FOUNTAIN CREEK WATERSHED STUDY

WATERSHED MANAGEMENT PLAN

January 2009

US Army Corps
of Engineers ®
Albuquerque District

Executive Summary

The Fountain Creek Watershed Study started in 2003, and is a collaborative effort of 13 study sponsors who represent most of the public entities within the watershed. These sponsors are participants in the Fountain Creek Watershed Technical Advisory Committee (TAC) which has been working to address problems within the watershed since the 1990's. The U.S. Army Corps of Engineers became involved in watershed planning for Fountain Creek after the 1999 flood.

A watershed management plan was developed to address major issues identified by the TAC and other stakeholders within the Fountain Creek watershed. These issues are:

- Flooding,
- Erosion, and
- Sedimentation.

Four interim products were developed during the watershed study:

- A hydrology report and associated models for the watershed were developed and released to the public in March 2006;
- A hydraulics report and associated models for the watershed were developed and released to the public in March 2006;
- A baseline of existing environmental conditions was compiled and released to the public in March 2006; and
- A geomorphology report for selected stream segments was prepared and released to the public in July 2007.

This watershed management plan ties together all the existing information, along with a description of the problems and opportunities present in the watershed, and establishes the objectives for improved management of the Fountain Creek watershed. These objectives are:

- Reduce flood risk in the Fountain Creek watershed;
- Reduce erosion in the Fountain Creek watershed;
- Reduce sedimentation in the Fountain Creek watershed; and
- Improve water management in urban and urbanizing areas in the Fountain Creek watershed.

A list of 17 general recommendations for improved management of the watershed was developed. These recommendations are not specific to any location within the watershed and are meant to address the root causes of the problems within the watershed. The recommendations focus on 4 areas: development, rehabilitation/preservation, modeling/project design, and administration.

To address site-specific problems a list of 46 potential projects was developed. These projects would reduce flooding, improve channel stability, or restore the riparian ecosystem. These potential projects were ranked and prioritized using criteria developed in conjunction with the sponsors. The top 13 ranked potential projects were analyzed in greater detail. Potential project features for the remaining projects were briefly discussed.

Recommendations for Corps spin-off projects include:

- A large-scale ecosystem restoration project through the Corps' General Investigations (GI) program on the mainstem of Fountain Creek from Colorado Springs to Pueblo, similar to the Fountain Creek Crown Jewel Project envisioned by Senator Salazar;
- A Section 216 Review of Completed Projects for the Pueblo Levees;
- A Section 205 flood risk reduction project on Fountain Creek from the Monument Creek confluence to the city limits in Colorado Springs;
- A potential Section 205 or GI program flood risk reduction project on Highway 24; and
- Two Section 14 emergency streambank restoration projects at the Highway 85/87 Bridge and Rainbow Bridge;

An implementation matrix listing different agencies and programs that could assist in funding or constructing projects was also developed.

During the course of this watershed study a second effort to address problems within the Fountain Creek watershed was started by the Fountain Creek Vision Task Force. Although their focus was somewhat different than this study, many of the ideas put forth in the general recommendations are mirrored in the recommendations of the Vision Task Force. Implementation of the recommendations from both efforts is of utmost importance to developing and maintaining a healthy watershed.

Table of Contents

1. Section 1 Study Information
1.1 Overview ... 1-1
1.2 Study Area ... 1-1
1.3 Study Authority ... 1-4
1.4 Reconnaissance Study ... 1-4
1.5 Feasibility Study ... 1-6
1.6 Local Sponsor's Support ... 1-6
1.7 Collaborative Efforts in the Fountain Creek Watershed ... 1-8
1.7.1 Fountain Creek Watershed Technical Advisory Committee ... 1-8
1.7.2 Fountain Creek Vision Task Force ... 1-9
1.8 Watershed Problems, Planning Goals, Objectives, and Constraints ... 1-10
1.8.1 Population and Land Use Changes ... 1-10
1.8.2 Watershed Problems ... 1-11
1.8.3 Watershed Planning Goals ... 1-24
1.8.4 Watershed Planning Objectives ... 1-24
1.8.5 Watershed Planning Constraints ... 1-25
1.9 Prior Studies ... 1-25
1.10 Public Involvement ... 1-26

2. Section 2 Affected Environment ... 2-1

2.1 Climate and Precipitation ... 2-1
2.2 Geology ... 2-1
2.3 Soils ... 2-2
2.4 Vegetation ... 2-4
2.5 Land Use Overview ... 2-4
2.6 Hydrologic, Hydraulic, and Geomorphologic Studies ... 2-5
2.6.1 Scope ... 2-5
2.6.2 Hydrologic Studies ... 2-12
2.6.3 Hydraulic Studies ... 2-24
2.6.4 Geomorphology Studies ... 2-36
2.6.5 Hydrologic, Hydraulic, and Geomorphologic Study Results Summary ... 2-60
2.7 Biological Resources ... 2-69
2.7.1 Wildlife and Habitats ... 2-69
2.7.2 Migratory Corridors ... 2-72
2.7.3 Threatened, Endangered, and Sensitive Species ... 2-77
2.7.4 Fish ... 2-86
2.7.5 Wetland and Riparian Areas ... 2-89
2.7.6 Invasive Species ... 2-96
2.8 Hazardous Materials ... 2-98
2.9 Water Quality ... 2-100

3. Section 3 Alternatives ... 3-1

3.1 Alternative Formulation ... 3-1

Table of Contents

3.2 Plan Formulation.. 3-1
3.2.1 General Recommendations.. 3-2
3.2.2 Potential Projects 3-3
3.2.3 Ranking Criteria.. 3-107
3.2.4 Management Measures 3-19
3.2.5 Flood Risk Reduction Measures... 3-19
3.2.6 Ecosystem Restoration Measures 3-19
3.2.7 Channel Stability Measures 3-19

4. Section 4 13 Conceptual Projects Within the Watershed…………………..**4-1**

4.1 13 Conceptual Projects Within the Watershed………………………….4-1
4.1.1 Rank 1: Pueblo Levees ……………………….........................4-1
4.1.2 Rank 2: Highway 24 Corridor ………………………………..…4-6
4.1.3 Rank 3: Cheyenne Creek …………………………………….…4-7
4.1.4 Rank 4: Jimmy Camp Creek Confluence ……………………...4-10
4.1.5 Rank 5: Clear Springs Ranch Vicinity………….……………...4-12
4.1.6 Rank 6: Fountain Valley Park Vicinity……….………………..4-14
4.1.7 Rank 7: Frost-Hannah Vicinity………………………………...4-16
4.1.8 Rank 8: LFC-2 (Fountain Creek Mainstem Near Pinon)……....4-18
4.1.9 Rank 12: Fountain/Monument Confluence to City Limits…....4-18
4.1.10 Rank 13: Dam Above Pueblo……………………………......4-23
4.1.11 Rank 14: Pinon to Pueblo Reach……………………………....4-26
4.1.12 Rank 15: LFC-3 (Fountain Creek in Pueblo from Hwy 47 to 4th St)…………………………………………………………………4-27
4.1.13 Rank 16: Highway 47 Vicinity………………………………...4-27
4.1.14 Rank 17: Fountain Creek- Fountain Valley Park to Clear Springs Ranch……………………………………………………….……4-29

5. Section 5 Other Potential Projects Within the Watershed..……….………..**5-1**

5.1 Other Potential Projects Within The Watershed………………………..5-1
5.2 Potential Flood Risk Reduction Features For The Fountain Creek Watershed……………………………………………………………….5-1
5.3 Potential Ecosystem Restoration Features For Projects Within The Fountain Creek Watershed …………………………………………………5-15
5.4 Potential Channel Stability Features For Projects Within The Fountain Creek Watershed …………………………………………………………5-17
5.4.1 Stability General Recommendations……………………….….5-17

Table of Contents

5.4.2 Stability Projects to Limit Sediments Sources……..………...…5-20
5.4.3 Stability Projects to Protect Infrastructure………….………….5-20
5.4.4 Stability Projects for Streams with Changed Hydrology………5-21
5.4.5 Stability Projects for Streams with Unchanged Hydrology...…5-22

6. Section 6 Implementation Program/Authority Matrix ...………………..….6-1

7. Section 7 Summary and Conclusions..……………..…………...………........7-1

8. **Section 8 References**………………………………...………………………**8-1**

Table of Contents

List of Appendices

A Public Involvement Presentation Materials December 2004

List of Tables

Table 1-1 Fountain Creek Watershed Study Sponsors
Table 1-2 Fountain Creek Vision Task Force Consensus Committee Participants
Table 1-3 Fountain Creek Watershed Population Change
Table 2-1 Soil Characteristics Summary
Table 2-2 Project Streams
Table 2-3 Summary of Peak Discharges
Table 2-4 Summary of Flow Volumes
Table 2-5 Expected Increase in Peak Discharges
Table 2-6 Expected Increase in Flow Volumes
Table 2-7 Data Collected During Field Investigations
Table 2-8 Bankfull Discharge and Bankfull Hydraulic Geometry
Table 2-9 Summary of Limited Sediment Analysis
Table 2-10 Percentage of Wildlife Habitats in Study Area
Table 2-11 Occurrence of Threatened, Endangered, and Candidate Species by County
Table 2-12 Other Special Status Birds in the Fountain Creek Study Area
Table 2-13 Other Special Status Mammals in the Fountain Creek Study Area
Table 2-14 Other Special Status Wildlife in the Fountain Creek Study Area
Table 2-15 Other Special Status Plants in the Fountain Creek Study Area
Table 2-16 Fountain Creek Watershed Species List and Native Status
Table 2-17 Amount of Wetlands in the Fountain Creek Watershed
Table 2-18 Noxious Weeds Observed During Field Visits
Table 3-1 Implementation Program/Authority Matrix
Table 3-2 Project Selection Ranking Criteria- Ecosystem Restoration
Table 3-3 Project Selection Ranking Criteria- Channel Stability
Table 3-4 Project Rankings
Table 4-1 Cheyenne Creek Alternatives
Table 4-2 Colorado Springs Floodwalls
Table 4-3 Reasonable Contract Estimate
Table 5-1 Bridge Overtopping Locations
Table 6-1 Implementation Program/ Authority Matrix

Table of Contents

List of Figures

Figure 1-1	Vicinity Fountain Creek Watershed
Figure 1-2	Fountain Creek Watershed Subwatersheds
Figure 1-3	Study Areas
Figure 1-4	Existing Land Use
Figure 1-5	Future Land Use
Figure 1-6	Existing and Future Land Use Legend
Figure 2-1	Soils Physiographic Regions
Figure 2-2	Project Watersheds
Figure 2-3	Existing Runoff Curve Number
Figure 2-4	Future Runoff Curve Number
Figures 2-5 through 2-12	2-Year and 100-Year Discharge and Volume
Figure 2-13	Geomorphology Study Reaches
Figure 2-14	Photo Locations
Figure 2-15	Time-Series (1955-2003) Changes in Channel Length
Figure 2-16	Example Changes in Channel Characteristics – Cottonwood Creek Segment 5
Figure 2-17	Example Changes in Meander Characteristics – Fountain Creek Segment 8A
Figure 2-18	Bankfull Flow Analysis
Figure 2-19	Aggradation/Degradation Tendency (Existing Conditions)
Figure 2-20	Potential Conservation Areas
Figure 2-21	Monument Creek Watershed Current Wetlands
Figure 2-22	Lower Fountain Creek Current Wetlands
Figure 4-1	13 Conceptual Projects Within the Watershed, Sheet 1
Figure 4-2	13 Conceptual Projects Within the Watershed, Sheet 2
Figure 4-3	13 Conceptual Projects Within the Watershed, Sheet 3
Figure 4-4	CBC Drain Half and Entire Lengths
Figure 4-5	Flooding at Power Pant
Figure 4-6	Flooding at Tejon and Nevada Bridges
Figure 4-7	Flooding at Wastwater Treatment Plant
Figure 4-8	Proposed wetland site, North Pueblo, CO near Highway 47
Figure 4-9	Highway 85 Bridge
Figure 5-1	Other Potential Projects within the Watershed, Sheet 1
Figure 5-2	Other Potential Projects within the Watershed, Sheet 2
Figure 5-3	Other Potential Projects within the Watershed, Sheet 3

Table of Contents

Figure 5-4	Other Potential Projects within the Watershed, Sheet 4
Figure 5-5	Other Potential Projects within the Watershed, Sheet 5
Figure 5-6	Potential Bridge Overtopping Locations, Sheet 1
Figure 5-7	Potential Bridge Overtopping Locations, Sheet 7
Figure 5-8	Different Phases of Channel Evolution Model

List of Photos

Photo 1-1	Flood damage in Palmer Lake
Photo 1-2	Flooding in Manitou Springs in 1999
Photo 1-3	Pipeline damage in Colorado Springs
Photo 1-4	Collapsed Railroad Bridge on Sand Creek
Photo 1-5	Damage on Monument Creek in Colorado Springs
Photo 1-6	Damage at Rampart Park in Colorado Springs
Photo 1-7	Erosion on Sand Creek below Chelton Road in Colorado Springs
Photo 1-8	Floodplain encroachment on Cheyenne Creek in Colorado Springs
Photo 1-9	Damage to electrical utilities in Fountain
Photo 1-10	Erosion in El Paso County
Photo 1-11	Erosion at Old Pueblo Road in El Paso County
Photo 1-12	Sedimentation on agricultural land during the 1999 flood
Photo 1-13	Erosion at the Target store in Pueblo during the 1999 flood
Photo 1-14	Sedimentation at the Arkansas River confluence in Pueblo
Photo 1-15	Sand Creek Detention Pond 1
Photo 1-16	Erosion in Sand Creek immediately downstream of Sand Creek Detention
Photo 1-17	Sedimentation in Sand Creek below Powers Boulevard
Photo 2-1	Fountain Creek below Martin Luther King Bypass/Hwy 24
Photo 2-2	Fountain Creek at Sand Creek confluence
Photo 2-3	Fountain Creek at USGS Security Gauge
Photo 2-4	Fountain Creek at Williams Creek confluence
Photo 2-5	Fountain Creek at new Pinon Road Bridge
Photo 2-6	Fountain Creek cut bank near Overton Road
Photo 2-7	Fountain Creek below Hwy 47
Photo 2-8	Monument Creek below USAF Academy south boundary
Photo 2-9	Monument Creek near Templeton Gap Floodway confluence
Photo 2-10	Monument Creek at Colorado Avenue
Photo 2-11	Cottonwood Creek near Infinity Place
Photo 2-12	Cottonwood Creek near Wicklow Circle

Table of Contents

Photo 2-13 Black Forest Creek west of I-25
Photo 2-14 Monument Branch below Voyager Parkway
Photo 2-15 Sand Creek upstream of Constitution Avenue
Photo 2-16 Sand Creek along Space Center Drive
Photo 2-17 East Fork Sand Creek at Tamlin Road
Photo 2-18 Jimmy Camp Creek at Railroad Bridge in Fountain
Photo 2-19 Arkansas River at Fountain Creek confluence
Photo 4-1 Confluence of Jimmy Camp Creek with Fountain Creek
Photo 4-2 Looking upstream from Confluence
Photo 4-3 View of terrace above Fountain Creek
Photo 4-4 Upstream property that contributes sediment to the City's park property
Photo 4-5 Aerial View of Diversion Dam
Photo 4-6 Drop Structure Dam
Photo 4-7 View of gate at Clear Springs Diversion Dam
Photo 4-8 Property of Possible Interest to purchase adjacent to Fountain Valley Park
Photo 4-9 Cottonwood meadow area that could be converted to a wet meadow
Photo 4-10 Abandoned oxbow and Salt Cedar stands on Frost-Hannah property
Photo 4-11 Aerial view of Frost Ranch projects
Photo 4-12 Photo of proposed wetland site looking W- SW

Table of Contents

List of Acronyms and Abbreviations

%	percent
ac	acre
AFB	Air Force Base
ARS	U.S. Department of Agriculture, Agricultural Research Service
BA	Biological Assessment
BCZ	Block Clearance Zone
BE	Biological Evaluation
BO	Biological Opinion
BMP	Best Management Practice
CDA	Colorado Department of Agriculture
CDOW	Colorado Division of Wildlife
cfs	cubic feet per second
CNHP	Colorado Natural Heritage Program
CSU	Colorado Springs Utilities
CWCB	Colorado Water Conservation Board
DO	Dissolved Oxygen
ERDC	U.S. Army Corps of Engineers, Engineer Research and Development Center
ESA	Endangered Species Act
ESRI	Environmental System Research Institute
FCRP	Fountain Creek Regional Park
FCW	Fountain Creek Watershed
FEMA	Federal Emergency Management Agency
Fr	Froude Number
ft	foot (or feet)
FWCA	Fish and Wildlife Coordination Act
GIS	Geospatial Information Systems
GPS	global positioning system
HEC-HMS	Hydraulic Engineering Center – Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center – River Analysis System
I-25	Interstate 25
IBA	Important Birding Area
in.	inch (or inches)
LOMR	Letter of Map Revision
MBTA	Migratory Bird Treaty Act

Table of Contents

M&E	Monitoring and Evaluation List
mi	mile(s)
mm	millimeters
MOA	Memorandum of Agreement
MBTA	Migratory Bird Treaty Act
MPM	Meyer-Peter and Muller
NAVD	North American Vertical Datum
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service (formerly SCS)
ODNR	Ohio Department of Natural Resources
PCA	Potential Conservation Areas
PCE	Perchloroethylene
PEM	palustrine emergent
PFO	palustrine forested
PPACG	Pikes Peak Area Council of Governments
ppm	parts per million
PSS	palustrine scrub shrub
RNA	Research Natural Areas
SAM	U.S. Army Corps of Engineers SAM Hydraulic Design Package for Channels
SDR	sediment delivery ratio
sp.	Species
sq mi	square mile(s)
study area	Fountain Creek Watershed
TCE	Trichloroethylene
TDS	Total Dissolved Solids
TIFF	Tag Image File Format
TMDL	Total Maximum Daily Load
TO	Task Order
TSS	Total Suspended Solids
URS	URS Group, Inc.
US 24	United States Highway 24
US	United States

USACE	U.S. Army Corps of Engineers
USAFA	U.S. Air Force Academy
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USLE	Universal Soil Loss Equation
WISE	Watershed Information System
WRDA	Water Resources Development Act
WWTF	Wastewater Treatment Facilities
yr	year

1.1 OVERVIEW

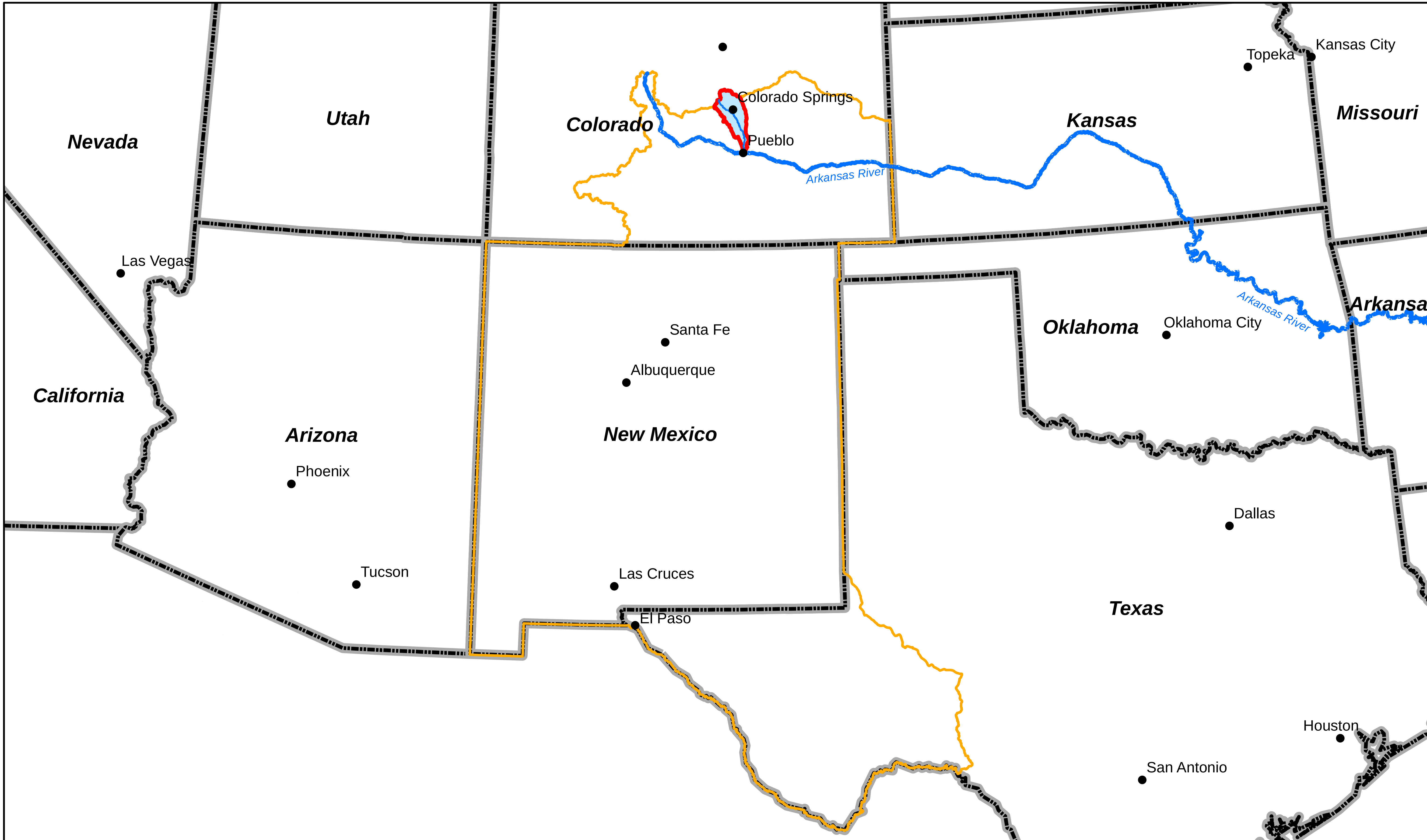
The Fountain Creek, Colorado, Watershed Study (watershed study) is being conducted in response to local concerns related to flooding, sedimentation, and erosion within the watershed. The watershed study presents an opportunity for local, state, and federal agencies to work together in developing watershed solutions to manage resources of the Fountain Creek Watershed (FCW) in Colorado. The study will result in a comprehensive watershed management plan that assesses watershed characteristics, identifies watershed issues/concerns, develops structural and non-structural solutions, and identifies potential “spin-off” projects for implementation.

The watershed study is not a project implementation document. The level of detail in investigations is at a scale adequate for making watershed-level resource assessments and recommendations. If specific projects are identified for potential implementation under existing authorities of the U.S. Army Corps of Engineers (USACE) (for example, flood risk reduction or ecosystem restoration), separate interim reports will be required covering specific project features and including a detailed engineering appendix and appropriate NEPA documentation.

1.2 STUDY AREA

Fountain Creek is a perennial stream located within the Arkansas River watershed in central Colorado, see vicinity map, Figure 1-1, Vicinity Fountain Creek Watershed. The creek generally flows south-easterly along the Front Range from the communities of Palmer Lake and Woodland Park, through Colorado Springs, to the city of Pueblo. The Fountain Creek Watershed encompasses all or portions of eight municipalities (Colorado Springs, Pueblo, Green Mountain Falls, Fountain, Manitou Springs, Monument, Palmer Lake, and Woodland Park) and three counties (El Paso, Pueblo, and Teller). The watershed is bounded by Pikes Peak, the Rampart Range, and Ute Pass to the west; Monument Hill and the Palmer Divide to the north; and by a third less-distinct divide shared with the Chico watershed to the east. The Fountain Creek Watershed has a contributing drainage area of approximately 930 square miles (sq mi) at its confluence with the Arkansas River near downtown Pueblo.

Twenty-two streams and their associated sub-watersheds within the larger Fountain Creek Watershed were identified and selected by the local sponsors as areas of interest for detailed hydrologic, hydraulic, and geomorphologic studies. Final selection of the individual sub-watersheds was based upon issues previously identified in the Fountain Creek Watershed Plan (PPACG 2003) and through agreement between USACE and the local sponsors. A map of the watershed, showing all of the sub-watersheds, is provided in Figure 1-2, Fountain Creek Watershed – sub-watersheds.



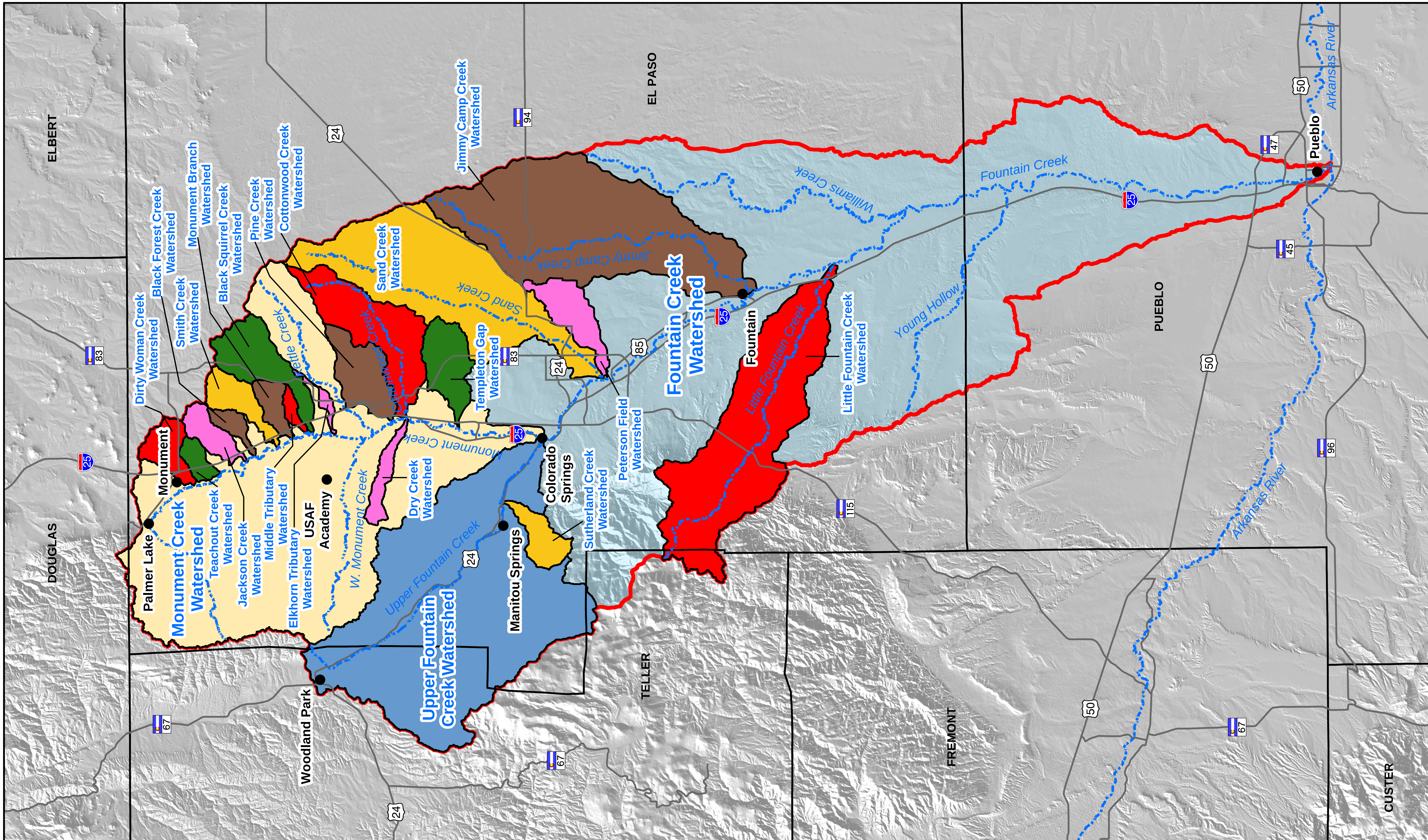
URS
URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers
Albuquerque District

Vicinity
Figure 1-1

10/2007

Fountain Creek Watershed Study, URS Project 21711283



URS
URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers ®
Albuquerque District

Fountain Creek Watershed
Upper Fountain Creek Watershed
Monument Creek Watershed
Other Project Watersheds
Major Streams
Counties
Highways

Scale is: 1:285,120
or
1 inch equals 4.5 miles

0 4.5 9 Miles

Fountain Creek Watershed Subwatersheds

Figure 1-2

4/2008

Fountain Creek Watershed Study, URS Project 21711283

1.3 STUDY AUTHORITY

The watershed study is being conducted in response to a House Resolution adopted on 23 September 1976, which reads as follows:

> Be it resolved by the Committee on Public Works and Transportation of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on the Arkansas River above John Martin Dam, published in House Document No. 93-143, Ninety-third Congress, First Session, dated 5 September 1973, with a view to determining whether any modifications of the recommendations contained therein are advisable at the present time, with particular reference to providing improvements in the interest of flood control and allied purposes in the Fountain Creek Basin upstream of Pueblo, Colorado.

1.4 RECONNAISSANCE STUDY

The Water Resources Development Act Section 905(b) Analysis (reconnaissance study) was conducted by the USACE to review and assess water resources-related problems in the Fountain Creek watershed. The goal of the reconnaissance study was to determine if a federal interest existed for investing public resources in a more detailed feasibility study of Fountain Creek, north of Pueblo, Colorado.

Throughout the year 2000, public concerns were solicited and expressed during numerous public forums conducted by the Pikes Peak Area Council of Governments (PPACG), as well as various meetings with their member governments. A summary of the public concerns, relative to the establishment of planning objectives and constraints, is as follows:

- Bank erosion
- Sedimentation
- Flooding
- Water Quality
- Quality of Riparian Habitat
- Safety
- Aesthetics
- Lack of Recreational Opportunities

The objectives identified during the reconnaissance phase were:

- To develop a holistic baseline model that portrays the existing hydrologic, hydraulic, and geomorphologic characteristics of the Fountain Creek watershed so that comprehensive watershed planning and management can be accomplished;

- To restore the natural structure, functions, habitat, and stability of Fountain Creek and its tributaries, including the riparian corridor, to enhance ecosystem quality for existing native and/or endangered species populations;
- To reduce flood damages within the urban and suburban areas within the Fountain Creek watershed; and
- To increase the opportunity for passive recreation through basin-wide planning, management, restoration, and flood damage reduction.

The reconnaissance study, which identified federal interest in further cost-shared feasibility-level studies, was approved in November 2001.

While the reconnaissance study was underway, a separate watershed-wide study was conducted by the PPACG and the Pueblo Area Council of Governments (PACOG). The resulting Fountain Creek Watershed Plan was completed in 2001 and updated in 2003. It can be found online at http://www.fountain-crk.org. The executive summary states:

> "The *Fountain Creek Watershed Plan* was developed in 2000-01 and updated in 2003 to address the need expressed by local governments, soil and water conservation districts, and private property owners for a more comprehensive understanding of the Fountain Creek Watershed. This *Plan* describes the existing conditions in the Fountain Creek Watershed and serves as a foundation to build upon in current and future planning efforts, including the Army Corps of Engineers Watershed Study. The *Plan* documents the problems and issues related to erosion, sedimentation and flooding within the watershed; establishes priorities upon which to focus in future work; and makes specific technical and policy implementation recommendations. The issues are addressed in the context of a watershed and, as such, recognize that problems must be solved collectively by the federal and state governments, local governments and private property owners."

The boards of PPACG and PACOG adopted the recommendations of the Fountain Creek Watershed Plan in October 2003. The Fountain Creek Watershed Plan helped to focus the efforts of the Fountain Creek Watershed Study. A number of the recommendations made in the Fountain Creek Watershed Plan have already been addressed by the Fountain Creek Watershed Study.

During development of the scope for the watershed study, the goals and objectives were altered from those presented in the reconnaissance study. Continued sponsor and stakeholder input throughout 2001 and 2002, as well as the Fountain Creek Watershed Plan, refined the goals and objectives to three simple statements that have guided the watershed study:

- Reduce flood risk in the Fountain Creek watershed,
- Reduce erosion in the Fountain Creek watershed, and
- Reduce sedimentation in the Fountain Creek watershed.

Baseline modeling efforts shifted from an objective of the study to technical components necessary to meet the revised objectives.

As the study objectives were focused during scope development, so too were the limits of the study. Sponsor input to the Fountain Creek Watershed Plan and to the scope for the Corps' Fountain Creek Watershed Study identified a total of 34 stream reaches as high priority areas of interest for detailed hydraulic and geomorphic studies. These areas are shown in Figure 1-3, Study Areas.

1.5 FEASIBILITY STUDY

The purpose of the watershed study is to develop an integrated watershed management plan for the Fountain Creek watershed. Currently, there is no long-term plan for sustainable management of the watershed. This must be developed to prevent further damage from flooding, erosion, and sedimentation in the watershed.

The watershed study will ultimately develop an integrated watershed management plan for the Fountain Creek watershed. Aspects of this management plan may include both general recommendations and the recommendation of specific projects for detailed implementation studies. The watershed management plan will serve as a framework for future watershed management decisions by the sponsors and other local, state, and federal agencies. A range of watershed management alternatives will be formulated that address the major problems within the watershed—flooding, erosion, and sedimentation. Alternatives may include watershed management practices to be implemented by local agencies as well as specific projects for potential participation by the USACE and other agencies.

1.6 LOCAL SPONSOR'S SUPPORT

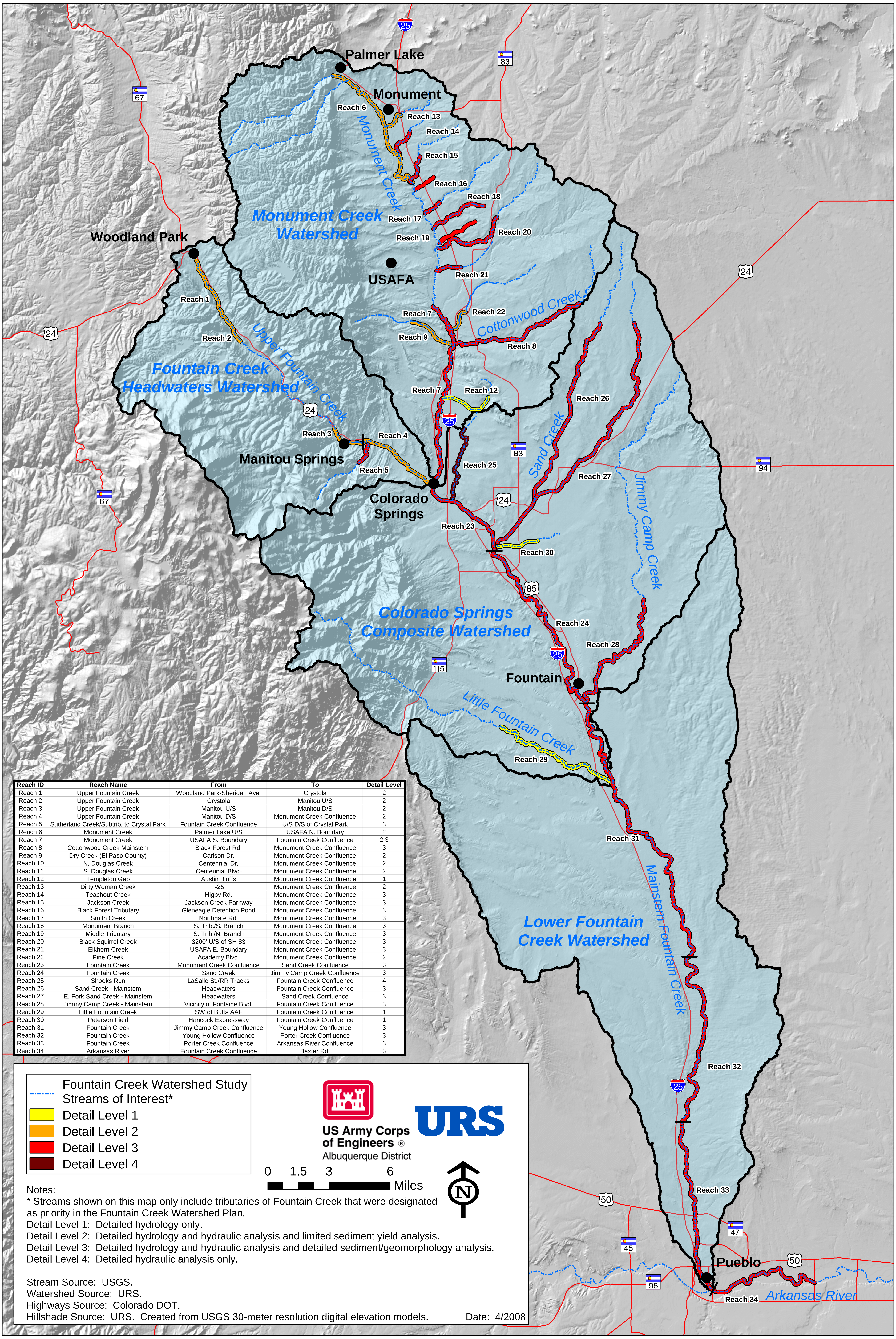
During the reconnaissance phase of this study, various federal (U.S. Geological Survey [USGS], Natural Resources Conservation Service [NRCS], Federal Emergency Management Agency [FEMA], U.S. Air Force Academy, Fort Carson), state, and local agencies, as well as watershed stakeholders, participated in various coordination activities. Thirteen sponsors, participants in the Fountain Creek Watershed Technical Advisory Committee (TAC), were identified in the reconnaissance study. Table 1-1, Fountain Creek Watershed Study Sponsors, lists the Fountain Creek Watershed Study sponsors. The City of Colorado Springs expressed an interest and willingness to participate in the cost-shared feasibility study as the signatory sponsor, with the goal of developing a comprehensive watershed management plan. The remaining sponsors have cost-sharing agreements with the City of Colorado Springs. All thirteen sponsors have a voice in determining the direction of the watershed study. Decisions on study-related issues are typically resolved during meetings of the TAC.

Table 1-1
Fountain Creek Watershed Study Sponsors

City of Colorado Springs – Signatory Sponsor	
El Paso County	Town of Monument
Pueblo County	City of Fountain
City of Pueblo	City of Manitou Springs
Teller County	Town of Green Mountain Falls
Town of Palmer Lake	Colorado Water Conservation Board
City of Woodland Park	Colorado Department of Local Affairs

Fountain Creek Watershed

Figure 1-3. Study Areas



Reach ID	Reach Name	From	To	Detail Level
Reach 1	Upper Fountain Creek	Woodland Park-Sheridan Ave.	Crystola	2
Reach 2	Upper Fountain Creek	Crystola	Manitou U/S	2
Reach 3	Upper Fountain Creek	Manitou U/S	Manitou D/S	2
Reach 4	Upper Fountain Creek	Manitou D/S	Monument Creek Confluence	2
Reach 5	Sutherland Creek/Subtrib. to Crystal Park	Fountain Creek Confluence	~~U/S~~ D/S of Crystal Park	3
Reach 6	Monument Creek	Palmer Lake U/S	USAFA N. Boundary	2
Reach 7	Monument Creek	USAFA S. Boundary	Fountain Creek Confluence	~~2~~ 3
Reach 8	Cottonwood Creek Mainstem	Black Forest Rd.	Monument Creek Confluence	3
Reach 9	Dry Creek (El Paso County)	Carlson Dr.	Monument Creek Confluence	2
~~Reach 10~~	~~N. Douglas Creek~~	~~Centennial Dr.~~	~~Monument Creek Confluence~~	~~2~~
~~Reach 11~~	~~S. Douglas Creek~~	~~Centennial Blvd.~~	~~Monument Creek Confluence~~	~~2~~
Reach 12	Templeton Gap	Austin Bluffs	Monument Creek Confluence	1
Reach 13	Dirty Woman Creek	I-25	Monument Creek Confluence	2
Reach 14	Teachout Creek	Higby Rd.	Monument Creek Confluence	3
Reach 15	Jackson Creek	Jackson Creek Parkway	Monument Creek Confluence	3
Reach 16	Black Forest Tributary	Gleneagle Detention Pond	Monument Creek Confluence	3
Reach 17	Smith Creek	Northgate Rd.	Monument Creek Confluence	3
Reach 18	Monument Branch	S. Trib./S. Branch	Monument Creek Confluence	3
Reach 19	Middle Tributary	S. Trib./N. Branch	Monument Creek Confluence	3
Reach 20	Black Squirrel Creek	3200' U/S of SH 83	Monument Creek Confluence	3
Reach 21	Elkhorn Creek	USAFA E. Boundary	Monument Creek Confluence	3
Reach 22	Pine Creek	Academy Blvd.	Monument Creek Confluence	2
Reach 23	Fountain Creek	Monument Creek Confluence	Sand Creek Confluence	3
Reach 24	Fountain Creek	Sand Creek	Jimmy Camp Creek Confluence	3
Reach 25	Shooks Run	LaSalle St./RR Tracks	Fountain Creek Confluence	4
Reach 26	Sand Creek - Mainstem	Headwaters	Fountain Creek Confluence	3
Reach 27	E. Fork Sand Creek - Mainstem	Headwaters	Sand Creek Confluence	3
Reach 28	Jimmy Camp Creek - Mainstem	Vicinity of Fontaine Blvd.	Fountain Creek Confluence	3
Reach 29	Little Fountain Creek	SW of Butts AAF	Fountain Creek Confluence	1
Reach 30	Peterson Field	Hancock Expressway	Fountain Creek Confluence	1
Reach 31	Fountain Creek	Jimmy Camp Creek Confluence	Young Hollow Confluence	3
Reach 32	Fountain Creek	Young Hollow Confluence	Porter Creek Confluence	3
Reach 33	Fountain Creek	Porter Creek Confluence	Arkansas River Confluence	3
Reach 34	Arkansas River	Fountain Creek Confluence	Baxter Rd.	3

Fountain Creek Watershed Study Streams of Interest*
Detail Level 1
Detail Level 2
Detail Level 3
Detail Level 4

US Army Corps of Engineers®
Albuquerque District

URS

0 1.5 3 6 Miles

N

Notes:
* Streams shown on this map only include tributaries of Fountain Creek that were designated as priority in the Fountain Creek Watershed Plan.
Detail Level 1: Detailed hydrology only.
Detail Level 2: Detailed hydrology and hydraulic analysis and limited sediment yield analysis.
Detail Level 3: Detailed hydrology and hydraulic analysis and detailed sediment/geomorphology analysis.
Detail Level 4: Detailed hydraulic analysis only.

Stream Source: USGS.
Watershed Source: URS.
Highways Source: Colorado DOT.
Hillshade Source: URS. Created from USGS 30-meter resolution digital elevation models.

Date: 4/2008

1.7 COLLABORATIVE EFFORTS IN THE FOUNTAIN CREEK WATERSHED

A watershed study is a collaborative effort. Any attempt to compile, comprehend, and address the issues and concerns in a 930-square-mile watershed while working with 13 local sponsors requires a great deal of collaboration. During the course of the Fountain Creek Watershed Study, two distinctly different collaborative efforts have played important roles in steering the study.

1.7.1 Fountain Creek Watershed Technical Advisory Committee

The need for an organization geared toward protecting the Fountain Creek Watershed was first recognized by landowners who live and work along Fountain Creek between Colorado Springs and Pueblo. As early as the 1970s, Board Members of the El Paso County Soil Conservation District noted that the behavior of Fountain Creek was changing negatively in response to hydrologic modification.

The Fountain Creek Watershed Project (Project) was formed in 1995 to combat the many problems associated with streambank erosion, flooding, and water quality occurring throughout the watershed. The Project brought attention to the problems along Fountain Creek through newsletters, distribution of Best Management Practice pamphlets, videos, tours of the watershed, media interviews, and other community outreach efforts. The project raised awareness among stakeholders and established a mailing list of over 350 individuals.

In 1998, the members of the Project created the Fountain Creek Watershed Forum (Forum) in conjunction with PPACG. The Forum was an interim, tri-level, regional structure formed to increase public awareness and education and to build long-term solutions. It consisted of the:

- PPACG and PACOG Boards of Directors (regional planning agencies governed by the elected officials of their member entities),
- Policy Development Committee (PDC) made up of elected officials, and
- TAC made up of technical representatives of all local governments in the watershed and state and federal agencies.

This structure involved the elected officials from throughout the watershed and all the cities and counties within the watershed and was able to leverage funding better than previous watershed efforts. During this period, in April/May 1999 a flood occurred in the Fountain Creek Watershed, which brought renewed awareness to the problems in the watershed and a new sense of urgency.

Meetings of the PDC were discontinued in 2001, and updates were made directly of the PPACG and PACOG Boards. The TAC still has regular monthly meetings. Some of the accomplishments of the TAC include development of the Fountain Creek Watershed Plan, Impervious Surface Area Analysis Report, and Public Outreach and Education, which includes development of a website and newsletters, initiation of the Fountain Creek Watershed Study, and the creation of a GIS database.

Throughout the course of the Fountain Creek Watershed Study, the TAC has served as the conduit through which information has passed on study-related tasks. Updates on study progress are presented at the semi-monthly TAC meetings. Changes in scope, requests for information, and scheduling of tasks are frequently discussed in these meetings. Members of the TAC address day-to-day technical issues. The TAC is ultimately responsible for sponsor direction of the watershed study.

1.7.2 Fountain Creek Vision Task Force

The Vision Task Force was created in July 2006 and includes representatives from local, state, and federal governments and agencies; citizens and landowners; environmental organizations; land conservation organizations; and members of Colorado's Congressional delegation.

The stated mission of the Vision Task Force:

> The members of the Fountain Creek Vision Task Force have come together to turn the Fountain Creek watershed into a regional asset that adds value to our communities. We are working to create a healthy waterway with appropriate erosion, sedimentation, and flooding that supports diverse economic, environmental, and recreational interests. We will cooperate to enhance and protect Fountain Creek, promoting sustainable use by members of our watershed community and by the visitors we know this wonderful natural amenity will attract.

The Vision Task Force is made up of a Consensus Committee and a number of working groups. The Consensus Committee is the decision-making body of the Fountain Creek Vision Task Force. It is a representative group of 28 individuals, interests, agencies, and organizations that meet monthly and makes decisions by consensus. All meetings are open to the public. Each of the groups or entities in Table 1-2, Fountain Creek Vision Task Force Consensus Committee Participants, has one participant on the Consensus Committee.

Table 1-2
Fountain Creek Vision Task Force Consensus Committee Participants

City of Colorado Springs	Fountain Utilities
City of Fountain	Lower Arkansas Valley Water Conservation District
City of Palmer Lake	Pikes Peak Area Council of Governments (elected)
City of Pueblo	Pikes Peak Area Council of Governments (staff)
City of Pueblo residents (Colorado Progressive Coalition)	Pueblo Area Council of Governments (elected)
Colorado Open Lands	Pueblo Area Council of Governments (staff)
Colorado Springs Utilities	Pueblo Board of Water Works
Colorado State Parks	Pueblo County
Congressman Lamborn	Pueblo County property owners
Congressman Salazar	Senator Allard
Department of Defense	Senator Salazar
El Paso County	Sierra Club
El Paso County property owners	Technical Advisory Committee (TAC)
El Paso County Water Authority	Teller County

In addition to the Consensus Committee, working groups meet monthly to address water quality, water quantity, land use and environment, funding options, and public outreach. Working group membership is not restricted, and anyone who is interested may participate. Issue experts are often invited from other agencies or geographic areas to participate in discussions or working groups. All working group meetings are open to the public.

As the watershed study heads to completion, the collaborative interplay with the Vision Task Force has increased. The recommendations of the Vision Task Force are expected to be finalized in 2008, near the same time as the draft Fountain Creek Watershed Management Plan.

The Fountain Creek Vision Task Force is a parallel effort to the Fountain Creek Watershed Study with no oversight or direct control of the study.

1.8 WATERSHED PROBLEMS, PLANNING GOALS, OBJECTIVES, AND CONSTRAINTS

1.8.1 Population and Land Use Changes

Development of land, no matter the purpose, has the effect of changing how water interacts with the land. Changes in amount and type of vegetative cover can increase the amount of water that infiltrates through the ground or can increase the amount of water used by evapotranspiration. Changes in impervious cover can decrease the amount of water that infiltrates through the ground and increase the amount of water that runs off to nearby streams. Flooding, erosion, and sedimentation are all processes that occur in nature without human influence. However, when the population of an area begins to grow and humans begin to change the land such that the impervious cover increases, these natural processes of flooding, erosion, and sedimentation are increased as well.

The Fountain Creek Watershed has undergone substantial growth in the past 50 years. Table 1-3, Fountain Creek Watershed Population Change shows change in population of the major counties and communities within the watershed. The total population in the combined counties increased by 156% since 1960.

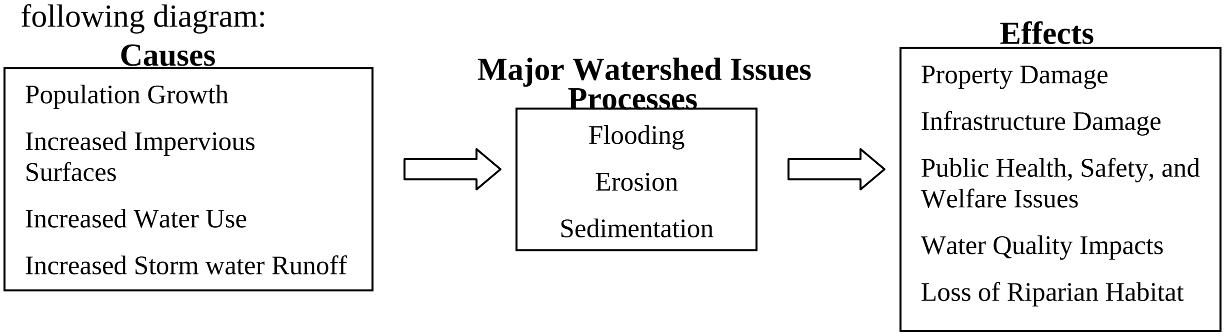
Table 1-3 Fountain Creek Watershed Population Change					
	1960	1970	1980	1990	2000
El Paso County	143,742	235,972	309,424	397,014	516,929
Pueblo County	118,707	118,238	125,972	123,051	141,472
Teller County	2,495	3,316	8,034	12,468	20,555
Woodland Park	*	*	2,634	4,610	6,515
Manitou Springs	3,626	4,278	4,475	4,535	4,980
Green Mountain Falls	*	*	607	663	773
Colorado Springs	70,194	135,060	215,105	281,140	360,890
Palmer Lake	*	*	1,130	1,480	2,179
Monument	*	*	690	1,020	1,971
Fountain	1,602	3,515	8,324	9,984	15,197
Pueblo	97,453	91,181	101,686	98,640	102,121

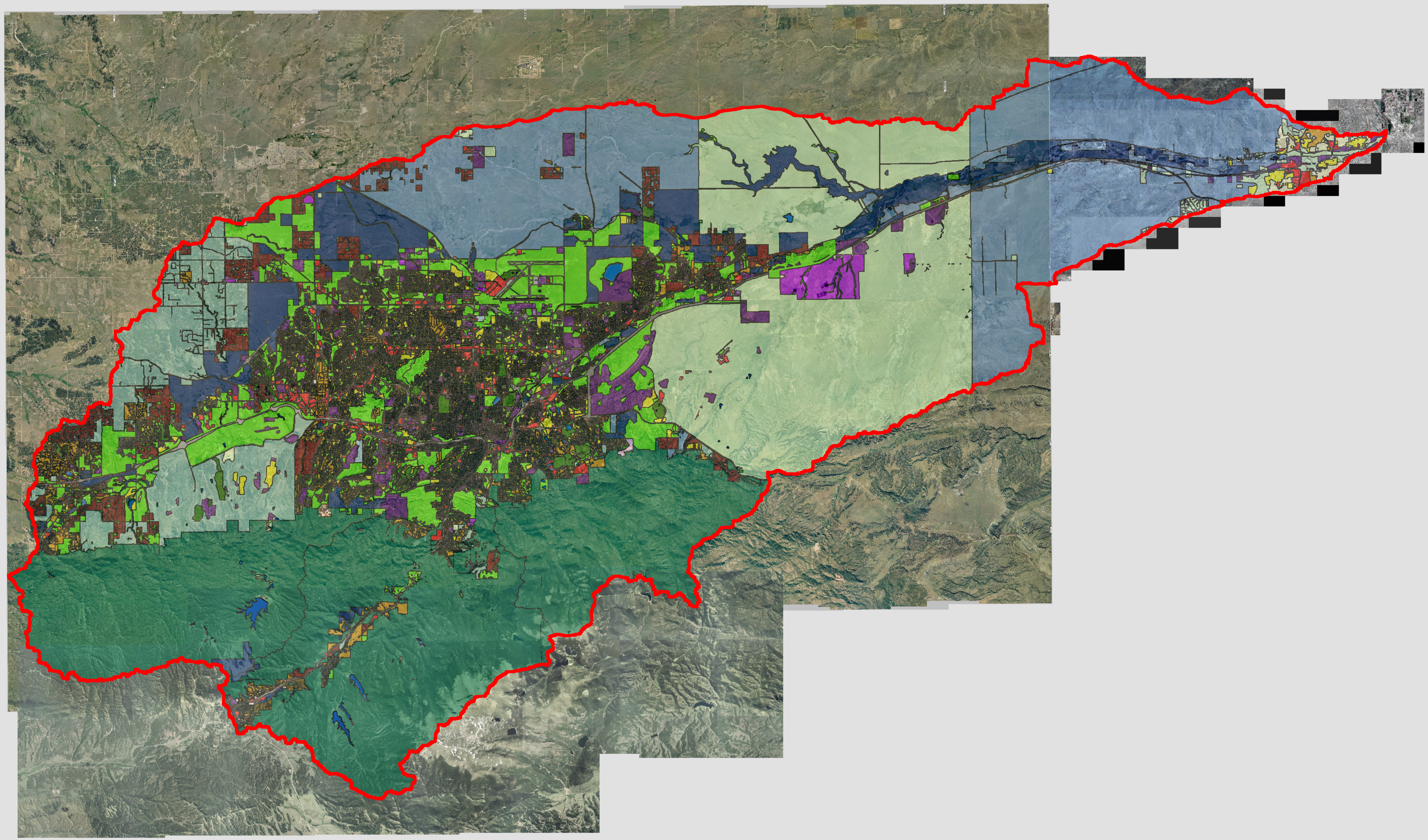
Note: * indicates data not available

Figure 1-4, Existing Land Use; Figure 1-5, Future Land Use; and Figure 1-6, Existing and Future Land Use Legend, show existing and future land use within the Fountain Creek Watershed. The future condition is a composite from the various watershed entities roughly representing the year 2025. Major changes are expected to occur in the Jimmy Camp Creek subwatershed, the mainstem of Monument Creek, and the mainstem of Fountain Creek above Pueblo. The 2005 Impervious Surface Area and Watershed Health Analysis Report prepared by PPACG indicates that pasture, grassland, or range land uses will decrease by over 50% within the Jimmy Camp Creek subwatershed. Residential 1/8 acre or less land use will almost entirely replace the existing land use. Similar changes are expected to occur in the Monument Creek mainstem adjacent to the U.S. Air Force Academy. On the Fountain Creek mainstem north of Pueblo significant reductions in the pasture, grassland, or range land uses will result in increases of commercial and business land use.

1.8.2 Watershed Problems

Meetings were held in October 2004 and June 2007 with sponsors and stakeholders to discuss their issues. The October 2004 meeting reiterated the concerns identified in the reconnaissance study. The June 2007 meeting identified a new concern with water quality. Problems were identified through these meetings. The major issues in the watershed can be summarized by the following diagram:





URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

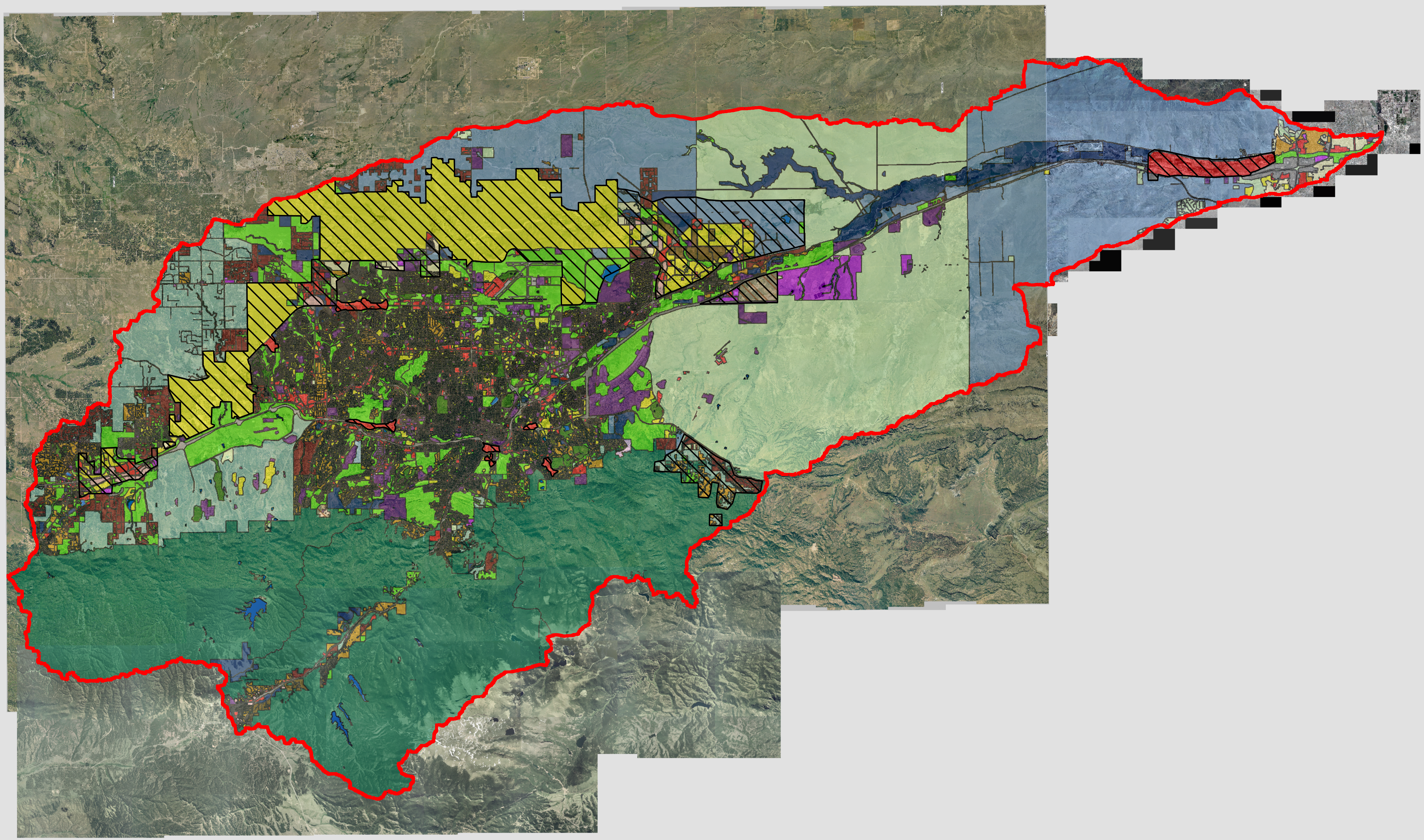
US Army Corps of Engineers ®
Albuquerque District

Existing Land Use

Figure 1-4

4/2008

Fountain Creek Watershed Study, URS Project 21711283



Future Land Use

Figure 1-5

Watershed Boundary

Major Planned Developments (Approx.)

Note: See Figure 1-6 for future land use legend.

Scale is: 1:285,120
or
1 inch equals 4.5 miles

0 4.5 9 Miles

URS

URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers ®
Albuquerque District

4/2008

Fountain Creek Watershed Study, URS Project 21711283

Existing and Future Assigned NRCS Land Use Classes

- Commercial and Business
- Commercial and Business-50%, Open Space, fair condition-50%
- Industrial and Institutional
- Industrial and Institutional-50%, Open Space, fair condition-50%
- Industrial and Institutional-50%, Pasture, Grassland, or Range, fair condition-50%
- Newly Graded Areas
- Open Space, fair condition
- Open Space, good condition
- Open Space, poor condition
- Open Space, poor condition-50%, Streets and Roads, paved-50%
- Open Space, poor condition-80%, Impervious-20%
- Pasture, Grassland, or Range, fair condition
- Pasture, Grassland, or Range, poor condition
- Paved Parking Lots
- Residential 1 acre
- Residential 1/2 acre
- Residential 1/3 acre
- Residential 1/4 acre
- Residential 1/8 acre or less
- Residential 2 acre
- Streets and Roads, dirt
- Streets and Roads, gravel
- Streets and Roads, paved
- Streets and Roads, paved w/ROW
- Water
- Woods, fair condition
- Pine-Fir Forest (URS Designated)

URS
URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers ®
Albuquerque District

Existing and Future Land Use Legend

Figure 1-6

4/2008

Fountain Creek Watershed Study, URS Project 21711283

The major factors at work in the watershed are the processes of flooding, erosion, and sedimentation. The following photographs, photos 1-1 through 1-14, are indicative of the problems experienced within the Fountain Creek watershed.

Photo 1-1. Flood damage in Palmer Lake.

Photo 1-2. Flooding in Manitou Springs in 1999.

Photo 1-3. Pipeline damage in Colorado Springs.

Photo 1-4. Collapsed Railroad Bridge on Sand Creek.

Photo 1-5. Damage on Monument Creek in Colorado Springs.

Photo 1-6. Damage at Rampart Park in Colorado Springs.

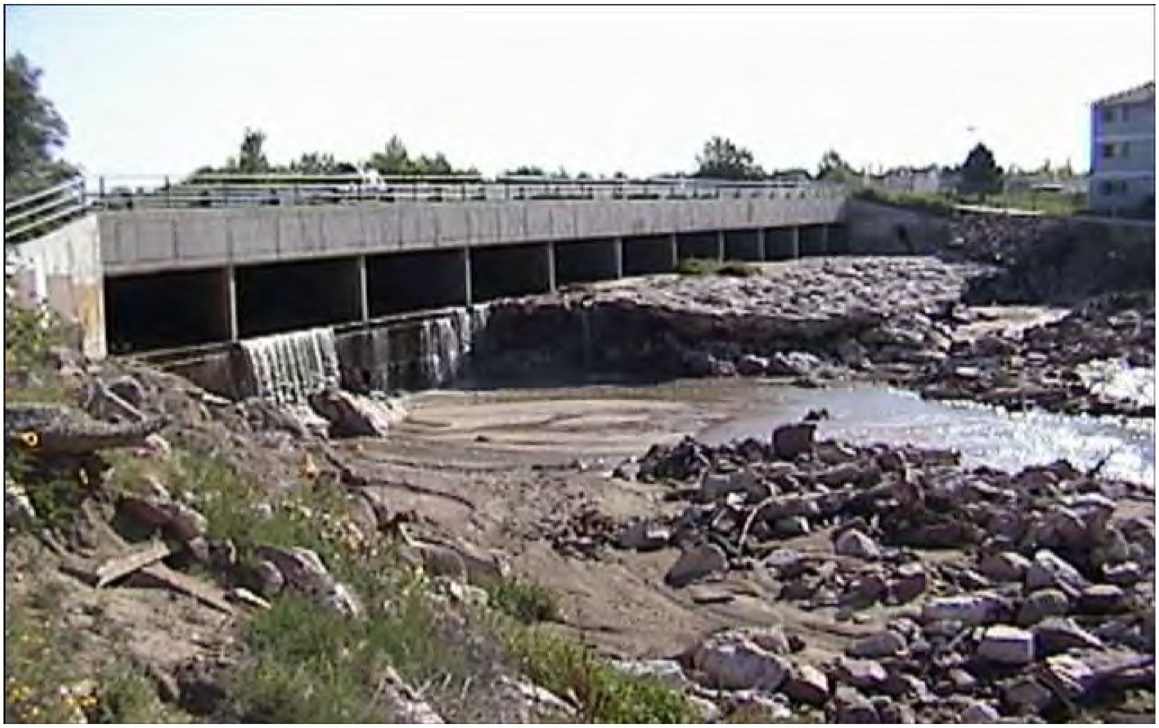


Photo 1-7. Erosion on Sand Creek below Chelton Road in Colorado Springs.

Photo 1-8. Floodplain encroachment on Cheyenne Creek in Colorado Springs.

Photo 1-9. Damage to electrical utilities in Fountain.

Photo 1-10. Erosion in El Paso County.

Photo 1-11. Erosion at Old Pueblo Road in El Paso County.

Photo 1-12. Sedimentation on agricultural land during the 1999 flood.

Photo 1-13. Erosion at the Target store in Pueblo during the 1999 flood.

Photo 1-14. Sedimentation at the Arkansas River confluence in Pueblo.

The watershed study includes an examination of watershed-wide problems; primarily erosion, sedimentation, and flooding. These issues are interrelated, as are their evaluation and potential solutions. As an example, Photo 1-15, Sand Creek Detention Pond 1, shows an on-line facility that was designed and functioning as a flood risk reduction facility. However, the facility upset the natural sediment transport balance in the stream channel. Photo 1-16, Erosion in Sand Creek immediately downstream of Sand Creek Diversion, shows considerable erosion of the stream bed (degradation) and sloughing of the banks downstream of the facility, causing the failure of an abandoned railroad bridge and drop structures. Further downstream, the sediment-laden flows reached a lower energy stream reach and deposited sediment on the stream bed (aggradation), thereby resulting in sedimentation as shown in Photo 1-17, Sedimentation in Sand Creek below Powers Boulevard.

Photo 1-15. Sand Creek Detention Pond 1.

Photo 1-16. Erosion in Sand Creek immediately downstream of Sand Creek Detention Pond 1.

Photo 1-17. Sedimentation in Sand Creek below Powers Boulevard.

This example is an oversimplification and does not clearly define the complex interaction of hydrology, hydraulics, and sediment transport. It is intended as a demonstration of the fact that the issues of flooding, erosion, and sedimentation are interrelated. These issues are being addressed in the watershed study through a comprehensive approach.

An abridged description of the overarching causes, processes, and effects related to the issues of flooding, erosion, and sedimentation is outlined below.

- Population growth has lead to changes in land use, (e.g., increase in impervious surface area) and increased water use.
- Changes in land use and increased water use have lead to an increase in the quantity of water, both peak flow and flow volume, in the stream system through increased flooding and increased baseflow.
- The stream system within the watershed is forced to “adjust” through the processes of erosion and sedimentation.
- Flooding, erosion, and sedimentation contribute to property and infrastructure damage, public health, safety, and welfare issues, and impacts to environmental resources (e.g., riparian habitat) and water quality.

1.8.3 Watershed Planning Goals

The overall goal of the watershed study is to develop a comprehensive basin-wide management plan that will:

- Incorporate public input and involvement;
- Assess watershed characteristics and conditions;
- Outline watershed issues/concerns with erosion/sedimentation as a key component;
- Analyze watershed issues/concerns;
- Develop, evaluate and prioritize conceptual alternatives including both structural and non-structural measures;
- Identify potential “spin-off” projects under appropriate federal, state, and/or local authorities; and
- Identify potential locally-funded projects.

1.8.4 Watershed Planning Objectives

Key planning objectives of the watershed study were developed with input by the Project Delivery Team, the local sponsors, and participating stakeholders. Three major objectives were identified at the outset of the study and have persisted through the development of the without project conditions. These objectives are:

- Reduce flood risk in the Fountain Creek watershed;
- Reduce erosion in the Fountain Creek watershed;

- Reduce sedimentation in the Fountain Creek watershed; and
- Improve water management in urban and urbanizing areas in the Fountain Creek watershed.

The last objective was added during the review of the "without project" condition phase of the watershed study.

1.8.5 Watershed Planning Constraints

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions. The planning constraints identified in this study are:

- Compliance with applicable state and local regulations;
- Compliance with Arkansas River Compact;
- Avoidance of impacts to existing riparian, wetland, and aquatic habitats;
- Avoidance of impacts to threatened and endangered species;
- Availability of water for development of ecosystem restoration features; and
- Avoidance of impacts downstream of Fountain Creek watershed.

1.9 PRIOR STUDIES

Numerous studies have been conducting pertaining to water and related land resources within the study area. The listing is not intended to be a comprehensive list of previous reports, but rather provides a sample of types of studies that have been completed in the study area.

The following reports are being reviewed as a part of this study:

1) U.S. Army Corps of Engineers, Albuquerque District. *Reconnaissance Study, Fountain Creek North of Pueblo, CO, Woodland Park to U.S. Highway 24*. August 1985.
2) U.S. Army Corps of Engineers, Albuquerque District. *Reconnaissance Study, Fountain Creek North of Pueblo, CO, Monument Creek to Arkansas River, CO*. August 1985.
3) U.S. Army Corps of Engineers, Albuquerque District. *Reconnaissance Study, Fountain Creek North of Pueblo, CO, Central Fountain Creek, U.S. Highway 24 to Monument Creek, CO*. August 1985.
4) U.S. Army Corps of Engineers, Albuquerque District. *Reconnaissance Study, Fountain Creek, Colorado Springs, CO, 33rd Street to Monument Creek.*
5) U.S. Army Corps of Engineers, Albuquerque District. *Data Book, Flow-Damage Data for Selected Locations in the Albuquerque District*. April 1994.
6) U.S. Army Corps of Engineers, Albuquerque District. *Post Flood Assessment, Arkansas River and Tributaries*. September 1999.
7) Pikes Peak Area Council of Governments. *Fountain Creek Watershed Plan*. 2003.

1.10 PUBLIC INVOLVEMENT

Two public meetings were held in December 2004, one in Colorado Springs and one in Pueblo, to inform the public of the watershed study and also to get feedback on issues within the watershed. Copies of presentation materials are included as Appendix A, Public Involvement Presentation Materials December 2004. The only new issue to appear from the public meetings was the presence of selenium in groundwater that mobilized into Fountain Creek between Fountain and Pueblo.

An additional public meeting, in the form of an elected officials briefing, was held in June 2005 in Fountain, Colorado.

Upon completion of the draft Fountain Creek Watershed Management Plan two public meetings were held in November, 2008, in Pueblo and Colorado Springs seeking public comment on the draft document. No major issues were identified at these final public meetings.

2.1 CLIMATE AND PRECIPITATION

The climate of the Fountain Creek watershed is broadly characterized as semiarid with warm summers and mild to cold winters. It can vary from alpine arctic to semiarid depending on the elevation and proximity to the Front Range. The U.S. Geological Survey (USGS) reports that annual precipitation generally decreases with distance from the Fountain Creek and Monument Creek headwaters as elevation decreases (Stogner 2000). The USGS precipitation gauge at Ruxton Park station consistently receives the most average annual precipitation within the Fountain Creek watershed at 24.5 inches (in). The reporting station at Pueblo receives the least average rainfall annually at 11.9 in. Approximately 70 to 80 percent of daily precipitation that occurs in the region is less than or equal to about 0.25 in. (PPACG 2003).

Most of the storms in the Fountain Creek watershed occur from May through August. During this period, masses of warm, moist air from the Gulf of Mexico combine over higher land with cooler, drier air from the Polar Regions to cause thunderstorm activity. The most severe storms often occur in the transitional periods of late spring and early fall, when polar air intrusions are most intense. Snowmelt has seldom contributed significantly to flood occurrences on Fountain Creek (FEMA 1999).

2.2 GEOLOGY

The Fountain Creek watershed lies primarily in the Piedmont Province, an erosional valley separating the Rocky Mountain Province from the High Plains Province. The present Rocky Mountains were formed during a period of intense mountain building and faulting, known as the Laramide Orogeny. During this period the Front Range, which forms the western boundary of the Fountain Creek watershed, was uplifted. Precambrian rocks, composed of granite, gneiss and schist (1–1.75 million years old), were thrust upward. Overlying younger sedimentary rocks were uplifted, stretched, and draped across the mountain cores. Twenty million years after the uplift ceased, the mountains began to erode. Rivers and streams carried large amounts of sediments to the base. These Quaternary sediments now comprise much of the surficial deposits through which the streams in the Fountain Creek watershed flow.

In the northern portion of the Fountain Creek watershed, a series of steeply tilted sedimentary rocks marks a transition from the higher elevations of the Front Range to the gently sloping sandstone and shale deposits of the Piedmont Province. The sandstone formations were deposited as ancient beaches, bars, and coastal floodplains during the retreat of a shallow sea in the Cretaceous period. Underlying these sandstones is the older Pierre shale, a sedimentary rock that dominates the southern portion of the watershed and is made up of clay-sized minerals deposited in a shallow marine environment before the seas began to retreat from the area (PPACG 2003).

2.3 SOILS

Soils in the Fountain Creek watershed differ in accordance with the variations in physiography and elevation. There are nearly 200 unique NRCS soil-mapping units identified within the watershed. The watershed can be divided into three general physiographic regions as shown in Figure 2-1, Soils Physiographic Region, and summarized in Table 2-1, Soil Characteristics Summary: the Mountains and Foothills (Pikes Peak-West and Foothills-North); the Plains (Colorado Springs area and Plains to the East); and Terraces and Floodplains (Valley-South).

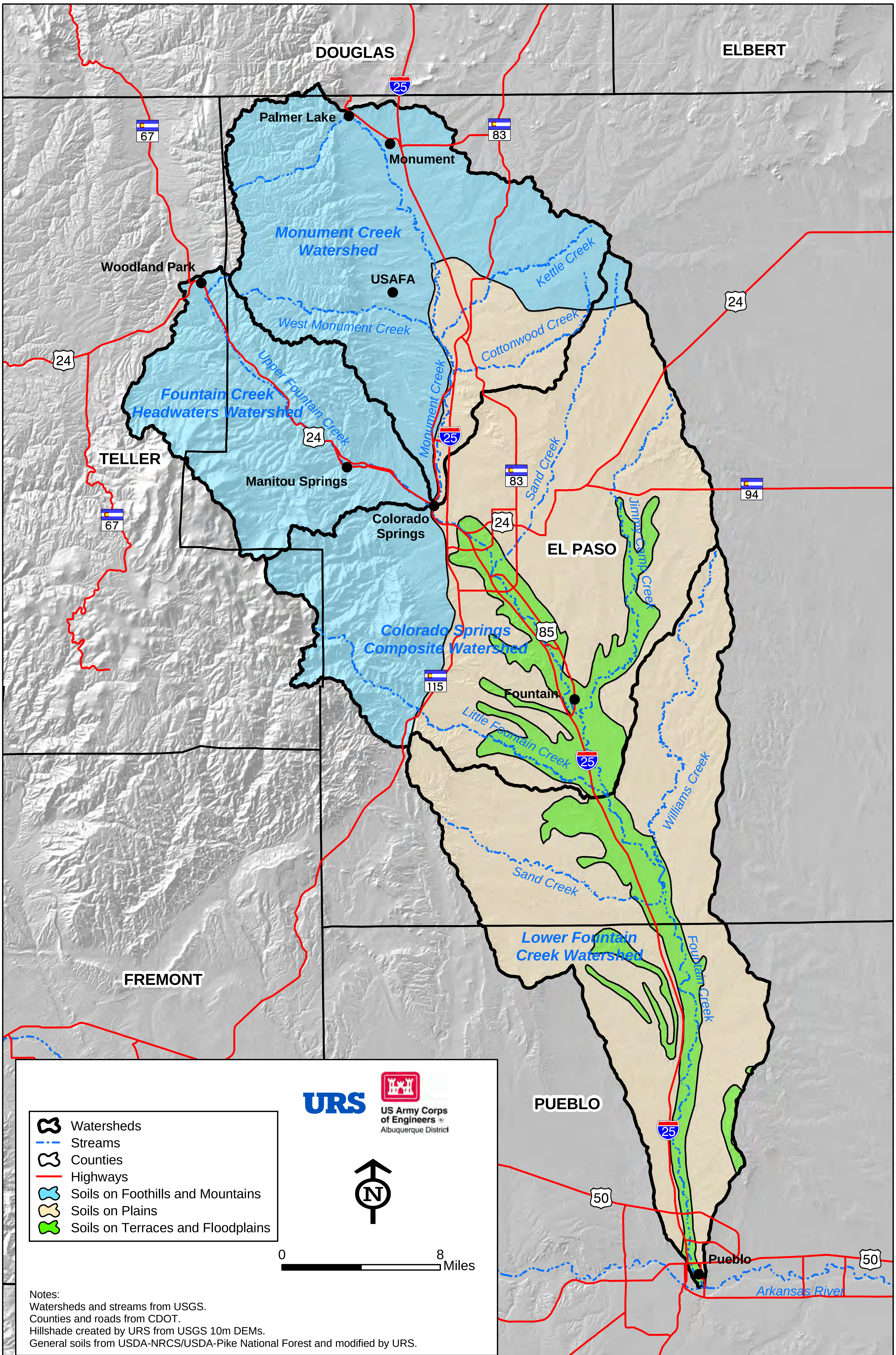
Table 2-1
Soil Characteristics Summary

	Pikes Peak-West	Foothills-North	Colorado Springs Area and Plains to the East	Valley-South
Soil Characteristics	Shallow, gravelly soils derived from Pikes Peak Granite	Moderately deep, coarse sand derived from layers of sandstone	Deep sands deposited by wind	Shallow and moderately deep, derived from shale
Soil Description	Shallow and poorly developed	Moderately deep to sandstone bedrock with some areas exposed to the surface	Deep, well-developed, existing on gentle slopes, high sand content combined with high wind (from plains) result in high wind erodibility	Clays in this area expand and contract with changes in moisture content; therefore, shrink-swell is a major management concern
Erosion Susceptibility	High	Moderate	Low	Moderate – High
Runoff Susceptibility	Rapid	Medium	Slow	Moderate – Rapid
Elevation	7000-14000 feet	6800-7700 feet	6000-7000 feet	4600-6100 feet
Slope	25-90%	1-40%	1-20%	3-25%
Average Precipitation	22 inches	18 inches	15 inches	13 inches
Geographic Extent	Present in the quadrant extending from the confluence of Fountain Creek and Monument Creek north and west approximately along the Creek boundaries	Present in the quadrant extending from the confluence of Fountain Creek and Monument Creek north and east approximately along the Creek boundaries	Present in the quadrant extending from the confluence of Fountain Creek and Monument Creek south and east approximately along the Creek boundaries	Present in the quadrant extending from the confluence of Fountain Creek and Monument Creek south and west approximately along the Creek

Source: U.S. Department of Agriculture, Natural Resources Conservation Service, and El Paso County Service Center Staff

Fountain Creek Watershed Study

Figure 2-1. Soils Physiographic Regions



Date: 10/2007

The Mountains and Foothills contain shallow to moderately deep, poorly developed soils that consist of gravelly sandy loam and coarse sandy loam textures combined with areas of exposed bedrock. The soils and outcrops associated with Mountains and Foothills are generally found on hills, ridges, mesas, mountainsides and foothill slopes, as well as alluvial fans and terraces.

The Plains primarily contain deep, well-developed soils that consist of sandy loam, loamy sands, or clay loam textures. Soils associated with Plains are typically found on terraces, hills, low dune-like ridges, escarpments, side slopes, uplands, and alluvial fans that spread from the base of mesas. Terraces and Floodplains areas comprise shallow to moderately deep soils of sandy clay loam, sandy loam, or silt loam textures. The soils are located on ridges, terrace side slopes, escarpments, and gently undulating mesas, and are associated with major stream corridors (URS 2005).

Soils are classified into hydrologic soil groups by the NRCS for the purpose of hydrologic modeling. Hydrologic soil group is a parameter assigned to each soil series by the NRCS to reflect the relative rate of infiltration of water into the soil profile. NRCS *Technical Release 55* (*TR-55*) (1986) defines four hydrologic soil groups A, B, C, and D. The hydrologic soil group was determined for each of the soil-mapping units from the NRCS and Pike National Forest soils data obtained for El Paso, Pueblo, and Teller counties.

2.4 VEGETATION

Vegetation in the Fountain Creek watershed varies dramatically with climate and landscape position. Vegetation patterns generally follow the three physiographic regions outlined above. The Mountains and Foothills region consists of mixed conifers including ponderosa pine (*Pinus ponderosa*), Douglas fir (*Pseudotsuga menziesii*), white fir (*Abies magnifica*), Gambel's oak (*Quercus gambelii*), and a variety of upland grasses and forbs. Plains vegetation consists of short- and mid-height upland grasses with widely scattered ponderosa pine, pinyon pine (*Pinus monophylla*) and juniper (*Juniperus scopulorum*). Upland grasses include grama (*Bouteloua sp*.), western wheatgrass (*Pascopyrum smithii*), needleandthread (*Stipa comata*), and little bluestem (*Schizachyrium scoparium*) among others. The Terraces and Floodplains associated with stream corridors are dominated by riparian vegetation including willow (*Salix sp.*), alder (*Alnus incana*), cottonwoods and poplars (*Populus sp.*), sedges (*Carex sp.*), and rushes (*Juncus sp.*), interspersed with upland grasses (URS 2005). Non-native invasive species present along riparian corridors include salt cedar (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*).

2.5 LAND USE OVERVIEW

The cities of Colorado Springs and Pueblo are respectively the second and sixth largest metropolitan areas along the Front Range (Colorado Department of Local Affairs 2001). The Fountain Creek watershed reflects a variety of land uses including residential (high, medium, and low density), commercial and office, industrial, parks and open space, schools and institutions, agricultural, and rangeland land. Most agricultural land is located along the lower portion of the main stem of Fountain Creek. Driven by projected population growth in the northern and central portions of El Paso County, land use is expected to reflect an increasing percentage of residential and commercial/industrial use (PPACG 2003). Existing and future land use data and graphics are provided in *Fountain Creek Watershed Study Hydrology Report* (URS 2006a). For the purposes of this study, existing land use was determined from data for circa 2005 while future land use was estimated from the best available long-term planning data. In Pueblo County, future land use was based on zoning data for circa 2025. In El Paso County, future land use was based on projected land use for circa 2035.

2.6 HYDROLOGIC, HYDRAULIC, AND GEOMORPHOLOGIC STUDIES

2.6.1 Scope

Hydrologic, hydraulic, and geomorphologic studies of Fountain Creek and select major tributaries were conducted as part of the watershed study. In total, 24 streams were evaluated in varying detail as outlined in Table 2-2, Project Streams. The scope of hydrologic, hydraulic, and geomorphologic studies is represented graphically in the map shown in Figure 2-2, Fountain Creek Watershed – Subwatersheds.

Table 2-2
Project Streams

Stream Name	Hydrologic Study Area (sq mi)	Hydraulic Study Length (mi)	Geomorphology Study Length (mi)
Fountain Creek	930	47.5	56.4
Tributaries included in project:			
Upper (West) Fountain	119	11.4	Limited Study Only
Sutherland Creek	5	1.4	1.5
Monument Creek	237	20	11.3*
Cottonwood Creek	19	8	8.2
Dry Creek (El Paso County)	4	2.3	Limited Study Only
Templeton Gap Floodway	9	Not Studied	Not Studied
Dirty Woman Creek	5	1.3	Limited Study Only
Teachout Creek	3	1.7	1.8
Jackson Creek	4	1.6	1.7
Black Forest Creek	2	1.2	1.3
Smith Creek	6	1.1	1.2
Monument Branch	3	3.4	3.6
Middle Tributary	1	2.5	2.6
Black Squirrel Creek	11	4.9	3.8
Elkhorn Tributary	1	1.3	1.4
Pine Creek	9	1.4	Limited Study Only
Sand Creek	53	13.7	14
East Fork Sand Creek	27	12.4	12.6
Jimmy Camp Creek	68	8.6	4.2
Little Fountain Creek	54	Not Studied	Not Studied

Table 2-2 Project Streams			
Stream Name	Hydrologic Study Area (sq mi)	Hydraulic Study Length (mi)	Geomorphology Study Length (mi)
Peterson Field Tributary	8	Not Studied	Not Studied
Arkansas River	Not Studied	6.7	7.4
Shooks Run	Not Studied	4.4	Not Studied

*In addition to the 11.3 miles of Monument Creek that was analyzed in the detailed geomorphologic study, another 9 miles of Monument Creek was studied by limited methods.

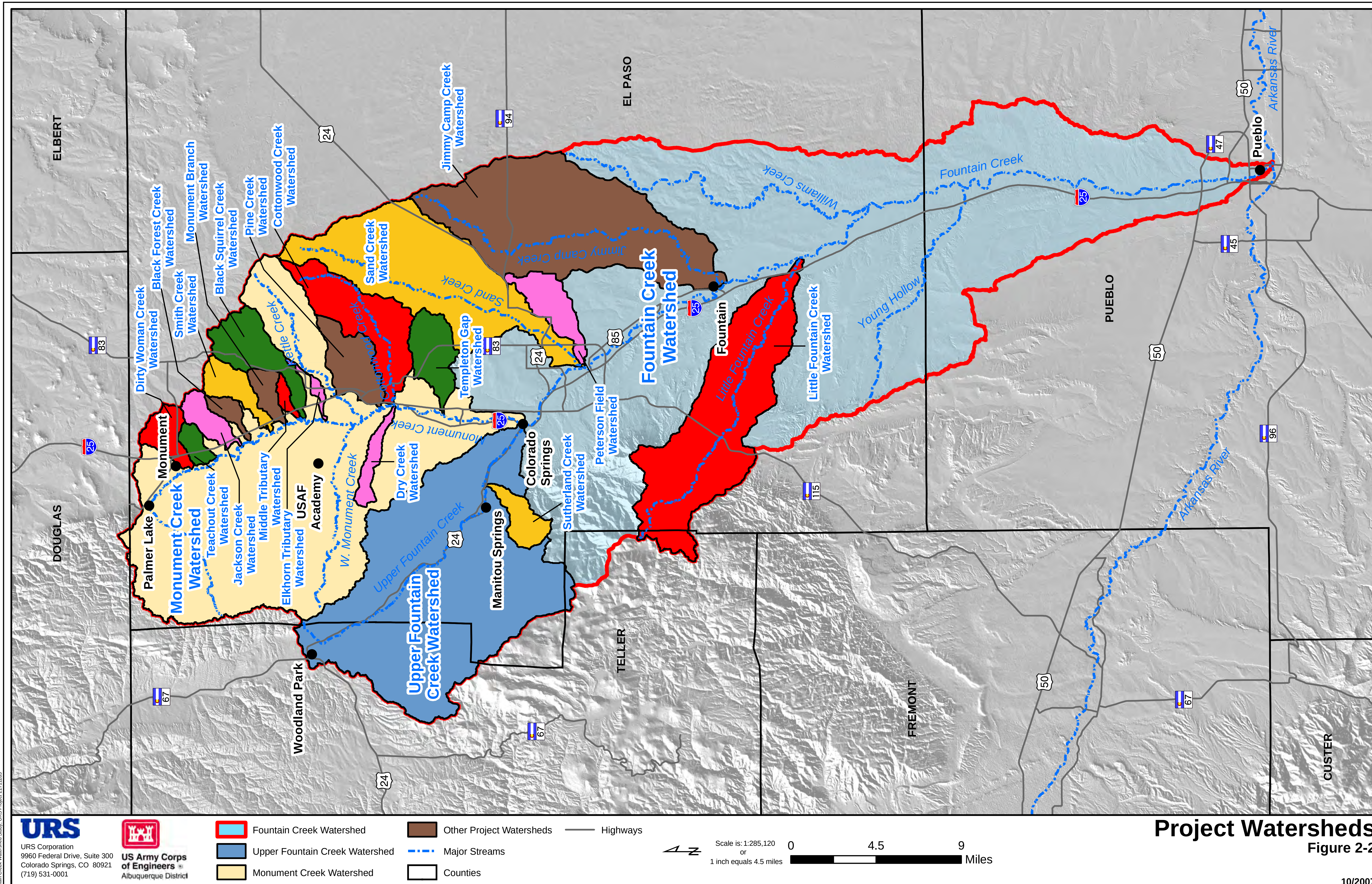
Hydrologic studies included the development of existing (circa 2005) and future (circa 2025) conditions hydrology models to generate flood hydrographs and estimate peak discharges at select concentration points throughout the Fountain Creek watershed. The complete hydrologic studies are detailed in *Fountain Creek Watershed Study Hydrology Report* (URS 2006a). Hydraulic studies included the development of existing and future conditions hydraulic models to establish water surface profiles and hydraulic conditions for a range of flood events. The complete hydraulic studies are detailed in *Fountain Creek Watershed Study Hydraulics Report* (URS 2006b). Geomorphologic studies included field investigations, time-series aerial photography analysis, bankfull flow analysis, and sediment transport modeling. The complete geomorphologic studies are detailed in *Fountain Creek Watershed Study Geomorphology Report* (URS 2007).

2.6.1.1 Flood History

According to the *Fountain Creek Watershed Plan*, the Fountain Creek floods of 1864, 1885, 1935, and 1965 would be classified as “major” flood events in destructive capability. The 1935 flood was the largest and most destructive in the history of the city of Colorado Springs, and serves as Fountain Creek’s flood of record from Colorado Springs to the city of Fountain. Reported peak discharges were 50,000 cubic feet per second (cfs) for Monument Creek and 55,000 cfs for Fountain Creek above the confluence of Jimmy Camp Creek (FEMA 1999).

The flood resulted from excessive rainfall of short duration over an area of less than 100 sq mi in the Monument Creek watershed. In Colorado Springs, the storm total measured 7.19 in. at the Colorado College weather observatory (PPACG 2003).

The 1965 flood exceeded all known floods below the confluence of Fountain and Jimmy Camp Creeks to the El Paso County line. While it did not cause appreciable damage at Colorado Springs, the 1965 flood caused severe damage further downstream (PPACG 2003). The peak discharge in Jimmy Camp Creek was estimated to be 124,000 cfs at a point 4.5 mi upstream from its confluence with Fountain Creek (FEMA 1999). The peak flow reported at the USGS gauge on Fountain Creek at Pueblo was 47,000 cfs and is the largest flood of record at that site (USGS 2005).



Project Watersheds
Figure 2-2

Millions of dollars of damage resulted from flooding that occurred during the last day of April and the first few days of May 1999, when flood flows peaked at 20,100 cfs at the USGS gauge on Fountain Creek near Fountain and 18,900 at the USGS gauge on Fountain Creek at Pueblo (USGS 2005). This flood resulted in a federal disaster declaration for several counties within the Fountain Creek watershed and downstream on the Arkansas River. Floodwaters destroyed bridges, utility lines, and agricultural lands. High flows caused damage to numerous utility line crossings in the city of Colorado Springs and sent floodwaters down the main streets of Manitou Springs (PPACG 2003).

2.6.1.2 Stream and Watershed Descriptions

Descriptions of Fountain Creek and its associated tributaries evaluated for the project are summarized in Table 2-2, Project Streams, and described below.

Fountain Creek

Fountain Creek is the primary stream in the Fountain Creek watershed and is described in Section 1.1, Overview.

Upper (West) Fountain Creek

Upper (West) Fountain Creek is a perennial stream located west of the city of Colorado Springs with headwaters in the city of Woodland Park down to its confluence with Monument Creek near I-25 and Hwy 24. Upper (West) Fountain Creek flows south-easterly out of the Rampart Range along Hwy 24. The Upper (West) Fountain Creek watershed has a contributing drainage area of approximately 119 sq mi at its confluence with Fountain Creek and Monument Creek near downtown Colorado Springs.

Sutherland Creek

Sutherland Creek is a perennial stream located in the southern portion of the Upper (West) Fountain Creek watershed and flows north-easterly from the Pike National Forest. The Sutherland Creek watershed has a contributing drainage area of approximately 5.1 sq mi at its confluence with Upper (West) Fountain Creek just west of the Hwy 24 and the Manitou Springs bypass interchange.

Monument Creek

Monument Creek is a perennial stream located in the upper portion of the Fountain Creek watershed and is the primary tributary to Fountain Creek. Monument Creek flows easterly out of the Rampart Range and then southerly from the southern slope of the Palmer Divide. The Monument Creek watershed has a contributing drainage area of approximately 237 sq mi at its confluence with Fountain Creek near downtown Colorado Springs.

Cottonwood Creek

Cottonwood Creek is a perennial stream located in the eastern portion of the Monument Creek watershed and flows south-westerly from the southern slope of the Black Forest. The

Cottonwood Creek watershed has a contributing drainage area of approximately 19 sq mi at its confluence with Monument Creek about 0.5 mile (mi) south of the I-25 and Woodmen Road interchange in north-central Colorado Springs.

Dry Creek

Dry Creek is an ephemeral stream located in the western portion of the Monument Creek watershed and flows easterly from the eastern slope of the Rampart Range. The Dry Creek watershed has a contributing drainage area of approximately 3.5 sq mi at its confluence with Monument Creek about 0.5 mi south of the I-25 and Woodmen Road interchange in north-central Colorado Springs.

Templeton Gap Floodway

Templeton Gap Floodway is a perennial stream located in the southeastern portion of the Monument Creek watershed near its confluence with Fountain Creek in Colorado Springs and flows westerly from the eastern Monument Creek watershed boundary near Powers Boulevard. The Templeton Gap watershed has a contributing drainage area of approximately 8.7 sq mi at its confluence with Monument Creek about 0.5 mi southeast of the I-25 and Garden of the Gods Road interchange in north-central Colorado Springs.

Dirty Woman Creek

Dirty Woman Creek is an intermittent stream located in the northeastern portion of the Monument Creek watershed and flows westerly from an area northeast of the I-25 and Hwy 105 interchange. The Dirty Woman Creek watershed has a contributing drainage area of approximately 5.0 sq mi at its confluence with Monument Creek about 0.5 mi west of the Mitchell Avenue and Mount Herman Road intersection near the town of Monument.

Teachout Creek

Teachout Creek is an ephemeral stream located in the northeastern portion of the Monument Creek watershed and flows westerly from an area southeast of the I-25 and Hwy 105 interchange. The Teachout Creek watershed has a contributing drainage area of approximately 2.5 sq mi at its confluence with Monument Creek about 0.75 mi northwest of the I-25 and Baptist Road interchange.

Jackson Creek

Jackson Creek is an intermittent stream located in the northeastern portion of the Monument Creek watershed and flows south-westerly from the northwestern slope of the Black Forest. The Jackson Creek watershed has a contributing drainage area of approximately 4.4 sq mi at its confluence with Monument Creek just north of the United States Air Force (USAF) Academy boundary.

Black Forest Creek

Black Forest Creek is an intermittent stream located in the northeastern portion of the Monument Creek watershed and flows south-westerly from the western slope of the Black Forest. The Black Forest Creek watershed has a contributing drainage area of approximately 2.2 sq mi at its confluence with Monument Creek about 0.5 mi south of the USAF Academy north boundary.

Smith Creek

Smith Creek is a perennial stream located in the northeastern portion of the Monument Creek watershed and flows south-westerly from the western slope of Black Forest. The Smith Creek watershed has a contributing drainage area of approximately 5.7 sq mi at its confluence with Monument Creek just southwest of North Gate Boulevard on the USAF Academy.

Monument Branch

Monument Branch is an ephemeral stream located in the northeastern portion of the Monument Creek watershed and flows south-westerly from the southwestern edge of Black Forest. The Monument Branch watershed has a contributing drainage area of approximately 3.3 sq mi at its confluence with Monument Creek about 0.75 mi north of Reservoir No. 1 on the USAF Academy.

Middle Tributary

Middle Tributary is an intermittent stream located in the northeastern portion of the Monument Creek watershed and flows south-westerly from the southwestern edge of Black Forest. The Middle Tributary watershed has a contributing drainage area of approximately 1.3 sq mi at its confluence with Monument Creek about 0.25 mi west of Reservoir No. 1 on the USAF Academy.

Black Squirrel Creek

Black Squirrel Creek is a perennial stream located in the northeastern portion of the Monument Creek watershed and flows south-westerly from the southwestern slope of the Black Forest. The Black Squirrel Creek watershed has a contributing drainage area of approximately 11 sq mi at its confluence with Monument Creek near Reservoir No. 1 on the USAF Academy about 0.5 mi east of Stadium Boulevard and Road 402 interchange on the USAF Academy.

Elkhorn Tributary

Elkhorn Tributary is an ephemeral stream located in the northeastern portion of the Monument Creek watershed and flows south-westerly from the southwestern edge of the Black Forest. The Elkhorn watershed has a contributing drainage area of approximately 0.89 sq mi for the existing model and 1.1 sq mi for the future model at its confluence with Monument Creek northwest of the USAF Academy Airfield.

Pine Creek

Pine Creek is an intermittent stream located in the eastern portion of the Monument Creek watershed and flows south-westerly from the southwestern edge of the Black Forest. The Pine Creek watershed has a contributing drainage area of approximately 9.4 sq mi at its confluence with Monument Creek about 0.5 mi northwest of the I-25 and Woodmen Road interchange in north-central Colorado Springs.

Sand Creek and East Fork Sand Creek

Sand Creek – Main Stem and East Fork are ephemeral streams located in the eastern portion of the Fountain Creek watershed and flow south-westerly from the southern edge of the Black Forest. The Sand Creek – Main Stem watershed has a contributing drainage area of approximately 53 sq mi, including the Sand Creek – East Fork watershed, at its confluence with Fountain Creek about 1 mi north of the I-25 and South Academy Boulevard interchange in southeast Colorado Springs. The Sand Creek – East Fork watershed has a contributing drainage area of approximately 27 sq mi at its confluence with Sand Creek – Main Stem about 1 mile north-west of the Powers Boulevard and Fountain Boulevard interchange in southeast Colorado Springs.

Jimmy Camp Creek

Jimmy Camp Creek is an intermittent stream located in the eastern portion of the Fountain Creek watershed and flows south-westerly from the open plains east of Colorado Springs. The Jimmy Camp Creek watershed has a contributing drainage area of approximately 68 sq mi at its confluence with Fountain Creek near downtown Fountain.

Little Fountain Creek

Little Fountain Creek is an intermittent stream located in the western portion of the Fountain Creek watershed and flows easterly toward the town of Fountain. The Little Fountain Creek watershed has a contributing drainage area of approximately 54 sq mi at its confluence with Fountain Creek near downtown Fountain.

Peterson Field Tributary

Peterson Field Tributary is an ephemeral stream located in the eastern portion of the Fountain Creek watershed and flows westerly from Peterson Air Force Base (AFB). The Peterson Field watershed has a contributing drainage area of approximately 7.9 sq mi at its confluence with Sand Creek about 0.25 mi east of the Sand Creek confluence with Fountain Creek.

Arkansas River

The Arkansas River is a perennial river that runs west to east through the city of Pueblo. Above the mouth of Fountain Creek, the Arkansas River watershed descends from its mountain headwaters near Leadville, Colorado, where mountain peaks exceed 14,000 ft, to approximately 4,700 ft at the Fountain Creek confluence. The study reach for the Arkansas River begins at this confluence and extends downstream to Baxter Road.

Shooks Run

Shooks Run is an intermittent urban stream that runs south through downtown Colorado Springs to its confluence with Fountain Creek about 0.25 mi east of Nevada Avenue. The study reach for Shooks Run extends from East LaSalle Road downstream to this confluence.

2.6.2 Hydrologic Studies

This watershed study included the development of both existing and future conditions hydrologic models to generate flood hydrographs and estimate peak discharges at selected concentration points throughout the 930 sq mi Fountain Creek watershed. The models were used to simulate the rainfall-runoff process and develop flood hydrographs for storm events.

This project supplements the original USACE *Fountain Creek Hydrologic Watershed Analysis* (2004) and contains additional data and analysis of the hydrology of Fountain Creek. Significant augmentations include detailed hydrologic analysis of 21 tributary watersheds to include additional analysis of the Fountain Creek composite watershed, updated high fidelity land use data, revised topographic and soils data, additional storm frequency events, additional reservoir elements, detailed development of baseflow, and methodical calibration of the hydrologic models.

Of the 24 streams evaluated in the watershed study, 22 streams and their associated watersheds were identified and selected by the local sponsors for detailed hydrologic analyses. Final selection of the individual watersheds was based upon issues previously identified in the *Fountain Creek Watershed Plan* (PPACG 2003), a document prepared by local sponsors to broadly characterize watershed issues, and through agreement between USACE and the local sponsors. All of the sub watersheds are within the boundary of the 930 sq mi Fountain Creek watershed, shown in Figure 2-2, Fountain Creek Watershed – Subwatersheds.

2.6.2.1 Method Summary

Fountain Creek watershed hydrologic models were developed for both existing and future conditions applying a 24-hour storm event with 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence intervals. Hydrologic modeling was completed using the USACE Hydrologic Engineering Center – Hydrologic Modeling System Version 2.2.2 (HEC-HMS). A detailed description of the methodology used for the hydrologic analyses is provided in the *Fountain Creek Watershed Study Hydrology Report* (URS 2006a). A brief summary of major model elements follows.

A separate, individual hydrologic model was developed for the entire composite Fountain Creek watershed (macro model) and separate models were developed for each of the other 21 tributary watersheds (micro models). The major difference between the methodology applied in each case was the selected rainfall distribution. For the Fountain Creek macro model, an elliptical storm pattern was created using National Oceanic Atmospheric Administration (NOAA) Hydrometeorological Report No. 52 (HMR 52) (1982). For the tributary micro models, a uniform rainfall distribution was used with rainfall depths determined from isopluvial maps published in NOAA Atlas 2 (Miller et al. 1973)

Generally, development of most hydrologic model input parameters followed NRCS Technical Release 55 (TR-55) (1986). Likewise, runoff curve numbers were determined from existing and future land use, hydrologic soil group, and antecedent moisture condition. Runoff curve number is a parameter developed by the NRCS to quantify the relationship between precipitation, infiltration, and runoff. These are shown in Figure 2-3, Existing Runoff Curve Numbers, and Figure 2-4, Future Runoff Curve Numbers.

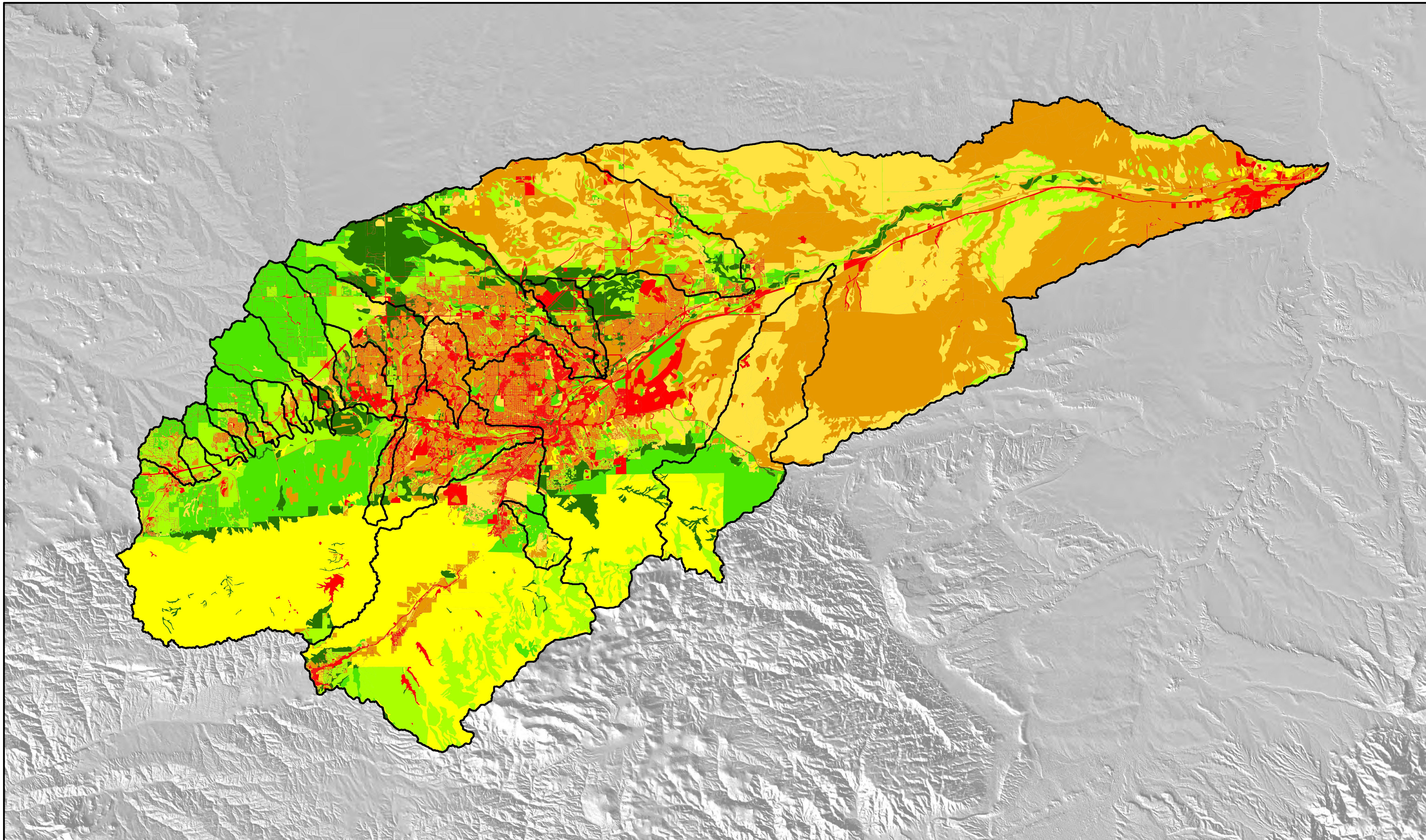
Baseflows were estimated for select reaches based upon analysis of USGS monthly streamflow statistics (USGS 2005). Point sources for wastewater treatment plant discharges were added for the existing and future conditions models per information provided by Colorado Springs Utilities (CSU).

Detention/retention reservoirs were incorporated as reservoir routing elements within the hydrologic models where appropriate. For the future conditions models, the only additional reservoirs included in the models were those that were currently funded and deemed significant by the local sponsors.

2.6.2.2 Results Summary

Detailed results from Fountain Creek and tributary hydrologic analyses for both existing and future conditions models are included within *Fountain Creek Watershed Study Hydrology Report* (URS 2006a). Comparisons of results from this study with previous studies, as well as available USGS gauge data, are also presented and analyzed therein. An abbreviated summary of hydrology results follows.

A summary of peak discharges at select locations for both existing and future conditions and the corresponding flow volumes are provided for 2- and 100-year flood events in Table 2-3, Summary of Peak Discharges, and Table 2-4, Summary of Flow Volumes. Table 2-5, Expected Increase in Peak Discharges, and Table 2-6, Expected Increase in Flow Volumes, show the expected percent change between modeled existing and future conditions for both peak discharge and flow volume. Highlighted rows include streams where the 2-year flow changes by more than 50 percent. Comparing existing and future modeled peak discharges for Fountain Creek at the confluence with the Arkansas River, flows are predicted to increase in the future by 20 percent for the 2-year storm event and about 13 percent for the 100-year storm event. Similarly the flow volumes increase by 25 percent for the 2-year storm event and 10 percent for the 100-year event.



Existing Runoff Curve Numbers

Figure 2-3

Watersheds

36 - 50

50 - 65

65 - 70

70 - 75

75 - 80

80 - 90

90 - 98

Scale is: 1:285,120
or
1 inch equals 4.5 miles

0 4.5 9 Miles

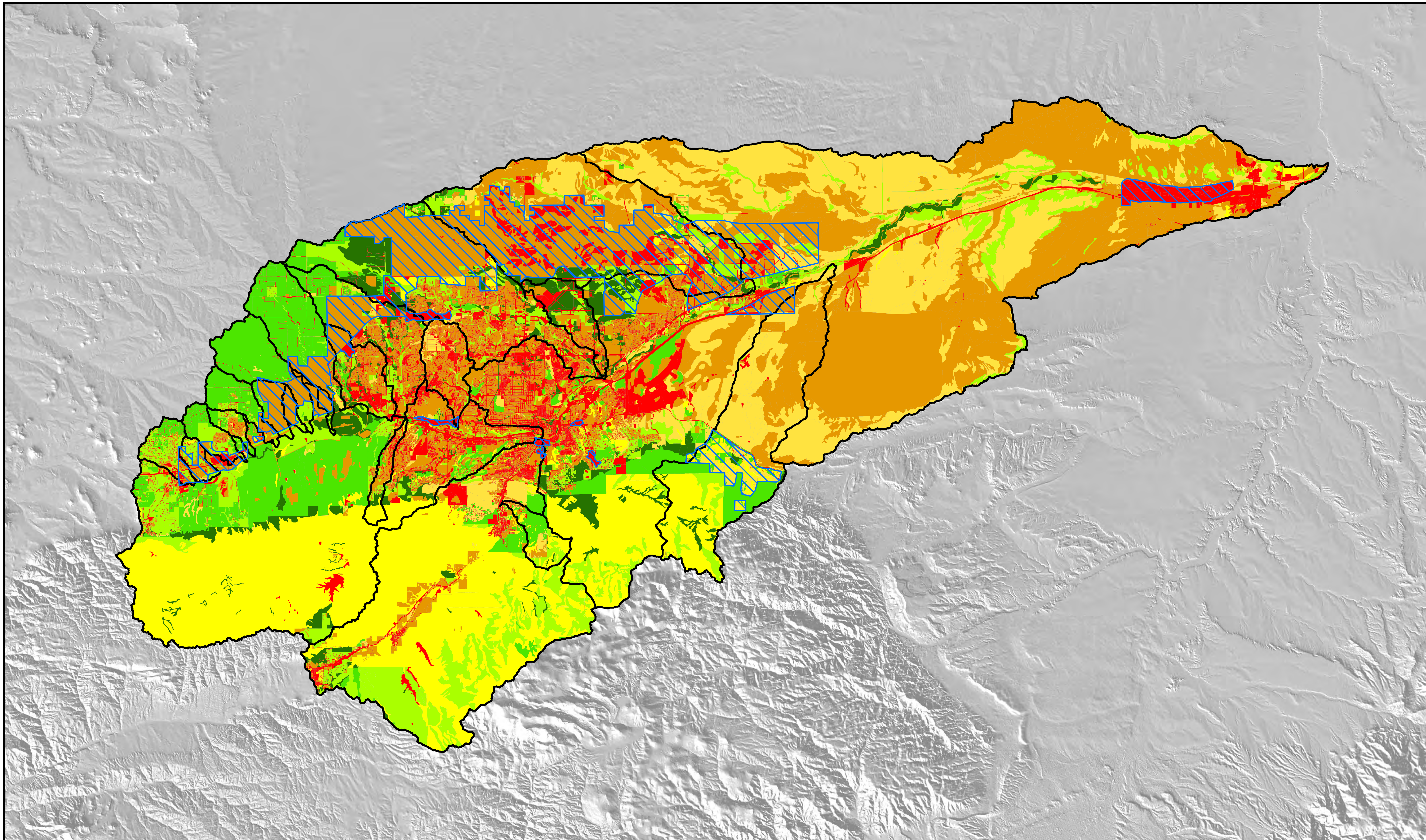
URS

URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers
Albuquerque District

10/2007

Fountain Creek Watershed Study, Project 21711283



URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers
Albuquerque District

Future Runoff Curve Numbers

Figure 2-4

10/2007

Fountain Creek Watershed Study, Project 21711283

Table 2-3 Summary of Peak Discharges								
Location	Area (mi²)		Existing Peak Discharge (cfs)			Future Peak Discharge (cfs)		
		1999 Event	2-yr	10-yr	100-yr	2-yr	10-yr	100-yr
Fountain Creek at confluence with Monument Creek	355	9,490	2,400	12,000	36,000	2,500	12,000	36,000
Fountain Creek downstream of CO 16 (USGS Security Gauge)	485	17,600	3,900	12,000	34,000	4,500	13,000	34,000
Fountain Creek downstream of Old Pueblo Rd (USGS Fountain Gauge)	672	20,100	6,100	15,000	45,000	7,600	18,000	51,000
Fountain Creek at El Paso/Pueblo county line	789		4,800	17,000	53,000	6,000	20,000	60,000
Fountain Creek at Pinon Road (USGS Pinon Gauge)	849	19,100	4,500	17,000	56,000	5,600	20,000	63,000
Fountain Creek at confluence with the Arkansas River	930	18,900	4,700	16,000	45,000	5,800	17,000	51,000
Tributaries included in project:								
Upper (West) Fountain	119		1,400	4,300	19,000	1,500	4,400	19,000
Sutherland Creek	5		520	2,100	5,100	520	2,100	5,100
Monument Creek downstream of Red Rock Ranch Road (USGS Palmer Lake Gauge)	27		63	1,100	5,300	63	1,100	5,300
Monument Creek Upstream of North Gate Boulevard (USGS North Gate Boulevard Gauge)	81	1,790	92	850	8,100	220	1,400	8,400
Monument Creek downstream of Woodmen Road (USGS Woodmen Road Gauge)	180	3,580	570	2,500	9,700	570	2,500	11,000

Table 2-3 (Continued) Location	Area (mi²)		Existing Peak Discharge (cfs)			Future Peak Discharge (cfs)		
		1999 Event	2-yr	10-yr			1999 Event	2-yr
Monument Creek at confluence with Fountain Creek	237		2,400	12,000	36,000	2,500	12,000	36,000
Cottonwood Creek	19		1,100	4,000	10,000	1,300	44,000	11,000
Dry Creek (El Paso County)	3		510	1,200	2,900	510	1,200	2,900
Templeton Gap Floodway	9		4,600	9,500	18,000	4,600	9,600	18,000
Dirty Woman Creek	5		130	470	1,300	220	550	1,300
Teachout Creek	2		200	660	1,700	380	980	2,200
Jackson Creek	4		210	660	1,700	320	850	2,000
Black Forest Creek	2		230	670	1,700	230	670	1,700
Smith Creek	6		82	510	1,800	110	560	1,900
Monument Branch	3		160	630	1,800	580	1,400	3,100
Middle Tributary	1		250	640	1,400	320	760	1,600
Black Squirrel Creek	11		72	640	2,800	210	730	3,000
Elkhorn Tributary	1		4.2	31	130	21	160	420
Pine Creek	9		2,600	5,500	11,000	2,600	5,500	11,000
Sand Creek (Plus Peterson Field)	61		6,000	14,000	29,000	5,900	14,000	29,000
East Fork Sand Creek (Plus Peterson Field)	27		1,100	2,700	7,000	1,300	3,100	7,300
Jimmy Camp Creek	68		300	4,100	22,000	1,500	9,400	31,000
Little Fountain Creek	54		1,200	4,000	13,000	1,300	4,100	15,000
Peterson Field Tributary	8		620	1,500	3,200	620	1,400	3,200

Table 2-4 Summary of Flow Volumes					
Location	Area (mi²)	Existing Volume (ac-ft)		Future Volume (ac-ft)	
		2-yr	100-yr	2-yr	100-yr
Fountain Creek at confluence with Monument Creek	355	1,700	14,000	2,000	15,000
Fountain Creek downstream of CO 16 (USGS Security Gauge)	485	3,300	22,000	4,500	24,000
Fountain Creek downstream of Old Pueblo Road (USGS Fountain Gauge)	672	5,300	34,000	7,200	39,000
Fountain Creek at El Paso/Pueblo county line	789	6,700	43,000	8,600	47,000
Fountain Creek at Pinon Road (USGS Pinon Gauge)	849	7,300	46,000	9,200	51,000
Fountain Creek at confluence with the Arkansas River	930	7,900	50,000	9,900	55,000
Tributaries included in project:					
Upper (West) Fountain	119	430	6,300	440	6,300
Sutherland Creek	5	88	540	88	540
Monument Creek downstream of Red Rock Ranch Road (USGS Palmer Lake Gauge)	27	76	1,700	76	1,700
Monument Creek Upstream of North Gate Blvd (USGS North Gate Boulevard Gauge)	81	170	4,300	230	4,500
Monument Creek downstream of Woodmen Rd (USGS Woodmen Rd Gauge)	180	360	6,800	460	7,700
Monument Creek at confluence with Fountain Creek	237	890	12,000	1,000	13,00
Cottonwood Creek	19	260	1,800	380	2,200
Dry Creek (El Paso County)	3	92	430	92	430
Templeton Gap Floodway	9	420	1,500	420	1,500
Dirty Woman Creek	5	70	410	83	430
Teachout Creek	2	44	260	69	320
Jackson Creek	4	60	410	76	440
Black Forest Creek	2	45	240	45	250
Smith Creek	6	51	440	60	470
Monument Branch	3	47	320	110	470
Middle Tributary	1	32	160	47	190
Black Squirrel Creek	11	55	710	82	770

Table 2-4
Summary of Flow Volumes

Location	Area (mi²)	Existing Volume (ac-ft)		Future Volume (ac-ft)	
		2-yr	100-yr	2-yr	100-yr
Elkhorn Tributary	1	4.4	44	43	130
Pine Creek	9	290	1,300	330	1,400
Sand Creek (Plus Peterson Field)	61	940	5,400	1,300	6,200
East Fork Sand Creek (Plus Peterson Field)	27	190	1,600	530	2,500
Jimmy Camp Creek	68	200	4,600	610	6,000
Little Fountain Creek	54	490	4,000	520	4,300
Peterson Field Tributary	8	150	840	150	840

Table 2-5
Expected Increase in Peak Discharges

Location	Future Peak Discharge Increase (%)	
	2-yr	100-yr
Fountain Creek at confluence with Monument Creek	4%	0%
Fountain Creek downstream of CO 16 (USGS Security Gauge)	15%	0%
Fountain Creek downstream of Old Pueblo Road (USGS Fountain Gauge)	25%	13%
Fountain Creek at El Paso/Pueblo county line	25%	13%
Fountain Creek at Pinon Road (USGS Pinon Gauge)	24%	13%
Fountain Creek at confluence with the Arkansas River	23%	13%
Tributaries included in project:		
Upper (West) Fountain	7%	0%
Sutherland Creek	0%	0%
Monument Creek downstream of Red Rock Ranch Road (USGS Palmer Lake Gauge)	0%	0%
Monument Creek Upstream of North Gate Blvd (USGS North Gate Boulevard Gauge)	139%	4%
Monument Creek downstream of Woodmen Rd (USGS Woodmen Road Gauge)	0%	13%
Monument Creek at confluence with Fountain Creek	4%	0%
Cottonwood Creek	18%	10%
Dry Creek (El Paso County)	0%	0%
Templeton Gap Floodway	0%	0%
Dirty Woman Creek	69%	0%
Teachout Creek	90%	29%
Jackson Creek	52%	18%
Black Forest Creek	0%	0%
Smith Creek	34%	6%
Monument Branch	263%	72%
Middle Tributary	28%	14%

Table 2-5
Expected Increase in Peak Discharges

Location	Future Peak Discharge Increase (%)	
	2-yr	100-yr
Black Squirrel Creek	192%	7%
Elkhorn Tributary	400%	223%
Pine Creek	0%	0%
Sand Creek	-2%	0%
East Fork Sand Creek	18%	4%
Jimmy Camp Creek	400%	41%
Little Fountain Creek	8%	15%
Peterson Field Tributary	0%	0%

Note: Highlighted streams have increases in expected 2-year Peak Discharges >50%

Table 2-6 Expected Increase in Flow Volumes		
Location	Future Volume Increase (%)	
	2-yr	100-yr
Fountain Creek at confluence with Monument Creek	18%	7%
Fountain Creek downstream of CO 16 (USGS Security Gauge)	36%	9%
Fountain Creek downstream of Old Pueblo Road (USGS Fountain Gauge)	36%	15%
Fountain Creek at El Paso/Pueblo county line	28%	9%
Fountain Creek at Pinon Road (USGS Pinon Gauge)	26%	11%
Fountain Creek at confluence with the Arkansas River	25%	10%
Tributaries included in project:		
Upper (West) Fountain	2%	0%
Sutherland Creek	0%	0%
Monument Creek downstream of Red Rock Ranch Road (USGS Palmer Lake Gauge)	0%	0%
Monument Creek Upstream of North Gate Blvd (USGS North Gate Boulevard Gauge)	35%	5%
Monument Creek downstream of Woodmen Rd (USGS Woodmen Road Gauge)	28%	13%
Monument Creek at confluence with Fountain Creek	12%	8%
Cottonwood Creek	46%	22%
Dry Creek (El Paso County)	0%	0%
Templeton Gap Floodway	0%	0%
Dirty Woman Creek	19%	5%
Teachout Creek	57%	23%
Jackson Creek	27%	7%
Black Forest Creek	0%	4%
Smith Creek	18%	7%
Monument Branch	134%	47%
Middle Tributary	47%	19%

Table 2-6
Expected Increase in Flow Volumes

Location	Future Volume Increase (%)	
	2-yr	100-yr
Black Squirrel Creek	49%	8%
Elkhorn Tributary	514%	195%
Pine Creek	14%	8%
Sand Creek	38%	15%
East Fork Sand Creek	179%	56%
Jimmy Camp Creek	205%	30%
Little Fountain Creek	6%	8%
Peterson Field Tributary	0%	0%

Note: Highlighted streams have increases in expected 2-year Peak Flow Volumes >50%

Figures 2-5 through 2-12 illustrate the predicted percent increase in the 2- and 100-year peak discharges and flow volumes throughout the Fountain Creek watershed. These figures graphically identify the specific locations where the change in peak discharge and/or flow volume is predicted to increase by 11 percent or more from existing to future conditions. Most of the increase in flow along Fountain Creek occurs near the city of Fountain, downstream of the Jimmy Camp Creek confluence. This is a direct result of the extensive development expected to occur in the Jimmy Camp Creek watershed as reflected in the future conditions land use for circa 2035.

The hydrologic models predict the most significant changes in flood hydrology between existing and future conditions are in the following streams.

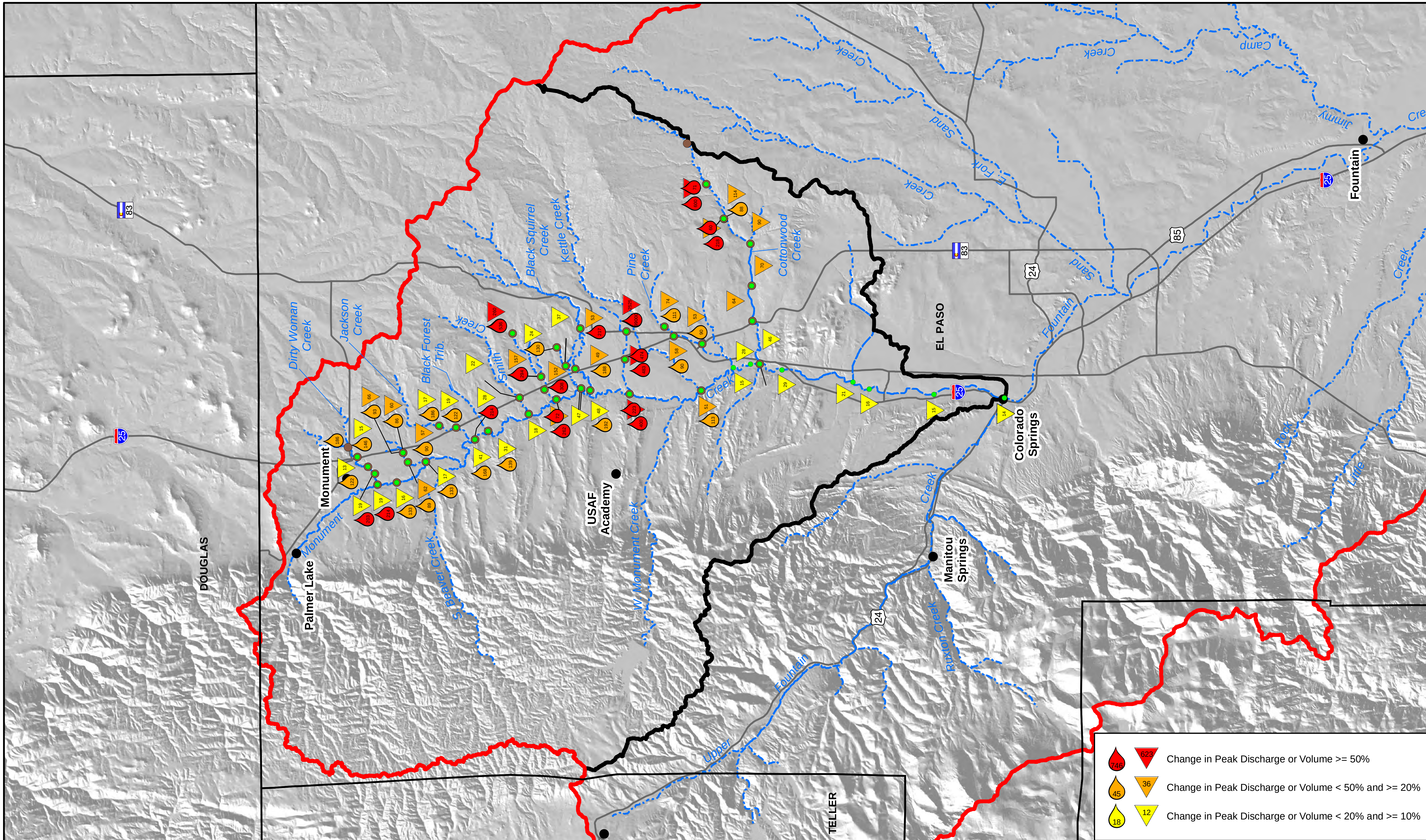
- Jimmy Camp Creek,
- East Fork Sand Creek, and
- Eastern Tributaries of Monument Creek, including among others:
  - Elkhorn Tributary,
  - Monument Branch,
  - Teachout Creek, and
  - Black Squirrel Creek.

It is important to note that modeled future peak discharges include limited detention facilities that may be constructed as part of planned development reflected in the future conditions land use for circa 2035. As noted above, only detention facilities that are currently funded and deemed significant by the local sponsors were modeled. Regardless, most standard detention facility design does not address the hydrologic impact of small, frequently recurring storm events (e.g., 2-year or less) and their influence on channel stability and resultant downstream impacts.

2.6.3 Hydraulic Studies

The Watershed Study included the development of hydraulic models for Fountain Creek and select major tributaries to establish water surface profiles and hydraulic conditions for a range of flood events. The models were used to simulate one-dimensional, steady flow for existing and future conditions; peak discharges determined during the hydrologic studies are described in Section 3.2.4, Flood Risk Reduction Measures.

Of the 24 streams within the Fountain Creek watershed, the local sponsors selected 21 for hydraulic analyses as listed in Table 2-2, Project Streams.



URS

URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers ® Albuquerque District

Fountain Creek Watershed
Monument Creek Watershed
Modeled Discharge Locations
Modeled Volume Locations
Problem Regional Detention Ponds
Streams
Counties
Highways

Scale is: 1:158,400
or
1 inch equals 2.5 miles

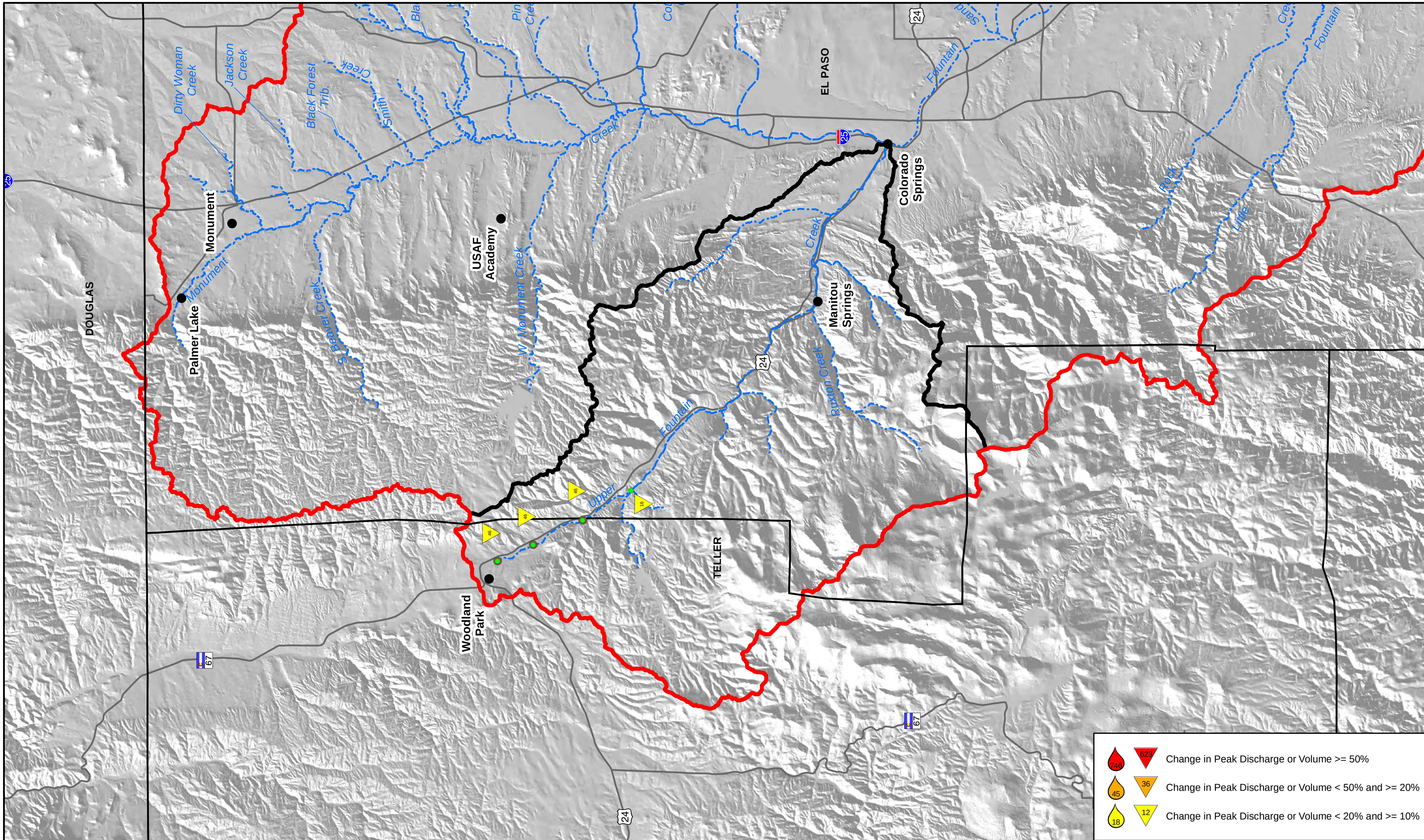
0 2.5 5 Miles

Monument Creek Watershed

Figure 2-5. 2-Year Discharge and Volume, Existing vs. Future Conditions

10/2007

Fountain Creek Watershed Study, URS Project 21711283



URS

URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers
Albuquerque District

Fountain Creek Watershed
Upper Fountain Creek Watershed
Modeled Discharge Locations
Modeled Volume Locations
Problem Regional Detention Ponds
Streams
Counties
Highways

Scale is: 1:158,400
or
1 inch equals 2.5 miles

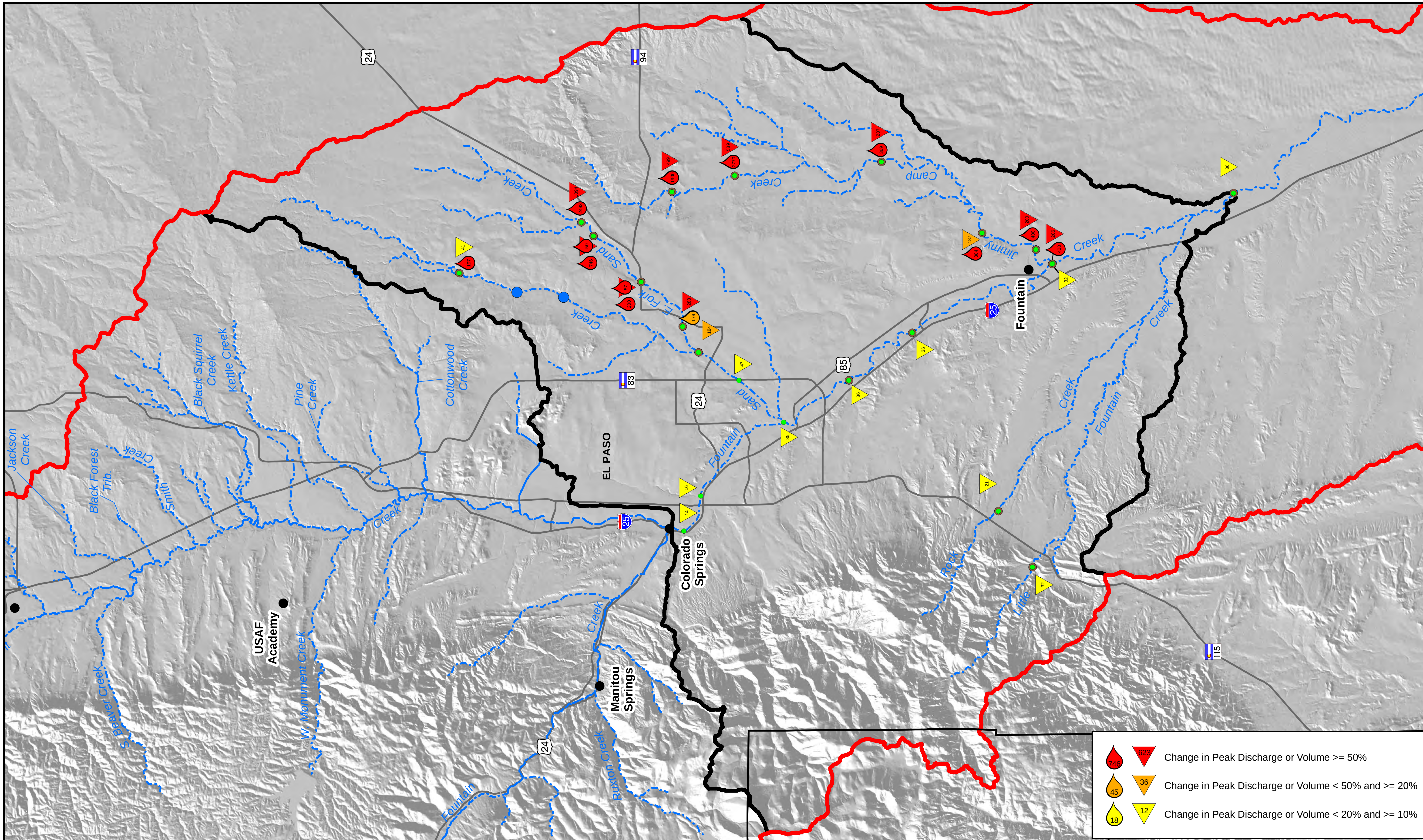
0 2.5 5 Miles

Upper Fountain Creek Watershed

Figure 2-6. 2-Year Discharge and Volume, Existing vs. Future Conditions

10/2007

Fountain Creek Watershed Study, URS Project 21711283



URS

URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers
Albuquerque District

Fountain Creek Watershed
Colorado Springs Composite Watershed
Modeled Discharge Locations
Modeled Volume Locations
Problem Regional Detention Ponds
Streams
Counties
Highways

Scale is: 1:158,400
or
1 inch equals 2.5 miles

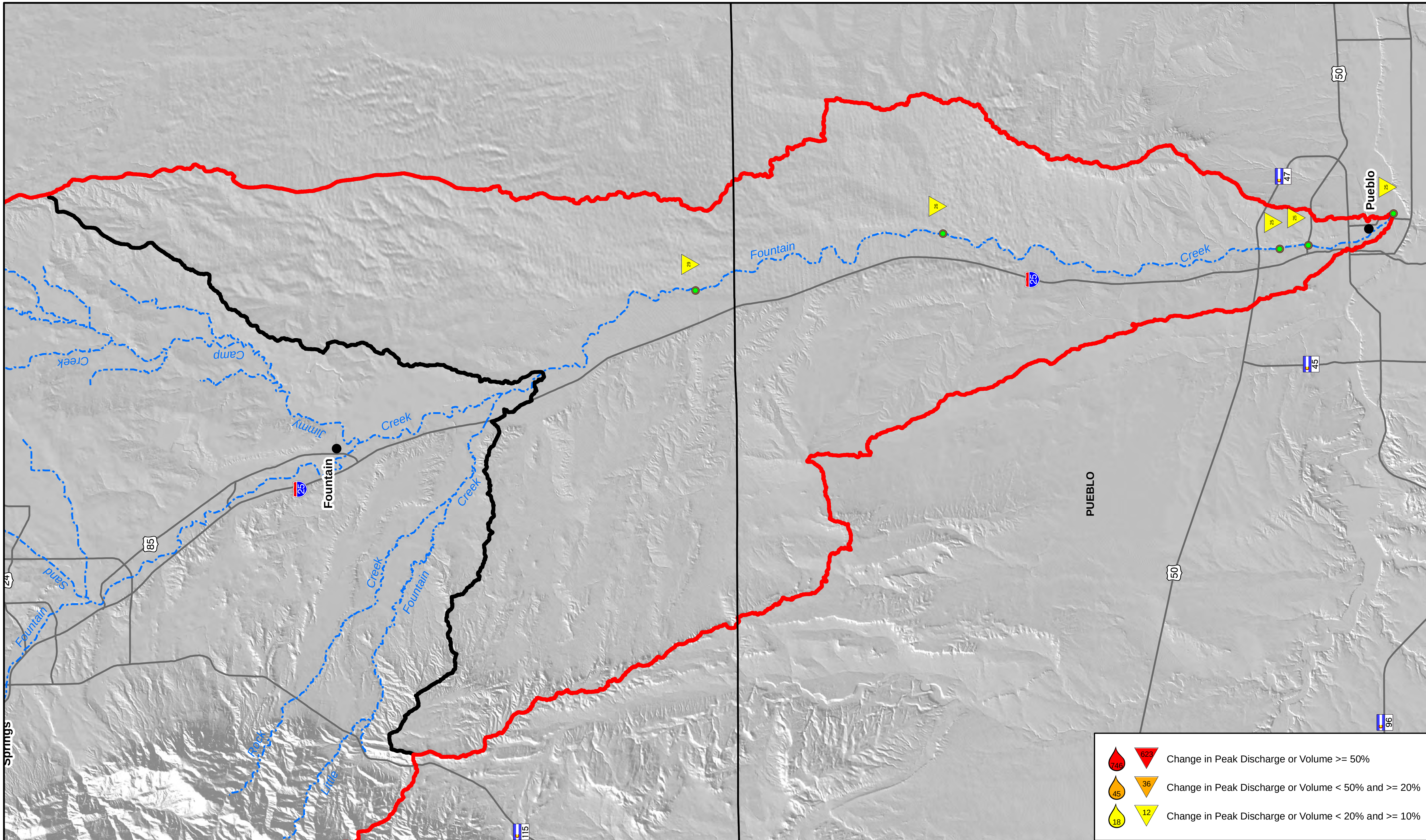
0 2.5 5 Miles

Colorado Springs Composite Watershed

Figure 2-7. 2-Year Discharge and Volume, Existing vs. Future Conditions

10/2007

Fountain Creek Watershed Study, URS Project 21711283



URS
URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers ®
Albuquerque District

Fountain Creek Watershed
Lower Fountain Creek Watershed
Modeled Discharge Locations
Modeled Volume Locations
Problem Regional Detention Ponds
Streams
Counties
Highways

Scale is: 1:158,400
or
1 inch equals 2.5 miles

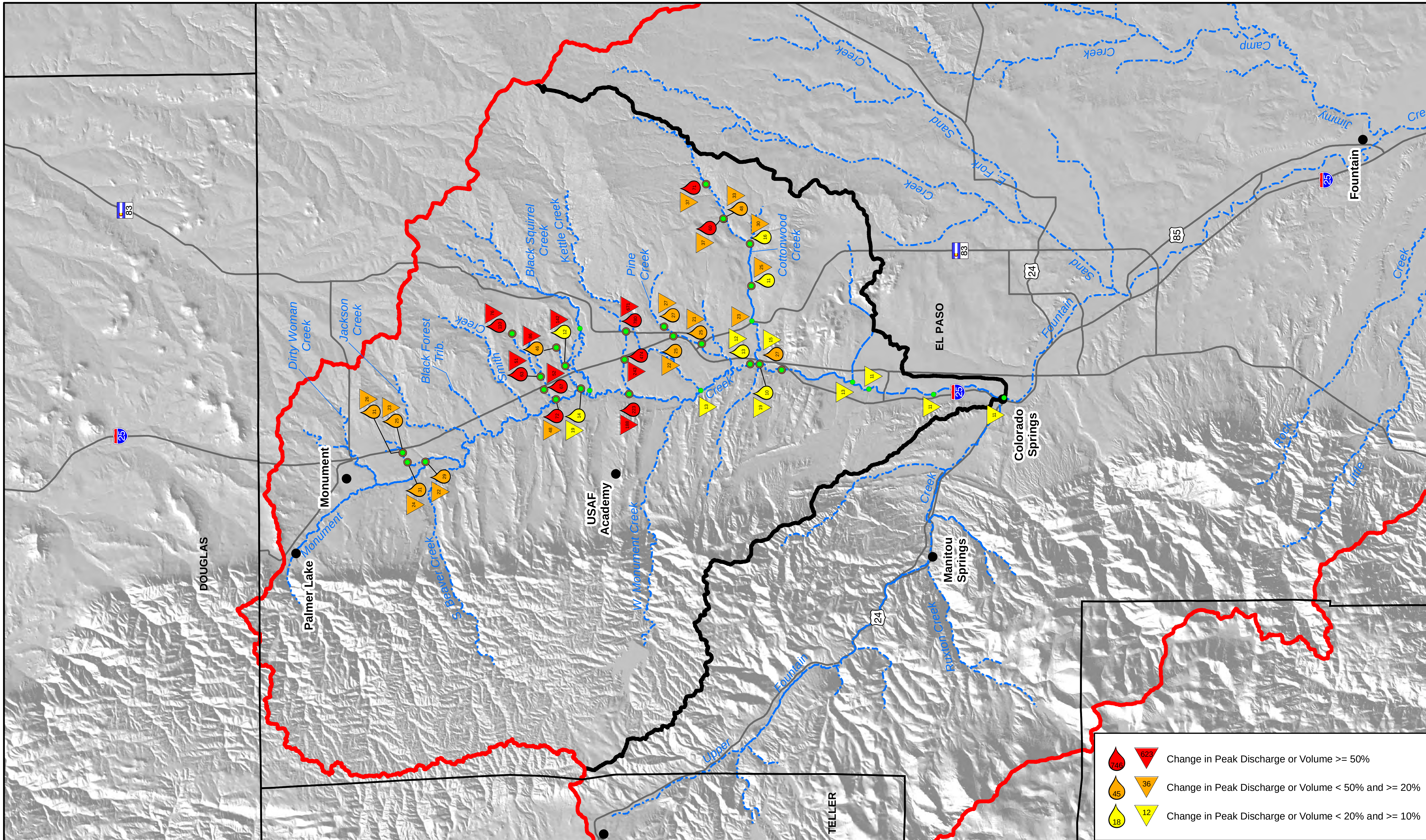
0 2.5 5 Miles

Lower Fountain Creek Watershed

Figure 2-8. 2-Year Discharge and Volume, Existing vs. Future Conditions

10/2007

Fountain Creek Watershed Study, URS Project 21711283



URS
URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers ®
Albuquerque District

Fountain Creek Watershed
Monument Creek Watershed
Modeled Discharge Locations
Modeled Volume Locations
Streams
Counties
Highways

Scale is: 1:158,400
or
1 inch equals 2.5 miles

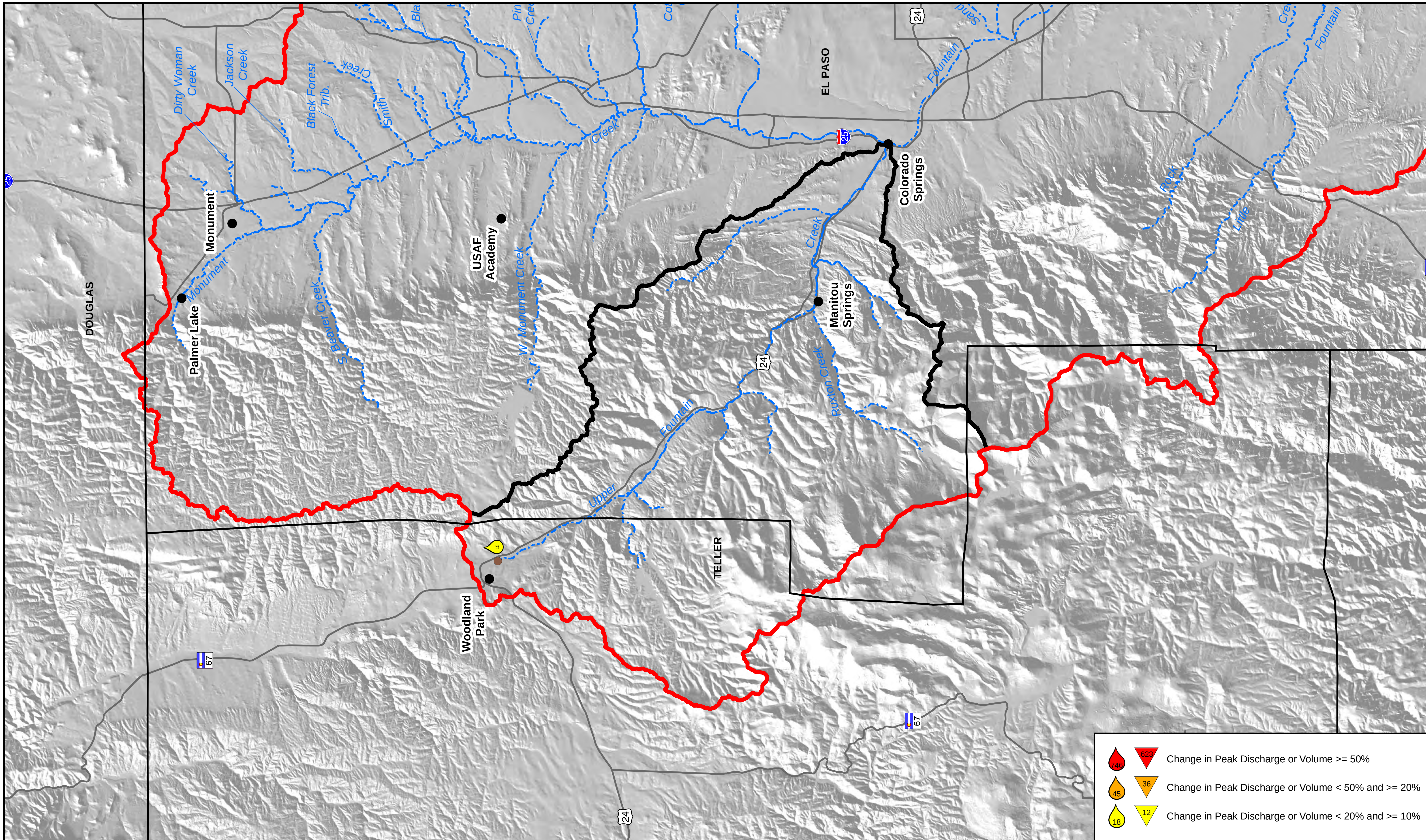
0 2.5 5 Miles

Monument Creek Watershed

Figure 2-9. 100-Year Discharge and Volume, Existing vs. Future Conditions

10/2007

Fountain Creek Watershed Study, URS Project 21711283



URS

URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers
Albuquerque District

Fountain Creek Watershed
Upper Fountain Creek Watershed
Modeled Discharge Locations
Modeled Volume Locations
Streams
Counties
Highways

Scale is: 1:158,400
or
1 inch equals 2.5 miles

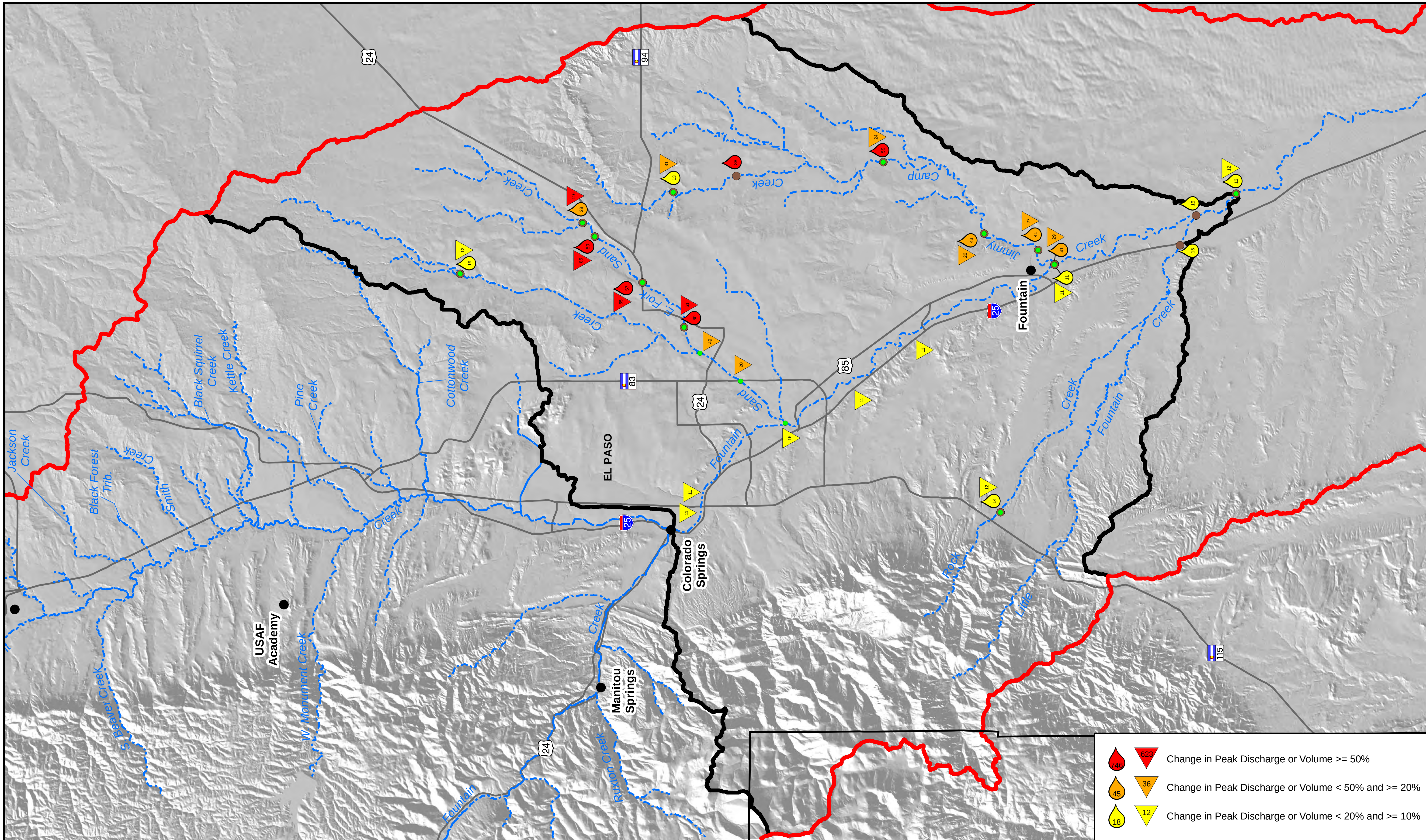
0 2.5 5 Miles

Upper Fountain Creek Watershed

Figure 2-10. 100-Year Discharge and Volume Existing vs. Future Conditions

10/2007

Fountain Creek Watershed Study, URS Project 21711283



URS

URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers ®
Albuquerque District

Fountain Creek Watershed
Colorado Springs Composite Watershed
Modeled Discharge Locations
Modeled Volume Locations
Streams
Counties
Highways

Scale is: 1:158,400
or
1 inch equals 2.5 miles

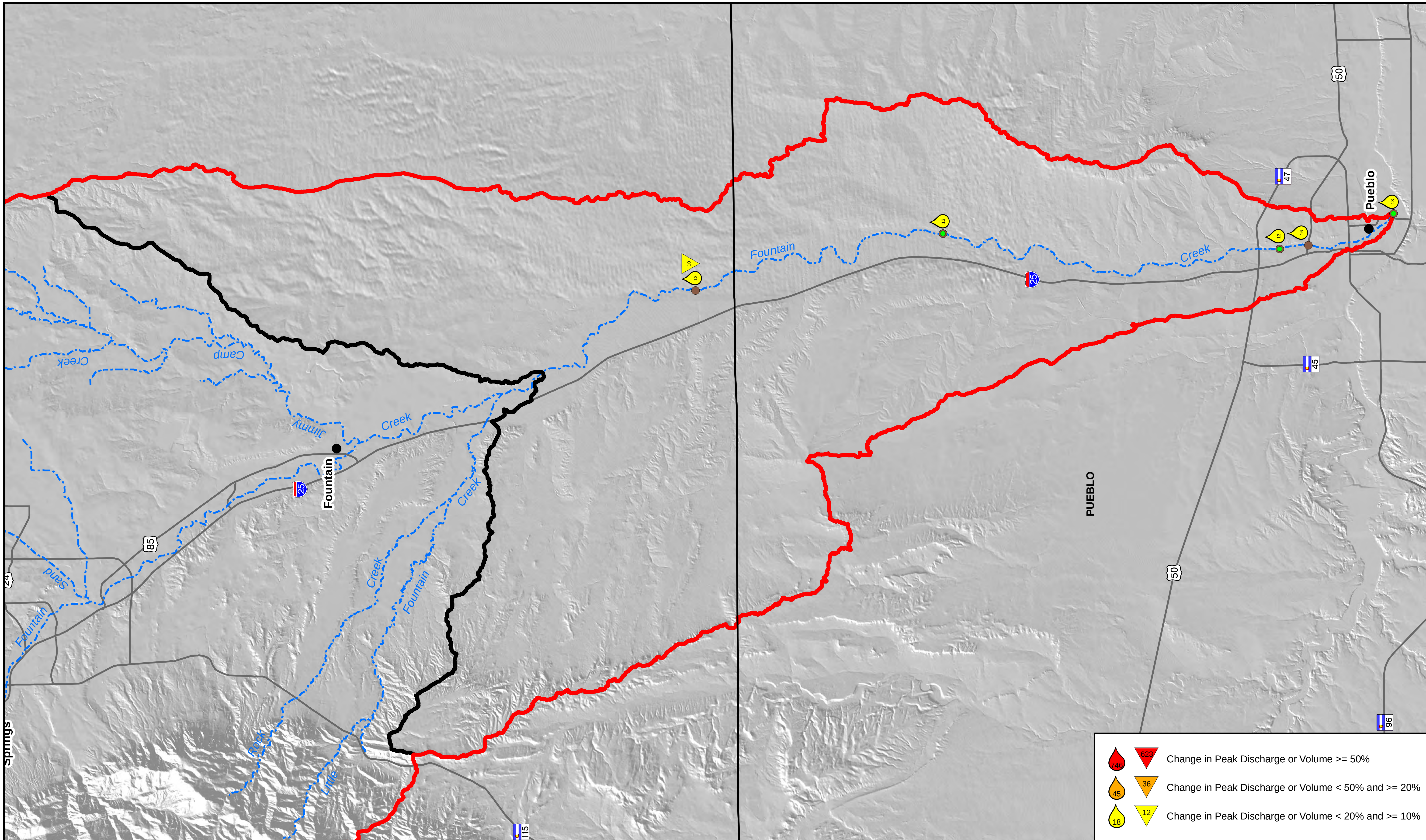
0 2.5 5
Miles

Colorado Springs Composite Watershed

Figure 2-11. 100-Year Discharge and Volume Existing vs. Future Conditions

10/2007

Fountain Creek Watershed Study, URS Project 21711283



URS

URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers
Albuquerque District

Fountain Creek Watershed
Lower Fountain Creek Watershed
Modeled Discharge Locations
Modeled Volume Locations
Streams
Counties
Highways

Scale is: 1:158,400
or
1 inch equals 2.5 miles

0 2.5 5 Miles

Lower Fountain Creek Watershed

Figure 2-12. 100-Year Discharge and Volume Existing vs. Future Conditions

10/2007

Fountain Creek Watershed Study, URS Project 21711283

2.6.3.1 Method Summary

Hydraulic modeling was completed using the USACE Hydrologic Engineering Center – River Analysis System Version 3.1.2 (HEC-RAS) and Watershed Concepts Watershed Information SystEm Version 2.0.9 (WISE). A detailed description of the methodology used for the hydraulic analyses is provided in the *Fountain Creek Watershed Study Hydraulics Report* (URS 2006b).

Hydraulic models for the project streams were developed for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year flood events for existing and future conditions. Models were used to establish water surface profiles for these flood events and to generate hydraulic parameters including velocity, flow depth, top width, and Froude number for existing and future conditions. It was not part of the scope of this project to delineate floodplains and prepare floodplain maps. However, the hydraulic models prepared are suitable as a foundation for more detailed hydraulic study and for future floodplain mapping.

Models were constructed on topographic data which included: 1) 2-foot digital contour data for El Paso county based on a vertical control datum of National Geodetic Vertical Datum of 1929 (NGVD 29); and 2) 2-foot and 5-foot digital contour data based on a vertical control datum of North American Vertical Datum of 1988 (NAVD 88) for Pueblo County.

All significant hydraulic structures (e.g., bridges, major culverts, detention ponds, improved channels, and drop structures) along the studied streams were surveyed and geospatially referenced between February and November 2005. A total of 314 structures along Fountain Creek and project tributaries were surveyed and coded for inclusion in the hydraulic models.

The stream centerlines and alignments were taken from the National Hydrography Dataset and trimmed to the final study reaches. Stream alignments were compared to available digital contour data and were adjusted accordingly within an Arc-View GIS environment.

WISE was used to place cross sections automatically and perform take-offs for stream distances, cross sections, and Manning's n-values. Cross-sections were placed automatically 500 ft apart for all project streams within the Fountain Creek watershed. The automated cross-section placements were checked and adjusted manually where necessary. Cross-section take-offs produced the cross-section geometry of each cross section. Likewise, stream take-offs produced the bed profile for each stream. WISE was then used to generate geometric data for hydraulic analysis by retrieving information from terrain, hydrologic, and survey datasets stored in the WISE databases.

The Manning's roughness values (n-values) for the main channel and the overbank portions for each stream were determined at all cross-sections and structures along each project stream. The n-values were based on the tables from *Open Channel Hydraulics* (Chow 1959; Reissued 1988). The n-values were estimated from aerial photography and direct field observations considering factors such as channel bed materials, type, density, and height of existing vegetation and existing structures in the overbank areas.

Special attention was given to evaluation of n-values for the high-gradient streams (e.g. Upper Fountain Creek) referencing *Determination of Roughness Coefficients for Streams in Colorado* (Jarret 1985), and to the evaluation of n-values for sand bed alluvial channels (e.g., Monument Creek and Fountain Creek) referencing *Geomorphic, Hydrologic, Hydraulic and Sediment Transport Concepts Applied to Alluvial Rivers–2004* (Simons et al, 2004).

Other hydraulic model elements including boundary conditions, ineffective flow areas, culvert entrance and exit loss coefficients, and bridge expansion and contraction coefficients were compiled within WISE. Stream centerlines and cross sections, as well as river stations, bank stations, reach lengths, surveyed structures, stream topology, levees, and ineffective flow area stations generated by WISE were imported into HEC-RAS. One-dimensional, steady flow hydraulics calculations were completed in HEC-RAS and water surface profiles were generated.

2.6.3.2 City of Pueblo Levee System

Fountain Creek has a levee system within the City of Pueblo located on the east and west sides of Fountain Creek. The east side levee, approximately 9,000 ft in length, begins 500 ft upstream of 12th Street and proceeds downstream, roughly paralleling the existing bank where the levee terminates at the Missouri and Pacific Railroad bridge abutment. The east side levee includes segments of both earth and soil cement, with a 3-ft high concrete parapet wall placed along the top of the soil cement portion. The 3-ft concrete parapet wall starts upstream of the 8th Street Bridge and terminates at the upstream end of the 4th Street Bridge.

The east side levee is included in the Fountain Creek HEC-RAS model. All elevations related to the east side levee were obtained from the as-built drawings “Plan and ProfileI-III, Fountain Creek, Pueblo, Colorado” dated May 19, 1988, prepared by Sellards & Grigg for the USACE, Albuquerque District. Levee elevations presented on these as-built drawings are based on vertical control datum of NGVD 29. These levee elevations were converted to vertical control datum of NAVD 88 using USACE’s software, Corpscon, Version 6.0.

There are currently several openings in the levee/parapet wall where the levee/parapet wall breaks for a road crossing. The City of Pueblo requested that these openings be modeled the levee/parapet wall assuming there is no break, since the City reportedly has an operations plan to sandbag the openings during design flood occurrence. As such, the parapet wall/levee was assumed to be uninterrupted for its entire length within the HEC-RAS model completed for this study.

2.6.3.3 Results Summary

Detailed results from Fountain Creek and tributary hydraulic analyses for both existing and future conditions models are included within *Fountain Creek Watershed Study Hydraulics Report* (URS 2006b). A summary of results for each project stream includes tables with average channel velocity, average flow depth, average top width, and average Froude number for existing and future conditions, respectively. Water surface elevation profiles, cross-section plots and HEC-RAS model output results for each project stream are provided in the report’s technical appendices.

Upon review of the water surface profiles and cross sections for each project stream, the following flooding issues were identified:

- City of Pueblo levee
    - Eastside levee overtops during the 500-year flood event.
    - Levee barely contains the 100-year flood event; continuous vegetation removal is necessary to maintain flood conveyance.

- Highway 24 corridor including Manitou Springs and Old Colorado City
  - Over 30 low capacity culvert crossings in Manitou Springs and Old Colorado City readily overtop during floods with most overtopping during the 10-year and larger events.
  - Inundation of commercial and residential properties along Upper Fountain Creek through Manitou Springs and Old Colorado City would be expected in 10-year and larger flood events.
  - Considerable flooding along Hwy 24 occurs for floods larger than the 25-year event including overtopping of 8th, 21st, 26th, and 31st Street Bridges and the highway itself.
- Fountain Creek below Monument Creek confluence
  - 100-year and larger events flood the neighborhood near Tejon Marsh, overtop Tejon and Nevada Avenue Bridges, and inundate Las Vegas Wastewater Treatment Facility.
- Shooks Run
  - Overtopping of nearly all culvert and bridge crossings and inundation of the adjacent urban residential areas occur in the 100-year flood event.
- Jimmy Camp Creek
  - Considerable flooding of the residential area and golf course upstream of Peaceful Valley Road occurs for floods larger than the 2-year event.
- Sutherland Creek
  - Overtopping of nearly all culvert crossings and inundation of the adjacent urban residential areas occurs for floods larger than the 2-year event.
- Old Pueblo Road corridor
  - Rural residential properties along Old Pueblo Road near Clear Springs flood during the 100-year and larger events.
- Upper Monument Creek
  - Walnut Road and several private drives overtop in the 2-year and larger flood events.
  - Spring Street and Redrock Ranch Road overtop in the 25-year and larger flood events.
- Lower Monument Creek
  - Polk Street Bridge overtops in the 25-year and larger flood events.
  - Mesa Road and Uintah Street Bridges overtop in the 100-year and large flood events.
- Other structure overtopping
  - Numerous other bridges and culverts throughout the watershed appear to have insufficient capacity to convey flood events ranging from the 5-year to the 100-year.

- Several pedestrian and railroad bridges are overtopped in larger events; notably the railroad bridge downstream of Hwy 85/87 in the City of Fountain overtops during the 50-year flood event.

2.6.3.4 Results for the City of Pueblo Levee System

For both existing conditions and future conditions, the modeling results indicate that the 500-year flood overtops the east side levee at several locations. However, the 100-year flood is contained within the east side levee for its entire length for both existing conditions and future conditions. A Letter of Map Revision (LOMR) study for the same area submitted to FEMA by the USACE in 1991 indicates the levee contains the 100-year flood with at least 3 ft of freeboard available.

In some past studies, the Manning's n-values for the main (active, sand-bed) channel (0.3-0.035) were applied to the entire width of the hydraulic cross sections, sometimes as wide as 600 ft.

However, for this current study, based on the field visits along Fountain Creek, the Manning's n-values for the main channel (0.02-0.04) were applied only for the active, sand-bed portion, usually 100 to 250 ft wide and not the vegetated overbank portions. Therefore, Fountain Creek shows higher water surface elevations for this current study compared to some past studies.

The Manning's n-values for both the left overbank area and the right overbank area of Fountain Creek were lowered to between 0.05 to 0.08 for the entire length of the east side levee. This was done based on information provided by the City of Pueblo (a written memo and pictures submitted to URS on February 9, 2006, and a telephone conference call on March 6, 2006) that an extensive operation is in place to remove all brush and trees along the entire width of Fountain Creek between 14th Street (upstream end of east side levee) and the Missouri and Pacific Railroad bridge (downstream end of the east side levee). The City of Pueblo has indicated that the stream banks will continue to be maintained. The continuous maintenance of the overbanks will be necessary if actual physical conditions within this reach are to be represented by the Fountain Creek HEC-RAS model developed for this project.

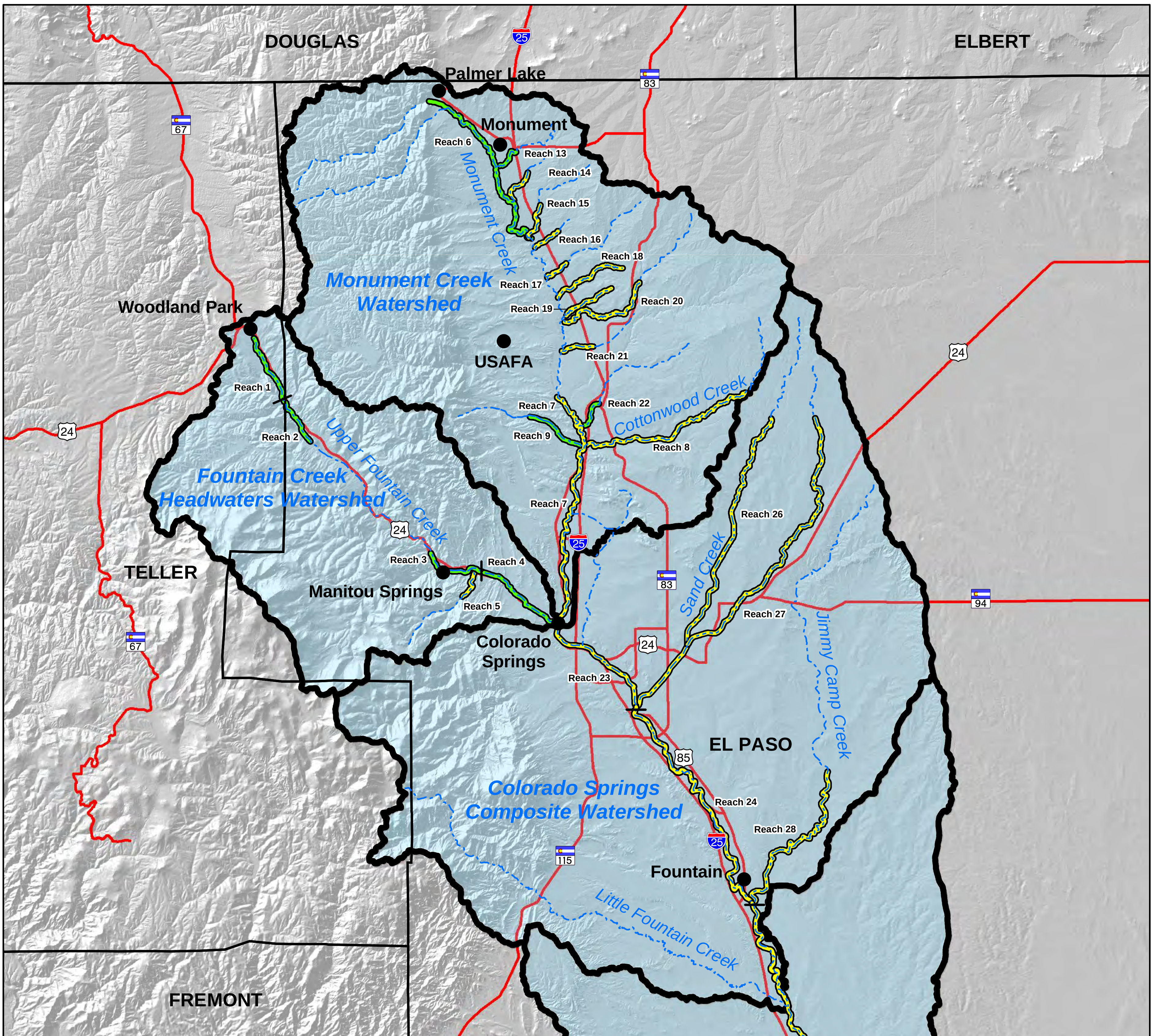
2.6.4 Geomorphology Studies

The Watershed Study included an assessment of the geomorphologic characteristics, an estimate of channel aggradation/degradation tendencies, and evaluation of channel stability under the existing hydrologic conditions. The assessment is based on a field investigation to identify the bankfull stage and discharge at five stations, an aerial photo analysis to determine the changes in morphologic features from 1953, and a sediment transport analysis to determine aggradation/degradation tendencies for Fountain Creek and selected major tributaries.

Twenty streams within the Fountain Creek watershed were selected by the local sponsors for the analysis. These streams included 30 individual reaches that were analyzed by either detailed or limited methods as listed in Table 2-2, Project Streams, and shown in Figure 2-13, Geomorphology Study Reaches.

Fountain Creek Watershed

Figure 2-13. Geomorphology Study Reaches



Reach ID	Reach Name	From	To	Detail Level
Reach 1	Upper Fountain Creek	Woodland Park-Sheridan Ave.	Crystola	2 - Limited
Reach 2	Upper Fountain Creek	Crystola	Manitou U/S	2 - Limited
Reach 3	Upper Fountain Creek	Manitou U/S	Manitou D/S	2 - Limited
Reach 4	Upper Fountain Creek	Manitou D/S	Monument Creek Confluence	2 - Limited
Reach 5	Sutherland Creek/Subtrib. to Crystal Park	Fountain Creek Confluence	D/S of Crystal Park	3 - Detailed
Reach 6	Monument Creek	Palmer Lake U/S	USAFA N. Boundary	2 - Limited
Reach 7	Monument Creek	USAFA S. Boundary	Fountain Creek Confluence	3 - Detailed
Reach 8	Cottonwood Creek Mainstem	Black Forest Rd.	Monument Creek Confluence	3 - Detailed
Reach 9	Dry Creek (El Paso County)	Carlson Dr.	Monument Creek Confluence	2 - Limited
Reach 13	Dirty Woman Creek	I-25	Monument Creek Confluence	2 - Limited
Reach 14	Teachout Creek	Higby Rd.	Monument Creek Confluence	3 - Detailed
Reach 15	Jackson Creek	Jackson Creek Parkway	Monument Creek Confluence	3 - Detailed
Reach 16	Black Forest Tributary	Gleneagle Detention Pond	Monument Creek Confluence	3 - Detailed
Reach 17	Smith Creek	Northgate Rd.	Monument Creek Confluence	3 - Detailed
Reach 18	Monument Branch	S. Trib./S. Branch	Monument Creek Confluence	3 - Detailed
Reach 19	Middle Tributary	S. Trib./N. Branch	Monument Creek Confluence	3 - Detailed
Reach 20	Black Squirrel Creek	3200' U/S of SH 83	Monument Creek Confluence	3 - Detailed
Reach 21	Elkhorn Creek	USAFA E. Boundary	Monument Creek Confluence	3 - Detailed
Reach 22	Pine Creek	Academy Blvd.	Monument Creek Confluence	2 - Limited
Reach 23	Fountain Creek	Monument Creek Confluence	Sand Creek Confluence	3 - Detailed
Reach 24	Fountain Creek	Sand Creek	Jimmy Camp Creek Confluence	3 - Detailed
Reach 26	Sand Creek - Mainstem	Headwaters	Fountain Creek Confluence	3 - Detailed
Reach 27	E. Fork Sand Creek - Mainstem	Headwaters	Sand Creek Confluence	3 - Detailed
Reach 28	Jimmy Camp Creek - Mainstem	Vicinity of Fontaine Blvd.	Fountain Creek Confluence	3 - Detailed
Reach 31	Fountain Creek	Jimmy Camp Creek Confluence	Young Hollow Confluence	3 - Detailed
Reach 32	Fountain Creek	Young Hollow Confluence	Porter Creek Confluence	3 - Detailed
Reach 33	Fountain Creek	Porter Creek Confluence	Arkansas River Confluence	3 - Detailed
Reach 34	Arkansas River	Fountain Creek Confluence	Baxter Rd.	3 - Detailed

Fountain Creek Watershed Study Streams of Interest*
Detail Level 2
Detail Level 3

N

US Army Corps of Engineers ®
Albuquerque District

URS

0 4.5 9 Miles

Notes:
* Streams shown on this map only include tributaries of Fountain Creek that were designated as priority in the Fountain Creek Watershed Plan.

Detail Level 2: Limited sediment yield analysis.
Detail Level 3: Detailed sediment/geomorphology analysis.

Stream Source: USGS.
Watershed Source: URS.
Highways Source: Colorado DOT.
Hillshade Source: URS. Created from USGS 10-meter resolution digital elevation models.

Date: 10/2007

Fountain Creek Watershed Study, Project 21711283

Thirty individual reaches were identified for study totaling approximately 160 miles (mi) along watershed streams. The selection of the individual reaches was based upon issues previously identified in the Fountain Creek Watershed Plan (PPACG 2003) and through agreement between USACE and the local sponsors. A detailed description of the methodology used for the geomorphologic analyses is provided in the *Fountain Creek Watershed Study Geomorphology Report* (URS 2007).

Each study reach was divided into segments for quantitative comparison. Field investigations were conducted to photo document the study reaches and collect physical measurements and bed material sediment samples for subsequent aerial photography analyses and sediment transport analyses. Aerial photographs were reviewed to gain a historical perspective on how the hydraulic planform of streams in the watershed has changed and to identify stream segments that may present problems with respect to channel stability. Sediment transport analyses were conducted to determine relative sediment balance (or imbalance) between successive stream segments based on a comparison of their sediment transport capacities. Thus, the aggradation, degradation, or equilibrium tendency of each stream segment was determined.

For the limited geomorphologic analysis, soil erosion from the upland area of a study reach was estimated and used to calculate the total soil loss. A sediment delivery ratio, as a function of watershed area, was assigned to calculate the sediment yield at the outlet of the study reach.

Detailed results from Fountain Creek and tributary geomorphology studies for field investigations, aerial photograph analysis, and sediment transport analysis are included within *Fountain Creek Watershed Study Geomorphology Report* (URS 2007). A summary of results for each project stream includes representative photos, discussion of planform change and tables with measured values for geomorphologic parameters, along with a discussion of sediment transport and calculated aggradation/degradation tendencies. Bankfull flow analysis results and field data spreadsheets for each of six gauge locations are provided in the report’s technical appendix. The technical appendix also includes detail of the sediment transport capacity analysis for each project stream including HEC-RAS model output results, flow frequency distribution plots, sediment transport rating curve plots and spreadsheets, sediment load histogram spreadsheets, and aggradation/degradation plots and spreadsheets, as well as input data and results for the limited study sediment yield analysis.

2.6.4.1 Field Investigations

Physical observations were recorded in the field to approximate channel dimensions at bankfull flow, to determine the ground-truth stream centerline locations, and to estimate vegetation / roughness factors. Bulk bed, material sediment samples were collected along each study reach at locations believed to be representative of the mean particle size distribution. Photo documentation included representative digital photographs of each reach as well as specific problem locations (locations of photographs are shown in Figure 2-14, Photo Locations). A summary of data collected is listed in Table 2-7, Data Collected during Field Investigations.

Fountain Creek Watershed

Figure 2-14. Photo Locations

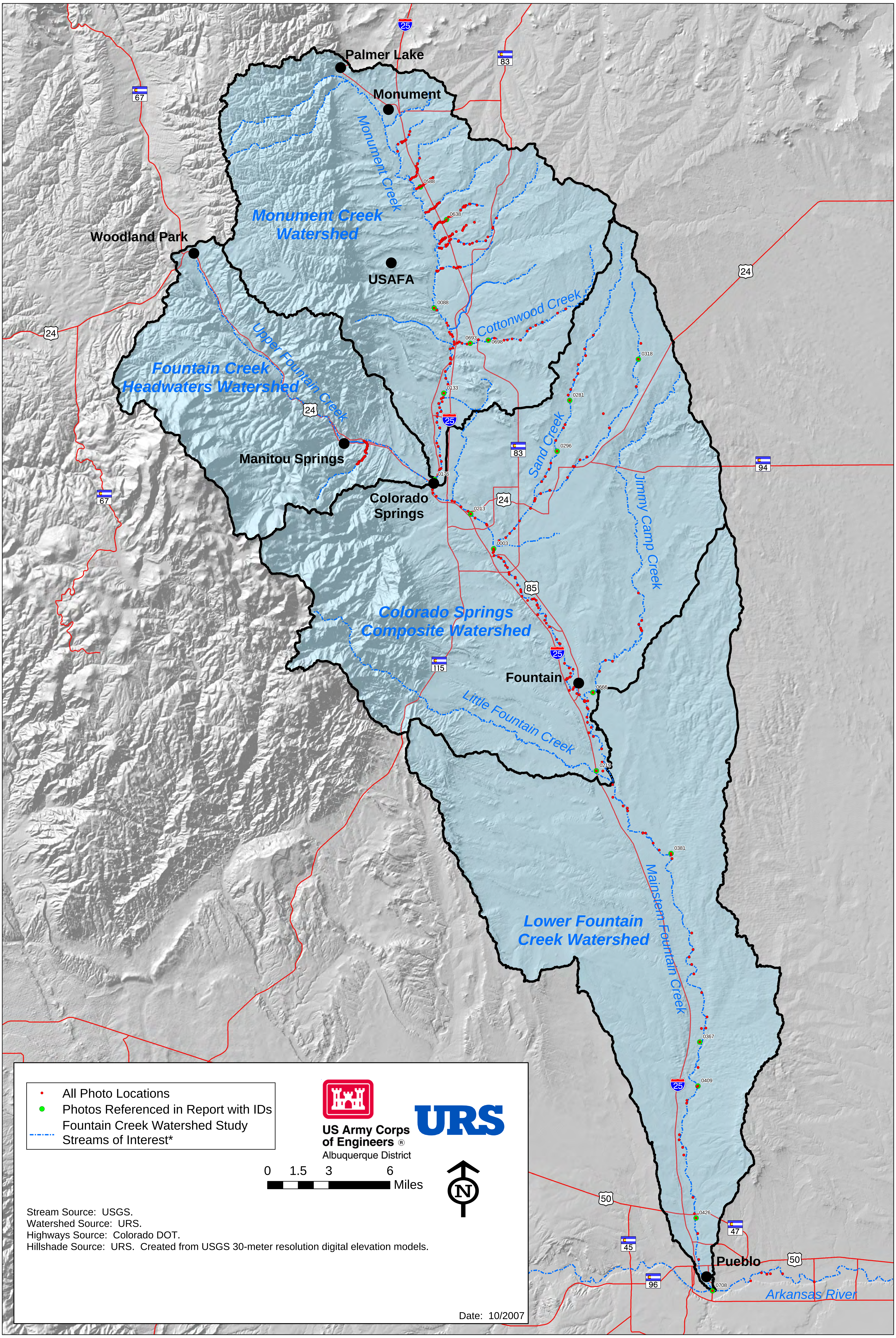


Table 2-7 Data Collected During Field Investigations	
Data Element	Number
GPS Points	487
Photographs	836
Bulk Bed Material Samples	54
Locations with Approx. Bankfull Dimensions	88

Photographs typical of project reaches are provided below to represent the broad range of stream conditions throughout the Fountain Creek Watershed.

Photo 2-1. Fountain Creek below Martin Luther King Bypass/Hwy 24
Upstream view of double rock drop below on-ramp (0213)

Photo 2-2. Fountain Creek at Sand Creek confluence
Upstream view of Fountain Creek choked by Sand Creek sediment deposition (0003)

Photo 2-3. Fountain Creek at USGS Security Gauge
Downstream view of pipeline crossing showing evidence of degradation on bridge pier (0219)

Photo 2-4. Fountain Creek at Williams Creek confluence
Downstream view on Frost property of aggrading channel reach with large cut bank (0381)

Photo 2-5. Fountain Creek at new Pinon Road Bridge
Upstream view of typical channel reach with braided low flow (0367)

Photo 2-6. Fountain Creek cut bank near of Overton Road
Upstream view of large actively eroding left bank with person in background for scale (0409)

Photo 2-7. Fountain Creek below Hwy 47
Upstream view of typical channel reach with bridge in background (0426)

Photo 2-8. Monument Creek below USAF Academy south boundary
Downstream view of typical channel with well-vegetated, stable banks (0088)

Photo 2-9. Monument Creek near Templeton Gap Floodway confluence
Downstream view of showing channel degradation and riprap on eroding right bank (0133)

Photo 2-10. Monument Creek at Colorado Avenue
Upstream view of two rock drops with Bijou Street Bridge in background (0176)

Photo 2-11: Cottonwood Creek near Infinity Place
Upstream view of a large drop structure with person in background for scale (0698)

Photo 2-12. Cottonwood Creek near Wicklow Circle
Upstream view of a suspended utility and severe channel degradation (0693)

Photo 2-13. Black Forest Creek west of I-25
Downstream view of unstable gully channel (0588)

Photo 2-14. Monument Branch below Voyager Parkway
Upstream view at the confluence of the north and south tributaries of unstable degraded reach (0638)

Photo 2-15. Sand Creek upstream of Constitution Avenue
Upstream view of severely aggraded, channelized reach with drop structures (0281)

Photo 2-16. Sand Creek along Space Center Drive
Upstream view of channelized reach in Sand Creek; riprap on banks (0296)

Photo 2-17. East Fork Sand Creek at Tamlin Road
Downstream view of stable, well vegetated meandering channel (0318)

Photo 2-18. Jimmy Camp Creek at Railroad Bridge in Fountain
Downstream view of a stable, meandering sand bed channel and floodplain (0666)

Photo 2-19. Arkansas River at Fountain Creek confluence
Upstream view from the Hwy 227 Bridge showing sediment deposition at the confluence (0708)

2.6.4.2 Aerial Photo Analysis

Aerial photographs were reviewed to gain a historical perspective on how the planform of the streams in the watershed has changed and to identify the stream segments with probable channel instability problems. The analysis was performed using aerial photographs from three time periods: 1955/1956, 1980/1983, and 2003/2004. The aerial photographs were obtained from several sources as outlined in *Fountain Creek Watershed Study Geomorphology Report* (URS 2007).

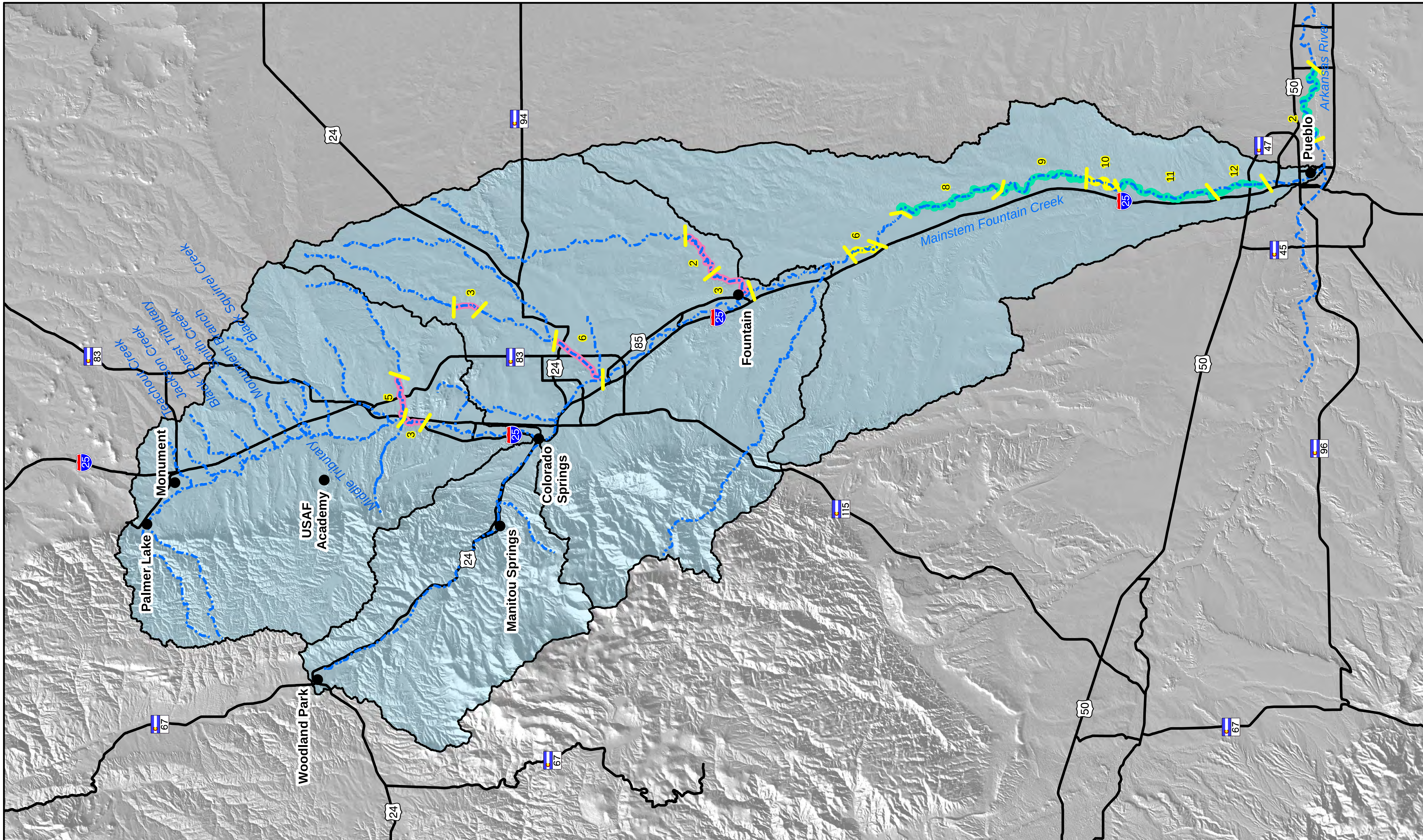
A map of the watershed showing stream segments that have changed in channel length more than 10% over the period from 1955 to 2003 is shown in Figure 2-15, Time-series Changes. This figure represents specific stream segments where geomorphic alteration has been most pronounced. These segments would be expected to experience marked boundary adjustment through erosion and sedimentation in the future.

The most significant decreases in channel length occur in the northern part of the watershed in the following streams. With the exception of Jimmy Camp Creek, these streams have been anthropogenically straightened to allow urban development. Jimmy Camp Creek experienced natural straightening that is suspected to have occurred by avulsion during the 1965 flood.

- Cottonwood Creek (Segment 5)
- Monument Creek (Segment 3),
- East Fork Sand Creek (Segment 3)
- Sand Creek (Segment 6)
- Jimmy Camp Creek (Segments 2 and 3)

An example of changes in channel characteristics for the straightened stream segment of Cottonwood Creek is shown in Figure 2-16, Example Changes in Channel Characteristics – Cottonwood Creek Segment 5. Between 1955 and 1983, the creek was channelized and numerous meanders removed.

The most significant increases in channel length occur in the southern part of the watershed along the main stem of Fountain Creek. Figure 2-17, Example Changes in Meander Characteristics – Fountain Creek Segment 8A, provides and example of changes in meander characteristics for a lengthening segment of Fountain Creek. The observed changes within this segment and along lower Fountain Creek are suspected to have occurred as the stream adjusted to changes in hydrology and sediment load. The potential exists for continued pronounced lateral migration and bank erosion.



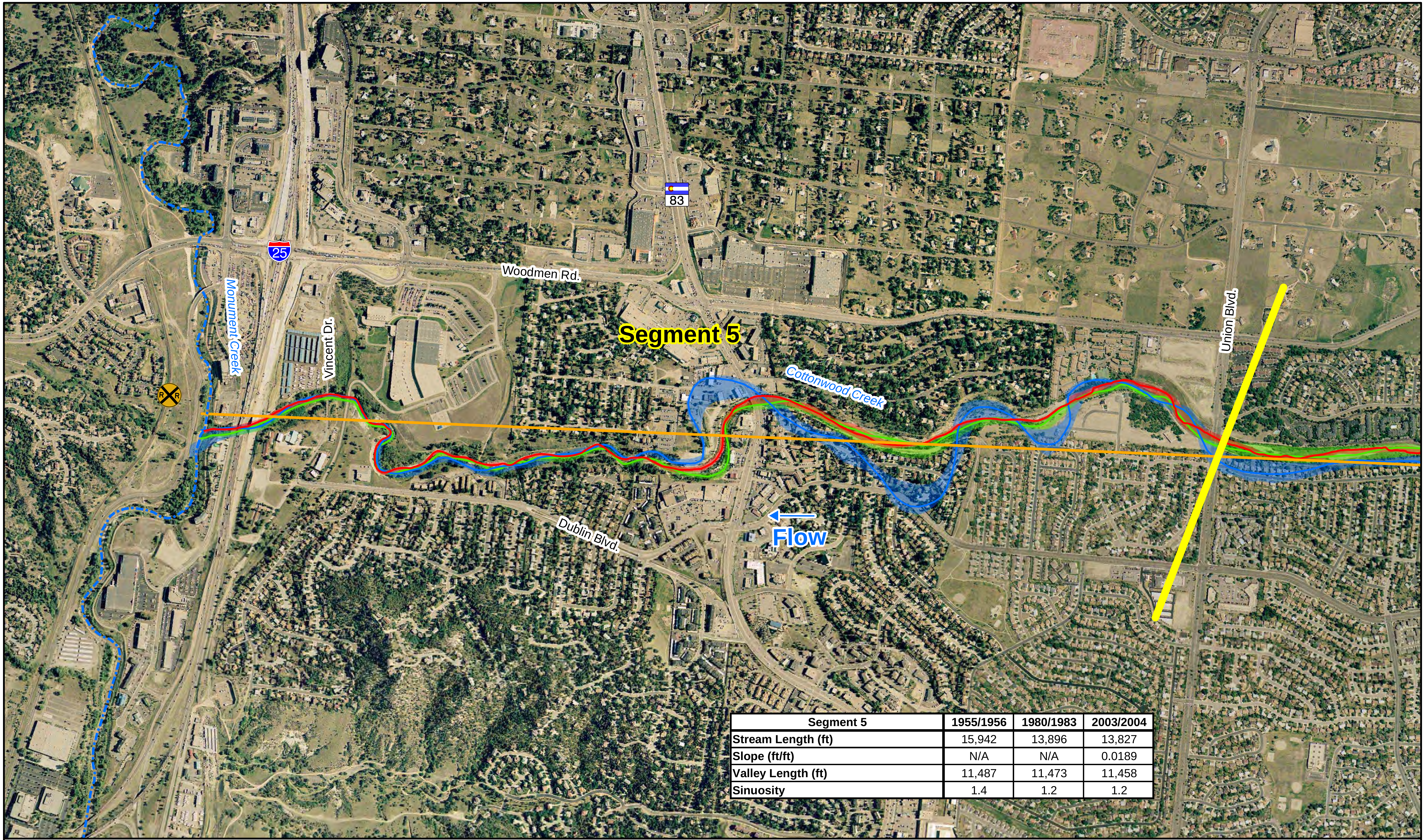
URS
URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers
Albuquerque District

Time-Series (1955-2003)
Changes in Channel Length

Figure 2-15
10/2007

Fountain Creek Watershed Study, URS Project 21711283



Segment 5	1955/1956	1980/1983	2003/2004
Stream Length (ft)	15,942	13,896	13,827
Slope (ft/ft)	N/A	N/A	0.0189
Valley Length (ft)	11,487	11,473	11,458
Sinuosity	1.4	1.2	1.2

URS

URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers
Albuquerque District

1955/1956 Centerline
1980/1983 Centerline
2003/2004 Centerline
1955/1956 Bankfull Channel
1980/1983 Bankfull Channel
2003/2004 Bankfull Channel
Valley Length
Segment Breaks

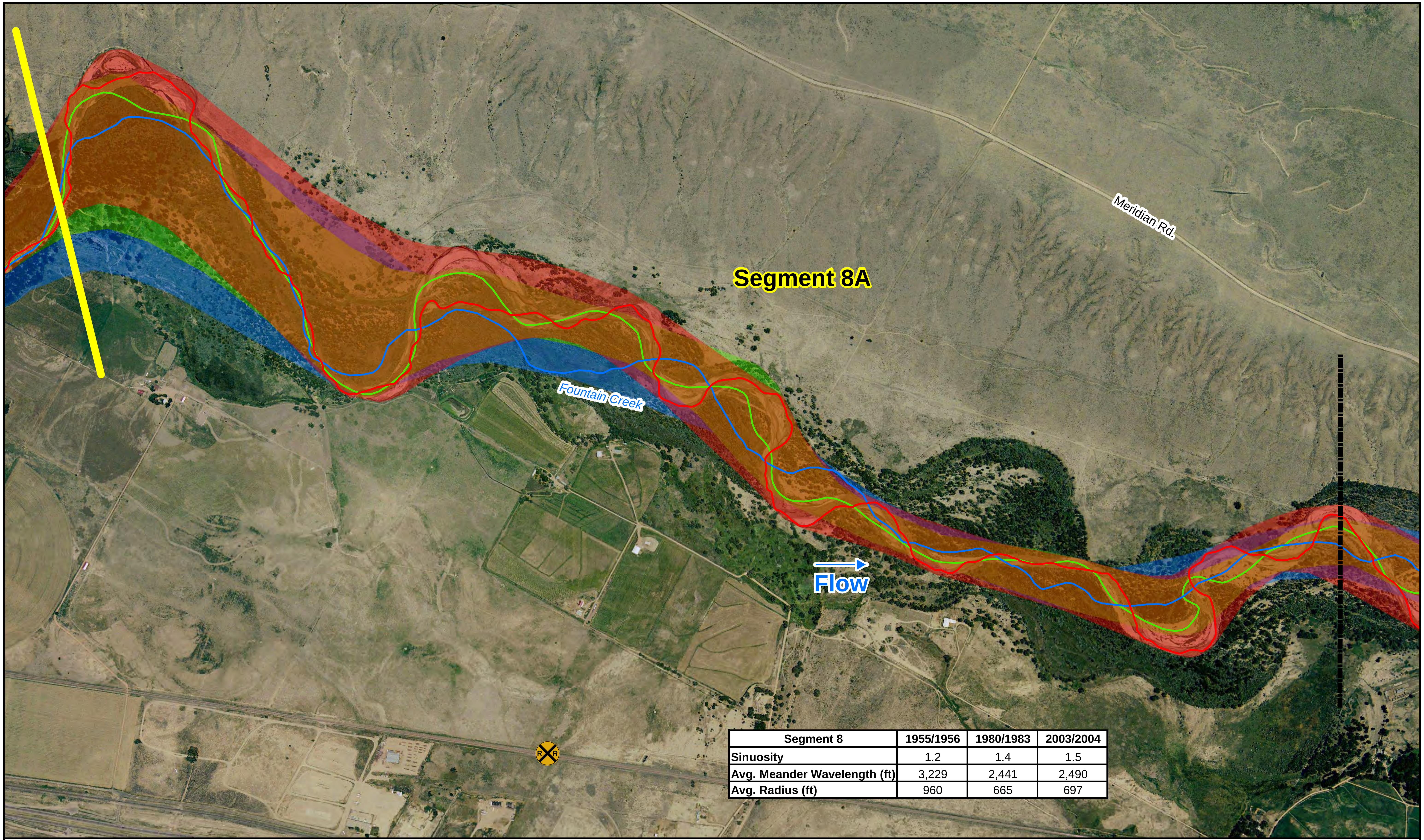
N

Scale is: 1:12,000
or
1 inch equals 1,000 feet

0 1,000 2,000
Feet

Example Changes in Channel Characteristics
Cottonwood Creek Segment 5
Figure 2-16
10/2007

Fountain Creek Watershed Study, Project 21711283 El Paso County photos: AirPhotoUSA, 2003.



Segment 8	1955/1956	1980/1983	2003/2004
Sinuosity	1.2	1.4	1.5
Avg. Meander Wavelength (ft)	3,229	2,441	2,490
Avg. Radius (ft)	960	665	697

URS
URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers
Albuquerque District

1955/1956 Centerline
1980/1983 Centerline
2003/2004 Centerline
1955/1956 Meander Belt
1980/1983 Meander Belt
2003/2004 Meander Belt
Segment Breaks
Match Line (if applicable)

Scale is: 1:12,000
or
1 inch equals 1,000 feet

0 1,000 2,000
Feet

Example Changes in Meander Characteristics

Fountain Creek Segment 8A

Figure 2-17

10/2007

Fountain Creek Watershed Study, Project 21711283 El Paso County photos: AirPhotoUSA, 2003; Pueblo County photos: Pueblo County, 2004.

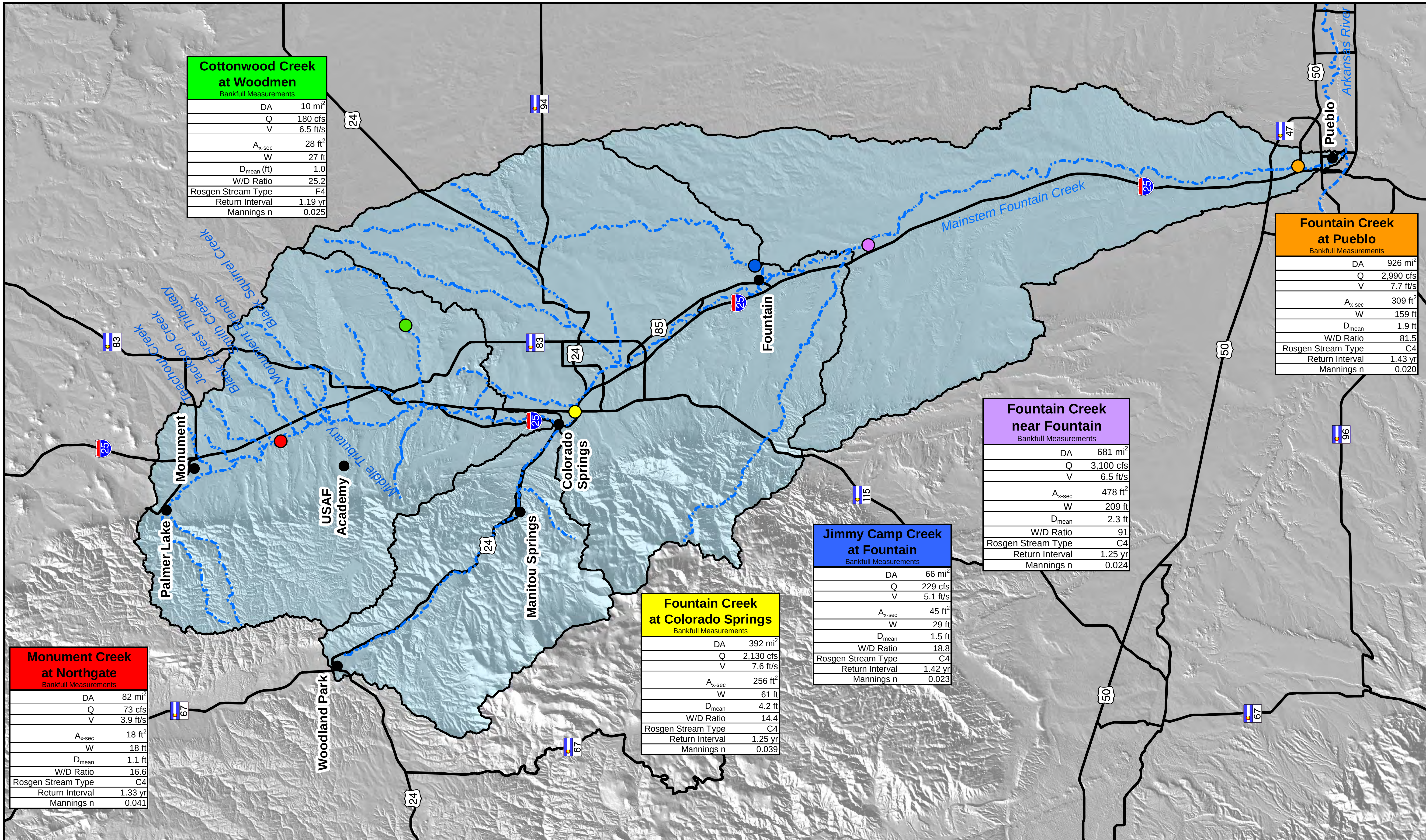
2.6.4.3 Bankfull Discharge Analysis

As part of the sediment transport analysis, a bankfull flow analysis was conducted at six USGS gauge stations. The selection of sites for the study was based on the objective to analyze gauges representing a full range of contributing drainage areas within the Fountain Creek watershed while exhibiting a reasonable period of record. These field-based bankfull discharges were then compared to the calculated effective discharges and against a range of recurrence intervals to determine the appropriate representative discharges to be used in the aggradation/degradation tendency analysis.

A summary of the bankfull characteristics at the six gauge stations studied is provided in Table 2-8, Bankfull Discharge and Bankfull Hydraulic Geometry. A map of the watershed showing a summary of measured bankfull characteristics is provided in Figure 2-18, Bankfull Flow Analysis. The bankfull flows shown have a recurrence interval on the order of a 1.25-year flood event. As documented in geomorphology literature and observed in the Fountain Creek watershed, small, frequently recurring storm events (e.g., 2-year or less) have a significant influence on channel stability and resultant downstream impacts.

Table 2-8
Bankfull Discharge and Bankfull Hydraulic Geometry

Gauge Station	Drainage Area (mi^2)	Bankfull Discharge (cfs)	Bankfull Area (ft^2)	Top Width (ft)	Depth (ft)	Top Width/Depth	Return Interval (years)	Bank Height Ratio
Monument Creek above Northgate	82	72	18	18	1.1	16.6	1.33	3.1
Fountain Creek at Colorado Springs	392	2,130	256	61	4.2	14	1.25	1.4
Fountain Creek at Fountain	681	3,100	478	209	2.3	91	1.25	1.6
Fountain Creek at Pueblo	926	2,990	309	159	1.9	82	1.43	1.4
Cottonwood Creek at Woodmen	10	180	28	27	1.0	25	1.19	3.3
Jimmy Camp Creek at Fountain	66	229	45	29	1.5	19	1.42	1.0



Cottonwood Creek at Woodmen
Bankfull Measurements

DA	10 mi^2
Q	180 cfs
V	6.5 ft/s
$A_{x\text{-}sec}$	28 ft^2
W	27 ft
D_{mean} (ft)	1.0
W/D Ratio	25.2
Rosgen Stream Type	F4
Return Interval	1.19 yr
Mannings n	0.025

Monument Creek at Northgate
Bankfull Measurements

DA	82 mi^2
Q	73 cfs
V	3.9 ft/s
$A_{x\text{-}sec}$	18 ft^2
W	18 ft
D_{mean}	1.1 ft
W/D Ratio	16.6
Rosgen Stream Type	C4
Return Interval	1.33 yr
Mannings n	0.041

Fountain Creek at Colorado Springs
Bankfull Measurements

DA	392 mi^2
Q	2,130 cfs
V	7.6 ft/s
$A_{x\text{-}sec}$	256 ft^2
W	61 ft
D_{mean}	4.2 ft
W/D Ratio	14.4
Rosgen Stream Type	C4
Return Interval	1.25 yr
Mannings n	0.039

Jimmy Camp Creek at Fountain
Bankfull Measurements

DA	66 mi^2
Q	229 cfs
V	5.1 ft/s
$A_{x\text{-}sec}$	45 ft^2
W	29 ft
D_{mean}	1.5 ft
W/D Ratio	18.8
Rosgen Stream Type	C4
Return Interval	1.42 yr
Mannings n	0.023

Fountain Creek near Fountain
Bankfull Measurements

DA	681 mi^2
Q	3,100 cfs
V	6.5 ft/s
$A_{x\text{-}sec}$	478 ft^2
W	209 ft
D_{mean}	2.3 ft
W/D Ratio	91
Rosgen Stream Type	C4
Return Interval	1.25 yr
Mannings n	0.024

Fountain Creek at Pueblo
Bankfull Measurements

DA	926 mi^2
Q	2,990 cfs
V	7.7 ft/s
$A_{x\text{-}sec}$	309 ft^2
W	159 ft
D_{mean}	1.9 ft
W/D Ratio	81.5
Rosgen Stream Type	C4
Return Interval	1.43 yr
Mannings n	0.020

Streams of Interest
USGS Gage Locations

Scale is: 1:285,120 or 1 inch equals 4.5 miles
0 4 8 Miles

URS
URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001
US Army Corps of Engineers
Albuquerque District

Bankfull Flow Analysis
Figure 2-18

10/2007

Fountain Creek Watershed Study, Project 21711283

2.6.4.4 Detailed Sediment Transport Analysis

A sediment transport analysis was conducted to facilitate the detailed geomorphologic analysis, and involved the determination of relative sediment balance (or imbalance) between successive stream segments based on a comparison of their sediment transport capacities. Thus, the aggradation, degradation, or equilibrium tendency of each stream segment was determined.

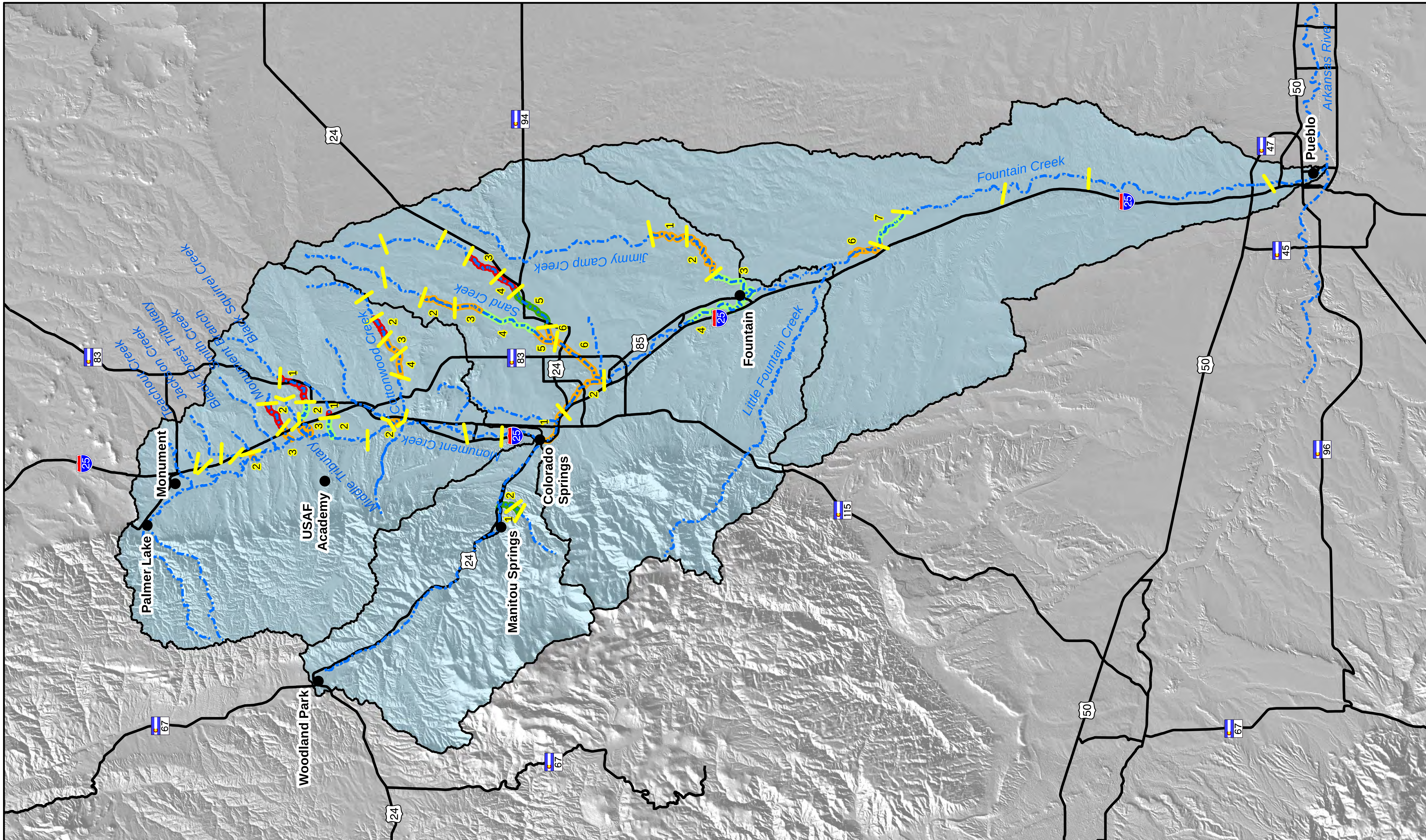
The analysis included:

- Development of sediment transport rating curves based on a selected sediment transport equation and the hydraulic model developed for each study reach;
- The derivation of flow frequency distributions based on recorded USGS gauge data;
- The integration of sediment transport capacity with flow frequency distribution for each study reach to determine the effective discharge and the expected total sediment load under the flow frequency distribution; and
- The accounting of sediment transport capacity between successive stream segments within each reach to determine aggradation, degradation, or equilibrium tendency.

Sediment transport capacity was calculated using the USACE Hydrologic Engineering Center – River Analysis System Version 3.1.3 (HEC-RAS) and the “Hydraulic Design – Sediment Transport Capacity” function. The sediment transport capacity at bankfull discharge was determined at each channel cross-section represented in the models developed for hydraulic studies.

The results indicate that the calculated effective discharges are generally much smaller than the field estimated bankfull discharges. The discrepancy is even more profound for the tributaries where no flow records were available for developing a site-specific flow-frequency distribution. Because the calculated effective discharges are uncharacteristically low, the bankfull discharges were then selected to calculate the representative sediment load for aggradation/degradation tendency evaluation.

Figure 2-19, Aggradation/Degradation Tendency, shows the stream segments in the watershed that have the most pronounced tendency toward aggradation or degradation based on the sediment transport analysis. In general, the results indicate that more reaches in Fountain Creek as well as its tributaries have a tendency for degradation than reaches that have a tendency for aggradation due to the relative steep slopes of the streams. The results indicate high degradation tendency for Cottonwood Creek, East Sand Creek, Sand Creek, Jackson Creek, Black Forest Creek, and some reaches of Monument and Fountain Creeks.



URS

URS Corporation
9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
(719) 531-0001

US Army Corps of Engineers®
Albuquerque District

Flow-Proportional Sediment Transport Balance at Bankfull Flow

- Severe Degradation (<-1000 tons/d/cfs)
- Moderate Degradation (-1000 tons/d/cfs < -200 tons/d/cfs)
- Moderate Aggradation (200-1000 tons/d/cfs)
- Severe Aggradation (>1000 tons/d/cfs)
- Streams of Interest
- 3 Stream Segment Number

Scale is: 1:285,120
or
1 inch equals 4.5 miles

0 4.5 9 Miles

Aggradation/Degradation Tendency
(Existing Conditions)

Figure 2-19
10/2007

Fountain Creek Watershed Study, URS Project 21711283

Results represented in Figure 2-19, Aggradation/Degradation Tendency, have been "normalized" based on the stream's bankfull flow. In other words, the sediment transport results and the aggradation/degradation tendency have been proportioned to the amount of flow in the respective stream to allow for a relative comparison between Fountain Creek and its tributaries on a single map. In terms of absolute sediment transport in tons/day, the main stems of Monument and Fountain Creeks exhibit markedly higher transport. For Fountain Creek, the upper reach (Segments 1 through 3) appears to have high tendency for degradation while the lower reach (Segments 7 through 13, except 10) appears to have a tendency for aggradation. Refer to the *Fountain Creek Watershed Study Geomorphology Report* (URS 2007) for comprehensive results for each creek by stream segment.

It is important to note that calibration of sediment transport rating curves using field measurements of sediment load is critical to develop valid estimates of absolute sediment transport capacity, but this data was not available for this study. Without calibrated sediment transport rating curves, it is extremely difficult to judge the appropriateness of the absolute values (in tons/day) of sediment transport. As such, the results of this analysis should be used only as a relative comparison of transport capacity between stream segments.

Finally, all of the sediment transport equations are based on the assumption that there is an unlimited supply of sediment for transport in the stream. The equations provide an estimate only for the transport potential, but it could be quite different from reality where the sediment availability is limited. In addition, the lateral sediment inflow, which could be significant, was not considered in the balance calculation because it was not available and needs detailed study in order to quantify. The aggradation/degradation tendency analysis, therefore, was based on an uncalibrated sediment transport capacity on the main stems of each project stream assuming unlimited upstream sediment supply. The tendency analysis should be considered preliminary or conceptual in nature and would require more detailed field verification for consideration of future design projects.

2.6.4.5 Limited Sediment Analysis

For the limited geomorphologic analysis, soil erosion from the upland area of a study reach was estimated and used to calculate the total soil loss. A sediment delivery ratio, as a function of watershed area, was assigned to calculate the sediment yield at the outlet of the study reach. The sediment yield rate for the watersheds with the limited sediment analysis is summarized in Table 2-9, Summary of Limited Sediment Analysis.

Table 2-9
Summary of Limited Sediment Analysis

Stream	USACE Reach ID No.	Estimated Gross Soil Erosion (tons/ac/yr)	Sediment Yield at Reach Outlet (tons/yr)
Upper Fountain	1	0.79	1,590
	2	0.63	5,940
	3	0.98	21,650
	4	1.00	23,470
Dry Creek	9	0.90	1,241

Table 2-9
Summary of Limited Sediment Analysis

Stream	USACE Reach ID No.	Estimated Gross Soil Erosion (tons/ac/yr)	Sediment Yield at Reach Outlet (tons/yr)
Dirty Woman Creek	9	0.91	1,700
Pine Creek	9	0.64	1,970

Flow Regime Changes in Fountain Creek Watershed

Fluvial streams are subject to significant geomorphologic changes if the stream flow regime undergoes changes when the hydrologic characteristics of the watershed evolve. For Fountain Creek, the watershed has experienced a large scale of urbanization in the last few decades, which has led to higher baseflow and more frequent flood flows. These changes have contributed to bank erosion and bed degradation in many tributaries and the main stem of Fountain Creek.

A flow regime change in the Fountain Creek watershed was evaluated through a statistical analysis of the flow records at the USGS gauging stations in the watershed. In this analysis, the multi-decade flow records at the USGS gauges were divided into several 10-year periods, with the latest from 1996-2005. The flow frequency distributions were then developed for all 10-year periods of the same station, based on the same flow discharge bins. The frequency distributions of grouped 10-year periods were then compared to observe the possible changes in flow regimes in the watershed. The results showing the shifting of the flow frequency distributions are shown in Figures B-65 to B-74 of the *Fountain Creek Watershed Study Geomorphology Report, Technical Appendix B* (URS 2007).

The analysis indicated a general trend that the flow frequency distributions have been shifting to the right, i.e., that higher stream flows are occurring more often than in the past. As the flows are increasing in the streams, the sediment transport capacity is increased. Consequently, the streams in the watershed are experiencing degradation in general, as observed in the field.

2.6.5 Hydrologic, Hydraulic, and Geomorphologic Study Results Summary

Following is a summary of the current hydrologic and hydraulic conditions and the aggradation/degradation tendencies of the Fountain Creek Watershed study area streams, and a brief description of expected future conditions based on the results of the study. The use of general terms “minor,” “major,” and “severe” to describe the predicted changes in future 2-year and 100-year peak flow rates and volumes corresponds to the yellow, orange and red colored symbols in Figures 2-5 through 2-12.

Upper Fountain Creek

- No major changes in future 2-year peak flow
- Minor changes in future 2-year flow volume
- Minor changes in future 100-year peak flow
- No detailed geomorphology was performed
- Continued degradation is expected in incised Teller County reach above Safeway store
- Accelerated aggradation is expected in City of Woodland Park reach from Safeway to Walmart due to overwidening
- Accelerated degradation is expected in Teller County reach below Walmart due to localized induced instability from impervious area and minor changes in future flow

- Reach through El Paso County and Manitou is relatively stable although confined by Hwy 24 and urban encroachment

Sutherland Creek

- No changes in future hydrology are expected
- Aggradation is expected at the upstream end due to unstable tributary sediment supply
- Most of stream is relatively stable and is expected to remain so
- Minor degradation is expected to continue below Hwy 24 on-ramp and contribute sediment to downstream aggrading reach
- Aggradation due to flat slope and overwidening is expected to continue below Manitou Ave. resulting in persistent cleaning of box culvert and dredging of downstream channel
- Degradation is possible at confluence with Fountain Creek due to main stem base level drop

Monument Creek

- Major changes (168% increase) are expected in future 2-year peak flow at north boundary of USAFA due to future development in eastern tributaries
- A 44% increase in future 2-year flow volume is predicted at south boundary of USAFA
- Minor changes in future 2-year and 100-year flow volumes but little change is expected to peak flows in lower reaches within the City of Colorado Springs
- Segment 3 has been shortened (straightened) by over 1500 ft via channelization which has lead to increased slope and degradation
- Lower segments 5 and 6 shortened (straightened) via channelization prior to 1955 which has lead to increased slope and degradation
- Field observations indicate degradation in reaches within the City of Colorado Springs, which is supported by sediment modeling results
- Channelization and grade-control structures in place throughout City of Colorado Springs may limit trend toward continued degradation
- Hydraulic widening of incised lower reaches will continue to provide sediment supply downstream to Fountain Creek
- Several drop structures have been flanked, failed, or are at risk

Cottonwood Creek

- Severe changes are expected in future 2-year and 100-year peak flows in upper reaches
- Major changes in future 2- and 100-year flow volumes are expected throughout the watershed (see hydrology summary maps for locations)

- Minor changes are expected in future 2-year and 100-year peak flows and flow volumes at mouth
- Lower reach, segment 5, has been shortened (straightened) by over 2000 ft via channelization which has lead to increased slope and severe degradation
- Severe degradation has occurred from mouth upstream to Cowpoke Road (about 7 miles) which conflicts with sediment modeling results that show alternating reaches of aggradation/degradation
- There are no stable reaches until above Cowpoke Road, and only isolated locations of stability where bedrock controls or grade control structures exist (e.g., downstream of Woodmen, just downstream of Union, just upstream of Academy)
- The most significant head cuts exist at Vincent Ave., just downstream of Academy Blvd., near Infinity Place, at Rangewood Ave., at Powers Blvd., and at Cowpoke Rd.
- Grade-control structures and bedrock control may limit the trend toward continued degradation below Woodmen Road, but hydraulic widening of these incised reaches is expected to continue and provide sediment supply to downstream reaches
- Reaches upstream of Woodmen Road are expected to have continued degradation, widening and provide significant sediment supply
- Major channel "improvements" are ongoing below Rangewood Ave., in planning stages below Academy Blvd., and are expected to occur with Wolf Ranch development above Cowpoke Road

Dry Creek

- No changes are expected in future hydrology, due to limited development
- No detailed geomorphology was performed, but there are no known or expected issues

Templeton Gap

- No change is expected in future hydrology, due to limited development
- No detailed geomorphology was performed, but there are no known or expected issues

Dirty Woman Creek

- Major changes are expected in future 2-year peak flows in all reaches
- Minor changes are expected in future 2-year flow volumes in all reaches
- No detailed geomorphology was performed, and there are no known sediment/channel instability issues
- Future degradation is expect to occur below I-25 due to changes in hydrology

Teachout Creek

- Major changes are expected in future 2-year and 100-year peak flows in all reaches
- Major changes are expected in future 2- and 100-year flow volumes in all reaches
- Major aggradation is expected downstream of I-25 due to unstable I-25 ditch sediment supply, and the ditch is expect to be armored by CDOT
- Sediment modeling results indicate slight degradation tendency
- Severe degradation and widening downstream of Higby Road are expected to continue
- Future degradation is expect to occur below I-25 where minor degradation has occurred in the past, due to changes in hydrology

Jackson Creek

- Major changes are expected in future 2-year peak flows in all reaches
- Minor changes are expected in future 100-year peak flows in all reaches
- Minor changes are expected in future flow volumes
- Minor degradation is expected upstream of Jackson Creek Parkway, downstream of Baptist Road, upstream of Railroad
- Major degradation is expected downstream of the railroad due to recent increases in developed peak flows and volumes over a historic head cut
- Given changes in hydrology, expect future degradation to occur below I-25 with some reaches at risk of pronounced instability

Black Forest Creek

- No change is expected in future hydrology, due to limited development
- Severe degradation exists downstream of I-25 on USAFA property, which is consistent with sediment modeling results
- A major channel stabilization and restoration project by USAFA is underway, and channel improvements upstream of Struthers Road were recently completed

Smith Creek

- Minor changes are expected in future 2-year peak flows and volumes in lower reaches
- Minor degradation is expected along the I-25 exit ramp, east of I-25
- Major degradation exists downstream of railroad, and the channel has since naturally re-stabilized as a result of beaver activity (ponding) and an influx of dense vegetation
- Large meanders downstream of railroad are at imminent risk of avulsion (meander cut-off) and subsequent degradation

Monument Branch

- Impacts to future hydrology are expected due to ongoing and planned development of 80% of the watershed
- Severe changes are expected in future 2- and 100-year peak flows; for example, future 2-year peak flow increases 308% and 100-year peak flow increases 67% at I-25
- Major changes are expected in future 2- and 100-year flow volumes; for example, future 2-year flow volume increases 154% and 100-year flow volume increases 52% at I-25
- Sediment modeling results indicate degradation tendencies
- Severe degradation and widening observed from mouth upstream to east of USAFA boundary at confluence of north and south tributaries are expected to continue and propagate upstream to Voyager Road
- Major head cuts exist near mouth, downstream of the railroad, at I-25 SB, at I-25 NB, upstream of I-25, and at confluence of tributaries
- Temporary riprap repair have been placed in two head cuts (downstream of railroad and upstream of I-25) by USAFA
- USAFA has initiated planning for potential restoration on its property, but pronounced instability exists upstream

Middle Tributary

- Major changes are expected in future 2- and 100-year peak flows in upper reaches; for example, at Voyager Pkwy, 2-year peak increases 130% and 100-year increases 46%
- Minor changes are expected in future 2- and 100-year peak flows in lower reaches
- Increases in future 2-year and 100-year flow volumes at Voyager Pkwy are 85% and 34% respectively
- Minor aggradation is expected upstream of railroad on USAFA due to unstable tributary sediment supply
- Severe degradation and widening on USAFA property below railroad is consistent with degradation tendency predicted by sediment modeling results
- Temporary riprap repair has been placed in head cut by USAFA
- Aggradation upstream of mouth is expected to continue from available upstream sediment supply
- Temporary riprap repair of minor head cuts at mouth has been placed by USAFA
- USAFA has initiated planning for a potential restoration project

Black Squirrel Creek

- Major to severe changes are expected in future 2-year peak flows in lower reaches; for example, increases at Voyager Pkwy are 217% and at mouth 192%

- Major change is expected in future 2-year flow volumes
- Minor change is expected in future 100-year flow volume at Voyager Pkwy
- Severe degradation exists on USAFA property, with primary head cuts below railroad
- Severe degradation exists from Voyager Pkwy upstream to SH83, with primary head cuts downstream of SH83
- The alternating reaches of aggradation and degradation tendencies predicted by sediment modeling results are consistent with field observations

Elkhorn Tributary

- Future conditions hydrology is expected to change due to ongoing and planned development of nearly 100% of the watershed
- Severe changes in future 2- and 100-year peak flows; for example, future 2-year peak flow increases 483% and 100-year peak flow increases 474% at I-25
- Major changes in future 2- and 100-year flow volume; for example, future 2-year flow volumes increase 611% and 100-year flow volumes increase 253% at I-25
- Upstream reaches are concrete channel, therefore no degradation is expected
- Severe degradation and widening downstream of City of Colorado Springs detention facility at USAFA boundary is expected to continue to provide downstream sediment supply
- Aggradation on USAFA property north of Airfield is expected to continue from referenced upstream supply
- Upstream degradation and downstream aggradation tendencies predicted by sediment modeling results are consistent with field observations

Pine Creek

- Major changes are expected in North Pine Creek tributary future 2-year (51% increase) and 100-year (23% increase) peak flows at SH83
- No change in peak flows at mouth is expected
- Minor increase is expected in future 2-year flow volume at the mouth
- No detailed geomorphology was performed
- Severe degradation from the mouth upstream to confluence of the North and South tributaries is expected to continue upstream on the North tributary to Academy Blvd
- Widening of degraded reaches and continued sediment supply expected
- South Tributary is concrete lined, therefore no degradation is expected

Sand Creek

- Major change is expected in future 2-year peak flow in upper reaches
- Peak flow rates increase in some reaches (197% upstream of Stetson Hills Blvd for 2-year and 19% for 100-year), and decrease in others (-79% downstream of proposed detention pond near Sky Sox Stadium for 2-year and -28% for 100-year)
- No change is expected in future 2-year or 100-year peak flow in lower reaches
- Major changes are expected in future 2- and 100-year flow volumes; for example, 2-year at Stetson Hills increases 40%, 53% at Academy Blvd, and 38% at mouth, and the 100-year increases at 12% at Stetson Hills, 19% at Academy Blvd., and 15% at mouth
- Minor aggradation in upper reach is consistent with sediment modeling results
- Grade-control structures and bedrock control may limit trend toward continued degradation observed and supported by sediment modeling results
- Severe aggradation exists upstream of Constitution Ave to N. Carefree Cir, due to drastic overwidening and flat slopes between existing grade-control structures; although this conflicts with the sediment modeling results, it is expected to continue
- Construction of proposed detention pond near Sky Sox stadium could drastically alter sediment transport in this reach and increase aggradation upstream to Stetson Hills Blvd. while possible initiating degradation downstream
- Severe degradation exists immediately downstream of Constitution Ave., with several failing drop structures currently being repaired
- Repair and construction of new grade-control structures may limit trend toward continued degradation
- Aggradation observed just above Powers Blvd. is consistent with sediment modeling results
- Moderate to severe aggradation observed in lower reaches conflicts with sediment modeling results
- Segments 3 through 6 have been dramatically shortened (straightened) via channelization and grade control structures will limit future degradation

East Fork Sand Creek

- Severe changes are expected in future 2-year peak flows and volumes, and 100-year volumes in upper reaches; for example, 2-year peak flow increases 2493% below Constitution Ave., 2-year volume increases 1108%, and 100-year volume increase 117%
- Severe increase in future 100-year peak flows is expected in lower reaches
- Severe increases in flow volumes are expected throughout the watershed
- Upper reaches were relatively stable at the time of study but rapid development has occurred particularly in Segments 3 and 4, which is expected to result in increased sediment supply to the main channel

- Segments 3 and 4 exhibit minor degradation and widening, which is consistent with sediment modeling results; however, future aggradation is expected due to overwidening with channelization as development upstream increases supply
- Segment 5 is experiencing minor aggradation from upstream supply, which is consistent with sediment modeling results
- Lower reaches are channelized and have been shortened (straightened) via channelization and as a result are incised and are expected to continue to degrade
- Major degradation observed in Segment 6, and this trend is expected to continue along with widening
- Future channel stability expected to be at great risk due to development, channelization, and expected change in hydrology

Jimmy Camp Creek

- Severe changes are expected in future 2-year peak flows and volumes; for example, peak flow increases 400% at mouth and volume 205%
- Major changes are expected in future 100-year peak flows and volumes; for example, peak increases 41% at mouth and volume 30%
- Severe change is expected in future 2-year flow volume at mouth
- Major change is expected in future 100-year flow volume at mouth
- The creek is relatively stable throughout
- Segment 1 has been dramatically shortened (straightened) via channelization which has led to increased slope and a trend towards degradation
- Minor degradation exists below Link Road as a result of 1965 flood avulsion, but the reach has since re-stabilized naturally at a lower level
- Limited sediment modeling results indicate degradation tendency
- Future channel stability is expected to be at great risk due to planned future development, expected channelization, and expected change in hydrology

Little Fountain Creek

- Minor changes are expected in future 2-year and 100-year peak flows
- Major increase is expected in future 100-year peak flows at mouth
- Minor changes are expected in future 2-year and 100-year flow volumes in upper reaches
- No detailed geomorphology was performed

Peterson Field Tributary

- No change is expected in future hydrology, due to limited development

- No detailed geomorphology was performed

Fountain Creek

- Minor changes are expected in future 2-year and 100-year peak flows and volumes; for example, 2-year peak flow increases 25% and volume 36%, and the 100-year peak increases 13% and volume 15% at Fountain Gauge (Old Pueblo Hwy); at the mouth, the 2-year peak increases 23% and volume 25%; and the 100-year peak increases 13% and volume 10%
- Instability issues are expected to propagate due to continued development and resulting changes in hydrology
- Straightened and degraded upper reaches (Segments 1 through 3) are consistent with pronounced degradation tendency predicted by sediment modeling results
- Numerous cut banks along terraces provide sediment supply to downstream reaches
- Grade-control structures throughout City of Colorado Springs reach may limit trend toward continued degradation, but widening and continued sediment supply are expected to continue
- The channel is relatively stable with minor lateral migration below Hwy 16 through the City of Fountain, consistent with modeling results indicating slight aggradation tendency
- The channel has a much greater tendency for lateral migration with pronounced shift in planform (meandering) over time, indicating aggradation, at the north end of Clear Springs Ranch near an irrigation diversion (Segments 5B and 6) and continuing through Hanna Reach below Old Pueblo Hwy, which contradicts the sediment modeling results indicating a degradation tendency
- Lateral migration of the channel and downstream sediment supply is expected to continue, due to numerous cut banks along terraces providing sediment supply to downstream reaches
- In Frost Reach (Segment 7), the channel becomes much more stable with a slight tendency for aggradation but much less migration (e.g., Frost terrace wall)
- Dense riparian vegetation and floodplain connectivity provide stability through Segments 7 and 8
- From the City of Pueblo (Segment 10) to Segment 8 (below Frost), meander migration over time becomes more pronounced with a wholesale lengthening of the creek by thousands of feet between 1955 and present, suggesting an aggradation tendency supported by sediment modeling results which is expected to continue
- Below Pace Rd (new Pinon), Segment 10 exhibits lateral migration but no lengthening over time; interestingly, sediment transport tendency shifts to degradation unlike all the other lower reaches
- Below Beacon Hill (Segment 11), reaches are expected to lengthen over time with an aggradation tendency

- Segments 10 through 12 have numerous large cut banks along terraces providing sediment supply downstream, and continued lateral migration and downstream supply are expect to increase with lengthening
- The reach within City of Pueblo (Segment 13) is confined laterally by levees on both sides, and aggradation has been observed by the City and confirmed by sediment modeling results; this trend expected to continue with changes in hydrology, upstream lengthening, and increases in sediment supply from upstream

2.7 BIOLOGICAL RESOURCES

2.7.1 Wildlife and Habitats

Wildlife includes mammals, birds, reptiles, and amphibians that inhabit one or more of the vegetative communities present in the Fountain Creek Watershed (study area) seasonally or year-round. Seven general habitat types occur in the study area. Table 2-10, Percentage of Wildlife Habitats in Study Area, lists these habitats and the percentage of area covered by each type in the study area. Section 4.2 of the Environmental Baseline Report describes these habitats in detail.

Table 2-10
Percentage of Wildlife Habitats in Study Area

Wildlife Habitat	Percent of Study Area
Agricultural	2
Grassland	49
Riparian woodland	1
Pinyon-juniper woodland	1
Montane shrubland	8
Montane forest	25
Urban/built-up area	11
Other (open water, cliffs, etc.)	3

Source: CDOW 1995.

Changes in the hydrology of Fountain Creek, such as changes in baseflow due to increasing stormwater runoff, or additional wastewater and irrigation return flows, have created year-round baseflow that has contributed to the establishment of riparian vegetation along the creek within the last century. At the same time, the rapid development occurring along the Front Range is degrading and replacing riparian habitats with impervious surfaces or other land uses. This is especially evident in urbanized areas. In addition, riparian areas have been altered by introduction of non-native plants such as saltcedar (*Tamarix gallica*) and Russian olive (*Eleagnus angustifolia*) and by livestock grazing, which can significantly alter streambanks and can contribute to erosion.

Riparian woodlands are important to wildlife for food, cover, migratory corridors, and water. Fountain Creek is the major lowland riparian habitat in the study area and supports migrant and resident wildlife. Common mammals include muskrats (*Ondatra zibethicus*), beaver (*Castor* *canadensis*), mink (*Mustela vison*), Preble's meadow jumping mice (*Zapus hudsonius preblei*), and white-tailed deer (*Odocoileus virginianus*) (Fitzgerald et al. 1994).

Big Game

Big game are economically important wildlife species that are managed by CDOW for seasonal hunting. These include ungulates (hoofed animals including deer, pronghorn, mountain sheep, and American Elk) as well as mountain lions, and black bear. Each of these species and their distribution in the watershed are described in detail in Section 4.3.1 of the Environmental Baseline Report. Ungulates breed in the fall and generally occur in the project area year-round. Several wildlife highway conflict/crossing areas are identified by the CDOW; these include Highway 24 between 31st Street west to Manitou Canyon, Highway 24, just south of Woodland Park; and Highway 115, from Colorado Springs to the El Paso County line (Cooley 2005). These locations are considered areas with high elk and mule deer movement across the highway from seasonal movements from winter to summer range. No structures for wildlife crossing are located along Highway 115; several wildlife crossing structures occur on Highway 24 to assist wildlife in crossing the highway safely.

Small and Medium-Sized Mammals

Medium sized mammal species known to inhabit the study area include: carnivores, such as bobcat (*Lynx rufus*), coyote (*Canis latrans*), red fox *(Vulpes vulpes)*, swift fox (*Vulpes velox*), gray fox (*Urocyon cinereoargenteus*), and raccoon *(Procyon lotor)*, as well as short-tailed weasels (*Mustela erminea*), long-tailed weasels (*Mustela frenata*), mink, ringtail (*Bassariscus astutus*), badger (*Taxidea taxus*), Western spotted skunk (*Spilogale gracilis*), and striped skunk (*Mephitis mephitis*). Northern river otters (*Lutra canadensis*) do not occur in the Fountain Creek Watershed (Schnurr 2005). Small Mammals inhabiting the study area include: bats, lagomorphs (rabbits and hares), rodents, and shrews. Mammals and their distribution in the watershed are described in detail in Section 4.3.3 of the Environmental Baseline Report.

Birds

Birds and their habitat associations in the watershed are described in detail in Section 4.3.4 of the Environmental Baseline Report. Transitional zones between montane forest and shrub, or between pinyon-juniper woodland and montane shrub, support higher bird diversity due to the mix of two habitats. The Front Range supports a high diversity of bird species, though the area between the towns of Monument south to southern El Paso County is even more diverse (Kingery 1998). This area supports high species diversity because of its high-quality riparian woodland and/or other forest habitats, and its geographic location at the foothills and higher mountainous areas.

Nearly all birds are protected under the Migratory Bird Treaty Act (MBTA), a federal act administered by the U.S. Fish and Wildlife Service (USFWS), which prohibits disturbance or destruction to an active nest, nesting birds, or their eggs or young. This applies to all birds (including raptors), except non-native species including house sparrow, European starling, rock dove, and game birds.

Vegetation clearing, earth-moving, and other construction activities have the potential to alter breeding behavior and destroy nests of bird species protected under the MBTA, including raptors. Destruction or disturbance of nests that results in loss of eggs or young is a violation of the MBTA. Construction projects should be timed to avoid the bird-breeding season (generally April 1 through August 15, but may vary depending on target species). A nest depredation permit must be obtained from USFWS Migratory Bird Office if project activities will disturb or destroy an active bird nest.

The most common bird species in the study area are: American robin (*Turdus migratorius*), mourning dove (*Zenaida macroura*), western meadowlark (*Sturnella neglecta*), northern flicker, and lark buntings (*Calamospiza melanocorys*) (Kingery 1998). American kestrels (*Falco sparverius*) and red-tailed hawks (*Buteo jamaicensis*) are the most numerous raptors in the study area, as well as Colorado (Kingery 1998).

Over 250 bird species have been observed in the Fountain Creek Regional Park (FCRP) alone. Fountain Creek is a very important migratory bird corridor, as it provides birds the opportunity to move northward continually while foraging during migration.

Reptiles and Amphibians

In the Fountain Creek study area, 7 amphibians and 16 reptile species are known or are likely to occur in suitable habitats. Reptile and amphibian occurrence in the watershed are described in detail in Section 4.3.5 of the Environmental Baseline Report. Reptiles that occur in mountainous areas generally occupy south-facing slopes, where heat from the sun is highest.

Important Habitat Areas

Wetlands

Wetland and marsh habitats provide good nesting and foraging habitat for some bird species, especially areas with well-developed vegetative cover, such as willows, cattails, rushes, and sedges. Marshy wetland habitat supports a higher diversity and number of bird species including waterbirds, shorebirds, raptors, and songbirds.

Mudflats, streambanks, and shores of ponds, lakes, and reservoirs provide nesting habitat for shorebirds and waterfowl. Common shorebirds are killdeer (*Charadrius vociferous*), solitary sandpiper (*Tringa solitaria*), spotted sandpiper (*Actitis macularia*), and American avocet (*Recurvirostra americana*) (Kingery 1998). Ospreys (*Pandion haliaetus*) nest around mountain reservoirs. In addition to providing breeding habitat for some species, shores and banks provide foraging habitat for many other species. In winter, horned larks (*Eremophila alpestris*), pipits, and various sparrows utilize these areas to forage (CO Partners in Flight 2000). Section 3.3 of the Environmental Baseline Report describes these wetlands in detail.

Open Water

Open water supports waterfowl during winter and migration. A variety of waterfowl occur in the reservoirs, lakes, and major riparian waters during spring and fall migration and winter within the study area. Mallard (*Anas platyrhynchos*) and Canada goose (*Branta canadensis*) are the most common nesters. Wood ducks (*Aix sponsa*), blue-winged teal (*Anas discors*), cinnamon teal (*A. cyanoptera*), and northern shoveler (*A. clypeata*) also nest in the study area but are much less common (Kingery 1998). Numerous ducks occur in the study area during winter and migration; they can be observed on large reservoirs including Big Johnson Reservoir in the Colorado Springs Composite Watershed, an important area during all seasons for waterfowl (Andrews and Righter 1992; Holt 2002).

Potential Conservation Areas

Colorado Natural Heritage Program (CNHP) designates Potential Conservation Areas (PCA) that are areas that can provide habitat and ecological processes upon which a species or community depends for its continued existence (see Figure 2-20). PCA boundaries are meant to be used for conservation planning purposes and have no legal status but should be used for management decisions.

CNHP ranks PCAs according to their biodiversity significance. Biodiversity Significance is the ranked significance of an area according to specified biodiversity values to account for ecological concepts such as rarity, diversity, fragmentation, habitat condition, resilience, threats, and ecosystem processes. Sections 3.5.2 and 4.4.2 of the Environmental Baseline Report describe these PCAs in detail. Of the 22 PCAs located in the study area, 2 are of outstanding significance (B1), 3 are of very high significance (B2), 3 are of high significance (B3), 7 are of moderate significance (B4), and 7 are of general significance (B5).

Research Natural Areas

Colorado State Parks designates Natural Areas to preserve habitats that exhibit unique or high-quality features of statewide significance. Natural areas may be on public or private land and are designated through voluntary agreements with landowners (CNAP 2005). These features consist of one or more of the following: native plant communities, habitat for rare plants or animals, geologic formations or processes, and paleontological localities.

U.S. Department of Agriculture/ U.S. Forest Service (USDA/USFS) designates Research Natural Areas (RNA) where the primary management is for non-manipulative research. Therefore, when an area is established as a RNA, it receives a high level of protection and is no longer considered for timber harvest. RNAs are usually the best examples of natural communities in the area. One designated natural area and two candidate natural areas occur within the study area because they feature native plant communities (Olson 2004).

Hurricane Canyon was established as a Natural Area in 1931 and designated as an USDA/USFS RNA in 1966. The RNA is 520-acre remnant of the original east-slope montane forest. The site vegetation is dominated by Douglas fir with abundant ponderosa pine.

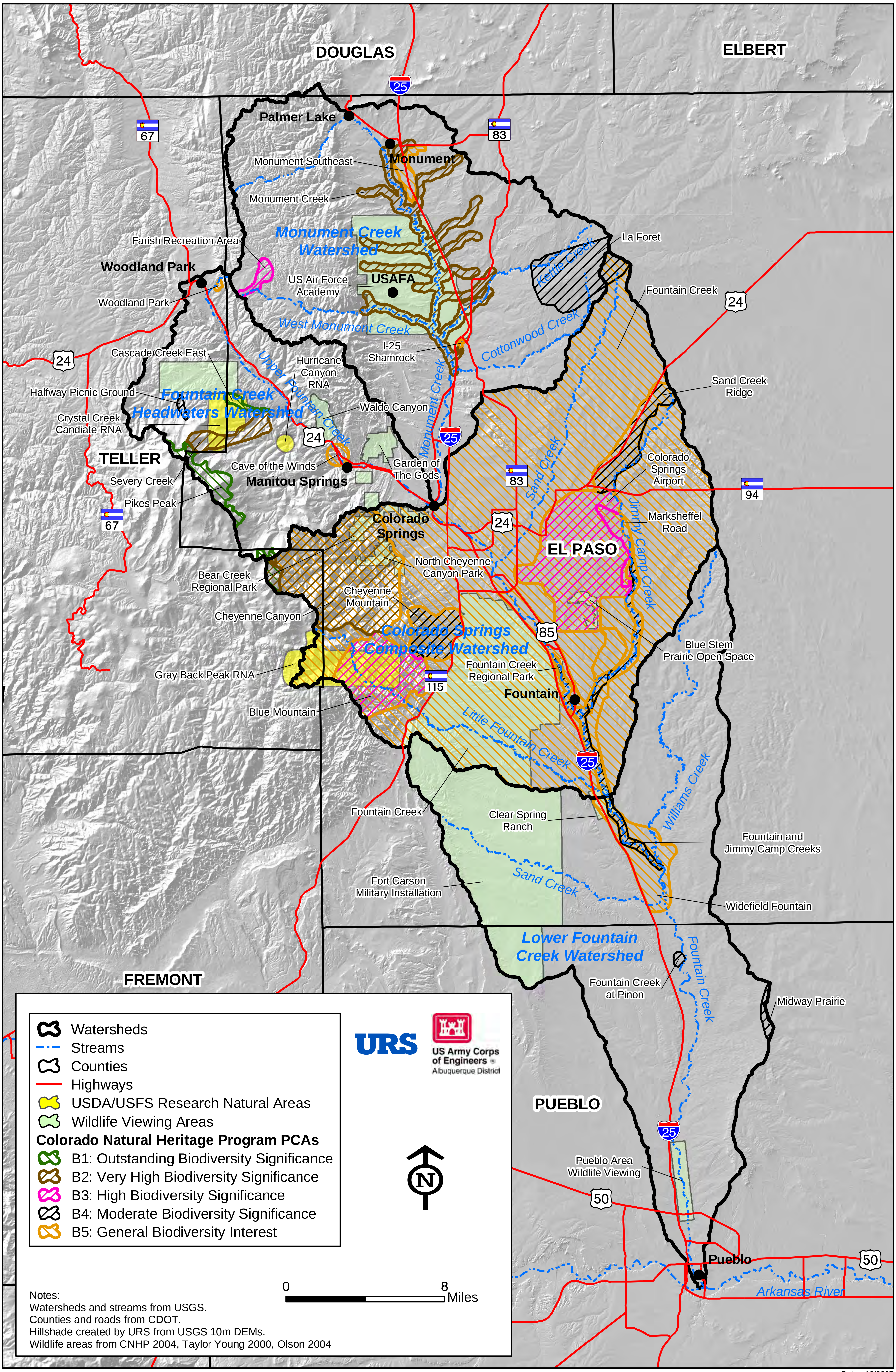
Two additional sites were evaluated in 1998 for consideration as RNAs (Olson 2004). Gray Back Peak is a candidate RNA that encompasses 2,100 acres of ponderosa pine, mixed conifer, and oak shrubland communities. Crystal Creek is a 1,029 hectare montane forest habitat with mixed coniferous forest, ponderosa pine forest, bristlecone and limber pine woodland, and Engelmann spruce forest.

2.7.2 Migratory Corridors

Migratory corridors for resident birds, reptiles, and amphibians occur in the Fountain Creek Watershed. Migratory corridors are contiguous areas or a disconnected series of areas that provide the necessary resources such as food, shelter, and water for animals while they move

Fountain Creek Watershed Study

Figure 2-20. Potential Conservation Areas



Date: 10/2007

from wintering to breeding grounds or vice versa. Birds may migrate long or short distances between nesting and winter sites. For amphibians and reptiles, individuals may make local migrations between breeding and non-breeding habitats, depending on the species and availability of suitable habitats. Section 6 of the Environmental Baseline Report describes migratory corridors in detail.

Nearly all birds are protected under the MBTA, which prohibits disturbance or destruction to an active nest, nesting birds, or their eggs or young. This applies to all birds (including raptors), except non-native species including house sparrow, European starling, rock dove, and upland game birds.

Migration allows animals to utilize areas with the most abundant resources during all stages of their life. The driving factor in migration is usually food resources, but breeding or nesting sites, nesting materials or substrate, and access to mates can also initiate migration.

Reptiles and Amphibians

Amphibians present in the study area are not highly vagile, and the reptile species present, excluding turtles, are stationary. Large rivers, canals, highways, and buildings are barriers to amphibian movements. Roads are the major barrier to movement between suitable habitats; cultivated fields also limit amphibian migrations on a local scale.

Many other species of reptiles and amphibians occur in the Fountain Creek Watershed, though those species are not known to migrate. Buffer zones around wetlands and ponds allow for normal breeding and non-breeding behavior to occur. The use of corridors to connect isolated populations would benefit amphibians in the study area.

Birds

Bird species that travel south to the tropical zones during the northern winters are known as "neotropical migrants." Birds migrate south to wintering grounds in the fall from the U.S. by seven generalized routes; the study area is within the Central or Rocky Mountain Flyway (Lincoln et al 1998). Flyways are a very general term; different species of birds migrate by different routes. Migration routes used by birds in the spring are not well known; spring migrants head in a "northward preferred" direction in the neotropic–nearctic migration (Berthold 1996).

Migration allows animals to utilize areas with the most abundant resources during all stages of their life. For birds, the driving factor in migration is food, but nesting sites, nesting materials, and access to mates can also initiate migration. Birds may migrate short distances from higher to lower elevations or thousands of miles spanning continents. Most migratory birds do not require continuous migratory corridors. Birds can stop overnight in a pond in a suburb or city, as well as a wetland, cottonwood grove, or lake. However, migratory journeys are most successful when migratory corridors are continuous and undisturbed.

For migratory birds, migratory corridors are important to rest or refuel energy during long migrations. Birds are selective in which locations they stop and will fly farther to reach a suitable stopover habitat unless bad weather or insufficient energy requires them to stop in a less than suitable location. If a suitable stopover habitat is not available, birds must either fly farther, even if a weakened condition makes it unlikely that they will survive, or remain in poor habitat and risk starving or becoming easy prey for a predator (CO Partners in Flight 2000). The location, timing, and duration of a stopover are dependent on several factors, including the condition of the bird (especially the amount of fat reserves), weather, wind direction, and the availability and quality of stopover habitat.

In the western US, migratory stopover sites are generally restricted to relatively defined areas such as farm shelterbelts and riparian corridors on the plains. During fall migration, higher elevation sites, such as montane grassland meadows, are important for migratory birds because of the abundant populations of insects which peak late in the season. At lower elevations in the fall, foothill riparian areas provide important fruiting plants for birds such as tanagers and grosbeaks (CO Partners in Flight 2000).

Migration Corridors and Stopover Habitats in the Fountain Creek Study Area

In the study area and surrounding vicinity, habitats for migrating birds have and continue to decline due to conversion to other land uses, and urban and water development.

The majority of passerines (song birds) in the study area migrate along riparian corridors within Fountain Creek. Fountain Creek is an important corridor for migrating wildlife due to the presence of water and dense vegetative cover in lowland riparian habitat with associated wetlands and ponds. Additionally, while most riparian corridors in Colorado are oriented east-west, Fountain Creek is the only major north-south drainage along the eastern foothills of the Rocky Mountain Range (Holt 1997). This orientation allows birds the opportunity to restore energy reserves while continually migrating northward (Pals 2005).

Several areas along Fountain Creek have recently been designated as parkland. The site considered one of the best sites for observing migratory birds in the study area is FCRP, which the National Audubon Society designated as an Important Birding Area (IBA) of Colorado. An IBA is any site that provides essential habitat to one or more bird species during some portion of the year and is distinguishable from the surrounding landscape. These include nesting areas, migratory stopover sites, and wintering grounds.

The following areas are good bird habitat sites that are related to the mainstem of Fountain Creek as identified by local birding societies, field experts, and in field guides. These areas may be protected as wildlife preserves; federal-, state- or county-owned parks; city open space; CNHP PCAs; or other commonly known locations to reliably observe birds. Some areas are considered important for a specific bird species, while other areas support larger numbers of birds seasonally or year-round.

Migratory birds utilize the following habitats that are present in the study area.

Monument Creek

Monument Creek confluences with Fountain Creek and is also important for migratory birds due to the availability of cottonwood/willow (*Populus angustifolia*/*Salix exigua*) riparian habitat (Armstrong and Stevens 2002). CNHP has designated the portion of Monument Creek and its tributaries from the Town of Monument to the northern edge of Colorado Springs as a PCA due to the presence of several federally listed threatened species and state-listed subspecies that are found only in certain types of riparian habitats of the Front Range. The Monument PCA also encompasses the USAFA, where Monument Creek crosses through. The riparian habitat along Monument Creek support springs and fall migrants including warblers (*Dendroica sp.*), greentailed towee (*Piplio chlorurus*), house wrens (*Troglodytes aedon*), and lazuli buntings (*Passerina amoena*), as well as nesting species (Holt 1997). Migrating warblers can be seen in the willows and other riparian shrubs from March through October (Holt 1997). Additionally, vertical migrators spend winters in the area.

Fountain Creek Regional Park

FCRP is a 3-mile-long, 400-acre site situated south of the town of Widefield and north of the town of Fountain along the eastern side of Fountain Creek. FCRP consists of six ponds with adjacent marsh habitat, meadows, as well as dense cottonwood/willow riparian woodland. The Audubon Society recently designated this site as an IBA of Colorado, as it provides nesting areas, migratory stopover sites, and wintering grounds. Over 257 bird species have been observed at FCRP as the park supports numerous and diverse bird species in all seasons, but especially during migration. The most birds are in the area during spring migration, especially during wet, cool weather conditions that deter migrants from flying (Holt 1997). The fall migration from August through October is less dense/concentrated. Additionally, over 50 bird species nest in the park (Great Pikes Peak Birding Trail 2005), including a colony of great blue herons (*Ardea herodias*).

Blue Stem Prairie Open Space/Big Johnson Reservoir

The city of Colorado Springs recently created this open space area, which includes the largest body of water in El Paso County, Big Johnson Reservoir. The open space is situated in a large, open expanse of shortgrass prairie that supports scattered yucca (*Yucca glauca*). The stand of cottonwood trees located at the western edge of the reservoir is a stopover point for numerous migratory birds of many species as well as wintering waterfowl (CNHP 2004; Pals 2005).

The reservoir has its greatest concentrations of waterfowl in the late fall and early winter with good numbers again in the spring, as the reservoir is generally frozen solid in mid-winter (Great Pikes Peak Birding Trail 2005). Common wintering species include greater and lesser scaup (*Aythya affinis*), redhead (*A. americana*), canvasback (*A. valisineria*), ring-necked duck (*A. collaris*), bufflehead (*Bucephala albeola*), and common goldeneye (*B. clangula*). Common mergansers and hooded mergansers (*Lophodytes cucullatus*) migrate through in early spring; black terns (*Chlidonisa niger*) and Forster's terns (*S. forsteri*) migrate through in late spring (Great Pikes Peak Birding Trail 2005). Common loons are regular visitors in the fall and spring migration, while tundra swans (*Cygnus columbianus*) and snow geese (*Chen caerulescens*) migrate through in fall.

Fifteen species of raptors are regularly seen each year including wintering bald eagle (*Haliaeetus leucocephalus*), northern harrier, and ferruginous hawk (Great Pikes Peak Birding Trail 2005). The grasslands in the Blue Stem Prairie Open Space support sparrows including chipping (*Spizella passerina*), clay-colored (*S. pallida*), Brewer's (*S. breweri*), vesper (*Pooecetes gramineus*), lark (*Chondestes grammacus*), and savannah sparrow (*Passerculus sandwichensis*) during spring migration (Great Pikes Peak Birding Trail 2005). Additionally, shorebirds occur along the mud flats on the north side of the reservoir in late September through late October (Great Pikes Peak Birding Trail 2005).

Clear Spring Ranch

Clear Spring Ranch (formerly known as Colorado Springs State Wildlife Area or Hanna Ranch) is located on the west side of Fountain Creek at exit 123 and supports high densities of spring migrants (Holt 1997). Little Fountain Creek traverses the area from west-east and flows into Fountain Creek within this site. Both creeks support a continuous riparian forest of plains cottonwood and other woody riparian species (Holt 1997). Barn owls (*Tyto alba*) have nested in the eroded cut-banks of Little Fountain Creek (Great Pikes Peak Birding Trail 2005). The Widefield Fountain PCA encompasses this area and was designated because the area is essential riparian and wetland habitat for many species of migratory birds (CNHP 2004).

The common migrants include: thrushes, ruby-crowned kinglet, blue-gray gnatcatcher (*Polioptila caerulea*), many V*ireo* sp., warblers, common yellowthroat (*Geothlypis trichas*), and yellow-headed blackbird (*Xanthocephalus xanthocephalus*). Townsend's (*Dendroica townsendi*) and Wilson's warblers tend to be more common in the fall, especially the Wilson's warbler.

Rare, but regular migrants include: broad-winged hawk, olive-sided flycatcher (*Contopus borealis*), veery (*Catharus fuscescens*), Nashville warbler (*Vermivora ruficapilla*), northern parula (*Parula americana*), chestnut-sided warbler (*Dendroica pensylvanica*), blackpoll warbler, American redstart (*Setophaga ruticilla*), ovenbird (*Seiurus aurocapilus*), northern waterthrush (*S. noveboracensis*), and rose-breasted grosbeak (*Pheucticus ludovicianus*) (Holt 1997; Great Pikes Peak Birding Trail 2005).

Fountain Creek at Pinon PCA

This CNHP PCA consists of a spring-fed marsh on the west bank of Fountain Creek that supports wetlands and small ponds. Birds observed within the wetlands include mallard, American avocet (*Recurvirostra americana*), green heron (*Butorides virescens*), and red-winged blackbird (*Agelaius pheoniceus*). The marsh has been drained in the past to provide pasture for grazing; however, the native community returns despite the attempts at alteration. In this area, Fountain Creek supports a discontinuous band of plains cottonwood/sandbar willow woodland and is heavily degraded by non-native (*Tamarisk sp.*) and Russian olive (*Elaeagnus angustifolia*). Recent flooding within Fountain Creek has removed some of the cottonwood forest and widened and downcut the banks (CNHP 2004).

2.7.3 Threatened, Endangered, and Sensitive Species

The Endangered Species Act (ESA) is administered by the USFWS and identifies plants and animal species that are considered to be in danger of extinction. Section 7 of the ESA is triggered when a federal agency is involved in a project, provides funding for a project, or has regulatory jurisdiction over a proposed action. Federal action agencies are required to consider the impacts of proposed federal projects on threatened and endangered species found in the project area for proposed projects.

Table 2-11, Occurrence of Threatened, Endangered, and Candidate Species by County, lists state- and federally listed threatened, endangered, and candidate wildlife and plants and their occurrence in the Fountain Creek study area. Some species included by USFWS do not occur in the study area; however, any water depletions occurring in the study area could adversely affect populations or critical habitat occurring downstream from the study area. A more detailed description of the species that do occur in the Fountain Creek Watershed including their habitat, life history, listing status and history, existing and future threats, and recovery potential are found in Table 2-11.

Table 2-11
Occurrence of Threatened, Endangered, and Candidate Species by County

Common Name	Scientific Name	Federal Status	State Status	County				Occurrence in Study Area
				Teller	Pueblo	El Paso	Douglas	
Fish								
Arkansas darter	*Etheostoma cragini*	C	T	--	⌘	⌘	--	Occurs in Fountain and Jimmy Camp creeks, as well as Cottonwood Spring in Fort Carson. Water depletions may affect known populations of the species in downstream reaches in other states.
Greenback cutthroat trout	*Oncorhynchus clarki stomias*	T	T	--	⌘	⌘	⌘	Occurs in Severy Creek. Water depletions may affect the species and/or critical habitat in downstream reaches in other states.
Birds								
Bald eagle	*Haliaeetus leucocephalus*	--	T	X	X	X	X	Present; winter foraging and roosting areas along Fountain, Jimmy Camp, and Williams creeks, as well as Catamount Reservoir.
Burrowing owl	*Athene cunicularia*	--	T	--	X	X	X	Present in shortgrass prairie habitats in association with prairie dog colonies.
Interior least tern	*Sterna antillarum athalassos*	E	E	⌘	--	⌘	⌘	Presence unlikely; water depletions may affect the species and/or critical habitat in downstream reaches in other states.
Lesser prairie chicken	*Tympanuchus pallidicinctus*	C	T	--	X	X	--	May be present in winter only in eastern portion of study area. Inhabits sandy grassland areas with mid- and tallgrass, sand sage, and yucca in southeastern Colorado. Individuals were transplanted east of Pueblo in 1988 and 1989; current status of that population is unknown.
Mexican spotted owl	*Strix occidentalis lucida*	T	T	X	X	X	X	Present; inhabits steep canyon areas in montane forest or pinyon-juniper woodland. Critical habitat is located in the western portion of the study area.
Piping plover	*Charadrius melodus*	T	T	⌘	--	⌘	⌘	Presence unlikely; nests in southeastern Colorado from April through May at reservoirs east of study area. Water depletions may affect the species and/or critical habitat in downstream reaches in other states.

Table 2-11 Occurrence of Threatened, Endangered, and Candidate Species by County								
Common Name	Scientific Name	Federal Status	State Status	County				Occurrence in Study Area
				Teller	Pueblo	El Paso	Douglas	
Whooping crane	*Grus americana*	E	E	⌘	--	⌘	⌘	Not present. Water depletions may affect the species and/or critical habitat in downstream reaches in other states.
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	C	--	--	--	--	--	May be present. Probable nest records in Pueblo County.
Mammals								
Black-footed ferret	*Mustela nigripes*	E	E	--	X	X	X	Not present. Reintroduced in prairie dog colonies in northwestern Colorado.
Canada lynx	*Lynx canadensis*	T	E	--	X	--	--	Presence unlikely. Subalpine and upper montane forest zones, between 8,000 and 12,000 feet in elevation. Not known to occur as far east as study area.
Preble's meadow jumping mouse	*Zapus hudsonius preblei*	T	T	X	X	X	X	Present in Monument Creek Watershed; designated critical habitat in Teller and Douglas counties outside the study area.
Plants								
Colorado butterfly plant	*Gaura neomexicana ssp. coloradensis*	T	--	--	X	X	X	Potentially present. Occurs in sub-irrigated fields and/or floodplains and drainage bottoms in prairie habitats.
Slender moonwort or narrowleaf grapefern	*Botrychium lineare*	C	--	--	--	X	--	Present in Fountain Creek Headwaters Watershed in the Pike-San Isabel National Forest in the Cascade Creek East Potential Conservation Area.
Ute ladies'-tresses	*Spiranthes diluvialis*	T	--	--	--	X	X	Potentially present. Occurs in mesic or wet meadows near springs, lakes, or perennial streams.

Source: T&E Species - Source: U.S. Fish and Wildlife Services (USFWS), November 2005
Notes:
T = Threatened
E = Endangered
C = Candidate for federal listing
X = Projects occurring in county may affect species
⌘ = Projects occurring in county may affect species where occurs in downstream habitats

Other Special Status Species

This section describes those species that receive no protection under the ESA or Colorado state laws but are still considered as Colorado species of concern, USDA/USFS sensitive species, Bureau of Land Management (BLM) sensitive species, or tracked by the CNHP as a rare or imperiled species. These species are still considered when assessing potential impacts from a project under the National Environmental Policy Act (NEPA). USDA/USFS species are monitored and managed by the Pike-San Isabel National Forest where they occur on USFS properties. CNHP monitors and tracks the following species that they have designated as globally or locally vulnerable, rare, or imperiled.

Birds

Four birds are known or likely to occur in the study area and are considered species of special concern by CDOW, Pike-San Isabel National Forest or BLM sensitive species, or are considered vulnerable or rare by CNHP. These birds known to occur in the study area include American peregrine falcon, ferruginous hawk, mountain plover, and ovenbird; Table 2-12, Other Special Status Birds in the Fountain Creek Study Area, lists their habitat requirements, known areas of occurrence, and their status.

Table 2-12
Other Special Status Birds in the Fountain Creek Study Area

Common Name	Scientific Name	Habitat	Known Occurrence in Study Area	CDOW	USFS	BLM	CNHP
American peregrine falcon	*Falco peregrinus anatum*	Nest on cliffs, primarily in coniferous and riparian forests.	Known aeries (nests) in the Blue Mountain PCA, west of the Fort Carson Military Installation; and the Cheyenne Canyon PCA.	SC	S	S	G4T3 S2B
Ferruginous hawk	*Buteo regalis*	Nest in isolated trees or small groves of trees, and on other elevated sites such as rock outcrops, buttes, large shrubs, haystacks, and low cliffs. Nests are typically adjacent to open areas.	Occurs in grasslands and lowland riparian woodland in study area from November through March. Preys on prairie dogs and rabbits.	SC	S	S	G4 S2B, S4N
Mountain plover	*Charadrius montanus*	Shortgrass prairie, occurring primarily on flat areas with very short vegetation with scattered *Opuntia*; often found in or near prairie dog towns.	Occurs in shortgrass prairie in study area from mid-April to late September. According to CNHP, may occur in the Cheyenne Canyon PCA.	SC	S	S	G2 S2B
Ovenbird	*Seiurus aurocapillus*	Deciduous or mixed conifer forest with little undergrowth, and occasionally pine forests.	Known to occur in the Monument Creek PCA during migration and summer.				G5 S2B

Sources: Andrews and Righter 1992; CNHP 2004; Ehrlich et al. 1988; Kingery 1998
Notes:
PCA = Potential Conservation Area
SC = CDOW species of special concern
S = Sensitive
CNHP Criteria:
G/S1 – Critically imperiled globally/state because of rarity (5 or fewer occurrences in the world/state; or 1,000 or fewer individuals), or because some factor of its biology makes it especially vulnerable to extinction
G/S2 – Imperiled globally/state because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make it very vulnerable to extinction throughout its range
G/S3 – Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals)
G/S4 – Apparently secure globally/state, though it may be quite rare in parts of its range, especially at the periphery; usually more than 100 occurrences and 10,000 individuals
G/S5 – Demonstrably secure globally/state, though it may be quite rare in parts of its range, especially at the periphery

Mammals

Three mammal species are known or likely to occur in the study area and are considered species of special concern by CDOW, sensitive by Pike-San Isabel National Forest or BLM, or vulnerable or rare by CNHP. Table 2-13, Other Special Status Mammals in the Fountain Creek Study Area, lists their habitat requirements, known areas of occurrence, and their status. A more detailed description of each species is provided following the table.

Table 2-13
Other Special Status Mammals in the Fountain Creek Study Area

Common Name	Scientific Name	Habitat	Known Occurrence in Study Area	CDOW	USFS	BLM	CNHP
Black-tailed prairie dog	*Cynomys ludovicianus*	Shortgrass and mixed-grass prairie habitats.	Widefield Fountain and Marksheffel Road PCAs, Fountain Creek Regional Park, and other isolated areas.	SC	S		G3G4 S4
Townsend's Big-eared bat	*Plecotus townsendii*	Pinyon-juniper woodlands and open montane forest.	At least two caves at the Cave of the Winds PCA are used as maternity roosts.	SC	S	S	G4T4 S2
Swift fox	*Vulpes velox*	Shortgrass and midgrass prairie dominated by blue grama and buffalograss.	Occurs on eastern plains in El Paso and Pueblo counties.	SC	S		G3 S3

Source: CNHP 2004
Notes:
PCA = Potential Conservation Area
S = Sensitive
SC = CDOW species of special concern
CNHP Criteria:
G/S1 – Critically imperiled globally/state because of rarity (5 or fewer occurrences in the world/state; or 1,000 or fewer individuals), or because some factor of its biology makes it especially vulnerable to extinction
G/S2 – Imperiled globally/state because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make it very vulnerable to extinction throughout its range
G/S3 – Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals)
G/S4 – Apparently secure globally/state, though it may be quite rare in parts of its range, especially at the periphery; usually more than 100 occurrences and 10,000 individuals
G/S5 – Demonstrably secure globally/state, though it may be quite rare in parts of its range, especially at the periphery

Other Wildlife

One reptile and five invertebrates are likely to occur in the study area and are considered vulnerable or rare by CNHP, but do not have status with CDOW, Pike-San Isabel National Forest, or BLM. Table 2-14, Other Special Status Wildlife in the Fountain Creek Study Area, lists their habitat requirements, known areas of occurrence, and their status.

Table 2-14 Other Special Status Wildlife in the Fountain Creek Study Area				
Common Name	Scientific Name	Habitat	Known Occurrence in Study Area	CNHP Status
Reptiles				
Triploid Colorado checkered whiptail	*Aspidoscelis neotesselata*	Occupies arid grasslands, rocky canyons and hillsides, shrubby areas, and open savannahs associated with the Arkansas River and its tributaries. Hibernates between late August and mid-October and emerges in April.	Documented in El Paso and Pueblo counties from Fort Carson Military Installation in the Colorado Springs Composite Watershed and from an area northwest of Pueblo in the Lower Fountain Creek Watershed.	G2Q S2
Invertebrates				
Simius roadside skipper (butterfly)	*Amblyscirtes simius*	Open pinyon-juniper woodland, shortgrass and mixed-grass prairie. Feeds on nectar from a variety of flowers including *Penstemon*, *Cirsium*, and *Verbena*.[1, 2, 3]	CNHP documented species east of the confluence of Fountain and Little Fountain creeks in the north-central portion of the Lower Fountain Creek Watershed, as well as east of Sand Creek, just outside the study area.	G4 S3
Moss's elfin (butterfly)	*Callophrys mossii schryveri*	Inhabits canyon slopes, brushy ravines, and steep hills. It never wanders far from the food plants. Males sip moisture at patches of damp earth.[4]	Occurs in the Monument Creek PCA in the Monument Creek Watershed.	G4T3 S2S3
Hops feeding azure (butterfly)	*Celastrina humulus*	Mountain foothill canyons and ravines from about 5,800 to 6,500 feet in elevation; usually associated with patches of hops.[1, 2, 3]	Occurs in the Monument Creek PCA in the Monument Creek Watershed.	G2G3 S2
Colorado blue (butterfly)	*Euphilotes rita coloradensis*	Arid areas such as desert foothills and shortgrass prairie. Occurs during one flight from July to late September.[2, 3, 7, 8]	Documented by CNHP in the Colorado Springs Composite and Lower Fountain Creek watersheds in the study area.	G3G4 S2
Tiger beetle	*Cicindela nebraskana*	Bare ground in shortgrass prairie; commonly found in open areas and trails near woodlands in spring and fall. [5, 6, 1]	CNHP documented this species just east of the Monument Creek Watershed, outside the study area.	G4 S1

Source: Sargeant et al. 1993[1]; Scott 1986[2]; Stanford and Opler 1993[3]; Layberry et al. 1998[4]; Kippenhan 1994[5]; Pearson et al. 1997[6]; Ferris and Brown 1981[7]; Opler 1999[8.]

Notes:

PCA = Potential Conservation Area

CNHP Criteria:

G/S1 – Critically imperiled globally/state because of rarity (5 or fewer occurrences in the world/state; or 1,000 or fewer individuals), or because some factor of its biology makes it especially vulnerable to extinction

G/S2 – Imperiled globally/state because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make it very vulnerable to extinction throughout its range

G/S3 – Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals)

G/S4 – Apparently secure globally/state, though it may be quite rare in parts of its range, especially at the periphery; usually more than 100 occurrences and 10,000 individuals

G/S5 – Demonstrably secure globally/state, though it may be quite rare in parts of its range, especially at the periphery

GQ – Indicates uncertainty about taxonomic status

Plants

The plants listed in Table 2-15, Other Special Status Plants in the Fountain Creek Study Area, are considered sensitive species by USDA/USFS Pike-San Isabel National Forest or BLM, or are listed by CNHP. Their known habitat association and occurrence in the study area are included where known.

Table 2-15
Other Special Status Plants in the Fountain Creek Study Area

Common Name	Scientific Name	Habitat	Known Occurrence in Study Area	USFS	BLM	CNHP
Adders mouth	*Malaxis brachypoda*	Shaded streamsides and mossy wet areas from 7,200 to 8,000 feet in elevation. Flowering and fruiting period is July to August.	Occurs in Pike National Forest within study area.	S		G4Q S1
Alpine bluebells	*Mertensia alpina*	Occurs in alpine meadows, rock crevices, and rocky areas from 11,000 to 14,000 feet in elevation. Flowers from late June to early August.	Occurs in El Paso and Teller counties. Documented near Pikes Peak.			G4 S1
American currant	*Ribes americanum*	Marsh and lake borders, wet meadows, stream banks, floodplains and moist woods. Flowers between May and June; fruiting occurs July to August.[1, 2]	Occurs in the I-25 Shamrock PCA.			G5 S2
Arkansas Valley evening primrose	*Oenothera harringtonii*	On compacted silty clays to looser rocky and sandy soils in open grasslands at elevations from 4,700 to 6,100 feet [2]	Occurs in Pike National Forest within study area.	S		G2 S2
Arrow-leaved tearthumb	*Truellum sagittatum*	Annual plant found in marshes and damp meadows in Great Plains. Flowers June through September	Occurs on the U.S. Air Force Academy.			G5 S1
Arctic draba	*Draba fladnizensis*	Hummocks; dry, calcareous, or circumneutral gravel substrates with low organic content.	Documented in Pikes Peak PCA.			G4 S2S3
Birdbill day-flower	*Commelina dianthifolia*	Rocky soils; flowers between July and September.[3]	Documented in the vicinity of Fort Carson.			G5 S1
Bristlystalk sedge	*Carex leptalea*	Rich fens; moist meadows or wetlands at elevations between 9,000 and 10,000 feet. Flowering/fruiting period is June to August.[2]	Occurs in the Cheyenne Canyon PCA.	S		G5 S1
Dwarf false indigo	*Amorpha nana*	Wetland and riparian areas on the plains; usually at elevations between 3,500 and 4,500 feet. Blooms in late June.[1]	Documented in the Monument Creek Watershed in the study area on the U.S. Air Force Academy by CNHP.			G5 S2S3
Gary's Peak draba	*Draba exunguiculata*	Rocky, gravelly slopes and talus; fell fields; usually granite bedrock between 12,000 to 14,000 feet in elevation.[2]	Occurs in El Paso County. Population near Pikes Peak.	S		G2 S2

Table 2-15 Other Special Status Plants in the Fountain Creek Study Area						
Common Name	Scientific Name	Habitat	Known Occurrence in Study Area	USFS	BLM	CNHP
Golden blazing star	*Nuttallia chrysantha*	Barren slopes of limestone, shale, or clay from 5,120 to 5,700 feet in elevation.[2]	Documented in the Lower Fountain Creek Watershed, east of Fountain Creek.		S	G1G2 S1S2
Grassy slope sedge	*Carex oreocharis*	Dry grasslands, montane and subalpine forests.	Documented in El Paso County.	S		G5 S1
James' telesonix	*Telesonix jamesii*	Grows on rocky granite outcropping and deep boulder pockets at elevations ranging from 8,000 to 13,600 feet. Flowers in late July and early August.	Documented in the Pikes Peak and Cheyenne Canyon PCAs in Teller and El Paso counties.			G2 S2
Least moonwort	*Botrychium simplex*	Dry fields, marshes, bogs, swamps, and roadside ditches.	Historic populations documented by CNHP east of Pikes Peak in the Pike National Forest.			G5 S1
Lesser yellow lady's slipper	*Cypripedium pariflorum*	Aspen grove and ponderosa pine/Douglas fir forests at elevations between 7,400 and 8,500 feet. Flowers in June and July. [2]	Found in the Fountain Creek Headwaters Watershed near Woodland Park. Also in the Blue Mountain and Cheyenne Canyon PCAs.	S		G5 S2
New Mexico cliff fern	*Woodsia neomexicana*	Usually grows on rocks in arctic, low arctic, or alpine areas from 7,080 to 7,700 feet in elevation.[4, 5]	Documented on the U.S. Air Force Academy in the Monument Creek Watershed by CNHP.			G4 S2
Pale Botrychium	*Botrychium pallidum*	Open exposed hillsides, burned or cleared areas, and historic mining sites from 9,800 to 10,600 feet in elevation. Spores produced from July to August.[2]	Seven records in El Paso county (near the Halfway Picnic Ground PCA); remainder of the occurrences in El Paso are small, ranging from 5 to 25 individuals.			G3 S2
Porter's feather grass	*Ptilagrostis porteri*	Hummocks in fens and willow carrs at elevations between 9,200 and 12,000 feet.[2]	Occurs in the Farish Recreation Area PCA. There are 27 occurrences documented in Colorado.	S	S	G2 S2
Prairie goldenrod	*Oligoneuron album (Unamia alba)*	Outwash mesas along the Front Range and onto the plains in dry, open rocky areas. Flowers from June to September.	Occurs in the La Foret PCA, which is approximately 10 miles southeast of Monument.			G5 S2S3
Prairie violet	*Viola pedatifida*	Prairie, open woodland, and forest openings, as well as rocky sites from 5,800 to 8,800 feet in elevation.[2]	Occurs in the La Foret PCA, approximately 10 miles southeast of Monument.			G5 S2
Purple cliffbrake	*Pellaea atropurpurea*	Dry shaded ledges and cervices of limestone, sandstone, and basalt at 4,000 to 7,200 feet in elevation. Produces spores from July to September.[2, 6]	Documented in the Cheyenne Canyon PCA.			G5 S2S3

Table 2-15 Other Special Status Plants in the Fountain Creek Study Area						
Common Name	Scientific Name	Habitat	Known Occurrence in Study Area	USFS	BLM	CNHP
Rattlesnake fern	*Botrychium virginanum*	Springs and moist areas in cool ravines at elevations between 6,000 and 9,500 feet. Spores produced in June and July.[2]	Occurs in the Cheyenne Canyon PCA.			G5 S1
Reflected grapefern	*Botrychium echo*	Rocky hillsides, grassy slopes, and meadows in gravelly soils at elevations between 9,500 and 11,000 feet. Produces spores in July.[2]	Documented near the Halfway Picnic Ground PCA, on the north slope of Pikes Peak.			G3 S3
Richardson alum-root	*Heuchera richardsonii*	Typically found in dry to mesic conditions in prairies and woodlands on shaded slopes and rocks. Blooms from May to July.[1, 2]	Documented in the La Foret PCA.			G5 S1
Rocky Mountain alpine parsley	*Oreoxis humilis*	Occurs on granite substrate above timberline from 12,000 to 13,000 feet in elevation. Grows on soils that are often sparsely vegetated and early eroded.[2]	In El Paso County at the Pikes Peak PCA.			G1 S1
Rocky Mountain bladderpod	*Lesquerella calcicola*	Shale bluffs, limy hillsides, gypseous knolls and ravines, and various calcareous substrates at 5,000 to 7,500 feet in elevation.[7, 8]	Documented in southeastern Colorado in El Paso, Fremont, and Pueblo counties. [7, 8]			G2 S2
Rocky Mountain blazing star	*Liatris ligulistylis*	Foothills or in grasslands bordering prairie wetlands up to 7,500 feet in elevation. Flowers in late July.[2]	Documented on the U.S. Air Force Academy in the Monument Creek Watershed by CNHP.			G5 S1S2
Rocky Mountain blue columbine	*Aquilegia saximontana*	Cliffs and rocky slopes, in subalpine and alpine forests at elevations between 9,000 and 12,300 feet. Blooms between July and August. [2]	Occurs in the Pikes Peak and Cheyenne Canyon PCAs, southwest of Colorado Springs.			G3 S3
Round-leaf four-o'-clock	*Oxybaphus rotundifolius*	Restricted to barren shale outcrops in sparse shrublands or woodlands between 4,800 and 5,600 feet in elevation. Flowers in June. Flowers open before dawn and remain open until mid morning.[2]	Documented in Lower Fountain Creek Watershed, west of I-25 by CNHP.			G2 S2
Rydberg's golden columbine	*Aquilegia chrysantha rydbergii*	In mountains, especially along streams or in rocky ravines at elevations between 5,500 and 6,000 feet.[2]	This variety is only known in Colorado; occurs in the Cheyenne Canyon and Cheyenne Mountain PCAs.	S	S	G4T1Q S1
Southern Rocky Mountain cinquefoil	*Potentilla ambigens*	Unknown.	Occurs in the Monument Creek and La Foret PCAs.			G3 S1S2

Table 2-15 Other Special Status Plants in the Fountain Creek Study Area						
Common Name	Scientific Name	Habitat	Known Occurrence in Study Area	USFS	BLM	CNHP
Western moonwort	*Botrychium hesperium*	Grassy slopes, and at lake edges; also documented in gravelly road shoulders.[2]	Documented near the Halfway Picnic Ground PCA at elevations from 9,400 to 10,400 feet.			G3G4 S2

Source: Sargeant et al. 1993[1]; Spackman et al. 1997[2]; Huxley 1992[3]; Brown 1964[4]; Wagner 1987[5]; Coffin and Pfannmuller 1988[6]; Rollins 1993[7]; Rollins and Shaw 1973[8].
Notes:
PCA = Potential Conservation Area
S = Sensitive
CNHP Criteria:
G/S1 - Critically imperiled globally/state because of rarity (5 or fewer occurrences in the world/state; or 1,000 or fewer individuals), or because some factor of its biology makes it especially vulnerable to extinction
G/S2 - Imperiled globally/state because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make it very vulnerable to extinction throughout its range
G/S3 - Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals)
G/S4 - Apparently secure globally/state, though it may be quite rare in parts of its range, especially at the periphery, Usually more than 100 occurrences and 10,000 individuals
G/S5 - Demonstrably secure globally/state, though it may be quite rare in parts of its range, especially at the periphery
GQ - Indicates uncertainty about taxonomic status

2.7.4 Fish

The Fountain Creek watershed contains resident populations of both native and non-native fishes. Thirteen species collected from the Fountain Creek watershed are native and 17 species and two hybrids are non-native (Table 2-16, Fountain Creek Watershed Species List and Native Status). The species composition in the Fountain Creek watershed includes the greenback cutthroat trout (federally- and state-listed threatened), the Arkansas darter (state-listed threatened) and the flathead chub (a state species of special concern).

Table 2-16 Fountain Creek Watershed Species List and Native Status				
Common Name	Abbreviation	Family	Scientific Name	Status
Arkansas darter	ARD	Percidae	*Etheostoma cragini*	Native
Bigmouth shiner	BMS	Cyprinidae	*Notropis dorsalis*	Non-native
Black bullhead	BBH	Ictaluridae	*Ameiurus melas*	Native
Bluegill	BGL	Centrarchidae	*Lepomis macrochirus*	Non-native
Brook stickleback	BST	Gasterosteidae	*Culaea inconstans*	Non-native
Brook trout	BRK	Salmonidae	*Salvelinus fontinalis*	Non-native
Brown trout	LOC	Salmonidae	*Salmo trutta*	Non-native
Central stoneroller	STR	Cyprinidae	*Campostoma anomalum*	Native
Channel catfish	CCF	Ictaluridae	*Ictalurus punctatus*	Native
Common carp	CPP	Cyprinidae	*Cyprinus carpio*	Non-native
Creek chub	CRC	Cyprinidae	*Semotilus atromaculatus*	Non-native
Cutbow trout (hybrid)	RXN	Salmonidae	*O. mykiss x O. clarki*	Non-native
Cutthroat trout	NAT	Salmonidae	*Oncorhynchus clarkii*	Non-native

Table 2-16
Fountain Creek Watershed Species List and Native Status

Common Name	Abbreviation	Family	Scientific Name	Status
Fathead minnow	FMW	Cyprinidae	*Pimephales promelas*	Native
Flathead chub	FHC	Cyprinidae	*Platygobio gracilis*	Native
Golden shiner	GDS	Cyprinidae	*Notemigonus crysoleucas*	Non-native
Grass carp	HGC	Cyprinidae	*Ctenopharyngodon idella*	Non-native
Green sunfish	GSF	Centrarchidae	*Lepomis cyanellus*	Native
Greenback cutthroat trout	GBN	Salmonidae	*Oncorhynchus clarkii stomias*	Native
Lake trout	MAC	Salmonidae	*Salvelinus namaycush*	Non-native
Largemouth bass	LMB	Centrarchidae	*Micropterus salmoides*	Non-native
Longnose dace	LND	Cyprinidae	*Rhinichthys cataractae*	Native
Longnose sucker	LGS	Catostomidae	*Catostomus catostomus*	Non-native
Plains killifish	PKF	Fundulidae	*Fundulus zebrinus*	Native
Rainbow trout	RBT	Salmonidae	*Oncorhynchus mykiss*	Non-native
Red shiner	RDS	Cyprinidae	*Cyprinella lutrensis*	Native
Sand shiner	SAH	Cyprinidae	*Notropis stramineus*	Native
Smallmouth bass	SMB	Centrarchidae	*Micropterus dolomieu*	Non-native
Sunfish (hybrid)	HGB	Centrarchidae	*L. macrochirus x L. cyanellus*	Non-native
Western mosquitofish	MSQ	Poeciliidae	*Gambusia affinis*	Non-native
White sucker	WHS	Catostomidae	*Catostomus commersonii*	Native
Yellow perch	YPE	Percidae	*Perca flavescens*	Non-native

Source: Nesler 1997.

A total of 21 species and one hybrid were collected in Fountain Creek from 22 sampling locations' 12 species are native and 9 species and the hybrid are non-native. The cyprinid (minnow) family had the most number of species with nine. Brook and brown trout were collected in the upper sampling reaches of the stream, where conditions are more favorable for coldwater fishes. Arkansas darters, a State of Colorado threatened species, were collected from three sites in lower Fountain Creek. Two collection sites contained no fish, although both of these sites were sampled only once in the mid-1990s.

Barriers

A total of 14 barriers were located in Fountain Creek. Three were located in the Pueblo to Colorado Springs section, six were located in the section within Colorado Springs, and five barriers were located in the section upstream of the Monument Creek confluence. The most downstream barrier was located on the Clear Spring Ranch near Fountain. The most upstream barrier was located in the town of Manitou Springs. The two most upstream barriers were within 100 feet of each other. In Colorado Springs, four consecutive barriers were within 100 feet of each other. All 14 barriers located on Fountain Creek were man-made structures.

The trend in species distribution is for more species at sites downstream of the barriers and fewer species in Fountain Creek and Monument Creek upstream of the barriers. This suggests that the barriers may be limiting the upstream movement of some fish species. However, some of these patterns of species distribution are due to changes in habitat. Section 7.3 of the Environmental Baseline Report describes native and non-native fish mapping results in detail.

Restoration Opportunities

Restoration opportunities designed to improve fish populations overall and to increase the range of native species include protection of existing resources, species re-introductions, removal of barriers, habitat improvements, and water quality improvements. Each of these is discussed below.

Protection of existing resources can usually be done more easily than restoration of degraded stream sections. This appears to be the case in the Fountain Creek watershed. Fountain Creek from near Fountain downstream to its mouth contains more fish species and a higher proportion of native species than upstream sections. The habitat in this lower section also appears to be less channelized and less affected by development than upstream sections. In Monument Creek, the section upstream of Colorado Springs and on the Air Force Academy appears to have better habitat and, at least at some sites, more fish species and more native fish species. Protection of the fish and habitat resources in these sections of Fountain and Monument creeks would seem to be one of the better opportunities for maintaining or enhancing fish populations in the watershed.

Species introductions can be used to increase the range of fish species in the watershed directly. The CDOW currently has species introduction or re-introduction projects for greenback cutthroat trout (a federal- and state-listed threatened species) and Arkansas darters (a state-listed threatened species). Both of these native species occur in only a small fraction of their original range in the Fountain Creek watershed.

The presence of barriers to upstream movements of fish does not appear to be having a substantial influence on fish distribution in the Fountain Creek watershed. See Section 7.3.4 of the Environmental Baseline Report for further detail. Many fish species have distributions in the watershed both upstream and downstream of the concentration of barriers in the Colorado Springs area. Barrier removal does not appear to be a high priority for restoration. However, the diversion dam near the Clear Spring Ranch, downstream of Fountain, may be limiting the upstream distribution of a few species. Improving upstream migration of fish past this barrier may extend the range of a few native species from this point upstream to Colorado Springs, permitting access to several more miles of stream. Also, improving migration past the many barriers in the Colorado Springs area could provide a net benefit to fish distribution for a few species, although this benefit would be small.

Much of the habitat degradation in the Fountain Creek watershed appears to be the result of urbanization, channelization, and high storm flows. Urban development also changes the hydrologic regime which can result in habitat loss and other ecological impairments due to relatively frequent, intense, and longer bankfull events, lower baseflows, and increased stream channel erosion. With continued urban growth it is anticipated that pressure from these influences on the in-stream aquatic habitat are expected only to increase in the future. The potential for large-scale improvements is limited given the expected increase in urbanization in the watershed. However, opportunities for habitat improvements that may benefit large sections of the watershed include employing measures to increase the chemical, biological, and physical integrity of effluent water with the implementation of both temporary and permanent best management practices (BMPs) described in Section 8, Water Quality, of the Environmental Baseline Report.

Smaller, localized habitat improvements may provide benefits to short sections of stream and should be encouraged. Localized habitat improvement may include creation of stream restoration by creation of bankfull floodplains, restoration of the riffle-pool complex, installation of in-stream structures, vegetated riparian buffer restoration, floodplain wetlands creation, construction of fish passage structures, bio-retention ponds, and stakeholder participation through outreach opportunities (i.e., stream clean-up, reduced dumping of yard wastes in channel).

2.7.5 Wetland and Riparian Areas

Wetlands are important biological resources that perform many functions including groundwater recharge, flood flow attenuation, erosion control, and water quality improvement. They also provide habitat for multiple plants and animals, including special status species.

Wetlands and other biological resources in the Fountain Creek Watershed (FCW) were identified for the purpose of assessing potential preservation and restoration sites. Wetlands in the Monument Creek and Fountain Creek watersheds are shown on Figure 2-21, Monument Creek Watershed Current Wetlands, and Figure 2-22, Lower Fountain Creek Current Wetlands, respectively.

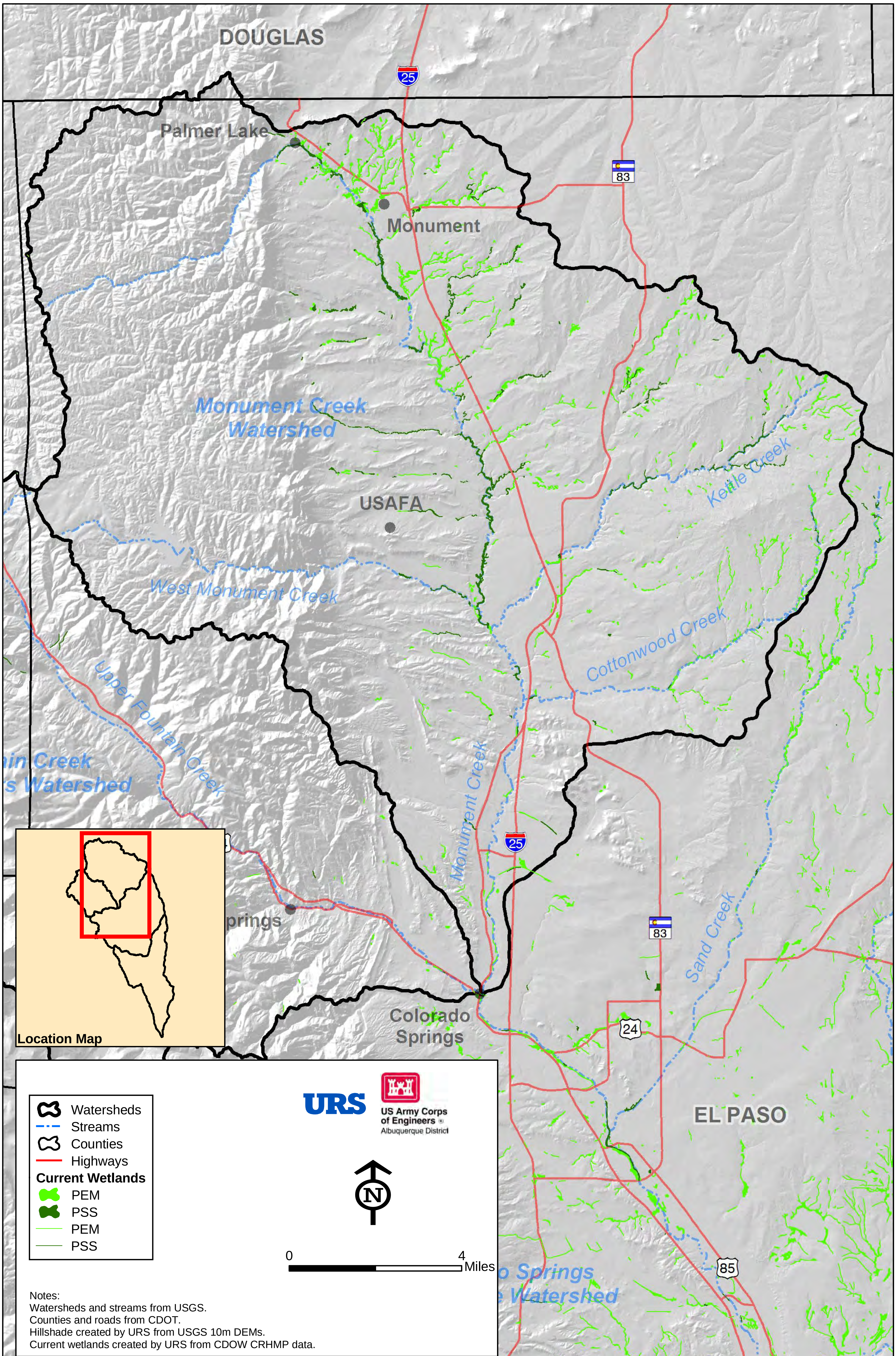
The Lower FCW provides the greatest opportunity for the preservation of large high quality wetland and riparian areas. Fountain Creek is a wide, meandering channel throughout the sub-watershed with sections containing large plains cottonwood complexes. An important restoration effort in this sub-watershed would be the control of saltcedar.

The Colorado Springs Composite Watershed provides the greatest opportunity for the restoration of wetland/riparian areas. The sub-watershed, in general, has more urban development and more degraded floodplains than the other sub-watersheds. The increased flow of the creek over time has created deep cut banks along many sections of the channel. The larger, higher quality wetlands in the sub-watershed are south of the Sand Creek confluence with Fountain Creek. Other potential preservation and restoration areas lie along Jimmy Camp and Little Fountain creeks where many degraded wetlands and riparian areas are found.

Monument Creek Watershed has smaller high-quality wetlands ideal for preservation at the edge of rural areas that are being pressured by development. Monument Creek Watershed, in general, contains healthy, wetland ecosystems with good wildlife habitat and fewer degraded areas. The most degraded areas in need of restoration occur at the southern end of the sub-watershed in Colorado Springs.

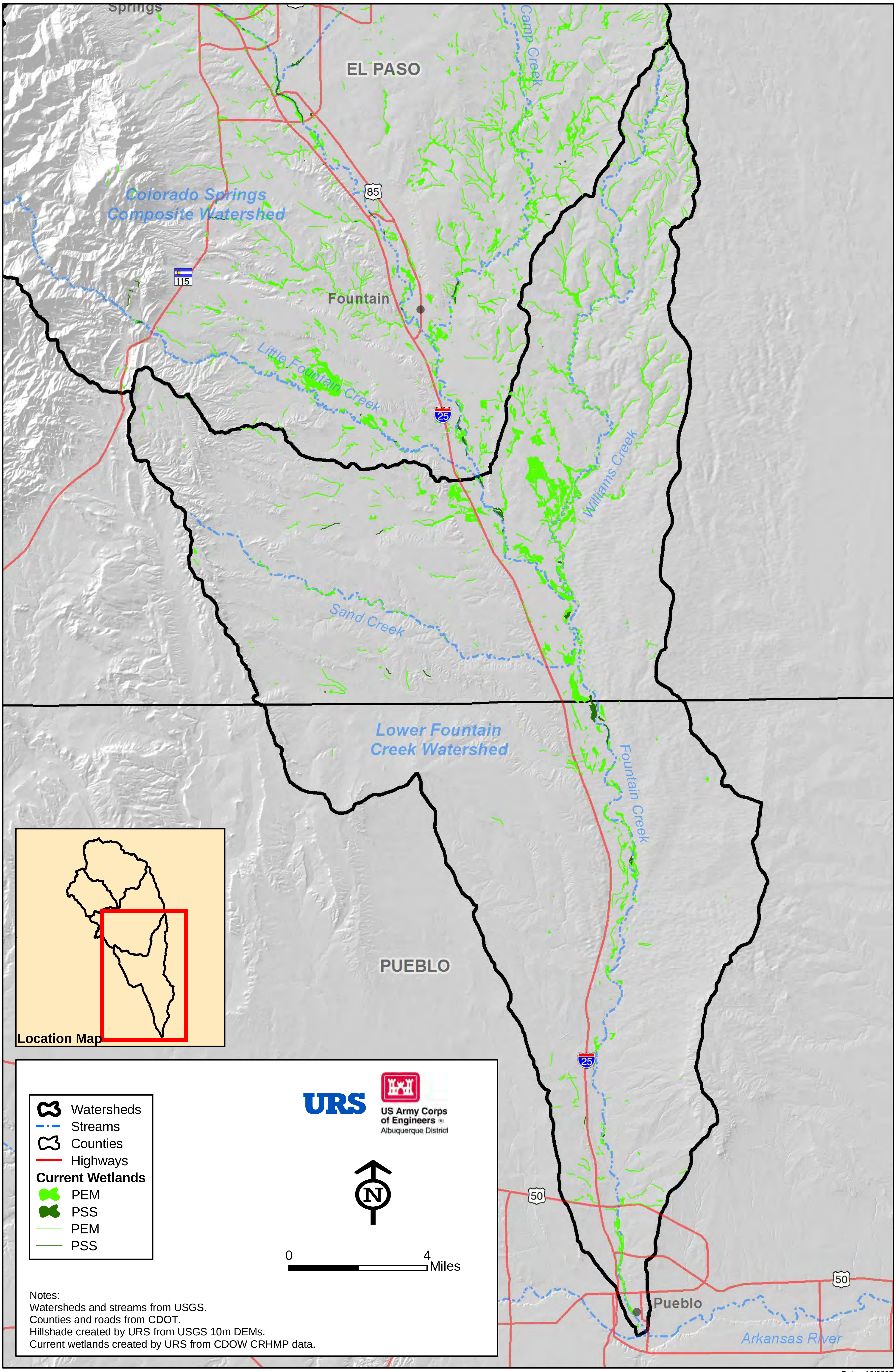
There is less need for either restoration or preservation of wetlands in the Fountain Creek Headwater Watershed than the other sub-watersheds because this area includes mostly small fringe wetlands along first- and second-order stream channels. These fringe wetlands do not appear to be degraded and/or threatened by development.

Fountain Creek Watershed Study
Figure 2-21. Monument Creek Watershed Current Wetlands



Date: 10/2007

Fountain Creek Watershed Study
Figure 2-22. Lower Fountain Creek Watershed Current Wetlands



Notes:
Watersheds and streams from USGS.
Counties and roads from CDOT.
Hillshade created by URS from USGS 10m DEMs.
Current wetlands created by URS from CDOW CRHMP data.

Date: 10/2007

Two sets of spatial data were obtained to represent a historic view and current status of wetlands within the FCW. The data sets were compared to assess the status of wetlands in the watershed and identify any major trends concerning the loss of wetlands. A summary of wetland acreage within the watershed can be found in Table 2-17, Amount of Wetlands in the Fountain Creek Watershed.

Table 2-17
Amount of Wetlands in the Fountain Creek Watershed

Sub-watershed	Amount of Wetlands (acres)							
	Historic Wetland Type				Current Wetland Type			
	PEM	PSS	PFO	Total	PEM	PSS	PFO	Total
Monument Creek	329	389	32	**750**	1393	648	0	**2,041**
Fountain Creek Headwater	149	147	0	**296**	192	84	0	**276**
Colorado Springs Composite	155	454	493	**1,102**	3,818	132	0	**3,950**
Lower Fountain Creek	599	2,073	517	**3,189**	2,954	115	0	**3,069**
Total	**1,232**	**3,063**	**1,042**	**5,337**	**8,357**	**979**	**0**	**9,336**

Source: Cowardin et al. 1979.
Notes:
PEM = palustrine emergent
PFO = palustrine forested
PSS = palustrine scrubshrub

The historic wetland data set includes 1,232 acres of palustrine emergent (PEM) wetlands, 3,063 acres of palustrine scrubshrub (PSS) wetlands and 1,042 acres of palustrine forested (PFO) wetlands for a total of 5,337 acres. The current wetland data set includes 8,357 acres of PEM wetlands and 979 acres of PSS wetlands for a total of 9,336 acres. According to the data, PSS wetlands decreased by 2,084 acres (68 percent), but PEM wetlands increased by 7,125 acres (578 percent).

The large amount of wetland acreage increase from the historic wetlands data to the current data, a difference of 3,999 acres (75 percent), may be the result of many factors. The means by which the data were collected (current satellite vs. historic aerial photography interpretation) can create disparities in data interpretation. Other possibilities include the occurrence of additional surface water inputs into the watershed, including increased runoff caused by the dramatic increase in impermeable surfaces associated with development and water pumped from other watersheds for urban use.

The lack of PFO wetlands in the current data set does not appear to reflect a loss of PFO wetlands, but a distinction in defining them. Many of the historic wetland PFO areas show up as current non-wetland riparian areas. Some of these areas were verified during field visits as riparian woodland dominated by plains cottonwoods (*Populus deltoides*).

The wetlands have been grouped according to the major sub-watersheds within FCW. Two major tributaries feed the main stem of Fountain Creek: Upper Fountain Creek and Monument Creek. Fountain Creek flows through both the Colorado Springs Composite Watershed and the Lower FCW.

Monument Creek Watershed Wetlands

The historic wetland data set for Monument Creek Watershed includes 329 acres of PEM wetlands, 389 acres of PSS wetlands, and 32 acres of PFO wetlands for a total of 750 acres (Table 2-17). The current wetland data set includes 1,393 acres of PEM wetlands and 648 acres of PSS wetlands for a total of 2,041 acres (Table 2-17).

The Monument Creek Watershed, in general, contains healthy, wetland ecosystems with good wildlife habitat and relatively few degraded areas. Monument Creek and its tributaries accommodate numerous PSS wetlands dominated by sandbar (*Salix exigua*), mountain (*Salix monticola*) and Drummond's (*Salix drummondiana*) willows that provide shoreline stabilization and flood attenuation. Numerous PEM and PSS wetlands in the sub-watershed provide food chain support, and remove and retain sediment and nutrients. The most degraded areas occur at the southern end of the sub-watershed in Colorado Springs.

Fountain Creek Headwater Watershed Wetlands

The historic wetland data set for the Fountain Creek Headwater Watershed includes 149 acres of PEM wetlands and 147 acres of PSS wetlands for a total of 296 acres (Table 2-17, Amount of Wetlands in the Fountain Creek Watershed). The current wetland data set includes 192 acres of PEM wetlands and 84 acres of PSS wetlands for a total of 276 acres (Table 2-17).

Fountain Creek Headwater Watershed has fewer wetlands than the other sub-watersheds. Upper Fountain Creek has a very narrow to non-existent floodplain along most of its length due to surrounding rock, U.S. Highway 24 (US 24), and development. The creek and its tributaries have mostly narrow fringe wetlands. These wetlands provide some wildlife habitat and minor shoreline stabilization.

Colorado Springs Composite Watershed Wetlands

The historic wetland data set for the Colorado Springs Composite Watershed includes 155 acres of PEM wetlands, 454 acres of PSS wetlands, and 493 acres of PFO wetlands for a total of 1,102 acres (Table 2-17, Amount of Wetlands in the Fountain Creek Watershed). The current wetland data set includes 3,818 acres of PEM wetlands and 132 acres of PSS wetlands for a total of 3,950 acres (Table 2-17).

The Colorado Springs Composite Watershed, in general, has more urban development than the other sub-watersheds. Fountain Creek has a wide floodplain throughout the sub-watershed, except for the northern-most section in Colorado Springs. The increased flow of the creek over time has created deep cut banks along many sections of the channel that have left wetlands dry. Wetlands are generally less common along Fountain Creek and Sand Creek in and near Colorado Springs than in most other sub-watersheds. The majority of wetlands in the sub-watershed are PEM and occur along Fountain Creek south of the Sand Creek confluence, and along Jimmy Camp and Little Fountain creeks. Areas with larger wetlands and riparian buffers that are less degraded provide wildlife habitat, shoreline stabilization, flood attenuation, and removal and retention of sediment and nutrients.

Lower Fountain Creek Watershed Wetlands

The historic wetland data set for Lower FCW includes 599 acres of PEM wetlands, 2,073 acres of PSS wetlands, and 517 acres of PFO wetlands for a total of 3,189 acres (Table 2-17), Amount of Wetlands in the Fountain Creek Watershed). The current wetland data set includes 2,954 acres of PEM wetlands and 115 acres of PSS wetlands for a total of 3,069 acres (Table 2-17). The extreme increase in PEM wetland data and decrease in PSS wetland data may be the result of disparities in the current and historic data sets.

The Lower FCW has less urban development than the Colorado Springs Composite Watershed. Fountain Creek shows a meandering channel with a wide floodplain throughout the sub-watershed. The wetlands in the sub-watershed are mostly PEM and generally of higher quality than the other sub-watersheds. Areas with larger less degraded wetlands and riparian buffers provide wildlife habitat, shoreline stabilization, flood attenuation, and removal and retention of sediment and nutrients. Fringe wetlands were observed at all field visit sites in this sub-watershed, even when the current mapped data showed otherwise.

Woody Riparian Corridors Greater than 100 Feet in Width

Woody riparian corridors of substantial size provide important habitat for many species and buffer wetlands. Woody riparian corridors greater than 100 feet wide can be found throughout all four sub-watersheds. The corridors in the Monument Creek and Fountain Creek Headwaters Watersheds are mostly found along tributaries in mountain valleys and are dominated by narrowleaf cottonwood (*Populus angustifolia*) and various willows (*Salix* spp.). The corridors in the Lower FCW are mostly along the main stem of Fountain Creek and tend to be wider areas dominated by plains cottonwood and sandbar willow (*Salix exigua*). The Colorado Springs Composite Watershed contains an abundance of both.

Native Prairie Plant Communities

Native prairie plant communities are found throughout the FCW. These areas include grass dominated, mixed grass/forb and mixed shrub/grass/forb herbaceous rangeland. Typical land use for these areas includes grazing and general wildlife habitat. The dominant species in these communities include blue grama (*Bouteloua gracilis*), western wheatgrass (*Pascopyrum smithii*), crested wheatgrass (*Agropyron cristatum*), needle and thread (*Hesperostipa comata*), sand dropseed (*Sporobolus cryptandrus*), arrowleaf balsamroot (*Balsamorhiza sagittata*), mules ears (*Wyethia amplexicaulis*) and brome (*Bromus* spp.). The largest areas of native prairie can be found in the Lower Fountain Creek and Colorado Springs Composite Watersheds outside the development of Pueblo, Fountain, and Colorado Springs.

These communities contain various degrees of disturbance and invasive species. They may include areas of seeded range and non-native pasture; however, the data do not allow segregation for this distinction. For a more detailed analysis of individual areas, further research is required.

Other Biological Resources Observed During Field Visits

Areas With High Woody Fuel Loads and Woody Debris

Woody fuel loads were part of the required observations at field visit sites. Generally, an area with high woody fuel loads contained numerous large dead trees or large stands of dead shrubs. Although these areas provide habitat for many different animals such as birds and insects, they present a high fire potential.

Woody debris was also part of the required observations at field visit sites. Areas with high woody debris consist of locations with scattered logs or brush in the creek that provide habitat for many different vertebrates and invertebrates.

Field observations showed a much higher degree of both in the Colorado Springs Composite and the Lower FCWs. The Monument Creek and Fountain Creek Headwaters Watersheds showed low amounts to none of both.

Recruitment of Native Species in Riparian Areas

Although recruitment of native riparian woody plants (especially plains cottonwood) is a concern due to the dense strands of saltcedar and Russian olive, two of the field visit locations in the Lower FCW confirmed the regeneration of plains cottonwood on some of the larger sandbars and along the edges of the channel.

Protected Wetland/Riparian Areas

Research was initiated to determine what wetland and riparian areas in the watershed are currently protected. It was determined that no USFWS wildlife refuges occur in the watershed (USFWS 2005). Also, no agricultural land within the watershed has been retired into the NRCS Wetlands Reserve Program (NRCS 2005). It was also determined through contact with the CDOW (Cooley 2005) that there is no state documentation of preserved wetland and/or riparian areas.

Potential Wetland and Riparian Preservation and Restoration Areas

PCAs have been established by the CNHP. These areas represent habitat that helps sustain rare, diverse and/or significant ecological processes (Doyle et. al. 2001). PCAs are intended for conservation planning purposes and have no legal status. PCAs are shown on Figure 2-22, Lower Fountain Creek Current Wetlands.

CNHP biological diversity rankings provided for the PCAs include:

- Outstanding significance (B1)
- Very high significance (B2)
- High significance (B3)
- Moderate significance (B4)
- General significance (B5)

Within the watershed there are 6 areas rated B1, 9 areas rated B2, 10 areas rated B3, 15 areas rated B4, and 33 areas rated B5.

In addition to the CNHP-listed areas, other areas with high potential for either preservation or restoration purposes were noted during field visits. The criteria for high preservation potential include diversity of vegetation, relatively large area, minimum level of disturbance, and the threat of development.

In general, the Lower FCW provides the greatest opportunity for the preservation of large high quality wetland and riparian areas. Large plains cottonwood complexes along Fountain Creek, mixed with wetlands, can be found in southern El Paso County and in Pueblo County. Monument Creek Watershed also has smaller high quality wetlands ideal for preservation at the edge of rural areas that are being pressured by development.

The criteria for high restoration potential include some level of disturbance combined with a relatively large undeveloped area. Disturbance could include weed infestation, erosion, sedimentation, etc.

Generally, the Colorado Springs Composite Watershed provides the greatest opportunity for the restoration of wetland/riparian areas. Field observations showed numerous high cut banks and areas with floodplains degraded by noxious weed invasion and extreme erosion. Many of the wetlands are also in need of preservation due to high development pressure. For data on specific sites, reference the field data sheets.

Fountain Creek Headwaters Watershed contains few opportunities for either restoration or preservation. The confined, rocky mountain stream valleys contain mostly narrow wetlands and provide little opportunity for floodplain protection. Wetlands that fall within the Pike National Forest are provided protection.

2.7.6 Invasive Species

Invasive plants are an ever-growing threat to the ecological resources of the area. Each county in the FCW has reported 11 noxious weed species in 2004 to the Colorado Department of Agriculture (CDA 2005). Those species reported are from the 40 listed on the CDA State Noxious Weeds List B, which are species of statewide distribution that are specified for required control and management (CGA 2003). These include:

- Chinese clematis (*Clematis orientalis*)
- Diffuse knapweed (*Centaurea diffusa*)
- Hoary cress (*Cardaria draba*)
- Leafy spurge (*Euphorbia esula*)
- Orange hawkweed (*Hieracium auranticaum*)
- Perennial pepperweed (*Lepidium latifolium*)
- Russian knapweed (*Centaurea repens*)
- Russian olive (*Elaeagnus angustifolia*)
- Saltcedar (Tamarix ramosissima)
- Spotted knapweed (*Centaurea maculosa*)

- Yellow toadflax (*Linaria vulgaris*)

Infested acreage estimates shown on maps provided in the complete Fountain Creek Watershed Study.

Table 2-18, Noxious Weeds Observed During Field Visits, summarizes the number of each weed species observed in each sub-watershed

Table 2-18
Noxious Weeds Observed During Field Visits

Scientific Name	Common Name	Observations in Sub-watersheds			
		Monument Creek (out of 8 sites)	Fountain Creek Headwater (out of 5 sites)	Colorado Springs Composite (out of 12 sites)	Lower Fountain Creek (out of 12 sites)
Centaurea diffusa	diffuse knapweed	4	0	0	1
Euphorbia esula	leafy spurge	0	0	1	1
Lepidium latifolium	perennial pepperweed	0	0	1	5
Elaeagnus angustifolia	Russian olive	1	0	8	8
Tamarix ramosissima	saltcedar	0	0	5	10
Centaurea maculosa	spotted knapweed	2	1	1	0
Linaria vulgaris	yellow toadflax	3	0	0	0
Cirsium arvense	Canada thistle	8	3	8	10
Carduus nutans	musk thistle	4	1	0	1
Cirsium vulgare	bull thistle	2	0	0	0
Saponaria officinalis	bouncingbet	0	2	1	0
Onopordum acanthium	Scotch thistle	0	0	1	1

Source: Noxious Weeds - Source: Field visits conducted by URS, August 2005

Saltcedar is an important noxious weed in Pueblo and southern El Paso counties. Saltcedar can create dense monocultures on shorelines and riverbanks, and transpire larger amounts of water than the displaced natural wetland and riparian vegetation. The CDA data show reported occurrences of saltcedar only in Pueblo County. Saltcedar was also observed at eight locations in southern El Paso County during field visits including five in the Colorado Springs Composite Watershed and three in the upper portion of the Lower Fountain Creek Watershed.

The CDA data show Russian olive along Fountain Creek only in Pueblo County, however, field observations show it extending into southern El Paso County similarly to saltcedar. The typical floodplain along Fountain Creek in Pueblo and southern El Paso counties contain many areas invaded by both saltcedar and Russian olive.

Hoary cress and perennial pepperweed appear to be spread along the same areas as saltcedar, however they grow in more diverse habitat and are likely more dispersed in the quarter quad.

Diffuse knapweed is the most abundant of noxious weeds of concern in El Paso County. The highest abundance of the weed appears to be in the northern third of the county, however, occurrences extend to southern areas mostly following Fountain Creek. Some are found in the west mostly following Upper Fountain Creek.

The quarter areas with yellow toadflax mostly extend northward into Douglas County and only slightly extend into El Paso County. Leafy spurge appears to be a problem in the north quarter of El Paso County. Chinese clematis and spotted knapweed are spread throughout the watershed within El Paso County.

2.8 HAZARDOUS MATERIALS

Multiple facilities with known hazardous materials issues exist within the watershed. The majority of these sites are concentrated in the more developed areas of Colorado Springs and Pueblo. Both cities have numerous manufacturing and industrial facilities that have operated over the past century. The smaller towns of Palmer Lake, Monument, Woodland Park, Manitou Springs, and Fountain had very few hazardous materials facilities, and were limited to open Leaking Underground Storage Tanks (LUSTs) and landfills.

Many hazardous materials facilities in the watershed have been cleaned up and have received “no further action” or “closure” status from the state of Colorado. Many of the remaining sites are open LUSTs that are currently being remediated under the direction of the state of Colorado. The Corrective Action (CORRACT) sites, Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS) sites, Voluntary Cleanup Plan (VCUP) site, and some of the landfills are also undergoing soil and/or groundwater remediation.

Although hazardous materials in numerous areas within the watershed have impacted groundwater and surface water, the majority of these areas are currently being remediated. A more detailed hazardous materials analysis can be conducted for those specific sites where restoration activities are being recommended.

Major hazardous materials/waste issues within the project area were identified as part of the Fountain Creek Watershed Study through a limited Phase I Environmental Site Assessment.

Approximately 5,000 sites were listed on the database report as within the appropriate ASTM search radii. After a review of the database report using the criteria listed above, 71 sites were deemed by professional opinion as the facilities that would have the most negative environmental impact on the watershed, and are described as potential RECs. These included 43 open LUST sites, 21 landfills, three CERCLIS sites, three CORRACT sites, and one VCUP site. Fort Carson Military Reservation was also included in its entirety since it had multiple listings (including CORRACT, open LUSTs, landfills, and CERCLIS), most of which were unmapped. Again, it should be understood that the identification of these sites as the most critical, was based on a quick review of the material and a professional opinion.

LUST sites are described as facilities, usually service stations, with aboveground or underground storage tank leaks of petroleum products that have been reported to the Colorado Department of Labor and Employment, Division of Oil and Public Safety. The contamination from the LUSTs may have impacted surrounding soils and potentially groundwater, which in turn has the potential to impact the watershed.

CERCLIS sites are being assessed by the EPA for possible inclusion on the National Priority List. If a site does not qualify for the National Priority List (NPL), it is removed from CERCLIS and archived on the No Further Remedial Action Planned (NFRAP) list. The CERCLIS facilities in the watershed include sites such as old industrial dumps, or have groundwater contaminated with solvents such as PCE, or air and surface water contaminated with hazardous materials such as acids, cyanides and corrosives.

- The Fillmore and Cascade PCE Plume are located in the area of Fillmore Street and Cascade Avenue in Colorado Springs. The PCE groundwater plume has impacted domestic wells in the area. Residents overlying the groundwater plume may also be exposed to PCE through the indoor air pathway.
- High Quality Circuits, located in Colorado Springs, had issues with the improper storage of multiple drums containing various chemicals including acids, cyanides, and corrosives. The drums were reportedly abandoned and some of them were leaking, resulting in the potential for air and surface water contamination.
- The Galley Road Dump Site, located in Colorado Springs, is an old industrial dumpsite containing milling, oven cinders, ash, and other items. Numerous deteriorating drums containing solid-colored materials are present. The primary contaminant is heavy metals.

CORRACT sites have hazardous waste violations, often involving contamination of soil or groundwater. Under Resource Conservation and Recovery Act (RCRA), the owners or operators of these facilities are responsible for investigating and, as necessary, cleaning up releases. The CORRACT sites in the watershed include facilities with soil and groundwater contaminated with various hazardous materials such as perchloroethylene (PCE), trichloroethylene (TCE), and waste oil.

- The Ingersoll-Rand Security and Safety facility (previously called Schlage Lock Company), located in Security, operates a manufacturing plant where PCE was used as a metal degreasing agent during the production of locks. The company reportedly illegally disposed of used PCE, which resulted in a PCE plume in the underlying groundwater. This plume impacted public and private wells, the former Little Johnson Reservoir, and the Willow Springs fishing ponds in the Fountain Creek Regional Park. The company has been conducting groundwater testing and remediation since the late 1980s to clean up the PCE plume.
- Hewlett-Packard, located in Colorado Springs, began operation in the late 1960s as an electric and electrical test equipment manufacturing facility. Major processes include circuit board etching, plating, unit assembly and testing. Improper handling of TCE resulted in a TCE plume in the groundwater that Hewlett-Packard has been remediating since the 1980s.
- The Lory Oil Company, located in Colorado Springs, is a CORRACT site and an open LUST site. Groundwater underneath the site has been contaminated with waste oil and is undergoing continuing remediation.

Landfills include solid waste facilities that have received permits from the state, and may be currently in use or closed. Landfills, particularly historical landfills, are a concern because of various contaminants that have been discarded in them, including hazardous materials. In addition, older landfills that were created before the promulgation of environmental laws such as CERCLA (1980) and RCRA (1976) have a higher likelihood of being unlined; consequently the contents of the solid waste can leach through the soil into the groundwater and contaminate the groundwater.

VCUP sites are facilities whose owners have submitted a Voluntary Cleanup Plan for approval from the Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division. The list also includes sites where owners have requested a No Further Action Determination from the state and have been rejected. The state's cleanup decisions are based on existing standards and the proposed use of the property. The VCUP site that was considered a potential REC had an unresolved issue regarding a contaminated aquifer. Further investigation is necessary to determine the extent of contamination.

Fort Carson Military Reservation has numerous LUSTs, several landfills, a CORRACT site and a CERCLIS site. Few details were provided in the Satisfi database report about the Reservation, except that groundwater has been impacted as a result of contamination from several facilities. CORRACT areas listed on the database report include the landfills, used oil tanks, an oil pit, vapor degreaser building, jet spray washer building, sludge trench pit, industrial waste treatment facility, sewage treatment plant and lagoons, battery neutralization area, golf course holding pond and sewage treatment plant, open burn grounds, former long-term hazardous waste storage, sewer system, and lime pit.

2.9 WATER QUALITY

Water quality issues are a key component of the Fountain Creek Watershed Study, as the integrity of the watershed is interdependent with the quality of water. Water quality data are collected by the USGS at numerous gauging stations along Fountain Creek and its tributaries, including flow rates, nutrients, organics, inorganics, physical properties, radiochemical constituents, and sediment. A list of these USGS stations is included in Table 8-1, *Environmental Baseline Report*.

CDPHE classifies streams based on how well the stream meets inorganic, metals, and dissolved oxygen (D.O.) water quality standards. Another important indicator of the biological integrity of a waterbody is the health and diversity of the fish and macroinvertebrate population. The Colorado Division of Wildlife (DOW), in conjunction with the USGS, periodically conducts fish and macroinvertebrate surveys/samplings in stream segments within the Fountain Creek Watershed. The status of how well Fountain Creek and its tributaries are meeting their designated uses can be found in the 2004 CDPHE Status of Water Quality in Colorado 305(b) Report, within the Designated Use Summary (*Environmental Baseline Report - Section 8.0 Appendix A*).

Point and nonpoint sources contribute pollutant loads of varying magnitude to the watershed streams. Point source pollution is commonly associated with wastewater treatment plant discharge, factories, industries or any type of facility that has a defined point of discharge, such as a pipe or channel. In the Fountain Creek Watershed there are various municipal wastewater point source facilities that discharge into Fountain Creek and its tributaries. See Table 8-6 of the

Environmental Baseline Report for a list of these point discharge locations. Nonpoint source pollution is commonly associated with erosion and sedimentation causing serious and pervasive impacts to surface water quality. Runoff from agricultural land uses contribute to sediment loads as a result of return flows from irrigated lands and pastureland along Fountain Creek. Highways, particularly the I-25 corridor, are another nonpoint source pollution contributor. Increased stormflow and flooding in the Fountain Creek watershed has resulted in increased erosion and escalated stream channel degradation, which is detrimental to water quality.

Point source contaminated Willow Springs Pond, located within the Fountain Creek Watershed, is listed on the CDPHE 303(d) List for Perchloroethylene (PCE) impairment. PCE was used by Schlage Lock Company from 1977 to 1992 to clean metal parts and other related items. The PCE leached through the soil to the groundwater below. Once in the groundwater, the PCE reached the aquifer path and ultimately ended up in Willow Springs Pond. This pond is currently being remediated.

Two main nonpoint source constituents of concern in Fountain Creek are selenium and sediment. Selenium is found naturally in the Pierre Shale geologic formation and leaches into the surface and ground water system due to natural processes and irrigation return flows. Selenium has caused two segments in the Fountain Creek Watershed to be listed on the CDPHE 303(d) List identifying those water bodies impaired by one or more pollutants, and sediment has caused six segments in the Fountain Creek Watershed to be listed on the CDPHE Monitoring and Evaluation List (*Environmental Baseline Repor*t, Tables 8-2 and 8-3). These stream segments can be seen in Figure 8-1 of the *Environmental Baseline Repor*t . Because of the interrelationship between selenium, geologic conditions, soils, and the volume of runoff, many BMPs that reduce sediment inherently promote the reduction of selenium as well.

In the Arkansas River Basin of Colorado, which includes segments of Fountain Creek, varying climatic conditions, erodible alkaline soils, and underlying geologic formations can naturally affect the quality of water under human-created circumstances. To address this, the City of Colorado Springs has prepared “Stormwater Quality Policies, Procedures, and Best Management Practices (BMPs), November 1, 2002.” as part of their permit requirements. This drainage criteria manual provides owners, developers, engineers, and contractors with information they need to comply with the City’s stormwater quality requirements for drainage planning/design relating to new development, significant redevelopment and construction activities. Erosion control and stormwater quality guidance for applicable BMPs for highway runoff can be found in the 2002 Colorado Department of Transportation Erosion Control and Stormwater Quality Guide. Agricultural BMPs can promote irrigation efficiency, improve water conservation opportunities, reduce runoff, decrease erosion, and reduce pollutant loading. Water quality management of agricultural and urban lands can be effective in reducing selenium and sediment impacts to water quality in the watershed.

3.1 ALTERNATIVE FORMULATION

This chapter describes the development of alternative plans that address the planning objectives. During a study, six planning steps that are set forth in the Corps' Planning Guidance Notebook (ER 1105-2-100) are repeated to focus the planning effort and eventually to select and recommend a plan for authorization. The six planning steps are: 1) identify problems and opportunities, 2) inventory and forecast conditions, 3) formulate alternative plans, 4) evaluate effects of alternative plans, 5) compare alternative plans, and 6) select recommended plan.

In a typical feasibility-level study, the six-step planning process would be used to formulate alternatives, evaluate them, compare them against each other, and select a single recommended plan for implementation using an appropriate Corps authority. In this watershed study a number of plans will be developed at a more conceptual level; but a single, feasibility-level plan will not be selected for implementation. Instead, a prioritized list of potential projects will be compiled and a list of general recommendations to address the watershed-wide issues, which led to the specific planning objectives, will be developed. The projects identified in this watershed study will not necessarily all be implemented via a Corps authority.

3.2 PLAN FORMULATION

The three major objectives identified at the outset of the watershed study are:

- Reduce flood risk in the Fountain Creek watershed,
- Reduce erosion in the Fountain Creek watershed,
- Reduce sedimentation in the Fountain Creek watershed.

An additional objective was added during the review of the "without project" condition documentation that addresses a larger, overarching theme of the problems within the watershed:

- Improve water management in urban and urbanizing areas in the Fountain Creek watershed.

The planning constraints identified in this study are:

- Compliance with applicable state and local regulations,
- Compliance with Arkansas River Compact,
- Avoid impacts to existing riparian, wetland, and aquatic habitats,
- Avoid impacts to threatened and endangered species,
- Availability of water for development of ecosystem restoration features, and
- Avoid impacts downstream of Fountain Creek watershed.

A set of general recommendations was developed in addition to identification of specific project locations and types. The intent of the general recommendations is to address the root causes of the problems in the watershed. The intent of the specific projects is to address site-specific issues.

3.2.1 General Recommendations

Development

- Review and modify development policies as necessary to include appropriate consideration of open space needs in development (focus on more habitat development within traditional parks).
- Limit sediment sources during construction by minimizing overlot grading.
- Review and modify development policies and landscape ordinances as necessary to include appropriate low impact development techniques (lowimpactdevelopment.org) such as those put forth by organizations such as the Center for Watershed Protection (cwp.org).
- Review and modify development policies as necessary to require post development hydrographs match predevelopment hydrographs for peak, volume, and timing to the extent practicable.
- Review and modify development policies as necessary to require post-development sediment transport matches pre-development sediment transport to the extent practicable.
- Review and modify development policies as necessary to require assessment of upstream/downstream impacts (particularly the impacts due to small frequently occurring storm events such as the 2-yr event).
- Review and modify development policies as necessary to ensure involvement by regulatory agencies and stakeholders as soon as possible in the development process.
- Entities must follow through with review of development plans, adherence to approved plans through the construction process, and inspection/maintenance of completed projects.

Rehabilitation/Preservation

- Rehabilitate riparian areas to a healthy, functioning condition where opportunities exist to the extent practicable.
- Preserve existing wetlands and create additional wetlands where opportunities exist to the extent practicable.
- Entities constructing remedial projects in the watershed should develop a consistent approach and methodology for project design and construction while considering site-specific conditions and latest design methodologies.

- Collect sediment load data for the Fountain Creek Watershed so that appropriate sediment transport modeling can be calibrated for all future development in the watershed.
- Entities should use the hydrologic and hydraulic models developed as a part of the Fountain Creek Watershed Study as a basis for updating FEMA floodplains on the mainstems of Fountain Creek and Monument Creek.
- Entities should use the models developed as a part of the Fountain Creek Watershed Study as a basis for certifying their levees on the mainstem of Fountain Creek.
- Remedial projects that affect Fountain Creek or its tributaries should utilize stable channel design principles.

Administration

- Designers and reviewers should be educated/trained in the principles of geomorphology and sediment transport to support the design and review process for new development.
- Create a Fountain Creek Watershed Entity to promote cooperation and partnerships, to establish a set of watershed standards, to serve as a funding source for the construction and maintenance of large scale projects, and to assist entities with training and review.

These general recommendations were developed through discussions with sponsors and stakeholders and analysis of the baseline conditions data and modeling. They represent a list of guidelines that, if followed, should have a major impact on reducing the erosion, sedimentation, and water quality issues in the Fountain Creek watershed.

3.2.2 Potential Projects

The potential project locations identified were separated into three categories that are slightly different than the three overall objectives. Measures to address erosion and sedimentation would fall into the categories of ecosystem restoration and channel stability so the types of potential projects were broken down as follows:

- Flood Risk Reduction,
- Ecosystem Restoration, and
- Channel Stability.

Locations of potential projects were then identified using baseline conditions data collected during the study.

3.2.2.1 Flood Risk Reduction

Flood risk reduction sites were identified through analysis of stream profiles and cross sections from the Hydraulic Analysis Report. Due to cost limitations, no floodplains were developed for the study reaches. Stream reaches and areas identified for potential flood risk reduction projects would have floodplains developed as a part of a spin-off project. Sites for potential flood risk reduction projects include:

- Pueblo Levee,
- Dam above Pueblo,
- Highway 24 Corridor,
- Fountain/Monument Confluence to City Limits,
- Old Pueblo Road Corridor,
- Bridge Overtoppings,
- Upper Monument Creek,
- Cheyenne Creek, and
- Peaceful Valley Road Vicinity.

Pueblo levee is a high priority to address in the watershed study due to sedimentation above the Arkansas River confluence reducing channel capacity and covering drain outlets that could lead to flooding of protected areas behind the levee.

The possibility of a dam on Fountain Creek above Pueblo was considered in many previous studies. Ultimately the high cost and low benefit/cost ratio made other alternatives more attractive and resulted in the construction of the levees in Pueblo. During the course of the watershed study the concept of a dam on Fountain Creek was popularized by a number of stakeholders. The intent of the dam is to provide water supply, regulate flows, and provide recreation opportunities.

The Highway 24 corridor from Colorado Springs to Manitou Springs was identified in a number of studies as having flooding issues. The Colorado Department of Transportation (CDOT) is currently looking at plans to take Highway 24 out of the floodplain. Opportunities exist to further address flooding in this corridor in tandem with the CDOT project.

The Fountain/Monument Creek confluence reach and the Old Pueblo Road corridor reach both have issues with infrastructure that could be damaged in flood events as well as damages to homes and businesses. The Old Pueblo Road corridor is a more rural setting, while the Fountain/Monument Creek confluence reach is heavily urbanized.

There are a large number of bridges within El Paso County (mostly Colorado Springs) that were identified as overtopping in 50- or 100-year flood events. These structures are also creating significant backwaters.

There are sporadic areas of residential structures encroaching on the flood plain in Upper Monument Creek.

Flooding concerns on Cheyenne Creek were previously identified under Section 205 prior to the start of the watershed study. Development on Cheyenne Creek has encroached on the floodplain.

3.2.2.2 Ecosystem Restoration

Ecosystem restoration project locations were determined through a multi-step screening process. Sites were first pre-screened using GIS data for key indicators (soils, wetlands, threatened and endangered species, presence of invasive species, migratory corridors, identified biodiversity areas, etc.). Presence or absence of each key indicator was assigned a value from -1 to +2. AGIS coverage was produced of the resulting combined score. Visual inspection of this map led to identification of the sites listed below as viable for ecosystem restoration projects:

- Jimmy Camp Creek confluence,
- Clear Springs Ranch Vicinity,
- Fountain Valley Park Vicinity,
- Frost-Hannah Vicinity,
- Pinon to Pueblo Reach,
- Monument Branch,
- Beaver Creek,
- Kettle Creek,
- Jackson Creek,
- LFC-1 (Fountain Creek Mainstem in northern Pueblo County),
- LFC-2 (Fountain Creek Mainstem near Pinon),
- LFC-3 (Fountain Creek in Pueblo from Hwy 47 to 4th St),
- CSC-1 (Fountain Creek Mainstem below Sand Creek Confluence),
- MC-1 (Kettle Creek tributary),
- MC-2 (Monument Creek Mainstem between Cottonwood Creek and Fountain Creek),
- Highway 47 Vicinity, and
- Highway 24 Corridor.

Sites that offered greater connectivity possibilities were placed higher on the list than other, smaller, more remote sites. Sites LFC-1, LFC-2, LFC-3, CSC-1, MC-1, and MC-2 were identified in the Environmental Baseline Conditions Report, but were prioritized lower due to limited size and lack of connectivity.

The first five reaches listed provide a high degree of connectivity from Fountain to Pueblo and when combined could provide a green belt corridor similar to the Fountain Creek Crown Jewel Project proposed by Senator Salazar in 2006.

3.2.2.3 Channel Stability

Potential projects to address channel stability issues were broken down into the following four categories:

- Limit Sediment Sources,
- Protect Infrastructure,
- Stabilize Streams with Changed Hydrology, and
- Protect Streams with Unchanged Hydrology.

Limiting sediment sources was determined to be the highest priority. If these sources could be reduced then the damage associated with both erosion and sedimentation could be reduced.

Infrastructure damage due to erosion is common and recurring throughout the watershed. Protecting infrastructure could reduce a major source of recurring damage and protect water quality.

Areas that are highly urbanized have already experienced changes in hydrology that result in erosion and sedimentation issues. Stabilizing streams in these areas would be the next focus after addressing major sediment source issues and threatened infrastructure issues.

The final priority is for areas that have not yet been urbanized, but soon will be. In these areas it is important to try and protect the streams through the development process.

Channel Stability – Limit Sediment Sources

- Sand Creek
- Cottonwood Creek
- Fountain Creek – Mainstem below Colorado Springs
- Eastern Tribs - Pine Creek, Black Squirrel Creek, Middle Trib, Monument Branch, Black Forest, Jackson Creek

These stream reaches were identified as the largest contributors to sediment load in the watershed. The City of Colorado Springs is currently addressing issues on Sand Creek and Cottonwood Creek.

Channel Stability – Protect Infrastructure

- Sand Creek
- Cottonwood Creek

- Pine Creek
- Fountain Creek – Fountain Valley Park to Clear Springs Ranch
- Fountain Creek – Monument Creek Confluence to Sand Creek Confluence
- Monument Creek

Roads, bridges, railroads, sewer lines, electrical utilities, and wastewater treatment plants are all threatened in these stream reaches.

Channel Stability – Stabilize Streams with Changed Hydrology

- Monument Branch
- Upper Cottonwood Creek – above Rangewood
- Teachout Creek
- Elkhorn Creek
- Black Squirrel Creek
- Jackson Creek
- Upper Fountain Creek

All of these stream reaches were recently developed or are in development. Current changes in hydrology have already resulted in negative impacts on the streams via downcutting.

Channel Stability – Protect Streams with Unchanged Hydrology

- Jimmy Camp Creek
- East Fork Sand Creek – above Constitution
- Beaver Creek

These stream reaches are in good condition at the moment. All will most likely be fully developed within the next 20 years.

3.2.3. Ranking Criteria

As a way to compare each of the potential projects against the others a scoring system was developed. Composite scores for potential project ranking were divided into three categories: flood risk reduction, ecosystem restoration, and channel stability. These categories correspond to the main objectives of the watershed study: reducing flooding, sedimentation, and erosion in the Fountain Creek watershed. For each category a list of criteria were developed that would provide the basis for the composite score. At the request of the sponsors flood risk reduction was given a higher possible score to reflect the importance of the protection of life and property from flood damages.

3.2.3.1 Flood Risk Reduction

Table 3-1 shows the rankings for flood risk reduction projects.

Flood Risk Reduction: 6 points total

2 points for large number of structures at risk, 1 point for smaller number of structures at risk.

2 points for large-scale infrastructure protection, 1 point for smaller-scale infrastructure protection.

Up to 2 points for potential net benefits (0.5, 1, 1.5, or 2 possible).

3.2.3.2 Ecosystem Restoration

Table 3-2 shows the rankings for ecosystem restoration projects.

Ecosystem Restoration: 5 points total

1 point for off-channel wetland/oxbow restoration or flood attenuation---rationale is that wetlands and oxbows are a declining landform in the SW (as evidenced by many studies) and provide flood attenuation.

1 point for riparian corridor connection---rationale is that corridors are documented important travel routes for birds, mammals, other animals of large cruising radius, fragmentation disrupts movement, connectivity enhances movement.

1 point for anticipated increase in species richness of animals using the proposed project area as a result of construction of a project.

1 point for presence or proximity of federal or state listed species or federal candidates or proposed threatened.

1 point for improvement of quality of existing aquatic or riparian habitat, e.g. increase in carrying capacity of animals (quality of habitat or increased acreage), or transition to native versus exotic fish or vegetation.

3.2.3.3 Channel Stability

Table 3-3 shows the rankings for channel stability projects.

Channel Stability: 5 points total

1 point for large sediment source, based on degree of degradation, sediment transport rates, and miles of stream.

1 point for large impact to system, based on potential adverse impacts to upstream or downstream geomorphology.

1 point for threatened infrastructure.

1 point for feasibility/chance of success.

1 point for possible holistic solution.

3.2.3.4 Composite Score and Priority Ranking

Total possible composite score: 16 points (flood risk reduction was given a slightly higher ranking than the other categories at the request of the sponsors)

Points were assigned by project delivery team members based on professional judgment.

Two examples of how the scoring criteria were applied are the Dam above Pueblo (flooding) and the Pinon to Pueblo Reach (ecosystem restoration).

Dam above Pueblo - 2 points for structures at risk, 2 points for infrastructure, and 0 points for potential net benefits (due to levee downstream). Total score of 4 points.

Pinon to Pueblo Reach - 0 points for wetland/oxbow restoration, 1 point for riparian corridor connection, 1 point for species richness, 1 point for listed species, 1 point for habitat quality improvement. Total score of 4 points.

Once the composite scores were calculated all of the potential projects were given a ranking, with the highest-scored projects receiving the highest rankings. Not all of the potential projects could be analyzed in detail as a part of the study. This ranking system was created to assist in selecting a top ten list for further study. The sponsors reviewed the project rankings and selected potential projects for further analysis from the list. Some lower-ranked projects were selected for further analysis due to the type of project (flood risk or ecosystem restoration vs. channel stability), location, or public interest. Ultimately, the top ten list was expanded to thirteen based on some overlap of project areas. Table 3-4 shows the project rankings. Projects listed in red indicate sponsor selection for further evaluation.

3.2.3 Ranking Criteria

Table 3-1 Project Selection Ranking Criteria - Flood Risk Reduction				
Project Location	**Structures at Risk**	**Infrastructure**	Potential Net Benefits	Total Flood Risk Reduction Score
Flood Risk Reduction				
Pueblo Levee	2	2	2	6
Dam above Pueblo	2	2		4
Highway 24 Corridor	1	2	1	4
Fountain/Monument Confluence to City Limits	0.5	2	2	4.5
Old Pueblo Road Corridor	0.5	1		1.5
Bridge Overtoppings	0.5	2	0.5	3
Upper Monument Creek	0.5	0.5	0.5	1.5
Cheyenne Creek	2	2	1	5
Peaceful Valley Road Vicinity	1	0.5	0.5	2
Ecosystem Restoration				
Jimmy Camp Creek Confluence				0
Clear Springs Ranch Vicinity				0
Fountain Valley Park Vicinity				0
Frost-Hannah Vicinity				0
Pinon to Pueblo Reach				0
Monument Branch				0
Beaver Creek				0
Kettle Creek				0
Jackson Creek				0
LFC-1 (Fountain Creek Mainstem in northern Pueblo County)				0
LFC-2 (Fountain Creek Mainstem near Pinon)				0
LFC-3 (Fountain Creek in Pueblo from Hwy 47 to 4th St)				0
CSC-1 (Fountain Creek Mainstem below Sand Creek Confluence)				0
MC-1 (Kettle Creek tributary)				0

Project Location	Structures at Risk	Infrastructure	Potential Net Benefits	Total Flood Risk Reduction Score
MC-2 (Monument Creek Mainstem between Cottonwood Creek and Fountain Creek)				0
Highway 47 Vicinity				0
Highway 24 Corridor				0
Stability - Limit Sediment Sources				
Sand Creek				0
Cottonwood Creek				0
Fountain Creek - Mainstem below Colorado Springs				0
Eastern Tribs				0
Stability - Protect Infrastructure				
Sand Creek				0
Cottonwood Creek				0
Pine Creek				0
Fountain Creek - Fountain Valley Park to Clear Springs Ranch				0
Fountain Creek - Monument Creek Confluence to Sand Creek Confluence				0
Monument Creek				0
Stability - Streams with Changed Hydrology				
Monument Branch				0
Upper Cottonwood Creek - Above Rangewood				0
Teachout Creek				0
Elkhorn Creek				0
Black Squirrel Creek				0
Jackson Creek				0
Upper Fountain Creek				0
Stability - Streams with Unchanged Hydrology				
Jimmy Camp Creek				0
East Fork Sand Creek - Above Constitution				0
Beaver Creek				0

Table 3-2

Project Selection Ranking Criteria - Ecosystem Restoration

Project Location	Wetland/ Oxbow Restoration	Riparian Corridor Connection	Species Richness	Listed Species	Habitat Quality Improvement	Total Ecosystem Restoration Score
Flood Risk Reduction						
Pueblo Levee	1		1	1	1	4
Dam above Pueblo						0
Highway 24 Corridor		1			1	2
Fountain/Monument Confluence to City Limits						0
Old Pueblo Road Corridor						0
Bridge Overtoppings						0
Upper Monument Creek						0
Cheyenne Creek						0
Peaceful Valley Road Vicinity						0
Ecosystem Restoration						
Jimmy Camp Creek Confluence	1	1	1	1	1	5
Clear Springs Ranch Vicinity	1	1	1	1	1	5
Fountain Valley Park Vicinity	1	1	1	1	1	5
Frost-Hannah Vicinity	1	1	1	1	1	5
Pinon to Pueblo Reach		1	1	1	1	4
Monument Branch		1	1		1	3
Beaver Creek		1				1
Kettle Creek		1	1		1	3
Jackson Creek				1	1	2
LFC-1 (Fountain Creek Mainstem in northern Pueblo County)	1			1	1	3
LFC-2 (Fountain Creek Mainstem near Pinon)	1	1	1	1	1	5

Project Location	Wetland/ Oxbow Restoration	Riparian Corridor Connection	Species Richness	Listed Species	Habitat Quality Improvement	Total Ecosystem Restoration Score
LFC-3 (Fountain Creek in Pueblo from Hwy 47 to 4th St)	1	1	1		1	4
CSC-1 (Fountain Creek Mainstem below Sand Creek Confluence)	1		1		1	3
MC-1 (Kettle Creek tributary)					1	1
MC-2 (Monument Creek Mainstem between Cottonwood Creek and Fountain Creek)		1	1		1	3
Highway 47 Vicinity	1	1	1		1	4
Highway 24 Corridor		1			1	2
Stability - Limit Sediment Sources						
Sand Creek						0
Cottonwood Creek						0
Fountain Creek - Mainstem below Colorado Springs						0
Eastern Tribs						0
Stability - Protect Infrastructure						
Sand Creek						0
Cottonwood Creek						0
Pine Creek						0
Fountain Creek - Fountain Valley Park to Clear Springs Ranch						0
Fountain Creek - Monument Creek Confluence to Sand Creek Confluence						0
Monument Creek						0
Stability - Streams with Changed Hydrology						
Monument Branch						0
Upper Cottonwood Creek - Above Rangewood						0
Teachout Creek						0

Project Location	Wetland/ Oxbow Restoration	Riparian Corridor Connection	Species Richness	Listed Species	Habitat Quality Improvement	Total Ecosystem Restoration Score
Elkhorn Creek						0
Black Squirrel Creek						0
Jackson Creek						0
Upper Fountain Creek						0
Stability - Streams with Unchanged Hydrology						
Jimmy Camp Creek						0
East Fork Sand Creek - Above Constitution						0
Beaver Creek						0

Table 3-3

Project Selection Ranking Criteria - Channel Stability

Project Location	Sediment Source	Watershed Impact	Infrastructure	Feasibility	Holistic Solution	Total Channel Stability Score
Flood Risk Reduction						
Pueblo Levee						0
Dam above Pueblo						0
Highway 24 Corridor						0
Fountain/Monument Confluence to City Limits						0
Old Pueblo Road Corridor						0
Bridge Overtoppings						0
Upper Monument Creek						0
Cheyenne Creek						0
Peaceful Valley Road Vicinity						0
Ecosystem Restoration						
Jimmy Camp Creek Confluence						0
Clear Springs Ranch Vicinity						0
Fountain Valley Park Vicinity						0
Frost-Hannah Vicinity						0
Pinon to Pueblo Reach						0
Monument Branch						0
Beaver Creek						0
Kettle Creek						0
Jackson Creek						0
LFC-1 (Fountain Creek Mainstem in northern Pueblo County)						0
LFC-2 (Fountain Creek Mainstem near Pinon)						0
LFC-3 (Fountain Creek in Pueblo from Hwy 47 to 4th St)						0
CSC-1 (Fountain Creek Mainstem below Sand Creek Confluence)						0
MC-1 (Kettle Creek tributary)						0

Project Location	Sediment Source	Watershed Impact	Infrastructure	Feasibility	Holistic Solution	Total Channel Stability Score
MC-2 (Monument Creek Mainstem between Cottonwood Creek and Fountain Creek)						0
Highway 47 Vicinity						0
Highway 24 Corridor						0
Stability - Limit Sediment Sources						
Sand Creek	1	1	1			3
Cottonwood Creek	1	1	1			3
Fountain Creek - Mainstem below Colorado Springs	1	1	1			3
Eastern Tribs	1	1			1	3
Stability - Protect Infrastructure						
Sand Creek	1	1	1			3
Cottonwood Creek	1	1	1			3
Pine Creek			1	1		2
Fountain Creek - Fountain Valley Park to Clear Springs Ranch	1	1	1	1		4
Fountain Creek - Monument Creek Confluence to Sand Creek Confluence		1	1	1		3
Monument Creek			1		1	2
Stability - Streams with Changed Hydrology						
Monument Branch	1	1	1	1	1	5
Upper Cottonwood Creek - Above Rangewood	1	1	1	1	1	5
Teachout Creek				1	1	2
Elkhorn Creek				1	1	2
Black Squirrel Creek	1			1	1	3
Jackson Creek	1	1		1	1	4
Upper Fountain Creek				1	1	2
Stability - Streams with Unchanged Hydrology						
Jimmy Camp Creek	1	1	1			3
East Fork Sand Creek - Above Constitution	1	1	1	1	1	5
Beaver Creek				1	1	2

Table 3- 4
Project Rankings

Rank	Project Location	Project Type	Composite Score
1	Pueblo Levee	Flood Risk Reduction	10
2	Highway 24 Corridor	Flood Risk Reduction	6
3	Cheyenne Creek	Flood Risk Reduction	5
4	Jimmy Camp Creek Confluence	Ecosystem Restoration	5
5	Clear Springs Ranch Vicinity	Ecosystem Restoration	5
6	Fountain Valley Park Vicinity	Ecosystem Restoration	5
7	Frost-Hannah Vicinity	Ecosystem Restoration	5
8	LFC-2 (Fountain Creek Mainstem near Pinon)	Ecosystem Restoration	5
9	Monument Branch	Channel Stability	5
10	Upper Cottonwood Creek - Above Rangewood	Channel Stability	5
11	East Fork Sand Creek - Above Constitution	Channel Stability	5
12	Fountain/Monument Confluence to City Limits	Flood Risk Reduction	4.5
13	Dam above Pueblo	Flood Risk Reduction	4
14	Pinon to Pueblo Reach	Ecosystem Restoration	4
15	LFC-3 (Fountain Creek in Pueblo from Hwy 47 to 4th St)	Ecosystem Restoration	4
16	Highway 47 Vicinity	Ecosystem Restoration	4
17	Fountain Creek - Fountain Valley Park to Clear Springs Ranch	Channel Stability	4
18	Jackson Creek	Channel Stability	4
19	Bridge Overtoppings	Flood Risk Reduction	3
20	Monument Branch	Ecosystem Restoration	3
21	Kettle Creek	Ecosystem Restoration	3
22	LFC-1 (Fountain Creek Mainstem in northern Pueblo County)	Ecosystem Restoration	3
23	CSC-1 (Fountain Creek Mainstem below Sand Creek Confluence)	Ecosystem Restoration	3
24	MC-2 (Monument Creek Mainstem between Cottonwood Creek and Fountain Creek)	Ecosystem Restoration	3

Rank	Project Location	Project Type	Composite Score
25	Sand Creek (Sediment Source)	Channel Stability	3
26	Cottonwood Creek	Channel Stability	3
27	Fountain Creek - Mainstem below Colorado Springs	Channel Stability	3
28	Eastern Tribs	Channel Stability	3
29	Sand Creek (Infrastructure)	Channel Stability	3
30	Cottonwood Creek	Channel Stability	3
31	Fountain Creek - Monument Creek Confluence to Sand Creek Confluence	Channel Stability	3
32	Black Squirrel Creek	Channel Stability	3
33	Jimmy Camp Creek	Channel Stability	3
34	Peaceful Valley Road Vicinity	Flood Risk Reduction	2
35	Jackson Creek	Ecosystem Restoration	2
36	Highway 24 Corridor	Ecosystem Restoration	2
37	Pine Creek	Channel Stability	2
38	Monument Creek	Channel Stability	2
39	Teachout Creek	Channel Stability	2
40	Elkhorn Creek	Channel Stability	2
41	Upper Fountain Creek	Channel Stability	2
42	Beaver Creek	Channel Stability	2
43	Old Pueblo Road Corridor	Flood Risk Reduction	1.5
44	Upper Monument Creek	Flood Risk Reduction	1.5
45	Beaver Creek	Ecosystem Restoration	1
46	MC-1 (Kettle Creek tributary)	Ecosystem Restoration	1

3.2.4 Management Measures

A management measure is a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives. Measures are the building blocks of which alternative plans are made and become more specific and better defined as planning progresses. For a watershed study the measures, and the alternatives formed from them, will remain less specific since the level of planning is more of a conceptual nature.

3.2.5 Flood Risk Reduction Measures

Measures that could form the basis for alternatives for flood risk reduction projects include:

- Floodproofing,
- Floodwalls,
- Levees, and
- Buyouts/Relocations.

3.2.6 Ecosystem Restoration Measures

Measures that could form the basis for alternatives for ecosystem restoration projects include:

- Restore wetlands,
- Remove invasive species,
- Plant native species, and
- Create oxbows/reopen cutoff meanders.

3.2.7 Channel Stability Measures

Measures that could form the basis for alternatives for channel stability projects include:

- Modify channel to attain stable geomorphology,
- Grade control structures,
- Flexible bank protection,
- Longitudinal stone toes, and
- Bankfull benches.

4.1 13 CONCEPTUAL PROJECTS WITHIN THE WATERSHED

This section analyzes the thirteen projects which were identified for further study in the course of the watershed study. The conclusion is that a General Investigation Study of ecosystem restoration opportunities would apply to Fountain Creek. There are a minimum of two potential Section 206 projects with several other projects in the intervening areas, related directly to ecosystem restoration via wetlands, meanders, exotic vegetation removal, replantings and significant recreational opportunities exist.

A potential Section 205 is identified from the confluence with Monument Creek to the Colorado Springs City limits. There are sufficient benefits to justify a project in this area and preliminary costs indicate a benefit/cost ratio will exceed 2/1. Two additional potential Section 205 projects exist along the Highway 24 corridor. Preliminary cost estimates indicate that the benefit/cost ratios are less than 0.7; however, more detailed design could well show that one or both reaches are feasible.

Two potential Section 14 projects were identified. The first, at the Highway 85/87 Bridge was analyzed and showed a high benefit/cost ratio was feasible and the cost was toward the upper limit of a Section 14. The second, at Rainbow Bridge, was not fully analyzed here, but is expected to have a sufficient benefit/cost ratio as well.

One potential Section 216 was identified at the Pueblo Levees. This is a modification of an existing project based on sediment control. Neither the original design or the Operations and Maintenance Manual accounted for the sediment accumulation that has occurred, and will continue to occur, within the channel. A Section 216 would be focused on preventing the reduction of channel capacity through sedimentation.

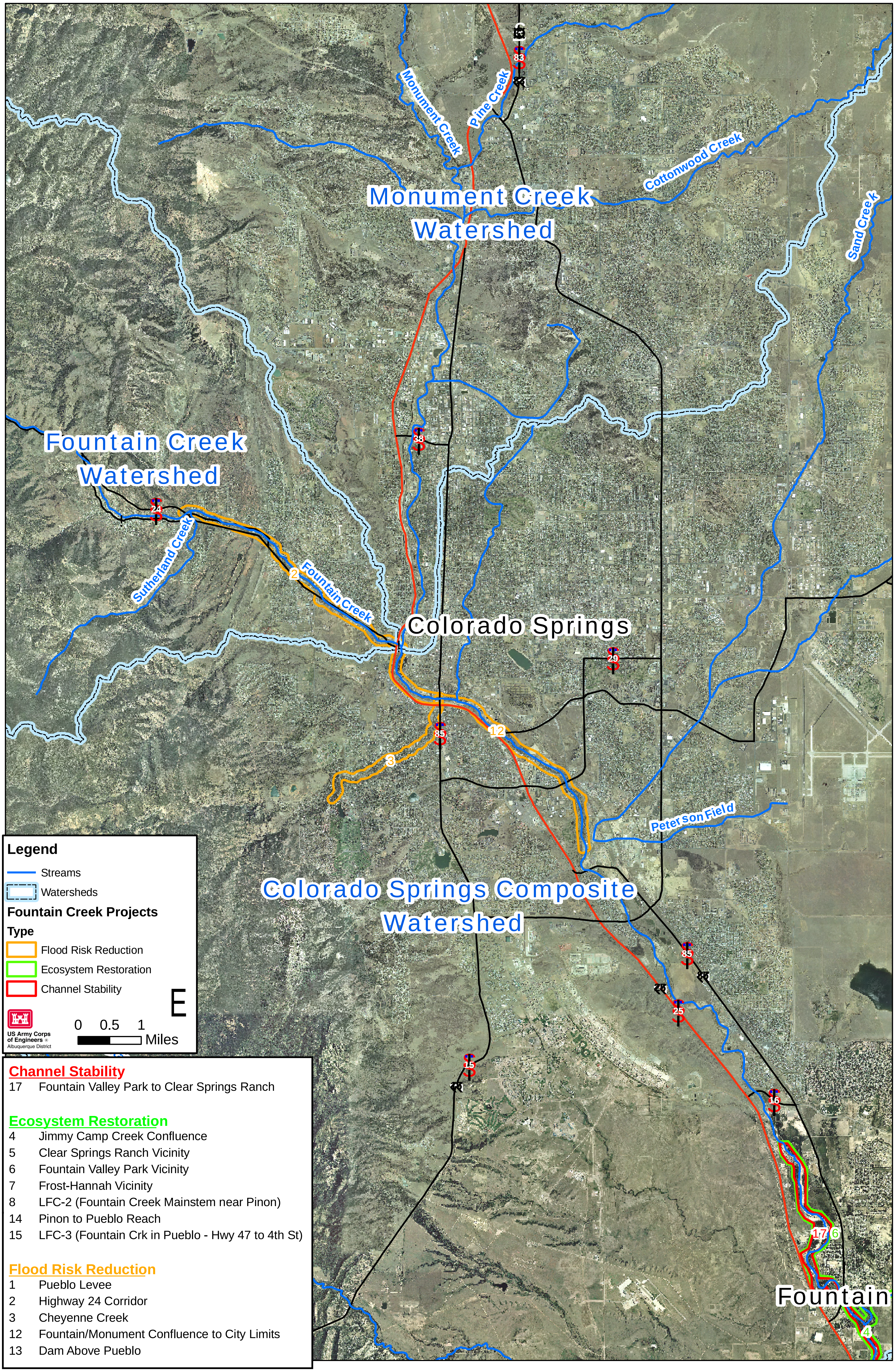
The projects are located from Manitou Springs through Pueblo and are identified on Figures 4-1 through 4-3.

4.1.1 Rank 1: Pueblo Levees

There is significantly less floodway capacity remaining within the Pueblo levees than that for which the project was designed. There is evidence of Fountain Creek overbank aggradation as it passes through Pueblo within the USACE levee project, resulting in siltation of storm drains, sedimentation on trails and picnic areas, and sand and silt deposits after overbanking events. Additionally, there is evidence of this reach having an aggradational tendency within the channel that includes a grade control structure being buried at the lower end of the project and a braided planform of the channel during low flows. Hydraulic modeling done for this study and based on existing topography indicates a continuing reduction in channel capacity. If this trend continues the expected damages will increase and the level of protection offered by the current levees will be compromised.

Fountain Creek Watershed Study

Figure 4-1. 13 Conceptual Projects Within the Watershed, Sheet 1



Channel Stability

17 Fountain Valley Park to Clear Springs Ranch

Ecosystem Restoration

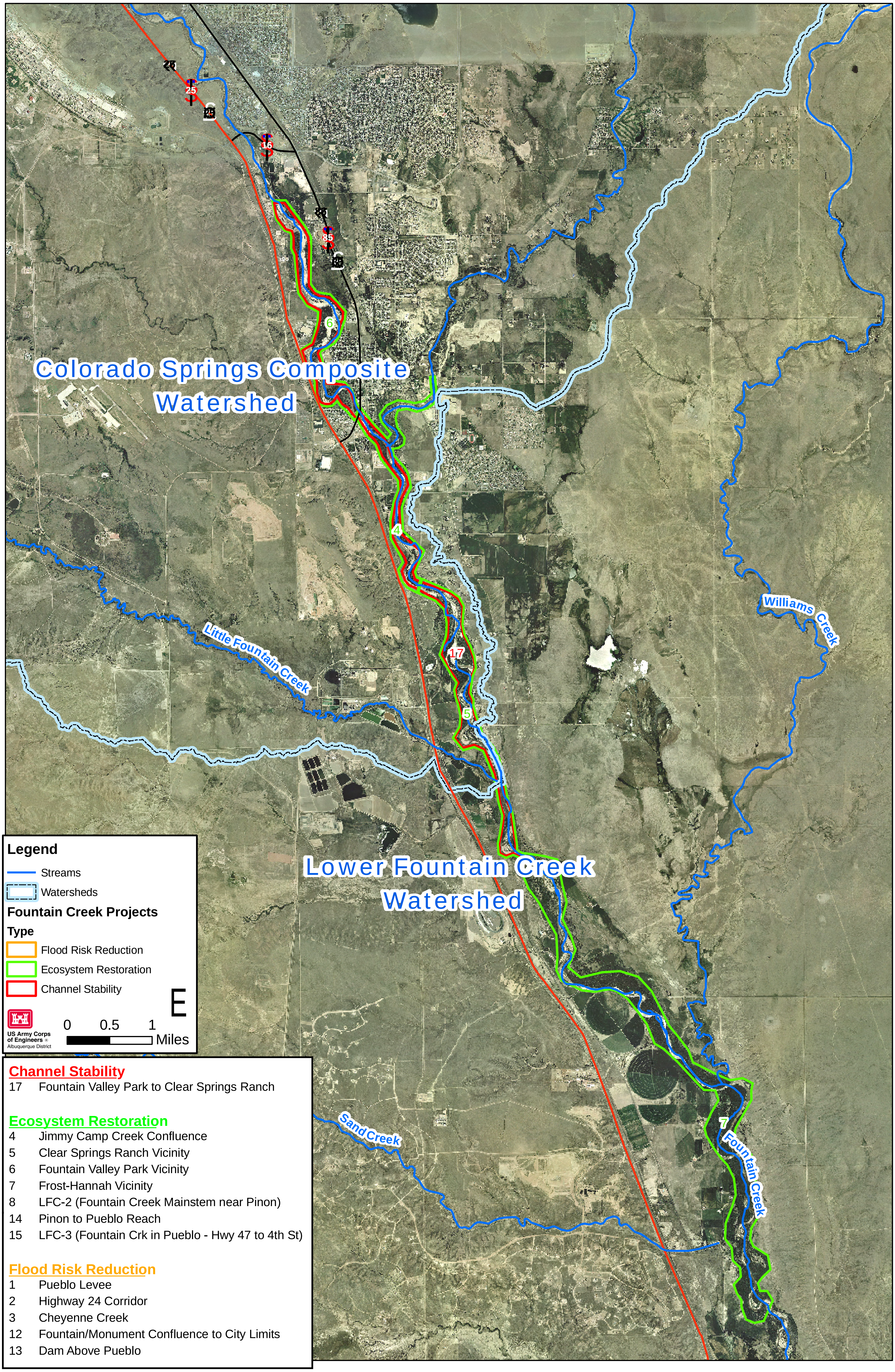
4 Jimmy Camp Creek Confluence
5 Clear Springs Ranch Vicinity
6 Fountain Valley Park Vicinity
7 Frost-Hannah Vicinity
8 LFC-2 (Fountain Creek Mainstem near Pinon)
14 Pinon to Pueblo Reach
15 LFC-3 (Fountain Crk in Pueblo - Hwy 47 to 4th St)

Flood Risk Reduction

1 Pueblo Levee
2 Highway 24 Corridor
3 Cheyenne Creek
12 Fountain/Monument Confluence to City Limits
13 Dam Above Pueblo

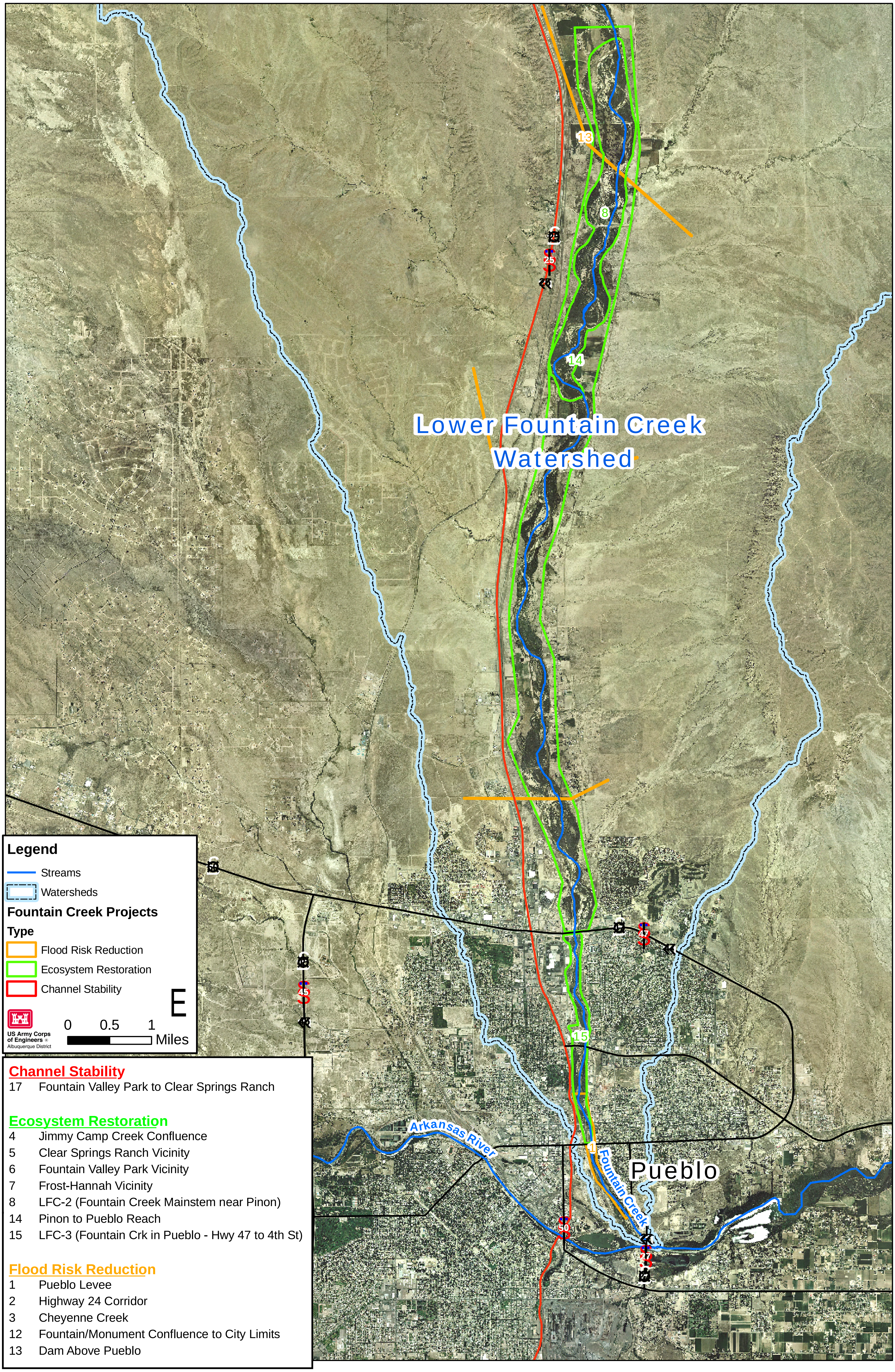
Fountain Creek Watershed Study

Figure 4-2. 13 Conceptual Projects Within the Watershed, Sheet 2



Fountain Creek Watershed Study

Figure 4-3. 13 Conceptual Projects Within the Watershed, Sheet 3



Both sedimentation and vegetation play a major role in the reduced capacity. The watershed study indicates that the Pueblo levees are currently providing protection from the 1% annual chance event flow. The impact of the abandoned railroad bridge may impinge upon the flood protection in that area, such that its removal could allow for a higher level of flood protection. The reduction in capacity has been in the neighborhood of an original design of 85,000 cfs throughout the system to a capacity limited to 45,000 cfs in some of the systems chokepoints. The rapid sediment aggradation and vegetation impacting channel capacity will continue to negatively impact the level of protection.

Analyses during the watershed study has examined areas of aggradation within the Corps project area and estimated sedimentation rates. The design drawings from the Corps levee project containing topographic data (2 foot contours) from 1983 were digitized and georeferenced. The elevation of these features was then converted to NAVD 1988 so that this topographic data could be compared to the most current topographic data used in the Fountain Creek Watershed Study. Cross sections used in the HEC-RAS model for this study were used for comparison of the two sets of data. In all, 9 cross sections in the nearly 2 mile reach were used as a basis for comparison. The comparison of these 9 cross sections showed a fairly consistent increase in both channel and overbank elevation between the two time periods. The amount of aggradation within the channel indicated by the cross sections was approximately 3 feet for all but one of the cross sections. The amount of aggradation in the overbank areas varied more than in the channel, but fairly consistently showed approximately one foot of aggradation. Using the average amount of aggradation from these cross sections, the volume of sedimentation within the levees was then estimated. This was done by multiplying the average depth of sedimentation in the channel and overbanks by their respective areas. A total volume of added sediment to the floodway within the Corps levee project was calculated to be approximately 300 acre-feet (500,000 cubic yards). A more detailed investigation into the sedimentation process is recommended at a future stage. The annual cost of sediment removal is estimated at $235,000. This is based on the assumption that the estimates from the cross sections are representative of the whole reach, the rough cost to remove a cubic yard of sediment is $2.50 for excavation and $7 haul (20 miles), therefore the total cost is $4.7 million. This does not include the cost of the removal of vegetation from the channel and overbank. It should be noted that either the removal or retention of sediment from the river has dual benefits, it maintains the level of protection at the Pueblo levees and ensures that that sediment will not negatively impact flood protection levels for communities on the Arkansas River.

Continued action needs to occur to insure the current or an improved level of flood risk management. This should include both the removal of vegetation and the removal and/or transport of sediment. This should occur at the local level. However, in addition,

1. Recommend pursuit of a Section 216 study (modification of completed projects) through the US Army Corps of Engineers. The initial design did not account for natural river processes of sedimentation, which was not identified in the earlier documentation, nor the operations and maintenance manual. The cost sharing on a Section 216 is after the first federal $100,000 (905b), 50-50 feasibility and then 65-35 project. The potential outputs are: (a) detailed sediment study, including removal costs and alternatives, (b) potential cost shared projects include channel modification and/or levee height adjustments (c) revised O+M manual.

2. Recommend pursuit of a Planning Assistance to States study through the Corps of Engineers. This would be a backup recommendation to begin work if a Section 216 was not initially funded. While Planning Assistance to States can perform a detailed sediment study, including costs of removal and alternatives for planning purposes, it cannot provide federal funds for project construction.

4.1.2 Rank 2: Highway 24 Corridor

Highway 24 and significant properties are in the Fountain Creek 1% annual chance floodplain, between Manitou Springs and the Fountain Creek-Monument Creek confluence. Colorado Springs and the Colorado Department of Transportation are currently working on a plan which would elevate the highway and purchase a portion of the properties in the 1% annual chance floodplain. However, there are properties remaining in the floodplain. Preliminary cost estimates for all work developed through CH2MHill were estimated at $352,000,000 in the first quarter of 2008. The bulk of the costs were tied to the elevation and protection of Highway 24. Of the 187 properties that are in 1% annual chance floodplain, 71 properties would be acquired and removed. In that study, $65,000,000 in flood risk reduction features are identified for the remaining properties.

The Corps looked at flood risk management with ancillary ecosystem restoration benefits. Ecosystem restoration was eliminated due to lack of connectivity and critical species. However, recreation features within the corridor in conjunction with a Corps project could be feasible if a flood risk reduction alternative was identified. The Corps analysis used cost data from CH2MHill for the whole system and divided it into 6 sections based on area between the bridges. Costs were based on per lineal foot of the preliminary CH2MHill data. As the alternative projects become clearly identified this data will be refined.

Without project damages for each of the 6 reaches were computed using flood depth information derived in coordination with the CH2MHill study and hydrology/hydraulics from the watershed study. Each property in the floodplain was assigned to a category (e.g. commercial, residential, etc) with as many subcategories as necessary. Each category has an associated depth-damage relationship expressed as a cumulative percentage of value for each foot of inundation. The depth-damage relationships were derived from historical data obtained from insurance companies, the Flood Insurance Administration, and Corps of Engineers experience. Sensitivity analyses were performed on several of the key variables to measure impacts. It was then assumed that the project would provide protection to the 1% chance annual flow event. The difference between the without project average annual damages and the project average annual damages comprise the benefits.

The average annual benefits divided by the average annual costs depict the benefit cost ratio, those that are greater than unity indicate the project will be a net economic benefit. On the 6 reaches all benefit-cost ratios were insignificant (less than .05) except from I-25 to 8th Street where benefits support a project of $4.8 million and costs are $7.738 million, and from Ridge to 31st are estimated at $10,500,000, benefits would support almost $7 million.

It is recommended that if the refined costs on the latter two reaches show a significant reduction, that either two Section 205 projects or one General Investigation study be considered.

4.1.3 Rank 3: Cheyenne Creek

There are significant properties in Colorado Springs along Cheyenne Creek area which are in the 1% annual flow floodplain. It was not included as one of the critical reaches due to previous work in the area. However, as the Corps study progressed it was determined that the hydrology may have changed since the previous work, based on gage data and methodology. The Corps had looked at a potential Section 205 project previously and determined that based on hydrology of the earlier FEMA studies a justified project could be proposed which would meet our General Investigation Authority. A further analysis conducted in the course of this watershed study used the current watershed hydrology methodology and gage data and recomputed flows. The analyses shows a significant reduction in the estimated 1% annual peak flows, more likely falling between 1,500 and 2,000 cfs. Benefits and costs were computed based upon the lower estimated flows.

The floodplains were delineated and the properties that fell within them were aligned. Each property in the floodplain was assigned to a category (e.g. commercial, residential, etc) with as many subcategories as necessary. Each category has an associated depth-damage relationship expressed as a cumulative percentage of value for each foot of inundation. The depth-damage relationships were derived from historical data obtained from insurance companies, the Flood Insurance Administration, and Corps of Engineers experience. The difference between the without project average annual damages and the project average annual damages comprise the benefits.

The average annual benefits divided by the average annual costs depict the benefit cost ratio; those that are greater than unity indicate the project will be a net economic benefit. The associated benefit-cost ratio is less than 0.5. Project benefits would support a project of approximately $12,000,000. Project costs for an off channel dam, as well as overflow piping were computed, both costs exceeded $26,000,000 and $28,000,000 respectively for the entire floodplain. A cost estimate reducing the area protected by approximately ½ results would cost greater than $12,000,000.

It is recommended that a reanalysis of the FEMA floodplains be pursued.

CBC HALF THE LENGTH

CBC ENTIRE LENGTH

Figure 4-4. CBC Drain Half and Entire Lengths.

Table 4- 1
Cheyenne Creek Alternatives

	Item of Work	AMOUNT	UNIT	UNIT PRICE	TOTAL
Offline Dam					
1	Excavation	2,500,000	C.Y.	$3.50	$8,750,000.00
2	Embankment	1,000,000	C.Y.	$3.50	$3,500,000.00
3	Waste	1,675,000	C.Y.	$1.50	$2,512,500.00
4	Outlet Works	1	EA	$1,500,000.00	$1,500,000.00
5	Inlet	1	EA	$645,000.00	$645,000.00
6	CBC	2,500	L.F.	$800.00	$2,000,000.00
7	Pavement Replacement	4,700	S.Y.	$35.00	$164,500.00
8	Sewer Relocation	1,200	L.F.	$200.00	$240,000.00
				Subtotal	$19,312,000.00
		9.00%		Engineering Design	$1,738,080.00
					$21,050,080.00
		7.50%		Supervision and Admin	$1,578,756.00
					$22,628,836.00
		25.00%		Contingency	$5,657,209.00
				TOTAL	$28,286,045

Assumptions:
*All items include G&A, Profit, & Tax
*All quantities same as prior study, costs indexed to current prices

	Item of Work	AMOUNT	UNIT	UNIT PRICE	TOTAL
CBC Half the Length					
1	Inlet	1	Job	$645,000.00	$645,000.00
2	CBC	6,400	L.F.	$800.00	$5,120,000.00
3	Water Relocation	3,600	L.F.	$140.00	$504,000.00
4	Pavement Replacement	15,700	S.Y.	$35.00	$549,500.00
5	Sewer Relocation	4,700	L.F.	$200.00	$940,000.00
6	Outlet	1	Job	$775,000.00	$775,000.00
				Subtotal	$8,533,500.00
		9.00%		Engineering Design	$768,015.00
					$9,301,515.00
		7.50%		Supervision and Admin	$697,613.63
					$9,999,128.63
		25.00%		Contingency	$2,499,782.16
				TOTAL	$12,498,911

Assumptions:
*All items include G&A, Profit, & Tax
*All quantities same as prior study, costs indexed to current prices
*Inlet and outlet lump sums are high due to unknowns at each location

	Item of Work	AMOUNT	UNIT	UNIT PRICE	TOTAL
CBC Entire Length					
1	Inlet	1	Job	$645,000.00	$645,000.00
2	CBC 6' X 6'	15,000	L.F.	$800.00	$12,000,000.00
3	Water Relocation	13,200	L.F.	$140.00	$1,848,000.00
4	Pavement Replacement	49,000	S.Y.	$35.00	$1,715,000.00
5	Sewer Relocation	4,400	L.F.	$200.00	$880,000.00
6	Outlet	1	Job	$775,000.00	$775,000.00
				Subtotal	$17,863,000.00
		9.00%		Engineering Design	$1,607,670.00
					$19,470,670.00
		7.50%		Supervision and Admin	$1,460,300.25
					$20,930,970.25
		25.00%		Contingency	$5,232,742.56
				TOTAL	$26,163,713

Assumptions:
*All items include G&A, Profit, & Tax
*All quantities same as prior study, costs indexed to current prices
*Inlet and outlet lump sums are high due to unknowns at each location

4.1.4 Rank 4: Jimmy Camp Creek Confluence

The city of Fountain is considering purchase of approximately 80 acres of land north of and adjacent to Jimmy Camp Creek and east of and adjacent to Fountain Creek (Figures 1-3). The Arkansas darter, a federal candidate and state threatened species has been sampled at the confluence of these two creeks. The site was reconnoitered for improvement of aquatic habitat for the darter, which prefers slow velocity flows that are conducive to establishment of water cress and other aquatic plants that allow for the swim-bladderless darter to perch upon. However, the site was discounted after observing the current level of entrenchment (~10 ft.) and consideration of predicted high sediment aggradation at the mouth of Jimmy Camp Creek. Future high sediment loads at this confluence would likely render structural features to improve habitat tenuous and short-lived.

There is some stormwater discharge outfall into the property; however, the site is currently mesic to xeric and encroachment of Siberian elm and Russian olive is proceeding rapidly. A small scale effort to control these exotic invasive trees would allow native species to compete. This would be a recommended management activity that could be likely be accomplished more economically through other local, state or federal programs than through the Corps' ecosystem restoration authorities of the Water Resource Development Act (WRDA).

A second site, upstream on Jimmy Camp Creek within the City of Fountain Park, was investigated for project potential. Substantial wetlands and a riparian bosque were observed, with no need for intervention. However, an adjacent and upstream property (Figure 4) was observed to be producing considerable sediment load onto the City property and would be a candidate for purchase by the City.

There is little opportunity for Corps involvement at these sites under specific ecosystem restoration authorities. However, these sites could be incorporated into a larger, Congressionally-authorized General Investigation Study, which could combine many projects along the lower Fountain Creek reach, with multiple sponsors, and which could proceed directly into construction after feasibility studies and design are completed.

Photo 4-1. Confluence of Jimmy Camp Creek with Fountain Creek.

Photo 4-2. Looking upstream from confluence.

Photo 4-3. View of terrace above Fountain Creek.

Photo 4-4. Upstream property that contributes sediment to the City's park property.

4.1.5 Rank 5: Clear Springs Ranch Vicinity

This site on Colorado Springs Utility's property in El Paso County has potential for consideration as a Corps project either under Section 206 Aquatic Ecosystem Restoration of the WRDA or as a Congressionally authorized General Investigation Study. The project could provide for upstream fish passage for federal candidate and Colorado state threatened Arkansas darter, and also for native plains killifish, flathead chub, red shiner, central stoneroller, creek chub, fathead minnow, golden shiner, longnose dace, longnose sucker, sand shiner, and white sucker. Photos of the dam are included in photos 4-5 through 4-7.

Some salient facts about the dam are:

- The dam was built about 30 years ago, probably 1976 or 1978. As builts are available.
- There is a five foot drop over the dam which is an impediment to fish passage.
- When the gate is closed, flows back up about 100 yards.
- The dam is used for diversion from April through end of October in most years.
- During irrigation season, once or twice a week, the gate is opened for 3-4 hours to move sediment that has accrued behind the gate.
- A small sluice gate adjacent to the main gate is usually only opened if high flow (then it is just partially opened); otherwise at low flow it is not opened.
- Flows are diverted into a canal for irrigation, then return flow is dumped back into Fountain Creek about a mile downstream.

Messrs. Gary Dowler (CDOW), Jim Bruce (USGS biologist), and Paul Foutz (CDOW) visited the Clear Springs site March 12, 2008. Following is an overview of what they documented.

The velocity measurements were taken at 0930 hours on March 12th, 2008. The biologists took velocity measurements at the far west bank (3 foot width across and a depth of .8 feet) at what they identified as the most probable point of fish migration.

Mean velocity across that width was 6.29 ft./sec. The lowest measurement taken across that width was 3.59 ft./sec. at the far west bank measurement at the 0.2 observation depth of the 0.8 foot depth. Hargrave and Johnson (2003) in their study found darters in the Arkansas River at moderate velocities averaging 1.2 ft./sec. plus or minus 0.6 ft./sec.

The highest measurement taken across that width was 8.03 ft./sec. at 3 feet from the far west bank at the .8 observation depth of the .8 foot depth. Jim Bruce checked the nearby gauging stations upon returning to the office and determined the estimated discharge at the time of our measurements to be 103cfs.

Also, the area (~15' x 40') below the gate opening to the drop is lined by ~1/2' steel plates.

In their consensus opinion, the fish biologists felt that the velocity (as measured) is an impediment/barrier to the migration of stream fish species in the area near the diversion.

It should be noted that there is also an upwardly protruding lip (~ 2 inches) at the edge of the drop structure that is an additional impediment to fish passage over the drop. During the irrigation season, when the gate is briefly opened to move sediment, migration is likely further impeded by the increased flow and increased flush of sediment through the gate.

The area is heavily utilized by flathead chubs. Data from a 2005 survey just below the diversion shows 693 flathead chubs collected. Gary Dowler noted that this is one of the highest densities of flathead chubs he has seen anywhere in Fountain Creek, and he believes these fish were staging and attempting to swim upstream.

While Arkansas darters are not regularly sampled within the area of interest and habitat suitability at the site is suspect, Arkansas darters do potentially utilize the area as a transition corridor.

A conservative, estimated cost of a fish ladder structure, design and construction, is $175,000, constructed on the east flank of the dam if space is available. Otherwise, more expensive structural solutions would need to be evaluated.

Photo 4-5. Aerial view of the Diversion Dam.

Photo 4-6. Drop structure at the dam.

Photo 4-7. View of the gate at Clear Springs Diversion Dam.

Other, smaller restoration opportunities such as non-native invasive vegetation control and native plantings may exist on the Clear Springs Ranch, but were not specifically identified nor evaluated for costs and acreage at this time.

4.1.6 Rank 6: Fountain Valley Park Vicinity

This potential project site is owned by El Paso Co. Parks and Leisure Services. The original interest in this site related to possible habitat improvements for the Arkansas darter, but upon examination, it was discovered that available habitat for the darter at the Park was in excellent condition and that augmentation of darters had been attempted by CDOW (Ken Pals, Naturalist, Fountain Valley Regional Park, pers. comm.). Another potential project was suggested by staff at the park regarding purchase of a mesic meadow (Figure 10) that once may have been a wetland, just north of the Cattail Marsh Wildlife Area. This potential purchase of property might add up to 13 acres of additional wet meadow property to the Park. Yet another potential project would involve diverting water from the Chilcotte Ditch to Cottonwood Meadows (Figure 11) to the west and could support establishment of approximately 40 ac. of wetlands. Construction of a diversion turnout, lateral ditch, several sluices, and land leveling would need to precede planting. Planting of a mix of native aquatic herbaceous and riparian shrub and tree species, per the Native Plant Re-vegetation Guide for Colorado (CDNR 1998) is recommended. The amount of water needed to support a wet meadow wetland of this size might approach 280 ac. ft. per year, which would equate to less than 1 cfs diversion throughout the growing season. The diversion rate at the concrete and rock grouted dam on Fountain Creek historically ranges from 0 to 37 cfs. Unless the City of Fountain has an appropriate water right, a plan for augmentation by the City would be needed to prevent injury to other water users' water rights due to out-of-priority stream depletions (Steve Witte, pers. comm.).

Cost of engineering and construction would total up to $250,000. Cost of the plantings on a 40 ac. meadow would range from $125K to$1,219K depending on the mix of native riparian shrubs and trees versus native, aquatic herbaceous forbs and grasses.

Photo 4-8. Property of possible interest to purchase adjacent to Fountain Valley Regional Park.

Photo 4-9. Cottonwood meadow area that could be converted to a wet meadow.

4.1.7 Rank 7: Frost-Hannah Vicinity

This private property with associated small-scale restoration projects could be considered typical of many private properties within the Fountain Creek watershed where collectively, these properties could offer opportunity for a large scale, reach-wide restoration effort with considerable federal interest and investment, while individually, might only be efficiently addressed under small state, local, or, in some cases, limited federal authorities.

This is private property located in southern El Paso County. An abandoned oxbow on Williams Creek about 6,500 ft. north of the confluence with Fountain Creek could be rewet by splitting flows at the convergence of the straightened channel and the abandoned oxbow above Hanover Rd. This could restore approx. 6.4 ac. of riparian and wetland habitat and could provide low velocity habitat for Arkansas darters that have been documented to occur on lower Williams Creek. Salt cedar growing on Williams Creek above Hanover Road is also recommended for control (5.1 ac.). These stands extend to about 8,500 ft. north of the confluence with Fountain Creek. Using technology such as the City of Pueblo's masticating head mounted on a Bobcat, the saltcedar could be chipped to ground level, then treated with a foliar herbicide once the resprouts emerge. Sandbar willows could be planted at both locations to slow future anticipated velocities on Williams Creek and to provide riparian habitat. Planting costs might approach $188,000. Photo 4-10 below illustrates a portion of the abandoned, now mesic oxbow, as well as discrete stands of salt cedar in the background. Photo 4-11 illustrates an aerial view of the potential projects.

Photo 4-10. Abandoned oxbow (mid-ground) and salt cedar stands (background) on the Frost-Hannah Property.

Photo 4-11. Aerial view of Frost Ranch Projects.

4.1.8 Rank 8: LFC-2 (Fountain Creek Mainstem near Pinon)

Overall this area is currently in good condition. There are pockets of exotic vegetation that could be removed and additional ponds or meandering that could be encouraged. The Pueblo Springs Ranch project is excellent regarding information and recreation and could be used as a portion in tandem with a large GI study.

4.1.9 Rank 12: Fountain/Monument Confluence to City Limits

There are significant properties in Colorado Springs along Fountain Creek from the Monument Creek confluence to the Colorado Springs city limit. The area analyzed ran from the power plant to the wastewater treatment plant and could be divided into six distinct reaches. Five of the reaches are on the left bank of Fountain Creek and one is on the right bank.

The expected without project damages were derived from field inspection of the properties in conjunction with the GIS database available from the assessors office. There were approximately 101 lots within the 1% annual chance flow floodplain. The start of damages varied from the 4% annual chance flow event for an area near the wastewater treatment plant to near the 1% annual event in the power plant reach. The benefits for the analyzed project were derived by providing risk management to the 1% annual chance flow event. A sensitivity analysis was performed on the economic data resulting in an estimate of benefits which ranged from $328,000 to $258,000.

Floodwalls were looked at for the stretch from the power plant to the wastewater treatment plant. An additional emplacement to block flow from going to the south side was not included in this preliminary cost analysis, but is not expected to exceed costs. Supportable construction downstream of the powerplant appears to be from $4.8-6.1 million, whereas costs are estimated at $1.4 million. Costs to protect the power plant and the wastewater treatment plant are $800,000 and $900,000 respectively. There are questions whether the power plant is endangered by the 1% annual chance flow event. The wastewater treatment plant, based on similar structures would justify over $1.3 million in protection.

Based upon this analysis, under the Corps authorities Section 205 would be applicable.

Figure 4-5. Floodway at Power Plant.

Figure 4-6. Flooding at Tejon and Nevada Bridges.

Figure 4-7. Flooding at Wastewater Treatment Plant.

Table 4- 2
Colorado Springs Floodwalls

	Item of Work	AMOUNT	UNIT	UNIT PRICE	TOTAL
Wetlands Area					
8' Concrete Wall, 8" thick					
1	Clearing and Grubbing	0.40	acre	$3,500.00	$1,400.00
2	Excavation	6,700	C.Y.	$2.50	$16,750.00
3	Concrete Floodwall	2,800	L.F.	$250.00	$700,000.00
4	Backfill	6,700	C.Y.	$4.25	$28,475.00
5	Pavement Replacement (if any)	700	S.Y.	$35.00	$24,500.00
6	Utility Relocation (if any)	1,000	L.F.	$180.00	$180,000.00
				Subtotal	$951,125.00
		9.00%		Engineering Design	$85,601.25
					$1,036,726.25
		7.50%		Supervision and Admin	$77,754.47
					$1,114,480.72
		25.00%		Contingency	$278,620.18
				TOTAL (round)	$1,393,100

Assumptions:
*All items include G&A, Profit, & Tax
*Utility and Pavement costs approximate and unknown
*Floodwall includes 4'X1' footer, 4' below grade to bottom of footing, typical reinforcing
*Cost does not include beautification, anti-graffiti, seeding, real estate, and access control

	Item of Work	AMOUNT	UNIT	UNIT PRICE	TOTAL
Power Plant					
3' Concrete Wall, 8" thick					
1	Clearing and Grubbing	0.20	acre	$3,500.00	$700.00
2	Excavation	4,100	C.Y.	$2.50	$10,250.00
3	Concrete Floodwall	1,700	L.F.	$230.00	$391,000.00
4	Backfill	4,100	C.Y.	$4.25	$17,425.00
5	Pavement Replacement (if any)	500	S.Y.	$35.00	$17,500.00
6	Utility Relocation (if any)	500	L.F.	$180.00	$90,000.00
				Subtotal	$526,875.00
		9.00%		Engineering Design	$47,418.75
					$574,293.75
		7.50%		Supervision and Admin	$43,072.03
					$617,365.78
		25.00%		Contingency	$154,341.45
				TOTAL (round)	$771,700

Assumptions:
*All items include G&A, Profit, & Tax
*Utility and Pavement costs approximate and unknown
*Floodwall includes 4'X1' footer, 4' below grade to bottom of footing, typical reinforcing
*Cost does not include beautification, anti-graffiti, seeding, real estate, and access control

	Item of Work	AMOUNT	UNIT	UNIT PRICE	TOTAL
	Wastewater Treatment Plant				
	5' Concrete Wall, 8" thick				
1	Clearing and Grubbing	0.30	acre	$3,500.00	$1,050.00
2	Excavation	4,800	C.Y.	$2.50	$12,000.00
3	Concrete Floodwall	2,000	L.F.	$235.00	$470,000.00
4	Backfill	4,800	C.Y.	$4.25	$20,400.00
5	Pavement Replacement (if any)	350	S.Y.	$35.00	$12,250.00
6	Utility Relocation (if any)	500	L.F.	$180.00	$90,000.00
				Subtotal	$605,700.00
		9.00%		Engineering Design	$54,513.00
					$660,213.00
		7.50%		Supervision and Admin	$49,515.98
					$709,728.98
		25.00%		Contingency	$177,432.24
				TOTAL (round)	$887,200

Assumptions:
*All items include G&A, Profit, & Tax
*Utility and Pavement costs approximate and unknown
*Floodwall includes 4'X1' footer, 4' below grade to bottom of footing, typical reinforcing
*Cost does not include beautification, anti-graffiti, seeding, real estate, and access control

4.1.10 Rank 13: Dam Above Pueblo

As indicated previously there is significantly less floodway capacity remaining within the Pueblo levees than that for which the project was designed. Additionally, other properties can be threatened by flooding on Fountain Creek, both along Fountain Creek and below the confluence with the Arkansas River. Prior to the construction of the Pueblo levees, the Corps of Engineers had analyzed a dam on Fountain Creek, which initially was justified in a 1971 study. A more detailed study was completed in 1981, which found that a dam did not meet Corps economic criteria; however, a levee system along Fountain Creek in Pueblo would significantly reduce the flood hazard. Major reasons for the change between the two years, was the more detailed analysis and rise in dam construction costs, and the construction of the Pueblo Dam on the Arkansas River above Pueblo. This study relooked at the dam, as a flood risk reduction alternative based on current conditions. Therefore, the Pueblo levees were assumed to be in place and actions taken to maintain a level of flood risk management approximating the 1% annual flow event. The dam was downsized from the 1981 plan to capture sediment and the peak flow from the 1% to the .2% annual chance flow event. Further downsizing for the dam to serve only to capture sediment and a temporary peak indicated savings that were not significant from that analyzed. Placement was in the college park area, which was the optimum location in the 1981 analysis. Benefits were updated based on newer values, growth, and new procedures (higher damage curves for a given depth of flooding and risk analysis procedures) and could support a project of $22 million. This value rises to $26 million assuming $200,000 sediment removal costs are averted at the Pueblo levee. Costs of the dam, excluding relocations, including 6.1 miles of highway and railroad, were calculated at $186,000,000. The majority of the costs relate to the outlet works and the spillway, with the exception of $52,000,000. When costs of relocation are included, the flood risk reduction benefit costs for dam construction are expected to be less than 1.

Recommendation: Any dam or series of dams should be pursued as a multipurpose project. A dam or series of dams above Pueblo does not lend itself to a Corps project unless specific directing legislation is passed.

Table 4-3 Reasonable Contract Estimate				Sheet 1 of 2
FOUNTAIN CREEK (College Site, 10a) Pueblo County, Colorado				
ITEM	ESTIMATED QUANTITY	UNIT	UNIT PRICE	ESTIMATED AMOUNT
General				
* General costs include an unknown quantity for Instrumentation due				
unknown type of reservoir to be constructed (recreational vs flood risk reduction).				
Costs indexed up from previous studies.				
Diversion Care of Water	1	L.S.	$ 610,000.00	$ 610,000
Instrumentation	1	L.S.	$2,435,000.00	$ 2,435,000
Contingency		25%		$ 761,250
Subtotal				$ 3,806,250
Embankment				
*Embankment quantities reflect new design w/ Top of Dam = 4890',				
3:1 side slopes, and crest width of 20'. Assumption is that fill will be				
excavated from existing site.				
Surface Prep	91	acre	$ 3,500.00	$ 318,182
Excavation				
Inspection Trench	35,900	C.Y.	$ 2.85	$ 102,315
Impervious Fill Borrow	569,280	C.Y.	$ 3.50	$ 1,992,480
Embankment Fill				
Random	5,239,400	C.Y.	$ 3.50	$ 18,337,900
Impervious	474,400	C.Y.	$ 3.50	$ 1,660,400
Drain Material	922,400	C.Y.	$ 9.00	$ 8,301,600
Riprap 18"	81,900	C.Y.	$ 60.00	$ 4,914,000
Grout	82,000	L.F.	$ 30.00	$ 2,460,000
Contingency		25%		$ 9,521,719
Subtotal				$ 47,608,596
Spillway				Sheet 2 of 2
*Spillway assumed to be same as previous studies (2000' width) with				
Crest Elev = 4870'. Spillway location is Right Bank. Excavation				
adjusted to match current topo.				
Waste	4,000,000	C.Y.	$ 1.50	$ 6,000,000
Excavation Common	8,000,000	C.Y.	$ 5.50	$ 44,000,000
Excavation Structural	1,745	C.Y.	$ 10.00	$ 17,450
Concrete Structural	12,200	C.Y.	$ 625	$ 7,625,000
Concrete Lean	10,000	C.Y.	$ 275	$ 2,750,000
Contingency		25%		$ 15,098,113
Subtotal				$ 75,490,563

ITEM	ESTIMATED QUANTITY	UNIT	UNIT PRICE	ESTIMATED AMOUNT
Outlet Work				
*Outlet Works assumed to be same as previous studies. Costs				
indexed up to current rates.				
Excavation Common	24,000	C.Y.	$ 5.50	$ 132,000
Excavation Rock	35,250	C.Y.	$ 12.00	$ 423,000
Waste	80,000	C.Y.	$ 1.50	$ 120,000
Concrete Conduit	7,600	C.Y.	$ 850	$ 6,460,000
Concrete Service Bridge	450	C.Y.	$ 1,100	$ 495,000
Concrete Structural	21,000	C.Y.	$ 575.00	$ 12,075,000
Bridge superstructure	270	L.F.	$ 1,900	$ 513,000
Gates	1	job	$ 10,000,000	$ 10,000,000
RipRap	6,000	C.Y.	$ 80	$ 480,000
Contingency		25%		$ 7,674,500
Subtotal				$ 38,372,500
	Total			$ 165,277,909
	Engineering and Design (5%)			$ 8,263,895
	Construction Management (S&A 7.5%)			$ 12,395,843
	Grand Total			$ 185,937,600
* Grand Total does not include relocation costs for I-25, County Rds, Powerlines, and R.R. Also does not include costs for land acquisition and damages or permanent facilities at the dam to operate and maintain the project.				

4.1.11 Rank 14: Pinon to Pueblo Reach

This reach, largely in Pueblo County, is bounded on both sides of the creek by private land. Thus, access to the creek for the purpose of reconnaissance and ground-truthing of aerial photo interpretation was extremely limited. The Pueblo Springs Ranch property is included in this reach. From the old Pinon Bridge to the Highway 50 crossing in north Pueblo is approximately 11 river miles. Use of masticating machines to chip patches and homogenous stands of salt cedar to ground level could lessen channel entrenchment and promote more widespread sinuosity and overbank wetting at desired locations, increasing off-channel wetland and riparian habitat. Some abandoned oxbows might be re-wetted. Particularly on Pueblo Springs Ranch, opportunities exist to tie-in with the Crown Jewel trail concept, together with considerable educational opportunities to demonstrate riparian ecology and river hydrology. In order to obtain funding from some agencies, private landowners might have to convey an easement to an entity such as a soil and water conservation district, which in turn would assume responsibility for maintenance of the project through its useful life. Other funding sources might deal directly with individual landowners.

However, there are significant areas from Colorado Springs to Pueblo which could benefit from restoration features such as salt cedar removal, plantings of native species, establishment of wetlands and oxbows, and recreational facilities. These lend themselves to a General Investigation environmental restoration study.

4.1.12 Rank 15: LFC-3 (Fountain Creek in Pueblo from Hwy 47 to 4th St)

The City of Pueblo has already started a campaign to control invasive vegetation between the levees with the use of a Bobcat loader with a mounted masticating head. This effort is being undertaken to increase channel and sediment movement capacity of Fountain Creek between the levees. Restoration plantings would be counterproductive in this situation. Further, hazardous and toxic wastes are issues at some potential sites along this reach. The removal of the abandoned railroad bridge or approach berm situated above the confluence with the Arkansas River could cause undesirable meander pattern that threatens other infrastructure in the vicinity. Thus, this reach was discounted as a priority restoration reach.

4.1.13 Rank 16: Highway 47 Vicinity

The City of Pueblo owns land just east of the Walmart store near Highway 47 (Figures 4-8). Much of the area was excavated for borrow material upon which to build the Walmart store. In some lower areas, wetland plants such as phragmites, cattails, sandbar willow and Plains cottonwood have colonized successfully. In other areas such as in Photo 4-12 below, the ground is bare. The City has expressed interest in controlling the moderate colonization of exotic invasive plants and planting native woody riparian and wetland herbaceous species in the subject area, which is estimated to be 15 acres. An infiltration gallery could be constructed to capture water from Fountain Creek. It would be placed below the channel invert in order to ensure availability of water into the basin. The water could then be piped under the existing levee along the west side of Fountain Creek where it would outlet into a French Drain. The drain would distribute water to the entire area. Earthwork and grading would be required to inundate the entire area. The cost of engineering and construction of these features would total up to $1.2 million. Cost of the plantings would range between $47K and $457K, depending on the mix of tree and shrubs versus aquatic herbaceous plants utilized.

Wetland plants might consume up to 133 acre feet of water per year in evapotranspiration. Unless the City of Pueblo has an appropriate water right, a plan for augmentation by the City would be needed to prevent injury to other water users' water rights due to out-of-priority stream depletions (Steve Witte, pers. comm.).

In addition to these restoration features, an overflow weir at the downstream end of the wetland could be constructed to return diverted water back to Fountain Creek. This feature would also offer ancillary flood alleviation diverting a portion of a flood hydrograph, thereby attenuating the peak flow downstream. The actual amount of flood peak attenuation was not investigated as a part of this study. The cost of this added feature would total up to $1.5 million.

Figure 4-8. Aerial View of Potential wetland basin near Highway 47 in Pueblo, Colorado.

Photo 4-12. Photo of proposed wetland site looking W-SW.

4.1.14 Rank 17: Fountain Creek- Fountain Valley Park to Clear Springs Ranch

This reach has several areas of channel instability. The primary area of immediate concern is the bank stability issues upstream of and under US Highway 85/87 Bridge.

Fountain Creek is threatening the right bank (southwest) and Highway 85/87 roadway embankment just upstream of the bridge as well as the left (northeast) bridge abutment. A meander is moving into and undercutting the roadway embankment and starting to curl back on itself as it passes under the bridge, directing impinging flows onto the left (northeast) bridge abutment.

This reach of the Fountain appears to have a degradational tendency (agrees with geomorphic report). A large drop structure was recently constructed upstream of the bridge and channel bend. This may increase the streams energy downstream of the drop structure, creating more channel instability at the bridge.

A project which could improve conditions at this location includes channel realignment upstream of the bridge to direct the flows at a more perpendicular angle as Fountain Creek passes under the bridge. Additionally, bank armament (Longitudinal Peak Stone Toe Protection) upstream of and under Highway 85/87 Bridge, with construction of a floodplain terrace where the old (existing) channel is.

The cost estimate is as follows:

	Contract Cost	Contingency	Project Cost
Total Project Cost	$2,277,066	$615,260	$2,892,321
Construction Costs	$1,787,061	$493,260	$2,280,321
Lands and Damages	$85,000	$15,000	$100,000
Planning and Engineering	$215,000	$55,000	$270,000
Construction Management	$190,000	$52,000	$242,000

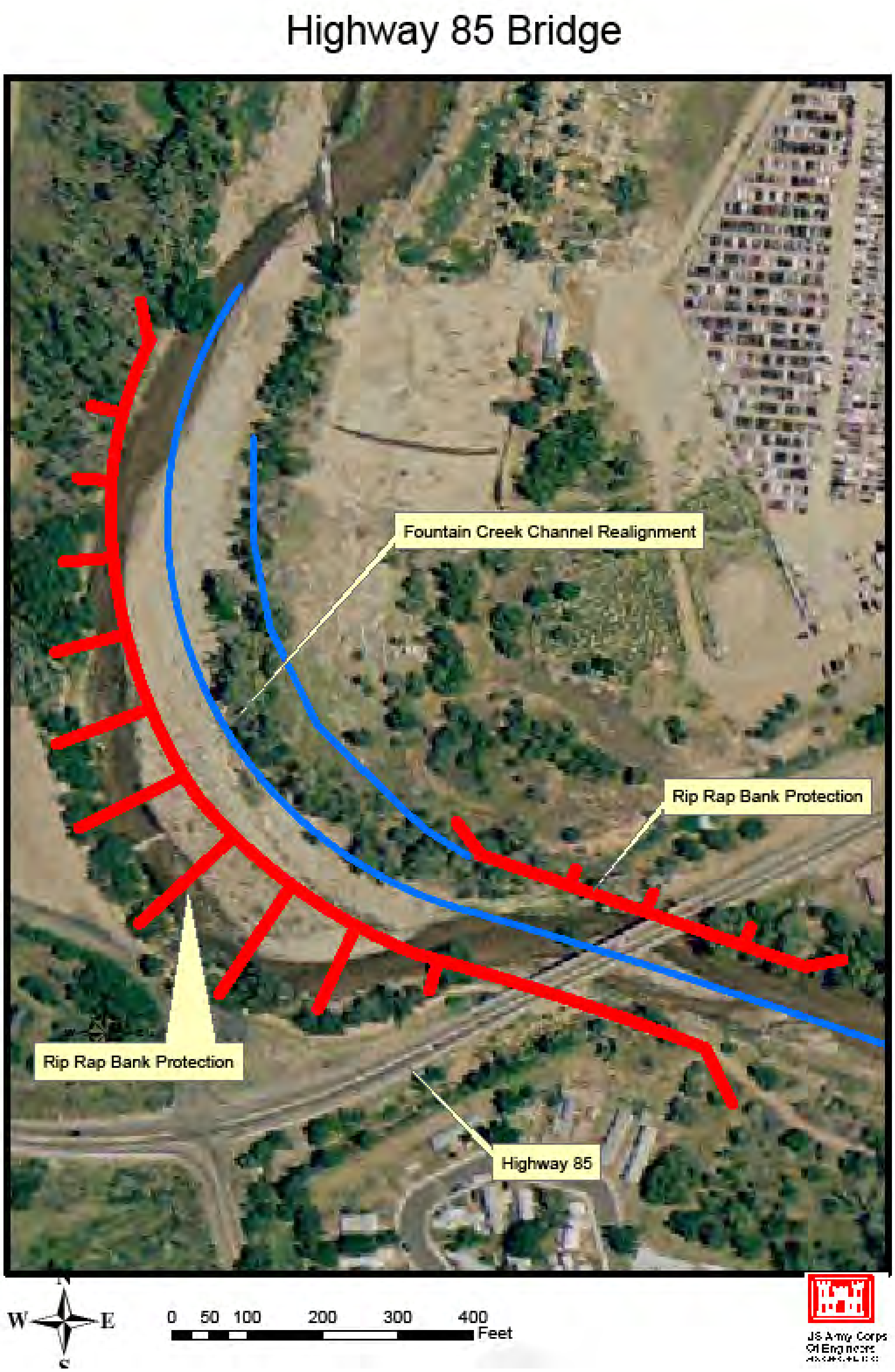


Figure 4-9. Highway 85 Bridge.

5.1 OTHER POTENTIAL PROJECTS WITHIN THE WATERSHED

This section outlines project areas considered other than the 13 projects analyzed in detail. Many of these projects meet the scope and intent of the watershed study and should be considered when practicable.

This chapter examines the types of issues that exist at the locations now and the types of problems that may develop over time. Potential activities are discussed in some of the locations. It should be noted that these and the 13 projects were developed at one point in time. As other projects develop through other organizations, such as the Fountain Creek Vision Task Force, when they meet the goals and objectives of this study they should be supported. When they meet the goals and objectives of Corps funding authorities consideration should be given to working with the Corps in their implementation.

Figures 5-1 through 5-5 show the locations of the remaining projects identified in Section 3.

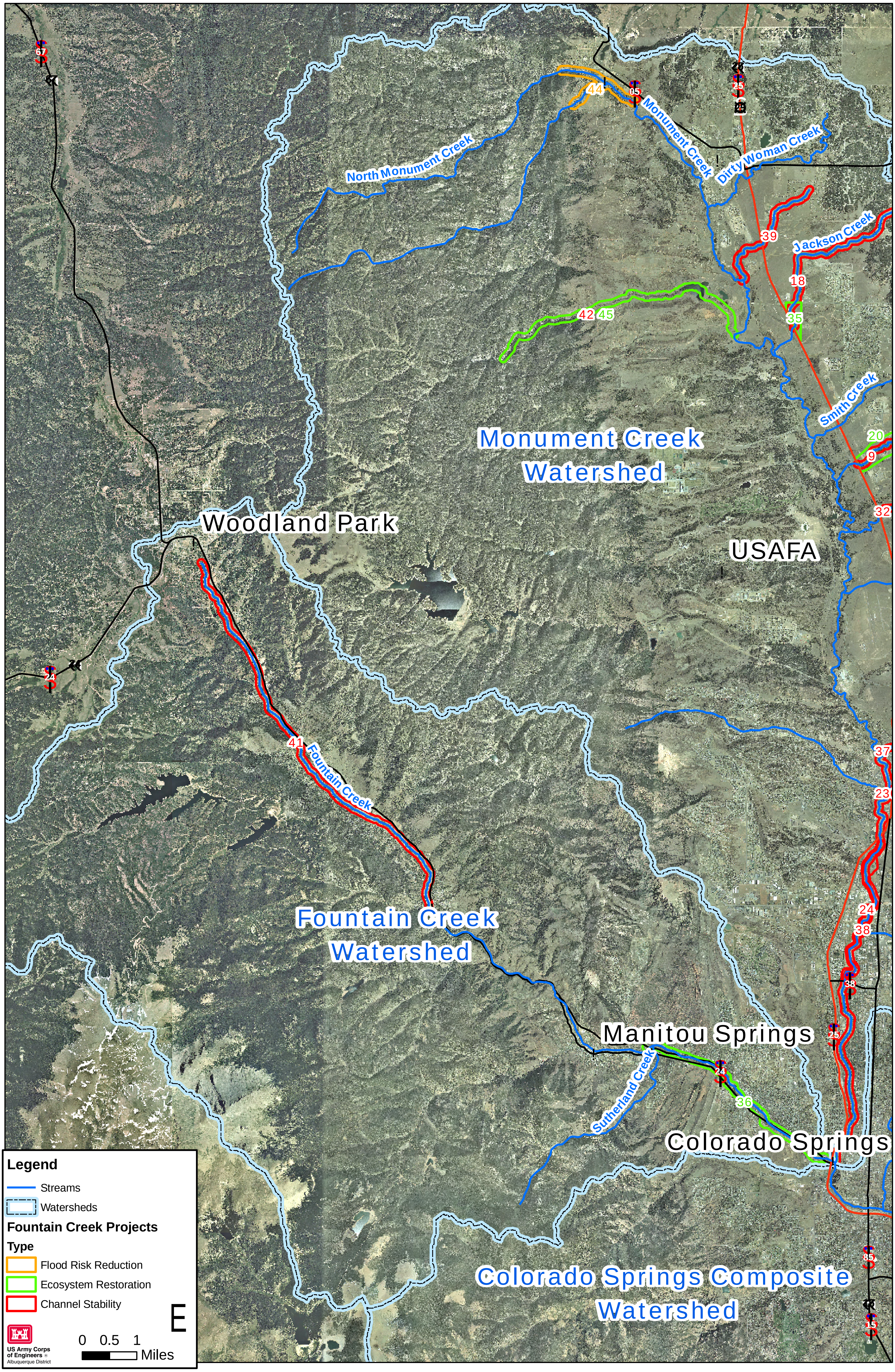
5.2 POTENTIAL FLOOD RISK REDUCTION FEATURES FOR THE FOUNTAIN CREEK WATERSHED

Investigation of the Fountain Creek watershed was done in order to identify locations that may be susceptible to flooding. The Fountain Creek Watershed Study's Hydrology and Hydraulics reports were primarily used for this investigation.

Floodplains were not created as a part of this study. This made definitive assessment of flood hazard for individual areas more difficult. The HEC-RAS hydraulic model created for the Fountain Creek Watershed Study was used to assess the potential for flooding in individual areas. The cross sections from the model were georeferenced and plotted on aerial photography. The depth and lateral extent of flooding taken from these cross sections was then used to assess flood hazard within the vicinity of each cross section. In this way, flood prone areas were identified for closer study.

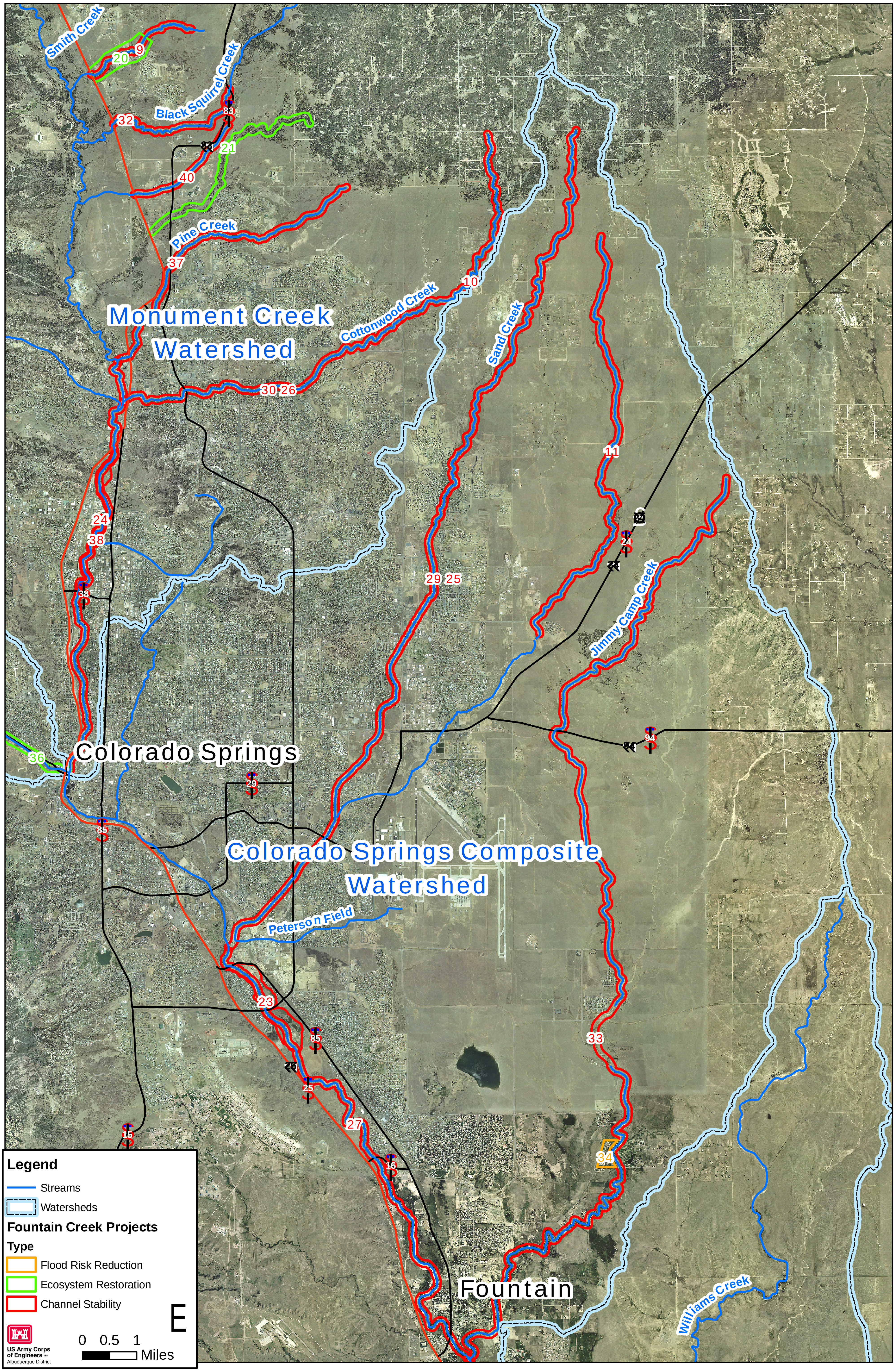
Fountain Creek Watershed Study

Figure 5-1. Other Potential Projects Within the Watershed, Sheet 1



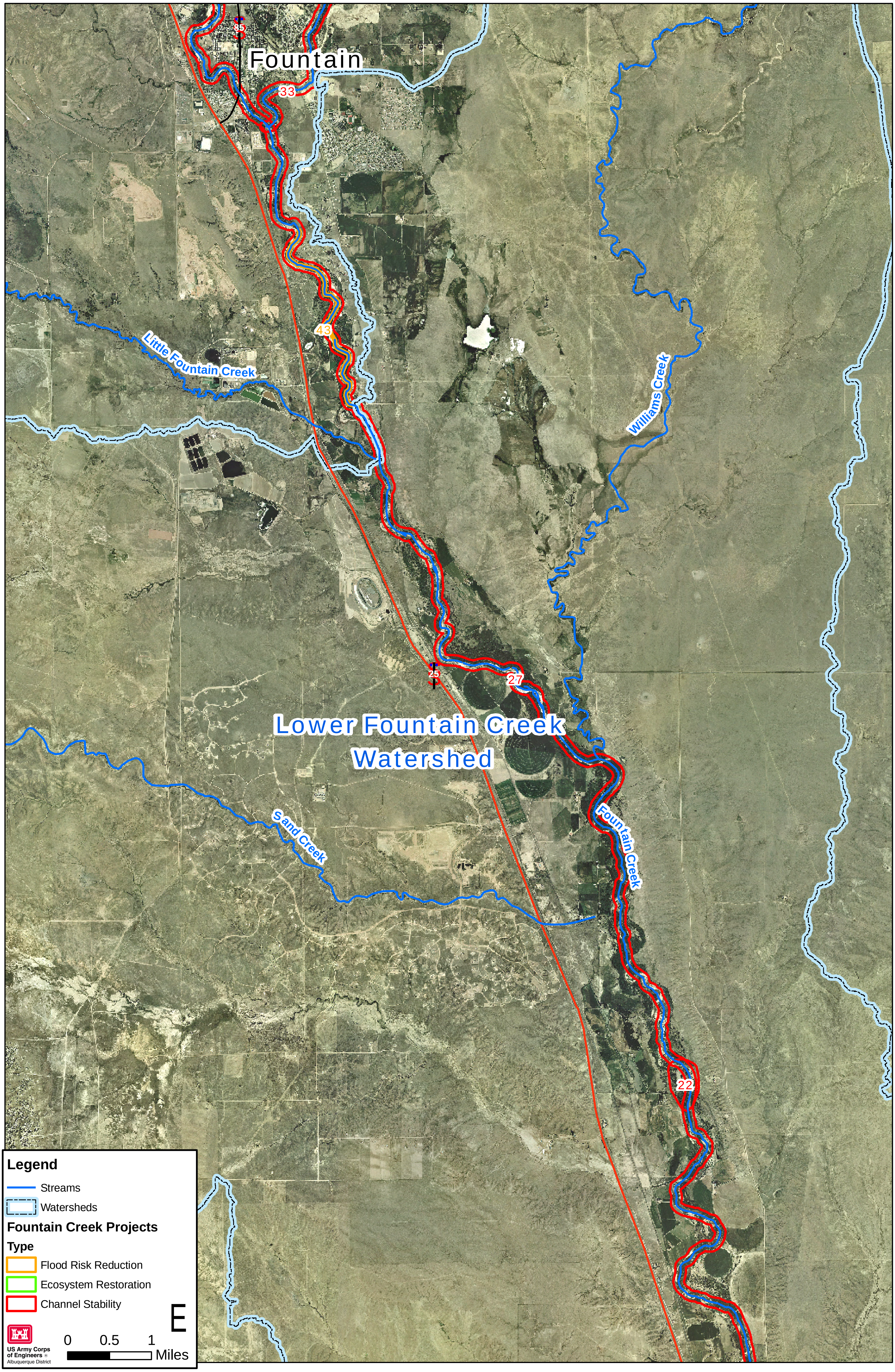
Fountain Creek Watershed Study

Figure 5-2. Other Potential Projects Within the Watershed, Sheet 2



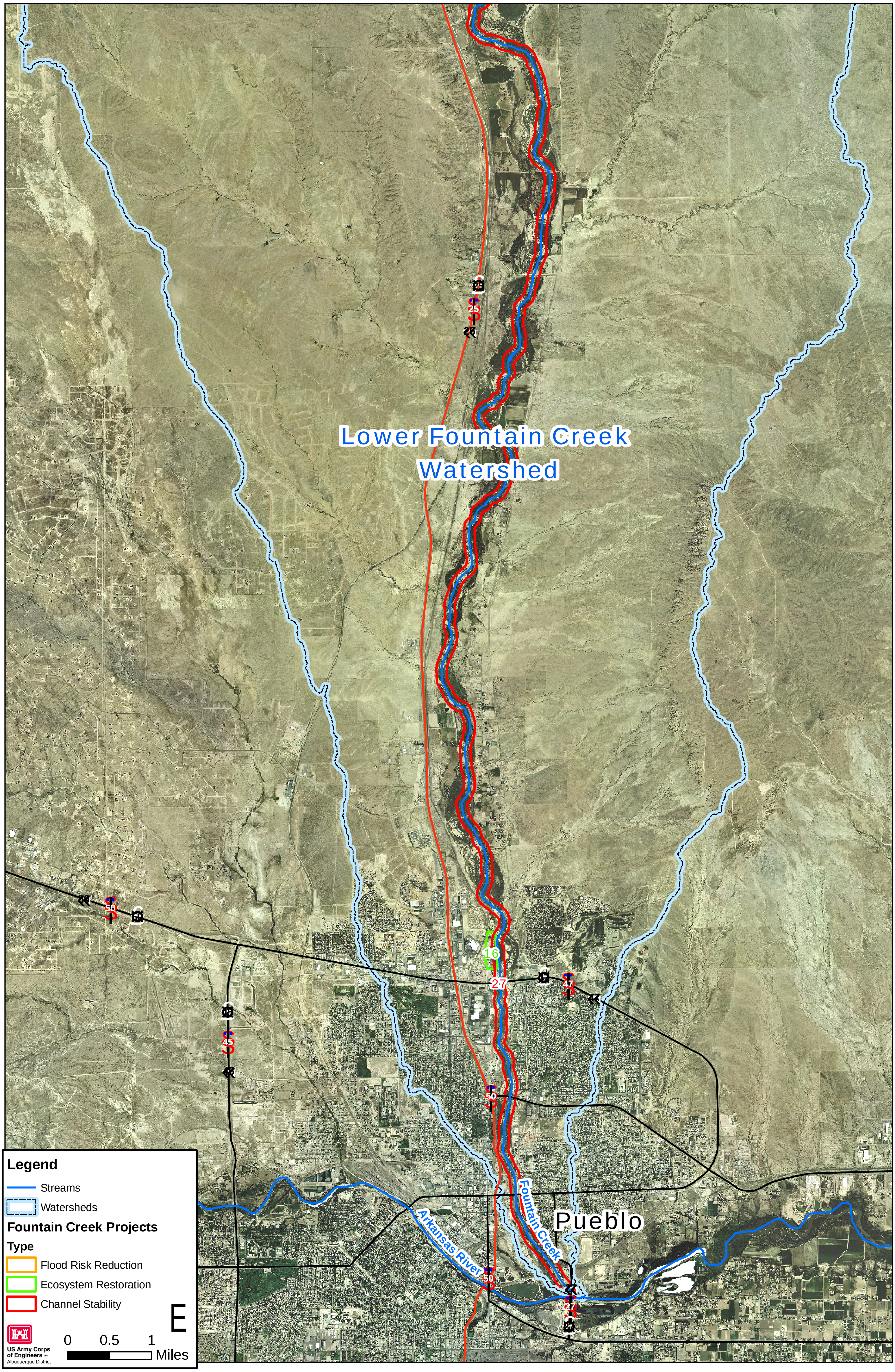
Fountain Creek Watershed Study

Figure 5-3. Other Potential Projects Within the Watershed, Sheet 3



Fountain Creek Watershed Study

Figure 5-4. Other Potential Projects Within the Watershed, Sheet 4



Fountain Creek Watershed Study

Figure 5-5. Other Potential Projects Within the Watershed, Sheet 5

Channel Stability

9 Monument Branch

10 Upper Cottonwood Creek - Above Rangewood

18 Jackson Creek

22 LFC-1 (Fountain Creek Mainstem in northern Pueblo County)

23 CSC-1 (Fountain Creek Mainstem below Sand Creek confluence)

24 MC-2 (Monument Creek Mainstem between Cottonwood Creek and Fountain Creek)

25 Sand Creek (Sediment Source)

26 Cottonwood Creek

27 Fountain Creek – Mainstem below Colorado Springs

29 Sand Creek (Infrastructure)

30 Cottonwood Creek

32 Black Squirrel Creek

33 Jimmy Camp Creek

37 Pine Creek

38 Monument Creek

39 Teachout Creek

40 Elkhorn Creek

41 Upper Fountain Creek

42 Beaver Creek

Ecosystem Restoration

16 Highway 47 Vicinity

20 Monument Branch

21 Kettle Creek

35 Jackson Creek

36 Highway 24 Corridor

45 Beaver Creek

Flood Risk Reduction

28 Eastern Tributaries - Pine Creek, Black Squirrel
. Creek, Middle Trib, Monument Branch, Black
. Forest, Jackson Creek (Not Shown)

34 Peaceful Valley Road Vicinity

43 Old Pueblo Road Corridor

44 Upper Monument Creek

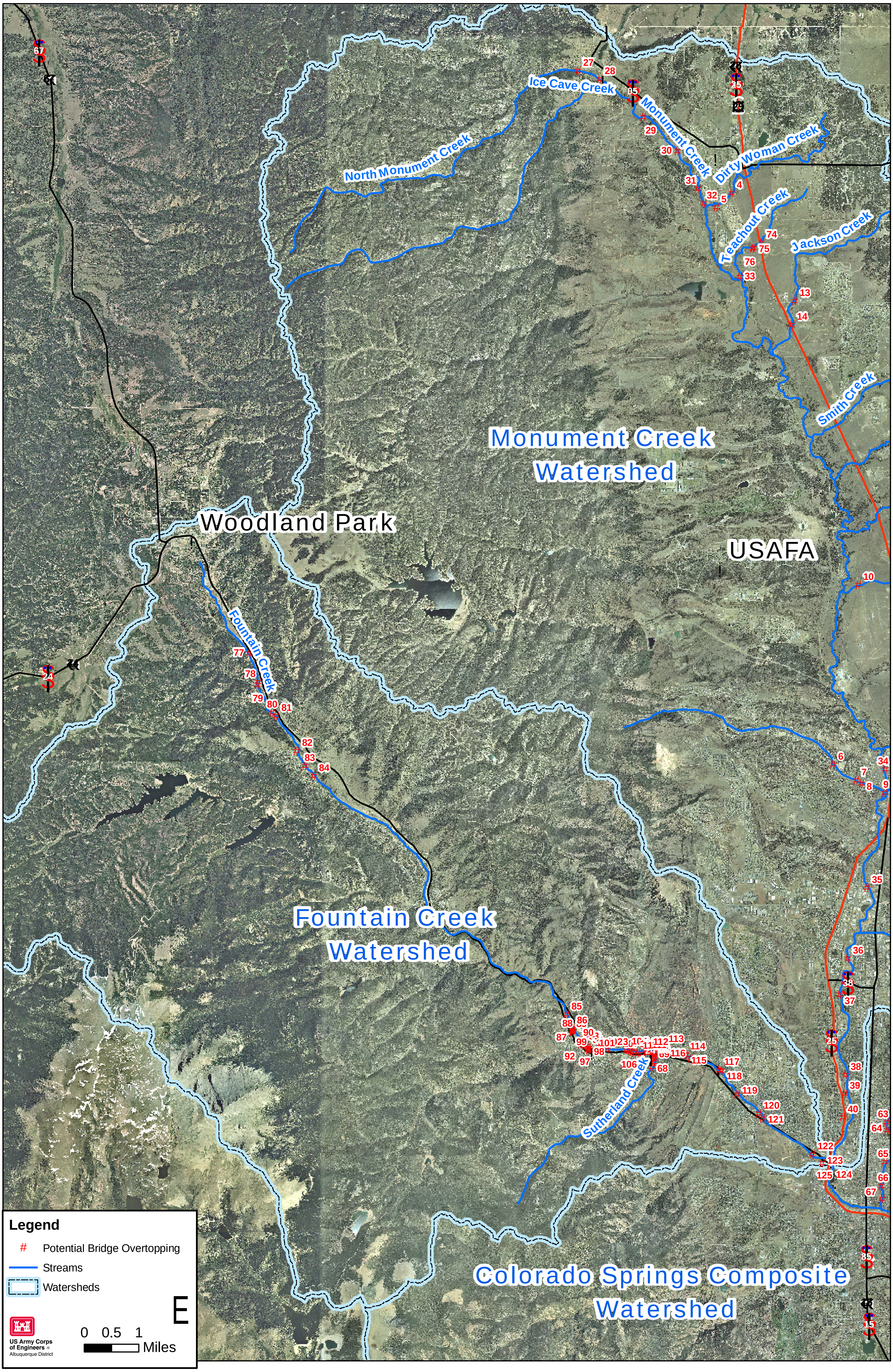
Rank 19: Bridge Overtoppings

There are a large number of bridges within El Paso County (mostly Colorado Springs) that were identified as overtopping in 2% to 1%annual chance flow events. These structures are also creating significant backwaters. Most of these bridges do not pose significant flooding risk, but do create some backwater. Figures 5-5 through 5-6 show the locations of the bridges.

The HEC-RAS model showed that several bridges and culverts appeared to have inadequate capacity and would overtop relatively frequently. The backwater upstream of these structures was often the cause for flood inundation shown in the model. A list was made of all bridges within the watershed that were studied and were shown to overtop in the HEC-RAS model (Table 5-1). The list is shown below, along with the frequency that it may overtop, as well as observations and notes. It should be noted that hydraulic modeling of bridges is a complex exercise leading to greater uncertainty in water surface elevations. Therefore, the frequency of bridge overtopping listed here should not be considered sufficient in making an assessment of the flood hazard posed by each structure. Rather, this list is provided in order to identify bridges and culvert crossings that may warrant a more detailed evaluation.

Fountain Creek Watershed Project Locations

Figure 5-6. Potential Bridge Overtopping Locations, Sheet 1



Fountain Creek Watershed Project Locations

Figure 5-7. Potential Bridge Overtopping Locations, Sheet 2

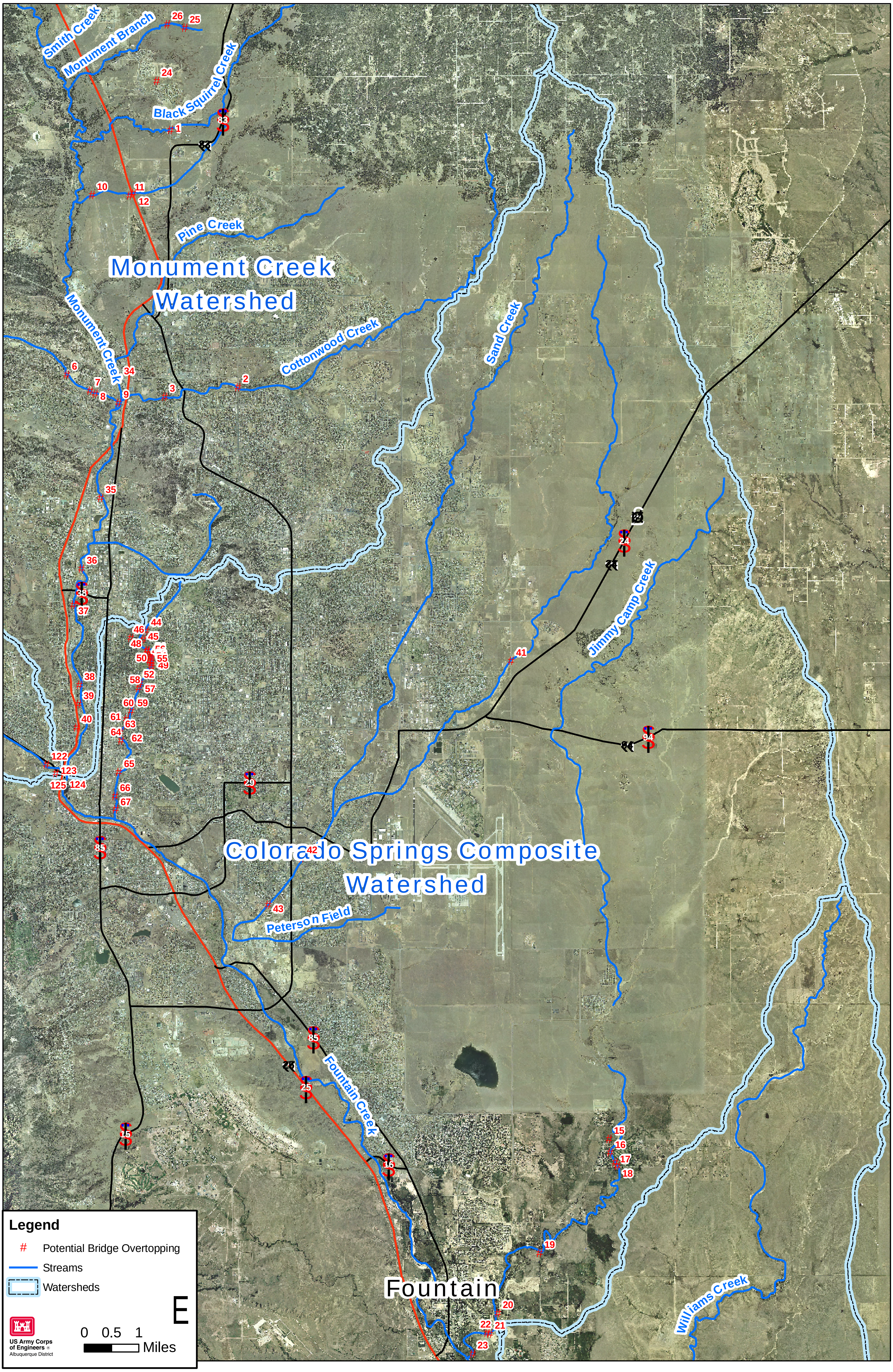


Table 5-1
Bridge Overtopping Locations

Map Location	Tributary	Crossing Flooded	Annual Chance of Exceedance	Other Flooding	Notes
	Black Forest	Bike Path			
	Black Forest	Santa Fe Trail			
	Black Forest			No significant structures flooded	
1	Black Squirrel	Voyager Parkway	.02 future		
	Black Squirrel			No significant structures flooded	
2	Cottonwood	Union Blvd	.04		
3	Cottonwood	Pipeline at Academy	.04		
	Cottonwood			No significant structures flooded	
4	Dirty Woman	Old Denver Highway	.2		
5	Dirty Woman	Mitchel Ave	.2		
	Dirty Woman			No significant structures flooded	
6	Dry Creek	Pebble Way	.2		
7	Dry Creek	Rockrimmon Blvd	.1		
8	Dry Creek	Dawson Dr	.04		
9	Dry Creek	Mark Dabling	.04		
	Dry Creek			Structures Flood upstream of Rockrimmon Blvd	
10	Elkhorn	I-25	.02 future		Culvert is undersized for future conditions hydrology
11	Elkhorn	Abandoned Highway	.02 future		
12	Elkhorn	Trail	.02 future		
	Elkhorn	Trail	.02 future		
	Elkhorn			No significant structures flooded	
13	Jackson	Baptist Rd	.5 yr		
14	Jackson	Struthers Rd	.5 yr		
	Jackson			No significant structures flooded	

Map Location	Tributary	Crossing Flooded	Annual Chance of Exceedance	Other Flooding	Notes
15-17	Jimmy Camp Creek	Apple Tree Golf Course crossings	.2 future		Occurs somewhat less frequently with existing conditions
18	Jimmy Camp Creek	Peaceful Valley Road	.5 future		Occurs somewhat less frequently with existing conditions
19	Jimmy Camp Creek	Link Road	.04 future		Occurs somewhat less frequently with existing conditions
20	Jimmy Camp Creek	Ohio Ave	.02 future		Occurs somewhat less frequently with existing conditions
21	Jimmy Camp Creek	Metcalf Park	.5 future		Occurs somewhat less frequently with existing conditions
22	Jimmy Camp Creek	RR at Metcalf Park	.04 future		Occurs somewhat less frequently with existing conditions
23	Jimmy Camp Creek	Old Pueblo Road	.04 future		
	Jimmy Camp Creek			Residential flooding between Ohio Ave and Metcalf Park	
	Jimmy Camp Creek			Extensive flooding to neighborhood in the vicinity of Appletree Golf Course	Appears to occur during high frequency existing conditions floods, need to investigate further
	Jimmy Camp Creek			Appletree Golf Course	Appears to occur during high frequency existing conditions floods, need to investigate further
24	Middle Tributary	Behind Da Vinci Academy	.1		
25	Monument Branch	New road North Gate 2	.04		
26	Monument Branch	New road North Gate 1	.1		
27	Monument Creek	Walnut road	.2		
28	Monument Creek	Spring St	.04		
29	Monument Creek	Redrock Ranch Dr	.04		
30	Monument Creek	Private Dr	.02		
31-32	Monument Creek	Mt Herman Rd	.04		
33	Monument Creek	Private Dr	.04		
34	Monument Creek	Pipe Crossing near Woodman Rd	.01		
35	Monument Creek	Upstream of Garden of Gods Rd	.01		
36	Monument Creek	Upstream of Fillmore St	.04		

Map Location	Tributary	Crossing Flooded	Annual Chance of Exceedance	Other Flooding	Notes
37	Monument Creek	Polk St	.04		
38	Monument Creek	Unitah St	.01		
39	Monument Creek	Mesa Rd	.01		
40	Monument Creek	Mesa Rd	.04		
	Monument Creek			Flooding in upper Monument Floodplain (Palmer Lake)	
	Monument Creek			Upstream of Fillmore St, left bank	
	Monument Creek			Downstream of Polk St, bothe banks	
	Monument Creek			Flooding I-25 near Bijou St	Nead to check for flood proofing not shown in HEC-RAS model
	Pine Creek				No issues
41	East Fork Sand Creek	Markshettel Rd	.2		culvert
	East Fork Sand Creek				No serious issues, not developed
42	Sand Creek	Chefton Ave	.1		Concrete box culvert
43	Sand Creek	Hancock Ave	.04		Concrete box culvert
	Sand Creek				Bridge below golf course (RS 40616-40408) and Detention pond are not modeled in HEC-RAS
	Sand Creek				Several pedestrian bridges overtop at low return intervals
	Sand Creek				Residential flooding around RS 20183-19532
44	Shooks Run	La Salle Bridge	less than .1		only 10 yr and 100 yr modeled
45	Shooks Run	Jefferson St	less than .1		only 10 yr and 100 yr modeled
46	Shooks Run	Paseo Rd	less than .1		only 10 yr and 100 yr modeled
47-55	Shooks Run	Several Pedestrian Bridges	less than .1		only 10 yr and 100 yr modeled
56	Shooks Run	Espanola St	less that .01		only 10 yr and 100 yr modeled
57	Shooks Run	San Miguel	less that .01		only 10 yr and 100 yr modeled

Map Location	Tributary	Crossing Flooded	Annual Chance of Exceedance	Other Flooding	Notes
58	Shooks Run	Uintah	less that .01		only 10 yr and 100 yr modeled
59	Shooks Run	Cache La Poudre	less that .01		only 10 yr and 100 yr modeled
60	Shooks Run	E Dale St	less that .01		only 10 yr and 100 yr modeled
61	Shooks Run	Wilamette St	less that .01		only 10 yr and 100 yr modeled
62	Shooks Run	Pearl St	less that .01		only 10 yr and 100 yr modeled
63	Shooks Run	E Boulder St	less that .01		only 10 yr and 100 yr modeled
64	Shooks Run	E Bijou St	less that .01		only 10 yr and 100 yr modeled
65	Shooks Run	E Castilla St	less that.01		only 10 yr and 100 yr modeled
66	Shooks Run	Fountain Blvd	less that .01		only 10 yr and 100 yr modeled
67	Shooks Run	Las Vegas St	less that.01		only 10 yr and 100 yr modeled
	Shooks Run			Residential Flooding throughout the reach	
	Smith Creek			Possible residential flooding upstream of I-25	
68	Sutherland Creek	Sutherland Rd	.5		
69	Sutherland Creek	Walla Ln	.5		
70	Sutherland Creek	Entrance to Town-Country Cottages	.5		
71	Sutherland Creek	Crystal Park Rd	.5		
72	Sutherland Creek	Ramp to Highway 24	.2		
73	Sutherland Creek	Manitou Ave	.5		
	Sutherland Creek			Probable flooding througout reach	
74	Teachout Creek	Struthers Rd	.2		
75	Teachout Creek	Santa Fe Trail	.02		
76	Teachout Creek	Old Denver Highway	.5		
77	Teachout Creek				Mostly undeveloped
78	Upper Fountain	Off Woodland Ave 2	.01		
79	Upper Fountain	Crystal Canyon Rd	.02		
80	Upper Fountain	Creekside Dr	.02		
81	Upper Fountain	Private Ranch	.02		
82	Upper Fountain	Private Ranch	.1		
83	Upper Fountain	Off Green Mtn Falls Rd	.1		

Map Location	Tributary	Crossing Flooded	Annual Chance of Exceedance	Other Flooding	Notes
84	Upper Fountain	El Paso Ave 1	.02		
85	Upper Fountain	El Paso Ave 2	.04		
86	Upper Fountain	Serpentine Dr	.04		
87	Upper Fountain	Off Manitou Ave 1	.1		
88	Upper Fountain	Off Manitou Ave 2	.1		
89	Upper Fountain	Off Manitou Ave 3	.2		
90	Upper Fountain	Parking Lot at Millwheel	.1		
91	Upper Fountain	Park Ave	.1		
92	Upper Fountain	Off Manitou Ave 4	.04		
93	Upper Fountain	Off Manitou Ave 5	.04		
94	Upper Fountain	Off Manitou Ave 6	.1		
95	Upper Fountain	Off Manitou Ave 7	.1		
96	Upper Fountain	Under Penny Arcade	.04		
97	Upper Fountain	Off Manitou Ave 8	.1		
98	Upper Fountain	Canon Ave	.1		
99	Upper Fountain	Lovers Lane	.1		
100	Upper Fountain	Laffayette Rd	.1		
101	Upper Fountain	SW Lovers Lane	.1		
102	Upper Fountain	Parking Lot	.04		
103	Upper Fountain	El Paso Blvd	.1		
104	Upper Fountain	Old Man Trail	.1		
105	Upper Fountain	Entrance to Blue Skies Inn	.2		
106	Upper Fountain	Mayfield Ave	.1		
107	Upper Fountain	Old Bridge off Manitou 1	.1		
108	Upper Fountain	Old Bridge off Manitou 2	.1		
109	Upper Fountain	Entrance to Willow Motel	.1		
110	Upper Fountain	Entrance to Pikes Peak RV Park	.1		
111	Upper Fountain	Manitou Springs Swimming Pool entrances	.1		
112	Upper Fountain	Pass St	.02		
113	Upper Fountain	Berkers Lane	.1		
114	Upper Fountain	Timber Lodge Dr	.1		
115	Upper Fountain	Tiberlane Lodge	.1		
116	Upper Fountain	Ridge Rd	.04		
117	Upper Fountain	31st St	.1		
118	Upper Fountain	Golden Lane Rd	.04		
119	Upper Fountain	26th St	.04		
120	Upper Fountain	21st St	.04		
121	Upper Fountain	Highway 24 (2)	.01		
122	Upper Fountain	8th St	.1		
123	Upper Fountain	Highway 24 (1)	.1		
124	Upper Fountain	I-25 ramp	.04		

Map Location	Tributary	Crossing Flooded	Annual Chance of Exceedance	Other Flooding	Notes
125	Upper Fountain	I-25 ramp	.1		
	Upper Fountain			Extensive Flooding Throughout Entire Reach	

Rank 34: Peaceful Valley Road Vicinity

Structures in floodplain adjacent to golf course. More information required to determine if meets Corps criteria. Flood risk reduction in this area could be addressed by flood-proofing or non-structural solutions.

Rank 43: Old Pueblo Road Corridor

Has a high potential for future problems due to changing hydrology. Rural area. The size of the affected area is not conducive to participation in Corps programs, but the area is a prime candidate for flood-proofing or non-structural solutions.

Rank 44: Upper Monument Creek

There are sporadic areas of residential structures encroaching on the flood plain in Upper Monument Creek. The size of the affected area is not conducive to participation in Corps programs, but the area is a prime candidate for flood-proofing or non-structural solutions.

5.3 POTENTIAL ECOSYSTEM RESTORATION FEATURES FOR PROJECTS WITHIN THE FOUNTAIN CREEK WATERSHED

Rank 16: Highway 47 Vicinity

This site is a prime area for wetland creation. The high water table has already resulted in establishment of a wetland ecosystem, but with a great deal of invasive/exotic species. There is also potential use for detention of stormwater flows via inclusion of a weir on the downstream end. Excellent recreational opportunities exist at this site.

Rank 20: Monument Branch

Many objectives could be achieved through a project on this segment. There is space to work just north of Oracle building. Site has connection to AFA with a good potential for wildlife crossing. There are multiple opportunities to address flooding, retention, restoration, and wildlife migration. This area is also a large sediment sources.

Rank 21: Kettle Creek

If Trust for Public Lands is involved, they could be potential sponsor. Riparian corridor vegetation establishment and/or maintenance could be beneficial to many species. Connect the La Foret Potential Conservation Area to AFA through the open stretch. Trust for Public Lands may be working on this. Unique combination of highest point in Black Forest. Much of this area is owned by a Church group and is not highly developed. Any project at this location should be managed for invasive species. Local technical expertise can be used.

Rank 22: LFC-1 (Fountain Creek Mainstem in northern Pueblo County)

This is a very small area, with limited opportunities for restoration. Approximately 11 acres of potential project area, fragmented from other wetlands or legitimate riparian corridor. Restoration at this site should have a lower priority than others listed.

Rank 23: CSC-1 (Fountain Creek Mainstem below Sand Creek Confluence)

Large area (approximately 377 acres) project opportunity but proximity to highways is dampening. Site lacks connectivity, and is close to several highways just south of the new wastewater emergency catching facility. A large gravel pit east of the channel could be used as a wetland restoration area. There is floodplain restoration potential on the west side of the channel, and an opportunity to restore the channel on east side. Native plantings would be a part of the restoration project. The restoration area could extend considerably further south.

Rank 24: MC-2 (Monument Creek Mainstem between Cottonwood Creek and Fountain Creek)

Many restoration opportunities available at this site, and linkage to City trail system is a positive. High visibility. Approximately 178 ac. Monument Creek at Garden of Gods Rd. erosion damage, 10 ft. cut bank. Restoration could include bank stabilization, native riparian plantings, re-connection of floodplain. Part of City trail connection. Urban setting.

Rank 35: Jackson Creek

Not a large-scale opportunity for a restoration project here. Needs the head cut stopped. A portion is mitigation for CDOT. Area is potential Preble’s meadow jumping mouse habitat. Some open space on east side. Lower priority.

Rank 36: Highway 24 Corridor

Other agencies are already progressing on this project site. Highway proximity is a dampening effect due to wildlife-automobile concerns. CDOT and City are already involved. Plan drawings at some stage of completion. Five miles x 300 ft. buffer around highway corridor. Could be sink habitat because of proximity to Highway 24, could be traffic safety issue, possible wildlife-vehicle collisions.

Rank 45: Beaver Creek

Development planning may be too far along to intervene at this point. Protection needed. Development will occur on either side of channel. Site located just north of AFA.

Rank 46: MC-1 (Kettle Creek tributary)

This is a relatively small, isolated area (approximately 58 acres), with few opportunities for restoration other than some vegetation maintenance. Tributary to Kettle Creek that experiences intermittent flow. Large population of Canada thistle at this site should be controlled.

5.4 POTENTIAL CHANNEL STABILITY FEATURES FOR PROJECTS WITHIN THE FOUNTAIN CREEK WATERSHED

5.4.1 Stability General Recommendations

Many areas in the Fountain Creek Watershed are negatively impacted by erosion and sedimentation. Several of these areas were identified as potential project locations and are listed in Table 3-3. Those projects addressing channel stability were further categorized by the primary common issues and goals in those areas and put into 4 groups: Excess sediment supply to downstream reaches, areas with changed hydrology, areas with unchanged hydrology, and areas where infrastructure is threatened by erosion.

These projects generally do not identify specific locations. Even those that are categorized as threatening infrastructure do not identify those structures that are threatened. Rather, these project locations include longer reaches of stream. This was done purposefully, with the intent of looking at stability issues in a larger context. Rather than focusing just on local areas of erosion, upstream and downstream factors, as well as changing conditions need to be assessed.

Fountain Creek and several of its tributaries are not in an equilibrium state. Much of this instability can be better understood in the context of the Channel Evolution Model (Schumm, Harvey & Watson 1984). This conceptual model illustrates the evolution of a channel primarily as it responds to the changes of its bed and bank geometries (Figure 5-8). Before remedial action is taken to stabilize any of these project locations, a thorough understanding of where the stream reach is with respect to the Channel Evolution Model is useful. These stability project categories generally fall within the Channel Evolution Model as follows:

Areas with *Unchanged Hydrology* generally fall into Phase I of the Channel Evolution Model (CEM). These stream reaches are generally in a relatively stable state, with respect to their bed/bank elevation relationships. However, projected development within these watersheds may threaten the stability of these streams. The General Recommendations (Section 3.2.1) should be followed in order to reduce the effects of urbanization on the hydrologic regime of these streams, and the associated channel response.

Streams with *Changed Hydrology* generally fall into Phase II of the CEM. These stream reaches have already begun to show the effects of upstream urbanization, with bed incision occurring at an accelerated rated (though not yet having reached the threshold where critical bank height (h_c) has been exceeded). The vertical stability of these reaches should be addressed and grade control should be established before extensive degradation occurs.

Stream reaches that are categorized as *Excess Sediment Supply* share the common mitigation approach of limiting sediment sources, and generally fall within Phase III or Phase IV of the CEM, with associated bed aggradation. These stream reaches may be increasingly difficult to address due to the less-predictable nature of the channel response to instability. Localized bank protection and grade control measures may have a high likelihood of failure in these reaches. Large scale projects encompassing long reaches of stream and addressing more systematic (as opposed to localized) approaches are more likely to be successful.

Streams reaches that are categorized as areas where *Infrastructure is Threatened* typically fall into Phase III and Phase IV of the CEM as well. However, these reaches generally have numerous locations where infrastructure is currently threatened, or may soon be threatened.

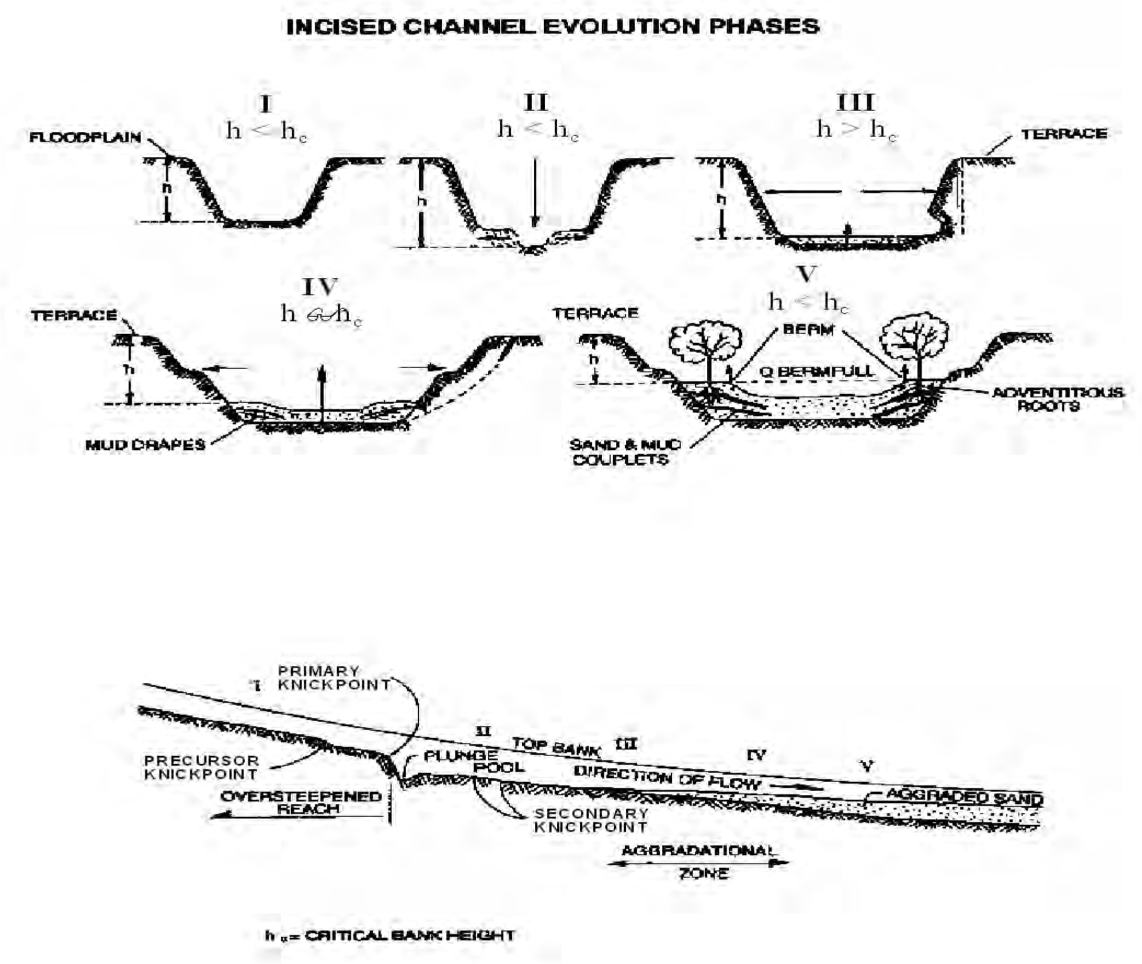


Figure 5-8. Different phases of the Channel Evolution Model (Schumm, Harvey & Watson 1984).

A list of Stream Stabilization and Restoration Guidance Documents has been included in the references. This listing is provided for educational purposes and does not constitute an endorsement of any specific technique or practice for any specific location. The practices of stream stabilization and restoration are highly complex and should only be undertaken under the guidance of experienced licensed professionals. As always, early coordination with agencies having permitting jurisdiction is highly advisable.

5.4.2 Stability Projects to Limit Sediments Sources

Rank 25: Sand Creek

This tributary is one of the largest contributors of sediment to the watershed. Channel is generally aggrading, but with lateral migration, possibly indicating upland sediment sources. City is already working on this reach.

Rank 26: Cottonwood Creek

Limiting lateral migration through bank stabilization and grade control in the lower reach would substantially decrease the sediment load of one of the largest contributors to the watershed. Numerous drop structures are already in place. Upper reach may have potential for channel and floodplain improvements through restoration. Major channel degradation indicates channel bed/bank sources in lower reach. City is already working on this reach.

Rank 27: Fountain Creek - Mainstem below Colorado Springs

Lateral migration and channel degradation from the mainstream. Fountain is one of the largest contributors of sediment to the watershed. Even if a holistic approach is not taken, local bank stabilization in key sites along the whole reach could decrease sediment load substantially.

Rank 28: Eastern Tribs

Stabilizing the mainstem of Monument Creek in this area would minimize head cuts moving up the Eastern Tributaries. Decreasing runoff from upper watersheds would also be necessary. There is a potential for damage working down to USAFA property from these tributaries.

5.4.3 Stability Projects to Protect Infrastructure

Rank 29: Sand Creek

Roads, bridges, railroads, sewer lines, electrical utilities, and wastewater treatment plants are all threatened in these stream reaches. City is already working on this reach. Infrastructure threatened by lateral migration or downcutting.

Rank 30: Cottonwood Creek

Roads, bridges, railroads, sewer lines, electrical utilities, and wastewater treatment plants are all threatened in these stream reaches. City is already working on this reach. Infrastructure threatened by lateral migration or down cutting.

Rank 31: Fountain Creek - Monument Creek Confluence to Sand Creek Confluence

Roads, bridges, railroads, sewer lines, electrical utilities, and wastewater treatment plants are all threatened in these stream reaches. City is already working on this reach. Infrastructure threatened by lateral migration or downcutting.

Rank 37: Pine Creek

Roads, bridges, railroads, sewer lines, electrical utilities, and wastewater treatment plants are all threatened in these stream reaches. Infrastructure threatened by lateral migration or downcutting.

Rank 38: Monument Creek

Roads, bridges, railroads, sewer lines, electrical utilities, and wastewater treatment plants are all threatened in these stream reaches. Existing streambank protection and grade controls failing within this reach.

5.4.4 Stability Projects for Streams with Changed Hydrology

Rank 9: Monument Branch

All of these stream reaches were recently developed or are in development. Current changes in hydrology have already resulted in negative impacts on the streams via down cutting. A top priority site for stabilizing stream before it degrades.

Rank 10: Upper Cottonwood Creek- Above Rangewood

All of these stream reaches were recently developed or are in development. Current changes in hydrology have already resulted in negative impacts on the streams via downcutting. A top priority site for stabilizing stream before it degrades.

Rank 18: Jackson Creek

All of these stream reaches were recently developed or are in development. Current changes in hydrology have already resulted in negative impacts on the streams via downcutting. Possibility to save this creek from current headcut that has not moved up the system. Has room to do channel/floodplain improvements.

Rank 32: Black Squirrel Creek

All of these stream reaches were recently developed or are in development. Current changes in hydrology have already resulted in negative impacts on the streams via downcutting. Reach is in a changing state, and should be protected before further degradation occurs.

Rank 39: Teachout Creek

All of these stream reaches were recently developed or are in development. Current changes in hydrology have already resulted in negative impacts on the streams via downcutting. Reach is in a changing state, and should be protected before further degradation occurs.

Rank 40: Elkhorn Creek

All of these stream reaches were recently developed or are in development. Current changes in hydrology have already resulted in negative impacts on the streams via downcutting. Reach is in a changing state, and should be protected before further degradation occurs.

Rank 41: Upper Fountain Creek

Reach downstream of Woodland Park has potential hazards due to aggradation. Continued upstream development could increase instability. Aggrading reaches could pose flooding problems in the vicinity of bridges. Degrading reaches causing lateral migration and downcutting. Some lateral migration into major sediment sources.

5.4.5 Stability Projects for Streams with Unchanged Hydrology

Rank 11: East Fork Sand Creek - Above Constitution

Has a high potential for future problems due to changing hydrology. Opportunity exists to protect this reach before it degrades due to development via preserving areas for open space.

Rank 33: Jimmy Camp Creek

Has a high potential for future problems due to changing hydrology. Opportunity exists to protect this reach before it degrades due to development via preserving areas for open space.

Rank 42: Beaver Creek

Has a high potential for future problems due to changing hydrology. Opportunity exists to protect this reach before it degrades due to development via preserving areas for open space.

6.1 IMPLEMENTATION PROGRAM/AUTHORITY MATRIX

A list of existing programs and authorities available through a number of federal and state agencies was compiled to assist sponsors and stakeholders in identifying potential avenues to assist with project implementation. Table 3-1, Implementation Program/Authority Matrix, lists the pertinent agencies, programs, and authorities. Although no suitable matches were found with any other agency or program outside the Corps for the potential projects identified in the watershed study these programs could still prove useful in the future.

Table 6-1
Implementation Program/Authority Matrix

Agency/Program	Type of Program	Qualifications	Cost Share/Grant	POC	Notes
U.S. Army Corps of Engineers (USACE)					
General Investigations	Flood Damage Reduction	Local and state agencies with taxing authority	65% Federal/ 35% non-Federal	Deb Foley, Albuquerque District (505) 342-3428	Examines structural and nonstructural measures to reduce recurring flood damages.
General Investigations	Environmental Restoration	Local and state agencies with taxing authority	65% Federal/ 35% non-Federal	Deb Foley, Albuquerque District (505) 342-3428	Improves the riparian ecosystem degraded by channel instability, channel straightening, encroachment, and invasive species.
Continuing Authorities Program Section 205	Flood Damage Reduction	Local and state agencies with taxing authority	65% Federal/ 35% non-Federal. Maximum Federal cost $7,000,000.	Deb Foley, Albuquerque District (505) 342-3428	Provides for local protection from flooding by the construction or improvement of flood control works.
Continuing Authorities Program Section 206	Aquatic Ecosystem Restoration	Local and state agencies with taxing authority	65% Federal/ 35% non-Federal. Maximum Federal cost $5,000,000.	Deb Foley, Albuquerque District (505) 342-3428	Restores degraded aquatic ecosystem structure, function, and dynamic processes to a less degraded, more natural condition.
Continuing Authorities Program Section 14	Emergency Streambank Erosion Protection	Local and state agencies with taxing authority	65% Federal/ 35% non-Federal. Maximum Federal cost $1,500,000	Deb Foley, Albuquerque District (505) 342-3428	Prevents erosion damage to public facilities by the emergency construction or repair of streambank protection works.
Natural Resources Conservation Service (NRCS)					
Wetlands Reserve Program (WRP)	Restore wetlands to establish wildlife habitat. Perpetual and 30-year easements and restoration only agreements.	Most private wetlands converted to agricultural use prior to 1985 are eligible. Wetlands must be restorable and suitable for wildlife benefits.	Up to 100% Federal for perpetual easements; 75% for 30-yr easements & restoration only agreements.	John Knapp - NRCS Area Conservationist - La Junta 719-384-5408 Greg Langer - NRCS Colorado Springs - 719-632-9598 Rich Rhoades - NRCS Pueblo - 719-543-3914	Develop and follow a plan for the restoration and maintenance of the wetland. If necessary, assist with the cost of restoration.
Grassland Reserve Program (GRP)	Manage grasslands to improve forage quality, control invasive species, and conserve fish and wildlife habitat. Perpetual and 30 year easements, restoration agreements and 10-, 15, 20-, and 30-year rental agreements.	Private grassland, shrubland, and land containing forbs or land that historically contained those features is eligible.	Easement and rental rate terms vary by length of agreements. Restoration cost share of 75-90%.	John Knapp - NRCS Area Conservationist - La Junta 719-384-5408 Greg Langer - NRCS Colorado Springs - 719-632-9598 Rich Rhoades - NRCS Pueblo - 719-543-3914	Develop and comply with a plan for the easement or restoration agreement; assist with the remaining installation costs. GRP authorization ends 30 Sep 2007.
Wildlife Habitat Incentives Program (WHIP)	Stabilize streams; establish wildlife habitat	All private land is eligible, unless it is currently enrolled in CRP, WRP, or a similar program	Up to 75% Federal – $450,000 from EQIP/WHIP/CSP for the life of the Farm Bill	John Knapp - NRCS Area Conservationist - La Junta 719-384-5408 Greg Langer - NRCS Colorado Springs - 719-632-9598 Rich Rhoades - NRCS Pueblo - 719-543-3914	Prepare and follow a wildlife habitat development plan; assist with installation costs. Focus on habitats of key wildlife species of concern.

Table 6-1
Implementation Program/Authority Matrix

Agency/Program	Type of Program	Qualifications	Cost Share/Grant	POC	Notes
Environmental Quality Incentives Program (EQIP)	Improve soil and water resources; stabilize streams; curb water erosion	All private land in agricultural production is eligible; includes cropland, grassland, pastureland, and non-industrial private forestland.	Typically 50% Federal – $450,000 from EQIP/WHIP/CSP for the life of the Farm Bill	John Knapp - NRCS Area Conservationist - La Junta 719-384-5408 Greg Langer - NRCS Colorado Springs - 719-632-9598 Rich Rhoades - NRCS Pueblo - 719-543-3914	Develop and follow an EQIP plan that describes the conservation and environmental purposes to be achieved; assist with installation costs. Focus on national, state and watershed conservation priorities.
Farm and Ranch Land Protection Program	Perpetual easement program administered in cooperation with qualified land trusts and local units of government to protect working agricultural lands.	Prime farm and ranchlands.	NRCS funds typically match with land trust or local funding, sometimes with Great Outdoors Colorado funds as well.	Gary Finstadd - Easements Prog. Coord., NRCS Lakewood - 720-544-2820 John Knapp - NRCS Area Conservationist - La Junta 719-384-5408 Greg Langer - NRCS Colorado Springs - 719-632-9598 Rich Rhoades - NRCS Pueblo - 719-543-3914	
U.S. Environmental Protection Agency (EPA)					
Targeted Watershed Implementation Grant	Implementation of on-the-ground restoration and protection activities designed to achieve quick, measurable environmental results, based on a technically sound watershed plan.	State, local, and interstate gov't entities, or nonprofit organizations. Project must be nominated by Governor. Nomination process managed by Colorado Department of Public Health & Environment.	25% min non-federal match required.	http://www.epa.gov/owow/watershed/initiative/	Designed to implement 3-5 year major protection or restoration projects.
Wetlands Program Development Grant	projects to develop and refine comprehensive wetland programs	States, Tribes, local government agencies are eligible for the Regional competition. A separate national competition for nonprofits is managed by EPA HQ.	25% min non-federal match required.	http://www.epa.gov/owow/wetlands/grantguidelines/	Annual competition. Not for implementation projects.
Five Star Restoration Grant	Community-based, multi-partner projects that restore wetland, riparian, and coastal habitat.	Government entities and nonprofit organizations	No minimum match listed, but multiple partners are expected to contribute funding or in-kind services.	http://www.epa.gov/owow/wetlands/restore/5star/	Small grants ($5,000-$20,000).
Water Quality Cooperative Agreements	Research, investigations, experiments, training, environmental technology demonstrations, surveys, and studies related to the causes, effects, extent, and prevention of pollution	State, local, and interstate government entities, or nonprofit organizations	Match requirement varies	http://www.epa.gov/owm/cwfinance/waterquality.htm	Clean Water Act 104(b) (3) competed projects. Has not been available in recent years, but may be in the future.
Nonpoint Source Program	Address water quality impacts from non-permitted, diffuse sources.	Federal funding provided to states. States select and manage individual projects	40% minimum match required	EPA Region 8 contact for Colorado: Marcella Hutchinson (303) 312-6753 http://www.epa.gov/owow/nps/	Colorado request for proposals typically in September.
Regional Geographic Initiative	Watershed and air quality projects focused on priority geographic areas.	State, local, and interstate gov't entities, or nonprofit organizations	Optional	http://epa.gov/region8/community_resources/grants/index.html	Included in annual Regional Priority Grant Program request for proposals. Specific criteria vary annually.

Table 6-1
Implementation Program/Authority Matrix

Agency/Program	Type of Program	Qualifications	Cost Share/Grant	POC	Notes
Regional Priority Grant Program	Multi-program/funding opportunity request for proposals. Includes Regional Geographic Initiative and Total Maximum Daily Load Program opportunities related to water quality. Other programs of interest may be included.	Varies by specific assistance agreement program. Typically, state, local, and tribal governments, and nonprofit organizations are eligible.	Varies by program.	http://epa.gov/region8/community_resources/grants/index.html	Annual competition. Request for proposals usually posted in October. Proposals may be submitted under more than one grant program, but individual proposal must be submitted for each. Criteria and requirements vary by program.
Clean Water State Revolving Loan Program	Capitalizes state loan fund for water pollution control projects.	Federal funding goes to state. See state program for project selection criteria.		http://www.epa.gov/owm/cwfinance/cwsrf/index.htm	Loan program.
Brownfields	Assessment or clean up for redevelopment of contaminated sites (or sites suspected of contamination.) Assessment, Revolving Loan Fund, and Clean-up Grants are available from EPA.	Varies by type of assistance. In general, state, tribal, and local governments and their subdivisions are eligible. Nonprofit organizations are eligible for clean up grants.	Varies by specific type of assistance agreement. Often 20%.	http://www.epa.gov/swerosps/bf/mmatters.htm	Other assistance is available from Housing and Urban Development. http://www.hud.gov/offices/cpd/economicdevelopment/programs/bedi/index.cfm
Environmental Education grants	Projects and programs that enhance knowledge and skills needed to make informed decisions about environmental quality	Local, state, and Tribal schools; local and state environmental agencies, colleges and universities; nonprofit organizations, and noncommercial broadcasting agencies	25% min non-federal match required.	http://www.epa.gov/region8/ee/grants.html	Small grants (typically less than $15,000.)
Environmental Justice Grant Programs	Build the capacity of community-based organizations to address environmental and/or public health issues at the local level	Nonprofit organizations. See guidelines for specific exclusions.	Varies by program.	http://www.epa.gov/Compliance/environmentaljustice/grants/index.html	Focus on collaboration and disadvantaged communities.
Community Action for a Renewed Environment (CARE)	Multi-media competitive grant program that offers an innovative way for a community to organize and take action to reduce toxic pollution in its local environment	Local, Public non-profit institution/organizations, Federally Recognized Indian Tribal Government, Native American Organizations, Private nonprofit institution/organization, Quasi-public nonprofit institution/organization both interstate and intrastate, local government, colleges, and universities	Match optional. Ability to leverage other funds/resources may be a ranking criterion.	http://www.epa.gov/CARE/index.htm	Cannot fund projects that duplicate Targeted Watershed Grant Program activities.
Colorado Water Conservation Board (CWCB)					
CWCB Construction Loan Program	Low interest loans for flood-related projects	Applicant must complete feasibility study and demonstrate financial capability to repay loan	90% loans are available	Kirk Russell, CWCB Water Supply Planning & Finance Section.	Policy information for various CWCB grant/loan programs can be found at this website. http://cwcb.state.co.us/Finance/policiesOnly.htm

Table 6-1
Implementation Program/Authority Matrix

Agency/Program	Type of Program	Qualifications	Cost Share/Grant	POC	Notes
CWCB Watershed Restoration Program	Small grant funds for stream and watershed restoration	Applicant must compete with other entities; limited funds available	Varies, but typically 50% if federal partners involved	Tom Browning, CWCB Flood Protection Section	Annually funded at the discretion of the Board and staff. Must be a statewide priority and target multi-objective goals
CWCB Floodplain Technical Services Program	Small grant funds for technical services; typically hydrology & hydraulic studies in support of floodplain maps or projects	Applicant must compete with other entities; limited funds available	Varies, but typically 50% if federal partners involved	Kevin Houck, CWCB Flood Protection Section	Annually funded at the discretion of the Board and staff. Must be a statewide priority.
Colorado Watershed Protection Fund	Implementation of on-the-ground projects to restore and protect the lands and natural resources within Colorado watersheds. Two categories of grants: Planning Grants and Project Grants.	Applicant must compete with other entities; limited funds available	Minimum 20% cash or in-kind match required.	http://www.cowaterfund.org/ http://www.cowaterfund.org/grantapplication/ http://www.coloradowater.org/fund/grant-application.htm	Funded by income tax checkoff. http://www.coloradowater.org/fund/grant-application.htm
Fish and Wildlife Resources Fund	Grants to appropriate new or existing water rights to preserve or improve the natural environment to mitigate the impact of an existing water facility. Funded activities include conducting river restoration feasibility studies; constructing river restoration projects to mitigate or improve environmental impacts of existing water facilities; and any combination of river restoration and water right acquisition or appropriation.	Operators of existing water diversion, delivery, or existing storage facility projects; CWCB. Groups that do not fit this description (e.g., municipalities, watershed groups, and others should contact CWCB staff to explore opportunities for joint application with CWCB.	Applicants can request up to a maximum of 25% of the total project cost, with the total request not to exceed $250,000.	Tom Browning, CWCB Flood Protection Section http://cwcb.state.co.us/Flood/riverrestoration.htm.	Policy information for various CWCB grant/loan programs can be found at this website. http://cwcb.state.co.us/Finance/policiesOnly.htm
Water Supply Reserve Account	Grants or low-interest loans to address Colorado's future water needs with an emphasis on water efficiency (agricultural and municipal and industrial); alternative agricultural transfers to permanent dry-up; prioritizing and quantifying recreation and environment needs; and addressing the 20% M&I gap, agricultural shortages, and environmental and recreational needs.	All--Government entities; public water districts; private corporations and citizens; and nonprofit organizations. Eligible water activities include competitive grants for environmental compliance and feasibility studies; technical assistance regarding permitting, feasibility studies, and environmental compliance; studies or analysis of structural, nonstructural, consumptive, and nonconsumptive water needs, projects, or activities; and structural and nonstructural water projects or activities.	Grants and low-interest loans. The Basin Roundtable approves water activities that are to be recommended to CWCB for funding. The approving Basin Roundtable shall be the roundtable for the basin in which the proposed water diversion or nonstructural activity would occur.	Rick Brown, CWCB Interstate Water Management and Development Section. http://cwcb.state.co.us/IWMD/grantsLoansIndex.htm	Monies from the Statewide Account will be allocated in March and September of each year. Monies from the Basin Accounts will be allocated at the CWCB's bimonthly Board meetings.

Table 6-1
Implementation Program/Authority Matrix

Agency/Program	Type of Program	Qualifications	Cost Share/Grant	POC	Notes
Colorado Department of Public Health and Environment (CDPHE)					
Non-point Source (NPS) Grant Program	Reduction/control of non-point sources (NPS) (diffuse) of water pollution	Governmental and quasi-governmental (COGs) entities and registered non-profits i.e. watershed groups, etc.	60% federal, 40% non-federal	Lucia Machado, WQCD Restoration & Protection Unit (303) 692-3585 http://www.cdphe.state.co.us/wq/nps/index.html	Annually funded through U.S. EPA to states. CO receives @ $2M each year as 60% federal share. Priority given to project that will address impaired waters, those not meeting water quality standards.
Source Water Assessment & Protection Program	Development of protection plans for public drinking water systems	Public water systems (PWSs), watershed groups working with PWSs	Dollar for dollar match.	John Duggan, WQCD Restoration & Protection Unit (303) 692-3534	Two types of grants are available for source water protection planning, D&I (development and implementation) at @$5,000 each, and Pilot Project at @ $50,000 for larger, replicable approaches.
Water Pollution Control Revolving Funds (WPCRF) and Drinking Water Revolving Fund (DWRF)	Low interest loans to correct water quality problems or for drinking water system projects	Governmental entities	Varies and reloan funds	Donna Davis, WQCD Outreach and Project Assistance Unit, (303) 692-3562	Disadvantaged Community Program offers loans to eligible communities at reduced rates
WPCRF Planning Grants, DWRF Planning Grants	Grants to develop plans for wastewater or drinking water facilities	Governmental entities	$100,000 available for each program - wastewater and drinking water annually.	Donna Davis, WQCD Outreach and Project Assistance Unit, (303) 692-3562	Must be considering a project on the eligibility list.
Domestic Wastewater & Drinking Water Grant programs	Assistance for design, planning and construction of projects	Governmental entities for wastewater, governmental entities and non-profits for Drinking Water	State legislature allocates a fixed amount as resources allow.	Donna Davis, WQCD Outreach and Project Assistance Unit, (303) 692-3562	Small communities <5,000 population for water and wastewater grants.
Voluntary Clean Up Program (VCUP)	State program that allows owners of contaminated properties to voluntarily propose cleanup actions or petition for no further action determinations for eligible sites.	Land owners	Varies	Mark Walker, HMWMD (Hazardous materials Waste Management Division) (303) 692-3449	State version of Brownfields.
Supplemental Environmental Project (SEP)	Opportunity to direct penalty assessed to regulated entity to other uses.	Entity regulated by a CDPHE Environmental Division	Varies with the penalty assessed.		Violator must agree to the SEP grant as an alternative to paying the penalty and has input into who receives it.
Colorado Water Resources and Power Development Authority (CWRPDA)					
Drinking Water Revolving Fund	Loan program to address drinking water infrastructure needs.			http://www.cwrpda.com/Programs.htm	
Water Pollution Control Revolving Fund	Loan program to address waste water treatment plant and nonpoint source abatement.			http://www.cwrpda.com/Programs.htm	

Table 6-1
Implementation Program/Authority Matrix

Agency/Program	Type of Program	Qualifications	Cost Share/Grant	POC	Notes
Colorado Division of Wildlife (CDOW)					
Land Acquisition / Habitat Protection by Easement	Land and water acquisition for wildlife habitat protection, recreational access	Any	Variable	Anne Kelson, Real Estate Unit Manager, 303-291-7457	
Water Right Protection and Development	Water acquisition and use for wildlife purposes	Any	Variable	Jay Skinner, Water Resources Unit Manager, 303-291-7260	
Rivers of Colorado Water Watch Network (RiverWatch)	Water quality monitoring and assessment	Volunteer organizations, watershed groups, schools	None, must sign contract for commitment	Barb Horn, Water Resource Specialist - Water Quality Monitoring and Assessment, 303-291-6667 OR Curtis Hartenstine, Colorado Watershed Network - RiverWatch Program Coordinator 303-291-7412	
Instream Flow Protection	Quantification of in situ water needs for environmental purposes	Any	None	Jeffrey Baessler, CWCB, 303-866-3906 OR Mark Uppendahl, CDOW, 303-291-7467	
Fishing is Fun Grant Program	Habitat improvement, access improvement/acquisition, facility improvements	Any	Variable, match required	Any CDOW Regional or Area Office, Aquatic Biologist	
Aware Colorado	Statewide program to educate local decision makers about the impacts of land use choices on water quality. Seeks to protect Colorado's water and natural resources from polluted runoff through innovative land use strategies.	N/A	N/A. Water and natural resource education. Group does not provide grants/funding.	Cynthia Peterson (303) 861-5195 http://www.awarecolorado.org/	League of Women Voters of Colorado Education Fund is leading the effort. The program is funded by the CDPHE through a grant from the EPA.

SUMMARY AND CONCLUSIONS

This watershed management plan ties together all the existing information produced as a part of the watershed study (hydrology, hydraulics, environmental baseline, and geomorphology), along with a description of the problems and opportunities present in the watershed, and establishes the objectives for improved management of the Fountain Creek watershed. These objectives are:

- Reduce flood risk in the Fountain Creek watershed;
- Reduce erosion in the Fountain Creek watershed;
- Reduce sedimentation in the Fountain Creek watershed; and
- Improve water management in urban and urbanizing areas in the Fountain Creek watershed.

A list of 17 general recommendations for improved management of the watershed was developed. These recommendations are not specific to any location within the watershed and are meant to address the root causes of the problems within the watershed. The recommendations focus on 4 areas: development, rehabilitation/preservation, modeling/project design, and administration.

To address site-specific problems a list of 46 potential projects was developed. These projects would reduce flooding, improve channel stability, or restore the riparian ecosystem. These potential projects were ranked and prioritized using criteria developed in conjunction with the sponsors. The top 13 ranked potential projects were analyzed in greater detail. Potential project features for the remaining projects were briefly discussed.

Recommendations for Corps spin-off projects include:

- A large-scale ecosystem restoration project through the Corps' General Investigations (GI) program on the mainstem of Fountain Creek from Colorado Springs to Pueblo, similar to the Fountain Creek Crown Jewel Project envisioned by Senator Salazar;
- A Section 216 Review of Completed Projects for the Pueblo Levees;
- A Section 205 flood risk reduction project on Fountain Creek from the Monument Creek confluence to the city limits in Colorado Springs;
- A potential Section 205 or GI program flood risk reduction project on Highway 24; and
- Two Section 14 emergency streambank restoration projects at the Highway 85/87 Bridge and Rainbow Bridge;

An implementation matrix listing different agencies and programs that could assist in funding or constructing projects was also developed.

During the course of this watershed study a second effort to address problems within the Fountain Creek watershed was started by the Fountain Creek Vision Task Force. Although their focus was somewhat different than this study, many of the ideas put forth in the general recommendations are mirrored in the recommendations of the Vision Task Force. Implementation of the recommendations from both efforts is of utmost importance to developing and maintaining a healthy watershed.

Water Quality References

Bruce, James F. 2002. Characterization and Analysis of Temporal and Spatial Variations in Habitat and Macroinvertebrate Community Structure, Fountain Creek Basin, Colorado Springs and Vicinity, Colorado, 1998-2001. USGS Water Resources Investigations Report 02-4093.

[2]Colorado Department of Public Health and Environment Water Quality Control Division. April 2004. 2004 Status of Water Quality in Colorado.

[3]Colorado Department of Public Health and Environment Water Quality Control Division. December, 2003. Compliance Order on Consent- Colorado Springs Utilities. No. MC-031211-1.

[4]Colorado Department of Public Health and Environment Water Quality Control Division. September 9, 2003. Colorado's Section 303(d) Listing Methodology.

Colorado Springs Gazette. April 29, 2007. "Fountain Creek Loses Bid for Big EPA Grant." http://findarticles.com/p/articles/mi_qn4191/is_20070429/ai_n19065921 (Accessed August 28, 2007).

Colorado State University – Pueblo (CSU-P). September 22, 2006. "Press Release: Colorado State University – Pueblo to commence water quality study." Colorado State University – Pueblo, Development and Communications Department. http://www.colostate-pueblo.edu/news/releases06/108.htm (Accessed August 28, 2007).

Markuson, Christopher. Phone conversation on January 20, 2005. Pueblo County GIS Center.

[3]Pikes Peak Area Councils of Governments (PPACG). 2003. Water Quality Management 208 Plan.

[4]Pikes Peak Area Councils of Governments (PPACG). August 2003. Fountain Creek Watershed Plan.

[5]Pikes Peak Area Councils of Governments (PPACG). 1999. Water Quality Management Plan for the Pikes Peak Region.

[2]URS, Muller Engineering, AMEC, WRA and ERO. August 2003. Cherry Creek Reservoir and Watershed Plan 2003.

USGS. 2006. "Development of a fecal contamination monitoring and control strategy in upper Fountain Creek, Colorado." USGS Colorado Water Science Center. http://co.water.usgs.gov/projects/8582CST00/index.html (Accessed August 28, 2007).

Wildlife and Habitats References

Andrews, R. and R. Righter. 1992. *Colorado Birds: A Reference to their Distribution and Habitat*. Denver Museum of Natural History, Denver, Colorado.

Colorado Division of Wildlife (CDOW). 1995. Percentage of Wildlife Habitats in Study Area

Colorado Natural Areas Program (CNAP). 2005. CNAP website accessed on-line at http://www.parks.state.co.us/default.asp?action=park&parkID=104 on January 28, 2005.

Colorado Natural Heritage Program (CNHP). 2004. Database Search for Fountain Creek Watershed Study conducted in November. Fort Collins, Colorado.

Cooley, C. 2005. Personal Communication between C. Cooley, Habitat Biologist with Colorado Division of Wildlife and Kim Sandoval, URS Corporation on January 19.

Colorado (CO) Partners in Flight. 2000. *Colorado Partners in Flight Bird Conservation Plan*. Version 1.0. January.

Fitzgerald, J. P., C. A. Meaney, and D. M. Armstrong. 1994. *Mammals of Colorado*. Denver Museum of Natural History and University Press of Colorado. Niwot, Colorado.

Holt, H. 1997. A Birder's Guide to Colorado. American Birding Association, Inc. Colorado Springs, Colorado.

Kingery, H. 1998. Colorado Breeding Bird Atlas. Edited by Hugh Kingery. Colorado Bird Atlas Partnership and Colorado Division of Wildlife, Denver, Colorado.

Olson, S. 2004. Personal Communication between Steve Olson, Botanist, Pike and San Isabel National Forests and Kim Sandoval, URS Corporation via e-mail on November 18.

Pals, K. 2005. Personal Communication between Ken Pals, Fountain Creek Regional Park and Kim Sandoval, URS Corporation on January 13, 2005.

Schnurr, P. 2005. Personal Communication between Pam Schnurr, Colorado Division of Wildlife River Otter Specialist and Kim Sandoval, URS Corporation on August 30, 2005.

Taylor Young, M. 2000. Colorado Wildlife Viewing Guide. Second Edition. Falcon Publishing, Inc. Helena, Montana.

URS. 2005. Fountain Creek Watershed Study Migratory Corridors Report.

Watershed References

Armstrong, J. and J. Stevens. 2002. *Monument Creek Watershed Landscape Assessment.* Colorado Natural Heritage Program. Colorado State University. Prepared for United States Air Force Academy. CNHP, CSU, Fort Collins, CO. January 31.

Berthold, P. 1996. *Control of Bird Migration.* Chapman and Hall, London, UK

Colorado Natural Heritage Program (CNHP). 2004. Database Search for Fountain Creek Watershed Study conducted in November. Fort Collins, Colorado.

Colorado (CO) Partners in Flight. 2000. *Colorado Partners in Flight Bird Conservation Plan*. Version 1.0. January.

Great Pikes Peak Birding Trail. 2005. Promoting the Recreation of Colorado's Birds. Accessed on-line at http://www.gppbt.org/.

Holt, H. 1997. *A Birder's Guide to Colorado*. American Birding Association, Inc. Colorado Springs, Colorado.

Lincoln, Frederick C., Steven R. Peterson, and John L. Zimmerman. 1998. Migration of birds. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C.

Circular 16. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. Access on line at http://www.npwrc.usgs.gov/resource/othrdata/migratio/migratio.htm. (Version 02APR2002).

Pals, K. 2005. Personal Communication between Ken Pals, Fountain Creek Regional Park and Kim Sandoval, URS Corporation on January 13, 2005.

URS. 2005. *Fountain Creek Watershed Study Migratory Corridors Report.*

Species References:

Andrews, R. and R. Righter. 1992. *Colorado Birds: A Reference to their Distribution and Habitat*. Denver Museum of Natural History, Denver, Colorado.

Brown, D. F. M. 1964. A Monographic Study of the Fern Genus Woodsia. Nova Hedwigia 16: 1-154.

Coffin, B. and L. Pfannmuller, eds. 1988. Minnesota's Endangered Flora and Fauna. University of Minnesota Press, Minneapolis, Minnesota. 473 pp.

Colorado Natural Heritage Program (CNHP). 1999. Conservation and Management Plan for the Preble's meadow jumping mouse on the U.S. Air Force Academy. Produced under contract with the U.S. Air Force Academy.

Colorado Natural Heritage Program (CNHP). 2004. Database Search for Fountain Creek Watershed Study conducted in November. Fort Collins, Colorado.

Ehrlich, P., D. Dobkin, and D. Wheye. 1988. The Birder's Handbook: A Field Guide to the Natural History of North American Birds. New York, Simon & Schuster, Inc.

Ferris, C.D. and F.M. Brown. 1981. Butterflies of the Rocky Mountain States. University of Oklahoma Press, Norman. 442 pages

Fitzgerald, J.P., C.A. Meaney, and D.M. Armstrong. 1994. *Mammals of Colorado*. University Press of Colorado, Niwot, Colorado.

Heidel, B. 1998. *Conservation Status of Spiranthes diluvialis Sheviak in Montana.* Montana Natural Heritage Program. Ute Ladies'-Tresses (Spiranthes *diluvialis*) Recovery Plan is in preparation by the USFWS.

Huxley, A. 1992. The New RHS Dictionary of Gardening. MacMillan Press.

Kingery, H. 1998. Colorado Breeding Bird Atlas. Edited by Hugh Kingery. Colorado Bird Atlas Partnership and Colorado Division of Wildlife, Denver, Colorado.

Kippenhan, M.G. 1994. The Tiger Beetles (Coleoptera: Cicindelidae) of Colorado. Trans. American Entomologist. Soc. 120: 1-86.

Layberry, R.A., P.W. Hall, and D.J. Lafontaine. 1998. The Butterflies of Canada. University of Toronto Press.

Natural Diversity Information Source (NDIS). 2004. Database and online mapping for Colorado wildlife species. Accessed online at http://ndis.nrel.colostate.edu/.

Opler, P.A. 1999. A Field Guide to Western Butterflies. Houghton-Mifflin Co., Boston, Massachusetts. 540 pages, 44 color plates.

Pearson, D. L., T.G. Barraclough, and A.P. Vogler. 1997. Distributional maps for North American species of tiger beetles (Coleoptera: Cicindelidae). Cicindela 29(3-4): 33-84.

Rollins, R.C. and E.A. Shaw. 1973. The Genus Lesquerella (Cruciferae) in North America. Harvard University Press, Cambridge, Massachusetts.

Rollins, R.C. 1993. The Cruciferae of Continental North America. Stanford University Press, Stanford, California.

Sargeant, Alan B., Raymond J. Greenwood, Marsha A. Sovada, and Terry L. Shaffer. 1993. *Distribution and abundance of predators that affect duck production - Prairie Pothole Region*. U.S. Fish and Wildlife Service, Resource Publication 194. Jamestown, ND: Northern Prairie Wildlife Research Center Online. Accessed on-line at http://www.npwrc.usgs.gov/resource/distr/others/predator/predator.htm (Version 29MAR97).

Scott, J.A. 1986. *The Butterflies of North America.* Stanford University Press, Stanford, Calif. 583 pages, 64 color plates

Spackman, S., B. Jennings, J. Coles, C. Dawson, M. Minton, A. Kratz, and C. Spurrier. 1997. Colorado Rare Plant Field Guide. Prepared for the Bureau of Land Management, the U.S. Forest Service and the Fish and Wildlife Service3 by the Colorado Natural Heritage Program.

Stanford, R. E. and P.A. Opler. 1993. Atlas of Western USA Butterflies Including Adjacent Parts of Canada and Mexico. Denver and Fort Collins, Colorado.

U.S. Air Force Academy (USAFA). 1997. *Integrated Natural Resources Management Plan and Environmental Assessment for the U.S. Air Force Academy*. Department of Defense Legacy Resource Management Program. NPS D-315A. 95 pp.

United States Fish and Wildlife Service (USFWS). 2005. State and Federally Listed Threatened, Endangered, and Candidate Wildlife and Plants in the Fountain Creek Study Area.

Wagner, F.S. 1987. Evidence for the Origin of the Hybrid Cliff Fern, Woodsia ×abbeae (Aspleniaceae: Athyrioideae). Syst. Bot. 12: 116--124.

Fish Reference

Nesler, T.P. 1997. Native and introduced fish species by major river basins in Colorado. Nongame and Endangered Aquatic Wildlife Program. Colorado Division of Wildlife.

Wetland Riparian References

Cowardin, Lewis M., Virginia Carter, Francis C. Golet, and Edward T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. U.S. Department of the Interior, Fish and Wildlife Service, FWS/OBS-79/31.

Cooley, Casey. 2005. Personal Communication between Casey Cooley, Habitat Biologist with Colorado Division of Wildlife and Bryan Lucas, URS Corporation, on May 16.

Doyle, Georgia, Jim Gionfriddo, Dave Anderson, and Denise Culver. 2001. *Survey of Critical Wetlands and Riparian Areas in El Paso and Pueblo Counties, Colorado*. CNHP.

College of Natural Resources, Colorado State University. Prepared for the Colorado Department of Natural Resources. [Online] Available: http://www.cnhp.colostate.edu/documents/2001/CNHP_ElPaso_Pueblo_Wetland0827.pdf

NRCS. 2005. NRCS Colorado and the Wetlands Reserve Program. [Online] Available: http://www.co.nrcs.usda.gov/programs/wetland/wetland.htm

USFWS. 2005. National Wildlife Refuges in the Mountain-Prairie Region. [Online] Available: http://grandjunctionfishandwildlife.fws.gov/refuges/co/

Hydraulic, Engineering, and Stability References

Engineer Research and Development Center Manuals / Reports / Technical Notes.

The WES Stream Investigation and Streambank Stabilization Handbook, Oct-1997
ERDC/EL SR-W-00-1 *Stream Management*, Mar-2000
ERDC-CHL TR-00-15 *Effective Discharge Calculation - A Practical Guide*, Aug-2000
ERDC/CHL TR-01-28 *Hydraulic Design of Stream Restoration Projects*, Sep-2001
All downloadable through ERDC Digital Library searches at
http://134.164.46.19/uhtbin/cgisirsi/x/0/0/49/1?new_gateway_db=HYPERION
ERDC/CHL CHETN-VIII-4 *Effective Discharge Calculation*, Dec-2000
ERDC/CHL CHETN-VIII-5 *Channel Forming Discharge*, Dec-2000
Available at http://chl.erdc.usace.army.mil/CHL.aspx?p=s&a=ARTICLES;370
ERDC TN-EMRRP-SR-29 Stability Thresholds for Stream Restoration Materials, May-2001
Available at http://el.erdc.usace.army.mil/emrrp/tnotes.html (with numerous other Stream Restoration tech notes)

Forest Service – Stream Systems Technology Center.
http://www.stream.fs.fed.us

HQUSACE Publications
Available at http://www.usace.army.mil/inet/usace-docs

ER 1110-2-1405 *Hydraulic Design for Local Flood Protection Projects*, 30-Sep-1982
EM 1110-2-1204 *Environmental Engineering for Coastal Shore Protection*, 10-Jul-1989
EM 1110-2-1205 *Environmental Engineering for Local Flood Control Channels*, 15-Nov-1989
EM 1110-2-1418 *Channel Stability Assessment for Flood Control Projects*, 31-Oct-1994
EM 1110-2-1601 *Hydraulic Design of Flood Control Channels*, 30-Jun-1994
EM 1110-2-1612 *Ice Engineering*, 30-Oct-2002
EM 1110-2-4000 *Sedimentation of Rivers and Reservoirs*, 31-Oct-1995

Institute for Water Resources

Illustrations of Environmental Engineering Features for Planning, Dec-1998
http://www.iwr.usace.army.mil/iwr/pdf/98r08.pdf

McCullah, John. Environmentally Sensitive Streambank Stabilization
http://www.e-senss.com - Commercial version for purchase

http://trb.org/news/blurb_detail.asp?id=5617 - Freely downloadable public domain version. Contains design guidance, typical details, etc.

Other (Non-USACE) – General

Stream Corridor Restoration: Principles, processes, and practices, 1998
http://www.nrcs.usda.gov/technical/stream_restoration/
Comprehensive reference prepared by the Federal Interagency Stream Restoration Working Group

Rosgen, David. Guidance / Technical Papers. downloadable from Wildland Hydrology website
http://wildlandhydrology.com/html/references_.html

USDA NRCS National Water Management Center – Regional Hydraulic Geometry Curves
http://wmc.ar.nrcs.usda.gov/technical/HHSWR/Geomorphic/index.html

Appendix A

Public Involvement Presentation Materials December 2004

WHAT'S THE PROBLEM?

Watershed Problems

The primary driving factor that affects water quality and quantity in the Fountain Creek watershed is **growth and development**.

Growth and development can lead to:

- Increased water use,
- Increased waste water treatement plant (WWTP) discharge,
- Increased baseflow,
- Potential loss of natural cover and an increased impervious area
- Property damage and property loss,
- Water quality degradation, and
- Public hazards.

The three primary watershed processes that cause quality and quantity problems are:

- Erosion,
- Sedimentation, and
- Flooding.

1999 Flooding in Manitou Springs

Picture of the Upper Watershed

Failed Railroad Bridge, Sand Creek 2004

Incised Channel, Cottonwood Creek

Fountain Creek Grade Control

Cottonwood Creek Bank Erosion

Erosion Downststream of a Detention Pond in the Elkhorn Basin

Sediment Deposits, Upper Watershed

Bank Erosion in the Vicinity of Target Store in Pueblo

Storm flows 2004, Fountain Creek

WHAT'S THE PROBLEM? (Cont.)

Terrain
- Upper Watershed - Steep, Heavier Vegetative Cover
- Lower Watershed – Flatter, Less Vegetative Cover

Soils
- Very Sandy, Easily Eroded

Floodplains
- Upper Watershed – Narrower, Little Meandering
- Middle Watershed – Highly constrained
- Lower Watershed – Wider, More Meandering

Problems identified through Fountain Creek Watershed Plan
- Flooding
- Erosion
- Sedimentation

Additional Problems in the watershed
- Ecosystem Impacts

Areas of Interest
- Established in Fountain Creek Watershed Plan
- 34 Reaches in 4 Subwatersheds

Watershed Conditions
- Increased Population Leads to Increased Water Use
- Interbasin Transfers Increase Return Flows
- Increased Groundwater Use Increases Return Flows
- Shift in Land Use from Agricultural to Urban
- Impervious Surfaces Increase Runoff
- Wastewater Treatment Return Flows
- Agriculture Return Flows

Flooding
- Increased Impervious Surface
  - Increased Flow Rates & Volumes of More Frequent Storm Events
- Historical Development in Upper Watershed
  - Encroaching on Floodplain (Manitou Springs)
- Ongoing Development in Watershed
  - Within Historic Meander Belt

Erosion
- Increased base flows result in increased erosion
- Loss of public/private land
- Loss of infrastructure (utility lines, etc.)
- Erosion Changes Channel Alignment

Sedimentation
- Increased sedimentation reduces channel capacity
- Adversely impacts infrastructure
  - Drains blocked
  - Sewer treatment plant outfall blocked
- Sedimentation Changes Channel Alignment

Ecosystem Impacts
- Water quality issues
- Loss of aquatic habitat
- Alteration of riparian ecosystem function
- Invasive species encroachment
- Increased Base Flow Leads to Increased Vegetation

Fountain Creek WATERSHED STUDY

FACT SHEET

LOCATION
The Fountain Creek Watershed is the drainage basin that contains Fountain and Monument Creeks and its tributaries. The watershed encompasses areas of Colorado Springs, Pueblo, Fountain, Monument, Green Mountain Falls, Palmer Lake, Manitou Springs, and Woodland Park as well as portions of El Paso, Pueblo, and Teller Counties.

PROBLEM
The amount of water flowing in Fountain Creek and its tributaries as well as the quality of that water has been affected by growth and development. This has led to:

- Erosion and sedimentation;
- Flooding and increased water quantity;
- Reduced water quality; and
- Habitat and ecosystem degradation.

THIS STUDY
To begin to address these problems, the Fountain Creek Watershed Study was initiated. The purpose of the Study is to:

- Identify and assess the watershed's characteristics and current conditions;
- Analyze and understand specific problems and issues;
- Develop, evaluate, and prioritize conceptual alternatives that address the problems and issues;
- Establish a series of projects that can be implemented in a logical sequence to improve water quality and address the problems noted above.

Please note that the Fountain Creek Watershed Study is a regional effort that identifies potential projects at a conceptual level so that a comprehensive framework plan can be established. Watersheds and their environs are complex ecosystems, and careful, strategic planning helps address the problems without creating unintended consequences. Preliminary cost estimates will be established so that these projects can logically be "spun off" to the appropriate agency or program for design and implementation. The project implementation will be based on this study, but not a part of it.

PROJECT COMPONENTS

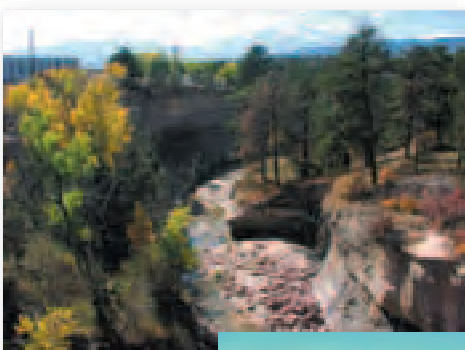
- The involvement and collaboration among the cities and counties (listed above) that share the watershed is critical to creating the framework to implement projects. Likewise, public involvement in shaping a workable plan is a key component to success.
- GIS mapping is a powerful tool that will be used to identify the location of flood hazards, channel stability or instability, buildings and infrastructure, wetlands, vegetation, soils, sediment deposits, and other elements critical to establishing a baseline.
- Computer modeling of the terrain as well as a comprehensive study of the hydrology, soils, and the watershed's ecological systems and man-made structures will give the project team a clear understanding of the forces at work along Fountain Creek and its tributaries.
- Preliminary cost estimates, based on the understanding of the above information, will help establish priorities and an implementation plan based in reality. Design and implementation are the next steps after the Fountain Creek Watershed Study is completed.

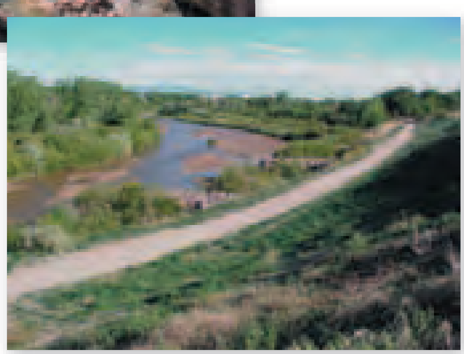
The key to this Study is to identify how to address the problems of the Fountain Creek Watershed with regional solutions, in a comprehensive manner, and with a logical implementation strategy.

YOUR ADVICE AND OPINIONS COUNT
Please be sure to discuss the issues with project participants and let us know what you think. There are comment cards for your convenience and for the record. The Fountain Creek Watershed communities need to work together to make progress and your participation is needed. A list of contacts is included on the back.

SPONSORS

Colorado Springs
El Paso County
Pueblo County
Pueblo
Teller County
Palmer Lake
Woodland Park
Monument
Fountain
Manitou Springs
Green Mountain Falls
Colorado Water Conservation Board
Colorado Department of Local Affairs





POINTS OF CONTACT

April Sanders - US Army Corps of Engineers
ph: 505-342-3443 email: april.f.sanders@usace.army.mil

Charles Wilson - US Army Corps of Engineers
ph: 505-342-3341 email: charles.m.wilson@usace.army.mil

Ken Sampley - City of Colorado Springs
ph: 719-385-5417 email: ksampley@springsgov.com

Kim Headley - Pueblo County
ph: 719-583-6100 fx: 719-583-6376
email: kheadley@co.pueblo.co.us

Dennis Maroney - City of Pueblo
ph: 719-543-2860 fx: 719-543-6244
email: dmaroney@pueblo.us

Rich Muzzy - Pikes Peak Area Council of Governments
ph: 719-471-7080 fx: 719-471-1226 email: rmuzzy@ppacg.org

André Brackin - El Paso County
ph: 719-520-6460 fx: 719-520-6878
email:andrebrackin@elpasoco.com

Kathy Verlo - City of Manitou Springs
ph:719-685-4205 fx: 719-685-5046 email: katve@qwest.net

Carol Baker - Colorado Springs Utilities
ph: 719-688-8699 fx: 719-520-6878 email: cbaker@csu.org

Bob Miner - Town of Palmer Lake
ph: 719-481-2142 fx: 719-481-2029 email: rminer@quik.com

David Buttery - City of Woodland Park
ph: 719-687-5213 fx: 719-687-5232
email: dbuttery@city-woodlandpark.org

Jean Garren - Teller County
ph: 719-687-5260 fx: 791-687-5256
email: garrenj@co.teller.co.us

Kim Headley - Pueblo County
ph: 719-583-6100 fx: 719-583-6376
email: kheadley@co.pueblo.co.us

Scott Stevens - City of Fountain
ph: 719-322-2036 fx: 719-382-5194
email: scott@fountaincolorado.org

Byron Glenn - Town of Monument
ph: 303-708-0200 fx: 719-488-1604
email: bglenn@cvranch.org

Tyler Stevens - Town of Green Mountain Falls
ph: 719-684-2439 fx: 719-684-2326 email: tylerscs@aol.com

Kevin Stilson - Regional Floodplain
ph: 719-327-2906 email: kevin@pprbd.org

AREA PHOTOS

Sedimentation

Clear Water Scour

Downcutting

Incised Channel

Meander

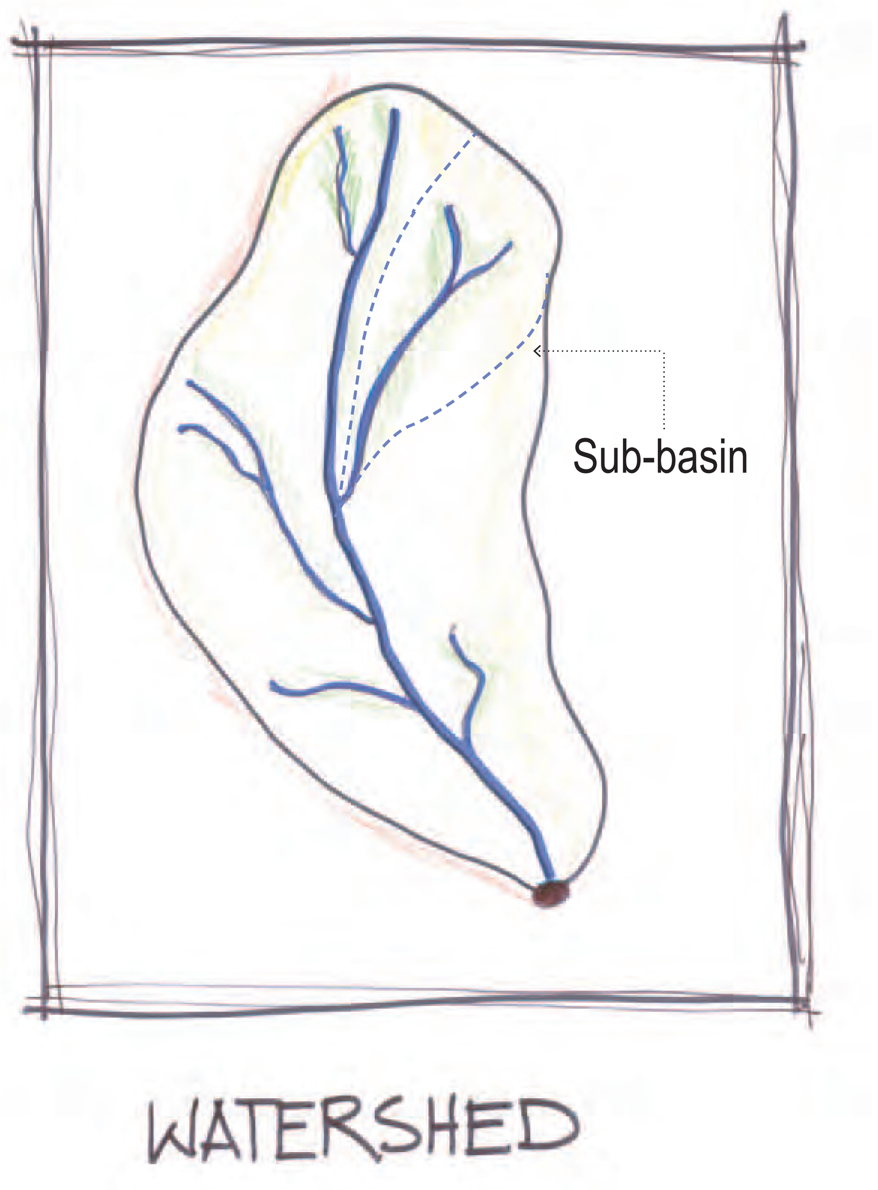
Aggradation

Point Bar

Headcutting

Cutbanks

DEFINITIONS



Watershed

Area that drains to a common outlet.
For a river or stream, it is all the land that drains to it or its tributaries. Variously called Basin, Drainage Basin or Catchment. A Sub-basin or Subwatershed is a discriminate drainage basin within a larger watershed, typically defined for planning or modeling purposes. The size of a watershed is termed its drainage area.

Hydrology

The study of the properties, movement and behavior of water on the land surface and under ground:
• where and how much water there is,
• where it came from, and
• where it is going.

Hydraulics

The study of the properties, movement and behavior of water flowing in open channels or pipes; how the water gets from one place to another including its velocity and the forces it applies to streams and channels.

Geomorphology

A branch of geology that deals with the form of the earth, the general configuration of its surface, and the changes that take place due to erosion of the primary elements and the buildup of erosional debris.

Fluvial Geomorphology

How a stream or river changes the configuration of the earth by eroding its banks and streambed and transporting sediment from one location to another.

Base Flows

The flow of water that normally occurs in a stream without any contribution from snowmelt or storm runoff.

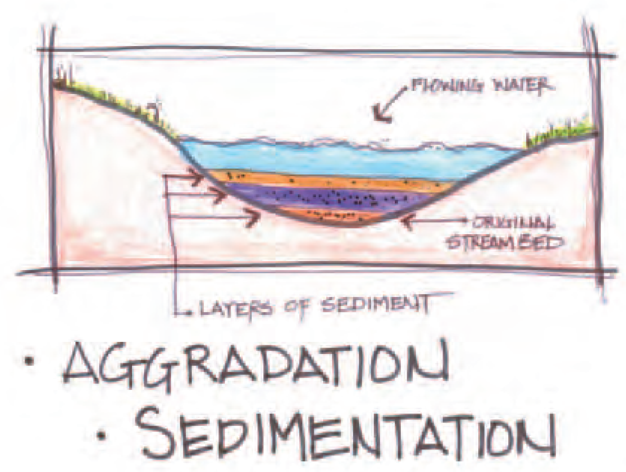
Floodplain

The level area around a river channel that floods during moderate flow events.

Overbank

Water flow over the top of bank.

DEFINITIONS

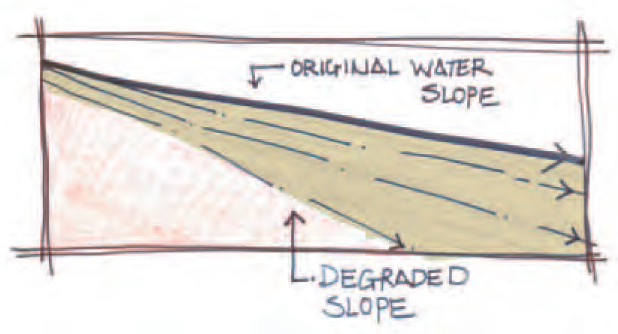


Sedimentation

Deposition of soil particles. As sediment is removed from one part of a stream by erosive forces, it is deposited at another part of the stream. Usually the sediment is deposited in an area with slower moving water, causing the stream bed to build up at this location.

Aggradation

The process by which a stream's bed raises over time through the deposition of additional sediment to it's bed.

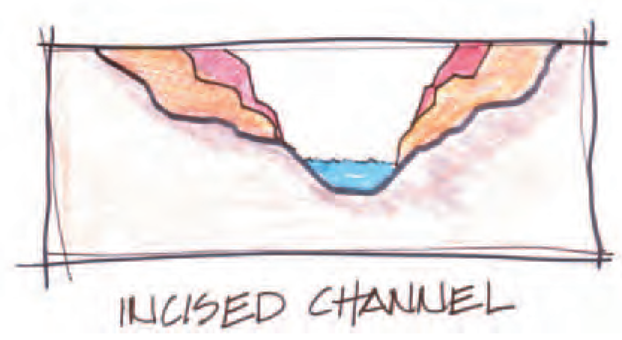


Downcutting or Channel Degradation

The process by which a stream's bed is lowered over time through erosion of the bed's material.

Incised Channel

A stream that, through degradation, has cut its channel into the bed of the terrain it flows through.

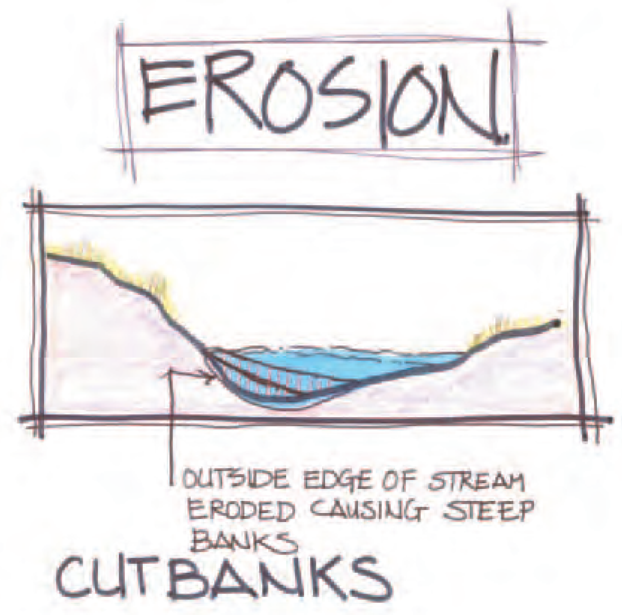


Headcutting

The process by which the stream is actively eroding the streambed downward (degrading, incising, downcutting) to a new base level. Because of the resultant increase in slope, this erosional action progresses upstream. Drop structures are often used to stop a headcut from progressing upstream.

Clear Water Scour

Erosion of a stream's bed and banks caused by large clear water flows. Clear water is water that carries little sediment, thus it has the ability to carry more bed and bank material from an area and lacks the sediment load to replace what it removes.

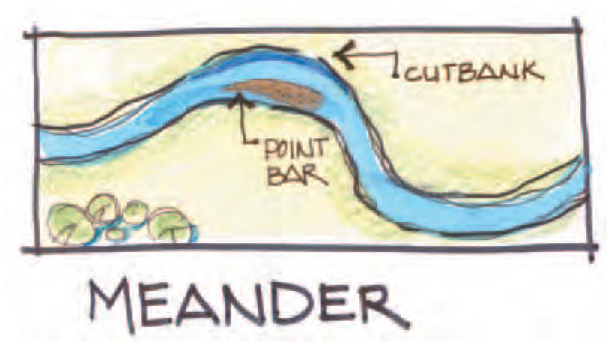


Erosion

Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical, chemical, or biological forces. In a stream, the soil is removed from the banks and bed of the stream.

Cutbanks

A steep bank caused by erosion, usually on the outside of a river bend. As the stream erodes material at the base or "toe" of the bank slope, material above it falls into the stream. Over time the outside edge of the stream moves, or meanders, farther into the bank.



Meander

Bends in rivers and streams that are formed and move over time through erosion of the stream banks.

Point Bar

An accumulation of alluvium - usually sand or gravel - caused by a decrease in sediment transport capacity on the inside of a meander bend.

Channel Forming Flows

The amount of flow in a stream or river that causes the most geomorphic change over time (usually coincides with the one year storm).

Stream Stability

(Source: Rosgen, 1996) - A stream is stable when it maintains its dimension, pattern, and profile such that, over time, channel features are maintained and the stream system neither aggrades nor degrades.

STUDY PROCESS

1994 - 2003

Collaborative Effort
- Multiple Organizations (see below)
- Local, State, and Federal Effort

History of Fountain Creek Watershed Study - Committees
- 1995 - 1998 Fountain Creek Watershed Project Committee
- 1998 - 2000 Fountain Creek Watershed Forum Committee
- 2000 - Present Fountain Creek Watershed TAC

History of Fountain Creek Watershed Study - Activities
- 2000 - 2002 Fountain Creek Watershed GIS
- 2000 - 2003 Fountain Creek Watershed Plan
- 2000 - 2003 USACE Reconnaissance Study
- 2004 - Present USACE Watershed Study
- 2004 - Present Public Outreach and Education

Fountain Creek Watershed Plan
- Identified Problems within the Watershed
  - Flooding
  - Erosion
  - Sedimentation
- Identified Areas of Interest
- Stakeholders Prioritized Areas of Interest
- Recommended Methods to Address Multiple Problems

What We've Done

2003 - 2007

Fountain Creek Watershed Study
- Mapping
- Hydrology & Hydraulics Modeling
- Sedimentation Analysis
- Geomorphological Analysis
- Identification of Specific Areas & Conceptual Alternatives
- Spin Off Projects into Appropriate Programs

Mapping
- For Modeling, Specific Levels of Detail
- For Mainstem & Select Tributaries

Hydrology & Hydraulics Modeling
- Level of Detail for Updating Floodplain Maps (Not FEMA)
- FEMA & CWCB Will Review Hydrology
- Sponsors Can Add Information to Models to Get to FEMA Level
- Models will Help Screen Conceptual Alternatives
- Impacts of the Southern Delivery System will be Included

Sedimentation & Geomorphological Analysis
- Used to Identify & Refine Problem Areas
- Used to Develop Alternatives

What We're Doing

2007 +

Identification of Specific Areas & Alternatives
- Builds on Areas of Interest Previously Determined
  Fountain Creek Watershed Plan Areas
- Initial Critical Area Identification Prior to Modeling
  Refine FCWP Areas to Specific Locations
- Further Refined after Completion of Modeling
- Alternatives Spun Off where Appropriate

Further Study/Implementation
- Authorize Corps Projects
- NRCS (Natural Resource Conservation Services)
- EPA (Environmental Protection Agency)
- Local or State-Funded Programs Initiated

Next Steps

WHAT ARE WE DOING ABOUT IT?

Corps of Engineers Fountain Creek Watershed Study

The study will define and evaluate existing and future conditions in the watershed, primarily through comprehensive

- Hydrologic Modeling & Analysis,
- Hydraulic Modeling, and
- Geomorphic Analysis.

Once existing and future conditions are analyzed, the study goal is to identify and prioritize remedial projects that can be further developed and implemented by the sponsors through various Federal, State, and local programs.