RECLAMATION

Managing Water in the West

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Predecisional

Technical Memorandum No. PUB-8140-APP-2012-01
Volume 1 – Appraisal Design Report and Appendices A-O

Arkansas Valley Conduit

Fryingpan-Arkansas Project, Colorado
Great Plains Region

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U.S. Department of the Interior
Bureau of Reclamation

August 2012

Mission Statements

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

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

Cover photo: Photo looking upstream at Pueblo Dam. Fish hatchery is in foreground, and Fountain Valley Authority Pump Station is at right.

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Denver, Colorado

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Arkansas Valley Conduit Appraisal Design Report

Fryingpan-Arkansas Project, Colorado
Great Plains Region

This Appraisal Design Report was prepared by the U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, Denver, Colorado.

Steven Robertson P.E. 8/7/12

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Abbreviations and Acronyms

ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
AVC	Arkansas Valley Conduit
AWWA	American Water Works Association
BHE	Black Hills Energy
BWWP	Board of Water Works of Pueblo, Colorado
CCL	Contaminant Candidate List
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
Cl_2	free chlorine
CLSM	controlled low strength material
CPDWR	Colorado Primary Drinking Water Regulations
CR	county road
CT	concentration multiplied by time
CWCB	Colorado Water Conservation Board
DBE	design basis earthquake
DBP	disinfection byproduct
DCB	disinfection contact basin
D/DBPR	disinfectants and disinfection byproducts rule
DEC	Design, Engineering, and Construction
ECAO	Eastern Colorado Area Office
EIS	Environmental Impact Statement
El.	elevation
EPA	United States Environmental Protection Agency
Fry-Ark Project	Fryingpan-Arkansas Project
ft^3/s	cubic feet per second
ft/s	feet per second
GAC	granular activated carbon
gal/min	gallons per minute
$gal/min/ft^2$	gallons per minute per square foot
GIS	Geographic Information Systems
HAA5	five haloacetic acids
HARP	Historic Arkansas Riverwalk of Pueblo
HDD	horizontal directional drilling
HHS	Health and Human Services
HID	High Intensity Discharge
I-25	Interstate 25
IBC	International Building Code
IEEE	Institute of Electrical and Electronics Engineers
IGCE	Independent Government Cost Estimate
JUM	joint use manifold
JUP	joint use pipeline
kW	kilowatts
kWh	kilowatthours

lb/in^2	pounds per square inch
LLRW	low level radioactive waste
L/mg/m	liters per milligram per meter
LRAA	locational running annual average
m	meters
m^3/s	cubic meters per second
MCE	maximum considered earthquake
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
Mgal	million gallons
mgd	million gallons per day
mg/L	milligrams per liter
min	minutes
MSWLF	Municipal Solid Waste Landfill
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NDMA	N-Nitrosodimethylamine
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NOW	north outlet works
NRC	Nuclear Regulatory Commission
NTP	notice to proceed
NTU	nephelometric turbidity units
O&M	operation and maintenance
OM&R	operation, maintenance, and replacement
PAC	powdered activated carbon
pCi/g	average picocuries per gram
PHA	peak horizontal ground acceleration
PreVal	Prevalidation of Funds Cost Estimate
PRV	pressure reducing valve
PSHA	Probabilistic Seismic Hazard Analysis
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
Reclamation	Bureau of Reclamation
RSA	Response Spectrum Analysis
RTCR	Revised Total Coliform Rule
RTU	remote terminal units
SCADA	supervisory control and data acquisition
SDS	Southern Delivery System
SDWA	Safe Drinking Water Act
SEI	Structural Engineering Institute
Southeastern	Southeastern Colorado Water Conservancy District
SOW	south outlet works
STAG	State and Tribal Assistance Grant
s.u.	standard units
SUVA	Specific Ultraviolet Light Absorbance

TCR	Total Coliform Rule
TDH	total dynamic head
TDS	total dissolved solids
TEFC	totally enclosed, fan-cooled
TENORM	Technologically Enhanced Naturally Occurring Radioactive Material
TOC	total organic carbon
TT	treatment technique
TTHM	total trihalomethanes
TSC	Technical Service Center
µg/L	micrograms per liter
USGS	U.S. Geological Survey
UV	ultraviolet light
VOIP	Voice Over Internet Protocol
WQCD	Water Quality Control Division
WTP	water treatment plant

Conversions

1 cubic foot per second = 0.646 million gallons per day
1 million gallons per day = 1.547 cubic feet per second
1 acre-foot = 325,851 gallons
1 million gallons per day = 1,120 acre-feet per year
1 cubic foot per second = 1.98 acre-feet per day
1 pound per square inch = 2.31 feet of water elevation head
1 cubic meter per second = 35.29 cubic feet per second

Executive Summary

The purpose of the proposed Arkansas Valley Conduit (AVC) is to deliver a bulk water supply pipeline to meet existing and future municipal and industrial water demands of the AVC participants. A small number of industrial livestock operations are customers of the AVC participants and would also be served by the project. The AVC would include construction of buried pipelines, a water treatment plant (WTP), water storage tanks, regulating tanks, pumping plants, valve vaults, meter vaults, participant deliveries (tie-ins), and other related facilities.

The study area for the AVC appraisal level design includes participating entities located in six Colorado counties in the Lower Arkansas River Basin: Pueblo, Crowley, Otero, Bent, Prowers, and Kiowa. Generally, the AVC route is from Pueblo Reservoir to Lamar, Colorado, with several spurs to provide water to participant delivery tie-in points located along the route.

Congress approved the AVC as part of the original authorizing legislation for the Fryingpan-Arkansas (Fry-Ark) Project in 1962 (Public Law 87-590). However, it was not constructed with the original project, primarily because the project beneficiaries were unable to repay the costs of construction. In 2009, Congress amended the original Fry-Ark authorization in Public Law 111-11, which authorized annual appropriations as necessary for construction of the AVC and included a cost sharing plan with 65-percent Federal funding and 35-percent local funding.

The U.S. Department of the Interior, Bureau of Reclamation (Reclamation) is the lead agency for this Federal action. Reclamation owns, operates, and maintains the Fry-Ark Project. Reclamation is responsible for preparing this Appraisal Design Report; the Long-Term Excess Capacity Master Contract, Fryingpan-Arkansas Project, draft Environmental Impact Statement (EIS); and a Record of Decision. Reclamation would be responsible for constructing the AVC.

Southeastern Colorado Water Conservancy District (Southeastern) is a cooperating agency and plays an administrative role, including securing grants and loans for local funding, supporting legislation, and working with project beneficiaries. Southeastern was formed in 1958 for developing, administering, and repaying the Fry-Ark Project. Its Colorado boundaries extend along the Arkansas River from Buena Vista to Lamar, and along Fountain Creek from Colorado Springs to Pueblo. Forty water providers have signed a Memorandum of Agreement with Southeastern to participate in the AVC. The AVC would not serve all water supply providers or users within Southeastern's boundaries; only those entities participating in the AVC. Refer to figure 1 in chapter 1 for a map of AVC participants.

This Appraisal Design Report, which has more detailed data than would generally be provided within an appraisal level document, was built upon readily available data and information from: (1) preliminary phase activity and preparation of a report funded by a Pre-National Environmental Policy Act (NEPA) State and Tribal Assistance Grant (STAG) from the U.S. Environmental Protection Agency (STAG Final Report, 2010a), and (2) modified information based on the particular alternatives developed in this Appraisal Design Report and other information collected since the STAG Final Report. The overall purpose of the work under the STAG was to prepare for the NEPA process, gather data, and conduct the evaluation necessary to allow the process to begin. The Appraisal Level Design Report will allow for comparison of alternative features, engineering, and costs. The action alternatives have components which can be interchanged to develop a preferred alternative. This Appraisal Design Report will provide the EIS team with a consistent level of information, including study corridors and cost estimates, for each of the five AVC EIS Action Alternatives prior to conducting planned feasibility level designs. Action alternative cost estimates were prepared for use in planning, evaluating, and comparing alternatives and their features; to aid in selecting a preferred alternative through the EIS process by comparing features in each alternative; and to determine if more detailed investigations of this project are justified. Appraisal level cost estimates are not suitable for requesting project authorization or construction fund appropriations from Congress due to the early stages of project development and the availability of limited design data.

An appraisal level planning and construction schedule that includes the planned feasibility design, final designs, and construction phases for the AVC project was prepared. The schedule was separated into six separate final design packages and six construction contracts ranging in size to accommodate various contracting procurement methods and a range of contractors. As the project progresses, and as details of required water deliveries and fiscal appropriations become known, these contract packages may be revised accordingly. The overall timeframe developed and shown in the schedule (see appendix K) to accomplish the work was not constrained by potential congressional fiscal appropriations and depicts completing the entire project by May 2022.

The overall purpose of this Appraisal Design Report is to perform engineering support for the NEPA process, gather data, conduct the evaluations necessary to the NEPA process, and complete the Reclamation Appraisal Study. The Appraisal Design Report may be inserted as an appendix in the AVC Draft EIS. The Appraisal Design Report identifies technically feasible construction action alternatives along with cost estimates. These action alternatives and estimates are used in the decision process to identify the preferred alternative. The Appraisal

Design Report will be a stepping stone in the planning process into the feasibility level design using the preferred alternative as a design basis.

The appraisal level design used information from questionnaires collected during the STAG Final Report planning phase and other information collected since the STAG Final Report. The goal of the questionnaires was to collect quantifiable water data related to supplies, demands, treatment, and quality; and to collect qualitative data related to system operations and planning.

The estimate of AVC water demands is based on the analysis of demands from the Colorado Water Conservation Board and the demands obtained from participant questionnaires. The maximum day demands to be used for the AVC, approximately 20 million gallons per day (mgd) (19.78 mgd), were estimated to provide a basis for performing hydraulic calculations to determine appraisal level estimates of AVC costs.

Construction of an Interconnect between the existing south outlet works (SOW) and north outlet works (NOW) downstream of Pueblo Dam was evaluated. The purpose of the Interconnect is to take water from either the NOW or the SOW without loss of service. The Interconnect would be used during intra-day to multi-day outages that occur due to emergencies and routine maintenance activities, as well as longer multiple week outages for occasional substantial maintenance activities. Maintenance activities could include maintenance or replacement of outlet works valves, meters, piping, and other dam related facilities by Reclamation. The Interconnect would provide this alternative outlet flexibility to the other water providers as well. At this time, it is difficult to determine the frequency of these outages. Allocation of the Interconnect capacity would be addressed in a future Interconnect contract.

The AVC presented in this Appraisal Design Report is composed of five AVC EIS Action Alternatives. Generally speaking, there are two conduit routes for the AVC EIS Action Alternatives: one south and one north of the Arkansas River. There are generally three options to traverse through or around the City of Pueblo. There are two distinct, direct water source diversion sites: Pueblo Reservoir and Arkansas River upstream of Fountain Creek. There are five optional water treatment sites, which directly influence the requirement for various pumping plants. Two general sites are proposed for on-line storage tanks, located in the Fowler and La Junta community areas. Maps of each alternative are included in appendix A. A brief description of the five AVC EIS Action Alternatives is as follows:

Alternative 1 (Comanche South) - This alternative would generally follow the existing Comanche Power Plant Raw Water Line route west and south of the City of Pueblo and then follow U.S. Highway 50 south of the Arkansas River from Pueblo to Lamar. Three primary spurs under this alternative are the Highway 96 spur, the Eads spur, and the spur loop from Rocky Ford northeast along Highway 266 and then back south to La Junta. A high lift pumping plant, located near the base of the dam, would be required to raise the water over high ground. A booster pumping plant, located north of U.S. Highway 50 along county road (CR) 34, would be required for the Eads spur. This alternative would require a new regulating tank located south of Pueblo, water storage tanks located south of Fowler, and water storage tank located east of La Junta. A new WTP, located east of St. Charles Mesa, would be provided, and the pipeline would convey filtered and disinfected (potable) water to AVC participants. This alternative would include an Interconnect between the NOW and the SOW at Pueblo Reservoir.

Alternative 2 (Pueblo Dam South) - This alternative is described as a south route because the route generally follows U.S. Highway 50 from Pueblo to Lamar. Three primary spurs under this alternative are the Highway 96 spur, the Eads spur, and the spur loop from Rocky Ford northeast along Highway 266 and then south to La Junta. This alternative would begin at Pueblo Reservoir. It would require a new WTP located near the intersection of South Road and 21st Street, water storage tanks located south of Fowler, and water storage tanks located east of La Junta. The WTP would provide filtered water to the AVC participants. This is the only alternative that would not require a main pumping plant; however, it would require a booster pumping plant north of U.S. Highway 50 along CR 34, for the Eads spur. This alternative would not include an Interconnect between the NOW and the SOW at Pueblo Reservoir.

Alternative 3 (Joint Use Pipeline North) - This alternative would generally use a northern alignment through and downstream of the City of Pueblo. Pueblo Reservoir water would be diverted from the existing Joint Use Pipeline ―wye” immediately west of Pueblo Boulevard. Water would be filtered at a new WTP, or alternatively at the existing Whitlock WTP, and delivered through the City of Pueblo in a pipeline route that would generally follow 11th/14th/13th Streets through Pueblo. The pipeline would then follow the north alignment east of Pueblo along U.S. Highway 50 and north of the Arkansas River to Lamar. This alternative would require a new regulating tank east of Interstate 25, water storage tanks located north of Fowler, and water storage tanks located North of La Junta. A main pumping plant would be required after the Whitlock WTP to lift the water out of Pueblo and into the storage tank north of Fowler. The three primary spurs under this alternative are the Highway 96 spur, the Eads spur, and the spur loop from Manzanola southeast along U.S. Highway 50 to La Junta and north along Highway 109 to rejoin the AVC. A booster pumping plant, located north of U.S. Highway 50 along CR 34, would be required for the Eads spur. This alternative would include an Interconnect between the NOW and the SOW at Pueblo Reservoir.

Alternative 4 (Pueblo Dam North) - This alternative would require a new WTP located below Pueblo Dam. The WTP would provide filtered water. A low lift pumping plant would be required to ensure water supply from low reservoir water levels to the WTP. A second pumping plant, low lift, would be required to raise the water over high ground on the east edge of the Pueblo route. The AVC would use a parallel conduit along the north side of the existing Board of Water Works of Pueblo raw water pipeline from Pueblo Reservoir and bypass the existing Whitlock WTP, and follow 11th/14th/13th Streets through Pueblo. The pipeline would then follow the north alignment east of Pueblo along U.S. Highway 50 and north of the Arkansas River to Lamar. This alternative would require a new regulating tank east of Interstate 25, water storage tanks north of Fowler, and water storage tank north of La Junta. The three primary spurs under this alternative are the Highway 96 spur, the Eads spur, and the spur loop from Manzanola southeast along U.S. Highway 50 to La Junta and north along Highway 109 to rejoin the AVC. A booster pumping plant, located north of U.S. Highway 50 along CR 34, would be required for the Eads spur. This alternative would include an Interconnect between the NOW and the SOW at Pueblo Reservoir.

Alternative 5 (River South) - This alternative would divert Pueblo Reservoir water releases from the Arkansas River upstream of the Fountain Creek confluence. The pipeline would follow the south alignment east of Pueblo along U.S. Highway 50 to Rocky Ford, then route north of the Arkansas River to Lamar. This alternative would require a riverside pumping plant to lift the water to the new WTP located near the existing St. Charles Mesa WTP site. The WTP would provide potable and disinfected water. This alternative would require a new regulating tank located east of the WTP, water storage tanks located north of Fowler, and water storage tanks located north of La Junta. The three primary spurs under this alternative are the Highway 96 spur, the Eads spur, and the spur loop from Rocky Ford south along Highway 71 to Highway 10, then east to La Junta and north along Highway 109 to rejoin the AVC. A booster pumping plant, located north of U.S. Highway 50 along CR 34, would be required for the Eads spur. The alternative would not include an Interconnect because it would not provide redundancy for AVC since releases would be made to the river.

Environmental impact considerations, along with direct and indirect construction and operational costs of the various project components of the five alternatives, can be –mixed and matched” to possibly arrive at a separate –preferred alternative.”

The Technical Service Center was directed to include a cursory review and investigation of hydroelectric generation potential and possible facility site locations along the AVC during the preparation of this Appraisal Design Report. Each alternative possesses slightly differing amounts of energy availability. The available flow and pipe head varies throughout the year. As the flow increases with increased demand in the summer, the available head is decreased. Additional minor sites could be located but were not evaluated in this appraisal level design. The hydroelectric generation potential was not estimated as part of the AVC alternative costs presented in this Appraisal Design Report.

In accordance with *Reclamation Manual*, Policy and Directives and Standards, appraisal level construction costs and operation, maintenance, and replacement (OM&R) costs were prepared for the five AVC EIS Action Alternatives. The construction costs and OM&R costs are in January 2011 dollars. Appraisal level costs were based on facility and features assuming a delivery based on maximum day demands.

Summary of Total Construction and Present Worth OM&R Costs (January 2011 Dollars) for AVC EIS Action Alternatives

Cost Description	**Alternative 1** (Comanche South)	**Alternative 2** (Pueblo Dam South)	**Alternative 3** (Joint Use Pipe North)	**Alternative 4** (Pueblo Dam North)	**Alternative 5** (River South)
Total construction cost	$515,000,000	$495,000,000	$495,000,000	$505,000,000	$475,000,000
Present worth total OM&R costs (less WTP OM&R costs)	$50,000,000	$28,500,000	$38,500,000	$37,000,000	$46,000,000
Present worth total WTP OM&R costs	$43,000,000	$43,000,000	$43,000,000	$43,000,000	$43,000,000
Total costs (50-year period)	**$608,000,000**	**$566,500,000**	**$576,500,000**	**$585,000,000**	**$564,000,000**

Summary of Annualized OM&R Costs (January 2011 Dollars) for AVC EIS Action Alternatives

Cost Description	**Alternative 1** (Comanche South)	**Alternative 2** (Pueblo Dam South)	**Alternative 3** (Joint Use Pipe North)	**Alternative 4** (Pueblo Dam North)	**Alternative 5** (River South)
Annual OM&R costs (less annual WTP OM&R costs)	$2,400,000	$1,360,000	$1,830,000	$1,760,000	$2,200,000
Annual WTP OM&R costs	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000
Total annual OM&R costs	**$4,400,000**	**$3,360,000**	**$3,830,000**	**$3,760,000**	**$4,200,000**

A No Action Alternative represents how the participants may meet their future water needs without the AVC or the Interconnect. If the AVC project is not implemented, the AVC participants would meet water supply and water quality needs with a combination of regional water treatment systems and nonregional systems. The No Action Alternative would be funded by the participants without any Federal cost share. Since Reclamation is not responsible financially for the No Action Alternative, no engineering, designs, and costs were included for the No Action Alternative in this Appraisal Design Report. The No Action Alternative was evaluated by an architecture/engineering firm under separate contract by others for inclusion into the EIS. Also, the Master Contract Only Alternative is not included in the appraisal level estimates but will be evaluated in the EIS.

1. Report Purpose

This Appraisal Design Report presents engineering support for the Arkansas Valley Conduit Long-Term Excess Capacity Master Contract, Fryingpan-Arkansas Project, draft Environmental Impact Statement (EIS) and presents designs used to develop action alternative cost estimates prior to conducting feasibility level designs. This is in accordance with the standards below:

> *Reclamation Manual,* Directives and Standards, CMP 05-02, –Feasibility Studies” (Bureau of Reclamation, 2000b) states:
>
> > **Appraisal Studies** - The responsible office will propose proceeding to feasibility based on the results of an Appraisal Design Report. Appraisal Studies are brief preliminary investigations to determine the desirability of proceeding to a Feasibility Study. They use primarily existing data and information to identify plans for meeting current and projected needs and problems of the planning area. The Appraisal Study will identify at least one potential solution that requires Federal involvement or identify an array of options that have been screened and evaluated to substantiate potential Federal involvement.
>
> *Reclamation Manual,* Directives and Standards, FAC 09-01, –Cost Estimating” (Bureau of Reclamation, 2007a) states:
>
> > **Appraisal Estimate** - Appraisal cost estimates are used in appraisal reports to determine whether more detailed investigations of a potential project are justified. These estimates may be prepared from cost graphs, simple sketches, or rough general designs which use the available site-specific design data. These estimates are intended to be used as an aid in selecting the most economical plan by comparing alternative features such as dam types, dam sites, canal or transmission line routes, and powerplant or pumping plant capacities.
> >
> > Appraisal cost estimates are not suitable for requesting project authorization or construction fund appropriations from the Congress due to the early stage of project development.

1.1 Project Background

In 1936, Lower Arkansas Valley farmers asked the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) to begin studying the possibility of a diversion project to bring water under the Continental Divide from Colorado’s West Slope to the Arkansas Basin. The Arkansas Valley Conduit (AVC) was approved by Congress as part of the original authorizing legislation for the Fryingpan-Arkansas (Fry-Ark) Project that was signed into public law (Public

Law 87-590) by President John F. Kennedy on August 16, 1962, in Pueblo, Colorado. However, the AVC was not constructed with the original project, primarily because the project beneficiaries were unable to repay the construction costs within 50 years as required by the authorizing legislation. Congress authorized Pueblo Dam and Reservoir construction, which began in 1970 and was completed 5 years later. In 2009, Congress amended the original Fry-Ark authorization in Public Law 111-11, which authorized annual appropriations as necessary for construction of the AVC and included a cost sharing plan with 65-percent Federal funding and 35-percent local funding.

Since 2000, local community leaders have shown renewed interest in the feasibility of the AVC, and three notable investigation reports were completed: (1) Final Report Feasibility Evaluation of the Arkansas Valley Pipeline (GEI Consultants, Inc., 2003); (2) Arkansas Valley Conduit Re-evaluation Statement (Bureau of Reclamation, 2005); and (3) Arkansas Valley Conduit Pre-NEPA State and Tribal Assistance Grant (STAG) (STAG Final Report, 2010a).

1.2 Agency Participation

Reclamation is the lead agency for this Federal action. Reclamation owns, operates, and maintains the Fry-Ark Project and would be responsible for constructing the AVC. Reclamation is responsible for preparing this Appraisal Design Report, the EIS, and a Record of Decision.

Southeastern Colorado Water Conservancy District (Southeastern) is a cooperating agency and plays an administrative role, including securing grants and loans for local funding, supporting legislation, and working with project beneficiaries. Southeastern was formed in 1958 for developing, administering, and repaying the Fry-Ark Project. Its Colorado boundaries extend along the Arkansas River from Buena Vista to Lamar, and along Fountain Creek from Colorado Springs to Pueblo. Forty water providers have signed a Memorandum of Agreement(s) with Southeastern to participate in the AVC.

1.3 Project Purpose and Scope

The purpose of the proposed AVC is to construct a bulk water supply pipeline to meet existing and future municipal and industrial water demands of the AVC participants. This water supply is necessary to supplement or replace poor quality water and to meet a portion of the AVC participants' projected water demands through 2070. A small number of industrial livestock operations are customers of the AVC participants and would be served by the project.

The overall purpose of this Appraisal Design Report is to perform engineering support for the National Environmental Policy Act (NEPA) process, gather data, conduct the evaluations necessary to the NEPA process, and complete the Reclamation Appraisal Study. The Appraisal Design Report may be inserted as an appendix in the NEPA document. The Appraisal Design Report identifies technically feasible construction action alternatives along with cost estimates. These action alternatives and estimates are used in the decision process to identify the preferred alternative. The Appraisal Design Report will be a stepping stone in the planning process into the feasibility level design, using the preferred alternative as a design basis.

The AVC would include construction of buried pipelines and spurs, a water treatment plant (WTP), water storage tanks, regulating tanks, pumping plants, valve vaults, meter vaults, participant deliveries (tie-ins), Supervisory Control and Data Acquisition (SCADA), network, and other related facilities.

Generally, the AVC route would be from Pueblo Reservoir to Lamar, Colorado, with several spurs to provide water to the participants located along the route. The AVC would not serve all water supply providers or users within Southeastern’s boundaries; only those entities opting to participate in the AVC. Participants in the AVC would include towns and rural water districts in Pueblo, Crowley, Otero, Bent, Prowers, and Kiowa Counties. Refer to figure 1 for a map of AVC participants.

Each of the five AVC EIS Action Alternatives would use pipelines to convey Pueblo Reservoir water to communities along its route east of Pueblo to Lamar, Colorado. The maximum daily flow rate would be approximately 20 million gallons per day (mgd). The approximate pipeline size would range between 48 inches and 16 inches in diameter, with several smaller diameter spurs. The combined main pipeline and spur length would be approximately 230 miles.

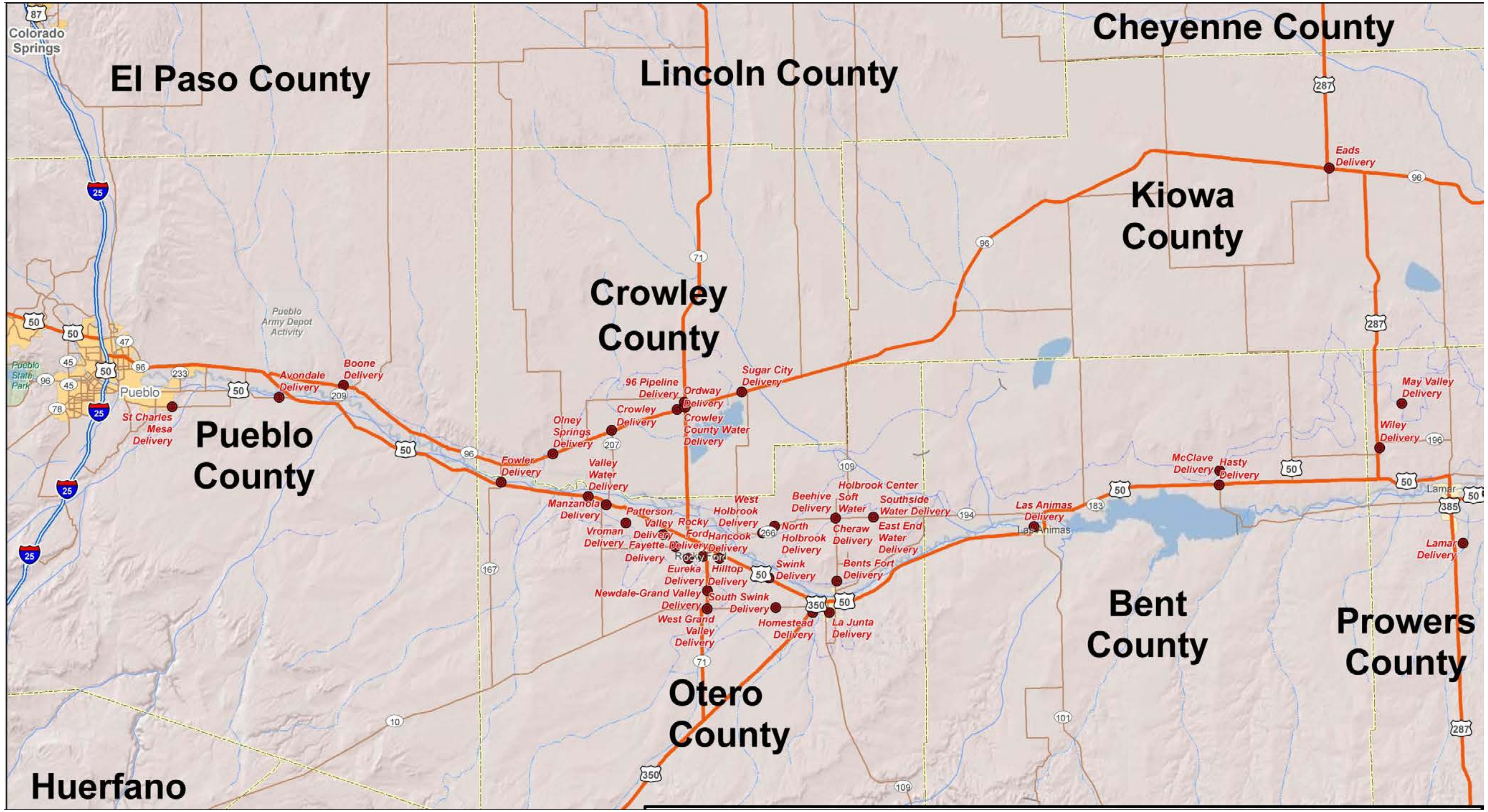

Figure 1. AVC participants.

2. Participant Water Demands

This study used information from participant questionnaires collected during the STAG project planning phase (STAG Final Report, 2010a). This section discusses the questionnaires; AVC participant water demands, including the population projections; demand forecasts; and the amount of water to be conveyed through the AVC.

2.1 Participant Questionnaires

The appraisal level design used information from questionnaires collected during the STAG Final Report planning phase and other information collected since the STAG Final Report. The goal of the questionnaires was to collect quantifiable water data related to supplies, demands, treatment, and quality; and to collect qualitative data related to system operations and planning. The questionnaires used for the STAG Final Report were updated and expanded versions of questionnaires used in 2002 and 2005.

The 2009 version of the questionnaire included additional data requests related to water system planning if the AVC is not constructed, as well as additional details on water demands and water supply conditions. The questionnaire was to gather information about service populations, current and future water demands, water quality issues, augmentation supplies, treatment processes, and distribution systems. Each participant submitted responses to the survey between November 2009 and January 2010. Every survey provided a value for existing service population, which was assumed for this study to be equal to the 2010 service area population.

Questionnaire responses were collected from 98 percent of the participants to whom questionnaires were distributed. Many of the questionnaires were complete and detailed and provided all of the data needed; however, some followup by Black & Veatch, Inc., and Southeastern worked with a number of the participants.

2.2 Population Projections

The AVC would be designed for populations projected to the year 2070 in accordance with maintaining a 50-year design point from the projected construction date of 2020. The STAG Final Report population projections were to the year 2050 and were updated.

The study area for this appraisal level analysis includes 40 AVC participating entities located in 6 Colorado counties in the Lower Arkansas River Basin: Pueblo, Crowley, Otero, Bent, Prowers, and Kiowa.

Service area resident population estimates were developed using a combination of data obtained from the individual participants during the STAG Final Report data collection period in the form of survey responses and other documentation; the Colorado State Demography Office; a study conducted by Camp, Dresser, and McKee; and Harvey Economics on behalf of the Colorado Water Conservation Board (CWCB).

Future service populations were not provided on all surveys; those that were provided did not consistently use future condition years. As a result, developing consistent 2070 population forecasts required multiple data sources and a series of calculations.

Colorado population forecasts by county for the years 2000-2035 were obtained from the State of Colorado (State of Colorado, 2011). The datasets were published in October 2009 and represent the most recent available population forecast data for the period 2000-2035. Colorado population forecasts by county for the years 2035-2050 were obtained from the STAG Final Report as referenced in appendix B, exhibit 34, of the State of Colorado 2050 Municipal and Industrial Water Use Projections draft report (Colorado Water Conservation Board, 2009). The 2050 out year was reevaluated based on a project repayment contract of 50 years. The repayment and conveyance contract would address AVC construction repayment; operation, maintenance, and replacement (OM&R) payment; and conveyance of Fry-Ark Project and non-Fry-Ark Project water. Repayment of the locally funded portion of the AVC would begin after construction of the AVC, which at the time was initially estimated to be completed in about 2020. Therefore, this appraisal level design of the AVC would be through 2070, when considering a 50-year repayment contract period. Reclamation performed an independent evaluation of population projections and extended them through 2070.

To evaluate the accuracy of the CWCB and Colorado State Demography Office population forecasts, the growth trends, which result from the model assumptions, were compared to the historical growth patterns and the likelihood that there will be changes in the growth patterns. Bent, Kiowa, Otero, and Prowers Counties have experienced a decrease in population from 1950 to 2009. Although this decline was not constant in all cases, the likelihood of a sudden reversal of these trends to rapid growth, resulting from an abrupt change in social or economic variables, would be small; therefore, modest growth is assumed. Crowley and Pueblo Counties experienced growth at the historical rate; therefore, similar levels of future growth would be justified. Based on these observations, the population growth rates of less than 1 percent per year were applied to the AVC participants to estimate 2070 populations.

The population for the Town of Fowler was adjusted to account for their service area, including a significant area around the city. The Las Animas population variance is due to the fact that Las Animas provides water to a nearby prison. The prison is not included in the town census, but it is included in the census for demands and population.

It is challenging to accurately forecast future populations due to numerous factors that can influence population growth. Population is influenced by fertility, mortality, and migration, which change over time due to a number of factors, including economic conditions. Although there are uncertainties associated with future population projection, the assumptions about future population growth were made with the best available information and provide a reasonable estimate for projecting future water needs. Population growth and water demand changes will be discussed during the future feasibility level planning phase. The resulting service area population estimates, based on potential best population growth forecasts, are shown in table 1.

Table 1. Population Estimates Based on Potential Best Population Growth Forecasts

Water Provider	2010 Service Population Based on STAG Final Report	2070 Service Population Based on Combined STAG Final Report and Census Data	Annual Average % Growth Rate
96 Pipeline Company	160	255	0.78
Avondale	2,000	3,570	0.97
Beehive Water Association	165	210	0.40
Bents Fort Water Company	900	1,160	0.42
Boone	324	580	0.85
Cheraw	193	250	0.37
Crowley County Water Association	2,530	4,010	0.77
Town of Crowley	163	260	0.44
Eads	626	625	-0.19
East End Water Association	75	100	0.48
Eureka Water Company	330	425	0.42
Fayette Water Association	60	80	0.48
Fowler	1,700	2,183	0.42

Table 1. Population Estimates Based on Potential Best Population Growth Forecasts

Water Provider	2010 Service Population Based on STAG Final Report	2070 Service Population Based on Combined STAG Final Report and Census Data	Annual Average % Growth Rate
Hancock, Incorporated	150	195	0.44
Hasty Water Company	285	355	0.37
Hilltop Water Company	284	365	0.42
Holbrook Center Soft Water	50	65	0.44
Homestead Improvement Association	67	85	0.40
La Junta	7,102	9,120	0.25
Lamar	8,171	9,500	0.11
Las Animas	4,405	5,488	0.37
Manzanola	476	610	0.30
May Valley Water Association	1,500	1,740	0.25
McClave Water Association	440	550	0.37
Newdale-Grand Valley Water Company	463	595	0.42
North Holbrook Water	40	50	0.37
Olney Springs	332	530	0.58
Town of Ordway	1,086	1,720	0.51
Patterson Valley	96	125	0.44
City of Rocky Ford	3,994	5,130	0.40
South Side Water Association (La Junta)	48	60	0.37
South Swink Water Company	610	780	0.41
St. Charles Mesa Water District	10,937	19,540	0.97
Sugar City	238	380	0.14
Town of Swink	664	850	0.36
Valley Water Company	325	415	0.41
Vroman	150	195	0.44
West Grand Valley Water, Incorporated	84	110	0.45
West Holbrook Water	23	30	0.44
Wiley	434	505	0.07
Total	51,680	72,796	

2.3 Demands Used

Populations use water at different rates during summer months than during winter months, and also at different average rates during certain days during the maximum use summer month. The average flow rate used during that day is referred to as the maximum day demand (mgd or cubic feet per second [ft^3/s]). Theoretically, 24-hour operation of the system would be required to deliver the 2070 year maximum day demand.

The AVC estimated pipeline diameter sizes were determined to allow the maximum day demand to be provided to the AVC participants with limited pumping. These pipeline sizes were used to determine planning phase estimates of AVC costs. The estimate of annual demand (acre-feet) is based on the analysis as outlined in the *AVC Preliminary Water Demands* letter revised December 16, 2010, as shown in appendix O. All information provided in the letter was considered Predecisional Draft information and was subject to change as the Draft EIS and Final EIS progress.

Annual 2070 deliveries through the AVC for each participant were estimated. This analysis was based on the consideration that it is not AVC's intent to have the capacity to deliver maximum hour flows to participants. It is anticipated that the participants will rely on local supplies, treatment, and treated water storage to satisfy hourly demand variations that exceed the maximum day flow rate. The appraisal level alternatives' hydraulic analysis was based on a 2070 maximum day flow of 20 mgd (31 ft^3/s). The hydraulic analyses, as shown in appendix H, use maximum day demands being delivered.

The CWCB demand projections; STAG participant survey responses; results from individual participant interviews from the November 18th and 19th, 2009, workshops; supplemental data requests on monthly water production; and followup interviews were used to provide potential annual maximum month conduit demands by participant.

2.3.1 Method for Estimating 2070 Demand Monthly Distribution

Historical monthly production data from 2000-2009 were requested from all potential participants during the STAG Final Report phase. Monthly production data were received from 11 participants. For those participants that provided monthly water production data, the historical maximum month as percent of annual demand for the years 2002-2008 was determined for each participant. As seen in table 2, for most participants, the maximum month was July.

These data were used to develop a weighted average maximum month as a percent of annual water demands for those participants who did not provide monthly water production data. The maximum month value used was 14 percent (rounded down) in July. The maximum month peaking factor resulting from these data is 1.68 of the average annual conduit demands.

The weighted monthly water production as a percent of annual demand is shown in table 2 and figure 2. These monthly percentages are consistent with other values from Colorado water providers.

Table 2. Monthly Water Production as a Percentage of Annual Demand

Participant	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cheraw	6	6	6	8	11	12	14	12	9	7	5	5
La Junta	4	4	5	8	11	13	15	13	11	7	4	4
Lamar	5	5	6	8	11	12	14	13	11	8	5	5
Las Animas	6	5	6	8	11	12	14	12	9	7	6	6
May Valley	8	7	8	8	10	10	11	10	9	7	7	7
McClave	8	7	8	8	9	10	11	10	9	8	7	7
North Holbrook	7	7	7	12	8	9	10	10	10	9	5	5
Olney Springs	6	6	7	8	10	15	14	8	8	8	5	5
Rocky Ford	6	5	6	8	10	11	13	11	10	8	6	6
St. Charles Mesa	5	4	5	8	11	14	15	11	10	8	4	4
South Swink	7	7	7	8	9	10	12	10	9	7	6	7
Weighted Average	5	4.5	5.5	8	11	13	14.5	12	10	7.5	4.5	4.5

The percentage of 2070 maximum month demand to be supplied from the AVC was estimated for each participant based on the best available information. For each participant, the projected 2070 AVC demand was multiplied by the historical or weighted average maximum month demand (rounded down) of 14 percent as described above. A critical assumption used in the analysis is that each participant would use the conduit deliveries on a consistent prorated basis throughout the year. For example, if a participant is projected to deliver 50 percent of its annual demands via the AVC, the participants would only use the conduit for 50 percent of its maximum day and monthly demands.

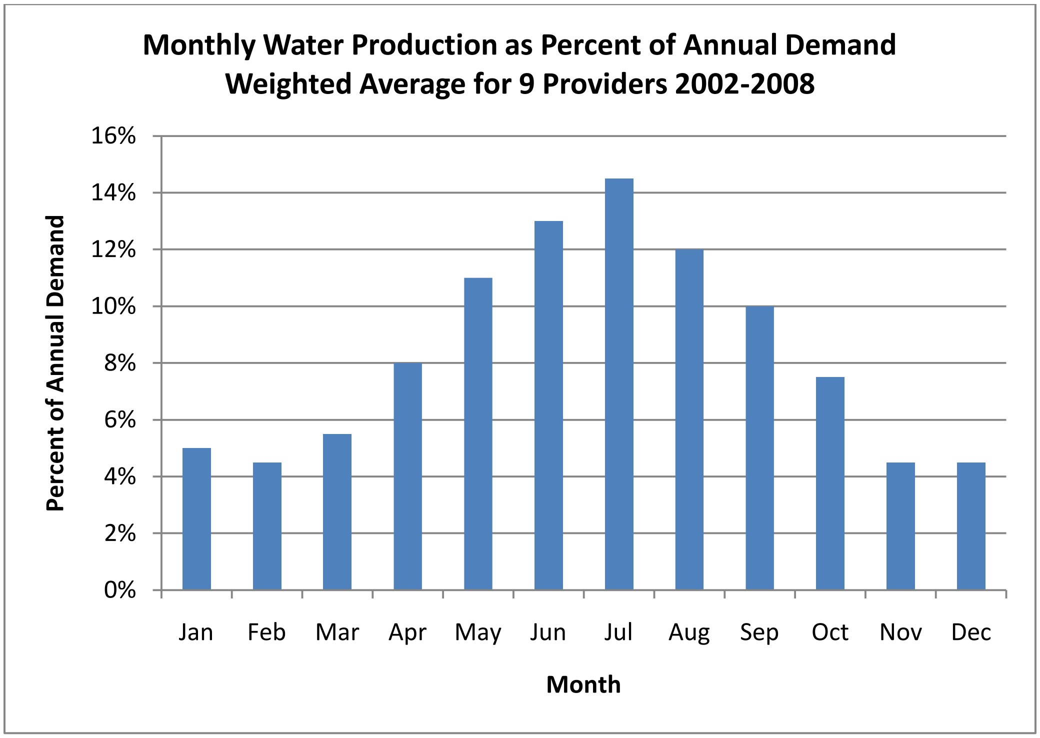

Figure 2. Monthly water demand.

2.3.2 Survey Responses for Demands

Rocky Ford indicated during the participants' meeting in November 2010, and in a followup interview, that it is interested in maximizing its AVC deliveries during the winter months. During the summer months, it has surface water rights delivered by local ditches that provide acceptable quality water. During the winter months, it relies on local wells that are high in hardness and total dissolved solids (TDS) and other constituents, and AVC deliveries would be used to blend with the ground water. The projected 2070 maximum month conduit demands were adjusted to reflect that Rocky Ford would not be using AVC capacity during July, the maximum month.

Some AVC participants may have indicated a desire to carry additional supplies to provide additional high quality water to blend with local supplies, to eliminate or reduce local water treatment, and/or to meet a projected 2070 demand.

Based on examination of the participant survey responses, the maximum day deliveries estimate was obtained by applying a peaking factor of 2.4 to the average annual conduit deliveries. Table 3 shows the projected annual delivery and maximum day deliveries for each participant.

Table 3. AVC Participants and Requested Water Deliveries in 2070

AVC Participant		Annual AVC Deliveries (acre-feet)	AVC Deliveries - Maximum Day (mgd)[1]
Pueblo County			
1	St. Charles Mesa Water District	2,698	5.781
2	Avondale	138	0.296
3	Boone	94	0.201
Crowley County			
4	Fowler	142	0.304
5	Olney Springs	283	0.129
6	Crowley	56	0.054
7	Ordway	60	0.604
8	96 Pipeline Company	23	0.049
9	Crowley County Water Association	617	1.322
10	Sugar City	128	0.274
Otero County			
11	Valley Water Company	39	0.084
12	Manzanola	37	0.079
13	Vroman	37	0.079
14	Fayette Water Association	14	0.030
15	Patterson Valley	17	0.036
16	Eureka Water Company	86	0.184
17	Hancock, Incorporated	18	0.038
18	Rocky Ford	576	1.234
19	Newdale-Grand Valley Water Company	60	0.128
20	West Grand Valley Water, Incorporated	15	0.032
21	Hilltop Water Company	33	0.071
22	Swink	30	0.064
23	South Swink Water Company	88	0.189
24	Homestead Improvement Association	7	0.015
25	La Junta	1,735	3.717
26	Bents Fort Water Company	55	0.118
27	West Holbrook Water	9	0.019
28	North Holbrook Water	7	0.015
29	Holbrook Center Soft Water	22	0.047
30	Cheraw	25	0.054
31	East End Water Association	13	0.028
32	Beehive Water Association	6	0.013
33	South Side Water Association (La Junta)	5	0.011

Table 3. AVC Participants and Requested Water Deliveries in 2070

AVC Participant		Annual AVC Deliveries (acre-feet)	AVC Deliveries - Maximum Day (mgd)[1]
Bent County			
34	Las Animas	604	1.294
35	Hasty Water Company	32	0.069
36	McClave Water Association	49	0.105
Prowers County			
37	May Valley Water Association	222	0.476
38	Wiley	16	0.034
39	Lamar	1,041	2.230
Kiowa County			
40	Eads	116	0.249
Total		9,253	19.755

[1] (466.7 acre-feet per year) (43,560 cubic feet per acre-foot) (7.48 gallons per cubic foot) (365 days per year) (M gal/1,000,000 gal) (2.4) = 1.0 mgd

Potential water losses that have not been accounted for are: (1) 5-percent loss or more, depending on the WTP process; and (2) seepage and evaporation within a river flow alternative. The Pueblo Dam south outlets works (SOW) has a reserved capacity of 31 ft^3/s dedicated for AVC.

3. Action Alternatives

An alternative analysis addressed key issues. The analysis used a structured identification and screening process that disseminated a wide range of technical and conceptual options into a set of alternatives. The public scoping process produced a range of reasonable alternatives that could be effectively evaluated in the EIS screening process and made available for evaluation in this appraisal level design. The following terminology was used in the process:

- **Components**.—Discrete activities or facilities (e.g., an intake location) that, when combined with other components, form an alternative.

- **Option**.—A conceptual or detailed way of completing a component, or an alternative geographic location for a component, such as alternative methods for diverting water or alternative geographic locations for a water intake. Options generate the differences among alternatives.

- **Alternative**.—A complete project that has all the components and associated options necessary to fulfill the project purpose and need.

Specific components and screening criteria were developed as part of the process by the EIS team. Components were based on actions in the alternatives identified in the STAG Final Report (2010). Criteria for the screening processes were based on previous NEPA work, issues identified during the scoping process, and the expected spatial extent of the project and its effects. Both conceptual and specific options were developed from previous studies, alternatives brought forth during scoping meetings and comment letters coordinated by the EIS team, information in the STAG Final Report, the AVC Value Planning Report (Bureau of Reclamation, 2010), and through EIS team brainstorming activities. Additional details of the methodology used for choosing options and components and for assembling alternatives will be included in the EIS document.

Several short-listed options were identified that should be considered during the feasibility level planning phase, including the different levels of water treatment needed by different participants (e.g., St. Charles Mesa requested delivery of raw water), use of abandoned railroad right-of-way (ROW), and individual versus combined spurs. Other options that were not included in the screening analysis, but were included in either the STAG Final Report or Value Planning Study, should be considered in future design efforts. Further variations of AVC routes were identified during NEPA public scoping and are documented in the *Variations of AVC Alignment Identified During NEPA Public Scoping Week and*

CDOT Cooperating Agency Meeting and *Preliminary Alternatives Analysis* letters dated September 13 and November 15, 2010, respectively (see appendix O). Some of the items were included in this Appraisal Design Report, and the others can be reconsidered during further design studies. Table 4 shows the AVC EIS Action Alternatives and the major engineering components.

Table 4. AVC EIS Action Alternatives, Major Components, and Options

	Components					
Action Alternative	**Intake/through Pueblo, then east**	**WTP Location**	**Water Treatment Level**	**Pumping Plant Location**	**St. Charl es Mesa Water**	**Pueblo Reservoir North/South Interconnect**
1 – Comanche South (235 miles)	Dam/Comanche Power Plant raw water line route, then southern route	East of St. Charles Mesa	Filtered and disinfected	Pueblo Dam, high lift (480 feet)	Raw	Yes
2 - Pueblo Dam South (230 miles)	Dam/Bessemer Ditch, southern route	South Road and 21st Street, near St. Charles Mesa	Filtered	None	Filtered	No
3 – JUP North (233 miles)	JUP to Whitlock WTP/ 14th Street, northern route	Whitlock	Filtered	Whitlock WTP pond, medium lift (155 feet)	Filtered	Yes
4 - Pueblo Dam North (236 miles)	Dam/parallel JUP, 14th Street, northern route	Reclamation property at Pueblo Dam	Filtered	Pueblo Dam, low lift (55 feet) and WTP exit low lift (40 feet)	Filtered	Yes
5 – River South (216 miles)	Divert from Arkansas River/ south route to Rocky Ford, then north route	Adjacent to existing St. Charles Mesa WTP site	Filtered and disinfected	River diversion site medium lift (285 feet) and WTP exit, medium lift (130 feet)	Raw	No

Note: JUP denotes Joint Use Pipeline, and lengths in miles, as shown in column 1 in parentheses (e.g., 216 miles), identify length of pipeline.

3.1 Action Alternative Descriptions

The following subsections describe each alternative route and the associated component facilities. Each component mentioned is proposed to be constructed, unless the component specifically identified as utilizing an existing component. Refer to the following for more details:

Appendix A – General Project Maps (Large Scale)
Appendix B – Alternatives Maps (Small Scale)
Appendix C – Facility Photos
Appendix D – Facility Aerials
Appendix F – Facility Drawings
Appendix G – Pump Data Sheets
Appendix H – Hydraulic Calculation Sheets

3.1.1 Alternative 1 – Comanche South

Alternative 1 would generally follow the existing Comanche Power Plant (Public Service Company of Colorado, an Xcel Energy Company) Raw Water Line route west and south of the City of Pueblo and then follow U.S. Highway 50 south of the Arkansas River from Pueblo to Lamar. The AVC would parallel U.S. Highway 50 to Fowler, where the AVC would be routed approximately 1.5 miles south of Fowler to a storage tank site. From the storage tank south of Fowler, the AVC would join back with U.S. Highway 50 and parallel U.S. Highway 50 to east of Manzanola. Then, the AVC would zigzag on county roads (CR) until reaching the south side of Rocky Ford. From Rocky Ford, the AVC would parallel U.S. Highway 50 through Swink, La Junta, and Las Animas to near the intersection of U.S. Highway 50 and U.S. Highway 287. From this intersection, the AVC would travel cross country to Lamar's participant delivery tie-in on the south side of Lamar. A second storage tank site would be located in eastern La Junta.

The three primary spurs would be the Highway 96 spur, the Eads spur, and the spur loop from Rocky Ford northeast along Highway 266 and then back south to La Junta. This alternative's AVC portion east of Pueblo would be essentially the same as described in the STAG Final Report Alternative 1.

A new high lift pumping plant, located near the base of the dam, would be required to raise the water over high ground up to approximately elevation (El.) 5100 feet on the southwest edge of the Pueblo route. A new regulating tank would be required near the high ground along the route. A new booster plant located north of U.S. Highway 50 along CR 34, near the intersection with CR Ss, would be needed to service the Eads spur and May Valley. The alternative would use a new WTP east of St. Charles Mesa, near high ground east of St. Charles

Creek, and convey filtered and disinfected (potable) water to AVC participants. The exception would be St. Charles Mesa Water District, which has requested to be conveyed unfiltered and nondisinfected (raw) water; further coordination and discussions on this request would be required. This alternative would include an Interconnect between the north outlet works (NOW) and SOW at Pueblo Reservoir.

3.1.2 Alternative 2 – Pueblo Dam South

Alternative 2 is described as a south route because the route would generally follow U.S. Highway 50 from Pueblo to Lamar. The AVC would begin at Pueblo Reservoir and follow the Bessemer Ditch through Pueblo to South Road until intersecting with U.S. Highway 50 east of Avondale. The AVC would then parallel U.S. Highway 50 to Fowler, where the AVC would be routed approximately 1.5 miles south of Fowler, to a new storage tank site south of Fowler. From the storage tank site, the AVC would join back with U.S. Highway 50 and parallel U.S. Highway 50 to east of Manzanola. East of Manzanola, the AVC would zigzag on county roads until reaching the south side of Rocky Ford. From Rocky Ford, the AVC would parallel U.S. Highway 50 through Swink, to La Junta. A second new storage tank site would be located in eastern La Junta. The AVC would continue from La Junta to Las Animas and to near the intersection of U.S. Highway 50 and U.S. Highway 287. From this intersection, the AVC would travel cross country to Lamar's participant tie-in on the south side of Lamar.

The three primary spurs would be the Highway 96 spur, the Eads spur, and the spur loop from Rocky Ford northeast along Highway 266 and then south to La Junta. This alternative's AVC portion would be essentially the same as STAG Final Report Alternative 1.

This alternative would begin at Pueblo Reservoir, use a new WTP located near the intersection of South Road and 21st Street, and use new water storage tanks south of Fowler. The WTP would provide filtered water to the AVC participants. This is the only alternative that would not require a main pumping plant; however, it would require a new booster plant located north of U.S. Highway 50 along CR 34, near the intersection with CR Ss, to service the Eads spur and May Valley. This alternative would not include an Interconnect between the NOW and SOW at Pueblo Reservoir.

3.1.3 Alternative 3 – Joint Use Pipeline North

This alternative generally would use a northern alignment through and downstream of the City of Pueblo. Water would be diverted from the existing

Joint Use Pipeline[1] (JUP) ―wye" immediately west of Pueblo Boulevard. Water would be treated at a new WTP or, alternatively, at the existing Whitlock WTP and then be delivered through the City of Pueblo in a pipeline route that generally follows 11th/14th/13th Streets. The pipeline would then follow the north alignment east of Pueblo along U.S. Highway 50 and parallel the highway until intersecting with Highway 96 north of Avondale. The AVC would then parallel Highway 96 to Fowler and to a new storage tank site north of Fowler. From the storage tank site north of Fowler, the AVC alignment would travel cross country, staying north of the Arkansas River, Dye Reservoir, and Holbrook Reservoir until intersecting with Highway 266. The AVC would then parallel CR Hh until CR Hh becomes Highway 194. A second new storage tank site would be located north of La Junta. The AVC would then parallel Highway 194 until intersecting with U.S. Highway 50 north of Las Animas. From Las Animas, the AVC would parallel U.S. Highway 50 to near the intersection of U.S. Highway 50 and U.S. Highway 287. From this intersection, the AVC would travel cross country to Lamar's participant delivery tie-in on the south side of Lamar.

Three primary spurs would be the Highway 96 spur, the Eads spur, and the spur loop from Manzanola southeast along U.S. Highway 50 (including the zigzag on county roads until reaching the south side of Rocky Ford) to La Junta and north along Highway 109 to rejoin the AVC. This alternative's AVC portion east of Pueblo would be essentially the same as described in the STAG Final Report Alternative 2.

This alternative would use treatment at or near the existing BWWP's Whitlock WTP site located north of the Arkansas River on the west side of Pueblo, a new storage tank site north of Fowler, and a new storage tank site north of La Junta. A new pumping plant would be required after the existing Whitlock WTP to lift the water out of Pueblo and into the new storage tanks north of Fowler. A new booster plant north of U.S. Highway 50 along CR 34, near the intersection with CR Ss, would be needed to service the Eads spur and May Valley. This alternative would include an Interconnect between the NOW and SOW at Pueblo Reservoir.

3.1.4 Alternative 4 – Pueblo Dam North

Alternative 4 would use a new WTP located below Pueblo Dam (on Reclamation property) that would provide filtered water. A low lift pumping plant would be required to ensure water supply from low reservoir water levels to the WTP. A second pumping plant, low lift, would be required to raise water from the WTP over high ground on the east edge of the Pueblo route. The AVC would use a

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[1] The JUP is owned and operated by the Board of Water Works of Pueblo, Colorado [BWWP]).

parallel conduit along the north side of the existing JUP from Pueblo Reservoir and bypass the existing Whitlock WTP.

From the bypass to the north of BWWP Whitlock WTP, the AVC would then follow 11th/14th/13th Streets through Pueblo to U.S. Highway 50 north of Avondale. The AVC would then parallel U.S. Highway 50 to a Fowler north storage tank. From the new storage tank site north of Fowler, the AVC would cross the Arkansas River to U.S. Highway 50 and parallel U.S. Highway 50 to the east side of Manzanola. East of Manzanola, the AVC would zigzag on county roads until reaching the south side of Rocky Ford. From Rocky Ford, the AVC would parallel Highway 266. A second new storage tank site would be located north of La Junta. The AVC would then parallel CR Hh until CR Hh becomes Highway 194. The AVC would parallel Highway 194 until intersecting with U.S. Highway 50 north of Las Animas. From Las Animas, the AVC would parallel U.S. Highway 50 to near the intersection of U.S. Highway 50 and U.S. Highway 287. From this intersection, the AVC would travel cross country to Lamar’s participant delivery tie-in on the south side of Lamar.

The three primary spurs would be the Highway 96 spur, the Eads spur, and the spur loop from Rocky Ford southeast along U.S. Highway 50 to La Junta and north along Highway 109 to rejoin the AVC. This alternative’s AVC portion east of Pueblo would most closely resemble Alternative 2 as described in the STAG Final Report This alternative would include an Interconnect between the NOW and SOW at Pueblo Reservoir.

A booster pumping plant located north of U.S. Highway 50 along CR 34, near the intersection with CR Ss, would be necessary to service the Eads spur and May Valley.

3.1.5 Alternative 5 – River South

This alternative would divert water from the Arkansas River upstream of the Fountain Creek confluence. The exact location of the new diversion is yet to be determined but would be downstream of the existing Pueblo kayak course, which terminates at approximately Union Avenue. A new WTP would be constructed adjacent (west) to the existing St. Charles Mesa WTP site and would provide filtered and disinfected (potable) water to downstream users.

From St. Charles Mesa, the AVC would travel east through Pueblo to South Road until intersecting with U.S. Highway 50 east of Avondale. The AVC would then parallel U.S. Highway 50 to a new storage tank site north of Fowler. From the storage tank site, the AVC would cross back under the Arkansas River to U.S. Highway 50 and parallel U.S. Highway 50 to the east side of Manzanola. East of Manzanola, the AVC would zigzag on county roads until reaching the south side of Rocky Ford. From Rocky Ford, the AVC would parallel

Highway 266 northeast. The AVC would then parallel CR Hh until CR Hh becomes Highway 194. A second new storage tank site would be located north of La Junta. The AVC would parallel Highway 194 until intersecting with U.S. Highway 50 north of Las Animas. From Las Animas, the AVC would parallel U.S. Highway 50 to near the intersection of U.S. Highway 50 and U.S. Highway 287. From this intersection, the AVC would travel cross country to Lamar's participant delivery tie-in on the south side of Lamar.

The three primary spurs would be the Highway 96 spur, the Eads spur, and the spur loop from Rocky Ford south along Highway 71 to Highway 10, then east to La Junta and north along Highway 109 to rejoin the AVC. This alternative's AVC portion east of Pueblo would be similar to STAG Final Report Alternative 4.

This alternative would use a new river diversion from the Arkansas River and a new riverside pumping plant to lift the water to the new WTP located near the existing St. Charles Mesa WTP site. Alternatively, in lieu of a physical diversion inlet structure, a multi-pipe inlet structure arrangement could be used to allow pedestrians to cross over the site via the existing bike paths along the river. A multi-pipe arrangement would reduce unwanted conditions to pedestrians and prevent river water users from being drawn into a river diversion inlet structure. Nevertheless, the inlet structure, pipes, and plant sump would be subject to sand and debris accumulation issues that would require potential extensive operation and maintenance (O&M) requirements and river hydraulic modeling requirements during the design phase.

The cost estimate of this alternative does not include a cross-river crest used to stabilize the river bottom elevation to provide a dependable diversion water surface. The item was not included because the cross-river crest may not be deemed necessary.

Because the new WTP is located at a low point, an additional new pumping plant would be required to lift the AVC water over high ground east of St. Charles Mesa and to the new storage tank site north of Fowler.

A new booster pumping plant located north of U.S. Highway 50 along CR 34, near the intersection with CR Ss, would be necessary to service the Eads spur and May Valley.

The alternative would not include an Interconnect because it would not provide redundancy for AVC since releases are made to the river.

3.2 Conduit Routes

The conduit routes and facility locations are illustrated on the Geographic Information Systems (GIS) General Project Maps and Alternatives Maps in appendix A and appendix B. GIS maps include the AVC routes, WTP, pumping plants, air chambers, pump regulating tanks, on-line storage tanks, and AVC participant delivery locations. Photographs of each major facility site are in appendix C. Aerial views of the neighborhoods surrounding facilities are in appendix D, and participant delivery locations used in this study, as well as updated locations, are shown in appendix E. Appraisal level drawings of proposed facilities associated with alternatives are discussed in subsection 3.4 of this report and are shown in appendix F.

The precise locations of conduit within the routes and location of the facilities were not set during this appraisal level design. These features may shift by several hundred feet or more during further planning and final design level development and during the land acquisition process. Such shifts frequently occur during project design.

AVC corridors would include a buffer zone that defines the study area for EIS field work and other studies in the NEPA process (see appendix I). Buffer distances were established to enable alignment options to be balanced against being within a corridor width and yet not setting the distance too wide. A corridor that was too narrow would limit the ability to make minor alignment changes based on the results of the NEPA process. A corridor too wide could create excessive NEPA studies and unnecessary costs, as well as delay the NEPA process.

If a shift in route is within the corridor analyzed in the EIS, then no additional environmental analysis is necessary. If the shift takes the route outside the corridor, then the new route would be analyzed. An environmental commitment will address this in the EIS. Design level surveys, land ownership, and land classification studies have not been completed. Upon final design, minor changes to the pipeline alignment would be made to minimize interference with existing utilities, buildings, and other features where possible. The pipeline is planned to be located on private lands or adjacent to existing public rights-of-way as much as possible. Communication has begun with the Colorado Department of Transportation (CDOT) about: (1) sharing ROW for the future U.S. Highway 50 expansion; (2) Reclamation’s plans to potentially acquire exclusive, perpetual ROW for alignments located adjacent to existing U.S. Highway 50 corridor; and (3) the potential need to be in the U.S. Highway 50 ROW when passing through local communities, towns, and/or cities. CDOT has expressed concerns regarding segments of the alignments that would be within their planned corridors.

The AVC consists of segments identified by a section number and letter so that alternative routes can easily be assembled. A summary of the AVC sections is included in table 5. Descriptions of the AVC segments are included in appendix I.

Table 5. AVC Sections

Section	Beginning Point	Ending Point
1	Pueblo Reservoir	Avondale
2	Avondale	Fowler
3	Fowler	La Junta
4	La Junta	Las Animas
5	Las Animas	Lamar
6	Fowler	Sugar City
7	Eads spur at intersection with U.S. Highway 50	Eads

For cost estimating purposes, the AVC was divided into four reaches that extend between major hydraulic features along the route (table 6). Additionally, since the WTP has been identified for various locations, and to account for a similar section extent, the AVC alternatives' cost estimates combined Reaches 1 and 2.

Table 6. AVC Reaches

Reach	Beginning Point	Ending Point
1	Conduit intake	WTP
2	WTP	Fowler storage tank (including Highway 96 spur)
3	Fowler storage tank	La Junta storage tank (including loop)
4	La Junta storage tank	Lamar (including Eads and May Valley spurs)

Five AVC EIS Action Alternatives were identified to be carried forward into the appraisal level design. Descriptions of the five alternatives were summarized in previous report subsections, and maps of each alternative are included in appendices A and B. Each of the alternatives would include pipeline deliveries that maintain pressure and water quality to AVC participants.

CDOT is considering a new corridor for the U.S. Highway 50 expansion around the cities of Fowler, Manzanola, Swink, Las Animas, and La Junta. However, at this time, these possible U.S. Highway 50 corridors are currently confidential and cannot be described or represented further in this Appraisal Design Report.

The option of supplying water through La Junta's system to the participants north of the Arkansas River between Rocky Ford and La Junta would require additional negotiations. This could eliminate the need for the northern loop spur associated with Alternatives 1 and 2 and will be evaluated during an anticipated future feasibility level planning phase.

3.2.1 Additional Route Concerns

During the next design stage, precautions will be taken when considering the use of ―abandoned railroad rights-of-way.” Extra care is necessary when using old railroad ROWs due to potential contamination and hazardous materials. In addition, Reclamation will need to check on current ownership; the railroad may still own the ROW. The subgrade fill may contain oversized materials which would need to be removed. Additional grading may be needed if the rail bed was built with a significant crown.

During the next planning level phase, when following the Bessemer Ditch through Pueblo, Reclamation will determine the seepage rate of the ditch and possible high water tables adjacent to it. Construction in areas of high water table could lead to failure of the ditch and add expenses. Past experience of conveying water through urban areas has shown that there may be numerous ―unknown” irrigation facilities providing water to adjacent landowners. Continuous use of a trench box and dewatering could be required, adding significantly to the time and cost to construct.

3.2.2 Urban Route Concerns

For any alternative route running through an urban area, designers/contractors would have to deal with confined construction limits, existing utilities, traffic, and congested haul routes. Estimated costs need to include costs for repair of damage to existing streets (other than those disturbed by excavation), traffic detours, and relocating existing utilities due to conflicts in vertical alignments. The limited construction areas and access may require excavated materials to be hauled, stored, and then returned for backfilling operations. In addition, construction could progress at a substantially slower pace through urban areas. At this level of study, these concerns are accounted for through reduced production rates for pipe installation and allowances in design contingencies.

3.3 Participant Delivery Locations

Desired delivery location depends on several items, including the level of water treatment. This appraisal level design used preliminary participant delivery locations. As the project develops, coordination between Southeastern and each AVC participant will continue to refine the locations and other compatibility information with the individual systems. The level of water treatment (i.e., filtered water or filtered and disinfected [potable] water) will impact participant delivery tie-in locations. Appendix E contains a map showing the appraisal level design and the updated delivery locations. The following sections identify items to be considered during selection of the final delivery locations.

3.3.1 Water System Delivery Considerations

The purpose of evaluating the participant delivery locations was to develop input for the appraisal level hydraulic analysis of the AVC and to provide preliminary input to the AVC participants on how the AVC could impact the future operation of their systems. The primary considerations for determining the preliminary preferred location for each AVC participant's water system connection include:

- Existing facility locations within the participant water system, including the location of water supplies, treatment, and storage facilities (STAG Final Report, table 2-1)
- Hydraulic operating characteristics of the participant water system, including distribution pipe sizes and locations, operating pressure, and storage tank overflow elevation (STAG Final Report, table 2-1)
- Hydraulic grade line of the AVC for the worst case operating condition, which is the lowest pressure during maximum day flow
- Length and size of the required spur pipe from the AVC to the delivery location

Secondary considerations for selecting the system delivery tie-in location are related to the specific site requirements for the connection(s), which include:

- Flow metering, controls, monitoring, and telemetry equipment
- An operations building or below grade vault to house the equipment
- Availability of electrical power service for equipment needs
- Chlorine disinfection facilities, unless handled through existing participant facilities
- Chlorine contact chamber, if needed
- Dechlorination and draining facilities if a chlorine contact chamber requires service
- Hydraulic surge control/pressure relief valves and related facilities, if needed

- Consideration for routing of drain or blowoff water to offsite channel or other provision
- Other chemical dosing equipment for water conditioning or pH control, if needed
- Electrical emergency backup power or hookup for trailer mounted generator
- Maintenance access, fencing, and other site security facilities

Land requirements for the delivery facilities would generally be less than 1 acre, unless a chlorine contact chamber is required. Availability and ownership of portable trailer mounted generators should be considered if emergency backup power cannot be provided onsite.

3.3.2 Preliminary Delivery Locations

The preliminary delivery locations were selected by evaluating the water system data provided by the participant questionnaires and through discussions with the participants at the regional meetings. The preliminary selected delivery locations for the participants' water systems are shown on the GIS maps included in appendix A and appendix B, which also illustrate the AVC routes and facility locations.

In most cases, the delivery locations would exist where the participants' treatment and supply connections to the distribution system are located. In various other cases, a single spur pipeline from the AVC could serve multiple participants. These ―regional" deliveries could allow for efficient use of disinfection and metering facilities to serve multiple users.

3.3.3 Updated Delivery Locations

Southeastern contacted each participant in May 2011 and updated their request for the location of the AVC delivery. During these meetings, several refinements to the general preliminary locations used during the appraisal level design were introduced. Two participants, Avondale and Cheraw, had not signed an agreement with Southeastern. The updated information was not incorporated into the Appraisal Design Report but is an example of the continuous efforts between Southeastern and the participants.

The level of water treatment has a significant effect on where the participant desires to take possession of the water. If the water is filtered and disinfected (potable), the participant may desire delivery directly to their storage tank; if the water is only filtered (not potable), they may desire a location near their treatment facility.

Appendix E contains maps which depict the variation between the appraisal level design locations versus the updated May 2011 delivery locations. Overall, even though several participant locations have been revised by up to a few miles, the effect on costs of the alternatives is judged to be minimal.

3.4 Facility Descriptions

This subsection presents a summary of the major general facilities required for the AVC alternatives selected to be carried forward into the NEPA process. The project team participated in a 1-day workshop to brainstorm the potential options for the project. The potential options from that workshop are listed in the following subsections. **Note: These options were screened by the EIS team against the purpose and need developed during the NEPA public scoping process, and options that did not meet the purpose and need were eliminated from further consideration.** See appendix O, letter of *Preliminary Alternative Analysis*, dated November 15, 2010.

3.4.1 Project Regulating Storage

Regulating storage is the location(s) where the Fry-Ark Project water and nonproject water are stored prior to conveyance to the participants. The Fry-Ark Project water is currently, and will continue to be, stored in Pueblo Reservoir.

3.4.2 Conduit Intake

The intake is the location where water would enter the AVC. The options for an intake for this appraisal level design are:

- Pueblo Reservoir SOW, capacity currently exists for the AVC.
- Pueblo Reservoir NOW, once modified through use of a north/south outlet works Interconnect during outlet works maintenance/emergency operations.
- Existing BWWP JUP between Pueblo Reservoir and Whitlock WTP.
- Releases from the Pueblo Dam flow into the Arkansas River to a new diversion upstream of the confluence of Fountain Creek. Releases may be approximately 32 ft^3/s to 35 ft^3/s at the diversion to produce 30 ft^3/s out of the WTP (as a result of seepage, evaporation, and diversion bypass).

3.4.3 Conveyance

Conveyance would be required to transport the water from the intake to AVC participant delivery points. Conveyance would include the main conduit and the spurs to the AVC participants.

Conveyance would also include any pumping and on-line operational storage, but these have been broken out for the purposes of this appraisal level design. The options for conveyance identified are discussed below:

Options for conveyance route through Pueblo:

- New pipeline alignment southwest of Pueblo generally paralleling the existing Comanche Power Plant Raw Water Line and rejoining near South Road east of Pueblo.
- New pipeline along Bessemer Ditch.
- Use existing BWWP system JUP pipeline and Whitlock WTP and going east through Pueblo, primarily on 11th and 14th streets.
- New pipeline parallel to JUP, bypassing Whitlock WTP, and going east through Pueblo, primarily on 11th and 14th streets.
- Arkansas River and diverting prior to Fountain Creek confluence. An additional benefit to releasing water from the reservoir into the river would be increased riverflows through Pueblo and opportunity for increased energy production at the proposed Lease of Power Privilege powerplant currently being proposed at Pueblo Dam.

Options for conveyance route east of Pueblo:

- New pipeline (closed) – south of Arkansas River
- New pipeline (closed) – north of Arkansas River

3.4.4 Dam Outlet Works Interconnect

Pueblo Dam has three outlet works to provide water to several users. These outlets are referred to as NOW, SOW, and Hatchery. In 2011, the NOW was modified under the Southern Delivery System (SDS) Work Package 1A to include the function of river outlet (including dam evacuation) and a 90-inch wye with blind flange to provide Reclamation with a potential future hydroelectric facility connection. Currently, under final design by CH2M HILL, the SDS Work Package 1B tentatively would include a 90-inch-diameter welded steel pipe, a connection to the Work Package 1A pipeline, and a valve vault containing an isolation valve, combination air release valve(s), ultrasonic flowmeter, inline trash screen, and a chemical feed pipeline for mussel control. The SDS Work Package 1B pipeline would end near a proposed 90-inch by 90-inch by 90-inch tee, where the proposed Interconnect for Joint Use Manifold (JUM) users and proposed Juniper Pump Station suction pipeline would connect.

Via the JUM, the following Interconnect participants are allocated water from the existing SOW at Pueblo Reservoir:

- Pueblo West
- Fountain Valley Authority (serves Colorado Springs, Fountain, Security, Widefield, and Stratmoor Hills)
- AVC participants
- BWWP
- The existing fish hatchery would be provided a connection to the Interconnect to provide an emergency supply if its primary outlet works is unavailable. The fish hatchery is located on Reclamation land but is owned by the State of Colorado and is managed by the Colorado Division of Parks and Wildlife, a State agency.

The Interconnect would allow partial deliveries of water to existing and future water connections at Pueblo Reservoir. For purposes of this Appraisal Design Report, the participants of the Interconnect will be referred to as the ―Interconnect participants."

The purpose of the Interconnect is to take water from either the NOW or the SOW without loss of service. The Interconnect would be used during intra-day to multi-day outages that occur due to emergencies and routine maintenance activities, as well as longer multiple week outages for occasional substantial maintenance activities. Maintenance activities could include maintenance or replacement of outlet works valves, meters, piping, and other related facilities by Reclamation.

Two options (Option A and Option B) were developed and are shown on appraisal level drawings provided in appendix F. Option A is a further development of the layout suggested by CH2M HILL in the 30-percent design package document for the SDS dated October 10, 2009. Option B was developed during an Interconnect participants meeting on January 10, 2011, and was further developed during meetings with CH2M HILL in June 2011. Three advantages of Option B over Option A are: (1) eliminates the four large diameter pipe under crossings, (2) eliminates two valves (one large and one medium size), and (3) provides for easier construction. Therefore, only Option B is evaluated in the EIS.

During an emergency or scheduled event that takes either the NOW or the SOW out of operation, the major Interconnect participants on the operating outlet would be able to switch water sources or use water from storage. When only the SOW is in operation, BWWP could use its river pump station and reduce reservoir demands by 100 mgd (reduce to 40 mgd). When only the NOW is in operation, the SDS would have no reservoir demand (from 78 mgd) but would use its reserve contractual rights to access full shares from the NOW. All other Interconnect participants could have the ability to receive full demands as shown in the tables of Option A and Option B appraisal level drawings. Allocation of the Interconnect capacity will be addressed in a future Interconnect contract.

During emergencies, BWWP can typically start its river diversion with 24-hour notice, although seasonal issues can cause variation. In the summer, BWWP can often respond with less than a 24-hour notice. In the winter, it could take slightly longer, depending on icing, water levels, etc. Under normal operations, water is not expected to be flowing through the Interconnect, but the Interconnect would be ―watered up.” Pueblo West expresses an interest in the ability to flush stagnant water via the proposed blowoff structure. BWWP does not wish to see the valves open all the time; this seems to defeat the purpose of the multilevel SOW. Routine maintenance activities would typically be scheduled to minimize outages and work with customers to use off-peak hours and demand seasons.

As recommended by Southeastern and some Interconnect participants, all valves would be manually operated via portable powered wrenches and be suitable for buried service, each with square-nut operator and valve box. This would eliminate the need for large concrete vaults with electrical service, as well as concerns about submerging electrical devices/equipment in the vault; however, the issue of providing sump pumps and ventilation will require further consideration. The use of concrete vaults with electrical service is inherently prone to equipment damage during vault flooding. Interconnect participants expressed a desire for a 48-inch, vertical manhole access around the valve gear box operator for maintenance and replacement purposes. The gear box could be flooded and would be pumped out only when access was required. The manhole would be labeled as a ―confined space” for entry.

The Interconnect is expected to be operated infrequently. However, it is vital to provide a reliable source of water from the reservoir during maintenance of valves/gates and their operators in the dam and during maintenance/repair of pipes immediately downstream of the dam. It is largely unknown if adult invasive mussels will be present; however, if they are, major structures would require cleaning and physical removal. Asian clams are a nuisance but only create debris problems; they do not physically attach and cling to structures. At this time, it is difficult to determine the frequency of these outages. Nevertheless, the Interconnect may be used an average duration of 2 weeks per 10-year period. The extent and time duration of emergency operations are unknown at this time and are outside the scope of this Appraisal Design Report.

Interconnect participant agreements would be needed for Option B to allocate responsibilities for managing delivery tie-ins (i.e., JUP, SDS, etc.) and implementing emergency operations procedures. Further negotiations and coordination efforts will be required between Reclamation's Eastern Colorado Area Office (ECAO), Great Plains Region, and Interconnect participants to fully establish emergency operations criteria, which are outside the scope of this Appraisal Design Report.

3.4.5 Water Treatment

Data and information provided in this subsection regarding the WTP feature were provided by Black & Veatch Corporation located in Centennial, Colorado.

The project would be delivering either filtered (nonpotable) water[2] or filtered and disinfected (potable) water to the AVC participants, which would be treated at a centralized project facility. Filtered water meets all requirements of the Surface Water Treatment Rules, except that a disinfectant residual is not provided. Disinfected water receives the same treatment as filtered water, but a disinfectant residual is also provided. If residual disinfection with free-chlorine is provided in a long pipeline, disinfection byproduct (DBP) standards may be exceeded. Therefore, the treatment components of several action alternatives would provide filtered water without a disinfection residual (nonpotable) for conveyance through the AVC to participant turnouts.

For alternatives that provide filtered water, participants would be responsible for adding a disinfectant residual (likely free-chlorine) at the entry point(s) to their distribution system(s). OM&R of AVC turnout disinfection stations would be the responsibility of pertinent AVC participants. Based on conversations thus far with the Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Division (WQCD), many of the testing requirements for treated surface water would be performed at the WTP, and the participants would only be responsible for distribution system monitoring and reporting requirements for water received from the AVC. However, each AVC participant would still be responsible for all monitoring and reporting requirements for other water supplies that were used in addition to their AVC supply per CDPHE Primary Drinking

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[2] See Section 3.5 for discussions of water treatment.

Water Regulations and project-specific guidance from Mr. Ron Falco, CDPHE Safe Drinking Water Program Manager (CDPHE, 2011; appendix O).

In addition to the AVC turnout disinfection stations (if required), each AVC participant delivery location would require a pressure reducing/control valve, flowmeter, and isolation valves. The pressure reducing/control valve would be needed to limit the pressure of water delivered to the participant and to control the flow. The flowmeter would be used to measure the rate of flow and quantity of flow. The rate and quantity of flow would be communicated to a SCADA central control center, which would likely be located at the AVC WTP.

The WTP site options of the alternatives' treatment component are:

- Option 1: New WTP located east of existing St. Charles Mesa. There are several sites owned by St. Charles Mesa in the area. St. Charles Mesa is willing to negotiate the use of this site.
- Option 2: New WTP located near the intersection of South Road and 21st Street. This site is on private property. There are additional privately owned properties in the area that would be suitable for the AVC WTP.
- Option 3: New WTP on property owned by the BWWP. New facilities dedicated to the AVC could be located on property directly across the Arkansas River from the existing Whitlock WTP or potentially co-located with existing BWWP facilities on the Whitlock WTP site. BWWP has indicated willingness to negotiate an agreement for use of either of these adjacent properties.
- Option 4: New WTP located below Pueblo Dam at a site on Reclamation property reserved for a future BWWP WTP.
- Option 5: New WTP near the existing St. Charles Mesa WTP located on private property that is outside of the flood plain.

The locations of action alternative WTP sites are shown on drawing 19 in appendix F. Further variations for WTP sites were identified during the NEPA public scoping process and are documented in the *Variations of AVC Alignments Identified During NEPA Public Scoping Week and CDOT Cooperating Agency Meeting* memorandum dated September 13, 2010 (Black & Veatch, 2010; appendix O).

The issues with treatment for the project are discussed further in subsection 3.5.

3.4.6 Pumping Plants

The quantity, capacity, and location of pumping plants required would depend on which intake, conveyance, and treatment options are selected. Pumping plant associated facilities would include air chambers and regulating tanks. Air chambers would be located within the plant yards, and regulating tanks could be located within a few miles from the plant sites.

Note: In situations where a WTP is located near or at a pumping plant site, the pumping plant could be integrally constructed within the WTP facility.

Pumping plants would be required at the following locations:

- Alternative 1 (Comanche South) - A new pumping plant located below Pueblo Dam for the conveyance route southwest of Pueblo. The bluff on the south side of Highway 96, just downstream of Pueblo Dam, is approximately at elevation (El.) 5100, which is approximately 200 feet higher than the Pueblo Reservoir spill elevation.

- Alternative 2 (Pueblo Dam South) – No pumping plant required; however, a booster plant is required for Eads and May Valley spurs.

- Alternative 3 (Joint Use Pipeline North) - If the existing BWWP Whitlock WTP is used or a new one constructed adjacent to this existing feature for treatment, a new pumping plant would be needed downstream of the WTP to lift the water out of this low spot.

- Alternative 4 (Pueblo Dam North) - The ground elevation of the WTP site located below Pueblo Dam (generic site on Reclamation property) is higher than the low reservoir level. Therefore, to ensure that water is delivered under all reservoir conditions, a pumping plant would be needed between Pueblo Reservoir and the WTP. A pumping plant would also be needed downstream of the WTP to lift the water out of this low spot. There is higher ground located along the route through Pueblo that would require pumping from the WTP clearwell.

- Alternative 5 (River South) - If the WTP is located near the existing St. Charles Mesa's WTP site, then a pumping plant would be needed downstream of the new WTP to lift the water out of this low spot.

Booster pumping plants are those located directly within the pipeline to boost the pressure:

- Alternatives 1 through 5 - A booster plant would be needed to pump the water to Eads and May Valley participants. The May Valley pipeline would be located south of the new booster pumping plant for Alternative 1, and a new booster pumping plant would not be required to boost the pressure.

- Booster plant(s) may be needed to deliver water to other participants (consisting of a pump station located on spurs only). Further coordination would be required with the participants to confirm delivery tie-in locations and their existing system operating parameters. The costs for any additional booster plants would be a portion of the design contingencies.

3.4.7 On-Line Water Storage Tanks

On-line water storage tanks would be located along the AVC. The tanks would be used for operational storage and to provide a minimal amount of water if a system outage were to occur (e.g., a pipeline break). A storage tank would also provide a location to positively reduce the AVC internal pressure, which would reduce pipe cost. It would be the responsibility of each AVC participant to provide storage and/or a water supply, in addition to and outside of the AVC, to meet maximum hour and fire flow demands.

Each storage tank would be a covered system to prevent changes to the AVC water quality at that location. Use of multiple tanks would allow the AVC to continue to operate if a tank were taken out of service for maintenance or repair.

The storage tanks would be sized to provide approximately 1 day of water to downstream participants under maximum day conditions. The preliminary proposed locations of storage tanks used in this study are:

- **Fowler South**.—Three surface mounted tanks of approximately 2 million gallons each. Approximate ground elevation is El. 4410 feet. Tanks at this site were portrayed to be constructed at ground level. With this configuration, some participants' desired delivery pressure would not be achieved when operating at maximum day demand. For example, the participants and low pressure versus desired pressure are: Valley Water (Alternative 2, 42 pounds per square inch [lb/in^2] versus 65 lb/in^2), Rocky Ford and Hancock (Alternative 2, 52 lb/in^2 versus 65 lb/in^2), and South Swink (Alternative 2, 48 lb/in^2 versus 65 lb/in^2). During periods of less than maximum day demand, higher pressures would be present.

As an option to provide the participants their desired delivery pressure during maximum day demand, a set of smaller volume elevated tanks could be substituted for the large volume ground level South Fowler tanks.

- **Fowler North**.—Four surface mounted tanks of approximately 2 million gallons each. This site is located north of Fowler in Crowley County, north of Highway 96. The site is on the bluff where ground elevation is approximately El. 4550 feet. Pipe segment routes exist that would allow use of this site for either the north or the south AVC alignment route alternatives. It should be noted that this site has existing transmission lines located on the bluffs that would need to be considered in the designs.

- **La Junta North**.—Five elevated tanks of approximately 1 million gallons each would be located north of La Junta, near Cheraw. Tanks used in Alternatives 3 and 4 would be 200 feet tall, while Alternative 5 tanks would be 50 feet tall. The ground elevation at the site is approximately El. 4145 feet.

- **La Junta South**.—Five elevated tanks of approximately 1 million gallons each would be located west of La Junta's stockyards, where ground elevation is approximately El. 4100 feet. Tanks used in Alternatives 1 and 2 would be elevated approximately 65 to 80 feet above the ground.

- **La Junta Central**.—Tanks could be placed atop the hill west of the La Junta airport, near the existing La Junta storage tanks. These tanks would be surface mounted at a ground elevation of approximately El. 4270 feet. There would be low-pressure pipe laid away from the tank parallel to the high-pressure pipe. The added pipeline lengths would be approximately 4.5 miles south or approximately 3.5 miles north to rejoin their respective routes.

Each alternative provides options for different tank heights. The height of the tank affects AVC participants' delivery pressures, as well as pipe diameters. Final participant delivery pressures have not been supplied, so various options of tank heights have been accounted for across all five AVC EIS Action Alternatives. Upon finalization of these required pressures, tank heights and pipe diameters (directly affecting final costs) may require some design changes to accommodate participant requirements. The type and appearance (e.g., fluted, lattice) of tanks would need to be coordinated further with Southeastern.

3.4.8 Hydroelectric Sites

There are opportunities for hydroelectric generation along the AVC, which could be developed by others. Each alternative possesses slightly differing amounts of energy availability. The locations for these sites in each alternative are at the Fowler and La Junta on-line storage tanks. In Alternative 1 (Comanche-South), the WTP site is also available.

The flow and pipe head available vary throughout the year. As the flow increases with increased demand in the summer, the available head for hydroelectric generation decreases. Tables and plots illustrating typical results for these factors are included in appendix N. The information is presented based on the predicted monthly average flow. Additional minor sites were not evaluated in this appraisal level design but could be considered.

See Section 10 for more details of the potential facilities.

3.5 Water Treatment

Data and information provided in this subsection and subsection 3.6.5 regarding the WTP feature were provided by Black & Veatch Corporation located in Centennial, Colorado.

The AVC participants would be required to meet primary drinking water standards, which limit levels of contaminants in drinking water to protect public health, and they desire to meet secondary drinking water standards, which provide guidelines for aesthetic considerations such as taste, color, and odor. Currently, all but one of the AVC participants rely on ground water as their sole water supply source. The ground water supplies of the AVC participants can be divided into two types: (1) water from deep bedrock aquifers, and (2) water from alluvial aquifers. The largest AVC participants rely almost exclusively on alluvial ground water, making these supplies the highest use by volume, even though the majority of AVC participants rely on bedrock ground water. St. Charles Mesa, which delivers surface water from the Bessemer Ditch and the Arkansas River in addition to ground water supply, is the only AVC participant that directly diverts surface water as a primary drinking water supply. The AVC project would provide an additional treated surface water supply to the participants, with a total design production of 20 mgd.

3.5.1 Treatment Technologies Evaluated

The water treatment component of the Draft AVC EIS Action Alternatives is based on conventional water treatment technologies. Full-conventional pretreatment and granular media filtration are mature technologies that have been used to reliably and economically treat surface water supplies along the Front Range of Colorado with water quality similar to that historically observed in Pueblo Reservoir and the

Arkansas River upstream of its confluence with Fountain Creek. The Fountain Valley Authority and BWWP have provided safe drinking water using these technologies to treat source water from Pueblo Reservoir. Other pretreatment and filtration process options that provide equivalent levels of water treatment are available and could also be used in the AVC EIS Preferred Alternative if they would provide additional benefits or mitigate adverse environmental consequences of the project.

An operational plan for the AVC WTP has not been developed at this level of evaluation, and it is not known if any more stringent finished water quality goals above enforceable primary standards of the Colorado Primary Drinking Water Regulations (CPDWR) (CDPHE, 2010b) will be set. Because improved water quality is one of the major motivating factors for AVC participants, it is assumed that the AVC WTP would be operated in a manner to meet nonenforceable secondary standards of the CPDWR. Based on the lack of compelling regulatory or aesthetic water quality drivers, advanced treatment processes such as reverse osmosis, hydroxyl radical-based oxidation, or ultraviolet light (UV) disinfection were not included or expected at this time.

3.5.2 Water Treatment Component

Options considered within the water treatment component of Draft AVC EIS Action Alternatives include:

- Raw water delivery to any of five potential water treatment plant sites through either a river intake and pump station on the Arkansas River or through a dedicated pipeline from the Pueblo Reservoir SOW.
- Presedimentation if raw water is delivered from the Arkansas River.
- Full conventional pretreatment including coagulation, tapered flocculation, and plate-assisted sedimentation.
- Powdered activated carbon (PAC) for seasonal taste and odor control.
- Deep-bed dual-media filtration.
- Primary disinfection with free-chlorine.
- Residual disinfection with either free- or combined-chlorine.
  Note: A disinfectant residual would not be added or maintained in the AVC in all alternatives. If a disinfectant residual was not provided during distribution within the AVC, it would be added at each participant turnout water treatment

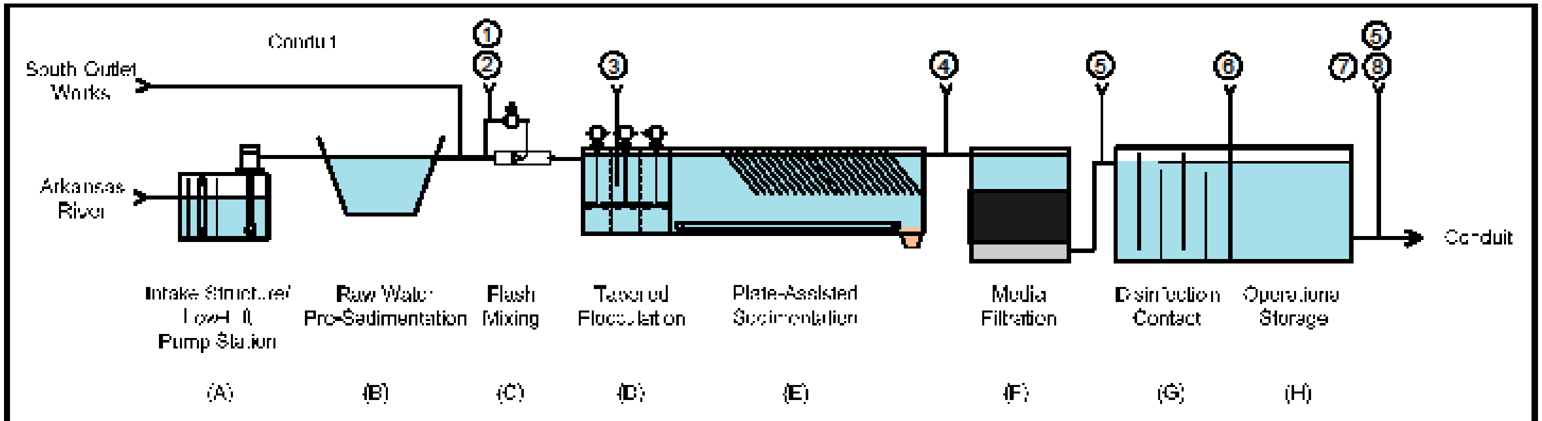
- Operational storage.
- Liquid and solid residuals management.

The combination of all the water treatment components above without the addition of a disinfectant residual is referred to as filtered water treatment. Each AVC EIS Action Alternative would provide filtered water treatment. The water treatment component of several alternatives (i.e., Alternatives 1 and 5) would also include maintenance of a disinfectant residual in the AVC. Process options included in the water treatment component of each Draft AVC EIS Action Alternative are listed in table 7.

Figure 3 shows a simplified process schematic for the Draft AVC EIS water treatment component. Process options were sized using preliminary design parameters that are consistent with CDPHE design criteria (CDPHE, 1997). Other ancillary water treatment facilities in each option not shown on figure 3 include an electrical power substation, filter backwash water recovery basins, and residual drying basins. Note that not all water treatment process options or water treatment chemicals are included in the water treatment component of each alternative; however, each water treatment option was included in the water treatment component of at least one alternative.

3.5.3 Water Treatment Plant Sites

The locations of WTP sites for Draft AVC EIS Action Alternatives throughout the Arkansas Valley are indicated on drawing 19 in appendix F. Conceptual layout of the water treatment component options of each Action Alternative on their respective WTP sites are shown on drawings 21 through 26 in appendix F. In addition to the water treatment facilities presented for Alternative 3, there is a possibility that an agreement could be reached with the BWWP Whitlock WTP to co-locate within their facilities and footprint, which is located just to the northeast of the site shown on drawing 24 in appendix F. This facility layout configuration subalternative is not shown graphically here because it would be entirely contained within the existing Whitlock WTP site. This subalternative is discussed generally below to capture scope and impacts.



Process Options

	Process	Description
(A)	Intake/Pump Station	Self-Cleaning/Low-Lift
(B)	Pre-sedimentation	12 hr Detention @ Design Flow
(C)	Coagulation	Pumped-Jet Diffusion Flash Mixing
(D)	Flocculation	3-Stage, Tapered, Vertical Shaft
(E)	Clarification	Plate-Assisted Sedimentation
(F)	Media Filtration	Deep-Bed Dual-Media
(G)	Disinfection Contact	Baffled Channel Basin
(H)	Operational Storage	Baffled Channel Basin

Treatment Chemicals

①	Carbon Dioxide/Acid
②	Coagulant
③	Powdered Activated Carbon
④	Filter-Aid Polymer
⑤	Disinfectant
⑥	Sodium Bisulfite
⑦	Fluoride
⑧	Caustic Soda

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Drinking Water Treatment Component: 20 MGD Design Flow

Figure 3

Figure 3. Drinking water treatment component: 20-mgd design flow.

Table 7. Process Options in Water Treatment Component of Draft AVC EIS Action Alternatives(1)

Alternative	Raw Water Delivery(2)	Presedimentation(3)	Filtered Water Treatment(4)	Disinfectant Residual
Alternative 1: Comanche South	Dedicated pipeline	No	Yes	Yes
Alternative 2: Pueblo Dam South	Dedicated pipeline	No	Yes	No
Alternative 3: Joint Use Pipeline North	Dedicated pipeline	No	Yes	No
Alternative 4: Pueblo Dam North	Dedicated pipeline	No	Yes	No
Alternative 5: River South	River/pipeline	Yes	Yes	Yes

(1) Each AVC EIS Action Alternative would include the following ancillary facilities: electrical power substation, filter backwash water recovery basins, and residual drying basins.

(2) Dedicated pipeline from the existing Pueblo Dam Reservoir SOW to WTP site. May include use of the existing JUP. Alternative 5 would use the Arkansas River to a point just upstream of the confluence with Fountain Creek, followed by diversion through a river intake and pump station, with a new pipeline to the Alternative 5 WTP site.

(3) Only provided in AVC EIS Action Alternatives that would use the Arkansas River for raw water delivery.

(4) Filtered water treatment includes coagulation, flocculation, clarification, and granular media filtration. Primary disinfection with free-chlorine would be provided for each alternative. Residual disinfection of filtered water required to produce potable water would only be provided for Alternatives 1 and 5 and would be provided for other alternatives that would use either free-chlorine or combined-chlorine.

Current water treatment capacity of facilities at the existing Whitlock WTP is 84 mgd, with an ultimate future build-out capacity of 140 mgd to serve BWWP customers. Initial conceptual evaluation indicates that an additional 20 mgd of capacity could also be accommodated on the existing Whitlock WTP site to provide dedicated water treatment for the AVC project. Several modifications and additions to existing Whitlock facilities would be required to increase total site capacity to 160 mgd including:

- A parallel pipeline from the JUP wye to convey an additional 20 mgd of raw water to the existing Whitlock WTP site.
- Modification of the existing pressure dissipation structure to accommodate additional raw water flow.
- Additional yard piping between the pressure dissipation facility and a dedicated pretreatment facility.
- Construction of a dedicated 20-mgd pretreatment facility.
- Construction of 20 mgd of dedicated filtration capacity.
- Depending on the disinfection strategy ultimately adopted for the AVC, a dedicated disinfection facility may be required.
- High-service pumping plant for conveyance of treated water through the AVC.

In addition to possibly co-locating the WTP, there may be opportunities to share use of several BWWP facilities located at the existing Whitlock WTP site, including:

- Storage facilities for pretreatment chemicals.
- Residuals handling facilities.
- Other ancillary facilities such as power supply and distribution.

3.5.4 Water Treatment Evaluations

Selected technical evaluations were performed to establish the suitability of technologies used in the Draft AVC EIS water treatment component described in subsections 3.5.2 and 3.6.5.

3.5.4.1 Source Water Quality

Water quality of Pueblo Reservoir is characterized by low turbidity, slightly alkaline pH, moderate to high alkalinity, high hardness, and low to moderate

DBP precursor (as measured by total organic carbon [TOC]) and TDS concentrations. Calcium and sulfate are the dominant inorganic constituents, collectively accounting for 57 percent of TDS on average. Fluoride levels are consistently less than the 0.8 milligrams per liter (mg/L) to 1.2 mg/L range recommended for dental health, and silica levels are low. Dissolved iron and manganese concentrations are typically below their respective secondary maximum contaminant levels (MCL). Other regulated trace inorganic contaminants including arsenic, selenium, heavy metals, and radionuclides are also well below their respective primary MCLs. Table 8 summarizes historical water quality data for Pueblo Reservoir used in water treatment evaluations presented here.

Table 8. Historical Water Quality in Pueblo Reservoir(3)

Parameter	Q1	Q2	Q3	Q4	Standard (1,2)
Temperature, °C	8.6	13.4	20.5	13.0	n/a
Dissolved oxygen , mg/L	11.5	10.0	8.5	9.3	n/a
Turbidity, NTU	1.7	3.4	6.3	5.1	TT(4)
pH, s.u.	8.4	8.3	8.0	8.3	6.5 to 8.5(2)
Alkalinity, mg/L as $CaCO_3$	127	120	98	121	n/a
Hardness, mg/L as $CaCO_3$	208	199	156	201	n/a
TDS, mg/L	337	321	253	311	500(2)
TOC, mg/L	2.0	2.2	2.3	2.2	TT(5)
Sodium, mg/L	23.3	24.0	16.0	21.4	n/a
Nitrate, mg/L as N	0.27	0.22	0.22	0.15	10(1)
Chloride, mg/L	9.2	8.9	8.0	9.4	250(2)
Bromide(6), mg/L	0.027	0.026	0.024	0.028	n/a
Fluoride, mg/L	0.59	0.50	0.46	0.51	4.0(1)/2.0(2)
Sulfate, mg/L	130	123	97	123	250(2)
Silica, mg/L as SiO_2	12	9.6	10	12	n/a

Table 8. Historical Water Quality in Pueblo Reservoir⁽³⁾

Parameter	Q1	Q2	Q3	Q4	Standard (1,2)
Iron, mg/L	0.008	0.016	0.010	0.009	0.3⁽²⁾
Manganese, mg/L	0.004	0.007	0.010	0.020	0.05⁽²⁾
Arsenic, mg/L	< 0.001	< 0.001	< 0.001	< 0.001	0.01⁽¹⁾
Selenium, mg/L	0.004	0.004	0.003	0.004	0.05⁽¹⁾

Abbreviations: n/a – not applicable, NTU – nephelometric turbidity units, s.u. – standard units, TT - treatment technique

(1) Enforceable primary drinking water MCL.

(2) Nonenforceable secondary drinking water MCL.

(3) Quarterly median values calculated from data provided by BWWP and downloaded from the National Water Information System, U.S. Geological Survey (USGS) Station 07099400 (http://waterdata.usgs.gov/nwis), accessed November 12, 2010. Samples collected at varying frequencies from 1986 to 2010; not all parameters measured in each sample.

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

(5) Removal for conventional treatment facilities varies with source water TOC and alkalinity per the Stage 1 Disinfectants and Disinfection Byproducts Rule.

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

3.5.4.2 Treatment Performance Modeling

Treatment performance of the AVC WTP and subsequent water quality in the AVC and participant consecutive systems were evaluated for the historical Pueblo Reservoir source water quality data in table 8 using the U.S. Environmental Protection Agency’s (EPA) WTP Model (EPA, 2001). This WTP model is an integrated software package that simulates performance of common drinking water treatment processes and predicts disinfectant decay and DBP formation during distribution for user-defined source water quality and treatment conditions. WTP model output provides a summary of treatment chemical addition, water quality as flow progresses through the treatment process train, and finished water quality following disinfection and onsite operational storage.

The WTP model may be used to gain an understanding of how source water quality and treatment conditions affect disinfectant decay and DBP formation under different operating scenarios. However, the WTP model is not intended to be used as the sole tool for real-time operational control of drinking water treatment facilities. Although the historical water quality in Pueblo Reservoir is relatively stable throughout the year, as measured by median quarterly values (see table 8), significant source water quality variations may occur within any given year and from year to year based on recent hydrologic conditions. Therefore, actual treatment performance of the AVC WTP, once constructed, and associated drinking water quality may be expected to differ somewhat from predictions presented here based on median water quality values.

3.5.4.3 Baseline Treatment

A baseline treatment approach was formulated and evaluated for the process technologies as proposed in the Draft AVC EIS Action Alternatives. The principal objectives of this approach were to provide reliable compliance with the CPDWR (CDPHE, 2010b) and affordable construction and OM&R costs for the AVC participants. Baseline treatment evaluations assumed raw water delivery to the AVC WTP through a dedicated pipeline from Pueblo Reservoir, with average water quality as given in table 8. Primary and residual disinfection with free-chlorine was also assumed as part of the baseline treatment approach to provide chemical compatibility with the free-chlorine disinfection residual currently used by all AVC participants. Because of the long distances that water must be conveyed through the AVC and associated high water ages during low-demand periods, baseline treatment evaluations focused on compliance with disinfectant residual and regulated disinfection byproduct regulations.

Per EPA National Primary Drinking Water Regulations (EPA, 1998), the Stage 1 Disinfectants and Disinfection Byproducts Rule (Stage 1 D/DBPR) specifies TOC removal requirements based on raw water TOC and alkalinity concentrations, as well as several alternative compliance criteria based on other raw or treated water quality parameters. Because of typically low to moderate historical TOC in Pueblo Reservoir, Stage 1 D/DBPR compliance was based on a combination of TOC removal and alternative compliance criteria. The EPA WTP Model was used to determine treatment conditions (coagulant dose and coagulation pH) that would provide 15-percent TOC removal and associated UV absorbance of treated water based on average historical water quality for each quarter of the year. The following assumptions were used in performance evaluations:

- No TOC removal through short-term seasonal addition of PAC for taste and odor control.
- TOC removal required by the Stage 1 D/DBPR would be 15 percent throughout most of the year based on historical source water quality (table 8).
- During other times of the year, when higher TOC removal would be required, compliance would be based on treated water specific ultraviolet light absorbance (SUVA) alternative compliance criteria (SUVA $\leq$ 2.0 L/mg/m).

Performance evaluation with the EPA WTP Model indicated that if treatment conditions were specified to provide 15-percent TOC removal, predicted SUVA of treated water was consistently less than or equal to 1.3 liters per milligram per meter (L/mg/m), comfortably below the alternative compliance criteria value of 2.0 L/mg/m. Accordingly, baseline treatment conditions were set to achieve TOC removal of 15 percent throughout the year to reduce OM&R costs associated with chemical usage and residuals disposal.

Maintaining of an appropriate free-chlorine residual throughout the AVC and participant consecutive systems at all times would be a significant challenge due to the long distances that water must be conveyed and seasonal variations in participant demands. Hydraulic modeling (appendix H) indicates that water age in the AVC may be expected to vary between less than 6 hours at consecutive system turnouts closest to the AVC WTP under high-demand conditions, to more than 24 days at the most distant consecutive system turnout under low-demand conditions. Residence time in participant consecutive systems will further increase water age and reduce free-chlorine residual: detailed hydraulic modeling of consecutive systems was not available, so the maximum water age during low-demand periods was conservatively assumed to be 10 days, with proportionally reduced water age under higher demand conditions.

Preliminary analysis using the EPA WTP indicated that adding enough free-chlorine addition at the AVC WTP to provide a measurable residual at the end of distant consecutive systems would result in unacceptably high residuals at the entry points to consecutive systems closest to the AVC WTP. Therefore, baseline treatment was configured with chlorine doses at the AVC WTP seasonally adjusted to provide a measurable residual within the AVC, and rechlorination at participant turnouts was used in the model to provide an appropriate residual within consecutive systems.

Free-chlorine residuals in the AVC and participant consecutive systems predicted using the EPA WTP Model for baseline treatment are given in table 9.

Regulated total trihalomethanes (TTHM) and five haloacetic acids (HAA5) DBP formation during conveyance through the AVC and subsequent distribution in participant consecutive systems for baseline treatment was also predicted using the EPA WTP Model. The locational running annual averages (LRAA) of TTHM and HAA5 DBPs in the AVC were less than their respective Stage 2 D/DBPR MCLs (80 micrograms per liter [µg/L] and 60 µg/L, respectively), as shown in tables 10 and 11. However, predicted LRAA values exceeded the TTHM MCL at the end of consecutive systems served by AVC turnouts located at La Junta and beyond.

Table 9. Chlorine Residuals in AVC and at the End of Consecutive Systems with Baseline Treatment

Location	Disinfectant Residual, mg/L as Cl_2				
	Q1	Q2	Q3	Q4	RAA
WTP effluent	1.7	2.0	2.3	2.0	2.00
Turnout at AVC location(1)					
Avondale	1.1	1.4	1.9	1.4	1.45
Fowler	0.8	1.2	1.6	1.2	1.20
La Junta	0.4	0.8	1.2	0.8	0.80
Las Animas	0.3	0.6	1.0	0.6	0.62
Lamar	0.2	0.4	0.8	0.4	0.45
Eads	0.1	0.4	0.7	0.3	0.38
End of consecutive system supplied from turnout at AVC location(2)					
Avondale	0.2	0.2	0.2	0.2	0.20
Fowler	0.2	0.2	0.2	0.2	0.20
La Junta	0.2	0.2	0.2	0.2	0.20
Las Animas	0.2	0.2	0.2	0.2	0.20
Lamar	0.2	0.2	0.2	0.2	0.20
Eads	0.2	0.2	0.2	0.2	0.20

(1) Water age in AVC based on hydraulic modeling per appendix H.

(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

Experience has shown that target TTHM and HAA5 levels should be set at 80 percent or less of their respective MCLs (64 µg/L TTHM and 48 µg/L HAA5) in higher water age regions of a utility's distribution system to account for year-to-year variations in source water quality. Predicted TTHM and HAA5 levels both exceeded these target levels in higher water age portions of participant consecutive systems located along the length of the AVC, as shown in tables 10 and 11. Therefore, alternative treatment and disinfection strategies may be required for the WTP to provide an appropriate disinfectant residual and mitigate DBP formation.

Table 10. Predicted TTHM in AVC and at the End of Consecutive Systems for Baseline Treatment

Location	TTHM, μg/L				
	Q1	Q2	Q3	Q4	LRAA
WTP effluent	25	25	25	26	25.2
Turnout at AVC location[(1)]					
Avondale	36.1	38.0	39.2	38.5	37.9
Fowler	39.8	41.7	42.7	42.1	41.6
La Junta	48.0	50.3	52.0	50.8	50.3
Las Animas	53.4	55.9	57.7	56.6	55.9
Lamar	58.3	60.0	61.2	60.8	60.1
Eads	62.1	63.1	63.9	63.9	63.3
End of consecutive system supplied from turnout at AVC location[(2)]					
Avondale	72.0	72.2	72.8	72.9	72.5
Fowler	75.6	75.9	76.3	76.4	76.1
La Junta	84.0	84.3	85.2	85.1	84.7(3)
Las Animas	88.5	89.5	90.1	90.2	89.6(3)
Lamar	93.1	93.5	93.2	94.4	93.6(3)
Eads	97.0	96.6	95.9	97.5	96.7(3)

(1) Water age in AVC based on hydraulic modeling per appendix H.

(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

(3) LRAA value exceeds the 80-μg/L MCL of the Stage 2 D/DBP Rule.

Table 11. Predicted HAA5 in AVC and at the End of Consecutive Systems for Baseline Treatment

Location	HAA5, µg/L				
	Q1	Q2	Q3	Q4	LRAA
WTP effluent	20	22	25	22	22.2
Turnout at AVC location[(1)]					
Avondale	24.6	28.0	31.6	28.0	28.1
Fowler	26.0	29.4	33.0	29.4	29.5
La Junta	29.0	32.7	36.7	32.6	32.8
Las Animas	30.9	34.7	38.9	34.6	34.8
Lamar	32.6	36.2	40.2	36.0	36.2
Eads	33.8	37.3	41.2	37.1	37.4
End of consecutive system supplied from turnout at AVC location[(2)]					
Avondale	45.0	46.8	50.4	46.8	47.2
Fowler	46.5	48.6	51.8	48.2	48.8
La Junta	49.3	52.8	55.5	52.5	52.5
Las Animas	51.6	54.8	58.4	54.7	54.9
Lamar	53.6	56.6	60.0	56.1	56.6
Eads	54.8	57.7	61.0	57.2	57.7

(1) Water age in AVC based on hydraulic modeling per appendix H.

(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

3.5.4.4 AVC Disinfection Byproduct Mitigation

The previous analyses indicate that if conventional treatment, as outlined in subsection 3.5.2, were applied to source water from Pueblo Reservoir, in conjunction with free-chlorine for primary and residual disinfection, levels of regulated DBPs near or above their legally enforceable primary MCLs may form during conveyance in the AVC and subsequent distribution through participant consecutive systems. Furthermore, rechlorination by participants to maintain disinfectant residual within their respective distribution systems may result in regulated DBP levels well in excess of MCLs mandated in CPDWR (CDPHE, 2010b).

Three disinfection options that could potentially be used to mitigate DBP formation in the AVC and maintain an appropriate disinfectant residual in AVC participant consecutive systems have been identified:

- Adding disinfectant residual at each AVC participant turnout
- Adding treatment to allow maintenance of a free-chlorine residual in the AVC
- Maintaining a combined-chlorine (chloramine) residual in the AVC

Each of these mitigation options retains the multiple barrier approach of filtration and disinfection prior to delivery to the public. In addition, based on consultation with CDPHE WQCD, each option is consistent with the CPDWR (CDPHE, 2010b). Option-specific technical, operational, and regulatory requirements are discussed in the following sections.

3.5.4.4.1 Adding Disinfectant Residual at Each AVC Participant Turnout

This disinfection option would provide full conventional treatment (pretreatment, filtration, and primary disinfection) at the AVC WTP to produce filtered water that would comply with CDPHE primary drinking water standards in all regards, except that a disinfectant residual would not be maintained during conveyance through the AVC and associated on-line storage tanks. Under this strategy, residual disinfectant would be added at each participant turnout and be monitored by each respective consecutive water distribution system.

Because filtered water without a disinfectant residual would be distributed through the AVC up to participant turnouts, additional engineered safeguards would likely be included in the pipeline design. Continuous remote pressure sensing and monitoring could be used to indicate potential pipeline breaks or leaks. The capability to disinfect the AVC and on-line storage tanks periodically could also be included in this disinfection option to manage potential biological regrowth.

Chlorination facilities would be required at each participant turnout, which could potentially be combined with existing disinfection facilities on a case-by-case basis. Each participant would be responsible for residual disinfectant addition at the point of delivery. Capital expenditures and increased annual OM&R costs would result for each participant, as well as the potential for an increased level of system maintenance and oversight.

The EPA WTP model was used to predict DBP precursor removal provided by baseline full conventional treatment, as well as free-chlorine residual and DBP formation resulting from primary disinfection in the AVC WTP, and subsequent rechlorination at the entry points to participant consecutive systems. Predicted TOC removal achieved through baseline treatment was 15 percent. The free-chlorine dose applied prior to the AVC WTP disinfection contact basin (DCB) for primary disinfection was seasonally adjusted to meet the concentration multiplied by time (CT) requirements of the CPDWR (CDPHE, 2010b), with residual free-chlorine chemically quenched at the DCB outlet. The free-chlorine dose at AVC participant turnouts was seasonally adjusted to provide a residual of 0.2 mg/L as Cl2 at the end of the consecutive systems. Predicted free-chlorine residual was satisfactory throughout participant consecutive systems, as shown in table 12. Regulated TTHM and HAA5 DBP species were significantly reduced by removing free-chlorine residual prior to conveyance and on-line storage in the AVC, and predicted levels in the AVC and participant consecutive systems were less than 80 percent of CDPHE MCLs (target values of 64 μg/L TTHM and 48 μg/L HAA5), as shown in tables 13 and 14.

Table 12. Free-Chlorine Residuals in AVC and at the End of Consecutive Systems with Free-Chlorine Residual Added at Turnouts from AVC to Participant Consecutive Systems

Location	Disinfectant Residual, mg/L as Cl_2				
	Q1	Q2	Q3	Q4	RAA
WTP effluent	n/a	n/a	n/a	n/a	n/a
Turnout at AVC location(1)					
Avondale	n/a	n/a	n/a	n/a	n/a
Fowler	n/a	n/a	n/a	n/a	n/a
La Junta	n/a	n/a	n/a	n/a	n/a
Las Animas	n/a	n/a	n/a	n/a	n/a
Lamar	n/a	n/a	n/a	n/a	n/a
Eads	n/a	n/a	n/a	n/a	n/a
End of consecutive system supplied from turnout at AVC location(2)					
Avondale	0.2	0.2	0.2	0.2	0.2
Fowler	0.2	0.2	0.2	0.2	0.2
La Junta	0.2	0.2	0.2	0.2	0.2
Las Animas	0.2	0.2	0.2	0.2	0.2
Lamar	0.2	0.2	0.2	0.2	0.2
Eads	0.2	0.2	0.2	0.2	0.2

(1) Water age in AVC based on hydraulic modeling per appendix H.
(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

Table 13. Predicted TTHM in AVC and at the End of Consecutive Systems with Free-Chlorine Residual Added at Turnouts from AVC to Participant Consecutive Systems

Location	TTHM, μg/L				
	Q1	Q2	Q3	Q4	LRAA
WTP effluent	18	19	20	19	19.0
Turnout at AVC location[1]					
Avondale	18	19	20	19	19.0
Fowler	18	19	20	19	19.0
La Junta	18	19	20	19	19.0
Las Animas	18	19	20	19	19.0
Lamar	18	19	20	19	19.0
Eads	18	19	20	19	19.0
End of consecutive system supplied from turnout at AVC location[2]					
Avondale	54.1	54.3	53.7	51.4	53.4
Fowler	54.1	54.3	53.7	51.4	53.4
La Junta	54.1	54.3	53.7	51.4	53.4
Las Animas	54.1	54.3	53.7	51.4	53.4
Lamar	54.1	54.3	53.7	51.4	53.4
Eads	54.1	54.3	53.7	51.4	53.4

(1) Water age in AVC based on hydraulic modeling per appendix H.

(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

Table 14. Predicted HAA5 in AVC and at the End of Consecutive Systems with Free-Chlorine Residual Added at Turnouts from AVC to Participant Consecutive Systems

Location	HAA5, μg/L				
	Q1	Q2	Q3	Q4	LRAA
WTP effluent	16	17	19	17	17.3
Turnout at AVC location[1]					
Avondale	16	17	19	17	17.3
Fowler	16	17	19	17	17.3
La Junta	16	17	19	17	17.3
Las Animas	16	17	19	17	17.3
Lamar	16	17	19	17	17.3
Eads	16	17	19	17	17.3
End of consecutive system supplied from turnout at AVC location[2]					
Avondale	36.0	36.6	37.8	34.9	36.3

Table 14. Predicted HAA5 in AVC and at the End of Consecutive Systems with Free-Chlorine Residual Added at Turnouts from AVC to Participant Consecutive Systems

Location	HAA5, μg/L				
	Q1	Q2	Q3	Q4	LRAA
Fowler	36.0	36.6	37.8	34.9	36.3
La Junta	36.0	36.6	37.8	34.9	36.3
Las Animas	36.0	36.6	37.8	34.9	36.3
Lamar	36.0	36.6	37.8	34.9	36.3
Eads	36.0	36.6	37.8	34.9	36.3

(1) Water age in AVC based on hydraulic modeling per appendix H.

(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

3.5.4.4.2 Adding Treatment to Allow Free-Chlorine Residual in the AVC

This disinfection option would provide all the treatment necessary to comply with CDPHE primary drinking water standards (pretreatment, filtration, and primary and residual disinfection) accompanied by supplemental treatment to reduce DBP precursors to levels that would allow maintenance of a free-chlorine residual throughout the AVC and associated on-line storage tanks. Under this disinfection option, each participant would maintain a free-chlorine residual in any existing nonproject water supply. This disinfection option would require additional management of DBP precursor levels prior to primary disinfection with free-chlorine.

Treatment processes that could be used to reduce DBP precursor levels include oxidation (chlorine dioxide or ozone), advanced oxidation such as UV/peroxide, activated carbon adsorption, or high-pressure membrane filtration (nanofiltration or reverse osmosis). Additional treatment for DBP precursor removal would result in higher capital and annual OM&R costs for water delivered to participants through the AVC; however, the participants would not incur additional costs related to treating their existing non-AVC supplies.

Replacing anthracite in the AVC WTP granular media filters with granular activated carbon (GAC) was evaluated as an additional treatment step to further reduce DBP precursors prior to disinfection with free-chlorine. Empty bed contact time for GAC adsorption would be between 7 minutes and 9 minutes, based on seasonal variation in WTP production and number of filters in service. The GAC bed life was assumed to be 6 months, with media replacement for filters evenly spaced throughout the year. Water treatment plant configuration and operations, including chemical dosages, were otherwise the same as for baseline treatment.

The EPA WTP Model was used to predict DBP precursor removal provided after supplemental GAC treatment, and free-chlorine residual and DBP formation during conveyance through the AVC and distribution in participant consecutive systems. Total TOC removal achieved through full conventional treatment and GAC adsorption ranged between 55 percent and 59 percent, significantly greater than the 15 percent predicted for baseline treatment. Predicted chlorine residual was satisfactory throughout the AVC and participant consecutive systems, as shown in table 15. The same chlorine doses assumed for baseline treatment were applied following supplemental GAC treatment to provide similar levels of primary disinfection, and rechlorination at participant turnouts was not required. Regulated TTHM and HAA5 DBP species were significantly reduced by supplemental GAC treatment, and predicted levels in the AVC and participant consecutive systems were less than 80 percent of CDPHE MCLs (target values of 64 µg/L TTHM and 48 µg/L HAA5), as shown in tables 16 and 17.

Table 15. Chlorine Residuals in AVC and at the End of Consecutive Systems with GAC Treatment

Location	Disinfectant Residual, mg/L as Cl_2				
	Q1	Q2	Q3	Q4	LRAA
WTP effluent	2.2	2.4	2.5	2.4	2.38
Turnout at AVC location(1)					
Avondale	1.8	1.9	2.3	2.0	2.00
Fowler	1.6	1.8	2.2	1.9	1.88
La Junta	1.4	1.7	2.0	1.7	1.70
Las Animas	1.2	1.5	1.8	1.5	1.50
Lamar	1.1	1.4	1.7	1.4	1.40
Eads	1.0	1.3	1.6	1.3	1.30
End of consecutive system supplied from turnout at AVC location(2)					
Avondale	1.2	1.6	2.0	1.6	1.60
Fowler	1.2	1.5	1.9	1.5	1.53
La Junta	1.1	1.4	1.7	1.4	1.40
Las Animas	1.0	1.3	1.6	1.3	1.30
Lamar	0.9	1.2	1.5	1.2	1.20
Eads	0.8	1.1	1.4	1.1	1.10

(1) Water age in AVC based on hydraulic modeling per appendix H.

(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

Table 16. Predicted TTHM in AVC and at the End of Consecutive Systems with GAC Treatment

Location	TTHM, μg/L				
	Q1	Q2	Q3	Q4	LRAA
WTP effluent	9	10	10	10	9.8
Turnout at AVC location[(1)]					
Avondale	15.5	16.8	17.7	17.2	16.8
Fowler	17.8	19.1	20.1	19.6	19.1
La Junta	22.9	24.9	26.6	25.6	25.0
Las Animas	26.3	28.9	30.9	29.6	28.9
Lamar	29.4	31.8	33.6	32.7	31.9
Eads	31.9	34.1	35.6	35.0	34.1
End of consecutive system supplied from turnout at AVC location(2)					
Avondale	24.9	25.5	27.1	26.6	25.9
Fowler	26.1	26.8	28.3	27.5	27.2
La Junta	29.5	30.7	32.5	31.5	31.1
Las Animas	32.1	33.8	35.8	34.7	34.1
Lamar	34.7	36.3	38.0	37.2	36.5
Eads	36.7	38.2	39.7	39.2	38.5

(1) Water age in AVC based on hydraulic modeling per appendix H.

(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

Table 17. Predicted HAA5 in AVC and at the End of Consecutive Systems with GAC Treatment

Location	HAA5, μg/L				
	Q1	Q2	Q3	Q4	LRAA
WTP effluent	6	7	7	7	6.8
Turnout at AVC location(1)					
Avondale	8.1	9.7	10.8	9.7	9.6
Fowler	8.9	10.6	11.8	10.6	10.5
La Junta	10.8	12.7	14.2	12.7	12.6
Las Animas	12.0	14.2	15.7	14.2	14.0
Lamar	13.1	15.2	16.6	15.2	15.1

Table 17. Predicted HAA5 in AVC and at the End of Consecutive Systems with GAC Treatment

Location	HAA5, μg/L				
	Q1	Q2	Q3	Q4	LRAA
Eads	14.0	16.0	17.3	16.0	15.9
End of consecutive system supplied from turnout at AVC location(2)					
Avondale	11.5	12.9	14.4	12.9	12.9
Fowler	11.9	13.4	14.8	13.4	13.4
La Junta	13.2	14.8	16.3	14.8	14.8
Las Animas	14.1	15.9	17.4	15.9	15.8
Lamar	15.1	16.8	18.1	16.8	16.7
Eads	15.8	17.5	18.7	17.5	17.4

(1)Water age in AVC based on hydraulic modeling per appendix H.

(2)Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

3.5.4.4.3 Maintaining Combined-Chlorine Residual in the AVC

This disinfection option would provide all treatment necessary to comply with CDPHE primary drinking water standards (pretreatment, filtration, and primary and residual disinfection), followed by maintenance of a combined-chlorine residual throughout the AVC and associated on-line storage tanks. This disinfection option would require each participant to either break-point chlorinate to remove the combined chlorine residual from purchased AVC water, then rechlorinate prior to distribution, or convert any other supplies to a combined-chlorine residual. Mixing chlorinated and chloraminated drinking water in a distribution system is not advisable due to potential loss of disinfectant residual. Because of the significant operational, financial, and management issues for each AVC participant associated with breakpoint chlorination, it was not considered further.

As evaluated here, each participant would convert to maintain a combined-chlorine residual throughout its distribution system. AVC WTP plant configuration and operations, including chemical dosages, were otherwise the same as for baseline treatment. Additional treatment facilities to add ammonia to create a combined-chlorine residual in non-AVC supplies would be required for each participant under this option. Capital expenditures and increased annual OM&R costs would result for each participant, as well as an increased level of system maintenance and oversight.

The EPA WTP Model was used to predict DBP precursor removal provided by baseline full conventional treatment, and combined-chlorine residual and DBP formation during conveyance through the AVC and distribution in participant consecutive systems. Predicted TOC removal achieved through baseline treatment was 15 percent. Predicted combined-chlorine residual was satisfactory throughout the AVC and participant consecutive systems, as shown in table 18. The same chlorine doses and contact times assumed for baseline treatment were applied prior to formation of a combined-chlorine residual to provide similar levels of primary disinfection. Rechlorination at participant turnouts was not required. Regulated TTHM and HAA5 DBP species were significantly reduced by maintenance of a combined-chlorine residual in the AVC, and predicted levels in the AVC and participant consecutive systems were less than 80 percent of CDPHE MCLs (target values of 64 µg/L TTHM and 48 µg/L HAA5), as shown in tables 19 and 20.

Table 18. Chloramine Residuals in AVC and at the End of Consecutive Systems

Location	Disinfectant Residual, mg/L as Cl_2				
	Q1	Q2	Q3	Q4	RAA
WTP effluent	2.1	2.3	2.5	2.3	2.30
Turnout at AVC location[(1)]					
Avondale	2.0	2.3	2.5	2.3	2.28
Fowler	2.0	2.3	2.5	2.3	2.28
La Junta	1.9	2.2	2.4	2.2	2.18
Las Animas	1.8	2.1	2.4	2.1	2.10
Lamar	1.7	2.0	2.3	2.0	2.00
Eads	1.7	2.0	2.3	2.0	2.00
End of consecutive system supplied from turnout at AVC location[(2)]					
Avondale	1.8	2.2	2.4	2.2	2.15
Fowler	1.8	2.1	2.4	2.1	2.10
La Junta	1.7	2.1	2.3	2.1	2.05
Las Animas	1.7	2.0	2.3	2.0	2.00
Lamar	1.6	2.0	2.3	2.0	1.98
Eads	1.6	2.0	2.3	2.0	1.98

(1) Water age in AVC based on hydraulic modeling per appendix H.

(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

Table 19. Predicted TTHM in AVC and at the End of Consecutive Systems with Chloramine Residual

Location	TTHM, μg/L				
	Q1	Q2	Q3	Q4	LRAA
WTP effluent	18	19	19	19	18.8
Turnout at AVC location[(1)]					
Avondale	20.2	21.0	21.3	21.2	20.9
Fowler	20.7	21.5	21.8	21.8	21.5
La Junta	21.9	22.8	23.2	23.2	22.8
Las Animas	22.7	23.6	24.1	24.1	23.6
Lamar	23.3	24.2	24.7	24.8	24.3
Eads	23.8	24.7	25.1	25.3	24.7
End of consecutive system supplied from turnout at AVC location[(2)]					
Avondale	22.4	22.9	23.4	23.4	23.0
Fowler	22.6	23.2	23.6	23.6	23.3
La Junta	23.4	24.0	24.5	24.5	24.1
Las Animas	23.9	24.6	25.1	25.2	24.7
Lamar	24.4	25.1	25.5	25.7	25.2
Eads	24.8	25.5	25.8	26.2	25.6

(1) Water age in AVC based on hydraulic modeling per appendix H.

(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

Table 20. Predicted HAA5 in AVC and at the End of Consecutive Systems with Chloramine Residual

Location	HAA5, μg/L				
	Q1	Q2	Q3	Q4	LRAA
WTP effluent	16	18	20	18	18.0
Turnout at AVC location(1)					
Avondale	16.6	18.6	20.2	18.2	18.4
Fowler	16.7	18.6	20.2	18.3	18.5
La Junta	16.9	18.8	20.4	18.6	18.7
Las Animas	17.1	18.9	20.5	18.7	18.8
Lamar	17.2	19.0	20.6	18.8	18.9
Eads	17.3	19.0	20.7	18.9	19.0
End of consecutive system supplied from turnout at AVC location(2)					
Avondale	17.0	18.8	20.4	18.6	18.7
Fowler	17.1	18.9	20.5	18.6	18.8
La Junta	17.2	19.0	20.6	18.8	18.9
Las Animas	17.3	19.0	20.7	18.9	19.0
Lamar	17.4	19.1	20.7	19.0	19.1
Eads	17.4	19.1	20.8	19.1	19.1

(1) Water age in AVC based on hydraulic modeling per appendix H.

(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

3.5.4.5 Raw Water Conveyance Impacts on Water Treatment

Alternative 5 (River South) of the Draft AVC EIS would use the Arkansas River to deliver raw water from Pueblo Reservoir to a point just upstream of the confluence with Fountain Creek, followed by diversion through a river intake, pumping plant (drawing 7 in appendix F), and new pipeline to an AVC WTP site near St. Charles Mesa for treatment (drawing 26 in appendix F). Because the Arkansas River flows through an urban corridor between Pueblo Reservoir and the confluence with Fountain Creek, raw water delivered to the Alternative 5 AVC WTP site would be subject to water quality impacts related to industrial and municipal discharges, managed stormwater flows, and uncontrolled surface runoff. Water quality degradation associated with raw water conveyance through the Arkansas River could potentially have higher AVC WTP construction and OM&R costs than alternatives that would use a dedicated pipeline for raw water delivery.

Water quality in the Arkansas River near the river intake structure proposed for Alternative 5 was evaluated using available historical data for most parameters of interest, and estimated from known data for several other parameters of interest, as given in tables 21 and 22. Dissolved constituent concentrations in the Arkansas River generally increase between Pueblo Reservoir and the confluence of Fountain Creek, with increases of less that 10 percent to more than 50 percent, depending on the constituent and time of year, as indicated in table 23. Although the percentage of increase in turbidity is quite large (because quarterly median values at Pueblo Reservoir are typically low), predicted values at the Alternative 5 river intake location are still well within the range considered suitable for full conventional treatment.

Table 21. Historical Water Quality in the Arkansas River Above Pueblo, Colorado(1)

Parameter	Q1	Q2	Q3	Q4
Temperature, ºC	4.6	11.6	20.0	8.0
Dissolved oxygen , mg/L	11.3	9.8	8.1	9.3
pH, s.u.	8.4	8.2	8.1	8.3
Alkalinity, mg/L as $CaCO_3$	113	109	87	113
Hardness, mg/L as $CaCO_3$	221	231	163	216
TDS, mg/L	348	352	269	333
Sodium, mg/L	25	25	17	25
Chloride, mg/L	8.6	9.1	6.1	8.7
Bromide(2), μg/L	25	27	18	26
Fluoride, mg/L	0.59	0.53	0.46	0.53
Sulfate, mg/L	140	149	90	130
TOC(3), mg/L	2.0	2.2	2.3	2.2
Turbidity(3), NTU	1.7	3.4	6.3	5.1

(1) From USGS Station 07099400 (http://waterdata.usgs.gov/nwis) for the period 1990 through 2010. Only data paired with data from USGS Station 07099970 were used to calculate quarterly mean values.
(2) Bromide calculated based on correlation with chloride concentration (Magazinovic, 2004).
(3) TOC and turbidity data provided by BWWP for the period 1998 to 2009.

Table 22. Historical Water Quality in the Arkansas River at Moffat St. at Pueblo, Colorado(1)

Parameter	Q1	Q2	Q3	Q4
Temperature, °C	6.3	13.3	21.0	7.6
Dissolved oxygen, mg/L	12.4	9.7	8.5	9.9
pH, s.u.	8.4	8.4	8.4	8.4
Alkalinity, mg/L as $CaCO_3$	122	112	94	126
Hardness, mg/L as $CaCO_3$	266	242	181	294
TDS, mg/L	427	394	309	373
Sodium, mg/L	34	27	20	38
Chloride, mg/L	13.5	10	7.3	14.0
Bromide(2), µg/L	40	29	22	41
Fluoride, mg/L	0.59	0.55	0.50	0.60
Sulfate, mg/L	188	160	110	203
TOC(3), mg/L	2.5	2.5	2.6	2.5
Turbidity(4), NTU	6.7	9.3	29.3	12.0

(1) From USGS Station 07099970 (http://waterdata.usgs.gov/nwis) for the period 1990 through 2010. Only data paired with data from USGS Station 07099400 used to calculate quarterly mean values.

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

(3) TOC estimated based on change in TDS between USGS Station 07099400 and USGS Station 07099970 (see table 21).

(4) Estimated as turbidity = total suspended sediment/1.5.

The AVC WTP facilities for Alternative 5 would include presedimentation to reduce the impact of high turbidity episodes in the Arkansas River prior to coagulation of raw water. The principal impact of raw water conveyance that uses the Arkansas River on treatment performance within the AVC WTP is anticipated to be related to TOC removal and subsequent DBP formation. Incrementally higher construction and OM&R costs associated with the AVC WTP as developed for Alternative 5 are discussed in subsection 8.1. The impact of raw water conveyance in the Arkansas River on AVC WTP treatment performance and finished water quality was evaluated for the three disinfection options that could potentially be used to mitigate DBP formation in the AVC and maintain an appropriate disinfectant residual in AVC participant consecutive systems described in subsection 3.5.4.4. The baseline treatment configuration was not evaluated further because of the elevated DBP levels (as described in subsection 3.5.4.3).

Table 23. Percent Change in Historical Water Quality in the Arkansas through Pueblo, Colorado(1)

Parameter	Q1	Q2	Q3	Q4
Temperature, °C	37.0	15.2	5.0	-5.0
Dissolved oxygen , mg/L	9.7	-1.5	5.6	6.5
pH, s.u.	0.6	2.4	3.7	1.2
Alkalinity, mg/L as $CaCO_3$	8.0	2.8	7.5	11.1
Hardness, mg/L as $CaCO_3$	20.4	4.5	11.0	36.1
TDS, mg/L	22.9	12.0	15.0	12.1
Sodium, mg/L	37.9	6.7	20.0	54.7
Chloride, mg/L	55.7	10.5	19.7	60.9
Bromide, µg/L	55.7	10.5	19.7	60.9
Fluoride, mg/L	0.0	4.8	9.9	13.2
Sulfate, mg/L	34.4	7.7	22.2	56.4
TOC(2), mg/L	22.9	12.0	15.0	12.1
Turbidity, NTU	292	174	366	135

(1) Calculated as the difference between quarterly mean values from USGS Station 07099970 (table 22) and USGS Station 07099400 (table 21).
(2) Estimated based on change in TDS.

3.5.4.5.1 Adding Disinfectant Residual at Each Participant Turnout

This disinfection option would provide full conventional treatment (pretreatment, filtration, and primary disinfection) at the AVC WTP to produce filtered water that would comply with CDPHE primary drinking water standards in all regards, except that a disinfectant residual would not be maintained during conveyance through the AVC and associated on-line storage tanks. Under this strategy, a free-chlorine residual would be added at each participant turnout and would be monitored by each respective consecutive water system. Design parameters were the same as those used in subsection 3.5.4.4.1 to evaluate conveyance of filtered water through the AVC in Alternative 5, which uses the Arkansas River to convey raw water to the AVC WTP. Water treatment plant configuration and operations, including chemical dosages, would otherwise be the same as for baseline treatment.

Chlorination facilities would be required at each participant turnout, which could potentially be combined with existing disinfection facilities on a case-by-case basis. The capability to disinfect the AVC and on-line storage tanks periodically would be included in this disinfection option. Each participant would be responsible for residual disinfectant addition at the point of delivery. Capital expenditures and increased annual OM&R costs would result for each participant, as well as the potential for an increased level of system maintenance and oversight.

The EPA WTP Model was used to predict DBP precursor removal provided by baseline full conventional treatment, as well as free-chlorine residual and DBP formation resulting from primary disinfection in the AVC WTP and subsequent rechlorination at the entry points to participant consecutive systems. Predicted TOC removal achieved through baseline treatment was 15 percent. Free-chlorine dose applied prior to the AVC WTP DCB for primary disinfection was seasonally adjusted to meet the CT requirements of the CPDWR (CDPHE, 2010b) with residual free-chlorine chemically quenched at the DCB outlet. Free-chlorine dose at AVC participant turnouts was seasonally adjusted to provide a residual of 0.2 mg/L as Cl_2 at the end of the consecutive systems. Predicted free-chlorine residual was satisfactory throughout participant consecutive systems, as shown in table 24. Predicted TTHM and HAA5 DBP levels were somewhat higher when raw water was conveyed to the AVC WTP in the Arkansas River (approximately 23 percent and 16 percent, respectively), and predicted levels in the AVC were less than 80 percent of CDPHE MCLs (target values of 64 µg/L TTHM and 48 µg/L HAA5), as shown in tables 25 and 26. However, predicted TTHM levels at the end of consecutive systems were slightly higher than 80 percent of the CDPHE MCL.

Table 24. Free-Chlorine Residuals in AVC and at the End of Consecutive Systems with Free-Chlorine Residual Added at Turnouts from AVC to Participant Consecutive Systems: Raw Water Conveyed to the AVC WTP Site through the Arkansas River

Location	Disinfectant Residual, mg/L as Cl_2				
	Q1	Q2	Q3	Q4	RAA
WTP effluent	n/a	n/a	n/a	n/a	n/a
Turnout at AVC location[(1)]					
Avondale	n/a	n/a	n/a	n/a	n/a
Fowler	n/a	n/a	n/a	n/a	n/a
La Junta	n/a	n/a	n/a	n/a	n/a
Las Animas	n/a	n/a	n/a	n/a	n/a
Lamar	n/a	n/a	n/a	n/a	n/a
Eads	n/a	n/a	n/a	n/a	n/a

Table 24. Free-Chlorine Residuals in AVC and at the End of Consecutive Systems with Free-Chlorine Residual Added at Turnouts from AVC to Participant Consecutive Systems: Raw Water Conveyed to the AVC WTP Site through the Arkansas River

	Disinfectant Residual, mg/L as Cl_2				
Location	**Q1**	**Q2**	**Q3**	**Q4**	**RAA**
End of consecutive system supplied from turnout at AVC location(2)					
Avondale	0.2	0.2	0.2	0.2	0.2
Fowler	0.2	0.2	0.2	0.2	0.2
La Junta	0.2	0.2	0.2	0.2	0.2
Las Animas	0.2	0.2	0.2	0.2	0.2
Lamar	0.2	0.2	0.2	0.2	0.2
Eads	0.2	0.2	0.2	0.2	0.2

(1) Water age in AVC based on hydraulic modeling per appendix H.

(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

Table 25. Predicted TTHM in AVC and at the End of Consecutive Systems with Free-Chlorine Residual Added at Turnouts from AVC to Participant Consecutive Systems: Raw Water Conveyed to the AVC WTP Site through the Arkansas River

	TTHM, μg/L				
Location	**Q1**	**Q2**	**Q3**	**Q4**	**LRAA**
WTP effluent	24	22	22	23	22.8
Turnout at AVC location(1)					
Avondale	24	22	22	23	22.8
Fowler	24	22	22	23	22.8
La Junta	24	22	22	23	22.8
Las Animas	24	22	22	23	22.8
Lamar	24	22	22	23	22.8
Eads	24	22	22	23	22.8
End of consecutive system supplied from turnout at AVC location(2)					
Avondale	75.0	62.7	61.2	63.2	65.5
Fowler	75.0	62.7	61.2	63.2	65.5
La Junta	75.0	62.7	61.2	63.2	65.5
Las Animas	75.0	62.7	61.2	63.2	65.5
Lamar	75.0	62.7	61.2	63.2	65.5
Eads	75.0	62.7	61.2	63.2	65.5

(1) Water age in AVC based on hydraulic modeling per appendix H.

(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

Table 26. Predicted HAA5 in AVC and at the End of Consecutive Systems with Free-Chlorine Residual Added at Turnouts from AVC to Participant Consecutive Systems: Raw Water Conveyed to the AVC WTP Site through the Arkansas River

Location	HAA5, μg/L				
	Q1	Q2	Q3	Q4	LRAA
WTP effluent	19	19	21	19	19.5
Turnout at AVC location(1)					
Avondale	19	19	21	19	19.5
Fowler	19	19	21	19	19.5
La Junta	19	19	21	19	19.5
Las Animas	19	19	21	19	19.5
Lamar	19	19	21	19	19.5
Eads	19	19	21	19	19.5
End of consecutive system supplied from turnout at AVC location(2)					
Avondale	45.1	41.3	43.1	39.4	42.2
Fowler	45.1	41.3	43.1	39.4	42.2
La Junta	45.1	41.3	43.1	39.4	42.2
Las Animas	45.1	41.3	43.1	39.4	42.2
Lamar	45.1	41.3	43.1	39.4	42.2
Eads	45.1	41.3	43.1	39.4	42.2

(1) Water age in AVC based on hydraulic modeling per appendix H.
(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

3.5.4.5.2 Adding Treatment to Allow Free-Chlorine Residual in the AVC

Replacing anthracite in the granular media filters of the AVC WTP with GAC was evaluated as an additional treatment step to further reduce DBP precursors prior to disinfection with free-chlorine. Design parameters were the same as those used in subsection 3.5.4.4.2 to evaluate additional GAC treatment for Alternatives 1 through 4 that use a dedicated pipeline to convey raw water to the AVC WTP. Water treatment plant configuration and operations, including chemical dosages, would be otherwise the same as for baseline treatment.

The EPA WTP Model was used to predict DBP precursor removal provided after supplemental GAC treatment, and free-chlorine residual and DBP formation during conveyance through the AVC and distribution in participant consecutive systems. Due to slightly higher influent TOC when raw water is conveyed to the AVC WTP in the Arkansas River, total TOC removal achieved through full conventional treatment and GAC adsorption was marginally lower, ranging between 53 percent and 55 percent. Predicted chlorine residual was slightly lower when raw water was conveyed to the AVC Alternative 5 WTP site, but it was still satisfactory throughout the AVC and participant consecutive systems, as shown in table 27. The same chlorine doses assumed for baseline treatment were applied following supplemental GAC treatment to provide similar levels of primary disinfection. Rechlorination at participant turnouts was not required. Predicted TTHM and HAA5 DBP levels were somewhat higher when raw water was conveyed to the AVC WTP in the Arkansas River (approximately 38 percent and 21 percent, respectively), but they were still significantly less than 80 percent of CDPHE MCLs (target values of 64 µg/L TTHM and 48 µg/L HAA5) in the AVC and participant consecutive systems, as shown in tables 28 and 29.

Table 27. Chlorine Residuals in AVC and at the End of Consecutive Systems with GAC Treatment: Raw Water Conveyed to the AVC WTP through the Arkansas River

Location	Disinfectant Residual, mg/L as Cl_2				
	Q1	Q2	Q3	Q4	LRAA
WTP effluent	2.0	2.3	2.5	2.3	2.28
Turnout at AVC location[(1)]					
Avondale	1.6	2.0	2.2	2.0	1.95
Fowler	1.4	1.8	2.1	1.8	1.78
La Junta	1.0	1.5	1.9	1.5	1.48
Las Animas	0.8	1.2	1.6	1.2	1.20
Lamar	0.6	1.1	1.5	1.1	1.08
Eads	0.5	1.0	1.4	1.0	0.98
End of consecutive system supplied from turnout at AVC location[(2)]					
Avondale	0.9	1.5	1.8	1.5	1.43
Fowler	0.8	1.4	1.7	1.4	1.33
La Junta	0.6	1.2	1.6	1.2	1.15
Las Animas	0.5	1.0	1.4	1.0	0.98
Lamar	0.4	0.9	1.3	0.9	0.88
Eads	0.4	0.9	1.3	0.9	0.88

(1) Water age in AVC based on hydraulic modeling per appendix H.
(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

Table 28. Predicted TTHM in AVC and at the End of Consecutive Systems with GAC Treatment: Raw Water Conveyed to the AVC WTP through the Arkansas River

Location	TTHM, µg/L				
	Q1	Q2	Q3	Q4	LRAA
WTP effluent	15	13	13	14	13.8
Turnout at AVC location(1)					
Avondale	23.8	20.8	21.6	22.4	22.2
Fowler	27.8	24.2	25.0	26.0	25.7
La Junta	36.6	32.0	33.7	34.5	34.2
Las Animas	42.2	37.3	39.3	40.1	39.7
Lamar	47.5	41.2	42.7	44.3	43.9
Eads	51.7	44.1	45.4	47.5	47.2
End of consecutive system supplied from turnout at AVC location(2)					
Avondale	39.9	32.9	34.4	35.4	35.6
Fowler	42.0	34.6	35.9	37.2	37.7
La Junta	47.8	39.7	41.4	42.7	42.9
Las Animas	52.1	43.8	45.6	47.1	47.7
Lamar	56.4	47.0	48.4	50.5	50.6
Eads	59.9	49.5	50.6	53.3	53.3

(1) Water age in AVC based on hydraulic modeling per appendix H.

(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

Table 29. Predicted HAA5 in AVC and at the End of Consecutive Systems with GAC Treatment: Raw Water Conveyed to the AVC WTP through the Arkansas River

Location	HAA5, µg/L				
	Q1	Q2	Q3	Q4	LRAA
WTP effluent	8	8	8	8	8.0
Turnout at AVC location(1)					
Avondale	11.3	11.4	12.2	10.9	11.4
Fowler	12.5	12.6	13.5	12.0	12.7
La Junta	15.1	15.3	16.6	14.6	15.4
Las Animas	16.7	17.0	18.4	16.3	17.1
Lamar	18.2	18.2	19.5	17.6	18.4
Eads	19.3	19.1	20.4	18.5	19.3
End of consecutive system supplied from turnout at AVC location(2)					
Avondale	16.0	15.5	16.8	14.9	15.8
Fowler	16.6	16.1	17.3	15.4	16.4
La Junta	18.2	17.7	19.1	17.1	18.0
Las Animas	19.4	19.0	20.4	18.4	19.3
Lamar	20.5	20.0	21.3	19.4	20.3
Eads	21.4	20.7	22.0	20.2	21.1

(1) Water age in AVC based on hydraulic modeling per appendix H.
(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

3.5.4.5.3 Combined-Chlorine Residual in the AVC

This disinfection option would provide all treatment necessary to comply with CDPHE primary drinking water standards (pretreatment, filtration, and primary and residual disinfection), followed by maintenance of a combined-chlorine residual throughout the AVC and associated on-line storage tanks. As evaluated here, each participant would convert to maintenance of a combined-chlorine residual throughout its distribution system. Design parameters were the same as those used in subsection 3.5.4.4.3 to evaluate combined-chlorine residual for Alternatives 1 through 4 that use a dedicated pipeline to convey raw water to the AVC WTP. Water treatment plant configuration and operations, including chemical dosages, were otherwise the same as for baseline treatment.

Additional treatment facilities would be required for each participant under this option to add ammonia to create a combined-chlorine residual in non-AVC supplies. Capital expenditures and increased annual OM&R costs would result for each participant, as well as an increased level of system maintenance and oversight.

The EPA WTP Model was used to predict DBP precursor removal provided by baseline full conventional treatment, and combined-chlorine residual and DBP formation during conveyance through the AVC and distribution in participant consecutive systems. Predicted TOC removal achieved through baseline treatment was 15 percent. Predicted chlorine residual was slightly lower when raw water was conveyed to AVC Alternative 5 WTP site using the Arkansas River, but it was still satisfactory throughout the AVC and participant consecutive systems, as shown in table 30. The same chlorine doses and contact times assumed for baseline treatment were applied prior to formation of a combined-chlorine residual to provide similar levels of primary disinfection. Rechlorination at participant turnouts was not required. Predicted TTHM and HAA5 DBP levels were somewhat higher when raw water was conveyed to the AVC WTP in the Arkansas River (approximately 22 percent and 12 percent respectively), but they were still significantly less than 80 percent of CDPHE MCLs (target values of 64 µg/L TTHM and 48 µg/L HAA5) in the AVC and participant consecutive systems, as shown in tables 31 and 32.

Table 30. Chloramine Residuals in AVC and at the End of Consecutive Systems: Raw Water Conveyed to the AVC WTP through the Arkansas River

Location	Disinfectant Residual, mg/L as Cl2				
	Q1	Q2	Q3	Q4	RAA
WTP effluent	1.9	2.3	2.5	2.3	2.25
Turnout at AVC location(1)					
Avondale	1.9	2.3	2.5	2.2	2.22
Fowler	1.8	2.2	2.4	2.2	2.15
La Junta	1.7	2.1	2.4	2.1	2.08
Las Animas	1.6	2.0	2.3	2.0	1.98
Lamar	1.6	2.0	2.3	2.0	1.98
Eads	1.5	1.9	2.2	1.9	1.88
End of consecutive system supplied from turnout at AVC location(2)					
Avondale	1.7	2.1	2.4	2.1	2.08
Fowler	1.6	2.1	2.4	2.1	2.05
La Junta	1.6	2.0	2.3	2.0	1.98
Las Animas	1.5	1.9	2.2	1.9	1.88
Lamar	1.4	1.9	2.2	1.9	1.85
Eads	1.3	1.9	2.2	1.9	1.83

(1) Water age in AVC based on hydraulic modeling per appendix H.

(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

Table 31. Predicted TTHM in AVC and at the End of Consecutive Systems with Chloramine Residual: Raw Water Conveyed to the AVC WTP through the Arkansas River

Location	TTHM, μg/L				
	Q1	Q2	Q3	Q4	LRAA
WTP effluent	25	22	22	23	23.0
Turnout at AVC location⁽¹⁾					
Avondale	27.2	24.3	24.1	25.5	25.3
Fowler	28.0	25.1	24.7	26.3	26.0
La Junta	29.8	26.7	26.4	28.0	27.7
Las Animas	30.9	27.8	27.4	29.1	28.8
Lamar	31.9	28.5	28.0	29.9	29.6
Eads	32.7	29.1	28.5	30.4	30.2
End of consecutive system supplied from turnout at AVC location⁽²⁾					
Avondale	30.4	26.9	26.5	28.2	28.0
Fowler	30.8	27.2	26.8	28.5	28.3
La Junta	31.9	28.3	27.8	29.6	29.4
Las Animas	32.7	29.0	28.5	30.4	30.2
Lamar	33.5	29.6	29.0	31.0	30.8
Eads	34.2	30.1	29.4	31.5	31.3

(1) Water age in AVC based on hydraulic modeling per appendix H.

(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

Table 32. Predicted HAA5 in AVC and at the End of Consecutive Systems with Chloramine Residual: Raw Water Conveyed to the AVC WTP through the Arkansas River

Location	HAA5, μg/L				
	Q1	Q2	Q3	Q4	LRAA
WTP effluent	19	20	22	19	20.0
Turnout at AVC location[1]					
Avondale	19.1	20.5	22.5	19.7	20.5
Fowler	19.3	20.6	22.7	19.8	20.6
La Junta	19.7	20.8	22.9	19.9	20.8
Las Animas	19.9	20.9	23.1	20.0	21.0
Lamar	20.2	21.0	23.2	20.0	21.1
Eads	20.4	21.0	23.3	20.0	21.2
End of consecutive system supplied from turnout at AVC location[2]					
Avondale	19.8	20.8	22.9	19.9	20.9
Fowler	19.9	20.9	23.0	19.9	20.9
La Junta	20.2	21.0	23.1	20.0	21.1
Las Animas	20.4	21.0	23.3	20.0	21.2
Lamar	20.7	21.1	23.3	20.0	21.3
Eads	20.9	21.1	23.4	20.1	21.4

(1) Water age in AVC based on hydraulic modeling per appendix H.
(2) Water age in consecutive systems calculated based on an assumed maximum residence time of 10 days and maximum age/average age = 2.39 and average age/minimum age = 2.15.

3.5.5 Regulatory Considerations for AVC Water Treatment

The Draft AVC EIS water treatment option, illustrated on figure 3 and outlined in subsection 3.5.2, is based on proven technologies that have been successfully used to treat surface water supplies along the Front Range of Colorado with water quality similar to that expected in Pueblo Reservoir and the Arkansas River upstream of the confluence with Fountain Creek. Process options presented in subsection 3.5.4 were sized using preliminary design parameters that are consistent with CDPHE design criteria (CDPHE, 1997). Discussions with CDPHE WQCD staff indicate that the three disinfection options outlined in Subsection 3.5.4.4 to mitigate DBP formation in the AVC and maintain an appropriate disinfectant residual in AVC participant consecutive systems (adding disinfectant residual at each AVC participant turnout, adding treatment to allow maintenance of a free-chlorine residual in the AVC, or maintaining a combined-chlorine residual in the AVC) are consistent with the requirements set forth in the CPDWR (CDPHE, 2010b). WQCD issued preliminary Public Water System Identification Number for the AVC WTP (Lori Gerzina, personal communication, September 2011) (Public Water System Identification Number CO 0151120).

The Safe Drinking Water Act (SDWA) and its amendments require that the EPA reevaluate existing drinking water regulations on a periodic basis and develop and promulgate new standards and regulations as necessary to protect public health. The purpose of the review, termed the *Six-Year Review*, is to identify those National Primary Drinking Water Regulations for which current health effects assessments, changes in technology, and/or other factors provide a health or technical basis to support a regulatory revision that will maintain or strengthen public health protection.

The SDWA also requires EPA to publish a Contaminant Candidate List (CCL) every 5 years of contaminants that are not currently regulated but are known or anticipated to occur in public water systems. The CCLs are used to set regulatory, research, and occurrence-investigation priorities within EPA. Contaminants of emerging concern contained in CCL 3 (EPA, 2009) include 116 microbial pathogens, inorganic compounds, synthetic organic chemicals, hormones, and pharmaceuticals. Current regulatory schedules call for final determinations regarding the need to regulate at least five of the contaminants listed in the CCL 3 by 2013, which may include one or more of the microbial pathogens listed. EPA would then have 3.5 years to finalize MCLs for any contaminants selected for regulation.

The following sections outline several considerations related to compliance of the proposed AVC WTP with existing, pending, and potential future drinking water regulations.

3.5.5.1 Disinfection Byproducts

Analysis of the AVC WTP baseline treatment approach (subsection 3.5.4.3) indicates that levels of regulated DBPs near or above their legally enforceable primary MCLs may form during conveyance in the AVC and subsequent distribution through participant consecutive systems. Each of the disinfection options proposed to mitigate DBP formation in the AVC and participant consecutive systems (adding of disinfectant residual at each AVC participant turnout, adding treatment to allow maintenance of a free-chlorine residual in the AVC, or maintaining a combined-chlorine residual in the AVC) substantially lowered regulated DBP levels compared to the baseline treatment approach and met regulated DBP MCLs for raw water conveyed to the AVC WTP sites through either a dedicated pipeline or through the Arkansas River. Model results indicated that target DBP values (64 µg/L TTHM and 48 µg/L HAA5) at the end of participants consecutive systems were also generally met, except for levels of TTHM formation when raw water would be conveyed to the AVC WTP using the Arkansas River.

CCL 3 lists five organic nitrogen-containing compounds (four nitrosamines and nitrosopyrrolidine) that have been detected in treated drinking water. Formation of these compounds is associated with disinfection with free-chlorine in the presence of ammonia (either naturally occurring in the source water or added to treated water to form a combined-chlorine residual). Formation of these nitroso-compounds requires a nitrogenous organic precursor. Dimethylamine has been shown to be particularly reactive in formation of N-nitrosodimethylamine (NDMA) in drinking water, with formation from several other less reactive precursors possible. Occurrence data for precursors of these compounds in Pueblo Reservoir and the Arkansas River above the confluence with Fountain Creek were not available for review here. The AVC WTP drinking water treatment facilities outlined in subsection 3.5.2 do not have an effective barrier for these disinfection byproducts that contain nitrogen, and additional treatment processes such as photolysis by UV, membrane selective processes, or biological treatment would be required to comply with a potential future standard.

3.5.5.2 Microbial Pathogens

Existing monitoring data for Pueblo Reservoir and the Arkansas River upstream of the confluence with Fountain Creek indicate that the source water for the AVC WTP would be classified in Stage 2 D/DBPR Bin 1, and no additional treatment for *Cryptosporidium* removal/inactivation would be required. However, if future changes in the watershed of the AVC WTP water supply increase *Cryptosporidium* levels, additional removal/inactivation credit may be required, which could include new or enhanced pretreatment, filtration, and/or disinfection treatment processes.

Proposed revisions to the Total Coliform Rule (TCR) were published by EPA in July 2010. The Revised Total Coliform Rule (RTCR) is currently expected to be finalized during mid- to late 2012, and it would become effective 3 years later. The intent of the RTCR is to increase public health protection by reducing potential pathways of entry for fecal contamination into the distribution system. As *E. coli* is considered to be a more specific indicator of fecal contamination and the potential presence of harmful pathogens than total coliform bacteria, the proposed RTCR reflects a shift in compliance requirements that focuses more on the presence/absence of *E. coli* in the distribution system. As with the current TCR, provisions of the proposed RTCR will apply to all public water systems.

Because the RTCR focuses primarily on distribution systems, it will likely have little or no impact on required treatment or operation at the AVC WTP.

CCL 3 lists 12 microbial pathogens that will be evaluated for potential future regulation. Occurrence of these bacterial and viral pathogens in the AVC WTP water supply has not been established. However, the drinking water treatment component of the Draft AVC EIS is based on a multi-barrier approach that includes effective removal and inactivation processes for these classes of microbial pathogens.

3.5.5.3 Fluoride

The optimal fluoride level is determined based upon the ambient air temperature of the geographic region. In January 2011, the United States Department of Health and Human Services (HHS) announced a recommendation that fluoride levels in drinking water be set at an optimal level of 0.7 mg/L. Concurrent with the HHS announcement, EPA announced plans to initiate a review of the current MCL and maximum contaminant level goal (MCLG) for fluoride. HHS's proposed recommendation would replace the 1962 United States Public Health Standard of 0.7 to 1.2 mg/L. HHS believes that this revised optimal concentration will provide the best balance of public protection from dental caries and the desire to limit the risk of dental fluorosis (spotting/pitting damage to tooth enamel), particularly in children.

HHS is expected to publish final guidance on fluoridation of public water supplies during 2012. While the HHS guidance is advisory, rather than regulatory, EPA could elect to modify current regulations governing maximum fluoride levels in response to the HHS recommendations and to the agency's review of recent research results. Review of historical water quality data for Pueblo Reservoir and the Arkansas River above the confluence with Fountain Creek (subsection 3.5.4.5, tables 21 and 22) indicates that the HHS recommendation for fluoride in drinking water would likely be met by the AVC WTP without additional treatment.

3.5.5.4 Radionuclides

Naturally occurring radionuclides have historically been present in the Arkansas River and Pueblo Reservoir at concentrations well below their respective CPDWR standards. Treatment for radionuclide removal is, therefore, not currently provided by Front Range utilities that convey source water from Pueblo Reservoir and is not explicitly included in the AVC WTP process options described in subsection 3.5.2. However, incidental removal of radionuclides, particularly uranium, does occur through incorporation in coagulation process solids. Thus, radionuclides may be concentrated in dewatered solid residuals, which are classified as technologically enhanced naturally occurring radioactive material (TENORM).

Disposal of radioactively contaminated wastes is regulated by many Federal and State agencies and codes, including the United States Nuclear Regulatory Commission (NRC), SDWA, Clean Water Act, Atomic Energy Act, Resource Conservation and Recovery Act (RCRA), National Pollutant Discharge Elimination System, Department of Transportation, and Hazardous Materials and Waste Management Division within CDPHE. Residual disposal options depend on the quantity, concentration, and chemical identity of radioactive contamination in a solid waste. Incidental removal of trace levels of radionuclides by conventional treatment produces a diffuse solid waste classified as low level radioactive waste (LLRW) that is not subject to NRC regulation.

CDPHE regulates disposal of TENORM produced at drinking water treatment facilities in Colorado as a type of solid waste within the broader LLRW classification (CDPHE, 2007). Disposal criteria based on specific activity of combined ^{226}Ra and ^{228}Ra, ^{NAT}U, and ^{NAT}Th are listed in table 33. Conventional drinking water treatment plants that use surface waters originating in the Rocky Mountains typically produce dewatered solid residuals that are classified in Tier 1 (Exempt) or Tier 2 (municipal solid waste landfill – MSWLF). The TENORM disposal classification at any given facility may vary from year to year based on recent hydrologic conditions and treatment operations.

Table 33. TENORM Disposal Tiers Based on Specific Activity (CDPHE, 2007)

Tier	Combined $^{226/228}$Ra (pCi/g)$^{(1)}$	^{NAT}U (pCi/g)$^{(1)}$	^{NAT}Th (pCi/g)$^{(1)}$
Exempt	< 3	< 30	< 3
Approved MSWLF or compost	< 10	< 100	< 10
Industrial landfill	< 50	< 300	< 50
RCRA C hazardous waste landfill	< 400	0.05 wt %	0.05 wt %

(1) Specific activity above background values for ^{226}Ra of 1.4 pCi/g, ^{228}R of 1.3 pCi/g, ^{NAT}U of 2.4 pCi/g, and ^{NAT}Th of 1.3 pCi/g (average picocuries per gram).

3.5.5.5 Perchlorate

On February 11, 2011, EPA published its decision to move forward with the development of a regulation for perchlorate in the *Federal Register*. Under the current regulatory development framework, a proposed MCL for perchlorate is expected no later than mid-February 2013, and a final MCL no later than mid-August 2014, with compliance required by August 2017. Occurrence data for perchlorate in Pueblo Reservoir and the Arkansas River above the confluence with Fountain Creek were not available for review here. The AVC WTP drinking water treatment facilities outlined in subsection 3.5.2 do not have an effective barrier for perchlorate, and additional treatment processes such as ion exchange, membrane selective processes, or biofiltration would be required to comply with a potential future perchlorate standard.

3.5.5.6 Hexavalent Chromium

Hexavalent chromium (Cr^{6+}) has come under increased scrutiny recently with the release of a study in December 2010 (Environmental Working Group, 2010) that found levels of hexavalent chromium exceeding the nonenforceable public health goal set by the California Department of Health in the tap water of 31 of 35 United States cities tested. EPA began a rigorous and comprehensive review of hexavalent chromium health effects following the release of the toxicity studies by the National Toxicology Program in 2008. In September, 2010, EPA released a draft scientific assessment for public comment and external peer review. When this human health assessment is finalized in 2015, EPA will carefully review the conclusions and consider all relevant information to determine if a new standard needs to be set. Occurrence data for hexavalent chromium in Pueblo Reservoir and the Arkansas River above the confluence with Fountain Creek were not available for review. The AVC WTP drinking water treatment facilities outlined in subsection 3.5.2 do not have an effective barrier for hexavalent chromium, and additional treatment processes such as ion exchange or membrane selective processes will be required to comply with a potential future hexavalent chromium standard.

3.5.6 AVC Treatment Facilities Construction Duration

Construction duration for drinking water treatment facilities of this type and capacity typically ranges between 24 and 36 months, depending on the method of project delivery: the traditional design-bid-build project delivery method would require approximately 12 months longer than an accelerated design-build project delivery approach. With the exception of minor differences in the chemical feed systems, the treatment facilities are essentially the same for Draft AVC EIS Action Alternatives and would require similar construction duration. The presedimentation basins included in Alternative 5 (River South) that use the Arkansas River to convey raw water to the AVC WTP could be constructed in parallel with other treatment facilities and would not prolong construction of this alternative compared to others. Extensive preparation of the AVC WTP site for Alternative 3 (Joint Use Pipeline North), including removal of existing decommissioned WTP facilities and abandoned materials, clearing of trees and vegetation, and backfill and compaction, would extend the construction duration an additional 3 to 6 months compared with other Draft AVC EIS Action Alternatives.

3.5.7 AVC Treatment Facilities Staffing Requirements

Staffing levels at drinking water treatment facilities vary widely, based on a number of factors including facility capacity, technologies used, extent of automation, facility age, facility location, and specific utility preferences. Because the operating arrangements of the proposed AVC WTP options have not been established yet, typical staffing levels used at facilities of similar size and process complexity were assumed for this analysis. Because of the large number of the participants' consecutive systems that would be served by the AVC WTP, continuously manned operation 365 days per year was specified. Routine daily operation of AVC WTP facilities was assumed to be conducted in two 12-hour shifts. Training and certification of water treatment plant operators per CDPHE Regulation 100 was assumed (CDPHE, 2010a). Table 34 lists drinking water treatment staffing for the AVC WTP (distribution system operations staff required to operate the AVC are not included).

Table 34. AVC Water Treatment Plant Operations Staff

WTP Staff Function	Number
Treatment Operations Supervisor	1
Process Optimization Specialist	1
Administration/Clerical	1
Lead Plant Operator (A Certification)	2
Plant Operator (B Certification)	2
Plant Operator (C Certification)	2
Plant Operator (D Certification)	1
Laboratory Technician	2
Mechanical Operator	2
Electrical Operator	1
Instrumentation/Controls Technician	1
SCADA Technician	1

3.6 Overview of Design Criteria

This section presents additional detail on the design criteria for the selected components and their options including pipeline hydraulics and design requirements, pipeline appurtenances, pipeline surge, pumping plants and associated facilities, water treatment facilities, and on-line storage facilities.

3.6.1 Pipeline

A pipeline beginning at Pueblo Dam and Reservoir and ending at Lamar would serve as the primary conveyance to deliver water. The pipeline would be buried with approximately 3 to 5 feet of cover. In urban areas, the pipeline would be buried at a depth below existing storm and sewer lines, as well as other buried utilities. Casing pipes may be required around the carrier pipe when crossing sewer lines. The pipeline would be sized to deliver year 2070 maximum day demands. This analysis did not include plans for a future parallel pipeline or additional pumping to increase capacity. Primary spur pipelines would be used along Highway 96 between Manzanola or Rocky Ford and La Junta (looped per the alternatives), and to serve Eads and May Valley. Shorter spur pipelines would be used to deliver water to the participants located along the primary conduit.

3.6.1.1 Pipeline Hydraulics

Section 2 discussed the water demands that were used in the alternative analysis. The 2070 demands and demand peak factors were calculated using the responses from questionnaires, the CWCB analyses, allocated Fry-Ark Project water, historical information from the participants, and discussions with the participants.

AVC hydraulics and pipeline sizing were based on the maximum day demands from 2070. The pipeline design flows, hydraulic gradients, and diameters are presented in appendix H.

The maximum water surface in Pueblo Reservoir (top of active conservation pool) is El. 4880. The minimum ground elevation west of Lamar is approximately El. 3640. The total drop is approximately 1,240 feet, which could impose a hydrostatic pressure of 537 lb/in^2 on the pipeline west of Lamar. However, this maximum pressure would be reduced by breaking the static head at the WTP and at the on-line water storage tanks. Using the tank site north of Fowler would reduce the pressures to approximate elevation 4580 feet. The tank site near La Junta could be either east of La Junta (southern route; Alternatives 1 and 2) or north of La Junta near Cheraw (northern route; Alternatives 3, 4, and 5). When the La Junta tank would be used to break AVC pressure, the maximum static head west of Lamar could be reduced to 500 feet (200 lb/in^2). During normal operations, the pressure in the pipeline would be significantly reduced (to below the static pressure) by friction losses resulting from water flowing through the pipe.

The hydraulic grade line along the conduit and at each participant delivery tie-in location was calculated for maximum day demand in year 2070. The hydraulic analysis included starting and ending stations for AVC participants, the flow in the conduit, pipe diameter, total head loss, beginning hydraulic grade line, ending hydraulic grade line, the flow to each AVC participant, the pressure in the AVC at each participant delivery tie-in, and an estimation of the desired pressure by the participant. The desired pressure by the AVC participants would need to be further clarified in the feasibility level planning phase. The hydraulic analysis also include graphs illustrating the ground profile, hydraulic profile, and desired pressures by participant. The ground profile was based on the contour data from the GIS maps.

Hydraulic analysis's that predict the pipe pressure for each alternative were developed using Microsoft Excel. Pipeline hydraulics for the AVC appraisal level design were developed in accordance with Reclamation's *Design Standards No. 3, Water Conveyance Systems*, Chapter 11, –General Hydraulic Considerations" (Reclamation, 1994). The Hazen-Williams method was used to calculate pipe friction losses, using a nominal value of 120 for the C coefficient. This value is conservative for steel and polyvinyl chloride (PVC) pipe and was used to account for the anticipated lifetime condition of these pipes. Typical bend and other minor losses were calculated using methods described in chapter 11 of Reclamation (1994) and were applied based on the lengths and alignments of the segment reaches. Surge pressures in the pipe were calculated by adding a 30-percent factor to the static design pressure of the pipe. Hydraulics for the pipe loop near La Junta were calculated using the Bentley WaterCAD V8i (Bentley, 2011) software program and confirmed using Microsoft Excel worksheets. The WaterCAD analysis was used to determine balanced flow around the La Junta loop area. This balanced flow rate was then entered into the hydraulic spreadsheets to provide the proper pressure around the loop system.

Steel pipe design was in general accordance with the American Water Works Association's (AWWA) M11 Manual (AWWA, 2004). Pipes were designed using a minimum allowable design stress of 17,500 lb/in^2. Pipe thicknesses were also checked to confirm that they met the minimum handling stress requirements defined in AWWA (2004). All steel pipes were designed to have a mortar coating inside and tape coating outside. The metallic pipe options would need to be evaluated for cathodic protection requirements. Joints were specified using rubber gaskets and bell and spigot construction.

PVC pipe was designed in general accordance with either the AWWA M23 Manual and AWWA C900-07 or C905-10 Standard, depending on size. PVC pipes did not require specification of a cathodic protection system. Joint details were specified for the PVC pipe as rubber gasket connections.

Valves and other pipe appurtenances were designed to withstand, at a minimum, the maximum surge pressures expected within the pipe. The valves chosen were of the next higher head class above the calculated surge pressure for safety and reliability. Valves were specified using manual operators for this project to reduce costs and system complexity.

The pipe diameters in the spreadsheet were selected based on: (1) keeping the velocity in the pipe below 5 feet per second (ft/s), and (2) achieving the desired pressure gradient for the participants. Generally, the velocities needed to be between 2 and 4 ft/s to reduce the head loss enough to achieve the desired AVC participant delivery pressures.

Some pipe sizes were varied between alternatives to obtain estimated cost impacts and to test how certain actions affect the sensitivity of hydraulics. This was done with the interaction of May Valley and Eads booster plant versus May Valley spur size, height of the La Junta on-line storage tank north versus south, location of La Junta on-line storage tank (north or south versus near airport with low-pressure parallel pipe), south Fowler tank versus north Fowler tank, etc.

Two options have been provided for the Eads booster plant (see appendix F, drawing 9). Alternative 1 would have the spur to May Valley before the booster plant. This would require the plant to pump at a smaller flow rate of 175 gallons per minute (gal/min) (0.39 ft^3/s), but May Valley would need its own booster plant because its requested delivery pressure of 65 lb/in^2 would not be met. For Alternatives 2 through 5, the booster plant would have a flow rate of 175 gal/min plus 330 gal/min, for a total of 505-gal/min (1.125-ft^3/s) plant capacity. This would require a larger booster pump; however, May Valley's request for a delivery pressure of 65 lb/in^2 would then be met. This requested pressure is questioned because the delivery point is to a hilltop tank. The final location of the booster plant and meter vaults could be placed on either side of the road(s) and will require further coordination based on land acquisition allowances.

Final selection of a specific alternative for route selection may still require design features from other alternatives (varying tank heights, delivery locations, etc.) after completion of final land surveys, utility locations, and participant delivery requirements.

3.6.1.2 Pipeline Quantities

Pipeline quantities for the main conveyance conduit of each of the five AVC Alternatives were calculated using four reaches (see subsection 3.2, table 6). Each reach is defined with quantity sheets that extend between major conduit features of: (1) conduit intake to WTP, (2) to the Fowler storage tank, (3) to the La Junta storage tank, and (4) to Lamar. There are also quantity sheets for 17 minor spurs and 1 loop segment to complete the distribution system to the participants.

Each of the pipeline quantity sheets includes several individual items to perform cost advantage/disadvantage evaluations.

3.6.1.2.1 Site Work

Site work would consist of clearing and grubbing, stripping, and seeding. Clearing would consist of removing and disposing of vegetation (i.e., trees, shrubs, brush, stumps, exposed roots, down timber, branches, grasses, and weeds), rubbish, and objectionable material. Clearing would be performed within the rights-of-way to be occupied by permanent construction and rights-of-way required for access to the work, as well as surfaces of borrow areas, stockpile sites, and waste pile sites. Vegetation designated for preservation in the EIS within clearing limits would be protected. Clearing in orchards, shelter belts, municipal parks, urban or suburban areas, or other special areas would take place only as directed. Grubbing would consist of removing stumps, roots, and vegetative matter to a depth of 5 feet or until root diameter is less than 3 inches.

Stripping would consist of removing and stockpiling topsoil from areas to be excavated, under embankments, under excavation spoil piles, parking and staging areas, access and service roads, and borrow areas. A stripping depth of 6 inches was assumed for all lands in this Appraisal Design Report. Agricultural lands typically contain more topsoil and a growth zone. Area of agricultural lands would be identified during feasibility level studies. As more information on the preferred alternative alignment is determined and feasibility level design data are collected, desired topsoil stripping depth through agricultural lands would be identified; typically, this is a 12-inch depth or more. Following construction, the topsoil would be spread over disturbed areas, and nonagricultural lands would be seeded.

Stockpiling of the soil growth zone below topsoil in farmed agricultural areas may also be advised. The zone would be returned in the proper place of the pipeline trench backfill. Depth of this zone will need to be identified where stockpiling would be needed.

3.6.1.2.2 Pipe Trench Earthwork

Pipe trench earthwork would consist of excavation (soil and rock), pipe bedding and embedment, pipe trench cover backfill, and earth material compaction.

There are two basic types of pipe, which affect the pipe installation costs: rigid and flexible. Rigid pipe must be supported on the bottom portion of the pipe. Flexible pipe must be supported on both the bottom and sides of the pipe. Proper soil support of the pipe is critical to the performance of both types of pipe. This appraisal level design assumes that flexible pipe would be used, rather than rigid pipe.

Shoring and dewatering would probably be required adjacent to any existing surface irrigation ditches. Unless lined, existing irrigation ditches would have seepage, and a higher water table could be expected. Saturated soils should be expected to be unstable until dried, typically by spreading and discing. In some soils, the excavation may have to be overexcavated, and additional material would have to be imported to stabilize the conduit’s foundation.

To properly support the pipe, the trench dimension of minimum installation width, slope of the trench walls, trench depth, and flexible pipe clearance must always be carefully determined. For quantity estimate purposes, this Appraisal Design Report used soil pipe trench slopes of 1.5 (horizontal) to 1 (vertical) for the sand and silty soils in the construction area. However, State or local regulations may be more stringent and override these requirements. The structural performance of flexible pipe depends on the stiffness of the soil at the sides of the pipe. Reclamation performs geologic explorations at feasibility levels rather than appraisal level studies of pipelines; therefore, *in situ* trench wall strengths must be assumed. The appraisal cost estimate assumed that the *in situ* soils would be of medium strength.

Detailed geologic explorations are conducted for more refined levels of studies. During the geologic investigations for a pipeline, it is important that areas be identified where the trench wall soils are soft and easily compressible. Pressure pipe trench installation with select material is illustrated on Reclamation standard drawing 40-D-6551 in appendix F. Pipe would be laid directly on the bedding. After the pipe has been placed on the uncompacted layer of bedding material, embedment soil would be compacted into place beside the pipe up to the specified height. This embedment, in combination with the *in situ* soil in the trench wall, would provide the required side support for flexible pipe. Rarely can soils from the trench excavation be used for select material without processing. The select material used for the bedding and embedment is imported to the site from a processing plant in most cases.

Controlled low strength material (CLSM) (also referred to as soil-cement slurry or flowable fill) is an alternative to compacted soil for embedment material for installing pipe. The excavation of the trench and the installation of the pipe would be completely different than the compacted earth installation. For the CLSM construction, the bottom of the trench would be most economically excavated to a section about 6 inches greater than the outside pipe diameter. The contractor may elect to use a rectangular or trapezoidal shape trench bottom. The CLSM would be used to fill the gap between the pipe and the excavated trench and would only be used to ensure complete contact between the pipe and the soil. The CLSM would transfer the load from the pipe to the *in situ* material; therefore, the native soil must be able to provide the necessary support for the pipe. This is particularly important for flexible pipe because the design of the pipe is based on the stiffness (or strength) of the soil at the sides of the pipe. Pressure pipe trench installation with CLSM is illustrated on Reclamation standard drawing 40-D-6552 in appendix F.

Shoring is generally defined as a temporary trench wall support system that has to be disassembled and reassembled as the trench progresses. Trench boxes are allowed under the shoring requirement. Trench boxes (trench shields) are rigid structures that are pushed or pulled forward as the work progresses. Where soil is to be compacted at the bottom of a shield or support system, the shield/support must be positioned so that the soil can be compacted across the full trench width so that a void is not created in the soil when the shield/support is moved.

Routes through urban areas would have a very limited construction area. Excavated materials would probably be stockpiled during pipe laying operations. The excavated material typically would be hauled and stockpiled on side streets with front-end loaders to allow room for pipe and bedding delivery, pipe installation, and backfilling operations. Urban construction using techniques like unguided horizontal boring or microtunneling for short lengths may be viable. Lengths in excess of 3,000 feet at 42 inches in diameter could be installed through directional drilling, bypassing areas of concentrated infrastructure.

Most soils may be used for backfill over the pipe, except that there are maximum particle size restrictions in a zone 12 inches around the pipe. These restrictions are necessary to prevent damage to the pipe or its coating from a hard, possibly sharp rock particle. Above this zone, larger rock particles with a dimension greater than 8 to 12 inches may be allowed in the backfill. Where backfill is to be compacted to the ground surface (such as at road crossings), peat or other organic materials shall not be used. Local requirements for compacted backfill under roads must also be met.

It is recommended that the pipeline cross agricultural fields using moderate backfill compaction (i.e., 85-percent Proctor density) to prevent settlement concerns when the field is irrigated. Low use land would have pipe trench backfill mounded to accommodate ground settlement conditions. Roadway crossings would have pipe trench backfill fully compacted (i.e. 95-percent Proctor density) to prevent settlement concerns.

Site restoration would be an important component of the project. It is important that the impacted area be restored to its current condition or better. The pipeline alignment would cross many existing utilities, roads, highways, rivers, canals, railroads, agricultural irrigation facilities, fences, etc., and the design should include replacement/repair/restoration of any impacted area/facility. Further detail on the existing features affected by each pipeline segment is quantified in subsection 3.6.2.5.

3.6.1.3 Pipe Material

Pipe on the project would range in diameter between 48 inches and 4 inches, with heads of up to 750 feet. Pipe may be manufactured of various materials. Common materials available for use with the diameter and pressure range consist of: (1) steel, (2) ductile iron, and (3) PVC. Hydraulic design calculations used steel throughout the entire system, while the cost estimate divided the assumed pipe material between steel and PVC. This approach allowed the hydraulic calculations to use the most likely conservative energy losses. General perceptions are that PVC pipe is more economical when the size and pressure capacity is within its limits. The cost estimate used PVC pipe with diameters 12 inches and smaller with predicted transient pressures less than 750 feet, or diameters between 14 inches and 24 inches with predicted transient pressures less than 375 feet. An additional advantage of PVC is that this pipe material does not require installing cathodic protection to protect against corrosion, whereas steel and ductile iron may need cathodic protection. The soils generally are expected to be of low resistivity, which indicates corrosive potential. Pipe pressures were estimated in 50-lb/in^2 (125 feet) increments to determine pipe wall thickness and material weights.

3.6.2 Pipeline Appurtenances

The pipeline would need appurtenances including isolating valves, air/vacuum valves, blowoff valves, pressure sensing devices, cathodic protection, and, potentially, chlorination/cleaning points. Pressure reducing/altitude valves would be installed upstream of each on-line storage tank to prevent overflow and to maintain pressure in the pipeline upstream of the tanks. The AVC would be designed for the water to pass through the tanks at Fowler and La Junta so that, in the unlikely circumstance that the upstream pressure reducing station malfunctions, the water would overflow the tank and safeguard the pipeline from excessive pressure. The upstream pipeline would be designed for the maximum static pressure and maximum surge pressure conditions.

3.6.2.1 Isolation Valves

Isolation valves were assumed to be used for each 5-mile increment. Isolation valves would be used to limit the length of pipe required to be drained during maintenance and repair activities. For cost estimating purposes, butterfly valves with manual operator were assumed. Also, the cost estimate includes manholes to provide possible valve/operator access. Various methods exist to accomplish these functions, and Southeastern should investigate its preference for the feasibility level planning phase.

Isolation valves were identified for pipeline head class (in feet of cold water) and would correspond to AWWA and American National Standards Institute (ANSI) valve classes as outlined in table 35.

Table 35. Pipe Head Class and Valve Class

Head Class (feet)	Valve Class [1] (lb/in^2 gauge)
125	AWWA Class 150B butterfly valve with operator
250	AWWA Class 150B butterfly valve with operator
375	AWWA Class 150B butterfly valve with operator
500	AWWA Class 250 butterfly valve with operator
625	ANSI Class 150 butterfly valve with operator
750	ANSI Class 300 butterfly valve with operator
875	ANSI Class 300 butterfly valve with operator
1000	ANSI Class 300 butterfly valve with operator

[1] AWWA valve class is a lb/in^2 cold water rating, while ANSI valve class is a steam rating with an equivalent lb/in^2 cold water rating.

3.6.2.2 Air Valve Structures

Air valve structures were assumed to be used on a 1-per-mile average increment. Air valves of the combination large and small orifice types, and of the air release/vacuum style, would be required. These valves would be used to evacuate air from the pipe during filling and during operations and to admit air into the pipe during draining for OM&R activities.

Without air valves being properly installed, if air became trapped in the pipe during filling or during operations, the air bubble would restrict flow, causing an additional pipeline energy loss and, at times, choking off flow. When draining a line, air must be admitted to prevent low pressures from developing, as that could lead to pipe collapse. For the cost estimate, 6-inch-diameter valves were assumed to be used on the main conduit reach between Pueblo Reservoir and Fowler storage tank, 3-inch valves to La Junta storage tank, and 2-inch valves along all other pipelines and spurs.

3.6.2.3 Blowoff Structures

Blowoff structures would be used to perform the pipeline draining. For this analysis, the cost estimate used 6-inch-diameter facilities, 1-per-mile average increment. Smaller structures that are referred to as ―drains" would be used on the smaller pipes (less than about 18 inches in diameter) during the feasibility level planning phase. At that time, specific blowoff /drain discharge locations should be identified.

3.6.2.4 Buried Manholes

Buried manholes would be used to enter pipes of 36 inches in diameter or larger for OM&R purposes. This feature would typically be spaced at each half-mile increment.

3.6.2.5 Typical Pipeline Crossings

Typical pipeline crossings of gravel roads, paved roads, major roads, interstates and highways, railroads, and streams were itemized along each of the five route alternatives.

Crossings of gravel roads were assumed to be performed by temporarily detouring traffic (for 2 days) around the site on existing roads and by installing the pipe using traditional cut and cover methods. The roadway would be reestablished per the affected county's requirements. During the feasibility level planning phase, these requirements from each of the involved counties should be determined.

Crossings of two-lane traffic paved road were assumed to be performed by temporarily detouring traffic (for 5 days) around the site on existing roads and by installing the pipe using traditional cut and cover methods. The roadway would be reestablished per the affected county's requirements. During the feasibility level planning phase, these requirements should be determined from each of the involved counties.

Crossings of major four-lane roads were assumed to be performed by temporarily detouring traffic (for 10 days) around the site on existing roads and by installing the pipe using traditional cut and cover methods. The roadway would be reestablished per the affected jurisdiction requirements. During the feasibility level planning phase, these requirements should be determined from each of the involved jurisdictions.

Crossings of interstate and other divided highways were assumed to be performed by a bore and jack method of operations, which does not disturb or interrupt traffic. A casing pipe would be installed, and the carrier pipe would be installed within the casing. An average length of 500 feet was assumed to reach across the rights-of-way of these crossings.

The construction requirements for all roadway crossings must also meet community requirements. During the feasibility level planning phase, these requirements should be determined from each of the involved communities.

Crossings of railroads were assumed to be performed by a bore and jack method of operations, which does not disturb or interrupt traffic. A casing pipe would be installed, and the carrier pipe would be installed within the casing. An average length of 150 feet was assumed to reach across the rights-of-way of these crossings. The construction requirements must also meet the railroad owner's requirements. During the feasibility level planning phase, these requirements should be determined from each of the involved owners.

Major river (stream) crossings were assumed to be performed by horizontal directional drilling (HDD) operations, which do not disturb the stream channel or the adjacent wetlands. A casing pipe was assumed to be required during the HDD operation, and the carrier pipe would be installed within the casing. Direct installation of the carrier pipe during the HDD operation may be allowed at these crossing for conveyance of nonpotable water; however, potable water delivery assumed the addition of the casing pipe. An average length of 1,000 feet was assumed to reach across the areas. The construction requirements may also need to meet other jurisdictional requirements. During the feasibility level planning phase, these requirements should be determined.

Table 36 provides a listing of anticipated crossings, based on available information.

Table 36. Number of Crossings

Type of Crossing	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
Divided highway (interstate highway)	32 (1)	32 (1)	31 (1)	31 (1)	23 (1)
Major road	26	34	35	35	23
Paved road (Pueblo streets)	238 (4)	275 (50)	237 (46)	237 (46)	240 (14)
Gravel road	18	17	10	10	14
Railroad	12	13	14	14	12
Major river/stream	7	7	7	7	8
Minor creek/stream (costs are included in design contingencies)	36	35	48	48	32
Irrigation ditch or small drainage (costs are included in design contingencies)	85	83	77	77	78

3.6.2.6 Water for Dust Abatement

Water for dust abatement requirements was estimated along the construction areas throughout the expected 6-year (see subsection 5.1 and appendix K) construction period.

3.6.3 Pipeline Surge

Surge pressures in pipelines result from changes in flow velocity. These velocity changes may originate from pumps starting/stopping or from valves closing/opening. Surge pressures at appraisal level design were based upon assumed guides without performing specific analyses. Surge pressure was determined by assuming future surge protection devices that resulted in limiting the increased pressures to 30 percent above static pressure at the end of the line.

Surge pressure was determined by assuming pipe head classes were grouped in 125-foot (approximately 50-lb/in^2) increments.

3.6.3.1 Dam Pumping Plant Intake Surge

CH2M Hill performed a hydraulic analysis that included the dam outlet works Interconnect. That analysis of the NOW design/operations indicates that there are probably intake surge considerations regarding operations of the pumping plants and possibly isolation valves associated with the dam outlet works in the proposed Interconnect. The most significant basic concern is pumping plant intake pipeline surges caused by loss of electrical power. The initial surge evaluation is contained in SDS Technical Memorandum 22-M.3, *Work Package 1B - Hydraulic Modeling and Surge Analysis*. That CH2M Hill analysis for Colorado Springs Utilities, relating to the design of the intake to Juniper Pump Station, states —…each connection to the dam piping (whether on NOW or SOW side) is to negate their own transient conditions without negatively affecting existing features. Flow conditions analyzed should include the controlling flow and reservoir elevation condition examined in this TM….” (Southern Delivery System, 2011).

3.6.3.2 Intake Pipeline Air Chamber

The AVC appraisal level design did not anticipate the need for an intake pipeline air chamber. The intake pipeline surge would be further evaluated during the feasibility design phase. The cost for the intake pipeline air chamber is assumed to be a portion of the design contingency.

3.6.4 Pumping Plants and Associated Facilities

Issues to consider when determining the desirability of a particular site for pumping plant development include soils, availability of utilities, zoning and nearby land uses, access, and proximity to AVC alignment.

The AVC EIS Action Alternatives may require the use of pumping plants at various locations to lift water from a low elevation to higher elevations for conveyance to AVC participants. For a summary of the potential pumping plant locations, specific characteristics (flow and lift range), and conceptual layouts, see facility drawings 3 through 9, provided in appendix F. Pump data sheets are provided in appendix G.

Pumping plants have additional associated facilities that would assist in plant operations and protect the AVC from excessively low/high pressures during loss of electrical power event surges. These additional facilities may include: (1) an air chamber at the pumping plant, and/or (2) a pump regulating tank at high ground near the site. When the water supply is at a lower elevation than the surrounding ground, a pumping plant would be required to lift the AVC water over the adjacent higher ground. Each pumping plant could include a spare unit to raise the reliability of the plant's ability to deliver full flow at all times.

Air chambers are for surge protection during loss of electrical power at peak pumping operations. An air chamber (approximately 8 to 20 feet in diameter by 15 to 30 feet tall) was assumed necessary at most pumping plants. For explanation of surge protection, see subsection 3.6.3.

Pump regulating tanks would be located near the ground surface high point nearest the pumping plant (see facility drawings 15 through 18 provided in appendix F). A regulating tank was assumed required at the highest feasible downstream location of the pumping plants on this project. The function of the regulating tank is to determine the number of pumps required to nearly match flow demand of the AVC pipeline. This would be accomplished by building a small tank on the highest feasible and available location downstream of the plant. This elevation would allow the pumps to lift the required flows into the tank, and for that head to be maintained within the tank, even during nonpumping periods. Using a small tank would allow the pump run times and cycling to be more efficient without the need to constantly switch the pumps on and off to maintain the water surface elevation at the regulating tank location.

The expected tank site layout would occupy approximately 2 acres. The high point may be located within several miles from the pumping plant site. There is a consideration for having dual tanks to provide for continued conduit operations during tank maintenance. The tanks may be 50 feet in diameter and approximately 40 to 85 feet tall. The tanks would serve a dual purpose of pump regulating tank and surge protection device. As a pump regulating tank, the tank would control the number of pumps (and/or pump speed) in response to AVC demand.

Pipelines are subject to large surge pressures when rapid changes of flows occur. As a surge protection device, the tank would absorb pressure surges from the downstream storage tank valve closure upon loss of electrical power at the pumping plant.

3.6.4.1 Alternative 1 – Comanche South Pumping Facilities

The Comanche Pumping Plant would be sited near the base of Pueblo Dam (see facility drawing 3, appendix F). Ground near this site is approximately at El. 4755. The plant deck elevation would be established at least 3 feet above the Arkansas River 100-year flood elevation. Supporting facilities associated with the pumping plant would provide surge protection of the conduit and operation of the plants. These facilities include: (1) air chamber at the plants, and (2) regulating tank at high ground.

The pumping plant would provide raw water from Pueblo Reservoir to the WTP. The pumping plant would consist of four vertical turbine type pumps, each rated at 8.310 ft^3/s (3,730 gal/min) and 480 feet total dynamic head (TDH). The pumping units would be driven by 600-horsepower, totally enclosed fan-cooled (TEFC), vertical induction electric motors operating at 1,800 revolutions per minute (4,160 volts, 3 phase, 60 hertz).

In lieu of vertical turbine type pumps, the pumping plant could be configured to take advantage of the existing driving/suction head, and a horizontal centrifugal type pumping plant could be considered (which would be similar to the existing Fountain Valley Authority Pump Station near this site). Further details will be considered during the feasibility level design phase.

The pumping plant would be of an open sump style, which means that the reservoir water pressure would be reduced to a constant sump water elevation by an inlet pressure reducing valve and energy dissipating plant feature. The valve pressure drop would vary between approximately 50 feet and 160 feet, with Pueblo Reservoir at low and high water surface elevations, respectively.

The AVC alignment routes would be around the southwestern edge of Pueblo, with a high point of approximately El. 5100. A regulating tank would be located downstream of the pumping plant, near the high ground the pipeline is crossing.

The Eads booster plant would provide additional pressure necessary to deliver water to the Eads community. The plant would deliver filtered and disinfected (potable) water to the local community for distribution. The booster plant would consist of two units: one operating unit and an additional installed spare unit to maintain system reliability. The pumps would be vertical turbine can type pumps, each rated at 0.390 ft^3/s (175 gal/min) and 317 feet TDH. The pump can or barrel would act like a sump for providing adequate submergence for the first-stage impeller/bowl assembly of the pump. Each pumping unit would be powered by a 20-horsepower TEFC, vertical induction electric motor operating at 1,800 revolutions per minute, (460 volts, 3 phase, 60 hertz). Pump flow is required only to the Eads community, with only gravity flow needed to the May Valley community.

The pumping plant would include a shallow reinforced concrete –bathtub” type substructure. The booster plant would consist of a thickened edge slab-on-grade. Both plants would include a preengineered metal superstructure. Since no provision is made for overhead cranes, removable roof hatches would be provided to gain access to pumping units for installation and removal purposes.

The layout of the pumping and booster plant service yards would be based on the existing site topography, the submergence requirements of the pumping units, the alignment of the steel pipe, equipment space requirements for the pumps, and access into and around the plants for maintenance vehicles. The pumping and booster plant sites would be surrounded by a perimeter chain link fence and would have gravel surfaced finished grade. Vaults, air chambers, and outdoor type electrical equipment (e.g., breakers, unit substations, transformers) would be located within the fenced perimeter. Since the fenced area would be offset from existing roadways, the construction of an access road would be required to span the distance.

3.6.4.2 Alternative 2 – Pueblo Dam South Pumping Facilities

While a pumping plant along this route would not be needed, the Eads/May Valley booster plant would be needed. There would be sufficient pressure available at Pueblo Reservoir low water level of El. 4796 to convey water to the WTP near South Road and 21st Street with a basin water surface of approximately El. 4760. For this alternative, the AVC size was increased slightly to conserve pressure. The water would flow by gravity from the WTP clearwell to Fowler South storage tank. The Fowler South storage tank would be located at approximate ground El. 4410.

The Eads/May Valley booster plant would provide the additional pressure necessary to deliver water to the Eads and May Valley communities. The booster plant would deliver filtered water to the two local communities for distribution. The booster plant would consist of two units: one operating unit and an additional installed spare unit to maintain system reliability. The pumps would be vertical turbine can or barrel type pumps, each rated at 1.125 ft^3/s (505 gal/min) and 455 feet TDH. The can or barrel housing the pump would act like a sump for providing adequate submergence for first-stage impeller/bowl assembly of the pump. Each pumping unit would be powered by a 75-horsepower TEFC, vertical induction electric motor operating at 1,800 revolutions per minute, 460 volts, 3-phase, 60 hertz. The required pump flows are 0.390 ft^3/s (175 gal/min) to the Eads community and 0.735 ft^3/s (330 gal/min) to the May Valley community. They would be controlled via valves in the manifold piping downstream of the pumping units.

The booster plant would consist of a thickened edge slab-on-grade and would include a preengineered superstructure. Since no provision is made for overhead cranes, removable roof hatches would be provided to gain access to pumping units for installation and removal.

The layout of the booster plant service yards would be based on the existing site topography, the submergence requirements of the pumping units, the alignment of the steel pipe, equipment space requirements for the pumps, and access into and around the booster plant for maintenance vehicles. The booster plant site would be surrounded by a perimeter chain link fence and would have a gravel surfaced finished grade. Vaults, air chambers, and outdoor type electrical equipment (e.g., breakers, unit substations, transformers) would be located within the fenced perimeter. Meter vaults could be outside the perimeter fencing to accommodate access restrictions by two different AVC participant entities. Since the fenced area would be offset from existing roadways, construction of an access road would be required to span the distance.

3.6.4.3 Alternative 3 – JUP North Pumping Facilities

This alternative would use the existing Whitlock WTP, which would require a pumping plant to lift the water out of the low elevation site (see facility drawing 4, appendix F). Additional supporting facilities associated with the new Whitlock Pumping Plant would provide surge protection of the conduit and operations of the pumping plant. These facilities would include: (1) air chamber at the pumping plant, (2) regulating tank, and (3) use of the Fowler North storage tank.

The Whitlock WTP location has a lower ground elevation (El. 4690) than the surrounding area (high ground El. 4760). Therefore, the new pumping plant would lift the AVC water from Whitlock WTP clearwell, or settling pond, over the high ground to the east. The high point is approximately 3 miles east of the new AVC Whitlock Pumping Plant site. The high ground is approximately 0.5 mile east of the I-25/Fountain Creek crossing. There appears to be an industrial area approximately 500 feet north of the alignment where a regulating tank could possibly be located. The ground at the regulating tank site is approximately El. 4780.

The new Whitlock Pumping Plant pumps treated water from the WTP to a storage tank for distribution. The pumping plant would consist of four vertical turbine type pumps, each rated at 7.687 ft^3/s (3,450 gal/min) and 155 feet TDH. The pumping units would be driven by 200-horsepower, TEFC, vertical induction electric motors operating at 1,200 revolutions per minute (460 volts, 3 phase, 60 hertz).

The Eads/May Valley booster plant would provide additional pressure needed to deliver water to the Eads and May Valley communities. The plant would deliver filtered water to the two local communities for distribution. The booster plant would consist of two units: one operating unit and an additional installed spare unit to maintain system reliability. The pumps would be vertical turbine can type pumps, each rated at 1.125 ft^3/s (505 gal/min) and 405 feet TDH. The can or barrel housing the pump would act like a sump for providing adequate submergence for first-stage impeller/bowl assembly of the pump. Each pumping unit would be powered by a 75-horsepower TEFC, vertical induction electric motor operating at 1,800 revolutions per minute (460 volts, 3 phase, 60 hertz). The required pump would flow at 0.390 ft^3/s (175 gal/min) to the Eads community and 0.735 ft^3/s (330 gal/min) to the May Valley community, and they would be controlled via valves in the manifold piping located downstream of the pumping units.

The pumping plant would include a shallow reinforced concrete ―bathtub” type substructure, and the booster plant would consist of a thickened edge slab-on-grade. Both plants would include a preengineered metal superstructure. Since no provision is made for overhead cranes, removable roof hatches would be provided to gain access to pumping units for installation and removal.

The layout of the pumping and booster plant service yards would be based on the existing site topography, the submergence requirements of the pumping units, the alignment of the steel pipe, equipment space requirements for the pumps, and access into and around the plants for maintenance vehicles. The pumping and booster plant sites would be surrounded by a perimeter chain link fence and would have gravel surfaced finished grade. Vaults, air chambers, and outdoor type electrical equipment (e.g., breakers, unit substations, transformers) would be located within the fenced perimeter. Booster plant meter vaults could be located outside the perimeter fencing to accommodate access restrictions by two different AVC participant entities. Because the fenced area is offset from existing roadways, construction of an access road would be required to span the distance.

3.6.4.4 Alternative 4 – Pueblo Dam North Pumping Facilities

The new Pueblo Dam Pumping Plant 1 would be sited near the foot of Pueblo Dam to lift water to the nearby WTP (See facility drawing 5, appendix F). Pueblo Dam Pumping Plant 2 would lift filtered water from the WTP over high grounds within Pueblo City (see facility drawing 6, appendix F). Ground near the dam site for Pueblo Dam Pumping Plant 1 is approximately El. 4755, and ground near the site for the new Pueblo Dam Pumping Plant 2 is approximately El. 4810.

The new Pueblo Dam Pumping Plant 1 would be of the open sump style, which means the reservoir water pressure would be reduced to a constant sump water elevation by an inlet altitude pressure reducing valve. The valve pressure drop would vary between approximately 50 feet and 160 feet with Pueblo Reservoir at low and high water surface elevations, respectively.

The new Pueblo Dam Pumping Plant 1 pump discharge would deliver water to the WTP located on higher ground south of the existing fish hatchery site. This site is congested with transmission line alignments that would require coordination and clearance restrictions. WTP inlet basin water surface would be at approximately El. 4820. A preliminary assessment of the facilities' characteristics led to the determination that an air chamber would probably not be required. The WTP basin water level would be used for the pump regulation in lieu of a regulating tank. Filtered water would be pumped from the

WTP clearwell, over high ground with Pueblo City, to the new Fowler North storage tank site. The site would be located at approximate ground El. 4525.

The new Pueblo Dam Pumping Plant 1 could have bypass piping included, which would be used during periods of medium to high reservoir levels. During these times, there would be sufficient pressure to directly deliver the water to the WTP basin.

The new Pueblo Dam Pumping Plant 1, located near the toe of the dam, would provide raw water from Pueblo Reservoir to the beginning of the water treatment process train at the new Pueblo Dam WTP nearby. The pumping plant would consist of four vertical turbine type pumps, each rated at 8.310 ft^3/s (3,730 gal/min) and 55 feet TDH. The pumping units would be driven by 75-horsepower, TEFC, vertical induction electric motors operating at 600 revolutions per minute (460 volts, 3 phase, 60 hertz).

In lieu of vertical turbine type pumps, the new Pueblo Dam Pumping Plant 1 could be configured to take advantage of the existing driving/suction head, and a horizontal centrifugal type pumping plant could be considered, which would be similar to the existing Fountain Valley Authority Pump Station nearby. The new Pueblo Dam Pumping Plant 2 could be integrally designed and constructed with the WTP.

The new Pueblo Dam Pumping Plant 2 would pump filtered water from the WTP to a storage tank for distribution. The pumping plant would consist of four vertical turbine type pumps, each rated at 7.687 ft^3/s (3,450 gal/min) and 40 feet TDH. The pumping units would be driven by 50-horsepower, TEFC, vertical induction electric motors operating at 600 revolutions per minute (460 volts, 3 phase, 60 hertz).

The Eads/May Valley booster plant would provide the additional pressure necessary to deliver water to the Eads and May Valley communities. The booster plant would deliver filtered water to the two local communities for distribution. The booster plant would consist of two units: one operating unit and an additional installed spare unit to maintain system reliability. The pumps would be vertical turbine can type pumps, each rated at 1.125 ft^3/s (505 gal/min) and 405 feet TDH. The can or barrel housing the pump would act like a sump for providing adequate submergence for first-stage impeller/bowl assembly of the pump. Each pumping unit would be powered by a 75-horsepower, TEFC, vertical induction electric motor operating at 1,800 revolutions per minute (460 volts, 3 phase, 60 hertz). The required pump flows are 0.390 ft^3/s (175 gal/min) to the Eads community and 0.735 ft^3/s (330 gal/min) to the May Valley community. Pump flows would be controlled via valves in the manifold piping located downstream of the pumping units.

The pumping plants would include a shallow reinforced concrete ―bathtub” type substructure, and the booster plant would consist of a thickened edge slab-on-grade; both would include a preengineered metal superstructure. Because no provision is made for overhead cranes, roof hatches would be provided to gain access to pumping units for installation and removal purposes.

The layout of the pumping and booster plant service yards would be based on the existing site topography, the submergence requirements of the pumping units, the alignment of the steel pipe, equipment space requirements for the pumps, and access into and around the plants for maintenance vehicles. The pumping and booster plant sites would be surrounded by a perimeter chain link fence and would have gravel surfaced finished grade. Vaults, air chambers, and outdoor type electrical equipment (e.g., breakers, unit substations, transformers) would be located within the fenced perimeter. Booster plant meter vaults could be located outside the perimeter fencing to accommodate access restrictions by two different AVC participant entities. Since the fenced area would be offset from existing roadways, construction of an access road would be required to span the distance.

3.6.4.5 Alternative 5 – River South Pumping Facilities

This alternative would require two pumping plants. The new River Intake Pumping Plant (see facility drawing 7, appendix F) would be required to lift raw water from the river to the new AVC St. Charles Mesa WTP site, which is adjacent to the existing St. Charles Mesa WTP. The new St. Charles Mesa Pumping Plant (see facility drawing 8, appendix F) would lift filtered and disinfected (potable) water from the new AVC St. Charles WTP over high ground to the east.

The new River Intake Pumping Plant would be a sump style structure in which the sump water level would fluctuate with the river level. The high ground is approximately 5 miles east from the pumping plant site and approximately 2.5 miles prior to the WTP site. A preliminary assessment of the characteristics of the facilities led to the determination that an air chamber would probably be required at the pumping plant site. An upstream pressure sustaining, pressure reducing valve (PRV) at the WTP inlet could possibly be used to provide sufficient protection from surges without using a regulating tank. While this may be possible because of the relative close proximity between the high ground and the WTP inlet, a pump regulating tank was assumed for this appraisal level design.

The new St. Charles Mesa Pumping Plant would lift water from the new AVC St. Charles WTP clearwell over high ground to the east, where the regulating tank would be located, and water would then flow by gravity to the new Fowler North storage tank site . The site would be located at approximate ground El. 4550.

The new St. Charles Mesa Pumping Plant could be integrally designed and constructed with the new AVC St. Charles Mesa WTP.

The new River Intake Pumping Plant would consist of four vertical turbine type pumps, each rated at 8.199 ft^3/s (3,680 gal/min) and 285 feet TDH. The pumping units would be driven by 250-horsepower, TEFC, vertical induction electric motors operating at 1,200 revolutions per minute, 460 volts, 3 phase, 60 hertz.

The new St. Charles Mesa Pumping Plant would consist of four vertical turbine type pumps, each rated at 5.704 ft^3/s (2,560 gal/min) and 130 feet TDH. The pumping units would be driven by 125-horsepower, TEFC, vertical induction electric motors operating at 900 revolutions per minute, 460 volts, 3 phase, 60 hertz.

The new Eads/May Valley Booster Plant would provide additional pressure necessary to deliver water to the Eads and May Valley communities. The plant would deliver filtered and disinfected (potable) water to the two local communities for distribution. The booster plant would consist of two units: one operating unit and an additional installed spare unit to maintain system reliability. The pumps would be vertical turbine can type pumps, each rated at 1.125 ft^3/s (505 gal/min) and 455 feet TDH. The can or barrel housing the pump would act like a sump for providing adequate submergence for first-stage impeller/ bowl assembly of the pump. Each pumping unit would be powered by a 75-horsepower, TEFC, vertical induction electric motor operating at 1,800 revolutions per minute, 460 volts, 3 phase, 60 hertz. The required pumps would flow at 0.390 ft^3/s (175 gal/min) to the Eads community and 0.735 ft^3/s (330 gal/min) to the May Valley community. They would be controlled via valves in the manifold piping located downstream of the pumping units.

The new pumping plants would include a shallow reinforced concrete ―bathtub” type substructure, and the booster plant would consist of a thickened edge slab-on-grade; both would include a preengineered metal superstructure. Since no provision is made for overhead cranes, roof hatches would be provided to gain access to pumping units for installation and removal purposes.

The layout of the pumping and booster plant service yards would be based on the existing site topography, the submergence requirements of the pumping units, the alignment of the steel pipe, equipment space requirements for the pumps, and access into and around the plants for maintenance vehicles. The pumping and booster plant sites would be surrounded by a perimeter chain link fence and would have gravel surfaced finished grade. Vaults, air chambers, and outdoor type electrical equipment (e.g., breakers, unit substations, transformers) would be located within the fenced perimeter. Booster plant meter vaults could be located outside the perimeter fencing to accommodate access restrictions by two different

AVC participant entities. Because the fenced area would be offset from existing roadways, construction of an access road would be required to span the distance.

3.6.5 Water Treatment Component Process Options

The WTP component of the Draft AVC EIS would use conventional treatment technologies, as outlined in subsection 3.5 and briefly described in the following subsections. Process options were sized using preliminary design parameters that are consistent with CDPHE design criteria (CDPHE, 1997). The planning-level footprint of facilities included in the WTP component is shown on drawing 20 in appendix F. Conceptual layouts for WTP component facilities on action alternative WTP sites are shown on drawings 21 through 26 in appendix F.

3.6.5.1 Presedimentation

Presedimentation would be provided in the water treatment component of Alternative 5 (River South), which would use the Arkansas River for delivery of raw water from Pueblo Reservoir to a point just upstream of the confluence with Fountain Creek, followed by diversion through a river intake, pumping plant, and new pipeline. Presedimentation would be sized for 12 hours of settling at the AVC WTP design flow of 20 mgd, which would require a footprint of 4.6 acres.

3.6.5.2 Coagulation

Coagulation would be provided as part of the full conventional pretreatment option in the water treatment component of each action alternative. A ferric-iron metal-salt coagulant would be applied to raw or presettled water using pumped-jet diffusion flash mixing. This method of coagulant addition provides rapid and uniform dispersion that reduces chemical consumption and power required. Mixing energy, measured as velocity gradient G, would be 1000 sec^{-1} for a contact time of 1 sec.

3.6.5.3 Flocculation

Three-stage tapered flocculation would be provided as part of the full conventional pretreatment option in the water treatment component of each action alternative. Flocculation would be configured using vertical-shaft pitched-blade turbines in compartments separated by baffled walls to minimize flow short circuiting. This configuration provides ease of access to drive-train components for maintenance. Mixing energy, measured as velocity gradient G, would vary between 70 sec^{-1} and 10 sec^{-1} across the three stages. Total flocculation time across the three stages would be 30 minutes at design flow.

3.6.5.4 Clarification

Clarification would be provided as part of the full conventional pretreatment option in the water treatment component of each action alternative. Clarification would be configured using plate-assisted sedimentation to reduce the footprint required for this process. Loading rate would be 0.3 gallon per minute per square foot (gal/min/ft^2) of projected plate area based on a derating factor of 0.8, which would provide 32 minutes of settling time at design flow. Continuous removal of settled solids would be provided.

3.6.5.5 Granular Media Filtration

Granular media filters would be provided as the filtration option in the water treatment component of each action alternative. Filtration would be configured using deep-bed dual-media (anthracite/sand) filters. Filter loading rate would be 7.2 gal/min/ft^2 at design flow with three filters in service and one filter offline. Capability for air scour and filter-to-waste during backwash evolutions would be provided. Granular activated carbon could also be used in these filters to provide additional natural organic matter removal if required.

3.6.5.6 Primary Disinfection

Primary disinfection with free-chlorine would be provided as the disinfection option in the water treatment component of each action alternative. Primary disinfection would be configured using a channeled basin design that would provide superior baffling (baffling factor of 0.7). Basin volume would be sized to meet Giardia and virus CT requirements at design flow and temperature of 2 degrees Celsius, pH of 7.8 s.u., and a 1-mg/L free-chlorine residual. Residual free-chlorine following primary disinfection would be chemically quenched prior to distribution through the AVC in Alternatives 2 (Pueblo Dam South), 3 (Joint Use Pipe North), and 4 (Pueblo Dam North), which would produce and distribute filtered water to participant turnouts.

3.6.5.7 Taste and Odor Control

PAC addition would be provided for seasonal taste and odor control in the water treatment component of each action alternative. PAC would be added following flash mixing, and the flocculation basins would provide suitable mixing and contact time.

3.6.5.8 Liquid and Solid Residuals Management

Filter backwash water recovery would be provided as part of the residuals management option in the water treatment component of each action alternative. Two backwash water recovery basins would be provided, each sized to accept backwash and filter-to-waste flows from two successive backwash operations. Decant from these basins would be recycled to the head of the plant, and settled solids would be periodically transferred to solids dewatering lagoons. Total area required for backwash water recovery basins would be 1.3 acres.

Solids dewatering would be provided as part of the residuals management option in the water treatment component of each action alternative. Settled solids underflows from sedimentation basins and settled backwash wastewater solids would be dewatered in a lined lagoon. Three cells would be provided in the lagoon, each sized to accept residual solids flows from 1 year of water treatment plant operation. In any given year, one cell would receive solid residual flows, one cell would be dewatering solids through settling and evaporation, and one cell would be out of service for residuals removal. The total area for the residual drying basins would be 6.5 acres.

3.6.6 On-line Water Storage and Regulating Tank Sites

Proposed sites for AVC WTP, regulating tanks, and on-line water storage tanks were selected based on land availability, alignments in the AVC Alternatives, AVC hydraulic considerations, and recommendations from AVC participants.

The identified new on-line water storage tanks are described in subsection 3.4.7, and they include two new sites in the vicinity of Fowler and two sites near La Junta. The purposes of the water storage tanks are to provide temporary water supply to the AVC during emergency operations (e.g., repairs to the AVC to reduce cost of the pipeline due to high pressures) and to balance hydraulic operation of the AVC.

Regulating tank sites would be near high elevation points close to pumping plants. General considerations for tank site development include soils and geotechnical features, site elevation, proximity to utilities, and access to roadways.

3.7 Electrical

Energy supply for pumping plants, WTPs, and other appurtenants in the Pueblo metropolitan area and to the west side of La Junta, would be provided by Black Hills Energy (BHE). Power for the new Eads/May Valley Booster Plant, and anything needed east of La Junta, would be provided by Southeast Colorado Power Association. The power association’s service boundaries around La Junta are blurred with Black Hills, but the proper energy supplier would be worked out when the preferred alternative is chosen. Nevertheless, in May 2011, both electrical utility companies were made aware of the proposed AVC project and provided data regarding projected monthly energy usage and demand rates (see subsection 8.2 and appendix M).

3.7.1 Pumping Plants

A new service from BHE would be provided to power the new pumping plants included in this report. The assumed distribution voltage is 13.2 kilovolts. (However, 69 kilovolts were used for plant quantity estimating purposes since energy usage and demand rates were not available until later in the appraisal level design process.) A unit substation would be installed outside the pumping plant and within the fenced perimeter. The unit substation would provide a single 480-volt, 3-phase feeder to the pumping plant motor bus. Single-phase, 120-volt loads within the pumping plant would be provided by a 208Y/120-volt lighting and distribution transformer (see table 37).

Table 37. Pumping Plant Electrical Criteria

Subject	Criteria	Comments/Reason
Maximum electrical load	Size for the individual pumping plant loads	Would be determined in power supply analysis
Incoming service	Feeder from unit substation	Would be determined in power supply analysis
Redundancy requirements	None	Not required
Equipment operating voltages	480 volts, 3Ø and 120 volts, 1Ø as required by equipment	Standard voltages
Grounding	Concrete-encased electrodes and ground rods	Minimum required
General lighting	Fluorescent, compact fluorescent, and High Intensity Discharge (HID)	Consistent with the client requirements
Codes	National Electrical Code, National Fire Protection Association (NFPA) 70 Life Safety Code, NFPA 101	Industry-wide and client accepted practices; latest adopted versions by the authority with jurisdiction

Note: Ø denotes electrical “phase.”

3.7.2 Eads/May Valley Booster Plant

A new service from Southeast Colorado Power Association would be provided to power the new booster plant. The distribution voltage would be Southeast Colorado Power Association’s standard. A pole-mounted transformer would be installed outside the new booster plant. The transformer would provide a single 480-volt, 3-phase feeder to the booster plant motor bus. Single-phase, 120-volt loads within the booster plant would be provided by a 240/120-volt lighting and distribution transformer (see table 38).

Table 38. Booster Plant Electrical Criteria

Subject	Criteria	Comments/Reason
Maximum electrical load	Size for the booster pumping plant loads	Would be determined in power supply analysis
Incoming service	Feeder from pole-mounted transformer	Would be determined in power supply analysis
Redundancy requirements	None	Not required
Equipment operating Voltages	480 volts, 3Ø and 120 volts, 1Ø as required by equipment.	Standard voltages
Grounding	Concrete-encased electrodes (Ufer) and ground rods	Minimum required
General lighting	Fluorescent, compact fluorescent, and HID	Consistent with the client requirements
Codes	National Electrical Code, NFPA 70 Life Safety Code, NFPA 101	Industry-wide and client accepted practices; latest adopted versions by authority with jurisdiction

Ø denotes electrical "phase."

3.7.3 Pumping Plant Valve Vaults

The following criteria, as shown in table 39, are for the new Alternative 1 Comanche Pumping Plant and the new Alternative 4 Pueblo Dam Pumping Plant 1. A 240/120-volt, single-phase feeder from the pumping plant would provide power for the valve vault. A service disconnect switch would be installed just outside of the valve vault. A transformer load center would be installed inside the vault and would provide branch circuits for the 240- and 120-volt loads within the vault.

Table 39. Valve Vault Electrical Criteria

Subject	Criteria	Comments/Reason
Maximum electrical load	Size for vault loads	Would be determined in power supply analysis
Incoming service	Feeder from pumping plant	Would be determined in power supply analysis. Approximately 10 kilovolt amperes.
Redundancy requirements	None	Not required
Equipment operating voltages	240-volts, 1Ø or 120 volts, 1Ø as required by equipment	Standard voltages

Table 39. Valve Vault Electrical Criteria

Subject	Criteria	Comments/Reason
Grounding	Ground rods	Minimum required
General lighting	Vaportite fluorescent or compact fluorescent	Consistent with the client requirements
Codes	National Electrical Code, NFPA 70 Life Safety Code, NFPA 101	Industry-wide and client accepted practices; latest adopted versions by authority with jurisdiction

3.7.4 Pumping Plant Meter Vault

It is assumed that single-phase, 240/120-volt power would be required for the vault with the feeder provided from the nearby pumping plant. The maximum electrical load would be determined during final design.

3.7.5 Participant Delivery Vaults

A new electrical service from the local utility would be provided to power each of the 40 participant delivery vaults. It is assumed that a 240/120-volt, 1-phase service would be required. A service disconnect switch would be installed just outside of the valve vault. A transformer load center would be installed inside the vault and would provide branch circuits for the 240- and 120-volt loads within the vault (see table 40).

Table 40. Participant Delivery Vaults Electrical Criteria

Subject	Criteria	Comments/Reason
Maximum electrical load	Size for vault loads	Would be determined in power supply analysis
Incoming service	Service from the local utility	Would be determined in power supply analysis. Approximately 10 kilovolt amperes
Redundancy requirements	None	Not required
Equipment operating voltages	240 volts, 1Ø or 120 volts, 1Ø as required by equipment	Standard voltages
Grounding	Ground rods	Minimum required
General lighting	Vaportite fluorescent or compact fluorescent	Consistent with the client requirements
Codes	National Electrical Code, NFPA 70 Life Safety Code, NFPA 101	Industry-wide and client accepted practices; latest adopted versions by authority with jurisdiction

3.8 Supervisory Control and Data Acquisition

The general objectives of a SCADA system designed for the AVC project are as follows:

- Provide centralized automatic control and remote monitoring of all facilities and equipment covered by the AVC project
- Provide alarm capabilities on all measurements and equipment status information
- Facilitate and automate emergency responses and administrative functions in order to reduce operator workload
- Improve the efficiency and safety of the project operation
- Process all collected data in graphical format for operator review
- Provide comprehensive data recording functions to support graphical trending and reports

Control, monitoring, recording, and programming of specific functions and facilities would need to be coordinated with input from ECAO, Southeastern, and AVC participants prior to and during the feasibility planning level and final designs.

3.8.1 System Overview

Hardware and software implemented for SCADA would provide the capability to control and/or monitor project features, including WTP, pumping plants, booster plant, water storage tanks, regulator tanks, vaults, participant deliveries, and other related facilities.

The SCADA system considered for this project would consist of a master station, most likely located in the new WTP or at the existing Whitlock WTP facility (if included in the preferred alternative), and a remote terminal unit (RTU) at each of the project facilities that need to be controlled and monitored. Besides control, the SCADA system would also perform monitoring, data logging, alarming, and diagnostic functions so that large and complicated processes could be performed safely.

The master station would provide a human interface for the system and automatically regulate the managed system in response to sensor inputs. The SCADA servers would provide communications drivers for all field devices including programmable logic controllers, RTUs, multiple intelligent electronic device support, closed-circuit television controllers, etc.

The RTU could be considered a condensation point for data that were aggregated and delivered to the control center master station. An RTU would be installed at each pumping plant, WTP, and other facilities where control and monitoring would be required.

RTUs would serve as local Input/Output points for gathering reports from sensors and delivering commands to control relays, acquiring data from sensors on the infrastructure, delivering control signals to the field equipment, and communicating with the master station. The RTUs would control and monitor various equipment and electronic devices and sensors in WTP, pumping plants, and water tanks using an industrial standard, open communication protocol.

3.8.2 Communication Methods

Due to the large area this project covers and the cost of cable, using fiber optic cable as a communication link for all features along the pipeline route may not be a practical approach. Once a more indepth investigation is performed to identify existing utilities along the Arkansas River Corridor, opportunities may exist to partner with municipalities and/or utilities to install (or use existing) fiber or digital microwave. Reclamation would need to coordinate with Southeastern and existing utility owners on the viability of this approach. Nevertheless, other communication methods such as microwave/very high frequency, or spread spectrum radio would be suitable for this project because of the cost and technical considerations (see table 41).

3.8.3 Network Security

Network security would be provided for the SCADA system to prevent cyber attack and to detect and block invasive software attacks and intruder access. The security appliances would integrate firewall, communication security, virtual private network, and intrusion prevention. The remote login processes would require virtual private networks or encryption to communicate the user’s name and password over the network.

Table 41. Communication Methods

Communication Method	Advantage	Disadvantage
Fiber optic cable	Reliable, high data rate, wide bandwidth. Secure communication. Long distance transmission without repeater.	Installation cost is high.
Microwave/very high frequency radio	Suitable for any terrain. Lower cost than fiber optic cable.	Towers are expensive to build. Difficulty obtaining suitable radio frequency assignments. Line-of-sight will be disrupted if any obstacle, such as new buildings or trees, is in the way. Impact on performance by atmospheric conditions.
Spread spectrum radio	Suitable for any terrain. Lower cost than fiber optic cable and microwave/very high frequency radio.	Same as above.

3.8.4 Facility Security System

The system would provide a means of intrusion detection for the overall site and the equipment building. The surveillance system would provide near-real-time viewing of critical areas of the AVC sites for:

- Observing and identifying instances of vandalism and intrusion
- Observing authorized and unauthorized entry and egress from the equipment building
- Observing operations of the equipment

3.8.5 Telephone System

The telephone system would provide interconnections in and between the pumping plants, booster plants, and WTP. The telephone system would use the hybrid voice over internet protocol (VOIP) Private Branch Exchange as the core technology. The telephone system would be installed by methods standard to the telephone industry and to the National Electrical Safety Code for 120-volt alternating current circuits.

3.8.6 On-Line Storage Tank Controls

AVC control SCADA would direct the inlet altitude PRV at the storage tank to close upon loss of power at a pumping plant. The inlet altitude PRV would be powered via hydraulic (water) pressure. The inlet altitude PRV would open with a tank low water surface (approximately 5-foot depth) and close with a high tank water surface (approximately 20-foot depth). The open valve would control the flow at somewhat more than the maximum day flow rate.

The inlet altitude PRV would be subjected to a static head cut equivalent to the difference between the upstream regulating tank and the storage tank water surfaces. As the AVC flow rate increased, pipeline friction losses would reduce the head cut required at the PRV.

Depending on the storage tank water volume selected, there would be three to five new storage tanks at each of the sites. Provisions would be made to continue AVC deliveries during storage tank maintenance. Isolation valves would be used to direct the flow appropriately within the tank manifold piping. With the multiple tanks provided, storage volume would be reduced during tank maintenance. Pipe manifolding and valving would be provided to allow routing water through tanks while performing maintenance on other tanks. The estimated time for maintenance at each tank site would be 5 days.

More detailed control system description would be required to manage a situation with the booster plant when La Junta storage tank reduced to a ―low low” level, and this would be developed in later designs.

3.9 Arkansas River Intake (used only in Alternative 5)

Alternative 5 (River South) would include Pueblo Dam releasing AVC demand flows into the Arkansas River and diverting these riverflows to the AVC after passing through most of the City of Pueblo. The purpose would be to reduce the construction and environmental impacts of installing the AVC through the city. This alternative would have the highest minimum flow in the Arkansas River through Pueblo to reduce recreation and aquatic impacts.

The St. Charles Mesa Water District presently uses their Moffat Street diversion site on the Arkansas River upstream of the Fountain Creek confluence. The new AVC river inlet structure would be upstream from the Moffat Street diversion structure.

Due to uncontrolled storm water discharges into the Arkansas River, this alternative would experience some degradation of water quality during its flow in the river between Pueblo Reservoir and the diversion point. Also, there would inevitably be somewhat more water released from the reservoir than would be diverted from the river to supply AVC participant demands. These excess releases would account for losses such as seepage, evaporation, diversion loss, WTP processing, and others.

After the 1921 flood, a levee was installed to protect downtown Pueblo, and the riverbed was moved to the south side of the levee—its current location. In the 1990s, as part of an effort to restore downtown Pueblo, the ―Riverwalk” project was designed to imitate the Riverwalk in San Antonio, Texas. The layout of Pueblo’s Riverwalk actually follows the old riverbed of the Arkansas River before it was diverted behind the levees. The Historic Arkansas Riverwalk of Pueblo (HARP) diversion that is in the river was built years ago to divert cooling water for the powerplant. This cooling water is now returned downriver at the end of the Riverwalk. The diversion is also the start of the kayak course on the river.

St. Charles Mesa Water District has considered the possibility of moving their Moffat Street diversion all the way up to the HARP diversion above the kayak course. One reason for moving this diversion that far is because when a major sewer line under the river below the HARP division breaks, the river is completely diverted at the HARP diversion and does not come back to the Arkansas River until just above Fountain Creek, which leaves the Moffat St. diversion empty. Additionally, since the City of Pueblo has recently revived and renovated Minnequa Lake Park (around 2008), the releases from the lake now are released into the Arkansas River just above the Moffat Street intake, resulting in a significant negative impact to water quality. (This is another reason St. Charles Mesa Water District considered moving all the way above the kayak course.)

St. Charles Mesa Water District considered moving to the HARP outlet, but the cost and permitting issues were considered too expensive to justify further review. This is, in part, why St. Charles Mesa Water District wants to participate in the AVC—to have an alternate diversion for when the Moffat Street diversion is not available or has severe water quality issues.

St. Charles Mesa Water District has not held discussions with railroad companies because it was considering a move much further upstream than that. St. Charles Mesa Water District (Mr. David Simpson) stated that the U.S. Geological Survey (USGS) has about 20 years of history on water quality specific conductance for a streamflow gauge at this location. The AVC EIS will have a water quality appendix with data on water quality at the gage.

4. GIS Mapping

In August 2010, Reclamation received a comprehensive GIS database (Environmental Systems Research Institute, 2009) generated and acquired by several contracting agencies associated with the STAG Final Report (STAG Final Report, 2010a). Subsequently, Reclamation's engineering team used these data to analyze geospatially referenced data in this appraisal level design to assess five AVC EIS Action Alternatives and to calculate cost estimates for each alternative being considered within the AVC.

The Farnsworth Group was retained for services in the development of the STAG Final Report. They gathered GIS mapping information, prepared GIS base maps, and identified property ownership along the various conduit alignments. The Farnsworth Group provided the bulk of geospatial information used by Reclamation for quantitative analysis consisting of a compilation of extensive data from various sources representing:

- Utilities
- Land ownership
- Ortho rectified aerial imagery
- Environmental
- Terrain
- Diverse additional features

The projection, vertical datum, and horizontal datum established by the Farnsworth Group: a modified Colorado State Plane, Southern Zone, North American Horizontal Datum of 1983 (NAD83), and North American Vertical Datum of 1988 (NAVD88) were employed by Reclamation in its data and analysis.

The projection parameters for this spatial reference are:

AVC-Proj_coords-COSP-COSP-SZ-83_mod
Projection: Lambert Conformal Conic
False Easting: 3000685.98631616
False Northing: 1000228.661996
Central Meridian: -105.5
Standard_Parallel_1: 37.23333333
Standard_Parallel_2: 38.43333333
Scale Factor: 1.000228662

Latitude of Origin: 36.66666666666
Linear Unit: Foot US
Horizontal Datum: North American Datum 1983 (NAD83)
Vertical Datum: North American Vertical Datum 1988 (NAVD88)

Two specific geodatabases in a common Environmental Systems Research Institute compatible data storage and management framework were provided by the Farnsworth Group: (1) AVC_Static.gdb, and (2) AVC_Dynamic.gdb.

- AVC_Static.gdb.—Contained established available data features that would rarely change or need to be modified. Data such as land use, wetland, soils, political boundaries, and other data sets from various sources are represented in this geodatabase.

- AVC_Dynamic.gdb.—Contained data that represented alternative features that had a potential to be updated, either by the sources' publishing cycle or due to planning processes. Most importantly, data such as the alternative routes, taps, deliveries, pumping plants, and other features are represented by this geodatabase.

A listing of the geodatabase files and their feature sets are included as appendix J. The static and modified dynamic data were used in two key ways in the estimates in this Appraisal Design Report:

- The assessment of project constructability factors, including items that affect alignment selection, such as:
    - Location of roads and bridges
    - Location of interfering infrastructure (e.g., buildings, railroads)
    - Location of rivers and canals
    - Preliminary topography for identification of high/low points and delivery elevations along alignment
- The quantification of engineering data, hydraulic design and layout, and construction quantity estimates (including):
    - Length of alternative selections
    - Alignment for reach and spur location
    - Ground water areas of concern

- Pumping and booster plant and tank locations
- Presentation figures for alternatives
- Delivery location and existing infrastructure confirmation where visible
- Lengths of —urban” or —rural” type construction
- Buffer corridor identification for EIS purposes

4.1 AVC EIS Buffer Corridors

Buffer corridors were identified to perform environmental impact evaluations. Appendix I contains a list of the segment corridor widths.

4.2 Crossings

GIS was used to determine the number and category of crossings. The number of crossings was determined within each reach of each alternative. The category of crossing were either a secondary road, primary road, highway, major highway, or railroad. Table 35 in section 3.6.2.5 provides a list of the number of crossings per alternative.

4.3 Ground Water Level Estimate

To generate surface of static water level and alternative intersect in the Arkansas Valley, the bulk —Well Permit” data for the Arkansas Basin from the State of Colorado Department of Water Resources Web site (http://www.dwr.state.co.us) was used. For more details of the procedure used, see subsection 5.10.

5. Project Constructability

The team quantified and assessed the constructability issues that would influence the construction of the AVC project and its related facilities at an appraisal level. The issues addressed during the STAG Final Report and appraisal level planning phases include:

- Planning and construction schedule
- Construction equipment
- Traffic disruptions
- Facility and site access
- Excavation and backfill considerations
- Roadway, railroad, river, stream, and ditch/canal crossings
- Ground water level
- Surface restoration
- Above and below ground utilities
- Summary and other constructability issues

This evaluation was based on the alternative AVC corridors, WTP sites, pumping plant and booster plant, and on-line storage and pump regulating tank locations as described earlier in this report. The AVC alignments would cross areas that would present two distinct types of construction considerations:

- The urban segments of the AVC alternative routes would include urban areas with relatively dense residential and commercial/industrial developments. The western end of the Pueblo urban segment would be at Pueblo Dam and Reservoir and extend eastward to Avondale. There are a few other urban areas along the route to Lamar.

- The rural segments of the AVC alternative routes would extend east from Avondale to Lamar and include significant lengths that cross prairie, pastures, and farmland. There are also a few urban areas along the route to Lamar.

The urban segments of the AVC would be in dense residential areas with high-traffic roads, limited AVC corridor widths, and/or limited areas available for construction staging. Therefore, consideration would be given to the hours of construction, noise, dust, traffic control, and related issues for its entire length. The possibility of using existing ditch/canal corridors or other utility corridors could reduce the construction effects on the public but may increase construction issues due to restricted corridor widths. Using existing ditch/canal corridors also may increase construction issues due to potential high water tables adjacent to these facilities.

5.1 Planning and Construction Schedule

Appendix K shows an appraisal level planning and construction schedule that includes the feasibility design, final designs, and construction phases for the AVC project. The overall timeframe developed and shown in the schedule to accomplish the work was not constrained by potential congressional fiscal appropriations and depicts completing the entire project by May 2022. At this time, there are no constraints imposed based on yearly spending or budget caps. If funding was not continuous or in sufficient amounts, the overall project duration would likely lengthen.

The schedule was developed based on Alternative No. 4 (Pueblo Dam North). This alternative was selected because it encompasses the features that are generally common to all of the other alternatives. Therefore, the summary-level schedule (see appendix K) is representative of all the alternatives. Individual contracts for some of the alternatives would have varying completion dates; however, the final overall project completion date would be approximately the same for each alternative.

The schedule is separated into six separate final design packages and six construction contracts ranging in size to accommodate various contracting procurement methods and a range of contractors. As the project progresses, and as details of required water deliveries and funding become known, these contract packages may be revised accordingly.

As shown in the schedule, after the feasibility level design phase was complete, the final design phase would begin; however, if deemed appropriate by the Regional Director of Reclamation’s Great Plains Region, the AVC project would be subject to a Reclamation design, estimating, and construction review at that time. The final design phase activity would be accomplished in series (one after the other), with the exception of the WTP, which would be designed by a consultant/contractor concurrently with the design of the Reach 1 features. After each phased final design, the construction contracts would be procured. The

6-month procurement timeframe used in the schedule for each contract would be adequate for the typical acquisition process, whether the contract is a negotiated procurement or sealed bid procurement.

The construction contract durations were calculated and based on one of many approaches to completion of the project. The durations were based on the logical sequencing of work activities and interdependencies between features. The construction schedule for each feature was determined based on location and type of construction. The construction schedule was developed using concurrent construction activities for many of the features, with the assumption that multiple crews would begin work at the same time.

Activities in the construction schedule were assigned to calendars that allow the work to be performed in accordance with a normal 5-day workweek. No work was assumed on major holidays. All onsite work was assigned to a –rain” calendar that assumes there will be winter days when no work will be performed due to weather or weather impacts. The durations incorporated time for normal equipment breakdowns. The contract durations were sufficient to schedule the work during optimal times, such as when the water is lower in the rivers.

The construction schedule provides one of many possible scenarios and durations to complete the project. The schedule would be further developed during the feasibility design phase of the project and again during the final design phase.

5.2 Construction Equipment

Use of typical heavy construction equipment was expected to complete the project. This equipment may include excavators, backhoes, bulldozers, loaders, tunneling and boring equipment, compactors, pavers, water trucks, front-end loaders, dump trucks, drill rigs, cement pump trucks, cranes, pickup trucks, and other miscellaneous equipment.

Pipeline construction activities would involve, but not be limited to, demolition of existing roadways as required: clearing, grubbing, excavation, pipe laying, backfill, and compaction. Controlled blasting may be required for rock excavation in some of the pipe reaches.

Clearing and grubbing would be accomplished using ground-skidding equipment. Pipeline construction would typically include a Cat 345 excavator, Cat 966 front-end wheel loader, and 433E padfoot vibratory compactor. A Cat 330 excavator may be used for the pipeline spurs.

Pavers, smooth drum compactors, and pipe boring or tunneling equipment may be required to install pipeline adjacent to and beneath roadways in the urban areas. HDD, microtunneling, or piping boring equipment would likely be required for the major roadway, streams and rivers, and railroad crossings.

In addition to the equipment stated above, cranes, cement trucks, forklifts, genie aerial lifts, portable generators, and drill rigs may be used for construction of the pumping plants, WTPs, air chambers, regulating tanks, and water storage tanks. Equipment for shoring and unwatering or dewatering may be needed to divert or control surface water and ground water. Hydromulch equipment may be used to reseed disturbed areas.

No equipment causing excessive noise would be anticipated for road construction work (e.g., no pile driving). Typical noise would include noise from trucks and diesel-powered equipment.

Total construction duration was estimated to be approximately 6 years. An overlap was expected in the timing of some construction components. Construction would be phased, when feasible, to avoid negative environmental impacts. Construction would typically occur during daylight hours, Monday through Friday. However, the construction contractors may extend these hours and schedule construction work on weekends, if necessary, to complete aspects of the work within a given timeframe.

5.3 Traffic Disruptions

Traffic disruptions associated with the AVC project would generally be temporary and localized. Disruptions would be related directly to the construction within a specific area for a relatively short time period (usually no more than 30 days). The disruptions could be caused by material deliveries, equipment mobilization, or actual road closures for construction of the facilities. Short-term disruptions could also result from an increase in vehicular traffic resulting from the influx of construction workers.

- **General**.—Identifying key alternate or detour routes, whenever available, could mitigate traffic disruptions, as could working within the shoulder and one lane of a multilane roadway or highway and allowing passing capabilities on smaller roadways that are less traveled. Safety and hazard barriers, as well as lighting, should be used to bring awareness to the open trench hazards on either side of the backfilled roadway. All construction signage, flagmen, and detour signage should comply with the latest edition of the Colorado adopted version of the *Manual of Uniform Traffic Control Devices* (Federal Highway Administration, 2009).

- **Urban Segments**.—Within urban areas, the construction contractor would need to coordinate with multiple agencies and entities with regard to traffic control and mitigation of traffic impacts. There would be additional concerns related to maintaining access for private roadways and driveways, and road closures, especially during peak traffic times. Mitigation may include such measures as night time/weekend construction that could be performed without affecting nearby residences, boring under larger and busier roadways such as highways and major collector streets, or construction within existing rights-of-way or easements that are part of or adjacent to roadways. The construction should be limited in the length of detours that are permitted during construction. No more than two city blocks should be unavailable for general traffic at any time. The contractor should be required to provide for residential/business access and emergency vehicles at all times. Trenches should not be permitted to remain open and uncovered overnight.

  Costs and construction schedule impacts listed above have been assessed and addressed to the extent practical within this Appraisal Design Report.

- **Rural Segments**.—In general, rural construction of the AVC would be less likely to disrupt traffic. The density of improved roads would be much lower than within the Pueblo segment. Key roadways may be important to keep open, however, due to the lack of alternative routing available. One mitigation technique would be to require continuous backfilling over the pipeline to keep key access roads and roadways open to the maximum practical extent, minimizing down time. Backfill over the off-road portions of the line could then be handled on a separate schedule, but the unexposed pipe length should be limited to 300 feet unless the contractor’s means and methods of construction warranted special consideration and approval by the engineer.

- **Pumping Plants, WTPs, and Tanks**.—Sites for these facilities would be on properties generally isolated from the traveling public. With the exception of a needed construction and/or permanent access road, traffic disruption and effects should be minimal.

5.4 Facilities and Site Access

The primary facilities that would be included in the overall AVC project include pumping plants, WTP, and tanks. Appurtenant facilities, such as booster plants, disinfection facilities, SCADA-related tower facilities, and pipeline structures (air valves, blowoffs, buried manholes, isolation valves) would also be needed, but their site access requirements would be small relative to the primary facilities.

The majority of the pipeline would be installed along, or directly adjacent to, existing easements. A study of existing easements would be conducted to determine that construction of the new pipeline is allowed. Existing easements may not be wide enough to allow for the construction and maintenance of the new pipeline and may require additional negotiations to widen. Obtaining new easements through urban areas may be difficult due to the number of landowners involved. The Great Plains Region has experienced problems on other municipal and industrial pipelines running through urban areas that have resulted in relocating the pipelines and replacing sections of pipe to handle new surface vehicle loading. Easements through urban areas would need to be wide enough to make future repairs.

Paved urban roads rarely provide easy emergency or all-weather access due to the difficulty of verifying the location of all buried utilities in the area before digging. An excavator on a low-boy trailer may need to travel a circuitous route to a site to avoid overhead hazards. Therefore, typically smaller equipment would need to be used in urban areas. Large equipment can nearly always access most rural sites.

Discussions of the site access issues for the primary AVC facilities are included below:

- **Pumping Plants and WTP**.—Depending on the preferred alternative selected, these facilities may be constructed adjacent to an existing WTP or on new sites. Minimizing the length of new road construction for site access is one of several factors in the final site selection process. A paved access road would be required to provide the site with all-weather access for trucks, personnel, and emergency equipment. The relative location of the site to electric power and transportation is also an important factor. The more remote the site is from existing utilities and roadways, the more expensive site development becomes, and the more costly the initial construction would be.

- **Tank Sites**.—Two to four tank sites (i.e., water storage and regulating), spread along the AVC corridor, have been considered for balancing demand with treatment capacity, pumping plant regulations, and providing emergency water supply. Generally, the tank sites would be located on high ground or be elevated for hydraulic efficiency. Adequate site access could be a gravel roadway, one or two lanes wide, depending on length. Steep grades are not recommended because winter access and heavy equipment access may be required. Since telemetry equipment is anticipated to support system-wide control and monitoring, close proximity to a power supply is desirable.

- **Main Trunk and Spur Pipelines**.—A majority of the AVC would be installed along existing roadways, existing canal/ditch easements, or other established ROW or easements. This would provide all-weather access to the pipeline for routine OM&R. For lengths that would not be adjacent to a ROW, a permanent easement 100 feet wide was proposed. However, widths would vary depending on site-specific conditions such as the need to avoid existing facilities or to conform to property boundaries. The easement width may be reduced for areas with constraints, depending on the diameter of the pipeline. Temporary construction easement width of an additional 40 to 60 feet would provide room for construction. Access to easements would be required via a gravel surfaced road from an existing roadway. AVC lengths across cultivated agricultural land would not require a permanent access road. AVC lengths across grazing and open prairie lands may include location marker posts to identify the location of pipe alignments. By the completion of construction, the wheel paths for vehicular access should be established within the permanent easement and between marker posts. The wheel paths would be seeded as part of the final restoration; however, it would not be essential to establish a gravel surface across the dry open prairie lands. For pipelines that traverse along existing canals or farm roads, the contractor should restore the roadways or motorized trails to the original preconstruction condition. Any fence line crossings should be secured by a lockable gate.

- **Site Security**.—Securing facility sites is essential for ensuring public health and preventing theft. These facilities would require protection by means of a security fence and a lockable gate. Increased security measures may be warranted if the site is remote or not generally in plain view of the public. Any above or below ground controls or vaults should be secured with padlocks or have keyed entries. All facilities should be limited to access by authorized personnel only.

5.5 Difficulty of Excavation

Considering the length of the project and the variation in terrain, a wide variation in soil conditions should be expected. Based on mapping from the Natural Resource Conservation Service/U.S. Department of Agriculture Web Soil Survey, four areas along the proposed pipeline alternative routes were sampled to evaluate the soils that may be encountered.

While sandy and clay loams are prevalent, some gravelly soils would be encountered. This is typical of alluvium found along river basins in Colorado. In the hillsides and bluffs where tanks may be constructed, larger boulders and bedrock may be encountered near the surface. Further geotechnical investigations would be needed on the sites to determine specific site suitability. Soils along the alternative pipeline routes should not present any difficulty in excavation. Standard precautions meeting Occupational Safety and Health Administration requirements for trench safety would need to be taken at all times. The STAG Final Report contains additional mapping details.

If blasting is required near the dam or other pipelines or structures, it should be expected that ground acceleration restrictions will be imposed and monitoring/ instrumentation will be required. Blasting may be required for pipe installation near the dam. It should be noted that blasting near Pueblo Dam on the SDS project was not used, not because Reclamation prohibited the activity, but because the materials were observed to be excavatable using conventional excavators, rather than dealing with blasting restrictions and performing damage surveys. Recent geologic explorations were conducted for the Colorado Springs Utilities SDS, Geologic and Geotechnical Data Report for Pueblo Dam Connections. The exploration was performed by RJH Consultants (RJH Consultants, 2009). Bedrock along the alignment consisted of Dakota Sandstone and Graneros Shale. South of the Arkansas River, Dakota Sandstone was present at about 2.5 feet to 14 feet. The Dakota Sandstone was observed to be excavatable along a portion of the alignment in a test pit (TP-2). A Volvo EC 160B excavator was equipped with a 3,500-lb/in^2 hydraulic jack, and a Hitachi 450LC excavator was equipped with a 3.5-foot-wide bucket with tiger teeth. The Hitachi excavated at a rate of about 50 minutes per foot of depth, while the Volvo excavated at approximately 40 minutes per foot of depth.

It should be noted that during the irrigation season, excavation could be affected by localized high water tables resulting from irrigation and field runoff, and additional dewatering may be required.

5.6 Backfill Requirements

The soil ratings evaluated in the STAG Final Report were base on sample areas that have been compiled and are shown in table 42. Approximately 40 percent of the soils in the sample areas would be rated as *Poor* for their use as roadfill backfill, which is similar to pipe embedment material requirements. In these areas, significant quantities of imported or processed backfill would be required for pipe bedding/embedment. Suitable material for bedding/embedment can be imported from other local sources or from areas of construction to meet the quality requirements. Loam soils would be removed and set aside for use as topsoil in the areas disturbed by construction. Expansive clay soils may be encountered. These, too, may require segregation and disposal in an area approved by the project engineer. Preservation and restoration of the topsoil to the quality and depth that exist on cultivated agricultural lands would be particularly important.

Table 42. Ratings of Soils as Pipe Bedding/Embedment (Roadfill) Source

Sample Area	Good (acres)	Fair (acres)	Poor (acres)	Not Rated[1] (acres)
Pueblo	667.9	433.2	1,319.0	86.8
Avondale	962.0	455.4	1,424.5	90.3
Swink	6,084.3	119.4	1,723.6	303.1
Las Animas	1,605.0	1,337.9	4,477.7	54.9
Subtotal – acres	9,319.2	2,345.9	8,944.8	535.1
Composite %	44.07%	11.09%	42.30%	2.53%
Total sample acres	21,145.0			

[1] Not rated areas include surface water acres and areas of disturbed use not suited to soil classification.

Reclamation would identify suitable borrow and spoil sites and/or existing commercial sources as required. This would be identified during the feasibility design phase. Limited spoil would be allowed within the construction corridors when it would not interfere with land use.

Ability to use local materials for backfill/embedment and recontouring versus need to import and export materials would affect constructability, cost, and the area of construction easement required.

5.7 Road Crossings

Generally, it is expected that AVC construction within the urban segments would be along other utility easements or within existing street and road rights-of-way, while construction of the AVC in the rural segment would follow adjacent to available road rights-of-way whenever practical.

5.7.1 Urban Segments

The pipeline would be constructed under the pavements of city streets when street ROW is not sufficient for pipe installation outside of the paved area. This would also be true when necessary to avoid conflicts or realignment of other existing utilities and structures. State highways and major city streets are expected to require pipe installation via trenchless technology methods to avoid disruption of vehicular and pedestrian traffic in highly congested areas.

The crossing under Interstate 25 (I-25) would be a major construction issue, and selection of the I-25 crossing site would be an important engineering and construction undertaking. A location that passes under an existing bridge on I-25 would be the most desirable and least costly. Other sites would require trenchless technology methods, for which the primary crossing site selection parameters are crossing length and soil conditions. Such undertakings would be subject to rules and regulations of CDOT.

5.7.2 Rural Segments

State highways would require that pipe crossings be installed by tunneling or boring and jacking methods to minimize disruption of vehicle traffic. The crossings on U.S. Highway 50 would cause the greatest concern. Major county roads may require tunneling or boring and jacking methods, but the requirements for each road crossing may require negotiation with the local authorities. Open cut installation for crossings of unpaved county roads is usually the preferred option.

In rural communities, the same policy as currently exists for Pueblo for working in city streets would be applied. The pipeline would be installed under pavement unless adequate ROW existed and there were no other utilities present. Working inside the corporate limits of rural communities would be avoided to the greatest extent practicable.

5.8 Railroad Crossings

Active railroad crossings can only be constructed by tunneling, boring and jacking, HDD, or microtunneling methods. Construction is usually not permitted to encroach on railroad ROW, so entry and exit pits must remain off of the railroad property. Alternative pipe alignments would be selected to minimize the number of tracks at any required crossing, thereby reducing the length of the crossing. For each proposed pipe alignment, a total of approximately 15 railroad crossings are under consideration. The Burlington-Northern-Santa Fe, Union Pacific, and Colorado-Kansas Pacific railroad companies could be involved in the proposed crossings. Historically, discussions with these entities are a long lead time item and should begin early.

One of the proposed alternative alignments (i.e., Alternative 5, [River South]) would use an abandoned railroad ROW as the location for the easement and pipeline. This would be a unique opportunity to take advantage of a pregraded length of ROW that would both facilitate construction and provide a no-cost stabilized roadbed for access. However, care must be used when using old railroad ROWs due to potential contamination and hazardous materials. Also, current ownership would need to be verified.

5.9 River/Stream/Canal Crossings

The Arkansas River poses the greatest challenge to the project, in terms of river crossings. Three critical constructability considerations for the Arkansas River crossings are to:

- Facilitate construction by avoiding steep, vertical, sandy banks that impair construction and would be difficult to restabilize.
- Avoid environmentally sensitive areas, including any wetlands or substantial tree and vegetation growth.
- Select crossing locations where the width of the river is minimal (as compared to the average width of the river).

5.9.1 Cofferdam/Dewater/Open Trench

This is the conventional method of pipe installation. It consists of diverting the stream flow to one side, removing water from the soil and work space, and installing the pipe into an excavated trench. Then, the process is repeated for the other side of the crossing. The stream channel is then reestablished after pipe installation.

5.9.2 Horizontal Directional Drilling

HDD is a trenchless construction method used to install pipelines of various sizes and materials below the ground surface. HDD is often used where open cut installations are not feasible, such as road and river crossings. Using directional drilling techniques, one guides a drill string along a bore path under obstacles such as rivers, lakes, railway crossings, or highways. As the hole is bored, a steel drill string is extended behind a cutting head. Drilling mud is used to cool the cutter, to flush excavated soil from the borehole, and to lubricate the borehole. The cutting head is removed, and a backreamer is attached. The pipe string is attached to the backreamer through a weak-link device. As the drill string is withdrawn to the drilling rig, the backreamer enlarges the borehole and the pipe string is drawn in.

5.10 Ground Water Level

During the irrigation season, excavation could be affected because of localized high water tables resulting from irrigation and field runoff, and additional dewatering would be required.

A determination of locations where probable ground water would have effects on construction activities was based upon the following procedure:

1. Download the bulk —Well Permit” data for the Arkansas Basin from the State of Colorado Department of Water Resources Web site: http://www.dwr.state.co.us/HBGuestExport/HBGuestExport.aspx (State of Colorado, 2011)

2. Delete any permit record meeting the following criteria

    a. Did not have record of static water level (depth to water) recorded

    b. The static water level was recorded prior to year 2000; a representative from the Department of Water Resources stated that sample dates equated to the date of well construction – 819 wells remained

    c. The well was outside of the study area

3. Generate a raster surface representing depth to water from the 819 remaining wells with an inverse distance weighted technique within the ArcMAP software

4. Reclassify the raster surface to 15 classes at 5-foot increments

5. Generate geospatial polygon data set from reclassified raster surface in areas classified with static water level of 15 feet or less

6. Increase the width of the output polygon data by 250 feet (buffering function) as a precaution to err on the side of overestimation in the following analysis
7. Clip portions of the alternative segment database that spatially intersected polygons representing static water levels of 15 feet or less with the added 250-foot buffer
8. Generate tabular information on length of segment intersected by polygons representing static water levels of 15 feet or less by alternative and alternative spur

Note: Inverse distance weighted is a surface interpretation process, and accuracies depend on the spacing and accuracy of the input data.

5.11 Surface Restoration

All areas disturbed by construction that do not require special surface treatment, such as pavement replacement, would be seeded and mulched after construction or, if agricultural land, would have loam topsoil replaced. Temporary seeding may be required when disturbed areas remain untouched for more than 30 days. A turf seed mix would be required for established lawns. A native seed mix would be required for all other vegetated areas. Cultivated agricultural areas would not require reseeding. Sod may be required for limited areas within public areas or ROW. Requirements for erosion and sediment control would be established during final project design.

All areas with existing landscape cover or mulch would be replaced with similar size and type of cover materials. Pavements, sidewalks, and other hardscaped areas would be replaced with an equal or better surface as provided for in the final project specifications and plans.

Disturbed portions of the banks and beds of rivers, streams, and other waterways would be protected by rock riprap of adequate size and type to minimize erosion and scour. Any slopes greater than 3:1 should be protected with erosion control blankets after seeding. Some water conveyances may require additional protective measures if site-specific conditions dictate.

Irrigated cropland would require special consideration and attention during construction. Not only would it be critical to restore cropland with topsoil to the depth that exists, but also the quality of the topsoil, the relative density, and the original surface grading must be restored. Restoration of the existing surface grades is critical to farmers who rely on gravity irrigation of the crop rows. The quality of the topsoil and its depth would impact the yield that farmers expect from the croplands. Soil density must be adequate to support tractors and equipment but not dense enough to prevent water infiltration. Each negotiation for ROWs across cropland must include the specific requirements of the property owner with regard to these factors. While the cropland owners can be compensated for crop damages and losses during the construction period, the potential for postconstruction litigation could be higher if these factors were not considered.

5.12 Above and Below Ground Utilities

Above and below ground utilities could exist over the entire length of the AVC project. Their abundance in Pueblo would require special attention during final design of the project. Whenever possible, final design should minimize crossing under overhead utilities; this would be subject to the preferred alternative route selected. Horizontal clearances would be established and maintained during design and construction to minimize possible disruption of services and potential safety hazards during construction.

To minimize conflicts between highway and utility facilities along the U.S. Highway 50 corridor and to be consistent with State-wide regulations for accommodating utilities within State Highway ROW, coordination efforts with CDOT would be required per the process and regulations outlined in the *State Highway Utility Accommodation Code* (State of Colorado, 2009).

The utility design data collection activity would include the use of American Society of Civil Engineers (ASCE) *Standard Guide for the Depiction of Existing Subsurface Utility Data* (ASCE, 2002) recommendations for the quality of location.

In July, 2011, the Farnsworth Group was retained for services to perform GIS project coordination services, which include gathering utility GIS documentation. Work was performed at the ―Utility Quality Level Attributes – Quality Level D," as defined in ASCE 38-02, *Standard Guide for the Depiction of Existing Subsurface Utility Data*. Utility quality level D is the least level attribute of data collection of information derived from existing records or oral recollections.

It is recommended that as the AVC approaches the feasibility and final design phases, the level of effort of utility design data collection for the preferred alternative be expanded and migrate toward a ―Utility Quality Level Attributes – Quality Level A." Utility quality level A is precise horizontal and vertical location of utilities obtained by the actual potholing exposure (or verification of previously exposed and surveyed utilities) and subsequent measurements of subsurface utilities, usually at a specific point. Minimally intrusive excavation equipment is typically used to minimize the potential for utility damage. A precise horizontal and vertical location, as well as other utility attributes, is shown on utility plan documents. Accuracy is typically set to approximately 9/16 inch (15 millimeters) vertical and to applicable horizontal survey and mapping accuracy as defined or expected by the project owner.

Utility data will be placed on the AVC plan and profile and feature drawings for both the feasibility level phase and the final design level phase.

5.13 Summary and Other Constructability Issues

Considerations for constructability in the urban Pueblo segments, and other community segments, include:

- Extensive traffic control, impact planning, and public notifications/communications
- Consideration of alternative hours of construction
- More detailed routing considerations to avoid conflicts
- Ability to negotiate and use existing easements
- Greater number and complexity of pipeline crossings of roads, drainages, other utility impacts, etc.
- More expensive construction techniques such as extensive use of trenching/shoring techniques, bores, HDD, etc., will be required
- Potential need to work within very restricted ROW
- More repaving, replacing, and upgrading of impacted areas including roads, driveways, parking lots, drainages, landscaped areas, other utilities, etc.
- Need to carefully plan for adequate staging areas
- More extensive signage and hazard warnings within the construction zone

- Coordination of access with emergency services such as police and fire during limited access times

Considerations for constructability in the rural segment include:

- Routing pipelines adjacent to private land that is adjacent or parallel to roadways to provide ease of construction and maintenance access, while remaining off the road to minimize impacts and utility conflicts.

- Routing along less used roadways, where convenient, to avoid other structures, facilities, and utilities.

- Avoiding disturbances to sensitive habitat such as undisturbed prairie habitat, riparian zones, wetlands, and migratory and raptor nesting areas.

- Considering waterway (channel, stream, river, and canal) crossings by either open cut or bore or directional drill. Open cutting of a natural surface drainage should be accomplished during dry times of the year to minimize diversion and dewatering needs. Directional drilling should be used when open cutting is not practical or to reduce environmental impacts. Open cutting ditches and canals should be scheduled during the nonirrigation season. For most canals, the irrigation season is March 15 through November 15. During the winter, some of the storage canals run water, and junior ditches irrigate because they are in priority and not part of the Winter Water Storage Program.

- Avoiding wetlands, cemeteries, cultural resources, and historical areas whenever practical.

- Adjusting pipeline corridor widths as needed for construction and for permanent easements.

- Considering local soils, export of unusable excavated materials, and import of bedding/embedment and backfill materials when determining the pipeline construction width and trench design details. Acknowledging other pipeline features, such as valve stations, blowoff stations, etc., that will typically necessitate more convenient access, possibly greater easement requirements, and the potential need for a convenient drainage channel for discharging large volumes of water.

- Acquiring multiple staging areas, which may be the responsibility of the general contractor to acquire and manage.

- Backfilling roadway and driveways immediately after pipe placement when they provide the only option for access to homes, farms, and businesses.
- Potentially expanding the pipeline construction width when dealing with stockpiling surface soils for revegetation, exporting unusable materials, importing bedding/embedment materials, dealing with wet areas, and around channel, roadway, stream, railroad, or other pipeline/utility crossings. These potential issues would need to be analyzed and handled on a case-by-case basis during final design.

Issues related to a particular site being considered for WTP would include:

- Soils and geotechnical features
- Topography—more vertical sites generally require more land area
- Location with respect to residential development
- Zoning and nearby land uses
- Buffer zone availability
- Roadway access
- Proximity to pipeline alignment
- Ability to secure site from unwanted visitors
- Nearness to three-phase electric power service
- Provision of onsite backup power facilities
- Backwash discharge requirements/ability to obtain discharge permit
- Sewer facilities
- Adequate offsite drainage facilities to route onsite drainage

General considerations for tank site development would include:

- Soils and geotechnical features
- Topography/elevation

- Roadway access
- Location to power service for telemetry, supply monitoring, and security systems
- Good access to roadways, but probably 100 feet from a roadway in more rural areas, to discourage casual visitation by unauthorized individuals
- Proximity to pipeline alignment
- Enough area for the tank or tanks and a valve/metering/control house, as well as about 50 feet of width around the facilities for access and maintenance
- Ability to secure from unwanted visitors
- Electrical emergency backup power or hookup for trailer mounted generator (if required)
- Specific land requirements will be determined as tank designs and SCADA system needs are further investigated

6. Regional Site Conditions

6.1 Geology

Geologic characterization described in this section was developed from a review of available information discussing geologic conditions within the AVC project area. This section presents a general discussion of engineering geologic considerations that relate to the site geology that may be encountered along AVC alternative alignments.

It is recommended that future work include site-specific geologic design data collection based on the preferred alternative. A future report may include station-to-station geology based on smaller scale geologic surface maps and Natural Resources Conservation Service soils data. The report may include a comprehensive search of geologic logs and data from Federal and State agencies, city and county records, local water and irrigation districts, etc. A drive along the selected alternative alignment(s) and site visits to proposed structure locations are recommended.

6.1.1 Geologic Explorations for Appraisal, Feasibility, and Design Phases

Surface and subsurface geologic explorations would be required for each phase of the project to adequately characterize the geologic site conditions and reduce construction costs at unfavorable locations identified by geologic investigations. Geologic investigations conducted at each phase would assist engineers in selecting the best engineering design options and alignments for the particular site conditions.

Explorations would likely be required at many natural features (e.g., streams, rivers, cliffs) and infrastructure locations that intersect proposed AVC alignments. Explorations may include geologic mapping, borings, test pits, penetration testing, cone penetration testing, and additional geologic exploration methods along the selected alternative alignment and at intersections with natural features and infrastructure. Geophysics methods may be used to investigate conductivity and corrosion potential of soils and depths to bedrock. Borrow investigations may be required to identify suitable materials for elevated portions of the AVC and portions of the alignment where replacement of unsuitable material was required. Laboratory analysis of soil and rock samples would be required to verify soil and rock physical properties, verify soil gradations, and study the compatibility of soil and rock with concrete structures as well as the suitability of soil and rock to various design alternatives that may be required.

Site-specific geologic investigations would be required at locations with adverse foundation conditions. Geotechnical engineers and geologists would be required to identify specific adverse conditions and develop investigation programs that attempt to acquire the required surface and subsurface data during each phase of design and construction as problem areas were identified.

In January 2011, at the request of ECAO for fiscal 2012 budget planning needs, a general field exploration program was estimated based on the assumption that explorations would occur at:

- Railroad, highway, and other road intersections that may require exploration for HDD or cut and cover construction methods
- Proposed AVC structure/feature locations
- Environmentally sensitive areas
- Areas where previous explorations were inadequate to characterize the foundation conditions

Two drill holes and two test pits per mile of alignment would also be needed.

Using these general assumptions, about 825 drill holes and about 775 test pits were estimated to be required along a single preferred alignment. Further work was completed to estimate the potential number of samples that may require laboratory testing. The number of soil samples to be collected and analyzed for physical properties was estimated to be about 2,300. It was estimated that about 55 rock core samples may require laboratory testing. Additional research of the geologic site conditions along the preferred alternative alignment would allow a more refined and accurate exploration program estimate. Further effort will be performed during the preparation of the field exploration request that will be prepared by Reclamation's TSC engineering team and made available to Reclamation's ECAO and Great Plains Region regional geologist for processing and coordinating the design data collection effort.

If the alignment route was modified as a result of the planning level feasibility study or the final design, additional explorations would likely be required. Performing a field exploration request along the preferred alignment versus a potential alternative route would affect the number of drill holes, test pits, and laboratory testing samples required. The availability of upcoming fiscal budgets could impact the field exploration request activity and potentially affect the planning level feasibility design and final design tentative schedule(s). If budget constraints are accommodated by reducing the number of drill holes and test pits along the preferred alignment, depending on site conditions, the risk of uncertainties to the overall project could increase.

Additionally, Reclamation is currently undertaking several major investigations for long pipelines using cone penetration tests and will be using them on this project. The cone penetration tests can reduce the cost of a field exploration request activity by eliminating the number of test pits and/or drill holes and related standard penetration testing blow counts required. Limitations of the cone penetration test include:

- It cannot be used in bedrock or with soils that have cobbles and boulders
- The procedure does not retrieve a soil sample.

There are real advantages to using test pits and drill holes including:

- It is possible to see the real soil conditions in test pits and drill logs,
- The degree of compaction can be accurately evaluated,
- Lab tests can be run on the soil, and
- They provide the designer confidence in the soil conditions.

Because of these advantages, exploration by test pits and drill holes should not be completely removed from any pipe investigation program. The use of the cone penetration test and potential cost savings would review and consider during the field exploration request activity.

6.1.2 Regional Geology

The AVC would begin at Pueblo Dam and Reservoir, at the eastern edge of the southern Rocky Mountains, where they join with the High Plains Province of the Great Plains. The bedrock underlying Pueblo Dam is composed of Cretaceous- and Tertiary-age sandstone, siltstone, and shale. These rocks were deposited in a marine, shallow marine, or near shore environment. The Rockies were uplifted during the Laramide Orogeny in late Cretaceous and early Tertiary, and the horizontally bedded sediments were tilted. The sedimentary units dip approximately 45 degrees east along the mountain front and flatten to approximately 5 degrees eastward within a few miles of the Front Range.

Rivers and streams flow eastward from the mountains and deposit their sediment loads in alluvial fans known as the Colorado Piedmont. Secondary streams have dissected the piedmont and grade into the western portion of the High Plains

Province. The Arkansas River has developed a river valley 3,000 to 12,000 feet wide across the Piedmont and High Plains Province and is filled with alluvial deposits.

Middle and lower portions of the project are located within the Quaternary alluvial deposits of the Arkansas River Valley. East of the mountain front, the sediments have been flexed into gently dipping synclines and anticlines.

6.1.3 Site Geology

Subsurface conditions along the alternative alignments are not well characterized at this time. Geotechnical field exploration programs would be conducted along the proposed pipeline and lateral spur alignments prior to feasibility and final design phases to further characterize subsurface conditions. The field exploration programs would be developed to gather geotechnical and geologic information at locations near roadways, rivers, streams, wetlands, or other sensitive areas where additional geotechnical information may be required or where specialized construction techniques may be used.

The proposed pipeline would cross many different soil types and Cretaceous sedimentary bedrock units along its approximate 240-mile-long alignment (depending on selected alternative). A USGS 1:150,000 scale geologic map was used to determine which geologic formations the proposed pipeline would cross (Tweto, 1979). Each alternative alignment was transposed over the USGS geologic map to generally review the soil and rock units the pipeline crosses (Geologic Surface Map – AVC Alternative Nos. 1, 2, 3, 4, and 5, appendix L).

The geologic units that the proposed AVC alternative alignments would cross are listed below.

Surficial units:

- Qa – Quaternary modern alluvium – mixture of silt, sand, gravel, and cobbles
- Qg – Quaternary gravels and alluvium – mixture of silt, sand, gravel, and cobbles
- Qgo – Quaternary older alluvium – mixture of silt, sand, gravel, and cobbles
- Qe – Quaternary eolian deposits – silt and fine sand (primarily windblown deposits)

Bedrock units:

- Kp – Cretaceous Pierre shale
- Kpl – Lower Unit, organic rich shale and numerous bentonite beds
- Kpm – Middle Unit, shale with numerous sandstone interbeds
- Kcg – Cretaceous Carlile shale, Greenhorn limestone, and Graneros shale
- Kdp – Cretaceous Dakota sandstone
- Kn – Cretaceous Niobrara Formation – calcareous shale and limestone

For this Appraisal Design Report, soil and rock units with similar physical properties were grouped together to help characterize the surface and shallow subsurface foundation geology for the AVC pipeline and supporting infrastructure. Soil and rock units that have similar constructability requirements were grouped together, including: bearing capacity/strengths, required trench widths, slope stability requirements, relative permeabilities, etc.

All Quaternary alluvium units (Qa, Qg, and Qgo) are comprised of similar materials and would have very similar constructability issues. These units were deposited by the ancient and current Arkansas River and its tributaries. It is anticipated that older alluvial units (Qgo and Qg to a lesser extent) have greater densities than Qa deposits.

Strength of foundation materials is anticipated to be variable in the alluvial deposits with some zones of loose, low density materials. They are anticipated to likely be clean coarse grained (poorly graded sand and poorly graded gravel) zones that have no cohesion and very high relative permeabilities. Relative permeabilities are anticipated to be high in all soil deposits, except clayey deposits. The occurrence and percentage of cobble- and boulder-size clasts is anticipated to be high in the western portions of the alignment near the foothills and low in the eastern portions. Temporary slopes are anticipated to be stable at 1:1 or flatter in most dry (or dewatered) cut slopes excavated in alluvium.

Quaternary eolian deposits (Qe) were grouped separately from alluvial units. Qe is comprised of windblown deposits of fine sand and silt. This unit is anticipated to be loose and unconsolidated. Excavation through Qe materials would require flatter side slopes than excavations in alluvial units. Additional engineering and design may have to accommodate changes in sand dune shape and configuration to maintain access to AVC features.

Eolian deposits are anticipated to have low foundation strength and would likely require compaction efforts or additional design to achieve adequate bearing capacity. The soil is anticipated to be loose with low densities, and no to low cohesion. Although most eolian deposits are anticipated to be dry, the unit has high relative permeabilities. Temporary slopes are anticipated to be stable at 2:1 or flatter in most dry (or dewatered) cut slopes excavated in eolian deposits.

Although not discussed at this level of study, more refined geologic characterization along alternative alignments would likely delineate clay deposits (if encountered). Clay foundations may require treatment or may need to be overexcavated and replaced with better materials to construct AVC features. Clay foundations may be susceptible to expansion, shrinkage, and other issues that cause constructability concerns.

All bedrock units were grouped together. Future, more in-depth geologic studies may result in dividing rock units based on their properties that may require different construction/excavation methods.

All rock units are anticipated to have moderate to high foundation strengths and to provide adequate bearing capacity. Rock units would likely vary from low to high rates of permeability and secondary permeability. If permeability becomes an issue, site-specific analysis would likely be required. Temporary slopes are anticipated to be stable at near vertical to 1:1 slopes in moderately weathered to fresh rock units. Decomposed and intensely weathered rock units may require 1.5:1 or flatter temporary slopes.

Most rock units are anticipated to be excavatable using common excavation methods. Some rock units or portions of rock units may require rock excavation, or it may be more economical to use rock excavation techniques. Site-specific analysis would be required to better define excavation requirements.

Table 43 shows an estimate of the percent soil units and rock crossed by each alignment. Distances were estimated using geologic surface maps in appendix L. Actual subsurface geologic units may differ from those shown on the geologic maps. Site-specific data to be collected in future phases of geologic exploration would refine station to station geology.

Table 43. Geologic Units

Soil and Rock Group	Geologic Symbol	Alternative No. 1 (Comanche South) Alignment (%)	Alternative No. 2 (Pueblo Dam South) Alignment (%)	Alternative No. 3 (JUP North) Alignment (%)	Alternative No. 4 (Pueblo Dam North) Alignment (%)	Alternative No. 5 (River South) Alignment (%)
Alluvial soil	Qa, Qg, Qgo	50	55	55	55	50
Eolian soil	Qe	10	10	10	10	10
Clay soil	Not identified	Not identified	Not identified	Not identified	Not identified	Not identified
Rock units	Kp, Kcg, Kdp, Kn	40	35	35	35	40

Notes:
Alignment % = estimated percentage of length per geologic group.
Alignment based on surface geology; subsurface geology may be different.
Geologic symbols are explained above. Geologic surface data compiled from geologic surface maps.

6.1.4 General Geotechnical Considerations

Construction of the AVC alignment would require typical construction techniques to construct the pipeline, directional drilled and installed pipeline sections, cofferdams, and infrastructure (e.g., pumping plants, valve vaults). Areas with potential adverse geologic site conditions would require site-specific exploration and lab testing. Possible adverse site conditions anticipated within the AVC project area are discussed in the following paragraphs. In addition, the proposed alignment would cross urban areas. Required AVC features will need to be constructed to minimize impacts to urban infrastructure.

Most soil and rock foundations are assumed to provide adequate bearing capacity for pipelines and required infrastructure. Areas of loose and unconsolidated alluvium would require site-specific investigation, lab testing, design, and construction methods. Ground improvement, modification, or overexcavation may be required at heavy structures or elements under hydraulic stress (pumping plants, storage tanks, etc.) and/or areas of adverse foundation conditions as discussed below.

Expansive soils and rock units are common along the front range of the Rocky Mountains. Many local soils and rock units have extremely high shrink-swell potential and are moderately to highly corrosive to uncoated steel, and some are moderately corrosive to concrete. Identification, delineation, and lab characteristics of these materials would be necessary to complete the design of the required AVC features.

Rapid and severe concrete deterioration can occur when concrete is improperly proportioned and comes in contact with soil or ground water with abnormal levels of sulfates or chlorides, or water with a low pH. Strength loss of concrete and significant corrosion of reinforcing steel can occur in these conditions.

Cathodic protection may be required for sections of a proposed pipeline and related infrastructure in corrosive environments identified by future geologic explorations.

AVC pipeline intersections with stream channels, intermittent stream channels, and storm water runoff channels with the potential for scour would require additional erosion protection design and construction. Site-specific exploration and evaluation may be required for areas susceptible to high rates of scour and erosion.

6.1.5 Excavation Requirements

The vast majority of the excavation along the proposed alignments for AVC would require common excavation methods through alluvial and eolian soil deposits, and rock units.

The review of existing geologic information shows that the proposed pipeline would cross a range of geological formations, including formations of sedimentary rock. Rock excavation techniques, like blasting or hydraulic hoe ramming, may be required in some of these areas to allow for excavation of a pipeline trench and other AVC feature foundations. Blasting may be needed if hard rocks were encountered near the surface.

Intersection with existing infrastructure (including roadways, railroad tracks, above and below ground utilities, canals, etc.) may require HDD methods. Site-specific exploration and design will be required at each HDD location.

6.1.6 Ground Water

The alignment of the pipeline would generally follow the Arkansas River. Relatively permeable alluvial deposits and shallow ground water can be expected along most of the alignment with considerable seasonal fluctuations. Trenching and excavations for AVC feature foundations in wet conditions would need to be addressed in future planning and design phases. Dewatering and/or unwatering techniques would be required to construct portions of the AVC project that intersect areas with high ground water levels. See appendix L for a map depicting areas of static water level within 15 feet of the surface.

6.1.7 Slope Stability

Recommendations for cut slopes in surficial deposits were based on material type and texture. All cut slopes would need to be constructed in accordance with *Reclamation Safety and Health Standards* (Reclamation, 2009) and pertinent Occupational Safety and Health Administration standards. Materials with excessive moisture would require further flattening for stability.

Cut slopes in bedrock would depend on the rock type and degree of weathering. Cut slopes in decomposed to intensely weathered, very soft to soft bedrock may require benching or cut slopes similar to those in soils, depending on the composition of the rock. Moderately weathered to fresh, moderately soft to hard bedrock could have vertical slopes if all requirements of the *Reclamation Safety and Health Standards* (Reclamation, 2009) are met.

6.1.8 Geologic Hazards

There have been no identified landslides of significance identified along the alignment. The gentle slopes over most of the alignment make the potential for landslide hazards remote. However, more detailed, site specific review would be warranted during subsequent studies.

Although there may be loose and potentially liquefiable soils along the alignment, seismic risk is low within the project area. AVC pipelines and structures would be light and would not intersect any known active faults.

6.2 Seismic

Pueblo Dam is located in south-central Colorado, approximately 3 miles west of the city of Pueblo. As discussed in the 2006 *Pueblo Dam Comprehensive Facility Review* (Reclamation, 2006), this area, lying at the eastern base of the central Rocky Mountains, is characterized by low rates of historic seismicity and few known or suspected Quaternary faults. The closest suspected Quaternary fault to the dam is the Goodpasture Fault, some 15 miles to the southwest of Pueblo Dam. The 30-mile-long Cheraw Fault, which was first mapped in 1976 and is one of the few documented Quaternary surface-rupturing faults east of the Rocky Mountains, lies about 62 miles (100 kilometers) east of Pueblo Dam, while the recurrently active late Quaternary Sangre de Christo fault zone lies about 56 miles to the west. See figure 4, which shows the location of Pueblo Dam, Quaternary faults, and earthquake epicenters in south-central Colorado.

Seismic loadings for Pueblo Dam were updated in 2009 with a Probabilistic Seismic Hazard Analysis (PSHA) prepared by URS Corporation, which was documented in the *Final Report Issue Evaluation* (URS Corporation, 2009).

Reclamation dam safety related features, such as Pueblo Dam, are reviewed using probabilistic loadings considering approximate return periods of 10,000 years and 50,000 years, while building type structures such as pumping plants, booster plants, and WTPs considered in the AVC would be evaluated for a return period of 2,500 years.

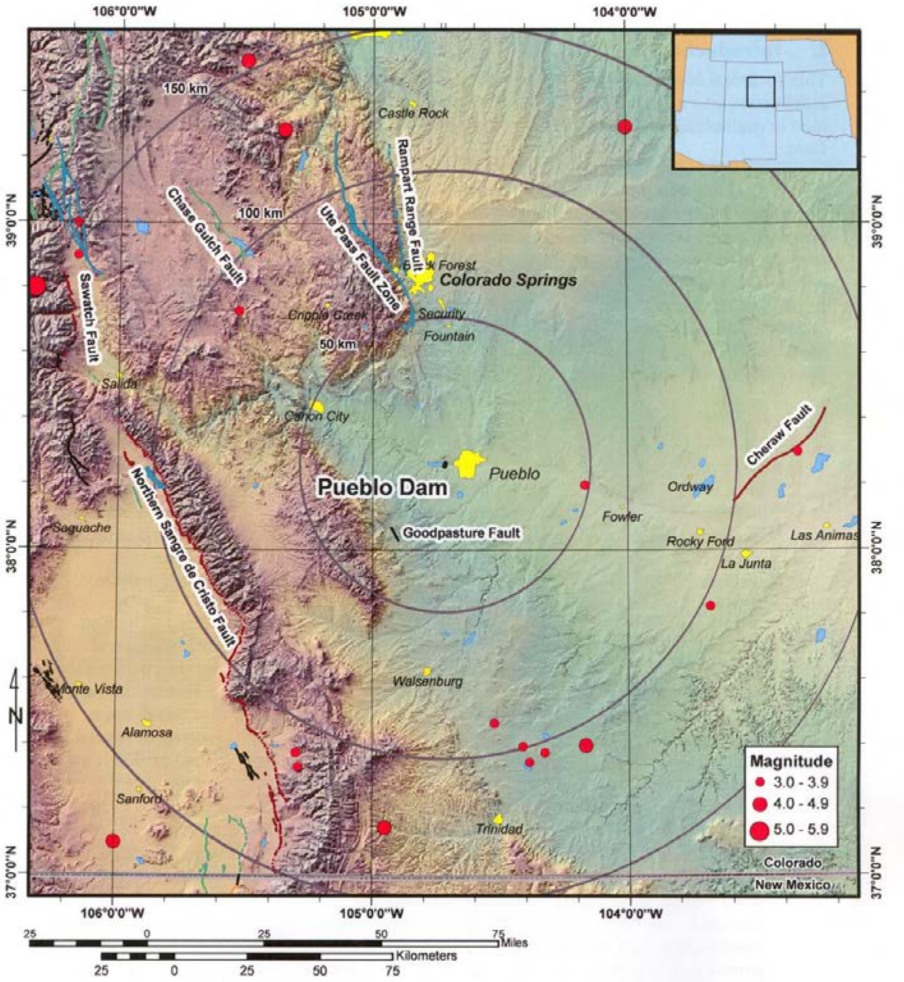


Figure 4. Map showing the location of Pueblo Dam, Quaternary faults, and epicenters of earthquakes of M 3 and greater in south-central Colorado. (Source: Bureau of Reclamation, 2006)

Ground movement seismic activity is anticipated to be minimal and should not adversely affect proposed AVC features.

6.2.1 Seismic Design Criteria for New Building and Other Structures

Local ground motions in regions with well-defined earthquake sources, known as deterministic motions, are used to develop Maximum Considered Earthquake (MCE) maps. The MCE is a term introduced by the Building Seismic Safety Council, which is an expert panel established by the National Institute of Building Sciences to develop national earthquake design standards. Current practice for the seismic analysis and design of new buildings establishes the Design Basis Earthquake (DBE) as a fraction of the MCE. In most of the Nation, the MCE is defined as a probabilistic ground motion having a 2-percent probability of being exceeded in 50 years, or in other words, it has an approximate return period of 2,500 years. In regions near faults, deterministic values establish the MCE, which remains equal to or less than the 2,500-year event. The Building Seismic Safety Council acknowledges that stronger shaking than the MCE could occur; however, it is judged economically impractical to design for such very rare ground motions, and selection of the 2,500-year event as the MCE ground motion would result in acceptable levels of seismic safety for the Nation. The Building Seismic Safety Council further substantiates its selection of the MCE by two aspects: (1) the seismic margin (i.e., built-in conservatism) in actual current design provisions is estimated to be at least a factor of 1.5, and (2) the positive response of newly designed buildings in coastal California during recent earthquakes. Based on the above discussion, the MCE selected for most facilities that would be constructed as part of the AVC (such as WTP, pumping plants, and other building type structures) should be the 2,500-year event.

Following current standards for building design, the DBE for buildings should be considered as two-thirds of the MCE. This reduction is based largely on the estimated seismic margin believed to be embedded in current design standards. This seismic margin is based on several factors including the inherent conservatism in the analysis procedure, ratio of actual-to-specific material strength, and most importantly, prescriptive ductile detailing.

As mentioned above, the second aspect of a performance-based seismic evaluation is the expected performance level of the facility at the selected evaluation event. For most Reclamation buildings, the minimum performance level to be satisfied is that which provides life-safety for the occupants and visitors. In some instances, however, given the economical value of the building, its content, or its operation, it is desirable to satisfy a higher performance level, which allows for minimal damage in the structure and the equipment.

Given the small tolerances necessary for functional operation of hydraulic equipment, many WTPs and pumping plant substructures should remain elastic under the DBE. This performance condition would be the standard applied to that portion of the structure that is below ground or supports critical hydraulic equipment. For those portions of the structure that are above grade, the seismic design provisions in the International Building Code (IBC) (International

Building Code Council, Inc., 2009) and the ASCE/SEI 7 *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2005) are intended to be followed in their entirety because the reductions applied to the seismic loads are coupled with specific detailing requirements described in those provisions. To reduce the seismic loads, the superstructure must absorb the earthquake energy through nonlinear deformations, which could only be realized if proper detailing is provided. It should also be understood that the lower the acceptable level of risk of damage for the building, the lower the reduction factors should be.

It should be noted that the DBE ground motion level specified could result in both structural and nonstructural damage when evaluated for a life-safety performance level. For essential facilities, it is expected that the damage from the DBE ground motion would not be severe enough to preclude continued occupancy and function of the facility.

Current practice is to characterize the seismic demand at a site with a design response spectrum, which comprises a relationship of the maximum response ordinate (commonly spectral response acceleration) over the entire response-history record of a single-degree-of-freedom oscillator and the period or frequency of the oscillator, for a specified level of damping. Modern design standards such as ASCE/SEI 7 contain prescriptive provisions for developing a site design response spectrum using values of spectral response accelerations for short and long periods. These spectral accelerations are often obtained from ground shaking hazard maps for the MCE and are adjusted for specific site classification or may be developed based on site-specific seismic hazard characterization.

6.2.2 Site-Specific Determination of the MCE and DBE

In some cases, a site-specific seismic hazard study will be required. In general, a PSHA based on seismic sources and ground motion attenuation relationships with corresponding return periods of (but not limited to) 5,000, 10,000, and 50,000 years may be available because it is the preferred procedure used in dam analysis.

Current code requirements noted in ASCE/SEI 7 require that site-specific ground motion spectra of the DBE and the MCE be developed if:

- The structure is located on a Site Class F
- The structure is located at a site with the 1-second spectral response acceleration parameter (S1) greater than or equal to 0.60

If a site-specific PSHA is performed, the value of the peak horizontal ground acceleration (PHA) for the 2,500-year recurrence period (2-percent probability of exceedance within a 50-year period) would be extracted from the mean hazard curve developed in the site-specific study. This value for PHA would be considered the PHA for the MCE ground motion. The design spectral response acceleration at any period should be determined as two-thirds of the MCE spectral response acceleration. Many Reclamation facilities, particularly dam sites, have existing and recently developed data from site-specific seismic hazard analysis. The availability of recently developed data for Pueblo Dam should be investigated and considered for evaluation of existing buildings or development of designs for new buildings at or near a dam site.

6.2.3 Prescriptive Determination of the MCE and DBE

In most cases, a site-specific PSHA would not be performed for pumping plant and WTP designs. A more common approach to determine the DBE demand would be to develop the site design response spectra curve using values of spectral accelerations obtained from national maps for the MCE and modified based on site classification. National maps depicting spectral accelerations for the MCE are currently available from the U.S. Geological Survey Web site: (http://earthquake.usgs.gov/hazards/designmaps/buildings.php) (U.S. Geological Survey, 2011).

6.2.4 Seismic Analysis Procedures for Superstructures

Current seismic analysis for superstructures (portion of facility or building above grade) uses one of three analytical procedures in accordance with ASCE/SEI 7. These procedures are known as:

- Equivalent Lateral Force Analysis
- Modal Response Spectrum Analysis
- Seismic Response History Procedure

It should be noted that the Equivalent Lateral Force Analysis may not be suitable for the seismic analysis and design of many new Reclamation pumping plants. The required occupancy categories and the seismic design categories for many Reclamation facilities may eliminate this method from consideration.

The definitions for irregular structures in ASCE/SEI 7 can be difficult to correlate directly to Reclamation plants. Current Reclamation practice considers a plant with an overhead crane to have a mass irregularity and a plant with stepped columns to be a vertical irregularity. Many of these plants are located in seismic areas with foundation conditions and occupancy categories that produce a seismic design category of D or E. These conditions result in a requirement to use the Modal Response Spectrum Analysis or Seismic Response History Procedure.

Nevertheless, it is not anticipated that AVC plants would have overhead cranes; they would be designed with removable hatch covers to allow the use of mobile cranes for performing OM&R activities on pumps and related equipment.

The Linear Response History Analysis requires extensive ground motion data, as well as time for preparing the mathematical model and processing the analysis and results. Based on current computer modeling methods and techniques, the preparation and processing costs, in terms of time and money, and the benefits obtained from this method do not justify its use for most Reclamation plants and facilities.

The use of Modal Response Spectrum Analysis is well suited for structures supported above ground, in which the structure undergoes various modes of vibration, having different periods in response to the ground excitation. The structural response results in an amplification of the input ground acceleration. The total response of the structure is determined by combining the responses in the various modes of vibrations.

Common practice within Reclamation is to characterize the seismic demand at a site with a design response spectrum, which comprises a relationship of the maximum response ordinate (commonly spectral response acceleration) over the entire response-history record of a single-degree-of-freedom oscillator and the period or frequency of the oscillator, for a specified level of damping. Modern design standards such as ASCE/SEI 7 contain prescriptive provisions for constructing a site design response spectrum using values of spectral response accelerations for short periods (S_s, 0.2 second) and long periods (S_1, 1 second), which are often obtained from national maps for the MCE and are adjusted for specific site classification or may be developed based on site-specific seismic hazard characterization.

6.2.5 Seismic Analysis Procedure for Structures Below Ground

For underground structures, such as substructures for pumping plants and WTPs, the dynamic response is different. It is reasonable to assume that these portions of the plant structure are restrained against free vibration, and hence, they only experience the ground excitation. Accordingly, the DBE demand for plant substructures will typically be represented by two-thirds of the PHA for the 2,500-year event. It should be understood, however, that systems and components within the plant structure may experience spectral accelerations higher than the PHA, depending on their dynamic characteristics (i.e., stiffness and mass).

If the substructure for the plant is not cast against rock, but is buried by placing backfill or embankment against the substructure, then the lateral earth pressures against the substructure are calculated similarly to the lateral earth pressures against retaining walls. Common Reclamation practice computes a total active fill force, P_{AE}, during a seismic event by adding a dynamic force component, $\Delta P_{AE,}$ to the active static lateral earth pressure force. Refer to *Design Criteria for Retaining Walls* (Reclamation, 1977) for a detailed description of this method.

The design value for the horizontal earthquake ground acceleration (PHA) used for analysis and design of structures below ground is obtained by extracting the acceleration at period T = 0 seconds from the response spectrum curve. For values of the PHA at T = 0 seconds that are greater than approximately 0.5g, methods other than that described in *Design Criteria for Retaining Walls* would be required.

The procedure described above for computing lateral earth pressures is based on Rankine's theory and the Mononobe-Okabe method for calculating lateral earth pressure. Also, the *Design Criteria for Retaining Walls* is limited to specific values of the effective angle of internal friction for the backfill material and to values of PHA less than approximately 0.5g. Other methods are available and have been developed since that method was initially adopted within Reclamation in 1971, including advanced computer modeling methods for soil/structure interaction in both the static and dynamic conditions. Other methods may be appropriate and/or required for computing lateral earth pressures for seismic loading, particularly for large ground accelerations and/or unique soil conditions.

6.2.6 General Design Requirements

Selection of categories, design factors, and load factors required to perform designs in accordance with the IBC and ASCE /SEI 7 will be the responsibility of the design engineers. The following paragraphs briefly discuss the basis and recommendations for selecting values for parameters commonly required when Reclamation designs plants and other building type structures. Selection of values for these parameters is based on Reclamation's interpretation and application of the seismic design requirements found in the IBC and ASCE/SEI 7. Although the values for these parameters are assigned to each building on an individual basis, the paragraphs that follow present what is considered common practice within Reclamation.

Per ASCE/SEI 7, Reclamation typically assigns an occupancy category of III to major and minor pumping plants, and it can be extended to WTPs. Occupancy category III is selected for pumping plants if the loss of these facilities would have substantial economic impacts and/or cause a mass disruption of day-to-day civilian life in the event of failure.

The importance factor originated with the seismic base shear equation in the Uniform Building Code (International Conference of Building Officials, 1976). The concept and purpose of the importance factor at that time was to increase the design seismic forces in order to provide additional seismic resistance and prevent catastrophic collapse. Current practice within Reclamation is to use ASCE/SEI 7 to assign occupancy importance factor of 1.25 to buildings in occupancy category III. The importance factors greater than 1.0 have the effect of reducing the potential for damage.

Based on current IBC and ASCE/SEI 7 provisions, structures designed to comply with the requirements of occupancy category III are expected to meet the life safety structural performance level.

In accordance with ASCE/SEI 7, depending on plant superstructure model building type(s), a Response Modification Coefficient, R, would need to be determined. The coefficient depends on the plant superstructure lateral-force resisting system(s) and accounts for facility ductility and require appropriate structural member and connection detailing. The coefficient would reduce site spectral response acceleration parameters.

Site soil classifications would need to be made along the AVC preferred alternative route and should be based on a geological investigation that must be conducted during the data collection phase of the project. Site class type should be assigned in accordance with ASCE/SEI 7.

As seen in table 44, spectral response acceleration parameters were determined, using ASCE/SEI 7 mapped MCE ground motion parameters, for several sites along the AVC alternative routes for a range of soil classifications. Depending on the soil classification and occupancy category, the AVC project area most likely would fall within a seismic design category of B or C and have a low to moderate level of seismicity and, hence, a low level of seismic hazard.

Design and installation of electrical equipment such as power transformers, breakers, unit substations, electrical cabinets, etc., shall be in accordance with Institute of Electrical and Electronics Engineers (IEEE) Standard 693, *Recommended Practice for Seismic Design of Substations* (IEEE, 2005).

Other nonstructural components such as miscellaneous building structural subsystems, architectural elements, mechanical, and electrical equipment (not covered in IEEE Standard 693) shall be permanently attached to structures in accordance with design criteria provided in chapter 13 of ASCE/SEI 7, entitled *Seismic Design Requirements for Nonstructural Components* (ASCE, 2005).

Table 44. Summary of Multiple Site Spectral Response Acceleration Parameters

Location	Latitude (degrees)	Longitude (degrees)	S_s 0.2 sec (g)	S_1 1.0 sec (g)	Soil Class	F_a	F_v	$S_{MS} = F_aS_s$ (g)	$S_{M1} = F_aS_1$ (g)	$S_{DS} =$ 2/3 S_{MS} (g)	$S_{D1} =$ 2/3 S_{M1} (g)	PHA 0.4 S_{DS} (g)
Pueblo Dam	38.27N	104.72W	0.199	0.062	A	0.8	0.8	0.159	0.050	0.106	0.033	0.04
					B	1.0	1.0	0.199	0.062	0.133	0.041	0.05
					C	1.2	1.7	0.239	0.105	0.159	0.070	0.06
					D	1.6	2.4	0.318	0.149	0.212	0.099	0.08
					E	2.5	3.5	0.498	0.217	0.332	0.145	0.13
Fowler	38.13N	104.02W	0.192	0.058	A	0.8	0.8	0.154	0.046	0.102	0.031	0.04
					B	1.0	1.0	0.192	0.058	0.128	0.039	0.05
					C	1.2	1.7	0.230	0.099	0.154	0.066	0.06
					D	1.6	2.4	0.307	0.139	0.205	0.093	0.08
					E	2.5	3.5	0.480	0.203	0.320	0.135	0.13
La Junta	37.99N	103.54W	0.186	0.056	A	0.8	0.8	0.149	0.045	0.099	0.030	0.04
					B	1.0	1.0	0.186	0.056	0.124	0.037	0.05
					C	1.2	1.7	0.223	0.095	0.149	0.063	0.06
					D	1.6	2.4	0.298	0.134	0.198	0.090	0.08
					E	2.5	3.5	0.465	0.196	0.310	0.131	0.12
Las Animas	38.07N	103.22W	0.165	0.050	A	0.8	0.8	0.132	0.040	0.088	0.027	0.04
					B	1.0	1.0	0.165	0.050	0.110	0.033	0.04
					C	1.2	1.7	0.198	0.085	0.132	0.057	0.05
					D	1.6	2.4	0.264	0.120	0.176	0.080	0.07
					E	2.5	3.5	0.413	0.175	0.275	0.117	0.11

Table 44. Summary of Multiple Site Spectral Response Acceleration Parameters

Location	Latitude (degrees)	Longitude (degrees)	S_s 0.2 sec (g)	S_1 1.0 sec (g)	Soil Class	F_a	F_v	$S_{MS} = F_aS_s$ (g)	$S_{M1} = F_aS_1$ (g)	$S_{DS} =$ 2/3 S_{MS} (g)	$S_{D1} =$ 2/3 S_{M1} (g)	PHA 0.4 S_{DS} (g)
Lamar	38.09N	102.62W			A	0.8	0.8	0.103	0.035	0.069	0.024	0.03
			0.129	0.044	B	1.0	1.0	0.129	0.044	0.086	0.029	0.03
					C	1.2	1.7	0.155	0.075	0.103	0.050	0.04
					D	1.6	2.4	0.206	0.106	0.138	0.071	0.06
					E	2.5	3.5	0.323	0.155	0.215	0.103	0.09

S_s = Mapped MCE, 5-percent damped, spectral response acceleration parameter at short period.

S_1 = Mapped MCE, 5-percent damped, spectral response acceleration parameter at period of 1 second.

F_a = Short period site coefficient (at a period of 0.2 second).

F_v = Long period site coefficient (at a period of 1.0 second).

S_{MS} = The MCE, 5-percent damped, spectral response acceleration at short periods adjusted for site class effects.

S_{M1} = The MCE, 5-percent damped, spectral response acceleration at a period of 1 second adjusted for site class effects.

S_{DS} = Design, 5-percent damped, spectral response acceleration at short periods.

S_{D1} = Design, 5-percent damped, spectral response acceleration at a period of 1 second.

PHA = Peak horizontal ground acceleration at T = 0 seconds

7. Items Requiring Further Clarification

Many items would need to be further clarified during the feasibility level design and final design phases. Specifically, the following issues have surfaced during the appraisal level design work that should be addressed:

1. Finalize location of participant delivery tie-in and desired hydraulic pressures.
2. Finalize the hydraulic grade line of the participant's system at the delivery.
3. Determine if the project will deliver maximum month or maximum day demands, or some combination thereof. Demands at the maximum day rates were assumed for the appraisal level design.
4. Determine if maximum day demands will be delivered to participants with radionuclides.
5. Determine acceptable pipe materials, pipe pressure classes, and valve classes.
6. Coordinate with the BWWP regarding the use of the existing Whitlock WTP and agree on process to determine costs, operations, and staffing.
7. Coordinate with Interconnect participants on having capacity available at Pueblo Reservoir's NOW as a backup to the SOW.
8. Update hydraulic analyses to further incorporate the looped spur.
9. Define the delivery box location point(s) at which responsibility/ ownership is transferred from the AVC to the AVC participants.
10. Coordinate with La Junta to determine if AVC participants north of the Arkansas River between Rocky Ford and La Junta can be supplied from La Junta's storage tanks.
11. Coordinate with the new corridor for the U.S. Highway 50 expansion being considered around the cities of Fowler, Manzanola, Swink, Las Animas, and La Junta. The AVC EIS is evaluating these corridors, but because these U.S. Highway 50 corridors are currently confidential, they are not described or displayed in this report.
12. Evaluate additional alternatives identified during NEPA public scoping process.

8. Cost Summary

This section summarizes the construction and OM&R costs for the five AVC EIS Action Alternatives that were analyzed for this Appraisal Design Report and will provide the AVC EIS team with a consistent level of information. Cost information for both the No Action Alternative and the Master Contract Only Alternative is not included in the appraisal level estimates but would be evaluated in the AVC EIS.

Appraisal level cost estimates are not suitable for requesting project authorization or construction fund appropriations from Congress due to the early stages of project development and limited design data. These cost estimates do not include costs for purchasing additional water rights.

8.1 Project Cost Summary

Costs prepared are associated with the delivery of maximum day demands. Table 45 summarizes contract cost, field cost, and total construction cost by reach for each of the five AVC EIS Action Alternatives.

The following cost items had quantities and unit prices developed for each reach in each alternative:

- **Pipeline**.—Clearing, grubbing, stripping, seeding, excavation (soil and rock), bedding, backfill, compacted backfill, pipe type, diameter and length, isolation valve type, diameter and number, isolation valve manholes (buried), air valve and structure, blowoff valves and structure, and cathodic protection.

- **Pumping Plants and Booster Plants**.—Lump sum costs based on flow rate, total dynamic head, number of vertical pumps, horsepower of pumps, and supply voltage.

- **River Diversion Structure (Alternative 5 [River South] only)**.—Stripping, removal and control of water during construction, diversion and care of Arkansas River, excavation, compacted backfill and embankment, access road, riprap, gravel, steel sheet pile cofferdam, drain system, gravel surfacing, chain link fence, guardrails, topsoil and seeding, concrete with reinforcement, trashrack, seats and guides, fish screens, airburst cleaning system, water-level measuring devices, and fence grounding.

Table 45 Summary of Total Construction Costs (January 2011)

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Alternative Name	Comanche South	Pueblo Dam South	Joint Use Pipe North	Pueblo Dam North	River South
			Alternatives Components		
AVC Intake	Dam	Dam	Whitlock	Dam	River
Route through Pueblo	South of Pueblo	Along Bessemer Ditch	Pueblo City 11th/14th/13th Streets	Pueblo City 11th/14th/13th Streets	Along south riverbank and U.S. Highway 50
Route East of Pueblo	U.S. Highway 50	U.S. Highway 50	North of Arkansas River	North of Arkansas River	U.S. Highway 50, north at Rocky Ford
Water Treatment	East of St. Charles, filter and disinfect	South Road and 21st, filter	Whitlock, filter	Pueblo Dam, filter	Near existing St. Charles Mesa WTP, filter and disinfect
Dam Outlet Works Interconnect	Yes	No	Yes	Yes	No
Reach 1 and 2 pipeline and pumping plant(s)	$81,082,185	$69,594,455	$59,310,069	$66,549,655	$55,458,470
Reach 3 pipeline and storage tanks between Fowler and La Junta	$58,533,858	$59,239,581	$46,373,191	$46,939,525	$51,977,581
Reach 4 pipeline between La Junta and Lamar	$33,657,742	$33,068,660	$39,053,753	$38,688,011	$35,581,930
Highway 96 spur pipeline	$12,114,245	$12,681,095	$6,875,093	$8,138,090	$5,960,670
Eads spur (includes May Valley) pipeline and booster plant	$7,495,700	$8,996,640	$9,277,315	$9,566,440	$9,393,369
Loop pipeline between Manzanola (north routes) or Rocky Ford (south routes) and La Junta	$10,647,216	$8,032,003	$24,821,848	$24,560,705	$20,979,393
Roadway, railroad, and stream/drainage crossings	$25,730,000	$27,245,000	$26,105,000	$26,105,000	$23,860,000
Dewatering of soil for construction	$4,690,000	$4,095,000	$4,515,000	$4,515,000	$3,570,000
Dust abatement during construction	$4,000,000	$4,000,000	$4,000,000	$4,000,000	$4,000,000
Dam outlet works Interconnect	$3,701,082		$3,701,082	$3,701,082	

Table 45 Summary of Total Construction Costs (January 2011)

	Alternative 1	**Alternative 2**	**Alternative 3**	**Alternative 4**	**Alternative 5**
Alternative Name	Comanche South	Pueblo Dam South	Joint Use Pipe North	Pueblo Dam North	River South
WTP[1]	$25,924,061	$25,924,061	$30,076,061	$25,924,061	$27,851,216
Subtotal	$267,576,089	$252,876,495	$254,108,412	$258,687,569	$238,632,629
Mobilization (5%)	$13,500,000	$12,500,000	$12,500,000	$13,000,000	$12,000,000
Design contingencies (12%)	$28,923,911	$34,623,505	$33,391,588	$28,312,431	$29,367,371
Contract Cost (January 2011)	$310,000,000	$300,000,000	$300,000,000	$300,000,000	$280,000,000
Construction contingencies (25%)	$80,000,000	$70,000,000	$70,000,000	$80,000,000	$70,000,000
Field Cost (January 2011)	$390,000,000	$370,000,000	$370,000,000	$380,000,000	$350,000,000
Noncontract costs[2]	$125,000,000	$125,000,000	$125,000,000	$125,000,000	$125,000,000
Total Construction Cost (January 2011)	$515,000,000	$495,000,000	$495,000,000	$505,000,000	$475,000,000

[1] Costs include updated February 16, 2012, costs from subconsultant B&V (estimate sheets dated December 1, 2011).
[2] Noncontract costs were produced and supplied by a joint effort of Reclamation's ECAO and Great Plains Region with input from the TSC.

- **Interconnect (Alternatives 1 [Comanche South], 3 [JUP North], and 4 [Pueblo Dam North]).**—Valve type, diameter, and number; pipe type, diameter, and length; flanges; pipe fittings; isolation valve manholes; cathodic protection; sitework and earthwork items; sandbag cofferdam items; and dewatering pumping.

- **Water Storage Tanks**.—Type, size, and height of tank; stripping; excavation; compacted backfill; gravel surfacing; chain link fence; reinforced concrete foundation; and access road/bridge quantities.

- **Regulating Tanks**.—Type, size, and height of tank; stripping; excavation; compacted backfill; gravel surfacing; chain link fence; reinforced concrete foundation; and access road/bridge quantities.

- **Air Chambers**.—Type, size, height, and diameter of air chamber and reinforced concrete foundation.

- **Valve Operator Vaults**.—Reinforced concrete for vaults, access and service hatches, miscellaneous metalwork, type, and diameter.

- **Meter Vaults**.—Reinforced concrete for vaults, access and service hatches, miscellaneous metalwork, type, and diameter.

- **Participant Tie-In Vaults**.—Reinforced concrete for vaults, access and service hatches, miscellaneous metalwork, type, and diameter.

- **Crossings**.—Typical components for various categories.

- **Dewatering.—**Ground water to be encountered during construction.

- **Dust Abatement.—**Water used for mitigation during construction.

- **Water Treatment Plants**.—Developed and provided by subconsultant B&V (estimate sheets dated February 17, 2012). Unit quantities for the WTP process included presedimentation basin, water treatment building, disinfection contact basin, finished water storage, backwash recovery basins, residuals basins, and an electrical substation.

8.1.1 Cost Estimates

Quantity estimate worksheets were assembled to develop total construction cost estimates and OM&R cost estimates for each of the five AVC EIS Action Alternatives. These worksheets are provided in appendix P of Volume 2. The cost estimates were prepared in accordance with the *Reclamation Manual,* and, in particular, the following Directives and Standards:

- FAC P09 – *Cost Estimating* (Bureau of Reclamation, 2007e).
- FAC 09-01 – *Cost Estimating* (Bureau of Reclamation, 2007a).
- FAC 09-02 – *Construction Cost Estimates and Project Cost Estimates* (Bureau of Reclamation, 2007c).
- FAC 09-03 – *Representation and Referencing of Cost Estimates in Bureau of Reclamation Documents Used for Planning, Design and Construction* (Bureau of Reclamation, 2007d).

The appraisal level cost estimates are intended for planning and evaluating alternatives, helping to select a preferred alternative by comparing features in each alternative, and determining if more detailed investigations of this project are justified.

The appraisal level cost estimates were generated using industry-wide accepted methods, standards, and practices. The estimates are intended to capture current pricing for materials, typical construction practices, procurement methods, current economic conditions, and specific site conditions. The cost estimates were developed from preliminary quantities and data, as well as preliminary general designs and drawings.

All of the unit prices and costs were peer reviewed, and the math was checked, in accordance with the established policies and procedures of the offices preparing the estimates.

8.1.1.1 Basis of Cost Estimates

Appraisal level unit prices for the alternatives were developed using various estimating methods including:

- Reclamation historical cost/bid data
- Robert Snow (RS) Means Cost Data catalogs
- Vendor budget quotes
- Estimator experience
- Other resources (e.g., Internet cost resources, vendors, etc.).

Two major cost drivers for this project, the pipeline (furnish and install pipe) and the water storage tanks, comprise approximately 70 to 75 percent of the contract costs. Therefore, the cost estimates are very sensitive to the prices of materials for pipes and tanks. Unit prices for pipe materials were primarily developed by obtaining budget quotes from several pipe manufacturers and adjusting for installation. Quotes from tank manufacturers and erectors were obtained and used in developing the unit prices for the water storage and regulating tanks.

8.1.1.2 Price Level

All costs shown correspond to January 2011 dollars.

8.1.1.3 Mobilization

Mobilization costs include contractor bonds and mobilizing contractor personnel and equipment to the project site during initial project startup. The mobilization line item is a rounded value per Reclamation rounding criteria, which may cause the dollar value to slightly deviate from the actual percentage shown. A value of ±5 percent was used for mobilization. This value is based on past experience with similar projects and estimator judgment.

8.1.1.4 Escalation to Notice to Proceed

In accordance with *Reclamation Manual*, Directives and Standards, FAC 09-01 (4) (J) (Reclamation, 2007c), for projects that are to be constructed over an extended period of time or at some distant time in the future, it is prudent to consider the time value of money. Therefore, appropriation ceiling indexing is a method that will account for escalation. This method allows project managers to use Reclamation's Construction Cost Trends to adjust the appropriation ceiling as the project is constructed. Per ECAO, indexing is currently assumed to be acceptable until further assessment can be made. It is assumed that the construction cost, at the end of construction, would be approximately the same regardless of whether indexing was used or whether escalation was included.

8.1.1.5 Escalation During Construction

The unit prices in the cost estimates include escalation during construction.

8.1.1.6 Design Contingency

In accordance with *Reclamation Manual*, Directives and Standards, FAC 09-01 (4) (E) (1) (Reclamation, 2007c), design contingencies allow for uncertainties within the design and the respective level of detail and knowledge used to develop the estimated cost. Design contingencies are intended to account for three types of uncertainties inherent as a project advances from the planning stage through final design, which directly affects the estimated cost of the project. These include: (1) minor unlisted items, (2) minor design and scope changes, and (3) minor cost estimating refinements. For each alternative, a value of ±12 percent was used for design contingencies based on the level of design. The *Cost Estimating Handbook,* page 2-7, ―Appraisal Estimate" section, recommends that unlisted items be at least 10 percent (15 percent is typically used).

Minor unlisted items that were not quantified or priced in the cost estimate include, but are not limited to: erosion control, irrigation ditch crossings, curb and gutter or sidewalk encountered in the urban areas, fence crossings, replacing cropland topsoil, bringing power to the participant tie-ins and the meter and valve vaults, and SCADA and associated yard and towers. Minor design and scope changes that may also occur include, but are not limited to, the use of CLSM for pipe backfill (instead of 3/4-inch rock bedding), and weak soil conditions instead of moderate strength soil conditions.

8.1.1.7 Allowance for Procurement Strategies

In accordance with *Reclamation Manual*, Directives and Standards, FAC 09-01 (4) (E) (2) (Bureau of Reclamation, 2007c), a line item allowance for procurement strategies (considerations) is often included in appraisal level cost estimates to account for additional costs when solicitations for construction will be advertised and awarded under procurement strategies that limit competition, allow award for best value (other than the lowest bid or proposal), or include set asides under socioeconomic programs. The Allowance for Procurement Strategies was set at zero percent, assuming the solicitations for the project will be full and open competition, receipt of sealed bids, with award to the lowest responsive and responsible bidder. However, the noncontract cost allowance does include a small component for the managing authority to administer noncompetitive procurements (see subsection 8.1.2.4).

8.1.1.8 Construction Contingency

Appraisal estimates include a percentage allowance for construction contingencies as a separate item to cover minor differences in actual and estimated quantities, unforeseeable difficulties at the site, changed site conditions, possible minor changes in plans, and other uncertainties. The allowance is based on engineering judgment of the major pay items in the estimate, reliability of the data, adequacy of the projected quantities, and general knowledge of site conditions. Construction contingencies are considered funds available in the budget to be used after award.

A value of ±25 percent was used for construction contingencies based on the completeness and reliability of the engineering design data provided, geological information, and the general knowledge of the conditions at the site. This is in accordance with *Reclamation Manual*, Directives and Standards, FAC 09-01 (4) (E) (3) (Reclamation, 2007c) and the *Cost Estimating Handbook* (Reclamation, 1989), page 2-7, ―Contingencies" section. The field costs are a rounded value per

Reclamation rounding criteria, which may cause the dollar value to slightly deviate from the actual percentage shown.

8.1.1.9 Uncertainty and Contingencies

Reclamation prepares studies and designs at various levels during the evaluation and planning of a project. Similarly, various levels of cost estimates are prepared throughout the life of that project. Table 46, provides a partial list of the recognized levels of cost estimates prepared by Reclamation and some common percentages used in preparation of those cost estimates:

Table 46. Common Contingency Percentages

Level	Design Contingency (%)	Construction Contingency (%)
Preliminary	20-30	25-30
Appraisal	15-20	20-30
Feasibility	10-15	20-25
30% design	5-15	20
90% design	2-10	20
PreVal [1/]	0-3 [3/]	0 [3/]
IGCE [2/]	0 [3/]	0 [3/]

[1/] PreVal denotes Prevalidation of Funds Cost Estimate.

[2/] IGCE denotes Independent Government Cost Estimate.

[3/] It should be noted that even though contingencies are not formally computed and included in PreVal and IGCE cost estimates, it is widely recognized and understood that the budget established at the feasibility level, which is generally used for authorization and appropriation of a Reclamation project, should be maintained and carried in the budget by EACO.

Typically, the addition of contingencies, both design and construction contingencies, is an attempt to capture the unknowns at that particular level of study to portray the appropriate overall cost magnitude of the project. However, it should be noted that there are instances where the percentages added for contingencies at the appraisal level are proven insufficient based on the results of field explorations and design data collection.

In general, designs and cost estimates at the preliminary and appraisal levels are prepared based on local knowledge and existing project data. Designs and cost estimates at the subsequent feasibility, 30-percent design, 90-percent design, PreVal, and IGCE levels are developed and supported with an extensive design data and field exploration program. As such, the confidence level of the design and cost estimate increases based on the level of exploration and availability of design data available to the design staff. Simply stated, the confidence of the design and cost estimate is directly related to the amount and quality of the design data collected for the project. Therefore, it has been a common and consistent practice to include higher levels of contingencies at earlier levels of study/design to account for the uncertainties of limited or no design data, in addition to the more general and/or abbreviated design analysis that is performed at these levels. As the design progresses to the feasibility and later levels of study, the percentages for contingencies are commonly reduced to reflect a greater understanding of field conditions and, therefore, a reduced risk to the project.

8.1.2 Noncontract Costs

Noncontract costs were produced and supplied by a joint effort between Reclamation's ECAO and Great Plains Region offices with input from the TSC.

Table 47 includes the elements of the noncontract costs developed in accordance with the cost estimating sections of the Reclamation Manual, Directives and Standards, FAC 09-02 (6) (Reclamation, 2007c). At the appraisal level of investigation, only a few of the elements apply. The assumed total cost of all the elements that apply determines the total noncontract cost. The total noncontract cost is added to the field cost to get the construction cost. The resulting noncontract cost is rounded to $125 million and applied to all AVC EIS Action Alternatives.

Specific items considered for inclusion in the table 47 are described in detail below.

8.1.2.1 Right-of-Way/Easements/Purchase (Land Costs)

This allowance accounts for lands purchased for the WTP, pumping plants, booster plants, water storage tanks, regulating tanks, and Reclamation acquired exclusive, perpetual ROW obtained for the main transmission and spur lines. Depending on the SCADA system selected for the AVC, additional lands may be needed along the route to account for communication towers.

8.1.2.2 Relocation of Facilities

This allowance accounts for facilities that need to be relocated during the construction of the project facilities.

8.1.2.3 Distributive Costs

Distributive costs are expenses that have a broad, nonspecific nature and cannot be attributed to any specific project feature. Examples of such costs include, but are not limited to: facilitating services, investigations, design and specifications, construction management, environmental compliance, archeological considerations, and O&M during construction.

Table 47. Noncontract Cost Summary

Noncontract Cost Items			$ Million
Right-of-way/easements purchase (land costs)			$5.50
Relocation of facilities			$1.00
Distributive costs			$110.91
Service facilities		$1.00	
Planning investigations (postauthorization)		$17.70	
Studies			
Design data collection, surveys, and topography			
Engineering and other costs		$84.23	
Design and specification	$37.51		
Construction engineering and management	$46.72		
Management and office engineering			
Offsite offices			
Construction inspection and surveying			
Laboratories			
Program management			
Construction safety			
Construction office costs			
Other costs		$7.98	
Procurement			$0.65
Legislative			$0.00
Reclamation grant administration			$0.00
Reclamation postauthorization oversight			$4.00
Sponsor postauthorization oversight			$2.00
		Total	$124.06

8.1.2.3.1 Service Facilities

Service facilities are those items intended primarily for use while constructing permanent properties. Camps, construction roads and trails, utility systems, transportation equipment, and most costs of temporary plants used during construction are included under this heading. The category does not include materials and equipment fabricated in shops, nor plants producing materials for use in the operations; such items become materials and supplies when charged to permanent work.

8.1.2.3.2 Planning Investigations (Postauthorization)

This item includes all appropriate planning (investigation) costs, regardless of nature, that will be required to be charged to the project if an action alternative is selected in the Record of Decision and Congress appropriates funding:

- *Studies (postauthorization).* Included in this category are the collection, assembly, analysis of data, and preparation and review of reports in connection with project planning, rehabilitation, betterment, or extension; collection, assembly, analysis of data, and the preparation and review of reports in connection with NEPA compliance, meteorology, hydrologic, biologic, cultural, economic, commercial, industrial, agricultural, power and water supply and demand, power marketing and network, and similar studies and investigations; collection, assembly, and submission of planning reports, preparation and review of preliminary designs and cost estimates, and related design activities in connection with project planning (appraisal and feasibility reports). Throughout the life of the construction project, there will be occasional studies such as value analysis, environmental, and archeological.

- *Design Data Collection, Surveys, and Topography.* Included here are the collection, assembly, and submission of survey and design data for the preparation of designs and specifications, and acquisition of ROW.

8.1.2.3.3 Engineering and Other Costs

Several categories of items in the group are::

- *Designs and Specifications*. This category includes the preparation and review of final designs, construction drawings, specifications, construction cost estimates; design reviews, including value engineering and the design, engineering, and construction (DEC) activity; and procurement activities and similar or related activity, including construction cost estimate, percent design, Preval, and IGCE, in connection with construction, reconstruction, fabrication, rehabilitation, or extension of project works. These expenses occur primarily before contract award but may also include contract modifications work.

- *Construction Engineering and Management.* This category includes construction engineering and contract administration, management, coordination, and control of construction, reconstruction, rehabilitation, betterment, major repair, or extension of projects and other works. Expenses within this element generally occur after contract award.

    - *Management and Office Engineering.* Management and office engineering includes the construction engineer, field engineer, and the office engineer and their staff on construction operations and contract administration, exclusive of design; and other construction engineering employees, regardless of organizational assignments, not specifically included in survey and inspection and laboratories categories.

- *Offsite Office.* If not included as part of the design and specifications costs, the costs for employees of offsite (Reclamation's ECAO, Great Plains Region, and TSC) offices engaged in construction administration must be accounted for here.
- *Construction Inspection and Survey.* Construction survey and inspection includes surveyors and inspectors engaged in layout and inspection, quality reports, field tests, inspection of materials, equipment, construction methods, safety practices, etc.
- *Laboratories.* Laboratories include employees engaged in concrete, soils, and other laboratory technology.
- *Program Management.* Program management includes salaries and expenses of the program manager and assistants.
- *Construction Safety.* Construction safety engineering includes salaries and expenses of safety engineers and assistants.
- *Construction Office Costs.*

8.1.2.3.4 Other Costs.

Included in this category are the general expenses incurred after appropriation of funds for construction, not readily identified within studies, surveys, designs and specifications, or construction management, including general office salaries, general office supplies, general office expenses (e.g., rent and utility services), general transportation expenses, security, environmental oversight, mitigation/cultural resources services, legal services, etc.; O&M during construction (if applicable) is included here.

8.1.2.4 Procurement

In accordance with *Reclamation Manual*, Directives and Standards, FAC 09-02 (Reclamation, 2007c), the Regional Director or delegate shall determine, as soon as practicable, the procurement strategy(s) that will be used for procuring associated project features. If this strategy includes noncompetitive procurements or limits the competition, the Regional Director or delegate will consider if additional costs would be realized. Refer to subsection 8.1.1.7 for assumptions made in this cost estimate.

8.1.2.5 Legislative

In accordance with *Reclamation Manual*, Directives and Standards, FAC 09-02 (7) (Reclamation, 2007c), the Regional Director or delegate shall determine, as soon as practicable, if specific legislative requirements will impact the project or any associated project features.

8.1.2.6 Reclamation Postauthorization Oversight

These are the general ongoing activities by Reclamation including budgeting, finance, correspondence, etc.

8.1.2.7 Sponsor Postauthorization Oversight

This is the administration of the overall agreement with Reclamation on the project.

8.2 Operations, Maintenance and Replacement Costs

Data and information provided in this section of the Appraisal Design Report regarding the WTP feature were provided by Black & Veatch Corporation, located in Centennial, Colorado. The data and information provided in this

section of the Appraisal Design Report regarding the remaining features were prepared by the Reclamation TSC Engineering Team.

8.2.1 Present Worth and Annual Costs of OM&R Expenses

Estimates include the computation of the total dollar present worth cost of OM&R of a feature(s) over a period of time. Appendix P includes these cost estimates. OM&R cost estimates are presented in present worth dollars at a price level of January 2011.

The OM&R analysis contains the following three components: (1) a detailed analysis and development of costs for OM&R for the feature, (2) the period of time (study period) over which these costs are incurred, and (3) the interest (discount) rate that is applied to future costs to equate them with present day costs.

- The first component in an OM&R cost analysis is developing the OM&R costs. OM&R costs are costs incurred after occupation of the facility. There are two major OM&R cost categories:
    - OM&R periodic costs, which include replacement equipment costs calculated in present worth dollars (see table 48).

- OM&R annual costs, which include daily operational costs and routine maintenance costs. The annual costs are calculated as uniform series present worth costs. Daily operational costs include costs to operate the facility, such as operator wages and benefits, utilities, chemicals, power consumption, etc. (see table 49).

Routine maintenance costs include costs associated to maintain the facility and equipment in satisfactory condition.

- The second component of the OM&R analysis is the study period. The study period is the period of time over which OM&R expenses are to be evaluated. For this analysis, the period is 50 years.
- The third component in the OM&R analysis is the interest rate. For this analysis, the discount rate of 4.125 percent was used as required by *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (United States Water Resources Council, 1983).

Table 48. Summary of OM&R Present Worth Costs (January 2011 Dollars) for 50-Year Life Cycle (assuming a discount rate of 4.125%) for AVC EIS Action Alternatives

	Alternative 1 (Comanche South)	**Alternative 2** (Pueblo Dam South)	**Alternative 3** (Joint Use Pipe North)	**Alternative 4** (Pueblo Dam North)	**Alternative 5** (River South)
Present worth of all future periodic (replacement) costs (less WTP)	$19,000,000	$17,000,000	$20,000,000	$20,000,000	$21,000,000
Present worth of all future WTP periodic (replacement) costs	Included in annual O&M costs below	Included in annual O&M costs below	Included in annual O&M costs below	Included in annual O&M costs below	Included in annual O&M costs below
Present worth of all future annual (O&M) costs (less WTP)	$31,000,000	$11,500,000	$18,500,000	$17,000,000	$25,000,000
Present worth of all future WTP annual (O&M) costs	$43,000,000	$43,000,000	$43,000,000	$43,000,000	$43,000,000
Total OM&R present worth costs[1]	**$93,000,000**	**$71,500,000**	**$81,500,000**	**$80,000,000**	**$89,000,000**

[1] These life cycle costs do not include overhead expenses (office space, administration, etc.) incurred by the managing authority. These life cycle costs assume that the pipeline operators are based in the WTP building.

Table 49. Summary of Annualized OM&R Costs for AVC EIS Action Alternatives

Cost Description	**Alternative 1** (Comanche South)	**Alternative 2** (Pueblo Dam South)	**Alternative 3** (Joint Use Pipe North)	**Alternative 4** (Pueblo Dam North)	**Alternative 5** (River South)
Annual OM&R costs (less annual WTP OM&R costs)	$2,400,000	$1,360,000	$1,830,000	$1,760,000	$2,200,000
Annual WTP OM&R costs	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000
Total annual OM&R costs	**$4,400,000**	**$3,360,000**	**$3,830,000**	**$3,760,000**	**$4,200,000**

[1] These life cycle costs do not include overhead expenses (office space, administration, etc.) incurred by the managing authority. These life cycle costs assume that the pipeline operators are based in the WTP building.

8.2.2 Energy Cost

Energy supply for pumping plants and WTPs, and other appurtenants in the Pueblo area, would be provided by BHE. All the rate analyses were based on the information provided to BHE by the TSC. BHE indicated all power drops would go on the large general service secondary rate. BHE provided Microsoft Excel spreadsheets which gave monthly cost, annual cost, load factor, and average all-in cost per kilowatt hour.

Southeast Colorado Power Association would provide power for the Eads and May Valley booster plant and anything necessary east of La Junta. Their service boundaries around La Junta are blurred with BHE, but that would be worked out when the preferred alignment is determined by the AVC EIS team.

See appendix M for power costs provided by BHE and Southeast Colorado Power Association.

Based on the information from the power supply companies, the annual energy costs for operation of the pumping plants and booster plant in each alternative are presented in table 50. The energy cost category is just for operations of a typical WTP, per conceptual appraisal level design, and is based on operations at the Whitlock WTP for the year 2010.

Table 50. Annual Plant Energy Costs

Alternative	Location	Energy Costs
1 - Comanche South	Pueblo Dam	$696,036
	Eads booster	$3,360
2 - Pueblo Dam South	None	$0
	Eads/May Valley booster	$12,740
3 - Joint Use Pipe North	Whitlock WTP	$239,549
	Eads/May Valley booster	$12,740
4 - Pueblo Dam North	Dam to WTP	$87,581
	Clearwell WTP	$59,968
	Eads/May Valley booster	$12,740
5 - River South	Arkansas River	$292,506
	St. Charles Mesa WTP	$171,940
	Eads/May Valley booster	$12,740
6 - WTP	Whitlock WTP	$99,300

8.3 Cost Risk Modeling and Uncertainty

Some degree of design/cost risk and uncertainty is inherent within each cost component in the cost estimate. This uncertainty can be further broken down to the risk inherent to the design and related quantity takeoffs for a selected item of work and the risk associated with the respective unit cost for that item of work. In addition, other factors can be add to the uncertainty and risk in the cost estimate. Labor rates are assumed for the project location, and crews are assembled to predict the effort associated with constructing Reclamation projects. Production rates are estimated based on assumed means and methods, which may be adversely impacted by future regulatory requirements, environmental constraints, or discovery of more efficient construction techniques and equipment. Unusual weather conditions or labor shortages may also impact production rates and costs. Unit prices may be impacted by higher fuel prices, material costs, labor rates, and equipment costs than those assumed. Changes in both regional and/or the overall country's economic conditions may impact the bidding environment and the overall price magnitude. Because of these uncertainties, cost risk modeling methods are used to help quantify these uncertainties and their potential impacts on the total project cost.

Reclamation has adopted a strategy to identify, evaluate, and quantify cost risk on cost estimates developed for selected Reclamation projects. This process is used most frequently on projects in the Safety of Dams Program; however, the process has been successfully applied to other traditional projects in the organization on an as-requested basis.

At Reclamation's TSC, potential risks and the associated costs are identified and evaluated using a Monte Carlo-based simulation process. Monte Carlo simulation is a problem-solving technique used to approximate the probability of certain outcomes by running multiple trials using random variables, called simulations. It is based on a mathematical technique that accounts for risk in quantitative analysis and decisionmaking. Monte Carlo simulations furnish the decisionmaker with a range of possible outcomes and the probabilities with which they could occur. For each uncertain variable in a simulation, the possible values are defined using probability distributions. The type of distribution selected depends on the factors surrounding the variable. Some of the commonly used distributions in the cost risk models are normal, triangular, and beta-PERT.

Monte Carlo simulation performs risk analysis by building models of possible results using a range of values (probability distributions) for any factor that has inherent uncertainty. Values are sampled at random from the input probability distributions during simulation runs. Each set of samples is called an iteration, and the resulting outcome from that iteration is recorded. The Monte Carlo simulation is typically run for 10,000 iterations to model the forecast values for contract cost, field cost, and total construction cost for each feature.

For cost risk modeling, the Monte Carlo simulation and risk analysis are performed using Oracle Crystal Ball software. The software uses inputs, or assumptions, to define the range of uncertainties associated with variables and outputs, or forecasts, to calculate results based on simulations. Triangular distributions are typically selected to model risks and assumptions for quantities associated with individual pay items. Beta-PERT distributions are typically used to model risks and assumptions assigned for unit prices. Deterministic methods are used to estimate the range of possible values for the unit prices and quantities of each item. Input value ranges are modeled in the Crystal Ball tool and categorized in ranges as follows:

- **Most Probable Estimate (MP).—**A compilation of pay items, quantities, and unit prices representing the designer's and cost estimator's best opinion and assessment of the scope of work and cost for the project.

- **Most Probable Low Estimate (MPL).—** A compilation of pay items, quantities, and unit prices representing the designer's and cost estimator's most optimistic opinion and assessment of the scope of work and cost for the project.

- **Most Probable High Estimate (MPH).**—A compilation of pay items, quantities, and unit prices representing the designer's and cost estimator's most conservative opinion and assessment of the scope of work and cost for the project.

Additional cost contributors in the cost estimate (e.g., escalation, contingencies, non-contract costs), computed as a percentage and noncontract costs, are modeled within each feature's Monte Carlo simulation.

For each of the forecast values, a probability curve and sensitivity chart are developed for use by decisionmakers to understand the risks and probabilities of the estimated project costs. The probability curves provide a tool to understand the potential range of costs possible for the project and the associated probability for each project cost to occur. Similarly, the sensitivity charts help promote understanding of those items (either quantity and/or cost components) in the model that introduce the greatest amount of risk for each forecast assumption. Sensitivity analyses help determine which inputs affect forecasts the most, so that risk mitigation efforts can be concentrated on those factors. The sensitivity chart ranks the assumptions from the most important to the least important in the model.

At the feasibility level design phase, it is recommended that cost estimates be prepared, which takes into considerations cost risk modeling.

9. Feasibility Level Data Collection

An important issue to resolve that could have substantial consequences to the project schedule is the need for additional design data collection to describe the feasibility design and environment effects analysis. Additionally, the land acquisition and coordination effort process could be a time-critical factor that could delay construction activities if not implemented sooner rather than later. Fiscal budgetary constraints, and any delays in gaining access to properties during the corridor flight activity and the geological/geotechnical investigation activity, could affect the design data collection process and impact the feasibility design tentative start date.

Reclamation Manual, ―Design Data Collection Guidelines” (Reclamation, 2007b), provides a comprehensive list of data to be collected for preparing feasibility level designs performed by or for Reclamation. The quality and quantity of data to be collected would increase as the level of design increases but would be subject to availability of congressionally approved fiscal funding.

A significant amount of design data prepared for previous studies may be available and should be used for the design. A feasibility design report requires sufficient information to determine, with reasonable certainty, that the project will be successful and able to fulfill the repayment contract. For feasibility designs, funding for design data collection is often limited; the critical design data items should be determined and receive maximum attention.

Communication between designers and project personnel is essential to produce adequate design data.

The guidelines would be modified as new issues arise and as new types of project features become more prevalent. The design data collected should be sufficient to determine and verify:

- Project purpose and goals
- Scope of the project
- Environmental considerations of the project
- Design requirements of the project
- OM&R requirements and effects
- Construction considerations
- Construction cost and approximate schedule of the project

9.1 Coordination of Design Data Request and Collection

The design data items are listed to serve as a guide for preparing a design data collection program. The design data collection guidelines apply to new construction, modifications to existing structures, and replacement of existing structures. Seldom does any given investigation require all of the design data items listed. Design data items should be added as required for a specific project.

The collection and documentation of design data consist of items that may require:

- Work in the field, such as survey data
- Work in the office, such as preliminary analysis and drawings
- Results of coordination and inquiries with other Federal, State, and local agencies; utility companies; and water districts
- Previous studies and authorizing legislation requirements that will impact design
- Laboratory testing of materials

From *Reclamation Manual,* Policy, FAC P03, ―Performing Design and Construction Activities": ―The responsible official for the program is also responsible for the design data collection activities. The responsible official may obtain the services of another Reclamation office to perform this work" (Reclamation, 2000a).

Typically, the design office initiates the process by submitting the design data request to the responsible official (originating office). The design team will review the design data collection guideline list(s) for applicable items for their project.

The design office, the originating office, and offices responsible for collecting the design data then agree on:

- The required content and degree of detail of the design data that are appropriate for the project complexity and design stage
- Offices or personnel who are responsible for each design data item requirement

- Schedule for providing design data to the originating office and the design team

Design data should be submitted in the format requested and agreed upon (i.e., material samples, hard copy, electronic file, or all three formats).

9.2 Schedule for Collecting Design Data

It is common to prioritize and stage (schedule) collecting and submitting design data because not all items are required in order to start design work. All design data that impact selection of the design concept should be submitted before the concept design data date, and a firm schedule for collection of remaining data should be made. A comprehensive design data file should be established and maintained throughout the project, with updates and additions as they occur, and a final report should be prepared when all design data are collected.

9.3 Scope of Design Data Request

The specific design data required for feasibility level designs may typically include the following:

1. A description of the purpose and goals of the project.
2. References to and copies of previous studies as applicable.
3. Foundation material properties including strength and settlement parameters for more heavily loaded features.
4. Base drawings/files required to show location, design, and layout of facilities such as:
    a. General map, including key map, should cover the project area and the area immediately surrounding the project within approximately 2 or 3 miles. The scale of the general map should be adequate to clearly show listed details. A scale of approximately 1 to 3 miles per inch is commonly used.

       Location maps are commonly used as a condensed method of showing location and alignment of the features and associated structures. The location map may be combined with the general map, site plan, or plan and profile drawings for small areas. A scale of 1 inch equals 1,000 feet to 1 inch equals 2,000 feet is commonly used for location maps.

b. Survey control required for all surveys, including surveys associated with aerial photography. Tying to the State plane coordinate system is recommended. If designs are required to modify or connect to an existing system, verification of the original coordinate system and datum should be made.

c. Topographic maps or strip topography for specific sites, depending on the project features. The design and layout of the pipe system would be based on topographic maps. A survey with a scale of 1 inch equals 100 feet to 1 inch equals 400 feet and a 2-foot contour interval is satisfactory for these maps, depending on the size of project and topography. The contour interval may be increased in hilly or mountainous terrain. If the project area is flat or small, a 1-foot contour interval may be required. The map must cover the entire project area, including water source where it is outside the distribution service area.

d. Plan and profile drawings along pipelines and roads. Plan and profile drawings are normally requested for linear features such as pipelines and roads. Drawings are prepared so that both plan and profile are plotted on one sheet. Strip topography may be used on the plan view. These drawings are normally prepared with a 1 inch equals 10 feet vertical scale, and 1 inch = 100 feet to 1 inch = 400 feet horizontal scale, unless more or less detail is required. The scale should be adjusted, as required, if it is necessary to show details. Plan and profile drawings should show features such as: existing utility lines within the ROW and requirements for relocation, low wire elevations and station of power lines (include voltage) where they cross the alignment, anticipated ROW widths, and existing centerline elevations of pipelines, canals, utilities, or other subsurface features where they cross the alignment.

e. Site plans for structures such as pumping plants, regulating and storage tanks, and WTPs.

5. Description of local conditions.

6. Description of existing facilities, including the future intentions of stakeholders.

7. Surface geologic investigations sufficient to define approximate boundaries of major areas of soil and unconsolidated material and exposed bedrock outcrops, and estimated range and average depth of the soils strata overlying bedrock. Identify locations and extent of areas of unusual conditions such as:

   a. Existing or potential landslides
   b. Low-density or expanding clay soils
   c. Spoil banks
   d. Hazardous materials
   e. Corrosive soils

   Determine estimated depth to ground water where shallow enough to be encountered in pipe trenches.

8. Information about cathodic protection systems that may be employed in the project area.

9. Operating data and maintenance requirements:

   a. Develop hydraulic data and basic criteria for sizing pipelines and deliveries.

   b. Determine whether data acquisition or automatic and/or supervisory control (SCADA) is desired (including future provisions). If supervisory controlled, give location of master station.

10. Environmental considerations. Include information that will aid the designer in minimizing the environmental impacts due to construction of these systems.

11. Criteria for design of alternatives that would fulfill project requirements, including:

    a. Water levels, flow requirements, reservoir storage requirements.

    b. Input from outside agencies and stakeholders (design requirements, O&M requirements, construction requirements, etc.).

    c. Design standards which have to be met (e.g., State, county, and local codes for designs of bridges).

   d. Review requirements (intermediate and final design products) by Reclamation offices and outside agencies.

12. Photographs of existing area and facilities, including aerial photographs. Historical photographs may also be required.

13. Existing ROW and requirements for additional ROW.

14. Availability of materials for construction such as pipe embedment, and materials from borrow areas (impervious, sand and gravel, and riprap).

15. Water for backfill soil conditioning and dust control.

16. Data for design study/analysis requirements such as: hydrologic studies, geologic investigations, seismic studies, operating studies, water quality studies, water demand studies, traffic counts.

17. Construction considerations such as: site access, time limits for construction, flow bypass channel requirements, how construction will be staged, number and type and schedule for potential contracts, and coordination with other construction projects or district operations.

18. Availability of utilities:

    a. Potable water
    b. Electricity
    c. Sewage

19. Data to allow a suitable cost estimate, including:

    a. Allowance for procurement strategy if other than by open competition bids.

    b. State and local (tribal) taxes.

    c. Method of projecting costs into the future (if required).

    d. Power rates, interest rates, and plant factor for economic studies for pumping plants and powerplants.

    e. Location and cost of local materials (e.g., precast concrete).

    f. Quantities for items which cannot readily be determined in a design office, such as earthwork quantities for canals, removal of vegetation, and existing facilities.

   g. Borrow and/or waste sites for earthwork.

20. Miscellaneous items such as:
    a. Corrosion potential.
    b. Public and worker safety.
    c. Recreation requirements.
    d. Construction of small buildings (control centers, equipment storage, etc.).
    e. Removal of vegetation and revegetation.
    f. Existing facilities.
21. Site security requirements.

The specifications design data collection guidelines are generally more extensive and detailed than the feasibility level design data collection guidelines. The feasibility design team should review the specifications design data collection guidelines for inclusion of potential additional requirements in the feasibility design data request.

9.4 Miscellaneous Design Data Collection Considerations

When the design data collection includes a request for a specific preliminary feature arrangement, layout, or recommendation for types and configuration of equipment, etc., the design data should include background information for the recommendation.

When a project involves using an existing facility, replacing an existing facility, modifying an existing facility, connecting to an existing facility, or working in the area of an existing facility, the design data should include pertinent data concerning the existing facility.

10. Hydroelectric Generation Potential

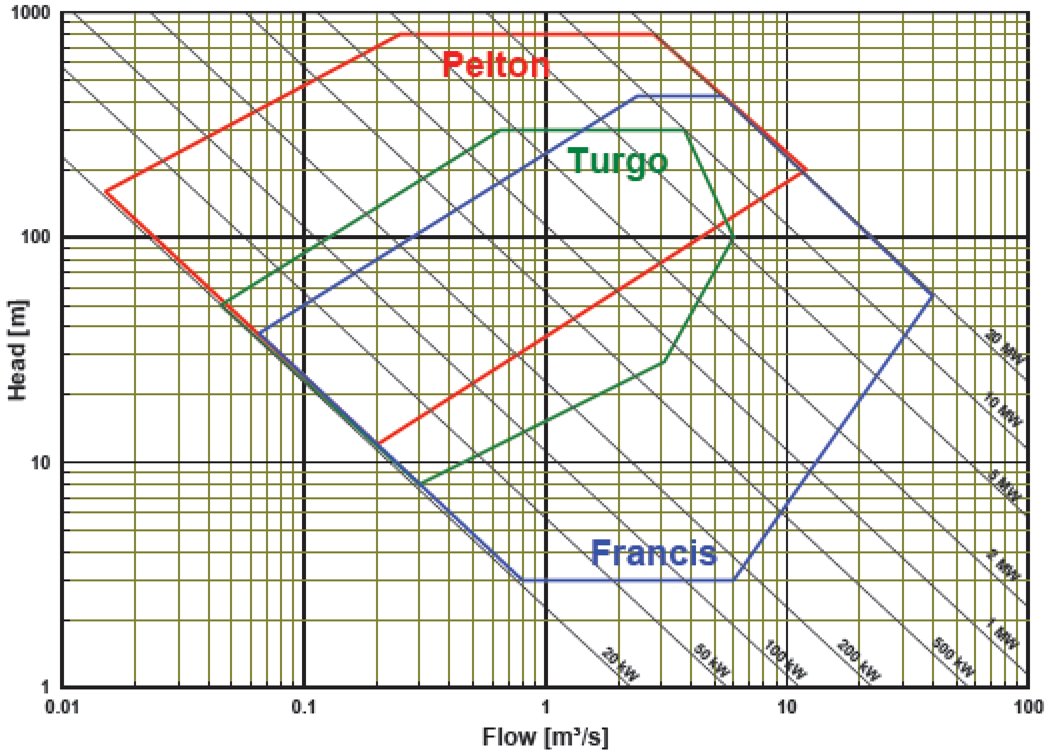
10.1 Potential Sites

Locations along the pipeline with energy dissipation devices provide an opportunity for energy recovery through the use of hydroelectric generation facilities. Factors to consider when appraising for power generation include flow rate and available head, plant factor of the facility, accessibility to transmission line and switchyard, adequate space for the power facility, maintenance costs, replacement costs, connections to the pipeline for the power flows and transient effects of a power load rejection on the pipeline pressure rating, and the value of power.

The power facility would be in parallel with the energy dissipation device and use the water storage tank as a tailbay.

In general, 200-kilowatt (kW) and 100-kW facilities would use flows of between 7 to 10 ft^3/s and 4.5 to 7 ft^3/s, respectively, and a design head of approximately 250 to 350 feet. A 15-kW microturbine facility would use flows between 1.5 and 3 ft^3/s and a design head of approximately 85 to 125 feet. Facilities that have a plant factor of less than approximately 65 percent (operating less than 8 months per year) would normally not be commercially feasible because of the long payback period of the present worth cost. Each of the available sites has existing power lines in its vicinity. There is a high probability that available ground space exists in the area of each site. Pipeline surge/transient pressure considerations for hydroelectric connection sites for power load rejection were not evaluated during this appraisal level design.

Figure 5 shows the appropriate ranges for flow rate and available head for various turbine styles (i.e., Pelton, Turgo, and Francis). See appendix N for additional data. Note that data presented in figure 5 use the International System of Units (abbreviated SI from French: *Système International d'Unités*), which is the modern form of the metric system. Data provided throughout this Appraisal Design Report use the United States customary units of measurement; therefore, both units are presented in the following subsections to assist the reader when referencing the manufacturer's data.



[Site 1: 10 $ft^3/s = 0.28\ m^3/s$, 320 feet Head = 98 m]

Figure 5. Appropriate ranges for flow rate and available head for various turbine styles (i.e., Pelton, Turgo, and Francis).

10.1.1 Site 1 – Alternative 1 (Comanche South), Water Treatment Plant

Site 1 appears to have the best potential for adding power generation. The flow is available at 7 ft^3/s for the entire year, with much larger summer flows. On the low capacity end, a power facility rated 200 kW would use flows between 7 and 10 ft^3/s, with flows above those needed for rated power being dissipated through a PRV. Plant factor for this capacity is essentially 100 percent. Using higher flows would reduce the plant factor and might require multiple units or dissimilar size units. New unit analyzed is:

<u>Pelton Unit:</u>

Power: 200 kW
Unit flow rate: 7.0 to 10.0 ft^3/s (0.196 to 0.280 cubic meters per second [m^3/s])
Unit design head: 320 feet (97.6 meters)
Operating head range: 255 to 380 feet (77.7 to 115.8 meters)

Yearly generation of 1,670,000 kilowatt-hours (kWh), operating 24 hours per day
Yearly generation ($0.025 per kWh): $41,740
Present worth over 50 years of continuous operation: $761,800

10.1.2 Site 2a – Alternatives 1 (Comanche South) and 2 (Pueblo Dam South), Fowler South Storage Tank

Site 2, Fowler South, appears to have good potential for adding power generation. The flow is available at 4.5 ft^3/s for the entire year, with much larger summer flows. On the low capacity end, a power facility rated 100 kW would use flows between 4.5 and 7 ft^3/s, with flows above those needed for rated power being dissipated through a PRV. Plant factor for this capacity is essentially 100 percent. Using higher flows would reduce the plant factor and might require multiple units or dissimilar size units. New unit analyzed is:

<u>Pelton Unit:</u>

Power: 125 kW
Unit flow rate: 4.5 to 7.0 ft^3/s (0.126 to 0.196 m^3/s)
Unit design head: 300 feet (91 meters)
Operating head range: 240 to 360 feet (73.2 to 109.7 meters)
Yearly generation of 1,024,000 kWh, operating 24 hours per day
Yearly generation ($0.025 per kWh): $25,600
Present worth over 50 years of continuous operation: $467,240

10.1.3 Site 2b – Alternatives 3 (JUP North), 4 (Pueblo Dam North), and 5 (River South), Fowler North Storage Tank

Site 2, Fowler North, appears to have low potential for adding power generation. The large head range from 31 to 229 feet does not allow the unit to operate over the full head range. If a unit was designed for higher heads, the unit would operate for 7 months with a maximum output of 100 kW. New unit analyzed is:

<u>Pelton Unit:</u>

Power: 100 kW
Unit flow rate: 5 to 8 ft^3/s (0.142 to 0.226 m^3/s)
Unit design head: 190 feet (57.9 meters)
Operating head range: 150 to 230 feet (45.7 to 70.1 meters)
Yearly generation of 417,000 kWh, operating 24 hours per day
Yearly generation ($0.025 per kWh): $10,431
Present worth over 50 years of continuous operation: $190,360

10.1.4 Site 3 – Alternatives 1 (Comanche South) and 2 (Pueblo Dam South), La Junta South Storage Tank

Site 3 appears to have a low potential for adding power generation. The large head range does not allow for operation for 2 months of the year. The flow is available at 1.5 ft^3/s for the entire year, with larger summer flows. On the low capacity end, a power facility rated 15 kW microturbine would use flows between 1.5 and 3 ft^3/s, with flows above those needed for rated power are dissipated. Plant factor for this design is 83 percent. Using higher flows would reduce the plant factor and might require multiple units or dissimilar size units. This unit is outside the normal design limits, as shown in figure 5, and with overall cost and maintenance, this site is not viable. New unit analyzed is:

Pelton Unit:

Power: 15 kW microturbine
Unit flow rate: 1.5 ft^3/s to 3.0 ft^3/s (0.042 to 0.093 m^3/s)
Unit design head: 105 feet (32 meters)
Operating head range: 84 to 125 feet (25.6 to 38.1 meters)
Yearly generation of 104,000 kWh, operating 24 hours per day
Yearly generation ($0.025 per kWh): $2,610
Present worth over 50 years of continuous operation: $47,626

10.1.5 Site 4 – Alternatives 3 (JUP North), 4 (Pueblo Dam North), and 5 (River South), La Junta North Storage Tank

Site 4 appears to have low potential for adding power generation. The large head range from 30 to 156 feet does not allow the unit to operate over the full head range. A unit designed for only the higher heads could operate 8 months of the year and would never pay back the initial investment of the unit. New unit analyzed is:

Pelton Unit:

Power: 50 kW
Unit flow rate: 2 to 5 ft^3/s (0.056 to 0.142 m^3/s)
Unit design head: 125 feet (38.1 meters)
Operating head range: 100 to 150 feet (30.5 meters to 45.7 meters)
Yearly generation of 171,000 kWh, operating 24 hours per day
Yearly generation ($0.025 per kWh): $4,280
Present worth over 50 years of continuous operation: $78,150

10.2 Conclusion

Since the hydroelectric features are not included in approved features of the AVC, a cursory review of readily available cost data was obtained by performing a ―Google” search on the subject. A micro hydro web article, entitled *Remote Power, Communications, and Living Systems* (Pioneer Systems, 2011), was located.

OM&R was not included because it requires a more detailed design to come up with a proper size and configuration that would be feasible for each application. Nevertheless, the cost to develop a small hydroplant is in the range of $3,000 to $6,000 per kW, with additional yearly O&M costs to keep the units operating. Adding small or micro hydroplants to existing sites requires high plant factor to recover the construction and O&M costs.

Site 1 (Alternative 1, WTP) and Site 2a (Fowler South Storage Tank) show the best payback potential for energy recovery in the current AVC system. If Site 1 operates continuously for 50 years (including present worth), it would pay back the investment if the initial cost was $3,800 per kW. If Site 2a operates continuously for 50 years (including present worth), it would pay back the investment if the initial cost was $4,000 per kW.

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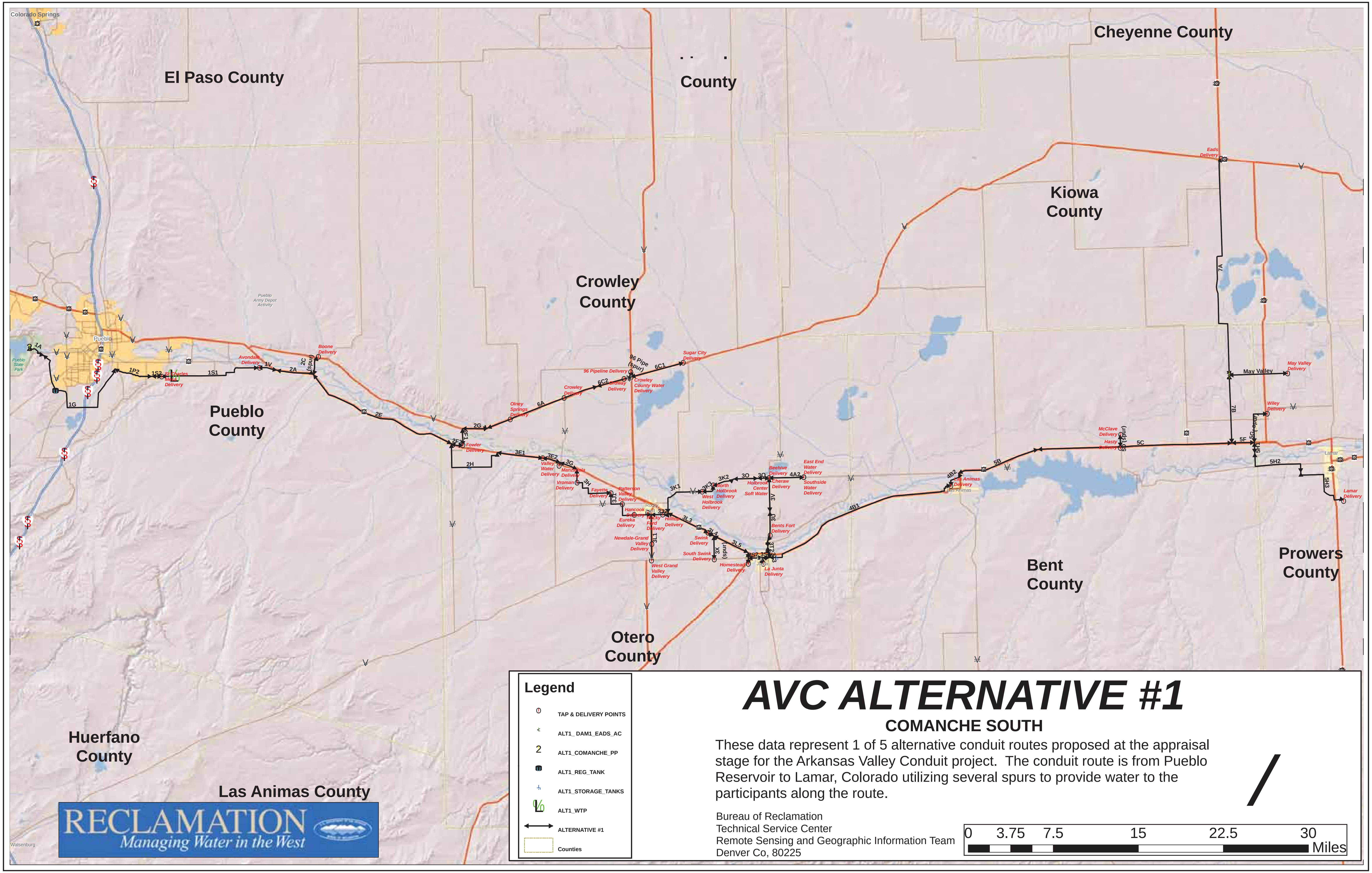
Appendix A

General Project Maps (Large Scale)



AVC ALTERNATIVE #1

COMANCHE SOUTH

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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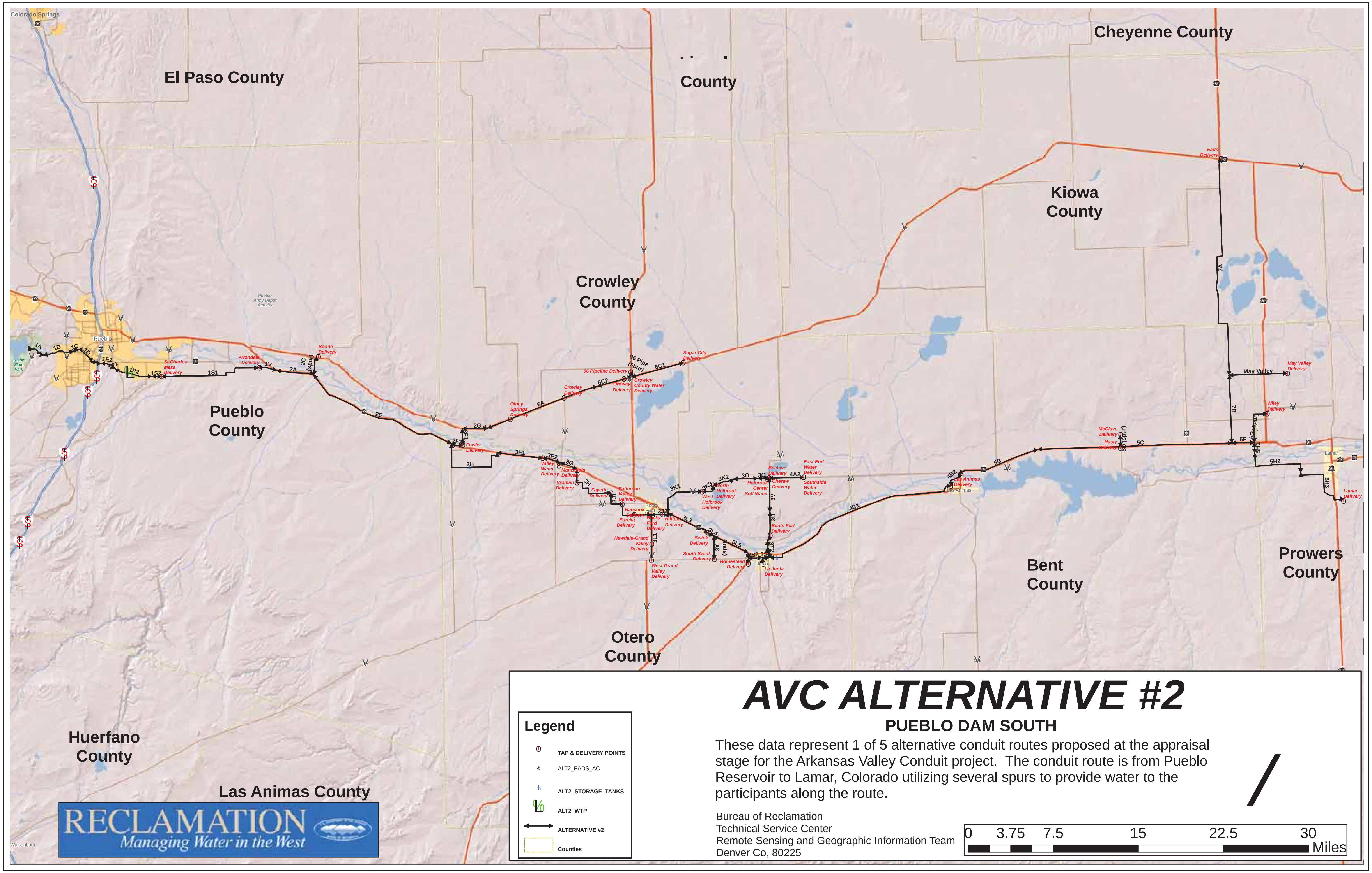

AVC ALTERNATIVE #2

PUEBLO DAM SOUTH

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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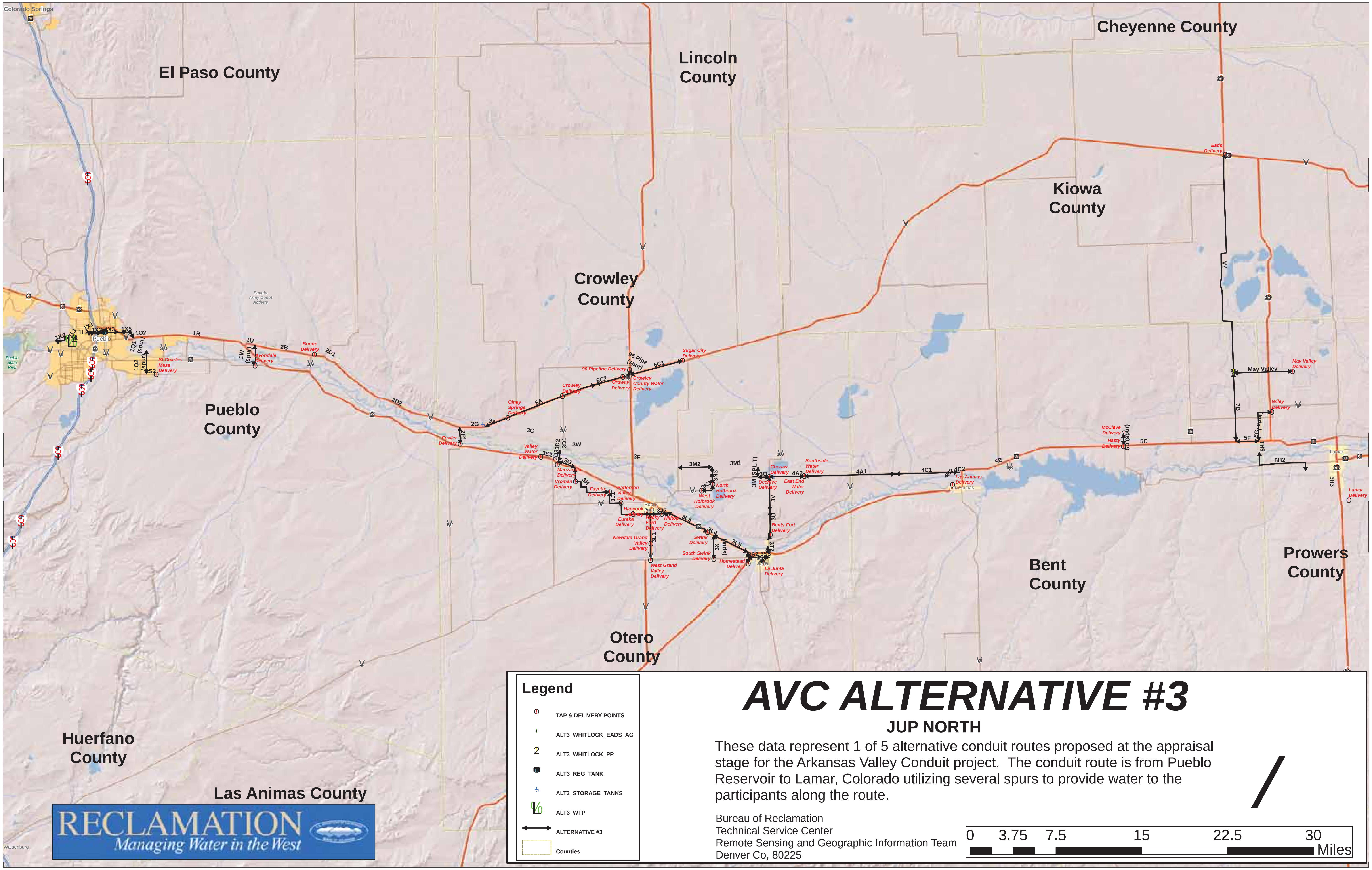

AVC ALTERNATIVE #3

JUP NORTH

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

Legend

- TAP & DELIVERY POINTS
- ALT3_WHITLOCK_EADS_AC
- ALT3_WHITLOCK_PP
- ALT3_REG_TANK
- ALT3_STORAGE_TANKS
- ALT3_WTP
- ALTERNATIVE #3
- Counties

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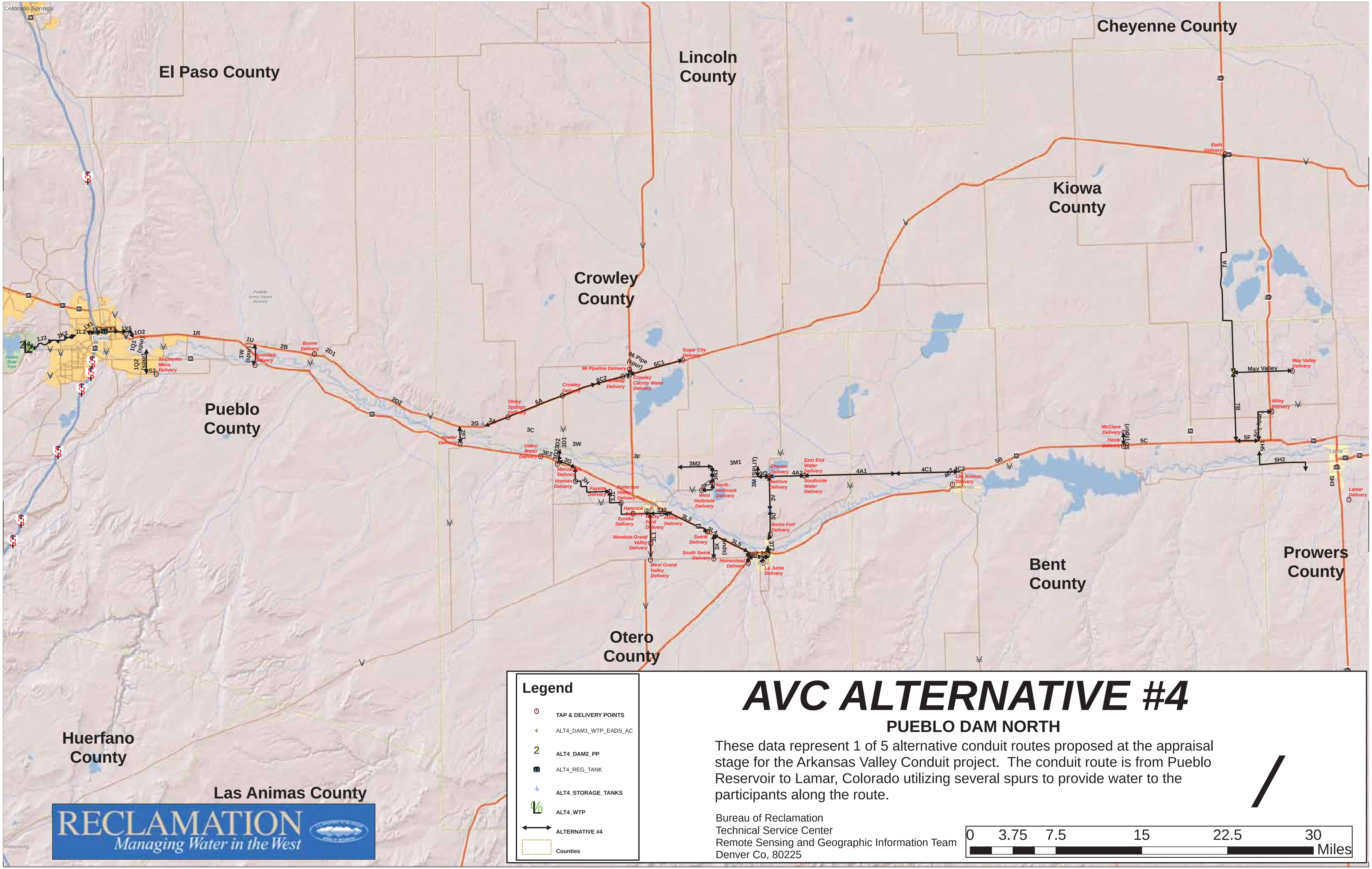

AVC ALTERNATIVE #4

PUEBLO DAM NORTH

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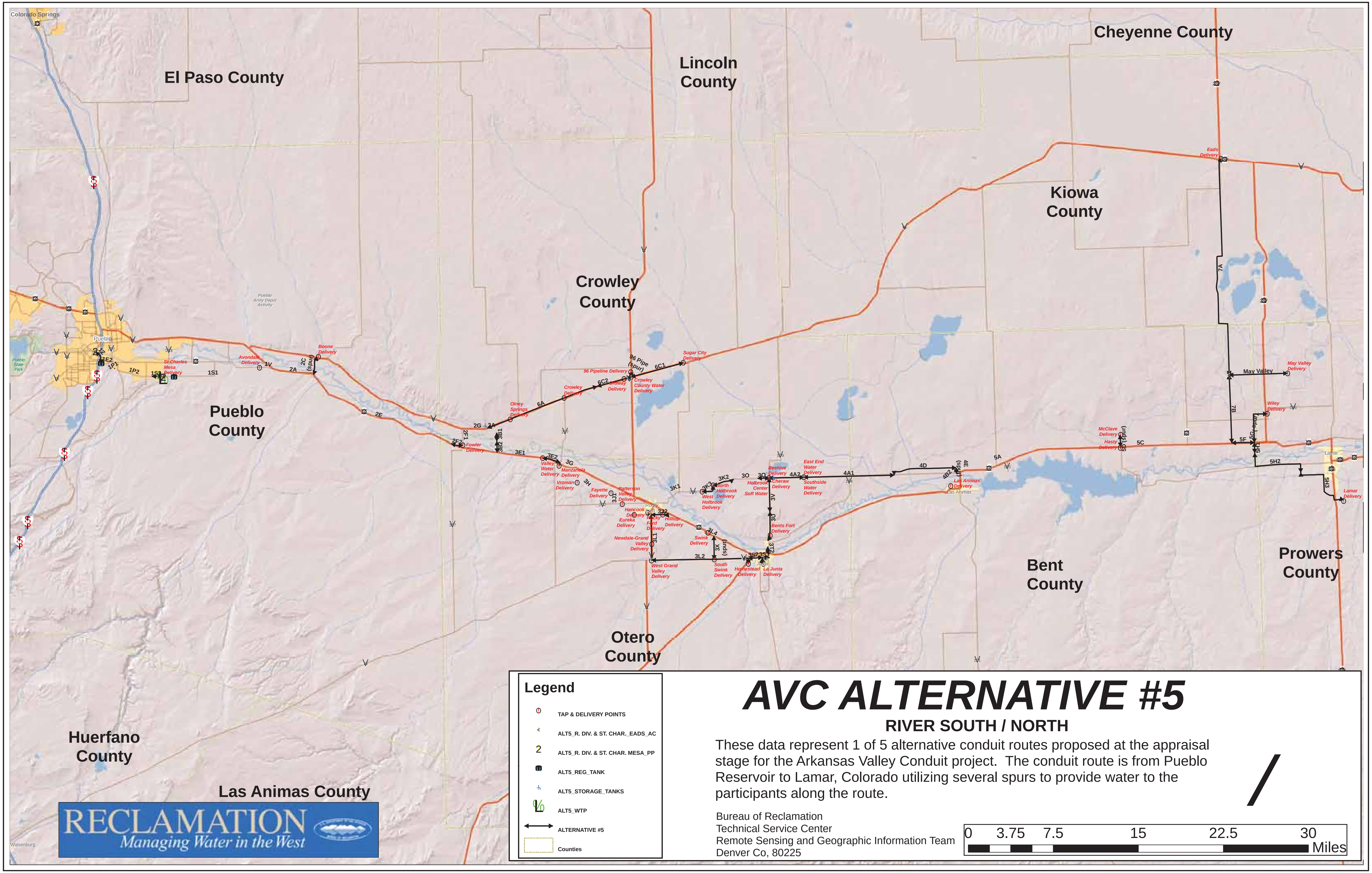

AVC ALTERNATIVE #5

RIVER SOUTH / NORTH

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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Appendix B

Alternatives Maps (Small Scale)

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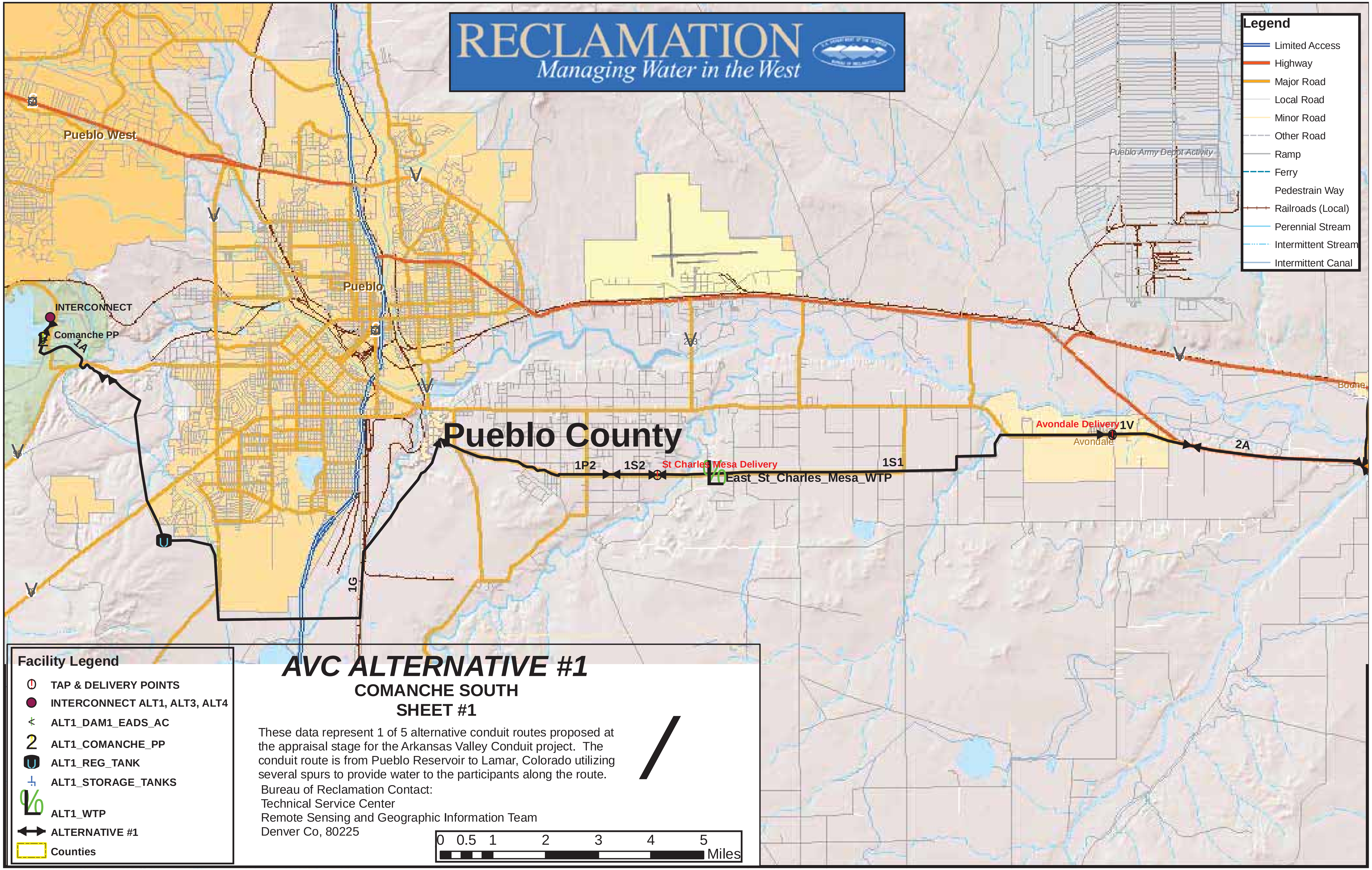

Legend

- Limited Access
- Highway
- Major Road
- Local Road
- Minor Road
- Other Road
- Ramp
- Ferry
- Pedestrain Way
- Railroads (Local)
- Perennial Stream
- Intermittent Stream
- Intermittent Canal

Facility Legend

- TAP & DELIVERY POINTS
- ● INTERCONNECT ALT1, ALT3, ALT4
- ALT1_DAM1_EADS_AC
- 2 ALT1_COMANCHE_PP
- ALT1_REG_TANK
- ALT1_STORAGE_TANKS
- ALT1_WTP
- ↔ ALTERNATIVE #1
- ☐ Counties

AVC ALTERNATIVE #1

COMANCHE SOUTH

SHEET #1

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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0 0.5 1 2 3 4 5 Miles

RECLAMATION
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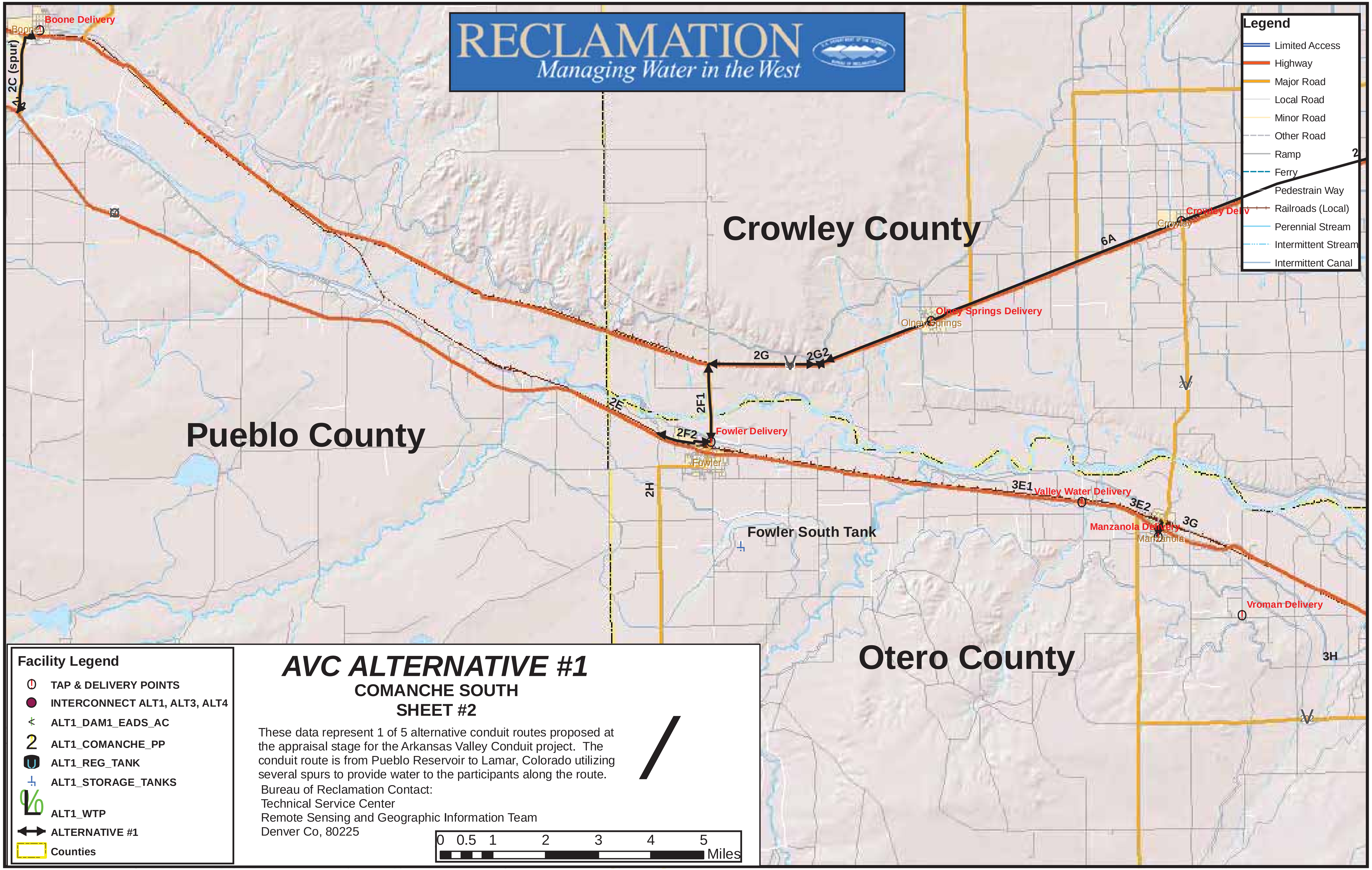

AVC ALTERNATIVE #1

COMANCHE SOUTH

SHEET #2

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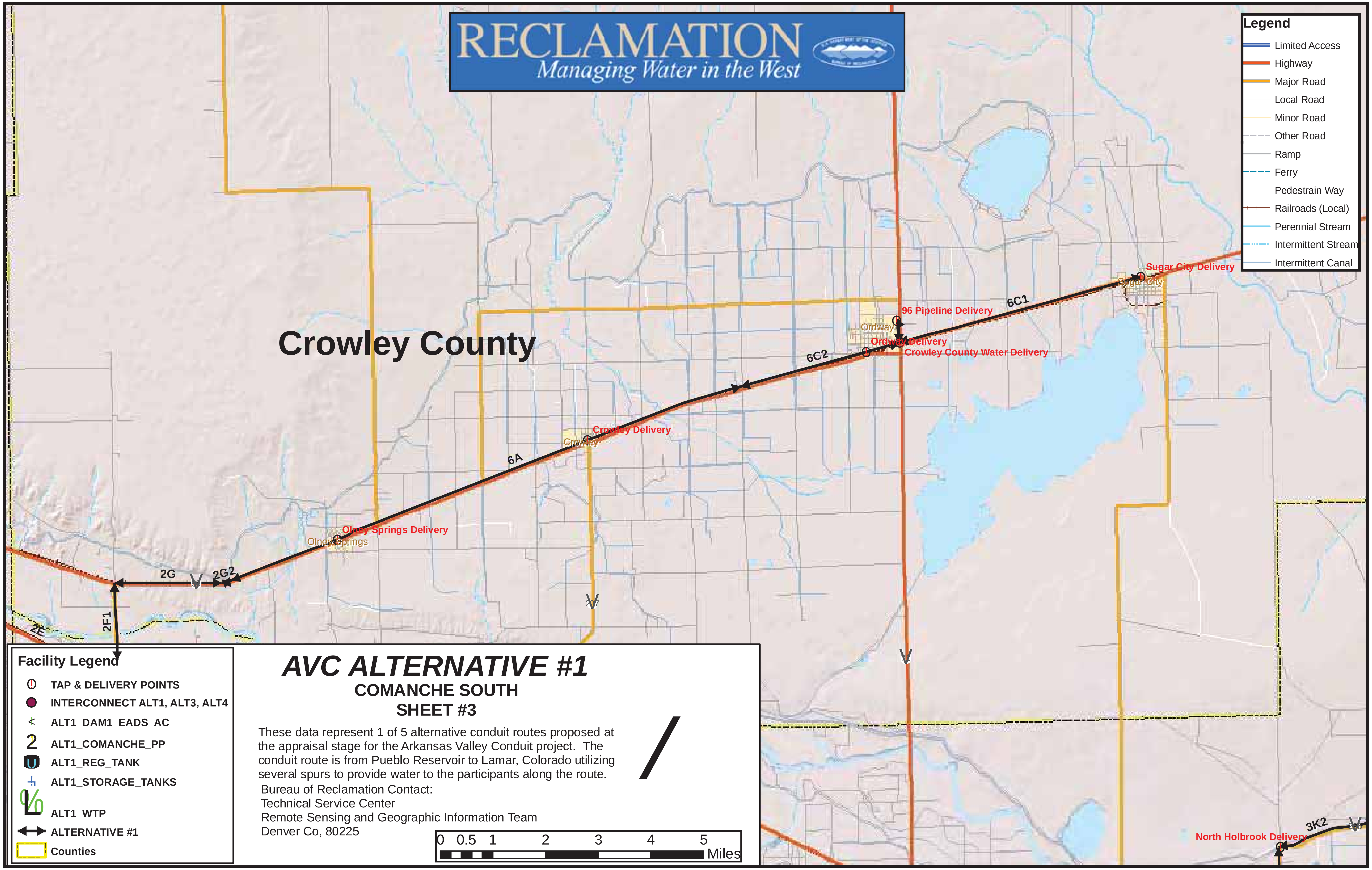

AVC ALTERNATIVE #1

COMANCHE SOUTH

SHEET #3

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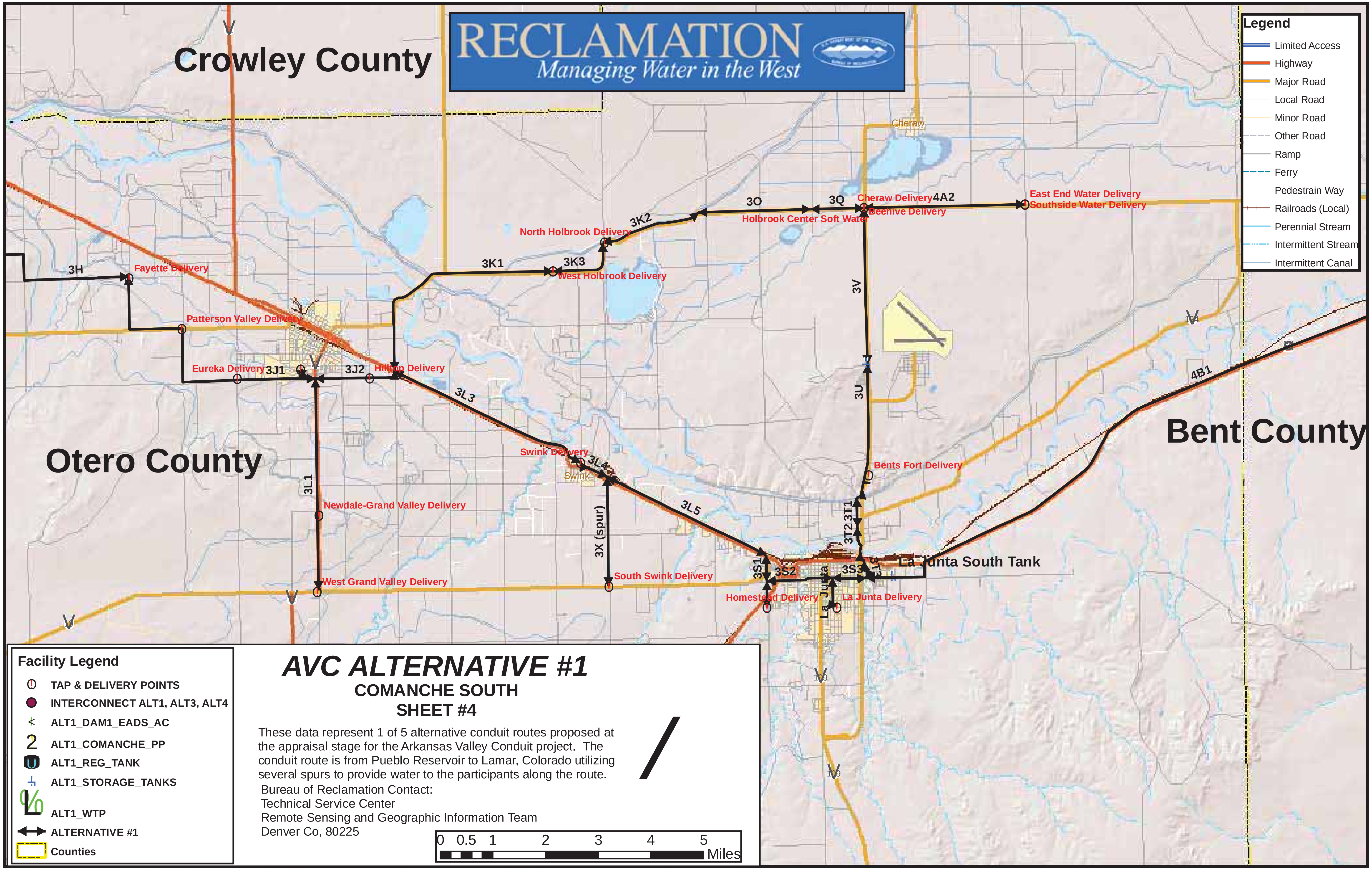

AVC ALTERNATIVE #1

COMANCHE SOUTH

SHEET #4

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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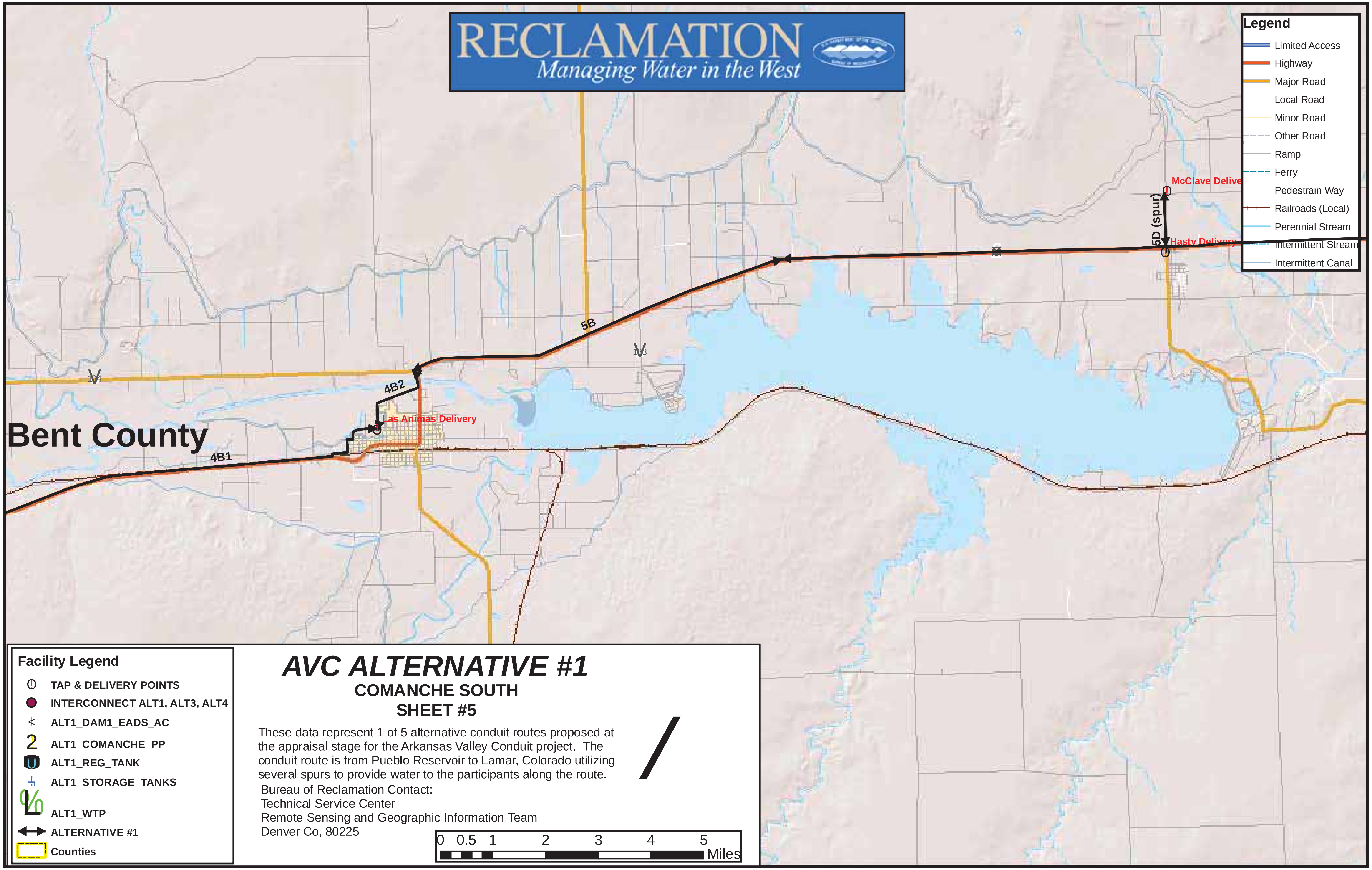

AVC ALTERNATIVE #1

COMANCHE SOUTH

SHEET #5

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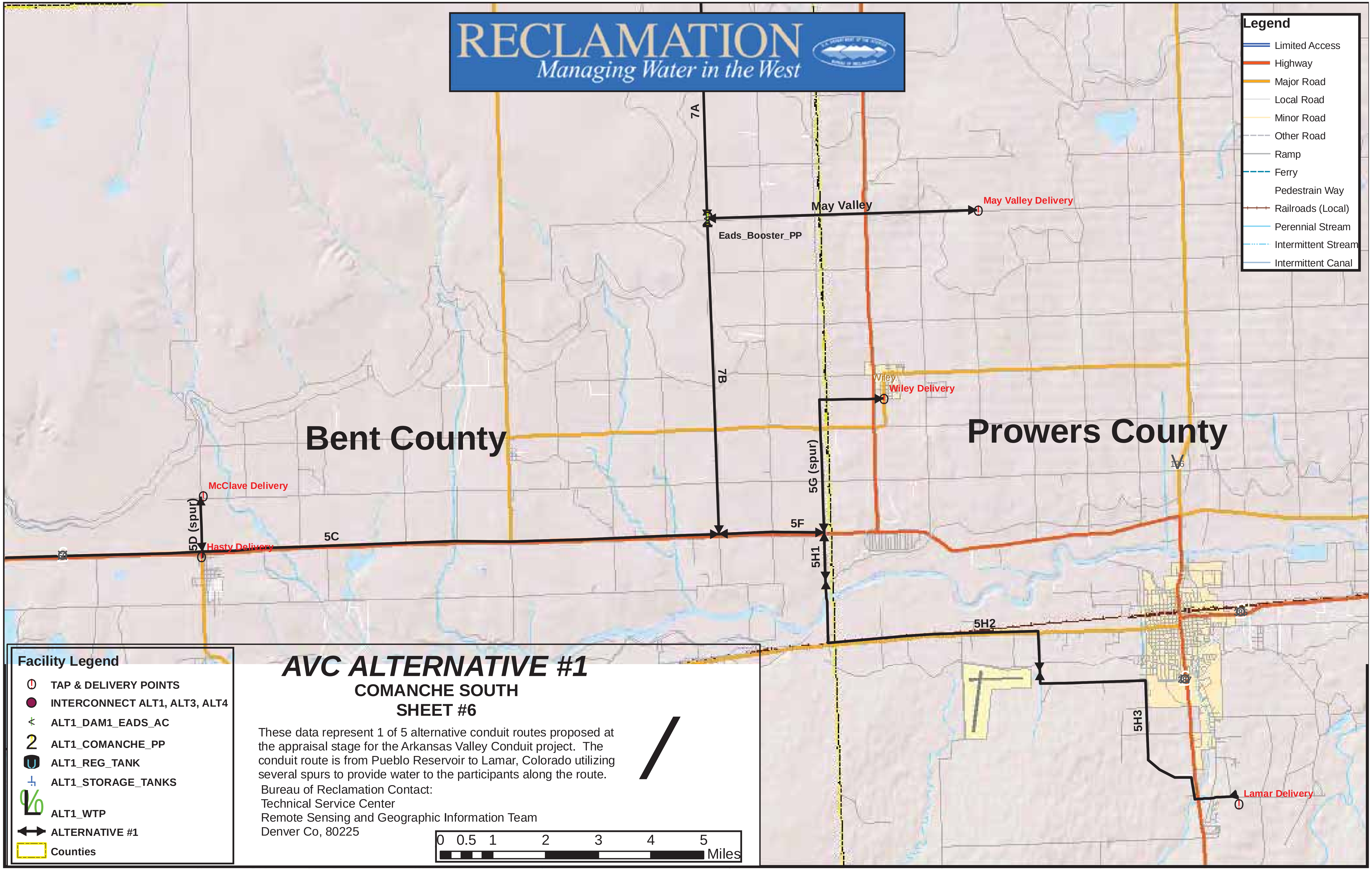

AVC ALTERNATIVE #1

COMANCHE SOUTH

SHEET #6

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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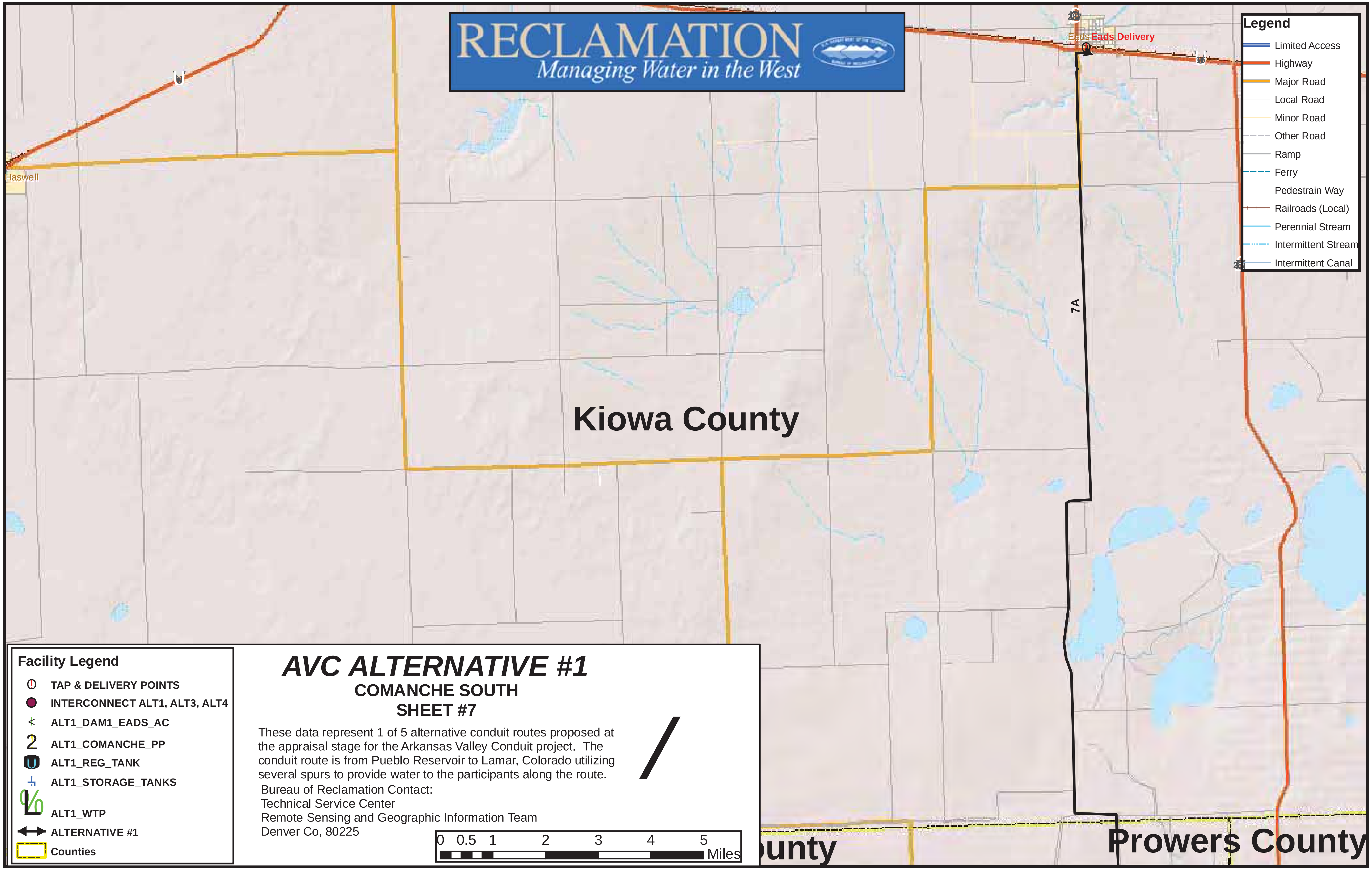

AVC ALTERNATIVE #1

COMANCHE SOUTH

SHEET #7

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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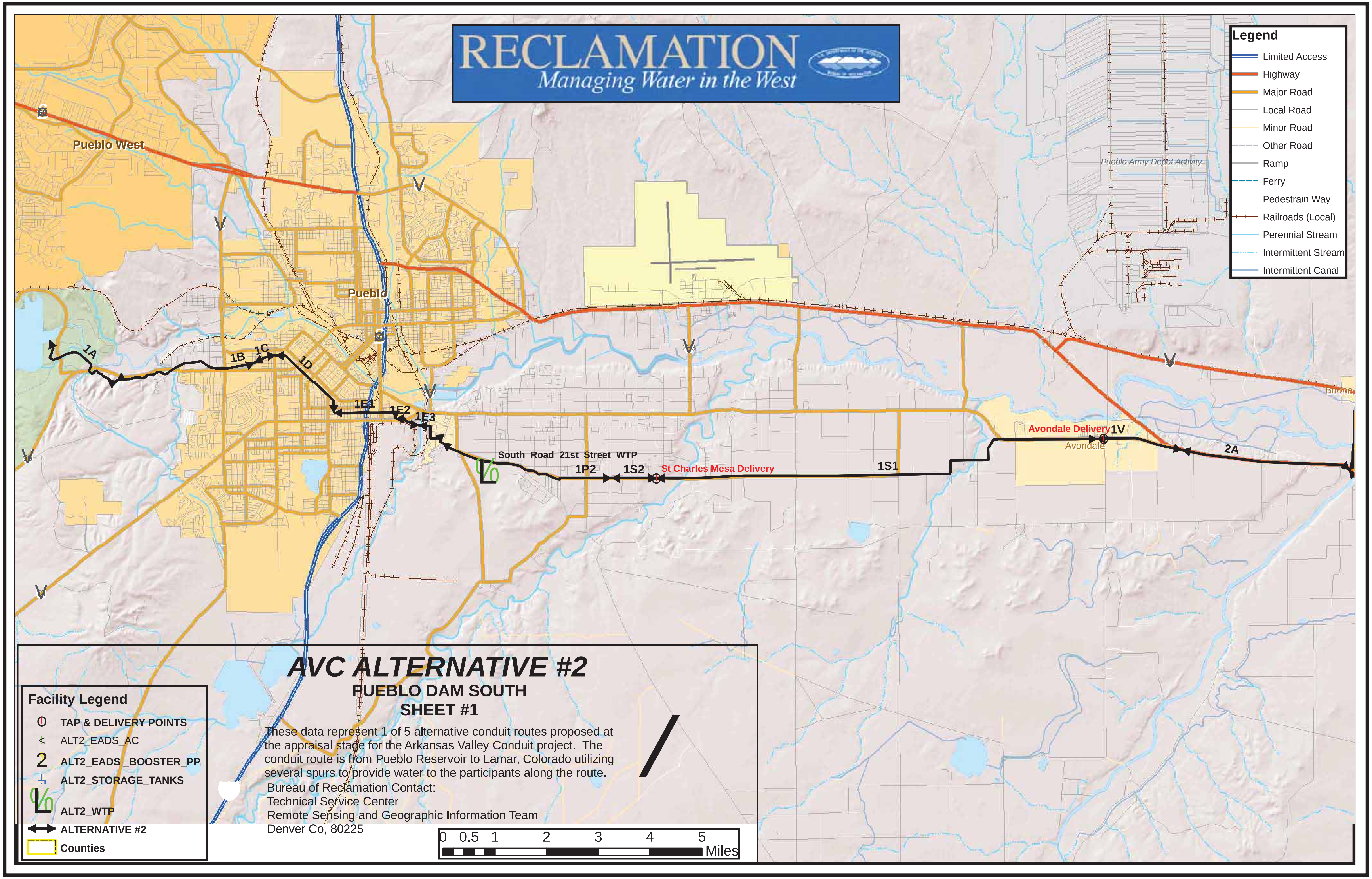

AVC ALTERNATIVE #2

PUEBLO DAM SOUTH

SHEET #1

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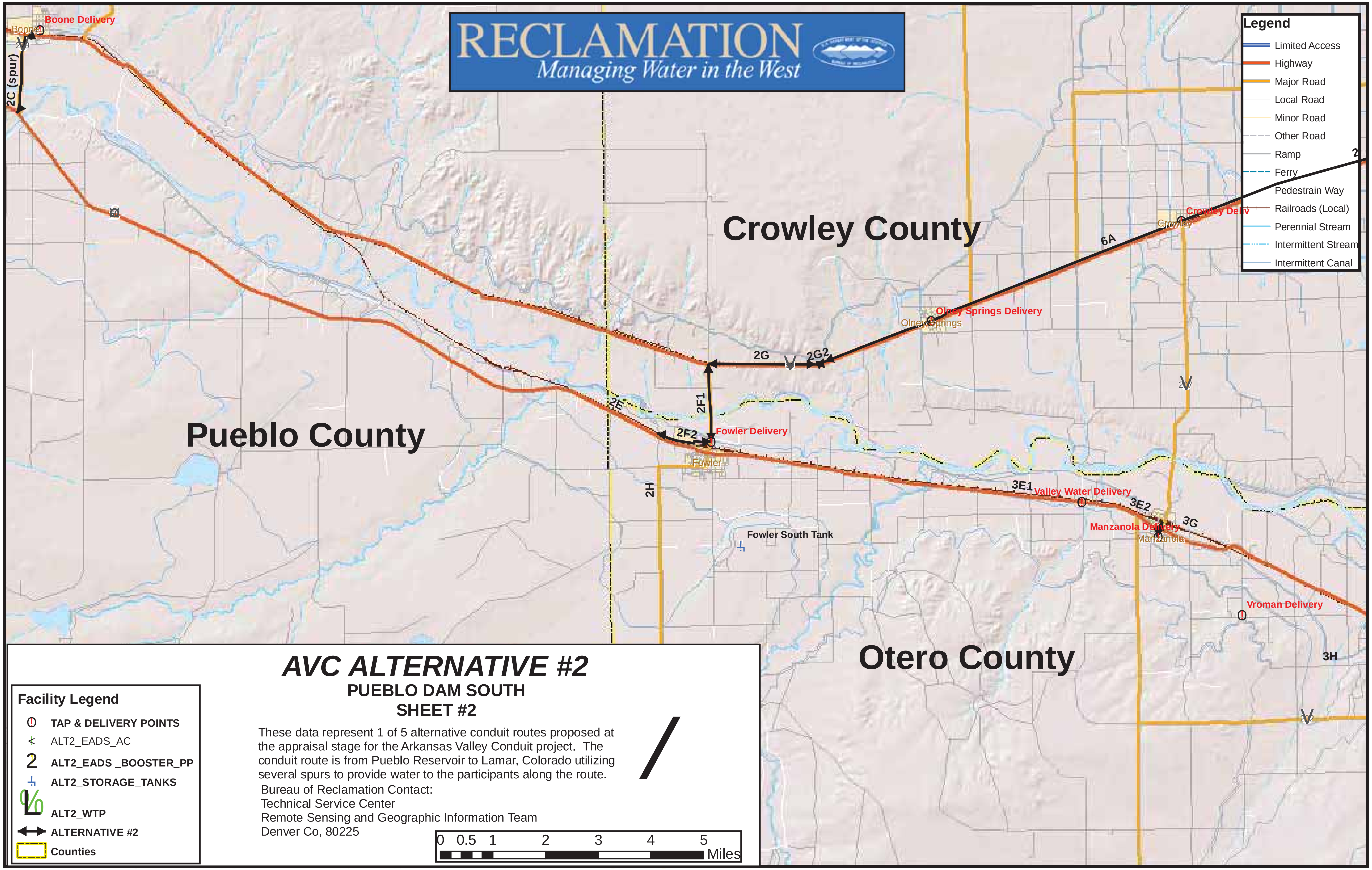

AVC ALTERNATIVE #2

PUEBLO DAM SOUTH

SHEET #2

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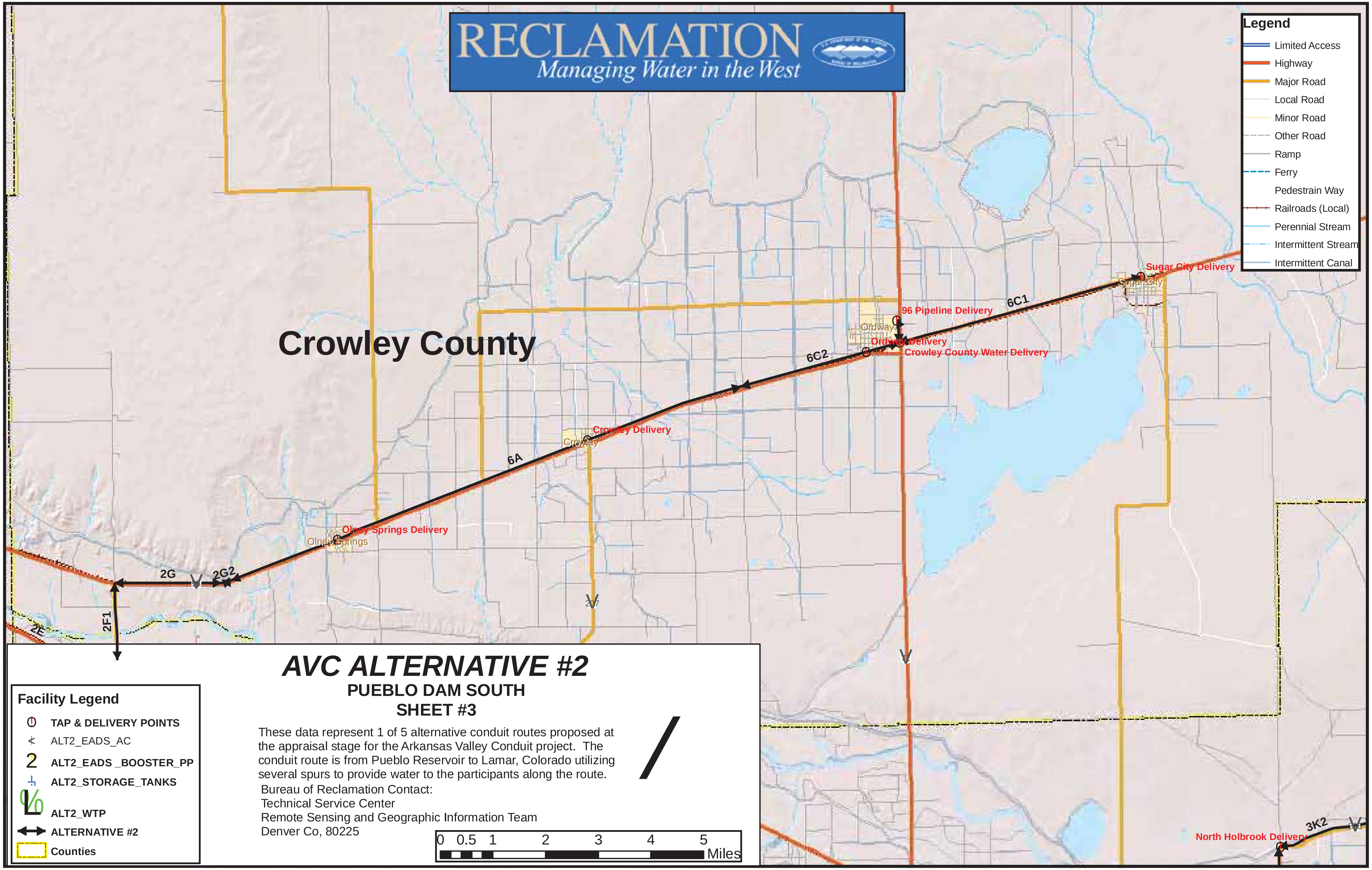
Facility Legend

TAP & DELIVERY POINTS
ALT2_EADS_AC
ALT2_EADS _BOOSTER_PP
ALT2_STORAGE_TANKS
ALT2_WTP
ALTERNATIVE #2
Counties



AVC ALTERNATIVE #2

PUEBLO DAM SOUTH

SHEET #3

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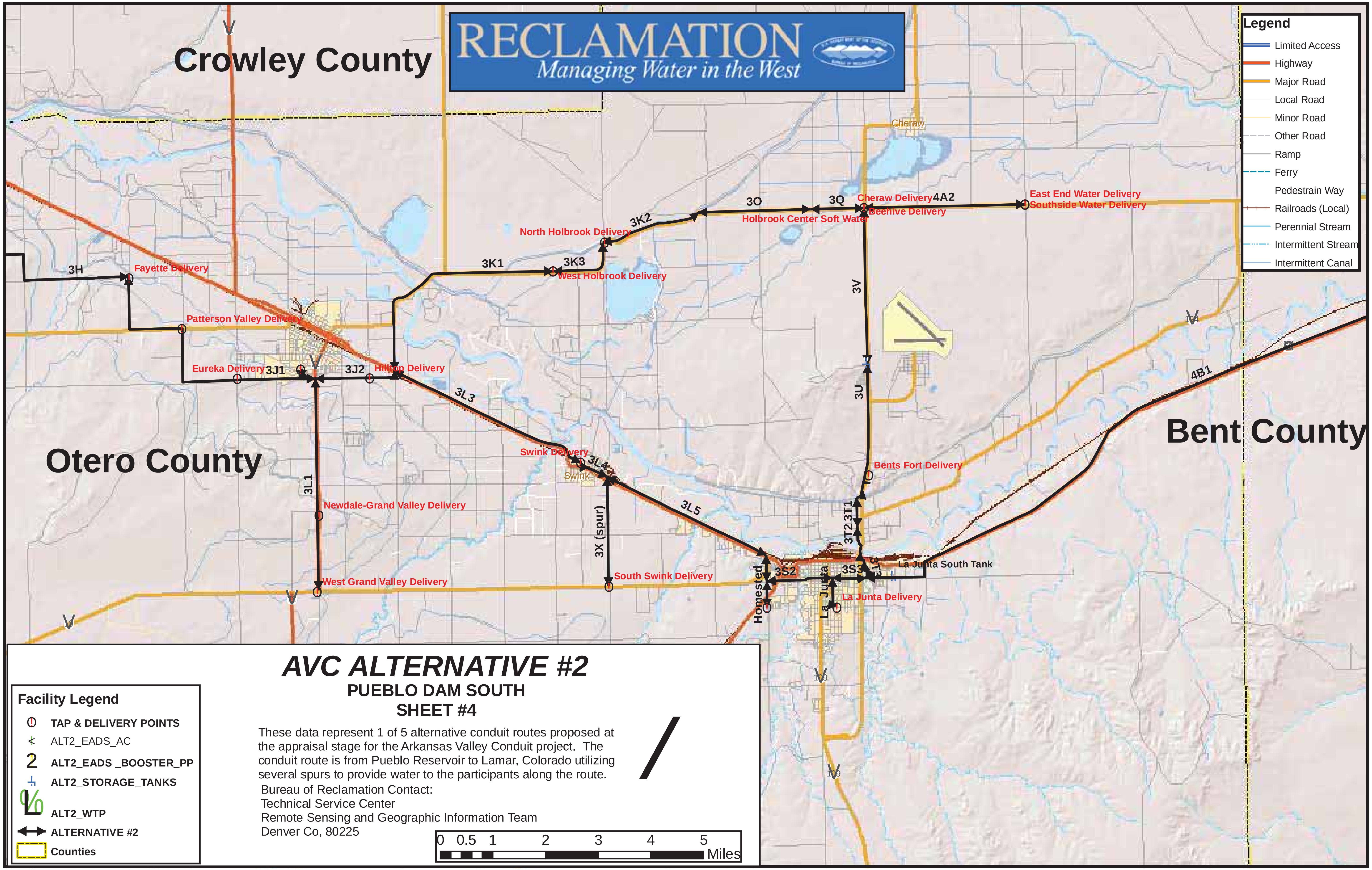

AVC ALTERNATIVE #2

PUEBLO DAM SOUTH

SHEET #4

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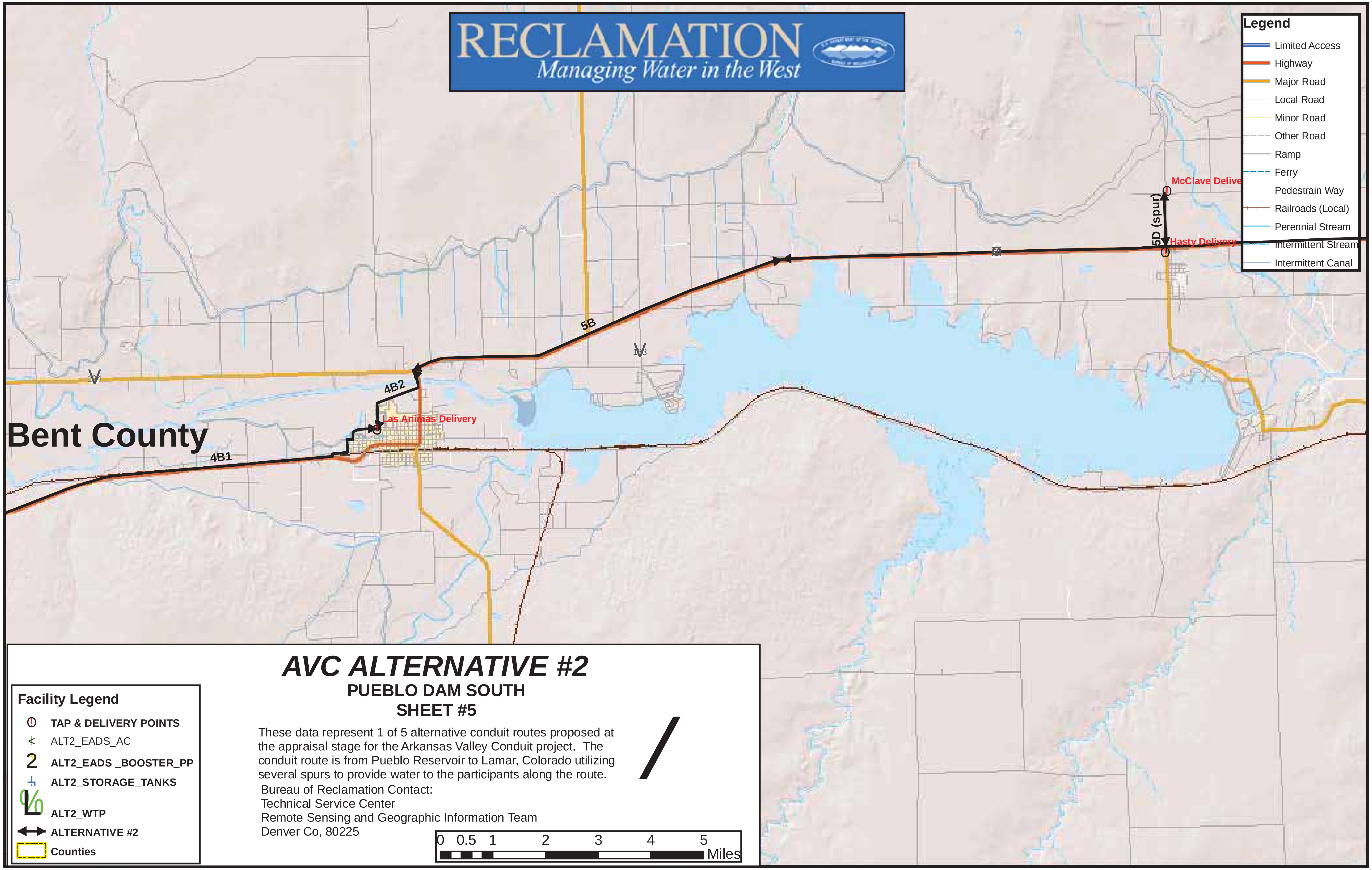

AVC ALTERNATIVE #2

PUEBLO DAM SOUTH

SHEET #5

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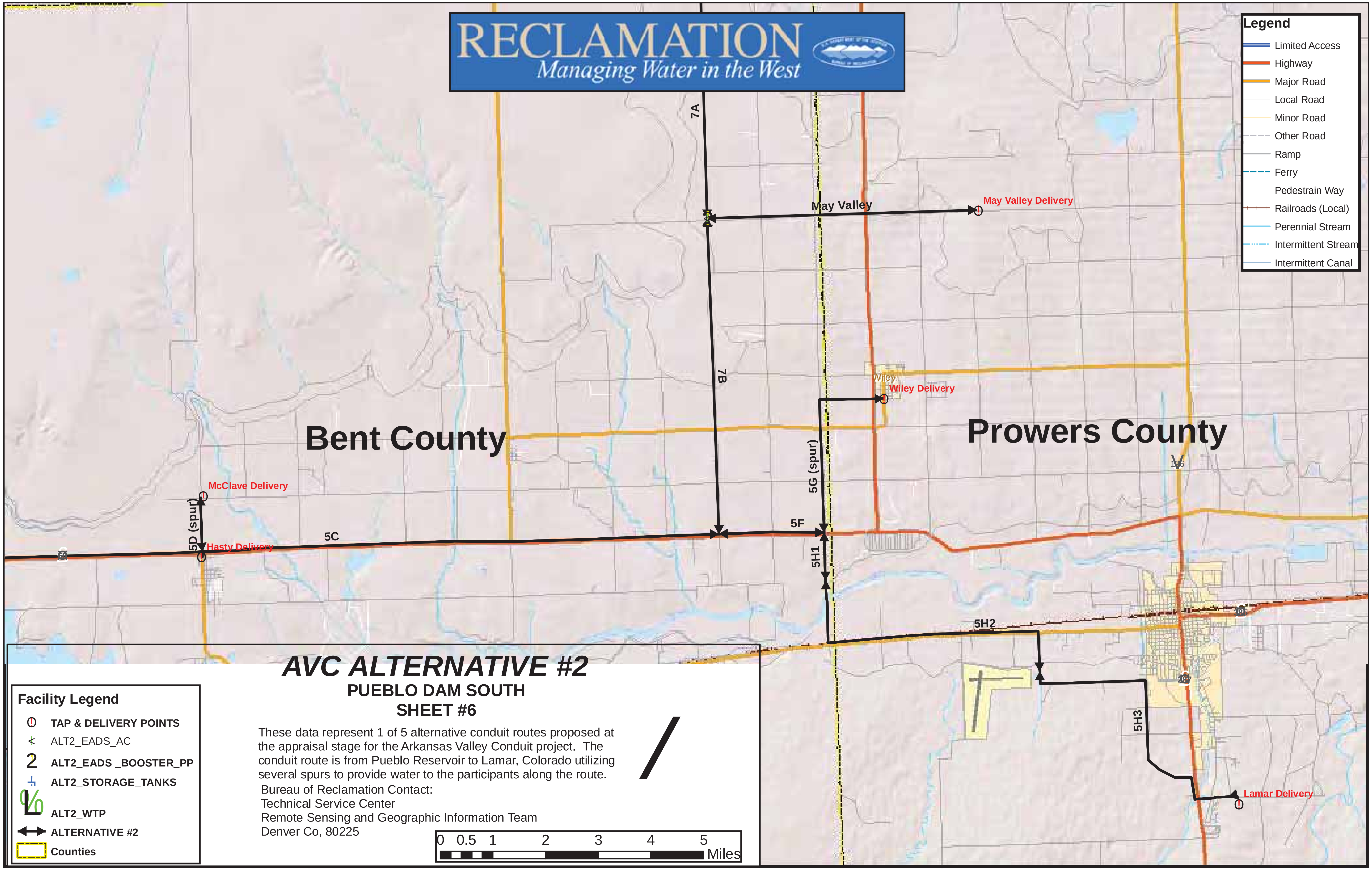

AVC ALTERNATIVE #2

PUEBLO DAM SOUTH

SHEET #6

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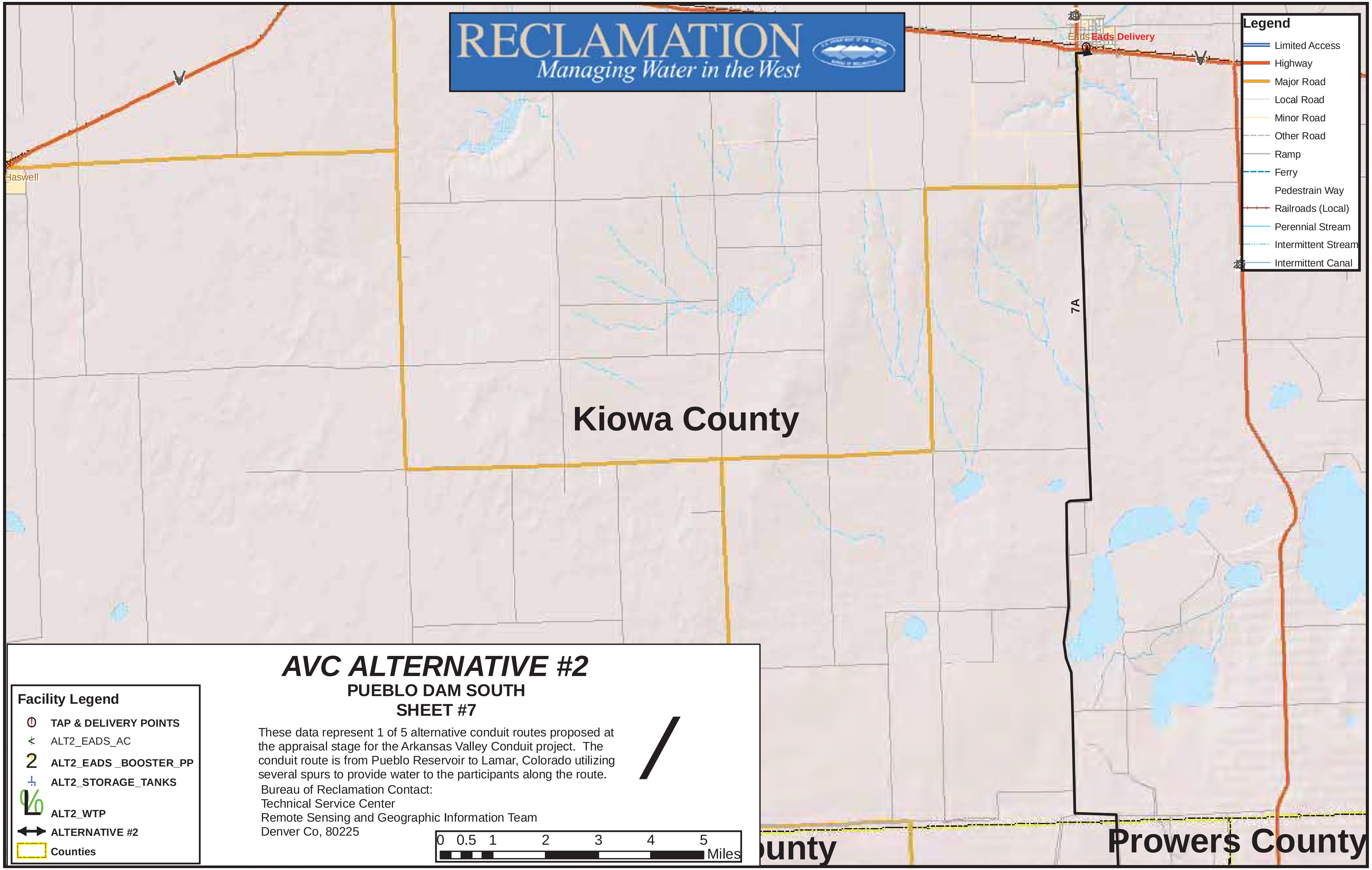

AVC ALTERNATIVE #2

PUEBLO DAM SOUTH

SHEET #7

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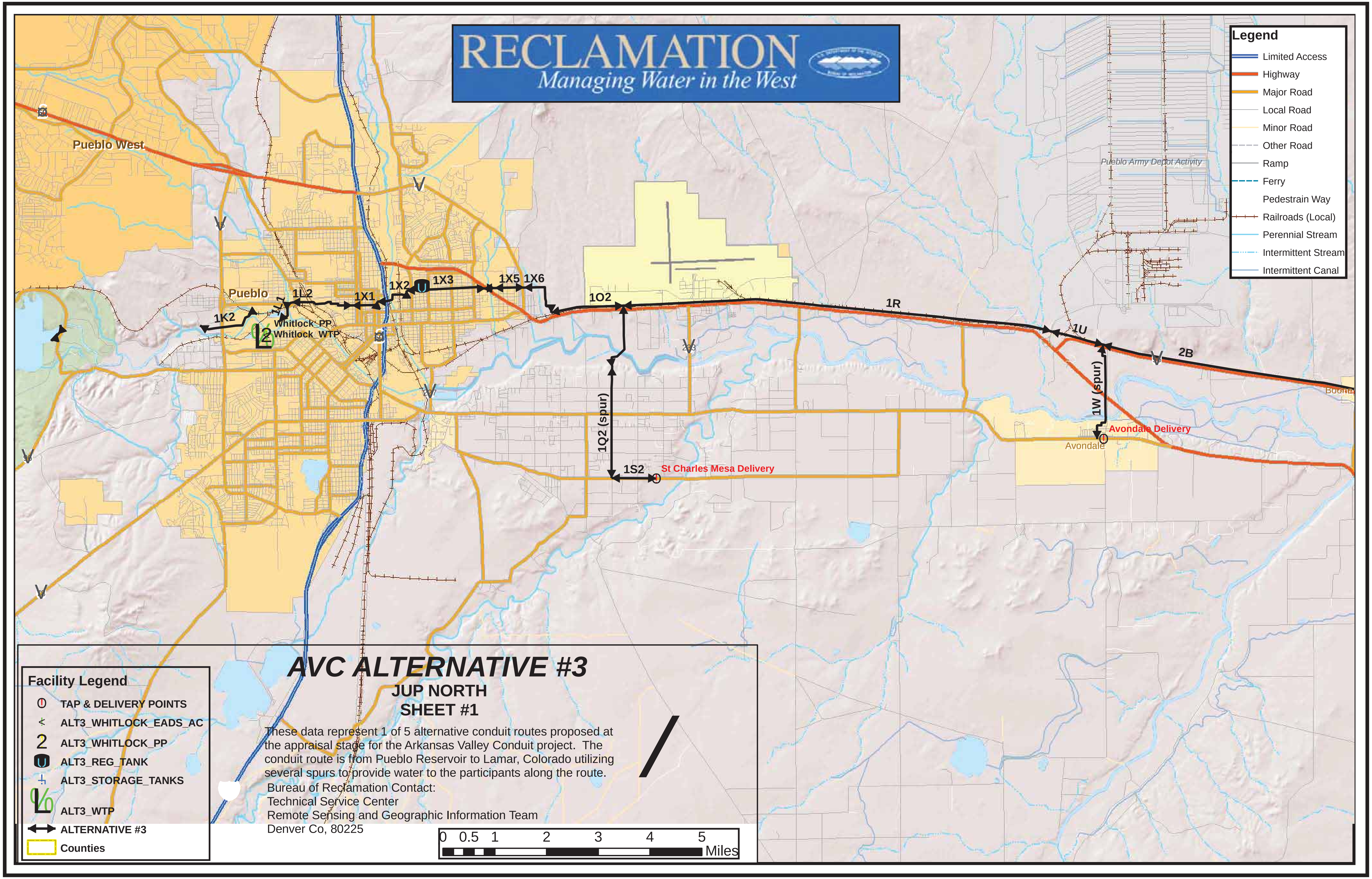

AVC ALTERNATIVE #3

JUP NORTH

SHEET #1

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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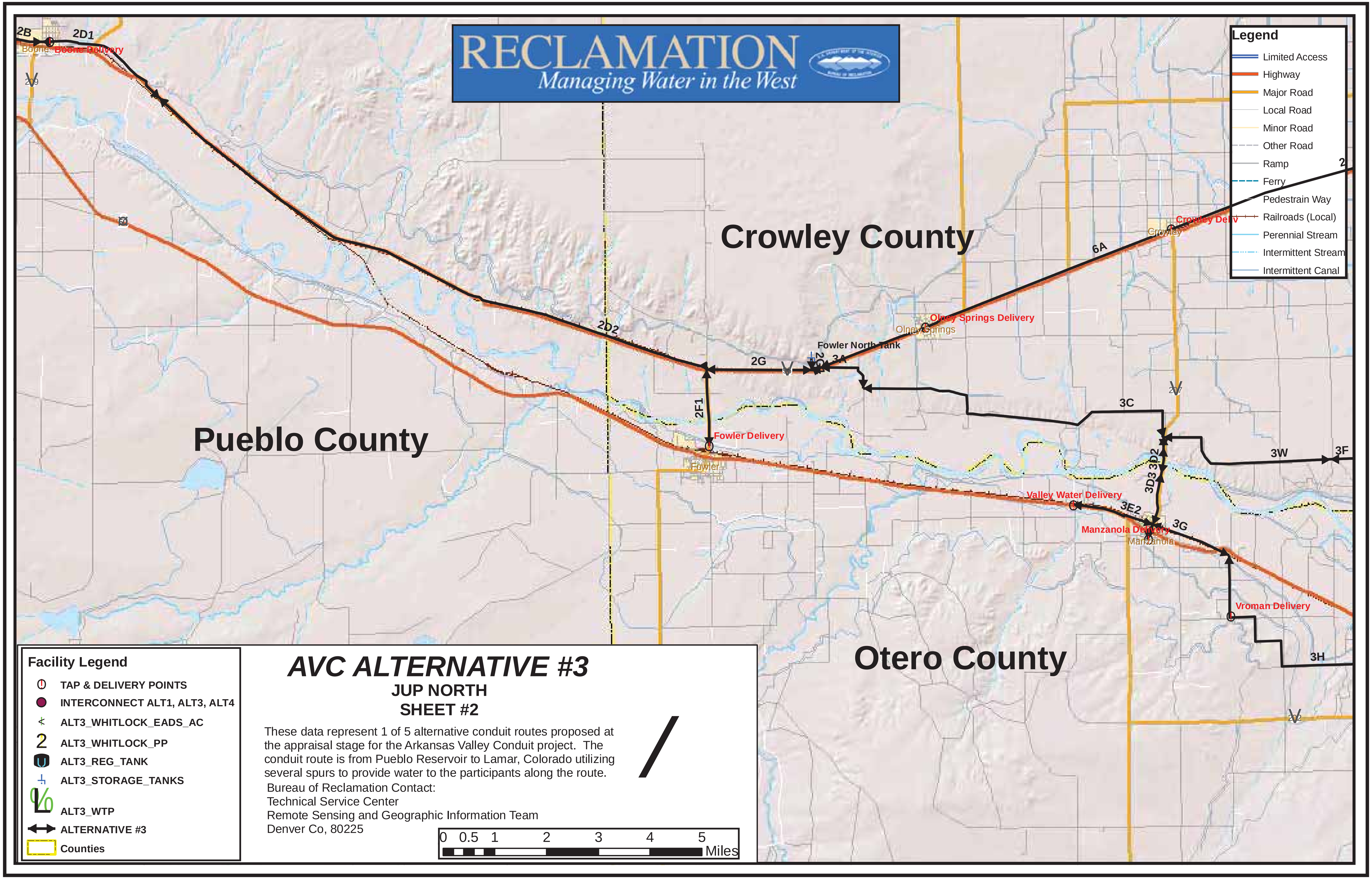

AVC ALTERNATIVE #3

JUP NORTH

SHEET #2

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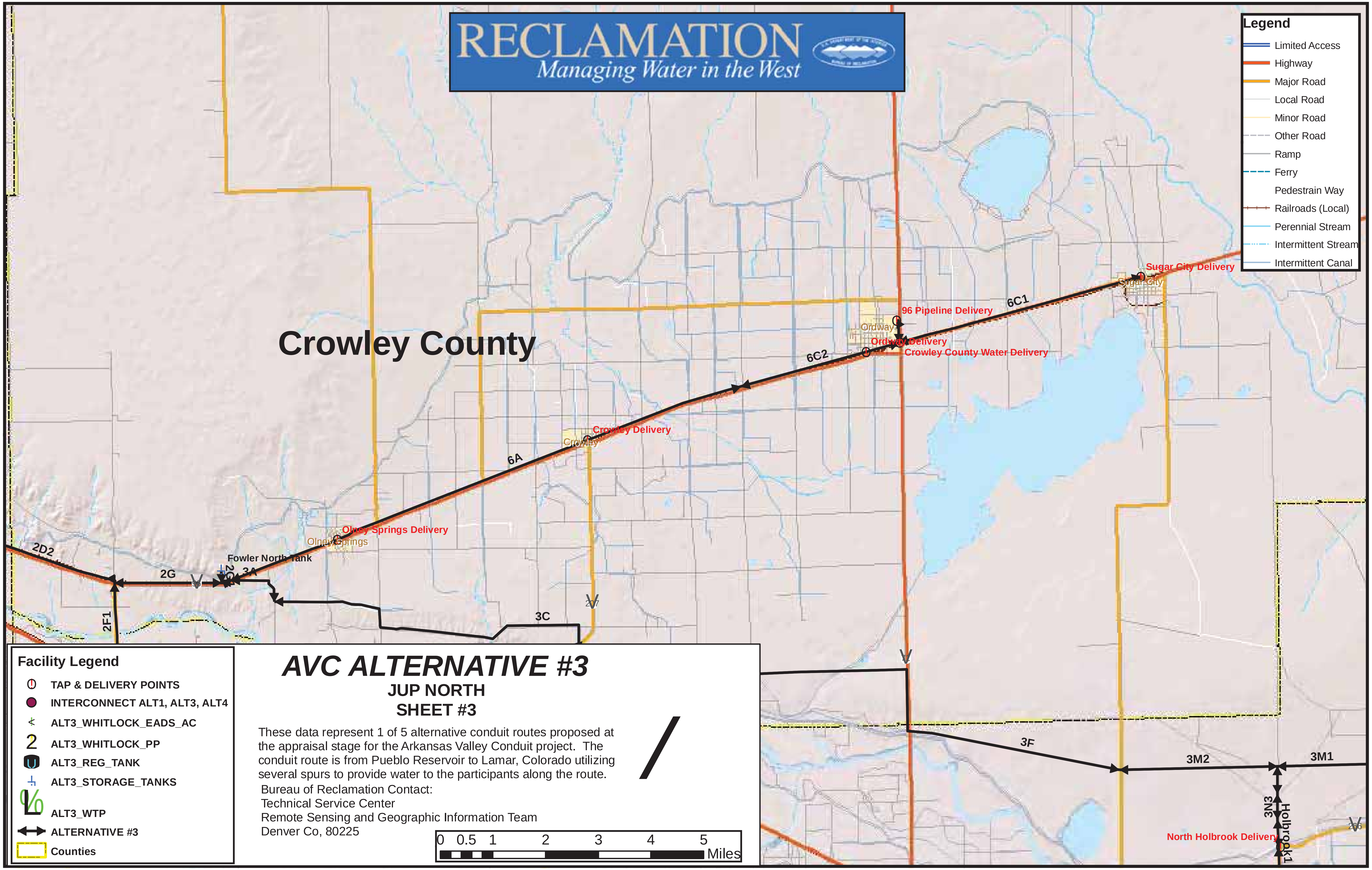

AVC ALTERNATIVE #3

JUP NORTH

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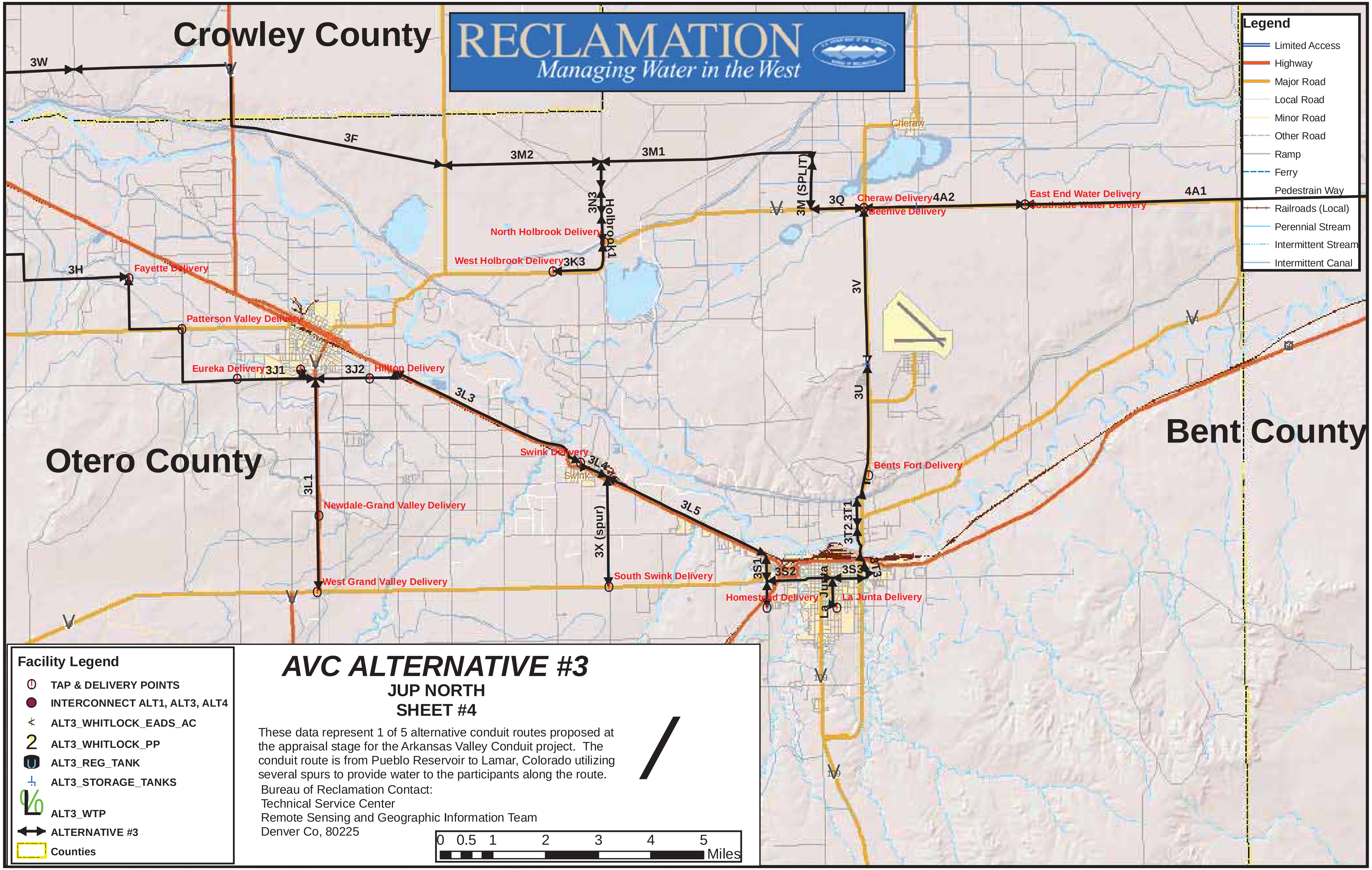

AVC ALTERNATIVE #3

JUP NORTH

SHEET #4

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AVC ALTERNATIVE #3

JUP NORTH

SHEET #5

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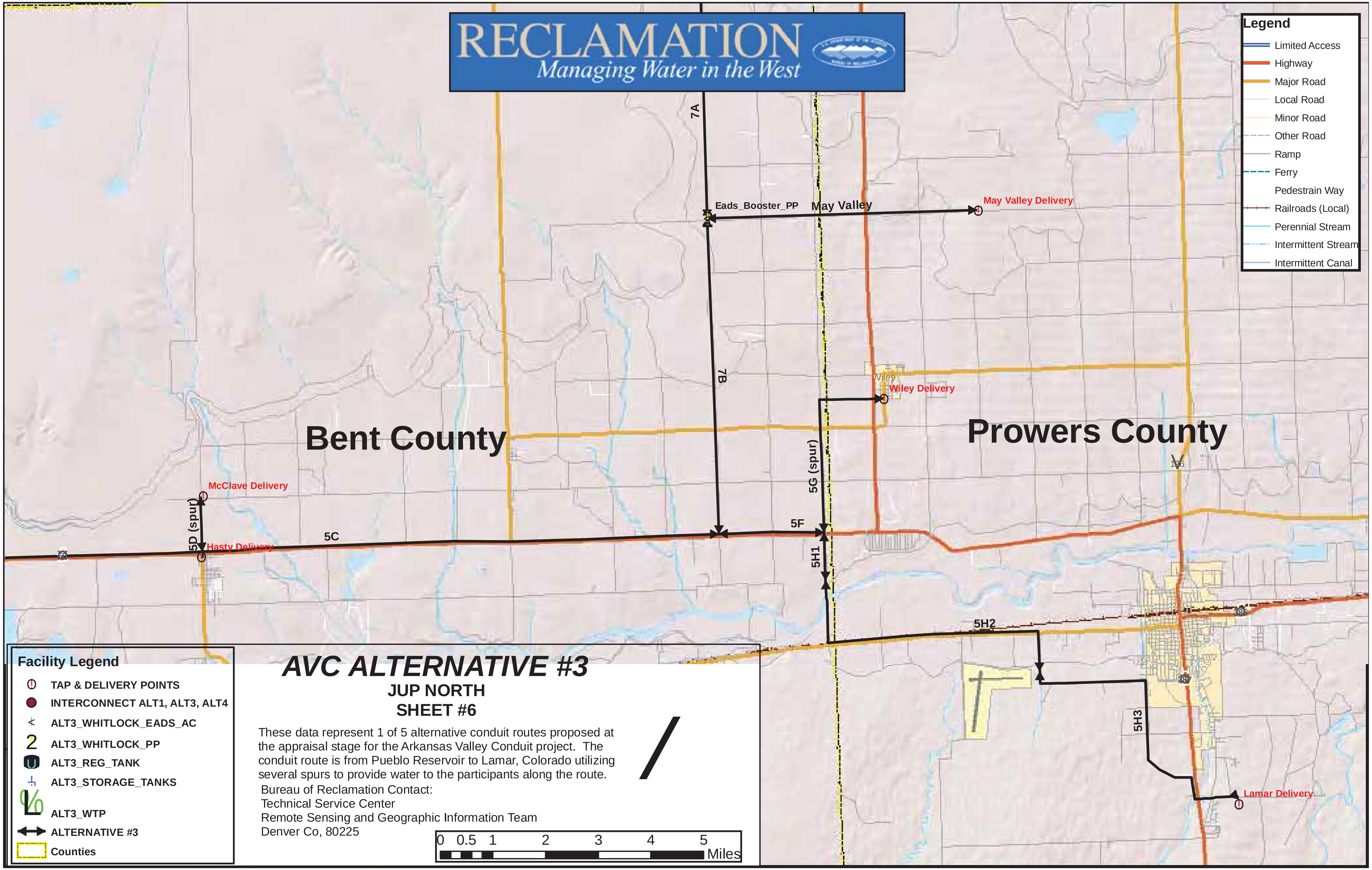

AVC ALTERNATIVE #3

JUP NORTH

SHEET #6

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RECLAMATION
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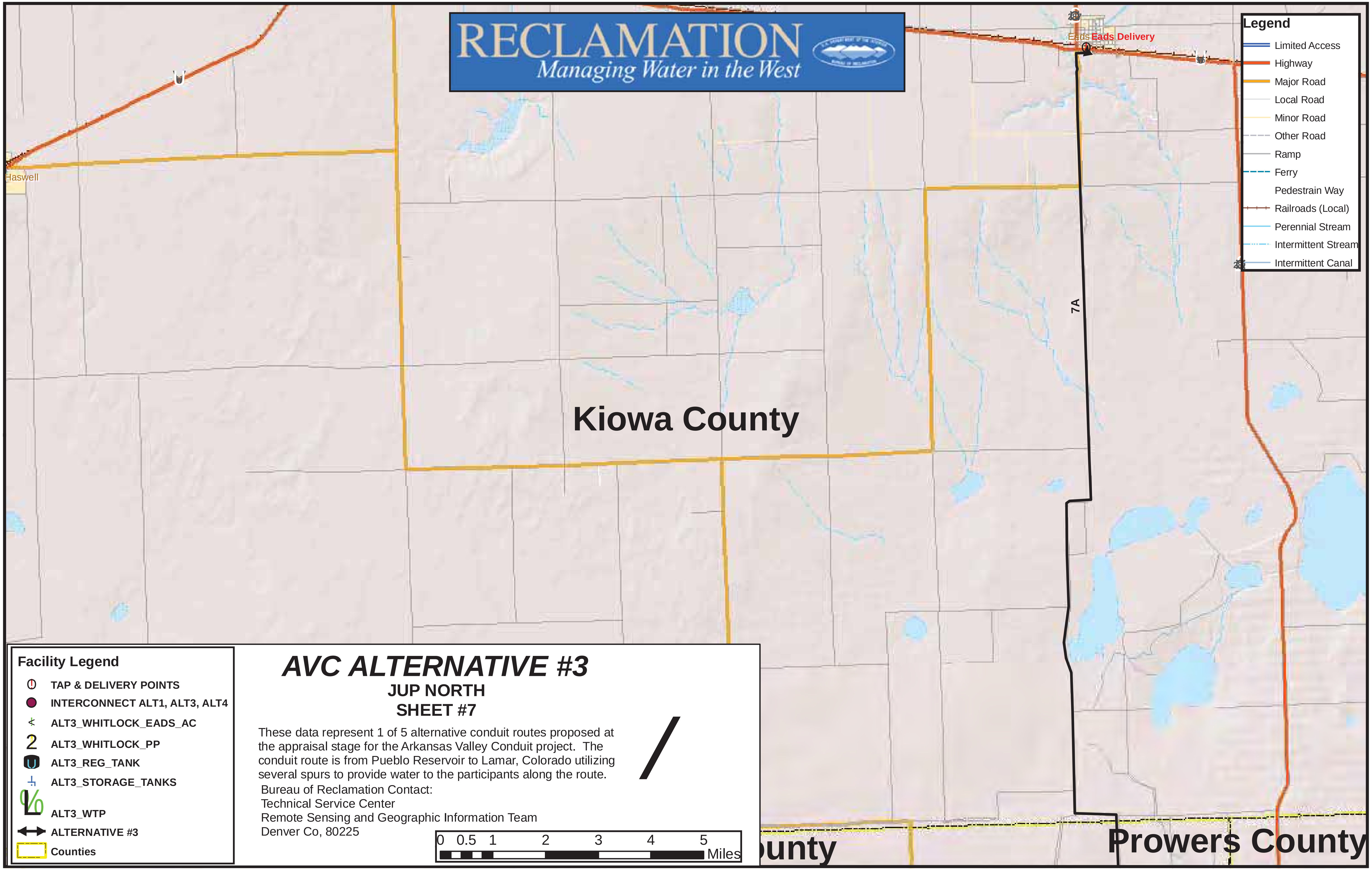

AVC ALTERNATIVE #3

JUP NORTH

SHEET #7

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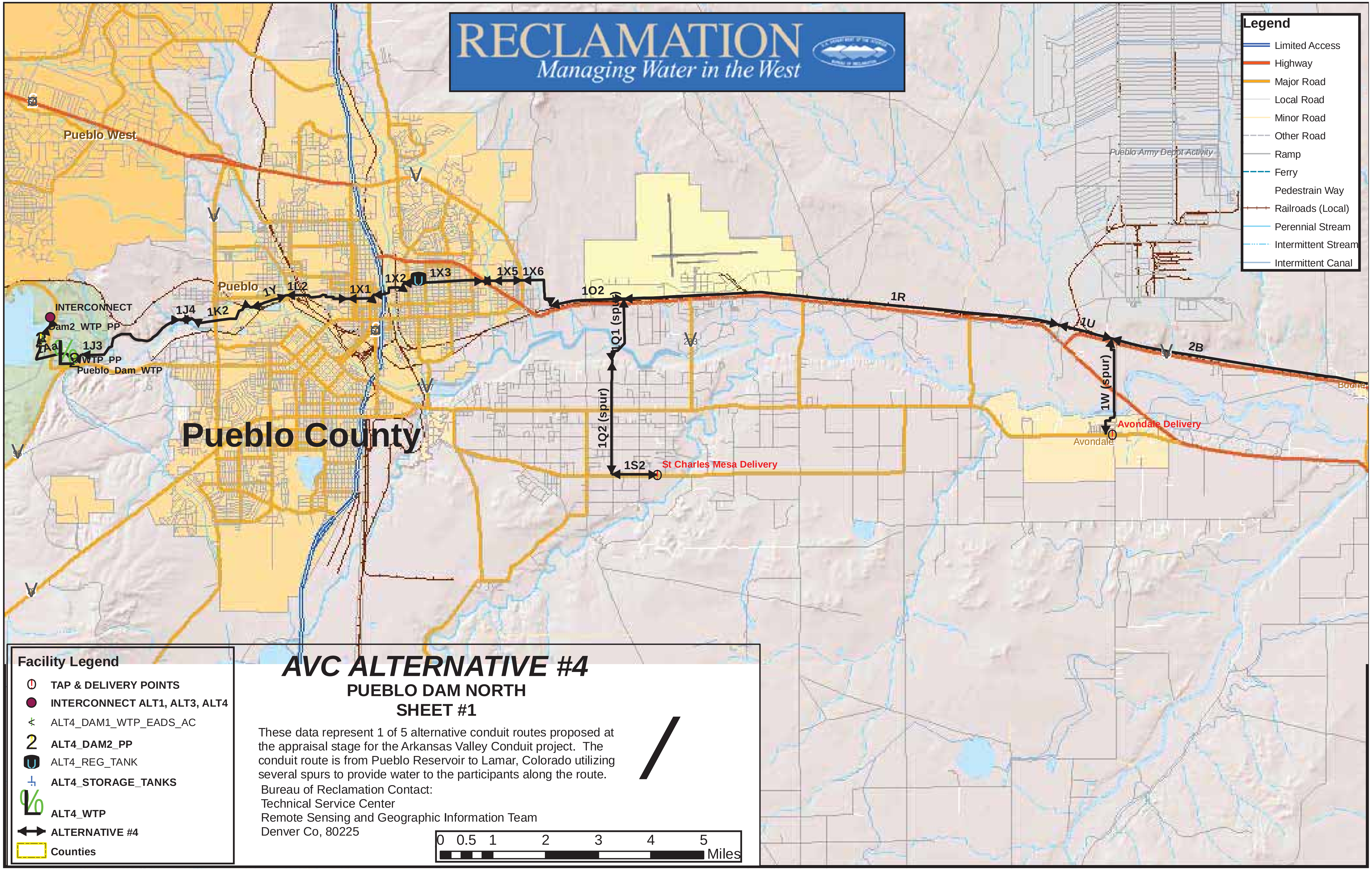

AVC ALTERNATIVE #4

PUEBLO DAM NORTH

SHEET #1

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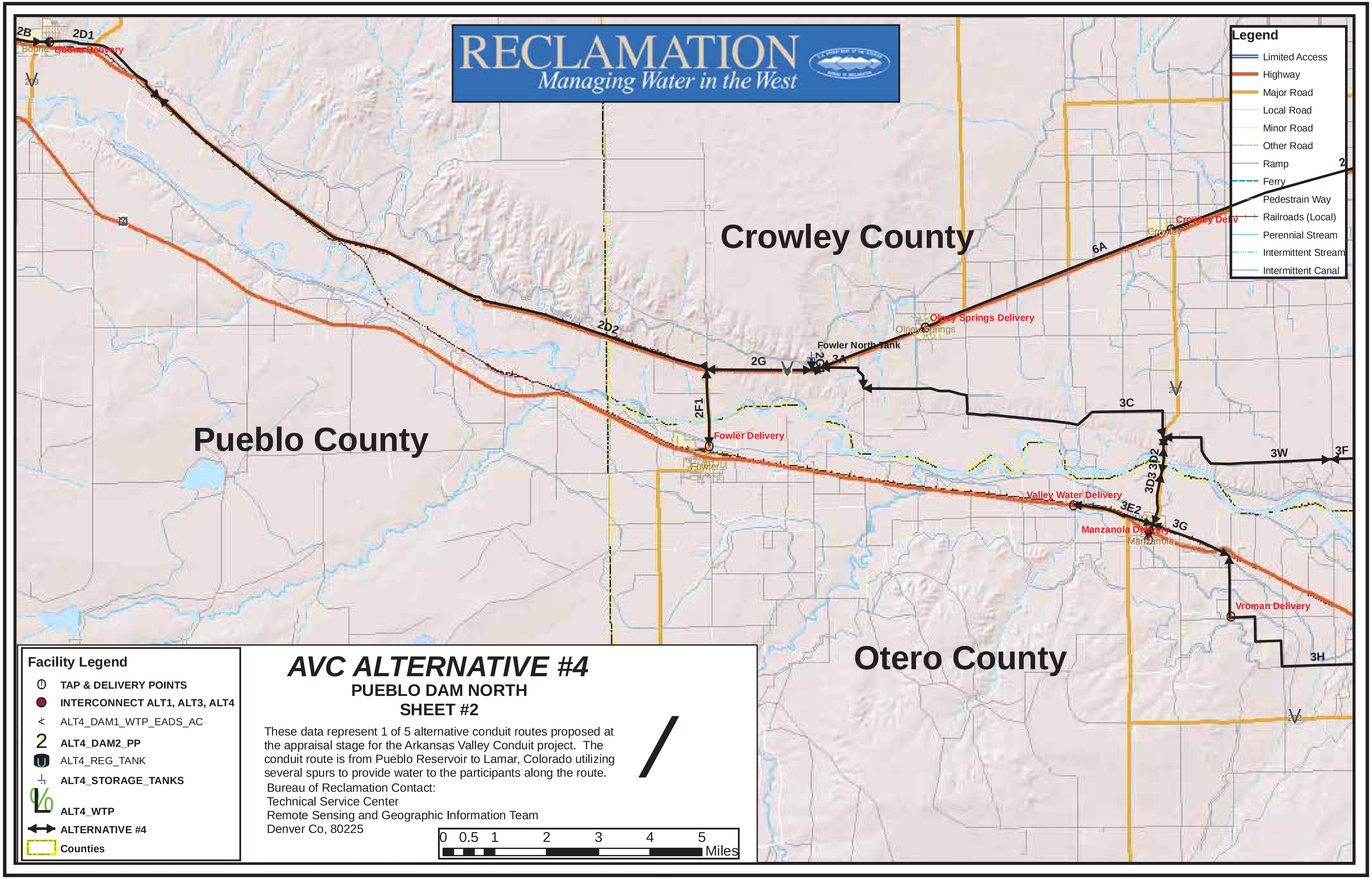

AVC ALTERNATIVE #4

PUEBLO DAM NORTH

SHEET #2

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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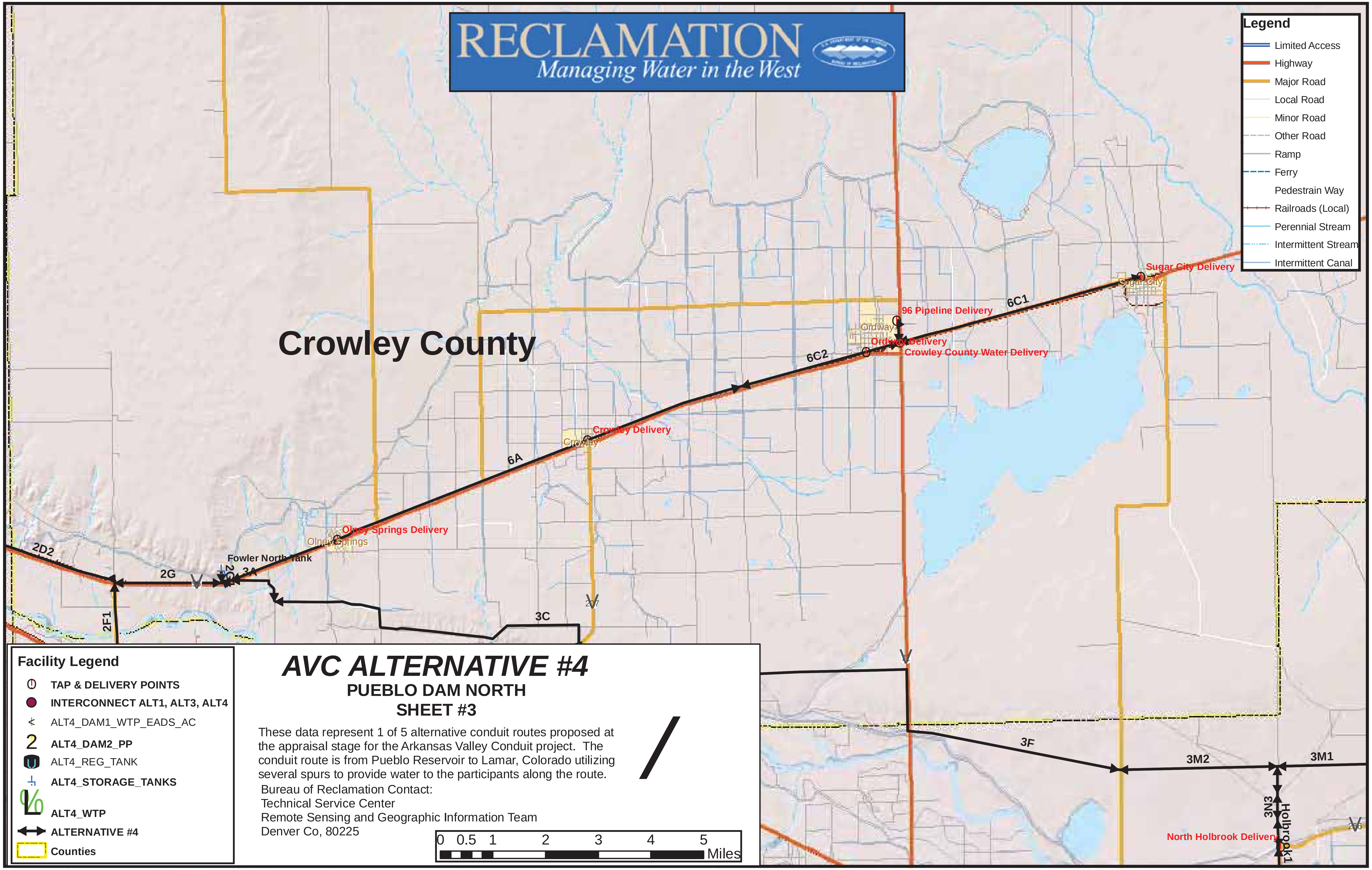

AVC ALTERNATIVE #4

PUEBLO DAM NORTH

SHEET #3

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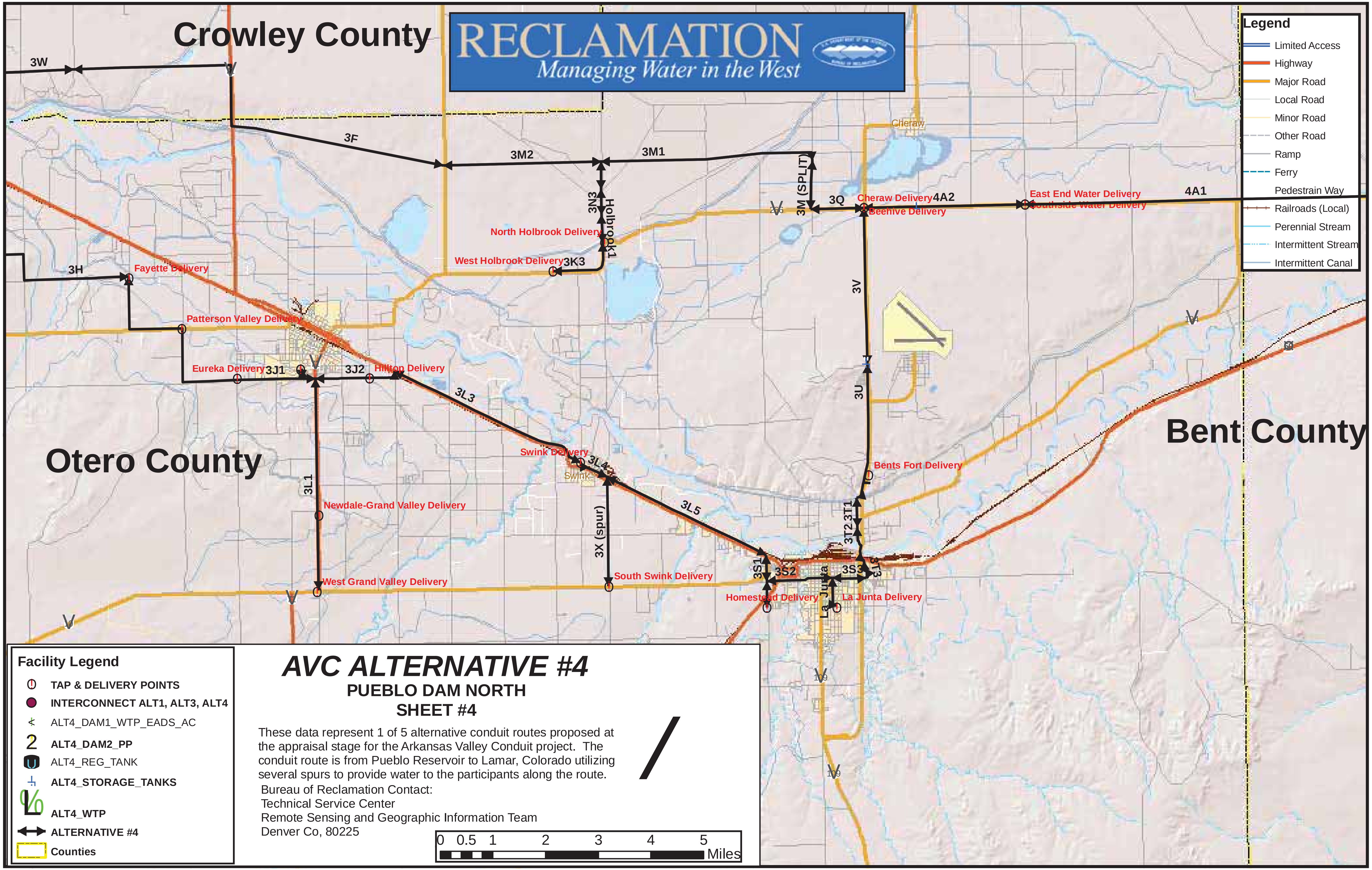

AVC ALTERNATIVE #4

PUEBLO DAM NORTH

SHEET #4

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Denver Co, 80225

AVC ALTERNATIVE #4

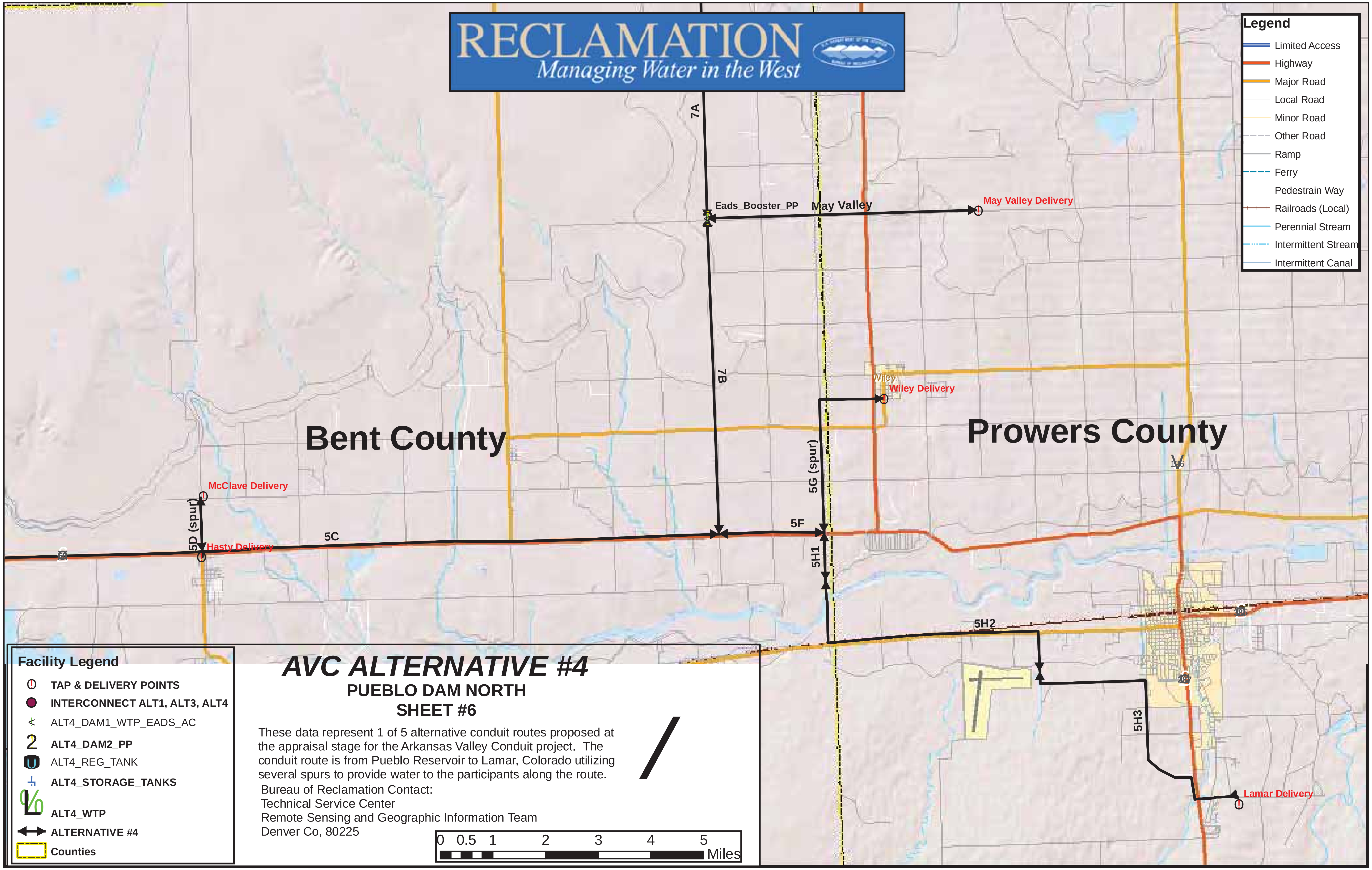
PUEBLO DAM NORTH

SHEET #5

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

Bureau of Reclamation Contact:
Technical Service Center
Remote Sensing and Geographic Information Team
Denver Co, 80225

RECLAMATION
Managing Water in the West



AVC ALTERNATIVE #4

PUEBLO DAM NORTH

SHEET #6

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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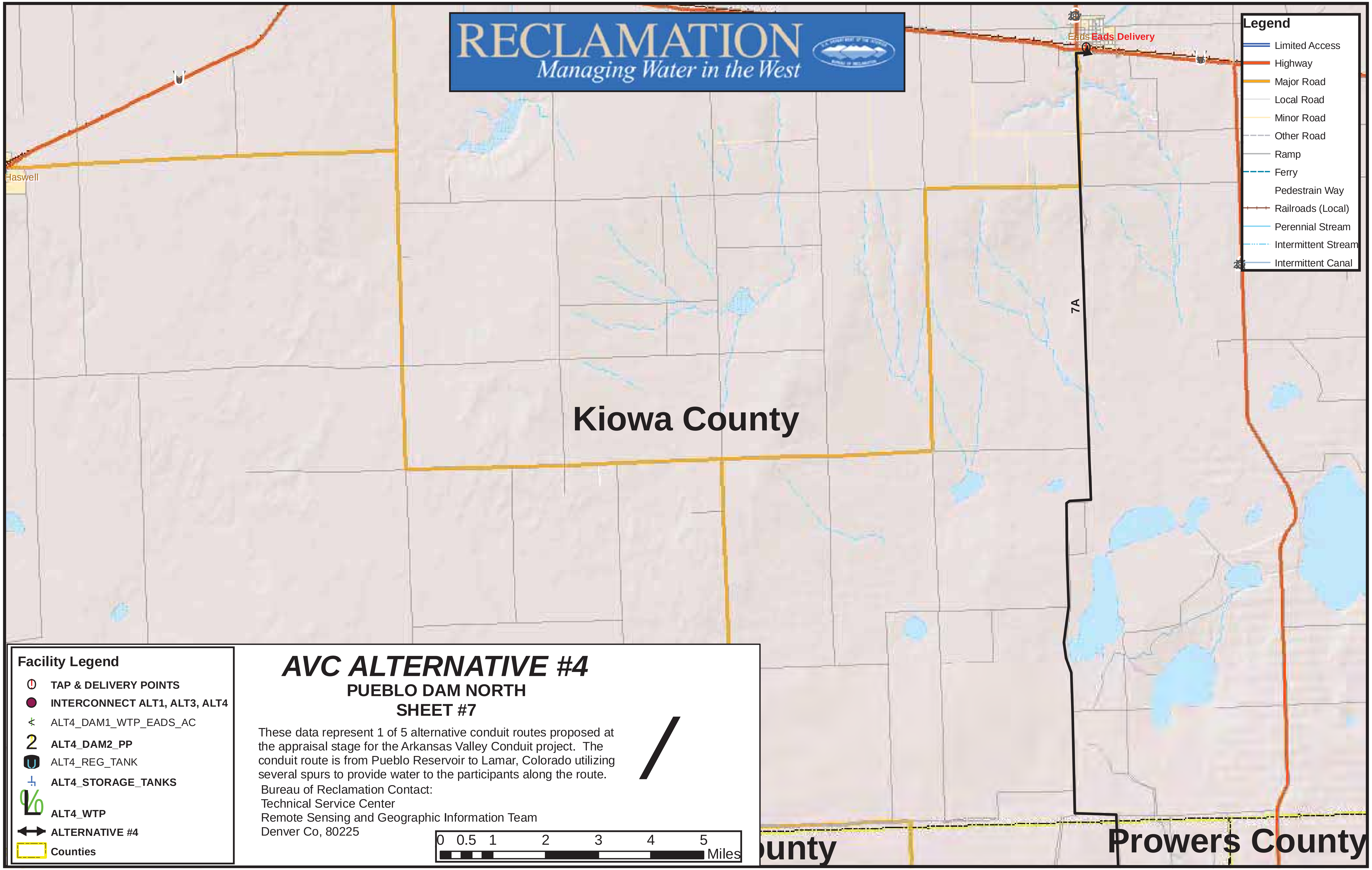
Denver Co, 80225



AVC ALTERNATIVE #4

PUEBLO DAM NORTH

SHEET #7

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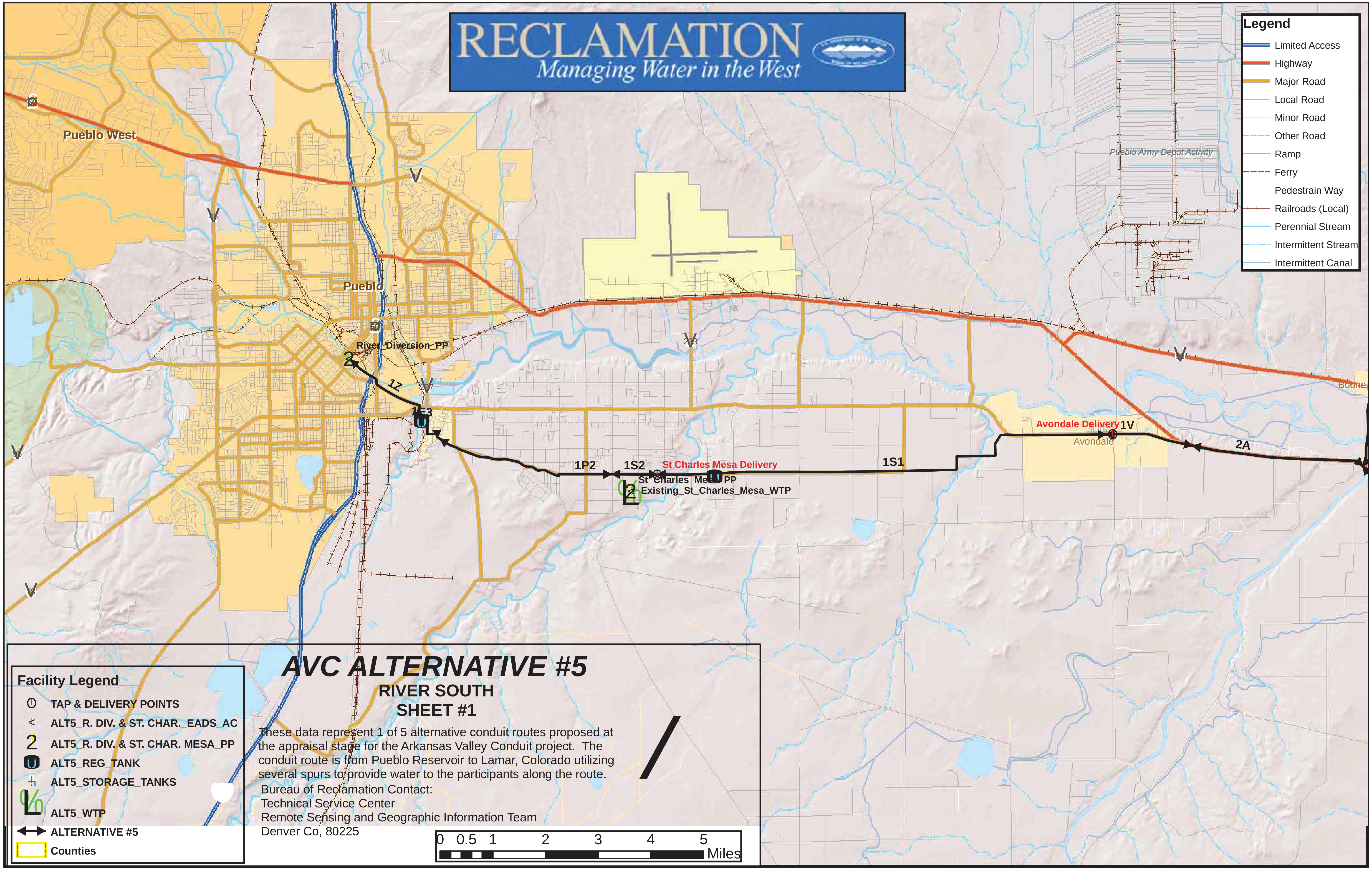
Remote Sensing and Geographic Information Team
Denver Co, 80225



AVC ALTERNATIVE #5

RIVER SOUTH

SHEET #1

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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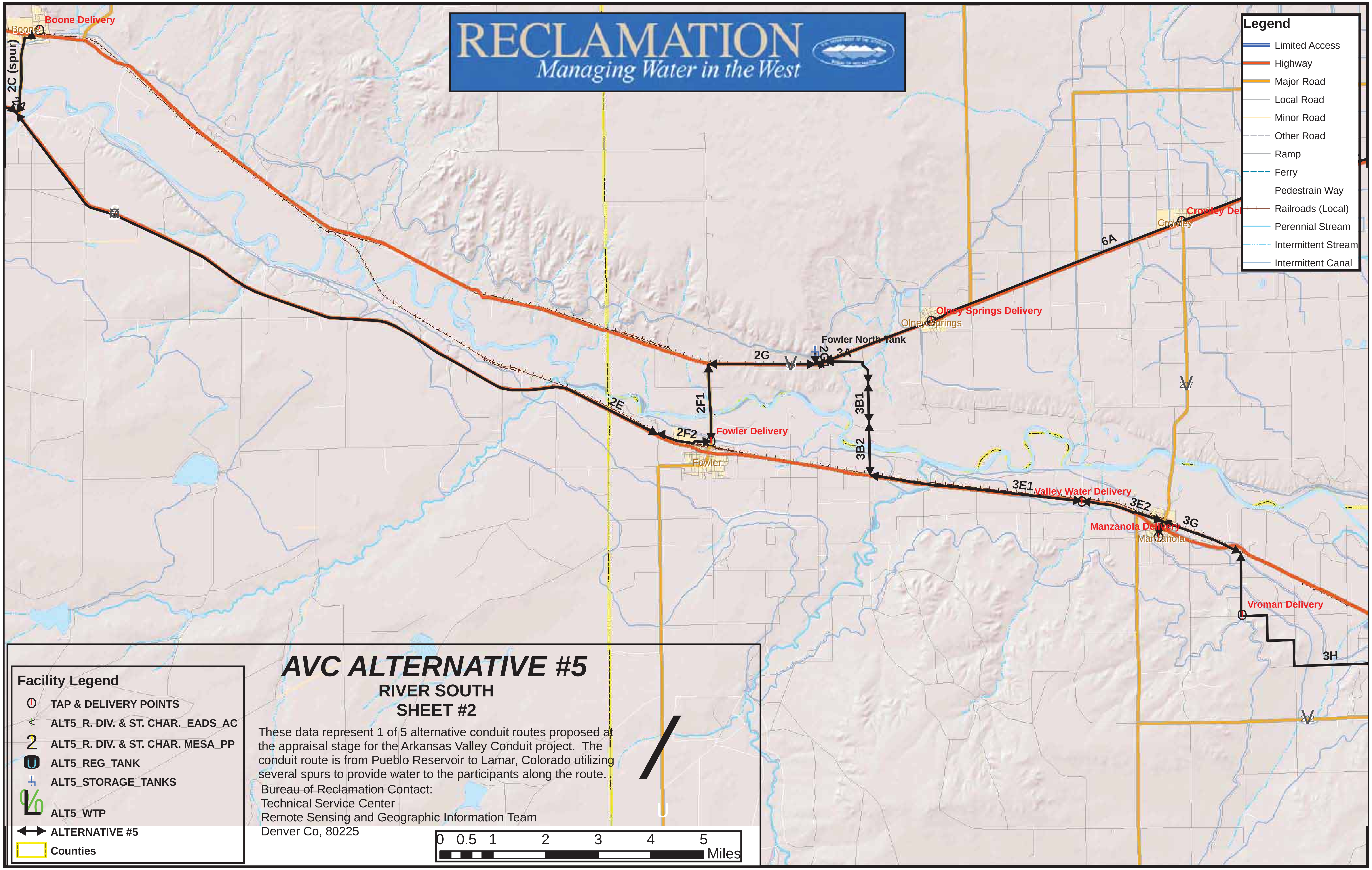

AVC ALTERNATIVE #5

RIVER SOUTH

SHEET #2

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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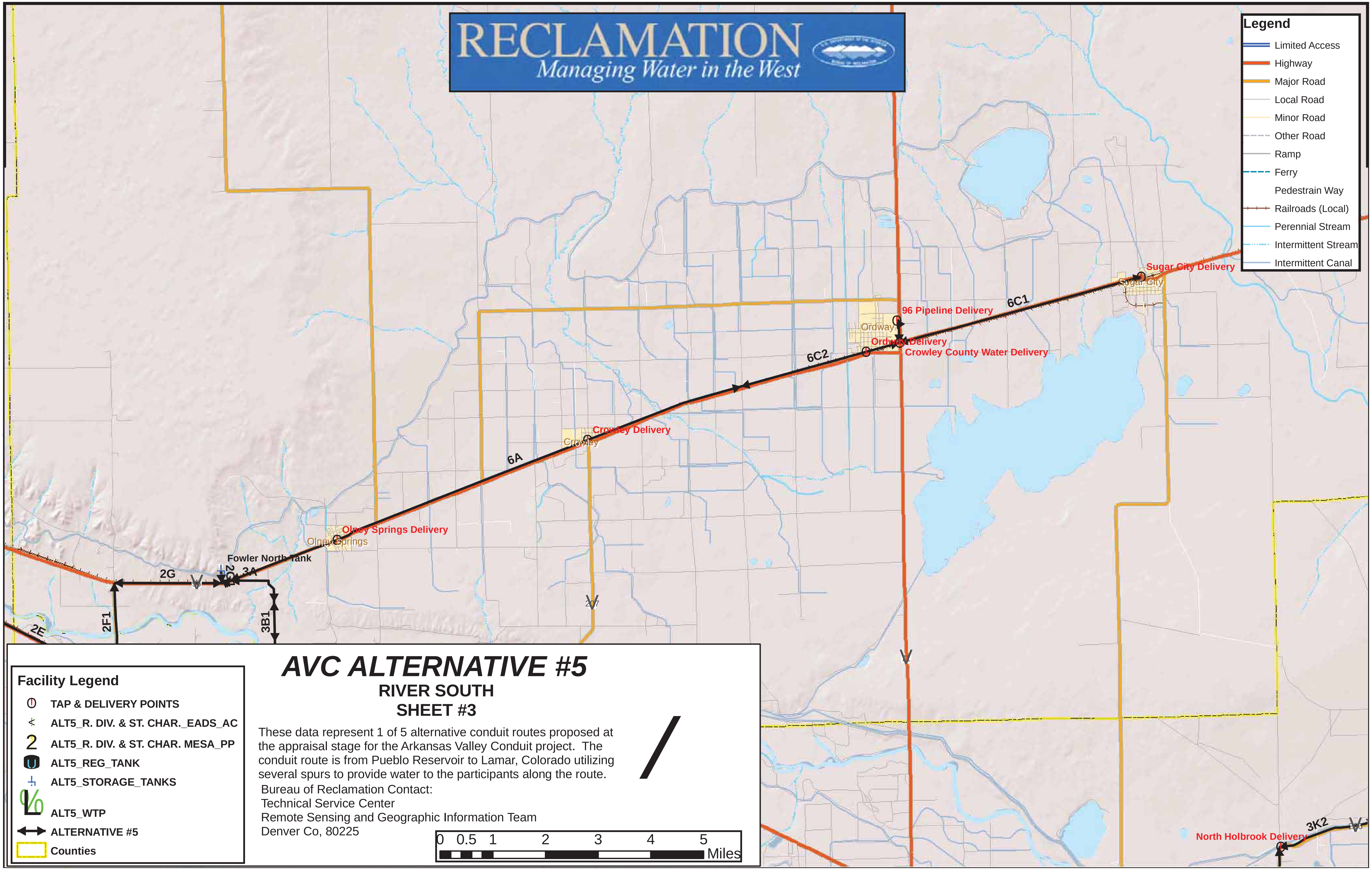

AVC ALTERNATIVE #5

RIVER SOUTH

SHEET #3

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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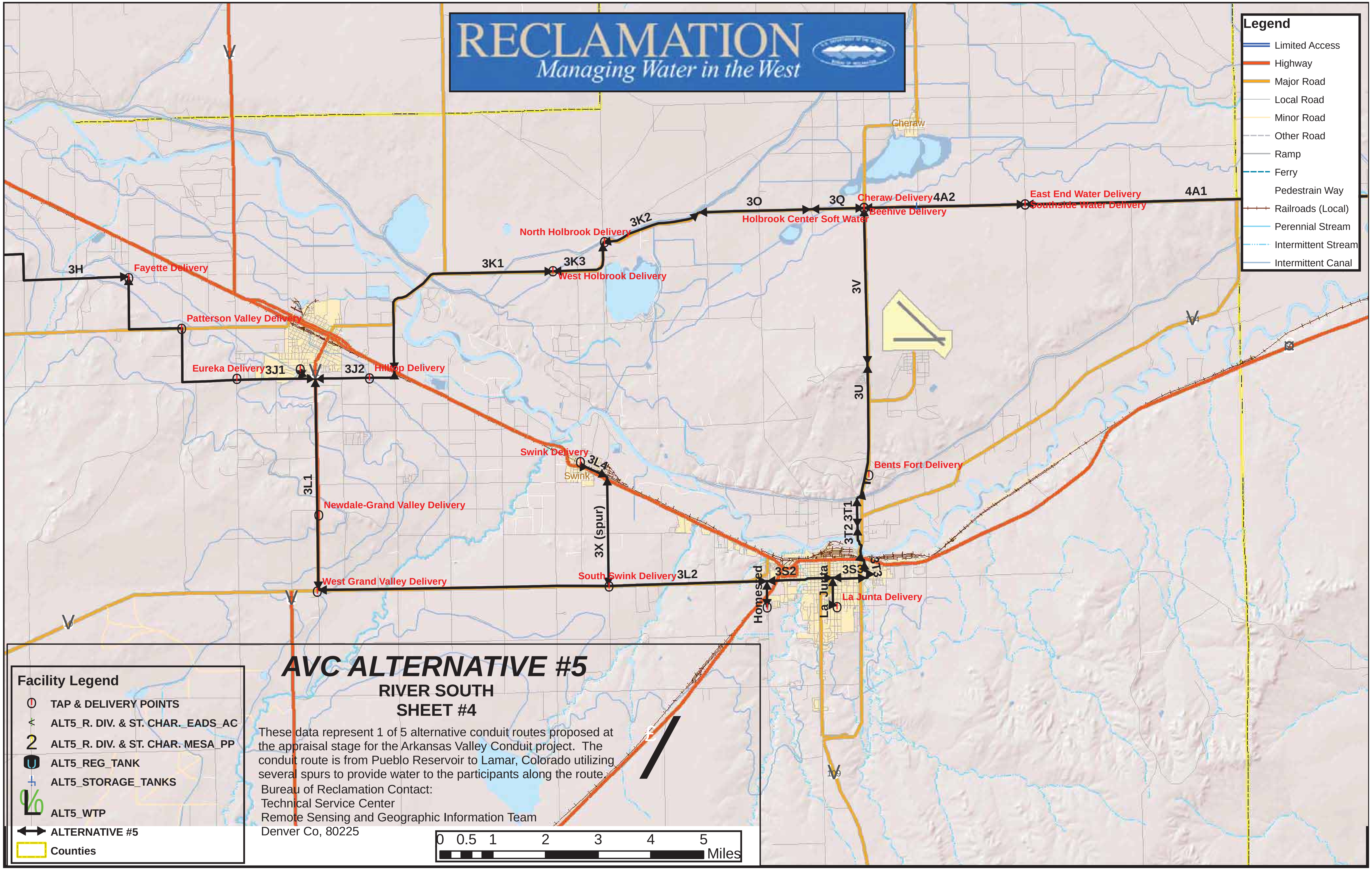
Denver Co, 80225



AVC ALTERNATIVE #5

RIVER SOUTH

SHEET #4

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

Bureau of Reclamation Contact:
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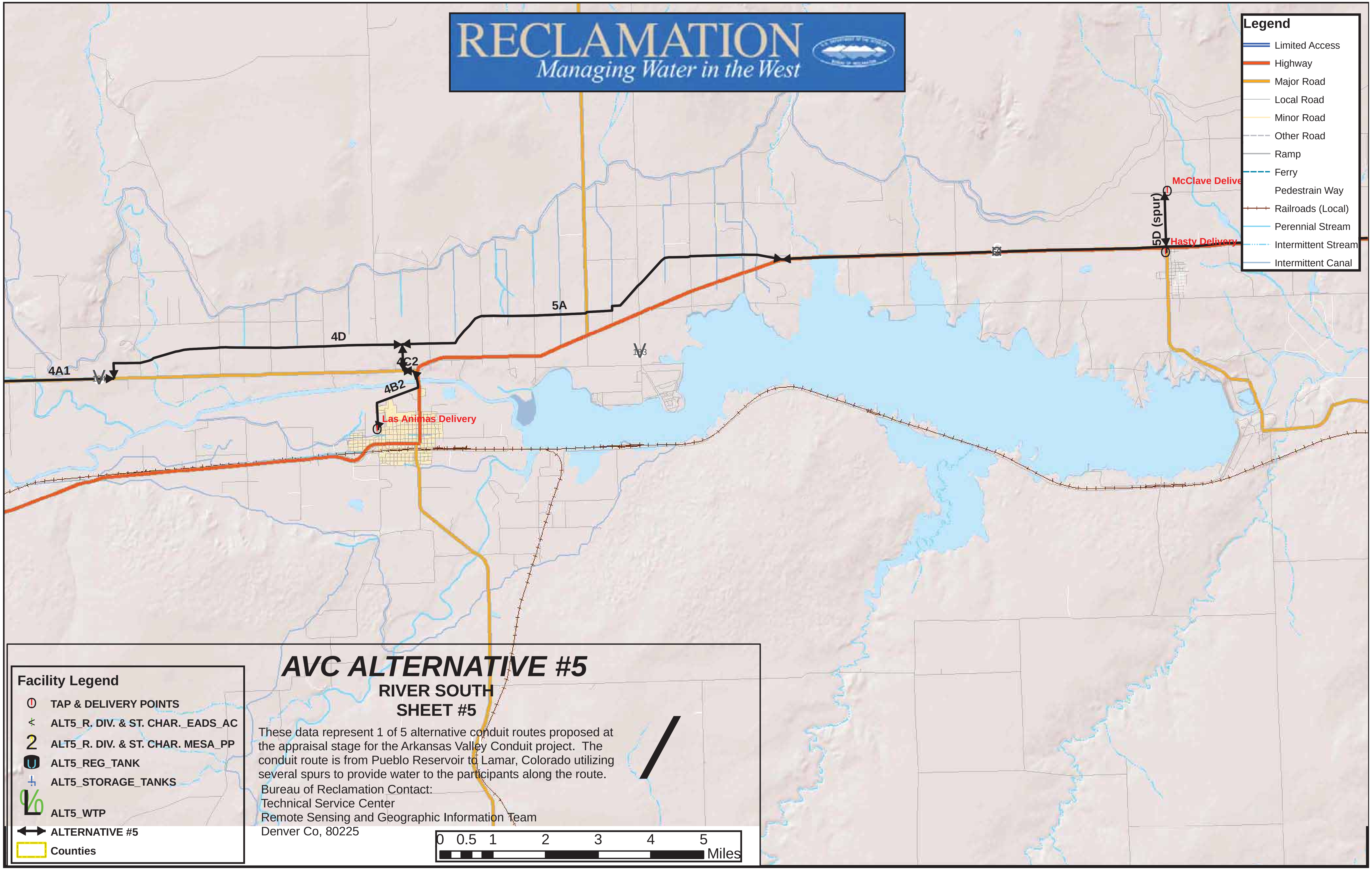

AVC ALTERNATIVE #5

RIVER SOUTH

SHEET #5

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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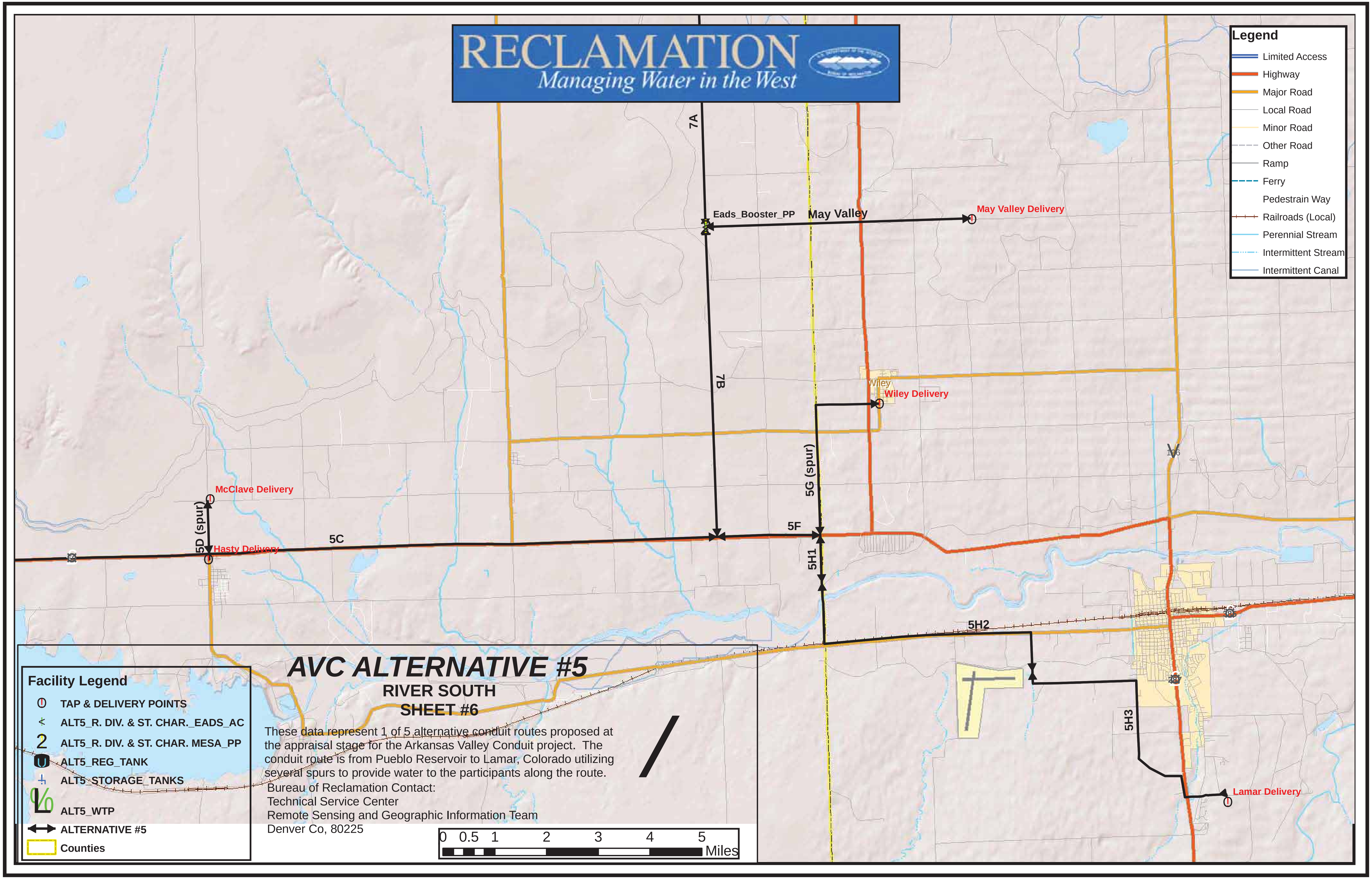

AVC ALTERNATIVE #5

RIVER SOUTH

SHEET #6

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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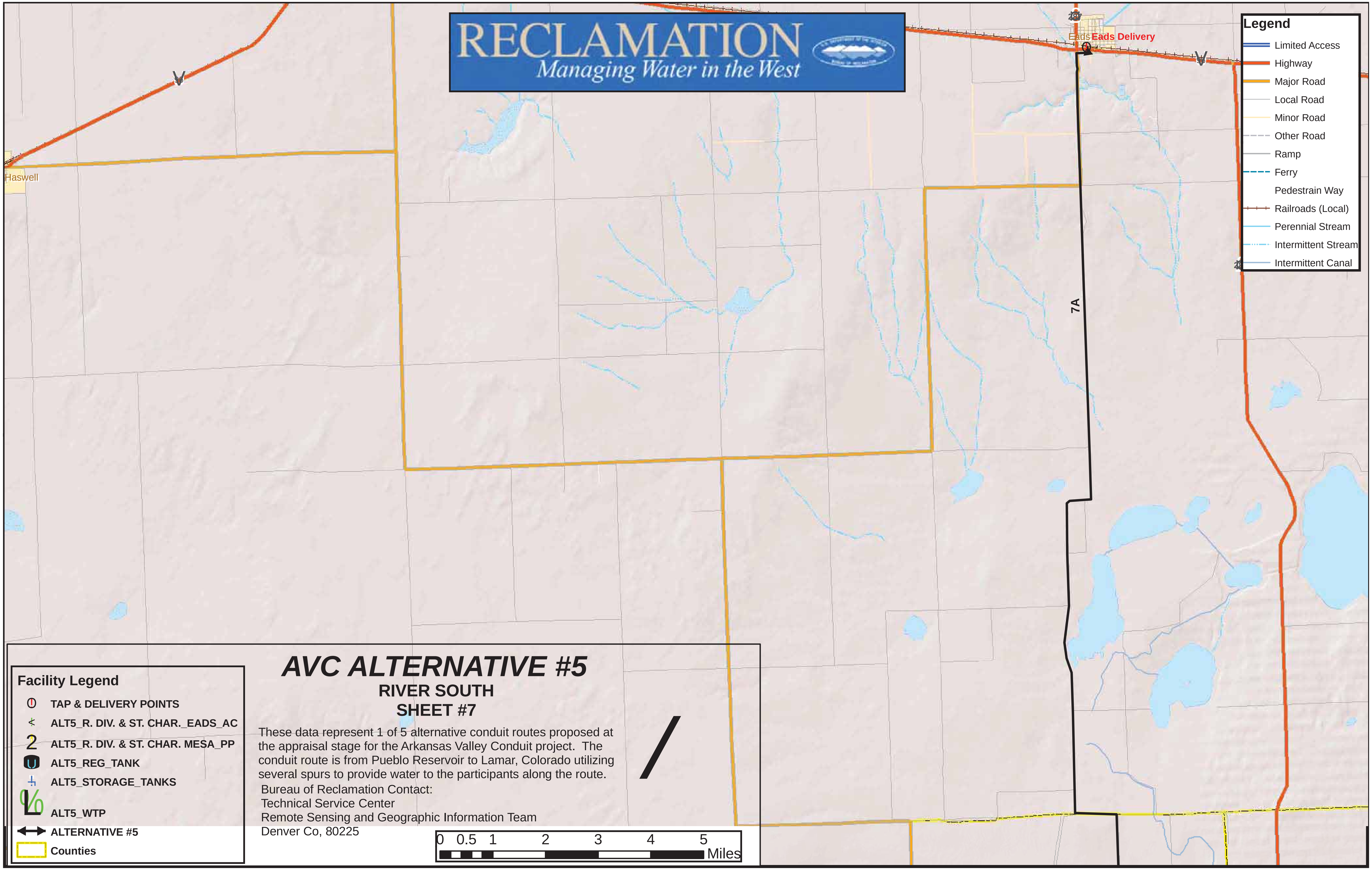
RECLAMATION
Managing Water in the West



AVC ALTERNATIVE #5

RIVER SOUTH

SHEET #7

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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Denver Co, 80225

Appendix C

Facility Photos

Photo 1 - AVC Pueblo Dam. Photo zoomed from Reclamation Field Office, looking northwest. Fish Hatchery in foreground and Fountain Valley Authority Pump Station to right. Photo by Rodney Barthel

Photo 2 - AVC SDS NOW in foreground. Photo zoomed from Pueblo Dam left abutment. Fountain Valley Authority Pump Station in center of photo, Fish Hatchery on left and center of photo, looking south. Photo by Rodney Barthel

Photo 3 - AVC view downstream along Arkansas River. Photo taken from top of Pueblo Dam, looking east. Photo by Rodney Barthel

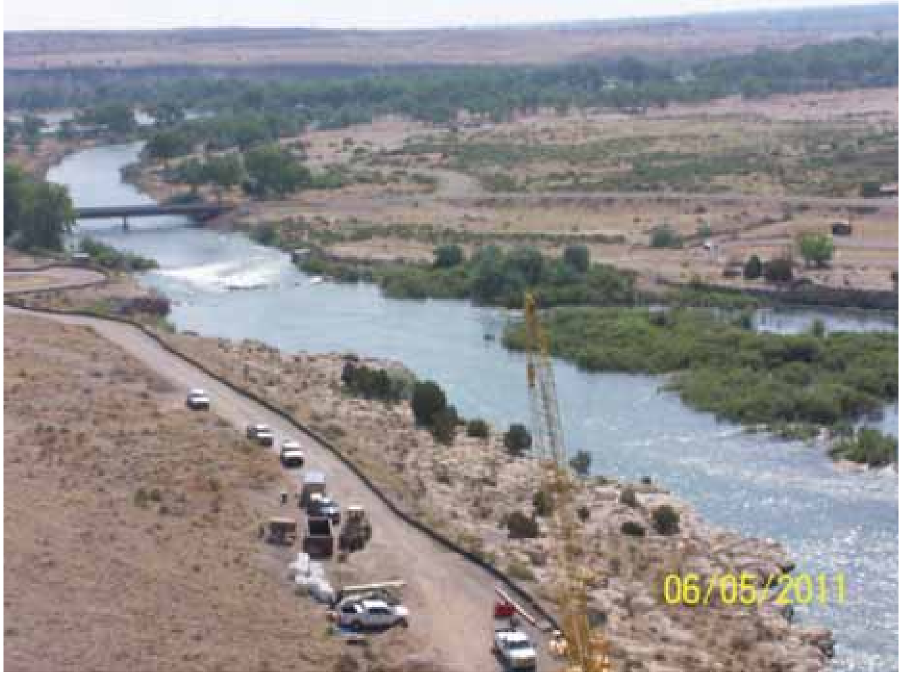


Photo 4 - AVC Pueblo Dam Outlet Works Interconnect site. Photo taken from top of Pueblo Dam, looking east. Pipeline crossing approximately 150 feet upstream of Juniper Road bridge. Photo by Rodney Barthel

Photo 5 - AVC Alt 1 Comanche Pumping Plant site & Alt 4 Pueblo Dam Pumping Plant No 1 Site. Photo taken from near existing Fountain Valley Authority Pump Station, looking south. Photo by Rodney Barthel

Photo 6 - Pueblo Dam toe Electrical Switchgear located near abutment No.7 on south side of dam. Photo by Rodney Barthel

Photo 7 - Fountain Valley Authority Pump Station. Note unit substation located in front of building. Looking east. Photo by Rodney Barthel

Photo 8 - AVC Alt 4 Pueblo Dam North WTP Site near Reclamation Field Office. Photo taken toward Pueblo Dam, looking northeast. Photo by Rodney Barthel

Photo 9 - AVC Alt 4 Pueblo Dam North WTP Site near Reclamation Field Office. Photo taken toward recreational archery range, looking south. Photo by Rodney Barthel

Photo 10 - AVC Alt 4 Pueblo Dam North WTP Site near Reclamation Field Office. Looking west. Photo by Rodney Barthel

Photo 11 - AVC Alt 4 Pueblo Dam North Pueblo Pumping Plant 2 Site near Reclamation Field Office. Photo taken toward Pueblo Dam T-Lines. Looking north. Photo by Rodney Barthel

Photo 12 - AVC Alt 4 Pueblo Dam North WTP Site near BOR Field Office toward Pueblo Dam T-Lines. Photo by Rodney Barthel

Photo 13 - AVC Alt 4 Pueblo Dam North Pueblo PP No 2 site. Photo taken from Bessemer Ditch & Hwy 96, looking north. Photo by Rodney Barthel

Photo 14 – View of Bessemer Ditch & Hwy 96 Intersection, looking east. Photo by Rodney Barthel

Photo 15 – View of Bessemer Ditch at Hwy 96, looking downstream. Looking southwest. Photo by Rodney Barthel

Photo 16 - BWWP Comanche Pump Station by Arkansas River. Photo taken looking north. Photo by Rodney Barthel

Photo 17 - Bessemer Ditch at Hwy 96 upstream, looking northeast. Photo by Rodney Barthel

Photo 18 - AVC Alt 1 Comanche South Pumping Plant regulating tank site, looking southwest. Photo taken from near Bardera Parkway (3500) and Pascadero Drive (5200) block. Photo by Rodney Barthel

Photo 19 - St. Charles Mesa Pump Station river intake site on Arkansas River, looking north. Photo by Rodney Barthel

Photo 20 - St. Charles Mesa existing Pump Station site Arkansas River, looking south. Photo by Rodney Barthel

Photo 21 - AVC Alt 5 River South/North Intake Pumping Plant Regulation Tank site along northern edge of abandoned steel mill, looking east. Photo by Rodney Barthel

Photo 22 – AVC southern routes through Pueblo, behind (north east) of steel mill site by Bessemer Ditch, looking north. Photo by Rodney Barthel

Photo 23 - AVC southern routes through Pueblo, behind (north east) of steel mill site by Bessemer Ditch, looking north. Photo by Rodney Barthel

Photo 24 - AVC Alt 3 and 4 Whitlock Regulating Tank Site, looking north, and near 14th Street and Kingston Ave. Photo by Rodney Barthel

Photo 25 - AVC Alt 3 and 4 Whitlock Regulating Tank Site, looking north northwest, and near 14th Street and Kingston Ave. Photo by Rodney Barthel

Photo 26 - AVC Alt 3 and 4 Whitlock Regulating Tank Site, looking north northeast, and near 14th Street and Kingston Ave. Photo by Rodney Barthel

Photo 27 - AVC Alt 2 Pueblo Dam South WTP Site near 21 st Street & South Road, looking north.
Photo by Rodney Barthel

Photo 28 - AVC Alt 2 Pueblo Dam South WTP Site near 21 st Street & South Road, looking south.
Photo by Rodney Barthel

Photo 29 - AVC Alt 5 River South/North St. Charles Mesa WTP & PP Site adjacent to existing WTP, looking east. Near South Road and 30th Lane. Photo by Rodney Barthel

Photo 30 - AVC Alt 1 Comanche South East St Charles Mesa WTP site and Alt 5 River South/North Regulating Tank site near 32 1/4 Lane & South Road, looking south. Comanche Power Plant can be seen in far background. Photo by Rodney Barthel

Photo 31 - AVC Alt 5 River South/North River Intake Pumping Plant site, looking west. Photo by Rodney Barthel

Photo 32 - AVC Alt 5 River South/North River Intake Pumping Plant site, looking west. Photo by Rodney Barthel

Photo 33 - AVC Alt 3 JUP North and Alt 4 Pueblo Dam North route east through Pueblo at 13th Street & 47 Hwy Crossing, looking west. Photo by Rodney Barthel

Photo 34 - AVC Alt 3 JUP North and Alt 4 Pueblo Dam North route east through Pueblo at 13th Street & 47 Hwy crossing commercial property above salvage yard, looking east. Photo by Rodney Barthel

Photo 35 - AVC Alt 3 JUP North and Alt 4 Pueblo Dam North route east through Pueblo at 13th Street & 47 Hwy Crossing, looking south. Photo by Rodney Barthel

Photo 36 - AVC South Fowler Tank site from Road JJ, looking north. Photo by Rodney Barthel

Photo 37 - AVC North Fowler Tank site on top of bluffs. Photo taken from 4968 Hwy 96, looking north. Photo by Rodney Barthel

Photo 38 - AVC South La Junta Storage Tank site. Photo taken on 3rd Ave, looking east. Photo by Rodney Barthel

Photo 39 - AVC North La Junta Storage Tank site. Photo taken along Road 31 & Road HH, looking east. Photo by Rodney Barthel

Photo 40 - AVC North La Junta Storage Tank site. Photo taken on Road 31 & Road HH, looking south. Photo by Rodney Barthel

Photo 41 - AVC North La Junta Storage Tank site. Photo taken from Road 31, looking north. Photo by Rodney Barthel

Photo 42 - AVC Central La Junta Optional Storage Tank Site alternate across airport, looking west. Photo by Rodney Barthel

Photo 43 - AVC Central La Junta Optional Storage Tank Site across Hwy 109 from airport, looking northwest. Photo by Rodney Barthel

Photo 44 - AVC Central La Junta Optional Storage Tank Site, looking east across Hwy 109 at airport. Photo by Rodney Barthel

Photo 45 - AVC Eads Pump Plant site near Rd 34 & Road SS, looking north northwest. Photo by Rodney Barthel

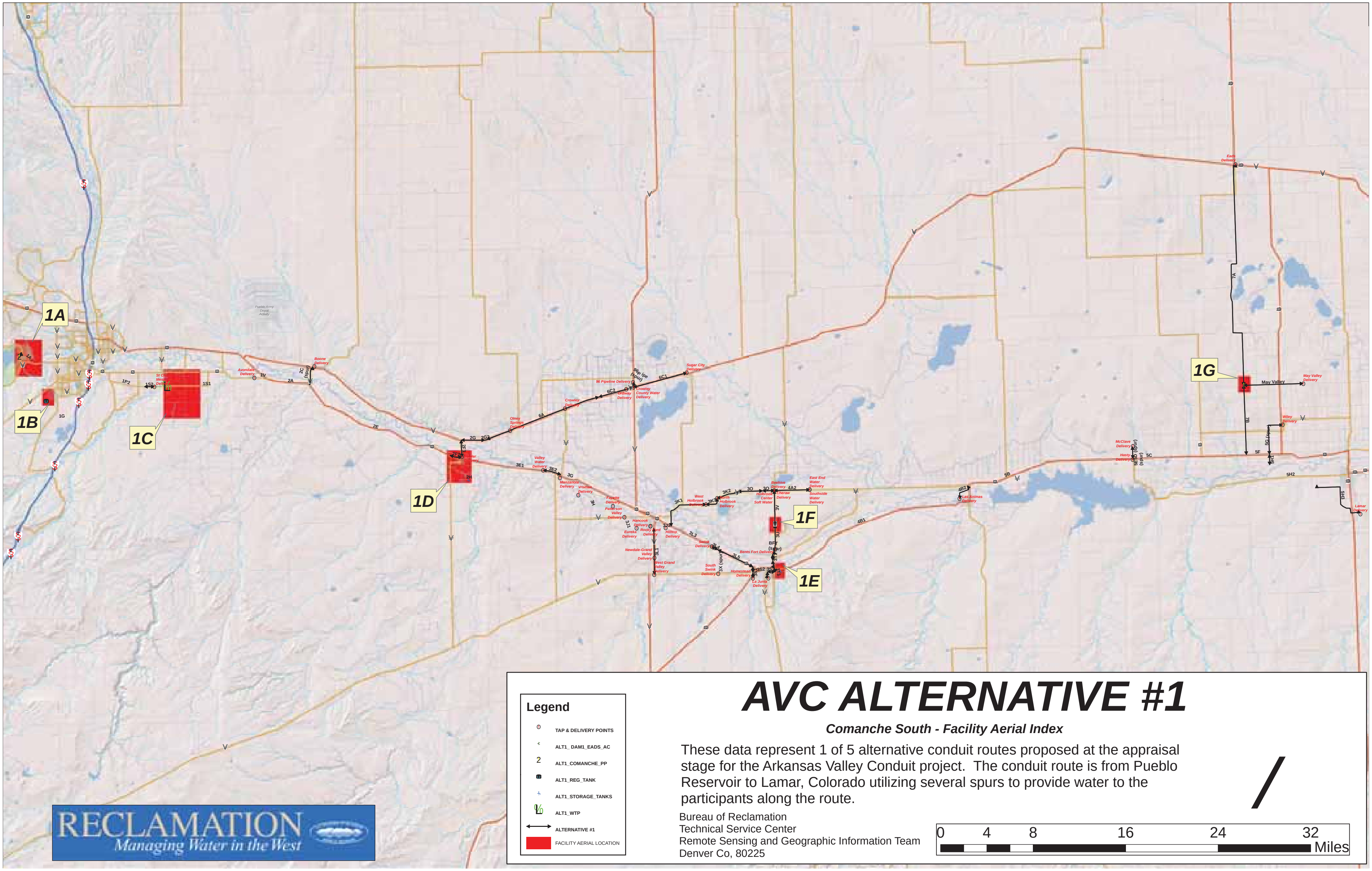
Photo 46 - AVC Eads Pump Plant site near Rd 34 & Road SS, looking north. Photo by Rodney Barthel

Appendix D

Facility Aerials

Contents – Appendix D – Facility Aerials

Contents – Appendix D – Facility Aerials



AVC ALTERNATIVE #1

Comanche South - Facility Aerial Index

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Denver Co, 80225

Legend

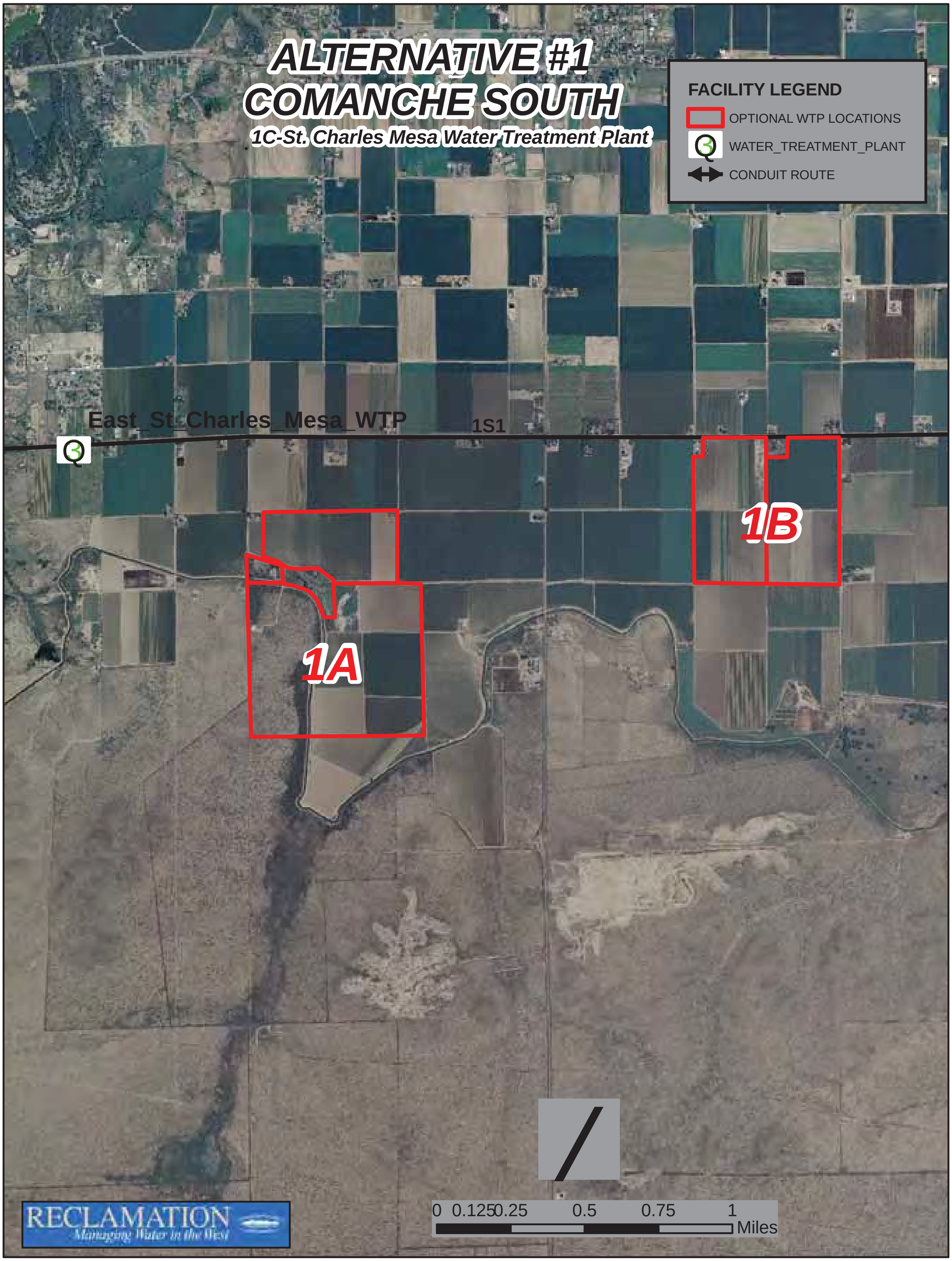
- ⊙ TAP & DELIVERY POINTS
- ALT1_DAM1_EADS_AC
- ALT1_COMANCHE_PP
- ALT1_REG_TANK
- ALT1_STORAGE_TANKS
- ALT1_WTP
- ⟷ ALTERNATIVE #1
- 🟥 FACILITY AERIAL LOCATION

0 4 8 16 24 32
Miles

RECLAMATION
Managing Water in the West

ALTERNATIVE #1
COMANCHE SOUTH
1A-Dam Outlet, Comanche Pumping Plant and Air Chamber
FACILITY LEGEND
AIR_CHAMBER
PUMPING _PLANT
CONDUIT ROUTE
INTERCONNECT
Comanche PP
1A
1G
RECLAMATION
Managing Water in the West
0
0.125
0.25
0.5
0.75
1
Miles


ALTERNATIVE #1
COMANCHE SOUTH
1B-Comanche Regulating Tank
FACILITY LEGEND
REGULATION_TANK
CONDUIT ROUTE
1G
0
0.05
0.1
0.2
0.3
0.4
0.5
Miles
RECLAMATION
Managing Water in the West



ALTERNATIVE #1
COMANCHE SOUTH
1C-St. Charles Mesa Water Treatment Plant

ALTERNATIVE #1
COMANCHE SOUTH

1D-Fowler South Water Storage Tank

ALTERNATIVE #1

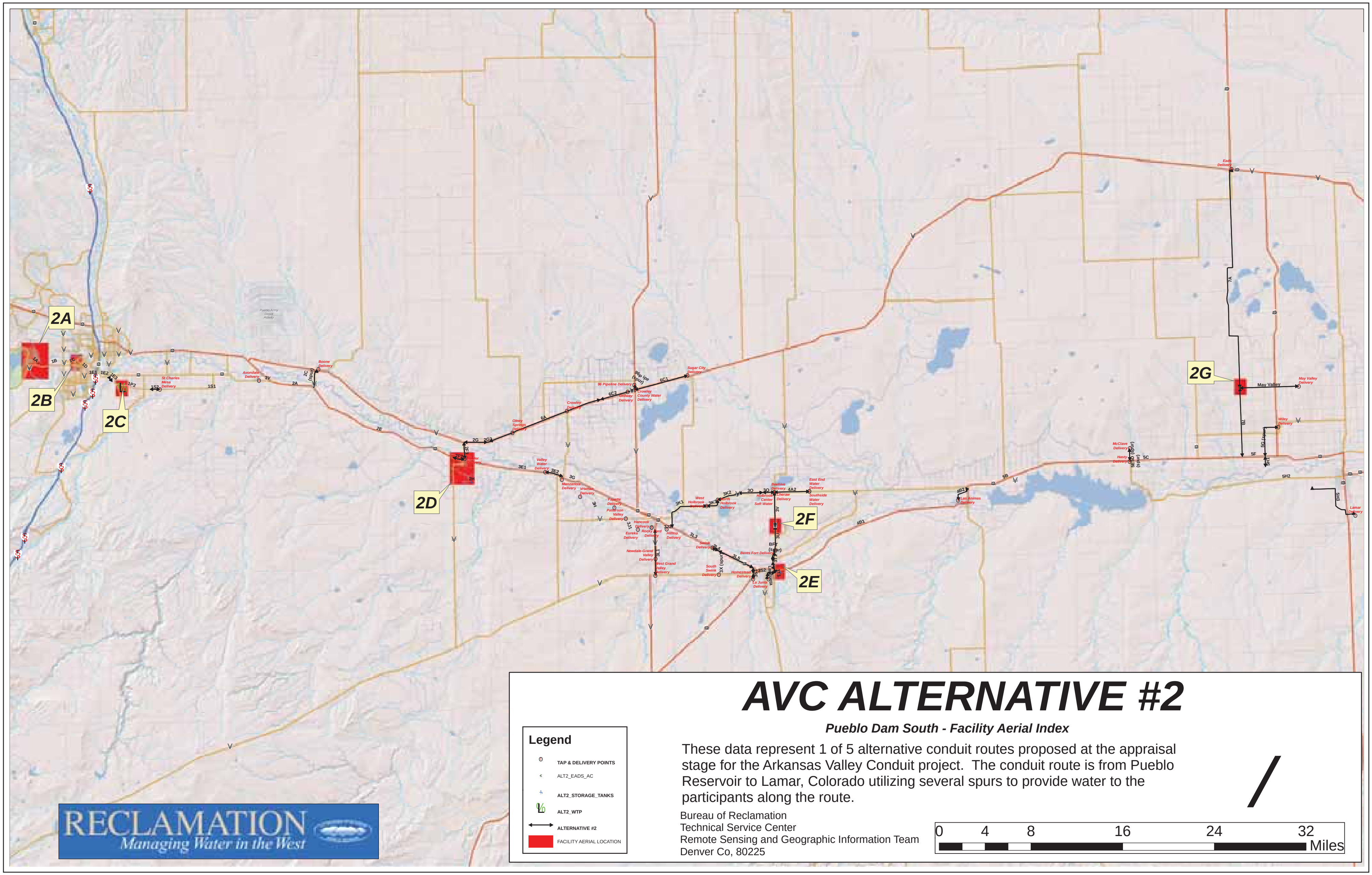
COMANCHE SOUTH

1E-La Junta South Water Storage Tank


ALTERNATIVE #1
COMANCHE SOUTH
1F-La Junta Central Optional Water Storage Tank
FACILITY LEGEND
STORAGE_TANKS
CONDUIT ROUTE
109
3U
0
0.045
0.09
0.18
0.27
0.36
0.45
Miles
RECLAMATION
Managing Water in the West

ALTERNATIVE #1
COMANCHE SOUTH

1G-Eads Booster Pumping Plant and Air Chamber



AVC ALTERNATIVE #2

Pueblo Dam South - Facility Aerial Index

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Bureau of Reclamation
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Denver Co, 80225

Legend

- TAP & DELIVERY POINTS
- ALT2_EADS_AC
- ALT2_STORAGE_TANKS
- ALT2_WTP
- ALTERNATIVE #2
- 🟥 FACILITY AERIAL LOCATION

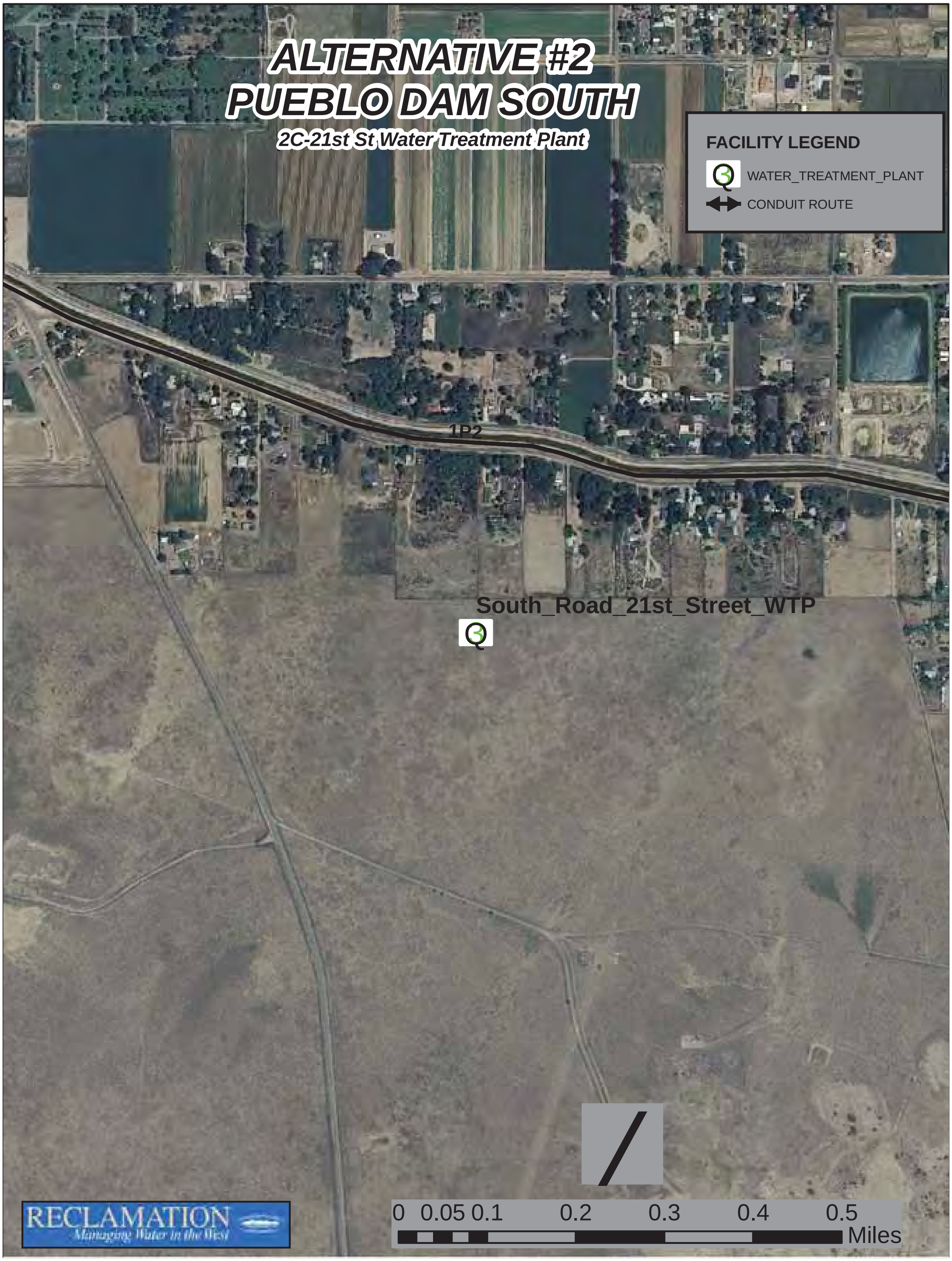
0 4 8 16 24 32 Miles

RECLAMATION
Managing Water in the West

ALTERNATIVE #2
PUEBLO DAM SOUTH
2A-Dam Outlet

ALTERNATIVE #2
PUEBLO DAM SOUTH

2B-Typical Bessemer Route Through Pueblo


ALTERNATIVE #2
PUEBLO DAM SOUTH
2C-21st St Water Treatment Plant
FACILITY LEGEND
WATER_TREATMENT_PLANT
CONDUIT ROUTE
1P2
South_Road_21st_Street_WTP
0 0.05 0.1 0.2 0.3 0.4 0.5
Miles
RECLAMATION
Managing Water in the West

ALTERNATIVE #2
PUEBLO DAM SOUTH
2D-Fowler South Water Storage Tank

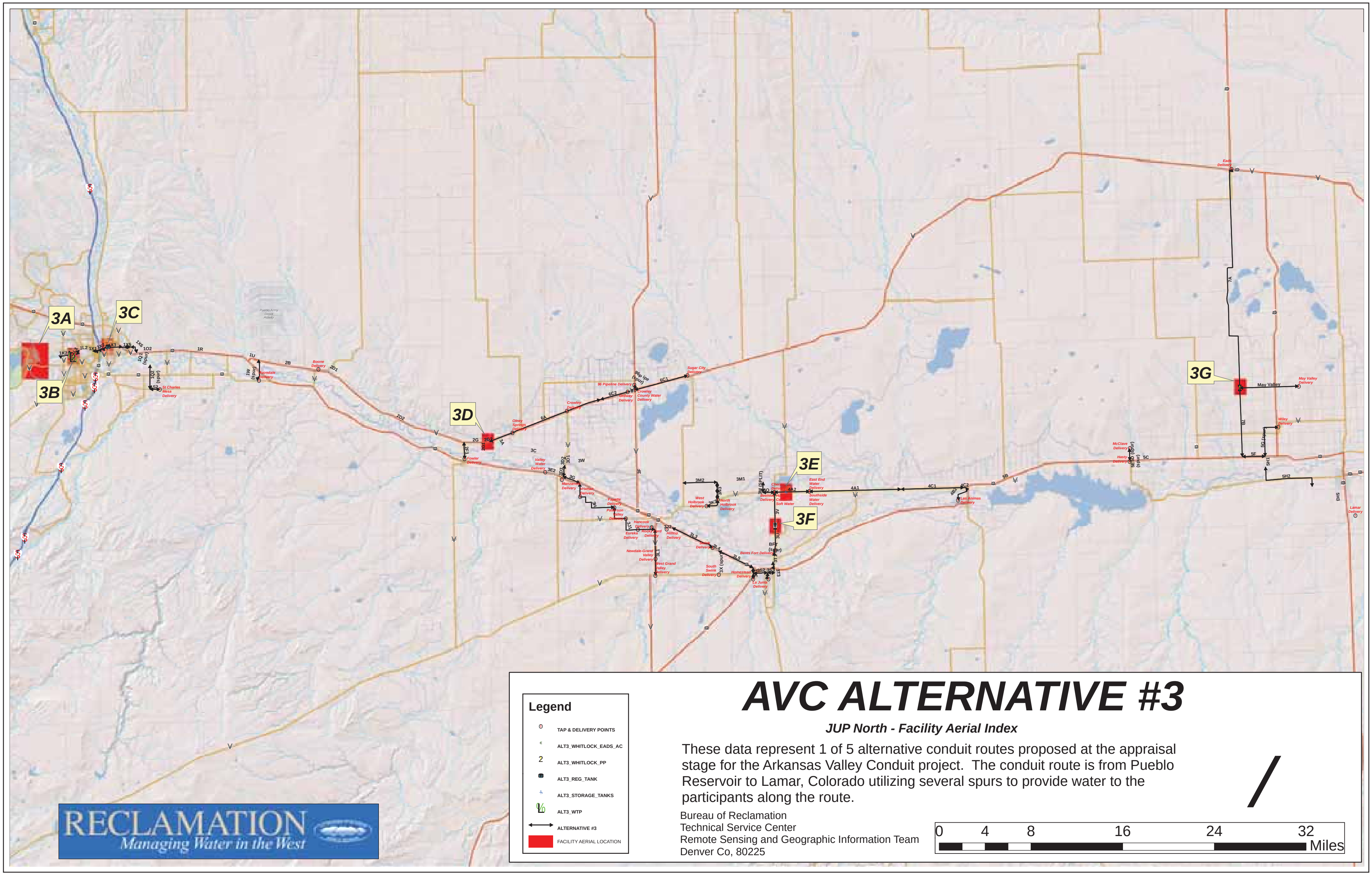
ALTERNATIVE #2
PUEBLO DAM SOUTH
2E-La Junta South Water Storage Tank

ALTERNATIVE #2
PUEBLO DAM SOUTH

2F-La Junta Central Optional Water Storage Tank

ALTERNATIVE #2
PUEBLO DAM SOUTH

2G-Eads Booster Pumping Plant and Air Chamber



AVC ALTERNATIVE #3

JUP North - Facility Aerial Index

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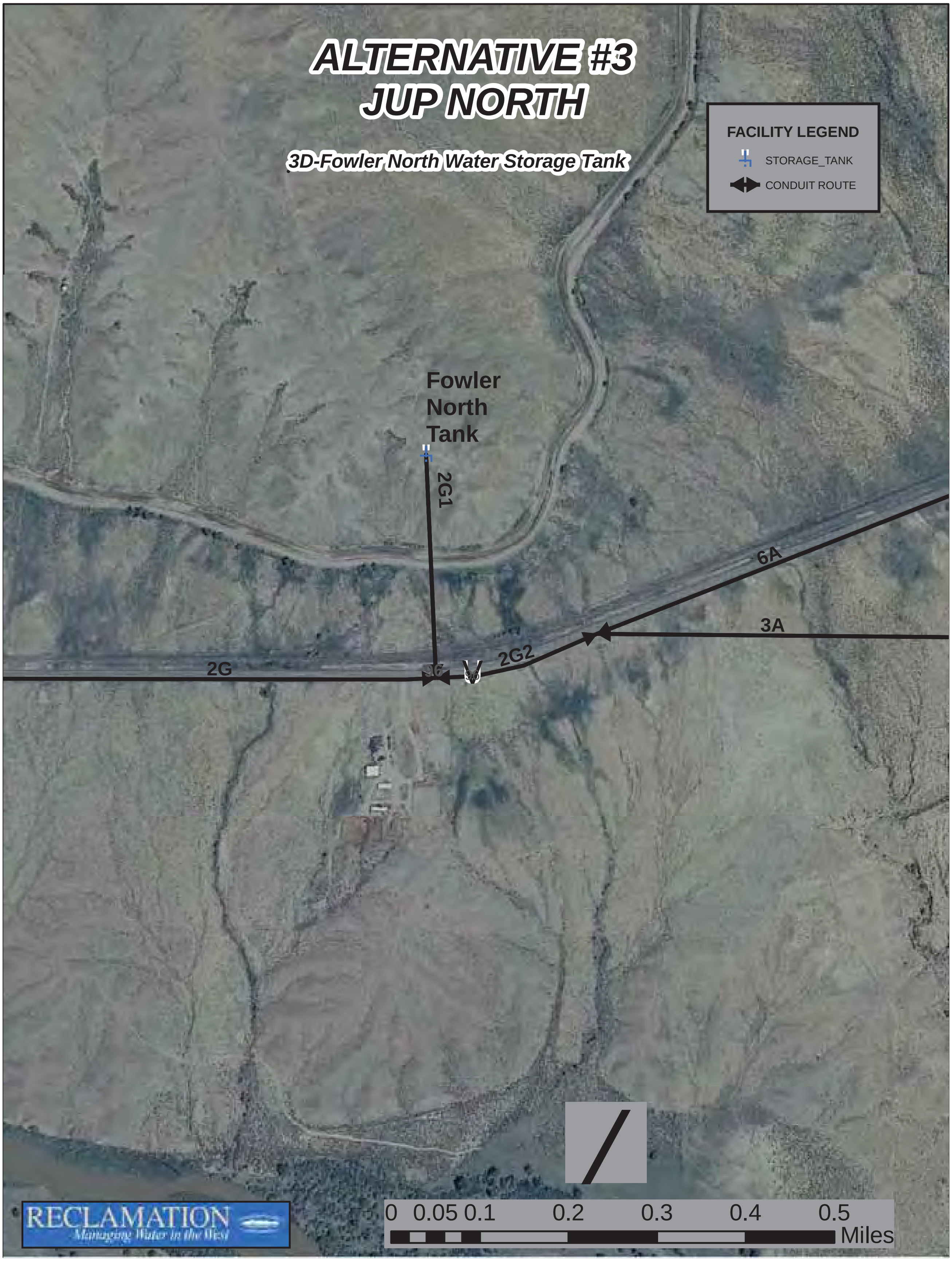
RECLAMATION
Managing Water in the West

ALTERNATIVE #3
JUP NORTH
3A-Dam Outlet and Existing JUP

ALTERNATIVE #3
JUP NORTH
3B-Whitlock Water Treatment Plant, Pumping Plant and Air Chamber

ALTERNATIVE #3
JUP NORTH

3C-Whitlock Regulating Tank



ALTERNATIVE #3
JUP NORTH

3D-Fowler North Water Storage Tank

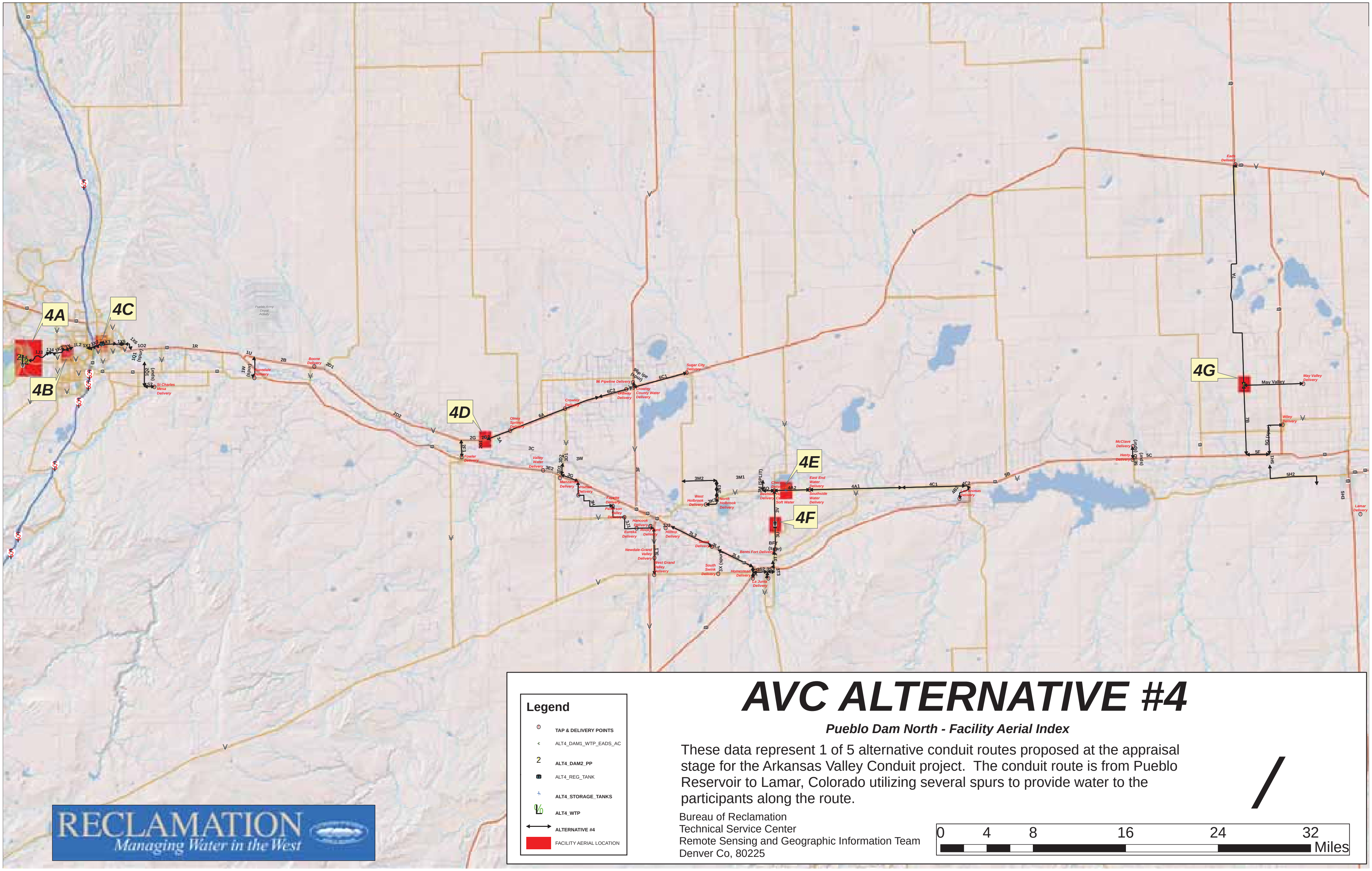
ALTERNATIVE #3
JUP NORTH

3E-La Junta North Water Storage Tank

ALTERNATIVE #3
JUP NORTH
3F-La Junta Central Optional Water Storage Tank

ALTERNATIVE #3
JUP NORTH

3G-Eads Booster Pumping Plant and Air Chamber



AVC ALTERNATIVE #4

Pueblo Dam North - Facility Aerial Index

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Bureau of Reclamation
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Denver Co, 80225

Legend

- ○ TAP & DELIVERY POINTS
- < ALT4_DAM1_WTP_EADS_AC
- 2 ALT4_DAM2_PP
- ● ALT4_REG_TANK
- ALT4_STORAGE_TANKS
- ALT4_WTP
- ↔ ALTERNATIVE #4
- 🟥 FACILITY AERIAL LOCATION

RECLAMATION
Managing Water in the West

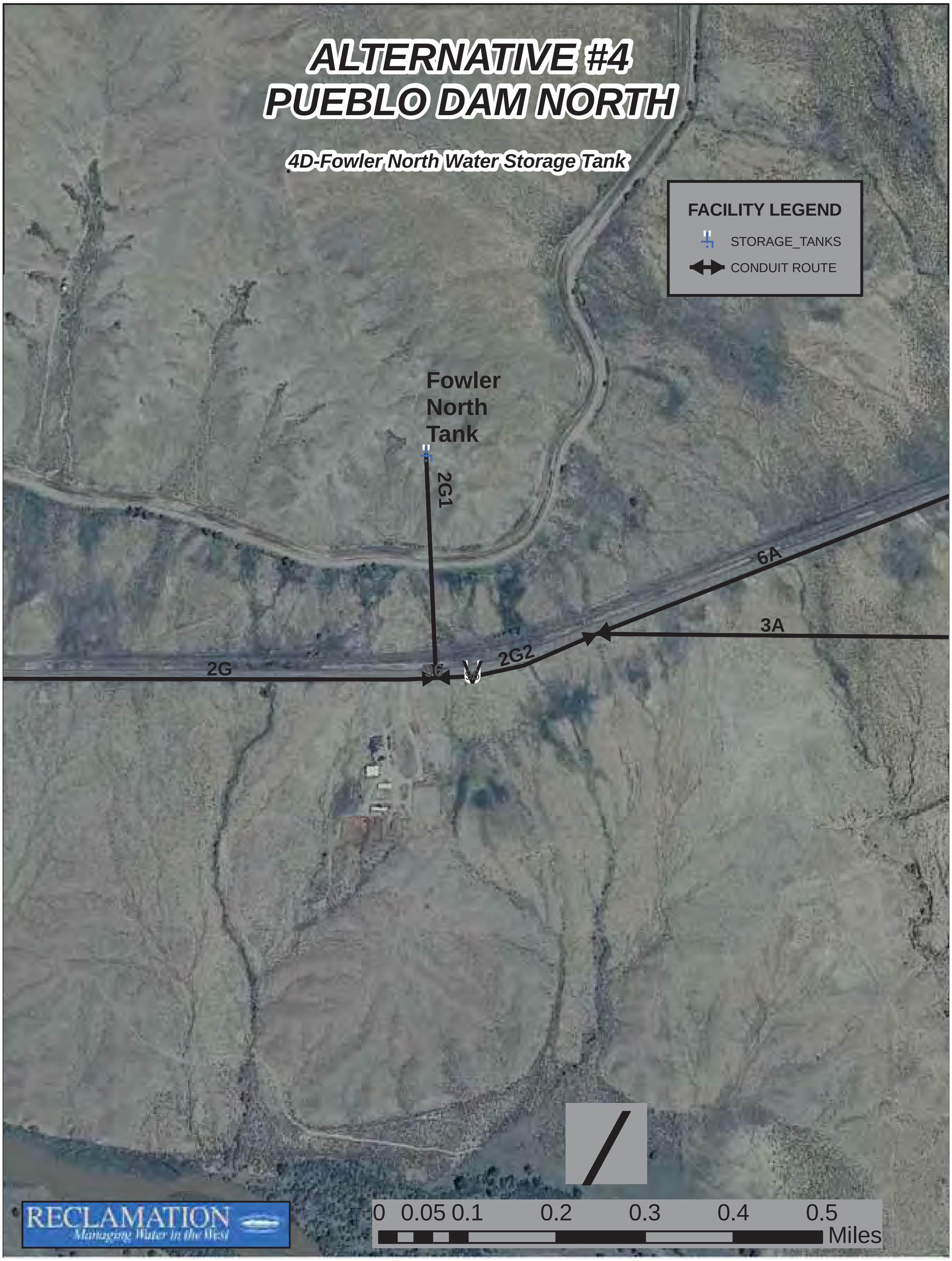
ALTERNATIVE #4
PUEBLO DAM NORTH

4A-Dam Outlet & P.Plant/WTP Clearwell P. Plant/Air Chamber/JUP


ALTERNATIVE #4
PUEBLO DAM NORTH
4B-AVC Whitlock WTP Bypass
1L2
1Y
1K2
FACILITY LEGEND
CONDUIT ROUTE
BESSEMER DITCH
0
0.05
0.1
0.2
0.3
0.4
0.5
Miles
RECLAMATION
Managing Water in the West

ALTERNATIVE #4
PUEBLO DAM NORTH

4C-Whitlock Regulating Tank



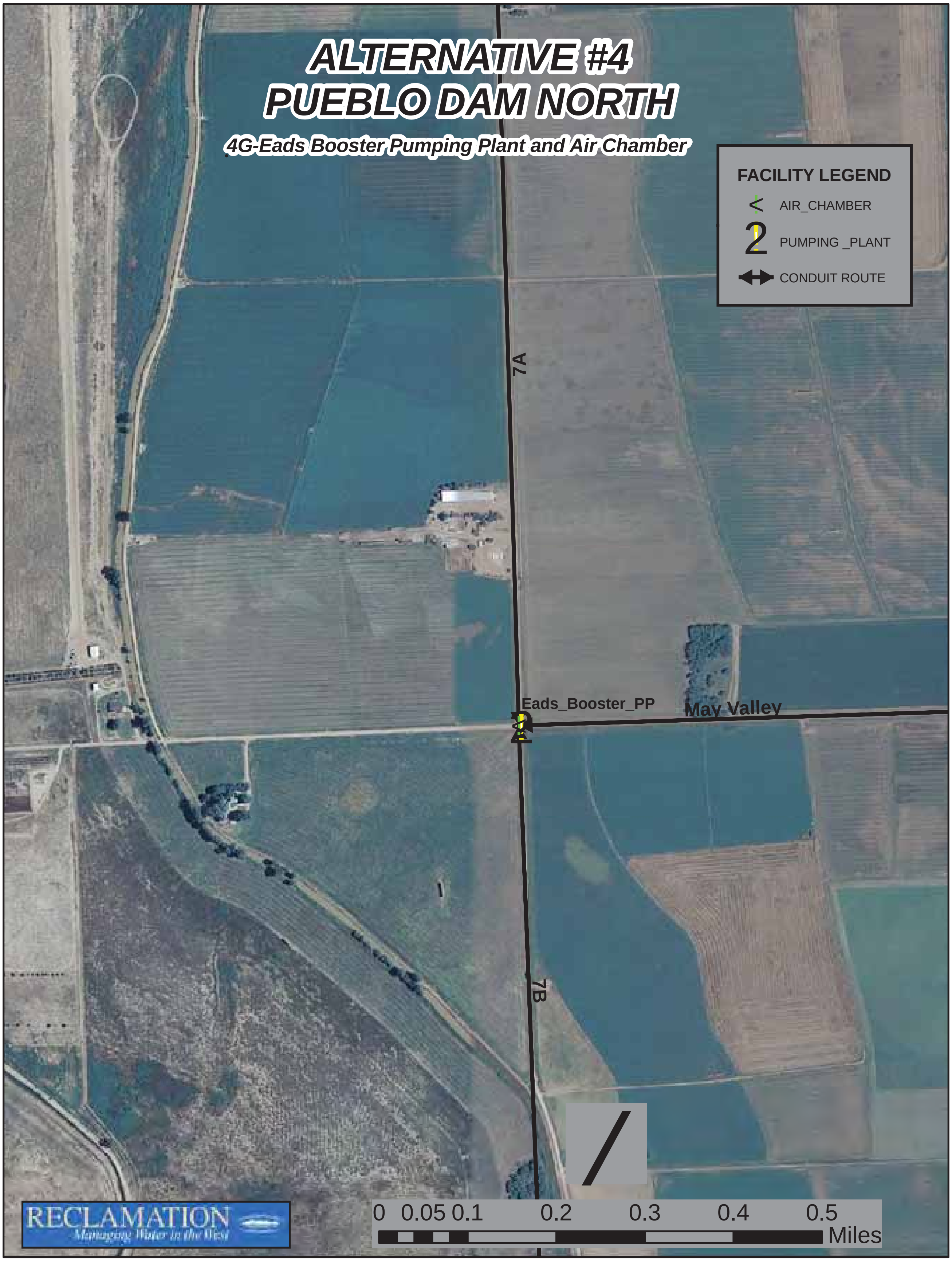
ALTERNATIVE #4
PUEBLO DAM NORTH

4D-Fowler North Water Storage Tank

ALTERNATIVE #4
PUEBLO DAM NORTH

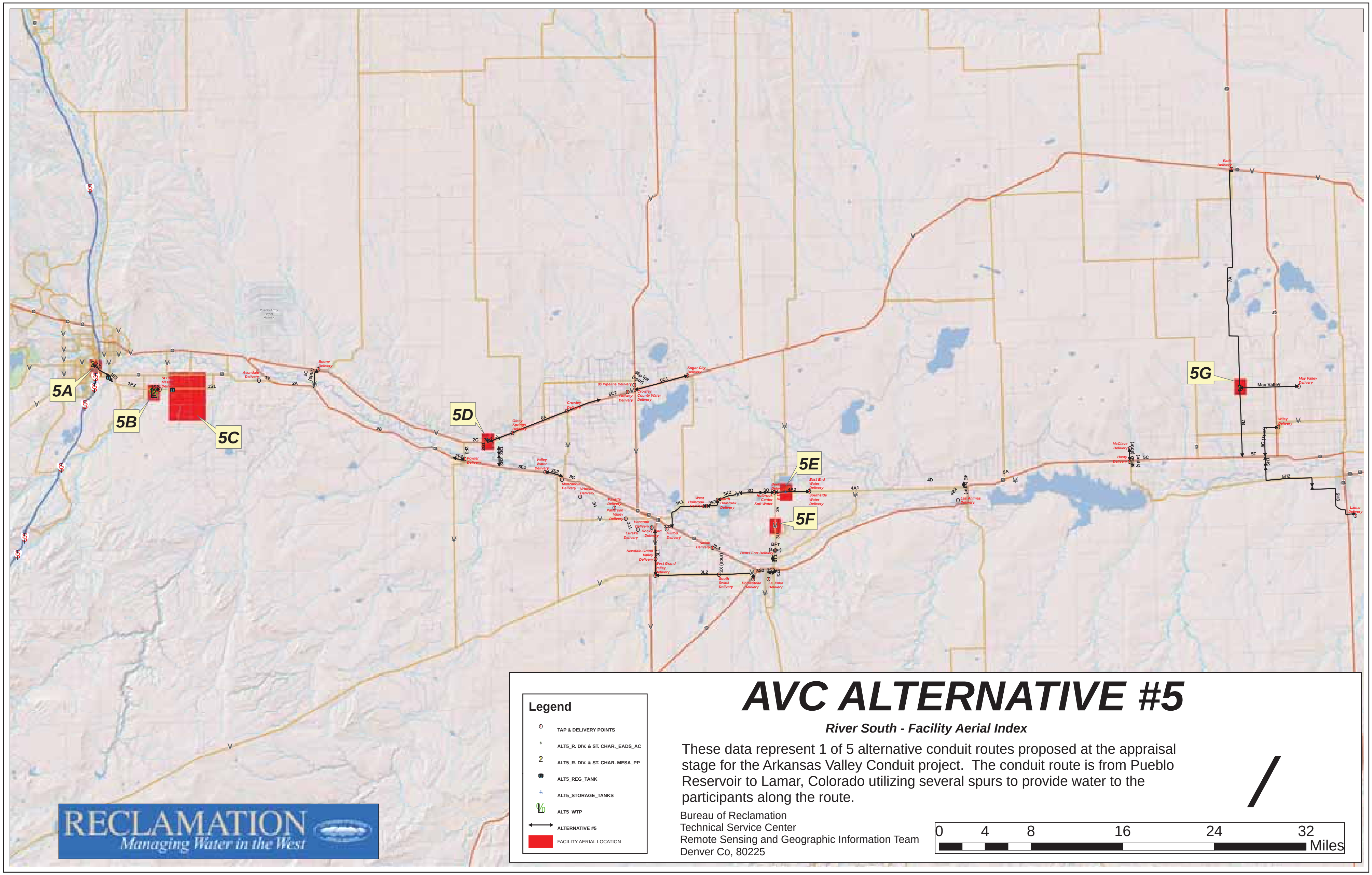
4E-La Junta North Water Storage Tank

ALTERNATIVE #4
PUEBLO DAM NORTH
4F-La Junta Central Optional Water Storage Tank



ALTERNATIVE #4
PUEBLO DAM NORTH

4G-Eads Booster Pumping Plant and Air Chamber



AVC ALTERNATIVE #5

River South - Facility Aerial Index

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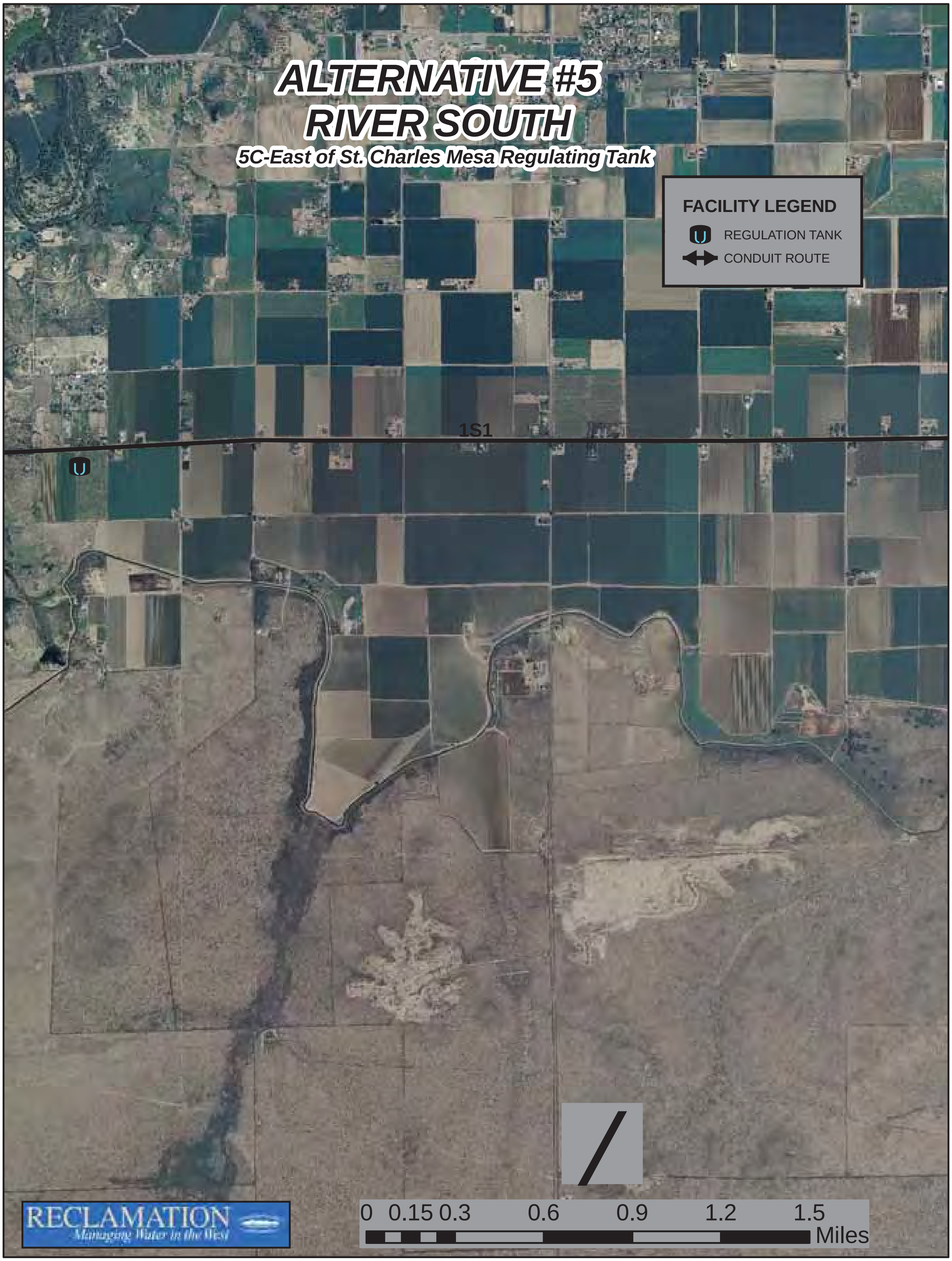
RECLAMATION
Managing Water in the West

ALTERNATIVE #5
RIVER SOUTH
5A-River Intake Pumping Plant

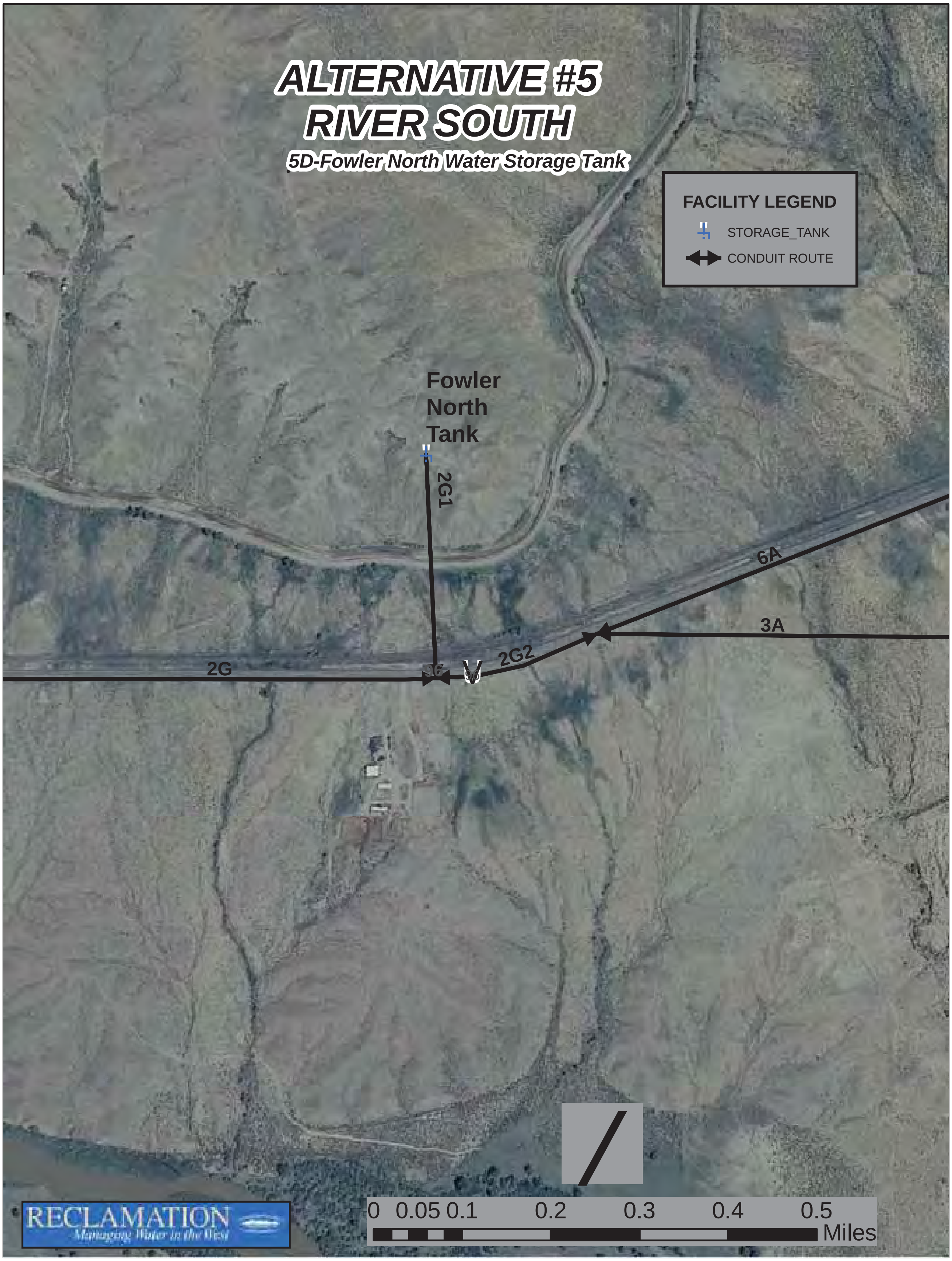
ALTERNATIVE #5
RIVER SOUTH

5B-AVC St. Charles Mesa WTP/Clearwell P. Plant and Air Chamber



ALTERNATIVE #5
RIVER SOUTH

5C-East of St. Charles Mesa Regulating Tank



ALTERNATIVE #5
RIVER SOUTH

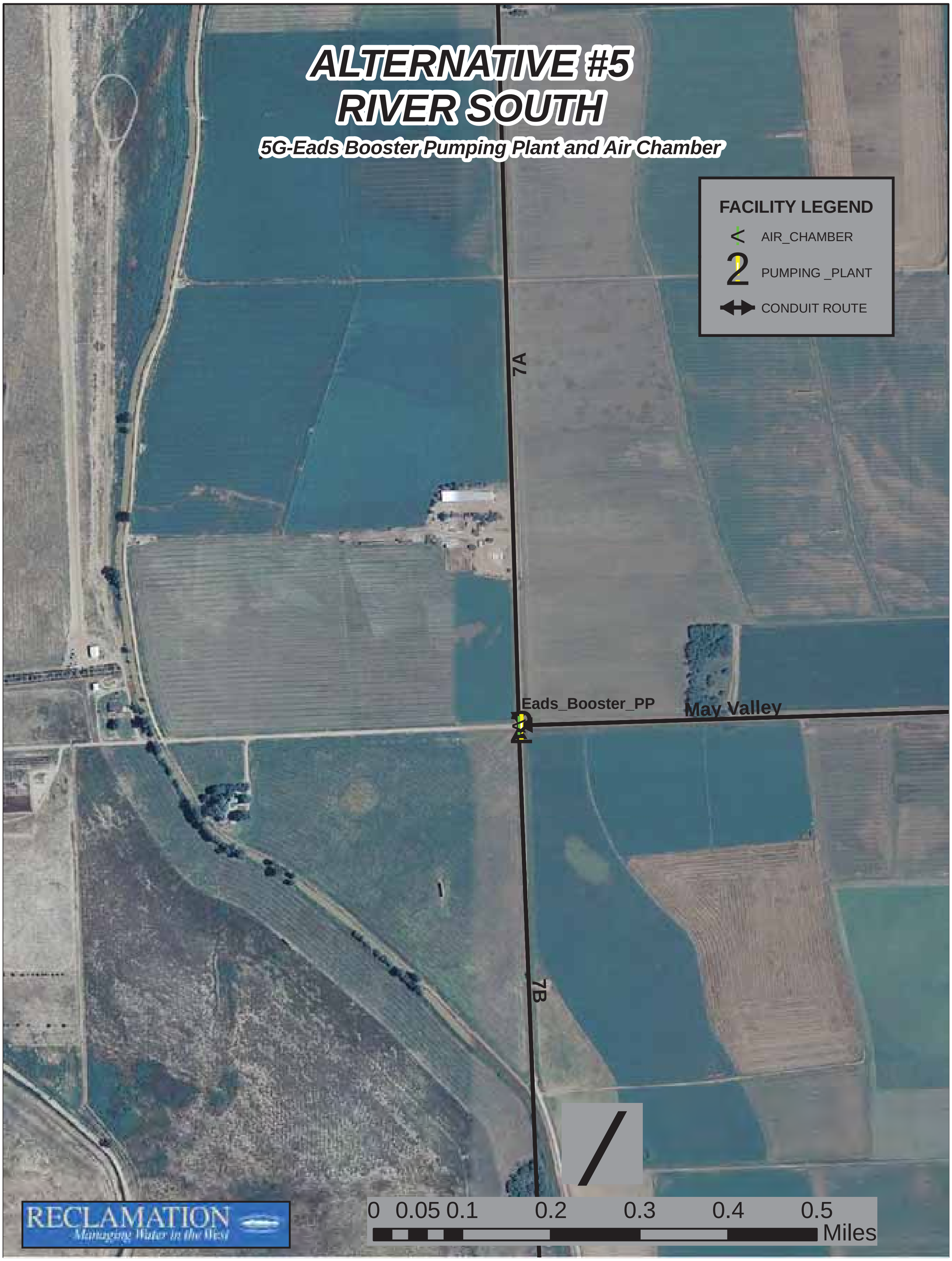
5D-Fowler North Water Storage Tank

ALTERNATIVE #5
RIVER SOUTH

5E-La Junta North Water Storage Tank

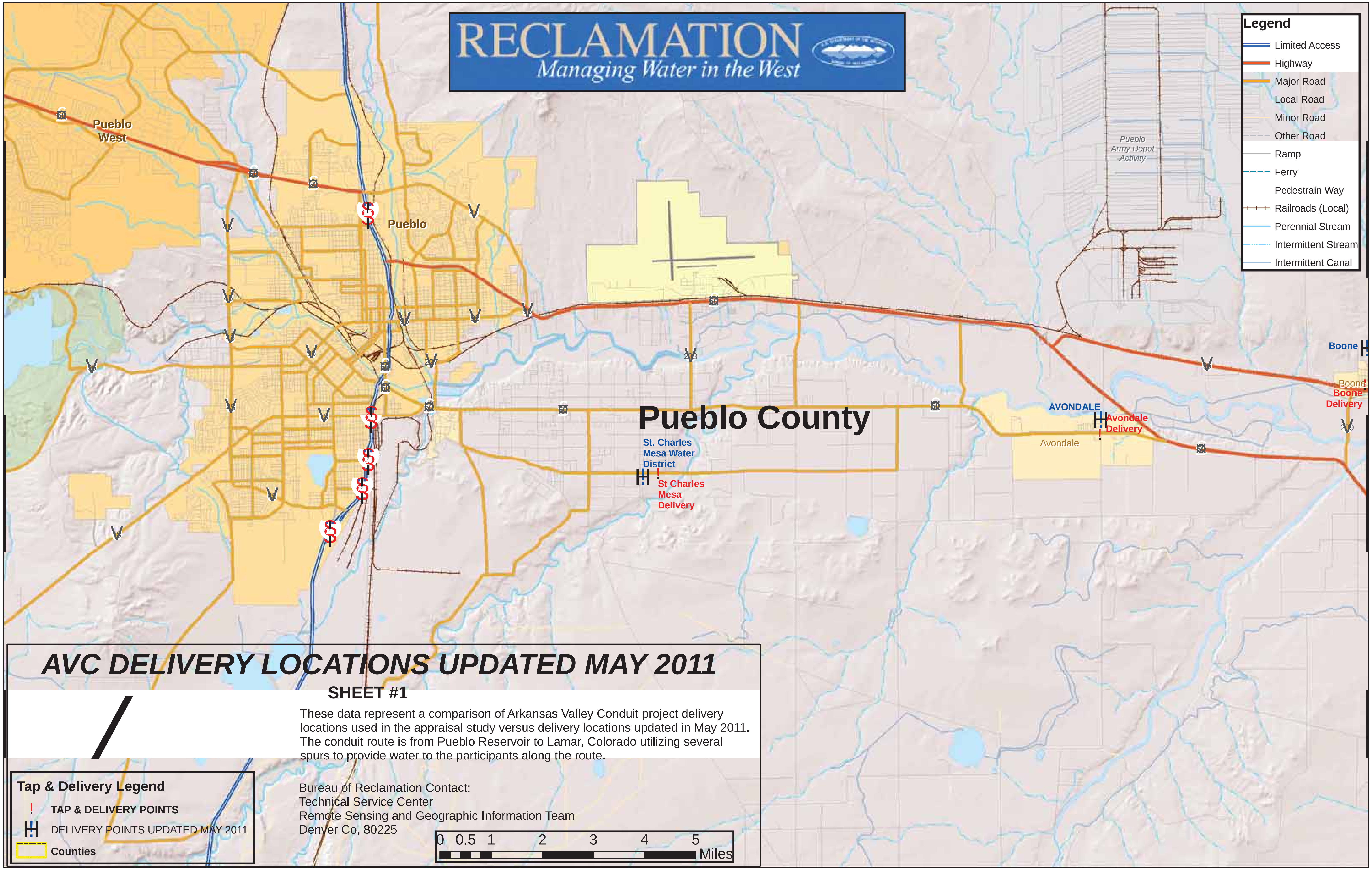
ALTERNATIVE #5
RIVER SOUTH
5F-La Junta Central Optional Water Storage Tank

ALTERNATIVE #5
RIVER SOUTH
5G-Eads Booster Pumping Plant and Air Chamber



Appendix E

Delivery Locations



AVC DELIVERY LOCATIONS UPDATED MAY 2011

SHEET #1

These data represent a comparison of Arkansas Valley Conduit project delivery locations used in the appraisal study versus delivery locations updated in May 2011. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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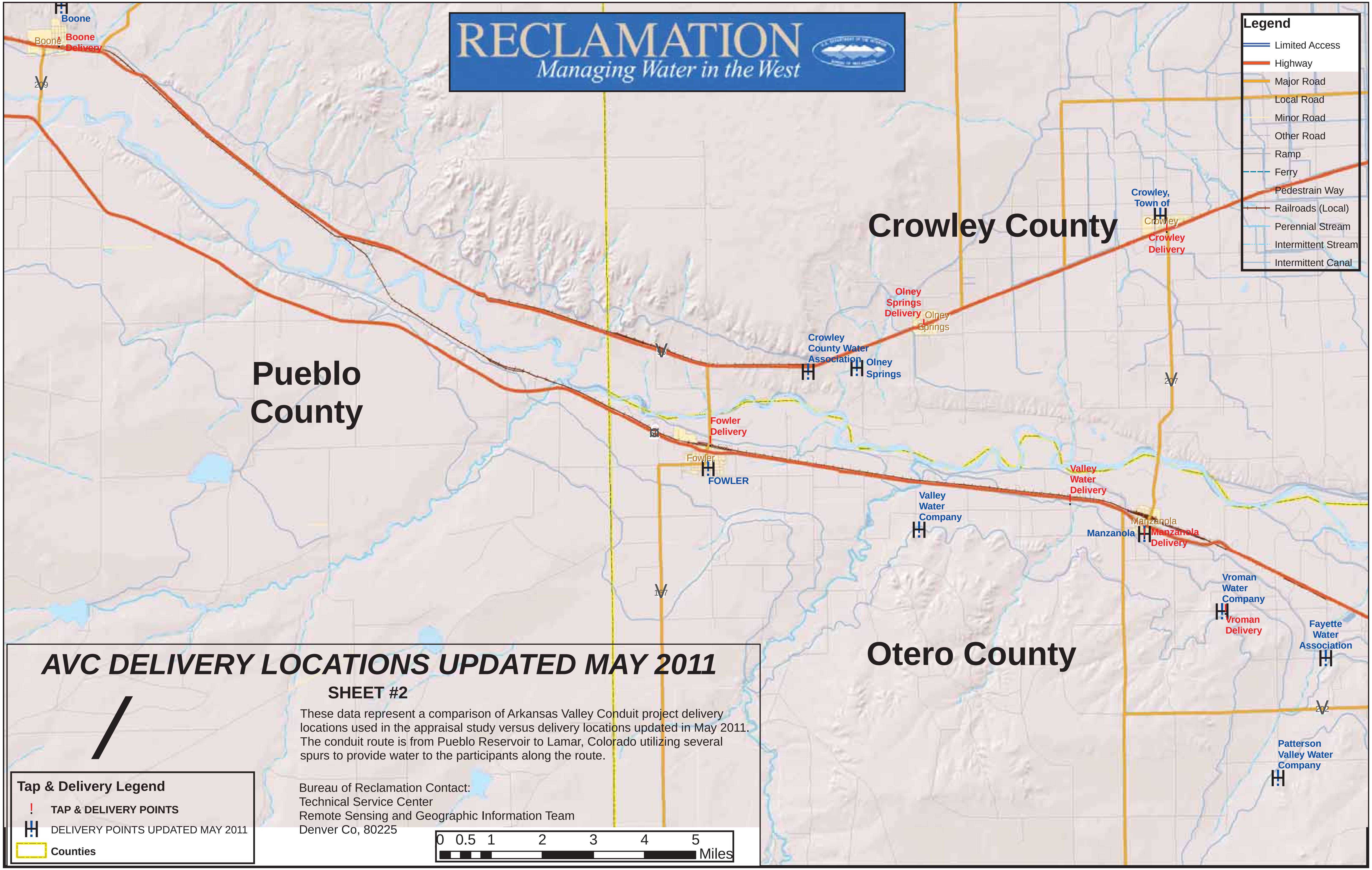

AVC DELIVERY LOCATIONS UPDATED MAY 2011

SHEET #2

These data represent a comparison of Arkansas Valley Conduit project delivery locations used in the appraisal study versus delivery locations updated in May 2011. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

Tap & Delivery Legend

- ! TAP & DELIVERY POINTS
- Ħ DELIVERY POINTS UPDATED MAY 2011
- ☐ Counties

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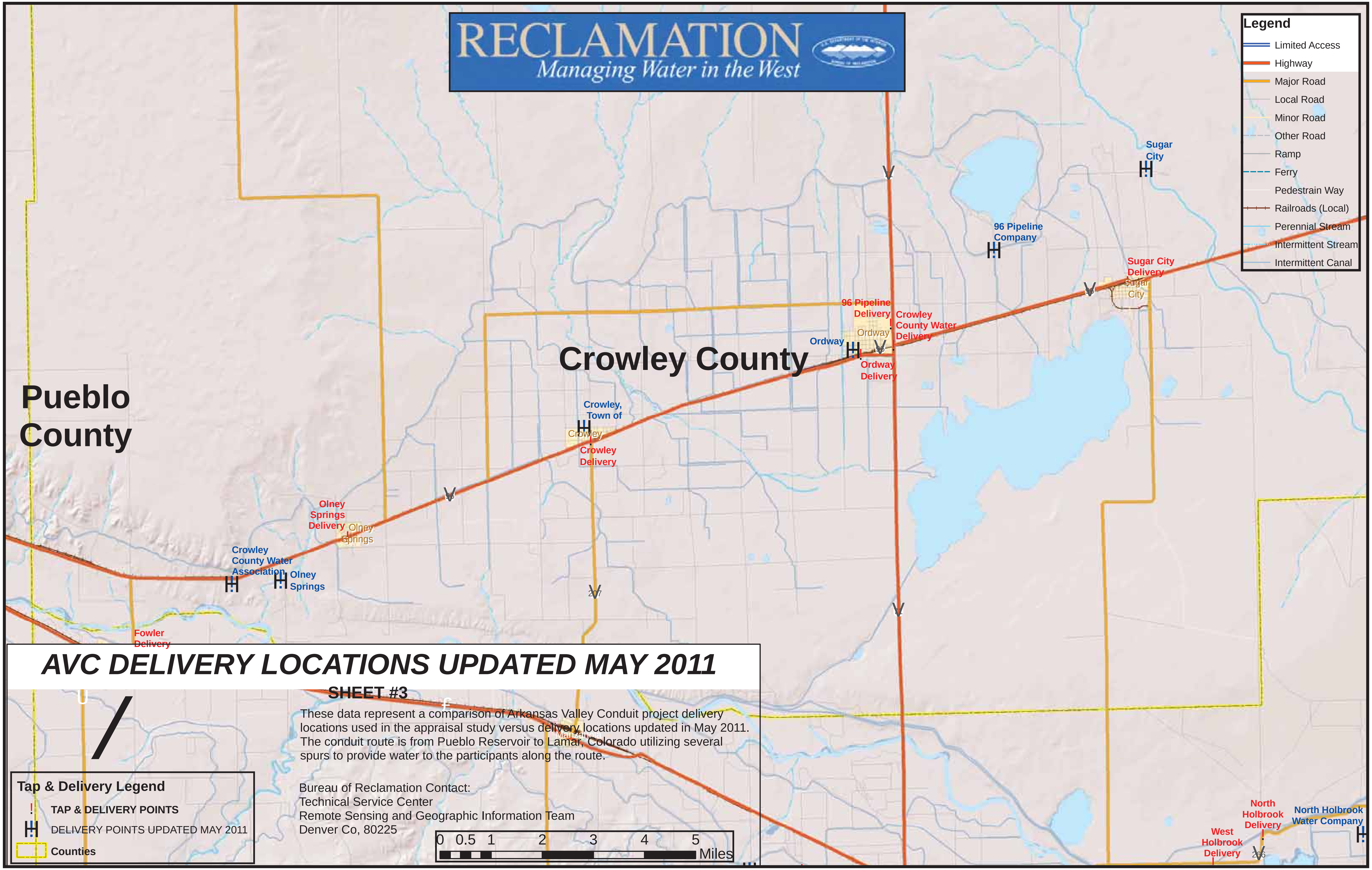
Remote Sensing and Geographic Information Team
Denver Co, 80225

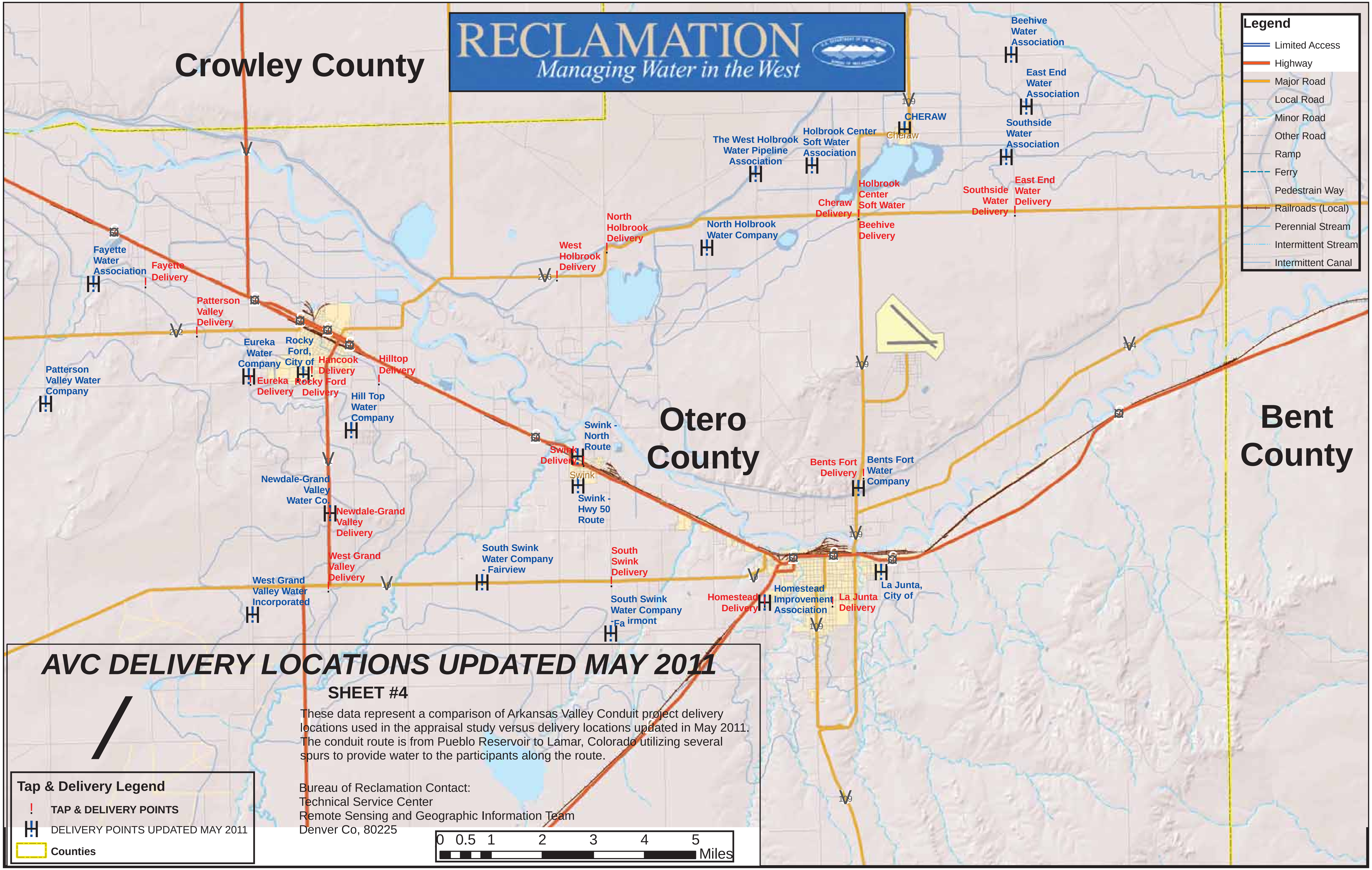


AVC DELIVERY LOCATIONS UPDATED MAY 2011

SHEET #3

These data represent a comparison of Arkansas Valley Conduit project delivery locations used in the appraisal study versus delivery locations updated in May 2011. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

Bureau of Reclamation Contact:
Technical Service Center
Remote Sensing and Geographic Information Team
Denver Co, 80225



AVC DELIVERY LOCATIONS UPDATED MAY 2011

SHEET #4

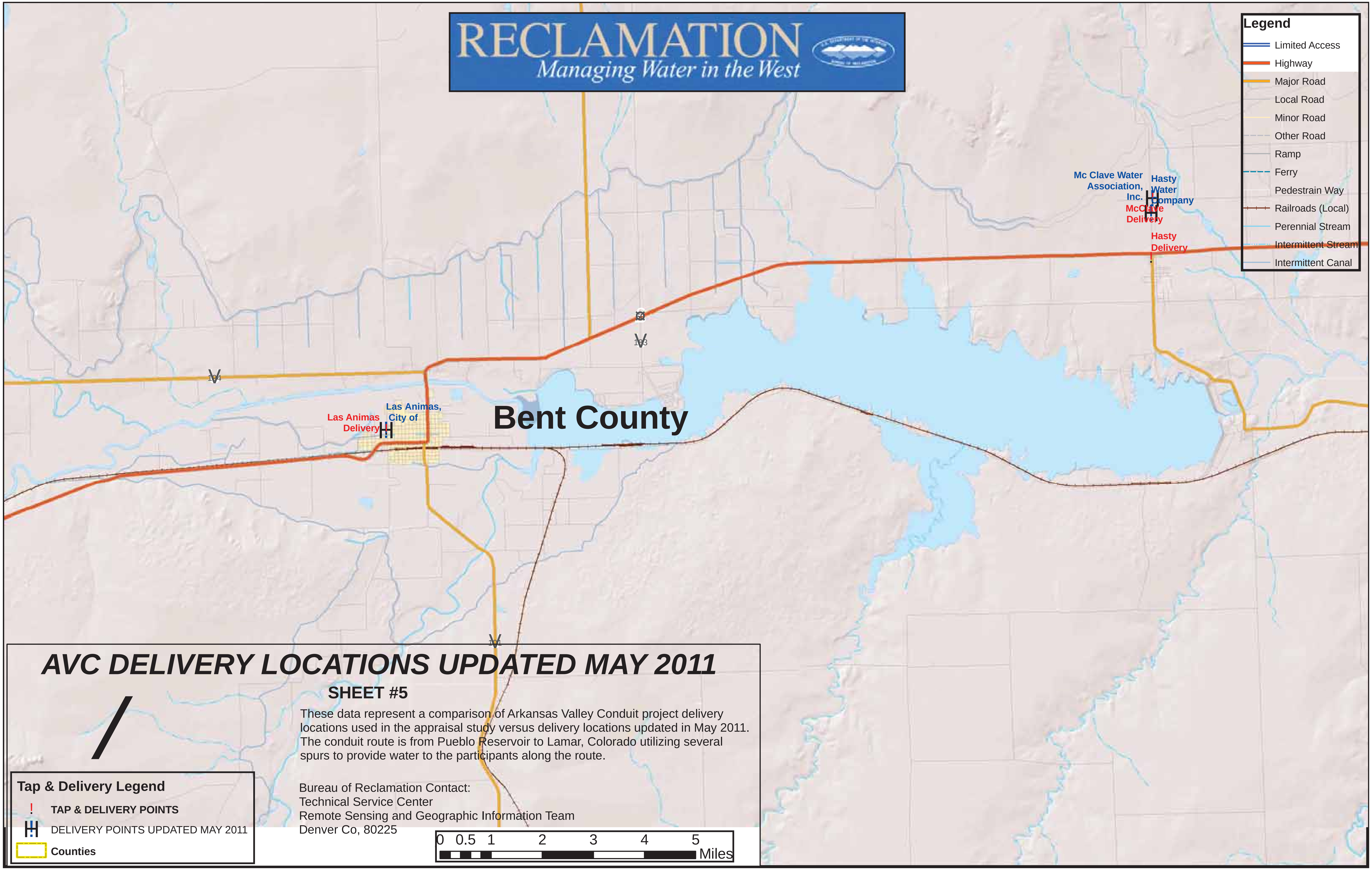
These data represent a comparison of Arkansas Valley Conduit project delivery locations used in the appraisal study versus delivery locations updated in May 2011. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

Bureau of Reclamation Contact:
Technical Service Center
Remote Sensing and Geographic Information Team
Denver Co, 80225

Tap & Delivery Legend

- ! TAP & DELIVERY POINTS
- H DELIVERY POINTS UPDATED MAY 2011
- ▭ **Counties**

RECLAMATION
Managing Water in the West



AVC DELIVERY LOCATIONS UPDATED MAY 2011

SHEET #5

These data represent a comparison of Arkansas Valley Conduit project delivery locations used in the appraisal study versus delivery locations updated in May 2011. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

Bureau of Reclamation Contact:
Technical Service Center
Remote Sensing and Geographic Information Team
Denver Co, 80225

Tap & Delivery Legend

- ! TAP & DELIVERY POINTS
- H DELIVERY POINTS UPDATED MAY 2011
- ▭ Counties

RECLAMATION
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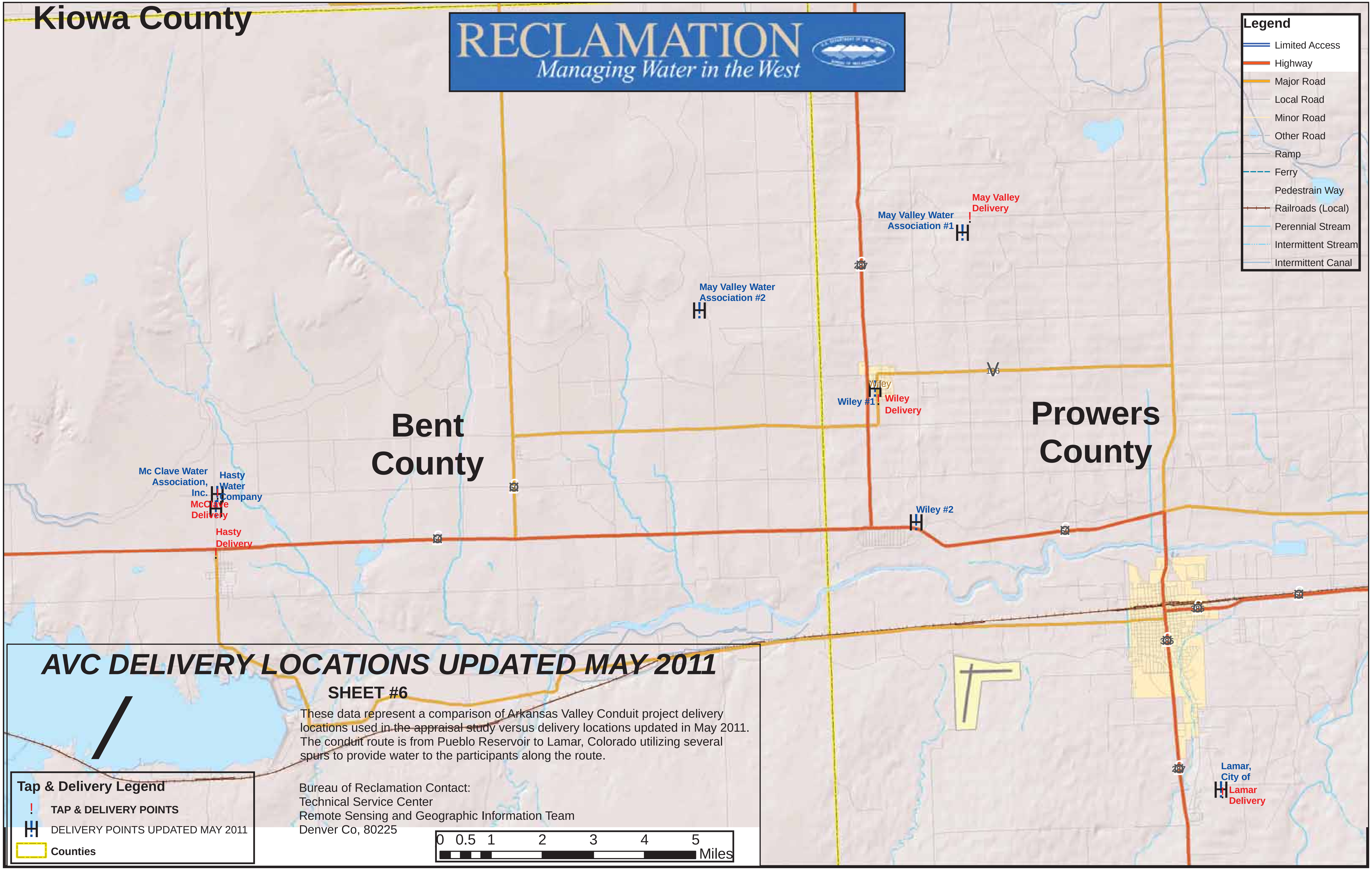
AVC DELIVERY LOCATIONS UPDATED MAY 2011

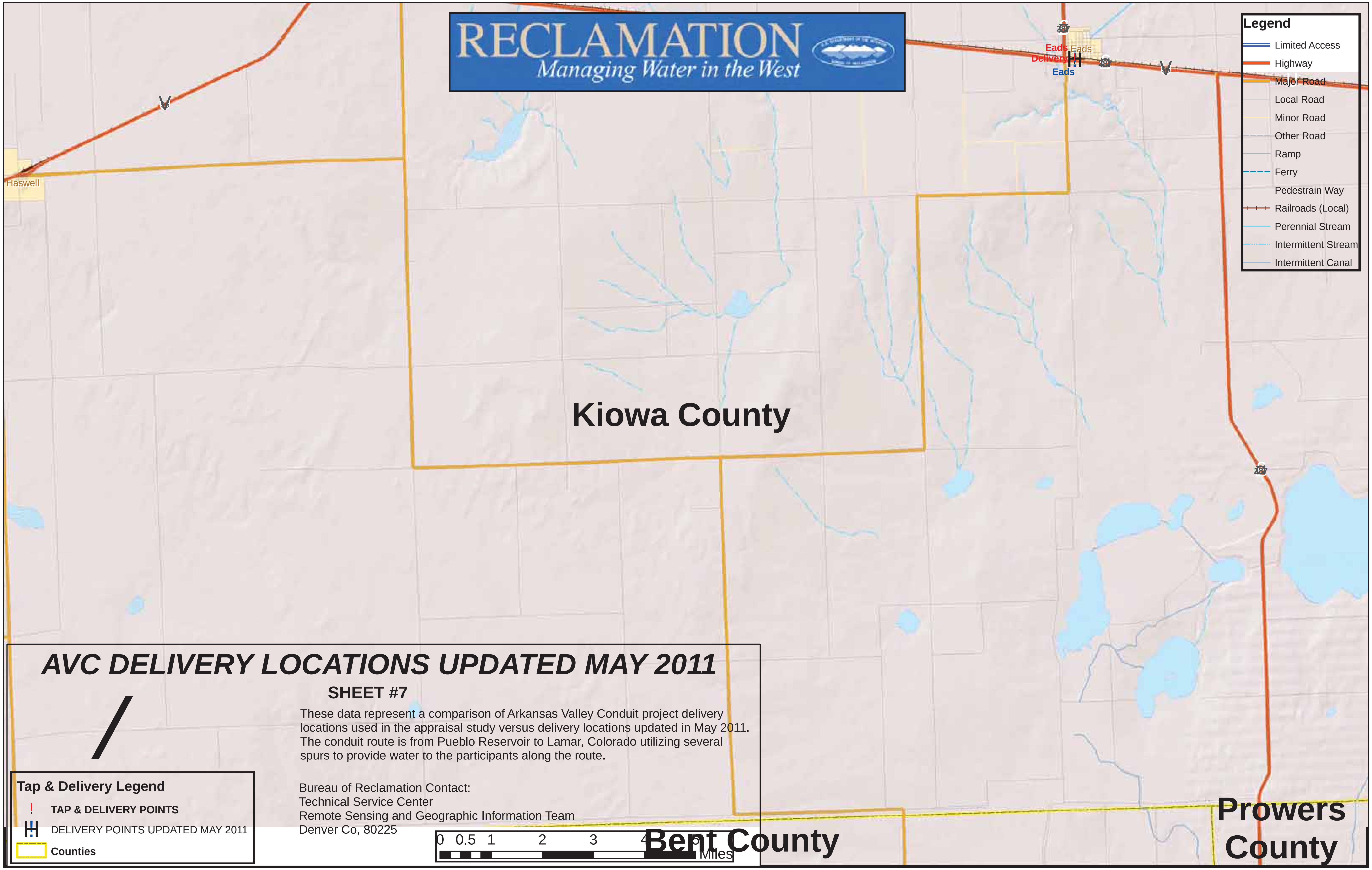
SHEET #6

These data represent a comparison of Arkansas Valley Conduit project delivery locations used in the appraisal study versus delivery locations updated in May 2011. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

Bureau of Reclamation Contact:
Technical Service Center
Remote Sensing and Geographic Information Team
Denver Co, 80225



RECLAMATION
Managing Water in the West



AVC DELIVERY LOCATIONS UPDATED MAY 2011

SHEET #7

These data represent a comparison of Arkansas Valley Conduit project delivery locations used in the appraisal study versus delivery locations updated in May 2011. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

Bureau of Reclamation Contact:
Technical Service Center
Remote Sensing and Geographic Information Team
Denver Co, 80225

Tap & Delivery Legend

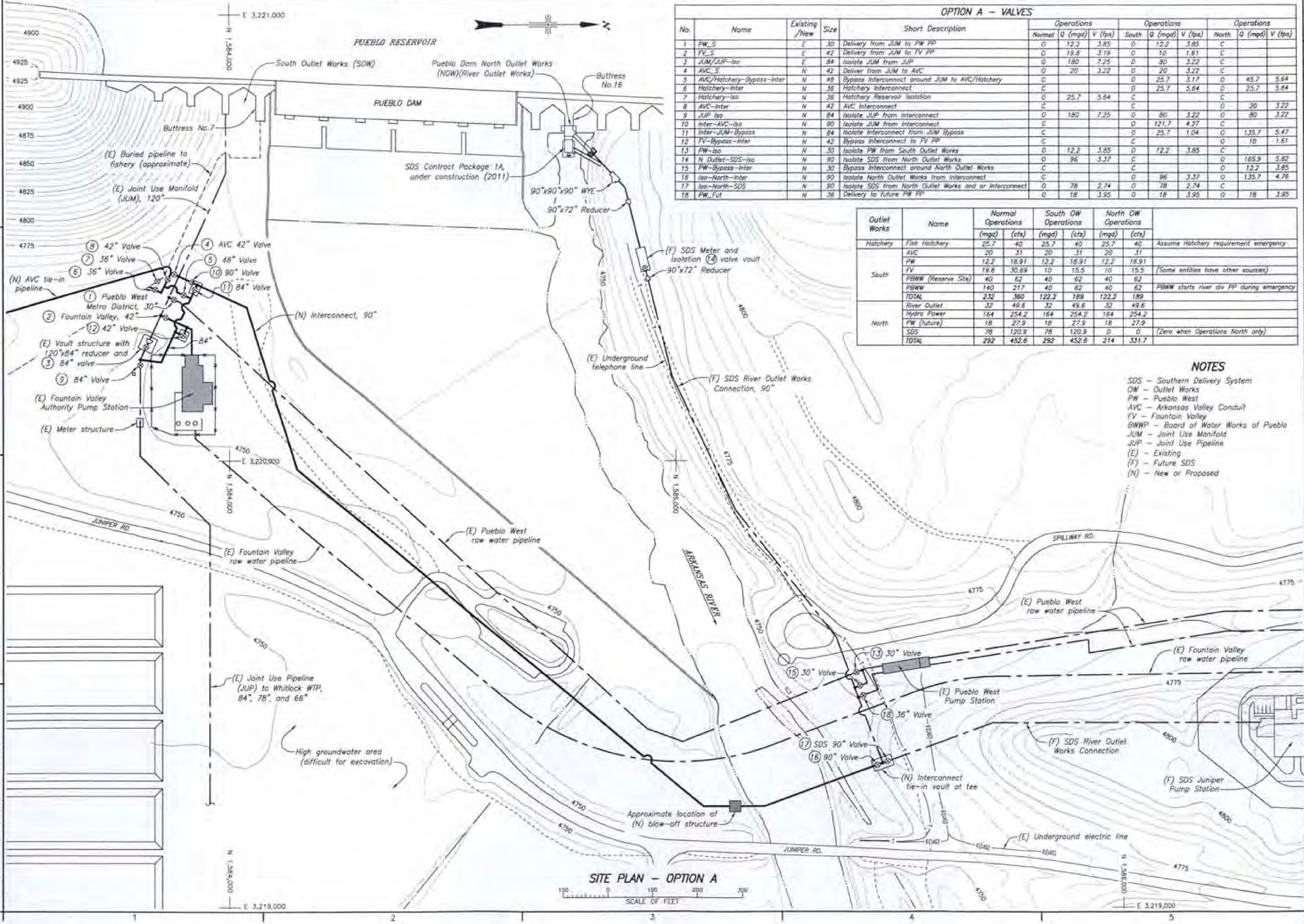
!	TAP & DELIVERY POINTS
ⵗ	DELIVERY POINTS UPDATED MAY 2011
☐	Counties

Appendix F

Facility Drawings

Contents – Appendix F, Facility Drawings

Contents– Appendix F, Facility Drawings



SITE PLAN – OPTION A

OPTION A – VALVES

No.	Name	Existing /New	Size	Short Description	Operations Normal	Q (mgd)	V (fps)	Operations South	Q (mgd)	V (fps)	Operations North	Q (mgd)	V (fps)
1	PW_S	E	30	Delivery from JUM to PW PP	O	12.2	3.85	O	12.2	3.85	C		
2	FV_S	E	42	Delivery from JUM to FV PP	O	19.8	3.19	O	10	1.61	C		
3	JUM/JUP–Iso	E	84	Isolate JUM from JUP	O	180	7.25	O	80	3.22	C		
4	AVC_S	N	42	Deliver from JUM to AVC	O	20	3.22	O	20	3.22	C		
5	AVC/Hatchery–Bypass–Inter	N	48	Bypass Interconnect around JUM to AVC/Hatchery	C			O	25.7	3.17	O	45.7	5.64
6	Hatchery–Inter	N	36	Hatchery Interconnect	C			O	25.7	5.64	O	25.7	5.64
7	Hatchery–Iso	N	36	Hatchery Reservoir Isolation	O	25.7	5.64	C			C		
8	AVC–Inter	N	42	AVC Interconnect	C			C			O	20	3.22
9	JUP Iso	N	84	Isolate JUP from Interconnect	O	180	7.25	O	80	3.22	O	80	3.22
10	Inter–AVC–Iso	N	90	Isolate JUM from Interconnect	C			O	121.7	4.27	C		
11	Inter–JUM–Bypass	N	84	Isolate Interconnect from JUM Bypass	C			O	25.7	1.04	O	135.7	5.47
12	FV–Bypass–Inter	N	42	Bypass Interconnect to FV PP	C			C			O	10	1.61
13	PW–Iso	N	30	Isolate PW from South Outlet Works	O	12.2	3.85	O	12.2	3.85	C		
14	N Outlet–SDS–Iso	N	90	Isolate SDS from North Outlet Works	O	96	3.37	C			O	165.9	5.82
15	PW–Bypass–Inter	N	30	Bypass Interconnect around North Outlet Works	C			C			O	12.2	3.85
16	Iso–North–Inter	N	90	Isolate North Outlet Works from Interconnect	C			O	96	3.37	O	135.7	4.76
17	Iso–North–SDS	N	90	Isolate SDS from North Outlet Works and or Interconnect	O	78	2.74	O	78	2.74	C		
18	PW_Fut	N	36	Delivery to future PW PP	O	18	3.95	O	18	3.95	O	18	3.95

Outlet Works	Name	Normal Operations (mgd)	Normal Operations (cfs)	South OW Operations (mgd)	South OW Operations (cfs)	North OW Operations (mgd)	North OW Operations (cfs)	
Hatchery	Fish Hatchery	25.7	40	25.7	40	25.7	40	Assume Hatchery requirement emergency
South	AVC	20	31	20	31	20	31	
	PW	12.2	18.91	12.2	18.91	12.2	18.91	
	FV	19.8	30.69	10	15.5	10	15.5	(Some entities have other sources)
	PBWW (Reserve Site)	40	62	40	62	40	62	
	PBWW	140	217	40	62	40	62	PBWW starts river div PP during emergency
	TOTAL	232	360	122.2	189	122.2	189	
North	River Outlet	32	49.6	32	49.6	32	49.6	
	Hydro Power	164	254.2	164	254.2	164	254.2	
	PW (future)	18	27.9	18	27.9	18	27.9	
	SDS	78	120.9	78	120.9	0	0	(Zero when Operations North only)
	TOTAL	292	452.6	292	452.6	214	331.7	

NOTES

SDS – Southern Delivery System
OW – Outlet Works
PW – Pueblo West
AVC – Arkansas Valley Conduit
FV – Fountain Valley
BWWP – Board of Water Works of Pueblo
JUM – Joint Use Manifold
JUP – Joint Use Pipeline
(E) – Existing
(F) – Future SDS
(N) – New or Proposed

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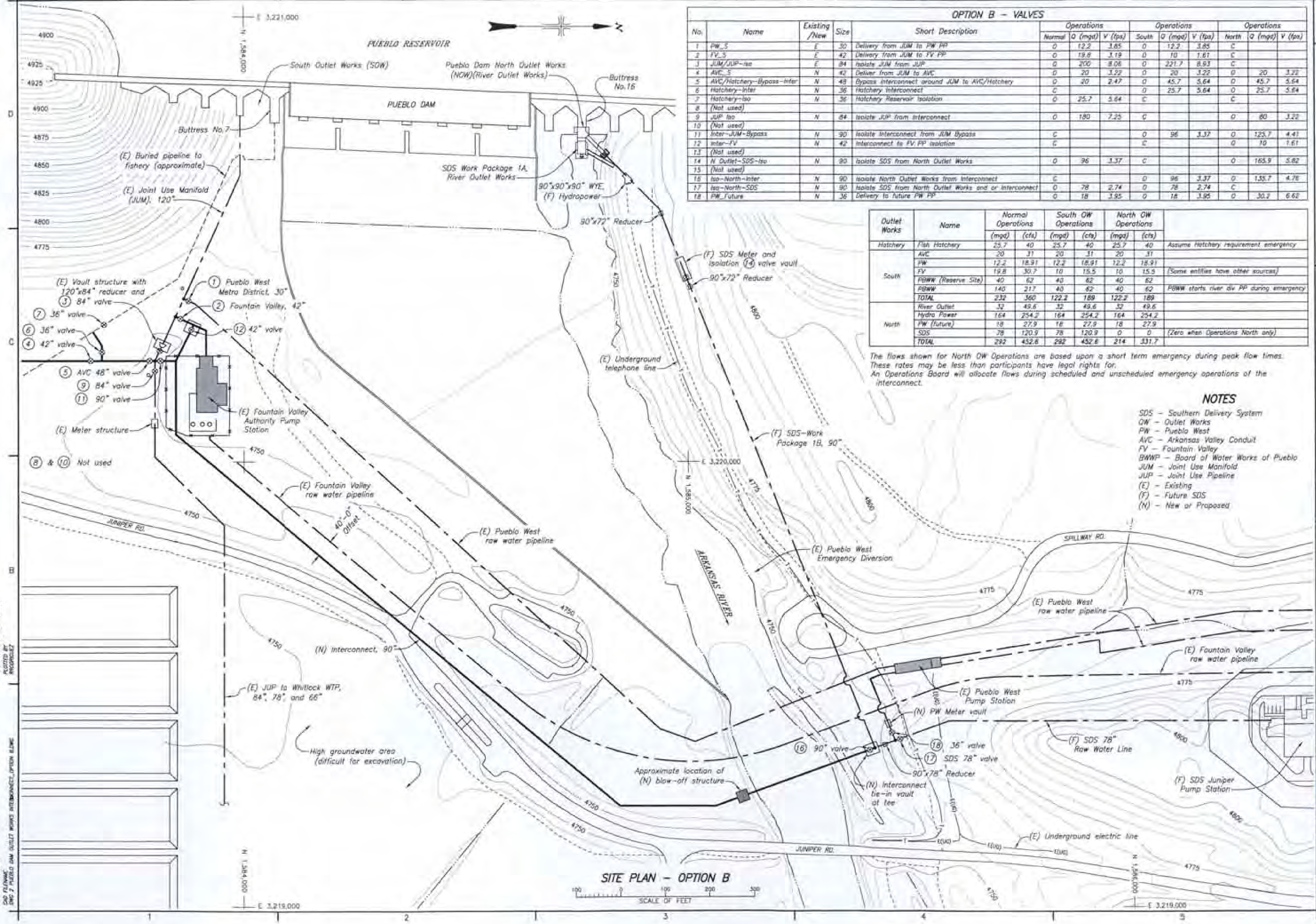
BUREAU OF RECLAMATION
FRYINGPAN–ARKANSAS PROJECT – COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
OUTLET WORKS INTERCONNECT
SITE PLAN – OPTION A

REVIEWED
DAVID EDWARDS, P.E. – WATER CONVEYANCE GROUP
DENVER, COLORADO 2011-08-01

OUTLET WORKS
INTERCONNECT
SITE PLAN–OPTION A

DRAWING 1
SHEET 1 OF 1



SITE PLAN - OPTION B

OPTION B - VALVES

No.	Name	Existing /New	Size	Short Description	Operations Normal	Q (mgd)	V (fps)	Operations South	Q (mgd)	V (fps)	Operations North	Q (mgd)	V (fps)
1	PW_S	E	30	Delivery from JUM to PW PP	O	12.2	3.85	O	12.2	3.85	C		
2	FV_S	E	42	Delivery from JUM to FV PP	O	19.8	3.19	O	10	1.61	C		
3	JUM/JUP-Iso	E	84	Isolate JUM from JUP	O	200	8.06	O	221.7	8.93	C		
4	AVC_S	N	42	Deliver from JUM to AVC	O	20	3.22	O	20	3.22	O	20	3.22
5	AVC/Hatchery-Bypass-Inter	N	48	Bypass interconnect around JUM to AVC/Hatchery	O	20	2.47	O	45.7	5.64	O	45.7	5.64
6	Hatchery-Inter	N	36	Hatchery Interconnect	C			O	25.7	5.64	O	25.7	5.64
7	Hatchery-Iso	N	36	Hatchery Reservoir Isolation	O	25.7	5.64	C			C		
8	(Not used)												
9	JUP Iso	N	84	Isolate JUP from Interconnect	O	180	7.25	C			O	80	3.22
10	(Not used)												
11	Inter-JUM-Bypass	N	90	Isolate Interconnect from JUM Bypass	C			O	96	3.37	O	125.7	4.41
12	Inter-FV	N	42	Interconnect to FV PP isolation	C			C			O	10	1.61
13	(Not used)												
14	N Outlet-SDS-Iso	N	90	Isolate SDS from North Outlet Works	O	96	3.37	C			O	165.9	5.82
15	(Not used)												
16	Iso-North-Inter	N	90	Isolate North Outlet Works from Interconnect	C			O	96	3.37	O	135.7	4.76
17	Iso-North-SDS	N	90	Isolate SDS from North Outlet Works and or Interconnect	O	78	2.74	O	78	2.74	C		
18	PW_Future	N	36	Delivery to future PW PP	O	18	3.95	O	18	3.95	O	30.2	6.62

Outlet Works	Name	Normal Operations (mgd)	Normal Operations (cfs)	South OW Operations (mgd)	South OW Operations (cfs)	North OW Operations (mgd)	North OW Operations (cfs)	
Hatchery	Fish Hatchery	25.7	40	25.7	40	25.7	40	Assume Hatchery requirement emergency
South	AVC	20	31	20	31	20	31	
	PW	12.2	18.91	12.2	18.91	12.2	18.91	
	FV	19.8	30.7	10	15.5	10	15.5	(Some entities have other sources)
	PBWW (Reserve Site)	40	62	40	62	40	62	
	PBWW	140	217	40	62	40	62	PBWW starts river div PP during emergency
	TOTAL	232	360	122.2	189	122.2	189	
North	River Outlet	32	49.6	32	49.6	32	49.6	
	Hydro Power	164	254.2	164	254.2	164	254.2	
	PW (future)	18	27.9	18	27.9	18	27.9	
	SDS	78	120.9	78	120.9	0	0	(Zero when Operations North only)
	TOTAL	292	452.6	292	452.6	214	331.7	

The flows shown for North OW Operations are based upon a short term emergency during peak flow times.
These rates may be less than participants have legal rights for.
An Operations Board will allocate flows during scheduled and unscheduled emergency operations of the interconnect.

NOTES

SDS - Southern Delivery System
OW - Outlet Works
PW - Pueblo West
AVC - Arkansas Valley Conduit
FV - Fountain Valley
BWWP - Board of Water Works of Pueblo
JUM - Joint Use Manifold
JUP - Joint Use Pipeline
(E) - Existing
(F) - Future SDS
(N) - New or Proposed

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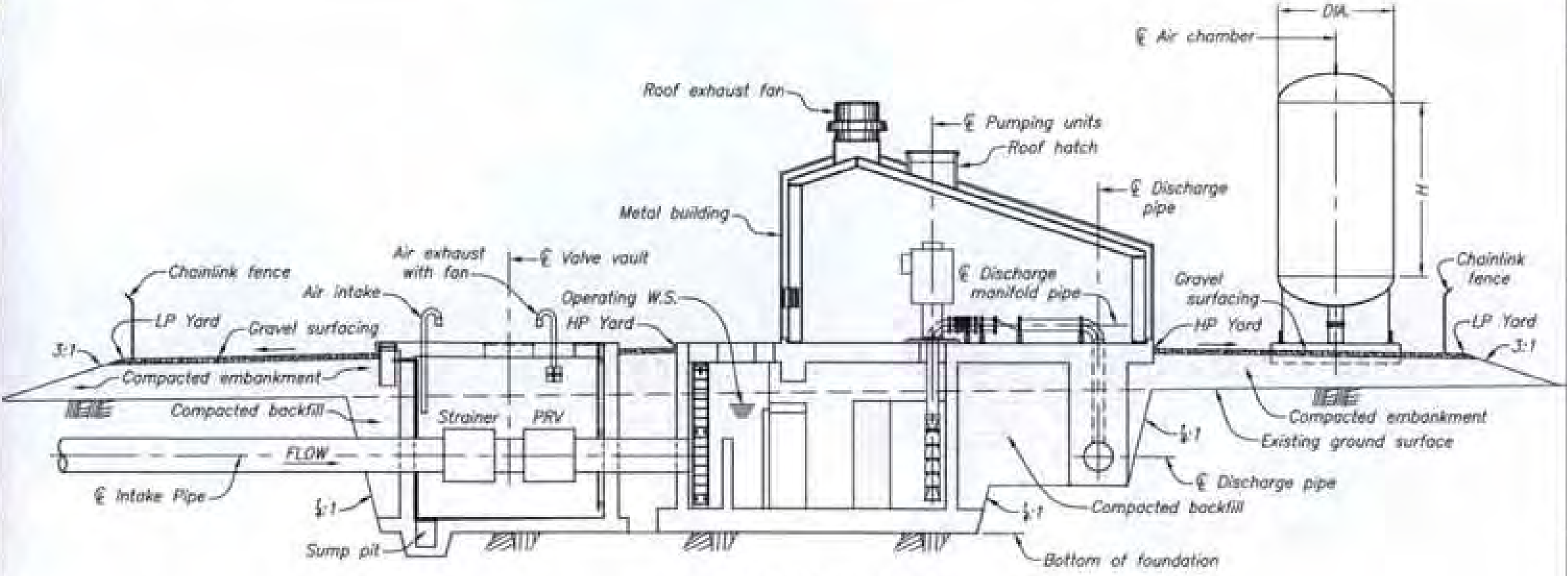
BUREAU OF RECLAMATION
FRYINGPAN-ARKANSAS PROJECT - COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
OUTLET WORKS INTERCONNECT
SITE PLAN - OPTION B

S Robertson
APPROVED
DAVID EDWARDS, P.E. - WATER CONVEYANCE GROUP
DENVER, COLORADO 2011-08-0

OUTLET WORKS
INTERCONNECT
SITE PLAN-OPTION B

DRAWING 2
SHEET 1 OF 1

SITE PLAN



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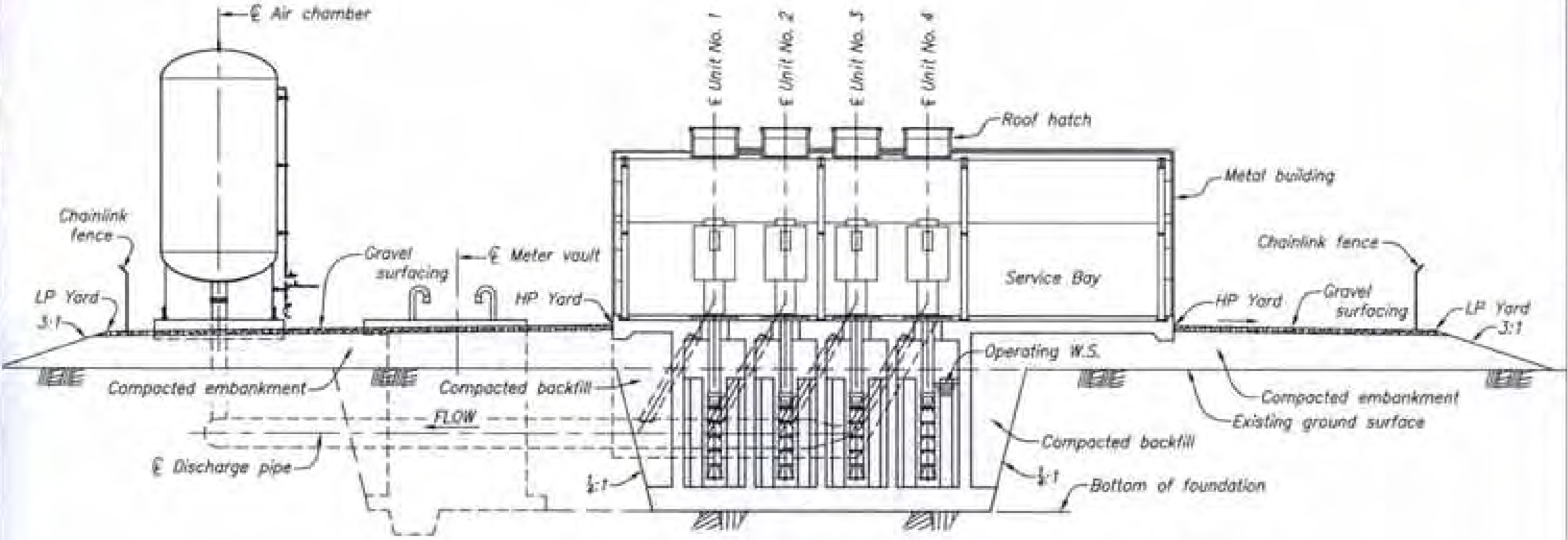
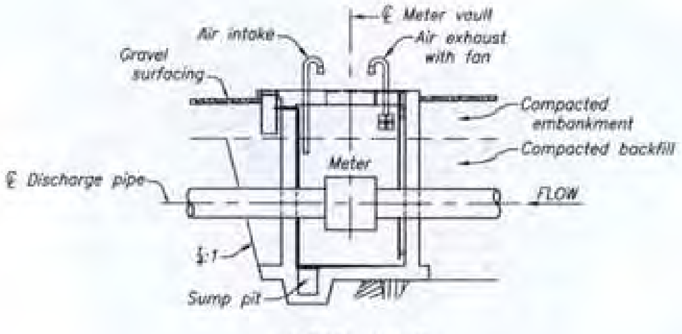


LONGITUDINAL SECTION

PUMP DATA				AIR CHAMBER		
PUMP NUMBER	RATED CAPACITY * (CFS)	NO. STAGES (EA.)	RATED HEAD (FT.)	CYLINDER DIA. (FT.)	CYLINDER H (FT.)	VOLUME (CU FT.)
1 Thru 4	8.31 ea.	4	480	12	18	2,452
Total	33.24	—	—	—	—	—

* Includes a 3% wear factor.



METER VAULT

SCALE OF FEET
SITE PLAN
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SCALE OF FEET
SECTIONS AND METER VAULT
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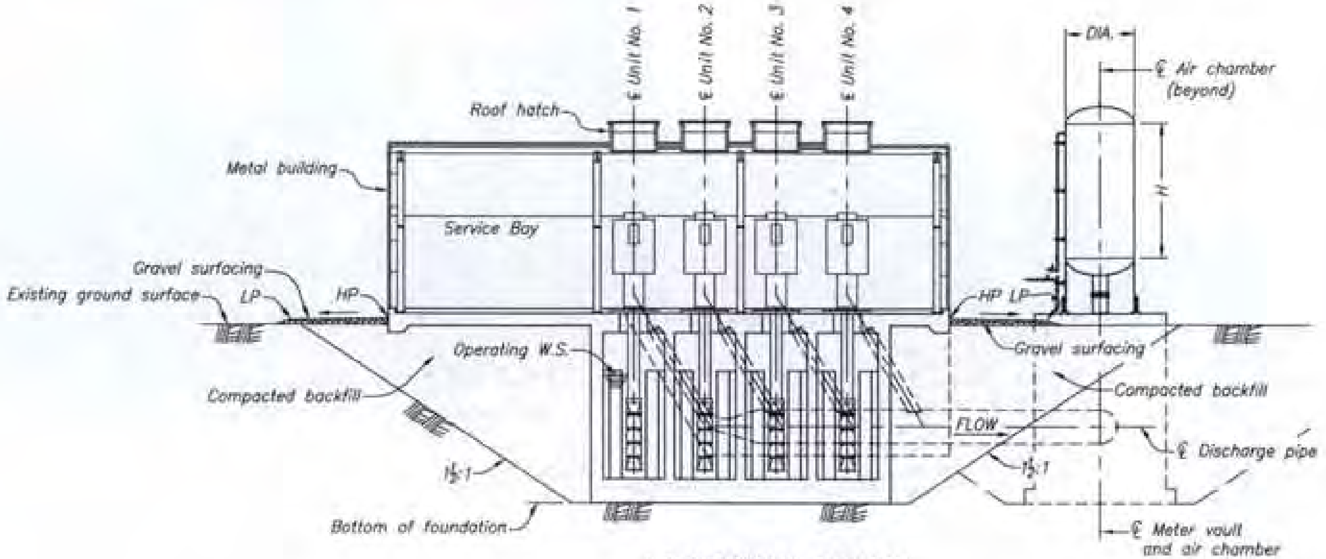
BUREAU OF RECLAMATION
FRYINGPAN–ARKANSAS PROJECT – COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
ALT. 1 – COMANCHE PUMPING PLANT
SITE PLAN AND SECTIONS

DESIGNED
REVIEWED
Alfred J. B PE
ALFRED I. BERNSTEIN, P.E. – PLANT STRUCTURES GROUP
DENVER, COLORADO 2011-06-01

ALT. 1 – COMANCHE
PUMPING PLANT
SITE PLAN & SECTIONS

DRAWING 3
SHEET 1 OF 1

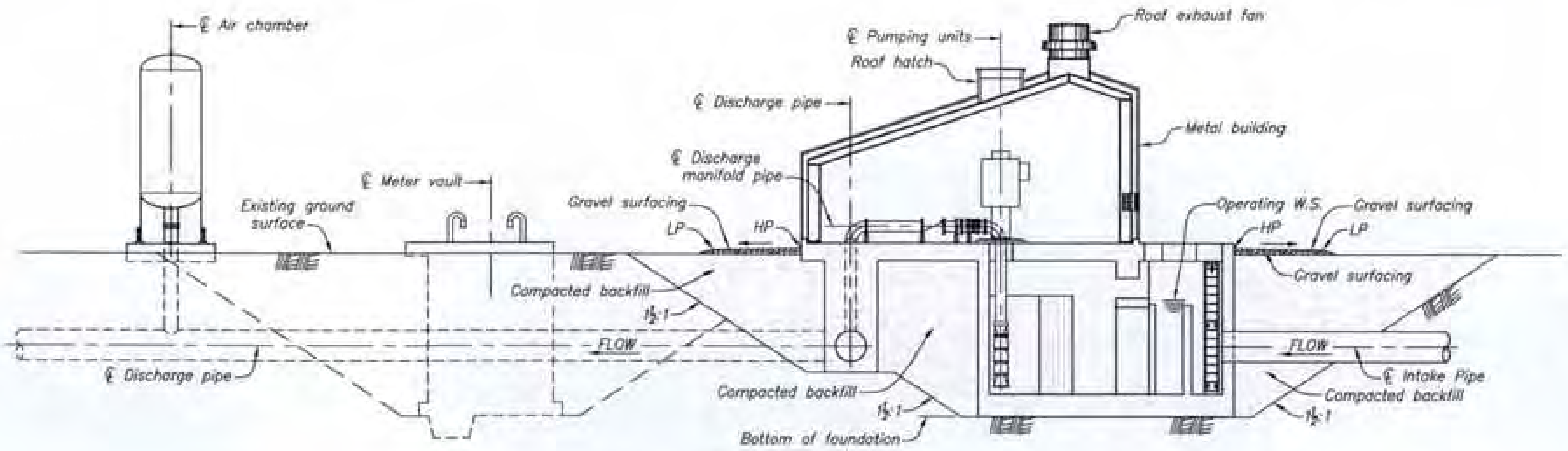
SITE PLAN



LONGITUDINAL SECTION

PUMP DATA				AIR CHAMBER		
PUMP NUMBER	RATED CAPACITY * (CFS)	NO. STAGES (EA.)	RATED HEAD (FT.)	CYLINDER DIA (FT.)	CYLINDER H (FT.)	VOLUME (CU FT.)
1 Thru. 4	7.69 ea.	3	155	7	14	629
Total	30.76	—	—	—	—	—

* Does not include wear factor



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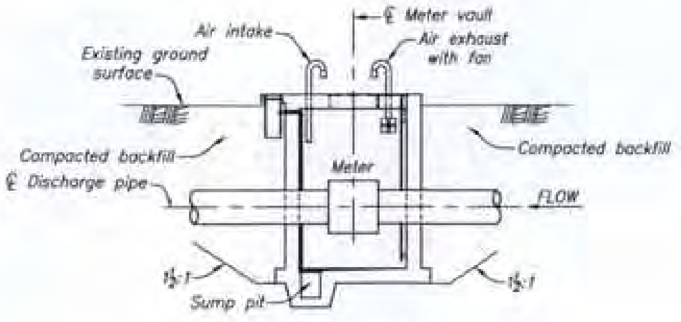

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PLOTTED BY
RODRIGUEZ

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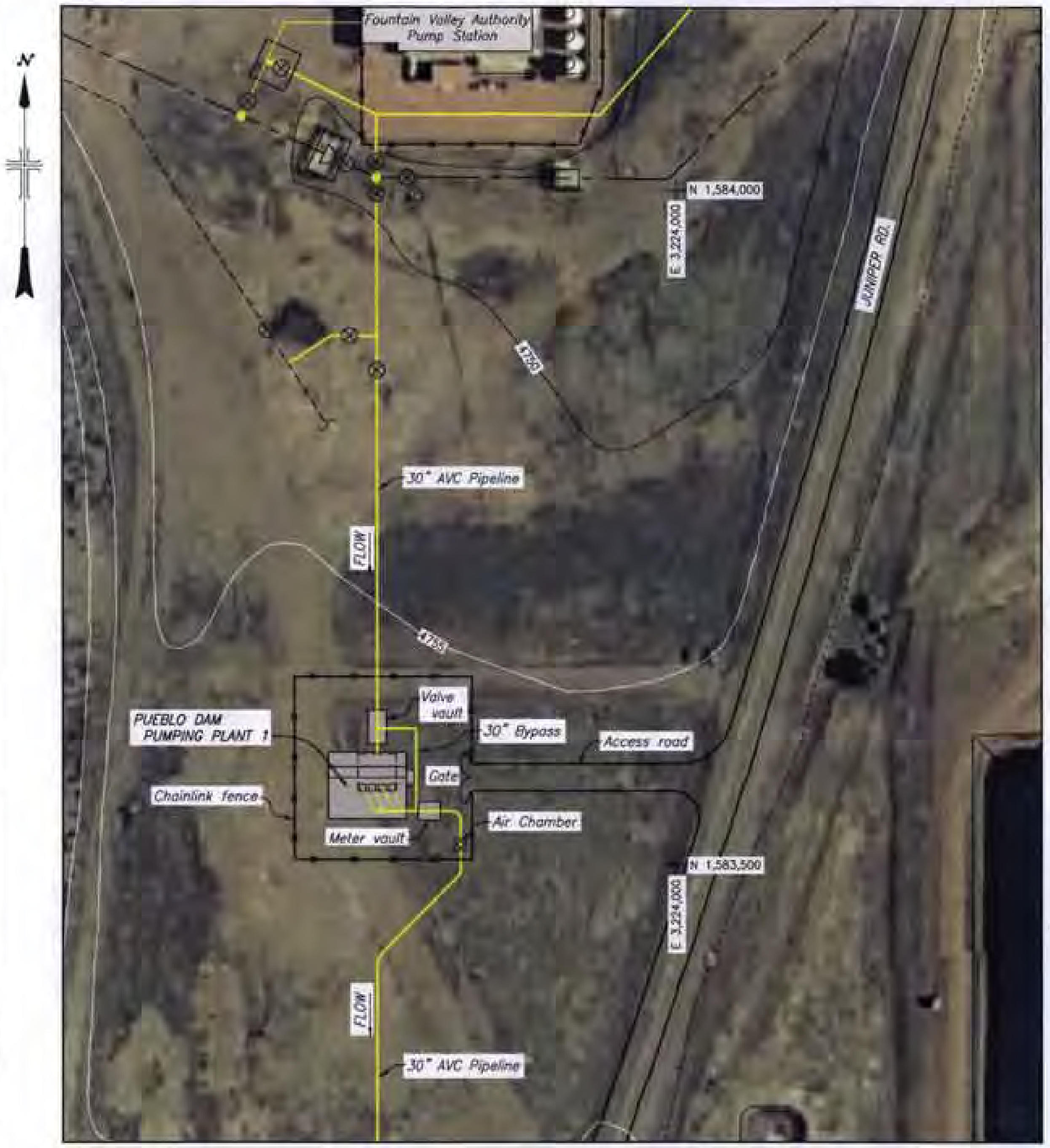
FRYINGPAN–ARKANSAS PROJECT – COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
ALT. 3 – WHITLOCK PUMPING PLANT
SITE PLAN AND SECTIONS

R Ba
DESIGNED
Alfred I. B PE
REVIEWED
ALFRED I. BERNSTEIN, P.E. – PLANT STRUCTURES GROUP
DENVER, COLORADO 2011-06-01

ALT. 3 – WHITLOCK
PUMPING PLANT
SITE PLAN & SECTIONS

DRAWING 4
SHEET 1 OF 1



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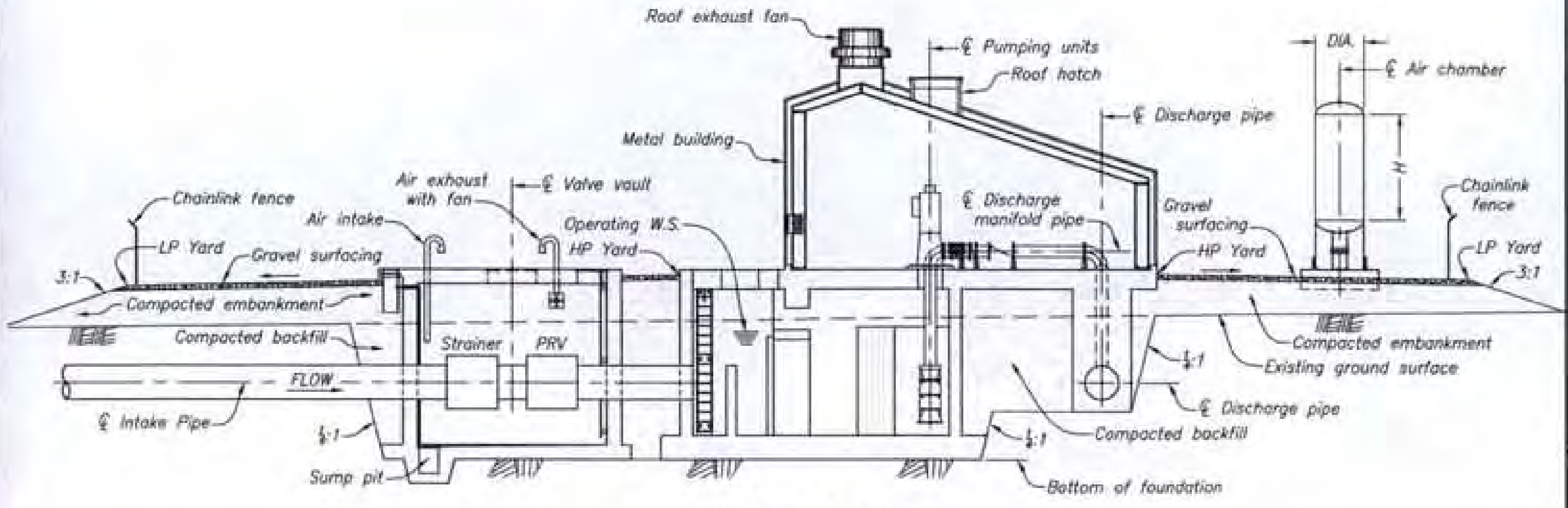

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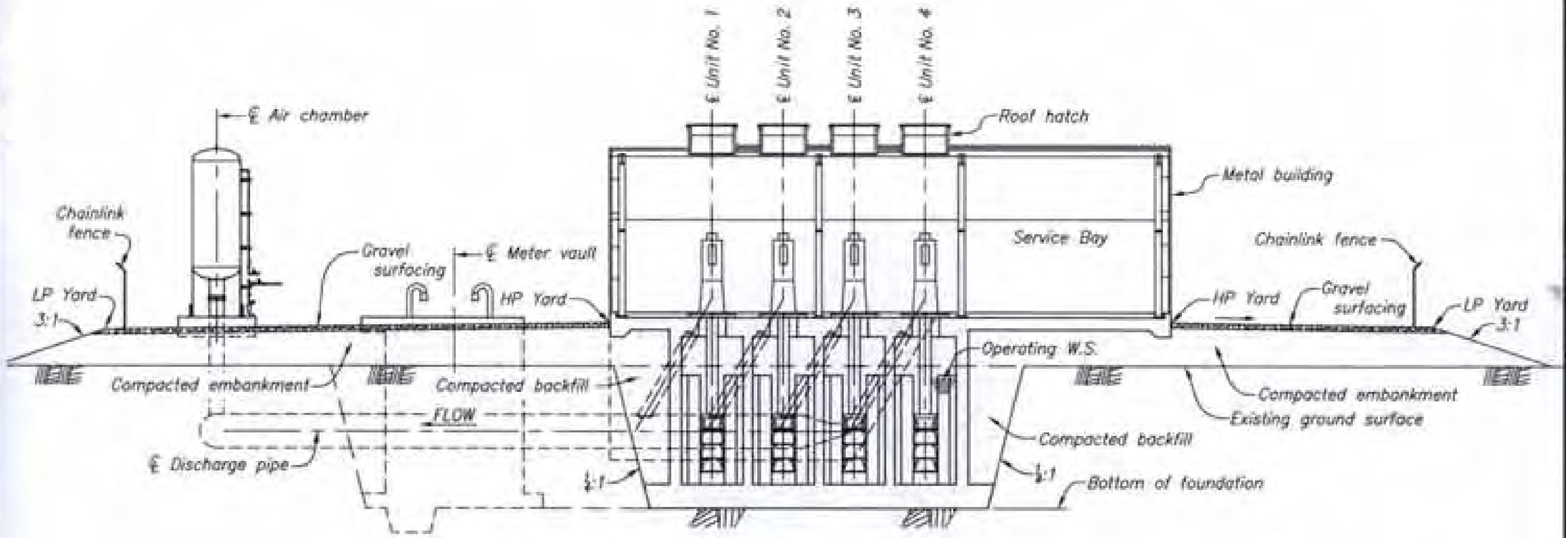

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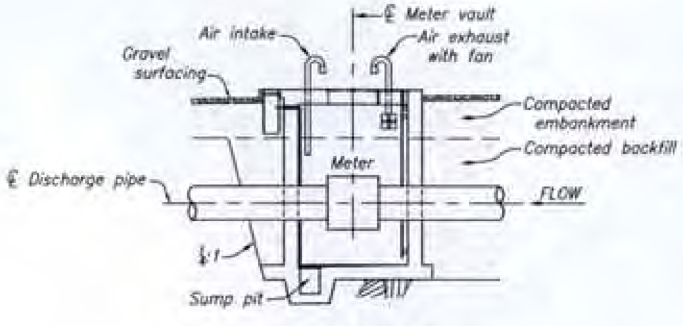

METER VAULT

PUMP DATA				AIR CHAMBER		
PUMP NUMBER	RATED CAPACITY* (CFS)	NO. STAGES (EA.)	RATED HEAD (FT.)	CYLINDER DIA. (FT.)	CYLINDER H (FT.)	VOLUME (CU FT.)
1 Thru 4	8.31 ea.	2	55	5	11	249
Total	33.24	–	–	–	–	–

* Includes 3% wear factor

SCALE OF FEET SITE PLAN: 60 0 60 120 180

SCALE OF FEET SECTIONS AND METER VAULT: 10 0 10 20 30

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BUREAU OF RECLAMATION

FRYINGPAN-ARKANSAS PROJECT – COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
ALT. 4 – PUEBLO DAM PUMPING PLANT 1
SITE PLAN AND SECTIONS

DESIGNED

Alfred L. Bernstein, P.E.
REVIEWED
ALFRED L. BERNSTEIN, P.E. – PUMP STRUCTURES GROUP

DENVER, COLORADO 2011-06-01

ALT. 4 – PUEBLO DAM
PUMPING PLANT 1
SITE PLAN & SECTIONS

DRAWING 5

SHEET 1 OF 1

DATE AND TIME PLOTTED
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PLOTTED BY
RRODRIGUEZ

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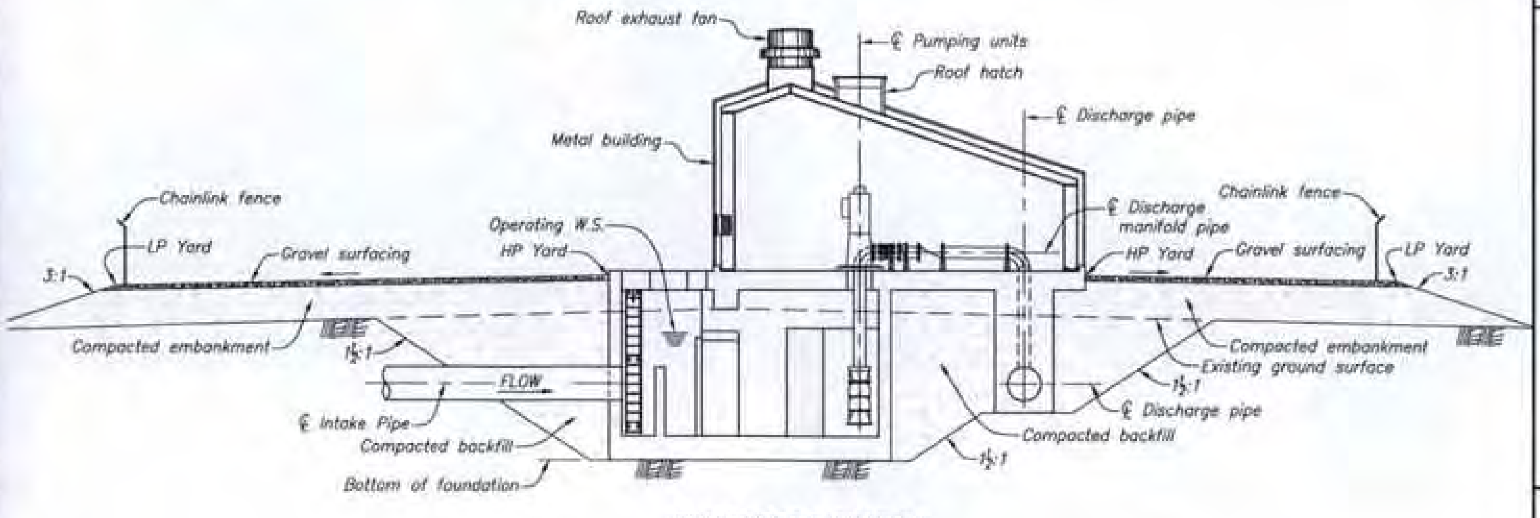
RECLAMATION
Managing Water in the West

SITE PLAN



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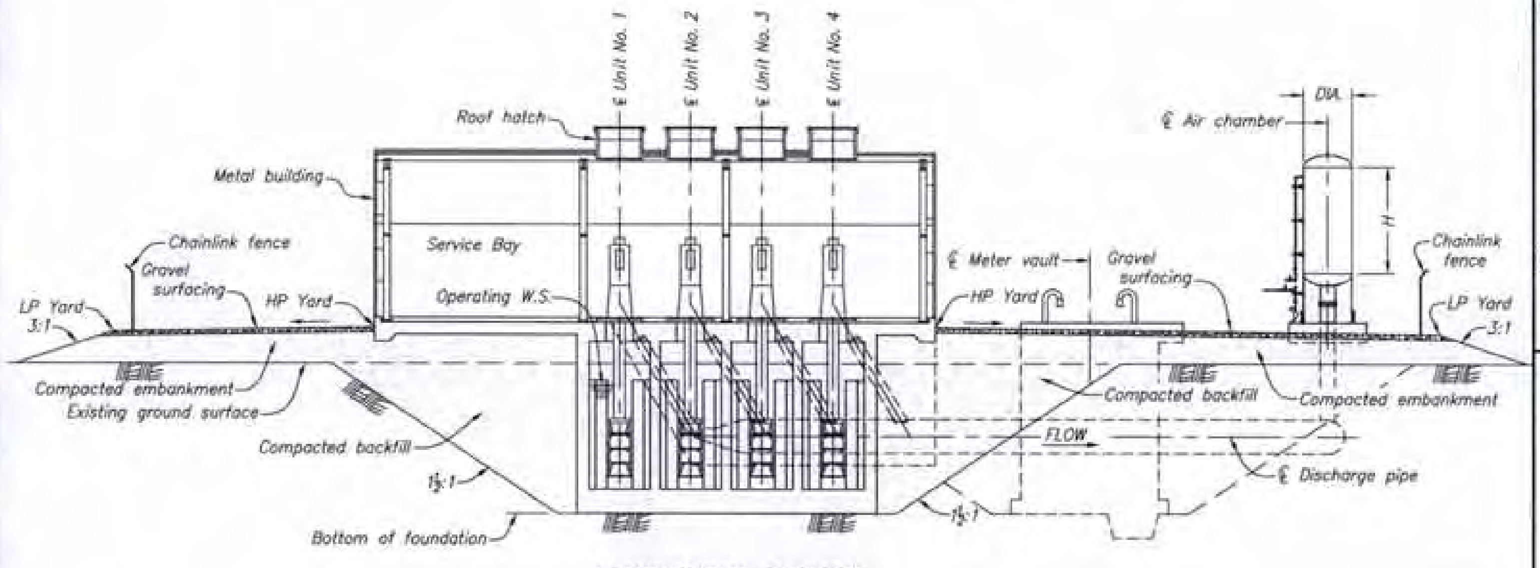

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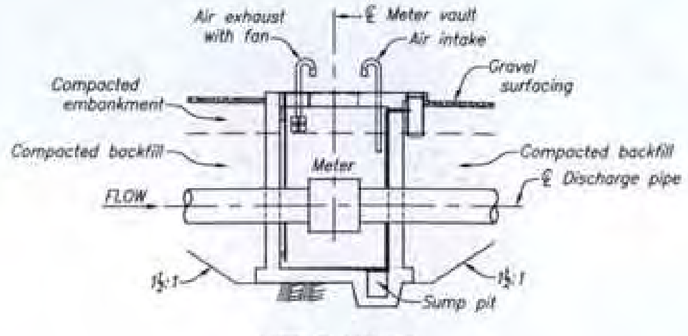

METER VAULT

PUMP DATA				AIR CHAMBER		
PUMP NUMBER	RATED CAPACITY * (CFS)	NO. STAGES (EA.)	RATED HEAD (FT.)	CYLINDER DIA. (FT.)	CYLINDER H (FT.)	VOLUME (CU FT.)
1 Thru 4	7.69 ea.	2	40	5	11	249
Total	30.76	–	–	–	–	–

* Does not include wear factor.

60 0 60 120 180
SCALE OF FEET
SITE PLAN

10 0 10 20 30
SCALE OF FEET
SECTIONS AND METER VAULT

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BUREAU OF RECLAMATION
FRYINGPAN-ARKANSAS PROJECT – COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
ALT. 4 – PUEBLO DAM PUMPING PLANT 2
SITE PLAN AND SECTIONS

R Bartel
DESIGNED
Alfred I. Bernstein PE
REVIEWED
ALFRED I. BERNSTEIN, P.E. – PLANT STRUCTURES GROUP
DENVER, COLORADO 2011-06-01

ALT. 4 – PUEBLO DAM
PUMPING PLANT 2
SITE PLAN & SECTIONS

DRAWING 6
SHEET 1 OF 1

DATE AND TIME PLOTTED
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PLOTTED BY
PRODRIGUEZ

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RECLAMATION
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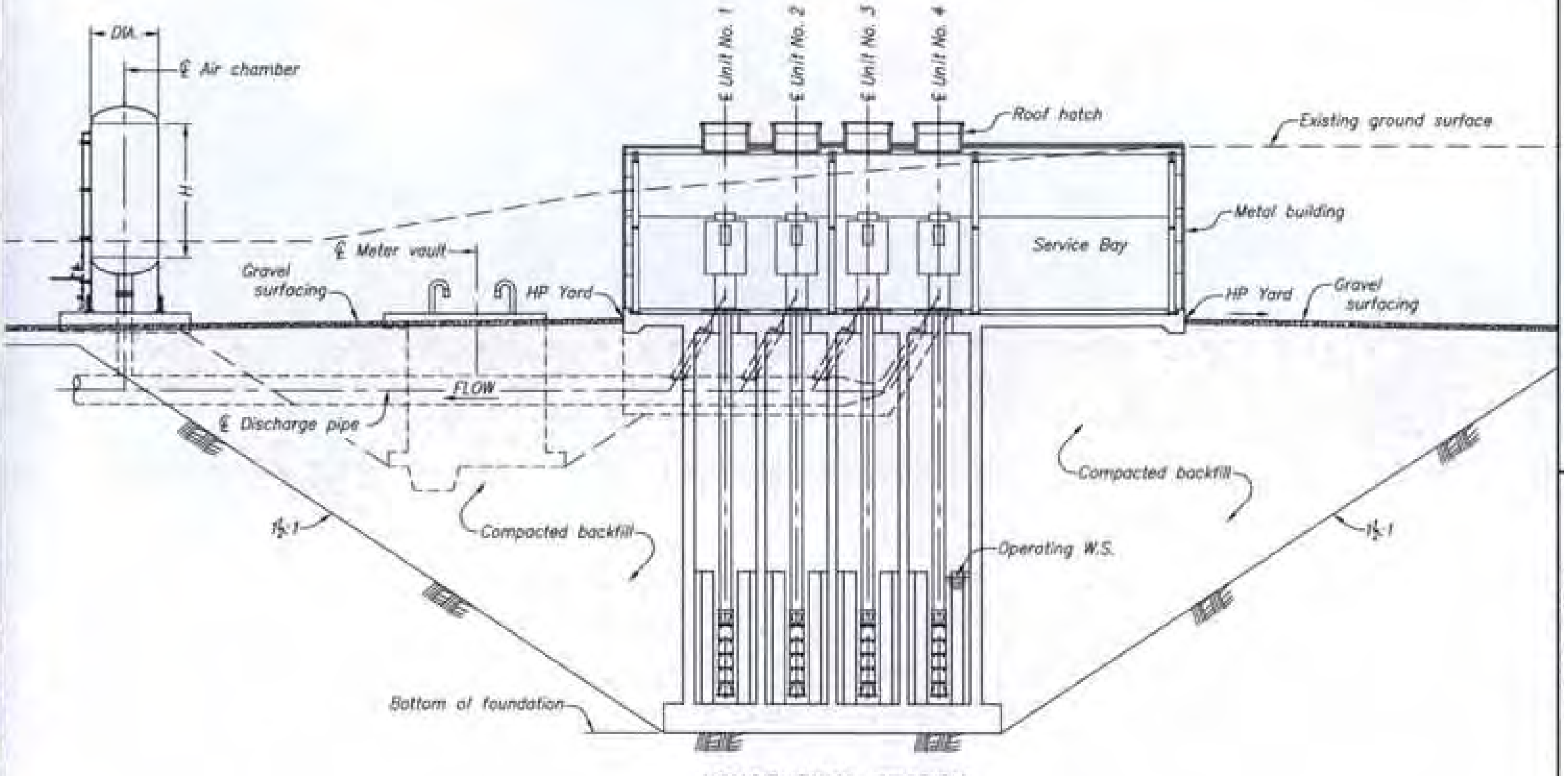
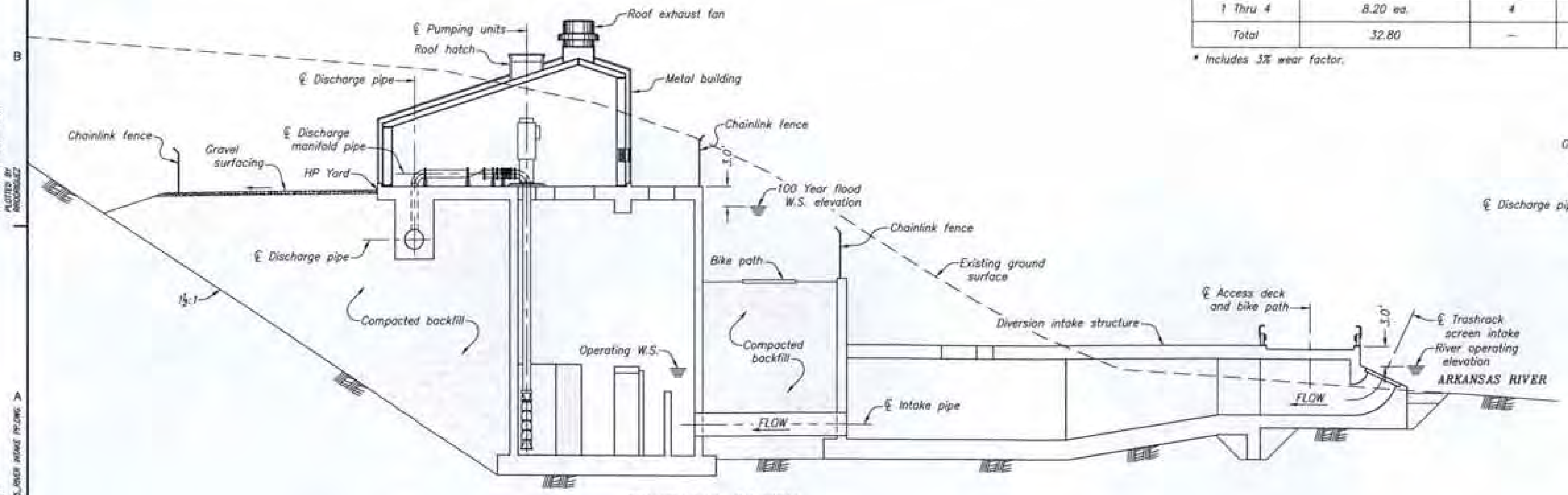
SITE PLAN



LONGITUDINAL SECTION

PUMP DATA				AIR CHAMBER		
PUMP NUMBER	RATED CAPACITY * (CFS)	NO. STAGES (EA.)	RATED HEAD (FT.)	CYLINDER DIA. (FT.)	CYLINDER H (FT.)	VOLUME (CU FT.)
1 Thru 4	8.20 ea.	4	205	7	14	629
Total	32.80	–	–	–	–	–

* Includes 3% wear factor.



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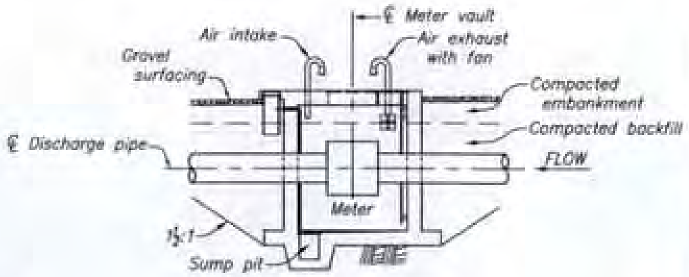

METER VAULT

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SCALE OF FEET
SITE PLAN

10 0 10 20 30
SCALE OF FEET
SECTIONS AND METER VAULT

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
FRYINGPAN–ARKANSAS PROJECT – COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
ALT. 5 – RIVER INTAKE PUMPING PLANT
SITE PLAN AND SECTIONS

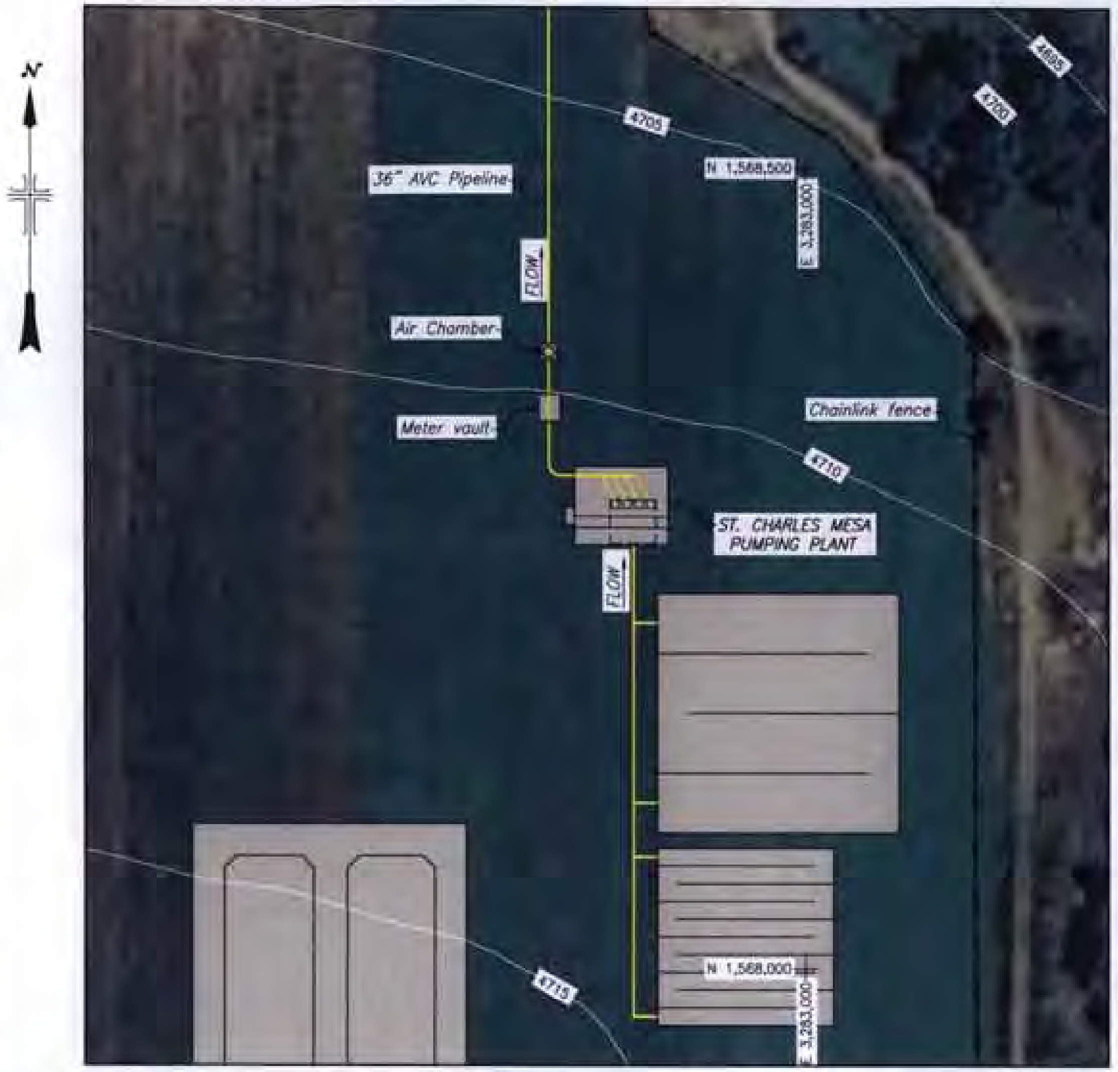
DESIGNED
REVIEWED Alfred J. Bernstein P.E.
ALFRED I. BERNSTEIN, P.E. – PLANT STRUCTURES GROUP
DENVER, COLORADO 2011-06-07

ALT. 5 – RIVER INTAKE
PUMPING PLANT
SITE PLAN & SECTIONS

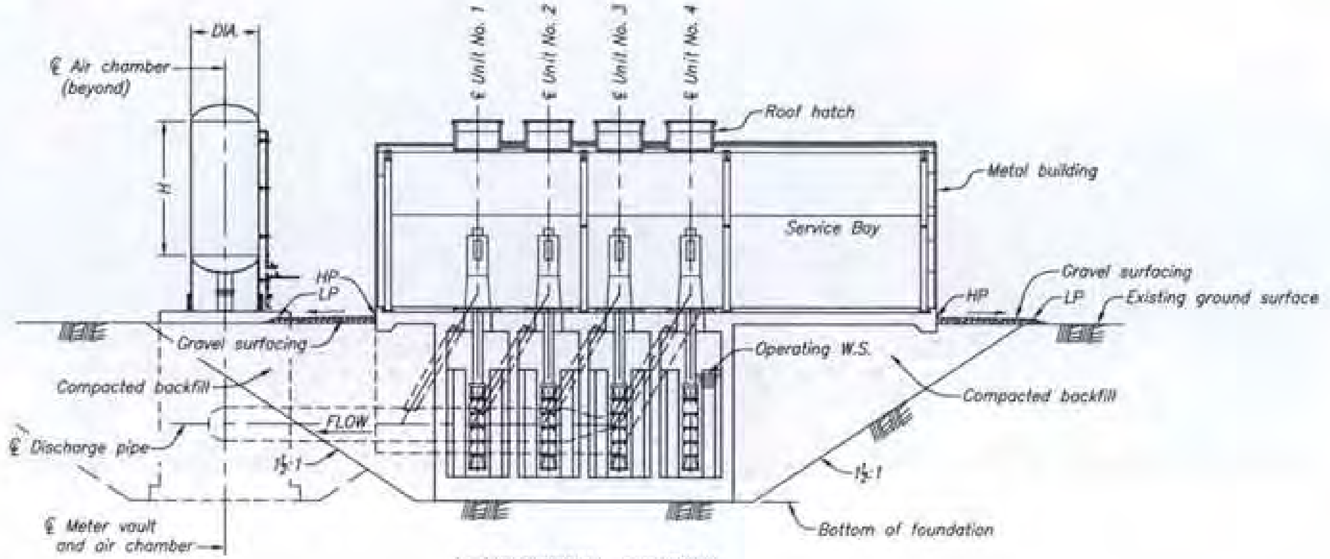
DRAWING 7
SHEET 1 OF 1

DATE AND TIME PLOTTED
FEBRUARY 27, 2012 14:58
PLOTTER BY
RRODRIGUEZ

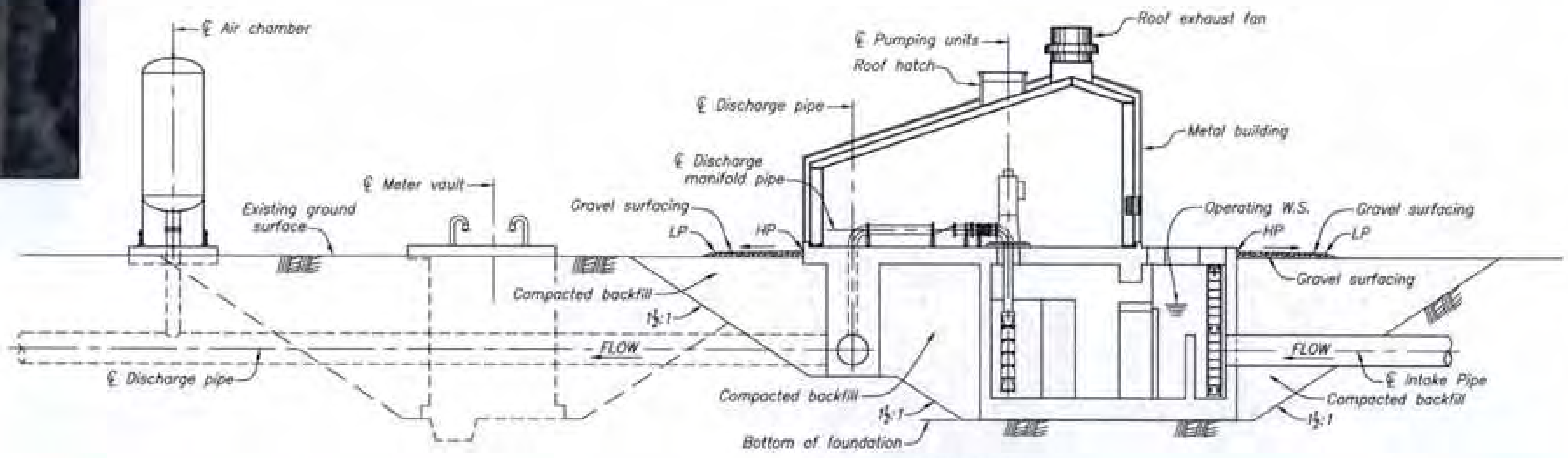
CAD SYSTEM
AutoCAD Rel. 18.1s
CAD FILENAME
DWG 7 AVC_ALT5_RIVER INTAKE PP.DWG



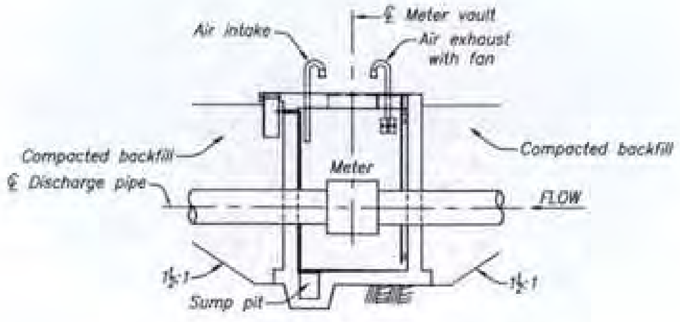
SITE PLAN



LONGITUDINAL SECTION



TRANSVERSE SECTION



METER VAULT

PUMP DATA				AIR CHAMBER		
PUMP NUMBER	RATED CAPACITY * (CFS)	NO. STAGES (EA.)	RATED HEAD (FT.)	CYLINDER DIA. (FT.)	CYLINDER H (FT.)	VOLUME (CU FT.)
1 Thru 4	5.70 ea.	4	130	5	11	249
Total	22.80	–	–	–	–	–

* Includes 3% wear factor.

60 0 60 120 180
SCALE OF FEET
SITE PLAN

10 0 10 20 30
SCALE OF FEET
SECTIONS AND METER VAULT

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BUREAU OF RECLAMATION

FRYINGPAN-ARKANSAS PROJECT – COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
ALT. 5 – ST. CHARLES MESA PUMPING PLANT
SITE PLAN AND SECTIONS

P Bailey
DESIGNED
Alfred I. Bernstein PE
REVIEWED
ALFRED I. BERNSTEIN, P.E. – PLANT STRUCTURES GROUP

DENVER, COLORADO 2011-06-01

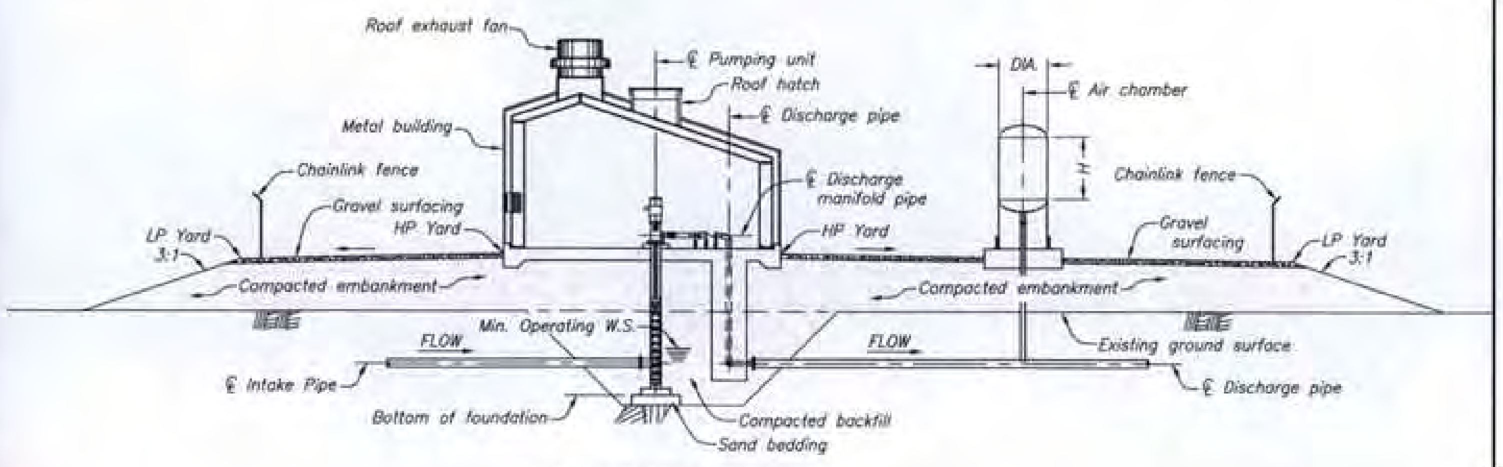
ALT. 5 – ST. CHARLES MESA
PUMPING PLANT
SITE PLAN & SECTIONS

DRAWING 8
SHEET 1 OF 1

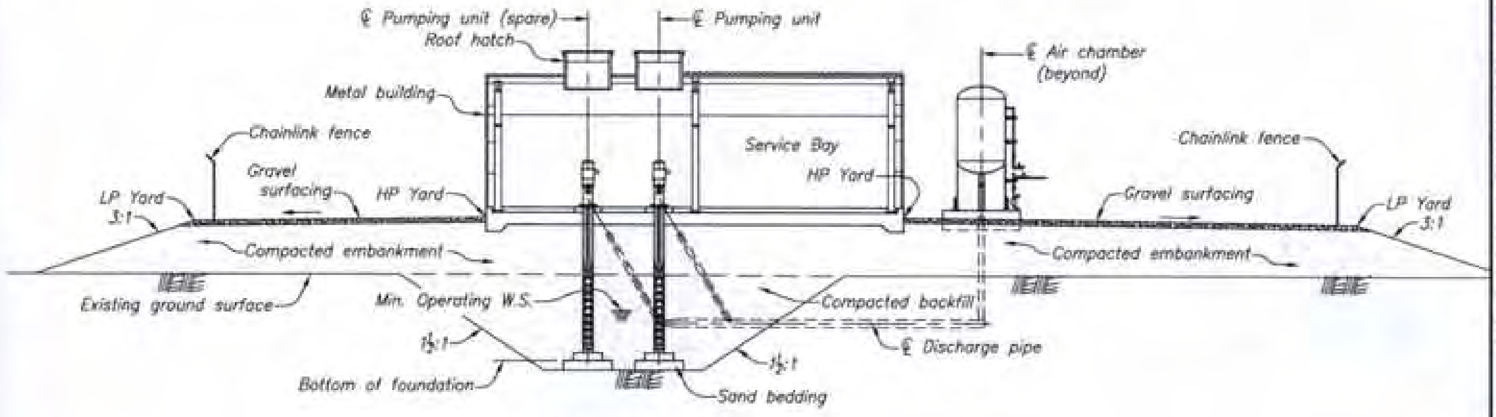
DATE AND TIME PLOTTED
FEBRUARY 27, 2012 10:49
PLOTTED BY
RRODRIGUEZ

CAD SYSTEM
AutoCAD Rel. 18.1s
CAD FILENAME
DWG 8 AVC_ALT5_ST. CHARLES MESA PP.DWG

SITE PLAN



TRANSVERSE SECTION



LONGITUDINAL SECTION

PUMP DATA					AIR CHAMBER		
ALTERNATIVE	PUMP NUMBER *	RATED CAPACITY (CFS)	NO. STAGES	RATED HEAD (FT.)	CYLINDER DIA. (FT.)	CYLINDER H (FT.)	VOLUME (CU FT.)
1	1	0.39 ea.**	9	317	5	6.5	160
2	1	1.125 ea.***	11	455	5	6.5	160
3	1	1.125 ea.***	9	405	5	6.5	160
4	1	1.125 ea.***	9	405	5	6.5	160
5	1	1.125 ea.***	11	455	5	6.5	160

* Pumping plant includes a spare canned type pump assembly in addition to number of pumps indicated in table.
** Includes 3% wear factor.
*** Does not include wear factor.

NOTE

1. The May Valley pipeline route is located south of the booster pumping plant for Alternative 1.

60 0 60 120 180
SCALE OF FEET
SITE PLAN

10 0 10 20 30
SCALE OF FEET
SECTIONS AND METER VAULT

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BUREAU OF RECLAMATION
FRYINGPAN-ARKANSAS PROJECT - COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
ALL ALTS. - EADS BOOSTER PUMPING PLANT
SITE PLAN AND SECTIONS

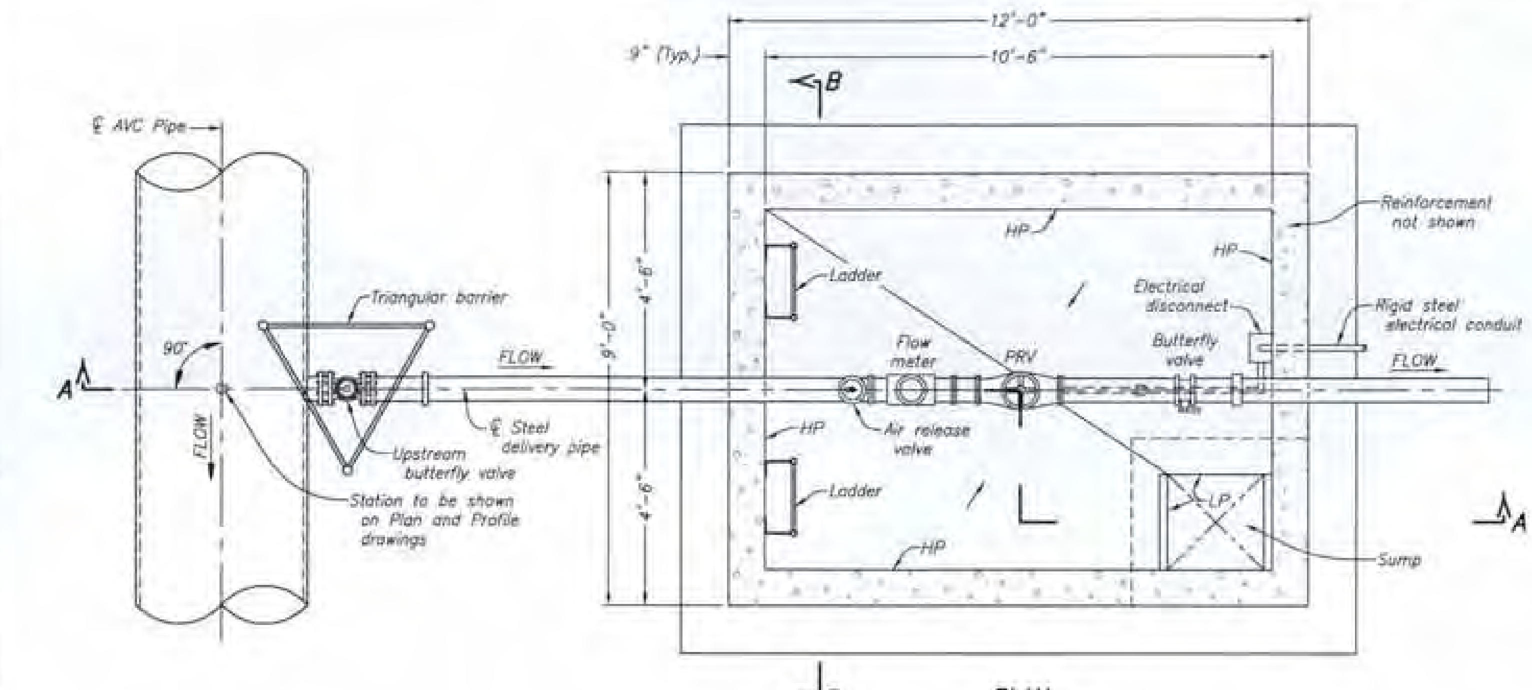
DESIGNED
REVIEWED Alfd I. B PE
ALFRED I. BERNSTEIN, P.E. - PLANT STRUCTURES GROUP
DENVER, COLORADO 2011-06-01

ALL ALTS. - EADS BOOSTER PUMPING PLANT
SITE PLAN & SECTIONS

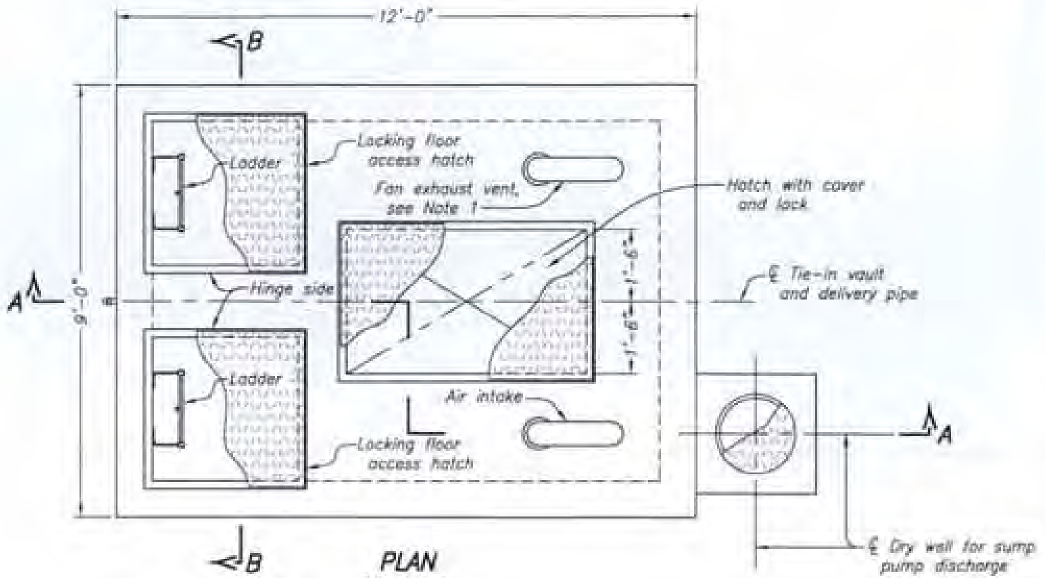
DRAWING 9
SHEET 1 OF 1

DATE AND TIME PLOTTED
FEBRUARY 27, 2012 14:59
PLOTTED BY
RRODRIGUEZ

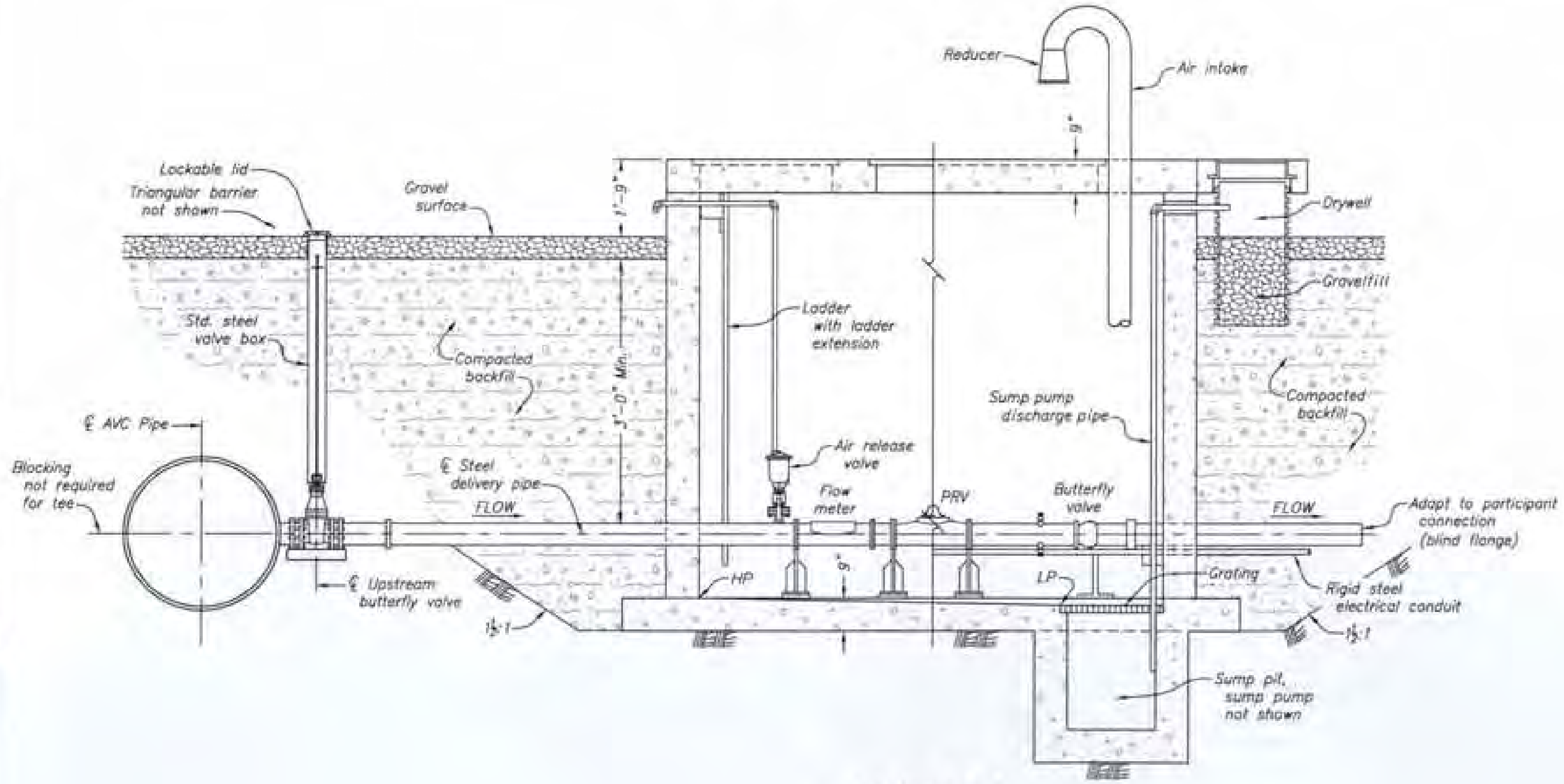
CAD SYSTEM
AutoCAD Rel. 18.1s
CAD FILENAME
DWG 9 EADS BOOSTER PP.DWG



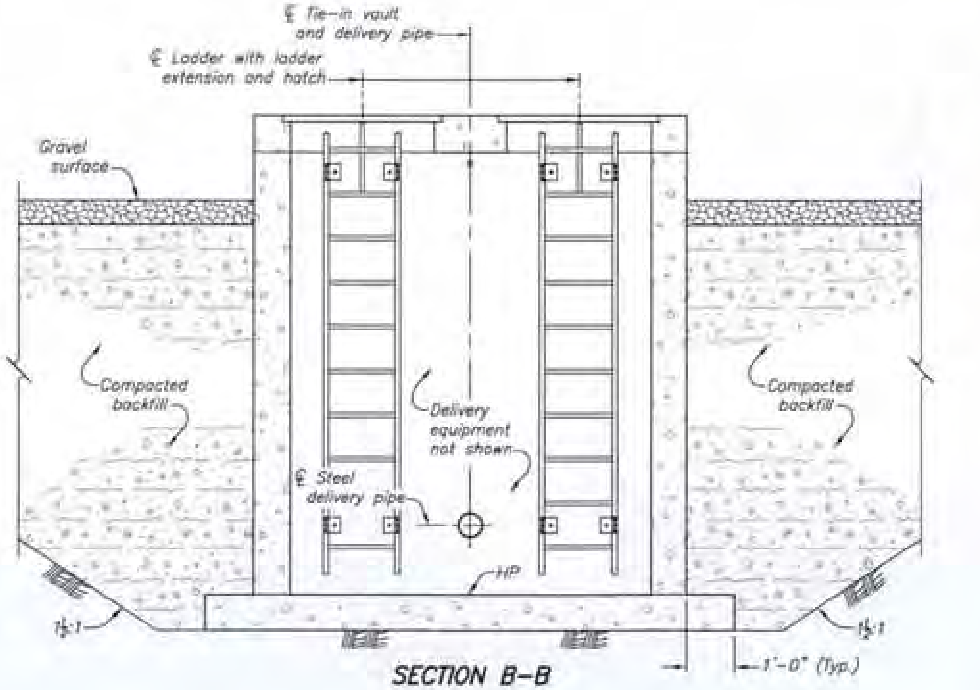
PLAN



PLAN
TOP COVER



SECTION A–A



SECTION B–B

NOTE

1. Mount fan on wall support and duct exhaust from less than 24" above floor. Min. 8" dia. inlet to duct.

1 0 1 2 3 4 5
SCALE OF FEET

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FRYINGPAN–ARKANSAS PROJECT – COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
ALL ALTS. – PARTICIPANT DELIVERY VAULT
PLANS AND SECTIONS

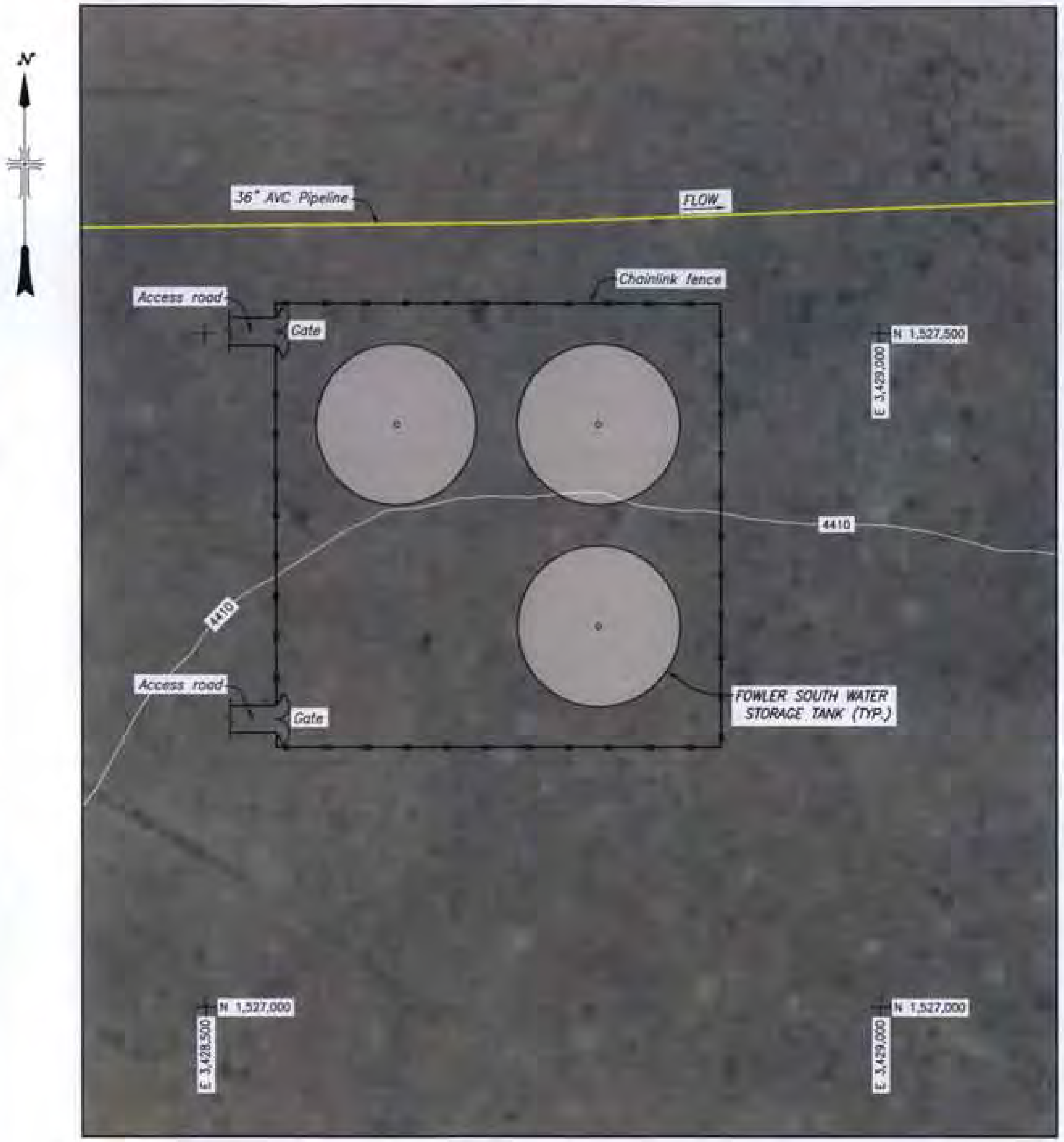
DESIGNED
REVIEWED
DAVID EDWARDS, P.E. – WATER CONVEYANCE GROUP
DENVER, COLORADO 2011-06-01

ALL ALTS. – PARTICIPANT
DELIVERY VAULT
PLANS & SECTIONS

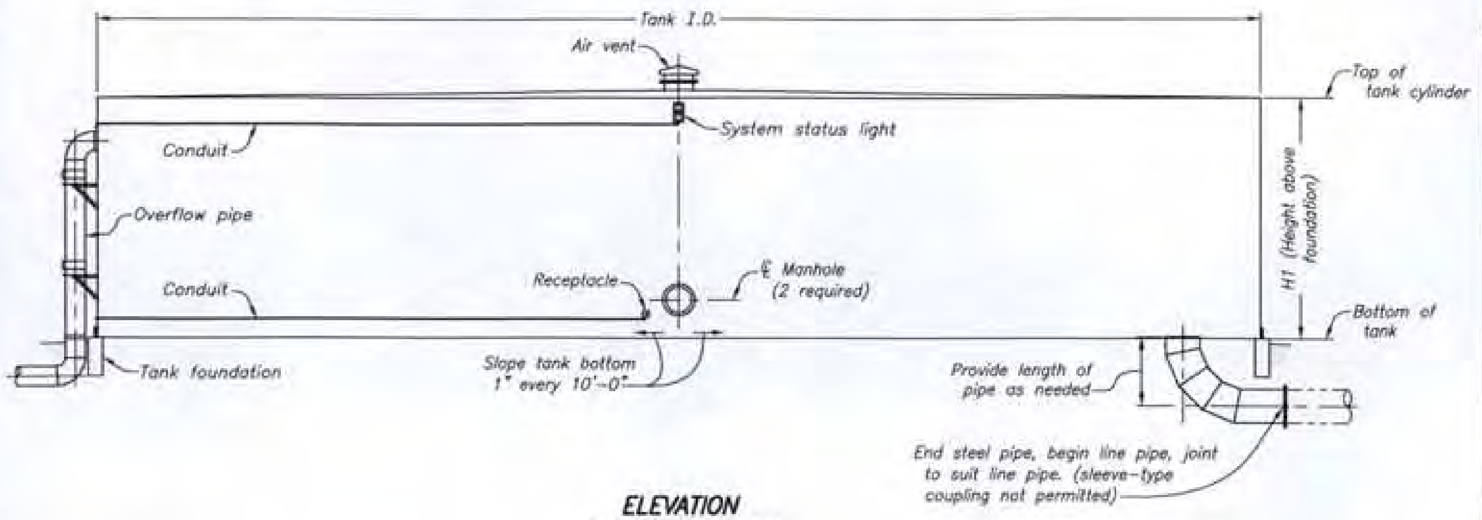
DRAWING 10
SHEET 1 OF 1

DATE AND TIME PLOTTED
FEBRUARY 27, 2012 10:07
PLOTTED BY
RRODRIGUEZ

CAD SYSTEM
AutoCAD Ver. 18.1s
CAD FILENAME
DWG 10 PARTICIPANT DELIVERY VAULT.DWG



SITE PLAN



ELEVATION
WATER STORAGE TANK

WATER STORAGE TANK						
ALTERNATIVE	NUMBER OF TANKS	EACH TANK CAPACITY (GAL.)	TANK I.D. (FT.)	HEIGHT ABOVE FOUNDATION – H1 (FT.)	NORTHING	EASTING
1	3	2,115,000	120	25	1,527,357	3,428,717
2	3	2,115,000	120	25	1,527,357	3,428,717

LONGITUDINAL SECTION THRU SERVICE YARD

60 0 60 120 180
SCALE OF FEET
SITE PLAN AND LONGITUDINAL SECTION

10 0 10 20 30
SCALE OF FEET
ELEVATION

DATE AND TIME PLOTTED
FEBRUARY 27, 2012 14:26
PLOTTED BY
RRODRIGUEZ

CAD SYSTEM
AutoCAD Rel. 18.1s
CAD FILENAME
DWG 11 AVC_ALT1&2_FOWLER SOUTH TANK.DWG

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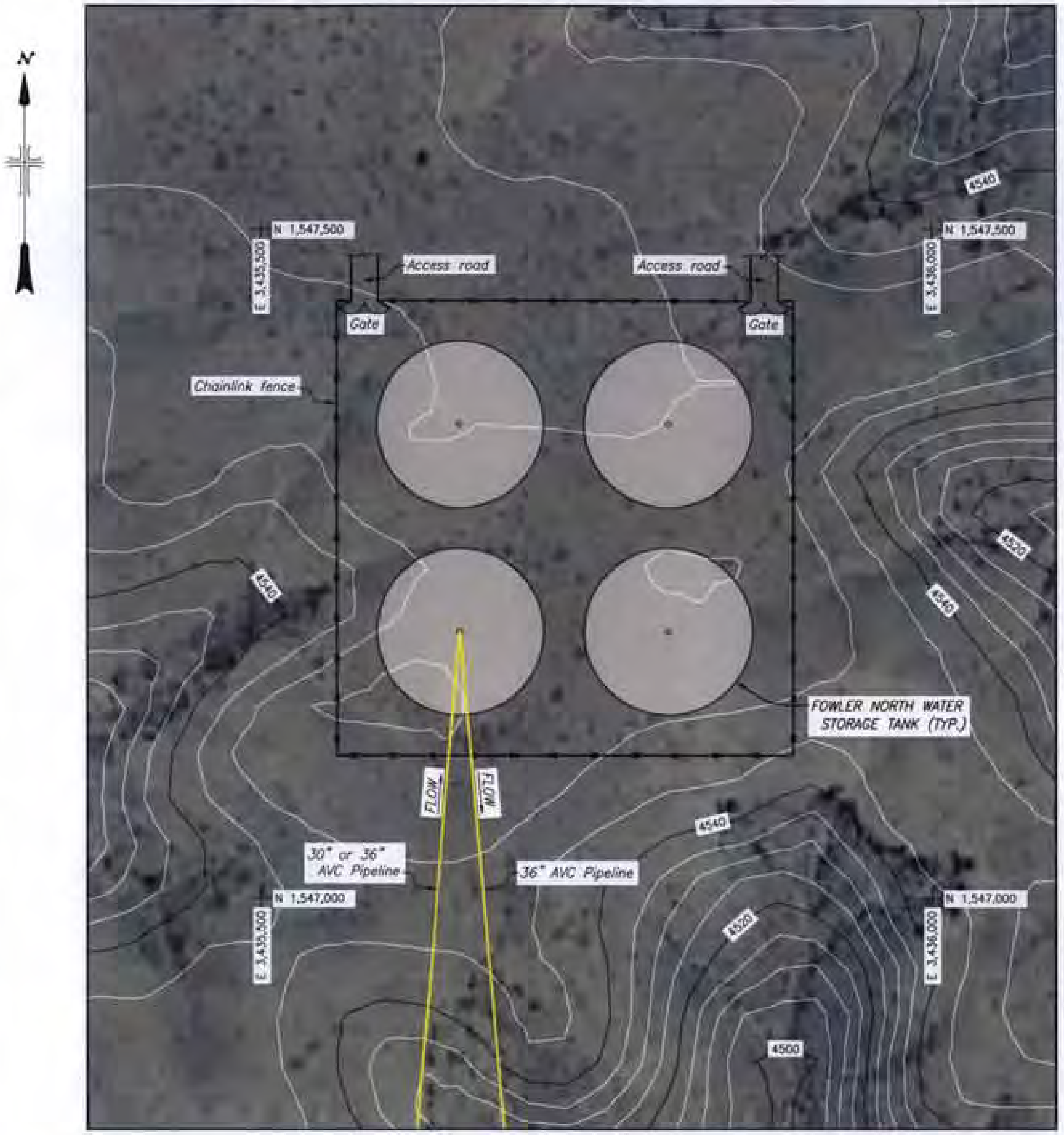
FRYINGPAN–ARKANSAS PROJECT – COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
ALTS. 1 & 2 – FOWLER SOUTH WATER STORAGE TANK
SITE PLAN, ELEVATION, AND SECTION

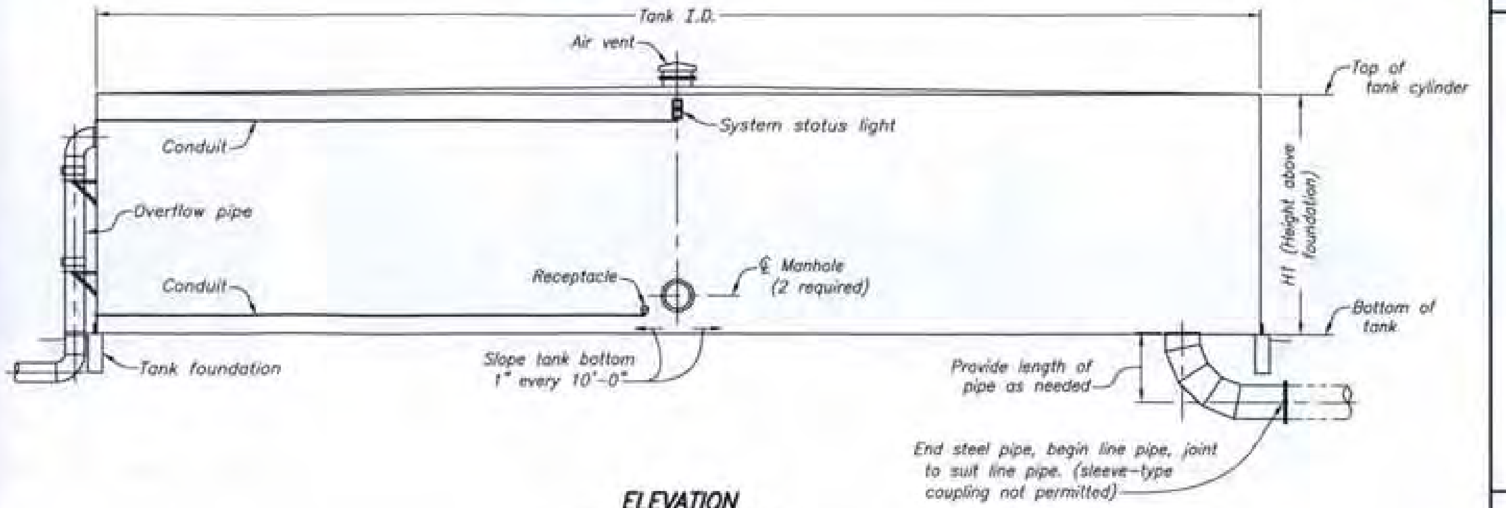
DESIGNED
RB
REVIEWED
K.R. Smith
K.R. SMITH, P.E. – HYDRAULIC EQUIPMENT GROUP
DENVER, COLORADO 2011-06-01

ALTS. 1 & 2 –
FOWLER SOUTH
WATER STORAGE TANK

DRAWING 11
SHEET 1 OF 1



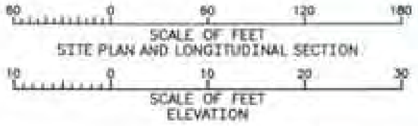
SITE PLAN



ELEVATION
WATER STORAGE TANK

WATER STORAGE TANK						
ALTERNATIVE	NUMBER OF TANKS	EACH TANK CAPACITY (GAL.)	TANK I.D. (FT.)	HEIGHT ABOVE FOUNDATION - H1 (FT.)	NORTHING	EASTING
3	4	2,295,000	125	25	1,547,276	3,435,727
4	4	2,295,000	125	25	1,547,276	3,435,727
5	4	2,295,000	125	25	1,547,276	3,435,727

LONGITUDINAL SECTION THRU SERVICE YARD



SCALE OF FEET
SITE PLAN AND LONGITUDINAL SECTION

SCALE OF FEET
ELEVATION

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FRYINGPAN-ARKANSAS PROJECT - COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
ALTS. 3, 4, & 5 - FOWLER NORTH WATER STORAGE TANK
SITE PLAN, ELEVATION, AND SECTION

DESIGNED
K.R. Smith
REVIEWED
K.R. SMITH, P.E. - HYDRAULIC EQUIPMENT GROUP
DENVER, COLORADO 2011-06-0

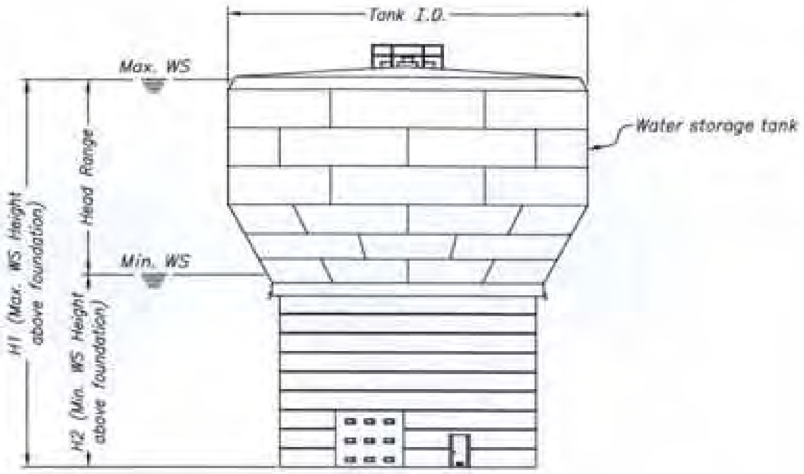
ALTS. 3, 4, & 5 -
FOWLER NORTH
WATER STORAGE TANK

DRAWING 12
SHEET 1 OF 1

DATE AND TIME PLOTTED
FEBRUARY 27, 2012 14:37
PLOTTED BY
RRODRIGUEZ

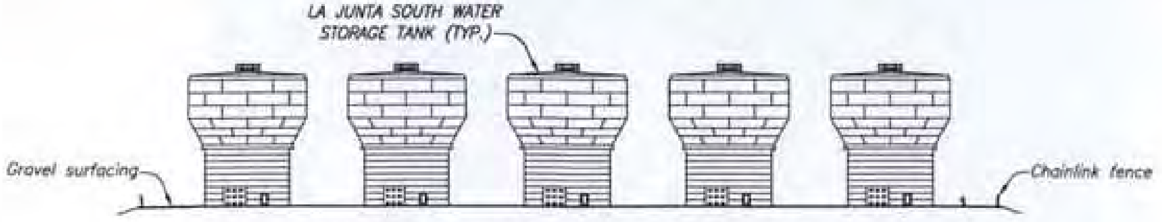
CAD SYSTEM
AutoCAD Rel. 18.1s
CAD FILENAME
DWG 12 AVC_ALT3,4,&5_FOWLER NORTH TANK.DWG

SITE PLAN



ELEVATION
WATER STORAGE TANK

WATER STORAGE TANK							
ALTERNATIVE	NUMBER OF TANKS	EACH TANK CAPACITY (GAL.)	TANK I.D. (FT.)	MAX. WS HEIGHT ABOVE FOUNDATION – H1 (FT.)	MIN. WS HEIGHT ABOVE FOUNDATION – H2 (FT.)	NORTHING	EASTING
1	5	1,000,000	74	80	40	1,485,880	3,571,152
2	5	1,000,000	74	65	25	1,485,880	3,571,152



LONGITUDINAL SECTION THRU SERVICE YARD
ALTERNATIVES 1 (AS SHOWN)
ALTERNATIVE 2 (SIMILAR)

60 0 60 120 180
SCALE OF FEET
SITE PLAN AND LONGITUDINAL SECTION

20 0 20 40 60
SCALE OF FEET
ELEVATION

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FRYINGPAN–ARKANSAS PROJECT – COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
ALTS. 1 & 2 – LA JUNTA SOUTH WATER STORAGE TANK
SITE PLAN, ELEVATION, AND SECTION

DESIGNED
K.R. Smith
REVIEWED
K.R. SMITH, P.E. – HYDRAULIC EQUIPMENT GROUP
DENVER, COLORADO 2011-06-01

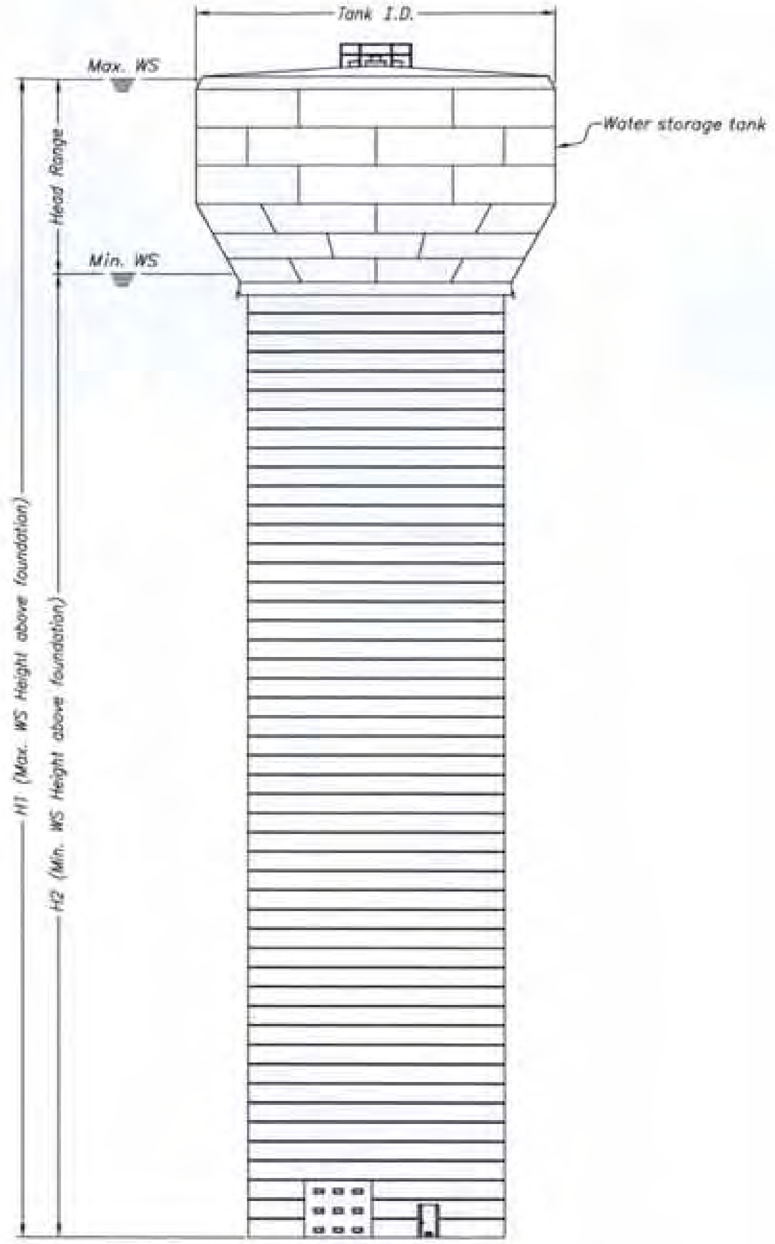
ALTS. 1 & 2 –
LA JUNTA SOUTH
WATER STORAGE TANK

DRAWING 13
SHEET 1 OF 1

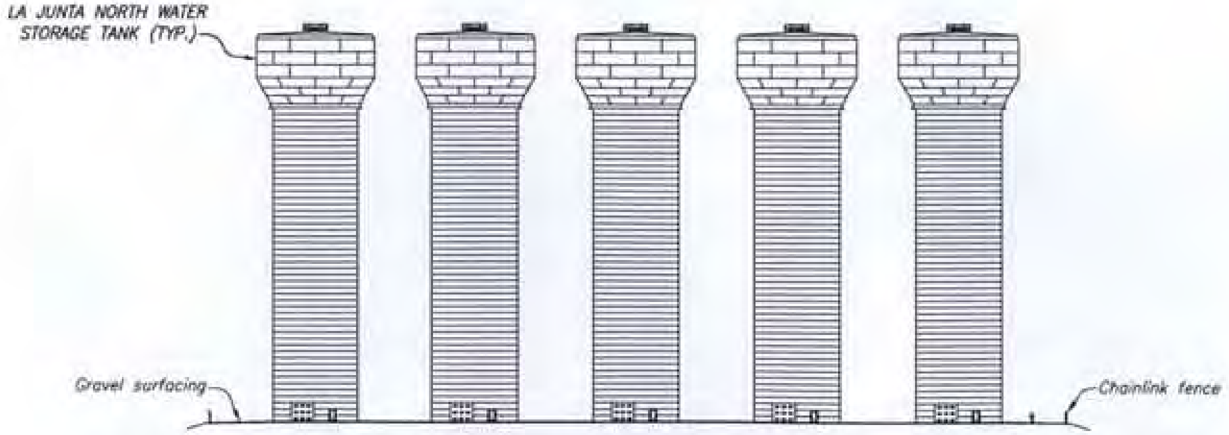
DATE AND TIME PLOTTED
FEBRUARY 27, 2012 14:39
PLOTTED BY
RRODRIGUEZ

CAD SYSTEM
AutoCAD Rel. 18.1s
CAD FILENAME
DWG 13 AVC_ALT1&2_LAJUNTA SOUTH TANK.DWG

SITE PLAN



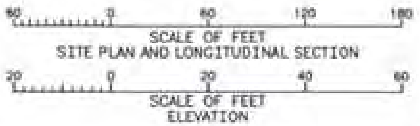
ELEVATION
WATER STORAGE TANK



LONGITUDINAL SECTION THRU SERVICE YARD
ALTERNATIVES 3 AND 4 (AS SHOWN)
ALTERNATIVE 5 (SIMILAR)

WATER STORAGE TANK

ALTERNATIVE	NUMBER OF TANKS	TANK CAPACITY (GAL.)	TANK I.D. (FT.)	MAX. WS HEIGHT ABOVE FOUNDATION – H1 (FT.)	MIN. WS HEIGHT ABOVE FOUNDATION – H2 (FT.)	NORTHING	EASTING
3	5	1,000,000	74	240	200	1,522,650	3,573,250
4	5	1,000,000	74	240	200	1,522,650	3,573,250
5	5	1,000,000	74	90	50	1,522,650	3,573,250



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BUREAU OF RECLAMATION

FRYINGPAN–ARKANSAS PROJECT – COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
ALTS. 3, 4, & 5 – LA JUNTA NORTH WATER STORAGE TANK
SITE PLAN, ELEVATION, AND SECTION

DESIGNED
K.R. Smith
REVIEWED
K.R. SMITH, P.E. – HYDRAULIC EQUIPMENT GROUP
DENVER, COLORADO 2011-06-01

ALTS. 3, 4, & 5 –
LA JUNTA NORTH
WATER STORAGE TANK

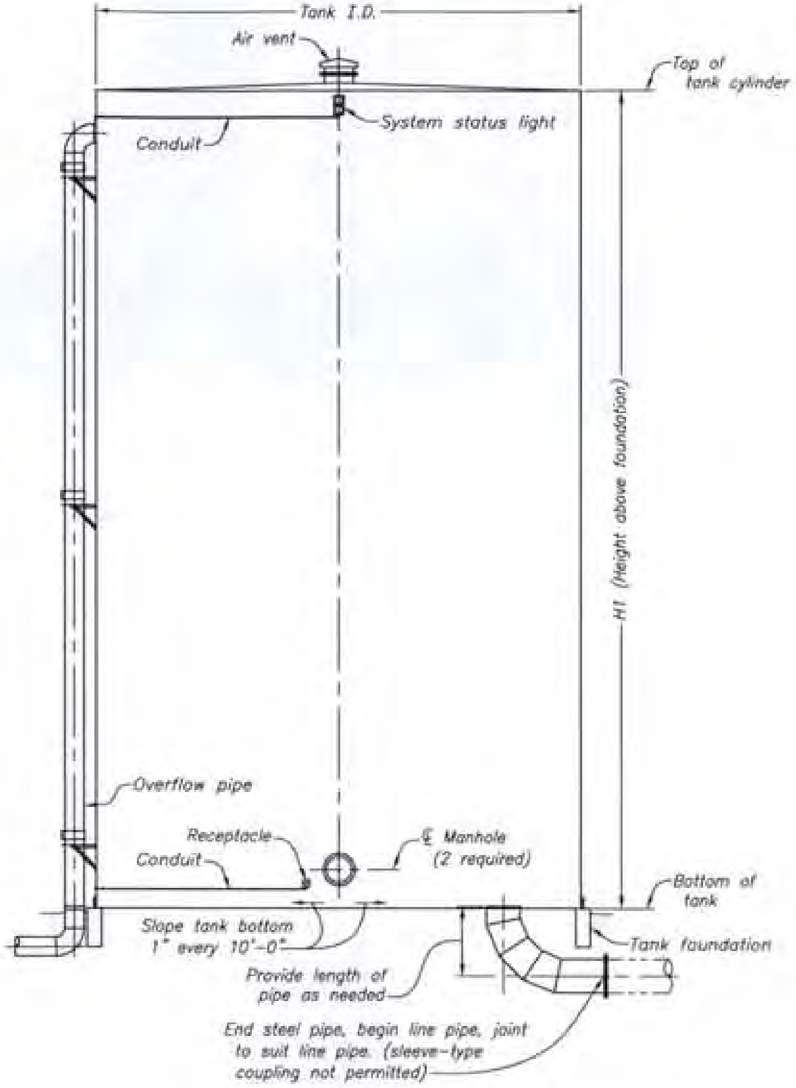
DRAWING 14
SHEET 1 OF 1

DATE AND TIME PLOTTED
FEBRUARY 27, 2012 14:40
PLOTTED BY
RRODRIGUEZ

CAD SYSTEM
AutoCAD Rel. 18.1s
CAD FILENAME
DWG 14 AVC_ALTS. 4, & 5_LAJUNTA NORTH TANK.DWG

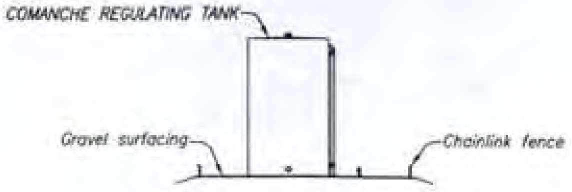
RECLAMATION
Managing Water in the West

SITE PLAN



ELEVATION
WATER REGULATING TANK

REGULATING TANK						
ALTERNATIVE	NUMBER OF TANKS	TANK CAPACITY (GAL.)	TANK I.D. (FT.)	HEIGHT ABOVE FOUNDATION– H1 (FT.)	NORTHING	EASTING
1	1	1,250,000	50	85	1,563,349	3,236,031



LONGITUDINAL SECTION THRU SERVICE YARD

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

FRYINGPAN–ARKANSAS PROJECT – COLORADO

ARKANSAS VALLEY CONDUIT

APPRAISAL DESIGN REPORT

ALT. 1 – COMANCHE REGULATING TANK
SITE PLAN, ELEVATION, AND SECTION

DESIGNED

K.R. Smith
REVIEWED
K.R. SMITH, P.E. – HYDRAULIC EQUIPMENT GROUP

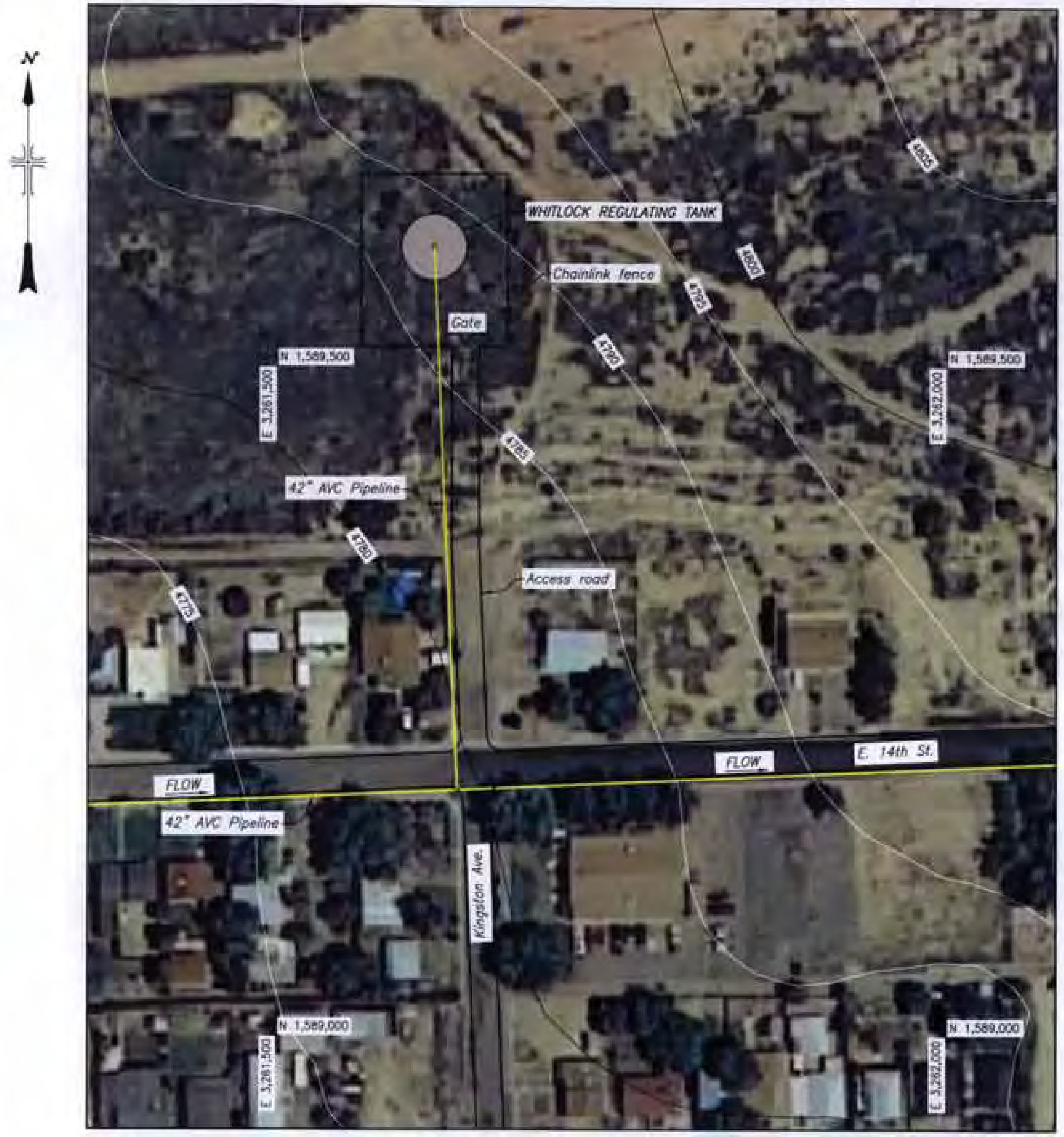
DENVER, COLORADO 2011-08-01

ALT. 1 – COMANCHE REGULATING TANK

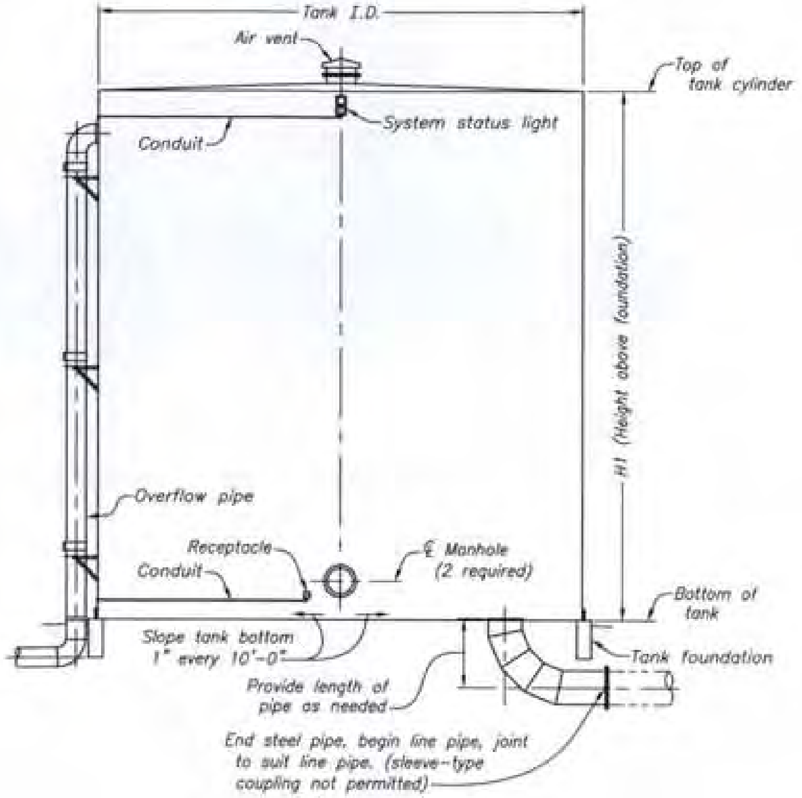
DRAWING 15
SHEET 1 OF 1

DATE AND TIME PLOTTED
FEBRUARY 27, 2012 14:42
PLOTTED BY
RRODRIGUEZ

CAD SYSTEM
AutoCAD Rel. 18.1s
CAD FILENAME
DWG 15 AVC_ALT1_COMANCHE REG. TANK.DWG

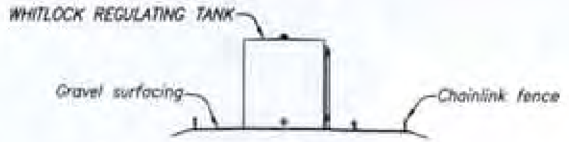


SITE PLAN

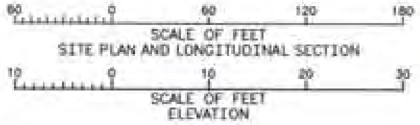


ELEVATION
WATER REGULATING TANK

REGULATING TANK						
ALTERNATIVE	NUMBER OF TANKS	TANK CAPACITY (GAL.)	TANK I.D. (FT.)	HEIGHT ABOVE FOUNDATION – H1 (FT.)	NORTHING	EASTING
3	1	590,000	50	40	1,589,573	3,261,546
4	1	810,000	50	55	1,589,573	3,261,546



LONGITUDINAL SECTION THRU SERVICE YARD
ALTERNATIVES 4 (AS SHOWN)
ALTERNATIVE 3 (SIMILAR)



DATE AND TIME PLOTTED
FEBRUARY 27, 2012 14:43
PLOTTED BY
RRODRIGUEZ

CAD SYSTEM
AutoCAD Rel. 18.1s
CAD FILENAME
DWG 16 AVC_ALT3&4_WHITLOCK REG. TANK.DWG

RECLAMATION
Managing Water in the West

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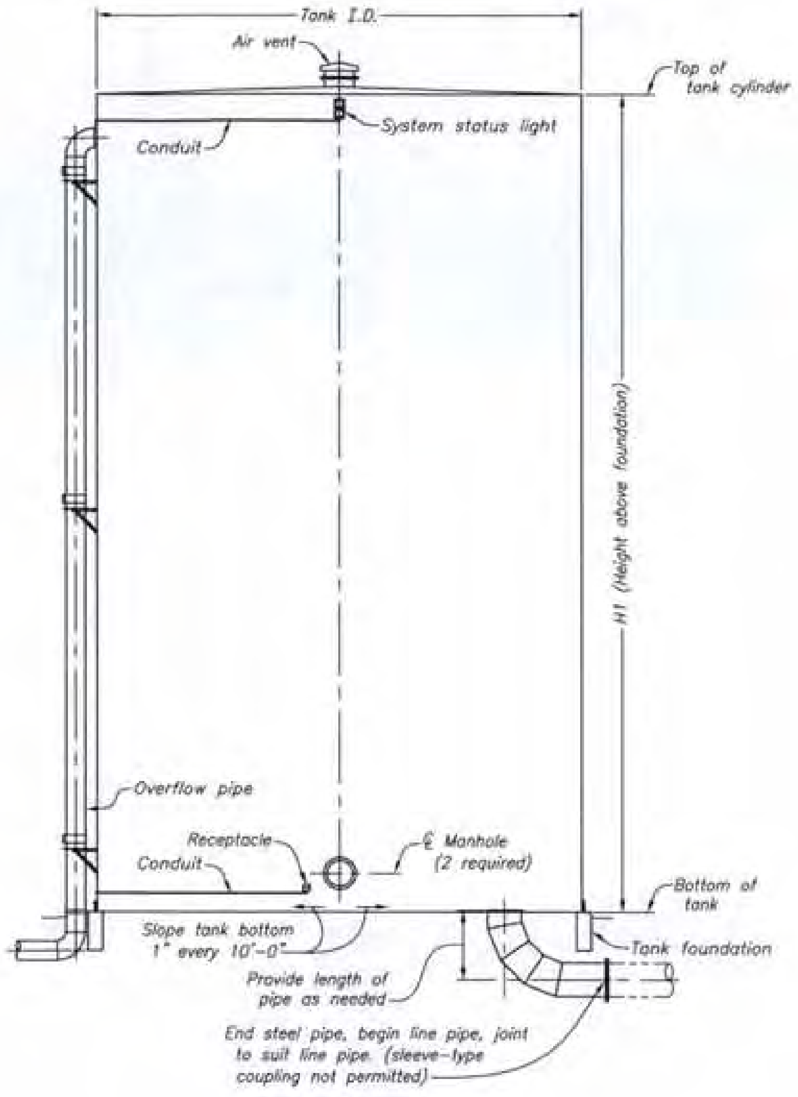
BUREAU OF RECLAMATION
FRYINGPAN-ARKANSAS PROJECT – COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
ALTS. 3 & 4 – WHITLOCK REGULATING TANK
SITE PLAN, ELEVATION, AND SECTION

DESIGNED
K.R. Smith
REVIEWED
K.R. SMITH, P.E. – HYDRAULIC EQUIPMENT GROUP
DENVER, COLORADO 2011-08-01

ALTS. 3 & 4 – WHITLOCK
REGULATING TANK
SITE PLAN, ELEVATION, &
SECTION

DRAWING 16
SHEET 1 OF 1

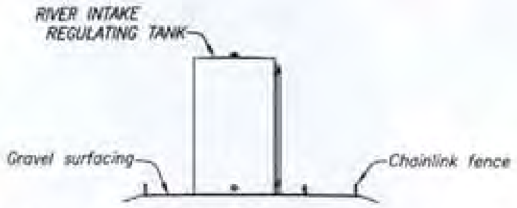
SITE PLAN



ELEVATION

WATER REGULATING TANK

REGULATING TANK						
ALTERNATIVE	NUMBER OF TANKS	TANK CAPACITY (GAL.)	TANK I.D. (FT.)	HEIGHT ABOVE FOUNDATION– H1 (FT.)	NORTHING	EASTING
5	1	1,250,000	50	85	1,575,388	3,261,914



LONGITUDINAL SECTION THRU SERVICE YARD

60 0 60 120 180
SCALE OF FEET
SITE PLAN AND LONGITUDINAL SECTION

10 0 10 20 30
SCALE OF FEET
ELEVATION

DATE AND TIME PLOTTED
FEBRUARY 27, 2012 14:45
PLOTTED BY
RRODRIGUEZ

CAD SYSTEM
AutoCAD Rel. 18.1x
CAD FILENAME
DWG 17 AVC_ALT5_RIVER INTAKE REG TANK.dwg

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Managing Water in the West

ALWAYS THINK SAFETY

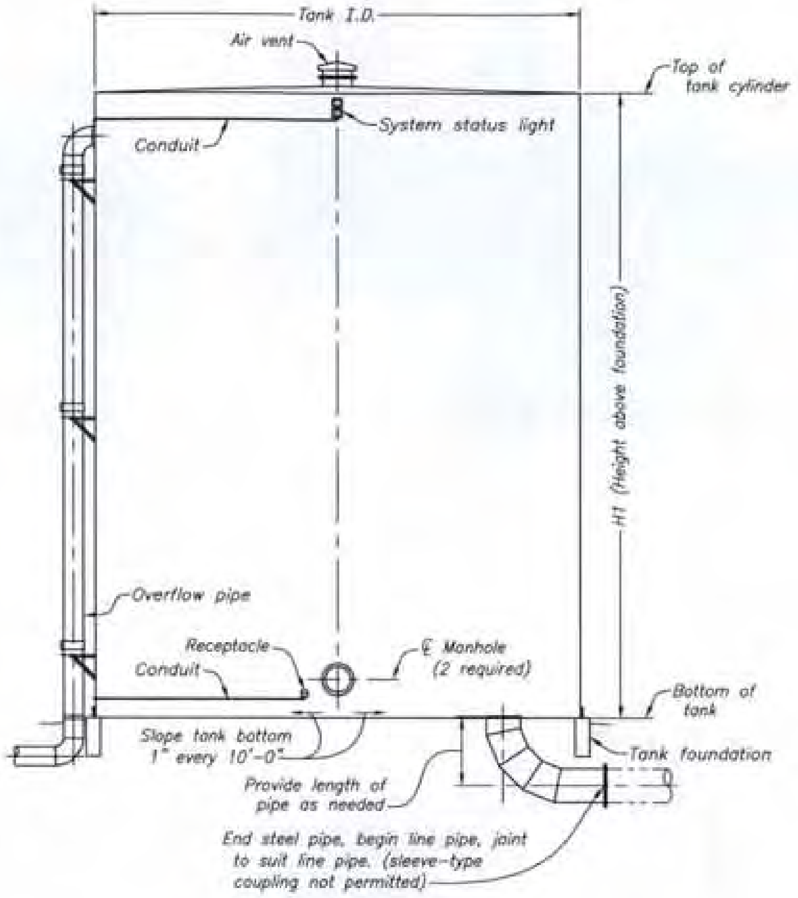
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
FRYINGPAN–ARKANSAS PROJECT – COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
ALT. 5 – RIVER INTAKE REGULATING TANK
SITE PLAN, ELEVATION, AND SECTION

B Ball
DESIGNED
K.R. Smith
REVIEWED
K.R. SMITH, P.E. – HYDRAULIC EQUIPMENT GROUP
DENVER, COLORADO 2011-08-01

ALT. 5 – RIVER INTAKE REGULATING TANK

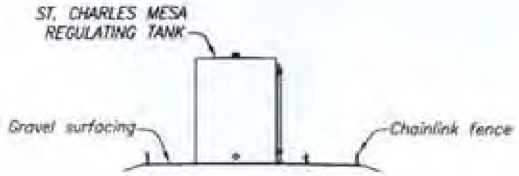
DRAWING 17
SHEET 1 OF 1

SITE PLAN

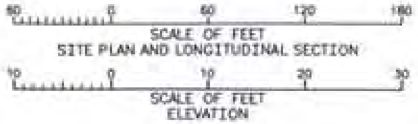


ELEVATION
WATER REGULATING TANK

REGULATING TANK						
ALTERNATIVE	NUMBER OF TANKS	TANK CAPACITY (GAL.)	TANK I.D. (FT.)	HEIGHT ABOVE FOUNDATION – H1 (FT.)	NORTHING	EASTING
5	1	960,000	50	65	1,569,747	3,291,205



LONGITUDINAL SECTION THRU SERVICE YARD



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FRYINGPAN–ARKANSAS PROJECT – COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL DESIGN REPORT
ALT. 5 – ST. CHARLES MESA REGULATING TANK
SITE PLAN, ELEVATION, AND SECTION

P. Ba
DESIGNED

K.R. Smith
REVIEWED
K.R. SMITH, P.E. – HYDRAULIC EQUIPMENT GROUP

DENVER, COLORADO 2011-06-01

ALT. 5 – ST. CHARLES MESA
REGULATING TANK

DRAWING 18
SHEET 1 OF 1

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FRYINGPAN–ARKANSAS PROJECT - COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL LEVEL DESIGN
WATER TREATMENT FACILITIES
KEY MAP

B&V
DRAWN
Ron LeBlanc, P.E.
ACCEPTED
RON LEBLANC, P.E.
PLANT STRUCTURES GROUP
DENVER, COLORADO 2011-09-06

WATER TREATMENT FACILITIES
KEY MAP

DRAWING 19
SHEET 1 OF 1

DATE AND TIME PLOTTED
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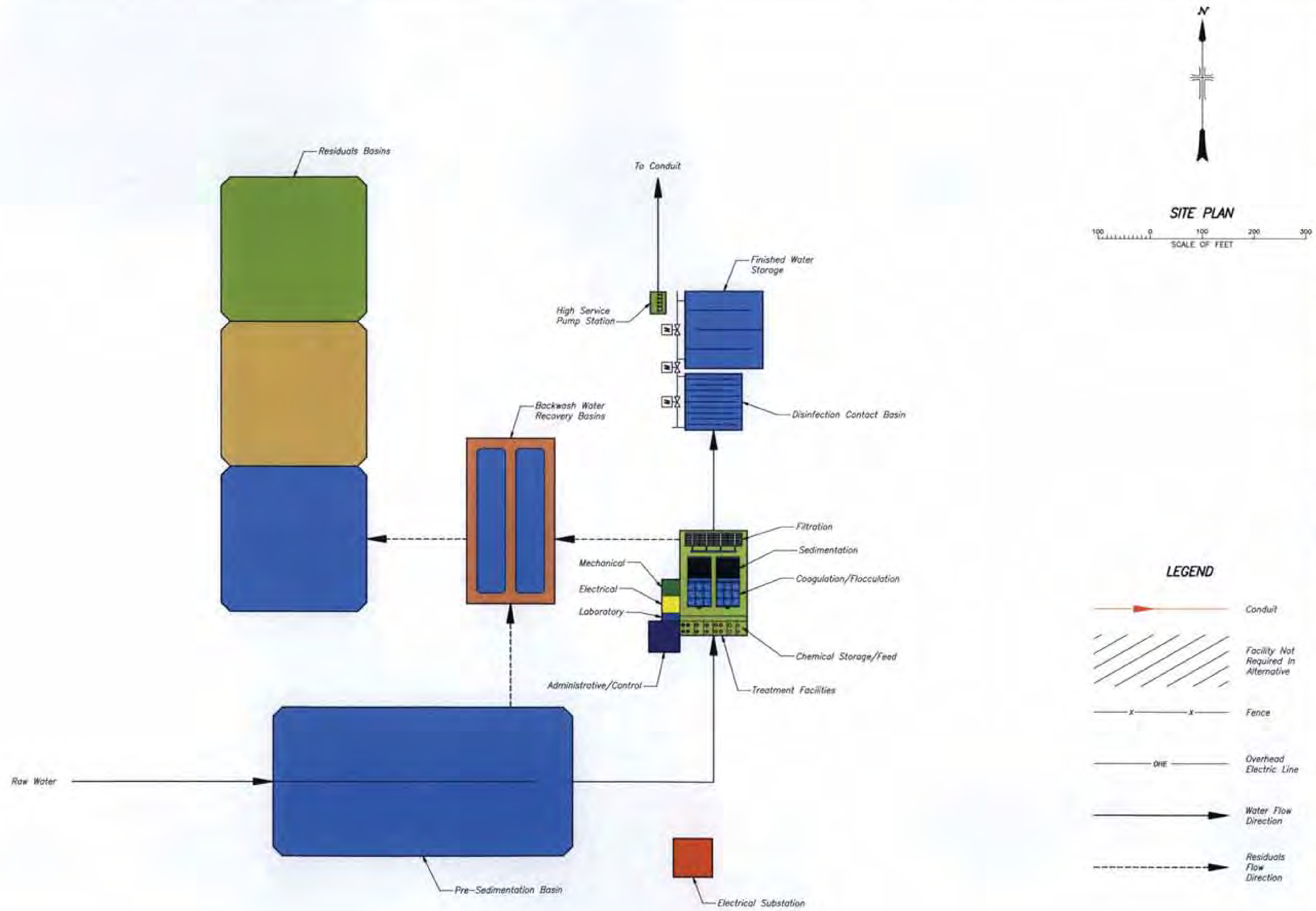

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ARKANSAS VALLEY CONDUIT
APPRAISAL LEVEL DESIGN
WATER TREATMENT FACILITIES
LEGEND

B&V
DRAWN
Ron LeBlanc PE
ACCEPTED
RON LEBLANC, P.E.
PLANT STRUCTURES GROUP
DENVER, COLORADO 2011-09-06

WATER TREATMENT FACILITIES LEGEND

DRAWING 20
SHEET 1 OF 1

DATE AND TIME PLOTTED
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PRODRIGUEZ

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DATE AND TIME PLOTTED
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PLOTTED BY
RRODRIGUEZ

CAD SYSTEM
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CAD FILENAME
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ARKANSAS VALLEY CONDUIT
APPRAISAL LEVEL DESIGN
ALT. 1A – COMANCHE SOUTH WATER TREATMENT PLANT
(D/S OF ST. CHARLES MESA) – SITE PLAN

B&V
DRAWN
Ron LeBlanc, PE
ACCEPTED
RON LEBLANC, P.E.
PLANT STRUCTURES GROUP
DENVER, COLORADO 2011-09-08

ALT. 1A –
COMANCHE SOUTH
WATER TREATMENT PLANT

DRAWING 21
SHEET 1 OF 1

SITE PLAN

LEGEND

Conduit

Facility Not Required In Alternative

Fence

Overhead Electric Line

CAD SYSTEM
AutoCAD Rel. 18.1x
CAD FILENAME
AVC_ALT1B_COMANCHE SOUTH WTP.DWG

DATE AND TIME PLOTTED
FEBRUARY 29, 2012 09:06
PLOTTED BY
RRODRIGUEZ

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ARKANSAS VALLEY CONDUIT

APPRAISAL LEVEL DESIGN

ALT. 1B – COMANCHE SOUTH WATER TREATMENT PLANT
(D/S OF ST. CHARLES MESA) – SITE PLAN

B&V
DRAWN

Ron LeBlanc, P.E.
ACCEPTED
RON LEBLANC, P.E.
PLANT STRUCTURES GROUP

DENVER, COLORADO 2011-09-06

ALT. 1B –
COMANCHE SOUTH
WATER TREATMENT PLANT

DRAWING 22
SHEET 1 OF 1

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ARKANSAS VALLEY CONDUIT
APPRAISAL LEVEL DESIGN
ALT. 2 – PUEBLO DAM SOUTH WATER TREATMENT PLANT
(NEAR SOUTH RD. & 21ST ST.) – SITE PLAN

B&V
DRAWN
Ron LeBlanc, P.E.
ACCEPTED
RON LEBLANC, P.E.
PLANT STRUCTURES GROUP
DENVER, COLORADO 2011-09-06

ALT. 2 –
PUEBLO DAM SOUTH
WATER TREATMENT PLANT

DRAWING 23
SHEET 1 OF 1

DATE AND TIME PLOTTED
FEBRUARY 29, 2012 12:19
PLOTTED BY
RRODRIGUEZ

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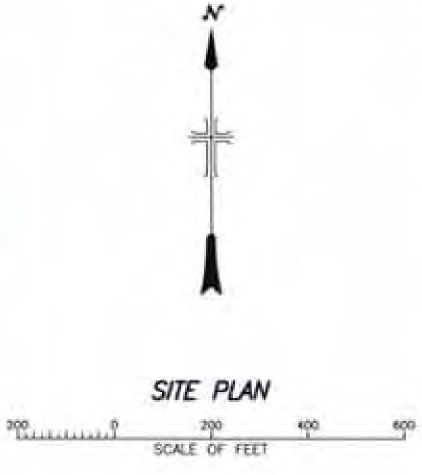
SITE PLAN



LEGEND

▶	Conduit
▨	Facility Not Required In Alternative
——x——x——	Fence
—— OHE ——	Overhead Electric Line

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ARKANSAS VALLEY CONDUIT
APPRAISAL LEVEL DESIGN
ALT. 3 – JUP NORTH WATER TREATMENT PLANT
(AT WHITLOCK WTP) – SITE PLAN

B&V
DRAWN
Ron LeBlanc PE
ACCEPTED
RON LEBLANC, P.E.
PLANT STRUCTURES GROUP
DENVER, COLORADO 2011-09-08

ALT. 3 –
JUP NORTH
WATER TREATMENT PLANT

DRAWING 24
SHEET 1 OF 1

DATE AND TIME PLOTTED
MARCH 9, 2012 09:44
PLOTTED BY
RRODRIGUEZ

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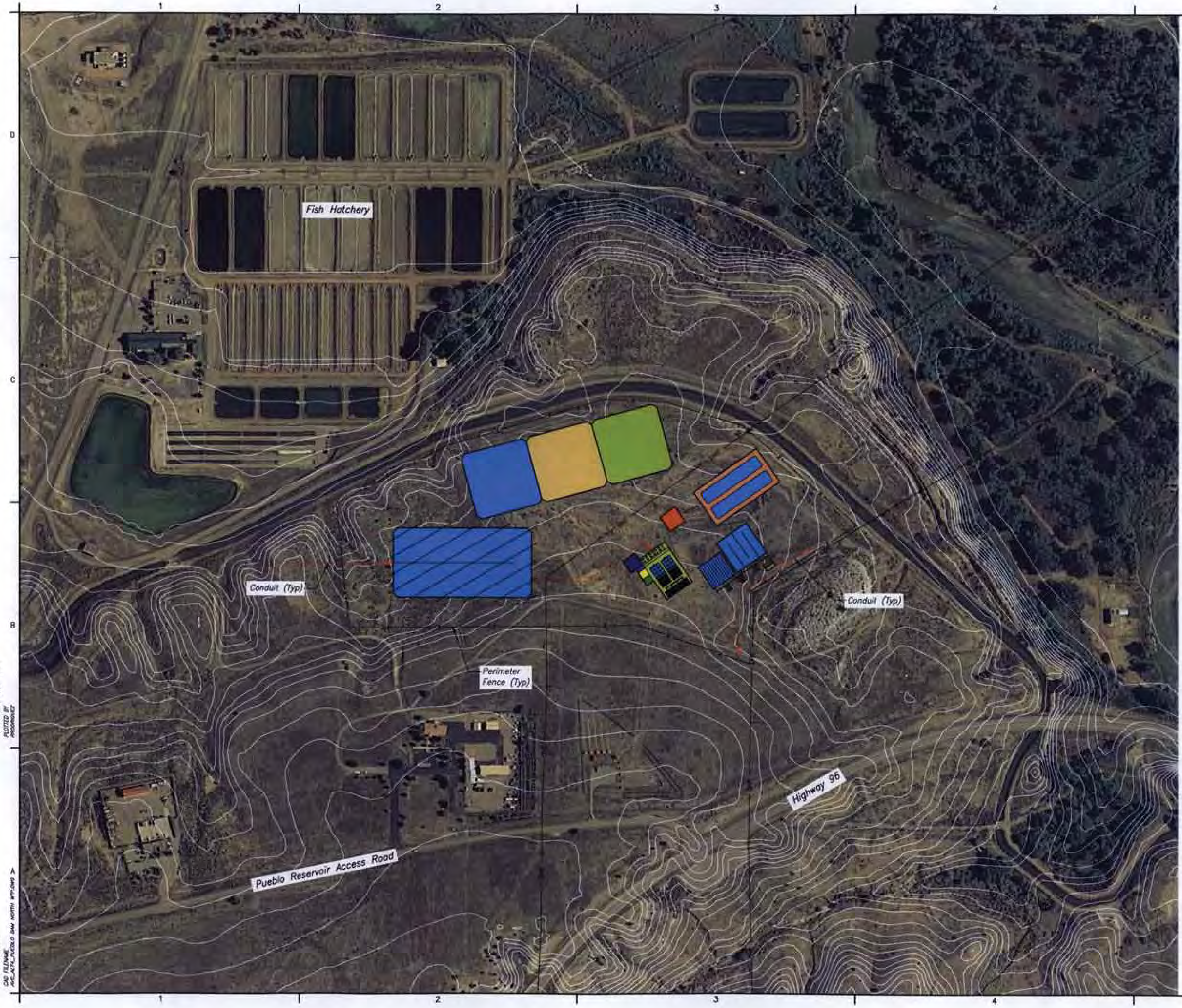

SITE PLAN

LEGEND

─►	Conduit
▨	Facility Not Required In Alternative
——x——x——	Fence
—— OHE ——	Overhead Electric Line

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FRYINGPAN–ARKANSAS PROJECT – COLORADO
ARKANSAS VALLEY CONDUIT
APPRAISAL LEVEL DESIGN
ALT. 4 – PUEBLO DAM NORTH WATER TREATMENT PLANT
(AT PUEBLO RES.) – SITE PLAN

B&V
DRAWN
Ron Leblanc, P.E.
ACCEPTED
RON LEBLANC, P.E.
PLANT STRUCTURES GROUP
DENVER, COLORADO 2011-09-06

ALT. 4 –
PUEBLO DAM NORTH
WATER TREATMENT PLANT

DRAWING 25
SHEET 1 OF 1

DATE AND TIME PLOTTED
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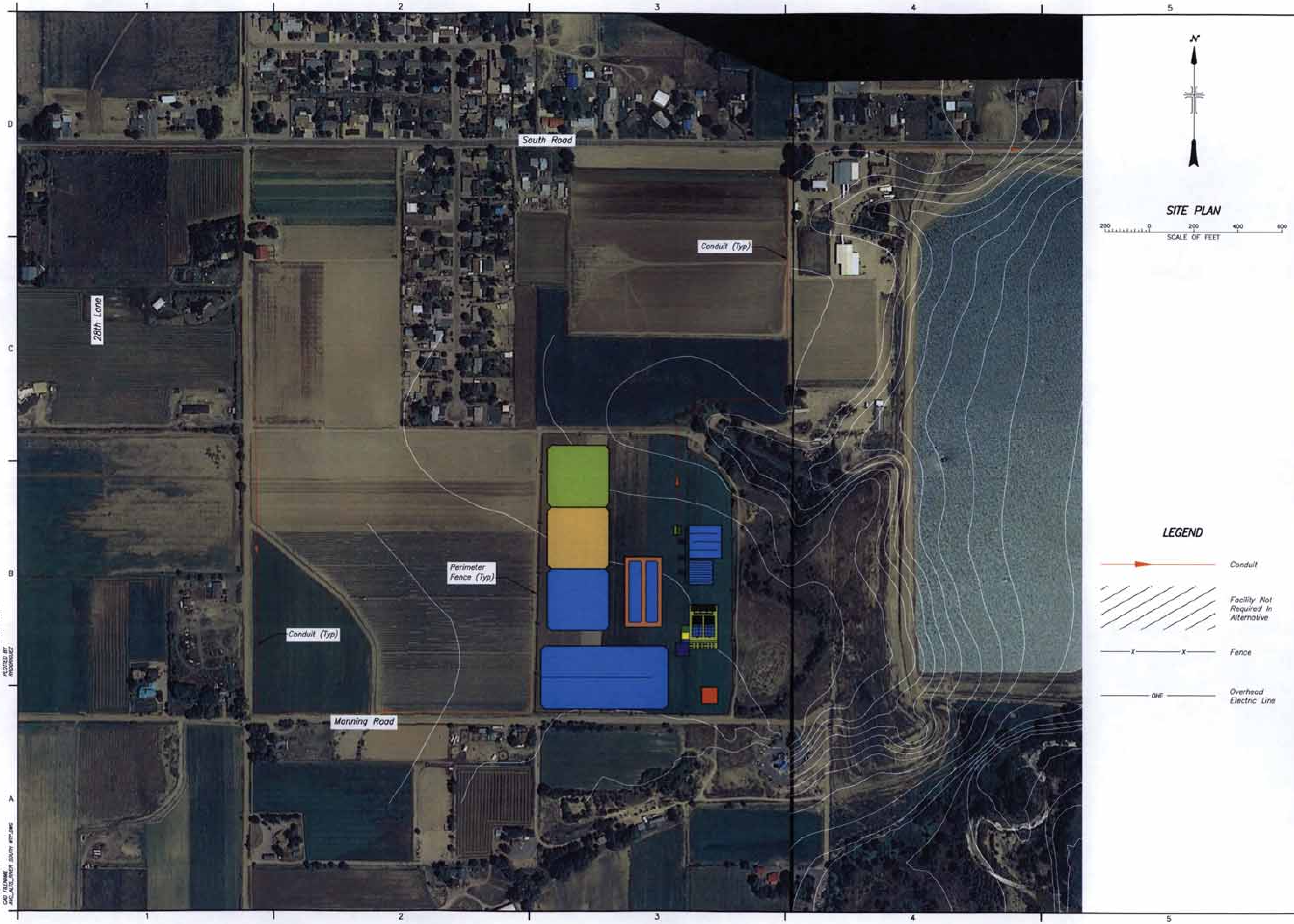

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ARKANSAS VALLEY CONDUIT

APPRAISAL LEVEL DESIGN

ALT. 5 – RIVER SOUTH WATER TREATMENT PLANT
(NEAR ST. CHARLES MESA WTP) – SITE PLAN

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Ron LeBlanc, P.E.
ACCEPTED
RON LEBLANC, P.E.
PLANT STRUCTURES GROUP
DENVER, COLORADO 2011-09-06

ALT. 5 –
RIVER SOUTH
WATER TREATMENT PLANT

DRAWING 26
SHEET 1 OF 1

DATE AND TIME PLOTTED
FEBRUARY 28, 2012 09:16
PLOTTED BY
RRODRIGUEZ

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CAD FILENAME
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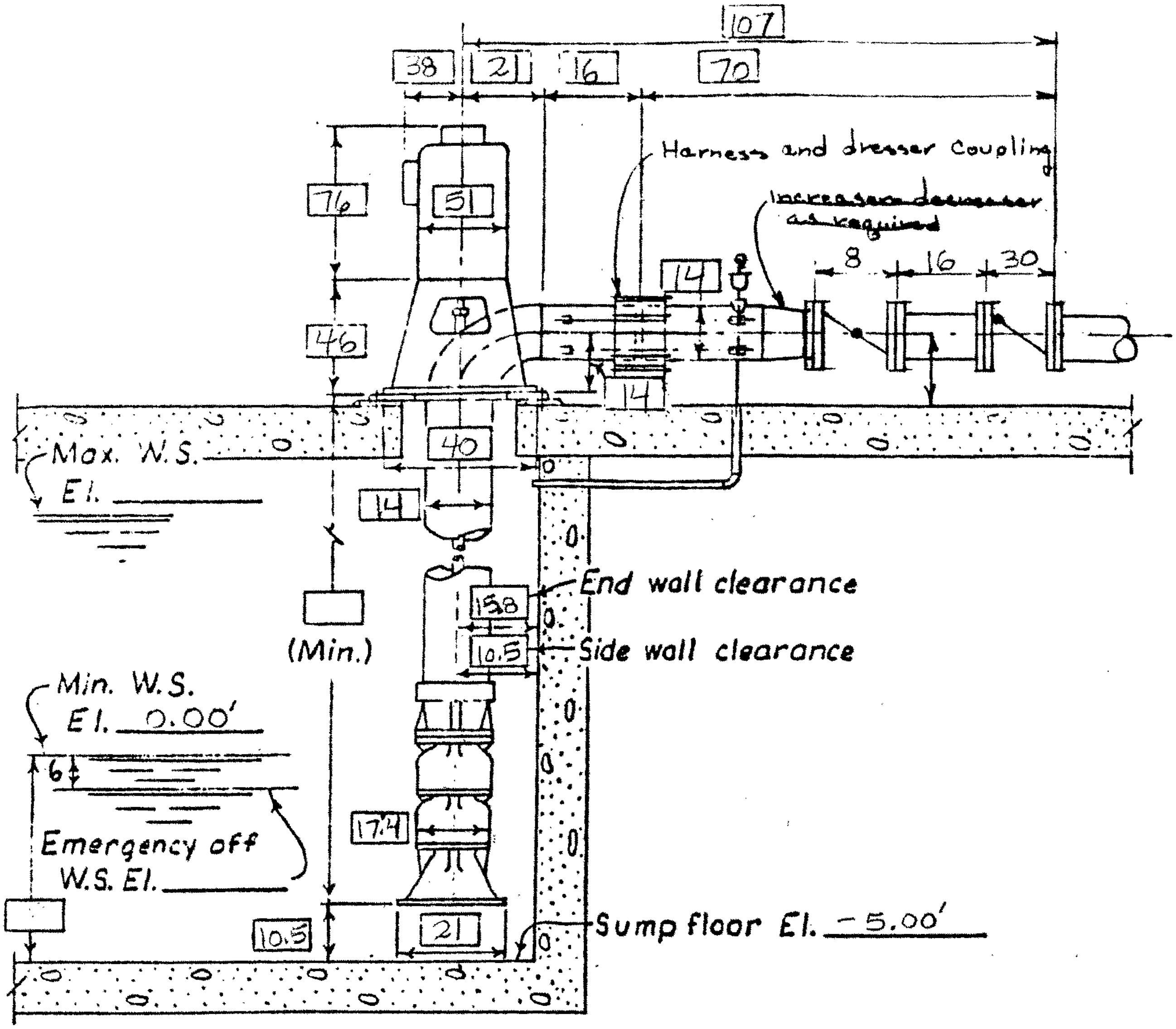
Appendix G

Pump Data Sheets

Contents – Appendix G, Pump Data Sheets



PUMP DATA:

Unit No. 1-4

Discharge (3730gpm) 8.31 c.f.s.

Total head 480 ft.

No. of stages 4

Shut off head 700 ft.

R.P.M. 1800 (Max.)

B.H.P. 551.4

Weight 4,400 lbs.

MOTOR DATA: @ 4160 volts

Rated H.P. 600

Weight 4,000 lbs.

UNIT DATA

Weight 8,400 lbs.

VALVE DATA:

Weir-Floway Model 18MKL/N, 1770rpm

TEFC Motor, 30.5"BD,

Alt 1, Comanche South
Comanche Pumping Plant

PUMP SETTING DIMENSIONS

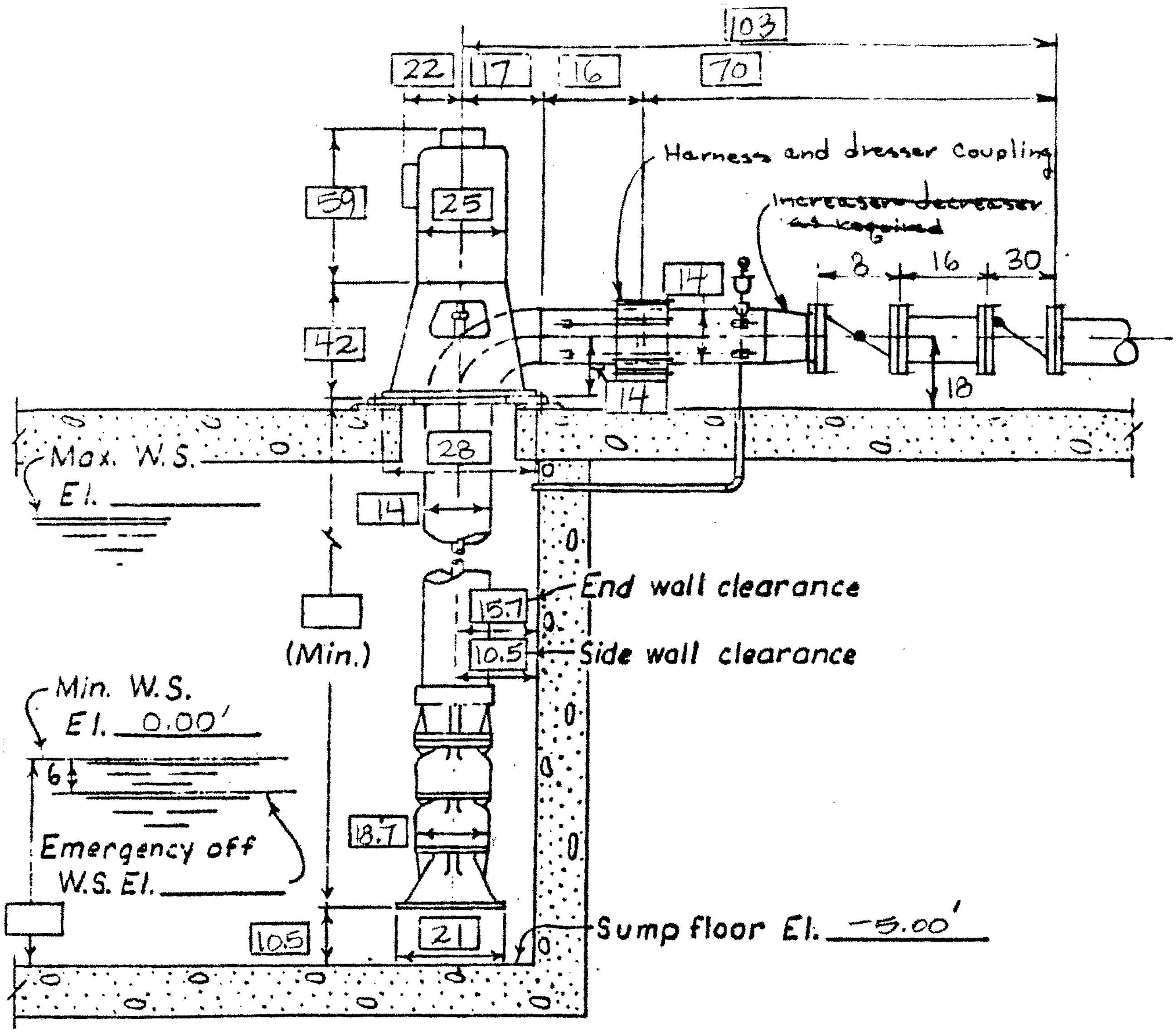
Arkansas Valley Conduit Project

Booster Pmp. Plant

(Est. dimensions, inches, not to scale)

Est. by R. Zelenka Chkd.

Denver, Colorado



VALVE DATA:

Weir-Floway Model 19FKM, 1180 rpm

TEFC Motor, 16.5" BD, L449VP frame, VSS

14" tilted-disc & motor-op. BF valves

Alt 3, JUP North
Whitlock WTP Clearwell Pumping Plant

PUMP DATA:

Unit No. 1-4

Discharge (3430gpm) 7.69 c.f.s.

Total head 155 ft.

No. of stages 3

Shut off head 238 ft.

R.P.M. 1300 (Max.)

B.H.P. 163.3

Weight 4,400 lbs.

MOTOR DATA: @ 480 volts

Rated H.P. 200

Weight 3,200 lbs.

UNIT DATA:

Weight ____ lbs.

PUMP SETTING DIMENSIONS

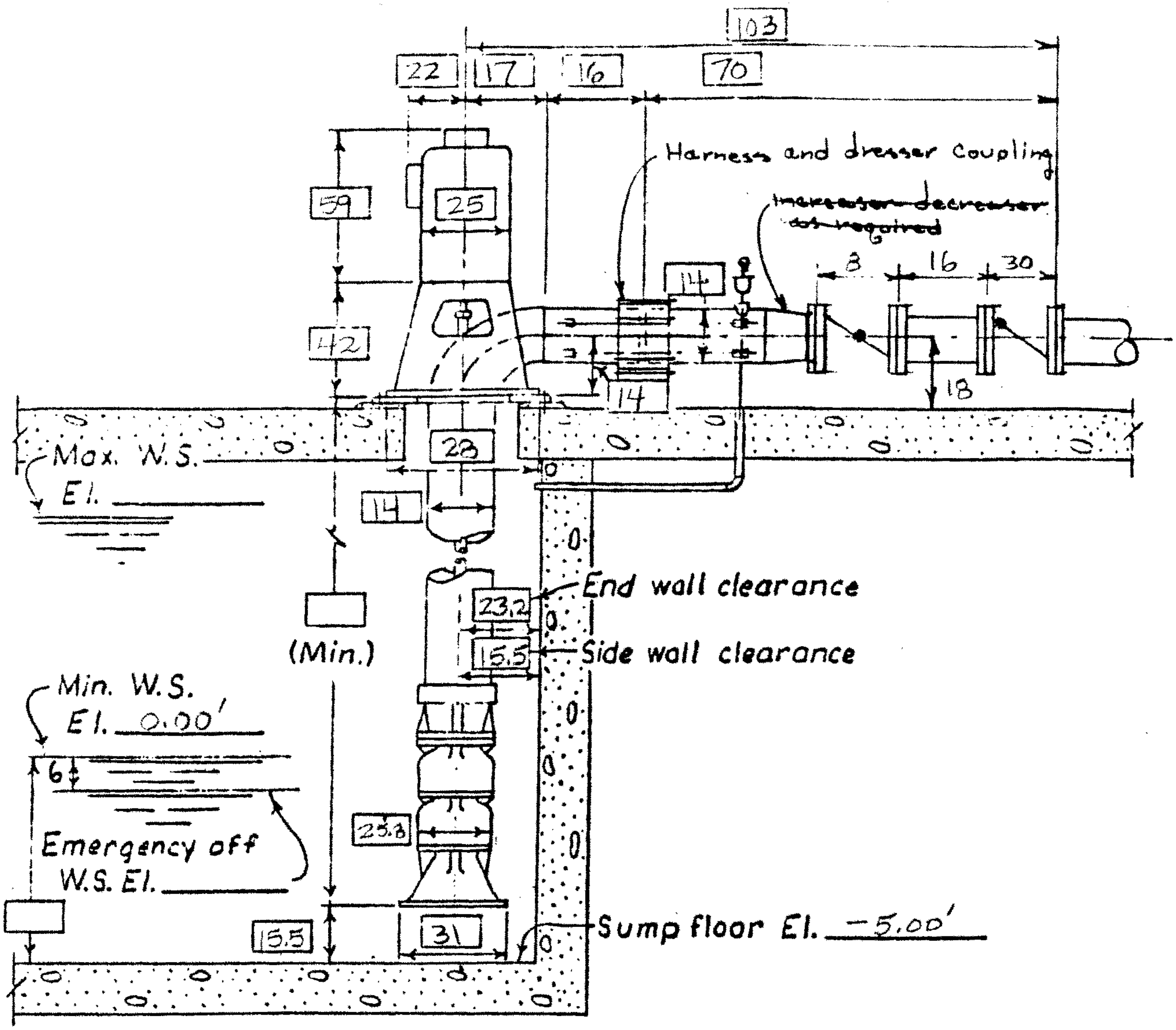
Arkansas Valley Conduit Project

Clearwell Pmp. Plant

(Est. dimensions, inches, not to scale)

Est. by R. Zelenka Chkd. ____

Denver, Colorado ____ ____



VALVE DATA:

Weir-Floway Model 27FKH, 585 rpm

TEFC Motor, 20" 3P, L449VP frame, VSS

PUMP DATA:

Unit No. 1-4

Discharge (3730gpm) 8.31 c.f.s.

Total head 55 ft.

No. of stages 2

Shut off head 78 ft.

R.P.M. 600 (Max.)

B.H.P. 64.3

Weight 5,400 lbs.

MOTOR DATA @ 480 volts

Rated H.P. 75

Weight 2,300 lbs.

UNIT DATA:

Weight ______ lbs.

Alt 4, Pueblo Dam North
Dam Pumping Plant

PUMP SETTING DIMENSIONS

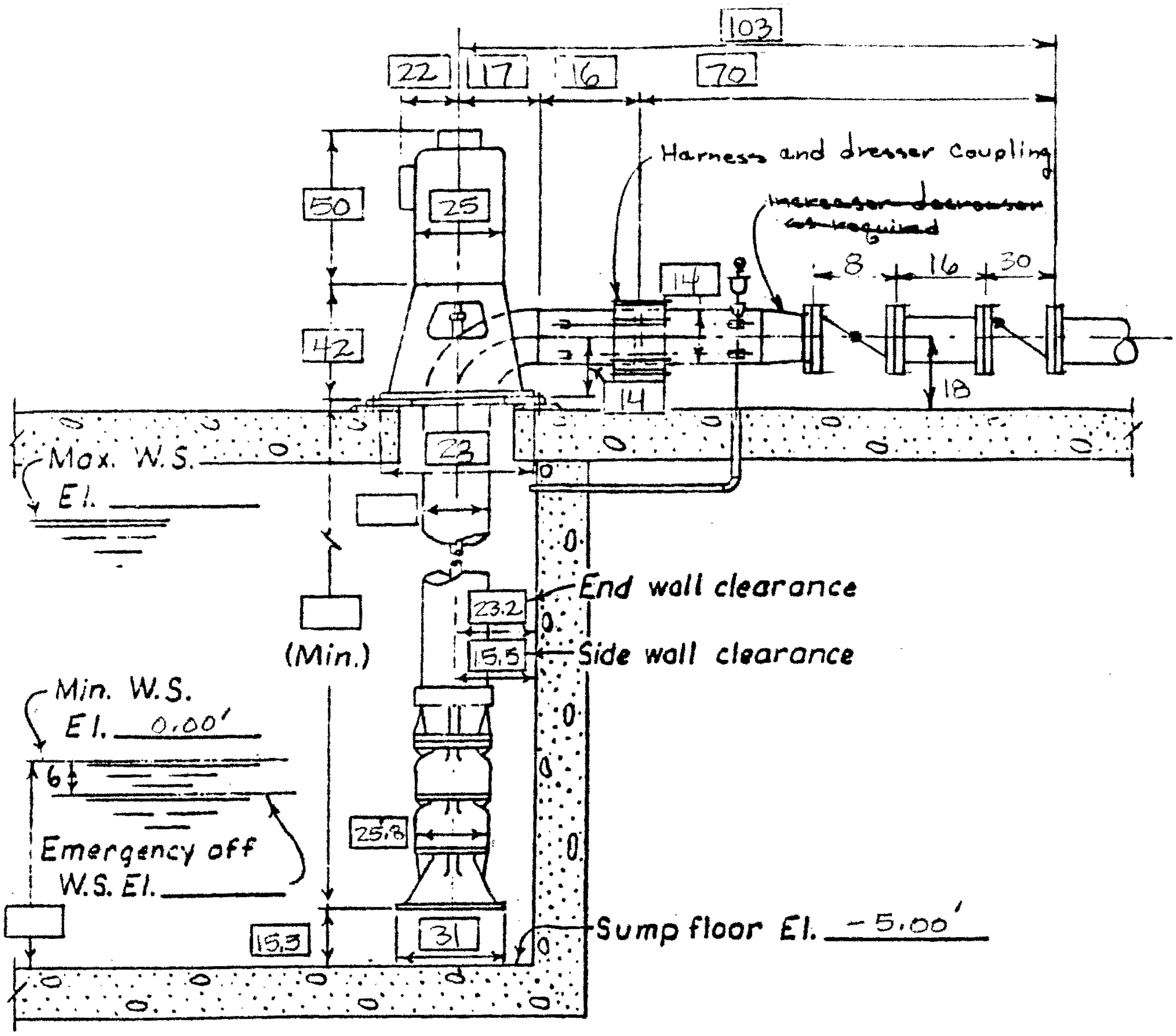
Arkansas Valley Conduit Project

Booster Pmp. Plant

(Est. dimensions, inches, not to scale)

Est. by R. Zelenka Chkd. ______

Denver, Colorado ______



VALVE DATA:
Weir-Floway Model 27FKL, 585 rpm
TEFC Motor, 16.5" BD, L445VP frame, VSS

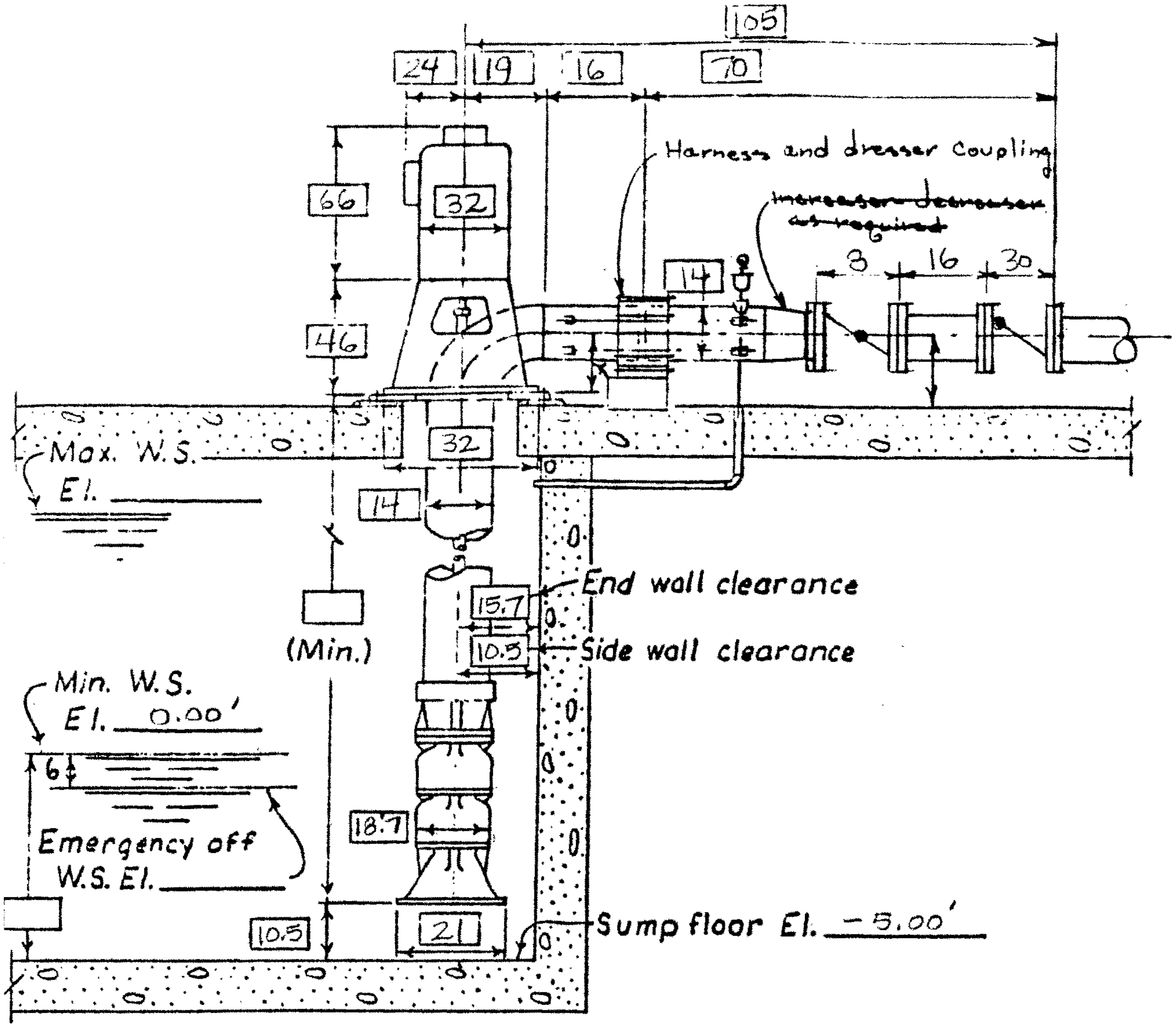
PUMP DATA:
Unit No. 1-4
Discharge (3450gpm) 7.69 c.f.s.
Total head 40 ft.
No. of stages 2
Shut off head 70 ft.
R.P.M. 600 (Max.)
B.H.P. 43.5
Weight 5,400 lbs.

MOTOR DATA @ 480 volts
Rated H.P. 50
Weight 2,050 lbs.

UNIT DATA:
Weight ______ lbs.

Alt 4, Pueblo Dam North
Dam WTP Clearwell Pumping Plant

PUMP SETTING DIMENSIONS
Arkansas Valley Conduit Project
Clearwell Pmp. Plant
(Est. dimensions, inches, not to scale)
Est. by R. Zelenka Chkd. ______
Denver, Colorado ______

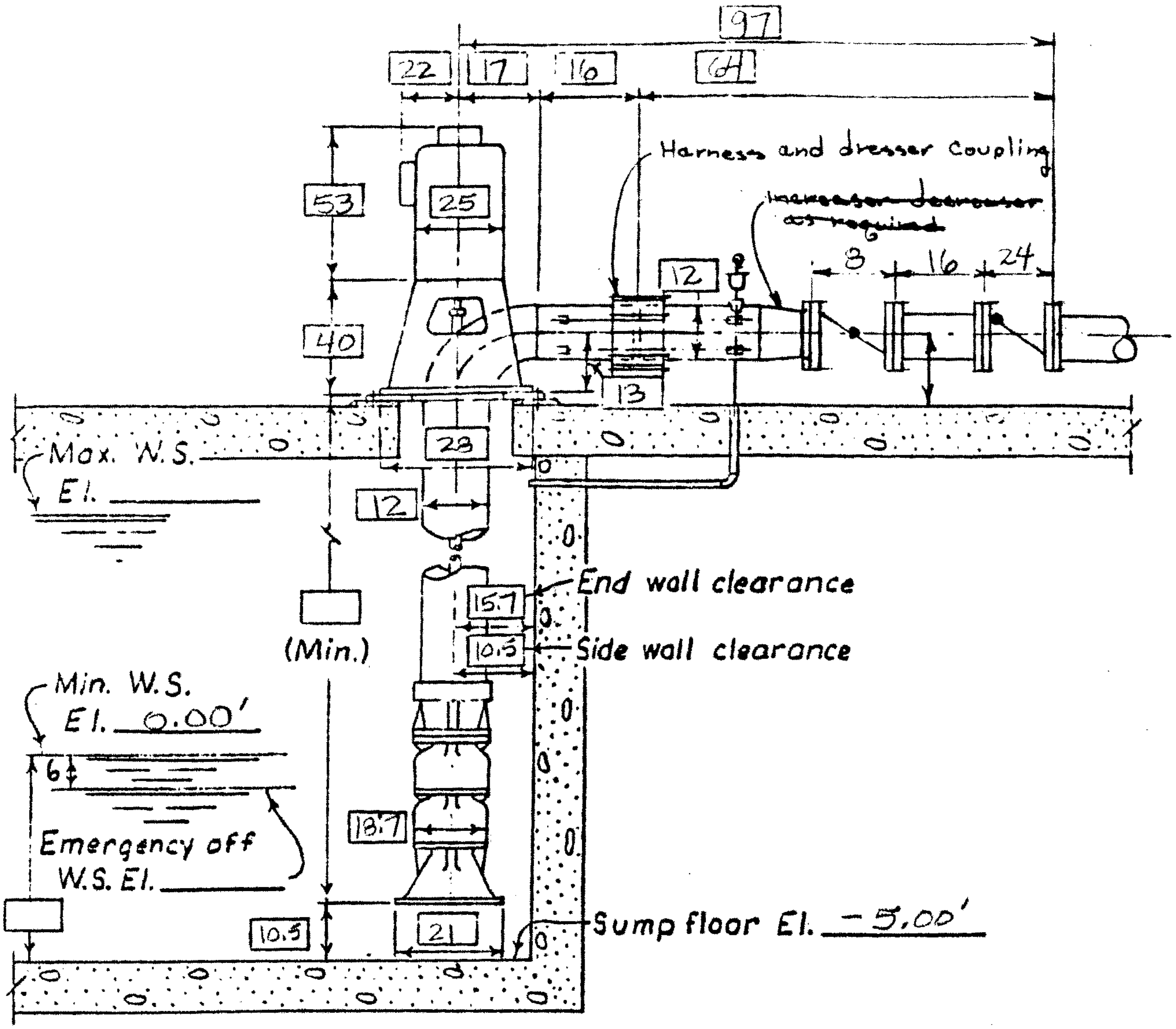


PUMP DATA:
Unit No. 1-4
Discharge (3680 gpm) 8.20 c.f.s.
Total head 205 ft.
No. of stages 4
Shut off head 295 ft.
R.P.M. 1200 (Max.)
B.H.P. 231.2
Weight 5,000 lbs.
MOTOR DATA: @ 480 volts
Rated H.P. 250
Weight 4,000 lbs.
UNIT DATA:
Weight ____ lbs.

VALVE DATA:
Weir-Floway Model 19FKH, 1130 rpm
TEFC Motor, 24.5"BD, L509VP frame, VSS

Alt 5, River South
River Intake Pumping Plant

PUMP SETTING DIMENSIONS
____ Project
Booster Pmp. Plant
(Est. dimensions, inches, not to scale)
Est. by R. Zelenka Chkd. ____
Denver, Colorado ____ ____



VALVE DATA:

Weir-Floway Model 19FKM, 380 rpm

TEFC Motor, 20" BD, L447VP frame, VSS

PUMP DATA:

Unit No. 1-4

Discharge (2560 gpm) 5.70 c.f.s.

Total head 130 ft.

No. of stages 4

Shut off head 190 ft.

R.P.M. 900 (Max.)

B.H.P. 102.5

Weight 4,200 lbs.

MOTOR DATA @ 480 volts

Rated H.P. 125

Weight 3,300 lbs.

UNIT DATA:

Weight ______ lbs.

Alt 5, River South
St. Charles Mesa WTP Clearwell
Pumping Plant

PUMP SETTING DIMENSIONS

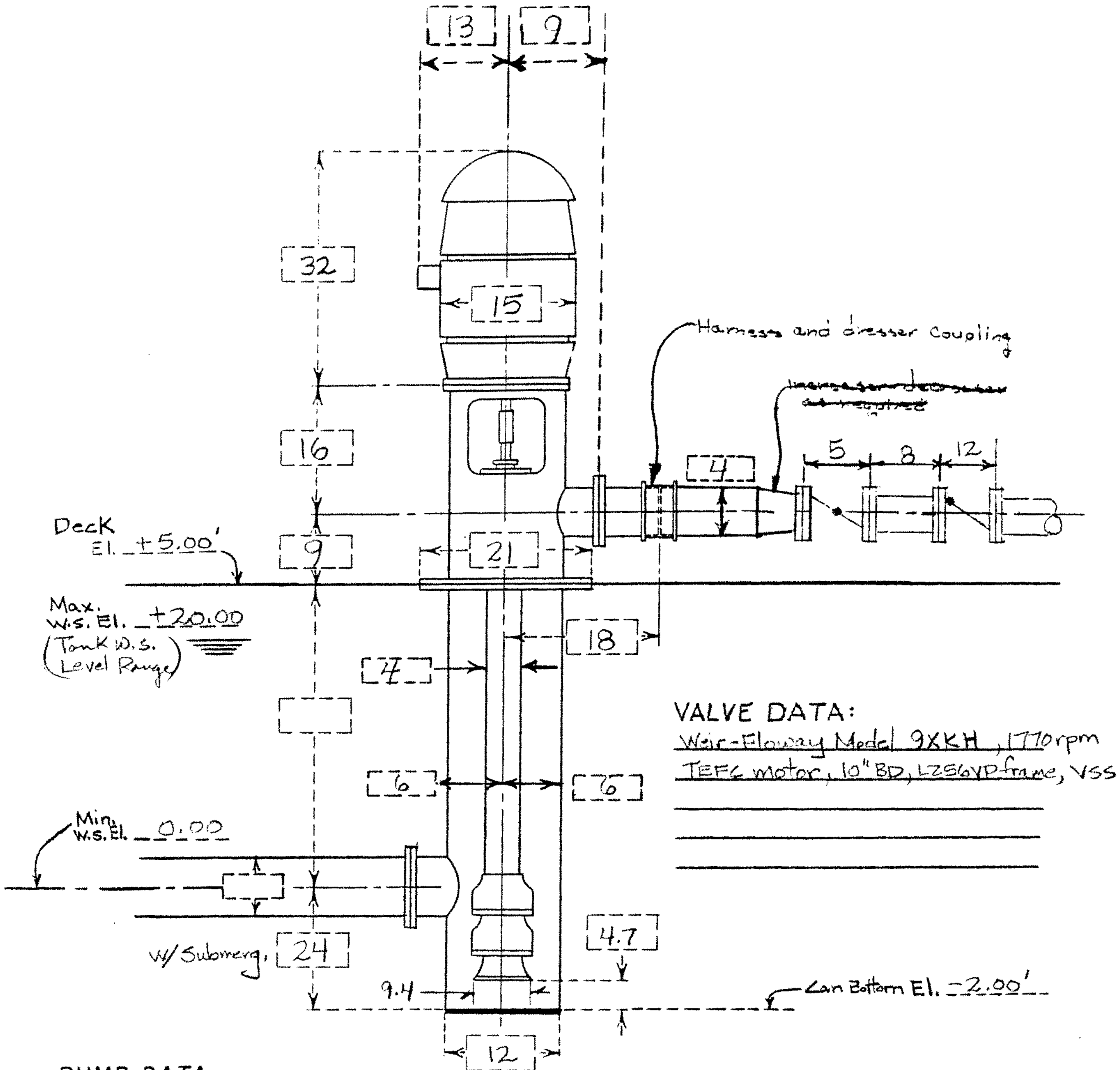
Arkansas Valley Conduit Project

Clearwell Pmp. Plant

(Est. dimensions, inches, not to scale)

Est. by R. Zelenka Chkd. ______

Denver, Colorado ______



VALVE DATA:

Weir-Floway Model 9XKH, 1770rpm

TEFC motor, 10" BD, LZ56VP frame, VSS

PUMP DATA

Total head 317 ft. (9 stgs)

Discharge (1259pm) 2.39 c.f.s.

S.O.H. (max.) 339 ft.

RPM 1800 (Max.)

BHP 18.0

Weight 1,600 lbs.

MOTOR DATA

Rated HP 20

Weight 300 lbs.

UNIT DATA

Weight 1,900 lbs.

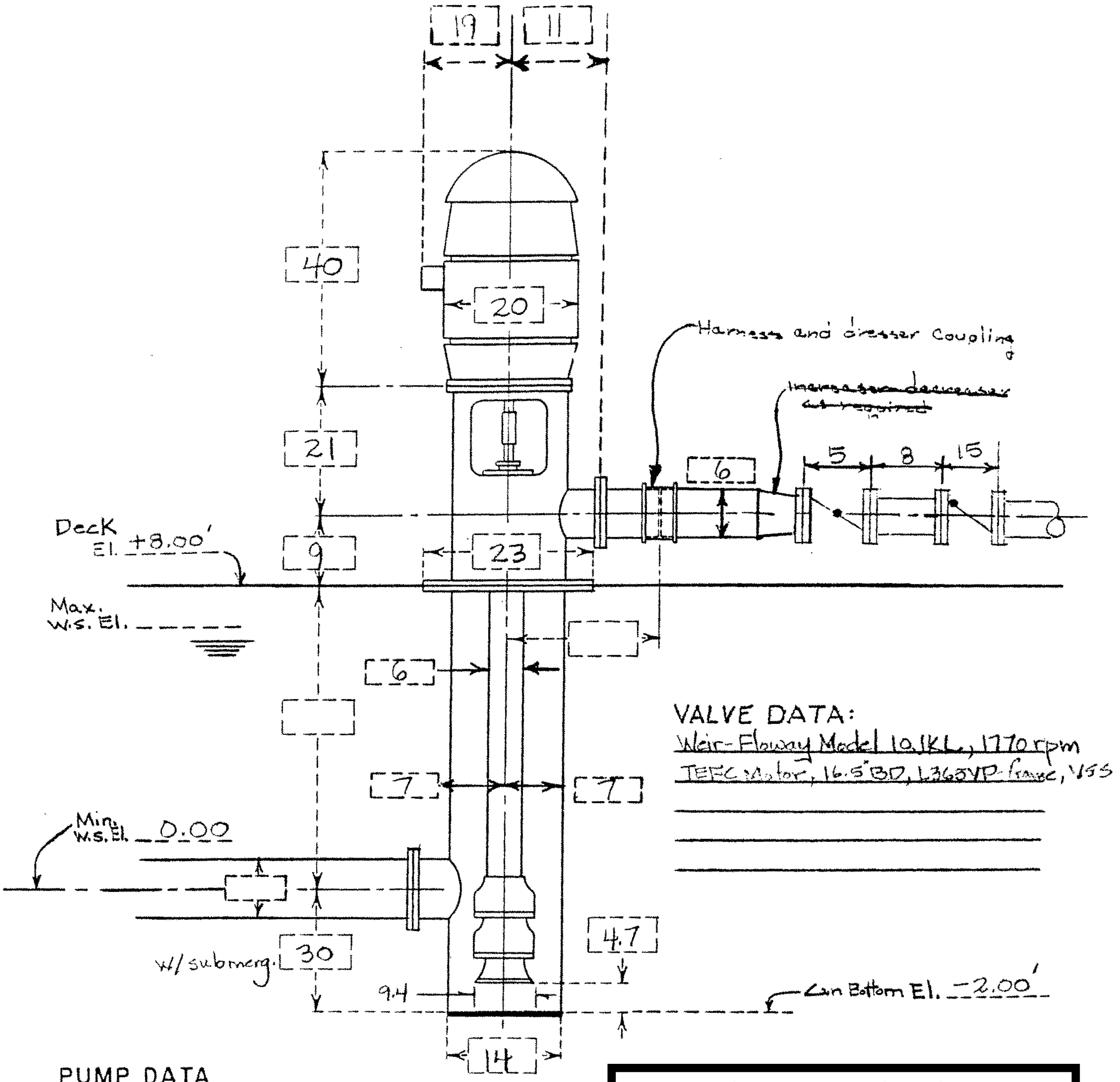
Alt 1, Comanche South
Eads Booster Plant

Arkansas Valley Conduit PROJECT
Eads Booster PMP. PLT.

PUMP SETTING DIMENSIONS

(PRELIMINARY-NOT TO SCALE)

Denver, Colorado
Drawn R. Zelenka Chkd.



VALVE DATA:
Weir-Floway Model 10JKL, 1770 rpm
TEFC Motor, 16.5" BD, L365VP-frame, VSS

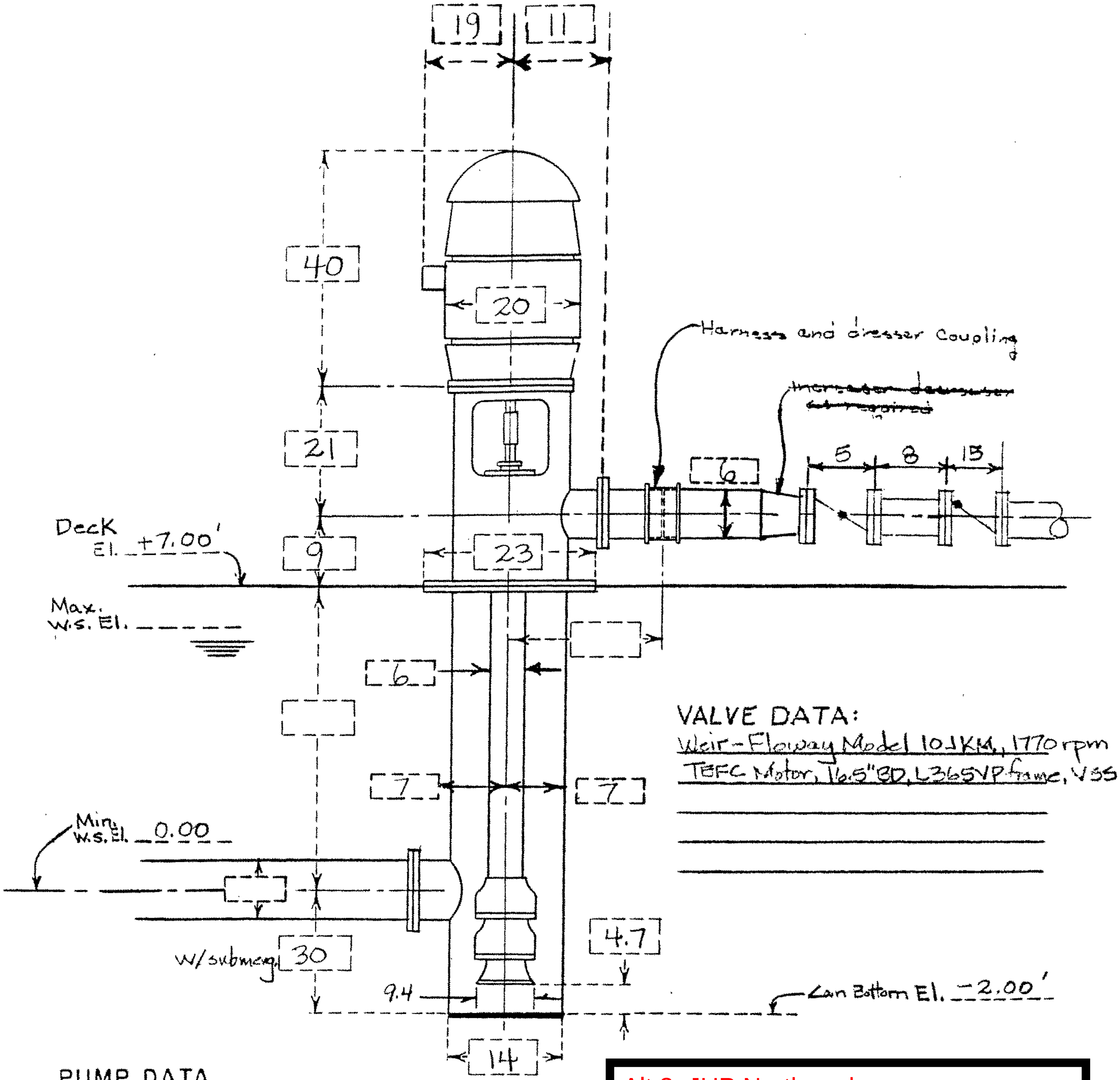
PUMP DATA
Total head 455 ft. (11 stgs)
Discharge (505 gpm) 1.125 c.f.s.
S.O.H. (max.) 630 ft.
RPM 1800 (Max.)
BHP 71.5
Weight 2,500 lbs.

MOTOR DATA
Rated HP 75
Weight 1,200 lbs.

UNIT DATA
Weight 3,700 lbs.

Alt 2, Pueblo Dam South and
Alt 5, River South
Eads Booster Pumping Plant

Arkansas Valley Conduit PROJECT
Eads/May Valley Booster PMP. PLT.
PUMP SETTING DIMENSIONS
(PRELIMINARY-NOT TO SCALE)
Denver, Colorado
Drawn R. Zelenka Chkd.



VALVE DATA:

Weir-Floway Model 10JKM, 1770 rpm

TEFC Motor, 16.5"BD, L365VP frame, V55

PUMP DATA

Total head 403 ft. (9 stgs)
Discharge (505 gpm) 1.125 c.f.s.
S.O.H. (max.) 530 ft.
RPM 1800 (Max.)
BHP 64.0
Weight 2,300 lbs.

MOTOR DATA

Rated HP 75
Weight 1,200 lbs.

UNIT DATA

Weight 3,500 lbs.

Alt 3, JUP North and
Alt 4, Pueblo Dam North
Eads Booster Pumping Plant

Arkansas Valley Conduit PROJECT
Eads/May Valley Booster PMP. PLT.
PUMP SETTING DIMENSIONS
(PRELIMINARY-NOT TO SCALE)

Denver, Colorado
Drawn R. Zelenka Chkd.

Appendix H

Hydraulic Calculation Sheets

Contents – Appendix H – Hydraulic Calculation Sheets

Arkansas Valley Conduit
Environmental Impact Statement / Apprasial Level Study
Hydraulic Analysis
Comanche_South - Alt 1

Intake, Comanche Power Plant Pipeline route
Dam N/S Interconnect
WTP (Filter & Disinfect) East of St Charlse Mesa TBD
St Charles Mesa gets raw water
Southern Route

= Input
4796 Pueblo Reservoir Min Water Surface (Top of Inactive Pool)
4880 Pueblo Reservoir Max Water Surface (Top of Active Conservation Pool)
4750 WS El in PP Sump @ bottom of Dam site
475 Pump lift
5225 HGL beginning of pipe, after Pump

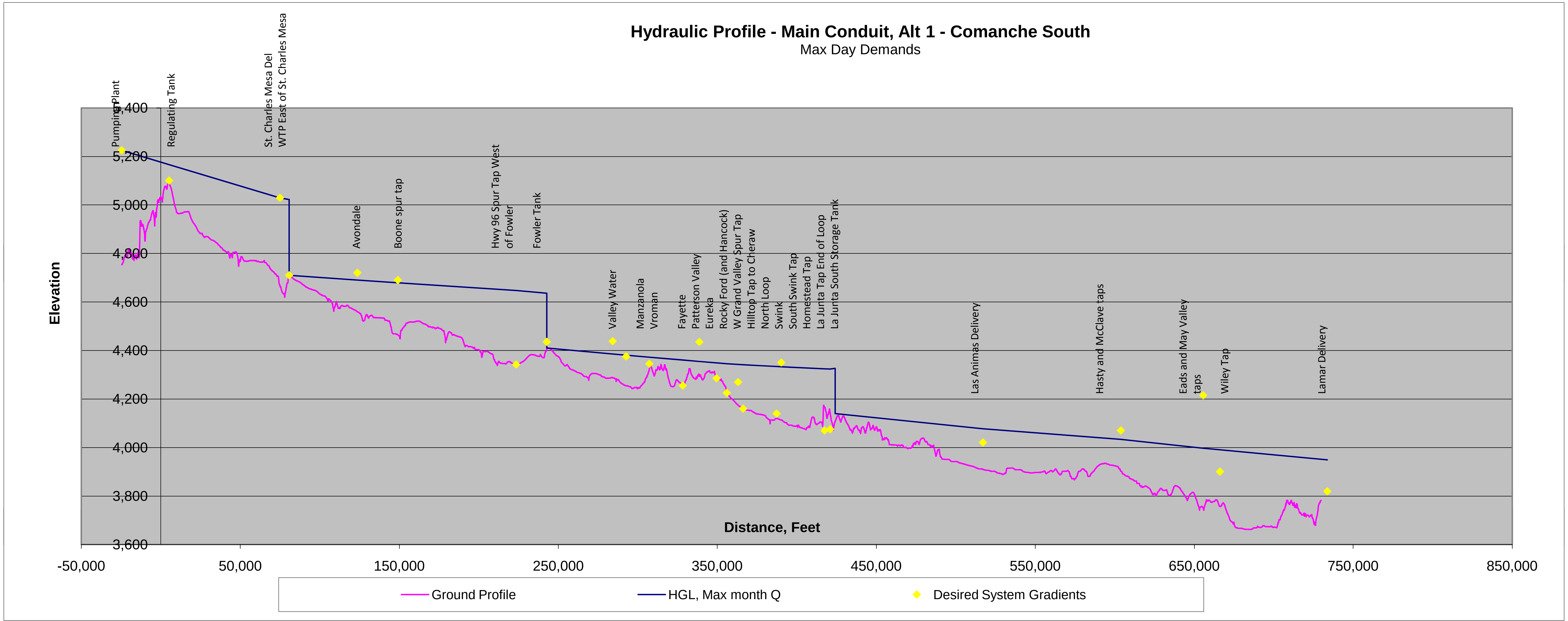
Condition 1 - Minimum Pueblo Reservoir, Max Month Demands
Condition 2 - Maximum Pueblo Reservoir, Max Month Demands
Condition 3 - Maximum Pueblo Reservoir, Min Day Demands
Condition 4 - Minimum Pueblo Reservoir, Max Day Demands
Condition 5 - Minimum Pueblo Reservoir, Max Month Demands (Except Radionuclides
Participants Being Provided Max Day)
Condition 4 - Selected Condition

Participants Being Provided Max Day Demands Due to Radionuclides (Condition 5)

East End Water	Manzanola	Valley Water
Eureka Water Co	May Valley	Vroman
Fayette Water	Patterson Valley	Wiley
Hancock	South Swink	
Holbrook Center Soft Water		
Homestead Improvement		

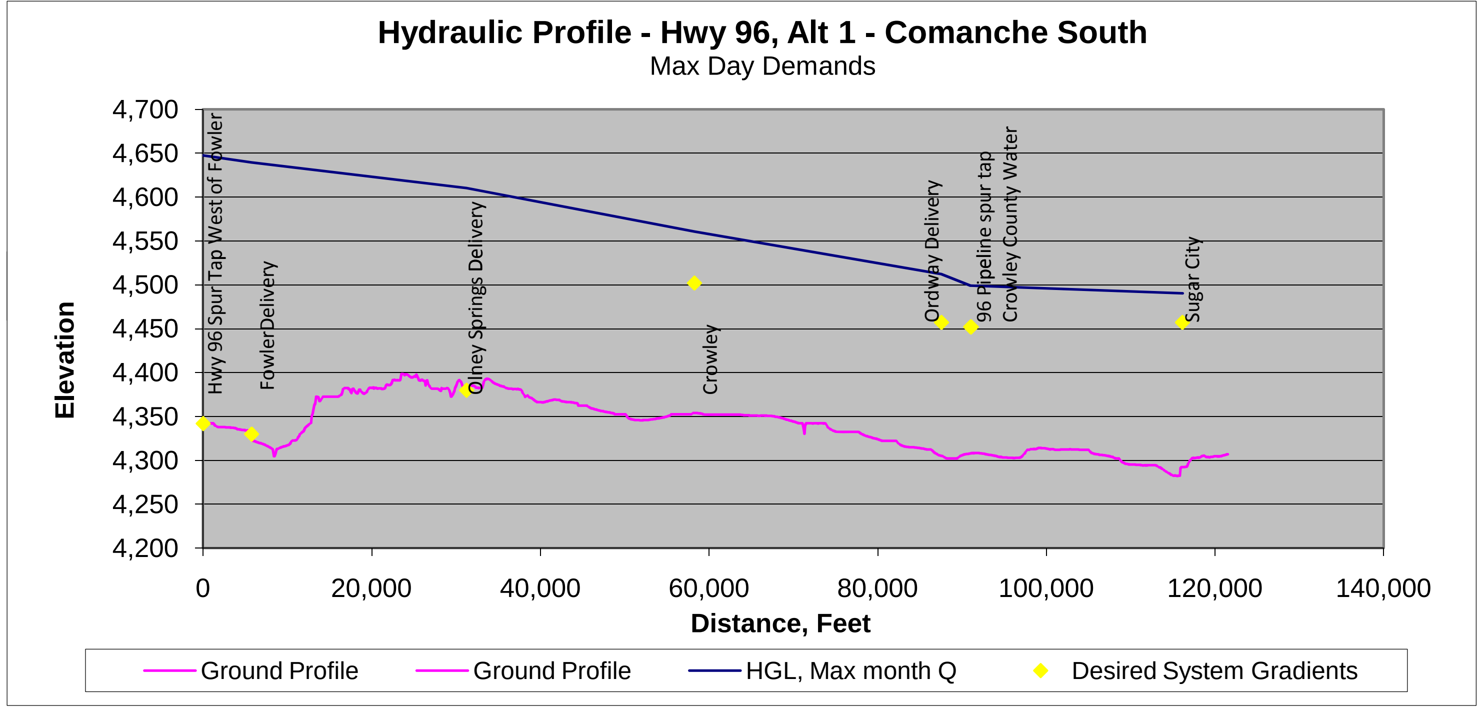
December 28, 2010

		Description		Station		Length	Total Flow, Q			Inside Pipe Diameter	Inside Pipe Area	Velocity		Friction Headloss	Minor Headloss		Total Headloss				Participant Flow		Actual Tap Pressure, psi	Desired System Pressure psi	Pressure Met?	Desired System Gradient	
Overall Pipe Segment	Individual Pipe Segment	Starting Point	Ending Point	Starting Station	Ending Station	ft	mgd	cfs	gpm	in	ft^2	ft/s	C Value	ft	Loss/ft	Minor H_L, ft	ft	Begin HGL	End HGL	Participant Tap/ Delivey	mgd	Maximum Ground Elev					Comments
Main	1a	Pueblo Reservoir	High Point S of Pueblo Reservoir	-246+05	52+00	29,805	20.817	32.20	14,456	36	7.07	4.56	120	58.43	9.1287E-06	0.27	58.70	5225.00	5166.30	NA	0.000	5106	26.10	0		5106.00	
Main	1b	High Point S of Pueblo Reservoir	St. Charles Mesa	52+00	749+55	69,755	20.817	32.20	14,456	36	7.07	4.56	120	136.75	9.1287E-06	0.64	137.39	5166.30	5028.91	St. Charles Mesa	5.781	4755	118.58	0		4755.00	St. Charles Mesa
Main	2	St. Charles Mesa	WTP East of St. Charles Mesa	749+55	806+96	5,741	15.036	23.26	10,442	36	7.07	3.29	120	6.16	9.1287E-06	0.05	6.21	5028.91	5022.70	NA	0.000	4660	157.01	0		4660.00	Tap Pressure is head available for plant to use.
Main	3	WTP East of St. Charles Mesa	Avondale	806+96	1236+19	42,923	14.045	21.73	9,753	42	9.62	2.26	120	19.16	9.1287E-06	0.39	19.56	4710	4690.44	Avondale	0.296	4570	52.14	65	-12.9	4720.15	Clearwell WS in WTP.
Main	4	Avondale	Boone spur tap	1236+19	1491+10	25,491	13.749	21.27	9,548	42	9.62	2.21	120	10.94	9.1287E-06	0.23	11.17	4690.44	4679.27	Boone	0.201	4540	60.29	65	-4.7	4690.15	
Main	5	Boone spur tap	Hwy 96 Spur Tap West of Fowler	1491+10	2234+96	74,386	13.548	20.96	9,408	42	9.62	2.18	120	31.07	9.1287E-06	0.68	31.75	4679.27	4647.52	Hwy 96 Spur Total	2.805	4342	132.26	0		4342.00	
Main	6	Hwy 96 Spur Tap West of Fowler	Fowler Tank (South of Fowler)	2234+96	2427+18	19,222	10.743	16.62	7,460	36	7.07	2.35	120	11.07	9.1287E-06	0.18	11.24	4647.52	4636.28	NA	0.000	4435	87.13	0		4435.00	Ground Elev 4410, top of tank elev 4435.
Main	7	Fowler Tank (South of Fowler)	Valley Water	2427+18	2841+66	41,448	10.743	16.62	7,460	36	7.07	2.35	120	23.87	9.1287E-06	0.38	24.25	4410.00	4385.75	Valley Water	0.084	4288	42.32	65	-22.7	4438.15	Ground Elev 4288 at conduit tap
Main	8	Valley Water	Manzanola	2841+66	2926+58	8,492	10.659	16.49	7,402	36	7.07	2.33	120	4.82	9.1287E-06	0.08	4.90	4385.75	4380.86	Manzanola	0.079	4285	41.50	39		4375.09	Manzanola max ground elev is 4285. Tank Spill El 4375.
Main	9	Manzanola	Vroman	2926+58	3073+05	14,647	10.580	16.37	7,347	36	7.07	2.32	120	8.20	9.1287E-06	0.13	8.33	4380.86	4372.52	Vroman	0.079	4345	11.92			4345.00	
Main	10	Vroman	Fayette	3073+05	3283+41	21,036	10.501	16.24	7,292	36	7.07	2.30	120	11.61	9.1287E-06	0.19	11.80	4372.52	4360.72	Fayette	0.030	4255	45.77			4255.00	
Main	11	Fayette	Patterson Valley	3283+41	3387+24	10,383	10.471	16.20	7,271	36	7.07	2.29	120	5.70	9.1287E-06	0.09	5.80	4360.72	4354.92	Patterson Valley	0.036	4300	23.78	58.4	-34.6	4434.90	Tank spill El 4435
Main	12	Patterson Valley	Eureka	3387+24	3495+65	10,841	10.434	16.14	7,246	36	7.07	2.28	120	5.91	9.1287E-06	0.10	6.01	4354.92	4348.91	Eureka	0.184	4285	27.67			4285.00	
Main	13	Eureka	Rocky Ford (and Hancock)	3495+65	3560+10	6,445	10.250	15.86	7,118	36	7.07	2.24	120	3.40	9.1287E-06	0.06	3.46	4348.91	4345.45	Rocky Ford (& Hancock)	1.273	4225	52.14	0		4225.00	At WTP
Main	14	Rocky Ford (and Hancock)	W Grand Valley Spur Tap	3560+10	3576+58	1,648	8.977	13.89	6,234	36	7.07	1.96	120	0.68	9.1287E-06	0.02	0.70	4345.45	4344.75	W Grand Valley Spur Tap	0.161	4350	-2.27		-2.3		
		W Grand Valley Spur Tap	Hilltop	3576+58	3630+74	5,416	8.817	13.64	6,123	36	7.07	1.93	120	2.16	9.1287E-06	0.05	2.21	4344.75	4342.54	Hilltop	0.071	4181	69.93	38.3		4269.47	Tank El 4266. 72 psi high pressure.
Main	16	Hilltop	Tap to Cheraw North Loop	3630+74	3662+52	3,178	8.746	13.53	6,074	36	7.07	1.91	120	1.25	9.1287E-06	0.03	1.28	4342.54	4341.26	Cheraw Loop Total	0.304	4160	78.47	0		4160.00	
Main	17	Tap to Cheraw North Loop	Swink	3662+52	3873+27	21,075	7.987	12.36	5,547	36	7.07	1.75	120	7.01	9.1287E-06	0.19	7.20	4341.26	4334.06	Swink	0.064	4140	84.01			4140.00	
Main	19	Swink	South Swink Tap	3873+27	3902+38	2,911	7.923	12.26	5,502	36	7.07	1.73	120	0.95	9.1287E-06	0.03	0.98	4334.06	4333.08	South Swink Tap	0.189	4200	57.61	65	-7.4	4350.15	
Main	20	South Swink Tap	Homestead Tap	3902+38	4108+97	20,659	7.734	11.96	5,371	36	7.07	1.69	120	6.47	9.1287E-06	0.19	6.66	4333.08	4326.42	Homestead Tap	0.015						
Main	20a	Homestead Tap	La Junta Tap	4108+97	4175+25	6,628	7.719	11.94	5,361	36	7.07	1.69	120	2.07	9.1287E-06	0.06	2.13	4326.42	4324.29	La Junta Tap	3.717	4070	110.08	0		4070.00	At La Junta WTP. 4374 is max system water elevation.
		La Junta Tap	End of Loop	4175+25	4210+26	3,501	4.002	6.19	2,779	36	7.07	0.88	120	0.32	9.1287E-06	0.03	0.36	4324.29	4323.93	No delivery, end of loop	0.000	4075	107.76	0		4075.00	End of La Junta Loop, south leg
Main	20b	End of Loop	La Junta South Storage Tank	4210+26	4240+89	3,063	4.002	6.19	2,779	36	7.07	0.88	120	0.28	9.1287E-06	0.03	0.31	4323.93	4323.62								
Main	21	La Junta South Storage Tank	Las Animas Delivery	4240+89	5171+26	93,037	4.002	6.19	2,779	24	3.14	1.97	120	61.98	9.1287E-06	0.85	62.83	4140	4077.17	Las Animas Delivery	1.294	3905	74.53	50		4020.50	40' surface tank
Main	22	Las Animas Delivery	Hasty and McClave taps	5171+26	6037+82	86,656	2.708	4.19	1,880	22	2.64	1.59	120	42.78	9.1287E-06	0.79	43.57	4077.17	4033.60	Hasty and McClave taps	0.174	3920	49.18	65	-15.8	4070.15	
Main	23	Hasty and McClave taps	Eads and May Valley taps	6037+82	6556+57	51,875	2.534	3.92	1,760	20	2.18	1.80	120	36.03	9.1287E-06	0.47	36.51	4033.60	3997.10	Eads and May Valley taps	0.724	3775	96.15	190.5	-94.4	4215.06	4215 is Eads tie-in at ground storage tank.
Main	24	Eads and May Valley taps	Wiley Tap	6556+57	6661+76	10,519	1.810	2.80	1,257	18	1.77	1.58	120	6.54	9.1287E-06	0.10	6.64	3997.10	3990.46	Wiley Tap	0.034	3750	104.09	65		3900.15	3750 is max ground in Wiley
Main	25	Wiley Tap	Lamar Delivery	6661+76	7336+87	67,511	1.776	2.75	1,233	18	1.77	1.55	120	40.54	9.1287E-06	0.62	41.15	3990.46	3949.30	Lamar Delivery	2.230	3819.3	56.28	0		3819.30	Spill elevation of tanks.
		Totals																			**19.825**						
Hwy 96		Hwy 96 Spur Tap West of Fowler	FowlerDelivery	0+00	57+53	5,753	2.805	4.34	1,948	18	1.77	2.46	120	8.05	9.1287E-06	0.05	8.11	4647.52	4639.41	FowlerDelivery	0.304	4330	133.95	0		4330.00	Lower tank spill elev ?
Hwy 96		FowlerDelivery	Olney Springs Delivery	57+53	312+29	25,476	2.500	3.87	1,736	18	1.77	2.19	120	28.83	9.1287E-06	0.23	29.07	4639.41	4610.35	Olney Springs Delivery	0.129	4380	99.72	0		4380.00	Tank spill elev of 4486
Hwy 96		Olney Springs Delivery	Crowley	312+29	582+71	27,041	2.372	3.67	1,647	16	1.40	2.63	120	49.26	9.1287E-06	0.25	49.50	4610.35	4560.84	Crowley	0.122	4352	90.41	65		4502.15	System pressure unknown.
Hwy 96		Crowley	Ordway Delivery	582+71	875+65	29,295	2.250	3.48	1,562	16	1.40	2.49	120	48.38	9.1287E-06	0.27	48.65	4560.84	4512.19	Ordway Delivery	0.604	4307	88.83	65		4457.15	
Hwy 96		Ordway Delivery	96 Pipeline spur tap	875+65	910+07	3,442	1.646	2.55	1,143	12	0.79	3.24	120	12.93	9.1287E-06	0.03	12.96	4512.19	4499.23	96 Pipeline spur tap	0.049	4302	85.38	65		4452.15	
Hwy 96		96 Pipeline spur tap	Crowley County Water	910+07	910+76	69	1.596	2.47	1,108	12	0.79	3.14	120	0.24	9.1287E-06	0.00	0.24	4499.23	4498.99	Crowley County Water	1.322	4302	85.27	65		4452.15	
Hwy 96		Crowley County Water	Sugar City	910+76	1161+39	25,064	0.274	0.42	190	10	0.55	0.78	120	8.29	9.1287E-06	0.23	8.51	4498.99	4490.47	Sugar City	0.274	4307	79.42	65		4457.15	
		Totals																			**2.805**						
Spur 2	32	Tap to Main Conduit at Rocky Ford	West Holbrook	0+00	239+39	23,939	0.759	1.17	527	16	1.40	0.84	120	5.29	9.1287E-06	0.22	5.50	4341.26	4335.76	West Holbrook	0.019	4200	58.77			4200.00	
Spur 2	33	West Holbrook	North Holbrook	239+39	313+26	7,387	0.740	1.14	514	16	1.40	0.82	120	1.56	9.1287E-06	0.07	1.62	4335.76	4334.13	North Holbrook	0.015	4185	64.56			4185.00	
Spur 2	34	North Holbrook	Holbrook Center Soft Water Tap (Includes Cheraw, East End, South Side Deliveries)	313+26	581+58	26,832	0.725	1.12	503	16	1.40	0.80	120	5.44	9.1287E-06	0.24	5.69	4334.13	4328.45	Holbrook Center Soft Water Tap (Includes Cheraw, East End, South Side Deliveries)	0.139	4130	85.91	14		4162.34	4162 is tank max wse.
Spur 2	35	Holbrook Center Soft Water Tap (Includes Cheraw, East End, South Side Deliveries)	Beehive	581+58	581+58	0	0.586	0.91	407	16	1.40	0.65	120	0.00	9.1287E-06	0.00	0.00	4328.45	4328.45	Beehive	0.013	4130	85.91			4130.00	
Spur 2	36	Beehive	End of Seg3V (Tank N of LaJunta-OLD)	581+58	738+33	15,675	0.573	0.89	398	16	1.40	0.63	120	2.06	9.1287E-06	0.14	2.20	4328.45	4326.25	Tank N of LaJunta-OLD	0.000	4345	-8.12	0	-8.1	4345.00	Need ground elevation on Hwy 109 if no tank at high ground near this location
Spur 2	37	End of Seg3V (Tank N of LaJunta-OLD)	Bents Fort tap	738+33	857+15	11,882	0.573	0.89	398	16	1.40	0.63	120	1.56	9.1287E-06	0.11	1.67	4326.25	4324.58	Bents Fort	0.118	4155	73.41			4155.00	
Spur 2	38	Bents Fort tap	End of La Junta Loop	857+15	963+84	10,669	0.455	0.70	316	16	1.40	0.50	120	0.91	9.1287E-06	0.10	1.01	4324.58	4323.57	NA	0.000	4070	109.77			4070.00	
		Totals																			**0.304**						
Spur 3	39	Main Line Tap	May Valley Tap	0+00	316+33	31,633	0.724	1.12	503	12	0.79	1.43	120	25.99	9.1287E-06	0.29	26.28	3997.10	3970.82	May Valley Tap	0.724	3889	35.42	0		3889.00	
		May Valley Tap	Eads Delivery	316+33	1399+71	108,338	0.249	0.38	173	10	0.55	0.70	120	29.85	9.1287E-06	0.99	30.84	4282.82	4251.98	Eads Delivery	0.249	4225	11.68	0		4225.00	4215 is Eads tie-in at ground storage tank.
Spur 4	40	Main Line Tap	Boone Delivery	0+00	91+54	9,154	0.201	0.31	140	4	0.09	3.57	120	148.10	9.1287E-06	0.08	148.18	4679.27	4531.09	Boone Delivery	0.201	4474	24.71	65	-40.3	4624.15	
	41	Main Line Tap	Manzanola Delivery	0+00	16+36	1,636	0.079	0.12	55	4	0.09	1.41	120	4.71	9.1287E-06	0.01	4.72	4380.86	4376.13	Manzanola Delivery	0.079	4285	39.45	39		4375.09	Manzanola max ground elev is 4285. Tank Spill El 4375.
	42	Main Line Tap	Rocky Ford WTP Delivery (Hancock)	0+00	9+60	960	1.273	1.97	884	12	0.79	2.51	120	2.24	9.1287E-06	0.01	2.25	4345.45	4343.20	ocky Ford WTP Delivery (Hancoc	1.273	4225	51.17	0		4225.00	At WTP
		Main Line Tap	Newdale-Grand Valley Delivery	0+00	135+25	13,525	0.161	0.25	112	6	0.20	1.27	120	19.99	9.1287E-06	0.12	20.12	4344.75	4324.64	Newdale-Grand Valley Delivery	0.129	4355	-13.14	0	-13.1	4355.00	
		Newdale-Grand Valley Delivery	West Grand Valley Delivery	135+25	211+81	7,656	0.032	0.05	22	4	0.09	0.57	120	4.14	9.1287E-06	0.07	4.21	4324.64	4320.43	West Grand Valley Delivery	0.032	4225	41.31	0		4225.00	
		Hwy 96 Spur tap	96 Pipeline Co.	0+00	23+95	2,395	0.049	0.08	34	4	0.09	0.87	120	2.86	9.1287E-06	0.02	2.88	4499.23	4496.35	96 Pipeline Co.	0.049	4317	77.64	0		4317.00	
		Main Line Tap	Homestead Delivery	0+00	26+26	2,626	0.015	0.02	10	4	0.09	0.27	120	0.35	9.1287E-06	0.02	0.37	4328.45	4328.08	Homestead Delivery	0.015	4133	84.45			4133.00	
		Main Line Tap	La Junta WTP Delivery	0+00	31+54	3,154	3.717	5.75	2,582	12	0.79	7.32	120	53.60	9.1287E-06	0.03	53.63	4326.25	4272.62	La Junta WTP Delivery	3.717	4173	43.12			4173.00	
	43	Main Line Tap	Bents Fort Tank Delivery	0+00	7+15	715	0.118	0.18	82	4	0.09	2.09	120	4.29	9.1287E-06	0.01	4.29	4324.58	4320.29	Bents Fort Tank Delivery	0.118	4155	71.55			4155.00	
	44	Main Line Tap	Holbrook Center Soft Water Delivery	0+00	161+42	16,142	0.139	0.22	97	4	0.09	2.47	120	131.87	9.1287E-06	0.15	132.02	4328.45	4196.43	Holbrook Center Soft Water Deliv	0.139	4130	28.76	14		4162.34	4162 is tank max wse.
		Main Line Tap	East End and South Side Deliveries	0+00	161+42	16,142	0.039	0.06	27	4	0.09	0.68	120	12.23	9.1287E-06	0.15	12.37	4328.45	4316.07	East End and South Side Deliveri	0.039	4160	67.56			4160.00	
	45	Main Line Tap	South Swink Delivery	0+00	109+19	10,919	0.189	0.29	131	6	0.20	1.49	120	21.70	9.1287E-06	0.10	21.80	4333.08	4311.28	South Swink Delivery	0.189	4200	48.17	65	-16.8	4350.15	
Spur 5	46	Main Line Tap	McClave Delivery	0+00	54+84	5,484	0.105	0.16	73	6	0.20	0.83	120	3.69	9.1287E-06	0.05	3.74	4033.60	4029.87	McClave Delivery	0.105	3920	47.56	65	-17.4	4070.15	
Spur 14	47	Main Line Tap	Hasty Delivery	0+00	6+26	626	0.069	0.11	48	4	0.09	1.22	120	1.38	9.1287E-06	0.01	1.38	4033.60	4032.22	Hasty Delivery	0.069	3920	48.58	65	-16.4	4070.15	
Spur 13	48	Main Line Tap	Wiley Delivery	0+00	197+50	19,750	0.034	0.05	24	4	0.09	0.61	120	12.03	9.1287E-06	0.18	12.21	3990.46	3978.25	Wiley Delivery	0.034	3750	98.81	65		3900.15	3750 is max ground in Wiley
	49	May Valley Tap	May Valley Delivery	0+00	270+56	27,056	0.476	0.74	330	12	0.79	0.94	120	10.21	9.1287E-06	0.25	10.45	3970.82	3960.36	May Valley Delivery	0.476	3920	17.47	65	-47.5	4070.15	



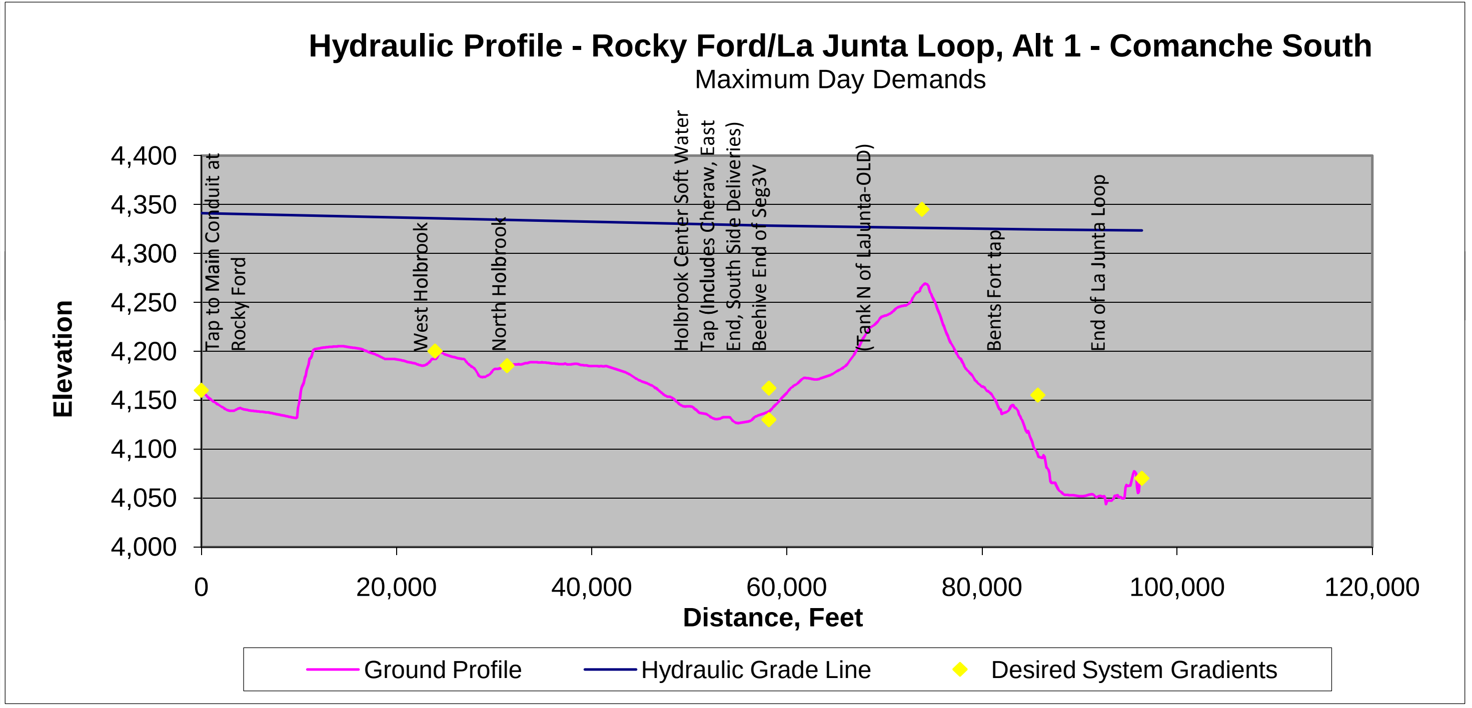
Hydraulic Profile - Main Conduit, Alt 1 - Comanche South

Max Day Demands



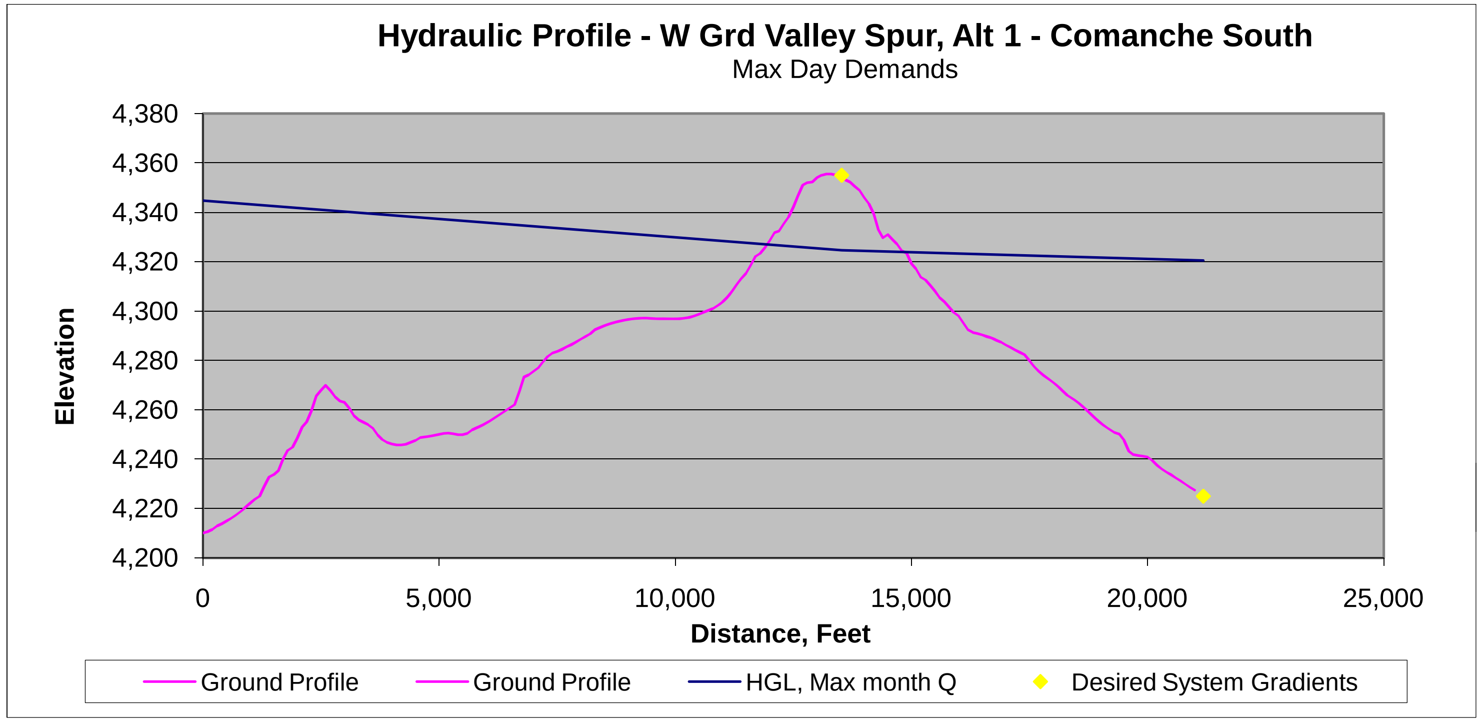
Hydraulic Profile - Hwy 96, Alt 1 - Comanche South

Max Day Demands

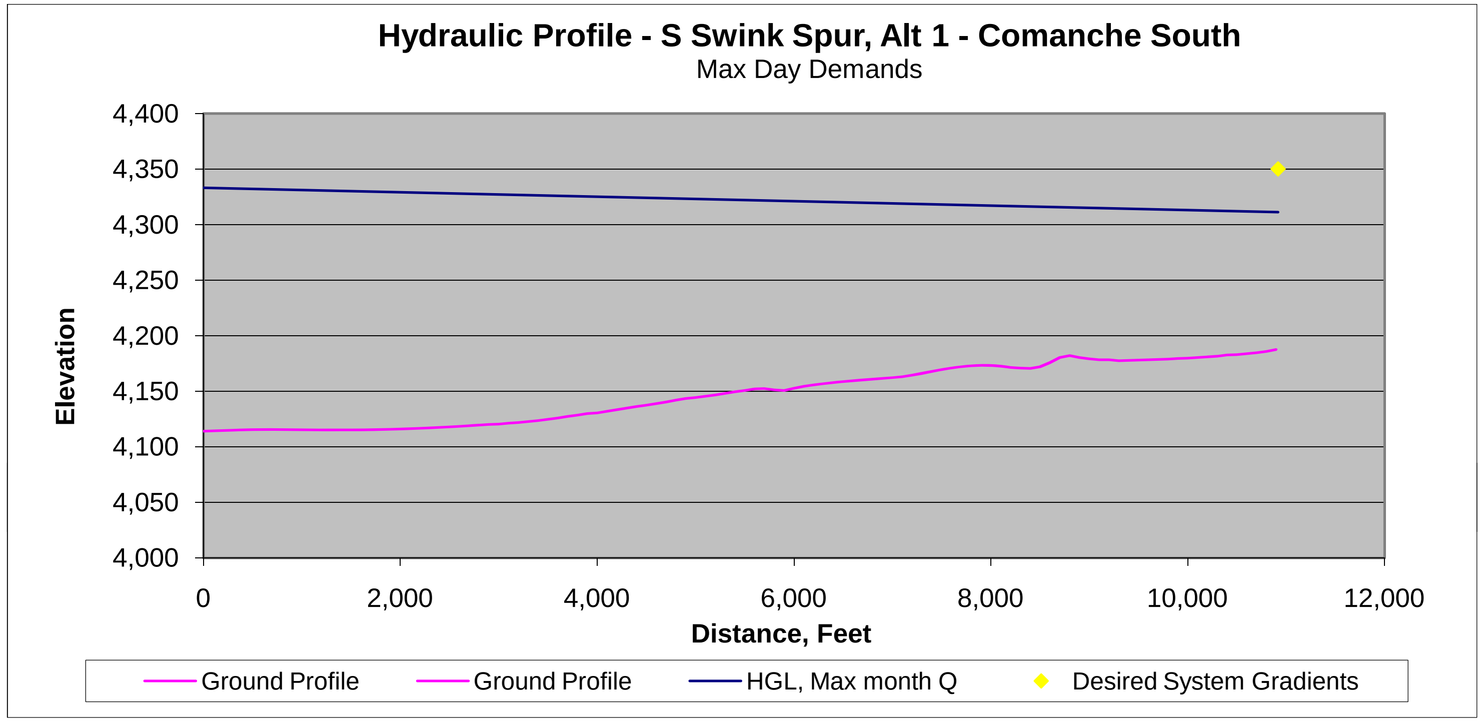


Hydraulic Profile - Rocky Ford/La Junta Loop, Alt 1 - Comanche South

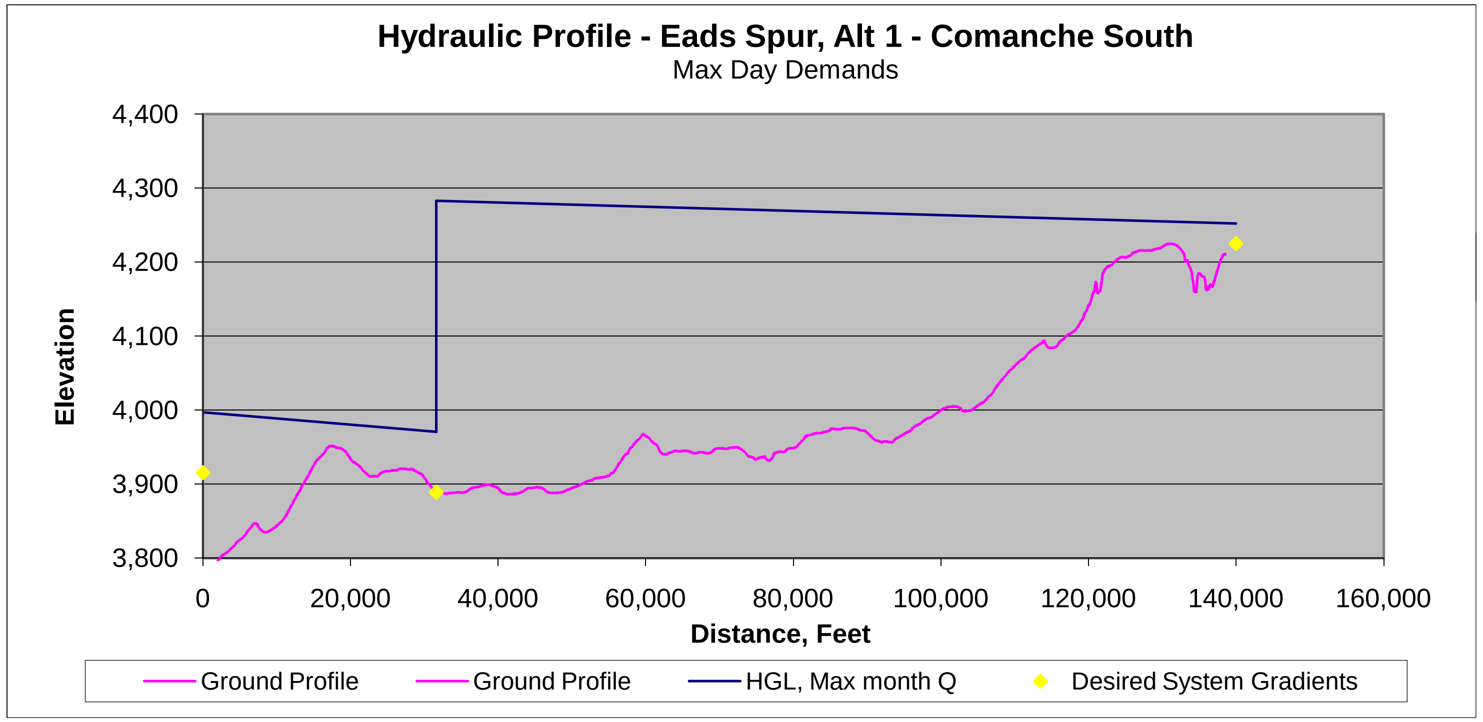
Maximum Day Demands



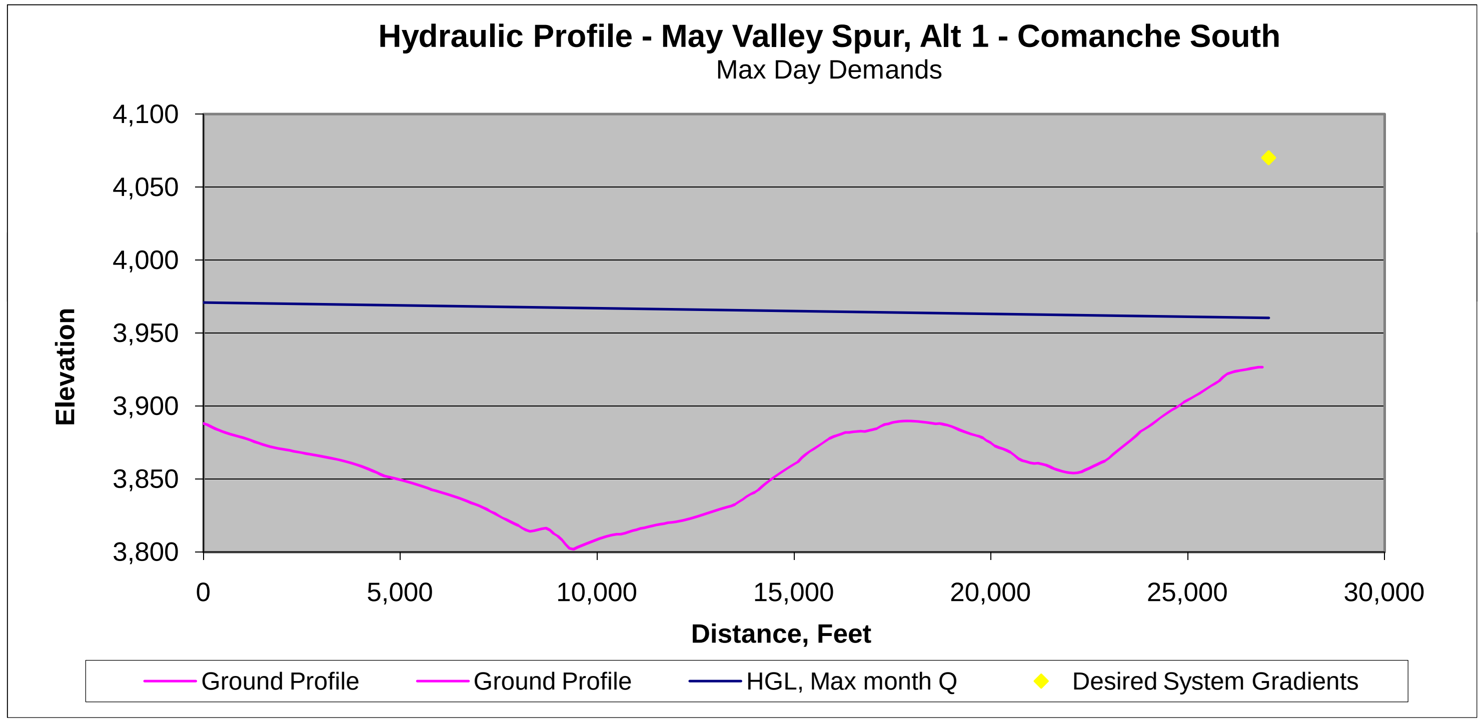
Hydraulic Profile - W Grd Valley Spur, Alt 1 - Comanche South
Max Day Demands



Hydraulic Profile - S Swink Spur, Alt 1 - Comanche South
Max Day Demands



Hydraulic Profile - Eads Spur, Alt 1 - Comanche South
Max Day Demands



Hydraulic Profile - May Valley Spur, Alt 1 - Comanche South
Max Day Demands

Arkansas Valley Conduit
Environmental Impact Statement / Apprasial Level Study
Hydraulic Analysis
Pueblo Dam_S Alt 2

Intake, Reservoir and along Bessemer Ditch
No Dam Outlet Works Interconnect
WTP (Filtered) @ S Rd & 21st St
St Charles Mesa gets filtered water
Southern Route

= Input
4796 Pueblo Reservoir Min Water Surface (Top of Inactive Pool)
4880 Pueblo Reservoir Max Water Surface (Top of Active Conservation Pool)

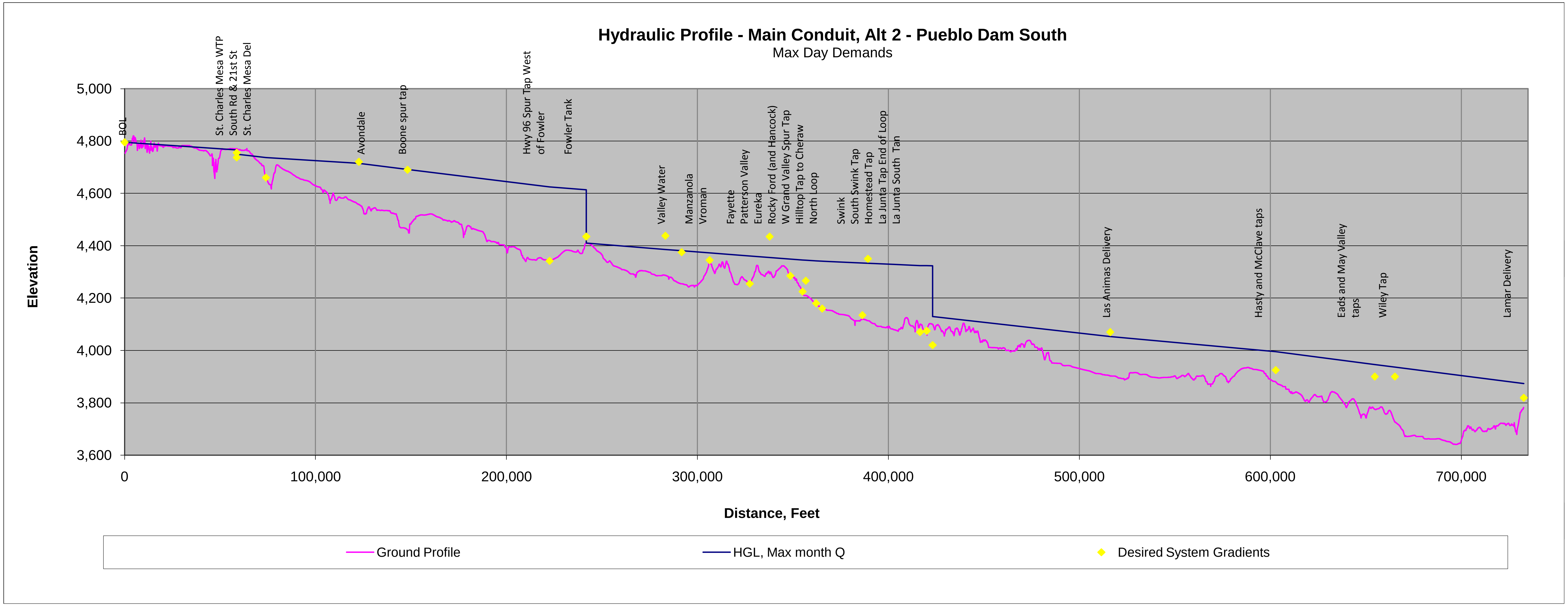
Condition 1 - Minimum Pueblo Reservoir, Max Month Demands
Condition 2 - Maximum Pueblo Reservoir, Max Month Demands
Condition 3 - Maximum Pueblo Reservoir, Min Day Demands
Condition 4 - Minimum Pueblo Reservoir, Max Day Demands
Condition 5 - Minimum Pueblo Reservoir, Max Month Demands (Except Radionuclides
Participants Being Provided Max Day)
Condition 4 - Selected Condition

Participants Being Provided Max Day Demands Due to Radionuclides (Condition 5)

East End Water	Manzanola	Valley Water
Eureka Water Co	May Valley	Vroman
Fayette Water	Patterson Valley	Wiley
Hancock	South Swink	
Holbrook Center Soft Water		
Homestead Improvement		

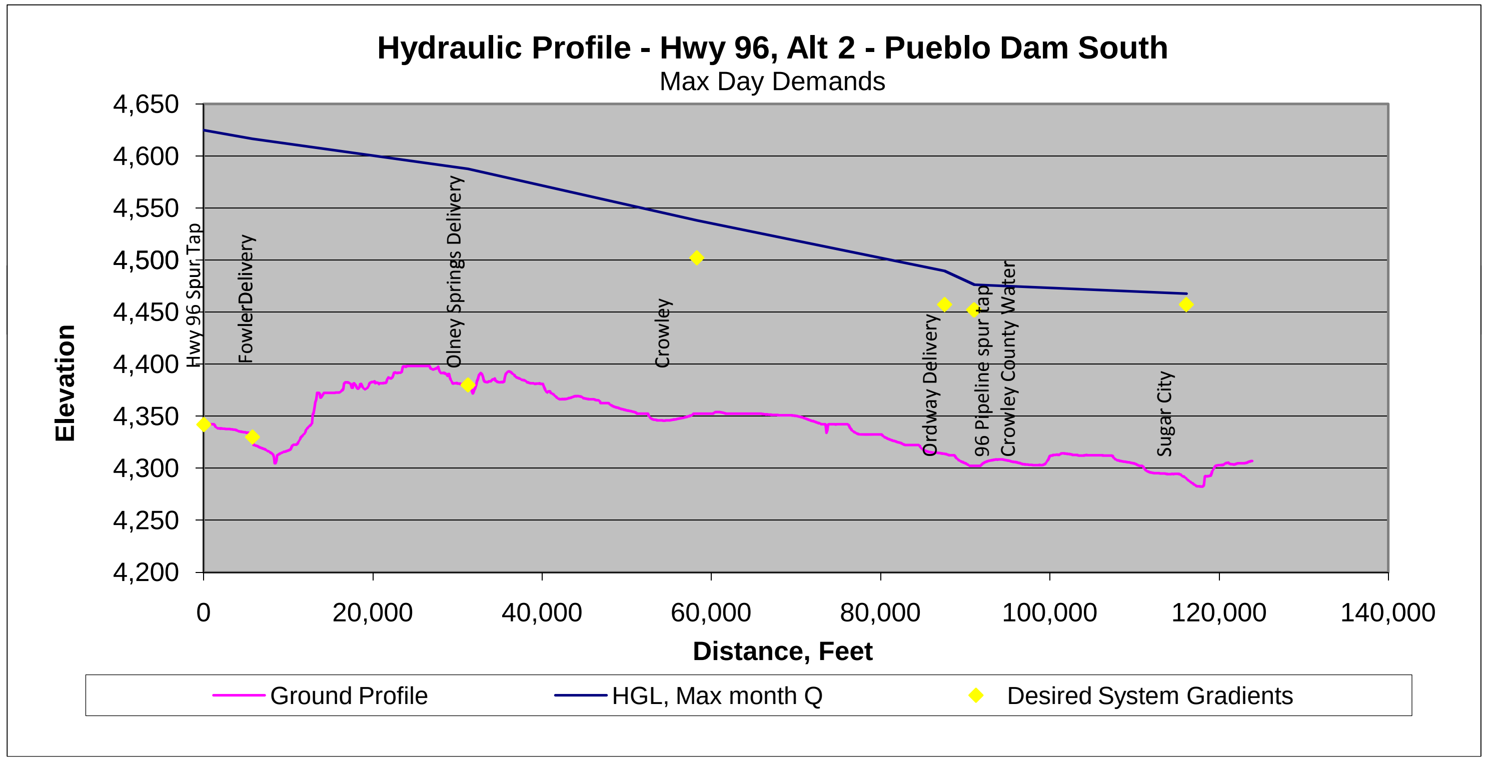
December 28, 2010

Overall Pipe Segment	Individual Pipe Segment	Description Starting Point	Ending Point	Station Starting Station	Ending Station	Length ft	Total Flow, Q mgd	cfs	gpm	Inside Pipe Diameter in	Inside Pipe Area ft^2	Velocity ft/s	C Value	Friction Headloss ft	Minor Headloss Loss/ft	Minor H_L, ft	Total Headloss ft	Begin HGL	End HGL	Participant Tap	Participant Flow mgd	Maximum Ground Elev	Actual Tap Pressure, psi	Desired System Pressure psi	Desired System Gradient	Comments
Main	1	Pueblo Reservoir	WTP at South Road and 21st ST	0+00	587+12	58,712	20.817	32.20	14,456	48	12.57	2.56	120	28.35	9.13E-06	0.54	28.89	4795.00	4766.11	NA	0.000	4755	4.81	0	4755.00	Tap Pressure is head available for WTP to use.
Main	2	WTP at South Road and 21st ST	St. Charles Mesa Delivery	587+12	740+01	15,289	19.825	30.67	13,768	42	9.62	3.19	120	12.93	9.13E-06	0.14	13.07	4750.00	4736.93	St. Charles Mesa Delivery	5.781	4660	33.31	0	4660.00	Tie in at WTP.
Main	3	St. Charles Mesa Delivery	AvondaleDelivery	740+01	1226+65	48,664	14.045	21.73	9,753	42	9.62	2.26	120	21.73	9.13E-06	0.44	22.17	4736.93	4714.76	AvondaleDelivery	0.296	4570	62.67	65	4720.15	
Main	4	AvondaleDelivery	Boone Tap	1226+65	1481+56	25,491	13.749	21.27	9,548	36	7.07	3.01	120	23.18	9.13E-06	0.23	23.41	4714.76	4691.35	Boone Tap	0.201	4540	65.52	65	4690.15	
Main	5	Boone Tap	Hwy 96 Spur Tap West of Fowler	1481+56	2225+42	74,386	13.548	20.96	9,408	36	7.07	2.96	120	65.82	9.13E-06	0.68	66.50	4691.35	4624.85	Hwy 96 Spur Tap West of Fo	2.805	4342	122.45	0	4342.00	
Main	6	Hwy 96 Spur Tap West of Fowler	Fowler Tank (South)	2225+42	2417+64	19,222	10.743	16.62	7,460	36	7.07	2.35	120	11.07	9.13E-06	0.18	11.24	4624.85	4613.61	Fowler Tank (South)	0.000	4435	77.32	0	4435.00	Ground Elev 4410, top of tank elev 4435.
Main	7	Fowler Tank (South)	Valley Water Delivery	2417+64	2832+12	41,448	10.743	16.62	7,460	36	7.07	2.35	120	23.87	9.13E-06	0.38	24.25	4410.00	4385.75	Valley Water Delivery	0.084	4288	42.32	65	4438.15	Ground Elev 4288 at conduit tap
Main	8	Valley Water Delivery	Manzanola Tap	2832+12	2917+04	8,492	10.659	16.49	7,402	36	7.07	2.33	120	4.82	9.13E-06	0.08	4.90	4385.75	4380.86	Manzanola Tap	0.079	4285	41.50	39	4375.09	Manzanola max ground elev is 4285. Tank Spill El 4375.
Main	9	Manzanola Tap	Vroman Delivery	2917+04	3063+51	14,647	10.580	16.37	7,347	36	7.07	2.32	120	8.20	9.13E-06	0.13	8.33	4380.86	4372.52	Vroman Delivery	0.079	4345	11.92		4345.00	
Main	10	Vroman Delivery	Fayette Delivery	3063+51	3273+87	21,036	10.501	16.24	7,292	36	7.07	2.30	120	11.61	9.13E-06	0.19	11.80	4372.52	4360.72	Fayette Delivery	0.030	4255	45.77		4255.00	
Main	11	Fayette Delivery	Patterson Valley Delivery	3273+87	3377+70	10,383	10.471	16.20	7,271	36	7.07	2.29	120	5.70	9.13E-06	0.09	5.80	4360.72	4354.92	Patterson Valley Delivery	0.036	4300	23.78	58.4	4434.90	Tank spill El 4435
Main	12	Patterson Valley Delivery	Eureka Delivery	3377+70	3486+11	10,841	10.434	16.14	7,246	36	7.07	2.28	120	5.91	9.13E-06	0.10	6.01	4354.92	4348.91	Eureka Delivery	0.184	4285	27.67		4285.00	
Main	13	Eureka Delivery	Rocky Ford (include Hancock) Tap	3486+11	3550+56	6,445	10.250	15.86	7,118	36	7.07	2.24	120	3.40	9.13E-06	0.06	3.46	4348.91	4345.45	Rocky Ford (include Hancocl	1.273	4225	52.14	0	4225.00	At WTP
Main	14	Rocky Ford (include Hancock) Tap	W Grand Valley Spur Tap	3550+56	3567+04	1,648	8.977	13.89	6,234	36	7.07	1.96	120	0.68	9.13E-06	0.02	0.70	4345.45	4344.75	W Grand Valley Spur Tap	0.161	4180	71.32	37.3	4266.16	Tank El 4266. 72 psi high pressure.
		W Grand Valley Spur Tap	Hilltop Delivery	3567+04	3621+20	5,416	8.817	13.64	6,123	36	7.07	1.93	120	2.16	9.13E-06	0.05	2.21	4344.75	4342.54	Hilltop Delivery	0.071	4180	70.36		4180.00	
Main	16	Hilltop Delivery	Tap to Cheraw North Loop	3621+20	3652+98	3,178	8.746	13.53	6,074	36	7.07	1.91	120	1.25	9.13E-06	0.03	1.28	4342.54	4341.26	Tap to Cheraw North Loop	0.304	4160	78.47	0	4160.00	
Main	17	Tap to Cheraw North Loop	Swink Delivery	3652+98	3863+73	21,075	7.987	12.36	5,547	36	7.07	1.75	120	7.01	9.13E-06	0.19	7.20	4341.26	4334.06	Swink Delivery	0.064	4135	86.17		4135.00	
Main	19	Swink Delivery	South Swink Tap	3863+73	3892+84	2,911	7.923	12.26	5,502	36	7.07	1.73	120	0.95	9.13E-06	0.03	0.98	4334.06	4333.08	South Swink Tap	0.189	4200	57.61	65	4350.15	
	19a	South Swink Tap	Homestead Tap	3892+84	4099+43	20,659	7.734	11.96	5,371	36	7.07	1.69	120	6.47	9.13E-06	0.19	6.66	4333.08	4326.42	Homestead Tap	0.015	4125	87.19			
Main	20	Homestead Tap	La Junta Tap	4099+43	4165+71	6,628	7.719	11.94	5,361	36	7.07	1.69	120	2.07	9.13E-06	0.06	2.13	4326.42	4324.29	La Junta Tap	3.717	4070	110.08	0	4070.00	At La Junta WTP. 4374 is max system water elevation.
Main	20a	La Junta Tap	End of Loop	4165+71	4200+72	3,501	4.002	6.19	2,779	36	7.07	0.88	120	0.32	9.13E-06	0.03	0.36	4324.29	4323.93	End of Loop	0.000	4075	107.76	0	4075.00	La Junta Storage tank is Elevated 25 ft
Main	21	End of Loop	La Junta Storage Tank	4200+72	4231+35	3,063	4.457	6.89	3,095	36	7.07	0.98	120	0.35	9.13E-06	0.03	0.37	4323.93	4323.56	La Junta Storage Tank	0.000	3905	181.19	50	4020.50	4020 is tank spill elevation
Main	21	La Junta Storage Tank	Las Animas Delivery	4231+35	5161+72	93,037	4.457	6.89	3,095	24	3.14	2.19	120	75.65	9.13E-06	0.85	76.50	4130.00	4053.50	Las Animas Delivery	1.294	3905	64.29	50	4020.50	4020 is tank spill elevation
Main	22	Las Animas Delivery	Hasty and McClave Tap	5161+72	6028+28	86,656	3.162	4.89	2,196	22	2.64	1.85	120	57.03	9.13E-06	0.79	57.82	4053.50	3995.68	Hasty and McClave Tap	0.174	3920	32.76	65	4070.15	
Main	23	Hasty and McClave Tap	Eads and May Valley Tap	6028+28	6547+03	51,875	2.989	4.62	2,076	20	2.18	2.12	120	48.91	9.13E-06	0.47	49.39	3995.68	3946.29	Eads and May Valley Tap	0.724	3775	74.15	65	3925.15	4215 is Eads tie-in at ground storage tank.
Main	24	Eads and May Valley Tap	Wiley Tap	6547+03	6652+22	10,519	2.265	3.50	1,573	18	1.77	1.98	120	9.91	9.13E-06	0.10	10.01	3946.29	3936.29	Wiley Tap	0.034	3750	80.64	65	3900.15	3750 is max ground in Wiley
Main	25	Wiley Tap	Lamar Delivery	6652+22	7327+33	67,511	2.230	3.45	1,549	18	1.77	1.95	120	61.84	9.13E-06	0.62	62.45	3936.29	3873.83	Lamar Delivery	2.230	3819.3	23.61	0	3819.30	Spill elevation of tanks.
		Totals																			**19.825**					
Hwy 96	26	Hwy 96 Spur Tap West of Fowler	Fowler Delivery	0+00	57+53	5,753	2.805	4.34	1,948	18	1.77	2.46	120	8.05	9.13E-06	0.05	8.11	4624.85	4616.74	Fowler Delivery	0.304	4330	124.13	0	4330.00	Lower tank spill elev ?
Hwy 96	27	Fowler Delivery	Olney Springs	57+53	312+29	25,476	2.500	3.87	1,736	18	1.77	2.19	120	28.83	9.13E-06	0.23	29.07	4616.74	4587.68	Olney Springs	0.129	4380	89.90	0	4380.00	Tank spill elev of 4486
Hwy 96	28	Olney Springs	Crowley	312+29	582+71	27,041	2.372	3.67	1,647	16	1.40	2.63	120	49.26	9.13E-06	0.25	49.50	4587.68	4538.17	Crowley	0.122	4352	80.59	65	4502.15	System pressure unknown.
Hwy 96	29	Crowley	Ordway Delivery	582+71	875+65	29,295	2.250	3.48	1,562	16	1.40	2.49	120	48.38	9.13E-06	0.27	48.65	4538.17	4489.52	Ordway Delivery	0.604	4307	79.01	65	4457.15	
Hwy 96	30	Ordway Delivery	96 Pipeline Co. spur tap	875+65	910+07	3,442	1.646	2.55	1,143	12	0.79	3.24	120	12.93	9.13E-06	0.03	12.96	4489.52	4476.56	96 Pipeline Co. spur tap	0.049	4302	75.57	65	4452.15	
Hwy 96	31	96 Pipeline Co. spur tap	Crowley County Water	910+07	910+76	69	1.596	2.47	1,108	12	0.79	3.14	120	0.24	9.13E-06	0.00	0.24	4476.56	4476.32	Crowley County Water	1.322	4302	75.46	65	4452.15	
Hwy 96	31	Crowley County Water	Sugar City Delivery	910+76	1161+39	25,064	0.274	0.42	190	10	0.55	0.78	120	8.29	9.13E-06	0.23	8.51	4476.32	4467.80	Sugar City Delivery	0.274	4307	69.61	65	4457.15	
		Totals																			**2.805**					
Spur 2	32	Tap from Main Conduit at Rocky Ford	West Holbrook Delivery	0+00	239+39	23,939	0.759	1.17	527	16	1.40	0.84	120	5.29	9.13E-06	0.22	5.50	4341.26	4335.76	West Holbrook Delivery	0.019	4200	58.77		4200.00	
Spur 2	33	West Holbrook Delivery	North Holbrook Delivery	239+39	313+26	7,387	0.740	1.14	514	16	1.40	0.82	120	1.56	9.13E-06	0.07	1.62	4335.76	4334.14	North Holbrook Delivery	0.015	4185	64.56		4185.00	
Spur 2	34	North Holbrook Delivery	Holbrook Center Soft Water Delivery (Includes Cheraw Del, East End Tap, South Side Tap)	313+26	581+58	26,832	0.725	1.12	503	16	1.40	0.80	120	5.44	9.13E-06	0.24	5.68	4334.14	4328.45	Holbrook Center Soft Water Delivery (Includes Cheraw Del, East End Tap, South	0.139	4130	85.91	14	4162.34	4162 is tank max wse.
Spur 2	35	Holbrook Center Soft Water Delivery (Includes Cheraw Del, East End Tap, South Side Tap)	Beehive Delivery	581+58	581+58	0	0.585	0.91	407	16	1.40	0.65	120	0.00	9.13E-06	0.00	0.00	4328.45	4328.45	Beehive Delivery	0.013	4130	85.91		4130.00	
Spur 2	36	Beehive Delivery	End of Seg 3V	581+58	738+33	15,675	0.573	0.89	398	16	1.40	0.63	120	2.05	9.13E-06	0.14	2.20	4328.45	4326.26	End of Seg 3V	0.000	4345	-8.11	0	4345.00	
Spur 2	37	End of Seg 3V	Bents Fort Tap	738+33	857+15	11,882	0.573	0.89	398	16	1.40	0.63	120	1.56	9.13E-06	0.11	1.67	4326.26	4324.59	Bents Fort Tap	0.118	4155	73.42		4155.00	
Spur 2	38	Bents Fort Tap	La Junta Loop tie-in (EOL)	857+15	963+84	10,669	0.455	0.70	316	16	1.40	0.50	120	0.91	9.13E-06	0.10	1.01	4324.59	4323.58	La Junta Loop tie-in (EOL)	0.000	4070	109.78		4070.00	
		Totals																			**0.304**					
Spur 3	39	Main Line Tap	May Valley Tap	0+00	316+33	31,633	0.724	1.12	503	12	0.79	1.43	120	25.99	9.13E-06	0.29	26.28	3946.29	3920.01	May Valley Tap	0.724	3960	-17.31	0	3960.00	
		May Valley Tap	Eads Delivery	316+33	1399+71	108,338	0.249	0.38	173	8	0.35	1.10	120	88.48	9.13E-06	0.99	89.47	3920.01	4280.54	Eads Delivery	0.249	4225	24.04	0	4225.00	4215 is Eads tie-in at ground storage tank.
Spur 4	40	Main Line Tap	Boone Delivery	0+00	91+54	9,154	0.201	0.31	140	4	0.09	3.57	120	148.10	9.13E-06	0.08	148.18	4691.35	4543.17	Boone Delivery	0.201	4540	1.37	65	4690.15	
	41	Main Line Tap	Manzanola Delivery	0+00	16+36	1,636	0.079	0.12	55	4	0.09	1.41	120	4.71	9.13E-06	0.01	4.72	4380.86	4376.13	Manzanola Delivery	0.079	4285	39.45	39	4375.09	Manzanola max ground elev is 4285. Tank Spill El 4375.
	42	Main Line Tap	Rocky Ford WTP Delivery	0+00	9+60	960	1.273	1.97	884	12	0.79	2.51	120	2.24	9.13E-06	0.01	2.25	4345.45	4343.20	Rocky Ford WTP Delivery	1.273	4225	51.17	0	4225.00	At WTP
		Main Line Tap	Newdale-Grand Valley Delivery	0+00	135+25	13,525	0.161	0.25	112	8	0.35	0.71	120	4.93	9.13E-06	0.12	5.05	4344.75	4339.71	Newdale-Grand Valley Delive	0.161	4350	-4.46	0	4350.00	
		Newdale-Grand Valley Delivery	West Grand Valley Delivery	135+25	211+81	7,656	0.032	0.05	22	4	0.09	0.57	120	4.14	9.13E-06	0.07	4.21	4339.71	4335.50	West Grand Valley Delivery	0.032	4225	47.83	0	4225.00	
		Hwy 96 Spur Tap	96 Pipeline Co. spur	0+00	23+95	2,395	0.049	0.08	34	4	0.09	0.87	122	2.77	9.13E-06	0.02	2.79	4476.56	4473.77	96 Pipeline Co. spur	0.049	4317	67.86	0	4317.00	
		Main Line Tap	Homestead	0+00	26+26	2,626	0.015	0.02	10	4	0.09	0.27	120	0.35	9.13E-06	0.02	0.37	4328.45	4328.08	Homestead	0.015	4133	84.45		4133.00	
		Main Line Tap	La Junta WTP	0+00	31+54	3,154	3.717	5.75	2,582	12	0.79	7.32	120	53.60	9.13E-06	0.03	53.63	4335.76	4282.13	La Junta WTP	3.717	4173	47.24	14	4205.34	At La Junta WTP. 4374 is max system water elevation.
	43	Main Line Tap	Bents Fort Tank Delivery	0+00	7+15	715	0.118	0.18	82	4	0.09	2.09	120	4.29	9.13E-06	0.01	4.29	4324.59	4320.30	Bents Fort Tank Delivery	0.118	4155	71.56		4155.00	
	44	Main Line Tap	Holbrook Center Soft Water Delivery	0+00	161+42	16,142	0.139	0.22	97	4	0.09	2.47	120	131.87	9.13E-06	0.15	132.02	4328.45	4196.44	brook Center Soft Water Deliv	0.139	4130	28.76	14	4162.34	4162 is tank max wse.
Spur 5	45	Main Line Tap	South Swink Delivery	0+00	109+19	10,919	0.189	0.29	131	6	0.20	1.49	120	21.70	9.13E-06	0.10	21.80	4333.08	4311.28	South Swink Delivery	0.189	4200	48.17	65	4350.15	
Spur 14	46	Main Line Tap	McClave Delivery	0+00	54+84	5,484	0.105	0.16	73	6	0.20	0.83	120	3.69	9.13E-06	0.05	3.74	3995.68	3991.94	McClave Delivery	0.105	3920	31.14	65	4070.15	
Spur 13	47	Main Line Tap	Hasty Delivery	0+00	6+26	626	0.069	0.11	48	4	0.09	1.22	120	1.38	9.13E-06	0.01	1.38	3995.68	3994.30	Hasty Delivery	0.069	3920	32.16	65	4070.15	
	48	Main Line Tap	Wiley Delivery	0+00	197+50	19,750	0.034	0.05	24	4	0.09	0.61	120	12.03	9.13E-06	0.18	12.21	3936.29	3924.08	Wiley Delivery	0.034	3750	75.36	65	3900.15	3750 is max ground in Wiley
	49	Main Line Tap	May Valley Delivery	0+00	270+56	27,056	0.476	0.74	330	6	0.20	3.75	120	298.44	9.13E-06	0.25	298.68	3920.01	4071.33	May Valley Delivery	0.476	3920	65.51	65	4070.15	



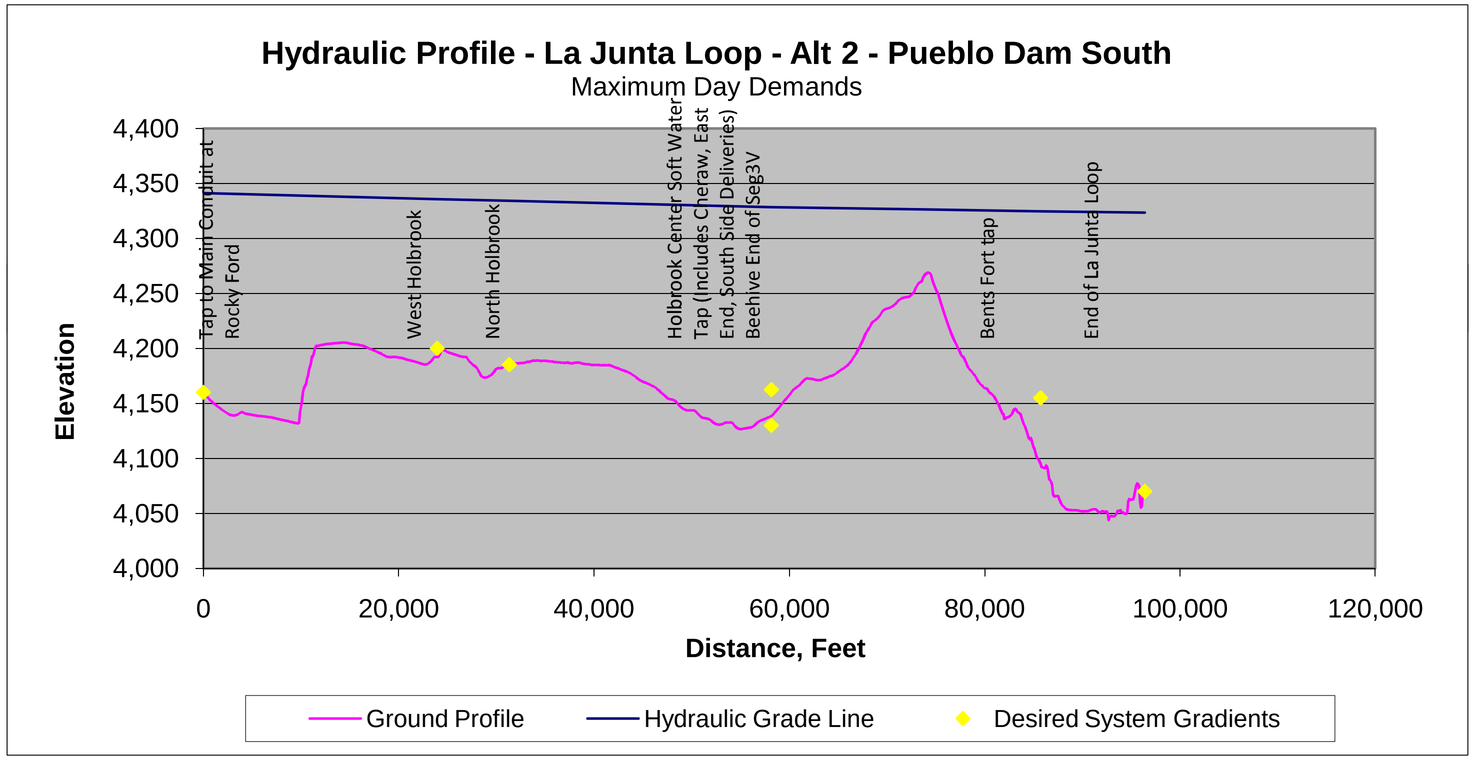
Hydraulic Profile - Main Conduit, Alt 2 - Pueblo Dam South

Max Day Demands



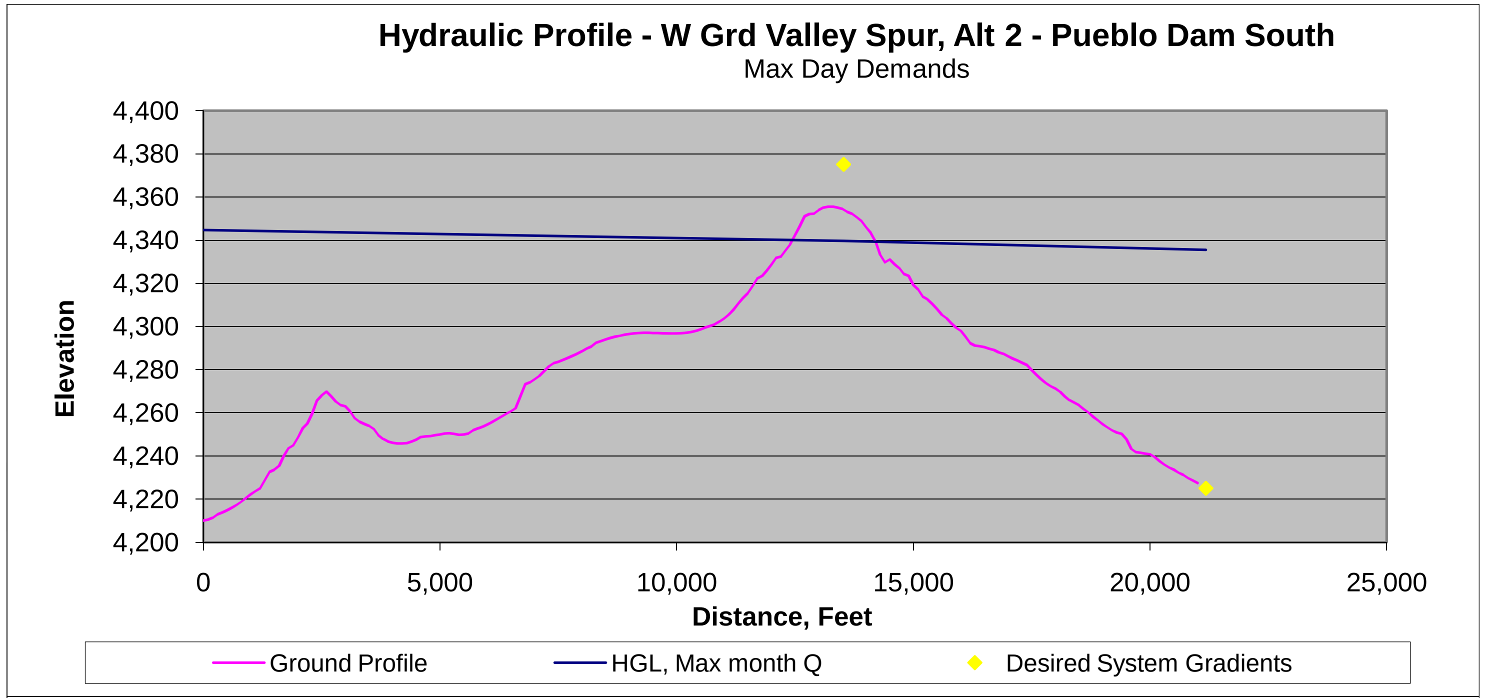
Hydraulic Profile - Hwy 96, Alt 2 - Pueblo Dam South

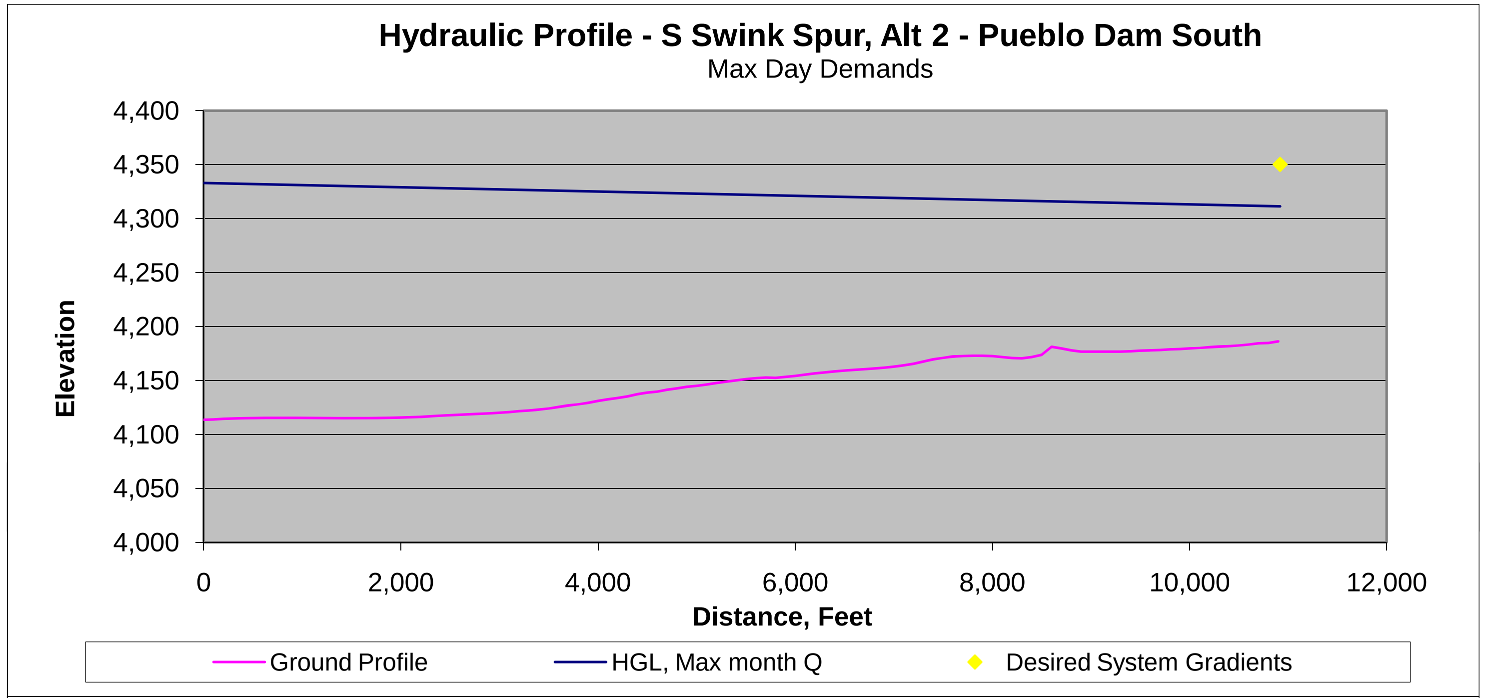
Max Day Demands

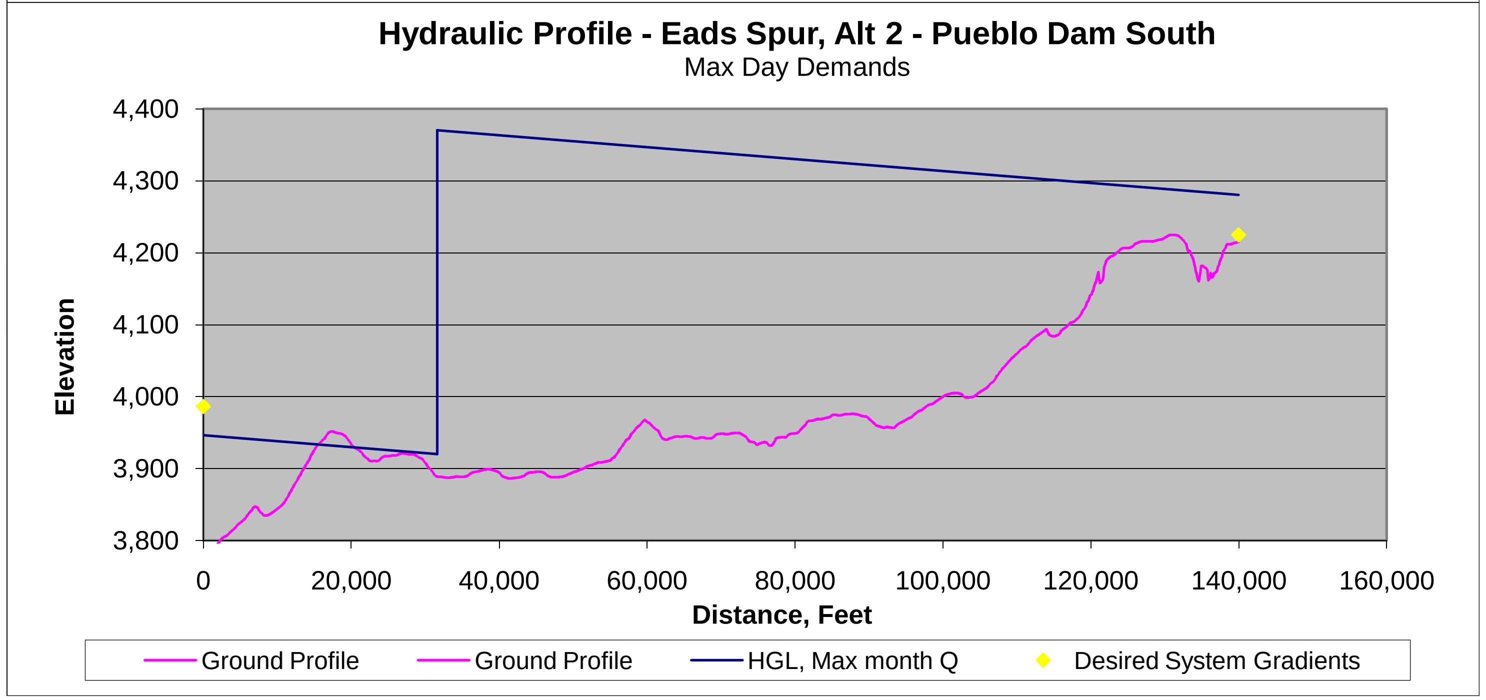


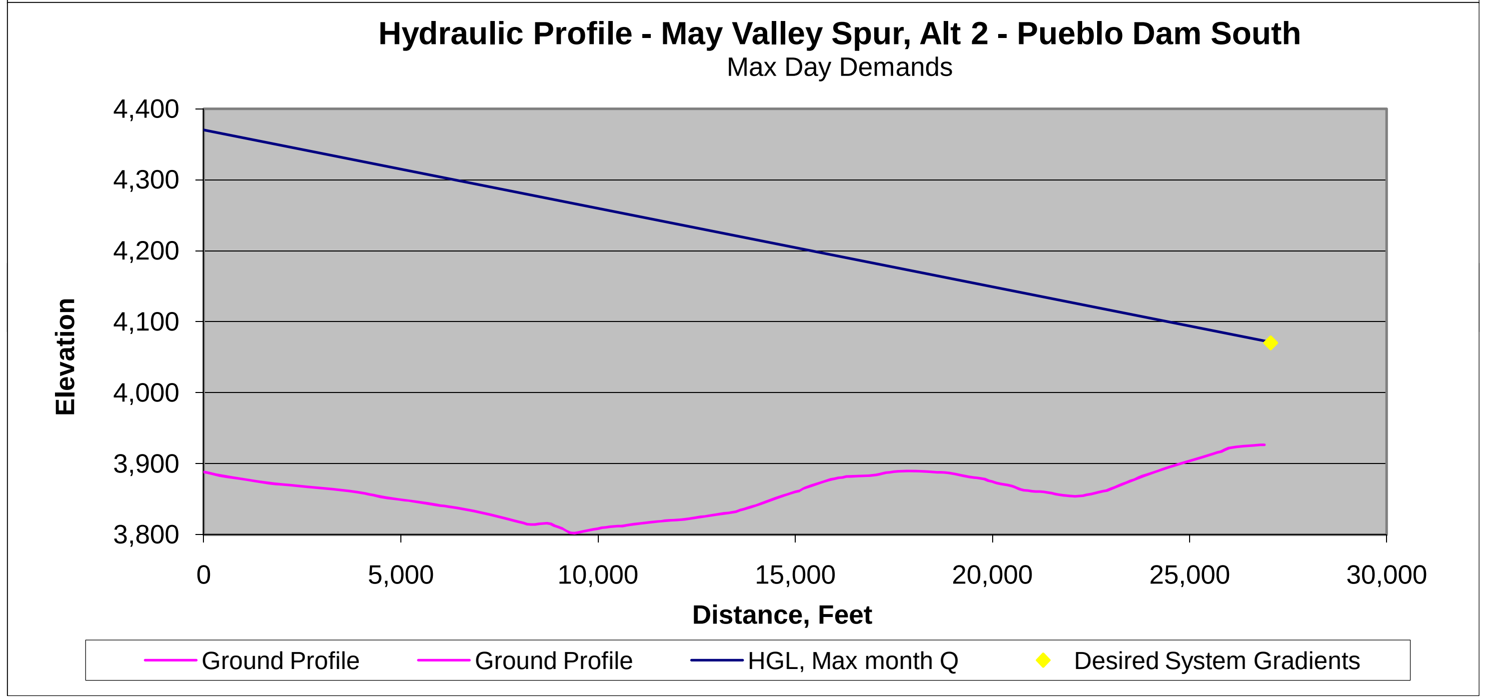
Hydraulic Profile - La Junta Loop - Alt 2 - Pueblo Dam South

Maximum Day Demands


Hydraulic Profile - W Grd Valley Spur, Alt 2 - Pueblo Dam South
Max Day Demands


Hydraulic Profile - S Swink Spur, Alt 2 - Pueblo Dam South
Max Day Demands


Hydraulic Profile - Eads Spur, Alt 2 - Pueblo Dam South
Max Day Demands


Hydraulic Profile - May Valley Spur, Alt 2 - Pueblo Dam South
Max Day Demands

Arkansas Valley Conduit

Environmental Impact Statement / Apprasial Level Study

December 28, 2010

Hydraulic Analysis

JUP_North - Alt 3

Intake, Existing PBWW Whitlock JUP
Dam N/S Interconnect
WTP (Filtered) @ Whitlock
St Charles Mesa gets filtered water
Northern Route

Existing JUP Peak Flow Rate 232.82 mgd

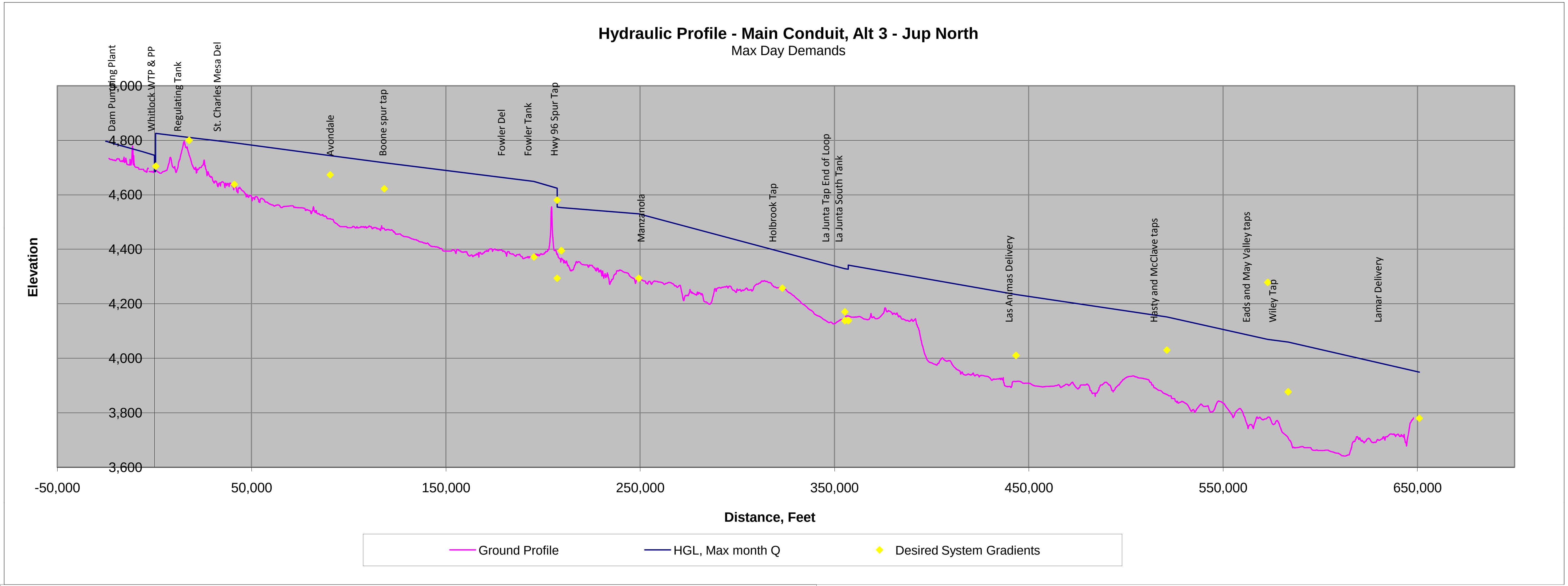
= Input
4796 Pueblo Reservoir Min Water Surface (Top of Inactive Pool)
4880 Pueblo Reservoir Max Water Surface (Top of Active Conservation Pool)
48.51 Loss in existing raw water feed pipeline
4675 Whitlock WTP Clearwell
150 Pump Head @ WTP

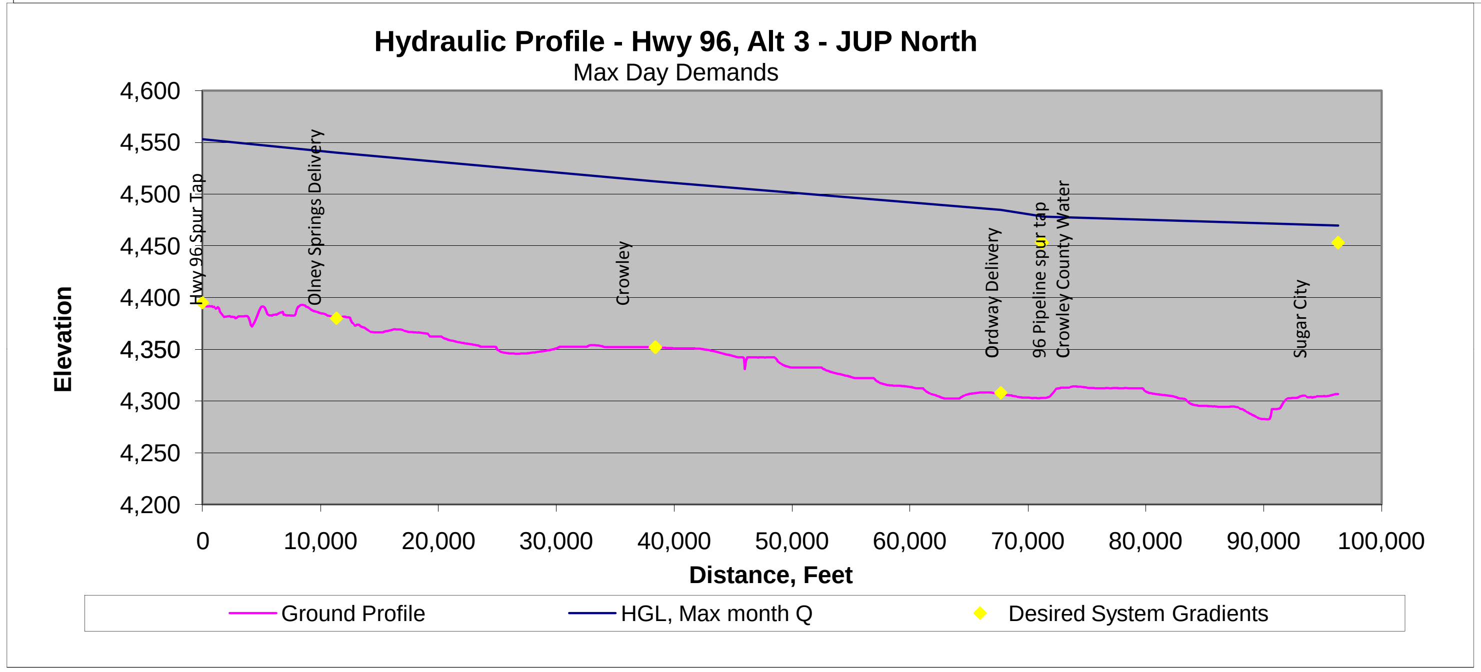
Condition 1 - Minimum Pueblo Reservoir, Max Month Demands
Condition 2 - (Not Used)
Condition 3 - Maximum Pueblo Reservoir, Min Day Demands
Condition 4 - Minimum Pueblo Reservoir, Max Day Demands
Condition 5 - Minimum Pueblo Reservoir, Max Month Demands (Except Radionuclides Participants Being Provided Max Day)
Condition 4 - Selected Condition

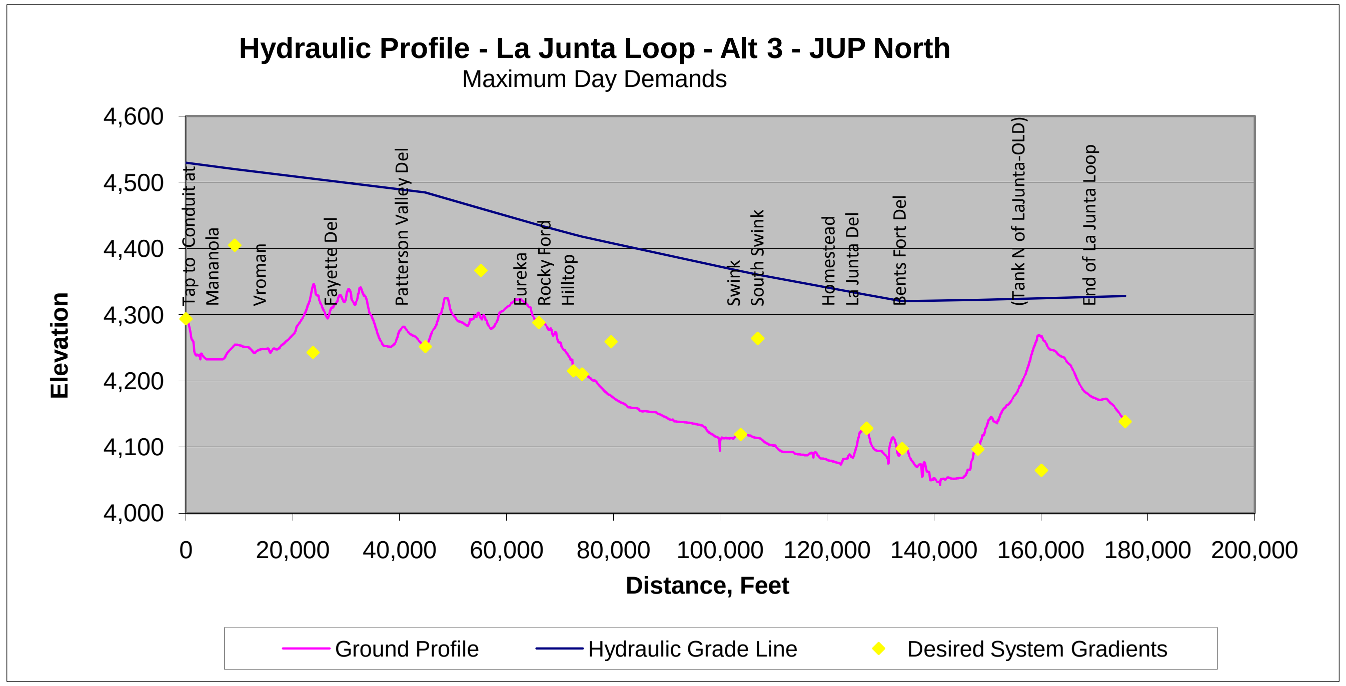
Participants Being Provided Max Day Demands Due to Radionuclides (Condition 5)

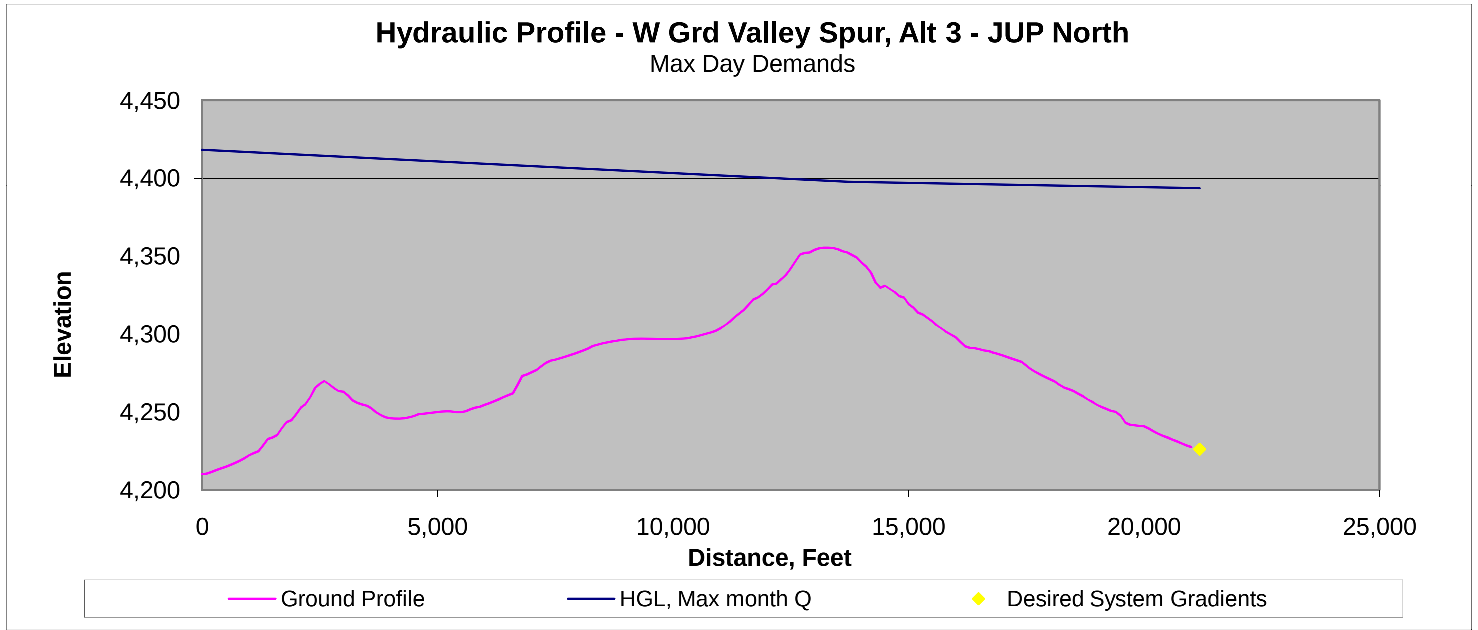
East End Water	Manzanola	Valley Water
Eureka Water Co	May Valley	Vroman
Fayette Water	Patterson Valley	Wiley
Hancock	South Swink	
Holbrook Center Soft Water		
Homestead Improvement		

Overall Pipe Segment	Individual Pipe Segment	Description		Station		Length	Total Flow, Q			Inside Pipe Diameter	Inside Pipe Area	Velocity	C Value	Friction Headloss	Minor Headloss		Total Headloss				Participant Flow	Maximum Ground Elev	Actual Tap Pressure, psi	Desired System Pressure, psi	Desired System Gradient	Comments
		Starting Point	Ending Point	Starting	Ending	ft	mgd	cfs	gpm	in	ft^2	ft/s		ft	Loss/ft	H_L, ft	ft	Begin HGL	End HGL	Participant Tap	mgd					
		Pueblo Reservoir	End of JUM (end of 120" segment)	-251+20	-246+05	515	232.817	360.17	161,678	120	78.54	4.59	120	0.25	9.1287E-06	0.00	0.26	4796.00	4795.74	Pueblo W. & Fountain Valley	32.000					Existing JUM
		End of JUM (end of 120" segment)	JUP - end of 84" segment	-246+05	-192+05	5,400	200.817	310.66	139,456	84	38.48	8.07	120	11.37	9.1287E-06	0.05	11.42	4795.74	4784.32	Future PBWW	40.000					Existing JUP
		JUP - end of 84" segment	JUP - WYE (in 78" segment)	-192+05	-63+56	12,849	160.817	248.78	111,678	78	33.18	7.50	120	25.72	9.1287E-06	0.12	25.84	4784.32	4758.48	Current PBWW	140.000					Wye in JUP, split of AVC & PBWW flows
		JUP - WYE (in 78" segment)	New WTP Inlet @ Whitlock	-63+56	6+21	6,977	20.817	32.20	14,456	36	7.07	4.56	120	13.68	9.1287E-06	0.06	13.74	4758.48	4744.74	New WTP @ Whitlock	0.991	4685	25.86	0	4705.00	Whitlock desired HGL = 4705 ft per PBWW
Main	1	New WTP PP Outlet @ Whitlock	Pumping Plant Reg. Tank	6+21	177+89	17,168	19.825	30.67	13,768	42	9.62	3.19	120	14.51	9.1287E-06	0.16	14.67	4825.00	4810.33	Reg. Tank	0.000	4800	4.47	0	4800.00	Reg. Tank on highspot at El. 4800
Main	1	Pumping Plant Reg. Tank	St. Charles Mesa Tap	177+89	410+56	23,267	19.825	30.67	13,768	42	9.62	3.19	120	19.67	9.1287E-06	0.21	19.88	4810.33	4790.45	St. Charles Mesa	5.781	4638	65.99	0	4638.00	Tie in at WTP.
Main	2	St. Charles Mesa Tap	Avondale Tap	410+56	903+95	49,339	14.045	21.73	9,753	36	7.07	3.07	120	46.67	9.1287E-06	0.45	47.12	4790.45	4743.33	Avondale	0.296	4523	95.38	65	4673.15	
Main	3	Avondale Tap	BooneDelivery	903+95	1182+53	27,858	13.749	21.27	9,548	36	7.07	3.01	120	25.33	9.1287E-06	0.25	25.59	4743.33	4717.74	Boone	0.201	4472	106.38	65	4622.15	
Main	4	BooneDelivery	Fowler Tap	1182+53	1953+00	77,047	13.548	20.96	9,408	36	7.07	2.96	120	68.17	9.1287E-06	0.70	68.88	4717.74	4648.86	Fowler	0.304	4372	119.85	0	4372.00	Lower tank spill elev ?
Main	5	Fowler Tap	Fowler Tank (North of Fowler)	1953+00	2072+38	11,938	13.243	20.49	9,197	30	4.91	4.17	120	24.61	9.1287E-06	0.11	24.72	4648.86	4624.14	Fowler Tank	0.000	4555	29.93	11	4580.41	Ground Elev 4555, top of tank elev 4580.
Main	6	Fowler Tank (North of Fowler)	Hwy 96 Spur Tap East of Fowler Tank	2072+38	2094+08	2,170	13.243	20.49	9,197	36	7.07	2.90	120	1.84	9.1287E-06	0.02	1.86	4555.00	4553.14	Hwy 96 Spur	2.500	4395.19	68.38	0	4395.19	
Main	7	Hwy 96 Spur Tap East of Fowler Tank	Tap to Spur 7 (S. Loop)	2094+08	2492+39	39,831	10.743	16.62	7,460	36	7.07	2.35	120	22.94	9.1287E-06	0.36	23.30	4553.14	4529.84	Spur 7 (Loop) Total	6.100	4293.76	102.20	0	4293.76	
Main	8	Tap to Spur 7 (S. Loop)	W. Holbrook & N. Holbrook Spur tap	2492+39	3231+20	73,881	5.59492	8.66	3,885	22	2.64	3.28	120	139.86	9.1287E-06	0.67	140.54	4529.84	4389.30	West Holbrook and North Holbrook Spur tap	0.034	4257.76	56.95	0	4257.76	
Main	9	W. Holbrook & N. Holbrook Spur tap	Holbrook Center Soft Water (Includes Cheraw) Tap	3231+20	3552+80	32,160	5.561	8.60	3,862	22	2.64	3.26	120	60.19	9.1287E-06	0.29	60.49	4389.30	4328.82	Holbrook Center Soft Water and Cheraw	0.101	4138.5	82.39	14	4170.84	4162 is tank max wse.
Main	10	Holbrook Center Soft Water (Includes Cheraw) Tap	Beehive Delivery	3552+80	3552+80	0	5.460	8.45	3,792	22	2.64	3.20	120	0.00	9.1287E-06	0.00	0.00	4328.82	4328.82	Beehive	0.013	4138.5	82.39	0	4138.50	
Main	11	Beehive Delivery	End of Loop @ La Junta	3552+80	3552+80	0	5.447	8.43	3,783	22	2.64	3.19	120	0.00	9.1287E-06	0.00	0.00	4328.82	4328.82	End of Loop @ La Junta	0.000	4138.5	82.39	0	4138.50	
Main	11a	End of Loop @ La Junta	La Junta North Elevated Storage Tank	3552+80	3571+00	1,820	4.495	6.95	3,122	22	2.64	2.63	120	2.30	9.1287E-06	0.02	2.31	4328.82	4326.51	La Junta N. Tank	0.000	4142	79.87	0	4142.00	4142 Ground El. at Tank
Main	12	La Junta North Elevated Storage Tank	East End and South Side Deliveries	3571+00	3714+22	14,322	4.495	6.95	3,122	22	2.64	2.63	120	18.08	9.1287E-06	0.13	18.21	4342.00	4323.79	East End & South Side	0.039	3976.2	150.47	0	3976.20	200' Elevated Tank
		East End and South Side Deliveries	Las Animas Tap	3714+22	4434+10	71,988	4.456	6.89	3,095	22	2.64	2.61	120	89.42	9.1287E-06	0.66	90.08	4323.79	4233.72	Las Animas	1.294	3895	146.63	50	4010.50	4020 is tank spill elevation
Main	13	Las Animas Tap	Hasty and McClave Taps	4434+10	5210+63	77,653	3.162	4.89	2,196	20	2.18	2.24	120	81.28	9.1287E-06	0.71	81.99	4233.72	4151.72	Hasty and McClave	0.174	3880	117.63	65	4030.15	
Main	14	Hasty and McClave Taps	Eads and May Valley Tap	5210+63	5729+38	51,875	2.989	4.62	2,076	18	1.77	2.62	120	81.70	9.1287E-06	0.47	82.18	4151.72	4069.55	Eads and May Valley	0.724	3775	127.51	217.94	4278.45	4215 is Eads tie-in at ground storage tank
Main	15	Eads and May Valley Tap	Wiley Tap	5729+38	5834+57	10,519	2.265	3.50	1,573	18	1.77	1.98	120	9.91	9.1287E-06	0.10	10.01	4069.55	4059.54	Wiley	0.034	3727	143.96	65	3877.15	3750 is max ground in Wiley
Main	16	Wiley Tap	Lamar Delivery	5834+57	6509+67	67,510	2.230	3.45	1,549	16	1.40	2.47	120	109.73	9.1287E-06	0.62	110.34	4059.54	3949.20	Lamar	2.230	3780	73.25	0	3780.00	Spill elevation of tanks.
		Totals																			**19.825**					
Hwy 96	17	Hwy 96 Spur East of Fowler Tank	Olney Springs Delivery	0+00	113+68	11,368	2.500	3.87	1,736	18	1.77	2.19	120	12.87	9.1287E-06	0.10	12.97	4553.14	4540.17	Olney Springs	0.129	4380	69.34	0	4380.00	Tank spill elev of 4486
Hwy 96	18	Olney Springs Delivery	Crowley	113+68	384+09	27,041	2.372	3.67	1,647	18	1.77	2.08	120	27.76	9.1287E-06	0.25	28.00	4540.17	4512.17	Crowley	0.122	4352	69.34	0	4352.00	System pressure unknown.
Hwy 96	18	Crowley	Ordway Delivery	384+09	677+05	29,296	2.250	3.48	1,562	18	1.77	1.97	120	27.27	9.1287E-06	0.27	27.53	4512.17	4484.63	Ordway	0.604	4308	76.46	0	4308.00	System pressure unknown.
Hwy 96	19	Ordway Delivery	96 Pipeline Co. Spur	677+05	711+47	3,442	1.646	2.55	1,143	14	1.07	2.38	120	6.10	9.1287E-06	0.03	6.14	4484.63	4478.50	96 Pipeline Co. Spur	0.049	4303.46	75.77	65	4453.61	
Hwy 96	20	96 Pipeline Co. Spur	Crowley County Water Assoc. Delivery	711+47	712+13	66	1.596	2.47	1,108	12	0.79	3.14	120	0.23	9.1287E-06	0.00	0.23	4478.50	4478.26	Crowley County Water Assoc.	1.322	4303	75.87	65	4453.15	
Hwy 96	21	Crowley County Water Assoc. Delivery	Sugar City Delivery	712+13	963+10	25,097	0.274	0.42	190	10	0.55	0.78	120	8.30	9.1287E-06	0.23	8.53	4478.26	4469.74	Sugar City	0.274	4303	72.18	65	4453.15	
		Totals																			**2.500**					
Spur 7	22	Tap to Main Conduit North of Manzanola	Manzanola and Valley Water Spur taps	0+00	91+31	9,131	5.148	7.96	3,575	24	3.14	2.54	120	9.70	9.1287E-06	0.08	9.78	4529.84	4520.06	Manzanola and Valley Water	0.163	4254.95	114.77	65	4405.10	Manzanola max ground elev is 4285. Tank Spill El 4375. Valley Water ground elev 4288 at conduit tap plus 65 psi system pressure.
Spur 7	23	Manzanola and Valley Water Spur taps	Vroman Delivery	91+31	237+78	14,647	4.985	7.71	3,462	24	3.14	2.45	120	14.66	9.1287E-06	0.13	14.79	4520.06	4505.27	Vroman	0.079	4243	113.54	0	4243.00	
Spur 7	24	Vroman Delivery	Fayette Delivery	237+78	448+14	21,036	4.906	7.59	3,407	24	3.14	2.42	120	20.44	9.1287E-06	0.19	20.63	4505.27	4484.64	Fayette	0.030	4251.86	100.77	0	4251.86	
Spur 7	25	Fayette Delivery	Patterson Valley Delivery	448+14	551+97	10,383	4.876	7.54	3,386	20	2.18	3.46	120	24.23	9.1287E-06	0.09	24.33	4484.64	4460.31	Patterson Valley	0.036	4232	98.84	58.4	4366.90	Tank spill El 4435
Spur 7	26	Patterson Valley Delivery	Eureka Delivery	551+97	660+32	10,835	4.839	7.49	3,361	20	2.18	3.43	120	24.94	9.1287E-06	0.10	25.04	4460.31	4435.27	Eureka	0.184	4288	63.75	0	4288.00	
Spur 7	27	Eureka Delivery	Rocky Ford (and Hancock)	660+32	725+10	6,478	4.655	7.20	3,233	20	2.18	3.30	120	13.88	9.1287E-06	0.06	13.94	4435.27	4421.33	Rocky Ford and Hancock	1.273	4215	89.32	0	4215.00	At WTP
Spur 7	28	Rocky Ford (and Hancock)	W Grand Valley Spur Tap	725+10	741+31	1,621	3.383	5.23	2,349	18	1.77	2.96	120	3.21	9.1287E-06	0.01	3.23	4421.33	4418.11	W. Grand Valley Spur	0.161	4210.06	90.06	0	4210.06	
		W Grand Valley Spur Tap	Hilltop Delivery	741+31	795+51	5,420	3.222	4.98	2,237	18	1.77	2.82	120	9.81	9.1287E-06	0.05	9.86	4418.11	4408.25	Hilltop	0.071	4173	101.84	37.3	4259.16	Tank El 4266. 72 psi high pressure.
Spur 7	29	Hilltop Delivery	Swink Delivery	795+51	1038+00	24,249	3.151	4.87	2,188	18	1.77	2.76	120	42.12	9.1287E-06	0.22	42.34	4408.25	4365.91	Swink	0.064	4118.99	106.89	0	4118.99	
Spur 7	32	Swink Delivery	South Swink Spur tap	1038+00	1069+93	3,193	3.087	4.78	2,144	18	1.77	2.70	120	5.34	9.1287E-06	0.03	5.37	4365.91	4360.54	South Swink	0.189	4114	106.73	65	4264.15	
		South Swink Spur tap	Homestead Tap	1069+93	1273+70	20,377	2.898	4.48	2,013	18	1.77	2.54	120	30.32	9.1287E-06	0.19	30.50	4360.54	4330.03	Homestead	0.015	4128.27	87.34	0	4128.27	
Spur 7	33	Homestead Tap	La Junta Tap	1273+70	1339+98	6,628	2.883	4.46	2,002	18	1.77	2.52	120	9.77	9.1287E-06	0.06	9.83	4330.03	4320.21	La Junta	3.717	4097.55	96.39	0	4097.55	At La Junta WTP. 4374 is max system water elevation.
Spur 7	34	La Junta Tap	Bents Fort Tap	1339+98	1481+66	14,168	0.834	1.29	579	18	1.77	0.73	120	2.10	9.1287E-06	0.13	2.23	4320.21	4322.44	Bents Fort	0.118	4096.71	97.72	0	4096.71	
Spur 7	35	Bents Fort Tap	Top of hill North of La Junta, near airport	1481+66	1600+49	11,883	0.952	1.47	661	18	1.77	0.83	120	2.25	9.1287E-06	0.11	2.36	4322.44	4324.79	La Junta Airport	0.000	4064.71	112.59	0	4064.71	
Spur 7	36	Top of hill North of La Junta, near airport	Tap to Main Conduit	1600+49	1757+24	15,675	0.952	1.47	661	18	1.77	0.83	120	2.97	9.1287E-06	0.14	3.11	4324.79	4327.90	End of South Loop	0.000	4138.5	81.99	0	4138.50	
		Totals																			**6.100**					
Spur 3	37a	Main Line Tap	May Valley Spur Tap	0+00	316+33	31,633	0.724	1.12	503	10	0.55	2.05	120	63.16	9.1287E-06	0.29	63.45	4069.55	4006.10	May Valley Spur Tap	0.724	3888	51.13	0	3888.00	
Spur 3	37	May Valley Spur Tap	Eads Delivery	316+33	1399+71	108,338	0.249	0.38	173	8	0.35	1.10	120	88.48	9.1287E-06	0.99	89.47	4006.10	4316.63	Eads	0.249	4225	39.67	0	4225.00	4215 is Eads tie-in at ground storage tank
Spur 8	38	Main Line Tap	St Charles Mesa Delivery	0+00	229+66	22,966	5.781	8.94	4,014	20	2.18	4.10	120	73.47	9.1287E-06	0.21	73.68	4790.45	4716.77	St Charles Mesa Delivery	5.781	4665	22.41	0	4665.00	Tie in at WTP.
Spur 9	39	Main Line Tap	Avondale Delivery	0+00	106+89	10,689	0.296	0.46	205	8	0.35	1.31	120	12.04	9.1287E-06	0.10	12.14	4743.33	4731.19	Avondale Delivery	0.296	4560	74.11	65	4710.15	
		Main Line Tap	Fowler Delivery	0+00	77+65	7,765	0.304	0.47	211	6	0.20	2.40	120	37.44	9.1287E-06	0.07	37.51	4648.86	4611.35	Fowler Delivery	0.304	4330	121.80	0	4330.00	
	40	Spur 7 (Loop) Tap	Valley Water Delivery	0+00	298+87	29,887	0.084	0.13	58	4	0.09	1.48	120	94.81	9.1287E-06	0.27	95.08	4520.06	4424.98	Valley Water Delivery	0.084	4288	59.30	65	4438.15	Valley Water ground elev 4288 at conduit tap plus 65 psi system pressure.
	41	Spur 7 (Loop) Tap	Manzanola Delivery	0+00	16+36	1,636	0.079	0.12	55	4	0.09	1.41	120	4.71	9.1287E-06	0.01	4.72	4520.06	4515.34	Manzanola Delivery	0.079	4276.16	103.54	39	4366.25	Manzanola max ground elev is 4285. Tank Spill El 4375.
	42	Main Line Tap	Rocky Ford WTP Delivery	0+00	9+60	960	1.273	1.97	884	12	0.79	2.51	120	2.24	9.1287E-06	0.01	2.25	4421.33	4419.08	Rocky Ford WTP Delivery	1.273	4220.84	85.82	0	4220.84	At WTP
		Spur 7 (Loop) Tap	Newdale-Grand Valley Delivery	0+00	137+13	13,713	0.161	0.25	112	6	0.20	1.27	120	20.27	9.1287E-06	0.13	20.40	4418.11	4397.71	Newdale-Grand Valley	0.129	4137	112.86	0	4137.00	
		Newdale-Grand Valley Delivery	West Grand Valley Delivery	137+13	211+81	7,468	0.032	0.05	22	4	0.09	0.57	120	4.04	9.1287E-06	0.07	4.11	4397.71	4393.61	West Grand Valley	0.032	4226.17	72.48	0	4226.17	
		Spur 7 (Loop) Tap	Homestead	0+00	26+26	2,626	0.015	0.02	10	4	0.09	0.27	120	0.35	9.1287E-06	0.02	0.37	4330.03	4329.66	Homestead	0.015	4133.8	84.79	0	4133.80	
		Spur 7 (Loop) Tap	La Junta	0+00	31+54	3,154	3.717	5.75	2,582	12	0.79	7.32	120	53.60	9.1287E-06	0.03	53.63	4320.21	4266.58	La Junta	3.717	4147.04	51.75	0	4147.04	
					0+00																					
Spur ?		Hwy 96 Spur	96 Pipeline Co.	0+00	23+95	2,395	0.049	0.08	34	4	0.09	0.87	120	2.86	9.1287E-06	0.02	2.88	4478.50	4475.62	96 Pipeline Co.	0.049	4317.41	68.49	0	4317.41	
	43	Main Line Tap	N. Holbrook Delivery (incl. W Holbrook)	0+00	81+35	8,135	0.034	0.05	24	4	0.09	0.61	120	4.96	9.1287E-06	0.07	5.03	4389.30	4384.28	N. Holbrook Delivery (incl. W Holbrook)	0.034	4186.62	85.56	0	4186.62	
	43	N. Holbrook Delivery (incl. W Holbrook)	W. Holbrook Delivery	0+00	73+87	7,387	0.019	0.03	13	4	0.09	0.34	120	1.55	9.1287E-06	0.07	1.62	4384.28	4382.66	W. Holbrook Delivery	0.019	4192.45	82.34	0	4192.45	
	44	Spur 7 (Loop) Tap	South Swink Delivery	0+00	109+19	10,919	0.189	0.29	131	6	0.20	1.49	120	21.70	9.1287E-06	0.10	21.80	4360.54	4338.73	South Swink Delivery	0.189	4187.57	65.44	65	4337.72	
Spur 5	45	Spur 7 (Loop) Tap	Bents Fort Tank Delivery	0+00	7+15	715	0.118	0.18	82	8	0.35	0.52	120	0.15	9.1287E-06	0.01	0.15	4322.44	4322.28	Bents Fort Tank Delivery	0.118	4156.09	71.94	0	4156.09	
	46	Main Line Tap	Las Animas WTP Delivery	0+00	90+04	9,004	1.294	2.00	899	12	0.79	2.55	120	21.68	9.1287E-06	0.08	21.76	4233.72	4211.95	Las Animas WTP Delivery	1.294	3903	133.75	50	4018.50	4020 is tank spill elevation
Spur 14	47	Main Line Tap	McClave Delivery	0+00	54+84	5,484	0.105	0.16	73	4	0.09	1.86	120	26.55	9.1287E-06	0.05	26.60	4151.72	4125.12	McClave Delivery	0.105	3920	88.80	65	4070.15	
Spur 13	48	Main Line Tap	Hasty Delivery	0+00	6+26	626	0.069	0.11	48	4	0.09	1.22	120	1.38	9.1287E-06	0.01	1.38	4151.72	4150.34	Hasty Delivery	0.069	3875	119.20	65	4025.15	
	49	Main Line Tap	Wiley Delivery	0+00	197+50	19,750	0.034	0.05	24	4	0.09	0.61	120	12.03	9.1287E-06	0.18	12.21	4059.54	4047.33	Wiley Delivery	0.034	3733	136.07	65	3883.15	3750 is max ground in Wiley, 3733 @ delivery
	50	May Valley Spur Tap	May Valley Delivery	0+00	270+56	27,056	0.476	0.74	330	6	0.20	3.75	120	298.44	9.1287E-06	0.25	298.68	4006.10	4107.42	May Valley Delivery	0.476	3927	78.10	0.00	3927.00	


Hydraulic Profile - Main Conduit, Alt 3 - Jup North
Max Day Demands
Elevation
5,000
4,800
4,600
4,400
4,200
4,000
3,800
3,600
-50,000
50,000
150,000
250,000
350,000
450,000
550,000
650,000
Distance, Feet
Dam Pumping Plant
Whitlock WTP & PP
Regulating Tank
St. Charles Mesa Del
Avondale
Boone spur tap
Fowler Del
Fowler Tank
Hwy 96 Spur Tap
Manzanola
Holbrook Tap
La Junta Tap End of Loop
La Junta South Tank
Las Animas Delivery
Hasty and McClave taps
Eads and May Valley taps
Wiley Tap
Lamar Delivery
Ground Profile
HGL, Max month Q
Desired System Gradients

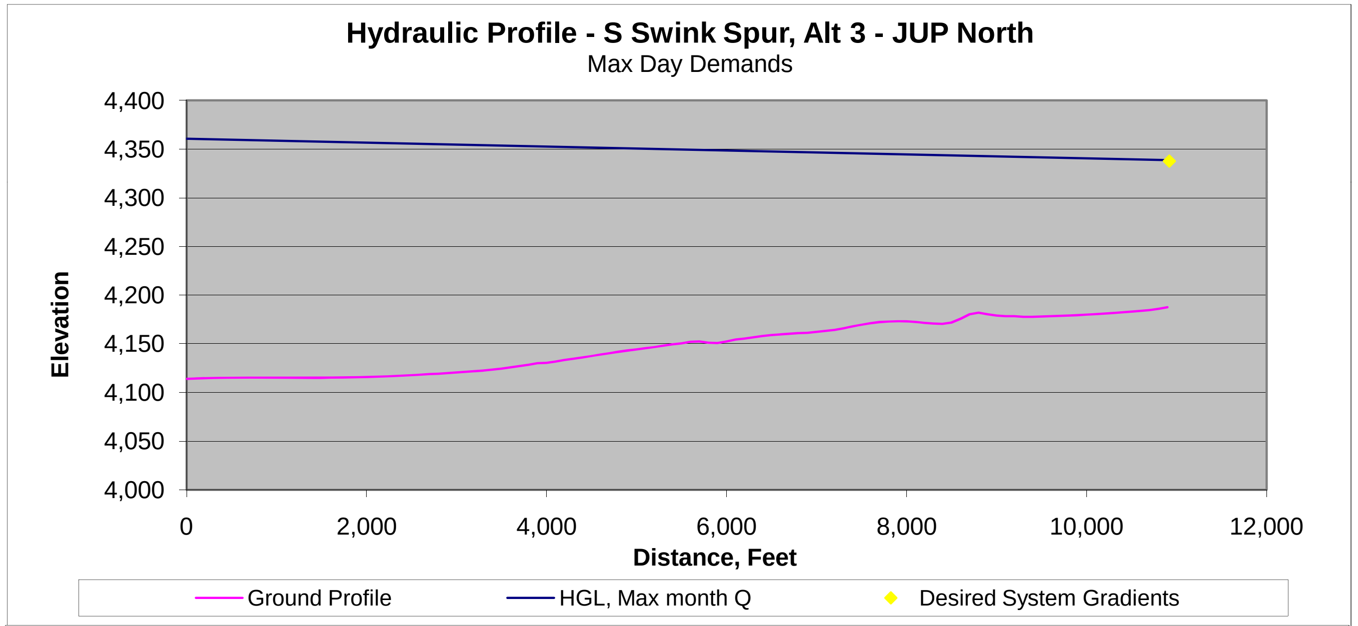

Hydraulic Profile - Hwy 96, Alt 3 - JUP North
Max Day Demands
Elevation
4,600
4,550
4,500
4,450
4,400
4,350
4,300
4,250
4,200
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
Distance, Feet
Hwy 96 Spur Tap
Olney Springs Delivery
Crowley
Ordway Delivery
96 Pipeline spur tap
Crowley County Water
Sugar City
Ground Profile
HGL, Max month Q
Desired System Gradients


Hydraulic Profile - La Junta Loop - Alt 3 - JUP North
Maximum Day Demands
Elevation
4,600
4,500
4,400
4,300
4,200
4,100
4,000
0
20,000
40,000
60,000
80,000
100,000
120,000
140,000
160,000
180,000
200,000
Distance, Feet
Tap to Conduit at
Mananola
Vroman
Fayette Del
Patterson Valley Del
Eureka
Rocky Ford
Hilltop
Swink
South Swink
Homestead
La Junta Del
Bents Fort Del
(Tank N of LaJunta-OLD)
End of La Junta Loop
Ground Profile
Hydraulic Grade Line
Desired System Gradients



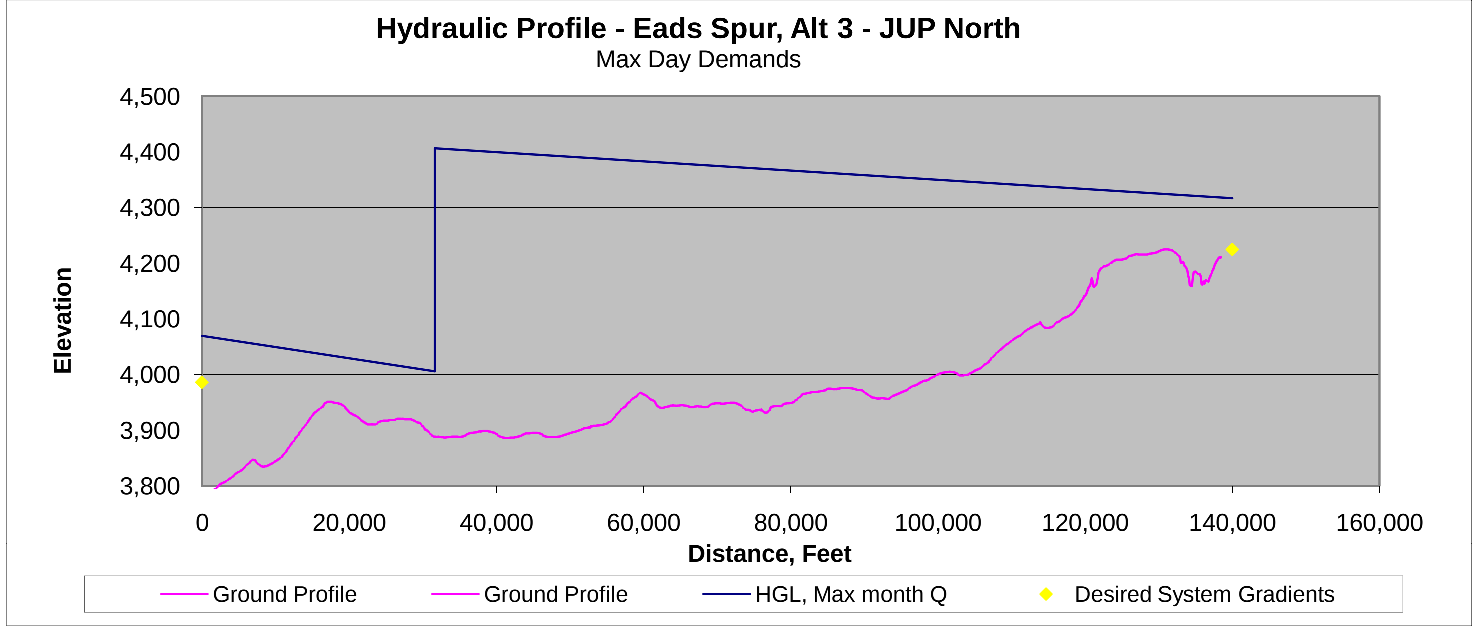
Hydraulic Profile - W Grd Valley Spur, Alt 3 - JUP North

Max Day Demands



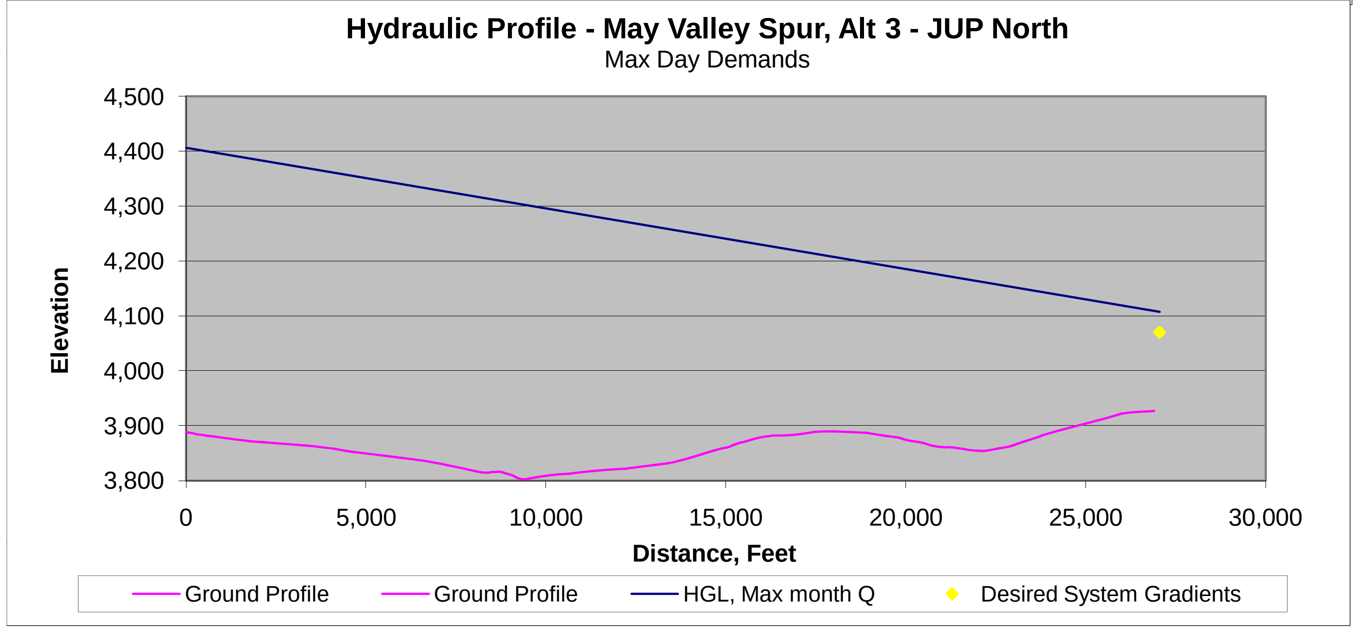
Hydraulic Profile - S Swink Spur, Alt 3 - JUP North

Max Day Demands



Hydraulic Profile - Eads Spur, Alt 3 - JUP North

Max Day Demands



Hydraulic Profile - May Valley Spur, Alt 3 - JUP North

Max Day Demands

Arkansas Valley Conduit
Environmental Impact Statement / Apprasial Level Study
Hydraulic Analysis
Pueblo Dam_North - Alt 4

Intake, Parallel Pipe to JUP
Dam N/S Outlet Works Interconnect
WTP (Filtered) @ Dam
St Charles Mesa gets filtered water
Northern Route

= Input
4796 Pueblo Reservoir Low water
50 Pumping Head lift @ Dam
4846 Starting HGL to WTP
4825 WTP Clearwell
35 Pumping Head lift @ WTP
4860 Starting HGL From WTP

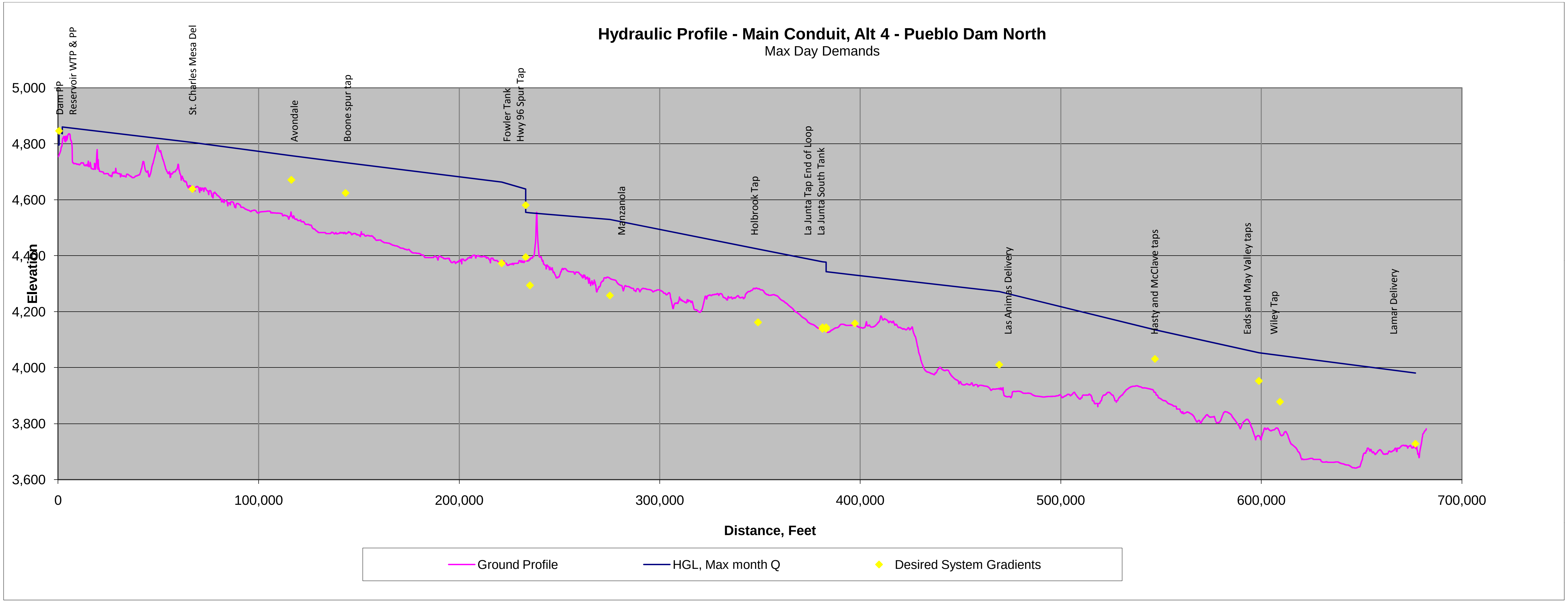
Condition 1 - Minimum Pueblo Reservoir, Max Month Demands
Condition 2 - (Not Used)
Condition 3 - Maximum Pueblo Reservoir, Min Day Demands
Condition 4 - Minimum Pueblo Reservoir, Max Day Demands
Condition 5 - Minimum Pueblo Reservoir, Max Month Demands (Except Radionuclides Participants Being Provided Max Day)
Condition 4 - Selected Condition

Participants Being Provided Max Day Demands Due to Radionuclides (Condition 5)

East End Water	Manzanola	Valley Water
Eureka Water Co	May Valley	Vroman
Fayette Water	Patterson Valley	Wiley
Hancock	South Swink	
Holbrook Center Soft Water		
Homestead Improvement		

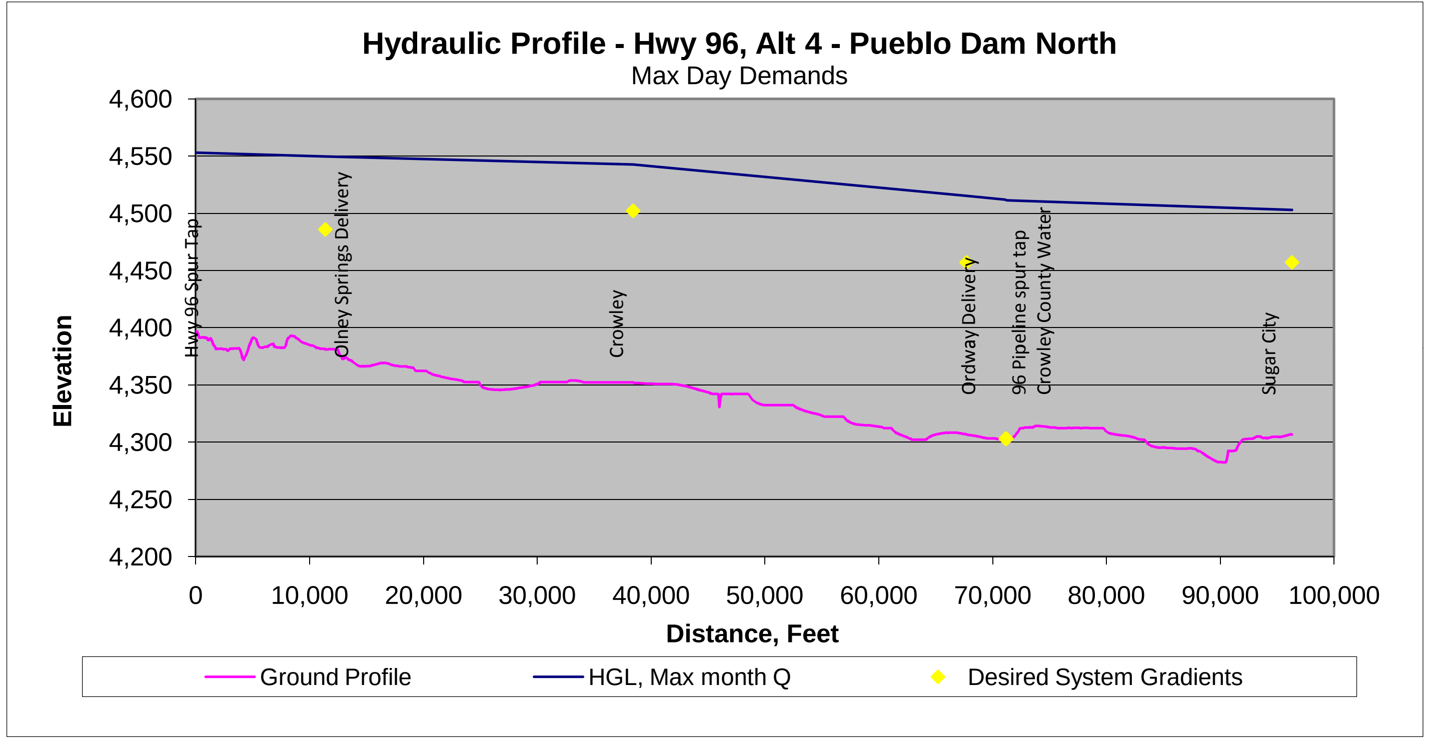
February 24, 2011

Overall Pipe Segment	Individual Pipe Segment	Description		Station		Length	Total Flow, Q			Inside Pipe Diameter	Inside Pipe Area	Velocity	C Value	Pipe Friction Headloss	Minor Headloss		Total Headloss				Participant Flow	Maximum Ground Elev	Elev at Tap ft	Actual Tap Pressure, psi	Desired System Pressure, psi	Desired System Gradient	Comments
		Starting Point	Ending Point	Starting	Ending	ft	mgd	cfs	gpm	in	ft^2	ft/s		ft	Total K	H_L, ft	ft	Begin HGL	End HGL	Participant Tap	mgd						
Main	1	Pueblo Dam	WTP Inlet @ Pueblo Dam	0+00	21+36	2,136	20.817	32.20	14,456	30	4.91	6.56	120	10.18	9.1287E-06	0.02	10.20	4846.00	4835.80	WTP @ near Dam	0.000	4,825	4825	4.68	0	4825.00	Tie in at WTP.
Main	1a	WTP PP @ Pueblo Dam	St. Charles Mesa Tap	21+36	670+05	64,869	19.825	30.67	13,768	42	9.62	3.19	120	54.84	9.1287E-06	0.59	55.43	4860.00	4804.57	St. Charles Mesa	5.781	4,795	4638	72.11	0	4638.00	WTP and associated PP info is not known and was assumed using cells J5 through J7
Main	2	St. Charles Mesa Tap	Avondale Tap	670+05	1163+44	49,339	14.045	21.73	9,753	36	7.07	3.07	120	46.67	9.1287E-06	0.45	47.12	4804.57	4757.45	Avondale	0.296	4,643	4521	102.36	65	4671.15	
Main	3	Avondale Tap	Boone Delivery	1163+44	1433+99	27,055	13.749	21.27	9,548	36	7.07	3.01	120	24.60	9.1287E-06	0.25	24.85	4757.45	4732.60	Boone	0.201	4,521	4474	111.95	65	4624.15	
Main	4	Boone Delivery	Fowler Tap	1433+99	2212+49	77,850	13.548	20.96	9,408	36	7.07	2.96	120	68.88	9.1287E-06	0.71	69.59	4732.60	4663.00	Fowler	0.304	4,481	4373	125.54	0	4373.00	Lower tank spill elev ?
Main	5	Fowler Tap	Fowler Tank (North of Fowler)	2212+49	2331+89	11,940	13.243	20.49	9,197	30	4.91	4.17	120	24.62	9.1287E-06	0.11	24.72	4663.00	4638.28	Fowler Tank	0.000	4,555	4555	36.05	11	4580.41	Ground Elev 4555, top of tank elev 4580.
Main	6	Fowler Tank (North of Fowler)	Hwy 96 Spur East of Fowler Tank	2331+89	2353+57	2,168	13.243	20.49	9,197	36	7.07	2.90	120	1.84	9.1287E-06	0.02	1.86	4555.00	4553.14	Hwy 96 Spur	2.500	4,550	4395	68.46	0	4395.00	
Main	7	Hwy 96 Spur East of Fowler Tank	Start Loop (to Manzanola)	2353+57	2751+88	39,831	10.743	16.62	7,460	36	7.07	2.35	120	22.94	9.1287E-06	0.36	23.30	4553.14	4529.84	Start Loop	4.710	4,395	4294	102.10	0	4294.00	
Main	8	Start Loop (to Manzanola)	N & W Holbrook Spur Tap	2751+88	3490+68	73,880	6.033	9.33	4,190	24	3.14	2.97	120	105.27	9.1287E-06	0.67	105.94	4529.84	4423.90	West Holbrook and North Holbrook	0.034	4,293	4258	71.82		4258.00	
Main	9	N & W Holbrook Spur Tap	Holbrook Center Soft Water (Includes Cheraw) Tap	3490+68	3812+28	32,160	5.999	9.28	4,166	24	3.14	2.95	120	45.34	9.1287E-06	0.29	45.63	4423.90	4378.27	Holbrook Center Soft Water & Cheraw	0.101	4,258	4139	103.58	14	4162.00	4162 is tank max wse.
Main	10	Holbrook Center Soft Water (Includes Cheraw) Tap	Beehive Delivery	3812+28	3812+28	0	5.898	9.12	4,096	24	3.14	2.90	120	0.00	9.1287E-06	0.00	0.00	4378.27	4378.27	Beehive	0.013	4,258	4139	103.58		4139.00	
Main	11	Beehive Delivery	End Loop (La Junta)	3812+28	3812+28	0	5.885	9.10	4,087	24	3.14	2.90	120	0.00	9.1287E-06	0.00	0.00	4378.27	4378.27	End Loop	1.390	4,258	4139	103.58	0	4139.00	
Main	11a	End Loop (La Junta)	La Junta North elevated Storage Tank	3812+28	3830+36	1,808	4.495	6.95	3,122	24	3.14	2.21	120	1.49	9.1287E-06	0.02	1.51	4378.27	4376.76		0.000	4,155	4144	100.76	0	4144.00	
Main	12	La Junta North elevated Storage Tank	East End and South Side Delivery	3830+36	3973+70	14,334	4.495	6.95	3,122	24	3.14	2.21	120	11.84	9.1287E-06	0.13	11.97	4343.00	4331.03	East End and South Side	0.039	4,155	4158	74.90		4158.00	
		East End and South Side Delivery	Las Animas Tap	3973+70	4693+58	71,988	4.457	6.89	3,095	24	3.14	2.19	120	58.54	9.1287E-06	0.66	59.19	4331.03	4271.83	Las Animas	1.294	4,184	3895	163.13	50	4010.50	4020 is tank spill elevation
Main	13	Las Animas Tap	Hasty and McClave Taps	4693+58	5470+51	77,693	3.162	4.89	2,196	18	1.77	2.77	120	135.86	9.1287E-06	0.71	136.57	4271.83	4135.26	Hasty and McClave	0.174	3,935	3881	110.07	65	4031.15	
Main	14	Hasty and McClave Taps	Eads and May Valley Tap	5470+51	5988+86	51,835	2.989	4.62	2,076	18	1.77	2.62	120	81.65	9.1287E-06	0.47	82.12	4135.26	4053.14	Eads and May Valley	0.724	3,880	3777	119.54	75.95	3952.45	4215 is Eads tie-in at ground storage tank
Main	15	Eads and May Valley Tap	Wiley Tap	5988+86	6094+05	10,519	2.265	3.50	1,573	18	1.77	1.98	120	9.91	9.1287E-06	0.10	10.01	4053.14	4043.13	Wiley	0.034	3,784	3728	136.42	65	3878.15	3750 is max ground in Wiley
Main	16	Wiley Tap	Lamar Delivery	6094+05	6769+16	67,511	2.230	3.45	1,549	18	1.77	1.95	120	61.84	9.1287E-06	0.62	62.45	4043.13	3980.68	Lamar	2.230	3,782	3728	109.39	0	3728.00	Spill elevation of tanks.
		Totals																			**19.825**						
Hwy 96	17	Hwy 96 Spur East of Fowler Tank	Olney Springs Delivery	0+00	113+69	11,369	2.500	3.87	1,736	24	3.14	1.23	120	3.17	9.1287E-06	0.10	3.27	4553.14	4549.87	Olney Springs	0.129	4,395	4,382	72.67	0	4486.00	Tank spill elev of 4486
Hwy 96	18	Olney Springs Delivery	Crowley Delivery	113+69	384+10	27,041	2.372	3.67	1,647	24	3.14	1.17	120	6.84	9.1287E-06	0.25	7.08	4549.87	4542.78	Crowley	0.122	4,382	4,352	82.59	65	4502.15	
Hwy 96	19	Crowley Delivery	Ordway Delivery	384+10	677+07	29,297	2.250	3.48	1,562	18	1.77	1.97	120	27.27	9.1287E-06	0.27	27.53	4542.78	4515.25	Ordway	0.604	4,352	4,307	90.15	65	4457.15	
Hwy 96	20	Ordway Delivery	Highway 96 Pipe Co Tap	677+07	711+47	3,440	1.646	2.55	1,143	16	1.40	1.82	120	3.18	9.1287E-06	0.03	3.22	4515.25	4512.03	Highway 96 Pipe Co	0.049	4,307	4,303	90.49		4303.00	System pressure unknown.
Hwy 96	21	Highway 96 Pipe Co Tap	Crowley County Water Delivery	711+47	712+13	66	1.596	2.47	1,108	10	0.55	4.53	120	0.57	9.1287E-06	0.00	0.57	4512.03	4511.46	Crowley County Water	1.322	4,303	4,303	90.24		4303	
Hwy 96	22	Crowley County Water Delivery	Sugar City Delivery	712+13	963+10	25,097	0.274	0.42	190	10	0.55	0.78	120	8.30	9.1287E-06	0.23	8.53	4511.46	4502.94	Sugar City	0.274	4,313	4,307	84.82	65	4457.15	
		Totals																			**2.500**						
Spur 7	23	Tap to Main Conduit North of Manzanola	Manzanola Delivery (and Valley Water Tap)	0+00	91+31	9,131	4.710	7.29	3,271	24	3.14	2.32	120	8.23	9.1287E-06	0.08	8.31	4529.84	4521.53	Manzanola and Valley Water	0.163	4,293	4,255	115.38	0	4255.00	
Spur 7	24	Manzanola Delivery (and Valley Water Tap)	Vroman Delivery	91+31	239+08	14,777	4.547	7.03	3,158	24	3.14	2.24	120	12.47	9.1287E-06	0.13	12.61	4521.53	4508.93	Vroman	0.079	4,347	4,347	70.10		4347.00	
Spur 7	25	Vroman Delivery	Fayette Delivery	239+08	448+14	20,906	4.468	6.91	3,103	24	3.14	2.20	120	17.08	9.1287E-06	0.19	17.27	4508.93	4491.66	Fayette	0.030	4,347	4,252	103.75		4252.00	
Spur 7	26	Fayette Delivery	Patterson Valley Delivery	448+14	514+32	6,618	4.438	6.87	3,082	20	2.18	3.15	120	12.98	9.1287E-06	0.06	13.04	4491.66	4478.62	Patterson Valley	0.036	4,325	4,287	82.95	58.4	4421.90	Tank spill El 4435
Spur 7	27	Patterson Valley Delivery	Eureka Delivery	514+32	621+72	10,740	4.401	6.81	3,057	20	2.18	3.12	120	20.74	9.1287E-06	0.10	20.84	4478.62	4457.78	Eureka	0.184	4,323	4,292	71.77		4292.00	
Spur 7	28	Eureka Delivery	Rocky Ford (and Hancock) Tap	621+72	727+59	10,587	4.217	6.52	2,929	20	2.18	2.99	120	18.89	9.1287E-06	0.10	18.98	4457.78	4438.80	Rocky Ford and Hancock	1.273	4,292	4,220	94.72	0	4220.00	At WTP
Spur 7	29	Rocky Ford (and Hancock) Tap	Newdale-Grand Valley Spur Tap	727+59	741+31	1,372	2.944	4.56	2,045	18	1.77	2.58	120	2.10	9.1287E-06	0.01	2.11	4438.80	4436.69	Newdale Grand Valley Spur	0.161	4,219	4,210	98.13	0	4210.00	
Spur 7	31	Newdale-Grand Valley Spur Tap	Hilltop Delivery	741+31	795+89	5,458	2.784	4.31	1,933	18	1.77	2.44	120	7.54	9.1287E-06	0.05	7.59	4436.69	4429.10	Hilltop	0.071	4,210	4,178	108.70	37.3	4264.16	Tank El 4266. 72 psi high pressure.
Spur 7	32	Hilltop Delivery	Swink Delivery	795+89	1038+00	24,211	2.713	4.20	1,884	18	1.77	2.38	120	31.87	9.1287E-06	0.22	32.10	4429.10	4397.00	Swink	0.064	4,177	4,119	120.35		4119.00	
Spur 7	33	Swink Delivery	South Swink Tap	1038+00	1069+90	3,190	2.649	4.10	1,839	18	1.77	2.32	120	4.02	9.1287E-06	0.03	4.05	4397.00	4392.96	South Swink Spur	0.189	4,119	4,114	120.76	65	4264.15	
Spur 7		South Swink Tap	HomesteadTap	1069+90	1273+70	20,380	2.460	3.81	1,708	18	1.77	2.15	120	22.39	9.1287E-06	0.19	22.57	4392.96	4370.39	Homestead	0.015	4,128	4,128	104.93		4128.00	
Spur 7	34	HomesteadTap	La Junta Tap	1273+70	1339+98	6,628	2.445	3.78	1,698	18	1.77	2.14	120	7.20	9.1287E-06	0.06	7.26	4370.39	4363.13	La Junta	3.717	4,128	4,098	114.77	0	4098.00	At La Junta WTP. 4374 is max system water elevation.
Spur 7	35	La Junta Tap	Bents Fort Tap	1339+98	1481+70	14,172	1.272	1.97	883	18	1.77	1.11	120	4.59	9.1287E-06	0.13	4.72	4363.13	4367.85	Bents Fort	0.118	4,097	4,097	117.25		4097.00	
Spur 7	36	Bents Fort Tap	Top of hill North of La Junta	1481+70	1600+49	11,879	1.390	2.15	965	18	1.77	1.22	120	4.53	9.1287E-06	0.11	4.64	4367.85	4372.49	NA	0.000	4,266	4,266	46.10		4266.00	
Spur 7	37	Top of hill North of La Junta	Tap to Main Conduit	1600+49	1757+24	15,675	1.390	2.15	965	18	1.77	1.22	120	5.98	9.1287E-06	0.14	6.12	4372.49	4378.61	NA	0.000	4,266	4,139	103.73		4139.00	
		Totals																			**6.100**						
Spur 24	38	Main Line Tap	North Holbrook Delivery	0+00	81+35	8,135	0.034	0.05	24	4	0.09	0.61	120	4.96	9.1287E-06	0.07	5.03	4423.90	4418.87	North Holbrook Delivery	0.015	4,257	4,187	100.38		4187.00	
Spur 24	39	North Holbrook Delivery	West Holbrook	81+35	155+22	7,387	0.019	0.03	13	4	0.09	0.34	120	1.55	9.1287E-06	0.07	1.62	4418.87	4417.25	West Holbrook	0.019	4,198	4,192	97.51		4192.00	
Spur 16	40	Spur 7 Tap	Newdale-Grand Valley Delivery	0+00	136+32	13,632	0.161	0.25	112	6	0.20	1.27	120	20.15	9.1287E-06	0.12	20.28	4436.69	4416.41	Newdale-Grand Valley Delivery	0.129	4,355	4,353	27.45	0	4353.00	
Spur 16	41	Newdale-Grand Valley Delivery	West Grand Valley Delivery	136+32	211+81	7,549	0.032	0.05	22	4	0.09	0.57	120	4.08	9.1287E-06	0.07	4.15	4416.41	4412.26	West Grand Valley Delivery	0.032	4,353	4,226	80.63	0	4226.00	
Spur 8	42	Main Line Tap	St Charles Mesa Delivery	0+00	229+66	22,966	5.781	8.94	4,014	20	2.18	4.10	120	73.47	9.1287E-06	0.21	73.68	4804.57	4730.89	St Charles Mesa Delivery	5.781	4,726	4,664	28.96	0	4664.00	Tie in at WTP.
Spur 9	43	Main Line Tap	Avondale Delivery	0+00	106+89	10,689	0.296	0.46	205	8	0.35	1.31	120	12.04	9.1287E-06	0.10	12.14	4757.45	4745.31	Avondale Delivery	0.296	4,560	4,560	80.22	65	4710.15	
Spur 1	44	Main Line Tap	Fowler Delivery	0+00	77+65	7,765	0.304	0.47	211	6	0.20	2.40	120	37.44	9.1287E-06	0.07	37.51	4663.00	4625.49	Fowler	0.304	4,372	4,330	127.92		4330.00	
Spur 25	45	Hwy 96 Pipe Co Tap	Hwy 96 Pipe Co Delivery	0+00	23+95	2,395	0.049	0.08	34	6	0.20	0.39	120	0.40	9.1287E-06	0.02	0.42	4512.03	4511.62	Hwy 96 Pipe Co Delivery	0.049	4,317	4,317	84.25		4317.00	
Spur 23	46	Main Line Tap	Manzanola Delivery	0+00	16+36	1,636	0.079	0.12	55	4	0.09	1.41	120	4.71	9.1287E-06	0.01	4.72	4521.53	4516.81	Manzanola Delivery	0.079	4,276	4,276	104.25	39	4366.09	Manzanola max ground elev is 4285. Tank Spill El 4375.
	47	Main Line Tap	Valley Water Delivery	0+00	298+87	29,887	0.084	0.13	58	4	0.09	1.48	120	94.81	9.1287E-06	0.27	95.08	4521.53	4426.45	Valley Water Delivery	0.084	4,287	4,287	60.37	65	4437.15	Valley Water ground elev 4288 at conduit tap plus 65 psi system pressure.
Spur 15	48	Main Line Tap	Rocky Ford WTP Delivery	0+00	9+60	960	1.273	1.97	884	6	0.20	10.03	120	65.54	9.1287E-06	0.01	65.54	4438.80	4373.26	Rocky Ford WTP and Hancock	1.273	4,222	4,221	65.91	0	4221.00	At WTP
Spur 5	49	Main Line Tap	South Swink Delivery	0+00	109+19	10,919	0.189	0.29	131	6	0.20	1.49	120	21.70	9.1287E-06	0.10	21.80	4392.96	4371.16	South Swink Delivery	0.189	4,187	4,188	79.29	65	4338.15	
Spur 17	50	Spur 7 Tap	Homestead Delivery	0+00	26+26	2,626	0.015	0.02	10	4	0.09	0.27	120	0.35	9.1287E-06	0.02	0.37	4370.39	4370.02	Homestead Delivery	0.015	4,134	4,134	102.17	0		
Spur 18	51	Spur 7 Tap	La Junta	0+00	31+54	3,154	3.717	5.75	2,582	12	0.79	7.32	120	53.60	9.1287E-06	0.03	53.63	4363.13	4309.50	La Junta	3.717	4,147	4,147	70.35	0		
Spur 5	52	Main Line Tap	Bents Fort Tank Delivery	0+00	7+15	715	0.118	0.18	82	4	0.09	2.09	120	4.29	9.1287E-06	0.01	4.29	4367.85	4363.55	Bents Fort Tank Delivery	0.118	4,156	4,156	89.85		4156.00	
Spur 12	53	Main Line Tap	Las Animas WTP Delivery	0+00	90+04	9,004	1.294	2.00	899	8	0.35	5.74	120	156.17	9.1287E-06	0.08	156.26	4271.83	4115.58	Las Animas WTP Delivery	1.294	3,903	3,903	92.02	50	4018.50	4020 is tank spill elevation
Spur 14	54	Main Line Tap	McClave Delivery	0+00	54+84	5,484	0.105	0.16	73	4	0.09	1.86	120	26.55	9.1287E-06	0.05	26.60	4135.26	4108.66	McClave Delivery	0.105	3,919	3,919	82.10	65	4069.15	
Spur 13	55	Main Line Tap	Hasty Delivery	0+00	6+26	626	0.069	0.11	48	4	0.09	1.22	120	1.38	9.1287E-06	0.01	1.38	4135.26	4133.88	Hasty Delivery	0.069	3,880	3,877	111.20	65	4027.15	
Spur 3a	56	Main Line Tap	Eads & May Valley Pumping Plant	0+00	316+33	31,633	0.724	1.12	503	10	0.55	2.05	120	63.16	9.1287E-06	0.29	63.45	4053.14	3989.69	Eads & May Valley Pumping Plant	0.000	3,949	3,889	43.59	0	3889.00	400' head pumping plant
Spur 3b	57	Eads & May Valley Pumping Plant	Eads Delivery	0+00	1083+38	108,338	0.249	0.38	173	8	0.35	1.10	120	88.48	9.1287E-06	0.99	89.47	4389.69	4300.22	Eads	0.249	4,225	4,215	36.89	0	4215.00	4215 is Eads tie-in at ground storage tank
Spur 21	58	Eads & May Valley Pumping Plant	May Valley Delivery	0+00	270+56	27,056	0.476	0.74	330	6	0.20	3.75	120	298.44	9.1287E-06	0.25	298.68	4389.69	4091.01	May Valley Delivery	0.476	3,926	3,927	71.00	65	4077.15	
Spur 20	59	Main Line Tap	WileyDelivery	0+00	197+50	19,750	0.034	0.05	24	4	0.09	0.61	120	12.03	9.1287E-06	0.18	12.21	4043.13	4030.92	WileyDelivery	0.034	3,791	3,734	128.54	65	3884.15	3750 is max ground in Wiley



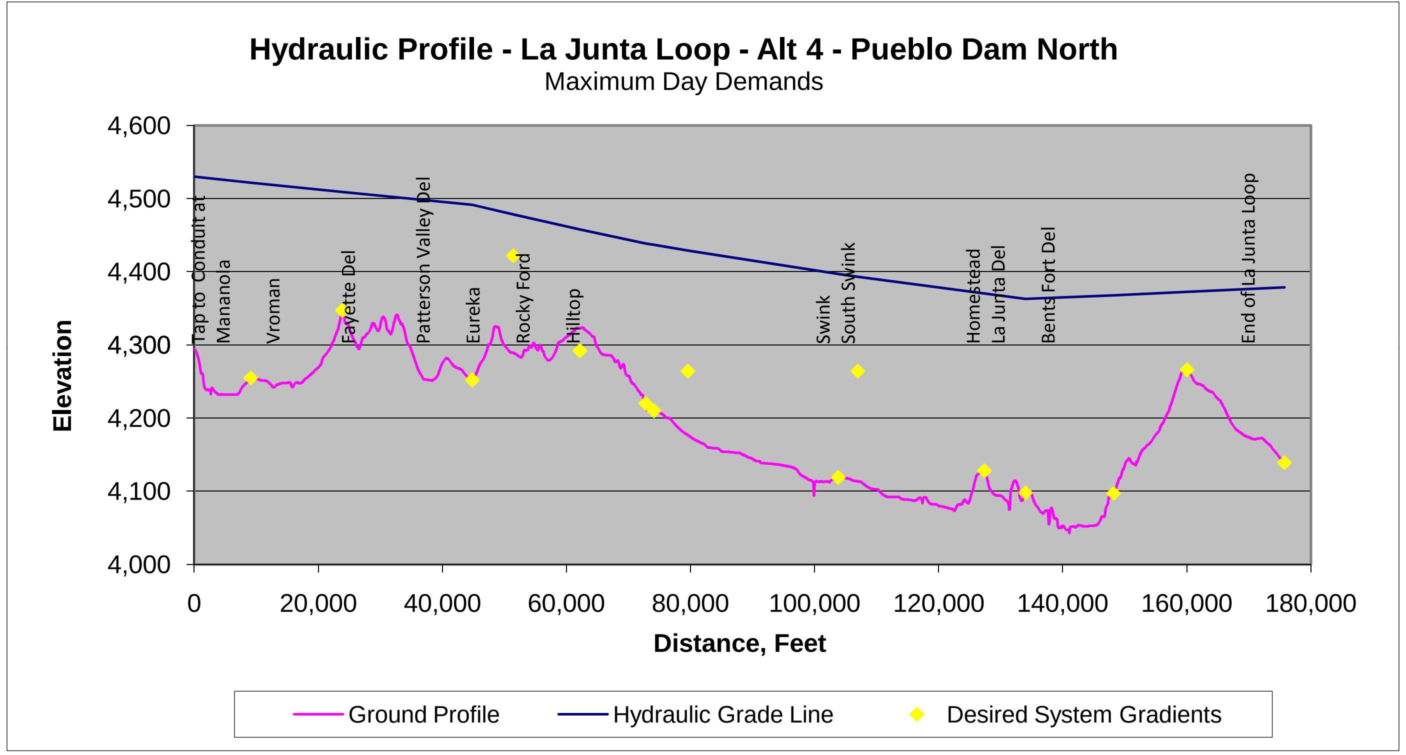
Hydraulic Profile - Main Conduit, Alt 4 - Pueblo Dam North

Max Day Demands



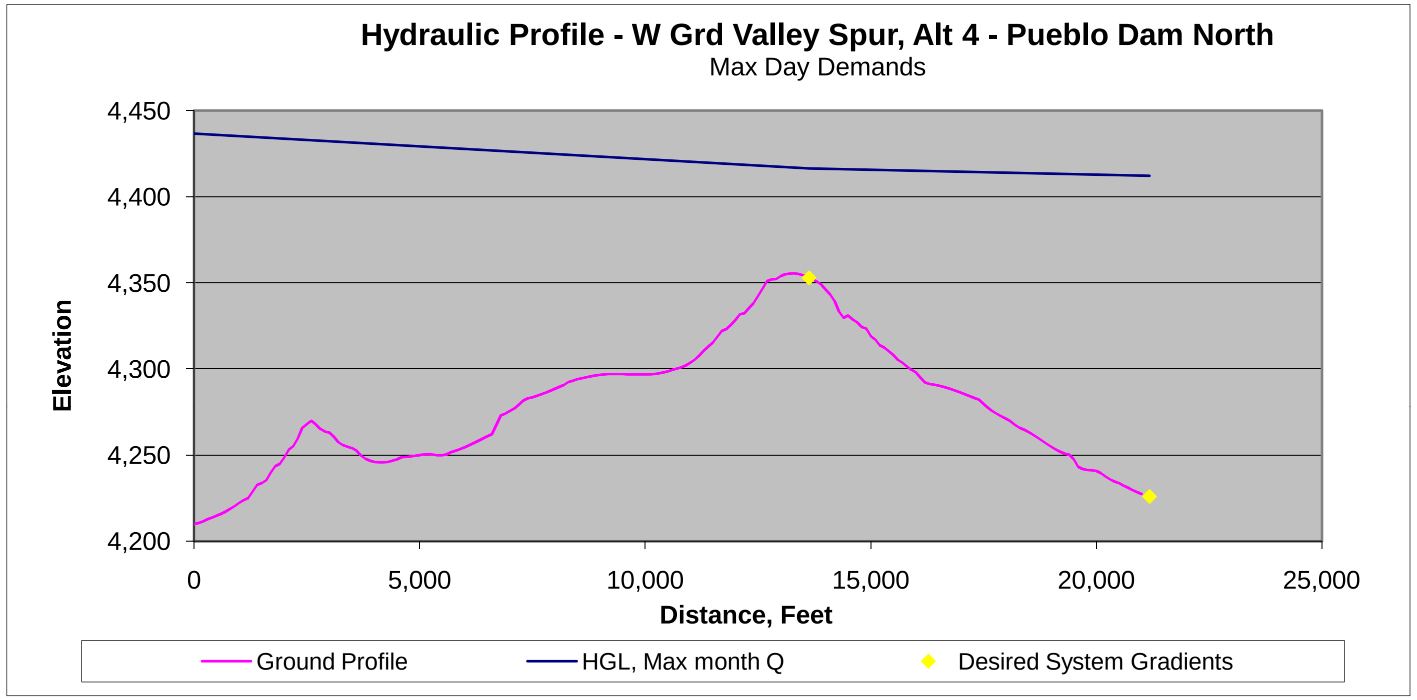
Hydraulic Profile - Hwy 96, Alt 4 - Pueblo Dam North

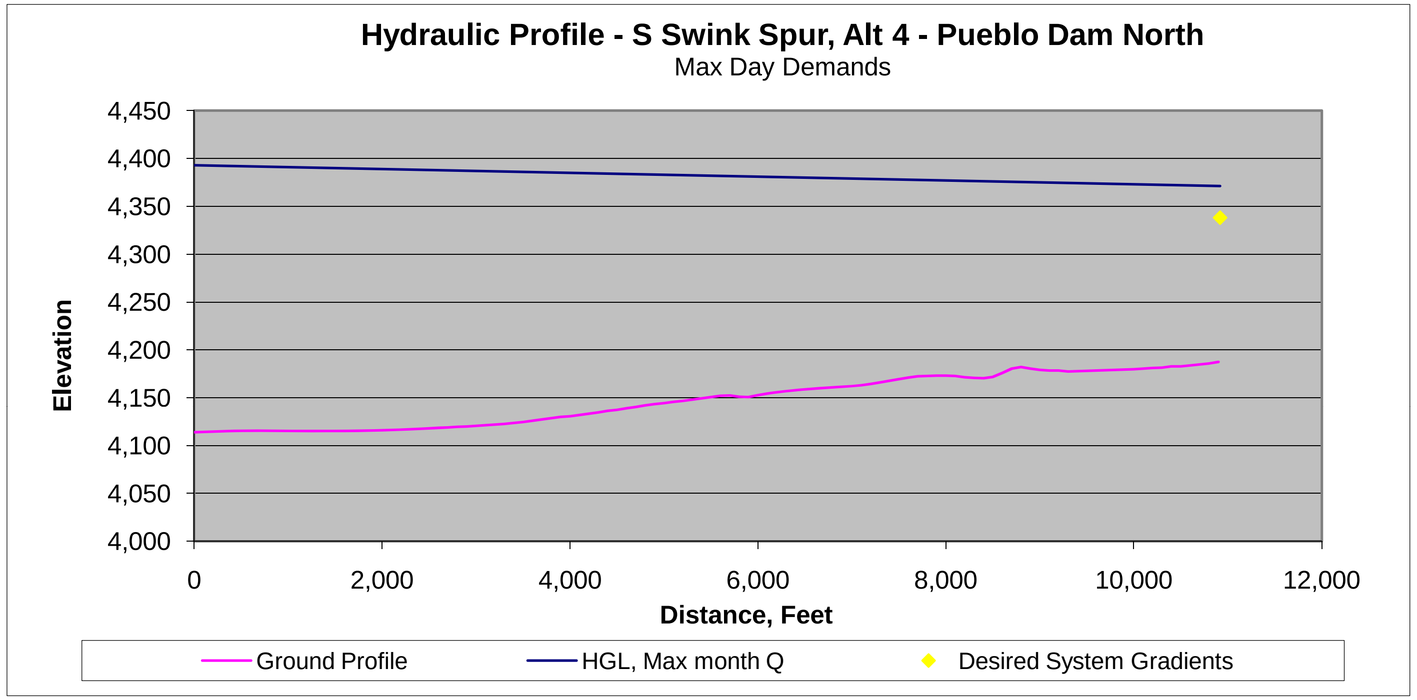
Max Day Demands

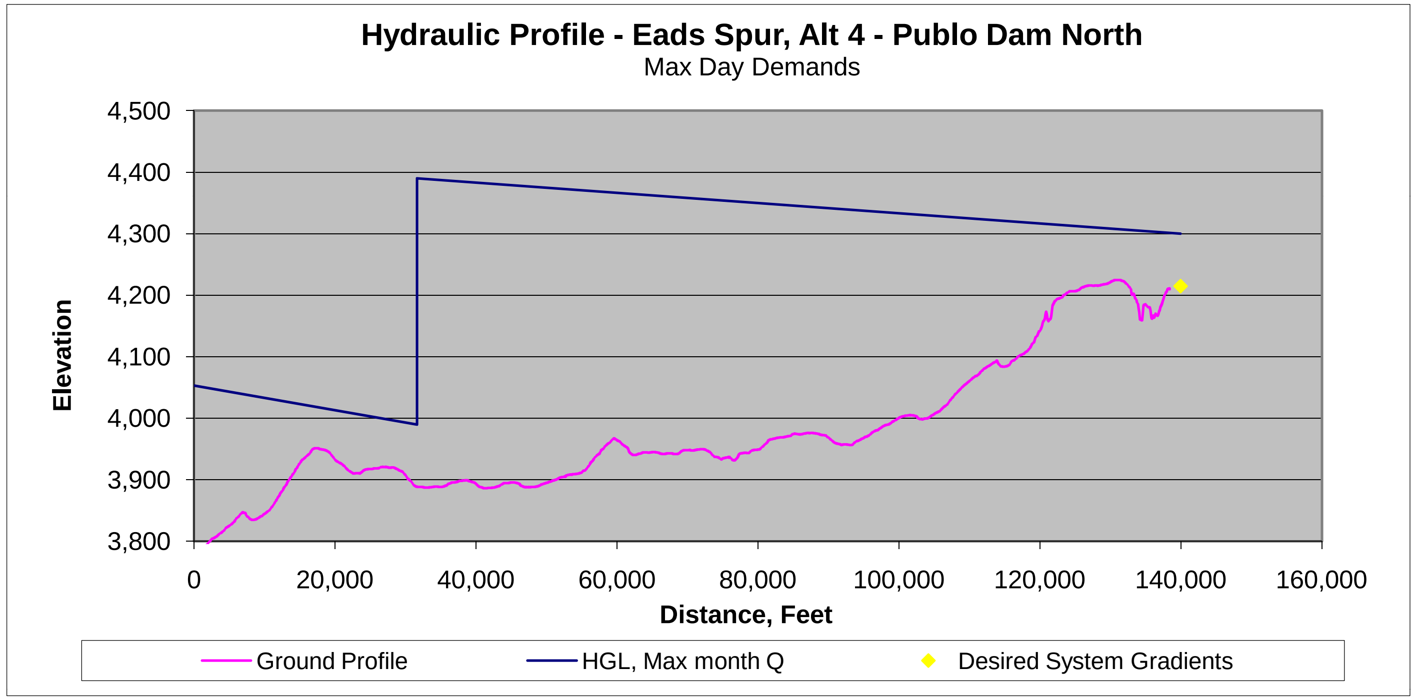


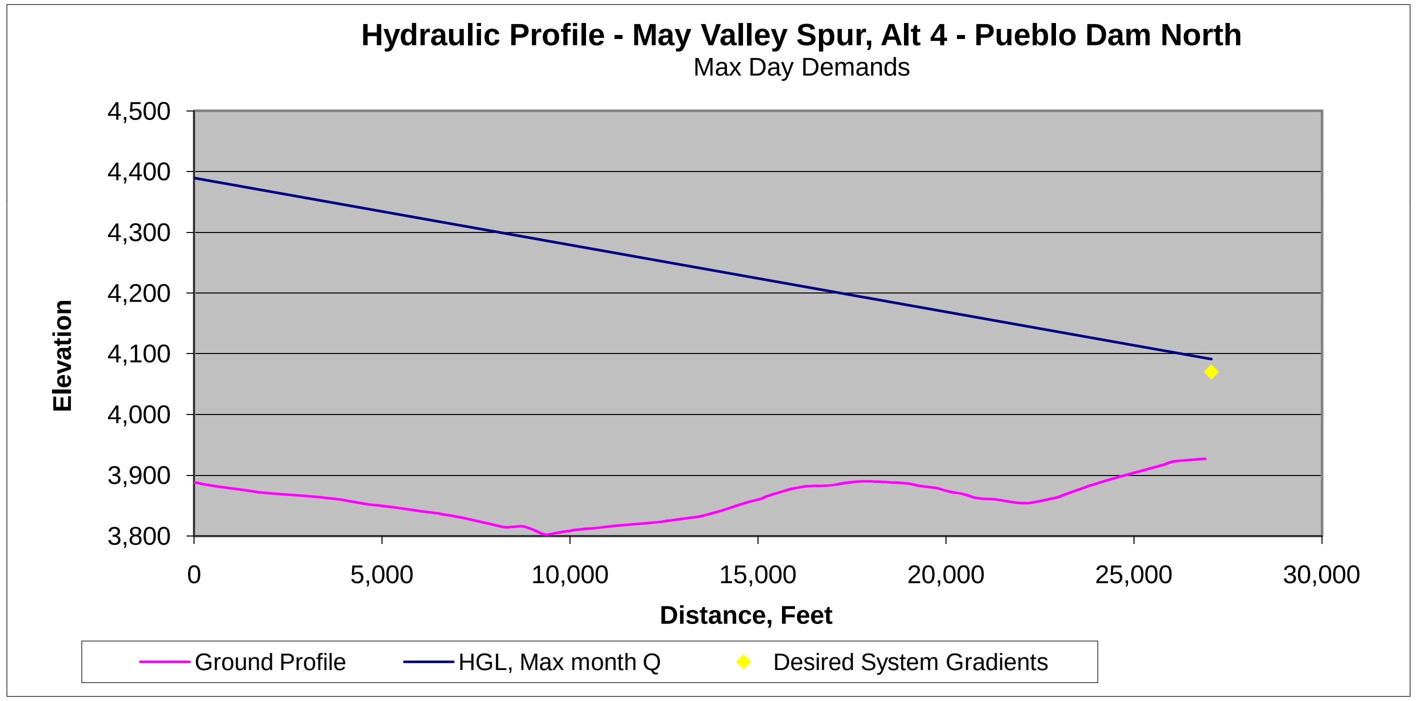
Hydraulic Profile - La Junta Loop - Alt 4 - Pueblo Dam North

Maximum Day Demands


Hydraulic Profile - W Grd Valley Spur, Alt 4 - Pueblo Dam North
Max Day Demands
Elevation
4,450
4,400
4,350
4,300
4,250
4,200
0
5,000
10,000
15,000
20,000
25,000
Distance, Feet
Ground Profile
HGL, Max month Q
Desired System Gradients


Hydraulic Profile - S Swink Spur, Alt 4 - Pueblo Dam North
Max Day Demands
Elevation
4,450
4,400
4,350
4,300
4,250
4,200
4,150
4,100
4,050
4,000
0
2,000
4,000
6,000
8,000
10,000
12,000
Distance, Feet
Ground Profile
HGL, Max month Q
Desired System Gradients


Hydraulic Profile - Eads Spur, Alt 4 - Publo Dam North
Max Day Demands
Elevation
4,500
4,400
4,300
4,200
4,100
4,000
3,900
3,800
0
20,000
40,000
60,000
80,000
100,000
120,000
140,000
160,000
Distance, Feet
Ground Profile
HGL, Max month Q
Desired System Gradients


Hydraulic Profile - May Valley Spur, Alt 4 - Pueblo Dam North
Max Day Demands
Elevation
4,500
4,400
4,300
4,200
4,100
4,000
3,900
3,800
0
5,000
10,000
15,000
20,000
25,000
30,000
Distance, Feet
Ground Profile
HGL, Max month Q
Desired System Gradients

Arkansas Valley Conduit

Environmental Impact Statement / Apprasial Level Study

Hydraulic Analysis

River_S/N - Alternative 5

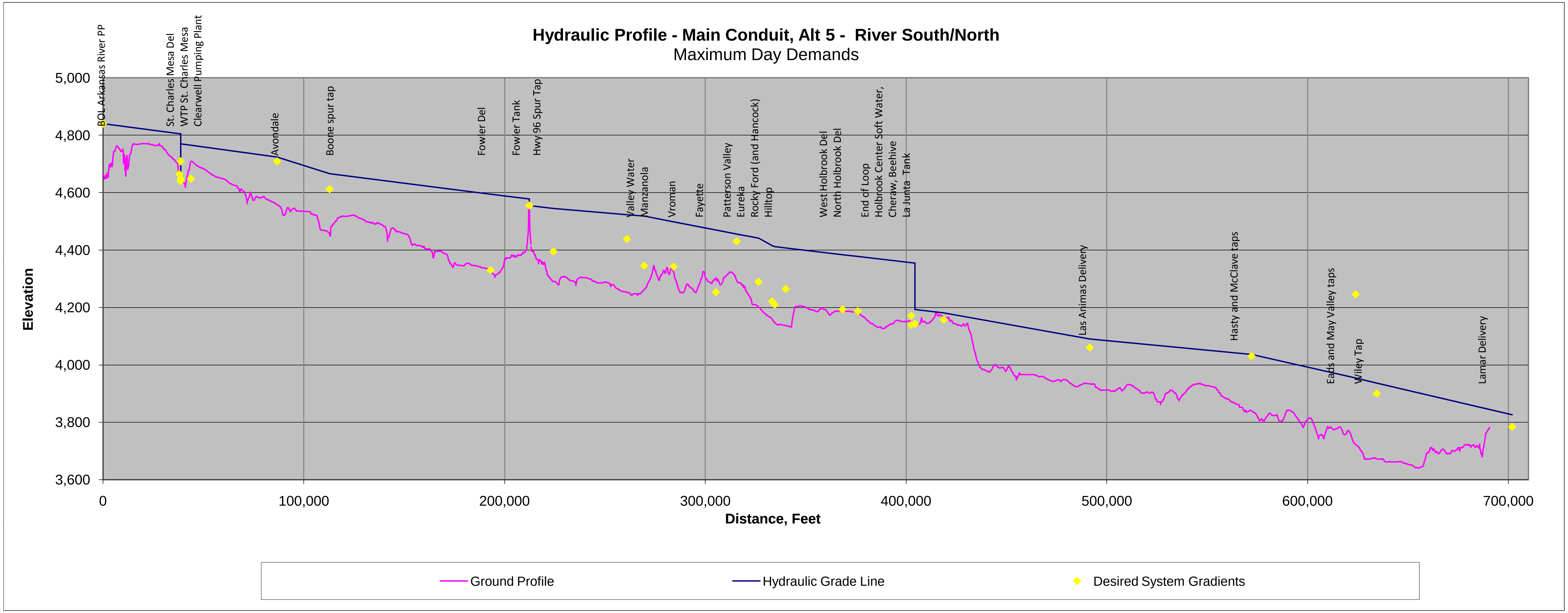
Divert from Arkansas River		= Input
No Interconnect		
WTP (Filter & Disinfect), Exist St Charles Mesa Site	4640 Arkansas River WS min	4645 St Charles WTP Clearwell
St Charles Mesa gets raw water	200 Pumping Head	125 Pumping Head
Southern to Fowler, the Northern Route	4840 Starting HGL at River PP	4770 Starting HGL at WTP PP

Condition 1 - Minimum Pueblo Reservoir, Max Month Demands
Condition 2 - (Not Used)
Condition 3 - Maximum Pueblo Reservoir, Min Day Demands
Condition 4 - Minimum Pueblo Reservoir, Max Day Demands
Condition 5 - Minimum Pueblo Reservoir, Max Month Demands (Except Radionuclides Participants Being Provided Max Day)
Condition 4 - Selected Condition

Participants Being Provided Max Day Demands Due to Radionuclides (Condition 5)

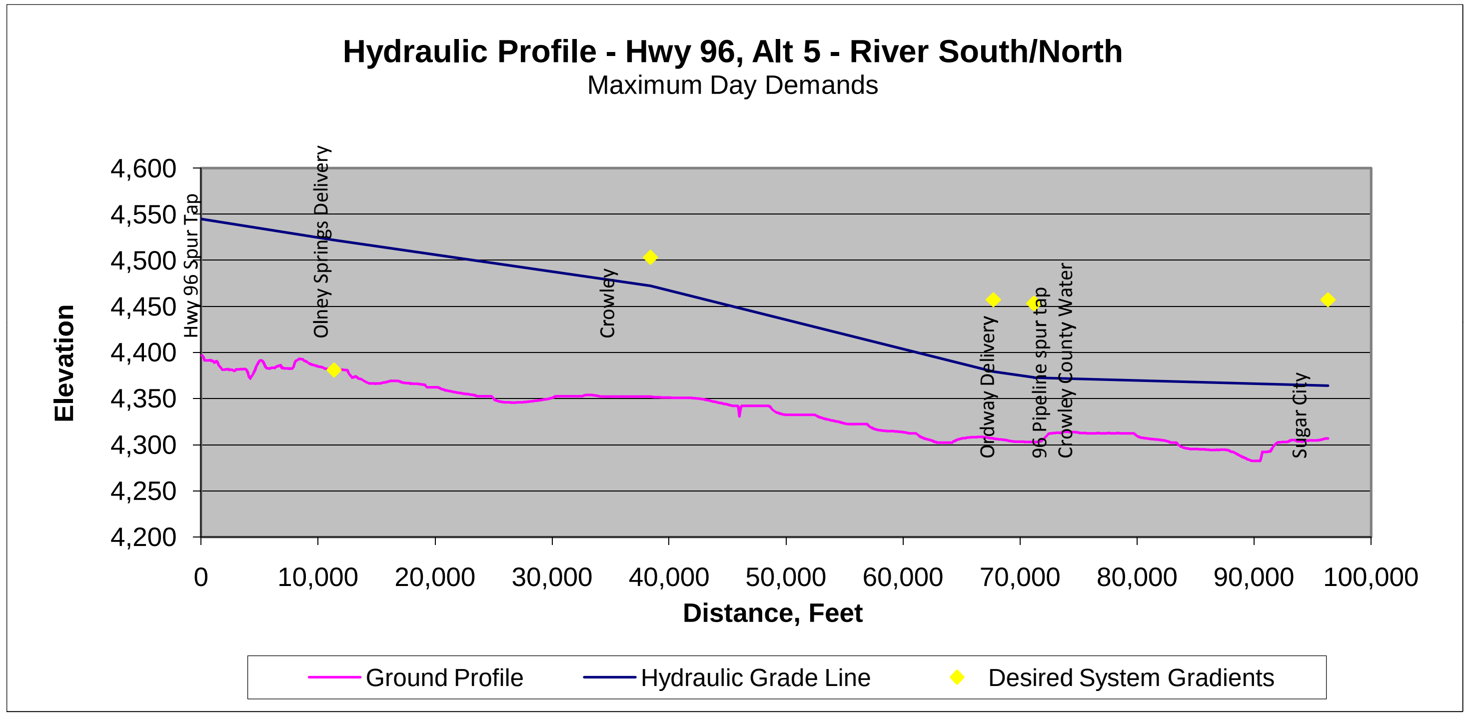
East End Water	Manzanola	Valley Water
Eureka Water Co	May Valley	Vroman
Fayette Water	Patterson Valle	Wiley
Hancock	South Swink	
Holbrook Center Soft Water		
Homestead Improvement		

Overall Pipe Segment	Individual Pipe Segment	Description		Station		Length	Total Flow, Q			Inside Pipe Diameter	Inside Pipe Area	Velocity		Friction Headloss	Minor Headloss		Total Headloss	Begin HGL	End HGL		Participant Flow	Maximum Ground Elev @ Tap	Actual Tap Pressure, psi	Desired System Pressure	Pressure Met?	Desired System Gradient	
		Starting Point	Ending Point	Starting	Ending	ft	mgd	cfs	gpm	in	ft^2	ft/s	C Value	ft	Loss/ft	H_L, ft	ft			Participant Tap	mgd			psi			Comments
Main	1	Diversion on Arkansas River	St. Charles Mesa Delivery	0+00	379+97	37,997	20.528	31.76	14,255	42	9.62	3.30	120	34.26	9.1287E-06	0.35	34.61	4840.00	4805.39	St. Charles Mesa	5.781	4664	61.21	0		4664.00	River lift = 200', Raw water to St Charles Mesa
Main	2	St. Charles Mesa Delivery	Exist WTP @ St. Charles Mesa Site	379+97	386+38	641	14.747	22.81	10,241	42	9.62	2.37	120	0.31	9.1287E-06	0.01	0.32	4805.39	4805.07	New WTP	0.702	4648	68.00	0		4648.00	WTP Inlet HGL
Main	2a	Exist WTP @ St. Charles Mesa Site	Regulating Tank	386+38	437+35	5,097	14.045	21.73	9,753	36	7.07	3.07	120	4.82	9.1287E-06	0.05	4.87	4770.00	4765.13	Reg. Tank	0.000	4709	24.30	0		4709.00	WTP outlet + 125 lift PP
		Regulating Tank	Avondale Delivery	437+35	866+82	42,947	14.045	21.73	9,753	36	7.07	3.07	120	40.62	9.1287E-06	0.39	41.02	4765.13	4724.12	Avondale	0.296	4558	71.91	65			PRV?
Main	3	Avondale Delivery	Boone spur tap	866+82	1128+42	26,160	13.749	21.27	9,548	30	4.91	4.33	120	57.81	9.1287E-06	0.24	58.05	4724.12	4666.07	Boone	0.201	4462	88.34	65		4612.15	PRV?
Main	4	Boone spur tap	Fowler Delivery	1128+42	1929+81	80,139	13.548	20.96	9,408	36	7.07	2.96	120	70.91	9.1287E-06	0.73	71.64	4666.07	4594.43	Fowler	0.304	4330	114.47	0		4330.00	PRV
Main	5	Fowler Delivery	Fowler Tank (North of Fowler)	1929+81	2123+54	19,373	13.243	20.49	9,197	36	7.07	2.90	120	16.44	9.1287E-06	0.18	16.61	4594.43	4577.82	Fowler Tank	0.000	4555	9.88	0		4555.00	
Main	6	Fowler Tank (North of Fowler)	Hwy 96 spur tap East of Fowler Tank	2123+54	2242+93	11,939	13.243	20.49	9,197	36	7.07	2.90	120	10.13	9.1287E-06	0.11	10.24	4555.00	4544.76	Hwy 96 Spur Total	2.500	4395	64.83	0		4395.00	Ground Elev 4555, top of tank elev 4580.
Main	7	Hwy 96 spur tap East of Fowler Tank	Valley Water Delivery	2242+93	2609+93	36,700	10.743	16.62	7,460	36	7.07	2.35	120	21.13	9.1287E-06	0.34	21.47	4544.76	4523.29	Valley Water	0.084	4288	101.86	65		4438.15	Ground Elev 4288 at conduit tap, PRV
Main	8	Valley Water Delivery	Manzanola spur tap	2609+93	2695+55	8,562	10.659	16.49	7,402	36	7.07	2.33	120	4.86	9.1287E-06	0.08	4.94	4523.29	4518.36	Manzanola	0.079	4255	114.01	39		4345.09	Max grd. elev is 4285. Tank Spill El 4375. PRV
Main	9	Manzanola spur tap	Vroman Delivery	2695+55	2842+02	14,647	10.580	16.37	7,347	30	4.91	3.33	120	19.92	9.1287E-06	0.13	20.06	4518.36	4498.30	Vroman	0.079	4342	67.66	0		4342.00	
Main	10	Vroman Delivery	Fayette Delivery	2842+02	3052+38	21,036	10.501	16.24	7,292	30	4.91	3.31	120	28.22	9.1287E-06	0.19	28.41	4498.30	4469.89	Fayette	0.030	4253	93.89	0		4253.00	PRV
Main	11	Fayette Delivery	Patterson Valley Delivery	3052+38	3156+21	10,383	10.471	16.20	7,271	30	4.91	3.30	120	13.85	9.1287E-06	0.09	13.95	4469.89	4455.94	Patterson Valley	0.036	4295	69.67	58.4		4429.90	
Main	12	Patterson Valley Delivery	Eureka Delivery	3156+21	3264+67	10,846	10.434	16.14	7,246	30	4.91	3.29	120	14.38	9.1287E-06	0.10	14.48	4455.94	4441.46	Eureka	0.184	4289	66.00	0		4289.00	
Main	13	Eureka Delivery	Rocky Ford (and Hancock) spur tap	3264+67	3331+83	6,716	10.250	15.86	7,118	24	3.14	5.05	120	25.54	9.1287E-06	0.06	25.60	4441.46	4415.86	Rocky Ford (& Hancock)	1.273	4221	84.36	0		4221.00	PRV?
Main	14	Rocky Ford (and Hancock) spur tap	South Loop Tap	3331+83	3345+55	1,372	8.977	13.89	6,234	24	3.14	4.42	120	4.08	9.1287E-06	0.01	4.09	4415.86	4411.77	South Loop Tap	4.447	4210	87.35	0		4210.00	PRV?
		South Loop Tap	Hilltop Delivery	3345+55	3399+71	5,416	4.530	7.01	3,146	24	3.14	2.23	120	4.54	9.1287E-06	0.05	4.59	4411.77	4407.18	Hilltop	0.071	4178	99.21	37.3		4264.16	Tank El 4266. 72 psi high pressure, PRV
Main	16	Hilltop Delivery	West Holbrook Delivery	3399+71	3683+71	28,400	4.460	6.90	3,097	24	3.14	2.20	120	23.12	9.1287E-06	0.26	23.38	4407.18	4383.80	West Holbrook	0.019	4193	82.60	0		4193.00	PRV?
Main	18	West Holbrook Delivery	North Holbrook Delivery	3683+71	3759+43	7,572	4.440	6.87	3,084	24	3.14	2.19	120	6.12	9.1287E-06	0.07	6.18	4383.80	4377.61	North Holbrook	0.015	4187	82.52	0		4187.00	PRV?
Main	19	North Holbrook Delivery	Holbrook Center Soft Water, Cheraw, End of Loop	3759+43	4025+90	26,647	4.425	6.85	3,073	24	3.14	2.18	120	21.39	9.1287E-06	0.24	21.63	4377.61	4355.98	Holbrook Center Soft Water/Cheraw	0.101	4139	93.93	14		4171.34	PRV
Main	20	Holbrook Center Soft Water, Cheraw, End of Loop	Beehive Delivery	4025+90	4025+90	0	4.508	6.97	3,131	24	3.14	2.22	120	0.00	9.1287E-06	0.00	0.00	4355.98	4355.98	Beehive	0.013	4139	93.93	0		4139.00	PRV?
Main	21a	Beehive Delivery	La Junta North Elevated Storage Tank	4025+90	4044+01	1,811	4.495	6.95	3,122	24	3.14	2.21	120	1.50	9.1287E-06	0.02	1.51	4355.98	4354.47	La Junta North Tank	0.000	4143	91.54	0		4143.00	PRV?
Main	22	La Junta North Elevated Storage Tank	East End, South Side Delivery	4044+01	4187+32	14,331	4.495	6.95	3,122	24	3.14	2.21	120	11.84	9.1287E-06	0.13	11.97	4193.00	4181.03	East End & South Side	0.039	4158	9.97	0		4158.00	Ground at tank = 4143, 50' elev. Tank
Main	22	East End, South Side Delivery	Las Animas spur tap	4187+32	4915+40	72,808	4.457	6.89	3,095	22	2.64	2.61	120	90.44	9.1287E-06	0.66	91.11	4181.03	4089.92	Las Animas	1.294	3945	62.74	50		4060.50	4020 is tank spill elevation
Main	23	Las Animas spur tap	Hasty and McClave spur taps	4915+40	5720+44	80,504	3.162	4.89	2,196	22	2.64	1.85	120	52.98	9.1287E-06	0.73	53.71	4089.92	4036.21	Hasty and McClave	0.174	3880	67.62	65		4030.15	
Main	24	Hasty and McClave spur taps	Eads and May Valley spur taps	5720+44	6238+80	51,836	2.989	4.62	2,076	18	1.77	2.62	120	81.65	9.1287E-06	0.47	82.12	4036.21	3954.09	Eads and May Valley	0.724	3777	76.66	0		4245.84	
Main	25	Eads and May Valley spur taps	Wiley spur tap	6238+80	6343+99	10,519	2.265	3.50	1,573	16	1.40	2.51	120	17.59	9.1287E-06	0.10	17.68	3954.09	3936.40	Wiley	0.034	3750	80.69	65		3900.15	3750 is max ground in Wiley
Main	26	Wiley spur tap	Lamar Delivery	6343+99	7019+09	67,510	2.230	3.45	1,549	16	1.40	2.47	120	109.74	9.1287E-06	0.62	110.36	3936.40	3826.05	Lamar	2.230	3784	18.20	0		3784.00	Spill elevation of tanks.
		Totals																			**14.045**						
Hwy 96	27	Hwy 96 spur tap East of Fowler Tank	Olney Springs Delivery	0+00	113+68	11,368	2.500	3.87	1,736	16	1.40	2.77	120	22.83	9.1287E-06	0.10	22.94	4544.76	4521.82	Olney Springs	0.129	4381	60.96	0		4381.00	Tank spill elev of 4486
Hwy 96	28	Olney Springs Delivery	Crowley Delivery	113+68	384+09	27,041	2.372	3.67	1,647	16	1.40	2.63	120	49.26	9.1287E-06	0.25	49.50	4521.82	4472.32	Crowley	0.122	4353	51.65	65	-13.3	4503.15	System pressure unknown.
Hwy 96	29	Crowley Delivery	Ordway Delivery	384+09	677+05	29,296	2.250	3.48	1,562	14	1.07	3.26	120	92.72	9.1287E-06	0.27	92.98	4472.32	4379.34	Ordway	0.604	4307	31.32	65	-33.7	4457.15	
Hwy 96	30	Ordway Delivery	96 Pipeline Co. spur tap	677+05	711+47	3,442	1.646	2.55	1,143	14	1.07	2.38	120	6.10	9.1287E-06	0.03	6.14	4379.34	4373.20	96 Pipeline Co.	0.049	4303	30.39	65	-34.6	4453.15	
Hwy 96	31	96 Pipeline Co. spur tap	Crowley County Water Assoc. Delivery	711+47	712+13	66	1.596	2.47	1,108	10	0.55	4.53	120	0.57	9.1287E-06	0.00	0.57	4373.20	4372.63	CCWA	1.322	4303	30.14	65	-34.9	4453.15	
Hwy 96	31	Crowley County Water Assoc. Delivery	Sugar City Delivery	712+13	963+10	25,097	0.274	0.42	190	10	0.55	0.78	120	8.30	9.1287E-06	0.23	8.53	4372.63	4364.11	Sugar City	0.274	4307	24.72	65	-40.3	4457.15	
		Totals																			**2.500**						
S. Loop	15	South Loop Tap	Newdale-Grand Valley Delivery	0+00	137+13	13,713	4.447	6.88	3,088	24	3.14	2.19	120	11.11	9.1287E-06	0.13	11.23	4411.77	4400.54	Newdale-Grand Valley	0.129	4355	19.71	0		4355.00	
S. Loop	32	Newdale-Grand Valley Delivery	West Grand Valley Delivery	137+13	211+81	7,468	4.318	6.68	2,999	24	3.14	2.13	120	5.73	9.1287E-06	0.07	5.80	4400.54	4394.74	West Grand Valley	0.032	4226	73.05	0		4226.00	
S. Loop	33	West Grand Valley Delivery	Swink spur tap	211+81	502+93	29,112	4.286	6.63	2,977	24	3.14	2.11	120	22.02	9.1287E-06	0.27	22.29	4394.74	4372.45	Swink Tap	0.064	4188	79.85	0		4188.00	
S. Loop	34	Swink spur tap	South Swink Delivery	502+93	503+43	50	4.222	6.53	2,932	24	3.14	2.08	120	0.04	9.1287E-06	0.00	0.04	4372.45	4372.41	South Swink Delivery	0.189	4187	80.26	65		4337.15	
S. Loop	34	South Swink Delivery	Homestead spur tap	503+43	661+12	15,769	4.033	6.24	2,801	24	3.14	1.99	120	10.66	9.1287E-06	0.14	10.80	4372.41	4361.61	Homestead Tap	0.015	4128	101.13	0		4128.00	
S. Loop	35	Homestead spur tap	La Junta spur tap	661+12	727+40	6,628	4.018	6.22	2,791	24	3.14	1.98	120	4.45	9.1287E-06	0.06	4.51	4361.61	4357.10	La Junta Tap	3.717	4097	112.60	0		4097.00	At La Junta WTP. 4374 is max water elev.
S. Loop	36	La Junta spur tap	Bent's Fort spur tap	727+40	869+09	14,169	0.301	0.47	209	24	3.14	0.15	120	0.08	9.1287E-06	0.13	0.21	4357.10	4356.89	Bents Fort	0.118	4097	112.51	0		4097.00	
S. Loop	38	Bent's Fort spur tap	End of S. Loop	869+09	1144+66	27,557	0.183	0.28	127	24	3.14	0.09	120	0.06	9.1287E-06	0.25	0.31	4356.89	4356.58	End of S. Loop	0.000	4139	94.19	0			
		Totals																			**4.264**						
Spur 3	39	Main Line Tap	May Valley spur tap	0+00	316+33	31,633	0.724	1.12	503	12	0.79	1.43	120	25.99	9.1287E-06	0.29	26.28	3954.09	3927.81	May Valley & Eads	0.724	3889	16.80	0		3889.00	
Spur 3	39a	May Valley spur tap	Eads Delivery	0+00	1083+38	108,338	0.249	0.38	173	10	0.55	0.70	120	29.85	9.1287E-06	0.99	30.84	4377.81	4346.97	Eads	0.249	4225	52.80	0		4225.00	4215 is Eads tie-in at ground storage tank.
		Hwy 96 spur tap	96 Pipeline Co.	0+00	23+95	2,395	0.049	0.08	34	4	0.09	0.87	120	2.86	9.1287E-06	0.02	2.88	4373.20	4370.32	96 Pipeline Co.	0.049	4317	23.08	0		4317.00	
Spur 4	40	Main Line Tap	Boone Delivery	0+00	91+54	9,154	0.201	0.31	140	6	0.20	1.59	120	20.56	9.1287E-06	0.08	20.64	4666.07	4645.43	Boone Delivery	0.201	4474	74.21	65		4624.15	
	41	S. Loop Tap	Rocky Ford (and Hancock) WTP Delivery	0+00	9+60	960	1.273	1.97	884	12	0.79	2.51	120	2.24	9.1287E-06	0.01	2.25	4415.86	4413.61	Rocky Ford/Hancock	1.273	4221	83.38	0		4221.00	At WTP
Spur 5	42	S. Loop Tap	Swink Delivery	0+00	141+09	14,109	0.064	0.10	45	4	0.09	1.14	120	27.53	9.1287E-06	0.13	27.66	4372.45	4344.79	Swink Delivery	0.064	4120	97.31	0		4120.00	
	43	Main Line Tap	Manzanola Delivery	0+00	16+36	1,636	0.079	0.12	55	4	0.09	1.41	120	4.71	9.1287E-06	0.01	4.72	4518.36	4513.63	Manzanola Delivery	0.079	4276	102.87	39		4366.09	Max grd. Elev=4285, tank Spill El 4375. PRV req'd
		S. Loop Tap	Homestead Delivery	0+00	26+26	2,626	0.015	0.02	10	4	0.09	0.27	120	0.35	9.1287E-06	0.02	0.37	4361.61	4361.24	Homestead Delivery	0.015	4135	97.94	0		4135.00	PRV?
		S. Loop Tap	La Junta Delivery	0+00	31+54	3,154	3.717	5.75	2,582	12	0.79	7.32	120	53.60	9.1287E-06	0.03	53.63	4357.10	4303.47	La Junta Delivery	3.717	4152	65.57	0		4152.00	
	44	S. Loop Tap	Bent's Fort Tank Delivery	0+00	7+15	715	0.118	0.18	82	4	0.09	2.09	120	4.29	9.1287E-06	0.01	4.29	4356.89	4352.60	Bent's Fort	0.118	4156	85.11	0		4156.00	PRV?
Spur 12	46	Main Line Tap	Las Animas WTP Delivery	0+00	125+34	12,534	1.294	2.00	899	12	0.79	2.55	120	30.18	9.1287E-06	0.11	30.29	4089.92	4059.63	Las Animas	1.294	3903	67.80	50		4018.50	4020 is tank spill elevation
Spur 14	47	Main Line Tap	McClave Delivery	0+00	54+84	5,484	0.105	0.16	73	8	0.35	0.47	120	0.91	9.1287E-06	0.05	0.96	4036.21	4035.25	McClave Delivery	0.105	3919	50.32	65	-14.7	4069.15	
Spur 13	48	Main Line Tap	Hasty Delivery	0+00	6+26	626	0.069	0.11	48	8	0.35	0.30	120	0.05	9.1287E-06	0.01	0.05	4036.21	4036.15	Hasty Delivery	0.069	3877	68.90	65		4027.15	
		Main Line Tap	Wiley Delivery	0+00	197+50	19,750	0.034	0.05	24	4	0.09	0.61	120	12.03	9.1287E-06	0.18	12.21	3936.40	3924.19	Wiley Delivery	0.034	3750	75.41	65		3900.15	3750 is max ground in Wiley
	49	May Valley spur tap	May Valley Delivery	0+00	270+56	27,056	0.476	0.74	330	6	0.20	3.75	120	298.44	9.1287E-06	0.25	298.68	4377.81	4079.12	May Valley Delivery	0.476	3927	65.85	0		3927.00	



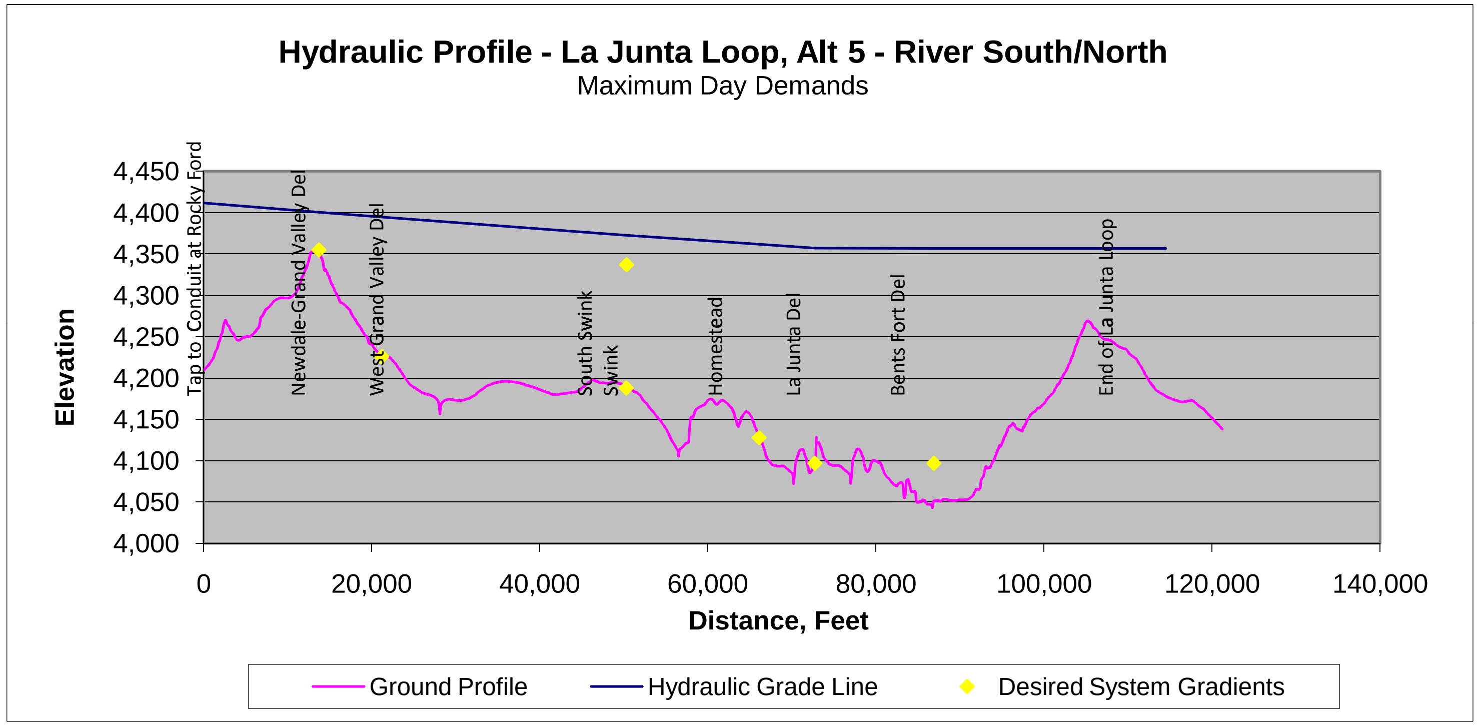
Hydraulic Profile - Main Conduit, Alt 5 - River South/North

Maximum Day Demands



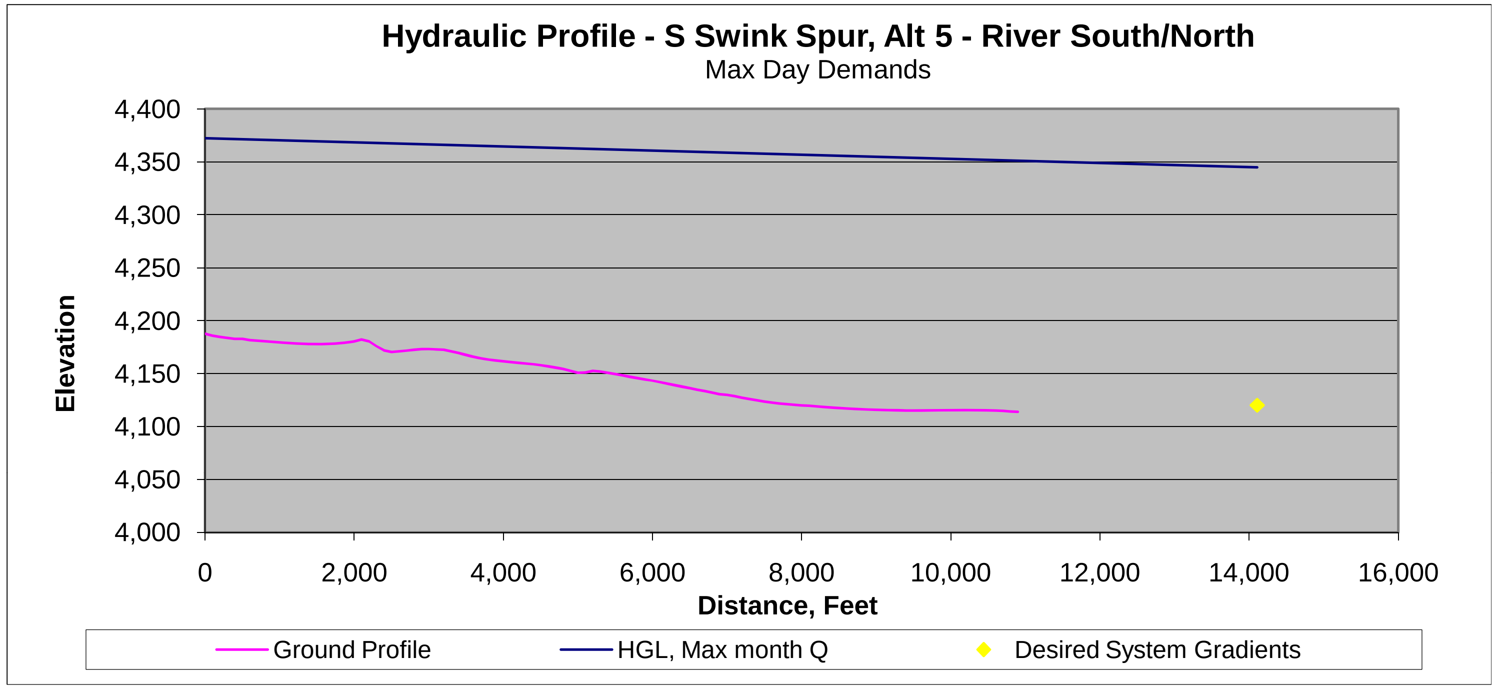
Hydraulic Profile - Hwy 96, Alt 5 - River South/North

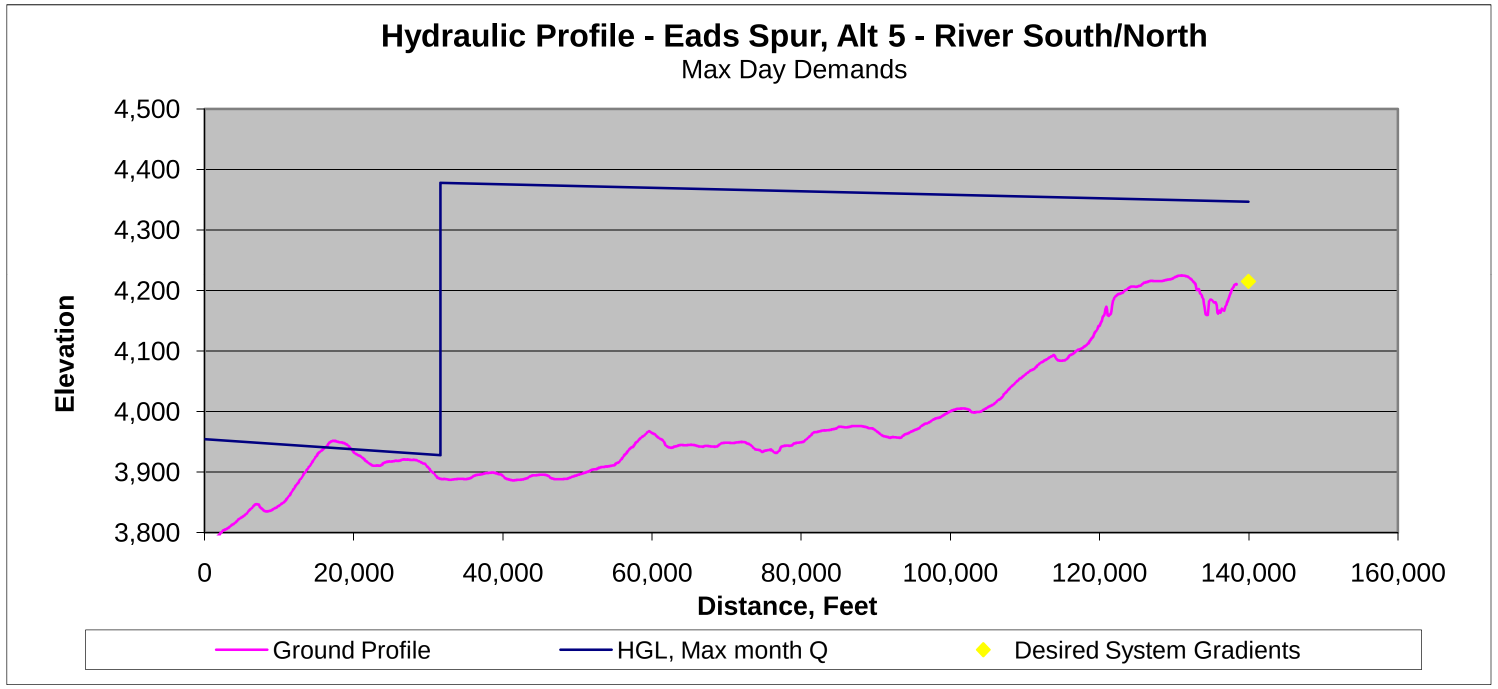
Maximum Day Demands



Hydraulic Profile - La Junta Loop, Alt 5 - River South/North

Maximum Day Demands


Hydraulic Profile - S Swink Spur, Alt 5 - River South/North
Max Day Demands
Elevation
4,400
4,350
4,300
4,250
4,200
4,150
4,100
4,050
4,000
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
Distance, Feet
Ground Profile
HGL, Max month Q
Desired System Gradients


Hydraulic Profile - Eads Spur, Alt 5 - River South/North
Max Day Demands
Elevation
4,500
4,400
4,300
4,200
4,100
4,000
3,900
3,800
0
20,000
40,000
60,000
80,000
100,000
120,000
140,000
160,000
Distance, Feet
Ground Profile
HGL, Max month Q
Desired System Gradients

Appendix I

Conduit Segments and EIS Buffer Zones

Alt 1 **Comanche-South**
Alt 2 **Pueblo Dam-South**
Alt 3 **JUP-North**
Alt 4 **Pueblo Dam-North**
Alt 5 **River-South/North**

Arkansas Valley Conduit
Reach Summary Descriptions and Corridor Widths for EIS/Apprasial Level Design

Apirl 4, 2011
Revised: July 28, 2011
Revised: September 13, 2011

	Alternatives										
Length	**1**	**2**	**3**	**4**	**5**	**Reach**	**Beginning Point**	**Ending Point**	**Corridor Basic Description**	**Corridor Width, ft**	**Summary**
						1	**Pueblo Reservoir**	**Avondale**			
2,103	✓		✓	✓		Interconnect	Pueblo Dam North Outletworks, Southern Delivery System intake line	Pueblo Dam South Outlet Works, Joint Use Pipeline	Reclamation ROW	200	Dam Outlet works inteconnect
11,076	✓	✓				1A	Pueblo Reservoir South Outlet Works	Junction with Pueblo South Route (Approx. 3,000 feet downstream of Bessemer Ditch (stay on Bessmer) and Hwy 96 Intersection)	Grass/Gravel	200	Alignment is adjacent to Bessemer Ditch.
7,666				✓		1Aa	Pueblo Reservoir South Outlet Works	WTP on Reclamation property	Grass/Gravel	200	Alignment is east and south of hatchery
15,017		✓				1B	Junction with Pueblo South Route (Approx. 3,000 feet downstream of Bessemer Ditch (stay on Bessmer) and Hwy 96 Intersection)	Nuckolls Ave and Calla Ave Intersection	Grass/Gravel and Asphalt/Concrete	200	Alignment is adjacent to Bessemer Ditch. Nuckolls Ave and Calla Ave intersection is southeast of Pueblo Zoo and southeast of tennis courts.
2,332		✓				1C	Nuckolls Ave and Calla Ave Intersection	Collins Ave and Prairie Ave Intersection	Grass/Gravel and Asphalt/Concrete	100	Alignment is adjacent to Bessemer Ditch. Ending point would be the pipe from Whitlock WTP.
9,007		✓				1D	Collins Ave and Prairie Ave Intersection	Mesa Ave and Stone Ave Intersection	Asphalt and/or Concrete	100	Alignment is adjacent to Bessemer Ditch. At Palmer, depart Bessemer Ditch to follow Adams Ave SE to Stone Ave. At ending point, the alignment either will go through the steel mill or pass to the north of the steel mill.
6,943		✓				1E.1 *	Mesa Ave and Stone Ave Intersection	Mesa and Santa Fe Intersection	Asphalt and/or Concrete	100	Alignment is east on Mesa Ave, crosses I-25, to Sante Fe. Alignment is one block north of steel mill along Mesa Ave.
2,622		✓				1E.2 *	Mesa and Santa Fe Ave Intersection	Northeast corner of steel mill, just east of Salt Creek and RR.	Asphalt and/or Concrete	600	Alignment is one block north of steel mill and follows Mesa Ave east to Harlem, south across Northern Ave and then is partially diagonal to across Salt Creek and RR.
3,893		✓			✓	1E.3 *	Northeast corner of steel mill, just east of Salt Creek and RR.	Intersection of Bessmer Ditch and South Road	Asphalt and/or Concrete	600	Alignment is from northeast corner of steel mill, just east of Salt Creek and RR, diagonall to South Road.
						1F	Mesa Ave and Stone Ave Intersection	Intersection of Bessmer Ditch and South Road	Grass/Gravel and Asphalt/Concrete	100 ft outside steel mill, 1500 ft inside steel mill	Alignment follows Bessemer Ditch through the steel mill.
65,783	✓					1G	Junction with Pueblo South Route (Approx. 3,000 feet downstream of Bessemer Ditch (stay on Bessmer) and Hwy 96 Intersection)	Intersection of Bessmer Ditch and South Road	Grass/Gravel	400	Pueblo South Route and adjacent to Comanche pipeline.
						1H	Colorado Springs Utilities Wye in the Whitlock Raw Water Line	Nuckolls Ave and Calla Ave Intersection	Grass/Gravel and Asphalt/Concrete	200	Alignment crosses Arkansas River and follows Pueblo Blvd to Nuckolls and then follows Nuckolls. Nuckolls Ave and Calla Ave intersection is southeast of Pueblo Zoo and southeast of tennis courts.
						1I	Whitlock WTP	Collins Ave and Prairie Ave Intersection	Grass/Gravel and Asphalt/Concrete	600	Alignment crosses Arkansas River and follows Prairie Ave to Collins Ave.
2,136						1J.1	Pueblo Reservoir South Outlet Works	East edge of hatchery	Existing Pipe	100	Parallel to existing Whitlock Raw Water Line.
12,049				✓		1J.3	East edge of hatchery	Nature Center	Existing Pipe	400	Parallel to existing Whitlock Raw Water Line.

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Alt 1 **Comanche-South**
Alt 2 **Pueblo Dam-South**
Alt 3 **JUP-North**
Alt 4 **Pueblo Dam-North**
Alt 5 **River-South/North**

Arkansas Valley Conduit
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	Alternatives										
Length	**1**	**2**	**3**	**4**	**5**	**Reach**	**Beginning Point**	**Ending Point**	**Corridor Basic Description**	**Corridor Width, ft**	**Summary**
1,335				✓		1J.4	Nature Center	Colorado Springs Utilities Wye in the Whitlock Raw Water Line	Existing Pipe	400	Parallel to existing Whitlock Raw Water Line.
6,755			✓	✓		1K.2	Colorado Springs Utilities Wye in the Whitlock Raw Water Line	Whitlock WTP Inlet ponds	Gravel Road	400	Parallel to Existing Whitlock Raw Water Line.
2,754			✓			1L.1	Whitlock WTP Clearwell area	1 block west of Cheyenne and 11th St	Grass/Gravel and Asphalt/Concrete	100	Alignment crosses the railroads and Wild Horse Creek and follows 11th St.
6,596			✓	✓		1L.2	1 block west of Cheyenne and 11th St	Intersection of 11th St and West Ave	Grass/Gravel and Asphalt/Concrete	100	Alignment follows 11th St, crosses I-25/ Railroad/ Fountain Creek to 11th and West Ave.
						1M	11th St and Erie Ave	Intersection of Hwy 50 and Railroad	Asphalt and/or Concrete	100	Alignment follows 11th, 10th, and 8th to Hwy 50.
						1N	11th St and Erie Ave	Intersection of Hwy 50 and Railroad	Grass/Gravel and Asphalt/Concrete	200	Alignment follows Fountain Creek and then follows the railroad.
						1O.1	Intersection of Hwy 50 and Railroad	Intersection of CR 25 and Hwy 50	Grass/Gravel	800	Alignment is north of railroad on north side of Hwy 50.
7,412			✓	✓		1O.2	Intersection of CR 25 and Hwy 50	Spur to St Charles Mesa at 28th Ln and Hwy 51	Grass/Gravel	600	Alignment is north of railroad on north side of Hwy 50.
269		✓			✓	1P.1	Intersection of Bessmer Ditch and South Road	Intersection of South Road and Harlem	Grass/Gravel and Asphalt/Concrete	300	Alignment follows Bessemer Ditch and South Road
18,169	✓	✓			✓	1P.2	Intersection of South Road and Harlem	Intersection of 28th Ln and South Road	Grass/Gravel and Asphalt/Concrete	300	Alignment follows Bessemer Ditch and South Road
7,071			✓	✓		1Q.1 Spur	Spur to St Charles Mesa at 28th Ln and Hwy 50	500 feet south of Arkansas River	Grass/Gravel and Asphalt/Concrete	600	Alignment follows 28th Ln, crosses Arkansas River
11,319			✓	✓		1Q.2 Spur	500 feet south of Arkansas River	Intersection South Road and 28th Ln	Grass/Gravel and Asphalt/Concrete	200	Alignment follows follows 28th Ln to South Road
43,844			✓	✓		1R	Spur to St Charles Mesa at 28th Ln and Hwy 50	Hwy 50 and Pueblo Chemical Depot Entrance Road	Grass/Gravel	600	Alignment is adjacent to railroad on north side of Hwy 50.
4,576	✓	✓	✓	✓	✓	1S.2	Intersection South Road and 28th Ln	St Charles Mesa Delivery	Gravel Road	200	Alignment follows South Road, Grant Road, and Hwy 50 Business
47,995	✓	✓			✓	1S.1	St Charles Mesa Delivery	Intersection of Avondale St and Hwy 50 (Business) in Avondale	Gravel Road	200	Alignment follows South Road, Grant Road, and Hwy 50 Business
						1T	Hwy 50 and Pueblo Chemical Depot Entrance Road	Intersection of Hwy 50 and Hwy 50 (Business) east of Avondale	Grass/Gravel	400	Alignment follows Hwy 50 and crosses Arkansas River
5,495			✓	✓		1U	Hwy 50 and Pueblo Chemical Depot Entrance Road	Intersection of Avondale Blvd and Hwy 96	Grass/Gravel	600	Alignment follows Hwy 96
8,822	✓	✓			✓	1V	Intersection of Avondale St and Hwy 50 (Business) in Avondale	Intersection of Hwy 50 and Hwy 50 (Business) east of Avondale	Gravel Road	200	Alignment follows Hwy 50 Business
10,689			✓	✓		1W Spur	Intersection of Avondale Blvd and Hwy 96	Intersection of Avondale St and Hwy 50 (Business) in Avondale	Grass/Gravel and Asphalt/Concrete	400	Spur to Avondale from North Alignment. Alignment follows Avondale Blvd and crosses Arkansas River and Hwy 50.
2,908			✓	✓		1X.1 *	Intersection of 11th St and West Ave	Intersection of 11 th St and 500 feet east of Sante Fe	Asphalt and/or Concrete	100	Alignment follows 11th St.
3,899			✓	✓		1X.2 *	Intersection of 11 th St and 500 feet east of Sante Fe	Intersection of 14 th St and Glendale	Grass/Gravel	600	Crosses I-25 and Fountain Creek, north one block on Dayton to 12 th, east 3 blocks to Glendale and north to 14 th.
8,196			✓	✓		1X.3	Intersection of 14 th St and Glendale	600 ft east of Utica	Asphalt and/or Concrete	100	Alignment follows 14th St to 600 ft east of Utica
1,125			✓	✓		1X.4	600 ft east of Utica	Intersection of 13th St and Amarillo	Grass/Gravel	400	Alignment crosses Dry Creek Arroyo east on 14th.
2,962			✓	✓		1X.5	Intersection of 13th St and Amarillo	Intersection of 13th St and Gray	Asphalt and/or Concrete	100	Alignment follows 13th St east.

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Alt 4 Pueblo Dam-North
Alt 5 River-South/North

Arkansas Valley Conduit
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	Alternatives										
Length	**1**	**2**	**3**	**4**	**5**	**Reach**	**Beginning Point**	**Ending Point**	**Corridor Basic Description**	**Corridor Width, ft**	**Summary**
5,178			✓	✓		1X.6	Intersection of 13th St and Gray	East of salvage yard	Grass/Gravel	600	Alignment follows around north and east boundary of salvage yard to Intersection with Hwy 50
3,912				✓		1Y	Pueblo Reservoir South Outlet Works (Existing Tee in JUM)	North of Whitlock WTP Site	Grass/Gravel and Asphalt/Concrete	400	Alignment follows north of existing JUP and north of existing Whitlock WTP and connects to segment 1L
10,156					✓	1Z *	Arkansas River, near (south of) Main St	Northeast corner of steel mill, just east of Salt Creek and RR.	Grass/Gravel and Asphalt/Concrete	100	Arkansas River south bank, cross under I-25, go south within RR, west of Santa Fe, go southeast at Hwy 50, past RR, turn south and join segment 1E3.
						2	**Avondale**	**Fowler**			
17,338	✓	✓			✓	2A	Intersection of Hwy 50 and Hwy 50 (Business) east of Avondale	Intersection of Hwy 50 and Hwy 209 (South of Boone)		600	Alignment is adjacent to Hwy 50
27,055			✓	✓		2B	Intersection of Avondale Blvd and Hwy 96	Baker Ave and Railroad Street in Boone	Grass/Gravel	600	Alignment is north of railroad on north side of Hwy 96.
9,154	✓	✓			✓	2C Spur	Intersection of Hwy 50 and Hwy 209 (South of Boone)	Baker Ave and Railroad Street in Boone	Grass/Gravel	600	Spur from Hwy 50 to Boone. Alignment is adjacent to Hwy 209, crosses Arkansas River, and crosses a canal/ditch.
14,322			✓	✓		2D.1	Baker Ave and Railroad Street in Boone	2 Miles southeast of Boone where RR departs farther north.	Grass/Gravel	600	Alignment is adjacent to RR allong Hwy 96.
63,528			✓	✓		2D.2	2 Miles souteast of Boone where RR departs farther north.	Intersection of Hwy 96 and Hwy 167 north of Fowler.	Grass/Gravel	600	Alignment is adjacent to Hwy 96.
74,386	✓	✓			✓	2E	Intersection of Hwy 50 and Hwy 209 (South of Boone)	Intersection of Hwy 50 and CR 2 (approx. 1 mile west of Fowler)	Grass/Gravel	600	Alignment is adjacent to Hwy 50.
5,753	✓	✓			✓	2F.2	Intersection of Hwy 50 and CR 2 (approx. 1 mile west of Fowler)	Intersection of Cr Ll 5 and Hwy 167 north of Fowler.	Grass/Gravel	600	Alignment is adjacent to railroad to Fowler, then follows Ll 5 to Hwy 167, Folwer delivery point
7,765	✓	✓	✓	✓	✓	2F.1	Intersection of Cr Ll 5 and Hwy 167 north of Fowler.	Intersection of Hwy 96 and Hwy 167 north of Fowler.	Grass/Gravel	600	Alignment follows 167 north and crosses a canal and the Arkansas River.
10,734	✓	✓	✓	✓	✓	2G	Intersection of Hwy 96 and Hwy 167 north of Fowler.	Near storage tank north of Fowler on the Main Conduit.	Grass/Gravel	600	Alignment follows Hwy 96 to spur to tank north of Fowler on the bluff.
2,669			✓	✓	✓	2G1 *	High pressure pipeline from Mainline to north Fowler storage tank	Low pressure pipeline from north Fowler storage tank to Mainline.	Grass/Gravel	600	Spurs to/from north Fowler storage tank.
1,005	✓	✓	✓	✓	✓	2G2 *	Near storage tank north of Fowler on the Main Conduit.	Intersection of Hwy 96 and and the Main Conduit	Grass/Gravel	600	Alignment follows Hwy 96 from spur from tank north of Fowler on the bluff to Hwy 96 spur.
39,275	✓	✓				2H	Intersection of Hwy 50 and CR 2 (approx. 1 mile west of Fowler)	Intersection of CR 6 and Highway 50 (east of Fowler).	Gravel Road	600	Alignment goes straight south to Road Jj 5/10, then east to the tank south of Fowler, north to Road Kk 5/10 (between CR 5 and CR 6), east to CR 6, and north to Hwy 50.
						3	**Fowler**	**La Junta**			
6,088			✓	✓	✓	3A	Near tank North of Fowler and at intersection of Hwy 96 Spur and the Main Conduit.	Approx 3,800 feet south of Hwy 96 on CR Ln	Prairie	600	Alignment goes straight east and then south.
3,952					✓	3B.1	Approx 3,800 feet south of Hwy 96 on CR Ln	Half mile north of Arkansas River	Prairie	600	Alignment is due south on CR 6

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Alt 5 River-South/North

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	Alternatives										
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5,266					✓	3B.2	Half mile north of Arkansas River	Intersection of CR 6 and Highway 50 (east of Fowler).	Prairie	600	Alignment is due south on CR 6 and crosses Arkansas River to Hwy 50.
35,711			✓	✓		3C	Approx 3,800 feet south of Hwy 96 on CR Ln	Intersection of CR 4 and Hwy 207 (North of Manzanola)	Prairie	600	Alignment is adjacent to CR 65, CR B 5/10, cross-country, CR 6, CR 2175, and Hwy 207.
1,116			✓	✓		3D.1	Intersection of CR 4 and Hwy 207 (North of Manzanola)	Arkansas River Crossing north bank	Grass/Gravel	600	Alignment is adjacent to Hwy 207.
2,666			✓	✓		3D.2	Arkansas River Crossing north bank	Arkansas River Crossing south bank	Grass/Gravel	600	Alignment is adjacent to Hwy 207.
5,349			✓	✓		3D.3	Arkansas River Crossing south bank	Center of Manzanola	Grass/Gravel	600	Alignment is adjacent to Hwy 207.
21,379	✓	✓			✓	3E.1	Intersection of CR 6 and Highway 50 (east of Fowler).	Valley Water Delivery	Grass/Gravel	600	Alignment is adjacent to Hwy 50.
8,508	✓	✓	✓	✓	✓	3E.2	Valley Water Delivery	Center of Manzanola	Grass/Gravel	600	Alignment is adjacent to Hwy 50.
1,636	✓	✓	✓	✓	✓	Manzanola spur	Center of Manzanola	Manzanola Delivery	Grass/Gravel	100	Installed in South St.
43,505			✓	✓		3F *	Intesection of County Line and CR 4 (16,500 feet west of Hwy 71) (north of Arkansas River between Manzanola and Rocky Ford).	Intersection of CR 21 and 4,400 feet northeast of Dye Reservoir.	Prairie	600	Alignment goes southeast cross-country and parallels existing telephone line east of Hwy 71.
8,445	✓	✓	✓	✓	✓	3G	Center of Manzanola	Intersection of Hwy 50 and CR 13 (east of Manzanola)	Grass/Gravel	600	Alignment is adjacent to railroad north of Hwy 50 and then crosses Hwy 50.
27,238	✓	✓	✓	✓	✓	3H	Intersection of Hwy 50 and CR 13 (east of Manzanola)	Intersection of CR 16 and CR Gg (3,500 feet south of Hwy 50).	Grass/Gravel	400	Alignment follows CR 13, CR Hh, CR 135, CR 14, and CR Gg.
						3I	Intersection of Hwy 50 and CR 13 (east of Manzanola)	Intersection of CR 16 and CR Gg (3,500 feet south of Hwy 50).	Grass/Gravel	600	Alignment is adjacent to Hwy 50 and then goes south on CR 16.
29,317	✓	✓	✓	✓	✓	3J.1	Intersection of CR 16 and CR Gg (3,500 feet south of Hwy 50).	Intersection of CR Ee and Hwy 71 (south of Rocky Ford).	Grass/Gravel	400	Alignment follows CR 16, Hwy 202, CR 17, CR Ee straight east to Intersection of Hwy 71
960	✓	✓	✓	✓	✓	RF Spur	Main Line	Rocky Ford delivey box	Asphalt and/or Concrete	200	Spur to WTP
8,594	✓	✓	✓	✓	✓	3J.2	Intersection of CR Ee and Hwy 71 (south of Rocky Ford).	Intersection of Hwy 50 and CR 21 (east of Rocky Ford).	Grass/Gravel	400	Alignment follows CR Ee from Intersection of Hwy 71 straight east to CR 21, north on CR 21 to Hwy 50 (RR and Hwy 50 crossing).
23,939	✓	✓			✓	3K.1	Intersection of Hwy 50 and CR 21 (east of Rocky Ford).	Intersection of Hwy 266 and Ft Lyons Storage Canal	Grass/Gravel	400	Alignment follows CR 21 to Hwy 266 and is then adjacent to Hwy 266. (Alignment crosses 4 canals.)
7,387	✓	✓	✓	✓	✓	3K.3	Intersection of Hwy 266 and Ft Lyons Storage Canal	Intersection of CR 25 and Hwy 266	Grass/Gravel	400	Alignment follows adjacent to Hwy 266. (Alignment crosses 1 canal.)
10,256	✓	✓			✓	3K.2	Intersection of CR 25 and Hwy 266	Approx 700 feet West of Intersection of CR 27 and Hwy 266	Grass/Gravel	400	Alignment follows CR 21 to Hwy 266 and is then adjacent to Hwy 266.
21,181	✓	✓	✓	✓	✓	3L.1	Intersection of CR Ee and Hwy 71 (south of Rocky Ford).	Intersection of Hwy 71 and Hwy 10	Grass/Gravel	200	Alignment is adjacent to Hwy 71.
44,931					✓	3L.2	Intersection of Hwy 50 and CR 21 (east of Rocky Ford).	West Side of La Junta near Intersection of Hwy 10 and Hwy 50	Grass/Gravel	200	Alignment is adjacent to Hwy 50.
21,075	✓	✓	✓	✓		3L.3	Intersection of Hwy 50 and CR 21 (east of Rocky Ford).	Swink Delivery	Grass/Gravel	600	Alignment is adjacent to Hwy 50.
3,191	✓	✓	✓	✓	✓	3L.4	Swink Delivery	Intersection of Hwy 50 and CR 25	Grass/Gravel	600	Alignment is adjacent to CR 25. South Swink Delivery
17,742	✓	✓	✓	✓		3L.5	Intersection of Hwy 50 and CR 25	West Side of La Junta near Intersection of Hwy 10 and Hwy 50	Grass/Gravel	600	Alignment is adjacent to CR 25. South Swink Delivery

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Alt 1	**Comanche-South**
Alt 2	**Pueblo Dam-South**
Alt 3	**JUP-North**
Alt 4	**Pueblo Dam-North**
Alt 5	**River-South/North**

Arkansas Valley Conduit
Reach Summary Descriptions and Corridor Widths for EIS/Apprasial Level Design

Apirl 4, 2011
Revised: July 28, 2011
Revised: September 13, 2011

Length	**Alternatives**					**Reach**	**Beginning Point**	**Ending Point**	**Corridor Basic Description**	**Corridor Width, ft**	**Summary**
	1	**2**	**3**	**4**	**5**						
15,822			✓	✓		3M.2	Intersection of CR 21 and 4,400 feet northeast of Dye Reservoir.	Intersection of CR 25 and 8,000 feet north of Hwy 266 at Holbrook Reservoir.	Prairie	600	Alignment is cross-country.
21,967			✓	✓		3M.1	Intersection of CR 25 and 8,000 feet north of Hwy 266.	Intersection of CR 29 and 750 feet south of CR Jj	Prairie	600	Alignment is cross-country, crosses Holbrook Canal, follows CR Jj, and turns south on CR 29.
4,861			✓	✓		3M (Split)	Intersection of CR 29 and 750 feet south of CR Jj	Intersection of CR 29 and Hwy 266	Prairie	600	Alignment is south on CR 29 to Hwy 266.
						3N	4,400 feet northeast of Dye Reservoir	Approx 700 feet West of Intersection of CR 27 and Hwy 266	Prairie	600	Alignment is cross-country (parallels existing telephone line at beginning), crosses Holbrook Canal, and stops near Hwy 266.
2,748			✓	✓		Holbrook2 Spur	Intersection of CR 25 and 8,000 feet north of Hwy 266 at Holbrook Reservoir.	Intersection of CR 25 and 5,400 feet north of Hwy 266 at Holbrook Reservoir.	Prairie	600	Alignment is cross-country (parallels existing telephone line at beginning) south along CR 25
2,600			✓	✓		3N.3	Intersection of CR 25 and 5,400 feet north of Hwy 266 at Holbrook Reservoir.	Intersection of CR 25 and 2,700 feet north of Hwy 266 at Holbrook Reservoir.	Prairie	600	Alignment is cross-country south along CR 25.
2,787			✓	✓		Holbrook1 Spur	4,400 feet northeast of Dye Reservoir	Approx 700 feet West of Intersection of CR 27 and Hwy 266	Prairie	600	Alignment is cross-country, crosses Holbrook Canal, and stops near Hwy 266.
11,244	✓	✓			✓	3O	Approx 700 feet West of Intersection of CR 27 and Hwy 266	Intersection of CR 29 and Hwy 266	Grass/Gravel	400	Alignment is adjacent to Hwy 266.
						3P	Intersection of CR 29 and Hwy 266	Intersection of Hwy 109 and CR Ee	Prairie	400	Alignment goes straight south on CR 29, crosses 2 canals, and then turns east on CR Ee to Hwy 109.
5,332	✓	✓	✓	✓	✓	3Q	Intersection of CR 29 and Hwy 266	Intersection of Hwy 109 and Hwy 266	Grass/Gravel	400	Alignment is adjacent to Hwy 266.
						3R	West Side of La Junta near Intersection of Hwy 10 and Hwy 50	Intersection of Canal Rd and Elm St in north La Junta	Grass/Gravel	1,500	Alignment crosses Hwy 50 and RR, follows Vista Ave, crosses Arkansas River, follows Jachim St, east on Himebaugh St, north on Jackson Ave, and east on Canal Rd.
2,637	✓	✓	✓	✓		3S.1	West Side of La Junta near Intersection of Hwy 10 and Hwy 50	Intersection of CR 28 and 6th St	Asphalt and/or Concrete	100	Alignment goes south on Hwy 10, south on Dalton Ave.
6,628	✓	✓	✓	✓	✓	3S.2	Intersection of CR 28 and 6th St	Intersection of 6th St and Raton	Asphalt and/or Concrete	100	Alignment goes east on 6th St and stops at Raton.
2,626	✓	✓	✓	✓	✓	Homested Spur	Intersection of CR 28 and 6th St	Homested Delivery	Asphalt and/or Concrete	200	Alignment goes south on Raton and stops at La Junta WTP Storage tank.
3,154	✓	✓	✓	✓	✓	La Junta Spur	Intersection of 6th St and Raton	La Junta WTP Storage tank	Asphalt and/or Concrete	100	Alignment goes south on Raton and stops at La Junta WTP Storage tank.
3,501	✓	✓	✓	✓	✓	3S.3	Intersection of 6th St and Raton	La Junta WTP	Asphalt and/or Concrete	100	Alignment goes east on 6th St, crosses RR, and stops at La Junta WTP.
2,031	✓	✓	✓	✓	✓	3T.3	La Junta WTP	King Arroyo to 300 feet south of Hwy 50	Grass/Gravel and Asphalt/Concrete	600	Alignment follows King Arroyo north of WTP to 300 feet south of Hwy 50
3,847	✓	✓	✓	✓	✓	3T.2	300 feet south of Hwy 50	Intersection of Elm St and Chalmers St in north La Junta	Grass/Gravel and Asphalt/Concrete	600	Alignment crosses Hwy 50, RR, and Arkansas River, and then follows Elm St to Intersection with Chalmers St
2,919	✓	✓	✓	✓	✓	3T.1	Intersection of Elm St and Chalmers St in north La Junta	Intersection of Canal Rd and Elm St in north La Junta	Grass/Gravel and Asphalt/Concrete	100	Alignment follows Elm St
13,753	✓	✓	✓	✓	✓	3U	Intersection of Canal Rd and Elm St in north La Junta	Intersection of Hwy 109 and CR Ee. Top of hill and west of airport	Prairie	400	Alignment crosses a canal and is adjacent to Hwy 109
15,675	✓	✓	✓	✓	✓	3V	Intersection of Hwy 109 and CR Ee. Top of hill and west of airport	Intersection of Hwy 109 and CR Ee	Prairie	400	Alignment is adjacent to Hwy 109.

Alt 1 **Comanche-South**
Alt 2 **Pueblo Dam-South**
Alt 3 **JUP-North**
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Alt 5 **River-South/North**

Arkansas Valley Conduit
Reach Summary Descriptions and
Corridor Widths for EIS/Apprasial Level Design

Apirl 4, 2011
Revised: July 28, 2011
Revised: September 13, 2011

	Alternatives										
Length	**1**	**2**	**3**	**4**	**5**	**Reach**	**Beginning Point**	**Ending Point**	**Corridor Basic Description**	**Corridor Width, ft**	**Summary**
19,066			✓	✓		3W *	Intersection of CR 4 and Hwy 207 (North of Manzanola)	Intesection of County Line and CR 4 (16,500 feet west of Hwy 71) (north of Arkansas River between Manzanola and Rocky Ford).	Prairie	600	Alignment follows CR 4.
10,919	✓	✓	✓	✓	✓	3X Swink Spur	Intersection of Hwy 50 and CR 25 (0.5 miles east of Swink)	Intersection of CR 25 and Hwy 10.	Grass/Gravel	200	Alignment is parallel to CR 25 and is straight south of Hwy 50. This is the spur to South Swink.
715	✓	✓	✓	✓	✓	Bents Fort Spur	Alignment is adjacent to Hwy 109, north for 1500 feet from Canal St	Bents Fort Spur to storage tanks.	Prairie	400	Alignment is adjacent to Hwy 109, north for 1500 feet from Canal St. .Bents Fort Spur to storage tanks.
						4	**La Junta**	**Las Animas**			
42,119			✓	✓	✓	4A.1	Intersection of CR Hh and Cr 33	Approx 4300 feet west of Intersection of Adobe Crk and Hwy 194	Grass/Gravel	600	Alignment is east on CR Hh, and east on Hwy 194.
16,142	✓	✓	✓	✓	✓	4A.2	Intersection of Hwy 109 and Hwy 266	Intersection of CR Hh and Cr 33	Grass/Gravel	600	Alignment is east on CR Hh, to CR 33, Southside Delivery
96,100	✓	✓				4B.1	La Junta WTP	Las Animas Delivery	Grass/Gravel	600	Alignment goes east on 6th St, east on CR Aa, north on CR 31, follows Hwy 50 to Las Animas, crosses a canal and the RR, north on Hurd Ave, east on 6th St, north on Peck Ave, east to 4th and Lois, delivery point.
9,004	✓	✓	✓	✓	✓	4B.2	Las Animas Delivery	Intersection of Hwy 194 and Hwy 50 North of Las Animas	Grass/Gravel	600	Alignment goes from delivery point at east to 4th and Lois, north on Lois Ave, northeast (north of Las Animas) to Hwy 50, north on Hwy 50, and crosses Arkansas River. Flow is in reverse direction for Alternatives 3, 4 and 5, when this becomes the Las Animus Spur.
28,981			✓	✓		4C.1	Approx 4300 feet west of Intersection of Adobe Crk and Hwy 194	900 ft west of Intersection of Hwy 194 and Hwy 50 North of Las Animas	Grass/Gravel	600	Alignment is adjacent to Hwy 194.
888			✓	✓	✓	4C.2	900 ft west of Intersection of Hwy 194 and Hwy 50 North of Las Animas	Intersection of Hwy 194 and Hwy 50 North of Las Animas	Grass/Gravel	600	Alignment is adjacent to Hwy 194.
30,689					✓	4D	Approx 4300 feet west of Intersection of Adobe Crk and Hwy 194	On Exist Railroad Approx 2700 feet north of Intersection of Hwy 194 and Hwy 50 North of Las Animas.	Railroad Grade	600	Alignment follows existing railroad grade (RR is abandoned and tracks removed).
2,642					✓	4E Spur	On Exist Railroad Approx 2700 feet north of Intersection of Hwy 194 and Hwy 50 North of Las Animas.	Intersection of Hwy 194 and Hwy 50 North of Las Animas	Agriculture	600	Alignment is adjacent to CR 105 between two agricultural fields.
						4F	Intersection of 4th Street and Lois Ave in Las Animas.	Intersection with Segment 4B between Las Animas and Arkansas River Crossing.	Asphalt and/or Concrete	200	Alignment is east on 4th Street to Hwy 50 then north on Highway 50.
						5	**Las Animas**	**Lamar**			
42,020					✓	5A	On Exist Railroad Approx 2700 feet north of Intersection of Hwy 194 and Hwy 50 North of Las Animas.	Near Intersection of CR Kk and Hwy 50	Railroad Grade	600	Alignment follows existing railroad grade (RR is abandoned and tracks removed).
39,208	✓	✓	✓	✓		5B	Intersection of Hwy 194 and Hwy 50 North of Las Animas	Near Intersection of CR Kk and Hwy 50	Grass/Gravel	600	Alignment is adjacent to Hwy 50.
90,320	✓	✓	✓	✓	✓	5C	Near Intersection of CR Kk and Hwy 50	Eads Spur at Intersection of Hwy 50 and CR 34	Grass/Gravel	600	Alignment is adjacent to Hwy 50.

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Alt 1 **Comanche-South**
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Alt 3 **JUP-North**
Alt 4 **Pueblo Dam-North**
Alt 5 **River-South/North**

Arkansas Valley Conduit
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Apirl 4, 2011
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	Alternatives										
Length	**1**	**2**	**3**	**4**	**5**	**Reach**	**Beginning Point**	**Ending Point**	**Corridor Basic Description**	**Corridor Width, ft**	**Summary**
5,484	✓	✓	✓	✓	✓	5D Spur	Near Intersection of CR 24 and Hwy 50 in Hasty	McClave Tie-In at Intersection of CR 24 and CR Ll (approx. 1 mile north of Hasty)	Grass/Gravel	600	Mc Clave Spur alignment is adjacent to CR 24.
626	✓	✓	✓	✓	✓	5E Spur	Near Intersection of CR 24 and Hwy 50 in Hasty	Hasty Tie-In Approx. 1 block south of Hwy 50	Asphalt and/or Concrete	100	Hasty Spur alignment follows CR 24 south to Hasty tie-in.
10,519	✓	✓	✓	✓	✓	5F	Eads Spur at Intersection of Hwy 50 and CR 34	Intersection of CR 1 and Hwy 50 (1 mile west of intersection of Hwy 287 and Hwy 50)	Grass/Gravel	600	Alignment is adjacent to Hwy 50.
19,750	✓	✓	✓	✓	✓	5G Spur	Intersection of CR 1 and Hwy 50 (1 mile west of intersection of Hwy 287 and Hwy 50)	South Side of Wiley	Agriculture	400	Wiley Spur alignment is north on CR 1, and then east across an agricultural field to the south side of Wiley.
4,833	✓	✓	✓	✓	✓	5H.1	Intersection of CR 1 and Hwy 50 (1 mile west of intersection of Hwy 287 and Hwy 50)	Arkansas River crossing	Prairie	600	Alignment goes south to Arkansas River crossing
31,354	✓	✓	✓	✓	✓	5H.2	Arkansas River crossing, north side	Arkansas River crossing, south side	Prairie	600	Alignment goes south and crosses Arkansas River, east on CR Hh, south on CR 5 to 1000 ft south of CR Gg 5 and canal crossing.
31,323	✓	✓	✓	✓	✓	5H.3	Arkansas River crossing, south side	Lamar Tanks south of Lamar	Prairie	600	Alignment goes south on CR 5 from 1000 ft south of CR Gg 5, east on Prairie Dr, south on CR 7, and southeast to Lamar's tanks (route is south of golf course).
						6	**Fowler**	**Sugar City**			
54,706	✓	✓	✓	✓	✓	6A	Near tank North of Fowler and at intersection of Hwy 96 Spur and the Main Conduit.	Intersection of Hwy 96 and County Line (14,000 feet southwest of Ordway along Hwy 96)	Grass/Gravel	400	Alignment is adjacent to Hwy 96.
						6B	Intesection of County Line and CR 4 (16,500 feet west of Hwy 71) (north of Arkansas River between Manzanola and Rocky Ford).	Intersection of Hwy 96 and County Line (14,000 feet southwest of Ordway along Hwy 96)	Prairie	600	Alignment is adjacent to County Line.
16,441	✓	✓	✓	✓	✓	6C.2	Intersection of Hwy 96 and County Line (14,000 feet southwest of Ordway along Hwy 96)	Intersection of Hwy 96 and Hwy 71, east of Ordway	Grass/Gravel	400	Alignment is adjacent to Hwy 96.
25,163	✓	✓	✓	✓	✓	6C.1	Intersection of Hwy 96 and Hwy 71, east of Ordway	Sugar City	Grass/Gravel	400	Alignment is adjacent to Hwy 96.
2,395	✓	✓	✓	✓	✓	96 Pipeline Co Spur	Intersection of Hwy 96 and Hwy 71, east of Ordway	96 Pipeline Co delivery	Grass/Gravel	200	Alignment is adjacent to Hwy 71.
						7	**Intersection of Hwy 50 and CR 34**	**Eads**			
31,633	✓	✓	✓	✓	✓	7B	Eads Spur at Intersection of Hwy 50 and CR 34	Intersection of CR 34 and CR Ss	Grass/Gravel	400	Alignment is north on CR 34 to CR Ss
27,056	✓	✓	✓	✓	✓	May Valley Spur	Intersection of CR 34 and CR Ss	May Valley Delivery	Grass/Gravel	200	Alignment is east on CR Ss to May Valley Deliver near existing storage tank to the south
108,338	✓	✓	✓	✓	✓	7A	Intersection of CR 34 and CR Ss	Eads	Grass/Gravel	400	Alignment is north on CR 34, west on CR Ww, north on CR 40 to Eads, east on Lowell Ave, and north on Maine St.

Appendix J

GIS Data Tables

An inclusive list of the static geospatial data provided by the Farnsworth Group is as follows (Note that features portrayed in red font were not transferred to Reclamation by the Farnsworth Group):

File Geodatabase:	AVC_Static.gdb	Features to be updated rarely or not at all		
Feature Set	Feature	Source	Date Acquired	Date Published by Source
Atlas Basemap				
	Airports	U.S. National Atlas	10/02/2009	04/01/2008
	AMTRAK Stations	Tele Atlas, ESRI	10/02/2009	04/01/2008
	Arkansas Basin Cities and Towns	U.S. Census Bureau (Provided by CDM)	12/16/2009	unknown
	Bus Stations	Tele Atlas, ESRI	10/02/2009	04/01/2008
	Churches	USGS, ESRI	10/05/2009	04/01/2008
	Counties CDOT	CDOT	12/16/2009	05/19/2009
	Golf Courses	USGS, ESRI	10/05/2009	04/01/2009
	Hospitals	USGS, ESRI	10/05/2009	04/01/2008
	Hospitals Health Department	Colorado Department of Public Health and Environment	12/16/2009	11/2008
	Hospitals AHA	Health Forum LLC, ESRI	10/02/2009	04/01/2008
	Lakes CDOT	CDOT	12/16/2009	01/29/2009
	Landmarks Regional	Tele Atlas, ESRI	10/02/2009	04/01/2008
	Major Lakes State	ESRI	10/02/2009	04/01/2008
	National Forests State	NPS, ESRI, Tele Atlas	10/02/2009	04/01/2008
	National Parks State	NPS, ESRI, Tele Atlas	10/02/2009	04/01/2008
	Nartional Forests Regional	NPS, ESRI, Tele Atlas	10/02/2009	04/01/2008
	Parks Local	Tele Atlas, ESRI	10/02/2009	04/01/2008
	Parks Regional	Tele Atlas, ESRI	10/02/2009	04/01/2008
	Places Outline	Tele Atlas, ESRI	10/02/2009	04/01/2008
	Populated Places	USGS, ESRI	10/05/2009	04/01/2008
	Public Buildings	USGS, ESRI	10/05/2009	04/01/2008
	Rail 100K CDOT	CDOT	3/19/2010	12/31/2006
	Rail Lines CDOT	CDOT	12/16/2009	12/31/2006
	Railroads Pueblo County	Pueblo County GIS Department	12/16/2009	unknown
	Rest Areas	CDOT	12/16/2009	unknown

File Geodatabase:	AVC_Static.gdb	Features to be updated rarely or not at all		
Feature Set	Feature	Source	Date Acquired	Date Published by Source
	Rivers Detailed	USGS, ESRI	10/02/2009	04/01/2008
	Rivers Local	USGS, ESRI	10/02/2009	04/01/2008
Atlas Basemap	Rivers Regional	National Atlas of the U.S., USGS, ESRI	10/02/2009	04/01/2008
	Roads - Highways CDOT	CDOT	3/23/2010	1/6/2010
	Roads - Local CDOT	CDOT	3/23/2010	1/6/2010
	Roads - Major CDOT	CDOT	3/23/2010	1/6/2010
	Roads Pueblo County	Pueblo County GIS Department	12/16/2009	unknown
	Schools	USGS, ESRI	10/02/2009	04/01/2008
	State Boundaries Detailed	Tele Atlas, ESRI	10/02/2009	04/01/2008
	Streams CDOT	CDOT	12/16/2009	12/31/2004
	Inhibited Places	USGS, ESRI	10/05/2009	04/01/2008
	Urban Areas Regional	Department of Commerce, Census Bureau, ESRI	10/02/2009	04/01/2008
	Urban Areas State	National Atlas of the U.S., USGS, ESRI	10/02/2009	04/01/2008
	Urban Outlines Regional	Department of Commerce, Census Bureau, ESRI	10/02/2009	04/01/2008
	Urban Outlines States	National Atlas of the U.S., USGS, ESRI	10/02/2009	04/01/2008
	USGS Quad Sheet Boundaries	ESRI	10/02/2009	04/01/2008
	Water Regional	National Atlas of the U.S., USGS, ESRI	10/02/2009	04/01/2008
ENV BLM				
	Areas of Critical & Environmental Concern for Public Lands	BLM Colorado State Office	12/16/2009	05/2006
	BLM Wilderness Areas	BLM Colorado State Office	12/16/2009	04/24/2009
	BLM Wilderness Study Areas	BLM Colorado State Office	12/16/2009	04/24/2009
	Federal Sub Surface Ownership	BLM Colorado State Office	12/16/2009	unknown
	National Conservation Areas	Bureau of Land Management	12/16/2009	4/23/2009
ENV CDOT				
	Alts Merged	CDOT (US50 Highway Project)	3/22/2010	12/18/2008

File Geodatabase:	AVC_Static.gdb	Features to be updated rarely or not at all		
Feature Set	Feature	Source	Date Acquired	Date Published by Source
	APE	CDOT (US50 Highway Project)	3/22/2010	7/10/2009
	Farmland	CDOT (US50 Highway Project)	3/22/2010	12/18/2008
ENV CDOT	Historic	CDOT (US50 Highway Project)	3/22/2010	7/13/2009
	Historic Districts	CDOT (US50 Highway Project)	3/22/2010	6/19/2008
	Historic Linear	CDOT (US50 Highway Project)	3/22/2010	3/23/2009
	Project Area	CDOT (US50 Highway Project)	3/22/2010	12/6/2007
	Wet Riparian	CDOT (US50 Highway Project)	3/22/2010	11/6/2008
ENV CDOW				
	Colorado Vegetation Classification Project	CDOW (Provided by ERO)	2/4/2010	6/26/1905
	Division 2 Structures	CDOW	3/26/2010	unknown
	Riparian - La Junta	ERO Resources Corp.	2/4/2010	2/2/2010
	Riparian - Lamar	ERO Resources Corp.	2/4/2010	2/2/2010
	Riparian - Las Animas	ERO Resources Corp.	2/4/2010	2/2/2010
	Riparian - Pueblo	ERO Resources Corp.	2/4/2010	2/2/2010
ENV Conservation Board				
	CDSS Reservoirs	State of Colorado Division of Water Resources	12/16/2009	7/1/2009
	CDSS Wells	State of Colorado Division of Water Resources	12/16/2009	7/1/2009
	Climate Stations	State of Colorado Division of Water Resources	12/16/2009	7/1/2009
	Decreed Wells	State of Colorado Division of Water Resources	12/16/2009	7/1/2009
	Diversions	State of Colorado Division of Water Resources	12/16/2009	7/1/2009
	Evaporation Stations	State of Colorado Division of Water Resources	12/16/2009	7/1/2009
	Flow Stations	State of Colorado Division of Water Resources	12/16/2009	7/1/2009
	National Water Quality Assessment	NWIS	12/16/2009	unknown
	Precipitation Stations	State of Colorado Division of Water Resources	12/16/2009	7/1/2009

File Geodatabase:	AVC_Static.gdb	Features to be updated rarely or not at all		
Feature Set	Feature	Source	Date Acquired	Date Published by Source
	Real Time Gaging Stations	USGS	12/16/2009	unknown
	Surface Water Sampling Sites	USGS	12/16/2009	1/1/2001
ENV Conservation Board	Temperature Stations	State of Colorado Division of Water Resources	12/16/2009	7/1/2009
	USGS Ground Water Response Network Wells	USGS	12/16/2009	6/1/2005
ENV Cultural / Historical				
	Cemeteries URS	URS Corporation	12/16/2009	unknown
	Fossil Locations - CU	URS Corporation	12/16/2009	03/05/2002
	Fossil Locations - DMNS	URS Corporation	12/16/2009	03/05/2002
	Historical Sites	URS Corporation	12/16/2009	03/29/2001
	Historical Sites Lines	URS Corporation	12/16/2009	03/29/2001
	Historical Sites Points	URS Corporation	12/16/2009	03/29/2001
	Historical Sites USGS	URS Corporation	12/16/2009	03/29/2001
ENV Floodplain				
	Floodplain FEMA	Federal Emergency Management Agency	12/16/2009	1996
ENV Hydro				
	Arkansas Basin HUC12	Colorado Division of Wildlife	12/16/2009	01/25/2005
	Ditch Owners Irrigation Types	Division Engineer's Office	12/16/2009	unknown
	Hydrological Unit Boundary	USGS	12/16/2009	06/2005
	Water Shed Boundary	USGS	12/16/2009	1994
	Water Shed Boundary HU12	USGS	12/16/2009	1994
ENV Land Use				
	Land Use Land Cover	Multi-Resolution Land Characteristics (MRLC) Consortium	3/12/2010	2001
	National Agriculture Statistics Service	USDA	3/12/2010	unknown
	National Land Cover Data	Multi-Resolution Land Characteristics (MRLC) Consortium	3/12/2010	2001
ENV Wetlands				
	CONUS Public Historic Map Info (Location of Historic Map Reports)	USFWS	12/16/2009	05/22/2008

File Geodatabase:	AVC_Static.gdb	Features to be updated rarely or not at all		
Feature Set	Feature	Source	Date Acquired	Date Published by Source
	CONUS Public Metadata (NWI Wetland Mapping Projects)	USFWS	12/16/2009	05/22/2008
ENV Wetlands	CONUS Wetland (Approx. Wetland Locations)	USFWS	12/16/2009	05/22/2008
	Dams	National Atlas of the United States	12/16/2009	03/2006
	NHD Rivers and Streams	EPA, USGS	12/16/2009	unknown
	NHD Waterbody	EPA, USGS	12/16/2009	unknown
	Noxious Weeds 1 CDOT	CDOT	12/16/2009	2004-2005
	Noxious Weeds 2 CDOT	CDOT	12/16/2009	2004-2005
	Noxious Weeds 3 CDOT	CDOT	12/16/2009	2005
	USGS Principal Aquifers	USGS	12/16/2009	09/2002
	Weed Buffers 2006 CDOT	CDOT	12/16/2009	07/12/2006
	Weed Buffers 2007 CDOT	CDOT	12/16/2009	06/10/2008
	Wetlands Reserve Program Easements	Natural Resource Conservation Service	12/16/2009	09/14/2001
ENV Wildlife				
	Alberts Squirrel	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Bald Eagle	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Bighorn Sheep	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Black Bear	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Columbian Sharp-tailed Grouse	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Cutthroat Trout	CDOW - NDIS NREL	8/20/2009	8/29/2005
	Elk	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Fox	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Geese	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Great Blue Heron	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Greater Prairie Chicken	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Greater Sage Grouse	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Least Tern	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Lesser Prairie Chicken	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Massasauga	CDOW - NDIS NREL	8/20/2009	7/22/2009

File Geodatabase:	AVC_Static.gdb	Features to be updated rarely or not at all		
Feature Set	Feature	Source	Date Acquired	Date Published by Source
	Moose	CDOW - NDIS NREL	8/20/2009	7/22/2009
ENV Wildlife	Mountain Goat	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Mountain Lion	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Mule Deer	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Osprey	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Peregrine	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Pheasant	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Piping Plover	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Plains Sharp-tailed Grouse	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Prairie Dog	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Prebels Jumping Mouse	CDOW - NDIS NREL	8/20/2009	8/5/2004
	Pronghorn	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Quail (Bobwhite Quail)	CDOW - NDIS NREL	8/20/2009	7/22/2009
	River Otter	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Scaled Quail	CDOW - NDIS NREL	8/20/2009	7/22/2009
	SREP Linkages	Southern Rockies Ecosystem Project	10/1/2009	6/26/1905
	State Wildlife Areas	CDOW	10/1/2009	2/28/2007
	Swift Fox Overall Range	CDOW	10/1/2009	7/1/1905
	Texas-horned Lizard	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Wildlife Arcs	CDOT	9/24/2009	unknown
	White Pelican	CDOW - NDIS NREL	8/20/2009	7/22/2009
	White-tailed Deer	CDOW - NDIS NREL	8/20/2009	7/22/2009
	White-tailed Ptarmigan	CDOW - NDIS NREL	8/20/2009	7/22/2009
	Wild Turkey	CDOW - NDIS NREL	8/20/2009	7/22/2009
GeoTech Hazmat				
	EPA Sites	The Environmental Protection Agency (EPA)	12/16/2009	08/12/2009
	Hazmat Points	URS Corporation	12/16/2009	3/29/2001
GeoTech Mines				
	Permitted Mines	Division of Reclamation, Mining & Safety	9/21/2009	2/1/2009
	USGS Mines (Missing	USGS	9/11/2009	5/1/1981

File Geodatabase:	AVC_Static.gdb	Features to be updated rarely or not at all		
Feature Set	Feature	Source	Date Acquired	Date Published by Source
	Metadata)			
GeoTech Soils				
	Bent County Soil Survey Area	USDA, Natural Resources Conservation Service	9/21/2009	4/28/2009
	Crowley County Soil Survey Area	USDA, Natural Resources Conservation Service	9/21/2009	4/28/2009
	Otero County Soil Survey Area	USDA, Natural Resources Conservation Service	9/21/2009	4/28/2009
	Prowers County Soil Survey Area	USDA, Natural Resources Conservation Service	9/21/2009	4/28/2009
	Pueblo Area Soil Survey Area	USDA, Natural Resources Conservation Service	9/21/2009	4/28/2009
SURV Contours				
	5 Foot Contours	2009 USGS 1/3" DEM Rater Files	9/18/2009	2/1/2009
	20 Foot Contours	2009 USGS 1/3" DEM Rater Files	9/18/2009	2/1/2009
SURV Control				
	NGS Monuments CO	NOAA, National Geodetic Survey	9/18/2009	9/9/2009
SURV Political Boundaries				
	Metro DOLA (Colorado Metro Boundaries)	Colorado Division of Local Government	12/16/2009	11/15/2001
	Pueblo County (City of Pueblo Metro Boundaries)	Pueblo County GIS Department	12/16/2009	11/15/2001
	Recreation DOLA (Recreation Outlines & Boundaries)	Colorado Division of Local Government	12/16/2009	11/15/2001
	Sanitation DOLA (Sanitation District Boundaries)	Colorado Division of Local Government	12/16/2009	11/15/2001
	Water Sewer DOLA (Water & Sanitation District Boundaries)	Colorado Division of Local Government	12/16/2009	11/15/2001
	Water Board (DWR District Boundaries)	Colorado Division of Water Resources	12/16/2009	9/1/2006
	Water DOLA (Water District Boundaries)	Colorado Division of Local Government	12/16/2009	11/15/2001

An inclusive list of the dynamic geospatial data provided by the Farnsworth Group is as follows (Note that features portrayed in red font were not transferred to Reclamation by the Farnsworth Group, features in green font were provided by the Farnsworth Group but significantly modified by Reclamation):

File Geodatabase:	AVC_Dynamic.gdb	Features likely to be updated during project		
Feature Set	Feature	Source	Date Acquired	Date Published by Source
Civil AVC Route				
	AVC Routes	Black & Veatch/Reclamation	02/05/2010	02/05/2010
	Route Buffers	Black & Veatch/Reclamation	02/09/2010	02/09/2010
	Route Buffers - Dissolved	Black & Veatch (Dissolved Line types by Farnsworth Group, Inc.)	02/09/2010	n/a
	Spur	Black & Veatch/Reclamation	12/14/2009	12/11/2009
	Storage Tanks	Black & Veatch/Reclamation	12/14/2009	12/11/2009
	Tie In Points	Black & Veatch/Reclamation	12/14/2009	12/11/2009
	Water Treatment Plants (WTP)	Black & Veatch/Reclamation	12/14/2009	12/11/2009
ENV Hydro				
	Irrigated Lands	Division of Water Resources, ArcCDSS	10/20/2009	07/01/2009
	Boundary Correction 2003	Black & Veatch	10/20/2009	2003
	Recreational and Environmental	CDM	10/20/2009	unknown
	Water Provider Locations	InfoGrafix (Based on 2006 SECWCD data)	12/17/2009	2006
	Waste Water Treatment Plant Locations	InfoGrafix (Based on EPA Website)	12/17/2009	unknown
Surv Map Book				
	Map Book Sheets	Farnsworth Group, Inc./Reclamation	3/23/2010	n/a
	Map Book Sheet Labels	Farnsworth Group, Inc./Reclamation	3/23/2010	n/a
	Map Book Township Polygons	Farnsworth Group, Inc./Reclamation	3/23/2010	n/a
SURV Ownership				
	Arkansas Basin Boundary	Farnsworth Group, Inc. (Colorado Basin District Boundaries)	10/30/2009	9/22/2003
	Bent County Parcels	Bent County Assessor's Office	3/3/2010	3/3/2010
SURV Ownership	BLM PLSS 16th Sections	Premier Data Services	10/20/2009	08/2008

File Geodatabase:	AVC_Dynamic.gdb	Features likely to be updated during project		
Feature Set	Feature	Source	Date Acquired	Date Published by Source
	BLM PLSS Sections	Premier Data Services	10/20/2009	08/2008
	BLM PLSS Townships	Premier Data Services	10/20/2009	08/2008
	CDOT Land Ownership	CDOT	10/20/2009	12/31/2004
	CO Land Board - Stewardship Trust	Colorado State Land Board	10/20/2009	2007
	Colorado Land Ownership	Colorado State Land Board	10/20/2009	07/15/2005
	Crowley County Parcels	Farnsworth Group, Inc.	3/12/2010	3/12/2010
	District Clip	Farnsworth Group, Inc.	10/20/2009	09/2009
	Federal Lands - National Atlas	National Atlas of the United States	10/20/2009	12/2005
	Kiowa County Parcels	Farnsworth Group, Inc.	2/10/2010	2/10/2010
	Otero County Parcels	Farnsworth Group, Inc.	3/1/2010	3/1/2010
	Prowers County Parcels	URS (For CDOT Hwy 50 Project)	10/20/2009	12/17/2001
	Pueblo County Parcels	Pueblo County GIS Department	11/2009	unknown
	State Trust Lands	Colorado State Land Board	10/20/2009	1/5/2009
	Sub Surface	Colorado Bureau of Land Management	10/20/2009	unknown
SURV Political Boundaries				
	Cities CDOT	CDOT	12/16/2009	5/19/2009
SURV Utilities				
	Pipeline 96 (Hwy 96 Water Pipeline)	SECWCD Utility Maps	11/2009	unknown
	Pipeline 96 Accessories (Hwy 96 Water Pipeline)	SECWCD Utility Maps	11/2009	unknown
	URS Utilities	URS Corporation	10/20/2009	03/15/2002

File Geodatabase:	AVC_CDOT_Images.gdb	Image Catalog		
Imagery Set	Feature	Source	Date Acquired	Date Published by Source
CIRS	CDOT US50 CIRs	CDOT (URS US50 Project)	10/2009	1/1/2002
SIDS	CDOT US50 SIDs East	CDOT (Wilson & Co. US50 Project)	10/2009	1/1/2002
SIDS	CDOT US50 SIDs West	CDOT (Wilson & Co. US50 Project)	10/2009	1/1/2002

File Geodatabase:	AVC_Images.gdb	Image Catalog		
Imagery Set	Feature	Source	Date Acquired	Date Published by Source
NED DEM	National Elevation Dataset	USGS	10/2009	02/01/2009
USGS	USGS 24k Quad Maps	Department of the Interior, USGS	2006	2006
NLCD	National Land Cover Data	Multi-Resolution Land Characteristics (MRLC) Consortium	3/12/2010	2001
USGS 100k	USGS 100k Topo Quad Index	USGS	10/2009	1992
USGS 250k	USGS 250k Topo Quad Index	USGS	10/2009	1992

File Geodatabase:	AVC_Images_05NAIP.gdb	Image Catalog		
Imagery Set	Feature	Source	Date Acquired	Date Published by Source
NAIP 2005 Images	National Agriculture Imagery Program	USGS, National Map Seamless Server	10/2009	2008

The dynamic data features have changed significantly since the STAG Report, the action alternatives have been redefined, several significant alignment modifications and additions of features representing proposed locations for WTPs, taps and delivery points, pump regulation tanks, pumping plants and air chambers were added within the geodatabase.

An inclusive list of the dynamic geospatial data acquired, developed or modified by Reclamation is as follows (Note that features in blue font were acquired or created by Reclamation and features in green font were provided by the Farnsworth Group but significantly modified by Reclamation, these data should be considered as the most current representation of the proposed alternatives and their associated facilities):

File Geodatabase:	AVC_ALTS_4_25_11.gdb	Features acquired, developed or modified by the BOR during appraisal		
Feature Set	Feature	Source	Date Acquired	Date Published by Source
ALT_FEATURES				
	AIR_CHAMBERS	U. S. Bureau of Reclamation	8\2010	4\2011
	ALT_BUFFERS	U. S. Bureau of Reclamation	8\2010	4\2011
	ALT_RTS_BOR	U. S. Bureau of Reclamation	8\2010	4\2011
	PP_SURGE_REG_TANK	U. S. Bureau of Reclamation	8\2010	4\2011
	PUMPING_PLANTS	U. S. Bureau of Reclamation	8\2010	4\2011
	STORAGE_TANKS	U. S. Bureau of Reclamation	8\2010	4\2011
	TIE_IN_POINTS	U. S. Bureau of Reclamation	8\2010	4\2011
	WTP	U. S. Bureau of Reclamation	8\2010	4\2011
ALT_INTERSECTS				
	RAILROAD_INT	U. S. Bureau of Reclamation	1/2011	1/2011
	RIVER_INT	U. S. Bureau of Reclamation	1/2011	1/2011
	ROAD_INT	U. S. Bureau of Reclamation	1/2011	1/2011

File Geodatabase:	BOR_Images.gdb	Image Catalog		
Imagery Set	Feature	Source	Date Acquired	Date Published by Source
DEM_MOSAIC_FT	10M NED DEM Mosaic	USGS	11/2010	2/1/2009
NAIP_TC	2009 True Color Orthophoto	U.S. Department of Agriculture	10/2010	2009
NAIP_CIR	2009 CIR Orthophoto	U.S. Department of Agriculture	10/2010	2009

DATA DICTIONARY

The geo-spatial base map products described in this section represent the most current appraisal level design effort GIS products that can be acquired from Reclamation's Remote Sensing and Geographic Information Team, Denver CO. This data dictionary is intended to be used as an information and navigation tool for AVC data created or modified by Reclamation as of April 2011. Fully compliant FGDC metadata and geodetic control results can be found within the database. The nomenclature of "N_" is utilized to demote the new alternatives as redefined from those in the STAG report.

1) File Name: AVC_ALTS_4_25_11.gdb
   Description: File Geodatabase and Feature Dataset containing several feature classes representing the routes and features associated with the AVC appraisal level design effort.
   Area of coverage: Pueblo Reservoir to Lamar
   Format: File Geodatabase / Feature Dataset

   Feature Dataset: **ALT_FEATURES**, This dataset contains structural feature components located along the Conduit route for each Alternative. The components included are: tie-in points, Alternative routes, corridor buffer zones, water treatment plant sites, pumping plant sites, storage tank sites, pump regulating tank sites, and air chamber sites.

   Feature Dataset: **ALT_INTERSECTS –** The following intersect analysis was conducted to determine the number of railroad, roadway, and river/stream crossings were present in each of the action alternative routes. The initial results were verified by visually examining the identified points on the image and determining whether the reported crossing was incidental or justified.

2) File Name: BOR_IMAGES.gdb
   Description: File Geodatabase containing raster catalogs of U.S. Geological digital elevation models (DEMs) and U.S. Department of Agriculture National Agriculture Imagery Program (NAIP) orthophotography
   Area of coverage: Pueblo to Lamar
   Format: File Geodatabase / Raster Catalog

   Raster Catalog (unmanaged):
   a) DEM_MOSAIC_FT = mosaic of 10 meter DEM data covering the AVC study area

      Significant Entity & Attribute Fields:

      Value = elevation in feet
      Directory containing DEM = USGS_10M_DEM

   b) NAIP_CIR = series of 2009 1m resolution color infrared NAIP orthophotography covering the AVC study area, tiles are 3.75 X 3.75 minutes on a side

Significant Entity & Attribute Fields:

Name = name of individual frame
Directory containing individual images = 2009_NAIP\NAIP_CIR

c) NAIP_TC = series of 2009 1m resolution true color NAIP orthophotography covering the AVC study area, tiles are defined by county boundaries

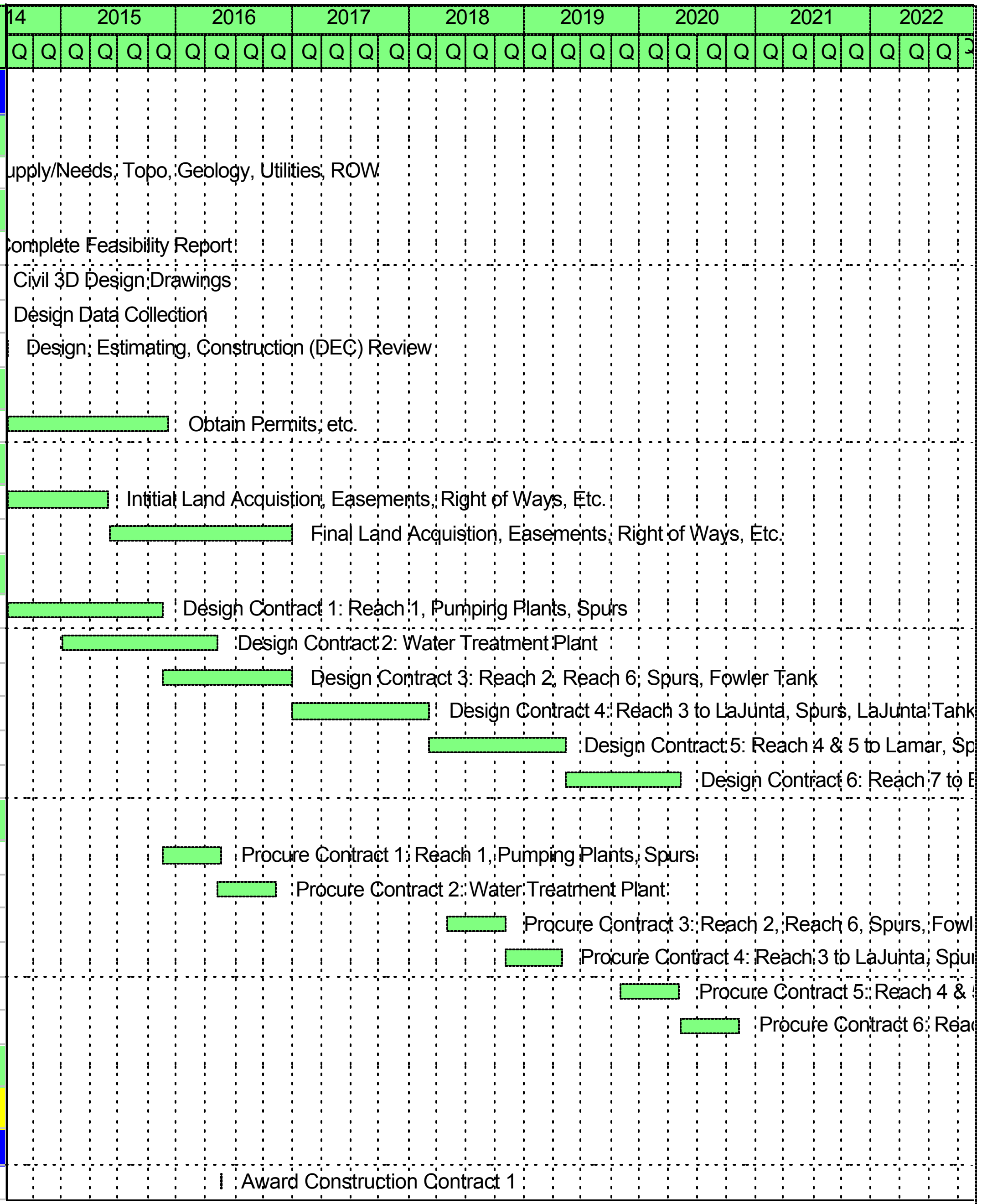
Significant Entity & Attribute Fields:

Name = name of individual frame
Directory containing individual images = 2009_NAIP\NAIP_TRUE_COLOR

Appendix K

Construction Schedule

Activity ID	Activity Name	Duration	Start	Finish
	Arkansas Valley Conduit - Appraisal Study	2511	01-Oct-12	16-May-22
	Design Data Collection	129	01-Oct-12	28-Mar-13
100	Data - Water Supply/Needs, Topo, Geology, Utilities, ROW	120	01-Oct-12	28-Mar-13
	Feasibility Design	467	01-Oct-12	15-Jul-14
160	Complete Feasibility Report	377	01-Oct-12	11-Apr-14
140	Prepare Civil 3D Design Drawings	174	01-Feb-13	10-Oct-13
120	Continue Design Data Collection	120	29-Mar-13	18-Sep-13
180	Design, Estimating, Construction (DEC) Review	65	14-Apr-14	15-Jul-14
	Permitting	363	16-Jul-14	04-Dec-15
200	Obtain Permits, etc.	350	16-Jul-14	04-Dec-15
	Land Acquisition	642	16-Jul-14	29-Dec-16
300	Intitial Land Acquistion, Easements, Right of Ways, Etc.	220	16-Jul-14	01-Jun-15
320	Final Land Acquistion, Easements, Right of Ways, Etc.	400	02-Jun-15	29-Dec-16
	Final Design	1518	16-Jul-14	08-May-20
410	Design Contract 1: Reach 1, Pumping Plants, Spurs	340	16-Jul-14	19-Nov-15
420	Design Contract 2: Water Treatment Plant	340	09-Jan-15	11-May-16
430	Design Contract 3: Reach 2, Reach 6, Spurs, Fowler Tank	280	20-Nov-15	29-Dec-16
440	Design Contract 4: Reach 3 to LaJunta, Spurs, LaJunta Tank	300	30-Dec-16	08-Mar-18
450	Design Contract 5: Reach 4 & 5 to Lamar, Spurs	300	09-Mar-18	14-May-19
460	Design Contract 6: Reach 7 to Eads, Booster Plant, Spurs	250	15-May-19	08-May-20
	Procurement	1298	20-Nov-15	10-Nov-20
510	Procure Contract 1: Reach 1, Pumping Plants, Spurs	128	20-Nov-15	23-May-16
520	Procure Contract 2: Water Treatment Plant	128	12-May-16	11-Nov-16
530	Procure Contract 3: Reach 2, Reach 6, Spurs, Fowler Tank	128	03-May-18*	02-Nov-18
540	Procure Contract 4: Reach 3 to LaJunta, Spurs, LaJunta Tank	128	01-Nov-18	03-May-19
550	Procure Contract 5: Reach 4 & 5 to Lamar, Spurs	128	05-Nov-19	06-May-20
560	Procure Contract 6: Reach 7 to Eads, Booster Plant, Spurs	128	11-May-20	10-Nov-20
	Construction	1560	24-May-16	16-May-22
	Contract 1: Reach 1, Pumping Plants, Spurs	771	24-May-16	07-May-19
	Award, Submittals, Materials, Mobilize	157	24-May-16	28-Dec-16
1100	Award Construction Contract 1	1	24-May-16	24-May-16



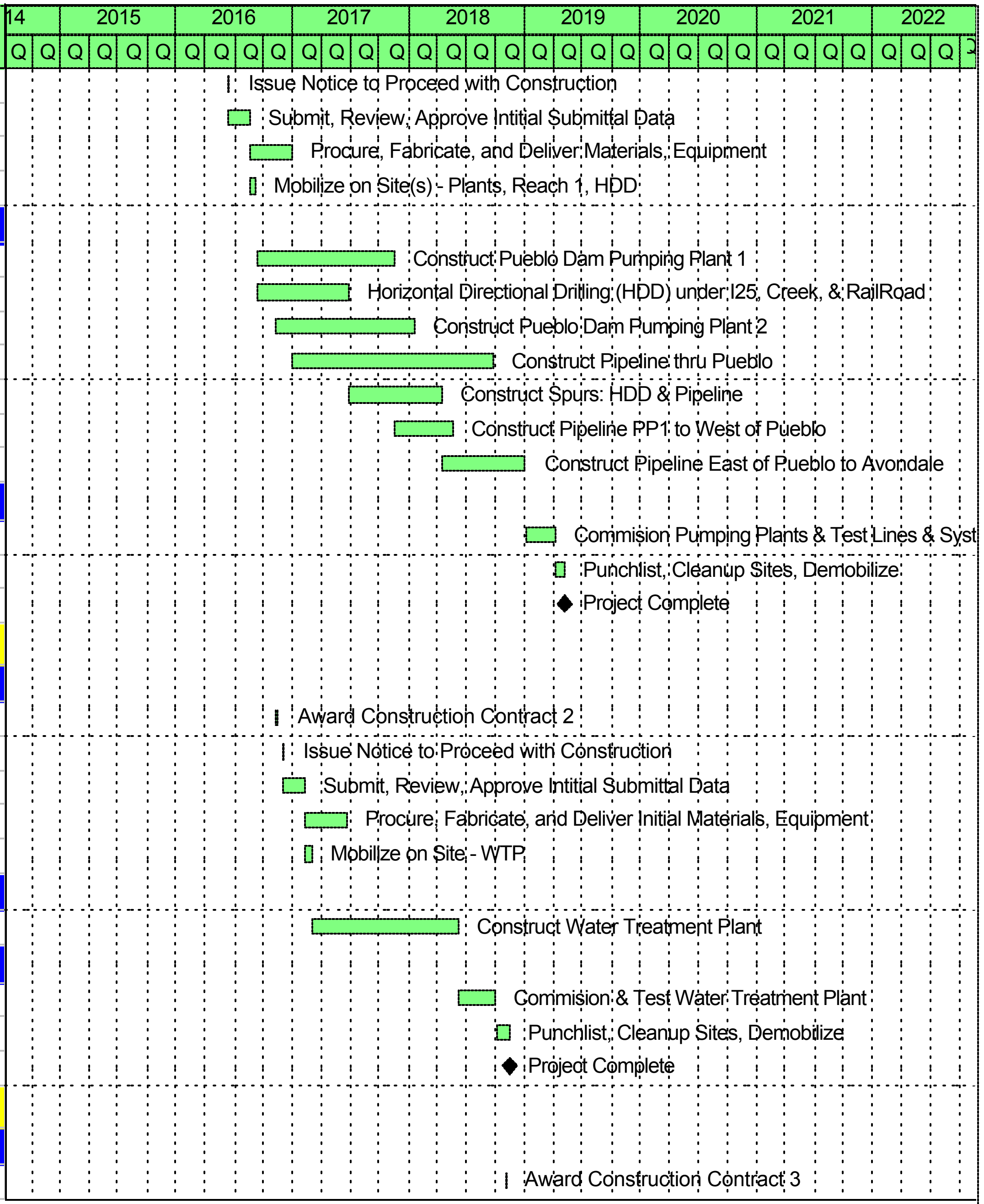
🟦	Actual Work
🟩	Remaining Work
🟥	Critical Remaining Work
◆ ◆	Milestone

Arkansas Valley Conduit

Planning and Construction Schedule - Alternative 4

May 16, 2011

Activity ID	Activity Name	Duration	Start	Finish
1120	Issue Notice to Proceed with Construction	1	15-Jun-16	15-Jun-16
1140	Submit, Review, Approve Intitial Submittal Data	45	16-Jun-16	18-Aug-16
1160	Procure, Fabricate, and Deliver Materials, Equipment	90	19-Aug-16	28-Dec-16
1180	Mobilize on Site(s) - Plants, Reach 1, HDD	15	19-Aug-16	09-Sep-16
	Construction	605	12-Sep-16	04-Jan-19
1200	Construct Pueblo Dam Pumping Plant 1	300	12-Sep-16	16-Nov-17
1280	Horizontal Directional Drilling (HDD) under I25, Creek, & RailRoad	200	12-Sep-16	26-Jun-17
1220	Construct Pueblo Dam Pumping Plant 2	300	14-Nov-16	22-Jan-18
1260	Construct Pipeline thru Pueblo	440	29-Dec-16	24-Sep-18
1320	Construct Spurs: HDD & Pipeline	200	27-Jun-17	11-Apr-18
1240	Construct Pipeline PP1 to West of Pueblo	128	17-Nov-17	21-May-18
1300	Construct Pipeline East of Pueblo to Avondale	185	12-Apr-18	04-Jan-19
	Commission, Test, Demobilize, Project Complete	87	07-Jan-19	07-May-19
1800	Commision Pumping Plants & Test Lines & Systems	66	07-Jan-19	09-Apr-19
1820	Punchlist, Cleanup Sites, Demobilize	20	10-Apr-19	07-May-19
1840	Project Complete	0		07-May-19
	Contract 2: Water Treatment Plant	522	14-Nov-16	13-Nov-18
	Award, Submittals, Materials, Mobilize	156	14-Nov-16	19-Jun-17
2100	Award Construction Contract 2	1	14-Nov-16	14-Nov-16
2120	Issue Notice to Proceed with Construction	1	06-Dec-16	06-Dec-16
2140	Submit, Review, Approve Intitial Submittal Data	45	07-Dec-16	09-Feb-17
2160	Procure, Fabricate, and Deliver Initial Materials, Equipment	90	10-Feb-17	19-Jun-17
2200	Mobilize on Site - WTP	15	10-Feb-17	03-Mar-17
	Construction	329	06-Mar-17	07-Jun-18
2220	Construct Water Treatment Plant	320	06-Mar-17	07-Jun-18
	Commission, Test, Demobilize, Project Complete	113	08-Jun-18	13-Nov-18
2300	Commision & Test Water Treatment Plant	80	08-Jun-18	01-Oct-18
2320	Punchlist, Cleanup Sites, Demobilize	30	02-Oct-18	13-Nov-18
2340	Project Complete	0		13-Nov-18
	Contract 3: Reach 2, Reach 6, Fowler Tank	424	05-Nov-18	18-Jun-20
	Award, Submittals, Materials, Mobilize	187	05-Nov-18	23-Jul-19
3100	Award Construction Contract 3	1	05-Nov-18	05-Nov-18



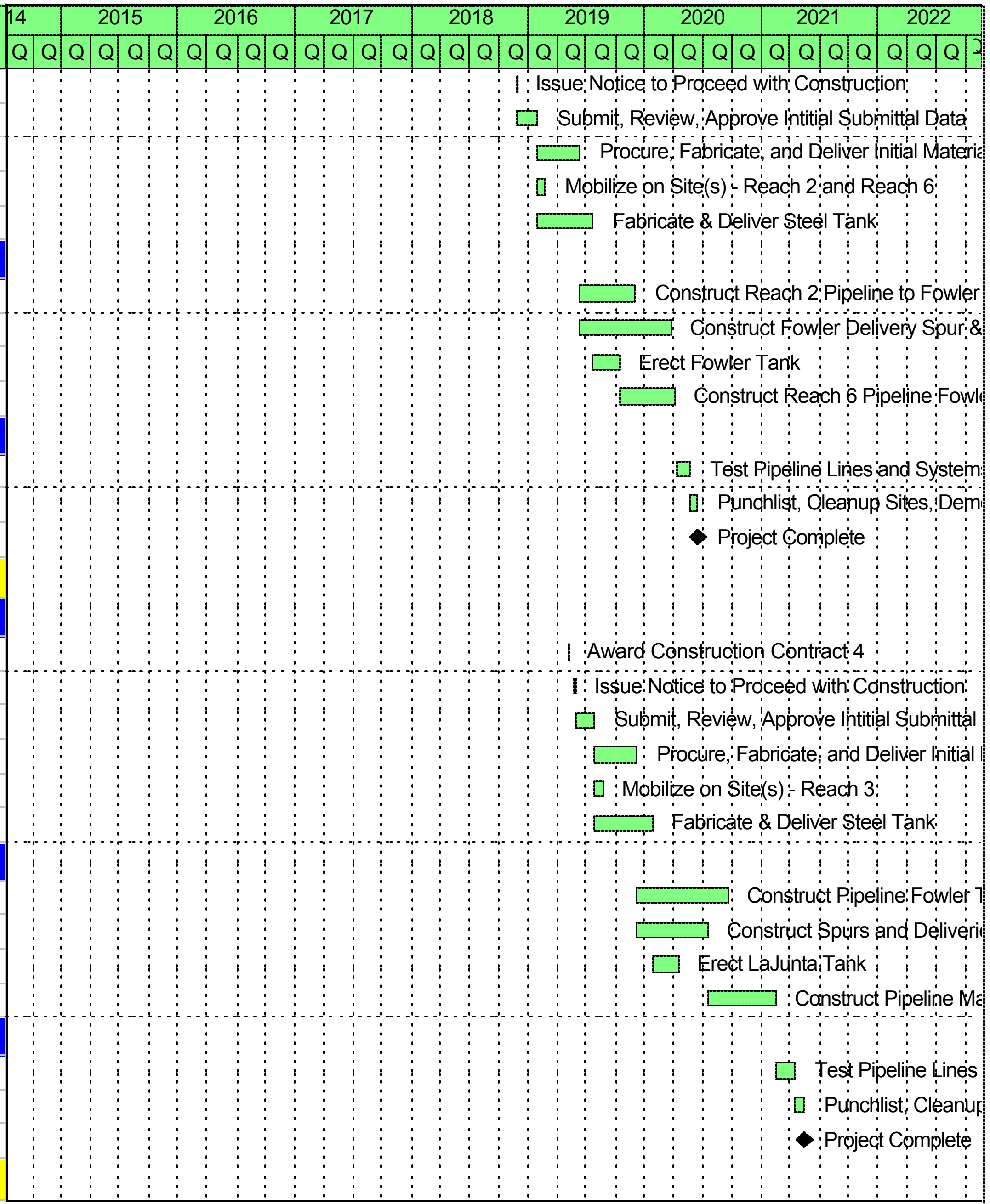
🟦 Actual Work ◆ ◆ Milestone
🟩 Remaining Work
🟥 Critical Remaining Work

Arkansas Valley Conduit

Planning and Construction Schedule - Alternative 4

May 16, 2011

Activity ID	Activity Name	Duration	Start	Finish
3120	Issue Notice to Proceed with Construction	1	27-Nov-18	27-Nov-18
3140	Submit, Review, Approve Intitial Submittal Data	45	28-Nov-18	31-Jan-19
3180	Procure, Fabricate, and Deliver Initial Materials, Equipment	90	01-Feb-19	10-Jun-19
3200	Mobilize on Site(s) - Reach 2 and Reach 6	15	01-Feb-19	22-Feb-19
3220	Fabricate & Deliver Steel Tank	120	01-Feb-19	23-Jul-19
	Construction	217	11-Jun-19	08-Apr-20
3300	Construct Reach 2 Pipeline to Fowler Tank	120	11-Jun-19	29-Nov-19
3340	Construct Fowler Delivery Spur & HDD Crossing	200	11-Jun-19	25-Mar-20
3360	Erect Fowler Tank	60	24-Jul-19	17-Oct-19
3320	Construct Reach 6 Pipeline Fowler Tank to Sugar City	120	18-Oct-19	08-Apr-20
	Commission, Test, Demobilize, Project Complete	51	09-Apr-20	18-Jun-20
3380	Test Pipeline Lines and Systems	30	09-Apr-20	20-May-20
3400	Punchlist, Cleanup Sites, Demobilize	20	21-May-20	18-Jun-20
3420	Project Complete	0		18-Jun-20
	Contract 4: Reach 3 to LaJunta, LaJunta Tank	530	06-May-19	14-May-21
	Award, Submittals, Materials, Mobilize	188	06-May-19	22-Jan-20
4100	Award Construction Contract 4	1	06-May-19	06-May-19
4120	Issue Notice to Proceed with Construction	1	28-May-19	28-May-19
4140	Submit, Review, Approve Intitial Submittal Data	45	29-May-19	31-Jul-19
4160	Procure, Fabricate, and Deliver Initial Materials, Equipment	90	01-Aug-19	09-Dec-19
4180	Mobilize on Site(s) - Reach 3	15	01-Aug-19	21-Aug-19
4200	Fabricate & Deliver Steel Tank	120	01-Aug-19	22-Jan-20
	Construction	310	10-Dec-19	15-Feb-21
4240	Construct Pipeline Fowler Tank to LaJunta Tank	200	10-Dec-19	22-Sep-20
4260	Construct Spurs and Deliveries	150	10-Dec-19	13-Jul-20
4300	Erect LaJunta Tank	60	23-Jan-20	16-Apr-20
4280	Construct Pipeline Manzanola to LaJunta & Spurs	150	14-Jul-20	15-Feb-21
	Commission, Test, Demobilize, Project Complete	64	16-Feb-21	14-May-21
4400	Test Pipeline Lines and Systems	44	16-Feb-21	16-Apr-21
4420	Punchlist, Cleanup Sites, Demobilize	20	19-Apr-21	14-May-21
4440	Project Complete	0		14-May-21
	Contract 5: Reach 4 & 5 to Lamar	522	07-May-20	06-May-22



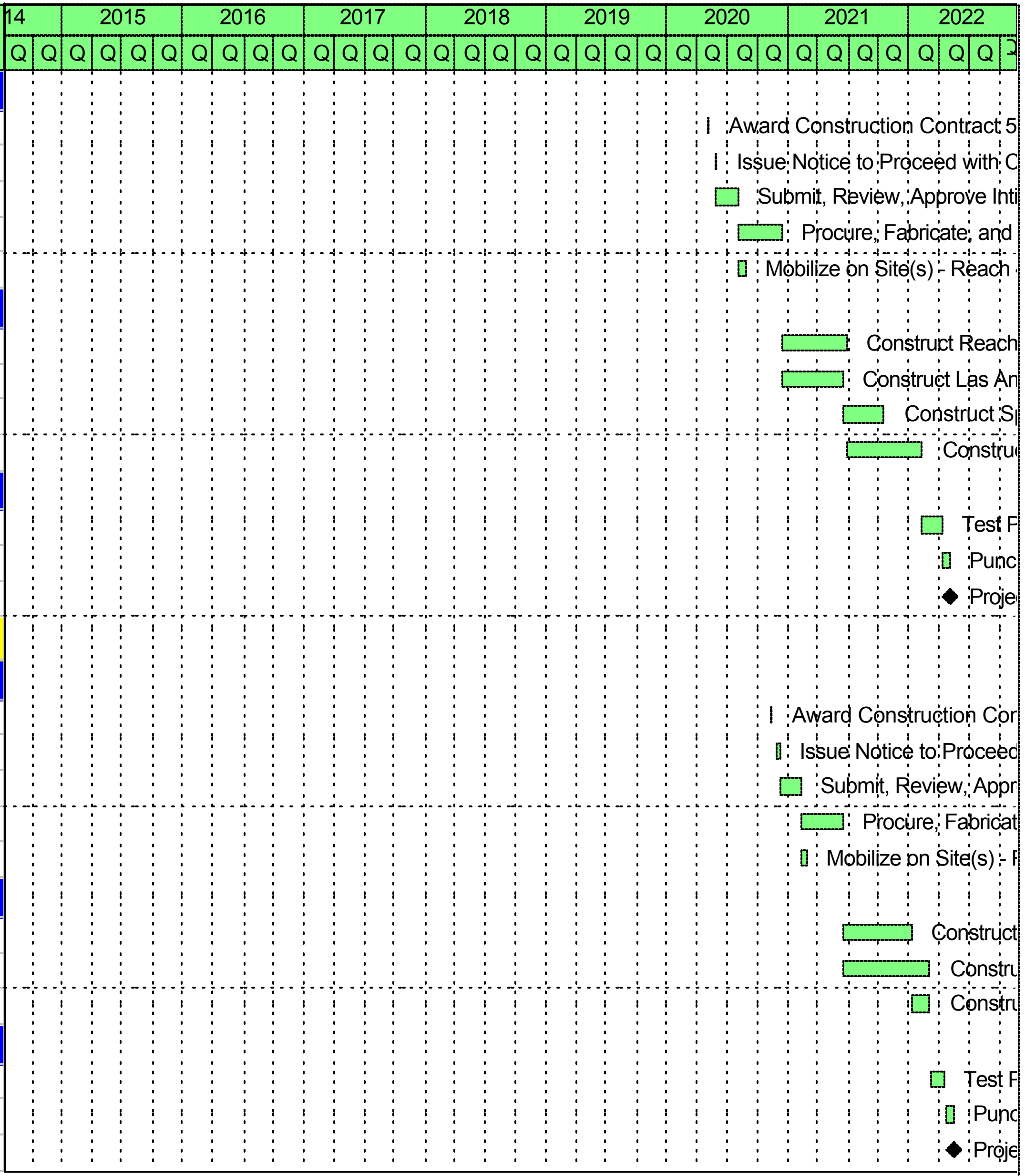
🟦	Actual Work	◆	◆ Milestone
🟩	Remaining Work		
🟥	Critical Remaining Work		

Arkansas Valley Conduit

Planning and Construction Schedule - Alternative 4

May 16, 2011

Activity ID	Activity Name	Duration	Start	Finish
Award, Submittals, Materials, Mobilize		156	07-May-20	10-Dec-20
5100	Award Construction Contract 5	1	07-May-20	07-May-20
5120	Issue Notice to Proceed with Construction	1	29-May-20	29-May-20
5140	Submit, Review, Approve Intitial Submittal Data	45	01-Jun-20	03-Aug-20
5160	Procure, Fabricate, and Deliver Initial Materials, Equipment	90	04-Aug-20	10-Dec-20
5180	Mobilize on Site(s) - Reach 4 and 5	15	04-Aug-20	24-Aug-20
Construction		302	11-Dec-20	07-Feb-22
5200	Construct Reach 4 Pipeline LaJunta to Las Animas	140	11-Dec-20	28-Jun-21
5240	Construct Las Animas Delivery (HDD)	130	11-Dec-20	14-Jun-21
5260	Construct Spurs	90	15-Jun-21	18-Oct-21
5220	Construct Reach 5 Las Animas to Lamar	160	29-Jun-21	07-Feb-22
Commission, Test, Demobilize, Project Complete		64	08-Feb-22	06-May-22
5300	Test Pipeline Lines and Systems	44	08-Feb-22	08-Apr-22
5320	Punchlist, Cleanup Sites, Demobilize	20	11-Apr-22	06-May-22
5340	Project Complete	0		06-May-22
Contract 6: Reach 7 to Eads, Booster Plant, Spurs		394	11-Nov-20	16-May-22
Award, Submittals, Materials, Mobilize		154	11-Nov-20	14-Jun-21
6100	Award Construction Contract 6	1	11-Nov-20	11-Nov-20
6120	Issue Notice to Proceed with Construction	1	03-Dec-20	03-Dec-20
6140	Submit, Review, Approve Intitial Submittal Data	45	04-Dec-20	08-Feb-21
6160	Procure, Fabricate, and Deliver Initial Materials, Equipment	90	09-Feb-21	14-Jun-21
6180	Mobilize on Site(s) - Reach 7	15	09-Feb-21	01-Mar-21
Construction		190	15-Jun-21	07-Mar-22
6200	Construct Reach 7 Pipeline North to Eads	150	15-Jun-21	10-Jan-22
6220	Construct Booster Pumping Plant	190	15-Jun-21	07-Mar-22
6240	Construct May Valley Delivery	40	11-Jan-22	07-Mar-22
Commission, Test, Demobilize, Project Complete		50	08-Mar-22	16-May-22
6300	Test Plant, Pipelines and Systems	30	08-Mar-22	18-Apr-22
6320	Punchlist, Cleanup Sites, Demobilize	20	19-Apr-22	16-May-22
6340	Project Complete	0		16-May-22



🟦 Actual Work ◆ ◆ Milestone

🟩 Remaining Work

🟥 Critical Remaining Work

Arkansas Valley Conduit

Planning and Construction Schedule - Alternative 4

May 16, 2011

Appendix L

Geology

ALTERNATIVE GEOLOGIC INTERSECT

Soil and Rock Group	Geologic Symbol	Alt. #1 Alignment Feet	Alt. #2 Alignment Feet	Alt. #3 Alignment Feet	Alt. #4 Alignment Feet	Alt. #5 Alignment Feet
ALLUVIAL SOIL	Qa, Qg, Qgo	614,395	640,293	654,365	655,621	588,141
EOLIAN SOIL	Qe	123,587	123,587	141,829	141,829	131,000
CLAY SOIL	Not Identified	Not Identified	Not Identified	Not Identified	Not Identified	Not Identified
ROCK UNITS	Kp, Kcg, Kdp, Kn	502,395	450,938	444,754	465,280	422,231
Total distance (ft)	---	1,240,377	1,214,818	1,240,948	1,262,730	1,141,372

Geology Surface Map Key

Quaternary-age
Qa - QUATERNARY MODERN ALLUVIUM
Qg - QUATERNARY GRAVELS AND ALLUVIUM
Qgo - QUATERNARY OLDER GRAVELS and ALLUVIUM
Qe - QUATERNARY EOLIAN DEPOSITS

Cretaceous-age
Kf - FOX HILLS SANDSTONE
Kp - CRETACEOUS PIERRE SHALE
- Kpu - Upper Unit
- Kpm - Middle Unit, shale with numerous sandstone interbeds
- Kpl - Lower Unit, organic rich shale and numerous bentonite beds

Kn - CRETACEOUS NIOBRARA FORMATION
Kcg - CRETACEOUS CARLILE SHALE, GREENHORN LIMESTONE, and GRANEROS SHALE
Kdp - CRETACEOUS DAKOTA SANDSTONE

Jurassic-age
Jmre - MORRISON, RALSTON CREEK, and ENTRADA FORMAITONS

Digital geologic base map = U.S.G.S. National Scale Geologic Map, original source Colorado 1:500,000 Series.

GEOLOGIC SURFACE MAP - AVC ALTERNATIVE #1

COMANCHE SOUTH

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

Bureau of Reclamation
Remote Sensing and Geographic
Information Team
Denver Co, 80225

ALTERNATIVE GEOLOGIC INTERSECT

Soil and Rock Group	Geologic Symbol	Alt. #1 Alignment Feet	Alt. #2 Alignment Feet	Alt. #3 Alignment Feet	Alt. #4 Alignment Feet	Alt. #5 Alignment Feet
ALLUVIAL SOIL	Qa, Qg, Qgo	614,395	640,293	654,365	655,621	588,141
EOLIAN SOIL	Qe	123,587	123,587	141,829	141,829	131,000
CLAY SOIL	Not Identified	Not Identified	Not Identified	Not Identified	Not Identified	Not Identified
ROCK UNITS	Kp, Kcg, Kdp, Kn	502,395	450,938	444,754	465,280	422,231
Total distance (ft)	---	1,240,377	1,214,818	1,240,948	1,262,730	1,141,372

Geology Surface Map Key

Quaternary-age
Qa - QUATERNARY MODERN ALLUVIUM
Qg - QUATERNARY GRAVELS AND ALLUVIUM
Qgo - QUATERNARY OLDER GRAVELS and ALLUVIUM
Qe - QUATERNARY EOLIAN DEPOSITS

Cretaceous-age
Kf - FOX HILLS SANDSTONE
Kp - CRETACEOUS PIERRE SHALE
- Kpu - Upper Unit
- Kpm - Middle Unit, shale with numerous sandstone interbeds
- Kpl - Lower Unit, organic rich shale and numerous bentonite beds

Kn - CRETACEOUS NIOBRARA FORMATION
Kcg - CRETACEOUS CARLILE SHALE, GREENHORN LIMESTONE, and GRANEROS SHALE
Kdp - CRETACEOUS DAKOTA SANDSTONE

Jurassic-age
Jmre - MORRISON, RALSTON CREEK, and ENTRADA FORMAITONS

Digital geologic base map = U.S.G.S. National Scale Geologic Map, original source Colorado 1:500,000 Series.

GEOLOGIC SURFACE MAP - AVC ALTERNATIVE #2

PUEBLO DAM SOUTH

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

Legend

- ● TAP & DELIVERY POINTS
- ◐ ALT2_EADS_AC
- ● ALT2_STORAGE_TANKS
- ⬢ ALT2_WTP
- ↔ ALTERNATIVE #2
- ☐ Counties

N
W E
S

0 25,000 50,000 100,000 150,000 200,000 Feet

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Information Team
Denver Co, 80225

ALTERNATIVE GEOLOGIC INTERSECT

Soil and Rock Group	Geologic Symbol	Alt. #1 Alignment Feet	Alt. #2 Alignment Feet	Alt. #3 Alignment Feet	Alt. #4 Alignment Feet	Alt. #5 Alignment Feet
ALLUVIAL SOIL	Qa, Qg, Qgo	614,395	640,293	654,365	655,621	588,141
EOLIAN SOIL	Qe	123,587	123,587	141,829	141,829	131,000
CLAY SOIL	Not Identified	Not Identified	Not Identified	Not Identified	Not Identified	Not Identified
ROCK UNITS	Kp, Kcg, Kdp, Kn	502,395	450,938	444,754	465,280	422,231
Total distance (ft)	---	1,240,377	1,214,818	1,240,948	1,262,730	1,141,372

Geology Surface Map Key

Quaternary-age
Qa - QUATERNARY MODERN ALLUVIUM
Qg - QUATERNARY GRAVELS AND ALLUVIUM
Qgo - QUATERNARY OLDER GRAVELS and ALLUVIUM
Qe - QUATERNARY EOLIAN DEPOSITS

Cretaceous-age
Kf - FOX HILLS SANDSTONE
Kp - CRETACEOUS PIERRE SHALE
- Kpu - Upper Unit
- Kpm - Middle Unit, shale with numerous sandstone interbeds
- Kpl - Lower Unit, organic rich shale and numerous bentonite beds

Kn - CRETACEOUS NIOBRARA FORMATION
Kcg - CRETACEOUS CARLILE SHALE, GREENHORN LIMESTONE, and GRANEROS SHALE
Kdp - CRETACEOUS DAKOTA SANDSTONE

Jurassic-age
Jmre - MORRISON, RALSTON CREEK, and ENTRADA FORMAITONS

Digital geologic base map = U.S.G.S. National Scale Geologic Map, original source Colorado 1:500,000 Series.

Legend

● TAP & DELIVERY POINTS
● ALT3_WHITLOCK_EADS_AC
● ALT3_WHITLOCK_PP
● ALT3_REG_TANK
● ALT3_STORAGE_TANKS
● ALT3_WTP
⟷ ALTERNATIVE #3
☐ Counties

GEOLOGIC SURFACE MAP - AVC ALTERNATIVE #3

JUP NORTH

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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Remote Sensing and Geographic Information Team
Denver Co, 80225

0 25,000 50,000 100,000 150,000 200,000 Feet

N W E S

RECLAMATION
Managing Water in the West

ALTERNATIVE GEOLOGIC INTERSECT

Soil and Rock Group	Geologic Symbol	Alt. #1 Alignment Feet	Alt. #2 Alignment Feet	Alt. #3 Alignment Feet	Alt. #4 Alignment Feet	Alt. #5 Alignment Feet
ALLUVIAL SOIL	Qa, Qg, Qgo	614,395	640,293	654,365	655,621	588,141
EOLIAN SOIL	Qe	123,587	123,587	141,829	141,829	131,000
CLAY SOIL	Not Identified	Not Identified	Not Identified	Not Identified	Not Identified	Not Identified
ROCK UNITS	Kp, Kcg, Kdp, Kn	502,395	450,938	444,754	465,280	422,231
Total distance (ft)	---	1,240,377	1,214,818	1,240,948	1,262,730	1,141,372

Geology Surface Map Key

Quaternary-age
Qa - QUATERNARY MODERN ALLUVIUM
Qg - QUATERNARY GRAVELS AND ALLUVIUM
Qgo - QUATERNARY OLDER GRAVELS and ALLUVIUM
Qe - QUATERNARY EOLIAN DEPOSITS

Cretaceous-age
Kf - FOX HILLS SANDSTONE
Kp - CRETACEOUS PIERRE SHALE
- Kpu - Upper Unit
- Kpm - Middle Unit, shale with numerous sandstone interbeds
- Kpl - Lower Unit, organic rich shale and numerous bentonite beds

Kn - CRETACEOUS NIOBRARA FORMATION
Kcg - CRETACEOUS CARLILE SHALE, GREENHORN LIMESTONE, and GRANEROS SHALE
Kdp - CRETACEOUS DAKOTA SANDSTONE

Jurassic-age
Jmre - MORRISON, RALSTON CREEK, and ENTRADA FORMAITONS

Digital geologic base map = U.S.G.S. National Scale Geologic Map, original source Colorado 1:500,000 Series.

Legend

- ● TAP & DELIVERY POINTS
- ● ALT4_DAM1_WTP_EADS_AC
- ● ALT4_DAM2_PP
- ● ALT4_REG_TANK
- ● ALT4_STORAGE_TANKS
- ● ALT4_WTP
- ⟷ ALTERNATIVE #4
- ☐ Counties

GEOLOGIC SURFACE MAP - AVC ALTERNATIVE #4

PUEBLO DAM NORTH

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

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Denver Co, 80225

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Managing Water in the West

GEOLOGIC SURFACE MAP - AVC ALTERNATIVE #5

RIVER SOUTH / NORTH

These data represent 1 of 5 alternative conduit routes proposed at the appraisal stage for the Arkansas Valley Conduit project. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

ALTERNATIVE GEOLOGIC INTERSECT

Soil and Rock Group	Geologic Symbol	Alt. #1 Alignment Feet	Alt. #2 Alignment Feet	Alt. #3 Alignment Feet	Alt. #4 Alignment Feet	Alt. #5 Alignment Feet
ALLUVIAL SOIL	Qa, Qg, Qgo	614,395	640,293	654,365	655,621	588,141
EOLIAN SOIL	Qe	123,587	123,587	141,829	141,829	131,000
CLAY SOIL	Not Identified	Not Identified	Not Identified	Not Identified	Not Identified	Not Identified
ROCK UNITS	Kp, Kcg, Kdp, Kn	502,395	450,938	444,754	465,280	422,231
Total distance (ft)	---	1,240,377	1,214,818	1,240,948	1,262,730	1,141,372

Geology Surface Map Key

Quaternary-age

Qa - QUATERNARY MODERN ALLUVIUM
Qg - QUATERNARY GRAVELS AND ALLUVIUM
Qgo - QUATERNARY OLDER GRAVELS and ALLUVIUM
Qe - QUATERNARY EOLIAN DEPOSITS

Cretaceous-age

Kf - FOX HILLS SANDSTONE
Kp - CRETACEOUS PIERRE SHALE
- Kpu - Upper Unit
- Kpm - Middle Unit, shale with numerous sandstone interbeds
- Kpl - Lower Unit, organic rich shale and numerous bentonite beds

Kn - CRETACEOUS NIOBRARA FORMATION
Kcg - CRETACEOUS CARLILE SHALE, GREENHORN LIMESTONE, and GRANEROS SHALE
Kdp - CRETACEOUS DAKOTA SANDSTONE

Jurassic-age

Jmre - MORRISON, RALSTON CREEK, and ENTRADA FORMAITONS

Digital geologic base map = U.S.G.S. National Scale Geologic Map, original source Colorado 1:500,000 Series.

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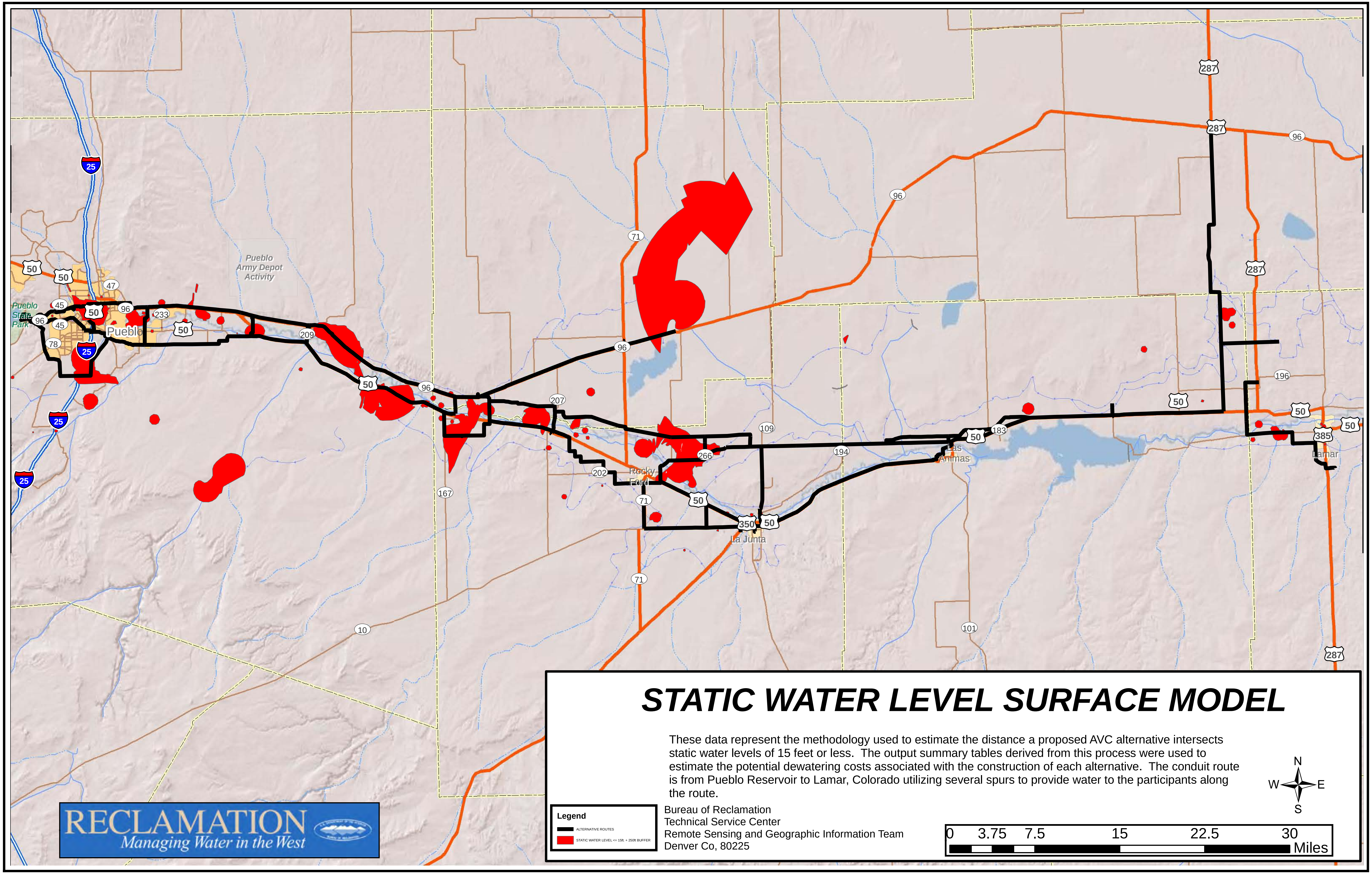
Information Team
Denver Co, 80225



STATIC WATER LEVEL SURFACE MODEL

These data represent the methodology used to estimate the distance a proposed AVC alternative intersects static water levels of 15 feet or less. The output summary tables derived from this process were used to estimate the potential dewatering costs associated with the construction of each alternative. The conduit route is from Pueblo Reservoir to Lamar, Colorado utilizing several spurs to provide water to the participants along the route.

Legend

■	ALTERNATIVE ROUTES
🟥	STATIC WATER LEVEL <= 15ft. + 250ft BUFFER

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Technical Service Center
Remote Sensing and Geographic Information Team
Denver Co, 80225

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Appendix M

Power Costs

Black Hills Energy - CO.

Customer name	Arkansas Valley Conduit			
Customer account	Comanche			
Service voltage	Secondary			
Rate Designation	CO720	$18.93	$0.04827	$54.41
			$0.04676	

Rate Code CO720	**Minimum 50 Kw**
	75% Ratchet kW 1344

	Billing Demand	kWh	PCCA and Demand Charge	Energy Charge w/eca	Customer Charge	Total Bill
JAN	1,792.00	301,800	$33,930	$14,568	$54.41	$48,553
FEB	1,792.00	271,600	$33,930	$13,110	$54.41	$47,095
MAR	1,792.00	332,000	$33,930	$16,026	$54.41	$50,011
APR	1,792.00	482,900	$33,930	$23,122	$54.41	$57,106
MAY	1,792.00	664,000	$33,930	$31,590	$54.41	$65,574
JUN	1,792.00	784,700	$33,930	$37,233	$54.41	$71,218
JUL	1,792.00	875,200	$33,930	$41,465	$54.41	$75,450
AUG	1,792.00	724,300	$33,930	$34,409	$54.41	$68,394
SEP	1,792.00	603,600	$33,930	$28,765	$54.41	$62,750
OCT	1,792.00	452,700	$33,930	$21,709	$54.41	$55,694
NOV	1,792.00	271,600	$33,930	$13,110	$54.41	$47,095
DEC	1,792.00	271,600	$33,930	$13,110	$54.41	$47,095
		6,036,000	$407,165	$288,218	$653	$696,036

KW Peak	**1,792.00**
Annual Load Factor	**38%**

Average cost per kWh **$0.1153**

Does not include taxes, franchise fees or power factor adjustment

Rates effective August 6, 2011 plus 2% RESA, DSM, TCA, PCCA and current ECA

Black Hills Energy - CO.

Customer name	Arkansas Valley Conduit		Rate Code CO720	Minimum 50 Kw	
Customer account	Whitlock			**75% Ratchet kW**	447
Service voltage	**Secondary**				
Rate Designation	CO720	**$18.93**	**$0.04827**	**$54.41**	
			$0.04676		

	Billing Demand	kWh	PCCA and Demand Charge	Energy Charge w/eca	Customer Charge	Total Bill
JAN	596.00	108,500	$11,285	$5,237	$54.41	$16,577
FEB	596.00	97,600	$11,285	$4,711	$54.41	$16,050
MAR	596.00	119,300	$11,285	$5,759	$54.41	$17,098
APR	596.00	173,500	$11,285	$8,293	$54.41	$19,632
MAY	596.00	238,600	$11,285	$11,337	$54.41	$22,676
JUN	596.00	282,000	$11,285	$13,366	$54.41	$24,705
JUL	596.00	314,600	$11,285	$14,890	$54.41	$26,230
AUG	596.00	260,900	$11,285	$12,380	$54.41	$23,719
SEP	596.00	216,900	$11,285	$10,322	$54.41	$21,661
OCT	596.00	162,700	$11,285	$7,788	$54.41	$19,127
NOV	596.00	97,600	$11,285	$4,711	$54.41	$16,050
DEC	596.00	97,600	$11,285	$4,711	$54.41	$16,050
		2,169,800	$135,419	$103,505	$653	$239,577

KW Peak	**596.00**
Annual Load Factor	**42%**

Average cost per kWh	**$0.1104**

Does not include taxes, franchise fees or power factor adjustment

Rates effective August 6, 2011 plus 2% RESA, DSM, TCA, PCCA and current ECA

Black Hills Energy - CO.

Customer name	Arkansas Valley Conduit		Rate Code CO720		**Minimum 50 Kw**
Customer account	Dam1 PP				**75% Ratchet kW** 168
Service voltage	**Secondary**				
Rate Designation	CO720	**$18.93**	**$0.04827**	**$54.41**	
			$0.04676		

	Billing Demand	kWh	PCCA and Demand Charge	Energy Charge w/eca	Customer Charge	Total Bill
JAN	224.00	37,700	$4,241	$1,820	$54.41	$6,116
FEB	224.00	34,000	$4,241	$1,641	$54.41	$5,937
MAR	224.00	41,500	$4,241	$2,003	$54.41	$6,299
APR	224.00	60,400	$4,241	$2,892	$54.41	$7,188
MAY	224.00	83,000	$4,241	$3,949	$54.41	$8,244
JUN	224.00	98,100	$4,241	$4,655	$54.41	$8,950
JUL	224.00	109,400	$4,241	$5,183	$54.41	$9,479
AUG	224.00	90,500	$4,241	$4,299	$54.41	$8,595
SEP	224.00	75,400	$4,241	$3,593	$54.41	$7,889
OCT	224.00	56,600	$4,241	$2,714	$54.41	$7,010
NOV	224.00	34,000	$4,241	$1,641	$54.41	$5,937
DEC	224.00	34,000	$4,241	$1,641	$54.41	$5,937
		754,600	$50,896	$36,032	$653	$87,581

KW Peak	**224.00**
Annual Load Factor	**38%**

Average cost per kWh **$0.1161**

Does not include taxes, franchise fees or power factor adjustment

Rates effective August 6, 2011 plus 2% RESA, DSM, TCA, PCCA and current ECA

Black Hills Energy - CO.

Customer name	Arkansas Valley Conduit		Rate Code CO720		**Minimum 50 Kw**
Customer account	Dam 2 PP				**75% Ratchet kW** 111
Service voltage	**Secondary**				
Rate Designation	CO720	**$18.93**	**$0.04827**	**$54.41**	
			$0.04676		

	Billing Demand	kWh	PCCA and Demand Charge	Energy Charge w/eca	Customer Charge	Total Bill
JAN	148.00	26,900	$2,802	$1,298	$54.41	$4,155
FEB	148.00	24,200	$2,802	$1,168	$54.41	$4,025
MAR	148.00	29,600	$2,802	$1,429	$54.41	$4,286
APR	148.00	43,100	$2,802	$2,060	$54.41	$4,917
MAY	148.00	59,300	$2,802	$2,818	$54.41	$5,674
JUN	148.00	70,000	$2,802	$3,318	$54.41	$6,175
JUL	148.00	78,100	$2,802	$3,697	$54.41	$6,553
AUG	148.00	64,600	$2,802	$3,065	$54.41	$5,922
SEP	148.00	53,900	$2,802	$2,565	$54.41	$5,422
OCT	148.00	40,400	$2,802	$1,934	$54.41	$4,790
NOV	148.00	24,200	$2,802	$1,168	$54.41	$4,025
DEC	148.00	24,200	$2,802	$1,168	$54.41	$4,025
		538,500	$33,627	$25,688	$653	$59,968

KW Peak	**148.00**
Annual Load Factor	**42%**

Average cost per kWh	**$0.1114**

Does not include taxes, franchise fees or power factor adjustment

Rates effective August 6, 2011 plus 2% RESA, DSM, TCA, PCCA and current ECA

Black Hills Energy - CO.

Customer name	Arkansas Valley Conduit	Rate Code CO720	**Minimum 50 Kw**
Customer account	River Intake		**75% Ratchet kW** 561
Service voltage	**Secondary**		

Rate Designation	CO720	**$18.93**	**$0.04827**	**$54.41**
			$0.04676	

	Billing Demand	kWh	PCCA and Demand Charge	Energy Charge w/eca	Customer Charge	Total Bill
JAN	748.00	127,700	$14,163	$6,164	$54.41	$20,381
FEB	748.00	114,900	$14,163	$5,546	$54.41	$19,764
MAR	748.00	140,400	$14,163	$6,777	$54.41	$20,994
APR	748.00	204,300	$14,163	$9,779	$54.41	$23,996
MAY	748.00	280,900	$14,163	$13,361	$54.41	$27,578
JUN	748.00	331,900	$14,163	$15,745	$54.41	$29,963
JUL	748.00	370,200	$14,163	$17,536	$54.41	$31,754
AUG	748.00	306,400	$14,163	$14,553	$54.41	$28,770
SEP	748.00	255,300	$14,163	$12,164	$54.41	$26,381
OCT	748.00	191,500	$14,163	$9,180	$54.41	$23,398
NOV	748.00	114,900	$14,163	$5,546	$54.41	$19,764
DEC	748.00	114,900	$14,163	$5,546	$54.41	$19,764
		2,553,300	$169,955	$121,898	$653	$292,506

KW Peak	**748.00**
Annual Load Factor	**39%**

Average cost per kWh	**$0.1146**

Does not include taxes, franchise fees or power factor adjustment

Rates effective August 6, 2011 plus 2% RESA, DSM, TCA, PCCA and current ECA

Black Hills Energy - CO.

Customer name	Arkansas Valley Conduit		Rate Code CO720	**Minimum 50 Kw**	
Customer account	St Charles			**75% Ratchet kW**	279
Service voltage	**Secondary**				
Rate Designation	CO720	**$18.93**	**$0.04827**	**$54.41**	
			$0.04676		

	Billing Demand	kWh	PCCA and Demand Charge	Energy Charge w/eca	Customer Charge	Total Bill
JAN	372.00	91,300	$7,044	$4,382	$54.41	$11,480
FEB	372.00	82,200	$7,044	$3,956	$54.41	$11,054
MAR	372.00	100,500	$7,044	$4,812	$54.41	$11,910
APR	372.00	146,100	$7,044	$6,944	$54.41	$14,042
MAY	372.00	200,900	$7,044	$9,506	$54.41	$16,604
JUN	372.00	237,500	$7,044	$11,218	$54.41	$18,316
JUL	372.00	264,900	$7,044	$12,499	$54.41	$19,597
AUG	372.00	219,200	$7,044	$10,362	$54.41	$17,460
SEP	372.00	182,700	$7,044	$8,655	$54.41	$15,753
OCT	372.00	82,200	$7,044	$3,956	$54.41	$11,054
NOV	372.00	82,200	$7,044	$3,956	$54.41	$11,054
DEC	372.00	114,900	$7,044	$5,485	$54.41	$12,583
		1,804,600	$84,523	$85,730	$653	$170,906

KW Peak	**372.00**
Annual Load Factor	**55%**

Average cost per kWh	**$0.0947**

Does not include taxes, franchise fees or power factor adjustment

Rates effective August 6, 2011 plus 2% RESA, DSM, TCA, PCCA and current ECA

		Energy Costs Calculation Form - Annual Costs								
		(Ref. - Southeast Colorado Power Assn. - Energy Rates - E-mail from Phil Reynolds dtd. 5/17/11)								
		Eads Booster Plant (Connected motor hp = 20 hp)								
	$/hp									
Access Charge	$2.00					**November thru March**		**April thru October**		
		Month	**Demand (kW)**	**Energy (kWh)**	**Energy Charge**	**1st 100 kwh per kW**	**Remaining kWh**	**Next 150 kWh per kW**	**> 250 kWh**	**Access Charge**
Energy Charge		JAN	15	2,700	$100	1,500	1,200			$40
		FEB	15	2,400	$79	1,500	900			$40
November thru March	**$/kWh**	MAR	15	3,000	$121	1,500	1,500			$40
For the 1st 100 kWh	$0.01168	APR	15	4,300	$249	1,500		2,250	550	$40
For all over 100 kWh	$0.06873	MAY	15	5,900	$349	1,500		2,250	2,150	$40
		JUN	15	7,000	$418	1,500		2,250	3,250	$40
		JUL	15	7,800	$469	1,500		2,250	4,050	$40
April thru October	**$/kWh**	AUG	15	6,500	$387	1,500		2,250	2,750	$40
For the 1st 100 kWh	$0.01288	SEP	15	5,400	$318	1,500		2,250	1,650	$40
For next 150 kWh	$0.08677	OCT	15	4,000	$230	1,500		2,250	250	$40
For all over 250 kWh	$0.06272	NOV	15	2,400	$79	1,500	900			$40
		DEC	15	2,400	$79	1,500	900			$40
				53,800	**$2,880**					**$480**
Total Annual Energy Costs		**$3,360**								
Avg. cost per kWh		$0.0624								
		Eads/May Valley Booster Plant (Connected motor hp = 75 hp)								
	$/hp									
Access Charge	$2.00					**November thru March**		**April thru October**		
		Month	**Demand (kW)**	**Energy (kWh)**	**Energy Charge**	**1st 100 kwh per kW**	**Remaining kWh**	**Next 150 kWh per kW**	**> 250 kWh**	**Access Charge**
Energy Charge		JAN	56	10,200	$382	5,600	4,600			$150
		FEB	56	9,200	$313	5,600	3,600			$150
November thru March	**$/kWh**	MAR	56	11,200	$450	5,600	5,600			$150
For the 1st 100 kWh	$0.01168	APR	56	16,300	$945	5,600		8,400	2,300	$150
For all over 100 kWh	$0.06873	MAY	56	22,400	$1,328	5,600		8,400	8,400	$150
		JUN	56	26,500	$1,585	5,600		8,400	12,500	$150
		JUL	56	29,500	$1,773	5,600		8,400	15,500	$150
April thru October	**$/kWh**	AUG	56	24,400	$1,453	5,600		8,400	10,400	$150
For the 1st 100 kWh	$0.01288	SEP	56	20,400	$1,202	5,600		8,400	6,400	$150
For next 150 kWh	$0.08677	OCT	56	15,300	$883	5,600		8,400	1,300	$150
For all over 250 kWh	$0.06272	NOV	56	9,200	$313	5,600	3,600			$150
		DEC	56	9,200	$313	5,600	3,600			$150
				203,800	**$10,940**					**$1,800**
Total Annual Energy Costs		**$12,740**								
Avg. cost per kWh		$0.0625								

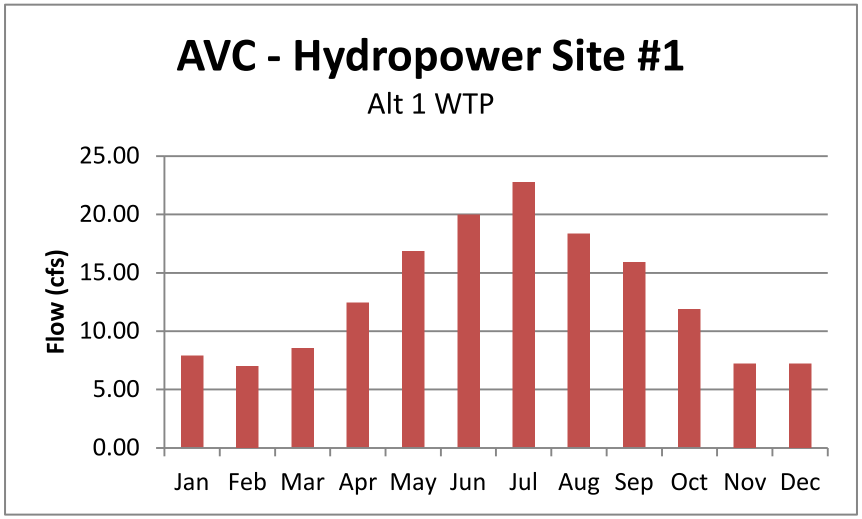
Appendix N

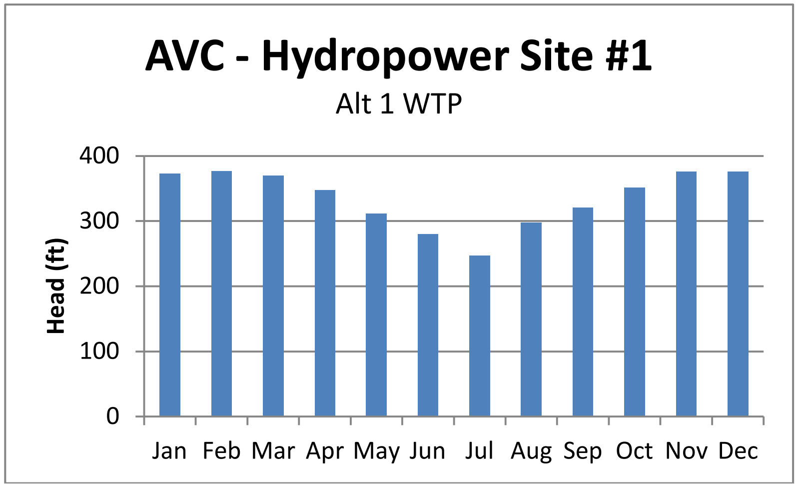
Hydroelectric Generation Potential

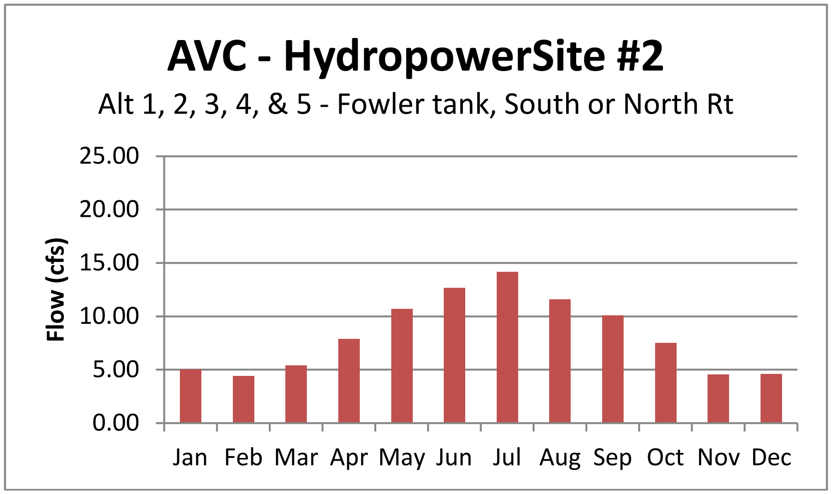
Contents

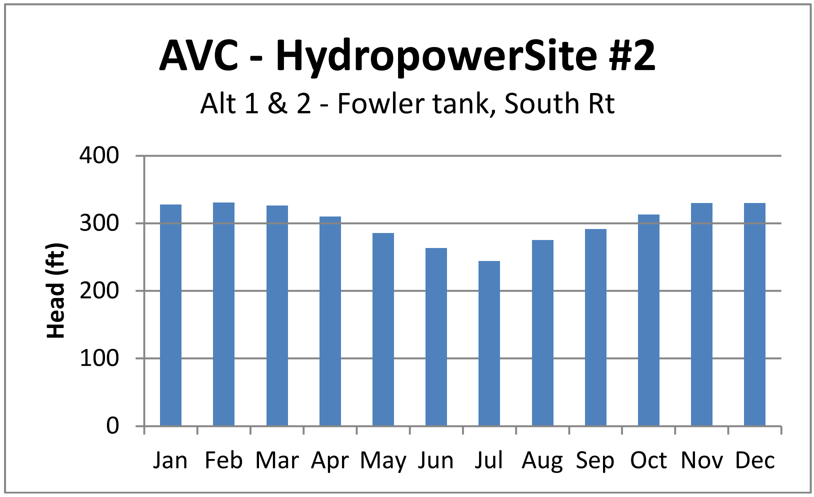
There are opportunities for hydroelectric generation along the AVC could be developed by others. The flow and pipe head available vary throughout the year. As the flow increases with increased demand in the summer, the available head for hydroelectric generation decreases. Tables and plots illustrating typical results for these factors are:

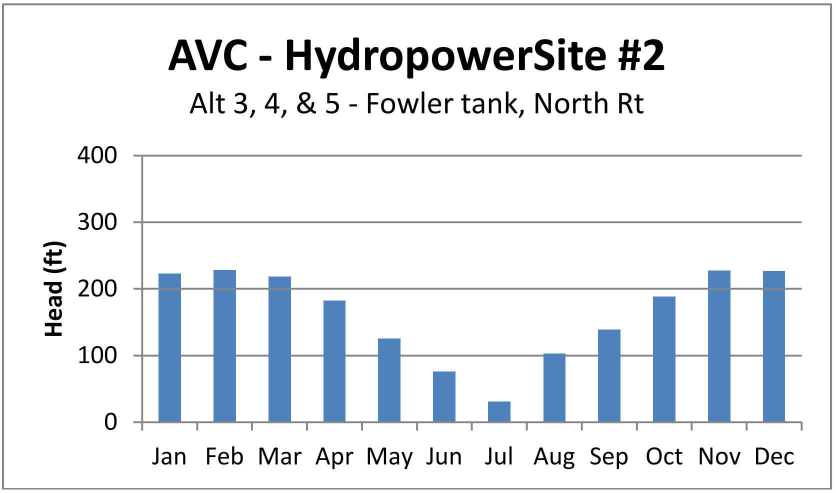
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		**HydroPower Site #1**
7.89	6.98	8.51	12.45	16.85	19.97	22.76	18.34	15.92	11.86	7.20	7.22	cfs	Flow into Alt 1 (Comanche North) WTP
373	377	370	347	312	280	247	297	320	351	376	376	ft	Head for hydrpower Alt 1 WTP
													HydroPower Site #2
5.00	4.43	5.39	7.89	10.68	12.66	14.19	11.62	10.09	7.51	4.56	4.58	cfs	Flow into Fowler tank
328	331	326	310	286	264	244	276	292	313	330	330	ft	Head for hydrpower into Fowler tank, South Rt
223	229	218	182	126	76	31	103	139	189	227	227	ft	Head for hydrpower into Fowler tank, North Rt
													HydroPower Site #3
1.64	1.45	1.76	2.58	3.49	4.14	4.64	3.80	3.30	2.46	1.49	1.50	cfs	Flow into La Junta tank, South Rt
125	127	123	110	89	70	53	80	94	112	127	126	ft	Head for hydrpower into Fowler tank, South Rt
													HydroPower Site #4
3.11	2.75	3.36	4.91	6.65	7.88	8.83	5.92	4.46	2.48	0.91	0.92	cfs	Flow into La Junta tank, North Rt
153	156	150	127	91	59	30	76	99	131	156	155	ft	Head for hydrpower into Fowler tank, North Rt

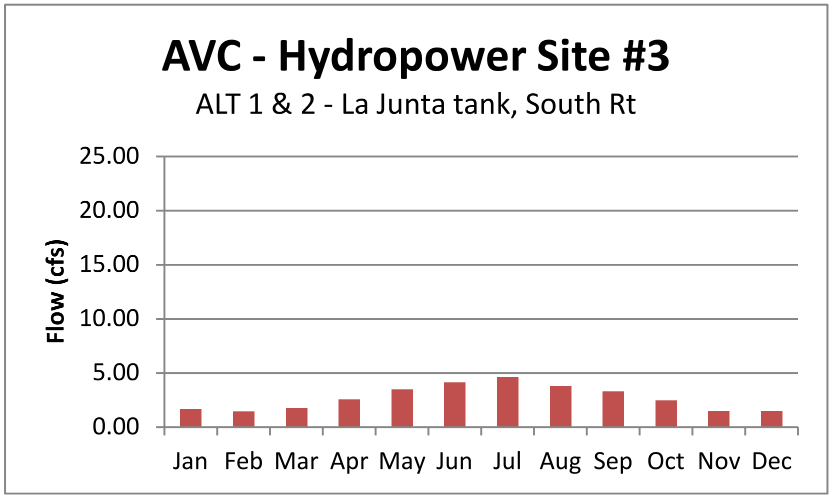




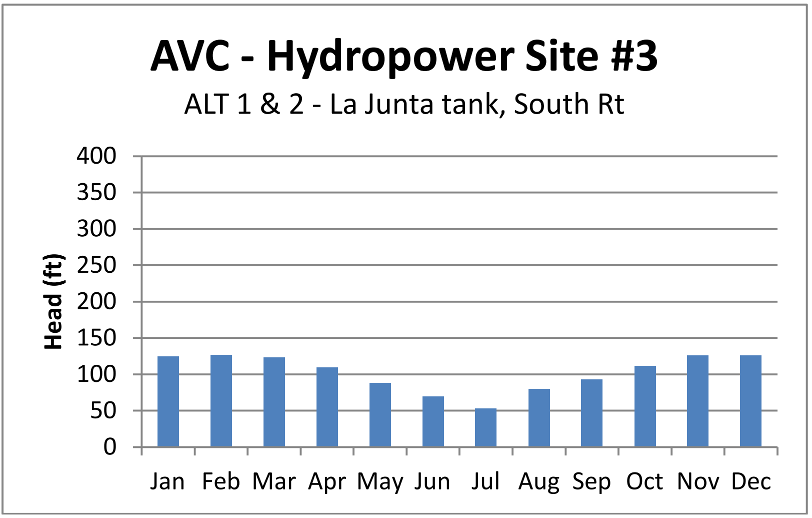

AVC - HydropowerSite #2
Alt 1, 2, 3, 4, & 5 - Fowler tank, South or North Rt
Flow (cfs)
25.00
20.00
15.00
10.00
5.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


AVC - HydropowerSite #2
Alt 1 & 2 - Fowler tank, South Rt
Head (ft)
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

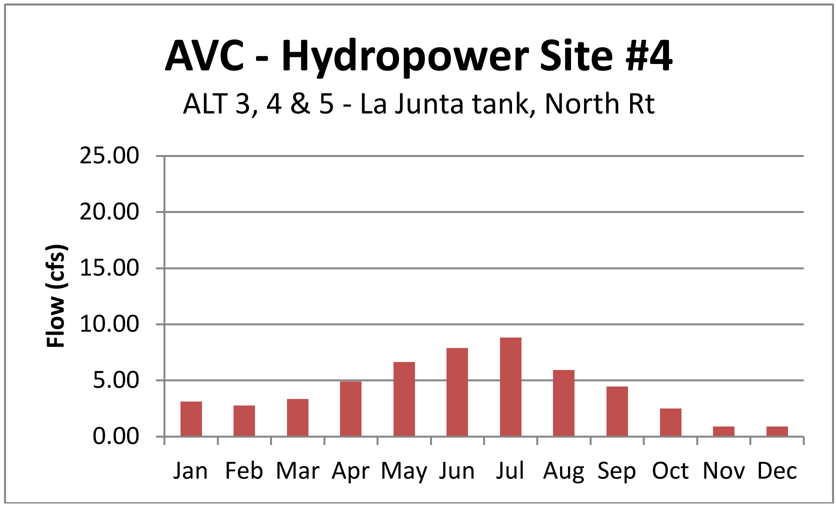

AVC - HydropowerSite #2
Alt 3, 4, & 5 - Fowler tank, North Rt
Head (ft)
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


AVC - Hydropower Site #3

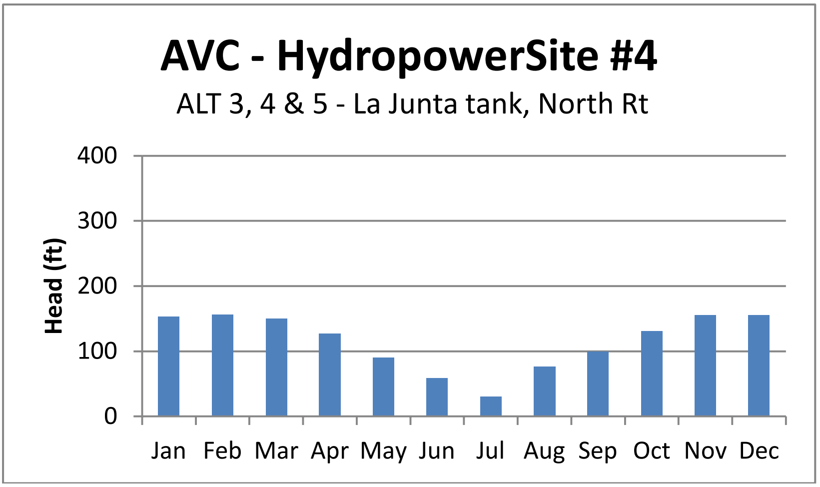
ALT 1 & 2 - La Junta tank, South Rt


AVC - Hydropower Site #3

ALT 1 & 2 - La Junta tank, South Rt


AVC - Hydropower Site #4

ALT 3, 4 & 5 - La Junta tank, North Rt


AVC - HydropowerSite #4

ALT 3, 4 & 5 - La Junta tank, North Rt

Appendix O

Letters

Contents – Appendix O, Letters

BLACK & VEATCH

Southeastern Colorado Water Conservancy District
Arkansas Valley Conduit

Memorandum

To: **Phil Reynolds, SECWCD**

From: **Dan Kugler, B&V**

CC: **Signe Snortland, Reclamation**
Bill Cole, Reclamation
Jerry Gibbens, MWH
Kevin Meador, B&V

Date: **September 13, 2010**

Subject: **Variations of AVC Alignments Identified During NEPA Public Scoping Week and CDOT Cooperating Agency Meeting**

This memorandum summarizes potential AVC alignment variations that were identified during the NEPA public scoping meetings (week of August 16, 2010) and the CDOT cooperating agency meeting (September 1, 2010). These variations were identified from both the site tour and from public input at the meetings.

STAG Report Clarifications

- The STAG report GIS files contain some alignment variations that were not included with a particular alternative; however, these alignments/corridors should still be included in the NEPA work.
- It is important to note that Section 4.12 of the STAG report includes a list of items that should be further clarified during the NEPA process and preliminary design.

Alignment Variations Through Pueblo

- Northeast side of Pueblo – 4th, 8th, and 12th streets should be avoided by the Conduit as these are the most heavily traveled streets.
- See the attached PDF for additional routes (in pink) that should be considered.

WTP Sites

- See the attached PDF for potential additional locations of water treatment plant sites (shown in yellow boxes).

Alignment Variations East Pueblo

- Between Fowler and Manzanola, see the attached PDF for an additional corridor south of Highway 50.

- Between Rocky Ford and La Junta, see the attached PDF for an additional corridor that follows Road 19.5 south to Hawley and then Highway 10 east to La Junta.
- Lamar. Consider a straight diagonal alignment from the airport to Lamar's system tie-in (additional alignment).
- Lamar. Add an alignment to parallel Lamar's existing 30 foot easement (for a 24-inch waterline) from the storage tanks to the north side of the golf course.

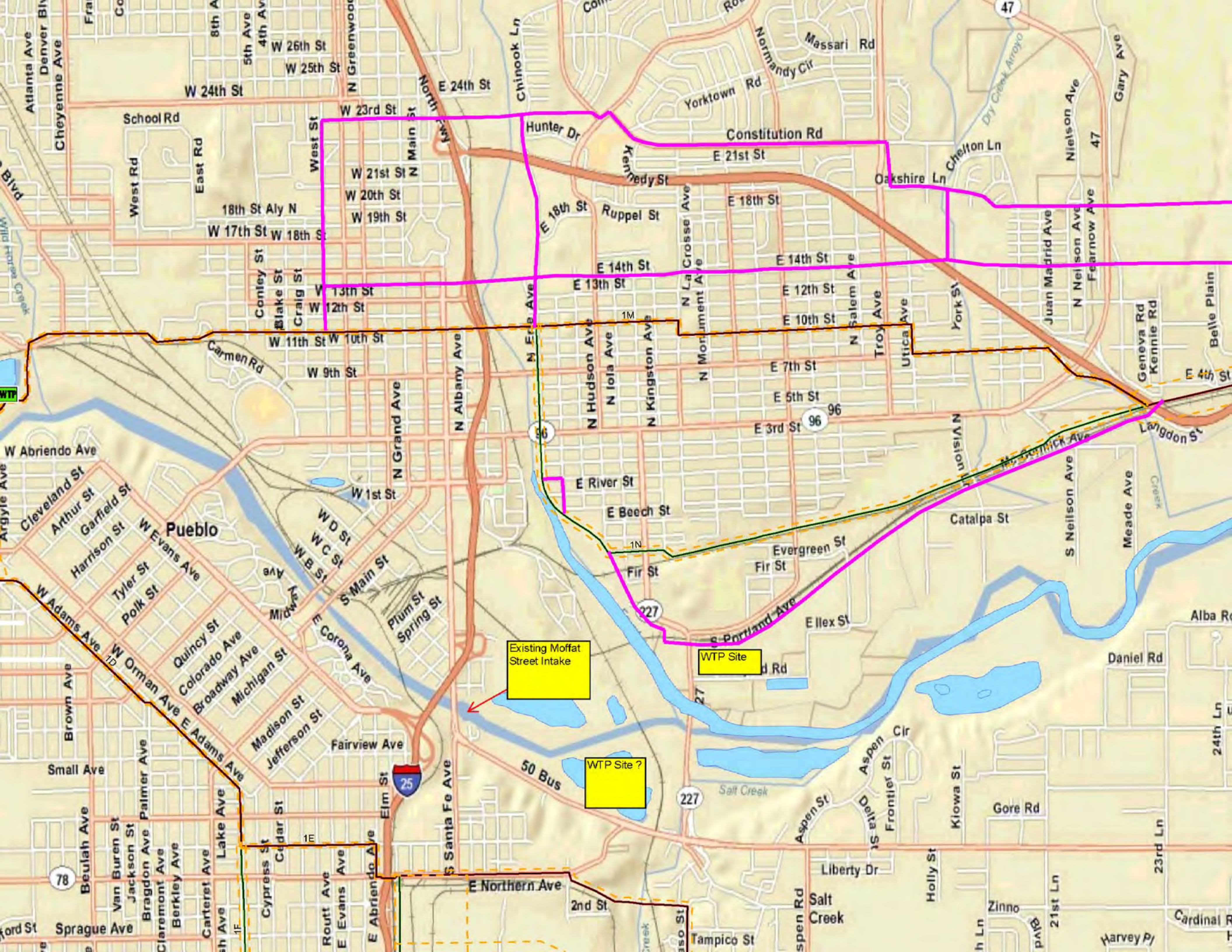
Other

- There may be a National Historic Building at the intersection of Road 33.5 and Highway 50 east of McClave.
- Newdale Grand Valley's system tie-in point is a tank north of Hawley.
- West Grand Valley's system tie-in point is generally southwest of Hawley.
- Connection to BWWP raw water line west of Pueblo Blvd. Further investigation is needed to determine if there is enough hydraulic head to flow by gravity from this location to the Bessemer Ditch alignment without reducing head to Whitlock WTP. If there is not enough head, a pump station will be needed. The Whitlock WTP has sleeve valves at the end of the raw water line from Pueblo Reservoir.
- Lamar has an 18-inch blind flange (with isolation valve) for the Conduit tie-in on the north side of their tanks. Lamar's raw water tanks will be converted to treated water in 2010. Lamar will greatly benefit from putting project water into the Conduit as Lamar currently uses project water to recharge wells northeast of the tanks (putting the project water in the Conduit will eliminate the large transit loss from Pueblo to Lamar).
- Need to contact the railroad about using their property on the north side of Highway 50 between Las Animas and Hasty. The railroad tracks have been removed from this property.
- An alternative for a tank site north of Hawley should be added. The elevation of this tank would be the same as the tank site north of La Junta.

CDOT Cooperating Agency Meeting

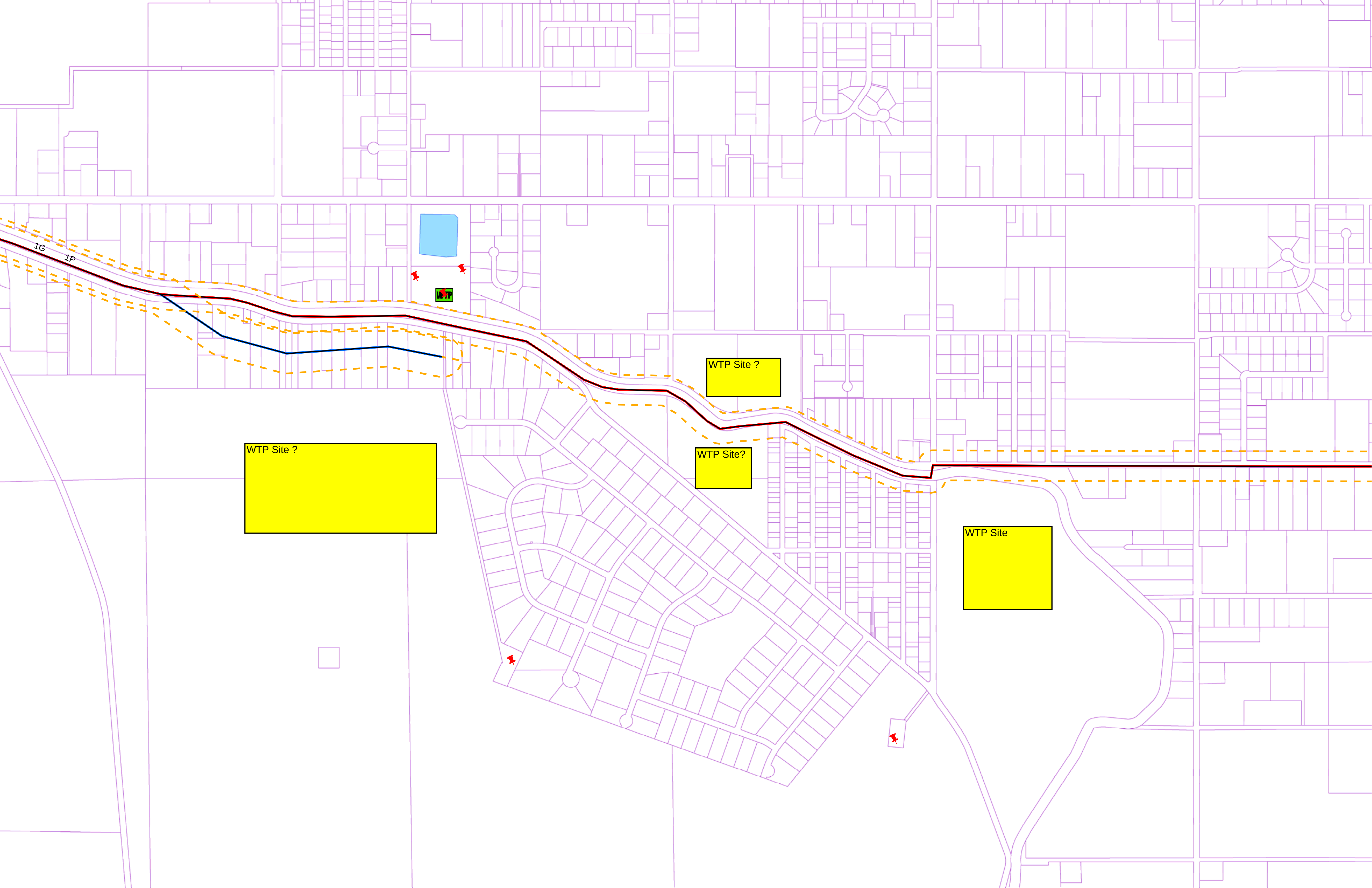
- Between Pueblo and Fowler, CDOT prefers the Conduit follow Highway 96 because CDOT has no plans to expand Hwy 96.
- CDOT generally plans to use its existing 2 lanes and then add two more lanes. Therefore, the Conduit corridor for the NEPA work should extend far enough outside CDOT's existing property to allow the Conduit to be located outside the future property that may be acquired by CDOT for the Hwy 50 expansion.
- CDOT is planning to construct some minor improvements within approximately 1 mile of Hasty (on both sides of Hasty).
- The Conduit should not be located in CDOT's existing property. If the Conduit is located within CDOT's property and in the future the Conduit must be relocated for the Hwy 50 expansion project, the cost to relocate the Conduit would be paid by Reclamation/SECWCD/Participants.

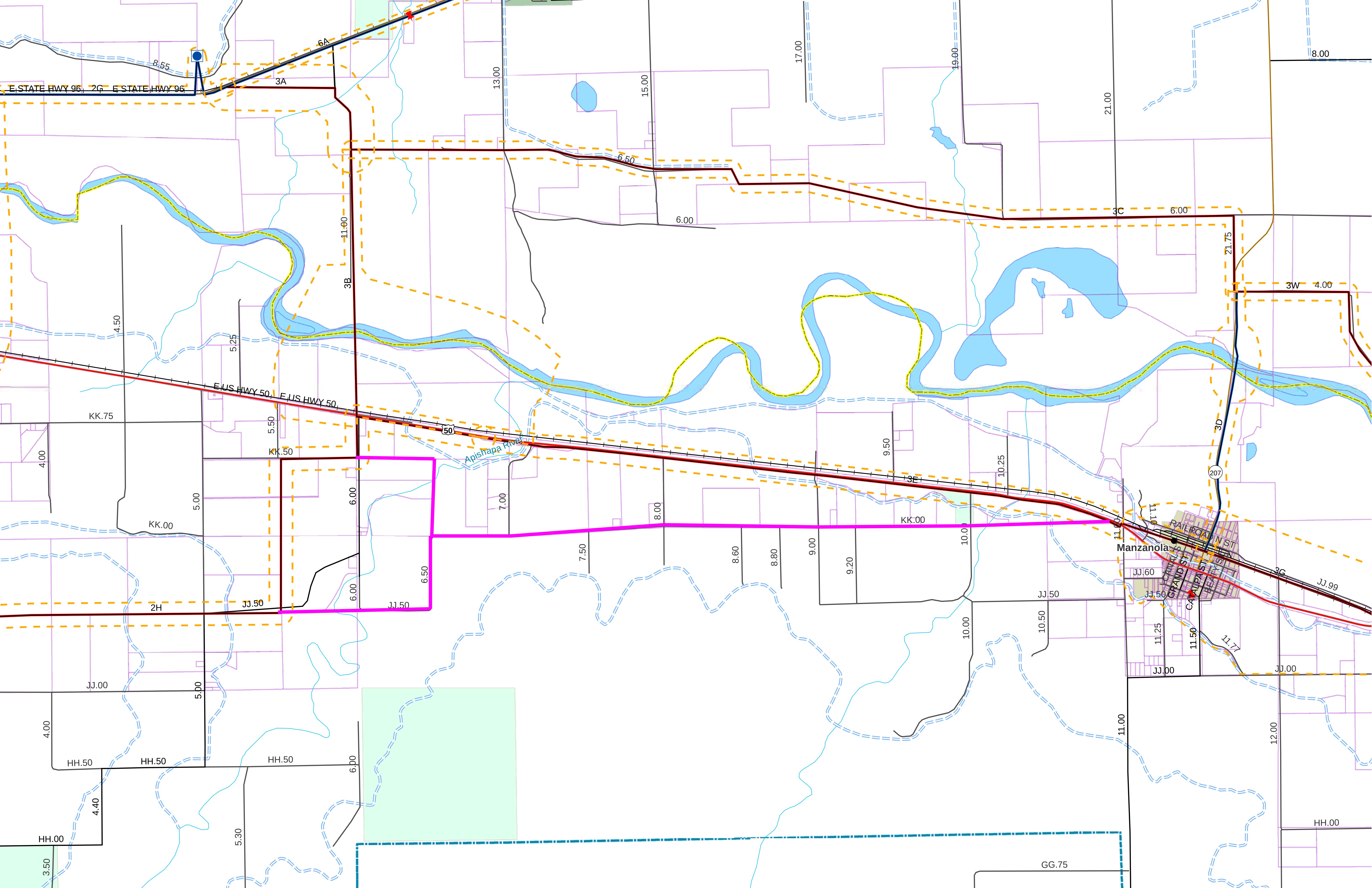
- CDOT’s property/ROW/easement drawings for Highway 50 should be obtained and added to GIS.


Existing Moffat Street Intake

WTP Site

WTP Site ?


1G
1P
WTP
WTP Site ?
WTP Site ?
WTP Site?
WTP Site


E STATE HWY 96
2G
E STATE HWY 96
8.55
6A
3A
13.00
15.00
17.00
19.00
21.00
8.00
11.00
3B
6.50
6.00
3C
6.00
21.75
3W
4.00
4.50
5.25
E US HWY 50
E US HWY 50
50
Apishapa River
KK.75
KK.50
5.50
4.00
5.00
KK.00
6.00
7.00
8.00
9.50
10.25
3E
KK.00
10.00
11.00
11.10
3D
207
Manzanola
RAILROAD ST
GRAND ST
CATALPA ST
BERRY ST
JJ.60
JJ.50
3G
JJ.99
7.50
8.60
8.80
9.00
9.20
6.50
6.00
2H
JJ.50
JJ.50
JJ.50
10.00
10.50
11.25
11.50
11.77
JJ.00
JJ.00
JJ.00
5.00
4.00
HH.50
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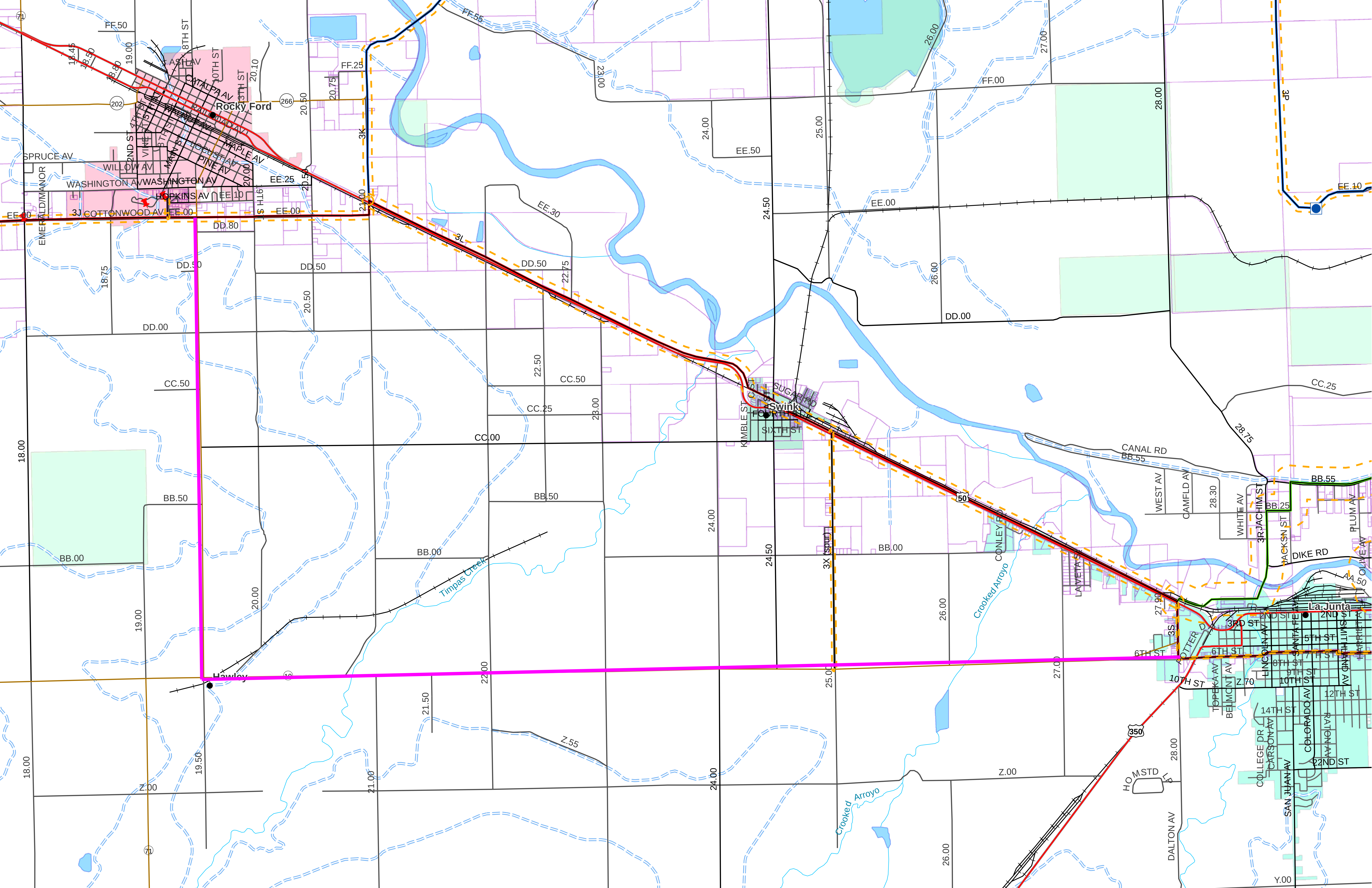
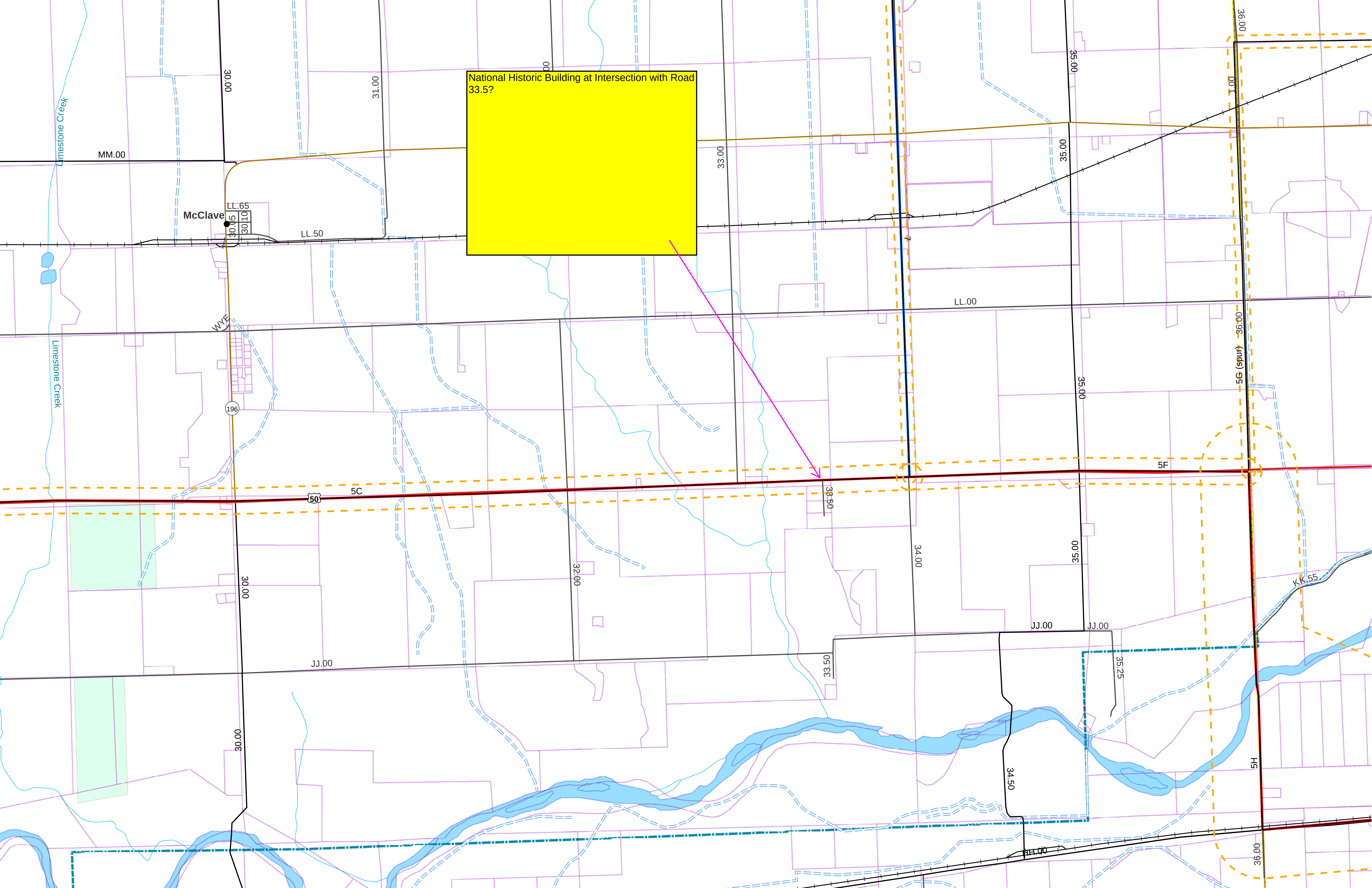
HH.00
5.30
3.50
GG.75



Rocky Ford
Swink
La Junta
Hawley
FF.50
FF.25
FF.55
FF.00
EE.50
EE.25
EE.10
EE.00
EE.30
DD.80
DD.50
DD.00
CC.50
CC.25
CC.00
BB.50
BB.55
BB.25
BB.00
AA.50
Z.00
Z.55
Z.70
Y.00
18.00
18.45
18.50
18.75
18.80
19.00
19.50
20.00
20.10
20.50
20.75
21.00
21.50
22.00
22.50
22.75
23.00
24.00
24.50
25.00
26.00
27.00
27.90
28.00
28.30
28.75
3J
3K
3L
3P
3S
3X (spur)
50
71
202
266
350
ASH AV
CATALPA AV
RAILROAD AV
MAPLE AV
PINE AV
SPRUCE AV
WILLOW AV
WASHINGTON AV
HOPKINS AV
COTTONWOOD AV
EMERALD MANOR
MAIN ST
VINE
2ND ST
8TH ST
10TH ST
13TH ST
9TH S
SUGAR RD
FOURTH ST
SIXTH ST
KIMBLE ST
Timpas Creek
Crooked Arroyo
CONLEY RD
LA VETA
CANAL RD
WEST AV
CAMFLD AV
WHITE AV
3RJACHIM ST
JACKSON ST
DIKE RD
PLUM AV
OLIVE AV
2ND ST
3RD ST
5TH ST
6TH ST
7TH ST
8TH ST
9TH ST
10TH ST
12TH ST
14TH ST
22ND ST
POTTER
LINCOLN AV
SANTA FE AV
SMITHLAND AV
TOPEKA AV
BELMONT AV
COLORADO AV
RATON AV
COLLEGE DR
CARSON AV
SAN JUAN AV
HOMESTD LP
DALTON AV



National Historic Building at Intersection with Road 33.5?

MWH

BUILDING A BETTER WORLD

MEMORANDUM

TO: Reclamation

DATE: November 15, 2010

FROM: MWH

REFERENCE: AVC EIS

SUBJECT: Preliminary Alternatives Analysis

This memorandum presents results of the Preliminary Alternatives Analysis for the Arkansas Valley Conduit (AVC) Environmental Impact Statement (EIS). The purpose of this memorandum is to provide a basis for Reclamation review prior to developing the Draft EIS Chapter 2 text, and to provide Reclamation the alternatives to be developed further in the appraisal level study being performed by the Technical Services Center. All information in this document should be considered Predecisional Draft information, and could be modified as the Draft EIS and Final EIS progress.

The preliminary alternatives analysis generally follows the procedures outlined in the Draft Work Plan (MWH, October 2010), and are summarized below. A more detailed description of the process and screening results will be presented in the Draft EIS and supporting documents.

General Methods

The alternative analysis methods consist of a structured identification and screening process that disseminates a wide range of technical and conceptual options into a set of alternatives that address key issues. This process produces a range of reasonable alternatives that can be effectively evaluated in the EIS process. The following terminology is used in this process:

Components - Discrete activities or facilities (e.g., an intake location) that, when combined with other components, form an alternative.

Option – A conceptual or detailed way of completing a component, or an alternative geographic location for a component, such as alternative methods for diverting water or alternative geographic locations for a water intake. Options generate the differences among alternatives.

Alternative - A complete project that has all the components and associated options necessary to best fulfill the project purpose and need.

Specific components and screening criteria were developed as part of the process. Components were based on the Proposed Action and other alternatives identified in the Pre-NEPA State and Tribal Assistance Grant (STAG) report (Southeastern 2010) and the description of the Master Contract. Criteria for the screening processes were based on previous NEPA work, issues identified during the scoping process, and the expected spatial extent of the project and its effects. Both conceptual and specific options were developed from previous studies, alternatives brought forth during scoping meetings and comment letters, information in the STAG report, the Arkansas

Valley Conduit Value Planning Report (Reclamation 2010), and through brainstorming of the EIS team.

Appendix A presents a summary of the alternatives process, including a schematic of the process (Figure A-1) and results. The first step of the process generally consisted of component development and options development and screening. Six components to the project were identified, including water supply, regulating storage, intake location, conveyance through Pueblo, conveyance east of Pueblo, and water treatment. Then, detailed and conceptual options were developed that could potentially be used to fulfill each of the components (Table A-1). This initial long-list of options was then consolidated to a short list of options using a two-step screening proves that included both significant issues and environmental characteristics screening. The significant issues screening was a pass/fail type of screening used to quickly eliminate those options that could not be used to meet the purpose and need of the project (Tables A-2 and A-3). Then, an environmental screening process assigned technical data that was used to either eliminate or determine which options best met certain criteria (Tables A-4, A-5a, A-5b, A-5c and A-5d). Overall, approximately 170 options were identified for screening, and approximately 40 options passed through the screening process to the table of short-listed options (Table A-6).

The next step of the process was compilation of short-listed options into alternatives. This process consisted of identification of alternative themes, determination of which short-listed options best fulfilled the alternative themes, and development of final alternatives based on alternative themes and options. Alternative themes address a key scoping issue, and were developed based on information from the scoping process and other NEPA projects in the basin. A total of 12 alternative themes were developed (Table 1; Table A-7). Options that best meet each of the alternative themes were then determined using the information developed in the environmental screening process (Table A-8). These alternative themes were then consolidated into the six alternatives identified for further study (Table A-9). Most of the short-listed options were in at least one of the final alternatives. Some short-listed options were determined to be options that needed to be further considered during final design.

Table 1. Major Alternative Themes

Theme Number	Alternative Theme	Description
1	No Action	A No Action Alternative is required by NEPA
2	Minimize Cost	The participants, Reclamation and the public have an interest in evaluating the least cost alternative.
3	Minimize Wetland Acres Disturbed	This NEPA document could serve as the basis for the 404(b)(1) permit. An alternative that minimizes wetlands disturbed should be analyzed.
4	Highest Minimum Flow in the Arkansas River through Pueblo	Several commenters, as well as comments received during previous NEPA activities, have identified maintaining the maximum streamflow through the City of Pueblo.
5	Minimize Farmland Disturbed	Several comments were received requesting that alternatives minimize the amount of farmland disturbed.
6	Minimize Construction Disturbance	Construction disturbances in general can be somewhat indicative of environmental effects.
7	Minimize Urban Construction Disturbance	Construction disturbances through the City of Pueblo, and through other communities is a key scoping issue.
8	Maximize Use of Existing ROW	Several comments were received requesting that alternatives maximize the use of existing ROW, including the Highway 50 expansion corridor.
9	Avoid Highway 50 Expansion Corridor	Initial reaction from CDOT was to minimize the amount of pipeline that could be within the Highway 50 expansion corridor.
10	Maximize Non-Structural Options	Comments were received requesting non-structural solutions.
11	Maximize Source Water Quality and Yield	The overall purpose and need is to provide high-quality water. Some alternatives would provide higher quality than others.
12	Maximize Operational Flexibility	With 41 participants and additional Master Contract participants, operational flexibility is desirable.

Description of Final Alternatives

The final alternatives, including the options included in the final alternatives for each component, are shown in Table 2. In addition, the table provides an information on which of the major alternative theme (as shown in Table 1) each alternative addresses. A summary of each alternative is contained below.

No Action Alternative: Development of the No Action Alternative, which must be considered as part of the NEPA process, was not subject to the screening process related above. Rather, a separate process was used to define the No Action Alternative, and is described in a separate memorandum (MWH, No Action Alternative Development). The AVC participants who are currently meeting Primary Drinking Water Standards would continue their current treatment processes. For the 13 AVC participants who are under enforcement actions from the Colorado Department of Public Health and Environment (CDPHE) and other smaller water providers who expressed an interest, entities would regionalize with larger neighboring water utilities whose systems are in compliance. No Master Contract would be issued, with all participants using existing short-term If and When contracts.[1]

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[1] The No Action Alternative is being developed in a separate memorandum. Descriptions in this memorandum are based on current understanding of the No Action Alternative. This description may require modification based on the outcome of the No Action Alternative memorandum.

Table 2. Alternatives to be Studied in Detail

Name (1)	Regulating Storage	Intake Location	Conveyance - Through Pueblo (2)	Conveyance - East of Pueblo (2)	Treatment	Alternative Theme (2)
No Action	Short-Term If & When Contracts	Wells/Existing River Diversion Points	N/A	N/A	Regional WTPs Individual treatment	1, 10
Comanche - South	Location - Pueblo Reservoir - Excess Capacity	Location - Pueblo Reservoir South Outlet Works	Location - South (Comanche route) Concept - Interconnect	Location - South Route	Location - New WTP downstream from St Charles Mesa Concept - Filtered and disinfected treatment	7, 8, 11
Pueblo Dam - South	Location - Fry-Ark System - Excess Capacity	Location - Pueblo Reservoir South Outlet Works	Location - South (Pueblo Dam, along Bessemer Ditch)	Location - South Route	Location - New WTP located near South Road and 21st Street Concept - Filtered only treatment	3, 8
JUP - North	None	Location - Joint Use Pipeline (JUP) at Pueblo Boulevard	Location - North (JUP Wye, along 11th Street) Concept - Interconnect	Location - North Route	Location - Whitlock WTP (BWWP) Concept - Filtered only treatment	2, 5, 6, 9
Pueblo Dam - North	Location - Fry-Ark System - Excess Capacity	Location - Pueblo Reservoir South Outlet Works	Location - North (Pueblo Dam, JUP route, along 11th Street) Concept - Interconnect	Location - North Route	Location - New WTP located below Pueblo Dam (on BOR property) Concept - Filtered only treatment	9,12
River - South	Location - Pueblo Reservoir - Excess Capacity	Location - Arkansas River upstream of the Fountain Creek confluence	Location - Downstream Intake	Location - South Route	Location - New WTP located adjacent to the existing St. Charles Mesa WTP Concept - Filtered and disinfected treatment	3, 4, 8

Notes:

(1) All Action Alternatives include the following:

Water Supplies

WS-1	Source - Fry-Ark Project Water
WS-2	Source - Fry-Ark Project Return Flows (1939 Decree)
WS-3	Source - Fry-Ark Project Return Flows (01CW151)
WS-4	Concept - Use of Existing Agricultural Water Rights
WS-5	Concept - Use of New Agricultural Water Rights
WS-6	Concept - Rotational Fallowing and Leasing
WS-7	Source - Water Rights specifically for AVC associated with the Super Ditch Project.
WS-14	Concept – Conservation

Water Treatment

WT-3	Concept - Blended supplies

(2) All spurs, connection points, pump stations, operational storage, and any other engineered features required to support these conveyance options are included in these options.

(3) Numbers correspond to Alternative Theme numbers in Table 1.

Comanche – South Alternative: Generally follows southern alignments from Pueblo Dam through the Arkansas Valley. The alternative would divert water from Pueblo Dam, and generally follow the existing Comanche Power Plant pipeline route south of the City of Pueblo, as described in the STAG report. The pipeline would then follow the south alignment east of the City of Pueblo. The alternative would use a new water treatment plant located east of St. Charles Mesa (at an site yet to be identified) to convey filtered and disinfected water to AVC participants. The exception is St. Charles Mesa Water District, which would be conveyed unfiltered and non-disinfected water. This alternative would include Master Contract storage in Pueblo Reservoir excess capacity storage space, and an interconnect between the north and south outlet works at Pueblo Reservoir. This alternative fulfills the "minimize urban construction disturbance", "maximize use of existing right-of-way", and "maximize source water quality and yield" alternative themes.

Pueblo Dam – South Alternative: Generally follows a southern alignment from Pueblo Dam through the Arkansas Valley, but utilizes the Bessemer Ditch alignment through the City of Pueblo. A new water treatment plant would be located near South Road and 21st Street. This alternative would convey filtered water to the participants. The AVC portion of this alternative is identical to STAG Alternative 1. This alternative would include Master Contract storage in Fry-Ark System reservoirs (Pueblo Reservoir, Twin Lakes and Turquoise Reservoir) excess capacity storage space, but would not include an interconnect in order to analyze at least one alternative that diverts water from Pueblo Dam but does not include the interconnect. This alternative fulfills the "minimize wetland acres disturbed" and "maximize use of existing right-of-way" alternative themes.

JUP – North Alternative: Generally uses a northern alignment through and downstream of the City of Pueblo. Water would be diverted from the existing Joint Use Pipeline "wye" immediately west of Pueblo Boulevard. Water would be treated at the existing Whitlock Water Treatment Plant (owned and operated by the Board of Water Works of Pueblo), and delivered through the City of Pueblo in a pipeline route that generally follows 11th Street. The pipeline would then follow the north alignment east of Pueblo. This alternative would convey filtered water to the participants. The AVC portion of this alternative is identical to STAG Alternative 2. This alternative would not include Master Contract storage in order to analyze at least one Action Alternative that does not include Master Contract storage. The alternative would include an interconnect between the north and south outlet works at Pueblo Reservoir. The alternative fulfills the "minimize cost", "minimize farmland disturbed", "minimize construction disturbance", and "avoid Highway 50 expansion corridor" alternative themes.

Pueblo Dam – North Alternative: Generally follows a northern alignment through the Arkansas Valley, but utilizes diversion directly from the south outlet works at Pueblo Dam. Water would be treated at a new water treatment plan on Reclamation property at the dam. Filtered water would be conveyed downstream in a new pipeline constructed along the existing Joint Use Pipeline route from Pueblo Dam to Pueblo Boulevard, and northern pipeline alignments through and downstream of the City of Pueblo. This alternative would include Master Contract storage in Fry-Ark System reservoirs (Pueblo Reservoir, Twin Lakes and Turquoise Reservoir) excess capacity storage space, and an interconnect between the north and south outlet works at Pueblo Reservoir. The alternative fulfills the "avoid Highway 50 expansion corridor" and "maximize operational flexibility" alternative themes.

River – South Alternative: Diverts water from the Arkansas River immediately upstream of the Fountain Creek confluence. The exact location of the diversion is unknown, but would be downstream of the existing Pueblo kayak course, which terminates at approximately Union

Avenue. The pipeline would use the southern alignment east of the City of Pueblo. A new water treatment plant would be located adjacent to the existing St. Charles Mesa water treatment plant, and would provide filtered and disinfected water. The alternative would include Master Contract storage in Pueblo Reservoir excess capacity storage space, but would not include an interconnect because it would not provide redundancy for AVC since releases are made to the river. The alternative fulfills the "minimize wetland acres disturbed", "highest minimum flow in the Arkansas River through Pueblo", and "maximize use of existing right-of-way" alternative themes.

All alternatives include only those water supplies that are being proposed by the AVC and Master Contract participants. Water supplies options were included in the alternatives analysis. Following screening, the short-list of water supplies included only those water supplies being proposed by each entity. Additionally, no major alternative theme directly dealt with alternative water supplies.

Conservation is included as an option to be retained in all action alternatives. Conservation plans are currently being more fully developed individually by several AVC and Master Contract participants. For those participants without conservation plans, Southeastern is developing an AVC conservation plan that addresses conservation activities. Therefore, demand projections being performed as part of the EIS include reductions in per capita water use due to conservation.

Several short-listed options were identified as options that should be considered during the design stage, including running parallel pipes where needed when existing pipelines exist or different levels of water treatment are needed by different participants (i.e. St. Charles Mesa), use of abandoned railroad right-of-way, and individual versus combined spurs. Other options that were not included in the screening analysis, but were included in either the STAG report or Value Planning Study should also be considered during the design process.

The alternatives were developed to fulfill major alternative themes, and to provide the maximum number of options ultimately included in the EIS analyses. It is possible that the Preferred Alternative could be a combination of options from any or all of these alternatives that are identified above. More information on the alternatives development process and a more thorough description of the alternatives studied in detail will be provided in the Draft EIS.

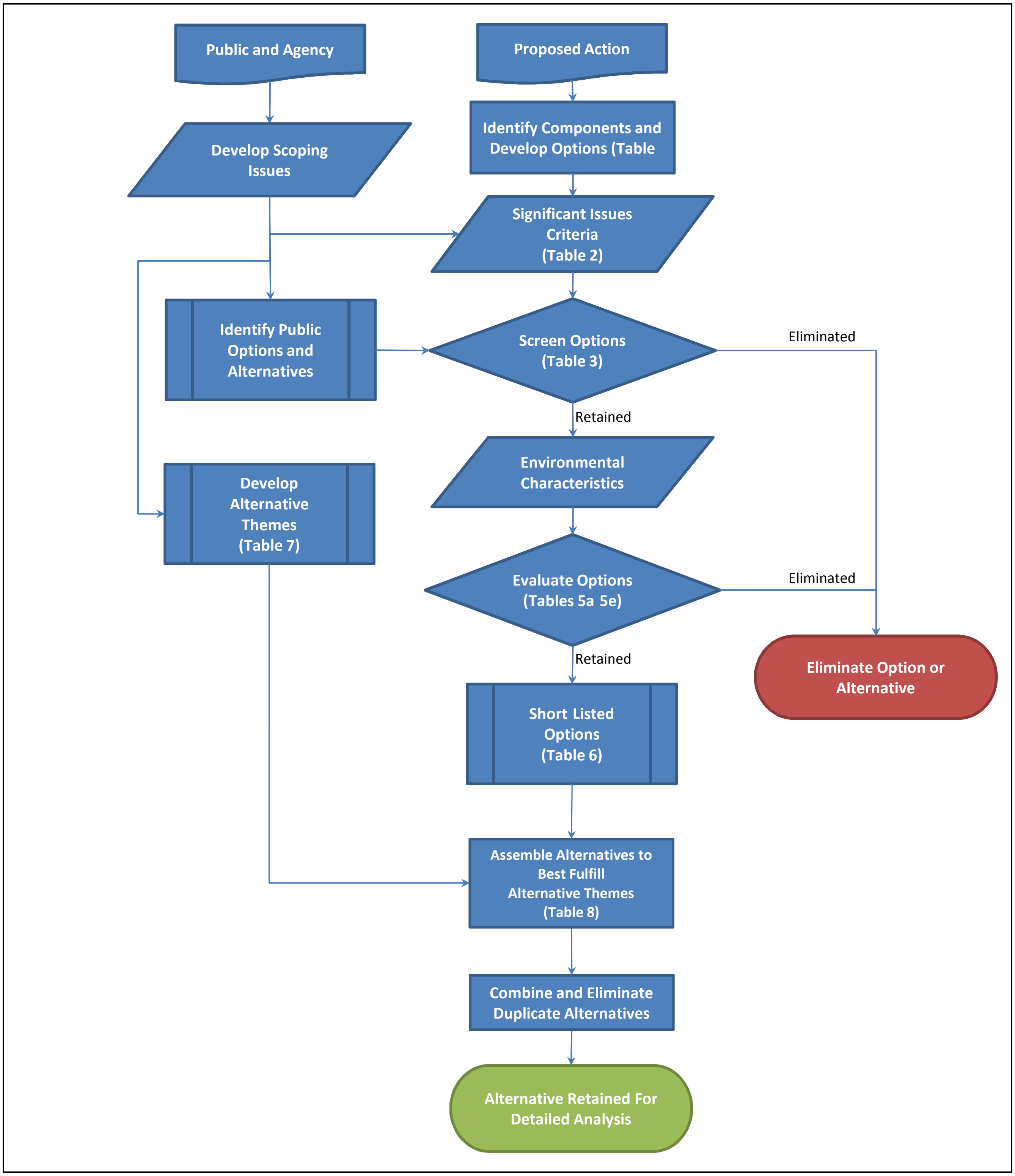
References

Reclamation. 2010a. Value Planning Final Report Arkansas Valley Conduit Project. Conducted in Cooperation with and for Southeastern Colorado Water Conservancy District and Bureau of Reclamation, Great Plains Region. A10-C382-1000-002-00-0-0. May 17.

Southeastern Colorado Water Conservancy District. 2010. Arkansas Valley Conduit Pre-NEPA State and Tribal Assistance Grant (STAG) – STAG Final Report. Prepared by Black & Veatch, et al. B&V Project Number 142542. August.

Appendix A –
Summary of Alternatives Development Process

Figure A-1. Alternatives Screening Flowchart - CURRENT



ID	Description	Source of Option	Description
Water Supply			
WS-1	Source - Fry-Ark Project Water	STAG	Use "East of Pueblo" allocation of Fry-Ark Project yields. Fry-Ark Project water is the primary proposed water source for the AVC as identified in the STAG report.
WS-2	Source - Fry-Ark Project Return Flows (1939 Decree)	STAG	Use return flows generated from uses of Fry-Ark Project water. Measured municipal Fry-Ark Project return flows that are purchased from Southeastern by the entity that generated them can be exchanged under Southeastern's existing 1939 exchange decree. Fry-Ark Project Return flows can be used to extinction.
WS-3	Source - Fry-Ark Project Return Flows (01CW151)	STAG	Use return flows generated from uses of Fry-Ark Project water. Measured municipal Fry-Ark Project return flows that are purchased by other users and unmeasured municipal and agricultural return flows can be exchanged under Southeastern's proposed 01CW151 exchange decree. Southeastern is currently in the process of adjudicating this water right. It is expected that this water right will be decreed prior to completion of the AVC EIS. Fry-Ark Project Return flows can be used to extinction.
WS-4	Concept - Use of Existing Agricultural Water Rights	EIS Team	Use existing transfers of water from agricultural to municipal uses. Several AVC and Master Contract participants have proposed using existing decreed agricultural water rights transfers. These water rights are from a variety of sources upstream and downstream of Pueblo Reservoir, and in the Fountain Creek basin.
WS-5	Concept - Use of New Agricultural Water Rights	EIS Team	Use new transfers of water from agricultural to municipal uses. Several AVC and Master Contract participants are proposing new agricultural water rights transfers. These water supplies are in a variety of states, with some sources just in he process of being identified, and others in the transfer process. These water rights are from a variety of sources upstream and downstream of Pueblo Reservoir, and in the Fountain Creek basin.
WS-6	Concept - Rotational Fallowing and Leasing	EIS Team	Develop new contracts with ditch companies or farms to lease water from farms on a temporary basis. General rotational fallowing and leasing programs have been identified as potential water sources.
WS-7	Source - Water Rights specifically for AVC associated with the Super Ditch Project.	EIS Team	Use water supplies from the proposed Arkansas River Super Ditch, a coordinated rotational fallowing program among several ditches in the lower Arkansas Basin. Several AVC and Master Contract participants have identified water sources associated with the proposed Arkansas Valley Super Ditch.
WS-8	Concept - New Western Slope Project	Previous NEPA	Construct new or expanded diversion projects from Colorado's Western Slope to the Eastern Slope. No specific projects were identified as part of this option. As currently proposed, these projects would only provide supplemental water to the Arkansas River basin, and is not proposed to convey water to Participants.

ID	Description	Source of Option	Description
WS-9	Source - Flaming Gorge Pipeline	Previous NEPA	Construct new diversion and conveyance project from Flaming Gorge Reservoir in southwestern Wyoming to Colorado's Front Range. As currently proposed, this project would only provide supplemental water to the Arkansas River basin, and is not proposed to convey water to Participants.
WS-10	Concept - Canada or Alaska Water Supply Project	Previous NEPA	Construct a new water project to convey water from Canada or Alaska to the Colorado Front Range. Details on this project are unknown.
WS-11	Source - Fort Lyon Ditch/ Great Plains Reservoirs	EIS Team	Purchase and transfer shares of the Fort Lyon Ditch and Great Plains Reservoirs. It is unclear how these water supplies would be conveyed to Pueblo Reservoir. It is likely that without significant infrastructure (i.e. a pipeline and pump stations), substantial supplies would need to be purchased in order to provide a firm supply.
WS-12	Concept - New Groundwater	Public Scoping	Develop new groundwater supplies in tributary alluvial aquifers and non-tributary bedrock aquifers. Aquifer sources available to the AVC Participants are generally the same sources as those currently being used by the Participants.
WS-13	Source - Central Colorado Project (CCP)	Public Scoping	Divert water from the Gunnison River basin on Colorado's Western Slope to the Arkansas River basin on the Eastern Slope. As currently proposed, this project would only provide supplemental water to the Arkansas River basin, and is not proposed to convey water to Participants.
WS-14	Concept - Conservation	Public Scoping	Incorporate active and passive conservation projects by water supplier customers to reduce overall demand. Although not specifically a water supply, it has been included in this category because it has the potential to serve as a supply through reduced demands.
WS-15	Concept - Reuse (Potable/Non-Potable) of Available Supplies	Public Scoping, Value Planning Study	Construct new facilities for reuse of direct potable or non-potable use. This would require downstream diversion structures, treatment systems, other infrastructure, and agreements/exchanges with other water users.
WS-16	Concept - Dual Use, Non-Potable System	Public Scoping, Value Planning Study	Construct separate non-potable distribution systems for each participant that would deliver non-potable water for use in landscape irrigation, industrial, and other uses in which lower quality water could be used. This would involve a significant amount of infrastructure to retrofit existing distribution systems.
WS-17	Concept - Build a bottled water treatment plant	Value Planning Study	Construct a bottled water plant that would provide potable water to the Participants rather than building a new conveyance system.
WS-18	Concept - Cloud Seeding	Value Planning Study	Incorporate cloud seeding as a water supply component. The c\concept of cloud seeding has been an on-going activity in the upper Arkansas River basin for many years. These activities are generally intended to increase the overall yield of the river basin. However, based on Colorado Water Law, and entity cannot take direct delivery of increased yields that may occur due to cloud seeding.

ID	Description	Source of Option	Description
WS-19	Concept - Exchange return Fryingpan-Arkansas flows for Fryingpan-Arkansas agricultural deliveries	Value Planning Study	Develop a "paper exchange" of Fryingpan-Arkansas Project Return Flows and agricultural deliveries. When Fry-Ark Project agricultural deliveries are being made, rather than making a direct release of water from Pueblo Reservoir, deliveries would be made using Fry-Ark Project Return Flows, and a like amount of water would be stored in Pueblo Reservoir. This type of operation would likely require a water rights decree to quantify return flows.
WS-20	Concept - Remove tamarisk / phreatophytes	Value Planning Study	Incorporate a tamarisk/phreatophyte removal within Arkansas River as a water supply. Removal is an on-going activity in the Lower Arkansas River basin for many years. These activities are generally intended to increase the overall yield of the river basin. However, based on Colorado Water Law, and entity cannot take direct delivery of increased yields that may occur due to cloud seeding.
WS-21	Concept - Pump back for return flows	Value Planning Study	Divert reusable return flows from downstream portions of the Arkansas Basin and convey them through a pipeline to upstream locations (i.e. Pueblo Reservoir). Although a project such as this is technically feasible, there would be substantial legal, permitting and financial obstacles to overcome.
Regulating Storage **(Location must me upstream from Intake)**			
RS-1	Location - Pueblo Reservoir - Excess Capacity	STAG	Provide storage using excess capacity storage space in existing Pueblo Reservoir, similar to other long-term excess capacity contracts (i.e. Pueblo Board of Water Works, SDS). Spill priorities would be the same as existing spill priorities, with the spill priority being equal between all long-term Excess Capacity contracts.
RS-2	Location - Pueblo Reservoir - Enlargement	Previous NEPA, Value Planning Study	Enlarge existing Pueblo Reservoir to provide firm storage capacity. This alternative was studied by Southeastern during the Preferred Storage Options Plan.
RS-3	Location - Brush Hollow Enlargement	Previous NEPA	Enlarge existing Brush Hollow Reservoir near Penrose. Enlargement of the reservoir would inundate approximately 55 acres of wetlands (SDS EIS Alternatives Analysis). Deliveries from the Arkansas River could potentially be made through existing canal infrastructure. Water rights would potentially need to be changed to store in Brush Hollow Reservoir, as many existing water rights are not decreed for storage in Brush Hollow Reservoir.
RS-4	Location - Tennessee Creek Reservoir	Previous NEPA	Construct a new reservoir on Tennessee Creek in the Upper Arkansas River basin. This options has been studied in previous EIS documents. Tennessee Creek is a perennial stream, and enlargement would inundate approximately 750 acres of wetlands (SDS EIS Alternatives Analysis).
RS-5	Location - Turquoise Reservoir Enlargement	Previous NEPA	Enlarge existing Turquoise Reservoir to provide firm storage capacity. This alternative was studied by Southeastern during the Preferred Storage Options Plan.

ID	Description	Source of Option	Description
RS-6	Location - Clear Creek Reservoir Enlargement	Previous NEPA	Enlarge existing Clear Creek Reservoir in the upper Arkansas River basin to provide firm water storage capacity. Clear Creek Reservoir is owned by the Board of Water Works of Pueblo. Water would need to be exchanged into the reservoir. Any deliveries directly from the Arkansas River would require significant pumping and pipeline infrastructure.
RS-7	Location - Elephant Rock Reservoir	Previous NEPA	Construct a new reservoir on the Arkansas River near Buena Vista. Colorado Springs Utilities has an existing conditional water right for this reservoir.
RS-8	Location - Lake Henry/Lake Meredith Excess Capacity	Previous NEPA	Provide storage using excess capacity storage space in the existing Colorado Canal System reservoirs (Lake Henry and Lake Meredith). Details on operations would be need to be discussed with these Colorado Canal companies and their existing shareholders.
RS-9	Location - Lake Meredith Enlargement	Previous NEPA	Enlarge existing Lake Meredith reservoir within the existing Colorado Canal system of the lower Arkansas Valley. Enlargement of this facility has been considered in previous NEPA documents. Enlargement of Lake Meredith would inundate approximately 450 acres of wetlands.
RS-10	Location - Fry-Ark System - Excess Capacity	STAG	Provide storage using excess capacity storage space in existing Pueblo Reservoir, Twin Lakes and Turquoise Reservoir. Contracts would be similar to other long-term excess capacity contracts (i.e. Pueblo Board of Water Works, SDS). Spill priorities would be the same as existing spill priorities, with the spill priority being equal between all long-term Excess Capacity contracts. Upper Basin storage would be used to store water for entities west of Pueblo. Details on these operations would need to be determined by Reclamation.
RS-11	Location - Aquifer Storage and Recovery	Previous NEPA, Value Planning Study	Store water supplies in available alluvial and/or bedrock aquifers. In the Arkansas Basin, most of the aquifers that could potentially be used for this type of operation are east of Pueblo Reservoir.
RS-12	Location - Twin Lakes Reservoir Enlargement	Previous NEPA	Enlarge existing Twin Lakes Reservoir in upper Arkansas River basin. Little information is available regarding this enlargement.
RS-13	Location - Holbrook Reservoir / Dye Reservoir	Previous NEPA	Provide storage in existing Holbrook and Dye Reservoirs in lower Arkansas River Basin. Holbrook and Dye Reservoir are smaller reservoirs in the lower Arkansas Basin that could potentially Storage of municipal water supplies is currently taking place in Holbrook Reservoir. Therefore, storage capacity would be limited.
RS-14	Location - John Martin Reservoir Excess Capacity	Previous NEPA	Provide storage using excess capacity storage space in existing John Martin Reservoir. Details on operations would need to be determined by the U.S. Army Corps of Engineers and the Arkansas River Compact Committee. Execution of these contracts could take many years.
RS-15	Location (Gravel Lake) - Bessemer Pit (est. cap. 72 ac-ft)	Previous NEPA, CDRMS	Use existing gravel lakes for water supply storage. Gravel lakes storage sites are permitted gravel mining sites from the Colorado Division of Reclamation and Mining Safety (CDRMS) GIS data (http://mining.state.co.us/GIS%20Data.htm). GIS data was queried for those gravel lakes between Pueblo Reservoir and the Fort Lyon Canal headgate (it would be difficult to use any storage downstream of the
RS-16	Location (Gravel Lake) - Smokstad Pit (est. cap. 106 ac-ft)	Previous NEPA, CDRMS	
RS-17	Location (Gravel Lake) - Institutions Pit (est. cap. 640 ac-ft)	Previous NEPA, CDRMS	
RS-18	Location (Gravel Lake) - Pueblo West Pit (est. cap. 2540 ac-ft)	Previous NEPA, CDRMS	

ID	Description	Source of Option	Description
RS-19	Location (Gravel Lake) - Hausman-Xmas Pit (est. cap. 158 ac-ft)	Previous NEPA, CDRMS	Fort Lyon Canal headgate for regulating storage). Potential storage volumes were estimated assuming a 20-foot depth.
RS-20	Location (Gravel Lake) - Wington/Datz Pit (est. cap. 0 ac-ft)	Previous NEPA, CDRMS	
RS-21	Location (Gravel Lake) - Mine Pit 111 (est. cap. 286 ac-ft)	Previous NEPA, CDRMS	
RS-22	Location (Gravel Lake) - Stockyard Pit (est. cap. 914 ac-ft)	Previous NEPA, CDRMS	
RS-23	Location (Gravel Lake) - Beltramo Mine (est. cap. 156 ac-ft)	Previous NEPA, CDRMS	
RS-24	Location (Gravel Lake) - Runyon Lake (est. cap. 480 ac-ft)	Previous NEPA, CDRMS	
RS-25	Location (Gravel Lake) - Vista Mine (est. cap. 418 ac-ft)	Previous NEPA, CDRMS	
RS-26	Location (Gravel Lake) - Chantala Pit (est. cap. 12800 ac-ft)	Previous NEPA, CDRMS	
RS-27	Location (Gravel Lake) - Glover (est. cap. 0 ac-ft)	Previous NEPA, CDRMS	
RS-28	Location (Gravel Lake) - Fisher Pit (est. cap. 786 ac-ft)	Previous NEPA, CDRMS	
RS-29	Location (Gravel Lake) - 34th Lane Pit (est. cap. 188 ac-ft)	Previous NEPA, CDRMS	
RS-30	Location (Gravel Lake) - Pueblo Pit (est. cap. 1660 ac-ft)	Previous NEPA, CDRMS	
RS-31	Location (Gravel Lake) - Tomich Pit (est. cap. 172 ac-ft)	Previous NEPA, CDRMS	
RS-32	Location (Gravel Lake) - Oakleaf Pit (est. cap. 0 ac-ft)	Previous NEPA, CDRMS	
RS-33	Location (Gravel Lake) - RBK Pit No. 30 (est. cap. 198 ac-ft)	Previous NEPA, CDRMS	
RS-34	Location (Gravel Lake) - RBK Pit No. 31 (est. cap. 198 ac-ft)	Previous NEPA, CDRMS	
RS-35	Location (Gravel Lake) - Morgan Pit (est. cap. 242 ac-ft)	Previous NEPA, CDRMS	
RS-36	Location (Gravel Lake) - Pisciotta Gravel Pit (est. cap. 200 ac-ft)	Previous NEPA, CDRMS	
RS-37	Location (Gravel Lake) - Pisciotta Gravel Pit (est. cap. 0 ac-ft)	Previous NEPA, CDRMS	
RS-38	Location (Gravel Lake) - Pisciotta Gravel Pit (est. cap. 100 ac-ft)	Previous NEPA, CDRMS	
RS-39	Location (Gravel Lake) - Andenusio-Buffalo Pit (est. cap. 198 ac-ft)	Previous NEPA, CDRMS	
RS-40	Location (Gravel Lake) - Piscotte Gravel Pit (est. cap. 0 ac-ft)	Previous NEPA, CDRMS	
RS-41	Location (Gravel Lake) - Cullen S & G Pit (est. cap. 198 ac-ft)	Previous NEPA, CDRMS	
RS-42	Location (Gravel Lake) - Allen Pit (est. cap. 196 ac-ft)	Previous NEPA, CDRMS	
RS-43	Location (Gravel Lake) - Special Operation (est. cap. 198 ac-ft)	Previous NEPA, CDRMS	
RS-44	Location (Gravel Lake) - Rich Pit (est. cap. 7280 ac-ft)	Previous NEPA, CDRMS	
RS-45	Location (Gravel Lake) - Rich Pit (est. cap. 198 ac-ft)	Previous NEPA, CDRMS	
RS-46	Location (Gravel Lake) - Beltramo No. 2 (est. cap. 198 ac-ft)	Previous NEPA, CDRMS	
RS-47	Location (Gravel Lake) - Stealey Mine #1 (est. cap. 198 ac-ft)	Previous NEPA, CDRMS	
RS-48	Location (Gravel Lake) - Stealey Mine #2 (est. cap. 1206 ac-ft)	Previous NEPA, CDRMS	
RS-49	Location (Gravel Lake) - Grant Pit (est. cap. 200 ac-ft)	Previous NEPA, CDRMS	
RS-50	Location (Gravel Lake) - Blue Grass Gravel Pit (est. cap. 6460 ac-ft)	Previous NEPA, CDRMS	
RS-51	Location (Gravel Lake) - Stonewall Springs Quarry (est. cap. 0 ac-ft)	Previous NEPA, CDRMS	

Table A-1. Range of Options

ID	Description	Source of Option	Description
RS-52	Location (Gravel Lake) - Evans #2 Pit (est. cap. 8960 ac-ft)	Previous NEPA, CDRMS	
RS-53	Location (Gravel Lake) - St. Barbara Sand and Gravel (est. cap. 7280 ac-ft)	Previous NEPA, CDRMS	
RS-54	Location (Gravel Lake) - Murillow Gravel Pit (est. cap. 198 ac-ft)	Previous NEPA, CDRMS	
RS-55	Location (Gravel Lake) - Wayt Pit (est. cap. 198 ac-ft)	Previous NEPA, CDRMS	
RS-56	Location (Gravel Lake) - Two Rivers Pit (est. cap. 600 ac-ft)	Previous NEPA, CDRMS	
RS-57	Location (Gravel Lake) - Big G Gravel Pit (est. cap. 3860 ac-ft)	Previous NEPA, CDRMS	
RS-58	Location (Gravel Lake) - Fowler Pit (est. cap. 600 ac-ft)	Previous NEPA, CDRMS	
RS-59	Location (Gravel Lake) - Nepesta Hills Pit (est. cap. 0 ac-ft)	Previous NEPA, CDRMS	
RS-60	Location (Gravel Lake) - Boone-Martin Pit (est. cap. 198 ac-ft)	Previous NEPA, CDRMS	
RS-61	Location (Gravel Lake) - Boone-Filmore Pit (est. cap. 1680 ac-ft)	Previous NEPA, CDRMS	
RS-62	Location (Gravel Lake) - Lucero Pit (est. cap. 100 ac-ft)	Previous NEPA, CDRMS	
RS-63	Location (Gravel Lake) - Fellhauer Pit (est. cap. 140 ac-ft)	Previous NEPA, CDRMS	
RS-64	Location (Gravel Lake) - Pheasant Run Gravel Pit (est. cap. 1854 ac-ft)	Previous NEPA, CDRMS	
RS-65	Location (Gravel Lake) - Filmore (est. cap. 0 ac-ft)	Previous NEPA, CDRMS	
RS-66	Location (Gravel Lake) - Filmore Pit (est. cap. 198 ac-ft)	Previous NEPA, CDRMS	
RS-67	Location (Gravel Lake) - Hancock Gravel Pit (est. cap. 1840 ac-ft)	Previous NEPA, CDRMS	
RS-68	Location (Gravel Lake) - Rocky Ford South Pit (est. cap. 2948 ac-ft)	Previous NEPA, CDRMS	
RS-69	Location (Gravel Lake) - Hancock Pit (est. cap. 600 ac-ft)	Previous NEPA, CDRMS	
RS-70	Location (Gravel Lake) - Rocky Ford Pit (est. cap. 468 ac-ft)	Previous NEPA, CDRMS	
RS-71	Location (Gravel Lake) - Caldwell Pit (est. cap. 0 ac-ft)	Previous NEPA, CDRMS	
RS-72	Location (Gravel Lake) - Caldwell Brothers 3 (est. cap. 1020 ac-ft)	Previous NEPA, CDRMS	
RS-73	Location (Gravel Lake) - Campbell Pit (est. cap. 40 ac-ft)	Previous NEPA, CDRMS	
RS-74	Location (Gravel Lake) - Rocky Ford East Pit (est. cap. 3784 ac-ft)	Previous NEPA, CDRMS	
RS-75	Location (Gravel Lake) - Nichols Pit (est. cap. 200 ac-ft)	Previous NEPA, CDRMS	
RS-76	Location (Gravel Lake) - Paul Scott Pit (est. cap. 140 ac-ft)	Previous NEPA, CDRMS	
RS-77	Location (Gravel Lake) - Cuckow Gravel Pit (est. cap. 0 ac-ft)	Previous NEPA, CDRMS	
RS-78	Location (Gravel Lake) - Reed Pit (est. cap. 644 ac-ft)	Previous NEPA, CDRMS	
RS-79	Location (Gravel Lake) - Reed Pit (est. cap. 646 ac-ft)	Previous NEPA, CDRMS	
RS-80	Location (Gravel Lake) - Witt-Man Pit (est. cap. 0 ac-ft)	Previous NEPA, CDRMS	
RS-81	Location (Gravel Lake) - Harold Edgar Pit (est. cap. 108 ac-ft)	Previous NEPA, CDRMS	
RS-82	Location (Gravel Lake) - Korinek S&G Pit (est. cap. 170 ac-ft)	Previous NEPA, CDRMS	
RS-83	Location (Gravel Lake) - Caldwell Nesselhuf Pit No. 1 (est. cap. 1840 ac-ft)	Previous NEPA, CDRMS	

ID	Description	Source of Option	Description
RS-84	Location (Gravel Lake) - Walter Pit (est. cap. 6 ac-ft)	Previous NEPA, CDRMS	
RS-85	Location (Gravel Lake) - Walter Pit (est. cap. 400 ac-ft)	Previous NEPA, CDRMS	
RS-86	Location (Gravel Lake) - Ordway Pit (est. cap. 593.4 ac-ft)	Previous NEPA, CDRMS	
RS-87	Location (Gravel Lake) - Ordway Pit (est. cap. 1960 ac-ft)	Previous NEPA, CDRMS	
RS-88	Location (Gravel Lake) - Crowley Countly Grav 2 (est. cap. 600 ac-ft)	Previous NEPA, CDRMS	
RS-89	Location (Gravel Lake) - Rough Cut Pit (est. cap. 9340 ac-ft)	Previous NEPA, CDRMS	
RS-90	Location (Gravel Lake) - Argo Gravel Pit (est. cap. 4580 ac-ft)	Previous NEPA, CDRMS	
RS-91	Location (Gravel Lake) - Cash Pit (est. cap. 3320 ac-ft)	Previous NEPA, CDRMS	
RS-92	Location (Gravel Lake) - State Pit (est. cap. 0 ac-ft)	Previous NEPA, CDRMS	
Intake Location			
IL-1	Concept - Diversion above Pueblo Dam	Value Planning Study	Construct a diversion from the Arkansas River upstream of Pueblo Reservoir, likely in Fremont County.
IL-2	Location - Pueblo Reservoir South Outlet Works	STAG	Divert water from the existing South Outlet works at Pueblo Reservoir.
IL-3	Location - Pueblo Reservoir North Outlet Works (SDS)	STAG	Divert water from the future North Outlet works at Pueblo Reservoir. The North Outlet works are currently being designed and constructed as part of the Southern Delivery System.
IL-4	Location - Joint Use Pipeline (JUP) at Pueblo Boulevard	STAG	Divert water from the existing Joint Use Pipeline "wye" immediately upstream of Pueblo Boulevard, north of the Arkansas River. This pipeline currently delivers water from Pueblo Reservoir to the Whitlock Water Treatment Plant. Excess capacity is likely available in the pipeline upstream of the "wye" to potentially serve AVC.
IL-5	Location - Whitlock WTP	EIS Team	Divert water before, during or following treatment at the Whitlock Water Treatment Plant.
IL-6	Concept - Bessemer Ditch	STAG	Divert water out of the Bessemer Ditch, likely downstream of the City of Pueblo in the St. Charles Mesa area.
IL-7	Location - Arkansas River upstream of the Fountain Creek confluence	STAG	Construct a diversion from the Arkansas River between Pueblo Reservoir and the Fountain Creek confluence. It is assumed, at this point, the diversion would be located at the existing St. Charles Mesa diversion structure. However, water quality may be better slightly upstream of this structure (upstream of stormwater system discharges), and should be investigated during design.
IL-8	Concept - Arkansas River downstream of the Fountain Creek confluence	STAG	Construct a diversion from the Arkansas River downstream of the Fountain Creek confluence. The diversion would need to remain in Pueblo County in order to best serve AVC participants.
IL-9	Concept - Downstream Regulating Storage (Lake Henry, Lake Meredith, Holbrook, Dye, John Martin, Gravel Lakes)	Previous NEPA	Construct a diversion from one of the potential downstream regulating storage facilities.
IL-10	Concept - CF&I Conduit / Minnequa Ditch	STAG	Construct a diversion from either the CF&I Conduit or Minnequa Ditch. It is likely that this diversion would be east of Pueblo.
Conveyance - Through Pueblo			

Table A-1. Range of Options

ID	Description	Source of Option	Description
CP-1	Location - North (JUP Wye, along 11th Street)	STAG	Convey AVC water through the existing JUP, then construct a new pipeline that follows 11th street to Hwy 50.
CP-2	Location - North (JUP Wye, along railroad)	STAG	Convey AVC water through the existing JUP, then construct a new pipeline generally adjacent to railroad on north side of Hwy 50.
CP-3	Location - North (Pueblo Dam, JUP route, along 11th Street)	EIS Team	Construct new pipeline from Pueblo Dam that parallels the JUP, then follows 11th street to Hwy 50.
CP-4	Location - South (Pueblo Dam, along Bessemer Ditch)	STAG	Construct a new pipeline from Pueblo Dam that follows the Bessemer Ditch alignment. Note a portion of this alignment from the Pueblo Dam may follow Hwy 96.
CP-5	Location - South (JUP Wye, along Bessemer Ditch)	STAG	Convey AVC water through the existing JUP, then construct a new pipeline that follows the Bessemer Ditch alignment.
CP-6	Location - South (Pueblo Dam, JUP route, Bessemer Ditch)	EIS Team	Construct new pipeline from Pueblo Dam that parallels the JUP, then follow the Bessemer Ditch alignment.
CP-7	Location - South (Whitlock, along Bessemer Ditch)	STAG	Convey AVC water through the existing JUP, then construct a new pipeline to the Whitlock WTP, and a new pipeline from the Whitlock WTP along the Bessemer Ditch alignment.
CP-8	Location - South (Comanche route)	STAG, Value Planning Study	Construct a new pipeline from Pueblo Dam that follows an alignment generally along the existing pipeline to the Comanche Power Plant pipeline south of the City of Pueblo.
CP-9	Location - Downstream Intake	Value Planning Study	Construct a new pipeline from the Arkansas River upstream of Fountain Creek, then along a route south of the Arkansas River.
CP-10	Concept - Bessemer Ditch - Flow in existing open channel	Value Planning Study	Convey AVC water in the Bessemer ditch (along with existing ditch deliveries).
CP-11	Concept - Bessemer Ditch - In channel pipeline dedicated for AVC	Value Planning Study	Construct a pipeline in the current Bessemer Ditch channel that would convey AVC water only.
CP-12	Concept - Bessemer Ditch - All water (Agricultural and AVC) into one pipeline	STAG, Value Planning Study	Replace the current open channel Bessemer Ditch and construct a new pipeline along this alignment that would convey all flows (AVC water and existing ditch deliveries).
CP-13	Concept - BWWP System, with or without replacement	STAG, Value Planning Study	Convey AVC water through the existing Board of Water Works of Pueblo delivery systems. These deliveries would be fully treated water.
CP-14	Location - CF&I Conduit / Minnequa Ditch	EIS Team	Convey AVC water in the existing CF&I Conduit and/or Minnequa Ditch.
CP-15	Concept - Tunnel the main pipe	Value Planning Study	Construct a pipeline that would be tunneled under the City of Pueblo to avoid conflicts. The exact alignment is unknown at this time.
CP-16	Concept - Rail water to users	Value Planning Study	Use the existing railroad system to deliver water to project participants in railcars.
CP-17	Location - Run conduit within riverbed	Value Planning Study	Construct a new pipeline that runs in the existing Arkansas riverbed.
CP-18	Concept - Interconnect	STAG	Construct a new pipeline beneath the Arkansas River immediately below Pueblo day to connect the north and south outlet works pipelines. This concept would provide redundancy and operational flexibility in Pueblo Cam releases to support maintenance and other occurrences that could require an outlet to be out of service.
CP-19	Concept - Canal to WTP	Value Planning Study	Convey AVC water in a new canal rather than a pipeline.

ID	Description	Source of Option	Description
CP-20	Concept - Directional drill under Pueblo	Value Planning Study	Directional drill a new pipeline beneath the City of Pueblo. Similar to CP-15 except it would use directional drilling construction method.
CP-21	Concept - Run parallel pipes	Value Planning Study	Construct parallel pipelines to provide redundancy, convey different water qualities, and/or deliver from north and south routes/participants.
Conveyance - East of Pueblo			
CE-1	Location - South Route	STAG	Construct a new pipeline following the Highway 50 route as identified in the STAG report. This route generally corresponds to the route identified in STAG Alternative 1.
CE-2	Location - North Route	STAG	Construct a new pipeline following the North of the Arkansas River route as identified in the STAG report. This route generally corresponds to the route identified in STAG Alternative 2.
CE-3	Concept - Use abandoned Railroad ROW	STAG	Construct pipelines using routes that take advantage of abandoned railroad ROW that exists in portions of the north alignment. The exact ownership and availability of this ROW is unknown at this time but can be further investigated if retained.
CE-4	Concept - Canal (open)	Value Planning Study	Construct a new open canal to convey AVC water rather than a pipeline.
CE-5	Concept - Canal (covered and lined)	EIS Team	Construct a new open canal that is covered and lined, to convey AVC water rather than a pipeline.
CE-6	Concept - Individual vs. combined spurs	Public Scoping	Convey AVC water in individual spurs verses combined spurs to each participant.
CE-7	Concept - Put pipe above the ground at river crossings	Value Planning Study	Construct a pipeline above ground at river and other crossings rather than drilling or open cuts.
CE-8	Concept - Put pipe in prairie rather than farmlands	Value Planning Study	Maximize AVC routes that go through prairie verses farmlands whenever practicable.
CE-9	Location - WTP for Eads / eliminate the spur	Value Planning Study	Locate a new WTP at Eads rather than conveying AVC water to them directly in a pipeline.
CE-10	Concept - Rail water to users	Value Planning Study	Use the existing railroad system to deliver water to project participants in railcars.
CE-11	Concept - Regionalization of water distribution systems	Value Planning Study	Regionalize participants through interconnecting their distributions systems and convey AVC water to these newly regionalized systems.
CE-12	Concept - Stop conduit at La Junta / use John Martin Reservoir and Las Animas RO treatment plant	Value Planning Study	Construct a new pipeline to La Junta, then integrate John Martin Reservoir and the Las Animas existing RO plant (upgraded and expanded as needed) for water deliveries further east.
CE-13	Concept - Regionalization of water suppliers	Value Planning Study	Regionalize participants water supplies and infrastructure and convey AVC water to these newly regionalized systems.
Water Treatment			
WT-1	Location - New WTP located near South Road and 21st Street	STAG	Construct a new WTP in this general location. No specific location is identified, however option do exist that will need to be further evaluated in the Appraisal Level if retained for further investigation.
WT-2	Location - Whitlock WTP (BWWP)	STAG, Value Planning Study	Use the existing Whitlock WTP facilities with necessary improvement and expansion to meet AVC water.

ID	Description	Source of Option	Description
WT-3	Concept - Blended supplies	STAG, Value Planning Study	Blend existing water with AVC water at some or all of the Participant locations.
WT-4	Concept - De-centralized, regional facilities	Value Planning Study	Construct more than one WTP along the AVC route verses just one WTP location for the entire AVC.
WT-5	Concept - Reverse Osmosis for existing water supplies.	Public Scoping, Value Planning Study	Construct Reverse Osmosis WTP(s) to treat existing waters that require this level of treatment verses conveying AVC water to these participants.
WT-6	Location - New WTP located below Pueblo Dam (on BOR property)	STAG	Construct a new WTP on existing BOR property just below the Pueblo Dam.
WT-7	Concept - Deliver Treated Water to St Charles Mesa	EIS Team	Deliver treated (filtered or higher level of treatment) to St Charles Mesa rather than raw water.
WT-8	Location - New WTP located adjacent to the existing St. Charles Mesa WTP	STAG	Construct a new WTP adjacent to the existing St Charles Mesa WTP.
WT-9	Location - New WTP downstream from St Charles Mesa	STAG	Construct a new WTP downstream from the existing St Charles Mesa WTP. There are a few potential sites that need to be considered. More detailed analysis of these sites will be required if this Location is retained to determine the preferred site location.
WT-10	Concept - Filtered treatment	EIS Team	Treat AVC water to the "filtered" level, no disinfection, for conveyance to project participants delivery points.
WT-11	Concept - Filtered and disinfected treatment	Value Planning Study	Treat AVC water to the "filtered and disinfected" level treatment, for conveyance to project participants delivery points.
WT-12	Concept - Convert all participants to chloramines	Value Planning Study	Use chloramines in the water treatment process. Each participant would need to be able to accommodate this in their systems.
WT-13	Concept - Point-of-Use (POU) treatment under sink	Value Planning Study	Require each individual home, tap, etc to treat water at their location. There would be limited or no prior treatment.
WT-14	Concept - Individualized water treatment plants	Value Planning Study	Require each participant to have their own treatment plant to treat conveyed AVC water. There would be no prior treatment by the AVC system.
WT-15	Concept - Pueblo water system to convert to chlorine disinfection	Value Planning Study	Request that the Board of Water Works of Pueblo water system to convert to chlorine disinfection.
WT-16	Concept - Challenge water quality regulations	Value Planning Study	Challenge the current water quality regulations such that the Colorado Department of Public Health and Environment would "relax" water quality requirements for potable water delivered by the Participants.
WT-17	Concept - UV / Ozone treatment at WTP	Value Planning Study	Use UV / Ozone treatment technology at the AVC WTP.
WT-18	Concept - Advanced treatment at WTP	Value Planning Study	Use advanced treatment technologies at the AVC WTP.

Table A-2. Significant Issues Screening Criteria (Options)

General Category	Screening Category	Criterion Description	Rationale/Basis for Screening Criterion
Logistical			
	Capacity of Supply/Conveyance	Must be able to convey project deliveries	To be retained, an option must be able to supply at least 14.4 mgd of water total and convey the water required to meet the purpose & need, with conveyance to the participant service areas.
	Land Use	Must be outside national parks, designated wild and scenic river corridor or wilderness areas, and military installations.	To be retained, the location for an option must not conflict with sensitive land uses, National parks and designated wild and scenic river corridor or wilderness areas. Portions of military installations are also incompatible with municipal infrastructure (e.g. outdoor training and impact areas). For gravel pits, permitted reclaimed use must be consistent with water storage. Uses for farming and rangeland will be eliminated.
	Capacity of Intakes	Must provide 100 percent of the required intake capacity to meet average yield	To be retained, an option must provide the capacity required to meet the Participants’ projected water demands (14.4 mgd) as required in the purpose and need.
	Capacity of Regulating Storage	Must provide at least 10 percent of the required regulating storage capacity	To be retained, an option must provide the required storage (28,200 ac-ft) or be capable of being combined with other facilities to provide required storage as defined by the purpose and need. The 10% was used to eliminate sites that would not have adequate capacity. Use of more than 10 facilities (other than regulating operational storage tanks, new or existing) or enlargements of existing facilities to fulfill the purpose of a single storage component would be inefficient and also impact excessive areas of land.
	Water Supply Timing	Must be available and be decreed within 5-years of issuance of the Final EIS.	Water Supplies must be able to be decreed within 5-years of the Final EIS. Reclamation can only enter into contracts using decreed water supplies.
	Conveyance of Bulk Water	Must be able to meet the requirements of the Projects Purpose and Need	To be retained an option must convey bulk water to all participants. Modifications to Participants' distribution systems or options that do not convey water to all Participants are not consistent with the Purpose and Need.
	Time for Implementation	Must be able to convey water to the Participants within 8-years of the Final EIS.	To be retained, an option must provide a reasonable schedule (8 years maximum after the issuance of a Final EIS based on availability of funds) to convey water to the Participants.
Technical			
	Proven Technology	Must use existing technology	To be retained an option must use technologies, in an application consistent with sound engineering practices that can be permitted by the regulatory agencies (i.e.: CDPHE, State Engineers Office). Technologies that differ substantially from sound engineering practices involve increased risks of failure and risks to public health and safety.
	Long-term Stability	Must avoid geological features that could adversely affect long-term stability of component	To be retained, an option must avoid known geological features, such as landslides, mines, and/or active faults that could adversely affect long-term stability.
Environmental			

Table A-2. Significant Issues Screening Criteria (Options)

General Category	Screening Category	Criterion Description	Rationale/Basis for Screening Criterion
	New Reservoirs on Perennial Streams	Must not involve new reservoirs on perennial streams	To be retained, a new storage option must not be located on a perennial stream (e.g., Arkansas River and Fountain Creek). New storage components located off-channel, on an intermittent stream, were retained as were existing or enlarged storage components on a perennial stream. If options involving off-channel locations, intermittent stream locations, or existing or enlarged facilities were available, construction of a new reservoir on a perennial stream would likely have greater adverse impacts on the aquatic ecosystem and would not meet 404(b)(1) Guidelines.
	Wetland Disturbance	Must avoid fens (a special wetland type)	To be retained, an option must not have effects to a substantial amount of wetlands or special aquatic sites. An option was eliminated if any fen was permanently disturbed.
	Drinking Water Quality	Must Improve Drinking Water Quality	Must convey water to Participants that can be treated using existing or new conventional water treatment plants to meet current drinking water standards (Purpose and Need).

Table A-3. Significant Issues Screening (Options)

ID	Description	Keep/Eliminate	Reason for Elimination
Water Supply			
WS-1	Source - Fry-Ark Project Water	Keep	N/A
WS-2	Source - Fry-Ark Project Return Flows (1939 Decree)	Keep	N/A
WS-3	Source - Fry-Ark Project Return Flows (01CW151)	Keep	N/A
WS-4	Concept - Use of Existing Agricultural Water Rights	Keep	N/A
WS-5	Concept - Use of New Agricultural Water Rights	Keep	N/A
WS-6	Concept - Rotational Fallowing and Leasing	Keep	N/A
WS-7	Source - Water Rights specifically for AVC associated with the Super Ditch Project.	Keep	N/A
WS-8	Concept - New Western Slope Project	Eliminate	Water Supply Timing, Time for Implementation
WS-9	Source - Flaming Gorge Pipeline	Eliminate	Water Supply Timing, Time for Implementation
WS-10	Concept - Canada or Alaska Water Supply Project	Eliminate	Water Supply Timing, Time for Implementation
WS-11	Source - Fort Lyon Ditch/ Great Plains Reservoirs	Keep	N/A
WS-12	Concept - New Groundwater	Eliminate	Drinking Water Quality, Conveyance of Bulk Water
WS-13	Source - Central Colorado Project (CCP)	Eliminate	Water Supply Timing , Time for Implementation, Land Use, Conveyance of Bulk Water
WS-14	Concept - Conservation	Keep	N/A
WS-15	Concept - Reuse (Potable/Non-Potable) of Available Supplies	Eliminate	Proven Technology
WS-16	Concept - Dual Use, Non-Potable System	Keep	N/A
WS-17	Concept - Build a bottled water treatment plant	Eliminate	Conveyance of Bulk Water
WS-18	Concept - Cloud Seeding	Eliminate	Proven Technology
WS-19	Concept - Exchange return Fryingpan-Arkansas flows for Fryingpan-Arkansas agricultural deliveries	Eliminate	Capacity of Supply/Conveyance
WS-20	Concept - Remove tamarisk / phreatophytes	Eliminate	Capacity of Supply/Conveyance
WS-21	Concept - Pump back for return flows	Eliminate	Water Supply Timing
Regulating Storage (28,200 AF) (Must be located upstream from Intake)			
RS-1	Location - Pueblo Reservoir - Excess Capacity	Keep	N/A
RS-2	Location - Pueblo Reservoir - Enlargement	Eliminate	Time for Implementation
RS-3	Location - Brush Hollow Enlargement	Keep	N/A
RS-4	Location - Tennessee Creek Reservoir	Eliminate	New Reservoir on Perennial Stream, Time for Implementation
RS-5	Location - Turquoise Reservoir Enlargement	Eliminate	Time for Implementation
RS-6	Location - Clear Creek Reservoir Enlargement	Eliminate	Capacity of Supply/Conveyance, Land Use
RS-7	Location - Elephant Rock Reservoir	Eliminate	New reservoir on Perennial Stream, Time for Implementation

Table A-3. Significant Issues Screening (Options)

ID	Description	Keep/Eliminate	Reason for Elimination
RS-8	Location - Lake Henry/Lake Meredith Excess Capacity	Keep	N/A
RS-9	Location - Lake Meredith Enlargement	Eliminate	Wetland Disturbance
RS-10	Location - Fry-Ark System - Excess Capacity	Keep	N/A
RS-11	Location - Aquifer Storage and Recovery	Keep	N/A
RS-12	Location - Twin Lakes Reservoir Enlargement	Eliminate	Time for Implementation
RS-13	Location - Holbrook Reservoir / Dye Reservoir	Eliminate	Time for Implementation
RS-14	Location - John Martin Reservoir Excess Capacity	Eliminate	Time for Implementation
RS-15	Location (Gravel Lake) - Bessemer Pit (est. cap. 72 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-16	Location (Gravel Lake) - Smokstad Pit (est. cap. 106 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-17	Location (Gravel Lake) - Institutions Pit (est. cap. 640 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-18	Location (Gravel Lake) - Pueblo West Pit (est. cap. 2540 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-19	Location (Gravel Lake) - Hausman-Xmas Pit (est. cap. 158 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-20	Location (Gravel Lake) - Wington/Datz Pit (est. cap. 0 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-21	Location (Gravel Lake) - Mine Pit 111 (est. cap. 286 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-22	Location (Gravel Lake) - Stockyard Pit (est. cap. 914 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-23	Location (Gravel Lake) - Beltramo Mine (est. cap. 156 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-24	Location (Gravel Lake) - Runyon Lake (est. cap. 480 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-25	Location (Gravel Lake) - Vista Mine (est. cap. 418 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-26	Location (Gravel Lake) - Chantala Pit (est. cap. 12800 ac-ft)	Keep	N/A
RS-27	Location (Gravel Lake) - Glover (est. cap. 0 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-28	Location (Gravel Lake) - Fisher Pit (est. cap. 786 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-29	Location (Gravel Lake) - 34th Lane Pit (est. cap. 188 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-30	Location (Gravel Lake) - Pueblo Pit (est. cap. 1660 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-31	Location (Gravel Lake) - Tomich Pit (est. cap. 172 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-32	Location (Gravel Lake) - Oakleaf Pit (est. cap. 0 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-33	Location (Gravel Lake) - RBK Pit No. 30 (est. cap. 198 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-34	Location (Gravel Lake) - RBK Pit No. 31 (est. cap. 198 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-35	Location (Gravel Lake) - Morgan Pit (est. cap. 242 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-36	Location (Gravel Lake) - Pisciotta Gravel Pit (est. cap. 200 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-37	Location (Gravel Lake) - Pisciotta Gravel Pit (est. cap. 0 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-38	Location (Gravel Lake) - Pisciotta Gravel Pit (est. cap. 100 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-39	Location (Gravel Lake) - Andenusio-Buffalo Pit (est. cap. 198 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-40	Location (Gravel Lake) - Piscotte Gravel Pit (est. cap. 0 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-41	Location (Gravel Lake) - Cullen S & G Pit (est. cap. 198 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-42	Location (Gravel Lake) - Allen Pit (est. cap. 196 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-43	Location (Gravel Lake) - Special Operation (est. cap. 198 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-44	Location (Gravel Lake) - Rich Pit (est. cap. 7280 ac-ft)	Keep	N/A
RS-45	Location (Gravel Lake) - Rich Pit (est. cap. 198 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-46	Location (Gravel Lake) - Beltramo No. 2 (est. cap. 198 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-47	Location (Gravel Lake) - Stealey Mine #1 (est. cap. 198 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-48	Location (Gravel Lake) - Stealey Mine #2 (est. cap. 1206 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-49	Location (Gravel Lake) - Grant Pit (est. cap. 200 ac-ft)	Eliminate	Capacity of Regulating Storage

Table A-3. Significant Issues Screening (Options)

ID	Description	Keep/Eliminate	Reason for Elimination
RS-50	Location (Gravel Lake) - Blue Grass Gravel Pit (est. cap. 6460 ac-ft)	Keep	N/A
RS-51	Location (Gravel Lake) - Stonewall Springs Quarry (est. cap. 0 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-52	Location (Gravel Lake) - Evans #2 Pit (est. cap. 8960 ac-ft)	Keep	N/A
RS-53	Location (Gravel Lake) - St. Barbara Sand and Gravel (est. cap. 7280 ac-ft)	Eliminate	Land Use
RS-54	Location (Gravel Lake) - Murillow Gravel Pit (est. cap. 198 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-55	Location (Gravel Lake) - Wayt Pit (est. cap. 198 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-56	Location (Gravel Lake) - Two Rivers Pit (est. cap. 600 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-57	Location (Gravel Lake) - Big G Gravel Pit (est. cap. 3860 ac-ft)	Eliminate	Land Use
RS-58	Location (Gravel Lake) - Fowler Pit (est. cap. 600 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-59	Location (Gravel Lake) - Nepesta Hills Pit (est. cap. 0 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-60	Location (Gravel Lake) - Boone-Martin Pit (est. cap. 198 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-61	Location (Gravel Lake) - Boone-Filmore Pit (est. cap. 1680 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-62	Location (Gravel Lake) - Lucero Pit (est. cap. 100 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-63	Location (Gravel Lake) - Fellhauer Pit (est. cap. 140 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-64	Location (Gravel Lake) - Pheasant Run Gravel Pit (est. cap. 1854 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-65	Location (Gravel Lake) - Filmore (est. cap. 0 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-66	Location (Gravel Lake) - Filmore Pit (est. cap. 198 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-67	Location (Gravel Lake) - Hancock Gravel Pit (est. cap. 1840 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-68	Location (Gravel Lake) - Rocky Ford South Pit (est. cap. 2948 ac-ft)	Eliminate	Land Use
RS-69	Location (Gravel Lake) - Hancock Pit (est. cap. 600 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-70	Location (Gravel Lake) - Rocky Ford Pit (est. cap. 468 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-71	Location (Gravel Lake) - Caldwell Pit (est. cap. 0 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-72	Location (Gravel Lake) - Caldwell Brothers 3 (est. cap. 1020 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-73	Location (Gravel Lake) - Campbell Pit (est. cap. 40 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-74	Location (Gravel Lake) - Rocky Ford East Pit (est. cap. 3784 ac-ft)	Keep	N/A
RS-75	Location (Gravel Lake) - Nichols Pit (est. cap. 200 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-76	Location (Gravel Lake) - Paul Scott Pit (est. cap. 140 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-77	Location (Gravel Lake) - Cuckow Gravel Pit (est. cap. 0 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-78	Location (Gravel Lake) - Reed Pit (est. cap. 644 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-79	Location (Gravel Lake) - Reed Pit (est. cap. 646 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-80	Location (Gravel Lake) - Witt-Man Pit (est. cap. 0 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-81	Location (Gravel Lake) - Harold Edgar Pit (est. cap. 108 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-82	Location (Gravel Lake) - Korinek S&G Pit (est. cap. 170 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-83	Location (Gravel Lake) - Caldwell Nesselhuf Pit No. 1 (est. cap. 1840 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-84	Location (Gravel Lake) - Walter Pit (est. cap. 6 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-85	Location (Gravel Lake) - Walter Pit (est. cap. 400 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-86	Location (Gravel Lake) - Ordway Pit (est. cap. 593.4 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-87	Location (Gravel Lake) - Ordway Pit (est. cap. 1960 ac-ft)	Eliminate	Capacity of Regulating Storage

Table A-3. Significant Issues Screening (Options)

ID	Description	Keep/Eliminate	Reason for Elimination
RS-88	Location (Gravel Lake) - Crowley Countly Grav 2 (est. cap. 600 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-89	Location (Gravel Lake) - Rough Cut Pit (est. cap. 9340 ac-ft)	Eliminate	Land Use
RS-90	Location (Gravel Lake) - Argo Gravel Pit (est. cap. 4580 ac-ft)	Eliminate	Land Use
RS-91	Location (Gravel Lake) - Cash Pit (est. cap. 3320 ac-ft)	Eliminate	Capacity of Regulating Storage
RS-92	Location (Gravel Lake) - State Pit (est. cap. 0 ac-ft)	Eliminate	Capacity of Regulating Storage
Intake Location			
IL-1	Concept - Diversion above Pueblo Dam	Keep	N/A
IL-2	Location - Pueblo Reservoir South Outlet Works	Keep	N/A
IL-3	Location - Pueblo Reservoir North Outlet Works (SDS)	Eliminate	Capacity of Intakes
IL-4	Location - Joint Use Pipeline (JUP) at Pueblo Boulevard	Keep	N/A
IL-5	Location - Whitlock WTP	Eliminate	Capacity of Intakes
IL-6	Concept - Bessemer Ditch	Eliminate	Capacity of Intakes
IL-7	Location - Arkansas River upstream of the Fountain Creek confluence	Keep	N/A
IL-8	Concept - Arkansas River downstream of the Fountain Creek confluence	Eliminate	Drinking Water Quality
IL-9	Concept - Downstream Regulating Storage (Lake Henry, Lake Meredith, Holbrook, Dye, John Martin, Gravel Lakes)	Eliminate	Drinking Water Quality
IL-10	Concept - CF&I Conduit / Minnequa Ditch	Eliminate	Capacity of Intakes
Conveyance - Through Pueblo **(Conveyance includes all features associated with conveying the water; i.e.: pumps, storage, etc.)**			
CP-1	Location - North (JUP Wye, along 11th Street)	Keep	N/A
CP-2	Location - North (JUP Wye, along railroad)	Keep	N/A
CP-3	Location - North (Pueblo Dam, JUP route, along 11th Street)	Keep	N/A
CP-4	Location - South (Pueblo Dam, along Bessemer Ditch)	Keep	N/A
CP-5	Location - South (JUP Wye, along Bessemer Ditch)	Keep	N/A
CP-6	Location - South (Pueblo Dam, JUP route, Bessemer Ditch)	Keep	N/A
CP-7	Location - South (Whitlock, along Bessemer Ditch)	Keep	N/A
CP-8	Location - South (Comanche route)	Keep	N/A
CP-9	Location - Downstream Intake	Keep	N/A
CP-10	Concept - Bessemer Ditch - Flow in existing open channel	Eliminate	Capacity of Supply/Conveyance, Drinking Water Quality
CP-11	Concept - Bessemer Ditch - In channel pipeline dedicated for AVC	Eliminate	Capacity of Supply/Conveyance, Proven Technology
CP-12	Concept - Bessemer Ditch - All water (Agricultural and AVC) into one pipeline	Eliminate	Drinking Water Quality
CP-13	Concept - BWWP System, with or without replacement	Eliminate	Capacity of Supply/Conveyance
CP-14	Location - CF&I Conduit / Minnequa Ditch	Eliminate	Capacity of Supply/Conveyance
CP-15	Concept - Tunnel the main pipe	Eliminate	Time for Implementation
CP-16	Concept - Rail water to users	Eliminate	Capacity of Supply/Conveyance
CP-17	Location - Run conduit within riverbed	Eliminate	Proven Technology

Table A-3. Significant Issues Screening (Options)

ID	Description	Keep/Eliminate	Reason for Elimination
CP-18	Concept - Interconnect	Keep	N/A
CP-19	Concept - Canal to WTP	Eliminate	Drinking Water Quality
CP-20	Concept - Directional drill under Pueblo	Eliminate	Proven Technology
CP-21	Concept - Run parallel pipes	Keep	N/A
Conveyance - East of Pueblo **(Conveyance includes all features associated with conveying the water; i.e.: pumps, storage, etc.)**			
CE-1	Location - South Route	Keep	N/A
CE-2	Location - North Route	Keep	N/A
CE-3	Concept - Use abandoned Railroad ROW	Keep	N/A
CE-4	Concept - Canal (open)	Eliminate	Wetland Disturbance
CE-5	Concept - Canal (covered and lined)	Eliminate	Wetland Disturbance
CE-6	Concept - Individual vs. combined spurs	Keep	N/A
CE-7	Concept - Put pipe above the ground at river crossings	Eliminate	Proven Technology
CE-8	Concept - Put pipe in prairie rather than farmlands	Keep	N/A
CE-9	Location - WTP for Eads / eliminate the spur	Eliminate	Conveyance of Bulk Water
CE-10	Concept - Rail water to users	Eliminate	Capacity of Supply/Conveyance
CE-11	Concept - Regionalization of water distribution systems	Eliminate	Conveyance of Bulk Water
CE-12	Concept - Stop conduit at La Junta / use John Martin Reservoir and Las Animas RO treatment plant	Eliminate	Drinking Water Quality
CE-13	Concept - Regionalization of water suppliers	Eliminate	Conveyance of Bulk Water

ID	Description	Keep/Eliminate	Reason for Elimination
Water Treatment			
WT-1	Location - New WTP located near South Road and 21st Street	Keep	N/A
WT-2	Location - Whitlock WTP (BWWP)	Keep	N/A
WT-3	Concept - Blended supplies	Keep	N/A
WT-4	Concept - De-centralized, regional facilities	Keep	N/A
WT-5	Concept - Reverse Osmosis for existing water supplies.	Eliminate	Drinking Water Quality
WT-6	Location - New WTP located below Pueblo Dam (on BOR property)	Keep	N/A
WT-7	Concept - Deliver Treated Water to St Charles Mesa	Keep	N/A
WT-8	Location - New WTP located adjacent to the existing St. Charles Mesa WTP	Keep	N/A
WT-9	Location - New WTP downstream from St Charles Mesa	Keep	N/A
WT-10	Concept - Filtered treatment	Keep	N/A
WT-11	Concept - Filtered and disinfected treatment	Keep	N/A
WT-12	Concept - Convert all participants to chloramines	Keep	N/A
WT-13	Concept - Point-of-Use (POU) treatment under sink	Eliminate	Drinking Water Quality
WT-14	Concept - Individualized water treatment plants	Keep	N/A
WT-15	Concept - Pueblo water system to convert to chlorine disinfection	Eliminate	Drinking Water Quality
WT-16	Concept - Challenge water quality regulations	Eliminate	Drinking Water Quality
WT-17	Concept - UV / Ozone treatment at WTP	Eliminate	Drinking Water Quality
WT-18	Concept - Advanced treatment at WTP	Eliminate	Drinking Water Quality

Table A-3. Significant Issues Screening (Options)

ID	Description	Keep/Eliminate	Reason for Elimination

Notes:

(1) Could include south outlet works, north outlet works, or PBWW Raw Water Pipeline (CSU excess capacity)

Table A-3a. Significant Issues Screening - Gravel Lakes

Gravel Lake Operation	Area (acres)	Estimated Storage @ 20 ft deep (ac-ft)	Status	Post Mining Land use	Keep or Eliminate?	Reason for Elimination
Bessemer Pit	3.6	72	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Smokstad Pit	5.3	106	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Institutions Pit	32	640	Terminated	Unknown	Eliminate	Capacity of Regulating Storage
Pueblo West Pit	127	2,540	Active	Residential	Eliminate	Capacity of Regulating Storage
Hausman-Xmas Pit	7.9	158	Denied	Commercial/Industrial	Eliminate	Capacity of Regulating Storage
Wington/Datz Pit	0	0	Application Withdrawn	Rangeland	Eliminate	Capacity of Regulating Storage
Mine Pit 111	14.3	286	Terminated		Eliminate	Capacity of Regulating Storage
Stockyard Pit	45.7	914	Active		Eliminate	Capacity of Regulating Storage
Beltramo Mine	7.8	156	Terminated		Eliminate	Capacity of Regulating Storage
Runyon Lake	24	480	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Vista Mine	20.9	418	Active		Eliminate	Capacity of Regulating Storage
Chantala Pit	640	12,800	Active		Keep	N/A
Glover	0	0	Application Withdrawn		Eliminate	Capacity of Regulating Storage
Fisher Pit	39.3	786	Terminated	Pastureland	Eliminate	Capacity of Regulating Storage
34th Lane Pit	9.4	188	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Pueblo Pit	83	1,660	Terminated		Eliminate	Capacity of Regulating Storage
Tomich Pit	8.6	172	Terminated		Eliminate	Capacity of Regulating Storage
Oakleaf Pit	0	0	Terminated		Eliminate	Capacity of Regulating Storage
RBK Pit No. 30	9.9	198	Terminated		Eliminate	Capacity of Regulating Storage
RBK Pit No. 31	9.9	198	Terminated		Eliminate	Capacity of Regulating Storage
Morgan Pit	12.1	242	Terminated		Eliminate	Capacity of Regulating Storage
Pisciotta Gravel Pit	10	200	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Pisciotta Gravel Pit	0	0	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Pisciotta Gravel Pit	5	100	Terminated		Eliminate	Capacity of Regulating Storage
Andenusio-Buffalo Pit	9.9	198	Terminated	Wildlife Habitat	Eliminate	Capacity of Regulating Storage
Piscotte Gravel Pit	0	0	Denied	Rangeland	Eliminate	Capacity of Regulating Storage
Cullen S & G Pit	9.9	198	Terminated		Eliminate	Capacity of Regulating Storage
Allen Pit	9.8	196	Terminated	Industrial/Commercial	Eliminate	Capacity of Regulating Storage
Special Operation	9.9	198	Terminated	General Agriculture	Eliminate	Capacity of Regulating Storage
Rich Pit	364	7,280	Active	Wildlife Habitat	Keep	N/A
Rich Pit	9.9	198	Terminated	Wildlife Habitat	Eliminate	Capacity of Regulating Storage
Beltramo No. 2	9.9	198	Terminated		Eliminate	Capacity of Regulating Storage
Stealey Mine #1	9.9	198	Active		Eliminate	Capacity of Regulating Storage
Stealey Mine #2	60.3	1,206	Active	Pastureland	Eliminate	Capacity of Regulating Storage
Grant Pit	10	200	Terminated	Wildlife Habitat	Eliminate	Capacity of Regulating Storage
Blue Grass Gravel Pit	323	6,460	Active		Keep	N/A
Stonewall Springs Quarry	0	0	In Review		Eliminate	Capacity of Regulating Storage
Evans #2 Pit	448	8,960	Active	Recreation	Keep	N/A
St. Barbara Sand and Gravel	364	7,280	Active	Cropland	Eliminate	Land Use
Murillow Gravel Pit	9.9	198	Active	Rangeland	Eliminate	Capacity of Regulating Storage
Wayt Pit	9.9	198	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Two Rivers Pit	30	600	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage

Table A-3a. Significant Issues Screening - Gravel Lakes

Gravel Lake Operation	Area (acres)	Estimated Storage @ 20 ft deep (ac-ft)	Status	Post Mining Land use	Keep or Eliminate?	Reason for Elimination
Big G Gravel Pit	193	3,860	Active	Rangeland	Eliminate	Land Use
Fowler Pit	30	600	Active	Rangeland	Eliminate	Capacity of Regulating Storage
Nepesta Hills Pit	0	0	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Boone-Martin Pit	9.9	198	Active	Rangeland	Eliminate	Capacity of Regulating Storage
Boone-Filmore Pit	84	1,680	Active	Rangeland	Eliminate	Capacity of Regulating Storage
Lucero Pit	5	100	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Fellhauer Pit	7	140	Denied	Rangeland	Eliminate	Capacity of Regulating Storage
Pheasant Run Gravel Pit	92.7	1,854	Active	Rangeland	Eliminate	Capacity of Regulating Storage
Filmore	0	0	Application Withdrawn	Rangeland	Eliminate	Capacity of Regulating Storage
Filmore Pit	9.9	198	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Hancock Gravel Pit	92	1,840	Active	Rangeland	Eliminate	Capacity of Regulating Storage
Rocky Ford South Pit	147.4	2,948	Active	Rangeland	Eliminate	Land Use
Hancock Pit	30	600	Active	Rangeland	Eliminate	Capacity of Regulating Storage
Rocky Ford Pit	23.4	468	Active	Rangeland	Eliminate	Capacity of Regulating Storage
Caldwell Pit	0	0	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Caldwell Brothers 3	51	1,020	Active	General Agriculture	Eliminate	Capacity of Regulating Storage
Campbell Pit	2	40	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Rocky Ford East Pit	189.2	3,784	Active	Wildlife Habitat	Keep	N/A
Nichols Pit	10	200	Terminated	Pastureland	Eliminate	Capacity of Regulating Storage
Paul Scott Pit	7	140	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Cuckow Gravel Pit	0	0	Terminated	General Agriculture	Eliminate	Capacity of Regulating Storage
Reed Pit	32.2	644	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Reed Pit	32.3	646	Active	Rangeland	Eliminate	Capacity of Regulating Storage
Witt-Man Pit	0	0	Withdrawn	Rangeland	Eliminate	Capacity of Regulating Storage
Harold Edgar Pit	5.4	108	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Korinek S&G Pit	8.5	170	Active	Mining	Eliminate	Capacity of Regulating Storage
Caldwell Nesselhuf Pit No. 1	92	1,840	Active	Rangeland	Eliminate	Capacity of Regulating Storage
Walter Pit	0.3	6	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Walter Pit	20	400	Active	Wildlife Habitat	Eliminate	Capacity of Regulating Storage
Ordway Pit	29.67	593	Terminated	Rangeland	Eliminate	Capacity of Regulating Storage
Ordway Pit	98	1,960	Active	Rangeland	Eliminate	Capacity of Regulating Storage
Crowley Countly Grav 2	30	600	Active	Rangeland	Eliminate	Capacity of Regulating Storage
Rough Cut Pit	467	9,340	Active	Rangeland	Eliminate	Land Use
Argo Gravel Pit	229	4,580	Active	Rangeland	Eliminate	Land Use
Cash Pit	166	3,320	Active	Rangeland	Eliminate	Capacity of Regulating Storage
State Pit	0	0	Application Withdrawn	Rangeland	Eliminate	Capacity of Regulating Storage

Table A-4. Environmental Characteristics Criteria (Options)

Option Type	Screening Category	Units
Water Supplies		
	Substantial New Infrastructure Required	Yes/No
	Dry-Up Irrigated Agriculture	None/Temporary/Permanent
Storage		
	New or Existing Reservoir	New/Existing
	Surface Area Disturbance	Acres
	Wetland Area\Playa Disturbance	Acres
	Annual Evaporation	Ac-ft/year
	Compatible with Existing Fry-Ark Water Rights and Operations	Yes/No
Intakes		
	New or Existing Diversion Structure	New/Existing
	Distance between the Intake Location and Nearest AVC Delivery	Miles
	Annual Arkansas River Streamflow Effects Through City of Pueblo	Miles of River Affected
	Source Water Quality	Improved, No Substantial Improvement
	Compatible with Existing Fry-Ark Water Rights and Operations	Yes/No
Pipelines		
	Surface Area Disturbance	Acres
	Pipeline Length	Miles
	Wetland Area\Playa Disturbance	Acres
	Species of Concern	Acres
	Highway 50 Right-of-Way Interface	Maximized/Incidental
	Urban Area Disturbance	Acres
	Farmland Disturbance	Acres
Water Treatment		
	New or Existing Water Treatment Plan	New/Existing
	CDPHE Permitting Issues	Unlikely/Possible/Substantial
	Logistical Issues	Unlikely/Possible/Substantial
	Distance to Nearest Delivery Point	Miles

Table A-5a. Environmental Characteristics Screening - Water Supplies

ID	Description	Substantial New Infrastructure Required (Yes/No)	Dry-Up Irrigated Agriculture (None/temp/perm)	Result
Water Supplies				
WS-1	Source - Fry-Ark Project Water	No	None	Retain
WS-2	Source - Fry-Ark Project Return Flows (1939 Decree)	No	None	Retain
WS-3	Source - Fry-Ark Project Return Flows (01CW151)	No	None	Retain
WS-4	Concept - Use of Existing Agricultural Water Rights	No	Permanent	Retain
WS-5	Concept - Use of New Agricultural Water Rights	No	Temporary	Retain
WS-6	Concept - Rotational Fallowing and Leasing	No	Permanent	Retain
WS-7	Source - Water Rights specifically for AVC associated with the Super Ditch Project.	No	None	Retain
WS-11	Source - Fort Lyon Ditch/ Great Plains Reservoirs	Yes	None	Eliminate
WS-14	Concept - Conservation	No	None	Retain
WS-16	Concept - Dual Use, Non-Potable System	Yes	None	Eliminate

Table A-5b. Environmental Characteristics Screening - Storage

ID	Description	New or Existing Reservoir (New/Existing)	Surface Area Disturbance (1) (Acres)	Wetland Area/Playa Disturbance (1) (Acres)	Annual Evaporation (Ac-ft/year)	Compatible with Existing Fry-Ark Water Rights and Operations Yes/No	Result
Regulating Storage **(Location must be upstream from Intake)**							
RS-1	Location - Pueblo Reservoir - Excess Capacity	Existing	0	0		Yes	Retain
RS-3	Location - Brush Hollow Enlargement	New	> 55	55		No	Eliminate
RS-8	Location - Lake Henry/Lake Meredith Excess Capacity	Existing	0	0		Yes	Retain
RS-10	Location - Fry-Ark System - Excess Capacity	Existing	0	0		Yes	Retain
RS-11	Location - Aquifer Storage and Recovery	Existing	0	0		Yes	Retain
RS-26	Location (Gravel Lake) - Chantala Pit (est. cap. 12800 ac-ft)	Existing	0	0		No	Retain
RS-44	Location (Gravel Lake) - Rich Pit (est. cap. 7280 ac-ft)	Existing	0	0		No	Retain
RS-50	Location (Gravel Lake) - Blue Grass Gravel Pit (est. cap. 6460 ac-ft)	Existing	0	0		No	Retain
RS-52	Location (Gravel Lake) - Evans #2 Pit (est. cap. 8960 ac-ft)	Existing	0	0		No	Retain
RS-74	Location (Gravel Lake) - Rocky Ford East Pit (est. cap. 3784 ac-ft)	Existing	0	0		No	Retain

Notes:

(1) For all excess capacity and gravel lakes options, assume that no additional land disturbance occurs beyond that currently occupied by the facility.

Table A-5c. Environmental Characteristics Screening - Intakes

ID	Description	New or Existing Diversion Structure (New/Existing)	Distance between the Intake Location and Nearest AVC Delivery (1) (Miles)	Annual Arkansas River Streamflow Effects Through City of Pueblo (2) (Miles of River Affected)	Source Water Quality (Improved, No Improvement)	Compatible with Existing Fry-Ark Water Rights and Operations Yes/No	Result
Intake Location							
IL-1	Concept - Diversion above Pueblo Dam	New	29.6 (3)	26.3 (3)	Improved	No	Eliminate
IL-2	Location - Pueblo Reservoir South Outlet Works	Existing	12.1	10.1	Improved	Yes	Retain
IL-4	Location - Joint Use Pipeline (JUP) at Pueblo Boulevard	Existing	8.9	10.1	Improved	Yes	Retain
IL-7	Location - Arkansas River upstream of the Fountain Creek confluence	New	5.7	1.3	Improved	Yes	Retain

Note:

(1) For all diversions, straight-line distance St. Charles Mesa Water Treatment Plant

(2) Measured as distance between intake and Fountain Creek confluence.

(3) Assumes intake near Portland at Highway 120 bridge over Arkansas River.   Other routes may be possible.

Table A-5d. Environmental Characteristics Screening - Pipelines

ID	Description	Surface Area Disturbance	Pipeline Length	Wetland Area/Playa Disturbance	Species of Concern	Highway 50 Right-of-Way Interface	Urban Area Disturbance	Farmland Disturbance	Result
		(Acres)	(miles)	(Acres)	(Acres)	(Maximized/Incidental)	(Acres)	(Acres)	
Conveyance Through Pueblo									
CP-1	Location - North (JUP Wye, along 11th Street)	102	8	5	12	Incidental	89	0	Retain
CP-2	Location - North (JUP Wye, along railroad)	110	10	5	24	Incidental	79	0	Retain
CP-3	Location - North (Pueblo Dam, JUP route, along 11th Street)	152	12	17	22	Incidental	89	0	Retain
CP-4	Location - South (Pueblo Dam, along Bessemer Ditch)	171	14	3	2	None	48	0	Retain
CP-5	Location - South (JUP Wye, along Bessemer Ditch)	120	10	4	9	None	59	0	Retain
CP-6	Location - South (Pueblo Dam, JUP route, Bessemer Ditch)	170	14	16	19	None	59	0	Retain
CP-7	Location - South (Whitlock, along Bessemer Ditch)	104	9	1	3	None	48	0	Retain
CP-8	Location - South (Comanche route)	236	20	4	2	None	12	0	Retain
CP-9	Location - Downstream Intake	73	6	0	0	None	18	0	Retain
CP-18	Concept - Interconnect	Concept only - no data available.							Retain
CP-21	Concept - Run parallel pipes	Concept only - no data available.							Retain
Conveyance East of Pueblo									
CE-1	Location - South Route	2,223	183	34	4,656	Maximized	97	314	Retain
CE-2	Location - North Route	2,452	208	40	4,561	Incidental	150	264	Retain
CE-3	Concept - Use abandoned Railroad ROW	Concept only - no data available.							Retain
CE-6	Concept - Individual vs. combined spurs	Concept only - no data available.							Retain
CE-8	Concept - Put pipe in prairie rather than farmlands	Concept only - no data available.							Retain

Table A-5e. Environmental Characteristics Screening - Water Treatment Plants

ID	Description	New or Existing WTP (New/Existing)	CDPHE Permitting Issues (Unlikely/Possible/Substantial)	Logistical Issues (Unlikely/Possible/Substantial)	Result
Water Treatment					
WT-1	Location - New WTP located near South Road and 21st Street	New	Unlikely	Unlikely	Retain
WT-2	Location - Whitlock WTP (BWWP)	Existing	Unlikely	Unlikely	Retain
WT-3	Concept - Blended supplies	N/A	Possible	Possible	Retain
WT-4	Concept - De-centralized, regional facilities	N/A	Possible	Possible	Retain
WT-6	Location - New WTP located below Pueblo Dam (on BOR property)	New	Unlikely	Unlikely	Retain
WT-7	Concept - Deliver Treated Water to St Charles Mesa	N/A	Unlikely	Unlikely	Retain
WT-8	Location - New WTP located adjacent to the existing St. Charles Mesa WTP	New	Unlikely	Unlikely	Retain
WT-9	Location - New WTP downstream from St Charles Mesa	New	Unlikely	Unlikely	Retain
WT-10	Concept - Filtered treatment	N/A	Possible	Unlikely	Retain
WT-11	Concept - Filtered and disinfected treatment	N/A	None	Unlikely	Retain
WT-12	Concept - Convert all participants to chloramines	New	Possible	Substantial	Eliminate
WT-14	Concept - Individualized water treatment plants	New	Substantial	Substantial	Eliminate

Table A-6. Short-Listed Options

ID	Description	Notes
Water Supply		
WS-1	Source - Fry-Ark Project Water	Participants' proposed supply - Use in all Action Alternatives
WS-2	Source - Fry-Ark Project Return Flows (1939 Decree)	Participants' proposed supply - Use in all Action Alternatives
WS-3	Source - Fry-Ark Project Return Flows (01CW151)	Participants' proposed supply - Use in all Action Alternatives
WS-4	Concept - Use of Existing Agricultural Water Rights	Participants' proposed supply - Use in all Action Alternatives
WS-5	Concept - Use of New Agricultural Water Rights	Participants' proposed supply - Use in all Action Alternatives
WS-6	Concept - Rotational Fallowing and Leasing	
WS-7	Source - Water Rights specifically for AVC associated with the Super Ditch Project.	Participants' proposed supply - Use in all Action Alternatives
WS-14	Concept - Conservation	Considered in base demand calculations - Use in all alternatives
Regulating Storage **(Location must be upstream from Intake)**		
RS-1	Location - Pueblo Reservoir - Excess Capacity	
RS-8	Location - Lake Henry/Lake Meredith Excess Capacity	Location is downstream of Fountain Creek
RS-10	Location - Fry-Ark System - Excess Capacity	
RS-11	Location - Aquifer Storage and Recovery	Location is downstream of Fountain Creek
RS-26	Location (Gravel Lake) - Chantala Pit (est. cap. 12800 ac-ft)	Location is downstream of Fountain Creek
RS-44	Location (Gravel Lake) - Rich Pit (est. cap. 7280 ac-ft)	Location is downstream of Fountain Creek
RS-50	Location (Gravel Lake) - Blue Grass Gravel Pit (est. cap. 6460 ac-ft)	Location is downstream of Fountain Creek
RS-52	Location (Gravel Lake) - Evans #2 Pit (est. cap. 8960 ac-ft)	Location is downstream of Fountain Creek
RS-74	Location (Gravel Lake) - Rocky Ford East Pit (est. cap. 3784 ac-ft)	Location is downstream of Fountain Creek
Intake Location		
IL-2	Location - Pueblo Reservoir South Outlet Works	
IL-4	Location - Joint Use Pipeline (JUP) at Pueblo Boulevard	
IL-7	Location - Arkansas River upstream of the Fountain Creek confluence	
Conveyance - Through Pueblo		
CP-1	Location - North (JUP Wye, along 11th Street)	
CP-2	Location - North (JUP Wye, along railroad)	
CP-3	Location - North (Pueblo Dam, JUP route, along 11th Street)	
CP-4	Location - South (Pueblo Dam, along Bessemer Ditch)	The eastern portion of this alignment from the Pueblo Dam may follow Hwy 96.
CP-5	Location - South (JUP Wye, along Bessemer Ditch)	
CP-6	Location - South (Pueblo Dam, JUP route, Bessemer Ditch)	
CP-7	Location - South (Whitlock, along Bessemer Ditch)	
CP-8	Location - South (Comanche route)	
CP-9	Location - Downstream Intake	
CP-18	Concept - Interconnect	
CP-21	Concept - Run parallel pipes	To be considered in final design

Table A-6. Short-Listed Options

ID	Description	Notes
Conveyance - East of Pueblo		
CE-1	Location - South Route	
CE-2	Location - North Route	
CE-3	Concept - Use abandoned Railroad ROW	To be considered in final design. Also need better understanding of ownership/status of ROW.
CE-6	Concept - Individual vs. combined spurs	To be considered in final design
CE-8	Concept - Put pipe in prairie rather than farmlands	Considered as an Alternative Theme
Water Treatment		
WT-1	Location - New WTP located near South Road and 21st Street	
WT-2	Location - Whitlock WTP (BWWP)	
WT-3	Concept - Blended supplies	
WT-4	Concept - De-centralized, regional facilities	Although this option was short-listed, there are concerns with this option that were discussed during STAG and the Value Planning Study. Concerns with this option include spreading of operators and O&M costs, and a likely net increase in pipeline length. Furthermore, it does not address any alternative themes. Therefore, not considered for final alternatives.
WT-6	Location - New WTP located below Pueblo Dam (on BOR property)	
WT-7	Concept - Deliver Treated Water to St Charles Mesa	
WT-8	Location - New WTP located adjacent to the existing St. Charles Mesa WTP	
WT-9	Location - New WTP downstream from St Charles Mesa	Various open areas are located along the route to be considered based on engineering, ownership and availability.
WT-10	Concept - Filtered treatment	
WT-11	Concept - Filtered and disinfected treatment	

Table A-7. Alternative Themes

Theme Number	Alternative Theme	Description
1	No Action	A No Action Alternative is required by NEPA
2	Minimize Cost	The participants, Reclamation and the public have an interest in evaluating the least cost alternative.
3	Minimize Wetland Acres Disturbed	This NEPA document could serve as the basis for the 404(b)(1) permit. An alternative that minimizes wetlands disturbed should be analyzed.
4	Highest Minimum Flow in the Arkansas River through Pueblo	Several commenters, as well as comments received during previous NEPA activities, have identified maintaining the maximum streamflow through the City of Pueblo.
5	Minimize Farmland Disturbed	Several comments were received requesting that alternatives minimize the amount of farmland disturbed.
6	Minimize Construction Disturbance	Construction disturbances in general can be somewhat indicative of environmental effects.
7	Minimize Urban Construction Disturbance	Construction disturbances through the City of Pueblo, and through other communities is a key scoping issue.
8	Maximize Use of Existing ROW	Several comments were received requesting that alternatives maximize the use of existing ROW, including the Highway 50 expansion corridor.
9	Avoid Highway 50 Expansion Corridor	Initial reaction from CDOT was to minimize the amount of pipeline that could be within the Highway 50 expansion corridor.
10	Maximize Non-Structural Options	Comments were received requesting non-structural solutions.
11	Maximize Source Water Quality and Yield	The overall purpose and need is to provide high-quality water. Some alternatives would provide higher quality than others.
12	Maximize Operational Flexibility	With 41 participants and additional Master Contract participants, operational flexibility is desirable.

Table A-8. Development of Alternatives

Theme Number	Alternative Theme	Regulating Storage (must be located upstream of Intake)	Intake Location	Conveyance - Through Pueblo	Conveyance - East of Pueblo	Water Treatment	Notes
1	No Action	Short-Term If & When Contracts	Wells	N/A	Regional Conveyance	Regional WTP	
2	Minimize Cost		IL-4 Location - Joint Use Pipeline (JUP) at Pueblo Boulevard	CP-1 Location - North (JUP Wye, along 11th Street)	CE-2 Location - North Route	WT-2 Location - Whitlock WTP (BWWP)	Use minimum cost alternative from STAG report.
3	Minimize Wetland Acres Disturbed			CP-7 Location - South (Whitlock, along Bessemer Ditch) CP-9 Location - Downstream Intake	CE-1 Location - South Route		From GIS overlays using wetland area/playa disturbance.
4	Highest Minimum Flow in the Arkansas River through Pueblo		IL-7 Location - Arkansas River upstream of the Fountain Creek confluence	CP-9 Location - Downstream Intake			Highest flows will result from downstream intake alternatives.
5	Minimize Farmland Disturbed			CP-1 Location - North (JUP Wye, along 11th Street) CP-2 Location - North (JUP Wye, along railroad)	CE-2 Location - North Route		From GIS overlays using impact to prime farmland. Farmland GIS layers not available for Through Pueblo routes. Assume North Routes minimize disturbance
6	Minimize Construction Disturbance		IL-4 Location - Joint Use Pipeline (JUP) at Pueblo Boulevard	CP-9 Location - Downstream Intake CP-1 Location - North (JUP Wye, along 11th Street)	CE-1 Location - South Route	WT-2 Location - Whitlock WTP (BWWP)	From GIS overlays of surface area disturbance.
7	Minimize Urban Construction Disturbance		IL-2 Location - Pueblo Reservoir South Outlet Works	CP-8 Location - South (Comanche route)	CE-1 Location - South Route		From GIS overlays of urban area disturbance.

Table A-8. Development of Alternatives

Theme Number	Alternative Theme	Regulating Storage (must be located upstream of Intake)	Intake Location	Conveyance - Through Pueblo	Conveyance - East of Pueblo	Water Treatment	Notes
8	Maximize Use of Existing ROW				CE-1 Location - South Route		Typically, all alternatives would maximize use of existing ROW.
9	Avoid Highway 50 Expansion Corridor				CE-2 Location - North Route		Highway 50 is not being expanded through Pueblo. Therefore, there is no advantageous route through Pueblo.
10	Maximize Non-Structural Options						The No Action Alternative minimizes non-structural options.
11	Maximize Source Water Quality and Yield		IL-2 Location - Pueblo Reservoir South Outlet Works			WT-9 Location - New WTP downstream from St Charles Mesa WT-11 Concept - Filtered and disinfected treatment	Water supplies will typically be best for supplies originating closest to Pueblo Dam. WTPs further downstream will have less higher disinfection contact time.
12	Maximize Operational Flexibility	RS-10 Location - Fry-Ark System - Excess Capacity	IL-2 Location - Pueblo Reservoir South Outlet Works	CP-3 Location - North (Pueblo Dam, JUP route, along 11th Street) CP-6 Location - South (Pueblo Dam, JUP route, Bessemer Ditch)	CE-2 Location - North Route	WT-10 Concept - Filtered treatment	The South Outlet Works provide more flexibility than JUP (capacity and operations could be limited). Filtered water, as well as a new WTP provides treatment flexibility. The North route is more flexible because it avoids highway 50 expansion.

Note:

(1) Blank cells indicate that there is not a preferred (or advantageous) option for the component that fulfills the alternative theme.

(2) For all alternatives, since the short-list of water supplies included only those water supplies being proposed by each entity, and because no major alternative them directly dealt with alternative water supplies, water supplies for all alternatives will consist of those water supplies being proposed by each entity.

Table A-8. Development of Alternatives

Theme Number	Alternative Theme	Regulating Storage (must be located upstream of Intake)	Intake Location	Conveyance - Through Pueblo	Conveyance - East of Pueblo	Water Treatment	Notes
STAG Alternatives							
STAG Alt 1			IL-2 Location - Pueblo Reservoir South Outlet Works	CP-4 Location - South (Pueblo Dam, along Bessemer Ditch)	CE-1 Location - South Route	WT-1 Location - New WTP located near South Road and 21st Street	No pump station required. But, some low delivery pressures. (217 miles, $349 million)
STAG Alt 2			IL-4 Location - Joint Use Pipeline (JUP) at Pueblo Boulevard	CP-1 Location - North (JUP Wye, along 11th Street)	CE-2 Location - North Route	WT-2 Location - Whitlock WTP (BWWP)	Pump station required after treatment at Whitlock WTP. (222 miles, $286 million)
STAG Alt 3			IL-4 Location - Joint Use Pipeline (JUP) at Pueblo Boulevard	CP-7 Location - South (Whitlock, along Bessemer Ditch)	CE-1 Location - South Route	WT-2 Location - Whitlock WTP (BWWP)	Pump station required after treatment at Whitlock WTP. (209 miles, $295 million)
STAG Alt 4			IL-4 Location - Joint Use Pipeline (JUP) at Pueblo Boulevard	CP-5 Location - South (JUP Wye, along Bessemer Ditch)	CE-1 Location - South Route	WT-1 Location - New WTP located near South Road and 21st Street	No pump station required. (211 miles, $340 million)

Table A-9. Alternatives to be Studied in Detail

Alt. Number	Name	Regulating Storage	Intake Location	Conveyance - Through Pueblo	Conveyance - East of Pueblo	Treatment	Alternative Theme Number
1	No Action	Short-Term If & When Contracts	Wells/Existing River Diversion Points	N/A	N/A	Regional WTPs Individual treatment	1, 10
2	Comanche - South	Location - Pueblo Reservoir - Excess Capacity	Location - Pueblo Reservoir South Outlet Works	Location - South (Comanche route) Concept - Interconnect	Location - South Route	Location - New WTP downstream from St Charles Mesa Concept - Filtered and disinfected treatment	7, 8, 11
3	Pueblo Dam - South	Location - Fry-Ark System - Excess Capacity	Location - Pueblo Reservoir South Outlet Works	Location - South (Pueblo Dam, along Bessemer Ditch)	Location - South Route	Location - New WTP located near South Road and 21st Street Concept - Filtered treatment	3, 8
4	JUP - North	None	Location - Joint Use Pipeline (JUP) at Pueblo Boulevard	Location - North (JUP Wye, along 11th Street) Concept - Interconnect	Location - North Route	Location - Whitlock WTP (BWWP) Concept - Filtered treatment	2, 5, 6, 9
5	Pueblo Dam - North	Location - Fry-Ark System - Excess Capacity	Location - Pueblo Reservoir South Outlet Works	Location - North (Pueblo Dam, JUP route, along 11th Street) Concept - Interconnect	Location - North Route	Location - New WTP located below Pueblo Dam (on BOR property) Concept - Filtered treatment	9,12
6	River - South	Location - Pueblo Reservoir - Excess Capacity	Location - Arkansas River upstream of the Fountain Creek confluence	Location - Downstream Intake	Location - South Route	Location - New WTP located adjacent to the existing St. Charles Mesa WTP Concept - Filtered and disinfected treatment	3, 4, 8

Notes:

(1) All Action Alternatives include the following:

<u>Water Supplies</u>

WS-1	Source - Fry-Ark Project Water
WS-2	Source - Fry-Ark Project Return Flows (1939 Decree)
WS-3	Source - Fry-Ark Project Return Flows (01CW151)
WS-4	Concept - Use of Existing Agricultural Water Rights
WS-5	Concept - Use of New Agricultural Water Rights
WS-6	Concept - Rotational Fallowing and Leasing
WS-7	Source - Water Rights specifically for AVC associated with the Super Ditch Project.
WS-14	Concept - Conservation

<u>Water Treatment</u>

WT-3	Concept - Blended supplies

(2) All spurs, connection points, pump stations, operational storage, and any other engineered features required to support these conveyance options are included in these options.

(3) Numbers correspond to Alternative Theme numbers in Table A-7.

MWH
BUILDING A BETTER WORLD

MEMORANDUM

TO: Reclamation
DATE: November 15, 2010
REVISED: December 16, 2010

FROM: MWH
REFERENCE: AVC EIS

SUBJECT: AVC Preliminary Water Demands

Introduction

This memorandum presents preliminary water demands for the Arkansas Valley Conduit (AVC). The preliminary water demands were developed using population and water demand information in Southeastern Colorado Water Conservancy District's (Southeastern) State and Tribal Assistance Grant (STAG) report (Southeastern 2010), water conservation information from Great Western Institute, and population growth estimates developed by Reclamation (Reclamation 2010). This information is intended to provide Reclamation's Technical Service Center (TSC) approximate flow rates for use in the AVC Appraisal Level study. All information in this document should be considered Predecisional Draft information, and could be modified as the Draft EIS and Final EIS progress.

Methods and Limitations

The AVC participants are expected to experience population growth of up to 1 percent per year and will need the AVC and other supplies to meet future water demands associated with population growth. Future water demands were evaluated based on current supplies, population projections, and water conservation:

- Current Supplies: Current per capita water use was determined based on existing populations and water deliveries as presented in the STAG report. Those Participants with unusually high per capita water use were investigated further to determine the reason for high per capita water use and whether these per capita use rates should be used for future population projections.

- Population Projections: Reclamation has used existing data from the Colorado State Demography Office (CSDO) and Colorado Water Conservation Board (CWCB) to estimate population growth within the AVC service area. AVC water demand was evaluated through 2070.

- Water Conservation: Per capita water use may be reduced in the future due to active and passive water conservation by AVC participants. Southeastern is currently preparing a regional water conservation plan that will cover those AVC participants who do not have an individual conservation plan. Because Southeastern's water conservation plan will not be available for use in the EIS, water savings from passive water conservation were estimated by Great Western Institute (2010).

Future water demand for AVC participants was calculated as:

Current Per Capita Water Use * Population Projection – Water Conservation Savings

Deliveries in the AVC were determined based on future water demand, and existing and future water supplies:

- Usable Existing Supplies: For those AVC participants with enforcement actions from the Colorado Department of Public Health and Environment (CDPHE), it was assumed that these sources would only be used as an emergency supply and would not be used to fill regular daily water demand. Useable existing supplies were assumed to be sum of "Reliable Deep Well Supplies" and "Other Reliable Supplies" from Table 5-11, STAG report (Southeastern 2010).

- Additional Supply Required: Additional supplies required by the AVC participants were assumed as 2070 water demands minus usable existing supplies. In some cases, the AVC participants may not have enough existing supply to meet future demand. In those cases, it is assumed that the AVC participants would obtain future water rights to be delivered in the AVC. These future water rights would likely be in the form of a transfer of agricultural water rights to municipal and industrial use.

- Total Fryingpan-Arkansas Allocation: It was assumed that all AVC participants would take delivery of their allocation of Fryingpan-Arkansas (Fry-Ark) project and Not Previously Allocated Non-Irrigation Water (NPANIW) water through the AVC.

- Potential Useable Supplies in the AVC: Any usable existing supplies that the AVC participants indicated in the STAG report, Table 3-7 (Southeastern 2010) they would take delivery of through the AVC were included in the AVC delivery calculations.

- AVC Deliveries: AVC deliveries were determined based on the above calculations and the AVC participants delivery preferences noted in the Table 3-7, STAG report (Southeastern 2010) and review by Black and Veatch. AVC delivery calculations were based on one of the following methods:
    - Only Fry-Ark allocation water deliveries in the AVC
    - Fry-Ark allocation water plus additional supplies in the AVC to meet up to 100% of demand
    - Partial future supply from AVC by use of existing supply and delivery future supply in the AVC
    - 50/50 blending with future and current sources
    - Fry-Ark allocation water plus additional supply required

The water demands presented are preliminary estimates based on information received to date, and may change as the EIS progresses due to additional or modified information from the AVC participants, such as change in the number of AVC participants or change in the AVC participants expected deliveries from AVC. Additionally, Southeastern plans to receive legal commitments from the participants regarding AVC deliveries in early 2011.

Population Projections

In 2010, Southeastern prepared a pre-NEPA Report under a State and Tribal Assistance Grant (STAG), which evaluated projected water demands. The population projections presented in the STAG report are based on population projections from the Colorado State Demography Office (CSDO) (2009) and data from Colorado Water Conservation Board (CWCB) (2009). Reclamation's economist, Dr. Steven Piper, performed an independent evaluation of population projections presented in the STAG report and extended them through 2070 (Reclamation 2010). The following presents a summary of Reclamation's findings.

Reclamation compared historical population trends with projected trends and changes in components of population that would lead to the forecasted future populations in the STAG report. The U.S. Census Bureau historical population estimates from 1950 to 2009 were combined with CWCB population projections to compare the historical trends with projected future trends. Figure 1 and Figure 2 illustrate population trends for the counties within the AVC service area.

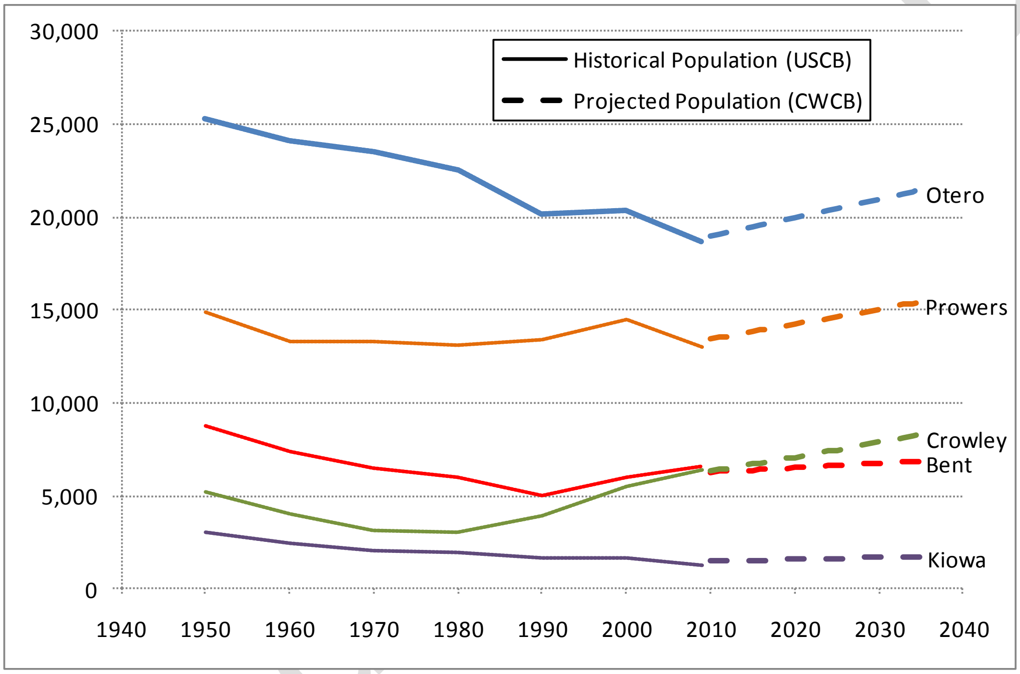


Figure 1. Historical and Projected Population of Bent, Crowley, Kiowa, Otero, and Prowers Counties

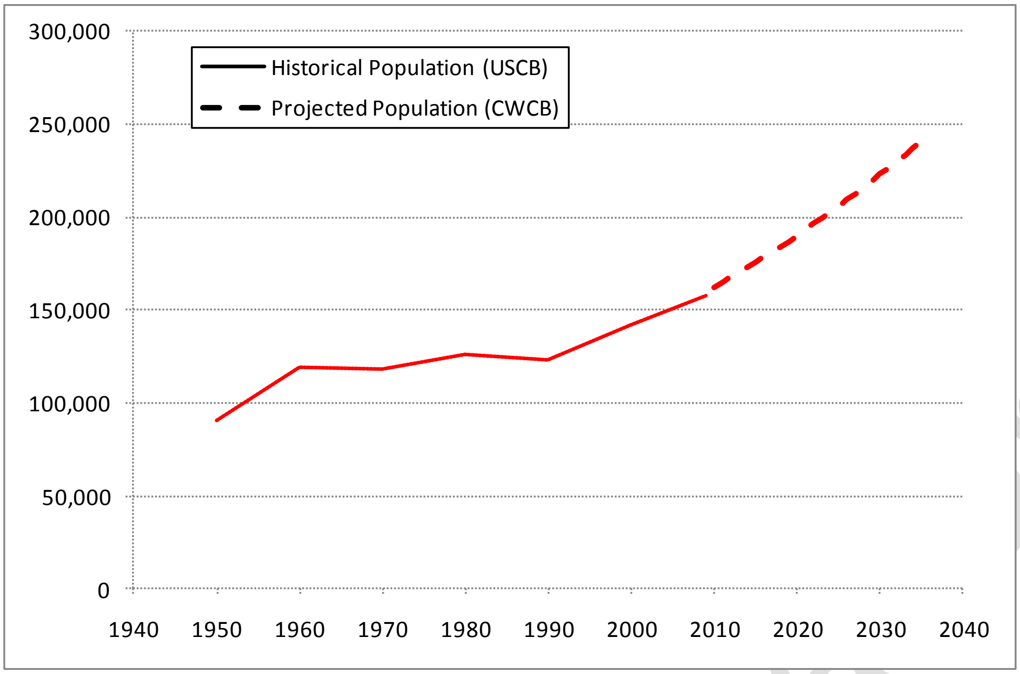


Figure 2. Historical and Projected Population of Pueblo County

Figure 1 and Figure 2 indicate a projected change in population trends over the next 25 years for each of the AVC area counties. Otero and Kiowa counties are projected to reverse nearly 60 years of population decline. Prowers County is projected to increase in population after 50 years of stable population, while Bent County is projected to have stable population in the future after periods of both increase and decline. Crowley County's population is expected to increase at a rate that is less than what was experienced from 1980 to 2009. Finally, Pueblo County is projected to grow at a rate similar to that from 1990 to 2009, but greater than the 1950 to 1990 rate.

The CSDO county-level population projections are based on regional and county economic forecasts of jobs and employment, labor demand, labor force participation, net migration, and age-sex distribution of migrants. Assumptions are also made regarding survival rates and fertility rates. The population projections are based on census data from 2000, which was a time of economic growth in Colorado. Since the Colorado population projection model is greatly influenced by economic forecasts, the projections may potentially overestimate the future population if predicted economic growth does not occur. Since the CWCB population projections closely follow the CDSO projections, it is assumed that the bases for the two sets of projections are similar.

To evaluate the accuracy of the CWCB and CSDO population forecasts, the growth trends, which result from the model assumptions, were compared to the historical growth patterns and the likelihood that there will be changes in the growth patterns. As mentioned above, Bent, Kiowa, Otero, and Prowers counties have experienced a decrease in population from 1950 to 2009. Although this decline has not been constant in all cases, the likelihood of a sudden reversal of these trends to rapid growth resulting from an abrupt change in social or economic variables would been small. Crowley and Pueblo counties have experienced historical growth; therefore similar levels of future growth would be justified. Based on these observations, the population growth rates shown in Table 1 indicate potential growth rates that were applied to the AVC participants to estimate 2070 populations.

Table 1. Estimated Population Growth Rates in the AVC Study Area

County	CSDO and CWCB Projected Growth Rate	Projected Growth Rate Used for AVC Demand Estimates	Source/Rationale
Pueblo	0.615% to 0.972%	0.972%	CWCB mid growth estimate / very close to historical rate
Crowley	0.772% to 1.097%	0.772%	CWCB low growth estimate
Otero	0% to 0.418%	0.418%	CWCB low growth estimate / historical growth moderately negative
Bent	0% to 0.558%	0.367%	CSDO estimate
Prowers	0% to 0.252%	0.252%	CWCB low growth estimate / historical growth slightly negative
Kiowa	0% to 0.382%	0%	Historical growth strongly negative

Water Conservation

Water conservation was considered when determining the water demand for the AVC participants through 2070. Three of the AVC participants, St. Charles Mesa; Lamar; and La Junta, have existing or draft water conservation plans. Southeastern is preparing a regional water conservation plan that would serve the remaining AVC participants. Water conservation can lower the Participants' future water demand.

Existing per capita water use was calculated by dividing existing water deliveries presented in the STAG report (Southeastern 2010) with population estimates from Reclamation (2010). Those AVC participants with unusually high per capita water use were interviewed by Great Western Institute (2010a) to determine why water use was high (Table 2).

Because Southeastern's regional water conservation plan is not yet complete, it was assumed the AVC Participants could save water based on passive conservation. Passive water savings are those that result from the impacts of plumbing codes, ordinances, and standards that improve the efficiency of water use. These conservation savings are called "passive" savings because water utilities do not actively fund and implement programs that produce these savings (CDM 2004). Great Western Institute (2010) calculated potential passive water savings as a result of retrofitting housing stock and businesses with high efficiency toilets, clothes washers, and dishwashers for the AVC participants. Passive savings are dependent on the age of the housing stock, the rate of population growth, current and future per capita water use, and the timing of fixture and appliance replacement. Great Western Institute (2010) prepared minimum and maximum water conservation savings estimates that averaged between 7 and 9 percent overall. The maximum water conservation savings estimate was used to develop AVC demands because additional water conservation savings are expected due to active conservation, although these savings cannot be quantified at this time.

Lamar and St. Charles Mesa have state-approved water conservation plans. Lamar has identified a water conservation goal of 10% through the year 2019. No additional water conservation was assumed for Lamar. St. Charles Mesa's water conservation goal is 0.4% per year through the year 2030, which amounts to less water conservation than that estimated by Great Western Institute (2010); therefore the higher water conservation savings based on passive conservation was used. La Junta's water conservation plan was not available because it is currently in revision, so passive water conservation savings as described above were assumed for La Junta.

Table 2. Current Per Capita Water Use

County	Participant	2010 Deliveries (ac-ft)	2010 Population	2010 Per Capita Water Use	Explanation of High Per Capita Water Use
Pueblo	Avondale	160	2000	71	
	Boone	66	324	182	
	St. Charles Mesa Water District	1,660	10,937	135	
Crowley	Crowley County Commissioners(1)	--	--	--	
	96 Pipeline Co.	56	160	311	Livestock Watering
	Crowley County Water Assoc.	564	2530	199	Livestock Watering, Large commercial use
	Crowley, Town of	27	163	150	
	Ordway, Town of	250	1086	206	Livestock Watering, Large commercial use
	Olney Springs	40	332	108	
	Sugar City	82	238	308	Explanation unknown; interview could not be scheduled.
Otero	Beehive Water Assn	8	165	43	
	Bents Fort Water Co.	63	900	62	
	Cheraw	48	193	222	Explanation unknown
	East End Water Assn.	11	75	131	
	Eureka Water Co.	74	330	200	Leaking Distribution Lines
	Fayette Water Assn.	12	60	179	
	Fowler	210	1,700(2)	110	
	Hancock Inc.	17	150	101	
	Hilltop Water Co.	45	284	141	
	Holbrook Center Soft Water	18	50	321	Livestock Watering, Leaking Distribution System
	Homestead Improvement Assn.	7	67	93	
	La Junta	2,040	7,102	256	Outdoor Irrigation, Reverse Osmosis Backwashing, Large Commercial Users
	Manzanola	39	476	73	
	Newdale-Grand Valley Water Co.	57	463	110	
	North Holbrook Water	7	40	156	
	Patterson Valley	15	96	139	
	Rocky Ford, City of	890	3,994	199	No Metering, Leaking Distribution System
	South Side Water Assoc. (La Junta)	7	48	130	
	South Swink Water Co.	82	610	120	
	Swink, Town of	38	664	51	
	Valley Water Co.	38	325	104	
	Vroman	32	150	190	
	West Grand Valley Water Inc.	25	84	266	Livestock Watering
	West Holbrook Water	14	23	543	Livestock Watering
Bent	Hasty Water Company	32	285	100	
	Las Animas	570	4,405 (2)	116	
	McClave Water Assoc.	56	440	114	
Prowers	Lamar	2,400	8,171	262	Leaking Distribution System, Large Commercial Users
	May Valley Water Assoc.	410	1,500	244	Livestock Watering, Leaking Distribution System
	Wiley	24	434	49	
Kiowa	Eads	250	626	357	Livestock Watering, Large Commercial Users, Bulk Water Station Used by Summer

County	Participant	2010 Deliveries (ac-ft)	2010 Population	2010 Per Capita Water Use	Explanation of High Per Capita Water Use
					Residents and Campers
Total		**10,437**	**47,741**		
Average (3)				**166**	
Weighted Average (4)				**179**	

Notes:
(1) Crowley County Commissioners wholesale water to other water providers within Crowley County, including 96 Pipeline Company, Crowley County Water Association, Town of Crowley, and Town of Ordway.
(2) Existing population was modified from Reclamation 2010 to account for differences in municipal boundaries compared to water utility boundaries (Reynolds 2010)
(3) Average calculated as the sum of 2010 per capita water use per participant divided by the number of participants. Calculations do not include demand for Crowley County Commissioners
(4) Weighted average calculated as the sum of (2010 population per participant) * (2010 per capita water use per participant) divided by total 2010 population. Calculations do not include demand for Crowley County Commissioners.

Water Demand

About 12,849 ac-ft per year of water will be needed by the AVC participants in 2070. Current populations from the U.S. Census were extended to 2070 using Reclamation's best estimate of growth rates (Table 1) and coupled with current water use data from the AVC participants (Southeastern 2010) and water conservation assumptions to project water demands in 2070 (Table 3).

The AVC would deliver about 9,232 ac-ft per year to the AVC participants (Table 4). The methodologies for the calculations presented in Table 4 are presented in the Methods section, above. The AVC would deliver a mixture of Fry-Ark allocations, the AVC participants' usable existing supplies, and future water supplies that are assumed to be obtained from agricultural water rights. This delivery value very close to the 9,231 ac-ft delivery calculated in the STAG report for 2050 demands. The primary reasons for this difference are differences in existing population estimates and future population projections for the AVC service area and passive water conservation savings applied to Participant water demands in this document.

These demands were calculated based on Reclamations projected 2070 population, 2010 per capita water use reduced for future conservation, and expected use of AVC by the Participants. No additional factors have been added to these projections for additional future use or other considerations. Reclamation will determine the proper pipeline size based on these water demand projections and other factors. It is recommended that consideration be given to sizing AVC for peak day capacity to allow for maximum flexibility in future operations. Furthermore, Reclamation and Southeastern will determine whether any additional capacity should be allotted for growth beyond 2070.

The data presented herein are preliminary estimates of demand and deliveries through AVC. The EIS team is continuing to develop information for purpose and need, while Southeastern is verifying demands and proposed AVC operations individually with each Participant. Changes to proposed operations by Participants, or changes that may occur due to additional information gathered during the purpose and need development could affect the demand and delivery values shown herein. Demands and AVC deliveries could be modified as the Draft EIS and Final EIS progress.

Table 3. Water Demands for AVC Participants

County	Participant	2070 Per Capita Water Use (gpcpd)	2070 Population	2070 Demand (ac-ft)
Pueblo	Avondale	59	3,570	237
	Boone	171	580	111
	St. Charles Mesa Water District	123	19,540	2,698
Crowley	Crowley County Commissioners(1)	--	--	--
	96 Pipeline Co.	182	255	52
	Crowley County Water Assoc.	183	4,010	824
	Crowley, Town of	223	260	65
	Ordway, Town of	215	1,720	414
	Olney Spring	101	530	60
	Sugar City	301	380	128
Otero	Beehive Water Assn	26	210	6
	Bents Fort Water Co.	42	1,160	55
	Cheraw	204	250	57
	East End Water Assn.	116	100	13
	Eureka Water Co.	181	425	86
	Fayette Water Assn.	156	80	14
	Fowler	91	2,183	222
	Hancock Inc.	82	195	18
	Hilltop Water Co.	122	365	50
	Holbrook Center Soft Water	302	65	22
	Homestead Improvement Assn.	74	85	7
	La Junta	237	9,120	2,417
	Manzanola	54	610	37
	Newdale-Grand Valley Water Co.	90	595	60
	North Holbrook Water	143	50	8
	Patterson Valley	121	125	17
	Rocky Ford	180	5,130	1,032
	South Side Water Assoc. (La Junta)	104	60	7
	South Swink Water Co.	101	780	88
	Swink, Town of	32	850	30
	Valley Water Co.	84	415	39
	Vroman	169	195	37
	West Grand Valley Water Inc.	243	110	30
	West Holbrook Water	536	30	18
Bent	Hasty Water Company	83	355	33
	Las Animas, City of	98	5,488	604
	McClave Water Assoc.	96	550	59
Prowers	Lamar, City of	236	9,500	2,511
	May Valley Water Assoc.	223	1,740	435
	Wiley	28	505	16
Kiowa	Eads	331	625	232
Total			**66,551**	**12,849**
Average (2)		**148**		
Weighted Average (3)		**154**		

Notes:

(1) Crowley County Commissioners wholesale water to other water providers within Crowley County, including 96 Pipeline Company, Crowley County Water Association, Town of Crowley, and Town of Ordway. (2)

Average calculated as the sum of 2070 per capita water use per participant divided by the number of participants. Calculations do not include demand for Crowley County Commissioners

(3) Weighted average calculated as the sum of (2070 population per participant) * (2070 per capita water use per participant) divided by total 2070 population. Calculations do not include demand for Crowley County Commissioners.

Table 4. AVC Water Deliveries

		2070 Supply/Demand			AVC Deliveries			
County	**Participant**	**Demand (ac-ft)**	**Useable Existing Supplies (1) (ac-ft)**	**Additional Supply Required (1) (ac-ft)**	**Total Fry-Ark Allocation (1) (ac-ft)**	**Potential Usable Existing Supplies in AVC (1) (ac-ft)**	**AVC Delivery Notes (2)**	**AVC Deliveries (3) (ac-ft)**
Pueblo	Avondale	237	159	78	138		(a)	138
	Boone	111	17	94	42		(c)	94
	St. Charles Mesa Water District	2,698	1,555	1,143	1,092	1,552	(b)	2,698
Crowley	Crowley County Commissioners	--	--	--		9 (4)	--	--
	96 Pipeline Co.	52	62	0	23		(e)	23
	Crowley County Water Assoc.	824	625	199	418	8	(e)	617
	Crowley, Town of	65	30	35	22	48	(e)	56
	Ordway, Town of	414	278	136	146	347	(e)	283
	Olney Springs	60	28	32	45	72	(b)	60
	Sugar City	128	20	108	48	58	(c)	108
Otero	Beehive Water Assn	6	8	0	18		(a)	6
	Bents Fort Water Co.	55	63	0	106		(a)	55
	Cheraw	57	48	9	25		(a)	25
	East End Water Assn.	13	0	13	8		(b)	13
	Eureka Water Co.	86	0	86	48		(b)	86
	Fayette Water Assn.	14	0	14	7		(b)	14
	Fowler	222	151	71	142		(a)	142
	Hancock Inc.	18	0	18	16		(c)	18
	Hilltop Water Co.	50	45	5	33		(a)	33
	Holbrook Center Soft Water	22	0	22	6		(b)	22
	Homestead Improvement Assn.	7	0	7	7		(b)	7
	La Junta	2,417	1,562	855	889	880	(c)	1,735
	Manzanola	37	0	37	62		(b)	37
	Newdale-Grand Valley Water Co.	60	57	3	55		(b)	60
	North Holbrook Water	8	7	1	7		(a)	7
	Patterson Valley	17	0	17	11		(b)	17
	Rocky Ford	1,032	706	326	503	250	(c)	576
	South Side Water Assoc. (La Junta)	7	7	0	5		(a)	5
	South Swink Water Co.	88	0	88	69		(b)	88
	Swink	30	38	0	82		(a)	30
	Valley Water Co.	39	0	39	31		(b)	39
	Vroman	37	0	37	17		(b)	37
	West Grand Valley Water Inc.	30	25	5	10		(d)	15
	West Holbrook Water	18	17	1	2		(d)	9
Bent	Hasty Water Company	33	32	1	32		(a)	32
	Las Animas	604	0	604	419		(b)	604
	McClave Water Assoc.	59	56	3	49		(a)	49

County	Participant	2070 Supply/Demand			AVC Deliveries			
		Demand (ac-ft)	Useable Existing Supplies (1) (ac-ft)	Additional Supply Required (1) (ac-ft)	Total Fry-Ark Allocation (1) (ac-ft)	Potential Usable Existing Supplies in AVC (1) (ac-ft)	AVC Delivery Notes (2)	AVC Deliveries (3) (ac-ft)
Prowers	Lamar	2,511	2,209	302	1,041		(a)	1,041
	May Valley Water Assoc.	435	213	222	161		(c)	222
	Wiley	16	0	16	57		(b)	16
Kiowa	Eads	232	162	70	88		(d)	116
Total		**12,849**	**8,180**	**4,697**	**5,977**	**3,224**		**9,232**

Notes:

(1) See Methods section for description of data. Total Fry-Ark Allocation includes first use Fry-Ark water and NPANI water.

(2) AVC Delivery Notes indicate the method for calculating AVC deliveries as follows

(a) Only Fry-Ark allocations in conduit.
(b) Fry-Ark first allocation plus additional supplies to meet up to 100% of demand.
(c) Partial future supply from conduit = Additional Supply Required + Simulated Useable Existing Supplies in AVC
(d) 50/50 blending (to be verified in EIS)
(e) Fry-Ark allocations + additional supply required

(3) See AVC Delivery Notes for method of calculating AVC deliveries.

(4) Crowley County Commissioners owns 11 shares of Twin Lakes water independent of the other Crowley County participants.

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STATE OF COLORADO

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Christopher E. Urbina, MD, MPH
Executive Director and Chief Medical Officer

Dedicated to protecting and improving the health and environment of the people of Colorado

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Colorado Department
of Public Health
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December 15, 2011

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RE: DK-500
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Arkansas Valley Conduit

Dear Mr. Collins:

The Safe Drinking Water Program in the Water Quality Control Division (WQCD) of the Colorado Department of Public Health and Environment is responding to your letter dated October 6, 2011 regarding the environmental impact statement for the Arkansas Valley Conduit (AVC) the Bureau of Reclamation is preparing and specifically providing input on disinfection strategies. The general views of the WQCD related to disinfection during treatment and disinfectant residual maintenance strategies during conveyance of the AVC water are summarized below, and then specific comments on each of the three treatment options are provided below.

General views

In general, the WQCD strongly supports the AVC project because it has the potential to help numerous public drinking water systems to replace or reduce the use of water supplies containing elevated levels of radionuclides and attain compliance with the Colorado Primary Drinking Water Regulations (CPDWR). As discussed in your letter, the design of the centralized water treatment system and conveyance will require WQCD approval. Additionally, any additional treatment proposed by the individual water providers will also need WQCD approval. We agree with the terminology in your letter regarding "filtered water" and "bulk water", and this will not hinder our design review process. The WQCD will not consider the transmission main prior to the individual customer turnouts to be a distribution system and therefore will not require a continuous disinfection residual to be present. We also strongly support the concept of centralized treatment conducted in a manner that will reduce the formation of disinfection byproducts. It is important for water providers that are currently out of compliance with radionuclides standards, who will receive water from the AVC to understand that they must develop an engineering plan to blend their current water sources if they intend to continue using them, and will need to do so in a way the leads to compliance with the CPDWR. Additionally, water providers may need to undertake environmental cleanup activities required by the Hazardous Materials and Waste Management regulations if merited, due to prior practices specifically with regard to iron removal from groundwaters that contain radionuclides even in the event that the radionuclides are not present above the health-based standards. We agree that responsibility for compliance with CPDWR by individual participants after the point of delivery will continue to be the responsibility of individual participants.

Each of the three options discussed in your letter recognizes that the length of the pipeline poses challenges for delivering fully-treated surface water, with no need for further treatment nor risk of creating disinfection by-products, to the public water systems that will connect to the pipeline. Regardless of which option is selected, the total treatment process must reliably achieve:

(1) At least 99.9 percent (3-log) removal and/or inactivation of Giardia lamblia cysts between a point where the raw water is not subject to recontamination by surface water runoff and a point downstream before or at the first customer; and
(2) At least 99.99 percent (4-log) removal and/or inactivation of viruses between a point where the raw water is not subject to recontamination by surface water runoff and a point downstream before or at the first customer.
The WQCD believes that each of the options presented could achieve the treatment objectives.

Option 1. Filtered Water with Addition of Disinfectant Residual at Each Participant Turnout
The WQCD's view of this option is that it is likely the most functional strategy given the nature of the customer cities and relative complexity of the other proposed options. In this case, the AVC central filtration treatment must be established, and documentation readily available such that each connecting public water system is able to add disinfectant treatment sufficient to achieve the total treatment objectives required by the Surface Water Treatment Rule(s). The AVC would be required to comply with the applicable provisions of the CPDWR related to monitoring, reporting, recordkeeping, etc. The WQCD would apply additional treatment, monitoring, reporting, and other requirements to each connection to the pipeline as provided for in the Regulations. Additional comments are:

- Organic growth in the AVC transmission system may be significant and proper operations and maintenance of the AVC transmission line and storage tanks will be necessary;
- It is likely that the ability to disinfect the conduit on an intermittent basis and water quality monitoring of parameters such as HPC, and TC to control biofilm growth and mitigate water quality issues will be needed;
- Alternative disinfection processes like ozone, chlorine dioxide or UV light may support removal of naturally organic material (NOM) should be evaluated; and,
- Total treatment will include the multiple barrier approach of filtration and disinfection.

Option 2. Filtered Water with Additional Treatment to Allow Free-Chlorine Residual in the AVC
The WQCD's view of this option is that significant management efforts would likely be needed to maintain compliance with Maximum Contaminant Levels (MCLs) for Disinfection By-Products (DBPs). Formation of elevated DBPs is likely due to long residence time and use of free chlorine based on DBP formation potential graphs presented by the BOR. Measures to reduce NOM at the AVC filtration plant may need to be evaluated such as enhanced coagulation, granular activated carbon, ozone with dual media filtration, or nanofiltration. Customer systems (participants) may also struggle to maintain compliance with the DBP MCLs.

Option 3. Filtered Water with Combined-Chlorine (Monochloramine) Residual in the AVC
The WQCD's view of this option is that while viable, it may be most challenging considering the limited resources associated with the small system participants, and may represent a significant management challenge for them. As with Option 2, measure to reduce NOM at the AVC filtration plant may need to be evaluated. Additional comments are

- Nitrification in the AVC transmission line or storage tanks may be a problem due to the relatively complex nature of controlling free ammonia in systems with long residence times coupled with higher temperatures (summer in southern Colorado);
- The ability of AVC participants to control and monitor breakpoint chlorination followed by re-chlorination plants may be a challenge;
- If consecutive water systems breakpoint chlorinate the water, the Division agrees with the BOR data that DBP issues may still arise in customer distribution systems as well as have the potential to be difficult to operate;
- If consecutive systems choose to maintain monochloramine residual in their distribution systems, they would likely have to deploy sophisticated control strategies to re-combine the chlorine in the appropriate ratio to optimize monochloramine. This may involve analysis of free chlorine, total chlorine, and total ammonia residual. Also, any groundwater sources that would be utilized would have to be configured to provide a monochoramine residual in lieu of a free chlorine residual, as the Division does not recommend mixing of different forms of disinfection residuals within a given distribution system as a general practice. This may involve additional ammonia feed points and associated monitoring equipment.

We look forward to continue working with the Bureau of Reclamation on this project. We are committed to working with BOR to ensure that water provided by AVC will be able to meet the CPDWR and solve long standing regional water quality problems. We trust that this comment letter meets your needs. Please do not hesitate to contact me with any additional questions. Thank you.

Sincerely,

Ron Falco P.E./jmain

Ron Falco, P.E.
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Colorado Department of Public Health and Environment

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