	7.8	7.8	7.8	7.8	6.7	7.4
Mar	5.0	5.4	5.5	5.5	5.5	5.5	5.1	5.3
Apr	4.7	5.2	5.4	5.4	5.3	5.4	5.2	5.2
May	4.6	5.2	5.3	5.3	5.3	5.3	5.1	5.3
Jun	3.7	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Jul	3.6	4.1	4.2	4.3	4.2	4.3	3.8	4.1
Aug	4.8	6.0	6.3	6.4	6.3	6.4	5.2	6.0
Sep	6.0	7.5	7.9	7.9	7.8	7.9	6.7	7.5
Oct	5.4	6.7	7.0	7.0	6.9	7.0	6.5	6.7
Nov	6.3	7.1	7.3	7.3	7.4	7.3	6.7	7.1
Dec	6.9	7.8	8.0	8.0	8.0	8.0	7.3	7.8
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.3 (4.4)	0.3 (4.5)	0.3 (4.1)	0.3 (4.4)	-0.4 (-5.6)	0 (0.2)
Feb	---	---	0.4 (6.1)	0.4 (6.1)	0.4 (5.8)	0.4 (6.1)	-0.7 (-10.0)	0 (0.3)
Mar	---	---	0.1 (2.7)	0.1 (3.0)	0.1 (2.7)	0.1 (2.8)	-0.3 (-5.2)	-0.1 (-0.2)
Apr	---	---	0.2 (3.2)	0.2 (3.1)	0.1 (2.0)	0.2 (3.0)	0 (-0.8)	0 (0.4)
May	---	---	0.1 (1.0)	0.1 (0.9)	0.1 (0.9)	0.1 (1.1)	-0.1 (-1.6)	0.1 (0.7)
Jun	---	---	0 (0.6)	0 (0.8)	0 (0.9)	0 (0.9)	0 (-1.2)	0 (-0.5)
Jul	---	---	0.1 (3.2)	0.2 (3.5)	0.1 (3.3)	0.2 (3.4)	-0.3 (-6.5)	0 (0.7)
Aug	---	---	0.3 (5.2)	0.4 (5.6)	0.3 (4.7)	0.4 (5.8)	-0.8 (-13.3)	0 (-0.1)
Sep	---	---	0.4 (5.6)	0.4 (5.5)	0.3 (5.1)	0.4 (5.6)	-0.8 (-9.7)	0 (0.0)
Oct	---	---	0.3 (4.8)	0.3 (4.8)	0.2 (3.1)	0.3 (4.9)	-0.2 (-2.9)	0 (0.7)
Nov	---	---	0.2 (2.6)	0.2 (2.6)	0.3 (3.4)	0.2 (2.6)	-0.4 (-5.4)	0 (0.1)
Dec	---	---	0.2 (3.2)	0.2 (3.1)	0.2 (3.1)	0.2 (3.1)	-0.5 (-5.9)	0 (-0.2)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	0.5 (7.8)	0.8 (12.5)	0.8 (12.6)	0.8 (12.2)	0.8 (12.6)	0.1 (1.8)	0.5 (8.0)
Feb	---	0 (-0.3)	0.4 (5.8)	0.4 (5.8)	0.4 (5.5)	0.4 (5.8)	-0.7 (-10.3)	0 (0.0)
Mar	---	0.4 (7.4)	0.5 (10.3)	0.5 (10.7)	0.5 (10.3)	0.5 (10.4)	0.1 (1.8)	0.3 (7.2)
Apr	---	0.5 (9.6)	0.7 (13.1)	0.7 (13.0)	0.6 (11.8)	0.7 (13.0)	0.5 (8.8)	0.5 (10.1)
May	---	0.6 (14.7)	0.7 (15.8)	0.7 (15.7)	0.7 (15.8)	0.7 (15.9)	0.5 (12.8)	0.7 (15.5)
Jun	---	0.3 (8.1)	0.3 (8.7)	0.3 (8.9)	0.3 (9.0)	0.3 (9.0)	0.3 (6.8)	0.3 (7.5)
Jul	---	0.5 (14.3)	0.6 (17.9)	0.7 (18.3)	0.6 (18.1)	0.7 (18.2)	0.2 (6.9)	0.5 (15.1)
Aug	---	1.2 (24.6)	1.5 (31.1)	1.6 (31.6)	1.5 (30.5)	1.6 (31.8)	0.4 (8.0)	1.2 (24.4)
Sep	---	1.5 (25.3)	1.9 (32.4)	1.9 (32.2)	1.8 (31.7)	1.9 (32.3)	0.7 (13.2)	1.5 (25.3)
Oct	---	1.3 (23.8)	1.6 (29.7)	1.6 (29.7)	1.5 (27.6)	1.6 (29.8)	1.1 (20.1)	1.3 (24.7)
Nov	---	0.8 (13.0)	1 (15.9)	1 (15.9)	1.1 (16.9)	1 (16.0)	0.4 (6.9)	0.8 (13.2)
Dec	---	0.9 (12.6)	1.1 (16.2)	1.1 (16.2)	1.1 (16.2)	1.1 (16.2)	0.4 (5.9)	0.9 (12.4)

Table 59 and Table 60 show selenium modeling results for the Arkansas River near Avondale gage. All alternatives would have negligible effects on selenium, compared to No Action, as effects are around 2 percent or less. Simulated concentration at the Arkansas River near Avondale gage for the alternatives compared with No Action would have a relatively small percent change with the largest increase in concentration during July and August, except for the River South Alternative, which would slightly decrease in January, February, July and August. All alternatives would increase selenium concentrations in late spring months, compared to existing conditions because of streamflow changes.

Table 59. Cumulative Effects Simulated Selenium Concentration Comparison for Arkansas River near Avondale Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	10.3	10.4	10.5	10.4	10.5	10.4	10.5	10.4
15th percentile	6.0	6.7	6.9	6.9	6.9	6.8	6.8	6.8
25th percentile	7.3	8.3	8.4	8.4	8.4	8.4	8.4	8.4
50th percentile	10.1	10.6	10.7	10.6	10.7	10.6	10.6	10.6
75th percentile	13.3	12.7	12.8	12.8	12.8	12.7	12.8	12.7
85th percentile	14.2	13.5	13.5	13.5	13.5	13.5	13.5	13.5
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0.1 (1.0)	0.0 (0.0)	0.1 (1.0)	0.0 (0.0)	0.1 (1.0)	0.0 (0.0)
15th percentile	---	---	0.2 (3.0)	0.2 (3.0)	0.2 (3.0)	0.1 (1.5)	0.1 (1.5)	0.1 (1.5)
25th percentile	---	---	0.1 (1.2)	0.1 (1.2)	0.1 (1.2)	0.1 (1.2)	0.1 (1.2)	0.1 (1.2)
50th percentile	---	---	0.1 (0.9)	0.0 (0.0)	0.1 (0.9)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
75th percentile	---	---	0.1 (0.8)	0.1 (0.8)	0.1 (0.8)	0.0 (0.0)	0.1 (0.8)	0.0 (0.0)
85th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	0.1 (1.0)	0.2 (1.9)	0.1 (1.0)	0.2 (1.9)	0.1 (1.0)	0.2 (1.9)	0.1 (1.0)
15th percentile	---	0.7 (11.7)	0.9 (15.0)	0.9 (15.0)	0.9 (15.0)	0.8 (13.3)	0.8 (13.3)	0.8 (13.3)
25th percentile	---	1.0 (13.7)	1.1 (15.1)	1.1 (15.1)	1.1 (15.1)	1.1 (15.1)	1.1 (15.1)	1.1 (15.1)
50th percentile	---	0.5 (5.0)	0.6 (5.9)	0.5 (5.0)	0.6 (5.9)	0.5 (5.0)	0.5 (5.0)	0.5 (5.0)
75th percentile	---	-0.6 (-4.5)	-0.5 (-3.8)	-0.5 (-3.8)	-0.5 (-3.8)	-0.6 (-4.5)	-0.5 (-3.8)	-0.6 (-4.5)
85th percentile	---	-0.7 (-4.9)	-0.7 (-4.9)	-0.7 (-4.9)	-0.7 (-4.9)	-0.7 (-4.9)	-0.7 (-4.9)	-0.7 (-4.9)

Table 60. Cumulative Effects Monthly Simulated Selenium Concentration for Arkansas River near Avondale Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	13.2	12.3	12.4	12.4	12.4	12.4	12.3	12.3
Feb	14.6	12.9	13.0	13.0	13.0	13.0	12.8	12.9
Mar	11.8	11.5	11.5	11.5	11.5	11.5	11.5	11.5
Apr	9.4	10.2	10.2	10.2	10.2	10.3	10.3	10.3
May	7.3	9.3	9.4	9.1	9.4	9.1	9.4	9.3
Jun	5.6	7.5	7.6	7.6	7.5	7.5	7.7	7.5
Jul	5.9	6.5	6.6	6.6	6.6	6.6	6.4	6.5
Aug	8.3	8.6	8.7	8.7	8.8	8.6	8.5	8.6
Sep	10.6	11.1	11.1	11.1	11.1	11.1	11.4	11.1
Oct	11.7	11.4	11.5	11.5	11.4	11.5	11.5	11.5
Nov	12.4	11.8	11.9	11.9	11.9	11.9	11.8	11.8
Dec	13.5	12.5	12.5	12.5	12.5	12.5	12.5	12.4
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.1 (0.4)	0.1 (0.4)	0.1 (0.4)	0.1 (0.3)	0 (-0.3)	0 (-0.3)
Feb	---	---	0.1 (0.7)	0.1 (0.7)	0.1 (0.8)	0.1 (0.7)	-0.1 (-0.1)	0 (0.0)
Mar	---	---	0 (-0.3)	0 (-0.4)	0 (0.1)	0 (-0.4)	0 (0.0)	0 (-0.6)
Apr	---	---	0 (-0.1)	0 (-0.2)	0 (-0.1)	0.1 (0.4)	0.1 (0.8)	0.1 (0.3)
May	---	---	0.1 (0.4)	-0.2 (-2.5)	0.1 (0.1)	-0.2 (-2.4)	0.1 (0.2)	0 (-0.7)
Jun	---	---	0.1 (1.1)	0.1 (1.2)	0 (0.3)	0 (0.7)	0.2 (3.2)	0 (0.7)
Jul	---	---	0.1 (2.6)	0.1 (2.3)	0.1 (2.3)	0.1 (2.5)	-0.1 (-1.7)	0 (1.0)
Aug	---	---	0.1 (1.9)	0.1 (1.7)	0.2 (2.4)	0 (0.9)	-0.1 (-0.2)	0 (0.4)
Sep	---	---	0 (-0.5)	0 (-0.6)	0 (-0.1)	0 (-0.7)	0.3 (2.6)	0 (-0.5)
Oct	---	---	0.1 (0.8)	0.1 (1.0)	0 (0.3)	0.1 (0.8)	0.1 (0.4)	0.1 (0.6)
Nov	---	---	0.1 (0.7)	0.1 (0.6)	0.1 (0.6)	0.1 (0.8)	0 (0.2)	0 (0.2)
Dec	---	---	0 (0.0)	0 (-0.1)	0 (0.5)	0 (-0.1)	0 (0.0)	-0.1 (-0.3)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	-0.9 (-6.3)	-0.8 (-6.0)	-0.8 (-6.0)	-0.8 (-5.9)	-0.8 (-6.1)	-0.9 (-6.6)	-0.9 (-6.6)
Feb	---	-1.7 (-11.9)	-1.6 (-11.2)	-1.6 (-11.2)	-1.6 (-11.2)	-1.6 (-11.2)	-1.8 (-11.9)	-1.7 (-11.9)
Mar	---	-0.3 (-2.1)	-0.3 (-2.4)	-0.3 (-2.5)	-0.3 (-2.0)	-0.3 (-2.5)	-0.3 (-2.1)	-0.3 (-2.7)
Apr	---	0.8 (8.6)	0.8 (8.4)	0.8 (8.4)	0.8 (8.4)	0.9 (9.0)	0.9 (9.4)	0.9 (8.9)
May	---	2 (28.1)	2.1 (28.7)	1.8 (25.0)	2.1 (28.3)	1.8 (25.0)	2.1 (28.3)	2 (27.3)
Jun	---	1.9 (32.6)	2 (34.1)	2 (34.2)	1.9 (33.0)	1.9 (33.6)	2.1 (36.9)	1.9 (33.6)
Jul	---	0.6 (9.3)	0.7 (12.1)	0.7 (11.9)	0.7 (11.9)	0.7 (12.0)	0.5 (7.5)	0.6 (10.4)
Aug	---	0.3 (3.7)	0.4 (5.7)	0.4 (5.5)	0.5 (6.2)	0.3 (4.6)	0.2 (3.4)	0.3 (4.1)
Sep	---	0.5 (5.3)	0.5 (4.7)	0.5 (4.6)	0.5 (5.1)	0.5 (4.6)	0.8 (8.0)	0.5 (4.8)
Oct	---	-0.3 (-2.8)	-0.2 (-2.0)	-0.2 (-1.8)	-0.3 (-2.5)	-0.2 (-2.0)	-0.2 (-2.4)	-0.2 (-2.2)
Nov	---	-0.6 (-4.7)	-0.5 (-4.1)	-0.5 (-4.2)	-0.5 (-4.2)	-0.5 (-4.0)	-0.6 (-4.5)	-0.6 (-4.6)
Dec	---	-1 (-7.3)	-1 (-7.3)	-1 (-7.4)	-1 (-6.9)	-1 (-7.4)	-1 (-7.3)	-1.1 (-7.6)

Table 61 and Table 62 show the statistics of the simulated selenium concentration for the alternatives for the Arkansas River at Catlin Dam gage. All alternatives would have negligible effects on selenium, compared to the No Action. Compared with the No Action Alternative, the selenium concentration simulated at the Arkansas River at Catlin Dam for the alternatives would increase after July and slightly decrease or not change before July, with the exception of River South, which would increase or not change in concentration from February to June. All alternatives would increase selenium concentrations in late spring months, compared to existing conditions, because of changes in streamflow.

Table 61. Cumulative Effects Simulated Selenium Concentration Comparison for Arkansas River at Catlin Dam Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
15th percentile	6.0	6.7	6.6	6.6	6.5	6.5	6.6	6.6
25th percentile	7.1	7.6	7.5	7.5	7.5	7.5	7.6	7.6
50th percentile	9.8	10.3	10.3	10.3	10.3	10.3	10.3	10.3
75th percentile	12.5	12.1	12.2	12.1	12.1	12.1	12.1	12.1
85th percentile	13.9	13.3	13.2	13.1	13.2	13.1	13.3	13.2
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
15th percentile	---	---	-0.1 (-1.5)	-0.1 (-1.5)	-0.2 (-3.0)	-0.2 (-3.0)	-0.1 (-1.5)	-0.1 (-1.5)
25th percentile	---	---	-0.1 (-1.3)	-0.1 (-1.3)	-0.1 (-1.3)	-0.1 (-1.3)	0.0 (0.0)	0.0 (0.0)
50th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
75th percentile	---	---	0.1 (0.8)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
85th percentile	---	---	-0.1 (-0.8)	-0.2 (-1.5)	-0.1 (-0.8)	-0.2 (-1.5)	0.0 (0.0)	-0.1 (-0.8)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
15th percentile	---	0.7 (11.7)	0.6 (10.0)	0.6 (10.0)	0.5 (8.3)	0.5 (8.3)	0.6 (10.0)	0.6 (10.0)
25th percentile	---	0.5 (7.0)	0.4 (5.6)	0.4 (5.6)	0.4 (5.6)	0.4 (5.6)	0.5 (7.0)	0.5 (7.0)
50th percentile	---	0.5 (5.1)	0.5 (5.1)	0.5 (5.1)	0.5 (5.1)	0.5 (5.1)	0.5 (5.1)	0.5 (5.1)
75th percentile	---	-0.4 (-3.2)	-0.3 (-2.4)	-0.4 (-3.2)	-0.4 (-3.2)	-0.4 (-3.2)	-0.4 (-3.2)	-0.4 (-3.2)
85th percentile	---	-0.6 (-4.3)	-0.7 (-5.0)	-0.8 (-5.8)	-0.7 (-5.0)	-0.8 (-5.8)	-0.6 (-4.3)	-0.7 (-5.0)

Table 62. Cumulative Effects Monthly Simulated Selenium Concentration for Arkansas River at Catlin Dam Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	13.1	12.6	12.6	12.6	12.6	12.6	12.6	12.5
Feb	14.6	12.9	12.8	12.8	12.8	12.8	12.9	12.9
Mar	10.8	10.5	10.4	10.4	10.5	10.4	10.4	10.4
Apr	9.0	9.5	9.5	9.5	9.5	9.5	9.5	9.5
May	7.0	8.3	8.2	8.0	8.2	8.0	8.3	8.2
Jun	5.6	7.0	7.0	7.0	7.0	7.0	7.1	7.0
Jul	6.4	6.8	6.9	6.9	6.9	6.9	6.7	6.9
Aug	8.3	8.4	8.5	8.4	8.5	8.4	8.3	8.4
Sep	10.6	10.8	10.8	10.8	10.8	10.8	11.0	10.9
Oct	11.0	10.4	10.5	10.5	10.4	10.5	10.5	10.5
Nov	11.6	11.1	11.2	11.2	11.1	11.2	11.1	11.1
Dec	12.8	12.0	12.0	12.0	12.1	12.0	12.0	12.0
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0 (0.2)	0 (0.2)	0 (0.3)	0 (0.2)	0 (0.0)	-0.1 (-0.2)
Feb	---	---	-0.1 (-0.7)	-0.1 (-0.6)	-0.1 (-0.6)	-0.1 (-0.6)	0 (0.4)	0 (0.1)
Mar	---	---	-0.1 (-0.6)	-0.1 (-0.6)	0 (0.0)	-0.1 (-0.6)	-0.1 (-0.7)	-0.1 (-0.3)
Apr	---	---	0 (-0.5)	0 (-0.6)	0 (0.0)	0 (-0.4)	0 (0.1)	0 (0.3)
May	---	---	-0.1 (-0.5)	-0.3 (-3.5)	-0.1 (-1.0)	-0.3 (-3.3)	0 (0.5)	-0.1 (-1.1)
Jun	---	---	0 (0.4)	0 (0.4)	0 (-0.1)	0 (0.3)	0.1 (2.3)	0 (0.9)
Jul	---	---	0.1 (2.1)	0.1 (1.8)	0.1 (2.1)	0.1 (2.2)	-0.1 (-1.1)	0.1 (1.1)
Aug	---	---	0.1 (1.2)	0 (1.0)	0.1 (1.4)	0 (0.4)	-0.1 (-0.4)	0 (0.2)
Sep	---	---	0 (-0.4)	0 (-0.4)	0 (-0.1)	0 (-0.4)	0.2 (1.8)	0.1 (0.4)
Oct	---	---	0.1 (1.1)	0.1 (1.2)	0 (-0.1)	0.1 (0.9)	0.1 (1.0)	0.1 (1.3)
Nov	---	---	0.1 (1.0)	0.1 (1.0)	0 (0.2)	0.1 (1.1)	0 (0.2)	0 (0.4)
Dec	---	---	0 (-0.1)	0 (-0.1)	0.1 (0.3)	0 (-0.1)	0 (0.0)	0 (-0.3)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	-0.5 (-4.2)	-0.5 (-4.0)	-0.5 (-4.0)	-0.5 (-3.9)	-0.5 (-4.0)	-0.5 (-4.2)	-0.6 (-4.4)
Feb	---	-1.7 (-11.6)	-1.8 (-12.1)	-1.8 (-12.1)	-1.8 (-12.1)	-1.8 (-12.1)	-1.7 (-11.2)	-1.7 (-11.5)
Mar	---	-0.3 (-2.8)	-0.4 (-3.4)	-0.4 (-3.4)	-0.3 (-2.8)	-0.4 (-3.4)	-0.4 (-3.5)	-0.4 (-3.1)
Apr	---	0.5 (5.9)	0.5 (5.3)	0.5 (5.3)	0.5 (5.9)	0.5 (5.5)	0.5 (6.0)	0.5 (6.2)
May	---	1.3 (18.1)	1.2 (17.5)	1 (14.0)	1.2 (17.0)	1 (14.2)	1.3 (18.7)	1.2 (16.8)
Jun	---	1.4 (24.6)	1.4 (25.1)	1.4 (25.2)	1.4 (24.5)	1.4 (24.9)	1.5 (27.5)	1.4 (25.8)
Jul	---	0.4 (6.7)	0.5 (8.9)	0.5 (8.6)	0.5 (8.9)	0.5 (9.0)	0.3 (5.5)	0.5 (7.8)
Aug	---	0.1 (1.2)	0.2 (2.5)	0.1 (2.2)	0.2 (2.6)	0.1 (1.6)	0 (0.9)	0.1 (1.4)
Sep	---	0.2 (2.1)	0.2 (1.7)	0.2 (1.7)	0.2 (2.0)	0.2 (1.7)	0.4 (4.0)	0.3 (2.6)
Oct	---	-0.6 (-5.7)	-0.5 (-4.6)	-0.5 (-4.5)	-0.6 (-5.8)	-0.5 (-4.8)	-0.5 (-4.7)	-0.5 (-4.4)
Nov	---	-0.5 (-4.3)	-0.4 (-3.3)	-0.4 (-3.4)	-0.5 (-4.1)	-0.4 (-3.2)	-0.5 (-4.1)	-0.5 (-3.9)
Dec	---	-0.8 (-6.3)	-0.8 (-6.3)	-0.8 (-6.3)	-0.7 (-5.9)	-0.8 (-6.3)	-0.8 (-6.3)	-0.8 (-6.5)

Table 63 and Table 64 show the summary of the selenium modeling at the Arkansas River at Las Animas gage. All alternatives would have negligible effects on selenium, compared to the No Action. Selenium concentrations for the alternatives at Las Animas gage in the Arkansas River would decrease with respect to the No Action Alternative during February, March and April. All alternatives would not substantially change selenium concentrations, compared to existing conditions.

Table 63. Cumulative Effects Simulated Selenium Concentration Comparison for Arkansas River at Las Animas Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	11.2	11.1	11.1	11.1	11.1	11.1	11.1	11.1
15th percentile	8.4	8.7	8.7	8.7	8.7	8.7	8.6	8.6
25th percentile	9.7	9.8	9.7	9.7	9.7	9.7	9.7	9.8
50th percentile	11.7	11.5	11.5	11.5	11.5	11.5	11.6	11.5
75th percentile	12.6	12.5	12.5	12.5	12.5	12.5	12.5	12.5
85th percentile	13.3	13.2	13.2	13.2	13.2	13.2	13.2	13.2
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
15th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	-0.1 (-1.1)	-0.1 (-1.1)
25th percentile	---	---	-0.1 (-1.0)	-0.1 (-1.0)	-0.1 (-1.0)	-0.1 (-1.0)	-0.1 (-1.0)	0.0 (0.0)
50th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (0.9)	0.0 (0.0)
75th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
85th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	-0.1 (-0.9)	-0.1 (-0.9)	-0.1 (-0.9)	-0.1 (-0.9)	-0.1 (-0.9)	-0.1 (-0.9)	-0.1 (-0.9)
15th percentile	---	0.3 (3.6)	0.3 (3.6)	0.3 (3.6)	0.3 (3.6)	0.3 (3.6)	0.2 (2.4)	0.2 (2.4)
25th percentile	---	0.1 (1.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (1.0)
50th percentile	---	-0.2 (-1.7)	-0.2 (-1.7)	-0.2 (-1.7)	-0.2 (-1.7)	-0.2 (-1.7)	-0.1 (-0.9)	-0.2 (-1.7)
75th percentile	---	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)
85th percentile	---	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)	-0.1 (-0.8)

Table 64. Cumulative Effects Monthly Simulated Selenium Concentration for Arkansas River at Las Animas Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	11.7	11.5	11.6	11.6	11.5	11.6	11.5	11.5
Feb	11.8	10.9	10.7	10.7	10.7	10.8	11.0	10.9
Mar	12.3	11.7	11.7	11.7	11.8	11.7	11.7	11.7
Apr	12.9	13.0	13.0	12.9	13.0	12.9	13.0	13.0
May	10.1	10.7	10.7	10.6	10.7	10.6	10.7	10.6
Jun	8.7	9.2	9.3	9.3	9.3	9.3	9.3	9.3
Jul	9.5	9.7	9.7	9.7	9.7	9.7	9.6	9.7
Aug	10.1	10.2	10.2	10.2	10.2	10.2	10.1	10.1
Sep	11.8	11.8	11.7	11.7	11.7	11.7	11.8	11.8
Oct	11.8	11.7	11.7	11.7	11.7	11.7	11.7	11.7
Nov	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7
Dec	11.8	11.6	11.6	11.6	11.6	11.6	11.6	11.6
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	9 (1.5)	9 (1.5)	5 (0.8)	8 (1.5)	2 (0.3)	4 (0.7)
Feb	---	---	4 (1.0)	4 (0.9)	3 (0.8)	4 (1.1)	1 (0.2)	2 (0.5)
Mar	---	---	6 (1.2)	5 (1.2)	2 (0.4)	6 (1.2)	2 (0.5)	2 (0.5)
Apr	---	---	10 (1.6)	8 (1.3)	4 (0.7)	10 (1.6)	1 (0.2)	3 (0.4)
May	---	---	11 (1.6)	10 (1.5)	5 (0.7)	11 (1.6)	8 (1.1)	7 (1.0)
Jun	---	---	11 (1.5)	12 (1.5)	5 (0.7)	12 (1.5)	8 (1.0)	8 (1.0)
Jul	---	---	9 (1.5)	9 (1.5)	5 (0.8)	8 (1.5)	2 (0.3)	4 (0.7)
Aug	---	---	4 (1.0)	4 (0.9)	3 (0.8)	4 (1.1)	1 (0.2)	2 (0.5)
Sep	---	---	6 (1.2)	5 (1.2)	2 (0.4)	6 (1.2)	2 (0.5)	2 (0.5)
Oct	---	---	10 (1.6)	8 (1.3)	4 (0.7)	10 (1.6)	1 (0.2)	3 (0.4)
Nov	---	---	11 (1.6)	10 (1.5)	5 (0.7)	11 (1.6)	8 (1.1)	7 (1.0)
Dec	---	---	11 (1.5)	12 (1.5)	5 (0.7)	12 (1.5)	8 (1.0)	8 (1.0)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	-0.2 (-1.1)	-0.1 (-1.0)	-0.1 (-1.0)	-0.2 (-1.0)	-0.1 (-1.0)	-0.2 (-1.1)	-0.2 (-1.1)
Feb	---	-0.9 (-7.5)	-1.1 (-9.0)	-1.1 (-9.0)	-1.1 (-8.9)	-1 (-8.8)	-0.8 (-7.0)	-0.9 (-7.5)
Mar	---	-0.6 (-4.7)	-0.6 (-5.2)	-0.6 (-5.2)	-0.5 (-4.5)	-0.6 (-5.2)	-0.6 (-5.1)	-0.6 (-4.9)
Apr	---	0.1 (0.7)	0.1 (0.5)	0 (0.4)	0.1 (0.7)	0 (0.5)	0.1 (0.6)	0.1 (0.6)
May	---	0.6 (5.6)	0.6 (5.6)	0.5 (5.1)	0.6 (5.8)	0.5 (5.1)	0.6 (5.6)	0.5 (5.0)
Jun	---	0.5 (5.8)	0.6 (6.0)	0.6 (6.0)	0.6 (6.0)	0.6 (6.0)	0.6 (5.9)	0.6 (6.0)
Jul	---	0.2 (1.5)	0.2 (1.9)	0.2 (1.9)	0.2 (1.9)	0.2 (1.9)	0.1 (1.1)	0.2 (1.7)
Aug	---	0.1 (0.3)	0.1 (0.3)	0.1 (0.3)	0.1 (0.4)	0.1 (0.2)	0 (0.1)	0 (0.1)
Sep	---	0 (0.0)	-0.1 (-0.2)	-0.1 (-0.2)	-0.1 (-0.2)	-0.1 (-0.2)	0 (0.3)	0 (0.1)
Oct	---	-0.1 (-1.2)	-0.1 (-1.0)	-0.1 (-1.0)	-0.1 (-1.4)	-0.1 (-1.0)	-0.1 (-1.0)	-0.1 (-1.0)
Nov	---	0 (-0.4)	0 (-0.2)	0 (-0.2)	0 (-0.4)	0 (-0.1)	0 (-0.3)	0 (-0.3)
Dec	---	-0.2 (-1.6)	-0.2 (-1.6)	-0.2 (-1.6)	-0.2 (-1.5)	-0.2 (-1.6)	-0.2 (-1.5)	-0.2 (-1.6)

Table 65 and Table 66 show the results for the Fountain Creek at Pueblo gage. All alternatives would have negligible effects on selenium, compared to the No Action, as effects are around two percent or less. At the Fountain Creek at Pueblo gage the relative comparison of the simulated concentration between the alternatives and No Action would not show a clear tendency with relatively small percent change, except a consistent concentration reduction pattern for all the alternatives in May. All alternatives would decrease cumulative selenium concentrations in Fountain Creek, compared to existing conditions, because of increases in streamflow.

Table 65. Cumulative Effects Simulated Selenium Concentration Comparison for Fountain Creek at Pueblo Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	12.4	9.3	9.3	9.3	9.3	9.3	9.4	9.3
15th percentile	7.3	5.5	5.5	5.5	5.5	5.5	5.5	5.5
25th percentile	8.4	6.3	6.3	6.2	6.3	6.2	6.3	6.3
50th percentile	11.5	8.2	8.3	8.2	8.1	8.2	8.2	8.3
75th percentile	16.1	11.2	11.4	11.3	11.4	11.3	11.2	11.2
85th percentile	18.4	12.8	13.0	12.8	12.9	12.8	12.9	12.9
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (1.1)	0.0 (0.0)
15th percentile	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
25th percentile	---	---	0.0 (0.0)	-0.1 (-1.6)	0.0 (0.0)	-0.1 (-1.6)	0.0 (0.0)	0.0 (0.0)
50th percentile	---	---	0.1 (1.2)	0.0 (0.0)	-0.1 (-1.2)	0.0 (0.0)	0.0 (0.0)	0.1 (1.2)
75th percentile	---	---	0.2 (1.8)	0.1 (0.9)	0.2 (1.8)	0.1 (0.9)	0.0 (0.0)	0.0 (0.0)
85th percentile	---	---	0.2 (1.6)	0.0 (0.0)	0.1 (0.8)	0.0 (0.0)	0.1 (0.8)	0.1 (0.8)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	-3.1 (-25.0)	-3.1 (-25.0)	-3.1 (-25.0)	-3.1 (-25.0)	-3.1 (-25.0)	-3.0 (-24.2)	-3.1 (-25.0)
15th percentile	---	-1.8 (-24.7)	-1.8 (-24.7)	-1.8 (-24.7)	-1.8 (-24.7)	-1.8 (-24.7)	-1.8 (-24.7)	-1.8 (-24.7)
25th percentile	---	-2.1 (-25.0)	-2.1 (-25.0)	-2.2 (-26.2)	-2.1 (-25.0)	-2.2 (-26.2)	-2.1 (-25.0)	-2.1 (-25.0)
50th percentile	---	-3.3 (-28.7)	-3.2 (-27.8)	-3.3 (-28.7)	-3.4 (-29.6)	-3.3 (-28.7)	-3.3 (-28.7)	-3.2 (-27.8)
75th percentile	---	-4.9 (-30.4)	-4.7 (-29.2)	-4.8 (-29.8)	-4.7 (-29.2)	-4.8 (-29.8)	-4.9 (-30.4)	-4.9 (-30.4)
85th percentile	---	-5.6 (-30.4)	-5.4 (-29.3)	-5.6 (-30.4)	-5.5 (-29.9)	-5.6 (-30.4)	-5.5 (-29.9)	-5.5 (-29.9)

Table 66. Cumulative Effects Monthly Simulated Selenium Concentration for Fountain Creek at Pueblo Gage

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (μg/L)								
Jan	14.2	10.2	10.1	10.1	10.2	10.1	10.1	10.1
Feb	14.2	10.0	10.1	10.1	10.1	10.1	10.0	10.0
Mar	12.5	9.0	8.9	8.9	8.9	8.9	8.9	8.9
Apr	10.8	8.3	8.3	8.3	8.3	8.4	8.4	8.5
May	9.4	10.8	10.7	10.0	10.7	10.0	10.6	10.5
Jun	10.1	11.0	11.1	11.1	11.0	11.0	11.4	11.1
Jul	9.3	7.4	7.5	7.5	7.3	7.5	7.3	7.5
Aug	10.1	7.2	7.5	7.5	7.4	7.2	7.2	7.2
Sep	10.3	7.3	7.3	7.3	7.3	7.3	7.6	7.4
Oct	16.0	9.4	9.3	9.3	9.3	9.3	9.3	9.4
Nov	15.0	9.9	10.0	10.0	9.9	10.0	10.0	10.0
Dec	17.1	11.4	11.3	11.2	11.4	11.2	11.4	11.3
Change in Concentration Compared to No Action Alternative [μg/L (%)]								
Jan	---	---	-0.1 (-0.1)	-0.1 (-0.1)	0 (0.2)	-0.1 (-0.4)	-0.1 (-0.7)	-0.1 (-0.7)
Feb	---	---	0.1 (1.6)	0.1 (1.5)	0.1 (0.9)	0.1 (1.5)	0 (0.2)	0 (0.2)
Mar	---	---	-0.1 (-0.7)	-0.1 (-0.9)	-0.1 (-0.7)	-0.1 (-0.9)	-0.1 (-0.3)	-0.1 (-0.3)
Apr	---	---	0 (-0.8)	0 (-0.7)	0 (-0.5)	0.1 (1.2)	0.1 (0.4)	0.2 (1.4)
May	---	---	-0.1 (-1.2)	-0.8 (-7.4)	-0.1 (-1.2)	-0.8 (-7.4)	-0.2 (-2.0)	-0.3 (-2.8)
Jun	---	---	0.1 (0.5)	0.1 (0.6)	0 (-0.3)	0 (0.1)	0.4 (3.3)	0.1 (1.2)
Jul	---	---	0.1 (1.2)	0.1 (1.3)	-0.1 (-0.9)	0.1 (1.0)	-0.1 (-1.6)	0.1 (1.0)
Aug	---	---	0.3 (4.0)	0.3 (3.7)	0.2 (3.6)	0 (0.4)	0 (0.6)	0 (0.6)
Sep	---	---	0 (-0.6)	0 (-0.7)	0 (-0.6)	0 (-0.9)	0.3 (3.4)	0.1 (0.5)
Oct	---	---	-0.1 (-0.8)	-0.1 (-0.5)	-0.1 (-0.5)	-0.1 (-1.2)	-0.1 (-0.9)	0 (0.4)
Nov	---	---	0.1 (0.7)	0.1 (0.6)	0 (0.3)	0.1 (1.1)	0.1 (0.3)	0.1 (0.4)
Dec	---	---	-0.1 (-1.2)	-0.2 (-1.2)	0 (0.1)	-0.2 (-1.3)	0 (0.2)	-0.1 (-0.5)
Change in Concentration Compared to Existing Conditions [μg/L (%)]								
Jan	---	-4 (-28.5)	-4.1 (-28.5)	-4.1 (-28.5)	-4 (-28.3)	-4.1 (-28.7)	-4.1 (-29.0)	-4.1 (-29.0)
Feb	---	-4.2 (-30.0)	-4.1 (-28.8)	-4.1 (-28.9)	-4.1 (-29.4)	-4.1 (-28.9)	-4.2 (-29.9)	-4.2 (-29.9)
Mar	---	-3.5 (-28.0)	-3.6 (-28.5)	-3.6 (-28.7)	-3.6 (-28.5)	-3.6 (-28.6)	-3.6 (-28.2)	-3.6 (-28.2)
Apr	---	-2.5 (-23.0)	-2.5 (-23.5)	-2.5 (-23.5)	-2.5 (-23.3)	-2.4 (-22.0)	-2.4 (-22.7)	-2.3 (-21.9)
May	---	1.4 (15.1)	1.3 (13.7)	0.6 (6.6)	1.3 (13.8)	0.6 (6.7)	1.2 (12.8)	1.1 (11.9)
Jun	---	0.9 (9.3)	1 (9.9)	1 (10.0)	0.9 (9.0)	0.9 (9.4)	1.3 (12.9)	1 (10.6)
Jul	---	-1.9 (-20.6)	-1.8 (-19.6)	-1.8 (-19.6)	-2 (-21.3)	-1.8 (-19.8)	-2 (-21.8)	-1.8 (-19.8)
Aug	---	-2.9 (-28.8)	-2.6 (-26.0)	-2.6 (-26.2)	-2.7 (-26.3)	-2.9 (-28.5)	-2.9 (-28.4)	-2.9 (-28.4)
Sep	---	-3 (-28.3)	-3 (-28.8)	-3 (-28.8)	-3 (-28.8)	-3 (-29.0)	-2.7 (-25.9)	-2.9 (-28.0)
Oct	---	-6.6 (-41.2)	-6.7 (-41.7)	-6.7 (-41.5)	-6.7 (-41.5)	-6.7 (-41.9)	-6.7 (-41.7)	-6.6 (-41.0)
Nov	---	-5.1 (-33.8)	-5 (-33.4)	-5 (-33.4)	-5.1 (-33.7)	-5 (-33.1)	-5 (-33.6)	-5 (-33.6)
Dec	---	-5.7 (-33.2)	-5.8 (-34.0)	-5.9 (-34.1)	-5.7 (-33.2)	-5.9 (-34.1)	-5.7 (-33.1)	-5.8 (-33.6)

Sulfate and Uranium Analysis

This section describes the methods and results of the sulfate and uranium analysis. All references in this appendix to sulfate and uranium are to filtered sulfate in mg/L and filtered uranium in μg/L, respectively.

Methods

The analyses of sulfate and uranium were based on field measurements of sulfate and uranium, and their relationship with TDS. Sulfate and uranium data were obtained from the USGS published data at various USGS gaging stations located throughout the Arkansas River Basin study area.

Regression equations between TDS and the respective constituent were developed and applied to the salinity analysis results (see this Appendix F.2 – *Salinity Analysis*).

The significance criteria in Table 7 were used to evaluate sulfate and uranium effects.

Sulfate and Salinity Relationships

The estimated TDS data, using the measured specific conductance and the site-specific USGS relationships described in previous sections (USGS, 2010), were used to derive a relationship with measured sulfate. Measured sulfate corresponds to the USGS published discrete sampling of sulfate in mg/L.

Scatter plots were created to observe the relationship between sulfate and the TDS. For each site, regression equations were developed to predict the concentration of sulfate with TDS concentration as the explanatory variable. TDS was derived from the measured specific conductance using USGS site-specific relationships (as previously described in Table 2).

Figure 59 to Figure 68 shows relationship between TDS and sulfate at various USGS gaging stations located in the Arkansas River Basin study area. The coefficient of determination (R^2) values indicate a positive correlation between sulfate and salinity concentrations.

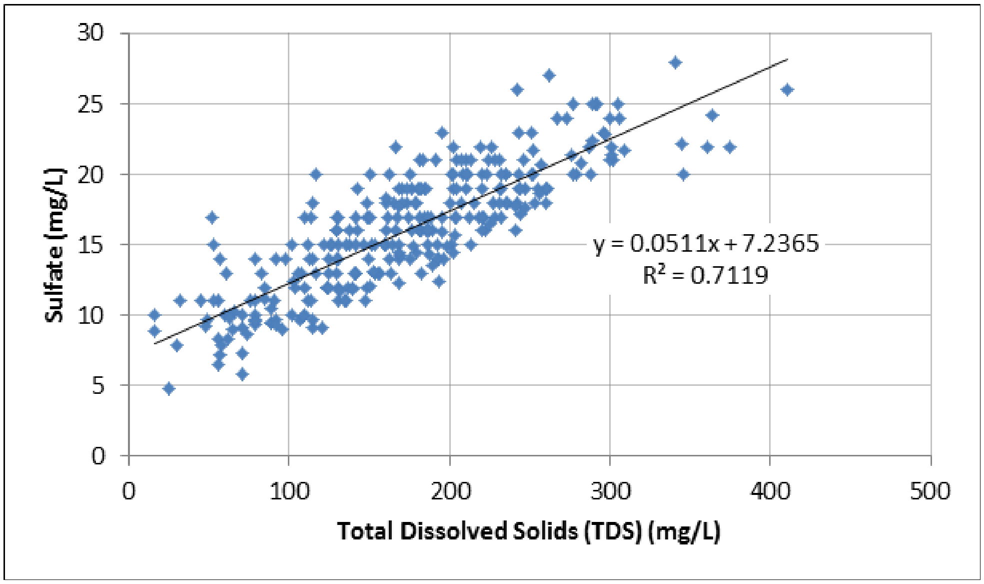


Figure 59. TDS and Sulfate Concentration Relationship for Fountain Creek near Colorado Springs Gage

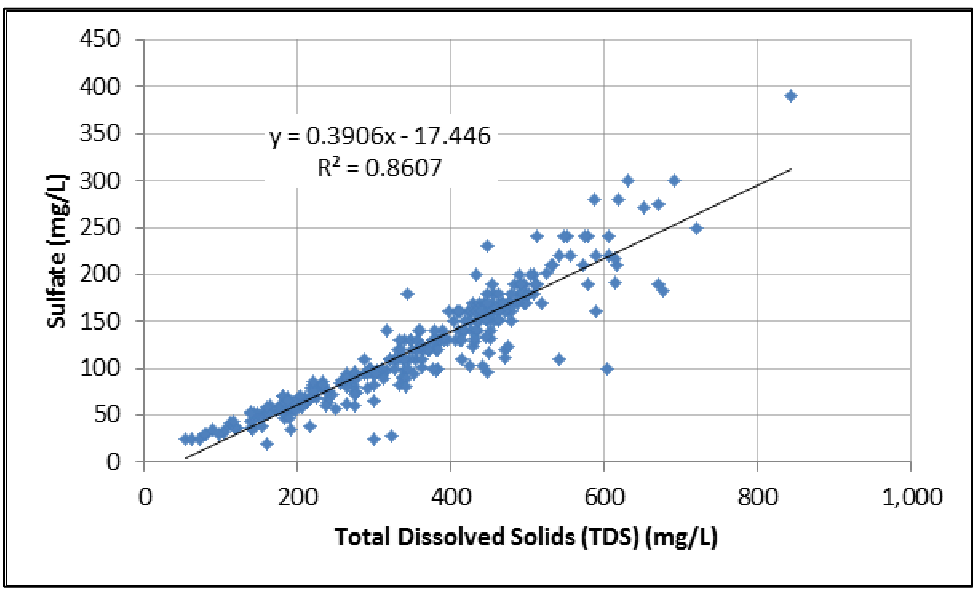


Figure 60. TDS and Sulfate Concentration Relationship for Fountain Creek at Colorado Springs Gage

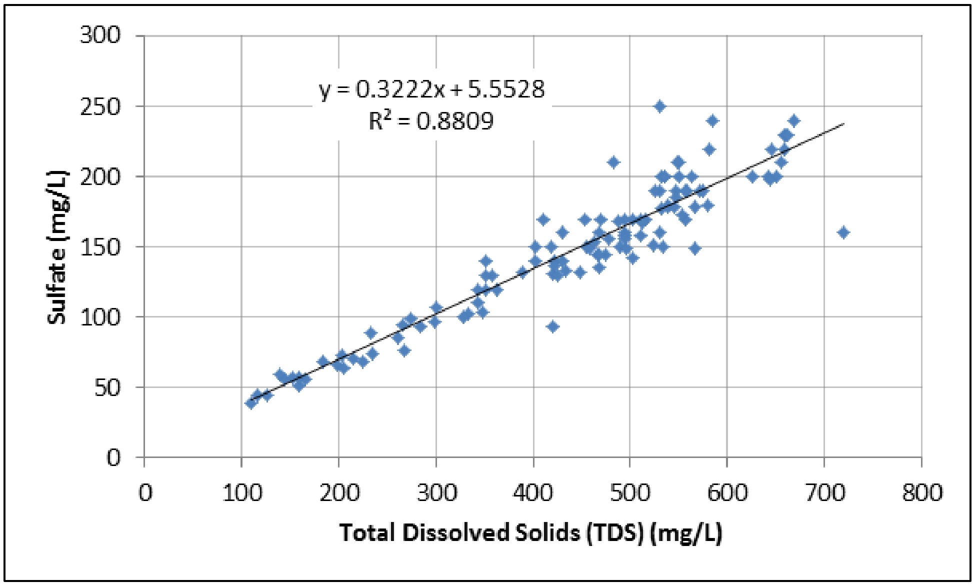


Figure 61. TDS and Sulfate Concentration Relationship for Fountain Creek at Security Gage

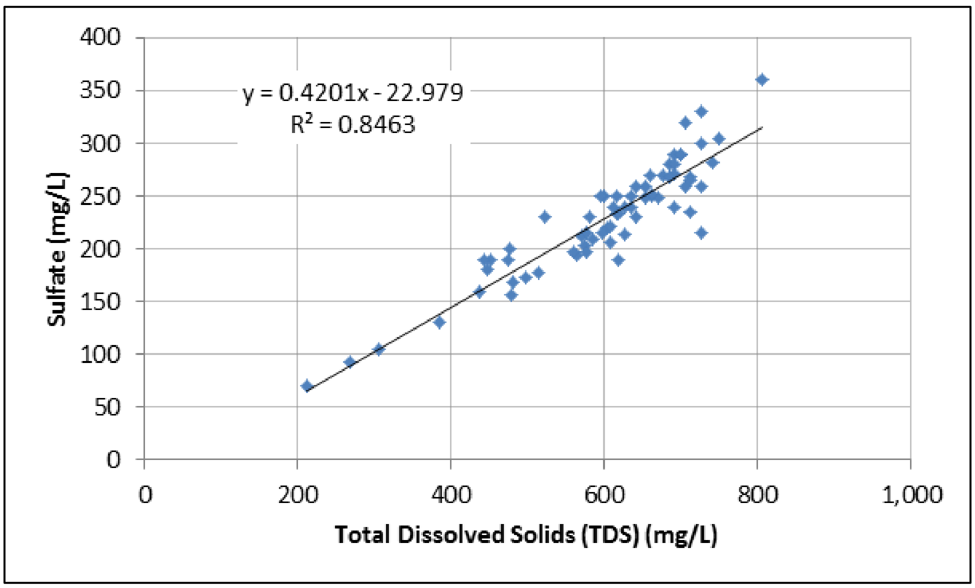


Figure 62. TDS and Sulfate Concentration Relationship for Fountain Creek near Fountain Gage

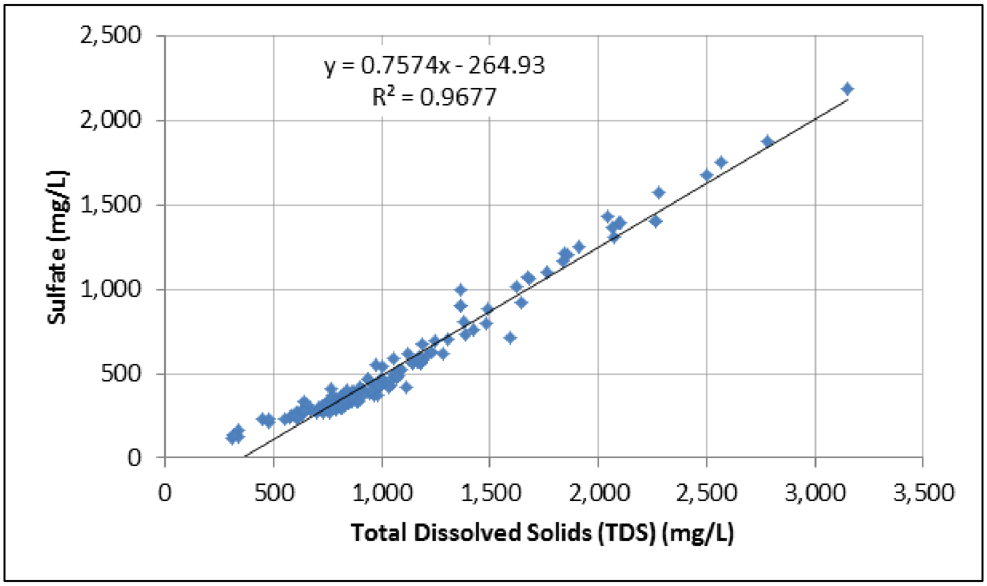


Figure 63. TDS and Sulfate Concentration Relationship for Fountain Creek at Pueblo Gage

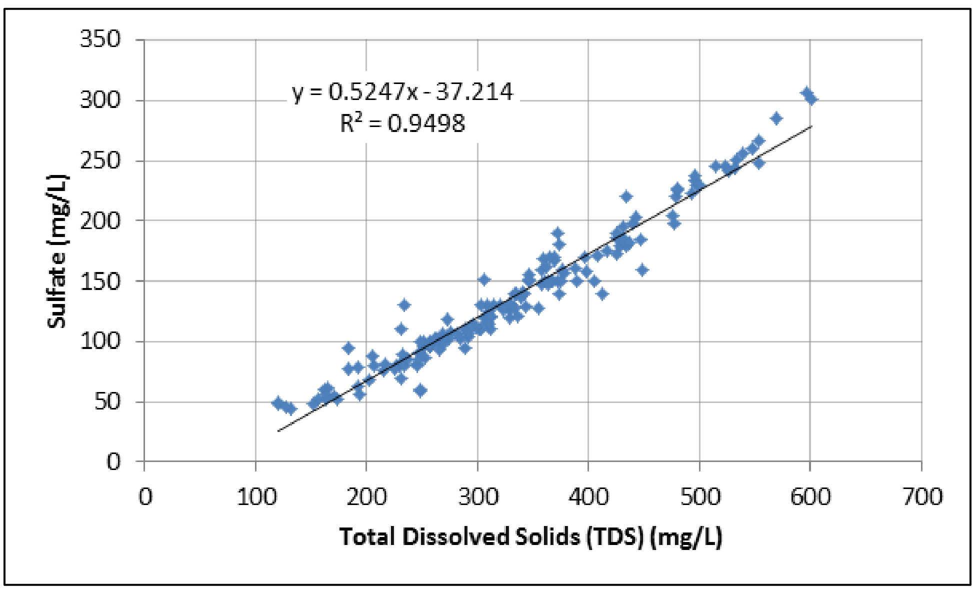


Figure 64. TDS and Sulfate Concentration Relationship for Arkansas River above Pueblo Gage

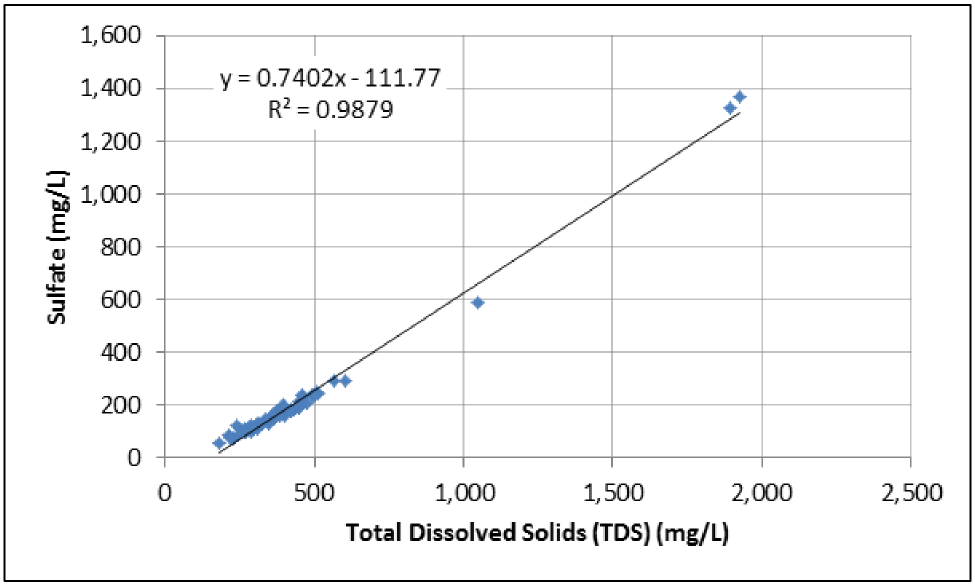


Figure 65. TDS and Sulfate Concentration Relationship for Arkansas River at Moffat St. Gage

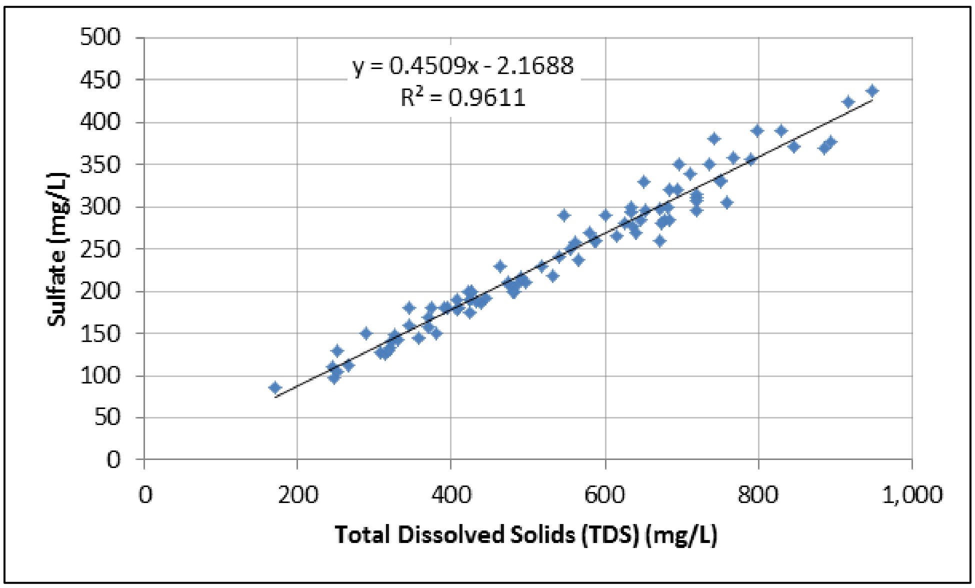


Figure 66. TDS and Sulfate Concentration Relationship for Arkansas River near Avondale Gage

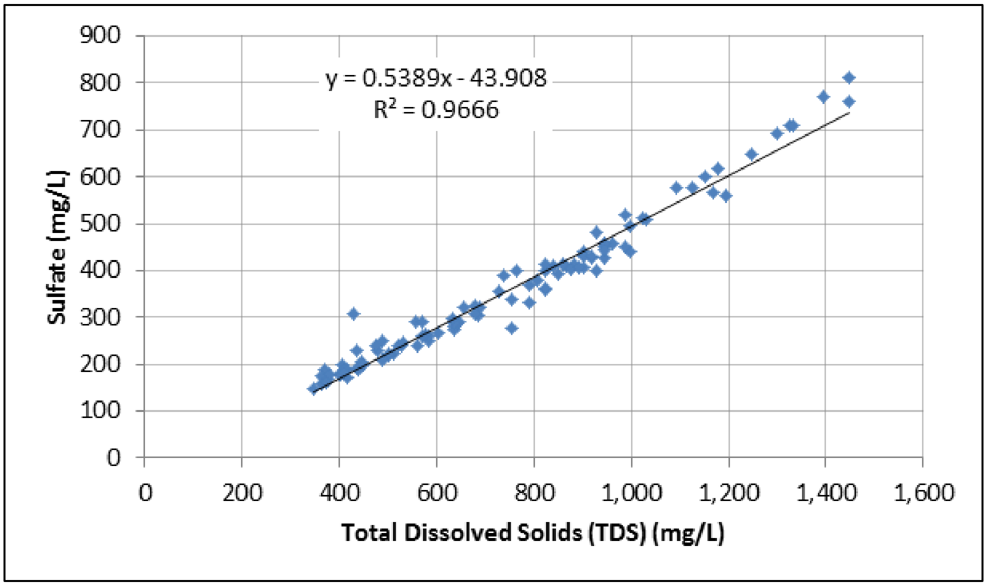


Figure 67. TDS and Sulfate Concentration Relationship for Arkansas River at Catlin Dam Gage

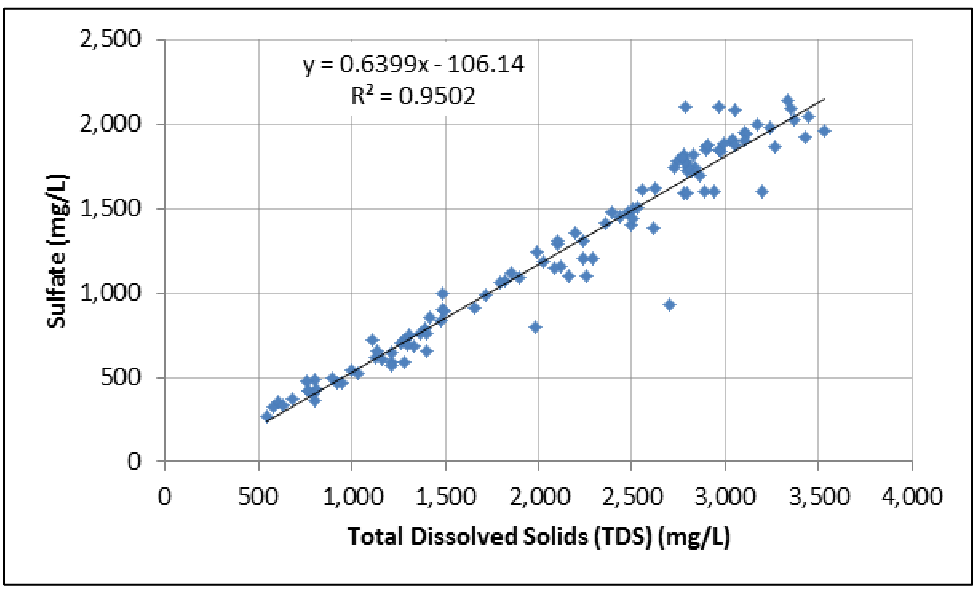


Figure 68. TDS and Sulfate Concentration Relationship for Arkansas River at Las Animas Gage

Uranium and Salinity Relationships

The estimated TDS dataset was also used to derive a relationship with measured sulfate. Measured uranium corresponds to the USGS published discrete sampling of uranium in µg/L.

Scatter plots were created to observe the relationship between uranium and the TDS. For each site, regression equations were developed to predict the concentration of uranium with TDS concentration as explanatory variable. TDS was derived from the measured specific conductance using USGS site-specific relationships (as previously described in Table 2).

Figure 69 to Figure 75 shows relationship between TDS and uranium at various USGS gaging stations located in the Arkansas River Basin. The coefficient of determination (R^2) values indicate a positive correlation between uranium and salinity concentrations.

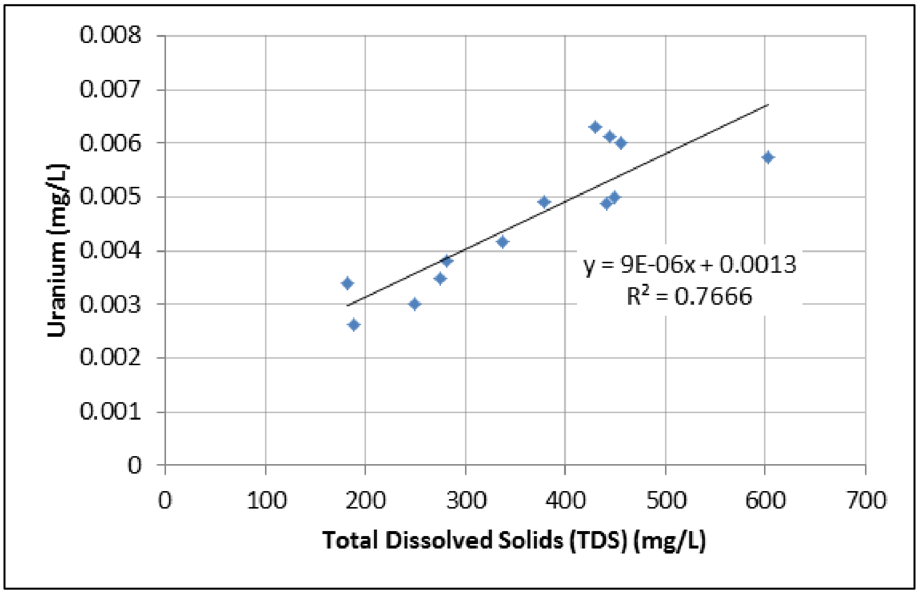


Figure 69. TDS and Uranium Concentration Relationship for Fountain Creek at Colorado Springs Gage

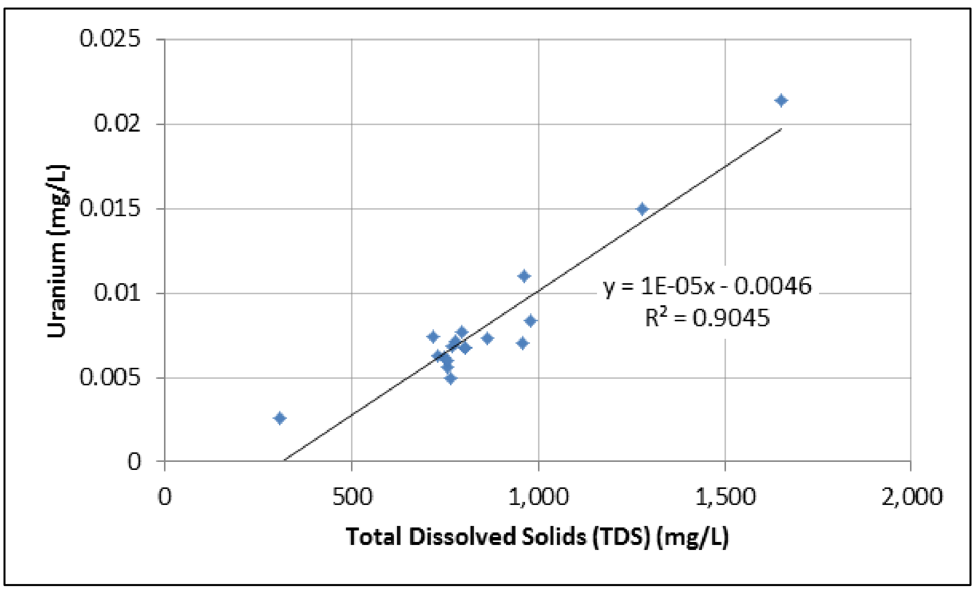


Figure 70. TDS and Uranium Concentration Relationship for Fountain Creek at Pueblo Gage

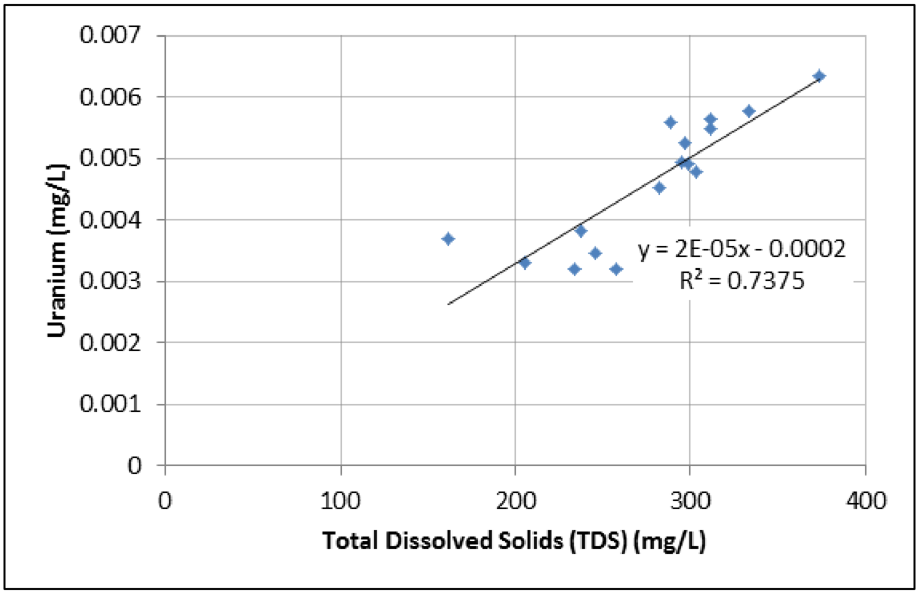


Figure 71. TDS and Uranium Concentration Relationship for Arkansas River above Pueblo Gage

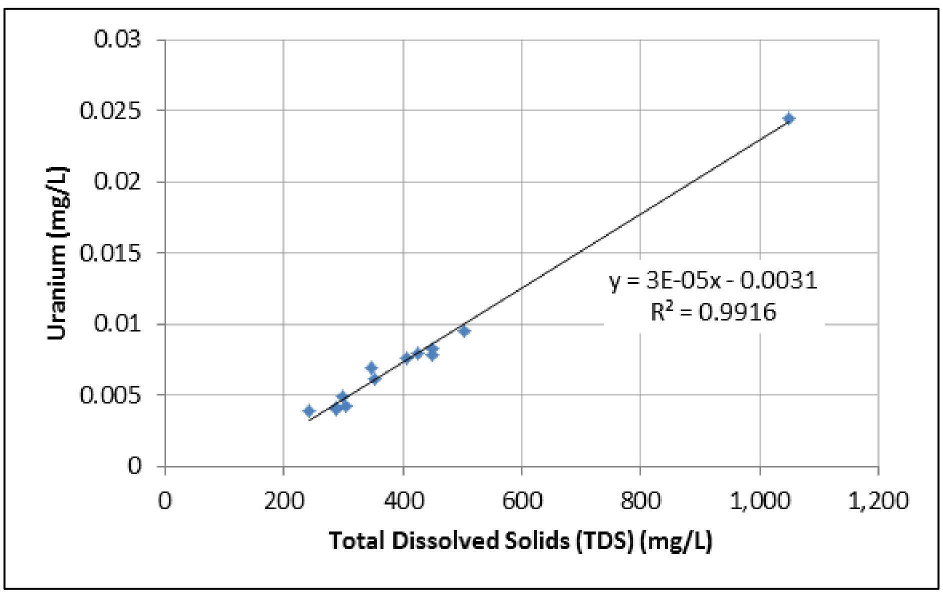


Figure 72. TDS and Uranium Concentration Relationship for Arkansas River at Moffat St. Gage

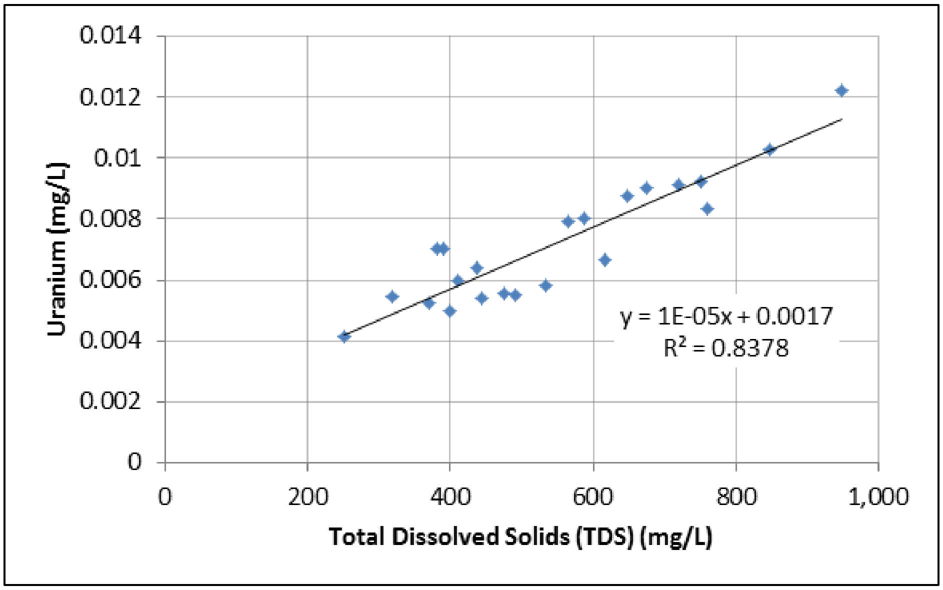


Figure 73. TDS and Uranium Concentration Relationship for Arkansas River near Avondale Gage

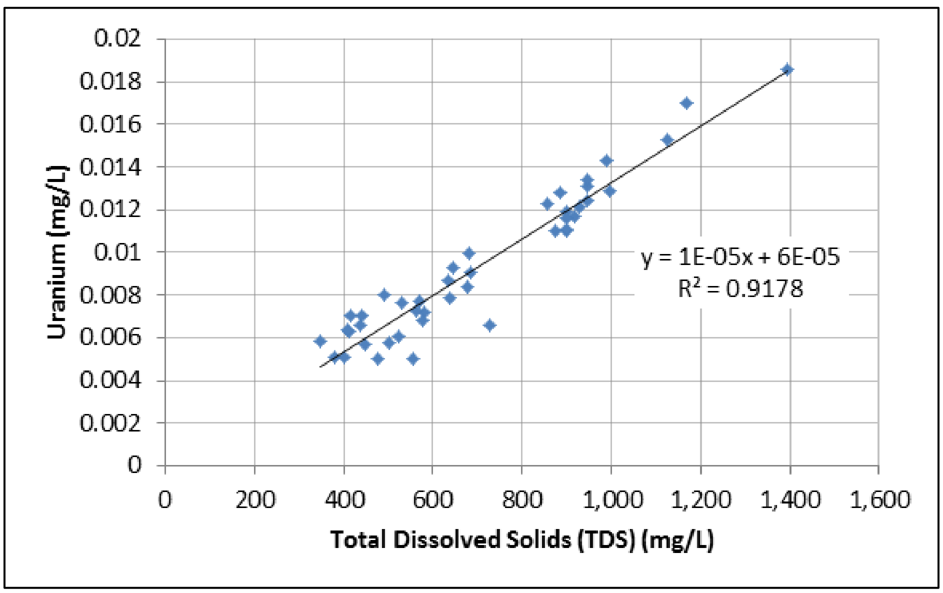


Figure 74. TDS and Uranium Concentration Relationship for Arkansas River at Catlin Dam Gage

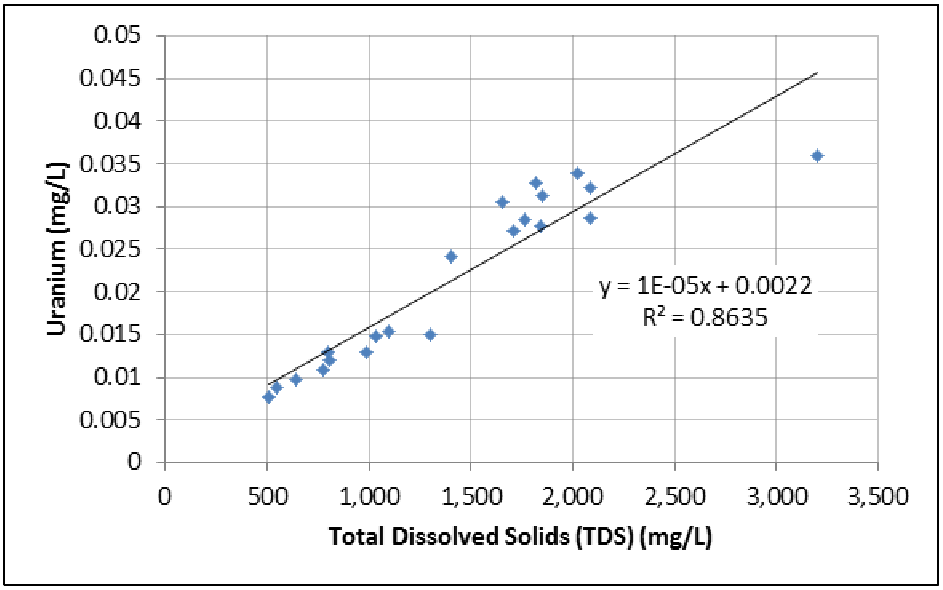


Figure 75. TDS and Uranium Concentration Relationship for Arkansas River at Las Animas Gage

Results

This section presents the direct, indirect, and cumulative effects for sulfate and uranium concentrations.

Direct and Indirect Effects

All alternatives would have negligible to minor adverse effects on sulfate and uranium concentrations, compared to No Action, at the Arkansas River at Moffat St. gage (Table 67 to Table 70) except River South and Master Contract Only. East of Pueblo municipal water supplies in the River South and Master Contract Only alternatives remain in the Arkansas River and flow past this gage, whereas the other alternatives deliver these supplies in the AVC, bypassing this gage. This bypass reduces flow and affects sulfate and uranium concentrations. The greatest increases occur in the fall and winter months.

Table 67. Direct Effects Simulated Sulfate Concentrations for Arkansas River at Moffat St. Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	178	189	199	199	198	199	176	190
15th percentile	84	86	86	86	86	86	82	86
25th percentile	110	113	113	113	113	113	112	113
50th percentile	158	166	173	173	170	173	160	169
75th percentile	198	212	223	223	222	223	208	213
85th percentile	219	242	261	263	257	259	238	243
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	10 (5.5)	11 (5.6)	9 (5.0)	10 (5.5)	-13 (-6.7)	1 (0.6)
15th percentile	---	---	0 (0.3)	0 (0.3)	0 (0.3)	0 (0.3)	-3 (-4.0)	0 (0.3)
25th percentile	---	---	1 (0.5)	1 (0.5)	1 (0.5)	1 (0.5)	-1 (-0.5)	0 (0.0)
50th percentile	---	---	7 (4.4)	7 (4.5)	5 (2.9)	7 (4.4)	-5 (-3.2)	3 (1.8)
75th percentile	---	---	11 (5.0)	11 (5.0)	10 (4.6)	10 (4.9)	-4 (-1.9)	1 (0.5)
85th percentile	---	---	20 (8.1)	21 (8.7)	15 (6.3)	18 (7.2)	-4 (-1.5)	1 (0.3)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	11 (6.0)	21 (11.8)	21 (11.9)	20 (11.3)	21 (11.8)	-2 (-1.1)	12 (6.6)
15th percentile	---	2 (2.1)	2 (2.4)	2 (2.4)	2 (2.4)	2 (2.4)	-2 (-2.0)	2 (2.4)
25th percentile	---	3 (2.8)	4 (3.4)	4 (3.4)	4 (3.3)	4 (3.4)	3 (2.3)	3 (2.9)
50th percentile	---	7 (4.7)	15 (9.3)	15 (9.4)	12 (7.7)	15 (9.3)	2 (1.3)	10 (6.6)
75th percentile	---	14 (7.0)	25 (12.4)	24 (12.3)	24 (12.0)	24 (12.2)	10 (5.0)	15 (7.5)
85th percentile	---	23 (10.6)	43 (19.5)	44 (20.2)	38 (17.6)	41 (18.6)	19 (8.9)	24 (11.0)

Table 68. Monthly Simulated Sulfate Concentration for Arkansas River at Moffat St. Gage - Direct and Indirect Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	238	246	264	265	261	264	231	249
Feb	270	285	307	308	308	307	247	286
Mar	179	189	204	204	203	203	176	192
Apr	160	168	175	175	176	174	166	169
May	148	150	152	151	151	152	150	151
Jun	93	95	95	95	95	95	94	95
Jul	85	89	91	91	91	91	84	89
Aug	135	144	152	152	152	151	125	144
Sep	190	203	218	219	216	219	185	203
Oct	187	209	225	224	217	225	204	214
Nov	223	239	247	247	248	247	220	236
Dec	246	266	279	279	277	279	248	267
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	18 (7.6)	19 (7.7)	15 (6.2)	18 (7.6)	-15 (-5.9)	3 (1.4)
Feb	---	---	22 (7.6)	23 (7.8)	23 (8.0)	22 (7.6)	-38 (-13.5)	1 (0.1)
Mar	---	---	15 (7.7)	15 (8.1)	14 (7.2)	14 (7.6)	-13 (-6.7)	3 (1.7)
Apr	---	---	7 (3.7)	7 (3.9)	8 (4.3)	6 (3.6)	-2 (-1.3)	1 (0.1)
May	---	---	2 (0.8)	1 (0.8)	1 (0.6)	2 (0.8)	0 (-0.2)	1 (0.4)
Jun	---	---	0 (0.7)	0 (0.8)	0 (0.7)	0 (0.7)	-1 (-0.9)	0 (0.0)
Jul	---	---	2 (2.7)	2 (2.6)	2 (2.1)	2 (2.7)	-5 (-5.4)	0 (0.0)
Aug	---	---	8 (5.5)	8 (5.4)	8 (5.8)	7 (5.3)	-19 (-13.0)	0 (0.5)
Sep	---	---	15 (7.5)	16 (7.8)	13 (6.6)	16 (7.7)	-18 (-8.7)	0 (-0.1)
Oct	---	---	16 (7.7)	15 (7.6)	8 (4.3)	16 (7.7)	-5 (-2.4)	5 (2.7)
Nov	---	---	8 (3.6)	8 (3.6)	9 (3.8)	8 (3.6)	-19 (-7.8)	-3 (-1.1)
Dec	---	---	13 (4.7)	13 (4.8)	11 (4.1)	13 (4.7)	-18 (-6.9)	1 (0.4)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	8 (3.3)	26 (11.1)	27 (11.2)	23 (9.6)	26 (11.2)	-7 (-2.8)	11 (4.7)
Feb	---	15 (5.6)	37 (13.6)	38 (13.8)	38 (14.0)	37 (13.6)	-23 (-8.6)	16 (5.7)
Mar	---	10 (5.7)	25 (13.8)	25 (14.3)	24 (13.4)	24 (13.7)	-3 (-1.3)	13 (7.6)
Apr	---	8 (5.1)	15 (8.9)	15 (9.1)	16 (9.6)	14 (8.9)	6 (3.7)	9 (5.2)
May	---	2 (1.7)	4 (2.6)	3 (2.5)	3 (2.3)	4 (2.6)	2 (1.5)	3 (2.2)
Jun	---	2 (1.6)	2 (2.4)	2 (2.4)	2 (2.3)	2 (2.3)	1 (0.7)	2 (1.7)
Jul	---	4 (5.3)	6 (8.1)	6 (8.0)	6 (7.6)	6 (8.1)	-1 (-0.4)	4 (5.3)
Aug	---	9 (6.6)	17 (12.5)	17 (12.4)	17 (12.8)	16 (12.3)	-10 (-7.2)	9 (7.2)
Sep	---	13 (7.1)	28 (15.1)	29 (15.5)	26 (14.1)	29 (15.3)	-5 (-2.3)	13 (6.9)
Oct	---	22 (11.4)	38 (20.0)	37 (19.9)	30 (16.2)	38 (20.0)	17 (8.7)	27 (14.4)
Nov	---	16 (7.0)	24 (10.9)	24 (10.9)	25 (11.2)	24 (10.9)	-3 (-1.3)	13 (5.9)
Dec	---	20 (8.1)	33 (13.1)	33 (13.2)	31 (12.6)	33 (13.1)	2 (0.6)	21 (8.6)

Table 69. Direct Effects Simulated Uranium Concentrations for Arkansas River at Moffat St. Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (μg/L)								
Mean	8.6	9.1	9.5	9.5	9.4	9.5	8.6	9.1
15th percentile	4.8	4.9	4.9	4.9	4.9	4.9	4.8	4.9
25th percentile	5.9	6.0	6.0	6.0	6.0	6.0	6.0	6.0
50th percentile	7.8	8.1	8.4	8.4	8.3	8.4	7.9	8.3
75th percentile	9.5	10.0	10.5	10.5	10.4	10.5	9.9	10.1
85th percentile	10.3	11.2	12.0	12.1	11.8	11.9	11.1	11.3
Change in Concentration Compared to No Action Alternative [μg/L (%)]								
Mean	---	---	0.4 (4.6)	0.4 (4.7)	0.4 (4.2)	0.4 (4.6)	-0.5 (-5.6)	0 (0.5)
15th percentile	---	---	0 (0.2)	0 (0.2)	0 (0.2)	0 (0.2)	-0.1 (-2.8)	0 (0.2)
25th percentile	---	---	0 (0.4)	0 (0.4)	0 (0.4)	0 (0.4)	0 (-0.4)	0 (0.0)
50th percentile	---	---	0.3 (3.6)	0.3 (3.7)	0.2 (2.4)	0.3 (3.6)	-0.2 (-2.7)	0.1 (1.5)
75th percentile	---	---	0.4 (4.3)	0.4 (4.3)	0.4 (4.0)	0.4 (4.2)	-0.2 (-1.6)	0 (0.4)
85th percentile	---	---	0.8 (7.0)	0.9 (7.6)	0.6 (5.5)	0.7 (6.3)	-0.2 (-1.3)	0 (0.3)
Change in Concentration Compared to Existing Conditions [μg/L (%)]								
Mean	---	0.4 (5.0)	0.9 (9.9)	0.9 (10.0)	0.8 (9.4)	0.9 (9.9)	-0.1 (-0.9)	0.5 (5.5)
15th percentile	---	0.1 (1.5)	0.1 (1.7)	0.1 (1.7)	0.1 (1.7)	0.1 (1.7)	-0.1 (-1.4)	0.1 (1.7)
25th percentile	---	0.1 (2.1)	0.1 (2.5)	0.1 (2.5)	0.1 (2.5)	0.1 (2.5)	0.1 (1.7)	0.1 (2.2)
50th percentile	---	0.3 (3.9)	0.6 (7.6)	0.6 (7.7)	0.5 (6.3)	0.6 (7.6)	0.1 (1.1)	0.4 (5.4)
75th percentile	---	0.6 (5.9)	1 (10.5)	1 (10.5)	1 (10.2)	1 (10.4)	0.4 (4.2)	0.6 (6.4)
85th percentile	---	0.9 (9.1)	1.7 (16.8)	1.8 (17.4)	1.6 (15.1)	1.6 (16.0)	0.8 (7.7)	1 (9.5)

Table 70. Monthly Simulated Uranium Concentration for Arkansas River at Moffat St. Gage - Direct and Indirect Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	11.1	11.4	12.1	12.2	12.0	12.1	10.8	11.5
Feb	12.4	13.0	13.9	13.9	13.9	13.9	11.4	13.0
Mar	8.7	9.1	9.7	9.7	9.6	9.7	8.6	9.2
Apr	7.9	8.3	8.5	8.5	8.5	8.5	8.2	8.3
May	7.4	7.5	7.6	7.6	7.6	7.6	7.5	7.5
Jun	5.2	5.3	5.3	5.3	5.3	5.3	5.2	5.3
Jul	4.9	5.0	5.1	5.1	5.1	5.1	4.8	5.0
Aug	6.9	7.3	7.6	7.6	7.6	7.6	6.5	7.3
Sep	9.1	9.7	10.3	10.3	10.2	10.3	8.9	9.6
Oct	9.0	9.9	10.5	10.5	10.2	10.5	9.7	10.1
Nov	10.5	11.1	11.4	11.4	11.5	11.5	10.3	11.0
Dec	11.4	12.2	12.7	12.7	12.7	12.7	11.5	12.3
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.7 (6.6)	0.8 (6.7)	0.6 (5.4)	0.7 (6.7)	-0.6 (-5.1)	0.1 (1.2)
Feb	---	---	0.9 (6.7)	0.9 (6.9)	0.9 (7.1)	0.9 (6.7)	-1.6 (-12.0)	0.0 (0.1)
Mar	---	---	0.6 (6.5)	0.6 (6.8)	0.5 (6.1)	0.6 (6.4)	-0.5 (-5.6)	0.1 (1.5)
Apr	---	---	0.2 (3.0)	0.2 (3.2)	0.2 (3.6)	0.2 (3.0)	-0.1 (-1.1)	0.0 (0.1)
May	---	---	0.1 (0.7)	0.1 (0.6)	0.1 (0.5)	0.1 (0.7)	0.0 (-0.1)	0.0 (0.4)
Jun	---	---	0.0 (0.5)	0.0 (0.5)	0.0 (0.5)	0.0 (0.5)	-0.1 (-0.7)	0.0 (0.0)
Jul	---	---	0.1 (1.9)	0.1 (1.8)	0.1 (1.5)	0.1 (1.9)	-0.2 (-3.9)	0.0 (0.0)
Aug	---	---	0.3 (4.4)	0.3 (4.4)	0.3 (4.6)	0.3 (4.2)	-0.8 (-10.5)	0.0 (0.4)
Sep	---	---	0.6 (6.4)	0.6 (6.7)	0.5 (5.6)	0.6 (6.5)	-0.8 (-7.4)	-0.1 (-0.1)
Oct	---	---	0.6 (6.6)	0.6 (6.5)	0.3 (3.7)	0.6 (6.6)	-0.2 (-2.0)	0.2 (2.3)
Nov	---	---	0.3 (3.1)	0.3 (3.1)	0.4 (3.3)	0.4 (3.2)	-0.8 (-6.8)	-0.1 (-0.9)
Dec	---	---	0.5 (4.1)	0.5 (4.2)	0.5 (3.7)	0.5 (4.1)	-0.7 (-6.1)	0.1 (0.4)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	0.3 (2.9)	1.0 (9.7)	1.1 (9.8)	0.9 (8.4)	1.0 (9.7)	-0.3 (-2.4)	0.4 (4.1)
Feb	---	0.6 (4.9)	1.5 (12.0)	1.5 (12.2)	1.5 (12.4)	1.5 (12.0)	-1.0 (-7.6)	0.6 (5.1)
Mar	---	0.4 (4.8)	1.0 (11.6)	1.0 (11.9)	0.9 (11.2)	1.0 (11.5)	-0.1 (-1.1)	0.5 (6.3)
Apr	---	0.4 (4.2)	0.6 (7.3)	0.6 (7.5)	0.6 (7.9)	0.6 (7.3)	0.3 (3.1)	0.4 (4.3)
May	---	0.1 (1.4)	0.2 (2.1)	0.2 (2.0)	0.2 (1.9)	0.2 (2.1)	0.1 (1.2)	0.1 (1.7)
Jun	---	0.1 (1.2)	0.1 (1.7)	0.1 (1.7)	0.1 (1.7)	0.1 (1.7)	0.0 (0.5)	0.1 (1.2)
Jul	---	0.1 (3.8)	0.2 (5.7)	0.2 (5.6)	0.2 (5.3)	0.2 (5.7)	-0.1 (-0.3)	0.1 (3.7)
Aug	---	0.4 (5.3)	0.7 (9.9)	0.7 (9.8)	0.7 (10.1)	0.7 (9.7)	-0.4 (-5.7)	0.4 (5.7)
Sep	---	0.6 (6.0)	1.2 (12.7)	1.2 (13.0)	1.1 (11.9)	1.2 (12.9)	-0.2 (-1.9)	0.5 (5.9)
Oct	---	0.9 (9.6)	1.5 (16.8)	1.5 (16.7)	1.2 (13.6)	1.5 (16.8)	0.7 (7.3)	1.1 (12.1)
Nov	---	0.6 (6.1)	0.9 (9.4)	0.9 (9.4)	1.0 (9.6)	1.0 (9.4)	-0.2 (-1.1)	0.5 (5.1)
Dec	---	0.8 (7.1)	1.3 (11.5)	1.3 (11.6)	1.3 (11.0)	1.3 (11.5)	0.1 (0.5)	0.9 (7.5)

All alternatives with both the AVC and a Master Contract would have negligible effects on sulfate and uranium concentrations at the Arkansas River near Avondale gage (Table 71 to Table 74). Alternatives without the AVC or a Master Contract would affect water quality less than alternatives that divert water in the AVC or exchange water into Pueblo Reservoir. Compared to existing conditions, sulfate and uranium concentrations would increase in all alternatives.

Table 71. Direct Effects Simulated Sulfate Concentrations for Arkansas River near Avondale Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	252	260	264	262	262	264	261	264
15th percentile	165	168	170	170	169	170	169	170
25th percentile	195	199	201	199	200	201	200	201
50th percentile	257	267	271	269	268	271	268	271
75th percentile	308	319	324	321	322	324	323	324
85th percentile	328	337	342	340	341	342	341	342
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	4 (1.5)	2 (0.8)	2 (0.7)	4 (1.5)	1 (0.3)	4 (1.5)
15th percentile	---	---	2 (1.0)	1 (0.8)	1 (0.5)	2 (1.1)	0 (0.2)	2 (1.0)
25th percentile	---	---	3 (1.3)	1 (0.4)	1 (0.5)	3 (1.3)	1 (0.5)	2 (1.2)
50th percentile	---	---	4 (1.6)	2 (0.7)	1 (0.4)	4 (1.6)	1 (0.2)	4 (1.3)
75th percentile	---	---	5 (1.6)	2 (0.7)	3 (1.0)	5 (1.6)	4 (1.1)	5 (1.5)
85th percentile	---	---	5 (1.5)	2 (0.7)	3 (1.0)	5 (1.5)	4 (1.0)	5 (1.6)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	8 (3.3)	12 (4.9)	10 (4.2)	10 (4.1)	12 (4.9)	9 (3.7)	12 (4.9)
15th percentile	---	3 (1.8)	5 (2.8)	4 (2.7)	4 (2.4)	5 (2.9)	3 (2.0)	5 (2.8)
25th percentile	---	4 (1.9)	6 (3.2)	5 (2.3)	5 (2.4)	6 (3.2)	5 (2.4)	6 (3.1)
50th percentile	---	10 (3.7)	14 (5.4)	12 (4.5)	11 (4.2)	14 (5.4)	10 (4.0)	13 (5.1)
75th percentile	---	12 (3.8)	17 (5.5)	14 (4.5)	15 (4.9)	17 (5.5)	15 (5.0)	16 (5.3)
85th percentile	---	9 (2.6)	14 (4.2)	11 (3.4)	12 (3.7)	14 (4.2)	12 (3.7)	14 (4.2)

Table 72. Monthly Simulated Sulfate Concentration for Arkansas River near Avondale Gage - Direct and Indirect Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	317	326	333	333	329	333	328	330
Feb	333	344	348	348	347	348	343	346
Mar	280	291	300	300	295	299	296	297
Apr	234	247	251	251	248	251	250	250
May	192	195	197	197	196	197	197	196
Jun	154	157	158	158	157	158	157	157
Jul	164	170	172	172	171	172	170	171
Aug	213	218	221	221	219	221	217	219
Sep	259	272	276	276	275	276	270	272
Oct	278	289	295	295	292	296	294	293
Nov	298	307	309	309	310	310	305	306
Dec	320	328	331	331	330	331	327	328
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	7 (2.1)	7 (2.1)	3 (0.9)	7 (2.1)	2 (0.4)	4 (1.2)
Feb	---	---	4 (1.2)	4 (1.3)	3 (0.9)	4 (1.2)	-1 (-0.2)	2 (0.5)
Mar	---	---	9 (3.0)	9 (3.1)	4 (1.5)	8 (2.8)	5 (1.6)	6 (1.9)
Apr	---	---	4 (1.7)	4 (1.7)	1 (0.6)	4 (1.7)	3 (1.5)	3 (1.4)
May	---	---	2 (0.8)	2 (0.8)	1 (0.3)	2 (0.8)	2 (0.7)	1 (0.6)
Jun	---	---	1 (0.5)	1 (0.6)	0 (0.4)	1 (0.5)	0 (0.1)	0 (0.2)
Jul	---	---	2 (1.3)	2 (1.1)	1 (0.7)	2 (1.3)	0 (0.0)	1 (0.6)
Aug	---	---	3 (1.3)	3 (1.3)	1 (0.4)	3 (1.3)	-1 (-0.4)	1 (0.3)
Sep	---	---	4 (1.3)	4 (1.2)	3 (0.8)	4 (1.3)	-2 (-0.9)	0 (-0.1)
Oct	---	---	6 (2.3)	6 (2.2)	3 (1.0)	7 (2.3)	5 (1.8)	4 (1.6)
Nov	---	---	2 (0.7)	2 (0.7)	3 (0.8)	3 (0.7)	-2 (-0.8)	-1 (-0.3)
Dec	---	---	3 (0.9)	3 (0.9)	2 (0.7)	3 (0.9)	-1 (-0.4)	0 (0.0)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	9 (3.1)	16 (5.2)	16 (5.2)	12 (4.0)	16 (5.2)	11 (3.5)	13 (4.3)
Feb	---	11 (3.2)	15 (4.4)	15 (4.5)	14 (4.1)	15 (4.4)	10 (3.0)	13 (3.7)
Mar	---	11 (3.8)	20 (6.9)	20 (6.9)	15 (5.3)	19 (6.7)	16 (5.5)	17 (5.8)
Apr	---	13 (5.2)	17 (7.0)	17 (7.0)	14 (5.8)	17 (7.0)	16 (6.7)	16 (6.6)
May	---	3 (1.9)	5 (2.7)	5 (2.7)	4 (2.2)	5 (2.7)	5 (2.5)	4 (2.4)
Jun	---	3 (1.5)	4 (2.1)	4 (2.1)	3 (1.9)	4 (2.1)	3 (1.7)	3 (1.7)
Jul	---	6 (4.0)	8 (5.3)	8 (5.1)	7 (4.7)	8 (5.3)	6 (3.9)	7 (4.6)
Aug	---	5 (2.4)	8 (3.7)	8 (3.7)	6 (2.7)	8 (3.7)	4 (2.0)	6 (2.7)
Sep	---	13 (5.1)	17 (6.4)	17 (6.4)	16 (6.0)	17 (6.4)	11 (4.2)	13 (5.0)
Oct	---	11 (4.0)	17 (6.3)	17 (6.3)	14 (5.0)	18 (6.4)	16 (5.8)	15 (5.6)
Nov	---	9 (3.0)	11 (3.7)	11 (3.7)	12 (3.8)	12 (3.7)	7 (2.1)	8 (2.6)
Dec	---	8 (2.5)	11 (3.4)	11 (3.4)	10 (3.2)	11 (3.4)	7 (2.1)	8 (2.5)

Table 73. Direct Effects Simulated Uranium Concentrations for Arkansas River near Avondale Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	3.9	4.1	4.2	4.2	4.2	4.2	4.1	4.2
15th percentile	2.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1
25th percentile	2.7	2.8	2.8	2.8	2.8	2.8	2.8	2.8
50th percentile	4.1	4.3	4.4	4.3	4.3	4.4	4.3	4.3
75th percentile	5.2	5.4	5.5	5.5	5.5	5.5	5.5	5.5
85th percentile	5.6	5.8	5.9	5.9	5.9	5.9	5.9	5.9
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0.1 (2.1)	0 (1.1)	0 (1.0)	0.1 (2.1)	0 (0.4)	0.1 (2.1)
15th percentile	---	---	0 (1.7)	0 (1.5)	0 (1.0)	0 (1.9)	0 (0.3)	0 (1.7)
25th percentile	---	---	0.1 (2.0)	0 (0.6)	0 (0.8)	0.1 (2.0)	0 (0.8)	0.1 (1.9)
50th percentile	---	---	0.1 (2.3)	0 (1.0)	0 (0.6)	0.1 (2.2)	0 (0.3)	0.1 (1.8)
75th percentile	---	---	0.1 (2.1)	0 (0.9)	0.1 (1.3)	0.1 (2.1)	0.1 (1.5)	0.1 (1.9)
85th percentile	---	---	0.1 (1.9)	0.1 (0.9)	0.1 (1.3)	0.1 (2.0)	0.1 (1.3)	0.1 (2.0)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	0.2 (4.8)	0.3 (6.9)	0.2 (5.9)	0.2 (5.8)	0.3 (6.9)	0.2 (5.2)	0.3 (6.9)
15th percentile	---	0.1 (3.4)	0.1 (5.2)	0.1 (4.9)	0.1 (4.4)	0.1 (5.4)	0.1 (3.7)	0.1 (5.1)
25th percentile	---	0.1 (3.1)	0.1 (5.2)	0.1 (3.7)	0.1 (3.9)	0.1 (5.2)	0.1 (3.9)	0.1 (5.1)
50th percentile	---	0.2 (5.3)	0.3 (7.7)	0.3 (6.3)	0.2 (5.9)	0.3 (7.6)	0.2 (5.6)	0.3 (7.2)
75th percentile	---	0.3 (5.0)	0.4 (7.2)	0.3 (5.9)	0.3 (6.4)	0.4 (7.2)	0.3 (6.6)	0.4 (7.0)
85th percentile	---	0.2 (3.4)	0.3 (5.4)	0.2 (4.4)	0.3 (4.8)	0.3 (5.5)	0.3 (4.8)	0.3 (5.5)

Table 74. Monthly Simulated Uranium Concentration for Arkansas River near Avondale Gage - Direct and Indirect Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	8.8	9.0	9.1	9.1	9.1	9.1	9.0	9.1
Feb	9.1	9.4	9.5	9.5	9.4	9.5	9.4	9.4
Mar	8.0	8.2	8.4	8.4	8.3	8.4	8.3	8.3
Apr	6.9	7.2	7.3	7.3	7.2	7.3	7.3	7.3
May	6.0	6.1	6.1	6.1	6.1	6.1	6.1	6.1
Jun	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
Jul	5.4	5.5	5.6	5.6	5.5	5.6	5.5	5.5
Aug	6.5	6.6	6.6	6.6	6.6	6.6	6.6	6.6
Sep	7.5	7.8	7.9	7.9	7.8	7.9	7.7	7.8
Oct	7.9	8.2	8.3	8.3	8.2	8.3	8.3	8.3
Nov	8.4	8.6	8.6	8.6	8.6	8.6	8.5	8.5
Dec	8.9	9.0	9.1	9.1	9.1	9.1	9.0	9.0
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.1 (1.7)	0.1 (1.7)	0.1 (0.7)	0.1 (1.7)	0.0 (0.4)	0.1 (0.9)
Feb	---	---	0.1 (1.0)	0.1 (1.0)	0.0 (0.8)	0.1 (1.0)	0.0 (-0.1)	0.0 (0.4)
Mar	---	---	0.2 (2.4)	0.2 (2.4)	0.1 (1.1)	0.2 (2.2)	0.1 (1.3)	0.1 (1.5)
Apr	---	---	0.1 (1.3)	0.1 (1.3)	0.0 (0.4)	0.1 (1.3)	0.1 (1.1)	0.1 (1.1)
May	---	---	0.0 (0.6)	0.0 (0.6)	0.0 (0.2)	0.0 (0.6)	0.0 (0.5)	0.0 (0.4)
Jun	---	---	0.0 (0.4)	0.0 (0.4)	0.0 (0.3)	0.0 (0.4)	0.0 (0.1)	0.0 (0.1)
Jul	---	---	0.1 (0.9)	0.1 (0.7)	0.0 (0.5)	0.1 (0.9)	0.0 (0.0)	0.0 (0.4)
Aug	---	---	0.0 (0.9)	0.0 (1.0)	0.0 (0.3)	0.0 (1.0)	0.0 (-0.3)	0.0 (0.2)
Sep	---	---	0.1 (1.0)	0.1 (1.0)	0.0 (0.6)	0.1 (1.0)	-0.1 (-0.7)	0.0 (-0.1)
Oct	---	---	0.1 (1.8)	0.1 (1.8)	0.0 (0.8)	0.1 (1.8)	0.1 (1.4)	0.1 (1.2)
Nov	---	---	0.0 (0.5)	0.0 (0.5)	0.0 (0.6)	0.0 (0.5)	-0.1 (-0.7)	-0.1 (-0.3)
Dec	---	---	0.1 (0.7)	0.1 (0.7)	0.1 (0.6)	0.1 (0.7)	0.0 (-0.3)	0.0 (0.0)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	0.2 (2.4)	0.3 (4.1)	0.3 (4.2)	0.3 (3.2)	0.3 (4.1)	0.2 (2.8)	0.3 (3.4)
Feb	---	0.3 (2.6)	0.4 (3.6)	0.4 (3.6)	0.3 (3.3)	0.4 (3.6)	0.3 (2.4)	0.3 (3.0)
Mar	---	0.2 (2.9)	0.4 (5.4)	0.4 (5.4)	0.3 (4.1)	0.4 (5.2)	0.3 (4.3)	0.3 (4.5)
Apr	---	0.3 (3.9)	0.4 (5.2)	0.4 (5.2)	0.3 (4.3)	0.4 (5.2)	0.4 (5.0)	0.4 (5.0)
May	---	0.1 (1.3)	0.1 (1.9)	0.1 (1.9)	0.1 (1.6)	0.1 (1.9)	0.1 (1.8)	0.1 (1.7)
Jun	---	0.0 (1.0)	0.0 (1.4)	0.0 (1.4)	0.0 (1.3)	0.0 (1.4)	0.0 (1.1)	0.0 (1.1)
Jul	---	0.1 (2.7)	0.2 (3.6)	0.2 (3.4)	0.1 (3.2)	0.2 (3.6)	0.1 (2.7)	0.1 (3.1)
Aug	---	0.1 (1.7)	0.1 (2.7)	0.1 (2.7)	0.1 (2.0)	0.1 (2.7)	0.1 (1.5)	0.1 (2.0)
Sep	---	0.3 (3.9)	0.4 (4.9)	0.4 (4.9)	0.3 (4.6)	0.4 (4.9)	0.2 (3.2)	0.3 (3.9)
Oct	---	0.3 (3.1)	0.4 (4.9)	0.4 (4.9)	0.3 (3.9)	0.4 (5.0)	0.4 (4.5)	0.4 (4.4)
Nov	---	0.2 (2.4)	0.2 (2.9)	0.2 (2.9)	0.2 (3.0)	0.2 (2.9)	0.1 (1.7)	0.1 (2.1)
Dec	---	0.1 (2.0)	0.2 (2.7)	0.2 (2.7)	0.2 (2.6)	0.2 (2.7)	0.1 (1.6)	0.1 (2.0)

All alternatives except Master Contract Only would have negligible to minor adverse effects on sulfate and uranium concentrations at the Arkansas River at Catlin Dam gage (Table 75 to Table 78). The largest concentration increases occur during winter months at times of low flow. The Master Contract Only Alternative would affect water quality less than alternatives that divert water in the AVC. Compared to existing conditions, sulfate and uranium concentrations would increase because streamflow decreases in all alternatives.

Table 75. Direct Effects Simulated Sulfate Concentrations for Arkansas River at Catlin Dam Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	376	382	389	389	389	389	387	383
15th percentile	208	209	211	211	211	211	210	209
25th percentile	246	256	262	262	261	262	262	260
50th percentile	385	397	402	403	402	402	399	398
75th percentile	478	482	491	489	488	490	488	481
85th percentile	528	525	545	542	537	544	540	527
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	7 (1.8)	7 (1.9)	7 (1.9)	7 (1.9)	4 (1.2)	1 (0.2)
15th percentile	---	---	2 (1.0)	2 (1.0)	2 (1.1)	2 (1.0)	1 (0.4)	0 (0.1)
25th percentile	---	---	6 (2.3)	6 (2.3)	5 (1.9)	6 (2.3)	5 (2.0)	4 (1.5)
50th percentile	---	---	5 (1.4)	6 (1.6)	5 (1.3)	5 (1.3)	2 (0.6)	1 (0.3)
75th percentile	---	---	9 (1.9)	7 (1.5)	6 (1.3)	8 (1.7)	7 (1.4)	0 (-0.1)
85th percentile	---	---	20 (3.9)	17 (3.2)	12 (2.3)	19 (3.7)	14 (2.8)	2 (0.5)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	6 (1.5)	13 (3.4)	13 (3.4)	13 (3.4)	13 (3.4)	10 (2.7)	7 (1.8)
15th percentile	---	1 (0.3)	3 (1.3)	3 (1.3)	3 (1.4)	3 (1.3)	2 (0.7)	1 (0.4)
25th percentile	---	10 (4.2)	16 (6.6)	16 (6.6)	15 (6.2)	16 (6.6)	16 (6.3)	14 (5.8)
50th percentile	---	12 (3.2)	18 (4.6)	19 (4.8)	18 (4.6)	17 (4.5)	15 (3.8)	14 (3.5)
75th percentile	---	4 (0.8)	13 (2.8)	11 (2.3)	10 (2.2)	12 (2.6)	11 (2.3)	3 (0.7)
85th percentile	---	-3 (-0.6)	17 (3.2)	14 (2.6)	9 (1.7)	16 (3.1)	11 (2.1)	-1 (-0.2)

Table 76. Monthly Simulated Sulfate Concentration for Arkansas River at Catlin Dam Gage - Direct and Indirect Effects

Month	Existing Conditions		No Action		Comanche North		Pueblo Dam South		JUP North		Pueblo Dam North		River South		Master Contract Only	
Simulated Concentration (mg/L)																
Jan	500		505		519		520		519		519		515		508	
Feb	539		534		552		552		544		552		547		539	
Mar	441		449		460		459		455		460		459		456	
Apr	342		351		359		360		360		359		359		355	
May	247		253		256		255		255		256		255		254	
Jun	188		192		194		194		194		194		193		191	
Jul	224		231		235		234		233		235		233		235	
Aug	296		300		302		303		302		303		300		298	
Sep	407		418		424		425		426		425		421		416	
Oct	421		437		442		442		444		442		440		436	
Nov	451		455		454		454		464		454		449		445	
Dec	493		492		504		504		506		504		497		493	
Change in Concentration Compared to No Action Alternative [mg/L (%)]																
Jan	---		---		14	(2.7)	15	(2.9)	14	(2.7)	14	(2.7)	10	(1.9)	3	(0.5)
Feb	---		---		18	(3.4)	18	(3.4)	10	(2.0)	18	(3.4)	13	(2.5)	5	(1.1)
Mar	---		---		11	(2.3)	10	(2.2)	6	(1.3)	11	(2.3)	10	(2.1)	7	(1.4)
Apr	---		---		8	(2.0)	9	(2.4)	9	(2.3)	8	(2.1)	8	(2.3)	4	(1.1)
May	---		---		3	(1.2)	2	(1.1)	2	(1.1)	3	(1.3)	2	(1.0)	1	(0.6)
Jun	---		---		2	(0.8)	2	(0.9)	2	(0.9)	2	(0.8)	1	(0.4)	-1	(-0.3)
Jul	---		---		4	(1.9)	3	(1.3)	2	(1.1)	4	(2.0)	2	(1.1)	4	(1.8)
Aug	---		---		2	(0.9)	3	(1.0)	2	(0.9)	3	(1.0)	0	(0.1)	-2	(-0.4)
Sep	---		---		6	(1.6)	7	(1.7)	8	(2.0)	7	(1.7)	3	(0.8)	-2	(-0.4)
Oct	---		---		5	(1.2)	5	(1.2)	7	(1.6)	5	(1.2)	3	(0.9)	-1	(-0.1)
Nov	---		---		-1	(-0.2)	-1	(-0.1)	9	(2.1)	-1	(-0.1)	-6	(-1.2)	-10	(-2.1)
Dec	---		---		12	(2.3)	12	(2.4)	14	(2.7)	12	(2.3)	5	(0.8)	1	(0.1)
Change in Concentration Compared to Existing Conditions [mg/L (%)]																
Jan	---		5	(0.9)	19	(3.7)	20	(3.8)	19	(3.6)	19	(3.7)	15	(2.9)	8	(1.4)
Feb	---		-5	(-1.0)	13	(2.4)	13	(2.4)	5	(1.0)	13	(2.4)	8	(1.5)	0	(0.1)
Mar	---		8	(1.9)	19	(4.3)	18	(4.1)	14	(3.3)	19	(4.3)	18	(4.1)	15	(3.4)
Apr	---		9	(2.7)	17	(4.8)	18	(5.2)	18	(5.1)	17	(4.9)	17	(5.1)	13	(3.8)
May	---		6	(2.3)	9	(3.6)	8	(3.4)	8	(3.4)	9	(3.6)	8	(3.3)	7	(3.0)
Jun	---		4	(2.0)	6	(2.8)	6	(2.9)	6	(2.9)	6	(2.8)	5	(2.4)	3	(1.7)
Jul	---		7	(3.2)	11	(5.1)	10	(4.5)	9	(4.3)	11	(5.3)	9	(4.3)	11	(5.0)
Aug	---		4	(1.2)	6	(2.1)	7	(2.3)	6	(2.1)	7	(2.2)	4	(1.3)	2	(0.8)
Sep	---		11	(2.7)	17	(4.4)	18	(4.5)	19	(4.8)	18	(4.5)	14	(3.5)	9	(2.3)
Oct	---		16	(3.6)	21	(4.9)	21	(4.9)	23	(5.3)	21	(4.9)	19	(4.5)	15	(3.5)
Nov	---		4	(0.8)	3	(0.6)	3	(0.7)	13	(2.9)	3	(0.7)	-2	(-0.4)	-6	(-1.3)
Dec	---		-1	(-0.1)	11	(2.2)	11	(2.3)	13	(2.5)	11	(2.2)	4	(0.7)	0	(0.0)

Table 77. Direct Effects Simulated Uranium Concentrations for Arkansas River at Catlin Dam Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	7.7	7.8	8.0	8.0	8.0	8.0	7.9	7.9
15th percentile	4.6	4.6	4.7	4.7	4.7	4.7	4.6	4.6
25th percentile	5.3	5.5	5.6	5.6	5.6	5.6	5.6	5.6
50th percentile	7.9	8.1	8.2	8.2	8.2	8.2	8.2	8.1
75th percentile	9.6	9.7	9.9	9.8	9.8	9.8	9.8	9.7
85th percentile	10.6	10.5	10.9	10.8	10.7	10.9	10.8	10.5
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0.1 (1.6)	0.1 (1.7)	0.1 (1.7)	0.1 (1.7)	0.1 (1.0)	0 (0.2)
15th percentile	---	---	0 (0.8)	0 (0.8)	0 (0.9)	0 (0.8)	0 (0.4)	0 (0.1)
25th percentile	---	---	0.1 (2.0)	0.1 (2.0)	0.1 (1.7)	0.1 (2.0)	0.1 (1.7)	0.1 (1.3)
50th percentile	---	---	0.1 (1.2)	0.1 (1.4)	0.1 (1.2)	0.1 (1.2)	0 (0.6)	0 (0.3)
75th percentile	---	---	0.2 (1.8)	0.1 (1.4)	0.1 (1.2)	0.2 (1.6)	0.1 (1.3)	0 (-0.1)
85th percentile	---	---	0.4 (3.6)	0.3 (3.0)	0.2 (2.1)	0.4 (3.4)	0.3 (2.6)	0 (0.4)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	0.1 (1.4)	0.2 (3.0)	0.2 (3.1)	0.2 (3.1)	0.2 (3.1)	0.2 (2.4)	0.1 (1.6)
15th percentile	---	0 (0.3)	0 (1.1)	0 (1.1)	0.1 (1.2)	0.1 (1.1)	0 (0.6)	0 (0.4)
25th percentile	---	0.2 (3.6)	0.3 (5.7)	0.3 (5.7)	0.3 (5.4)	0.3 (5.7)	0.3 (5.4)	0.3 (5.0)
50th percentile	---	0.2 (2.9)	0.3 (4.2)	0.3 (4.4)	0.3 (4.1)	0.3 (4.1)	0.3 (3.5)	0.3 (3.2)
75th percentile	---	0.1 (0.8)	0.2 (2.6)	0.2 (2.1)	0.2 (2.0)	0.2 (2.4)	0.2 (2.1)	0.1 (0.7)
85th percentile	---	-0.1 (-0.6)	0.3 (3.0)	0.3 (2.4)	0.2 (1.6)	0.3 (2.8)	0.2 (2.0)	0 (-0.1)

Table 78. Monthly Simulated Uranium Concentration for Arkansas River at Catlin Gage - Direct and Indirect Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	10.2	10.2	10.5	10.5	10.5	10.5	10.4	10.3
Feb	10.9	10.8	11.1	11.1	11.0	11.1	11.0	10.9
Mar	9.1	9.2	9.4	9.4	9.3	9.4	9.4	9.3
Apr	7.2	7.4	7.5	7.6	7.5	7.5	7.5	7.5
May	5.5	5.6	5.6	5.6	5.6	5.6	5.6	5.6
Jun	4.4	4.4	4.5	4.5	4.5	4.5	4.5	4.4
Jul	5.0	5.2	5.2	5.2	5.2	5.2	5.2	5.2
Aug	6.4	6.4	6.5	6.5	6.5	6.5	6.4	6.4
Sep	8.4	8.6	8.8	8.8	8.8	8.8	8.7	8.6
Oct	8.7	9.0	9.1	9.1	9.1	9.1	9.0	9.0
Nov	9.2	9.3	9.3	9.3	9.5	9.3	9.2	9.1
Dec	10.0	10.0	10.2	10.2	10.3	10.2	10.1	10.0
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.3 (2.5)	0.3 (2.6)	0.3 (2.4)	0.3 (2.5)	0.2 (1.8)	0.1 (0.4)
Feb	---	---	0.3 (3.1)	0.3 (3.2)	0.2 (1.8)	0.3 (3.1)	0.2 (2.3)	0.1 (1.0)
Mar	---	---	0.2 (2.1)	0.2 (2.0)	0.1 (1.2)	0.2 (2.1)	0.2 (1.9)	0.1 (1.3)
Apr	---	---	0.1 (1.8)	0.2 (2.1)	0.1 (2.1)	0.1 (1.8)	0.1 (2.0)	0.1 (0.9)
May	---	---	0.0 (1.0)	0.0 (0.9)	0.0 (0.9)	0.0 (1.1)	0.0 (0.8)	0.0 (0.5)
Jun	---	---	0.1 (0.6)	0.1 (0.7)	0.1 (0.7)	0.1 (0.6)	0.1 (0.3)	0.0 (-0.2)
Jul	---	---	0.0 (1.6)	0.0 (1.0)	0.0 (0.9)	0.0 (1.7)	0.0 (0.9)	0.0 (1.5)
Aug	---	---	0.1 (0.8)	0.1 (0.9)	0.1 (0.8)	0.1 (0.8)	0.0 (0.0)	0.0 (-0.4)
Sep	---	---	0.2 (1.5)	0.2 (1.6)	0.2 (1.8)	0.2 (1.5)	0.1 (0.7)	0.0 (-0.4)
Oct	---	---	0.1 (1.1)	0.1 (1.1)	0.1 (1.4)	0.1 (1.1)	0.0 (0.8)	0.0 (-0.1)
Nov	---	---	0.0 (-0.2)	0.0 (-0.1)	0.2 (1.9)	0.0 (-0.1)	-0.1 (-1.1)	-0.2 (-1.9)
Dec	---	---	0.2 (2.1)	0.2 (2.2)	0.3 (2.4)	0.2 (2.1)	0.1 (0.8)	0.0 (0.1)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	0.0 (0.9)	0.3 (3.3)	0.3 (3.5)	0.3 (3.3)	0.3 (3.3)	0.2 (2.6)	0.1 (1.3)
Feb	---	-0.1 (-0.9)	0.2 (2.2)	0.2 (2.3)	0.1 (0.9)	0.2 (2.2)	0.1 (1.4)	0.0 (0.1)
Mar	---	0.1 (1.8)	0.3 (3.9)	0.3 (3.7)	0.2 (3.0)	0.3 (3.9)	0.3 (3.7)	0.2 (3.1)
Apr	---	0.2 (2.4)	0.3 (4.2)	0.4 (4.6)	0.3 (4.5)	0.3 (4.3)	0.3 (4.4)	0.3 (3.4)
May	---	0.1 (2.0)	0.1 (3.0)	0.1 (2.9)	0.1 (2.9)	0.1 (3.0)	0.1 (2.8)	0.1 (2.5)
Jun	---	0.0 (1.6)	0.1 (2.2)	0.1 (2.3)	0.1 (2.3)	0.1 (2.2)	0.1 (1.9)	0.0 (1.3)
Jul	---	0.2 (2.6)	0.2 (4.2)	0.2 (3.7)	0.2 (3.5)	0.2 (4.4)	0.2 (3.6)	0.2 (4.2)
Aug	---	0.0 (1.0)	0.1 (1.8)	0.1 (1.9)	0.1 (1.8)	0.1 (1.9)	0.0 (1.1)	0.0 (0.7)
Sep	---	0.2 (2.5)	0.4 (4.0)	0.4 (4.0)	0.4 (4.3)	0.4 (4.0)	0.3 (3.2)	0.2 (2.1)
Oct	---	0.3 (3.3)	0.4 (4.4)	0.4 (4.4)	0.4 (4.8)	0.4 (4.4)	0.3 (4.1)	0.3 (3.2)
Nov	---	0.1 (0.7)	0.1 (0.6)	0.1 (0.6)	0.3 (2.6)	0.1 (0.6)	0.0 (-0.4)	-0.1 (-1.2)
Dec	---	0.0 (-0.1)	0.2 (2.0)	0.2 (2.1)	0.3 (2.3)	0.2 (2.0)	0.1 (0.7)	0.0 (0.0)

All alternatives would have predominately negligible sulfate and uranium effects at the Arkansas River at Las Animas gage, although occasional minor sulfate increases would occur (Table 79 to Table 82). Concentration compared to existing conditions would typically decrease for all alternatives because of increases in streamflow.

Table 79. Direct Effects Simulated Sulfate Concentrations for Arkansas River at Las Animas Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	972	933	932	934	938	932	931	928
15th percentile	454	449	453	452	447	453	448	443
25th percentile	649	634	631	633	637	631	632	630
50th percentile	1,016	986	989	992	1,001	990	991	987
75th percentile	1,198	1,147	1,144	1,150	1,151	1,143	1,149	1,144
85th percentile	1,380	1,282	1,292	1,292	1,306	1,286	1,292	1,284
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	-1 (-0.1)	1 (0.1)	5 (0.6)	-1 (-0.1)	-2 (-0.2)	-5 (-0.5)
15th percentile	---	---	4 (0.8)	3 (0.8)	-2 (-0.5)	4 (1.0)	-1 (-0.3)	-6 (-1.2)
25th percentile	---	---	-3 (-0.5)	-1 (-0.1)	3 (0.5)	-3 (-0.5)	-2 (-0.3)	-5 (-0.7)
50th percentile	---	---	3 (0.3)	6 (0.6)	15 (1.5)	3 (0.4)	5 (0.5)	1 (0.1)
75th percentile	---	---	-3 (-0.3)	3 (0.2)	4 (0.3)	-5 (-0.4)	1 (0.1)	-3 (-0.3)
85th percentile	---	---	10 (0.7)	10 (0.8)	23 (1.8)	3 (0.2)	10 (0.8)	1 (0.1)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	-39 (-4.0)	-39 (-4.1)	-38 (-3.9)	-33 (-3.4)	-39 (-4.1)	-41 (-4.2)	-44 (-4.5)
15th percentile	---	-5 (-1.1)	-1 (-0.3)	-2 (-0.3)	-7 (-1.6)	-1 (-0.1)	-6 (-1.4)	-11 (-2.3)
25th percentile	---	-15 (-2.3)	-18 (-2.8)	-16 (-2.5)	-12 (-1.8)	-18 (-2.8)	-17 (-2.6)	-20 (-3.1)
50th percentile	---	-30 (-2.9)	-27 (-2.6)	-23 (-2.3)	-15 (-1.4)	-26 (-2.6)	-25 (-2.5)	-29 (-2.8)
75th percentile	---	-50 (-4.2)	-53 (-4.4)	-48 (-4.0)	-47 (-3.9)	-55 (-4.6)	-49 (-4.1)	-53 (-4.5)
85th percentile	---	-98 (-7.1)	-88 (-6.4)	-88 (-6.4)	-75 (-5.4)	-95 (-6.9)	-88 (-6.4)	-97 (-7.0)

Table 80. Monthly Simulated Sulfate Concentration for Arkansas River at Las Animas Gage - Direct and Indirect Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	1,046	1,044	1,061	1,062	1,056	1,061	1,060	1,051
Feb	1,002	986	1,003	1,003	981	1,004	1,003	997
Mar	1,170	1,084	1,030	1,033	1,080	1,030	1,034	1,022
Apr	1,311	1,229	1,195	1,202	1,241	1,192	1,189	1,194
May	775	723	730	731	730	730	732	732
Jun	561	536	537	538	539	537	538	535
Jul	695	650	659	660	657	658	656	650
Aug	783	728	735	738	739	739	730	728
Sep	1,090	1,053	1,045	1,044	1,050	1,041	1,048	1,055
Oct	1,111	1,064	1,100	1,100	1,070	1,102	1,098	1,088
Nov	1,066	1,057	1,037	1,039	1,062	1,038	1,032	1,040
Dec	1,076	1,073	1,082	1,082	1,084	1,082	1,079	1,073
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	17 (1.6)	18 (1.7)	12 (1.1)	17 (1.6)	16 (1.5)	7 (0.6)
Feb	---	---	17 (1.7)	17 (1.6)	-5 (-0.5)	18 (1.8)	17 (1.7)	11 (1.1)
Mar	---	---	-54 (-5.0)	-51 (-4.7)	-4 (-0.4)	-54 (-5.0)	-50 (-4.7)	-62 (-5.7)
Apr	---	---	-34 (-2.8)	-27 (-2.1)	12 (1.0)	-37 (-3.0)	-40 (-3.2)	-35 (-2.8)
May	---	---	7 (1.0)	8 (1.1)	7 (0.9)	7 (1.0)	9 (1.2)	9 (1.2)
Jun	---	---	1 (0.3)	2 (0.3)	3 (0.5)	1 (0.3)	2 (0.3)	-1 (-0.1)
Jul	---	---	9 (1.4)	10 (1.5)	7 (1.1)	8 (1.2)	6 (1.0)	0 (0.0)
Aug	---	---	7 (0.9)	10 (1.3)	11 (1.4)	11 (1.4)	2 (0.2)	0 (0.0)
Sep	---	---	-8 (-0.7)	-9 (-0.9)	-3 (-0.3)	-12 (-1.2)	-5 (-0.5)	2 (0.2)
Oct	---	---	36 (3.3)	36 (3.4)	6 (0.6)	38 (3.5)	34 (3.2)	24 (2.3)
Nov	---	---	-20 (-1.9)	-18 (-1.8)	5 (0.5)	-19 (-1.8)	-25 (-2.4)	-17 (-1.7)
Dec	---	---	9 (0.9)	9 (0.9)	11 (1.1)	9 (0.9)	6 (0.6)	0 (0.0)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	-2 (-0.2)	15 (1.4)	16 (1.5)	10 (0.9)	15 (1.4)	14 (1.3)	5 (0.4)
Feb	---	-16 (-1.6)	1 (0.1)	1 (0.1)	-21 (-2.1)	2 (0.2)	1 (0.1)	-5 (-0.5)
Mar	---	-86 (-7.3)	-140 (-12.0)	-137 (-11.7)	-90 (-7.7)	-140 (-12.0)	-136 (-11.7)	-148 (-12.6)
Apr	---	-82 (-6.3)	-116 (-8.9)	-109 (-8.3)	-70 (-5.4)	-119 (-9.1)	-122 (-9.4)	-117 (-8.9)
May	---	-52 (-6.7)	-45 (-5.7)	-44 (-5.7)	-45 (-5.8)	-45 (-5.7)	-43 (-5.5)	-43 (-5.5)
Jun	---	-25 (-4.5)	-24 (-4.3)	-23 (-4.2)	-22 (-4.0)	-24 (-4.3)	-23 (-4.2)	-26 (-4.6)
Jul	---	-45 (-6.5)	-36 (-5.2)	-35 (-5.1)	-38 (-5.5)	-37 (-5.4)	-39 (-5.6)	-45 (-6.5)
Aug	---	-55 (-6.9)	-48 (-6.1)	-45 (-5.7)	-44 (-5.6)	-44 (-5.6)	-53 (-6.7)	-55 (-6.9)
Sep	---	-37 (-3.4)	-45 (-4.1)	-46 (-4.3)	-40 (-3.7)	-49 (-4.5)	-42 (-3.9)	-35 (-3.2)
Oct	---	-47 (-4.2)	-11 (-1.0)	-11 (-0.9)	-41 (-3.6)	-9 (-0.8)	-13 (-1.2)	-23 (-2.0)
Nov	---	-9 (-0.8)	-29 (-2.7)	-27 (-2.6)	-4 (-0.4)	-28 (-2.6)	-34 (-3.2)	-26 (-2.5)
Dec	---	-3 (-0.3)	6 (0.5)	6 (0.6)	8 (0.8)	6 (0.5)	3 (0.3)	-3 (-0.3)

Table 81. Direct Effects Simulated Uranium Concentrations for Arkansas River at Las Animas Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	14.6	14.0	14.0	14.1	14.1	14.0	14.0	14.0
15th percentile	6.6	6.5	6.5	6.5	6.4	6.5	6.5	6.4
25th percentile	9.6	9.4	9.3	9.4	9.4	9.3	9.3	9.3
50th percentile	15.3	14.9	14.9	15.0	15.1	14.9	14.9	14.9
75th percentile	18.2	17.4	17.3	17.4	17.4	17.3	17.4	17.3
85th percentile	21.0	19.5	19.6	19.7	19.9	19.5	19.7	19.5
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0 (-0.1)	0 (0.1)	0.1 (0.6)	0 (-0.1)	0 (-0.2)	-0.1 (-0.5)
15th percentile	---	---	0.1 (0.9)	0.1 (0.8)	0 (-0.6)	0.1 (1.1)	0 (-0.3)	-0.1 (-1.3)
25th percentile	---	---	0 (-0.5)	0 (-0.2)	0 (0.5)	0 (-0.5)	0 (-0.3)	-0.1 (-0.8)
50th percentile	---	---	0 (0.3)	0.1 (0.7)	0.2 (1.6)	0.1 (0.4)	0.1 (0.5)	0 (0.1)
75th percentile	---	---	0 (-0.3)	0 (0.3)	0.1 (0.3)	-0.1 (-0.4)	0 (0.1)	0 (-0.3)
85th percentile	---	---	0.1 (0.8)	0.2 (0.8)	0.4 (1.8)	0 (0.3)	0.2 (0.8)	0 (0.1)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	-0.6 (-4.1)	-0.6 (-4.2)	-0.6 (-4.0)	-0.5 (-3.6)	-0.6 (-4.2)	-0.6 (-4.3)	-0.7 (-4.6)
15th percentile	---	-0.1 (-1.2)	0 (-0.3)	0 (-0.4)	-0.1 (-1.8)	0 (-0.2)	-0.1 (-1.5)	-0.2 (-2.5)
25th percentile	---	-0.2 (-2.5)	-0.3 (-3.0)	-0.3 (-2.6)	-0.2 (-2.0)	-0.3 (-3.0)	-0.3 (-2.8)	-0.3 (-3.2)
50th percentile	---	-0.5 (-3.0)	-0.4 (-2.7)	-0.4 (-2.4)	-0.2 (-1.5)	-0.4 (-2.7)	-0.4 (-2.5)	-0.4 (-2.9)
75th percentile	---	-0.8 (-4.3)	-0.8 (-4.6)	-0.7 (-4.1)	-0.7 (-4.0)	-0.9 (-4.7)	-0.8 (-4.2)	-0.8 (-4.6)
85th percentile	---	-1.5 (-7.3)	-1.4 (-6.6)	-1.4 (-6.5)	-1.2 (-5.6)	-1.5 (-7.0)	-1.4 (-6.6)	-1.5 (-7.2)

Table 82. Monthly Simulated Uranium Concentration for Arkansas River at Las Animas - Direct and Indirect Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	20.2	20.2	20.4	20.5	20.4	20.4	20.4	20.3
Feb	19.5	19.3	19.5	19.5	19.2	19.5	19.5	19.4
Mar	22.1	20.8	20.0	20.0	20.7	20.0	20.0	19.8
Apr	24.4	23.1	22.5	22.6	23.3	22.5	22.4	22.5
May	16.0	15.2	15.3	15.3	15.3	15.3	15.3	15.3
Jun	12.6	12.2	12.3	12.3	12.3	12.3	12.3	12.2
Jul	14.7	14.0	14.2	14.2	14.1	14.1	14.1	14.0
Aug	16.1	15.2	15.3	15.4	15.4	15.4	15.3	15.2
Sep	20.9	20.3	20.2	20.2	20.3	20.1	20.2	20.3
Oct	21.2	20.5	21.0	21.1	20.6	21.1	21.0	20.9
Nov	20.5	20.4	20.1	20.1	20.5	20.1	20.0	20.1
Dec	20.7	20.6	20.8	20.8	20.8	20.8	20.7	20.6
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.2 (1.3)	0.3 (1.4)	0.2 (0.9)	0.2 (1.3)	0.2 (1.2)	0.1 (0.5)
Feb	---	---	0.2 (1.4)	0.2 (1.3)	-0.1 (-0.4)	0.2 (1.4)	0.2 (1.4)	0.1 (0.9)
Mar	---	---	-0.8 (-4.1)	-0.8 (-3.8)	-0.1 (-0.3)	-0.8 (-4.1)	-0.8 (-3.8)	-1.0 (-4.7)
Apr	---	---	-0.6 (-2.3)	-0.5 (-1.8)	0.2 (0.8)	-0.6 (-2.5)	-0.7 (-2.7)	-0.6 (-2.3)
May	---	---	0.1 (0.8)	0.1 (0.8)	0.1 (0.7)	0.1 (0.8)	0.1 (0.9)	0.1 (0.9)
Jun	---	---	0.1 (0.2)	0.1 (0.2)	0.1 (0.4)	0.1 (0.2)	0.1 (0.2)	0.0 (-0.1)
Jul	---	---	0.2 (1.0)	0.2 (1.1)	0.1 (0.8)	0.1 (0.9)	0.1 (0.7)	0.0 (0.0)
Aug	---	---	0.1 (0.7)	0.2 (1.0)	0.2 (1.1)	0.2 (1.1)	0.1 (0.2)	0.0 (0.0)
Sep	---	---	-0.1 (-0.6)	-0.1 (-0.7)	0.0 (-0.2)	-0.2 (-0.9)	-0.1 (-0.4)	0.0 (0.2)
Oct	---	---	0.5 (2.7)	0.6 (2.8)	0.1 (0.5)	0.6 (2.9)	0.5 (2.6)	0.4 (1.8)
Nov	---	---	-0.3 (-1.6)	-0.3 (-1.4)	0.1 (0.4)	-0.3 (-1.5)	-0.4 (-1.9)	-0.3 (-1.4)
Dec	---	---	0.2 (0.7)	0.2 (0.7)	0.2 (0.9)	0.2 (0.7)	0.1 (0.5)	0.0 (0.0)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	0.0 (-0.1)	0.2 (1.1)	0.3 (1.2)	0.2 (0.7)	0.2 (1.2)	0.2 (1.1)	0.1 (0.4)
Feb	---	-0.2 (-1.2)	0.0 (0.1)	0.0 (0.1)	-0.3 (-1.7)	0.0 (0.1)	0.0 (0.1)	-0.1 (-0.4)
Mar	---	-1.3 (-6.1)	-2.1 (-9.9)	-2.1 (-9.7)	-1.4 (-6.3)	-2.1 (-9.9)	-2.1 (-9.6)	-2.3 (-10.4)
Apr	---	-1.3 (-5.3)	-1.9 (-7.5)	-1.8 (-7.0)	-1.1 (-4.5)	-1.9 (-7.7)	-2.0 (-7.9)	-1.9 (-7.5)
May	---	-0.8 (-5.0)	-0.7 (-4.3)	-0.7 (-4.3)	-0.7 (-4.4)	-0.7 (-4.3)	-0.7 (-4.2)	-0.7 (-4.2)
Jun	---	-0.4 (-3.1)	-0.3 (-3.0)	-0.3 (-2.9)	-0.3 (-2.8)	-0.3 (-3.0)	-0.3 (-2.9)	-0.4 (-3.2)
Jul	---	-0.7 (-4.8)	-0.5 (-3.9)	-0.5 (-3.7)	-0.6 (-4.0)	-0.6 (-4.0)	-0.6 (-4.1)	-0.7 (-4.8)
Aug	---	-0.9 (-5.3)	-0.8 (-4.6)	-0.7 (-4.3)	-0.7 (-4.3)	-0.7 (-4.3)	-0.8 (-5.1)	-0.9 (-5.3)
Sep	---	-0.6 (-2.8)	-0.7 (-3.4)	-0.7 (-3.5)	-0.6 (-3.0)	-0.8 (-3.7)	-0.7 (-3.2)	-0.6 (-2.6)
Oct	---	-0.7 (-3.4)	-0.2 (-0.8)	-0.1 (-0.8)	-0.6 (-3.0)	-0.1 (-0.7)	-0.2 (-0.9)	-0.3 (-1.7)
Nov	---	-0.1 (-0.7)	-0.4 (-2.2)	-0.4 (-2.1)	0.0 (-0.3)	-0.4 (-2.1)	-0.5 (-2.6)	-0.4 (-2.0)
Dec	---	-0.1 (-0.3)	0.1 (0.4)	0.1 (0.5)	0.1 (0.6)	0.1 (0.4)	0.0 (0.3)	-0.1 (-0.2)

All alternatives would have negligible effects on sulfate concentrations at the Fountain Creek near Fountain gage (Table 83 to Table 84). Sulfate concentrations would increase for all alternatives compared to existing conditions. Uranium effects were not assessed at this gage because data were not available to develop a relationship to salinity concentrations.

Table 83. Direct Effects Simulated Sulfate Concentrations for Fountain Creek near Fountain Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	227	253	255	255	253	255	255	256
15th percentile	156	193	194	194	193	194	193	194
25th percentile	186	217	217	217	217	217	215	218
50th percentile	235	256	258	258	255	257	258	258
75th percentile	270	289	294	294	289	294	294	295
85th percentile	285	314	314	314	313	314	314	314
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	2 (0.7)	2 (0.6)	0 (0.0)	2 (0.6)	1 (0.6)	2 (0.9)
15th percentile	---	---	2 (0.9)	1 (0.7)	0 (0.0)	1 (0.7)	0 (0.0)	2 (0.9)
25th percentile	---	---	0 (0.1)	0 (0.0)	0 (0.2)	0 (0.0)	-2 (-0.8)	1 (0.3)
50th percentile	---	---	1 (0.4)	1 (0.4)	-2 (-0.7)	1 (0.4)	1 (0.4)	1 (0.5)
75th percentile	---	---	6 (2.0)	6 (2.0)	0 (0.0)	6 (2.0)	6 (2.0)	6 (2.1)
85th percentile	---	---	0 (0.1)	0 (0.1)	-1 (-0.3)	0 (0.1)	0 (0.1)	0 (0.1)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	26 (11.4)	28 (12.2)	28 (12.1)	26 (11.4)	28 (12.1)	27 (12.0)	28 (12.4)
15th percentile	---	36 (23.2)	38 (24.3)	38 (24.1)	36 (23.2)	38 (24.1)	36 (23.2)	38 (24.3)
25th percentile	---	31 (16.7)	31 (16.8)	31 (16.7)	31 (16.9)	31 (16.7)	29 (15.7)	32 (17.0)
50th percentile	---	21 (8.9)	22 (9.3)	22 (9.4)	19 (8.1)	22 (9.3)	22 (9.4)	22 (9.4)
75th percentile	---	19 (6.9)	24 (9.0)	24 (9.0)	19 (6.9)	24 (9.0)	24 (9.0)	25 (9.1)
85th percentile	---	29 (10.1)	29 (10.2)	29 (10.2)	28 (9.8)	29 (10.2)	29 (10.2)	29 (10.2)

Table 84. Monthly Simulated Sulfate Concentration for Fountain Creek near Fountain Gage - Direct and Indirect Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	245	272	276	276	272	276	272	276
Feb	242	266	271	271	266	271	271	272
Mar	233	255	262	260	256	260	261	261
Apr	203	250	250	250	249	250	253	254
May	191	223	227	227	225	227	227	226
Jun	201	227	228	228	227	228	228	228
Jul	196	234	234	234	234	234	234	234
Aug	208	218	217	217	217	217	217	218
Sep	232	275	272	272	272	272	269	274
Oct	269	282	285	285	285	285	285	285
Nov	256	271	271	271	271	271	271	271
Dec	262	273	272	272	272	272	272	272
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	4 (1.3)	4 (1.3)	0 (-0.2)	4 (1.3)	0 (0.0)	4 (1.5)
Feb	---	---	5 (1.9)	5 (1.9)	0 (0.2)	5 (2.0)	5 (2.0)	6 (2.2)
Mar	---	---	7 (2.7)	5 (2.1)	1 (0.5)	5 (2.0)	6 (2.4)	6 (2.5)
Apr	---	---	0 (0.2)	0 (0.1)	-1 (-0.2)	0 (0.2)	3 (1.4)	4 (1.4)
May	---	---	4 (1.7)	4 (1.7)	2 (0.7)	4 (1.8)	4 (1.8)	3 (1.2)
Jun	---	---	1 (0.3)	1 (0.4)	0 (0.0)	1 (0.3)	1 (0.4)	1 (0.3)
Jul	---	---	0 (0.1)	0 (0.1)	0 (0.0)	0 (0.1)	0 (0.1)	0 (0.1)
Aug	---	---	-1 (-0.2)	-1 (-0.2)	-1 (-0.4)	-1 (-0.2)	-1 (-0.2)	0 (-0.1)
Sep	---	---	-3 (-1.1)	-3 (-1.1)	-3 (-1.0)	-3 (-1.1)	-6 (-2.1)	-1 (-0.3)
Oct	---	---	3 (1.1)	3 (1.0)	3 (1.1)	3 (1.0)	3 (1.1)	3 (1.1)
Nov	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Dec	---	---	-1 (-0.4)	-1 (-0.4)	-1 (-0.5)	-1 (-0.4)	-1 (-0.4)	-1 (-0.4)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	27 (11.2)	31 (12.7)	31 (12.7)	27 (11.0)	31 (12.7)	27 (11.2)	31 (12.9)
Feb	---	24 (10.0)	29 (12.1)	29 (12.2)	24 (10.2)	29 (12.2)	29 (12.2)	30 (12.4)
Mar	---	22 (9.4)	29 (12.3)	27 (11.7)	23 (9.9)	27 (11.6)	28 (12.0)	28 (12.2)
Apr	---	47 (23.2)	47 (23.4)	47 (23.4)	46 (23.0)	47 (23.4)	50 (24.9)	51 (25.0)
May	---	32 (17.0)	36 (19.0)	36 (19.0)	34 (17.8)	36 (19.1)	36 (19.0)	35 (18.4)
Jun	---	26 (13.4)	27 (13.8)	27 (13.8)	26 (13.4)	27 (13.7)	27 (13.8)	27 (13.7)
Jul	---	38 (19.1)	38 (19.2)	38 (19.2)	38 (19.1)	38 (19.2)	38 (19.2)	38 (19.2)
Aug	---	10 (4.4)	9 (4.2)	9 (4.2)	9 (4.0)	9 (4.2)	9 (4.2)	10 (4.3)
Sep	---	43 (18.4)	40 (17.2)	40 (17.2)	40 (17.2)	40 (17.2)	37 (15.9)	42 (18.1)
Oct	---	13 (4.9)	16 (6.0)	16 (6.0)	16 (6.0)	16 (6.0)	16 (6.0)	16 (6.0)
Nov	---	15 (5.8)	15 (5.8)	15 (5.8)	15 (5.8)	15 (5.8)	15 (5.8)	15 (5.8)
Dec	---	11 (4.5)	10 (4.1)	10 (4.1)	10 (4.0)	10 (4.1)	10 (4.1)	10 (4.1)

All alternatives would have negligible effects on sulfate concentrations at the Fountain Creek at Pueblo gage (Table 85 to Table 86) as changes are around 2 percent or less. Sulfate concentrations would increase for all alternatives compared to existing conditions.

Uranium effects would be predominately negligible, compared to the No Action Alternative, and concentrations would increase for all alternatives compared to existing conditions (Table 87 and Table 88).

Table 85. Direct Effects Simulated Sulfate Concentrations for Fountain Creek at Pueblo Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	264	300	300	300	300	300	300	301
15th percentile	131	163	162	161	167	162	162	162
25th percentile	176	214	221	218	213	218	216	222
50th percentile	270	308	312	311	308	310	308	313
75th percentile	358	384	383	383	383	383	382	384
85th percentile	394	421	420	420	421	420	420	420
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	0 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (-0.1)	1 (0.4)
15th percentile	---	---	-1 (-0.8)	-2 (-1.0)	4 (2.7)	-2 (-0.9)	-1 (-0.8)	-1 (-0.5)
25th percentile	---	---	7 (3.2)	4 (2.0)	0 (-0.2)	4 (2.1)	2 (1.0)	8 (3.9)
50th percentile	---	---	4 (1.2)	2 (0.8)	0 (-0.1)	2 (0.7)	0 (-0.1)	4 (1.4)
75th percentile	---	---	-1 (-0.3)	-1 (-0.3)	-2 (-0.4)	-1 (-0.3)	-3 (-0.7)	0 (0.0)
85th percentile	---	---	-1 (-0.2)	-1 (-0.2)	-1 (-0.1)	-1 (-0.2)	-1 (-0.2)	-1 (-0.2)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	36 (13.7)	36 (13.8)	36 (13.7)	36 (13.7)	36 (13.7)	36 (13.6)	37 (14.1)
15th percentile	---	32 (24.8)	31 (23.8)	31 (23.5)	37 (28.1)	31 (23.6)	31 (23.8)	32 (24.1)
25th percentile	---	38 (21.7)	45 (25.6)	42 (24.1)	38 (21.4)	43 (24.2)	40 (22.9)	46 (26.3)
50th percentile	---	38 (14.2)	42 (15.6)	41 (15.1)	38 (14.1)	40 (15.0)	38 (14.2)	43 (15.8)
75th percentile	---	26 (7.4)	25 (7.0)	25 (7.0)	25 (6.9)	25 (7.0)	24 (6.7)	26 (7.4)
85th percentile	---	27 (6.9)	26 (6.6)	26 (6.6)	27 (6.7)	26 (6.6)	26 (6.6)	26 (6.7)

Table 86. Monthly Simulated Sulfate Concentration for Fountain Creek at Pueblo Gage - Direct and Indirect Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	294	333	332	332	331	332	326	333
Feb	302	336	339	339	337	339	339	340
Mar	273	304	311	309	306	309	311	312
Apr	242	311	305	305	310	305	309	309
May	190	240	243	244	243	243	244	242
Jun	205	248	249	249	248	249	249	249
Jul	197	255	255	255	255	255	255	255
Aug	220	231	230	230	230	230	230	231
Sep	229	299	294	293	294	293	288	297
Oct	361	366	371	371	371	371	371	371
Nov	319	333	332	332	333	332	332	332
Dec	345	351	346	346	349	346	346	346
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	-1 (-0.1)	-1 (-0.1)	-2 (-0.4)	-1 (-0.1)	-7 (-2.0)	0 (0.1)
Feb	---	---	3 (0.7)	3 (0.6)	1 (0.1)	3 (0.7)	3 (0.7)	4 (1.0)
Mar	---	---	7 (2.4)	5 (1.7)	2 (0.7)	5 (1.7)	7 (2.2)	8 (2.5)
Apr	---	---	-6 (-1.7)	-6 (-1.8)	-1 (-0.3)	-6 (-1.8)	-2 (-0.6)	-2 (-0.5)
May	---	---	3 (1.5)	4 (1.5)	3 (1.3)	3 (1.5)	4 (1.8)	2 (1.0)
Jun	---	---	1 (0.4)	1 (0.5)	0 (0.0)	1 (0.4)	1 (0.6)	1 (0.6)
Jul	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Aug	---	---	-1 (-0.5)	-1 (-0.5)	-1 (-0.6)	-1 (-0.5)	-1 (-0.4)	0 (-0.2)
Sep	---	---	-5 (-1.8)	-6 (-1.8)	-5 (-1.5)	-6 (-1.8)	-11 (-3.6)	-2 (-0.6)
Oct	---	---	5 (1.4)	5 (1.4)	5 (1.4)	5 (1.4)	5 (1.4)	5 (1.4)
Nov	---	---	-1 (-0.2)	-1 (-0.1)	0 (0.0)	-1 (-0.2)	-1 (-0.2)	-1 (-0.1)
Dec	---	---	-5 (-1.4)	-5 (-1.4)	-2 (-0.7)	-5 (-1.4)	-5 (-1.4)	-5 (-1.3)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	39 (13.1)	38 (13.0)	38 (13.0)	37 (12.6)	38 (13.0)	32 (10.8)	39 (13.2)
Feb	---	34 (11.2)	37 (12.0)	37 (11.9)	35 (11.4)	37 (12.0)	37 (12.0)	38 (12.3)
Mar	---	31 (11.3)	38 (14.0)	36 (13.2)	33 (12.1)	36 (13.1)	38 (13.7)	39 (14.1)
Apr	---	69 (28.4)	63 (26.2)	63 (26.0)	68 (28.0)	63 (26.1)	67 (27.6)	67 (27.7)
May	---	50 (26.2)	53 (28.1)	54 (28.1)	53 (27.8)	53 (28.1)	54 (28.5)	52 (27.4)
Jun	---	43 (21.1)	44 (21.6)	44 (21.6)	43 (21.1)	44 (21.5)	44 (21.8)	44 (21.8)
Jul	---	58 (29.6)	58 (29.6)	58 (29.6)	58 (29.6)	58 (29.6)	58 (29.6)	58 (29.6)
Aug	---	11 (5.1)	10 (4.6)	10 (4.6)	10 (4.4)	10 (4.6)	10 (4.6)	11 (4.9)
Sep	---	70 (30.8)	65 (28.4)	64 (28.4)	65 (28.9)	64 (28.4)	59 (26.2)	68 (30.1)
Oct	---	5 (1.3)	10 (2.7)	10 (2.7)	10 (2.7)	10 (2.7)	10 (2.7)	10 (2.7)
Nov	---	14 (4.5)	13 (4.3)	13 (4.3)	14 (4.4)	13 (4.3)	13 (4.3)	13 (4.3)
Dec	---	6 (1.8)	1 (0.4)	1 (0.4)	4 (1.2)	1 (0.5)	1 (0.4)	1 (0.5)

Table 87. Direct Effects Simulated Uranium Concentrations for Fountain Creek at Pueblo Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	2.4	2.9	2.9	2.9	2.9	2.9	2.9	2.9
15th percentile	0.6	1.1	1.0	1.0	1.1	1.0	1.0	1.0
25th percentile	1.2	1.7	1.8	1.8	1.7	1.8	1.8	1.8
50th percentile	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0
75th percentile	3.6	4.0	4.0	4.0	4.0	4.0	3.9	4.0
85th percentile	4.1	4.5	4.4	4.4	4.5	4.4	4.4	4.4
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (-0.1)	0 (0.5)
15th percentile	---	---	0 (-1.7)	0 (-2.1)	0.1 (5.5)	0 (-1.9)	0 (-1.6)	0 (-1.1)
25th percentile	---	---	0.1 (5.3)	0.1 (3.3)	0 (-0.4)	0.1 (3.4)	0 (1.7)	0.1 (6.3)
50th percentile	---	---	0 (1.6)	0 (1.1)	0 (-0.1)	0 (0.9)	0 (-0.1)	0.1 (1.9)
75th percentile	---	---	0 (-0.4)	0 (-0.4)	0 (-0.5)	0 (-0.4)	0 (-0.8)	0 (0.0)
85th percentile	---	---	0 (-0.3)	0 (-0.3)	0 (-0.1)	0 (-0.3)	0 (-0.3)	0 (-0.2)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	0.5 (20.0)	0.5 (20.2)	0.5 (20.1)	0.5 (20.0)	0.5 (20.1)	0.5 (19.9)	0.5 (20.6)
15th percentile	---	0.4 (68.6)	0.4 (65.8)	0.4 (65.0)	0.5 (77.9)	0.4 (65.4)	0.4 (65.9)	0.4 (66.8)
25th percentile	---	0.5 (41.2)	0.6 (48.7)	0.6 (45.9)	0.5 (40.7)	0.6 (46.0)	0.5 (43.6)	0.6 (50.2)
50th percentile	---	0.5 (20.6)	0.6 (22.5)	0.5 (21.9)	0.5 (20.5)	0.5 (21.7)	0.5 (20.5)	0.6 (22.9)
75th percentile	---	0.3 (9.6)	0.3 (9.1)	0.3 (9.1)	0.3 (9.1)	0.3 (9.1)	0.3 (8.7)	0.3 (9.7)
85th percentile	---	0.4 (8.7)	0.3 (8.4)	0.3 (8.4)	0.4 (8.5)	0.3 (8.4)	0.3 (8.4)	0.3 (8.5)

Table 88. Monthly Simulated Uranium Concentration for Fountain Creek at Pueblo - Direct and Indirect Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	2.8	3.3	3.3	3.3	3.3	3.3	3.2	3.3
Feb	2.9	3.3	3.4	3.4	3.3	3.4	3.4	3.4
Mar	2.5	2.9	3.0	3.0	2.9	3.0	3.0	3.0
Apr	2.1	3.0	2.9	2.9	3.0	2.9	3.0	3.0
May	1.4	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Jun	1.6	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Jul	1.5	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Aug	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Sep	1.9	2.8	2.8	2.8	2.8	2.8	2.7	2.8
Oct	3.7	3.7	3.8	3.8	3.8	3.8	3.8	3.8
Nov	3.1	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Dec	3.4	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.0 (-0.1)	0.0 (-0.1)	0.0 (-0.5)	0.0 (-0.1)	-0.1 (-2.7)	0.0 (0.1)
Feb	---	---	0.1 (0.9)	0.1 (0.9)	0.0 (0.2)	0.1 (1.0)	0.1 (0.9)	0.1 (1.3)
Mar	---	---	0.1 (3.4)	0.1 (2.3)	0.0 (1.0)	0.1 (2.3)	0.1 (3.1)	0.1 (3.5)
Apr	---	---	-0.1 (-2.3)	-0.1 (-2.5)	0.0 (-0.4)	-0.1 (-2.4)	0.0 (-0.8)	0.0 (-0.7)
May	---	---	0.0 (2.3)	0.0 (2.4)	0.0 (1.9)	0.0 (2.3)	0.0 (2.8)	0.0 (1.5)
Jun	---	---	0.0 (0.6)	0.0 (0.7)	0.0 (0.0)	0.0 (0.5)	0.0 (0.8)	0.0 (0.8)
Jul	---	---	0.0 (0.0)	0.0 (0.1)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Aug	---	---	0.0 (-0.7)	0.0 (-0.7)	0.0 (-1.0)	0.0 (-0.7)	0.0 (-0.7)	0.0 (-0.3)
Sep	---	---	0.0 (-2.5)	0.0 (-2.6)	0.0 (-2.1)	0.0 (-2.6)	-0.1 (-4.9)	0.0 (-0.8)
Oct	---	---	0.1 (1.8)	0.1 (1.8)	0.1 (1.9)	0.1 (1.8)	0.1 (1.9)	0.1 (1.8)
Nov	---	---	0.0 (-0.2)	0.0 (-0.2)	0.0 (0.0)	0.0 (-0.2)	0.0 (-0.2)	0.0 (-0.2)
Dec	---	---	0.0 (-1.8)	0.0 (-1.8)	0.0 (-0.9)	0.0 (-1.8)	0.0 (-1.8)	0.0 (-1.7)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	0.5 (18.3)	0.5 (18.1)	0.5 (18.1)	0.5 (17.7)	0.5 (18.1)	0.4 (15.1)	0.5 (18.4)
Feb	---	0.4 (15.5)	0.5 (16.5)	0.5 (16.5)	0.4 (15.7)	0.5 (16.6)	0.5 (16.6)	0.5 (17.0)
Mar	---	0.4 (16.2)	0.5 (20.1)	0.5 (18.9)	0.4 (17.4)	0.5 (18.9)	0.5 (19.8)	0.5 (20.3)
Apr	---	0.9 (43.3)	0.8 (40.0)	0.8 (39.7)	0.9 (42.7)	0.8 (39.9)	0.9 (42.2)	0.9 (42.2)
May	---	0.7 (46.7)	0.7 (50.0)	0.7 (50.2)	0.7 (49.5)	0.7 (50.1)	0.7 (50.7)	0.7 (48.9)
Jun	---	0.6 (35.6)	0.6 (36.4)	0.6 (36.5)	0.6 (35.6)	0.6 (36.3)	0.6 (36.7)	0.6 (36.7)
Jul	---	0.8 (51.4)	0.8 (51.4)	0.8 (51.5)	0.8 (51.4)	0.8 (51.4)	0.8 (51.3)	0.8 (51.4)
Aug	---	0.1 (8.2)	0.1 (7.4)	0.1 (7.4)	0.1 (7.1)	0.1 (7.4)	0.1 (7.4)	0.1 (7.9)
Sep	---	0.9 (48.6)	0.9 (44.8)	0.9 (44.8)	0.9 (45.5)	0.9 (44.8)	0.8 (41.3)	0.9 (47.4)
Oct	---	0.0 (1.6)	0.1 (3.5)	0.1 (3.5)	0.1 (3.5)	0.1 (3.5)	0.1 (3.5)	0.1 (3.5)
Nov	---	0.2 (6.1)	0.2 (5.8)	0.2 (5.9)	0.2 (6.0)	0.2 (5.8)	0.2 (5.8)	0.2 (5.9)
Dec	---	0.1 (2.4)	0.1 (0.6)	0.1 (0.6)	0.1 (1.5)	0.1 (0.6)	0.1 (0.6)	0.1 (0.6)

Cumulative Effects

All alternatives would have negligible to minor adverse cumulative effects on sulfate and uranium concentrations, compared to No Action, at the Arkansas River at Moffat St. gage (Table 89 to Table 92) except River South and Master Contract Only. The largest increases would occur in drier months in the fall and winter. All alternatives would increase sulfate and uranium concentrations compared to existing conditions.

Table 89. Cumulative Effects Simulated Sulfate Concentrations for Arkansas River at Moffat St. Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	178	213	224	224	224	224	198	214
15th percentile	84	92	96	95	95	95	90	92
25th percentile	110	128	131	131	130	131	127	128
50th percentile	158	192	201	201	201	201	179	191
75th percentile	198	241	253	254	254	254	231	242
85th percentile	219	277	288	289	286	288	268	278
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	11 (5.1)	11 (5.1)	10 (4.8)	11 (5.2)	-15 (-7.0)	1 (0.3)
15th percentile	---	---	4 (4.0)	3 (3.4)	3 (3.5)	3 (3.5)	-3 (-2.8)	0 (0.2)
25th percentile	---	---	3 (2.4)	3 (2.1)	2 (1.9)	3 (2.5)	-1 (-1.0)	0 (0.3)
50th percentile	---	---	9 (4.7)	9 (4.6)	9 (4.5)	9 (4.8)	-13 (-6.7)	-1 (-0.4)
75th percentile	---	---	13 (5.3)	14 (5.7)	13 (5.4)	14 (5.7)	-9 (-3.9)	1 (0.4)
85th percentile	---	---	12 (4.2)	12 (4.3)	10 (3.5)	11 (4.1)	-9 (-3.3)	1 (0.4)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	36 (20.0)	46 (26.1)	46 (26.1)	46 (25.7)	47 (26.2)	21 (11.5)	36 (20.3)
15th percentile	---	8 (9.9)	12 (14.3)	11 (13.6)	11 (13.7)	12 (13.8)	6 (6.9)	8 (10.1)
25th percentile	---	18 (16.6)	21 (19.4)	21 (19.0)	21 (18.8)	21 (19.5)	17 (15.5)	19 (16.9)
50th percentile	---	34 (21.5)	43 (27.3)	43 (27.1)	43 (27.0)	43 (27.3)	21 (13.3)	33 (21.0)
75th percentile	---	42 (21.3)	55 (27.7)	56 (28.2)	55 (27.8)	56 (28.2)	33 (16.6)	43 (21.8)
85th percentile	---	58 (26.6)	70 (31.9)	70 (32.1)	68 (31.0)	70 (31.8)	49 (22.4)	59 (27.1)

Table 90. Monthly Simulated Sulfate Concentration for Arkansas River at Moffat St. Gage - Cumulative Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	238	261	276	277	276	277	242	261
Feb	270	275	298	298	297	298	240	276
Mar	179	204	214	215	215	215	184	203
Apr	160	191	198	198	197	198	186	192
May	148	180	183	183	185	184	175	182
Jun	93	104	105	105	105	105	102	103
Jul	85	103	107	107	108	107	97	104
Aug	135	178	189	189	188	190	157	179
Sep	190	260	277	277	276	277	240	260
Oct	187	268	288	288	281	288	257	272
Nov	223	270	279	279	281	279	252	270
Dec	246	289	299	299	299	299	268	288
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	15 (6.0)	16 (6.1)	15 (5.7)	16 (6.1)	-19 (-7.2)	0 (0.2)
Feb	---	---	23 (8.4)	23 (8.4)	22 (8.1)	23 (8.4)	-35 (-12.8)	1 (0.2)
Mar	---	---	10 (5.2)	11 (5.6)	11 (5.5)	11 (5.3)	-20 (-9.5)	-1 (-0.4)
Apr	---	---	7 (3.8)	7 (3.7)	6 (3.3)	7 (3.8)	-5 (-2.6)	1 (0.4)
May	---	---	3 (1.8)	3 (1.8)	5 (2.7)	4 (2.0)	-5 (-2.6)	2 (1.2)
Jun	---	---	1 (0.9)	1 (1.2)	1 (1.2)	1 (1.2)	-2 (-1.3)	-1 (-0.5)
Jul	---	---	4 (3.9)	4 (3.8)	5 (4.8)	4 (4.2)	-6 (-5.4)	1 (1.3)
Aug	---	---	11 (5.9)	11 (6.2)	10 (5.3)	12 (6.4)	-21 (-11.9)	1 (0.2)
Sep	---	---	17 (6.6)	17 (6.6)	16 (6.1)	17 (6.6)	-20 (-7.7)	0 (0.1)
Oct	---	---	20 (7.3)	20 (7.4)	13 (4.7)	20 (7.6)	-11 (-4.0)	4 (1.4)
Nov	---	---	9 (3.1)	9 (3.1)	11 (3.9)	9 (3.2)	-18 (-6.8)	0 (0.0)
Dec	---	---	10 (3.6)	10 (3.6)	10 (3.6)	10 (3.6)	-21 (-7.2)	-1 (-0.2)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	23 (9.6)	38 (16.2)	39 (16.3)	38 (15.9)	39 (16.3)	4 (1.7)	23 (9.8)
Feb	---	5 (1.8)	28 (10.3)	28 (10.3)	27 (10.0)	28 (10.3)	-30 (-11.3)	6 (2.0)
Mar	---	25 (14.0)	35 (20.0)	36 (20.4)	36 (20.3)	36 (20.1)	5 (3.2)	24 (13.5)
Apr	---	31 (19.3)	38 (23.8)	38 (23.7)	37 (23.2)	38 (23.7)	26 (16.1)	32 (19.7)
May	---	32 (21.9)	35 (24.1)	35 (24.0)	37 (25.1)	36 (24.2)	27 (18.7)	34 (23.3)
Jun	---	11 (11.2)	12 (12.2)	12 (12.5)	12 (12.5)	12 (12.5)	9 (9.7)	10 (10.6)
Jul	---	18 (21.7)	22 (26.4)	22 (26.3)	23 (27.5)	22 (26.7)	12 (15.1)	19 (23.2)
Aug	---	43 (32.2)	54 (40.0)	54 (40.3)	53 (39.2)	55 (40.7)	22 (16.5)	44 (32.5)
Sep	---	70 (37.2)	87 (46.3)	87 (46.2)	86 (45.5)	87 (46.3)	50 (26.6)	70 (37.4)
Oct	---	81 (43.1)	101 (53.6)	101 (53.7)	94 (49.9)	101 (54.0)	70 (37.4)	85 (45.0)
Nov	---	47 (21.2)	56 (25.0)	56 (25.0)	58 (26.0)	56 (25.1)	29 (13.0)	47 (21.2)
Dec	---	43 (17.3)	53 (21.6)	53 (21.5)	53 (21.5)	53 (21.5)	22 (8.9)	42 (17.1)

Table 91. Cumulative Effects Simulated Uranium Concentrations for Arkansas River at Moffat St. Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	8.6	10.1	10.5	10.5	10.5	10.5	9.5	10.1
15th percentile	4.8	5.2	5.3	5.3	5.3	5.3	5.1	5.2
25th percentile	5.9	6.6	6.7	6.7	6.7	6.7	6.6	6.6
50th percentile	7.8	9.2	9.6	9.6	9.6	9.6	8.7	9.2
75th percentile	9.5	11.2	11.7	11.7	11.7	11.7	10.8	11.2
85th percentile	10.3	12.6	13.1	13.1	13.0	13.1	12.3	12.7
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0.4 (4.4)	0.4 (4.4)	0.4 (4.1)	0.4 (4.4)	-0.6 (-6.0)	0 (0.2)
15th percentile	---	---	0.1 (2.9)	0.1 (2.5)	0.1 (2.5)	0.1 (2.5)	-0.1 (-2.0)	0 (0.1)
25th percentile	---	---	0.1 (1.9)	0.1 (1.7)	0.1 (1.5)	0.1 (2.0)	-0.1 (-0.8)	0 (0.2)
50th percentile	---	---	0.4 (4.0)	0.4 (3.9)	0.4 (3.8)	0.4 (4.1)	-0.5 (-5.7)	0 (-0.4)
75th percentile	---	---	0.5 (4.6)	0.6 (5.0)	0.5 (4.7)	0.6 (4.9)	-0.4 (-3.4)	0 (0.4)
85th percentile	---	---	0.5 (3.7)	0.5 (3.9)	0.4 (3.1)	0.5 (3.7)	-0.4 (-2.9)	0 (0.4)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	1.4 (16.7)	1.9 (21.8)	1.9 (21.8)	1.9 (21.5)	1.9 (21.9)	0.8 (9.6)	1.5 (17.0)
15th percentile	---	0.3 (7.0)	0.5 (10.0)	0.5 (9.6)	0.5 (9.7)	0.5 (9.7)	0.2 (4.8)	0.3 (7.1)
25th percentile	---	0.7 (12.5)	0.9 (14.7)	0.8 (14.4)	0.8 (14.2)	0.9 (14.8)	0.7 (11.7)	0.8 (12.8)
50th percentile	---	1.4 (17.6)	1.7 (22.3)	1.7 (22.2)	1.7 (22.1)	1.8 (22.3)	0.9 (10.9)	1.3 (17.1)
75th percentile	---	1.7 (18.1)	2.2 (23.5)	2.3 (23.9)	2.2 (23.6)	2.3 (23.9)	1.3 (14.1)	1.8 (18.5)
85th percentile	---	2.4 (22.9)	2.8 (27.5)	2.8 (27.6)	2.7 (26.7)	2.8 (27.4)	2 (19.3)	2.4 (23.4)

Table 92. Monthly Simulated Uranium Concentration for Arkansas River at Moffat St. Gage - Cumulative Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	11.1	12.0	12.6	12.6	12.6	12.6	11.2	12.0
Feb	12.4	12.6	13.5	13.5	13.5	13.5	11.2	12.6
Mar	8.7	9.7	10.1	10.2	10.1	10.1	8.9	9.7
Apr	7.9	9.2	9.5	9.5	9.4	9.5	9.0	9.2
May	7.4	8.7	8.9	8.9	8.9	8.9	8.5	8.8
Jun	5.2	5.6	5.7	5.7	5.7	5.7	5.6	5.6
Jul	4.9	5.6	5.8	5.8	5.8	5.8	5.4	5.7
Aug	6.9	8.7	9.1	9.1	9.0	9.1	7.8	8.7
Sep	9.1	12.0	12.7	12.7	12.6	12.7	11.2	12.0
Oct	9.0	12.3	13.1	13.1	12.8	13.1	11.9	12.4
Nov	10.5	12.4	12.7	12.7	12.8	12.7	11.6	12.4
Dec	11.4	13.1	13.6	13.6	13.6	13.6	12.3	13.1
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.6 (5.3)	0.6 (5.4)	0.6 (5.0)	0.6 (5.4)	-0.8 (-6.4)	0.0 (0.2)
Feb	---	---	0.9 (7.4)	0.9 (7.4)	0.9 (7.1)	0.9 (7.4)	-1.4 (-11.4)	0.0 (0.2)
Mar	---	---	0.4 (4.5)	0.5 (4.8)	0.4 (4.7)	0.4 (4.6)	-0.8 (-8.1)	0.0 (-0.3)
Apr	---	---	0.3 (3.2)	0.3 (3.1)	0.2 (2.8)	0.3 (3.2)	-0.2 (-2.2)	0.0 (0.3)
May	---	---	0.2 (1.5)	0.2 (1.5)	0.2 (2.3)	0.2 (1.6)	-0.2 (-2.2)	0.1 (1.0)
Jun	---	---	0.1 (0.7)	0.1 (0.9)	0.1 (0.9)	0.1 (0.9)	0.0 (-1.0)	0.0 (-0.4)
Jul	---	---	0.2 (2.9)	0.2 (2.9)	0.2 (3.6)	0.2 (3.1)	-0.2 (-4.0)	0.1 (0.9)
Aug	---	---	0.4 (4.9)	0.4 (5.1)	0.3 (4.4)	0.4 (5.3)	-0.9 (-9.9)	0.0 (0.2)
Sep	---	---	0.7 (5.9)	0.7 (5.8)	0.6 (5.3)	0.7 (5.8)	-0.8 (-6.8)	0.0 (0.1)
Oct	---	---	0.8 (6.5)	0.8 (6.6)	0.5 (4.2)	0.8 (6.7)	-0.4 (-3.5)	0.1 (1.2)
Nov	---	---	0.3 (2.8)	0.3 (2.7)	0.4 (3.4)	0.3 (2.8)	-0.8 (-6.0)	0.0 (0.0)
Dec	---	---	0.5 (3.2)	0.5 (3.2)	0.5 (3.2)	0.5 (3.2)	-0.8 (-6.4)	0.0 (-0.2)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	0.9 (8.4)	1.5 (14.1)	1.5 (14.2)	1.5 (13.8)	1.5 (14.2)	0.1 (1.5)	0.9 (8.6)
Feb	---	0.2 (1.6)	1.1 (9.1)	1.1 (9.1)	1.1 (8.9)	1.1 (9.1)	-1.2 (-10.0)	0.2 (1.8)
Mar	---	1.0 (11.7)	1.4 (16.7)	1.5 (17.0)	1.4 (17.0)	1.4 (16.8)	0.2 (2.7)	1.0 (11.3)
Apr	---	1.3 (15.8)	1.6 (19.5)	1.6 (19.4)	1.5 (19.1)	1.6 (19.5)	1.1 (13.2)	1.3 (16.1)
May	---	1.3 (17.6)	1.5 (19.4)	1.5 (19.4)	1.5 (20.3)	1.5 (19.6)	1.1 (15.1)	1.4 (18.8)
Jun	---	0.4 (8.1)	0.5 (8.8)	0.5 (9.1)	0.5 (9.1)	0.5 (9.1)	0.4 (7.0)	0.4 (7.7)
Jul	---	0.7 (15.3)	0.9 (18.6)	0.9 (18.6)	0.9 (19.4)	0.9 (18.9)	0.5 (10.7)	0.8 (16.4)
Aug	---	1.8 (25.5)	2.2 (31.7)	2.2 (32.0)	2.1 (31.1)	2.2 (32.2)	0.9 (13.1)	1.8 (25.7)
Sep	---	2.9 (31.4)	3.6 (39.0)	3.6 (38.9)	3.5 (38.4)	3.6 (39.0)	2.1 (22.4)	2.9 (31.5)
Oct	---	3.3 (36.3)	4.1 (45.1)	4.1 (45.2)	3.8 (42.0)	4.1 (45.4)	2.9 (31.5)	3.4 (37.9)
Nov	---	1.9 (18.3)	2.2 (21.6)	2.2 (21.6)	2.3 (22.4)	2.2 (21.7)	1.1 (11.2)	1.9 (18.3)
Dec	---	1.7 (15.2)	2.2 (18.9)	2.2 (18.8)	2.2 (18.8)	2.2 (18.8)	0.9 (7.8)	1.7 (15.0)

All alternatives would have predominately negligible effects on sulfate and uranium concentrations at the Arkansas River near Avondale gage (Table 93 to Table 96). Compared to existing conditions, sulfate and uranium concentrations would increase in drier months.

Table 93. Cumulative Effects Simulated Sulfate Concentrations for Arkansas River near Avondale Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	264	271	273	272	273	272	271	271
15th percentile	170	190	192	192	192	192	189	189
25th percentile	201	229	230	229	228	230	230	232
50th percentile	271	283	286	285	285	285	282	284
75th percentile	324	317	318	318	318	317	319	317
85th percentile	342	334	335	334	334	333	333	332
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	2 (0.7)	1 (0.5)	2 (0.6)	1 (0.4)	0 (-0.1)	0 (0.0)
15th percentile	---	---	3 (1.5)	2 (1.1)	2 (1.3)	2 (1.1)	-1 (-0.3)	-1 (-0.3)
25th percentile	---	---	1 (0.3)	0 (0.1)	-1 (-0.3)	1 (0.3)	1 (0.4)	3 (1.3)
50th percentile	---	---	3 (1.0)	2 (0.7)	2 (0.8)	2 (0.6)	-1 (-0.2)	1 (0.4)
75th percentile	---	---	2 (0.6)	1 (0.3)	2 (0.5)	1 (0.3)	2 (0.6)	0 (0.0)
85th percentile	---	---	1 (0.4)	0 (0.0)	1 (0.2)	0 (-0.1)	-1 (-0.2)	-2 (-0.5)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	7 (2.6)	9 (3.3)	8 (3.1)	9 (3.2)	8 (3.0)	7 (2.5)	7 (2.7)
15th percentile	---	20 (11.6)	22 (13.2)	22 (12.8)	22 (13.0)	22 (12.8)	19 (11.2)	19 (11.2)
25th percentile	---	28 (13.9)	29 (14.2)	28 (14.0)	27 (13.5)	29 (14.2)	29 (14.3)	31 (15.3)
50th percentile	---	12 (4.3)	14 (5.3)	14 (5.0)	14 (5.2)	13 (5.0)	11 (4.1)	13 (4.7)
75th percentile	---	-8 (-2.4)	-6 (-1.8)	-7 (-2.1)	-6 (-1.9)	-7 (-2.1)	-6 (-1.8)	-8 (-2.4)
85th percentile	---	-9 (-2.5)	-7 (-2.1)	-9 (-2.5)	-8 (-2.3)	-9 (-2.6)	-9 (-2.7)	-10 (-3.0)

Table 94. Monthly Simulated Sulfate Concentration for Arkansas River near Avondale Gage - Cumulative Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	333	317	319	319	319	319	316	317
Feb	348	319	321	321	322	321	318	319
Mar	300	297	296	296	298	296	295	295
Apr	251	268	269	269	268	270	268	269
May	197	235	235	230	234	230	234	233
Jun	158	197	198	198	196	197	198	197
Jul	172	187	191	190	190	191	186	189
Aug	221	235	241	241	242	237	234	236
Sep	276	290	292	292	291	291	294	290
Oct	295	296	298	298	297	298	298	297
Nov	309	307	308	308	308	308	306	307
Dec	331	321	321	321	322	321	319	320
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	2 (0.6)	2 (0.6)	2 (0.5)	2 (0.6)	-1 (-0.4)	0 (-0.1)
Feb	---	---	2 (0.6)	2 (0.7)	3 (0.8)	2 (0.7)	-1 (-0.5)	0 (0.0)
Mar	---	---	-1 (-0.4)	-1 (-0.4)	1 (0.2)	-1 (-0.4)	-2 (-0.7)	-2 (-0.7)
Apr	---	---	1 (0.4)	1 (0.4)	0 (0.1)	2 (1.1)	0 (0.3)	1 (0.7)
May	---	---	0 (0.3)	-5 (-2.1)	-1 (-0.1)	-5 (-2.0)	-1 (-0.2)	-2 (-0.7)
Jun	---	---	1 (0.6)	1 (0.6)	-1 (-0.1)	0 (0.3)	1 (0.5)	0 (0.3)
Jul	---	---	4 (1.9)	3 (1.8)	3 (1.6)	4 (1.9)	-1 (-0.8)	2 (1.0)
Aug	---	---	6 (2.8)	6 (2.7)	7 (3.2)	2 (0.8)	-1 (-0.3)	1 (0.4)
Sep	---	---	2 (0.5)	2 (0.4)	1 (0.3)	1 (0.4)	4 (1.3)	0 (0.0)
Oct	---	---	2 (0.7)	2 (0.8)	1 (0.3)	2 (0.7)	2 (0.5)	1 (0.3)
Nov	---	---	1 (0.5)	1 (0.4)	1 (0.5)	1 (0.5)	-1 (-0.2)	0 (0.0)
Dec	---	---	0 (0.3)	0 (0.2)	1 (0.4)	0 (0.3)	-2 (-0.4)	-1 (-0.1)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	-16 (-4.8)	-14 (-4.2)	-14 (-4.2)	-14 (-4.3)	-14 (-4.2)	-17 (-5.1)	-16 (-4.9)
Feb	---	-29 (-8.3)	-27 (-7.7)	-27 (-7.7)	-26 (-7.6)	-27 (-7.7)	-30 (-8.7)	-29 (-8.4)
Mar	---	-3 (-0.9)	-4 (-1.3)	-4 (-1.3)	-2 (-0.7)	-4 (-1.3)	-5 (-1.6)	-5 (-1.6)
Apr	---	17 (6.7)	18 (7.1)	18 (7.1)	17 (6.8)	19 (7.8)	17 (7.0)	18 (7.4)
May	---	38 (19.1)	38 (19.5)	33 (16.7)	37 (19.0)	33 (16.7)	37 (18.9)	36 (18.3)
Jun	---	39 (24.7)	40 (25.5)	40 (25.5)	38 (24.6)	39 (25.0)	40 (25.4)	39 (25.1)
Jul	---	15 (8.5)	19 (10.6)	18 (10.5)	18 (10.3)	19 (10.6)	14 (7.7)	17 (9.6)
Aug	---	14 (6.4)	20 (9.4)	20 (9.3)	21 (9.8)	16 (7.3)	13 (6.2)	15 (6.8)
Sep	---	14 (5.3)	16 (5.8)	16 (5.8)	15 (5.6)	15 (5.7)	18 (6.7)	14 (5.3)
Oct	---	1 (0.2)	3 (0.9)	3 (0.9)	2 (0.5)	3 (0.9)	3 (0.7)	2 (0.5)
Nov	---	-2 (-0.9)	-1 (-0.4)	-1 (-0.4)	-1 (-0.3)	-1 (-0.3)	-3 (-1.1)	-2 (-0.8)
Dec	---	-10 (-3.2)	-10 (-2.9)	-10 (-2.9)	-9 (-2.8)	-10 (-2.9)	-12 (-3.6)	-11 (-3.3)

Table 95. Cumulative Effects Simulated Uranium Concentrations for Arkansas River near Avondale Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	4.2	4.4	4.4	4.4	4.4	4.4	4.4	4.4
15th percentile	2.1	2.6	2.6	2.6	2.6	2.6	2.5	2.5
25th percentile	2.8	3.4	3.4	3.4	3.4	3.4	3.4	3.5
50th percentile	4.4	4.6	4.7	4.7	4.7	4.7	4.6	4.6
75th percentile	5.5	5.4	5.4	5.4	5.4	5.4	5.4	5.4
85th percentile	5.9	5.7	5.8	5.7	5.8	5.7	5.7	5.7
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0 (0.9)	0 (0.6)	0 (0.8)	0 (0.5)	0 (-0.1)	0 (0.0)
15th percentile	---	---	0.1 (2.4)	0 (1.9)	0.1 (2.1)	0 (1.9)	0 (-0.5)	0 (-0.5)
25th percentile	---	---	0 (0.4)	0 (0.1)	0 (-0.4)	0 (0.5)	0 (0.6)	0.1 (1.9)
50th percentile	---	---	0.1 (1.3)	0 (0.9)	0.1 (1.2)	0 (0.9)	0 (-0.3)	0 (0.5)
75th percentile	---	---	0 (0.7)	0 (0.4)	0 (0.7)	0 (0.3)	0 (0.8)	0 (0.0)
85th percentile	---	---	0 (0.5)	0 (0.0)	0 (0.3)	0 (-0.1)	0 (-0.3)	0 (-0.6)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	0.2 (3.7)	0.2 (4.6)	0.2 (4.3)	0.2 (4.5)	0.2 (4.2)	0.1 (3.5)	0.2 (3.7)
15th percentile	---	0.4 (20.6)	0.5 (23.5)	0.5 (22.8)	0.5 (23.1)	0.5 (22.8)	0.4 (19.9)	0.4 (19.9)
25th percentile	---	0.6 (22.0)	0.6 (22.5)	0.6 (22.2)	0.6 (21.5)	0.6 (22.6)	0.6 (22.8)	0.7 (24.3)
50th percentile	---	0.3 (5.9)	0.3 (7.3)	0.3 (6.9)	0.3 (7.1)	0.3 (6.8)	0.2 (5.6)	0.3 (6.4)
75th percentile	---	-0.2 (-3.1)	-0.1 (-2.4)	-0.1 (-2.7)	-0.1 (-2.4)	-0.2 (-2.8)	-0.1 (-2.4)	-0.2 (-3.1)
85th percentile	---	-0.2 (-3.2)	-0.2 (-2.7)	-0.2 (-3.2)	-0.2 (-2.9)	-0.2 (-3.3)	-0.2 (-3.5)	-0.2 (-3.8)

Table 96. Monthly Simulated Uranium Concentration for Arkansas River near Avondale Gage - Cumulative Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	9.1	8.8	8.8	8.8	8.8	8.8	8.8	8.8
Feb	9.5	8.8	8.9	8.9	8.9	8.9	8.8	8.8
Mar	8.4	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Apr	7.3	7.7	7.7	7.7	7.7	7.7	7.7	7.7
May	6.1	7.0	7.0	6.8	6.9	6.8	6.9	6.9
Jun	5.2	6.1	6.1	6.1	6.1	6.1	6.1	6.1
Jul	5.6	5.9	6.0	6.0	6.0	6.0	5.9	5.9
Aug	6.6	7.0	7.1	7.1	7.1	7.0	6.9	7.0
Sep	7.9	8.2	8.2	8.2	8.2	8.2	8.3	8.2
Oct	8.3	8.3	8.4	8.4	8.3	8.4	8.3	8.3
Nov	8.6	8.6	8.6	8.6	8.6	8.6	8.5	8.6
Dec	9.1	8.9	8.9	8.9	8.9	8.9	8.8	8.8
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.0 (0.5)	0.0 (0.5)	0.0 (0.4)	0.0 (0.5)	0.0 (-0.3)	0.0 (-0.1)
Feb	---	---	0.1 (0.5)	0.1 (0.5)	0.1 (0.6)	0.1 (0.5)	0.0 (-0.4)	0.0 (0.0)
Mar	---	---	0.0 (-0.3)	0.0 (-0.3)	0.0 (0.1)	0.0 (-0.3)	0.0 (-0.6)	0.0 (-0.5)
Apr	---	---	0.0 (0.3)	0.0 (0.3)	0.0 (0.1)	0.0 (0.8)	0.0 (0.3)	0.0 (0.5)
May	---	---	0.0 (0.2)	-0.2 (-1.5)	-0.1 (-0.1)	-0.2 (-1.5)	-0.1 (-0.1)	-0.1 (-0.5)
Jun	---	---	0.0 (0.5)	0.0 (0.4)	0.0 (0.0)	0.0 (0.2)	0.0 (0.4)	0.0 (0.2)
Jul	---	---	0.1 (1.4)	0.1 (1.3)	0.1 (1.1)	0.1 (1.4)	0.0 (-0.5)	0.0 (0.7)
Aug	---	---	0.1 (2.1)	0.1 (2.0)	0.1 (2.4)	0.0 (0.6)	-0.1 (-0.2)	0.0 (0.3)
Sep	---	---	0.0 (0.4)	0.0 (0.3)	0.0 (0.2)	0.0 (0.3)	0.1 (1.0)	0.0 (0.0)
Oct	---	---	0.1 (0.6)	0.1 (0.6)	0.0 (0.2)	0.1 (0.5)	0.0 (0.4)	0.0 (0.3)
Nov	---	---	0.0 (0.4)	0.0 (0.3)	0.0 (0.4)	0.0 (0.4)	-0.1 (-0.2)	0.0 (0.0)
Dec	---	---	0.0 (0.2)	0.0 (0.2)	0.0 (0.3)	0.0 (0.2)	-0.1 (-0.3)	-0.1 (-0.1)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	-0.3 (-3.9)	-0.3 (-3.4)	-0.3 (-3.4)	-0.3 (-3.5)	-0.3 (-3.4)	-0.3 (-4.2)	-0.3 (-4.0)
Feb	---	-0.7 (-6.8)	-0.6 (-6.3)	-0.6 (-6.3)	-0.6 (-6.2)	-0.6 (-6.3)	-0.7 (-7.1)	-0.7 (-6.8)
Mar	---	-0.1 (-0.7)	-0.1 (-1.0)	-0.1 (-1.0)	-0.1 (-0.6)	-0.1 (-1.0)	-0.1 (-1.3)	-0.1 (-1.2)
Apr	---	0.4 (5.1)	0.4 (5.4)	0.4 (5.4)	0.4 (5.1)	0.4 (6.0)	0.4 (5.3)	0.4 (5.6)
May	---	0.9 (13.6)	0.9 (13.9)	0.7 (11.9)	0.8 (13.5)	0.7 (12.0)	0.8 (13.5)	0.8 (13.1)
Jun	---	0.9 (16.5)	0.9 (17.0)	0.9 (17.0)	0.9 (16.4)	0.9 (16.7)	0.9 (16.9)	0.9 (16.7)
Jul	---	0.3 (5.9)	0.4 (7.3)	0.4 (7.2)	0.4 (7.1)	0.4 (7.3)	0.3 (5.3)	0.3 (6.6)
Aug	---	0.4 (4.7)	0.5 (7.0)	0.5 (6.8)	0.5 (7.2)	0.4 (5.4)	0.3 (4.5)	0.4 (5.0)
Sep	---	0.3 (4.1)	0.3 (4.5)	0.3 (4.5)	0.3 (4.3)	0.3 (4.4)	0.4 (5.2)	0.3 (4.1)
Oct	---	0.0 (0.2)	0.1 (0.7)	0.1 (0.7)	0.0 (0.4)	0.1 (0.7)	0.0 (0.6)	0.0 (0.4)
Nov	---	0.0 (-0.7)	0.0 (-0.3)	0.0 (-0.4)	0.0 (-0.3)	0.0 (-0.3)	-0.1 (-0.9)	0.0 (-0.7)
Dec	---	-0.2 (-2.6)	-0.2 (-2.4)	-0.2 (-2.4)	-0.2 (-2.2)	-0.2 (-2.4)	-0.3 (-2.9)	-0.3 (-2.7)

All alternatives would have predominately negligible effects on sulfate and uranium concentrations at the Arkansas River at Catlin Dam gage (Table 97 to Table 100), although some minor increases occur late summer and early fall months. Compared to existing conditions, sulfate and uranium concentrations would increase.

Table 97. Cumulative Effects Simulated Sulfate Concentrations for Arkansas River at Catlin Dam Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	376	398	402	402	402	401	403	398
15th percentile	208	235	245	247	243	243	238	240
25th percentile	246	296	302	298	306	303	299	304
50th percentile	385	427	427	424	426	424	426	425
75th percentile	478	482	485	487	486	485	491	482
85th percentile	528	527	532	532	532	531	539	522
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	4 (1.0)	4 (0.9)	4 (0.9)	3 (0.8)	5 (1.3)	0 (-0.1)
15th percentile	---	---	10 (4.1)	12 (4.9)	7 (3.1)	8 (3.4)	2 (1.0)	5 (2.0)
25th percentile	---	---	6 (2.0)	1 (0.5)	9 (3.2)	6 (2.1)	3 (0.9)	8 (2.6)
50th percentile	---	---	0 (0.1)	-2 (-0.5)	-1 (-0.2)	-3 (-0.7)	-1 (-0.2)	-1 (-0.3)
75th percentile	---	---	3 (0.5)	5 (1.0)	4 (0.8)	3 (0.6)	8 (1.7)	0 (-0.1)
85th percentile	---	---	5 (1.0)	6 (1.1)	5 (1.0)	5 (0.9)	12 (2.2)	-5 (-0.9)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	22 (5.7)	26 (6.8)	25 (6.7)	25 (6.7)	25 (6.6)	27 (7.0)	21 (5.6)
15th percentile	---	27 (13.0)	37 (17.6)	39 (18.6)	34 (16.5)	35 (16.8)	30 (14.2)	32 (15.2)
25th percentile	---	50 (20.5)	56 (22.9)	52 (21.1)	60 (24.3)	57 (23.0)	53 (21.6)	58 (23.6)
50th percentile	---	42 (10.9)	42 (10.9)	40 (10.3)	41 (10.7)	39 (10.1)	41 (10.6)	40 (10.5)
75th percentile	---	5 (1.0)	7 (1.5)	10 (2.0)	8 (1.8)	8 (1.6)	13 (2.7)	4 (0.9)
85th percentile	---	-2 (-0.3)	4 (0.7)	4 (0.8)	4 (0.7)	3 (0.6)	10 (1.9)	-7 (-1.2)

Table 98. Monthly Simulated Sulfate Concentration for Arkansas River at Catlin Dam Gage - Cumulative Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	500	506	510	512	510	511	512	504
Feb	539	482	477	477	479	478	495	483
Mar	441	444	445	443	445	443	444	444
Apr	342	401	404	404	402	404	404	400
May	247	306	315	309	308	306	315	307
Jun	188	236	238	238	236	237	237	237
Jul	224	246	254	253	255	254	249	251
Aug	296	321	329	328	331	326	325	321
Sep	407	436	445	445	442	444	454	439
Oct	421	467	473	473	473	474	469	465
Nov	451	462	465	466	468	465	463	458
Dec	493	484	489	489	490	489	490	482
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	4 (0.9)	6 (1.1)	4 (0.8)	5 (1.0)	6 (1.1)	-2 (-0.3)
Feb	---	---	-5 (-1.0)	-5 (-1.0)	-3 (-0.7)	-4 (-0.8)	13 (2.6)	1 (0.2)
Mar	---	---	1 (0.0)	-1 (-0.4)	1 (0.2)	-1 (-0.4)	0 (-0.1)	0 (-0.1)
Apr	---	---	3 (0.6)	3 (0.7)	1 (0.2)	3 (0.8)	3 (0.8)	-1 (-0.4)
May	---	---	9 (2.8)	3 (1.0)	2 (0.5)	0 (0.0)	9 (2.8)	1 (0.1)
Jun	---	---	2 (0.7)	2 (0.7)	0 (-0.1)	1 (0.5)	1 (0.5)	1 (0.4)
Jul	---	---	8 (3.0)	7 (2.5)	9 (3.4)	8 (3.2)	3 (0.9)	5 (1.9)
Aug	---	---	8 (2.5)	7 (2.2)	10 (3.0)	5 (1.7)	4 (1.1)	0 (-0.1)
Sep	---	---	9 (1.9)	9 (2.0)	6 (1.3)	8 (1.6)	18 (4.1)	3 (0.7)
Oct	---	---	6 (1.3)	6 (1.2)	6 (1.3)	7 (1.4)	2 (0.4)	-2 (-0.5)
Nov	---	---	3 (0.7)	4 (0.8)	6 (1.4)	3 (0.7)	1 (0.3)	-4 (-0.7)
Dec	---	---	5 (0.9)	5 (1.0)	6 (1.2)	5 (0.9)	6 (1.1)	-2 (-0.5)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	6 (1.1)	10 (2.0)	12 (2.2)	10 (1.9)	11 (2.1)	12 (2.2)	4 (0.8)
Feb	---	-57 (-10.5)	-62 (-11.4)	-62 (-11.4)	-60 (-11.2)	-61 (-11.3)	-44 (-8.2)	-56 (-10.4)
Mar	---	3 (0.8)	4 (0.9)	2 (0.4)	4 (1.0)	2 (0.4)	3 (0.8)	3 (0.7)
Apr	---	59 (17.4)	62 (18.0)	62 (18.1)	60 (17.6)	62 (18.3)	62 (18.3)	58 (16.9)
May	---	59 (24.0)	68 (27.4)	62 (25.2)	61 (24.6)	59 (24.1)	68 (27.5)	60 (24.2)
Jun	---	48 (25.3)	50 (26.2)	50 (26.2)	48 (25.2)	49 (26.0)	49 (26.0)	49 (25.9)
Jul	---	22 (10.2)	30 (13.5)	29 (13.0)	31 (13.9)	30 (13.8)	25 (11.2)	27 (12.3)
Aug	---	25 (8.4)	33 (11.1)	32 (10.9)	35 (11.6)	30 (10.2)	29 (9.6)	25 (8.4)
Sep	---	29 (7.3)	38 (9.4)	38 (9.5)	35 (8.7)	37 (9.1)	47 (11.7)	32 (8.1)
Oct	---	46 (10.8)	52 (12.2)	52 (12.2)	52 (12.2)	53 (12.4)	48 (11.3)	44 (10.3)
Nov	---	11 (2.4)	14 (3.2)	15 (3.2)	17 (3.9)	14 (3.2)	12 (2.7)	7 (1.7)
Dec	---	-9 (-1.8)	-4 (-0.9)	-4 (-0.8)	-3 (-0.5)	-4 (-0.9)	-3 (-0.7)	-11 (-2.2)

Table 99. Cumulative Effects Simulated Uranium Concentrations for Arkansas River at Catlin Dam Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	7.7	8.1	8.2	8.2	8.2	8.2	8.2	8.1
15th percentile	4.6	5.1	5.3	5.3	5.3	5.3	5.2	5.2
25th percentile	5.3	6.3	6.4	6.3	6.4	6.4	6.3	6.4
50th percentile	7.9	8.7	8.7	8.6	8.7	8.6	8.7	8.6
75th percentile	9.6	9.7	9.8	9.8	9.8	9.8	9.9	9.7
85th percentile	10.6	10.5	10.6	10.6	10.6	10.6	10.7	10.4
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0.1 (0.9)	0.1 (0.8)	0.1 (0.9)	0.1 (0.7)	0.1 (1.1)	0 (-0.1)
15th percentile	---	---	0.2 (3.5)	0.2 (4.2)	0.1 (2.6)	0.1 (2.9)	0 (0.9)	0.1 (1.7)
25th percentile	---	---	0.1 (1.7)	0 (0.4)	0.2 (2.8)	0.1 (1.8)	0 (0.8)	0.1 (2.3)
50th percentile	---	---	0 (0.0)	0 (-0.5)	0 (-0.2)	-0.1 (-0.6)	0 (-0.2)	0 (-0.3)
75th percentile	---	---	0 (0.5)	0.1 (0.9)	0.1 (0.7)	0.1 (0.5)	0.2 (1.6)	0 (-0.1)
85th percentile	---	---	0.1 (0.9)	0.1 (1.0)	0.1 (0.9)	0.1 (0.8)	0.2 (2.1)	-0.1 (-0.9)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	0.4 (5.2)	0.5 (6.1)	0.5 (6.0)	0.5 (6.1)	0.5 (5.9)	0.5 (6.4)	0.4 (5.1)
15th percentile	---	0.5 (10.9)	0.7 (14.7)	0.7 (15.6)	0.6 (13.8)	0.7 (14.1)	0.5 (11.9)	0.6 (12.8)
25th percentile	---	0.9 (17.6)	1 (19.6)	1 (18.1)	1.1 (20.8)	1.1 (19.8)	1 (18.5)	1.1 (20.2)
50th percentile	---	0.8 (9.8)	0.8 (9.9)	0.7 (9.3)	0.8 (9.6)	0.7 (9.2)	0.8 (9.6)	0.8 (9.5)
75th percentile	---	0.1 (0.9)	0.1 (1.4)	0.2 (1.9)	0.2 (1.6)	0.1 (1.5)	0.2 (2.5)	0.1 (0.9)
85th percentile	---	0 (-0.3)	0.1 (0.6)	0.1 (0.7)	0.1 (0.7)	0.1 (0.6)	0.2 (1.8)	-0.1 (-1.1)

Table 100. Monthly Simulated Uranium Concentration for Arkansas River at Catlin Gage - Cumulative Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	10.2	10.3	10.3	10.4	10.3	10.4	10.4	10.2
Feb	10.9	9.8	9.7	9.7	9.8	9.7	10.1	9.8
Mar	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
Apr	7.2	8.3	8.4	8.4	8.3	8.4	8.4	8.3
May	5.5	6.6	6.7	6.6	6.6	6.6	6.7	6.6
Jun	4.4	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Jul	5.0	5.4	5.6	5.6	5.6	5.6	5.5	5.5
Aug	6.4	6.8	7.0	7.0	7.0	6.9	6.9	6.8
Sep	8.4	9.0	9.1	9.1	9.1	9.1	9.3	9.0
Oct	8.7	9.5	9.6	9.6	9.6	9.7	9.6	9.5
Nov	9.2	9.4	9.5	9.5	9.6	9.5	9.5	9.4
Dec	10.0	9.9	9.9	10.0	10.0	9.9	10.0	9.8
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.0 (0.8)	0.1 (1.0)	0.0 (0.7)	0.1 (0.9)	0.1 (1.0)	-0.1 (-0.3)
Feb	---	---	-0.1 (-0.9)	-0.1 (-0.9)	0.0 (-0.6)	-0.1 (-0.8)	0.3 (2.4)	0.0 (0.1)
Mar	---	---	0.0 (0.0)	0.0 (-0.3)	0.0 (0.1)	0.0 (-0.4)	0.0 (-0.1)	0.0 (-0.1)
Apr	---	---	0.1 (0.5)	0.1 (0.6)	0.0 (0.2)	0.1 (0.7)	0.1 (0.7)	0.0 (-0.4)
May	---	---	0.1 (2.4)	0.0 (0.9)	0.0 (0.4)	0.0 (0.0)	0.1 (2.4)	0.0 (0.1)
Jun	---	---	0.0 (0.6)	0.0 (0.6)	0.0 (-0.1)	0.0 (0.4)	0.0 (0.4)	0.0 (0.4)
Jul	---	---	0.2 (2.5)	0.2 (2.1)	0.2 (2.8)	0.2 (2.7)	0.1 (0.7)	0.1 (1.6)
Aug	---	---	0.2 (2.2)	0.2 (2.0)	0.2 (2.6)	0.1 (1.5)	0.1 (1.0)	0.0 (0.0)
Sep	---	---	0.1 (1.8)	0.1 (1.8)	0.1 (1.1)	0.1 (1.5)	0.3 (3.7)	0.0 (0.6)
Oct	---	---	0.1 (1.1)	0.1 (1.1)	0.1 (1.1)	0.2 (1.3)	0.1 (0.3)	0.0 (-0.4)
Nov	---	---	0.1 (0.7)	0.1 (0.7)	0.2 (1.3)	0.1 (0.7)	0.1 (0.3)	0.0 (-0.7)
Dec	---	---	0.0 (0.8)	0.1 (0.9)	0.1 (1.1)	0.0 (0.8)	0.1 (1.0)	-0.1 (-0.4)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	0.1 (1.0)	0.1 (1.8)	0.2 (2.1)	0.1 (1.7)	0.2 (2.0)	0.2 (2.0)	0.0 (0.7)
Feb	---	-1.1 (-9.7)	-1.2 (-10.5)	-1.2 (-10.5)	-1.1 (-10.3)	-1.2 (-10.4)	-0.8 (-7.6)	-1.1 (-9.6)
Mar	---	0.0 (0.8)	0.0 (0.8)	0.0 (0.4)	0.0 (0.9)	0.0 (0.4)	0.0 (0.7)	0.0 (0.7)
Apr	---	1.1 (15.2)	1.2 (15.9)	1.2 (15.9)	1.1 (15.5)	1.2 (16.1)	1.2 (16.0)	1.1 (14.8)
May	---	1.1 (20.2)	1.2 (23.0)	1.1 (21.2)	1.1 (20.7)	1.1 (20.2)	1.2 (23.1)	1.1 (20.3)
Jun	---	0.9 (20.3)	0.9 (20.9)	0.9 (21.0)	0.9 (20.2)	0.9 (20.8)	0.9 (20.8)	0.9 (20.7)
Jul	---	0.4 (8.4)	0.6 (11.2)	0.6 (10.7)	0.6 (11.5)	0.6 (11.4)	0.5 (9.2)	0.5 (10.2)
Aug	---	0.4 (7.3)	0.6 (9.6)	0.6 (9.4)	0.6 (10.0)	0.5 (8.8)	0.5 (8.3)	0.4 (7.2)
Sep	---	0.6 (6.6)	0.7 (8.5)	0.7 (8.5)	0.7 (7.8)	0.7 (8.2)	0.9 (10.5)	0.6 (7.2)
Oct	---	0.8 (9.7)	0.9 (11.0)	0.9 (11.0)	0.9 (11.0)	1.0 (11.2)	0.9 (10.1)	0.8 (9.3)
Nov	---	0.2 (2.2)	0.3 (2.9)	0.3 (2.9)	0.4 (3.5)	0.3 (2.9)	0.3 (2.5)	0.2 (1.5)
Dec	---	-0.1 (-1.6)	-0.1 (-0.8)	0.0 (-0.7)	0.0 (-0.5)	-0.1 (-0.8)	0.0 (-0.6)	-0.2 (-2.0)

All alternatives would have predominately negligible effects on sulfate and uranium concentrations at the Arkansas River at Las Animas gage (Table 101 to Table 104). Compared to existing conditions, sulfate concentrations would decrease. Uranium concentration for the alternatives would decrease in some months, compared to existing conditions.

Table 101. Cumulative Effects Simulated Sulfate Concentrations for Arkansas River at Las Animas Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	972	920	919	918	918	920	919	918
15th percentile	454	464	450	451	460	451	460	459
25th percentile	649	630	628	627	632	628	637	632
50th percentile	1,016	975	961	958	969	958	972	971
75th percentile	1,198	1,126	1,123	1,123	1,125	1,123	1,126	1,122
85th percentile	1,380	1,271	1,272	1,272	1,271	1,278	1,263	1,264
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	-1 (-0.1)	-2 (-0.2)	-2 (-0.2)	0 (-0.1)	-1 (-0.2)	-2 (-0.2)
15th percentile	---	---	-13 (-2.9)	-13 (-2.8)	-4 (-0.9)	-13 (-2.9)	-4 (-0.8)	-5 (-1.1)
25th percentile	---	---	-2 (-0.3)	-3 (-0.4)	2 (0.3)	-2 (-0.4)	7 (1.2)	3 (0.4)
50th percentile	---	---	-14 (-1.5)	-17 (-1.7)	-6 (-0.6)	-17 (-1.7)	-4 (-0.4)	-4 (-0.4)
75th percentile	---	---	-3 (-0.3)	-3 (-0.3)	-1 (-0.1)	-3 (-0.3)	0 (0.0)	-5 (-0.4)
85th percentile	---	---	1 (0.0)	1 (0.0)	0 (0.0)	7 (0.6)	-8 (-0.7)	-7 (-0.5)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	-52 (-5.3)	-52 (-5.4)	-53 (-5.5)	-54 (-5.5)	-52 (-5.4)	-53 (-5.4)	-53 (-5.5)
15th percentile	---	10 (2.2)	-4 (-0.8)	-3 (-0.7)	6 (1.3)	-3 (-0.8)	6 (1.4)	5 (1.1)
25th percentile	---	-20 (-3.0)	-22 (-3.4)	-22 (-3.4)	-18 (-2.7)	-22 (-3.4)	-12 (-1.9)	-17 (-2.6)
50th percentile	---	-41 (-4.0)	-55 (-5.4)	-57 (-5.7)	-47 (-4.6)	-58 (-5.7)	-44 (-4.4)	-45 (-4.4)
75th percentile	---	-72 (-6.0)	-75 (-6.2)	-75 (-6.3)	-73 (-6.1)	-74 (-6.2)	-72 (-6.0)	-76 (-6.4)
85th percentile	---	-109 (-7.9)	-109 (-7.9)	-109 (-7.9)	-109 (-7.9)	-102 (-7.4)	-118 (-8.5)	-116 (-8.4)

Table 102. Monthly Simulated Sulfate Concentration for Arkansas River at Las Animas Gage - Cumulative Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	1,046	1,041	1,049	1,048	1,048	1,048	1,048	1,040
Feb	1,002	905	872	871	875	874	927	905
Mar	1,170	1,021	1,010	1,014	1,030	1,013	1,008	1,008
Apr	1,311	1,178	1,185	1,175	1,175	1,179	1,160	1,162
May	775	704	710	707	713	709	704	702
Jun	561	514	509	509	512	508	511	516
Jul	695	687	687	688	678	695	671	697
Aug	783	746	750	749	750	749	750	748
Sep	1,090	1,053	1,046	1,047	1,047	1,046	1,035	1,050
Oct	1,111	1,105	1,116	1,115	1,100	1,116	1,111	1,109
Nov	1,066	1,060	1,066	1,066	1,051	1,065	1,064	1,057
Dec	1,076	1,062	1,068	1,068	1,069	1,068	1,069	1,062
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	8 (0.8)	7 (0.7)	7 (0.7)	7 (0.8)	7 (0.7)	-1 (-0.1)
Feb	---	---	-33 (-3.7)	-34 (-3.7)	-30 (-3.2)	-31 (-3.4)	22 (2.5)	0 (0.0)
Mar	---	---	-11 (-1.1)	-7 (-0.7)	9 (0.9)	-8 (-0.8)	-13 (-1.3)	-13 (-1.3)
Apr	---	---	7 (0.6)	-3 (-0.3)	-3 (-0.2)	1 (0.1)	-18 (-1.6)	-16 (-1.4)
May	---	---	6 (0.9)	3 (0.4)	9 (1.3)	5 (0.8)	0 (0.0)	-2 (-0.3)
Jun	---	---	-5 (-1.0)	-5 (-1.1)	-2 (-0.5)	-6 (-1.2)	-3 (-0.6)	2 (0.4)
Jul	---	---	0 (0.0)	1 (0.2)	-9 (-1.3)	8 (1.2)	-16 (-2.3)	10 (1.4)
Aug	---	---	4 (0.5)	3 (0.4)	4 (0.5)	3 (0.3)	4 (0.5)	2 (0.2)
Sep	---	---	-7 (-0.6)	-6 (-0.6)	-6 (-0.6)	-7 (-0.6)	-18 (-1.7)	-3 (-0.3)
Oct	---	---	11 (0.9)	10 (0.9)	-5 (-0.5)	11 (1.0)	6 (0.5)	4 (0.3)
Nov	---	---	6 (0.7)	6 (0.6)	-9 (-0.8)	5 (0.6)	4 (0.4)	-3 (-0.3)
Dec	---	---	6 (0.5)	6 (0.5)	7 (0.6)	6 (0.5)	7 (0.7)	0 (0.0)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	-5 (-0.5)	3 (0.3)	2 (0.1)	2 (0.2)	2 (0.2)	2 (0.2)	-6 (-0.6)
Feb	---	-97 (-9.7)	-130 (-13.0)	-131 (-13.0)	-127 (-12.6)	-128 (-12.8)	-75 (-7.5)	-97 (-9.6)
Mar	---	-149 (-12.8)	-160 (-13.7)	-156 (-13.4)	-140 (-12.0)	-157 (-13.4)	-162 (-13.9)	-162 (-13.9)
Apr	---	-133 (-10.2)	-126 (-9.7)	-136 (-10.4)	-136 (-10.4)	-132 (-10.1)	-151 (-11.6)	-149 (-11.4)
May	---	-71 (-9.1)	-65 (-8.3)	-68 (-8.8)	-62 (-7.9)	-66 (-8.4)	-71 (-9.1)	-73 (-9.4)
Jun	---	-47 (-8.4)	-52 (-9.3)	-52 (-9.4)	-49 (-8.8)	-53 (-9.5)	-50 (-8.9)	-45 (-8.0)
Jul	---	-8 (-1.1)	-8 (-1.2)	-7 (-0.9)	-17 (-2.4)	0 (0.0)	-24 (-3.4)	2 (0.3)
Aug	---	-37 (-4.7)	-33 (-4.2)	-34 (-4.3)	-33 (-4.1)	-34 (-4.4)	-33 (-4.2)	-35 (-4.5)
Sep	---	-37 (-3.4)	-44 (-4.0)	-43 (-4.0)	-43 (-4.0)	-44 (-4.0)	-55 (-5.0)	-40 (-3.7)
Oct	---	-6 (-0.5)	5 (0.5)	4 (0.4)	-11 (-0.9)	5 (0.5)	0 (0.0)	-2 (-0.1)
Nov	---	-6 (-0.6)	0 (0.0)	0 (0.0)	-15 (-1.4)	-1 (-0.1)	-2 (-0.2)	-9 (-0.9)
Dec	---	-14 (-1.3)	-8 (-0.8)	-8 (-0.8)	-7 (-0.7)	-8 (-0.8)	-7 (-0.6)	-14 (-1.3)

Table 103. Cumulative Effects Simulated Uranium Concentrations for Arkansas River at Las Animas Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	14.6	13.8	13.8	13.8	13.8	13.8	13.8	13.8
15th percentile	6.6	6.7	6.5	6.5	6.6	6.5	6.7	6.6
25th percentile	9.6	9.3	9.3	9.3	9.3	9.3	9.4	9.3
50th percentile	15.3	14.7	14.5	14.4	14.6	14.4	14.6	14.6
75th percentile	18.2	17.1	17.0	17.0	17.0	17.0	17.1	17.0
85th percentile	21.0	19.3	19.3	19.3	19.3	19.4	19.2	19.2
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0 (-0.1)	0 (-0.2)	0 (-0.2)	0 (-0.1)	0 (-0.2)	0 (-0.2)
15th percentile	---	---	-0.2 (-3.1)	-0.2 (-3.0)	-0.1 (-0.9)	-0.2 (-3.1)	-0.1 (-0.9)	-0.1 (-1.2)
25th percentile	---	---	0 (-0.4)	0 (-0.4)	0 (0.3)	0 (-0.4)	0.1 (1.2)	0 (0.4)
50th percentile	---	---	-0.2 (-1.5)	-0.3 (-1.8)	-0.1 (-0.6)	-0.3 (-1.8)	-0.1 (-0.4)	-0.1 (-0.4)
75th percentile	---	---	0 (-0.3)	-0.1 (-0.3)	0 (-0.1)	0 (-0.3)	0 (0.0)	-0.1 (-0.4)
85th percentile	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0.1 (0.6)	-0.1 (-0.7)	-0.1 (-0.6)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	-0.8 (-5.5)	-0.8 (-5.6)	-0.8 (-5.7)	-0.8 (-5.7)	-0.8 (-5.5)	-0.8 (-5.7)	-0.8 (-5.7)
15th percentile	---	0.2 (2.4)	-0.1 (-0.8)	0 (-0.7)	0.1 (1.4)	-0.1 (-0.8)	0.1 (1.5)	0.1 (1.2)
25th percentile	---	-0.3 (-3.2)	-0.3 (-3.6)	-0.3 (-3.6)	-0.3 (-2.9)	-0.3 (-3.6)	-0.2 (-2.0)	-0.3 (-2.8)
50th percentile	---	-0.6 (-4.1)	-0.9 (-5.6)	-0.9 (-5.9)	-0.7 (-4.7)	-0.9 (-5.9)	-0.7 (-4.5)	-0.7 (-4.6)
75th percentile	---	-1.1 (-6.2)	-1.2 (-6.4)	-1.2 (-6.4)	-1.1 (-6.3)	-1.2 (-6.4)	-1.1 (-6.1)	-1.2 (-6.6)
85th percentile	---	-1.7 (-8.1)	-1.7 (-8.1)	-1.7 (-8.1)	-1.7 (-8.1)	-1.6 (-7.6)	-1.8 (-8.7)	-1.8 (-8.6)

Table 104. Monthly Simulated Uranium Concentration for Arkansas River at Las Animas - Cumulative Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Jan	20.2	20.1	20.2	20.2	20.2	20.2	20.2	20.1
Feb	19.5	18.0	17.5	17.5	17.5	17.5	18.3	18.0
Mar	22.1	19.8	19.6	19.7	19.9	19.7	19.6	19.6
Apr	24.4	22.3	22.4	22.2	22.2	22.3	22.0	22.0
May	16.0	14.9	15.0	14.9	15.0	14.9	14.9	14.8
Jun	12.6	11.9	11.8	11.8	11.9	11.8	11.8	11.9
Jul	14.7	14.6	14.6	14.6	14.5	14.7	14.3	14.7
Aug	16.1	15.5	15.6	15.6	15.6	15.6	15.6	15.5
Sep	20.9	20.3	20.2	20.2	20.2	20.2	20.0	20.3
Oct	21.2	21.1	21.3	21.3	21.1	21.3	21.2	21.2
Nov	20.5	20.4	20.5	20.5	20.3	20.5	20.5	20.4
Dec	20.7	20.5	20.5	20.5	20.6	20.5	20.6	20.5
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Jan	---	---	0.1 (0.6)	0.1 (0.5)	0.1 (0.6)	0.1 (0.6)	0.1 (0.6)	0.0 (-0.1)
Feb	---	---	-0.5 (-2.9)	-0.5 (-2.9)	-0.5 (-2.5)	-0.5 (-2.7)	0.3 (1.9)	0.0 (0.0)
Mar	---	---	-0.2 (-0.9)	-0.1 (-0.6)	0.1 (0.7)	-0.1 (-0.6)	-0.2 (-1.0)	-0.2 (-1.0)
Apr	---	---	0.1 (0.5)	-0.1 (-0.2)	-0.1 (-0.2)	0.0 (0.1)	-0.3 (-1.3)	-0.3 (-1.1)
May	---	---	0.1 (0.7)	0.0 (0.3)	0.1 (1.0)	0.0 (0.6)	0.0 (0.0)	-0.1 (-0.2)
Jun	---	---	-0.1 (-0.6)	-0.1 (-0.7)	0.0 (-0.3)	-0.1 (-0.8)	-0.1 (-0.4)	0.0 (0.3)
Jul	---	---	0.0 (0.0)	0.0 (0.1)	-0.1 (-1.0)	0.1 (0.9)	-0.3 (-1.7)	0.1 (1.1)
Aug	---	---	0.1 (0.3)	0.1 (0.3)	0.1 (0.4)	0.1 (0.2)	0.1 (0.4)	0.0 (0.1)
Sep	---	---	-0.1 (-0.5)	-0.1 (-0.5)	-0.1 (-0.5)	-0.1 (-0.5)	-0.3 (-1.4)	0.0 (-0.2)
Oct	---	---	0.2 (0.8)	0.2 (0.7)	0.0 (-0.4)	0.2 (0.8)	0.1 (0.4)	0.1 (0.3)
Nov	---	---	0.1 (0.5)	0.1 (0.5)	-0.1 (-0.7)	0.1 (0.5)	0.1 (0.4)	0.0 (-0.2)
Dec	---	---	0.0 (0.4)	0.0 (0.4)	0.1 (0.5)	0.0 (0.4)	0.1 (0.5)	0.0 (0.0)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Jan	---	-0.1 (-0.4)	0.0 (0.2)	0.0 (0.1)	0.0 (0.1)	0.0 (0.2)	0.0 (0.2)	-0.1 (-0.5)
Feb	---	-1.5 (-7.8)	-2.0 (-10.4)	-2.0 (-10.5)	-2.0 (-10.1)	-2.0 (-10.3)	-1.2 (-6.0)	-1.5 (-7.7)
Mar	---	-2.3 (-10.5)	-2.5 (-11.3)	-2.4 (-11.0)	-2.2 (-9.9)	-2.4 (-11.1)	-2.5 (-11.5)	-2.5 (-11.5)
Apr	---	-2.1 (-8.6)	-2.0 (-8.1)	-2.2 (-8.8)	-2.2 (-8.7)	-2.1 (-8.5)	-2.4 (-9.7)	-2.4 (-9.6)
May	---	-1.1 (-6.9)	-1.0 (-6.3)	-1.1 (-6.6)	-1.0 (-6.0)	-1.1 (-6.4)	-1.1 (-6.9)	-1.2 (-7.1)
Jun	---	-0.7 (-5.8)	-0.8 (-6.4)	-0.8 (-6.5)	-0.7 (-6.1)	-0.8 (-6.6)	-0.8 (-6.2)	-0.7 (-5.6)
Jul	---	-0.1 (-0.8)	-0.1 (-0.9)	-0.1 (-0.7)	-0.2 (-1.8)	0.0 (0.0)	-0.4 (-2.5)	0.0 (0.2)
Aug	---	-0.6 (-3.5)	-0.5 (-3.2)	-0.5 (-3.2)	-0.5 (-3.1)	-0.5 (-3.3)	-0.5 (-3.2)	-0.6 (-3.4)
Sep	---	-0.6 (-2.8)	-0.7 (-3.3)	-0.7 (-3.2)	-0.7 (-3.2)	-0.7 (-3.3)	-0.9 (-4.1)	-0.6 (-3.0)
Oct	---	-0.1 (-0.4)	0.1 (0.4)	0.1 (0.3)	-0.1 (-0.8)	0.1 (0.4)	0.0 (0.0)	0.0 (-0.1)
Nov	---	-0.1 (-0.5)	0.0 (0.0)	0.0 (0.0)	-0.2 (-1.2)	0.0 (0.0)	0.0 (-0.1)	-0.1 (-0.7)
Dec	---	-0.2 (-1.0)	-0.2 (-0.6)	-0.2 (-0.6)	-0.1 (-0.5)	-0.2 (-0.6)	-0.1 (-0.5)	-0.2 (-1.1)

All alternatives would have predominately negligible cumulative effects on sulfate concentrations at the Fountain Creek near Fountain gage, although minor beneficial decrease also would occur (Table 105 to Table 106). Sulfate concentrations would increase and decrease for all alternatives compared to existing conditions, depending on the time of year. Uranium effects were not assessed at this gage because data was not available to develop a relationship to salinity concentrations.

Table 105. Cumulative Effects Simulated Sulfate Concentrations for Fountain Creek near Fountain Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	227	233	233	232	233	231	233	233
15th percentile	156	184	181	181	182	180	182	184
25th percentile	186	200	200	199	199	199	200	200
50th percentile	235	223	224	223	223	223	224	223
75th percentile	270	247	247	247	247	247	249	248
85th percentile	285	264	264	263	264	263	265	264
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	0 (0.2)	-1 (-0.3)	0 (-0.1)	-1 (-0.5)	0 (-0.1)	0 (0.1)
15th percentile	---	---	-3 (-1.8)	-3 (-1.8)	-2 (-1.2)	-4 (-1.9)	-2 (-1.2)	0 (0.0)
25th percentile	---	---	0 (0.1)	-1 (-0.3)	0 (-0.1)	-1 (-0.3)	1 (0.3)	1 (0.4)
50th percentile	---	---	1 (0.3)	0 (0.2)	0 (0.1)	1 (0.2)	1 (0.3)	1 (0.3)
75th percentile	---	---	1 (0.3)	0 (0.1)	0 (0.0)	0 (0.2)	2 (0.9)	1 (0.4)
85th percentile	---	---	0 (0.0)	-1 (-0.4)	0 (0.0)	-1 (-0.3)	1 (0.5)	0 (0.0)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	5 (2.3)	6 (2.5)	5 (2.0)	5 (2.2)	4 (1.8)	5 (2.2)	5 (2.4)
15th percentile	---	28 (17.6)	24 (15.5)	24 (15.5)	25 (16.2)	24 (15.3)	25 (16.2)	28 (17.7)
25th percentile	---	14 (7.4)	14 (7.4)	13 (7.0)	13 (7.2)	13 (7.0)	14 (7.7)	14 (7.8)
50th percentile	---	-13 (-5.4)	-12 (-5.1)	-12 (-5.2)	-12 (-5.3)	-12 (-5.2)	-12 (-5.1)	-12 (-5.1)
75th percentile	---	-23 (-8.6)	-23 (-8.4)	-23 (-8.5)	-23 (-8.6)	-23 (-8.4)	-21 (-7.8)	-22 (-8.3)
85th percentile	---	-21 (-7.4)	-21 (-7.4)	-22 (-7.7)	-21 (-7.4)	-22 (-7.7)	-20 (-7.0)	-21 (-7.4)

Table 106. Monthly Simulated Sulfate Concentration for Fountain Creek near Fountain Gage - Cumulative Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	245	234	234	234	234	234	233	233
Feb	242	224	226	226	225	226	224	224
Mar	233	232	230	229	230	229	230	231
Apr	203	223	223	223	223	228	224	228
May	191	250	246	233	246	234	245	243
Jun	201	263	263	263	261	262	265	264
Jul	196	220	222	222	218	222	217	222
Aug	208	208	218	218	219	208	210	209
Sep	232	233	234	234	233	233	237	235
Oct	269	231	228	228	229	227	232	231
Nov	256	231	231	230	231	231	231	231
Dec	262	238	238	238	238	238	238	238
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	0 (0.2)	0 (0.1)	0 (0.1)	0 (0.0)	-1 (-0.3)	-1 (-0.3)
Feb	---	---	2 (0.9)	2 (0.9)	1 (0.5)	2 (0.9)	0 (0.2)	0 (0.3)
Mar	---	---	-2 (-0.8)	-3 (-1.2)	-2 (-0.8)	-3 (-1.1)	-2 (-0.6)	-1 (-0.5)
Apr	---	---	0 (0.0)	0 (0.2)	0 (-0.1)	5 (2.5)	1 (0.4)	5 (2.3)
May	---	---	-4 (-1.5)	-17 (-6.7)	-4 (-1.5)	-16 (-6.6)	-5 (-2.2)	-7 (-2.7)
Jun	---	---	0 (0.1)	0 (0.1)	-2 (-0.7)	-1 (-0.3)	2 (0.7)	1 (0.6)
Jul	---	---	2 (1.0)	2 (1.1)	-2 (-0.9)	2 (1.1)	-3 (-1.6)	2 (0.7)
Aug	---	---	10 (4.7)	10 (4.7)	11 (5.0)	0 (0.0)	2 (0.6)	1 (0.6)
Sep	---	---	1 (0.2)	1 (0.2)	0 (-0.2)	0 (0.0)	4 (1.6)	2 (0.9)
Oct	---	---	-3 (-1.5)	-3 (-1.5)	-2 (-1.0)	-4 (-1.9)	1 (0.4)	0 (-0.3)
Nov	---	---	0 (-0.1)	-1 (-0.2)	0 (-0.1)	0 (0.1)	0 (0.2)	0 (0.1)
Dec	---	---	0 (0.0)	0 (0.0)	0 (-0.1)	0 (0.0)	0 (-0.1)	0 (0.0)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	-11 (-4.6)	-11 (-4.4)	-11 (-4.5)	-11 (-4.5)	-11 (-4.6)	-12 (-4.8)	-12 (-4.9)
Feb	---	-18 (-7.4)	-16 (-6.5)	-16 (-6.6)	-17 (-7.0)	-16 (-6.6)	-18 (-7.2)	-18 (-7.2)
Mar	---	-1 (-0.6)	-3 (-1.4)	-4 (-1.8)	-3 (-1.4)	-4 (-1.6)	-3 (-1.2)	-2 (-1.0)
Apr	---	20 (9.9)	20 (9.9)	20 (10.0)	20 (9.8)	25 (12.6)	21 (10.3)	25 (12.3)
May	---	59 (30.9)	55 (28.9)	42 (22.2)	55 (28.9)	43 (22.3)	54 (28.1)	52 (27.4)
Jun	---	62 (31.0)	62 (31.1)	62 (31.1)	60 (30.1)	61 (30.6)	64 (31.9)	63 (31.8)
Jul	---	24 (12.2)	26 (13.4)	26 (13.4)	22 (11.2)	26 (13.4)	21 (10.4)	26 (13.0)
Aug	---	0 (-0.1)	10 (4.6)	10 (4.6)	11 (4.9)	0 (-0.1)	2 (0.5)	1 (0.5)
Sep	---	1 (0.5)	2 (0.7)	2 (0.7)	1 (0.4)	1 (0.5)	5 (2.1)	3 (1.4)
Oct	---	-38 (-14.0)	-41 (-15.3)	-41 (-15.3)	-40 (-14.8)	-42 (-15.6)	-37 (-13.6)	-38 (-14.2)
Nov	---	-25 (-10.0)	-25 (-10.1)	-26 (-10.1)	-25 (-10.1)	-25 (-9.8)	-25 (-9.7)	-25 (-9.9)
Dec	---	-24 (-9.1)	-24 (-9.2)	-24 (-9.2)	-24 (-9.2)	-24 (-9.2)	-24 (-9.2)	-24 (-9.1)

All alternatives would have predominately negligible effects on sulfate concentrations at the Fountain Creek at Pueblo gage, although occasional minor increases would occur (Table 107 to Table 108). Sulfate concentrations would increase and decrease for all alternatives compared to existing conditions, depending on the time of year.

Uranium effects would be predominately negligible, compared to the No Action Alternative, although moderate cumulative increases would occur in the Comanche North, Pueblo Dam South, and JUP North alternatives (Table 109 and Table 110).

Table 107. Cumulative Effects Simulated Sulfate Concentrations for Fountain Creek at Pueblo Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Mean	264	236	237	235	236	234	236	236
15th percentile	131	124	124	122	124	124	126	126
25th percentile	176	159	159	159	159	159	160	161
50th percentile	270	223	225	225	221	225	225	225
75th percentile	358	279	280	278	279	278	282	279
85th percentile	394	314	317	315	317	314	311	315
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Mean	---	---	1 (0.5)	-1 (-0.5)	0 (0.0)	-2 (-0.9)	-1 (-0.3)	0 (0.0)
15th percentile	---	---	0 (0.1)	-1 (-1.2)	0 (-0.2)	0 (-0.2)	3 (2.1)	3 (2.1)
25th percentile	---	---	0 (-0.2)	-1 (-0.4)	0 (0.0)	-1 (-0.5)	1 (0.3)	2 (1.1)
50th percentile	---	---	2 (1.0)	2 (0.8)	-2 (-1.1)	2 (0.9)	2 (0.9)	2 (0.7)
75th percentile	---	---	1 (0.4)	-1 (-0.2)	0 (0.1)	-1 (-0.2)	3 (1.2)	0 (-0.1)
85th percentile	---	---	3 (1.0)	1 (0.4)	4 (1.1)	0 (0.1)	-3 (-0.8)	1 (0.4)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Mean	---	-27 (-10.4)	-26 (-10.0)	-29 (-10.8)	-28 (-10.4)	-30 (-11.2)	-28 (-10.7)	-28 (-10.4)
15th percentile	---	-7 (-5.2)	-7 (-5.1)	-8 (-6.3)	-7 (-5.4)	-7 (-5.4)	-4 (-3.2)	-4 (-3.2)
25th percentile	---	-16 (-9.3)	-17 (-9.5)	-17 (-9.6)	-16 (-9.3)	-17 (-9.7)	-16 (-9.0)	-15 (-8.3)
50th percentile	---	-47 (-17.4)	-45 (-16.6)	-45 (-16.8)	-49 (-18.3)	-45 (-16.7)	-45 (-16.7)	-45 (-16.8)
75th percentile	---	-79 (-22.0)	-78 (-21.7)	-80 (-22.2)	-79 (-22.0)	-79 (-22.2)	-76 (-21.1)	-79 (-22.1)
85th percentile	---	-80 (-20.4)	-77 (-19.6)	-79 (-20.1)	-77 (-19.5)	-80 (-20.3)	-83 (-21.0)	-79 (-20.0)

Table 108. Monthly Simulated Sulfate Concentration for Fountain Creek at Pueblo Gage - Cumulative Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (mg/L)								
Jan	294	246	247	247	247	246	243	244
Feb	302	235	236	236	237	236	235	234
Mar	273	234	230	229	231	230	232	233
Apr	242	220	218	219	218	227	221	227
May	190	239	232	209	232	210	230	228
Jun	205	265	266	265	263	264	268	268
Jul	197	203	208	208	200	208	197	207
Aug	220	189	207	207	207	190	191	191
Sep	229	216	220	220	217	219	224	220
Oct	361	254	253	252	252	251	257	255
Nov	319	251	253	252	252	253	251	251
Dec	345	272	270	270	273	270	271	271
Change in Concentration Compared to No Action Alternative [mg/L (%)]								
Jan	---	---	1 (0.2)	1 (0.1)	1 (0.3)	0 (-0.2)	-3 (-1.1)	-2 (-1.0)
Feb	---	---	1 (0.5)	1 (0.6)	2 (0.7)	1 (0.5)	0 (-0.1)	-1 (-0.5)
Mar	---	---	-4 (-1.7)	-5 (-2.2)	-3 (-1.7)	-4 (-2.0)	-2 (-1.2)	-1 (-0.8)
Apr	---	---	-2 (-1.0)	-1 (-0.8)	-2 (-1.0)	7 (3.2)	1 (0.2)	7 (2.9)
May	---	---	-7 (-2.8)	-30 (-12.4)	-7 (-2.8)	-29 (-12.3)	-9 (-3.9)	-11 (-4.8)
Jun	---	---	1 (0.3)	0 (0.1)	-2 (-0.8)	-1 (-0.4)	3 (1.0)	3 (1.1)
Jul	---	---	5 (2.6)	5 (2.6)	-3 (-1.4)	5 (2.4)	-6 (-3.0)	4 (2.1)
Aug	---	---	18 (9.4)	18 (9.2)	18 (9.6)	1 (0.4)	2 (0.9)	2 (0.9)
Sep	---	---	4 (1.7)	4 (1.6)	1 (0.3)	3 (1.3)	8 (3.7)	4 (1.8)
Oct	---	---	-1 (-0.5)	-2 (-0.7)	-2 (-0.8)	-3 (-1.2)	3 (0.9)	1 (0.2)
Nov	---	---	2 (0.7)	1 (0.7)	1 (0.4)	2 (1.0)	0 (0.2)	0 (0.3)
Dec	---	---	-2 (-0.6)	-2 (-0.6)	1 (0.3)	-2 (-0.6)	-1 (-0.3)	-1 (-0.4)
Change in Concentration Compared to Existing Conditions [mg/L (%)]								
Jan	---	-48 (-16.3)	-47 (-16.1)	-47 (-16.2)	-47 (-16.0)	-48 (-16.4)	-51 (-17.2)	-50 (-17.1)
Feb	---	-67 (-22.3)	-66 (-21.9)	-66 (-21.8)	-65 (-21.7)	-66 (-21.9)	-67 (-22.4)	-68 (-22.6)
Mar	---	-39 (-14.2)	-43 (-15.7)	-44 (-16.1)	-42 (-15.6)	-43 (-15.9)	-41 (-15.2)	-40 (-14.9)
Apr	---	-22 (-8.9)	-24 (-9.8)	-23 (-9.6)	-24 (-9.8)	-15 (-6.0)	-21 (-8.7)	-15 (-6.2)
May	---	49 (25.7)	42 (22.2)	19 (10.1)	42 (22.2)	20 (10.3)	40 (20.9)	38 (19.7)
Jun	---	60 (29.4)	61 (29.8)	60 (29.6)	58 (28.4)	59 (28.9)	63 (30.6)	63 (30.8)
Jul	---	6 (3.3)	11 (6.0)	11 (6.0)	3 (1.8)	11 (5.7)	0 (0.2)	10 (5.4)
Aug	---	-31 (-13.9)	-13 (-5.8)	-13 (-6.0)	-13 (-5.7)	-30 (-13.6)	-29 (-13.1)	-29 (-13.1)
Sep	---	-13 (-5.3)	-9 (-3.7)	-9 (-3.8)	-12 (-5.0)	-10 (-4.1)	-5 (-1.8)	-9 (-3.6)
Oct	---	-107 (-29.6)	-108 (-30.0)	-109 (-30.1)	-109 (-30.2)	-110 (-30.5)	-104 (-29.0)	-106 (-29.5)
Nov	---	-68 (-21.3)	-66 (-20.7)	-67 (-20.8)	-67 (-21.0)	-66 (-20.5)	-68 (-21.1)	-68 (-21.1)
Dec	---	-73 (-21.2)	-75 (-21.7)	-75 (-21.7)	-72 (-20.9)	-75 (-21.7)	-74 (-21.4)	-74 (-21.5)

Table 109. Cumulative Effects Simulated Uranium Concentrations for Fountain Creek at Pueblo Gage

Statistic	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (µg/L)								
Mean	2.4	2.0	2.0	2.0	2.0	2.0	2.0	2.0
15th percentile	0.6	0.5	0.5	0.5	0.5	0.5	0.6	0.6
25th percentile	1.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0
50th percentile	2.5	1.8	1.9	1.9	1.8	1.9	1.9	1.9
75th percentile	3.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
85th percentile	4.1	3.0	3.1	3.1	3.1	3.0	3.0	3.1
Change in Concentration Compared to No Action Alternative [µg/L (%)]								
Mean	---	---	0 (0.7)	0 (-0.7)	0 (0.0)	0 (-1.3)	0 (-0.5)	0 (0.0)
15th percentile	---	---	0 (0.2)	0 (-3.7)	0 (-0.7)	0 (-0.7)	0 (6.4)	0 (6.4)
25th percentile	---	---	0 (-0.3)	0 (-0.8)	0 (0.0)	0 (-1.0)	0 (0.7)	0 (2.3)
50th percentile	---	---	0 (1.5)	0 (1.2)	0 (-1.7)	0 (1.5)	0 (1.4)	0 (1.1)
75th percentile	---	---	0 (0.5)	0 (-0.3)	0 (0.1)	0 (-0.3)	0 (1.6)	0 (-0.1)
85th percentile	---	---	0 (1.4)	0 (0.5)	0 (1.6)	0 (0.1)	0 (-1.1)	0 (0.6)
Change in Concentration Compared to Existing Conditions [µg/L (%)]								
Mean	---	-0.4 (-15.2)	-0.3 (-14.6)	-0.4 (-15.9)	-0.4 (-15.3)	-0.4 (-16.4)	-0.4 (-15.7)	-0.4 (-15.3)
15th percentile	---	-0.1 (-14.3)	-0.1 (-14.2)	-0.1 (-17.5)	-0.1 (-14.9)	-0.1 (-14.9)	-0.1 (-8.8)	-0.1 (-8.8)
25th percentile	---	-0.2 (-17.7)	-0.2 (-18.0)	-0.2 (-18.3)	-0.2 (-17.8)	-0.2 (-18.5)	-0.2 (-17.2)	-0.2 (-15.8)
50th percentile	---	-0.6 (-25.2)	-0.6 (-24.0)	-0.6 (-24.3)	-0.7 (-26.5)	-0.6 (-24.1)	-0.6 (-24.2)	-0.6 (-24.4)
75th percentile	---	-1 (-28.7)	-1 (-28.4)	-1 (-29.0)	-1 (-28.7)	-1 (-29.0)	-1 (-27.6)	-1 (-28.8)
85th percentile	---	-1.1 (-25.9)	-1 (-24.8)	-1 (-25.5)	-1 (-24.7)	-1.1 (-25.8)	-1.1 (-26.7)	-1 (-25.4)

Table 110. Monthly Simulated Uranium Concentration for Fountain Creek at Pueblo - Cumulative Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Concentration (μg/L)								
Jan	2.8	2.1	2.2	2.2	2.2	2.1	2.1	2.1
Feb	2.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Mar	2.5	2.0	1.9	1.9	1.9	1.9	2.0	2.0
Apr	2.1	1.8	1.8	1.8	1.8	1.9	1.8	1.9
May	1.4	2.1	2.0	1.7	2.0	1.7	1.9	1.9
Jun	1.6	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Jul	1.5	1.6	1.7	1.7	1.5	1.6	1.5	1.6
Aug	1.8	1.4	1.6	1.6	1.6	1.4	1.4	1.4
Sep	1.9	1.8	1.8	1.8	1.8	1.8	1.9	1.8
Oct	3.7	2.3	2.2	2.2	2.2	2.2	2.3	2.3
Nov	3.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Dec	3.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Change in Concentration Compared to No Action Alternative [μg/L (%)]								
Jan	---	---	0.1 (0.3)	0.1 (0.2)	0.1 (0.5)	0.0 (-0.3)	0.0 (-1.7)	0.0 (-1.4)
Feb	---	---	0.0 (0.7)	0.0 (0.9)	0.0 (1.1)	0.0 (0.8)	0.0 (-0.1)	0.0 (-0.7)
Mar	---	---	-0.1 (-2.6)	-0.1 (-3.4)	-0.1 (-2.6)	-0.1 (-3.1)	0.0 (-1.8)	0.0 (-1.2)
Apr	---	---	0.0 (-1.6)	0.0 (-1.3)	0.0 (-1.7)	0.1 (5.1)	0.0 (0.4)	0.1 (4.7)
May	---	---	-0.1 (-4.2)	-0.4 (-19.0)	-0.1 (-4.3)	-0.4 (-18.8)	-0.2 (-5.9)	-0.2 (-7.3)
Jun	---	---	0.0 (0.5)	0.0 (0.2)	0.0 (-1.1)	0.0 (-0.6)	0.0 (1.4)	0.0 (1.6)
Jul	---	---	0.1 (4.5)	0.1 (4.5)	-0.1 (-2.4)	0.0 (4.1)	-0.1 (-5.0)	0.0 (3.5)
Aug	---	---	0.2 (16.9)	0.2 (16.5)	0.2 (17.2)	0.0 (0.7)	0.0 (1.6)	0.0 (1.7)
Sep	---	---	0.0 (2.7)	0.0 (2.6)	0.0 (0.5)	0.0 (2.0)	0.1 (6.1)	0.0 (2.9)
Oct	---	---	-0.1 (-0.7)	-0.1 (-1.1)	-0.1 (-1.2)	-0.1 (-1.8)	0.0 (1.3)	0.0 (0.3)
Nov	---	---	0.0 (1.1)	0.0 (1.0)	0.0 (0.6)	0.0 (1.5)	0.0 (0.3)	0.0 (0.4)
Dec	---	---	0.0 (-0.8)	0.0 (-0.9)	0.0 (0.5)	0.0 (-0.9)	0.0 (-0.4)	0.0 (-0.5)
Change in Concentration Compared to Existing Conditions [μg/L (%)]								
Jan	---	-0.7 (-22.7)	-0.6 (-22.5)	-0.6 (-22.6)	-0.6 (-22.3)	-0.7 (-22.9)	-0.7 (-24.1)	-0.7 (-23.8)
Feb	---	-0.9 (-30.8)	-0.9 (-30.3)	-0.9 (-30.2)	-0.9 (-30.0)	-0.9 (-30.2)	-0.9 (-30.9)	-0.9 (-31.3)
Mar	---	-0.5 (-20.4)	-0.6 (-22.5)	-0.6 (-23.1)	-0.6 (-22.5)	-0.6 (-22.9)	-0.5 (-21.9)	-0.5 (-21.4)
Apr	---	-0.3 (-13.5)	-0.3 (-14.9)	-0.3 (-14.7)	-0.3 (-15.0)	-0.2 (-9.1)	-0.3 (-13.2)	-0.2 (-9.5)
May	---	0.7 (45.9)	0.6 (39.7)	0.3 (18.1)	0.6 (39.6)	0.3 (18.4)	0.5 (37.2)	0.5 (35.2)
Jun	---	0.8 (49.6)	0.8 (50.3)	0.8 (49.9)	0.8 (47.9)	0.8 (48.7)	0.8 (51.7)	0.8 (51.9)
Jul	---	0.1 (5.7)	0.2 (10.4)	0.2 (10.4)	0.0 (3.1)	0.1 (10.0)	0.0 (0.3)	0.1 (9.4)
Aug	---	-0.4 (-22.4)	-0.2 (-9.4)	-0.2 (-9.6)	-0.2 (-9.1)	-0.4 (-21.9)	-0.4 (-21.2)	-0.4 (-21.1)
Sep	---	-0.1 (-8.4)	-0.1 (-5.9)	-0.1 (-6.0)	-0.1 (-7.9)	-0.1 (-6.5)	0.0 (-2.8)	-0.1 (-5.7)
Oct	---	-1.4 (-38.5)	-1.5 (-39.0)	-1.5 (-39.2)	-1.5 (-39.3)	-1.5 (-39.6)	-1.4 (-37.7)	-1.4 (-38.3)
Nov	---	-0.9 (-28.9)	-0.9 (-28.1)	-0.9 (-28.1)	-0.9 (-28.5)	-0.9 (-27.8)	-0.9 (-28.6)	-0.9 (-28.5)
Dec	---	-0.9 (-28.0)	-0.9 (-28.6)	-0.9 (-28.6)	-0.9 (-27.6)	-0.9 (-28.6)	-0.9 (-28.3)	-0.9 (-28.4)

Chronic Low Flows and Water Quality Assessments

Changes in streamflow could affect effluent limitations and treatment requirements for permitted discharges such as those from WWTFs. Of principal concern to WWTFs would be a reduction in receiving water streamflows, which dilute effluent concentrations. Reduced dilution would increase the stringency of those effluent limitations calculated using dilution in the receiving water. Effluent limits that typically consider dilution flow include ammonia, whole effluent toxicity, some metals, and some other inorganic parameters.

Methods

Chronic low flow and water quality assessment methods are described in this section. The results of chronic low flow analyses are inputs to water quality assessment methods.

Chronic Low Flow

The chronic low flow analysis used methods similar to the Health Department's method for determining low flows for discharge permits. For current discharge permits, chronic low flows are evaluated using the biologically-based design flow method to quantify the minimum low flow over a 30-day averaging period occurring every 3 years. The biologically-based method examines all low flow events within a period of record even if several occur in one year. The period of record for determining chronic low flows should be a minimum of 10 years (Health Department 2012). The Health Department's uses a version of the U.S. Environmental Protection Agency's DFLOW program (Oppelt 2004) along with historical streamflow data to calculated chronic low flows for current discharge permits.

The EIS chronic low flow effects analysis also used DFLOW, but replaced historical streamflow data with simulated streamflow. The Daily Model scenarios maintain a constant level of development for the entire 28 year simulation (e.g., 2010 demand and operations for existing conditions). Simulated existing conditions chronic low flow would not equal historical chronic low flow, even if the model was calibrated perfectly, because historical chronic low flow in the existing permit was calculated using historical streamflow that was subject to conditions changing over time (such as demand and operations). Simulated daily streamflow data for the last 10 years of the hydrologic model study period (1999 to 2009) were used to calculate simulated chronic low flows. The change in simulated chronic low flows between the baseline and alternative (such as between existing conditions and No Action, or No Action and action alternatives) is the effect of the alternative. The absolute simulated numbers compared to historical observation were not used in effects analyses.

Chronic low flows were estimated for major WWTFs (1 million gallons per day capacity or greater) in the Daily Model study area. The WWTF evaluated are summarized in Table 111. The approximate Daily Model links are located just upstream from the respective treatment plant discharges.

Table 111. Summary of WWTFs, Permitted Flow, and Hydrologic Model Links Upstream from WWTFs Evaluated Using DFLOW

WWTF	Permitted Flow (mgd)	Hydrologic Model Link
Buena Vista Sanitation District	1.5	LNODE200
City of Salida	2.1	LNODE240
Fremont Sanitation District Rainbow Park	8	LNODE360 – PenInL - FloInL
Pueblo West Metropolitan District	0.8	LNODE530
City of Pueblo	19	LNODE620
City of Rocky Ford	1.2	DSRF
City of La Junta	2.3	LNODE870
Security Sanitation District	2.4	LNODE6670
Widefield Water and Sanitation District and U.S. Department of Army Fort Carson	2.5 (Widefield) 4 (Fort Carson)	DSFCSEC
Fountain Sanitation District	1.9	DSJCC

Source: WWTF Discharge Permits

Potential effects of AVC alternatives on chronic low flows were evaluated using the following sequential process.

- Chronic low flow decreases of less than 10 percent compared to the No Action Alternative were not evaluated further, as these differences were within the range of Daily Model accuracy for low streamflows (Appendix D.3).

- Dilution flow was evaluated for chronic low flow decreases that exceeded 10 percent. Dilution flow is the percentage of streamflow at the discharge point that originates upstream from the discharge. The Colorado Mixing Zone Implementation Guidance (Health Department 2002) and Colorado Biomonitoring Guidance Document (Health Department 2006) indicate that discharges with greater that 90 percent dilution would not typically have discharge limits based on streamflow.

- Chronic low flows and discharge dilutions exceeding the above limits were further evaluated by applying chronic low flow percent differences between the No Action and action alternatives to chronic low flows in current permit water quality assessments. The existing discharge permits were used to evaluate if chronic low flow effects would affect permitted discharge limits. The significance criteria in Table 7 were used to guide this evaluation.

Acute Low Flow

Acute low flows, those that occur over a 1-day period, were not analyzed due to limitations in the Daily Model that could cause rare, short-term anomalies in simulated streamflows. The anomalies found in Daily Model output are unlikely to occur in reality, as flow management programs would typically prevent operations of alternatives that would cause decreases in acute low flows, even in reaches not covered by a flow management programs. Daily Model acute low flow anomalies likely result from one of two causes:

- Complex exchanges occurring simultaneously occasionally cannot be solved by the program (i.e., non-convergence error), resulting in an erroneous streamflow value.

- Simulated exchanges in the Daily Model occur instantaneously, whereas in reality, travel time of a transfer between the lower basin and the upper basin could take a day or two. The overall water delivered is not different between actual operations and simulated operations, but because travel time is not in the model, improbable simulated flows or major differences between alternatives can be simulated for a day.

These two factors could have slight effects on flows on individual days, but there is typically no net effect on flows summarized over a time step larger than a day. Because these statistically-based 1-day low flows cannot be directly compared, the effects analysis includes a short discussion of the flow management programs and binding minimum low flow agreements that limit exchanges by participants (see Appendix D.3 and Appendix D.4).

Water Quality Assessments

Adverse chronic low flow effects greater than 10 percent for WWTFs without 90 percent dilution flows were further evaluated using a water quality assessment. Water quality assessments are typically used to prepare and issue Colorado discharge permits. An assessment evaluates the assimilative capacities of various constituents available to a permittee, and guides development of permit discharge limits that would prevent stream water quality violations.

The water quality assessments in this EIS follow the Health Department's standard analysis of using steady-state, mass-balance calculations to calculate chronic (30-day average) water quality based effluent limits, or the maximum allowable effluent concentrations. The mass-balance equation accounts for the existing upstream pollutant concentration, annual low flow, discharge rate, and the water quality standard. The mass-balance equation is expressed as:

Equation 3

$$M_2 = \frac{M_3 Q_3 - M_1 Q_1}{Q_2}$$

Where
Q_1 = Upstream chronic low flow (lowest of monthly chronic low flows)
Q_2 = Average daily effluent flow (design hydraulic capacity)
Q_3 = Downstream flow ($Q_1 + Q_2$)
M_1 = In-stream background pollutant concentrations at the existing quality (ambient water quality)
M_2 = Calculated water quality based effluent limitations (assimilative capacity)
M_3 = Maximum allowable in-stream pollutant concentration (water quality standards)

WWTFs in streams not designated as Use Protected also use an antidegradation review to assess discharge limits. Antidegradation reviews assessed in the EIS used methodology outlined in *The Basic Standards and Methodologies for Surface Water* (Health Department 2012).

Because future permitted discharge limits, ambient water quality, and water quality standards are unknown, the water quality assessments in this EIS used water quality information from current discharge permits to evaluate effects. The chronic low flow percent changes of the alternatives compared to the No Action and existing conditions were applied to the current discharge permit chronic low flow, and then used in Equation 3 to evaluate effects on assimilative capacities. Changes in calculated assimilative capacities were compared with current permit capacities, discharge limits, and discharge limit rationales to evaluate effects of decreased low flow.

Results

Chronic low flow and dilution results are presented in this section for the Arkansas River and Fountain Creek basins. Water quality assessment results are then presented for WWTFs with chronic low flow effects.

Chronic Low Flow Effects

Major WWTFs in the Upper Arkansas River Basin are operated by the Buena Vista Sanitation District, the City of Salida, and the Fremont Sanitation District. The Lower Arkansas River Basin WWTFs include the Pueblo West Metropolitan District and the cities of Pueblo, Rocky Ford, La Junta, and Lamar. Fountain Creek Basin WWTFs are operated by the Security Sanitation District, the Widefield Water and Sanitation District, the U.S. Department of Army Fort Carson, and the Fountain Sanitation District.

Upper Arkansas River Basin Major WWTF Effects on chronic low flows in the Upper Arkansas River would be negligible for all action alternatives. Changes to streamflow in the Upper Arkansas River would be minimal, and would not affect permitted discharges (see Appendix D.4).

The Buena Vista Sanitation District WWTF discharges to the Arkansas River south of the City of Buena Vista. Link LNode200 of the hydrologic model was used to evaluate potential effects on chronic low flow. Decreases in chronic low flow for all alternatives compared to either the No Action or existing conditions would be less than 10 percent (Table 112 and Table 113).

The City of Salida WWTF discharges to the Arkansas River downstream from town. Link LNode240 of the hydrologic model was used to evaluate potential effects on chronic low flow. Decreases in chronic low flow for all alternatives compared to either the No Action or existing conditions would be less than 10 percent (Table 114 and Table 115).

The Fremont Sanitation District Rainbow Park Regional WWTF discharges to the Arkansas River east of the Town of Florence. Link number 3367 of the hydrologic model was used to evaluate potential effects on chronic low flow. Decreases in direct effects chronic low flow for all alternatives compared to the No Action would be less than 10 percent (Table 116). Compared to existing conditions, decreases in direct effects chronic low flow would be greater than 10 percent for the No Action and action alternatives. Decrease in cumulative effects chronic low flow, compared to either the No Action Alternative or existing conditions, would be greater than 10 percent for the Pueblo Dam South and River South alternatives (Table 117).

The permitted flow of this WWTF is 8 MGD or about 12.4 cfs. Projected permitted flow in 2060 would be 16.1 MGD (using projected demand growth of 100 percent), or 24.9 cfs. Dilution flows for direct and cumulative effects would be about 80 percent.

Table 112. Direct Effects Chronic Low Flow for Buena Vista Sanitation District

Month	Existing Conditions	No Action		Comanche North		Pueblo Dam South		JUP North		Pueblo Dam North		River South		Master Contract Only	
Simulated Streamflow (cfs)															
Jan	125	126		121		122		126		121		126		121	
Feb	125	126		121		122		126		121		126		121	
Mar	125	126		121		122		126		121		126		121	
Apr	139	139		140		140		141		140		139		140	
May	179	181		181		181		182		181		182		181	
Jun	205	220		209		209		218		209		209		209	
Jul	185	190		190		190		190		190		190		190	
Aug	180	183		183		183		183		183		183		183	
Sep	156	156		157		157		156		157		157		157	
Oct	139	139		139		139		140		139		139		139	
Nov	129	130		130		130		130		130		130		130	
Dec	125	126		121		122		126		121		126		121	
Annual	125	126		121		122		126		121		126		121	
Change in Streamflow Compared to No Action [cfs (%)]															
Jan	---	---		-5	(-4.0)	-4	(-3.2)	0	(0.0)	-5	(-4.0)	0	(0.0)	-5	(-4.0)
Feb	---	---		-5	(-4.0)	-4	(-3.2)	0	(0.0)	-5	(-4.0)	0	(0.0)	-5	(-4.0)
Mar	---	---		-5	(-4.0)	-4	(-3.2)	0	(0.0)	-5	(-4.0)	0	(0.0)	-5	(-4.0)
Apr	---	---		1	(0.7)	1	(0.7)	2	(1.4)	1	(0.7)	0	(0.0)	1	(0.7)
May	---	---		0	(0.0)	0	(0.0)	1	(0.6)	0	(0.0)	1	(0.6)	0	(0.0)
Jun	---	---		-11	(-5.0)	-11	(-5.0)	-2	(-0.9)	-11	(-5.0)	-11	(-5.0)	-11	(-5.0)
Jul	---	---		0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Aug	---	---		0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Sep	---	---		1	(0.6)	1	(0.6)	0	(0.0)	1	(0.6)	1	(0.6)	1	(0.6)
Oct	---	---		0	(0.0)	0	(0.0)	1	(0.7)	0	(0.0)	0	(0.0)	0	(0.0)
Nov	---	---		0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Dec	---	---		-5	(-4.0)	-4	(-3.2)	0	(0.0)	-5	(-4.0)	0	(0.0)	-5	(-4.0)
Annual	---	---		-5	(-4.0)	-4	(-3.2)	0	(0.0)	-5	(-4.0)	0	(0.0)	-5	(-4.0)
Change in Streamflow Compared to Existing Conditions [cfs (%)]															
Jan	---	1	(0.8)	-4	(-3.2)	-3	(-2.4)	1	(0.8)	-4	(-3.2)	1	(0.8)	-4	(-3.2)
Feb	---	1	(0.8)	-4	(-3.2)	-3	(-2.4)	1	(0.8)	-4	(-3.2)	1	(0.8)	-4	(-3.2)
Mar	---	1	(0.8)	-4	(-3.2)	-3	(-2.4)	1	(0.8)	-4	(-3.2)	1	(0.8)	-4	(-3.2)
Apr	---	0	(0.0)	1	(0.7)	1	(0.7)	2	(1.4)	1	(0.7)	0	(0.0)	1	(0.7)
May	---	2	(1.1)	2	(1.1)	2	(1.1)	3	(1.7)	2	(1.1)	3	(1.7)	2	(1.1)
Jun	---	15	(7.3)	4	(2.0)	4	(2.0)	13	(6.3)	4	(2.0)	4	(2.0)	4	(2.0)
Jul	---	5	(2.7)	5	(2.7)	5	(2.7)	5	(2.7)	5	(2.7)	5	(2.7)	5	(2.7)
Aug	---	3	(1.7)	3	(1.7)	3	(1.7)	3	(1.7)	3	(1.7)	3	(1.7)	3	(1.7)
Sep	---	0	(0.0)	1	(0.6)	1	(0.6)	0	(0.0)	1	(0.6)	1	(0.6)	1	(0.6)
Oct	---	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.7)	0	(0.0)	0	(0.0)	0	(0.0)
Nov	---	1	(0.8)	1	(0.8)	1	(0.8)	1	(0.8)	1	(0.8)	1	(0.8)	1	(0.8)
Dec	---	1	(0.8)	-4	(-3.2)	-3	(-2.4)	1	(0.8)	-4	(-3.2)	1	(0.8)	-4	(-3.2)
Annual	---	1	(0.8)	-4	(-3.2)	-3	(-2.4)	1	(0.8)	-4	(-3.2)	1	(0.8)	-4	(-3.2)

Table 113. Cumulative Effects Chronic Low Flow for Buena Vista Sanitation District WWTF

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	125	118	119	118	118	119	119	118
Feb	125	118	119	118	118	119	119	118
Mar	125	118	119	118	118	119	119	118
Apr	139	139	140	141	139	140	136	140
May	179	183	183	183	184	182	184	184
Jun	205	189	204	205	189	203	193	194
Jul	185	189	204	205	189	203	189	194
Aug	180	178	180	180	177	180	184	179
Sep	156	158	160	160	158	160	161	160
Oct	139	139	139	139	140	139	139	139
Nov	129	130	130	130	130	130	130	130
Dec	125	118	119	119	118	119	119	119
Annual	125	118	119	118	118	119	119	118
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	1 (0.8)	0 (0.0)	0 (0.0)	1 (0.8)	1 (0.8)	0 (0.0)
Feb	---	---	1 (0.8)	0 (0.0)	0 (0.0)	1 (0.8)	1 (0.8)	0 (0.0)
Mar	---	---	1 (0.8)	0 (0.0)	0 (0.0)	1 (0.8)	1 (0.8)	0 (0.0)
Apr	---	---	1 (0.7)	2 (1.4)	0 (0.0)	1 (0.7)	-3 (-2.2)	1 (0.7)
May	---	---	0 (0.0)	0 (0.0)	1 (0.5)	-1 (-0.5)	1 (0.5)	1 (0.5)
Jun	---	---	15 (7.9)	16 (8.5)	0 (0.0)	14 (7.4)	4 (2.1)	5 (2.6)
Jul	---	---	15 (7.9)	16 (8.5)	0 (0.0)	14 (7.4)	0 (0.0)	5 (2.6)
Aug	---	---	2 (1.1)	2 (1.1)	-1 (-0.6)	2 (1.1)	6 (3.4)	1 (0.6)
Sep	---	---	2 (1.3)	2 (1.3)	0 (0.0)	2 (1.3)	3 (1.9)	2 (1.3)
Oct	---	---	0 (0.0)	0 (0.0)	1 (0.7)	0 (0.0)	0 (0.0)	0 (0.0)
Nov	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Dec	---	---	1 (0.8)	1 (0.8)	0 (0.0)	1 (0.8)	1 (0.8)	1 (0.8)
Annual	---	---	1 (0.8)	0 (0.0)	0 (0.0)	1 (0.8)	1 (0.8)	0 (0.0)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	-7 (-5.6)	-6 (-4.8)	-7 (-5.6)	-7 (-5.6)	-6 (-4.8)	-6 (-4.8)	-7 (-5.6)
Feb	---	-7 (-5.6)	-6 (-4.8)	-7 (-5.6)	-7 (-5.6)	-6 (-4.8)	-6 (-4.8)	-7 (-5.6)
Mar	---	-7 (-5.6)	-6 (-4.8)	-7 (-5.6)	-7 (-5.6)	-6 (-4.8)	-6 (-4.8)	-7 (-5.6)
Apr	---	0 (0.0)	1 (0.7)	2 (1.4)	0 (0.0)	1 (0.7)	-3 (-2.2)	1 (0.7)
May	---	4 (2.2)	4 (2.2)	4 (2.2)	5 (2.8)	3 (1.7)	5 (2.8)	5 (2.8)
Jun	---	-16 (-7.8)	-1 (-0.5)	0 (0.0)	-16 (-7.8)	-2 (-1.0)	-12 (-5.9)	-11 (-5.4)
Jul	---	4 (2.2)	19 (10.3)	20 (10.8)	4 (2.2)	18 (9.7)	4 (2.2)	9 (4.9)
Aug	---	-2 (-1.1)	0 (0.0)	0 (0.0)	-3 (-1.7)	0 (0.0)	4 (2.2)	-1 (-0.6)
Sep	---	2 (1.3)	4 (2.6)	4 (2.6)	2 (1.3)	4 (2.6)	5 (3.2)	4 (2.6)
Oct	---	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)	0 (0.0)	0 (0.0)	0 (0.0)
Nov	---	1 (0.8)	1 (0.8)	1 (0.8)	1 (0.8)	1 (0.8)	1 (0.8)	1 (0.8)
Dec	---	-7 (-5.6)	-6 (-4.8)	-6 (-4.8)	-7 (-5.6)	-6 (-4.8)	-6 (-4.8)	-6 (-4.8)
Annual	---	-7 (-5.6)	-6 (-4.8)	-7 (-5.6)	-7 (-5.6)	-6 (-4.8)	-6 (-4.8)	-7 (-5.6)

Table 114. Direct Effects Chronic Low Flow for City of Salida

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	201	201	203	201	201	201	201	201
Feb	200	200	203	200	200	200	200	200
Mar	200	200	203	200	200	200	200	200
Apr	200	200	203	200	200	200	200	200
May	203	206	211	203	205	203	204	202
Jun	253	263	254	253	261	253	253	253
Jul	235	234	233	235	234	234	234	234
Aug	225	225	228	225	225	225	224	225
Sep	205	205	211	205	205	205	205	204
Oct	200	200	204	200	200	200	200	200
Nov	200	200	204	200	200	200	200	200
Dec	202	202	203	202	202	202	202	202
Annual	200	200	203	200	200	200	200	200
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	2 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Feb	---	---	3 (1.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Mar	---	---	3 (1.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Apr	---	---	3 (1.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
May	---	---	5 (2.4)	-3 (-1.5)	-1 (-0.5)	-3 (-1.5)	-2 (-1.0)	-4 (-1.9)
Jun	---	---	-9 (-3.4)	-10 (-3.8)	-2 (-0.8)	-10 (-3.8)	-10 (-3.8)	-10 (-3.8)
Jul	---	---	-1 (-0.4)	1 (0.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Aug	---	---	3 (1.3)	0 (0.0)	0 (0.0)	0 (0.0)	-1 (-0.4)	0 (0.0)
Sep	---	---	6 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	-1 (-0.5)
Oct	---	---	4 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Nov	---	---	4 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Dec	---	---	1 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Annual	---	---	3 (1.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	0 (0.0)	2 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Feb	---	0 (0.0)	3 (1.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Mar	---	0 (0.0)	3 (1.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Apr	---	0 (0.0)	3 (1.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
May	---	3 (1.5)	8 (3.9)	0 (0.0)	2 (1.0)	0 (0.0)	1 (0.5)	-1 (-0.5)
Jun	---	10 (4.0)	1 (0.4)	0 (0.0)	8 (3.2)	0 (0.0)	0 (0.0)	0 (0.0)
Jul	---	-1 (-0.4)	-2 (-0.9)	0 (0.0)	-1 (-0.4)	-1 (-0.4)	-1 (-0.4)	-1 (-0.4)
Aug	---	0 (0.0)	3 (1.3)	0 (0.0)	0 (0.0)	0 (0.0)	-1 (-0.4)	0 (0.0)
Sep	---	0 (0.0)	6 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	-1 (-0.5)
Oct	---	0 (0.0)	4 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Nov	---	0 (0.0)	4 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Dec	---	0 (0.0)	1 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Annual	---	0 (0.0)	3 (1.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Table 115. Cumulative Effects Chronic Low Flow for City of Salida

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	201	201	201	201	201	201	201	201
Feb	200	200	201	201	200	201	201	201
Mar	200	200	201	201	200	201	201	201
Apr	200	200	201	201	200	201	201	201
May	203	208	204	204	204	204	201	202
Jun	253	237	252	254	237	252	240	240
Jul	235	236	252	254	236	252	231	240
Aug	225	222	223	223	222	223	227	221
Sep	205	208	210	210	208	210	210	209
Oct	200	201	203	203	201	203	202	202
Nov	200	201	203	203	201	203	202	202
Dec	202	202	202	202	202	202	202	202
Annual	200	200	201	201	200	201	201	201
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Feb	---	---	1 (0.5)	1 (0.5)	0 (0.0)	1 (0.5)	1 (0.5)	1 (0.5)
Mar	---	---	1 (0.5)	1 (0.5)	0 (0.0)	1 (0.5)	1 (0.5)	1 (0.5)
Apr	---	---	1 (0.5)	1 (0.5)	0 (0.0)	1 (0.5)	1 (0.5)	1 (0.5)
May	---	---	-4 (-1.9)	-4 (-1.9)	-4 (-1.9)	-4 (-1.9)	-7 (-3.4)	-6 (-2.9)
Jun	---	---	15 (6.3)	17 (7.2)	0 (0.0)	15 (6.3)	3 (1.3)	3 (1.3)
Jul	---	---	16 (6.8)	18 (7.6)	0 (0.0)	16 (6.8)	-5 (-2.1)	4 (1.7)
Aug	---	---	1 (0.5)	1 (0.5)	0 (0.0)	1 (0.5)	5 (2.3)	-1 (-0.5)
Sep	---	---	2 (1.0)	2 (1.0)	0 (0.0)	2 (1.0)	2 (1.0)	1 (0.5)
Oct	---	---	2 (1.0)	2 (1.0)	0 (0.0)	2 (1.0)	1 (0.5)	1 (0.5)
Nov	---	---	2 (1.0)	2 (1.0)	0 (0.0)	2 (1.0)	1 (0.5)	1 (0.5)
Dec	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Annual	---	---	1 (0.5)	1 (0.5)	0 (0.0)	1 (0.5)	1 (0.5)	1 (0.5)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Feb	---	0 (0.0)	1 (0.5)	1 (0.5)	0 (0.0)	1 (0.5)	1 (0.5)	1 (0.5)
Mar	---	0 (0.0)	1 (0.5)	1 (0.5)	0 (0.0)	1 (0.5)	1 (0.5)	1 (0.5)
Apr	---	0 (0.0)	1 (0.5)	1 (0.5)	0 (0.0)	1 (0.5)	1 (0.5)	1 (0.5)
May	---	5 (2.5)	1 (0.5)	1 (0.5)	1 (0.5)	1 (0.5)	-2 (-1.0)	-1 (-0.5)
Jun	---	-16 (-6.3)	-1 (-0.4)	1 (0.4)	-16 (-6.3)	-1 (-0.4)	-13 (-5.1)	-13 (-5.1)
Jul	---	1 (0.4)	17 (7.2)	19 (8.1)	1 (0.4)	17 (7.2)	-4 (-1.7)	5 (2.1)
Aug	---	-3 (-1.3)	-2 (-0.9)	-2 (-0.9)	-3 (-1.3)	-2 (-0.9)	2 (0.9)	-4 (-1.8)
Sep	---	3 (1.5)	5 (2.4)	5 (2.4)	3 (1.5)	5 (2.4)	5 (2.4)	4 (2.0)
Oct	---	1 (0.5)	3 (1.5)	3 (1.5)	1 (0.5)	3 (1.5)	2 (1.0)	2 (1.0)
Nov	---	1 (0.5)	3 (1.5)	3 (1.5)	1 (0.5)	3 (1.5)	2 (1.0)	2 (1.0)
Dec	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Annual	---	0 (0.0)	1 (0.5)	1 (0.5)	0 (0.0)	1 (0.5)	1 (0.5)	1 (0.5)

Table 116. Direct Effects Chronic Low Flow for Fremont Sanitation District Rainbow Park

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	169	169	167	167	167	167	167	167
Feb	169	169	167	167	167	167	167	167
Mar	131	114	109	110	117	110	111	110
Apr	104	91	87	88	92	88	88	87
May	104	91	87	88	92	88	88	87
Jun	173	162	165	163	158	168	171	161
Jul	103	91	87	88	91	88	88	87
Aug	103	91	87	88	91	88	88	87
Sep	103	91	87	88	91	88	88	87
Oct	103	91	87	88	91	88	88	87
Nov	108	105	106	106	103	106	105	105
Dec	161	159	159	159	159	159	159	159
Annual	103	91	87	88	91	88	88	87
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)
Feb	---	---	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)
Mar	---	---	-5 (-4.4)	-4 (-3.5)	3 (2.6)	-4 (-3.5)	-3 (-2.6)	-4 (-3.5)
Apr	---	---	-4 (-4.4)	-3 (-3.3)	1 (1.1)	-3 (-3.3)	-3 (-3.3)	-4 (-4.4)
May	---	---	-4 (-4.4)	-3 (-3.3)	1 (1.1)	-3 (-3.3)	-3 (-3.3)	-4 (-4.4)
Jun	---	---	3 (1.9)	1 (0.6)	-4 (-2.5)	6 (3.7)	9 (5.6)	-1 (-0.6)
Jul	---	---	-4 (-4.4)	-3 (-3.3)	0 (0.0)	-3 (-3.3)	-3 (-3.3)	-4 (-4.4)
Aug	---	---	-4 (-4.4)	-3 (-3.3)	0 (0.0)	-3 (-3.3)	-3 (-3.3)	-4 (-4.4)
Sep	---	---	-4 (-4.4)	-3 (-3.3)	0 (0.0)	-3 (-3.3)	-3 (-3.3)	-4 (-4.4)
Oct	---	---	-4 (-4.4)	-3 (-3.3)	0 (0.0)	-3 (-3.3)	-3 (-3.3)	-4 (-4.4)
Nov	---	---	1 (1.0)	1 (1.0)	-2 (-1.9)	1 (1.0)	0 (0.0)	0 (0.0)
Dec	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Annual	---	---	-4 (-4.4)	-3 (-3.3)	0 (0.0)	-3 (-3.3)	-3 (-3.3)	-4 (-4.4)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	0 (0.0)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)
Feb	---	0 (0.0)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)
Mar	---	-17 (-13.0)	-22 (-16.8)	-21 (-16.0)	-14 (-10.7)	-21 (-16.0)	-20 (-15.3)	-21 (-16.0)
Apr	---	-13 (-12.5)	-17 (-16.3)	-16 (-15.4)	-12 (-11.5)	-16 (-15.4)	-16 (-15.4)	-17 (-16.3)
May	---	-13 (-12.5)	-17 (-16.3)	-16 (-15.4)	-12 (-11.5)	-16 (-15.4)	-16 (-15.4)	-17 (-16.3)
Jun	---	-11 (-6.4)	-8 (-4.6)	-10 (-5.8)	-15 (-8.7)	-5 (-2.9)	-2 (-1.2)	-12 (-6.9)
Jul	---	-12 (-11.7)	-16 (-15.5)	-15 (-14.6)	-12 (-11.7)	-15 (-14.6)	-15 (-14.6)	-16 (-15.5)
Aug	---	-12 (-11.7)	-16 (-15.5)	-15 (-14.6)	-12 (-11.7)	-15 (-14.6)	-15 (-14.6)	-16 (-15.5)
Sep	---	-12 (-11.7)	-16 (-15.5)	-15 (-14.6)	-12 (-11.7)	-15 (-14.6)	-15 (-14.6)	-16 (-15.5)
Oct	---	-12 (-11.7)	-16 (-15.5)	-15 (-14.6)	-12 (-11.7)	-15 (-14.6)	-15 (-14.6)	-16 (-15.5)
Nov	---	-3 (-2.8)	-2 (-1.9)	-2 (-1.9)	-5 (-4.6)	-2 (-1.9)	-3 (-2.8)	-3 (-2.8)
Dec	---	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)
Annual	---	-12 (-11.7)	-16 (-15.5)	-15 (-14.6)	-12 (-11.7)	-15 (-14.6)	-15 (-14.6)	-16 (-15.5)

Table 117. Cumulative Effects Chronic Low Flow for Fremont Sanitation District Rainbow Park

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	169	169	167	167	169	167	167	167
Feb	169	169	167	167	169	167	167	167
Mar	131	112	118	109	119	121	91	112
Apr	104	106	103	91	107	102	91	105
May	104	106	103	91	107	102	91	105
Jun	173	173	182	184	179	182	163	147
Jul	103	105	102	101	130	126	102	116
Aug	103	105	102	91	107	102	91	104
Sep	103	105	102	91	107	102	91	104
Oct	103	105	102	91	107	102	91	104
Nov	108	106	108	108	107	108	107	109
Dec	161	161	160	160	161	160	162	160
Annual	103	105	102	91	107	102	91	104
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	-2 (-1.2)	-2 (-1.2)	0 (0.0)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)
Feb	---	---	-2 (-1.2)	-2 (-1.2)	0 (0.0)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)
Mar	---	---	6 (5.4)	-3 (-2.7)	7 (6.3)	9 (8.0)	-21 (-18.8)	0 (0.0)
Apr	---	---	-3 (-2.8)	-15 (-14.2)	1 (0.9)	-4 (-3.8)	-15 (-14.2)	-1 (-0.9)
May	---	---	-3 (-2.8)	-15 (-14.2)	1 (0.9)	-4 (-3.8)	-15 (-14.2)	-1 (-0.9)
Jun	---	---	9 (5.2)	11 (6.4)	6 (3.5)	9 (5.2)	-10 (-5.8)	-26 (-15.0)
Jul	---	---	-3 (-2.9)	-4 (-3.8)	25 (23.8)	21 (20.0)	-3 (-2.9)	11 (10.5)
Aug	---	---	-3 (-2.9)	-14 (-13.3)	2 (1.9)	-3 (-2.9)	-14 (-13.3)	-1 (-1.0)
Sep	---	---	-3 (-2.9)	-14 (-13.3)	2 (1.9)	-3 (-2.9)	-14 (-13.3)	-1 (-1.0)
Oct	---	---	-3 (-2.9)	-14 (-13.3)	2 (1.9)	-3 (-2.9)	-14 (-13.3)	-1 (-1.0)
Nov	---	---	2 (1.9)	2 (1.9)	1 (0.9)	2 (1.9)	1 (0.9)	3 (2.8)
Dec	---	---	-1 (-0.6)	-1 (-0.6)	0 (0.0)	-1 (-0.6)	1 (0.6)	-1 (-0.6)
Annual	---	---	-3 (-2.9)	-14 (-13.3)	2 (1.9)	-3 (-2.9)	-14 (-13.3)	-1 (-1.0)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	0 (0.0)	-2 (-1.2)	-2 (-1.2)	0 (0.0)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)
Feb	---	0 (0.0)	-2 (-1.2)	-2 (-1.2)	0 (0.0)	-2 (-1.2)	-2 (-1.2)	-2 (-1.2)
Mar	---	-19 (-14.5)	-13 (-9.9)	-22 (-16.8)	-12 (-9.2)	-10 (-7.6)	-40 (-30.5)	-19 (-14.5)
Apr	---	2 (1.9)	-1 (-1.0)	-13 (-12.5)	3 (2.9)	-2 (-1.9)	-13 (-12.5)	1 (1.0)
May	---	2 (1.9)	-1 (-1.0)	-13 (-12.5)	3 (2.9)	-2 (-1.9)	-13 (-12.5)	1 (1.0)
Jun	---	0 (0.0)	9 (5.2)	11 (6.4)	6 (3.5)	9 (5.2)	-10 (-5.8)	-26 (-15.0)
Jul	---	2 (1.9)	-1 (-1.0)	-2 (-1.9)	27 (26.2)	23 (22.3)	-1 (-1.0)	13 (12.6)
Aug	---	2 (1.9)	-1 (-1.0)	-12 (-11.7)	4 (3.9)	-1 (-1.0)	-12 (-11.7)	1 (1.0)
Sep	---	2 (1.9)	-1 (-1.0)	-12 (-11.7)	4 (3.9)	-1 (-1.0)	-12 (-11.7)	1 (1.0)
Oct	---	2 (1.9)	-1 (-1.0)	-12 (-11.7)	4 (3.9)	-1 (-1.0)	-12 (-11.7)	1 (1.0)
Nov	---	-2 (-1.9)	0 (0.0)	0 (0.0)	-1 (-0.9)	0 (0.0)	-1 (-0.9)	1 (0.9)
Dec	---	0 (0.0)	-1 (-0.6)	-1 (-0.6)	0 (0.0)	-1 (-0.6)	1 (0.6)	-1 (-0.6)
Annual	---	2 (1.9)	-1 (-1.0)	-12 (-11.7)	4 (3.9)	-1 (-1.0)	-12 (-11.7)	1 (1.0)

Lower Arkansas River Basin Major WWTFs The Pueblo West WWTF discharges to the Pesthouse Gulch, a tributary to Wildhorse Creek, which itself is a tributary to the Arkansas River. These streams are not explicitly simulated in the Daily Model. Link LNODE530 of the hydrologic model was used to evaluate potential effects on Pueblo West chronic low flows in the Arkansas River. Chronic low flows for direct and cumulative effects, are in Table 118 and Table 119, respectively.

Under direct effects and cumulative effects, all alternatives would have annual chronic low flow reductions in the Arkansas River of less than 10 percent, compared to the No Action, which would be negligible. Both direct and cumulative effects would increase Arkansas River flows under River South. Compared to existing conditions, most alternatives would have reduced annual chronic low flow, up to 30 percent for cumulative effects.

The current 2011 permitted flow of Pueblo West WWTF is 1.8 MGD. Projected permitted flow in 2070 is 2.5 MGD (using projected demand growth of 41 percent), or 3.9 cfs. Direct effects Arkansas River dilution flows for all alternatives would be greater than 90 percent. Cumulative effects dilution flows for alternatives with the AVC would be about 88 percent, and greater than 90 percent for remaining alternatives.

The City of Pueblo WWTF discharges to the Arkansas River downstream from Pueblo. Link LNODE620 of the hydrologic model was used to evaluate potential effects on chronic low flows. Table 120 presents chronic low flows for direct effects and Table 121 presents chronic low flows for cumulative effects.

Direct and cumulative effects would not decrease flows more than 10 percent for any of the alternatives, as compared to either the No Action Alternative or existing conditions, and would be negligible. The current permitted flow of City of Pueblo WWTF is 19.0 MGD. Projected permitted flow in 2070 is 30.8 MGD (using projected demand growth of 62 percent), or 47.6 cfs. Direct effects dilution flows for all alternatives would be greater than 86 percent. Cumulative effects dilution for all alternatives would be about 80 percent.

Table 118. Direct Effects Chronic Low Flow for Pueblo West WWTF

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	43	42	43	42	42	43	49	43
Feb	43	41	38	38	38	38	49	38
Mar	43	41	38	38	38	38	49	38
Apr	73	66	59	59	56	59	68	61
May	96	82	68	68	74	68	79	72
Jun	135	136	115	115	122	115	139	121
Jul	48	45	40	40	39	40	58	43
Aug	43	41	37	37	37	37	51	38
Sep	43	41	37	37	37	37	50	38
Oct	43	41	37	37	37	37	49	38
Nov	56	45	37	37	42	37	49	40
Dec	74	66	55	55	69	55	63	61
Annual	43	41	37	37	37	37	49	38
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	1 (2.4)	0 (0.0)	0 (0.0)	1 (2.4)	7 (16.7)	1 (2.4)
Feb	---	---	-3 (-7.3)	-3 (-7.3)	-3 (-7.3)	-3 (-7.3)	8 (19.5)	-3 (-7.3)
Mar	---	---	-3 (-7.3)	-3 (-7.3)	-3 (-7.3)	-3 (-7.3)	8 (19.5)	-3 (-7.3)
Apr	---	---	-7 (-10.6)	-7 (-10.6)	-10 (-15.2)	-7 (-10.6)	2 (3.0)	-5 (-7.6)
May	---	---	-14 (-17.1)	-14 (-17.1)	-8 (-9.8)	-14 (-17.1)	-3 (-3.7)	-10 (-12.2)
Jun	---	---	-21 (-15.4)	-21 (-15.4)	-14 (-10.3)	-21 (-15.4)	3 (2.2)	-15 (-11.0)
Jul	---	---	-5 (-11.1)	-5 (-11.1)	-6 (-13.3)	-5 (-11.1)	13 (28.9)	-2 (-4.4)
Aug	---	---	-4 (-9.8)	-4 (-9.8)	-4 (-9.8)	-4 (-9.8)	10 (24.4)	-3 (-7.3)
Sep	---	---	-4 (-9.8)	-4 (-9.8)	-4 (-9.8)	-4 (-9.8)	9 (22.0)	-3 (-7.3)
Oct	---	---	-4 (-9.8)	-4 (-9.8)	-4 (-9.8)	-4 (-9.8)	8 (19.5)	-3 (-7.3)
Nov	---	---	-8 (-17.8)	-8 (-17.8)	-3 (-6.7)	-8 (-17.8)	4 (8.9)	-5 (-11.1)
Dec	---	---	-11 (-16.7)	-11 (-16.7)	3 (4.5)	-11 (-16.7)	-3 (-4.5)	-5 (-7.6)
Annual	---	---	-4 (-9.8)	-4 (-9.8)	-4 (-9.8)	-4 (-9.8)	8 (19.5)	-3 (-7.3)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	-1 (-2.3)	0 (0.0)	-1 (-2.3)	-1 (-2.3)	0 (0.0)	6 (14.0)	0 (0.0)
Feb	---	-2 (-4.7)	-5 (-11.6)	-5 (-11.6)	-5 (-11.6)	-5 (-11.6)	6 (14.0)	-5 (-11.6)
Mar	---	-2 (-4.7)	-5 (-11.6)	-5 (-11.6)	-5 (-11.6)	-5 (-11.6)	6 (14.0)	-5 (-11.6)
Apr	---	-7 (-9.6)	-14 (-19.2)	-14 (-19.2)	-17 (-23.3)	-14 (-19.2)	-5 (-6.8)	-12 (-16.4)
May	---	-14 (-14.6)	-28 (-29.2)	-28 (-29.2)	-22 (-22.9)	-28 (-29.2)	-17 (-17.7)	-24 (-25.0)
Jun	---	1 (0.7)	-20 (-14.8)	-20 (-14.8)	-13 (-9.6)	-20 (-14.8)	4 (3.0)	-14 (-10.4)
Jul	---	-3 (-6.3)	-8 (-16.7)	-8 (-16.7)	-9 (-18.8)	-8 (-16.7)	10 (20.8)	-5 (-10.4)
Aug	---	-2 (-4.7)	-6 (-14.0)	-6 (-14.0)	-6 (-14.0)	-6 (-14.0)	8 (18.6)	-5 (-11.6)
Sep	---	-2 (-4.7)	-6 (-14.0)	-6 (-14.0)	-6 (-14.0)	-6 (-14.0)	7 (16.3)	-5 (-11.6)
Oct	---	-2 (-4.7)	-6 (-14.0)	-6 (-14.0)	-6 (-14.0)	-6 (-14.0)	6 (14.0)	-5 (-11.6)
Nov	---	-11 (-19.6)	-19 (-33.9)	-19 (-33.9)	-14 (-25.0)	-19 (-33.9)	-7 (-12.5)	-16 (-28.6)
Dec	---	-8 (-10.8)	-19 (-25.7)	-19 (-25.7)	-5 (-6.8)	-19 (-25.7)	-11 (-14.9)	-13 (-17.6)
Annual	---	-2 (-4.7)	-6 (-14.0)	-6 (-14.0)	-6 (-14.0)	-6 (-14.0)	6 (14.0)	-5 (-11.6)

Table 119. Cumulative Effects Chronic Low Flow for Pueblo West WWTF

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	43	70	65	65	67	65	73	69
Feb	43	49	45	45	45	46	53	47
Mar	43	46	39	40	43	40	50	44
Apr	73	46	39	40	43	40	50	44
May	96	62	56	56	58	57	73	62
Jun	135	69	71	72	71	69	73	72
Jul	48	33	30	30	30	30	44	35
Aug	43	33	30	30	30	30	44	35
Sep	43	33	30	30	30	30	44	35
Oct	43	33	30	30	30	30	44	35
Nov	56	35	34	34	31	34	44	38
Dec	74	56	62	62	52	62	66	63
Annual	43	33	30	30	30	30	44	35
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	-5 (-7.1)	-5 (-7.1)	-3 (-4.3)	-5 (-7.1)	3 (4.3)	-1 (-1.4)
Feb	---	---	-4 (-8.2)	-4 (-8.2)	-4 (-8.2)	-3 (-6.1)	4 (8.2)	-2 (-4.1)
Mar	---	---	-7 (-15.2)	-6 (-13.0)	-3 (-6.5)	-6 (-13.0)	4 (8.7)	-2 (-4.3)
Apr	---	---	-7 (-15.2)	-6 (-13.0)	-3 (-6.5)	-6 (-13.0)	4 (8.7)	-2 (-4.3)
May	---	---	-6 (-9.7)	-6 (-9.7)	-4 (-6.5)	-5 (-8.1)	11 (17.7)	0 (0.0)
Jun	---	---	2 (2.9)	3 (4.3)	2 (2.9)	0 (0.0)	4 (5.8)	3 (4.3)
Jul	---	---	-3 (-9.1)	-3 (-9.1)	-3 (-9.1)	-3 (-9.1)	11 (33.3)	2 (6.1)
Aug	---	---	-3 (-9.1)	-3 (-9.1)	-3 (-9.1)	-3 (-9.1)	11 (33.3)	2 (6.1)
Sep	---	---	-3 (-9.1)	-3 (-9.1)	-3 (-9.1)	-3 (-9.1)	11 (33.3)	2 (6.1)
Oct	---	---	-3 (-9.1)	-3 (-9.1)	-3 (-9.1)	-3 (-9.1)	11 (33.3)	2 (6.1)
Nov	---	---	-1 (-2.9)	-1 (-2.9)	-4 (-11.4)	-1 (-2.9)	9 (25.7)	3 (8.6)
Dec	---	---	6 (10.7)	6 (10.7)	-4 (-7.1)	6 (10.7)	10 (17.9)	7 (12.5)
Annual	---	---	-3 (-9.1)	-3 (-9.1)	-3 (-9.1)	-3 (-9.1)	11 (33.3)	2 (6.1)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	27 (62.8)	22 (51.2)	22 (51.2)	24 (55.8)	22 (51.2)	30 (69.8)	26 (60.5)
Feb	---	6 (14.0)	2 (4.7)	2 (4.7)	2 (4.7)	3 (7.0)	10 (23.3)	4 (9.3)
Mar	---	3 (7.0)	-4 (-9.3)	-3 (-7.0)	0 (0.0)	-3 (-7.0)	7 (16.3)	1 (2.3)
Apr	---	-27 (-37.0)	-34 (-46.6)	-33 (-45.2)	-30 (-41.1)	-33 (-45.2)	-23 (-31.5)	-29 (-39.7)
May	---	-34 (-35.4)	-40 (-41.7)	-40 (-41.7)	-38 (-39.6)	-39 (-40.6)	-23 (-24.0)	-34 (-35.4)
Jun	---	-66 (-48.9)	-64 (-47.4)	-63 (-46.7)	-64 (-47.4)	-66 (-48.9)	-62 (-45.9)	-63 (-46.7)
Jul	---	-15 (-31.3)	-18 (-37.5)	-18 (-37.5)	-18 (-37.5)	-18 (-37.5)	-4 (-8.3)	-13 (-27.1)
Aug	---	-10 (-23.3)	-13 (-30.2)	-13 (-30.2)	-13 (-30.2)	-13 (-30.2)	1 (2.3)	-8 (-18.6)
Sep	---	-10 (-23.3)	-13 (-30.2)	-13 (-30.2)	-13 (-30.2)	-13 (-30.2)	1 (2.3)	-8 (-18.6)
Oct	---	-10 (-23.3)	-13 (-30.2)	-13 (-30.2)	-13 (-30.2)	-13 (-30.2)	1 (2.3)	-8 (-18.6)
Nov	---	-21 (-37.5)	-22 (-39.3)	-22 (-39.3)	-25 (-44.6)	-22 (-39.3)	-12 (-21.4)	-18 (-32.1)
Dec	---	-18 (-24.3)	-12 (-16.2)	-12 (-16.2)	-22 (-29.7)	-12 (-16.2)	-8 (-10.8)	-11 (-14.9)
Annual	---	-10 (-23.3)	-13 (-30.2)	-13 (-30.2)	-13 (-30.2)	-13 (-30.2)	1 (2.3)	-8 (-18.6)

Table 120. Direct Effects Chronic Low Flow for Pueblo WWTF

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	182	184	193	193	187	193	187	195
Feb	181	178	180	180	179	180	178	184
Mar	181	178	180	180	179	180	178	184
Apr	200	193	198	198	190	198	190	198
May	200	193	198	198	190	198	190	198
Jun	271	284	280	280	283	281	280	286
Jul	186	185	183	183	182	184	181	186
Aug	181	178	180	180	179	180	178	184
Sep	181	178	180	180	179	180	178	184
Oct	183	181	180	180	181	180	180	185
Nov	182	192	194	194	193	194	188	194
Dec	182	192	193	193	193	193	188	194
Annual	181	178	180	180	179	180	178	184
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	9 (4.9)	9 (4.9)	3 (1.6)	9 (4.9)	3 (1.6)	11 (6.0)
Feb	---	---	2 (1.1)	2 (1.1)	1 (0.6)	2 (1.1)	0 (0.0)	6 (3.4)
Mar	---	---	2 (1.1)	2 (1.1)	1 (0.6)	2 (1.1)	0 (0.0)	6 (3.4)
Apr	---	---	5 (2.6)	5 (2.6)	-3 (-1.6)	5 (2.6)	-3 (-1.6)	5 (2.6)
May	---	---	5 (2.6)	5 (2.6)	-3 (-1.6)	5 (2.6)	-3 (-1.6)	5 (2.6)
Jun	---	---	-4 (-1.4)	-4 (-1.4)	-1 (-0.4)	-3 (-1.1)	-4 (-1.4)	2 (0.7)
Jul	---	---	-2 (-1.1)	-2 (-1.1)	-3 (-1.6)	-1 (-0.5)	-4 (-2.2)	1 (0.5)
Aug	---	---	2 (1.1)	2 (1.1)	1 (0.6)	2 (1.1)	0 (0.0)	6 (3.4)
Sep	---	---	2 (1.1)	2 (1.1)	1 (0.6)	2 (1.1)	0 (0.0)	6 (3.4)
Oct	---	---	-1 (-0.6)	-1 (-0.6)	0 (0.0)	-1 (-0.6)	-1 (-0.6)	4 (2.2)
Nov	---	---	2 (1.0)	2 (1.0)	1 (0.5)	2 (1.0)	-4 (-2.1)	2 (1.0)
Dec	---	---	1 (0.5)	1 (0.5)	1 (0.5)	1 (0.5)	-4 (-2.1)	2 (1.0)
Annual	---	---	2 (1.1)	2 (1.1)	1 (0.6)	2 (1.1)	0 (0.0)	6 (3.4)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	2 (1.1)	11 (6.0)	11 (6.0)	5 (2.7)	11 (6.0)	5 (2.7)	13 (7.1)
Feb	---	-3 (-1.7)	-1 (-0.6)	-1 (-0.6)	-2 (-1.1)	-1 (-0.6)	-3 (-1.7)	3 (1.7)
Mar	---	-3 (-1.7)	-1 (-0.6)	-1 (-0.6)	-2 (-1.1)	-1 (-0.6)	-3 (-1.7)	3 (1.7)
Apr	---	-7 (-3.5)	-2 (-1.0)	-2 (-1.0)	-10 (-5.0)	-2 (-1.0)	-10 (-5.0)	-2 (-1.0)
May	---	-7 (-3.5)	-2 (-1.0)	-2 (-1.0)	-10 (-5.0)	-2 (-1.0)	-10 (-5.0)	-2 (-1.0)
Jun	---	13 (4.8)	9 (3.3)	9 (3.3)	12 (4.4)	10 (3.7)	9 (3.3)	15 (5.5)
Jul	---	-1 (-0.5)	-3 (-1.6)	-3 (-1.6)	-4 (-2.2)	-2 (-1.1)	-5 (-2.7)	0 (0.0)
Aug	---	-3 (-1.7)	-1 (-0.6)	-1 (-0.6)	-2 (-1.1)	-1 (-0.6)	-3 (-1.7)	3 (1.7)
Sep	---	-3 (-1.7)	-1 (-0.6)	-1 (-0.6)	-2 (-1.1)	-1 (-0.6)	-3 (-1.7)	3 (1.7)
Oct	---	-2 (-1.1)	-3 (-1.6)	-3 (-1.6)	-2 (-1.1)	-3 (-1.6)	-3 (-1.6)	2 (1.1)
Nov	---	10 (5.5)	12 (6.6)	12 (6.6)	11 (6.0)	12 (6.6)	6 (3.3)	12 (6.6)
Dec	---	10 (5.5)	11 (6.0)	11 (6.0)	11 (6.0)	11 (6.0)	6 (3.3)	12 (6.6)
Annual	---	-3 (-1.7)	-1 (-0.6)	-1 (-0.6)	-2 (-1.1)	-1 (-0.6)	-3 (-1.7)	3 (1.7)

Table 121. Cumulative Effects Chronic Low Flow for Pueblo WWTF

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	182	201	202	202	202	202	195	201
Feb	181	220	222	222	221	222	217	222
Mar	181	241	256	259	242	256	237	245
Apr	200	227	249	252	235	249	223	239
May	200	227	249	252	235	249	223	239
Jun	271	276	250	251	258	254	257	264
Jul	186	192	187	188	191	186	183	188
Aug	181	192	187	188	191	186	183	188
Sep	181	192	187	188	191	186	183	188
Oct	183	192	187	188	197	186	183	189
Nov	182	193	187	188	192	186	188	193
Dec	182	193	191	192	192	192	188	193
Annual	181	192	187	188	191	186	183	188
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	1 (0.5)	1 (0.5)	1 (0.5)	1 (0.5)	-6 (-3.0)	0 (0.0)
Feb	---	---	2 (0.9)	2 (0.9)	1 (0.5)	2 (0.9)	-3 (-1.4)	2 (0.9)
Mar	---	---	15 (6.2)	18 (7.5)	1 (0.4)	15 (6.2)	-4 (-1.7)	4 (1.7)
Apr	---	---	22 (9.7)	25 (11.0)	8 (3.5)	22 (9.7)	-4 (-1.8)	12 (5.3)
May	---	---	22 (9.7)	25 (11.0)	8 (3.5)	22 (9.7)	-4 (-1.8)	12 (5.3)
Jun	---	---	-26 (-9.4)	-25 (-9.1)	-18 (-6.5)	-22 (-8.0)	-19 (-6.9)	-12 (-4.3)
Jul	---	---	-5 (-2.6)	-4 (-2.1)	-1 (-0.5)	-6 (-3.1)	-9 (-4.7)	-4 (-2.1)
Aug	---	---	-5 (-2.6)	-4 (-2.1)	-1 (-0.5)	-6 (-3.1)	-9 (-4.7)	-4 (-2.1)
Sep	---	---	-5 (-2.6)	-4 (-2.1)	-1 (-0.5)	-6 (-3.1)	-9 (-4.7)	-4 (-2.1)
Oct	---	---	-5 (-2.6)	-4 (-2.1)	5 (2.6)	-6 (-3.1)	-9 (-4.7)	-3 (-1.6)
Nov	---	---	-6 (-3.1)	-5 (-2.6)	-1 (-0.5)	-7 (-3.6)	-5 (-2.6)	0 (0.0)
Dec	---	---	-2 (-1.0)	-1 (-0.5)	-1 (-0.5)	-1 (-0.5)	-5 (-2.6)	0 (0.0)
Annual	---	---	-5 (-2.6)	-4 (-2.1)	-1 (-0.5)	-6 (-3.1)	-9 (-4.7)	-4 (-2.1)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	19 (10.4)	20 (11.0)	20 (11.0)	20 (11.0)	20 (11.0)	13 (7.1)	19 (10.4)
Feb	---	39 (21.5)	41 (22.7)	41 (22.7)	40 (22.1)	41 (22.7)	36 (19.9)	41 (22.7)
Mar	---	60 (33.1)	75 (41.4)	78 (43.1)	61 (33.7)	75 (41.4)	56 (30.9)	64 (35.4)
Apr	---	27 (13.5)	49 (24.5)	52 (26.0)	35 (17.5)	49 (24.5)	23 (11.5)	39 (19.5)
May	---	27 (13.5)	49 (24.5)	52 (26.0)	35 (17.5)	49 (24.5)	23 (11.5)	39 (19.5)
Jun	---	5 (1.8)	-21 (-7.7)	-20 (-7.4)	-13 (-4.8)	-17 (-6.3)	-14 (-5.2)	-7 (-2.6)
Jul	---	6 (3.2)	1 (0.5)	2 (1.1)	5 (2.7)	0 (0.0)	-3 (-1.6)	2 (1.1)
Aug	---	11 (6.1)	6 (3.3)	7 (3.9)	10 (5.5)	5 (2.8)	2 (1.1)	7 (3.9)
Sep	---	11 (6.1)	6 (3.3)	7 (3.9)	10 (5.5)	5 (2.8)	2 (1.1)	7 (3.9)
Oct	---	9 (4.9)	4 (2.2)	5 (2.7)	14 (7.7)	3 (1.6)	0 (0.0)	6 (3.3)
Nov	---	11 (6.0)	5 (2.7)	6 (3.3)	10 (5.5)	4 (2.2)	6 (3.3)	11 (6.0)
Dec	---	11 (6.0)	9 (4.9)	10 (5.5)	10 (5.5)	10 (5.5)	6 (3.3)	11 (6.0)
Annual	---	11 (6.1)	6 (3.3)	7 (3.9)	10 (5.5)	5 (2.8)	2 (1.1)	7 (3.9)

The City of Rocky Ford WWTF discharges to the Arkansas River northeast of Rocky Ford. Link DSRF of the hydrologic model was used to evaluate potential effects on chronic low flows. Table 122 presents chronic monthly low flows for direct effects, and Table 123 shows flows for cumulative effects.

The direct effects annual chronic low flows increase for all alternatives compared to the No Action, up to 47 percent. The cumulative effects annual chronic low flow would not change for all alternatives, except for Master Contact Only which would increase flow by 12 percent. Compared to existing conditions, cumulative chronic low flow decreases more than 10 percent in for all alternatives except Master Contract Only.

The permitted flow of the Rocky Ford WWTF is 1.2 MGD or about 1.9 cfs. Projected permitted flow in 2070 would be 1.4 MGD (using projected demand growth of 16 percent), or 2.2 cfs. Direct effects dilution flows for all alternatives would be greater than 90 percent. Cumulative effects dilution flows for all alternatives would be about 88 percent.

The City of La Junta WWTF discharges to King Arroyo, a tributary to the Arkansas River downstream from La Junta. Link DSLJ of the hydrologic model, on the Arkansas River downstream from King Arroyo, was used to evaluate potential effects on chronic low flows. Table 124 lists chronic low flows for direct effects, and Table 125 presents flows for cumulative effects.

Under direct effects, all alternatives except Master Contract Only would reduce annual chronic low flows up to 73 percent, relative to the No Action, which would have a minor adverse effect. Under cumulative effects, the JUP North and River South alternatives would decrease annual chronic low flows more than 10 percent. Compared to existing conditions, all alternatives decrease annual chronic low in direct effects.

The permitted flow of this WWTF is 2.3 MGD or about 3.6 cfs. Projected permitted flow in 2070 would be 2.7 MGD (using projected demand growth of 19 percent), or 4.2 cfs. Direct effects dilution flows for all alternatives range between 49 and 77 percent. Cumulative effects dilution flows for all alternatives would range between 72 and 85 percent.

Table 122. Direct Effects Chronic Low Flow for Rocky Ford WWTF

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	20	17	23	23	22	23	23	25
Feb	20	24	23	23	22	23	23	26
Mar	23	28	24	24	26	24	23	26
Apr	58	69	67	66	69	67	67	64
May	81	75	73	71	67	73	72	73
Jun	39	48	49	48	47	50	50	48
Jul	19	18	25	28	24	28	29	25
Aug	19	17	23	23	22	23	23	25
Sep	19	17	23	23	22	23	23	25
Oct	27	22	23	23	23	24	24	25
Nov	21	17	25	25	23	25	25	26
Dec	20	17	24	23	22	23	24	25
Annual	19	17	23	23	22	23	23	25
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	6 (35.3)	6 (35.3)	5 (29.4)	6 (35.3)	6 (35.3)	8 (47.1)
Feb	---	---	-1 (-4.2)	-1 (-4.2)	-2 (-8.3)	-1 (-4.2)	-1 (-4.2)	2 (8.3)
Mar	---	---	-4 (-14.3)	-4 (-14.3)	-2 (-7.1)	-4 (-14.3)	-5 (-17.9)	-2 (-7.1)
Apr	---	---	-2 (-2.9)	-3 (-4.3)	0 (0.0)	-2 (-2.9)	-2 (-2.9)	-5 (-7.2)
May	---	---	-2 (-2.7)	-4 (-5.3)	-8 (-10.7)	-2 (-2.7)	-3 (-4.0)	-2 (-2.7)
Jun	---	---	1 (2.1)	0 (0.0)	-1 (-2.1)	2 (4.2)	2 (4.2)	0 (0.0)
Jul	---	---	7 (38.9)	10 (55.6)	6 (33.3)	10 (55.6)	11 (61.1)	7 (38.9)
Aug	---	---	6 (35.3)	6 (35.3)	5 (29.4)	6 (35.3)	6 (35.3)	8 (47.1)
Sep	---	---	6 (35.3)	6 (35.3)	5 (29.4)	6 (35.3)	6 (35.3)	8 (47.1)
Oct	---	---	1 (4.5)	1 (4.5)	1 (4.5)	2 (9.1)	2 (9.1)	3 (13.6)
Nov	---	---	8 (47.1)	8 (47.1)	6 (35.3)	8 (47.1)	8 (47.1)	9 (52.9)
Dec	---	---	7 (41.2)	6 (35.3)	5 (29.4)	6 (35.3)	7 (41.2)	8 (47.1)
Annual	---	---	6 (35.3)	6 (35.3)	5 (29.4)	6 (35.3)	6 (35.3)	8 (47.1)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	-3 (-15.0)	3 (15.0)	3 (15.0)	2 (10.0)	3 (15.0)	3 (15.0)	5 (25.0)
Feb	---	4 (20.0)	3 (15.0)	3 (15.0)	2 (10.0)	3 (15.0)	3 (15.0)	6 (30.0)
Mar	---	5 (21.7)	1 (4.3)	1 (4.3)	3 (13.0)	1 (4.3)	0 (0.0)	3 (13.0)
Apr	---	11 (19.0)	9 (15.5)	8 (13.8)	11 (19.0)	9 (15.5)	9 (15.5)	6 (10.3)
May	---	-6 (-7.4)	-8 (-9.9)	-10 (-12.3)	-14 (-17.3)	-8 (-9.9)	-9 (-11.1)	-8 (-9.9)
Jun	---	9 (23.1)	10 (25.6)	9 (23.1)	8 (20.5)	11 (28.2)	11 (28.2)	9 (23.1)
Jul	---	-1 (-5.3)	6 (31.6)	9 (47.4)	5 (26.3)	9 (47.4)	10 (52.6)	6 (31.6)
Aug	---	-2 (-10.5)	4 (21.1)	4 (21.1)	3 (15.8)	4 (21.1)	4 (21.1)	6 (31.6)
Sep	---	-2 (-10.5)	4 (21.1)	4 (21.1)	3 (15.8)	4 (21.1)	4 (21.1)	6 (31.6)
Oct	---	-5 (-18.5)	-4 (-14.8)	-4 (-14.8)	-4 (-14.8)	-3 (-11.1)	-3 (-11.1)	-2 (-7.4)
Nov	---	-4 (-19.0)	4 (19.0)	4 (19.0)	2 (9.5)	4 (19.0)	4 (19.0)	5 (23.8)
Dec	---	-3 (-15.0)	4 (20.0)	3 (15.0)	2 (10.0)	3 (15.0)	4 (20.0)	5 (25.0)
Annual	---	-2 (-10.5)	4 (21.1)	4 (21.1)	3 (15.8)	4 (21.1)	4 (21.1)	6 (31.6)

Table 123. Cumulative Effects Chronic Low Flow for Rocky Ford WWTF

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	20	16	16	16	16	16	16	18
Feb	20	19	22	22	22	22	21	20
Mar	23	25	23	23	23	23	23	25
Apr	58	63	51	51	67	50	65	61
May	81	126	136	136	136	136	137	109
Jun	39	27	38	34	40	26	45	27
Jul	19	17	16	16	16	16	16	18
Aug	19	16	16	16	16	16	16	18
Sep	19	16	16	16	16	16	16	18
Oct	27	23	18	17	17	18	17	30
Nov	21	16	18	18	18	18	18	18
Dec	20	16	16	16	16	16	16	18
Annual	19	16	16	16	16	16	16	18
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (12.5)
Feb	---	---	3 (15.8)	3 (15.8)	3 (15.8)	3 (15.8)	2 (10.5)	1 (5.3)
Mar	---	---	-2 (-8.0)	-2 (-8.0)	-2 (-8.0)	-2 (-8.0)	-2 (-8.0)	0 (0.0)
Apr	---	---	-12 (-19.0)	-12 (-19.0)	4 (6.3)	-13 (-20.6)	2 (3.2)	-2 (-3.2)
May	---	---	10 (7.9)	10 (7.9)	10 (7.9)	10 (7.9)	11 (8.7)	-17 (-13.5)
Jun	---	---	11 (40.7)	7 (25.9)	13 (48.1)	-1 (-3.7)	18 (66.7)	0 (0.0)
Jul	---	---	-1 (-5.9)	-1 (-5.9)	-1 (-5.9)	-1 (-5.9)	-1 (-5.9)	1 (5.9)
Aug	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (12.5)
Sep	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (12.5)
Oct	---	---	-5 (-21.7)	-6 (-26.1)	-6 (-26.1)	-5 (-21.7)	-6 (-26.1)	7 (30.4)
Nov	---	---	2 (12.5)	2 (12.5)	2 (12.5)	2 (12.5)	2 (12.5)	2 (12.5)
Dec	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (12.5)
Annual	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (12.5)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	-4 (-20.0)	-4 (-20.0)	-4 (-20.0)	-4 (-20.0)	-4 (-20.0)	-4 (-20.0)	-2 (-10.0)
Feb	---	-1 (-5.0)	2 (10.0)	2 (10.0)	2 (10.0)	2 (10.0)	1 (5.0)	0 (0.0)
Mar	---	2 (8.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (8.7)
Apr	---	5 (8.6)	-7 (-12.1)	-7 (-12.1)	9 (15.5)	-8 (-13.8)	7 (12.1)	3 (5.2)
May	---	45 (55.6)	55 (67.9)	55 (67.9)	55 (67.9)	55 (67.9)	56 (69.1)	28 (34.6)
Jun	---	-12 (-30.8)	-1 (-2.6)	-5 (-12.8)	1 (2.6)	-13 (-33.3)	6 (15.4)	-12 (-30.8)
Jul	---	-2 (-10.5)	-3 (-15.8)	-3 (-15.8)	-3 (-15.8)	-3 (-15.8)	-3 (-15.8)	-1 (-5.3)
Aug	---	-3 (-15.8)	-3 (-15.8)	-3 (-15.8)	-3 (-15.8)	-3 (-15.8)	-3 (-15.8)	-1 (-5.3)
Sep	---	-3 (-15.8)	-3 (-15.8)	-3 (-15.8)	-3 (-15.8)	-3 (-15.8)	-3 (-15.8)	-1 (-5.3)
Oct	---	-4 (-14.8)	-9 (-33.3)	-10 (-37.0)	-10 (-37.0)	-9 (-33.3)	-10 (-37.0)	3 (11.1)
Nov	---	-5 (-23.8)	-3 (-14.3)	-3 (-14.3)	-3 (-14.3)	-3 (-14.3)	-3 (-14.3)	-3 (-14.3)
Dec	---	-4 (-20.0)	-4 (-20.0)	-4 (-20.0)	-4 (-20.0)	-4 (-20.0)	-4 (-20.0)	-2 (-10.0)
Annual	---	-3 (-15.8)	-3 (-15.8)	-3 (-15.8)	-3 (-15.8)	-3 (-15.8)	-3 (-15.8)	-1 (-5.3)

Table 124. Direct Effects Chronic Low Flow for La Junta WWTF

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	54	54	55	55	54	55	55	54
Feb	28	35	7	8	4	7	7	14
Mar	22	24	7	8	4	7	7	14
Apr	22	23	7	8	4	7	7	14
May	22	15	24	24	23	24	25	14
Jun	22	15	25	24	25	25	25	14
Jul	31	29	34	33	34	34	33	29
Aug	39	28	38	38	41	39	41	27
Sep	37	15	36	36	19	35	31	27
Oct	28	15	7	8	4	7	7	24
Nov	28	15	7	8	4	7	7	24
Dec	38	37	7	8	13	7	7	39
Annual	22	15	7	8	4	7	7	14
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	1 (1.9)	1 (1.9)	0 (0.0)	1 (1.9)	1 (1.9)	0 (0.0)
Feb	---	---	-28 (-80.0)	-27 (-77.1)	-31 (-88.6)	-28 (-80.0)	-28 (-80.0)	-21 (-60.0)
Mar	---	---	-17 (-70.8)	-16 (-66.7)	-20 (-83.3)	-17 (-70.8)	-17 (-70.8)	-10 (-41.7)
Apr	---	---	-16 (-69.6)	-15 (-65.2)	-19 (-82.6)	-16 (-69.6)	-16 (-69.6)	-9 (-39.1)
May	---	---	9 (60.0)	9 (60.0)	8 (53.3)	9 (60.0)	10 (66.7)	-1 (-6.7)
Jun	---	---	10 (66.7)	9 (60.0)	10 (66.7)	10 (66.7)	10 (66.7)	-1 (-6.7)
Jul	---	---	5 (17.2)	4 (13.8)	5 (17.2)	5 (17.2)	4 (13.8)	0 (0.0)
Aug	---	---	10 (35.7)	10 (35.7)	13 (46.4)	11 (39.3)	13 (46.4)	-1 (-3.6)
Sep	---	---	21 (140.0)	21 (140.0)	4 (26.7)	20 (133.3)	16 (106.7)	12 (80.0)
Oct	---	---	-8 (-53.3)	-7 (-46.7)	-11 (-73.3)	-8 (-53.3)	-8 (-53.3)	9 (60.0)
Nov	---	---	-8 (-53.3)	-7 (-46.7)	-11 (-73.3)	-8 (-53.3)	-8 (-53.3)	9 (60.0)
Dec	---	---	-30 (-81.1)	-29 (-78.4)	-24 (-64.9)	-30 (-81.1)	-30 (-81.1)	2 (5.4)
Annual	---	---	-8 (-53.3)	-7 (-46.7)	-11 (-73.3)	-8 (-53.3)	-8 (-53.3)	-1 (-6.7)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	0 (0.0)	1 (1.9)	1 (1.9)	0 (0.0)	1 (1.9)	1 (1.9)	0 (0.0)
Feb	---	7 (25.0)	-21 (-75.0)	-20 (-71.4)	-24 (-85.7)	-21 (-75.0)	-21 (-75.0)	-14 (-50.0)
Mar	---	2 (9.1)	-15 (-68.2)	-14 (-63.6)	-18 (-81.8)	-15 (-68.2)	-15 (-68.2)	-8 (-36.4)
Apr	---	1 (4.5)	-15 (-68.2)	-14 (-63.6)	-18 (-81.8)	-15 (-68.2)	-15 (-68.2)	-8 (-36.4)
May	---	-7 (-31.8)	2 (9.1)	2 (9.1)	1 (4.5)	2 (9.1)	3 (13.6)	-8 (-36.4)
Jun	---	-7 (-31.8)	3 (13.6)	2 (9.1)	3 (13.6)	3 (13.6)	3 (13.6)	-8 (-36.4)
Jul	---	-2 (-6.5)	3 (9.7)	2 (6.5)	3 (9.7)	3 (9.7)	2 (6.5)	-2 (-6.5)
Aug	---	-11 (-28.2)	-1 (-2.6)	-1 (-2.6)	2 (5.1)	0 (0.0)	2 (5.1)	-12 (-30.8)
Sep	---	-22 (-59.5)	-1 (-2.7)	-1 (-2.7)	-18 (-48.6)	-2 (-5.4)	-6 (-16.2)	-10 (-27.0)
Oct	---	-13 (-46.4)	-21 (-75.0)	-20 (-71.4)	-24 (-85.7)	-21 (-75.0)	-21 (-75.0)	-4 (-14.3)
Nov	---	-13 (-46.4)	-21 (-75.0)	-20 (-71.4)	-24 (-85.7)	-21 (-75.0)	-21 (-75.0)	-4 (-14.3)
Dec	---	-1 (-2.6)	-31 (-81.6)	-30 (-78.9)	-25 (-65.8)	-31 (-81.6)	-31 (-81.6)	1 (2.6)
Annual	---	-7 (-31.8)	-15 (-68.2)	-14 (-63.6)	-18 (-81.8)	-15 (-68.2)	-15 (-68.2)	-8 (-36.4)

Table 125. Cumulative Effects Chronic Low Flow for La Junta WWTF

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	54	61	61	61	61	61	61	61
Feb	28	20	18	20	12	18	12	24
Mar	22	20	18	20	11	18	11	24
Apr	22	20	18	20	11	18	11	24
May	22	21	22	20	23	22	21	24
Jun	22	28	41	41	44	40	43	27
Jul	31	28	34	34	34	34	34	27
Aug	39	27	30	30	30	30	30	28
Sep	37	23	18	22	24	18	24	28
Oct	28	20	18	22	11	18	11	26
Nov	28	20	19	24	11	19	11	26
Dec	38	37	40	40	11	40	11	41
Annual	22	20	18	20	11	18	11	24
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Feb	---	---	-2 (-10.0)	0 (0.0)	-8 (-40.0)	-2 (-10.0)	-8 (-40.0)	4 (20.0)
Mar	---	---	-2 (-10.0)	0 (0.0)	-9 (-45.0)	-2 (-10.0)	-9 (-45.0)	4 (20.0)
Apr	---	---	-2 (-10.0)	0 (0.0)	-9 (-45.0)	-2 (-10.0)	-9 (-45.0)	4 (20.0)
May	---	---	1 (4.8)	-1 (-4.8)	2 (9.5)	1 (4.8)	0 (0.0)	3 (14.3)
Jun	---	---	13 (46.4)	13 (46.4)	16 (57.1)	12 (42.9)	15 (53.6)	-1 (-3.6)
Jul	---	---	6 (21.4)	6 (21.4)	6 (21.4)	6 (21.4)	6 (21.4)	-1 (-3.6)
Aug	---	---	3 (11.1)	3 (11.1)	3 (11.1)	3 (11.1)	3 (11.1)	1 (3.7)
Sep	---	---	-5 (-21.7)	-1 (-4.3)	1 (4.3)	-5 (-21.7)	1 (4.3)	5 (21.7)
Oct	---	---	-2 (-10.0)	2 (10.0)	-9 (-45.0)	-2 (-10.0)	-9 (-45.0)	6 (30.0)
Nov	---	---	-1 (-5.0)	4 (20.0)	-9 (-45.0)	-1 (-5.0)	-9 (-45.0)	6 (30.0)
Dec	---	---	3 (8.1)	3 (8.1)	-26 (-70.3)	3 (8.1)	-26 (-70.3)	4 (10.8)
Annual	---	---	-2 (-10.0)	0 (0.0)	-9 (-45.0)	-2 (-10.0)	-9 (-45.0)	4 (20.0)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	7 (13.0)	7 (13.0)	7 (13.0)	7 (13.0)	7 (13.0)	7 (13.0)	7 (13.0)
Feb	---	-8 (-28.6)	-10 (-35.7)	-8 (-28.6)	-16 (-57.1)	-10 (-35.7)	-16 (-57.1)	-4 (-14.3)
Mar	---	-2 (-9.1)	-4 (-18.2)	-2 (-9.1)	-11 (-50.0)	-4 (-18.2)	-11 (-50.0)	2 (9.1)
Apr	---	-2 (-9.1)	-4 (-18.2)	-2 (-9.1)	-11 (-50.0)	-4 (-18.2)	-11 (-50.0)	2 (9.1)
May	---	-1 (-4.5)	0 (0.0)	-2 (-9.1)	1 (4.5)	0 (0.0)	-1 (-4.5)	2 (9.1)
Jun	---	6 (27.3)	19 (86.4)	19 (86.4)	22 (100.0)	18 (81.8)	21 (95.5)	5 (22.7)
Jul	---	-3 (-9.7)	3 (9.7)	3 (9.7)	3 (9.7)	3 (9.7)	3 (9.7)	-4 (-12.9)
Aug	---	-12 (-30.8)	-9 (-23.1)	-9 (-23.1)	-9 (-23.1)	-9 (-23.1)	-9 (-23.1)	-11 (-28.2)
Sep	---	-14 (-37.8)	-19 (-51.4)	-15 (-40.5)	-13 (-35.1)	-19 (-51.4)	-13 (-35.1)	-9 (-24.3)
Oct	---	-8 (-28.6)	-10 (-35.7)	-6 (-21.4)	-17 (-60.7)	-10 (-35.7)	-17 (-60.7)	-2 (-7.1)
Nov	---	-8 (-28.6)	-9 (-32.1)	-4 (-14.3)	-17 (-60.7)	-9 (-32.1)	-17 (-60.7)	-2 (-7.1)
Dec	---	-1 (-2.6)	2 (5.3)	2 (5.3)	-27 (-71.1)	2 (5.3)	-27 (-71.1)	3 (7.9)
Annual	---	-2 (-9.1)	-4 (-18.2)	-2 (-9.1)	-11 (-50.0)	-4 (-18.2)	-11 (-50.0)	2 (9.1)

Fountain Creek Basin Major WWTF The Security Sanitation District WWTF discharges to Fountain Creek southwest of the community of Security. Link LNODE6670 of the hydrologic model was used to evaluate potential effects on chronic low flows. Table 126 presents chronic low flows for direct effects and Table 127 presents flows for cumulative effects.

None of the alternatives would have direct or cumulative effects that would cause a reduction in flow of ten percent or more compared to the No Action Alternative or existing conditions. Effects would be negligible. Under cumulative effects, there would be a substantial increase in chronic low flow.

The permitted flow of this WWTF is 2.4 mgd or about 3.7 cfs. Projected permitted flow in 2060 is 3.2 MGD (using projected demand growth of 35 percent), or 5 cfs. Dilution flow for all alternatives in direct and cumulative effects would be greater than 90 percent.

The Widefield Water and Sanitation District and U.S. Department of the Army – Fort Carson WWTFs discharge to Fountain Creek southwest of the community of Widefield. Link DFSCSEC of the hydrologic model was used to evaluate potential effects on chronic low flows. Table 128 displays chronic low flows for direct effects, and Table 129 presents flows for cumulative effects.

None of the alternatives would have direct or cumulative effects that would cause a reduction in flow of ten percent or more compared to the No Action Alternative or existing conditions. Effects would be negligible. Under cumulative effects, there would be a substantial increase in chronic low flow.

The permitted flow of the Widefield WWTF is 2.5 mgd or about 3.9 cfs. The permitted flow for the Fort Carson WWTF is 4.0 MGD or about 6.2 cfs. Projected permitted flow in 2060 for the combined facilities is 9.2 MGD (using projected demand growth of 109 percent), or 14.3 cfs. Dilution flow for all alternatives would be 78 percent for direct effects, and 91 percent for cumulative effects.

The Fountain Sanitation District WWTF discharges to Fountain Creek south of the City of Fountain. Link DSJCC of the hydrologic model was used to evaluate potential effects on chronic low flows. Table 130 addresses chronic low flows for direct effects, and Table 131 presents flows for cumulative effects.

None of the alternatives would have direct or cumulative effects that would cause a reduction in flow of ten percent or more compared to the No Action Alternative or existing conditions. Effects would be negligible. Under cumulative effects, there would be a substantial increase in chronic low flow.

The permitted flow of this WWTF is 1.9 mgd or about 2.9 cfs. Projected permitted flow in 2060 is 5.7 MGD (using projected demand growth of 201 percent), or 8.9 cfs. Dilution flow for all alternatives in direct and cumulative effects would be 88 percent.

Table 126. Direct Effects Chronic Low Flow for Security WWTF

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	42	43	43	43	43	43	43	43
Feb	43	46	46	46	46	46	46	46
Mar	63	63	63	63	63	63	63	63
Apr	68	71	71	71	71	71	71	71
May	68	71	71	71	71	71	71	71
Jun	59	62	62	62	62	62	62	62
Jul	56	58	58	58	58	58	58	58
Aug	56	58	58	58	58	58	58	58
Sep	64	65	66	66	66	66	65	65
Oct	55	57	57	57	57	57	57	57
Nov	42	43	43	43	43	43	43	43
Dec	42	43	43	43	43	43	43	43
Annual	42	43	43	43	43	43	43	43
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Feb	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Mar	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Apr	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
May	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Jun	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Jul	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Aug	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Sep	---	---	1 (1.5)	1 (1.5)	1 (1.5)	1 (1.5)	0 (0.0)	0 (0.0)
Oct	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Nov	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Dec	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Annual	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)
Feb	---	3 (7.0)	3 (7.0)	3 (7.0)	3 (7.0)	3 (7.0)	3 (7.0)	3 (7.0)
Mar	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Apr	---	3 (4.4)	3 (4.4)	3 (4.4)	3 (4.4)	3 (4.4)	3 (4.4)	3 (4.4)
May	---	3 (4.4)	3 (4.4)	3 (4.4)	3 (4.4)	3 (4.4)	3 (4.4)	3 (4.4)
Jun	---	3 (5.1)	3 (5.1)	3 (5.1)	3 (5.1)	3 (5.1)	3 (5.1)	3 (5.1)
Jul	---	2 (3.6)	2 (3.6)	2 (3.6)	2 (3.6)	2 (3.6)	2 (3.6)	2 (3.6)
Aug	---	2 (3.6)	2 (3.6)	2 (3.6)	2 (3.6)	2 (3.6)	2 (3.6)	2 (3.6)
Sep	---	1 (1.6)	2 (3.1)	2 (3.1)	2 (3.1)	2 (3.1)	1 (1.6)	1 (1.6)
Oct	---	2 (3.6)	2 (3.6)	2 (3.6)	2 (3.6)	2 (3.6)	2 (3.6)	2 (3.6)
Nov	---	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)
Dec	---	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)
Annual	---	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)

Table 127. Cumulative Effects Chronic Low Flow for Security WWTF

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	42	134	134	134	134	134	135	134
Feb	43	140	140	140	140	140	142	140
Mar	63	162	162	162	162	162	162	162
Apr	68	162	162	162	162	162	162	162
May	68	164	164	164	164	164	164	164
Jun	59	166	166	166	166	166	166	166
Jul	56	161	161	161	161	161	161	161
Aug	56	161	161	161	161	161	161	161
Sep	64	154	154	154	155	154	155	155
Oct	55	153	152	152	153	152	153	153
Nov	42	134	134	134	134	134	135	134
Dec	42	134	134	134	134	134	135	134
Annual	42	134	134	134	134	134	135	134
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)	0 (0.0)
Feb	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.4)	0 (0.0)
Mar	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Apr	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
May	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Jun	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Jul	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Aug	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Sep	---	---	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	1 (0.6)	1 (0.6)
Oct	---	---	-1 (-0.7)	-1 (-0.7)	0 (0.0)	-1 (-0.7)	0 (0.0)	0 (0.0)
Nov	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)	0 (0.0)
Dec	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)	0 (0.0)
Annual	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)	0 (0.0)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	92 (219.0)	92 (219.0)	92 (219.0)	92 (219.0)	92 (219.0)	93 (221.4)	92 (219.0)
Feb	---	97 (225.6)	97 (225.6)	97 (225.6)	97 (225.6)	97 (225.6)	99 (230.2)	97 (225.6)
Mar	---	99 (157.1)	99 (157.1)	99 (157.1)	99 (157.1)	99 (157.1)	99 (157.1)	99 (157.1)
Apr	---	94 (138.2)	94 (138.2)	94 (138.2)	94 (138.2)	94 (138.2)	94 (138.2)	94 (138.2)
May	---	96 (141.2)	96 (141.2)	96 (141.2)	96 (141.2)	96 (141.2)	96 (141.2)	96 (141.2)
Jun	---	107 (181.4)	107 (181.4)	107 (181.4)	107 (181.4)	107 (181.4)	107 (181.4)	107 (181.4)
Jul	---	105 (187.5)	105 (187.5)	105 (187.5)	105 (187.5)	105 (187.5)	105 (187.5)	105 (187.5)
Aug	---	105 (187.5)	105 (187.5)	105 (187.5)	105 (187.5)	105 (187.5)	105 (187.5)	105 (187.5)
Sep	---	90 (140.6)	90 (140.6)	90 (140.6)	91 (142.2)	90 (140.6)	91 (142.2)	91 (142.2)
Oct	---	98 (178.2)	97 (176.4)	97 (176.4)	98 (178.2)	97 (176.4)	98 (178.2)	98 (178.2)
Nov	---	92 (219.0)	92 (219.0)	92 (219.0)	92 (219.0)	92 (219.0)	93 (221.4)	92 (219.0)
Dec	---	92 (219.0)	92 (219.0)	92 (219.0)	92 (219.0)	92 (219.0)	93 (221.4)	92 (219.0)
Annual	---	92 (219.0)	92 (219.0)	92 (219.0)	92 (219.0)	92 (219.0)	93 (221.4)	92 (219.0)

Table 128. Direct Effects Chronic Low Flow for Widefield and Fort Carson WWTFs

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	50	52	52	52	52	52	52	52
Feb	50	55	55	55	55	55	55	55
Mar	73	73	74	74	73	74	74	74
Apr	72	72	73	73	72	73	74	73
May	72	72	73	73	72	73	74	73
Jun	63	68	68	68	68	68	68	68
Jul	59	63	63	63	63	63	63	63
Aug	59	63	63	63	63	63	63	63
Sep	68	70	71	71	70	71	70	70
Oct	65	68	68	68	68	68	68	68
Nov	50	52	52	52	52	52	52	52
Dec	50	52	52	52	52	52	52	52
Annual	50	52	52	52	52	52	52	52
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Feb	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Mar	---	---	1 (1.4)	1 (1.4)	0 (0.0)	1 (1.4)	1 (1.4)	1 (1.4)
Apr	---	---	1 (1.4)	1 (1.4)	0 (0.0)	1 (1.4)	2 (2.8)	1 (1.4)
May	---	---	1 (1.4)	1 (1.4)	0 (0.0)	1 (1.4)	2 (2.8)	1 (1.4)
Jun	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Jul	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Aug	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Sep	---	---	1 (1.4)	1 (1.4)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)
Oct	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Nov	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Dec	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Annual	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)
Feb	---	5 (10.0)	5 (10.0)	5 (10.0)	5 (10.0)	5 (10.0)	5 (10.0)	5 (10.0)
Mar	---	0 (0.0)	1 (1.4)	1 (1.4)	0 (0.0)	1 (1.4)	1 (1.4)	1 (1.4)
Apr	---	0 (0.0)	1 (1.4)	1 (1.4)	0 (0.0)	1 (1.4)	2 (2.8)	1 (1.4)
May	---	0 (0.0)	1 (1.4)	1 (1.4)	0 (0.0)	1 (1.4)	2 (2.8)	1 (1.4)
Jun	---	5 (7.9)	5 (7.9)	5 (7.9)	5 (7.9)	5 (7.9)	5 (7.9)	5 (7.9)
Jul	---	4 (6.8)	4 (6.8)	4 (6.8)	4 (6.8)	4 (6.8)	4 (6.8)	4 (6.8)
Aug	---	4 (6.8)	4 (6.8)	4 (6.8)	4 (6.8)	4 (6.8)	4 (6.8)	4 (6.8)
Sep	---	2 (2.9)	3 (4.4)	3 (4.4)	2 (2.9)	3 (4.4)	2 (2.9)	2 (2.9)
Oct	---	3 (4.6)	3 (4.6)	3 (4.6)	3 (4.6)	3 (4.6)	3 (4.6)	3 (4.6)
Nov	---	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)
Dec	---	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)
Annual	---	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)	2 (4.0)

Table 129. Cumulative Effects Chronic Low Flow for Widefield and Fort Carson WWTFs

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	50	143	144	143	144	144	143	144
Feb	50	147	150	150	148	150	152	150
Mar	73	164	165	165	164	165	165	165
Apr	72	164	165	165	164	165	165	165
May	72	165	165	165	164	165	165	165
Jun	63	171	171	171	171	171	171	171
Jul	59	166	166	166	166	166	166	166
Aug	59	166	166	166	166	166	166	166
Sep	68	159	158	158	159	158	159	159
Oct	65	158	157	157	158	157	158	158
Nov	50	143	144	143	144	144	143	144
Dec	50	143	144	143	144	144	143	144
Annual	50	143	144	143	144	144	143	144
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	1 (0.7)	0 (0.0)	1 (0.7)	1 (0.7)	0 (0.0)	1 (0.7)
Feb	---	---	3 (2.0)	3 (2.0)	1 (0.7)	3 (2.0)	5 (3.4)	3 (2.0)
Mar	---	---	1 (0.6)	1 (0.6)	0 (0.0)	1 (0.6)	1 (0.6)	1 (0.6)
Apr	---	---	1 (0.6)	1 (0.6)	0 (0.0)	1 (0.6)	1 (0.6)	1 (0.6)
May	---	---	0 (0.0)	0 (0.0)	-1 (-0.6)	0 (0.0)	0 (0.0)	0 (0.0)
Jun	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Jul	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Aug	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Sep	---	---	-1 (-0.6)	-1 (-0.6)	0 (0.0)	-1 (-0.6)	0 (0.0)	0 (0.0)
Oct	---	---	-1 (-0.6)	-1 (-0.6)	0 (0.0)	-1 (-0.6)	0 (0.0)	0 (0.0)
Nov	---	---	1 (0.7)	0 (0.0)	1 (0.7)	1 (0.7)	0 (0.0)	1 (0.7)
Dec	---	---	1 (0.7)	0 (0.0)	1 (0.7)	1 (0.7)	0 (0.0)	1 (0.7)
Annual	---	---	1 (0.7)	0 (0.0)	1 (0.7)	1 (0.7)	0 (0.0)	1 (0.7)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	93 (186.0)	94 (188.0)	93 (186.0)	94 (188.0)	94 (188.0)	93 (186.0)	94 (188.0)
Feb	---	97 (194.0)	100 (200.0)	100 (200.0)	98 (196.0)	100 (200.0)	102 (204.0)	100 (200.0)
Mar	---	91 (124.7)	92 (126.0)	92 (126.0)	91 (124.7)	92 (126.0)	92 (126.0)	92 (126.0)
Apr	---	92 (127.8)	93 (129.2)	93 (129.2)	92 (127.8)	93 (129.2)	93 (129.2)	93 (129.2)
May	---	93 (129.2)	93 (129.2)	93 (129.2)	92 (127.8)	93 (129.2)	93 (129.2)	93 (129.2)
Jun	---	108 (171.4)	108 (171.4)	108 (171.4)	108 (171.4)	108 (171.4)	108 (171.4)	108 (171.4)
Jul	---	107 (181.4)	107 (181.4)	107 (181.4)	107 (181.4)	107 (181.4)	107 (181.4)	107 (181.4)
Aug	---	107 (181.4)	107 (181.4)	107 (181.4)	107 (181.4)	107 (181.4)	107 (181.4)	107 (181.4)
Sep	---	91 (133.8)	90 (132.4)	90 (132.4)	91 (133.8)	90 (132.4)	91 (133.8)	91 (133.8)
Oct	---	93 (143.1)	92 (141.5)	92 (141.5)	93 (143.1)	92 (141.5)	93 (143.1)	93 (143.1)
Nov	---	93 (186.0)	94 (188.0)	93 (186.0)	94 (188.0)	94 (188.0)	93 (186.0)	94 (188.0)
Dec	---	93 (186.0)	94 (188.0)	93 (186.0)	94 (188.0)	94 (188.0)	93 (186.0)	94 (188.0)
Annual	---	93 (186.0)	94 (188.0)	93 (186.0)	94 (188.0)	94 (188.0)	93 (186.0)	94 (188.0)

Table 130. Direct Effects Chronic Low Flow for Fountain Sanitation District WWTF

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	58	64	64	64	64	64	64	64
Feb	58	66	66	66	66	66	66	66
Mar	72	78	79	79	78	79	79	79
Apr	70	77	78	78	77	78	78	78
May	70	77	78	78	77	78	78	78
Jun	66	74	74	74	74	74	74	74
Jul	63	70	70	70	70	70	70	70
Aug	63	70	70	70	70	70	70	70
Sep	71	77	77	77	77	77	77	77
Oct	70	76	77	77	76	77	77	76
Nov	58	64	64	64	64	64	64	64
Dec	58	64	64	64	64	64	64	64
Annual	58	64	64	64	64	64	64	64
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Feb	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Mar	---	---	1 (1.3)	1 (1.3)	0 (0.0)	1 (1.3)	1 (1.3)	1 (1.3)
Apr	---	---	1 (1.3)	1 (1.3)	0 (0.0)	1 (1.3)	1 (1.3)	1 (1.3)
May	---	---	1 (1.3)	1 (1.3)	0 (0.0)	1 (1.3)	1 (1.3)	1 (1.3)
Jun	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Jul	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Aug	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Sep	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Oct	---	---	1 (1.3)	1 (1.3)	0 (0.0)	1 (1.3)	1 (1.3)	0 (0.0)
Nov	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Dec	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Annual	---	---	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)
Feb	---	8 (13.8)	8 (13.8)	8 (13.8)	8 (13.8)	8 (13.8)	8 (13.8)	8 (13.8)
Mar	---	6 (8.3)	7 (9.7)	7 (9.7)	6 (8.3)	7 (9.7)	7 (9.7)	7 (9.7)
Apr	---	7 (10.0)	8 (11.4)	8 (11.4)	7 (10.0)	8 (11.4)	8 (11.4)	8 (11.4)
May	---	7 (10.0)	8 (11.4)	8 (11.4)	7 (10.0)	8 (11.4)	8 (11.4)	8 (11.4)
Jun	---	8 (12.1)	8 (12.1)	8 (12.1)	8 (12.1)	8 (12.1)	8 (12.1)	8 (12.1)
Jul	---	7 (11.1)	7 (11.1)	7 (11.1)	7 (11.1)	7 (11.1)	7 (11.1)	7 (11.1)
Aug	---	7 (11.1)	7 (11.1)	7 (11.1)	7 (11.1)	7 (11.1)	7 (11.1)	7 (11.1)
Sep	---	6 (8.5)	6 (8.5)	6 (8.5)	6 (8.5)	6 (8.5)	6 (8.5)	6 (8.5)
Oct	---	6 (8.6)	7 (10.0)	7 (10.0)	6 (8.6)	7 (10.0)	7 (10.0)	6 (8.6)
Nov	---	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)
Dec	---	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)
Annual	---	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)

Table 131. Cumulative Effects Chronic Low Flow for Fountain Sanitation District WWTF

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	58	64	63	63	64	63	64	66
Feb	58	64	66	66	64	66	66	66
Mar	72	111	105	105	102	106	112	111
Apr	70	109	115	118	108	116	112	111
May	70	109	128	131	114	129	112	118
Jun	66	146	135	137	137	138	149	144
Jul	63	91	91	91	90	91	92	90
Aug	63	88	91	91	87	89	89	88
Sep	71	83	79	79	79	78	83	83
Oct	70	78	78	78	79	77	79	79
Nov	58	64	63	63	64	63	64	66
Dec	58	64	63	63	64	63	64	66
Annual	58	64	63	63	64	63	64	66
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	-1 (-1.6)	-1 (-1.6)	0 (0.0)	-1 (-1.6)	0 (0.0)	2 (3.1)
Feb	---	---	2 (3.1)	2 (3.1)	0 (0.0)	2 (3.1)	2 (3.1)	2 (3.1)
Mar	---	---	-6 (-5.4)	-6 (-5.4)	-9 (-8.1)	-5 (-4.5)	1 (0.9)	0 (0.0)
Apr	---	---	6 (5.5)	9 (8.3)	-1 (-0.9)	7 (6.4)	3 (2.8)	2 (1.8)
May	---	---	19 (17.4)	22 (20.2)	5 (4.6)	20 (18.3)	3 (2.8)	9 (8.3)
Jun	---	---	-11 (-7.5)	-9 (-6.2)	-9 (-6.2)	-8 (-5.5)	3 (2.1)	-2 (-1.4)
Jul	---	---	0 (0.0)	0 (0.0)	-1 (-1.1)	0 (0.0)	1 (1.1)	-1 (-1.1)
Aug	---	---	3 (3.4)	3 (3.4)	-1 (-1.1)	1 (1.1)	1 (1.1)	0 (0.0)
Sep	---	---	-4 (-4.8)	-4 (-4.8)	-4 (-4.8)	-5 (-6.0)	0 (0.0)	0 (0.0)
Oct	---	---	0 (0.0)	0 (0.0)	1 (1.3)	-1 (-1.3)	1 (1.3)	1 (1.3)
Nov	---	---	-1 (-1.6)	-1 (-1.6)	0 (0.0)	-1 (-1.6)	0 (0.0)	2 (3.1)
Dec	---	---	-1 (-1.6)	-1 (-1.6)	0 (0.0)	-1 (-1.6)	0 (0.0)	2 (3.1)
Annual	---	---	-1 (-1.6)	-1 (-1.6)	0 (0.0)	-1 (-1.6)	0 (0.0)	2 (3.1)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	6 (10.3)	5 (8.6)	5 (8.6)	6 (10.3)	5 (8.6)	6 (10.3)	8 (13.8)
Feb	---	6 (10.3)	8 (13.8)	8 (13.8)	6 (10.3)	8 (13.8)	8 (13.8)	8 (13.8)
Mar	---	39 (54.2)	33 (45.8)	33 (45.8)	30 (41.7)	34 (47.2)	40 (55.6)	39 (54.2)
Apr	---	39 (55.7)	45 (64.3)	48 (68.6)	38 (54.3)	46 (65.7)	42 (60.0)	41 (58.6)
May	---	39 (55.7)	58 (82.9)	61 (87.1)	44 (62.9)	59 (84.3)	42 (60.0)	48 (68.6)
Jun	---	80 (121.2)	69 (104.5)	71 (107.6)	71 (107.6)	72 (109.1)	83 (125.8)	78 (118.2)
Jul	---	28 (44.4)	28 (44.4)	28 (44.4)	27 (42.9)	28 (44.4)	29 (46.0)	27 (42.9)
Aug	---	25 (39.7)	28 (44.4)	28 (44.4)	24 (38.1)	26 (41.3)	26 (41.3)	25 (39.7)
Sep	---	12 (16.9)	8 (11.3)	8 (11.3)	8 (11.3)	7 (9.9)	12 (16.9)	12 (16.9)
Oct	---	8 (11.4)	8 (11.4)	8 (11.4)	9 (12.9)	7 (10.0)	9 (12.9)	9 (12.9)
Nov	---	6 (10.3)	5 (8.6)	5 (8.6)	6 (10.3)	5 (8.6)	6 (10.3)	8 (13.8)
Dec	---	6 (10.3)	5 (8.6)	5 (8.6)	6 (10.3)	5 (8.6)	6 (10.3)	8 (13.8)
Annual	---	6 (10.3)	5 (8.6)	5 (8.6)	6 (10.3)	5 (8.6)	6 (10.3)	8 (13.8)

Water Quality Assessment of Permitted Dischargers

WWTFs with potential adverse chronic low flow effects greater than 10 percent that would not have greater than 90 percent dilution flows were evaluated using a water quality assessment. The City of La Junta WWTF chronic low flow direct effects and the Fremont Sanitation District Rainbow Park WWTF chronic low flow cumulative effects were the only facilities meeting this criterion. Chapter 4 – *Water Quality* describes the significance of these effects. Although effects on City of Pueblo chronic low flows would be negligible, a water quality assessment is included in this section at the city's request.

City of La Junta WWTF Direct effects chronic low flow for the City of La Junta WWTF would decrease more than 10 percent for most alternatives compared to the No Action Alternative and existing conditions (Table 124), and the dilution of La Junta's WWTF discharge in the Arkansas River would be below 90 percent. The chronic low flow effects were applied to the current discharge permit chronic low flow to evaluate effects on La Junta's current discharge limits (Table 132 and Table 133). An antidegradation review was not necessary in the current permit and was not assessed in this analysis, as both King's Arroyo and the Arkansas River at La Junta are designated Use Protected.

The assimilative capacities of all alternatives compared to the No Action and existing conditions are in Table 134 and Table 135, respectively. La Junta's current residual chlorine discharge limit equals the assimilative capacity of the current permit (0.029 mg/L, Health Department 2004). The alternatives would decrease this capacity, compared to the No Action, but would not affect La Junta's discharge permit as the method detection limit identified in the permit exceeds the assimilative capacity. The No Action Alternative, compared to existing conditions, would also decrease the assimilative capacity of residual chlorine.

The alternatives would increase the assimilative capacity of fecal coliform, compared to the No Action, and would not affect La Junta's current discharge permit. The upstream fecal coliform concentration exceeds the water quality standard in the current discharge permit. The alternatives would decrease the upstream flow, thereby decreasing upstream loading and increasing the assimilative capacity for La Junta's discharge. The No Action Alternative, compared to existing conditions, would also increase the assimilative capacity of fecal coliform.

The alternatives would decrease the selenium assimilative capacity, compared to the No Action, but capacities would be higher than the current discharge limit and would not affect La Junta's current permit. La Junta's current selenium discharge limit equals the water quality standard (27.1 µg/L, Health Department 2004). The No Action Alternative, compared to existing conditions, would also decrease the selenium assimilative capacity.

La Junta's current permit does not have set limits for remaining metals; rather La Junta is required to monitor discharge concentrations. After examining the current permit's water quality assessment and discharge monitoring data, the Health Department concluded that "[La Junta's] discharge does not present a reasonable potential to cause or contribute to an exceedence of stream standards for [these] metals" (Health Department 2004). The No Action and Master Contract Only alternatives assume a zero liquid discharge for La Junta's reverse osmosis water treatment plant, and the remaining alternatives provide AVC water supply. Both of these actions would further decrease La Junta's discharge metal concentrations because of lower source water concentration. Lower assimilative capacities for these metals for all alternatives would not affect La Junta's current permit.

Current ammonia discharge limits for the months of February through October are set the assimilative capacities in the water quality assessment. The assimilative capacities were calculated in the current permit using chronic low flow values in King's Arroyo, degradation of ammonia to the confluence, and chronic low flows in the Arkansas River. All alternatives may decrease the ammonia assimilative capacity because of changes in Arkansas River chronic low flows, although chronic low flows in King's Arroyo would not be affected. Effects on the discharge permit would be minor.

Table 132. City of La Junta WWTF Adjusted Chronic Low Flows of Alternatives Compared to No Action

Chronic Low Flow	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Daily Model Chronic Low Flow (cfs)	15	7	8	4	7	7	14
Change Compared to No Action (%)	0	-53	-47	-73	-53	-53	-7
Adjusted Chronic Low Flow (cfs) used in Water Quality Assessment Effects Analysis	12[(1)]	6	6	3	6	6	11

Notes:
(1) The No Action Alternative chronic low flow is assumed equal to the current discharge permit chronic low flow (12 cfs, Health Department 2004) to evaluate action alternatives.

Table 133. City of La Junta WWTF Adjusted Chronic Low Flows of Alternatives Compared to Existing Conditions

Chronic Low Flow	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Modeled Chronic Low Flow (cfs)	22	15	7	8	4	7	7	14
Change Compared to No Action (%)	0	-32	-68	-64	-82	-68	-68	-36
Adjusted Chronic Low Flow (cfs) used in Water Quality Assessment Effects Analysis	12[(1)]	8	4	4	2	4	4	8

Notes:
(1) The existing conditions chronic low flow is assumed equal to the current discharge permit chronic low flow (12 cfs, Health Department 2004) to evaluate all alternatives.

Table 134. City of La Junta Water Quality Assessment for Alternatives Compared to the No Action

Constituent	Water Quality Standards	Permit Limits	No Action[1]	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
			Assimilative Capacities[2]						
Chlorine (mg/L)	0.011	0.029	0.029	0.019	0.021	0.016	0.019	0.019	0.028
Fecal Coliform (#/100 mL)	200	194	194	197	197	198	197	197	194
Cd, Dis (µg/L)	6	Report	16	11	12	9	11	11	16
Cr^{+6}, Dis (µg/L)	11	Report	29	19	21	16	19	19	28
Cu, Dis (µg/L)	29	Report	55	41	43	36	41	41	53
Fe, Dis (µg/L)	369	Report	369	369	369	369	369	369	369
Fe, Trec (µg/L)	2,000	Report	-	-	-	664	-	-	-
Pb, Dis (µg/L)	11	Report	14	13	13	12	13	13	14
Mn, Dis (µg/L)	74	Report	93	83	84	79	83	83	92
Hg, Tot (µg/L)	0.010	Report	0.026	0.018	0.019	0.014	0.018	0.018	0.025
Ni, Dis (µg/L)	168	Report	435	293	310	239	293	293	417
Se, Dis (µg/L)	27.1	27.1	41.9	34.0	35.0	31.0	34.0	34.0	40.9
Ag, Dis (µg/L)	3.50	Report	8.67	5.91	6.26	4.88	5.91	5.91	8.33
Zn, Dis (µg/L)	382	Report	979	660	700	541	660	660	939

Notes:
(1) The No Action Alternative chronic low flow and assimilative capacities are assumed equal to the current discharge permit (Health Department 2004).
(2) Assimilative capacities greater than the permit limits would not adversely affect the WWTF.

Table 135. City of La Junta Water Quality Assessment for Alternatives Compared to Existing Conditions

Constituent	Water Quality Standards	Permit Limits	Existing Conditions [1]	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
			Assimilative Capacities [2]							
Chlorine (mg/L)	0.011	0.029	0.029	0.023	0.017	0.017	0.014	0.017	0.017	0.022
Fecal Coliform (#/100 mL)	200	194	194	196	198	198	199	198	198	196
Cd, Dis (µg/L)	6	Report	16	13	9	10	8	9	9	13
Cr^{+6}, Dis (µg/L)	11	Report	29	23	17	17	14	17	17	22
Cu, Dis (µg/L)	29	Report	55	47	37	38	34	37	37	46
Fe, Dis (µg/L)	369	Report	369	369	369	369	369	369	369	369
Fe, Trec (µg/L)	2,000	Report	-	-	406	178	1,089	406	406	-
Pb, Dis (µg/L)	11	Report	14	13	12	12	12	12	12	13
Mn, Dis (µg/L)	74	Report	93	87	80	81	78	80	80	86
Hg, Tot (µg/L)	0.010	Report	0.026	0.021	0.015	0.016	0.013	0.015	0.015	0.020
Ni, Dis (µg/L)	168	Report	435	350	253	265	217	253	253	338
Se, Dis (µg/L)	27.1	27.1	41.9	37.2	31.8	32.5	29.8	31.8	31.8	36.5
Ag, Dis (µg/L)	3.50	Report	8.67	7.03	5.15	5.38	4.44	5.15	5.15	6.79
Zn, Dis (µg/L)	382	Report	979	789	572	599	491	572	572	762

Notes:
[1] The existing conditions chronic low flow and assimilative capacities are assumed equal to the current discharge permit (Health Department 2004).
[2] Assimilative capacities greater than the permit limits would not adversely affect the WWTF.

Fremont Sanitation District Rainbow Park WWTF Cumulative effects chronic low flow for the Fremont Sanitation District Rainbow Park WWTF would decrease more than 10 percent for the Pueblo Dam South and River South alternatives compared to the No Action Alternative and existing conditions (Table 136 and Table 137), and dilution of the WWTF discharge in the Arkansas River would be below 90 percent. The chronic low flow effects were applied to the current discharge permit chronic low flow to evaluate effects on Rainbow Park's current discharge limits (Table 136 and Table 137). The antidegradation review in the current permit's water quality assessment was evaluated because this reach of the river is not designated Use Protected.

The antidegradation-based average concentrations (ADBAC) of all alternatives compared to the No Action and existing conditions are in Table 138 and Table 139, respectively. Rainbow Park currently disinfects effluent using UV treatment, and the current residual chlorine discharge limit has been retained from previous permits. Effects on the residual chlorine discharge would be negligible.

All alternatives except JUP North would decrease the fecal coliform ADBAC, compared to the No Action. Fremont Sanitation District elected to retain its prior fecal coliform discharge limit (2,073 counts/100 mL) rather than adopt the more stringent ADBAC (534 counts/100 mL) (Health Department 2003). Although the alternatives affect the ADBAC level, effects on the discharge limit would be negligible. The Comanche North, Pueblo Dam South, Pueblo Dam North, and River South alternatives would decrease the fecal coliform ADBAC, compared to existing conditions, but would not affect the discharge limit.

Several alternatives would decrease the lead and zinc ADBACs, compared to the No Action or existing conditions, but the ADBACs would be above the current discharge limit, which equals the table value standard. Effects would be negligible. No alternatives would affect the mercury ADBAC, compared to No Action or existing conditions. The current mercury discharge limit has also been retained from the previous permit. Effects on the mercury discharge limit would be negligible. Rainbow Park's current permit does not have set limits for remaining metals; rather it is required to monitor discharge concentrations.

All alternatives would decrease ammonia ADBACs by less than 10 percent, compared to the No Action and existing conditions. Fremont Sanitation District elected to retain its prior ammonia monthly limits rather than adopt the more stringent ADBAC limits (Health Department 2003). Effects would be negligible.

Table 136. Fremont Sanitation District Rainbow Park WWTF Adjusted Chronic Low Flows of Alternatives Compared to No Action

Chronic Low Flow	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Daily Model Chronic Low Flow (cfs)	105	102	91	107	102	91	104
Change Compared to No Action (%)	0	-3	-13	2	-3	-13	-1
Adjusted Chronic Low Flow (cfs) used in Water Quality Assessment Effects Analysis	234(1)	227	203	238	227	203	232

Notes:
(1) The No Action Alternative chronic low flow is assumed equal to the current discharge permit chronic low flow (234 cfs, Health Department 2003) to evaluate action alternatives.

Table 137. Fremont Sanitation District Rainbow Park WWTF Adjusted Chronic Low Flows of Alternatives Compared to Existing Conditions

Chronic Low Flow	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Modeled Chronic Low Flow (cfs)	103	105	102	91	107	102	91	104
Change Compared to No Action (%)	0	2	-1	-12	4	-1	-12	1
Adjusted Chronic Low Flow (cfs) used in Water Quality Assessment Effects Analysis	234(1)	239	232	207	243	232	207	236

Notes:
(1) The existing conditions chronic low flow is assumed equal to the current discharge permit chronic low flow (234 cfs, Health Department 2003) to evaluate all alternatives.

Table 138. Fremont Sanitation District Rainbow Park Water Quality Assessment for Alternatives Compared to the No Action

Constituent	Water Quality Standards	Permit Limits	No Action[1]	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
			Antidegradation-Based Average Concentrations[2][3]						
Chlorine (mg/L)	0.011	0.035	0.040	0.039	0.035	0.040	0.039	0.035	0.039
Fecal Coliform (#/100 mL)	200	2,073	534	521	473	542	521	473	529
Cd, Dis (µg/L)	4.1	Report	12	12	11	13	12	11	12
Cr^{+6}, Dis (µg/L)	11	Report	26	25	23	26	25	23	26
Cu, Dis (µg/L)	18	Report	52	51	47	53	51	47	52
Fe, Dis (µg/L)	300	Report	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fe, Trec (µg/L)	1,000	Report	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pb, Dis (µg/L)	6	6	17	17	15	17	17	15	17
Mn, Dis (µg/L)	50	Report	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hg, Tot (µg/L)	0.01	0.2	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Ni, Dis (µg/L)	103	Report	316	308	277	322	308	277	314
Se, Dis (µg/L)	4.6	Report	22.9	22.6	21.5	23.1	22.6	21.5	22.8
Ag, Dis (µg/L)	0.3	Report	0.9	0.9	0.8	0.9	0.9	0.8	0.9
Zn, Dis (µg/L)	234	234	712	694	626	724	694	626	706
NH3, Jan (mg/L)	0.7	8.6	3.4	3.4	3.4	3.4	3.4	3.3	3.4
NH3, Feb(mg/L)	0.6	6.6	2.2	2.2	2.1	2.3	2.3	2.1	2.1
NH3, Mar (mg/L)	0.4	4.1	3.4	3.4	3.4	3.4	3.4	3.3	3.4
NH3, Apr (mg/L)	0.4	4.2	2.2	2.2	2.1	2.3	2.3	2.1	2.1
NH3, May (mg/L)	0.3	2.9	0.9	0.9	0.8	0.9	0.9	0.8	0.9
NH3, Jun (mg/L)	0.3	3.5	2.2	2.2	2.1	2.3	2.3	2.1	2.1
NH3, Jul (mg/L)	0.3	3.6	2.2	2.2	2.1	2.3	2.3	2.1	2.1
NH3, Aug (mg/L)	0.3	3.3	0.9	0.9	0.8	0.9	0.9	0.8	0.9
NH3, Sep (mg/L)	0.3	2.8	0.9	0.9	0.8	0.9	0.9	0.8	0.9
NH3, Oct (mg/L)	0.3	3.1	0.9	0.9	0.8	0.9	0.9	0.8	0.9
NH3, Nov (mg/L)	0.3	3.3	0.9	0.9	0.8	0.9	0.9	0.8	0.9
NH3, Dec (mg/L)	0.5	3.5	2.2	2.2	2.1	2.3	2.3	2.1	2.1

Key: N/A = not available, effluent data was not available for calculation

Notes:

(1) The No Action Alternative chronic low flow and assimilative capacities are assumed equal to the current discharge permit (Health Department 2003).

(2) Permit limits greater than the No Action Alternative antidegradation-based average concentrations were retained from previous permit. The alternatives would not adversely affect the WWTF.

(3) Antidegradation-based average concentrations greater than the permit limits would not adversely affect the WWTF.

Table 139. Fremont Sanitation District Rainbow Park Water Quality Assessment for Alternatives Compared to Existing Conditions

Constituent	Water Quality Standards	Permit Limits	Existing Conditions [1]	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
			Antidegradation-Based Average Concentrations [2][3]							
Chlorine (mg/L)	0.011	0.035	0.040	0.040	0.039	0.036	0.041	0.039	0.036	0.040
Fecal Coliform (#/100 mL)	200	2,073	534	543	529	480	552	529	480	538
Cd, Dis (µg/L)	4.1	Report	12	13	12	11	13	12	11	13
Cr^{+6}, Dis (µg/L)	11	Report	26	26	26	23	27	26	23	26
Cu, Dis (µg/L)	18	Report	52	53	52	47	54	52	47	52
Fe, Dis (µg/L)	300	Report	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fe, Trec (µg/L)	1,000	Report	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pb, Dis (µg/L)	6	6	17	17	17	15	18	17	15	17
Mn, Dis (µg/L)	50	Report	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hg, Tot (µg/L)	0.01	0.2	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Ni, Dis (µg/L)	103	Report	316	322	314	282	328	314	282	319
Se, Dis (µg/L)	4.6	Report	22.9	23.1	22.8	21.7	23.3	22.8	21.7	23.0
Ag, Dis (µg/L)	0.3	Report	0.9	0.9	0.9	0.8	1.0	0.9	0.8	0.9
Zn, Dis (µg/L)	234	234	712	725	706	637	737	706	637	718
NH3, Jan (mg/L)	0.7	8.6	3.4	3.3	3.3	3.3	3.3	3.3	3.2	3.3
NH3, Feb(mg/L)	0.6	6.6	2.2	2.2	2.2	2.2	2.3	2.3	2.1	2.1
NH3, Mar (mg/L)	0.4	4.1	3.4	3.3	3.3	3.3	3.3	3.3	3.2	3.3
NH3, Apr (mg/L)	0.4	4.2	2.2	2.2	2.2	2.2	2.3	2.3	2.1	2.1
NH3, May (mg/L)	0.3	2.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9
NH3, Jun (mg/L)	0.3	3.5	2.2	2.2	2.2	2.2	2.3	2.3	2.1	2.1
NH3, Jul (mg/L)	0.3	3.6	2.2	2.2	2.2	2.2	2.3	2.3	2.1	2.1
NH3, Aug (mg/L)	0.3	3.3	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9
NH3, Sep (mg/L)	0.3	2.8	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9
NH3, Oct (mg/L)	0.3	3.1	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9
NH3, Nov (mg/L)	0.3	3.3	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9
NH3, Dec (mg/L)	0.5	3.5	2.2	2.2	2.2	2.2	2.3	2.3	2.1	2.1

Key: N/A = not available, effluent data was not available for calculation

Notes:

(1) The existing conditions chronic low flow and assimilative capacities are assumed equal to the current discharge permit (Health Department 2003).

(2) Permit limits greater than the antidegradation-based average concentrations were retained from previous permit. Changes in concentrations would not adversely affect the WWTF.

(3) Antidegradation-based average concentrations greater than the permit limits would not adversely affect the WWTF.

City of Pueblo WWTF Direct effects chronic low flow for the City of Pueblo WWTF would change less than 10 percent for all alternatives compared to the No Action Alternative and existing conditions (Table 120). Although effects on Pueblo's chronic low flows would be negligible, this water quality assessment is included in the EIS at the city's request. The chronic low flow effects were applied to the current discharge permit chronic low flow to evaluate effects on La Junta's current discharge limits (Table 140 and Table 141).

Effects compared to No Action on the dilution or instream waste concentration are in Table 142. The assimilative capacities of all alternatives compared to the No Action and existing conditions are in Table 143 and Table 144, respectively. Effects on the City of Pueblo's instream waste concentrations and assimilative capacities would be less than two percent; these effects would be negligible.

Table 140. City of Pueblo WWTF Adjusted Chronic Low Flows of Alternatives Compared to No Action

Chronic Low Flow	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Daily Model Chronic Low Flow (cfs)	178	180	180	179	180	178	184
Change Compared to No Action (%)	0	1.1	1.1	0.6	1.1	0.0	3.4
Adjusted Chronic Low Flow (cfs) used in Water Quality Assessment Effects Analysis	95	94	94	93	94	93	96

Notes:
(1) The No Action Alternative chronic low flow is assumed equal to the current discharge permit chronic low flow (95 cfs, Health Department 2010a) to evaluate action alternatives.

Table 141. City of Pueblo WWTF Adjusted Chronic Low Flows of Alternatives Compared to Existing Conditions

Chronic Low Flow	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Modeled Chronic Low Flow (cfs)	181	178	180	180	179	180	178	184
Change Compared to No Action (%)	0	-1.7	-0.6	-0.6	-1.1	-0.6	-1.7	1.7
Adjusted Chronic Low Flow (cfs) used in Water Quality Assessment Effects Analysis	95	93	93	93	93	93	92	95

Notes:
(1) The existing conditions chronic low flow is assumed equal to the current discharge permit chronic low flow (95 cfs, Health Department 2010a) to evaluate all alternatives.

Table 142. City of Pueblo WWTF Adjusted Instream Waste Concentration Compared to No Action

Annual Quarter	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Adjusted Chronic Low Flow (cfs)							
1	95	100	100	97	100	97	101
2	127	130	130	125	130	125	130
3	95	94	94	93	94	93	96
4	95	94	94	95	94	93	96
Existing Permitted Flow (cfs)							
1 – 4	29	29	29	29	29	29	29
Instream Waste Concentration (%)							
1	23.4	22.5	22.5	23.1	22.5	23.1	22.4
2	18.6	18.2	18.2	18.8	18.2	18.8	18.2
3	23.4	23.6	23.6	23.7	23.5	23.8	23.3
4	23.4	23.5	23.5	23.4	23.5	23.8	23.2
Change in Instream Waste Concentration Compared to No Action (%)							
1	---	-0.8	-0.8	-0.3	-0.8	-0.3	-1.0
2	---	-0.4	-0.4	0.2	-0.4	0.2	-0.4
3	---	0.2	0.2	0.3	0.1	0.4	-0.1
4	---	0.1	0.1	0.0	0.1	0.4	-0.2

Table 143. City of Pueblo Water Quality Assessment for Alternatives Compared to the No Action

Constituent	Water Quality Standards	Permit Limits	No Action[1]	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
			Assimilative Capacities[2]						
Chlorine (mg/L)	0.011	0.047	0.047	0.047	0.047	0.046	0.047	0.046	0.047
E. Coli (#/100 mL)	126	141	141	141	141	141	141	141	141
Sulfate (mg/L)	359	Report	400	400	400	399	400	399	400
As, TR (µg/L)	100	---	179	178	178	178	178	177	179
Cd, Dis (µg/L)	1.2	---	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Cr+6, Dis (µg/L)	11	---	20	20	20	20	20	19	20
Cu, Dis (µg/L)	29	---	49	49	49	49	49	49	49
Fe, Trec (µg/L)	2765	---	2765	2765	2765	2765	2765	2765	2765
Pb, Dis (µg/L)	11	---	20	20	20	20	20	20	20
Mn, Dis (µg/L)	2618	---	4726	4703	4703	4692	4714	4680	4737
Hg, Tot (µg/L)	0.010	Report	0.018	0.018	0.018	0.018	0.018	0.018	0.018
Ni, Dis (µg/L)	168	---	301	299	299	299	300	298	302
Se, Dis (µg/L)	14.1	Report	17	17	17	17	17	17	17
Ag, Dis (µg/L)	3.5	---	6.3	6.3	6.3	6.3	6.3	6.3	6.3
Zn, Dis (µg/L)	405	---	710	707	707	705	708	704	712
Se, Dis (µg/L) temp	14.1	---	17	17	17	17	17	17	17
Sulfate (mg/L) Dis, temp	329	---	346	346	346	346	346	346	346

Notes:
(1) The No Action Alternative chronic low flow and assimilative capacities are assumed equal to the current discharge permit (Health Department 2010a).
(2) Assimilative capacities greater than the permit limits would not adversely affect the WWTF.

Table 144. City of Pueblo Water Quality Assessment for Alternatives Compared to Existing Conditions

Constituent	Water Quality Standards	Permit Limits	Existing Conditions [1]	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
			Assimilative Capacities[2]							
Chlorine (mg/L)	0.011	0.047	0.047	0.046	0.046	0.046	0.046	0.046	0.046	0.047
E. Coli (#/100 mL)	126	141	141	141	141	141	141	141	141	141
Sulfate (mg/L)	359	Report	400	399	399	399	399	399	399	400
As, TR (µg/L)	100	---	179	178	178	178	177	178	177	179
Cd, Dis (µg/L)	1.2	---	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Cr+6, Dis (µg/L)	11	---	20	20	20	20	19	20	19	20
Cu, Dis (µg/L)	29	---	49	49	49	49	49	49	48	49
Fe, Trec (µg/L)	2765	---	1893	1908	1907	1907	1912	1907	1917	1893
Pb, Dis (µg/L)	11	---	20	20	20	20	20	20	20	20
Mn, Dis (µg/L)	2618	---	4726	4691	4691	4691	4680	4691	4669	4726
Hg, Tot (µg/L)	0.010	Report	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
Ni, Dis (µg/L)	168	---	301	299	299	299	298	299	297	301
Se, Dis (µg/L)	14.1	Report	16.6	16.6	16.6	16.6	16.5	16.6	16.5	16.6
Ag, Dis (µg/L)	3.5	---	6.3	6.3	6.3	6.3	6.3	6.3	6.2	6.3
Zn, Dis (µg/L)	405	---	710	705	705	705	704	705	702	710
Se, Dis (µg/L) temp	14.1	---	16.6	16.6	16.6	16.6	16.5	16.6	16.5	16.6
Sulfate (mg/L) Dis, temp	329	---	346	346	346	346	346	346	345	346

Notes:
[1] The existing conditions chronic low flow and assimilative capacities are assumed equal to the current discharge permit (Health Department 2010a).
[2] Assimilative capacities greater than the permit limits would not adversely affect the WWTF.

Total Maximum Daily Loads

Changes in streamflow could affect constituent load allocations assigned to permitted and non-permitted point dischargers, and to non-point sources. Allocations have been assigned in approved Total Maximum Daily Loads (TMDL).

Methods

Several TMDLs have been approved in the Upper Arkansas River Basin analysis area (Table 145). These TMDLs are further described in Appendix F.1.

Table 145. Upper Arkansas River Basin Approved Total Maximum Daily Loads in Daily Model Analysis Area

River Segment	Constituent
Lake Creek (COARUA10)	Copper
Arkansas River between Lake Fork Creek and Lake Creek (COARUA2c)	Cadmium, zinc
Arkansas River between Lake Creek and Pueblo Reservoir (COARUA3)	Cadmium, zinc, lead

Source: Health Department 2009, 2010b

The TMDL for Lake Creek (COARUA10) was not assessed in this EIS because streamflow and water quality at the Lake Creek above Twin Lakes gage was used to quantify the TMDL and allocations (Health Department 2010b). This gage is outside the Daily Model analysis area (see Appendix D.3). Streamflow effects at this gage would not occur. The TMDL for Lake Creek notes that all copper sources are natural and occur upstream from Twin Lakes. The sources are outside the analysis area and would not be affected. The copper loading into Twin Lakes would not be affected. Twin Lakes storage volume changes would be negligible (less than 2percent) and would not affect copper dilution and concentrations. Dissolved oxygen and pH would not be affected. Although Twin Lakes releases would be affected by the action alternatives, constituent concentrations in these releases would not be affected because concentrations in Twin Lakes would not change. The alternatives would not affect the copper TMDL; waste load allocations (none identified in this TMDL) and load allocations (hydrothermally altered natural background copper loading upstream from Twin Lakes) needed to attain the standard would not be affected.

The TMDL for the Arkansas River between Lake Fork Creek and Lake Creek (COARUA2c) used streamflow and water quality data at the Arkansas River below Leadville gage to quantify the TMDL and allocations (Health Department 2009). The Arkansas River below Leadville gage is an input of the Daily Model and was not simulated (i.e. outside the analysis area) (see Appendix D.3). The Arkansas River at Granite gage, which is located just below this stream segment, was used as a surrogate for the TMDL analysis. Median monthly flows and 95th percentile concentrations of cadmium and zinc were used to quantify the existing stream load. Median monthly flows and the water quality standard were used to quantify the TMDL.
The TMDL for the Arkansas River between Lake Creek and Pueblo Reservoir used streamflow and water quality data at the Arkansas River near Wellsville gage to quantify the TMDL and allocations (Health Department 2009). Median monthly flows and 95th percentile concentrations of cadmium, zinc, and lead were used to quantify the existing stream load. Median monthly flows and the water quality standard were used to quantify the TMDL.

Because future permitted discharge limits, ambient water quality, and water quality standards are unknown, the TMDL assessments in this EIS used water quality information from current TMDL documentation to evaluate effects. The median streamflow percent changes of the alternatives compared to the existing conditions simulation were applied to historical median streamflow used to quantify the TMDL. These adjusted median streamflows were then used to adjust the ambient water quality of each alternative. This adjustment was based on the assumption that Upper Arkansas River streamflow dilutes toxic metal loading. Most metal loading originates from non-permitted point sources and non-point sources outside the analysis area (e.g., California Gulch Superfund site in Leadville) (Health Department 2009). This mass loading was assumed constant between all simulations. The ratio of historical and adjusted median streamflow was applied to historical ambient water quality values in the TMDL to approximate changes in metal loading dilution. The adjusted median streamflow and water quality values were then used to calculate effects on existing stream load, the TMDL, and load reductions required to meet the TMDL.

Critical conditions periods in the Upper Arkansas River Basin, or periods when water quality exceedences are most likely to occur, are typically during high streamflow and dry periods (Health Department 2009). Chronic low flow periods for the Arkansas River between Lake Fork Creek and Pueblo Reservoir were evaluated in a previous section of this Appendix. Wet and dry periods were further assessed by examining the percent changes compared to existing conditions in streamflow during these critical periods.

Results

Effects on Arkansas River TMDLs for river segments downstream from the Lake Fork Creek confluence are described in this section.

Arkansas River between Lake Fork Creek and Lake Creek (COARUA2c)

Changes in median streamflow at the Arkansas River at Granite gage are in Table 146. Changes for all alternatives compared to No Action would typically be less than 2 percent, although occasional monthly decreases or increases of up to 7 percent would occur, especially in winter and spring months. These changes would be caused by small changes in Turquoise Reservoir operations (see Appendix D.4).

The No Action and action alternatives' effects compared to existing conditions on cadmium load reductions to meet TMDLs in the Arkansas River between Lake Fork Creek and Lake Creek (COARUA2c) are in Table 147 through Table 153. These results indicate that the predominately negligible effects on streamflow in this reach would not substantially affect existing load and TMDLs, and would not affect the required cadmium load reductions and associated allocations. Results would be similar for zinc.

Changes in critical conditions (wet and dry periods) for the Arkansas River TMDL between Lake Fork Creek and Lake Creek are in Figure 76 and Figure 77. The percent changes in streamflow are in Table 154. Maximum increases in wet period flows for action alternatives would change less than 4.2 percent for all alternatives compared to existing conditions, similar to No Action. Wet period flows would increase less than about 1 percent most of the time. Maximum decreases in dry period flows would change less than 3 percent for all alternatives compared to existing conditions. Dry period flows would increase most of the time.

Table 146. Median Streamflow at Arkansas River at Granite Gage – Direct Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	144	136	143	141	142	143	141	137
Feb	103	103	102	102	103	101	100	100
Mar	113	116	115	116	117	115	114	113
Apr	147	151	148	148	151	147	147	147
May	536	532	528	528	541	527	527	520
Jun	1,259	1,218	1,236	1,241	1,220	1,246	1,235	1,242
Jul	678	684	683	683	685	684	683	682
Aug	457	467	466	466	461	464	465	465
Sep	168	177	176	176	177	176	176	176
Oct	133	133	133	133	132	133	133	133
Nov	156	158	156	156	159	156	156	155
Dec	154	149	150	149	160	150	150	150
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	7 (5.1)	5 (3.7)	6 (4.4)	7 (5.1)	5 (3.7)	1 (0.7)
Feb	---	---	-1 (-1.0)	-1 (-1.0)	0 (0.0)	-2 (-1.9)	-3 (-2.9)	-3 (-2.9)
Mar	---	---	-1 (-0.9)	0 (0.0)	1 (0.9)	-1 (-0.9)	-2 (-1.7)	-3 (-2.6)
Apr	---	---	-3 (-2.0)	-3 (-2.0)	0 (0.0)	-4 (-2.6)	-4 (-2.6)	-4 (-2.6)
May	---	---	-4 (-0.8)	-4 (-0.8)	9 (1.7)	-5 (-0.9)	-5 (-0.9)	-12 (-2.3)
Jun	---	---	18 (1.5)	23 (1.9)	2 (0.2)	28 (2.3)	17 (1.4)	24 (2.0)
Jul	---	---	-1 (-0.1)	-1 (-0.1)	1 (0.1)	0 (0.0)	-1 (-0.1)	-2 (-0.3)
Aug	---	---	-1 (-0.2)	-1 (-0.2)	-6 (-1.3)	-3 (-0.6)	-2 (-0.4)	-2 (-0.4)
Sep	---	---	-1 (-0.6)	-1 (-0.6)	0 (0.0)	-1 (-0.6)	-1 (-0.6)	-1 (-0.6)
Oct	---	---	0 (0.0)	0 (0.0)	-1 (-0.8)	0 (0.0)	0 (0.0)	0 (0.0)
Nov	---	---	-2 (-1.3)	-2 (-1.3)	1 (0.6)	-2 (-1.3)	-2 (-1.3)	-3 (-1.9)
Dec	---	---	1 (0.7)	0 (0.0)	11 (7.4)	1 (0.7)	1 (0.7)	1 (0.7)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	-8 (-5.6)	-1 (-0.7)	-3 (-2.1)	-2 (-1.4)	-1 (-0.7)	-3 (-2.1)	-7 (-4.9)
Feb	---	0 (0.0)	-1 (-1.0)	-1 (-1.0)	0 (0.0)	-2 (-1.9)	-3 (-2.9)	-3 (-2.9)
Mar	---	3 (2.7)	2 (1.8)	3 (2.7)	4 (3.5)	2 (1.8)	1 (0.9)	0 (0.0)
Apr	---	4 (2.7)	1 (0.7)	1 (0.7)	4 (2.7)	0 (0.0)	0 (0.0)	0 (0.0)
May	---	-4 (-0.7)	-8 (-1.5)	-8 (-1.5)	5 (0.9)	-9 (-1.7)	-9 (-1.7)	-16 (-3.0)
Jun	---	-41 (-3.3)	-23 (-1.8)	-18 (-1.4)	-39 (-3.1)	-13 (-1.0)	-24 (-1.9)	-17 (-1.4)
Jul	---	6 (0.9)	5 (0.7)	5 (0.7)	7 (1.0)	6 (0.9)	5 (0.7)	4 (0.6)
Aug	---	10 (2.2)	9 (2.0)	9 (2.0)	4 (0.9)	7 (1.5)	8 (1.8)	8 (1.8)
Sep	---	9 (5.4)	8 (4.8)	8 (4.8)	9 (5.4)	8 (4.8)	8 (4.8)	8 (4.8)
Oct	---	0 (0.0)	0 (0.0)	0 (0.0)	-1 (-0.8)	0 (0.0)	0 (0.0)	0 (0.0)
Nov	---	2 (1.3)	0 (0.0)	0 (0.0)	3 (1.9)	0 (0.0)	0 (0.0)	-1 (-0.6)
Dec	---	-5 (-3.2)	-4 (-2.6)	-5 (-3.2)	6 (3.9)	-4 (-2.6)	-4 (-2.6)	-4 (-2.6)

Table 147. No Action Alternative Direct Effects on Upper Arkansas River Basin Segment 2c Cadmium TMDL

Month	Current TMDL - Cadmium						No Action Alternative					
	Median Flow (cfs)	Ambient Water Quality (µg/L)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)	Median Flow (cfs) [(1)]	Ambient Water Quality (µg/L) [(2)]	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)
Jan	15	0.40	0.032	0.113	-0.080	0	14	0.42	0.032	0.107	0.000	0
Feb	14	0.32	0.024	0.106	-0.082	0	14	0.32	0.024	0.105	0.000	0
Mar	15	0.43	0.035	0.109	-0.074	0	15	0.42	0.035	0.108	0.000	0
Apr	25	0.97	0.131	0.158	-0.027	0	26	0.95	0.131	0.166	0.000	0
May	124	1.01	0.674	0.583	0.091	14	123	1.01	0.674	0.598	0.076	11
Jun	283	0.40	0.617	1.406	-0.789	0	274	0.42	0.617	1.328	0.000	0
Jul	109	0.27	0.159	0.695	-0.536	0	110	0.27	0.159	0.712	0.000	0
Aug	49	0.73	0.193	0.336	-0.143	0	50	0.72	0.193	0.351	0.000	0
Sep	32	0.30	0.052	0.235	-0.183	0	34	0.29	0.052	0.254	0.000	0
Oct	26	0.68	0.095	0.181	-0.086	0	26	0.68	0.095	0.182	0.000	0
Nov	21	0.38	0.043	0.147	-0.105	0	21	0.38	0.043	0.148	0.000	0
Dec	17	1.13	0.104	0.138	-0.034	0	16	1.17	0.104	0.133	0.000	0

Notes:

(1) Alternative median flows (cfs) were calculated by multiplying the percent change between simulated existing conditions and alternative median flow to the current TMDL median flow.

(2) Alternative ambient water quality was calculated by multiplying the ratio of current TMDL and alternative median flow to the current TMDL ambient water quality.

Table 148. Comanche North Alternative Direct Effects on Upper Arkansas River Basin Segment 2c Cadmium TMDL

Month	Current TMDL - Cadmium						Comanche North Alternative					
	Median Flow (cfs)	Ambient Water Quality (µg/L)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)	Median Flow (cfs) [(1)]	Ambient Water Quality (µg/L) [(2)]	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)
Jan	15	0.40	0.032	0.113	-0.080	0	15	0.40	0.032	0.112	0.000	0
Feb	14	0.32	0.024	0.106	-0.082	0	14	0.32	0.024	0.105	0.000	0
Mar	15	0.43	0.035	0.109	-0.074	0	15	0.43	0.035	0.107	0.000	0
Apr	25	0.97	0.131	0.158	-0.027	0	25	0.96	0.131	0.163	0.000	0
May	124	1.01	0.674	0.583	0.091	14	122	1.02	0.674	0.593	0.081	12
Jun	283	0.40	0.617	1.406	-0.789	0	278	0.41	0.617	1.348	0.000	0
Jul	109	0.27	0.159	0.695	-0.536	0	110	0.27	0.159	0.710	0.000	0
Aug	49	0.73	0.193	0.336	-0.143	0	50	0.72	0.193	0.351	0.000	0
Sep	32	0.30	0.052	0.235	-0.183	0	33	0.29	0.052	0.253	0.000	0
Oct	26	0.68	0.095	0.181	-0.086	0	26	0.68	0.095	0.183	0.000	0
Nov	21	0.38	0.043	0.147	-0.105	0	21	0.38	0.043	0.147	0.000	0
Dec	17	1.13	0.104	0.138	-0.034	0	17	1.16	0.104	0.134	0.000	0

Notes:

(1) Alternative median flows (cfs) were calculated by multiplying the percent change between simulated existing conditions and alternative median flow to the current TMDL median flow.

(2) Alternative ambient water quality was calculated by multiplying the ratio of current TMDL and alternative median flow to the current TMDL ambient water quality.

Table 149. Pueblo Dam South Alternative Direct Effects on Upper Arkansas River Basin Segment 2c Cadmium TMDL

	Current TMDL - Cadmium						Pueblo Dam South Alternative					
Month	Median Flow (cfs)	Ambient Water Quality (µg/L)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)	Median Flow (cfs) (1)	Ambient Water Quality (µg/L) (2)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)
Jan	15	0.40	0.032	0.113	-0.080	0	15	0.40	0.032	0.111	0.000	0
Feb	14	0.32	0.024	0.106	-0.082	0	14	0.32	0.024	0.105	0.000	0
Mar	15	0.43	0.035	0.109	-0.074	0	15	0.42	0.035	0.108	0.000	0
Apr	25	0.97	0.131	0.158	-0.027	0	25	0.96	0.131	0.163	0.000	0
May	124	1.01	0.674	0.583	0.091	14	122	1.02	0.674	0.593	0.081	12
Jun	283	0.40	0.617	1.406	-0.789	0	279	0.41	0.617	1.354	0.000	0
Jul	109	0.27	0.159	0.695	-0.536	0	110	0.27	0.159	0.711	0.000	0
Aug	49	0.73	0.193	0.336	-0.143	0	50	0.72	0.193	0.350	0.000	0
Sep	32	0.30	0.052	0.235	-0.183	0	34	0.29	0.052	0.253	0.000	0
Oct	26	0.68	0.095	0.181	-0.086	0	26	0.68	0.095	0.183	0.000	0
Nov	21	0.38	0.043	0.147	-0.105	0	21	0.38	0.043	0.147	0.000	0
Dec	17	1.13	0.104	0.138	-0.034	0	16	1.17	0.104	0.133	0.000	0

Notes:
(1) Alternative median flows (cfs) were calculated by multiplying the percent change between simulated existing conditions and alternative median flow to the current TMDL median flow.
(2) Alternative ambient water quality was calculated by multiplying the ratio of current TMDL and alternative median flow to the current TMDL ambient water quality.

Table 150. JUP North Alternative Direct Effects on Upper Arkansas River Basin Segment 2c Cadmium TMDL

	Current TMDL - Cadmium						JUP North Alternative					
Month	Median Flow (cfs)	Ambient Water Quality (µg/L)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)	Median Flow (cfs) (1)	Ambient Water Quality (µg/L) (2)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)
Jan	15	0.40	0.032	0.113	-0.080	0	15	0.40	0.032	0.111	0.000	0
Feb	14	0.32	0.024	0.106	-0.082	0	14	0.32	0.024	0.105	0.000	0
Mar	15	0.43	0.035	0.109	-0.074	0	16	0.42	0.035	0.109	0.000	0
Apr	25	0.97	0.131	0.158	-0.027	0	26	0.95	0.131	0.166	0.000	0
May	124	1.01	0.674	0.583	0.091	14	125	1.00	0.674	0.608	0.066	10
Jun	283	0.40	0.617	1.406	-0.789	0	274	0.42	0.617	1.331	0.000	0
Jul	109	0.27	0.159	0.695	-0.536	0	110	0.27	0.159	0.713	0.000	0
Aug	49	0.73	0.193	0.336	-0.143	0	49	0.72	0.193	0.347	0.000	0
Sep	32	0.30	0.052	0.235	-0.183	0	34	0.29	0.052	0.254	0.000	0
Oct	26	0.68	0.095	0.181	-0.086	0	26	0.68	0.095	0.182	0.000	0
Nov	21	0.38	0.043	0.147	-0.105	0	21	0.37	0.043	0.149	0.000	0
Dec	17	1.13	0.104	0.138	-0.034	0	18	1.09	0.104	0.143	0.000	0

Notes:
(1) Alternative median flows (cfs) were calculated by multiplying the percent change between simulated existing conditions and alternative median flow to the current TMDL median flow.
(2) Alternative ambient water quality was calculated by multiplying the ratio of current TMDL and alternative median flow to the current TMDL ambient water quality.

Table 151. Pueblo Dam North Alternative Direct Effects on Upper Arkansas River Basin Segment 2c Cadmium TMDL

	Current TMDL - Cadmium						Pueblo Dam North Alternative					
Month	Median Flow (cfs)	Ambient Water Quality (µg/L)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)	Median Flow (cfs) (1)	Ambient Water Quality (µg/L) (2)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)
Jan	15	0.40	0.032	0.113	-0.080	0	15	0.40	0.032	0.112	0.000	0
Feb	14	0.32	0.024	0.106	-0.082	0	14	0.32	0.024	0.104	0.000	0
Mar	15	0.43	0.035	0.109	-0.074	0	15	0.43	0.035	0.107	0.000	0
Apr	25	0.97	0.131	0.158	-0.027	0	25	0.97	0.131	0.162	0.000	0
May	124	1.01	0.674	0.583	0.091	14	122	1.02	0.674	0.592	0.082	12
Jun	283	0.40	0.617	1.406	-0.789	0	280	0.41	0.617	1.359	0.000	0
Jul	109	0.27	0.159	0.695	-0.536	0	110	0.27	0.159	0.711	0.000	0
Aug	49	0.73	0.193	0.336	-0.143	0	50	0.72	0.193	0.349	0.000	0
Sep	32	0.30	0.052	0.235	-0.183	0	33	0.29	0.052	0.253	0.000	0
Oct	26	0.68	0.095	0.181	-0.086	0	26	0.68	0.095	0.183	0.000	0
Nov	21	0.38	0.043	0.147	-0.105	0	21	0.38	0.043	0.147	0.000	0
Dec	17	1.13	0.104	0.138	-0.034	0	17	1.16	0.104	0.134	0.000	0

Notes:
(1) Alternative median flows (cfs) were calculated by multiplying the percent change between simulated existing conditions and alternative median flow to the current TMDL median flow.
(2) Alternative ambient water quality was calculated by multiplying the ratio of current TMDL and alternative median flow to the current TMDL ambient water quality.

Table 152. River South Alternative Direct Effects on Upper Arkansas River Basin Segment 2c Cadmium TMDL

	Current TMDL - Cadmium						River South Alternative					
Month	Median Flow (cfs)	Ambient Water Quality (µg/L)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)	Median Flow (cfs) (1)	Ambient Water Quality (µg/L) (2)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)
Jan	15	0.40	0.032	0.113	-0.080	0	15	0.40	0.032	0.111	0.000	0
Feb	14	0.32	0.024	0.106	-0.082	0	14	0.33	0.024	0.103	0.000	0
Mar	15	0.43	0.035	0.109	-0.074	0	15	0.43	0.035	0.107	0.000	0
Apr	25	0.97	0.131	0.158	-0.027	0	25	0.97	0.131	0.162	0.000	0
May	124	1.01	0.674	0.583	0.091	14	122	1.02	0.674	0.592	0.082	12
Jun	283	0.40	0.617	1.406	-0.789	0	278	0.41	0.617	1.348	0.000	0
Jul	109	0.27	0.159	0.695	-0.536	0	110	0.27	0.159	0.710	0.000	0
Aug	49	0.73	0.193	0.336	-0.143	0	50	0.72	0.193	0.350	0.000	0
Sep	32	0.30	0.052	0.235	-0.183	0	33	0.29	0.052	0.253	0.000	0
Oct	26	0.68	0.095	0.181	-0.086	0	26	0.68	0.095	0.183	0.000	0
Nov	21	0.38	0.043	0.147	-0.105	0	21	0.38	0.043	0.147	0.000	0
Dec	17	1.13	0.104	0.138	-0.034	0	17	1.16	0.104	0.134	0.000	0

Notes:
(1) Alternative median flows (cfs) were calculated by multiplying the percent change between simulated existing conditions and alternative median flow to the current TMDL median flow.
(2) Alternative ambient water quality was calculated by multiplying the ratio of current TMDL and alternative median flow to the current TMDL ambient water quality.

Table 153. Master Contract Only Alternative Direct Effects on Upper Arkansas River Basin Segment 2c Cadmium TMDL

Month	Current TMDL - Cadmium						Master Contract Only Alternative					
	Median Flow (cfs)	Ambient Water Quality (µg/L)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)	Median Flow (cfs) (1)	Ambient Water Quality (µg/L) (2)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)
Jan	15	0.40	0.032	0.113	-0.080	0	14	0.42	0.032	0.107	0.000	0
Feb	14	0.32	0.024	0.106	-0.082	0	14	0.33	0.024	0.103	0.000	0
Mar	15	0.43	0.035	0.109	-0.074	0	15	0.43	0.035	0.105	0.000	0
Apr	25	0.97	0.131	0.158	-0.027	0	25	0.97	0.131	0.162	0.000	0
May	124	1.01	0.674	0.583	0.091	14	120	1.04	0.674	0.585	0.089	13
Jun	283	0.40	0.617	1.406	-0.789	0	279	0.41	0.617	1.355	0.000	0
Jul	109	0.27	0.159	0.695	-0.536	0	110	0.27	0.159	0.709	0.000	0
Aug	49	0.73	0.193	0.336	-0.143	0	50	0.72	0.193	0.349	0.000	0
Sep	32	0.30	0.052	0.235	-0.183	0	34	0.29	0.052	0.253	0.000	0
Oct	26	0.68	0.095	0.181	-0.086	0	26	0.68	0.095	0.183	0.000	0
Nov	21	0.38	0.043	0.147	-0.105	0	21	0.38	0.043	0.145	0.000	0
Dec	17	1.13	0.104	0.138	-0.034	0	17	1.17	0.104	0.134	0.000	0

Notes:

(1) Alternative median flows (cfs) were calculated by multiplying the percent change between simulated existing conditions and alternative median flow to the current TMDL median flow.

(2) Alternative ambient water quality was calculated by multiplying the ratio of current TMDL and alternative median flow to the current TMDL ambient water quality.

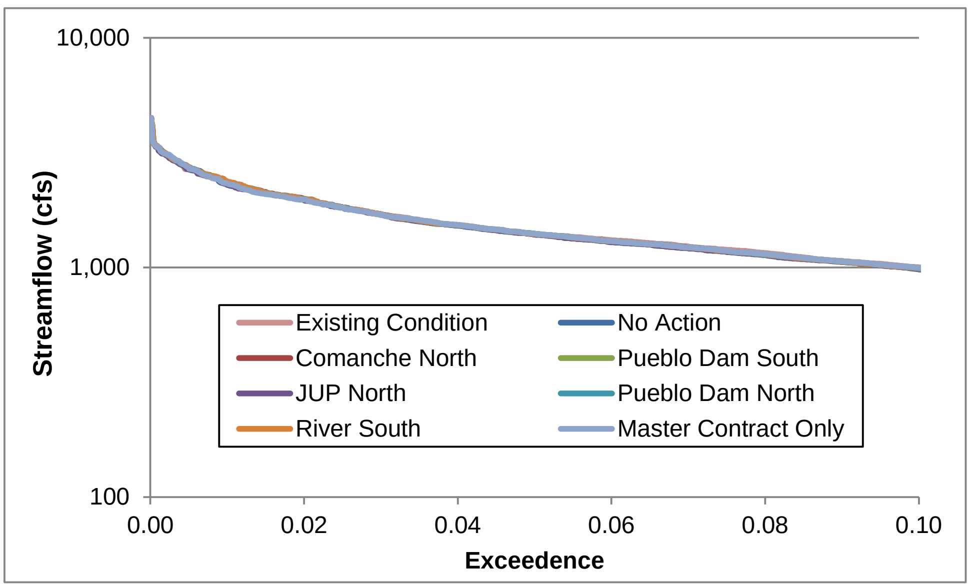


Figure 76. Wet Period Flows at Arkansas River at Granite Gage

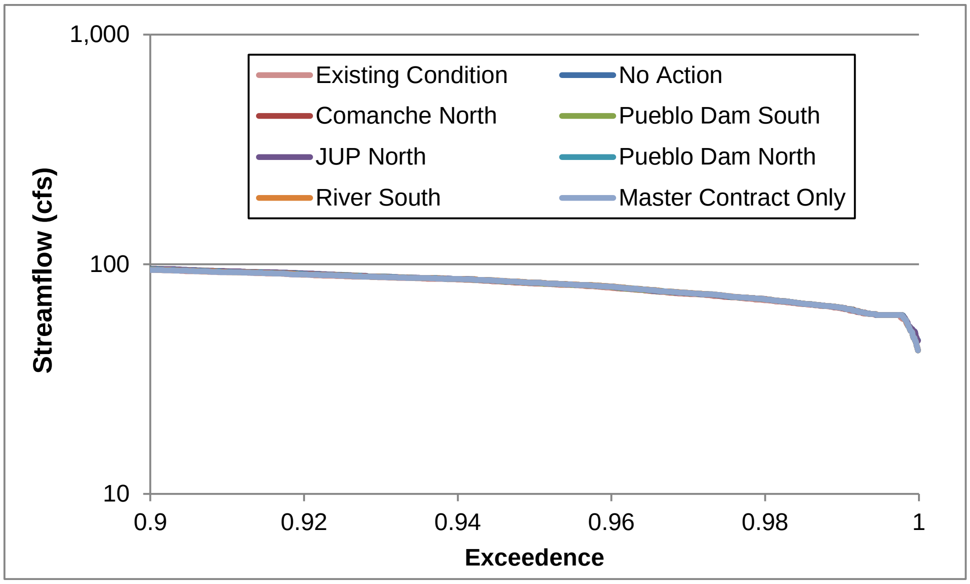


Figure 77. Dry Period Flows at Arkansas River at Granite Gage

Table 154. Changes in Critical Condition Flows at Arkansas River at Granite Gage

Percent Changes in Flow Compared to Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Wet Period (< 10 % exceedence)							
Mean	-0.8	-0.3	-0.4	-1.1	-0.2	-0.2	-0.3
Maximum decrease in flow	-13.0	-1.8	-2.0	-9.0	-2.0	-1.7	-13.0
5th Percentile	-1.9	-1.5	-1.6	-2.3	-1.6	-1.3	-1.3
25th Percentile	-1.6	-1.1	-1.1	-1.7	-1.0	-0.9	-0.8
Median	-0.9	-0.5	-0.5	-1.1	-0.3	-0.3	-0.4
75th Percentile	-0.2	0.1	0.1	-0.5	0.2	0.3	0.1
95th Percentile	0.8	1.7	1.6	0.2	1.7	1.9	0.8
Maximum increase in flow	4.1	4.1	3.6	1.8	4.1	4.2	4.0
Dry Period (> 90 % exceedence)							
Mean	0.8	0.7	0.7	0.9	0.7	0.7	0.5
Maximum decrease in flow	-0.2	-2.8	-2.8	-0.1	-2.8	-2.8	-2.8
5th Percentile	0.2	0.1	0.0	0.2	0.1	0.0	0.0
25th Percentile	0.5	0.5	0.5	0.6	0.5	0.4	0.2
Median	0.8	0.7	0.7	0.8	0.7	0.7	0.5
75th Percentile	1.0	0.9	0.9	1.1	1.0	1.0	0.8
95th Percentile	1.2	1.2	1.1	1.5	1.3	1.3	1.2
Maximum increase in flow	10.2	3.2	3.2	9.4	3.2	3.2	3.2

Arkansas River between Lake Creek and Pueblo Reservoir (COARUA3)

Changes in median streamflow at the Arkansas River near Wellsville gage are in Table 155. Changes for all alternatives compared to No Action would typically be less than 2 percent, although occasional monthly decreases or increases of up to 4 percent would occur, especially in spring months.

The No Action and action alternatives' effects on cadmium load reductions to meeting TMDLs in the Arkansas River between Lake Creek and Pueblo Reservoir (COARUA3) are in Table 156 through Table 162. These results indicate that the negligible effects on streamflow in this reach would not substantially affect existing load and TMDLs, and would not affect the required cadmium load reductions and associated allocations. Results would be similar for lead and zinc.

Changes in critical conditions (wet and dry periods) for the Arkansas River TMDL between Lake Creek and Pueblo Reservoir are in Figure 78 and Figure 79. The percent changes in streamflow are in Table 163. Maximum increases in wet period flows would change less than 5.5 percent for all alternatives compared to existing condition, similar to No Action. Wet period flows would increase less than 1 percent most of the time. Maximum decreases in dry period flows would change less than 3 percent for all alternatives compared to No Action. Dry period flows would increase most of the time.

Table 155. Simulated Median Streamflow at Arkansas River near Wellsville Gage – Direct Effects

Month	Existing Conditions	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Streamflow (cfs)								
Jan	258	255	252	253	257	253	252	249
Feb	168	164	164	165	164	166	164	161
Mar	141	137	138	138	143	138	137	135
Apr	173	179	174	175	184	175	174	174
May	626	628	624	624	630	624	624	624
Jun	1,419	1,396	1,399	1,402	1,397	1,404	1,397	1,403
Jul	774	777	775	776	780	775	775	776
Aug	532	537	537	537	540	536	536	538
Sep	186	193	192	192	193	192	192	192
Oct	154	156	155	155	155	155	155	155
Nov	186	185	184	184	185	184	184	183
Dec	207	204	205	204	204	205	205	204
Change in Streamflow Compared to No Action [cfs (%)]								
Jan	---	---	-3 (-1.2)	-2 (-0.8)	2 (0.8)	-2 (-0.8)	-3 (-1.2)	-6 (-2.4)
Feb	---	---	0 (0.0)	1 (0.6)	0 (0.0)	2 (1.2)	0 (0.0)	-3 (-1.8)
Mar	---	---	1 (0.7)	1 (0.7)	6 (4.4)	1 (0.7)	0 (0.0)	-2 (-1.5)
Apr	---	---	-5 (-2.8)	-4 (-2.2)	5 (2.8)	-4 (-2.2)	-5 (-2.8)	-5 (-2.8)
May	---	---	-4 (-0.6)	-4 (-0.6)	2 (0.3)	-4 (-0.6)	-4 (-0.6)	-4 (-0.6)
Jun	---	---	3 (0.2)	6 (0.4)	1 (0.1)	8 (0.6)	1 (0.1)	7 (0.5)
Jul	---	---	-2 (-0.3)	-1 (-0.1)	3 (0.4)	-2 (-0.3)	-2 (-0.3)	-1 (-0.1)
Aug	---	---	0 (0.0)	0 (0.0)	3 (0.6)	-1 (-0.2)	-1 (-0.2)	1 (0.2)
Sep	---	---	-1 (-0.5)	-1 (-0.5)	0 (0.0)	-1 (-0.5)	-1 (-0.5)	-1 (-0.5)
Oct	---	---	-1 (-0.6)	-1 (-0.6)	-1 (-0.6)	-1 (-0.6)	-1 (-0.6)	-1 (-0.6)
Nov	---	---	-1 (-0.5)	-1 (-0.5)	0 (0.0)	-1 (-0.5)	-1 (-0.5)	-2 (-1.1)
Dec	---	---	1 (0.5)	0 (0.0)	0 (0.0)	1 (0.5)	1 (0.5)	0 (0.0)
Change in Streamflow Compared to Existing Conditions [cfs (%)]								
Jan	---	-3 (-1.2)	-6 (-2.3)	-5 (-1.9)	-1 (-0.4)	-5 (-1.9)	-6 (-2.3)	-9 (-3.5)
Feb	---	-4 (-2.4)	-4 (-2.4)	-3 (-1.8)	-4 (-2.4)	-2 (-1.2)	-4 (-2.4)	-7 (-4.2)
Mar	---	-4 (-2.8)	-3 (-2.1)	-3 (-2.1)	2 (1.4)	-3 (-2.1)	-4 (-2.8)	-6 (-4.3)
Apr	---	6 (3.5)	1 (0.6)	2 (1.2)	11 (6.4)	2 (1.2)	1 (0.6)	1 (0.6)
May	---	2 (0.3)	-2 (-0.3)	-2 (-0.3)	4 (0.6)	-2 (-0.3)	-2 (-0.3)	-2 (-0.3)
Jun	---	-23 (-1.6)	-20 (-1.4)	-17 (-1.2)	-22 (-1.6)	-15 (-1.1)	-22 (-1.6)	-16 (-1.1)
Jul	---	3 (0.4)	1 (0.1)	2 (0.3)	6 (0.8)	1 (0.1)	1 (0.1)	2 (0.3)
Aug	---	5 (0.9)	5 (0.9)	5 (0.9)	8 (1.5)	4 (0.8)	4 (0.8)	6 (1.1)
Sep	---	7 (3.8)	6 (3.2)	6 (3.2)	7 (3.8)	6 (3.2)	6 (3.2)	6 (3.2)
Oct	---	2 (1.3)	1 (0.6)	1 (0.6)	1 (0.6)	1 (0.6)	1 (0.6)	1 (0.6)
Nov	---	-1 (-0.5)	-2 (-1.1)	-2 (-1.1)	-1 (-0.5)	-2 (-1.1)	-2 (-1.1)	-3 (-1.6)
Dec	---	-3 (-1.4)	-2 (-1.0)	-3 (-1.4)	-3 (-1.4)	-2 (-1)	-2 (-1.0)	-3 (-1.4)

Table 156. No Action Alternative Direct Effects on Upper Arkansas River Basin Segment 3 Cadmium TMDL

Month	Current TMDL - Cadmium						No Action Alternative					
	Median Flow (cfs)	Ambient Water Quality (μg/L)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)	Median Flow (cfs) (1)	Ambient Water Quality (μg/L) (2)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)
Jan	386	0.52	1.08	0.83	0.25	23	381	0.53	1.08	0.82	0.26	24
Feb	364	1.05	2.06	0.75	1.31	63	355	1.08	2.06	0.73	1.33	65
Mar	318	0.89	1.53	0.68	0.85	55	307	0.92	1.53	0.65	0.88	58
Apr	299	0.69	1.12	0.61	0.51	46	309	0.67	1.12	0.62	0.50	45
May	706	1.10	4.20	1.07	3.13	75	708	1.10	4.20	1.03	3.17	75
Jun	1,645	0.40	3.56	2.13	1.43	40	1,619	0.41	3.56	2.10	1.46	41
Jul	888	0.25	1.19	1.26	-0.07	0	892	0.25	1.19	1.30	0.00	0
Aug	657	0.35	1.23	1.25	-0.03	0	664	0.34	1.23	1.25	0.00	0
Sep	338	0.37	0.68	0.80	-0.12	0	352	0.36	0.68	0.80	0.00	0
Oct	356	0.49	0.95	0.79	0.16	17	359	0.49	0.95	0.79	0.16	16
Nov	403	0.32	0.69	0.85	-0.16	0	401	0.32	0.69	0.84	0.00	0
Dec	392	0.93	1.97	0.91	1.06	54	387	0.94	1.97	0.90	1.07	54

Notes:
(3) Alternative median flows (cfs) were calculated by multiplying the percent change between simulated existing conditions and alternative median flow to the current TMDL median flow.
(4) Alternative ambient water quality was calculated by multiplying the ratio of current TMDL and alternative median flow to the current TMDL ambient water quality.

Table 157. Comanche North Alternative Direct Effects on Upper Arkansas River Basin Segment 3 Cadmium TMDL

Month	Current TMDL - Cadmium						Comanche North Alternative					
	Median Flow (cfs)	Ambient Water Quality (μg/L)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)	Median Flow (cfs) (1)	Ambient Water Quality (μg/L) (2)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)
Jan	386	0.52	1.08	0.83	0.25	23	377	0.53	1.08	0.81	0.27	25
Feb	364	1.05	2.06	0.75	1.31	63	355	1.07	2.06	0.73	1.33	65
Mar	318	0.89	1.53	0.68	0.85	55	309	0.92	1.53	0.65	0.88	57
Apr	299	0.69	1.12	0.61	0.51	46	300	0.69	1.12	0.60	0.52	46
May	706	1.10	4.20	1.07	3.13	75	704	1.11	4.20	1.02	3.18	76
Jun	1,645	0.40	3.56	2.13	1.43	40	1,622	0.41	3.56	2.10	1.46	41
Jul	888	0.25	1.19	1.26	-0.07	0	889	0.25	1.19	1.29	0.00	0
Aug	657	0.35	1.23	1.25	-0.03	0	664	0.34	1.23	1.25	0.00	0
Sep	338	0.37	0.68	0.80	-0.12	0	350	0.36	0.68	0.79	0.00	0
Oct	356	0.49	0.95	0.79	0.16	17	358	0.49	0.95	0.79	0.16	17
Nov	403	0.32	0.69	0.85	-0.16	0	399	0.32	0.69	0.84	0.00	0
Dec	392	0.93	1.97	0.91	1.06	54	388	0.94	1.97	0.90	1.07	54

Notes:
(5) Alternative median flows (cfs) were calculated by multiplying the percent change between simulated existing conditions and alternative median flow to the current TMDL median flow.
(6) Alternative ambient water quality was calculated by multiplying the ratio of current TMDL and alternative median flow to the current TMDL ambient water quality.

Table 158. Pueblo Dam South Alternative Direct Effects on Upper Arkansas River Basin Segment 3 Cadmium TMDL

Month	Current TMDL - Cadmium						Pueblo Dam South Alternative					
	Median Flow (cfs)	Ambient Water Quality (µg/L)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)	Median Flow (cfs) [(1)]	Ambient Water Quality (µg/L) [(2)]	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)
Jan	386	0.52	1.08	0.83	0.25	23	378	0.53	1.08	0.81	0.27	25
Feb	364	1.05	2.06	0.75	1.31	63	357	1.07	2.06	0.73	1.33	65
Mar	318	0.89	1.53	0.68	0.85	55	309	0.92	1.53	0.65	0.88	57
Apr	299	0.69	1.12	0.61	0.51	46	302	0.69	1.12	0.60	0.52	46
May	706	1.10	4.20	1.07	3.13	75	703	1.11	4.20	1.02	3.18	76
Jun	1,645	0.40	3.56	2.13	1.43	40	1,626	0.41	3.56	2.10	1.46	41
Jul	888	0.25	1.19	1.26	-0.07	0	890	0.25	1.19	1.30	0.00	0
Aug	657	0.35	1.23	1.25	-0.03	0	663	0.34	1.23	1.25	0.00	0
Sep	338	0.37	0.68	0.80	-0.12	0	350	0.36	0.68	0.79	0.00	0
Oct	356	0.49	0.95	0.79	0.16	17	357	0.49	0.95	0.79	0.16	17
Nov	403	0.32	0.69	0.85	-0.16	0	398	0.32	0.69	0.84	0.00	0
Dec	392	0.93	1.97	0.91	1.06	54	387	0.94	1.97	0.90	1.07	54

Notes:
(1) Alternative median flows (cfs) were calculated by multiplying the percent change between simulated existing conditions and alternative median flow to the current TMDL median flow.
(2) Alternative ambient water quality was calculated by multiplying the ratio of current TMDL and alternative median flow to the current TMDL ambient water quality.

Table 159. JUP North Alternative Direct Effects on Upper Arkansas River Basin Segment 3 Cadmium TMDL

Month	Current TMDL - Cadmium						JUP North Alternative					
	Median Flow (cfs)	Ambient Water Quality (µg/L)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)	Median Flow (cfs) [(1)]	Ambient Water Quality (µg/L) [(2)]	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)
Jan	386	0.52	1.08	0.83	0.25	23	384	0.52	1.08	0.83	0.25	23
Feb	364	1.05	2.06	0.75	1.31	63	355	1.08	2.06	0.73	1.33	65
Mar	318	0.89	1.53	0.68	0.85	55	322	0.88	1.53	0.68	0.85	56
Apr	299	0.69	1.12	0.61	0.51	46	317	0.66	1.12	0.63	0.49	44
May	706	1.10	4.20	1.07	3.13	75	710	1.10	4.20	1.03	3.17	75
Jun	1,645	0.40	3.56	2.13	1.43	40	1,619	0.41	3.56	2.10	1.46	41
Jul	888	0.25	1.19	1.26	-0.07	0	895	0.25	1.19	1.30	0.00	0
Aug	657	0.35	1.23	1.25	-0.03	0	667	0.34	1.23	1.26	0.00	0
Sep	338	0.37	0.68	0.80	-0.12	0	352	0.36	0.68	0.80	0.00	0
Oct	356	0.49	0.95	0.79	0.16	17	358	0.49	0.95	0.79	0.16	17
Nov	403	0.32	0.69	0.85	-0.16	0	401	0.32	0.69	0.84	0.00	0
Dec	392	0.93	1.97	0.91	1.06	54	387	0.94	1.97	0.90	1.07	54

Notes:
(1) Alternative median flows (cfs) were calculated by multiplying the percent change between simulated existing conditions and alternative median flow to the current TMDL median flow.
(2) Alternative ambient water quality was calculated by multiplying the ratio of current TMDL and alternative median flow to the current TMDL ambient water quality.

Table 160. Pueblo Dam North Alternative Direct Effects on Upper Arkansas River Basin Segment 3 Cadmium TMDL

Month	Current TMDL - Cadmium						Pueblo Dam North Alternative					
	Median Flow (cfs)	Ambient Water Quality (µg/L)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)	Median Flow (cfs) (1)	Ambient Water Quality (µg/L) (2)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)
Jan	386	0.52	1.08	0.83	0.25	23	378	0.53	1.08	0.81	0.27	25
Feb	364	1.05	2.06	0.75	1.31	63	359	1.06	2.06	0.74	1.32	64
Mar	318	0.89	1.53	0.68	0.85	55	310	0.91	1.53	0.65	0.88	57
Apr	299	0.69	1.12	0.61	0.51	46	302	0.69	1.12	0.60	0.52	46
May	706	1.10	4.20	1.07	3.13	75	703	1.11	4.20	1.02	3.18	76
Jun	1,645	0.40	3.56	2.13	1.43	40	1,628	0.41	3.56	2.11	1.45	41
Jul	888	0.25	1.19	1.26	-0.07	0	890	0.25	1.19	1.30	0.00	0
Aug	657	0.35	1.23	1.25	-0.03	0	663	0.34	1.23	1.25	0.00	0
Sep	338	0.37	0.68	0.80	-0.12	0	350	0.36	0.68	0.79	0.00	0
Oct	356	0.49	0.95	0.79	0.16	17	357	0.49	0.95	0.79	0.16	17
Nov	403	0.32	0.69	0.85	-0.16	0	399	0.32	0.69	0.84	0.00	0
Dec	392	0.93	1.97	0.91	1.06	54	387	0.94	1.97	0.90	1.07	54

Notes:

(1) Alternative median flows (cfs) were calculated by multiplying the percent change between simulated existing conditions and alternative median flow to the current TMDL median flow.

(2) Alternative ambient water quality was calculated by multiplying the ratio of current TMDL and alternative median flow to the current TMDL ambient water quality.

Table 161. River South Alternative Direct Effects on Upper Arkansas River Basin Segment 3 Cadmium TMDL

Month	Current TMDL - Cadmium						River South Alternative					
	Median Flow (cfs)	Ambient Water Quality (µg/L)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)	Median Flow (cfs) (1)	Ambient Water Quality (µg/L) (2)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)
Jan	386	0.52	1.08	0.83	0.25	23	376	0.53	1.08	0.81	0.27	25
Feb	364	1.05	2.06	0.75	1.31	63	355	1.07	2.06	0.73	1.33	65
Mar	318	0.89	1.53	0.68	0.85	55	308	0.92	1.53	0.65	0.88	58
Apr	299	0.69	1.12	0.61	0.51	46	300	0.69	1.12	0.60	0.52	47
May	706	1.10	4.20	1.07	3.13	75	704	1.11	4.20	1.02	3.18	76
Jun	1,645	0.40	3.56	2.13	1.43	40	1,620	0.41	3.56	2.10	1.46	41
Jul	888	0.25	1.19	1.26	-0.07	0	890	0.25	1.19	1.30	0.00	0
Aug	657	0.35	1.23	1.25	-0.03	0	663	0.34	1.23	1.25	0.00	0
Sep	338	0.37	0.68	0.80	-0.12	0	350	0.36	0.68	0.79	0.00	0
Oct	356	0.49	0.95	0.79	0.16	17	357	0.49	0.95	0.79	0.16	17
Nov	403	0.32	0.69	0.85	-0.16	0	399	0.32	0.69	0.84	0.00	0
Dec	392	0.93	1.97	0.91	1.06	54	387	0.94	1.97	0.90	1.07	54

Notes:

(1) Alternative median flows (cfs) were calculated by multiplying the percent change between simulated existing conditions and alternative median flow to the current TMDL median flow.

(2) Alternative ambient water quality was calculated by multiplying the ratio of current TMDL and alternative median flow to the current TMDL ambient water quality.

Table 162. Master Contract Only Alternative Direct Effects on Upper Arkansas River Basin Segment 3 Cadmium TMDL

Month	Current TMDL - Cadmium						Master Contract Only Alternative					
	Median Flow (cfs)	Ambient Water Quality (µg/L)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)	Median Flow (cfs) (1)	Ambient Water Quality (µg/L) (2)	Existing Load (lbs/day)	TMDL (lbs/ day)	Reduction to Meet TMDL (lbs/day)	Reduction to Meet TMDL (%)
Jan	386	0.52	1.08	0.83	0.25	23	373	0.54	1.08	0.80	0.28	26
Feb	364	1.05	2.06	0.75	1.31	63	349	1.09	2.06	0.72	1.34	65
Mar	318	0.89	1.53	0.68	0.85	55	303	0.94	1.53	0.64	0.89	58
Apr	299	0.69	1.12	0.61	0.51	46	301	0.69	1.12	0.60	0.52	46
May	706	1.10	4.20	1.07	3.13	75	703	1.11	4.20	1.02	3.18	76
Jun	1,645	0.40	3.56	2.13	1.43	40	1,627	0.41	3.56	2.11	1.45	41
Jul	888	0.25	1.19	1.26	-0.07	0	890	0.25	1.19	1.30	0.00	0
Aug	657	0.35	1.23	1.25	-0.03	0	664	0.34	1.23	1.25	0.00	0
Sep	338	0.37	0.68	0.80	-0.12	0	350	0.36	0.68	0.79	0.00	0
Oct	356	0.49	0.95	0.79	0.16	17	357	0.49	0.95	0.79	0.16	17
Nov	403	0.32	0.69	0.85	-0.16	0	398	0.32	0.69	0.84	0.00	0
Dec	392	0.93	1.97	0.91	1.06	54	387	0.94	1.97	0.90	1.07	54

Notes:
(1) Alternative median flows (cfs) were calculated by multiplying the percent change between simulated existing conditions and alternative median flow to the current TMDL median flow.
(2) Alternative ambient water quality was calculated by multiplying the ratio of current TMDL and alternative median flow to the current TMDL ambient water quality.

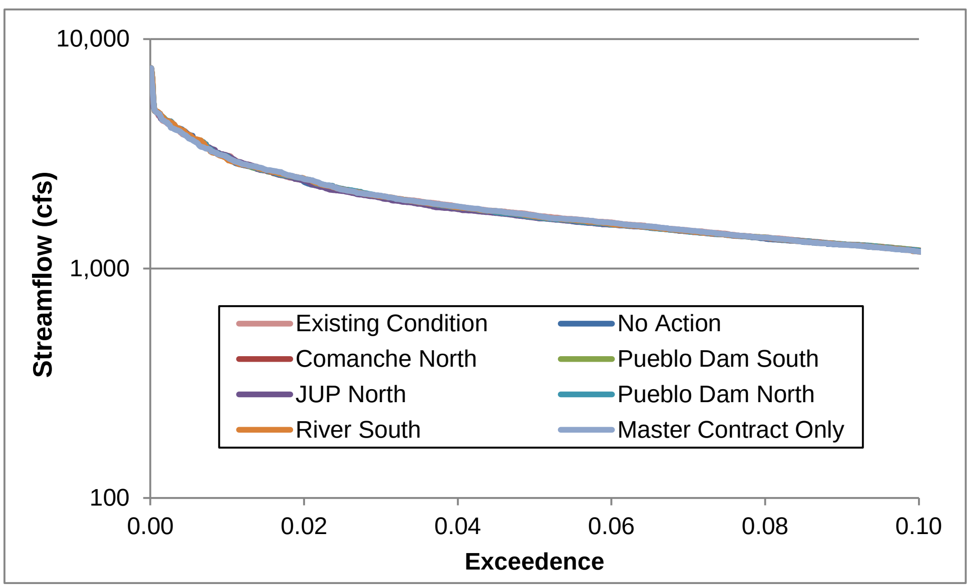


Figure 78. Wet Period Flows at Arkansas River near Wellsville Gage

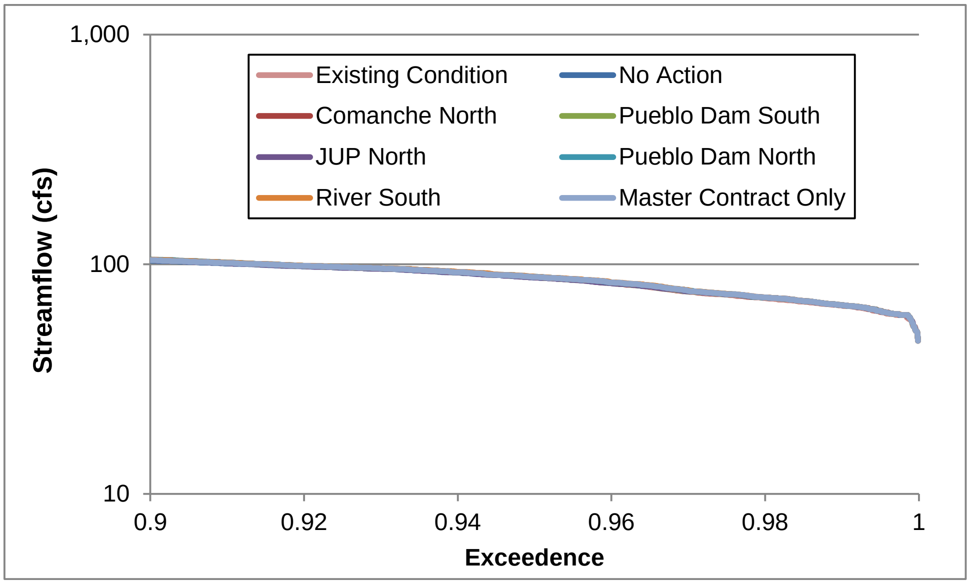


Figure 79. Dry Period Flows at Arkansas River near Wellsville Gage

Table 163. Changes in Critical Condition Flows at Arkansas River near Wellsville Gage

Percent Changes in Flow Compared to Existing Conditions	No Action (1)	Comanche North (2)	Pueblo Dam South	JUP North (2)	Pueblo Dam North (2)	River South (2)	Master Contract Only (2)
Wet Period (< 10 % exceedence)							
Mean	-0.8	-0.3	-0.4	-1.0	-0.3	-0.2	-0.2
Maximum decrease in flow	-7.6	-3.8	-3.0	-5.3	-3.5	-4.7	-7.6
5th Percentile	-2.2	-1.7	-1.5	-2.8	-1.7	-1.3	-1.0
25th Percentile	-1.4	-1.1	-1.0	-2.1	-1.1	-0.8	-0.5
Median	-0.9	-0.5	-0.6	-1.2	-0.4	-0.5	-0.2
75th Percentile	-0.5	0.2	0.0	-0.1	0.2	-0.1	0.0
95th Percentile	1.9	1.5	1.5	1.2	1.8	2.0	1.6
Maximum increase in flow	4.4	5.5	5.1	3.3	5.5	5.2	3.8
Dry Period (> 90 % exceedence)							
Mean	0.0	0.5	0.2	0.1	0.6	0.7	0.4
Maximum decrease in flow	-1.5	-2.8	-2.8	-1.4	-2.8	-2.8	-2.8
5th Percentile	-0.9	0.0	-0.4	-0.8	0.0	0.0	-0.2
25th Percentile	-0.4	0.2	-0.1	-0.3	0.3	0.3	0.0
Median	-0.2	0.5	0.2	0.0	0.6	0.6	0.3
75th Percentile	0.5	0.8	0.5	0.5	0.9	0.9	0.8
95th Percentile	1.0	1.3	1.0	0.9	1.5	1.6	1.4
Maximum increase in flow	3.2	3.2	3.2	2.8	3.2	3.2	3.2

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Appendix G.1 - Geomorphology Effects

Contents

Tables

Figures

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Introduction

Appendix G supplements the Chapter 4 – *Geomorphology* section in the EIS. This appendix contains further information on methodology and quantitative effects of alternatives on Lower Arkansas River and Fountain Creek geomorphology.

Geomorphology is the study of landforms and the processes that shape them. In this analysis, geomorphology is specific to stream channels where changes in discharge may affect sediment transport, erosion, sedimentation, and other processes that affect stream channel characteristics and stability. Geomorphic effects could potentially occur at any location in the study area where there is a change in hydrology, sediment inflow, or channel geometry. Geomorphic effects would include bank and channel bed erosion (collectively called erosion or degradation) and sediment deposition (also referred to as sedimentation or aggradation). Changes in discharge from the alternatives could affect sediment transport, erosion, sedimentation, and other processes potentially altering channel characteristics and stability resulting in erosion/sedimentation, changes in stream meander patterns, or reduced water quality.

Although there are no specific geomorphic related regulatory requirements, related regulatory requirements discussed in other sections of this EIS may indirectly apply to geomorphology (e.g., changes in sediment concentrations or channel stability could affect water quality regulated under the Clean Water Act or habitat for species regulated under the Endangered Species Act).

Study Area

The analysis area for geomorphology generally encompasses the stream systems identified in the surface water hydrology study area (Appendix D.3 and Appendix D.5), with the following exceptions:

- Reservoirs identified in the surface water hydrology study area are not included in the geomorphology study area.
- The Arkansas River between Pueblo Reservoir and Fountain Creek was not included because the channel is predominantly lined or otherwise

Aggradation is the accumulation of sediment in a stream channel resulting in reduced channel capacity.

Channel form is the shape and pattern of the path of the stream channel and its cross section.

Degradation is the erosion of sediment from the channel.

Discharge is the streamflow in a stream channel.

Entrenchment is the ratio of the stream width at flood conditions to the width at bankfull flow.

Sediment load is the sediment discharge or sediment concentration within the flowing water.

Sediment transport capacity is the amount of potential sediment that can be transported by flowing water given adequate sediment supply.

Stream power is a measure of energy of the flow of water in a stream, and is commonly used to estimate the magnitude of sediment transport capacity of flowing water.

Stream sinuosity is the length of a stream segment (following the path of water through stream meanders) divided by the length of the valley that the stream flows through. Higher sinuosity indicates a twisted or curvy channel form.

stabilized and would not be affected by changes in discharge (U.S. Army Corps of Engineers 2001).

- The Arkansas River downstream from John Martin Reservoir is not included in the analysis area because changes in hydrology downstream from John Martin Reservoir would be predominately negligible (Appendix D.5).
- West Slope stream geomorphology was not evaluated because West Slope streams are steeply sloped, cobble-bed streams with limited mobile sediment and would be generally unaffected by small hydrology effects reported in this Chapter 4 – *Surface Water Hydrology* (Reclamation 2008).

The study area streams were divided into geographical reaches as described below.

Arkansas River Upstream from Pueblo Reservoir

The perennial streams composing the Arkansas River headwaters are supplied by snow melting in mountains surrounding the area of Leadville, Colorado (Abbott 1985). Upstream from Pueblo Reservoir the Arkansas River is a single channel stream with moderate entrenchment characterized by steep gradient, high-velocity flows confined to a relatively narrow rock and cobble stream bed and abundant riparian vegetation. East of Cañon City, river gradient decreases as it flows out of the mountains to Pueblo Reservoir. This geographical reach also includes Lake Creek between Twin Lakes and the confluence with the Arkansas River, which varies from a sand bed, slightly entrenched stream upstream, to a gravel/boulder, moderately entrenched stream in the lower portion. The transition from a sand bed stream to a gravel and boulder stream is likely a result of an increase in stream slope from upstream to downstream.

Arkansas River Downstream from Fountain Creek

The Arkansas River, downstream from its confluence with Fountain Creek, is primarily an alluvial sand-bed stream with notable meandering and slight entrenchment. The bottom width varies from 100 to 250 feet (U.S. Army Corps of Engineers 2009). Photo 1 shows the Arkansas River at the USGS Rocky Ford Gaging Station. Riparian vegetation plays a significant role in geomorphic stability for sand bed streams within the analysis area (i.e., Fountain Creek and the Arkansas River downstream from Fountain Creek).

Source: Livingston 2011
Photo 1. Arkansas River at Gaging Station ARKROCCO, Arkansas River at Rocky Ford, Colorado

Fountain Creek

Fountain Creek is primarily an alluvial sandbed stream with notable meandering and bank storage with slight to moderate entrenchment. The width of Fountain Creek varies from 100 to 250 feet with side slopes of 3H:1V (horizontal to vertical distance ratio). The Fountain Creek Watershed Study noted historical changes in channel form for Fountain Creek and the Arkansas River downstream from Fountain Creek. The changes in channel form are likely a result of channel migration over time, indicating the susceptibility of these reaches for geomorphic change as a result of changes in discharge.

Methods and Analysis

Fluvial geomorphology is a complex science based on the interaction between streamflow and sediment transport. Detailed geomorphic analyses typically involve comprehensive sediment transport modeling that can be data and time intensive. A calibrated sediment transport model would produce more detailed predictions of long-term effects, but was not completed for this analysis because adequate sediment transport data were not available to develop and calibrate such a model and because uncertainty with the model results would still exist from the complex nature of geomorphic interactions. Because the extensive data required for detailed sediment transport analysis were not available to for this analysis, indirect methods were selected to evaluate potential geomorphic effects (i.e., approximate differences in geomorphic properties were estimated among alternatives).

The objective of this analysis is to evaluate the potential geomorphic effects (erosion and deposition) on study area streams caused by hydrologic effects. Potential changes in geomorphology were evaluated using:

- Rosgen Stream Classification System
- Changes in mobile grain size during baseflow conditions.

The sediment transport capacity and loadings at peak flows were not evaluated because the alternatives' effects on flood hydrology and floodplains would be negligible (Reclamation 2011). Potential change in flood flow would vary from a 0.1 percent increase to a 1.4 percent decrease for the Q_2, Q_{10}, and Q_{100} peak flows, which would cause a potential maximum change in flow depth of less than ½ inch for all gage locations, with the largest effects immediately downstream from Pueblo Dam. These amounts could be considered within the margin of error for determining flood hydrology and floodplains. Since anticipated changes in flood hydrology are negligible, there would be no measurable effect on floodplain width or stage caused by changes in peak flows.

Rosgen Stream Classification System

The Rosgen Stream Classification Method (Rosgen 1996) is the most widely used stream classification system in the United States. Figure 1 shows the Rosgen Classification Key for Natural Streams. Streams are grouped into categories A through G based on the water surface slope, entrenchment, width/depth ratio, and sinuosity. Using dominate stream bed particle size, each category is further refined into six sub-classes, 1 (bedrock) to 6 (silt/clay). Rosgen Stream Classifications for study area streams were obtained from both the Southern Delivery System EIS (Reclamation 2008) and Fountain Creek Watershed Study (U.S. Army Corps of Engineers 2009), and are in Figure 2.

The Rosgen Stream Classification System, along with pebble count and stream cross sections data (Reclamation 2008), were used to perform an initial screening of study area stream segments to identify segments that may be geomorphically sensitive to changes in discharge associated with the alternatives. In general, geomorphically sensitive segments have low to moderate entrenchment and/or sand or gravel bed material. These segments have the capability of being eroded and changing meander patterns as a result of changes in hydrology. Based on this initial screening, the potential geomorphically sensitive segments comprising the analysis include: the Arkansas River from Highway 115 to the inlet to Pueblo Reservoir; Fountain Creek from the City of Fountain to the Arkansas River confluence; and the Arkansas River from the Fountain Creek mouth to the Avondale Gage. The characteristics of these potential geomorphic sensitive stream segments are listed in Table 1 and the locations are in Figure 3. The remainder of the analysis will be limited to these potentially geomorphically sensitive segments.

Table 1. Characteristics of Potential Geomorphic Sensitive Arkansas River Basin Area Streams

Stream Segment	Geomorphic Parameter		
	Channel Material	Entrenchment	Riparian Vegetation Affects Stability
Arkansas River from Colorado 115 to Pueblo Reservoir	Gravel	Moderate	No
Fountain Creek from City of Fountain to Arkansas River	Sand	Slight/Moderate	Yes
Arkansas River from Fountain Creek to Avondale Gage	Sand	Slight	Yes

On identifying potential geomorphically sensitive streams, the Rosgen Stream Classification System parameters (width to depth ratio, sinuosity, channel slope, and channel bed material) were further analyzed using cross sectional survey data (LDC 2006) and satellite imagery and are summarized in Table 2, along with the recommended Rosgen classification ranges for each parameter and stream type. Although the Rosgen Stream Classification System uses channel forming discharge (effective discharge, approximately equal to the two-year flood event), the results from this analysis were further defined to evaluate if any stream segments were close to a potential geomorphic threshold, indicating a potential change from one Rosgen stream type to another under changing discharge conditions.

As presented in Table 2, no parameters used to classify the stream segments would be close to the outside of their respective ranges, therefore, existing Rosgen Stream Classifications would not likely change from one classification to another as a result of minor changes in discharge associated with the alternatives. In addition, as mentioned previously, changes in discharge associated with the alternatives would not affect the flood hydrology, which confirms that the Rosgen classifications should not change as a result of minor changes in discharge for study area streams.

Table 2. Summary of Estimated Rosgen Stream Classification Parameters for Study Area

Stream Segment	Rosgen Stream Type	Sinuosity		Slope		Width / Depth	
		Estimated	Rosgen Range [1]	Estimated	Rosgen Range [1]	Estimated	Rosgen Range [1]
Fountain Creek from Fountain to Pinion Gage	C4	1.47	> 1.2	0.0045	0.001 – 0.02	33	> 12
Fountain Creek from Pinion to Pueblo Gage	C4	1.30	> 1.2	0.0039	0.001 – 0.02	40	> 12
Arkansas River – Colorado 115 to Pueblo Reservoir	B4c	1.30	> 1.2	0.00507	< 0.02	21	> 12
Arkansas River - Fountain Creek to Avondale Gage	D5	1.36	n/a	0.00192	0.001 – 0.02	75	> 40

Notes:
(1) From Applied River Morphology (Rosgen 1996).

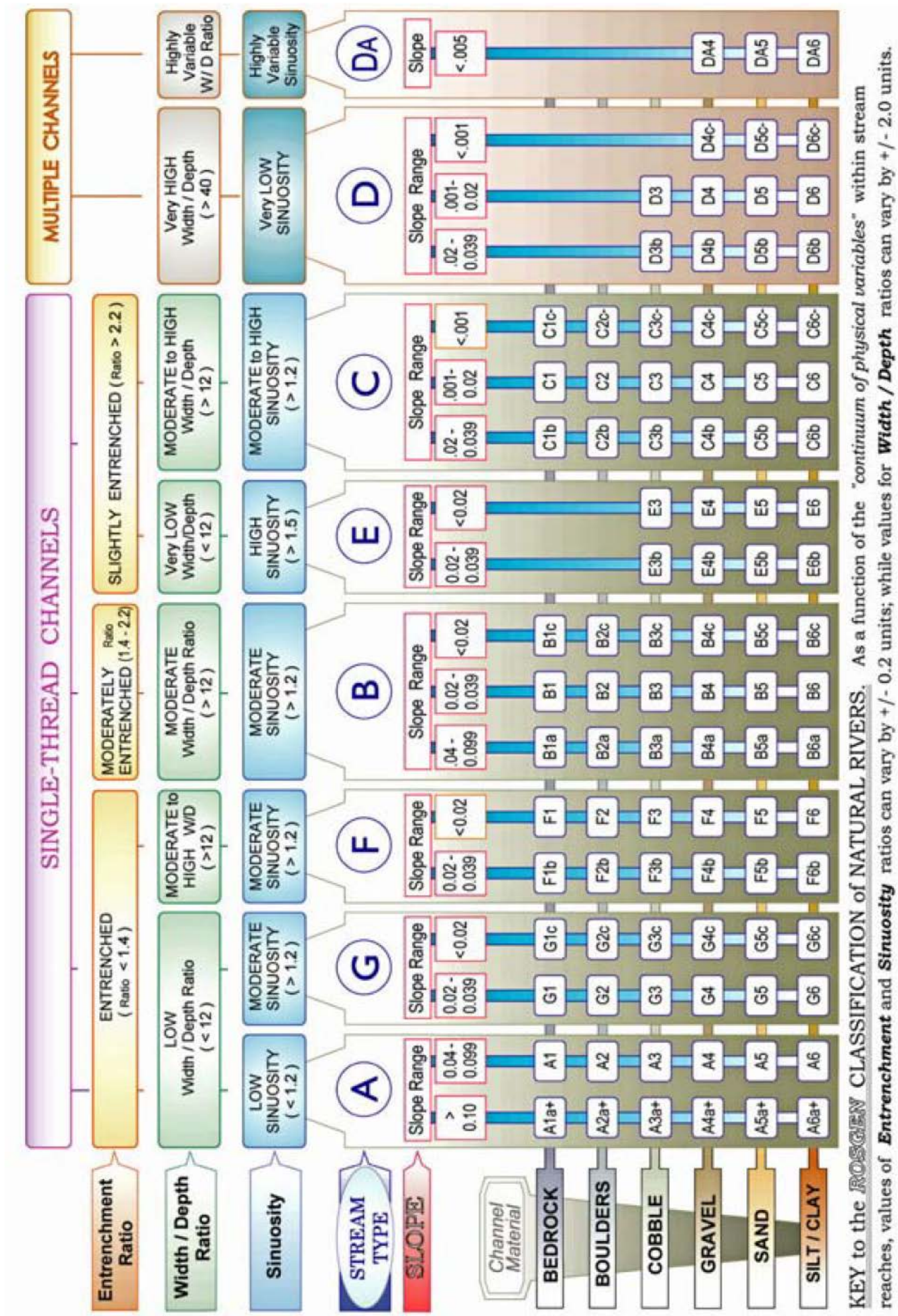


Figure 1. Rosgen Classification Key for Natural Streams

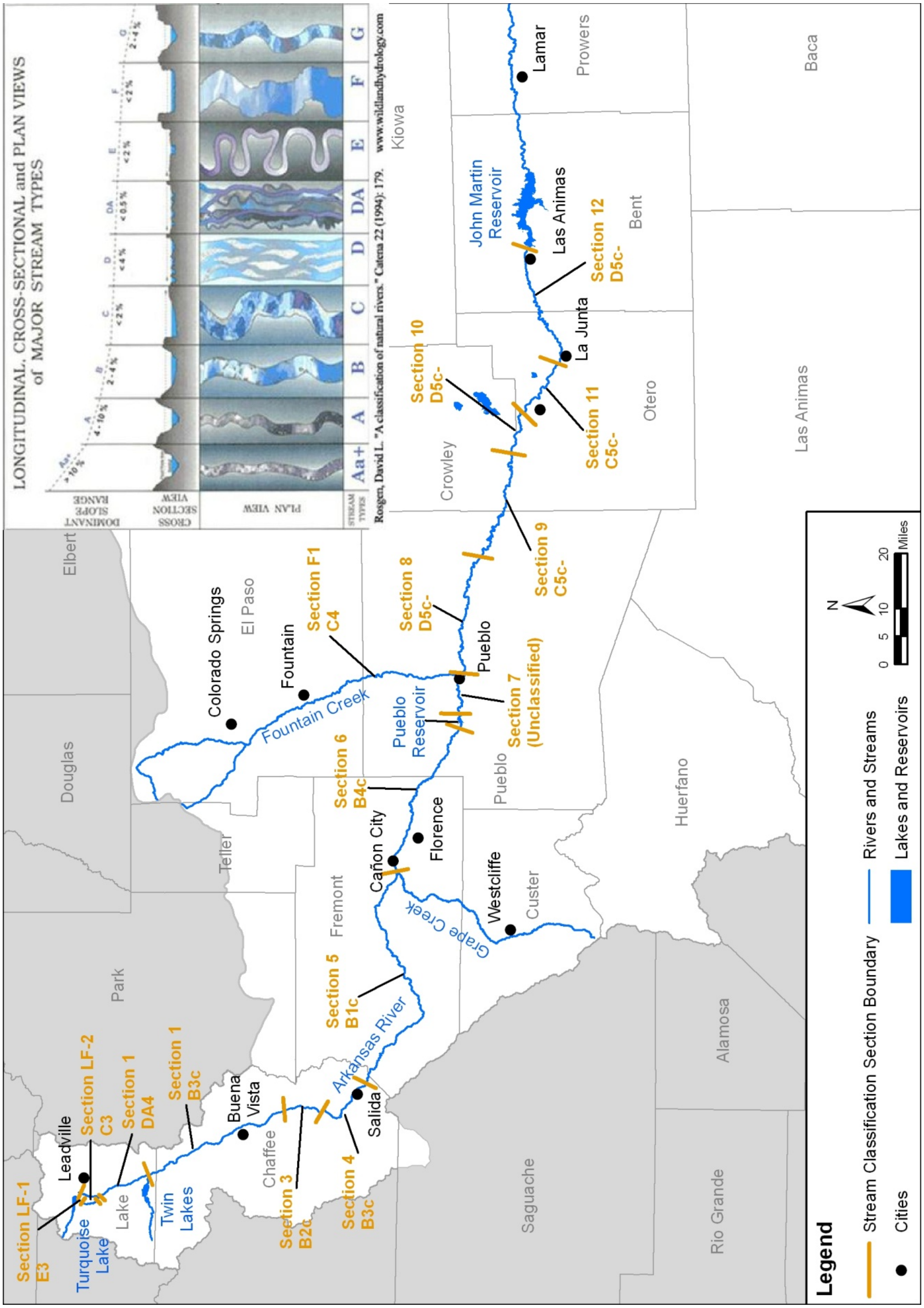


Figure 2. Arkansas River Basin Stream Segment Classifications

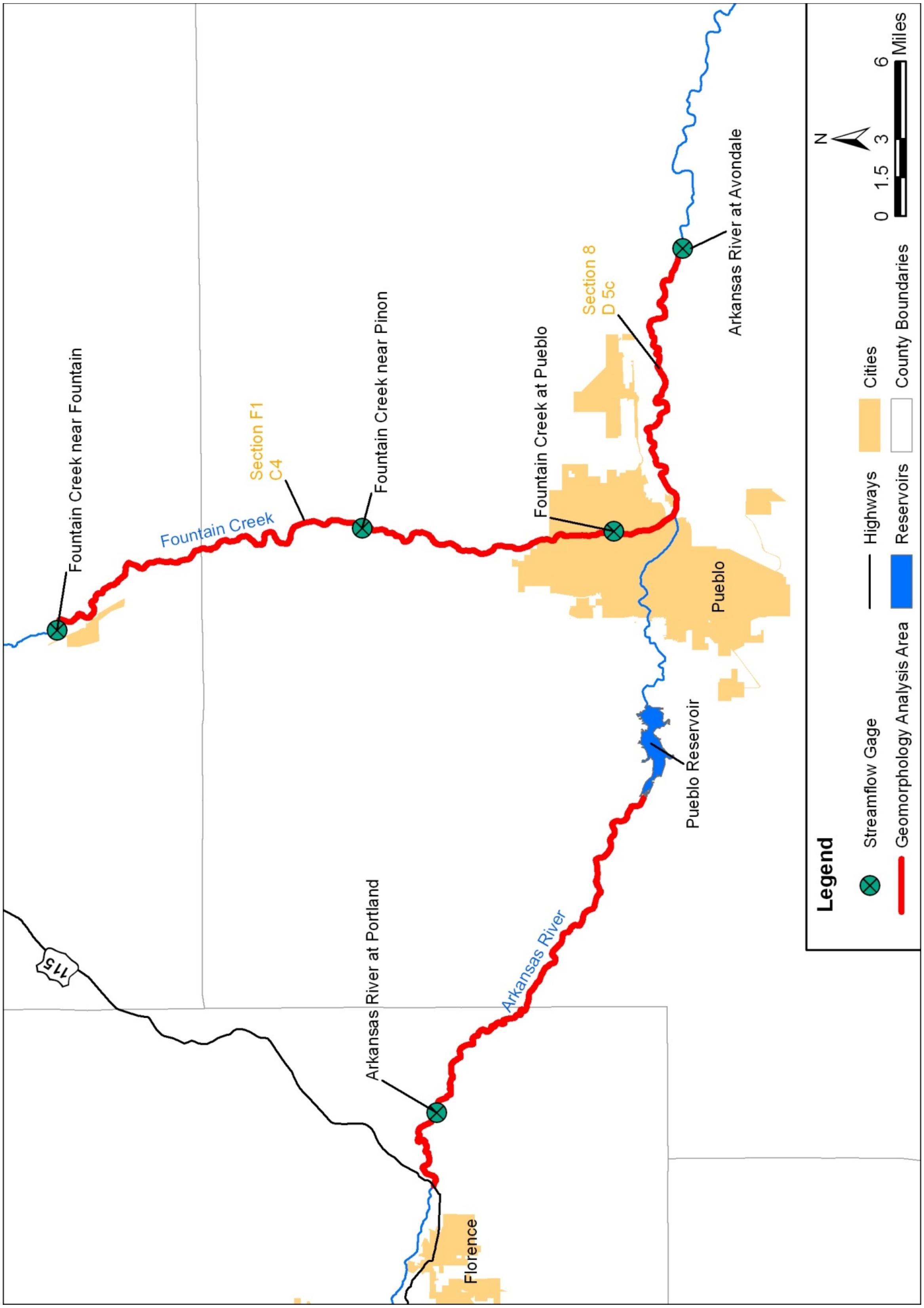


Figure 3. Geomorphic Effects Analysis Area

Mobile Grain Size Analysis

Changes in the sizes of sediment particles that can be transported at baseflows could cause a gradual, long-term geomorphic change. Baseflow is streamflow that occurs at low flow conditions as a result of soil moisture, ground water inflow, and wastewater effluent. Baseflow was estimated as the average daily flow from December through February (the winter period represents baseflows not associated with storm water runoff) for calculations of baseflow mobile grain size. Baseflow is considered to be a primary influence on long-term gradual transport of sediment on Fountain Creek, especially the finer portion of the sediment (e.g., suspended load and the finer material in the bed load) (Stogner 2000). Mobile grain size was evaluated using the critical Shields Parameter (Meyer-Peter and Muller 1948; Gessler 1965), which uses Equation 1 to calculate the largest sediment particle that would move at any given streamflow.

Equation 1

$$\theta = \left[\frac{\tau}{g \cdot \rho \left(\frac{\rho_s}{\rho} - 1 \right) \cdot D_{50}} \right]$$

Where,

θ = Shields parameter
g = gravity
ρ_s = sediment density
ρ = fluid density
D_{50} = median particle diameter
τ = shear stress

The Shields parameter was developed by Shields (1936) as a function of shear stress, fluid density, sediment density, and sediment size (D_{50}). Critical shear stress for incipient motion (the point where sediment is mobilized) occurs when the Shields parameter reaches the value 0.047. Shear stress was calculated using the Equation 2.

Equation 2

$$\tau = \gamma \cdot R \cdot S$$

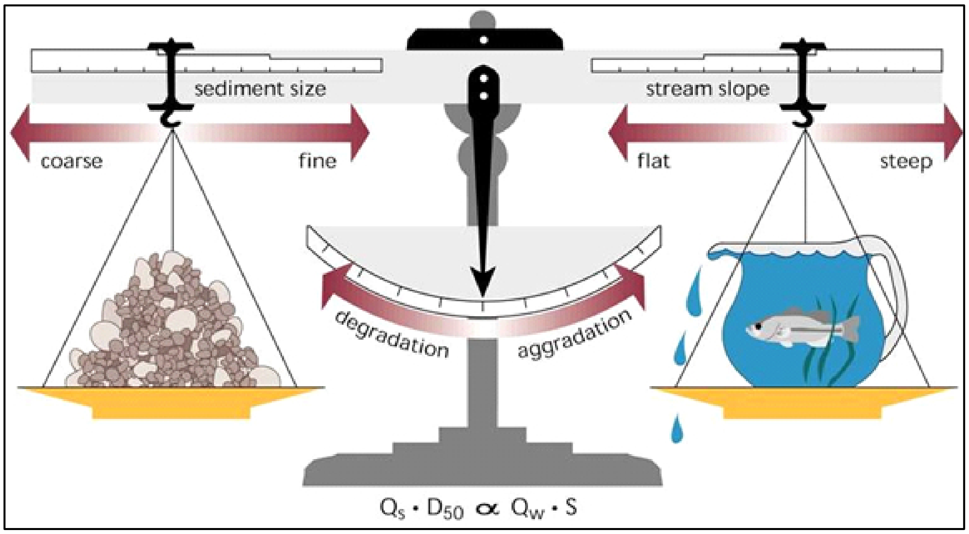
Where,

τ = wall shear stress
γ = specific weight of water
R = hydraulic radius
S = channel slope

Equation 1 was rearranged to solve for D_{50} to calculate the grain size transported at incipient motion (mobile grain size) for the baseflow condition. The hydraulic radius was calculated by using a stage discharge relationship developed from the Flowmaster at each cross section.

Evaluation of Results

Several uncertainties are associated with the geomorphic effects analysis. The effects described in this analysis are large-scale effects averaged for a stream segment. It is not possible to evaluate effects at an exact location using the methods for this analysis. Evaluating effects for a given location would require a calibrated sediment transport model and a large amount of sediment transport data that were not available for this analysis. Additionally, long-term dynamic changes that would occur as streams attempt to adjust to a new geomorphic equilibrium were estimated with the conceptual model in Figure 4. Short-term geomorphic analyses results (i.e., predictions of erosion or sedimentation) were considered in the context of the conceptual model to predict long-term geomorphic adjustments. These long-term effects should be considered as approximations of gross-scale effects that would occur, and specific long-term effects may vary from segment to segment.



Source: Natural Resources Conservation Service 1998

Criteria for Determining Significance of Effects

Linear relationships between the percent change in baseflow mobile grain size and the classification of geomorphic effects were assumed in developing the effects significance in Table 3. The intensity of geomorphic effects (e.g., minor versus major) was based on professional judgment using knowledge of study area streams.

Table 3. Intensity of Geomorphology Effects Based on Changes in Baseflow Mobile Grain Size

Effect Intensity [1]	Intensity Description
Negligible	The alternative would change geomorphic conditions, but the change would be so small that it would be immeasurable or imperceptible. The change would be within accuracies of calculation methods used to estimate sediment transport and other geomorphic characteristics. Effects on baseflow mobile grain size would less than 5 percent.
Minor	The alternative would cause a measureable change to geomorphic conditions, but the change would be small, localized, and of little consequence. The geomorphic condition would not affect other downstream reaches - any changes in sediment transport capacity or other geomorphic characteristics would be limited to a single reach. Effects on baseflow mobile grain size would be between 5 and 10 percent.
Moderate	The alternative would cause a measureable and consequential change to geomorphic conditions, but would be limited to existing areas of geomorphic instability and would not affect other downstream locations. Changes in sediment transport capacity or other geomorphic characteristics would be limited to existing locations of geomorphic instabilities. These areas of geomorphic instabilities would be covered under existing plans to improve geomorphic conditions within study area streams. Effects on baseflow mobile grain size would be between 10 and 15 percent.
Major	The alternative would cause a large, measurable, consequential change to geomorphic conditions. Changes in sediment transport capacity or other geomorphic characteristics would occur consistently at locations outside of existing locations of geomorphic instabilities. Geomorphic conditions would be exacerbated over a wide area and introduce new reaches of streams to geomorphic instabilities (erosion or sediment deposition) that were previously considered stable and not covered under existing plans to improve geomorphic conditions within study area streams. Effects on baseflow mobile grain size would be between greater than 15 percent.

Notes:
(1) Effects are relative to the No Action Alternative.

Results

Direct, indirect, and cumulative effects of alternatives on geomorphology, along with actions to minimize effects, are presented in this section. AVC and Master Contract operations would directly and indirectly affect geomorphology because of streamflow changes in sensitive stream segments. These same operations, along with other reasonably foreseeable actions, would cumulatively affect geomorphology.

As previously described, the analysis focused on large-scale geomorphic processes for stream reaches, but does not predict effects at point locations where local controls would play an important part in determining thresholds for estimating the degree of geomorphic effects.

Effects on geomorphic stability associated with changes to riparian vegetation were qualitatively considered. Erosion of channel banks could occur as a result of reduced riparian vegetation, especially in streams with sand and gravel bed material (e.g., Fountain Creek and the Arkansas River downstream from Fountain Creek). Riparian vegetation would not have a substantial effect on geomorphic stability in stream segments with more cohesive bed material such as bedrock. Overall effects on riparian vegetation would be negligible.

Direct and Indirect Effects

Differences in hydrology among the alternatives generally would result in effects on geomorphology when compared to the No Action Alternative and existing conditions. Effects on baseflow for all alternatives relative to both the No Action Alternative and existing conditions are in Table 4 and geomorphic effects of changes in mobile grain size relative to the No Action Alternative and existing conditions are in Table 5.

Arkansas River Upstream from Pueblo Reservoir

There would be negligible effects for the alternatives relative to the No Action Alternative along the Arkansas River from Highway 115 to Pueblo Reservoir, with estimated changes in mobile grain size ranging from -0.4 to 0.0 percent.

The estimated changes in mobile grain size compared to existing conditions would range from -0.8 to -0.1 percent, which would correspond to a decrease in mobile grain size of -0.2 to -0.1 mm. The alternatives would not affect sedimentation or aggradation for baseflow conditions along this reach when compared to existing conditions.

Arkansas River Downstream From Fountain Creek

Geomorphic effects of changes in mobile grain size would be negligible relative to both the No Action Alternative and existing conditions along the Arkansas River from the Fountain Creek mouth to the Avondale Gage. When comparing the alternatives to the No Action Alternative, the estimated change in mobile grain size would range from -1.1 to 1.4 percent, which would represent a change in mobile grain of -1.0 to 1.3 mm. The JUP North Alternative is the only alternative that would decrease mobile grain size, but effects would be negligible.

When comparing the alternatives to existing conditions, the estimated change in mobile grain size would range from 0.3 to 2.8 percent, which would increase the mobile grain size 0.3 to 2.6 mm and could cause minimal increased erosion at baseflow conditions.

Fountain Creek

Although some alternatives would affect baseflow more than 5 percent along Fountain Creek, compared to the No Action, effects on mobile grain size would be negligible. Mobile grain size would increase up to 0.2 mm or a 2.4 percent increase, which would be negligible.

The No Action Alternative would not adversely affect geomorphology compared to existing conditions. Although there would be minor effects on baseflow along Fountain Creek from Fountain to its confluence with the Arkansas River, this change in baseflow would result in a negligible effect on mobile grain size. The estimated changes in mobile grain size of the alternatives compared to existing conditions would range from 2.4 to 4.8 percent, which would change mobile grain size less than 0.5 mm, and would indicate negligible erosion along this reach as a result of changes in baseflow.

Although geomorphic effects on Fountain Creek would be predominately negligible, Fountain Creek historically has been a geomorphically unstable stream. Erosion typically occurs in the upper part of Fountain Creek leading to sedimentation in Lower Fountain Creek and the confluence with the Arkansas River as a result of decreased stream power. This leads to changes in channel form as a result of natural changes in streamflow from year to year. These existing erosion/sedimentation processes would still occur; however, from the results presented above, changes to the existing stream processes as a result of the alternatives would be negligible.

As previously stated, the Rosgen Stream Classification of the study area streams would not change as a result of minor changes in baseflow associated with the alternatives.

Cumulative Effects

Cumulative effects on baseflow and mobile grain size for all alternatives relative to the No Action Alternative are summarized in Table 6 and Table 7. Geomorphic effects caused by changes in mobile grain size for all alternatives relative to the No Action Alternative would be negligible.

The No Action Alternative would increase baseflow and mobile grain size in Fountain Creek, compared to existing conditions. Reasonably foreseeable urban and suburban development in the Fountain Creek watershed would increase baseflow because of increased water use and associated return flows, and could lead to increased erosion. The increase in mobile grain size would range from 1.9 mm to 2.5 mm, which would represent an increase of about 1/16 of an inch.

Similarly, baseflow and mobile grain size would increase in the No Action Alternative relative to existing conditions along the Arkansas River between Fountain Creek and the Arkansas River near Avondale Gage. The increase in mobile grain size would be about 1/2 of an inch (13 mm). The Southern Delivery System EIS (Reclamation 2008) found that cumulative flood flows would increase in the No Action Alternative, compared to existing conditions, and would affect Fountain Creek geomorphology.

Table 4. Direct and Indirect Geomorphic Effects – Baseflow

Aquifer	Existing Condition	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Baseflow (cfs)								
Arkansas River from CO 115 to the Pueblo Res.	401.3	397.3	396.7	396.3	399.7	396.7	396.3	396.0
Fountain Creek from Fountain to Pinion Gage	111.0	117.7	124.3	124.3	118.0	124.3	124.3	124.3
Fountain Creek from Pinion Gage to Pueblo Gage	122.7	129.3	135.3	135.3	129.3	135.3	135.3	135.3
Arkansas River from the Fountain Creek to Avondale Gage	253.6	257.7	260.3	260.0	254.7	260.3	257.7	261.7
Effects – Change in Baseflow (1) [cfs (%)] (No Action Baseline)								
Arkansas River from CO 115 to the Pueblo Res.	---	---	-0.6 (-0.2)	-1.0 (-0.3)	2.4 (0.6)	-0.6 (-0.2)	-1.0 (-0.3)	-1.3 (-0.3)
Fountain Creek from Fountain to Pinion Gage	---	---	6.6 (5.6)	6.6 (5.6)	0.3 (0.3)	6.6 (5.6)	6.6 (5.6)	6.6 (5.6)
Fountain Creek from Pinion Gage to Pueblo Gage	---	---	6.0 (4.6)	6.0 (4.6)	0.0 (0.0)	6.0 (4.6)	6.0 (4.6)	6.0 (4.6)
Arkansas River from the Fountain Creek to Avondale Gage	---	---	2.6 (1.0)	2.3 (0.9)	-3.0 (-1.2)	2.6 (1.0)	0.0 (0.0)	4.0 (1.6)
Effects – Change in Baseflow (1) [cfs (%)] (Existing Conditions Baseline)								
Arkansas River from CO 115 to the Pueblo Res.	---	-4.0 (-1.0)	-4.6 (-1.1)	-5.0 (-1.2)	-1.6 (-0.4)	-4.6 (-1.1)	-5.0 (-1.2)	-5.3 (-1.3)
Fountain Creek from Fountain to Pinion Gage	---	6.7 (6.0)	13.3 (11.9)	13.3 (11.9)	7.0 (6.3)	13.3 (11.9)	13.3 (11.9)	13.3 (11.9)
Fountain Creek from Pinion Gage to Pueblo Gage	---	6.6 (5.4)	12.6 (10.3)	12.6 (10.3)	6.6 (5.4)	12.6 (10.3)	12.6 (10.3)	12.6 (10.3)
Arkansas River from the Fountain Creek to Avondale Gage	---	4.1 (1.6)	6.7 (2.6)	6.4 (2.5)	1.1 (0.4)	6.7 (2.6)	4.1 (1.6)	8.1 (3.2)

Notes:
(1) Positive changes represent trends toward increased erosion or decreased aggradation; negative changes represent trends toward increased aggradation or decreased erosion.

Table 5. Direct and Indirect Geomorphic Effects – Mobile Grain Size

Aquifer	Existing Condition	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Mobile Grain Size (mm)								
Arkansas River from CO 115 to the Pueblo Res.	26.2	26.1	26.1	26.1	26.1	26.1	26.1	26.0
Fountain Creek from Fountain to Pinion Gage	8.3	8.5	8.7	8.7	8.5	8.7	8.7	8.7
Fountain Creek from Pinion Gage to Pueblo Gage	10.3	10.6	10.8	10.8	10.6	10.8	10.8	10.8
Arkansas River from the Fountain Creek to Avondale Gage	92.0	93.3	94.2	94.1	92.3	94.2	93.3	94.6
Effects – Change in Mobile Grain Size [1] [mm (%)] (No Action Baseline)								
Arkansas River from CO 115 to the Pueblo Res.	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	-0.1 (-0.4)
Fountain Creek from Fountain to Pinion Gage	---	---	0.2 (2.4)	0.2 (2.4)	0.0 (0.0)	0.2 (2.4)	0.2 (2.4)	0.2 (2.4)
Fountain Creek from Pinion Gage to Pueblo Gage	---	---	0.2 (1.9)	0.2 (1.9)	0.0 (0.0)	0.2 (1.9)	0.2 (1.9)	0.2 (1.9)
Arkansas River from the Fountain Creek to Avondale Gage	---	---	0.9 (1.0)	0.8 (0.9)	-1.0 (-1.1)	0.9 (1.0)	0.0 (0.0)	1.3 (1.4)
Effects – Change in Mobile Grain Size [1] [mm (%)] (Existing Conditions Baseline)								
Arkansas River from CO 115 to the Pueblo Res.	---	-0.1 (-0.4)	-0.1 (-0.4)	-0.1 (-0.4)	-0.1 (-0.4)	-0.1 (-0.4)	-0.1 (-0.4)	-0.2 (-0.8)
Fountain Creek from Fountain to Pinion Gage	---	0.2 (2.4)	0.4 (4.8)	0.4 (4.8)	0.2 (2.4)	0.4 (4.8)	0.4 (4.8)	0.4 (4.8)
Fountain Creek from Pinion Gage to Pueblo Gage	---	0.3 (2.6)	0.5 (4.5)	0.5 (4.5)	0.3 (2.6)	0.5 (4.5)	0.5 (4.5)	0.5 (4.5)
Arkansas River from the Fountain Creek to Avondale Gage	---	1.3 (1.4)	2.2 (2.4)	2.1 (2.3)	0.3 (0.3)	2.2 (2.4)	1.3 (1.4)	2.6 (2.8)

Notes:
[1] Positive changes represent trends toward increased erosion or decreased aggradation; negative changes represent trends toward increased aggradation or decreased erosion.

Table 6. Cumulative Geomorphic Effects – Baseflow

Aquifer	Existing Condition	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Simulated Baseflow (cfs)								
Arkansas River from CO 115 to the Pueblo Res.	401.4	420.3	423.0	423.0	423.7	423.0	421.3	419.0
Fountain Creek from Fountain to Pinion Gage	111.0	183.7	185.7	185.7	183.0	185.3	185.7	186.0
Fountain Creek from Pinion Gage to Pueblo Gage	122.6	191.7	193.3	193.0	191.0	193.3	193.7	194.0
Arkansas River from the Fountain Creek to Avondale Gage	253.7	295.3	296.3	295.7	293.7	296.0	292.7	297.3
Effects – Change in Baseflow [(1)] [cfs (%)] (No Action Baseline)								
Arkansas River from CO 115 to the Pueblo Res.	---	---	2.7 (0.6)	2.7 (0.6)	3.4 (0.8)	2.7 (0.6)	1.0 (0.2)	-1.3 (-0.3)
Fountain Creek from Fountain to Pinion Gage	---	---	2.0 (1.1)	2.0 (1.1)	-0.7 (-0.4)	1.6 (0.9)	2.0 (1.1)	2.3 (1.3)
Fountain Creek from Pinion Gage to Pueblo Gage	---	---	1.6 (0.8)	1.3 (0.7)	-0.7 (-0.4)	1.6 (0.8)	2.0 (1.0)	2.3 (1.2)
Arkansas River from the Fountain Creek to Avondale Gage	---	---	1.0 (0.3)	0.4 (0.1)	-1.6 (-0.5)	0.7 (0.2)	-2.6 (-0.9)	2.0 (0.7)
Effects – Change in Baseflow [(1)] [cfs (%)] (Existing Conditions Baseline)								
Arkansas River from CO 115 to the Pueblo Res.	---	18.9 (4.7)	21.6 (5.4)	21.6 (5.4)	22.3 (5.5)	21.6 (5.4)	19.9 (4.9)	17.6 (4.4)
Fountain Creek from Fountain to Pinion Gage	---	72.7 (65.5)	74.7 (67.3)	74.7 (67.3)	72.0 (64.9)	74.3 (66.9)	74.7 (67.3)	75.0 (67.6)
Fountain Creek from Pinion Gage to Pueblo Gage	---	69.1 (56.3)	70.7 (57.6)	70.4 (57.4)	68.4 (55.7)	70.7 (57.6)	71.1 (57.9)	71.4 (58.2)
Arkansas River from the Fountain Creek to Avondale Gage	---	41.6 (16.4)	42.6 (16.8)	42.0 (16.6)	40.0 (15.8)	42.3 (16.7)	39.0 (15.4)	43.6 (17.2)

Notes:
(1) Positive changes represent trends toward increased erosion or decreased aggradation; negative changes represent trends toward increased aggradation or decreased erosion.

Table 7. Cumulative Geomorphic Effects – Mobile Grain Size

Aquifer	Existing Condition	No Action	Comanche North	Pueblo Dam South	JUP North	Pueblo Dam North	River South	Master Contract Only
Mobile Grain Size (mm)								
Arkansas River from CO 115 to the Pueblo Res.	26.2	26.6	26.7	26.7	26.7	26.7	26.7	26.6
Fountain Creek from Fountain to Pinion Gage	8.3	10.2	10.2	10.2	10.2	10.2	10.2	10.2
Fountain Creek from Pinion Gage to Pueblo Gage	10.3	12.8	12.9	12.9	12.8	12.9	12.9	12.9
Arkansas River from the Fountain Creek to Avondale Gage	92.0	105.6	105.9	105.7	105.1	105.8	104.7	106.2
Effects – Change in Mobile Grain Size [(1)] [mm (%)] (No Action Baseline)								
Arkansas River from CO 115 to the Pueblo Res.	---	---	0.1 (0.4)	0.1 (0.4)	0.1 (0.4)	0.1 (0.4)	0.1 (0.4)	0.0 (0.0)
Fountain Creek from Fountain to Pinion Gage	---	---	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Fountain Creek from Pinion Gage to Pueblo Gage	---	---	0.1 (0.8)	0.1 (0.8)	0.0 (0.0)	0.1 (0.8)	0.1 (0.8)	0.1 (0.8)
Arkansas River from the Fountain Creek to Avondale Gage	---	---	0.3 (0.3)	0.1 (0.1)	-0.5 (-0.5)	0.2 (0.2)	-0.9 (-0.9)	0.6 (0.6)
Effects – Change in Mobile Grain Size [(1)] [mm (%)] (Existing Conditions Baseline)								
Arkansas River from CO 115 to the Pueblo Res.	---	0.4 (1.7)	0.5 (2.1)	0.5 (2.1)	0.5 (2.1)	0.5 (2.1)	0.5 (2.1)	0.4 (1.7)
Fountain Creek from Fountain to Pinion Gage	---	1.9 (22.2)	1.9 (22.2)	1.9 (22.2)	1.9 (22.2)	1.9 (22.2)	1.9 (22.2)	1.9 (22.2)
Fountain Creek from Pinion Gage to Pueblo Gage	---	2.5 (24.6)	2.6 (25.6)	2.6 (25.6)	2.5 (24.6)	2.6 (25.6)	2.6 (25.6)	2.6 (25.6)
Arkansas River from the Fountain Creek to Avondale Gage	---	13.6 (14.8)	13.9 (15.1)	13.7 (14.9)	13.1 (14.3)	13.8 (15.0)	12.7 (13.8)	14.2 (15.5)

Notes:
(1) Positive changes represent trends toward increased erosion or decreased aggradation; negative changes represent trends toward increased aggradation or decreased erosion.

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