FINAL REPORT

Arkansas Valley Conduit Regionalization Appraisal Study Report

October 4, 2019

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Table of Contents

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List of Figures

List of Tables

Appendices

List of Acronyms

≤	less than or equal to
µg/L	micrograms per liter
AGUA	Arkansas Groundwater Users Association
AF	acre-feet
AFY	acre-feet per year
AVC	Arkansas Valley Conduit
CCL	Contaminant Candidate List
CCWS	Crowley County Water System
CDPHE	Colorado Department of Public Health and Environment
CDWR	Colorado Division of Water Resources
CEC	contaminants of emerging concern
cfs	cubic feet per second
CO-RADS	Colorado Radionuclide Abatement and Disposal Strategy
CWPDA	Colorado Water Protective and Development Association
DAF	dissolved air flotation
DBP	disinfection byproducts
EDC	endocrine-disrupting compound
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
Fry-Ark	Fryingpan-Arkansas
GAC	granular activated carbon
GAPA	gross alpha particle activity
GO	general obligation
gpm	gallons per minute
GUDI	groundwater under direct influence of surface water
GWI	Great Western Institute
HCU	historical consumptive use
ISDS	individual sewage disposal system
LAWMA	Lower Arkansas Water Management Association
LIRF	lawn irrigation return flows
LRAA	locational running annual average
MCL	maximum contaminant level
MG	million gallons
MGD	million gallons per day
mg/L	milligrams per liter
mrem/yr	millirems per year
NEPA	National Environmental Policy Act
NTU	nephelometric turbidity unit
O&M	operations and maintenance
OIC	operator in charge
OM&R	operations, maintenance, and periodic replacement
P3	public-private partnership
PBBW	Pueblo Board of Water Works

pCi/L	picocuries per liter
PCP	personal care product
PFOAS	perfluoroalkyl substances
PhAC	pharmaceutically active compound
POTW	publicly owned treatment work
psi	pounds per square inch
RCAC	Rural Community Assistance Corporation
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
REDI	Rural Economic Development Initiative
RO	reverse osmosis
SDWA	Safe Drinking Water Act
Southeastern	Southeastern Colorado Water Conservancy District
TDS	total dissolved solids
TENORM	technically enhanced naturally occurring radioactive material
UCMR	Unregulated Contaminant Monitoring Rule
WERF	Water Research Foundation
WIFIA	Water Infrastructure Finance and Innovation Act
WIIN	Water Infrastructure Improvement for the Nation
WQCD	Water Quality Control Division
WWTP	wastewater plant treatment plant
ZDD	zero-discharge desalination
ZLD	zero-liquid discharge

Executive Summary

ES.1 Project Background

The Fryingpan-Arkansas (Fry-Ark) Project has been an ongoing water diversion and delivery effort led by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) for nearly 60 years. The Arkansas Valley Conduit (AVC) is an authorized portion of the Fry-Ark Project designed to transport filtered water from the Pueblo Reservoir eastward along the Arkansas River to Lamar, Colorado. Water from the Pueblo Reservoir would be filtered at the Whitlock Water Treatment Plant in Pueblo and delivered through the AVC to the counties of Pueblo, Crowley, Otero, Bent, Prowers, and Kiowa. Approximately 80 percent of future municipal and industrial water demands for the 40 participating water systems within these counties would be met through the AVC.

In 2009, Congress amended the original Fry-Ark authorization resulting in Public Law 111-11, which authorized annual appropriations as necessary for the construction of AVC. Annual appropriations contribute to the cost share plan where federal funding would cover 65 percent of AVC construction costs while beneficiaries would be responsible for the remaining 35 percent (Reclamation 2012). The beneficiaries will also be responsible for 100 percent of the operation and maintenance costs. However, the funding resources for the construction of the AVC have been limited, resulting in the continued delay of AVC construction and implementation.

ES.2 Project Purpose and Scope

With the continued delay of AVC construction, water supply and drinking water quality issues continue for the 40 participating water systems in Pueblo, Crowley, Otero, Bent, Prowers, and Kiowa counties. Additionally, 15 of the participating water systems are currently under enforcement by the Colorado Department of Public Health and Environment (CDPHE) for not meeting primary drinking water quality standards for radionuclides.

Water providers in the area serve small, rural towns and communities with little funding available to implement the treatment enhancements required to meet primary drinking water standards. Actions taken by systems currently under enforcement have been to contribute annual appropriations and wait for the eventual construction of AVC to address their water quality concerns. However, due to the ongoing delays for AVC construction, interim measures that address both water quality and water supply issues for AVC participants are warranted.

Regionalization would physically network water suppliers capable of providing CDPHE compliant drinking water to participants that cannot supply compliant drinking water to their service areas. Regionalization of water systems that have agreed to participate in AVC would serve as an interim measure that would provide a short-term solution to water quality and water supply issues until AVC construction is possible.

ES.3 Findings

In coordination with Reclamation and the Southeastern Colorado Water Conservancy District Southeastern, CDM Smith developed three regionalization alternatives that present an opportunity to provide water to AVC participants in the interim until the AVC construction is complete. This report presents an appraisal-level evaluation of regional system supplies, demands and deliveries, water treatment plant expansions, delivery hydraulics, conduit routes, and cost estimates for each proposed regionalization alternative. The alternatives were developed to address the following objectives:

- Address CDPHE enforcement orders (CDPHE 2019b)
- Provide a reliable interim water supply that would meet the requested AVC deliveries for each system
- Follow the proposed AVC alignment and incorporate sections of AVC to the greatest extent practicable to facilitate future AVC connections and water delivery

Table ES-1. Summary of Proposed Regionalization Alternatives

Regionalization Alternative	Alternative Description	Included Water Providers
No. 1 – AVC Regionalization	All-inclusive regionalization alternative that includes all AVC participants and follows the preferred AVC alignment and delivery locations. This alternative would construct portions of the AVC alignment in an effort to expedite the construction of the final AVC.	St. Charles Mesa, Crowley County Water Association, Rocky Ford, La Junta, Lamar
No. 2 – AVC-CDPHE Enforcement Regionalization	Moderate-level regionalization alternative that only serves participants currently under CDPHE enforcement, those with a high likelihood of future enforcement, and those that are already served by the regional water provider. This alternative also follows the preferred AVC alignment and delivery locations to help expedite future AVC construction while supplying high quality interim drinking water to systems struggling to meet CDPHE drinking water standards.	Avondale, Crowley County Water Association, La Junta, Lamar
No. 3 – CDPHE Enforcement Regionalization	Minimal-level regionalization alternative that only serves participants currently under CDPHE enforcement and those with a high likelihood of future enforcement. This alternative is not restricted by the preferred AVC alignment and instead uses alternate pipeline alignments and conveyance system configurations that optimize regionalization.	Avondale, Fowler, Rocky Ford, La Junta, Lamar

ES.4 Recommendations

In this AVC Regionalization Appraisal Study Report, three regionalization alternatives were identified and reviewed in this report. Each alternative was developed in accordance with the following goals and objectives:

- Address CDPHE enforcement orders
- Provide a reliable interim water supply that would meet the requested AVC deliveries for each participating water system
- Follow the proposed AVC alignment and incorporate sections of AVC to the greatest extent practicable to facilitate future AVC connections and water delivery

Table ES-2 includes comparison criteria that have been developed to better evaluate how each proposed alternative meets the established project goals and objectives. Each alternative either completely supports (✓), moderately supports (+), or minimally/does not support (✕) the comparison criteria.

Table ES-2. Qualitative Comparison of the Proposed Alternatives

Criteria	Description	Alternative 1	Alternative 2	Alternative 3
AVC Alignment	Regional pipelines follow the preferred AVC alignment	✓	✓	+
AVC Participants	All AVC participants are included	✓	+	✕
Water Quality	All existing and potential CDPHE enforcement orders are addressed	✓	✓	✓
Water Supply	An adequate short-term water supply will be provided to all participating systems	✓	+	+
Waste Disposal	Remove the need for ongoing radionuclide and residual waste disposal	✕	✕	✕
Implementability	Ease of implementation (e.g., permits, right of ways, National Environmental Policy Act [NEPA] compliance, etc.)	+	✓	✕
Institutional	Coordination with neighboring entities and the public is manageable and minimal (e.g., intergovernmental agreements, public acceptance, etc.)	✕	+	✓
Timeliness	Required improvements have minimal impact on existing infrastructure allowing for expedited project completion	✕	+	✓
Regionalization Cost	Regionalization pipelines are optimized to reduce cost	✕	+	✓

Once a recommended regionalization alternative is selected, feasibility studies and final designs will be developed. Outstanding information and clarifications needed to complete feasibility-level designs and analysis for regionalization include:

- Additional site visits to water systems to gather needed information for feasibility-level designs

- Further evaluation of current and projected operations and maintenance (O&M) costs
- Obtaining conveyance system and pipeline maps from water providers and connecting systems
- Further water rights evaluations
- Evaluation of potential water supply well locations and hydrogeologic characterizations
- Groundwater monitoring well sampling and blending studies to assess impacts of new water sources and quality on existing infrastructure
- Review of the current brine disposal permit for La Junta
- Confirmation of potential regional water providers and connections are in agreement with regionalization as depicted in each alternative

Based on a review of the alternatives in relation to the project goals and criteria, the following recommendations can be made:

- Consider the additional investigations and needed information as noted above to support findings and alternative selection.
- Connect participants that are currently under CDPHE enforcement or are likely to be under enforcement to regional providers or nearby systems that are in compliance as soon as possible and encourage 'grass roots' regionalization.
- The cost of impending AVC plus regionalization is greater than the cost of implementing AVC by itself. Extend AVC pipeline system to first hub area (Avondale and Boone) as soon as possible.
- Consider short- and long-term brine disposal in total costs and as part of schedule for AVC implementation. Brine disposal impacts support regionalization as only a short-term solution.
- Consider short- and long-term radionuclide disposal in total costs and as part of schedule for AVC implementation. Radionuclide waste stream management supports regionalization as only a short-term solution.
- Refine Alternatives 2 and 3 in the Lamar regional hub and implement regionalization in the hub due to the anticipated schedule to provide a reliable interim water supply.
- Develop a water rights action plan as required to implement regionalization.
- Develop a prioritized funding list and finalized funding source for both capital and O&M.
- Form regional governance groups to help manage regionwide actions, including the development of water rights action plans and the pursuit of funding opportunities for each regional hub.

Section 1

Introduction

1.1 Background

The Fryingpan-Arkansas (Fry-Ark) Project has been an ongoing water diversion and delivery effort led by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) for nearly 60 years. Normal rainfall in the Arkansas River Basin in southeast Colorado has proven to be insufficient for farming throughout the region, leading to the development of irrigation-based farming in the late 1800s. Irrigation waters from the Arkansas River were used to maintain crops for decades until years of drought led to consistent water shortages and hardship for local farmers. Lobbying efforts led to the enactment of the Fry-Ark Project Act in 1962, allowing for the construction of a multipurpose transmountain, transbasin water diversion and delivery project in southeast Colorado. The construction of water diversion and delivery infrastructure by Reclamation continued from 1964 through the mid-1980s, resulting in the diversion of approximately 48,500 acre-feet per year (AFY) of surplus water from the Fryingpan River and other tributaries to water-deficient communities throughout the Arkansas River Basin (Reclamation 2013).

The AVC is needed in the Arkansas River Basin to deliver water that meets federal and state drinking water standards, meets existing and future water demands, and provides system redundancy for water deliveries (Reclamation 2012).

Regionalization is not intended to replace the AVC, but rather provide an interim solution to water quality issues while potentially expediting the construction of portions of the preferred AVC alignment.

The Arkansas Valley Conduit (AVC) is an authorized portion of the Fry-Ark Project designed to transport filtered water from the Pueblo Reservoir eastward along the Arkansas River to Lamar, Colorado. Water from the Pueblo Reservoir would be filtered at the Whitlock Water Treatment Plant in Pueblo and delivered through the AVC to the counties of Pueblo, Crowley, Otero, Bent, Prowers, and Kiowa. Approximately 80 percent of future municipal and industrial water demands for participating water systems within these counties would be met through the AVC.

The 87th Congress authorized Public Law 87-590 on August 16, 1962 for the Fry-Ark Project. In 2009, Congress amended the original Fry-Ark authorization resulting in Public Law 111-11, which authorized annual appropriations as necessary for the construction of AVC. Annual appropriations contribute to the cost share plan where federal funding would cover 65 percent of AVC construction costs while beneficiaries would be responsible for the remaining 35 percent (Reclamation 2012). The beneficiaries will also be responsible for 100 percent of the operation and maintenance (O&M) costs. Beneficiaries have the option to cover all or a portion of their cost share requirement and O&M costs with other federal and nonfederal funding sources. The Southeastern Colorado Water Conservancy District (Southeastern) is the cooperating agency responsible for managing annual appropriations and for the repayment of AVC on behalf of the Fry-Ark beneficiaries. However, the annual appropriations for the construction of the AVC have been limited, resulting in the continued delay of AVC construction and implementation.

1.1.1 Current AVC Status

Since the authorization of Public Law 111-11, several planning-level reports and documents have been prepared by Reclamation, Southeastern, and other entities to support the proposal to construct the AVC. This includes the *Arkansas Valley Conduit and Long-Term Excess Capacity Master Contract Final Environmental Impact Statement* (EIS) (Reclamation 2013), which was finalized in August 2013. The EIS presented multiple alternatives for AVC construction and defined potential environmental consequences associated with constructing and operating the proposed AVC under each alternative. Following completion of the EIS, a record of decision was signed in February of 2014 identifying the Comanche North Alternative as the preferred AVC alignment (Reclamation 2016a). A planning-level Feasibility Design Report (Reclamation 2016a) and two supplements were prepared for the Comanche North preferred alternative. A more recent iteration of the AVC alignment, the New Concept, was developed by Southeastern in May of 2018 to expedite construction and reduce costs (Southeastern 2018). The New Concept AVC alignment proposed a phased approach with more direct pipeline connections. These connections ultimately would reduce the preferred Comanche North alignment by nearly 14 pipeline miles on the west side of the AVC by eliminating the need for pipeline transmission around the City of Pueblo (Southeastern 2018). The remaining pipeline alignment east of Boone would remain the same under the New Concept and would continue to follow the preferred Comanche North alignment.

Over the years, water providers that have agreed to participate and receive water supplies from AVC have varied. Water providers have taken various approaches to address continued water quality and supply issues for their respective systems while waiting for AVC construction. Some systems have had the funding necessary to address these issues and have declined continued participation in AVC as a result. Other water providers face growing water quality and water supply concerns they cannot address on their own, resulting in the decision to join as an AVC participant. Currently, there are 40 AVC participants, with the most recent addition being the Riverside Water Company in2017. Avondale is pending acceptance as an AVC participant, whereas the St. Charles Mesa Water District declined continued participation. The current status of AVC participants is shown in **Table 1-1**. Systems that choose to decline participation and discontinue paying annual appropriations to Southeastern may rejoin AVC later. This AVC Regionalization study includes the evaluation of all historical AVC participants regardless of current participation status.

Table 1-1. Current Status of AVC Participants

Water Provider	AVC Status
Fowler	Participant
Crowley County Water Association	Participant
Olney Springs	Participant
96 Pipeline Company	Participant
Town of Crowley	Participant
Ordway	Participant
Sugar City	Participant
Rocky Ford/Hancock	Participant
Valley Water Company	Participant

Water Provider	AVC Status
Manzanola	Participant
Vroman Water Company	Participant
Fayette Water Association	Participant
Patterson Valley Water Company	Participant
Eureka Water Company	Participant
Newdale-Grande Valley Water Company	Participant
West Grand Valley Water Inc.	Participant
Hilltop Water Company	Participant
La Junta	Participant
South Swink Water Company	Participant
Town of Swink	Participant
Homestead Improvement Association	Participant
Riverside	Participant
Bents Fort Water Company	Participant
North Holbrook Water Company	Participant
West Holbrook Water Pipeline Association	Participant
Holbrook Center Soft Water Association	Participant
Beehive Water Association	Participant
Cheraw	Participant
East End Water Association	Participant
Southside Water Association	Participant
Las Animas	Participant
Lamar	Participant
Hasty Water Company	Participant
McClave Water Association, Inc.	Participant
May Valley Water Association	Participant
Town of Eads	Participant
Town of Wiley	Participant
Boone	Participant
St. Charles Mesa Water District	Declined Participation
Avondale	Pending Participation

1.2 Purpose and Scope

Water supply and drinking water quality issues continue for AVC participants. The development of regulatory mandated monitoring programs has led to the identification of high levels of radionuclides in a number of deep groundwater aquifers in the area. Fifteen AVC participants are currently under enforcement by the Colorado Department of Public Health and Environment (CDPHE) for not meeting primary drinking water quality maximum contaminant levels (MCLs) for radionuclides, including combined radium, uranium, and gross alpha particle activity (GAPA).

Water providers in the area serve small, rural towns and communities with little funding available to implement the treatment enhancements required to meet primary drinking water standards. Actions taken by systems currently under enforcement have been to contribute annual appropriations and wait for the eventual construction of AVC to address their water quality concerns. However, due to the ongoing delays for AVC construction, interim measures that address both water quality and water supply issues for AVC participants are warranted.

Reclamation is the federal funding agency for this appraisal-level study that evaluates regionalization as a potential interim measure to address ongoing water quality and water supply issues faced by AVC participants. CDM Smith has been tasked by Reclamation to develop this AVC Regionalization Appraisal Study Report using readily available data and information about AVC. Data sources used to develop this report are depicted in **Figure 1-1**.

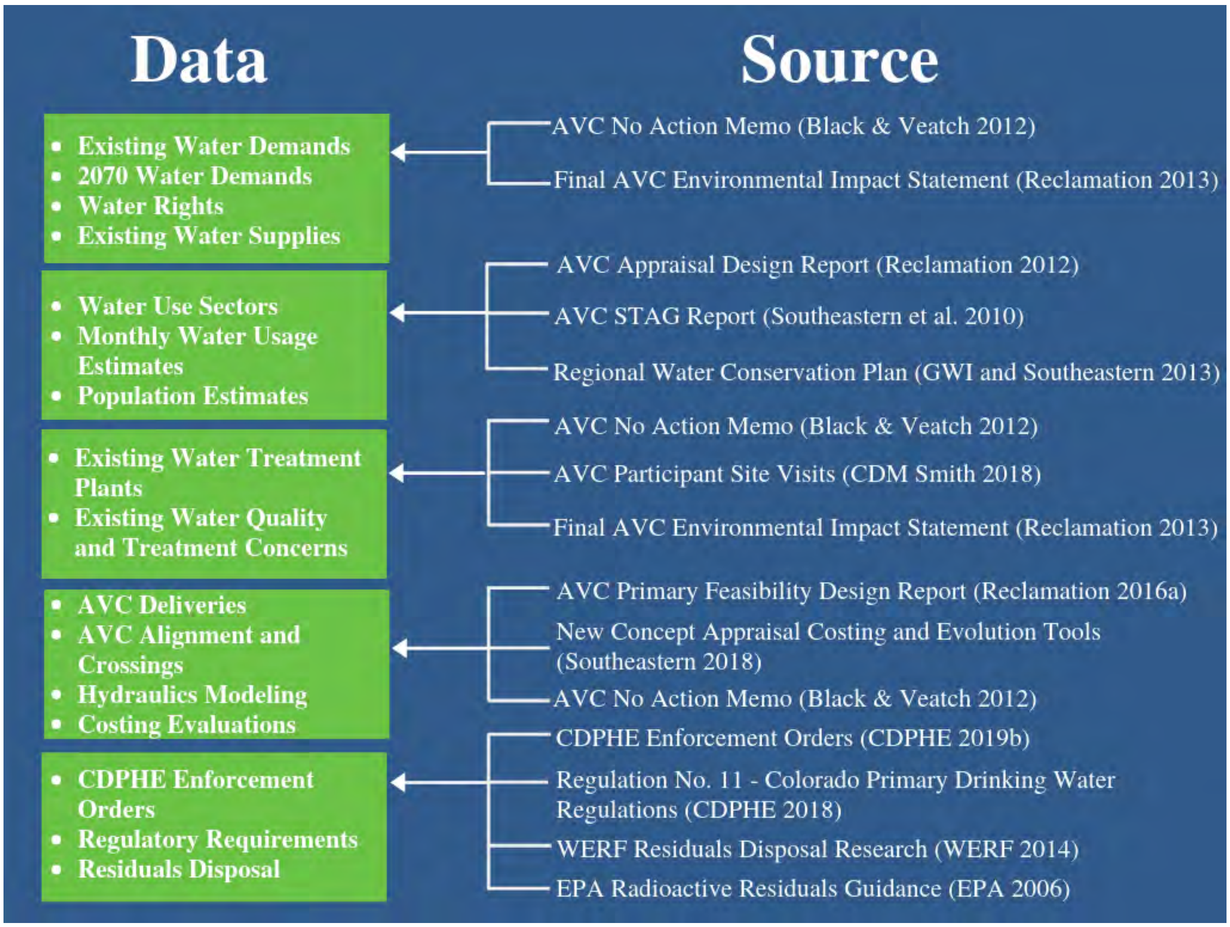

Figure 1-1. Summary of Data Used for the Appraisal-Level Study and the Sources Used to Acquire that Data

In addition to a review of existing data and information about AVC, CDM Smith also acquired data needed for the development of regionalization alternatives through in-person site visits and three separate AVC regionalization workshops held at the CDM Smith offices in Denver, Colorado. Representatives from Southeastern and Reclamation attended the workshops, which presented an opportunity for open discussion and feedback throughout the appraisal-level study process. Refer to Appendices A and B for notes from in-person site visits and from workshops conducted by CDM Smith, respectively.

In coordination with Reclamation and Southeastern, CDM Smith developed three regionalization alternatives that present an opportunity to provide water to AVC participants in the interim until the AVC construction is complete. This report presents an appraisal-level evaluation of regional system supplies, demands and deliveries, water treatment plant expansions, delivery hydraulics, conduit routes, and cost estimates for each proposed regionalization alternative. A review of regulatory considerations and potential cost share opportunities are also presented herein.

1.2.1 Regional Systems

Regionalization would physically network water suppliers capable of providing CDPHE compliant drinking water to participants that cannot supply compliant drinking water to their service areas. Regionalization of water systems that have agreed to participate in AVC would serve as an interim measure that would provide a short-term solution to water quality and water supply issues until AVC construction is possible. Under regionalization, regional system connections follow the preferred AVC alignment to the greatest extent practicable to facilitate future AVC construction and water delivery. As such, a small portion of the preferred AVC alignment would be constructed for each regional system and a designated water provider would implement short term water supply and treatment plant expansions to meet the demands of their respective regional systems. The criteria used to identify regional water providers are as follows:

- Providers that would require limited water treatment plant and water supply capacity enhancements to serve a regional system
- Providers that are not currently under CDPHE enforcement orders for radionuclides
- Providers that are located near other AVC participants

AVC construction post regionalization would connect segments of the regional system pipelines with the AVC. The regional water providers would then discontinue serving as the regional water provider and water deliveries would instead come from Pueblo through the completed AVC. This would allow for the expedited and phased construction of AVC while also supplying high quality interim drinking water to systems currently under CDPHE enforcement orders.

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Section 2

Participant Water Supply and Demands

Water providers with prior or current agreements to participate in AVC are included in the evaluation of regionalization and are referred to as "participating systems." The following provides a summary of the 2010 and projected 2070 population, water use, and water supply estimates for the 41 participating systems. Water demand estimates from 2010 are assumed to represent current conditions as there has been little to no change in population growth and overall usage since the 2010 assessment (Southeastern et al. 2010, Black & Veatch 2012).

2.1 2010 Water Demands

Water uses for participating systems within Bent, Crowley, Kiowa, Otero, Prowers, and Pueblo Counties are comprised of residential, municipal, commercial, industrial, and livestock uses (Great Western Institute [GWI] and Southeastern 2013). It is estimated that approximately 80 percent of water use in the Arkansas River Basin is for agricultural purposes followed by 16 percent municipal and industrial use, and 5 percent self-supplied industrial (Reclamation 2013). Participating systems currently serve small towns and rural communities with population sizes ranging from just over 20 people to near 11,000 (Reclamation 2012). Service populations and existing annual water demands for all participating systems are shown in **Table 2-1.** The existing service population for all participating systems combined is approximately 51,800, with an estimated demand of 10,464 AFY.

Table 2-1. 2010 Population and Water Demand Estimates for Participating Systems

Participating Systems	2010 Service Population	2010 Demand (AFY)	Annual Gross Per Capita Water Use	2010 Max Daily Demand (MGD)
Fowler	1,700	210	0.12	0.45
Crowley County Water Association	2,530	564	0.22	1.21
Olney Springs	332	40	0.12	0.09
96 Pipeline Company	160	56	0.35	0.12
Town of Crowley	163	27	0.17	0.06
Ordway	1,086	250	0.23	0.54
Sugar City	238	82	0.34	0.18
Rocky Ford/Hancock	4,144	907	0.22	1.95
Valley Water Company	325	38	0.12	0.08
Manzanola	476	39	0.08	0.08
Vroman Water Company	150	32	0.21	0.07
Fayette Water Association	60	12	0.20	0.03
Patterson Valley Water Company	96	15	0.16	0.03
Eureka Water Company	330	74	0.22	0.16
Newdale-Grande Valley Water Company	463	57	0.12	0.12
West Grand Valley Water Inc.	84	25	0.30	0.05
Hilltop Water Company	284	45	0.16	0.10

Participating Systems	2010 Service Population	2010 Demand (AFY)	Annual Gross Per Capita Water Use	2010 Max Daily Demand (MGD)
La Junta	7,102	2,040	0.29	4.37
South Swink Water Company[1]	610	82	0.13	0.18
Town of Swink	664	38	0.06	0.08
Homestead Improvement Association	67	7	0.10	0.01
Riverside	120	20	0.17	0.02
Bents Fort Water Company	900	63	0.07	0.13
North Holbrook Water Company	40	7	0.18	0.01
West Holbrook Water Pipeline Association	23	14	0.61	0.03
Holbrook Center Soft Water Association	50	18	0.36	0.04
Beehive Water Association	165	8	0.05	0.02
Cheraw	193	48	0.25	0.10
East End Water Association	75	11	0.15	0.02
Southside Water Association	48	7	0.15	0.01
Las Animas	4,405	570	0.13	1.22
Lamar	8,171	2,400	0.29	5.14
Hasty Water Company	285	32	0.11	0.07
McClave Water Association, Inc.	440	56	0.13	0.12
May Valley Water Association[2]	1,500	410	0.27	0.88
Town of Eads	626	250	0.40	0.54
Town of Wiley	434	24	0.06	0.05
Boone	324	66	0.20	0.14
St. Charles Mesa Water District	10,937	1,660	0.15	3.56
Avondale	2,000	160	0.08	0.34
TOTALS	**51,800**	**10,464**	**0.20**	**22.40**

Source: Black & Veatch 2012, Reclamation 2012
MGD = million gallons per day
[1]The South Swink Water Company has two separate AVC tie-in locations: South Swink – Fairview and South Swink – Fairmont. Reported values are assumed to include totals for both locations combined.
[2]The May Valley Water Association has two separate AVC tie-in locations: May Valley Water Association and May Valley Water Association #2. Reported values are assumed to include totals for both locations combined.

Water usage for the participating systems is generally higher during the summer months compared to the winter months. Average monthly demands are presented in **Figure 2-1** for AVC participants who provided monthly water use data (Southeastern et al. 2010). Approximately 35 percent of average annual demands occur within the summer months of June through August for AVC participants. For some systems, leaking distribution pipelines, livestock watering, and large commercial users drive higher than typical per capita water use rates (Reclamation 2013).

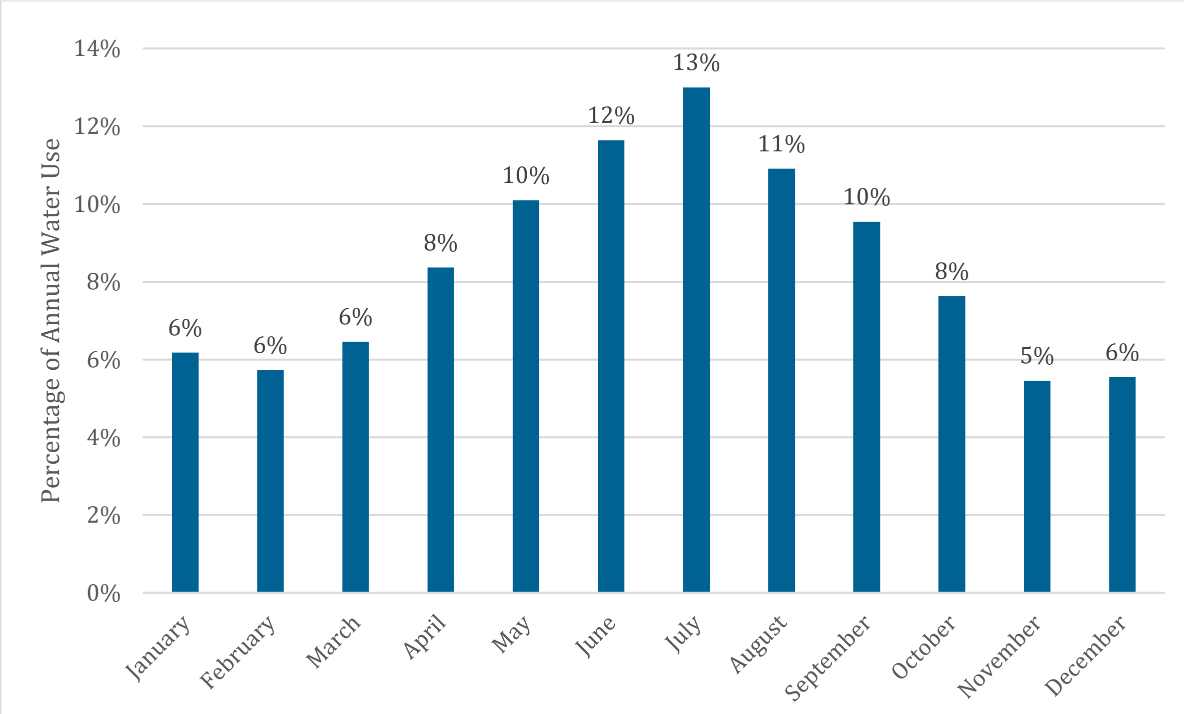

Figure 2-1. Average Monthly Water Use by AVC Participants
Source: Southeastern et al. 2010

2.2 2070 Water Demands

Countywide projected annual population growth rates were used to estimate future water demands through 2070 for the participating systems (**Table 2-2**). Projections were based on the assumption that municipal and industrial demands would grow at the same rate proportionate to population growth (Reclamation 2013) while per capita residential demands will remain constant. As determined by Reclamation, the resulting estimated 2070 water demands for all participating systems combined is 12,875 AFY to serve a projected population of 72,950 as shown in **Table 2-3**.

Table 2-2. Projected Growth Rates Used for AVC Demand Estimates

Participating Systems	County	Projected Annual Growth Rate (%)
Rocky Ford/Hancock	Otero	0.42
Valley Water Company		
Manzanola		
Vroman Water Company		
Fayette Water Association		
Patterson Valley Water Company		
Eureka Water Company		
Newdale-Grande Valley Water Company		
Hilltop Water Company		
La Junta		
South Swink Water Company		

Participating Systems	County	Projected Annual Growth Rate (%)
Town of Swink		
Homestead Improvement Association		
Riverside		
Bents Fort Water Company		
North Holbrook Water Company		
West Holbrook Water Pipeline Association		
Holbrook Center Soft Water Association		
Beehive Water Association		
Cheraw		
East End Water Association		
Southside Water Association		
West Grand Valley Water Inc.		
Fowler		
Crowley County Water Association		
Olney Springs		
96 Pipeline Company		
Town of Crowley	Crowley	0.77
Ordway		
Sugar City		
Crowley County Water Association		
Lamar		
Wiley	Prowers	0.25
May Valley Water Association		
Hasty Water Company		
McClave Water Association, Inc.	Bent	0.37
City of Las Animas		
Town of Eads	Kiowa	0
Boone		
St. Charles Mesa Water District	Pueblo	0.97
Avondale		

Source: Reclamation 2013

Table 2-3. Projected Population and Demand Estimates for Participating Systems

Participating Systems	2070 Service Population	2070 Demand (AFY)	Annual Gross Per Capita Water Use	2070 Max Daily Demand (MGD)
Fowler	2,183	222	0.10	0.48
Crowley County Water Association	4,010	824	0.21	1.77
Olney Springs	530	60	0.11	0.13
96 Pipeline Company	255	52	0.20	0.11
Town of Crowley	260	65	0.25	0.14
Ordway	1,720	414	0.24	0.89
Sugar City	380	128	0.34	0.27
Rocky Ford/Hancock	5,325	1,050	0.20	2.25
Valley Water Company	415	39	0.09	0.08
Manzanola	610	37	0.06	0.08
Vroman Water Company	195	37	0.19	0.08
Fayette Water Association	80	14	0.18	0.03
Patterson Valley Water Company	125	17	0.14	0.04
Eureka Water Company	425	86	0.20	0.18
Newdale-Grande Valley Water Company	595	60	0.10	0.13
West Grand Valley Water Inc.	110	30	0.27	0.06
Hilltop Water Company	365	50	0.14	0.11
La Junta	9,120	2,417	0.27	5.18
South Swink Water Company[1]	780	88	0.11	0.19
Town of Swink	850	30	0.04	0.06
Homestead Improvement Association	85	7	0.08	0.01
Riverside	154	26	0.17	0.03
Bents Fort Water Company	1,160	55	0.05	0.12
North Holbrook Water Company	50	8	0.16	0.02
West Holbrook Water Pipeline Association	30	18	0.60	0.04
Holbrook Center Soft Water Association	65	22	0.34	0.05
Beehive Water Association	210	6	0.03	0.01
Cheraw	250	57	0.23	0.12
East End Water Association	100	13	0.13	0.03
Southside Water Association	60	7	0.12	0.01
Las Animas	5,488	604	0.11	1.29
Lamar	9,500	2,511	0.26	5.38
Hasty Water Company	355	33	0.09	0.07
McClave Water Association, Inc.	550	59	0.11	0.13
May Valley Water Association[2]	1,740	435	0.25	0.93
Town of Eads	625	232	0.37	0.50
Town of Wiley	505	16	0.03	0.03
Boone	580	111	0.19	0.24

Participating Systems	2070 Service Population	2070 Demand (AFY)	Annual Gross Per Capita Water Use	2070 Max Daily Demand (MGD)
St. Charles Mesa Water District	19,540	2,698	0.14	5.78
Avondale	3,570	237	0.07	0.51
TOTALS	**72,950**	**12,875**	**0.18**	**27.56**

Source: Black & Veatch 2012, Reclamation 2012

[1] The South Swink Water Company has two separate AVC tie-in locations: South Swink – Fairview and South Swink – Fairmont. Reported values are assumed to include totals for both locations combined.

[2] The May Valley Water Association has two separate AVC tie-in locations: May Valley Water Association and May Valley Water Association #2. Reported values are assumed to include totals for both locations combined.

2.3 Water Supplies

Current water supplies for participating systems are managed through water systems dominated by individual, or sets of individual, alluvial or deep groundwater production wells. Most of these wells were installed between 30 and 60 years ago and have been maintained to meet the requirements of state and federal regulations (GWI and Southeastern 2013). However, it has been discovered through regulatory mandated monitoring programs that several of the aquifers in the area produce high levels of radionuclides and other contaminants above acceptable primary drinking water quality standards. Participating systems with contaminated water supply sources have been placed under enforcement orders by CDPHE. Current CDPHE enforcements for the 41 systems included in regionalization are shown in **Figure 2-2**. Refer to Section 3 of this report for more information about existing regulatory requirements and primary drinking water quality standards.

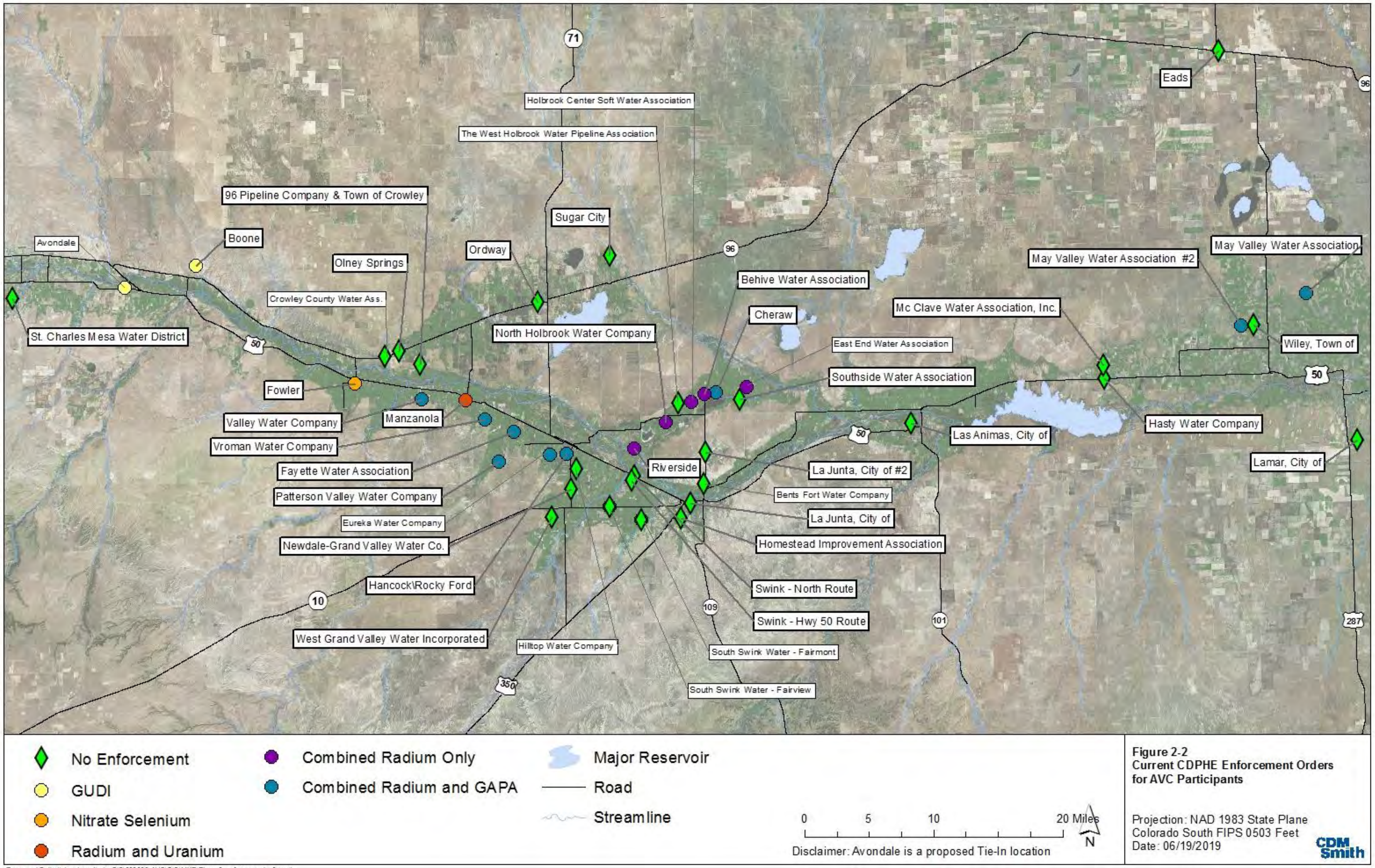

Figure 2-2. Current CDPHE Enforcement Orders for AVC Participants Included in Regionalization
GUDI = groundwater under direct influence of surface water

The only participating systems that also have the ability to use surface water as a source of water supply include St. Charles Mesa Water District and Rocky Ford. However, Rocky Ford does not currently use supplemental surface water to meet peak demands. All other participating systems rely on deep or alluvial groundwater wells as shown in **Table 2-4**.

Table 2-4. Existing Water Supplies for Participating Systems

Participating Systems	Deep Groundwater (AFY)	Alluvial Groundwater (AFY)	Surface Water (AFY)	Total Supplies (AFY)
Fowler	0	210	0	210
Crowley County Water Association	0	701	0	701
Olney Springs	0	40	0	40
96 Pipeline Company	0	44	0	44
Town of Crowley	0	27	0	27
Ordway	0	125	0	125
Sugar City	0	82	0	82
Rocky Ford/Hancock	0	1,122	365	1,487
Valley Water Company	38	0	0	38
Manzanola	10	29	0	39
Vroman Water Company	32	0	0	32
Fayette Water Association	12	0	0	12
Patterson Valley Water Company	15	0	0	15
Eureka Water Company	74	0	0	74
Newdale-Grande Valley Water Company	57	0	0	57
West Grand Valley Water Inc.	25	0	0	25
Hilltop Water Company	45	0	0	45
La Junta	0	2,040	0	2,040
South Swink Water Company	86	0	0	86
Town of Swink	38	0	0	38
Homestead Improvement Association	7	0	0	7
Riverside[1]	-	-	-	-
Bents Fort Water Company	35	30	0	65
North Holbrook Water Company	7	0	0	7
West Holbrook Water Pipeline Association	14	0	0	14
Holbrook Center Soft Water Association	18	0	0	18
Beehive Water Association	8	0	0	8
Cheraw	48	0	0	48
East End Water Association	11	0	0	11
Southside Water Association	7	0	0	7
Las Animas	0	570	0	570
Lamar	0	2,400	0	2,400
Hasty Water Company	32	0	0	32
McClave Water Association, Inc.	56	0	0	56
May Valley Water Association	213	0	0	213

Participating Systems	Deep Groundwater (AFY)	Alluvial Groundwater (AFY)	Surface Water (AFY)	Total Supplies (AFY)
Town of Eads	0	266	0	266
Town of Wiley	24	0	0	24
Boone	0	66	0	66
St. Charles Mesa Water District	0	200	1,898	2,098
Avondale	0	160	0	160
TOTALS	**912**	**8,112**	**2,263**	**11,287**

Source: Black & Veatch 2012
[1]No water supply data available for the Riverside Water Company as they recently signed an agreement to join AVC and were not evaluated in previous AVC studies.

2.3.1 Water Rights

Pumping of alluvial groundwater along the Arkansas River affects surface water flows in the river; therefore, out-of-priority pumping depletions must be offset by augmentation water to compensate for the depletions. The Arkansas River is over appropriated and is subject to the Arkansas River Compact approved in 1948. The compact limits post-compact water rights to be able to divert water only when John Martin Reservoir is spilling, which rarely happens.

Under AVC regionalization, the designated regional water providers may need to acquire additional groundwater pumping capacity to meet the future water demands or requested deliveries of their respective regional system connectors until the AVC construction is complete. The participating regional system water connectors could allow full use of their Fry-Ark Project water by their respective regional water provider to help compensate for the additional depletions from groundwater pumping required to meet future regional system demands and deliveries. Participating regional water connectors that are currently under CDPHE enforcement orders would abandon contaminated water supply sources, and those sources would no longer be used.

In evaluating the various regional water providers' water rights, there are some general factors affecting their ability to serve the needs of the regional water connectors. To the extent that they have been identified for a specific regional provider, they will be discussed in more detail for that specific provider. These factors are:

- Some water providers may have to amend their service area boundaries and service area maps to allow water to be provided to regional system connectors that are outside of the current boundaries.

- Water right decrees and plans for augmentations may have to be amended to allow service to regional connectors. Some decrees are very specific about the area for which the decrees or augmentation plans are allowed to operate, especially those decreed after the mid-1990s.

- In some cases, additional well pumping capacity will be required to meet the regional water connectors' demands. This will result in a need for a well permit from CDWR, which will require that a water court approved plan for augmentation be in place so the permit can be issued. This will require that the regional water provider use the Fry-Ark Project allocations of the regional water connectors and possibly other senior water rights changed to augmentation use in a plan for augmentation to offset all depletions resulting from the additional pumping. There will be legal and engineering costs associated with getting the plan for augmentation approved along with water acquisition costs. These costs can be significant.

- Return flow accounting of groundwater pumped to regional water connectors will need to be quantified to reduce net groundwater depletions. These return flows include lawn irrigation return flows (LIRFs), individual sewage disposal systems (ISDSs) and wastewater plant treatment plants (WWTP) in some cases.
- With respect to return flow accounting for the regional water connectors use of water provided by the regional water providers, it is a policy of the Colorado Division of Water Resources (CDWR) that a change in use of a regional water providers water rights decrees to allow it to serve the regional water connectors and a plan for augmentation will be needed to allow credit for return flows from LIRFs, ISDSs, and WWTPs of the regional water connectors. This protects the regional provider from a lawsuit by a senior water right owner.
- Fry-Ark Project water allocated to regional water providers, including Fry-Ark Project water transferred from regional water connectors, will be used to offset net alluvial well depletions in order to maximize the amount of pumping allowed for a regional provider.
- Transit losses on Fry-Ark Project water delivered to a reach of the river for replacement of depletions will be an important factor in this study as they will reduce the amount of water available for replacing net well depletions. The transit losses are estimated from information provided by Garrett Markus, Southeastern in an email dated July 26, 2019.
- In some cases, water court decree limitations will need to be increased to allow for additional pumping by a regional provider. Some decrees limit the annual pumping volume of wells for some regional water providers.

2.3.2 St. Charles Mesa Water District Water Rights (Alternative 1)

St. Charles Mesa Water District serves an area to the east of Pueblo and south of the Arkansas River. St. Charles Mesa Water District has a service plan and service area map approved by the district court when it was originally established. They cannot serve areas outside of the current service area without amending the service plan and map in district court.

St. Charles Mesa Water District provides treated water to mostly residential users using senior water rights that were changed from irrigation to municipal use and storage in two reservoirs. These senior water rights include the Bessemer Ditch (Water Court Case Nos. W-374, 04CW08, 09CW91), which diverts water from the Arkansas River; the Zoeller Ditch (Case No. 80CW164), which diverts water from the St. Charles River; and the Cottonwood Irrigating Ditch (Case No. W-4411), which diverts water from Cottonwood Creek near Buena Vista and is transported down the Arkansas River to the Bessemer headgate. These water rights allow the St. Charles Mesa Water District to divert around 6,000 AFY for municipal use and storage of 1,890 acre-feet (AF) in two reservoirs. These water rights must be used in the St. Charles Mesa Water District's service area and cannot be used elsewhere without water court approval.

St. Charles Mesa Water also has 1,301 AF of Fry-Ark Project water currently allocated to it for municipal use. The 2070 water demand is estimated to be 2,651 AF (Reclamation 2013). The District uses its senior water rights to meet its demands and clearly has more than adequate water rights to meet its 2070 demand.

The two regional water connectors, Avondale and Boone, have a combined 2070 demand of 349 AF and Fry-Ark Project allocations of 258 AF (Reclamation 2013). The Fry-Ark Project allocations can be assigned to the St. Charles Mesa Water District leaving a shortfall of 91 AF.

The St. Charles Mesa Water District can use its Fry-Ark Project water to meet the shortfall of 91 AF without creating any water shortage issues. They will have to amend its service plan and service area to allow it to provide water to Avondale and Boone. It will have to amend the current change of water rights decrees to include the accounting of return flows from ISDSs, LIRFs and WWTPs from Avondale and Boone.

2.3.3 Avondale Water Rights (Alternatives 2 and 3)

Avondale Water and Sanitation District provides water for residential and commercial needs and for irrigation demands of parks and school athletic fields in its service area. Avondale has two alluvial wells that serve the demands of the residential and commercial customers. It also has a Dakota well decreed as nontributary with an annual appropriation of 320 AF and a pumping rate of 0.44 cubic feet per second (cfs) (Case No. 02CW105). This well is currently being used to supply water to parks and school athletic fields and provide augmentation water.

According to Bill Jesik, District Manager (Interview, August 6, 2019), one of the alluvial wells does not have a groundwater under direct influence of surface water (GUDI) problem and he intends to use this well to meet the demands of Avondale and Boone as part of Alternatives 2 and 3. The two alluvial wells are close together and share a common totalizing flow meter. Well No. 1 has a decreed pumping rate of 500 gallons per minute (gpm) and Well No. 2 has a decreed pumping rate of 1000 gpm (Case No. 02CW100). In Case No. 02CW100, a plan for augmentation is also approved that replaces the wellhead[1] depletions from the use of the alluvial wells from the following sources:

- The yield of 20 shares of Bessemer Ditch water, about 30 AF
- Up to 320 AF from the nontributary well
- Return flows from the WWTP
- Return flows from ISDSs

[1]Wellhead pumping depletions are assumed to be 100 percent; any return flows from the pumping reduce the depletion and are referred to as a net depletion that must be replaced in a plan for augmentation or Rule 14 Plan.

- Return flows from LIRFs
- Fry-Ark Project water allocations (164 AF)

The 2070 demand of Avondale is projected to be 238 AF. However, it appears that the 2070 projection does not include the irrigation water requirements of parks and athletic fields, which are being met by the nontributary well. CDWR has provided accounting spreadsheets for the Avondale plan for augmentation that show that the nontributary well pumped 18.4 AF in 2017 and 44.6 AF in 2018. It also delivered 62.2 AF of augmentation water in 2017 and 441.1 AF in 2018. Therefore, the well has capacity for additional augmentation requirements to replace depletions related to 2070 demands.

The Boone 2070 demand is projected to be 111 AF and the Fry-Ark Project water allocated to the town is 94 AF. The total 2070 demand for the two towns would be 349 AF plus some irrigation demand for the parks and ball fields in Avondale.

The Town of Avondale is a member of the Arkansas Groundwater Users Association (AGUA), which is an umbrella association that provides replacement water for its members augmentation needs. AGUA uses members' water rights, leased water, and Fry-Ark Project water allocations along with other water assets that AGUA has acquired, to provide replacement water to comply with the State Engineer's 1996 "Amended Rules and Regulations Governing the Diversion and Use of Tributary Ground Water in the Arkansas River Basin, Colorado" (Amended Ground Water Use Rules). These replacement plans are often referred to as Rule 14 plans.

For 2019, the pumping in Boone is estimated to 25 AF and the depletions are 9.69 AF. The depletions are 38.76 percent of pumping, which is the depletion value used for municipalities with a WWTP (Reclamation 2013). The 2070 depletions for Boone would be 43 AFY, which is less than the Fry-Ark Project allocation of 94 AF.

The total annual amount of replacement water available to Avondale would be the 258 AF of Fry-Ark Project water, the Bessemer Ditch shares (30 AF) and 320 AF of nontributary groundwater before transit losses are considered. The transit loss on the Fry-Ark Project water would be around 4 percent or 10 AF leaving a net amount available of 248 AF. The total amount available to replace annual alluvial well depletions is 598 AF, which exceeds the projected combined 2070 demand of 349 AF.

Avondale will have to amend the plan for augmentation, Case No. 02CW 100, to include the depletions related to serving Boone and any return flows from LIRFs, any ISDSs if any and the WWTP. It may have to drill another well further from the river as an alternate point of diversion to the existing well to prevent having a GUDI issue with its water supply.

2.3.4 Fowler Water Rights (Alternative 3)

The Town of Fowler's water system serves the town's residential and commercial customers. The water system currently includes 8 alluvial wells and 1 collection gallery well that are permitted and adjudicated for pumping rates from 1,300 gpm to 177 gpm. The town has a dual water system with potable water provided in one system and nonpotable water in a separate system.

The 2070 demand for the town is shown to be 223 AF, which appears to be the potable demand and there is a nonpotable demand of 121 AF (Reclamation 2013).

The town has just completed a water filtration system and an ion exchange treatment system to remove nitrates and selenium from the potable water supply. The town's WWTP has evaporative lagoons and does not discharge water to the Arkansas River, which increases the net depletions to the river.

The town is a member of the Colorado Water Protective and Development Association (CWPDA), which is an umbrella association that provides replacement water for its members augmentation needs. CWPDA uses members' water rights, leased water, and Fry-Ark Project water allocations along with other water assets that CWPDA has acquired, to provide replacement water to comply with the Amended Ground Water Use Rules. These plans are often referred to as Rule 14 plans.

The CWPDA plan for 2019 for the town projects pumping from three wells and the collection gallery to be 500 AF for the potable and nonpotable demands and 125 AF of pumping from a separate well, which serves the town's 9 -hole golf course. The estimated well head depletions associated with these uses are estimated to be 592 AF. These depletions will be offset for the 2019 plan year with up to 169 AF of the town's Fry-Ark Project water, LIRFs of around 17 AF, 79 AF of water leased through the Super Ditch lease/fallow pilot program, and 350 AF of transmountain water leased from the Pueblo Board of Water Works (PBBW). Transit loss on the Fry-Ark Project water and the PBBW water released from Pueblo Reservoir to the reach of the river that the town's wells would impact will be around 8 percent. The loss varies depending on river flows at the time the release is made, and the 8 percent value is an average value.

The town has changed the use of 9.2 shares of Oxford Farmers ditch water to augmentation of municipal use in Case No. 13CW0007. The historic consumptive use was determined to be 49.9 AF. The town has an additional 60.23 shares of the Oxford Farmers ditch that it intends to change to augmentation of municipal use for its wells. These shares should yield around 327 AF of consumptive use for offsetting well depletions. The town has to construct the infrastructure for an augmentation station on the ditch so that it can receive the credit from the changed water rights. The town cannot afford to proceed with a change in use of its remaining shares due to the legal and engineering costs and will do so when it has the financial resources. In the meantime, it is relying on leased water to make up any shortfall in its augmentation needs through the CWPDA Rule 14 plan.

The 2070 water demands of the six regional water connectors are 243 AF and their Fry-Ark Project allocations are 243 AF. The total 2070 demand of water for the town and the regional water connectors is 587 AF, which is 466 AF plus the town's nonpotable demand of approximately 121 AF. The Fry-Ark Project water allocated to the town and the regional water connectors is 375 AF. With the change in use of the 60.23 shares of the Oxford Farmers Ditch, the historical consumptive use of 377 AF plus the 375 AF of Fry-Ark Project water less the average 8 percent transit loss, the total amount of augmentation water would be approximately 722 AF. The wellhead depletions would be 680 AF before accretions from LIRFs, ISDSs and WWTP return flows from Manzanola are accounted for, which would result in a lesser number than the 680 AF. Thus, it appears that the town will have adequate augmentation water in the long term but in the near future, it will have to rely on leased water for use in the CWPDA Rule 14 plan. The augmentation plan would have to include the accounting of return flows from the LIRFs, ISDSs and WWTPs of Fowler and the regional water connectors.

The town's 11 wells and one spring are listed in Case No. 13CW0007 and the total pumping capacity shown is 3633 gpm so the town may have the ability to supply the total 2070 the town and the demand of the regional water connectors without constructing more wells.

2.3.5 Crowley County Water Association Water Rights (Alternatives 1 and 2)

Crowley County Water Association serves a defined area in Crowley County and its customers are the Arkansas Valley Correctional Facility and the Crowley County Correctional Facility and rural customers in its service area. Crowley County Water Association has one well with a pumping capacity of 1000 gpm and the stream depletions from the use of this well are replaced in accordance with a plan for augmentation (Case No. 02CW185). The decree for this plan for augmentation limits the annual pumping volume to 800 AFY. The decree also states that the service area is limited to the area on a map attached to the decree. Crowley County Water Association currently purchases about 45 percent of its annual water demand from the Crowley County Water System (CCWS).

In Alternative 1 for this study, Crowley County Water Association would serve the Town of Fowler, Olney Springs, 96 Pipeline, Ordway, the Town of Crowley, and Sugar City. However, CCWS currently serves the 96 Pipeline, Ordway, and the Town of Crowley, along with a about one-half the demand of the Crowley County Water Association.

CCWS operates five wells with a total pumping capacity of 1,550 gpm. The depletions from the use of these wells are replaced in accordance with a plan for augmentation (03CW29). The augmentation sources are 251 paired shares of Colorado Canal and Lake Meredith and Fry-Ark Project water allocated to its customers; 96 Pipeline, Ordway and the Town of Crowley for Alternative 1. CCWS does not have an Fry-Ark Project allocation. Sugar City has its own water system and is a member of CWPDA and has 62 shares of Twin Lakes water to use for augmentation or in a Rule 14 plan. Further complicating this study is that Olney Springs has its own water system served by a well and a spring collection gallery, which operate under a decreed plan for augmentation (98CW169).

In Alternative 2, the Crowley County Water Association would serve six small regional water connectors with all of them having enforcement orders from the CDPHE. These regional water connectors have a combined 2070 water demand of 230 AF. The total water demand of Crowley County Water Association and the regional water connectors would be 1,054 AFY. The service areas of the six regional water connectors would have to be included in a new plan for augmentation. The new plan for augmentation would also authorize at least one new well to serve the additional demand of the six regional water connectors if deemed necessary. The six regional water connectors Fry-Ark Project water allocations would be included in the new plan for augmentation. It appears that the total amount of augmentation water available in the new plan for augmentation with the addition of Fry-Ark Project water from the six connectors would be adequate to prevent injury to senior water rights.

Crowley County Water Association would need an additional well to meet the increased pumping capacity needed to meet all of its current customers and the added demand of the proposed connected systems under Alternatives 1 and 2. Crowley County Water Association's plan for augmentation would need to be amended to accommodate this change. Plans for augmentation would have to be amended to include the accounting of return flows from ISDSs and LIRFs and any WWTPs. The existing interconnect between Crowley County Water Association and CCWS could be maintained to provide redundancy and allow the necessary pipelines to be constructed to accommodate the regionalization concept. The transit loss on Fry-Ark Project water for augmentation of depletions would be around 4 to 5 percent.

2.3.6 Rocky Ford Water Rights (Alternatives 1 and 3)

The Rocky Ford municipal water system serves its customers within the city's boundaries and it also serves an area outside the city that was previously supplied water by the Hancock Water Company.

Rocky Ford uses three alluvial wells to divert water for municipal use, which were adjudicated in Case No. 05CW76. These wells can divert up 3.72 cfs and have an annual pumping volume limit of 1,122 AF. These wells have very junior water rights associated with them and therefore must operate under a court approved plan for augmentation or a Rule 14 Plan. Rocky Ford has an original plan for augmentation (Case No. 06CW49) that also changed the shares of Rocky Ford Ditch and Catlin Canal from irrigation to municipal use and augmentation. This plan augments the depletions of the water diverted by the three wells with the Rocky Ford Ditch historical consumptive use (HCU), which is 150.6 AFY, and the Catlin Canal HCU, which is 214.8 AFY. The plan for augmentation also uses Fry-Ark Project water (584 AF), the Catlin Canal winter water storage program water in Pueblo Reservoir associated with the city's Catlin Canal shares and return flow credits form WWTP discharges and LIRFs. There is detailed monthly accounting of all these components performed by city staff and provided to CDWR.

Rocky Ford amended its original plan for augmentation in an application filed in 2010 (Case No. 10CW7) so that it could provide water to the service area of the Hancock Water Company. The Hancock Water Company could not continue to serve its customers so Rocky Ford agreed to. The plan for augmentation allows the city to serve the Hancock Water Company service area with the water from the three wells and augment the depletions associated with this municipal water use with the augmentation sources identified in its original plan for augmentation. The Hancock Water Company service area is a residential area with ISDS and lawn irrigation. The plan includes accounting for water delivered to the service area as a depletion and credit for the return flows from the ISDSs and LIRFs reduce this depletion.

The city's 2070 water demand is estimated to be 1,031 AF. In Alternative 1, the city would serve nine small regional water connectors with five of them having enforcement orders from the CDPHE. These regional water connectors have a combined 2070 water demand of 383 AF. The total water demand of the city and the regional water connectors would be 1,414 AFY. This exceeds the volumetric limit of 1,122 AFY for the 3 wells. In addition, the service areas of the nine regional water connectors would have to be included in a new plan for augmentation as was done in Case No. 10CW7. The new plan for augmentation would also authorize at least one new well to serve the additional demand of the nine regional water connectors and increase the pumping volumetric limit to an amount deemed reasonable by the city.

The nine regional water connectors Fry-Ark Project water allocations are 356 AF and would be included in the new plan for augmentation. The accounting of credits from ISDSs and LIRFs would require a lot of extra effort by the city's staff but is not an insurmountable issue. It appears that the total amount of augmentation water available in the new plan for augmentation with the addition of the 356 AF of Fry-Ark Project water from the nine connectors would be adequate to prevent injury to senior water rights. This same conclusion would apply for Alternative 3 with different regional water connectors because their 2070 demands are less than Alternate 1. The transit loss on the Fry-Ark Project water would be around 10 to 11 percent.

2.3.7 La Junta Water Rights (Alternatives 1, 2, and 3)

The La Junta municipal water system serves the area within the city and recently added the Bent Fort's Water Company to its system. The city uses reverse osmosis (RO) to remove minerals from the groundwater supplied by wells. It has a new WWTP that just went into operation.

La Junta uses 13 alluvial wells to supply its water demands. These wells were adjudicated in Case No. W0114 in 1970. One well has an appropriation date of September 9, 1898 and ten of the wells have appropriation date of December 31, 1902. The remaining two wells appropriation dates of December 31, 1925 and June 14, 1960 respectively. The decreed pumping rates vary from 1.11 cfs to 2.67 cfs. Even though these wells have appropriation dates that are senior with respect to well appropriation dates, they are junior to surface water rights with appropriation dates in the 1870s and 1880s. Therefore, these wells must be included in a Rule 14 plan or a decreed plan for augmentation that can replace all out of priority depletions associated with the use of the wells.

La Junta owns 883.7 shares (3.44 percent) of the Holbrook Mutual Irrigating Company and changed the use of these shares to municipal, industrial and augmentation within the La Junta service area in Case No. 11CW 0013. The decree states that the service area can be amended as needed. There are no wells to be augmented identified in this decree. Tom Seaba, the water department manager, stated that La Junta will be filing an application for a plan for augmentation for the city's wells using the changed Holbrook Mutual Irrigating Company shares in the future (Seaba 2019).

La Junta is a member of CWPDA and operates under their Rule 14 plan approved annually by the state engineer. For 2019, the wellhead depletions are estimated to be 3,100 AF, which includes water passing through the RO plant of 948 AF. These depletions are replaced with WWTP return flows, the RO return flow, LIRFs and Fry-Ark Project water allocated to La Junta. La Junta has 1,059 AF of Fry-Ark Project water allocated to the city and estimates that it will use 741 AF of Fry-Ark Project water this year (CWPDA accounting provided by Bret Swigle, P.E., consultant to CWPDA).

In Alternative 1, La Junta would serve 13 regional connectors, which include the Bent's Fort Water Company and the Town of Las Animas. La Junta's 2070 water demand is projected to be 2,421 AF, which does not include the RO water. The 2070 demand of the 13 connectors is projected to be 933 AF and the total demand for Alternative 1 is 3,354 AFY. The sum of La Junta's Fry-Ark Project water and the 13 connectors Fry-Ark Project water (847 AF) is 1,906 AF. The transit loss on the delivery of Fry-Ark Project water would be 10 to 11 percent.

The service areas of the 13 connectors would have to be included in an amended water court Case No. 11CW0013 and also in the future plan for augmentation application. The Fry-Ark Project water of the connectors would also have to be included in the plan for augmentation. The accounting of return flows from the WWTP (Las Animas), ISDSs and LIRFs would also need to be accounted for so that net depletions can be computed.

La Junta would have to continue to operate under the CWPDA Rule 14 plan until the plan for augmentation is approved. CWPDA and staff of the La Junta Water Department would have to do the accounting of net depletions from the pumping of the 13 wells to serve the demands of the city and the regional connectors as described in the above. It appears that the total amount of augmentation currently water available, 1,906 AFY, which includes the 847 AF of the regional connectors Fry-Ark Project water, would be adequate to allow CWPDA to replace net well depletions for Alternative 1. The same conclusion would apply for Alternates 2 and 3 with different regional connectors because their 2070 demands are less than Alternative 1.

2.3.8 Lamar Water Rights (Alternatives 1, 2, and 3)

The Lamar municipal water system serves areas inside and outside the city limits. The Lamar water system's potable water supply is obtained from 34 wells in the Clay Creek alluvium, which is located to the south of town. The nonpotable water supply is obtained from 9 wells in the Arkansas River alluvium in town.

Lamar has an approved plan for augmentation for 21 of the Clay Creek wells, Case No. W-4015, which uses the yield of 386 shares of the Fort Bent Ditch to recharge the Clay Creek alluvium with water diverted from the Arkansas River west of the city and is carried to the Clay Creek drainage by the Fort Bent Ditch and is discharged into ponds below the ditch for recharge of the Clay Creek alluvium. The pumping of the 21 wells for municipal use is accounted for in the decree and subsequent decrees of the water court.

Lamar acquired 1,890.6 additional shares of the Fort Bent Ditch and changed the use to municipal and augmentation (Case No. 05CW107-A). The historic consumptive use of these shares are used to augment depletions from 12 remaining wells in the Clay Creek alluvium and for the 9 nonpotable water supply wells in the Arkansas River alluvium. This plan also allows the use of Fry-Ark Project water for recharge of the Clay Creek alluvium.

Lamar acquired an additional 923 shares of the Fort Bent Ditch and these shares were changed to municipal and augmentation use in Case No. 02CW181 jointly with the Lower Arkansas Water Management Association (LAWMA). The 923 shares historic consumptive use was quantified, and the yield of these shares can be used either by Lamar or LAWMA for municipal use or augmentation depending on the need of Lamar.

LAWMA is an umbrella association that provides replacement water for its members augmentation needs. LAWMA uses members' water rights, leased water and Fry-Ark Project water allocations along with other water assets that LAWMA has acquired, to provide replacement water to comply with the Amended Ground Water Use Rules. Lamar is a member of LAWMA to provide insurance replacement water under its Rule 14 Plan in the event of a series of dry years according to Dan Gillham, P.E. (Gillham 2019).

The combined average historic consumptive use for the 3,199.6 shares of Fort Bent Ditch in the above three water court cases is 2,390 AFY. In the more recent two plans of augmentation, there is an accounting of return flow from the WWTP, LIRFs, and some areas with ISDSs to offset the depletions from well pumping covered in the plans.

Lamar has an allocation of Fry-Ark Project water of 1,241 AF. Lamar has experienced high transit losses on the delivery of the Fry-Ark Project water to the Fort Bent headgate in the last two releases with a loss of 72 percent in 2013 and a loss of 43 percent in 2014 (Gillham 2019). These high losses have discouraged Lamar from using Fry-Ark Project water in recent years. At one time, Lamar had a storage account in John Martin Reservoir, which allowed for more efficient delivery of Fry-Ark Project water to the Fort Bent Ditch. The State of Kansas disapproved this storage account in John Martin Reservoir and the high losses are the result. If the AVC Regionalization is approved, it would be helpful if Southeastern, Reclamation, the State of Colorado and others assist Lamar in convincing Kansas to allow the storage account in John Martin Reservoir.

In Alternative 1, Lamar would supply five regional water connectors with a 2070 demand of 798 AF. The 2070 demand of Lamar is 2,157 AF and the total demand that Lamar would have to meet would be 2,955 AFY. The amount of Fry-Ark Project water allocated to the five regional water connectors is 416 AF. The amount allocated to Lamar is 1,241 AF and the total amount would be 1,657 AF. Transit losses on the Fry-Ark Project water will reduce the amount of water available for augmentation significantly. If the average of the last two deliveries is used, 58 percent loss, the delivery would be 696 AF. Again, a storage account in John Martin Reservoir would reduce the transit losses considerably, possibly to 20 percent if the loss per mile to the Las Animas Consolidated Ditch loss of 15 percent (110 river miles from Pueblo Reservoir) from Garrett Markus is extrapolated to the Fort Bent Ditch (149 river miles from Pueblo Reservoir).

The average historic consumptive use from the Fort Bent change in use and augmentation cases of 2,340 AFY combined with the 696 Fry-Ark Project water is 3,036 AF of augmentation water. This exceeds the combined 2070 demand of 2,955 AF by 81 AF. In a series of dry years, the yield of the Fort Bent Ditch water would be less and Lamar would have to rely on its membership in LAWMA to have sufficient augmentation water.

Lamar would need to amend its augmentation plans to provide for the accounting of return flows from ISDSs and LIRFs and any wastewater treatment plants for regional connectors so that net depletions could be determined, which will improve the protection available from the augmentation plans.

The same conclusions can be reached for Alternates 2 and 3 since they have fewer regional water connectors and less 2070 demands.

Section 3

Regulatory Requirements

3.1 Current Water Treatment Requirements

The following section summarizes the standards and regulations pertaining to potable system drinking water and residual disposal requirements in the State of Colorado. This information provides a basis for establishing water treatment plant alternatives related to AVC regionalization.

3.1.1 Water Quality and Treatment Standards for Potable Systems

Drinking water rules are designated as either primary or secondary standards. Primary standards target public health issues and are enforceable, applying to all public water systems. Regulated contaminants are classified as follows: microorganisms, disinfectants, disinfectant byproducts (DBPs), radionuclides, organic chemicals, and inorganic chemicals. Secondary standards are related to aesthetic qualities such as color, taste, and odor and are not enforced by the federal government. The U.S. Environmental Protection Agency (EPA) can delegate "primacy" to a state if the state provides assurance that it will adopt drinking water standards at least as stringent as the federal standards and can appropriately enforce those standards. CDPHE maintains primacy for implementing and enforcing the Safe Drinking Water Act through Regulation No. 11 – Colorado Primary Drinking Water Regulations (Regulation 11) (CDPHE 2018).

The CDPHE Water Quality Control Division (WQCD) implements and enforces the regulations promulgated by Regulation 11. All public water systems in the state must comply with the standards outlined in Regulation 11 unless they are an integrated system that receive fully treated water from a separate regulated supplier (Black & Veatch 2012). If a public water system violates provisions outlined in Regulation 11, enforcement orders may be issued that would require the supplier to take actions required to correct the violation(s). If action is not taken within the assigned time frame, a supplier may be subject to fines and/or civil or criminal penalties.

Nearly 90 primary drinking water quality contaminants are regulated under Regulation 11 based on established health-based MCLs. An MCL is the maximum allowable concentration of a specific water quality contaminant in drinking water that has no known acute or chronic health risks to the consumer. Established MCLs are enforceable under Regulation 11 and must be met by all potable water systems. If sample collection for an analyte is conducted more frequently than annually, compliance with MCLs is dependent on the average of sample results collected from a single monitoring location during the most recent four calendar quarters or the locational running annual average (LRAA). Exceedance of the LRAA above the designated MCL constitutes a violation and may result in a CDPHE enforcement order.

REGULATORY CONSIDERATIONS FOR AVC REGIONALIZATION

Water Treatment Plant Design

Groundwater Rule
REGULATION 11.11, 11.12, AND 11.13

Revised Total Coliform Rule
REGULATION 11.16

Nitrate and Nitrite Rule
REGULATION 11.19

Organic Chemicals Rule
REGULATION 11.21

Radionuclides Rule
REGULATION 11.22

Disinfection Byproduct Rule
REGULATION 11.25

Lead and Copper Rule
REGULATION 11.26

Surface Water Treatment Rule
REGULATIONS 11.8, 11.9, AND 11.10

REGULATION NO. 11 - COLORADO PRIMARY DRINKING WATER REGULATIONS

Seventeen participating systems are currently under CDPHE enforcement orders for one or more primary drinking water quality violations. Of those, 14 participating systems are under enforcement for violations related to elevated levels of radionuclides in drinking water. The Radionuclides Rule Regulation, Section 11.22 of Regulation 11 (CDPHE 2018), was revised in 2000 to add uranium MCLs, establish updated radionuclide sampling frequencies, and define points of sample collection. Upon revision of the Radionuclides Rule, all potable water systems throughout the state were required to sample for radionuclides at their entry points to the distribution system on a quarterly basis from 2003 through 2007. If the LRAAs for the samples collected during this period were determined to be greater than or equal to the established MCLs, those suppliers were issued enforcement orders and were required to take further action to address the violations. Some participating systems have struggled to meet the requirements promulgated by the Radionuclides Rule. Potential actions that can be taken to comply with the Radionuclides Rule include costly advanced treatment options or the implementation of nontreatment alternatives such as regionalization, source water blending or development of a new high-quality water source.

Radionuclide monitoring frequencies following the initial accelerated sampling period were dependent on the LRAAs measured during sampling. If the radionuclide LRAA was:

- Less than the detection limit, the supplier must collect 1 sample every 9 years
- Greater than or equal to the detection limit but less than or equal to one-half the MCL, the supplier must collect 1 sample every 6 years
- Greater than one-half the MCL but less than or equal to the MCL, the supplier must collect 1 sample every 3 years
- Greater than or equal to the MCL, the supplier must continue to collect quarterly samples until the results from four consecutive quarters are less than or equal to the MCL

Because groundwater generally moves slowly, contamination often remains undetected for long periods. Due to the significant gap in required sampling frequencies as mentioned above, contaminated groundwaters may slowly begin to impact the source waters of neighboring systems over time. Therefore, participating systems that were previously in compliance with the Radionuclides Rule have a high likelihood of future violation if located near other systems with elevated radionuclide levels.

The established MCLs for radionuclides under enforcement for participating systems are listed in **Table 3-1**. Violations for combined radium 226 and 228 are the most prevalent for participating systems followed by GAPA violations. The average of all LRAAs on record for the systems currently under enforcement for combined radium and for GAPA are shown in **Figure 3-1** and **Figure 3-2**, respectively. In addition, Manzanola is currently under enforcement orders for elevated levels of uranium. Fowler has also had elevated selenium and nitrate levels but has recently implemented additional filtration technologies to address the issue.

Table 3-1. Drinking Water MCLs for Radionuclides

Drinking Water Quality Parameter	MCL	Units	Source	Health Effects from Prolonged Exposures Greater than MCL
Combined radium 226 and 228	5	pCi/L	Naturally occurring	Increased risk of cancer
GAPA	15	pCi/L	Naturally occurring	Increased risk of cancer
Uranium	30	µg/L	Naturally occurring	Increased risk of cancer and kidney disease
Beta/photon emitters	4	mrem/yr	Decay of natural and man-made deposits	Increased risk of cancer

Source: Regulation 11.34(4) (CDPHE 2018)
pCi/L = picocuries per liter
µg/L = micrograms per liter
mrem/yr = millirems per year

Regulation 11 (CDPHE 2018) also specifies treatment technology and monitoring requirements dependent on source water classifications. Fowler, Avondale, and Boone have recently been reclassified from using a groundwater source to using GUDI. Water supplies classified as surface water or as GUDI require filtration and more stringent monitoring compared to sources designated as groundwater. **Table 3-2** summarizes the required treatment technologies as defined by Regulations 11.8(2)(b), 11.8(3)(b), and 11.11(2)(b) and provides examples of approved treatment technologies available to suppliers.

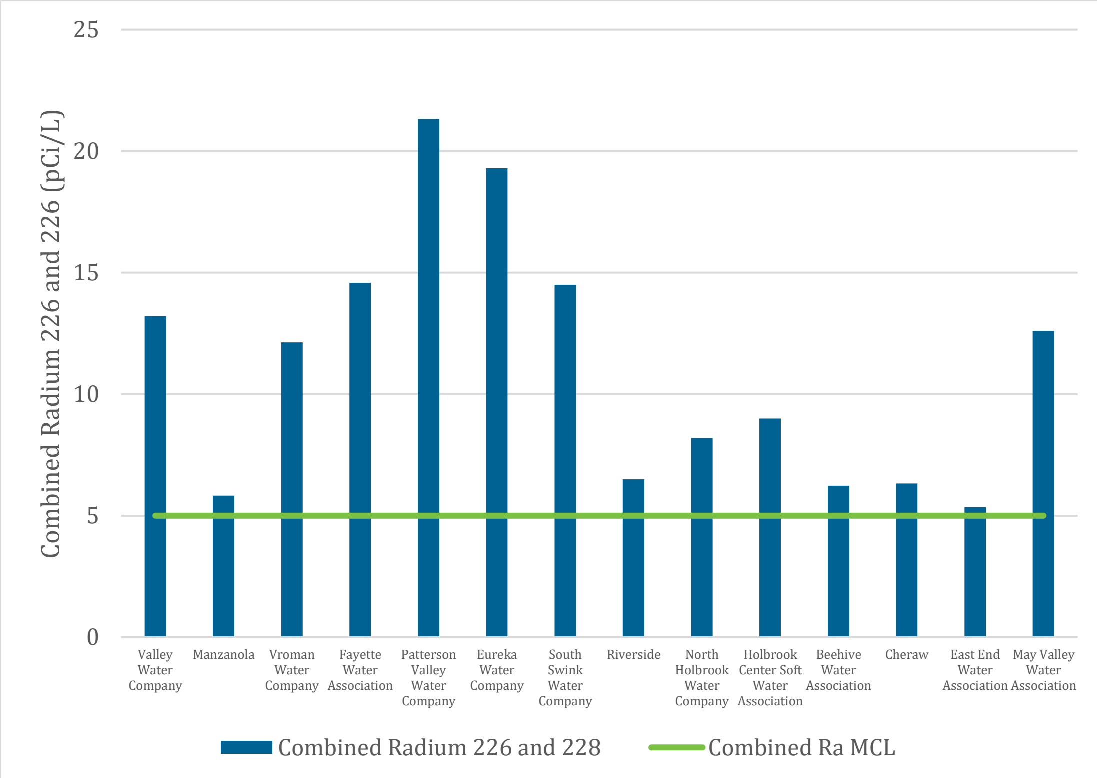

Figure 3-1. Participating Systems under Enforcement Orders for Combined Radium 226 and 228

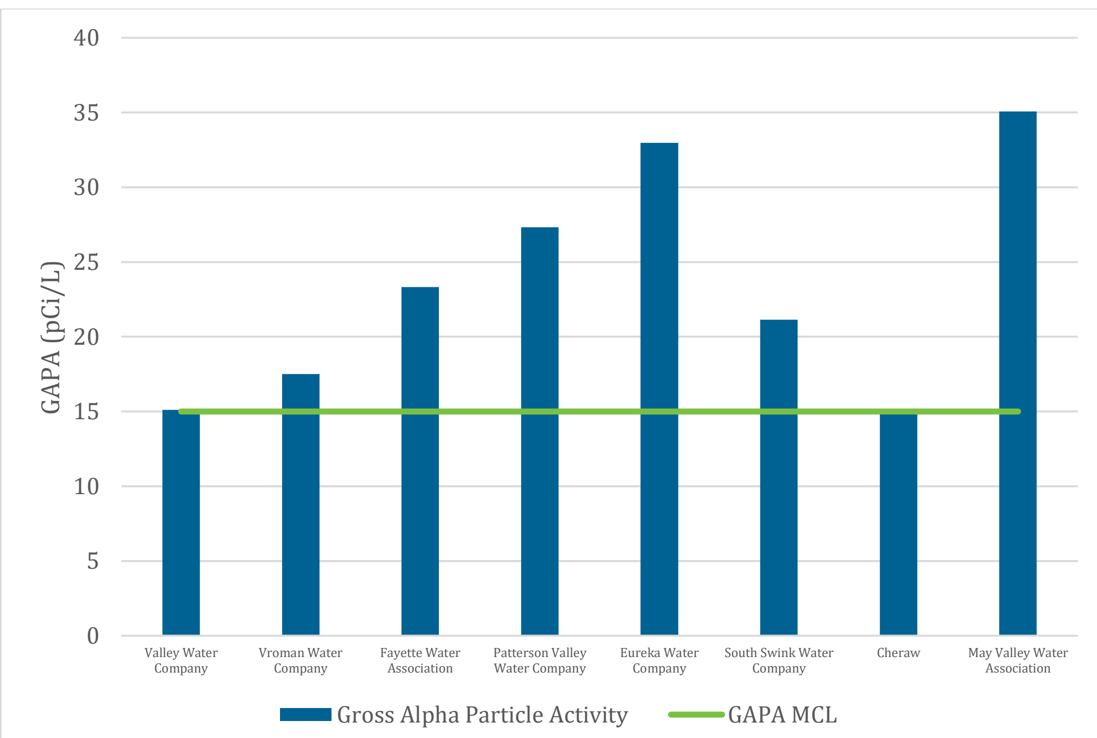

Figure 3-2. Participating Systems under Enforcement Orders for GAPA

Table 3-2. Required Treatment Technologies and Monitoring Frequency Based on Water Source Classifications

Water Source Classification	Treatment Requirements	Approved Treatment Technologies	Treatment Limits		Monitoring Frequency
			Turbidity (NTU) (95th Percentile/ Maximum Limit)	Chemical Disinfectant (mg/L)	
Groundwater	Disinfection	Maintain a residual disinfectant concentration at each entry point and throughout distribution system	-	0.2	Weekly
Surface Water or GUDI[1]	Filtration	Conventional filtration	0.3 / 1	-	Continuous[2]
		Direct filtration	0.3 / 1	-	
		Alternative filtration technologies (i.e., bag filtration, cartridge filtration)	1 / 5	-	
	Disinfection	Maintain a residual disinfectant concentration at each entry point and throughout distribution system	-	0.2	Continuous

Source: Regulations 11.8(2)(b), 11.8(3)(b), and 11.11(2)(b) (CDPHE 2018)

[1]The combination of filtration and disinfection for systems classified as surface water or GUDI are required to achieve 99 percent removal of *Cryptosporidium* (2-log) and 99.99 percent removal of *Giardia lamblia* (3-log) and viruses (4-log).

[2]Monitoring frequency may be reduced for systems serving populations less than or equal to 3,300.

[3]Monitoring frequency may be reduced to daily if determined that less frequent monitoring is sufficient to indicate effective filtration performance for systems meeting the criteria defined in Regulation 11.8(2)(c)(i)(B).

NTU = nephelometric turbidity unit

mg/L = milligrams per liter

3.1.2 Residual Disposal Requirements

Technically enhanced naturally occurring radioactive materials (TENORM) in the raw water of many participating systems exceed the established radionuclide MCLs. Of the participating systems with TENORM in their source waters, only La Junta and Las Animas have implemented RO systems that efficiently remove radionuclides to acceptable levels. Although these systems generally do not have problems meeting the drinking water standards for radionuclides, potential issues with radioactive residuals disposal may arise due to the increased treated water production associated with regionalization.

A Colorado Radionuclide Abatement and Disposal Strategy (CO-RADS) study was implemented by CDPHE to identify feasible residual disposal methods for potable systems throughout Colorado (Pirnie 2009). Thirteen participating systems were involved in the CO-RADS study. A defined treatment compliance alternative that would confidently provide water in compliance with the Radionuclides Rule was provided to each CO-RADS system (Pirnie 2009).

Radionuclides in the residuals produced from the treatment processes must be carefully handled and disposed of to avoid contamination issues. A review of potential residual disposal methods was presented in the CO-RADS study, which focused primarily on the disposal of liquid residuals. However, it was indicated in the CO-RADS report that liquid discharges of highly concentrated radioactive residuals would likely not be allowed to continue in the future due to environmental contamination and permitting issues (see **Table 3-3**). As such, many subsequent studies have focused on residual minimization strategies and zero-liquid discharge (ZLD) techniques.

Information from the CO-RADS study, along with federal regulations, were used by CDPHE to develop a draft interim policy and guidance on TENORM in 2007. The guidance focused mostly on the disposal of drinking water

Zero-Liquid Discharge

Zero-liquid discharge (ZLD) is a sustainable disposal option that may provide a long-term solution to residual disposal issues for water providers. With ZLD systems, water from brine concentrates produced through advanced membrane treatment separates from the solids. The water can be reused while the solids are properly disposed of at a landfill. These technologies would minimize contamination risks associated with residuals disposal while also helping to conserve water supplies.

Examples of existing ZLD technologies include:

- Intermediate treatment
- Thermal-based technologies
- Pressure-driven membrane technologies
- Electric potential-driven membrane-based technologies
- Alternative technologies, including forward osmosis, electrocoagulation, membrane distillation, dewvaporation, and eutectic freeze crystallization

WATER ENVIRONMENT RESEARCH FOUNDATION (WERF) 2012 treatment residuals. Dose-based limits of exposure to workers and the public were derived resulting in tiers for disposal of TENORM in landfills. The disposal tiers included in the 2007 guidance, which are levels at or below which no regulatory action would be necessary, are as follows:

- Less than 3 pCi/g above background levels of combined radium 226 and 228
- Less than 30 pCi/g above background levels of uranium
- Less than 3 pCi/g above background levels of thorium

The guidance also included information about approved landfill types a provider should use for disposal dependent on the concentration of TENORM in their water treatment residuals. It is the responsibility of the generator to characterize their residual waste concentrations prior to disposal.

More recently, Senate Bill 18-245 passed in 2018 gave the CDPHE the authority to promulgate rules for the safe management of TENORM. The *TENORM Report for the State of Colorado* was developed by Rule Engineering in June of 2019 (Rule Engineering 2019) to provide policy makers and Colorado stakeholders a common factual basis to understanding and evaluating the economic, environmental, energy, and public health impacts associated with the handling, transportation, beneficial use, and disposal of TENORM in the state. The report evaluated background levels of TENORM in Colorado and reviewed existing TENORM regulations from other states throughout the country. Additionally, various laboratory analysis techniques were reviewed to help determine appropriate approved methods of analysis of TENORM waste for generators. Results from the TENORM report will be used by the CDPHE and stakeholders to help develop updates to the TENORM interim policy and guidance of 2007 and potentially implement a final rule on TENORM handling, transportation, beneficial use, and disposal.

Table 3-3. Potential Radionuclide Residual Disposal Options

Residual Type	Options for Disposal	Potential Issues
Liquid Residuals	Discharge to waters of the U.S.	Receiving water contamination; permitting issues
	Discharge to a publicly owned treatment works (POTW)	Potential impacts to POTW treatment process; permitting issues
	Evaporation basins	Cost; space
	Deep injection wells	Hydrogeologic limitations[1]
	Spray irrigation	Environmental contamination; permitting issues
Solid Residuals	Municipal and industrial solid waste landfill	Cost; poor long-term reliability; highly complex systems that are difficult to manage
	Hazardous waste landfill	
	Low-level radioactive waste landfill	

Source: EPA 2006; Pirnie 2009; Water Research Foundation (WERF) 2014

[1]Depending on soil types and hydrogeologic characteristics, injection wells have the potential to contaminate groundwaters.

Other considerations pertaining to the evaluation and treatment of radionuclides and proper residuals disposal include:

- Filter-to-waste and backwash guidelines
- Watershed vulnerability and source water protection studies and risk assessments
- Micro-particle analysis for groundwater and GUDI wells
- Well construction considerations, including sanitary seals
- Surface water quality standards and related discharge permit requirements (average and max concentration, mass, nondegradation, and total maximum daily loads)
- Nondegradation groundwater standards for discharge to irrigation ditches
- Solid waste disposal regulations for potentially hazardous materials

3.2 Regulatory Outlook

In addition to the established standards and regulations pertaining to potable systems and water treatment plant discharges, consideration must be given to pending policy changes and their potential regulatory implications. EPA has several programs to identify potential regulatory opportunities for compounds and microorganisms that are not currently subject to proposed or promulgated drinking water regulations.

On the federal level, the Drinking Water Contaminant Candidate List (CCL) and the Unregulated Contaminant Monitoring Rule (UCMR) programs are the two primary tools EPA uses to identify candidates for regulation. Contaminants that may be regulated in the near-term or subject to increased stringency include perchlorate, chlorate, carcinogenic volatile organic compounds chromium VI, nitrosamines, and algal toxins. Additionally, there has been a rising awareness regarding the potential for contaminants of emerging concern (CECs) being present in all portions of the water cycle, including wastewater, surface water, groundwater, and drinking water. Studies evaluating the prevalence of CECs in both source waters and treated drinking water have been underway by state and federal agencies to determine if potential regulatory action is warranted.

The CECs of greatest concern include pharmaceutically active compounds (PhACs), personal care products (PCPs), endocrine-disrupting compounds (EDC), and other organic compounds such as perfluoroalkyl substances (PFOAS). Sources of PhACs, PCPs, EDC, and PFOAS include domestic waste, agricultural runoff, industrial sources, and solid waste. Currently, enforcement of these compounds is limited and guided primarily by health advisories to the consumer if elevated levels are detected in drinking water. Certain classes of these compounds included in the CCL and UCMR could lead to future federal regulations. On the state level, the WQCD is currently proposing the development of policy that will address PFOAS contamination. The policy will give the WQCD explicit authority to implement an interim narrative standard in Regulations 31 and 41 in discharge permits effective in May of 2020. Additional data gathering efforts and monitoring programs have been initiated to inform the development of numeric standards for dischargers and to ensure that drinking water supplies and public health are being protected. If monitoring and data gathering results indicate wide scale contamination of drinking water sources, additional drinking water standards for PFOAS may be implemented for impacted systems.

Other potential near-term regulatory changes include the development of CDPHE's WQCD 10-Year Water Quality Roadmap (WQCD 2018) and more stringent construction dewatering discharge requirements. In 2017, WQCD initiated a 10-year effort to develop or revise surface water quality standards for nutrients (total nitrogen, total phosphorus, and chlorophyll-*a*), ammonia, cadmium, arsenic, selenium, and temperature (WQCD 2018). Updates to the water quality standards for these constituents are planned to go into effect within the next 10 years and have the potential to impact discharger limits. Finally, increasingly stringent discharge requirements associated with construction dewatering permits may potentially have significant budgetary implications during construction. If groundwater quality in the project area is poor. additional treatment of dewatering water may be required.

Development of water treatment plant alternatives, including residuals disposal options, for the participating systems and regional water providers should consider the potential for future regulatory changes related to WQCD's 10-year Water Quality Roadmap, interim PFOAS policies, and construction dewatering discharge requirements.

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Section 4

Regionalization Alternatives

Three regionalization alternatives were developed to address the following objectives:

- Address CDPHE enforcement orders (CDPHE 2019b)
- Provide a reliable interim water supply that would meet the requested AVC deliveries for each system
- Follow the proposed AVC alignment and incorporate sections of AVC to the greatest extent practicable to facilitate future AVC connections and water delivery

A brief description of each proposed regionalization alternative is included below, and **Table 4-1** lists the proposed regional water providers for each alternative. The selection of water providers for each alternative was dependent on existing water treatment plant and water supply capacities, as well as quality of source water and proximity to other AVC participants.

AVC Regionalization (Alternative 1)

All-inclusive regionalization alternative that includes all AVC participants and follows the preferred AVC alignment and delivery locations. This alternative would construct portions of the AVC alignment in an effort to expedite the construction of the final AVC.

AVC-CDPHE Enforcement Regionalization (Alternative 2)

Moderate-level regionalization alternative that only serves participants currently under CDPHE enforcement, those with a high likelihood of future enforcement, and those that are already served by the regional water provider. This alternative also follows the preferred AVC alignment and delivery locations to help expedite future AVC construction while supplying high quality interim drinking water to systems struggling to meet CDPHE drinking water standards.

CDPHE Enforcement Regionalization (Alternative 3)

Minimal-level regionalization alternative that only serves participants currently under CDPHE enforcement and those with a high likelihood of future enforcement. This alternative is not restricted by the preferred AVC alignment and instead uses alternate pipeline alignments and conveyance system configurations that optimize regionalization and minimize cost.

Table 4-1. Summary of Proposed Regionalization Alternatives

Regionalization Alternative	Water Providers
No. 1 – AVC Regionalization	St. Charles Mesa, Crowley County Water Association, Rocky Ford, La Junta, Lamar
No. 2 – AVC-CDPHE Enforcement Regionalization	Avondale, Crowley County Water Association, La Junta, Lamar
No. 3 – CDPHE Enforcement Regionalization	Avondale, Fowler, Rocky Ford, La Junta, Lamar

The following sections further define each proposed alternative, including information about future AVC integration implementation for the systems within each regional hub and proposed regional system connections, descriptions of existing water provider water treatment plant and distribution systems, and proposed participant delivery locations and conduit routes. This section also presents preliminary information about the required regional system improvements for capacity and treatment for each alternative. Further detail and analysis of water treatment plant and conveyance system enhancements for each alternative are presented in Sections 5 and 6, respectively.

4.1 AVC Regionalization Alternative (Alternative 1)

The five proposed regional hubs for Alternative 1 were developed based on the preferred AVC alignment and delivery locations and include all the participating systems within Pueblo, Crowley, Otero, Bent, Prowers, and Kiowa Counties (**Figure 4-1**). Alternative 1 offers an all-inclusive option that has the potential to accommodate future water supply and water quality needs for all participating systems in the event that AVC is significantly delayed. Additionally, water quality conditions for the source waters of AVC participants may continue to degrade over time resulting in a need for water quality solutions for all AVC participants rather than only those under current CDPHE enforcement. The following general assumptions were made during the development of this alternative:

- Projected regional system demands are the sum of the water providers' 2070 demands and the participating systems requested AVC deliveries.
- For participating systems where requested AVC deliveries are less than projected 2070 demands, existing water supplies will continue to be used as supplemental supply.
- Water supply analyses are based on annual supplies in AFY.
- Water treatment plant alternatives are based on maximum day demands in MGD.
- Conveyance system alternatives are based on maximum month demands in MGD.
- Regionalization alternatives do not include considerations for fire flows.

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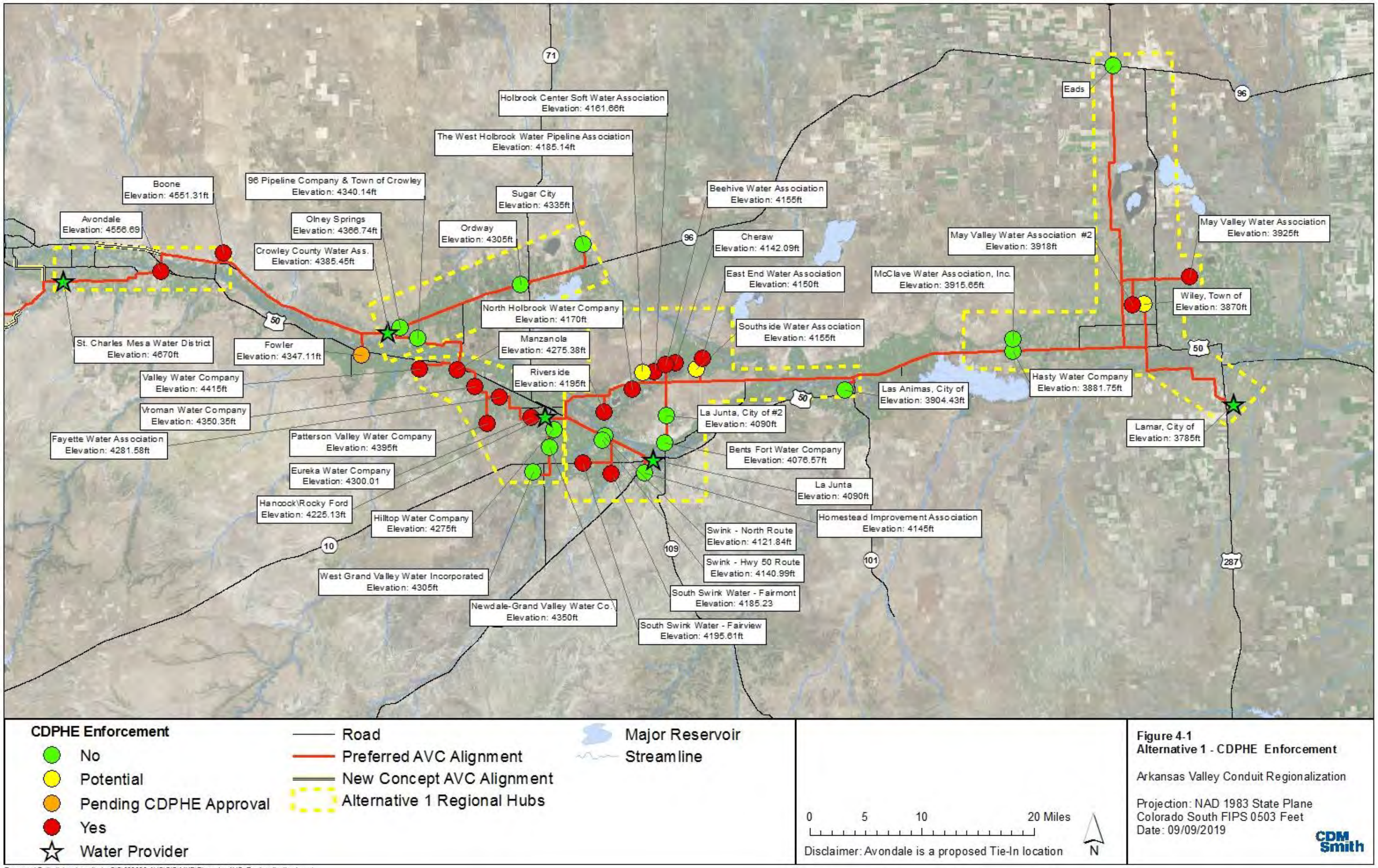

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Figure 4-1. Regional Hubs Included in Alternative 1

4.1.1 Future AVC Integration Implementation

This section summarizes the future AVC integration plan for the water providers and participating systems included in Alternative 1 and how those considerations were incorporated into the development of this alternative. Under this alternative the pipelines for regionalization represent approximately 75 percent of the proposed AVC pipelines, so only a few segments have to be constructed to begin supplying AVC water to the AVC participants.

4.1.1.1 St. Charles Mesa Water District Regional System

Under Alternative 1, St. Charles Mesa Water District would supply water meeting CDPHE standards to the systems of Avondale and Boone. Avondale and Boone are currently planned to be the first systems connected to the AVC during Phase 1 of AVC construction. St. Charles Mesa has declined continued participation in AVC. However, it is possible that St. Charles Mesa Water District will rejoin as an AVC participant at a future date. As such, St. Charles Mesa is currently planned to be the last system connected to AVC after all other participating systems have been connected. Based on this information, it was decided that St. Charles Mesa would be included in AVC regionalization due to the possibility of future acceptance into AVC and their water treatment plant's capability of supplying water to Avondale and Boone.

4.1.1.2 Crowley County Water Association Regional System

The Crowley County Water Association currently purchases about 45 percent of its annual water demand from the CCWS. The CCWS also provides water to the 96 pipeline, Town of Ordway, and the Town of Crowley. However, under Alternative 1, it is assumed that all existing regional pipelines and connections with CCWS will be disregarded and only the Crowley County Water Association will provide water through regional system pipelines that follow the preferred AVC alignment to connect these participating systems. Pipelines that follow the specifications of the AVC segment along Highway 96 will connect these systems, which will eventually tie into the AVC during Phase 2 of AVC construction.

4.1.1.3 Rocky Ford Regional System

The Rocky Ford system purchased and acquired the smaller system of Hancock to assist them in meeting their CDPHE enforcement order for combined radium and GAPA. All previously reported water demands and requested AVC deliveries for Hancock have been added to Rocky Ford for this regionalization study. The AVC segments east and west of Rocky Ford along Highway 50 will be constructed for regionalization and will become part of the AVC when the third segment of the AVC is constructed between Olney Springs and Manzanola.

4.1.1.4 La Junta Regional System

Due to La Junta's ability to treat radionuclides through their RO system, several AVC participants who were previously under CDPHE enforcement orders for radionuclides have taken action to address their violations by purchasing water from La Junta. Systems currently connected and receiving water from La Junta include the Bents Fort Water Company, the Homestead Improvement Association, and the Town of Swink. However, under Alternative 1, all existing regional pipelines and connections will be paralleled with the preferred AVC alignment to connect these participating systems.

4.1.1.5 Lamar Regional System

The Lamar regional system is the system located farthest from Pueblo Reservoir at the eastern end of the proposed AVC. The systems contained within the Lamar regional system for Alternative 1 would be the last systems connected to the AVC upon construction.

4.1.2 Proposed Regional System Connections

The total number of regional system connections for the five proposed regional hubs under Alternative 1 are included in **Table 4-2**. The estimated current and projected water demands for each of the five water providers and the total requested AVC deliveries for each regional system are depicted in **Figure 4-2**. The following subsections provide additional detail about water supplies and demands for the proposed regional systems of the St. Charles Mesa Water District, the Crowley County Water Association, Rocky Ford, La Junta, and Lamar for Alternative 1.

Table 4-2. Proposed System Connections for Each Regional System for Alternative 1

Regional Water Provider	Number of Participating Systems within Regional Hub[1]
St. Charles Mesa Water District	3
Crowley County Water Association	6
Rocky Ford	10
La Junta	14
Lamar	6

[1]Totals include the water provider and all participating systems

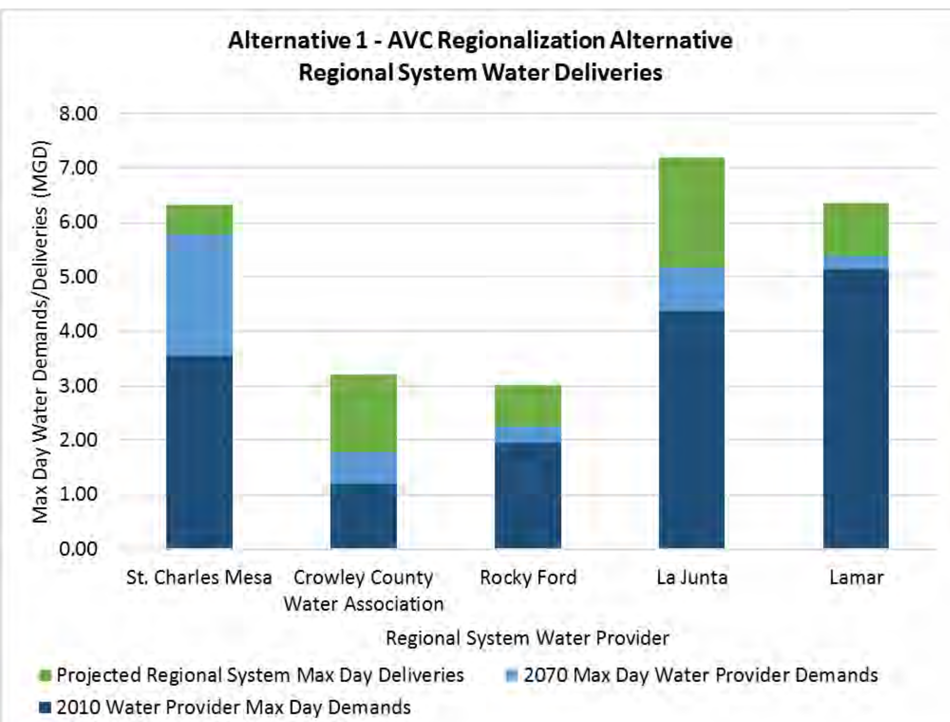

Figure 4-2. Projected Regional System Water Demands and Deliveries for Each Regional Water Provider Included in Alternative 1

4.1.2.1 St. Charles Mesa Water District Regional System

4.1.2.1.1 Water Demands

Under Alternative 1, the St. Charles Mesa water treatment plant would provide water meeting CDPHE requirements to two participating system connections in Pueblo County. Demands from 2010 and projected 2070 water demands and requested deliveries for the Alternative 1 St. Charles Mesa regional system are included in **Table 4-3**.

Table 4-3. Alternative 1 St. Charles Mesa Regional System Demands and Deliveries

Water Provider	Participating Systems	2010 Demand (AFY)	2010 Max Daily Demand (MGD)	2070 Demands (AFY)	2070 Max Daily Demand (MGD)	Annual Provider Deliveries (AFY)	Max Day Provider Deliveries (MGD)	Max Month Provider Deliveries (MGD)
St. Charles Mesa Water District	St. Charles Mesa Water District	1,660	3.56	2,698	5.78	2,651	5.68	3.90
	Boone*	66	0.14	111	0.24	94	0.20	0.14
	Avondale*	160	0.34	237	0.51	164	0.35	0.35
	St. Charles Mesa Regional System	**1,886**	**4.04**	**3,046**	**6.53**	**2,956**	**6.33**	**6.27**

Source: Black & Veatch 2012, Reclamation 2016a
*indicates systems currently under CDPHE enforcement orders
Projected regional system demands are the sum of the water providers' 2070 demands and the participating systems requested AVC deliveries.

4.1.2.1.2 Water Supplies

Water supply for St. Charles Mesa and the two participating systems is from a combination of surface water and groundwater sources. St. Charles Mesa Water District uses surface water supplies from the Arkansas River as their primary source of water while alluvial groundwater wells are used as supplemental supply during periods of peak demand.

A total of 2,956 AFY of water supplies are required to meet the proposed demands and deliveries for the St. Charles Mesa regional system. As shown in **Table 2-4**, St. Charles Mesa currently has access to 2,098 AFY of surface and alluvial groundwater supplies and would require an additional 858 AFY to meet regional system demands (**Figure 4-3**).

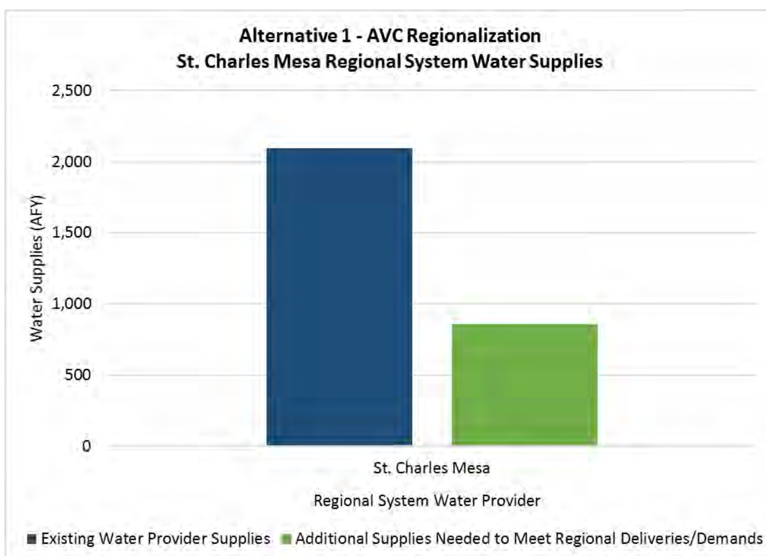

Figure 4-3. Additional Supplies Needed to Meet the Projected Demands and Deliveries for the Alternative 1 St. Charles Mesa Regional System

4.1.2.2 Crowley County Water Association Regional System

4.1.2.2.1 Water Demands

Under Alternative 1, the Crowley County Water Association, in addition to their own demands, would provide potable water to five participating systems in Otero and Crowley Counties. Demands from 2010 and projected 2070 water demands and requested deliveries for the Alternative 1 Crowley County Water Association regional system are included in **Table 4-4**.

Table 4-4. Alternative 1 Crowley County Water Association Regional System Demands and Deliveries

Water Provider	Participating Systems	2010 Demand (AFY)	2010 Max Daily Demand (MGD)	2070 Demands (AFY)	2070 Max Daily Demand (MGD)	Annual Provider Deliveries (AFY)	Max Day Provider Deliveries (MGD)	Max Month Provider Deliveries (MGD)
Crowley County Water Association	*Crowley County Water Association (Crowley County Water Association)*	564	1.21	824	1.77	617	1.32	0.91
	Olney Springs	40	0.09	60	0.13	59	0.13	0.09
	96 Pipeline Company	56	0.12	52	0.11	27	0.06	0.04
	Crowley	27	0.06	65	0.14	51	0.11	0.08
	Ordway	250	0.54	414	0.89	366	0.87	0.54
	Sugar City	82	0.18	128	0.27	127	0.27	0.19
	Crowley County Water Association Regional System	**1,019**	**2.20**	**1,543**	**3.31**	**1,454**	**3.21**	**2.70**

Source: Black & Veatch 2012, Reclamation 2016a
*indicates systems currently under CDPHE enforcement orders
Participating systems in italics are currently connected to and purchasing water from CCWS.
Projected regional system demands are the sum of the water providers' 2070 demands and the participating systems requested AVC deliveries.

4.1.2.2.2 Water Supplies

All participating systems within the Alternative 1 Crowley County Water Association regional system currently use alluvial groundwater wells as their source of water supply. No surface water resources are used within this regional hub.

A total of 1,454 AFY of water supplies are required to meet the proposed demands and deliveries for the Crowley County Water Association regional system. Currently, the Crowley County Water Association's groundwater supply capacity is only 701 AFY as shown in **Table 2-4**. An additional 753 AFY, more than double the existing groundwater supply capacity, would be required to meet the regional system demands and deliveries of the Alternative 1 Crowley County Water Association regional system (**Figure 4-4**).

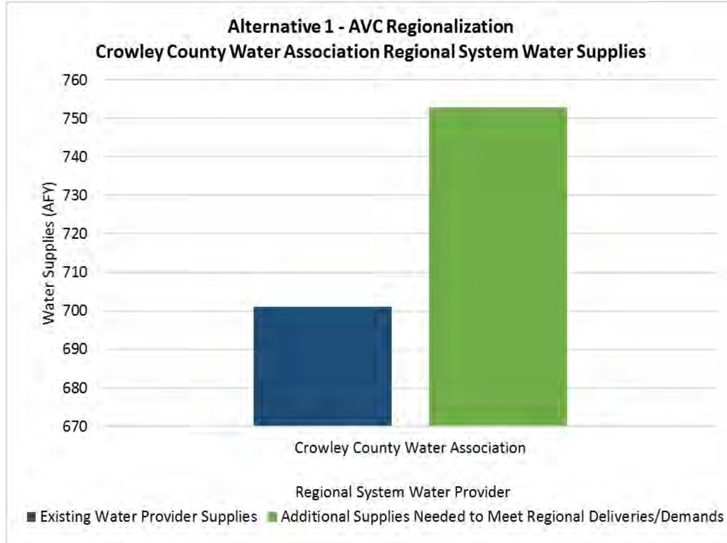

Figure 4-4. Additional Supplies Needed to Meet the Projected Demands and Deliveries for the Alternative 1 Crowley County Water Association Regional System

4.1.2.3 Rocky Ford Regional System

4.1.2.3.1 Water Demands

Under Alternative 1, the Rocky Ford water treatment plant would provide water meeting CDPHE standards to 10 smaller participating systems within Otero County. Demands from 2010 and projected 2070 water demands and requested deliveries for the Alternative 1 Rocky Ford regional system are included in **Table 4-5**.

Table 4-5. Alternative 1 Rocky Ford Regional System Demands and Deliveries

Regional Water Provider	Participating Systems	2010 Demand (AFY)	2010 Max Daily Demand (MGD)	2070 Demands (AFY)	2070 Max Daily Demand (MGD)	Annual Provider Deliveries (AFY)	Max Day Provider Deliveries (MGD)	Max Month Provider Deliveries (MGD)
Rocky Ford	Rocky Ford/Hancock	907	1.95	1050	2.25	594	1.27	0.87
	Valley Water Company*	38	0.08	39	0.08	39	0.08	0.06
	Manzanola*	39	0.08	37	0.08	50	0.11	0.07
	Vroman Water Company*	32	0.07	37	0.08	37	0.08	0.05
	Fayette Water Association*	12	0.03	14	0.03	14	0.03	0.02
	Patterson Valley Water Company*	15	0.03	17	0.04	17	0.04	0.03
	Eureka Water Company*	74	0.16	86	0.18	86	0.18	0.13

Regional Water Provider	Participating Systems	2010 Demand (AFY)	2010 Max Daily Demand (MGD)	2070 Demands (AFY)	2070 Max Daily Demand (MGD)	Annual Provider Deliveries (AFY)	Max Day Provider Deliveries (MGD)	Max Month Provider Deliveries (MGD)
	Newdale-Grande Valley Water Company	57	0.12	60	0.13	60	0.13	0.09
	West Grande Valley Inc	25	0.05	30	0.06	15	0.03	0.02
	Hilltop Water Company	45	0.10	50	0.11	40	0.09	0.06
	Rocky Ford Regional System	**1,244**	**2.67**	**1,420**	**3.04**	**1,408**	**3.02**	**2.78**

Source: Black & Veatch 2012, Reclamation 2016a
*indicates systems currently under CDPHE enforcement orders
Projected regional system demands are the sum of the water providers' 2070 demands and the participating systems requested AVC deliveries.

4.1.2.3.2 Water Supplies

Water supply for Rocky Ford and the nine participating systems is from a combination of deep and alluvial groundwater wells. Rocky Ford also has access to a supplemental surface water supply source to meet peak demands in the summer; however, the use of surface water has been discontinued for some time due to the lack of resources required to operate and maintain the surface water treatment plant.

The Alternative 1 Rocky Ford regional system requires 1,408 AFY of water supplies to meet the proposed demands and deliveries of all 10 participating systems. Currently, Rocky Ford's total water supply is estimated to be 1,487 AFY as shown in **Table 2-4**. The existing supplies are enough to meet regional system demands; however, additional supplies may be required for redundancy.

4.1.2.4 La Junta Regional System

4.1.2.4.1 Water Demands

Under Alternative 1, the La Junta water treatment plant would provide water meeting CDPHE standards to 13 participating systems within the counties of Otero and Bent, in addition to their own demands. Demands from 2010 and projected 2070 water demands and requested deliveries for the Alternative 1 La Junta regional system are included in **Table 4-6**.

Table 4-6. Alternative 1 La Junta Regional System Demands and Deliveries

Water Provider	Participating Systems	2010 Demand (AFY)	2010 Max Daily Demand (MGD)	2070 Demands (AFY)	2070 Max Daily Demand (MGD)	Annual Provider Deliveries (AFY)	Max Day Provider Deliveries (MGD)	Max Month Provider Deliveries (MGD)
La Junta	La Junta	2,040	4.37	2,417	5.18	2,300	4.93	3.38
	South Swink Water Company*	82	0.18	88	0.19	92	0.20	0.14
	Town of Swink	38	0.08	30	0.06	49	0.10	0.07
	Homestead Improvement Association	7	0.01	7	0.01	9	0.02	0.01
	Riverside*	20	0.02	26	0.03	20	0.02	0.02
	Bents Fort Water Company	63	0.13	55	0.12	81	0.17	0.12
	North Holbrook Water Company*	7	0.01	8	0.02	8	0.02	0.01
	West Holbrook Water Pipeline Association	14	0.03	18	0.04	9	0.02	0.01
	Holbrook Center Soft Water Association*	18	0.04	22	0.05	22	0.05	0.03
	Beehive Water Association*	8	0.02	6	0.01	10	0.02	0.02
	Cheraw*	48	0.10	57	0.12	30	0.06	0.04
	East End Water Association*	11	0.02	13	0.03	13	0.03	0.02
	Southside Water Association	7	0.01	7	0.01	5	0.01	0.01
	Las Animas	570	1.22	604	1.29	602	1.29	0.89
	La Junta Regional System	**2,933**	**6.24**	**3,358**	**7.16**	**3,367**	**7.19**	**6.57**

Source: Black & Veatch 2012, Reclamation 2016a
*indicates systems currently under CDPHE enforcement orders
Participating systems in italics are currently connected to and purchasing water from La Junta.
Projected regional system demands are the sum of the water providers' 2070 demands and the participating systems requested AVC deliveries.

4.1.2.4.2 Water Supplies

Water supply for La Junta and the 13 participating systems is from a combination of deep and alluvial groundwater wells. No surface water resources are used within this regional hub.

A total of 3,367 AFY of water supplies are required to meet the proposed demands and deliveries of the La Junta regional system. As shown in **Table 2-4**, La Junta's current groundwater supply capacity is 2,040 AFY. An additional 1,327 AFY of alluvial groundwater supply is required to meet regional system demands and deliveries for Alternative 1 (**Figure 4-5**).

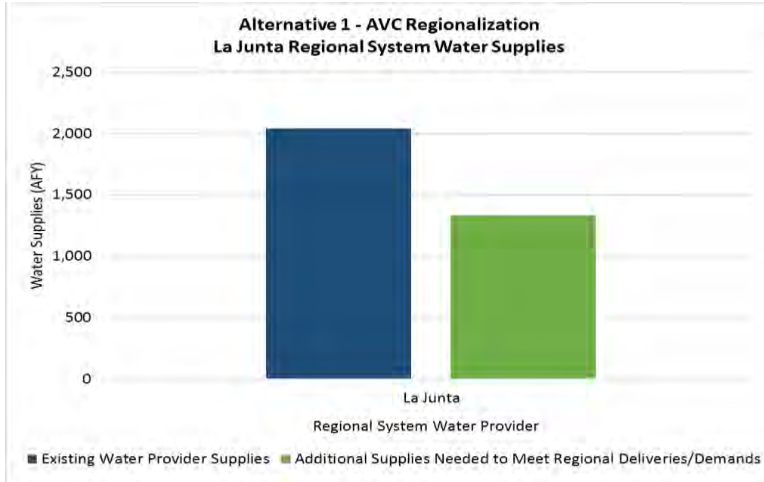

Figure 4-5. Additional Supplies Needed to Meet the Projected Demands and Deliveries for the Alternative 1 La Junta Regional System

4.1.2.5 Lamar Regional System

4.1.2.5.1 Water Demands

For Alternative 1, the Lamar water treatment plant would provide water meeting CDPHE Standards to five participating systems within Prowers, Bent, and Kiowa Counties, in addition to their own demands. Demands from 2010 and projected 2070 water demands and requested deliveries for the Alternative 1 Lamar regional system are included in **Table 4-7**.

Table 4-7. Alternative 1 Lamar Regional System Demands and Deliveries

Water Provider	Participating Systems	2010 Demand (AFY)	2010 Max Daily Demand (MGD)	2070 Demands (AFY)	2070 Max Daily Demand (MGD)	Annual Provider Deliveries (AFY)	Max Day Provider Deliveries (MGD)	Max Month Provider Deliveries (MGD)
Lamar	Lamar	2,400	5.14	2,511	5.38	1,241	2.66	1.83
	Hasty Water Company	32	0.07	33	0.07	33	0.07	0.05
	McClave Water Association, Inc.	56	0.12	59	0.13	59	0.13	0.09
	May Valley Water Association*	410	0.88	435	0.93	222	0.48	0.33
	Eads	250	0.54	232	0.50	116	0.25	0.17
	Town of Wiley	24	0.05	16	0.03	28	0.06	0.04
	Lamar Regional System	**3,172**	**6.80**	**3,286**	**7.04**	**2,969**	**6.36**	**6.05**

Source: Black & Veatch 2012, Reclamation 2016a
*indicates systems currently under CDPHE enforcement orders
Projected regional system demands are the sum of the water providers' 2070 demands and the participating systems requested AVC deliveries.

4.1.2.5.2 Water Supplies

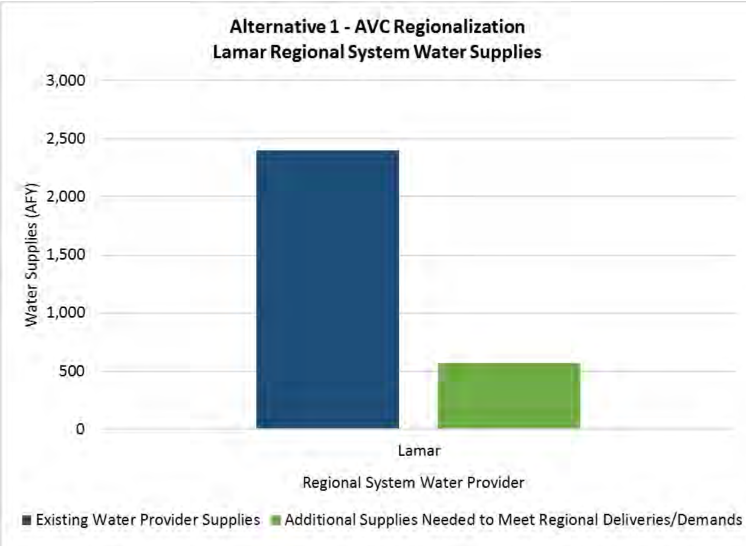

Figure 4-6. Additional Supplies Needed to Meet the Projected Demands and Deliveries for the Alternative 1 Lamar Regional System

Water supply for Lamar and the five participating systems is from a combination of deep and alluvial groundwater wells. No surface water resources are used within this regional hub.

A total of 2,969 AFY of water supplies are required to meet the proposed demands and deliveries of the Lamar regional system. Currently, Lamar's groundwater supply capacity is 2,400 AFY as shown in **Table 2-4**. An additional 569 AFY of alluvial groundwater supply is required to meet the regional system demands and deliveries for Alternative 1 (**Figure 4-6**).

4.1.3 Regional Provider's Existing Water Treatment and Distribution Systems

4.1.3.1 St. Charles Mesa Water District

The St. Charles Mesa Water District uses surface water as a primary source and alluvial well water as a supplemental source during peak demands. No current issues are reported with either of the district's sources. St. Charles Mesa Water District has enough surface water rights to accommodate projected expansions through 2070. Any treatment capacity expansions would then be met through upgrades of their surface water treatment plant (Black & Veatch 2012). **Table 4-8** summarizes St. Charles Mesa's source capacities and total treatment capacity.

Table 4-8. St. Charles Mesa Water District Source and Treatment Capacity Summary

Number of Wells	Average Well Capacity (MGD)	Total Well Capacity (MGD)	Surface Water Capacity (MGD)	Total Treatment Capacity (MGD)	Capacity Limiting Process
4	0.2	0.8	5.3	6.1	Filter Treatment Trains

St. Charles Mesa's surface water is treated in a conventional water treatment plant. Polyaluminium chloride coagulant is added, causing flocculation. Polymer is then dosed to bind the floccules together to encourage settling. Next, the water is filtered through granular media and then finally disinfected with chlorine dioxide before distribution. St. Charles Mesa has 4.4 million gallons (MG) of finished water storage upstream of their distribution system (Southeastern 2004). In 2019, St. Charles Mesa completed the installation of a third water filter in their treatment plant, increasing their total capacity to 4,200 gallons per minute or 6.1 MGD. A filter was also recently installed on the alluvial well water sources (St. Charles Mesa Water District Website 2019) and the filtered water is disinfected and blended with the treated surface water before distribution. **Figure 4-7** displays a process flow diagram for St. Charles Mesa Water District's treatment process.

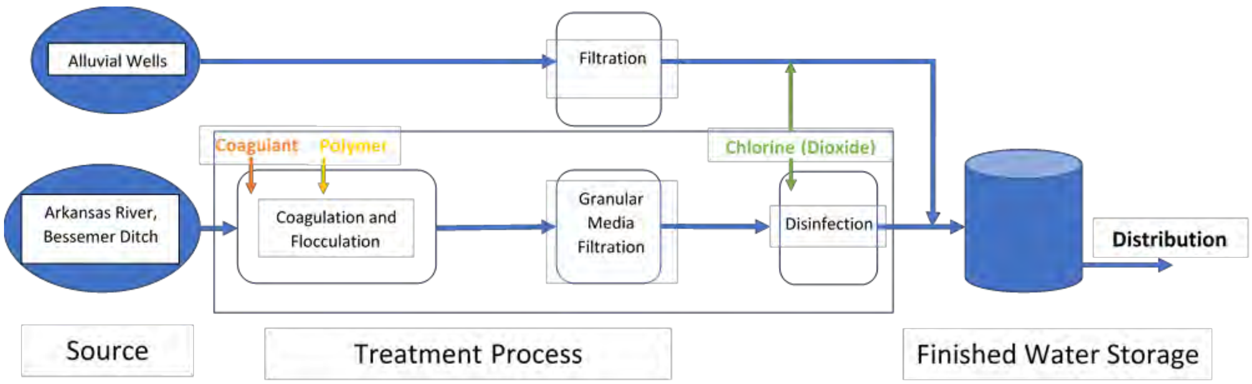

Figure 4-7. St. Charles Mesa Water District Regional Treatment System Process Flow Diagram

4.1.3.2 Crowley County Water Association

The Crowley County Water Association draws water from an alluvial well. There are no current reported issues with the source water. **Table 4-9** summarizes the well capacity information (Black & Veatch 2012).

Table 4-9. Crowley County Water Association Source and Treatment Capacity Summary

Number of Wells	Average Well Capacity (MGD)	Total Well Capacity (MGD)	Surface Water Capacity (MGD)	Total Treatment Capacity (MGD)	Capacity Limiting Process
1	1.3	1.3	NA	1.3	Alluvial well capacity

The alluvial well water is disinfected with chlorine gas before distribution. The Crowley County Water Association has 1.0 MG of finished water storage upstream of their distribution system (Southeastern 2004). The capacity of the chlorination disinfection system is 1.3 MGD (Talkington 2019). **Figure 4-8** is a basic flow diagram of the Crowley County Water Association's treatment process.

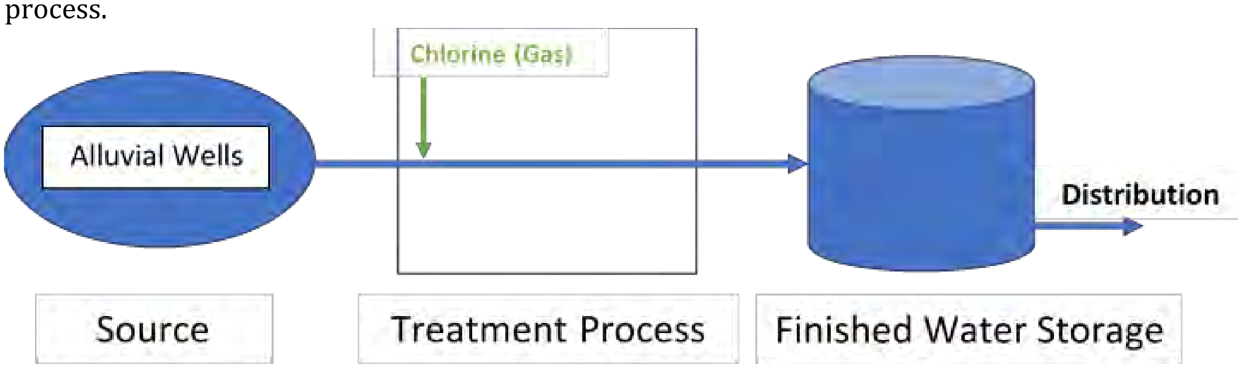

Figure 4-8. Crowley County Water Association

4.1.3.3 Rocky Ford

Rocky Ford's regional system has two water sources: alluvial wells by the Arkansas River and water diverted from the Catlin Canal. Before 2013, about half of Rocky Ford's supply came from the Catlin Canal, which was treated in a conventional water treatment plant during the months of May through September (Black & Veatch 2012). In recent years, all demands have been met with alluvial well water. **Table 4-10** summarizes the source capacities and total treatment capacity for Rocky Ford. The total treatment capacity only includes the well water because resources are not currently present to operate the water treatment plant.

Table 4-10. Rocky Ford Source and Treatment Capacity Summary

Number of Wells	Average Well Capacity (MGD)	Total Well Capacity (MGD)	Surface Water Capacity (MGD)	Total Treatment Capacity (MGD)[2]	Capacity Limiting Process
3	1.4	4.1	5.0	4.1	Alluvial well capacity

When the water treatment plant is operated, water from the Catlin Canal is conveyed into the head of the treatment facility where chlorine is added as a preoxidant to improve the coagulation process and initial disinfection. A coagulant is then dosed and flash mixed to adsorb dissolved organics and entrap suspended particles during the flocculation process. The water is then clarified using sedimentation basins equipped with high rate lamella plate packs. The clarified water is then filtered through gravity filters with sand and anthracite granular media to reduce turbidity to less than 0.3 NTU. Finally, the water is disinfected with chlorine gas in a dedicated contact basin (Black & Veatch 2012) to meet the disinfection contact requirements prior to pumping to finished water storage. Rocky Ford has 1.5 MG of finished water storage upstream of their distribution system (Southeastern 2004). The water treatment plant has not been operated since 2013 because the town lacks a Class A operator to fill the operator-in-charge (OIC) role. In addition, an estimated $0.5 to $1.5M in process improvements is needed to address O&M issues (TTG Consultants 2016).

Since 2013, all the region's demand has been met using water from alluvial wells. The well water is disinfected with chlorine and stored in two elevated storage tanks where it awaits distribution. **Figure 4-9** depicts the process flow diagram for Rocky Ford's treatment process (Black & Veatch 2012).

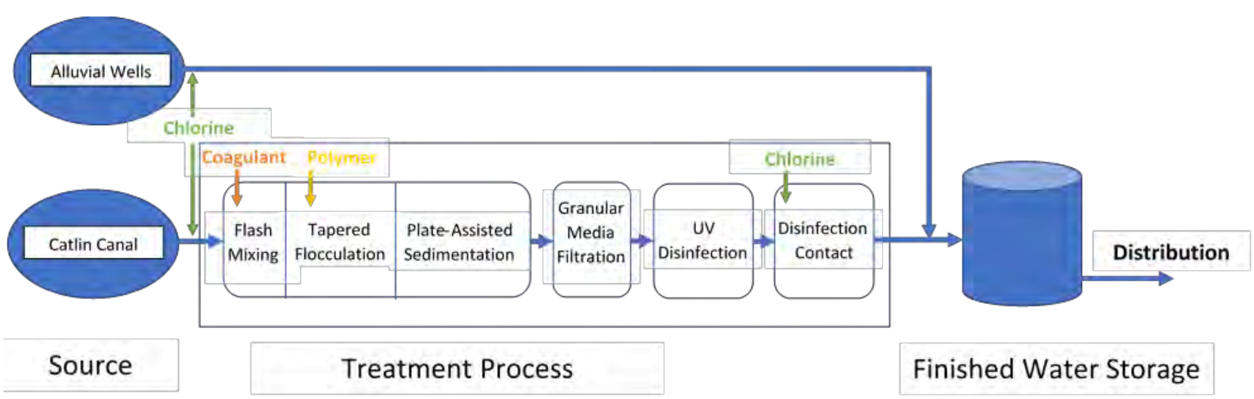

Figure 4-9. Rocky Ford Regional Treatment System Process Flow Diagram

[2]The water treatment plant has not been operated since 2013 due to lack of a Class A operator to act as an operator-in-charge. Facility upgrades were also recommended by TTG Consultants to address aging infrastructure. For these reasons, water treatment plant capacity is not included in total treatment capacity.

4.1.3.4 La Junta

Water for the La Junta regional system is provided by 14 alluvial wells. The alluvial well water has high concentrations of iron, manganese, total dissolved solids (TDS), selenium, uranium, radium, and sulfate. To reduce the concentrations of these contaminants, about 73 percent of the well water is treated using an RO process to produce a low-TDS permeate, and about 27 percent is treated using greensand filters to remove dissolved iron and manganese and then blended with the RO permeate to produce noncorrosive water meeting the CDPHE standards. La Junta has 5.4 MG of finished water storage upstream of their distribution system (Southeastern 2004). A portion of La Junta's well supplies, averaging about 1.0 MGD, is also used for blending with the brine discharge produced by the RO process (CDPHE 2019a) (Black & Veatch 2012). **Table 4-11** summarizes the source capacities and total treatment capacity of the La Junta regional system.

Table 4-11. La Junta Source and Treatment Capacity Summary

Number of Wells	Average Well Capacity (MGD)	Total Well Capacity (MGD)[3]	Surface Water Capacity (MGD)	Total Treatment Capacity (MGD)	Capacity Limiting Process
14	1.2	17.2	NA	6.6	RO Process

The dissolved salts in the raw water are concentrated in the RO, so the brine that has been diluted with well water is then blended with the town's wastewater treatment plant effluent to reduce the concentration of TDS prior to discharge to the Arkansas River. After the RO permeate and treated water from the iron and greensand filters is blended, it enters a dedicated chlorine contact basin where sodium hypochlorite is dosed. The disinfected water is stored in a tank before distribution (Black & Veatch 2012). **Figure 4-10** depicts the process flow diagram for La Junta's treatment system.

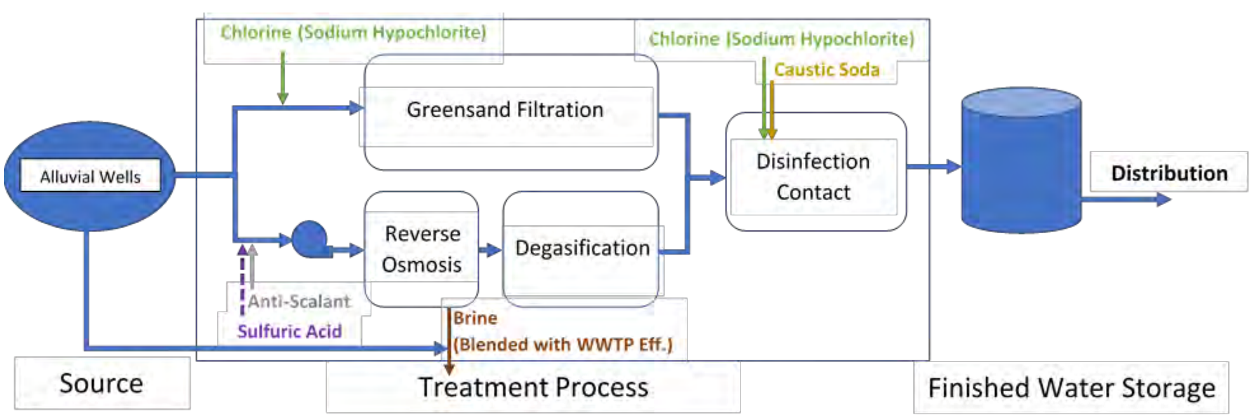

Figure 4-10. La Junta Regional Treatment System Process Flow Diagram

4.1.3.5 Lamar

The water source for the Lamar regional system is alluvial well groundwater from the Clay Creek aquifer. The aquifer is recharged from native water passing through the inactive Clay Creek Reservoir. This recharge is provided by 3,100 shares from the Fort Bent Ditch. The Clay Creek

[3]A portion of the well flow is blended with the brine discharge from the RO system (Black & Veatch 2012).

aquifer has lower TDS and hardness than the Arkansas River alluvium. **Table 4-12** summarizes the source capacities and total treatment capacity for Lamar (City of Lamar 2019).

Table 4-12. Lamar Source and Treatment Capacity Summary

Number of Wells	Average Well Capacity (MGD)	Total Well Capacity (MGD)	Surface Water Capacity (MGD)	Total Treatment Capacity (MGD)	Capacity Limiting Process
28	0.3	8.4	NA	4.0	Chlorination facility

Water from Lamar's 28 alluvial wells is pumped to a chlorination facility where sodium hypochlorite is added for disinfection. Fluoride is also added before the water is stored in two tanks totaling 8 million gallons of storage before distribution (Black & Veatch 2012). **Figure 4-11** depicts the process flow diagram for Lamar's treatment process.

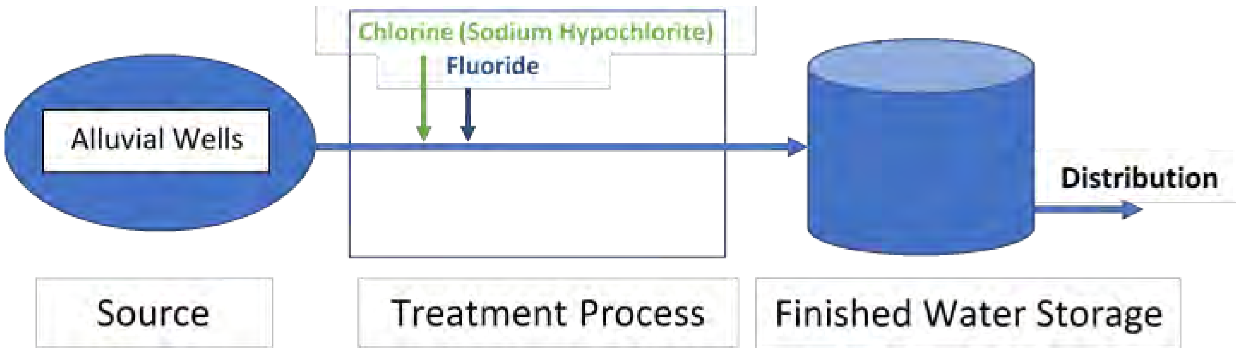

Figure 4-11. Lamar Regional Treatment System Process Flow Diagram

4.1.4 Proposed Participant Delivery Locations and Conduit Routes

The proposed participant delivery locations and conduit routes for the five regional systems under Alternative 1 are presented in this section. Refer to Section 6 of this report for further information and conveyance system modeling results.

4.1.4.1 St. Charles Mesa Water District Regional System

Under Alternative 1, the St. Charles Mesa Water District water treatment plant would provide treated water to its own service area and to the communities of Avondale and Boone. The proposed participant delivery locations and conduit routes for Alternative 1 are consistent with the preferred AVC alignment as depicted in **Figure 4-12**.

Figure 4-12. Alternative 1 St. Charles Mesa Regional System Participant Delivery Locations and Conduit Routes

4.1.4.2 Crowley County Water Association Regional System

For Alternative 1, the Crowley County Water Association water treatment plant would provide treated water to its own service area and to five other communities in Otero and Crowley Counties. The proposed participant delivery locations and conduit routes for the Alternative 1 Crowley County Water Association regional system are consistent with the preferred AVC alignment as depicted in **Figure 4-13**.

Figure 4-13. Alternative 1 Crowley County Water Association Regional System Participant Delivery Locations and Conduit Routes

4.1.4.3 Rocky Ford Regional System

The Rocky Ford water treatment plant would provide treated water to its own service area and to nine other communities in Otero County for Alternative 1. The proposed participant delivery locations and conduit routes for the Alternative 1 Rocky Ford regional system are consistent with the preferred AVC alignment as depicted in **Figure 4-14**.

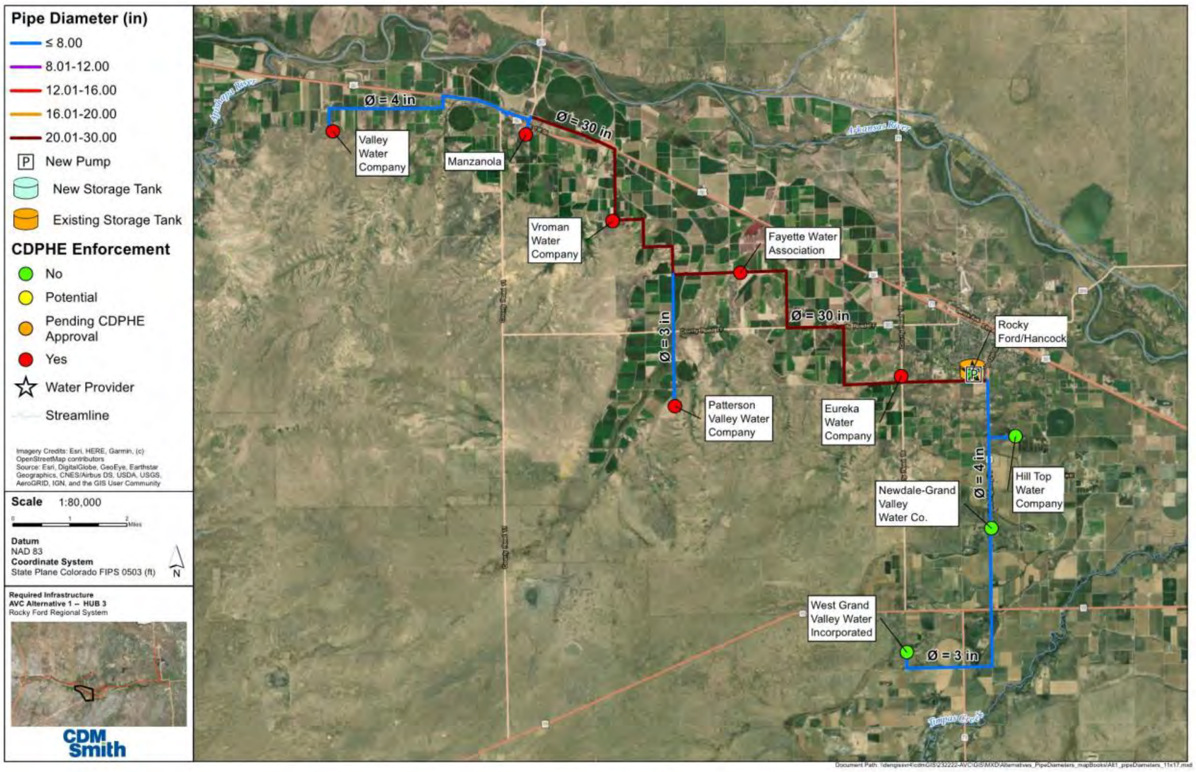

Figure 4-14. Alternative 1 Rocky Ford Regional System Participant Delivery Locations and Conduit Routes

4.1.4.4 La Junta Regional System

The La Junta water treatment plant would provide treated water to its own service area and to 13 other communities in Otero County for Alternative 1. The proposed participant delivery locations and conduit routes for the Alternative 1 La Junta regional system are consistent with the preferred AVC alignment as depicted in **Figure 4-15**.

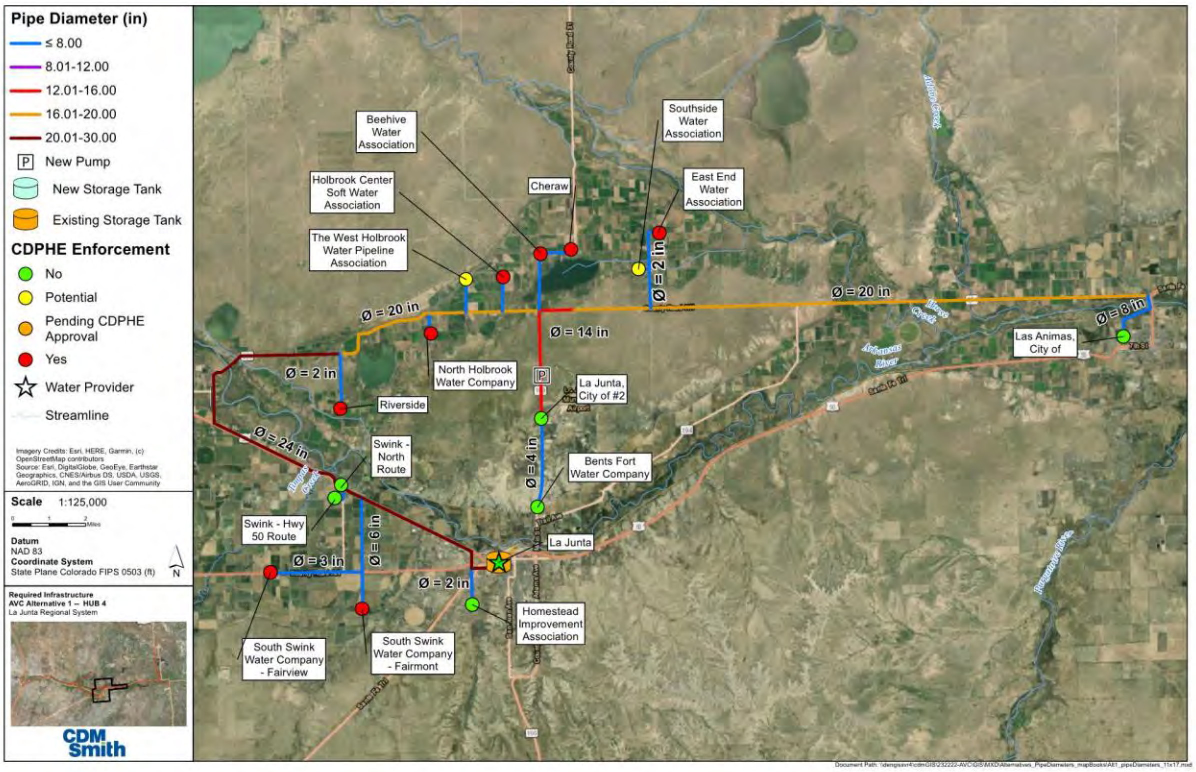

Figure 4-15. Alternative 1 La Junta Regional System Participant Delivery Locations and Conduit Routes

4.1.4.5 Lamar Regional System

Under Alternative 1, the Lamar water treatment plant would provide treated water to its own service area and to five communities within Bent, Prowers, and Kiowa Counties. The proposed participant delivery locations and conduit routes for Alternative 1 are consistent with the preferred AVC alignment as depicted in **Figure 4-16**.

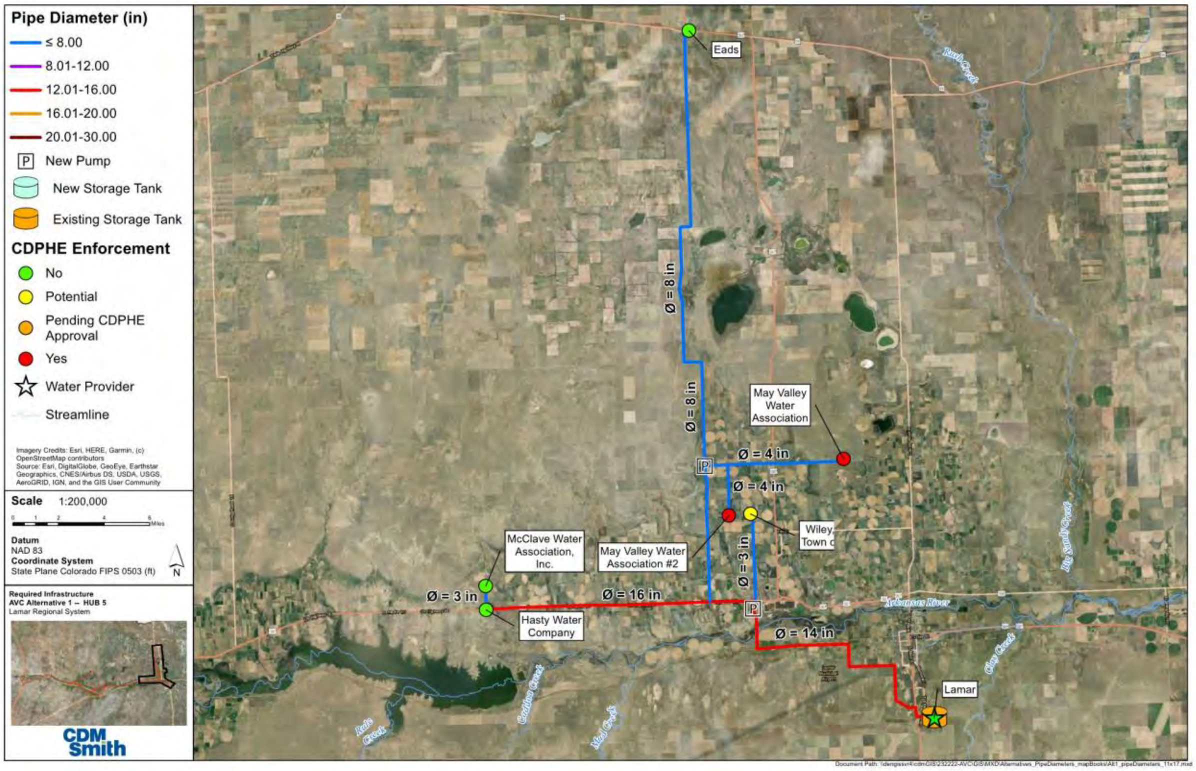

Figure 4-16. Alternative 1 Lamar Regional System Participant Delivery Locations and Conduit Routes

4.2 AVC-CDPHE Enforcement Regionalization Alternative (Alternative 2)

The four proposed regional hubs for Alternative 2 were developed based on the preferred AVC alignment and delivery locations and include only the participating systems that have current CDPHE enforcement orders, a high likelihood of future CDPHE enforcements, or are already purchasing and receiving water from the identified water provider (**Figure 4-17**). In addition to the general assumptions considered for Alternative 1, development of the AVC-CDPHE Enforcement Regionalization alternative required the identification of participating systems with a high potential for future source water quality issues and resulting CDPHE enforcement orders.

Previous studies evaluating radionuclide contamination in the Arkansas River Basin have shown that water providers using deep groundwater wells in Otero, Kiowa, and Prowers Counties have a 30 to 40 percent higher probability of having elevated TENORM levels in their water supply (Miller et al. 2010, Reclamation 2013). As such, the following assumptions were used to identify participating systems with a high potential for future CDPHE enforcement for Alternative 2:

- The water provider currently uses deep groundwater wells as the primary source of supply.
- The water provider is located within Otero, Kiowa, or Prowers Counties.
- The water provider is located less than 2 miles from other AVC participants that are currently under CDPHE enforcement orders.

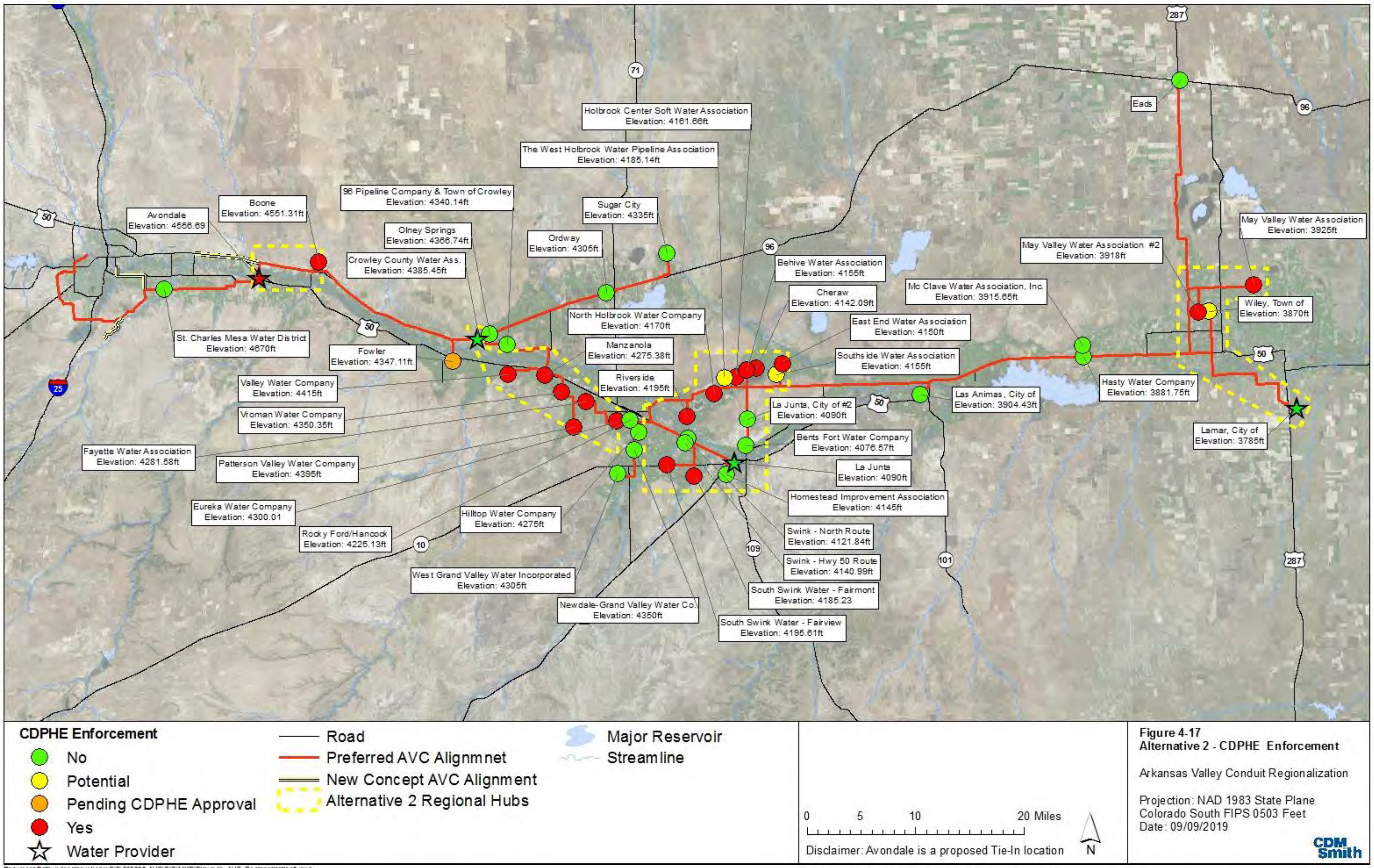

Figure 4-17. Regional Hubs Included in Alternative 2

4.2.1 Future AVC Integration Implementation

This section summarizes the future AVC integration plan for the water providers and participating systems included in Alternative 2, and how those considerations were incorporated into the development of this alternative.

4.2.1.1 Avondale Regional System

Under Alternative 2, Avondale would supply high quality water to Boone. Avondale and Boone are the most recent AVC participants and are currently planned to be the first systems connected to the AVC during Phase 1 AVC construction. Additionally, Boone and Avondale have both received CDPHE enforcement orders in 2018 and 2019, respectively, for the reclassification of their water supplies as GUDI. Designation of water supplies as GUDI requires additional treatment to meet existing drinking water quality standards as presented in Section 3. Avondale and Boone have already entered an agreement for Avondale to supply water to Boone to address this CDPHE enforcement. As such, Avondale as a regional water provider to Boone was evaluated as part of this AVC regionalization study.

4.2.1.2 Crowley County Water Association Regional System

The Crowley County Water Association currently purchases about 45 percent of its annual water demand from the CCWS. However, under Alternative 2, it is assumed that all existing regional pipelines and connections with CCWS will be disregarded and only the Crowley County Water Association will provide water through regional system pipelines that follow the preferred AVC alignment that connect to the participating systems.

4.2.1.3 La Junta Regional System

As discussed in Section 4.1.1.4, La Junta is currently connected and providing water to the Bents Fort Water Company, the Homestead Improvement Association, and the Town of Swink. As with Alternative 1, Alternative 2 will parallel all existing regional pipelines and connections and the larger AVC pipeline segment will be used to connect these participating systems.

4.2.1.4 Lamar Regional System

The Lamar regional system is the system located farthest from Pueblo Reservoir at the eastern end of the proposed AVC. The systems contained within the Lamar regional system for Alternative 2 would be some of the last systems connected to AVC upon construction.

4.2.2 Proposed Regional System Connections

The total number of regional system connections for the four proposed regional hubs under Alternative 2 are included in **Table 4-13**. The 2010 and projected 2070 water demands for each of the four water providers and the total requested AVC deliveries for each regional system are depicted in **Figure 4-18**. The following subsections provide additional detail about water supplies and demands for the proposed regional systems of Avondale, Rocky Ford, La Junta, and Lamar for Alternative 2.

Table 4-13. Total Number of Proposed System Connections for Each Regional System for Alternative 2

Regional Water Provider	Number of Participating Systems within Regional Hub[1]
Avondale	2
Crowley County Water Association	7
La Junta	13
Lamar	3

[1]Totals include the water provider and all participating systems

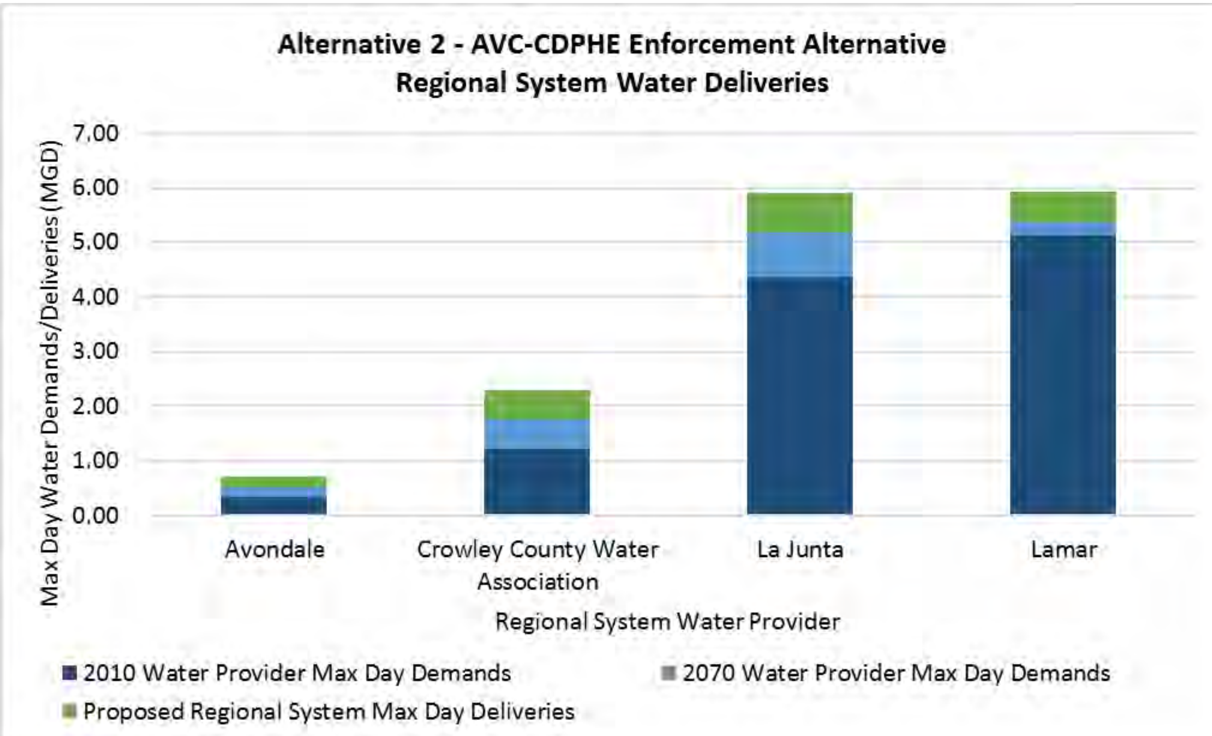

Figure 4-18. Projected Regional System Water Demands and Deliveries for Each Regional Water Provider Included in Alternative 2

4.2.2.1 Avondale Regional System

4.2.2.1.1 Water Demands and Deliveries

Under Alternative 2, the Avondale water treatment plant would provide high quality water to Boone in Pueblo County. Demands from 2010 and projected 2070 water demands and requested deliveries for the Alternative 2 Avondale regional system are included in **Table 4-14**.

Table 4-14. Alternative 2 Avondale Regional System Demands and Deliveries

Water Provider	Participating Systems	2010 Demand (AFY)	2010 Max Daily Demand (MGD)	2070 Demands (AFY)	2070 Max Daily Demand (MGD)	Annual Provider Deliveries (AFY)	Max Day Provider Deliveries (MGD)	Max Month Provider Deliveries (MGD)
Avondale	Avondale*	160	0.34	237	0.51	164	0.35	0.35
	Boone*	66	0.14	111	0.24	94	0.20	0.14
	Avondale Regional System	**226**	**0.48**	**348**	**0.75**	**331**	**0.71**	**0.65**

Source: Black & Veatch 2012, Reclamation 2016a
*indicates systems currently under CDPHE enforcement orders
Projected regional system demands are the sum of the water providers' 2070 demands and the participating systems requested AVC deliveries.

4.2.2.1.2 Water Supplies

Both Avondale and Boone currently use alluvial groundwater wells as their source of water supply. No surface water resources are used within this regional hub.

A total of 331 AFY of water supplies are required to meet the proposed demands and deliveries for the Avondale regional system. As shown in **Table 2-4**, Avondale currently has access to 160 AFY of alluvial groundwater supplies and would require an additional 171 AFY to meet regional system demands (**Figure 4-19**).

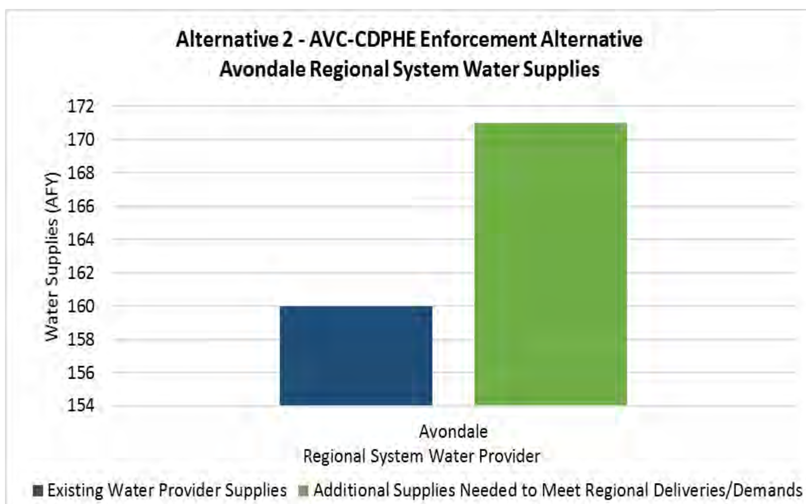

Figure 4-19. Additional Supplies Needed to Meet the Projected Demands and Deliveries for the Alternative 2 Avondale Regional System

4.2.2.2 Crowley County Water Association Regional System

4.2.2.2.1 Water Demands

Under Alternative 2, the Crowley County Water Association water treatment plant would provide water to six participating systems in Otero County, in addition to their own demands. Demands from 2010 and projected 2070 water demands and requested deliveries for the Alternative 2 Crowley County Water Association regional system are included in **Table 4-15**.

Table 4-15. Alternative 2 Crowley County Water Association Regional System Demands and Deliveries

Water Provider	Participating Systems	2010 Demand (AFY)	2010 Max Daily Demand (MGD)	2070 Demands (AFY)	2070 Max Daily Demand (MGD)	Annual Provider Deliveries (AFY)	Max Day Provider Deliveries (MGD)	Max Month Provider Deliveries (MGD)
Rocky Ford	Crowley County Water Association	564	1.21	824	1.77	617	1.32	0.91
	Valley Water Company*	38	0.08	39	0.08	39	0.08	0.06
	Manzanola*	39	0.08	37	0.08	50	0.11	0.07
	Vroman Water Company*	32	0.07	37	0.08	37	0.08	0.05
	Fayette Water Association*	12	0.03	14	0.03	14	0.03	0.02
	Patterson Valley Water Company*	15	0.03	17	0.04	17	0.04	0.03
	Eureka Water Company*	74	0.16	86	0.18	86	0.18	0.13
	Rocky Ford Regional System	**774**	**1.66**	**1,054**	**2.26**	**1,067**	**2.29**	**2.13**

Source: Black & Veatch 2012, Reclamation 2016a
*indicates systems currently under CDPHE enforcement orders
Projected regional system demands are the sum of the water providers' 2070 demands and the participating systems requested AVC deliveries.

4.2.2.2.2 Water Supplies

Water supply for the Crowley County Water Association and the six participating systems is primarily from a combination of deep and alluvial groundwater wells.

The Alternative 2 Crowley County regional system requires 1,067 AFY of water supplies to meet the proposed demands and deliveries of all seven participating systems. Currently, the Crowley County Water Association's total water supply as shown in **Table 2-4** is estimated to be 701 AFY. An additional 366 AFY would be needed to meet regional system demands (**Figure 4-20**).

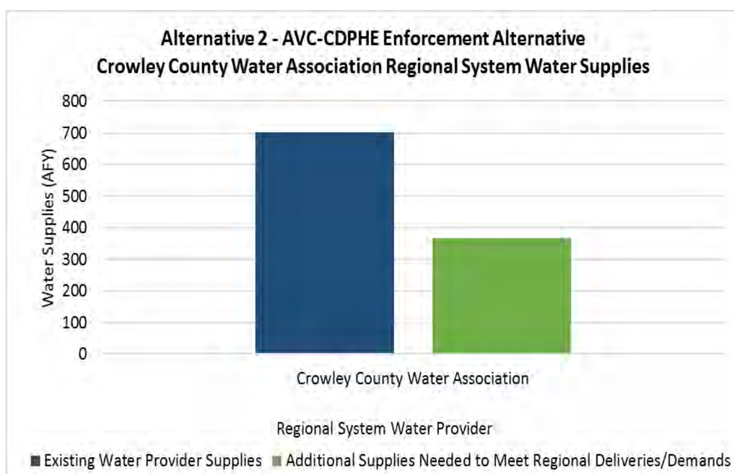

Figure 4-20. Additional Supplies Needed to Meet the Projected Demands and Deliveries for the Alternative 2 Crowley County Water Association Regional System

4.2.2.3 La Junta Regional System

4.2.2.3.1 Water Demands and Deliveries

Under Alternative 2, the La Junta water treatment plant would provide water to 12 participating systems within Otero County, in addition to their own demands. Current and projected water demands and requested deliveries for the Alternative 2 La Junta regional system are included in **Table 4-16**.

Table 4-16. Alternative 2 La Junta Regional System Demands and Deliveries

Water Provider	Participating Systems	2010 Demand (AFY)	2010 Max Daily Demand (MGD)	2070 Demands (AFY)	2070 Max Daily Demand (MGD)	Annual Provider Deliveries (AFY)	Max Day Provider Deliveries (MGD)	Max Month Provider Deliveries (MGD)
La Junta	La Junta	2,040	4.37	2,417	5.18	2,300	4.93	3.38
	South Swink Water Company*	82	0.18	88	0.19	92	0.20	0.14
	Town of Swink	38	0.08	30	0.06	49	0.10	0.07
	Homestead Improvement Association	7	0.01	7	0.01	9	0.02	0.01
	Riverside*	20	0.02	26	0.03	20	0.02	0.02
	Bents Fort Water Company	63	0.13	55	0.12	81	0.17	0.12
	North Holbrook Water Company*	7	0.01	8	0.02	8	0.02	0.01
	Holbrook Center Soft Water Association*	18	0.04	22	0.05	22	0.05	0.03
	Beehive Water Association*	8	0.02	6	0.01	10	0.02	0.02
	Cheraw*	48	0.10	57	0.12	30	0.06	0.04
	East End Water Association*	11	0.02	13	0.03	13	0.03	0.02
	West Holbrook Water Pipeline Association$^{\Delta}$	14	0.03	18	0.04	9	0.02	0.01
	Southside Water Association$^{\Delta}$	7	0.01	7	0.01	5	0.01	0.01
	La Junta Regional System	**2,363**	**5.02**	**2,754**	**5.87**	**2,765**	**5.90**	**5.68**

Source: Black & Veatch 2012, Reclamation 2016a
*indicates systems currently under CDPHE enforcement orders
$^{\Delta}$ indicates systems with the potential for future CDPHE enforcement orders
Participating systems in italics are currently connected to and purchasing water from La Junta.
Projected regional system demands are the sum of the water providers' 2070 demands and the participating systems requested AVC deliveries.

4.2.2.3.2 Water Supplies

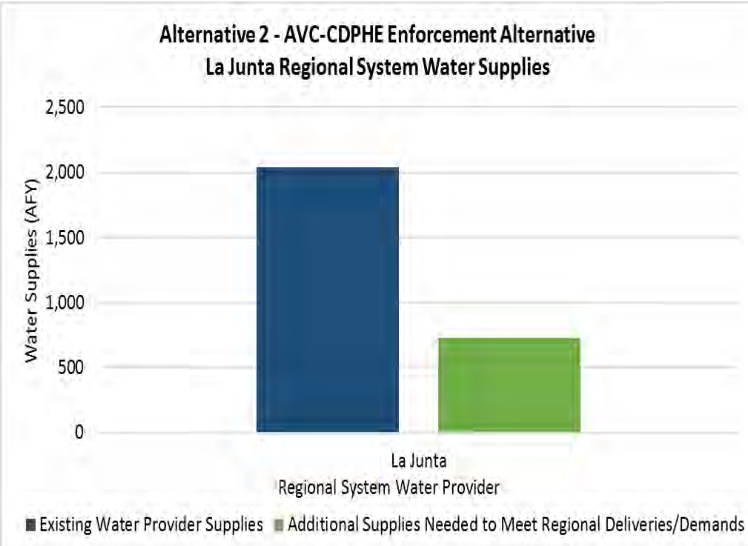

Figure 4-21. Additional Supplies Needed to Meet the Projected Demands and Deliveries for the Alternative 2 La Junta Regional System

Water supply for La Junta and the 12 participating systems is from a combination of deep and alluvial groundwater wells. No surface water resources are used within this regional hub.

A total of 2,765 AFY of water supplies are required to meet the proposed demands and deliveries of the La Junta regional system. Currently, La Junta's groundwater supply capacity is 2,040 AFY as shown in **Table 2-4**. An additional 725 AFY of alluvial groundwater supply is required to meet regional system demands and deliveries for Alternative 2 (**Figure 4-21**).

4.2.2.4 Lamar Regional System

4.2.2.4.1 Water Demands

For Alternative 2, the Lamar supply and disinfection system would provide water to two participating systems within Prowers and Bent Counties, in addition to their own demands. Demands from 2010 and projected 2070 water demands and requested deliveries for the Alternative 2 Lamar regional system are included in **Table 4-17**.

Table 4-17. Alternative 2 Lamar Regional System Demands and Deliveries

Water Provider	Participating Systems	2010 Demand (AFY)	2010 Max Daily Demand (MGD)	2070 Demands (AFY)	2070 Max Daily Demand (MGD)	Annual Provider Deliveries (AFY)	Max Day Provider Deliveries (MGD)	Max Month Provider Deliveries (MGD)
Lamar	Lamar	2,400	5.14	2,511	5.38	1,241	2.66	1.83
	May Valley Water Association*	410	0.88	435	0.93	222	0.48	0.33
	Town of Wiley$^{\Delta}$	24	0.05	16	0.03	28	0.06	0.04
	Lamar Regional System	**2,810**	**6.02**	**2,946**	**6.31**	**2,761**	**5.92**	**5.75**

Source: Black & Veatch 2012, Reclamation 2016a
*indicates systems currently under CDPHE enforcement orders
$^{\Delta}$ indicates systems with the potential for future CDPHE enforcement orders
Projected regional system demands are the sum of the water providers' 2070 demands and the participating systems requested AVC deliveries.

4.2.2.4.2 Water Supplies

Water supply for Lamar and the two participating systems is from a combination of deep and alluvial groundwater wells. No surface water resources are used within this regional hub.

A total of 2,761 AFY of water supplies are required to meet the proposed demands and deliveries of the Lamar regional system. Currently, Lamar's groundwater supply capacity is 2,400 AFY as shown in **Table 2-4**. An additional 361 AFY of alluvial groundwater supply is required to meet the regional system demands and deliveries for Alternative 2 (**Figure 4-22**).

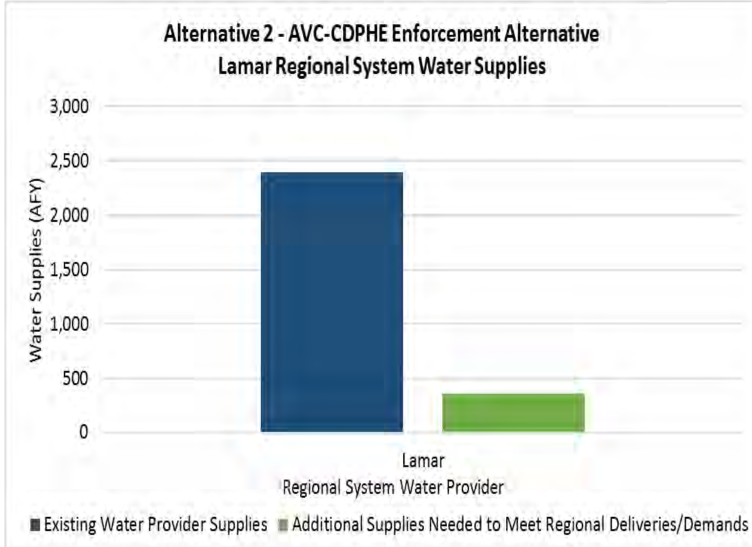

Figure 4-22. Additional Supplies Needed to Meet the Projected Demands and Deliveries for the Alternative 2 Lamar Regional System

4.2.3 Regional Provider's Existing Water Treatment and Distribution Systems

4.2.3.1 Avondale

Avondale's water sources consist of three alluvial wells, one of which was recently classified as GUDI. As a result, water from this well requires additional filtration to comply with surface water treatment standards (CDPHE 2019b). **Table 4-18** summarizes the source and treatment capacities for Avondale. Total treatment capacity considers only the wells that are currently in compliance.

Table 4-18. Avondale Source and Treatment Capacity Summary

Number of Wells	Average Well Capacity (MGD)	Total Well Capacity (MGD)	Surface Water Capacity (MGD)	Total Treatment Capacity (MGD)	Capacity Limiting Process
Groundwater (compliant): 2 GUDI (noncompliant): 1	0.3	0.6	NA	0.6	Well Capacity and Filtration

Water from Avondale's alluvial wells passes through greensand pressure filters and a granular activated carbon (GAC) system before it is disinfected with chlorine and distributed (Black & Veatch 2012). Avondale has 1.0 MG of finished water storage upstream of their distribution system (Southeastern 2005). **Figure 4-23** is a process flow diagram of Avondale's treatment process.

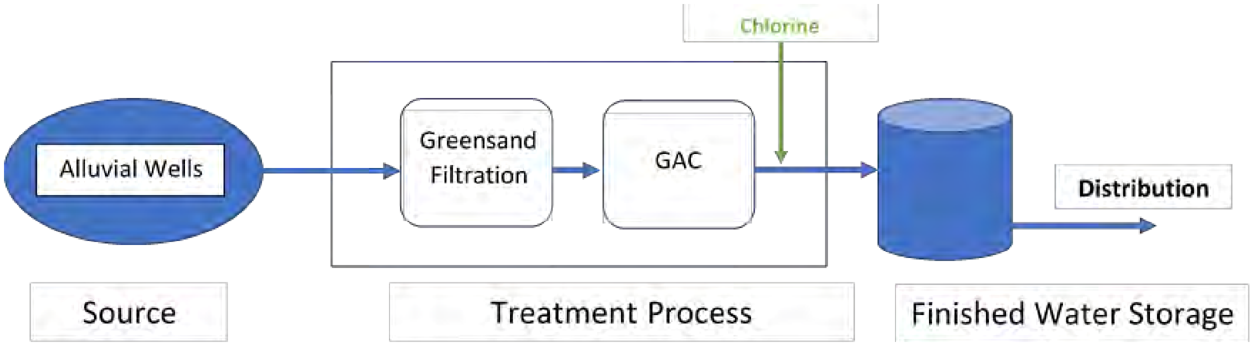

Figure 4-23. Avondale Regional Treatment System Process Flow Diagram

4.2.3.2 Crowley County Water Association

Refer to Section 4.1.3.2 for a description of the Crowley County Water Association's existing water treatment and distribution system.

4.2.3.3 La Junta

Refer to Section 4.1.3.4 for a description of La Junta's existing water treatment and distribution system.

4.2.3.4 Lamar

Refer to Section 4.1.3.5 for a description of Lamar's existing water treatment and distribution system.

4.2.4 Proposed Participant Delivery Locations and Conduit Routes

The proposed participant delivery locations and conduit routes for the five regional systems under Alternative 2 are presented in this section. Refer to Section 6 for further information and conveyance system modeling results.

4.2.4.1 Avondale Regional System

Under Alternative 2, the Avondale water treatment plant would provide treated water to its own service area and to the community of Boone in Pueblo County. The proposed participant delivery location and conduit routes for the Alternative 2 Avondale regional system are consistent with the preferred AVC alignment as depicted in **Figure 4-24**.

Figure 4-24. Alternative 2 Avondale Regional System Proposed Participant Delivery Locations and Conduit Routes

4.2.4.2 Crowley County Water Association Regional System

For Alternative 2, the Crowley County Water Association water treatment plant would provide treated water to its own service area and to six communities in Otero County. The proposed participant delivery locations and conduit routes for the Alternative 2 Crowley County Water Association regional system are consistent with the preferred AVC alignment as depicted in **Figure 4-25**.

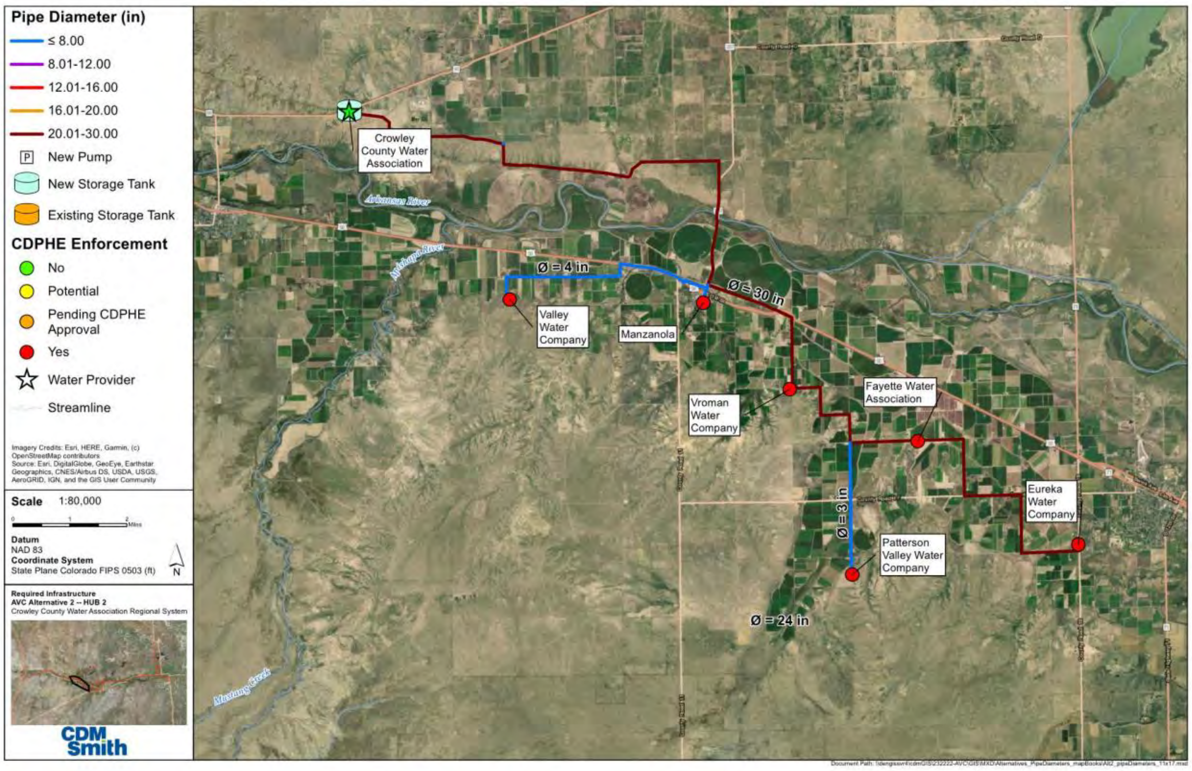

Figure 4-25. Alternative 2 Crowley County Water Association Regional System Proposed Participant Delivery Locations and Conduit Routes

4.2.4.3 La Junta Regional System

For Alternative 2, the La Junta water treatment plant would provide treated water to its own service area and to 12 communities in Otero County. The proposed participant delivery locations and conduit routes for the Alternative 2 La Junta regional system are consistent with the preferred AVC alignment as depicted in **Figure 4-26**.

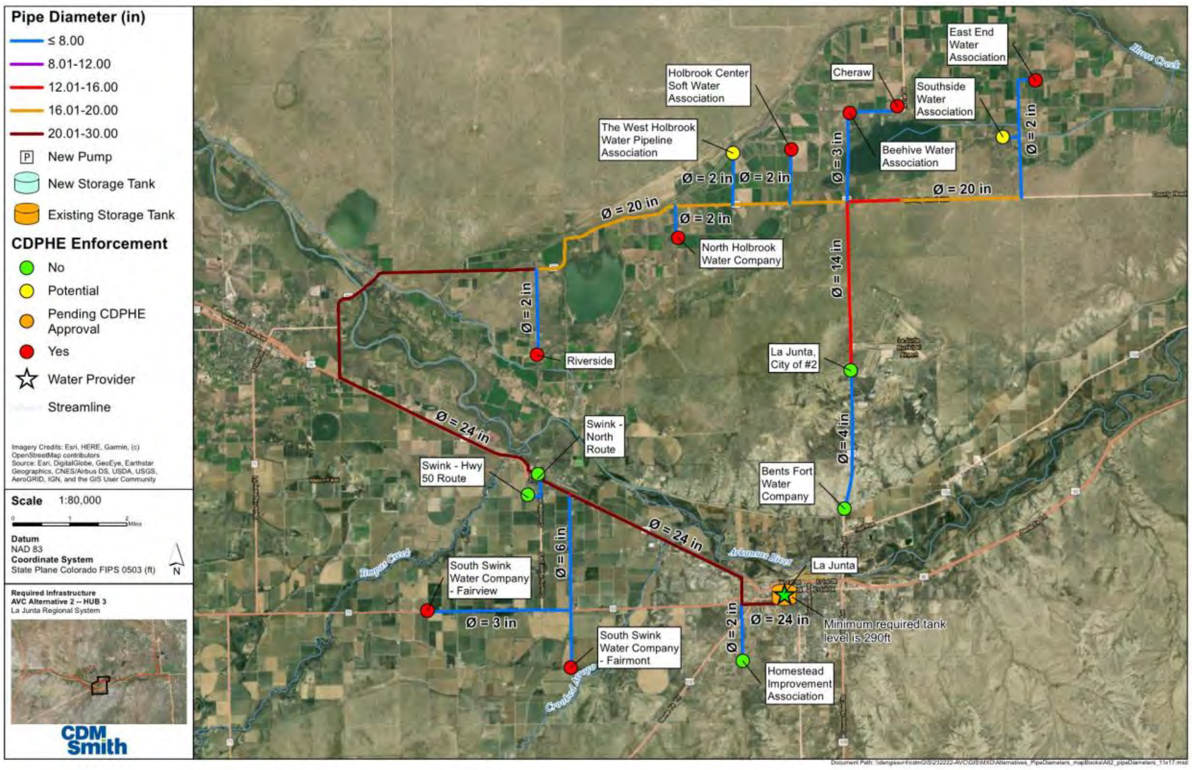

Figure 4-26. Alternative 2 La Junta Regional System Proposed Participant Delivery Locations and Conduit Routes

CDM Smith

4.2.4.4 Lamar Regional System

Under Alternative 2, the Lamar water treatment plant would provide treated water to its own service area and to two communities in Bent and Prowers Counties. The proposed participant delivery locations and conduit routes for the Alternative 2 Lamar regional system are consistent with the preferred AVC alignment as depicted in **Figure 4-27**.

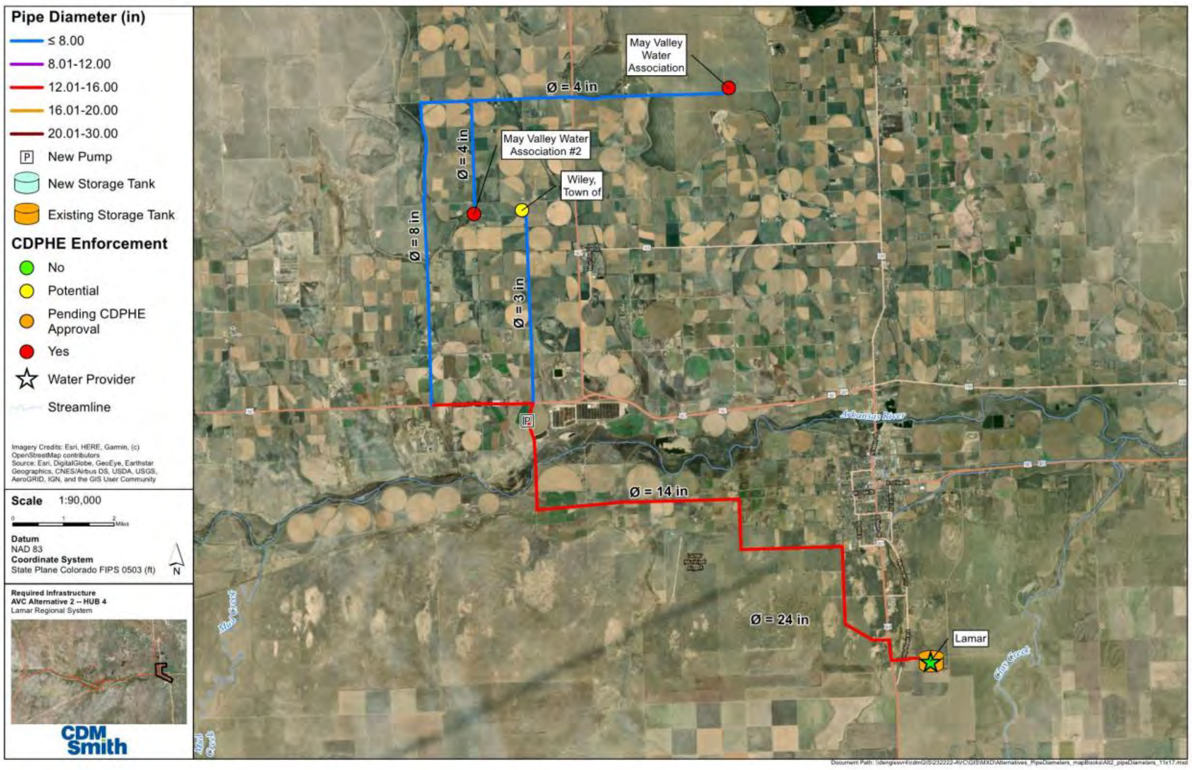

Figure 4-27. Alternative 2 Lamar Regional System Proposed Participant Delivery Locations and Conduit Routes

4.3 CDPHE Enforcement Regionalization Alternative (Alternative 3)

The five proposed regional hubs for Alternative 3 follow alternate pipeline alignments and delivery locations to optimize the system. The same participating systems from Alterative 2 that have current or a high likelihood of future CDPHE enforcements are included in Alternative 2 (**Figure 4-28**). In some instances, where existing regional system connections can be used, new pipeline would only be constructed to connect new connections under this alternative. The same general assumptions used for the development of Alternatives 1 and 2 were also used for Alternative 3.

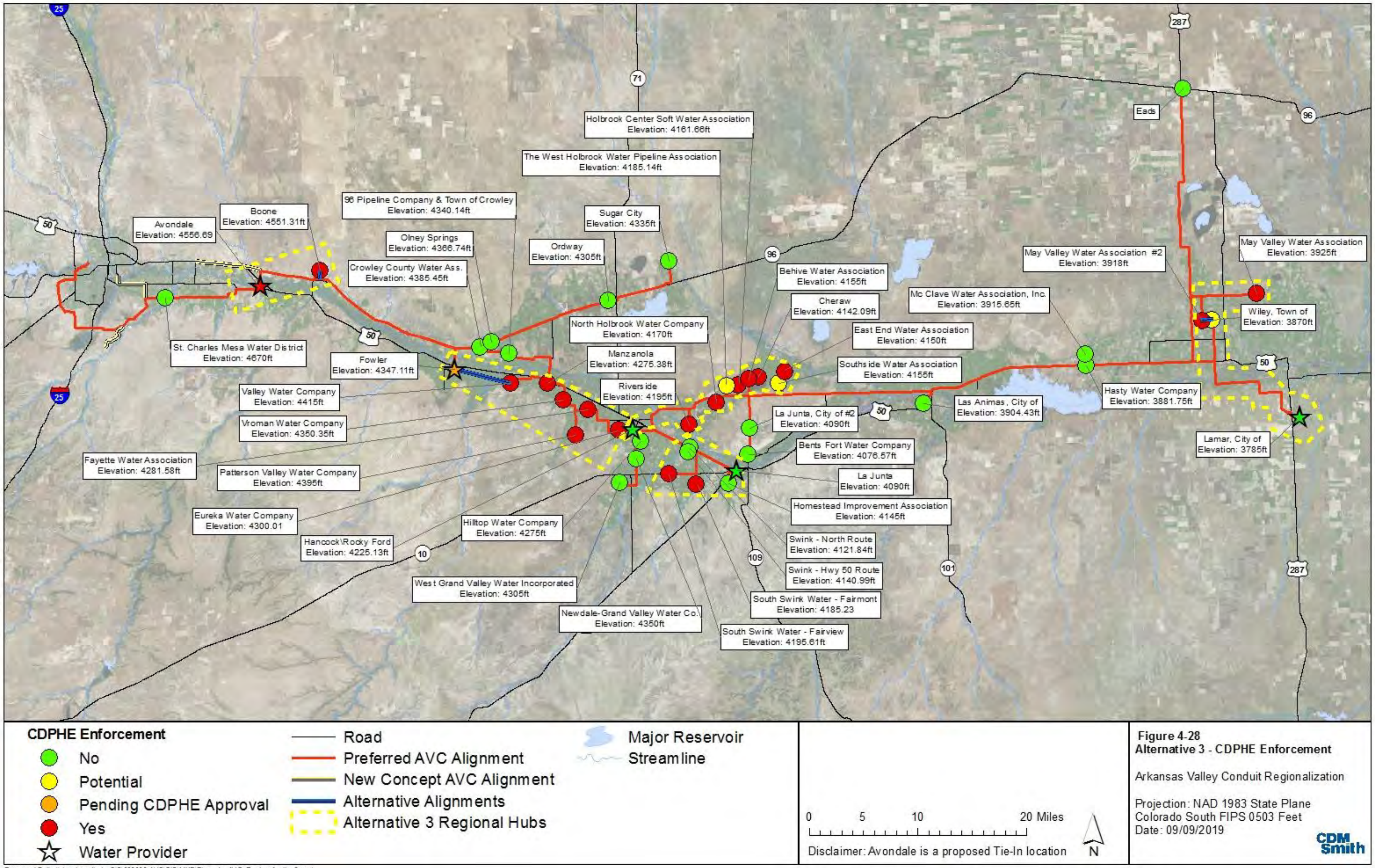

Figure 4-28. Regional Hubs Included in Alternative 3

4.3.1 Future AVC Integration Implementation

4.3.1.1 Avondale Regional System

Under Alternative 3, Avondale would supply high quality water to Boone. Avondale and Boone are the most recent AVC participants and are currently planned to be the first systems connected to the AVC during Phase 1 AVC implementation due to their proximity to Pueblo, Colorado. Additionally, Boone and Avondale have both received CDPHE enforcement orders in 2018 and 2019, respectively, for the reclassification of their water supplies as GUDI. Designation of water supplies as GUDI requires additional treatment to meet existing drinking water quality standards as presented in Section 3. Avondale and Boone have already entered an agreement for Avondale to supply water to Boone to address this CDPHE enforcement.

4.3.1.2 Fowler Regional System

Like Avondale and Boone, Fowler's alluvial groundwater supplies were recently reclassified as GUDI, which required the implementation of conventional surface water treatment at their water treatment plant. Fowler has taken steps to address this enforcement order but will continue to be in violation until CDPHE completes their observation period of actions taken.

4.3.1.3 Rocky Ford Regional System

The Rocky Ford system purchased and acquired the smaller system of Hancock to assist Hancock in meeting their CDPHE enforcement order. All previously reported water demands and requested AVC deliveries for Hancock have been added to Rocky Ford for this regionalization study.

4.3.1.4 La Junta Regional System

As discussed in Section 4.1.1.4, La Junta is currently connected and providing water to the Bents Fort Water Company, the Homestead Improvement Association, and the Town of Swink. Unlike Alternatives 1 and 2, pipeline alignments and connections points for Alternative 3 will take into account existing regional pipelines and connections in an effort to minimize costs associated with regionalization as an interim measure to AVC.

4.3.1.5 Lamar Regional System

The Lamar regional system is the system located farthest from Pueblo Reservoir at the eastern end of the proposed AVC. The systems contained within the Lamar regional system for Alternative 3 would be some of the last systems connected to AVC upon construction.

4.3.2 Proposed Regional System Connections

The total number of regional system connections for the five proposed regional hubs under Alternative 3 are included in **Table 4-19**. The current and projected water demands for each of the five water providers and the total requested AVC deliveries for each regional system are depicted in **Figure 4-29**. The following subsections provide additional detail about water supplies and demands for the proposed regional systems of Avondale, Rocky Ford, La Junta, and Lamar for Alternative 3.

Table 4-19. Total Number of Proposed System Connections for Each Regional System for Alternative 3

Regional Water Provider	Number of Participating Systems within Regional Hub[1]
Avondale	2
Fowler	7
Rocky Ford	9
La Junta	5
Lamar	3

[1]Totals include the water provider and all participating systems

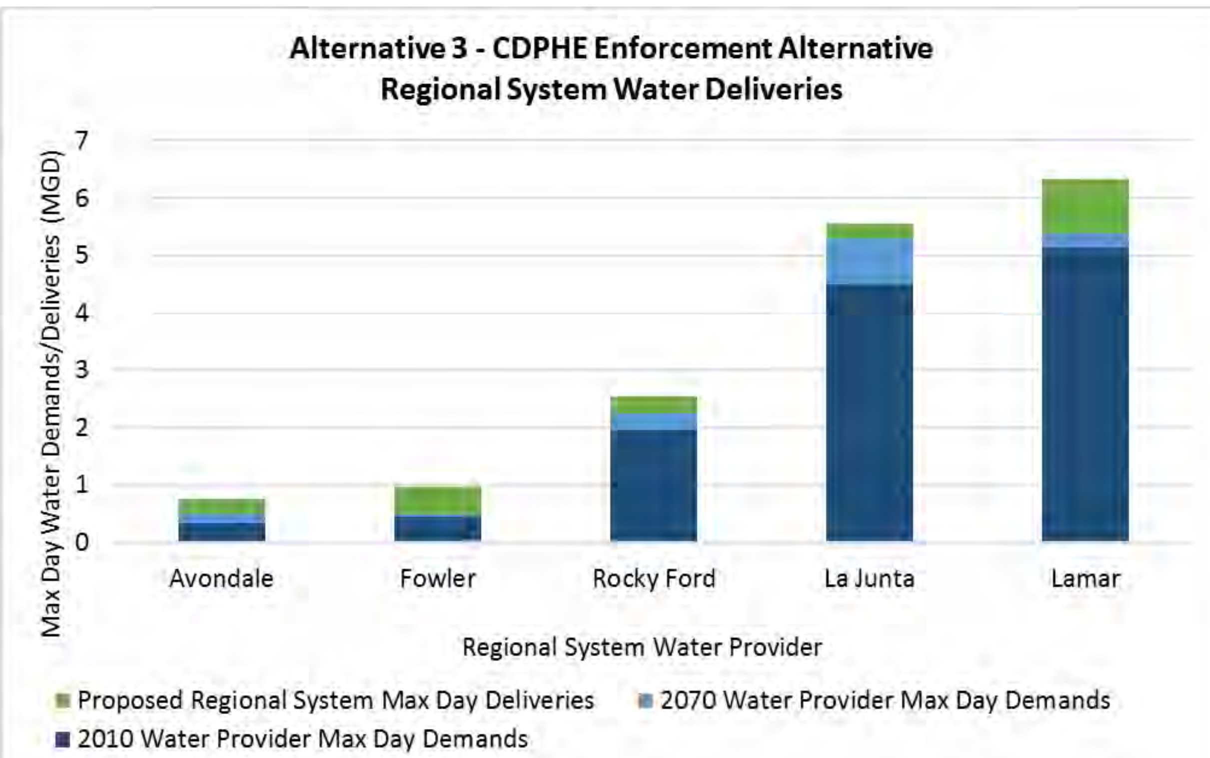

Figure 4-29. Projected Regional System Water Demands and Deliveries for Each Regional Water Provider Included in Alterative 3

4.3.2.1 Avondale Regional System

4.3.2.1.1 Water Demands

The regional system water demands and deliveries for the Alternative 3 Avondale regional system are the same as Alternative 2. Refer to Section 4.2.2.1.1 for more information.

4.3.2.1.2 Water Supplies

The regional system water supplies for the Alternative 3 Avondale regional system are the same as Alternative 2. Refer to Section 4.2.2.1.2 for more information.

4.3.2.2 Fowler Regional System

4.3.2.2.1 Water Demands

For Alternative 3, the Fowler water treatment plant would provide high quality water supply to six participating systems within Otero County, in addition to their own demands. Demands from 2010 and projected 2070 water demands and requested deliveries for the Alternative 3 Fowler regional system are included in **Table 4-20**.

Table 4-20. Alternative 3 Fowler Regional System Demands and Deliveries

Water Provider	Participating Systems	2010 Demand (AFY)	2010 Max Daily Demand (MGD)	2070 Demands (AFY)	2070 Max Daily Demand (MGD)	Annual Provider Deliveries (AFY)	Max Day Provider Deliveries (MGD)	Max Month Provider Deliveries (MGD)
Fowler	Fowler	210	0.45	222	0.48	220	0.47	0.32
	Valley Water Company*	38	0.08	39	0.08	39	0.08	0.06
	Manzanola*	39	0.08	37	0.08	50	0.11	0.07
	Vroman Water Company*	32	0.07	37	0.08	37	0.08	0.05
	Fayette Water Association*	12	0.03	14	0.03	14	0.03	0.02
	Patterson Valley Water Company*	15	0.03	17	0.04	17	0.04	0.03
	Eureka Water Company*	74	0.16	86	0.18	86	0.18	0.13
	Fowler Regional System	**420**	**0.90**	**452**	**0.97**	**465**	**1.00**	**0.84**

Source: Black & Veatch 2012, Reclamation 2016a
*indicates systems currently under CDPHE enforcement orders
Projected regional system demands are the sum of the water providers' 2070 demands and the participating systems requested AVC deliveries.

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4.3.2.2.2 Water Supplies

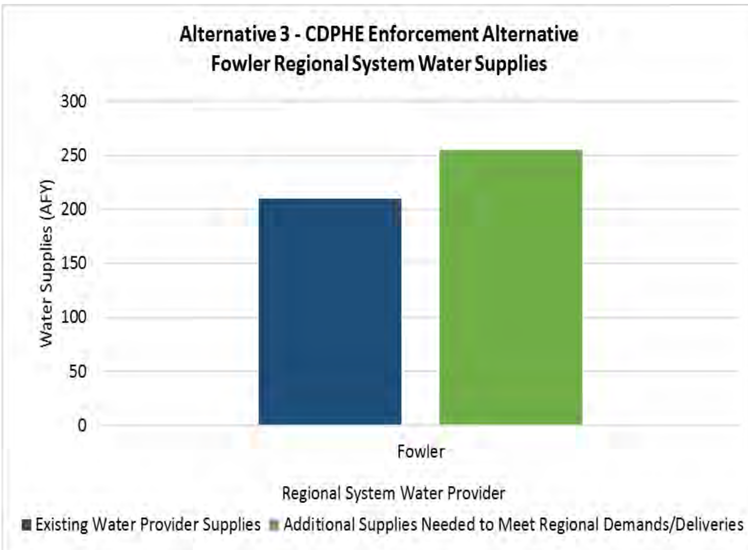

Figure 4-30. Additional Supplies Needed to Meet the Projected Demands and Deliveries for the Alternative 3 Fowler Regional System

Water supply for Fowler and the six participating systems is from a combination of deep and alluvial groundwater wells. No surface water resources are used within this regional hub.

A total of 465 AFY of water supplies are required to meet the proposed demands and deliveries of the Fowler regional system. As Shown in **Table 2-4**, Fowler's current groundwater supply capacity is 210 AFY. An additional 255 AFY of alluvial groundwater supply is required to meet the regional system demands and deliveries for Alternative 3 (**Figure 4-30**).

4.3.2.3 Rocky Ford Regional System

4.3.2.3.1 Water Demands

Under Alternative 3, the Rocky Ford water treatment plant would provide high quality water to eight participating systems in Otero County, in addition to their own demands. Demands from 2010 and projected 2070 water demands and requested deliveries for the Alternative 3 Rocky Ford regional system are included in **Table 4-21**.

Table 4-21. Alternative 3 Rocky Ford Regional System Demands and Deliveries

Water Provider	Participating Systems	2010 Demand (AFY)	2010 Max Daily Demand (MGD)	2070 Demands (AFY)	2070 Max Daily Demand (MGD)	Annual Provider Deliveries (AFY)	Max Day Provider Deliveries (MGD)	Max Month Provider Deliveries (MGD)
Rocky Ford	Rocky Ford/Hancock	907	1.95	1050	2.25	594	1.27	0.87
	Riverside*	20	0.02	26	0.03	20	0.02	0.02
	North Holbrook Water Company*	7	0.01	8	0.02	8	0.02	0.01
	Holbrook Center Soft Water Association*	18	0.04	22	0.05	22	0.05	0.03
	Beehive Water Association*	8	0.02	6	0.01	10	0.02	0.02
	Cheraw*	48	0.10	57	0.12	30	0.06	0.04
	East End Water Association*	11	0.02	13	0.03	13	0.03	0.02
	West Holbrook Water Pipeline Association$^{\Delta}$	14	0.03	18	0.04	9	0.02	0.01
	Southside Water Association$^{\Delta}$	7	0.01	7	0.01	5	0.01	0.01
	Rocky Ford Regional System	**1,040**	**2.20**	**1,207**	**2.56**	**1,167**	**2.48**	**2.41**

Source: Black & Veatch 2012, Reclamation 2016a
*indicates systems currently under CDPHE enforcement orders
$^{\Delta}$ indicates systems with the potential for future CDPHE enforcement orders
Projected regional system demands are the sum of the water providers' 2070 demands and the participating systems requested AVC deliveries.

4.3.2.3.2 Water Supplies

Water supply for Rocky Ford and the eight participating systems is primarily from a combination of deep and alluvial groundwater wells. Rocky Ford also has access to a supplemental surface water supply source to meet peak demands in the summer; however, the use of surface water has been discontinued for some time due to the lack of resources required to provide efficient surface water treatment.

The Alternative 3 Rocky Ford regional system requires 1,167 AFY of water supplies to meet the proposed demands and deliveries of all nine participating systems. Currently, Rocky Ford's total water supply is estimated to be 1,487 AFY as shown in **Table 2-4**. The existing supplies are enough to meet regional system demands; however, additional supplies may be required for redundancy.

4.3.2.4 La Junta Regional System

4.3.2.4.1 Water Demands

Under Alternative 3, the La Junta water treatment plant would provide high quality water to four participating systems within Otero County, in addition to their own demands. Demands from 2010 and projected 2070 water demands and requested deliveries for the Alternative 3 La Junta regional system are included in **Table 4-22**.

Table 4-22. Alternative 3 La Junta Regional System Demands and Deliveries

Water Provider	Participating Systems	2010 Demand (AFY)	2010 Max Daily Demand (MGD)	2070 Demands (AFY)	2070 Max Daily Demand (MGD)	Annual Provider Deliveries (AFY)	Max Day Provider Deliveries (MGD)	Max Month Provider Deliveries (MGD)
La Junta	La Junta	2,103	4.50	2,472	5.30	2,381	5.10	3.50
	South Swink Water Company*	82	0.18	88	0.19	92	0.20	0.14
	Town of Swink	38	0.08	30	0.06	49	0.10	0.07
	Homestead Improvement Association	7	0.01	7	0.01	9	0.02	0.01
	Bents Fort Water Company	63	0.13	55	0.12	81	0.17	0.12
	La Junta Regional System	**2,230**	**4.77**	**2,597**	**5.56**	**2,648**	**5.68**	**5.52**

Source: Black & Veatch 2012, Reclamation 2016a
*indicates systems currently under CDPHE enforcement orders
Participating systems in italics are currently connected to and purchasing water from La Junta.
La Junta also provides water to the Bents Fort Water Company through existing regional pipelines. Demands and deliveries for La Junta include Bents Fort demands and deliveries for this alternative.
Projected regional system demands are the sum of the water providers' 2070 demands and the participating systems requested AVC deliveries.

4.3.2.4.2 Water Supplies

Water supply for La Junta and the four participating systems is from a combination of deep and alluvial groundwater wells. No surface water resources are used within this regional hub. A total of 2,648 AFY of water supplies are required to meet the proposed demands and deliveries of the La Junta regional system. As shown in **Table 2-4**, La Junta's current groundwater supply capacity is 2,040 AFY. An additional 608 AFY of alluvial groundwater supply is required to meet regional system demands and deliveries for Alternative 3 (**Figure 4-31**).

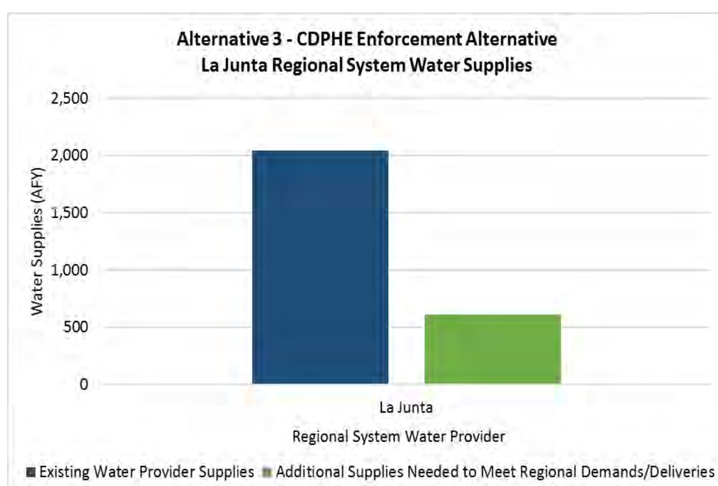

Figure 4-31. Additional Supplies Needed to Meet the Projected Demands and Deliveries for the Alternative 3 La Junta Regional System

4.3.2.5 Lamar Regional System

4.3.2.5.1 Water Demands

The regional system water demands and deliveries for the Alternative 3 Lamar regional system are the same as Alternative 2. Refer to Section 4.2.2.4.1 for more information.

4.3.2.5.2 Water Supplies

The regional system water supplies for the Alternative 3 Lamar regional system are the same as Alternative 2. Refer to Section 4.2.2.4.2 for more information.

4.3.3 Regional Provider's Existing Water Treatment and Distribution Systems

4.3.3.1 Avondale

Refer to Section 4.2.3.1 for a description of Avondale's existing water treatment and distribution system.

4.3.3.2 Fowler

The primary source of water for the Town of Fowler's water treatment facility is alluvial wells positioned next to the Arkansas River. Underground springs north of the Arkansas River act as a secondary source of water; however, any capacity upgrades would be achieved with additional alluvial wells. In 2014, Fowler's alluvial wells were classified as GUDI. Fowler is currently under CDPHE enforcement requiring approved surface water filtration and additional treatment of nitrate and selenium. **Table 4-23** summarizes the source and treatment capacity of Fowler's treatment process.

Table 4-23. Fowler Source and Treatment Capacity Summary

Number of Wells	Average Well Capacity (MGD)	Total Well Capacity (MGD)	Surface Water Capacity (MGD)	Total Treatment Capacity (MGD)	Capacity Limiting Process
In compliance: 1 Noncompliant: 5	1.1	1.1	NA	1.1	Alluvial well capacity and filtration

An alternatives analysis and preliminary engineering report has been developed by TTG Consultants and Bai Engineers for process upgrades to address the treatment challenges presented by the GUDI classification of the well sources. Following the report's recommendation, bag filters were installed on one of the wells as well as an ion exchange system targeting nitrate removal (CDPHE 2019b). After filtration, the water is chlorinated before distribution. Fowler has 0.63 MG of finished water storage upstream of their distribution system (Southeastern 2005). **Figure 4-32** displays a process flow diagram of Fowler's treatment process (Black & Veatch 2012).

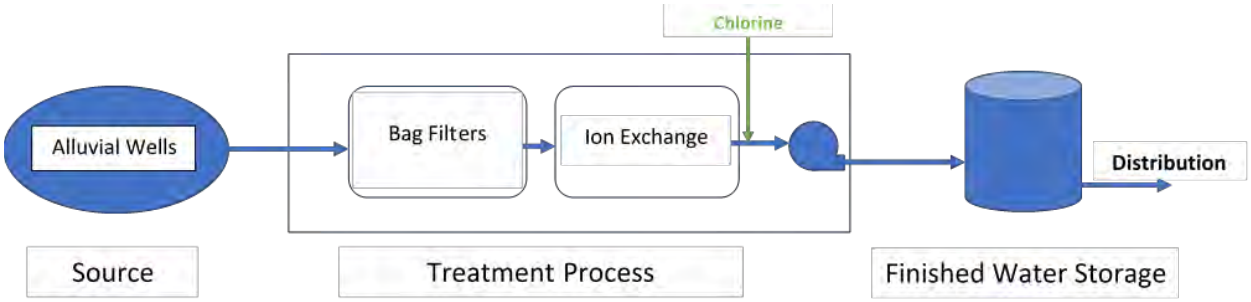

Figure 4-32. Fowler Regional Treatment System Process Flow Diagram

4.3.3.3 Rocky Ford

Refer to Section 4.1.3.3 for a description of Rocky Ford's existing water treatment and distribution system.

4.3.3.4 La Junta

Refer to Section 4.1.3.4 for a description of La Junta's existing water treatment and distribution system.

4.3.3.5 Lamar

Refer to Section 4.1.3.5 for a description of Lamar's existing water treatment and distribution system.

4.3.4 Proposed Participant Delivery Locations and Conduit Routes

The proposed participant delivery locations and conduit routes for the five regional systems under Alternative 3 are presented in this section. Refer to Section 6 of this report for further information and conveyance system modeling results.

4.3.4.1 Avondale Regional System

Under Alternative 3, the Avondale water treatment plant would provide treated water to its own service area and to the community of Boone in Pueblo County. The proposed participant delivery location and conduit routes for the Alternative 3 Avondale regional system are a hybrid of the preferred AVC alignment and an optimal geographical alignment for the regional system. Refer to **Figure 4-33** for the proposed participant delivery locations and conduit routes for the Alternative 3 Avondale regional system.

Figure 4-33. Alternative 3 Avondale Regional System Proposed Participant Delivery Locations and Conduit Routes

4.3.4.2 Fowler Regional System

Under Alternative 3, the Fowler water treatment plant would provide treated water to its own service area and to six communities in Otero County. The proposed participant delivery locations and conduit routes for the Alternative 3 Fowler regional system are a hybrid of the preferred AVC alignment and an optimal geographical alignment for the regional system. Refer to **Figure 4-34** for the proposed participant delivery locations and conduit routes for the Alternative 3 Fowler regional system.

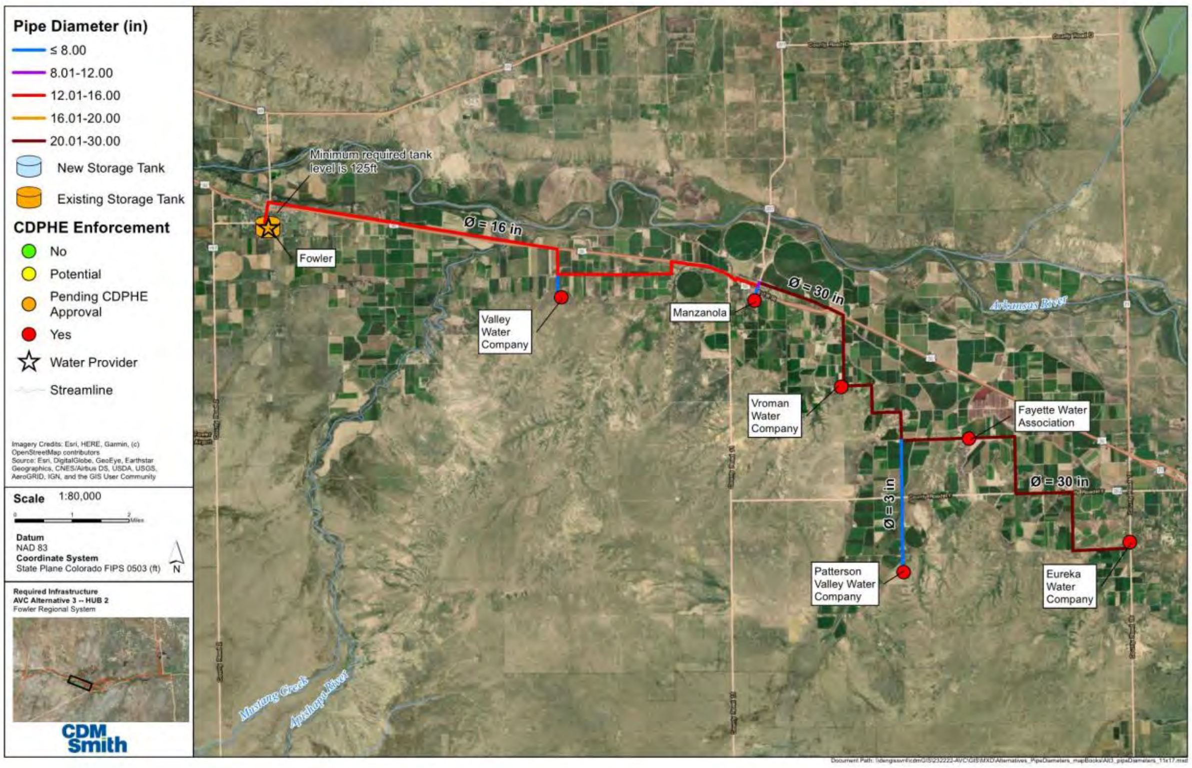

Figure 4-34. Alternative 3 Fowler Regional System Proposed Participant Delivery Locations and Conduit Routes

4.3.4.3 Rocky Ford Regional System

Under Alternative 3, the Rocky Ford water treatment plant would provide treated water to its own service area and to eight communities in Otero County. The proposed participant delivery locations and conduit routes for the Alternative 3 Rocky Ford regional system are a hybrid of the preferred AVC alignment and an optimal geographical alignment for the regional system. Refer to **Figure 4-35** for the proposed participant delivery locations and conduit routes for the Alternative 3 Rocky Ford regional system.

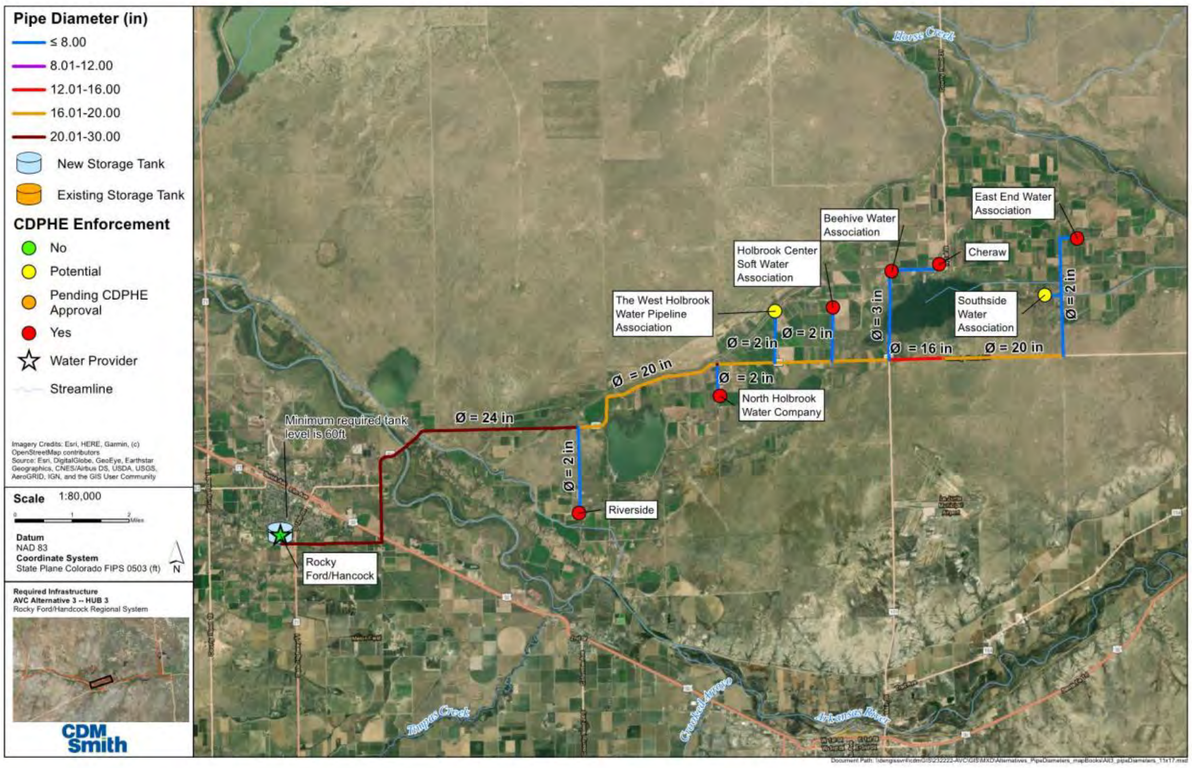

Figure 4-35. Alternative 3 Rocky Ford Regional System Proposed Participant Delivery Locations and Conduit Routes

4.3.4.4 La Junta Regional System

Under Alternative 3, the La Junta water treatment plant would provide treated water to its own service area and to three other communities in Otero County. The proposed participant delivery locations and conduit routes for the Alternative 3 La Junta regional system are a hybrid of the preferred AVC alignment and an optimal geographical alignment for the regional system. Refer to **Figure 4-36** for the proposed participant delivery locations and conduit routes for the Alternative 3 La Junta regional system.

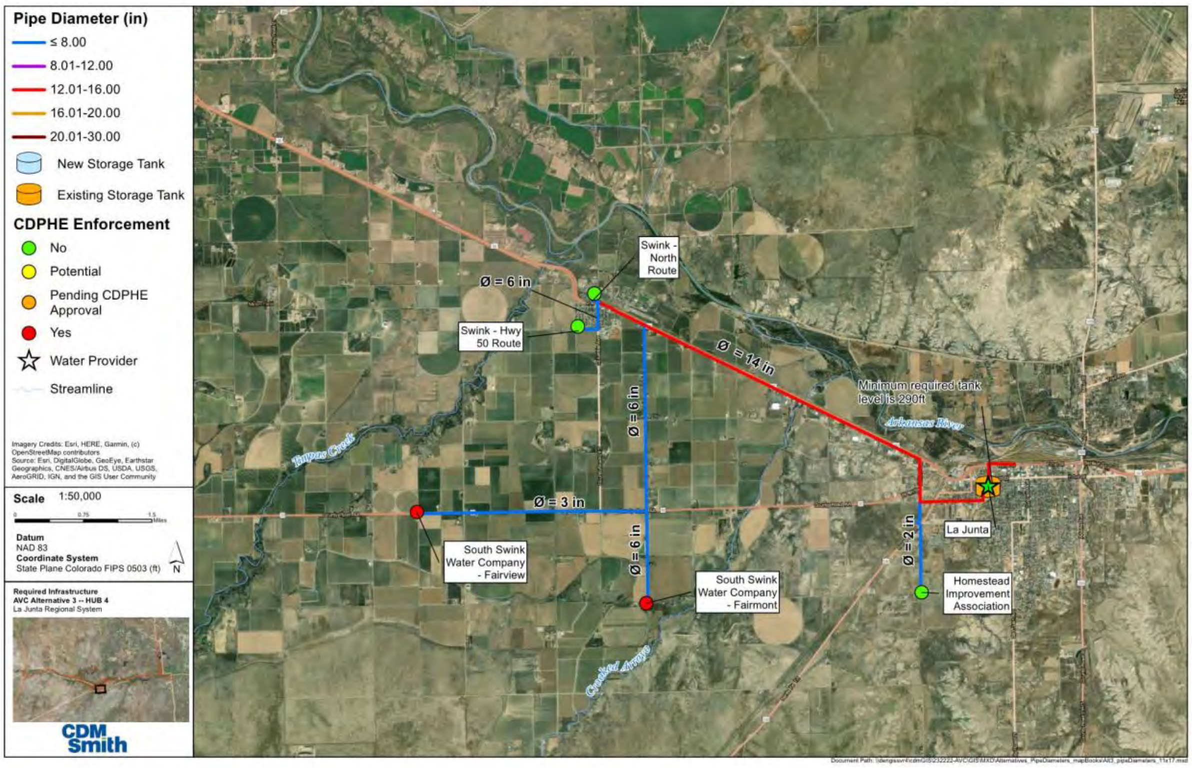

Figure 4-36. Alternative 3 La Junta Regional System Proposed Participant Delivery Locations and Conduit Routes

4.3.4.5 Lamar Regional System

Under Alternative 3, the Lamar water treatment plant would provide treated water to its own service area and two other communities in Bent and Prowers Counties. The proposed participant delivery locations and conduit routes for the Alternative 3 Lamar regional system are a hybrid of the preferred AVC alignment and an optimal geographical alignment for the regional system. Refer to **Figure 4-37** for the proposed participant delivery locations and conduit routes for the Alternative 3 Lamar regional system.

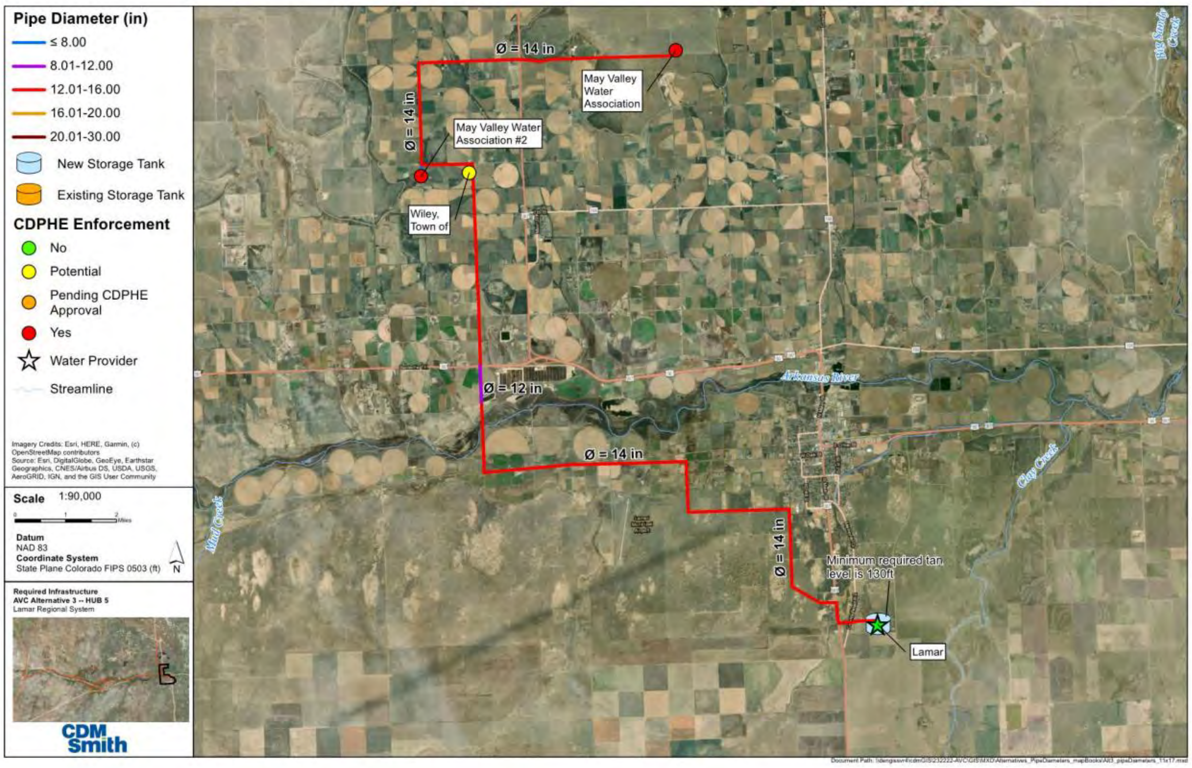

Figure 4-37. Alternative 3 Lamar Regional System Proposed Participant Delivery Locations and Conduit Routes

CDM Smith

Section 5

Treatment Alternatives

5.1 Treatment Processes Descriptions

5.1.1 Treatment Objectives

The water supply for towns and utilities in the Arkansas River Valley consists of surface water, shallow alluvial groundwater, groundwater under the influence of surface water and nontributary groundwater from deeper aquifers. The quality and quantity of the supplies derived from surface water have been impacted by various factors including naturally occurring selenium, radionuclides and urbanization along the Arkansas River and often require the construction of advanced treatment processes to reduce dissolved minerals, nitrates, and trace contaminants. The use of groundwater from nontributary aquifers as a primary or supplemental water supply is limited due to elevated concentrations of radium, uranium, selenium, and gross alpha that also require advanced treatment processes to meet regulatory standards. The AVC will provide a reliable water supply that complies with regulatory standards and a concentration of dissolved solids less than the secondary standards of 500 mg/L.

With the implementation of regionalization, regional water systems will need to treat the various water sources to comply with regulatory standards. The treatment options for various sources and contaminants include:

- Coagulation, sedimentation, and filtration for surface water and GUDI
- RO for high TDS
- Ion exchange for nitrate, gross alpha, uranium, and radium
- Precipitation and filtration for dissolved metals and radionuclides
- GAC for pesticides, herbicides, and organic contaminants
- Disinfection for pathogens

5.1.2 Treatment of Radionuclides

There are several advanced treatment alternatives that are effective at removing radionuclides from water. The treatment and alternative solutions are listed in **Table 5-1**. Treatment processes that are currently being used by regional provider or that are being recommended as upgrades to meet regional demands in an alternative are described in the following subsections.

Table 5-1. Potential Treatment Options to Reduce Radionuclides

Radionuclide	Treatment Methods
Radium 226/228, Uranium, Gross Alpha, Gross Beta	Ion exchange*
	RO*
	Lime softening
	Coprecipitation with barium sulfate
	Preformed hydrous manganese oxide filtration
	Coagulation/Filtration (conventional treatment)*
	Activated alumina
	Electrodialysis/Electrodialysis reversal

Source: EPA 2006
*indicates treatment processes are either being used by regional providers or recommended for regionalization upgrades

5.1.2.1 Ion Exchange Treatment Process

Ion-exchange treatment processes are generally used to decrease concentrations of ionic contaminants. They are most effective in waters that have low concentrations of minerals. In the process, ions are exchanged between the solid media and the water to be treated. The most common application of ion exchange is water softening, which targets the exchange of less soluble calcium and magnesium ions in water (American Water Works Association and American Society of Civil Engineers 2012) with sodium ions, but the process is also effective in exchanging the radium cations with sodium. The ion exchange media is typically regenerated with a 3 to 6 percent sodium chloride brine solution, which is typically discharged to the sanitary sewer. The regeneration process and disposal of the brine increase the concentration of TDS and the contaminants in the wastewater and can make it more difficult to meet effluent discharge standards or to reuse the effluent.

When the ion exchange resin is in the anionic form, it can be used to remove nitrates and uranium anions from the water source. The resin is regenerated using a sodium chloride brine in the same process used for softening, and it results in similar impacts when disposing the regeneration brine.

Specialty highly selective single use ion exchange resins that do not require regeneration can be used to remove uranium. The resins are removed and transported to an off-site processing and disposal facility once the exchange capacity of the resin is exhausted. This eliminates the disposal of regeneration brines to the local or regional sanitary sewer system.

5.1.2.2 Reverse Osmosis Treatment Process

RO is a pressure-driven membrane process that produces treated water (permeate) with low concentrations of dissolved salts, minerals, radionuclides, and organics and concentrates the dissolved components in a residual brine stream. RO uses a semipermeable membrane with a thin plastic-like material that limits the diffusion of salts through the membrane. RO is a diffusion-controlled process that is dependent on temperature, the ionic charge of the dissolved components, and the concentration of the dissolved components. Each type of RO membrane has different diffusion rates for the components. As the RO feedwater pressure is increased, the rate at which water diffuses through the membrane increases, but the rate at which dissolved components diffuse through the membrane is dependent on the concentration of the dissolved components. These factors affect the permeate water quality, the percentage of high quality permeate produced known as the recovery ratio, and the capacity of RO system.

A critical design parameter for RO is the feedwater must have low turbidity and suspended solids less than 5 microns; thus, the feedwater must be groundwater with low turbidity or filtered surface water. RO systems are not suitable for raw water with particles that will foul the RO membranes. It is also necessary to add antiscalants to the feedwater to prevent the precipitation of sparingly soluble salts in the brine. Chemicals may also be added for dechlorination (sodium bisulfite) and pH adjustment (acid or bases).

RO systems are typically able to recover 75 to 90 percent of the feedwater as permeate with a low concentration of dissolved components, but this means the raw water supply must be 10 to 20 percent higher for an RO system. This also means 10 to 20 percent of the feedwater with the concentrated dissolved components requires disposal; the higher the percentage of permeate produced, the higher the concentration of dissolved components. The high concentration of the salts, radionuclides, and metals in the RO brine can make it difficult to discharge the brine to the sanitary sewer or surface water. Occasional chemical acid, base, oxidizing, and detergent cleaning of the membranes is necessary to remove accumulated mineral scaling or fouling (EPA 2018). These chemical solutions need to be neutralized and then discharged to the wastewater treatment plant for final disposal.

5.1.2.3 Conventional Coagulation, Flocculation, Clarification, and Filtration

Conventional treatment processes typically consist of five stages: coagulation, flocculation, clarification, filtration, and disinfection.

During coagulation, positively charged metal salts are added to water to reduce the repelling forces between the negatively charged particles. This process binds together particulate, dissolved, and colloidal contaminants into flocs. Polymers may also be added to aid in the formation of flocs. It is also common to dose chlorine, calcium permanganate, or sodium permanganate upstream of coagulation for preoxidation (EPA 2018).

During clarification, the flocculated coagulants and entrained turbidity are removed either by gravity settling, ballasted flocculation, entrainment in sludge blanket, or dissolved air flotation (DAF) process. DAF uses microscopic fine bubbles of diffused air to float the flocculated particles to the surface of the tank where they are skimmed and removed. The flocculation and clarification process typically reduce the turbidity of the source water by 90 to 95 percent to 1 to 5 NTU. Any remaining suspended solids after the clarification process are removed in the filtration process (EPA 2018).

Filtration in a conventional treatment system is typically accomplished with granular media. The most common form of media consists of anthracite and sand. The media is regularly backwashed to remove particles and to remove particles captured by the media that result in increased headloss and pressure buildup. GAC can also be used in media filter systems. GAC is made up of carbon-based materials, including wood, lignite, and coal that has been heated to high temperatures in a reducing environment. GAC is used to target the removal of organic compounds and secondary contaminants (EPA 2018).

Conventional treatment produces two main waste streams: sludge formed in coagulation and filter backwash. Backwash may be recycled back to the head of the treatment process provided that the facility follows the Filter Backwash Recycling Rule, which requires that the return flow cannot exceed 10 percent of the raw water (EPA 2002. Sludge produced from coagulation is typically considered a nonhazardous municipal waste that can be disposed in a municipal landfill according to local regulations (EPA 2018).

5.1.3 Surface Water Filtration

A few of the provider's alluvial well water sources have been reclassified as GUDI of surface water. These sources require filtration to remove bacteria and viruses (see **Table 3-2**). **Table 5-2** lists the CDPHE-approved surface water filtration alternatives and other approaches for achieving compliance, including the respective advantages and disadvantages. Technologies listed as alternatives must be preapproved before implementation.

Table 5-2. CDPHE-Approved Surface Water Technologies and Nontreatment Alternatives for Compliance

Technology	Recommended Methods	Advantages	Disadvantages
CDPHE-Approved Filtration Technologies	Conventional Filtration	▪ Effective at treating a variety of contaminants ▪ Produces consistent quality water post filtration	▪ Produces solid waste ▪ Requires chemical addition (e.g., coagulants, polymers)
	Direct Filtration	▪ Less expensive than conventional ▪ Requires less space than conventional	▪ Produces solid waste ▪ Requires chemical addition (e.g., coagulants, polymers) ▪ Variable water quality post filtration is more likely than with conventional
	Slow Sand Filtration	▪ Does not require chemical addition ▪ Minimal sludge handling required ▪ Simple in design	▪ Large surface area and quantities of filter media ▪ Labor intensive ▪ Cannot handle high turbidity
	Diatomaceous Earth Filtration	▪ Compact layout and low head loss make it suitable for retrofitting existing wells	▪ More labor intensive than conventional ▪ Cannot handle variations in influent quality
Alternative Filtration Technologies	Bag Filtration	▪ Inexpensive ▪ Simple to operate	▪ Cannot handle high turbidity influent ▪ Not feasible for high flows ▪ Can be labor intensive depending on flows and turbidity
	Cartridge Filtration	▪ Similar to bag filters	▪ Similar to bag filters, potentially more expensive
	Membranes: Ultrafiltration and Microfiltration	▪ Requires less space compared to conventional ▪ Does not necessarily require coagulant addition	▪ Produces approximately 5 percent backwash flow ▪ Expensive

Source: CDPHE 2018, EPA 2018

5.1.4 Drinking Water Disinfection

Drinking water disinfection typically is achieved with dosing a chlorine-based disinfectant (i.e., gaseous chlorine, chlorine dioxide, sodium hypochlorite, or calcium hypochlorite), with ozone, or a combination of ultraviolet irradiation followed by a chlorine-based disinfectant. All the regional providers use a form of chlorine disinfection. When chlorine is added to raw or treated water with dissolved organics, bromines, and amines, it forms trihalomethanes, haloacetic acids, and other DBPs. These are controlled by reducing the DBP precursors or adding ammonia to convert the free chlorine to chloramines.

- **Chlorine gas** consumes the alkalinity of the water and reduces the pH. Lowering the pH increases the effectiveness of chlorine disinfection. Chlorine gas is toxic, and precautionary steps need to be taken to secure the storage area and limit exposure.
- **Sodium hypochlorite** raises the pH of the water at its dosing point. Sodium hypochlorite is less hazardous than gaseous chlorine; however, due to its reactivity, it can be a safety risk.
- **Chlorine dioxide** is highly soluble in water and an effective oxidizer and disinfectant. It also produces fewer organic byproducts during disinfection compared to free chlorine. Chlorine dioxide reacts to form chlorite when dosed to water, which has an MCL of 1 mg/L. Chlorine dioxide gas is also dangerous because of its explosive characteristics and toxicity. For these reasons, the gas must be generated on-site. Depending on the generation method, the use of chlorine dioxide can result in the production of undesirable chlorinated organic reaction by-products.

5.2 AVC Regionalization (Alternative 1) Treatment Plant Upgrades

5.2.1 St. Charles Mesa Water District

For St. Charles Mesa Water District to meet the regional demands under Alternative 1 and redundancy requirements, it would need to expand the capacity of its treatment process by 1.8 MGD. Upgrades to improve treated water quality are not necessary for St. Charles Mesa Water District because all the facilities meet the CDPHE standards and are not currently under enforcement action.

The St. Charles Mesa Water District requires no additional water rights to meet the increased demands associated with regionalization (Black & Veatch 2012). The district's treatment process has an overall capacity of 6.1 MGD, 0.8 of which is from well water sources. St. Charles Mesa Water District's conventional surface water treatment plant has three filter trains, each with an estimated capacity of 1.8 MGD. The water district plans to build an additional surface water treatment plant in the next decade to meet its current customers' projected demands. The plant would be built at a reservoir located at 21st Lane and South Road (Simpson 2019). With the addition of the plant, the water district would utilize some of its excess water rights (see Section 2.3.1). For regionalization under Alternative 1, the water district would expand its existing facility by adding an additional filter with 1.8 MGD of capacity. This filter would act as a redundancy in case another filter needs to be taken off-line for maintenance. **Table 5-3** summarizes the capacity upgrades necessary for St. Charles Mesa Water District to meet the demands of the region under Alternative 1.

Table 5-3. Alternative 1 St. Charles Mesa Water District Region Treatment Capacity Upgrades Summary

Alternative	Projected Regional Demand (MGD)	2019 Capacity (MGD)	Capacity Increase to Meet Projected Demand (MGD)	Filter Train Capacity (MGD)	Number of Filter Trains Needed for Redundancy	Recommended Upgrades to Meet Regional Demands and Redundancy Requirements
1	6.3	6.1	0.2	1.8	1	Expand existing facility by 1.8 MGD by adding a fourth filter.

5.2.2 Crowley County Water Association

For the Crowley County Water Association to meet the regional demands and redundancy requirements under Alternative 1, it would need to increase the overall treatment process capacity by 3.9 MGD. Upgrades to improve treated water quality are not necessary because the treated water currently meets the standards.

The Crowley County Water Association's treatment process capacity is limited both by the lack of alluvial well water supply and by the association's chlorine gas disinfection process capacity. An additional three alluvial wells will need to be drilled to meet the maximum day demands of the regional participants. Three additional wells provide a well for redundancy in case a well is off-line for maintenance. Disinfection for each well would be achieved by adding a small chlorination system to each new well site. **Table 5-4** summarizes the capacity upgrades necessary for the Crowley County Water Association to meet the regional demands under Alternative 1.

Table 5-4. Alternative 1 Crowley Water Association Region Treatment Capacity Upgrades Summary

Alternative	Projected Regional Demand (MGD)	2019 Capacity (MGD)	Capacity Increase to Meet Projected Demand (MGD)	Average Well Capacity (MGD)	Number of Wells Needed for Redundancy	Recommended Upgrades to Meet Regional Demands and Redundancy Requirements
1	3.2	1.3	1.9	1.3	3	Install three alluvial wells with small chlorine gas feed systems at each well head, increasing process capacity by 3.9 MGD including the redundant well.

Source: Talkington 2019

5.2.3 Rocky Ford

Rocky Ford's treatment system currently has the capacity to meet the demands of the regional participants under Alternative 1. It is recommended, however, that they increase their source capacity by 1.4 MGD to add source redundancy in case of technical problems or the need for maintenance that would require a well to be taken off-line. Upgrades to improve the treated water quality are not necessary because Rocky Ford complies with the standards and is not currently under enforcement action.

Because there are no water quality issues with Rocky Ford's alluvial well water sources, the relatively small capacity upgrades needed can be met cost effectively with the addition of alluvial wells. Starting up the water treatment plant requires Rocky Ford to hire a Class A operator to act as an OIC. Equipment upgrades are also necessary at the water treatment plant to mitigate future O&M issues (TTG Consultants 2016). Additional costs may be associated with startup of the surface water plant after years of not being operated. These may include costs associated with replacement of expired chemicals and recalibration and replacement of probes and lab equipment. For these reasons, it is recommended that alluvial well capacity be expanded such that all regional demands will be met with well water sources. For Alternative 1, only one well will need to be drilled to serve as a redundant source for regional participants. A small chlorination system will need to be installed at the well head for disinfection. **Table 5-5** summarizes the treatment capacity upgrades required for Rocky Ford to meet the regional demands under Alternative 1.

Table 5-5. Alternative 1 Rocky Ford Region Treatment Capacity Upgrades Summary

Alternative	Projected Regional Demand (MGD)	2012 Capacity (MGD)	Capacity Increase to Meet Projected Demand (MGD)	Average Capacity per Well (MGD)	Number of Additional Wells Needed for Redundancy	Recommended Upgrades to Meet Regional Demands and Redundancy Requirements
1	3.0	4.1	0.0	1.4	1	Install an additional alluvial well with a chlorination system at the well head to act as a redundant source for regional participants, expanding the process capacity by 1.4 MGD including the redundant well.

Source: Black & Veatch 2012, CDM Smith 2018 (Appendix A)

5.2.4 La Junta

For La Junta to meet the regional demands under Alternative 1, the WTP needs to increase the capacity by 2.2 MGD. Upgrades to improve treated water quality are not necessary because they currently meet standards and are not under enforcement action. WTP upgrades to meet the discharge standards for RO brine may be necessary, depending on upcoming CDPHE regulations.

The La Junta treatment system is limited by the capacity of its RO trains and by its distribution pumping capacity. A fourth RO train is needed to meet the regional demands. Each of La Junta's RO trains has a capacity of 2.2 MGD. Installation of a redundant RO unit is not recommended in this case because RO units are expensive and subject to biological fouling when not operated for extended periods. Treatment process redundancy may be achieved by modifying the RO/greensand filter flow blend ratio, which is typically 73 percent. After installation of a fourth RO unit, if a single unit is taken off-line during projected regional max day demands, the blend ratio would need to be modified to an estimated 67 percent. The RO process provides high rejection of radionuclides, metals, and selenium, therefore, the permeate has low concentration near the detection limits for these elements and a relatively small change in the blend ratio does not pose a risk of exceeding the standards. With the modified blend ratio, La Junta would remain compliant with TDS secondary standards (City of La Junta 2018).

Currently, an average of 1.0 MGD of well water is blended with the brine discharge from the RO units. With the addition of a fourth unit, this flow will need to be increased to about 1.3 MGD

(Seaba 2019). La Junta's 2019 wastewater discharge permit allows them to discharge the brine that has been blended with well water at a 30-day average rate of 2.5 MGD (CDPHE 2019a). La Junta has adequate well supplies to meet the increase in demands associated with regionalization. **Table 5-6** summarizes the treatment capacity upgrades required for regionalization of La Junta under Alternative 1.

Table 5-6. Alternative 1 La Junta Region Treatment Capacity Upgrades Summary

Alternative	Projected Regional Demand (MGD)	2019 Capacity (MGD)	Capacity Increase to Meet Projected Demand (MGD)	RO Unit Capacity (MGD)	Number of Additional RO Units Needed to Meet Demand	Recommended Upgrades to Meet Regional Demands and Redundancy Requirements
1	7.2	6.6	0.6	2.2	1	1. Installation of a fourth RO train, including an additional cartridge filter unit for RO prefiltration. This will increase overall capacity by 2.2 MGD. 2. Installation of an additional clean water distribution pump.

Source: Black & Veatch 2012, Seaba 2019

La Junta piloted a zero-discharge desalination (ZDD) technology during the summer of 2012 to compare costs and performance to their RO process. Their general findings were that ZDD was an effective treatment process although it was difficult and more expensive to operate than their current system. CDPHE is requiring that La Junta perform a study in 2019 on how to reduce or eliminate the blended brine discharge to the Arkansas River (CDPHE 2019a). Upgrades may be necessary in the future to mitigate or eliminate the brine discharge.

5.2.5 Lamar

For Lamar to meet the demands of the region under Alternative 1, they would need to increase their treatment capacity by 2.4 MGD. Upgrades to improve treated water quality are not necessary because Lamar complies with the standards and is not under enforcement action.

The Lamar treatment system is limited by the capacity of its 4.0 MGD sodium hypochlorite dosing process (Batdorf 2019). For the purposes of this planning study, the project team assumed the existing chlorination facility will be expanded to meet the regional demands. Lamar has adequate alluvial well supplies to accommodate the expansion. **Table 5-7** summarizes the capacity upgrades necessary for Lamar under Alternative 1.

Table 5-7. Alternative 1 Lamar Region Treatment Capacity Upgrades Summary

Alternative	Projected Regional Demand (MGD)	2019 Capacity (MGD)	Capacity Increase to Meet Projected Demand (MGD)	Sodium Hypochlorite Disinfection Process Capacity (MGD)	Additional Units Needed to Meet Demand and Redundancy	Recommended Upgrades to Meet Regional Demands and Redundancy Requirements
1	6.4	4.0	2.4	4.0	NA	Upgrade capacity of sodium hypochlorite process by 2.4 MGD. Install a redundant metering pump and upgrade chemical storage.

Source: Black & Veatch 2012, Batdorf 2019

5.3 AVC-CDPHE Enforcement Regionalization (Alternative 2) Treatment Plant Upgrades

5.3.1 Avondale

Avondale needs to increase the system capacity by 0.6 MGD to meet the demands of the region under Alternative 2. Avondale is currently under enforcement action because one of the three source water wells was classified as GUDI. Filtration is required for wells classified as GUDI.

The towns of Avondale and Boone are currently negotiating an agreement for Avondale to provide water to Boone because of a recent enforcement action implemented on Boone's system (CDPHE 2019b). For Avondale to meet the regional demands under Alternative 2, two additional wells that comply with treatment standards are required. The most cost-effective approach to provide additional capacity is by drilling alluvial wells with enough distance from the Arkansas River to provide 6 months of travel time for water in the recharge area to reach the well and be classified as groundwater. If it is not possible to drill wells that would be classified as groundwater, an additional GUDI well will need to be drilled and CDPHE-approved filtration will need to be implemented for all GUDI sources. **Table 5-8** summarizes the treatment upgrades necessary for Avondale to meet the regional demands under Alternative 2.

Table 5-8. Alternative 2 Avondale Region Treatment Capacity Upgrades Summary

Alternative	Projected Regional Demand (MGD)	2012 Capacity (MGD)	Capacity Increase to Meet Projected Demand (MGD)	Average Capacity per Well (MGD)	Number of Additional Wells Needed for Redundancy[4]	Recommended Upgrades to Meet Regional Demands and Redundancy Requirements
2	0.7	0.6	0.1	0.3	2	Drill two additional wells with a chlorine dosing system at each well head.

Source: Black & Veatch 2012, CDPHE 2019b

This study assumes Avondale will need to install centralized pressure filters that meet the CDPHE filtration requirement for GUDI to remove cryptosporidium, giardia lamblia, and viruses. **Table 5-9** summarizes the treatment upgrades necessary for Avondale to meet CDPHE standards and to provide clean water for their regional participants.

Table 5-9. Alternative 2 Avondale Region Treatment Process Upgrades Summary

Alternative	Contaminants of Concern	Standard Limits	Recommended Treatment Upgrade
2	Cryptosporidium, giardia lamblia, viruses, and turbidity	• Cryptosporidium: 2-log (99 percent) removal • Giardia lamblia: 3-log (99.99 percent) removal • Viruses: 4-log removal • Turbidity: 95th percentile – 0.3 NTU, maximum limit – 1 NTU	Install two 0.7 MGD granular pressure filter units, one to satisfy projected maximum daily flow, with one filter off-line for backwashing or maintenance.

[4]This includes Avondale's existing noncompliant GUDI well.

5.3.2 Crowley County Water Association

For the Crowley County Water Association to meet the regional demands under Alternative 2, the addition of two alluvial wells are necessary for redundancy. **Table 5-10** summarizes the treatment capacity upgrades required for the Crowley County Water Association under Alternative 2.

Table 5-10. Alternative 2 Crowley County Water Association Region Treatment Capacity Upgrades Summary

Alternative	Projected Regional Demand (MGD)	2012 Capacity (MGD)	Capacity Increase to Meet Projected Demand (MGD)	Average Capacity per Well (MGD)	Number of Additional Wells Needed for Redundancy	Recommended Upgrades to Meet Regional Demands and Redundancy Requirements
2	2.8	4.1	0.0	1.4	1	Install an additional alluvial well with a chlorination system at the well head to act as a redundant source for regional participants, expanding the process capacity by 1.4 MGD including redundant well.

Source: Talkington 2019

5.3.3 La Junta

The La Junta treatment system has sufficient capacity to meet the regional demands under Alternative 2. As described in Section 5.2.4, treatment process redundancy will be achieved through modifying the RO blending ratio. See Section 5.2.4 for information on the potential need for reduction of brine discharge. **Table 5-11** summarizes the treatment capacity information for La Junta under Alternative 2.

Table 5-11. Alternative 2 La Junta Region Treatment Capacity Upgrades Summary

Alternative	Projected Regional Demand (MGD)	2019 Capacity (MGD)	Capacity Increase to Meet Projected Demand (MGD)	RO Unit Capacity (MGD)	Number of Additional RO Units Needed to Meet Demand	Recommended Upgrades to Meet Regional Demands and Redundancy Requirements
2	5.9	6.6	0.0	2.2	0	No upgrades necessary.

Source: Black & Veatch 2012, Seaba 2019

5.3.4 Lamar

Lamar would need to expand their chlorination and fluoridation facility by 1.9 MGD to meet the regional demands under Alternative 2. **Table 5-12** summarizes the capacity upgrades necessary for Lamar for Alternative 2.

Table 5-12. Alternative 2 Lamar Region Treatment Capacity Upgrades Summary

Alternative	Projected Regional Demand (MGD)	2019 Capacity (MGD)	Capacity Increase to Meet Projected Demand (MGD)	Sodium Hypochlorite Disinfection Process Capacity (MGD)	Additional Units Needed to Meet Demand and Redundancy	Recommended Upgrades to Meet Regional Demands and Redundancy Requirements
2	5.9	4.0	1.9	4.0	NA	Upgrade capacity of sodium hypochlorite process by 1.9 MGD. Install a redundant metering pump and upgrade chemical storage.

Source: Black & Veatch 2012, Batdorf 2019

5.4 CDPHE Enforcement Regionalization Alternative (Alternative 3) Treatment Plant Upgrades

5.4.1 Avondale

Because the regional demands for Avondale under Alternative 3 are the same as Alternative 2, the required capacity and treatment upgrades are also the same. Refer to Section 5.3.1 for required upgrades.

5.4.2 Fowler

For Alternative 3, Fowler was selected as the regional provider to provide water for the noncompliant Valley Water Company system to minimize the pumping requirements associated with using Rocky Ford as the regional provider. Fowler has adequate capacity to meet the demands of the region under Alternative 3. Upgrades are needed, however, for capacity redundancy.

To meet the demands and provide redundancy under Alternative 3, Fowler needs another well in compliance with surface water treatment standards. This requires adding CDPHE-approved filtration to one of the existing noncompliant wells or drilling a compliant well in an area with 6 months travel time from the recharge location. Bag filters are a viable option for Fowler due to the relatively low flows of the system and the low turbidity of the influent well water. Fowler has already installed bag filters on one of its wells to bring the source into compliance. **Table 5-13** summarizes the treatment capacity upgrades necessary for Fowler under Alternative 3.

Table 5-13. Alternative 3 Fowler Region Treatment Capacity Upgrades Summary

Alternative	Projected Regional Demand (MGD)	2012 Capacity (MGD)	Capacity Increase to Meet Projected Demand (MGD)	Average Capacity per Well (MGD)	Number of Additional Wells Needed for Redundancy[5]	Recommended Upgrades to Meet Regional Demands and Redundancy Requirements
3	1.0	1.1	0.1	1.1	1	Install a second bag filter skid to bring one of Fowler's existing GUDI wells into CDPHE compliance. A chlorine disinfection system will also need to be installed on the well head. The upgraded well will account for system redundancy.

Source: Black & Veatch 2012 CDM Smith 2018 (Appendix A)

5.4.3 Rocky Ford

Rocky Ford has sufficient treatment capacity to accommodate the region under Alternative 3. **Table 5-14** summarizes Rocky Ford's treatment capacity information.

[5]Assumes that filtration will be installed on one of Fowler's existing GUDI wells to bring it into compliance.

Table 5-14. Alternative 3 Rocky Ford Region Treatment Capacity Upgrades Summary

Alternative	Projected Regional Demand (MGD)	2012 Capacity (MGD)	Capacity Increase to Meet Projected Demand (MGD)	Average Capacity per Well (MGD)	Number of Additional Wells Needed for Redundancy	Recommended Upgrades to Meet Regional Demands and Redundancy Requirements
3	2.5	4.1	0.0	1.4	0	No upgrades necessary.

Source: Black & Veatch 2012, Long 2019

5.4.4 La Junta

The La Junta treatment system has sufficient capacity to meet the regional demands under Alternative 3. As described in Section 5.2.4, treatment process redundancy will be achieved through modifying the RO blending ratio. See Section 5.2.4 for information on the potential need for reduction of brine discharge. **Table 5-15** summarizes the treatment capacity information for La Junta under Alternative 2.

Table 5-15. Alternative 3 La Junta Region Treatment Capacity Upgrades Summary

Alternative	Projected Regional Demand (MGD)	2019 Capacity (MGD)	Capacity Increase to Meet Projected Demand (MGD)	RO Unit Capacity (MGD)	Number of Additional RO Units Needed to Meet Demand	Recommended Upgrades to Meet Regional Demands and Redundancy Requirements
3	5.7	6.6	0.0	2.2	0	No upgrades necessary.

Source: Black & Veatch 2012, Seaba 2019

5.4.5 Lamar

Because the regional demands for Lamar under Alternative 3 are the same as Alternative 2, the required treatment upgrades are also the same. Refer to Section 5.3.4. for required upgrades.

Section 6

Pipeline Alternatives

Pipeline alignments and sizes for each regionalization alternative were analyzed by modifying the original AVC model from Reclamation using the InfoWater hydraulic modeling software. The alignment and diameters from the original model were adjusted for each regional system based on the alternative requirements. The criteria used for hydraulic modeling verification are based on the planning-level Feasibility Design Report (Reclamation 2016a) for consistency with the AVC design, and include:

- Minimum 20 pounds per square inch (psi) pressure at delivery points (See Feasibility Design Report Section 3.3.3 [Reclamation 2016a])
- Maximum monthly demands
- Roughness C = 145

The AVC model was set up to maintain a minimum pipeline pressure of 5 psi (See Feasibility Design Report Section 3.5.3 [Reclamation 2016a]). This was modified for the regionalization considerations to be a minimum of 20 psi, since regionalization will be running treated water instead of filtered.

The flow diagram in **Figure 6-1** illustrates the general methodology used for hydraulic modeling.

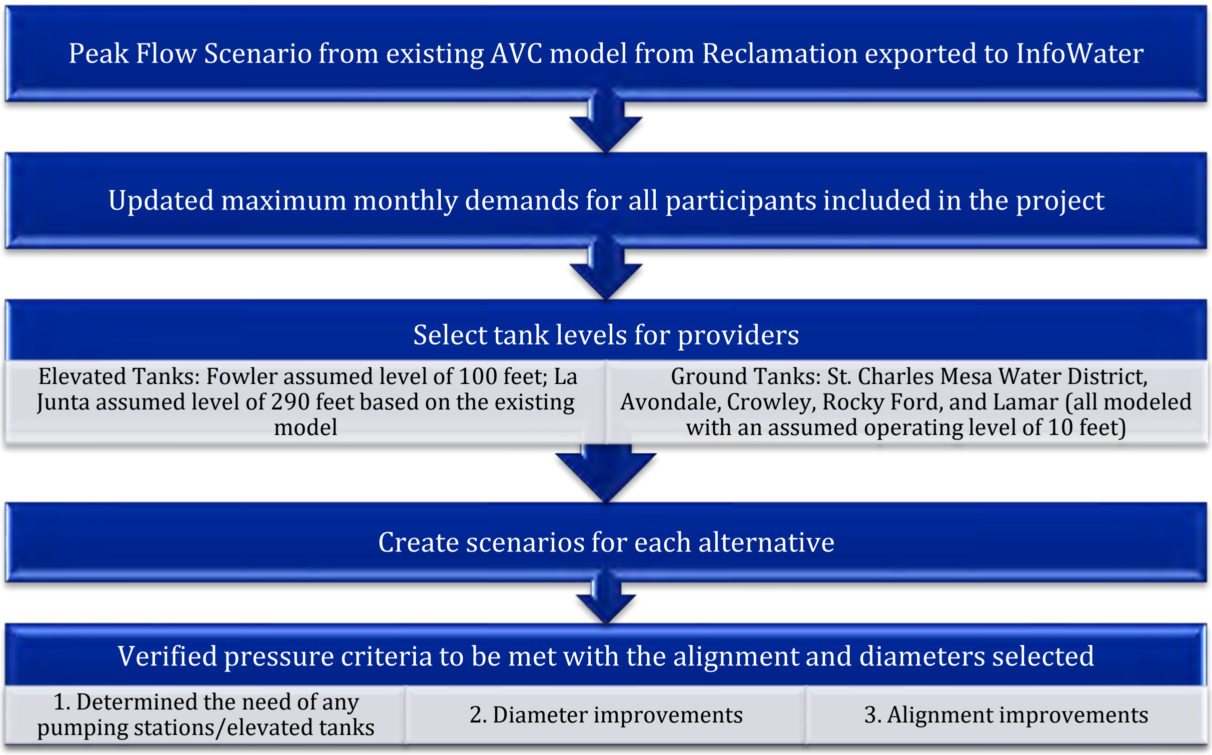

Figure 6-1. General Modeling Approach Flow Diagram

A hydraulic analysis was completed for each regional provider under each AVC regionalization alternative. The results of the analysis are shown in a series of graphics to illustrate the conditions consistent with the alternative. The first figure under each analysis is an aerial base map of the regional alternative with:

- Ground elevations indicated by color shading, where blue shading indicates lower elevations and red shading indicates higher elevations
- Pipeline routes showing connection of each participant to the regional provider, with the pipelines color coded to indicate pipe size (size is also noted in text near the pipeline segments)
- Pressure outputs for the model indicated as colored dots and in text at various nodes along the route (negative pressure indicates a vacuum condition)

The second figure for each alternative and regional system illustrates the hydraulic head as a red line and the ground elevation as a green line. Reaches or pipe segments where the green elevation line is above the red hydraulic head line indicate zones of zero to negative pressure (the red hydraulic head line should always be above the green elevation line).

For most of the regional systems under each alternative, the provider is located at a lower elevation than participant delivery locations. For this reason, most of the systems will required either pumping to an elevated tank or pumping directly to the network. In the modeling results, new elevated tanks are recommended where the hydraulic grade line needs to be increased by less than 200 feet and the location for the tank is close to the provider. Booster pumping is recommended for all other cases. For all the regional providers, a modeled tank elevation of 10 feet is assumed, with the exception of Fowler and La Junta, which have an assumed operation level.

6.1 AVC Regionalization Alternative (Alternative 1)

For Alternative 1, the AVC project participants are segregated into five regions or hubs, all designated by their respective water provider. For Alternative 1, all AVC participants are part of the regionalization and will be connected to a regional water provider. Because this alternative is intended to provide only a short-term solution until the overall AVC is completed, the hydraulics (i.e., size, pressure) are not optimized for regionalization but are instead consistent with the future AVC delivery system. The infrastructure provided in this alternative is intended to become part of the AVC system once it is fully implemented.

6.1.1 Connector Routes and Preliminary Hydraulic Considerations

This section presents the modeling results for the five regional systems proposed under Alternative 1. Hydraulic modeling for this alternative used the established pipeline sizes, routes to the connectors, and points of connection for the preferred AVC alignment.

6.1.1.1 Alternative 1 St. Charles Mesa Water District Regional System

In the St. Charles Mesa region, water will flow east for approximately 9 miles from the St. Charles Mesa Water District to Avondale. At Avondale, the route turns to the north then east for approximately 6 miles before turning north for about 2 miles to Boone. The pipe is 30 inches in diameter for most of the alignment, with a 4-inch-diameter spur serving Boone. The general alignment is shown in **Figure 6-2**.

The hydraulic modeling results for this regional hub indicate line pressures are within operating pressure ranges (minimum 20 psi) for the entire line except for the 3-mile section immediately to the east of St. Charles Mesa. The planned AVC pipe crosses a ridge of higher elevation prior to flowing back downgradient into the valley. This sudden increase in elevation produces negative pressures for approximately 1 mile, as shown in **Figure 6-2**. **Figure 6-3** illustrates the hydraulic head in comparison to ground elevation. The hydraulic modeling indicates that for this regional system, the preferred AVC alignment pipeline sizes and route do not meet the established design criteria and modification is required.

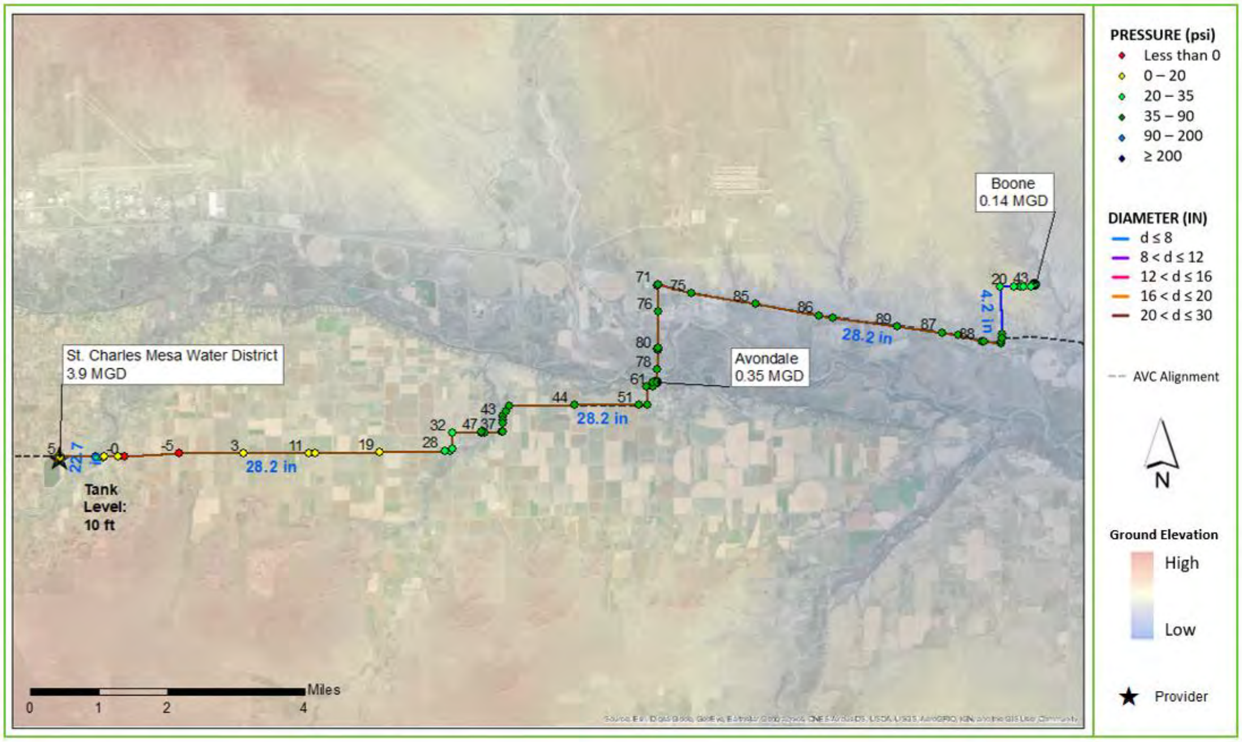

Figure 6-2. Conduit Route, Connection Points, Initial Diameters, and Pressures for the Alternative 1 St. Charles Mesa Water District Regional System

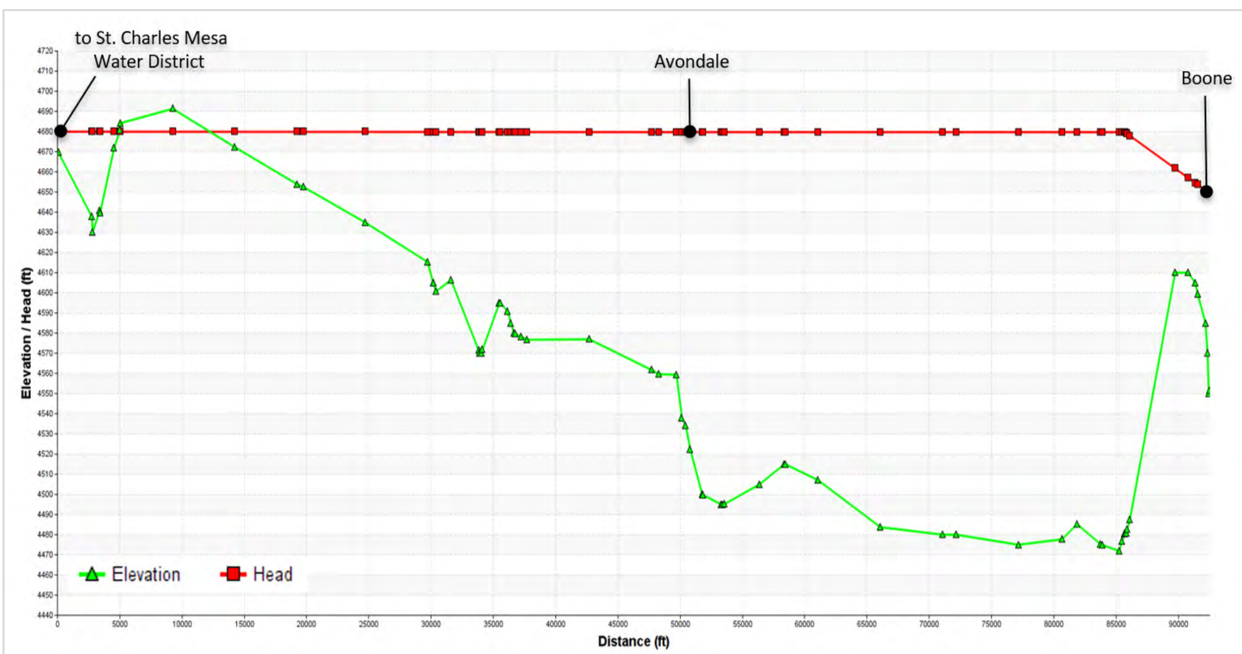

Figure 6-3. Initial Hydraulic Head and Ground Elevation for the Alternative 1 St. Charles Mesa Water District Regional System

6.1.1.2 Alternative 1 Crowley County Water Association Regional System

For the Crowley County region, the flow splits into two directions from the provider (Crowley County Water Association). The longest segment conveys flow through a 10-inch-diameter pipe for approximately 12 miles northeast to Ordway. From Ordway, the pipe diameter reduces to 6 inches and continues to the northeast for another 6 miles before turning north for 2 miles and ending at Sugar City. The second segment conveys flows from the provider east for 3 miles through a 30-inch-diameter pipe and ending at the Town of Crowley (**Figure 6-4**).

Because the regional provider (Crowley County Water Association) is located at the lower elevations in the valley, there is not enough head to reach most of the participants, including Ordway and Sugar City (**Figure 6-5**). When using the AVC alignment and pipe sizes with no modification, the Town of Crowley and the 96 Pipeline Company are the only participants for which the pressure criteria are met. For the other participants, pressure is below the minimum pressure of 20 psi and is negative in some cases.

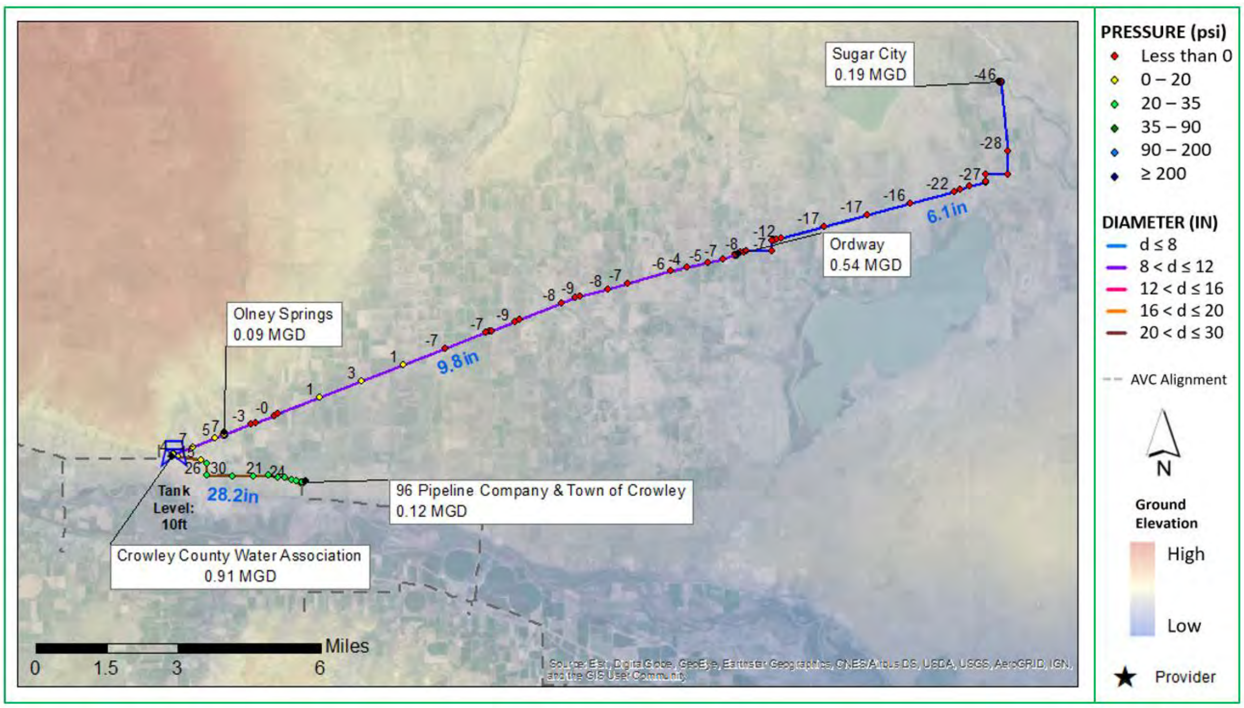

Figure 6-4. Conduit Route, Connection Points, Initial Diameters, and Pressures for the Alternative 1 Crowley County Water Association Regional System

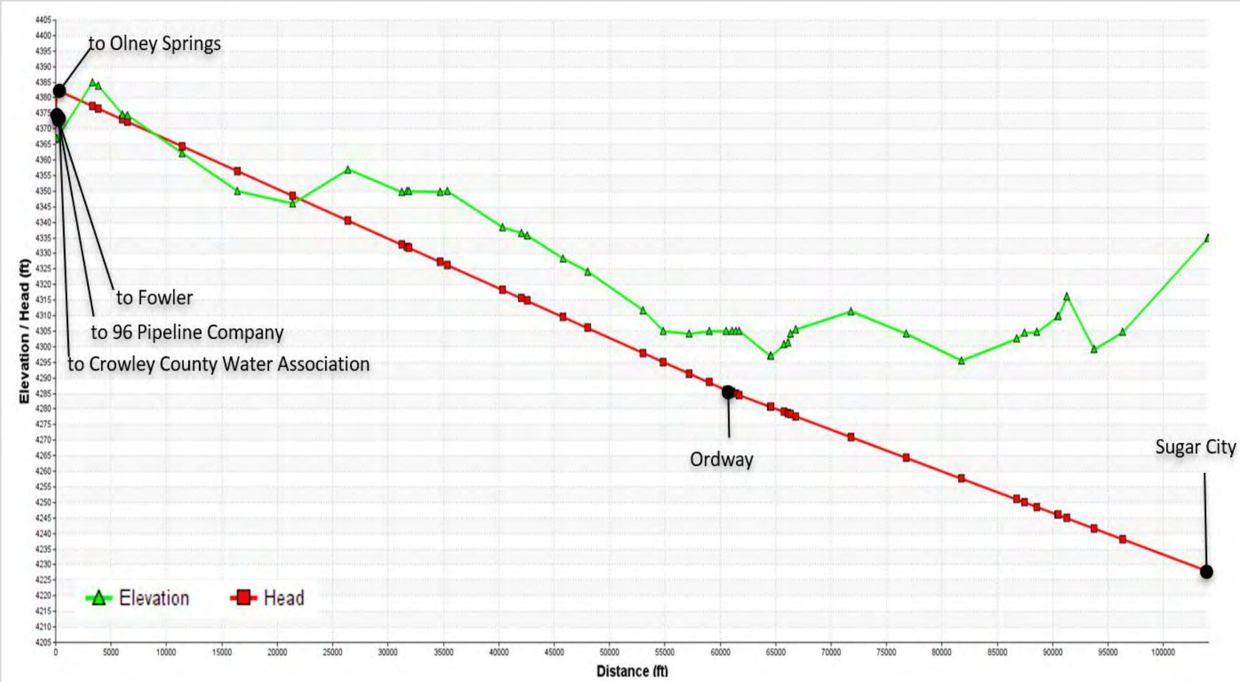

Figure 6-5. Initial Hydraulic Head and Ground Elevation for the Alternative 1 Crowley County Water Association Regional System

6.1.1.3 Alternative 1 Rocky Ford Regional System

For the Alternative 1 Rocky Ford Regional System, the flow splits in two directions from the provider (Rocky Ford). The shorter segment conveys water south through 3- and 4-inch-diameter pipes. After 1 mile, a segment branches westward, ending at the Hill Top Water Company. The main pipeline continues from this branch southward for another 5 miles then turns west for 1.5 miles and then north, ending at West Grand Valley Water Inc. The other segment from the source at Rocky Ford conveys flow through a 30-inch-diameter pipe northwest for approximately 8.5 miles, where a 3-inch-diameter pipe branches south for approximately 2.5 miles to the Patterson Valley Water Company. The 30-inch-diameter pipe continues from this branch northwest for approximately 14.5 miles, where a 3-inch-diameter pipe branches south to Manzanola. The last 4 miles of the main segment is approximately 4 miles of 4-inch-diameter pipe that terminates at the Valley Water Company (**Figure 6-6**).

Because the provider (Rocky Ford) is located approximately 200 feet lower in elevation than the end point of the regional system at the Valley Water Company, there is not enough head to reach most of the connectors at the AVC initial conditions (**Figure 6-7**). Most of the system is at negative pressure (or suction), which violates the hydraulic parameters established for the regional systems.

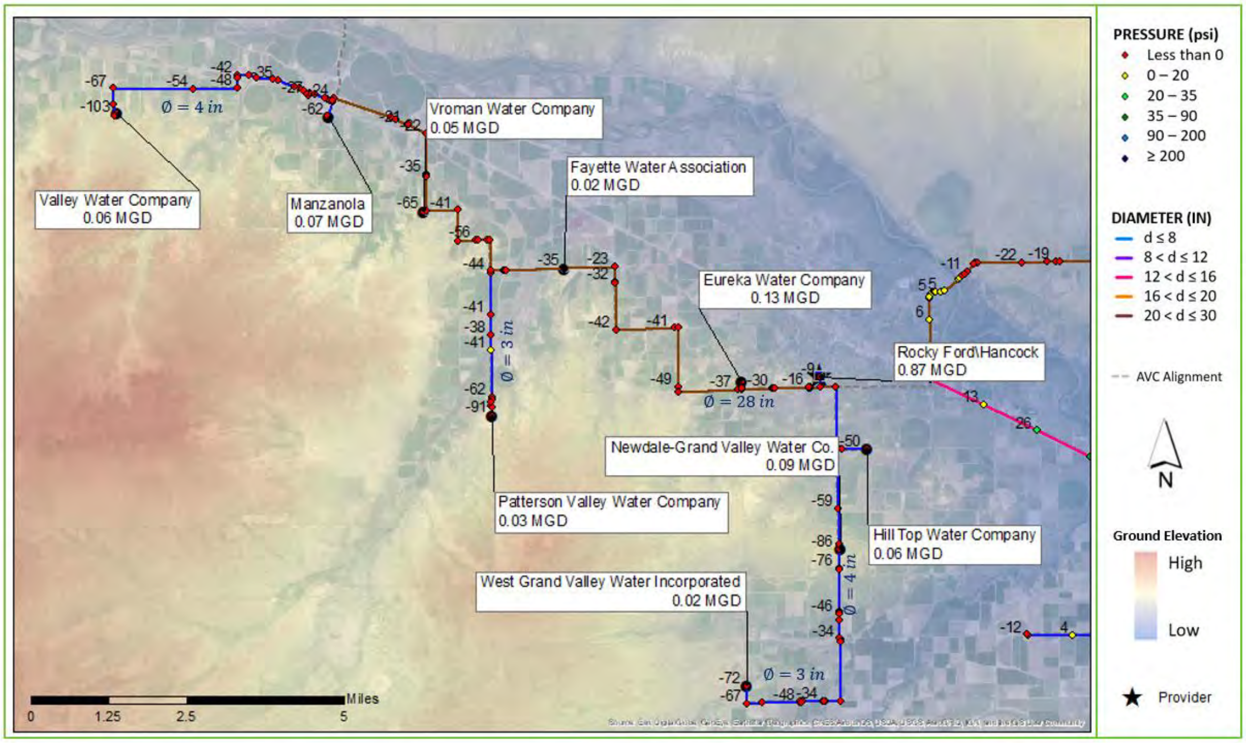

Figure 6-6. Conduit Route, Connection Points, Initial Diameters, and Pressures for the Alternative 1 Rocky Ford Regional System

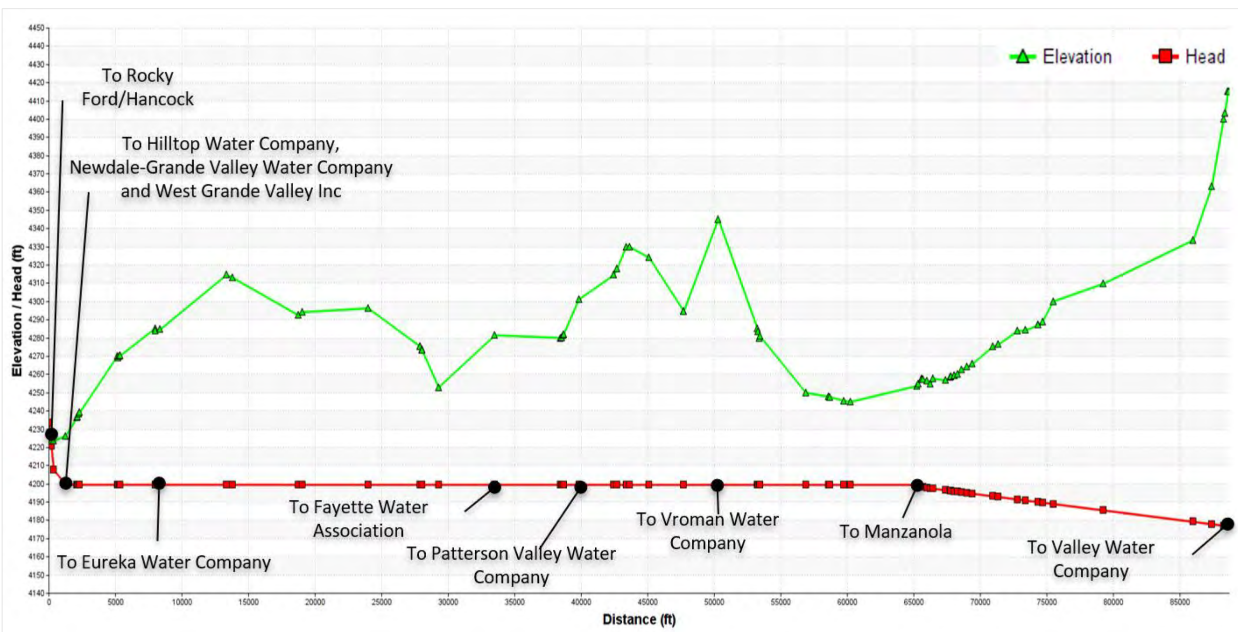

Figure 6-7. Initial Hydraulic Head and Ground Elevation for the Alternative 1 Rocky Ford Regional System

6.1.1.4 Alternative 1 La Junta Regional System

From the provider location (City of La Junta), water is conveyed westward through a 14-inch-diameter pipe. At 0.25 miles from the provider, a 2-inch-diameter branch runs southward for approximately 1 mile, ending at the Homestead Improvement Association. The main line continues from the branch for approximately 4 miles to the northwest, where there is a 6-inch-diameter southern branch. This branch extends approximately 2 miles, where it forks to the south and west. The southern fork extends another 1 mile and ends at Fairmont while the western fork extends 2 miles and ends at Fairview. The main line continues northwesterly, diverts northward, then swings toward the east, where there is a southern branch connecting to Riverside. The 20-inch-diameter main pipe continues east with several northern branch connections serving the North Holbrook Water Company, the West Holbrook Water Pipeline Association, the Holbrook Center Soft Water Association, the Beehive Water Association, Cheraw, the East End Water Association, and the Southside Water Association. A 14-inch-diameter branch extends to La Junta City #2 then reduces to a 4-inch-diameter branch, ending at the Bents Fort Water Company. The 20-inch-diameter main line continues east, then reduces to an 8-inch-diameter branch that serves Las Animas (**Figure 6-8**).

For the Alternative 1 La Junta Regional System, the water flows up the valley and then through the saddle north of La Junta, all at a relatively steady elevation increase. Under initial conditions, the operating pressures do not meet the design parameters on the segment between the Towns of Swink and Riverside (**Figure 6-9**).

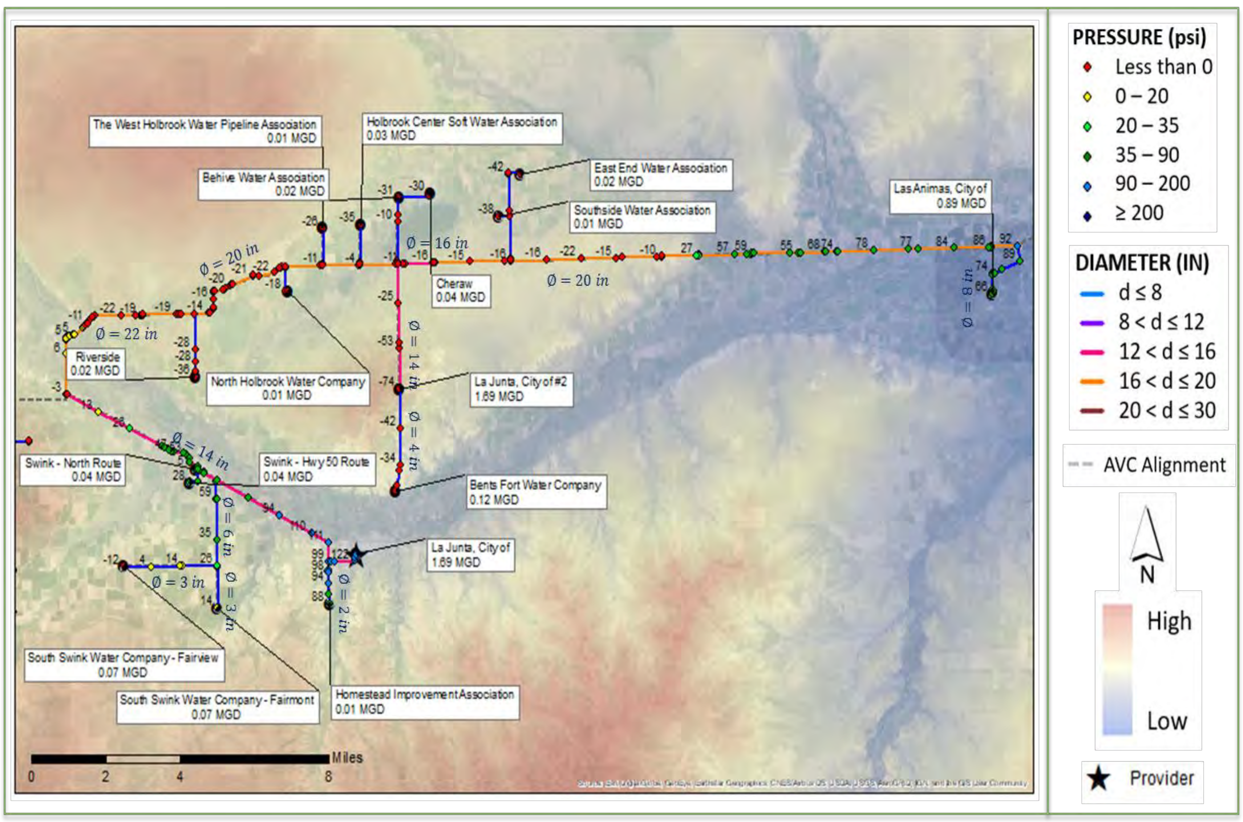

Figure 6-8. Conduit Route, Connection Points, Initial Diameters, and Pressures for the Alternative 1 La Junta Regional System

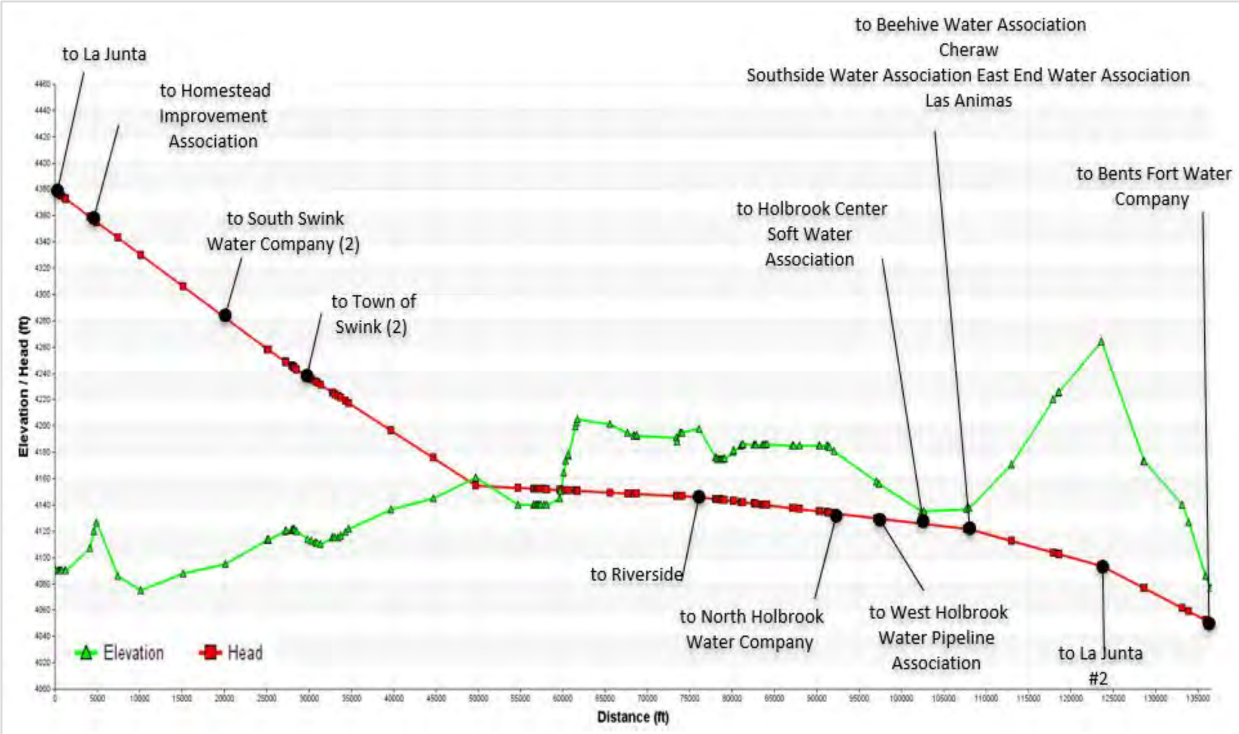

Figure 6-9. Initial Hydraulic Head and Ground Elevation for the Alternative 1 La Junta Regional System

6.1.1.5 Alternative 1 Lamar Regional System

From the provider location (City of Lamar), water is conveyed approximately 10 miles northwest through a 14-inch-diameter pipe, where there is a 3-inch-diameter northern branch that ends at the Town of Wiley. The main line continues 1.5 miles to an 8-inch-diameter northern branch that extends 30 miles to the Town of Eads. The May Valley Water Association has two connections to this 8-inch-diameter branch. The main line continues for 11.5 miles west and end at the McClave Water Association (**Figure 6-10**).

In the Lamar region, there is enough elevation head at the provider to maintain adequate pressure for approximately one-third of the system length. There is a significant elevation increase between the delivery locations of the McClave Water Association and the May Valley Water Association #2, resulting in negative operating pressures for the entire northern portion of the regional system (**Figures 6-10** and **6-11**).

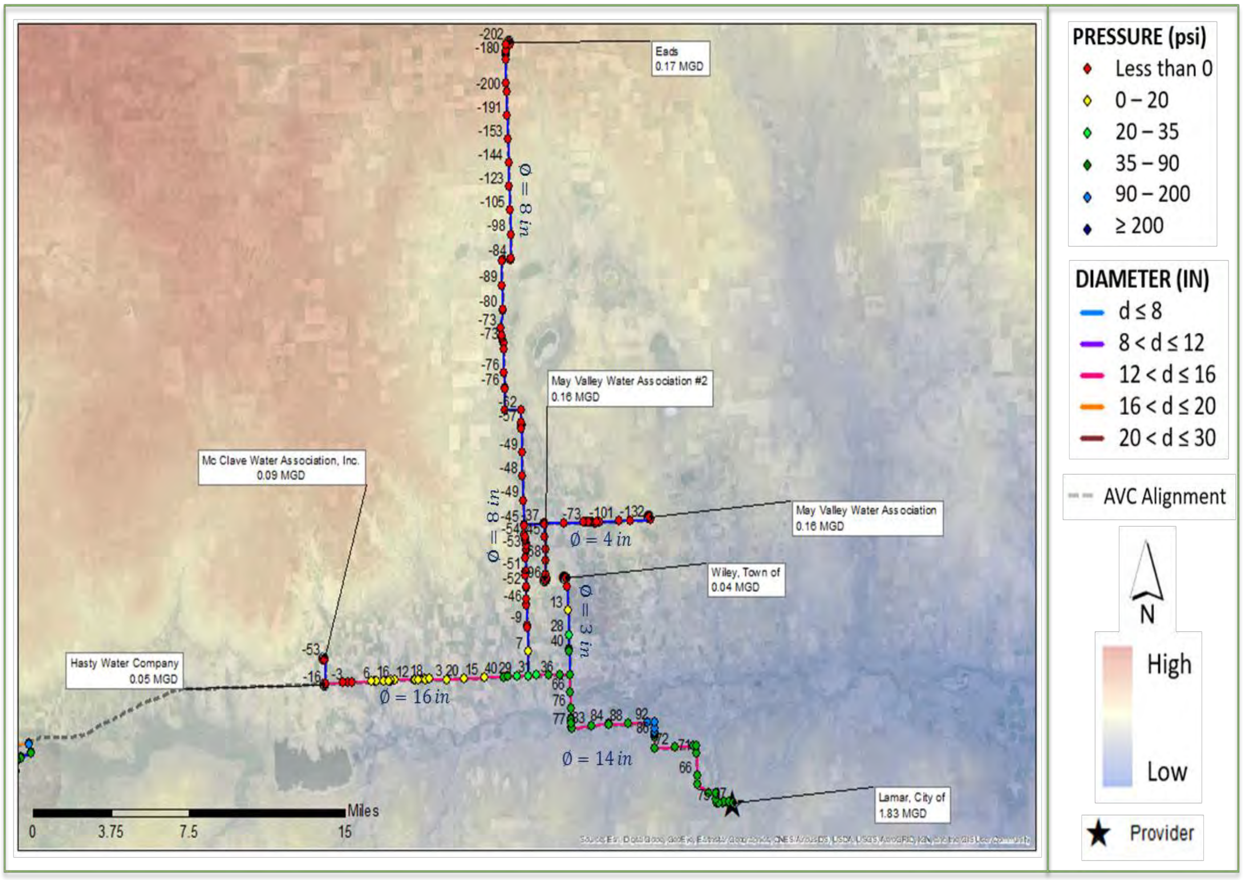

Figure 6-10. Conduit Route, Connection Points, Initial Diameters, and Pressures for the Alternative 1 Lamar Regional System

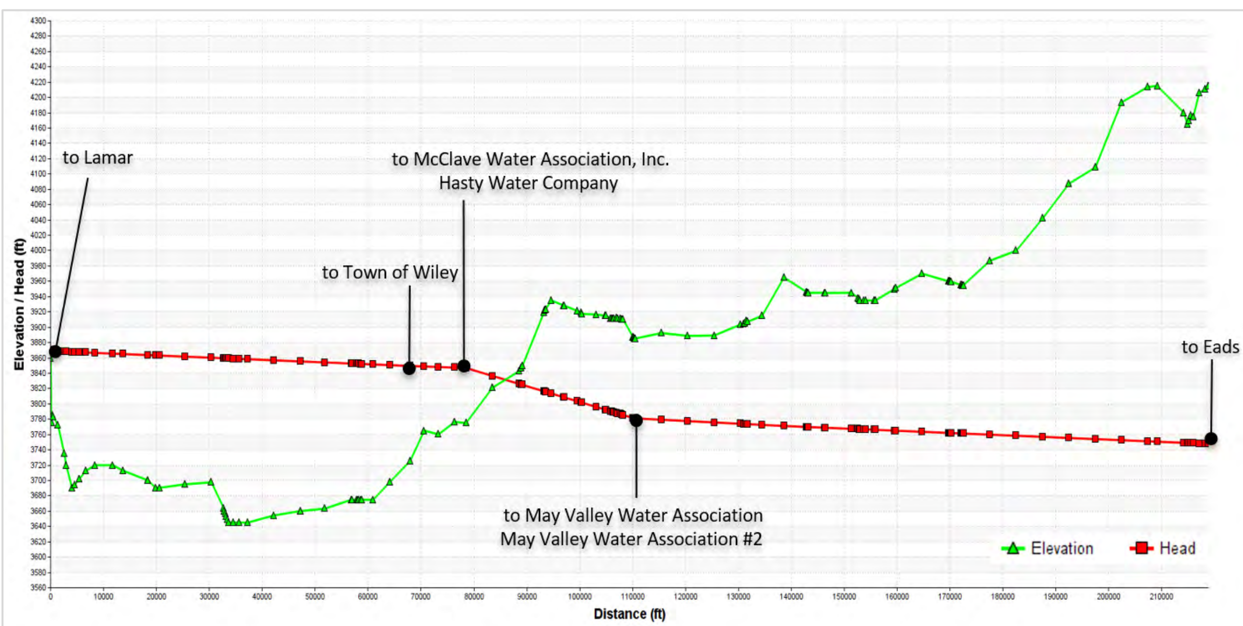

Figure 6-11. Initial Hydraulic Head and Ground Elevation for the Alternative 1 Lamar Regional System

CDM Smith

6.1.2 Hydraulic Modifications for Potential Routes

Based on the initial hydraulic modeling results for Alternative 1, modifications to the conveyance system are required in segments where the operating pressures do not meet the minimum established pressure for this analysis (i.e., 20 psi). Modifications to the regional systems include the addition of elevated tanks, pump stations, or changes to pipeline sizes where appropriate. The proposed conveyance system modifications for the five regional hubs under Alternative 1 are presented in this section.

6.1.2.1 Alternative 1 St. Charles Mesa Water District Regional System

Implementation of the preferred AVC alignment for water delivery under Alternative 1 for the St. Charles Mesa Regional System results in negative operating pressures east of St. Charles Mesa. Head, in the form of discharge elevation or energy through pumping, must be added at the provider locations to maintain the minimum operating pressures over the regional provider system. Modeling results indicate that increasing the level of the storage tank at St. Charles Mesa to 70 feet allows for sufficient operating pressures throughout the regional system **Figures 6-12** and **6-13**).

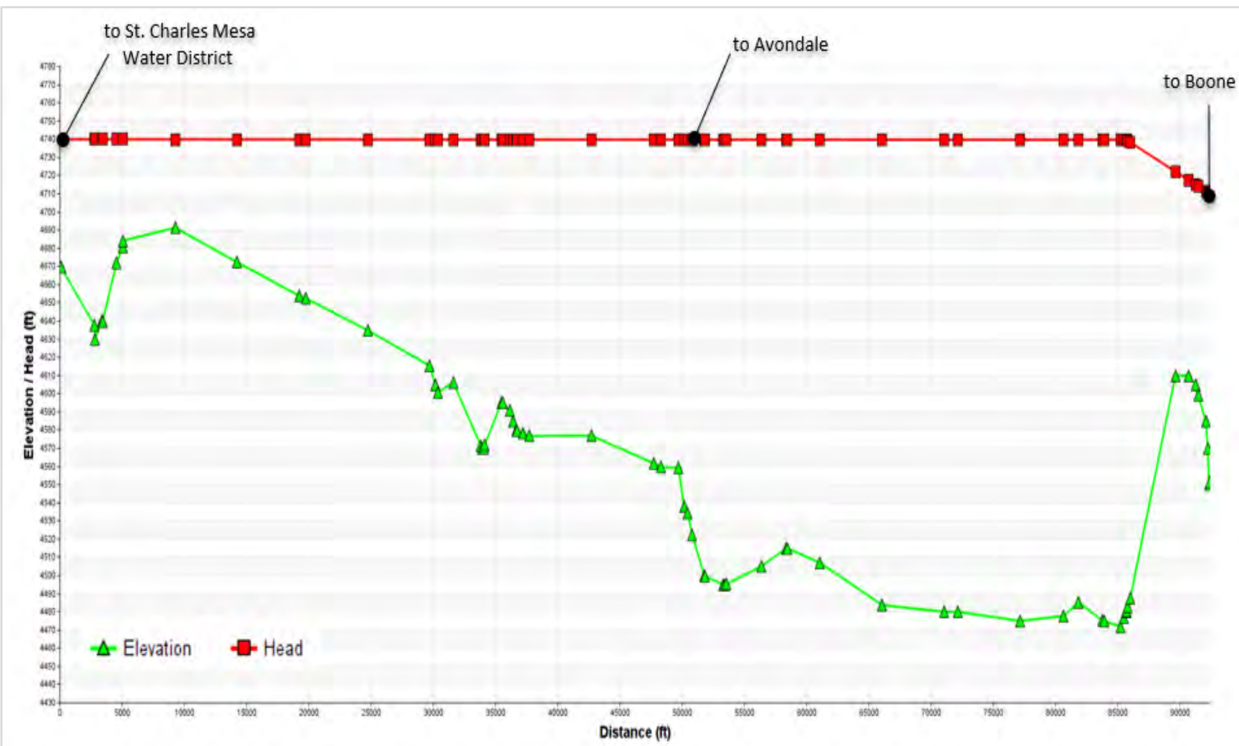

Figure 6-12. Hydraulic Head and Ground Elevation for the Alternative 1 St. Charles Mesa Water District Regional System with a Tank Operation Level at 70 Feet Incorporated into the System

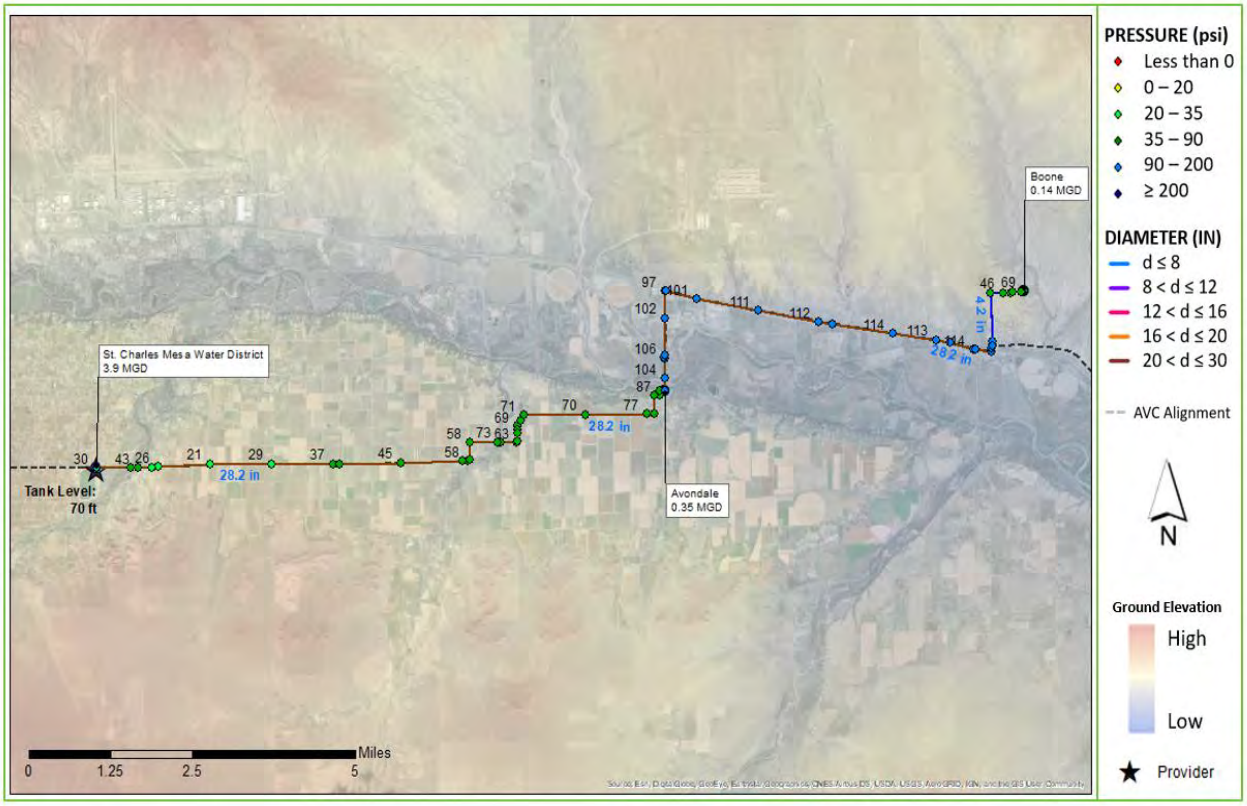

Figure 6-13. Diameters and Resulting Pressures for the Alternative 1 St. Charles Mesa Water District Regional System with a Tank Operation Level at 70 Feet Incorporated into the System

6.1.2.2 Alternative 1 Crowley County Water Association Regional System

A booster pump station or elevated tank at the regional provider is required to have sufficient head to maintain pressure at the end of the regional system. The provider tank needs a minimum operating level of 170 feet (**Figures 6-14** and **6-15**).

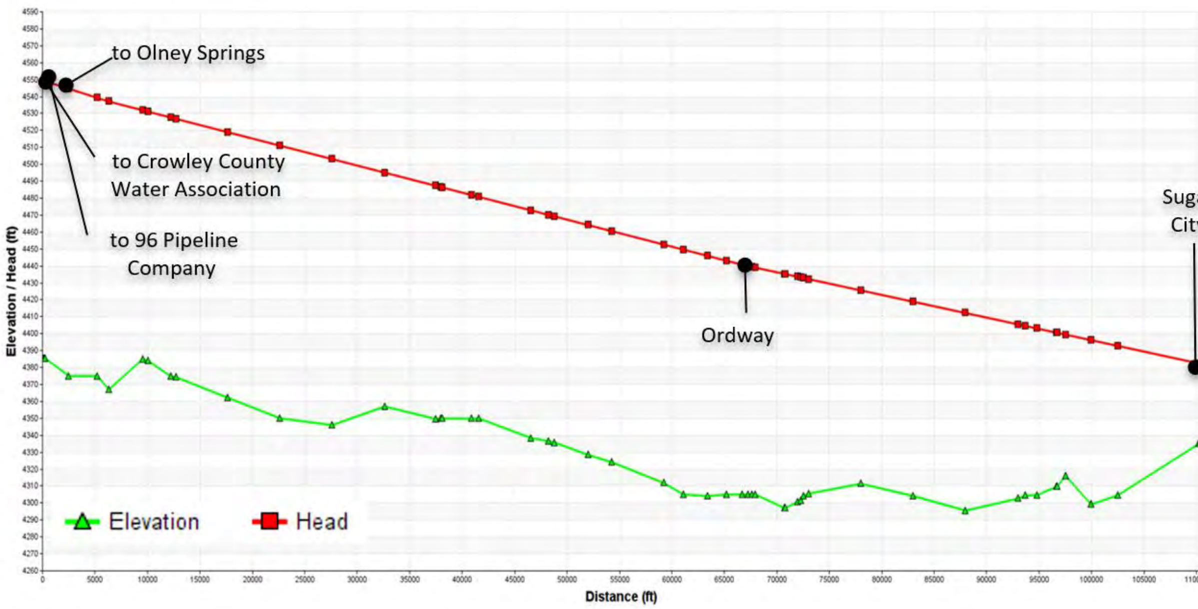

Figure 6-14. Hydraulic Head and Ground Elevation for the Alternative 1 Crowley County Water Association Regional System with a Tank Operation Level at 170 Feet Incorporated into the System

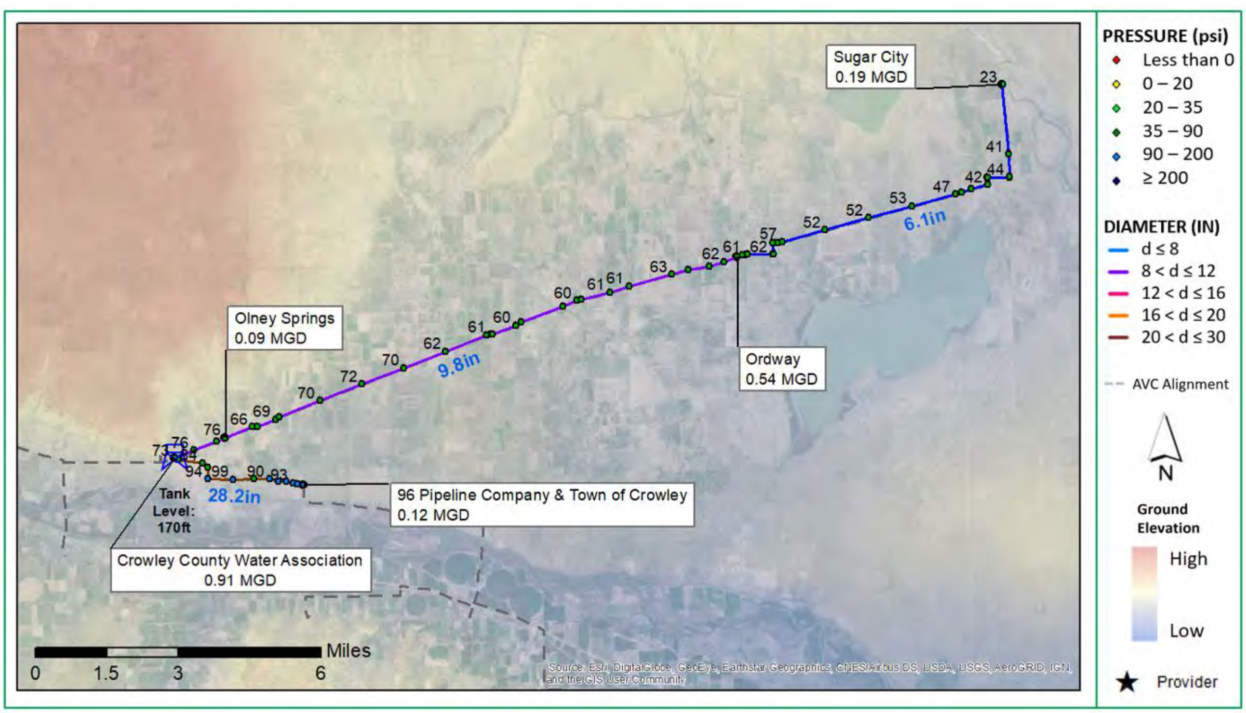

Figure 6-15. Diameters and Resulting Pressures for the Alternative 1 Crowley County Water Association Regional System with a Tank Operation Level at 170 Feet Incorporated into the System

6.1.2.3 Alternative 1 Rocky Ford Regional System

For the Alternative 1 Rocky Ford Regional System, an additional 260 feet of head is needed at the Rocky Ford provider location to maintain the required minimum pressure throughout the system to the Valley Water Company connector. This head increase is obtained through installation of a booster pump station at Rocky Ford. See **Figures 6-16** and **6-17** for the updated hydraulics with the additional pump station incorporated into the system.

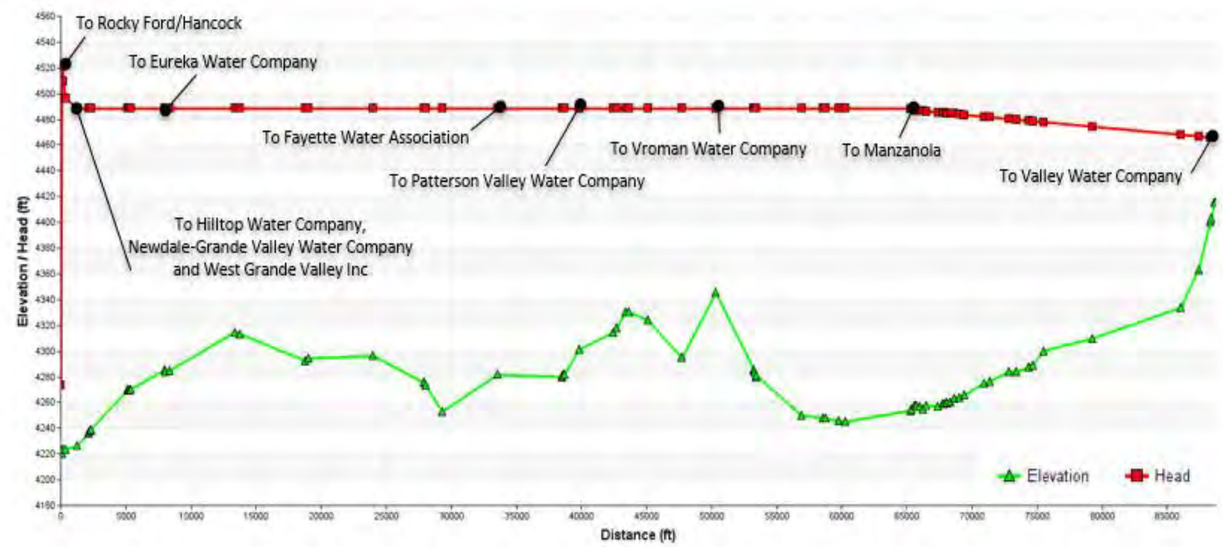

Figure 6-16. Hydraulic Head and Ground Elevation for the Alternative 1 Rocky Ford Regional System with Additional Pump Station Incorporated into the System

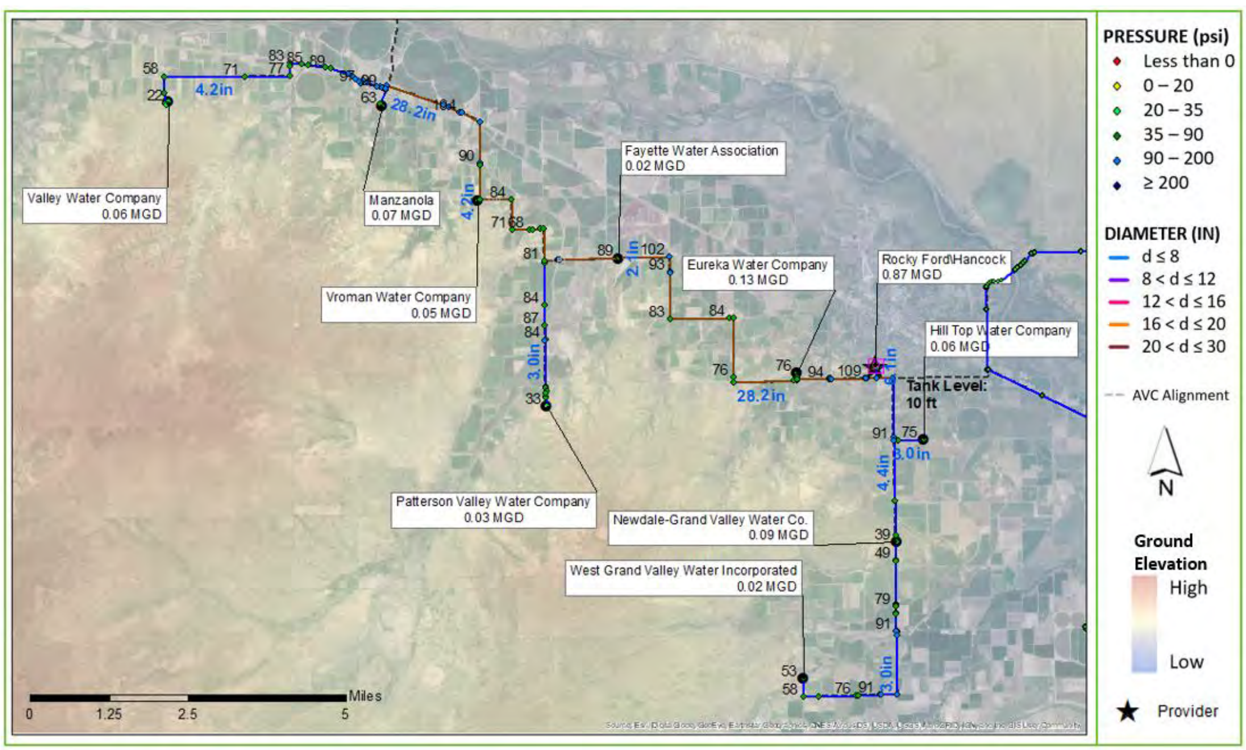

Figure 6-17. Diameters and Resulting Pressures for the Alternative 1 Rocky Ford Regional System with Additional Pump Station Incorporated into the System

6.1.2.4 Alternative 1 La Junta Regional System

For this regional system to maintain positive pressures, the diameter of the pipeline needs to be upsized from 14- to 24-inch-diameter pipe, which reduces the friction loss in the system. The branch line from the main line toward the Bents Fort Water Company has an elevation increase. To overcome this elevation increase, additional head from a booster pump station is required. **Figures 6-18** and **6-19** show the updated hydraulic conditions based on the increased pipe size and addition of the booster pump station.

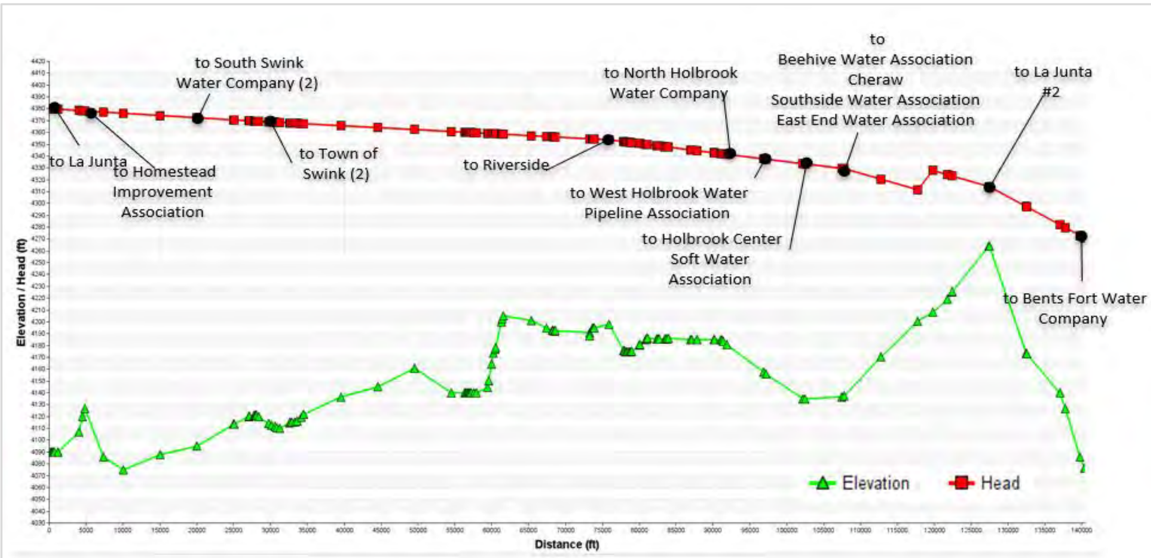

Figure 6-18. Hydraulic Head and Ground Elevation for the Alternative 1 La Junta Regional System with Pipeline Size Modifications and Additional Pump Station Incorporated into the System

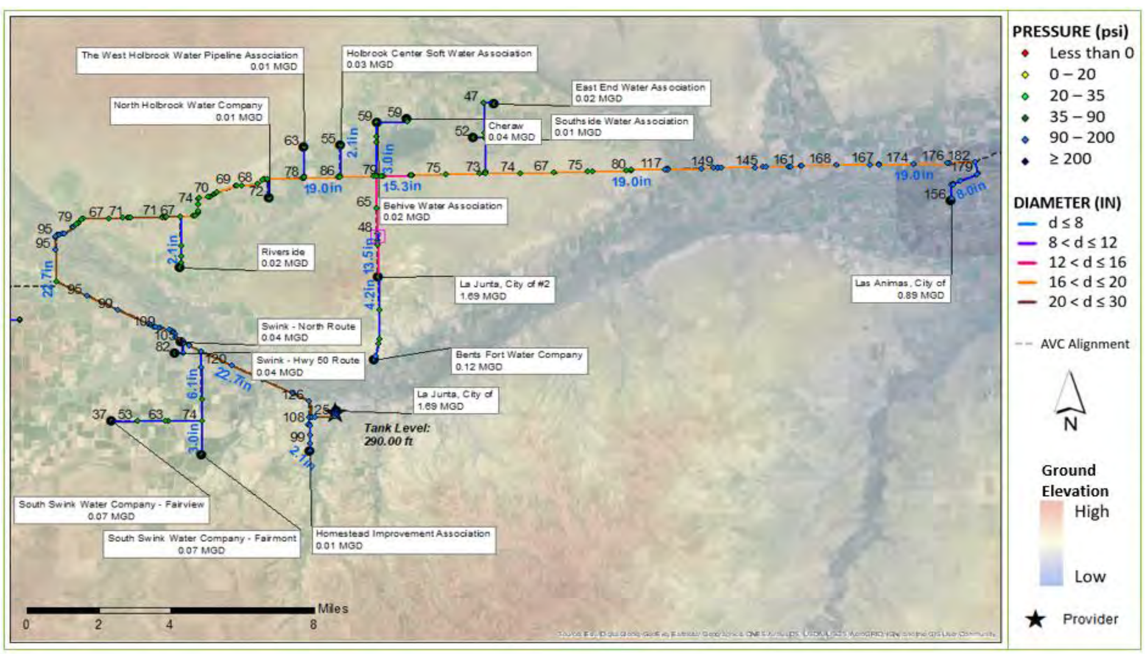

Figure 6-19. Diameters and Resulting Pressures for the Alternative 1 La Junta Regional System with Pipeline Size Modifications and Additional Pump Station Incorporated into the System

6.1.2.5 Alternative 1 Lamar Regional System

In the Lamar Regional System, there is adequate elevation head at the source to maintain pressure for only approximately one-third of the system length. Booster pump stations are required at two different points along the system prior to the branch to the Town of Wiley and at the branch to the May Valley Water Association. **Figures 6-20** and **6-21** show the updated hydraulic conditions with the additional booster pump stations incorporated into the system.

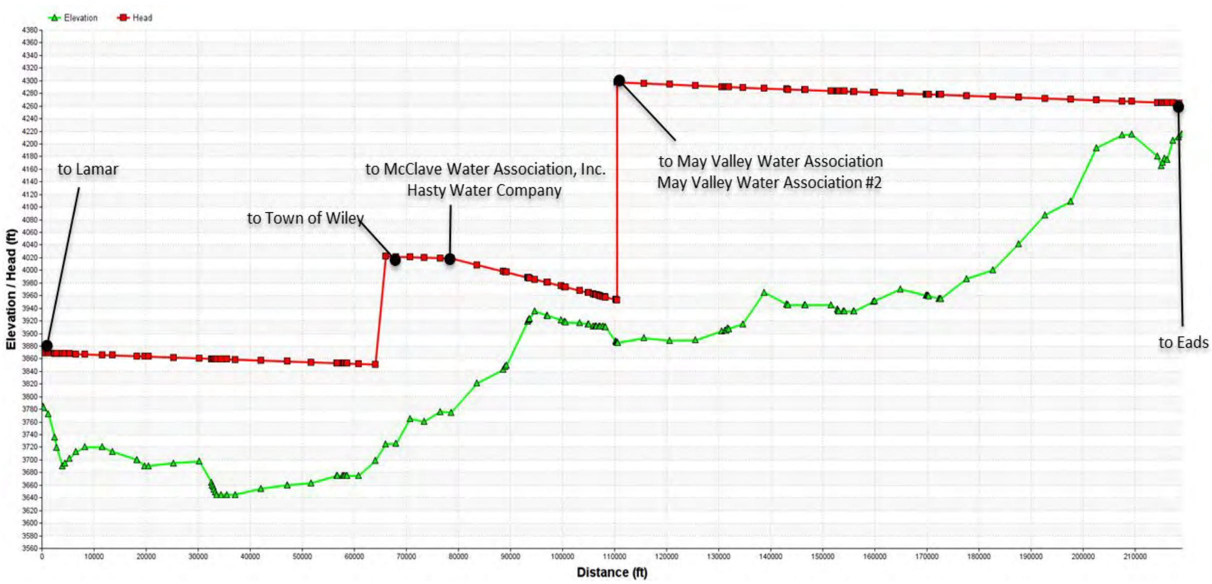

Figure 6-20. Hydraulic Head and Ground Elevation for the Alternative 1 Lamar Regional System with Additional Pump Stations Incorporated into the System

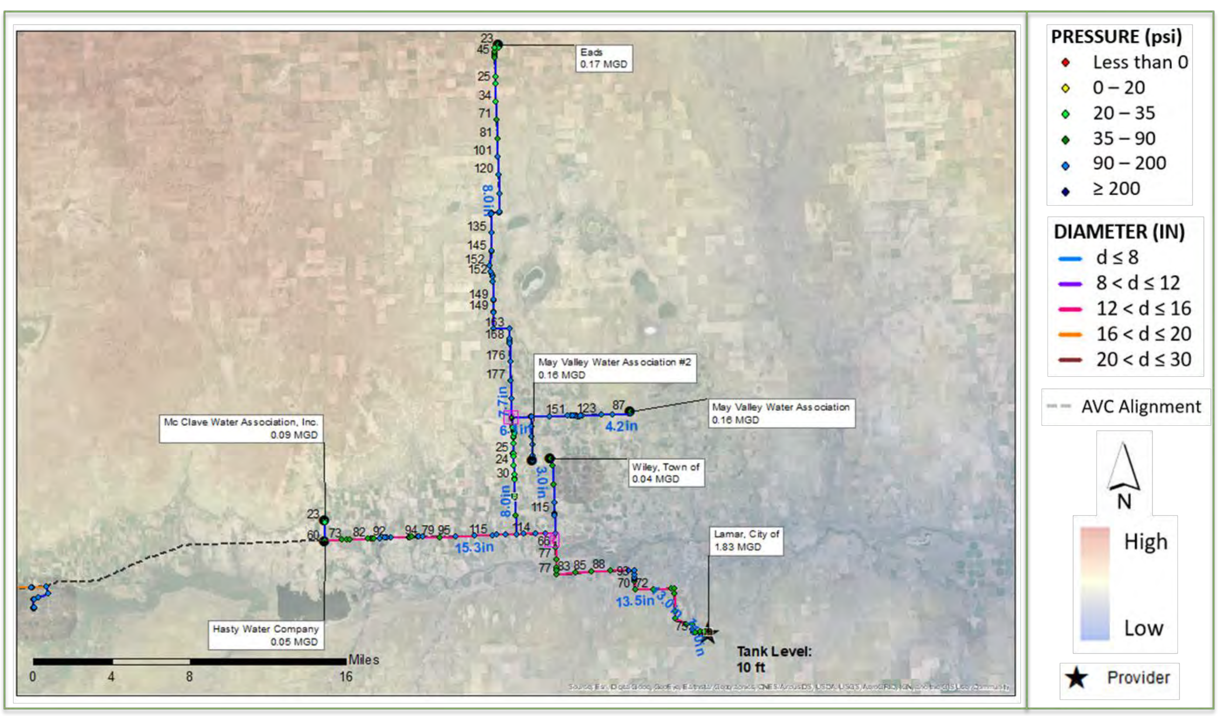

Figure 6-21. Diameters and Resulting Pressures for the Alternative 1 Lamar Regional System with Additional Pump Stations Incorporated into the System

6.1.2.6 Alternative 1 Modifications required summary

The table below summarizes the hydraulic modifications required to achieve operating pressures that meet the minimum established pressures (compared to the AVC feasibility design) for all Alternative 1 regional systems.

Table 6-1. Modifications Required for Regional Systems Under Alternative 1

Regional System Water Provider	Required Modifications Additional to AVC Feasibility Design
St. Charles Mesa Water District Regional System	Set provider tank minimal operation level to 70 feet[6] New 30-inch pipe (86 feet)
Crowley County Water Association Regional System	Set provider tank minimal operation level to 170 feet New 30-inch pipe (42 feet)
Rocky Ford Regional System	Pumping at Rocky Ford (Design Head: 260 feet) New 30-inch pipe (1,208 feet)
La Junta Regional System[7]	Upsized pipe from 14 to 24 inches (49,547 feet) Set pumping for La Junta #2 (Design Head: 20 feet)
Lamar Regional System	Pumping upstream Town of Wiley (Design Head: 175 feet) Pumping upstream May Valley (Design Head: 340 feet) New 14-inch pipe (246 feet)

6.1.3 Construction Considerations

A number of geologic investigations have been conducted for the AVC, including a feasibility-level geologic investigation along the pipeline alignment at a spacing of about one every 5 miles and an evaluation of 140 drill holes, 100 cone penetration test holes, and 11 groundwater monitoring wells (Reclamation 2016a). Detailed results from these data collection efforts are included in Reclamation's planning-level Feasibility Design Report (Reclamation 2016a).

The proposed AVC is located within the southern portion of the Colorado Piedmont section of the Great Plains Physiographic Province (Fenneman and Johnson 1946), which is underlain by a transgressive series of Jurassic and Cretaceous marine and marginal marine sedimentary bedrocks (Reclamation 2016a). Bedrock has been encountered at a depth of 12 feet or more near the ground surface at multiple areas along the AVC pipeline alignment. Outcropping occurs near the foothill margin and intermittently along the Arkansas River (Reclamation 2016a). Holocene and Pleistocene fluvial sands and gravels and eolian sands unconformably overlie the Jurassic and Cretaceous bedrock. These fluvial sands and gravels are found within river and stream valleys and in terrace deposits. Low and broad hills that gently slope eastward away from the Rocky Mountains make up the landscape of the project area due to the erosive forces of the Arkansas River and its tributaries on the topography.

Several geologic faults were identified throughout the project area; however, none were considered active or cause for potential concern for seismic activity during construction. Subsidence and/or karst features are also not considered to be a geologic hazard within the project area (Reclamation 2016a). The groundwater table ranged from 3.5 to approximately 45 feet below the surface in some areas along the preferred AVC pipeline alignment (Reclamation 2016a). With an average required trench excavation depth of about 8.5 feet for the AVC, there is a high likelihood of encountering groundwater during construction activities, especially in areas adjacent to the Arkansas River, tributaries, reservoirs, lakes, wetlands, and canals (Reclamation

[6]Ground to elevated tank
[7]Based on La Junta having a 290-foot elevated tank

2016a). Dewatering during construction is regulated by CDPHE and may require treatment prior to discharge, depending on the groundwater quality encountered. If dewatering treatment is required, it has the potential to significantly impact the overall cost of construction.

A desktop review of areal imagery for each regional system proposed under Alternative 1 was conducted to identify the total number of major crossings for each hub. The total number of major crossings for each regional system under Alternative 1 is presented in **Table 6-2**. Additionally, the total estimated pipeline length for each regional system is included in **Table 6-3**. The number of major crossings and total pipeline miles provide valuable information regarding potential construction considerations for each proposed regional system under Alternative 1.

Table 6-2. Major Crossings for Each Regional System Proposed Under Alternative 1

Regional System Water Provider	Crossing Category	Number of Crossings
St. Charles Mesa Water District Regional System	Highway	2
	Railroad	1
	Roads	21
	Water	4
Crowley County Water Association Regional System	Highway	1
	Roads	26
	Water	2
Rocky Ford Regional System	Highway	5
	Railroad	2
	Roads	30
	Water	21
La Junta Regional System	Highway	3
	Railroad	2
	Roads	50
	Water	10
Lamar Regional System	Highway	4
	Roads	45
	Water	11

Table 6-3. Total Estimated Pipeline Miles for Each Proposed Regional System Under Alternative 1

Regional System	Pipeline Diameter (Inches)	Pipeline Length (Miles)
St. Charles Mesa Water District Regional System	Less than or equal to (≤) 8	1.3
	10–12	0.0
	14–16	0.0
	20–30	16.2
	Total Pipeline Miles for Regional System	**17.5**
Crowley County Water Association Regional System	≤8	8.3
	10–12	12.6
	14–16	0.0
	20–30	3.0
	Total Pipeline Miles for Regional System	**27.2**
Rocky Ford Regional System	≤8	14.6
	10–12	0.0
	14–16	0.0
	20–30	12.6
	Total Pipeline Miles for Regional System	**27.2**
La Junta Regional System	≤8	20.5
	10–12	0.0
	14–16	4.7
	20–30	36.2
	Total Pipeline Miles for Regional System	**61.4**
Lamar Regional System	≤8	40.0
	10–12	0.0
	14–16	24.8
	20–30	0.0
	Total Pipeline Miles for Regional System	**64.8**

6.2 AVC-CDPHE Enforcement Regionalization Alternative (Alternative 2)

Similar to Alternative 1, the hydraulic modeling for Alternative 2 used the established pipeline sizes, connector routes, and points of connection for the preferred AVC alignment. However, this alternative serves only participating systems that are currently under CDPHE enforcement orders, have a high likelihood of future enforcement, or are already being served by a regional water provider. Twenty of the 41 participating systems are currently under an enforcement order or have conditions that indicate they may be under an enforcement order in the future.

Fowler is not included in this alternative despite it currently being under a CDPHE enforcement. Fowler has implemented improvements required by their current enforcement order and are currently in a monitoring period by CDPHE. Upon completion of this monitoring period and Fowler demonstrating continued compliance, the enforcement order will be removed.

This section presents the modeling results for the four regional systems proposed under Alternative 2 if no additional changes or modifications to the existing preferred AVC alignment and conveyance system are implemented. The regional systems are reduced to four for this alternative, with the water providers being Avondale, Rocky Ford, La Junta, and Lamar.

6.2.1 Connector Routes and Preliminary Hydraulic Considerations

6.2.1.1 Alternative 2 Avondale Regional System

Starting at the regional provider (Avondale), a 30-inch-diameter pipeline aligns north 2 miles then turns east for 5.5 miles. The pipeline then turns north and reduces to 4 inches in diameter for 0.75 miles. The pipeline then turns east and terminates at Boone. The Avondale Regional System operates within the established hydraulic criteria except for the last approximately 1 mile of the system, which rises in elevation before reaching Boone. **Figures 6-22** and **6-23** show the conduit route and initial hydraulic modeling results for the Alternative 2 Avondale Regional System.

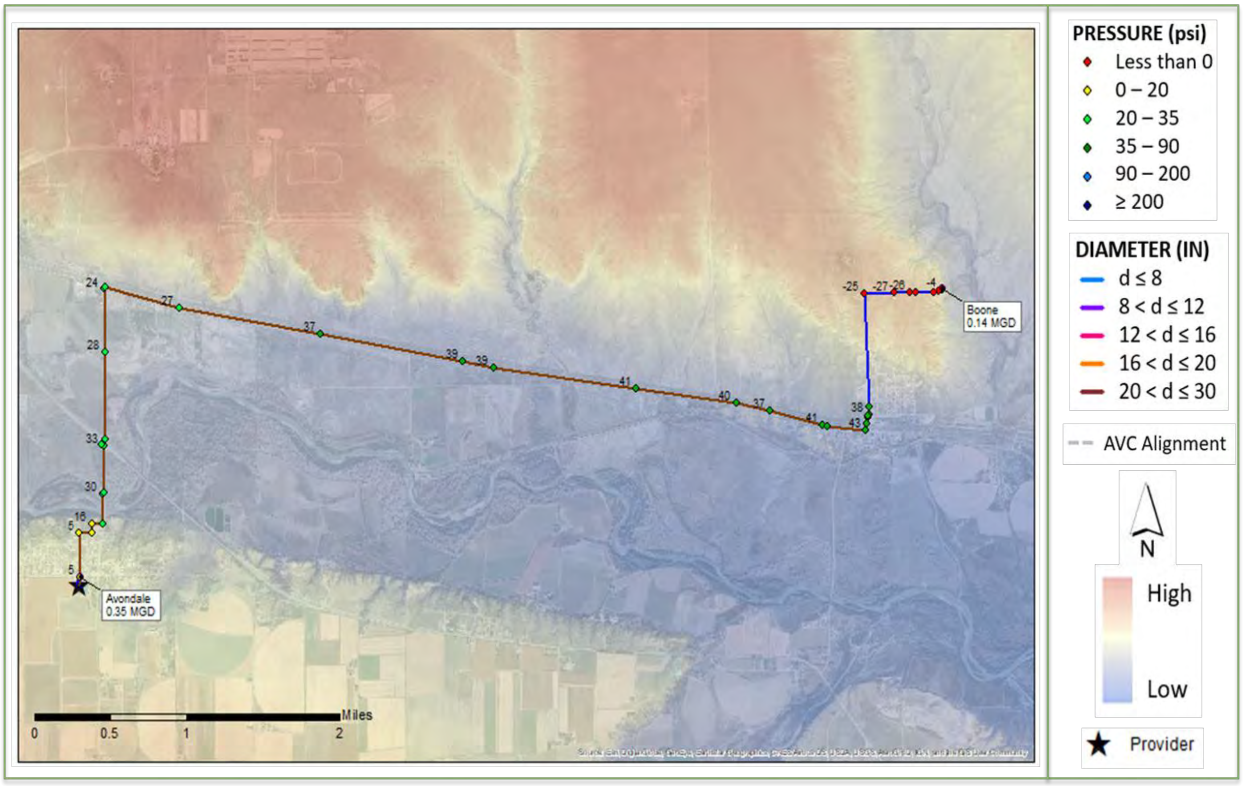

Figure 6-22. Conduit Route, Connection Points, Initial Diameters, and Pressures for the Alternative 2 Avondale Regional System

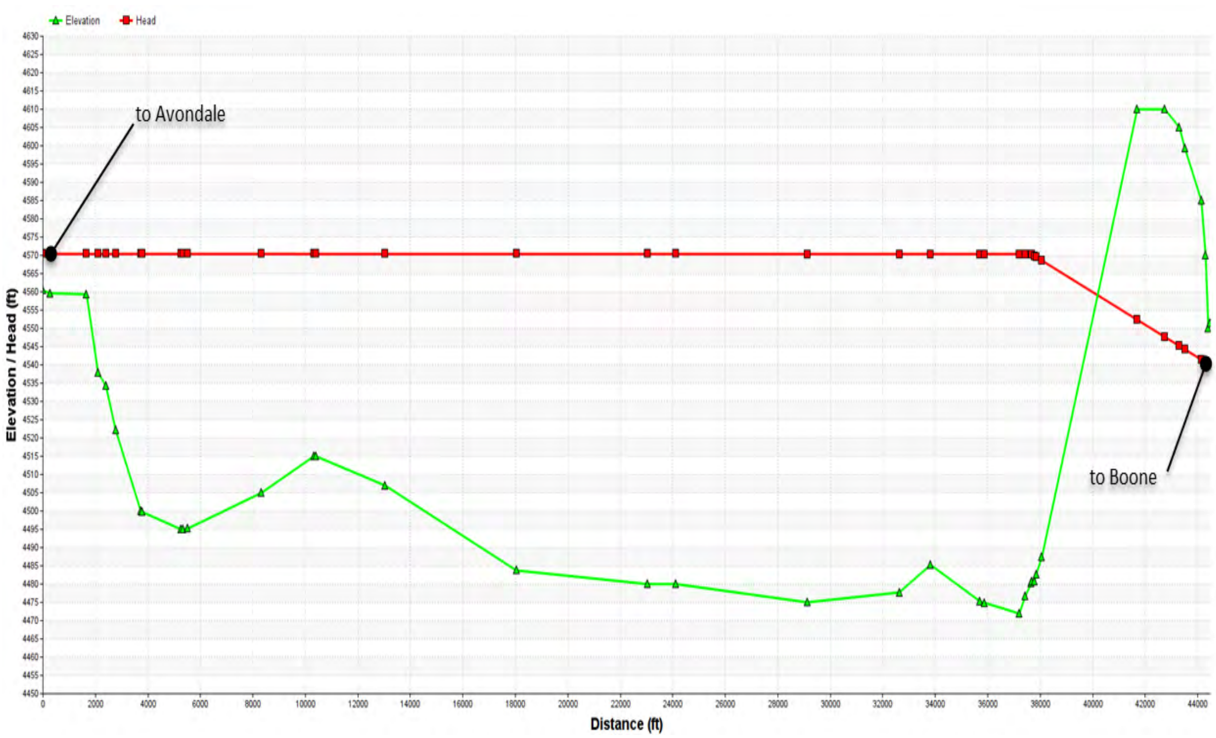

Figure 6-23. Initial Hydraulic Head and Ground Elevation for the Alternative 2 Avondale Regional System

6.2.1.2 Alternative 2 Crowley County Water Association Regional System

The Crowley County Water Association Regional System originates at the Crowley County Water Association then proceeds southeast through a 30-inch-diameter pipeline where it crosses the Arkansas River and splits in two directions. A 4-inch-diameter pipe branches to the west, connecting to Manzanola and the Valley Water Company. The main 30-inch line continues to the southeast, connecting the Vroman Water Company, the Fayette Water Association, and the Eureka Water Company. Another 3-inch-diameter pipeline spur extends south between Vroman and Fayette to connect the Patterson Valley Water Company (**Figure 6-24**). The Crowley County Water Association regional provider is at a lower elevation than the Valley Water Company and the Patterson Valley Water Company, which results in negative operating pressures for these AVC participants (**Figure 6-25**).

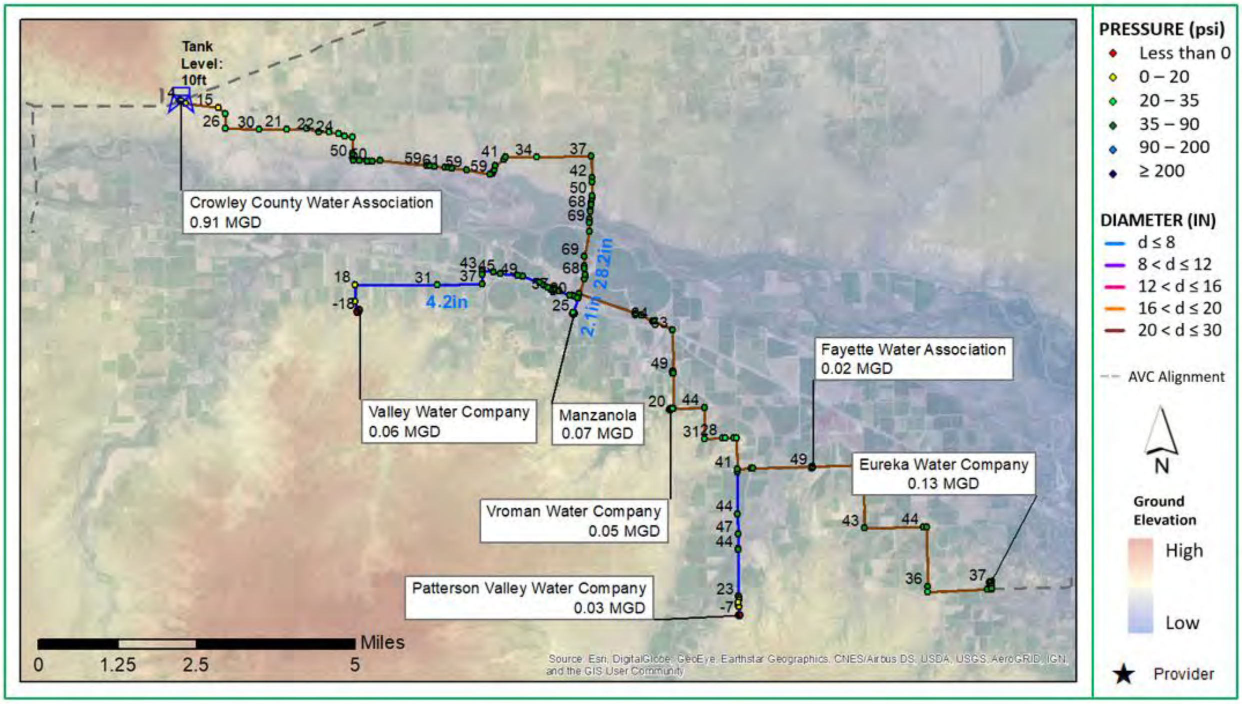

Figure 6-24. Conduit Route, Connection Points, Initial Diameters, and Pressures for the Alternative 2 Crowley County Water Association Regional System

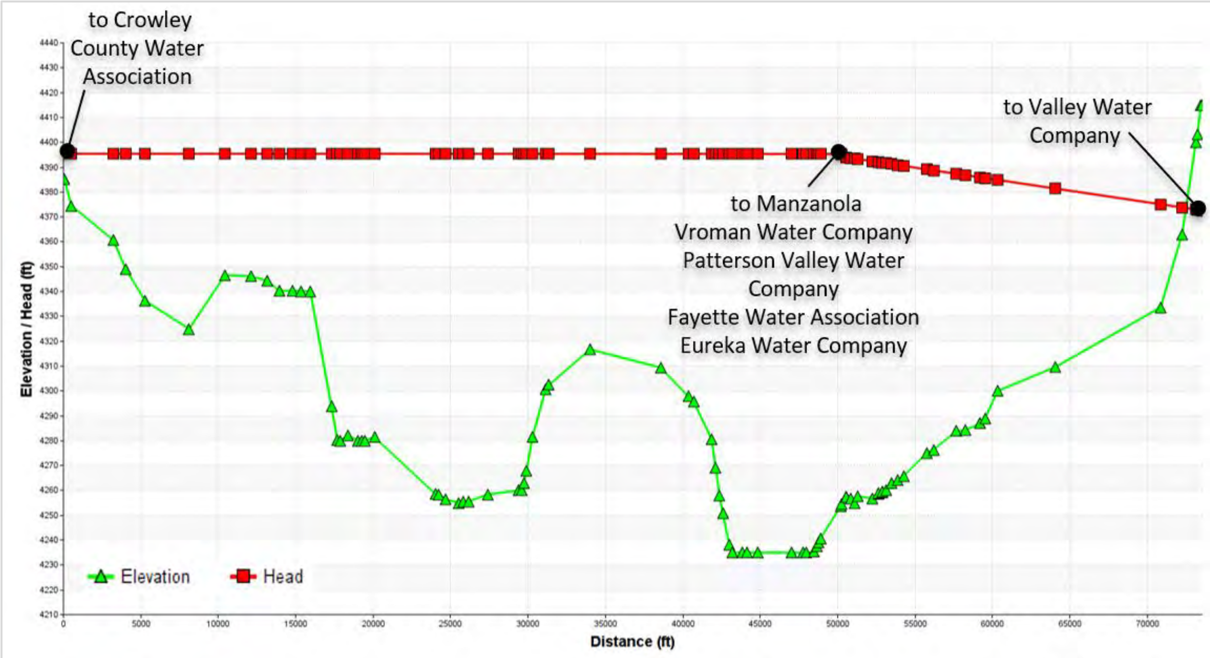

Figure 6-25. Initial Hydraulic Head and Ground Elevation for the Alternative 2 Crowley County Water Association Regional System

6.2.1.3 Alternative 2 La Junta Regional System

From the regional provider (City of La Junta), a 14-inch-diameter pipe extends west and at 0.25 miles, a 2-inch-diameter spur diverts south for 1 mile, ending at the Homestead Improvement Association. The main 14-inch-diameter pipe continues northwest for 4 miles to a branch connection to the south. This branch flows south for 2 miles then forks south and west. The southern fork flows for 1 mile and ends at Fairmont while the west fork ends after 2 miles at Fairview. The main line continues northwest for 5.5 miles until it diverts north as a 24-inch-diameter pipeline, cutting across the valley for 2 miles. The pipeline then continues west for 2.5 miles where it decreases to 20 inches in diameter. A branch diverts south for 2 miles, ending at Riverside. The main line continues northwest for 3 miles, where a 2-inch-diameter line branches south for 0.25 miles, ending at the North Holbrook Water Company. The main line continues east for 0.75 miles, where a 2-inch-diameter pipe forks north for 0.5 miles, ending at the West Holbrook Water Pipeline Association. The main line continues another 0.75 miles to a 2-inch-diameter northern branch that extends 0.5 miles, ending at the Holbrook Center Soft Water Association. The main pipeline extends another 0.75 miles to a 3-inch-diameter northern branch that ends in Cheraw and a 14-inch-diameter branch that connects La Junta City #2, then reduces to 4 inches in diameter before ending at the Bents Fort Water Company. The main line continues east for 4 miles then reduces to 2 inches in diameter and turns north, connecting the Southside Water Association and ending at the East End Water Association (**Figure 6-26**).

The La Junta region operates under high pressure from the regional provider and meets the hydraulic conditions for most of the alignment. The branch that serves the Bents Fort Water Company goes over an elevation change near the La Junta City #2 location. This steep increase in elevation results in negative pressure as the pipe goes over the peak (**Figure 6-27**).

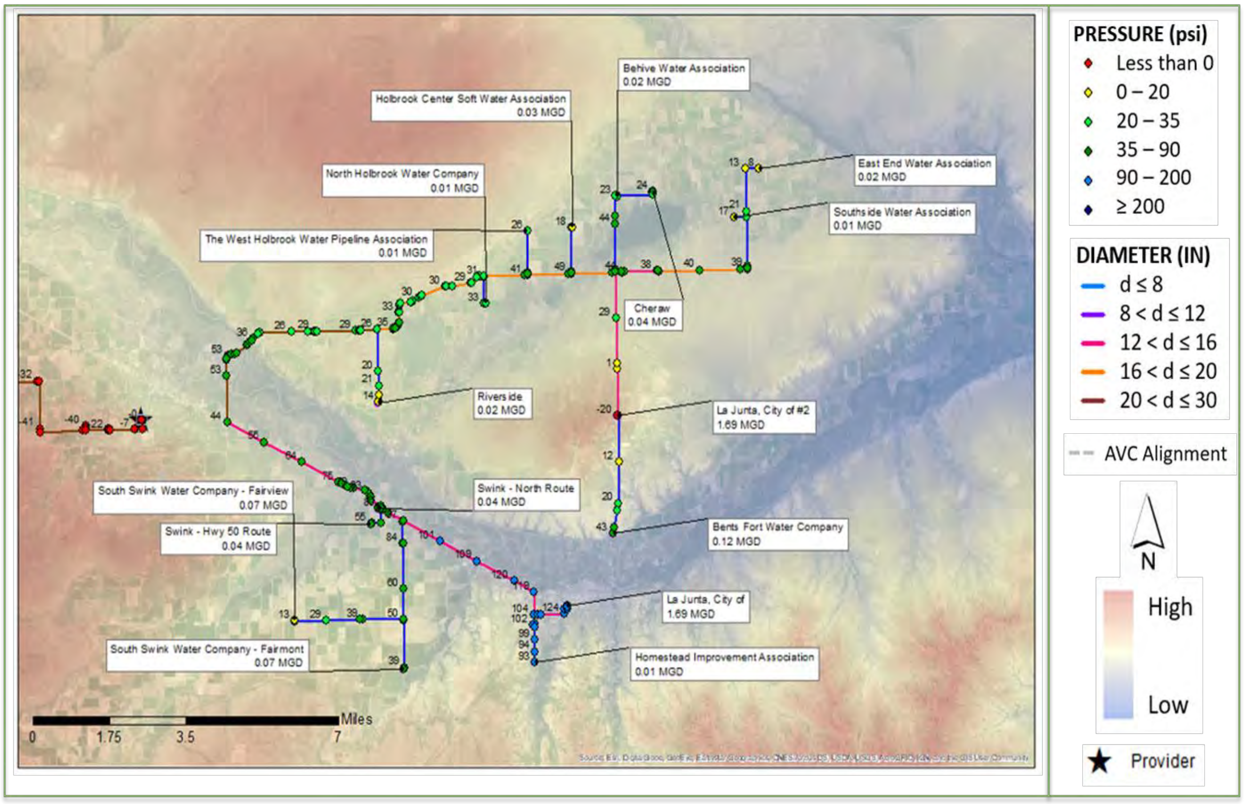

Figure 6-26. Conduit Route, Connection Points, Initial Diameters, and Pressures for the Alternative 2 La Junta Regional System

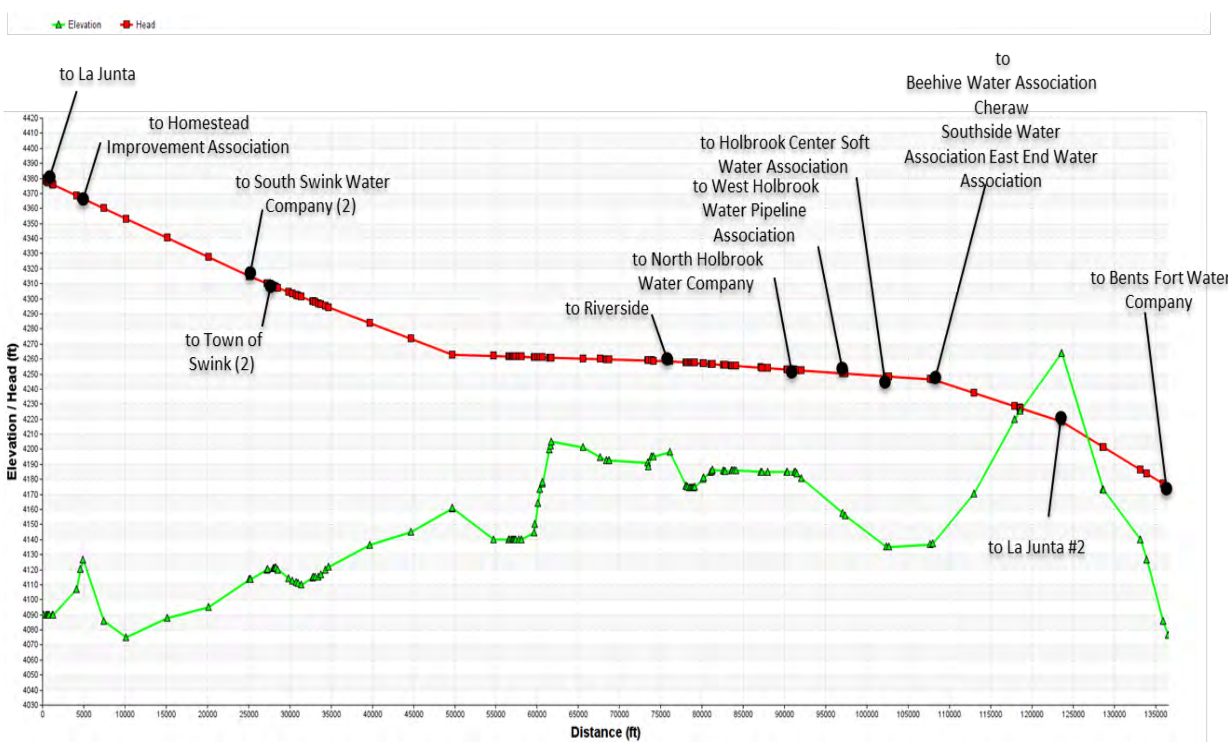

Figure 6-27. Initial Hydraulic Head and Ground Elevation for the Alternative 2 La Junta Regional System

6.2.1.4 Alternative 2 Lamar Regional System

The Lamar Regional System starts at the City of Lamar and extends 10 miles northwest through a 14-inch-diameter pipeline, where there is a 3-inch-diameter branch to the north that extends for 3.5 miles, ending at the Town of Wiley. The main line continues for 1.5 miles to an 8-inch-diameter northern branch. The main line continues north then east to a southern branch that extends 2.5 miles and ends at the May Valley Water Association #2. The main line continues another 5 miles east, ending at the May Valley Water Association.

The regional provider (Lamar) is at a low elevation and supplies water to the Town of Wiley and the May Valley Water Association, which are both higher in elevation. This change in elevation results in negative operating pressures along the northern portions of the regional system as shown in **Figures 6-28** and **6-29**.

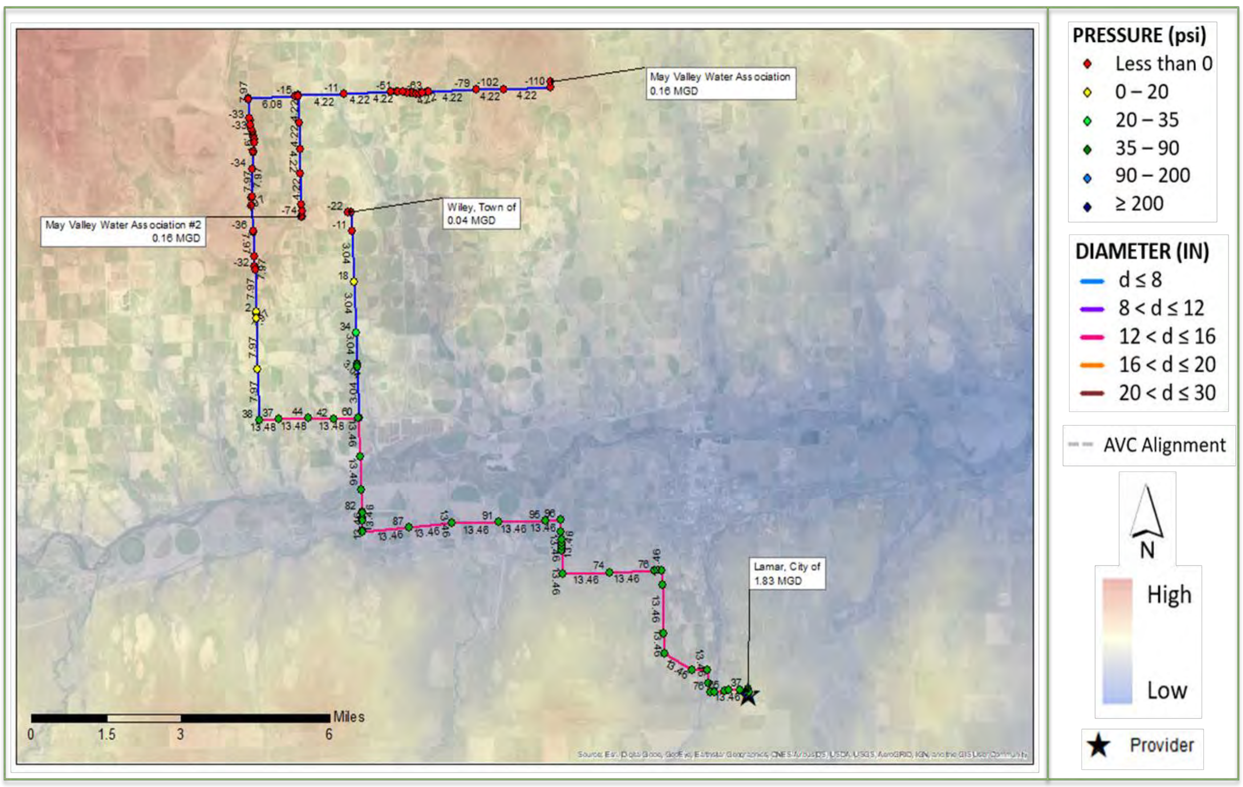

Figure 6-28. Conduit Route, Connection Points, Initial Diameters, and Pressures for the Alternative 2 Lamar Regional System

CDM Smith

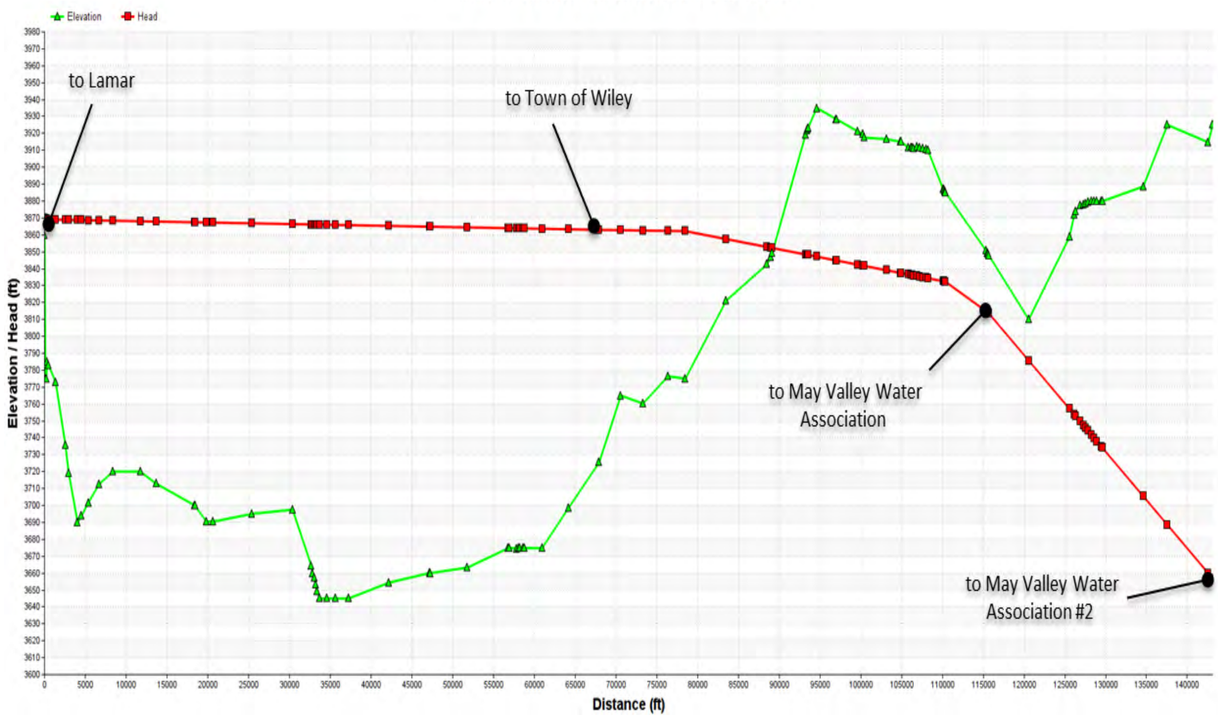

Figure 6-29. Initial Hydraulic Head and Ground Elevation for the Alternative 2 Lamar Regional System

6.2.2 Hydraulic Modifications for Potential Routes

Based on the initial hydraulic modeling results for Alternative 2, modifications to the conveyance system are required where operating pressures are insufficient for the proposed regional system. Modifications include the addition of elevated tanks, pump stations, or changes to pipeline sizes where appropriate. The proposed conveyance system modifications for the four regional systems proposed under Alternative 2 are presented in this section.

6.2.2.1 Alternative 2 Avondale Regional System

To accommodate for the sharp increase in elevation near the Boone delivery location, the tank elevation at Avondale must be raised by 120 feet to produce adequate pressure through the end of the line. See **Figures 6-30** and **6-31** for the updated hydraulics with the additional tank elevation incorporated into the system.

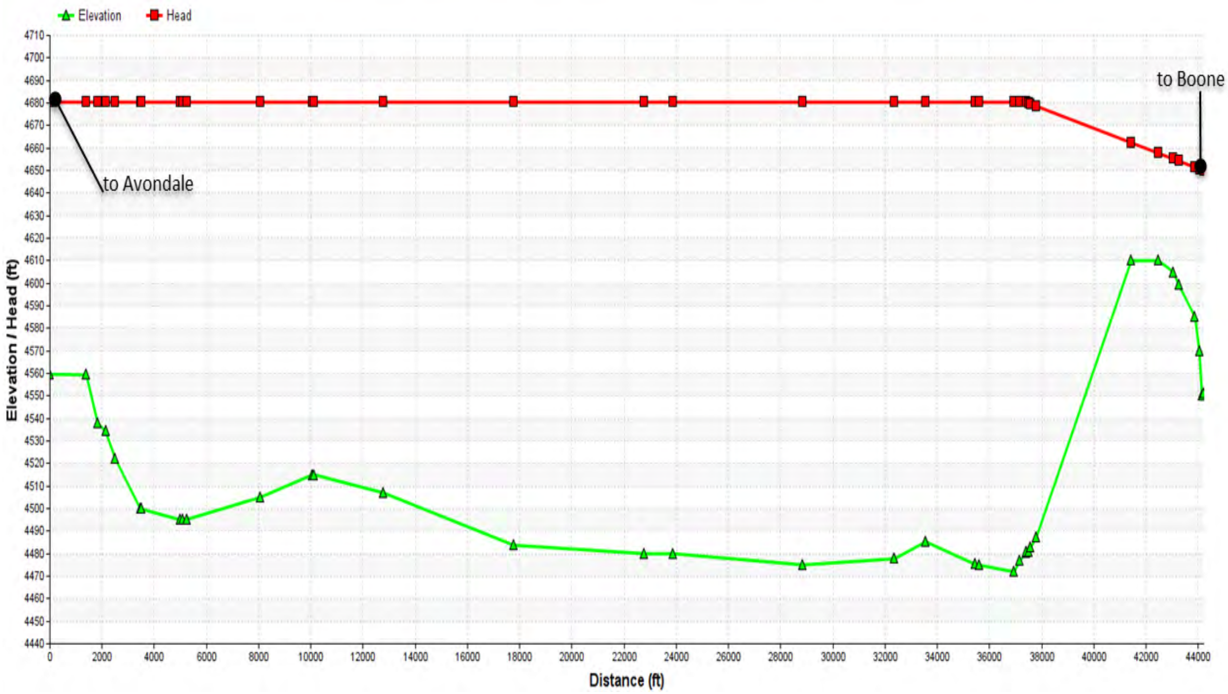

Figure 6-30. Hydraulic Head and Ground Elevation for the Alternative 2 Avondale Regional System with a Tank Operation Level of 120 Feet Incorporated into the System

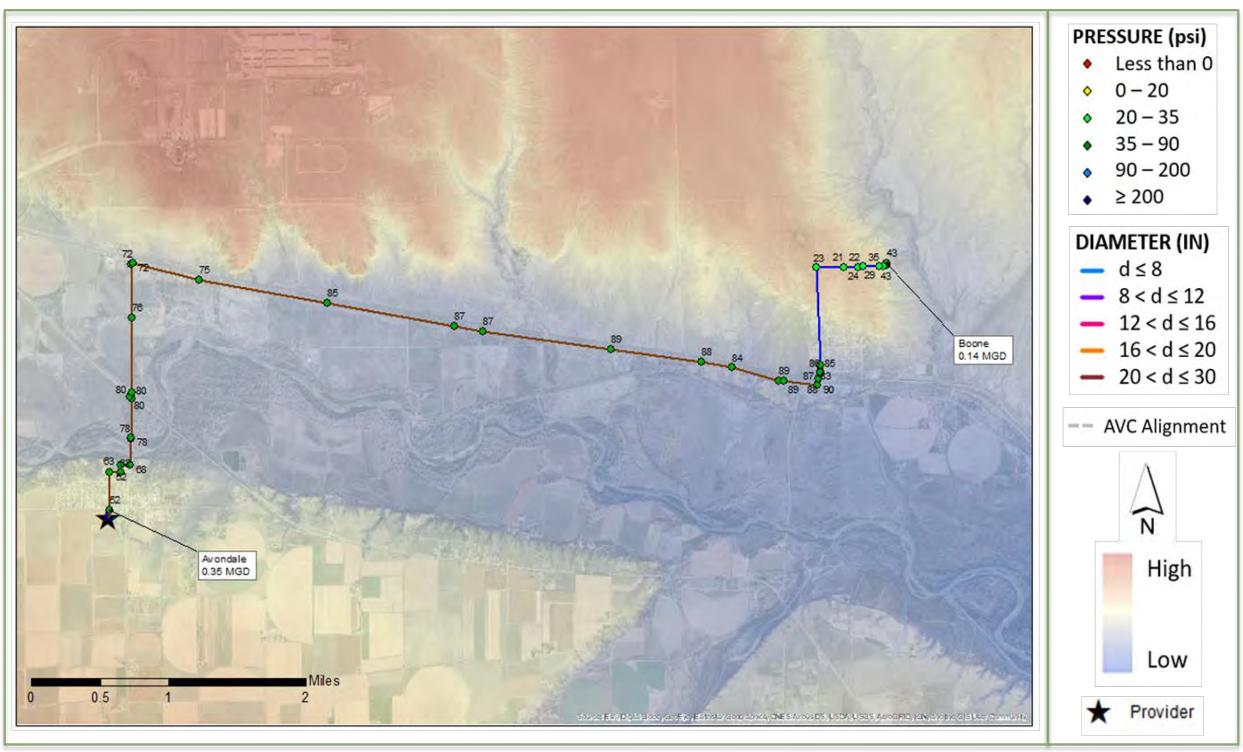

Figure 6-31. Diameters and Resulting Pressures for the Alternative 2 Avondale Regional System with a Tank Operation Level of 120 Feet Incorporated into the System

6.2.2.2 Alternative 2 Crowley County Water Association Regional System

Pumping is required at the Crowley County Water Association (the regional provider) to achieve the required operating pressures throughout the system. The Crowley County Water Association needs to have a 100 feet of head elevation upstream of the system to meet the minimum pressure requirements at each delivery location. See **Figures 6-32** and **6-33** for the updated hydraulics, including the addition of a tank level at the Crowley County Water Association.

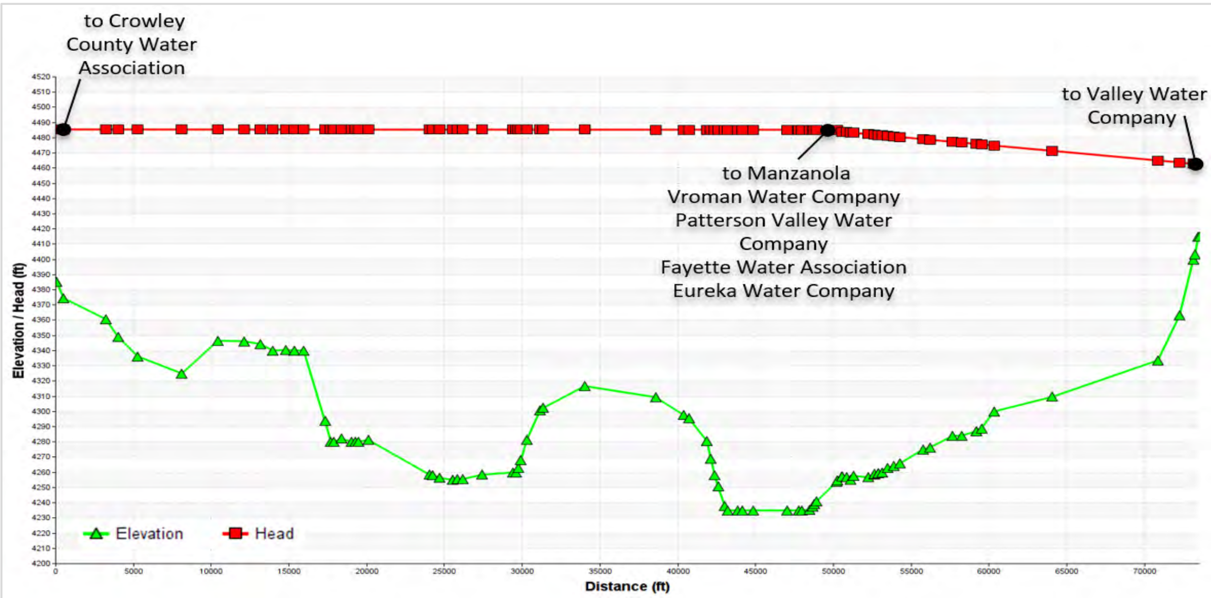

Figure 6-32. Hydraulic Head and Ground Elevation for the Alternative 2 Crowley County Water Association Regional System with Additional Pump Station Incorporated into the System

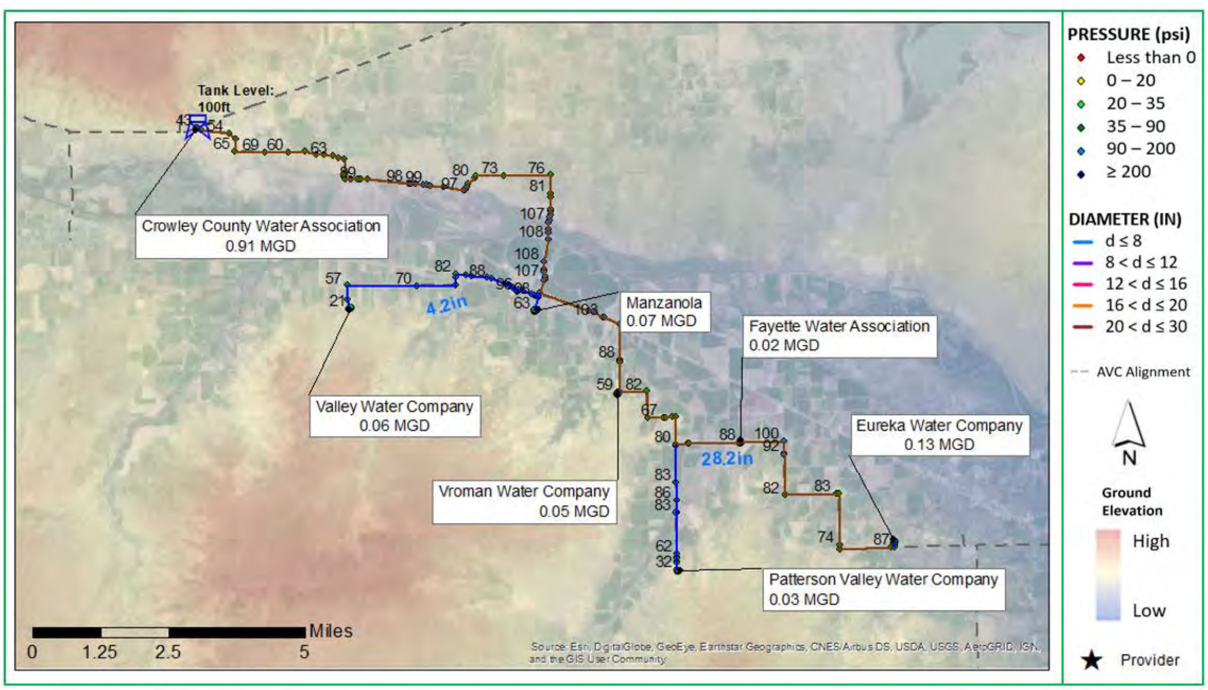

Figure 6-33. Diameters and Resulting Pressures for the Alternative 2 Crowley County Water Association Regional System with Additional Pump Station Incorporated into the System

6.2.2.3 Alternative 2 La Junta Regional System

Increasing the pipe from 14 to 24 inches in diameter for 9 miles of pipe from La junta to the northwest is required to maintain adequate pressures throughout the system. See **Figures 6-34** and **6-35** for the updated hydraulics with the modified pipeline size incorporated into the system.

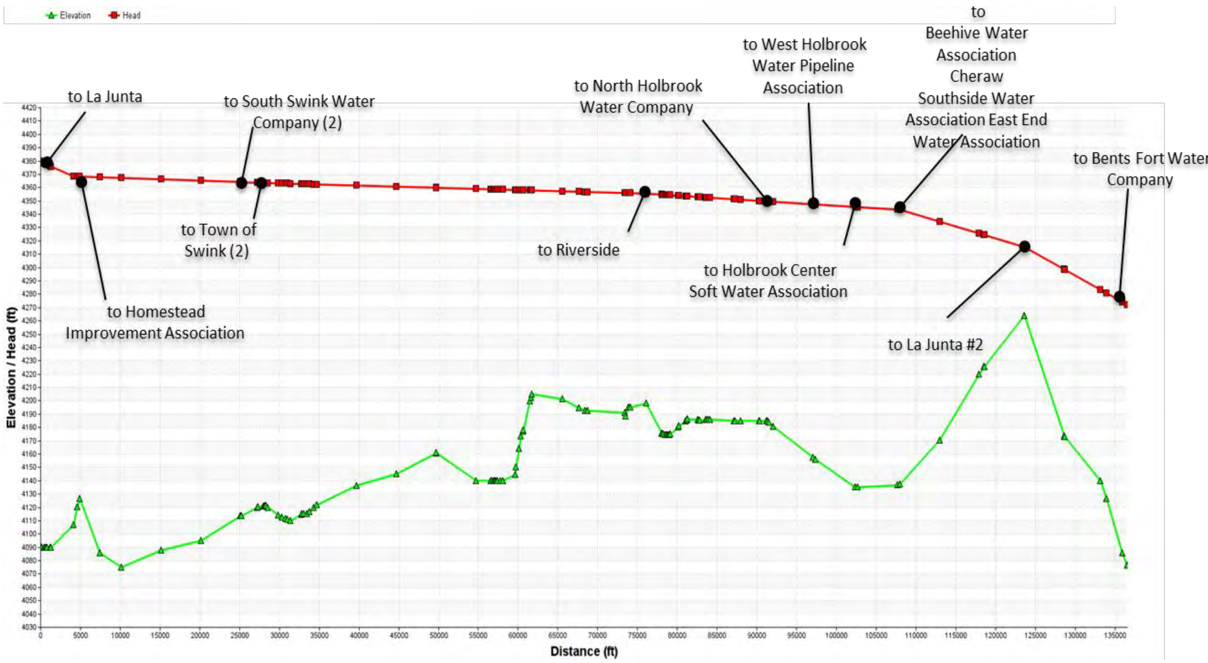

Figure 6-34. Hydraulic Head and Ground Elevation for the Alternative 2 La Junta Regional System with Modification to Pipeline Sizes Incorporated into the System

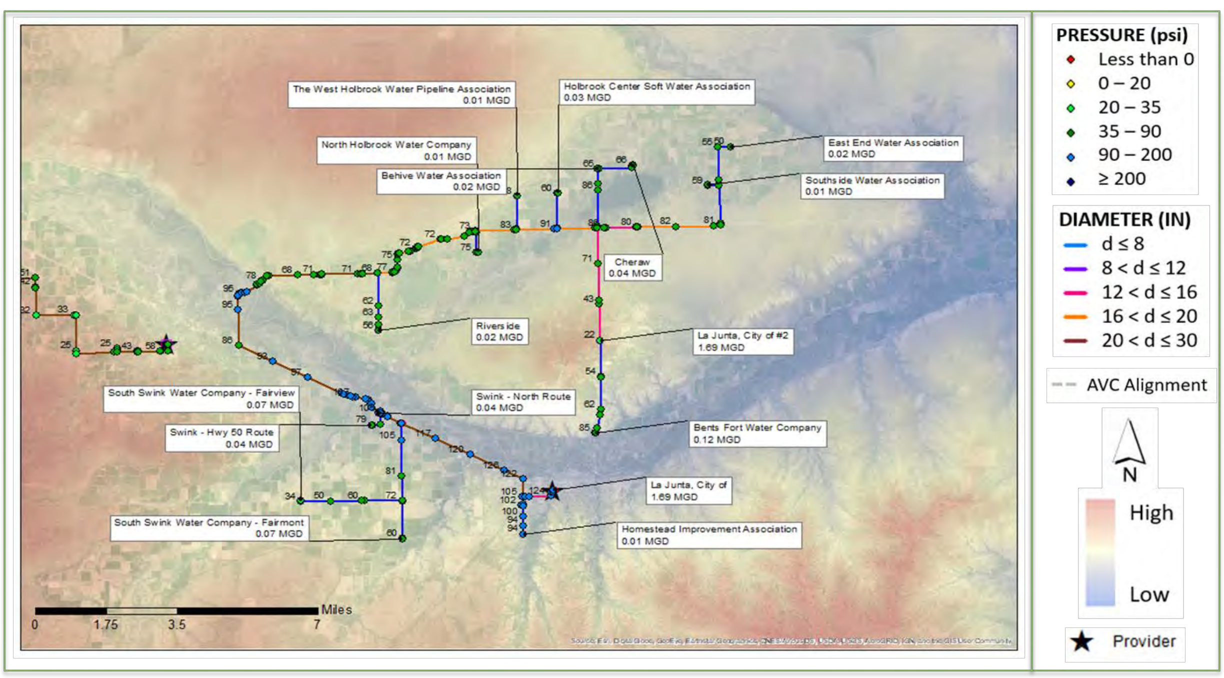

Figure 6-35. Diameters and Resulting Pressures for the Alternative 2 La Junta Regional System with Modified Pipeline Sizes Incorporated into the System

6.2.2.4 Alternative 2 Lamar Regional System

A pump station at either the Lamar location or before the Town of Wiley is required to maintain adequate pressure to the end of the system. However, the implementation of a pump station at any location would result in high operating pressures from the pump to the May Valley Water Association delivery location. See **Figures 6-36** and **6-37** for the updated hydraulics with the additional pumping at Wiley incorporated into the system.

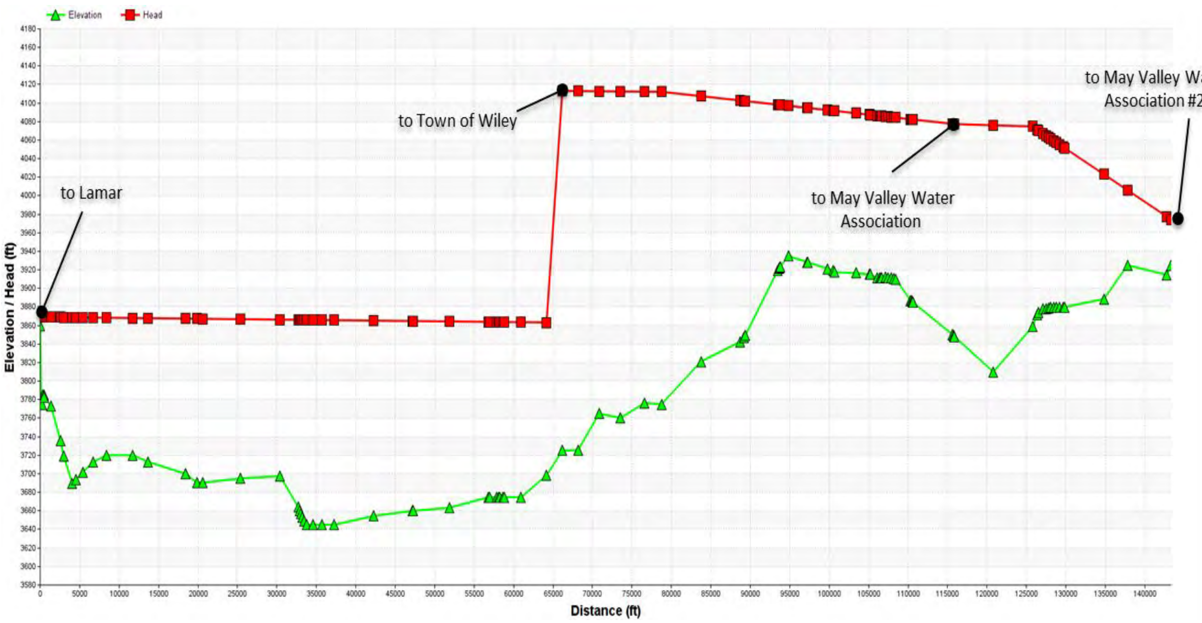

Figure 6-36. Hydraulic Head and Ground Elevation for the Alternative 2 Lamar Regional System with Pump Station at Wiley Incorporated into the System

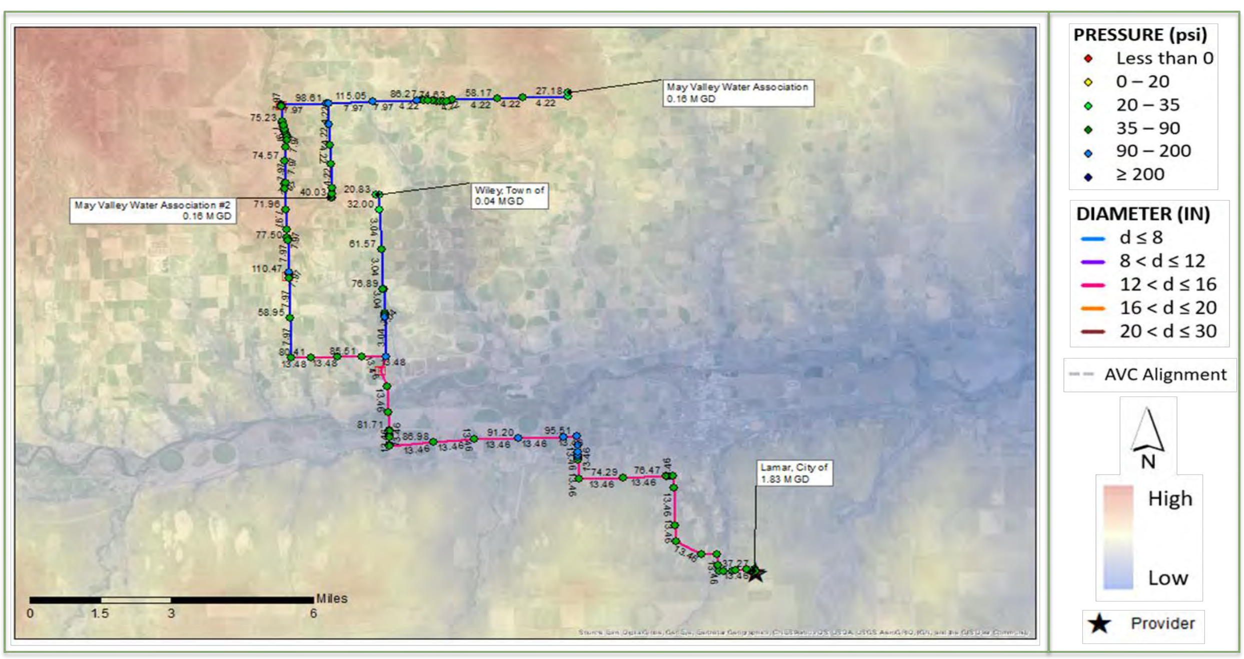

Figure 6-37. Diameters and Resulting Pressures for the Alternative 2 Lamar Regional System with Pump Station at Wiley Incorporated into the System

6.2.2.5 Alternative 2 Modifications required summary

The table below summarizes the hydraulic modifications required to achieve operating pressures that meet the minimum established pressures (compared to the AVC feasibility design) for the Alternative 2 regional systems.

Table 6-4. Modifications required for regional systems under Alternative 2

Regional System Water Provider	Required Modifications Additional to AVC Feasibility Design
Avondale Regional System	Provider tank operation level set to 120 feet[8] New 30-inch pipe (268 feet)
Crowley County Water Association Regional System	Provider tank operation level set to 100 feet New 30-inch pipe (42 feet)
La Junta Regional System[9]	Upsized pipe from 14 to 24 inches
Lamar Regional System	Pumping upstream of Wiley (Design Head: 320 feet) New 14 in pipe (240 feet)

6.2.3 Construction Considerations

The same geologic conditions and construction considerations presented in Section 6.1.3 apply to Alternative 2. A desktop review of areal imagery for each regional system proposed under Alternative 2 was conducted to identify the total number of major crossings for each hub. The total number of major crossings for each regional system under Alternative 2 are presented in **Table 6-5**. Additionally, the total estimated pipeline length for each regional system is included in **Table 6-6**. The number of major crossings and total pipeline miles provide valuable information regarding potential construction considerations for each proposed regional system under Alternative 2.

Table 6-5. Major Crossings for Each Regional System Proposed Under Alternative 2

Regional System	Crossing Category	Number of Crossings
Avondale Regional System	Highway	1
	Roads	9
	Water	2
Crowley County Water Association Regional System	Highway	3
	Railroad	2
	Roads	30
	Water	13
La Junta Regional System	Highway	3
	Railroad	3
	Roads	38
	Water	6
Lamar Regional System	Highway	3
	Roads	35
	Water	8

[8]Ground to elevated tank
[9]Based on La Junta having a 290-foot elevated tank

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Table 6-6. Total Estimated Pipeline Miles for Each Proposed Regional System Under Alternative 2

Regional System	Pipeline Diameter (Inches)	Pipeline Length (Miles)
Avondale Regional System	≤8	1.3
	10–12	0.0
	14–16	0.0
	20–30	6.7
	Total Pipeline Miles for Regional System	**8.0**
Crowley County Water Association Regional System	≤8	7.2
	10–12	0.0
	14–16	0.0
	20–30	20.3
	Total Pipeline Miles for Regional System	**27.6**
La Junta Regional System	≤8	18.9
	10–12	0.0
	14–16	4.9
	20–30	22.5
	Total Pipeline Miles for Regional System	**46.3**
Lamar Regional System	≤8	18.4
	10–12	0.0
	14–16	14.9
	20–30	0.0
	Total Pipeline Miles for Regional System	**33.3**

6.3 CDPHE Enforcement Regionalization Alternative (Alternative 3)

Both Alternatives 1 and 2 maintain the preferred AVC alignments and diameters. Alternative 3 deviates from the preferred AVC alignment, where alternatives routes between the regional providers and connectors are shorter or offer better hydraulic configurations. The AVC alignment is followed where practical. With the optimized alignments, significant lengths of piping can be saved and pumping costs reduced. In locations where the alignment is the same as the AVC alignment, the pipe size remains consistent with the AVC system where practical.

6.3.1 Preliminary Hydraulic Considerations for Connector Routes and Points of Connection

The same systems that are served under Alternative 2 are included in Alternative 3; however, the metrics used to develop the hydraulic model for Alternative 3 differ from the preferred AVC alignment in an effort to minimize total cost of implementation and optimize regionalization. This alternative incorporates modifications to pipeline sizes, connector routes, and points of connection for each proposed regional system. This section presents the modeling results for the five regional systems proposed under Alternative 3.

6.3.1.1 Alternative 3 Avondale Regional System

Alternative 3 is similar to Alternative 2 in that Avondale provides water to the Town of Boone; however, the pipeline alignment differs from the preferred AVC alignment as the conduit approaches Boone. Instead of going north along the west side of town, the Alternative 3 alignment continues east along the south side of town. This allows the piping to reach the same end point without going over the higher elevation ridge that is along the northeast side of Boone. Using this alternate route reduces the elevation increase in the last segment of the line. A 6-inch-diameter pipe is used for the last segment of the conduit connecting to Boone. This change in pipeline diameter, along with an added 70-foot-operation-level tank at Avondale, provides adequate head to meet the minimum pressures throughout the entire system. Refer to **Figures 6-38** and **6-39** for the conduit route and modeling results, respectively.

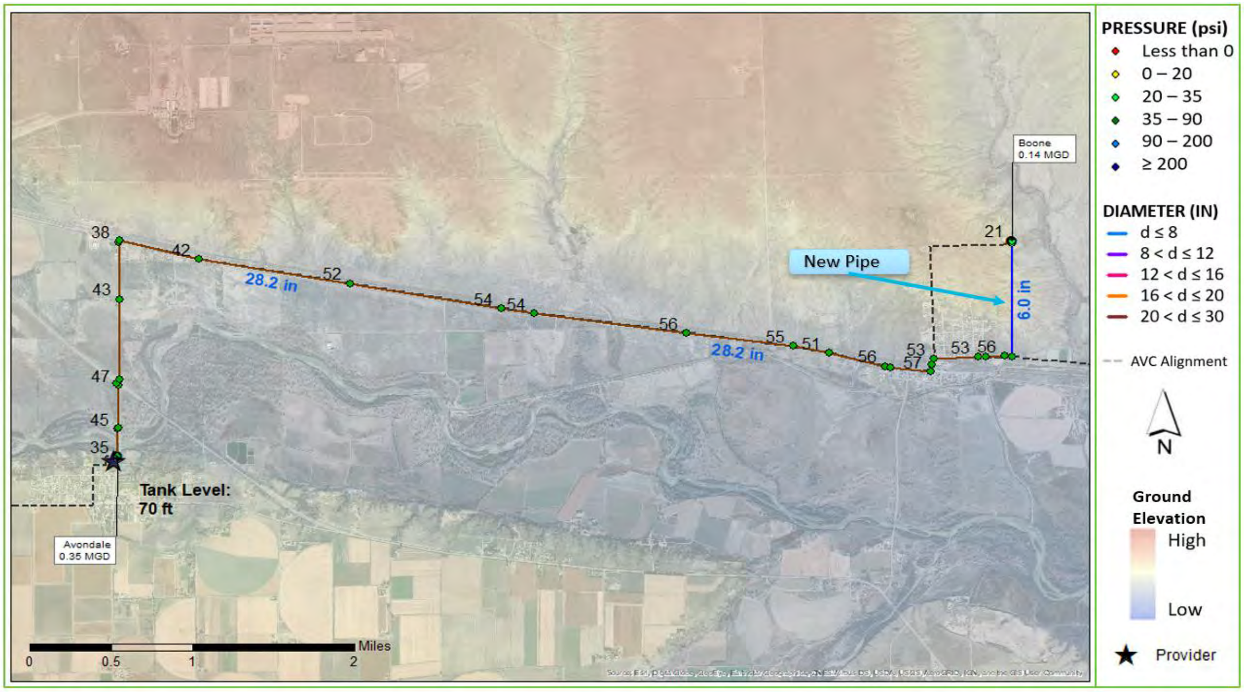

Figure 6-38. Diameters and Resulting Pressures for the Alternative 3 Avondale Regional System

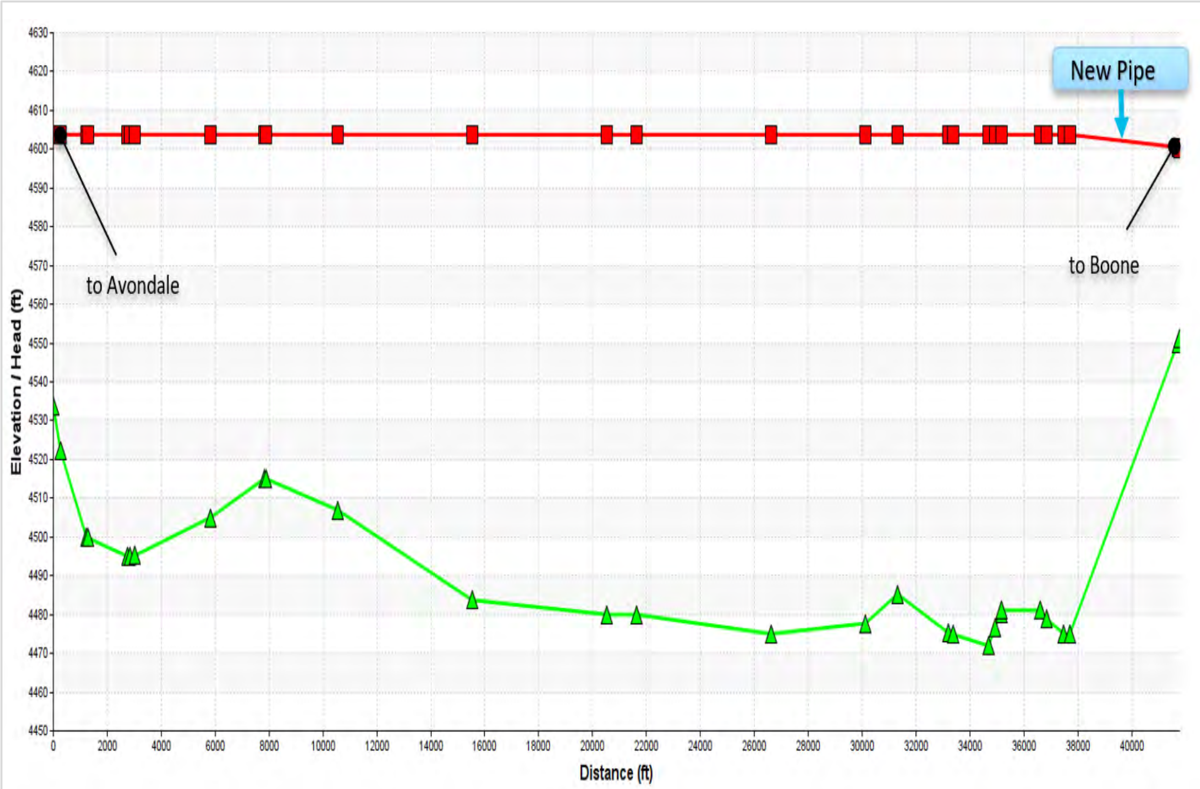

Figure 6-39. Hydraulic Head Versus Ground Elevation for the Alternative 3 Avondale Regional System with New 6-Inch Pipeline and 70-Foot-Level Tank Incorporated into the System

6.3.1.2 Alternative 3 Fowler Regional System

Fowler is the regional provider in Alternative 3. Although Fowler is currently under a CDPHE enforcement order, it has recently installed a new filtration system to meet CDPHE drinking water standards. Fowler is currently under an observational period of producing acceptable drinking water, and available data suggest that the order will be removed at the end of the observational period.

The Alternative 3 Fowler regional system alignment maintains the same route as the Alternative 2 alignment between the Valley Water Company going east to both the Patterson Water Company and the Eureka Water Company. However, the pipeline alignment east of Fowler bypasses a portion of the preferred AVC alignment and instead directly connects to the Valley Water Company to the east (**Figure 6-40**).

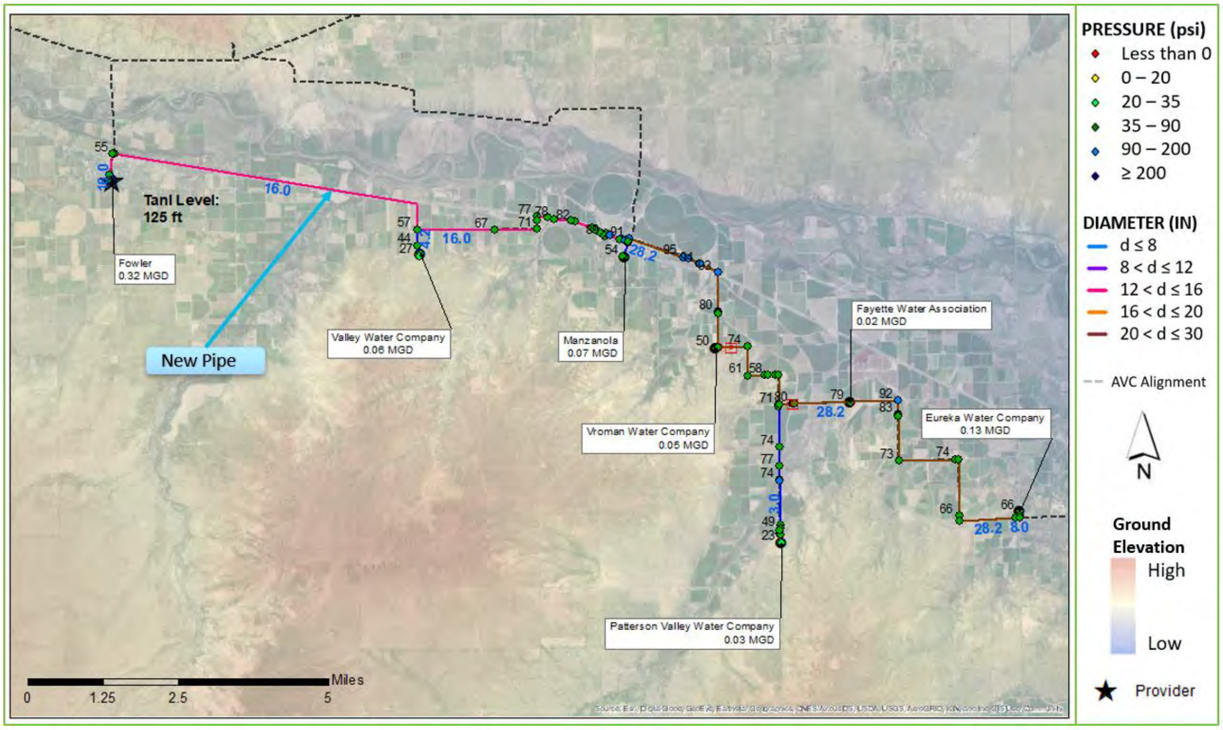

Figure 6-40. Diameters and Resulting Pressures for the Alternative 3 Fowler Regional System

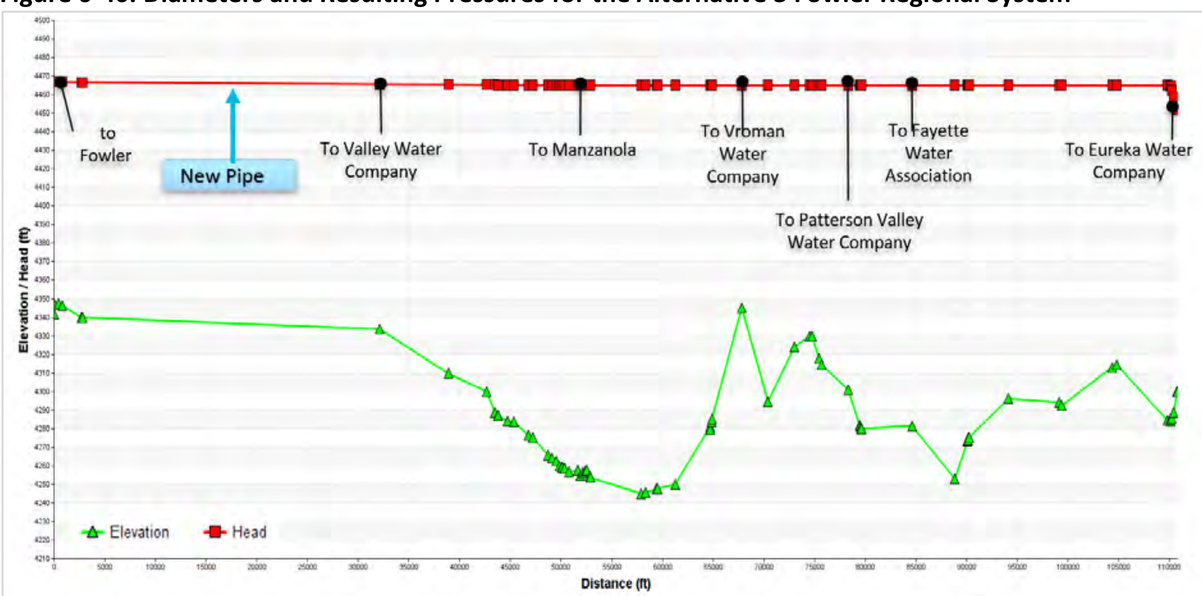

Figure 6-41. Hydraulic Head Versus Ground Elevation for the Alternative 3 Fowler Regional System with New Pipeline and 125-Foot Elevated Tank Incorporated into the System

To provide minimum pressure throughout the system, two different approaches could be implemented. The first option is to increase the provider tank water level from 100 to 125 feet using a 16-inch-diameter pipeline from Fowler to Manzanola (**Figure 6-41**). If increasing the elevation of the provider tank is not feasible, two booster pump stations located on the spurs to the Valley Water Company and the Patterson Valley Water Company should be evaluated. This modification increases operating pressures by 10 psi throughout the entire system and allows for adequate delivery pressures to each participating system.

6.3.1.3 Alternative 3 Rocky Ford Regional System

Under Alternative 3, the Rocky Ford regional system connects Rocky Ford to the section of the pipeline that flows to the northeast from Riverside to the East End Water Association, with several spurs along the way (**Figure 6-42**). In contrast with the Alternative 2 Rocky Ford regional system, the participating systems and route configuration for Alternative 3 start at a high ground elevation and end at a low ground elevation (**Figure 6-43**). Due to this change, the preferred AVC alignment and pipeline sizes and a 70-foot elevated tank at Rocky Ford provide sufficient operating pressures throughout the system without any additional modifications.

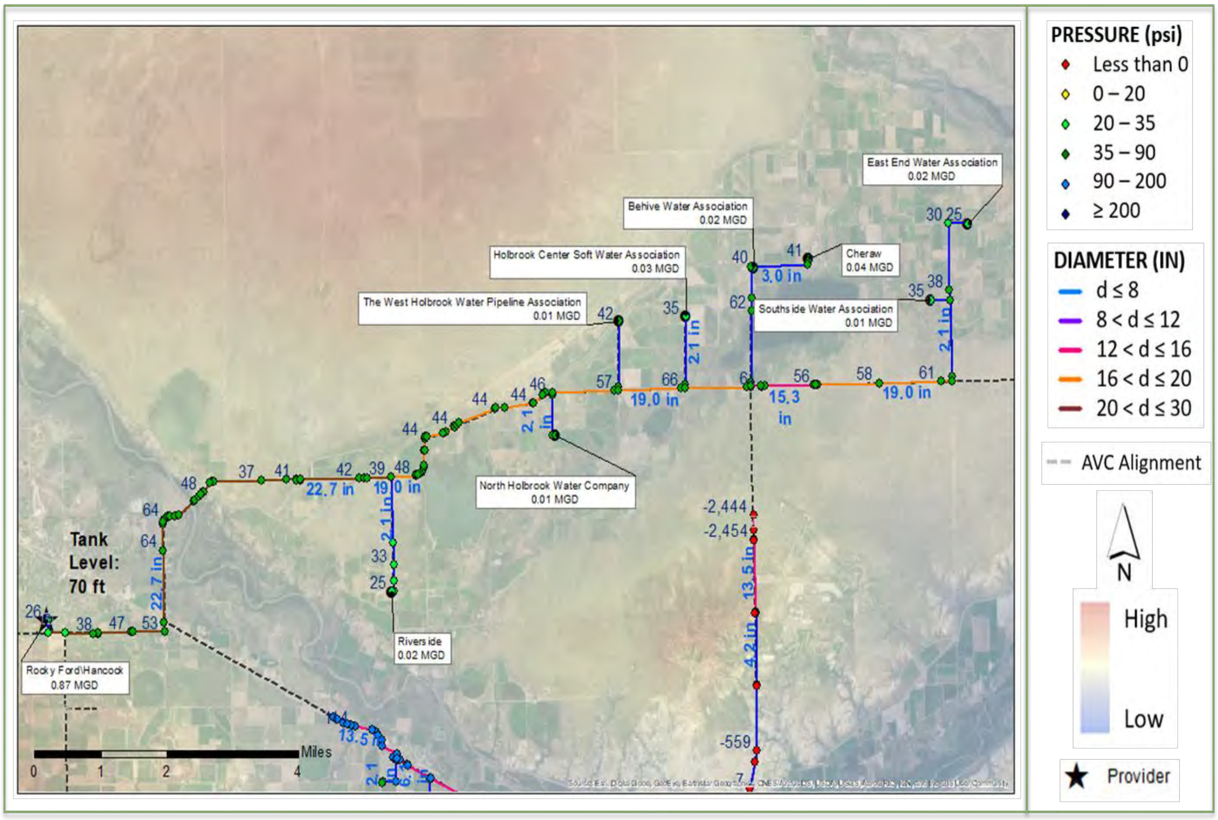

Figure 6-42. Diameters and Resulting Pressures for the Alternative 3 Rocky Ford Regional System

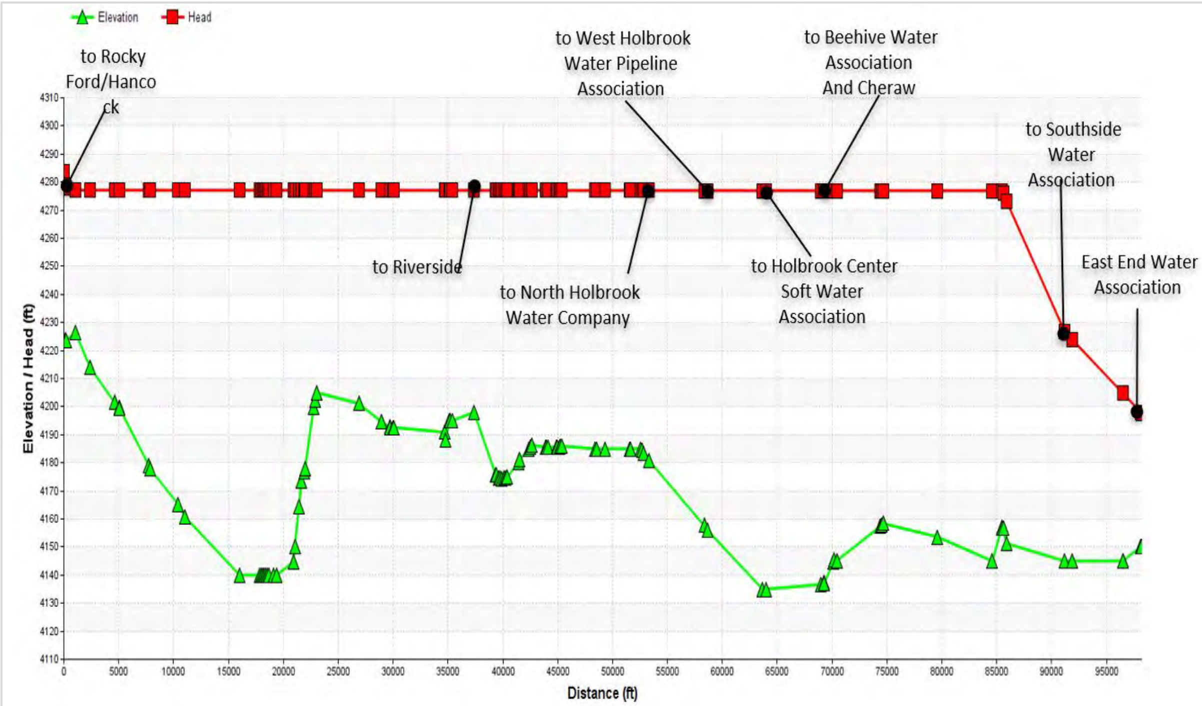

Figure 6-43. Hydraulic Head and Ground Elevation for the Alternative 3 Rocky Ford Regional System with Tank Level Set at 70 Feet

6.3.1.4 Alternative 3 La Junta Regional System

The Alternative 3 La Junta regional system maintains the preferred AVC alignment from La Junta to the Homestead Improvement Association to the south and to the Swink and South Swink delivery locations to the west (**Figure 6-44**). The Bents Fort Water Company and the La Junta #2 tie-ins are excluded from the Alternative 3 configuration as the continued use of existing regional system connections for Bents and La Junta #2 are assumed to be maintained.

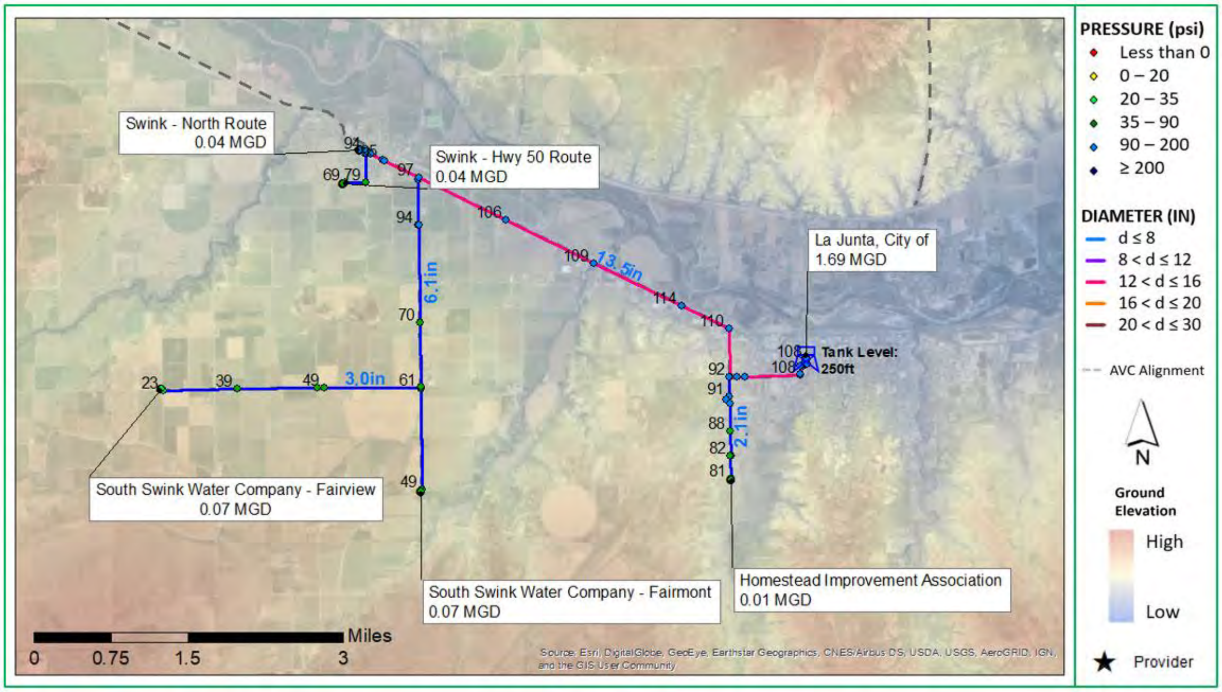

Figure 6-44. Diameters and Resulting Pressures for the Alternative 3 La Junta Regional System

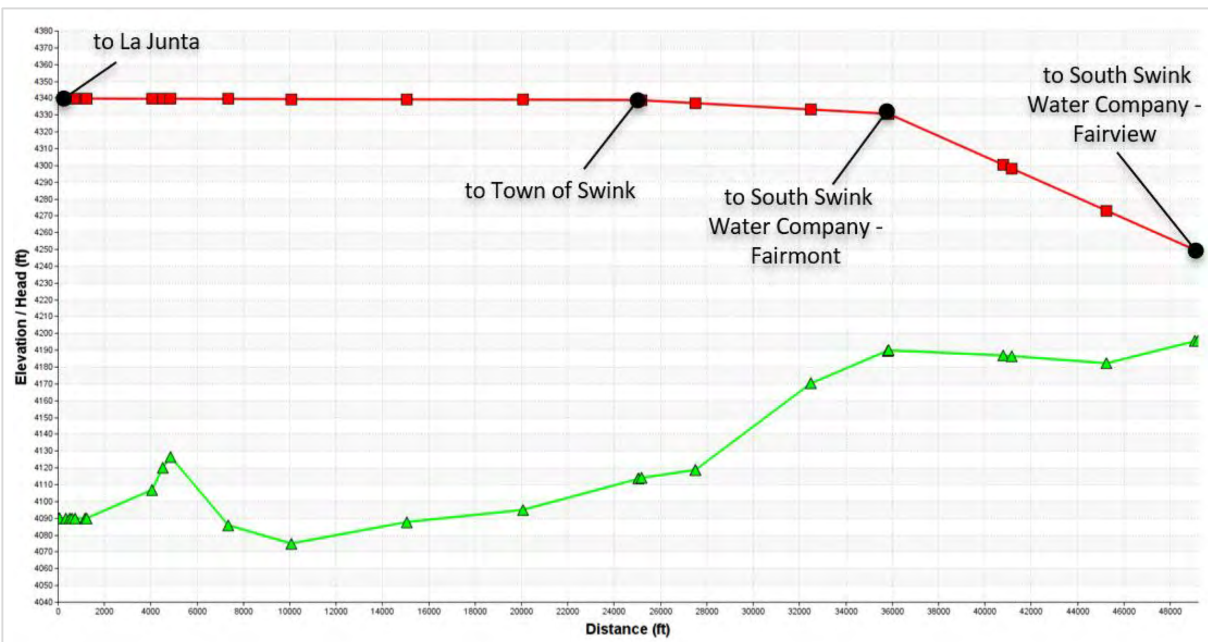

Figure 6-45. Hydraulic Head Versus Ground Elevation for the Alternative 3 La Junta Regional System

The La Junta regional system under Alternative 3 is hydraulically sufficient and no additional hydraulic modifications would be required (**Figure 6-45**).

6.3.1.5 Alternative 3 Lamar Regional System

The Lamar regional system under Alternative 3 follows the preferred AVC alignment from Lamar to Wiley and between the two May Valley Water Association locations. The only new piping proposed under this alternative is from Wiley, for approximately 1 mile west to the May Valley Water Association #2. This configuration allows for the bypass of approximately 8 miles of the preferred AVC pipeline alignment (**Figure 6-46**).

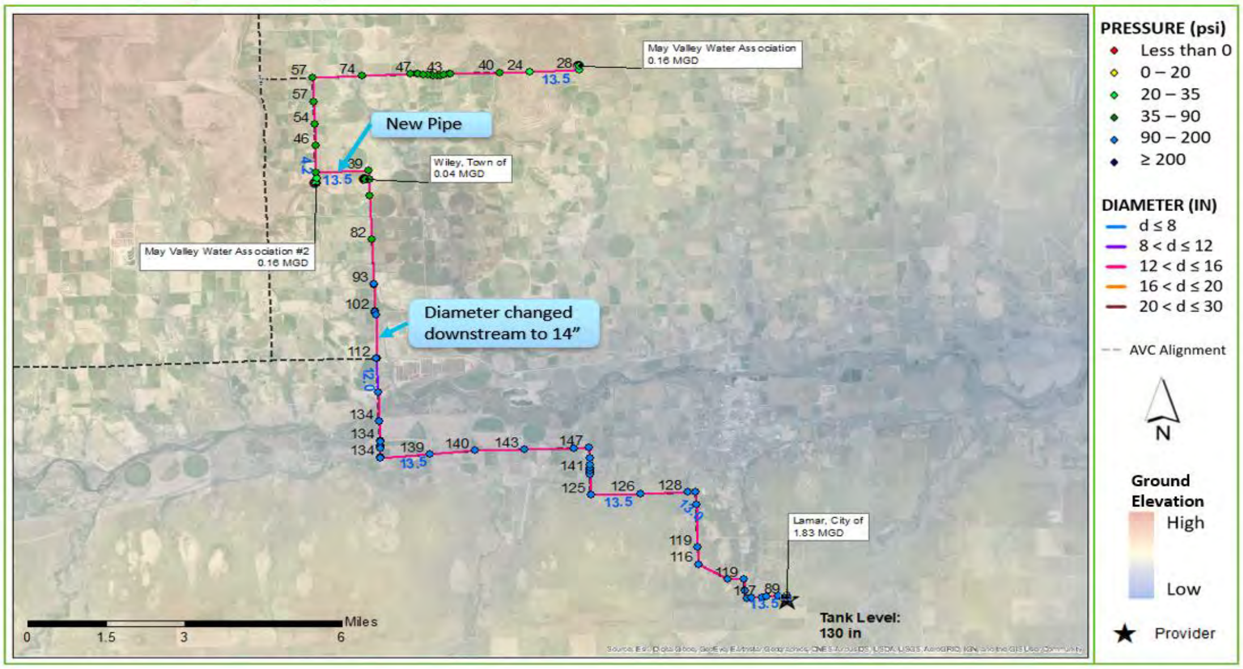

Figure 6-46. Diameters and Resulting Pressures for the Alternative 3 Lamar Regional System

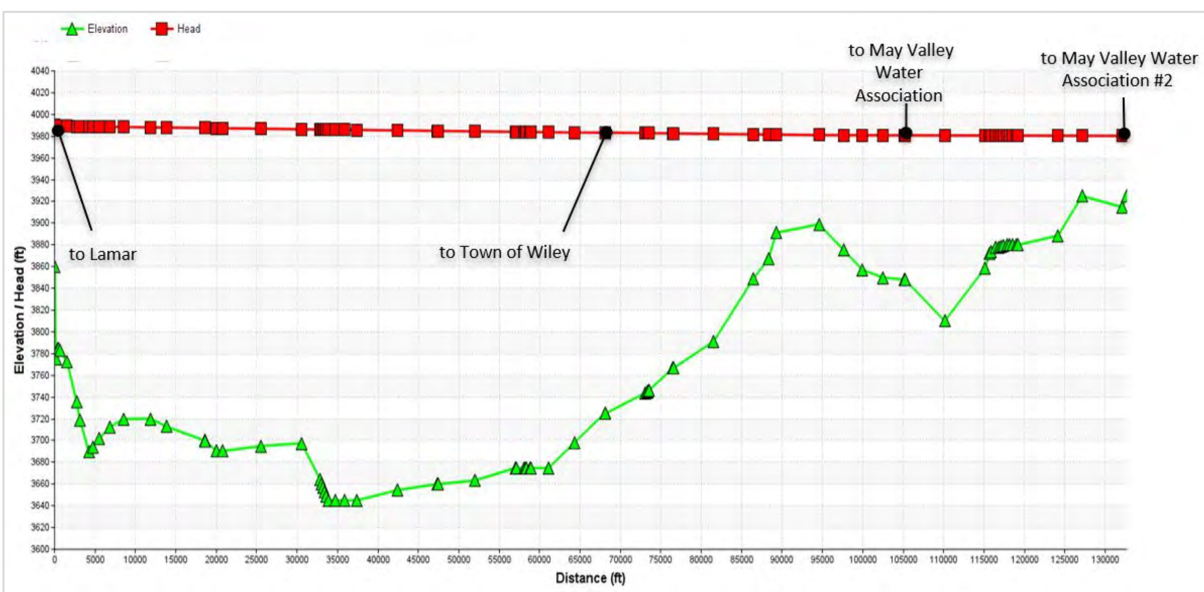

Figure 6-47. Hydraulic Head Versus Ground Elevation for the Alternative 3 Lamar Regional System with a 130-Foot Elevated Tank at Lamar and Upsized Pipeline Diameter Along the Spur to Wiley

Lamar is located on an elevated position on the south side of the valley. This increased elevation produces adequate pressures as the line crosses to the north side of the valley. However, once the pipeline starts gaining elevation as it approaches the Town of Wiley, the pressure becomes negative. To avoid the negative pressures, the provider tank needs to be elevated 130 feet and the pipeline north of the valley increased to 14 inches in diameter. With these changes, the hydraulic model shows acceptable operating pressures all the way to the terminus at the May Valley Water Association (**Figure 6-47**).

6.3.1.6 Alternative 3 Modifications required summary

The table below summarizes the hydraulic modifications required to achieve operating pressures that meet the minimum established pressures (compared to the AVC feasibility design).

Table 6-7. Modifications Required for Regional Systems Under Alternative 3

Regional System Water Provider	Required Modifications Additional to AVC Feasibility Design
Avondale Regional System	Provider tank operation level set to 70 feet[10] New 30-inch pipe (267 feet) New 6-inch pipe (4,069 miles)
Fowler Regional System	Increase initial tank level from 100 to 125 feet New 16-inch pipe from Fowler to Valley Water (29,315 feet) Upsize pipe from 4 inches to 16 inches from the Valley Water Company to Manzanola (52,785 feet)
Rocky Ford Regional System	Initial tank level set to 60 feet[11] New 30-inch pipe (1,082 feet)
La Junta Regional System[12]	New 14-inch pipe (78 feet)
Lamar Regional System	Initial tank level set to 130[1] New 14-inch pipe (240 feet) New 14-inch pipe (Willey to the May Valley Water Association #2 – 26,908 feet) Upsized 3- and 4-inch pipe to 14 inches (58,294 feet)

6.3.2 Construction Considerations

The same geologic conditions and construction considerations presented in Section 6.1.3 apply to Alternative 3. A desktop review of areal imagery for each regional system proposed under Alternative 3 was conducted to identify the total number of major crossings for each hub. The total number of major crossings for each regional system under Alternative 3 are presented in **Table 6-8**. Additionally, the total estimated pipeline length for each regional system is included in **Table 6-9**. The number of major crossings and total pipeline miles provide valuable information regarding potential construction considerations for each proposed regional system under Alternative 3.

Table 6-8. Major Crossings for Each Regional System Proposed Under Alternative 3

Regional System Water Provider	Crossing Category	Number of Crossings
Avondale Regional System	Highway	1
	Roads	7
	Water	3
Fowler Regional System	Highway	4
	Railroad	3
	Roads	31
	Water	13
Rocky Ford Regional System	Highway	0

[10]Ground to elevated tank
[11]Ground to elevated tank
[12]Based on La Junta having a 290-foot-level elevated tank

Regional System Water Provider	Crossing Category	Number of Crossings
	Roads	27
	Water	10
La Junta Regional System	Highway	3
	Railroad	2
	Roads	25
	Water	2
Lamar Regional System	Highway	3
	Roads	19
	Water	4

Table 6-9. Total Estimated Pipeline Miles for Each Proposed Regional System Under Alternative 3

Regional System	Pipeline Diameter (Inches)	Pipeline Length (Miles)
Avondale Regional System	≤8	0.8
	10–12	0.0
	14–16	0.0
	20–30	7.1
Total Pipeline Miles for Regional System		**7.9**
Fowler Regional System	≤8	3.3
	10–12	0.1
	14–16	9.9
	20–30	10.8
Total Pipeline Miles for Regional System		**24.1**
Rocky Ford Regional System	≤8	6.7
	10–12	0.0
	14–16	1.0
	20–30	15.2
Total Pipeline Miles for Regional System		**25.4**
La Junta Regional System	≤8	7.2
	10–12	0.0
	14–16	5.3
	20–30	0.0
Total Pipeline Miles for Regional System		**12.5**
Lamar Regional System	≤8	0.3
	10–12	0.0
	14–16	25.2
	20–30	0.0
Total Pipeline Miles for Regional System		**25.5**

Section 7

Items Requiring Further Clarifications

Once a recommended regionalization alternative is selected, feasibility studies will be conducted on the recommended regional systems. Outstanding information and clarifications needed to complete feasibility-level designs and analysis for regionalization include:

- Additional site visits to the selected water providers and connecting system facilities to gather needed information for feasibility-level design
- Further evaluation of O&M costs for existing water systems and projected O&M requirements for regionalization
- Obtaining conveyance system and pipeline maps from the water providers and connecting systems
- Further analysis of water rights reallocations, including an evaluation of potential cost (e.g., legal fees, augmentation plans, well permitting)
- Evaluation of potential water supply well locations for systems requiring additional wells to meet projected regional system demands
- Hydrogeologic evaluations of potential well locations to assess expected well capacities
- Monitoring well sampling and a blending study to assess the impacts of new water sources and quality on existing infrastructure
- La Junta's wastewater permit is currently under renewal by CDPHE, therefore, need to review the final permit in consideration for brine disposal
- Additional investigation regarding the disposal of radionuclide related waste
- Confirmation of potential regional water providers and connections are in agreement with regionalization as depicted in each alternative

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Section 8

Construction Cost Estimates (June 2019)

Disclaimer- Reclamation has provided the enclosed cost estimate as a resource for use in discussions among interested parties evaluating this specific project, activity, concept, issue, etc. Presentation of this estimate does not in and of itself imply Reclamation's support for moving forward with the effort. When appropriate, Reclamation specifically will articulate support for further action through other means, such as a report containing recommendations (FAC 09-03) (Reclamation 2016b).

8.1 Cost Estimating QA/QC Procedures

The cost estimations were reviewed in the following steps for quality assurance:

1. Sources for all costing factors were checked to ensure their relevance for this application.
2. Cost estimations were compared to estimations done in previous relevant appraisal-level reports.
3. Cost estimations were reviewed by a professional estimator, who was independent of the development process of the original estimates.
4. Estimations were then reviewed by technical experts, independent of the development of the original estimates, for each respective element of the estimation. For example, the water treatment facility cost estimation was reviewed by a technical expert engineer specialized in water treatment.

For more information on CDM Smith's approach to quality control for this report, refer to the Quality Control Plan.

8.2 Opinion of Total Construction Costs

This section summarizes the field costs of regionalization for each alternative. Field costs are incurred once and include the project's material and labor expenses. Relative, appraisal-level estimates were developed to compare the cost of each alternative. Costs were developed in accordance with the *Reclamation Manual* directives and standards (FAC 09-01, 09-02, and 09-03) (Reclamation 2016b). Major sources for cost factors include the No Action Memo by Black & Veatch (2012), the supplemental Feasibility Design Report by Black & Veatch (2017), the New Concept Report by the Southeastern Water Conservancy District (2018), the Statewide Water Supply Initiative costing tool developed by CDM Smith (2017), and from CDM Smith's previous experience with similar projects. Contingencies were included in the field costs for mobilization, design, allowance for procurement, and construction. All costs were estimated in June 2019 dollars.

8.2.1 Costing Methodology

8.2.1.1 Contingencies

The contingency factors for a project of this size need to be carefully considered to avoid total cost under- or overestimation by a large dollar amount.

Mobilization – Mobilization costs, mostly accrued during initial startup, include mobilizing contractor equipment and personnel to the job site along with contractor bonds. Using Reclamation's rounding criteria, the mobilization line item will be a rounded value and may result in the dollar amount deviating slightly from the actual percentage shown. The mobilization factor for this project was estimated to be 5 percent. Estimator judgement, prior reporting, and experience were used to compute this figure.

Design Contingency – Based on *Reclamation Manual* FAC 09-01 (4)(E)(1) (Reclamation 2016b), the design contingencies will encompass design uncertainties dependent on the amount of detail and knowledge used to produce the estimated costs. The design contingencies account for the effect of uncertainties for the major project, minor unlisted items, minor design and scope alterations, and cost estimation refinements. A 15 percent factor was designated for design contingencies, which is typical of an appraisal-level study (Black & Veatch 2017, 2012).

Allowance for Procurement Strategies – Based on *Reclamation Manual* FAC 09-01 (4)(E)(2) (Reclamation 2016b), procurement costs include strategies that either limit competition, award bids with the best value, or include allocations for socioeconomic strategic programs. Three percent was allocated for Allowance for Procurement Strategies, which is typical for appraisal-level estimates.

Construction contingencies – Construction contingencies cover unforeseen difficulties in the field, minor plan changes, changes in site conditions, and differences in actual and estimated quantities. This figure was computed based on observed factors used in previous relevant appraisal-level studies, confidence in the data, and engineering judgement. In most cases, 20 to 30 percent is used as construction contingencies based on site conditions, reliability of the engineering design data, the level of depth and detail of the estimate, geological conditions and utility data. Twenty-five percent contingency was designated for construction (Black & Veatch 2017, 2012).

Noncontract costs – Reclamation defines noncontract costs as referring to "work or services provided in support of the project, some of which can be expensed against a specific plant account, and other work which is of such broad nonspecific nature that it can only be attributed to the project as a whole" (Reclamation 2016b). Noncontract costs include but are not limited to: lands and rights, relocation of property by others, and distributive costs. Distributive costs include: service facilities, investigations, and engineering costs such as development of specifications and construction engineering management. Twenty-five percent of the total construction costs were allocated to noncontract costs, which is consistent with values used in previous appraisal and feasibility-level reports related to the AVC (Black & Veatch 2017, 2012; Reclamation 2016b).

8.2.1.2 Major Costing Components and Basis of Estimates

Below are the major items included in the field cost estimate, with a description of what is included in each item, the basis and approach for how the estimate was developed, and the major assumptions and unknowns associated with each item.

Pipelines – Cost factors based on the Statewide Water Supply Initiative costing tool developed by CDM Smith (2017). Material costs assume ductile iron pipe with an average of 2,500 feet between valves in the pipeline. Also includes labor costs including excavation assuming 6 feet of cover over the length of pipe, trench backfill, and installation costs. Estimations for pipe length were developed using a hydraulic model based upon the original preferred alignment for the AVC. Separate costing factors were applied for installation of pipelines in both urban and rural areas using GIS. The cost of pipe bends, blow offs, and other specific design features were not included in this estimate.

Crossings – Cost factor based on the No Action Memo by Black & Veatch (2012). Includes minor and major road, stream, river, canal, and railroad crossings. Cost factors include cost of excavation and traffic control. The number of each type of crossing listed above for each system was estimated using GIS. Consistent lengths were assumed for each type of crossing based upon values used in the No Action Memo (Black & Veatch 2012). Estimation does not account for elements such as specific variations in traffic volume for each roadway, specific required excavation depth depending on depth of waterways, or variations in width of crossings.

Wells – Cost factors based on a cost per depth of well from the No Action Memo by Black & Veatch (2012), and a base cost added from CDM Smith's experience with relevant designs. Material costs assume shallow, 45-foot-deep wells. This depth was chosen using groundwater depth data from the Reclamation's 2013 EIS report (Reclamation 2013a). Material costs include well lining, pump, motor, electrical, disinfection equipment where applicable, and well pipelines to treatment facility. Length of well pipelines were estimated using values from both the No Action Memo cost estimate sheets (Black & Veatch 2012), and from regional maps provided in Southeastern's investigation leading to the preliminary design of the AVC (Southeastern 2005). Labor costs include cost of drilling and installation. Estimation does not account for variations in well depth or diameter specific for each site.

Pump Stations – Cost factors based on the No Action Memo by Black & Veatch (2012). Cost factor is based upon the horsepower of the pump station, estimated from the maximum flow rate and hydraulic head for each respective system. A lump sum cost factor was added for the power drop for each pump station. Estimation does not account for variations in price due to diameter of pumps in station, number of pumps in station, or changes in specific type of pump required.

Tanks – Cost factors based on the New Concept Report by Southeastern (2018). Material costs assume 0.5 MG of storage. Includes stripping, excavation, backfill, surfacing, fence, and reinforced concrete foundation (Reclamation 2012). Estimation does not account for site-specific variations in price due to tank height, diameter, or materials.

Water Treatment Plants – Cost factors based on the No Action Alternative (Black & Veatch 2012), the New Concept Report (Southeastern 2018), the 2017 Feasibility Study (Black & Veatch 2017), and CDM Smith' experience designing treatment systems. Includes disinfection equipment, filtration, water and chemical storage, contact basins, chemical dosing pumps, and RO units where applicable. Cost factors account for the estimated capacity of each unit process. Site-specific conditions, including availability of space, were not accounted for in these estimates.

8.2.1.3 Dividing Costs Between Regional and AVC

Total capital costs were split between regional and AVC costs for each alternative. All capital items that are not consistent with the preferred AVC alignment plan were designated as regional costs. Regional capital items include: treatment upgrades, wells, tanks for regional systems, regional system pump stations, and pipe lengths that differ from AVC alignment. All capital items that are consistent with the preferred AVC alignment and thereby represent progress towards completion of the overall AVC, were designated as AVC costs. AVC capital items primarily consist of the pipelines that are consistent with the AVC alignment.

8.2.2 Summary of Construction Costs Alternative 1

8.2.2.1 Summary of Total Construction Materials, Labor, and Installation Costs

Table 8-1 summarizes the estimated capital costs of regionalization under alternative 1 before contingency factors are considered. Pipelines are the primary driver for regionalization costs, making up 85 percent of the total costs in Alternative 1. The second major cost driver is treatment upgrades for La Junta's regional system. Regionalization under Alternative 1 would require expansion of La Junta's advanced RO treatment process (see Section 5.2.4), which is relatively expensive.

Table 8-1. Alternative 1 Summary of Total Construction Materials, Labor, and Installation Costs ($June 2019×1000)

Category	St. Charles Mesa Water District Regional Hub	Crowley County Water Association Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Pipelines	$26,000	$17,500	$32,000	$59,000	$49,000
Pumping station	$470	$470	$520	$160	$550
Tanks	$3,600	$3,600	$0.00	$0.00	$0.00
Treatment facility upgrades (including wells)	$1,150	$1,600	$2,900	$22,000	$280
Total	$31,000	$23,000	$35,000	$81,000	$50,000

8.2.2.2 Summary of Regional Capital Costs

Table 8-2 summarizes the regional construction materials, labor, and installation costs before contingencies are considered for Alternative 1. Under Alternative 1, La Junta would have the greatest expenses. The primary cost contributing capital items for La Junta are treatment upgrades and piping. To make La Junta's regional system hydraulically feasible, the diameter of a 9-mile-long pipe segment along the AVC trunk line alignment from the La Junta spur to the Riverside spur would need to be upsized from the AVC planned 14 inches to 24 inches (see Section 6.1.2.4).

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Table 8-2. Alternative 1 Regional Construction Materials, Labor, and Installation Costs ($June 2019×1000)

Category	St. Charles Mesa Water District Regional Hub	Crowley County Water Association Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Pipelines	$32	$10	$450	$11,000	$36
Pumping station	$470	$470	$520	$160	$550
Tanks	$3,600	$3,600	$0.00	$0.00	$0.00
Treatment facility upgrades (including wells)	$1,150	$1,600	$2,900	$22,000	$280
Total	$5,300	$5,700	$3,900	$33,000	$870

After total costs for construction, materials, and labor are estimated, contingency factors for mobilization, design, and allowance for procurement are added to form the contract cost. The construction contingency is then added to the contract cost to from a field cost estimate. Finally, a contingency for noncontract costs is added to form the opinion of total project cost. The process of estimating an opinion of total regional project costs for each regional system in Alternative 1 is shown in **Table 8-3.**

Table 8-3. Alternative 1 Regional Capital Cost Contingency Factors ($June 2019×1000)

Category	Percent Contingency	St. Charles Mesa Water District Regional Hub	Crowley County Water Association Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Construction Materials, Labor, and Installation		**$5,300**	**$5,700**	**$3,900**	**$33,000**	**$870**
Mobilization	5%	$265	$285	$195	$1,650	$44
Design Contingency	15%	$795	$855	$585	$4,950	$130
Allowance for Procurement Strategies	3%	$159	$171	$117	$990	$26
Contract Cost		**$6,500**	**$7,000**	**$4,800**	**$41,000**	**$1,050**
Construction Contingency	25%	$1,625	$1,750	$1,200	$10,250	$263
Field Costs		**$8,100**	**$8,800**	**$6,000**	**$51,000**	**$1,300**
Noncontract Costs	25%	$2,025	$2,200	$1,500	$12,750	$325
Opinion of Total Construction Cost		**$10,000**	**$11,000**	**$7,500**	**$64,000**	**$1,650**

8.2.2.3 Summary of AVC Capital Costs

Table 8-4 summarizes the AVC construction, materials, and labor costs before contingencies. Regionalization under Alternative 1 includes the construction of about 180 miles of AVC pipeline.

Table 8-4. Alternative 1 AVC Construction Materials, Labor, and Installation Costs ($June 2019×1000)

Category	St. Charles Mesa Water District Regional Hub	Crowley County Water Association Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Pipelines	$26,000	$17,500	$32,000	$48,000	$49,000
Pumping station	$0.0	$0.0	$0.0	$0.0	$0.0
Tanks	$0.0	$0.0	$0.0	$0.0	$0.0
Treatment facility upgrades (including wells)	$0.0	$0.0	$0.0	$0.0	$0.0
Total	$26,000	$17,500	$32,000	$48,000	$49,000

The AVC construction materials, labor, and installation costs for each regional system were summed together and contingency factors were applied to form estimations for contract, field, and opinion of total project costs. The process of estimating a total project cost for AVC capital is summarized in **Table 8-5.**

Table 8-5. Alternative 1 AVC Capital Cost Contingency Factors

Category	Percent Contingency	Total Costs ($June 2019×1000)
Construction Materials, Labor, and Installation		**$175,000**
Mobilization	5%	$8,750
Design Contingency	15%	$26,250
Allowance for Procurement Strategies	3%	$5,250
Contract Cost		**$220,000**
Construction Contingency	25%	$55,000
Field Costs		**$280,000**
Noncontract Costs	25%	$70,000
Opinion of Total Construction Cost		**$350,000**

8.2.2.4 Summary of Total Project Capital Costs

Table 8-6 summarizes the total project costs including both regional and AVC costs.

Table 8-6. Alternative 1 Total Project Capital Costs

Category	Total Costs ($June 2019×1000)
Total Construction Materials, Labor, and Installation Costs	$220,000
Total Contract Costs	$280,000
Total Field Costs	$360,000
Opinion of Total Project Costs	$440,000

8.2.3 Summary of Construction Costs Alternative 2

8.2.3.1 Summary of Total Construction Materials, Labor, and Installation Costs

Table 8-7 summarizes the estimated capital costs of regionalization under Alternative 2 before contingency factors are considered. Like Alternative 1, pipelines are the primary driver for regionalization costs in Alternative 2, making up 93 percent of the total costs. Unlike Alternative 1, La Junta can meet the regional demands without having to upgrade the capacity of their treatment process under Alternative 2. As a result, Alternative 2 has significant savings in treatment capital compared to Alternative 1.

Table 8-7. Alternative 2 Summary of Total Construction Materials, Labor, and Installation Costs ($June 2019×1000)

Category	Avondale Regional Hub	Crowley County Water Association Regional Hub	La Junta Regional Hub	Lamar Regional Hub
pipelines	$11,500	$41,000	$46,000	$26,000
pumping station	$160	$250	$0.0	$250
tanks	$3,600	$3,600	$0.0	$0.0
treatment facility upgrades (including wells)	$880	$1,450	$0.0	$175
Total	$16,000	$46,000	$46,000	$26,000

8.2.3.2 Summary of Regional Capital Costs

Table 8-8 summarizes the regional construction materials, labor, and installation costs before contingencies are considered for Alternative 2. Like Alternative 1, to make La Junta's regional system hydraulically feasible, a significant pipe segment along the AVC trunk line alignment from the La Junta spur to the Riverside spur would need to be upsized from the AVC planned 14 inches to 24 inches (see Section 6.2.2.3).

Table 8-8. Alternative 2 Regional Construction Materials, Labor, and Installation Costs ($June 2019×1000)

Category	Avondale Regional Hub	Crowley County Water Association Regional Hub	La Junta Regional Hub	Lamar Regional Hub
pipelines	$64	$8,200	$13,000	$35
pumping station	$160	$250	$0.0	$250
tanks	$3,600	$3,600	$0.0	$0.0
treatment facility upgrades (including wells)	$880	$1,450	$0.0	$175
Total	$4,700	$13,500	$13,000	$460

Contingency factors were added to the construction materials, labor, and installation costs to form estimates for contract cost, field cost, and opinion of total project cost. These estimates are shown in **Table 8-9**.

Table 8-9. Alternative 2 Regional Capital Cost Contingency Factors ($June 2019×1000)

Category	Percent Contingency	Avondale Regional Hub	Crowley County Water Association Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Construction Materials, Labor, and Installation		**$4,700**	**$13,500**	**$13,000**	**$460**
Mobilization	5%	$235	$675	$650	$23
Design Contingency	15%	$705	$2,025	$1,950	$69
Allowance for Procurement Strategies	3%	$141	$405	$390	$14
Contract Cost		**$5,800**	**$16,500**	**$16,000**	**$570**
Construction Contingency	25%	$1,450	$4,125	$4,000	$143
Field Cost		**$7,300**	**$21,000**	**$20,000**	**$710**
Noncontract Costs	25%	$1,825	$5,250	$5,000	$178
Opinion of Total Construction Cost		**$9,100**	**$26,000**	**$25,000**	**$890**

8.2.3.3 Summary of AVC Capital Costs

Table 8-10 summarizes the construction materials, labor, and installation costs for Alternative 2 for each regional system. Regionalization under Alternative 2 would include the construction of about 100 miles of AVC pipeline.

Table 8-10. Alternative 2 AVC Construction Materials, Labor, and Installation Costs ($June 2019×1000)

Category	Avondale Regional Hub	Crowley County Water Association Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Pipelines	$11,500	$33,000	$33,000	$26,000
Pumping station	$0.0	$0.0	$0.0	$0.0
Tanks	$0.0	$0.0	$0.0	$0.0
Treatment facility upgrades (including wells)	$0.0	$0.0	$0.0	$0.0
Total	$11,500	$33,000	$33,000	$26,000

The AVC construction materials, labor, and installation costs for each regional system were summed together and contingency factors were applied to form estimations for contract, field, and opinion of total project costs. The process of estimating a total project cost for AVC capital is summarized in **Table 8-11.**

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Table 8-11. Alternative 2 AVC Capital Cost Contingency Factors

Category	Percent Contingency	Total Costs ($June 2019×1000)
Construction Materials, Labor, and Installation		**$105,000**
Mobilization	5%	$5,250
Design Contingency	15%	$15,750
Allowance for Procurement Strategies	3%	$3,150
Contract Cost		**$130,000**
Construction Contingency	25%	$32,500
Field Costs		**$165,000**
Noncontract Costs	25%	$41,250
Opinion of Total Construction Cost		**$210,000**

8.2.3.4 Summary of Total Project Capital Costs

Table 8-12 summarizes the total project costs including both regional and AVC costs.

Table 8-12. Alternative 2 Total Project Capital Costs

Category	Total Costs ($June 2019×1000)
Total Construction Materials, Labor, and Installation Costs	$135,000
Total Contract Costs	$170,000
Total Field Costs	$210,000
Opinion of Total Project Costs	$270,000

8.2.4 Summary of Construction Costs Alternative 3

8.2.4.1 Summary of Total Construction Materials, Labor, and Installation Costs

Table 8-13 summarizes the estimated capital costs of regionalization under Alternative 3 before contingency factors are considered. The largest cost item for Alternative 3 is the construction of the 30-mile length of piping required for the Fowler regional system.

Table 8-13. Alternative 3 Summary of Total Construction Materials, Labor, and Installation Costs ($June 2019×1000)

Category	Avondale Regional Hub	Fowler Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Pipelines	$12,000	$34,000	$24,000	$11,500	$23,000
Pumping station	$160	$210	$210	$0.0	$430
Tanks	$3,600	$3,600	$3,600	$0.0	$3,600
Treatment facility upgrades (including wells)	$880	$1,200	$0.0	$0.0	$175
Total	$16,500	$39,000	$28,000	$11,500	$27,000

8.2.4.2 Summary of Regional Capital Costs

Table 8-14 summarizes the regional construction materials, labor, and installation costs before contingencies are considered for Alternative 3. To make the Fowler distribution system hydraulically feasible, the diameter of pipeline within the segment from Fowler to The Valley Water Company along the AVC trunk line would need to be adjusted from 4 to 16 inches (See Section 6.3.1.2). This includes approximately 10 miles of piping. In addition, the Lamar regional system includes deviations from the preferred AVC alignment from the AVC trunk line to the end of the May Valley Water Association spur (See Section 6.3.1.5).

Table 8-14. Alternative 3 Regional Construction Materials, Labor, and Installation Costs ($June 2019×1000)

Category	Avondale Regional Hub	Fowler Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Pipelines	$740	$13,000	$260	$11	$9,400
Pumping station	$160	$210	$210	$0.0	$430
Tanks	$3,600	$3,600	$3,600	$0.0	$3,600
Treatment facility upgrades (including wells)	$880	$1,200	$0.0	$0.0	$175
Total	$5,400	$18,000	$4,100	$11	$13,500

Contingency factors were added to the construction materials, labor, and installation costs to form estimates for contract cost, field cost, and opinion of total project cost. These estimates are shown in **Table 8-15**.

Table 8-15. Alternative 3 Regional Capital Cost Contingency Factors ($June 2019×1000)

Category	Percent Contingency	Avondale Regional Hub	Fowler Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Construction Materials, Labor, and Installation		**$5,400**	**$18,000**	**$4,100**	**$11**	**$13,500**
Mobilization	5%	$270	$900	$205	$0.6	$675
Design Contingency	15%	$810	$2,700	$615	$2	$2,025
Allowance for Procurement Strategies	3%	$162	$540	$123	$0.3	$405
Contract Cost		**$6,600**	**$22,000**	**$5,000**	**$14**	**$16,500**
Construction Contingency	25%	$1,650	$5,500	$1,250	$4	$4,125
Field Costs		**$8,300**	**$28,000**	**$6,300**	**$17**	**$21,000**
Noncontract Costs	25%	$2,075	$7,000	$1,575	$4	$5,250
Opinion of Total Construction Cost		**$10,500**	**$35,000**	**$7,900**	**$21**	**$26,000**

8.2.4.3 Summary of AVC Capital Costs

Table 8-16 summarizes the construction materials, labor, and installation costs for Alternative 3 for each regional system. Regionalization under Alternative 3 would include the construction of about 70 miles of AVC pipeline.

Table 8-16. Alternative 3 AVC Construction Materials, Labor, and Installation Costs ($June 2019×1000)

Category	Avondale Regional Hub	Fowler Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Pipelines	$11,500	$21,000	$24,000	$11,500	$13,500
Pumping station	$0.0	$0.0	$0.0	$0.0	$0.0
Tanks	$0.0	$0.0	$0.0	$0.0	$0.0
Treatment facility upgrades (including wells)	$0.0	$0.0	$0.0	$0.0	$0.0
Total	$11,500	$21,000	$24,000	$11,500	$13,500

The AVC construction materials, labor, and installation costs for each regional system were summed together and contingency factors were applied to form estimations for contract, field, and opinion of total project costs. The process of estimating a total project cost for AVC capital is summarized in **Table 8-17**.

Table 8-17. Alternative 3 AVC Capital Cost Contingency Factors

Category	Percent Contingency	Total Costs ($June 2019×1000)
Construction Materials, Labor, and Installation		**$82,000**
Mobilization	5%	$4,100
Design Contingency	15%	$12,300
Allowance for Procurement Strategies	3%	$2,460
Contract Cost		**$100,000**
Construction Contingency	25%	$25,000
Field Costs		**$125,000**
Noncontract Costs	25%	$31,250
Opinion of Total Construction Cost		**$155,000**

8.2.4.4 Summary of Total Project Capital Costs

Table 8-18 summarizes the total project costs including both regional and AVC costs.

Table 8-18. Alternative 3 Total Project Capital Costs

Category	Total Costs ($June 2019×1000)
Total Construction Materials, Labor, and Installation Costs	$125,000
Total Contract Costs	$150,000
Total Field Costs	$190,000
Opinion of Total Project Costs	$230,000

8.3 Operations, Maintenance, and Periodic (Replacement) Costs

This section summarizes the operations, maintenance, and periodic replacement (OM&R) costs for each alternative incurred over a 50-year period after the capital portion of the project is complete. Relative, appraisal-level estimates were developed to compare the cost of each alternative. Costs were developed in accordance with the *Reclamation Manual* (FAC 09-01, 09-02, 09-03) (Reclamation 2016b). All costs were estimated in present (June 2019) value using a projected inflation rate of 2.78 percent.

8.3.1 Costing Methodology

8.3.1.1 Periodic (Replacement) and Maintenance Costs

Included in the periodic costs is tank cleaning and coating, pump station repairs and replacements, pipeline repair and replacement, and other general replacement costs for aging and damaged infrastructure. The same contingency factors that were applied to capital costs were applied to the periodic costs. Listed below are the major periodic cost items, along with a description of the assumptions associated with each.

Pipe Repair and Replacement – Cost factor based on the New Concept Report (Southeastern 2018). Assumes replacement of 100-foot section of largest-diameter pipe within 50-year period for each regional hub within each alternative. Includes costs for materials and labor.

Surge Tank Interior Cleaning, Interior Recoating, and Exterior Recoating – Cost factors based on the New Concept Report (Southeastern 2018). Assumes tank interior will need to be cleaned every 5 years. Also assumes that tank interiors will need to be recoated every 20 years and exteriors every 30 years. Includes costs for materials and labor.

Pump Station Unidentified Repairs and Replacements – Cost factor based on No Action Memo (Black & Veatch 2012). Assumed to be 15 percent of total pump station field costs every 15 years. Accounts for material and labor of pump station repairs and replacements.

Annual Treatment System Maintenance and Replacements – Cost factor based on CDM Smith experience with similar projects. Assumed to be 2 percent of total treatment capital costs annually. Includes maintenance capital and labor fees for treatment infrastructure upkeep.

8.3.1.2 Operations and Pumping Costs

Operations and pumping costs include wages for O&M staff and annual energy costs for pumping. Contingency factors were based on the No Action Memo (Black & Veatch 2012) and include a 10 percent contingency for design and 10 percent contingency for noncontract costs. Listed below are the major O&M cost items, along with a description of the assumptions associated with each item.

Annual Operations Staff – Cost factor based on No Action Memo (Black & Veatch 2012). Includes annual wages for regional system operator. Assumes hiring full-time or part-time operator depending on the size of the regional hub before expansion and on the amount of equipment added because of regionalization that requires operational supervision (e.g., RO units, pumping stations, chemical dosing systems).

Annual Pumping Costs – Cost factor based on 2019 Xcel Energy primary general electric rates (Xcel Energy 2019). Includes annual costs for electric power dedicated for pumping. Costs are dependent on estimated horsepower of pumps within each station.

8.3.2 Summary of Operations, Maintenance, and Periodic (Replacement) Costs Alternative 1

Table 8-19 summarizes the OM&R costs before contingencies in present value projected over a 50-year period for each regional system under Alternative 1. La Junta has the highest projected OM&R costs due to the upkeep costs of the upgrades on their advanced treatment process. La Junta would also have the longest length of piping to maintain of the regional systems.

Table 8-19. Alternative 1 Summary OM&R Costs Before Contingencies ($June 2019*1000)

Category	St. Charles Mesa Water District Regional Hub	Crowley County Water Association Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Periodic (Replacement) and Maintenance Costs	$900	$1,150	$1,750	$12,000	$340
Operations Costs	$640	$2,600	$1,300	$1,000	$1,300
Pumping Costs	$300	$300	$320	$180	$290
Total Operations and Pumping Costs	$950	$2,900	$1,600	$1,200	$1,600

As explained in Sections 8.3.1.1 and 8.3.1.2, different contingency factors were applied to periodic costs and operations and pumping costs. **Table 8-20** summarizes the process of accounting for contingency factors applicable for the periodic and maintenance costs for each region under Alternative 1. **Table 8-21** displays the contingency factors applied to the operations and pumping costs for each region under Alternative 1.

Table 8-20. Alternative 1 Periodic (Replacement) and Maintenance Cost Contingency Factors ($June 2019×1000)

Category	% Contingency	St. Charles Mesa Water District Regional Hub	Crowley County Water Association Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Subtotal Periodic and Maintenance Costs Before Contingencies		**$900**	**$1,150**	**$1,750**	**$12,000**	**$340**
Mobilization	5%	$46	$58	$88	$600	$17
Design Contingency	15%	$137	$173	$263	$1,800	$51
Allowance for Procurement Strategies	3%	$27	$35	$53	$360	$10
Subtotal		**$1,100**	**$1,400**	**$2,200**	**$15,000**	**$420**
Construction Contingency	25%	$275	$350	$550	$3,750	$105
Subtotal		**$1,400**	**$1,750**	**$2,800**	**$19,000**	**$530**
Noncontract Costs	25.00%	$350	$440	$700	$4,750	$133
Opinion of Total Periodic and Maintenance Present Worth Costs		**$1,750**	**$2,200**	**$3,500**	**$24,000**	**$660**

Table 8-21. Alternative 1 Operations and Pumping Cost Contingency Factors ($June 2019×1000)

Category	% Contingency	St. Charles Mesa Water District Regional Hub	Crowley County Water Association Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Subtotal Operations and Pumping Costs Before Contingencies		**$950**	**$2,900**	**$1,600**	**$1,200**	**$1,600**
Design Contingency	10%	$95	$290	$160	$120	$160
Subtotal		**$1,050**	**$3,200**	**$1,750**	**$1,300**	**$1,750**
Noncontract Costs	10%	$105	$320	$175	$130	$175
Opinion of Total Operations and Pumping Present Worth Costs		**$1,150**	**$3,500**	**$1,950**	**$1,450**	**$1,950**

8.3.3 Summary of Operations, Maintenance, and Periodic (Replacement) Costs Alternative 2

Table 8-22 summarizes the OM&R costs before contingencies in present value projected over a 50-year period for each regional system under Alternative 2. The OM&R costs for La Junta's regional system in Alternative 2 are significantly less than that of Alternative 1 primarily because treatment upgrades are not required. Less pipe would also have to be maintained overall for Alternative 2 compared to 1.

Table 8-22. Alternative 2 Summary OM&R Costs Before Contingencies ($June 2019×1000)

Category	Avondale Regional Hub	Crowley County Water Association Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Periodic (Replacement) and Maintenance Costs	$680	$1,100	$21	$200
Operations Costs	$1,300	$2,600	$1,300	$1,300
Pumping Costs	$180	$220	$0.0	$220
Total Operations and Pumping Costs	$1,450	$2,800	$1,300	$1,500

Table 8-23 summarizes the process of accounting for contingency factors applicable for the periodic and maintenance costs for each region under Alternative 2. **Table 8-24** displays the contingency factors applied to the operations and pumping costs for each region under Alternative 2.

Table 8-23. Alternative 2 Periodic (Replacement) and Maintenance Cost Contingency Factors ($June 2019×1000)

Category	% Contingency	Avondale Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Subtotal Periodic and Maintenance Costs Before Contingencies		**$680**	**$1,100**	**$21**	**$200**
Mobilization	5%	$34	$55	$1	$10
Design Contingency	15%	$100	$165	$3	$30
Allowance for Procurement Strategies	3%	$20	$33	$1	$6
Subtotal		**$840**	**$1,350**	**$26**	**$250**
Construction Contingency	25%	$210	$338	$7	$63
Subtotal		**$1,050**	**$1,700**	**$33**	**$310**
Noncontract Costs	25%	$265	$425	$8	$78
Opinion of Total Periodic and Maintenance Present Worth Costs		**$1,300**	**$2,100**	**$41**	**$390**

Table 8-24. Alternative 2 Operations and Pumping Cost Contingency Factors ($June 2019×1000)

Category	% Contingency	Avondale Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Subtotal Operations and Pumping Costs Before Contingencies		**$1,450**	**$2,800**	**$1,300**	**$1,500**
Design Contingency	10%	$145	$280	$130	$150
Subtotal		**$1,600**	**$3,100**	**$1,450**	**$1,650**
Noncontract Costs	10%	$160	$310	$145	$165
Opinion of Total Operations and Pumping Present Worth Costs		**$1,750**	**$3,400**	**$1,600**	**$1,800**

8.3.4 Summary of Operations, Maintenance, and Periodic (Replacement) Costs Alternative 3

Table 8-25 summarizes the OM&R costs before contingencies in present value projected over a 50-year period for each regional system under Alternative 3. Fowler has the highest projected OM&R costs. The reason for this is that it is necessary for Fowler to hire a full-time operator to manage the regional system. The other regional systems are more established before regionalization, therefore are only estimated to need additional part time operators to manage their regional systems.

Table 8-25. Alternative 3 Summary OM&R Costs Before Contingencies ($June 2019×1000)

Category	Avondale Regional Hub	Fowler Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Periodic (Replacement) and Maintenance Costs	$680	$850	$210	$21	$370
Operations Costs	$1,300	$2,600	$1,300	$1,000	$1,300
Pumping Costs	$180	$200	$200	$0.0	$290
Total Operations and Pumping Costs	$1,450	$2,800	$1,500	$1,000	$1,600

Table 8-26 summarizes the process of accounting for contingency factors applicable for the periodic and maintenance costs for each region under Alternative 3. **Table 8-27** displays the contingency factors applied to the operations and pumping costs for each region under Alternative 3.

Table 8-26. Alternative 3 Periodic (Replacement) and Maintenance Cost Contingency Factors ($June 2019×1000)

Category	% Contingency	Avondale Regional Hub	Fowler Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Subtotal Periodic and Maintenance Costs Before Contingencies		**$680**	**$850**	**$210**	**$21**	**$370**
Mobilization	5%	$34	$43	$11	$1	$19
Design Contingency	15%	$100	$130	$32	$3	$56
Allowance for Procurement Strategies	3%	$20	$26	$6	$1	$11
Subtotal		**$840**	**$1,050**	**$260**	**$26**	**$460**
Construction Contingency	25%	$210	$265	$65	$7	$115
Subtotal		**$1,050**	**$1,300**	**$330**	**$33**	**$580**
Noncontract Costs	25%	$265	$325	$83	$8	$145
Opinion of Total Periodic and Maintenance Present Worth Costs		**$1,300**	**$1,650**	**$410**	**$41**	**$730**

Table 8-27. Alternative 3 Operations and Pumping Cost Contingency Factors ($June 2019×1000)

Category	% Contingency	Avondale Regional Hub	Fowler Regional Hub	Rocky Ford Regional Hub	La Junta Regional Hub	Lamar Regional Hub
Subtotal Operations and Pumping Costs Before Contingencies		**$1,450**	**$2,800**	**$1,500**	**$1,000**	**$1,600**
Design Contingency	10%	$145	$280	$150	$100	$160
Subtotal		**$1,600**	**$3,100**	**$1,650**	**$1,100**	**$1,750**
Noncontract Costs	10%	$160	$310	$165	$110	$175
Opinion of Total Operations and Pumping Present Worth Costs		**$1,750**	**$3,400**	**$1,800**	**$1,200**	**$1,950**

8.4 Alternatives Cost Summary

Table 8-28 below summarizes the total construction and OM&R costs for each alternative. The table also breaks down the costs between regional and AVC. It is assumed that all OM&R costs would be designated as regional costs. More discussion is included in **Section 9** on the results of the cost analysis.

Table 8-28. Summary of Total Construction and OM&R Costs for Each Alternative ($June 2019×1000)

Category	Alternative	Total Regional Cost	Total AVC Cost	Total Project Cost
Total Construction Costs	1	$94,000	$350,000	$440,000
	2	$61,000	$210,000	$270,000
	3	$79,000	$155,000	$230,000
Total OM&R Costs	1	$42,000	$0	$42,000
	2	$12,500	$0	$12,500
	3	$14,500	$0	$14,500

Section 9

Recommendations

The AVC has been an ongoing effort in southeast Colorado for over 60 years intended to help small rural communities in the Arkansas River Valley meet long-term water quality and water supply needs. The continued delay of AVC construction due to lack of funding led to the evaluation of regionalization as a potential interim solution to water quality issues while potentially expediting the construction of portions of the preferred AVC alignment. As presented in Section 4, the three regionalization alternatives proposed in this report were developed in accordance with the following goals and objectives:

- Address CDPHE enforcement orders (CDPHE 2019b)
- Provide a reliable interim water supply that would meet the requested AVC deliveries for each participating water system
- Follow the proposed AVC alignment and incorporate sections of AVC to the greatest extent practicable to facilitate future AVC connections and water delivery

Table 9-1 includes comparison criteria that have been developed to better evaluate how each proposed alternative meets the established project goals and objectives. Each alternative either completely supports (✓), moderately supports (+), or minimally/does not support (✗) the comparison criteria.

Table 9-1. Qualitative Comparison of the Proposed Alternatives

Criteria	Description	Alternative 1	Alternative 2	Alternative 3
AVC Alignment	Regional pipelines follow the preferred AVC alignment	✓	✓	+
AVC Participants	All AVC participants are included	✓	+	✗
Water Quality	All existing and potential CDPHE enforcement orders are addressed	✓	✓	✓
Water Supply	An adequate short-term water supply will be provided to all participating systems	✓	+	+
Waste Disposal	Remove the need for ongoing radionuclide and residual waste disposal	✗	✗	✗
Implementability	Ease of implementation (e.g., permits, right of ways, National Environmental Policy Act [NEPA] compliance, etc.)	+	✓	✗
Institutional	Coordination with neighboring entities and the public is manageable and minimal (e.g., intergovernmental agreements, public acceptance, etc.)	✗	+	✓
Timeliness	Required improvements have minimal impact on existing infrastructure allowing for expedited project completion	✗	+	✓

Criteria	Description	Alternative 1	Alternative 2	Alternative 3
Regionalization Cost	Regionalization pipelines are optimized to reduce cost	✗	+	✓

The total project cost for each regionalization alternative is a significant factor in making a final recommendation. **Table 9-2** includes a comparison of regionalization cost components for each alternative, with three dollar signs being the most expensive and one dollar sign being the least expensive.

Table 9-2. Comparison of Cost Components for Each Regionalization Alternative

Cost Component	Description	Alternative 1	Alternative 2	Alternative 3
AVC Pipelines	The cost of pipelines that are sized and aligned with the preferred AVC alignment	$$$	$$	$
Alternate Pipelines	The cost of pipelines that do not meet the specifications of the preferred AVC alignment	$	$$	$$$
WTP Enhancements (Including New Supply Wells)	The cost of required water provider water treatment plan enhancements	$$$	$$	$$
Hydraulics	The cost of additional pumps or tanks needed for pipeline hydraulics	$$	$	$$$
Supply Wells	The cost of drilling and permitting additional water supply wells to meet future water demands for each regional system	$$$	$$	$
Water Rights	The cost associated with reallocation of water rights, updating of augmentation plans, purchasing or leasing new water rights, legal fees and water court approvals	$$$	$	$$
O&M	The overall cost of regional system operations and maintenance	$$$	$	$$
AVC Tie-In	The cost of constructing the preferred AVC to tie-in with regionalization pipelines	$	$$	$$$

In addition to the general cost comparison presented in **Table 9-2**, **Figures 9-1**, **9-2**, and **9-3** depict the total cost breakdown for Alternatives 1, 2, and 3, respectively. The AVC costs are shown separately from the regionalization costs for each regional hub to better evaluate and compare each alternative. Impending AVC construction costs would be in addition to the costs depicted in **Figures 9-1**, **9-2**, and **9-3**, making the total cost of regionalization and AVC implementation more expensive than AVC alone. However, regionalization as an interim measure would allow for AVC participants under CDPHE enforcement orders to expedite actions that address ongoing SDWA violations.

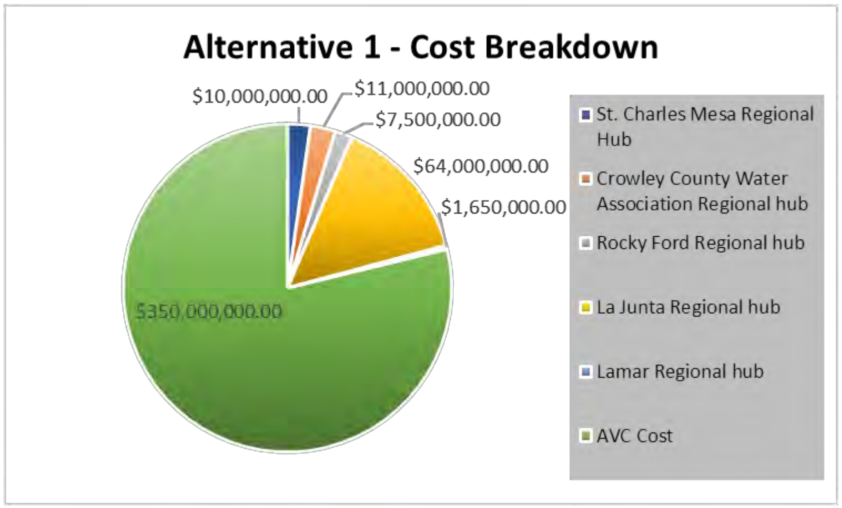


Figure 9-1. AVC and Regionalization June 2019 Cost Breakdown for Alternative 1

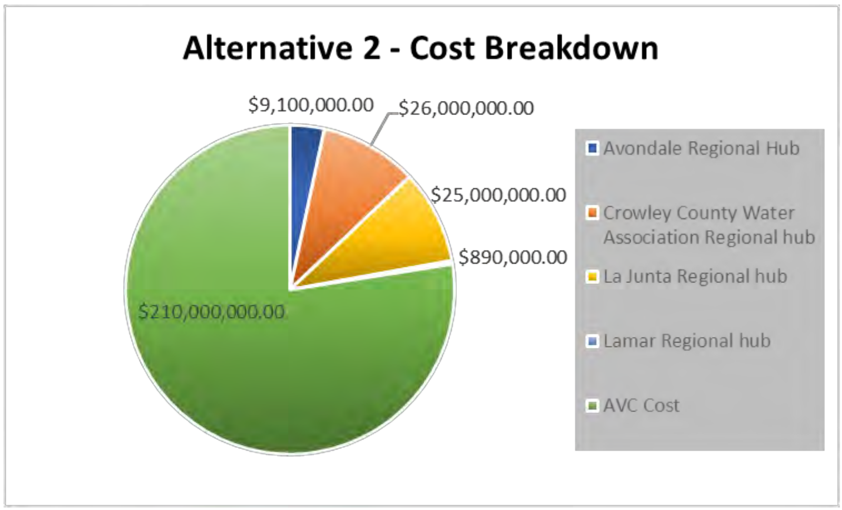


Figure 9-2. AVC and Regionalization June 2019 Cost Breakdown for Alternative 2

Figure 9-3. AVC and Regionalization June 2019 Cost Breakdown for Alternative 3

Based on a review of the alternatives in relation to the project goals and criteria, the following recommendations can be made:

- Complete additional investigations and gather additional information as noted in Section 7 to support findings and alternative selection.
- Connect participants that are currently under CDPHE enforcement or are likely to be under enforcement to regional providers or nearby systems that are in compliance as soon as possible and encourage grass roots regionalization.
- The cost of impending AVC plus regionalization is greater than the cost of implementing AVC by itself; therefore, extend the AVC pipeline system to the first hub area (Avondale and Boone) as soon as possible.
- Consider short- and long-term brine disposal in total costs and as part of the schedule for AVC implementation. Brine disposal impacts support regionalization only as a short-term solution.
- Consider short- and long-term radionuclide disposal in total costs and as part of the schedule for AVC implementation. Radionuclide waste stream management supports regionalization only as a short-term solution.
- Refine Alternatives 2 and 3 in the Lamar regional hub and implement regionalization in the hub due to the anticipated schedule to provide a reliable interim water supply.
- Develop a water rights action plan as required to implement regionalization.
- Develop a prioritized funding list and finalized funding source for both capital and O&M.
- Form regional governance groups to help manage regionwide water rights action plans and pursue funding opportunities for each regional hub.

Section 10

Cost Share Partner

One of the hurdles delaying AVC implementation is the lack of funding resources available to the 40 AVC participants. The participants have limited resources (tax base, users fees, tap sales, etc.) to repay the required 35 percent beneficiary contribution for AVC construction costs. Costs associated with the enhancements or expansions needed to implement regionalization as an interim measure are also cost prohibitive and require outside funding to implement.

One opportunity to acquiring the needed funding to cover costs associated with regionalization and AVC implementation is for municipalities to levy taxes on properties and issue both general obligation (GO) and revenue bonds. Tax free municipal GO and revenue bonds can provide significant funding for utilities that can be used toward design and construction of capital improvements, Additionally, a number of public and private sector financing opportunities are available, especially for small and rural communities, that can help these systems make progress toward regionalization and eventual AVC construction. The following sections summarize potential grant and loan funding avenues that the AVC participants can pursue to finance required system improvements proposed under regionalization.

10.1 Grants and Low-Interest Loan Analysis

A widely used source of funding for water infrastructure improvements is from state or federal grants or low interest loans. Grant or loan funding opportunities offer viable options for a portion of the funding needed for design or construction costs associated with capital improvements.

10.1.1 State and Federal Grants

State and federal grants offer funds for project completion without the need to identity revenue sources to repay loans. However, many state and federal grants have match or cost share requirements that may limit a systems ability to qualify for grant approval. Included below are brief summaries of grant opportunities that are most in line with the scope and objectives of interim regionalization and AVC implementation. A more extensive evaluation of potential grant opportunities available to AVC participants is included in Appendix C.

- **Water Infrastructure Improvement for the Nation (WIIN) Act:** The Assistance for Small and Disadvantaged Communities Drinking Water Grant Program was established under the WIIN Act of 2016 to support underserved communities achieve SDWA compliance. Grant funding is administered by EPA to states, and state governments award funding to small disadvantaged communities[13] to cover project costs that assist in returning a public water system back to compliance. A 45 percent cost share of total project costs is required under the grant program in the form of monetary funding, services, materials, supplies, or other in-kind services. States develop a list of fundable projects that meet the requirements of the grant program to receive funding from the

[13]Disadvantaged communities are defined under SDWA Section 1452(d)(3) and include communities with a population of 10,000 or less that do not have the capacity to incur debt sufficient to finance a project to comply with the SDWA.

EPA. The State of Colorado received $839,000 in 2019, which is only a small percentage of the total funding requests received, so only a small percentage of the funding for treatment plant enhancements required under regionalization including the drilling of new water supply wells would be available. Future funding allocations for Colorado may increase if the state proposes AVC regionalization as a priority project that meets the mission of WIIN Act funding.

- **Water and Waste Disposal Grants:** The Water and Waste Disposal Loan and Grant program administered by the U.S. Department of Agriculture provides low-income communities with populations of 10,000 or less funding to construct basic drinking water and waste disposal systems. Communities facing significant health risks from lack of access to safe, reliable drinking water may apply. Matching funds are not required although partnerships with other federal, state, or local entities are encouraged. Applications are accepted on a rolling basis year-round. The AVC participants may use this funding to construct water treatment plant enhancements, drill new water supply wells, or improve radionuclide residual disposal processes.

- **Rural Economic Development Initiative (REDI):** The REDI program is designed to help rural communities diversify their local economies and improve resiliency. Applicants must be from local governments and counties with less than 50,000, and communities with less than 20,000, are the most successful in receiving REDI funding. Grants are administered by the Colorado Department of Local Affairs and include the Local Government Economic Planning Grant, infrastructure grants, and entrepreneurial eco-systems grants. All three grant opportunities focus on improving economic diversity through planning or infrastructure enhancement. The entrepreneurial ecosystems grant also supports communities leveraging private investment or public-private partnerships (P3s) to achieve project objectives. Maintaining a high quality, sustainable, and reliable water supply source, whether through AVC or regionalization, would ultimately help improve economic resiliency and allow for continued growth and diversification within the AVC communities. The AVC participants can potentially leverage REDI funding to implement the water infrastructure expansions needed for AVC implementation or regionalization. Available REDI funding for the 2019–2020 fiscal year was $750,000. No minimum match is required; however, offering in-kind services and/or a cash match may increase the success of an application.

10.1.2 Loan Opportunities

Privately owned water systems may not be eligible for many state or federal grant opportunities and generally cannot issue bonds, making loans a more viable option for some participating systems. Additionally, loans are generally more likely to provide larger lump sums of funding compared to state or federal grants, allowing for water systems to implement most, if not all, of the enhancements necessary for AVC regionalization. Loan terms range from 1 to 40 years depending on the total loan amount. Interest rates vary depending on market rates and the water system's creditworthiness, but usually range from 0 to 6 percent. Low-interest loans are a low-risk option that would allow a water system to acquire the needed funding to accomplish a stated objective without dealing with the risks associated with P3s. Included below are brief summaries of loan opportunities that are most in line with the project scope and objectives of interim regionalization and AVC implementation. A more extensive evaluation of potential loan opportunities available to AVC participants is included in Appendix C.

- **Water Infrastructure Finance and Innovation Act (WIFIA):** The WIFIA program is a federal credit program administered by EPA for eligible water and wastewater infrastructure projects. The WIFIA program works separately, but in coordination with, State Revolving Fund programs to provide subsidized financing for large-dollar-value projects. Government entities, partnerships and joint ventures, and corporations and trusts are eligible to apply. Funds would cover planning, design, construction, reconstruction, rehabilitation, and/or replacement costs for eligible water infrastructure projects. The minimum loan amount for small communities with populations of less than 25,000 is $5M. A maximum of 49 percent of the total project cost can be funded through WIFIA if no more than 80 percent of the total cost is covered through other federal assistance. The WIFIA program offers 35-year loan repayment terms with a fixed interest rate that is equal to or greater than the U.S. Treasury rate of a similar maturity[14] at the date of closing.

- **Rural Community Assistance Corporation (RCAC) Loans:** The RCAC is a nonprofit organization that provides training and financial resources to rural communities in the western United States. Short-, intermediate-, and long-term environmental infrastructure loans are available through RCAC to help cover costs associated with capital improvements. The Community Facilities loan programs also offer variable term conditions with funds up to $6M available for construction, acquisition, and rehabilitation projects. Additionally, the RCAC provides other services that AVC participants could leverage, including facilitation of regionalization efforts to assist in the planning, coordination, and development of regionalization or AVC implementation. Rural communities with populations of 50,000 or less are eligible to apply.

- **Water Project Loan Program:** For projects that align with the goals of Colorado's Water Plan, low-interest loans are available to commercial, agricultural, and municipal borrowers. A total of $50M is available annually through the Colorado Water Conservation Board Water Project Loan Program, with a requested minimum loan amount of $100,000. The loan covers the design and construction of raw water projects. Interests rates vary based on the specific type of project. Current rates are 1.55 percent for agricultural, 6.00 percent for commercial, and 2.00 percent for hydroelectric. Municipal rates change based on the income level of the community. Current municipal rates are 2.15 percent for low income, 2.45 percent for middle income, and 2.75 percent for high income borrowers. The standard loan is 30 years, with 0.25 percent reduced rate for a 20-year term and 0.65 percent for a 10-year term. If a 40-year loan is required, the rate will increase by 0.25 percent and there is a 1.0 percent charge on the amount as a service fee. Applications are open to any public or private organization that can show the project is technically, economically, institutionally, and financially feasible.

[14]Daily Treasury long-term rates in 2019 have ranged from 1.8 to just under 3 percent. More information available on the U.S. Department of Treasury website.

10.2 Public-Private-Partnership Analysis

While there are many funding options in the form of grants or loans, another supplemental option is a P3. A successful P3 agreement can help a public sector entity gain access to capital and project management resources. P3s can be difficult to define, as they are found in many different models, but a commonly accepted definition comes from the U.S. Department of Transportation: "*A public-private partnership is a contractual agreement formed between public and private sector partners, which allows more private sector participation than is traditional. The agreements usually involve a government agency contracting with a private company to renovate, construct, operate, maintain, and/or manage a facility or system. While the public sector usually retains ownership in the facility or system, the private party will be given additional decision rights in determining how the project or task will be completed.*"

There is considerable debate as to what extent private interests should be involved in public projects. A significant obstacle to a P3 project is identifying a source of revenue that the private company can use to obtain a return on the capital investment. While the private entities involved in a P3 agreement provide an absorption of risk along with many other benefits that can make a major project feasible, the complexity of P3 contracts and the potential for loss of public control raises concern. A list of potential benefits and concerns associated with entering into a P3 agreement are shown in **Table 10-1**.

Table 10-1. Potential Benefits and Concerns Related to P3 Contract Agreements

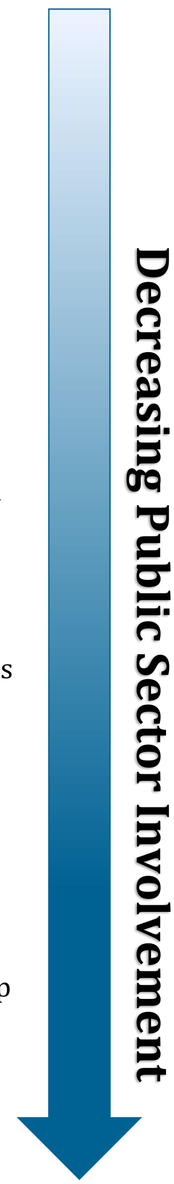
Potential Benefits	Potential Concerns
Access to private equity financing	Loss of public control and flexibility; higher cost of funds due to loss of tax exempt status and inability of private companies to assess property taxes; increases project costs due to need for of the private company to show a profit and return on investment that is not part of a publicly funded project
Project acceleration	Contract complexity
Monetization of existing assets, primarily water rights	Inability to use utility revenues for future utility projects and general municipal projects
Cost and time savings	Risk of bankruptcy or default by private company
Reduced labor and operating costs	Accountability and transparency
Reduced project scope	Environmental issues
Risk transfer to private company	Labor concerns
Increased emphasis on construction and operational efficiency	Loss of public control and flexibility
Access to innovative technologies	Increasing consulting needs/costs
More efficient O&M	Limited government oversight

Source: National Conference of State Legislatures 2017

The majority of P3 agreements have been related to transportation infrastructure, as the original legislative policies for P3s only included transportation projects. More recently, the debate over P3s has expanded to include other types of government-delivered infrastructure, including water utilities. The procurement process generally includes the public partner to release a request for qualifications followed by a competitive request for proposal for a project. The public sector partner can then negotiate contract terms and conditions with the selected private sector partner to achieve an agreed-upon P3 contract that meets project objectives.

If a public entity decides to pursue a P3 agreement, the traditional design-bid-build contract model would be replaced with a P3 project delivery model contract. A number of P3 contract models are available and the selected model will vary depending on public sector needs and available resources. The most common P3 model for water utilities has been the utilization of private sector contractors to assist with system operations. Under regionalization, a variation of the O&M project delivery model could be used to allow a private sector partner to operate and maintain one or more water systems within a regional hub. The AVC participants could potentially share the cost associated with hiring a private contractor to operate and maintain components of the regional water systems. This would allow for significant cost savings and a more efficient means of filling any operations gaps AVC participants currently face.

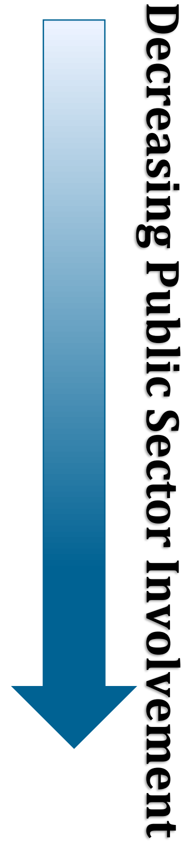
Below is a brief description of the other potential P3 project delivery models that participating systems may consider when pursuing a P3 to acquire needed funding for participants portion AVC implementation and/or regionalization (Cooper and Holms 2018). Boldened text indicates which entity would be responsible for providing funding for the described project delivery model.



- **Design-Build (DB):** The private sector partner both designs and builds the public facility or asset while the **government partner** provides the funding and owns and operates the facility.
- **Operations and Maintenance (OM):** The private sector partner operates and maintains a public facility or asset owned by the **government partner**.
- **Design-Build-Operate-Maintain (DBOM):** The private sector partner designs, builds, operates, and maintains the public facility or asset while the **government partner** provides the funding and owns the facility.
- **Design-Build-Finance (DBF):** The private sector partner designs, builds and finances a public project for a predetermined period of time while the **government partner** provides the funds needed for operations.
- **Other Private Financing;** A **private entity**, usually a financial services company or bank, funds a project directly or uses various mechanisms such as a long-term lease or bond issue.
- **Design-Build-Finance-Operate-Maintain (DBFOM):** The **private sector partner** designs, builds, finances**,** operates, and maintains a public facility or asset for a predetermined period of time while the government partner provides the funds needed for operations.
- **Design-Build-Operate-Transfer (DBOT):** The private sector partner designs, builds, and operates a public facility or asset and transfers ownership to the government partner **government partner** provides the funds needed for operations.
- **Build-Lease-Transfer-Maintain (BLTM):** The **private sector partner** finances**,** designs, and builds a public facility or asset and leases it to the

government partner for a predetermined period of time for a set price.

- **Build-Transfer-Operate (BTO):** The **private sector partner** finances and constructs a public facility asset and transfers title to the government partner. The public partner then leases the facility or asset back to the private partner under a long-term contract.
- **Build-(Own)-Operate-Transfer (BOT/BOOT):** The **private sector partner finances, builds, and operates** a public facility or asset. The private sector partner may initially own the public asset for a set period of time, after which point the ownership is transferred free of charge to the government partner.
- **Build-Own-Operate (BOO):** The **private sector partner finances, builds, owns,** and operates a public facility or asset in perpetuity.
- **Buy-Build-Operate (BBO):** Transfer of a public asset or facility to a **private sector partner who is obligated under the contract to finance** build/renovate and operate the facility for a specified period. All utility revenue goes to the private utility.



Section 11

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Appendix A

Site Visit Notes

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Appendix B

Meeting Notes from Workshops

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Appendix C

Potential Grant and Loan Opportunities for AVC Participants

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Appendix A

Site Visit Notes

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Memorandum

To: Sam Braverman, Bureau of Reclamation and Chris Woodka, Southeastern Water Conservation District

From: Mark McCluskey, CDM Smith

Date: January 21, 2019

*Subject: Field Notes – Review of Potential Regional Water Providers
Arkansas Valley Conduit (AVC) Regionalization Study*

On December 19 and 20, 2018, representatives from the Bureau of Reclamation, Southeastern Water Conservation District, and CDM Smith toured and met with potential regional water providers to assess their ability to provide water to potential connectors as an interim measure until the Arkansas Valley Conduit (AVC) is operational.

Attendees: Chris Woodka (Southeastern Water Conservation District); Sam Braverman and James Bishop (Bureau of Reclamation); Doug Brown and Jacqui Wesley (CDM Smith)

December 19, 2018

Fowler – Kelly Lotrich, Brent Bitter (operator)

- They currently provide water to only their service area. The supply is an alluvial well that pumps to an elevated tank in the central part of town, which then gravity feeds the distribution system. The well was recently classified as groundwater under the direct influence of surface water (GUDI), and new Colorado Department of Public Health and Environment (CDPHE) approved filters have been installed to comply with filtration requirements. The town is also finishing construction of an ion exchange system to reduce the hardness of the water prior to distribution.

- The Fowler water system has a separate supply, storage and distribution system for non-potable irrigation water, which significantly reduces the peak water demand for the potable water system. The current population is 1,200, so the required potable water supply is approximately 100 gallons per minute (gpm) assuming a potable water demand of 90 gallons per capita per day (gpcd). An alluvial well with high hardness along the river is the water source for the irrigation supply.

- The distribution system is all C-900 pipe, so no concerns with corrosion of the main distribution pipes. Most of the pipes are 6-inch diameter and there consistent 40-45 pounds per square inch gage (psig) water pressure throughout the system.

- When asked how a better source of water would help them, they replied that it would not. The conduit would be a back-up water source only. North Springs well is high in selenium (Se) and can't be used as a second water source. Other wells have uranium and are not used.

Photo 1 – Well Filtration System

Photo 2 – Ion Exchange System

Rocky Ford – Rick Long

- The system consists of three wells with only one necessary to be able to meet their current demand. They chlorinate and store in one of two tanks.

- The town has alluvial wells, and a 5 million gallons per day (mgd) conventional coagulation, sedimentation and filtration water treatment plant built with a United States Department of Agriculture (USDA) grant. The plant has not been operated since 2013. A Class A operator is required to supervise plant operations as the operator-in-charge (OIC), and Rocky Ford doesn't have a Class A operator due to lack of funding. In addition to hiring an operator, the water treatment plant requires $0.5 to $1.5 million of improvements to address O&M problems. An engineering report describing the requirement improvements was prepared by TTG Consultants in 2016, and the City has recently hired Farnsworth Consultants to reevaluate the water treatment plant. They do not feel they need the plant since the wells meet their demands.

- The water department currently has four operations and maintenance staff, and budget to hire one additional person.

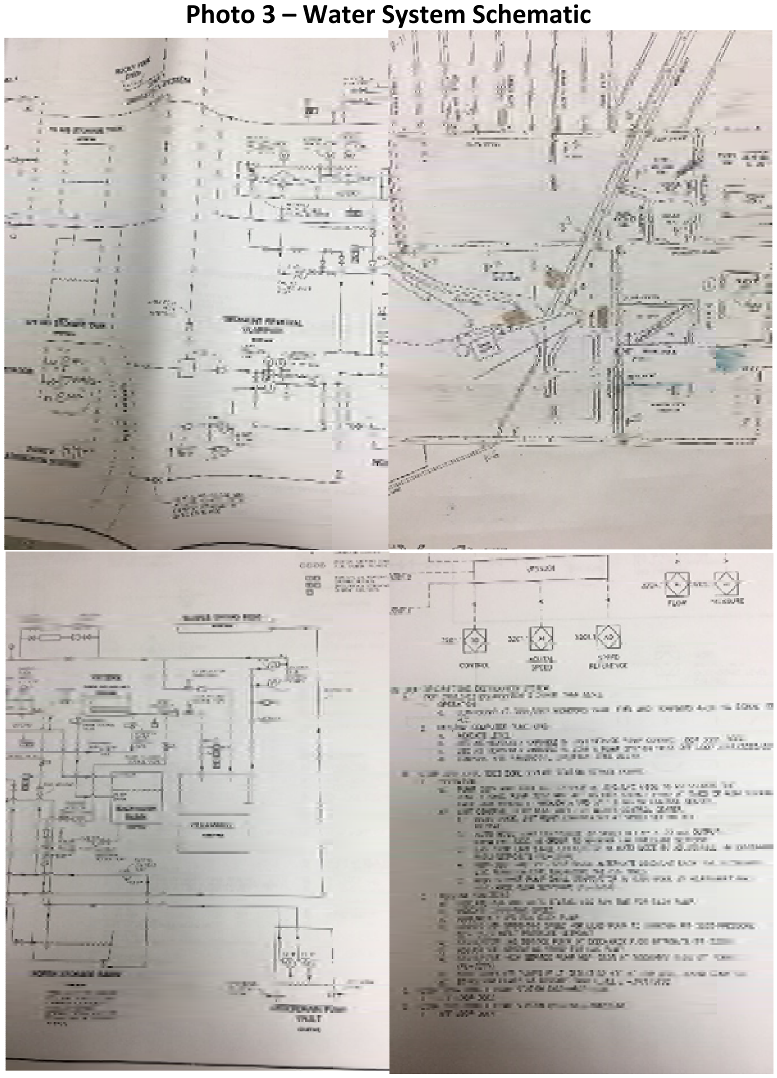
- One well is sufficient to meet demand. They pump from the wells and disinfect with free chlorine before distribution. There is also a separate supply and storage system to provide irrigation water in the Town.

- The water treatment plant is supplied by water from the Catlin Irrigation Ditch, which diverts water from the Arkansas River for approximately five months each year from May to September.

- There are two large steel storage tanks, and one tank that is relatively new (no date provided).

- Their piping system is old but can operate reliably at 40-45 psig. At higher pressures they experience line breaks. They do not currently provide water to any other communities but believe the wells and distribution could supply other small systems in the area. They have approximately 1,800 service connections serving approximately 3,200 people. It is a single system that also provides irrigation water.

Photo 3 – Water System Schematic



La Junta – Tom Seaba

- The La Junta water system consists of 14 alluvial raw water wells, iron and manganese treatment system, 4 mgd reverse osmosis (RO) water treatment plant and storage tanks. The source water has a high hardness. Total dissolved solids (TDS) has been stable for the past few years. Fifty percent of water will come from AVC then blend with current water source.

- La Junta supplies wholesale treated water to Swink, Homestead Loop and Bents Fort. La Junta has approached South Swink, but South Swink is not interested in connecting at this time. To make this connection, South Swink needs to install a mile of pipeline to a large La Junta treated water transmission pipeline. Some residents in South Swink connected to the wastewater system in La Junta, but not the water system.

- The current system operates between 41-48 psig and is reported in good condition. The reduced hardness and salinity of the treated water has reduced scaling and corrosion of the distribution pipe and extended the life of the distribution system piping. They treat approximately 27% of the raw alluvial well water to reduce Fe and Mg, and then blend the water with the reverse osmosis (RO) permeate to produce a non-corrosive treated water.

- Brine disposal is becoming an issue due to the Se. La Junta has obtained a discharge system variance (DSV) for Se.

- Cheraw is 8 miles north but may be challenging to pump water there. If the AVC were moved north, then it could serve them. They have a 400k gallon tank (treated water) at Boy's Ranch area to serve the light industrial and a few rows of houses. This is approximately half way to Cheraw and could be extended.

- Conservation plan reduced residential water use, however, some new industry including Dean Brewing have been added to the service area. Dean Brewing may require up to 0.8 mgd of flow at full capacity. La Junta can meet the existing summer peak demands and has space to add an additional RO train if demand increases.

- In 2022 they will complete payment on the water treatment plant but still have wastewater treatment debt service for the new wastewater plant.

Photo 4 – Storage Tank North of Town

Photo 5 - RO Decarbonator

Photo 6 – On-site Hypochlorite Generator

Photo 7 – Typical Chemical Storage system

Photo 8 – Iron and Manganese Removal Filters

Photo 9 – 2 Stage 30 x 15 RO System

December 20, 2018

Lamar

- The water source for Lamar is groundwater from the Clay Creek aquifer seven miles south of the town. The aquifer is recharged from irrigation water passing though the decommissioned Clay Creek Reservoir. Recharge water is provided from 3,100 shares the Ft Bent ditch.
- Water quality from the Clay Creek aquifer has lower TDS and hardness than the Arkansas River alluvium. The low TDS wells have 400 mg/L and the high TDS wells have 900 mg/L. The 43 high and low TDS wells are pumped to keep the TDS at reasonable concentration. To increase the source-water supply the city will need to drill additional wells and increase the recharge flow. The existing wells were re-drilled in 1966 after the 1965 floods.
- There are two wells that are pumped to the old reservoirs for golf course irrigation.
- There are two 24" diameter pipelines to convey treated from the 6 million gallon (MG) storage tanks. The pressure in the downtown area is typically 85 psig.

Photo 10 – Treated Water Storage Tank

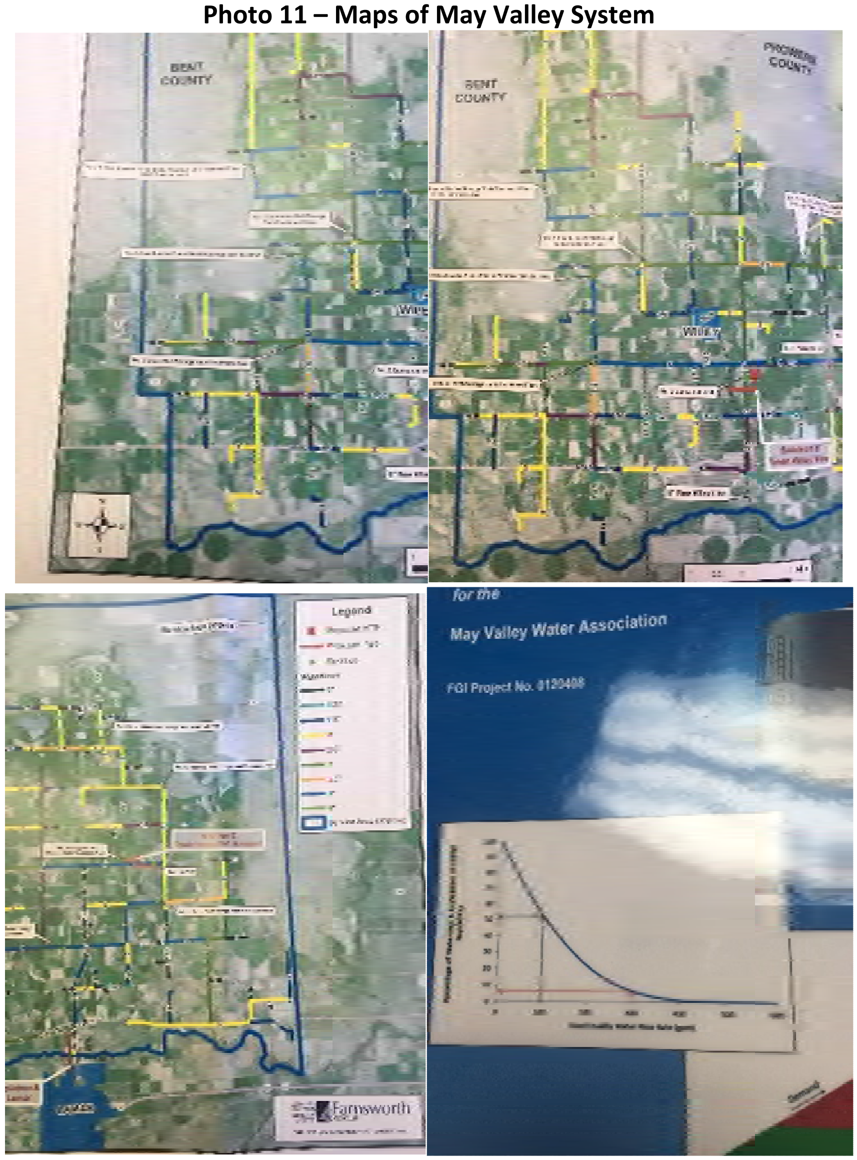
May Valley – Rick Jones (added to trip agenda)

- May Valley has conducted several studies to analyze the water system and develop a plan for water management. This includes a new tank across County Road 34.
- There are several large agricultural/crop irrigation lines located throughout the system, but they are not mapped and will need to be located prior to any system work.
- Nine wells are located throughout the service area and pumped to the system. At the low point near Lamar, pressure is 150 psig. The majority of pipe in the system is over 50 years old and PVC. They average 12 breaks or leaks per year. They have recently added VFDs to pumps to reduce surges. Pressures range from 60 psig to 125 psig. There are 623 taps their system. The water system provides potable water and livestock water ("we are watering a lot of cattle with potable water").
- The water quality compliance issue is radionuclides (radium). Two of the District wells are compliant. They need 400 gpm during peak summer demand periods. This may be peak hour demands due to the limited storage in the system. Their best well provides 75 gpm per day and they can obtain another 75 gpm per day of compliant water from other wells.
- The Wiley operations staff believe the system will be out of compliance for uranium when the 2019 samples are submitted, and then a compliance plan will need to be submitted to CDPHE. Wiley has no additional water to blend to improve their water quality. Wiley's wells are at Lamar HS and connect to an 8" line extending north under the Arkansas River to the southern end of the Wiley System. The wells are good producing wells at 250 gpm and 125 gpm but are non-compliant.
- Wiley typical demand is less than 50,000 gallons per day but in the summer the system at 1.5M gallons per month. The well is trending down (decreased water quality) with more

uranium. It's 350' deep. The operations staff recommended the regionalization analysis include consolidation of the May Valley and Wiley distribution systems.

- Within the May Valley service area there are lots of homes with individual RO units at a cost of approximately $1,000 installed. Due to water hardness, a softening unit is also required at an approximate cost of $1,500 (installed). The RO cartridges are estimated at $80 per cartridge. Total operating costs were not provided. The water system chlorinates therefore each home must dechlorinate the water with a granulated active carbon (GAC) filter prior to the RO treatment units.

Photo 11 – Maps of May Valley System



Las Animas – Roy Davis, WTP Lead

- Las Animas operates nine wells in town with one off-line. The water system includes a 5-micron cartridge filter and the addition of a scale inhibitor as part of the pre-treatment process. The treatment process consists of 2 stage RO that achieves 65% recovery. High TDS limits their recovery. TDS in the influent are approximately 3,000 ppm, and there is a significant concentration of sulfates and non-carbonate hardness. The RO concentration is combined with the wastewater effluent and discharged to the Arkansas River in accordance with the discharge permit. Se in the discharge to the river exceeds water quality standards and will likely impact the ability to discharge RO concentrate in the future.

- The RO membranes are 10 years old but are still producing good quality water. The membranes in the second stage were changed and this helped with performance. Following RO treatment, they chlorinate, adjust the pH and add corrosion inhibitor to the treated water and then pump it to an elevated storage tank for distribution. None of the well water is used for blending with the RO permeate because of the high TDS of the raw water. They have a 2 MG finished water storage tank and repump to an elevated tank.

- They meet demand with the current wells and water system. One northern well has non-detect concentration of Se, and one well on south side farther from the river has 30 ppm. Se may be naturally occurring from shale in the ground.

- The population is 2,500 plus an estimated 1,400 inmates and staff at the prison.

- Fort Lyon obtains water from Dakota wells and not really a problem so does not need to connect to regional providers.

- Las Animas obtains water from 30-35 feet deep alluvial wells that CDPHE says are under the influence of surface water, but they have not officially declared this.

- Las Animas will convert to 100% AVC water once available and eliminate the treatment system. Some sanitary sewer inflow and infiltration adds Se to the wastewater from the naturally occurring Se in the groundwater, but with AVC water this should keep the Se concentration below the effluent.

Photo 12 – RO Plant at Las Animas

Appendix B

Meeting Notes from Workshops

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Meeting Notes - FINAL

Arkansas Valley Conduit Regionalization Study
Appraisal Study - Workshop #1

Date: May 23, 2019
Time: 10:00 a.m. to 2:00 p.m.
Location: CDM Smith Office (555 17th Street, Suite 500, Denver, CO 80202)

Attendees:

Name	Organization
Braverman, Sam	U.S. Bureau of Reclamation
Waechter, Christopher	U.S. Bureau of Reclamation
Barthel, Rodney	U.S. Bureau of Reclamation
Steen, Timothy	U.S. Bureau of Reclamation
Morea, Sue	CDM Smith
Wesley, Jacqueline	CDM Smith
McCluskey, Mark	CDM Smith
Miesen, Paniz	CDM Smith
Brown, Doug	CDM Smith

Slides used in this workshop are attached to the meeting summary.

Overview of agenda and meeting purpose

- Mark McCluskey recapped the mission for the study, stated the workshop #1 goals for the Arkansas Valley Conduit (AVC) Regionalization Study—and gave an overview of the agenda (Slides 1 to 3).
    - The team agreed with the workshop goals and agenda.
- The group went around the table and gave brief introductions (Slide 3).

Introduction

- Mark provided project background information that will be used as the basis for the analysis CDM Smith is performing and asked for feedback from the team (Slides 5 to 13).
- Mark reviewed the list of the AVC participants including all the entities identified in previous AVC reports and entities that have been in/out over the history of the project.
    - The list of AVC participants was provided as a handout to the meeting attendees to review and is attached to the meeting summary.
    - ***Action Item:*** *CDM Smith to confirm list of participants with Kevin Meador who was not able to attend the meeting.*

  - The all-inclusive list of participants was previously agreed to by the Reclamation team and had been supported by SECWCD team in the previous meeting held on May 8, 2019.

- Mark shared a map showing the locations of each of the AVC participants (Slide 8). This information supplements the table of the AVC participant.

  - Chris Waechter questioned St. Charles Mesa being listed as a participant.

    - *Sam Braverman noted St. Charles Mesa was included in addition of the fifth regional hub to be evaluated in the Feasibility Study*

    - *Some participants have more than one tie-in location.*

    - ***Decision:** CDM Smith was instructed to leave St. Charles Mesa in the participant list in the event they request to re-enter the project.*

- Mark summarized the 2070 water demands and requested information about the requested AVC deliveries for each of the AVC participants.

  - Rodney mentioned the latest information would be from the AVC Feasibility Report (2016)

    - ***Action Item**: CDM Smith will confirm the demand and delivery data with that report.*

- Sam Braverman noted the 2070 demands assume growth and some entities have not observed growth.

- Rodney Barthel stated that water treatment plants are typically designed for maximum day demands. He noted that the AVC Feasibility design included pipeline sizing for maximum month to reduce project costs assuming participants existing storage systems could account for increased demands.

  - ***Decision**: CDM Smith will also use max day demands for Regionalization water treatment facility sizing and max month demands for Regionalization pipe sizing for consistency.*

- Mark went through the three entities (Cheraw, May Valley Water Association, and Boone) where the requested AVC water deliveries would not meet the projected 2070 demands (Slide 10).

- Mark showed a figure of the AVC participants with CDPHE enforcement orders (Slide 11). These include CDPHE enforcement orders associated with the characterization of supply being groundwater under direct influence of surface water (GUDI), nitrate – selenium, radium and uranium, combined radium only, and combined radium and GAPA.

  - Mark noted the Town of Swink and Fowler have pending CDPHE enforcement modifications (Slide 12). These entities have upgraded their systems to meet existing compliance order requirements, but the CDPHE enforcement orders have not yet been removed.

  - ***Action Item:*** CDM Smith to follow-up with CDPHE to confirm status of the enforcement orders for Swink and Fowler.

- Mark recapped the appraisal study goals (Slide 13).

Data Collection

- Paniz Miesen went through the data and reports that will be used as the basis for the analysis and asked for feedback from the team (Slides 14 to 16).

- Paniz summarized the data sources including government furnished documents: 29 reports, 21 CDPHE enforcement orders and geospatial data (Slide 15). This data has been reviewed and summarized in our notes. CDM Smith has been relying on information obtained in the December 2018 AVC regional provider site visits conducted by CDM Smith.

Alternatives

- Paniz presented the preliminary alternatives and asked for feedback from the team (Slides 17 to 31).

- She summarized each of the 4 proposed regionalization alternatives (Slide 18) and differentiated each of the alternatives by the following: water providers, regional system connections, water deliveries, pipeline alignments and participant delivery water locations.

  - Through discussions and some clarifications, the team decided on the following alternatives using AVC requested water demands:

    - *Alternative 1: All entities included using AVC proposed route and pipe sizes. This alternative serves as the baseline for the alternative analysis. No changes made to alternative 1 except for the potential addition of Las Animas as part of the La Junta regional system.*

    - *Alternative 2: Only include entities under enforcement action or likely to have enforcement action, use the AVC proposed route and pipe sizes where the Regionalization alternative overlaps the AVC Feasibility alignment. Identify and add systems with a high likelihood of future CDPHE enforcement orders and include those systems within the alternative 2 regional hubs. The proposed list of participants to be included will be confirmed by Southeastern and ECAO.*

    - *Alternative 3: Same as Alternative 2 but optimize the pipe size and route (may not align with AVC proposed routes or sizes). The same systems identified as having a high likelihood of future CDPHE enforcement orders for alternative 2 will also be included within the alternative 3 regional hubs. Alternative 3 will ignore the AVC route and pipe sizes to provide a design with the lowest cost and shortest schedule to deliver CDPHE compliant water to participants with active/pending enforcement actions.*

    - *Eliminate alternative #4*

- Paniz described Alternative 1 (Slides 19 to 22): proposed regional water providers (St. Charles Mesa, Crowley County Water Association, Rocky Ford, La Junta, and Lamar), the current and 2070 water demands for each of the regional water providers and the projected regional system deliveries.

- This alternative meets the three objectives of: 1) addressing CDPHE enforcement orders, 2) Provide reliable interim water supply that would meet the requested AVC deliveries and 3) follow the proposed AVC alignment to the greatest extent possible.

- Since Alternatives 2 through 4 were modified during the earlier discussion, the remaining alternatives were not reviewed in detail (Slides 23 to 31).

<BREAK> Team took a break for lunch.

Water Treatment

- Doug Brown reviewed the preliminary water treatment alternatives and asked for feedback from the team (Slides 32 to 56).

- Doug provided the assumptions associated with water treatment for the appraisal study (Slide 33). This includes accounting for redundancy in the system except for RO treatment trains.

  - Rodney asked if the systems will include fire flow.

    - *Fire flow is not included in the demands. Rodney confirmed that previous efforts assumed each entity would be required to provide considerations for fire flow such as storage and additional costs. CDM Smith will proceed under this assumption.*

- CDM Smith has prepared a brief description of the existing water treatment process used by each proposed regional provider including the existing water sources, number of wells, and the required treatment process upgrades to meet regional demands (Slide 33). Doug presented a summary of the assumptions for the analysis (Slide 34).

- Doug presented the water treatment process for St Charles Mesa (Slide 35). No detailed information on St. Charles Mesa's treatment plant was available so a typical conventional treatment process was shown. St. Charles Mesa is only used in Alternative 1. The water source is surface water with alluvial wells as backup. There are two options for water treatment plant upgrades to provide water for other entities under Alternative 1 (Slides 36 and 37).

- Doug presented the water treatment process for Avondale (Slide 38). Avondale uses greensand filtration to treat water from alluvial wells prior to chlorination then distribution. Avondale relies on alluvial wells as a water source. There are two options for water system upgrades (Slides 39 and 40) that include additional wells to meet the water demand

- Doug presented the water treatment process for Crowley Water Association (Slide 41). Crowley Water Association treats water from alluvial wells disinfecting with chlorine prior to distribution. Crowley Water Association relies on alluvial wells for water. There is a potential need to expand the chlorination system capacity to meet the treated water needs (Slides 42 and 43). Five additional wells would be required to meet the water demand.

- Doug presented the water treatment process for Fowler (Slide 44). Fowler is planning on well filtration and ion exchange to treat water from alluvial wells prior to chlorination then and distribution. Fowler relies on alluvial wells for water supply. There are two upgrade options (Slides 45 and 46) that include an additional well to meet the water demand.

- Doug presented the water treatment process for Rocky Ford (Slide 47). Rocky Ford treats its alluvial well supplies with chlorine and can use a conventional treatment plant to treat water from their surface water supplies. There are two options for water treatment plant upgrades (Slides 48 and 49) that include an additional well to meet the water demand.

- Doug presented the water treatment process for La Junta (Slides 50 through 52). La Junta has a dual treatment processes that splits flow between green sand filtration and Reverse Osmosis (RO) prior to blending. Their water source is alluvial wells. La Junta's water source is alluvial wells. An additional well is required to meet the regional water demands.

- Doug presented the water treatment process for Lamar (Slide 53). Lamar's water source is alluvial wells. They would have to expand their wellfield and chlorination system to meet the water demands of the regional system (Slides 54 and 55).

- Doug summarized the treatment capacities for each of the proposed regional water providers in each of the alternatives for which they are included (Slide 56). The line shown on some of the alternatives is the treatment capacity prior to redundancy.

Next Steps/Path Forward

- Jacqui Wesley reviewed the next steps for the project (Slides 58). CDM Smith will be documenting sections and sharing with the team as they are developed. The first draft will be provided in the next two weeks.

- The schedule for the upcoming meetings is:

  - Workshop #2 on June 26, 2019,
  - Workshop #3 on August 14, 2019,
  - Draft and Final Appraisal Study Report, and
  - Begin the Phase II Feasibility Studies.

- The next workshop will focus on the hydraulics and conveyance system modeling (Slide 59). Team will be looking at the model with AVC alignment and pipe diameters, verify hydraulic conditions (velocities and pressures) and identify modifications needed (resizing, different alignment, storages/pumping/etc.).

- Mark recapped the goals of the workshop (Slide 61) and the team agreed we had met each goal.

Meeting Adjourned at 1:30 p.m.

AGENDA

Workshop Agenda for Arkansas Valley Conduit Regionalization

Date: May23, 2019
Time: 10:00 am -2:00 pm
Location: CDM Smith Office (555 17th Street, Suite 500, Denver CO 80202)

Meeting Objectives:

- Confirm list of AVC participants to be included in the Regionalization Study and their status
- Verify the list of data sources used for the study and identify any missing sources
- Provide update on current CDPHE enforcement orders
- Obtain consensus on the alternatives to be evaluated in the appraisal study
- Summarize existing water treatment processes and upgrades at potential regional water providers

Mission Statement:

The objective of the study is to evaluate the feasibility and cost effectiveness of regionalization of infrastructure improvements that can be used to address CDPHE enforcement orders on an interim basis until full construction of the AVC, as opposed to development of individual water treatment systems for each community water system.

Time	Item
10:00 am	Introductions
10:10 am	Meeting Objectives and Mission Statement
10:30 am	Data Collection
10:45 pm	Regionalization Alternatives
12:00 pm	Lunch
12:30 pm	Water Treatment
1:30 pm	Path Forward / Next Steps
1:45 pm	Meeting Wrap up
2:00 pm	Adjourn

Meeting Notes

Arkansas Valley Conduit Regionalization Study
Appraisal Study - Workshop #2

Date: June 26, 2019
Time: 10:00 a.m. to 2:00 p.m.
Location: CDM Smith Office (555 17th Street, Suite 500, Denver, CO 80202)

Attendees:

Name	Organization
Braverman, Sam	U.S. Bureau of Reclamation, ECAO
Waechter, Christopher	U.S. Bureau of Reclamation, TSC
Barthel, Rodney	U.S. Bureau of Reclamation, TSC
Steen, Timothy	U.S. Bureau of Reclamation, TSC
Meador, Kevin	Southeastern Colorado Water Conservancy District
Woodka, Chris	Southeastern Colorado Water Conservancy District
Simpson, Hal	HD Simpson Consulting
Morea, Sue	CDM Smith
Wesley, Jacqueline	CDM Smith
McCluskey, Mark	CDM Smith
Miesen, Paniz	CDM Smith
Rubio, Diva	CDM Smith
Adamski, Alex	CDM Smith

Overview of agenda and meeting purpose

- Mark McCluskey welcomed the group and initiated introductions (Slide 1).
- Mark McCluskey recapped the mission for the study, stated the workshop #2 goals for the Arkansas Valley Conduit (AVC) Regionalization Study—and gave an overview of the agenda (Slides 2 to 4).
  - The team agreed with the workshop goals and agenda.
- Mark McCluskey asked Southeastern if there were any recent updates to AVC efforts.
  - Chris Woodka stated that there were a couple new developments related to AVC, including potential changes to the Radionuclides Rule and TENORM standards, as well as the initiation of the AVC Value Planning Study.
    - *Changes to Radionuclide standards anticipated to go into effect by 2020. CDM Smith team will further review potential regulatory changes and include in the final report.*

  - *Chris Woodka stated that coordination between this AVC Regionalization Study and the Value Planning Study is recommended. Sam Braverman is on the Value Planning team and will incorporate results from AVC Regionalization efforts into the Value Planning discussions.*

Introduction

- Mark went through the Appraisal Study goals and reviewed the overall criteria used to develop regionalization alternatives (Slide 6).

CDPHE Enforcement Orders

- Paniz Miesen provided an update on existing Colorado Department of Public Health and Environment (CDPHE) Enforcement Orders (Slides 8 and 9).

  - CDPHE confirmed that the Town of Swink is officially in compliance because they are receiving water from La Junta.

  - The Town of Fowler is currently in the observation period which generally takes 3-4 months. Once CDPHE confirms that the actions taken by Fowler have addressed their GUDI reclassification, their enforcement order will be officially removed. Fowler is anticipated to be in compliance again before 2020. For the purposes of this report, it will be assumed Fowler is not in compliance until CDPHE officially removes their enforcement order.

- Paniz summarized the criteria used to identify AVC participants with a high likelihood of future CDPHE Enforcement Orders (Slide 10). Systems identified as having a high likelihood of future enforcement are now included in Alternatives 2 and 3.

  - Chris Woodka raised concerns about the high likelihood of all participating systems, especially those connected to La Junta, having future water quality issues and enforcement orders. Sam Braverman stated that Alternative 1 would address that concern because all participating systems are included.

  - Chris Woodka will provide CDM Smith with a list of systems that have continued water quality issues so they can be further discussed in the report and highlighted in the alternatives maps.

Alternatives

- Paniz provided an overview of the updated regionalization alternatives based on feedback received during Workshop #1 (Slides 12).

- She walked the team through each of the three proposed regionalization alternatives and pointed out the specific changes made to each alternative based upon feedback during Workshop #1 (Slide 13-15). Changes include:

  - Alternative 1 - Las Animas has been added to the La Junta Regional System;

  - Alternative 2 – Addition of the three participating systems designated as having a high likelihood of future enforcement;

- Alternative 3 – Addition of the three participating systems designated as having a high likelihood of future enforcement.

- Chris Waechter raised concerns about the way the regional systems are named in the report and how they are different than the Project Work Statement which makes it difficult to follow.

  - After some discussion with the group, it was decided that as long as it is noted in the report correlating to the naming in the performance work statement was and how/why it has been changed, any naming system would be acceptable.

Water Rights Evaluation

- Mark McCluskey began the water rights discussion and presented the overall objective and basis for the water rights evaluation (Slide 17)

- Hal Simpson presented the assumptions that will be made for the water rights evaluations (Slide 18).

- Mark and Hal provided an overview of the water rights evaluation process and the steps that will be taken to evaluate each regional systems water rights plan (Slides 19 to 20).

  - Discussion amongst group about the water rights transfer process. Hal stated that initially, the water providers' existing supplies and water rights will be considered. If that alone is not enough to cover regional system demands, then additional water supply would be acquired and the existing Fry-Ark water rights from the participating systems would be transferred to the regional water provider. If the Fry-Ark reallocations still don't cover regional system demands, the transfer or purchase of additional water rights would be sought.

  - Chris Woodka confirmed that the transfer of Fry-Ark decrees between participants is a simple administrative process. The transfer or purchase of groundwater rights, however, is more complicated and would require revisions to the State Engineer approved Annual Replacement Plan and water court approvals.

- Mark wrapped up the water rights discussion by listing the results that will be included in the appraisal report (Slide 21).

<BREAK> Team took a break for lunch.

Hydraulic Modeling

- Jacqui Wesley presented the assumptions that were used to develop the hydraulic models for each regional system (Slide 23).

  - Tim Steen stated his concerns with the high roughness criteria that was set for the model (C≈145), particularly if the design incorporates steel pipe. Diva Rubio said it was the same value used for the AVC model, but Jacqui and Diva agreed that it seemed high. Tim said he would follow up with Reclamation personnel to review the basis of the roughness coefficient selected for the Feasibility design.

- Tim offered to help track down information about the water provider water tank elevations for Diva to include in the model. He also stated that the appendix of the Feasibility report has tank elevation information as well, but data is rough and needs to be confirmed with participants.

- Jacqui and Diva presented the preferred AVC alignment model and pointed out the pump station and tank locations (Slide 24).

- Jacqui briefly discussed the graphics and maps that will be presented for each of the regional hubs and explained how to interpret the model results.

- Diva Rubio presented the model results for each regional hub in Alternative 1 (Slides 27 to 50).

  - The St. Charles Mesa Water District regional system would require a 70ft elevated tank (energy equivalent) to meet the set minimum 20psi pressure criteria at each delivery location.

    - *Tim Steen mentioned that the 20psi criteria seemed a little high for locations along the pipeline between delivery points. Assumptions regarding minimum pressure along the pipeline and the minimum pressure at delivery points should be consistent with assumptions used in the Feasibility Design.*

  - The Crowley County Water Association regional system would require a 165ft elevated tank to meet the set minimum 20psi pressure criteria at each delivery location.

  - The Rocky Ford regional system would require a pumping station with a head of 300 ft to meet the minimum pressure criteria at each delivery location.

  - The La Junta regional system would require upsizing of 6 miles of pipeline from 14” to 22”, as well as a pump station at La Junta #2 with a head of 65 ft, to meet the minimum pressure criteria at each delivery location.

  - The Lamar regional system would require two separate pump stations and 2 different locations to meet the minimum pressure criteria at each delivery point.

    - *Sam Braverman stated that it would be better to use one pump station positioned where the water provider is to avoid potential land acquisition issues. Utilizing only one pump station at the water provider location will be added to the model assumptions by the CDM Smith team.*

- Diva presented the model results for each regional hub in Alternative 2 (Slides 53 to 72).

  - The Avondale regional system would require a 120ft elevated tank to meet the set minimum 20psi pressure criteria at Boone’s delivery location.

  - The Rocky Ford regional system would require 2 pump stations to meet the set minimum pressure at each delivery location.

- The La Junta regional system would require upsizing of 6 miles of pipeline from 14" to 22" to meet the set minimum pressure at each delivery point.

- The Lamar regional system would require one pump station and upsizing of ~2 miles of pipeline from 4-6" to 8" to meet the minimum pressure at each delivery location.

- Jacqui discussed the approach that will be taken for Alternative 3 and reviewed the updates that will be made modeling assumptions. The following assumptions were made for the pipeline alignment designs:

  - As per Tim's comment, further information on the basis for roughness criteria will be provided to the CDM Smith team to incorporate into the models, if needed.

  - As per Tim's comment, Tim will help try to find information on existing tank elevations and sizes for the CDM Smith team to incorporate into the models.

  - As per Sam's comment, preference should be given to using one large pump station at the water provider location rather than multiple smaller pump stations throughout the regional system, if possible. However, if system pressures and component costs get too high with limited pump stations, the idea to add additional pump stations may be re-visited.

  - Pipeline alignments for Alternative 3 may follow existing regional pipeline routes but it is assumed that all pipelines presented at the appraisal study level will be new pipeline. Known existing regional pipeline information (material type, alignment, size, etc.) will be called out in the appraisal study deliverable(s).

  - Further evaluation into the use of existing regional pipelines for AVC regionalization will be conducted during the Feasibility level study.

Water Treatment

- Mark McCluskey provided a brief update on the water treatment plant evaluations stating that information request packets have been sent to the regional water providers to confirm and update any data related to their water treatment plant processes (Slide 74).

  - A deadline of July 8th, 2019 was given to the water providers to respond to the information requests. Any updates will be incorporated into the final Appraisal Study Report.

    - *St. Charles Mesa Water District has already submitted a response providing additional information about their WTP processes.*

    - *Chris Woodka to follow up with providers if a response is not received by July 8th.*

Next Steps/Path Forward

- Mark McCluskey reviewed the next steps for the project (Slides 76). CDM Smith will be documenting sections and sharing with the team as they are developed. The second draft will be provided at least two weeks before Workshop #3.

- He went through the schedule for the upcoming meeting:

  - Workshop #3 on August 14, 2019,
  - Draft and Final Appraisal Study Report, and
  - Begin the Phase II Feasibility Studies.

- He noted the next workshop will focus on costing evaluations and cost share opportunities. The team will discuss the criteria that will be used to select a preferred alternative that will be further refined during the Feasibility Studies.

- Mark recapped the goals of the workshop (Slide 77). He went through the goals and the team agreed we had met all the goals of the meeting.

Meeting Adjourned at 1:00 p.m.

AGENDA

Workshop #2 Agenda for Arkansas Valley Conduit Regionalization

Date: June 26, 2019
Time: 10:00 am -2:00 pm
Location: CDM Smith Office (555 17th Street, Suite 500, Denver CO 80202)

Meeting Objectives:

- Provide a status update on the water rights evaluation for the proposed regional water providers ability to deliver water under an interim solution
- Provide update on current CDPHE enforcement orders
- Provide and obtain concurrence in the three regionalization alternatives refined based input from workshop #1
- Update team on data requests for existing water treatment processes and upgrades at potential regional water providers
- Provide an update on the hydraulic modeling of the alternatives

Mission Statement:

The objective of the study is to evaluate the feasibility and cost effectiveness of regionalization of infrastructure improvements that can be used to address CDPHE enforcement orders on an interim basis until full construction of the AVC, as opposed to development of individual water treatment systems for each community water system.

Time	Item
10:00 am	Introductions
10:10 am	Meeting Objectives and Mission Statement
10:20 am	CDPHE Enforcement Orders
10:30 am	Regionalization Alternatives Refinements and Water Treatment
10:50 am	Water Rights Evaluation
11:30 am	Lunch
12:00 pm	Hydraulic and Conveyance Modeling
1:30 pm	Path Forward / Next Steps
1:45 pm	Meeting Wrap up
2:00 pm	Adjourn

Meeting Notes - FINAL

Arkansas Valley Conduit Regionalization Study Appraisal Study – Workshop #3

Date: August 14, 2019
Time: 10:00 a.m. to 2:00 p.m.
Location: CDM Smith Office (555 17th Street, Suite 500, Denver, CO 80202)

Attendees:

Name	Organization
Braverman, Sam	U.S. Bureau of Reclamation
Waechter, Christopher	U.S. Bureau of Reclamation
Barthel, Rodney	U.S. Bureau of Reclamation
Steen, Timothy	U.S. Bureau of Reclamation
Meador, Kevin	Southeastern Colorado Water Conservancy District
Woodka, Chris	Southeastern Colorado Water Conservancy District
Simpson, Hal	HD Simpson Consulting
Morea, Sue	CDM Smith
Wesley, Jacqueline	CDM Smith
McCluskey, Mark	CDM Smith
Miesen, Paniz	CDM Smith
Rubio, Diva	CDM Smith
Tyler, Conor	CDM Smith

Overview of Agenda and Meeting Purpose

- Mark McCluskey welcomed the group and reviewed the workshop agenda (Slide 1).
- Mark recapped the mission for the study, stated the workshop #3 goals for the Arkansas Valley Conduit (AVC) Regionalization Study, and summarized the agenda (Slides 2 to 6).
  - The team agreed with the workshop goals and agenda.
- Rodney Barthel asked if there were any requests to change delivery locations when CDM Smith, Southeastern Colorado Water Conservancy District (SECWCD), and Reclamation conducted the site visits.
  - Jacqui responded that there were no requests by AVC participants at that time but there may be similar requests during feasibility level visits.
- Paniz reviewed the proposed AVC regionalization alternatives as they have been defined for the study (Slides 7 to 11).
- Rodney emphasized that Alternative 3 should not be based on the AVC alignment in the report. [1]
  - Jacqui noted this definition differs from what we have been developing for Alternative 3; thus, it would need to be revised to fully optimize alignment and pipe size.

[1] The direction for Alternative 3 was discussed further in a project team phone call on 8/29/2019. Alternative 3 will not be modified at this point in the project.

- The group discussed the differences between Alternatives 2 and 3.
    - *One difference was Rocky Ford versus Fowler as the regional provider.*
    - *Alternative 3 as it is defined followed AVC alignment where possible and alternative alignments where it would be more efficient.*
- Mark stated that because we have already performed the analysis for Alternative 3 using the previous definition, this may be a change in scope, requiring the addition of an alternative to the analysis. He will have to take a look at what would change the level of effort for each regional provider.

Water Treatment Data Request Update

- Mark provided a brief update on the water treatment plant data collection efforts.
    - Conor noted CDM Smith has incorporated all the data received to date, but we have not heard back from all the entities.
    - Chris Woodka said we could follow up on the remaining entities who have not yet responded.

Water Rights Update

- Hal Simpson provided an update on the AVC water rights evaluation.
    - Initially, began with the water rights summarized in the environmental impact statement (EIS), but upon initial review of the data it was realized the water rights information contained in the EIS was outdated.
    - Started by researching decrees via the State Engineers' website for each regional provider.
- General conclusions:
    - Some districts like St. Charles and Crowley County Water Users Association have defined service districts that would have to be revised if they became regional providers, and this would require court approval.
    - Decrees are so specific that they cannot operate without going to water court and revising decrees.
    - If a new well is needed, a new permit will require an augmentation plan.
    - Post-1985 will require an approval from water court:
        - *File for well permit*
        - *If a well permit is denied, then the applicant will need to go to water court with an augmentation plan*
    - Fry-Ark will be used to replace depletions (1:1 ratio); no Fry-Ark return flows.
    - There is approximately 58% transit loss of water when moved down to Lamar and; would need to work on establishing a storage account with John Martin Reservoir to reduce losses.
    - Avondale was calculating their withdrawals incorrectly, making it seem they were using more water than they were.
    - Water rights issues with Crowley, Fowler, and Avondale may result in a fatal flaw using them as a water provider. Details will be included in the report.

Hydraulic Modeling Update

- Diva Rubio provided an update on the hydraulics modeling for the study (Slide 14).
    - Reviewed assumptions used in the analysis (Slide 15).
    - Provided an update on provider tanks: only Fowler and La Junta currently have elevated tanks.

  - La Junta's tank may be situated at a lower elevation than currently depicted in the model; if so, this would require additional pumping to maintain the needed pressure.
- Diva reviewed the hydraulic modeling results for Alternative 1 (Slide 17).
  - Listed required modifications from AVC.
- Diva reviewed the hydraulics for Alternative 2 (Slide 19).
  - Listed required modifications from AVC.
- Diva reviewed the hydraulics for Alternative 3 (Slides 22 to 46).
  - Avondale pipeline alignment discussion:
    - *New pipeline used to go over the hill.*
    - *Based on discussion today, the 30-inch line will be reduced (potentially to 8 inches).*
- The group discussed the decision on pipe size versus pumping. The decision was to identify the lowest cost alternative.
  - Fowler
    - *CDM Smith will take a closer look at pipeline sizes to see if they can be reduced.*
    - *Fowler tank may be sufficient for pressure, but if not, a booster pump can be used to achieve minimum pressure requirement.*
    - *Pumps should preferably be located at the provider to avoid additional land acquisition costs, but in this case, a remote pump site may be more beneficial because there is only one connection that needs a minimal amount of added pressure.*
  - Rocky Ford
    - *Minimal increase at beginning is all that would be needed.*
    - *Size optimization may not be needed for this system.*
- The group discussed and agreed that Alternative 3 will be presented as an interim measure, not an AVC replacement. Providers would become distributors that use those regional pipelines to deliver AVC water.
  - La Junta: Pipelines for this regional provider are already optimized.
  - Lamar: Pipelines for this regional provider are already optimized.
- Mark asked if there were any questions about the hydraulics:
  - Tim Steen asked if we are considering the existing pipeline from La Junta going north under the river?
  - Sam Braverman noted we do not want to consider using existing pipelines.

Cost Estimating Approach

- Jacqui Wesley began the cost estimate approach portion of the workshop (Slide 47).
- Jacqui introduced the topics to be presented:
  - Kevin Meador asked if the feasibility study was also used as a costing source?
    - *Yes, the feasibility study was used.*
    - *Cost previously used was for April, but CDM Smith used June. The group agreed the June values should be used.*
- Conor Tyler discussed cost breakdowns and methodology (Slides 49 and 50).
- He reviewed the capital costs and unit prices used to develop the cost estimates.
  - Chris Waechter noted the performance work statement states costs will be projected to 2020 project costs.
    - *Group agreed leaving as June 2019 will be fine for the appraisal level.*
    - *Feasibility study can use 2020 project costs.*
- Conor described the Statewide Water Supply Initiative costing tool and reviewed the two categories of pipeline installation (1) installation in developed areas and (2) installation in undeveloped areas (Slide 51).
- Costs only include capital, no OM&R or contingency included in these costs:

    - Assumed La Junta's existing discharge methods would continue to be used and no change in cost was considered.
- Conor showed a figure of the Alternative 1 capital costs breakdown by regional provider and by infrastructure type (pipeline, tanks, treatment, and pumping stations (Slide 52).
- Conor also showed the information by infrastructure type for the total Alternative 1 costs (Slide 53). He noted about 83% of the capital costs are associated with pipelines.
- Kevin asked how much of the total costs are AVC and how much are not AVC and can the costs be broken out?
    - Jacqui stated this will be discussed further later in the presentation.
- Rodney suggested the appraisal level contingency for construction can be 25% instead of 30%; For terminology purposes and to match other Reclamation planning documents denote that field costs = opinion of probable construction cost; and field costs + non-contract costs = total project cost.
- Conor discussed cost of Alternative 1 compared to total AVC costs (Slide 55).
- Sam suggested a better way to show the cost comparison would be to show it in percentages rather that total cost in dollars.
- Chris Woodka stated the OM&R may be the determining factor for these small systems owing to their ability to run and maintain a regional system.
- Chris Waechter suggested we cost out system by year to see how prices would change over time. He asked how long regional systems can be operated before costs exceed the cost of the AVC. Then realized this is likely outside of the current scope.

Funding Opportunities

- Paniz Miesen went through the funding opportunities and mentioned there were two handouts with the list of grants and loans available (Slides 58 to 62).
- Chris noted there may be stipulations about partnerships that do not allow federal funding to cover specific parts of a cost share.
- Paniz also noted the opportunities may differ between private versus public water entities.
- SECWCD can potentially apply for these grants for the regional water providers.
- Paniz provided an overview of public-private partnerships (P3). She summarized the potential benefits and concerns associated with them (Slide 63).
- For the AVC, the group decided the focus on P3 would be better suited for the operations of consolidated systems not overall owner and operator of the regional system.

Summary

- The group discussed preparation of the draft report, in particular, how the alternatives will be evaluated to identify the alternative to recommend for the feasibility studies (Phase 2 of this project).
- Sam stated Reclamation would like to see a summary of each of the alternatives, which would include the pros/cons of each.
- After the discussion, it was decided that CDM Smith would present a summary of alternatives then Reclamation and its stakeholders will decide on the recommendations for the regional providers and which ones to move forward to the feasibility studies (Phase 2 of this study).[2]
- Chris Woodka asked which of the alternatives would meet the AVC purpose and need.

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[2] The direction for Appraisal Study recommendations was discussed further in a project team phone call on 8/29/2019. CDM Smith will provide recommendations based upon their third-party review of the alternatives and provide a matrix of the pros/cons of each alternative.

Next Steps

- Mark wrapped up the workshop by discussing the next steps:
  - Preparing and transmitting the next draft of the appraisal study
  - Preparing the final report
  - Identifying the four regional providers to include in Phase 2 feasibility studies.
- Mark reviewed the goals of workshop #3, stating we accomplished each of them.

Meeting Adjourned

AGENDA

Workshop #3 Agenda for Arkansas Valley Conduit Regionalization

Date: August 14, 2019
Time: 10:00 am -2:00 pm
Location: CDM Smith Office (555 17th Street, Suite 500, Denver CO 80202)

Meeting Objectives:

- Update team on data requests for existing water treatment processes and upgrades at potential regional water providers
- Update team on water rights evaluation for potential regional water providers
- Provide an update on the hydraulic modeling of the alternatives
- Provide an update on the cost estimates for the alternatives
- Provide an update on the funding opportunities

Mission Statement:

The objective of the study is to evaluate the feasibility and cost effectiveness of regionalization of infrastructure improvements that can be used to address CDPHE enforcement orders on an interim basis until full construction of the AVC, as opposed to development of individual water treatment systems for each community water system.

Time	Item
10:00 am	Introductions
10:05 am	Meeting Objectives and Mission Statement
10:10 am	Water Rights Update
10:30 am	Hydraulic and Conveyance Modeling
11:00 am	Cost Estimates
12:00 am	Lunch
12:30 pm	Funding opportunities
1:30 pm	Path Forward / Next Steps
1:45 pm	Meeting Wrap up
2:00 pm	Adjourn

Appendix C

Potential Grant and Loan Opportunities for AVC Participants

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State and Federal Grant Opportunities Available to AVC Participants

Funding Source	Agency	Available Funds	Required Match	Description	Planning	Design	Construction	Repair or Replacement	Operations	Outreach/ Trainings
Water Quality Planning Design and Engineering Grant	CDPHE	Max $10,000	20%	-To help disadvantaged communities[1] cover costs associated with State Revolving Fund (SRF) pre-application requirements -Service population of 10,000 or less -Project must be on current or subsequent year's project eligibility list -Applicant must be a government entity	X					
Small Communities Water and Wastewater Grants	CDPHE			-Serve max population of 5,000 -Protection of public health and water quality -Public water systems or domestic wastewater treatment works ***It is not anticipated that this grant will be funded for the forseeable future***	X	X		X		
Water Quality Small Systems Training and Technical Assistance (SSTTA) Grants	CDPHE	Max $20,000		-Communities under 10,000 and median household income (MHI) under 80% of Colorado or if current/post project water rates ≥ state average -Project must be on the Drinking Water Revolving Fund Project Eligibility List (Appendix A of the Colorado Drinking Water Revolving FUnd Intended Use Plan); Borrows can add projects to the list by completing an eligibility survey in June of each year	X	X				X
Water Infrastructure Improvements for the Nation Act (WIIN) Grants	USEPA	$839,000 for entire state	45% Cost Share Requirement	-Small (<10,000) OR disadvantaged communities, as defined by the Safe Drinking Water Act (SDWA) -Bring public drinking water systems into compliance with SDWA -Conduct household water quality testing -States submit list of eligible projects to recieve funding			X	X	X	
Solid Waste Management Grants	USDA			-Evaluate current landfill conditions to identify threats to water resources -Towns with population ≤ 10,000 with special consideration for those with <5,500 and <2,500 and lower-income populations	X					X
Water and Waste Disposal Grants for Health Risks to Tribal Lands	USDA			-Areas facing significant health risks due to lack of adequate water access -State and local governments may apply, as well as nonprofits, and federally recognized tribes -Eligible for federally recognized tribal lands, areas not located in a Colonia that meet per capita income and unemployment rate requirements, and towns with population <10,000 -To be used for construction of basic drinking water and waste disposal systems, including storm drainage -Utility districts may be able to provide grants to individual households to install indoor plumbing and connect to the system			X			

State and Federal Grant Opportunities Available to AVC Participants

Funding Source	Agency	Available Funds	Required Match	Description	Planning	Design	Construction	Repair or Replacement	Operations	Outreach/ Trainings
Water and Waste Disposal Technical Assistance and Training Grants	USDA			-May be used to identify and evaluate solutions to water problems related to source, storage, treatment, distribution, collection, treatment, and disposal; provide technical assistance and training to improve management, operations and maintenance of water, and waste disposal systems; and prepare water and waste disposal loan and grant applications -Towns with population < 10,000 and tribal lands -Nonprofits are eligible to apply -Project period is one year between Oct 1 and Sept 30 -Reimbursement grant	X			X		
Circuit Rider Program	USDA			-Technical assistance to rural systems for day-to-day operational, financial, or managerial issues -Check website for address eligibility	X				X	X
Special Evaluation Assistance for Rural Communities and Households (SEARCH)	USDA			-State and local governmental entities, nonprofits, & federally recognized tribes -Requires median household income of < 80% of the statewide non-metro household income AND population of ≤ 2,500 -To be used for predevelopment planning cost related to improving rural water infrastructure i.e. feasibility studies, preliminary design and engineering analysis, technical assistance for the development of an application for financial assistance -Predevelopment planning costs must be related to a proposed project that will improve rural water facilities; construct or relocate public buildings, roads, etc. for the successful operation or protection of facilities; or relocate private buildings, roads, etc. for the successful operation or protection of facilities	X	X				
Water Plan Grants	CWCB	$10 Million ($50,000 - $500,000 for individual project)	50%*	-Next application deadline is Feb 1, 2020 -Purpose of funding is to make progress on critical action items in Colorado's Water Plan -Priority given to projects with earlier start date -$3.75 million to facilitate the development of additional storage, artificial recharge into aquifers, and dredging existing reservoirs to restore the reservoirs' full decreed storage capacity for multi-beneficial projects and those projects identified in basin implementation plans to address the water supply and demand gap -$1.75 million to implement long-term strategies for conservation, land use, and drought planning. -$500,000 for water education, outreach, and innovation efforts. -$2.25 million for environmental and recreational projects. -$1.75 million to provide technical assistance, project, or program funding for agricultural projects.	X	X		X		X

State and Federal Grant Opportunities Available to AVC Participants

Funding Source	Agency	Available Funds	Required Match	Description	Planning	Design	Construction	Repair or Replacement	Operations	Outreach/ Trainings
Water Efficiency Grant Program (Planning)	CWCB		25%	-To assist in developing water conservation plans -Require water conservation plans to qualify for water project funding under Board and Colorado Water Resources and Power Authority (CWRPA) programs -Desire to improve, update and/or create water conservation plans -Requests less than $50,000: May be submitted any time throughout the year -Requests of $50,000 or more: Must be submitted by the first of the month prior to a bi-monthly Board meeting	X					X
Water Efficiency Grant Program (Implementation)	CWCB		25%	-To aid in implementing water conservation plan goals and programs -Covered entities and smaller water providers who currently have a CWCB-approved water conservation plan are eligible -Must have an approved water conservation plan on file with the state and must comply with requisite plan elements -Requests less than $50,000: May be submitted any time throughout the year -Requests of $50,000 or more: Must be submitted by the first of the month prior to a bi-monthly Board meeting		X	X	X		
Water Efficiency Grant Program (Drought Management)	CWCB		25%	-May be used to assist in developing drought mitigation and response plans, offset staff and other internal costs associated with plan devleopment, or engage technical assistance of a water conservation professional or consultant to aid in development of a drought mitigation plan -Requests less than $50,000: May be submitted any time throughout the year -Requests of $50,000 or more: Must be submitted by the first of the month prior to a bi-monthly Board meeting	X					
Water Efficiency Grant Program (Conservation, Public Education, Outreach)	CWCB		25%	-To be used for outreach and/or education programs aimed at demonstrating the benefits of water conservation -Public or private agency may apply whose primary purpose includes the promotion of water resource conservation -Requests less than $50,000: May be submitted any time throughout the year -Requests of $50,000 or more: Must be submitted by the first of the month prior to a bi-monthly Board meeting						X

State and Federal Grant Opportunities Available to AVC Participants

Funding Source	Agency	Available Funds	Required Match	Description	Planning	Design	Construction	Repair or Replacement	Operations	Outreach/ Trainings
Alternative Agricultural Water Transfer Methods Grants	CWCB	$619,373	10%	-Projects that further the agriculture viability goals of Colorado's Water Plan and provide usable and transferable information -Purpose is to assist in developing and implementing creative alternatives to the traditional purchase and transfer of agricultural water -Should fund projects that build upon work performed in past funding cycles -Any public entity that can contract with the state and establish and document the need for the project is eligible to apply for funds	X					
Rural Economic Development Initiative (Planning)	DOLA	$100,000		-Provide Local Government Economic Planning Grants that will help diversify the local economy, e.g. strategic plans, engineering plans, land use feasibility, and/or marketing studies -Counties with less than 50,000 people, and from communities with fewer than 20,000 -Project should strengthen the community and economic diversification	X	X				
Rural Economic Development Initiative (Infrastructure for economic diversification)	DOLA	$500,000		-Provide infrastructure grants such as facility expansion -Counties with less than 50,000 people, and from communities with fewer than 20,000 -Project should strengthen the community and economic diversification			X			
Rural Economic Development Initiative (Support for rural entrepreneurial)	DOLA			-Provides grants that support the growth and development of rural entrepreneurial eco-systems and that support entrepreneurship, leverage private investment, or public/private partnerships, e.g. innovation centers, co-working spaces, maker-spaces, business expansion and scaling up -Counties with less than 50,000 people, and from communities with fewer than 20,000 -Project should strengthen the community and economic diversification	X	X	X	X		X
The Water Research Foundation (WERF) (Research Priority Program)	WERF			-Provides funding for research focused on discrete, high-priority problems to be solved -Requires Co-funding -Projects are selected through a proposal process	X	X				
The Water Research Foundation (WERF) (Emerging Opportunities Program)	WERF			-Provides funding for research for time-critical issues -Requires Co-funding -Projects are selected through a proposal process	X	X				
The Water Research Foundation (WERF) (Tailored Collaboration Program)	WERF	$100,000	100%	-Provides funding for research for local or regional concerns and that address innovative ideas or expand upon existing research to determine application potential at a utility -Projects are selected through a proposal process	X	X				
The Water Research Foundation (WERF) (Unsolicitaed Research Program)	WERF			-Pre-proposals may be accepted for research on drinking water, wastewater, recycled water, stormwater, and other sources of water addressing water quality, nutrients, energy, reuse, and biosolids	X	X				
WateReuse (Principal Program)	WateReuse		25%	-Projects are competitively bid through a Request for Proposals process	X	X				

State and Federal Grant Opportunities Available to AVC Participants

Funding Source	Agency	Available Funds	Required Match	Description	Planning	Design	Construction	Repair or Replacement	Operations	Outreach/ Trainings
WateReuse (Tailored Collaboration Program)	WateReuse	$100,000 - $150,000	50%	-Projects are competitively bid through a a two-step process -Only members to the WateReuse Research Foundation are eligible to participate -Projects can address local and regional issues but are broadly applicable to the reuse community	X					
WateReuse (Partnership Program)	WateReuse		50%	-Projects are competitively bid through Requests for Proposals -Develops projects collaboratively with organizations that are not members of WateReuse; may be federal, state and local government agencies, or nonprofits -Projects are managed by either WateReuse or partner organization	X					
WateReuse (One Water Innovation Program)	WateReuse	$1 Million	50%	-Projects are competitively bid through a a two-step process -For research that furthers the concept that all water is usable and should be treated to safely use it for its designated purpose	X					

[1]Defining Disadvantaged Communities for SRF Funding

*Other CWCB funds may be used for plans and studies, but the total CWCB funding shall not exceed 75% of the total cost. No more than half of the match may be in the form of in-kind services

Loan Opportunities Available to AVC Participants

Funding Source	Agency	Available Funds	Required Match	Interest Rate	Description	Planning	Design	Construction	Repair or Replacement	Operations	Outreach/ Trainings
Colorado State Revolving Fund Loans	CDPHE, DOLA, CWRPDA	Direct loans for projects up to $3 million Leveraged loans for governmental entity projects >$3million		0-6% 20-year term	-Finances design and construction of Colorado water and water pollution control infrastructure -Eligibility dependent on inclusion in annual Intended Use Plans (IUP); Entity should request inclusion	X	X	X	X		
Clean Water State Revolving Fund	USEPA		20% by the State	0%-market rate 30-year term	-Provides funds to construct municipal wastewater facilities; control nonpoint sources of pollution; build decentralized wastewater treatment systems; create green infrastructure projects; protect estuaries; and fund other water quality projects -Provides low-interest loans to states to protect public health, protect valuable aquatic resources, and meet environmental standards			X	X		
Drinking Water State Revolving Fund	USEPA		20% by the State	0%-market rate 30-year term	-Provides funds to improve drinking water treatment, fix leaky or old pipes (water distribution), improve source of water supply, replace or construct finished water storage tanks, or other infrastructure projects needed to protect public health			X	X		
Water and Waste Disposal Loan & Grant Program	USDA			Based on median household income of area served 40-year repayment period	-Towns with population < 10,000 and tribal lands -To be used for acquisition, construction or improvement of: Drinking water sourcing, treatment, storage and distribution -May also be used for legal and engineering fees; land acquisition, water and land rights, permits and equipment; start-up operations and maintenance; interest incurred during construction; purchase of facilities to improve service or prevent loss of service -State and local government entities may apply, as well as private nonprofits and federally recognized tribes -Up to 40-year payback period; fixed interest			X	X		

Loan Opportunities Available to AVC Participants

Funding Source	Agency	Available Funds	Required Match	Interest Rate	Description	Planning	Design	Construction	Repair or Replacement	Operations	Outreach/ Trainings
Water Infrastructure Finance and Innovation Act (WIFIA)	USEPA		51% from SRF Loans and other sources	Equal to or greater than the U.S. Treasury Rate of a similar maturity	-Eligible borrowers include local, state, tribal, and federal government entities; partnerships and joint ventures; corporations and trusts; Clean Water and Drinking Water State Revolving Fund (SRF) programs -Can fund development and implementation activities for projects that are eligible for Clean Water and Drinking Water State Revloving Funds; enhanced energy efficiency projects at drinking water and wastewater facilities; brackish or seawater desalination, aquifer recharge, alternative water supply, and water recycling projects; drought prevention, reduction, or mitigation projects; acquisition of property -Coordination with State Revolving Fund to provide subsidized financing for large dollar-value projects -$20 million: Minimum project size for large communities. -$5 million: Minimum project size for small communities (population of 25,000 or less) -49%: Maximum portion of eligible project costs that WIFIA can fund -Total federal assistance may not exceed 80% of a project's eligible costs	X	X	X	X		
Water and Waste Disposal Loan Guarantees	USDA			40-year repayment period	-Assists private lenders in providing affordable financing to qualified borrowers to improve access to clean, reliable water and waste disposal systems for households and buisinesses in rural areas -Eligible borrowers include state and local government entities, nonprofit organizations, and federally-recognized tribes -Rural areas with population <10,000 -Funds may be used to construct or improve facilities for drinking water, sanitary sewers, solid waste disposal, and storm water disposal facilities -Some funds may be used for legal and engineering fees, land acquisition and equipment, start-up operations and maintenance, capitalized interest		X	X	X		
Water and Waste Disposal Revolving Loan Funds	USDA	$100,000	20% (2019)	10-year repayment period	-Helps qualified nonprofits create revolving loan funds that can provide financing to extend and improve water and waste disposal systems in rural areas -Revolving loan fund may be used for pre-development costs for water and wastewater treatment projects or for short-term capital improvement projects that are not part of the regular operations and maintenance -The interest rate is determined by utility district borrower nonprofit that manages the revolving loan fund -Rural areas and towns of < 10,000 or Tribal lands	X	X				

Loan Opportunities Available to AVC Participants

Funding Source	Agency	Available Funds	Required Match	Interest Rate	Description	Planning	Design	Construction	Repair or Replacement	Operations	Outreach/ Trainings
Environmental Infrastructure Loans (Short-Term)	Rural Community Assistance Corporation (RCAC)	Varies		Up to 3 year repayment period 5.25-5.5%	-To finance water, wastewater, solid waste, and storm water facilities that primarily serve lower-income rural communities -Provides early funds to determine project feasibility and to pay pre-development costs prior to receiving state and federal funding -Applicants must agree to provide green components or features as part of the project -Rural areas with populations of 50,000 or less -Eligible entities include nonprofits, government agencies, and tirbal governments	X	X				
Environmental Infrastructure Loans (Intermediate Term)	Rural Community Assistance Corporation (RCAC)	$100,000		Up to 20 year repayment period 5%	-To finance water, wastewater, solid waste, and storm water facilities that primarily serve lower-income rural communities -Provides funding for smaller capital improvement progects -Rural areas with populations of 50,000 or less -Eligible entities include nonprofits, government agencies, and tirbal governments			X	X		
Environmental Infrastructure Loans (Long-Term)	Rural Community Assistance Corporation (RCAC)	$6 Million		Up to 40 year repayment period Interest rates vary by term	-To finance water, wastewater, solid waste, and storm water facilities that primarily serve lower-income rural communities -Provides funding for large capital improvement projects -Rural areas with populations of 50,000 or less -Eligible entities include nonprofits, government agencies, and tirbal governments			X	X		
Community Facilities Loan	RCAC	Up to $6 Million		Up to 30 year repayment period Interest rate varies by term	-To help develop and improve essential community facilities -Short-term loans for early property acquisition and predevelopment costs, iterim construction costs, and long-term permanent financing -Priority is given to loan applications that incorporate significant green methods and materials -Rural areas with populations of 50,000 or less -Eligible entities include nonprofits, government agencies, and tirbal governments -Must meet USDA Community Facilities or Business and Industry Guaranteed Loan Program requirements	X		X	X		

Loan Opportunities Available to AVC Participants

Funding Source	Agency	Available Funds	Required Match	Interest Rate	Description	Planning	Design	Construction	Repair or Replacement	Operations	Outreach/ Trainings
Water Project Loan Program	CWCB	$100,000 Minimum		Low Income: 2.15% Middle Income: 2.45% High Income: 2.75% 30-year repayment period	-Low-interest loans to agricultural, municipal, and commercial borrowers for the design and construction of raw water projects -Eligible projects include new construction and rehabilitation of existing raw water storage and delivery facilities -Project sponsor must show that the project is technically, economically, institutionally and financially feasible		X	X	X		
Rural Water Loan Fund	National Rural Water Association (NRWA)	$100,000 Maximum or 75% of project cost (whichever is less)		3% (2019) 10-year repayment period	-Provides low-cost loans for short-term repair costs, small capital projects, or pre-development costs associated with larger projects -Eligible projects include pre-development (planning) costs for infrastructure projects; replacement equipment, system upgrades, maintenance and small capital projects; energy efficiency projects to lower costs and improve system sustainability; and disaster recover or other emergency loans -Systems must be public entities serving up to 10,000 persons, or in rural areas with no population limits	X			X		