Colorado's Water Supply Future

Colorado Water Conservation Board

Statewide Water Supply Initiative 2010

January 2011

CDM

Final Report

Table of Contents

Executive Summary

Section 1 – Introduction

1.1 Introduction to the SWSI 2010 Update 1-1
1.2 Purpose of the SWSI 2010 Update 1-2
1.3 CWCB History and Mission 1-3
1.4 Overview of the Water for the 21st Century Act 1-5
1.4.1 Basin Roundtable Process 1-6
1.4.2 Interbasin Compact Committee 1-6
1.5 Background on Colorado's Major River Basins 1-7
1.5.1 Colorado River System Basins 1-7
1.5.1.1 Colorado River Basin 1-8
1.5.1.2 Gunnison River Basin 1-9
1.5.1.3 Yampa River, White River, and Green River Basins 1-10
1.5.1.4 Dolores River, San Juan River, and San Miguel River Basins 1-10
1.5.2 South Platte River, Republican River, and North Platte River Basins 1-12
1.5.2.1 South Platte River Basin 1-12
1.5.2.2 Republican River Basin 1-13
1.5.2.3 North Platte River Basin 1-13
1.5.3 Arkansas River Basin 1-14
1.5.4 Rio Grande Basin 1-15
1.6 Overview of Report 1-16
1.7 Acknowledgements 1-17
1.7.1 2010 CWCB Board Members 1-18
1.7.2 2010 Basin Roundtable Leadership 1-18
1.7.3 2010 IBCC Members 1-18

Section 2 – Nonconsumptive Needs Assessments

2.1 Overview of Nonconsumptive Needs Assessment Process 2-1
2.2 Focus Area Mapping Methodology 2-5
2.2.1 SWSI 2 GIS Data Layers 2-6
2.2.2 Categorization of Data Layers 2-7
2.2.3 GIS Analysis of Data Layers 2-7
2.3 Nonconsumptive Focus Area Mapping Results 2-9

Section 3 – Nonconsumptive Projects and Methods

3.1 Nonconsumptive Projects and Methods Overview 3-1
3.2 Nonconsumptive Projects and Methods Methodology 3-2
3.3 Nonconsumptive Projects and Methods GIS Mapping and Analysis Methodology 3-4
3.4 Nonconsumptive Projects and Methods GIS Mapping Results 3-6
3.5 Funding and Legal Mechanisms to Assist Implementation of Nonconsumptive Projects and Methods 3-9
3.5.1 Federal and State Funding 3-9
3.5.2 Legal Mechanisms to Support Nonconsumptive Projects and Methods Implementation 3-10
3.5.2.1 Federal Tools 3-10
3.5.2.2 CWCB Program Tools 3-27
3.5.2.3 Other State and State Administered Federal Program Tools 3-28
3.5.2.4 Local Tools 3-30
3.5.2.5 Multi-stakeholder and Market Based Tools 3-31

Section 4 – Consumptive Needs Assessments

4.1 Overview of Consumptive Needs Assessment Process 4-1
4.2 M&I and SSI Consumptive Needs 4-2
4.2.1 Future Population Projections 4-2
4.2.1.1 2050 Population Projection Methodology 4-2
4.2.1.2 2050 Population Projection Results 4-3
4.2.2 Future M&I Water Demands 4-6
4.2.2.1 2050 M&I Water Demands Methodology 4-6
4.2.2.2 2050 M&I Water Demands Results 4-9
4.2.3 SSI Water Demands 4-10
4.2.3.1 Large Industry 4-12
4.2.3.2 Snowmaking 4-12
4.2.3.3 Thermoelectric Power Generation 4-13
4.2.3.4 Energy Development 4-14
4.2.3.5 Statewide SSI Demand Summary 4-15
4.2.4 Statewide 2050 M&I and SSI Consumptive Needs Summary 4-17
4.3 Agricultural Consumptive Needs 4-20
4.3.1 Agricultural Demand Methodology 4-20
4.3.1.1 Current Irrigated Acres Methodology 4-21
4.3.1.2 2050 Irrigated Acres Methodology 4-22
4.3.1.3 Current Agricultural Demand Methodology 4-23
4.3.1.4 2050 Agricultural Demand Methodology 4-24
4.3.2 Agricultural Demand Results 4-24
4.3.2.1 Current Irrigated Acres Results 4-24
4.3.2.2 Future Irrigated Acres Results 4-26
4.3.2.3 Current Agricultural Demand Results 4-26
4.3.2.4 Future Agricultural Demand Results 4-31

4.3.3 Agricultural Consumptive Needs Conclusions....4-32

Section 5 – Consumptive Projects and Methods and the M&I Gap

5.1 Projects and Methods to Address the M&I Gap Overview....5-1
5.2 Projects and Methods to Meet M&I Consumptive Needs....5-1
5.2.1 Identified Projects and Processes Methodology....5-2
5.2.2 Estimation of 2050 IPP Yield by Basin....5-3
5.2.2.1 Statewide....5-4
5.2.2.2 Arkansas Basin....5-6
5.2.2.3 Colorado Basin....5-9
5.2.2.4 Gunnison Basin....5-10
5.2.2.5 Metro Basin....5-12
5.2.2.6 North Platte Basin....5-15
5.2.2.7 Rio Grande Basin....5-16
5.2.2.8 South Platte Basin....5-17
5.2.2.9 Southwest Basin....5-19
5.2.2.10 Yampa-White Basin....5-20
5.3 M&I Gap Analysis....5-21
5.3.1 M&I Gap Analysis Methodology....5-22
5.3.1.1 Arkansas Basin....5-23
5.3.1.2 Colorado Basin....5-23
5.3.1.3 Gunnison Basin....5-23
5.3.1.4 Metro Basin....5-24
5.3.1.5 North Platte Basin....5-24
5.3.1.6 Rio Grande Basin....5-25
5.3.1.7 South Platte Basin....5-25
5.3.1.8 Southwest Basin....5-25
5.3.1.9 Yampa-White Basin....5-26
5.3.2 Gap Analysis with Alternate IPP Yield Scenarios....5-26
5.3.3 2050 M&I and SSI Gap Analysis Results....5-27
5.3.3.1 Statewide....5-27
5.3.3.2 Arkansas Basin....5-32
5.3.3.3 Colorado Basin....5-33
5.3.3.4 Gunnison Basin....5-33
5.3.3.5 Metro Basin....5-34
5.3.3.6 North Platte Basin....5-35
5.3.3.7 Rio Grande Basin....5-35
5.3.3.8 South Platte Basin....5-36
5.3.3.9 Southwest Basin....5-37
5.3.3.10 Yampa-White Basin....5-37

Section 6 – Water Availability

6.1 Water Availability Overview 6-1
6.2 Methodology to Evaluate Surface Water Supply Availability 6-1
6.3 Water Availability 6-3
6.3.1 Arkansas Basin 6-3
6.3.2 Colorado, Gunnison, Southwest, and Yampa-White Basins 6-4
6.3.2.1 Historical Hydrology 6-4
6.3.2.2 Paleohydrology 6-5
6.3.2.3 Climate-Adjusted Hydrology 6-5
6.3.3 North Platte Basin 6-6
6.3.4 Rio Grande Basin 6-6
6.3.5 South Platte Basin 6-7

Section 7 – Portfolios and Strategies to Address the M&I Gap

7.1 Portfolio Approach Overview 7-1
7.2 Strategy Elements of Colorado's Future Water Supply Portfolio 7-5
7.2.1 Identified Projects and Processes Portfolio Element 7-5
7.2.2 Conservation Portfolio Element 7-7
7.2.2.1 Three Conservation Strategies: Low, Medium, and High 7-8
7.2.2.2 Cost Estimates 7-12
7.2.2.3 Assumptions and Limitations 7-12
7.2.3 Land Use and Water Supply Planning 7-13
7.2.4 Agricultural Transfer and New Supply Development Portfolio Elements 7-15
7.2.4.1 Agricultural Transfer Strategy Overview 7-15
7.2.4.2 Alternative Agricultural Transfer Methods 7-18
7.2.4.3 New Supply Development Strategy Overview 7-21
7.2.4.4 Reconnaissance Level Capital and Operations and Maintenance Costs for Agricultural Transfer and New Supply Development Strategies 7-25
7.3 Portfolio Analysis 7-30
7.3.1 Water Demands in the Portfolio and Trade-off Tool 7-30
7.3.2 Portfolio Elements in the Portfolio and Trade-off Tool 7-31
7.3.2.1 Passive Conservation 7-31
7.3.2.2 Identified Projects and Processes 7-31
7.3.2.3 Active Conservation 7-32
7.3.2.4 Agricultural Transfers and New Supply Development 7-32
7.3.3 Trade-Offs in the Portfolio and Trade-off Tool 7-34
7.3.3.1 Decreases in Irrigated Acres 7-34
7.3.3.2 Colorado River Depletions 7-34
7.3.3.3 Size of Alternative Agricultural Transfer Program 7-35
7.3.3.4 Cost Estimates for User-Defined Portfolio 7-35
7.3.3.5 Nonconsumptive Trade-Off 7-36
7.3.4 Status Quo Portfolio 7-36

Section 8 –Recommendations

Section 9 – References

Appendices

Appendix A	Basin Roundtable Members
Appendix B	Overview of Colorado Water Law
Appendix C	Nonconsumptive Needs Assessment Focus Mapping Final Report
Appendix D	AdobeReader GeoPDF Overview
Appendix E	Colorado Division of Wildlife Nonconsumptive Projects and Methods
Appendix F	CWCB Interview and Survey Nonconsumptive Projects and Methods
Appendix G	Nonconsumptive Projects and Methods Protection Type Summary
Appendix H	State of Colorado 2050 Municipal and Industrial Water Use Projections
Appendix I	Technical Memorandum State of Colorado Current and 2050 Agricultural Demands
Appendix J	Technical Memorandum 2050 Municipal and Industrial Gap Analysis
Appendix K	SWSI Conservation Levels Analysis
Appendix L	SWSI 2010 Municipal and Industrial Water Conservation Strategies
Appendix M	Alternative Agricultural Transfer Methods Grants Summary
Appendix N	Reconnaissance Level Cost Estimates for Strategy Concepts

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Figures

1-1 Colorado's nine basin roundtables provide a voluntary and collaborative process to help the state address its water challenges 1-2
1-2 Colorado's Eight Major River Basins 1-7
2-1 Contribution to Rocky Mountain Census Division 8 by Annual Economic Activity by Type 2-2
2-2 Commercial River Rafting User Days in Colorado 2-3
2-3 Nonconsumptive Needs Assessment Methodology 2-4
2-4 Basin Roundtable Focus Area Mapping Methodology 2-5
2-5 Rio Grande Basin Environmental and Recreational Subcategories 2-8
2-6 Arkansas Basin Nonconsumptive Needs Assessment Environmental and Recreational Subcategories by 12-Digit HUC 2-13
2-7 Rio Grande Basin Nonconsumptive Needs Assessment Environmental and Recreational Subcategories by 12-Digit HUC 2-14
2-8 North Platte Basin Nonconsumptive Needs Assessment Environmental and Recreational Subcategory Count per Stream Segment 2-15
2-9 Southwest Basin Nonconsumptive Needs Assessment Environmental and Recreational Subcategory Count per Stream Segment 2-16
2-10 Gunnison Basin Nonconsumptive Needs Assessment Major Stream and Lake Segments 2-17
2-11 Yampa/White Basin Nonconsumptive Needs Assessment Major Environmental and Recreational Segments 2-18
2-12 Metro Basin Nonconsumptive Needs Assessment Candidate Environmental and Recreational Focus Areas 2-19
2-13 South Platte Basin Nonconsumptive Needs Assessment Candidate Environmental and Recreational Focus Areas 2-20
2-14 Colorado Basin Nonconsumptive Needs Assessment Environmental and Recreational Features at Risk 2-21
2-15 Statewide Nonconsumptive Needs Assessment Focus Map 2-22
3-1 Statewide Basins Nonconsumptive Needs Assessment Projects and Methods 3-33
3-2 Statewide Basins Nonconsumptive Needs Assessment Projects and Methods Status 3-34
3-3 Statewide Basins Nonconsumptive Needs Assessment Study Status 3-35
3-4 Statewide Basins Nonconsumptive Needs Assessment Focus Areas with Projects and Methods 3-36
4-1 State of Colorado Pupulation Projections through 2050 4-4
4-2 M&I Water Usage Rate by Basin 4-8
4-3 Comparison of M&I Demands for Baseline and with Passive Conservation 4-10
4-4 M&I Water Demands by Basin 4-12
4-5 Statewide SSI Water Demands by Sector 4-17
4-6 Statewide M&I and SSI Demands 4-18
4-7 Existing and Future M&I and SSI Demands 4-19
4-8 State of Colorado Current Irrigated Acres by Water District 4-25

4-9 Potential Changes in Irrigated Acres by 2050 4-28
4-10 Comparison of Current and 2050 Irrigated Acres 4-29
4-11 State of Colorado Current Agricultural Shortages by Water District 4-30
4-12 Current Agricultural Demands and Shortages 4-31
4-13 2050 Agricultural Demands and Shortages 4-32
5-1 Statewide Summary of Yield for IPP Categories at 100% Success Rate 5-5
5-2 Arkansas Basin Location Map 5-7
5-3 South Platte Basin Location Map 5-13
5-4 Statewide M&I and SSI Gap Summary Medium Scenario 5-29
5-5 2050 M&I and SSI Gap Analysis – Medium Gap Scenario 5-30
5-6 Potential Yield of NEPA Projects Relative to 2050 New Demands, Other IPPs, and Gap in South Platte and Metro Basins 5-31
5-7 Potential Yield of NEPA Projects Relative to 2050 New Demands, Other IPPs, and Gap in Arkansas Basin 5-32
6-1 Estimated Median Amount of Available Flows in South Platte Basin Based on Various Models 6-8
6-2 Yield Curve, South Platte River below Chatfield 6-9
7-1 Elements of the Visioning Process 7-1
7-2 Colorado's Water Supply Future Water Demand and Supply Scenarios 7-3
7-3 Portfolio Elements to Address Colorado's Future M&I Demands 7-4
7-4 Example 2050 M&I Needs and Associated Portfolio from Portfolio and Trade-off Tool 7-6
7-5 Overview of Agricultural Transfer and New Supply Development Concepts 7-16
7-6 Summary of Reconnaissance Capital Costs 7-28
7-7 Summary of Reconnaissance O&M Costs 7-28
7-8 Summary of Reconnaissance Life Cycle Costs 7-29
7-9 Summary of Reconnaissance Life Cycle Unit Costs 7-29
7-10 IPP Success Rate Data Entry Screen from Portfolio and Trade-Off Tool 7-31
7-11 Reduction in Irrigated Acres in 2050 Based on Status Quo Scenario 7-37
7-12 Size of Rotational Fallowing Program Required in the South Platte and Arkansas Basins for Status Quo Portfolio 7-38

Tables

1-1 2010 CWCB Board Members 1-4
2-1 SWSI 2 Environmental and Recreational Data Layers 2-6
2-2 Additional Environmental and Recreational Data Layers Based on Basin Roundtable Input 2-6
3-1 Summary of Meetings to Collect Nonconsumptive Project and Methods Information 3-2
3-2 Summary of CWCB Instream Flows and Natural Lake Levels 3-3
3-3 Summary of CWCB's Watershed Restoration and Nonconsumptive WSRA Projects 3-3
3-4 Summary of Project and Methods Status 3-7
3-5 Summary of Projects and Methods Type 3-7
3-6 Summary of Focus Area Cold Water and Warm Water Fisheries Environmental and Recreational Protections 3-8
3-7 Existing Federal Funding Programs for Environmental and Recreational Water Development 3-11
3-8 Existing State Funding Programs for Environmental and Recreational Water Development 3-15
3-9 Comparison of Types of Water Rights and Other Mechanisms that Provide Environmental and Recreational Flows 3-24
4-1 Population Projections by River Basin 4-4
4-2 Definition of M&I Demand Terms 4-5
4-3 M&I Forecast by River Basin 4-11
4-4 Large Industry Demands 4-12
4-5 Estimated Snowmaking Water Demands 4-13
4-6 Estimated Thermoelectric Power Generation Water Demands 4-14
4-7 Estimated Energy Development Direct Water Demands 4-15
4-8 Summary of Self-Supplied Industry Demands by Basin 4-16
4-9 Summary of M&I and SSI Demands for Each Basin and Statewide 4-17
4-10 Current Irrigated Acres by River Basin 4-24
4-11 Future Irrigated Acres by River Basin 4-27
4-12 Estimated Current Agricultural Demand by Basin 4-29
4-13 Estimated 2050 Agricultural Demand by Basin 4-31
5-1 Major Categories of Identified Projects and Processes by Basin 5-4
5-2 Arkansas Basin IPP Summary at 100% Success Rate 5-8
5-3 Colorado Basin IPP Summary at 100% Success Rate 5-10
5-4 Gunnison Basin IPP Summary at 100% Success Rate 5-11
5-5 Metro Basin IPP Summary at 100% Success Rate 5-14
5-6 North Platte Basin IPP Summary at 100% Success Rate 5-15
5-7 Rio Grande Basin IPP Summary at 100% Success Rate 5-16
5-8 South Platte Basin IPP Summary at 100% Success Rate 5-18
5-9 Southwest Basin IPP Summary at 100% Success Rate 5-20
5-10 Yampa-White Basin IPP Summary at 100% Success Rate 5-21

5-11 IPP Success Rates for the Medium and High Gap Scenarios 5-26
5-12 Statewide M&I and SSI Gaps in 2050 5-28
5-13 Arkansas Basin M&I and SSI Gaps in 2050 5-33
5-14 Colorado Basin M&I and SSI Gaps in 2050 5-33
5-15 Gunnison Basin M&I and SSI Gaps in 2050 5-34
5-16 Metro Basin M&I and SSI Gaps in 2050 5-35
5-17 North Platte Basin M&I and SSI Gaps in 2050 5-35
5-18 Rio Grande Basin M&I and SSI Gaps in 2050 5-36
5-19 South Platte Basin M&I and SSI Gaps in 2050 5-36
5-20 Southwest Basin M&I and SSI Gaps in 2050 5-37
5-21 Yampa-White Basin M&I and SSI Gaps in 2050 5-38
6-1 Major Interstate Compacts, Decrees, and Endangered Species Programs by Basin 6-2
6-2 South Platte Basin Water Allocation Models Summary 6-7
7-1 IPP Success Rates Considered by IBCC 7-6
7-2 Comparison of 2050 Implementation and Penetration Level for Three Conservation Strategies and Demand Reductions Used in Forecasts 7-9
7-3 Statewide Forecast Water Savings Potential from SWSI 1, SWSI 2, and SWSI 2010 7-10
7-4 Statewide Forecast Water Savings (separating passive and active) Potential from SWSI 1 and SWSI 2010 7-11
7-5 Agricultural Transfer Strategy Concepts Attributes 7-17
7-6 Benefits, Impacts, and Opportunities for Agricultural Transfer Strategy – Traditional and Alternative Agricultural Transfers 7-18
7-7 New Supply Development Concepts Attributes 7-21
7-8 Benefits, Impacts, and Opportunities for New Supply Development Strategy 7-23
7-9 Direct Water Use Scenarios for Build-out Oil Shale Industry 7-30
7-10 Total Yield After Reuse by Exchange or Recapture 7-34
7-11 Status Quo Medium M&I Demand Portfolio 7-38

Acronyms

Act	Colorado Water for the 21st Century Act
AF	Acre-Feet
AFY	Acre-Feet/Year
ATM	Alternative Transfer Methods
AVC	Arkansas Valley Conduit
BLM	Bureau of Land Management
BNDSS	Basin Needs Decision Support System
BOR	U.S. Bureau of Reclamation
CBEF	Center for Business and Economic Forecasting
CDOW	Colorado Division of Wildlife
CDPHE	Colorado Department of Public Health and Environment
CDSS	Colorado Decision Support System
CFWE	Colorado Foundation for Water Education
CRWAS	Colorado River Water Availability Study
CSA	Combined Service Area
CSU	Colorado Springs Utilities
CU	Consumptive Use
CU&L	Consumptive Uses and Losses
CWA	Clean Water Act
CWCB or Board	Colorado Water Conservation Board
CWI	Colorado Water Institute
CWRPDA	Colorado Water Resources and Power Development Authority
CWW	Colorado WaterWise
DLG	Division of Local Government
DMRP	Drought Mitigation and Response Plan
DNR	Department of Natural Resources
DOLA	Department of Local Affairs
DPOR	Division of Parks and Outdoor Recreation
DSS	Decision Support System
DWR	Division of Water Resources
ECCV	East Cherry Creek Valley
EIS	Environmental Impact Statement
EQIP	Environmental Quality Incentives Program
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FGIC	Financial Guaranty Insurance Company
FIF	Fishing is Fun
Fry-Ark	Fryingpan-Arkansas
GCMs	General Circulation Models
GIS	Geographic Information System
GOCO	Great Outdoors Colorado
gpcd	Gallons per Capita per Day
HB	House Bill
HUC	Hydrologic Unit Code

IBCC	Interbasin Compact Committee
IPPs	Identified Projects and Processes
ISAM	Irrigation Systems Analysis Model
ISF	Instream Flow
IUP	Intended Use Plan
IWR	Irrigation Water Requirement
LAVWCD	Lower Arkansas Valley Water Conservancy District
LSPWMSSR	Lower South Platte River Water Management and Storage Sites Reconnaissance Study
LWCF	Land and Water Conservation Fund
M&I	Municipal and Industrial
mg/L	Milligrams per Liter
NAWQA	National Water Quality Assessment Program
NCNA	Nonconsumptive Needs Assessment
NEPA	National Environmental Policy Act
NFWF	National Fish and Wildlife Foundation
NHD	National Hydrography Dataset
NISP	Northern Integrated Supply Project
NPS	Nonpoint Source
NPS	National Park Service
NRCS	Natural Resource Conservation Service
NSIP	National Streamflow Information Program
O&M	Operations and Maintenance
PBWW	Pueblo Board of Water Works
POR	Period of Record
PRRIP	Platte River Recovery Implementation Program
PRWCD	Purgatoire River Water Conservancy District
RCAC	Rural Community Assistance Corporation
RICD	Recreational In-Channel Diversion
RMPs	Resource Management Plans
RO	Reverse Osmosis
RRWCD	Republican River Water Conservation District
SB	Senate Bill
SDO	State Demographer's Office
SDS	Southern Delivery System
SPDSS	South Platte Decision Support System
SRGAP	Southwest Regional Gap Analysis Project
SSI	Self-Supplied Industrial
SWSI	Statewide Water Supply Initiative
TDS	Total Dissolved Solids
UAWCD	Upper Arkansas Water Conservancy District
UGRWCD	Upper Gunnison River Water Conservancy District
UPCO	Upper Colorado River Study
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEDA	U.S. Economic Development Administration
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey

WGFP	Windy Gap Firming Project
WISE	Water Infrastructure and Supply Efficiency
WQCC	Water Quality Control Commission
WQCD	Water Quality Control Division
WRP	Wetland Reserve Program
WSFR	Wildlife and Sport Fish Restoration
WSL CU	Water Supply Limited Consumptive Use
WSR	Wild and Scenic River
WSRA	Water Supply Reserve Account

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Executive Summary

Colorado faces significant and immediate water supply challenges and should pursue a mix of solutions to meet the state's consumptive and nonconsumptive water supply needs.

Preface

Colorado faces significant and immediate water supply challenges. Despite the recent economic recession, the state has experienced rapid population growth, and Colorado's population is expected to nearly double within the next 40 years. If Colorado's water supply continues to develop according to current trends, i.e., the status quo, this will inevitably lead to a large transfer of water out of agriculture resulting in significant loss of agricultural lands and potential harm to the environment.

Providing an adequate water supply for Colorado's citizens, agriculture, and the environment will involve implementing a mix of local water projects and processes, conservation, reuse, agricultural transfers, and the development of new water supplies, all of which should be pursued concurrently. With this Statewide Water Supply Initiative (SWSI) 2010 update, the Colorado Water Conservation Board (CWCB or Board) has confirmed and updated its analysis of the state's water supply needs and recommends Colorado's water community enter an implementation phase to determine and pursue solutions to meeting the state's consumptive and nonconsumptive water supply needs.

In 2003 the Colorado legislature recognized the critical need to understand and better prepare for Colorado's future water supply needs, and authorized the CWCB to implement SWSI 1. Approved by the Board in 2004, SWSI 1 comprehensively identified Colorado's current and future water needs and examined a variety of approaches Colorado could take to meet those needs. SWSI 1 implemented a collaborative approach to water resource issues by establishing "basin roundtables"—diverse groups of individuals representing water interests who provide input on water issues. The basin roundtables established a grass roots effort for education, planning, and collaborating on water planning issues.

This was followed by SWSI 2, which established four technical roundtables—Conservation, Alternative Agricultural Water Transfers, Environmental and Recreational Needs, and Addressing the Water Supply Gap.

Enacted in 2005, the Colorado Water for the 21st Century Act (Act) institutionalized the nine basin roundtables and created the 27-member Interbasin Compact Committee (IBCC) to facilitate conversations within and between basins. Together, these new bodies create a voluntary, collaborative process to help the state of Colorado address its water challenges.

The Act charges the basin roundtables to develop their consumptive and nonconsumptive needs assessments (NCNAs) and to propose projects and methods to meet those needs. These needs assessments are the basis for the CWCB's SWSI 2010 update, making SWSI 2010 the first comprehensive update to incorporate the needs assessment work of the basin roundtables.

SWSI 2010 is intended to enhance the available information and can be used for regional water planning.

SWSI 2010 is intended to enhance the available information and can be used for regional water planning. SWSI is a compilation of information to be used for developing a common understanding of existing and future water supplies and demands throughout Colorado, and possible means of meeting both consumptive and nonconsumptive water supply needs.

Key elements of this update include:

- Analysis of the water supply demands to 2050, including consideration of the effect of passive conservation on those demands
- Analysis of nonconsumptive needs in each basin, as recommended by the basin roundtables
- Analysis of water availability in the Colorado River basins
- Implementation elements associated with identified projects, water conservation, agricultural transfers (both permanent and nonpermanent), and development of new water supplies
- Development of representative costs for water supply strategies

SWSI 2010 is a comprehensive picture of Colorado's water needs, now and in the future. The Board intends SWSI to be updated and refined every few years. Also, to assure the local perspective in this report, each basin roundtable will supplement this report with individual basin reports later in 2011. Used as a statewide planning tool, SWSI 2010 provides comprehensive information to water providers, state policy makers, and the General Assembly as they make decisions for accomplishing our next step: to work together on implementing the necessary strategies to meet our near and long-term water supply challenges.

CWCB History and Mission

As the lead agency for SWSI, the CWCB plays a critical role in establishing water policy in Colorado. Created in 1937, the CWCB's Mission is to:

> ***Conserve, Develop, Protect and Manage Colorado's Water for Present and Future Generations***

The CWCB furthers this mission by developing and implementing programs to:

- Conserve the waters of the state for wise and efficient beneficial uses
- Develop waters of the state to:
  - Preserve the natural environment to a reasonable degree
  - Fully utilize state compact entitlements
  - Help ensure that Colorado has an adequate water supply for our citizens and the environment by implementation of CWCB adopted mission statements and the findings and recommendations identified in SWSI 1
- Protect the waters of the state for maximum beneficial use without waste
- Manage the waters of the state in situations of extreme weather conditions—both for floods and droughts

Structure, Authority, and Role of the Board

The CWCB consists of 15 members. The Governor appoints one representative Board member from each of the state's eight major river basins and one representative member from the City and County of Denver. All appointees are subject to Senate confirmation and serve 3-year terms. The

With more than 40 staff members, the CWCB functions under eight major program areas:

1. Administration and Management
2. Finance
3. Interstate and Federal
4. Office of Water Conservation and Drought Planning
5. Stream and Lake Protection
6. Water Information
7. Water Supply Planning
8. Watershed and Flood Protection

Executive Director of the Department of Natural Resources (DNR) is an ex-officio, voting member of the Board. The Director of the CWCB, the State Engineer, the Attorney General, the Director of the Colorado Division of Wildlife (CDOW), and the Commissioner of the Colorado Department of Agriculture are ex-officio, nonvoting members.

CWCB is part of Colorado's DNR, which administers programs related to the state's water, forests, parks, land, wildlife, and minerals. CWCB's overarching goal for SWSI is to help water providers, stakeholders, and state policymakers maintain an adequate water supply for Colorado's citizens, agriculture, and the environment.

To the greatest extent possible, Board appointees are persons experienced in water resource management; water project financing; engineering, planning, and development of water projects; water law; irrigated farming; and/or ranching. No more than five appointees can be members of the same political party. By statute, six voting members constitute a quorum for the conduct of business, with six affirmative votes needed for the Board to take a position on any matter.

Introduction to the Interbasin Compact Process

In the last few years, state leaders and resource management agencies have increasingly focused on helping ensure that Colorado has an adequate water supply for its citizens and the environment. In 2003, the Colorado General Assembly authorized CWCB to implement SWSI 1. SWSI 1 was a comprehensive identification of Colorado's current and future water needs and it examined a variety of approaches Colorado could take to meet those needs. SWSI 1 implemented a collaborative approach to water resource issues by establishing "basin roundtables"—diverse groups of individuals representing water interests who provide input on water issues. Nine basin roundtables were institutionalized in the 2005 Colorado Water for the 21st Century Act, which creates a voluntary, collaborative process to help the state address its water challenges. This process is based on the premise that Coloradoans can work together to address the water needs within the state.

The role of the Board is defined in statute (C.R.S. 37-60) and includes:

- Establishing policy to address state water issues
- Exercising the exclusive authority of the Board to hold instream and natural lake level water rights to protect and improve the environment
- Mediating and facilitating resolutions of disputes between basins and water interests
- Maintaining and upholding fiduciary responsibilities related to the management of state resources including, but not limited to, the Construction Fund and the Severance Tax Trust Fund
- Representing citizens within individual basins
- Identifying, prioritizing, and implementing water development projects to be funded using its funds and when necessary, recommending such projects for approval by the General Assembly
- Making Findings and Recommendations concerning applications for water rights for Recreational In-channel Diversions and defending its decisions in water courts
- Making decisions regarding Watershed Protection Fund grants, upholding fiduciary responsibilities related to the fund and implementing its own river restoration projects designed to help the CWCB accomplish its mission
- Provide technical support for the Water for the 21st Century Act
- Administering the Water Supply Reserve Account Grant Program

Figure ES-1 illustrates the nine basin roundtables, which were organized to represent Colorado's eight major river basins and a separate roundtable for the Denver Metro area. The Yampa-White, Colorado, Gunnison, and Southwest Basin Roundtables are all based on tributaries to the Colorado River.

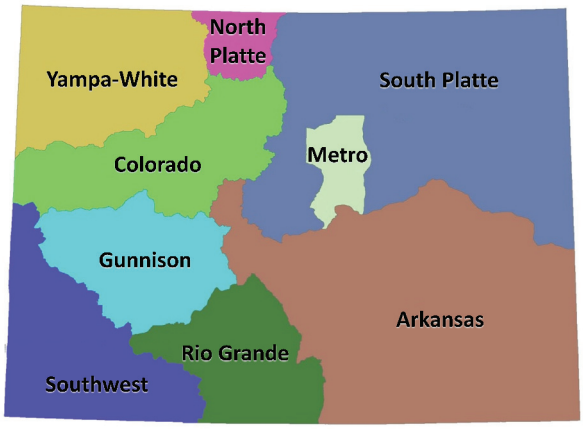


Figure ES-1 Colorado's nine basin roundtables provide a voluntary and collaborative process to help the state address its water challenges

The North Platte, Metro, and South Platte Basin Roundtables represent watersheds tributary to the Platte River. The Arkansas and Rio Grande Basin Roundtables are the headwaters of these river systems.

In addition to the nine basin roundtables, the Act established the 27-member IBCC to facilitate conversations between basins and to address statewide issues. IBCC established its charter in 2006, which was soon ratified by Colorado's General Assembly. The charter outlines the roles of IBCC—to provide a "framework that creates incentives for successful deliberations, agreements, and their implementation." To help advance this role, IBCC embarked on a visioning process, through which IBCC, CWCB, and basin roundtables agreed to evaluate water demand and supply strategies that could help address Colorado's water supply future.

Overview of the Water for the 21st Century Act

As described previously, in 2005 the Colorado General Assembly passed the Colorado Water for the 21st Century Act (House Bill [HB] 05-1177). The Act set up a framework that provides a permanent forum for broad-based water discussions, and it created two new structures—1) the IBCC, a statewide committee that addresses issues between basins; and 2) the basin roundtables, which were established in each of the state's eight major river basins plus the Denver Metro area. The purpose of the basin roundtables is to facilitate discussions on water issues and encourage locally driven collaborative solutions. The broad-based, collaborative nature of this process is reflected in the basin roundtable membership.

To help the basin roundtables accomplish their major responsibility of developing basinwide needs assessments, they have relied on groundwork completed during SWSI 1. To further develop their needs assessments, support water activities in each of the basins, and implement identified water projects and methods, it was clear that the basin roundtables needed staff support as well as technical and financial assistance Using resources provided through HB 06-1400, the CWCB provides staff support and technical assistance to the basin roundtables and the IBCC for the ongoing implementation of the Colorado Water for the 21st Century Act. The basin roundtables were also provided financial resources through Senate Bill (SB) 06-179, which established the Water Supply Reserve Account (WSRA). The WSRA appropriates money to the CWCB to help implement the consumptive and nonconsumptive water supply projects and methods identified by the basin roundtables. These bills and other relevant legislation are summarized in Figure ES-2.

SB03-110 authorized SWSI 1, which implemented a collaborative approach to water resources issues by establishing SWSI roundtables. SWSI 1 focused on using a common technical basis for identifying and quantifying water needs and issues.

HB05-1177 or The Colorado Water for the 21st Century Act provides a permanent forum for broad-based water discussions. It creates two new structures: 1) the IBCC, and 2) the basin roundtables. There are nine basin roundtables based on Colorado's eight major river basins and the Denver Metro area.

SB06-179 created the WSRA. Throughout SWSI and Colorado Water for the 21st Century Act processes, there has been a clear recognition that financial assistance is needed to address the water challenges in our state. This legislation funds the WSRA, which directs the State Treasurer to annually transfer $10 million from the Operational Account of the Severance Tax Trust Fund to the WSRA. These monies are available to the basin roundtables to fund water activities.

HB06-1385 created the CWCB's Intrastate Water Management and Development Section, which implements SWSI, the WSRA, develops reconnaissance level water supply alternatives, and tracks and supports water supply projects and planning processes. This section is now called the Water Supply Planning Section.

HB06-1400 appropriated money to the CWCB to fund staffing of the Water for the 21st Century Act process and monies for a contractor to technical assistance the basin roundtables.

SB09-106 authorized the funding of the WSRA in perpetuity.

Figure ES-2 Legislation Related to the Water for the 21st Century Act

Basin Roundtable Process

Basin roundtables are legislatively required to be made up of a diverse set of stakeholders, including representatives from counties, municipalities, water conservancy districts, the environmental and recreational communities, agriculture, and industry.

The responsibilities of the basin roundtables can be grouped into three categories—procedural, substantive, and public involvement. Each basin roundtable adopted bylaws that include the basin roundtable's goals, objectives, and operating procedures. These bylaws reflect the specific needs of the basin roundtable and reflect the uniqueness of each basin. Each basin roundtable developed procedures and selected two members of the IBCC to represent the basin roundtables' interests.

The most extensive substantive responsibility assigned to each basin roundtable is to develop a basinwide water needs assessment and projects and methods to meet those needs. These efforts are performed in cooperation with local governments, area water providers, and other stakeholders. The Act states "Using data from the Statewide Water Supply Initiative and other appropriate sources and in cooperation with the ongoing Statewide Water Supply Initiative, develop:"

- An assessment of consumptive water needs (municipal, industrial, and agricultural)
- An assessment of nonconsumptive water needs (environmental and recreational)
- An assessment of available water supplies (surface and groundwater) and an analysis of any unappropriated waters
- Proposed projects or methods to meet any identified water needs and achieve water supply sustainability over time

Equally important to selecting members of the IBCC and developing a basinwide water needs assessment, the basin roundtables serve as a forum for public involvement. The basin roundtable activities are required by law to be open, public meetings. The basin roundtable process creates an expanded foundation for public involvement.

This SWSI 2010 report is largely based on basin roundtables' water needs assessments. This report is summary in nature and is intended to summarize water needs at a statewide level. The basin roundtable needs assessment reports will be

more detailed and provide information at a finer level of detail than the contents of this report.

During the first part of 2011, CWCB will work with the basin roundtables to use information from this report and other basin roundtable needs assessments studies to develop individual basin roundtable needs assessments reports.

Interbasin Compact Committee

The other structure created by the Colorado Water for the 21st Century Act is the IBCC. This is a 27-member committee established to facilitate conversations between basins and to address statewide issues. The IBCC brings the issues of each basin roundtable to a statewide forum.

The Act gives the IBCC a series of responsibilities. These include establishing bylaws, developing a charter, helping oversee the WSRA program, and creating a Public Education and Outreach Working Group.

During 2005 and 2006, the IBCC established bylaws to govern its operations and actions. In addition, during this timeframe the IBCC developed a Charter to "govern and guide compact negotiations between basin roundtables." The Charter includes:

- A framework and principles to guide negotiations between basin roundtables, including policies to ensure that individual compacts do not conflict with one another.
- Procedures for ratification of compacts, including a mandatory provision that every affected basin roundtable must approve the draft compact.
- Authorities and procedures to ensure that approved compacts are legally binding and enforceable.
- Procedures for integrating the Interbasin Compact processes with other water planning and development processes, except that no provision may supersede, impair, or modify any local government's "authority, jurisdiction, or permitting powers."

The IBCC also established a Public Education and Outreach Working Group to ensure public education and participation concerning both the activities of the IBCC and compact negotiations between basin roundtables.

Overview of Colorado's Water Supply and Demand

Colorado's river systems generate, on average, 16 million AFY of renewable water. On average about two-thirds of this water leaves the state under Colorado's compacts and decrees. Figure ES-3 shows Colorado's population, irrigated acres, and flows. Of the 16 million acre-feet/year (AFY) of renewable water, about 80 percent is on the West Slope and 20 percent is on the East Slope. However, about 80 percent of Colorado's population is on the East Slope and 20 percent is on the West Slope and most of Colorado's irrigated agricultural lands are on the East Slope.

Colorado also has significant groundwater resources including alluvial aquifers, Denver Basin aquifers, High Plains aquifers, and San Luis Basin aquifers (see Figure ES-4). Colorado's renewable groundwater in the alluvial aquifers is considered part of the surface water system. Colorado's non-renewable groundwater is primarily in the San Luis Basin, High Plains (which is part of the Ogallala system) and the Denver Basin aquifers. The use of non-renewable groundwater, particularly for municipal use, creates reliability and sustainability concerns.

Water is vital to all aspects of Colorado's economy, including municipalities, businesses, industries, rural communities that are dependent on agriculture, West Slope communities that depend on industry and tourism, and statewide environmental amenities.

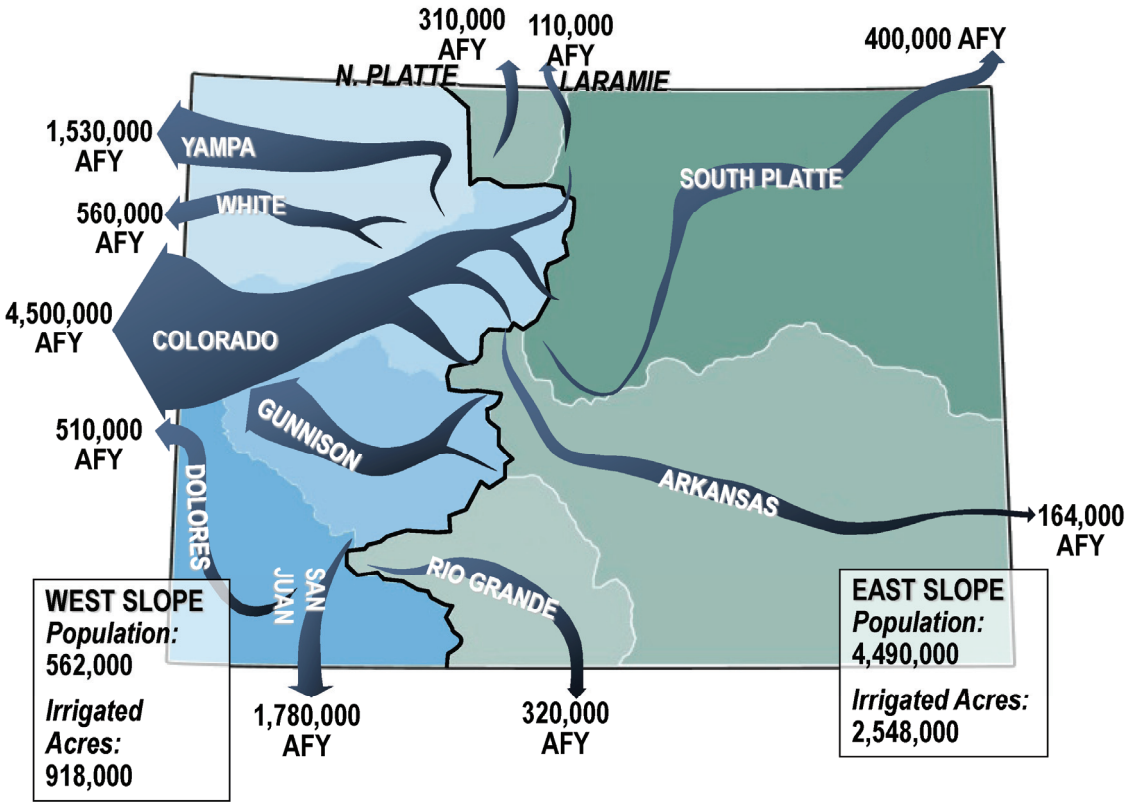


Figure ES-3 Colorado Population, Irrigated Acres and Flows

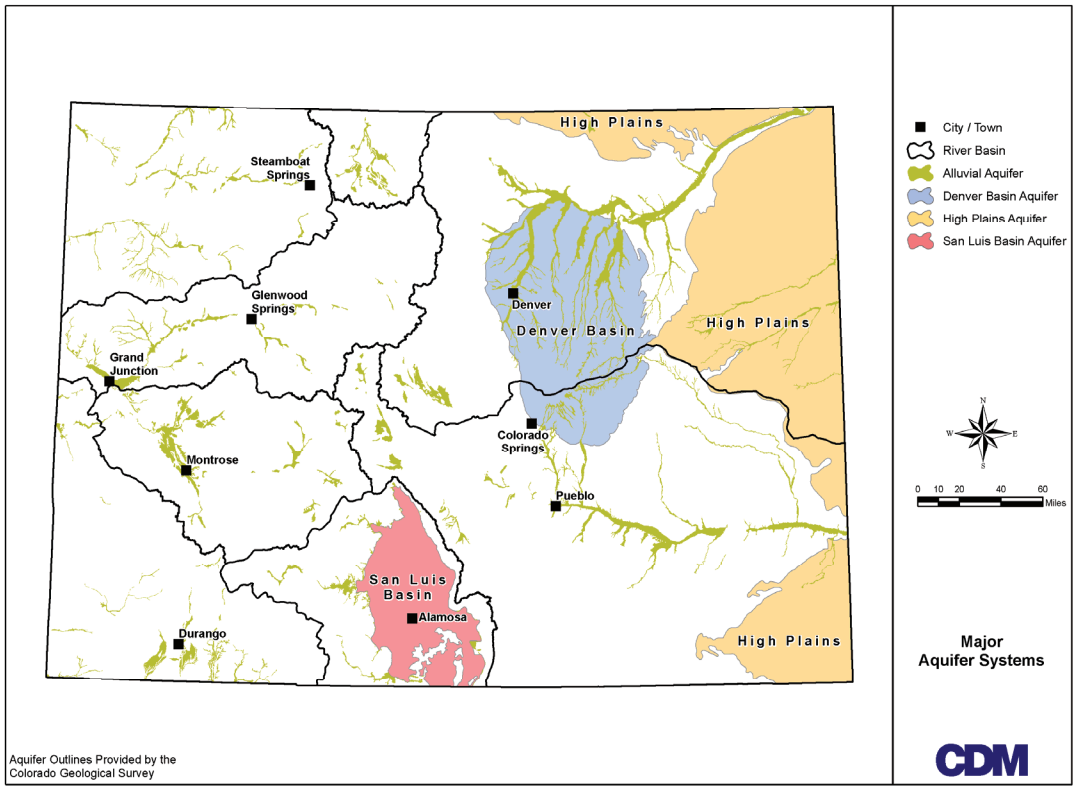


Figure ES-4 Colorado's Major Aquifer Systems

Colorado's agricultural and food industry supports about 4 percent of Colorado's jobs, and many of Colorado's counties are "ag dependent." In more than half of Colorado's counties, one in every ten jobs is tied to the agriculture and food industry, and in 13 of Colorado's 64 counties, one in every three jobs is tied to the agriculture and food industry.

Each basin faces continued shortages associated with existing agricultural demands. There are upward economic pressures to keep agriculture viable, however Colorado could also face a significant decline in irrigated acres by 2050 due to urbanization and water transfers.

Recreation and tourism injected about $8.6 billion into the state's economy during 2009 and employed about 9 percent of the total workforce. In certain regions, most notably headwaters communities, environmental and recreational amenities drive the local economy. Water-related activities comprise a significant component of Colorado's tourist activities including flatwater and river-based activities, fishing, boating, rafting, and snowmaking. The basin roundtables have spent significant time and effort identifying nonconsumptive focus areas in their basins and CWCB programs, most notably its instream flow program and watershed protection program, are critical to meeting these nonconsumptive needs.

Water for Colorado's growing cities and industries is a major issue. Colorado surpassed 5 million people in the summer of 2008. Colorado's population is expected to nearly double by 2050. About half of this growth is expected from net migration into the state and about half will be due to birth rates higher than death rates. This population increase is driven by available jobs.

On a percentage basis, the fastest growth will take place on the West Slope—between 2008 and 2050 the Colorado Basin will grow by about 140 percent, the Southwest Basin by about 115 percent, and the Gunnison Basin by about 115 percent. The Arkansas and South Platte Basins will have a slower growth rate (about 80 percent and 70 percent, respectively), but combine to add almost 3.3 million people by 2050. By 2050, over 6 million people will live in the South Platte Basin. This population growth will drive a significant need for additional water to meet future municipal and industrial (M&I) demands. Colorado also has a significant need for self-supplied industrial (SSI) water uses, including snowmaking, breweries, and other large industry, and our energy sector. By 2050, Colorado will need between 600,000 and 1 million AFY of additional M&I and SSI water. These needs are depicted in Figure ES-5.

Nonconsumptive Needs Assessments

The basin roundtables are required to complete NCNAs. This effort has included an extensive inventory, analysis, and synthesized mapping effort that built upon SWSI 2 environmental and recreational attribute mapping as a common technical platform for the basin roundtables. Figure ES-6 shows the process that was utilized by the CWCB and basin roundtables in completing their NCNAs. The basin roundtables have utilized environmental and recreational attribute mapping to identify nonconsumptive focus areas in their basins. In addition, the Arkansas, Colorado, and Yampa-White Basin Roundtables utilized WSRA funding to conduct further studies in their basins focused on quantifying environmental and recreational flow needs. The basin roundtables' nonconsumptive focus areas and further study efforts are intended to facilitate the identification of projects and methods to address environmental and recreational needs.

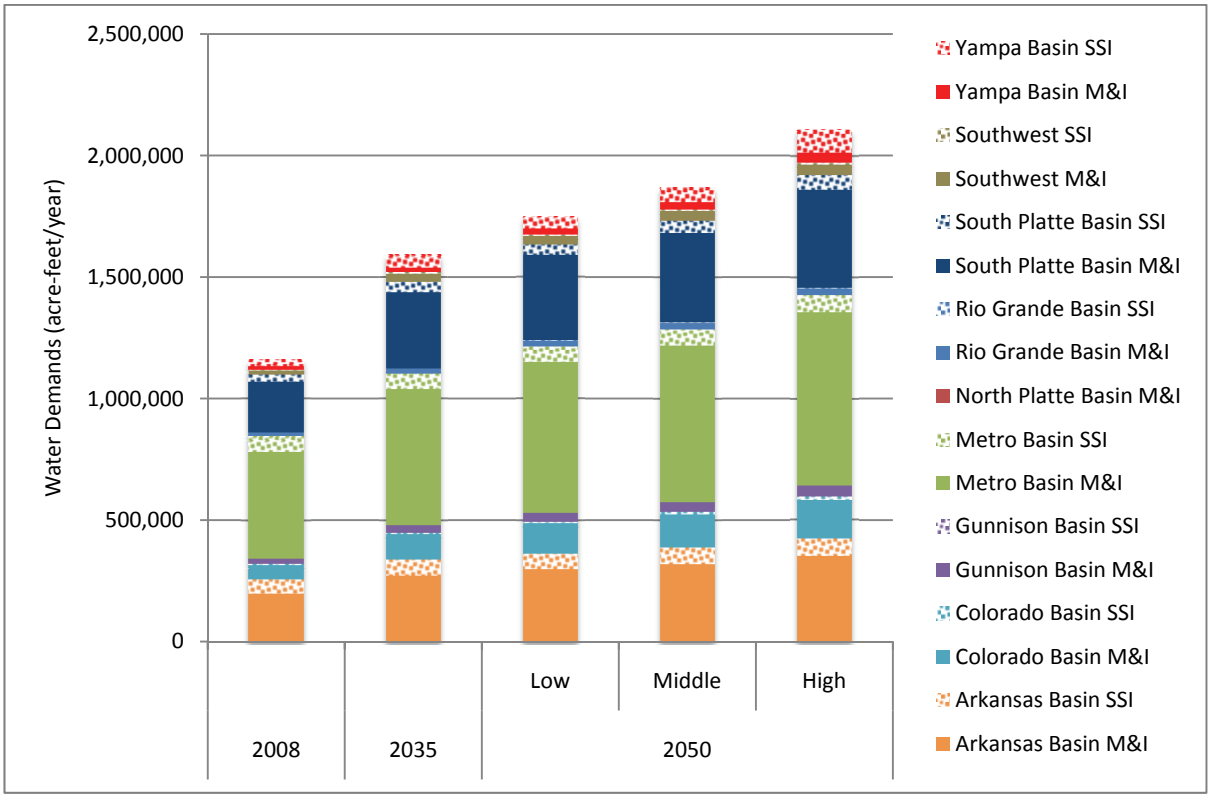


Figure ES-5 2050 M&I and SSI Demands by Basin

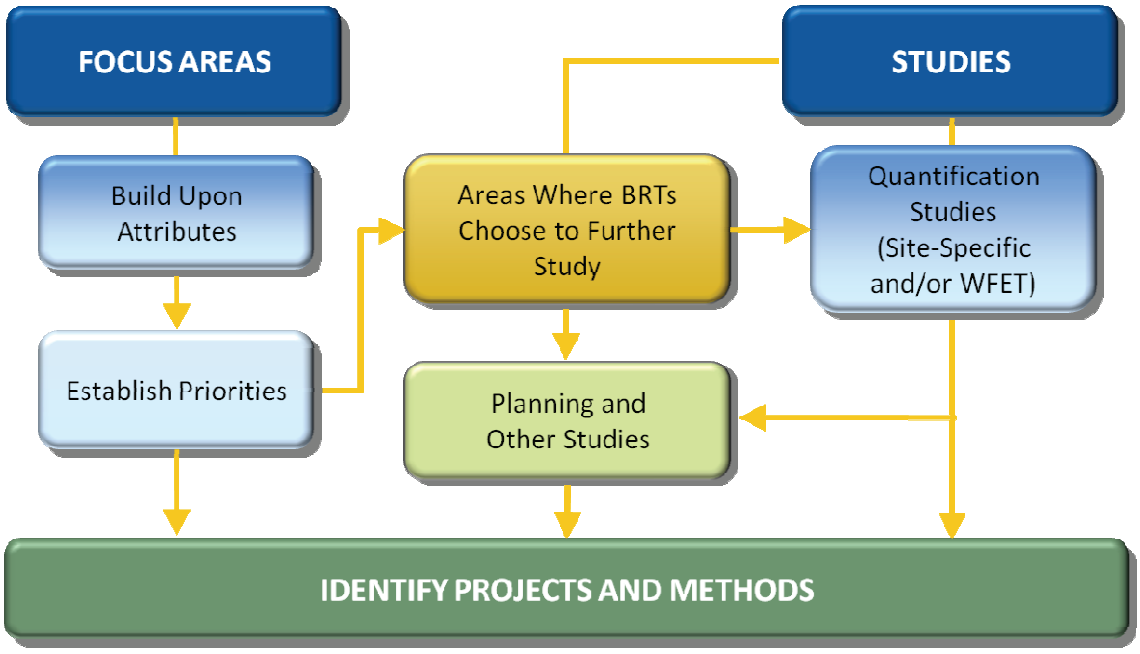


Figure ES-6 Nonconsumptive Needs Assessment Methodology

The focus area maps developed by each basin roundtable are based on a common set of environmental and recreational attributes and represent where Colorado's important water-based environmental and recreational attributes are located. The maps reflect stream reaches and subwatersheds with higher concentrations of environmental and recreational qualities. These maps were generated to provide information to the basin roundtables on important environmental and recreational areas in their basins but were not intended to dictate future actions. It should be noted that this effort has not identified all streams as important. The NCNAs are not intended to create a water right for the environment and will not diminish, impair, or cause injury to existing absolute or conditional water rights.

The environmental and recreational focus area maps can be used for the following purposes:

- The maps are intended to serve as a useful guide for water supply planning so that future conflicts over environmental and recreational needs can be avoided.
- The maps can assist in identifying environmental and recreational water needs status, such as where needs are being met, where additional future study may need to take place, or where implementation projects in the basin are needed.
- The maps can help basins plan for the water needs of species of special concern so that they do not become federally listed in the future.
- The maps can provide opportunity for collaborative efforts for future multi-objective projects.

Each basin developed a unique map showing focus areas with nonconsumptive environmental and recreational water needs.

Each basin developed a unique map showing focus areas with nonconsumptive environmental and recreational water needs. The resulting statewide compilation map is represented in Figure ES-7.

Consumptive Needs Assessments

The objectives of the consumptive needs part of this SWSI 2010 update effort are to:

- Update population projections and extend them to 2050
- Update M&I per capita estimates including passive conservation
- Extend the SWSI 1 consumptive water use projections to 2050 for the M&I sector
- Update the SSI sector forecast to 2050
- Update the current tally of irrigated acres throughout Colorado and forecast irrigated acres in 2050
- Update current agricultural demands and shortages and forecast 2050 agricultural demands

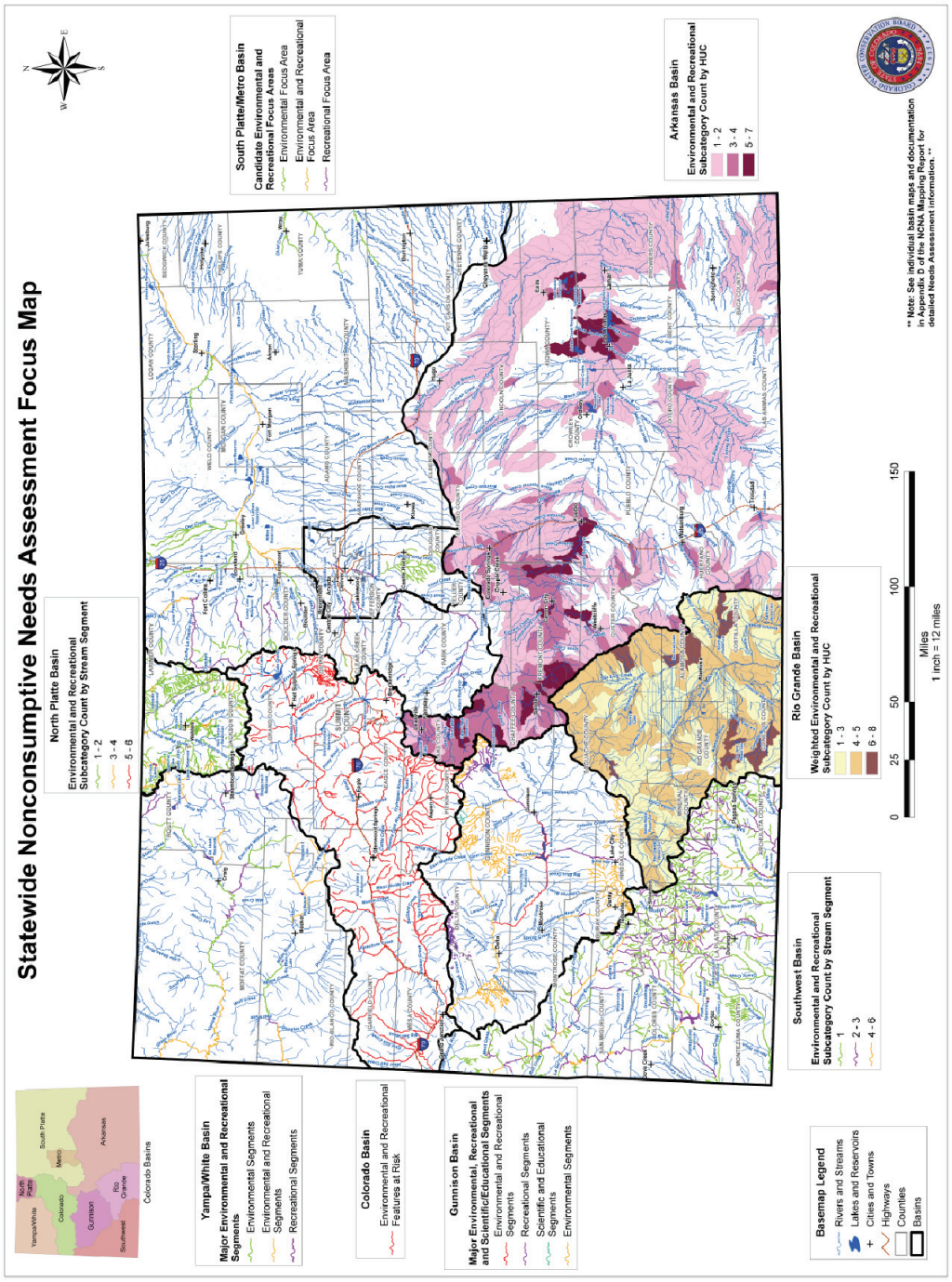


Figure ES-7 Nonconsumptive Needs Assessment Focus Map

M&I and SSI Consumptive Needs

Projected Water Use

The relative proportions of surface diversions for agricultural, M&I, and SSI gross water use in 2050 are depicted in Figure ES-8. By 2050 agriculture will continue to use the majority of Colorado's water supply. It is projected to decline from 89 percent today to 82 percent in 2050. M&I is projected to account for 15 percent of surface water diversions in 2050 and SSI about 3 percent.

2050 Population Projection Results

Between the year 2008 and 2050, the state of Colorado is projected to grow from approximately 5.1 million people to between 8.6 million and 10 million people. Under low economic development assumptions, the state's population is projected to grow to about 8.6 million people, or by about 70 percent. Under high economic development assumptions, including a 550,000 barrel per day oil shale industry, the state's population is projected to grow to just over 10 million people, or by 98 percent, as compared to the year 2008. On average, statewide population projections from 2008 forward indicate an increase of about 1.4 million people every 15 years.

On average, statewide population projections from 2008 forward indicate an increase of about 1.4 million people every 15 years.

Table ES-1 and Figure ES-9 show how population growth will vary across the state during the next 40 years. Based on these projections, the Arkansas, Metro, and South Platte Basins will continue to have the largest population in the state. However, the West Slope will continue to grow at a faster rate than the Front Range of Colorado.

Future M&I Water Demands

2050 M&I Water Demands Results

Colorado's population is projected to nearly double by the year 2050. Because the major driver for water use is population growth, M&I water usage is also expected to nearly double, even with savings from passive conservation.

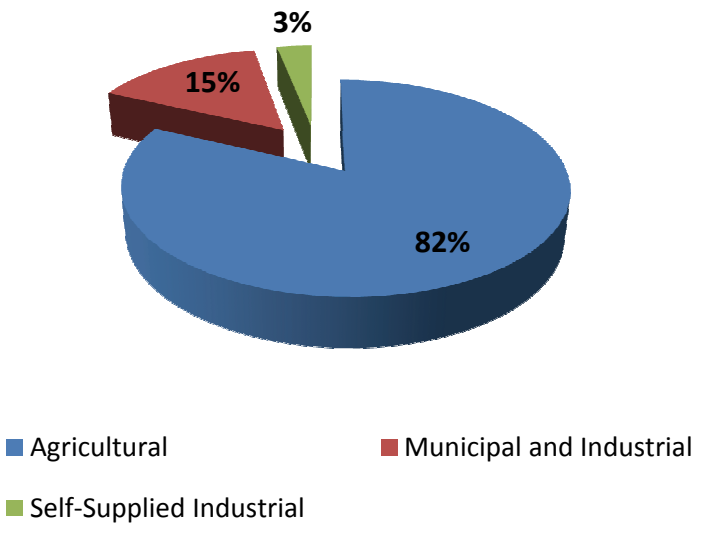


Figure ES-8 In 2050, Agriculture is still projected to utilize the majority of Colorado's water

Table ES-1 Population Projections by River Basin

Basin	2008	2035	Percent Change 2008 to 2035	Percent Average Annual Growth Rate	2050			Percent Change 2008 to 2050	Percent Average Annual Growth Rate
					Low	Medium	High		
Arkansas	948,000	1,451,000	53	1.6	1,581,000	1,688,000	1,841,000	67-94	1.2-1.6
Colorado	307,000	558,000	82	2.2	661,000	725,000	832,000	115-171	1.8-2.4
Gunnison	105,000	184,000	75	2.1	206,000	220,000	240,000	96-129	1.6-2.0
Metro	2,513,000	3,622,000	44	1.4	4,018,000	4,144,000	4,534,000	60-80	1.1-1.4
North Platte	1,500	1,800	20	0.7	2,000	2,200	2,500	33-67	0.7-1.2
Rio Grande	50,000	68,000	36	1.2	74,000	80,000	87,000	48-74	0.9-1.3
South Platte	977,000	1,622,000	66	1.9	1,808,000	1,902,000	2,065,000	85-111	1.5-1.8
Southwest	105,000	185,000	76	2.1	204,000	224,000	249,000	94-137	1.6-2.1
Yampa-White	45,000	81,000	80	2.2	94,000	117,000	153,000	109-240	1.8-3.0
TOTAL	**5,051,500**	**7,772,800**	**54**	**1.6**	**8,648,000**	**9,102,200**	**10,000,000**	**71-98**	**1.3-1.6**

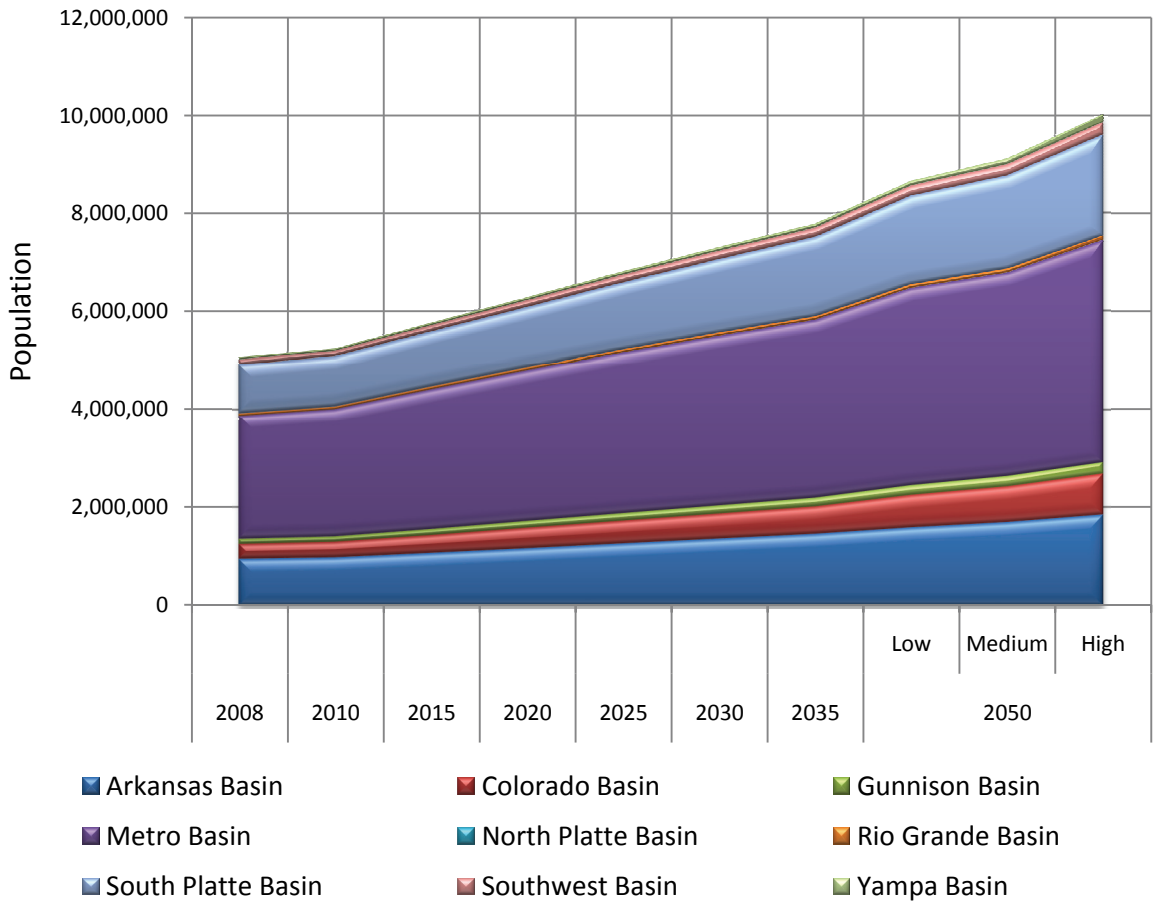


Figure ES-9 State of Colorado Population Projections through 2050

By 2050, Colorado will need between 538,000 and 812,000 AFY of additional water to meet municipal demands. Passive conservation savings are accounted for in these estimates and will result in approximately 150,000 AFY reduction or just over 8 percent decrease in M&I water demands by 2050 for the medium demand scenario relative to baseline conditions without passive conservation. The statewide current (2008) and future (2035 and 2050 low, medium, and high) water demands for baseline conditions and with passive conservation are summarized in Figure ES-10.

Colorado will need between 600,000 and 1 million acre-feet per year of additional M&I and SSI water by 2010.

Statewide SSI Demand Summary

Table ES-2 presents results of the SSI demand projections by basin. As shown, Moffat County could experience a significant increase in water demands, attributable to the electricity needed for energy development. Rio Blanco County could also experience a significant increase in water demands if the oil shale industry experiences significant growth. Both of these counties are located in the Yampa-White Basin. For the remaining counties and basins, increased demands are attributable to increases in thermoelectric power generation.

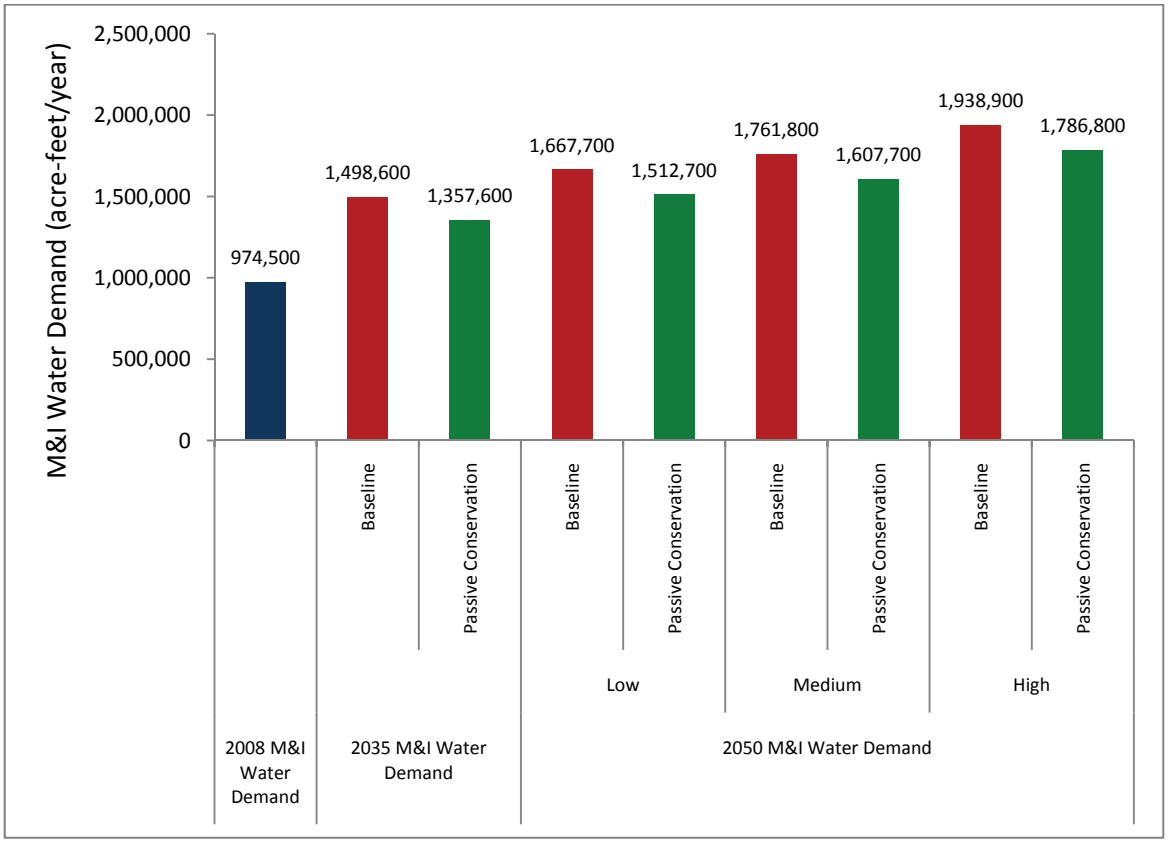


Figure ES-10 Comparison of M&I Demands for Baseline and with Passive Conservation

Table ES-2 Summary of Self-Supplied Industry Demands by Basin (AFY)

Basin	Sub-Sector	2008	2035	2050 Low	2050 Med	2050 High
Arkansas	Energy Development	—	—	—	—	—
	Large Industry	49,400	49,400	49,400	49,400	49,400
	Snowmaking	—	—	—	—	—
	Thermoelectric	9,000	14,700	15,400	18,400	22,100
	Total	58,400	64,100	64,800	67,800	71,500
Colorado	Energy Development	2,300	500	200	4,700	10,700
	Large Industry	—	—	—	—	—
	Snowmaking	3,180	4,740	4,740	4,740	4,740
	Thermoelectric	—	—	—	—	—
	Total	5,480	5,240	4,940	9,440	15,440
Gunnison	Energy Development	—	—	—	—	—
	Large Industry	—	—	—	—	—
	Snowmaking	260	650	650	650	650
	Thermoelectric	—	—	—	—	—
	Total	260	650	650	650	650
Metro	Energy Development	—	—	—	—	—
	Large Industry	52,400	52,400	52,400	52,400	52,400
	Snowmaking	—	—	—	—	—
	Thermoelectric	12,000	12,000	12,600	15,000	17,900
	Total	64,400	64,400	65,000	67,400	70,300
Rio Grande	Energy Development	—	600	1,200	1,500	2,000
	Large Industry	—	—	—	—	—
	Snowmaking	—	—	—	—	—
	Thermoelectric	—	—	—	—	—
	Total	—	600	1,200	1,500	2,000
South Platte	Energy Development	—	—	—	—	—
	Large Industry	6,600	6,600	6,600	6,600	6,600
	Snowmaking	320	320	320	320	320
	Thermoelectric	21,400	35,400	37,200	44,400	53,100
	Total	28,320	42,320	44,120	51,320	60,020
Southwest	Energy Development	—	—	—	—	—
	Large Industry	—	—	—	—	—
	Snowmaking	410	410	410	410	410
	Thermoelectric	1,900	3,900	4,100	4,900	5,900
	Total	2,310	4,310	4,510	5,310	6,310
Yampa-White	Energy Development	2,000	6,000	3,900	7,500	41,800
	Large Industry	6,100	9,500	9,500	9,500	9,500
	Snowmaking	290	570	570	570	570
	Thermoelectric	20,200	38,300	36,700	40,500	44,000
	Total	28,590	54,370	50,670	58,070	95,870
Total All Basins		**187,760**	**235,990**	**235,890**	**261,490**	**322,090**

Figure ES-11 summarizes projected SSI water usage statewide by subsector, indicating that among SSI needs, the large industry, thermoelectric, and energy development subsectors are projected to use the most water in the future. Future SSI demands are projected to range from 236,000 AFY to 322,000 AFY by 2050, an increase of 48,000 AFY to 134,000 AFY over current (2008) demands.

Statewide 2050 M&I and SSI Consumptive Needs Summary

Of the many factors affecting M&I water use, the projected increases in population clearly drive the increases in M&I use from 2008 to 2050. Figure ES-12 summarizes statewide M&I and SSI water use projections, including reductions as a result of passive conservation measures, for 2008, 2035, and the low, medium, and high scenario 2050 projections. Total statewide 2035 water demands are projected to be nearly 1.6 million AFY. 2050 water demands are projected to range from approximately 1.75 million AFY to nearly 2.1 million AFY. Figure ES-12 also shows that M&I water demands are estimated to exceed SSI demands for all of the future projections.

Figure ES-13 summarizes statewide existing water use and future water demands. Gross statewide M&I demands including oil shale and other SSI water demands for the low, medium, and high scenario projections are 1.75 million AFY, 1.9 million AFY, and 2.1 million AFY, respectively. These projections include passive conservation savings, but do not include the impacts of active water conservation efforts that are being implemented and planned by many M&I water providers. Current water use is just over 1.1 million AFY.

The following are the major conclusions from Colorado's 2050 M&I water use projections:

- Colorado's population is expected to nearly double to between 8.6 and 10 million people by 2050.
- The Front Range will continue to be the most populous place in Colorado with over 80 percent of the state's population residing in the Arkansas, Metro, and South Platte Basins. The Front Range is expected to grow by approximately 70 percent.
- The West Slope will grow at the fastest rate of any area in Colorado between now and 2050. Population on the West Slope is expected to more than double in the next 40 years with some growth rates as high as 240 percent.
- Statewide M&I water usage rates have decreased by 18 percent. This decrease is due to a combination of drought response, conservation savings, and additional data collection efforts. Additional data collected during this effort has improved the original SWSI water usage information.
- Because population growth is the driving factor in water use across the state, water use is also expected to nearly double by 2050.
- Passive conservation will save approximately 150,000 AFY by 2050 or an 8 percent savings relative to baseline 2050 M&I water demands.
- The basins with the largest SSI water usage in 2050 are projected to be the Yampa-White, Arkansas, Metro, and South Platte Basins.
- Colorado will need approximately 600,000 AFY to 1 million AFY of additional M&I and SSI water by 2050. These estimates incorporate new water demands from population growth, energy, and other SSI needs (including oil shale), and replacement of nontributary groundwater.
- An oil shale industry producing 1,550,000 barrels of oil/day could use between 0 to 120,000 AFY depending upon what technologies and other factors are implemented. Due to ramp up rates, by 2050 projected water use ranges from 0 to 44,000 AFY for an industry providing 550,000 barrels of oil/day.

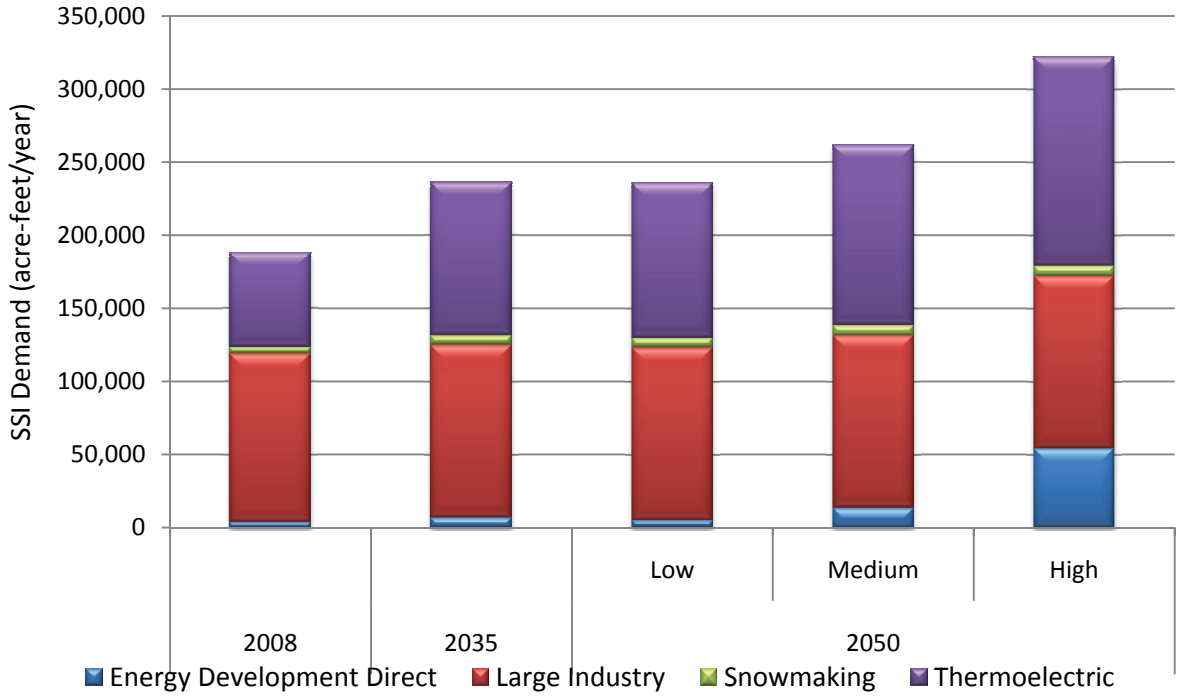


Figure ES-11 Statewide Self-Supplied Industrial Demands by Sector

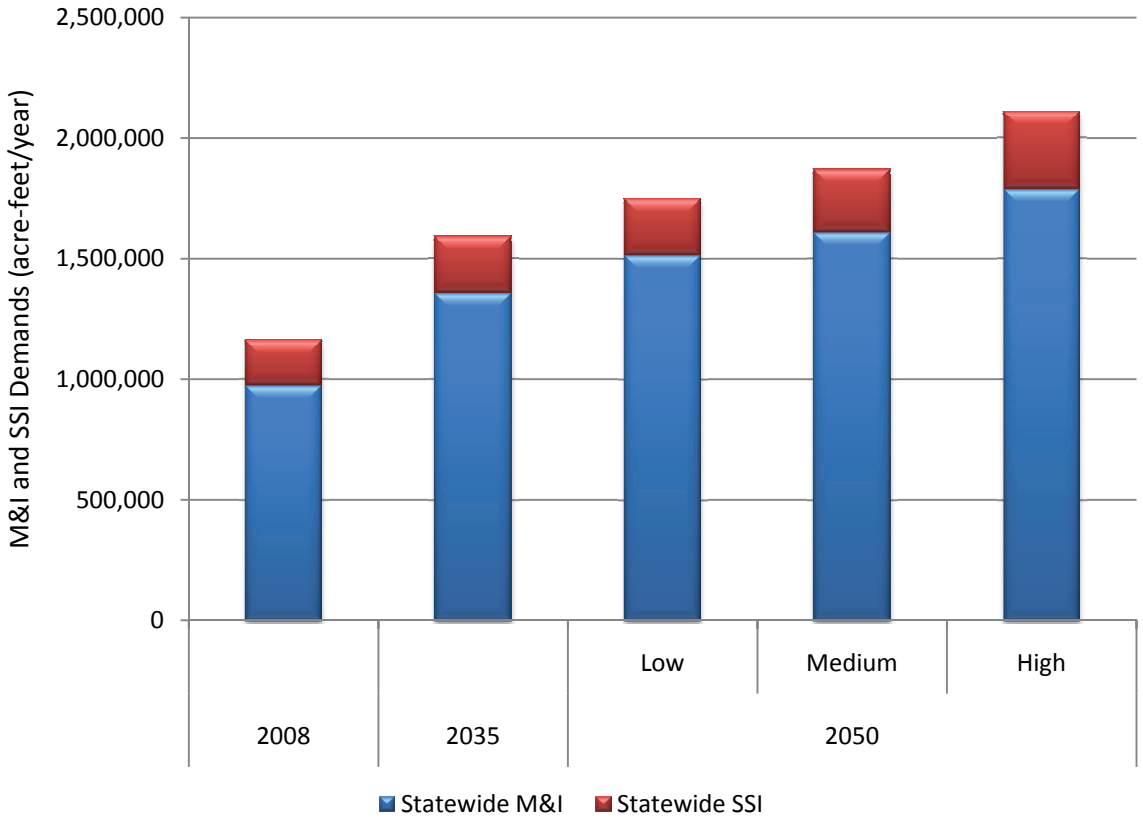


Figure ES-12 Statewide M&I and SSI Demands

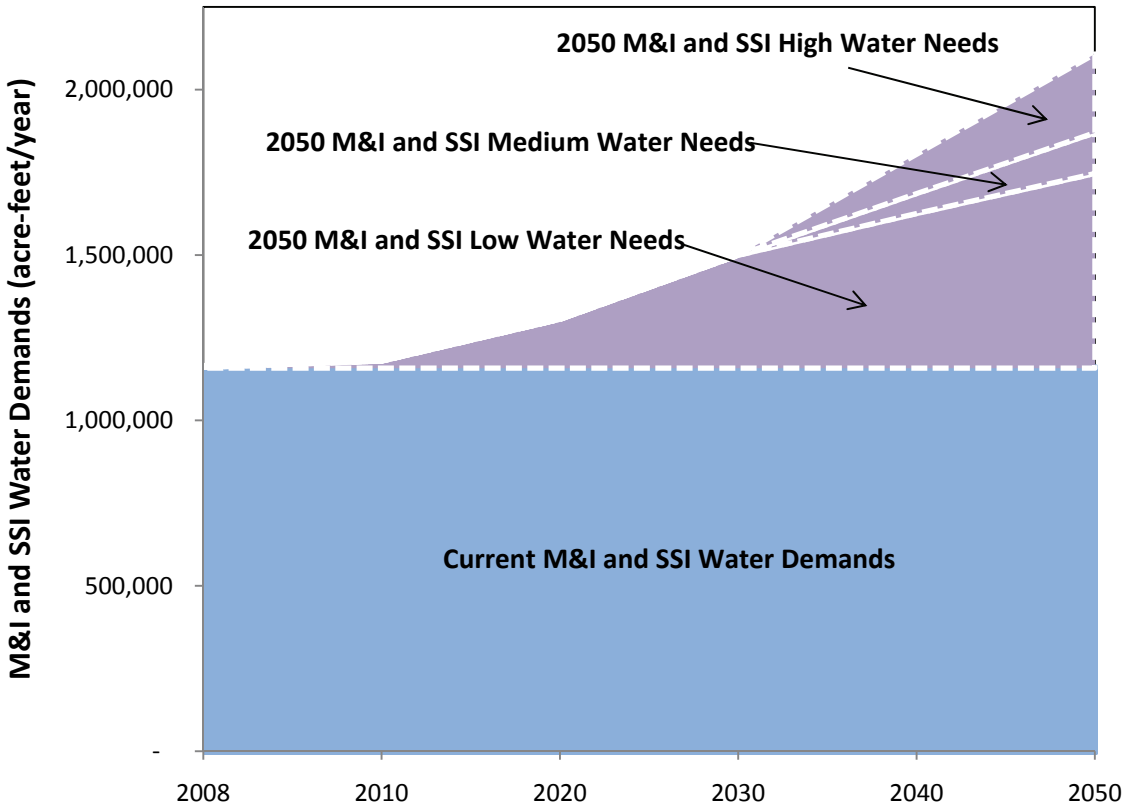


Figure ES-13 Existing and Future M&I and SSI Demands

Agricultural Consumptive Needs

Current Agricultural Demand Results

Each basin in Colorado faces continued water shortages associated with existing agricultural demands. Table ES-3 summarizes results of the average annual current agricultural demands and shortages by basin. It shows irrigated acres, Irrigation Water Requirement (IWR), Water Supply Limited Consumptive Use (WSL CU), and shortage (difference between IWR and WSL CU), and non-irrigation demand.

Figures ES-14 and ES-15 show the current WSL CU and shortage amounts by basin. Basins with the highest current agricultural water demand include the South Platte, Rio Grande, and Republican.

Future Agricultural Demand Results

There are upward economic pressures to keep agriculture viable, and some basins, such as the Yampa, are seeking to expand agriculture. However, the state could also face a significant decline in irrigated acres by 2050 due to urbanization and water transfers. As represented in Figure ES-16, between 500,000 and 700,000 irrigated acres could be dried up by 2050, and large-scale dry-up of irrigated agriculture has adverse economic and environmental impacts.

Table ES-3 Estimated Current Agricultural Demand by Basin

Basin	Irrigated Acres	Irrigation Water Requirement (AFY)	Water Supply-Limited Consumptive Use (AFY)	Shortage (AFY)	Non-Irrigation Demand (AFY)
Arkansas	428,000	995,000	542,000	453,000	56,000
Colorado	268,000	584,000	485,000	100,000	51,000
Gunnison	272,000	633,000	505,000	128,000	54,000
Metro and South Platte	831,000	1,496,000	1,117,000	379,000	115,000
North Platte	117,000	202,000	113,000	89,000	12,000
Republican	550,000	802,000	602,000	200,000	67,000
Rio Grande	622,000	1,283,000	855,000	428,000	45,000
Southwest	259,000	580,000	382,000	198,000	46,000
Yampa-White	119,000	235,000	181,000	54,000	24,000
Statewide Total	**3,466,000**	**6,819,000**	**4,791,000**	**2,028,000**	**470,000**

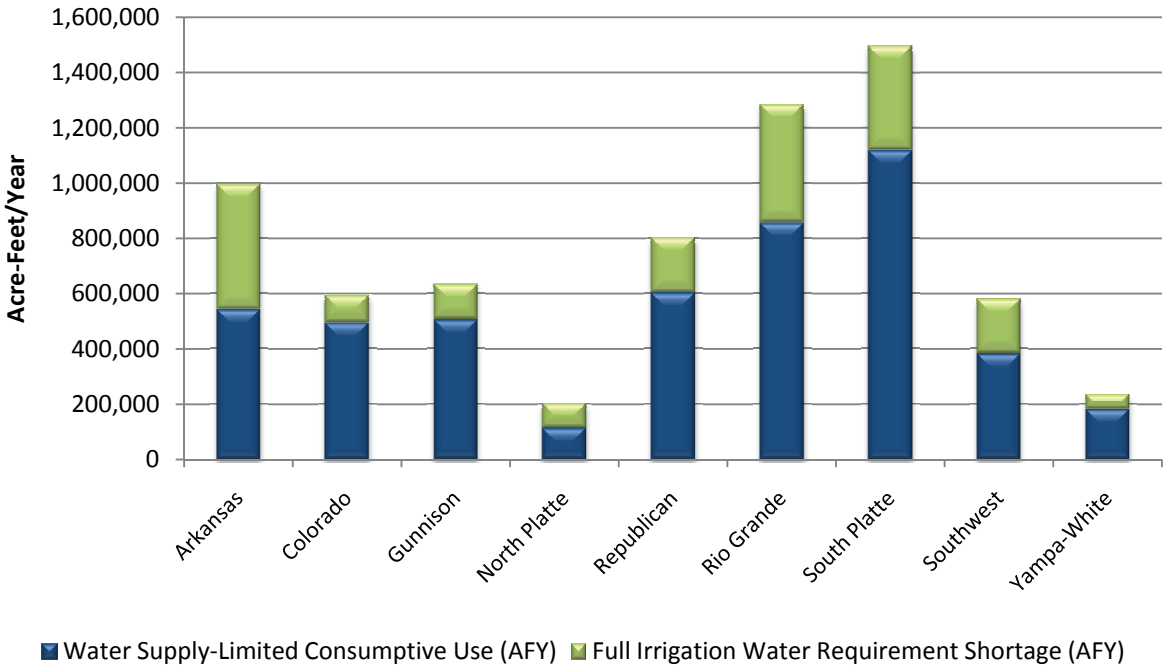


Figure ES-14 Current Agricultural Demands and Shortages

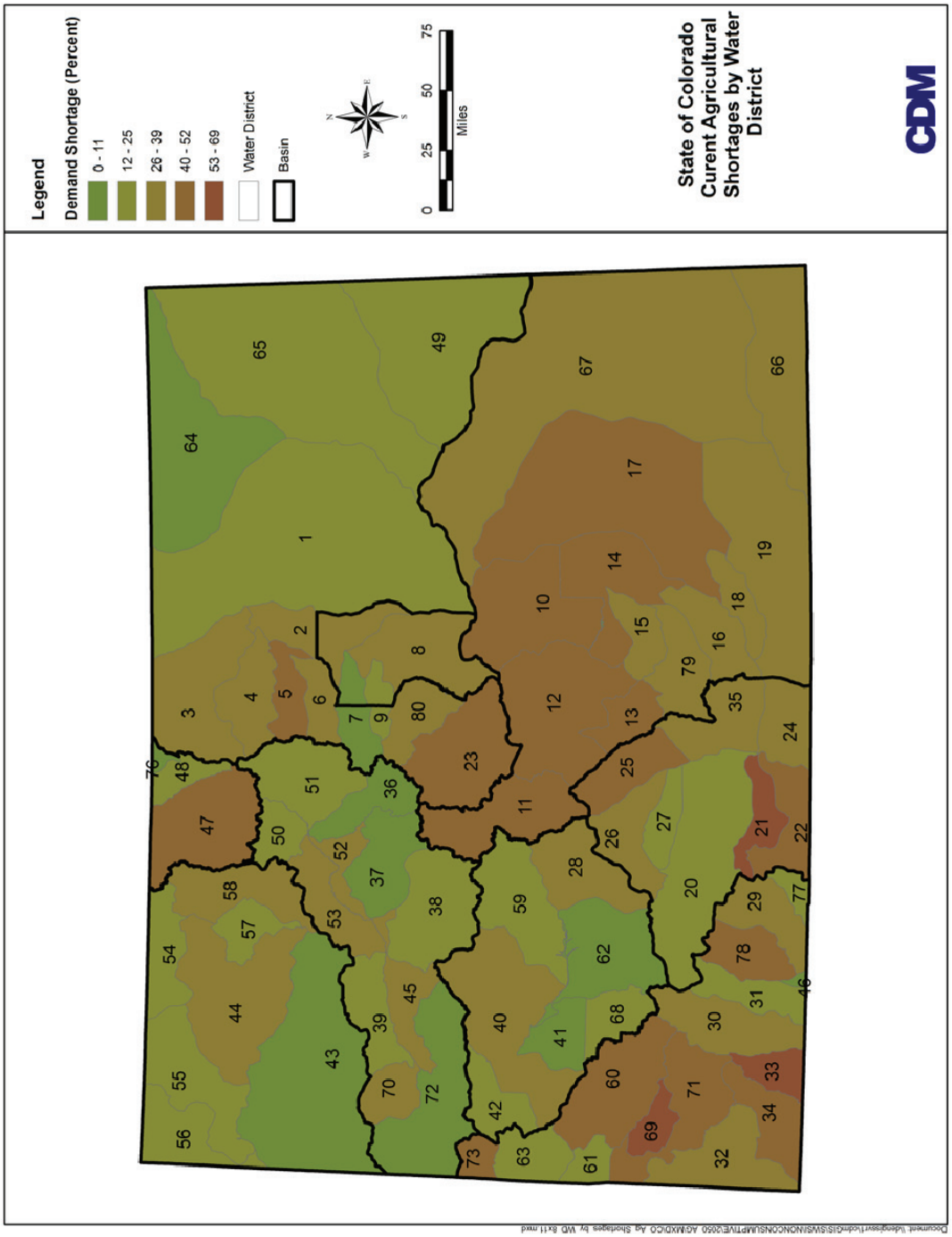


Figure ES-15 State of Colorado Current Agricultural Shortages by Water District

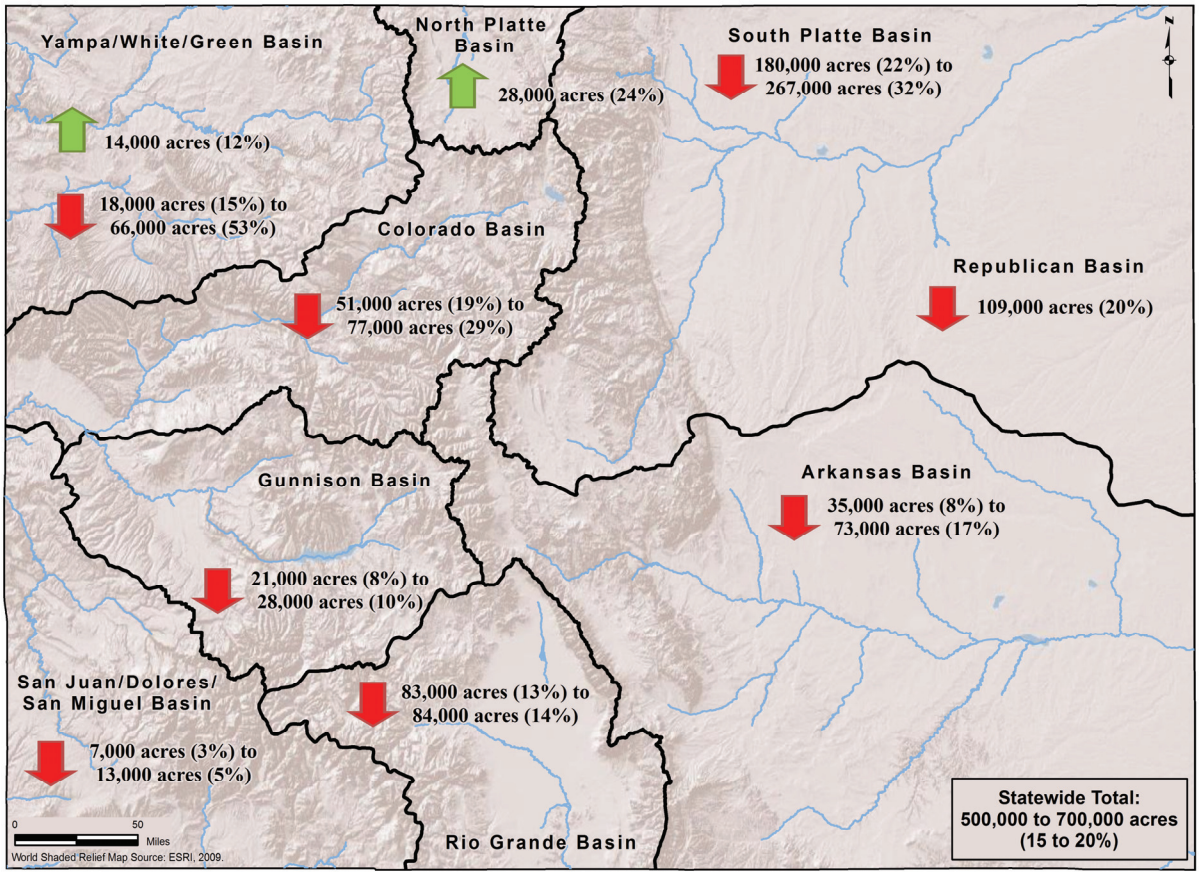


Figure ES-16 Potential Changes in Irrigated Acres by 2050

Table ES-4 summarizes the estimated average annual agricultural demand by basin for the year 2050, assuming that historical climate and hydrology continue into the future. It shows irrigated acres, IWR, WSL CU, shortage, and non-irrigation demand. Figure ES-17 shows the WSL CU and shortages by basin for the 2050 irrigated acres. Consistent with the projected decline in irrigated acres, declines in both irrigation and non-irrigation agricultural water demands are anticipated to occur in all basins except for the North Platte.

In 2050, Colorado's agricultural demands are projected to be approximately 4 million AFY as represented in Figure ES-17.

Projects and Methods to Meet Basin Needs

Projects and Methods to Meet M&I Consumptive Needs

The estimation of future M&I water supply gaps is dependent upon several factors, including current water use, forecasted future water use, and water provider predictions of new water supply that will be developed through identified projects and processes (IPPs). Statewide, these analyses were performed on a countywide basis and aggregated by basin roundtable area.

Table ES-4 Estimated 2050 Agricultural Demand by Basin

Basin	Irrigated Acres	Irrigation Water Requirement (AFY)	Water Supply-Limited Consumptive Use (AFY)	Shortage (AFY)	Non-Irrigation Demand (AFY)
Arkansas	373,000	862,000	476,000	386,000	49,000
Colorado	204,000	443,000	366,000	77,000	38,000
Gunnison	219,000	573,000	457,000	116,000	48,000
North Platte	145,000	250,000	140,000	110,000	14,000
Republican	441,000	640,000	480,000	160,000	5,000
Rio Grande	537,000	1,108,000	739,000	369,000	38,000
South Platte	607,000	1,094,000	820,000	274,000	84,000
Southwest	249,000	558,000	367,000	191,000	44,000
Yampa-White	85,000	209,000	170,000	39,000	17,000
Statewide Total	**2,860,000**	**5,737,000**	**4,015,000**	**1,722,000**	**337,000**

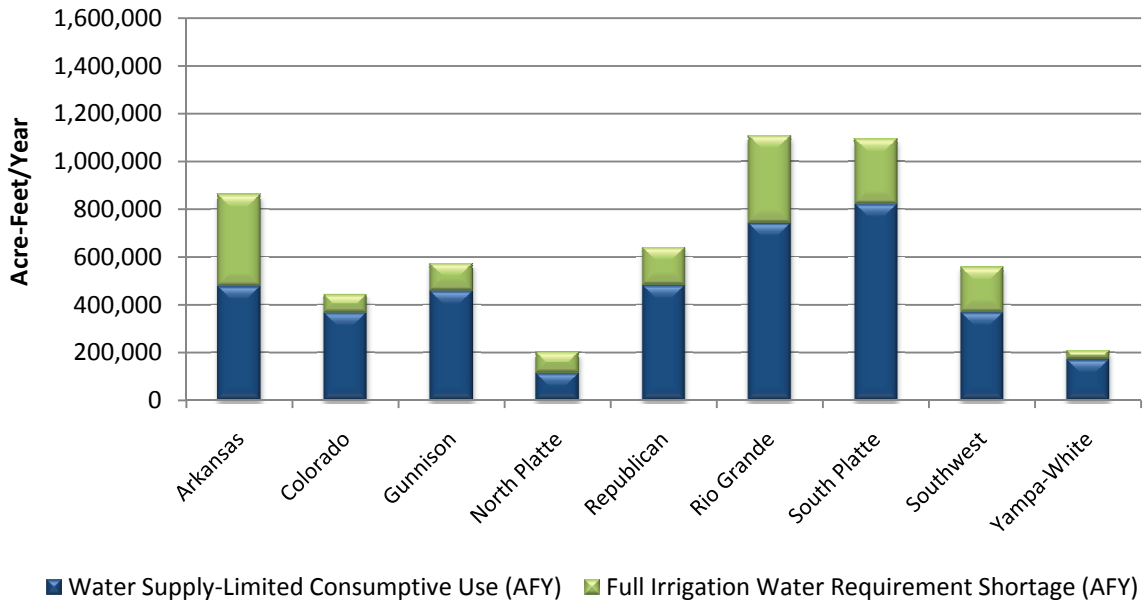


Figure ES-17 2050 Agricultural Demands and Shortages

Water providers throughout Colorado are pursuing water supply projects and processes to help meet future water demands. These IPPs, if successfully implemented, have the ability to meet some, but not all of Colorado's 2050 M&I water needs. IPPs are defined as projects and methods local water providers are counting on to meet future water supply needs. IPPs include:

- Agricultural water transfers
- Reuse of existing fully consumable supplies
- Growth into existing supplies
- Regional in-basin projects
- New transbasin projects
- Firming in-basin water rights
- Firming transbasin water rights

Table ES-5 identifies the anticipated range of IPP yield from each category for each basin at the 100 percent success rate.

As shown in Table ES-5, if 100 percent of the IPPs are successfully implemented they would provide 430,000 to 580,000 AFY. The largest categories of IPP yields by volume are projected to be regional in-basin projects (150,000 AFY to 170,000 AFY) and growth into existing supplies (100,000 AFY to 160,000 AFY). Figure ES-18 depicts the data graphically.

Implementation of these local projects and processes are critical to meeting Colorado's future water supply needs.

M&I Consumptive Gap Analysis

Colorado faces a significant M&I water supply gap in 2050. The M&I gap varies between 190,000 and 630,000 AFY depending on the success rate of the IPPs. By 2050, Colorado's M&I gap could be between 32 percent and 66 percent of new M&I demands.

Table ES-5 Major Categories of Identified Projects and Processes by Basin (Yields at 100% Success Rate) [1]

Basin	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Arkansas	9,200 – 11,000	23,000 – 32,000	2,300 – 2,600	37,000	0	6,100 – 7,300	10,000 – 11,000	88,000 – 100,000
Colorado	2,900 – 8,000	500	14,000 – 28,000	13,000 – 15,000	0	11,000 – 19,000	0	42,000 – 70,000
Gunnison	400 – 500	0	1,100 – 1,700	11,000 – 15,000	0	900	0	14,000 – 18,000
Metro	20,000 – 33,000	14,000 – 21,000	55,000 – 86,000	34,000 – 39,000	13,000 – 23,000	900 – 1,400	3,500 – 4,800	140,000 – 210,000
North Platte	0	0	100 – 300	0	0	0	0	100 – 300
Rio Grande	0	0	2,900 – 4,300	0	0	3,000 – 4,300	0	5,900 – 8,600
South Platte	19,000 – 20,000	5,000 – 7,000	20,000 – 30,000	37,000 – 39,000	0	22,000 – 26,000	18,000 – 21,000	120,000 – 140,000
Southwest	0	0	5,200 – 7,300	9,000 – 13,000	0	0	0	14,000 – 21,000
Yampa-White	0	0	3,500 – 4,900	6,600 – 9,000	0	0	0	10,000 – 14,000
Total	**51,000 – 73,000**	**43,000 – 61,000**	**100,000 – 160,000**	**150,000 – 170,000**	**13,000 – 23,000**	**44,000 – 58,000**	**32,000 – 37,000**	**430,000 – 580,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

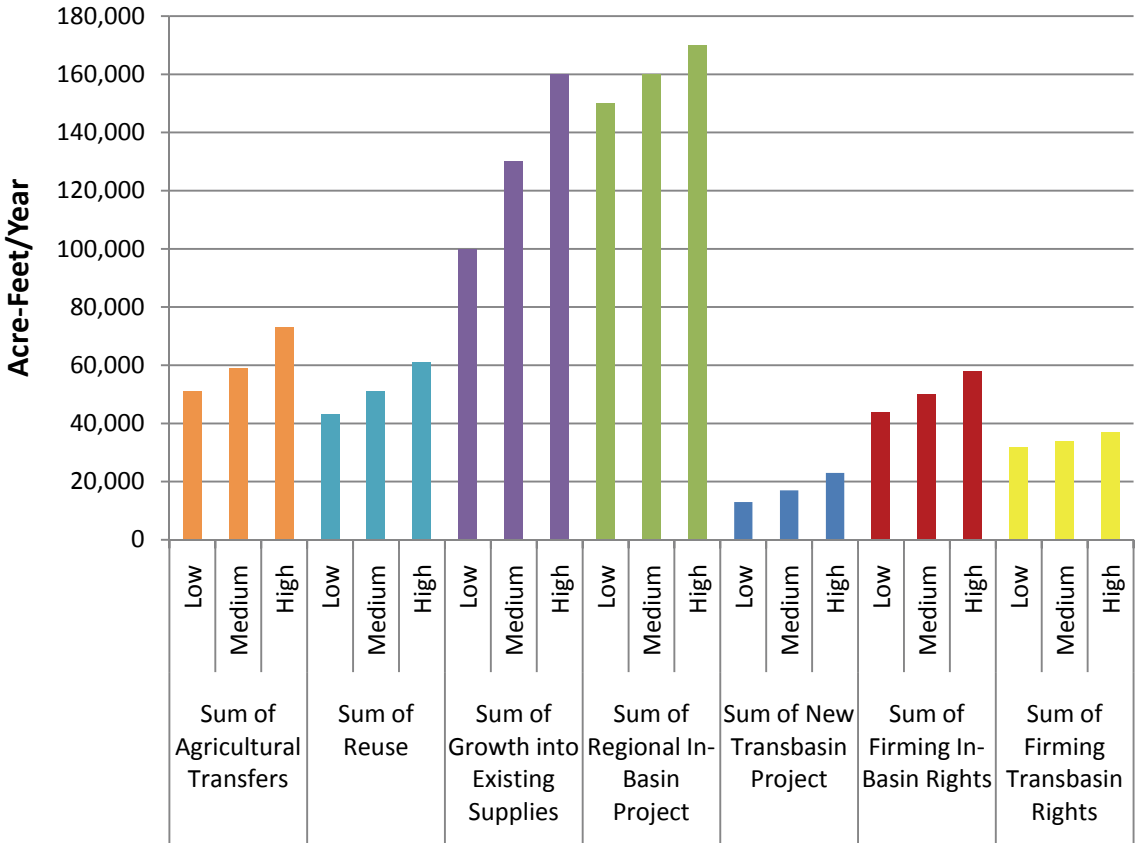


Figure ES-18 Statewide Summary of Yield for IPP Categories at 100 Percent Success Rate

Table ES-6 provides a summary of each basin's increased M&I and SSI demands relative to current conditions (defined for this study as 2008), the amount of that increase met by the IPPs, and the resulting M&I gap. The calculated gap values do not imply a future water supply shortfall; rather, the gap is representative of a future demand for which a project or method has not yet been identified.

SWSI 2010 estimated a low, medium, and high gap scenario. Under the low gap scenario (low demands and 100 percent IPP success rate), the statewide gap is 190,000 AFY. Under the medium gap scenario (medium demands and an alternative IPP success rate), the statewide gap is 390,000 AFY. Under the high gap scenario (high demands and status quo IPP success rate), the statewide gap is 630,000 AFY.

Figure ES-19 illustrates the timing of the M&I gap under the medium gap scenario. Colorado faces immediate M&I water supply needs. Under the medium gap scenario, these immediate needs are met with the successful implementation of the IPPs. The associated yield of the IPPs increases between 2010 and 2030. Under the medium gap scenario, the IPPs are implemented by 2030 and yield about 350,000 AFY. Without the successful implementation of additional IPPs, increases in demand after 2030 are assumed to be gap, leading to a 2050 M&I gap of 390,000 AFY.

This figure does not represent a definitive timeline. Instead, it represents the evolving temporal relationship between existing supplies, IPPs, and the gap, the sum of which is equal to total M&I and SSI demands at any point in time.

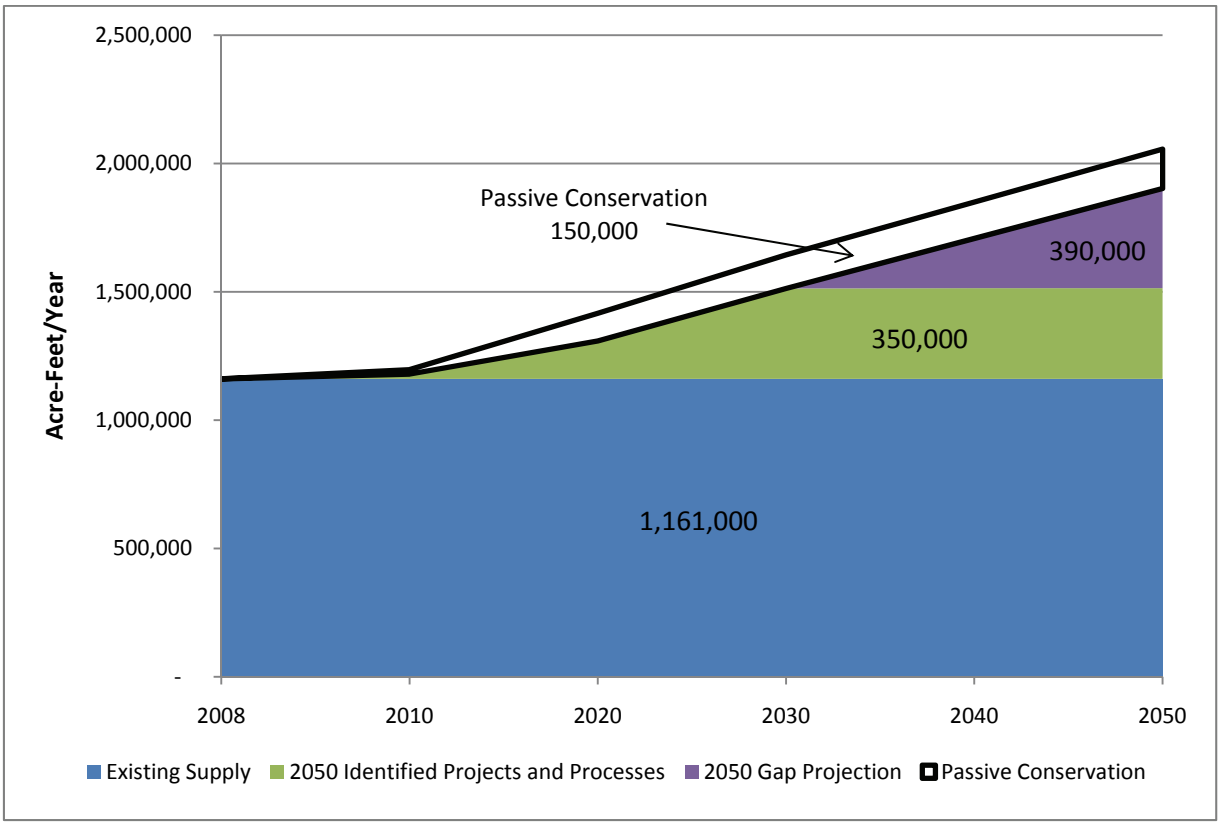
Table ES-6 Statewide M&I and SSI Gaps in 2050[1]

Basin	Increase in M&I and SSI Demand (AFY)			Estimated Yield of Identified Projects and Processes (AFY)			Estimated Remaining M&I/SSI Gap after Identified Projects and Processes (AFY)		
				100% IPP Success Rate	Alternative IPP Success Rates	Status Quo IPP Success Rates	Gap at 100% IPP Success Rate	Gap at Alternative IPP Success Rates	Gap at Status Quo IPP Success Rates
	Low	Med	High	Low	Med	High	Low	Med	High
Arkansas[2]	110,000	140,000	170,000	88,000	85,000	76,000	36,000	64,000	110,000
Colorado	65,000	82,000	110,000	42,000	49,000	63,000	22,000	33,000	48,000
Gunnison	16,000	19,000	23,000	14,000	14,000	16,000	2,800	5,100	6,500
Metro[3]	180,000	210,000	280,000	140,000	97,000	100,000	63,000	130,000	190,000
North Platte	100	200	300	100	200	300	0	20	30
Rio Grande	7,700	9,900	13,000	5,900	6,400	7,700	1,800	3,600	5,100
South Platte	160,000	180,000	230,000	120,000	78,000	58,000	36,000	110,000	170,000
Southwest	20,000	25,000	31,000	14,000	13,000	15,000	5,100	12,000	16,000
Yampa-White	34,000	48,000	95,000	10,000	11,000	13,000	23,000	37,000	83,000
Total	**590,000**	**710,000**	**950,000**	**430,000**	**350,000**	**350,000**	**190,000**	**390,000**	**630,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales

[2] Arkansas gaps include additional 13,500 AFY for Urban Counties replacement of nonrenewable groundwater supplies.

[3] Metro gaps include additional 20,850 AFY for South Metro replacement of nonrenewable groundwater supplies.



ES-19 Statewide M&I and SSI Gap Summary Medium Scenario (IPPs at 70% Yield)

Figure ES-20 illustrates the relative percentages of 2050 net new water needs occupied by IPPs and the gap for each basin for the medium gap scenario. The pie chart shown on the map for each basin is scaled to represent the magnitude of the 2050 medium demand, the blue represents the yield from the IPPs under the medium IPP success rate for each basin, and red represents the remaining gap.

Projects and Methods to Meet Nonconsumptive Needs

Similar to the M&I IPPs, CWCB conducted an analogous outreach effort with the environmental and recreational community and the basin roundtables to identify nonconsumptive projects and methods. CWCB digitized the project information into a geographic information system and compared this information with the nonconsumptive focus areas summarized previously. With this information, CWCB preliminarily identified nonconsumptive focus areas with and without projects and methods. Note that if a focus area does not have an associated project and method it does not mean that the area is in need of a protective project or method. Conversely, if an area does have one or more projects and methods, it does not mean it is sufficiently protected. The basin roundtables will use this information as they finalize their needs assessments during 2011. This information is intended to assist the basin roundtables in addressing the following questions:

1. Are there existing protections/efforts for environmental and recreational focus areas?
2. Are there areas without protections that need further study?

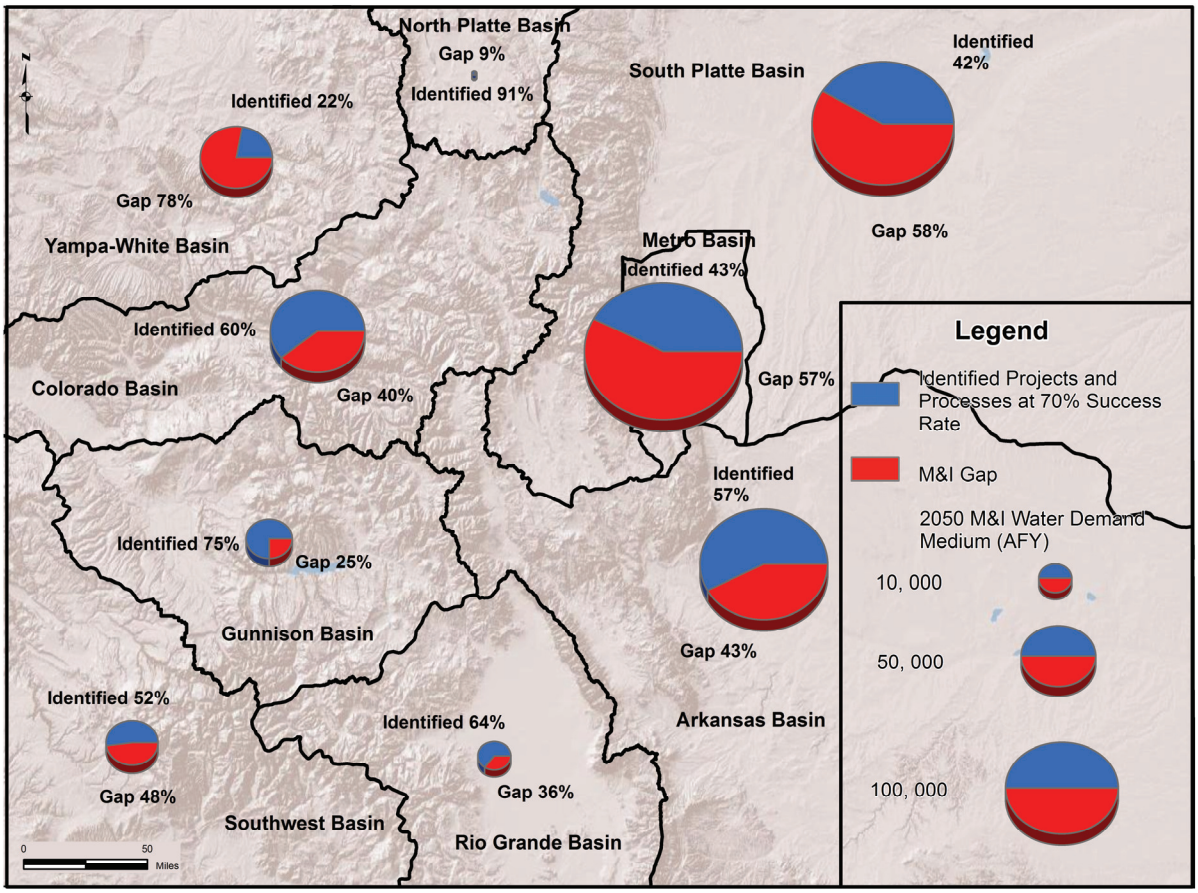


Figure ES-20 2050 M&I and SSI Gap Analysis – Medium Gap Scenario

3. What strategies are needed to support nonconsumptive priority areas?
4. Are there areas where new flow or water level quantification is appropriate?
5. Are there areas where a project, whether structural (e.g., river restoration) or nonstructural, can be identified and implemented?
6. Are there areas where no action is needed at this time?

In summary, environmental and recreational values will continue to be important to the state's economy and quality of life. Although Colorado has many existing projects and methods aimed at meeting these nonconsumptive values, additional projects and methods will be needed to meet Colorado's nonconsumptive water supply needs, especially in warmer waters with endangered, threatened, and imperiled species.

Key findings are:

- Nonconsumptive focus areas were identified on 33,000 miles of streams and lakes in the state with water related environmental and recreational values. Nearly one-third of these focus areas have an identified project or method to support one or more of the nonconsumptive values in the area.
- The focus areas include 12,000 stream miles that have cold water fisheries (e.g., cutthroat trout species and important fishing areas). Of these, nearly 50 percent have an identified project or method to support those values.
- The focus areas include 11,000 stream miles that have warm water fisheries (e.g., Colorado River endangered fish, and species of special concern, such as roundtail chub and Arkansas darter). Of these, approximately 30 percent have an identified project or method to support those values.

Water Availability

Surface Water Supply Availability

Supplies are not necessarily where demands are and localized shortages exist, especially in headwaters areas. Colorado River compact entitlements are not fully utilized. In the South Platte, Arkansas, and Rio Grande Basins, unappropriated water is extremely limited.

The Colorado River Water Availability Study confirmed planning ranges that may be available from the Colorado River system to meet future needs and identified local water availability throughout the Colorado River Basins. Projects and methods to manage risk will be needed in order to develop new water supplies in the Colorado River system.

Groundwater Supply Availability

Between now and 2050, there will need to be a decreased reliance on nonrenewable, nontributary groundwater as a permanent water supply. Without this, there are reliability and sustainability concerns in some areas, particularly along the Front Range.

In addition to meeting future M&I water needs, the South Metro area and northern El Paso County will need to replace nearly 35,000 AFY of nontributary groundwater with a renewable water supply.

Portfolios and Strategies to Address the M&I Gap

CWCB recognizes that Colorado faces significant and immediate water supply challenges and should pursue a mix of solutions to meet the

state's consumptive and nonconsumptive water supply needs.

Because of the growing M&I demands and the need to sustainably meet Colorado's nonconsumptive and agricultural water supply needs, the CWCB, IBCC, and Colorado's water community began a visioning process in 2008. Colorado's water community asked itself, if we let Colorado's water supply continue to develop according to current trends and existing policy, what will our state look like in 50 years? Is this our vision of the future of Colorado and if not, what can and should we do to effect changes? The visioning process included three parts—1) a Vision Statement; 2) Vision Goals; and 3) Water Supply Strategies.

The draft Vision Goals, which constitute Colorado's water management objectives, are as follows:

- Meet M&I demands
- Meet agricultural demands
- Meet Colorado's environment and recreation demands
- Encourage cooperation between water supply planners and land use planners
- Encourage more cooperation among all Colorado water users
- Optimize existing and future water supplies by:
  - Considering conservation as a baseline water supply strategy
  - Minimizing non-beneficial consumptive use (evaporation, nonnative phreatophytes, etc.)
  - Maximizing successive uses of legally reusable water
  - Maximizing use of existing and new in-basin supplies
- Promote cost-effectiveness by:
  - Allocating costs to all beneficiaries fairly
  - Achieving benefits at the lowest cost
  - Providing viable financing mechanisms, including local, state, and federal funding/ financing
  - Mitigating third-party economic impacts
- Minimize the net energy used to supply water, including both the energy used and/or generated with raw water delivery, and the energy used for treatment
- Protect cultural values by:
  - Maintaining and improving the quality of life unique to each basin
  - Maintaining open space
- Provide operational flexibility and coordinated infrastructure
- Promote increased fairness when water is moved between basins by:
  - Benefiting both the area of origin and the area of use
  - Minimizing the adverse economic and environmental impacts of future water projects and water transfers
- Comply with all applicable laws and regulations, meet all applicable compact obligations, and protect water rights including the right of water right owners to market their water, while recognizing some institutional changes may be needed to implement certain strategies
- Educate all Coloradoans on the importance and scarcity of water, and the need to conserve, manage, and plan for needs of this and future generations

The CWCB and IBCC have utilized the visioning process to address Colorado's future M&I Gap. As discussed previously, Colorado will need an additional 190,000 to 630,000 AFY beyond what is currently being planned for by local water providers in order to meet future M&I water demands and replace reliance on nonrenewable groundwater.

The visioning process led to the realization that the current approach for water management—the status quo—will not lead to a desirable future for Colorado. The status quo will likely lead to large transfers of water from agricultural to municipal uses. Maintaining the status quo could result in loss of agricultural lands, harm to ecosystems and

recreation based economies, water-inefficient land use decisions, and continued paralysis on water supply projects. In addition, costs associated with the status quo could cost Colorado's citizens billions of dollars more than a coordinated approach.

With the general agreement that the status quo approach to water management will not lead to a desirable future for Colorado, the IBCC and CWCB began scenario planning. Traditional planning efforts typically examine one predictive future. The scenario planning process is not intended to represent forecasts of the future, but to represent a wide range of potential future conditions that may impact M&I water supply and demand. A summary of the future scenarios is summarized in Figure ES–21.

As described above, the portfolio approach considers different future conditions and combinations of water supply strategies to address each scenario. Each ***scenario*** represents a different, but plausible, representation of circumstances that would result in differing statewide consumptive and nonconsumptive water demand and water supply. As shown in Figure ES-21, seven different future scenarios are being considered. ***Portfolios*** are combinations of strategies that collectively meet statewide water demands. Portfolios can be developed for each future scenario. ***Strategies*** are broad categories of solutions for meeting Colorado's consumptive and nonconsumptive water supply needs and include demand side strategies and supply side strategies. To date, the CWCB and IBCC have considered strategies for conservation, agricultural transfers, and new water supply development. Finally, the CWCB, IBCC, and basin roundtables have identified projects and methods to meet their future consumptive and nonconsumptive needs. ***Projects and methods*** are specific actions that help implement each strategy.

For example, a water project helps implement a new water supply development strategy, a rotational fallowing program helps implement an agricultural transfer strategy, and a block rate pricing program helps implement a conservation strategy.

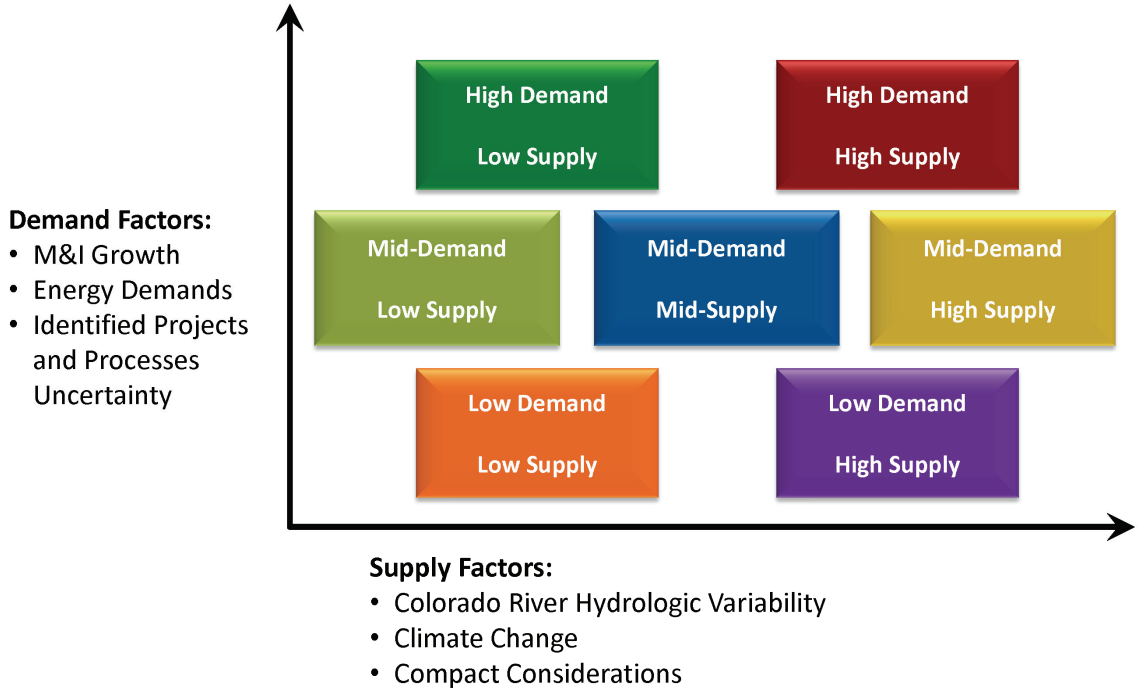
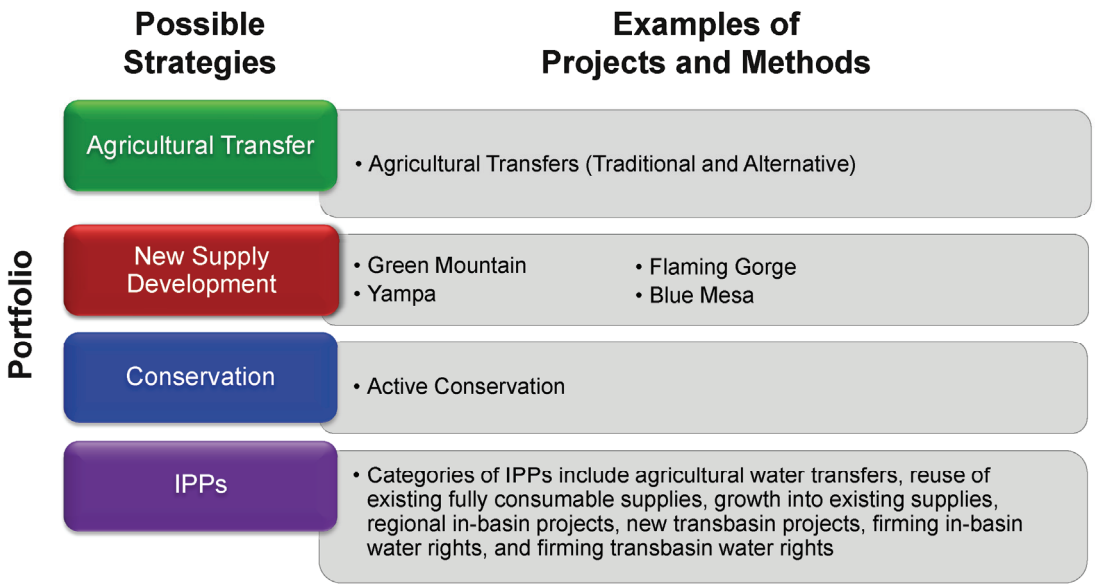


Figure ES-21 Colorado's Water Supply Future Water Demand and Supply Scenario

Figure ES-22 summarizes the portfolio elements that can be used to address future M&I demands. The left side of the figure shows the general category of the portfolio elements—agricultural transfer, new supply development, conservation, and IPPs. These portfolio elements represent strategies to address future M&I demands. The right side of the figure shows example projects and methods that could be used to implement the strategies.

After examining the trade-offs associated with the status quo portfolio, which relies mostly on traditional transfers of agricultural water to municipal uses using the portfolio and trade-off tool, the CWCB and IBCC found that it is clear that no one strategy can meet Colorado's growing water needs without harming values important to all Coloradoans. Therefore, a mix of solutions is needed and this mix of water supply solutions should include all four sources to meet the water supply gap in Colorado—conservation, IPPs, agricultural transfers, and new supply development—while also protecting Colorado's significant water-dependent ecological and recreational resources.

In summary, because the CWCB and IBCC have agreed that if Colorado's water supply continues to develop according to current trends, i.e., the status quo, this will inevitably lead to a large transfer of water out of agriculture resulting in significant loss of agricultural lands and potential harm to the environment. Providing an adequate water supply for Colorado's citizens, agriculture, and the environment will involve implementing a mix of local water projects and processes, conservation, reuse, agricultural transfers, and the development new water supplies, all of which should be pursued concurrently. To help weigh the trade-offs between possible mixes of strategies, the CWCB developed preliminary information for the following strategies— conservation, alternative and traditional agricultural transfers, and new supply development. It should be noted that at this time the CWCB and IBCC have agreed that a mix of strategies and solutions are necessary to meet Colorado's future M&I demands, however agreement has not been reached on what an alternative portfolio should include.



Fiaure ES-22 Portfolio Elements to Address Colorado's Future M&I Demands

Conservation Strategy

Water conservation will be an important tool for meeting future M&I demands, and is one piece of a larger water supply portfolio.

The CWCB defines water conservation as those measures and programs that provide for measurable and verifiable permanent water savings[1]. The purpose of the information provided in the conservation strategy is to update the range of potential future water conservation savings since SWSI 1 and 2, provide water conservation strategies that may contribute toward meeting the projected 2050 M&I water supply gap, and help address Colorado's future M&I water needs.[2]

The potential for future conservation by the year 2050 was estimated for three distinct conservation strategy scenarios titled simply—low, medium, and high. The conservation strategy looked at the potential savings from water conservation measures but did not determine the portion of those savings that could potentially be utilized toward meeting a future water supply gap. Water savings in 2050 were forecast for each river basin in Colorado using a conditional demand forecasting methodology that employed a set of efficiency targets, sectoral demand reductions, and assumed implementation rates. Each strategy includes an overview of the conservation measures and programs that could be implemented to achieve a range of efficiency targets (for indoor use) and estimated sectoral conservation savings that were based upon the best available literature and data on demand management. The conservation savings forecasts are conditional and rely on an assumption of implementation at the described levels in order to achieve the overall estimated savings level. The SWSI levels analysis of statewide passive water conservation potential showed that by 2050 demands will likely be reduced by about 150,000 AFY through the natural replacement of toilets, clothes washers, and other standard domestic fixtures. These passive savings are embedded in all three conservation strategies, but passive and active water savings estimates are presented separately (in Table ES-7) to help ensure double counting of water savings does not occur in the future as these estimates are used.

The conservation savings forecasts presented in the conservation strategy are intended for statewide planning purposes and are not intended to replace water conservation and water resources planning and projections prepared by local entities. There are also other important caveats and assumptions regarding the water conservation strategies that should be understood so that the results are not misinterpreted or misapplied.

Conditional Statewide Strategies to Assess Conservation Potential – These three strategies were used to prepare a conditional demand forecast. The savings estimates presented are expected to be achieved if the programs and measures described are implemented at the specified level across the entire state. The medium and high strategies in particular will require a significant and sustained effort in order to achieve the forecast water savings. The forecasting assumptions do not reflect differences that exist between individual water providers. Each water provider in Colorado is distinct and it is anticipated that over the next 40 years water conservation will be implemented differentially across the state. In order to prepare statewide forecasts of conservation potential it was assumed that the potential to conserve water may exist irrespective of an individual water provider's need or desire to conserve.

[1] Under this definition, water conservation may include measures and programs that are being implemented for political reasons and/or to improve customer satisfaction.

[2] Colorado's 2050 M&I water demands include water demands associated with SSI users – large industrial users that have their own water supplies or lease raw water from others. The potential water conservation savings provided in this SWSI 2010 update include only savings from the M&I demands associated with a typical municipal system. Potential SSI water savings are not estimated.

Table ES-7 Statewide Forecast Water Savings (separating passive and active) Potential from SWSI 1 and SWSI 2010[1]

Project	Level	2030 Forecast Savings[2] (AFY)	2050 Forecast Savings[2] (AFY)
SWSI Phase 1	Level 1 (Passive)	101,900	NA
	Level 2 (active only)	68,633	
	Level 3 (active only)	170,952	
	Level 4 (active only)	341,485	
	Level 5 (active only)	597,283	
SWSI 2010	Passive[3]	131,000	154,000
	Low (active only)	78,000	160,200
	Medium (active only)	133,000	331,200
	High (active only)	197,100	461,300

Notes:

1 Total water savings potential included, which does not decipher the portion of the savings that may be available to meet demands associated with new population versus other planning uses such as drought reserve.

2 Volumes savings estimates are total cumulative and include passive savings (e.g., SWSI 1, Level 3 savings build upon Levels 1 and 2; SWSI 2010, medium savings build upon low savings).

3 From SWSI levels analysis.

In reality, some providers will need little if any conservation savings to meet future demands while others will seek substantial demand reductions.

Permanency of Existing Conservation Efforts – The water savings projections in this report are conditioned on post-drought baseline demands, and assume water conservation savings since the 2002 drought period will be sustained into the future. The permanency of post-drought related reductions in water use is uncertain. Some of this uncertainty may be resolved as additional water utility-level data are obtained and further investigated. Additional and improved data is anticipated through future utility water conservation plans and under data reporting requirements established in Colorado HB 10-1051.

Climate Change Not Considered – The impacts of climate change on water demands were not included in this analysis. Time and budgetary limitation did not allow for this complexity to be included. Climate change is an important factor for consideration in conjunction with future water demands and should be included in subsequent forecasting efforts.

The Future is Uncertain and Water Use May Change – It is impossible to predict all of the technological and cultural changes that could occur over the next 40 years, which might impact water use. The trends over the past 15 years have been towards greater efficiency and lower use and at this moment in time, there is no indication that these trends will not continue. However, it is possible that new uses for water could emerge in the future, which might increase municipal demand (e.g., increased use of evaporative cooling, increased installation rates of swimming pools, spas, and/or multi-headed showering systems). Unanticipated demand increases could counteract some of the savings estimated in this report, even if conservation programs are implemented at the specified levels. Similarly, technology could also serve to reduce future water demands below those estimated here. Updating the baseline condition and demand forecasts regularly is the best way to incorporate unanticipated future changes.

Uses of Conserved Water Are Not Assumed – No assumptions have been made about the portion of the water savings forecast in this report that could potentially be utilized toward water supply, serving new customers, or meeting the M&I gap. Each water provider must decide how best to apply water garnered from demand reductions within their individual water supply portfolio. Utilities will need to make these decisions based on their integrated water resources planning efforts, consideration of their

system's reliability throughout drought periods, impacts of conservation on their return flows and availability of reusable supplies, effectiveness of water rates and impacts to their revenue streams, and other local considerations. Subsequent efforts will be needed to help determine what portion of active conservation savings can be applied to the M&I gap.

Impacts from New Construction – A substantial number of new homes and businesses will be constructed throughout the state between now and 2050. The projections provided for this basin-level planning effort do not distinguish between savings that will be achieved from existing versus new construction. Actual savings may be attributed more to higher efficiency new construction in portions of the state, particularly where more dense development occurs.

Land Use and Water Supply Planning

In 2009, the CWCB and the Western States Water Council conducted a Water and Land Use Planning symposium. This symposium brought together diverse participants from special districts, cities and counties, state and federal agencies, and nongovernmental organizations, including policy and decision-makers, planners, developers, and regulators to look at water and land use patterns, share experiences and concerns, identify problems and potential solutions, discuss obstacles and opportunities, and develop recommendations to better integrate and scale water and land use planning for a sustainable future. The group attending the symposium acknowledged that integrating water and land use planning at different scales is increasingly important as we strive to meet challenges related to growth, change, and sustainability in the arid West.

Overview of New Supply Development and Agricultural Transfer Strategies

In addition to conservation and the implementation of IPPs, the other portfolio elements include the transfer or agricultural water to M&I use and the development of new water supplies from the Colorado River system. The basic attributes of possible projects to implement the agricultural transfer and new supply development strategies are presented in Table ES-8 below and shown in Figure ES-23. Each of these concepts is based on projects that have been discussed in the past but may or may not be implemented.

For the Lower South Platte and Lower Arkansas concepts, the cost of water rights may decrease the further downstream the diversion is from urban areas; however, conveyance and treatment costs will increase accordingly. For the Flaming Gorge and Blue Mesa concepts, water supply would be acquired through the Bureau of Reclamation (BOR) marketable pool for each reservoir. For the other new supply development concepts the water supply would be a new acquisition. For both the Lower South Platte and Lower Arkansas concepts, reverse osmosis (RO) or advanced water treatment would be required due to source water quality. The new supply development concepts would not require advanced water treatment.

Table ES-8 New Supply Development and Agricultural Transfer Concept Attributes

Concept	Water Source/Water Rights	Conveyance and Storage	Water Quality and Treatment Costs
Lower South Platte	• South Platte agricultural rights	• 36 to 84 mile pipeline with static pumping requirement of 700 to 1,300 feet • Firming storage required	• RO or advanced water treatment will be required
Lower Arkansas	• Arkansas agricultural rights	• 96 to 133 mile pipeline with static pumping requirement of 3,100 to 3,600 feet • Firming storage required	• RO or advanced water treatment will be required
Green Mountain	• Blue River water in the Colorado River basin as well as new South Platte water rights	• 22 mile pipeline with static pumping requirement of 1,100 feet • Firming storage required	• Conventional treatment technology
Yampa	• New water rights appropriation	• 250 mile pipeline with static pumping requirement of 5,000 feet • Firming storage required	• Conventional treatment technology
Flaming Gorge	• Contract with BOR for water from the Flaming Gorge marketable pool	• 357 to 442 mile pipeline with static pumping requirements of 1,400 to 3,100 feet • Firming storage required	• Conventional treatment technology
Blue Mesa Reservoir	• Contract with BOR for water from the Aspinall marketable pool	• 81 mile pipeline with static pumping requirement of 3,400 feet • Firming storage required	• Conventional treatment technology

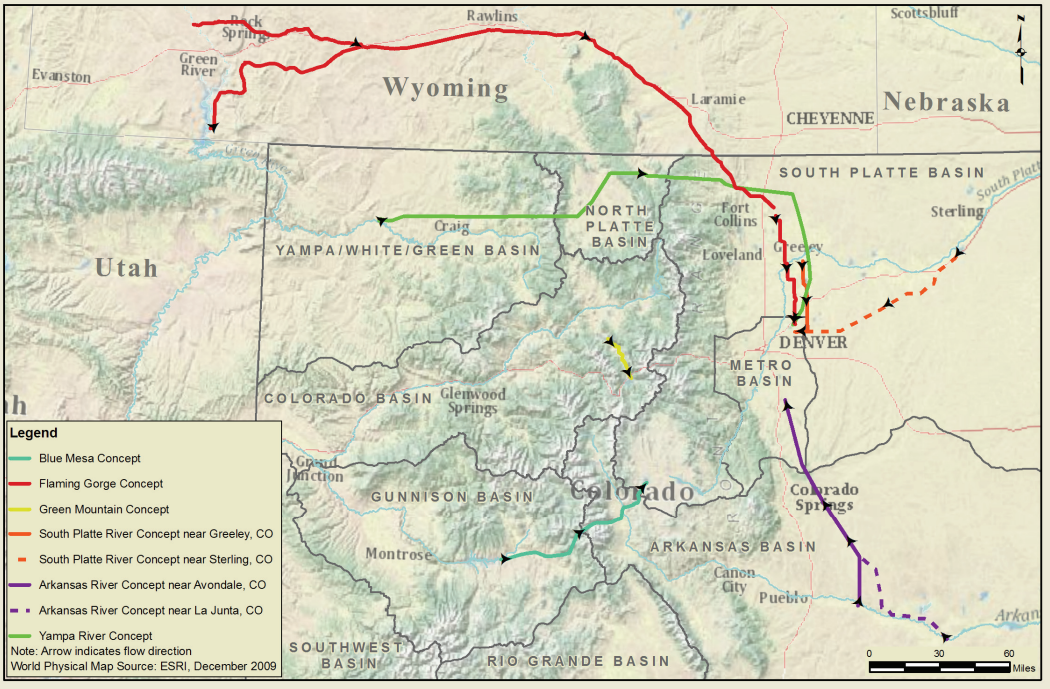


Figure ES-23 Overview of New Supply Development and Agricultural Transfer Concepts

Reconnaissance Level Capital and Operation and Maintenance Costs

With exception of the Green Mountain concept, which was assumed to deliver 68,000 AFY in a single phase, reconnaissance level cost estimates were developed for each of the concepts described above based on three options:

- Option 1: delivery of 100,000 AFY constructed in a single phase
- Option 2: delivery of 250,000 AFY constructed in a single phase
- Option 3: delivery of 250,000 AFY constructed with the first phase delivering 100,000 AFY and the second phase delivering the remaining 150,000 AFY

Key elements for each water supply concept were identified and evaluated using uniform assumptions to determine infrastructure requirements and sizing for the reconnaissance cost estimates. The following key elements were considered for each option—water rights, firming storage, transmission facilities (including pipelines, pump stations, and tunnels), diversion structures, water treatment, reuse, and engineering, legal and administrative costs including permitting.

Figure ES-24 shows the summary of the reconnaissance level capital costs for each of the concepts. The range of capital costs for all of the concepts is $840 million (Green Mountain) to $9.8 billion (Flaming Gorge Option 3). Although the new supply development concepts and agricultural transfer concepts are similar in total capital costs for each of the options, the relative percentages of subcomponent capital costs vary. For the agricultural transfer concepts, the majority of the capital cost is comprised of water rights acquisitions. For the new supply development concepts, the majority of the capital costs are associated with pipeline and pump stations.

Operation and maintenance costs for each concept are summarized in Figure ES-25.

Reconnaissance level annual operation maintenance range from $29 million per year (Green Mountain) to $273 million per year (Arkansas Option 3). The variability between concepts is due primarily to conveyance costs but differences between conventional treatment (Yampa, Blue Mesa, Green Mountain, and Flaming Gorge) and RO with zero liquid discharge (South Platte and Arkansas) also contribute to the variation.

Reconnaissance Life Cycle Costs

CWCB also developed reconnaissance level life cycle costs for all concepts. Life cycle costs allow comparison of not only the capital costs, but also the operational costs associated with the concepts, all brought back to present value in order to evaluate the long range economic feasibility of each concept. CWCB utilized the following key assumptions for the life cycle cost analysis:

- Planning period – 50 years after completion of construction
- Present worth – capital and operating costs brought based to 2009
- Capital costs expended in 2020, with operation and maintenance starting in 2021 for options 1 and 2
- Capital costs expended in 2020, with operation and maintenance starting in 2021 for Phase 1 of Option 3 and 2040, with operation and maintenance starting in 2041 for Phase 2 of Option 3
- Discount rate, or cost of money – 6 percent
- Escalation – Capital items (3 percent), annual operation and maintenance (3 percent), and energy (5 percent)
- 2009 energy costs ($/kilowatt hour) - $0.08

In addition to initial capital costs, CWCB considered replacement costs for the constructed facilities if the replacement was required during the 50-year planning period.

Figures ES-26 and ES-27 provide a summary of the total life cycle costs and the total life cycle costs per acre-foot of water developed by each concept.

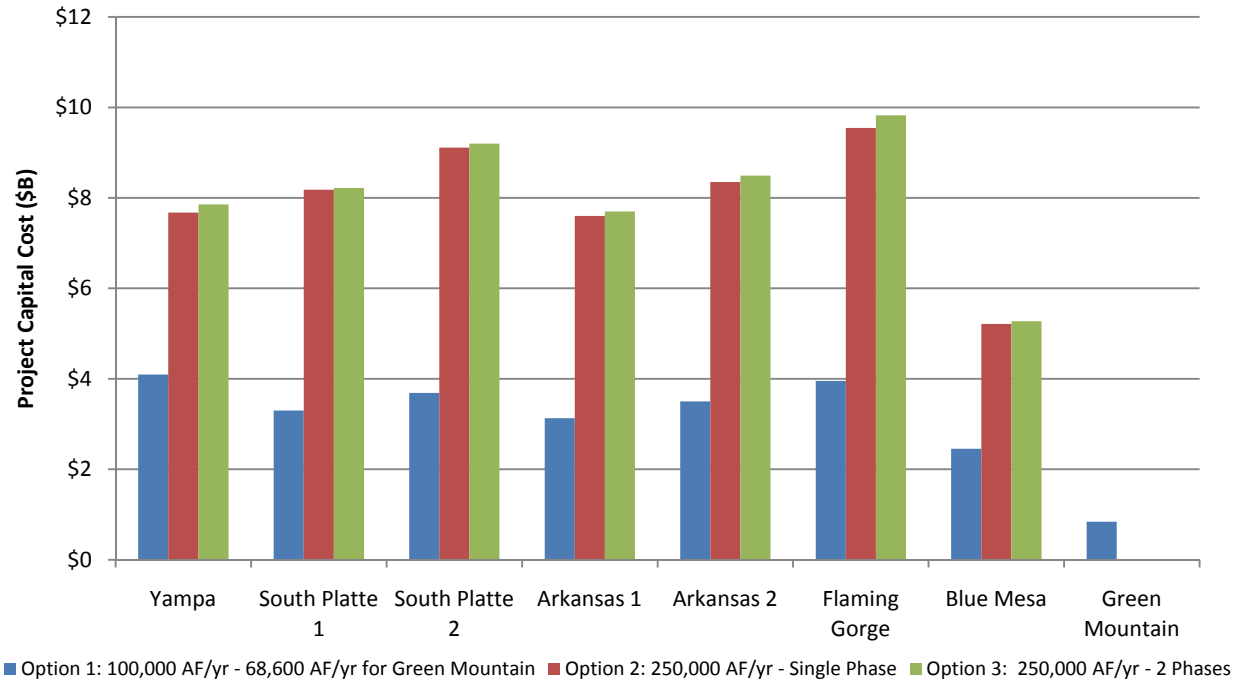


Figure ES-24 Summary of Reconnaissance Capital Costs

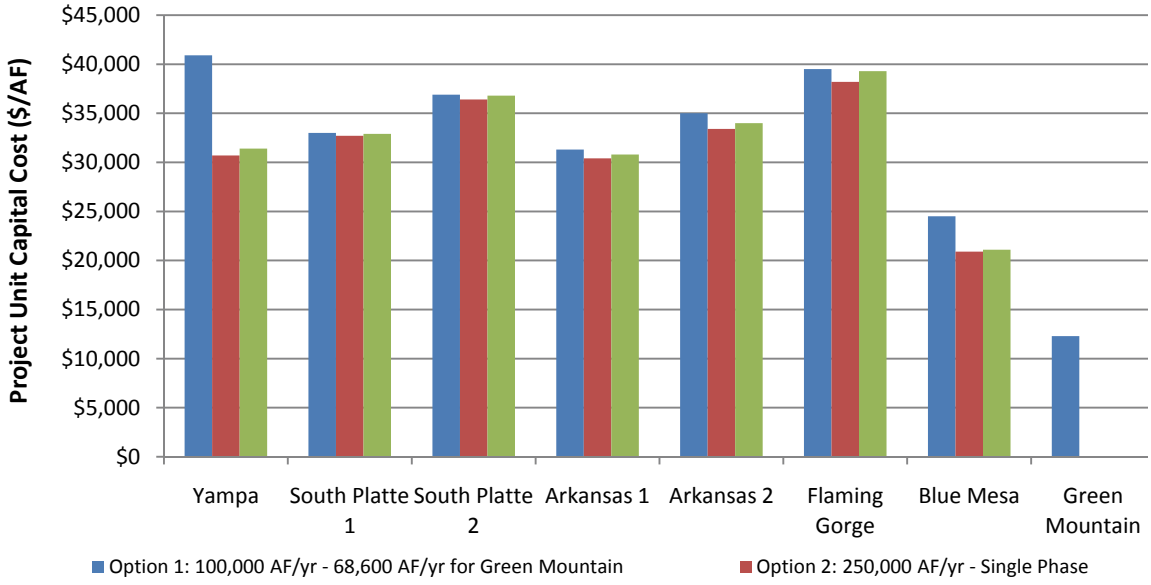


Figure ES-25 Summary of Reconnaissance O&M Costs

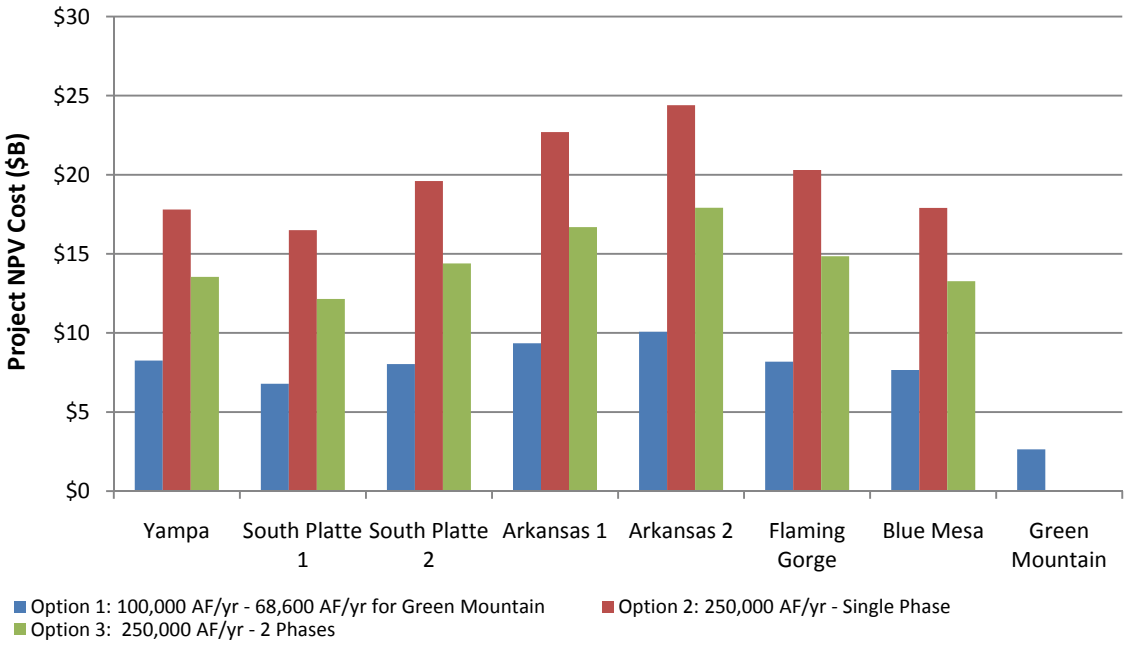


Figure ES-26 Summary of Reconnaissance Life Cycle Costs

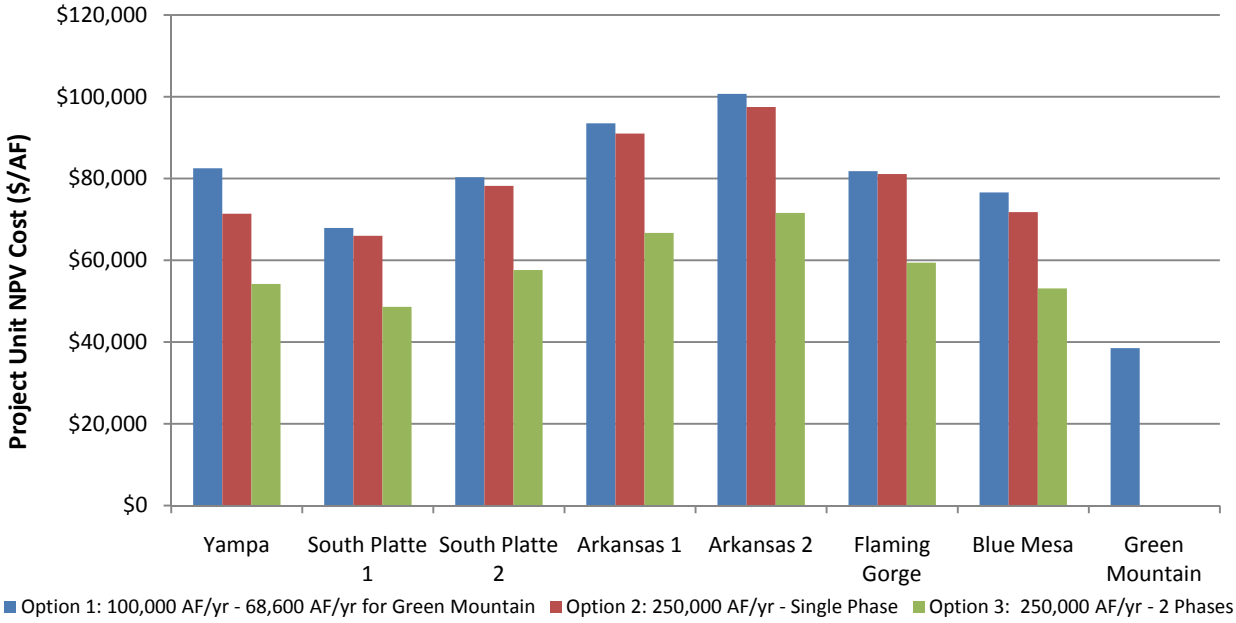


Figure ES-27 Summary of Reconnaissance Life Cycle Unit Costs

These figures show that the least expensive concept is Green Mountain and most expensive is either Arkansas concept. The Arkansas concepts are most expensive due to the annual treatment costs that would be associated with them. The remaining concepts generally have similar life cycle costs.

Status Quo Portfolio

If Colorado's water supply continues to develop according to current trends, i.e., the status quo, this will inevitably lead to a transfer of water out of agricultural lands and potentially harm the environment. The status quo is the default position—the results that will likely occur if current trends continue unchanged. Inaction is a decision itself, a decision with significant consequences. The general consensus is that the status quo scenario is not a desirable future for Colorado.

The summary below is an illustration of the status quo using the portfolio and trade-off tool. This tool was developed to evaluate water supply portfolios. The status quo scenario presented is based on the following assumptions:

- 2050 mid-demand scenario.
- The status quo IPP success by basin is defined in Figure ES-26. Applying these basin level success rates results in the implementation of about 60 percent of the IPP yield statewide by 2050.
- Passive conservation savings will be realized by 2050 and those savings will be used to meet new demands. Active conservation will not be utilized toward water supply, serving new customers, or meeting the M&I gap.
- New supply development from the Colorado River system will be available for West Slope uses only. No additional transbasin diversions beyond the IPPs are assumed in the status quo portfolio.
- The remaining M&I demands are met with agricultural transfers.

trade-off tool v11 STATUS QUO.xlsx - Microsoft Excel

Colorado's Water Supply Future Portfolio & Trade-Off Tool IPPs

IPP Success Rate	(% Yield)	(Yield AFY | Total IPP Yield AFY)
Arkansas	75%	71,000 | 95,000
Colorado	90%	49,000 | 54,000
Gunnison	90%	14,000 | 16,000
Metro	50%	82,000 | 163,000
North Platte	90%	200 | 200
Rio Grande	90%	6,000 | 7,000
South Platte	40%	52,000 | 129,000
Southwest	75%	13,000 | 17,000
Yampa/White	90%	11,000 | 12,000

S P C A A R T S R

Figure ES-26 IPP Success Rate Data Entry Screen from Portfolio and Trade-Off Tool

Water from over 500,000 irrigated acres statewide could be transferred to M&I use statewide with the status quo portfolio.

Figure ES-27 shows the resulting loss of irrigated acres that may potentially occur as a result of the status quo portfolio. The yellow bars in the figure relate to the left axis and show the percentage of irrigated acres that may be lost in the future if the status quo is maintained. The red squares relate to the right axis and specify the number of acres that may be lost. Based on the status quo scenario, the South Platte Basin could lose 35 percent of current irrigated agriculture or nearly 300,000 acres. The Arkansas, West Slope, and North Platte/Rio Grande Basins could lose over 10 percent of their irrigated agriculture under the status quo portfolio. Water from over 500,000 irrigated acres statewide could be transferred to M&I use statewide with the status quo portfolio. Other trade-offs associated with the status quo portfolio are described in Section 7 of this report.

Cost of Meeting Future Water Needs

Meeting Colorado's M&I water supply needs will require significant investment. The costs for the status quo portfolio are presented in Table ES-9. Implementing a mix of solutions to address Colorado's 2050 medium M&I water supply needs will cost around $15 billion under status quo assumptions. These costs will increase if Colorado experiences high M&I demands and will decrease if Colorado experiences low M&I demands or implements an alternative mix of solutions to the status quo. The costs associated with meeting Colorado's future M&I needs could be reduced if an alternative approach, incorporating fewer but larger projects and increased levels of conservation, were used. However, while an alternative approach could save the citizens of Colorado billions of dollars, it would require a higher level of state involvement including significant state funding.

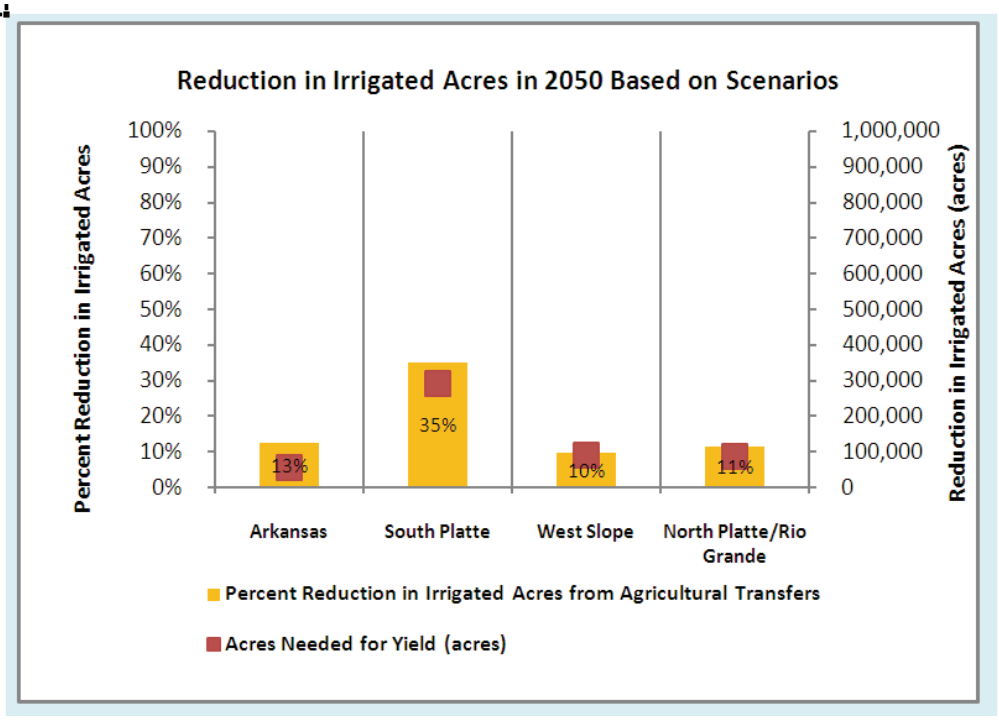


Figure ES-27 Reduction in Irrigated Acres in 2050 Based on Status Quo Scenario

Table ES-9 Status Quo Medium M&I Demand Portfolio (800,000 AFY of new water needed)

Strategy	West Slope[1] Unit Cost	West Slope[1] New Water Needed (AFY)	West Slope[1] Costs	East Slope Unit Cost	East Slope New Water Needed (AFY)	East Slope Costs	Total New Water Needed (AFY)	Total Costs
New Supply	$5,900	150,000	$860,000,000	$0	—	$0	150,000	$860,000,000
Ag Transfers	$40,000	3,500	$140,000,000	$40,000	270,000	$11,000,000,000	270,000	$11,000,000,000
IPPs	$5,900	93,000	$550,000,000	$14,000	200,000	$2,900,000,000	290,000	$3,400,000,000
Active Conservation	$7,200	—	$0	$7,200	—	$0	—	$0
Reuse[2]			$0		90,000	$0	90,000	
Total		**240,000**	**$1,600,000,000**		**560,000**	**$14,000,000,000**	**800,000**	**$15,000,000,000**

[1] Costs for the Rio Grande and North Platte Basins are the same as the West Slope and are integrated with the West Slope for the purpose of this cost analysis.

[2] The costs of reuse are incorporated into the costs associated with agricultural transfers or new supply development.

While there is general agreement that the status quo is not desirable and that a mix of solutions will be needed, there is not agreement on the specific quantities of water that will be needed for each strategy. However, there is agreement that in order to balance meeting municipal, agricultural, and nonconsumptive needs, Colorado will need a mix of new water supply development for West Slope and East Slope uses, conservation, completion of IPPs, and agricultural transfers. The CWCB and IBCC have agreed that all parts of this four-pronged framework are equally important and should be pursued concurrently.

In addition to meeting M&I needs, state funding will continue to be needed to meet agricultural and environmental water supply needs. Without a mechanism to fund environmental and recreational enhancement beyond the project mitigation measures required by law, conflicts among M&I, agricultural, recreational, and environmental users could intensify.

The ability of smaller, rural water providers and agricultural water users to adequately address their existing and future water needs is also significantly affected by their financial capabilities, and many of them rely on state funding to help meet their water supply needs.

Recommendations

With the completion of SWSI 2010, CWCB has updated its analysis of the state's water supply needs and recommends Colorado's water community enter an implementation phase to determine and pursue solutions to meeting the state's consumptive and nonconsumptive water supply needs. This will be accomplished through the following recommendations.

These recommendations do not necessarily represent a statewide consensus. The CWCB has deliberated on the information contained in SWSI 2010 and has put forth its view of how to move forward. Section 8 or this report provides additional detail on each recommendation.

1. Actively encourage projects to address multiple purposes, including municipal, industrial, environmental, recreational, agricultural, risk management, and compact compliance needs.
2. Identify and utilize existing and new funding opportunities to assist in implementing projects and methods to meet Colorado's consumptive and nonconsumptive water supply needs.
3. Continue to lead the dialogue and foster cooperation among water interests in every basin and between basins for the purpose of

implementing solutions to Colorado's water supply challenges.

4. Support water project proponents and opponents in resolving conflict and addressing concerns associated with implementing IPPs that will reduce the M&I water supply gap. Identify IPPs that could be implemented by 2020.
5. Support meeting Colorado's nonconsumptive water needs by working with Colorado's water stakeholders to help:
   - Promote recovery and sustainability of endangered, threatened, and imperiled species in a manner that allows the state to fully use its compact and decreed entitlements.
   - Protect or enhance environmental and recreational values that benefit local and statewide economies.
   - Encourage multi-purpose projects that benefit both water users and native species.
   - Pursue projects and other strategies, including CWCB's Instream Flow Program, that benefit consumptive water users, the riparian and aquatic environments, and stream recreation.
   - Recognize the importance of environmental and recreational benefits derived from agricultural water use, storage reservoirs, and other consumptive water uses and water management.
6. Help meet Colorado's agricultural water supply needs by incorporating agricultural water needs into the development of water supply portfolios and supporting the implementation of multi-purpose agricultural water supply projects.
7. In order to determine the appropriate combination of strategies (IPPs, conservation, reuse, agricultural transfers, and the development of new water supplies) and portfolios to meet the water supply needs, CWCB will identify what it considers is achievable for each portfolio element and how those portfolio elements could be implemented.
8. Evaluate multi-purpose projects or packages of projects to develop new water supplies for use on the West Slope and the Front Range.
9. Develop and support risk management strategies so that Colorado can fully use its compact and decree entitlements to best balance Colorado's diverse water needs.
10. Support, encourage, and incentivize water providers in planning for and implementing M&I active conservation best management practices and other demand management strategies.
11. Work with water providers to identify opportunities where additional water could be made available by increased regional cooperation, storage, exchanges, and other creative opportunities.
12. Continue the evaluation of Colorado's water supply availability in all basins to help provide water users with viable analysis tools.
13. Help safeguard Colorado's water supply during times of drought by incorporating drought mitigation and response in statewide and local water supply planning.
14. Support local water supply planning.
15. The CWCB, in consultation with other state agencies, shall develop and implement a plan to educate and promote stewardship of water resources that recognizes water's critical role in supporting the quality of life and economic prosperity of all Coloradoans.
16. Establish a 6-year planning cycle for assessing Colorado's long-term consumptive and nonconsumptive water needs and support the implementation of projects and methods to meet those needs.

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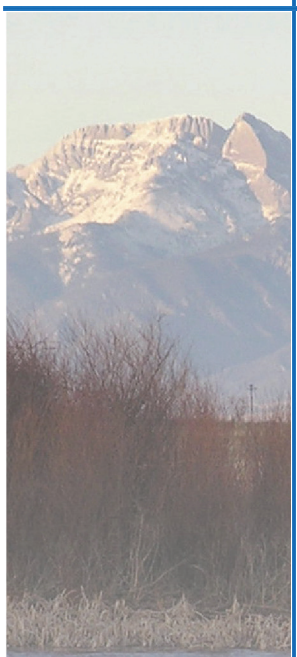

Section 1
Introduction

1.1 Introduction to the SWSI 2010 Update

The last decade brought many changes to the state of Colorado's water supply outlook. Despite the recent economic recession, the state has experienced significant population growth, and Colorado's population is expected to nearly double within the next 40 years. Colorado needs to provide an adequate water supply for its citizens and the environment, yet Colorado is transitioning from an era of undeveloped resources to an era of managing a more developed resource. Meeting the state's municipal, industrial, agricultural, environmental, and recreational water needs will involve implementing a mix of local water projects and processes, conservation, reuse, agricultural transfers, and the development of new water supplies, all of which should be pursued concurrently. Ultimately, the future of Colorado—both its vibrancy and its beauty—is dependent on how our water resources are sustained, used, and developed.

To help understand and address these trends, the Colorado Water Conservation Board (CWCB or Board) undertook a number of important initiatives. The CWCB is statutorily charged to conserve, protect, manage, and develop Colorado's water resources for current and future generations. In advancing this mission, the CWCB helps ensure that water is utilized to meet the needs of Colorado's citizens while protecting the environment.

In the last few years, state leaders and resource management agencies have increasingly focused on helping ensure that Colorado has an adequate water supply for its citizens, agriculture, and the environment. In 2003, the Colorado General Assembly recognized the critical need to understand and better prepare for our long-term water needs and authorized the CWCB to implement the Statewide Water Supply Initiative (SWSI). SWSI 1, approved by the Board in 2004, was a comprehensive identification of Colorado's current and future water needs, and it examined a variety of approaches Colorado could take to meet those needs. SWSI 1 implemented a collaborative approach to water resource issues by establishing "basin roundtables"—diverse groups of individuals representing water interests who provide input on water issues.

This was followed by SWSI 2, which established four technical roundtables—Conservation, Alternative Agricultural Water Transfers, Environmental and Recreational Needs, and Addressing the Water Supply Gap. The overall goal of SWSI 2 was to develop a range of potential solutions that would help water providers, policymakers, and stakeholders gain a deeper understanding of the relative role that water efficiency, agricultural transfers, and new water development can play in meeting future needs and the trade-offs associated with these solutions.

Index

1.1 Introduction to the SWSI 2010 Update ..... p. 1-1
1.2 CWCB History and Mission..... p.1-3
1.3 Overview of the Water for the 21st Century Act ..... p. 1-5
1.4 Background on Colorado's Major River Basins..... p. 1-7
1.5 Overview of Report..... p. 1-16
1.6 Acknowledgements..... p. 1-17

In 2005, the legislature reaffirmed the need to prepare for a future in which water resources are increasingly limited by passing the Colorado Water for the 21st Century Act. This legislation institutionalized nine basin roundtables and created a voluntary, collaborative process to help the state address its water challenges. This process is based on the premise that Coloradoans can work together to address the water needs within the state.

Figure 1-1 illustrates the nine basin roundtables, which were organized to represent Colorado's eight major river basins and a separate basin roundtable for the Denver Metro area. The Yampa-White, Colorado, Gunnison, and Southwest Basin Roundtables are all based on tributaries to the Colorado River. The North Platte, Metro, and South Platte Basin Roundtables represent watersheds tributary to the Platte River. The Arkansas and Rio Grande Basin Roundtables are the headwaters of these river systems.

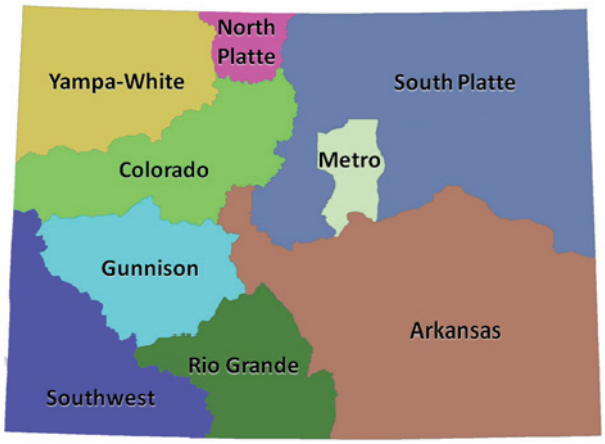

Figure 1-1 Colorado's nine basin roundtables provide a voluntary and collaborative process to help the state address its water challenges

In addition to the nine basin roundtables, the Colorado Water for the 21st Century Act established the 27-member Interbasin Compact Committee (IBCC) to facilitate conversations between basins and to address statewide issues. The IBCC established its charter in 2006, which was soon ratified by Colorado's General Assembly. The charter outlines the roles of the IBCC—to provide a "framework that creates incentives for successful deliberations, agreements, and their implementation." To help advance this role, the IBCC embarked on a visioning process, through which the IBCC, CWCB, and basin roundtables agreed to evaluate water demand and supply strategies that could help address Colorado's water supply future.

1.2 Purpose of SWSI 2010 Update

SWSI 2010 is intended to enhance the available information on Colorado's water supply future and to be used for general statewide and regional water supply planning. SWSI 2010 is not intended to take the place of local water planning initiatives or project-specific analysis. Rather, it is a forum to develop a common understanding of existing and future water supplies and demands throughout Colorado and to identify possible means of meeting Colorado's consumptive and nonconsumptive water needs.

Overall, the mission of SWSI is—*To help Colorado maintain adequate water supplies for its citizens, agriculture, and the environment through a mix of solutions, all of which should be pursued concurrently.*

SWSI 2010 is intended to incorporate and summarize the work of the basin roundtables. The basin roundtables are charged with developing their consumptive and nonconsumptive water supply needs assessments and identifying projects and methods to meet those needs. These needs assessments are the basis for the CWCB's SWSI 2010 update, making SWSI 2010 the first comprehensive update to incorporate the work of the basin roundtables.

The CWCB, through SWSI and future efforts, will help support and identify solutions to meet the state's water supply needs. To help attain this goal, SWSI 2010 looks beyond the original 2030 projections and summarizes the results out to 2050 by river basin, including:

- Extending the municipal and industrial (M&I), self-supplied industrial, and agricultural water supply demands to 2050 and incorporating the demand-reducing effects of passive conservation

- Developing more thorough analyses and understanding of nonconsumptive needs in each basin
- Evaluating water supply availability in the Colorado River Basin
- Increasing understanding of identified projects and methods for meeting future water supply needs
- Evaluating implementation elements associated with identified projects, water conservation, agricultural transfers (both permanent and nonpermanent), and development of new water supplies
- Developing representative costs for water supply strategies

This report helps to address the many changes the last decade has brought to Colorado's water supply outlook. When utilized as a statewide planning tool, SWSI 2010 will allow water providers, state policy makers, and the General Assembly to make informed decisions regarding the management and use of Colorado's surface water and groundwater resources.

While this is the most comprehensive picture of Colorado's future water needs the state has ever had, SWSI is an "initiative." This report will be broken out into needs assessment reports for each of the basin roundtables in the first half of 2011, incorporating more detail. SWSI will be used as a living document and the CWCB will continue to develop and incorporate the best information available. However, with this SWSI 2010 update, the CWCB has confirmed and updated its analysis of the state's water supply needs and recommends that Colorado's water community enter an implementation phase to determine and pursue solutions to meeting the state's consumptive and nonconsumptive water supply needs.

1.3 CWCB History and Mission

As the lead agency for SWSI, the CWCB plays a critical role in establishing water policy in Colorado. Created in 1937, the CWCB's Mission is to:

Conserve, Develop, Protect and Manage Colorado's Water for Present and Future Generations

The CWCB furthers this mission by developing and implementing programs to:

- Conserve the waters of the state for wise and efficient beneficial uses
- Develop waters of the state to:
  - Preserve the natural environment to a reasonable degree
  - Fully utilize state compact entitlements
  - Help ensure that Colorado has an adequate water supply for our citizens and the environment by implementation of CWCB adopted mission statements and the findings and recommendations identified SWSI 1
- Protect the waters of the state for maximum beneficial use without waste
- Manage the waters of the state in situations of extreme weather conditions—both for floods and droughts

These fundamental goals apply to all of the major programs and projects undertaken by the CWCB.

With more than 40 staff members, the CWCB has eight major sections:

1. Administration and Management
2. Finance
3. Interstate and Federal
4. Office of Water Conservation and Drought Planning
5. Stream and Lake Protection
6. Water Information
7. Water Supply Planning
8. Watershed and Flood Protection

The CWCB consists of 10 voting and 5 nonvoting members, identified in Table 1-1. The Governor appoints one representative Board member from each of the state's eight major river basins and one representative member from the City and County of Denver. All appointees are subject to Senate confirmation and serve 3-year terms. The Executive Director of the Department of Natural Resources (DNR) is an ex-officio, voting member of the Board. The Director of the CWCB, the State Engineer, the Attorney General, the Director of the Colorado Division of Wildlife, and the Commissioner of the Colorado Department of Agriculture are ex-officio, nonvoting members.

Table 1-1 2010 CWCB Board Members

Board Member	Basin/ Representation	Term	Type of Member
Reed Dils	Arkansas River	2008-2011	Appointed
John D. Redifer	Colorado River Mainstem	2010-2013	Appointed
Barbara Biggs	City and County of Denver	2010-2013	Appointed
John H. McClow	Gunnison-Uncompahgre River	2009-2012	Appointed
Carl Trick	North Platte River	2009-2012	Appointed
Travis Smith	Rio Grande River	2008-2011	Appointed
April Montgomery	San Miguel, Dolores, Animas, and San Juan Rivers	2009-2011	Appointed
Eric Wilkinson, Vice Chair	South Platte River	2009-2012	Appointed
Geoff Blakeslee, Chair	Yampa-White Rivers	2010-2013	Appointed
Mike King, Executive Director	Department of Natural Resources		Ex-Officio
John Stulp, Commissioner	Department of Agriculture		Nonvoting Ex-Officio
Jennifer Gimbel, Director	Colorado Water Conservation Board		Nonvoting Ex-Officio
Tom Remington, Director	Colorado Division of Wildlife		Nonvoting Ex-Officio
Dick Wolfe, State Engineer	Division of Water Resources		Nonvoting Ex-Officio
John Suthers	Attorney General		Nonvoting Ex-Officio

To the greatest extent possible, Board appointees are persons experienced in water resource management; water project financing; engineering, planning, and development of water projects; water law; irrigated farming; and/or ranching. No more than five appointees can be members of the same political party.

The role of the Board is defined in statute (C.R.S. 37-60) and includes:

- Establishing policy to address state water issues
- Exercising the exclusive authority of the Board to hold instream and natural lake level water rights to protect and improve the environment
- Mediating and facilitating resolutions of disputes between basins and water interests
- Maintaining and upholding fiduciary responsibilities related to the management of state resources including, but not limited to, the Construction Fund and the Severance Tax Trust Fund
- Representing citizens within individual basins
- Identifying, prioritizing, and implementing water development projects to be funded using its funds and when necessary, recommending such projects for approval by the General Assembly
- Making Findings and Recommendations concerning applications for water rights for Recreational In-channel Diversions and defending its decisions in water courts
- Making decisions regarding Watershed Protection Fund grants, upholding fiduciary responsibilities related to the fund and implementing its own river restoration projects designed to help the CWCB accomplish its mission
- Provide technical support for the Water for the 21st Century Act
- Administering the Water Supply Reserve Account Grant Program

1.4 Overview of the Water for the 21st Century Act

As described previously, in 2005 the Colorado General Assembly passed the Colorado Water for the 21st Century Act (House Bill [HB] 05-1177). This legislation set up a framework that provides a permanent forum for broad-based water discussions, and it created two new structures—1) the IBCC, a statewide committee that addresses issues between basins; and 2) the basin roundtables, which were established in each of the state's eight major river basins plus the Denver Metro area. The purpose of the basin roundtables is to facilitate discussions on water issues and encourage locally driven collaborative solutions. The broad-based, collaborative nature of this process is reflected in the basin roundtable membership (see Section 1.7.2 and Appendix A).

The purpose of the basin roundtables is to facilitate discussions on water issues and encourage locally driven collaborative solutions.

To help the basin roundtables accomplish their major responsibility of developing basinwide needs assessments, they have relied on groundwork completed during the SWSI Phase 1 study. To further develop their needs assessments, support water activities in each of the basins, and implement identified water projects and methods, it was clear that the basin roundtables needed staff support as well as technical and financial assistance. Using resources provided through HB 06-1400, the CWCB provides staff support and technical assistance to the basin roundtables and the IBCC for the ongoing implementation of the Colorado Water for the 21st Century Act. The basin roundtables were also provided financial resources through Senate Bill (SB) 06-179, which established the Water Supply Reserve Account (WSRA). The WSRA appropriates money to the CWCB to help implement the consumptive and nonconsumptive water supply projects and methods identified by the basin roundtables. These bills and other relevant legislation are summarized below.

SB03-110 authorized SWSI 1, which implemented a collaborative approach to water resources issues by establishing SWSI roundtables. SWSI 1 focused on using a common technical basis for identifying and quantifying water needs and issues.

HB05-1177 or The Colorado Water for the 21st Century Act provides a permanent forum for broad-based water discussions. It creates two new structures: 1) the IBCC, and 2) the basin roundtables. There are nine basin roundtables based on Colorado's eight major river basins and the Denver Metro area.

SB06-179 created the WSRA. Throughout SWSI and Colorado Water for the 21st Century Act processes, there has been a clear recognition that financial assistance is needed to address the water challenges in our state. This legislation funds the WSRA, which directs the State Treasurer to annually transfer $10 million from the Operational Account of the Severance Tax Trust Fund to the WSRA. These monies are available to the basin roundtables to fund water activities.

HB06-1385 created the CWCB's Intrastate Water Management and Development Section, which implements SWSI, the WSRA, develops reconnaissance level water supply alternatives, and tracks and supports water supply projects and planning processes. This section is now called the Water Supply Planning Section.

HB06-1400 appropriated money to the CWCB to fund staffing of the Water for the 21st Century Act process and monies for a contractor to technical assistance the basin roundtables.

SB09-106 authorized the funding of the WSRA in perpetuity.

1.4.1 Basin Roundtable Process

Basin roundtables are legislatively required to be made up of a diverse set of stakeholders, including representatives from counties, municipalities, water conservancy districts, the environmental and recreational communities, agriculture, and industry. A full list of basin roundtable members is provided in Appendix A. The responsibilities of the basin roundtables can be grouped into three categories—procedural, substantive, and public involvement. Each basin roundtable adopted bylaws that include the basin roundtable's goals, objectives, and operating procedures. These bylaws reflect the specific needs of the basin roundtable and reflect the uniqueness of each basin. Each basin roundtable developed procedures and selected two members of the IBCC.

The most extensive substantive responsibility assigned to each basin roundtable is to develop a basinwide water needs assessment. This is performed in cooperation with local governments, area water providers, and other stakeholders. The Colorado Water for the 21st Century Act states "Using data from the Statewide Water Supply Initiative and other appropriate sources and in cooperation with the ongoing Statewide Water Supply Initiative, develop:"

- An assessment of consumptive water needs (municipal, industrial, and agricultural)
- An assessment of nonconsumptive water needs (environmental and recreational)
- An assessment of available water supplies (surface and groundwater) and an analysis of any unappropriated waters
- Proposed projects or methods to meet any identified water needs and achieve water supply sustainability over time

Equally important to selecting members of the IBCC and developing a basinwide water needs assessment, the basin roundtables serve as a forum for public involvement. The basin roundtable activities are required by law to be open, public meetings. The basin roundtable process creates an expanded foundation for public involvement.

This SWSI 2010 Report is largely based on basin roundtables' water needs assessments. This report is summary in nature and is intended to summarize water needs at a statewide level. The basin roundtable needs assessment reports will be more detailed and provide information at a finer level of detail than the contents of this report.

During the first part of 2011, CWCB will work with the basin roundtables to use information from this report and other basin roundtable needs assessments studies to finalize their individual basin roundtable needs assessments reports.

1.4.2 Interbasin Compact Committee

The other structure created by the Colorado Water for the 21st Century Act is the IBCC. This is a 27-member committee established to facilitate conversations between basins and to address statewide issues. The IBCC brings the issues of each basin roundtable to a statewide forum.

The Colorado Water for the 21st Century Act gives the IBCC a series of responsibilities. These include establishing bylaws, developing a charter, helping oversee the WSRA program, and creating a Public Education and Outreach Working Group.

During 2005 and 2006, the IBCC established bylaws to govern its operations and actions. In addition, during this timeframe the IBCC developed a Charter to "govern and guide compact negotiations between basin roundtables." The Charter includes:

- A framework and principles to guide negotiations between basin roundtables, including policies to ensure that individual compacts do not conflict with one another.
- Procedures for ratification of compacts, including a mandatory provision that every affected basin roundtable must approve the draft compact.
- Authorities and procedures to ensure that approved compacts are legally binding and enforceable.
- Procedures for integrating the interbasin compact processes with other water planning and development processes, except that no provision may supersede, impair, or modify any local government's "authority, jurisdiction, or permitting powers."

The IBCC also established a Public Education and Outreach Working Group to ensure public education and participation concerning both the activities of the IBCC and compact negotiations between basin roundtables.

1.5 Background on Colorado's Major River Basins

Eight major river basins drain Colorado, all with their headwaters in the high mountains of the Continental Divide, as shown in Figure 1-2. Rivers east of the Continental Divide flow ultimately into the Gulf of Mexico, while the western rivers find their way, via the Colorado River, to the Gulf of California and the Pacific Ocean. The interrelationship of these eight river basins is described below in the context of four major river systems originating in Colorado. In addition, a general overview of the prior appropriation system of water allocation and other facets of Colorado water law is provided in Appendix B.

1.5.1 Colorado River System Basins

The Colorado River system (including tributary basins) drains over one-third of the state's area. Originating in the north central mountains, the mainstem of the Colorado River flows southwesterly and is met at Grand Junction by the Gunnison River before flowing west into Utah. The Yampa River and the White River move westward across the northwest quadrant of the state to the Utah border where they join the Green River, another tributary of the Colorado. The San Miguel River and the Dolores River begin near the southwestern corner and travel north along the western border and into Utah. The San Juan River and its tributaries collect the water in the southernmost regions west of the Continental Divide and carry it into New Mexico.

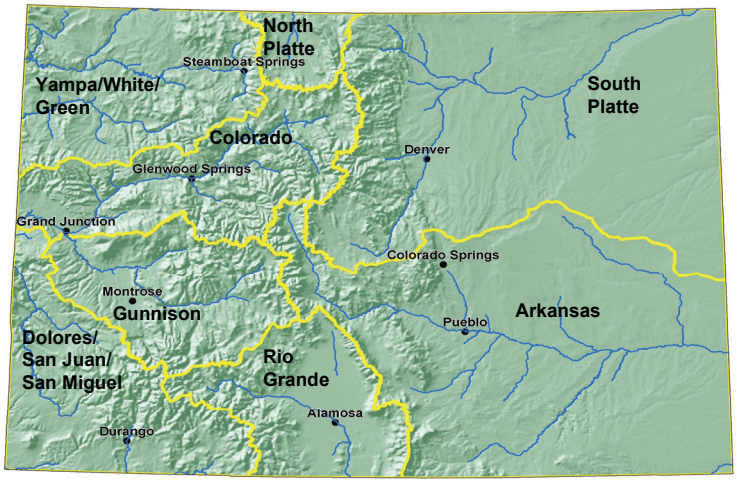

Figure 1-2 Colorado's Eight Major River Basins

Less than 20 percent of the entire Colorado River Basin lies inside Colorado, but about 75 percent of the water in the entire river basin originates in the state. Over 60 percent of the land in the combined Colorado River and tributaries basin is federal land. In the state of Colorado, transbasin diversions account for about 5 percent of the total water supply, or about 500,000 acre-feet/year (AFY). Most of these transbasin diversions move water from west to east to supply the Front Range.

Allocations of water in the Colorado River Basin and its tributaries are subject to the following interstate compacts and international treaties:

- **Colorado River Compact of 1922** – Allocates 7.5 million acre-feet (AF) of consumptive use (CU) annually to both the Upper and Lower Colorado River Basins, with the basin dividing point located at Lee Ferry, Arizona. The compact requires the Upper Basin (Colorado, New Mexico, Utah, and Wyoming) not to deplete the average flow below 75 million AF to the Lower Basin (Arizona, California, and Nevada) during any consecutive 10-year period.
- **Rio Grande, Colorado, and Tijuana Treaty of 1945 between the United States and Mexico** – Guarantees the delivery of 1.5 million AF of Colorado River water to Mexico each year, except in the event of extraordinary drought or serious accident to the irrigation system in the United States, in which case the United States may deliver less water to Mexico.
- **Upper Colorado River Basin Compact of 1948** – Allocates the Upper Basin's apportionment between the four Upper Basin states on a percentage basis. Colorado is entitled to 51.75 percent of the Upper Basin's apportionment. Additionally, the Colorado may not deplete the flow in the Yampa River below an aggregate of 5 million AF over any 10-year period.

Depending upon the interpretation of the compacts, other laws, and the long-term hydrology of the Colorado River system, Colorado's right to the amount of water that can be consumed under the compacts may range from 3,079,000 AFY to 3,855,000 AFY. Colorado's existing CU of Colorado River system water is estimated to be in the range 2,417,000 AF to 2,634,000 AF (CWCB 2009).

1.5.1.1 Colorado River Basin

The Colorado River Basin encompasses approximately 9,830 square miles. Elevations in the basin range from greater than 14,000 feet in the headwaters areas to about 4,300 feet at the Colorado-Utah state line. The basin's mountainous upper reaches gradually give way to a series of canyons and gentler terrain as the river flows along the Interstate 70 corridor toward Grand Junction, the Grand Mesa, and the Utah border.

Colorado River

A substantial portion of the basin is comprised of federally-owned land. Rangeland and forest are the predominant land uses in the Upper Colorado River Basin (about 85 percent). Forested land is present throughout many parts of the basin. Livestock grazing, recreation, and timber harvest are the predominant uses of the federal lands. Active and inactive mines can be found in the basin; coal mining occurs in the central portion of the Roaring Fork River Valley and in the lower Colorado River Valley.

The Colorado River Basin will face several key points and challenges with respect to water management issues and needs over the next 40 years, some of which are identified as follows:

- Recreation and the environment are key drivers in the basin and are important for economic health and quality of life.
- Agriculture is important in the basin, especially in the lower basin (Grand Valley).

- The success of the Upper Colorado River Endangered Fish Recovery Program is important. The Upper Colorado River Endangered Fish Recovery Program is designed to address the recovery needs of the Colorado River endangered fish while protecting existing water uses and allowing for the future use of Colorado River water in compliance with interstate compacts, treaties, and applicable federal and state law.
- There is concern over a potential compact shortage during severe and sustained drought and potential impacts to in-basin supplies.
- The development of water rights associated with transbasin projects are a concern, and their effect on in-basin supplies must be considered.
- Water quality is a concern, particularly related to selenium and salinity issues.

1.5.1.2 Gunnison River Basin

The Gunnison River Basin stretches over 8,000 square miles of western Colorado, extending from the Continental Divide to the confluence of the Gunnison and Colorado Rivers near Grand Junction. The Gunnison River Basin is defined by the Elk Range to the north, the Sawatch Range to the east, the San Juan Mountains to the south, and the Uncompahgre Plateau to the southwest. Water traveling from the headwaters to Grand Junction encounters greater than 9,500 feet of elevation change.

Gunnison River

The Gunnison River Basin is largely forested. Forest area is distributed throughout the basin and covers approximately 52 percent of the total basin area. About 5.5 percent of the land in the basin is classified as planted/cultivated land and is concentrated in the Uncompahgre River Valley between Montrose and Delta, with additional concentrations near Gunnison and Hotchkiss.

Several water management issues and needs have been identified that will present challenges to Gunnison River Basin water users over the next 40 years, summarized as follows:

- Growth in the headwaters will require additional water management strategies.
- Addressing agricultural water shortages in the upper portion of the basin is an important goal of the community; lack of financial resources is an impediment.
- There is concern over possible future transbasin diversions and the effect this might have on the basin's future.
- Resolving federal issues is a priority, including the completion of the Blue Mesa Reservoir/Aspinall Unit reoperations environmental impact statement, addressing endangered species issues in the Gunnison River near the confluence with the Colorado River mainstem, and developing a selenium management plan.
- The area between Ouray and Montrose is rapidly growing. Tourism is important in the headwaters areas, but agriculture is dominant in the Uncompahgre Valley. A rapid influx of retirees and growth in the Uncompahgre Valley may dramatically change the agricultural uses and other land uses in the area.

1.5.1.3 Yampa River, White River, and Green River Basins

The Yampa River, White River, and Green River Basins cover roughly 10,500 square miles in northwest Colorado and south-central Wyoming. The basin is defined in part by the Continental Divide on the east.

Yampa River

The elevations in the basin range from 12,200 feet (Mount Zirkel) in the Sierra Madre range to about 5,100 feet at the confluence of the Yampa and Green Rivers at Echo Park within Dinosaur National Monument. The basin contains diverse landforms including steep mountain slopes, high plateaus, rolling hills, incised sandstone canyons, and broad alluvial valleys and floodplains.

Large portions of the basin are federally-owned lands. Livestock, grazing, and recreation are the predominant land uses in the basin. Steamboat Springs is a destination ski resort and is likely to experience continued rapid population growth. Near the Towns of Craig, Hayden, Steamboat Springs, Yampa, and Meeker, much of the land is dedicated to agricultural use. The mountains are densely covered by forest. The valleys and plateaus are mostly covered by shrubland and are also dotted with forest.

For the Yampa River, White River, and Green River Basins, key water management issues and needs of the next 40 years include the following:

- The emerging development of gas and oil shale resources is impacting water needs both for the direct production needs and the associated increase in municipal use.
- Agriculture, tourism, and recreation are vital components of this basin's economy.
- Industrial uses, especially power production, are a major water use. Future energy development is less certain.
- While rapidly growing in some areas (Yampa River/Steamboat Springs area), the basin is not developing as rapidly as other portions of the state. This has led to concern that the basin will not get a "fair share" of water use afforded to Colorado under the Colorado River Compact in the event of a compact call.
- Implementation of a successful Upper Colorado River Endangered Fish Recovery Program is vital to ensuring protection of existing and future water uses.
- Agricultural producers in the basin would like to increase the amount of irrigated land by 14,000 to 18,000 acres, but the lack of financial resources is an impediment.

1.5.1.4 Dolores River, San Juan River, and San Miguel River Basins

The Dolores River, San Juan River, and San Miguel River Basins are located in the southwest corner of Colorado. It covers an area of approximately 10,169 square miles. The Upper San Juan River and its tributaries flow through two Native American reservations—the Ute Mountain Ute Reservation and the Southern Ute Indian Reservation—in the southern portion of the basin.

The terrain of the Dolores River Basin consists of high plateaus with deeply incised canyons and dry arroyos. Elevations in the Dolores River Basin range from about 14,200 feet near the Dolores River headwaters to 4,100 feet at its confluence with the Colorado River in Utah. The San Juan River Basin is characterized by rugged terrain, including mesas, terraces, escarpments, canyons, arroyos, and

mountains. Elevations in the San Juan River system range from greater than 14,000 feet in the headwaters areas of the Animas and Los Piños Rivers down to 4,500 feet where the Mancos River exits the state just east of the Four Corners.

Land use in the region is highly variable and often reflects a conflict between historic and modern uses, although three-quarters of the basin consists of forest and shrubland. Agriculture and ranching predominate in the lower elevations of Dolores, San Miguel, and Montrose Counties as they have for many generations. Tourism and recreation have become more prevalent in the region as the Animas, Piedra, Dolores, and San Miguel Rivers offer both fishing and rafting opportunities. Montezuma and La Plata Counties are dominated by agriculture, grassland, and forested land use types.

Dolores River

In addition to the three compacts governing water use across the broader Colorado River Basin, there are other compacts specific to the Dolores/San Juan/San Miguel region:

- **La Plata River Compact of 1922** – Apportions the La Plata River between Colorado and New Mexico.
- **Animas-La Plata Project Compact of 1969** – The right to store and divert water for use in New Mexico under this project shall be of equal priority to rights granted under Colorado court decrees for uses in Colorado from the project.
- **The Colorado Ute Indian Water Rights Settlement Act of 1988** – Settles the reserved water right claims of the Southern Ute and Ute Mountain Tribes on all streams that cross the Reservations of the two tribes, with respect to quantity, priority, and administration.

Identified water management issues and needs that the region's water users are anticipated to face over the next 40 years are summarized as follows:

- This multiple-basin area of the state is extremely diverse and is experiencing changing demographics
  - The Pagosa Springs-Bayfield-Durango corridor is rapidly growing, has areas of localized water shortages, and is transitioning from mining and agriculture to tourism/recreation, and a retirement/second home area.
  - The Cortez area remains strongly agricultural but is also seeing rapid growth with retirees moving to the area.
  - The San Miguel area is a mix of recreation and tourism along with a strong desire to maintain agriculture.
- The Upper Colorado River Endangered Fish Recovery Program and the San Juan River Basin Recovery Implementation Program are designed to work cooperatively to address the recovery needs of the Colorado River endangered fish while protecting existing water uses and allowing for the future use of Colorado River water in compliance with interstate compacts, treaties, and applicable federal and state law, i.e., "The Law of the Colorado River."
- Overall, water supply is available, but getting sufficient infrastructure and water distribution will be a key challenge.

- The Colorado River Compact places pressure on uses of the San Juan River because New Mexico's primary source of supply for its Upper Colorado River Basin Compact apportionment is the San Juan River.

1.5.2 South Platte River, Republican River, and North Platte River Basins

1.5.2.1 South Platte River Basin

The South Platte River drains the most populous section of the state and serves the area with the greatest concentration of irrigated agricultural lands. This basin (including the Republican River Basin, described below) comprises about 27,660 square miles in northeast Colorado.

The topographic characteristics of the South Platte Basin are diverse. Its waters originate chiefly in the mountain streams along the north half of the Front Range of the Eastern Slope, where elevations are about 11,500 feet. After emerging from the mountains southwest of the Denver metropolitan area, the main stream moves north through the Denver urban area, then east across the High Plains. The South Platte River crosses the Colorado-Nebraska state line near Julesburg at an elevation of about 3,400 feet and merges with the North Platte River in southwestern Nebraska to form the Platte River.

South Platte River

Approximately one-third of the South Platte Basin land area is publicly owned, and the majority of these lands are forest areas in the mountains. Western portions of the basin and its montane and subalpine areas are primarily forested, while the High Plains region is mainly grassland and planted/cultivated land. This includes the Pawnee National Grassland.

The South Platte River Compact of 1923 establishes Colorado's and Nebraska's rights to use water in Lodgepole Creek and the South Platte River. Water supply in the South Platte Basin is supplemented by transbasin diversions from the Colorado River Basin and to a lesser degree from the Arkansas and North Platte River Basins. Here, new industry and rapidly expanding urbanized areas compete with agriculture for the same supplies of water.

The South Platte Basin will face several key points and challenges with respect to water management issues over the next 40 years, identified as follows:

- The South Platte Basin is Colorado's most diverse and industrialized basin. Agriculture is still a dominant water use but rapid changes are occurring; the impacts to rural communities are a key concern.
- Competition for water is significant and it is unclear how much competition there is for the same water supplies.
- The success of the Upper Colorado River Endangered Fish Recovery Program for Colorado River endangered fish is important because this program provides Endangered Species Act (ESA) coverage for transbasin diversions.
- The success of the Platte River Recovery Implementation Program (PRRIP) for endangered birds and fish is important because the program provides ESA coverage for water depletions in the Platte River Basin.

- The lack of new major water storage in recent decades (aside from the recent construction of Reuter-Hess Reservoir) has led to reliance on nonrenewable groundwater in Douglas and Arapahoe Counties in the South Platte Basin. Explosive growth in these counties coupled with the lack of surface water supplies led to the creation of multiple small water districts and makes coordinated water development a challenge and less efficient, especially in light of limited renewable surface water supplies.
- Water reuse and conservation are major components to meeting future water needs, but this will put added pressure on agriculture as return flows diminish.
- The urban landscape is very important to the economy and an important component of quality of life.
- Transfers of agricultural water rights to M&I use will continue to be a significant option for meeting future needs.

1.5.2.2 Republican River Basin

The Republican River drains approximately 7 percent of the state's area in northeastern Colorado. The area is predominantly agricultural. Water supplies in the basin come from the Republican River and its tributaries, but the primary source of water is groundwater from the Northern High Plains Aquifer, also known as the Ogallala Aquifer.

Republican River

The Republican River Compact of 1942 establishes the rights of Colorado, Nebraska, and Kansas to water in the Republican River Basin and makes specific allocations of the right to make beneficial CU of water from identified streams. In late 2002, the Republican River Basin completed the settlement of a lawsuit between Kansas and Nebraska, which eventually also included Colorado. In general, the lawsuit resulted in the need to reduce some of the CU in the basin in Colorado. The Colorado State Engineer is responsible for administering the terms of the settlement. The Republican River Water Conservation District (RRWCD) was created by the Colorado State Legislature in 2004 to assure local involvement in the state's pursuit of Compact compliance (RRWCD 2010). There is pending arbitration (and potential litigation) resulting from the 2002 settlement; the resolution of these issues will be important to the basin and to the state.

1.5.2.3 North Platte River Basin

The North Platte River Basin is located in north-central Colorado in Jackson County and a small portion of Larimer County. The basin covers an area of roughly 2,050 square miles. The North Platte River Basin in Colorado is bounded on the east by the Front Range, on the west by the Park Range, on the south by the Rabbit Ears Range, and on the north by the Colorado-Wyoming state line. The land surface elevation of the basin valley ranges between 8,000 feet and 9,000 feet.

Land use in the North Platte River Basin includes forest (46 percent) located on the edges of the basin boundaries, shrubland (24 percent), and grassland (17 percent). The shrubland is concentrated in the central portion of the basin. Grassland is typically found near the basin edges just below the forested areas. Agricultural areas generally are concentrated in the central basin, but also follow the basin's streams and rivers.

A series of U.S. Supreme Court decisions govern interstate water use in the North Platte River Basin, as follows:

North Platte River

- **Nebraska v. Wyoming, 325 U.S. 589 (1945)** – Equitably apportions the water in the North Platte River between Colorado, Nebraska, and Wyoming. Imposes limits on Jackson County irrigated acreage, irrigation season storage, and exports from the Colorado River within Colorado.
- **Wyoming v. Colorado, 353 U.S. 953 (1957)** – Establishes the rights of Colorado and Wyoming to water in the Laramie River Basin; limits Colorado's total diversions and exports from the Laramie River.

The North Platte River Basin will face several key points and challenges with respect to water management issues and needs over the next 40 years, identified as follows:

- Storage, existing diversion structures, and water right use classification for the Town of Walden, Jackson County's only incorporated municipality.
- Forest management in light of the extensive mountain pine beetle epidemic and the potential damage to watersheds and water supplies from catastrophic wildland fire.
- Quantification of available unappropriated waters within the basin.
- Potential impacts from coal-bed methane development.
- Consumptive uses and high-altitude crop coefficients.
- Gaining knowledge and understanding of the South Platte Decision Support System, as it may affect the basin and historical documentation of irrigated acreage.
- It is important that endangered species issues on the Platte River in Central Nebraska are successfully resolved through the PRRIP in a manner that does not put pressure on water users to reduce existing uses.
- The equitable apportionment decrees on the North Platte and Laramie Rivers quantify the amount of available water and lands that can be irrigated.

1.5.3 Arkansas River Basin

The Arkansas River begins in the central mountains of the state near Leadville, at an elevation of more than 14,000 feet. It travels eastward through the southern part of Colorado toward the Kansas border, dropping over 10,000 feet to an elevation of 3,340 feet at the Colorado-Kansas state line. Several tributaries flow from the high southern mountains toward it from the southwest, and there is some drainage from the higher plains north of the main stream.

The Arkansas River Basin is spatially the largest river basin in Colorado, covering slightly less than one-third of the state's land area (28,268 square miles or 27 percent of the state's total surface area). Grassland and forest are the predominant land use types in the Arkansas River Basin, covering approximately 67 percent and 13 percent of the basin, respectively. Over 20 percent of the land is publicly owned. A high percentage of the land is devoted to agriculture and about one-third of this land is irrigated. Increasing urbanization is occurring in the Arkansas River Basin.

The Arkansas River Compact of 1948 apportions the waters of the Arkansas River between Colorado (60 percent) and Kansas (40 percent) based on the opinion of the U.S. Supreme Court in Colorado v. Kansas, 320 U.S. 383 (1943). The primary tool for administering the Arkansas River Compact is the 1980 Operating Principles, which provide for storage accounts in John Martin Reservoir and the release of water from those accounts for Colorado and Kansas water users. Colorado and Kansas have litigated claims concerning Arkansas River water since the early 20th century. In 1995, Colorado was found to have depleted stateline flows in violation of the Compact through the use of tributary groundwater. As a result, the Colorado State Engineer promulgated well administration rules to bring Colorado into compliance with the compact, and Colorado compensated Kansas for damage claims (approximately $34 million).

Arkansas River

The Arkansas Basin will face several key points and challenges with respect to water management issues and needs over the next 40 years. Issues identified through the SWSI process are as follows:

- Arkansas River Compact requirements and existing uses and water rights result in little to no water availability for new uses.
- Growth in the headwaters region will present challenges in obtaining augmentation water for new demands.
- Concerns over agricultural transfers and its impact on rural economies are significant in the lower portion of the basin downstream of Pueblo Reservoir.
- Recreational in-channel diversions or water rights for recreation will have an impact on the development of augmentation plans for agricultural transfers.
- Concern over water quality and suitable drinking water are key concerns in the lower basin.
- The success of two major projects—the Southern Delivery System and the Arkansas Valley Conduit—is key to meeting future water needs.
- The urban landscape is very important to the economy and an important component to quality of life.

1.5.4 Rio Grande Basin

The Colorado portion of the Rio Grande drainage basin is located in south central Colorado and is comparatively small with less than 10 percent of the state's land area (approximately 7,543 square miles). The San Juan Mountains in the west, the Sangre de Cristo Range in the north and east, the Culebra Range in the southeast, and the Colorado-New Mexico state line in the south define the boundaries of the Rio Grande Basin within Colorado. Between the San Juans and the Sangre de Cristos lies the San Luis Valley, a primary feature of the Rio Grande Basin with an average elevation of about 7,500 feet.

Basinwide, land is about evenly divided between public and private ownership. However, the majority of the San Luis Valley is privately owned. The primary land use of more than 600,000 acres of the irrigated land is agricultural operations in the central portion of the basin, which constitutes the second largest potato producing region in the United States. Areas in the valley that are not irrigated are mostly classified as shrubland (24 percent) and grassland (31 percent). The San Juan and the Sangre de Cristo

mountain ranges are largely forested. The northern one-third of the basin is considered to be a "closed basin" and does not contribute any surface flows to the Rio Grande.

Rio Grande River

Interstate compacts and international treaties affecting water use in the Rio Grande Basin include the Rio Grande, Colorado, and Tijuana Treaty of 1945 between the U.S. and Mexico, the Rio Grande Compact of 1938, and the Amended Costilla Creek Compact of 1963. In particular, the Rio Grande Compact establishes Colorado's obligations to ensure deliveries of water at the New Mexico state line and New Mexico's obligation to assure deliveries of water at the Elephant Butte Reservoir, with some allowance for credit and debit accounts. The obligations are calculated based on the amount of flow at indexed stations, which then by schedule in the compact determines the amount of flow that must be delivered to the downstream state during that year. The compact establishes the Rio Grande Compact Commission to administer the terms of the compact. The commission consists of one representative from each state and a nonvoting federal representative.

The Rio Grande Basin will face several key points and challenges with respect to water management issues and needs over the next 40 years, identified as follows:

- The Rio Grande Compact and the effects of sustained drought make the objective of sustainability difficult.
- Agricultural groundwater use is currently at unsustainable levels.
- Economic impacts of reducing irrigation use of groundwater supplies will be difficult, but working on community-based solutions offers the best hope of minimizing the impacts.
- Rapid residential growth, especially in the South Fork area, is creating a need for augmentation of water supplies.
- Groundwater is a key component of water use in the basin for both M&I and agriculture.

1.6 Overview of Report

An overview of each report section is described below. The technical information developed for each section below involved significant input from the Basin Roundtables, CWCB Board, IBCC, and other stakeholders throughout Colorado.

- **Section 2** provides an overview of the **Nonconsumptive Needs Assessments** that have been completed by the basin roundtables. Each basin roundtable completed an extensive inventory of their environmental and recreational attributes and has summarized this information in focus area mapping.
- **Section 3** provides an overview of **Nonconsumptive Projects and Methods** that have been gathered by the CWCB and summary of how this information can be utilized by the basin roundtables in completing their needs assessments.
- **Section 4** summarizes the states' M&I and agricultural water demands into a statewide look at Colorado's **Consumptive Needs Assessments**. These consumptive demands utilize a planning horizon of the year 2050.

- In **Section 5**, projects and methods to meet consumptive needs are considered. As part of the summary, the **Projects and Methods to Meet Basins M&I Needs** are described at the basin level.
- The CWCB recently developed the draft Colorado River Water Availability Study (CRWAS). In **Section 6**, **Water Availability** is considered statewide including a summary of the analyses considered in CRWAS as well as water availability information developed by the Basin Roundtables as part of their basinwide needs assessments and during SWSI 1.
- During the last 5 years, the CWCB, Basin Roundtables, and IBCC have discussed **Portfolios and Strategies to Address the M&I Gap**. Results of this work are summarized in **Section 7**.
- **Section 8** describes the **Findings and Recommendations** from the last 5 years of technical work that will be considered and implemented by the CWCB in its next cycle of water supply planning.

1.7 Acknowledgements

This 2010 update to SWSI was made possible by the tireless dedication and vision of countless Coloradoans to find creative solutions to meeting the state's future water needs. Under the leadership of the CWCB Board, the basin roundtable process, the IBCC process, SWSI 1, and SWSI 2 efforts came together with SWSI 2010. The diverse group of stakeholders involved in the basin roundtables served as an invaluable resource in updating information on statewide and basin water supply needs as well projects and methods to meet those needs. Without the local, grassroots input from the basin roundtables, this update would not have been possible.

This 2010 update to SWSI was made possible by the tireless dedication and vision of countless Coloradoans to find creative solutions to meeting the state's future water needs.

In addition, valuable progress and insight was provided by the IBCC. Members of the IBCC have volunteered innumerable hours in addressing the tough issues facing Colorado as we work to meet our future water needs. In 2010, Governor Bill Ritter challenged the IBCC to produce substantive recommendations on how Colorado can balance its future water needs. These efforts informed and strengthened SWSI 2010. The IBCC's determination to tackle the difficult trade-offs facing Colorado has significantly strengthened this report.

The critical leadership for SWSI 2010 came through the unwavering support of Board members and DNR leadership. The Board's time, energy, and engagement throughout the process was greatly appreciated. Members of the Board provided direction, gave constructive and timely feedback, and volunteered significant time for the effort. Past and present DNR directors, including Russell George, Harris Sherman, Jim Martin, and Mike King, also provided continuous support throughout the ongoing SWSI process. In addition, Alexandra Davis, the IBCC's Director of Compact Negotiations in 2010, focused the IBCC discussion to achieve progress on addressing the complicated issues raised by SWSI 1 and 2.

Finally, SWSI 2010 is the product of an immense and expedited effort from a large number of staff members at the CWCB and its consulting team, CDM. This effort was led by CWCB Director, Jennifer Gimbel along with Eric Hecox of CWCB's Water Supply Planning Section, and Sue Morea and Nicole Rowan from CDM. The team provided numerous comments, questions, and revisions to ensure the publication of an accurate and informative report.

CWCB Board members, basin roundtable leadership, and IBCC members are listed below.

1.7.1 2010 CWCB Board Members

Barbara Biggs, City and County of Denver
Geoff Blakeslee, Chair, Yampa-White Rivers
Reed Dils, Arkansas River
Jennifer Gimbel, Director, Colorado Water Conservation Board
Mike King, Executive Director, Department of Natural Resources
John H. McClow, Gunnison-Uncompahgre River
April Montgomery, San Miguel, Dolores, Animas, and San Juan Rivers
John D. Redifer, Colorado River Mainstem
Tom Remington, Director, Colorado Division of Wildlife
Travis Smith, Rio Grande River
John Stulp, Commissioner, Department of Agriculture
John Suthers, Attorney General
Carl Trick, North Platte River
Eric Wilkinson, Vice Chair, South Platte River
Dick Wolfe, State Engineer, Division of Water Resources

1.7.2 2010 Basin Roundtable Leadership

Arkansas Basin Leadership

Chair: Gary Barber
Vice-Chairs: Jim Broderick and SeEtta Moss
Recorder: Elise Bergsten

Colorado Basin Leadership

Chair: Jim Pokrandt
Vice-Chairs: Lurline Curran and James Carter
Recorder: Ken Ransford

Gunnison Basin Leadership

Chair: Michelle Pierce
Vice-Chair: Hugh Sanburg
Recorder: Mike Berry

Metro Basin Leadership

Chair: Rod Kuharich
Vice-Chair: John Hendrick
Recorder: Gary Thompson

Rio Grande Basin Leadership

Chair: Mike Gibson
Vice-Chair: Rio De La Vista
Recorder: J.B. Alexander

South Platte Basin Leadership

Chair: Jim Yahn
Vice-Chairs: Bob Streeter and Harold Evans
Recorder: Lisa McVicker

Southwest Basin Leadership

Chair: Mike Preston
Vice-Chairs: Ken Beegles and Gary Kennedy
Recorder: Jane Maxom

Yampa-White Basin Leadership

Chair: Tom Gray
Vice-Chairs: Tom Sharp and Forrest Luke
Recorder: Paul Strong

1.7.3 2010 IBCC Members

The membership of the IBCC includes the following:

- Two members appointed by each of the nine Basin Roundtables.
- Six members appointed by the Governor, who come from "geographically diverse parts of the state" and have expertise in environmental, recreational, local governmental, industrial, and agricultural matters:
  - Eric Kuhn, Glenwood Springs
  - Taylor Hawes, Boulder
  - Melinda Kassen, Boulder
  - T. Wright Dickinson, Maybell
  - Wayne Vanderschuere, Colorado Springs
  - Peter Nichols, Denver
- One member appointed by the chairperson of the Senate Agricultural Committee:
  - Bruce Whitehead
- One member appointed by the chairperson of the House Agricultural Committee:
  - Randy Fischer
- The Director of Compact Negotiations, appointed by the Governor, who chairs the IBCC:
  - Alexandra Davis

Arkansas Basin Members

Jay Winner, Pueblo
Jeris Danielson, La Junta

Colorado Basin Members

Stan Cazier, Granby
Carlyle Currier, Molina

Gunnison Basin Members

Marc Catlin, Montrose
Bill Trampe, Gunnison

Metro Basin Members

Mark Pifher, Aurora
Rod Kuharich, Greenwood Village

North Platte Basin Members

Kent Crowder, Walden
Carl Trick, Cowdrey

Rio Grande Basin Members

Steve Vandiver, Alamosa
Travis Smith, Center

South Platte Basin Members

Mike Shimmin, Boulder
Eric Wilkinson, Berthoud

Southwest Basin Members

John Porter, Cortez
Steve Harris, Durango

Yampa-White Basin Members

Dan Birch, Steamboat Springs
Jeff Devere, Rangely

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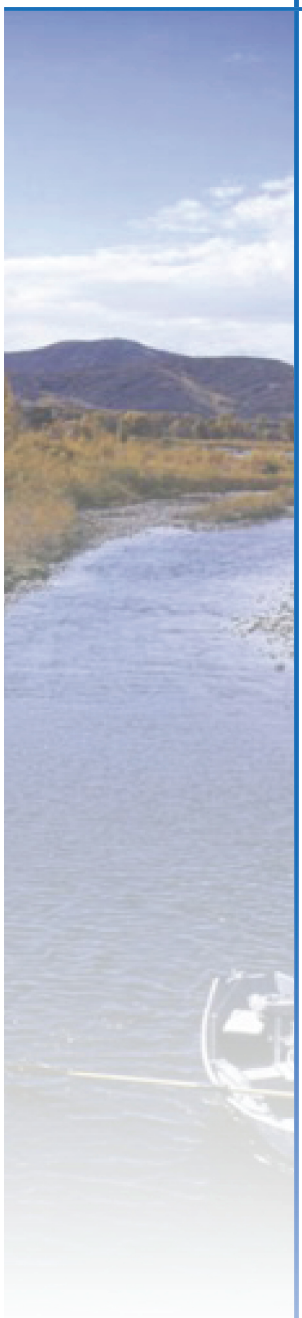

Section 2
Nonconsumptive Needs Assessments

2.1 Overview of Nonconsumptive Needs Assessment Process

During the last 20 years, Colorado has experienced a high growth rate. One of the important factors for this growth is the quality of life in Colorado. New residents and businesses are attracted to Colorado, not only because of its attractive climate, but because of the natural environment and wide array of recreational opportunities of the Rocky Mountains and plains. Recreational opportunities include skiing and snowboarding, golf, hunting, bicycling, camping, hiking, backpacking, reservoir-based recreation, stream and lake fishing, wildlife viewing, rafting and kayaking, boating, and water skiing. Many of these recreational activities are water-based (fishing, boating, rafting, kayaking, and water skiing), rely on water to support the activity (turf watering for golf and snowmaking for skiing and snowboarding), or have water as an integral part of the experience (camping and wildlife viewing).

In addition to the recreational opportunities for residents, recreation and the natural environment support tourism, which is a major economic driver in many parts of the state. In many headwaters counties, recreation and tourism are the largest industries. As population growth continues, there will be increasing and competing demands for water. The new residents and businesses will require water for their domestic uses, residential landscaping, urban recreation, and the associated municipal, commercial, and industrial uses that accompany population growth. These same residents will also seek water-based and other types of recreation in Colorado's natural environment.

The Outdoor Industry Foundation (2006) estimates that the outdoor economy contributes $730 billion annually to the U.S. economy. Estimates for the state of Colorado were not published individually, but the Rocky Mountain Census Division 8 (Arizona, Colorado, Idaho, New Mexico, Utah, Nevada, and Wyoming) estimates that the combined contributions of these states to the nation's total outdoor economic activity is $61.5 billion, or approximately 9 percent of the national total. The percent population in Division 8 compared to the national population is approximately 6 percent. The breakdown of individual activities for Census Division 8 is presented in Figure 2-1. The top economic producing activities are camping, snow sports, and trail-related outdoor activities.

Index

2.1 Overview of Nonconsumptive Needs Assessment Process..... p. 2-1
2.2 Focus Area Mapping Methodology ..... p. 2-5
2.3 Nonconsumptive Focus Area Mapping Results ..... p. 2-9

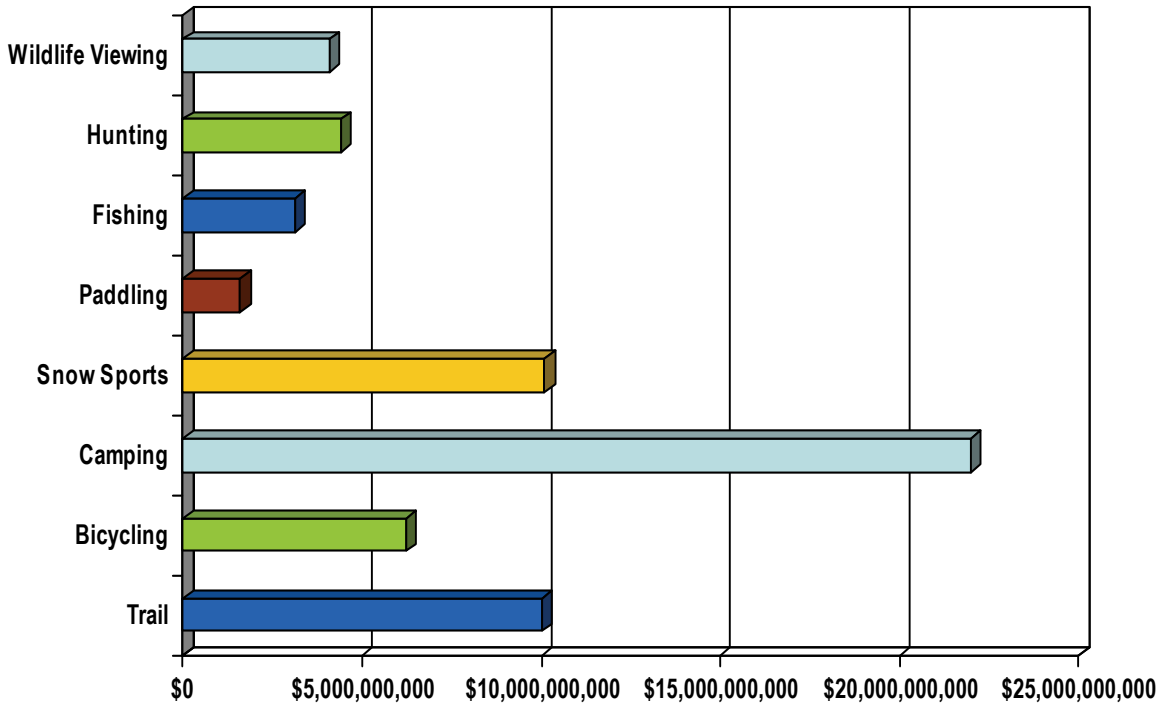

Figure 2-1 Contribution to Rocky Mountain Census Division 8 by Annual Economic Activity by Type

The Colorado River Outfitters Association's study on commercial river use in Colorado shows over $100 million of growth in the industry over the last 21 years. However, river days dropped in 2008 and 2009 due, in part, to the economic recession. The user days associated with commercial rafting in Colorado from 1988 through 2009 are shown in Figure 2-2. Regardless of the downturn, in 2009 the industry saw an economic impact of $141 million. That figure is down from $153 million in 2007, the industry's all-time high (Colorado River Outfitters Association 2009).

The Colorado River Outfitters Association's study on commercial river use in Colorado shows over $100 million of growth in the industry over the last 21 years.

The report by BBC Research & Consulting (2008) for Colorado Division of Wildlife (CDOW) investigated the economic impacts of hunting, fishing, and wildlife watching statewide. Data from 2007 show that hunters and anglers spent an estimated $1 billion on direct expenditures in Colorado (BBC Research & Consulting 2008). Examples of direct expenditures include food, lodging, transportation, fishing gear, and camping equipment. In addition, the report included a summary of the total economic impacts including the secondary impacts of direct expenditures such as salaries being re-circulated in the economy. The report estimated the total impact of these industries (direct and secondary expenditures) amounted to $1.8 billion (BBC Research & Consulting 2008).

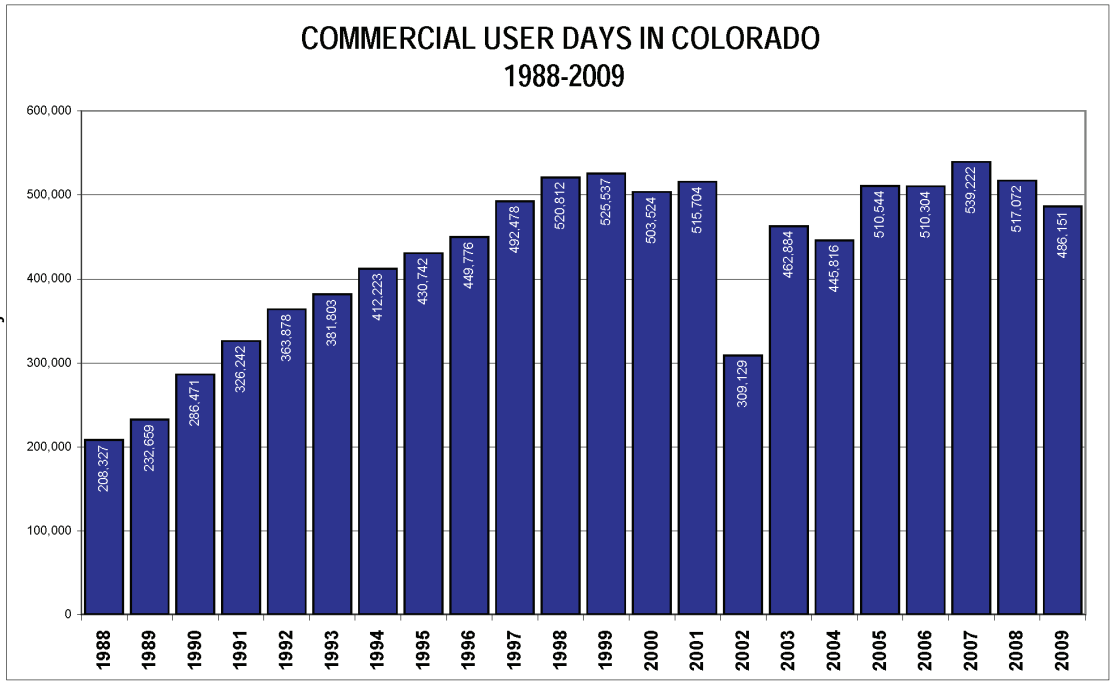

Figure 2-2 Commercial River Rafting User Days in Colorado (1988-2009)

As discussed in Section 1, the basin roundtables are required to complete Nonconsumptive Needs Assessments (NCNAs). This effort has included an extensive inventory, analysis, and synthesized mapping effort that built upon the Statewide Water Supply Initiative (SWSI) 2 environmental and recreational attribute mapping as a common technical platform for the basin roundtables. Figure 2-3 shows the process that was utilized by the Colorado Water Conservation Board (CWCB) and basin roundtables in completing their NCNAs. The basin roundtables have utilized environmental and recreational mapping to identify where the nonconsumptive focus areas are in their basins. In addition, the Arkansas, Colorado, and Yampa-White Basin Roundtables have utilized Water Supply Reserve Account funding to conduct further studies in their basins focused on quantifying environmental and recreational flow needs. The basin roundtables' nonconsumptive focus areas and further study efforts are intended to facilitate the identification of projects and methods to address environmental and recreational water needs. The nonconsumptive identified projects and methods are summarized in Section 3 of this report.

The basin roundtables have utilized environmental and recreational mapping to identify where the nonconsumptive focus areas are in their basins.

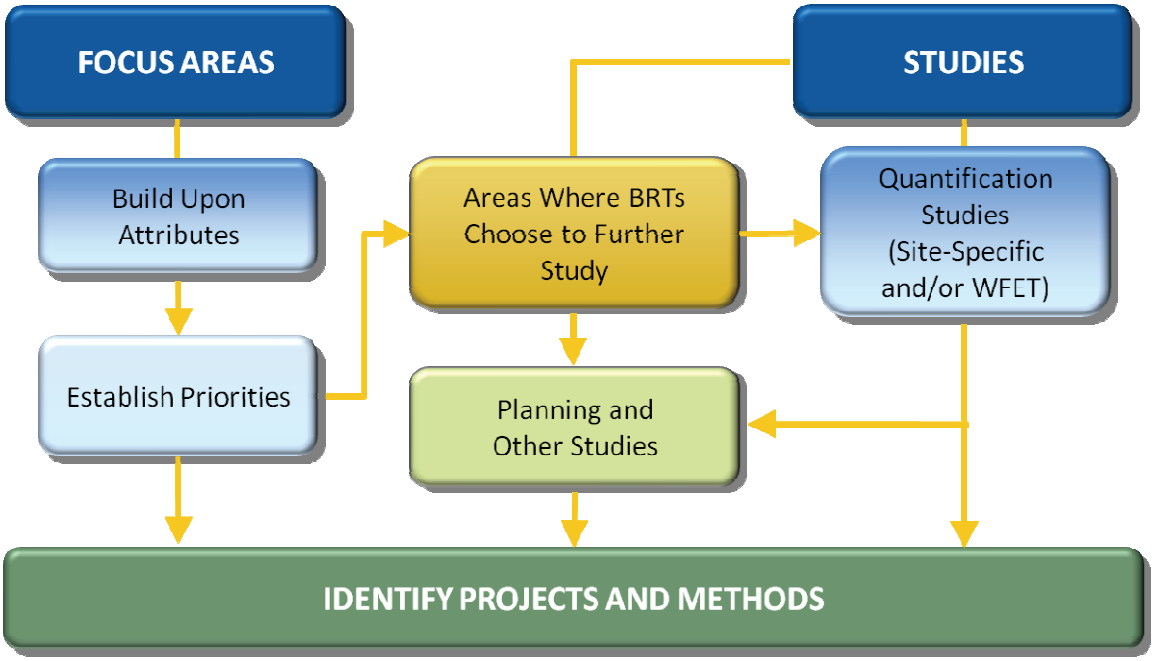

Figure 2-3 Nonconsumptive Needs Assessment Methodology

The focus area maps developed by each basin roundtable are based on a common set of environmental and recreational attributes and represent where Colorado's important water-based environmental and recreational attributes are located. The maps are reflective of stakeholder input for the focus areas and also reflect stream reaches and subwatersheds with higher concentrations of environmental and recreational qualities. These maps were generated to provide information to the basin roundtables on important environmental and recreational areas in their basins but were not intended to dictate future actions. It should be noted, and as will be shown in this section, that this effort has not identified all streams as important. The NCNAs are not intended to create a water right for the environment and will not diminish, impair, or cause injury to existing absolute or conditional water rights. The CWCB developed the environmental and recreational focus area mapping for the following purposes:

- The maps are intended to serve as a useful guide for water supply planning so that future conflicts over environmental and recreational needs can be avoided.
- The maps can assist in identifying environmental and recreational water needs status, such as where needs are being met, where additional future study may need to take place, or where implementation projects in the basin are needed.
- The maps can help basins plan for the water needs of species of special concern so that they do not become federally-listed as endangered or threatened in the future.
- The maps can provide opportunity for collaborative efforts for future multi-objective projects.

2.2 Focus Area Mapping Methodology

Underlying the work done by the basin roundtables is a common technical platform, which builds off SWSI 2, as described above. This common technical platform approach recognizes the need for each basin roundtable to utilize the technical work in the most effective manner for the stakeholders and concerns within the basin. For example, some basins that were focused on wetlands or bird habitat issues used a watershed approach, while others focused on instream habitat.

Overall, the basin roundtables used three methods to identify their focus areas as shown in Figure 2-4. After the basin roundtables gathered additional data layers beyond existing SWSI 2 geographic information system (GIS) data layers, they each developed a summary map that highlighted environmental and recreational focus areas for their basin. The Arkansas and Rio Grande Basin Roundtables utilized Method 1, which employed GIS software to summarize information at a watershed level (U.S. Geological Survey [USGS] 12-digit Hydrologic Unit Code [HUC] watershed). These two basin roundtables had many data layers that they summarized into "categories," such as threatened and endangered species, riparian communities, and recreational boating areas. Using GIS software, the number of categories in each watershed was counted, and using varying color scales, GIS watersheds with a higher number of categories were highlighted in a darker color. Using Method 2, the North Platte and Southwest Basin Roundtables utilized a similar technique as Method 1, but information was summarized at the stream level versus the watershed level. The Colorado, Metro/South Platte, and Yampa-White Basin Roundtables used Method 3, which reviewed all available data layers for their basin, and based on stakeholder knowledge and outreach, selected stream reaches that represented the majority of environmental and recreational activity in their basins.

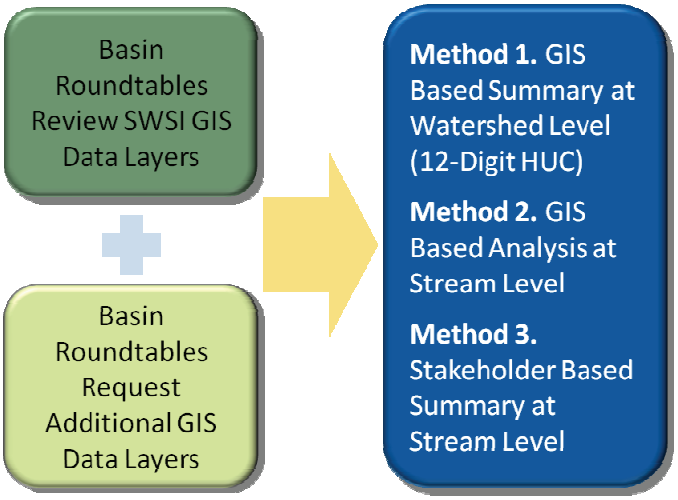

Figure 2-4 Basin Roundtable Focus Area Mapping Methodology

GIS software was used to organize the data layers for environmental and recreational attributes associated with nonconsumptive water needs for each basin. The term "data layer" refers to geographic data that represents a specific type of feature or attribute (e.g., wetlands or species habitat) and can also be referred to as a shapefile. Multiple data layers, organized collectively, are referred to as a dataset. The environmental and recreational data layers for each basin were selected using the SWSI 2 GIS data layers as a starting point. The basin roundtables reviewed the available data layers compiled during SWSI 2 and then suggested and contributed additional data layers as deemed appropriate for each basin. Appendix C contains the *Nonconsumptive Needs Assessment Focus Mapping Final Report* that provides the detailed methodology utilized by each basin roundtable in developing their focus area map.

2.2.1 SWSI 2 GIS Data Layers

The Environmental and Recreational Technical Roundtable that was formed under SWSI 2 developed a list of select environmental and recreational GIS data layers that could potentially be used by decisionmakers to determine areas of focus for environmental and recreational water needs. The complete list of SWSI 2 GIS data layers is shown in Table 2-1.

Table 2-1 SWSI 2 Environmental and Recreational Data Layers

Arkansas Darter	Gold Medal Trout Streams
Audubon Important Bird Areas	Greenback Cutthroat Trout
Bluehead Sucker	Greenback Cutthroat Trout
Bonytail Chub	Humpback Chub
Boreal Toad Critical Habitat	Rafting and Kayak Reaches
Colorado Department of Public Health and Environment Water Quality Control Division 303(D) Listed Segments	Rare Riparian Wetland Vascular Plants
Colorado Pikeminnow	Razorback Sucker
Colorado River Cutthroat Trout	Recreational In-Channel Diversions
CWCB Instream Flow Rights	Rio Grande Cutthroat Trout
CWCB Natural Lake Levels	Rio Grande Sucker
CWCB Water Rights Where Water Availability had a Role in Appropriation	Roundtail Chub
Flannelmouth Sucker	Significant Riparian/Wetland Communities
Gold Medal Trout Lakes	

In addition to the SWSI 2 environmental and recreational GIS data layers, the basin roundtables requested the attainment and development of other important environmental and recreational GIS data layers. Some of the additional GIS data were received directly from state and federal agencies, nongovernmental organizations and municipalities, or downloaded from their official websites. Other additional GIS data were digitized from available information, lists, or maps provided by basin roundtables, specialists (biologists, recreation guides), and other stakeholders. Table 2-2 contains a list of additional environmental and recreational data layers that were collected based on basin input. Appendix C contains a detailed description of these data layers and their source.

Table 2-2 Additional Environmental and Recreational Data Layers Based on Basin Roundtable Input

Additional Fishing	National Wetlands Inventory
Additional Greenback Cutthroat Trout Waters	Northern Leopard Frog Locations
Additional Paddling/Rafting/Kayaking/Flatwater Boating	Northern Redbelly Dace
Additional Rio Grande Sucker and Chub Streams	Osprey Nestsites and Foraging Areas
Bald Eagle Winter Concentration	Piping Plover
Bald Eagle Active Nestsites	Plains Minnow
Bald Eagle Summer Forage	Plains Orangethroat Darter
Bald Eagle Winter Forage	Preble's Meadow Jumping Mouse
Brassy Minnow	River Otter Confirmed Sightings
Colorado Birding Trails	River Otter Overall Range
Additional Fishing	National Wetlands Inventory

Table 2-2 Additional Environmental and Recreational Data Layers Based on Basin Roundtable Input, continued

Colorado Outstanding Waters	Rocky Mountain Biological Laboratory (scientific and educational reaches)
Common Garter Snake	Sandhill Crane Staging Areas
Common Shiner	Southwestern Willow Flycatcher
Ducks Unlimited Project Areas	Stonecat
Educational Segments	Waterfowl Hunting Areas
Eligible/Suitable Wild and Scenic	Wild and Scenic Study Rivers
GMUG Wilderness Waters/Areas	Wildlife Viewing
High Recreation Areas	Yellow Mud Turtle
Least Tern	

2.2.2 Categorization of Data Layers

Once the basin roundtables identified the focus environmental and recreational data layers in their basins, the data layers were grouped into subcategories representing a collective environmental or recreational category. This method had two advantages—1) it moderated redundancy among comparable, geographically overlapping individual data layers, and 2) it allowed for a more comprehensible presentation of the GIS data. For example, Colorado pikeminnow, razorback sucker, humpback chub, and bonytail chub and federal critical habitat individual data layers were all grouped under the subcategory "Federally Endangered Fish," which was included in the overarching environmental category. The Rio Grande subcategories are shown as an example below in Figure 2-5 and subcategories for each basin roundtable are described in Appendix C.

2.2.3 GIS Analysis of Data Layers

The Arkansas and Rio Grande Basin Roundtables chose to use 12-digit HUC watersheds as the basis for their GIS tool development. The HUC is a hierarchical, numeric code that uniquely identifies hydrologic units. Hydrologic units are subdivisions of watersheds nested from largest to smallest areas and are used to organize hydrologic data. HUCs are identifiers as assigned to basin polygons by the USGS. The USGS creates the digital data for HUCs, which are available for download through the USGS website. Twelve-digit HUCs are the smallest subdivision of hydrologic data available to-date in Colorado, with an average of 33 square miles. In contrast to the Arkansas and Rio Grande Basin Roundtables, the Colorado, Gunnison, Metro/South Platte, North Platte, Southwest, and Yampa-White Basin Roundtables summarized their environmental and recreational attributes on a stream segment basis. This information was also summarized using USGS information for stream segments provided by National Hydrography Dataset (NHD). Each stream segment that was included as a focus area by the basin roundtables was summarized at the NHD segment level and is related to the USGS NHD stream layers using the common identifier for the NHD database.

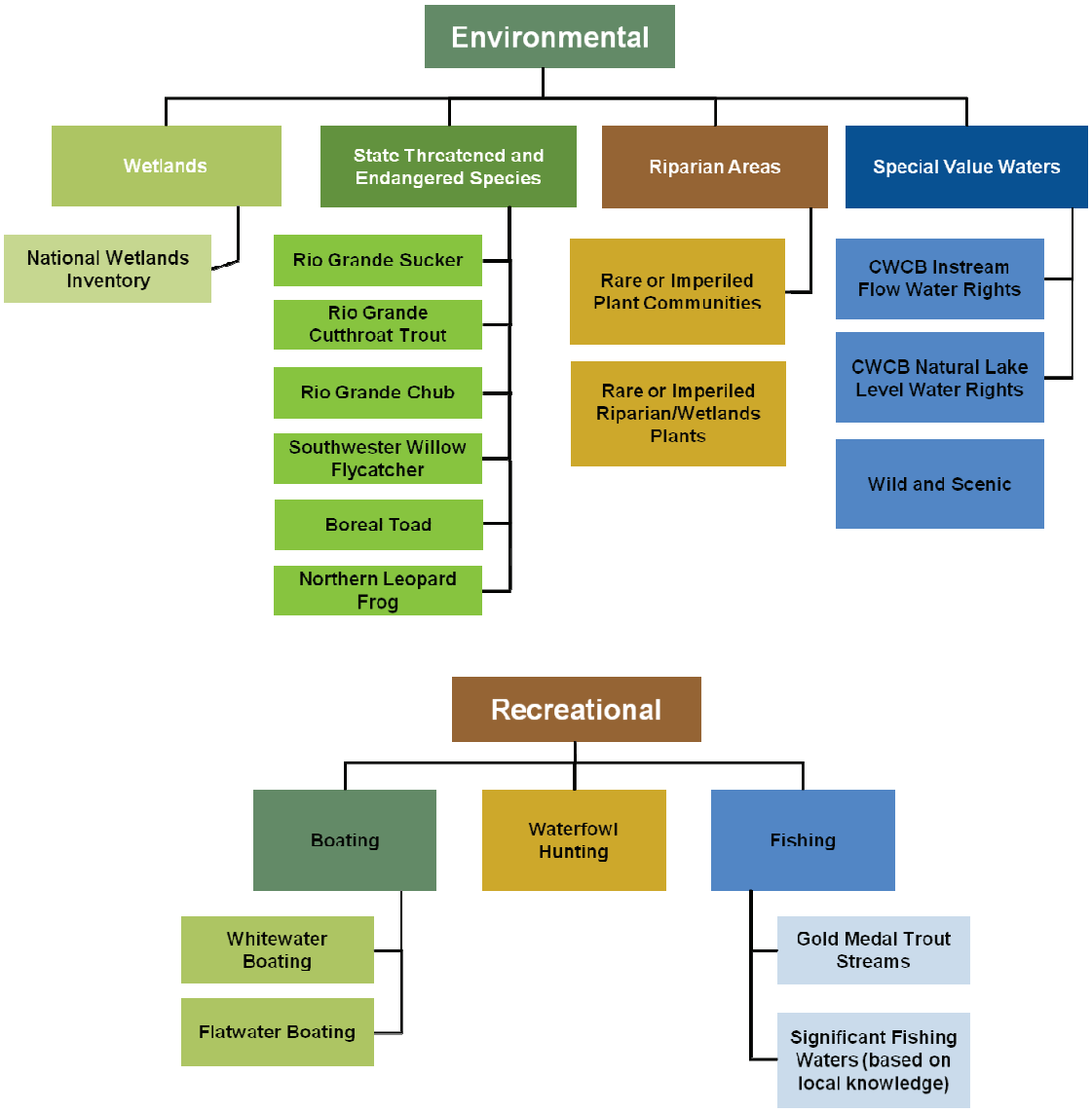

Figure 2-5 Rio Grande Basin Environmental and Recreational Subcategories

For the Arkansas and Rio Grande Basin Roundtables, each environmental and recreational data layer was categorized as described in Section 2.2.2. Using GIS software, the categories of data layers were intersected with the 12-digit HUCs to create HUC-based environmental and recreational category areas. These HUC-based environmental and recreational categories areas were then overlaid on one another using GIS software to create a density or number of environmental and recreational categories in a given 12-digit HUC. Detailed procedures for this analysis are described in Appendix C.

The North Platte and Southwest Basin Roundtables utilized an approach similar to the Arkansas and Rio Grande; however, information was summarized at the stream reach level versus the 12-digit HUC. Using GIS, the recreational and environmental category layers were summarized using GIS and then a buffer was applied to the stream segments. Environmental and recreational category layers within the buffer were summarized in the same way as the HUC approach by developing a density of number of environmental and recreational categories within the buffer. Detailed procedures for this analysis are described in Appendix C.

Finally, the Colorado, Gunnison, Metro/South Platte, and Yampa-White Basin Roundtables examined their collected environmental and recreational data layers and utilized a stakeholder process to establish what the environmental and recreational focus areas should be for their respective basins. These basin roundtables summarized their environmental and recreational attributes on a map and created a table summarizing why the segment was included as a focus area and important attributes for each segment. This information has been summarized at the NHD stream reach level. Detailed information about this approach is summarized in Appendix C.

2.3 Nonconsumptive Focus Area Mapping Results

Using the methodologies and techniques outlined above, each basin developed a unique map showing focus areas with nonconsumptive environmental and recreational water needs. The resulting maps for each basin and a statewide compilation map are described throughout the remainder of this section. Each basin's map differed based on the priority data layers selected and their chosen mapping technique. Color schemes and basemapping layers also varied by basin as dictated by the basin roundtables. Details relating to each basin's mapping product are described further below.

The basin and statewide maps were created as a Geospatial PDF file, or GeoPDF, to allow the user the ability to "click" areas of the map and view characteristics of that portion of the map such as what attribute subcategories are present for a given HUC or stream segment. In addition, the presence of specific attributes (e.g., razorback sucker, roundtail chub, kayaking, etc.) is also summarized as well as information designated by the basin roundtables through creation of tables associated with their maps. The maps in Figures 2-6 through 2-14 can be used as GeoPDFs in the electronic version of this report. To utilize the maps interactively, select the tools dropdown list, then select the analysis tools arrow and then click on the "object data tool." Using this tool, triple click a reach for additional information that will appear on the left side. More detailed instructions for using the nonconsumptive GeoPDFs as well as downloading and utilizing Adobe Reader are included in Appendix D.

Figures 2-6 and 2-7 show the environmental and recreational focus mapping for the Arkansas and Rio Grande Basins. These figures were developed as GeoPDFs that enable the viewer to select a 12-digit HUC focus area and view the environmental and recreational attributes for that HUC. The Arkansas Basin identified nine environmental and recreational subcategories as shown on the map. Areas with the most overlap of subcategories are shown in the darkest color and are primarily concentrated in three areas—1) the mainstem Arkansas River upstream of Pueblo, 2) the Fountain Creek watershed, and 3) in the areas around major reservoirs on the Lower Arkansas River between Las Animas and Eads.

The Rio Grande Basin used seven environmental and recreational subcategories for its mapping efforts. Nearly all HUCs within the Rio Grande Basin had at least one environmental or recreational subcategory present. The areas of the Rio Grande Basin with the highest concentration of priority subcategories are located near Crestone, south of Fort Garland, northeast of Alamosa, along Hot Springs Creek in the northwest portion of the basin, and in a number of HUCs in western Conejos County.

Figures 2-8 and 2-9 show the environmental and recreational focus mapping for the North Platte and Southwest Basins. These figures were developed as GeoPDFs that enable the viewer to select the environmental and recreational focus area segment and display the specific attributes associated with that stream segment. As discussed previously, the segments are presented at the NHD stream reach level.

The North Platte Basin used eleven environmental and recreational subcategories for its mapping while the Southwest Basin used six. Although eleven subcategories were used for the North Platte Basin mapping, the greatest number of overlap was six, meaning six different subcategories were present within the same segment. Segments with five or six subcategories present are highlighted in red on the map. The

highest concentrations of subcategories are located on the following segments: the Big Creek Lakes, a portion of the North Fork Michigan River, and a segment of the Illinois River south of Walden.

In the Southwest Basin, a large portion of the streams and lakes contained at least one environmental or recreational subcategory. The majority of streams found in the Weminuche Wilderness and U.S. Forest Service areas between Durango and Silverton were highlighted for their nonconsumptive water needs and nearly the entire lengths of the major rivers (the San Juan, San Miguel, and Dolores Rivers) are highlighted because they contain environmental and recreational subcategories deemed important by the basin roundtable. The GeoPDF allows the user to select individual NHD stream segments and display their specific attributes using Adobe Reader.

The Gunnison, Metro/South Platte, and Yampa-White Basins each created maps showing major stream and lake segments with environmental, recreational, and both environmental and recreational nonconsumptive water attributes. The Gunnison Basin also included scientific and education segments in their focus map. As described above, each of these basins created a table with the supporting data for the selected segments. These tables and other details for these basin roundtables mapping efforts are located in Appendix C. GIS analysis was performed to join these tables to their spatial location within the basin. A GeoPDF was then developed for each basin allowing the viewer the ability to select a stream segment and see the specific attributes for that NHD reach plus details from the associated tables that were created by the basin roundtables.

Figure 2-10 shows the Gunnison Basin Major Environmental and Recreational Stream Segments as determined by the basin roundtable. The Gunnison Basin chose to include waters within the Rocky Mountain Biological Laboratory property as scientific and educational waters. These are highlighted on the map in aqua. Waterbodies shown in purple are those that are known as boating and fishing reaches. Segments highlighted in orange have environmental nonconsumptive water attributes. Many of these streams are located within wilderness areas including the Roubideau Special Management Area and the Dominguez Canyons Wilderness Area. Segments highlighted in red have both environmental and recreational nonconsumptive water attributes. This overlap occurs on a large portion of the Gunnison River. The Gunnison Basin GeoPDF provides the viewer the ability to select stream segments and display their attribute categories and specific attributes (e.g., kayaking, wildlife viewing, waterfowl hunting, etc.). In addition, other details from the Gunnison table, such as the rationale for consideration, are also detailed in the GeoPDF. The attribute categories for the Gunnison Basin that are shown within the GeoPDF include:

- Federally listed fish species
- Aquatic-dependent state endangered, threatened, and species of concern
- Rare aquatic-dependent plants and significant riparian wetland plant communities
- Special value waters
- Whitewater and flat water boating
- Riparian/wetland wildlife viewing and waterfowl hunting
- Significant cold- and warm-water fishing
- High recreation areas

Figure 2-11 shows the Yampa-White Major Environmental and Recreational Stream Segments as determined by the basin roundtable NCNA subcommittee. Within the basin, substantial amounts of the major rivers (the Yampa, White, and Green Rivers) are highlighted for their environmental, recreational, or environmental and recreational attributes. A limited number of additional segments are included in the basin's focus map. The Yampa-White GeoPDF provides the viewer the ability to select stream segments and display their attribute categories and specific attributes (e.g., bluehead sucker,

flannelmouth sucker, Gold Medal trout streams, etc.). Details from the Yampa-White's table, such as the rationale for consideration as a major segment, are included in the GeoPDF. The attribute categories for the Yampa-White Basin that are shown within the GeoPDF include:

- Federal threatened and endangered fish
- State threatened and endangered species
- Important riparian habitat
- Instream flows and natural lake levels
- Fishing
- Boating
- Waterfowl hunting

Figure 2-12 shows the Metro Basin's Major Environmental and Recreational Stream Segments as determined by the basin roundtable. The South Platte Basin's map, which includes the Major Environmental and Recreational Stream Segments in the Metro Basin, is available in Figure 2-13. The South Platte Basin NCNA subcommittee opted to use the term "Candidate Focus Areas" for its major segments with environmental, recreational, and environmental and recreational nonconsumptive water attributes. The South Platte Basin Roundtable also divided the basin into the following subbasins—High Plains, Lower South Platte, Northern, Denver Metro, Upper Mountain, and South Metro. Twenty-four waterbody or waterbody groups were selected by the subcommittee. The map is labeled with numbers to correspond with the data matrix. The matrix was linked to the spatial data layers in GIS and exported as a GeoPDF. The GeoPDF allows the viewer to select the waterbody and display the linked table, which contains the following waterbody characteristic:

- Segment description
- Environmental (is this waterbody purpose environmental?)
- Recreational (is this waterbody purpose recreational?)
- Rationale for consideration

Finally, the Colorado Basin Roundtable used a similar stakeholder approach as the Gunnison, Yampa, South Platte, and Metro Basins. The map was developed primarily using site-specific knowledge of the waterbodies, and a detailed table with more than 65 segments was developed to be used in conjunction with the map. The map shows the identified segments highlighted in red with the corresponding table segment identification number for reference. The map was developed as a GeoPDF, which allows the viewer to select any identified segment (in red) and see their corresponding segment attributes. The Colorado Basin's map can be seen in Figure 2-14.

The statewide environmental and recreational focus map for nonconsumptive water needs (Figure 2-15) is a compilation of each individual basin's mapping efforts. The figure provides a statewide overview that combines each basin's effort together to show the variety of mapping methods employed and the varying results generated by basin-specific selection of environmental and recreational data layers.

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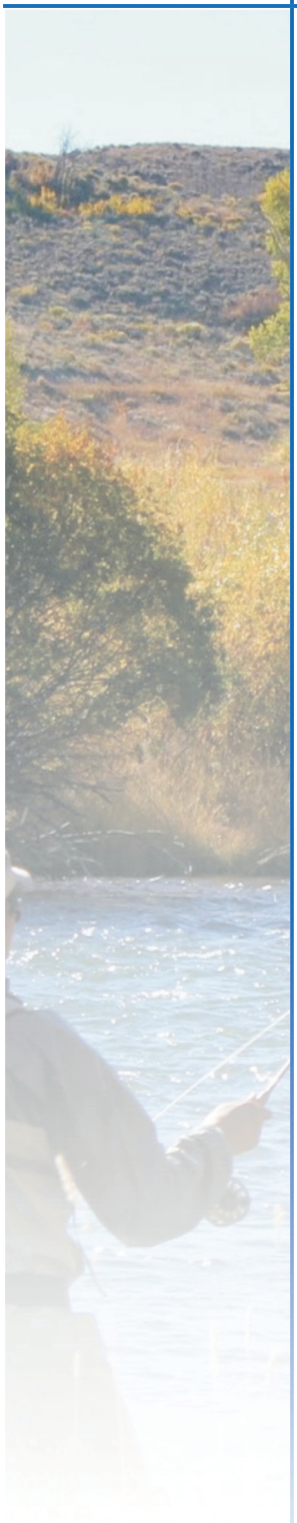
Section 3

Nonconsumptive Projects and Methods



3.1 Nonconsumptive Projects and Methods Overview

Section 2 of this report summarizes the nonconsumptive needs across the state of Colorado. As discussed in Section 1, the Water for the 21st Century Act requires the basin roundtables to identify projects and methods to meet their consumptive and nonconsumptive needs. For consumptive projects and methods, the Colorado Water Conservation Board (CWCB) worked with water providers and the basin roundtables to update the Statewide Water Supply Initiative (SWSI) 1 identified projects and processes (IPPs) from a planning horizon of 2030 to 2050. This effort is summarized in Section 5 of this report. For nonconsumptive needs, the CWCB has conducted an analogous outreach effort with the environmental and recreational community and the basin roundtables to identify nonconsumptive projects and methods similar to the municipal and industrial (M&I) consumptive IPPs. CWCB digitized the project information into geographical information system (GIS) and compared this information with the nonconsumptive focus areas summarized in Section 2. With this information, CWCB was able to preliminarily identify nonconsumptive focus areas with and without projects and methods. It is important to note that if a focus area does not have an associated project and method it does not mean that the area needs protective projects and methods. It is also important to note that CWCB did not judge the sufficiency of the projects and methods in each reach; rather, as with the M&I IPPs, CWCB did not judge the merits of the nonconsumptive projects and methods being pursued by local organizations. The basin roundtables will use this information as they finalize their needs assessments during 2011. This information gathered is intended to assist the basin roundtables in addressing the following questions:

1. Are there existing protections/efforts for environmental and recreational focus areas?
2. Are there areas without protections that need further study?
3. What strategies are needed to support Nonconsumptive priority areas?
4. Are there areas where new flow or water level quantification is appropriate?
5. Are there areas where a project, whether structural (e.g., river restoration) or nonstructural, can be identified and implemented?
6. Are there areas where no action is needed at this time?

Index

3.1 Nonconsumptive Projects and Methods Overview ..... p. 3-1
3.2 Nonconsumptive Projects and Methods Methodology ..... p. 3-2
3.3 Nonconsumptive Projects and Methods GIS Mapping and Analysis Methodology ..... p. 3-4
3.4 Nonconsumptive Projects and Methods GIS Mapping Results ..... p. 3-6
3.5 Funding and Legal Mechanisms to Assist Implementation of Nonconsumptive Projects and Methods ..... p. 3-9

Section 3.2 describes the methodology used to gather nonconsumptive projects and methods across the state. Section 3.3 summarizes the methodology used to analyze the project and method information. Section 3.4 explains the results of the analysis and Section 3.5 discusses funding and legal mechanisms to assist implementation of nonconsumptive projects and methods.

3.2 Nonconsumptive Projects and Methods Methodology

In January 2010, CWCB developed a survey to collect information on where there are existing or planned nonconsumptive projects, methods, and studies. Studies were included since they may recommend or inform the implementation of projects or methods that will provide protection or enhancement of environmental and recreational attributes. This survey was distributed through CWCB's basin roundtable and email database. On February 10, 2010, CWCB conducted a workshop in Silverthorne, Colorado to discuss the Phase II efforts and to collect information on nonconsumptive projects, methods, and studies from the workshop attendees. At the workshop, information on 116 stream segments and 209 projects, methods, or studies was provided to CWCB. In addition, CWCB also gathered information on individuals and organizations to follow up with the data collection effort. Since the February 2010 meeting, an additional 57 meetings have occurred to gather data on additional projects, methods, and studies. Table 3-1 below summarizes the number of individuals or organizations contacted since the February 2010 meeting, the number of follow-up meetings held, and the number of projects, methods, and studies identified to date for each basin. Table 3-1 details the number of projects, methods, and studies that are in the focus areas and the number of projects outside of the focus areas. In total, 648 projects were identified from the outreach effort. Examples of the types of projects collected during this outreach effort include:

- Habitat restoration projects such as bank stabilization projects or instream habitat restoration such as pool and riffle development. Another example of habitat restoration area projects that focus on the maintaining connectivity for fish passage such as fish ladders.
- Flow protection projects such as voluntary flow agreements, instream flow (ISF) donations, or voluntary re-operation of reservoirs for releases for environmental or recreational needs.

Table 3-1 Summary of Meetings to Collect Nonconsumptive Project and Methods Information

Basin Roundtable	No. of Individuals or Organizations Contacted	No. of Meetings	No. Projects and Methods in Focus Areas	No. Projects and Methods Outside Focus Areas	Total No. Projects and Methods
Arkansas	7	5	40	0	40
Colorado	21	12	168	35	203
Gunnison	9	4	44	15	59
Metro	See South Platte	See South Platte	See South Platte	See South Platte	See South Platte
North Platte	1	1	41	7	48
Rio Grande	10	5	59	0	59
South Platte	17	14	54	53	107
Southwest	17	12	84	10	94
Yampa-White	9	4	22	16	38
TOTAL	**91**	**57**	**512**	**136**	**648**

In addition, there is a great deal of information gathered from divisions within the Colorado Department of Natural Resources (DNR) that have been integrated into the projects and methods database. For instance, Table 3-2 summarizes CWCB's ISFs for each basin roundtable. Decreed ISFs have been confirmed by the water court. Pending ISFs have been approved by the CWCB Board and are going

through the water court process. Recommended ISFs include those areas submitted to CWCB as a recommendation, but not yet approved by the CWCB Board at this time.

Table 3-2 Summary of CWCB Instream Flows and Natural Lake Levels

Basin Roundtable	Natural Lakes	ISF Decreed	Pending ISF	Recommended ISF
Arkansas	86	171	11	8
Colorado	150	404	12	6
Gunnison	82	259	15	2
Metro	0	24	0	0
North Platte	31	45	1	3
Rio Grande	49	141	0	0
South Platte	31	208	2	2
Southwest	50	151	4	6
Yampa-White	150	175	7	5
TOTAL	**494**	**1,578**	**52**	**32**

The CWCB's Watershed Protection and Flood Mitigation section oversees the agency's watershed restoration efforts. In addition, many of the Water Supply Reserve Account (WSRA) grants fully or partially address nonconsumptive needs. Table 3-3 shows the funding programs implemented by CWCB and project type associated with each program. The table shows the status of the projects; pending in this case means that either the contract has not yet been signed, but has CWCB approval, or that applicants have applied, but are not yet approved by the CWCB.

Table 3-3 Summary of CWCB's Watershed Restoration and Nonconsumptive WSRA Projects

Funding Source	Type	Complete	On-going	Pending	Total
Colorado Healthy Rivers Fund	Report	19	9	3	31
Colorado Healthy Rivers Fund	Restoration Project	15	7	6	28
Colorado Watershed Restoration Program	Report	1	3	0	4
Colorado Watershed Restoration Program	Restoration Project	2	9	1	12
Fish and Wildlife Resources Fund	Restoration Project	2	2	0	4
Multi-Objective Watershed Protection Plan	Report	5	0	1	6
Multi-Objective Watershed Protection Plan	Restoration Project	6	0	4	10
WSRA Nonconsumptive Related Grants	Report	8	15	3	26
WSRA Nonconsumptive Related Grants	Restoration Project	13	12	4	29
	TOTAL	**71**	**57**	**22**	**150**
Total Restoration Projects	**Restoration Project**	**38**	**30**	**15**	**83**
Total Reports	**Report**	**33**	**27**	**7**	**67**
TOTAL CWCB Dollars Spent/Encumbered					$14,499,625
TOTAL Estimated Match Dollars					$34,323,697
TOTAL Approximate Expenditures					**$ 48,823,322**

In addition to CWCB's efforts, the Colorado Division of Wildlife (CDOW) is in the process of updating its water management plan for the Rio Grande Basin and plans to expand this effort to other river basins in the state. CDOW plans to use the basin roundtables in the process and this information will be incorporated into the basin reports in 2011. CDOW's current working list of statewide nonconsumptive projects and methods is summarized in Appendix E.

Finally, CWCB included the Southwest Regional Gap Analysis Project (SRGAP), coordinated by U.S. Geological Survey (USGS) into the projects and methods database. The SRGAP created detailed, seamless GIS data layers of land cover, all native terrestrial vertebrate species, land stewardship, and management status values. The management status values quantify the relationship between land management and

biodiversity throughout the state of Colorado. Four management status values are as described below (USGS 2010):

- Status 4 lands are where there are no known public or private institutional mandates or legally recognized easements or deed restrictions held by the managing entity to prevent conversion of natural habitat types to anthropogenic habitat types. The area generally allows conversion to unnatural land cover throughout.
- Status 3 lands comprise areas having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type (e.g., logging) or localized intense type (e.g., mining). It also confers protection to federally-listed endangered and threatened species throughout the area.
- Status 2 lands are areas having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance.
- Status 1 lands include areas having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management.

For this effort, CWCB include areas with a status between 1 and 2.5 as a project and method in the nonconsumptive projects database.

3.3 Nonconsumptive Projects and Methods GIS Mapping and Analysis Methodology

The project and method information collected by CWCB as described in Section 3.2 was spatially digitized in GIS. Each project was digitized separately using an existing stream database called National Hydrography Dataset (NHD) 12-digit segments. The average length of a NHD segment is 1.5 miles. Depending on the length of the project, multiple NHD segments could represent one project. Also, depending on the project location, multiple projects could exist on the same NHD segment. A unique Project ID and Segment ID were given to all surveyed and interviewed projects within the Nonconsumptive Needs Assessment database. In addition, the WSRA grant project locations were digitized in a similar fashion. The CWCB ISFs and natural lake levels, CWCB restoration projects, and the USGS SRGAP information had previously been summarized using GIS; therefore, this data did not have to be digitized. The USGS SRGAP information was analyzed further to calculate a weighted management status value for each NHD segment. This value was calculated in GIS for each NHD 12-digit HUC by a weighted average of each land management status within the HUC.

Following are the assumptions used in digitizing the nonconsumptive projects and methods:

- No NHD segment was edited (i.e., if the project was smaller than an NHD segment, the whole NHD segment was used to represent the project location).
- Projects were digitized based on hand drawn locations and/or brief descriptions. This information is still under review by the basin roundtables.

Following are the types of information included in the GIS geodatabase for each project:

- Project or Method Name
- Project or Method Type (i.e., study, flow protection, or restoration project)
- Project or Method Location
- Comments
- Project or Method Status (i.e., ongoing, planned, or completed)
- Project or Method Identification Number
- Project or Method Contact Name
- Project or Method Contact Identification Number

To help the basin roundtables answer the questions listed at the beginning of this section, CWCB developed a series of four maps that can be presented at a statewide or basinwide level. Because information is still under review by the basin roundtables, this information is presented at a statewide level for this report so that the basin roundtables and other stakeholders can develop an understanding of how this information can be used in finalizing their needs assessments. The four maps include:

- Projects and Methods Map
- Projects and Methods Status Map
- Studies Status Map
- Focus Areas with Projects and Methods Map

The **Projects and Methods Map** represents the spatial information for all nonconsumptive projects and methods that are planned, ongoing, or completed statewide. This map contains all nonconsumptive projects and methods including—1) CWCB interviews and workshops, 2) CWCB watershed restoration projects, and 3) WSRA grants. ISFs, decreed flows, pending ISFs, and land management status were not included in this map. Please note that this map includes projects and methods outside of the designated focus areas to spatially display the full extent of any project collected by CWCB. A complete list of projects is available in Appendix F.

The **Projects and Methods Status Map** shows nonconsumptive projects and methods from the interview data and CWCB restoration and WSRA grants. Examples of nonconsumptive projects and methods include instream habitat restoration projects and voluntary flow agreements that provide some level of environmental or recreational protection. In addition, the CWCB ISFs and the USGS Land Stewardship information are included as projects on this map. These projects and methods were intersected with the basin roundtable focus areas discussed in Section 2 of this report using GIS. For each project and method, the status (i.e., planned, ongoing, or completed) is differentiated using GIS. The USGS Land Stewardship was considered complete for this map. This map intersects with the roundtable identified environmental and recreational focus areas.

For the **Study Status Map**, GIS was used to differentiate the status of each of the identified studies identified in CWCB's outreach effort (i.e., planned, ongoing, or completed). Examples of studies include ISF studies, restoration planning studies, and water quality monitoring efforts. Studies are efforts that provide information but no measures have been implemented to protect environmental or recreational attributes. However, implementable projects or methods could be a likely outcome of studies. The studies identified in the **Study Status Map** tool are studies that intersect the environmental and recreational focus areas identified by the basin roundtables.

The **Focus Areas with Projects and Methods Map** identifies environmental and recreational focus areas with projects or methods that may be complete, ongoing, or planned in a stream reach. It also identifies environmental and focus areas without projects and methods. For focus areas with projects and

methods, the associated project and method does not necessarily provide sufficient protection for the focus area. Likewise, if a focus area does not have an associated project or method this does not indicate that the associated resource in the focus is not protected.

In addition to identifying the spatial extent and status of the identified projects and methods, CWCB also examined what type of protection the project or method may provide to a given environmental or recreational attribute. CWCB has classified the projects as having direct or indirect protections based on a given environmental or recreational attribute. Details of this analysis are provided in Appendix G. The definitions used for direct and indirect protections are as follows:

- **Direct Protection** – Projects and methods with components designed intentionally to improve a specific attribute. For example, ISFs have direct protection of fish attributes. Additionally, restoration of a stream channel would also provide direct protections for aquatic species.
- **Indirect Protection** – Projects and methods with components that were not designed to directly improve the specific attribute but may still provide protection. For example, flow protection for a fish species may also indirectly protect riparian vegetation that is located in the area of the flow protection. Another example includes protective land stewardship or a wetland or bank stabilization effort that could indirectly protect aquatic species.

The projects and methods identified through interviews were individually evaluated and compared to the environmental and recreational attributes gathered by the basin roundtables during their focus area mapping effort (focus area mapping is described in Section 2 of this report). For this report, CWCB examined warm water and cold water fish attributes throughout the state and identified if these areas have projects and methods that provide direct or indirect protections. In addition, CWCB identified where both indirect and direct protections occur for warm water and cold water fish. Examples of warm water fish include roundtail chub, flannelmouth sucker, bluehead sucker, and Iowa darter. Examples of cold water fish include Colorado River cutthroat trout, Gold Medal fishing areas and greenback cutthroat trout. Finally, note that CWCB has not identified the sufficiency or adequacy of these direct and indirect protections.

3.4 Nonconsumptive Projects and Methods GIS Mapping Results

The four projects and methods map types described above are shown in Figures 3-1 through 3-4. Figures 3-2 through 3-4 were created as Geospatial PDF (GeoPDF) files; information on how to utilize GeoPDFs is summarized in Section 2.3 and Appendix D of this report. Figure 3-1 shows the spatial extent of the projects and methods collected by CWCB. These include the projects and methods gathered through CWCB interviews and surveys, WSRA grants, Colorado Healthy Rivers grants, and Colorado Watershed Restoration Program grants. Note that many projects and methods "overlap" and individual projects are not distinguished in Figure 3-1. Table 3-4 summarizes the status of the projects and methods shown in Figure 3-1. For the 708 projects and methods shown in Figure 3-1, 48 percent are complete, 29 percent are ongoing, and 23 percent are planned/proposed.

Table 3-4 shows that approximately 80 percent of the identified projects, methods, and studies were within the basin roundtable focus areas. Although it is not clear why at this point in the analysis, there are some differences between the summary statistics of the areas within the focus areas compared to those outside of them. For instance, 25 percent of the identified projects, methods, and studies within the focus areas are planned or proposed, whereas only 14 percent are planned or proposed outside of the

focus areas. Related to this statistic, there is also a smaller proportion of completed projects within the focus areas.

Table 3-4 Summary of Project and Methods Status

Project and Methods Status	Number of Projects and Methods in Focus Segments	Number of Projects and Methods Outside Focus Segment	Total No. of Projects and Methods
Completed	254	90	334
Ongoing	169	34	203
Planned/Proposed	141	20	161
TOTAL	**564**	**144**	**708**

Table 3-5 summarizes the types of projects and methods summarized in Figure 3-1. Note that there is some overlap between project and method types (i.e., some projects and methods provide study information and an actual project such as a restoration project). For the 708 projects and method types shown in Figure 3-1 and summarized in Table 3-5, 57 percent are restoration projects, 18 percent are flow protection, and 25 percent are information or studies.

Note that ISF projects and USGS Stewardship Status areas are not included in these statistics. Data collected to-date indicate some differences when comparing project type between those projects, methods, and studies found within the focus areas and those found outside of them. Focus areas statewide have a higher proportion of studies and fewer restoration projects.

Table 3-5 Summary of Projects and Methods Type[1]

Project and Methods Status	Number of Projects and Methods in Focus Segments	Number of Projects and Methods Outside Focus Segments	Total No. of Projects and Methods
Restoration Project	301	96	397
Flow Protection	104	25	129
Information	159	23	182
TOTAL	**564**	**144**	**708**

[1] Some overlap occurs between project and methods types

Figure 3-2 shows the Projects and Methods Status Map for the CWCB surveyed and interviewed projects, CWCB watershed restoration projects, CWCB WSRA projects, CWCB ISF projects, and USGS Stewardship Status areas. The planned, ongoing, and completed projects and methods cover an area of 11,000 miles of basin roundtable environmental and recreational focus areas. The majority of projects and methods shown in Figure 3-2 are complete (57 percent). Thirty-three percent of the projects and methods are ongoing and 10 percent are planned or proposed. The Study Status map is provided as Figure 3-3. Of these projects 56 percent are completed, 36 percent are ongoing, and 8 percent are planned or proposed. Figure 3-4 is the Focus Areas with Projects and Methods Map. This figure was designed as a tool for the basin roundtable to identify focus areas without projects or methods. These areas are shown in red on Figure 3-4. If an environmental or focus area is shown in red it does not mean that there is not a project located there or that that area does not have some type of protection for environmental and recreational attributes. All four maps are intended to be utilized by the basin roundtables in completing their needs assessments.

In the state of Colorado, 33,000 miles of streams and lakes have been identified by the basin roundtables as environmental and recreational focus. Nearly one-third of the length (11,000 miles) of these focus areas have an associated project or method. The environmental and recreational focus areas have approximately 12,000 miles of cold water fish attributes and 11,000 miles of warm water fish attributes. For

cold water fisheries, approximately 5,000 miles of the 12,000 miles of identified fisheries have an associated project or method that offers direct or indirect protections. For warm water fisheries in the focus areas, 3,500 miles of the 11,000 miles have direct or indirect protections. Examples of other attributes besides cold water and warm water fish that are in the focus areas include riparian areas, water based terrestrial wildlife such as river otter and boreal toad, whitewater and flat water boating, and wildlife viewing. An analysis of additional attributes will be conducted for the basin reports.

Table 3-6 summarizes the direct and indirect protections for cold water and warm water fishery focus areas. Over 50 percent of cold water fishery focus areas have direct, indirect, or both types of protections. Nearly 30 percent of warm water fishery areas have direct, indirect, or both types of protections. Many of the cold water fisheries examined are protected by ISFs in headwaters areas across the state. This is one of the main reasons that the percentage of cold water focus areas with protections is higher than the warm water fishery areas. It is more difficult to file an instream flow water right in areas with a higher degree of management, since water availability is often limited. Warm water fish occurrences are very often in the highly managed reaches located further downstream.

Table 3-6 Summary of Focus Area Cold Water and Warm Water Fisheries Environmental and Recreational Protections

Protection Type	Cold Water Fish Focus Areas Length (miles)	Warm Water fish Focus Areas Length (miles)
Direct	2,000	1,100
Indirect	1,000	800
Direct and Indirect	2,300	1,600
No Known Protections	6,400	7,700
TOTAL[1]	**12,000**	**11,000**

[1] Totals rounded to two significant digits to reflect increased uncertainty at large geographic scales.

As was discussed previously, the CWCB has not made judgments about the adequacy or sufficiency of the identified projects and methods. During 2011, CWCB will work with the basin roundtables to complete their nonconsumptive needs assessments. Basin-specific maps similar to Figures 3-1 through 3-4 will be developed at the basin roundtable level. It is anticipated that the CWCB and basin roundtables will use the Projects and Methods Map (Figure 3-1) to understand the realm of different projects that has been identified for their basin. Basin roundtable members can utilize the Projects and Methods Status Map (Figure 3-2) to identify if there are ongoing or planned projects that need their support. This support could include financial support through WSRA funding or political support. Basin roundtables can utilize information in the Studies Status Map (Figure 3-3) to see if these studies recommended actions that could be turned into future projects by the basin roundtables. There is a small number of studies (1 percent) located in focus areas where no projects exist and these studies could be examined to see if they provide recommendations for project implementation. Information provided in Figure 3-4 will allow the basin roundtables to identify areas that need further action or areas where no further action is needed. In addition to the basin-specific figures, CWCB will work with the basin roundtables to develop basin-specific statistics similar to those described above for cold water and warm water fisheries. In addition to these two attributes, CWCB will develop additional statistics for other attributes such as riparian areas, whitewater boating, and a limited number of specific aquatic dependent species based on basin roundtable requests.

3.5 Funding and Legal Mechanisms to Assist Implementation of Nonconsumptive Projects and Methods

Environmental and recreational values will continue to be important to the state's economy and quality of life as was discussed in Section 2. As discussed above, Colorado has many existing projects and methods aimed at meeting these nonconsumptive values. Additional nonconsumptive projects and methods will be needed to meet Colorado's nonconsumptive water supply needs, especially in warmer waters with endangered, threatened, and imperiled species. Funding will continue to be an important issue for successful implementation of nonconsumptive projects and methods. In addition, several federal and state legal mechanisms could be utilized to assist with the implementation of nonconsumptive projects and methods. The remainder of this section summarizes funding and legal mechanisms that could be useful in implementing nonconsumptive projects and methods in the future.

3.5.1 Federal and State Funding

There are several ways that funding can be acquired for environmental and recreational water development. Existing federal and state programs can be drawn on and new programs at the state and local levels can also be created to provide funding. Table 3-7 shows existing federal funding sources appropriate for meeting the goals of environmental and recreational needs.

The federal funding programs identified are not dedicated entirely to recreational or environmental water development, but these purposes are eligible for development under each program to varying degrees. For instance, under the Continuing Authorities Program administered by the U.S. Army Corps of Engineers (USACE), there is a clear eligibility requirement consistent with environmental and recreational water development (Section 206 – Aquatic Ecosystem Restoration and Section 1135 – Project Modifications for Improvement of the Environment). Grant monies must be matched by local resources and funding must be authorized and approved by Congress, a significant challenge. The Rural Community Assistance Corporation (RCAC) loan program also has an environmental eligibility criterion; however, a dependable source of repayment must be identified to receive this loan. The U.S. Department of Agriculture (USDA), the U.S. Economic Development Administration (USEDA), and U.S. Environmental Protection Agency (USEPA) all have programs in which environmental or recreational project attributes represent legitimate purposes, although none of these programs are actually focused directly on recreation or the environment.

In sum, federal funding for environmental and recreational water development is possible through a number of eligible programs, but obtaining such monies is tenuous at best. Even so, these opportunities should not be ignored since combining environmental and recreational water purposes with other water development purposes may lead to sufficient public support to gain federal funding from one or more of these programs.

In addition to federal funding programs, a variety of state level funding sources are also available. Table 3-8 shows existing state level funding sources available for meeting the goals of environmental and recreational water needs. There are a host of state programs available for environmental and recreational water development led by the various programs of the CWCB. Several of these programs specifically call out eligibility requirements related to environmental and recreational water development. However, these grants are typically not large or common. The most widely used program available to water developers—the construction loan program—can also have an environmental or recreational purpose. However, these loans require a dependable source of repayment that can be a challenge for

environmental or recreational development. The Colorado Water Resources and Power Development Authority (CWRPDA) also has a number of loan programs that focus on environmental improvement, largely related to water pollution. These programs are mostly revolving fund programs that require loan repayment and are typically sponsored through public entities. Among the other available state programs, Great Outdoors Colorado (GOCO) has a specific focus on recreation and the environment. These grants, through one of three programs, typically entail other funding partners and public entities.

Although recreational and water development projects are eligible to receive funding from a number of state programs, significant challenges remain in accessing these funds. First, public entities and other partners are often required to secure the funding. Secondly, loan repayment sources must be identified, which is a considerable challenge for environmental and recreational water developments. Third, competition for public money is keen and identified constituencies for environmental and recreational water development are more difficult to identify than more traditional water resource development purposes.

Many of the challenges for state funding of environmental and recreational development are the same challenges that all other water development purposes face, especially agricultural water projects and rural water development.

While Tables 3-7 and 3-8 indicate many funding sources, they are not meant to be an exhaustive list. There are several other sources of funding from federal, state, and local governments as well as private and corporate foundations. While grant and loan sources are continually evolving and changing, many of these can be found for free by going to the Red Lodge Clearinghouse funding database at www.rlch.org/content/get-funding.

3.5.2 Legal Mechanisms to Support Nonconsumptive Projects and Methods Implementation

This section provides an overview of the type of water rights, federal tools, state tools, and local tools available for nonconsumptive projects and methods implementation. Table 3-9 provides a comparison of the type of water rights and other mechanisms that provide environmental and recreational flows. Table 3-9 also describes local, state, and federal mechanisms for establishing water rights for the environment and recreation as well as describing how multipurpose projects or structural improvements could provide environmental and recreational flows.

3.5.2.1 Federal Tools

Following is a summary of federal tools that could be utilized when implementing a nonconsumptive project or method.

Endangered Species Act

The Endangered Species Act (ESA) provides protection for fish, wildlife, and plant species that are listed as threatened or endangered in the U.S. The ESA gives procedures that federal agencies must follow when taking actions that may jeopardize a listed species. Federal agencies typically consult with the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service to ensure that listed species and their habitats are not harmed. If negative impacts are expected, plans such as a recovery plan or habitat conservation plan are required. In Colorado, recovery plans have been created to protect endangered species on a programmatic basis on the Colorado and Platte Rivers.

For more information see: http://www.fws.gov/endangered/.

Table 3-7 Existing Federal Funding Programs for Environmental and Recreational Water Development

Agency	Program	Purpose	Application Process	Funding Type	Recent Award	Eligibility/Comments	Website
USACE	Continuing Authorities Program	Develop solutions to water resource issues including aquatic ecosystem restoration and improvements to the environment from modification of Federal water resource projects.	Various.	Grant (35% - 50%)	$27 million	Authority and funding from Congress.	http://www.spk.usace.army.mil/organizations/cespk-pd/pdcap.html
RCAC	Rural Community Assistance Corporation Loan	Rural area focus on safe and decent housing, drinking water, wastewater, and community facilities.	Submit a loan application to the RCAC specific to the proposed project.	Loan	$4.47 million	Nonprofit organizations, municipalities, and tribal governments.	http://www.rcac.org/doc.aspx?82
USDA	Rural Development - Water and Environment Programs	Focus is water development for rural areas and towns of less than 10,000.	Various application processes.	Grant/Loan	Not Available	Various eligibility requirements. See fact sheet on website.	http://www.usda.gov/rus/water/program.htm
USDA	Natural Resource Conservation Service (NRCS) – Wetland Reserve Program (WRP)	Focus is on restoring, protecting, and enhancing wetlands and associated uplands on private land.	1. Submit an application to the local NRCS office. 2. The local NRCS office reviews the application for eligibility and then ranks all applications based on area ranking criteria. 3. Funds are allocated to applicants based on project rank.	Grant or Conservation Easement	$2.77 million total allocation for Colorado (FY07)	Landowners (must own land for previous 12 months) whose land is restorable and suitable to wildlife benefits.	http://www.nrcs.usda.gov/PROGRAMS/wrp/
USDA	NRCS – Wildlife Habitat Improvement Program (WHIP)	Focus is on creating high quality wildlife habitats for species of National, State, Tribal, or local significance.	See WRP process.	Grant	$0.5 million total allocation for Colorado (FY07)	Lands that are privately owned or tribal lands; adjusted gross income of land owners from the three preceding years does not exceed $2.5 million.	http://www.nrcs.usda.gov/programs/whip/

Table 3-7 Existing Federal Funding Programs for Environmental and Recreational Water Development, continued

Agency	Program	Purpose	Application Process	Funding Type	Recent Award	Eligibility/Comments	Website
USDA	NRCS – Environmental Quality Incentives Program (EQIP)	Focuses on soil, air, water, and other natural resource concerns.	See WRP process.	Grant (Cost-share up to 75% total project cost)	$40 million total allocation for Colorado (FY07)	Agricultural producers whose adjusted gross income from the three preceding years does not exceed $2.5 million.	http://www.nrcs.usda.gov/PROGRAMS/eqip/
USEDA	Public Works and Economic Development Program	Infrastructure in low income areas.	1. Applicant will meet with the Regional EDA office to determine eligibility of project. 2. If deemed eligible a request for proposal will be requested from the applicant. 3. If project is deemed viable a pre-application meeting will be requested. 4. After the pre-application meeting a request for formal application may be issued. 5. The applicant submits a formal application. 6. The EDA reviews the application and makes a determination. 7. The EDA notifies the applicant of its determination.	Grant	$2.5 million for Colorado (FY08)	State, city, county, or other political subdivision of a State, including a special purpose unit of a State or local government engaged in economic or infrastructure development activities, or a consortium of such political subdivision, an institution of higher education or a consortium of institutions of higher education, an Economic Development District organization, a private or public nonprofit organization or association, including a faith-based non-profit organization, acting in cooperation with officials of a political subdivision of a State, or an Indian Tribe, or a consortium of Indian Tribes.	http://www.eda.gov/AboutEDA/Programs.xml

Table 3-7 Existing Federal Funding Programs for Environmental and Recreational Water Development, continued

Agency	Program	Purpose	Application Process	Funding Type	Recent Award	Eligibility/Comments	Website
USEPA	Targeted Watershed Grant Program	Focus is water quality improvement along with habitat improvements.	1. Submit proposal to EPA in response to RFP. 2. EPA regional watershed experts will review and score all eligible applications. 3. The regional administrator will submit 4 recommended projects to the national panel. 4. The national panel will review 40 semi-finalists and submit its recommendation to the Selection official for final determinations. 5. Selected applicants are required to submit a complete application upon notification.	Grant	Not Available	States, local governments, public and private nonprofit institutions/organizations, federally recognized Indian tribal governments, U.S. territories or possessions, and interstate agencies are eligible to apply.	http://www.epa.gov/twg/
USEPA	Wetland Program Development Grants	Focus is water quality improvement along with habitat improvements.	1. Submit proposal to EPA in response to RFP. 2. EPA will review proposals. 3. Applicants will be notified of EPA's decision.	Grant	Not Available	States, tribes, local government agencies, interstate agencies, and intertribal consortia, and national non-profit, non-governmental organizations are eligible.	http://www.epa.gov/owow/wetlands/grantguidelines/
Bureau of Reclamation (BOR)	WaterSMART Grants (formerly known as 2025 Grants)	Focus is on projects that reduce conflicts through water conservation, efficiency, and markets.	1. Submit proposal to BOR in response to RFP. 2. BOR reviews proposal and makes determination. 3. Applicant is notified of BOR's determination.	Grant (50%)	Not Available	Irrigation and water districts, municipal governments, tribes, and states.	http://www.usbr.gov/WaterSMART/
USFWS	Partners for Fish and Wildlife	Focus is on restoring habitat on private lands including wetlands and riparian areas.	Contact Partners for Fish and Wildlife coordinator for more information.	Grant	Not Available	Individuals and groups who privately own land.	http://ecos.fws.gov/partners/viewContent.do?viewPage=home

Table 3-7 Existing Federal Funding Programs for Environmental and Recreational Water Development, continued

Agency	Program	Purpose	Application Process	Funding Type	Recent Award	Eligibility/Comments	Website
USFWS	Wildlife Restoration Program	Focus on projects to restore, conserve, manage, and enhance wild birds and mammals and their habitat.	Apply by contacting local Wildlife and Sport Fish Restoration (WSFR) Office (http://wsfrprograms.fws.gov/Subpages/ContactUs/ContactUs.htm)	Grant (with 25% state match)	Not Available	State agencies	http://wsfrprograms.fws.gov/Subpages/GrantPrograms/WR/WR.htm
USFWS	Sport Fish Restoration Program	Focus on restoring and better managing America's declining fishery resources.	Same as Wildlife Restoration Program	Grant (with 25% state match)	Not Available	State agencies	http://wsfrprograms.fws.gov/Subpages/GrantPrograms/SFR/SFR.htm
National Fish and Wildlife Foundation (NFWF)	General Matching Grant Program and Special Grant Programs	Focus in on projects that restore native populations of sensitive or species.	1. Submit a preproposal (only applicable for certain special grants). 2. If a preproposal application is required and successful the NFWF will request a full proposal from the applicant. 3. NFWF staff review and NFWF Board of Directors make final determinations on proposals. 4. Applicant is notified of final determination.	Grant	Not Available	Various eligible projects and applicants.	http://www.nfwf.org/AM/Template.cfm?Section=Grants

Source: Interviews with program officials and selected websites, 2010.

Table 3-8 Existing State Funding Programs for Environmental and Recreational Water Development

Agency	Program	Purpose	Application Process	Funding Type	Recent Award	Eligibility/Comments	Website/Reference
CWCB	Fish and Wildlife Mitigation Fund	Fund mitigation of impacts on fish and wildlife resources from water diversions, deliveries, or storage facilities.	1. Application is submitted to CWCB staff for review. 2. CWCB staff makes a recommendation to the CWCB Board. 3. CWCB Board will make a final determination. 4. CWCB notifies applicant of final determination.	Grants (Up to 25% of total project cost; maximum $250,000)	Elkhead Reservoir $1,048,000	• Used for the appropriation or acquisition of water rights to preserve or improve the natural environment to mitigate impact of an existing water facility. • Used to complete river restoration feasibility studies and construction projects. • Eligible applicants include operators of existing water diversions, delivery or existing storage projects and the CWCB.	http://cwcb.state.co.us/WatershedProtectionFloodMitigation/Watershed/WatershedRestorationProgram.htm
CWCB	Construction Loans (Water Project Loan Program)	Provide low-interest loans to agricultural, municipal, and commercial borrowers for the development of raw water resource projects.	1. Conduct a loan feasibility study and submit the study along with the loan application to the CWCB. 2. CWCB staff will review the application and provide a recommendation to the Board. 3. Board staff will evaluate the application for approval. 4. CWCB notifies applicant of decision.	Mostly Loan	Republican River Water Conservation District - Compact Compliance Pipeline Project $60,600,000 at 2.0%	• Overall project can have recreation and/or environment component.	http://cwcb.state.co.us/Finance/LoanProgram/waterProjectLoanProgram.htm

Table 3-8 Existing State Funding Programs for Environmental and Recreational Water Development, continued

Agency	Program	Purpose	Application Process	Funding Type	Recent Award	Eligibility/Comments	Website/Reference
CWCB	Severance Tax Trust Fund Operational Account	Water resources planning studies and associated demonstration projects, within mineral impacted areas of the state.	1. Application submitted to CWCB. 2. CWCB evaluates application. 3. CWCB notifies applicant of decision.	Grant	Annually	• Requests Reviewed Annually by CWCB.	http://cwcb.state.co.us/Finance/InvestmentProgram/SeveranceTaxTrustFundOperationalAccount/
CWCB	Senate Bill (SB) 179 - Water Supply Reserve Account	Fund water activities approved by the Basin roundtables.	1. Application submitted to CWCB. 2. CWCB evaluates application. 3. CWCB notifies applicant of decision.	Grant	Bimonthly	• Approval by Interbasin Compact Roundtables and non-consumptive water needs are one of the eligible activities.	http://cwcb.state.co.us/IWMD/WaterSupplyReserve/
CWCB	House Bill (HB) 1400 - Implementation of the Water for the 21st Century Act	Technical support to Interbasin Compact Roundtables	Task Orders from Basin Roundtables submitted to state project manager	Operations CWCB	Approximately $700,000 annually	• Funds available to complete Basin Roundtable Needs Assessments.	http://ibcc.state.co.us
CWCB/ Colorado Department of Public Health and Environment (CDPHE)	Healthy Rivers Fund (formerly the Colorado Watershed Protection Fund)	Colorado Individual Income Tax Refund checkoff program to give taxpayers the opportunity to voluntarily contribute to Watershed Protection. Grants are locally based water projects and planning.	1. Application submitted to CWCB 2. CWCB staff, CDPHE, Water Quality Control Commission (WQCC) staff, and Colorado Watershed Assembly review, rank, and identify funding proposals to be forwarded to the Board and WQCC. 3. The Board and WQCC may select two respective designees each responsible for making final grant award decisions, in consultation with the Colorado Watershed Assembly representative.	Grant	Raised $97,000 in 2008	• Collaborative locally-based watershed protection. Must provide 20 percent in-kind or cash match.	http://cwcb.state.co.us/WatershedProtectionFloodMitigation/Watershed/WatershedRestorationProgram.htm

Table 3-8 Existing State Funding Programs for Environmental and Recreational Water Development, continued

Agency	Program	Purpose	Application Process	Funding Type	Recent Award	Eligibility/Comments	Website/Reference
CWCB	Instream Flow Acquisition Fund	One million dollars dedicated to costs of acquiring water, water rights, and interests in water for ISF use.	CWCB's Policy 19 guides expenditures under the Instream Flow Acquisition Fund. Generally, CWCB staff must present the board with a summary of the financial aspects of the proposal, including a breakdown of costs and any in-kind services provided by the water rights owner or any other individual or entity.	Acquisition fund	Not Available	• Permanent or temporary water acquisitions that supplement existing ISF water rights that are not always fully satisfied by existing stream flows • Water acquisitions that facilitate the appropriation of the new ISF water rights that are the minimum amount necessary to preserve the natural environment to a reasonable degree • Preserve threatened or endangered species habitat, support wild and scenic alternative management plans, or provide federal regulatory certainty	http://www.cwcb.state.co.us/NR/rdonlyres/E6DA70D1-1D32-41D2-BF26-67A1BD6092E9/0/19.pdf
DNR	Native Species Conservation Trust Fund	Funds projects to protect native species and promote recovery of endangered species.	Projects are selected by agencies within the DNR. Selected programs are placed in an annual appropriations bill.	State budget appropriation	Not Available	• Projects may be completed by non-governmental agencies as well, agencies actually apply for the funding.	Colorado Revised Statutes Title 24 Article 33 Section 24-33-111
CWCB	Watershed Restoration Grants	Provides planning, engineering, and construction services for watershed/stream restoration studies and projects.	Apply to CWCB	Grant	Not Available	• No specific eligibility requirements for grantees, special consideration given to projects that integrate multi-objectives.	http://cwcb.state.co.us/WatershedProtectionFloodMitigation/Watershed/WatershedRestorationProgram.htm

Table 3-8 Existing State Funding Programs for Environmental and Recreational Water Development, continued

Agency	Program	Purpose	Application Process	Funding Type	Recent Award	Eligibility/Comments	Website/Reference
CDPHE/ USEPA	319 Program	Focus on nonpoint source pollution to impaired Colorado water bodies.	1. Submit draft proposal to nonpoint source (NPS) coordinator. 2. Review of draft proposals is conducted by technical committees, watershed coordinators, and EPA. 3. Feedback is given to project sponsors about project eligibility. 4. Final proposals are submitted to NPS coordinator. 5. Project is reviewed by Project Review Committee. 6. Proposals are submitted to NPS Council and EPA for final review. 7. NPS Council rank projects and provide recommendations to Water Quality Control Division (WQCD). 8. WQCD presents recommended project list to the WQCC for approval.	Grant	$1.8 million	• Program funds BMP construction and also Watershed Management Plans.	http://www.epa.gov/OWOW/NPS/cwact.html http://www.cdphe.state.co.us/wq/nps/index.html

Table 3-8 Existing State Funding Programs for Environmental and Recreational Water Development, continued

Agency	Program	Purpose	Application Process	Funding Type	Recent Award	Eligibility/Comments	Website/Reference
CWRPDA	Drinking Water Revolving Fund	Provides low interest loans to government agencies for the construction of water projects for public health and compliance purposes.	1. The borrower's project included in the adopted annual intended use plan (IUP) eligible project list. 2. The IUP and eligible project list included in a Joint Resolution approved by General Assembly and signed by Governor. 3. The borrower submits an application to the WQCD once the project is on the eligible project list. 4. Application is forwarded to Division of Local Government (DLG) who then conducts a review along with CWRPDA and WQCD. 5. CWRPDA Project Finance Committee and the Board of Directors review the borrower's credit report. 6. Board of Directors approves application.	Loan	$13 million	• Drinking water infrastructure.	http://www.cwrpda.com/ DWRFsubmenu.htm
CWRPDA	Water Pollution Control Revolving Fund	Provides loans to government entities for construction of water quality projects.	See Drinking Water Revolving Fund process.	Loan	$24 million	• Wastewater infrastructure; non-point source abatement.	http://www.cwrpda.com/WPCRFsubmenu.htm

Table 3-8 Existing State Funding Programs for Environmental and Recreational Water Development, continued

Agency	Program	Purpose	Application Process	Funding Type	Recent Award	Eligibility/Comments	Website/Reference
CWRPDA	Small Water Resource Projects	Finance water supply projects costing $10 million or less.	1. Submit application directly to CWRPDA (if the project involves raw water collection or storage application is forwarded to CWCB for informational purposes). 2. Application reviewed by CWRDPA staff and Financial Guaranty Insurance Company (FGIC). 3. CWRDPA Project Finance Committee and the Board of Directors review the borrower's credit report. 4. Board of Directors approves application.	Loan	$10 million	• All water supply systems components.	http://www.cwrpda.com/SWRPsubmenu.htm
Department of Local Affairs (DOLA)	Energy and Mineral Impact Assistance Program	Assist communities with implementing improvement projects and local government planning.	1. Submit application to the Department of Local Affairs. 2. Applications reviewed by department and state advisory committees. 3. Grant/loan awards announced.	Grant/Loans	$500,000/$1 million	• Municipalities, counties, school districts, and most special districts that have been affected by development, processing, or energy conversion of fuels and minerals. • Funding for 2009-2010 was used to fill gaps in the General Fund. Applications for 2009 are being held for 2010.	http://www.dola.state.co.us/dlg/fa/eiaf/index.html

Table 3-8 Existing State Funding Programs for Environmental and Recreational Water Development, continued

Agency	Program	Purpose	Application Process	Funding Type	Recent Award	Eligibility/Comments	Website/Reference
DOLA	Conservation Trust Fund	Implementation of projects that benefit state and local parks, recreation facilities, open space, environmental education, and wildlife habitat.	Funds dispersed quarterly on a per capita basis.	Grant	$51 million distributed in 2006.	• Municipalities, counties, school districts, and most special districts that intend to acquire, develop, or maintain new conservation sites or implement capital improvements or maintenance for recreational purposes on any public site.	http://www.dola.state.co.us/dlg/fa/ctf/index.html
State of Colorado	Colorado Conservation Easement Tax Credit	Protecting lands through conservation easements.	State income tax credit.	Tax Credit	Up to $375,000 for donations made on or after January 1, 2007	• Colorado resident individuals, C Corporations, trusts, estates, and members of pass-through entities.	http://www.revenue.state.co.us/fyi/html/
CWCB	Instream Flow Tax Credit	Tax credit for donated water rights to the CWCB's ISFs program	State income tax credit up to 50% of the donation value	Tax Credit	Not Available	• Eligible water rights, value determined by appraisal, seniority and historical consumptive use (CU), decreed use, location and extent to which aquatic habitat will benefit	http://www.coloradowatertrust.org/acquisitions/tax-credit/
CDOW	Habitat Stamp	Acquiring or preserving wildlife habitat.	Funding recommendations made by a citizen committee to the Wildlife Commission.	Grant	Not Available	•	http://wildlife.state.co.us/ShopDOW/AppsAndLicenses/HabitatStamp/

Table 3-8 Existing State Funding Programs for Environmental and Recreational Water Development, continued

Agency	Program	Purpose	Application Process	Funding Type	Recent Award	Eligibility/Comments	Website/Reference
CDOW	Fishing is Fun (FIF) Program	Improve fishing opportunities for anglers.	1. File an application with CDOW. 2. Various reviews by CDOW staff. 3. Presentation and Q&A session by applicants to FIF Review Panel meeting. 4. Review Panel recommendations forwarded to CDOW top management for final decision.	Grant	Not Available	• Local governments, park and recreation departments, water districts, individuals, conservation groups, and organizations with projects that either improve angler access, improve habitat, improve fishing sites, or improve motorboat access.	http://wildlife.state.co.us/Fishing/ResourcesTips/FishingIsFunProgram
CDOW	Colorado Wetland Wildlife Conservation Program	Preserve, restore, enhance, and create wetlands and adjacent habitat.	Projects are selected by a CDOW committee of biologists and field operations staff.	Allocated annually	$19,000 for Cottonwood State Wildlife Area	•	http://wildlife.state.co.us/LandWater/WetlandsProgram/
Various Counties	County Open Space Sales Tax	Open space protection.	Various.	Sales Tax	Not Available	• Focus is on acquiring land for open space.	See county websites
WQCC	Watershed protection fund	Protect lands and waterways in Colorado's watersheds.	1. Applications Available March 1. 2. Deadline April 30. 3. Applications reviewed and approved July 31. 4. Grants Awarded September 30.	Grants	$15,000 Design and $50,000 Projects	• Requires 20% match.	http://www.cdphe.state.co.us/op/wqcc/SpecialTopics/CWPF/colowtshdprot.html
GOCO	Legacy initiative	Implement projects of regional or statewide importance that preserve land and water, enhance critical wildlife habitats, create new state and local parks, construct trails, and provide environmental education.	1. File an application with GOCO. 2. GOCO reviews applications. 3. Grants awarded.	Grant	$13.2 million	• Parks, outdoor recreation, environmental education; regional or state significance.	http://www.goco.org/GrantPrograms/Legacy/tabid/ 125/Default.aspx

Table 3-8 Existing State Funding Programs for Environmental and Recreational Water Development, continued

Agency	Program	Purpose	Application Process	Funding Type	Recent Award	Eligibility/Comments	Website/Reference
GOCO	Local government	Implement projects that provide places to play, gather, and compete.	See Legacy Initiative process.	Grant	Not Available	• Similar emphasis for local governments.	http://www.goco.org/GrantPrograms/LocalGovt/tabid/120/Default.aspx
GOCO	Open space	Open space protection.	See Legacy Initiative process.	Grant	Not Available	• River corridors, habitat, broad objectives.	http://www.goco.org/GrantPrograms/OpenSpace/tabid/119/Default.aspx
Colorado State Parks/ National Park Service (NPS)	Land and Water Conservation Fund (LWCF)	Create parks and open spaces, protect wilderness, wetlands, and refuges, preserve wildlife habitat, and enhance recreational opportunities.	LWCF accepts applications from local governments and CSP	Grants with matching requirements	Not Available	• Acquisitions of land or water property interests to be used for recreational purposes • Construction or redevelopment of outdoor recreational facilities • Planning grants that address needs, problems or issues identified in the Statewide Comprehensive Outdoor Recreation Plan	http://parks.state.co.us/trails/lwcf/Pages/LWCFHome.aspx
Colorado Water Trust	Colorado Water Trust	Acquisition of water rights or interests in water rights for streamflow enhancement.	None.	Depends on project	Not Available	• Existing water users, willing participants.	http://www.coloradowatertrust.org

Source: Interviews with program managers and selected websites, 2010.

Table 3-9 Comparison of Types of Water Rights and Other Mechanisms that Provide Environmental and Recreational Flows

	Recreational In-Channel Diversions (RICDs)	CWCB Program		Voluntary Flow Agreements	Federal Permitting Conditions	Multipurpose Projects	Structural Improvements
		CWCB ISF and Natural Lake Level Water Rights (New Appropriations)	Dedication of Existing Water Right to CWCB for ISFs				
Entity	Local governmental entities. Private, State, and Federal entities are prohibited from appropriating these types of water rights.	CWCB is the only entity authorized to obtain a decree for ISF or natural lake level water rights.	CWCB can acquire by donation, purchase, lease, loan, or other contractual agreement from any person or entity.	Can be between any water users, subject to each party's legal authority and to applicable water court decrees.	Can be imposed by federal agencies such as the Forest Service, Bureau of Reclamation, USACE, National Park Service, Bureau of Land Management, or other agency.	Any type of water user, in conjunction with CWCB if providing ISFs, or with a local governmental entity if providing flows for RICDs.	Any type of water user, in conjunction with CWCB if providing ISFs, or with a local governmental entity if providing flows for RICDs.
Flow Amounts	Minimum stream flow for a reasonable recreation experience.	Minimum amount to preserve the natural environment to a reasonable degree.	Minimum amount to preserve or improve the natural environment to a reasonable degree.	Amounts determined by mutual agreement.	Variable – these sometimes mimic CWCB ISF decreed amounts.	Agreed upon and proposed by project sponsors and partners and confirmed by water court.	Variable - but may be limited by size of pumpback pipelines, pumping costs, or other logistical constraints.
For What Purposes	To provide stream flows for a reasonable recreation experience.	To preserve the natural environment to a reasonable degree.	To preserve or improve the natural environment to a reasonable degree.	Determined by mutual agreement.	Recreation/environment/ other uses associated with the original federal authorization legislation.	Recreation/ environment.	Recreation/ environment/ water quality.
Season	Can be year round or seasonal (usually summer).	Can be year round or seasonal.	Can be year round or seasonal.	Determined by mutual agreement.	Can be year round or seasonal. These sometimes mimic CWCB ISF decreed amounts.	Agreed upon and proposed by project sponsors and partners and confirmed by water court.	May be limited during the winter season because of icing/freezing pipelines or other frozen infrastructure.
Times of Day	Usually limited to daylight hours.	24 hours a day.	24 hours a day.	24 hours a day.	Typically 24 hours a day. May be limited by operational schedules.	Agreed upon and proposed by project sponsors and partners.	Variable.

Table 3-9 Comparison of Types of Water Rights and Other Mechanisms that Provide Environmental and Recreational Flows, continued

	Recreational In-Channel Diversions (RICDs)	CWCB Program		Voluntary Flow Agreements	Federal Permitting Conditions	Multipurpose Projects	Structural Improvements
Limits	Limited to the minimum flow to provide for a reasonable recreation experience.	Limited to the minimum flow to provide reasonable preservation of the natural environment.	CWCB may not 1) acquire water by eminent domain; 2) accept donations of water rights that either would require removal of existing infrastructure without approval of owner of infrastructure or that were acquired by condemnation; or 3) use money from the Construction Fund to acquire water or water rights.	Limitations determined by mutual agreement or imposed by law.	Can only be imposed when a new permit is needed, or when a current permit is up for renewal. These types of federal imposition of bypass flows have been, and could continue to be the subject of litigation.	Limitations determined by mutual agreement or imposed by law.	Costs associated with the pipeline, costs associated with pumping, costs associated with the storage vessel.
Effects on Compact Entitlements	Shall not impair the ability of Colorado to fully develop and place to consumptive beneficial use its compact entitlements.	Shall not deprive the people of the State of Colorado of the beneficial use of those waters available by law and interstate compact.	Shall not deprive the people of the State of Colorado of the beneficial use of those waters available by law and interstate compact.	Potential to impact Colorado's compact entitlements.	Potential to impact Colorado's compact entitlements.	In accordance with law governing ISFs or RICDs.	Should not affect Colorado's Compact entitlements.
Example Projects	Town of Avon, City of Longmont, and City of Steamboat Springs	CWCB has decreed 1,578 ISFs and 494 Natural Lake Levels	City of Boulder (Boulder Creek) and City of Aspen (Hunter Creek)	Arkansas River Voluntary Flow Program	Chatfield Reallocation	Elkhead Enlargement	Elkhead Enlargement

Federal Reserved Water Rights

Federal reserved water rights are implied and express water rights that are created when land is taken out of the public domain for national parks, national wildlife refuges, national forests, etc. The U.S. Supreme Court recognized these rights in 1907 in *Winters vs. United States*, which concluded that the U.S. could not deprive Native Americans of water reserved for them through the creation of tribal reservations (known as the "Winters Doctrine"). In Colorado, reserved water rights are finalized throughout the state with the exception of the U.S. Forest Service (USFS) reserved rights in Water Division 7 and the Black Canyon of the Gunnison National Park reserved rights.

For more information see: www.blm.gov/nstc/ WaterLaws/fedreservedwater.html.

Section 404 Dredge and Fill Permits

Section 404 of the Clean Water Act (CWA) instituted a permit program to regulate discharge of dredge and fill material in wetlands and in "waters of the U.S." USACE is responsible for issuing permits and assessing the potential impact to the environment including water quality. USACE may require terms and conditions on the permit to mitigate any potential impacts as per 404(B)(1) guidelines.

For more information see: http://www.usace.army.mil/CECW/Pages/reg_materials.aspx

Nonpoint Source Management Program

The Section 319 NPS Grant Program was created by Section 319 of the CWA to curb NPS pollution. USEPA administers funding to state and tribal agencies. The money is then used to assess nonpoint pollution and to develop and implement NPS management programs. In Colorado, the grant program funds voluntary NPS pollution projects that are intended to enhance water quality and potentially provide environment and recreation benefits.

For more information see: http://www.epa.gov/ OWOW/NPS/cwact.html.

Salinity Control Program

The salinity control program is a program in which the BOR, USDA, the Bureau of Land Management (BLM), and Colorado River Basin states are working together to cost-effectively reduce salinity in the Colorado River Basin. For example, in western Colorado, earthen canals have been replaced with pipes to reduce seepage and salt loading to the Colorado River. There may be funds available for projects that help improve water quality by reducing salinity levels.

For more information see: http://www.usbr.gov/uc/progact/salinity/

Federal Facilities

Federal water facilities, such as those operated by BLM and USACE, may provide multiple benefits, including water supply, flood control, power development, and environment and recreation benefits. Reservoirs often provide flatwater recreation and habitat opportunities as well as beneficial environmental and recreational downstream flows.

For more information see: http://www.usbr.gov/projects/, https://www.nwo.usace.army.mil/, http://www.spa.usace.army.mil/, and http://www.spk.usace.army.mil/

Federal Energy Regulatory Commission (FERC) Licenses

Under the Federal Power Act, FERC issues licenses for non-federal hydroelectric projects requiring compliance with state and local requirements. Many hydroelectric projects currently need to renew their licenses. This triggers a review process in which water quality and other environment and recreation benefits/impacts may be reviewed and addressed.

For more information see: http://www.ferc.gov/ and http://www.ferc.gov/docs-filing/elibrary.asp

National Environmental Policy Act (NEPA) Reviews

NEPA requires federal agencies to prepare an environmental impact statement to evaluate the environmental impacts of a proposed action(s) and to consider alternatives that may avoid or reduce impacts. Potential environment and recreation impacts as a result of changes in flows are identified and either avoided or mitigated.

For more information see: http://www.epa.gov/ compliance/nepa/eisdata.html

Forest Management Plans

In accordance with the National Forest Management Act of 1976, national forests are required to develop a comprehensive management plan. These plans include management, protection, use goals and guidelines, and monitoring plans. Periodically, these plans are revised to adapt to changing conditions and management strategies.

For more information see: http://www.fs.fed.us/emc/nfma/index.htm and each individual National Forest website.

Resource Management Plans (RMPs)

The Federal Land Policy and Management Act of 1976 requires the BLM to create extensive land use management plans, called RMPs, to guide agency actions for a particular region. In these plans, the BLM must manage the landscape for many uses while still protecting water quality.

For more information see: http://www.blm.gov and each individual BLM field office website.

USGS Data Gathering on Water Quality and Quantity

The USGS collects water quality and flow data through the National Water-Quality Assessment Program (NAWQA) and the National Streamflow Information Program (NSIP), respectively. The USGS operates and maintains approximately 7,000 stream gages that collect long-term stream flow data through the NSIP. In Colorado, the NAWQA program collects water quality data from the South Platte, Upper Colorado River, and Rio Grande Valley Basins.

For more information see: http://water.usgs.gov/nawqa/ and http://water.usgs.gov/nsip/

Wild and Scenic River Designation (WSR)

Passed in 1968, the WSR serves to preserve selected rivers that possess not just "wild and scenic" qualities but also "outstanding remarkable scenic, recreational, geologic, fish and wildlife, historic and cultural or other similar values." Congressional intent was to complement water development activities on some rivers with preservation of free flowing river conditions on other rivers. Currently, the Cache La Poudre River is the only WSR in Colorado. The BLM, NPS, and USFWS are the primary agencies charged with designating a river as a WSR.

For more information see: http://www.rivers.gov/

3.5.2.2 CWCB Program Tools

The following summary of CWCB programs may be used by the basin roundtables as they implement projects and methods for their nonconsumptive needs.

CWCB Instream Flow Program

The 1973 General Assembly enacted SB 97, which created the Colorado ISF and Natural Lake Level Program (ISF Program) to be administered exclusively by the CWCB. The CWCB is solely responsible for the appropriation and protection of ISF and natural lake level water rights to preserve the natural environment to a reasonable degree and the acquisition of water rights to preserve and improve the natural environment to a reasonable degree. To date, the CWCB has appropriated and adjudicated

approximately 1,500 water rights in approximately 8,500 miles of streams and 476 natural lakes. In addition to new appropriations, state law also authorizes the CWCB to acquire existing water rights on a voluntary basis to preserve or improve the natural environment.

For more information see: http://cwcb.state.co.us/Streamandlake/.

Recreational In-Channel Diversion (RICD) Rules

In 1998, Golden filed for water rights to create a kayak course running through its downtown. The state opposed the application, but the water court eventually decreed Golden's full claim.

After the water court ruled but before the case was appealed to the Colorado Supreme Court, the General Assembly passed SB 01-216. This bill provided that local governmental entities could apply for water rights for RICDs, but limited these types of water rights to the "minimum stream flow" "for a reasonable recreational experience in and on the water." Section 37-92-102, C.R.S. requires applicants for RICD water rights to provide a copy of their application to the CWCB. Under SB 01-216, the CWCB was required to review an application for an RICD and submit findings and recommendations to a water court within 90 days of the expiration of the Statement of Opposition period. SB 01-216 grandfathered in prior water right applications for recreational flows, such as Golden's.

By the time the case reached the Colorado Supreme Court, Vail and Breckenridge's efforts to create recreational flows had also been included in the case. The Colorado Supreme Court deadlocked 3-3, operationally affirming the lower court decisions and granting them recreational flows.

For more information see: http://cwcb.state. co.us/WaterSupply/RICD.htm

3.5.2.3 Other State and State-Administered Federal Program Tools

Rangewide Conservation Agreement for Roundtable Chub, Bluehead Sucker, and Flannelmouth Sucker

The CDOW and the BLM are both signatories to the Rangewide Three Species Conservation Agreement for the protection and conservation of flannelmouth sucker, bluehead sucker, and roundtail chub populations throughout their ranges. This agreement between the Upper Basin states, federal agencies including the USFS, BLM, and BOR, Native American tribes, and non-governmental organizations is intended to proactively prevent a federal listing of these three native fishes.

Interruptible Water Supply Agreements (C.R.S. 37-92-309)

The State Engineer may allow interruptible water supply agreements between two or more water right owners. Under an interruptible water supply agreement, the loaning water right owner stops its use of the loaned water right for a specified length of time. The State Engineer authorizes the approval and administration of interruptible water supply agreements that permit a temporary change in the point of diversion, location of use, and type of us of an absolute water right without the need for adjudication. An interruptible water supply agreement can be exercised 3 years in a 10-year period.

401 Certification

The state has to certify that the construction and operation of any project requiring a federal approval (404, FERC license, federal discharge permit) will meet all applicable state water quality requirements. The statute sets forth best management practices that may be imposed to help ensure compliance with state water quality standards. The state can also include conditions on the 401 certification to ensure compliance with state water quality standards.

For more detailed information see: http://www.cdphe.state.co.us/wq/PermitsUnit/ index.html

National Pollution Discharge Elimination System Permits

The National Pollution Discharge Elimination System, under the CWA, requires discharge permits for municipal and industrial wastewater and stormwater. The Colorado WQCD issues permits for the majority of discharges in Colorado. Permits may include conditions to protect water quality. USEPA issues permits for federal facilities and on American Indian reservations. Permits are renewed every 5 years.

For more information see: http://www.cdphe .state.co.us/wq/PermitsUnit/index.html and http://cfpub.epa.gov/npdes/

State Classifications and Standards

The Colorado WQCD decides on an appropriate level of water quality for stream reaches by first assessing how the water is used and identifying the desired future beneficial uses. Colorado surface waters may be classified for the following uses: recreation, aquatic life, agriculture, water supply, and wetlands. Numerical and narrative water quality standards are assigned to stream reaches to protect the classified uses.

For more information see: http://www.cdphe. state.co.us/op/wqcc/index.html

Exchange and Substitution Statutes

Colorado water law requires that if an upstream user takes water that a senior downstream user would otherwise receive, the water must be replaced at the time, location, quantity, and of suitable water quality that the downstream user experienced prior to the exchange or substitution. This protects senior downstream users and can indirectly help maintain water quality for downstream environmental and recreational purposes.

For more information see: http://water.state.co.us/wateradmin/wateradmin.asp

319 Projects

Section 319 of the CWA established the 319 NPS Management Program under which states, territories, and Indian tribes receive federal grant money for NPS implementation projects. The states are responsible for submitting their funding plans to USEPA, in which USEPA awards funding as long as the state's plans are within the grant eligibility requirements and procedures.

For an example project see: http://www.epa.gov/nps/Success319/state/co_mos.htm

HB 1132 Regulations

HB 07-1132 was enacted to address water quality protection in water court for change of use applications for large water transfers. Specifically, for a change of type of use of water rights that transfers more than 1,000 acre-feet of water per year, the water judge is allowed to include a term or condition that addresses decreases in water quality caused by the change.

For the exact bill text see: http://www.leg.state.co.us/clics/clics2007a/csl.nsf/fsbillcont3/B7940B3E87651B5A87257251007A063B?Open&file=1132_enr.pdf

HB 1012 Regulations

HB 07-1012 was enacted to amend C.R.S. 37-83-105(2) to state that any loaned water right used by the Board for ISF purposes will not negatively impact historic CU analysis. Additionally, HB 07-1012 under C.R.S. 37-92-103 revises the definition of "abandonment of a water right" to state that the loan of water to the CWCB for ISF use shall not be used to determine abandonment.

For the exact bill text see: http://www.leg.state.co.us/clics/clics2007a/csl.nsf/fsbillcont3/85F8683D5A1CD69887257251007B8552?Open&file=1012_enr.pdf

3.5.2.4 Local Tools

The following local tools may be utilized by nonconsumptive project and method proponents.

HB 1041 Regulations

HB 1041, codified at Section 24-65.1-101 et. seq., C.R.S., was passed in 1974 to address impacts associated with growth in Colorado. HB 1041 gave local governments a voice in the development of projects that benefit one community but cause impacts in another community. Specifically, HB 1041 Regulations allow consideration and mitigation of impacts associated with water projects. Typically, HB 1041 regulations require the project proponent to obtain a permit to construct the project. The local government may require terms and conditions in the permit to mitigate environmental, social, and economic impacts associated with the project.

HB 1280

HB 08-1280 (codified at Section 37-92-102(3), C.R.S.) provided needed protections to lessors of water to the state's ISFs program. Passed in 2008, the bill removed the threat of abandonment from water rights leased or loaned to the CWCB. It also ensured the right's historical CU would not be diminished for the duration of the lease/loan.

Local Land Use Regulations

Counties and municipalities have other land use tools available to protect water quality and even require mitigation of water projects. For example, municipalities may adopt a watershed ordinance to protect the watershed above its water supply intake. Special use permit regulations can also be structured to require mitigation of a project.

Conservation Easement

A conservation easement is a legal agreement between a landowner and a qualified land organization that restricts the amount and type of development that can occur on the property. This may prevent the landowner from selling or transferring water rights associated with the property. In Colorado, land owners are eligible for a state tax credit and conservation easements have been used to preserve open space and keep land in agriculture in perpetuity.

Recreational In-Channel Diversions Statute and Regulations

These regulations provide authority for local governments to seek RICDs. See Section 4.3.3 for more detail.

Stream Restoration Projects

As competition for water resources increases, local communities are looking for stream restoration projects that utilize less water. These projects often provide habitat enhancement to stream reaches that experience low flow conditions without requiring increased flows. Grants are often available for these projects.

Voluntary Flow Management Programs

These are programs in which reservoir operations are modified to provide recreational flows for downstream users. Dillon Reservoir has been operating voluntarily to optimize downstream flows for boaters for specific periods of time to benefit recreation and the environment.

Water System Re-optimization

The operation of major water systems can be optimized to enable a better balance between consumptive and nonconsumptive needs. Numerous tools are available to determine if re-operation of the system will provide additional benefits to both consumptive and nonconsumptive water users.

3.5.2 5 Multi-stakeholder and Market Based Tools

Following are examples of multi-stakeholder and market based tools that could be utilized to protect or enhance nonconsumptive needs

Multi-Party Voluntary Flow Management Programs

Multi-party programs in which river flows are managed to provide recreational flows for downstream users. For example, the Arkansas River Recreation Management Plan includes the BLM, Colorado DNR's Division of Parks and Outdoor Recreation (DPOR), the USFS, and CDOW. The objective of this plan is to emphasize the Arkansas River Headwaters Recreation Area's natural resources, sustainability, and public land health, while respecting private property and embracing education, recreation, and commercial activities. In some situations, these plans may be of use when RICDs or instream-flow water rights may not be exercised due to water rights constraints.

Water Court Decree Stipulations

In order to obtain a water right in Colorado, an application must be filed with the appropriate water court. All applications are filed in the "resume" and local newspaper. Any person may submit a statement of opposition within two months after the water court publishes its resume. The water referee manages the application and statement(s) of opposition. After the referee's ruling, parties may protest, initiating water court litigation. At trial, the parties either settle or the water judge decides whether the application is granted or denied. This process enables water right holders to protect their water rights and apply for new rights.

Decrees for Piscatorial Use

In order to obtain a decreed water right, the applicant must show that the water is being put to beneficial use. Piscatorial use is considered a beneficial use, usually in the context of a storage water right. Water rights for piscatorial uses have been granted at a number of locations, including Taylor Reservoir where the concept of using releases from storage to protect ISFs was first developed when the Upper Gunnison River Water Conservancy District filed for enough water for a second filling of the reservoir. Other examples with decrees for piscatorial use include Elkhead and Wolford Reservoirs.

Temporary Water Transfers

Water rights may be donated to the CWCB for ISF use. The donation of senior water rights is especially beneficial to the ISF Program. Water rights may also be donated on a temporary basis, providing additional flows to decreed ISF rights for a period of time. Special lease agreements between the CWCB and other governmental agencies, including the BLM and the Colorado DPOR have occurred where leased water supplemented ISF water rights.

Water Sales

Water rights may be sold and purchased for conservation and environment benefits. They must be donated to the CWCB or utilized for a recognized beneficial use. The mission of the Colorado Water Trust is to acquire and provide assistance to others in acquiring water rights for stream flow enhancement. The Nature Conservancy and Trout Unlimited also strive to acquire water for conservation purposes.

Subordination Agreements

A subordination agreement is a legal agreement by which a senior water right holder allows a junior right holder to be satisfied out of priority. Subordination agreements may be developed to allow senior water right holders to subordinate their water rights to a junior ISF water right, providing environmental benefits. The State Engineer's Office will generally not approve selective subordinations, but will administer a subordination that is authorized by a water court decree.

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Section 4

Consumptive Needs Assessments

4.1 Overview of Consumptive Needs Assessment Process

Water in Colorado is managed to meet the needs of Colorado's citizens, agriculture, and environment. Colorado's economy, quality of life, recreational opportunities, and the environment are all dependent on water. The broad diversity of water uses in Colorado is indicative of the many ways in which we are affected by the water that is available to us and our environment, and how we choose to use it. Severe and continuing drought conditions throughout the state in the early 2000s in conjunction with rapid economic growth and concern over interstate compact obligations have brought focus to the constraints on our state's water resources and the challenges associated with meeting multiple objectives and needs.

In 2004, the Colorado Water Conservation Board (CWCB) completed the Statewide Water Supply Initiative (SWSI) 1 study, which evaluated Colorado's water needs and solutions through 2030.

The objectives of the consumptive needs part of this SWSI 2010 update are to:

- Update population projections and extend them to 2050
- Update municipal and industrial (M&I) per capita estimates including passive conservation
- Extend the SWSI 1 consumptive water use projections to 2050 for the M&I sector
- Update the self-supplied industrial (SSI) sector forecast to 2050
- Update the current tally of irrigated acres throughout Colorado and forecast irrigated acres in 2050
- Update current agricultural demands and shortages
- Update the consumptive demand forecast to 2050 for the agricultural sector

Nonconsumptive water needs are addressed in Section 2 of this report.

The analyses summarized in this section use a water forecast horizon of 2050 for a number of reasons. The CWCB determined that the forecast horizon for the water demand projections needed to be extended to the year 2050 to better represent the long-term water needs that the state will face.

Index

4.1 Overview of Consumptive Needs Assessment Process ..... p. 4-1
4.2 M&I and SSI Consumptive Needs..... p. 4-2
4.3 Agricultural Consumptive Needs.... p. 4-20

In addition, West Slope basin roundtables suggested the 2050 timeframe for the demand projections so that potential growth rates on the West Slope could be better characterized. Infrastructure investments and commitment of water supplies require a longer term view into the future. In addition, several of the SWSI identified projects and processes (IPPs) (addressed in Section 5 of this report) with environmental impact statement requirements have used a planning horizon of 2050. Finally, the 2050 timeframe can better incorporate ongoing energy development in the Colorado and Yampa-White Basins.

The following sections provide an overview of the methods used in determining reconnaissance level consumptive water use projections for 2050, and the results of those analyses. Sections 4.2.1 and 4.2.2 describe the methods and results of projecting M&I demands, including population forecasting, estimation of per capita water use, and the application of passive conservation measures. The methods used to estimate SSI demands, and the results thereof, are presented in Section 4.2.3. Section 4.2.4 summarizes the statewide results of the M&I and SSI demand projections. Section 4.3 summarizes the same for agricultural demands. Detailed descriptions of these methodologies and results are available in Appendices H and I.

4.2 M&I and SSI Consumptive Needs

Standard methods were used for projecting future M&I and SSI water demands throughout Colorado. The objectives were to develop a reconnaissance level water use forecast that employs consistency in data collection and forecast methodology across the state and maximizes available data. The methods utilized in this approach are for the purpose of general statewide and basinwide planning and are not intended to replace demand projections prepared by local entities for project-specific purposes.

The M&I water demands forecast takes on a "driver multiplied by rate of use" approach. This is a commonly accepted forecast methodology that accounts for changes in water demand resulting from changes in the driver. County and statewide population projections are the most accepted predictor of future growth for the state. Therefore, the driver for the M&I water demands forecast is population and the rate of use is gallons per capita per day, or gpcd.

4.2.1 Future Population Projections

Population projections were estimated using the forecasting process and models utilized by the Colorado State Demographer's Office (SDO). Because of the uncertainty in projecting economic conditions and employment levels in 2050, low, medium, and high scenario population projections were developed. A detailed analysis of the population projections is included in Appendix H.

4.2.1.1 2050 Population Projection Methodology

The first step in developing 2050 population projections was to identify a population forecasting methodology that could meet the needs of the 2050 water demand projections. To be suitable, the water demand projections would need to satisfy the following criteria:

- The forecasting methodology must be valid and widely acceptable, both by users of the results and demographic forecasting practitioners.
- The forecasting approach must be transparent and understandable to the extent possible.
- The projections must be replicable.

- In keeping with state-of-the-art practice employed by the SDO, the projections must be economically based and then linked to demographic factors in an integrated manner.
- The projections must be able to produce population forecasts for each county to the year 2050 under high, medium, and low economic development assumptions.

It was determined that the forecasting process and models utilized by the SDO, in conjunction with its consultant, the Center for Business and Economic Forecasting (CBEF), met all of those criteria. Therefore, the SDO forecasting process was adopted for the 2050 effort.

As of 2010, the SDO/CBEF projections are available through the year 2035. It was determined that the forecasting models, equations, and algorithms could be extended or adjusted as needed from 2035 to 2050. To adjust the models from 2035 to 2050 assumptions regarding national and international driving forces behind Colorado's basic economic sectors were developed.

Basic economic sectors include those activities that bring money and economic stimulus into a geographic area. Employment was projected for each of Colorado's basic economic sectors on the basis of the assumptions for the driving forces behind those basic sectors. With projections of basic employment, industry-specific employment multipliers were applied to arrive at total Colorado jobs.

Because of the uncertainty in projecting economic conditions and employment levels in 2050, low, medium, and high employment scenarios were developed for each key employment sector, leading to low, medium, and high population projections. Each of the scenarios reflects unique assumptions for the economy and for each employment sector. These assumptions are detailed in Appendix H. Additionally, populations for counties that lie within two or more basins were allocated to the respective basins based on estimates from known population centers within each basin.

4.2.1.2 2050 Population Projection Results

Statewide Population Projections

Between the years 2008 and 2050, the state of Colorado is projected to grow from approximately 5.1 million people to between 8.6 million and 10 million people. Under low economic development assumptions, state population is projected to grow to about 8.6 million people, or by about 71 percent. Under high economic development assumptions, including a 550,000 barrel per day oil shale industry, the state's population is projected to grow to just over 10 million people, or by 98 percent, as compared to Colorado's 2008 population. On average, statewide population projections from 2008 forward indicate an increase of about 1.4 million people every 15 years.

Table 4-1 and Figure 4-1 show how population growth will vary across the state during the next 40 years. Based on these projections, the Arkansas, Metro, and South Platte Basins will continue to have the largest population in the state. However, the West Slope will continue to grow at a faster rate than the Front Range of Colorado.

Table 4-1 Population Projections by River Basin

Basin	2008	2035	Percent Change 2008 to 2035	Percent Average Annual Growth Rate	2050			Percent Change 2008 to 2050	Percent Average Annual Growth Rate
					Low	Medium	High		
Arkansas	948,000	1,451,000	53	1.6	1,581,000	1,688,000	1,841,000	67-94	1.2-1.6
Colorado	307,000	558,000	82	2.2	661,000	725,000	832,000	115-171	1.8-2.4
Gunnison	105,000	184,000	75	2.1	206,000	220,000	240,000	96-129	1.6-2.0
Metro	2,513,000	3,622,000	44	1.4	4,018,000	4,144,000	4,534,000	60-80	1.1-1.4
North Platte	1,500	1,800	20	0.7	2,000	2,200	2,500	33-67	0.7-1.2
Rio Grande	50,000	68,000	36	1.2	74,000	80,000	87,000	48-74	0.9-1.3
South Platte	977,000	1,622,000	66	1.9	1,808,000	1,902,000	2,065,000	85-111	1.5-1.8
Southwest	105,000	185,000	76	2.1	204,000	224,000	249,000	94-137	1.6-2.1
Yampa-White	45,000	81,000	80	2.2	94,000	117,000	153,000	109-240	1.8-3.0
TOTAL	**5,051,500**	**7,772,800**	**54**	**1.6**	**8,648,000**	**9,102,200**	**10,000,000**	**71-98**	**1.3-1.6**

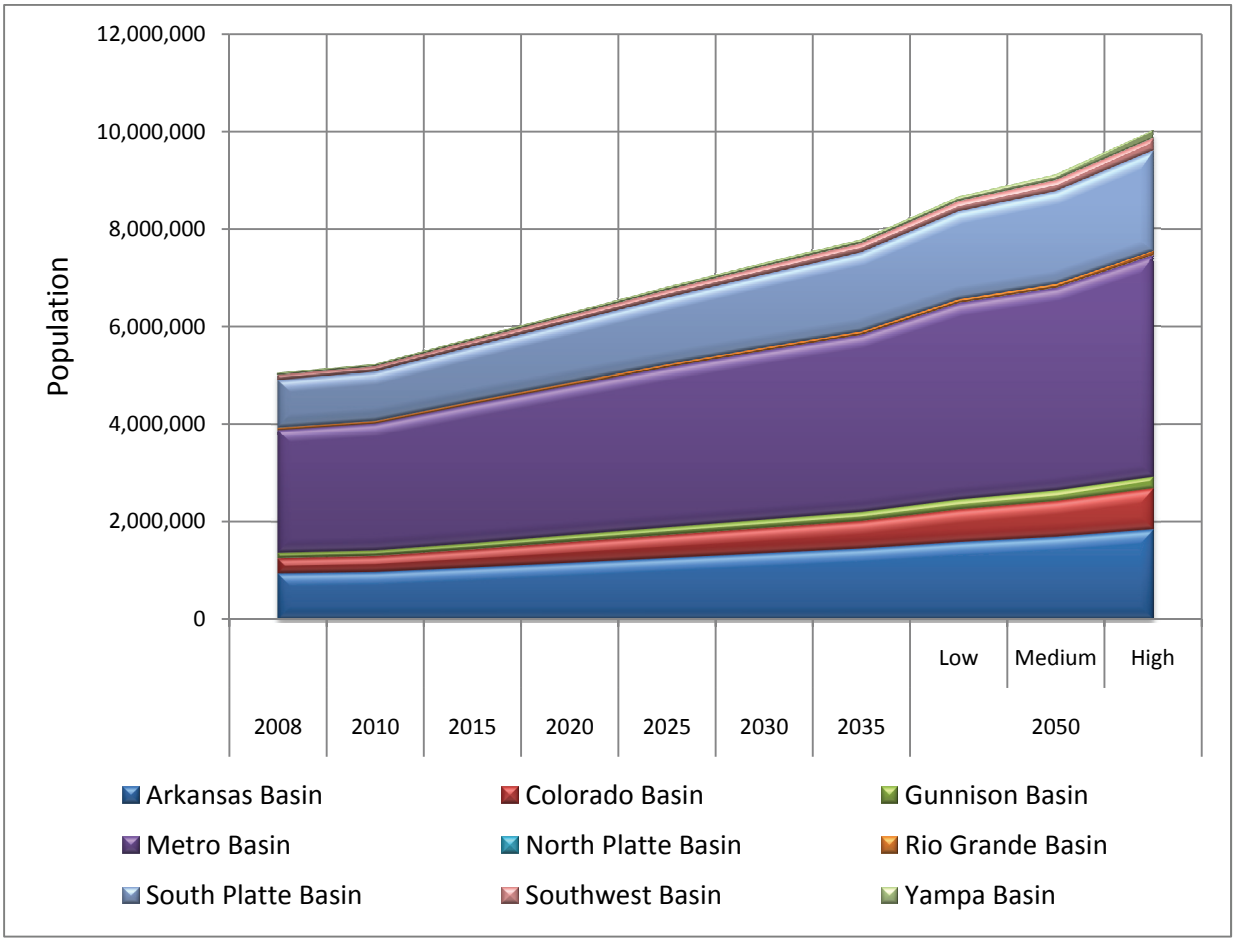


Figure 4-1 State of Colorado Population Projections through 2050

Basin and County Population Projections

Under medium economic development assumptions, the Arkansas River Basin population is projected to increase by about 78 percent between 2008 and 2050; El Paso County will account for much of the growth and will remain the largest population center in that basin. Household basic jobs, tourism jobs, and regional and national service jobs will be the drivers of growth in the basin by 2050.

As the most populous river basins in the state, the South Platte and Metro Basins are projected to grow from approximately 3.5 million people in the year 2008 to about 6 million people by the year 2050. This amounts to an increase of about 2.5 million people, or about 73 percent, during that period. About 69 percent of all Colorado residents resided in the South Platte Basin in the year 2008; by the year 2050, that proportion will decrease only slightly to about two-thirds. Consistent with predicted population trends, the South Platte and Metro Basins have the largest employment of all basins, totaling over 2 million jobs in 2007. Over 3.4 million job opportunities are expected by 2050. Regional and national service jobs led employment in 2007 and will remain the largest source of employment in these basins in 2050. Household basic sector employment is anticipated to grow more rapidly than other basic sectors (174 percent increase between 2007 and 2050), and tourism jobs are expected to grow by about 83 percent over the same period.

The Colorado River Basin is expected to grow by 2.4 times between the year 2008 and 2050 with considerable growth projected by all counties in that basin, especially Garfield and Mesa Counties. Household basic jobs are expected to grow at the fastest rate of any sector between 2007 and 2050, but tourism will remain the basin's largest base of employment. Mining is the only sector in the basin that is expected to experience decreased employment by 2050.

The Gunnison River Basin is projected to grow by about 2.1 times between 2008 and 2050, under the medium scenario, with Mesa and Montrose Counties being the most populous in that region. Household basic jobs will grow at the fastest rate of any basic sector and will remain the largest source of employment in the Gunnison Basin by 2050, followed by tourism and regional and national services. Other sectors will grow at slower rates, with decreased employment anticipated in the mining sector by 2050.

The Southwest Basin is projected to grow by about 2.1 times between the year 2008 and 2050 under medium economic development assumptions. La Plata County will remain the most populous county in that basin and will continue to experience robust growth. Tourism was the most important basic sector in the Southwest Basin in 2007, followed by household basic jobs and regional and national service jobs. Similar to the Colorado Basin, household basic jobs are expected to grow at the fastest rate of any sector between 2007 and 2050, but tourism will remain the Southwest Basin's largest source of employment. By 2050, mining jobs in the basin will have decreased compared to 2007.

The Yampa-White River Basin population is projected to increase by about 2.6 times between 2008 and 2050, under medium economic development assumptions, increasing from about 45,000 to about 117,000 residents during that period. By 2050, regional and national service jobs are expected to be the leading sector, followed by mining and tourism with near-equal levels of employment. Mining jobs in the basin are expected to grow by over 400 percent between 2007 and 2050.

The North Platte River Basin, which consists of Jackson County and a small portion of Larimer County, is projected to grow from about 1,500 people in 2008 to about 2,200 people by the year 2050; an increase of about 47 percent. Agriculture was the largest basic employment sector in the North Platte Basin in 2007 and is anticipated to retain this position in 2050. Household basic jobs and regional and national service jobs are also important to the region.

The Rio Grande Basin is projected to increase from approximately 50,000 people in the year 2008 to 80,000 people by the year 2050; an increase of about 60 percent. Agriculture was the largest basic employment sector in the Rio Grande Basin in 2007 but is expected to be slightly behind household basic sectors by 2050. Also by 2050, the portions of mining, regional and national service, and tourism jobs compared to total jobs in the basin are expected to increase.

Additional county and basin level population data is available in Appendix H.

4.2.2 Future M&I Water Demands

The M&I demand forecast is aimed at capturing the water needs of an increased population. M&I demands are the water uses typical of municipal systems, including residential, commercial, light industrial, non-agricultural related irrigation, non-revenue water, and firefighting. For the current effort, the M&I demand forecast also captures households across the state that are self-supplied and thus not connected to a public water supply system. Table 4-2 contains the definitions of the M&I demand terms used throughout this report.

Table 4-2 Definition of M&I Demand Terms

Demand Terminology	Definition
M&I Demand	All the water uses of typical municipal systems, including residential, commercial, industrial, irrigation, and firefighting
SSI Demand	Large industrial water uses that have their own water supplies or lease raw water from others
M&I Demand and SSI Demand	The sum of M&I and SSI demand

The updated demands presented in this document include both baseline demands (without passive conservation) and baseline demands minus passive conservation. It is important to note that the M&I demand forecasts do not include potential increases in demand due to climate change or potential decreases in demand due to active conservation programs.

4.2.2.1 2050 M&I Water Demands Methodology

The methodology used for the M&I water demands forecast in this update is nearly identical to the methodology employed in SWSI 1 (CWCB 2004). The method is based on a sample of water providers throughout the state as described in this section. The estimated per capita water use rates for each county were multiplied by the projected population of each county to estimate current and future municipal water demand (i.e., the residential, commercial, and industrial water use) of each county.

It is critical to note that the methods utilized in this approach are for the purpose of general statewide planning and are not intended to replace demand projections prepared by local entities for project-specific purposes. County and statewide population projections are the most accepted predictor of future growth for the state. Therefore, it was determined the SWSI 1 methodology was most appropriate. The methodology employed is a commonly accepted forecast methodology for statewide water supply planning purposes, but is not appropriate for project-specific purposes or for direct comparisons between basins or counties.

Estimates of Per Capita M&I Water Use

The M&I water demands forecast is developed by multiplying the population projections outlined in Section 4.2.1 by a rate of use. The rate of use is systemwide gpcd. Numerous factors affect per capita water use rates, and through the course of SWSI 1 and the current SWSI 2010, differences in the water use components that are included or excluded from individual entities' per capita estimates clearly affected the resulting values. Per capita water use rates are in large part a function of:

- Number of households
- Persons per household
- Median household income
- Mean maximum temperature
- Total precipitation
- Total employment
- Ratio of irrigated public land areas (e.g., parks) to population in service area
- Mix of residential and commercial water use and types of commercial use
- Level of tourism and/or second homes
- Ratio of employment by sector (e.g., agriculture, commercial, industrial)
- Urban/rural nature of county

Provider water use and service population data were gathered from various sources and organized to create a database. The database built upon existing information from 254 water providers gathered for SWSI 1. Efforts were made to update the data for these providers as part of analyses completed in 2009 and 2010. The CWCB also worked with water providers and basin roundtables across the state through the first part of 2010 to collect additional data. Based on these efforts, updated per capita estimates were collected for 214 water providers covering 87 percent of the population in Colorado. A systemwide gpcd estimate was calculated for each participating local water provider by dividing the total water deliveries by the service area population.

Because 2050 population projects were developed at the county level, the systemwide gpcd values needed to be aggregated from the water provider level to the county level. A weighting process was applied to develop a county average systemwide gpcd based upon the portion of the county population serviced by each water provider. Once the county level M&I demand forecast was developed, basin level M&I water use rates were calculated for the nine basin roundtable areas. Basin M&I demands were aggregated from the county demands based on the portion of the county within the basin. For four counties (Cheyenne, Lake, Saguache, and San Juan), no provider-level data were obtained. For these counties, the weighted basin average was assigned.

The population estimates developed for this update and the gpcd values determined through data collection are multiplied to estimate county demands. The population estimates represent permanent populations of each county; thus the water use rates are based on total water use divided by the permanent population. The resulting gpcd water use rates incorporate water used by tourists, students, and other transient populations in that the water used by the transient population is indexed to the permanent population along with the water use of the permanent population. The resulting gpcd also incorporates commercial and light industrial water use supplied by the water provider. For statewide planning purposes, this is a consistent approach to account for water use by transient populations, commercial, and light industry. Comparisons of gpcds between counties and basins should not be made directly, since differences in the amount of industry, tourism, and outdoor water use varies significantly between geographic regions.

The aggregated basin average per capita water use estimates from SWSI 1 and the July 2010 final updates are depicted in Figure 4-2; county per capita estimates are listed in Appendix H.

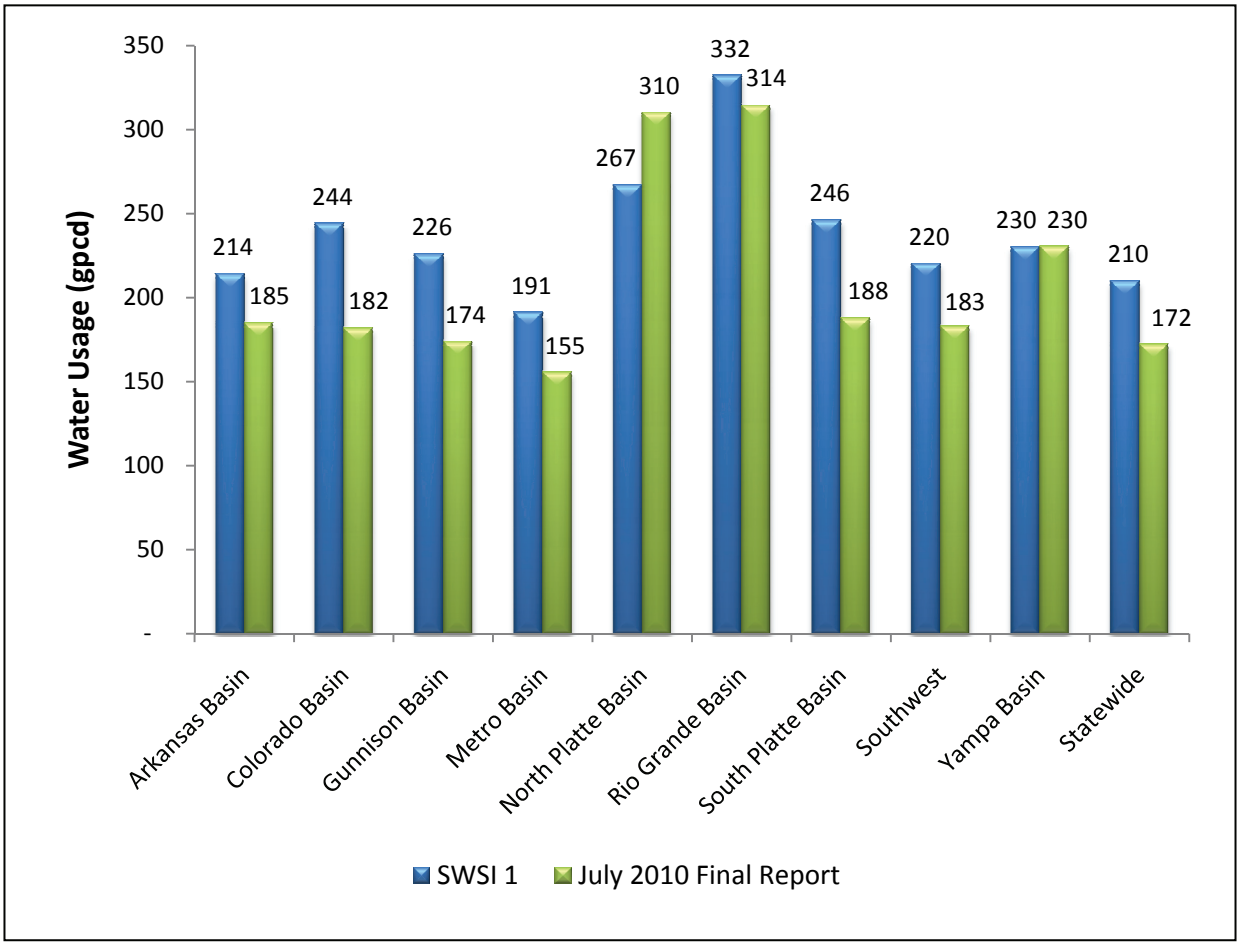


Figure 4-2 M&I Water Usage Rate by Basin

Overall, statewide water use has decreased since SWSI 1 from 210 gpcd to 172 gpcd; an 18 percent reduction in statewide per person daily water use. According to the data collected during this effort, 18 counties show an increase in gpcd demands since SWSI 1. These increases or decreases in systemwide gpcd may be due to a combination of factors including conservation efforts, behavioral changes from the 2002 drought (i.e., a "drought shadow"), changes in a community's socio-economic conditions, and better data. Better information likely accounts for a significant portion of these observed changes.

Passive Water Conservation Savings

The methodology for the M&I water demands projections outlined above develops baseline water demand estimates. In addition, CWCB has updated the passive conservation analysis, and these water savings are subtracted from the baseline estimates. This section provides an overview of passive water conservation savings, which chiefly relate to the water demand reductions associated with the impacts of state and federal policy measures and do not include active conservation measures and programs sponsored by water providers. A detailed description of this analysis is provided in the *SWSI Conservation Levels Analysis* report (CWCB 2010).

Several pieces of key federal and state legislation were considered in the development of the passive conservation savings estimates, including the 1992 National Energy Policy Act, the 2002 California Energy Commission Water Efficiency Standards, and the 2007 California Assembly Bill 715.

For this analysis, passive water savings were calculated to occur as a result of retrofitting housing stock and businesses that exist prior to 2016 through the replacement of washing machines, toilets, and dishwashers. Future water demand reductions associated with passive savings were calculated for each year beginning in 1996, which was when benchmark toilet flushing volume data from Denver was available. The calculations used to estimate future demand reductions from passive conservation were developed for minimum and maximum scenarios based on the assumptions related to the retrofit of existing housing and commercial construction with high-efficiency toilets, clothes washers, and dishwashers.

The calculations based on these assumptions were used to estimate a range of future passive water savings in each county for each year starting in 2000 and continuing until 2050. The total range of savings expected from passive conservation through 2050 is 19 to 33 gpcd (CWCB 2010). The upper range of these savings were applied to the county level baseline estimates described above to assess what the 2050 demands would be on a low, medium, and high basis with passive conservation. As stated in the *SWSI Conservation Levels Analysis* report (CWCB 2010) there are three major reasons for applying the high passive conservation savings:

1. Water and energy savings will become increasingly important to water customers as water and fuel costs rise. As water customers seek more efficiency in their homes and businesses, high efficiency fixtures and appliances will become increasingly efficient as technology improves and customers strive to reduce their variable costs related to water and energy.
2. The potential exists to realize substantial permanent water demand reductions in the future if appropriate regulations and ordinances are developed to address water use in existing and new construction.
3. The impact of commercial retrofits (e.g., restaurants, motels, ski area condominiums, centralized laundries, commercial laundries, bars, etc.), is not well captured in the passive savings analyses since information regarding numbers of and ages of individual types of commercial properties were not available.

4.2.2.2 2050 M&I Water Demands Results

Colorado's population is projected to nearly double by the year 2050. Because the major driver for water use is population growth, M&I water usage is also expected to nearly double, even with savings from passive conservation. Statewide municipal water demands are estimated to increase from 975,000 acre-feet/year (AFY) to 1.36 million AFY by 2035 requiring an additional 383,000 AFY of water to meet Colorado's municipal water needs in 2035.

Based on the population projections discussed in Section 4.2.1, total 2050 M&I water demands with passive conservation could range from 1.5 to 1.8 million AFY. By 2050, Colorado will need between 538,000 and 812,000 AFY of additional water to meet M&I demands. Passive conservation savings will result in approximately 154,000 AFY reduction or just over 8 percent decrease in M&I water demands by 2050 for the medium demand scenario. The statewide current (2008) and future (2035 and 2050 low, medium, and high) water demands for baseline conditions and with passive conservation are summarized in Figure 4-3 below.

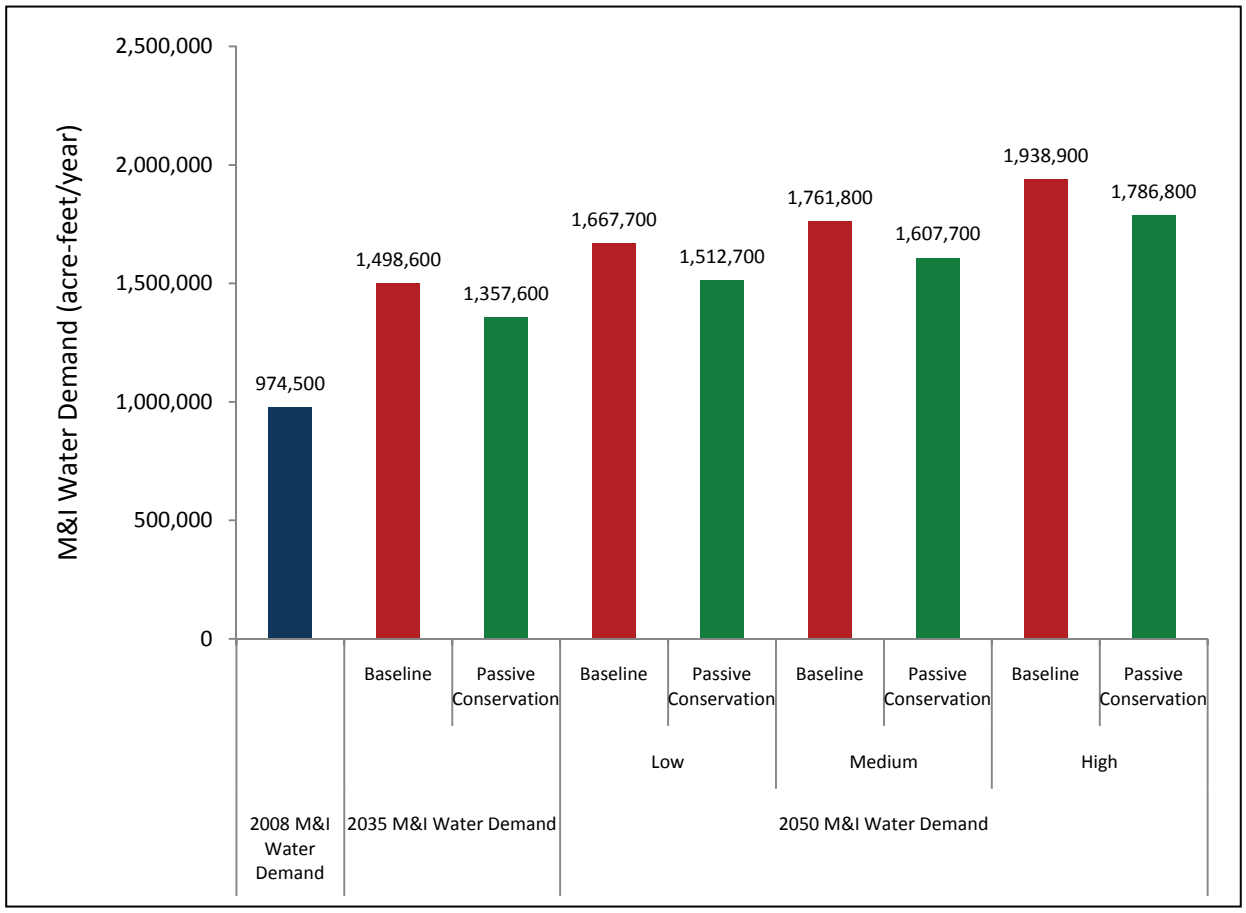


Figure 4-3 Comparison of M&I Demands for Baseline and with Passive Conservation

Table 4-3 on the following page and Figure 4-4 illustrates the M&I water demand projections with passive conservation savings for each of the nine basin roundtable areas. The majority of M&I water usage will be in the Arkansas, Colorado, Metro, and South Platte Basins.

4.2.3 SSI Water Demands

Standard methods were adapted for use in SWSI 1 for estimating future SSI water demands throughout Colorado (CWCB 2004). SSI water demands include water use by self-supplied and municipal provided large industries. The subsectors that are included in SSI are:

- Large industries, including mining, manufacturing, brewing, and food processing
- Water needed for snowmaking
- Thermoelectric power generation at coal- and natural gas-fired facilities
- Energy development, including the extraction and production of natural gas, coal, uranium, and oil shale

These industries represent economic growth within the state and the availability of water resources is imperative to their growth. Because of the diversity of the SSI subsectors, this section is organized to summarize each subsector separately, including data collection efforts and results. Detailed discussions of data sources, methodologies, and results are provided in Appendix H.

Table 4-3 M&I Forecast by River Basin

Basin	No. Utilities in Database	No. Updated since SWSI	SWSI GPCD	GPCD based on Update	Water Demand (AF) 2008	Baseline Water Demands (AFY)				Water Demands with Passive Conservation (AFY)			
						2035	2050 Low	2050 Medium	2050 High	2035	2050 Low	2050 Medium	2050 High
Arkansas	65	40	214	185	196,000	299,000	327,000	349,000	380,000	273,000	298,000	320,000	352,000
Colorado	55	46	244	182	63,000	115,000	135,000	150,000	174,000	106,000	125,000	140,000	164,000
Gunnison	21	18	226	174	20,000	36,000	40,000	43,000	46,000	33,000	36,000	39,000	43,000
Metro	100	35	191	155	437,000	627,000	695,000	717,000	785,000	557,000	620,000	642,000	709,000
North Platte	1	1	267	310	500	600	700	800	900	600	700	700	800
Rio Grande	9	4	332	314	18,000	24,000	26,000	27,000	30,000	22,000	24,000	26,000	28,000
South Platte	60	53	220	188	206,000	338,000	377,000	397,000	430,000	311,000	347,000	367,000	401,000
Southwest	16	9	246	183	22,000	38,000	42,000	47,000	52,000	35,000	39,000	43,000	49,000
Yampa-White	10	8	230	230	12,000	21,000	25,000	31,000	41,000	20,000	23,000	30,000	40,000
Statewide	**337**	**214**	**210**	**172**	**974,500**	**1,498,600**	**1,667,700**	**1,761,800**	**1,938,900**	**1,357,600**	**1,512,700**	**1,607,700**	**1,786,800**

Notes: Forecast is produced by aggregating the county forecast. If a county falls within two basins, the demand is split according to the portion of population in each basin.

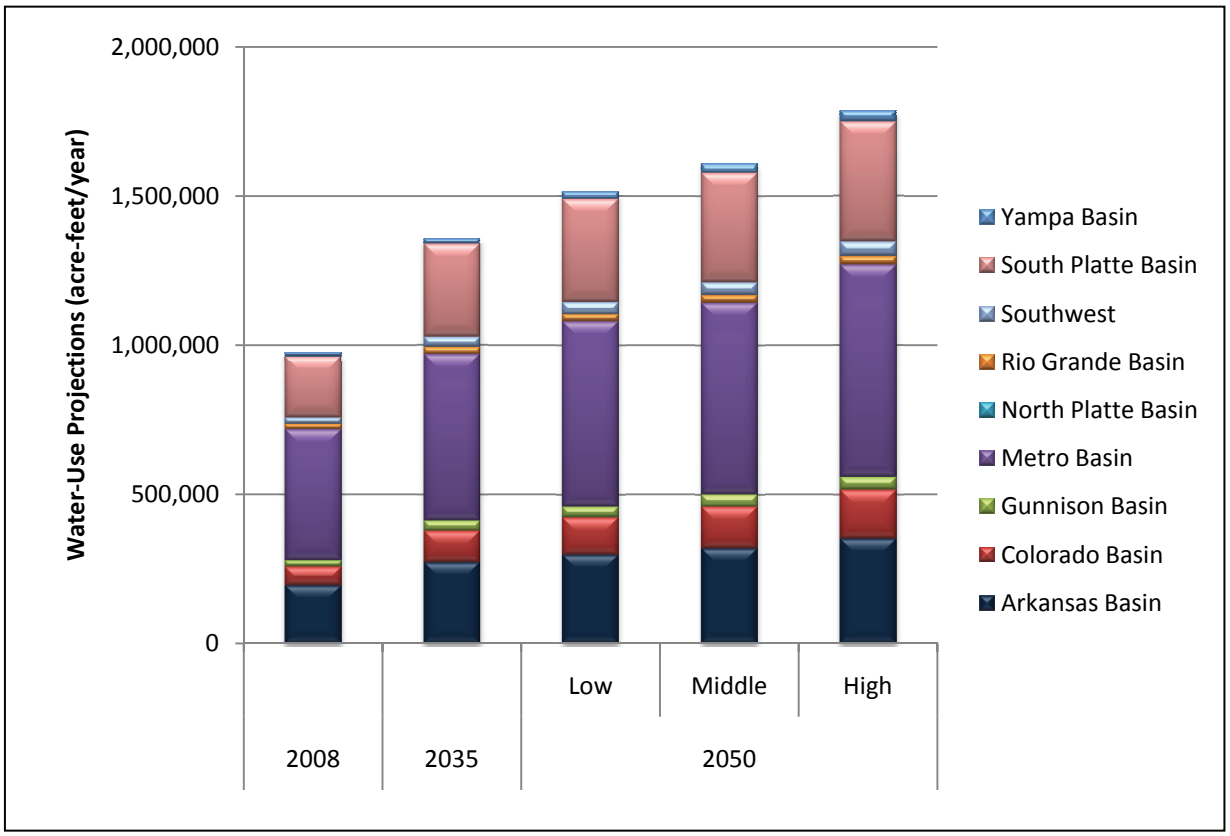


Figure 4-4 M&I Water Demands by Basin

4.2.3.1 Large Industry

The goal of this subsector is to identify large self-supplied industries in Colorado with significant consumptive water demands. Large industries were initially identified in four counties. These included Coors Brewing Company in Jefferson County, the mining industry in Moffat County, the Colorado Steel Company in Pueblo County, and the mining industry and golf courses in Routt County. While reviewing data for the M&I water demands forecast updates, three large industries were identified and their water use was removed from the M&I water demands forecast and added to the large industry subsector water demands forecast. These included Cargill Inc. in Morgan County, Swift Company in Weld County, and Kodak in Weld County. The sources of information used to develop the SSI estimates for large industry are detailed in Appendix H. Results of the large industry subsector water demands forecast are provided in Table 4-4. No low, medium, and high growth scenarios are considered for this subsector.

Table 4-4 Large Industry Demands (AFY)

County	2008	2035/2050
Jefferson	52,400	52,400
Moffat	2,600	3,900
Morgan	2,100	2,100
Pueblo	49,400	49,400
Routt	3,500	5,600
Weld	4,500	4,500
Total	**114,500**	**117,900**

4.2.3.2 Snowmaking

The ski industry in Colorado is the cornerstone of tourism and economic activity for a large region of the state. While the water used by the ski resorts does not have a high consumption rate, it is water removed from the stream system and thus important to estimate. The forecast methodology employed in this update differs from the SWSI 1 forecast methodology. Additional data were identified that proved useful in developing water use demands for snowmaking.

Table 4-5 Estimated Snowmaking Water Demands (AFY)

County	2008	2050
Boulder	230	230
Clear Creek	90	90
Eagle	600	600
Garfield	20	20
Grand	350	630
Gunnison	260	650
La Plata	230	230
Mesa	50	50
Pitkin	560	560
Routt	290	570
San Miguel	180	180
Summit	1,600	2880
Total	**4,460**	**6,690**

For this effort, several pieces of information were obtained—current snowmaking acres for each ski resort, current amount of water used for snowmaking, and expected future water use for snowmaking. Water use information was not available for all ski resorts. For these resorts, the known water use data were used to estimate current and future snowmaking demand. To stay within the bounds of the known data, water use was held constant for resorts with no known future expansions. Also, for resorts with known expansions, build out was assumed to be 2050. Results of the forecast for the snowmaking industry are shown in Table 4-5. At this time, no low, medium, or high growth scenario is considered for 2050.

4.2.3.3 Thermoelectric Power Generation

Water use at coal-fired and natural gas power facilities is included in the SSI water demands estimates. In 2006, nearly 95 percent of Colorado's electricity was produced from coal (71 percent) and natural gas (23 percent) (Department of Energy 2008). Although Colorado's General Assembly has adopted a state renewable electricity standard that requires 20 percent of the state's electric portfolio to be from renewable resources of energy by 2020, demand for coal-fired and natural gas energy production will remain significant into the future. Generation facilities using fossil fuels require cooling systems to condense steam turbine exhaust. Cooling water is the most economical method to condense steam.

For SWSI 1, estimates of current and future water use at various power generation facilities in Colorado were obtained from power producers (CWCB 2004). For this update, SWSI 1 baseline estimates were assumed to stay constant until 2035. SWSI 1 estimates were modified to include Phase 1 and Phase 2 of the Colorado and Yampa-White Basin's Energy Study. These demands account for scenarios of energy development in the Yampa-White and Colorado Basins. The Moffat County 2035 and 2050 thermoelectric power water demand scenarios were adapted to account for the direct electricity needs of energy development presented Phase 1 and Phase 2 of the Energy Study for natural gas, coal, and uranium development.

To extend 2035 projections to 2050 for the remaining counties (Adams, Boulder, Denver, Larimer, Montrose, Morgan, Pueblo, Routt, and Weld), percent increases were assumed for the low, medium, and high scenarios, respectively, as follows—5 percent, 25 percent, and 50 percent. These percentages were based on expected population increases throughout the state. Table 4-6 provides the estimates of thermoelectric water demands with 2050 low, medium, and high scenarios.

Table 4-6 Estimated Thermoelectric Power Generation Water Demands (AFY)

County	2008	2035	2050		
			Low	Med	High
Adams	9,600	9,600	10,100	12,000	14,400
Boulder	2,900	2,900	3,100	3,700	4,400
Denver	2,400	2,400	2,500	3,000	3,500
Larimer	5,200	11,200	11,700	14,000	16,700
Moffat	17,500	26,900	24,700	26,200	26,900
Montrose	1,900	3,900	4,100	4,900	5,900
Morgan	5,900	13,900	14,600	17,400	20,900
Pueblo	9,000	14,700	15,400	18,400	22,100
Routt	2,700	11,400	12,000	14,300	17,100
Weld	7,400	7,400	7,800	9,300	11,100
Total	**64,500**	**104,300**	**106,000**	**123,200**	**143,000**

4.2.3.4 Energy Development

In September of 2008, the Colorado and Yampa-White Basin Roundtables released a *Phase 1 Energy Development Water Needs Assessment Report* that assessed the water needs in northwest Colorado for energy development. The report estimated water demands needed to support the extraction and production of natural gas, coal, uranium, and oil shale through 2050 (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2008). Since the 2008 report, the Colorado and Yampa-White Basin Roundtables refined water demand estimates for oil shale development through Phase 2 of the Energy Study. This report also includes recent work completed to address water demands for oil shale development (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2010).

Direct water demands include the water required for the construction, operation, production, and reclamation needed to support the energy extractions and development processes. For the natural gas sector, Figure 3-2 from the Phase 1 Energy Study report was used to allocate demands to counties. The analysis completed by the basin roundtables found that for natural gas generation, activity was shifted from Garfield County to Rio Blanco County over the 40-year timeframe. For the coal sector, two mines were assumed in Moffat County and one each in Rio Blanco, Garfield, and Routt Counties. For the uranium sector, all future activity was allocated to Moffat County except for the long-term high scenario, which was allocated half to Moffat County and half to Mesa County (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2008).

The population projections for 2050 are based on an oil shale industry of zero barrels per day for the low scenario, 150,000 barrels per day for the medium (100,000 *in situ*, 50,000 above-ground), and 550,000 barrels per day for the high scenario (500,000 *in situ*, 50,000 above-ground). The selected medium and high barrels of water required per barrel of oil values were paired with the medium and high production scenarios. While this is not thought to represent the potential long-term or build-out needs of the oil shale industry, this production level was chosen to represent values for 2050, as build-out of the oil shale industry is not expected between now and 2050.

Direct water use estimates and scenarios from the Draft Phase 2 of the Energy Study were used to estimate 2050 direct water needs for oil shale production. The water uses detailed in the Phase 2 study include indirect and direct water needs for construction/preproduction, electrical energy (combined cycle gas turbines used onsite), production, reclamation, spent shale disposal, upgrading, and production work force (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2010). For this effort, indirect thermoelectric energy estimates were included in Section 4.2.3.3 as described above and the water needs for the production work force were accounted for in the population projections and M&I water demands sections of this report.

Oil shale estimates were disaggregated to the county level, making the following assumptions for Table 4-7, which summarizes energy development at the county level:

- Above-ground development was assumed to be conducted in Garfield County.
- Upgrading for above-ground was assumed to occur in Mesa County.
- All *in situ* related water requirements, including upgrading, were included in Rio Blanco County's SSI projections.

In addition to energy industry in northwest Colorado, the Rio Grande Basin Roundtable expects that within the next 40 to 50 years a solar energy development industry will occur in the Rio Grande Basin. Some of the technologies proposed are water intensive and recent estimates by the basin roundtable have identified a potential range of 1,200 to 2,000 AFY demand for solar energy development by 2050 (Mike Gibson 2009).

Table 4-7 shows the estimated energy development direct water demands for the Colorado counties where water demands for energy production will be required by 2050. Water demands for energy development have the potential to increase over twelve times 2008 levels by 2050 for the high scenario.

Table 4-7 Estimated Energy Development Direct Water Demands (AFY)

County	2008	2035	2050		
			Low	Med	High
Alamosa	—	300	1,200	1,500	2,000
Garfield	2,000	500	200	3,300	6,900
Mesa	300	—	—	1,400	3,800
Moffat	800	1,500	400	1,200	2,300
Rio Blanco	700	4,000	3,000	5,800	37,900
Routt	500	500	500	500	1,600
Total	**4,300**	**6,800**	**5,300**	**13,700**	**54,500**

Note that indirect water uses or water demands that result from the increase in the region's population due to energy development and production are not included in this SSI water demands forecast update, as they are captured in the M&I demands forecast in Section 4.2.2. Similarly, increases in thermoelectric power demands caused by energy development were aggregated to the thermoelectric power generation subsector described in the previous section.

4.2.3.5 Statewide SSI Demand Summary

Table 4-8 presents results of the SSI demand projections by basin. As shown, Moffat County could experience a significant increase in water demands, attributable to the electricity needed for energy development. Rio Blanco County could also experience a significant increase in water demands if the oil shale industry experiences significant growth. Both of these counties are located in the Yampa-White Basin. For the remaining counties and basins, increased demands are attributable to increases in thermoelectric power generation. The North Platte Basin does not have any SSI water demands identified at this time. There has been some discussion of oil and gas development in the North Platte Basin, but at this time, water needs for this industry have not been quantified.

Table 4-8 Summary of Self-Supplied Industry Demands by Basin (AFY)

Basin	Sub-Sector	2008	2035	2050 Low	2050 Med	2050 High
Arkansas	Energy Development	—	—	—	—	—
	Large Industry	49,400	49,400	49,400	49,400	49,400
	Snowmaking	—	—	—	—	—
	Thermoelectric	9,000	14,700	15,400	18,400	22,100
	Total	**58,400**	**64,100**	**64,800**	**67,800**	**71,500**
Colorado	Energy Development	2,300	500	200	4,700	10,700
	Large Industry	—	—	—	—	—
	Snowmaking	3,180	4,740	4,740	4,740	4,740
	Thermoelectric	—	—	—	—	—
	Total	**5,480**	**5,240**	**4,940**	**9,440**	**15,440**
Gunnison	Energy Development	—	—	—	—	—
	Large Industry	—	—	—	—	—
	Snowmaking	260	650	650	650	650
	Thermoelectric	—	—	—	—	—
	Total	**260**	**650**	**650**	**650**	**650**
Metro	Energy Development	—	—	—	—	—
	Large Industry	52,400	52,400	52,400	52,400	52,400
	Snowmaking	—	—	—	—	—
	Thermoelectric	12,000	12,000	12,600	15,000	17,900
	Total	**64,400**	**64,400**	**65,000**	**67,400**	**70,300**
Rio Grande	Energy Development	—	600	1,200	1,500	2,000
	Large Industry	—	—	—	—	—
	Snowmaking	—	—	—	—	—
	Thermoelectric	—	—	—	—	—
	Total	**—**	**600**	**1,200**	**1,500**	**2,000**
South Platte	Energy Development	—	—	—	—	—
	Large Industry	6,600	6,600	6,600	6,600	6,600
	Snowmaking	320	320	320	320	320
	Thermoelectric	21,400	35,400	37,200	44,400	53,100
	Total	**28,320**	**42,320**	**44,120**	**51,320**	**60,020**
Southwest	Energy Development	—	—	—	—	—
	Large Industry	—	—	—	—	—
	Snowmaking	410	410	410	410	410
	Thermoelectric	1,900	3,900	4,100	4,900	5,900
	Total	**2,310**	**4,310**	**4,510**	**5,310**	**6,310**
Yampa-White	Energy Development	2,000	6,000	3,900	7,500	41,800
	Large Industry	6,100	9,500	9,500	9,500	9,500
	Snowmaking	290	570	570	570	570
	Thermoelectric	20,200	38,300	36,700	40,500	44,000
	Total	**28,590**	**54,370**	**50,670**	**58,070**	**95,870**
Total All Basins		**187,760**	**235,990**	**235,890**	**261,490**	**322,090**

Figure 4-5 summarizes projected SSI water usage statewide by subsector, indicating that among SSI needs, the large industry, thermoelectric, and energy development subsectors are projected to use the most water in the future. SSI demands are projected to range from 236,000 AFY to 322,000 AFY by 2050, requiring an additional 48,000 AFY to 134,000 AFY of SSI water to meet these demands.

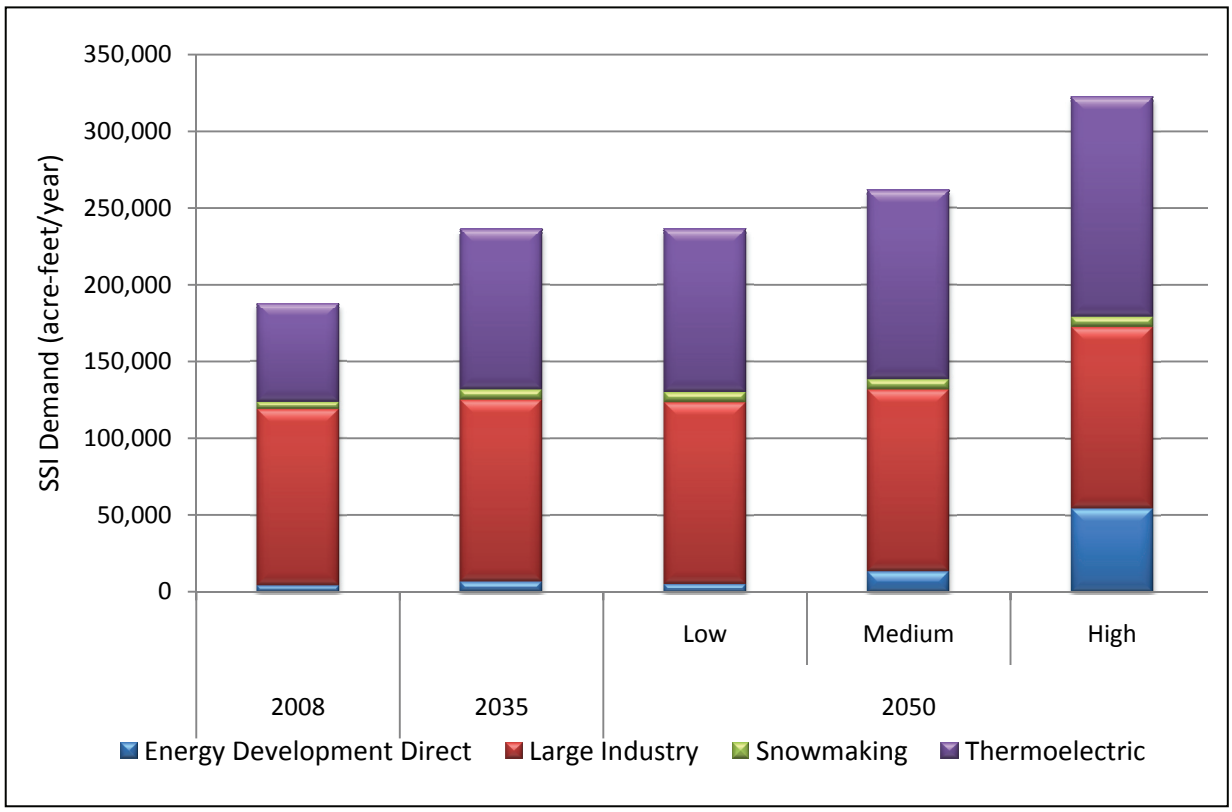


Figure 4-5 Statewide SSI Water Demands by Sector

4.2.4 Statewide 2050 M&I and SSI Consumptive Needs Summary

Of the many factors affecting M&I water use, the projected increases in population clearly drive the increases in M&I use from 2000 to 2050. Table 4-9 and Figure 4-6 summarize statewide M&I and SSI water use for 2008 and projections including reductions as a result of passive conservation measures for 2035 and the 2050 low, medium, and high scenarios. Total statewide 2035 water demands are projected to be nearly 1.6 million AFY. 2050 water demands are projected to range from approximately 1.75 million AFY to nearly 2.1 million AFY. Figure 4-6 also shows that M&I water demands are estimated to exceed SSI demands for all of the future projections.

Table 4-9 Summary of M&I and SSI Demands for Each Basin and Statewide (AFY)

Basin	Demand Type[1,2]	2008	2035	2050 Low	2050 Med	2050 High
Arkansas	M&I	196,000	273,000	298,000	320,000	352,000
	SSI	58,400	64,100	64,800	67,800	71,500
	Total	**254,400**	**337,100**	**362,800**	**387,800**	**423,500**
Colorado	M&I	63,000	106,000	125,000	140,000	164,000
	SSI	5,480	5,240	4,940	9,440	15,440
	Total	**68,480**	**111,240**	**129,940**	**149,440**	**179,440**
Gunnison	M&I	20,000	33,000	36,000	39,000	43,000
	SSI	260	650	650	650	650
	Total	**20,260**	**33,650**	**36,650**	**39,650**	**43,650**
Metro	M&I	437,000	557,000	620,000	642,000	709,000
	SSI	64,400	64,400	65,000	67,400	70,300
	Total	**501,400**	**621,400**	**685,000**	**709,400**	**779,300**

Table 4-9 Summary of M&I and SSI Demands for Each Basin and Statewide, continued

Basin	Demand Type[1,2]	2008	2035	2050 Low	2050 Med	2050 High
North Platte	M&I	500	600	700	700	800
	SSI	—	—	—	—	—
	Total	**500**	**600**	**700**	**700**	**800**
Rio Grande	M&I	18,000	22,000	24,000	26,000	28,000
	SSI	—	600	1,200	1,500	2,000
	Total	**18,000**	**22,600**	**25,200**	**27,500**	**30,000**
South Platte	M&I	206,000	311,000	347,000	367,000	401,000
	SSI	28,320	42,320	44,120	51,320	60,020
	Total	**234,320**	**353,320**	**391,120**	**418,320**	**461,020**
Southwest	M&I	22,000	35,000	39,000	43,000	49,000
	SSI	2,310	4,310	4,510	5,310	6,310
	Total	**24,310**	**39,310**	**43,510**	**48,310**	**55,310**
Yampa-White	M&I	12,000	20,000	23,000	30,000	40,000
	SSI	28,590	54,370	50,670	58,070	95,870
	Total	**40,590**	**74,370**	**73,670**	**88,070**	**135,870**
Statewide	**M&I**	**974,500**	**1,357,600**	**1,512,700**	**1,607,700**	**1,786,800**
	SSI	**187,760**	**235,990**	**235,890**	**261,490**	**322,090**
	Total	**1,162,260**	**1,593,590**	**1,748,590**	**1,869,190**	**2,108,890**

[1] M&I demands for 2035 and 2050 include passive conservation savings.
[2] SSI demands include energy development, large industry, snowmaking, and thermoelectric.

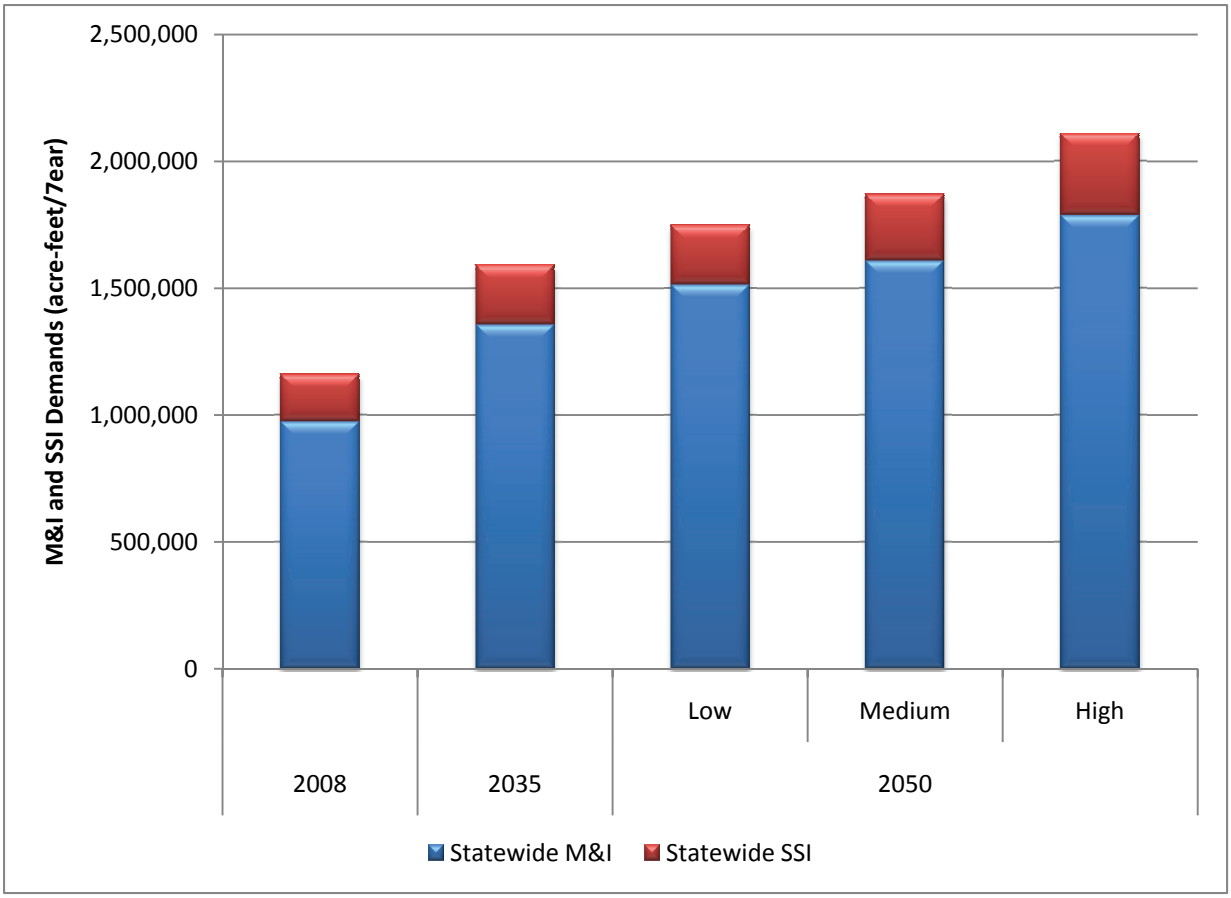


Figure 4-6 Statewide M&I and SSI Demands

Figure 4-7 summarizes statewide existing water use and future water demands. Gross statewide M&I demands including oil shale and other SSI water demands for the low, medium, and high scenario projections are 1.75 million AFY, 1.9 million AFY, and 2.1 million AFY, respectively. These projections include estimated demand reductions associated with passive conservation, but do not include the impacts of active water conservation efforts that are being implemented and planned by many M&I water providers. Current water use is just over 1.1 million AFY. Colorado will need between 600,000 and 1 million acre-feet of additional M&I water each year by 2050. These estimates incorporate new water demands from population growth, energy and other SSI needs (including oil shale), and replacement of nontributary groundwater.

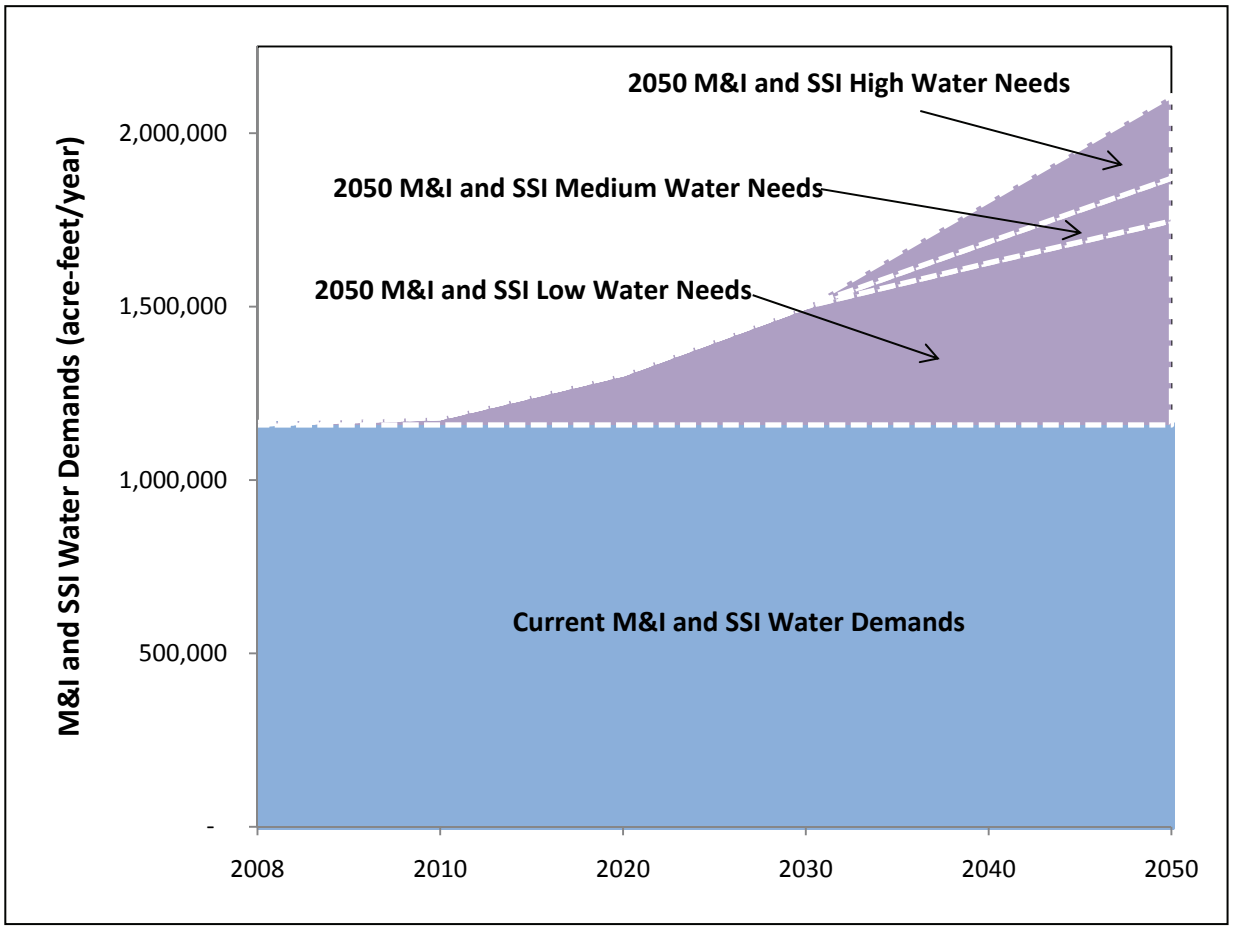


Figure 4-7 Existing and Future M&I and SSI Demands

The following are the major conclusions from State of Colorado's 2050 M&I water use projections:

- Significant increases in Colorado's population will intensify competition for water.
- Colorado's population is expected to nearly double to between 8.6 and 10 million by 2050 even after taking into account the current recession's impacts on Colorado's economy.
- The Front Range of Colorado will continue to be the most populous place in Colorado with over 80 percent of the state's population residing in the Arkansas, Metro, and South Platte Basins.

- The West Slope of Colorado will grow at the fastest rate of any area in Colorado between now and 2050. Population on the West Slope is expected to more than double in the next 40 years, and growth rates in some areas on the West Slope could be as high as 240 percent.
- Statewide M&I water usage rates have decreased by 18 percent relative to SWSI 1 findings. This decrease is due to a combination of drought response, conservation savings, and additional data collection efforts. Additional data collected during this effort has improved the SWSI 1 water usage information.
- Because population growth is the driving factor in water use across the state, water use is also expected to nearly double by 2050.
- Passive conservation will save approximately 150,000 AFY by 2050 or an 8 percent savings relative to baseline 2050 M&I water demands.
- The basins with the largest SSI water usage in 2050 are projected to be the Yampa-White, Arkansas, Metro, and South Platte Basins.
- Oil shale water demands have factored in recent information developed by the Colorado and Yampa-White Basin Roundtables' Energy Subcommittee that considered the amount of produced water that will be created during shale processing. In addition, recent work drafted by the subcommittee has shown that energy needed to develop oil shale could be produced by combined cycle gas turbines, not coal power plants. Both of these considerations have reduced previous estimates of oil shale water demands.
- Colorado will need between 600,000 and 1 million acre-feet of additional M&I water each year by 2050.

4.3 Agricultural Consumptive Needs

This section provides information about the methodologies utilized to develop a current tally of irrigated acres throughout Colorado and summarizes how 2050 irrigated acres were estimated. In addition, this section provides an overview of existing and 2050 agricultural demands.

4.3.1 Agricultural Demand Methodology

This section describes the methods used to estimate the water needed to support Colorado's agriculture, both currently and in 2050. The estimates include consumptive use (CU) water only—rather than the generally larger volumes of water pumped or diverted—both for the irrigation of crops and for livestock production. CU includes the amount of diverted water that is used by plants through evapotranspiration processes, as well as water that is "lost" to soil evaporation or deep percolation into the groundwater aquifer. A portion of the total diverted amount returns to the stream through surface runoff or lagged groundwater return flows and therefore is not consumptively used.

Colorado's water needs for irrigation are characterized in this analysis by the Irrigation Water Requirement (IWR), Water Supply Limited Consumptive Use (WSL CU), and the difference between these two numbers. CU modeling was executed using a recent decade of climate and water supply information. The objective was not to simulate what occurred over the past 10 years, but to estimate IWR and WSL CU for today's agricultural conditions and a plausible sample of climate and hydrology, exemplified by the recent decade. Future irrigation demand was examined by assuming that historical climate conditions will continue. The analysis assumed that agricultural demand is directly and linearly related to the number of acres irrigated.

In addition to the crop consumption described above, Colorado's agricultural demand includes three other types of CU that are associated with agricultural activity:

- Livestock CU
- Stockpond evaporation
- Losses incidental to delivering irrigation water

The Colorado Decision Support System (CDSS) program has developed processes for quantifying these uses in the context of developing basinwide water budgets, and water resources planning models. For this analysis, CDSS procedures were used to update the SWSI 1 estimates in those basins where a decision support system (DSS) has been implemented; where a DSS does not exist, the CDSS procedures were generally applied if data were available to support the method. The following subsections provide an overview of the methodologies used to estimate current and future irrigated acres and agricultural water demands and the results. A detailed description of these methodologies and results is in Appendix I.

4.3.1.1 Current Irrigated Acres Methodology

The CDSS program has produced irrigated lands mapping and crop CU models in the major basins where it has been implemented. These include the following:

- Colorado River tributary basins (Yampa River, White River, Colorado River mainstem, Gunnison River, and San Juan River)
- Rio Grande Basin
- North and South Platte Basins

The maps are available as spatial databases, and include crop types, irrigation practices, and association with diversion structures or wells. The structure identifier associated with the irrigated land indicates the location of the headgate that serves the land. Irrigated acres are assigned to the water district where the diversion is located, which may not be where the irrigated acreage lies. Dates of the irrigated lands information varied with the basins including the number of years information as collected. The first year information was collected ranges from 1993 for the Colorado River tributary basins to 1956 for the South Platte and North Platte Basins and 1939 for the Rio Grande Basin.

CDSS has not been implemented in the Republican and Arkansas Basins, so information had to be gathered from other sources or developed within this project. Groundwater irrigated acreage for the Republican River Basin was obtained from the Republican River Compact Administration accounting spreadsheets for 2007. Precise information on surface water irrigated lands in the Republican River Basin is not available, but according to the State Engineer's Office, the total amount is believed to be no more than 1,000 acres.

The Arkansas Basin can be divided into three areas, in terms of the irrigated acreage data available:

- The Lower Arkansas Basin, the area covered by the Hydrologic Institutional (HI) model that Colorado must use for compact accounting, pursuant to settlement of the *Kansas v. Colorado* litigation, comprising irrigated lands under Arkansas River canals from Pueblo Reservoir to the state line
- The Purgatoire River Water Conservancy District (PRWCD) in Water District 19
- All other irrigated land in the basin, including the Upper Arkansas Basin, tributaries above Pueblo Reservoir, and the Southern High Plains Designated Basin

For the Lower Arkansas region, irrigated acreage based on 2008 data was obtained from the Irrigation Systems Analysis Model (ISAM), developed by Division 2 as a refinement of the HI Model to the

individual farm level. Five small ditches within the HI Model domain were excluded from the acreage data in ISAM, so acreage for those structures was taken from 2003 imagery associated with the HI Model.

Division 2 recently completed an irrigated lands assessment of the PRWCD, a geographic information system (GIS) product based on 2008 imagery, which provided the necessary acreage data for this area of the Arkansas Basin. For the remainder of the Arkansas Basin, multiple scenes spanning the 2009 growing season were obtained from the Landsat 5 Thematic Mapper archive and analyzed. A vegetative index map was derived, indicating areas of vigorous plant growth, and additional analyses were performed to distinguish irrigated farmland from non-agricultural lands such as riparian areas and irrigated urban parks.

4.3.1.2 2050 Irrigated Acres Methodology

Using the most current irrigated acres for each basin as defined in the previous section as a baseline, estimates of 2050 irrigated acres were based on the following factors:

- Urbanization of existing irrigated lands
- Agricultural to municipal water transfers
- Water management decisions
- Demographic factors
- Biofuels production
- Climate change
- Farm programs
- Subdivision of agricultural lands and lifestyle farms
- Yield and productivity
- Open space and conservation easements
- Economics of agriculture

The first three factors (urbanization of existing irrigated lands, agricultural to municipal water transfers, and water management decisions) were quantified based on future growth estimates, municipal water demand gaps that will be met by 2050, and interviews with water management agencies across the state. The remaining factors were qualitatively addressed based on information provided by the CWCB and the Colorado Department of Agriculture.

The urbanization of existing irrigated lands was established using 2050 population projections, estimation of future urban area size, and the current irrigated acres as described in the previous section. As discussed above, current irrigated acres in each administrative water district were determined from GIS data sources. However, certain types of data (e.g., future population forecasts) were only available on a county basis. Therefore, future losses of irrigated acres were calculated first for each county, and then re-distributed by water district. The methodology is described in detail in Appendix I.

The M&I gap analysis (described in Section 5) was used as the basis for the analysis of irrigated acreage changes associated with agricultural to municipal water transfers. For each of Colorado's major river basins the amount of the M&I gap was summarized in AFY on a low, medium, and high basis. For the purposes of predicting future irrigated acres it was assumed that 70 percent of M&I gap would be met from agricultural to municipal transfers. This percentage is a conservative estimate based on the assumption of 100 percent yield success rate for IPPs (see Section 5). Therefore, it does not take into account the projects or methods that may not be successful in meeting Colorado's future M&I demands; if IPPs are unsuccessful, it is likely that M&I water providers will turn to increased agricultural transfers to meet future demands. The following equation was used to estimate irrigated acres that would be needed for agricultural to municipal transfers to address M&I gaps:

Irrigated Acres Transferred = M&I Gap ÷ Transferrable Consumptive Use x (1 – Safety Factor)

A safety factor of 25 percent was applied to account for the additional amount of irrigated acres that may be needed to provide the transferred water on a firm yield basis.

CWCB interviewed entities within the South Platte, Rio Grande, and Republican River Basins to estimate what changes may occur in irrigated acres due to water management decisions affected by compact compliance or maintain groundwater levels. For the remaining factors (demographic factors, biofuels production, climate change, farm programs, subdivision of agricultural lands and lifestyle farms, yield and productivity, open space and conservation easements, economics of agriculture), CWCB identified trends that are expected to occur within each area over the next 40 years and then developed a qualitative assessment on whether each factor would cause a negative or positive impact on irrigated agriculture by 2050. A detailed description of this qualitative assessment is available in Appendix I.

4.3.1.3 Current Agricultural Demand Methodology

Current irrigation demand for water in Colorado can be defined as the average amount of water consumptively used by crops on land currently under irrigation. Typically, water supply is plentiful early in the irrigation year, crop CU is not limited and is equal to the crop IWR. As the irrigation season continues, the available water supply generally decreases, becoming less than the crops' uptake capacity, and CU is limited by supply. In order to quantify crop CU, one must have credible estimates or measurements of the crops' average capacity to use irrigation water, referred to as IWR, as well as the average water supply. The minima of these two values over a series of time increments (typically months) is the WSL CU.

For this analysis, both average IWR and average WSL CU are reported. The latter may be considered to be the current agricultural demand; that is, the water required to sustain current levels of farming. IWR provides perspective on the amount of water that would be used, if it was physically and legally available. It is an upper limit on consumption by current agriculture, and a reminder that Colorado is a dry state with over-appropriated streams.

IWR estimation requires time series of climate information, particularly precipitation and temperature, over the study period; WSL CU estimation requires information about the time-varying water supply available to the crop. For this analysis, a recent 10-year study period was used in each basin, although the exact decade differed from basin to basin depending on available data. The 10-year period allowed for estimation of average conditions with respect to both climate and hydrology. IWR and WSL CU were calculated assuming that the most current estimate of number of irrigated acres, and most recent information on crop types, prevailed during each year of the study period. The results show demand for "today's" agricultural conditions in Colorado, based on a 10-year sample of climate and hydrology. Extensive details of the variations in methodology for the CDSS, Republican, and Arkansas Basins are described in Appendix H.

Where applicable, CDSS methodologies were applied to estimate non-irrigation agricultural consumptive demands (e.g., livestock and stockpond evaporation) as well. Livestock CU is estimated by multiplying the number of cattle, sheep, and hogs located within a basin by their corresponding per capita use. Stockpond evaporation is based on net evaporation rates and stock pond surface area estimates. Details differ among the basins, but in general, the method estimates net reservoir evaporation by subtracting average monthly effective precipitation from the estimated gross monthly free water surface evaporation.

Lastly, incidental losses may include, but are not limited to, vegetative CU that occurs along canals and in tailwater areas. The CDSS program, in preparing Consumptive Uses and Losses (CU&L) Reports for the state, has adopted 10 percent as the factor for computing incidental losses associated with irrigation CU.

The value is in the middle of the range of factors (5 percent to 29 percent) used by the Bureau of Reclamation in their parallel CU&L accounting throughout the upper basin states.

4.3.1.4 2050 Agricultural Demand Methodology

Following the techniques described in Section 4.3.1.2, changes in numbers of acres irrigated have been developed for each water district. Since this study intentionally avoids identifying specific water rights or ditches for change of use, there is no basis for calculating the structure-specific CU by which a water district's irrigation demand will change. CU per irrigated acre varies from structure to structure, and depends on available supply, seniority of a water right, and system efficiency. The variability of these factors makes it impossible to predict future losses of irrigated land on a structure-by-structure basis. Consequently, simplifying assumptions were made such that irrigation demand was considered directly proportional to number of acres irrigated. To derive future irrigation demand, current irrigation demand for each water district was scaled by the ratio of future irrigated acreage to current irrigated acreage.

Similarly, non-irrigation demand was estimated as being in proportion to irrigated acres. The relationship between losses incidental to irrigation and number of acres irrigated is proportional. With respect to stockponds and stock watering, it is assumed that predicted changes in irrigated acreage will be accompanied by similar changes in stock raising activities. To derive future non-irrigation demand, current non-irrigation demand was scaled by the ratio of future irrigated acreage to current irrigated acreage.

4.3.2 Agricultural Demand Results

The following sections describe the results of the current and future agricultural demand analyses, which were performed based on the methodologies described above. These analyses included assessments of both irrigated acreage and associated agricultural consumptive water demands. Maps are included to identify the locations of existing irrigated lands across the state, as well as to show the range of irrigated acreage losses anticipated in each basin by 2050.

4.3.2.1 Current Irrigated Acres Results

Information developed for this effort was generated at the water district level. Figure 4-8 shows the locations of Colorado's water districts and the spatial distribution of current irrigated acres in Colorado based on the methods presented previously. Note that spatial information was not available for the irrigated lands in the Republican River water districts.

Table 4-10 presents the number of irrigated acres in each river basin and the percentage of total that each basin represents. Colorado currently has 3,466,000 million acres of irrigated farmland across the state. The South Platte River Basin has the highest percentage of irrigated acres followed by the Rio Grande Basin and the Republican River Basin.

Table 4-10 Current Irrigated Acres by River Basin

Basin	Irrigated Acres	Percentage of Colorado's Irrigated Acres
Arkansas	428,000	12%
Colorado	268,000	8%
Gunnison	272,000	8%
North Platte	117,000	3%
Republican	550,000	16%
Rio Grande	622,000	18%
South Platte	831,000	24%
Southwest	259,000	7%
Yampa-White	119,000	3%
Statewide Total	**3,466,000**	**100%**

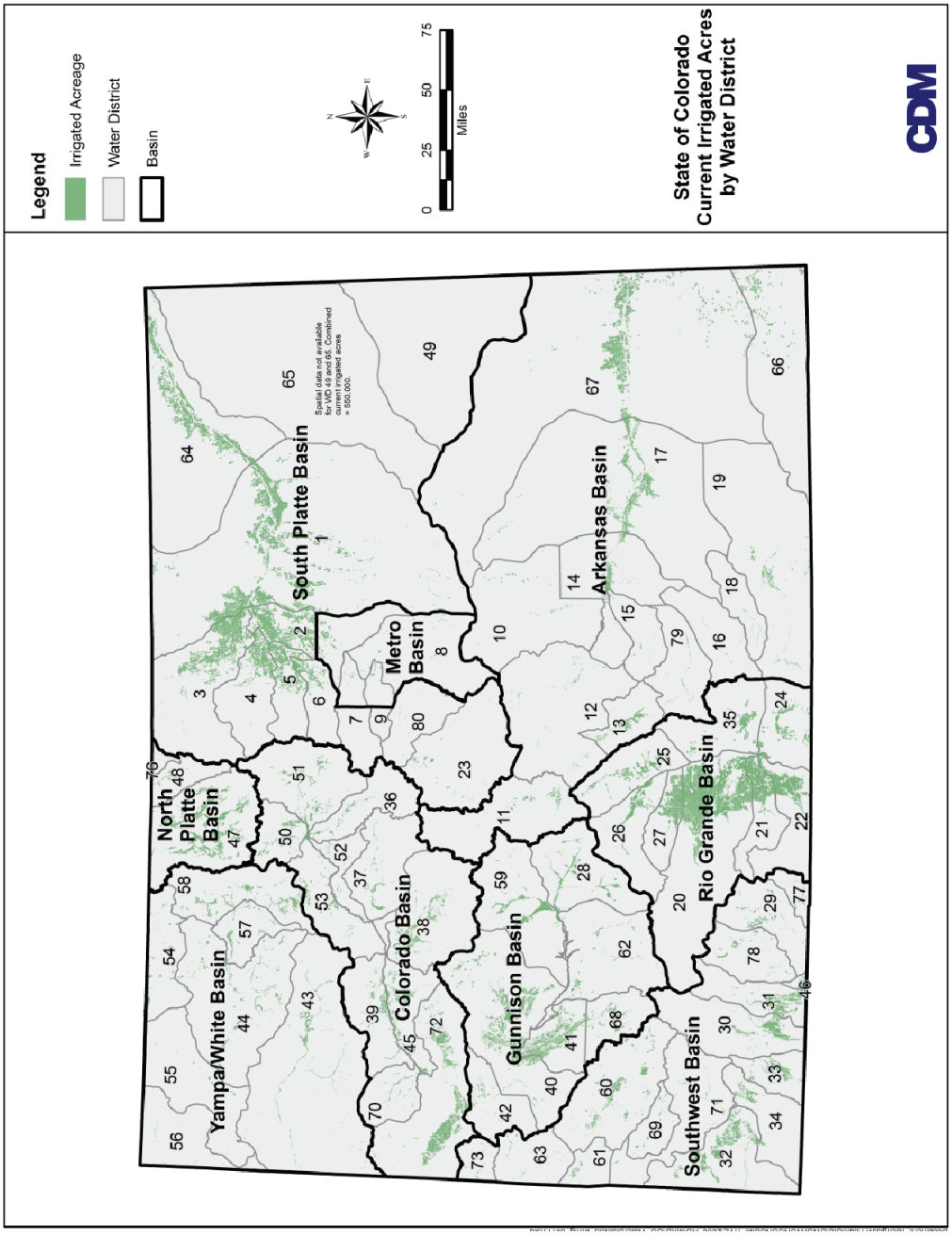


Figure 4-8 State of Colorado Current Irrigated Acres by Water District

4.3.2.2 Future Irrigated Acres Results

Table 4-11 shows the results of future irrigated acres analysis. Future irrigated acres in Colorado may decrease by 115,000 to 155,000 acres due to urbanization alone, under low and high population growth scenarios, respectively. The basins with largest expected loss of irrigated acres due to urbanization are the South Platte, Colorado, and Gunnison Basins.

Table 4-11 also shows the potential loss of irrigated acres due to other reasons. The South Platte, Republican, and Rio Grande Basins are expected to lose irrigated acres due to a variety of factors, as follows:

- For the South Platte Basin, up to 14,000 irrigated acres have been taken out of production in the last 5 years because a shortage of augmentation water led to numerous wells being shut down in the central South Platte Basin in 2006. This reduction of irrigated acres is expected to be more or less permanent since the cost of acquiring augmentation water in the central South Platte River Basin is prohibitive for the agricultural community. This reduction in acreage is not reflected in the current irrigated acreage.
- In the Republican River Basin, a total of about 35,000 acres were removed from irrigation through conservation programs by 2009. An additional 64,000 acres are estimated to be removed from irrigation due to the declining saturated thickness of the Ogallala aquifer, and another 10,000 acres are to be dried up in District 65 in association with the construction of a pipeline for compact compliance reasons.
- In the Rio Grande Basin, the estimated decline in irrigated acres (80,000 acres) is related to the protection of the water table and senior water rights in the San Luis Valley through the establishment of Groundwater Management Subdistricts. This action would also assist Colorado in complying with the Rio Grande Compact by providing augmentation water to the Rio Grande and Conejos River to offset well depletions.

Finally, Table 4-11 identifies approximately 26,000 acres that will be dried-up in the Arkansas, Colorado, and South Platte River Basins as a result of planned agricultural to municipal transfers. Additional transfers that may be required to meet M&I gaps are expected to decrease irrigated acreage from 160,000 acres to 334,000 acres statewide.

Overall, the future irrigation analysis shows that Colorado may lose about 500,000 to 700,000 acres of its irrigated lands by 2050 due to all factors combined. These acreages represent 15 to 20 percent of the current total irrigated lands. Figure 4-9 shows the range of potential changes by basin. Figure 4-10 shows the comparison between current irrigated acres and 2050 irrigated acres as both numbers of acres and percent change. Note that the basin with the highest percent change (Yampa-White, 34,000 acres, 29 percent) is not the same as the basin with the highest change in total acres (South Platte, 224,000 acres, 27 percent).

4.3.2.3 Current Agricultural Demand Results

Table 4-12 summarizes results of the average annual current agricultural demand by basin. It shows irrigated acres, IWR, WSL CU, and shortage (difference between IWR and WSL CU). Non-irrigation demand is also shown by basin. Figures 4-11 and 4-12 show the current WSL CU and shortage amounts by basin. Basins with the highest agricultural water demand include the South Platte, Rio Grande, and Republican.

Table4-11 Future Irrigated Acres by River Basin

Basin	Current Irrigated Acres	Decrease in Irrigated Acres Due to Urbanization		Decreases in Irrigated Acres Due to Other Reasons	Decreases in Irrigated Acres from Planned Agricultural to Municipal Transfers	Decreases in Irrigated Acres from Agricultural to Municipal Transfers to Address M&I Gap		Estimated 2050 Irrigated Acres	
		Low	High			Low	High	Low	High
Arkansas	428,000	2,000	3,000	—	7,000	26,000	63,000	355,000	393,000
Colorado	268,000	40,000	58,000	—	200	11,000	19,000	190,800	216,800
Gunnison	272,000	20,000	26,000	—	—	1,000	2,000	244,000	251,000
North Platte	117,000	—	—	—	—	—	—	117,000	117,000
Republican	550,000	300	600	109,000	—	—	—	440,400	440,700
Rio Grande	622,000	800	1,000	80,000	—	2,000	3,000	538,000	539,200
South Platte	831,000	47,000	58,000	14,000	19,000	100,000	176,000	564,000	651,000
Southwest	259,000	4,000	6,000	—	—	3,000	7,000	246,000	252,000
Yampa-White	119,000	1,000	2,000	—	—	3,000	64,000	53,000	115,000
Statewide Total	**3,466,000**	**115,100**	**154,600**	**203,000**	**26,200**	**146,000**	**334,000**	**2,748,200**	**2,975,700**

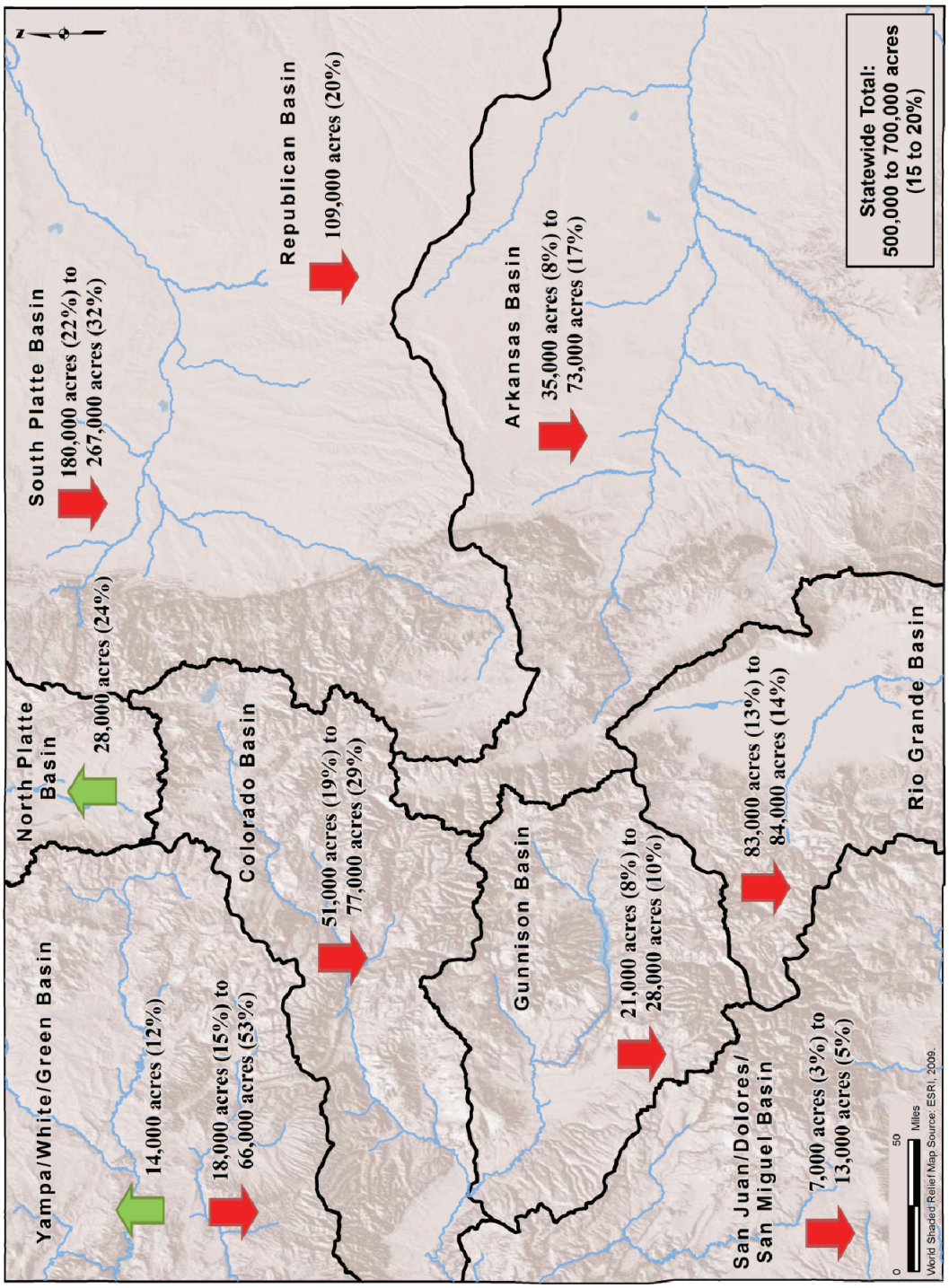


Figure 4-9 Potential Changes in Irrigated Acres by 2050

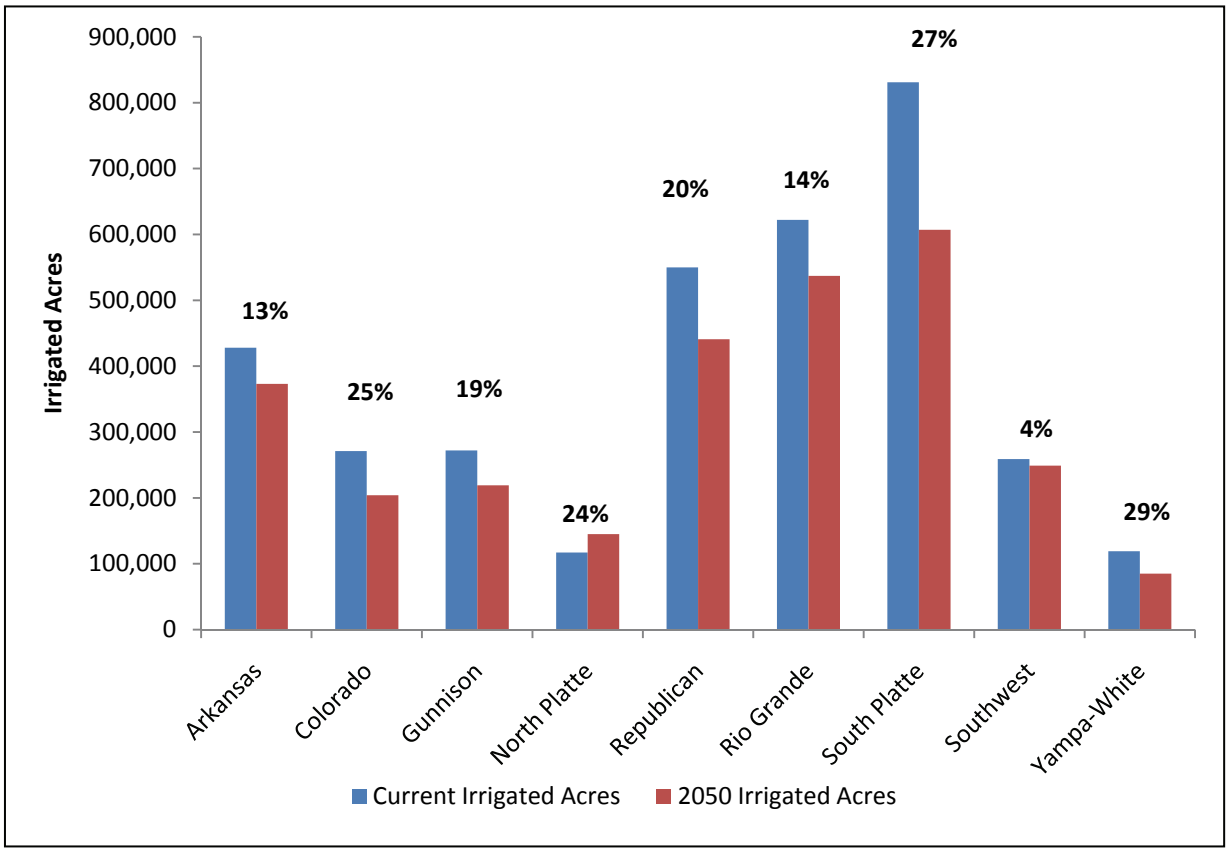


Figure 4-10 Comparison of Current and 2050 Irrigated Acres

Table 4-12 Estimated Current Agricultural Demand by Basin

Basin	Irrigated Acres	Irrigation Water Requirement (AFY)	Water Supply-Limited Consumptive Use (AFY)	Shortage (AFY)	Non-Irrigation Demand (AFY)
Arkansas	428,000	995,000	542,000	453,000	56,000
Colorado	268,000	584,000	485,000	100,000	51,000
Gunnison	272,000	633,000	505,000	128,000	54,000
North Platte	117,000	202,000	113,000	89,000	12,000
Republican	550,000	802,000	602,000	200,000	67,000
Rio Grande	622,000	1,283,000	855,000	428,000	45,000
South Platte	831,000	1,496,000	1,117,000	379,000	115,000
Southwest	259,000	580,000	382,000	198,000	46,000
Yampa-White	119,000	235,000	181,000	54,000	24,000
Statewide Total	**3,466,000**	**6,819,000**	**4,791,000**	**2,028,000**	**470,000**

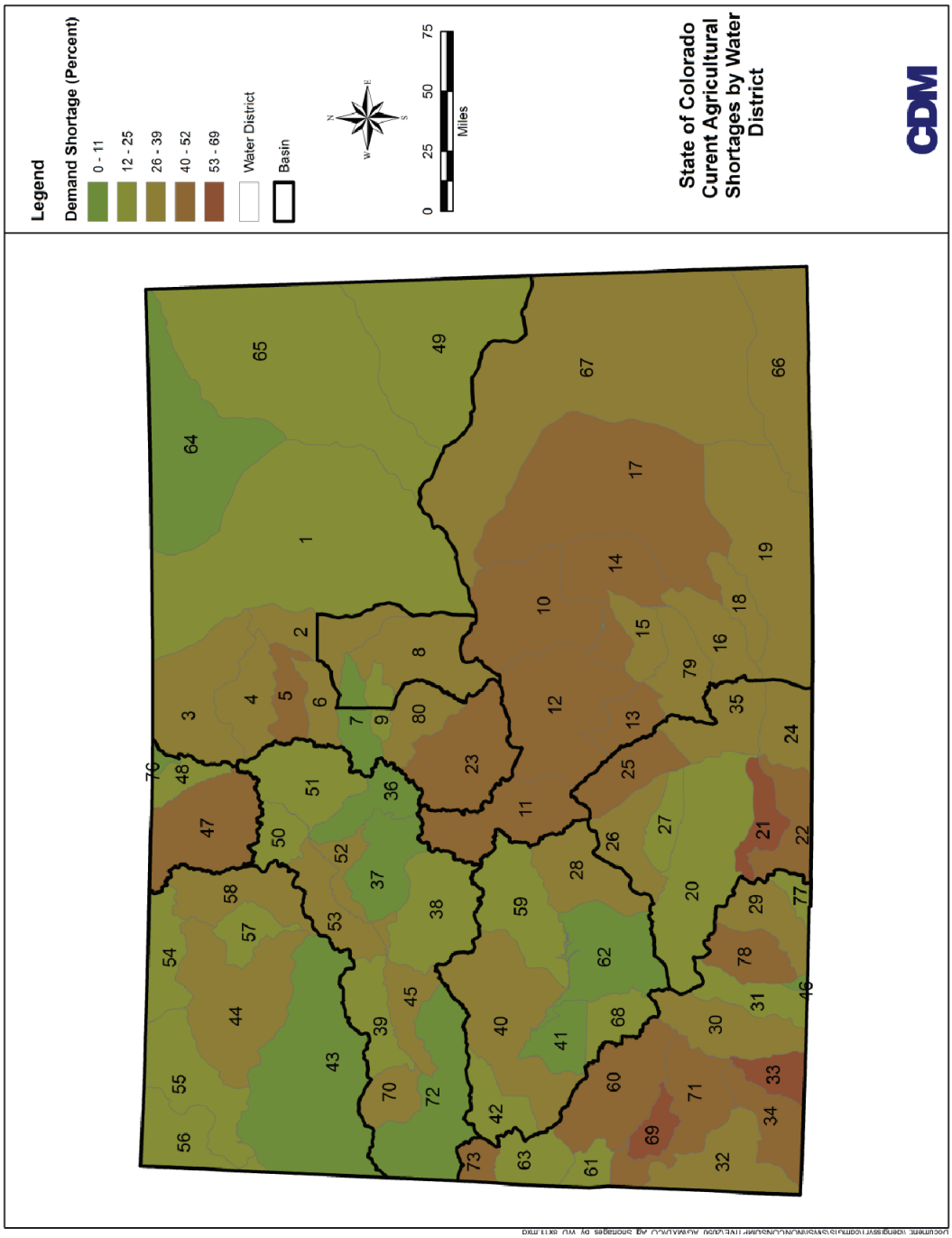


Figure 4-11 State of Colorado Current Agricultural Shortages by Water District

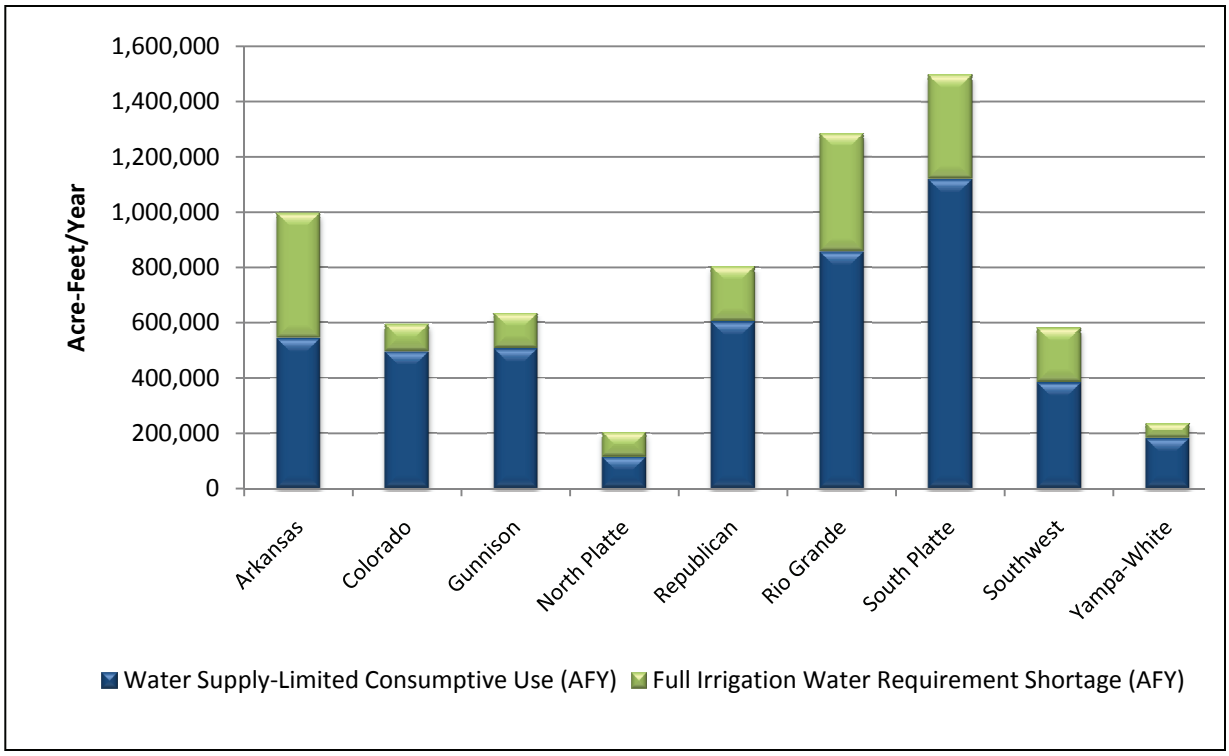


Figure 4-12 Current Agricultural Demands and Shortages

4.3.2.4 Future Agricultural Demand Results

Table 4-13 summarizes the estimated average annual agricultural demand by basin for the year 2050, assuming that historical climate and hydrology continue into the future. It shows irrigated acres, IWR, WSL CU, shortage, and non-irrigation demand. Figure 4-13 shows the WSL CU and shortages by basin for the 2050 irrigated acres. Consistent with the projected decline in irrigated acres, declines in both irrigation and non-irrigation agricultural water demands are anticipated to occur in all basins except for the North Platte.

Table 4-13 Estimated 2050 Agricultural Demand by Basin

Basin	Irrigated Acres	Irrigation Water Requirement (AFY)	Water Supply-Limited Consumptive Use (AFY)	Shortage (AFY)	Non-Irrigation Demand (AFY)
Arkansas	373,000	862,000	476,000	386,000	49,000
Colorado	204,000	443,000	366,000	77,000	38,000
Gunnison	219,000	573,000	457,000	116,000	48,000
North Platte	145,000	250,000	140,000	110,000	14,000
Republican	441,000	640,000	480,000	160,000	5,000
Rio Grande	537,000	1,108,000	739,000	369,000	38,000
South Platte	607,000	1,094,000	820,000	274,000	84,000
Southwest	249,000	558,000	367,000	191,000	44,000
Yampa-White	85,000	209,000	170,000	39,000	17,000
Statewide Total	**2,860,000**	**5,737,000**	**4,015,000**	**1,722,000**	**337,000**

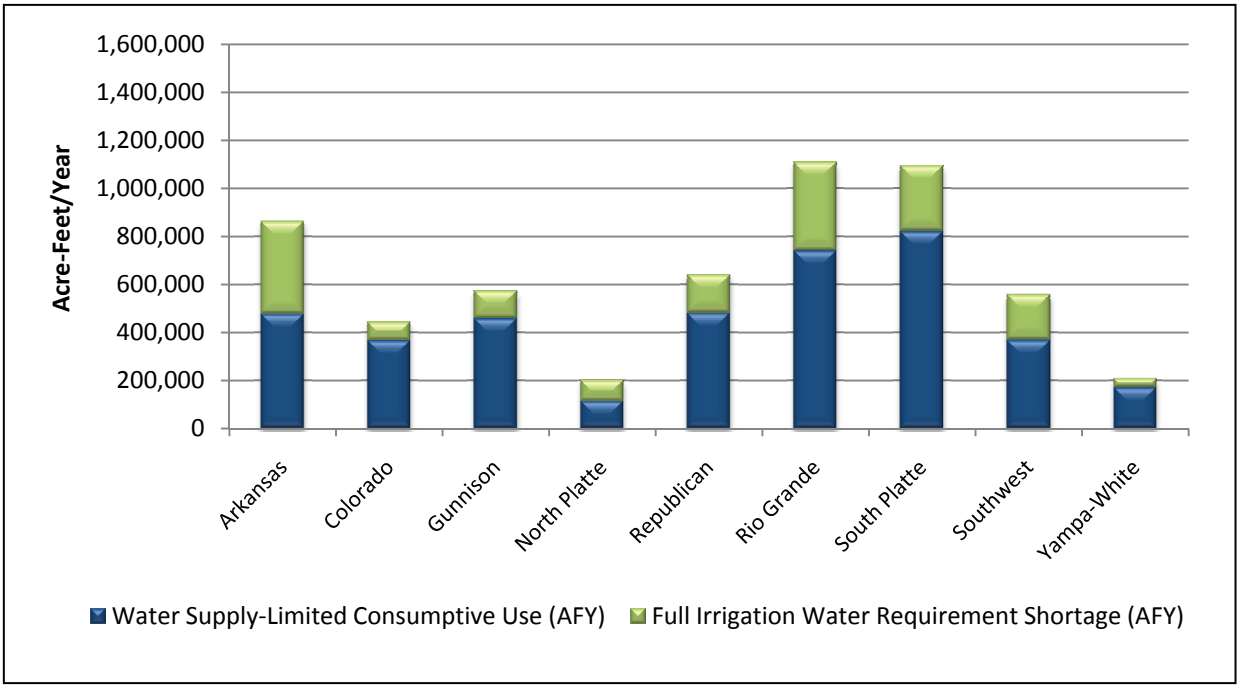


Figure 4-13 2050 Agricultural Demands and Shortages

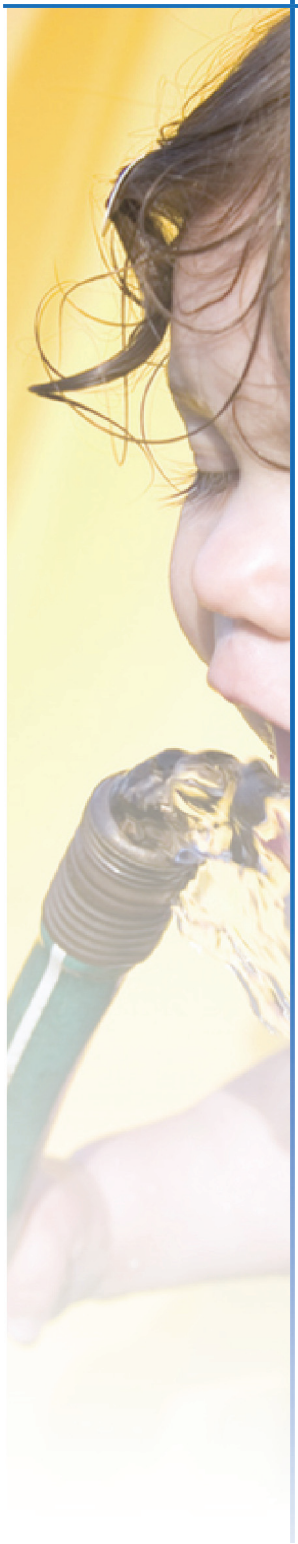
4.3.3 Agricultural Consumptive Needs Conclusions

The following are the major conclusions from the agricultural consumptive needs analysis:

- Each basin faces continued shortages associated with existing agricultural demands.
- There are upward economic pressures to keep agriculture viable in Colorado, and some basins, such as the Yampa, are seeking to expand agriculture.
- Despite upward economic pressures, Colorado could face a significant decline in irrigated acres by 2050 due to urbanization and water transfers. Between 500,000 and 700,000 irrigated acres in Colorado could be dried up by 2050, and large-scale dry-up of irrigated agriculture has adverse economic and environmental impacts.
- In 2050, Colorado's agricultural demands are projected to be approximately 4 million acre-feet.

Section 5

Consumptive Projects and Methods and the M&I Gap



5.1 Projects and Methods to Address the M&I Gap Overview

Section 4 of this report summarizes the consumptive water needs across the state of Colorado. As discussed in Section 1, the Colorado Water for the 21st Century Act requires the basin roundtables to identify projects and methods to meet their consumptive needs.

Section 5.2 summarizes the major projects and methods identified to meet future municipal and industrial (M&I) consumptive needs; Section 5.3 documents the resulting assessment of M&I gaps. The consumptive projects and methods will be summarized in further detail in the basin needs assessment reports during 2011.

In order to identify M&I projects and methods, the Colorado Water Conservation Board (CWCB) worked with water providers and the basin roundtables to update the Statewide Water Supply Initiative (SWSI) 1 identified projects and processes (IPPs). This information was used to estimate a low, medium, and high 2050 M&I gap corresponding to the M&I demand projections summarized in Section 4 and different IPP success rates. To be clear, an M&I "gap" in the context of this study is not indicative of a future water supply shortfall; rather, it is a future water supply need for which a project or method to meet that need is not presently identified.

It is important for the reader to recognize that the analyses documented in this section are intended for the purpose of "big picture" statewide planning. While data and other information were collected from individual water providers, the results presented herein are for the purpose of general statewide and basinwide planning and are not intended to be used for individual provider planning, site-specific analysis, or project-specific purposes.

5.2 Projects and Methods to Meet M&I Consumptive Needs

Water providers throughout Colorado are pursuing water supply projects and planning processes to help meet future water demands. These IPPs, if successfully implemented, have the ability to meet some, but not all of Colorado's 2050 M&I water needs. IPPs are defined as projects and methods local water providers are counting on to meet future water supply needs. Future M&I water supply needs that are not met by an IPP are considered an M&I water supply gap. The estimation of future M&I water supply gaps is dependent upon several factors, including current water use, forecasted future water use, and water provider predictions of new water supply that will be developed through IPPs.

Index

5.1 Projects and Methods to Address the M&I Gap Overview ..... p. 5-1
5.2 Projects and Methods to Meet M&I Consumptive Needs ..... p. 5-1
5.3 M&I Gap Analysis ..... p. 5-21

Statewide, these analyses were performed on a countywide basis and aggregated by basin roundtable area. For the Front Range counties in the Arkansas, Metro, and South Platte Basins, the county results were aggregated to a regional subbasin level for presentation in this report and consistency with SWSI 1. The majority of population growth over the next 40 years is expected to occur in these basins.

5.2.1 Identified Projects and Processes Methodology

The first part of the M&I gap analysis is to calculate 2050 total new M&I water needs, which is described in Section 4. The second part of the 2050 M&I and SSI gap analysis is to calculate the anticipated yield from the water providers' 2050 IPPs, assuming 100 percent success rate. For counties with more than one surveyed water provider, all relevant information was compiled to create the most complete picture of projected water supplies in the county. This IPP yield is then subtracted from the 2050 net new water needs (i.e., demand increases above existing supplies) at the county level. Where the total water provider IPP yield in a county exceeded the projected county demand for the low, medium, or high scenarios, the extra water was assumed to not be available for redistribution to other counties unless otherwise noted.

Information on water providers' IPPs was obtained from the following sources:

- CWCB interviews and data collected from water providers throughout the state in 2009–2010
- Section 6 of the SWSI 1 report (published 2004, data based on projections to 2030)
- Basin roundtable updates (e.g., Arkansas 2008 report, June 2010 presentation by Applegate)

CWCB staff conducted outreach interviews in 2010 with most municipal water providers delivering 2,000 acre-feet per year (AFY) or more, including the top three water providers in each basin, where possible. Not every water provider responded; however, with significant basin roundtable assistance, many water providers submitted data in addition to the original list. This outreach was used to determine what projects and methods water providers are pursuing to meet their future needs along with confirmation of water demand data. In an effort to obtain more detailed data on providers' IPPs than was available for SWSI 1, interviewed entities were asked to delineate IPPs into the following categories:

- Agricultural water transfers
- Reuse of existing fully consumable supplies
- Growth into existing supplies
- Regional in-basin projects
- New transbasin projects
- Firming in-basin water rights
- Firming transbasin water rights

Passive and active conservation measures are not included in the categorized IPPs. Passive conservation is already factored into the 2050 M&I demand forecasts presented in Section 4. As requested by the Conservation Technical Advisory Committee and for the purposes of this analysis, active conservation is considered a strategy for meeting the M&I gap and is described in Section 7.

The categorized IPP data presented in this section is based on information provided by the interviewed water providers on what their firm treated water deliveries will be for each category of IPP. While some IPPs include features that could be applied across more than one category, CWCB relied upon the water providers' data to assign the various projects and methods to the single most appropriate category. For example, although not explicitly quantified herein, it is likely that the true yield anticipated from agricultural water transfers is higher, but many water providers have captured agricultural transfers in IPPs falling in other categories such as regional in-basin projects or firming in-basin water rights. Some entities may also own agricultural water rights that are presently being leased back to agricultural water users; future M&I use of these supplies may be considered by some water providers to be growth into

existing supplies. Based on these efforts IPP data were updated for 75 providers covering approximately 80 percent of the population in Colorado. Many of the quantified IPPs specified by the interviewed M&I water providers are identified in Appendix J (*Technical Memorandum – 2050 Municipal and Industrial Gap Analysis*). The consumptive projects and methods will be summarized in further detail in the Basin Needs Assessment reports during 2011.

The interview summary provided by CWCB identified and quantified many of the water providers' IPPs associated with each category. Where IPP information was derived from other sources, professional judgment was used to assign predicted yield to the most appropriate category. This approach was primarily applied to IPP data from the SWSI 1 report, which tallied IPPs by county or subbasin, but generally did not categorize yields from specified types of IPPs.

Because of the need for flexibility, reliability, and future uncertainty, many water providers design projects to meet needs based on planning numbers, which are often greater than current per capita water usage rates. Some specific reasons include—1) ensuring water supply if another system fails, 2) planning for drought or climate change, 3) an expected increase in commercial water use, or 4) concerns that one or more planned project will not be successfully implemented. Furthermore, many water rights limit the use of water to the specific water right holder, causing legal barriers to sharing water supplies. For these reasons, where the total potential volume of IPPs exceeded either the 2050 total water needs or the 2050 total water needs minus any provider-specified gaps, a pro-rata share reduction was applied to each IPP category relevant to that county or subbasin. For example, total quantified IPPs for the interviewed providers in a particular county exceed 50,000 AFY, but IPPs required to meet 2050 net new water needs range from 18,000 AFY to 30,000 AFY. A percentage of the total 50,000 AFY yield from IPPs is associated with each of the seven categories of IPPs, but since less IPP yield is actually needed to meet demands, the same category distribution percentages were applied to the lesser need. In other words, the amount of yield from each IPP category is reduced such that only the amount actually necessary to meet 2050 new water needs is applied.

Note, however, that this methodology and data presentation does not in any way preclude water providers from developing IPPs in excess of their 2050 needs. Rather, it is beyond the scope of this gap analysis to present data for individual water providers whose demand projections, planning horizon, and system reliability may differ from the regional analysis presented here. Any excess IPP volume quantified for a particular county is assumed to not be available to meet water supply gaps in other counties, unless specified otherwise. Likewise, there was no intention of implying intra-county sharing among water providers, unless specifically noted. By proportionally scaling back each entity's 2050 IPP yields when the sum of all entities' IPPs in a particular county exceed the forecasted 2050 net new water needs for that county—and explicitly accounting for provider-specified gaps—it is CWCB's intention to avoid implying that any one provider's excess yield would be used to meet the shortfall (i.e., gap) of another water provider.

5.2.2 Estimation of 2050 IPP Yield by Basin

A broad range of water management solutions with varying levels of supply are planned for each of the basins. The following sections summarize the yields of IPPs statewide and for each county or region in each basin at the 100 percent success rate. As described above, due to the number of counties and distinct areas in the Arkansas, Metro, and South Platte Basins, those basins are summarized by region, whereas each of the other basins is discussed at a county level. Because of the overall volume of demand and the size of the projected gaps in the South Platte and Arkansas Basins, those basins' IPPs lists are more populated than the other basins' lists.

Many water providers are pursuing multiple projects and will need to pursue all of these identified projects to meet their increased demand by the year 2050. This is due to the reality that each of the IPPs has associated risk and may not yield all of the anticipated water supply. Alternate IPP yield success rates (i.e., less than 100 percent) are addressed subsequently in Section 5.3.2. The results of calculations based on the alternate IPP success rates are incorporated into the gap analysis presented in Section 5.3.3. Additionally, many of these IPPs will benefit multiple beneficiaries and therefore address a number of objectives concurrently. However, challenges exist in determining funding sources and acquiring water rights to support the multiple uses. In addition to quantified IPP yields, the tables for each basin also include a general summary of the major projects and other IPPs in each county or region. The consumptive projects and methods will be summarized in further detail in the Basin Needs Assessment reports during 2011.

5.2.2.1 Statewide

Statewide, the new water supplies needed for M&I and self-supplied industrial (SSI) use by the year 2050—above and beyond all existing supplies—are estimated to range from about 600,000 AFY to nearly 1 million AFY (see Section 4). This range reflects the uncertainty associated with forecasting water demands 40 years into the future, in particular SSI demands associated with energy development and other market-driven commodities. Based on extensive interviews with water providers, input from basin roundtable and Interbasin Compact Committee (IBCC) members, and a thorough review of other pertinent information, IPPs have been identified that will meet a significant portion of these future new demands.

Applying the general methodology for assessing IPPs described in Section 5.2.1, the IPPs were grouped into seven primary categories. Table 5-1 identifies the anticipated range of yield from each category for each basin. For this and many of the subsequent tables, values are presented as a range, with the low and high yield values shown. Where the yield values do not change from low to high, a single value is shown rather than a range. Although the interviewed water providers generally provided demand and IPP data for a 2050 medium growth scenario, the ranges presented herein derive from the use of low, medium, and high population and demand levels for 2050 for the various analyses associated with SWSI 2010.

As shown in Table 5-1, quantified IPPs at 100 percent yield success would provide approximately 430,000 AFY, or about 72 percent of the new demands under the low growth scenario. At the high end, again assuming 100 percent success rate, IPPs would total about 580,000 AFY and represent approximately 58 percent of the high demand increase. The largest categories of IPP yields by volume are projected to be regional in-basin projects (150,000 AFY to 170,000 AFY) and growth into existing supplies (100,000 AFY to 160,000 AFY). Figure 5-1 depicts the data graphically; for the individual basins that follow, the corresponding figures can be found in Appendix J.

Table 5-1 Major Categories of Identified Projects and Processes by Basin (Yields at 100% Success Rate) [1]

Basin	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Arkansas	9,200 – 11,000	23,000 – 32,000	2,300 – 2,600	37,000	0	6,100 – 7,300	10,000 – 11,000	88,000 – 100,000
Colorado	2,900 – 8,000	500	14,000 – 28,000	13,000 – 15,000	0	11,000 – 19,000	0	42,000 – 70,000
Gunnison	400 – 500	0	1,100 – 1,700	11,000 – 15,000	0	900	0	14,000 – 18,000

Table 5-1 Major Categories of Identified Projects and Processes by Basin (Yields at 100% Success Rate), continued

Basin	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Metro	20,000 – 33,000	14,000 – 21,000	55,000 – 86,000	34,000 – 39,000	13,000 – 23,000	900 – 1,400	3,500 – 4,800	140,000 – 210,000
North Platte	0	0	100 – 300	0	0	0	0	100 – 300
Rio Grande	0	0	2,900 – 4,300	0	0	3,000 – 4,300	0	5,900 – 8,600
South Platte	19,000 – 20,000	5,000 – 7,000	20,000 – 30,000	37,000 – 39,000	0	22,000 – 26,000	18,000 – 21,000	120,000 – 140,000
Southwest	0	0	5,200 – 7,300	9,000 – 13,000	0	0	0	14,000 – 21,000
Yampa-White	0	0	3,500 – 4,900	6,600 – 9,000	0	0	0	10,000 – 14,000
Total	**51,000 – 73,000**	**43,000 – 61,000**	**100,000 – 160,000**	**150,000 – 170,000**	**13,000 – 23,000**	**44,000 – 58,000**	**32,000 – 37,000**	**430,000 – 580,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

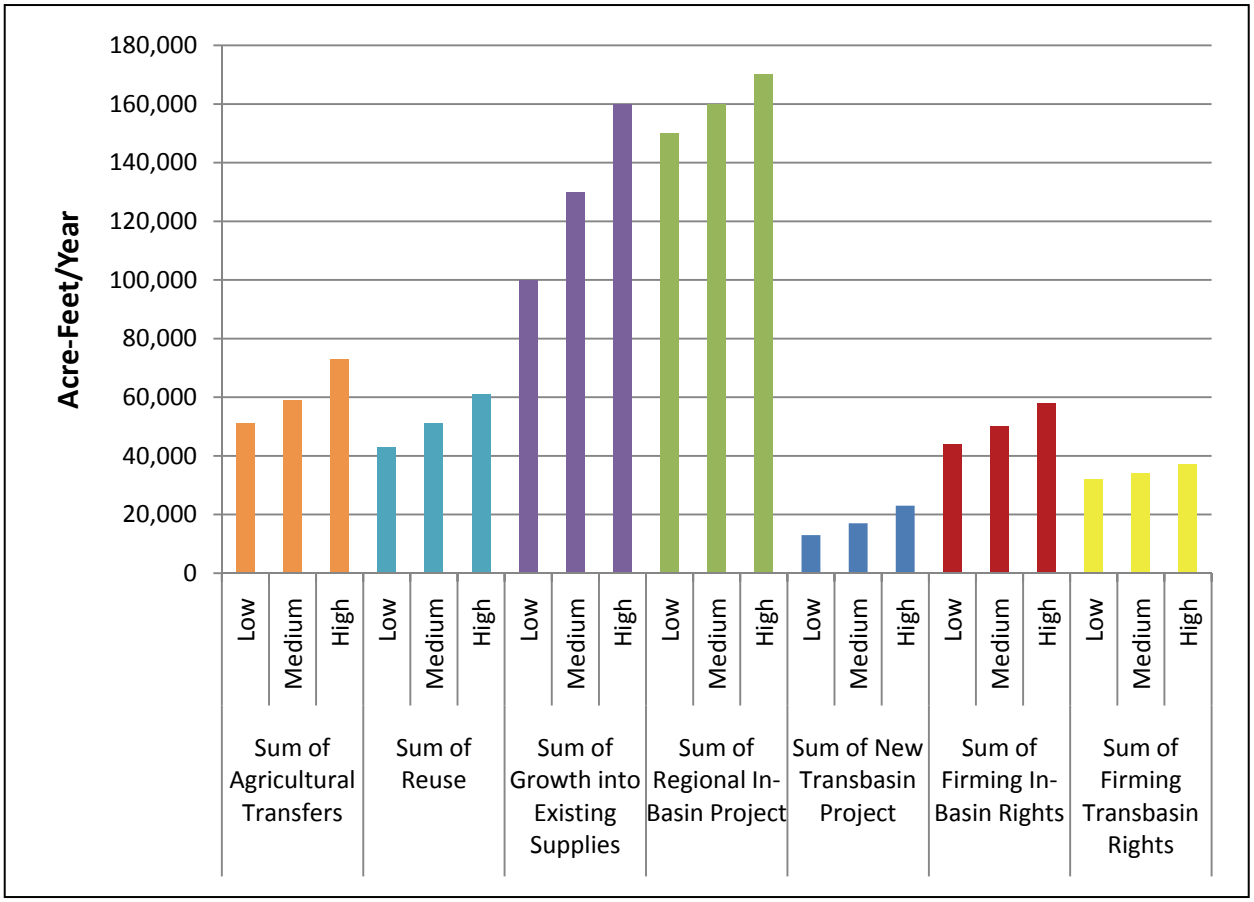


Figure 5-1 Statewide Summary of Yield for IPP Categories at 100% Success Rate

5.2.2.2 Arkansas Basin

For consistency with SWSI 1, the IPP and gap analysis updates for the Arkansas Basin were performed by aggregating county results to a regional subbasin level. The Arkansas Basin regions described below were defined in SWSI 1 and are illustrated in Figure 5-2.

- Upper Arkansas (Chaffee, Custer, Fremont, Lake, Teller)
- Urban Counties (El Paso, Pueblo)
- Lower Arkansas (Bent, Crowley, Otero, Prowers)
- Eastern Plains (Baca, Cheyenne, Elbert, Kiowa, Lincoln)
- Southwestern Arkansas (Huerfano, Las Animas)

In the Arkansas Basin, most of the major M&I water providers reported that they will be able to meet all or part of 2050 needs through existing supplies, projects underway, and planned projects.

Note that several counties (Cheyenne, Elbert, Lincoln, and Teller) are split between two basins, with a pro-rata share of current and future demands accounted for in each basin. This approach is consistent with the South Platte and Metro Basin needs assessment work.

In the Arkansas Basin, most of the major M&I water providers reported that they will be able to meet all or part of 2050 needs through existing supplies, projects underway, and planned projects. Reuse is being pursued by most providers that have reusable supplies. In most cases in Colorado, reuse is limited to nonnative water such as transbasin diversions, nontributary groundwater, and the unused first use portion of the consumptive use (CU) portion of transfers of agricultural rights. Most of the entities that are planning reuse projects in the Arkansas Basin anticipate using one or more of the following components:

- Augmentation plans
- Exchanges
- Nonpotable use for irrigation of parks and golf courses
- Groundwater recharge
- Gravel lake storage to regulate consumable return flows for exchange or nonpotable reuse

Colorado Springs Utilities (CSU) and the Pueblo Board of Water Works (PBWW) both indicated in recent interviews with CWCB that they have adequate existing water rights or are pursuing new projects to meet 2050 demands and beyond. Their "surplus" supplies in excess of 2050 demands are not available for permanent use by others, since these supplies will eventually be needed by CSU and PBWW. Given the lack of developable new supplies in the Arkansas Basin, agricultural transfers throughout the basin will continue via purchases, developer donations, and development of irrigated lands.

Providers in the Southeastern Colorado Water Conservation District, including entities in the Upper Arkansas, Urban Counties, and Lower Arkansas regions, are relying heavily on future Fryingpan-Arkansas (Fry-Ark) Project allocations. The Eastern Plains region will rely on nontributary groundwater and the Southwestern Arkansas region will rely on augmentation, existing water rights, and agricultural transfers.

Many providers are planning on maximizing the use of their existing transbasin and other fully consumable supplies. Even though there is very little potential for additional new water development in the Arkansas Basin, storage is needed throughout the basin to regulate existing and future supplies, firm the yield of agricultural transfers, provide for augmentation releases, and to capture return flows.

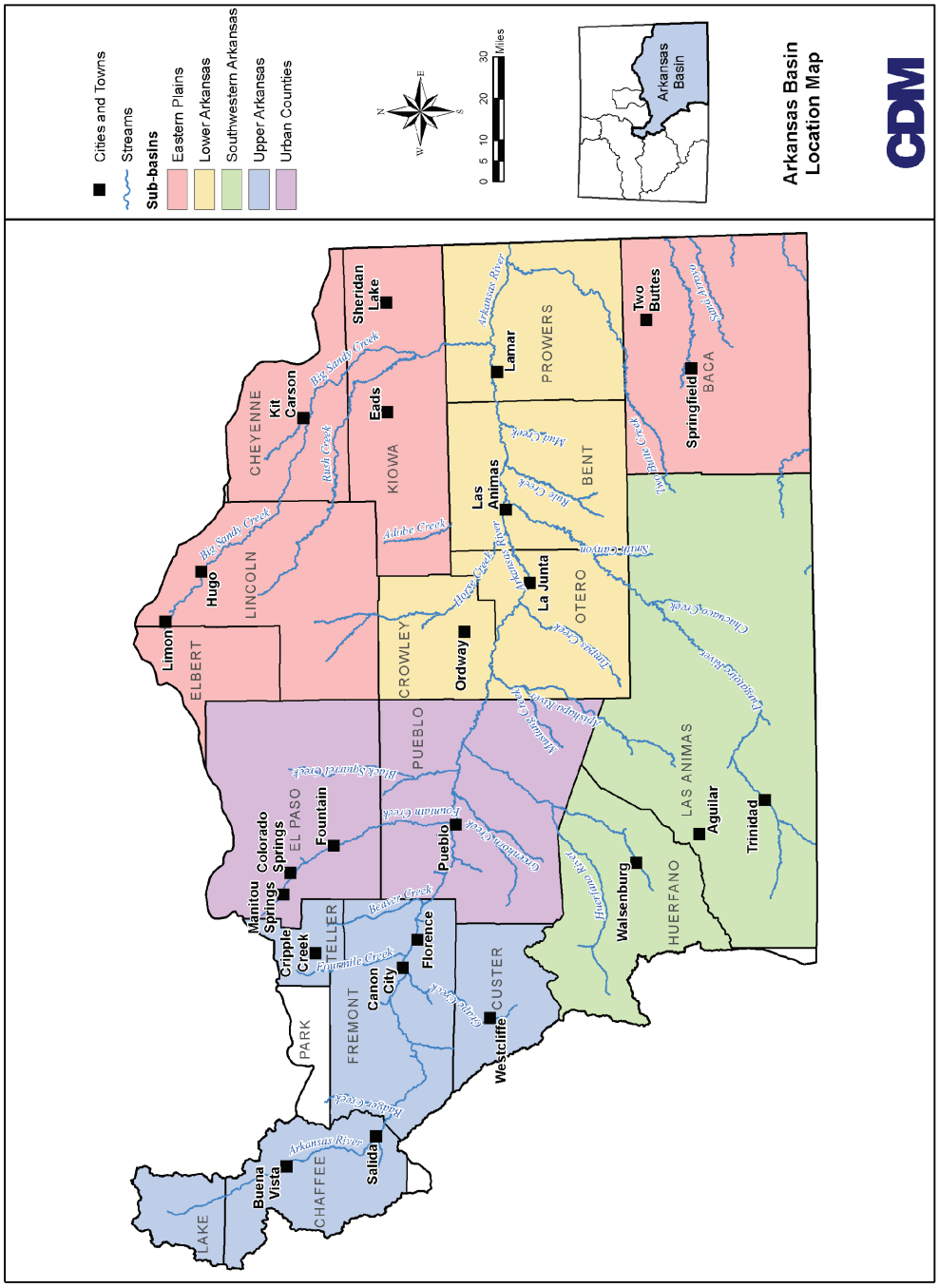


Figure 5-2 Arkansas Basin Location Map

Funding for the Arkansas Valley Conduit (AVC), which would improve drinking water quality and reduce transit losses for the Lower Arkansas Basin communities, has been authorized by the federal government. Pre-National Environmental Policy Act (NEPA) studies for the project, funded through a State and Tribal Assistance Grant, were completed in 2010. The towns along the mainstem of the Arkansas River downstream of the City of Pueblo divert from alluvial wells, nontributary deep wells, or from tributary surface water supplies. In addition to local water rights, these towns also have access to Fry-Ark Project allocations and return flows from the use of project water. Stream transit losses are assessed from Pueblo Reservoir to the downstream location and water quality is impacted by minerals and salts in the river channel and return flows as the water flows down the Arkansas River.

Fountain and Security are both participating in the Southern Delivery System (SDS) with CSU to help meet their future demands. The SDS is a regional project to deliver water from the Arkansas River that is stored in Pueblo Reservoir. Major components of the project include—1) a connection to the North Outlet Works of Pueblo Dam; 2) 62 miles of underground raw and treated water pipeline; 3) three pump stations; and 4) a 50-million-gallons-per-day treatment plant. A final environmental impact statement (EIS) for the project has been published by the Bureau of Reclamation (BOR), and a Record of Decision was issued in March 2009. Major construction activity is scheduled to begin in 2011.

The Upper Arkansas Water Conservancy District (UAWCD), which provides augmentation for wells in a portion of the upper basin, will be challenged to develop the CU water rights and storage required to meet the augmentation requirements for these wells. The upper basin, like many headwater areas throughout the state, is projected to experience high growth rates. Augmentation to existing or proposed environmental and recreation water rights, such as CWCB instream flow rights and recreational in-channel diversions (RICDs) and senior agricultural and M&I rights, will likely require the construction of storage in upper areas of tributaries. Economies of scale are generally not present in small reservoir construction and the engineering, permitting, and construction costs will tax the ability to provide for augmentation water at a reasonable cost. The acquisition of agricultural rights will likely be part of the augmentation supplies for the UAWCD due to limits on the availability of Fry-Ark allocations.

Anticipated yields from each category of IPPs at 100 percent success rate are summarized for the Arkansas Basin in Table 5-2.

Table 5-2 Arkansas Basin IPP Summary at 100% Success Rate

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Eastern Plains	0	0	1,600 – 1,900	0	0	0	100	1,700 – 2,000
Eastern Plains IPPs • Nontributary groundwater • AVC								
Lower Arkansas	0	0	0	0	0	800 – 2,000	0	800 – 2,000
Lower Arkansas IPPs • AVC								
Southwestern Arkansas	600	0	700	0	0	600	0	1,900
Southwestern Arkansas IPPs • Existing water rights • Augmentation plans • Agricultural transfers								

Table 5-2 Arkansas Basin IPP Summary at 100% Success Rate, continued

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Upper Arkansas	3,600	0	0	0	0	4,700	3,600	11,900
Upper Arkansas IPPs • UAWCD Augmentation plan • Other augmentation plans			• Agricultural transfers • Use of Fry-Ark M&I allocation directly or for augmentation					
Urban Counties	5,000 – 7,200	23,000 – 32,000	0	37,000	0	0	6,500 – 6,900	71,500 – 83,100
Urban Counties IPPs • Agricultural transfers • Reuse plans • Groundwater • SDS			• Eagle River Joint Use Project • Blue River Conditional Storage Development • AVC					
Total[1]	**9,200 – 11,000**	**23,000 – 32,000**	**2,300 – 2,600**	**37,000**	**0**	**6,100 – 7,300**	**10,000 – 11,000**	**88,000 – 100,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.2.2.3 Colorado Basin

M&I and SSI needs are expected to increase dramatically in the Colorado Basin by 2050. It is expected that augmentation contracts available out of Ruedi and Wolford Reservoirs will be a key part of meeting 2050 demands in the basin. In addition, agricultural transfers will continue from purchases, developer donations, and development of irrigated lands. Existing supplies will be used in all Colorado Basin counties, and agricultural transfers will be part of the future supplies used to meet increased demands in Eagle, Garfield, and Mesa Counties.

Summit and Grand Counties anticipate significant M&I gaps as a result of limited flows available for development in the Fraser River system and future increases in transbasin diversions associated with projects planned by Front Range water providers. These planned projects have water rights that are senior to many of the in-basin M&I rights and are currently undergoing NEPA review. The Upper Colorado River Study (UPCO 2003) outlined potential solutions, but these solutions have a high level of uncertainty and implementation challenges due to lack of physical availability of water and permitting issues for any structural alternatives. As a result, gaps are shown in Grand and Summit Counties.

Other key IPPs identified in the Colorado Basin include the Hunter Reservoir enlargement (Ute Water Conservancy District) in Mesa County and the West Aspen Reclaimed Water Project in Pitkin County. Additionally, the Eagle River Joint Use Project will provide up to 10,000 AFY of dry year firm yield for entities in Eagle County. Anticipated yields from each category of IPPs at 100 percent success rate are summarized for the Colorado Basin in Table 5-3.

Table 5-3 Colorado Basin IPP Summary at 100% Success Rate

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Eagle County	2,100 – 4,500	0	5,600 – 10,700	400	0	2,000 – 4,600	0	10,100 – 20,200
Eagle County IPPs • Growth into existing supplies and planned water rights acquisitions • Eagle River Joint Use Project • Ruedi Reservoir contracts for augmentation • Agricultural transfers								
Garfield County	200	0	6,400	3,500	0	6,500	0	16,600
Garfield County IPPs • Growth into existing supplies • Ruedi and Wolford Reservoir contracts for augmentation • Agricultural transfers								
Grand County	0	0	300 – 800	2,400	0	0	0	2,700 – 3,200
Grand County IPPs • Growth into existing supplies • UPCO								
Mesa County	700 – 3,200	0	1,300 – 6,500	0	0	1,900 – 4,500	0	3,900 – 14,200
Mesa County IPPs • Growth into existing supplies • Ruedi and Wolford Reservoir contracts for augmentation • Hunter Reservoir enlargement • Agricultural transfers								
Pitkin County	0	500	700 – 3,300	0	0	700 – 3,200	0	1,900 – 7,000
Pitkin County IPPs • Growth into existing supplies • Ruedi Reservoir contracts for augmentation • West Aspen Reclaimed Water Project								
Summit County	0	0	0	6,900 – 9,200	0	0	0	6,900 – 9,200
Summit County IPP • UPCO								
Total[1]	**2,900 – 8,000**	**500**	**14,000 – 28,000**	**13,000 – 15,000**	**0**	**11,000 – 19,000**	**0**	**42,000 – 70,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.2.2.4 Gunnison Basin

In the Gunnison Basin, much of the M&I and SSI new water needs will be addressed through greater use of existing water rights and new regional in-basin projects. The Tri-County Water Conservancy District, which serves much of Montrose, Delta, and Ouray Counties, holds water rights in the Dallas Creek Project. Combined with water from the Project 7 Water Authority, these counties are anticipated to have adequate water supplies through 2050.

The Upper Gunnison River Water Conservancy District (UGRWCD) provides augmentation for wells in a portion of the upper basin. Similar to the upper Arkansas Basin described in Section 5.2.2.2, the upper Gunnison Basin is projected to experience high rates of population growth. The Crested Butte area may

experience significant growth if adequate water supplies for M&I and snowmaking can be developed. Augmentation of existing or proposed environmental and recreational water rights, such as CWCB instream flow rights and RICDs and senior agricultural and M&I water rights, will likely require the construction of storage in upper areas of Gunnison River tributaries.

Through interviews conducted by CWCB, three projects sponsored by the UGRWCD and others were identified:

- UGRWCD/Hinsdale County Commissioners – Lake San Cristobal enlargement
- UGRWCD/Mt. Crested Butte – Augmentation storage
- UGRWCD – Augmentation plan for nonagricultural purposes using Aspinall Unit

The projected yield from the Lake San Cristobal enlargement is 950 AFY, far exceeding all levels of 2050 demand for Hinsdale County. Surplus supplies from this IPP were assumed to be made available to meet the gap in Gunnison County. Regarding the last project listed above, the UGRWCD has a 500 AFY pool in Blue Mesa Reservoir that can be used to replace depletions to downstream calls. The challenge for the UGRWCD will be to develop storage to replace depletions to CWCB instream flows, the Gunnison Whitewater Park RICD, and senior agricultural and M&I water rights upstream of Blue Mesa Reservoir. Collectively, these UGRWCD projects meet all or a part of the future water needs in Gunnison and Hinsdale Counties.

Anticipated yields from each category of IPPs at 100 percent success rate are summarized for the Gunnison Basin in Table 5-4.

Table 5-4 Gunnison Basin IPP Summary at 100% Success Rate

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Delta County	0	0	0	3,700 – 4,900	0	0	0	3,700 – 4,900
Delta County IPP • Project 7								
Gunnison County	0	0	0	700	0	900	0	1,600
Gunnison County IPPs • Lake San Cristobal water development • Augmentation for nonagricultural purposes using Aspinall Unit • Augmentation storage for Mt. Crested Butte								
Hinsdale County	0	0	0	200 – 300	0	0	0	200 - 300
Hinsdale County IPP • Lake San Cristobal water development								
Mesa County	400 – 500	0	1,100 – 1,700	0	0	0	0	1,500 – 2,200
Mesa County IPPs • Existing water rights • Agricultural transfers								

Table 5-4 Gunnison Basin IPP Summary at 100% Success Rate, continued

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Montrose County	0	0	0	6,700 – 8,600	0	0	0	6,700 – 8,600
Montrose County IPP • Project 7								
Ouray County	0	0	0	20 – 500	0	0	0	20 – 500
Ouray County IPP • Project 7								
Total[1]	**400 – 500**	**0**	**1,100 – 1,700**	**11,000 – 15,000**	**0**	**900**	**0**	**14,000 – 18,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.2.2.5 Metro Basin

As was done for the Arkansas Basin, the counties of the Metro Basin were aggregated to a regional subbasin level as follows:

- Denver Metro (Adams, Broomfield, Denver, Jefferson)
- South Metro (Arapahoe, Douglas, Elbert)

These regions are illustrated in Figure 5-3.

In the Metro Basin, reuse is being pursued by almost all cities that own reusable supplies. The trend toward the use of gravel pit sites that are no longer mined for storage of reusable effluent will expand. The potential for future water rights exchanges of effluent will be considerably less in the Denver and South Metro areas as most of the exchange potential has already been tied up with existing exchange water rights applications. These exchanges, however, will continue to be made when and where feasible. Direct reuse of effluent is largely focused on nonpotable uses such as irrigation of parks and golf courses, though other nonpotable uses are becoming more prevalent (e.g., power plant cooling water supply). A few cases of indirect potable reuse—intentionally augmenting raw drinking water supplies with treated reclaimed domestic wastewater effluent—are being implemented or planned, and more are likely in the future as water treatment technology advances. Specific IPPs associated with reuse include Aurora's Prairie Waters Project; Thornton, Northglenn, and Brighton recapture and exchange plans; the East Cherry Creek Valley (ECCV) Northern Pipeline Project; and planned reuse by the Town of Castle Rock.

The Denver Water Combined Service Area (CSA) extends into nearly every surrounding county, meeting at least some of the water supply needs of Denver, Arapahoe, Jefferson, Douglas, and Adams counties. Therefore, proposed future system refinements and modifications and the Moffat Collection System Project will meet some of the 2050 M&I needs in all of those counties. Other providers in the Denver Metro area will rely on existing supplies, reuse, exchanges, gravel lake storage, new storage and reservoir enlargements (e.g., Chatfield Reallocation Project), and agricultural transfers from Clear Creek and elsewhere.

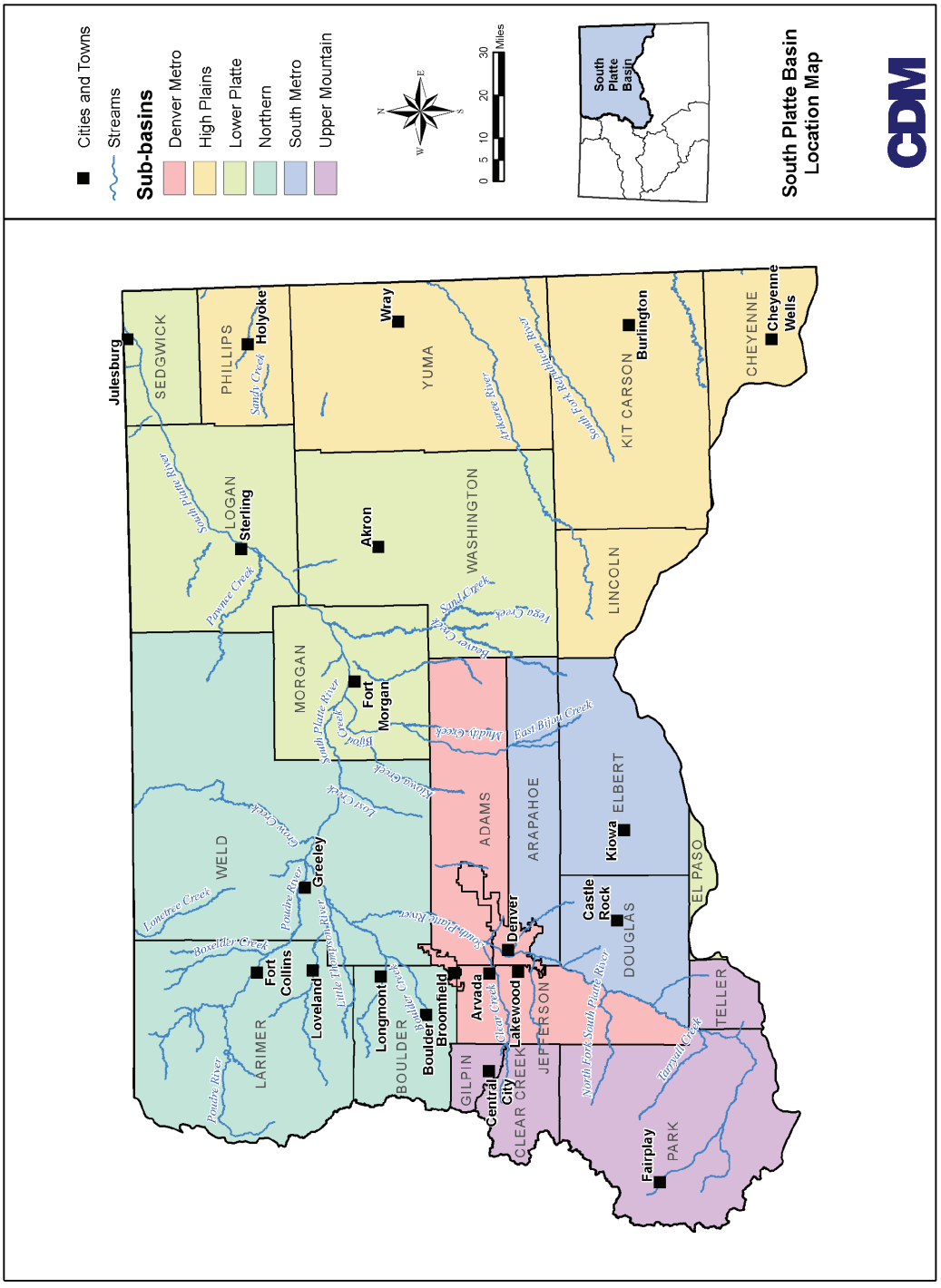


Figure 5-3 South Platte Basin Location Map

SWSI 1 noted that there are no reliable surface water supplies that can be developed from the South Platte using surface water diversions as the sole water supply source. In addition to reuse and other projects previously mentioned, IPPs for the South Metro area include the Water Infrastructure and Supply Efficiency (WISE) Partnership between Denver Water, Aurora Water, and the South Metro Water Supply Authority as well as the nearly 15,000 AF enlargement of Rueter-Hess Reservoir by Parker Water & Sanitation District and other water providers.

Based on data collected during the CWCB interview process, IPPs for the City of Aurora and Denver Water were apportioned to multiple counties as follows:

- City of Aurora IPPs were split between Adams County (40 percent), Arapahoe County (58 percent), and Douglas County (2 percent). These percentages are based on the portion of Aurora's population located in each county.
- Denver Water IPPs were proportionally split among several Metro Basin counties based on the percentage of county population located within Denver Water's CSA. The relative proportion of Denver Water IPPs and provider-specified gap applied to each county varied by growth scenario (low/medium/high). However, the base percentages served by Denver Water are as follows (Denver Water 2010):
  - Denver County – 100 percent
  - Arapahoe County – 35 percent
  - Jefferson County – 54 percent
  - Douglas County – 5 percent
  - Adams County – 10 percent

The yield associated with the Chatfield Reallocation Project was distributed based on participant storage ratios (CWCB 2007) adjusted to reflect the pending sale of Brighton's share to other participants. These adjusted storage ratios were assumed to be directly applicable to yield as well, so they were applied to the estimated 8,500 AFY project yield.

Anticipated yields from each category of IPPs at 100 percent success rate are summarized for the Metro Basin in Table 5-5.

Table 5-5 Metro Basin IPP Summary at 100% Success Rate

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Denver Metro	14,500 – 23,100	5,200 – 8,700	33,400 – 61,200	8,800 – 12,900	7,600 – 14,700	900 – 1,400	3,500 – 4,800	73,900 – 126,800
Denver Metro IPPs • Growth into existing supplies • Agricultural transfers (Clear Creek; South Platte and Beebe Draw Project) • Gravel lakes and other firming storage • Recapture and exchange plans • System refinements and modifications • Prairie Waters Project • Chatfield Reallocation Project • Eagle River Joint Use Project • Box Creek Reservoir • Moffat Collection System Project • Windy Gap Firming Project • Highway 93 Lakes								

Table 5-5 Metro Basin IPP Summary at 100% Success Rate, continued

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
South Metro	5,100 – 9,600	8,700 – 12,400	22,100 – 24,900	25,300 – 25,900	5,800 – 7,800	0	0	67,000 – 80,600
South Metro IPPs • Growth into existing supplies • Agricultural transfers • System refinements and modifications • Prairie Waters Project • ECCV Northern Pipeline Project • Chatfield Reallocation Project • Eagle River Joint Use Project • Box Creek Reservoir • Moffat Collection System Project • Rueter-Hess Reservoir enlargement • WISE • Other reuse projects								
Total[1]	**20,000 – 33,000**	**14,000 – 21,000**	**55,000 – 86,000**	**34,000 – 39,000**	**13,000 – 23,000**	**900 – 1,400**	**3,500 – 4,800**	**140,000 – 210,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.2.2.6 North Platte Basin

The North Platte River headwaters in Colorado are a relatively small portion of the overall North Platte Basin. Farming and ranching are the predominant economic base in the area, which includes Jackson County and a small portion of Larimer County. The North Platte Basin is expected to see a relatively small increase in M&I and SSI demands (increase in the range of 100 AFY to 300 AFY between 2008 and 2050). It is anticipated that this increase in demand will be met primarily by the further use of existing supplies and water rights.

For example, the Town of Walden is nearing the completion of a water supply improvement project funded by a Water Supply Reserve Account grant. This project has multiple objectives with the primary objective to eliminate the gap in the North Platte Basin. The project included—1) rehabilitation of the existing surface water diversion structure to allow the Town of Walden to capture its full water right on the Michigan River, 2) the filing of an application for a change of water right to designate the town's wells as alternate points of diversion for their senior water right for times when flows are low, and 3) steps to facilitate maximum beneficial use of the town's ownership in Walden Reservoir.

Anticipated yields from each category of IPPs at 100 percent success rate are summarized for the North Platte Basin in Table 5-6.

Table 5-6 North Platte Basin IPP Summary at 100% Success Rate

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Jackson County	0	0	100 – 300	0	0	0	0	100 – 300
Jackson County IPP • Growth into existing supplies and water rights								
Total[1]	**0**	**0**	**100 – 300**	**0**	**0**	**0**	**0**	**100 – 300**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.2.2.7 Rio Grande Basin

In the Rio Grande Basin, there is relatively minor growth projected for M&I needs by 2050. CWCB conducted interviews of the cities of Alamosa and Monte Vista in Alamosa County. IPPs were not quantified in the interview summaries, but it was determined that adequate supplies are available to meet 2050 M&I needs. Specifically, it was estimated during SWSI 1 that sufficient groundwater is physically available for most anticipated M&I growth, but augmentation of groundwater pumping will be required. Therefore, Alamosa County IPPs were set equal to 2050 net new M&I needs. New SSI demands are limited to proposed solar power generation facilities in Alamosa County and are anticipated to have demands in the range of 1,200 AFY to 2,000 AFY.

For all other Rio Grande counties, IPPs were based on SWSI 1 information. Conejos County and Mineral County were identified as having adequate water supplies to meet future needs beyond 2030; IPPs were therefore set equal to 2050 total water needs. No IPPs were identified for Costilla County. SWSI 1 quantified IPPs for Rio Grande County and Saguache County based on estimated yield from existing water rights, groundwater, and augmentation plans; the same values were applied as IPPs for the present gap analysis.

Augmentation will be provided by the San Luis Valley Water Conservancy District and other local water providers. There are no reliable new water supplies that can be developed under the Rio Grande Compact, so augmentation of M&I well pumping will be provided from a variety of sources including existing transbasin water rights diverted from the San Juan Basin and existing and future agricultural transfers.

Anticipated yields from each category of IPPs at 100 percent success rate are summarized for the Rio Grande Basin in Table 5-7.

Table 5-7 Rio Grande Basin IPP Summary at 100% Success Rate

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Alamosa County	0	0	1,400 – 2,300	0	0	1,500 – 2,300	0	2,900 – 4,600
Alamosa County IPPs • Existing water rights • Augmentation plans • Groundwater								
Conejos County	0	0	600 – 1,000	0	0	600 – 1,000	0	1,200 – 2,000
Conejos County IPPs • Existing water rights • Augmentation plans • Groundwater								
Costilla County	0	0	0	0	0	0	0	0
Costilla County IPPs • Existing water rights • Augmentation plans • Groundwater								

Table 5-7 Rio Grande Basin IPP Summary at 100% Success Rate, continued

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Mineral County	0	0	40 – 200	0	0	50 – 100	0	90 - 300
Mineral County IPPs • Existing water rights • Augmentation plans • Groundwater								
Rio Grande County	0	0	400	0	0	500	0	900
Rio Grande County IPPs • Existing water rights • Augmentation plans • Groundwater								
Saguache County	0	0	400	0	0	400	0	800
Saguache County IPPs • Existing water rights • Augmentation plans • Groundwater								
Total[1]	**0**	**0**	**2,900 – 4,300**	**0**	**0**	**3,000 – 4,300**	**0**	**5,900 – 8,600**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.2.2.8 South Platte Basin

For the purpose of conducting the IPP and gap analysis updates, the counties of the South Platte Basin were aggregated to regional subbasins, as follows:

- Northern (Boulder, Larimer, Weld)
- Upper Mountain (Clear Creek, Gilpin, Park, Teller)
- Lower Platte (Logan, Morgan, Sedgwick, Washington)
- High Plains (Cheyenne, Kit Carson, Lincoln, Phillips, Yuma)

The regions of the South Platte Basin are depicted in Figure 5-3 in Section 5.2.2.5.

Most of the interviewed M&I water providers indicated that they believe they will be able to meet 2050 needs using existing supplies, projects that are now underway, and future plans and projects. Most providers are pursuing enlargement of existing reservoirs and new storage, and consider those actions critical to meeting future needs.

Projects contributing to meeting the future needs of Northern South Platte M&I users include the Northern Integrated Supply Project (NISP) and the Windy Gap Firming Project (WGFP), both applied for by the Northern Colorado Water Conservancy District acting on behalf of numerous participating water providers and presently undergoing NEPA review. Yield from these projects was allocated to the counties in which the participants are located. Other major projects include the Halligan and Milton Seaman Reservoir enlargements proposed by the cities of Fort Collins and Greeley, respectively. In recent CWCB interviews, the cities of Longmont and Loveland indicated future yield from agricultural transfers via water rights dedication policies; the city of Greeley plans to pursue acquisition of Cache la Poudre Basin agricultural water rights. Other key Northern region projects include Erie's reclaimed water project; Longmont's Union Reservoir enlargement and Union Pumpback Project; and a portion of the Chatfield Reallocation Project yield for entities in Weld County.

In the High Plains region, continued reliance on nontributary groundwater supplies is expected to occur to meet future M&I needs through 2050. The northern High Plains Ogallala aquifer is anticipated to provide for the limited M&I growth anticipated in this region; thus, IPPs were set equal to 100 percent of 2050 net new M&I and SSI water needs. The Lower South Platte area will rely on existing rights and agricultural transfers for well augmentation. NISP represents a major new source of water for Morgan County (4,900 AFY). Based on SWSI 1 assumptions regarding these supply sources, IPPs for the Lower South Platte region were set equal to 50 percent of 2050 net new M&I and SSI water needs.

The Upper Mountain areas primarily rely on groundwater for M&I demands. These areas will have the challenge of the limited physical availability of groundwater. Much of the groundwater is in fractured bedrock and well yields can be highly variable and decline as additional growth occurs. Many of these areas already experience reduced well production. Additionally, the Upper Mountain Counties have large numbers of pre-1972 platted lots, which are not required to provide augmentation. Many of these lots are platted with high densities. These approved densities may impact well yields, and trucked water or onsite storage tanks may be required to meet peak demands for some in-home domestic uses if additional development occurs.

Jefferson County is in the process of regulating densities in certain mountain areas in order to prevent over development of the limited groundwater resources. The Upper Mountain Counties Aquifer Sustainability Project, which was completed in late 2010, provides much greater detail on the current and future water needs of this region (the results of this study will be incorporated into the South Platte Basin Needs Assessment, to be completed in the first half of 2011). Despite these potential limitations, yield assumptions from SWSI 1 were followed for the present study, and IPPs for the Upper Mountain Counties region were set equal to 90 percent of 2050 net new M&I and SSI water needs. A small amount of the Chatfield Reallocation Project was assumed to be included in Park County's IPPs (42 AFY for Center of Colorado Water Conservancy District).

Anticipated yields from each category of IPPs at 100 percent success rate are summarized for the South Platte Basin in Table 5-8.

Table 5-8 South Platte Basin IPP Summary at 100% Success Rate

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
High Plains	0	0	1,400 – 3,400	0	0	0	0	1,400 – 3,400
High Plains IPP • Nontributary groundwater								
Lower Platte	0	0	2,400 – 5,000	4,900	0	2,300 – 5,100	0	9,600 – 15,000
Lower Platte IPPs • Growth into existing supplies • Augmentation plans • NISP								

Table 5-8 South Platte Basin IPP Summary at 100% Success Rate, continued

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Northern	18,900 – 20,500	5,400 – 7,300	14,200 – 17,600	31,900 – 34,500	0	17,000	18,400 – 21,300	105,800 – 118,200
Northern IPPs • Growth into existing supplies • Agricultural transfers • Reclaimed water projects • Union Reservoir enlargement • NISP				• WGFP • Halligan Reservoir enlargement • Milton Seaman Reservoir enlargement • Chatfield Reallocation project				
Upper Mountain	0	0	2,500 – 3,700	40	0	2,500 – 3,700	0	5,000 – 7,500
Upper Mountain IPPs • Growth into existing supplies • Augmentation plans • Chatfield Reallocation Project								
Total[1]	**19,000 – 20,000**	**5,000 – 7,000**	**20,000 – 30,000**	**37,000 – 39,000**	**0**	**22,000 – 26,000**	**18,000 – 21,000**	**120,000 – 140,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.2.2.9 Southwest Basin

Numerous IPPs are under construction or planned for development to meet the diverse uses in the counties of the Southwest (Dolores/San Juan/San Miguel) Basin. During SWSI 1, both the Dolores Project (including McPhee Reservoir) and the Animas-La Plata Project were considered critical to meeting the M&I gap by basin roundtable members. The Dolores Project has been constructed and the construction of the Animas-La Plata Project is nearing completion as of late 2010. In recent interviews conducted by CWCB, the city of Durango indicated plans to acquire additional Animas-La Plata water, and the city of Cortez cited plans to purchase more M&I reserves in McPhee Reservoir.

Overall, the M&I allocations in these projects are projected to be adequate to meet M&I water supply needs in most areas of Dolores, La Plata, and Montezuma Counties. However, some of the infrastructure to deliver Dolores and Animas-La Plata Project water to its end users does not currently exist and must be constructed. This includes water system construction planned by the La Plata Archuleta Water District and the La Plata West Water Authority. This water treatment and delivery infrastructure will be very expensive to construct. It will likely not be financially feasible to serve some unincorporated areas not served by water districts and water hauling is anticipated unless financial assistance is provided to develop the supplies and infrastructure.

In addition, the Pagosa Area Water and Sanitation District has plans for two reservoir projects—Dry Gulch Reservoir and the enlargement of Stevens Reservoir. Overall, aggregate IPPs for Archuleta, Dolores, La Plata, and Montezuma County exceed the countywide 2050 net new water needs, but were reduced to account for a 5 percent M&I gap in unincorporated areas. Based on SWSI 1 analyses, existing supplies and water rights are anticipated to be adequate to meet future needs in Montrose, San Juan, and San Miguel Counties. Anticipated yields from each category of IPPs at 100 percent success rate are summarized for the Southwest Basin in Table 5-9.

Table 5-9 Southwest Basin IPP Summary at 100% Success Rate

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Archuleta County	0	0	0	3,300 – 4,400	0	0	0	3,300 – 4,400
Archuleta County IPPs • Dry Gulch Reservoir Project • Stevens Reservoir enlargement								
Dolores County	0	0	300 – 500	0	0	0	0	300 – 500
Dolores County IPPs • Rico Alluvial Pipeline Water Supply Project • Rights to water from Dolores WCD • Potable supplies from Montezuma Water Company								
La Plata County	0	0	1,000 – 1,700	5,400 – 8,600	0	0	0	6,400 – 10,300
La Plata County IPPs • Existing supplies and water rights • Animas-La Plata Project water • Western La Plata County Domestic Water System • Florida Water Conservancy District Multipurpose Project								
Montezuma County	0	0	2,500 – 3,600	300 – 400	0	0	0	2,800 – 4,000
Montezuma County IPPs • Existing supplies and water rights • McPhee Reservoir water • Totten Reservoir								
Montrose County	0	0	700	0	0	0	0	700
Montrose County IPP • Existing supplies and water rights								
San Juan County	0	0	30 – 100	0	0	0	0	30 - 100
San Juan County IPP • Existing supplies and water rights								
San Miguel County	0	0	700	0	0	0	0	700
San Miguel County IPP • Existing supplies and water rights								
Total[1]	**0**	**0**	**5,200 – 7,300**	**9,000 – 13,000**	**0**	**0**	**0**	**14,000 – 21,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.2.2.10 Yampa-White Basin

In the Yampa-White Basin (Moffat, Rio Blanco, and Routt Counties), existing supplies and water rights on the White River, Fish Creek, and other tributaries will be used to meet some of the region's M&I demands through 2050. High transit losses in delivering storage water downstream to the locations of use were experienced during the drought of the early 2000s; consequently, firm yields may be much lower than anticipated, requiring additional water supply development to meet dry year needs.

During SWSI 1, basin roundtable participants identified that the Elkhead Reservoir and Stagecoach Reservoir enlargements are critical to meeting the basin's projected water needs. Based on more recent CWCB interviews, additional IPPs include the Elk River Project (Steamboat Springs) and the Morrison Creek Reservoir Project (Upper Yampa River Water Conservancy District).

SSI demands associated with power generation in the Craig and Hayden areas are projected to increase significantly. As discussed in Section 4 and Appendix H, unknowns such as international markets,

national security, and proprietary processing methods may affect the rate of potential development of energy resources such as oil shale. The level of associated water demands is not known but could have a significant effect on the basin's water resources, increasing annual SSI water demands by nearly 100,000 AFY under the high growth scenario. The probability, timing, and extent of such demands are unknown at this time; hence, the increased demands and remaining M&I and SSI gap have a very wide range.

Anticipated yields from each category of IPPs at 100 percent success rate are summarized for the Yampa-White Basin in Table 5-10.

Table 5-10 Yampa-White Basin IPP Summary at 100% Success Rate

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Moffat County	0	0	2,100 – 3,200	0	0	0	0	2,100 – 3,200
Moffat County IPPs • Growth into existing supplies • Elkhead Reservoir enlargement								
Rio Blanco County	0	0	600	0	0	0	0	600
Rio Blanco County IPPs • Existing supplies and water rights from White River and tributaries								
Routt County	0	0	800 – 1,100	6,600 – 9,000	0	0	0	7,400 – 10,100
Routt County IPPs • Growth into existing supplies • Fish Creek direct flow and storage • Yampa River wells • Elk River Project • Morrison Creek Reservoir Project • Stagecoach Reservoir enlargement								
Total[1]	**0**	**0**	**3,500 – 4,900**	**6,600 – 9,000**	**0**	**0**	**0**	**10,000 – 14,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.3 M&I Gap Analysis

The IPPs being pursued by local water providers represent significant quantities of water and the implementation of these local projects and plans is critical to meeting Colorado's future water supply needs. However, even with the implementation of the IPPs, there are still remaining M&I and SSI consumptive water supply gaps that will need to be satisfied. As stated previously, the calculated gaps do not necessarily represent a future water supply shortage, but the gaps do demonstrate where additional work is needed to identify projects and methods to meet those future needs. The following sections summarize the calculations and results of the 2050 M&I and SSI gap analysis. As described previously, this analysis includes 2050 low, medium, and high gap values to account for the inherent uncertainty in long-range population, demand, and water supply forecasting. Future M&I and SSI demands were assessed in Section 4 of this report.

Section 5.3.1 presents the M&I and SSI gap calculation methodology generally, followed by details on the variations that occur within the calculations for each basin. The calculations as described in Section 5.3.1 are based on the assumption of 100 percent success rate for the development of IPP yield. Section 5.3.2 describes alternate (i.e., less than 100 percent) IPP yield success rates for each basin as they are applied to estimate the 2050 medium and high gaps. Section 5.3.3 summarizes the results of the gap analysis at the statewide level and for each of the nine basin roundtable areas.

The results of the gap analysis presented in this report are based on the estimated firm yield of IPPs. Furthermore, the demand values that are integral to the gap calculations are based on water providers' treated water deliveries and do not account for losses during raw water collection, treatment, and distribution, which are highly variable depending on, among other things, water source, types of treatment processes, and age and condition of distribution system. Additionally, there are many future uncertainties such as the potential for climate change, drought, infrastructure failure, and other factors. Therefore, raw water needs are very likely to be greater than the gap values presented in this report.

Note that current and future agricultural consumptive demands and shortages were assessed in Section 4 of this report. Calculated irrigation shortages are based on available water supply being less than the ideal amount required for meeting the CU requirements of a particular crop. Changes in these calculated results for 2050 relative to 2008 are generally driven by the anticipated loss of irrigated land to development and other factors. The discussions that follow apply only to the M&I and SSI consumptive gap analysis.

5.3.1 M&I Gap Analysis Methodology

For the purpose of this study, the M&I and SSI water supply gap is defined as follows:

M&I and SSI Water Supply Gap = 2050 Net New Water Needs – 2050 IPPs

where:

2050 Net New Water Needs = (2050 low/medium/high M&I baseline demands – high passive conservation - current M&I use) + (2050 low/medium/high SSI demands – current SSI use)

2050 IPPs = Water Provider Anticipated Yield from: Agricultural Transfers + Reuse + Growth into Exiting Supplies + Regional In-basin Projects + New Transbasin Projects + Firming In-basin Water Rights + Firming Transbasin Water Rights

If the available IPPs exceeded the 2050 water needs for a particular county, the IPPs were reset equal to the 2050 water needs. As stated previously herein, this calculation effectively scales back the yield of each IPP in a pro-rata fashion in order to present only the amount of yield necessary to meet water supply needs at the 2050 planning horizon. Sometimes this occurs for all three growth scenarios, sometimes for only low or low and medium. It is generally assumed that one county's surplus IPPs would not be reallocated to another county and that one provider's surplus would not be specifically allocated to meet another provider's gap. This approach was applied in all basins, unless specified otherwise.

The 2050 M&I and SSI gap is referred to in the results tables (see Section 5.3.3) as the "information/real" gap. The "real" gap is based on known numerical data from the Demands to 2050 Report (see Section 4 and Appendix H), water provider interviews and data, SWSI 1, and other sources. Based on this information, 2050 M&I and SSI demand forecasts exceed the anticipated yields of water providers' IPPs and the result is a real, defined gap. An "information" gap arises due to a lack of numerical data to support more detailed gap quantification for some water providers or even counties and subbasins.

The preceding description represents the general approach to the M&I gap analyses, with the yields of IPPs based on the 100 percent success rate. However, the process was modified as necessary for each county and basin based on the available source data. The following sections outline variations to the methodology in each basin. These are general descriptions and do not necessarily capture every variation for every county; however, additional details about the calculations for each county or region are provided in Appendix J.

5.3.1.1 Arkansas Basin

Following are the assumptions used to revise the gap calculations for the Arkansas Basin:

- The 2050 total water needs were calculated based on the Demands to 2050 Report, as described in the general approach.
- The July 2008 Arkansas Basin Roundtable update presents data consistent with SWSI 1, i.e., current conditions = 2000, future conditions = 2030. The gap analysis in the basin roundtable update was based on meeting 2030 demands.
- Provider-specified gaps were identified in SWSI 1 and the basin roundtable updates. In most cases, this information was retained as a "real" gap.
- For outlying areas of the Arkansas Basin where specific IPP data was not available from interviewed providers, IPPs were generally calculated as 2030 demand minus 2000 demand (both values from SWSI 1) minus specific provider gaps identified in SWSI 1 and the 2008 and 2010 basin roundtable updates. Thus, in these areas of limited data, IPPs are applied toward meeting 2030 demands, and increases in demand above 2030 levels were assumed to result in a gap.
- Additional provider-specific IPPs were identified and/or quantified based on CWCB interviews and data collection. Details are provided in Section 5.2.2.2.
- After accounting for known IPPs, the information/real gap was generally calculated as 2050 net new water needs minus IPPs (for low/medium/ high growth scenarios).

Additionally, unincorporated northern El Paso County needs renewable sources to meet future demands as it is currently 100 percent on nonrenewable, nontributary groundwater. If that area's existing nontributary sources fail or become technically or economically infeasible to continue to use as well yields decline, the amount needed (the gap between supply and demand) will become significantly larger in the northern portion of the basin. The El Paso County gap values therefore include an additional 13,500 AFY due to the necessary replacement of nonrenewable groundwater sources.

5.3.1.2 Colorado Basin

Following are the assumptions used to revise the gap calculations for the Colorado Basin:

- The 2050 net new water needs were calculated based on the M&I Demands to 2050 Report as described for the general approach.
- Provider-specified gaps were quantified based on CWCB interview data.
- IPPs for Colorado Basin counties were assessed as described in Section 5.2.2.3.
- The information/real gap was assessed based on provider-specified gaps and/or the difference between 2050 total water needs and IPPs.

Initial IPPs and information/real gap estimates were adjusted as necessary such that IPPs plus information/real gap equals 2050 net new water needs.

5.3.1.3 Gunnison Basin

Following are the assumptions used to revise the Gunnison Basin's gap calculations:

- The 2050 net new water needs were calculated based on the M&I Demands to 2050 Report as described for the general approach.
- IPPs for the Gunnison Basin were summarized in Section 5.2.2.4.

- Delta County included provider-specified gaps based on CWCB interview data. Delta County and Ouray County included additional gaps for specific providers identified in SWSI 1. Delta, Mesa, Montrose, and Ouray Counties included an M&I gap for unincorporated areas equal to 5 percent of 2050 M&I water needs, also based on SWSI 1. For these four counties, the information/real gap was calculated as the sum of known gaps.
- Based on the IPPs exceeding 2050 net new water needs, Hinsdale County has no 2050 water supply gaps.
- After applying the Hinsdale County surplus IPPs to Gunnison County and calculating the gap as 2050 net new water needs minus IPPs, Gunnison County has 2050 gaps for the low, medium, and high growth scenarios.

5.3.1.4 Metro Basin

Following are the assumptions used to revise the gap calculations for the Metro Basin:

- The 2050 net new water needs were calculated based on the Demands to 2050 Report as described for the general approach.
- For the Denver Metro and South Metro counties, the IPPs were quantified based on information gathered from water providers in CWCB interviews, as described in Section 5.2.2.5.
- The information/real gap was based on a combination of provider-specified gaps and/or 2050 net new water needs in excess of IPPs.

For several Metro-area counties, total IPPs exceed 2050 net new water needs. However, if there were provider-specified gaps for the county, the IPPs were scaled back accordingly. In other words, if an interviewed water provider specified a future water supply gap, IPP yield in from other providers in the county was not assumed to meet this gap, even if total county-wide IPPs appear to exceed 2050 new water needs.

The South Metro area currently relies primarily on nontributary, nonrenewable groundwater.

It was also necessary to account for additional gap in the South Metro area due to declining existing supplies. The South Metro area currently relies primarily on nontributary, nonrenewable groundwater. As noted in the South Metro Study (Black & Veatch et al. 2004), the costs of continued reliance on nonrenewable Denver Basin aquifer water will increase dramatically as well yields decline and additional wells and infrastructure are needed to maintain current level of groundwater pumping. These costs will not resolve the issue of the long-term reliability of the resource and the ultimate need to develop a renewable source of water. To continue to use as well yields decline, the amount needed (the gap between supply and demand) will become significant. Already, the gap values estimated for South Metro include 20,850 AFY—in addition to the amount of gap calculated based on 2050 demands and IPPs—due to the necessary replacement of existing nonrenewable groundwater supplies.

5.3.1.5 North Platte Basin

Following are the assumptions used to revise the gap calculations for the North Platte Basin:

- The 2050 net new water needs were calculated based on the Demands to 2050 Report as described for the general approach.

The primary objective of the Town of Walden project described in Section 5.2.2.6 is to eliminate the gap in the North Platte Basin. Therefore, IPPs at the 100 percent success rate were set equal to 2050 net new water needs, and the information/real gap for Jackson County is zero.

5.3.1.6 Rio Grande Basin

Following are the assumptions used to catalog the Rio Grande Basin's IPPs (at 100 percent success rate) and revise the gap calculations:

- The 2050 net new water needs were calculated based on the Demands to 2050 Report as described for the general approach.
- IPPs were quantified for the Rio Grande Basin as described in Section 5.2.2.7.
- The information/real gap for each Rio Grande Basin county was calculated as follows:
  - Alamosa County: IPPs cover the 2050 M&I water needs; the information/real gap was set equal to the 2050 new SSI water needs.
  - Conejos County and Mineral County: IPPs were set equal to 2050 total water needs and the information/real gaps were zero.
  - Costilla County: No IPPs were identified; the information/real gap was set equal to 2050 total water needs.
  - Rio Grande County and Saguache County: Quantified IPPs from SWSI Phase 1were applied, and the information/real gap for these two counties was calculated as 2050 net new water needs minus IPPs.

5.3.1.7 South Platte Basin

Following are the assumptions used to revise the South Platte Basin gap calculations:

- The 2050 net new water needs were calculated based on the Demands to 2050 Report as described for the general approach.
- IPPs for the various regions of the South Platte Basin were assessed as described in Section 5.2.2.8.
- Information/real gaps for the counties in the Northern region were calculated as 2050 net new water needs minus IPPs (low/medium/high); Boulder County appears to have no 2050 water supply gaps.
- Based on the calculation of IPPs, the effective information/real gaps for the outlying regions of the South Platte are as follows: Upper Mountain Counties (10 percent of 2050 net new M&I and SSI water needs); Lower South Platte (50 percent of 2050 net new M&I and SSI water needs); and High Plains (zero gap).

5.3.1.8 Southwest Basin

Following are the assumptions used to revise the Southwest Basin's gap calculations:

- The 2050 net new water needs were calculated based on the Demands to 2050 Report as described for the general approach.
- IPPs for the Southwest Basin were characterized as described in Section 5.2.2.9.
- Archuleta, Dolores, La Plata, Montezuma, Montrose, and San Miguel Counties were assumed to have a gap for unincorporated areas equal to 5 percent of 2050 net new M&I water needs. For Archuleta, Dolores, La Plata, and Montezuma Counties, this represents the entirety of the information/real gap.
- The information/real gaps for Montrose County and San Miguel County were calculated as 2050 net new water needs minus IPPs. San Juan County was found to have no gap in SWSI 1. This was assumed to remain accurate.

5.3.1.9 Yampa-White Basin

Following are the assumptions used to revise the gap calculations for the Yampa-White Basin:

- The 2050 net new water needs were calculated based on the Demands to 2050 Report as described for the general approach.
- IPPs were summarized as described in Section 5.2.2.10.
- Based on the assumption that IPPs meet all 2050 M&I needs for Moffat County, the information/real gap was set equal to the 2050 net new SSI water needs.
- For the gap analysis, Rio Blanco County IPPs were assumed to be equal to those identified in Section 6 of the SWSI 1 report. The information/real gap for Rio Blanco County was calculated as 2050 net new water needs minus IPPs. For Routt County, the majority of the IPP yield is applied toward meeting 2050 M&I demands. The information/real gap was calculated as 2050 net new water needs minus IPPs.

5.3.2 Gap Analysis with Alternate IPP Yield Scenarios

The assumptions and calculations described in Section 5.3.1 above evaluate the gap based on a 100 percent success rate for IPP yield development. To assess the full range of the 2050 M&I and SSI Gap, CWCB developed three potential scenarios to bracket the range of the M&I and SSI gap for low to high scenarios. Each scenario has a variable IPP yield success rate applied as a percentage of total IPP yield. For the low gap scenario, it was assumed that 100 percent of the IPPs (see Section 5.2.1) could be applied to the 2050 net new water needs.

For the medium and high gap estimates, the yield of the IPPs was assumed to be varied based on discussions from the IBCC, CWCB, and basin roundtables. For the medium gap scenario, it was assumed that the IPP yield would be reduced based on percent success rates discussed by IBCC in their scenario discussions for the alternative portfolio (see Section 7). IPP yield for the high gap scenario is assumed to be reduced based on the percent success rates as defined in the status quo portfolio that has been discussed by the IBCC. The percentage success rates for IPP yields for the medium and high scenarios are presented in Table 5-11.

Table 5-11 IPP Success Rates for the Medium and High Gap Scenarios

Basin	IBCC Alternative Portfolio IPP Yield Success Rates	IBCC Status Quo Portfolio IPP Yield Success Rates
Arkansas	90%	75%
Colorado	90%	90%
Gunnison	90%	90%
Metro	60%	50%
North Platte	90%	90%
Rio Grande	90%	90%
South Platte	60%	40%
Southwest	75%	75%
Yampa-White	90%	90%

The gap calculations based on alternate IPP yield success rates are best demonstrated by example. The Colorado Basin has an existing (2008) demand of 68,000 AFY and a 2050 low growth demand of about 132,000 AFY, representing an increase of nearly 65,000 AFY. IPPs associated with the Colorado Basin low growth scenario are 42,000 AFY (at 100 percent implementation), leaving a 2050 supply gap of 22,000 AFY under the low gap scenario. The Colorado Basin has a 2050 medium growth demand of 150,000 AFY, representing an increase of 82,000 AFY over the existing demand. Medium growth IPPs total 54,000 AFY

at 100 percent yield, but based on Table 5-11, only 90 percent (49,000 AFY) of the yield is assumed to be successfully developed under the medium gap scenario. The result is a gap of about 33,000 AFY in 2050. High growth scenario demands are approximately 180,000 AFY, which is an increase of about 110,000 AFY over the existing scenario. High growth IPPs total 70,000 AFY at 100 percent yield, but under the high gap scenario, again only 90 percent (63,000 AFY) success is achieved. Thus, the Colorado Basin high gap is about 48,000 AFY.

A similar process is utilized for the other basins. For the medium and high statewide analyses, the success rates in Table 5-11 are applied to each basin prior to calculating the overall gaps on an aggregate basis.

5.3.3 2050 M&I and SSI Gap Analysis Results

The water supply gaps resulting from the assumptions and calculations defined in Section 5.3.1 and Section 5.3.2 are summarized in the following sections, first statewide, then for each basin by subbasin (region) or county. The full set of gap results implies nine total gap scenarios based on low, medium, and high M&I demands and three IPP yield scenarios (100 percent success rate, an alternative success rate, and a status quo success rate). For the purpose of discussion, however, the results are reduced to three scenarios in the tables presented in the following sections. These three scenarios encapsulate the full range of anticipated M&I and SSI water supply gaps in 2050, from the lowest low gap scenario (lowest demands with 100 percent IPP success rate) to the highest high gap scenario (high demands with status quo IPP success rates).

5.3.3.1 Statewide

Colorado faces a significant M&I water supply gap in 2050. Under the low gap scenario (low demands and 100 percent IPP success rate), the statewide gap is 190,000 AFY. Under the medium gap scenario (medium demands and an alternative IPP success rate), the statewide gap is about 390,000 AFY. Under the high gap scenario (high demands and status quo IPP success rate), the statewide gap is about 630,000 AFY. By 2050, Colorado's M&I gap could be between 32 percent and 66 percent of new M&I demands.

Table 5-12 provides a summary of each basin's increased M&I and SSI demands relative to current conditions (defined for this study as 2008), the amount of that increase met by the IPPs, and the results of the gap calculations. In general, the low IPPs plus the low remaining M&I and SSI gap equal the low increase in M&I and SSI demand, with some minor variability due to rounding at the county or regional level. The same is true for the medium and high values. The Arkansas and Metro Basins are exceptions to this rule due to the inclusion of additional gap volumes associated with the replacement of existing nonrenewable groundwater sources (described in Section 5.3.1.1 and Section 5.3.1.4, respectively).

Table 5-12 Statewide M&I and SSI Gaps in 2050[1]

Basin	Increase in M&I and SSI Demand (AFY)			Estimated Yield of Identified Projects and Processes (AFY)			Estimated Remaining M&I and SSI Gap after Identified Projects and Processes (AFY)		
				100% IPP Success Rate	Alternative IPP Success Rates	Status Quo IPP Success Rates	Gap at 100% IPP Success Rate	Gap at Alternative IPP Success Rates	Gap at Status Quo IPP Success Rates
	Low	Med	High	Low	Med	High	Low	Med	High
Arkansas[2]	110,000	140,000	170,000	88,000	85,000	76,000	36,000	64,000	110,000
Colorado	65,000	82,000	110,000	42,000	49,000	63,000	22,000	33,000	48,000
Gunnison	16,000	19,000	23,000	14,000	14,000	16,000	2,800	5,100	6,500
Metro[3]	180,000	210,000	280,000	140,000	97,000	100,000	63,000	130,000	190,000
North Platte	100	200	300	100	200	300	0	20	30
Rio Grande	7,700	9,900	13,000	5,900	6,400	7,700	1,800	3,600	5,100
South Platte	160,000	180,000	230,000	120,000	78,000	58,000	36,000	110,000	170,000
Southwest	20,000	25,000	31,000	14,000	13,000	15,000	5,100	12,000	16,000
Yampa-White	34,000	48,000	95,000	10,000	11,000	13,000	23,000	37,000	83,000
Total	**590,000**	**710,000**	**950,000**	**430,000**	**350,000**	**350,000**	**190,000**	**390,000**	**630,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.
[2] Arkansas gaps include additional 13,500 AFY for Urban Counties replacement of nonrenewable groundwater supplies.
[3] Metro gaps include additional 20,850 AFY for South Metro replacement of nonrenewable groundwater supplies.

Colorado faces immediate M&I water supply needs. Figure 5-4 illustrates the timing of the statewide M&I and SSI gap for the medium gap scenario. The statewide existing supply is 1,161,000 AFY and is assumed to remain constant through 2050, except for the replacement of nontributary groundwater in Douglas and El Paso counties. Under the medium gap scenario Colorado's immediate M&I water supply needs are met with the successful implementation of the IPPs. The associated yield of the IPPs increases steadily from 2010 through 2020, then at a higher rate of growth through 2030. Under the medium gap scenario, the IPPs are fully implemented by 2030 and yield about 350,000 AFY. Without the successful implementation of additional IPPs, increases in demand after 2030 are assumed to be gap, leading to a 2050 M&I gap of approximately 390,000 AFY for the medium gap scenario.

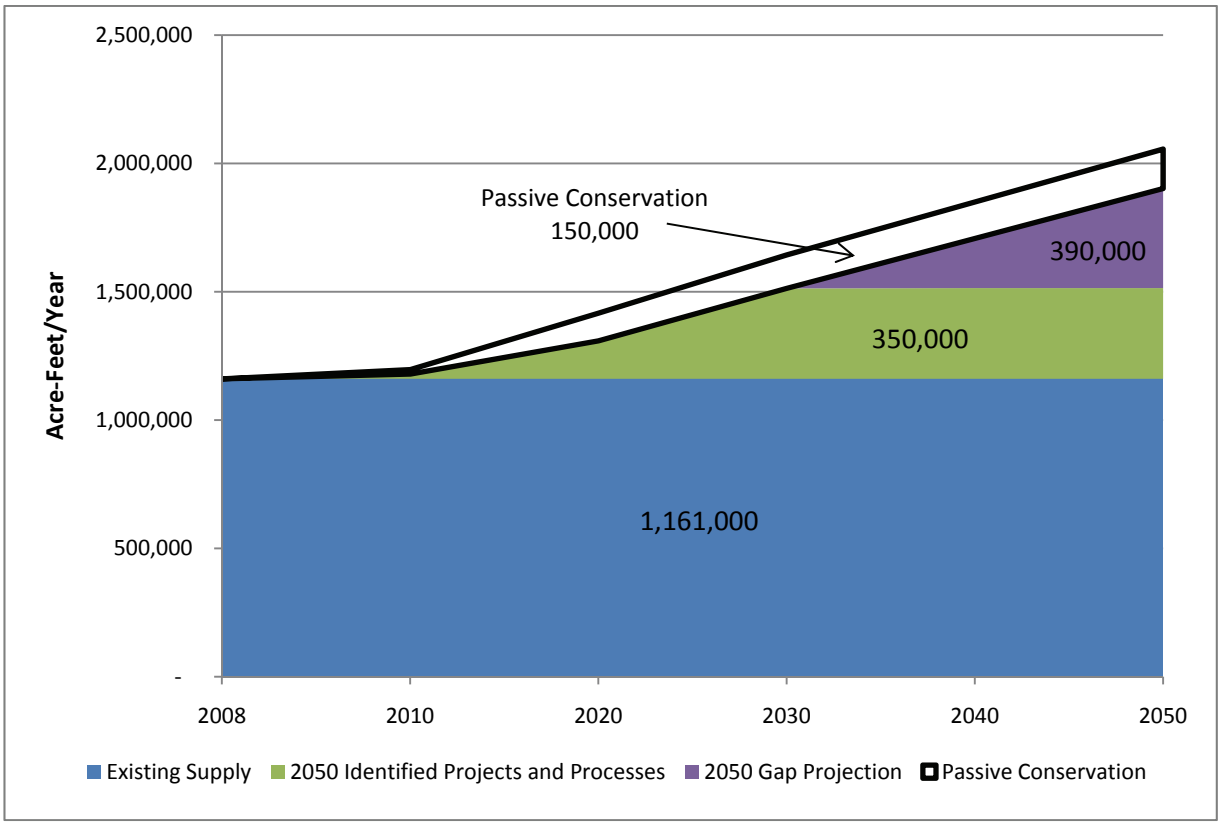


Figure 5-4 Statewide M&I and SSI Gap Summary Medium Scenario (IPPs at 70% Success Rate)

Note that while this plot does illustrate the temporal evolution of existing supplies, IPPs, and the gap, it is not intended to serve as a definitive timeline for the development of these parameters. A level of uncertainty remains for most components of this analysis; demand increases may come sooner or later than projected and IPPs may have more or less success than anticipated in these calculations. Thus, the figure functions as a representation of the interrelated nature of IPPs and the gap. At any given point in time, the sum of existing supplies, IPPs, and gap are equal to demands. The figure illustrates that the need for successful implementation of the IPPs is immediate. As long as the development of IPPs keeps pace with demands, the gap will be minimal. However, if demands continue to increase beyond the development of presently identified IPPs or if successful IPP yield development occurs at a lower rate, the gap will continue to grow in magnitude and will appear at an earlier point in time. It is also important to note the spatial variability of the M&I gap. Some areas of the state will have an M&I gap sooner than others. Plots illustrating the low and high gap scenario statewide and the low, medium, and high gap scenarios for all basins are included in Appendix J.

Figure 5-5 illustrates the relative percentages of 2050 net new water needs occupied by IPPs and the gap for each basin for the medium gap scenario. The pie chart shown on the map for each basin is scaled to represent the magnitude of the 2050 medium demand. IPP success rates are defined as shown for the "Alternative Portfolio" in Table 5-11; at the statewide level, the overall IPP success rate is approximately 70 percent for the medium gap scenario.

For the Arkansas, Colorado, Gunnison, North Platte, and Rio Grande Basins, IPPs (illustrated as the blue part of the pie charts) meet 50 percent or more of the 2050 medium demand as a result of 90 percent IPP yield success rate in these basins. Southwest Basin IPPs also exceed 50 percent of 2050 medium demand despite a success rate of only 75 percent. The Yampa-White Basin has a 90 percent IPP yield success rate for the medium gap scenario, but the high yet uncertain demands associated with future SSI uses result in a very large water supply gap (78 percent, illustrated in red) in 2050. Future M&I and SSI water supply gaps for the South Platte and Metro Basins exceed 50 percent due to significantly reduced IPP yield success rates, at 60 percent. For these basins in particular, and also in the Arkansas Basin, a significant reduction in the success of yield development from planned projects and processes identified by Front Range water providers will likely lead to much greater increases in agricultural transfers as a means to meet future demands (see Section 4).

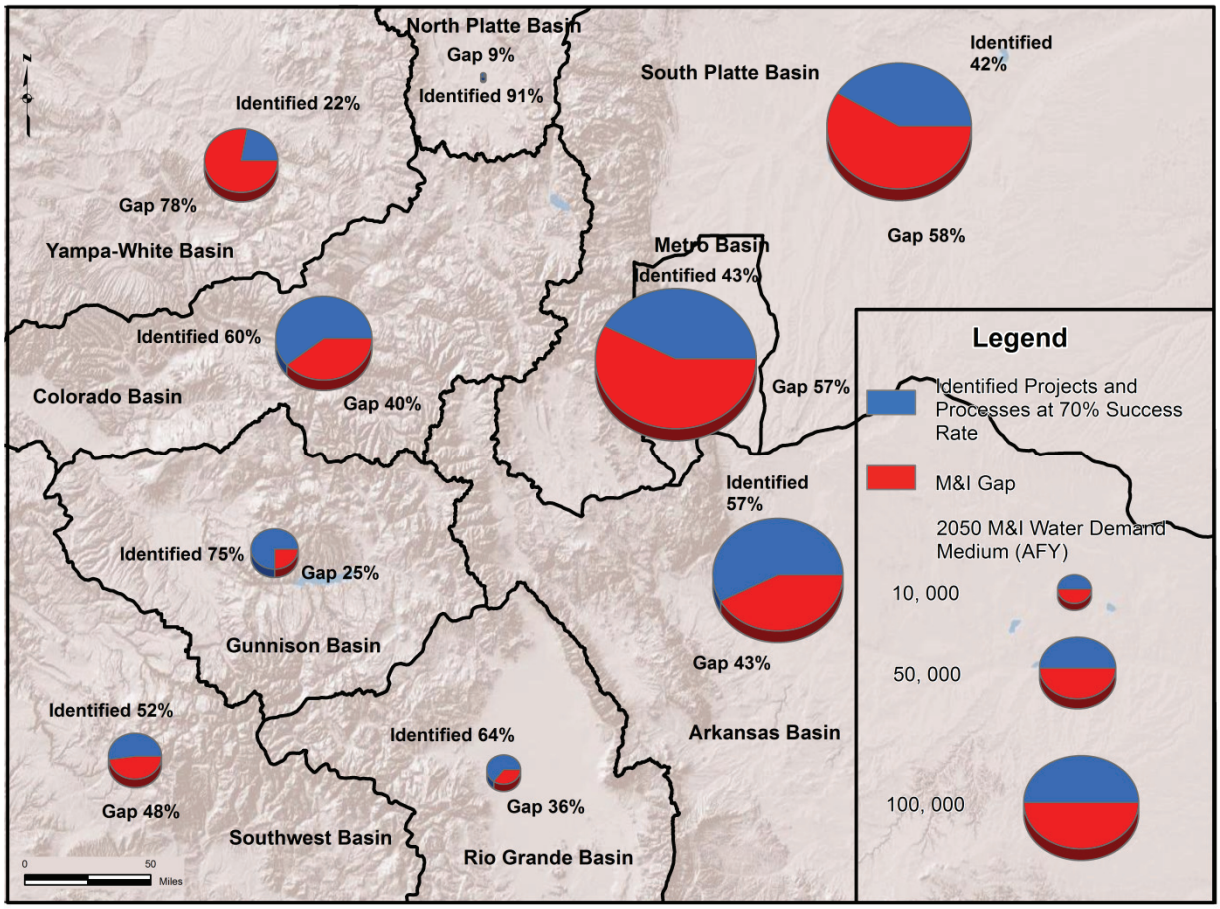


Figure 5-5 2050 M&I and SSI Gap Analysis – Medium Gap Scenario

It must be clearly understood that the low, medium, and high gap scenarios evaluated in this study are based on assumptions about the implementation of IPPs made for the purposes of conducting the analyses. In reality, both demand growth and the development of IPPs will be impacted by various factors that will likely cause them to fall somewhere between the low and high values highlighted above. However, it remains highly probable that there will be some level of gap regardless of the level of IPPs development, and a portfolio of solutions will be needed to meet Colorado's future M&I water needs.

Of particular importance will be the implementation of new projects and sources of water in the event that not all IPPs currently undergoing NEPA review receive permits for project construction from the jurisdictional federal agency (BOR or U.S. Army Corps of Engineers [USACE] for most ongoing EIS projects). The list of these projects includes high-yield regional projects such as NISP, WGFP, SDS, the Moffat Collection System Project, Chatfield Reallocation, and others.

The significance of the yield that would be provided by IPPs currently or soon to be engaged in the NEPA process—particularly in the South Platte, Metro, and Arkansas Basins—is illustrated in Figures 5-6 and 5-7. For the medium growth scenario and assuming 100 percent IPP success rate, South Platte Basin and Metro IPPs in NEPA represent 115,000 AFY of potential yield, or about 40 percent of the total IPP yield for the combined basins. Likewise, NEPA IPPs in the Arkansas Basin total nearly 49,000 AFY, or roughly 51 percent of overall IPP yield for the medium growth scenario. Note that in Figures 5-6 and 5-7 the new demand values also include the replacement of nonrenewable groundwater.

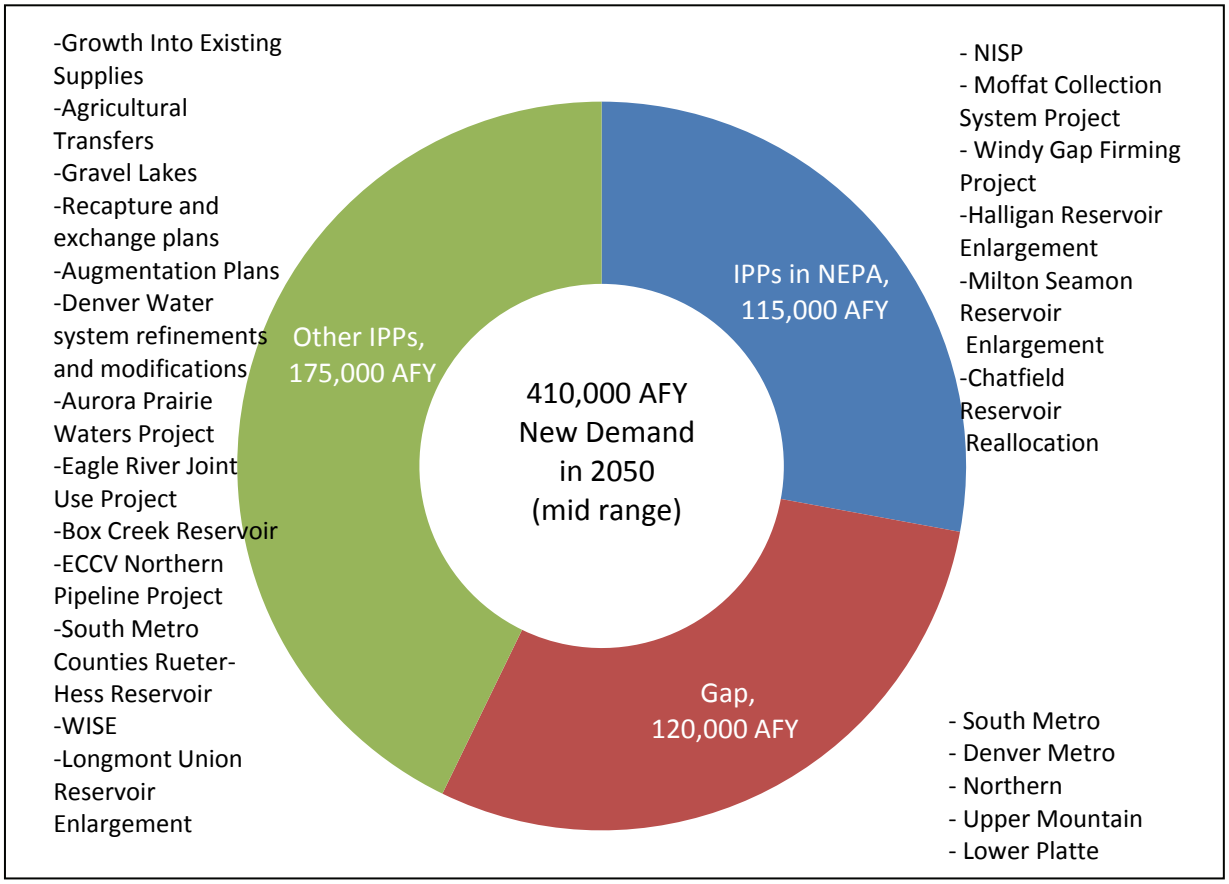


Figure 5-6 Potential Yield of NEPA Projects Relative to 2050 New Demands, Other IPPs, and Gap in South Platte and Metro Basins

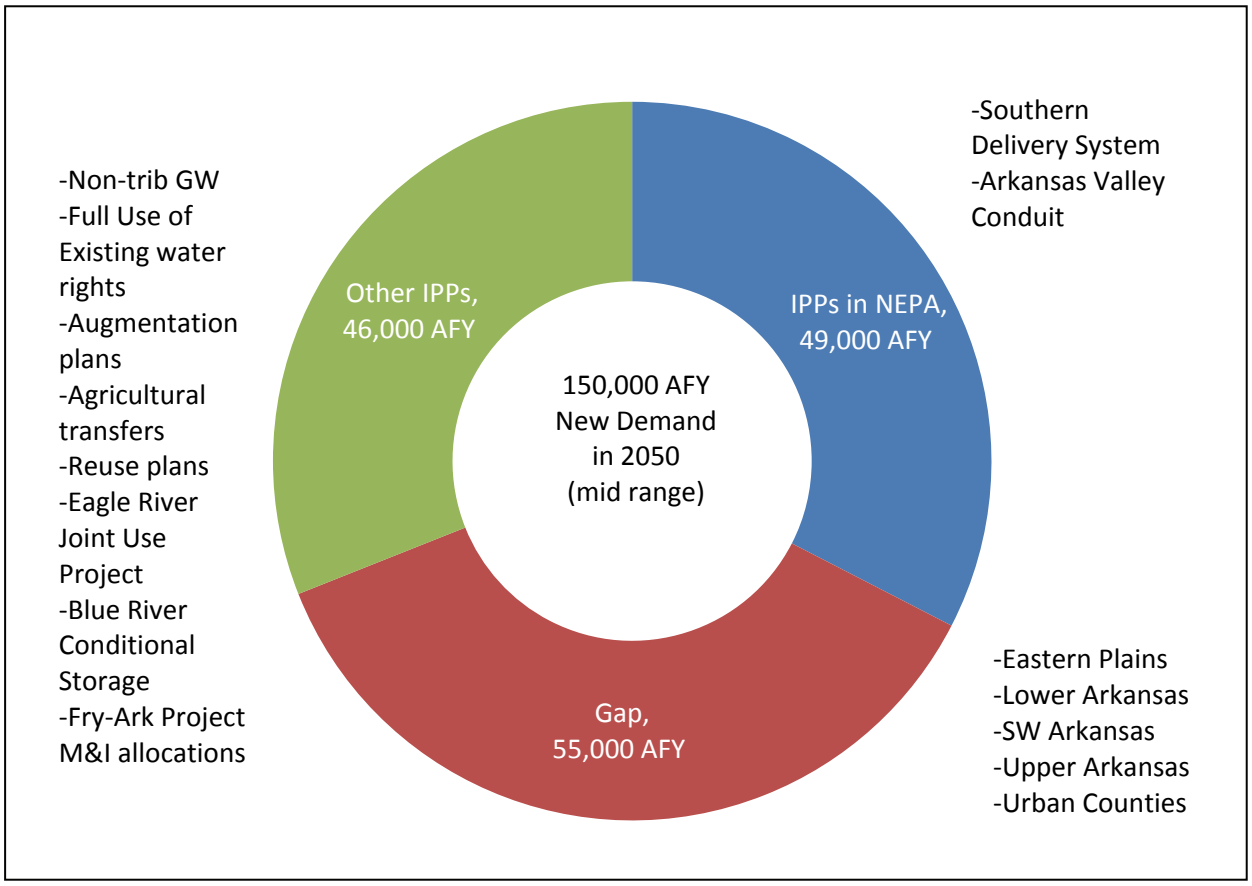


Figure 5-7 Potential Yield of NEPA Projects Relative to 2050 New Demands, Other IPPs, and Gap in Arkansas Basin

The following sections provide additional results of the gap analysis for each basin roundtable area.

5.3.3.2 Arkansas Basin

Table 5-13 provides a summary of increased M&I and SSI demands, the amount of IPP yield, and the volume of M&I and SSI gap for each region in the Arkansas Basin for the low, medium, and high gap scenarios. The baseline existing M&I and SSI water supply for the Arkansas Basin is 255,000 AFY and is assumed to remain constant through 2050; however, there may be a decline in the existing supply over time due to the current use of nonrenewable groundwater in some areas of the Arkansas Basin. After applying the alternative and status quo IPP success rates in Table 5-11, the estimated basinwide gaps for 2050 are as follows:

- Low gap (IPPs at 100 percent success) = 36,000 AFY
- Medium gap (IPPs at 90 percent success) = 64,000 AFY
- High gap (IPPs at 75 percent success) = 110,000 AFY

The gaps for the Urban Counties, and thus the entire basin, include an additional 13,500 AFY for the replacement of nonrenewable groundwater. The importance of achieving success for projects currently undergoing NEPA evaluation was discussed in Section 5.3.3.1. Graphical illustrations of the temporal development of IPPs and the gap are included in Appendix J for the low, medium, and high gap scenarios.

Table 5-13 Arkansas Basin M&I and SSI Gaps in 2050

	Increase in M&I and SSI Demand (AFY)			Estimated Yield of Identified Projects and Processes (AFY)			Estimated Remaining M&I and SSI Gap after Identified Projects and Processes (AFY)		
				100% IPP Success Rate	Alternative IPP Success Rate (90%)	Status Quo IPP Success Rate (75%)	Gap at 100% IPP Success Rate	Gap at Alternative IPP Success Rate (90%)	Gap at Status Quo IPP Success Rate (75%)
Region or County	Low	Med	High	Low	Med	High	Low	Med	High
Eastern Plains	2,300	2,700	3,200	1,700	1,600	1,500	600	1,100	1,700
Lower Arkansas	900	1,400	2,100	800	1,200	1,500	100	200	600
Southwestern Arkansas	3,000	3,700	4,600	1,900	1,700	1,400	1,100	2,000	3,200
Upper Arkansas	19,000	22,100	25,900	11,900	10,700	8,900	7,200	11,500	17,000
Urban Counties[1]	85,200	105,500	135,000	71,500	70,100	62,300	27,200	48,900	86,200
Total[2]	**110,000**	**140,000**	**170,000**	**88,000**	**85,000**	**76,000**	**36,000**	**64,000**	**110,000**

[1] Urban Counties Gap includes an additional 13,500 AF for replacement of nonrenewable groundwater.
[2] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.3.3.3 Colorado Basin

Table 5-14 provides a summary of increased M&I and SSI demands, the amount of yield provided by the IPPs, and the results of the gap calculations for each county in the Colorado Basin. The basin's existing M&I and SSI supply is 68,000 AFY and is assumed to remain constant through 2050; future demands and supplies will increase above this amount. After completing the necessary adjustments for the alternative and status quo IPP yield scenarios, the resulting gaps for the low, medium, and high scenarios are approximately 22,000 AFY, 33,000 AFY, and 48,000 AFY, respectively.

Table 5-14 Colorado Basin M&I and SSI Gaps in 2050

	Increase in M&I and SSI Demand (AFY)			Estimated Yield of Identified Projects and Processes (AFY)			Estimated Remaining M&I and SSI Gap after Identified Projects and Processes (AFY)		
				100% IPP Success Rate	Alternative IPP Success Rate (90%)	Status Quo IPP Success Rate (90%)	Gap at 100% IPP Success Rate	Gap at Alternative IPP Success Rate (90%)	Gap at Status Quo IPP Success Rate (90%)
Region or County	Low	Med	High	Low	Med	High	Low	Med	High
Eagle County	10,100	14,000	20,200	10,100	12,600	18,100	0	1,400	2,000
Garfield County	22,500	26,000	33,400	16,600	15,000	15,000	5,800	11,000	18,400
Grand County	4,100	5,200	6,700	2,700	2,900	2,900	1,400	2,300	3,900
Mesa County	14,100	17,500	24,300	3,900	6,700	12,800	10,100	10,900	11,600
Pitkin County	4,700	6,700	9,800	1,900	3,500	6,300	2,800	3,200	3,500
Summit County	9,000	12,100	16,800	6,900	8,300	8,300	2,000	3,800	8,500
Total[1]	**65,000**	**82,000**	**110,000**	**42,000**	**49,000**	**63,000**	**22,000**	**33,000**	**48,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.3.3.4 Gunnison Basin

Table 5-15 provides a summary of increased M&I and SSI demands, the estimated yield of IPPs, and the results of the gap calculations for each county in the Gunnison Basin.

The existing supply is estimated to be 21,000 AFY and remains constant through 2050. After accounting for IPPs to meet some or all of the net new water needs in each county, the estimated 2050 water supply gaps are as follows:

- Low gap (100 percent IPP success) = 2,800 AFY
- Medium gap (90 percent IPP success) = 5,100 AFY
- High gap (90 percent IPP success) = 6,500 AFY

The temporal development of IPPs and the gap for the Gunnison Basin is represented in figures included in Appendix J.

Table 5-15 Gunnison Basin M&I and SSI Gaps in 2050

Region or County	Increase in M&I and SSI Demand (AFY)			Estimated Yield of Identified Projects and Processes (AFY)			Estimated Remaining M&I and SSI Gap after Identified Projects and Processes (AFY)		
				100% IPP Success Rate	Alternative IPP Success Rate (90%)	Status Quo IPP Success Rate (90%)	Gap at 100% IPP Success Rate	Gap at Alternative IPP Success Rate (90%)	Gap at Status Quo IPP Success Rate (90%)
	Low	Med	High	Low	Med	High	Low	Med	High
Delta County	5,300	5,900	6,700	3,700	3,800	4,400	1,700	2,100	2,200
Gunnison County	1,900	2,700	3,800	1,600	1,400	1,400	300	1,300	2,400
Hinsdale County	200	300	300	200	300	300	0	30	30
Mesa County	1,600	1,800	2,300	1,500	1,600	2,000	80	300	300
Montrose County	7,000	7,900	9,100	6,700	6,700	7,700	400	1,100	1,300
Ouray County	300	500	800	20	200	500	300	300	300
Total[1]	**16,000**	**19,000**	**23,000**	**14,000**	**14,000**	**16,000**	**2,800**	**5,100**	**6,500**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.3.3.5 Metro Basin

Table 5-16 provides a summary of increased M&I and SSI demands, the amount of that increase that is met by the IPPs, and the results of the gap analysis for each region in the Metro Basin. The importance of successfully developing the IPP yield associated with projects undergoing NEPA review was discussed in Section 5.3.3.1.

The existing M&I and SSI supply for the Metro Basin is estimated to be 502,000 AFY and is assumed to remain constant through 2050; however, there may be a decline in the existing supply over time due to the current use of nonrenewable groundwater in some areas of the Metro Basin. After computing the 2050 net new M&I and SSI water needs and subtracting water providers' specified IPPs at varying levels of successful yield development, the estimated gaps for the Metro Basin are as follows:

- Low gap (100 percent IPP success) = 63,000 AFY
- Medium gap (60 percent IPP success) = 130,000 AFY
- High gap (50 percent IPP success) = 190,000 AFY

Note that these basinwide gap results include 20,850 AFY of gap—in addition to the differences between 2050 M&I and SSI demands and IPPs—to account for the replacement of nonrenewable groundwater supplies.

Table 5-16 Metro Basin M&I and SSI Gaps in 2050

Region or County	Increase in M&I and SSI Demand (AFY)			Estimated Yield of Identified Projects and Processes (AFY)			Estimated Remaining M&I and SSI Gap after Identified Projects and Processes (AFY)		
				100% IPP Success Rate	Alternative IPP Success Rate (60%)	Status Quo IPP Success Rate (50%)	Gap at 100% IPP Success Rate	Gap at Alternative IPP Success Rate (60%)	Gap at Status Quo IPP Success Rate (50%)
	Low	Med	High	Low	Med	High	Low	Med	High
Denver Metro	97,000	113,100	158,000	73,900	53,700	63,400	23,100	59,300	94,600
South Metro[1]	86,000	94,300	119,800	67,000	43,600	40,300	39,800	71,500	100,300
Total[2]	**180,000**	**210,000**	**280,000**	**140,000**	**97,000**	**100,000**	**63,000**	**130,000**	**190,000**

[1] South Metro gap includes an additional 20,850 AF for replacement of nonrenewable groundwater.
[2] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.3.3.6 North Platte Basin

Table 5-17 provides a summary of increased M&I and SSI demands, the amount of new demand that will be met by IPPs, and the results of gap calculations for the North Platte Basin. For the low, medium, and high gap scenarios, the North Platte existing supply is 500 AFY. Demand increases in the North Platte Basin are estimated to range from 100 AFY to 300 AFY, nearly all of which will be met by growth into existing supplies. At 100 percent IPP success (low gap scenario), there is no gap. Alternate scenarios for the medium and high gaps assume a 90 percent success rate for IPPs; thus, the medium and high gaps for the year 2050 are 20 AFY and 30 AFY, respectively.

Table 5-17 North Platte Basin M&I and SSI Gaps in 2050

Region or County	Increase in M&I and SSI Demand (AFY)			Estimated Yield of Identified Projects and Processes (AFY)			Estimated Remaining M&I and SSI Gap after Identified Projects and Processes (AFY)		
				100% IPP Success Rate	Alternative IPP Success Rate (90%)	Status Quo IPP Success Rate (90%)	Gap at 100% IPP Success Rate	Gap at Alternative IPP Success Rate (90%)	Gap at Status Quo IPP Success Rate (90%)
	Low	Med	High	Low	Med	High	Low	Med	High
Jackson County	100	200	300	100	200	300	0	20	30
Total[1]	**100**	**200**	**300**	**100**	**200**	**300**	**0**	**20**	**30**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.3.3.7 Rio Grande Basin

Table 5-18 summarizes increased M&I and SSI demands for the year 2050, the amount of that increase provided by the IPPs, and the calculated gaps for each county in the Rio Grande Basin. The basin's existing M&I and SSI supply is estimated to be approximately 18,000 AFY, which is assumed to remain constant through the 2050 planning horizon of this study.

Under the low gap scenario (100 percent IPP success), the gap reaches 1,800 AFY in 2050. Similar development trends are observed for the medium gap scenario (90 percent IPP success), resulting in a gap of about 3,600 AFY by 2050. Under the high gap scenario in the Rio Grande Basin (90 percent IPP success), the gap is approximately 5,100 AFY in 2050.

Table 5-18 Rio Grande Basin M&I and SSI Gaps in 2050

Region or County	Increase in M&I and SSI Demand (AFY)			Estimated Yield of Identified Projects and Processes (AFY)			Estimated Remaining M&I and SSI Gap after Identified Projects and Processes (AFY)		
				100% IPP Success Rate	Alternative IPP Success Rate (90%)	Gap at Status Quo IPP Success Rate (90%)	Gap at 100% IPP Success Rate	Gap at Alternative IPP Success Rate (90%)	Gap at Status Quo IPP Success Rate (90%)
	Low	Med	High	Low	Med	High	Low	Med	High
Alamosa County	4,100	5,100	6,600	2,900	3,300	4,100	1,200	1,900	2,500
Conejos County	1,200	1,600	2,000	1,200	1,400	1,800	0	200	200
Costilla County	100	200	200	0	0	0	100	200	200
Mineral County	90	200	300	90	200	300	0	20	30
Rio Grande County	1,200	1,700	2,400	900	800	800	300	900	1,600
Saguache County	1,000	1,100	1,300	800	700	700	200	400	600
Total[1]	**7,700**	**9,900**	**13,000**	**5,900**	**6,400**	**7,700**	**1,800**	**3,600**	**5,100**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.3.3.8 South Platte Basin

Table 5-19 summarizes the estimated 2050 increases in M&I and SSI demands, the amount of that increase met by the IPPs, and the estimates of the 2050 water supply gap for each region in the South Platte Basin. Figure 5-6 in Section 5.3.3.1 illustrates the importance of projects undergoing NEPA evaluation to the successful development of IPP yield in the basin. The existing supply, which remains constant through 2050 and across all gap scenarios, is estimated to be 234,000 AFY. Under the low gap scenario (100 percent IPP success), the gap is about 36,000 AFY by 2050. For the medium gap scenario (60 percent IPP success), maximum IPP development is 78,000 AFY and the corresponding gap is approximately 110,000 AFY by 2050. Under the South Platte high gap scenario, 58,000 AFY of IPPs are developed (based on a 40 percent success rate), resulting in a gap of 170,000 AFY in 2050. From a regional perspective, the largest gaps occur in the Northern region, consistent with the high levels of current and future demands and urbanization in Boulder, Larimer, and Weld Counties.

Table 5-19 South Platte Basin M&I and SSI Gaps in 2050

Region or County	Increase in M&I and SSI Demand (AFY)			Estimated Yield of Identified Projects and Processes (AFY)			Estimated Remaining M&I and SSI Gap after Identified Projects and Processes (AFY)		
				100% IPP Success Rate	Alternative IPP Success Rate (60%)	Status Quo IPP Success Rate (40%)	Gap at 100% IPP Success Rate	Gap at Alternative IPP Success Rate (60%)	Gap at Status Quo IPP Success Rate (40%)
	Low	Med	High	Low	Med	High	Low	Med	High
High Plains	1,400	2,300	3,400	1,400	1,400	1,400	0	900	2,100
Lower Platte	19,200	23,800	30,100	9,600	7,100	6,000	9,600	16,600	24,000
Northern	131,200	151,400	184,900	105,800	65,500	47,300	25,500	85,900	137,700
Upper Mountain	5,500	6,800	8,300	5,000	3,700	3,000	600	3,100	5,300
Total[1]	**160,000**	**180,000**	**230,000**	**120,000**	**78,000**	**58,000**	**36,000**	**110,000**	**170,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.3.3.9 Southwest Basin

Table 5-20 provides a summary of increased M&I and SSI demands, the amount of that increase provided by the IPPs, and the resulting gaps for each county in the Southwest Basin. The existing supply for the Southwest Basin is approximately 24,000 AFY and is anticipated to remain constant through the planning period ending in 2050. All IPPs in the basin are developed through growth into existing supplies or regional in-basin projects. After accounting for varying rates of IPP development success, the estimated gap values for the Southwest Basin are as follows:

- Low gap (100 percent IPP success) = 5,100 AFY
- Medium gap (75 percent IPP success) = 12,000 AFY
- High gap (75 percent IPP success) = 16,000 AFY

Table 5-20 Southwest Basin M&I and SSI Gaps in 2050

Region or County	Increase in M&I and SSI Demand (AFY)			Estimated Yield of Identified Projects and Processes (AFY)			Estimated Remaining M&I and SSI Gap after Identified Projects and Processes (AFY)		
				100% IPP Success Rate	Alternative IPP Success Rate (75%)	Status Quo IPP Success Rate (75%)	Gap at 100% IPP Success Rate	Gap at Alternative IPP Success Rate (75%)	Gap at Status Quo IPP Success Rate (75%)
	Low	Med	High	Low	Med	High	Low	Med	High
Archuleta County	3,500	4,000	4,600	3,300	2,800	3,300	200	1,100	1,300
Dolores County	300	400	500	300	300	300	20	100	100
La Plata County	6,800	8,600	10,800	6,400	6,100	7,700	300	2,500	3,100
Montezuma County	3,000	3,500	4,200	2,800	2,500	3,000	100	1,000	1,200
Montrose County	3,000	3,900	5,000	700	500	500	2,300	3,400	4,500
San Juan County	30	90	100	30	70	100	—	20	40
San Miguel County	2,900	4,300	6,000	700	500	500	2,200	3,800	5,500
Total[1]	**20,000**	**25,000**	**31,000**	**14,000**	**13,000**	**15,000**	**5,100**	**12,000**	**16,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.3.3.10 Yampa-White Basin

Table 5-21 summarizes increased M&I and SSI demands for the year 2050, the amount of that increase met by the IPPs, and the results of the gap calculations for each county in the Yampa-White Basin. The existing supply for the basin is estimated to be about 40,000 AFY; this amount is assumed to remain constant throughout the planning period. Owing to the uncertainty of future water needs associated with energy development, the gap projections for the Yampa-White Basin show much greater variability than the other basins. The range of 2050 gap estimates for the Yampa-White Basin is as follows:

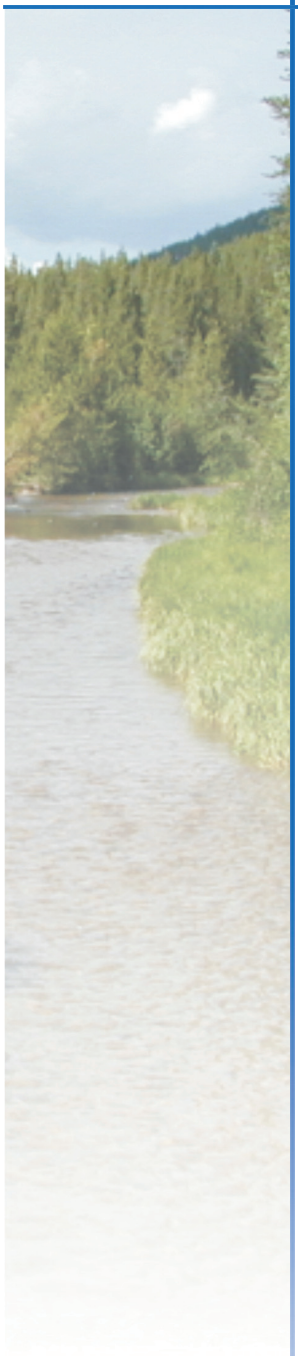
- Low gap (100 percent IPP success) = 23,000 AFY
- Medium gap (90 percent IPP success) = 37,000 AFY
- High gap (90 percent IPP success) = 83,000 AFY

A representation of the development of the IPPs and the gap over the 2008 through 2050 period is included in Appendix J for each gap scenario.

Table 5-21 Yampa-White Basin M&I and SSI Gaps in 2050

Region or County	Increase in M&I and SSI Demand (AFY)			Estimated Yield of Identified Projects and Processes (AFY)			Estimated Remaining M&I and SSI Gap after Identified Projects and Processes (AFY)		
				100% IPP Success Rate	Alternative IPP Success Rate (90%)	Status Quo IPP Success Rate (90%)	Gap at 100% IPP Success Rate	Gap at Alternative IPP Success Rate (90%)	Gap at Status Quo IPP Success Rate (90%)
	Low	Med	High	Low	Med	High	Low	Med	High
Moffat County	10,200	12,900	15,400	2,100	2,200	2,900	8,100	10,600	12,500
Rio Blanco County	5,200	12,800	52,300	600	500	500	4,600	12,200	51,700
Routt County	18,100	21,800	27,700	7,400	7,900	9,100	10,700	13,900	18,600
Total[1]	**34,000**	**48,000**	**95,000**	**10,000**	**11,000**	**13,000**	**23,000**	**37,000**	**83,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.



Section 6
Water Availability

6.1 Water Availability Overview

Justice Gregory J. Hobbs of the Colorado Supreme Court has stated "The 21st Century is the era of limits made applicable to water decisionmaking. Due to natural western water scarcity, we are no longer developing a resource. Instead, we are learning how to share a developed resource." These words of wisdom should serve as guidance for all parties interested in Colorado water. The amount of water available for use within the state is finite.

The Statewide Water Supply Initiative (SWSI) 2010 analyzes Colorado's water availability based on recent work by the Colorado Water Conservation Board (CWCB) and the basin roundtables. SWSI 2010 finds that unappropriated water in the South Platte, Arkansas, and Rio Grande Basins is extremely limited, and reliance on nonrenewable, nontributary groundwater as a permanent water supply creates reliability and sustainability concerns, particularly along the Front Range. It also finds that Colorado River compact entitlements are not fully utilized and that water in the Colorado River system may be available to meet future needs. However, in order to develop new water supplies in the Colorado River system, projects and methods will be needed to manage the risks of additional development.

6.2 Methodology to Evaluate Surface Water Supply Availability

This section provides a summary of statewide surface water and groundwater availability. This update summarizes work to-date completed by the CWCB and the basin roundtables through the development of their basinwide water needs assessments. A comprehensive analysis of water availability for each basin was completed in SWSI 1 (CWCB 2004) and is only partially updated. Future SWSI updates will provide updated water availability analysis in each basin based on additional Colorado Decision Support System (CDSS) modeling tools.

In addition to the analysis of water availability in SWSI 1, the SWSI 2010 update specifically includes an updated analysis for the basins within the Colorado River system as part of the CWCB's Colorado River Water Availability Study (CRWAS), which is summarized here. Updated information is also included for the South Platte Basin based on results of analysis directly associated with the South Platte Basin Roundtable Task Order (CWCB 2009b).

Index

6.1 Water Availability Overview.....p. 6-1
6.2 Methodology to Evaluate Surface Water Supply Availability .....p. 6-1
6.3 Water Availability.....p. 6-2

In another effort related to water availability, statewide drought planning has occurred through the preparation and implementation of the Colorado Drought Mitigation and Response Plan (DMRP) (CWCB and Department of Natural Resources 2010). In 2010, the CWCB conducted a comprehensive revision of the DMRP. The updated plan provides a blueprint for how the state will monitor, mitigate, and respond to drought.

The potential effects of climate change are quantified in the CRWAS, and provided at various locations throughout the Colorado River basins. Reliable climate change analyses are not yet available for the other basins and are not included in this update.

6.3 Water Availability

The purpose of this section is to summarize the available data and studies indicating the level of water availability in each basin and the location of opportunities for further new water supply development.

Table 6-1 below summarizes the findings from SWSI 1 related to water supply development potential under interstate compacts and U.S. Supreme Court decrees. Colorado has entered into and is affected by nine interstate compacts, two equitable apportionment decrees, and one international treaty.

Table 6-1 Major Interstate Compacts, Decrees, and Endangered Species Programs by Basin

River Basin	Flows Legally Available under Compact or Decrees for Future Development	Interstate Compacts, Equitable Apportionment Decrees and Endangered Species Recovery Programs	Year of Compact or Decree
Arkansas		Arkansas River Compact	1948
		Kansas vs. Colorado	1995
Colorado	✓	Colorado River Compact	1922
		Upper Colorado River Basin Compact	1948
		Upper Colorado River Endangered Fish Recovery Program	—
		Rio Grande, Colorado, and Tijuana Treaty between United States and Mexico	1945
Dolores/San Juan/ San Miguel (Southwest)	✓	Colorado River Compact	1922
		La Plata River Compact	1922
		Upper Colorado River Basin Compact	1948
		Animas-La Plata Project Compact	1969
		San Juan River Basin Recovery Implementation Program	—
		Rio Grande, Colorado, and Tijuana Treaty between United States and Mexico	1945
Gunnison	✓	Colorado River Compact	1922
		Aspinall Unit Operations	—
		Upper Colorado River Basin Compact	1948
		Upper Colorado River Endangered Fish Recovery Program	—
		Rio Grande, Colorado, and Tijuana Treaty between United States and Mexico	1945
North Platte/ Laramie	✓	Nebraska vs. Wyoming	1945
		Wyoming vs. Colorado	1957
		Platte River Recovery Implementation Program	—

Table 6-1 Major Interstate Compacts, Decrees, and Endangered Species Programs by Basin, continued

River Basin	Flows Legally Available under Compact or Decrees for Future Development	Interstate Compacts, Equitable Apportionment Decrees and Endangered Species Recovery Programs	Year of Compact or Decree
Rio Grande		Rio Grande River Compact	1938
		Costilla Creek Compact (amended)	1963
		Rio Grande, Colorado, and Tijuana Treaty between United States and Mexico	1945
South Platte	✓	South Platte River Compact	1923
		Republican River Compact	1942
		Platte River Recovery Implementation Program	—
Yampa/White/Green	✓	Colorado River Compact	1922
		Upper Colorado River Basin Compact and Yampa River Portion	1948
		Upper Colorado River Endangered Fish Recovery Program	—
		Rio Grande, Colorado, and Tijuana Treaty between United States and Mexico	1945

These agreements establish how water is apportioned between Colorado and downstream states as well as between the United States and Mexico. Each agreement has a significant effect on the development of future water supplies in Colorado. Additional information about the compacts is provided in Section 1.4.

SWSI 1 found there are no reliable additional water supplies that can be developed in the Arkansas and Rio Grande Basins, except in very wet years. The North Platte Basin has the ability to increase both irrigated acres and some additional consumptive uses, consistent with the North Platte Decrees. The South Platte Basin has water that is legally and physically available for development in wet years, although unappropriated water is extremely limited.

Compact entitlements in the Colorado River Basins are not fully utilized and those basins (Colorado, Gunnison, Southwest, and Yampa-White) have water supplies that are legally and physically available for development given current patterns of water use.

6.3.1 Arkansas Basin

During SWSI 1, it was documented that there are no reliable available surface water supplies for development in the Arkansas Basin except in very wet years. During these high flow years, water could be placed into storage or developed for use in a conjunctive use (e.g., aquifer recharge and recovery) project where nontributary groundwater could be used as a primary supply. In addition, the 1948 Arkansas River Compact plays a major role in limiting supply availability in the basin by restricting water use by post-1948 diversions to times when there would be no depletions to usable stateline flows. These times would only occur under high flows when John Martin Reservoir is spilling. The compact apportions the storage in John Martin Reservoir from the Arkansas River between Colorado (60 percent) and Kansas (40 percent), as administered by the Arkansas River Compact Administration. John Martin Reservoir does not spill very often, with the last spill occurring in 1999. It did not spill between 1965 and 1985.

In addition to infrequent surface water availability, some of the use of nontributary groundwater in the basin will need to be replaced. Currently, 13,350 acre-feet per year (AFY) of nontributary and nonrenewable groundwater is relied upon by water users in unincorporated El Paso County and the Town

of Monument (*Arkansas Basin Consumptive Use Water Needs Assessment: 2030*, CWCB 2008). The Arkansas Basin Roundtable identified that this 13,350 AFY of nontributary groundwater will need to be replaced. This replacement of nontributary groundwater was accounted for and discussed in Section 5 of this report in the municipal and industrial (M&I) gap section.

Unappropriated water in the Arkansas Basin is extremely limited.

6.3.2 Colorado, Gunnison, Southwest, and Yampa-White Basins

Gunnison River

CWCB's CRWAS analyzed water availability in the Colorado River Basins. Upon completion of the CRWAS Phase 1 study, an addendum to the SWSI 2010 report will be developed summarizing the results of the study for these basins.

The CRWAS Phase 1 Study is comprised of four interrelated components or steps (CWCB 2010b):

1. Update and expand the state's water availability computer simulation tools based on input solicited from water users (consumptive and nonconsumptive) through the basin roundtables, the Interbasin Compact Committee, and other public forums.
2. Assess potential water availability using records of historical water supplies.
3. Use scientific analyses and datasets previously developed by others to estimate streamflows over the past several hundred years, which was done using annual growth of trees (especially as an indicator of transitions between wet and dry years and as an indicator of the potential lengths of dry and wet periods). This extended natural flow hydrology was used to assess remaining water availability as if today's water uses existed throughout the extended period.
4. Superimpose the effects of potential changes in precipitation and temperature from previously developed global climate models (GCMs, also known as General Circulation Models) to reflect hydrologic conditions that may exist in 2040 and 2070 if the greenhouse gas emissions occur as postulated in the various scenarios ("storylines") simulated by the GCMs.

CRWAS compared future supply and current demand to determine whether there is enough water to meet either current demands based on the "supply-and-demand equation:"

Future Supply – Current Demand = Water Available for Future Consumptive Use

CRWAS Phase 1 held the demand side of the water availability equation constant at current levels (adjusted for changes in irrigation water requirements) and considered three different conditions for the water supply side of the equation as follows.

6.3.2.1 Historical Hydrology

Traditionally, water supply agencies use recorded historical information on water supply as an indication of likely future conditions; the premise being that history tends to repeat itself. Many agencies in Colorado used streamflow records dating back to at least 1950 so they could consider the impacts of the 1950s multi-year drought on the reliability of their systems. CWCB developed natural flow hydrology back to 1909 in the Colorado River Basin in Colorado, but this required filling missing records or records for discontinued stream and weather gages with scientifically estimated values. For the purposes of CRWAS, a 56-year study period is used to represent historical hydrology (1950 through 2005). This period includes both very wet and very dry years, contains

Historical hydrologic conditions are characterized by the record of natural flows at hundreds of points throughout the basin

the most reliable historical data upon which to base comparisons of the effects of climate change, and uses information that Colorado River stakeholders can relate to through their own experiences. Historical hydrologic conditions are characterized by the record of natural flows at hundreds of points throughout the basin; basin-scale record of precipitation, temperature, and wind disaggregated to thousands of cells in a rectangular grid covering the entire Colorado River Basin; and a record of local weather recorded at 54 weather stations within Colorado.

6.3.2.2 Paleohydrology

This approach extends historical records using information from more than 1,200 years of previously published tree-ring records. The CRWAS reviews alternative methods for correlating annual tree growth with streamflow and concludes that a "re-sequencing" approach best serves the needs of the study. This approach focuses on the probabilities of transitioning back and forth between wet and dry years. The lengths of the wet periods and dry periods have significant effects on water availability for future use, especially when combined with the effects of climate change. Development of 100 equally-probable 56-year-long flow traces test the effects of more severe droughts on water supply and management in Colorado and on the state's amount of water available for future consumptive use (CU) as potentially constrained by the compacts under various assumptions.

CRWAS reviews alternative methods for correlating annual tree growth with streamflow

6.3.2.3 Climate-Adjusted Hydrology

This approach assesses the magnitude of future water supply availability considering the effects of climate change scenarios. CRWAS reviews information from the climate projections that are available for the Colorado River Basin. Working with the Front Range Climate Change Vulnerability Study, CRWAS identified five projections for each of the 2040 and 2070 planning horizons (10 total). CWCB utilizes the state's Climate Change Technical Advisory Group, comprised of many federal, state, private scientists, water resource engineers, and managers to conduct a technical peer review of the approach and methods used in handling GCM data.

The Variable Infiltration Capacity model is used to translate changes in temperature and precipitation from the selected GCMs to changes in natural flows throughout the river basin. In Colorado, the potential climate-induced changes have been introduced into two models comprising the state's CDSS. First, "StateCU" is used to estimate CU of water by crops resulting from the generated higher temperatures and longer growing seasons. Second, "StateMod" is used to simulate the water management (for example, diversions, return flows, reservoir operations, and instream flows) that would result from changes in natural flows. Input of the basin roundtables during Phase I significantly enhanced the river operations of the models in the CDSS.

The CWCB is currently in the process of updating CRWAS based on comments received on the draft report. After Phase I of the study is completed, CWCB will issue an addendum to the SWSI 2010 report that summarizes the results of the study.

6.3.3 North Platte Basin

North Platte River

The North Platte River Basin Decree is a Supreme Court decree that limits the total irrigation in Jackson County to 145,000 acres and 17,000 acre-feet (AF) of storage for irrigation in each season. It also limits total water exports from transbasin diversions from the North Platte River in Colorado to no more than 60,000 AF during any 10-year period. However, there are no explicit limits on other types of uses such as M&I uses.

Currently, Colorado has additional capacity under the decree. However, the amount of capacity available under the North Platte Decree is also limited by the Platte River Recovery Implementation Program. Under this program, the North Platte River depletions plan includes the "one bucket concept." Under this concept, the North Platte Basin has the ability to meet future consumptive water needs associated with municipal, industrial, piscatorial, wildlife, and environmental uses by restricting and foregoing future irrigated acreage below the 134,467 historically irrigated acres.

6.3.4 Rio Grande Basin

Rio Grande River

SWSI 1 found that as a result of compact limitations, there is very infrequent available flow in the Rio Grande for use in Colorado and that these flows, as in the Arkansas, do not provide a reliable source for new supply development. Analyses of available flows found the following:

1. Colorado attempts to meet compact obligations each year, with little or no surplus or deficit. This is accomplished through regularly "curtailing" Colorado water users in order to meet stateline delivery requirements.
2. Slight over- or under-delivery from year to year is carried forward in the Colorado "account" and affects administration in subsequent years.
3. When Elephant Butte Reservoir in New Mexico spills, Colorado's credit and surplus on compact deliveries are canceled. Elephant Butte Reservoir spilled six times between 1950 and 1997.
4. During periods when Colorado has not reached its compact credit limit, and there is not a spill at Elephant Butte Reservoir, there is no available flow.

As was noted in Section 4, an estimated decline in irrigated acres of 80,000 acres is anticipated to protect the water table and senior water rights in the San Luis Valley. To bring about the reduction, groundwater management subdistricts were established. Special Improvement District No. 1 (the "subdistrict") was created for the closed basin in Water District 20. An amended plan of water management was created for the subdistrict; this amended plan was adopted and approved by the Division 3 Water Court subject to the terms and conditions outlined in the decree dated May 27, 2010. However, this ruling has been appealed to the Colorado Supreme Court. The Trinchera Water Conservancy District was established as a subdistrict for its area in Water District 35 but no water management plan has been developed. The State Engineer's Office is expected to issue rules for the Rio Grande Basin to facilitate well owners in the other water districts moving forward with getting subdistricts established and management plans approved.

6.3.5 South Platte Basin

South Platte River

As part of its needs assessment, the South Platte Basin Roundtable conducted additional water availability analysis that built upon the SWSI 1 findings. Several water allocation models have been developed to determine legally-available flow at various points throughout the basin. The state of Colorado through the CWCB and the Division of Water Resources is currently developing surface and groundwater models for the South Platte Basin through the South Platte Decision Support System (SPDSS). Since the SPDSS models are not yet completed, older results from Denver Water's model, PACSM, the Northern Integrated Supply Project (NISP) study, and the Lower South Platte River Water Management and Storage Sites Reconnaissance Study (LSPWMSSR) were used to illustrate legally available supplies. These studies use different period of records (PORs), have varying assumptions of the development of existing conditional storage rights, do not reflect the recent change in river administration, and are not directly comparable. However, they are used for illustrative purposes to show limited availability in the Metro and South Platte Basin. Table 6-2 shows the POR, model, minimum, median, average, and maximum available flows. Figure 6-1 shows the location and median amount of legally-available water based on the various models. As noted, there are varying assumptions incorporated into these models and many may not reflect current river administrative practices; therefore, these results should be viewed as illustrative, pending more detailed results. Recent Denver PACSM results for availability at the Henderson and Kersey gages were not available and are not shown in the table or graph.

Table 6-2 South Platte Basin Water Allocation Models Summary

Gage Location	Model	POR (Water Year)	Min (AF)	Median (AF)	Average (AF)	Max (AF)
Near South Platte	PACSM	1950-1980	0	**2,000**	30,452	235,000
Chatfield	PACSM	1950-1980	0	**2,000**	36,000	289,000
Henderson[1]	PACSM	1950-1980	0	**155,000**	196,300	559,000
Kersey[1]	NISP	1950-2001	0	**162,100**	305,500	1,672,500
Sedgwick	LSPWMSSR	1944-1998	0	**70,800**	198,000	1,722,500

[1] Values for Henderson and Kersey are best available estimates pending updated Denver PACSM results

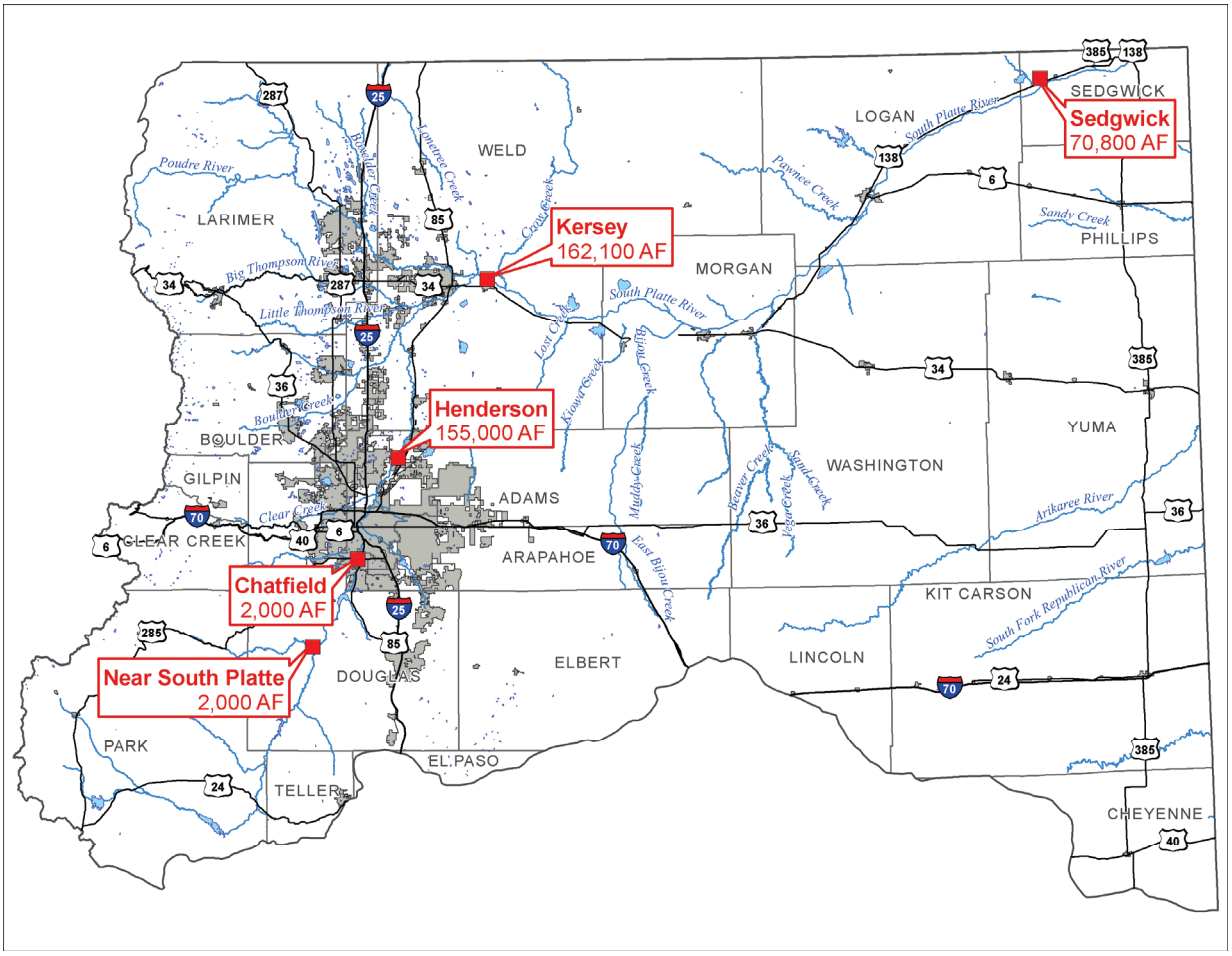


Figure 6-1 Estimated Median Amount of Available Flows in South Platte Basin Based on Various Models

Results from water allocation models can be used to generate firm yield to storage curves (yield curves). The yield curve uses water availability data to determine how much storage is needed to reliably yield a given amount of water assuming no monthly shortages. Figure 6-2 shows the yield curve for the South Platte River at Chatfield Reservoir. The curve shows storage to yield ratios of approximately 10:1 up to about 4,000 AFY of firm yield. Additional firm yield would require significant additional volumes of storage. For example, 10,000 AFY of firm yield at this location would require nearly 325,000 AF of storage. This may not meet the needs for some users of firm supplies. However, it constitutes a valuable opportunity for users in the southern portions of the Metro Basin that may be able to capture average yields in greater amounts than the firm yields to offset groundwater pumping.

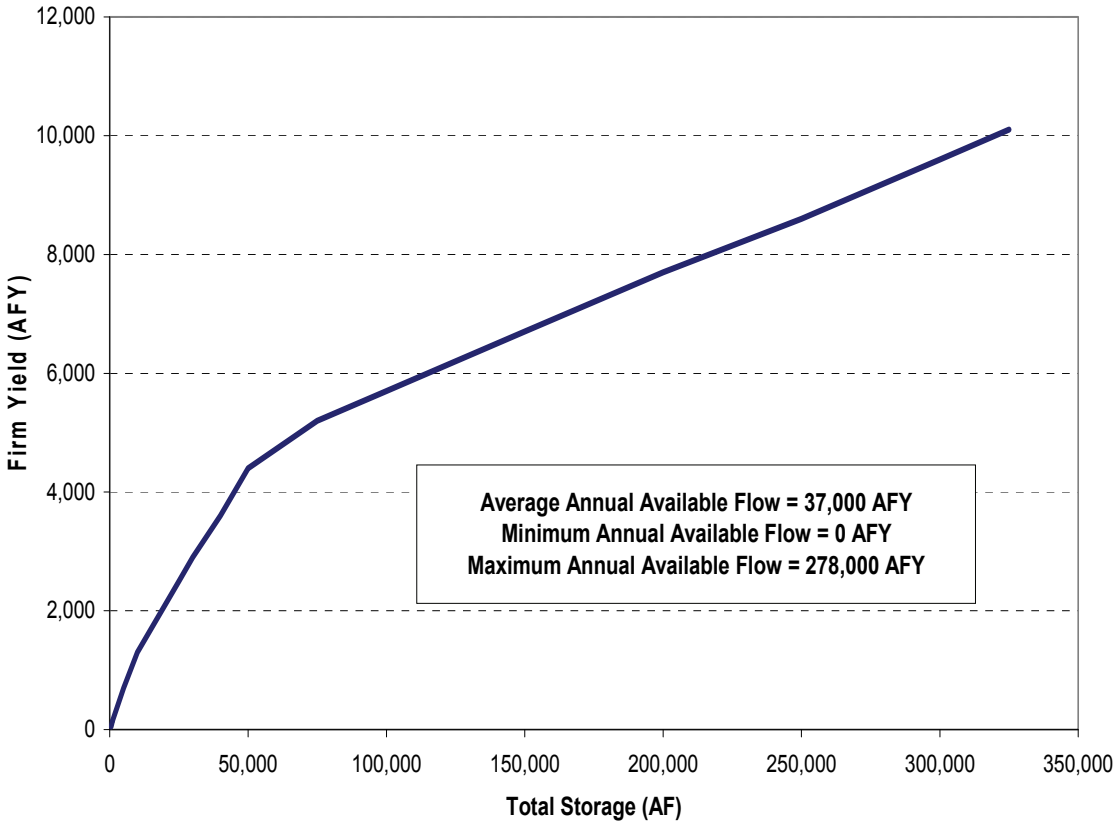


Figure 6-2 Yield Curve, South Platte River below Chatfield

Based on the analyses conducted by the South Platte Basin Roundtable, it was concluded that beyond the implementation of the basin's identified projects and processes, there is little to no unappropriated water remaining in the Metro and South Platte Basins that can produce a firm yield in the upper and lower portions of the South Platte River Basin. A large amount of storage would be required to obtain firm yield from storage in extremely wet years where water may be available for appropriation. This water would have to be carried over in storage over multiple dry years with annual evaporation and seepage losses.

In addition to limited surface water availability, some of the nontributary groundwater supplies in the South Metro area need to be replaced. As was discussed in Section 5 of this report, the Metro Basin Roundtable anticipates that 20,850 AFY of nontributary groundwater will need to be replaced in the South Metro area.

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Section 7
Portfolios and Strategies to Address the M&I Gap

7.1 Portfolio Approach Overview

The Colorado Water Conservation Board (CWCB) recognizes that Colorado faces significant and immediate water supply challenges and should pursue a mix of solutions to meet the state's consumptive and nonconsumptive water supply needs. Because of the growing municipal and industrial (M&I) demands described in Section 4 and the need to sustainably meet Colorado's nonconsumptive (Section 2) and agricultural (Section 4) water supply needs described in Section 5, the CWCB, Interbasin Compact Committee (IBCC), and Colorado's water community began a visioning process in 2008. Colorado's water community asked itself, if we let Colorado's water supply continue to develop according to current trends and existing policy, what will our state look like in 50 years? Is this our vision of the future of Colorado and if not, what can and should we do to effect changes?

The visioning process included three parts as shown in Figure 7-1—1) a Vision Statement, 2) Vision Goals, and 3) Water Supply Strategies. These terms are specifically defined as follows:

Figure 7-1 Elements of the Visioning Process

1. **Vision Statement** – This represents, in the broadest sense, the overall directive or mission. It describes "what" is to be achieved.
2. **Vision Goals** – These define the goals of the vision, and more importantly represent the benchmarks for the evaluation of strategies. The Vision Goals will play an important role in evaluating the performance of water supply strategies. This represents the "why" portion of the vision.
3. **Water Supply Strategies** – Strategies represent "how" we will achieve the Vision Statement. The performance of strategies is compared against the Vision Goals in order to see how well we are doing in achieving the overall Vision Statement. These strategies will lead to implementation.

The IBCC discussed and generally agreed on the following draft Vision Goals, which constitute Colorado's water management objectives:

- Meet M&I demands
- Meet agricultural demands
- Meet Colorado's environmental and recreational demands

Index

7.1 Portfolio Approach Overview.....p. 7-1
7.2 Strategy Elements of Colorado's Future Water Supply Portfolio .....p. 7-5
7.3 Portfolio Analysis .....p. 7-30

Vision Statement

We envision a Colorado that balances municipal, industrial, agricultural, environmental, and recreational water needs and promotes cooperation among all water uses.

- Encourage cooperation between water supply planners and land use planners
- Encourage more cooperation among all Colorado water users
- Optimize existing and future water supplies by:
  - Considering conservation as a baseline water supply strategy
  - Minimizing non-beneficial consumptive use (CU) (evaporation, nonnative phreatophytes, etc.)
  - Maximizing successive uses of legally reusable water
  - Maximizing use of existing and new in-basin supplies
- Promote cost-effectiveness by:
  - Allocating costs to all beneficiaries fairly
  - Achieving benefits at the lowest cost
  - Providing viable financing mechanisms, including local, state, and federal funding/financing
  - Mitigating third-party economic impacts
- Minimize the net energy used to supply water, including both the energy used and/or generated with raw water delivery, and the energy used for treatment
- Protect cultural values by:
  - Maintaining and improving the quality of life unique to each basin
  - Maintaining open space
- Provide operational flexibility and coordinated infrastructure
- Promote increased fairness when water is moved between basins by:
  - Benefiting both the area of origin and the area of use
  - Minimizing the adverse economic and environmental impacts of future water projects and water transfers

- Comply with all applicable laws and regulations, meet all applicable compact obligations, and protect water rights including the right of water right owners to market their water, while recognizing some institutional changes may be needed to implement certain strategies
- Educate all Coloradoans on the importance and scarcity of water, and the need to conserve, manage, and plan for needs of this and future generations

The CWCB and IBCC have utilized the visioning process to address Colorado's future M&I gap. As discussed in Section 5 of this report, Colorado will need an additional 190,000 to 630,000 acre-feet/year (AFY) beyond what is currently being planned for by local water providers in order to meet future M&I water demands and replace reliance on nonrenewable groundwater.

The visioning process led to the realization that the current approach for water management – the status quo – will not lead to a desirable future for Colorado. The status quo will likely lead to large transfers of water from agricultural to municipal uses. Maintaining the status quo could result in loss of agricultural lands, harm to ecosystems and recreation-based economies, water-inefficient land use decisions, and

continued paralysis of water supply projects. In addition, costs associated with the status quo could cost Colorado's citizens billions of dollars more than a coordinated approach.

With general agreement that the status quo approach to water management will not lead to a desirable future for Colorado, the IBCC and CWCB began scenario planning. Traditional planning efforts typically examine one predictive future. The scenario planning process is not intended to represent forecasts of the future, but to represent a wide range of potential future conditions that may impact M&I water supply and demand. A summary of the future scenarios is summarized in Figure 7-2.

This approach was used because of the broad scale nature of this effort and because many factors are largely outside the control of water managers, such as population growth, oil shale development, climate change, and weather patterns. The approach is based on being able to vary M&I demands on a low, medium, and high basis as presented in Section 4 of this report. After the future M&I demand scenario is chosen, different portfolios of solutions to meet the M&I demand can be constructed.

In 2009, CWCB developed a "portfolio and trade-off tool," which allowed the CWCB, IBCC, and basin roundtable members to test various water supply portfolios for different M&I demand scenarios and understand the implications of such. The portfolios that can be developed using the tool include different mixes of identified projects and processes (IPP) success, conservation, agricultural transfers, and new supply development. In addition, the tool examines several trade-offs to these scenarios, including the loss of irrigated acres, the capital cost of the portfolio, and potential impacts to nonconsumptive flows.

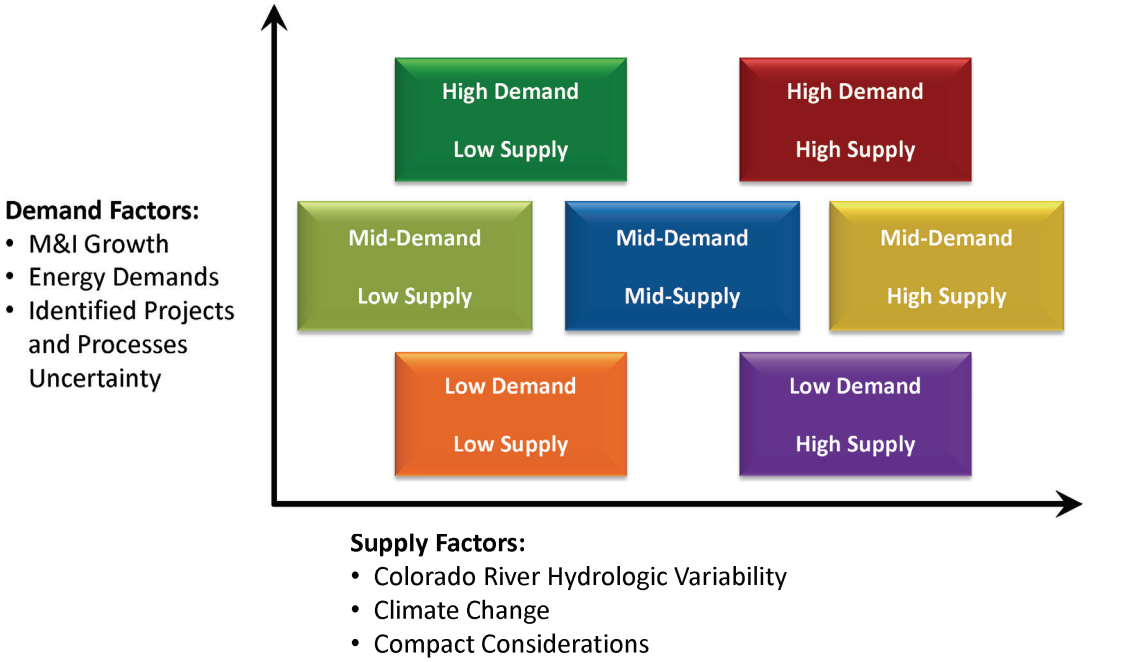


Figure 7-2 Colorado's Water Supply Future Water Demand and Supply Scenarios

As described above, the portfolio approach considers different future conditions and combinations of water supply strategies to address each scenario. Each ***scenario*** represents a different, but plausible, representation of circumstances that would result in differing statewide consumptive and nonconsumptive water demand and water supply. As shown in Figure 7-2, seven different future scenarios are being considered. ***Portfolios*** are combinations of strategies that collectively meet statewide water demands. Portfolios can be developed for each future scenario. ***Strategies*** are broad categories of solutions for meeting Colorado's consumptive and nonconsumptive water supply needs and include both demand and supply side strategies. To date, the CWCB and IBCC have considered strategies for conservation, agricultural transfers, and new water supply development. Finally, the CWCB, IBCC, and basin roundtables identified projects and methods to meet their future consumptive and nonconsumptive needs. ***Projects and methods*** are specific actions that help implement each strategy. For example, a water project helps implement a new water supply development strategy, a rotational fallowing program helps implement an agricultural transfer strategy, and a block rate pricing program helps implement a conservation strategy.

Figure 7-3 summarizes the portfolio elements that can be used to address future M&I demands. The left side of the figure shows the general category of the portfolio elements—agricultural transfer, Colorado River system, conservation, and IPPs. These portfolio elements represent strategies to address future M&I demands. The right side of the figure shows example projects and methods that could be used to implement the strategies. After examining the trade-offs associated with the status quo portfolio, which relies mostly on traditional transfers for agricultural water to municipal uses using the portfolio and trade-off tool, the CWCB and IBCC found that it is clear that no one strategy can meet Colorado's growing water needs without harming values important to all Coloradoans. Therefore, a mix of water supply solutions is needed and this mix of solutions should include all four sources (conservation, IPPs, agricultural transfers, and new supply development) to meet the water supply gap in Colorado while also protecting Colorado's significant water-dependent ecological and recreational resources.

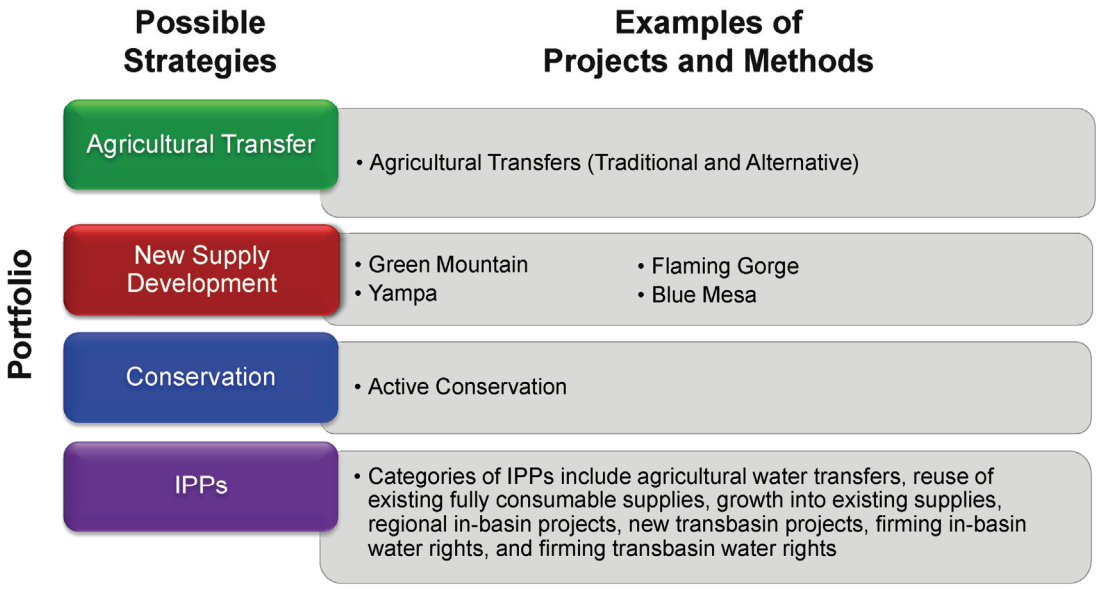


Figure 7-3 Portfolio Elements to Address Colorado's Future M&I Demands

In summary, this section describes the work that CWCB and IBCC have completed to-date with respect to developing information about future water supply strategies in the context of the portfolio and trade-off tool. This section contains a description of the status quo portfolio, which will inevitably lead to a large transfer of water out of agriculture resulting in significant loss of agricultural lands and potential harm to the environment. Providing an adequate water supply for Colorado's citizens, agriculture, and the environment will involve implementing a mix of local water projects and processes, conservation, reuse, agricultural transfers, and the development of new water supplies, all of which should be pursued concurrently. To help weigh the trade-offs between possible mixes of strategies, the CWCB developed preliminary information for the following strategies— conservation, alternative and traditional agricultural transfers, and new supply development. It should be noted that at this time the CWCB and IBCC have agreed that a mix of strategies and solutions are necessary to meet Colorado's future M&I demands, however agreement has not been reached on what an alternative portfolio should include.

7.2 Strategy Elements of Colorado's Future Water Supply Portfolio

As discussed above, the CWCB and IBCC agreed that a mix of strategies and solutions are necessary to meet Colorado's future M&I demands. Figure 7-4 shows example output from the CWCB's portfolio and trade-off tool. The left side of Figure 7-4 shows hypothetical future M&I demands. The M&I demands included in the portfolio and trade-off tool include the self-supplied industrial (SSI), oil shale, and M&I water needs presented in Section 4 and Appendix H of this report. In addition, the left side of Figure 7-4 indicates that passive conservation savings will result in demand reductions in the future that will not need to be addressed in the water supply portfolio. Passive conservation savings are discussed in Section 4 of this report and in Appendices H, K, and L. The right side of Figure 7-4 shows an example portfolio to address the future M&I needs and includes a mix of strategies including IPPs, conservation, new supply development (including additional reuse of new supply where possible), agricultural transfers (including additional reuse of transferred consumptive use where possible), and land use planning.

7.2.1 Identified Projects and Processes Portfolio Element

Section 5 and Appendix J of this report describe the basin roundtables' IPPs in detail. IPPs, if successfully implemented, have the ability to meet some, but not all of Colorado's 2050 M&I water needs. Implementation of these local projects and processes are critical to meeting Colorado's future water supply needs. As discussed, the different categories of IPPs include:

- Agricultural water transfers
- Reuse of existing fully consumable supplies
- Growth into existing supplies
- Regional in-basin projects
- New transbasin projects
- Firming in-basin water rights
- Firming transbasin water rights

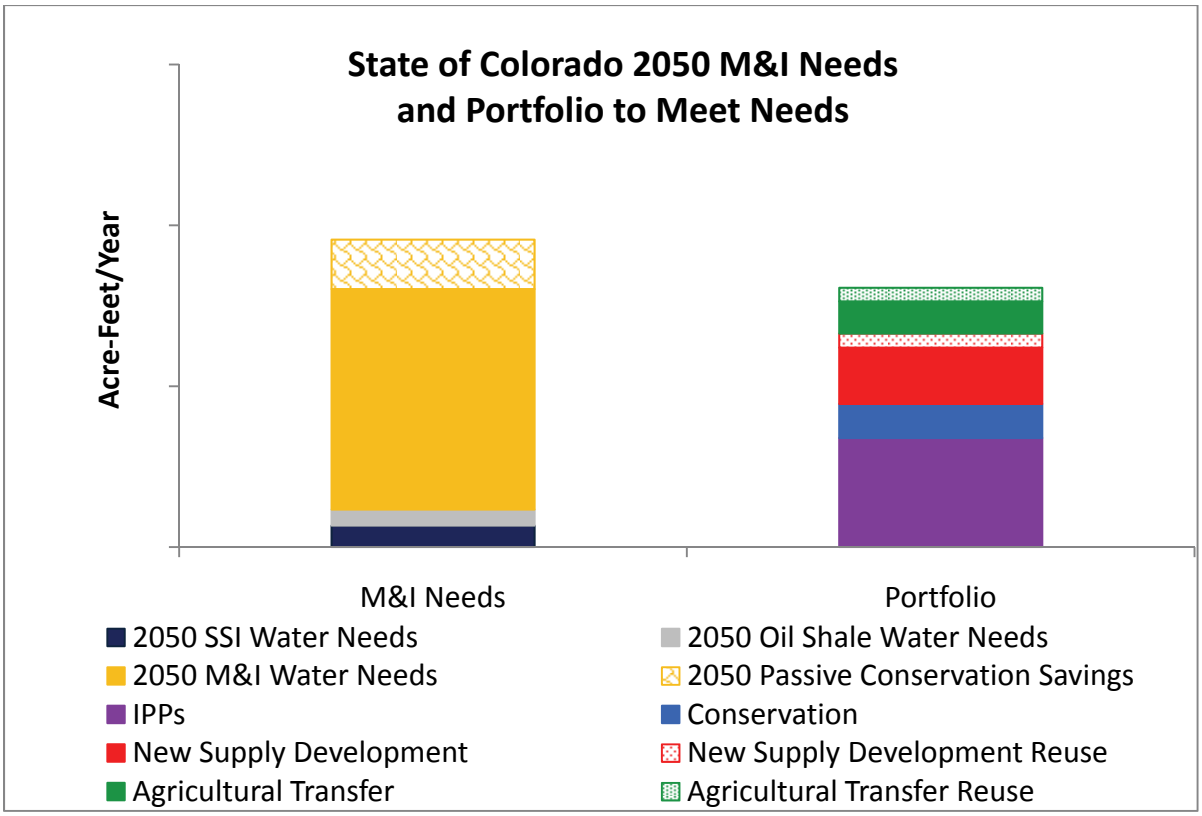


Figure 7-4 Example 2050 M&I Needs and Associated Portfolio from Portfolio and Trade-off Tool

As discussed in Section 5, the IPPs are expected to yield between 430,000 and 580,000 AFY by 2050 if all (100 percent) of the IPPs are successful; however, it is unlikely that the IPPs will be 100 percent successful. Table 7-1 shows IPPs success rates that were discussed by the IBCC during 2009 and 2010. The IBCC started with discussions regarding the status quo success rate of the IPPs and discussed that it is important to increase the success rate of the IPPs. The assumed status quo and increased success rates are detailed by basin in Table 7-1. As presented in Section 5, the range of the M&I gap based on 100 percent IPP success rates for the low gap scenario and the status quo IPP success rates in Table 7-1 for the high gap scenario is estimated to be between 190,000 and 630,000 AFY by 2050.

Table 7-1 IPP Success Rates Considered by IBCC

Basin	IBCC Alternative Portfolio IPP Yield Success Rates	IBCC Status Quo Portfolio IPP Yield Success Rates
Arkansas	90%	75%
Colorado	90%	90%
Gunnison	90%	90%
Metro	60%	50%
North Platte	90%	90%
Rio Grande	90%	90%
South Platte	60%	40%
Southwest	75%	75%
Yampa-White	90%	90%

The IBCC and CWCB found that implementing the IPPs is critical to minimizing the water supply gap, but IPPs should be implemented in a way that balances the state's responsibilities to protect and restore Colorado's natural resources. The state, through its various agencies, has differing responsibilities ranging from protecting the environment to helping secure necessary water supplies.

The CWCB, several roundtables, and the IBCC agree that there are significant challenges facing the successful implementation of IPPs. These challenges include the need for better coordination between state agencies and with federal permitting entities. Therefore it was found that there should be a better defined and coordinated state role in working with IPPs so that this strategy can be utilized successfully in the portfolio. IPPs need to be implemented and begin delivering water in the near term to prohibit an M&I water supply gap beginning in the near future. Ultimately a total of approximately 350,000 AFY of treated water deliveries, about 70 percent IPP success rate statewide, will need to be successfully implemented and online by 2030 under the medium gap scenario described in Section 5.

7.2.2 Conservation Portfolio Element

Water conservation will be an important tool for meeting future M&I demands, and is one piece of a larger water supply portfolio. CWCB developed the *Statewide Water Supply Initiative (SWSI) 2010 Municipal and Industrial Water Conservation Strategies Report* (Appendix L). This document represents the latest effort by the CWCB to integrate water conservation into overall water supply planning and to estimate the statewide water conservation potential up to the year 2050.

The CWCB defines water conservation as those measures and programs that provide for measurable and verifiable permanent water savings (CWCB 2010c).[1] The purpose of the information provided in the conservation strategy is to update the range of potential future water conservation savings since SWSI 1 and 2, provide water conservation strategies that may contribute toward meeting the projected 2050 M&I water supply gap as presented in Section 5 of this report, and help address Colorado's future M&I water needs[2].

As discussed above, water conservation is assumed to be one of several water supply strategies that Colorado will need to rely on to meet future M&I water demands. The conservation savings forecasts presented in the conservation strategy are intended for statewide planning purposes and are not intended to replace water conservation and water resources planning and projections prepared by local entities. The analysis presented here estimates potential future water conservation for three distinct strategies—low, medium, and high water conservation savings. This analysis looked at the potential savings from water conservation measures but does not determine the portion of those savings that could potentially be utilized toward meeting a future water supply gap. There are also other significant assumptions and limitations associated with this analysis and are further described in Section 7.2.2.3 of this report.

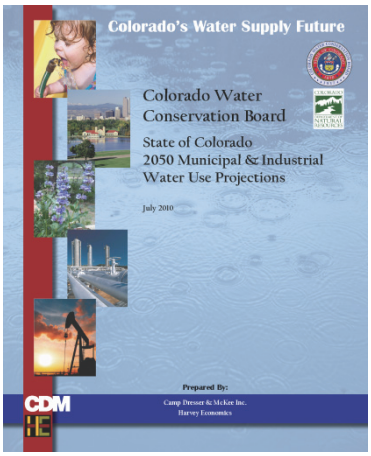
[1] Under this definition, water conservation may include measures and programs that are being implemented for political reasons and/or to improve customer satisfaction.

[2] Colorado's 2050 M&I water demands include water demands associated with SSI users – large industrial users that have their own water supplies or lease raw water from others. The potential water conservation savings provided in this SWSI 2010 update include only savings from the M&I demands associated with a typical municipal system. Potential SSI water savings are not estimated.

7.2.2.1 Three Conservation Strategies: Low, Medium, and High

Methodology

The potential for future conservation by the year 2050 was estimated for three distinct conservation strategy scenarios titled simply—low, medium, and high. Water savings in 2050 were forecast for each river basin in Colorado using a conditional demand forecasting methodology that employed a set of efficiency targets, sectoral demand reductions, and assumed implementation rates. Each strategy includes an overview of the conservation measures and programs that could be implemented to achieve a range of efficiency targets (for indoor use) and estimated sectoral conservation savings that were based upon the best available literature and data on demand management. The conservation savings forecasts are conditional and rely on an assumption of implementation at the described levels in order to achieve the overall estimated savings level.



The SWSI 2010 water conservation projections are founded upon the 2050 demand projections prepared under the *Colorado Water Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections* report (CWCB 2010d). Using the basin-level per capita current baseline water use data and 2050 population projections, this report disaggregates water demands in key water use sectors—residential and nonresidential indoor and outdoor uses and utility water loss. Water demands and conservation savings were estimated using a driver multiplied by rate of use approach, where the driver is population in each basin and the rate of use is in gallons per capita per day (gpcd) in each basin.

The conditional forecasting methodology used for this SWSI 2010 update assumes that the identified strategies will be implemented and does not account for water providers' management decisions, such as storing a portion of the savings for drought planning or using a portion to improve stream flows for environmental or recreational benefits. Management decisions consider legal, temporal, and spatial constraints that must be understood at a local utility level, and should be part of integrated resource planning that considers the specific water rights portfolio, system reliability, drought response, etc.

Conservation Strategies: Implementation Rates and Savings Levels

Table 7-2 presents a comparison of the low, medium, and high conservation strategies. Savings and measures for each water use sector are presented and the key demand reduction modeling assumptions for each sector are shown in **bold blue** font. The conservation strategy measures that apply to each sector are listed as bullet points beneath each demand reduction assumption. Table 7-2 includes the implementation/penetration levels and ranges that are assumed to be achieved by 2050 to accomplish the demand reductions.

Table 7-2 Comparison of 2050 Implementation and Penetration Level for Three Conservation Strategies and Demand Reductions Used in Forecasts

Measure	Implementation or Penetration Level by 2050		
	Low Strategy	Medium Strategy	High Strategy
Systemwide conservation measures with potential to impact all customers			
Public information and education	~100%	~100%	~100%
Integrated resources planning	~100%	~100%	~100%
Conservation-oriented water rates	~100%	~100%	~100%
Water budget-based water rates	<=10% of utilities implement	<=30% of utilities implement	<=50% of utilities implement
Conservation-oriented tap fees	0 - 5% of utilities implement	5 - 10% of utilities implement	<=50% of utilities implement
Smart metering with leak detection	<=10% of pop.	<=50% of pop.	50 - 100% of pop.
Residential indoor savings and measures			
Reduction in Residential Per Capita Indoor Use	**Res. Indoor gpcd = 40**	**Res. Indoor gpcd = 35**	**Res. Indoor gpcd = 30**
Conservation-oriented plumbing and building codes, green building, rules for new residential construction	30-50% of state impacted	50-70% of state impacted	70-100% of state impacted
High efficiency toilets, clothes washers, faucets, and commercial, industrial, and institutional equipment	Passive ~100%	Passive ~100%	Passive ~100%
Submetering of new multi-family housing	0%	~50%	~100%
Reduction in customer side leakage	33% savings - passive from toilet replacement	37% savings - passive from toilet replacement and active repairs	43% savings - passive from toilet replacement and active repairs
Non-residential indoor savings and measures			
Reduction in Non-Residential Per Capita Indoor Use	**15% reduction**	**25% reduction**	**30% reduction**
High efficiency toilets, urinals, clothes washers, faucets, and showers	Passive ~100%	Passive ~100%	Passive ~100%
Conservation-oriented plumbing and building codes, green building, rules for new non-residential construction	30-50% of state impacted	50-70% of state impacted	70-100% of state impacted
Specialized non-residential surveys, audits, and equipment efficiency improvements	0-10% of utilities implement	10-50% of utilities implement	50-80% of utilities implement
Landscape conservation savings and measures[1]			
Landscape water use restrictions (residential and non-residential)	**15% reduction**	**22-25% reduction**	**27-35% reduction**
Targeted audits for high demand landscape customers	0-30% of utilities implement	30-50% of utilities implement	50-80% of utilities implement
Landscape transformation of some high water requirement turf to low water requirement plantings	<=20% of landscapes	20-40% of landscapes	>50% of landscapes
Irrigation efficiency improvements	<=10% of landscapes	<=50% of landscapes	50-100% of landscapes
Utility Water Loss Control			
Improved utility water loss control measures	**<=7% real losses**	**<=6% real losses**	**<=6% real losses**

[1] Landscape water demand reductions include the anticipated impact of urban densification.

Broad conservation measures such as education and rates that impact across all customer sectors are presented at the top of Table 7-2. These broad measures are assumed to support and contribute to the savings levels estimated for each customer sector.

The demand reductions presented in Table 7-2 represent feasible levels of conservation savings based on an extensive review of the literature on the impacts of conservation measures and programs. Although these savings measures may be technically achievable, they are by no means automatic, and will require significant and sustained effort and investment by the state and local governments, by water providers, and by water customers.

The conservation measures presented in Table 7-2 are largely based on the recently published *Best Practices Guide for Municipal Water Conservation in Colorado* (Colorado WaterWise [CWW] 2010). Implementation levels are engineering estimates designed to be achievable and to deliver substantive water savings. Detailed cost-effectiveness analysis was not conducted for this study and should be the subject of future research; however, all water saving strategies were based on program measures determined to be cost-effective from the water provider perspective (CWW 2010).

Water Savings in 2050 Under Three Conservation Strategies

The total estimated water savings that may be achieved through implementation of the three conservation strategies are presented in Table 7-3. In Table 7-3 the water savings from each SWSI 2010 strategy builds upon the previous strategy starting with the passive savings.

Table 7-3 Statewide Forecast Water Savings Potential from SWSI 1, SWSI 2, and SWSI 2010[1]

Project	Level	2030 Forecast Savings[2] (AFY)	2050 Forecast Savings[2] (AFY)
SWSI 1	Level 1 (Passive)	101,900	NA
	Level 2	170,533	
	Level 3	272,852	
	Level 4	443,385	
	Level 5	699,183	
SWSI 2	Low	287,000	NA
	Mid	372,000	
	High	459,000	
SWSI 2010	Passive[3]	131,000	154,000
	Low	209,000	314,200
	Medium	264,000	485,200
	High	328,100	615,300

Notes:

1 Total water savings potential included, which does not decipher the portion of the savings that may be available to meet future demands versus other planning uses such as drought reserve. In addition, this analysis does not address issues such as the spatial, temporal, and legal availability of the potential savings.

2 Volumes savings estimates are total cumulative and include passive savings (e.g., SWSI 1, Level 3 savings build upon Levels 1 and 2; SWSI 2010, medium savings build upon low savings).

3 From SWSI levels analysis (CWCB 2010).

The SWSI levels analysis of statewide passive water conservation potential showed that by 2050, demands will likely be reduced by about 150,000 AFY through the natural replacement of toilets, clothes washers, and other standard domestic fixtures (CWCB 2010). In Table 7-3, these passive savings are embedded in all three conservation strategies. The SWSI 2010 conservation strategies add savings from active conservation program efforts to the passive savings estimates.

If successfully implemented to the levels described, in 2050, the low strategy plus passive savings results in estimated statewide water savings of 314,200 AFY. In 2050, the medium strategy plus passive savings results in estimated statewide water savings of 485,200 AFY and the high strategy plus passive savings results in estimated statewide water savings of 615,300 AFY.

In Table 7-4, the passive and active water savings estimates are presented separately to help ensure double counting of water savings does not occur in the future as these estimates are used.

Table 7-4 Statewide Forecast Water Savings (Separating Passive and Active) Potential from SWSI 1 and SWSI 2010[1]

Project	Level	2030 Forecast Savings[2] (AFY)	2050 Forecast Savings[2] (AFY)
SWSI 1	Level 1 (Passive)	101,900	NA
	Level 2 (active only)	68,633	
	Level 3 (active only)	170,952	
	Level 4 (active only)	341,485	
	Level 5 (active only)	597,283	
SWSI 2010	Passive[3]	131,000	154,000
	Low (active only)	78,000	160,200
	Medium (active only)	133,000	331,200
	High (active only)	197,100	461,300

Notes:

1 Total water savings potential included, which does not decipher the portion of the savings that may be available to meet demands associated with new population versus other planning uses such as drought reserve. In addition, this analysis does not address issues such as the spatial, temporal, and legal availability of the potential savings.

2 Volumes savings estimates are total cumulative and include passive savings (e.g., SWSI 1, Level 3 savings build upon Levels 1 and 2; SWSI 2010, Medium savings build upon Low savings).

3 From SWSI Levels analysis (CWCB 2010).

To provide perspective on how estimates of conservation savings have been adjusted over the past decade a summary of the statewide demand forecasts and total water savings in 2030 and 2050 developed for the SWSI 2010 update are presented in Table 7-3, along with similar forecasts from the SWSI 1 (2004), SWSI 2 (2007), and the recent SWSI levels (2010) analysis. This includes passive savings, which is constant in all strategies.

SWSI 2010 savings are estimated through 2050 rather than 2030, but 2030 savings are available for comparison against SWSI 1 and SWSI 2 estimates. Water savings estimated to be achieved by 2030 from the low, medium, and high SWSI 2010 strategies are generally smaller in magnitude than the 2030 savings estimates developed in the SWSI 1 and SWSI 2. The SWSI 2010 savings estimates are smaller because many water providers in Colorado have already reduced demand over the past 10 years particularly in response to the 2002 drought. Overall, statewide gpcd has decreased by 18 percent since the SWSI 1 report was completed; however, the cause and permanency of these savings is uncertain (CWCB 2010d). Changes in systemwide gpcd may be due to a combination of factors including conservation efforts, behavioral changes from the 2002 drought (i.e., a "drought shadow"), changes in a community's socio-economic condition, and/or better data. Better data and information account for a significant portion of these observed changes according to the team that developed the baseline demand profiles (CWCB 2010d).

In Table 7-4, forecasted passive and active conservation savings are compared. The data in Table 7-4 are the same as in Table 7-3, only the passive savings are not included for each program level. Data from SWSI 2 have not been included in Table 7-4 because passive and active savings are not disaggregated in that analysis.

7.2.2.2 Cost Estimates

The SWSI 2 analysis effort included a weighted utility program implementation cost estimate of $10,600/acre-foot (AF) of water saved for implementing the identified conservation measures. The SWSI 2010 includes similar utility cost estimates, but because of the methodology utilized to develop water savings forecasts that aggregated savings by end use sector, creating a single weighted average of the cost/AF of conservation was not possible. Customer side costs were not included because, as with all other SWSI 2010 supply strategies (i.e., agricultural transfers and new supply projects), only the direct utility costs for implementing conservation were considered. Water users must ultimately bear the costs of all new water supplies, but consideration of the customer-side costs for conservation implementation was beyond the scope of this effort. Because the SWSI 2010 conservation strategies rely on codes, ordinances, and the natural replacement of fixtures and appliances (passive savings) to a large extent, it is anticipated that the implementation costs/AF of savings will be significantly lower than what was estimated for SWSI 2, which included substantial rebates and financial incentives to spur savings.

Since cost estimates are necessary for planning purposes, per AF utility-side estimates for the SWSI 2010 low, medium, and high conservation strategies were developed using the SWSI 2 weighted average of $10,600/AF for all active savings and a cost of $0/AF for all passive savings. This analysis yielded an average utility cost of $5,358/AF savings for the high strategy. For comparison, a recent study prepared by the Western Water Policy Program and the University of Colorado titled *Relative Costs of New Water Supply Options for Front Range Cities* found an average per AF cost for water conservation program implementation of $5,200/AF of conserved water (Kenney et al. 2010). Improving understanding of the costs associated with implanting water conservation strategies is an important area for future research and analysis. An incremental cost analysis may be useful toward understanding the break points between costs to implement the low, medium, and high savings strategies as costs are likely to increase for the medium and high strategies.

7.2.2.3 Assumptions and Limitations

There are important caveats and assumptions regarding the water conservation strategies that should be understood so that the results are not misinterpreted or misapplied.

Conditional Statewide Strategies to Assess Conservation Potential – These three strategies were used to prepare a conditional demand forecast. The savings estimates presented are expected to be achieved if the programs and measures described are implemented at the specified level across the entire state. The medium and high strategies in particular will require a significant and sustained effort in order to achieve the forecast water savings. The forecasting assumptions do not reflect differences that exist between individual water providers. Each water provider in Colorado is distinct and it is anticipated that over the next 40 years water conservation will be implemented differentially across the state. In order to prepare statewide forecasts of conservation potential it was assumed that the potential to conserve water may exist irrespective of an individual water provider's need or desire to conserve. In reality, some providers will need little if any conservation savings to meet future demands while others will seek substantial demand reductions.

Permanency of Existing Conservation Efforts – The water savings projections in this report are conditioned on post-drought baseline demands, and assume water conservation savings since the 2002 drought period will be sustained into the future. The permanency of post-drought related reductions in water use is uncertain. Some of this uncertainty may be resolved as additional water utility-level data are obtained and further investigated. Additional and improved data is anticipated through future utility water conservation plans and under data reporting requirements established in Colorado House Bill (HB) 10-1051.

Climate Change Not Considered – The impacts of climate change on water demands were not included in this analysis. Time and budgetary limitation did not allow for this complexity to be included. Climate change is an important factor for consideration in conjunction with future water demands and should be included in subsequent forecasting efforts.

The Future is Uncertain and Water Use May Change – It is impossible to predict all of the technological and cultural changes that could occur over the next 40 years, which might impact water use. The trends over the past 15 years have been towards greater efficiency and lower use and at this moment in time, there is no indication that these trends will not continue (Coomes et al. 2010). However, it is possible that new uses for water could emerge in the future, which might increase municipal demand (e.g., increased use of evaporative cooling, increased installation rates of swimming pools, spas, and/or multi-headed showering systems). Unanticipated demand increases could counteract some of the savings estimated in this report, even if conservation programs are implemented at the specified levels. Similarly, technology could also serve to reduce future water demands below those estimated here. Updating the baseline condition and demand forecasts regularly is the best way to incorporate unanticipated future changes.

Uses of Conserved Water Are Not Assumed – No assumptions have been made about the portion of the water savings forecast in this report that could potentially be utilized toward water supply, serving new customers, or meeting the M&I gap. Each water provider must decide how best to apply water garnered from demand reductions within their individual water supply portfolio. Utilities will need to make these decisions based on their integrated water resources planning efforts, consideration of their system's reliability throughout drought periods, impacts of conservation on their return flows and availability of reusable supplies, effectiveness of water rates and impacts to their revenue streams, and other local considerations. Subsequent efforts will be needed to help determine what portion of active conservation savings can be applied to the M&I gap.

Impacts from New Construction – A substantial number of new homes and businesses will be constructed throughout the state between now and 2050. The projections provided for this basin-level planning effort do not distinguish between savings that will be achieved from existing versus new construction. Actual savings may be attributed more to higher efficiency new construction in portions of the State, particularly where more dense development occurs.

7.2.3 Land Use and Water Supply Planning

Colorado's water community recognizes that there needs to be a closer connection between land use planning and water supply planning. However, this should take place at the local government level with encouragement and support from the state. To help promote cooperation between water supply planners and land use planners, the CWCB and the Western States Water Council conducted a Water and Land Use Planning symposium in 2009. This symposium brought together diverse participants from special districts, cities and counties, state and federal agencies, and nongovernmental organizations, including policy and decisionmakers, planners, developers, and regulators to look at water and land use patterns, share experiences and concerns, identify problems and potential solutions, discuss obstacles and opportunities, and develop recommendations to better integrate and scale water and land use planning for a sustainable future. The group attending the symposium acknowledged that integrating water and land use planning at different scales is increasingly important as we strive to meet challenges related to growth, climate change, and sustainability in the arid West.

The findings from the Water and Land Use Planning symposium and subsequent report (CWCB 2010e) included:

- **Need for Data:** Currently there is not much data regarding the ability of denser and more sustainable developments to reduce water demand in Colorado. This data is necessary so that developers and city and county planners can understand what the best management practices and methodologies are, and reliably how much water savings they could expect.
- **Role of the Market:** As the value of water continues to increase, the market may naturally lead to more water efficient developments. However, it is not clear if current market conditions are sufficient. (Only 8 percent of Colorado buildings meet Leadership in Energy and Environmental Design standards, for instance, despite being fifth in the nation for these types of buildings.) Therefore, incentives to catalyze the market in ways that will reduce future per capita water demand should be considered.
- **Infrastructure Replacement:** Research from the Brookings Institute shows that approximately 75 percent of the Front Range's housing is going to be replaced or remodeled by 2050. This provides an opportunity to determine how to make this infrastructure replacement more reliably water efficient.
- **Regional Collaborative Planning:** Several case studies and presentations indicate that localized solutions are not effective, since water demand is simply transferred from one jurisdiction to one or many others. Therefore, regional solutions are critical and should be further explored.
- **Integration:** Many other efforts are currently underway that could reduce regional water demand, but are not specifically aimed at achieving that purpose. There are many opportunities for developing partnerships with other water conservation efforts, sustainable/walkable neighborhood developments, energy conservation and CO_2 reduction programs, water quality programs, food security programs, transportation projects, market drivers, and many others.

For the purposes of water supply planning, CWCB has assumed that increases in density are inversely correlated with water usage rates. Assuming that for single family homes 50 percent of the water is used indoors and 50 percent outdoors, water savings can be estimated with each increment of density increase. A general rule implies that a 20 percent increase in density would yield a 10 percent per capita water savings. Although significant savings can result from changes in density, these changes are usually outside of the control of water providers. For a more detailed analysis on potential savings from increases in density refer to CWCB's March 2010 draft technical memorandum *Calculating Per Capita Water Demand Savings from Density Increases to Residential Housing for Portfolio and Trade-off Tool*.

Land use is not included as a quantitative element in the portfolio analysis described in Section 7.3 below. Landscape water demand reductions associated with the active conservation strategy presented above include the anticipated impacts of urban densification.

7.2.4 Agricultural Transfer and New Supply Development Portfolio Elements

The remaining portfolio elements that the CWCB and IBCC considered in addressing Colorado's future M&I demands are transfers of water from agricultural to municipal use and the development of new supplies from the Colorado River system. For agricultural transfers both traditional and permanent transfers of agricultural water to municipal uses have been considered as well as alternatives to permanent transfers. These strategies were first examined in SWSI 2 under direction of CWCB and two technical roundtables. The Alternatives to Permanent Agricultural Transfers Technical Roundtable examined alternative methods to permanent transfers of water rights for M&I purposes. The Addressing the Gap Technical Roundtable addressed options to fill the M&I gap and recommended that agricultural transfer (traditional or alternative) and new supply development strategies be examined.

To address the SWSI 2 recommendations as well as requests by the CWCB Board and IBCC, CWCB staff examined six water supply concepts that are shown in Figure 7-5. There are two agricultural transfer concepts—one would deliver water from lower or middle Arkansas River to Reuter-Hess Reservoir and another that would deliver water from the lower or middle South Platte River downstream of Denver to the Brighton area. While agricultural transfers may occur on the West Slope, the analysis presented here focuses on the East Slope because that is where the majority of past, present, and future transfers are likely to occur. On the West Slope, new appropriations, rather than acquisitions, are the primary focus. The four new water supply appropriation concepts that were studied are the Flaming Gorge concept, Yampa River concept, Green Mountain Reservoir concept, and Blue Mesa Reservoir concept.

The remainder of Section 7.2.4 provides an overview of both the agricultural transfer and new supply development strategies. A discussion of recent efforts by the CWCB and IBCC regarding alternative transfer methods to permanent transfers is included as well as next steps taken to-date to examine the new supply development strategy. Finally, the Addressing the Gap Technical Roundtable, CWCB Board, and IBCC recommended that reconnaissance level cost estimates be developed for the strategies as a starting point for further evaluation. These cost estimates are also included in this section.

7.2.4.1 Agricultural Transfer Strategy Overview

The basic attributes of the agricultural transfer strategy concepts are summarized in Table 7-5. For each concept, Table 7-5 describes the water source, conveyance and storage, water quality and treatment considerations, and the technical implementability issues. As noted in Table 7-5, the Lower Arkansas Valley Water Conservancy District (LAVWCD) formed the Super Ditch as an alternative to traditional agricultural transfers. Regardless of whether traditional or alternative agricultural transfer methods are used as a mechanism for supplying water for this portfolio element, similar issues for conveyance and storage, water quality and treatment, and technical implementability will need to be considered. For both traditional and alternative agricultural transfers, the source water quality is such that reverse osmosis (RO) or advanced water treatment will be required for implementing these strategies.

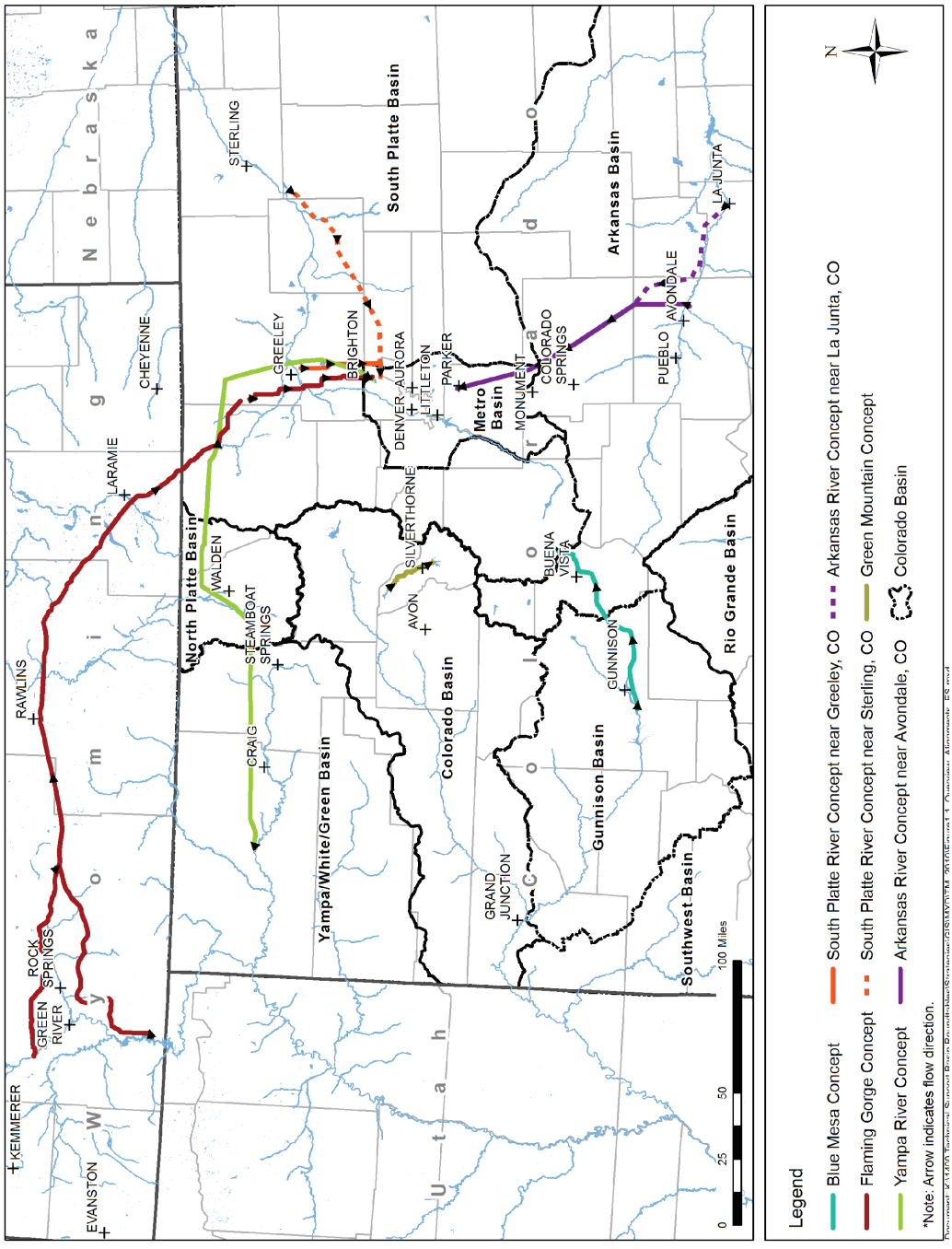


Figure 7-5 Overview of Agricultural Transfer and New Supply Development Concepts

Table 7-5 Agricultural Transfer Strategy Concepts Attributes

Concept	Water Source/ Water Rights	Conveyance and Storage	Water Quality and Treatment Costs	Technical Implementability
Lower South Platte	• South Platte agricultural water rights • Cost of water rights may decrease further downstream and away from urban areas	• Water pumped 36 to 84 miles with static pumping requirement of 700 to 1,300 feet • Conveyance costs will increase the further downstream the source is located • Firming storage required	• Water quality will decrease further downstream and treatment costs will increase • Expected Total Dissolved Solids (TDS) levels of 750 to 1,200 milligrams per liter (mg/L) • RO or advanced water treatment will be required	• If land is permanently dried up from an agricultural transfer will require revegetation • Recent water quality legislation allows water quality impacts for transfers over 2,000 AF to be reviewed as part of an agricultural transfer (C.R.S. 37-92-305 (4)(a)(V))
Lower Arkansas	• Arkansas agricultural water rights • Cost of water rights will likely decrease further downstream and away from urban areas • LAVWCD has formed the Super Ditch as an alternative to traditional agricultural transfer	• Water pumped 96 to 133 miles with static pumping requirement of 3,100 to 3,600 feet • Conveyance costs will increase the further downstream the source is located • Firming storage required	• Water quality will decrease further downstream and treatment costs will increase • Expected TDS levels of 500 to 2,000 mg/L • RO or advanced water treatment will be required	• If land is permanently dried up from an agricultural transfer will require revegetation • Recent water quality legislation allows water quality impacts for transfers over 2,000 AF to be reviewed as part of an agricultural transfer (C.R.S. 37-92-305 (4)(a)(V))

The following information in Table 7-6 outlines benefits, impacts, and additional opportunities presented for the Lower South Platte and Lower Arkansas agricultural transfer concepts. This information was developed by the basin roundtable members through outreach by CWCB staff during 2009. A benefit is defined as something that adds overall value. An impact is defined as something that has a negative value. Opportunities are defined as what could be added to a project in order for it to move forward as a more viable strategy, and includes some mitigation measures.

Table 7-6 Benefits, Impacts, and Opportunities for Agricultural Transfer Strategy – Traditional and Alternative Agricultural Transfers

Benefits	Impacts	Opportunities
Agricultural Transfer Strategy		
Lower and Mid-South Platte Concept		
Less reliance on additional deliveries from headwaters areas, thus minimizing streamflow impacts in environmentally sensitive areas	Water quality is poor and treatment costs (capital and operations and maintenance [O&M]) are high	Potential to collaborate with remaining agricultural users to construct lower basin storage or recharge facilities to improve agricultural yields or provide for well augmentation
Reduces need for future development of new supplies including transbasin diversions	Disposal of treatment waste stream concentrate is a challenge and very costly	Shared infrastructure among water providers, resulting in economies of scale for capital and O&M
Potentially no net increase in depletions to the river system (assuming only the consumptive use portion is transferred)	Loss of irrigated acreage in production annually regardless of the type of agricultural transfer	Can provide for coordinated acquisition of agricultural rights for either a traditional or alternative transfer preserving higher quality/value agricultural production
	Significant energy requirements for pumping and water treatment	Conjunctive use with non-tributary groundwater can potentially improve the overall project operation
	Socio-economic impacts to rural communities	
Lower Arkansas Concept		
Less reliance on additional deliveries from headwaters areas, thus minimizing streamflow impacts in environmentally sensitive areas	Water quality is poor and treatment costs (capital and O&M) are high	Potential to collaborate with remaining agricultural users to construct lower basin storage or recharge facilities to improve agricultural yields or provide for well augmentation
Decreases the need for additional transbasin diversions	Transfer to South Metro Area may be of concern	Shared infrastructure among water providers, resulting in economies of scale for capital and O&M
No net increase in depletions to the river system	Disposal of treatment waste stream concentrate is a challenge and very costly	Can provide for coordinated acquisition of agricultural rights for either a traditional or alternative transfer preserving higher quality/value agricultural production
	Loss of irrigated acreage in production annually regardless of the type of agricultural transfer	Conjunctive use with non-tributary groundwater can potentially improve the overall project operation
	Significant energy requirements for pumping and water treatment	

7.2.4.2 Alternative Agricultural Transfer Methods

It is likely that the transfer of agricultural water rights to M&I uses will continue in the coming decades. In order to minimize the negative socioeconomic impacts to rural communities that can result from such transfers, there is a desire to identify alternatives to traditional "buy-and-dry" transfers. The CWCB, IBCC, and the Colorado Water Congress have indicated their support for the facilitation of alternative agricultural transfer methods.

Rotational fallowing, interruptible supply agreements, fallowing-leasing agreements, water banks, purchase and lease-backs, deficit irrigation, and changing crop type are options that have been identified as potentially available as alternatives to permanent agricultural transfers. With the exception of purchase and lease-backs and some short-term fallowing-leasing agreements, these alternative agricultural transfer methods (ATMs) are just beginning to be explored as viable options for meeting other water demands. While promising, there are numerous technical, legal, institutional, and financial issues associated with ATMs that need further study. CWCB and others are currently exploring ways to address these issues and to stimulate greater awareness, interest, and participation from agricultural water users and municipalities with alternative agricultural water transfers, while still being careful to protect other water rights. Many of these efforts have been funded by CWCB's Alternative Agricultural Water Transfer Methods Grant Program and a summary of the results of the projects funded by this program are summarized in Appendix M.

Through the CWCB's ATM program, numerous hurdles have been identified that will need to be overcome for these alternative water transfer methods to be successful in Colorado. They include the need to develop specific methodologies for measuring, calculating, and monitoring the amounts of water that can be made available through ATMs without injury to other water rights; the potentially high transaction costs associated with water rights transfers; water rights administration uncertainties; water rights accounting questions; the procedures needed for protection of other water rights; and ways to increase the certainty and permanence of long-term supply that may be made available through ATMs.

Potentially High Transaction Costs – Currently, there are few incentives for water providers to seek alternatives to permanent water transfers. The cost of water court adjudication for changes of use is sometimes quite large, and absorbing that cost for a temporary transfer or other ATM could be a disincentive. Establishing a viable administrative process for approving ATMs without always facing a potentially expensive water court process has been raised by some as a needed incentive to encourage participation in ATM programs. Reducing transaction costs while still protecting other water rights, and providing the tools needed for proper oversight by Division of Water Resources (DWR) staff could be incentives that may help alternative agricultural transfer programs to succeed.

Water Rights Administration and Accounting Issues – While alternative agricultural transfer methods may be permissible under Colorado water law, there is some uncertainty as to how these alternative methods would be administered by the Division Engineer. They may require significant work by the Division Engineers and the water commissioners to properly administer an alternative program as compared to a permanent dry-up of irrigated agricultural lands. Other water users expect that the DWR will provide the impartial oversight needed to verify that an irrigator is not expanding his water right and that other water right holders are not injured. It may be that a third-party could provide the verification and report to the Division Engineer paid for by the city and/or farmers. However, additional tools and methodologies are needed before water users can be assured that this can and will be done.

Certainty/Permanence of Long-Term Supply – Municipal water providers made it clear that they are interested in securing permanent and firm-yield water supplies for their portfolios. An issue often raised in the ATM discussion is the need to reduce the uncertainty and address the permanence of supply for municipal water providers so they would be willing to participate in an alternative agricultural transfer program. Additional discussion is needed about how an alternative agricultural transfer program can work within a municipal provider's overall water strategy to provide firm yield, such as using dry-year leases or interruptible water supply agreements to provide for future dry-year water needs.

A subcommittee comprised of IBCC members and ATM grant recipients recommends three steps that should be pursued in the near term to facilitate the development of alternative agricultural transfers and to advance our understanding about how they can be measured and administered.

1. **Peer-reviewed studies are needed to develop specific methodologies for measuring, calculating, and monitoring the amounts of water that can be made available through alternative agricultural transfers without injury to other water rights.** It appears likely that some of the grant applications in the upcoming funding round of the ATM program and the Water Supply Reserve Account will address one or more components of this methodological question. If not, the IBCC recommends continued funding and support for encouraging such research through the basin roundtables, CWCB, or other funding sources.

2. **Additional research is needed to explore how alternative agricultural transfers would be administered by the Division Engineer and related entities.** In addition to the above information about how alternative agricultural transfers would be quantified and monitored, there is a need to develop specific information about how ATMs would be brought into the existing water rights administration process, how downstream water rights would be protected, and other related issues. Additional tools and methodologies are likely needed and should be developed.

3. **Amendments to the existing interruptible supply contract statute should be considered to facilitate longer-term agricultural fallowing-leasing programs.** Amendments to the statute on interruptible supply contracts have been suggested to facilitate the longer-term temporary transfer of irrigation water rights via fallowing-leasing agreements to another user. This could include allowing the State Engineer to approve these transfers (using a process similar to existing authority to approve substitute water supply plans) without requiring the potentially high transactional costs associated with a water court change case, while still providing that other vested water rights and decreed conditional water rights are not injured. Any proposed amendment to this statute should take into consideration the differences between basins, and this recommendation is made with the understanding that any amendment may need to be basin-specific.

The Subcommittee also recommended that the IBCC consider the following during its 2011 activities:

1. **Presumptive consumptive use**—In some areas, the adoption of presumptive historical crop CU procedures might help to streamline the process of using a water right through fallowing-leasing agreements. It is suggested that any presumptive CU amounts would need to be conservative in nature to minimize concern and opposition by other water right holders. Additional discussion is needed to consider how and where these could be developed and how they could work.

2. **Determining historical consumptive use analysis for a canal or ditch system**—A ditchwide assessment of CU could also streamline the process for some ATMs. For example, this could provide both the irrigators and cities some additional certainty before negotiating lease/fallowing agreements. This might significantly reduce the engineering and other transaction costs for a rotational fallowing program or other ATM. Additional work is needed to discuss how and where these could work to incentivize alternative transfers rather than to facilitate permanent water transfers.

3. **State funding of infrastructure cost**—Another incentive is for the state to help fund infrastructure (e.g., pipelines, supervisory control and data acquisition systems, storage, etc.) necessary to help ATMs work. Additional work is needed to define how this could work to encourage the use of ATMs.

4. **Transferring a portion of a water right**—Many of the ATM programs being pursued in Colorado are examining the potential of transferring for M&I purposes a portion of the historical CU of a water right through deficit irrigation, different crop types, and/or irrigation scheduling. This type of transfer could be permanent or temporary. While the transfer of water in this manner is possible under current Colorado water law, it has not yet been tested in water court or codified by the General Assembly. This increases the uncertainty associated with these types of transfers. Additional discussion is needed to evaluate whether changes are needed to encourage the use of these ATMs.

7.2.4.3 New Supply Development Strategy Overview

The basic attributes of the new supply development strategy concepts are summarized in Table 7-7. For each concept, Table 7-7 describes the water source, conveyance and storage, water quality and treatment considerations, and the technical implementability issues. For the Flaming Gorge and Blue Mesa concepts, the water supply would be acquired through the Bureau of Reclamation (BOR) marketable pool for each reservoir. For the other new supply development concepts, the water supply acquisition would be a new appropriation. The Green Mountain, Flaming Gorge, Yampa River, and Blue Mesa Reservoir concepts would not require advanced water treatment unlike the agricultural transfer strategy. Other important attributes are summarized in more detail in Table 7-7.

Table 7-7 New Supply Development Concepts Attributes

Concept	Water Source/ Water Rights	Conveyance and Storage	Water Quality and Treatment Costs	Technical Implementability
Green Mountain	• Blue River water in the Colorado River basin as well as new South Platte water rights • Water would likely be a new appropriation unless Denver Water conditional rights can be used • New appropriation may require significant firming storage and legal availability related to endangered fish need to be resolved for a new appropriation • Compact issues and legal availability need to be resolved or a new appropriation	• Water pumped 22 miles with static pumping requirement of 1,100 feet • Green Mountain storage will need to be replaced with other storage • Firming storage estimates vary significantly • Will depend on negotiations with Denver Water for terms of use of Dillon Reservoir and Roberts Tunnel • Conveyance on East Slope would be via South Platte River	• Relatively high water quality • Conventional treatment technology • Pumping high-phosphorus water to Dillon may be a concern	• Landslides in Green Mountain Reservoir from reservoir drawdown may limit ability to fully use storage in reservoir

Table 7-7 New Supply Development Concepts Attributes, continued

Concept	Water Source/ Water Rights	Conveyance and Storage	Water Quality and Treatment Costs	Technical Implementability
Yampa	• New water rights appropriation • Compact issues and legal availability related to endangered fish need to be resolved for a new appropriation	• Estimated 500,000 AF of off-channel West Slope storage would need to be constructed • East Slope storage also required • Would require approximately 250 miles of pipeline, with static pumping requirement of 5,000 feet • Pumping, pipeline, and tunneling required to deliver water to northern area of South Platte basin • Conveyance on East Slope would be via pipelines to the south Denver metropolitan area	• Moderate water quality • Estimated water quality higher than Lower South Platte, Lower Arkansas, or Flaming Gorge • Conventional treatment technology	• Constructible and permittable West Slope diversion, storage sites, and pipeline routes need to be verified
Flaming Gorge	• Contract with BOR for water from the Flaming Gorge marketable pool, to the extent the BOR is willing to contract out of the pool and it is not opposed by other Colorado River basin states • Compact issues and legal availability and administration of depletions in Wyoming for use in Colorado need to be resolved	• Volume of firming storage required will be dependent on terms of BOR contract • Limited Flaming Gorge storage may be available • Volume of firming storage is unknown • 357 to 442 miles of pipeline to the south Denver metropolitan area with static pumping requirements of 1,400 to 3,100 feet	• Would likely require higher level of treatment than other West Slope options • TDS is higher than other West Slope options but lower than Lower South Platte or Arkansas • Conventional treatment technology	• Constructible and permittable West Slope diversion, storage sites, and pipeline routes need to be verified

Table 7-7 New Supply Development Concepts Attributes, continued

Concept	Water Source/ Water Rights	Conveyance and Storage	Water Quality and Treatment Costs	Technical Implementability
Blue Mesa Reservoir	• Contract with BOR for water from the Aspinall pool • Possibility for new appropriation options influenced by Black Canyon reserved right and agreement with BOR or interruption of power generated by Aspinall Unit. • Compact issues and legal availability need to be resolved and legal availability related to endangered fish need to be resolved for a new appropriation	• Volume of firming storage required will be dependent on terms of BOR contract • Limited or no Blue Mesa storage may be available • 81 miles of pipeline with static pumping requirement of 3,400 feet • Conveyance on East Slope would be via South Platte and Arkansas Rivers	• Relatively high water quality • Conventional treatment technology	• Constructible and permittable West Slope diversion, storage sites, and pipeline routes need to be verified

Table 7-8 outlines benefits, impacts, and additional opportunities presented for the new supply development concepts. This information was compiled based on discussions with the basin roundtables during 2009. Similar to the agricultural transfer information above, a benefit is defined as something that adds overall value. An impact is defined as something that has a negative value. Opportunities are defined as what could be added to a project in order for it to move forward as a more viable strategy, and includes some mitigation measures.

Table 7-8 Benefits, Impacts, and Opportunities for New Supply Development Strategy

Benefits	Impacts	Opportunities
New Supply Development		
Green Mountain Concept		
Reduces loss of irrigated acres in South Platte and Arkansas Basins	Potential for increased compact call	Delivery to North Fork of South Platte upstream of Denver Metro area for gravity delivery to Denver Water customers and other water providers
Utilization of Colorado's Colorado River compact entitlement	Additional in-basin storage	Protect or enhance Blue River flows
Additional flows in Upper South Platte	Diminished flows in rivers below proposed diversions with potential increases in TDS and other water quality impacts	Exchanges for additional flows in Colorado headwaters
Could be coordinated with Grand County streamflow management	Phosphorus levels in Dillon Reservoir	Multi-purpose storage for endangered species and other Colorado Basin needs
Potentially additional Grand Valley water supplies	Green Mountain Reservoir levels	Wolcott Reservoir for future West Slope demands

Table 7-8 Benefits, Impacts, and Opportunities for New Supply Development Strategy, continued

Benefits	Impacts	Opportunities
New Supply Development, continued		
Green Mountain Concept, continued		
Maintain Dillon Reservoir Levels	Streamflow impacts from Green Mountain Reservoir/Wolcott Reservoir Swap	Ability to exchange water for Summit County M&I purposes
Additional water supplies for the upper Blue River		
Blue River flow enhancement		
Additional west slope supplies		
Partial abandonment of some Eagle River rights		Recreation component for Wolcott Reservoir
Yampa Concept		
Reduces loss of irrigated acres in South Platte and Arkansas Basins	Potential for increased compact call	Multiple Front Range delivery locations
Utilization of Colorado's Colorado River Compact entitlement	Large energy requirements	West Slope and East Slope storage
Acceptable quality water source that may not require advanced water treatment processes	Endangered species on Yampa and Green Rivers	East Slope hydropower facilities
	Dinosaur National Monument located downstream of proposed diversion	Exchanges for additional flows in Colorado headwaters
		Infrastructure for irrigation of additional acres in Moffat County (20,000 to 30,000 acres of land could be irrigated)
		Water for future municipal development particularly in Steamboat and Craig. (Upper basin interests have previously secured about 60,000 AF subordinations to protect future uses and they have indicated they would want a similar subordination or component of the project.)
		Operational agreements to benefit the endangered species recovery program
		Operational agreements to maintain environmental and recreational flows on the lower Yampa
Flaming Gorge Concept		
Reduces loss of irrigated acres in South Platte and Arkansas Basins	Potential impacts to endangered fish recovery program and other depletion issues on the Green River	Delivery to in-basin users for agricultural, augmentation, and instream flows
Acceptable quality water source that may not require advanced water treatment processes	Enlargement or construction of additional storage in South Platte or Arkansas	Exchanges for additional flows in Colorado headwaters
Utilization of Colorado's Colorado River Compact entitlement without impacting streamflows in Colorado	Large energy requirements	Conjunctive use with non-tributary Denver Basin aquifer in dry years
Allows water development while protecting environmental and recreational flows in Colorado	Potential for increased compact call	Aquifer storage and recovery terminal storage in the Denver Basin, Upper Black Squirrel, etc.

Table 7-8 Benefits, Impacts, and Opportunities for New Supply Development Strategy, continued

Benefits	Impacts	Opportunities
New Supply Development, continued		
Flaming Gorge Concept, continued		
Diversifies the state's water supplies. (The Green River is north of the Colorado's current water supplies. Climate change models for the western U.S. indicate that precipitation may decrease in the Southwest and may increase in the North with the dividing line often splitting Colorado. Adding a more northerly water supply could mitigate potential risks from climate change.)	Complexity of water rights administration (compact call or dry years on the Green River)	Project can be configured to encourage certain density patterns, and/or landscaping
	Additional storage in the South Platte or Arkansas basins (surface water storage or underground storage).	Project can be configured to encourage different conservation measures
		Maximum utilization of fully consumable water either through M&I reuse or "second use" by East Slope agriculture
		Operational agreements to benefit the endangered species recovery program
		Tie diversions to Lake Powell levels to avoid triggering a compact call
		Potential for small hydropower and use of renewable energy sources

In addition to the work by the basin roundtables, the IBCC agreed that new supply development should be used to meet both East Slope and West Slope needs. The IBCC also noted that transbasin diversion projects in addition to those already planned and in operation will be controversial. However, the necessity, size, and impact of such a project will be informed by the success of the IPPs, conservation, and alternative agricultural transfers. Some differences remain with some of the IBCC members. For example, some believe that if we are to prevent the loss of significant amounts of agricultural land, new water supply projects will be necessary even with implementation of aggressive conservation measures. There are others who have stated that water supply from a new transbasin diversion project may not be needed right away if the IPPs, conservation, and reuse are aggressively pursued and successfully implemented. However, the IBCC recognizes that concurrent planning for new supplies needs to begin now to ensure these supplies are developed and available to fill the gap when needed. Further, the IBCC recommends that any new supply should adequately address both Colorado River Compact curtailment risks and water supply certainty issues.

7.2.4.4 Reconnaissance Level Capital and Operation and Maintenance Costs for Agricultural Transfer and New Supply Development Strategies

Developing reconnaissance level costs is one element of the strategy evaluation process. The IBCC and CWCB are currently considering other factors in addition to cost as part of their ongoing efforts to address how Colorado will meet its future water needs. These efforts have included developing vision goals of which cost-effectiveness is one element in the overall visioning process. A detailed technical memorandum on reconnaissance level costs was developed for the following water supply and delivery concepts (Appendix N):

1. Middle and Lower South Platte
2. Middle and Lower Arkansas
3. Yampa River
4. Flaming Gorge
5. Green Mountain Reservoir
6. Blue Mesa Reservoir

With the exception of the Green Mountain concept, each of the agricultural transfer and new supply development concepts were evaluated based on three options:

- Option 1: delivery of 100,000 AFY constructed in a single phase.
- Option 2: delivery of 250,000 AFY constructed in a single phase.
- Option 3: delivery of 250,000 AFY, constructed with the first phase delivering 100,000 AFY and the second phase delivering the remaining 150,000 AFY. This option includes investment of a sufficient amount of funds needed for the second phase up front, and using returns on this investment to help fund the project.

Key elements of each water supply concept were identified and evaluated using uniform assumptions to determine infrastructure requirements and sizing for the reconnaissance cost estimates. The assumptions and requirements of each concept are presented below for the following elements—water rights; firming storage; diversions; transmission facilities, including pipelines, tunneling, and pump stations; treatment facilities; and reuse infrastructure. Hydropower facilities were not considered for this technical memorandum, nor electrical power substation and transmission facilities.

The maximum expected water supply yield from the Green Mountain concept is 68,600 AFY, which is less than the Option 1 delivery of 100,000 AFY. Therefore, only one scenario, 68,600 AFY total deliveries constructed in a single phase, was evaluated for the Green Mountain concept. The total delivery of 68,600 AFY consists of 42,500 AFY from the pumpback, 10,500 AFY from the new South Platte water right, and 19,800 AFY in West Slope demands met, including 4,200 AFY met by a decrease in Colorado Springs' substitution obligations.

Flaming Gorge is the only concept with two diversion points—the north diversion and the south diversion. It was assumed that the south diversion can convey 150,000 AFY and the north diversion can convey 100,000 AFY. Given this assumption, Option 1 was sized and costed assuming only the north diversion pipeline is constructed, Options 2 and 3 were sized and costed assuming both the north and south diversion pipelines are constructed.

A unit cost-based methodology was used to develop capital costs for planning year 2009 for all concepts. Unit cost values and contingency factors for various project components were developed based on a variety of sources, including existing reports when available, a national construction cost database, data from other recent projects, and professional opinions. It is important to note these costs were developed for planning level comparison of concepts; it is not guaranteed that these costs will not vary from contractors' bids or final costs. However, these planning level costs are appropriate for the initial planning level comparison of future regional projects as well as in comparing the individual projects with one another on an equitable basis.

Capital costs and O&M costs were developed for the following components of the agricultural transfer and new supply development concepts:

- Water rights
- Firming storage
- Transmission facilities (pipelines, tunnels, pump stations, diversions and appurtenances, and easements)
- Water treatment
- Reuse

Figure 7-6 shows the summary of the reconnaissance level capital costs for each of the concepts. The range of capital costs for all of the concepts is $840 million (Green Mountain) to $9.8 billion (Flaming Gorge Option 3). Although the new supply development concepts and agricultural transfer concepts are similar in total capital costs for each of the options, the relative percentages of subcomponent capital costs vary. For the agricultural transfer concepts, the majority of the capital cost is comprised of water rights acquisitions. For the new supply development concepts, the majority of the capital costs are associated with pipelines and pump stations.

O&M costs for each concept are summarized in Figure 7-7. Reconnaissance level annual O&M range from $29 million per year (Green Mountain) to $273 million per year (Arkansas Option 3). The variability between concepts is due primarily to conveyance costs but differences between conventional treatment (Yampa, Blue Mesa, Green Mountain, and Flaming Gorge) and RO with zero liquid discharge (South Platte and Arkansas) also contribute to the variation.

CWCB also developed reconnaissance level life cycle costs for all concepts. Life cycle costs allow comparison of not only the capital costs, but also the operational costs associated with the concepts, all brought back to present value in order to evaluate the long-range economic feasibility of each concept. CWCB utilized the following key assumptions for the life cycle cost analysis:

- Planning period—50 years after completion of construction
- Present worth—capital and operating costs brought based to 2009
- Capital costs expended in 2020, with O&M starting in 2021 for options 1 and 2
- Capital costs expended in 2020, with O&M starting in 2021 for Phase 1 of Option 3 and 2040, with O&M starting in 2041 for Phase 2 of Option 3
- Discount rate, or cost of money—6 percent
- Escalation—Capital items (3 percent), annual O&M (3 percent), and energy (5 percent)
- 2009 energy costs ($/kilowatt hour)—$0.08
- In addition to initial capital costs, CWCB considered replacement costs for the constructed facilities if the replacement was required during the 50-year planning period

Figures 7-8 and 7-9 provide a summary of the total life cycle costs and the total life cycle costs per acre-foot of water developed by each concept. These figures show that the least expensive concept is Green Mountain and most expensive is either Arkansas concept. The Arkansas concepts are most expensive due to the annual treatment costs that would be associated with them. The remaining concepts generally have similar life cycle costs.

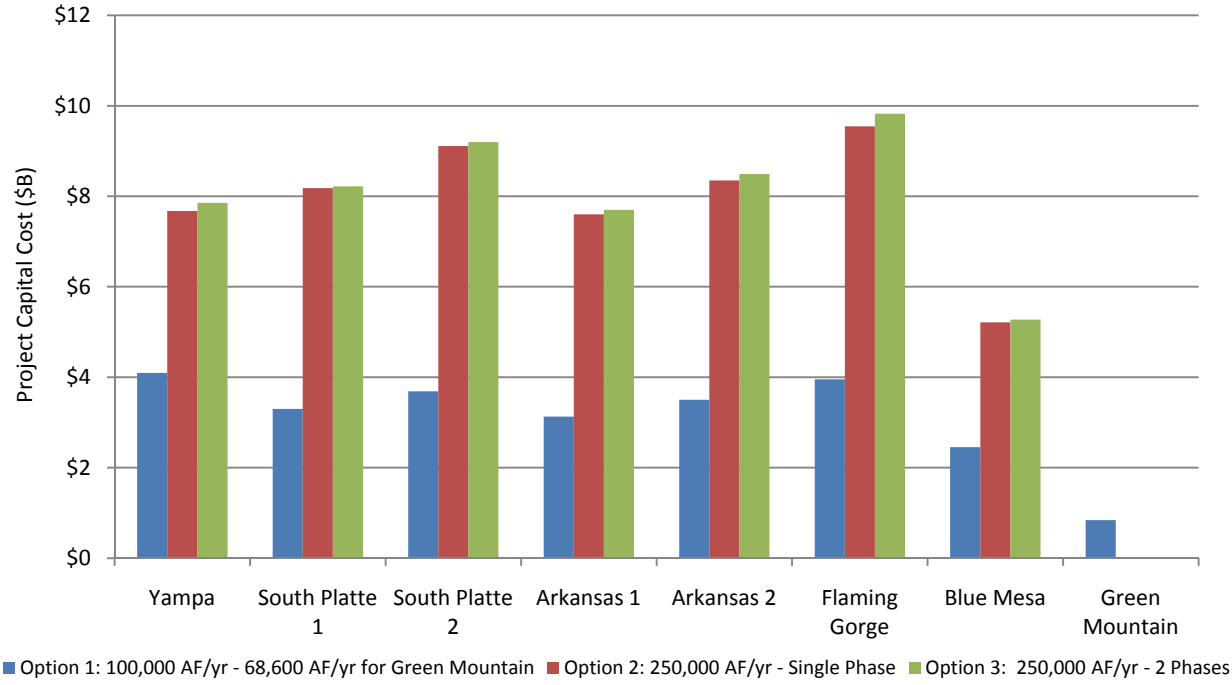


Figure 7-6 Summary of Reconnaissance Capital Costs

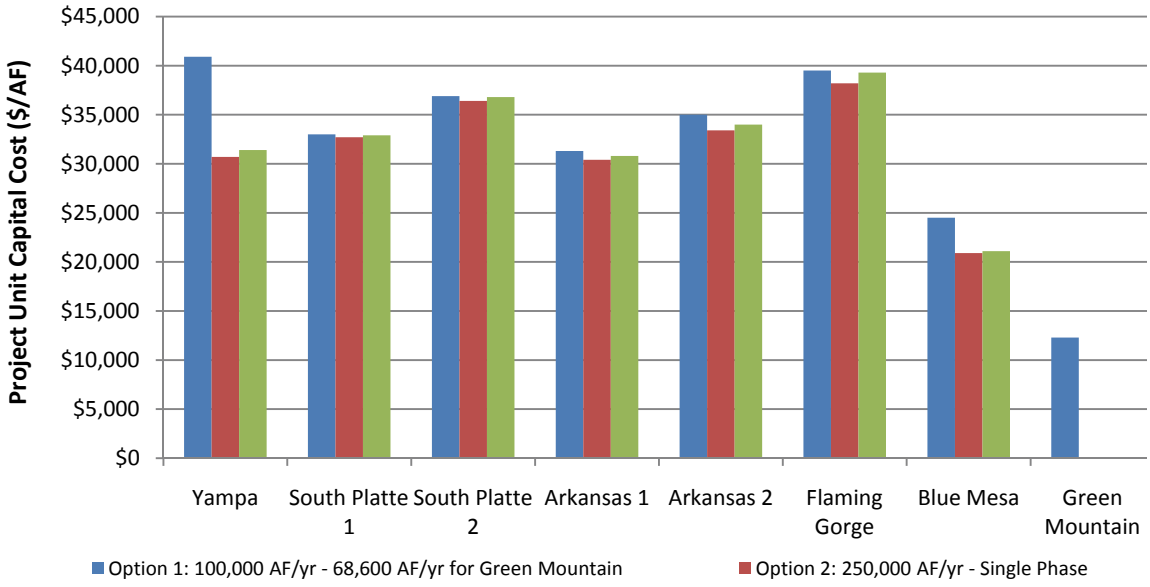


Figure 7-7 Summary of Reconnaissance O&M Costs

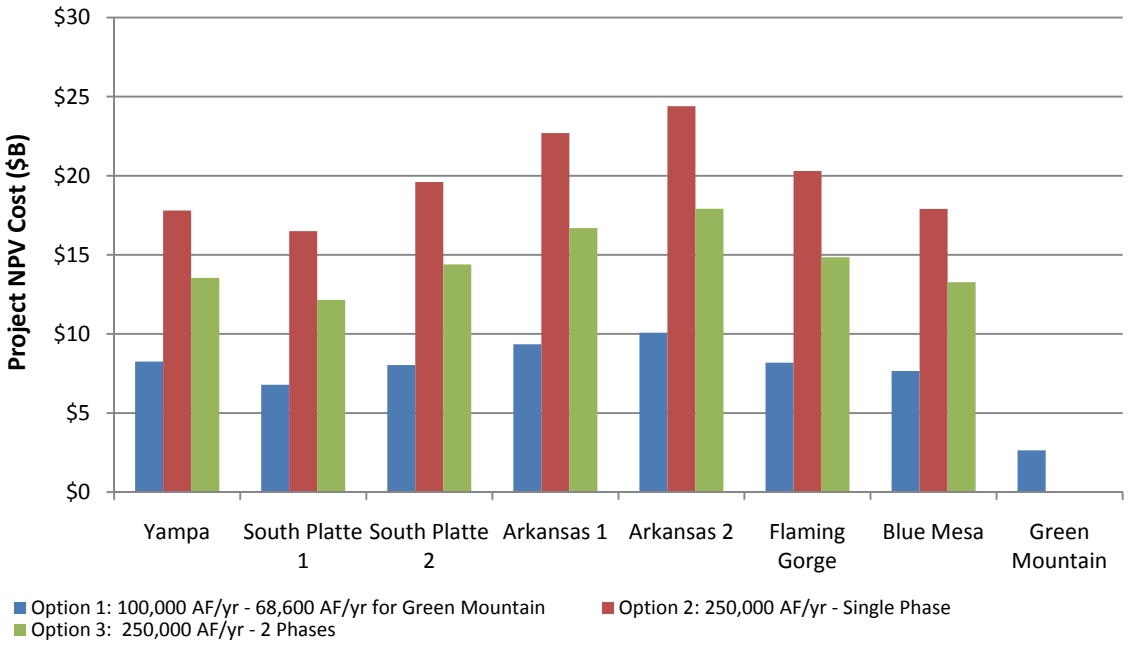


Figure 7-8 Summary of Reconnaissance Life Cycle Costs

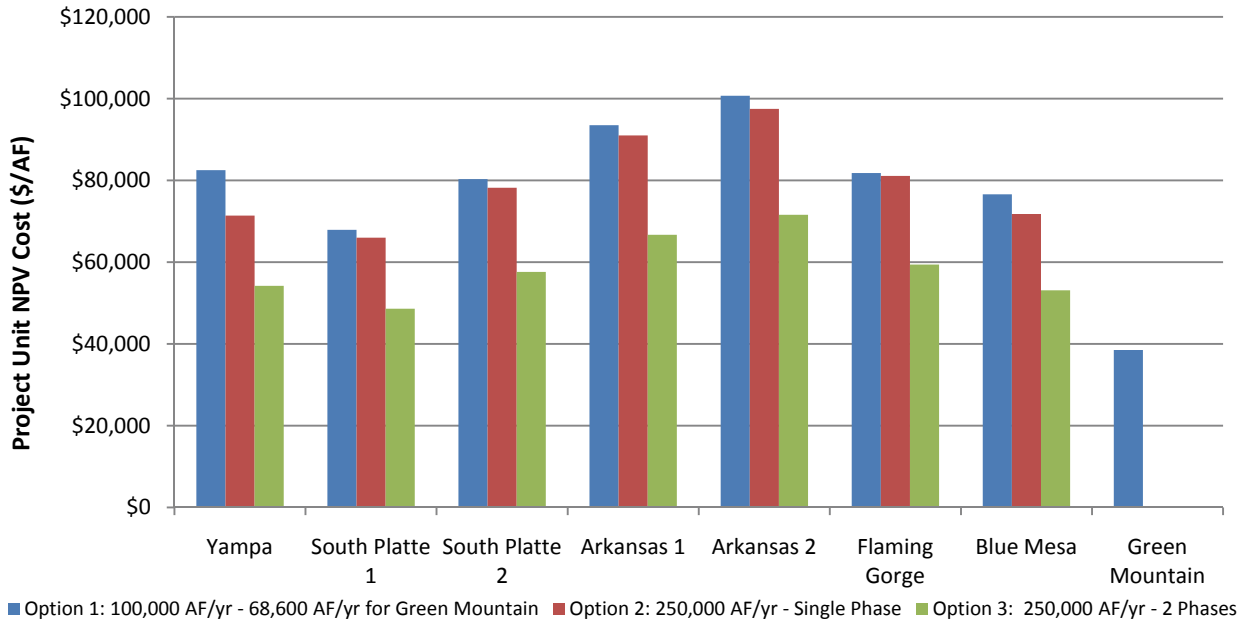


Figure 7-9 Summary of Reconnaissance Life Cycle Unit Costs

7.3 Portfolio Analysis

As discussed above and highlighted in Figure 7-4, the CWCB developed a portfolio and trade-off tool that allows for examining future M&I demand scenarios, developing a portfolio to address future M&I demands, and examining the trade-offs associated with a given portfolio. The summary below describes the components of the portfolio and trade-off tool and presents the status quo portfolio, which has been the basis for discussions by the CWCB Board and IBCC. As was discussed previously, while there is general agreement that the status quo is not desirable, there is not agreement on an alternative mix of solutions. However, there is agreement that in order to balance meeting municipal, agricultural, and nonconsumptive needs, Colorado will need a mix of new water supply development for West Slope and East Slope uses, conversation, completion of IPPs, and agricultural transfers. All parts of this four-pronged framework are equally important and should be pursued concurrently.

7.3.1 Water Demands in the Portfolio and Trade-off Tool

The portfolio and trade-off tool calculates water needs between 2008 and 2050 for the following:

- M&I needs
- SSI needs
- Oil shale development water needs

The source of data for the M&I and SSI 2050 needs is the *State of Colorado 2050 Municipal and Industrial Water Use Projections* (CWCB 2010d). This information is summarized in Section 4 of this report and is also included as Appendix H of this report. To determine 2050 low, medium, or high needs based on tool selections, the 2008 M&I estimates are subtracted from the 2050 low, medium, or high M&I estimates. Similarly, the SSI 2050 needs are calculated by subtracting the 2008 SSI needs from the 2050 low, medium, or high estimates. The tool also includes the replacement of nonrenewable groundwater in the South Metro area of Denver and unincorporated El Paso County. These are included as additional needs to be met by 2050 in the tool. The tool assumes that 20,850 AFY will need to be replaced for the South Metro and 13,500 AFY for unincorporated El Paso County for a total of 34,350 AFY statewide.

Oil shale water needs are included in the tool with an option that oil shale will develop or will not occur in the future. As discussed in Section 4, ongoing research being conducted for the Phase II Energy Study indicates that the long-term oil shale production scenario is 1.5 million barrels of oil per day of *in situ* production and 50,000 barrels of oil per day with above ground production. Table 7-9 summarizes the total direct water demands for the build-out industry scenario that were incorporated into the tool. The low scenario is presented as a negative number due to subtracting the amount of water that is produced as a byproduct of shale oil production (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2010). Within the tool, the low scenario is considered to have zero demand.

Table 7-9 Direct Water Use Scenarios for Build-out Oil Shale Industry (AFY)

Oil Shale Development Method	Low	Medium	High
In situ development	-23,000	46,000	104,000
Above-ground development	2,300	4,200	9,100
Total	**-20,700**	**50,200**	**113,100**

7.3.2 Portfolio Elements in the Portfolio and Trade-off Tool

The tool user can develop portfolios based on the 2050 water needs for the low, medium, or high scenarios. The portfolio elements are:

- Passive conservation
- IPP yield
- Active conservation
- Water use reductions from increased land use density for future development
- Agricultural transfers and reuse
- New supply development and reuse

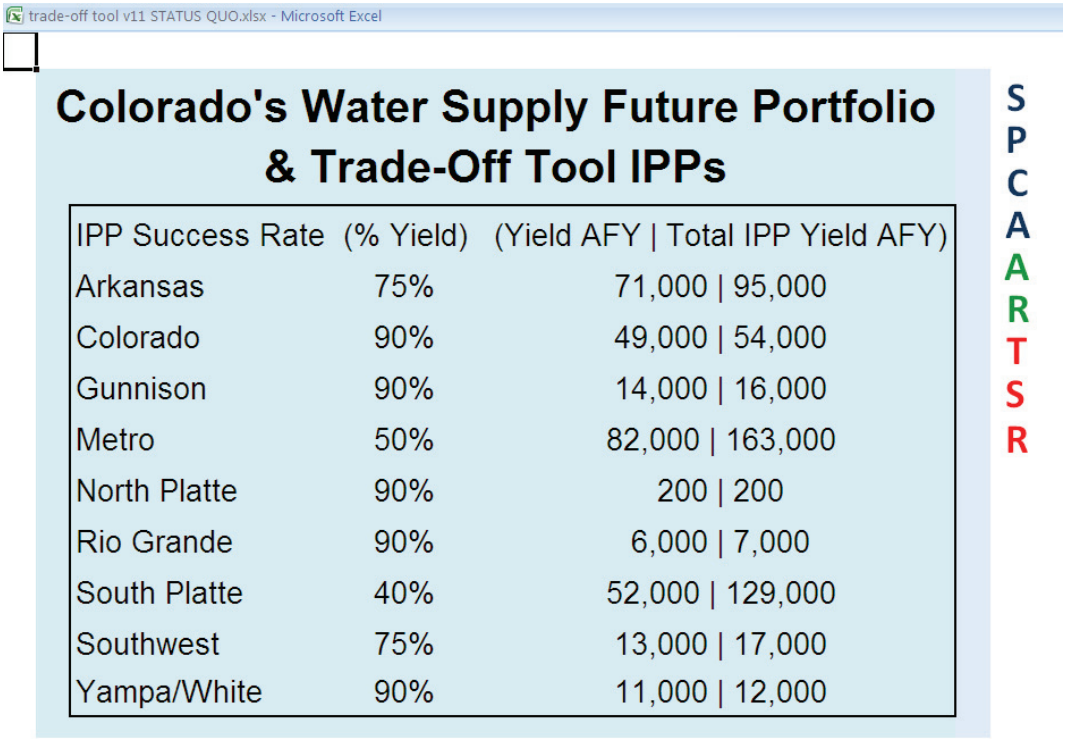
Each of the portfolio elements are described below.

7.3.2.1 Passive Conservation

As shown in Figure 7-4, the portfolio tool includes passive conservation as a demand reduction so that it is not included in the portfolio development. Passive conservation was discussed in Section 4 and in Section 7.2.2 above. Statewide, passive conservation is expected to reduce demands by about 150,000 AFY by 2050.

7.3.2.2 Identified Projects and Processes

In the tool, the user has the option at the basin level to set a success rate for the yield of the IPPs, as shown in Figure 7-10. The percent success rates shown in Figure 7-10 are the status quo portfolio success rates discussed in Section 5 of this report and in 7.2.1 of this section. The portfolio tool multiples the success rate times the IPP yield for a given basin and calculates the IPP yield based on this multiplication.



IPP Success Rate	(% Yield)	(Yield AFY | Total IPP Yield AFY)
Arkansas	75%	71,000 | 95,000
Colorado	90%	49,000 | 54,000
Gunnison	90%	14,000 | 16,000
Metro	50%	82,000 | 163,000
North Platte	90%	200 | 200
Rio Grande	90%	6,000 | 7,000
South Platte	40%	52,000 | 129,000
Southwest	75%	13,000 | 17,000
Yampa/White	90%	11,000 | 12,000

Figure 7-10 IPP Success Rate Data Entry Screen from Portfolio and Trade-Off Tool

7.3.2.3 Active Conservation

As was discussed in Section 7.2.2.2, no assumptions have been made about the portion of the active conservation savings that could potentially be utilized toward water supply, serving new customers, or meeting the M&I gap. Once subsequent efforts to help determine what portion of active conservation savings can be applied to the M&I gap are completed, this information will be incorporated into the portfolio and trade-off tool so that portfolios can be established with active conservation considered.

7.3.2.4 Agricultural Transfers and New Supply Development

The tool subtracts the IPPs and active conservation from the 2050 water needs. As was discussed previously at this time no assumptions have been made regarding what portion of active conservation can be applied to the gap. As more information is developed regarding the amount of conservation savings that can be applied to the gap, this will be incorporated into the portfolio and trade-off tool. The remaining water needs can be filled either first from agricultural transfers or new supply development. This is a user option specified in the tool. When filling first with agricultural transfers, the user can specify the amount of irrigated acres per basin that would be available for conversion to M&I use. These are calculated using the agricultural transfer options as described below. The amount of reuse for the consumable portion of the agricultural transfer is also included in the portfolio. The amount of reuse is calculated using a reuse multiplier that is described in the reuse options below. After the agricultural transfer and reuse yields are determined, these are subtracted from the remaining water needs. If there are still water needs then new supply development is utilized to fill the remaining gap. If the user chooses to fill the remaining water needs with new supply development first, the amount of water from the Colorado River System available to fill the need is based on a user generated value.

Reuse of any transfers of Colorado River system to the East Slope is included in the portfolio as described below. After the new supply development and reuse yields are determined, these are subtracted from the remaining water needs. If there are still water needs after the use of new water supplies, then agricultural transfers are utilized to fill the remaining gap.

Agricultural Transfer Options

The agricultural transfer options in the tool allow the user to set the amount of transferrable CU in AF/acre. There are several factors that impact yields from an agricultural transfer. Some of these factors include:

- Priority of water right (senior vs. junior)
- Physical availability
- Historical use
- Ditch and irrigation efficiencies
- Cropping patterns
- Return flow obligations (location, amount, and timing)
- Firming storage needed to provide meaningful yield for all but the most senior water rights

The tool does not address each of these factors individually; rather the user has the ability to set the amount of consumable yield per acre on the East Slope and the West Slope accounting for each of these factors collectively. Currently, the tool uses a default of 1.3 AF/acre of transferrable CU for both the East and West Slope. Historically in the South Platte Basin, the transferrable range of consumable water has approximated 0.8 AF/acre to 1.7 AF/acre.

The transfer yields described above are considered an average yield. To make sure that the yield is on a firm basis, a safety factor is included in the tool that allows the user to specify an additional percentage of additional irrigated acres that would be needed in order to have a firm supply. The tool currently uses a default of 25 percent for the average to firm yield safety factor.

Following is a description of how these options are used in calculations in the tool. If the user specifies that 1,000 irrigated acres are to be transferred to M&I use, the calculation to estimate a firm yield of supply would be:

1000 acres * 1.3 acre-feet/acre * (1 – 0.25) = 975 acre-feet

Similarly if the tool estimates the amount of yield from agricultural transfers needed to fulfill 2050 water needs, the amount of irrigated acres needed to transfer to M&I uses is calculated. For example, if the tool estimates that 1,000 AF are needed to fill a need, then the calculation to estimate the number of irrigated acres would be:

1000 acre-feet / (1.3 acre-feet/acre * (1-0.25)) = 1025 acres

Reuse Options

The tool allows the user to individually vary the percent of reuse on the East Slope and the West Slope from 0 percent to 100 percent. That percentage can be further subdivided into reuse by exchange or direct recapture (nonpotable) reuse in split percentages summing to 100 percent, e.g., 70/30 or 45/55. However, as a general planning and tradeoff tool, it does not include the location or timing of return flows and does not analyze exchange potential.

M&I reuse by water rights exchanges involves the exchange of legally reusable return flows for water diverted at a different location. Water is diverted at one source in exchange for water replaced to downstream users from a different source. In an M&I reuse exchange, the amount of non-CU water returned to the system, e.g., via effluent flows and/or return flows from landscape irrigation, depends on the CU associated with the demand (i.e., the higher the CU, the lower the percent of total diversions that can be reused).

Nonpotable reuse involves the capture and use of legally reusable return flows for the irrigation of urban landscapes or for industrial uses such as cooling or process water. Since return flows from landscape irrigation are hard to capture in one location, nonpotable reuse to date has involved the reuse of consumable effluent discharged from wastewater treatment facilities. The effluent undergoes additional treatment to meet nonpotable reuse standards. This treatment usually involves filtration and additional disinfection.

The tool uses multipliers at the basin level for amount of consumable water that is reused as shown in Table 7-10. The user can set the percentage of reuse achieved basinwide and then specify the amount of that reuse that is by exchange or through noncapture. A weighted average is then used to establish a total multiplier for the basin. For example, if 100 AF are available in a basin to reuse and 50 percent of that amount is reused by equal parts exchange and noncapture, then the weighted average multiplier would be 1.45 (0.5*1.6+0.5*1.3). Therefore yield of the reused water is 45 AF (100*1.45-100).

Table 7-10 Total Yield After Reuse by Exchange or Recapture

Percent of Consumable Supplies Reused	Exchange Reuse Multiplier [AF]	Non-Capture Reuse Multiplier [AF]
0%	1.0	1.0
5%	1.1	1.0
10%	1.2	1.1
15%	1.2	1.1
20%	1.3	1.1
25%	1.4	1.1
30%	1.4	1.2
35%	1.5	1.2
40%	1.5	1.2
45%	1.6	1.3
50%	1.6	1.3
55%	1.7	1.3
60%	1.7	1.3
65%	1.7	1.3
70%	1.8	1.4
75%	1.8	1.4
80%	1.8	1.4
85%	1.8	1.4
90%	1.9	1.4
95%	1.9	1.5
100%	1.9	1.5

7.3.3 Trade-Offs in the Portfolio and Trade-off Tool

The tool estimates the following trade-offs based on the M&I demand scenario and user defined portfolio:

- Decreases in irrigated acres
- Colorado river depletions
- Size of alternative agricultural transfer program
- Cost estimates for user-defined portfolio
- Nonconsumptive trade-off

These trade-offs are general basin-wide calculations and are intended for assessing the relative impacts of different portfolios. The tool is a general planning tool and is not intended for site-specific analysis.

7.3.3.1 Decreases in Irrigated Acres

The first trade-off in the tool is an analysis that shows the amount of decreases in irrigated acres at the state and regional level and is based on the estimated yield of agricultural transfers as described above in the portfolio development. The amount of irrigated acres are estimated using the equations described in Section 7.3.1.4.

7.3.3.2 Colorado River Depletions

The tool estimates Colorado River Depletions by completing the following assumptions:

- New supply development transferred to the East Slope is 100 percent consumptive
- SSI and energy uses on the West Slope are 100 percent consumptive
- M&I use on the West Slope is 35 percent consumptive
- Current depletions are assumed to be 2.634 million AF based on data from the Colorado Decision Support System

Additional future depletions such as IPPs can be added to the tool but are not included at this time. The tool estimates future depletions based on the user defined portfolio and adds these to the current depletions. Estimated future depletions and estimated total depletions are shown in the portfolio table in the tool. It is important to note that calculating this trade-off is intended for general planning purposes. The tool does not prove physical or legal water availability.

7.3.3.3 Size of Alternative Agricultural Transfer Program

The tool estimates the size of an alternative agricultural transfer program that would be required to deliver the yield associated with the agricultural transfers portion of the user defined portfolio. Based on work completed by the Super Ditch program in the Arkansas Basin and by Northern Colorado Water Conservancy District in the South Platte, the tool assumes that an alternative agricultural transfer program would need to include four times the amount of irrigated acres used for a traditional transfer. This assumes that no more than 25 percent of the lands in the alternative agricultural transfer program are fallowed at any one time.

7.3.3.4 Cost Estimates for User-Defined Portfolio

The tool estimates the costs for the user-defined portfolio versus the status quo portfolio. The cost trade-off tab uses the following unit costs for the status quo portfolio elements:

- **IPPs**—for construction costs, tool uses $5,900 AF for West Slope projects and $14,000 AF for East Slope projects based on information gathered by CWCB during their effort to update the Basin Needs Decision Support System (BNDSS).
- **Conservation**—for passive conservation, assume no cost to water providers and for active conservation $7,200 AF based on recent efforts completed by CWCB as part of the conservation strategy.
- **Agricultural Transfers**—since the status quo assumes agricultural transfers will occur as they are today and pursued by individual water providers instead of in a coordinated program or large project, a construction cost of $40,000 AF was assumed for agricultural transfers for the status quo portfolio cost estimate. Agricultural water is assumed to become more competitive, require conveying the water a longer distance, and need advanced water treatment.
- **New Supply Development**—For West Slope new supply development the tool assumes a cost of $5,900 AF based on the same cost assumptions as those associated with West Slope IPPs.

For the user defined portfolios in the tool the following assumptions are used for estimating the cost of the portfolio:

- **IPPs**—for construction costs, tool uses $5,900 AF for West Slope projects and $14,000 AF for East Slope projects based on information gathered by CWCB during their effort to update the BNDSS.
- **Conservation**—for passive conservation, assume no cost to water providers and for active conservation $7,200 AF based on information developed during SWSI 2.
- **Agricultural Transfer**—Assumes a range of $33,500 AF to $34,200 AF construction costs based on size of agricultural transfer. These costs assume a coordinated agricultural transfer project, and are based on the recent cost analysis summarized in Section 7.2.4.3.

- **New Supply Development**—Assumes a range of $28,600 AF to $32,200 AF construction costs based on size new supply development project for transfers to the East Slope. This range is based on the recent cost analysis summarized in Section 7.2.4.3. New supply development on the West Slope assumes a cost of $5,900 AF based on the same cost assumptions as those associated with West Slope IPPs.

7.3.3.5 Nonconsumptive Trade-Off

To assess potential nonconsumptive trade-offs in the tool, CWCB included two environmental flow metrics set forth in literature and as part of the federal reserve water right for the Gunnison and Rio Grand National Forest in Water Division 3. Richter (2009) suggests the development of "sustainability boundaries" as described below that are intended to set limits on the extent to which water withdrawals can alter natural variability in water flows and thereby sustain the social benefits and biodiversity of freshwater ecosystems. The first metric would allow diversion of 20 percent of the natural flow for all months of the year. The second metric would allow diversion of 20 percent of all the natural flow for baseline month (January – April and July – December) and 50 percent of the natural flow during peak flow periods (May – July). The yield estimated from these metrics are displayed in the tool and compared to the East Slope portion of the new supply development amount in the user defined portfolio for the following locations:

- Blue River downstream of Green Mountain Reservoir
- Gunnison River downstream of Blue Mesa Reservoir
- Yampa River at Maybell, Colorado
- Green River downstream of Flaming Gorge Reservoir

7.3.4 Status Quo Portfolio

If Colorado's water supply continues to develop according to current trends, i.e., the status quo, this will inevitably lead to a large transfer of water out of agriculture resulting in significant loss of agricultural lands and potential harm to the environment. The status quo is the default position—the results that will likely occur if current trends continue unchanged. Inaction is a decision itself, a decision with significant consequences. The general consensus is that the status quo scenario is not a desirable future for Colorado.

The summary below is an illustration of the status quo with the portfolio and trade-off tool. The status quo scenario presented is based on the following assumptions:

- 2050 mid-demand scenario.
- The status quo IPP success by basin is defined in Figure 7-10. Applying these basin level success rates results in the implementation of about 60 percent of the IPP yield statewide by 2050.
- Passive conservation savings will be realized by 2050 and those savings will be used to meet new demands. Active conservation will not be utilized toward water supply, serving new customers, or meeting the M&I gap.
- New supply development from the Colorado River System will be available for West Slope uses only. No additional transbasin diversions beyond the IPPs are assumed in the status quo portfolio.
- The remaining M&I demands are met with agricultural transfers.

Figure 7-11 shows the resulting loss of irrigated acres that may potentially occur as a result of the status quo portfolio. The yellow bars in the figure relate to the left axis and show the percentage of irrigated acres that may be lost in the future if the status quo is maintained. The red squares relate to the right axis

and specify the number of acres that may be lost. Based on the status quo scenario, the South Platte Basin could lose 35 percent of current irrigated agriculture or nearly 300,000 acres. The Arkansas, West Slope, and North Platte/Rio Grande Basins could lose over 10 percent of their irrigated agriculture under the status quo portfolio. Over 500,000 acres statewide could be transferred to M&I use statewide with the status quo portfolio.

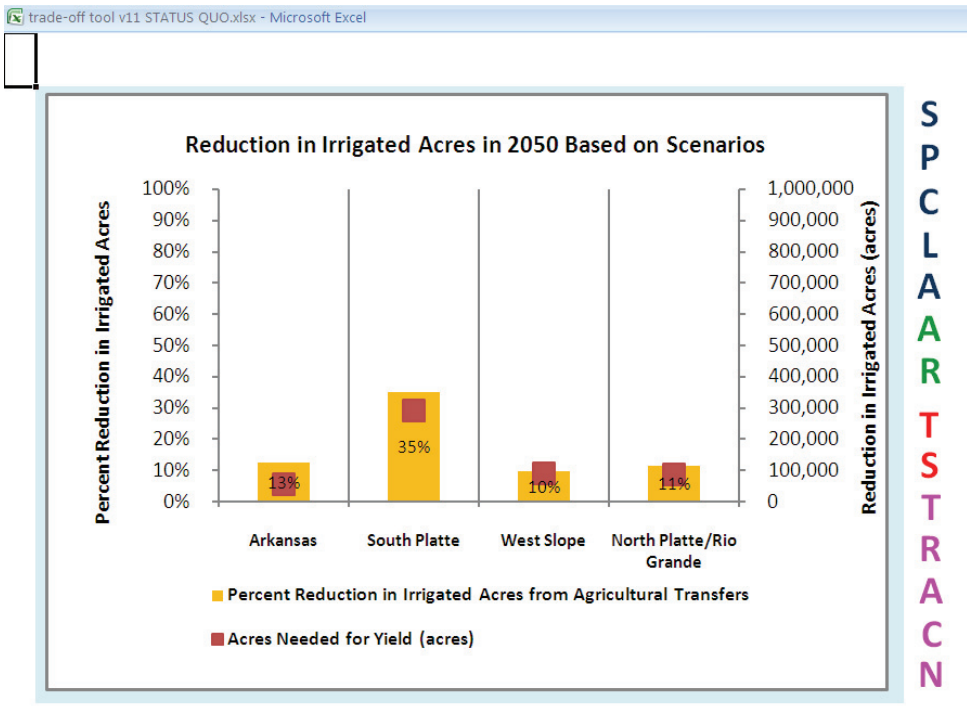


Figure 7-11 Reduction in Irrigated Acres in 2050 Based on Status Quo Scenario

Another trade-off to consider for the status quo portfolio is the size of a rotational fallowing program that would be needed if the irrigated acres required to meet future M&I demands as described above occur under the status quo portfolio. Figure 7-12 summarizes the size of the rotational fallowing program that would be needed in the Arkansas and South Platte Basins. For the Arkansas Basin, 50 percent of the irrigated lands in the program would need to participate in a rotational fallowing program to meet the yield needed from agricultural transfers under the status quo portfolio. In addition, the South Platte Basin would require 100 percent of its irrigated land be in a rotational fallowing program to meet the yield needed from agricultural transfers under the status quo portfolio.

Meeting Colorado's M&I water supply needs will require significant investment. The costs for the status quo portfolio are presented in Section 7.3.2.4. and in Table 7-11. Implementing a mix of solutions to address Colorado's 2050 medium M&I water supply needs will cost around $15 billion under status quo assumptions. These costs will increase if Colorado experiences high M&I demands and will decrease if Colorado experiences low M&I demands or implements an alternative mix of solutions to the status quo. The costs associated with meeting Colorado's future M&I needs could be reduced if an alternative approach were used that incorporates fewer but larger projects and increased levels of conservation. However, while an alternative approach could save the citizens of Colorado billions of dollars, it would require a higher level of state involvement including significant state funding.

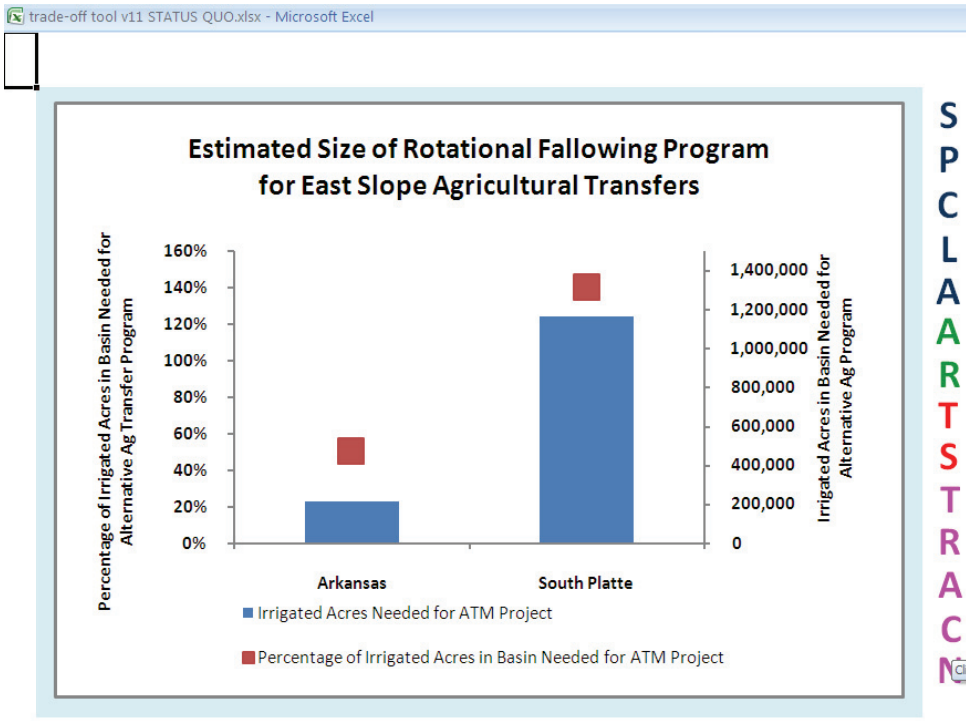


Figure 7-12 Size of Rotational Fallowing Program Required in the South Platte and Arkansas Basins for Status Quo Portfolio

Table 7-11 Status Quo Medium M&I Demand Portfolio (800,000 AF of new water needed)

Strategy	West Slope[1] Unit Cost	West Slope[1] New Water Needed (AF)	West Slope[1] Costs	East Slope Unit Cost	East Slope New Water Needed (AF)	East Slope Costs	Total New Water Needed (AF)	Total Costs
New Supply	$5,900	150,000	$860,000,000	$0	—	$0	150,000	$860,000,000
Ag Transfers	$40,000	3,500	$140,000,000	$40,000	270,000	$11,000,000,000	270,000	$11,000,000,000
IPPs	$5,900	93,000	$550,000,000	$14,000	200,000	$2,900,000,000	290,000	$3,400,000,000
Active Conservation	$7,200	—	$0	$7,200	—	$0	—	$0
Reuse[2]			$0		90,000	$0	90,000	
Total		**240,000**	**$1,600,000,000**		**560,000**	**$14,000,000,000**	**800,000**	**$15,000,000,000**

[1] Costs for the Rio Grande and North Platte Basins are the same as the West Slope and are integrated with the West Slope for the purpose of this cost analysis.

[2] The costs of reuse are incorporated into the costs associated with agricultural transfers or new supply development.

The Colorado River depletions and nonconsumptive trade-offs are not summarized here as the status quo portfolio does not utilize the Colorado River system for East Slope use. The CWCB and IBCC have recognized the need to protect and enhance Colorado's nonconsumptive water needs. The IBCC agreed that in meeting Colorado's nonconsumptive water supply needs it is important to—1) protect identified environmental and recreational values and restore environmental values; 2) promote recovery and sustainability of endangered, threatened, and imperiled species; 3) protect and enhance economic values to local and statewide economies derived from environmental and recreational water uses; 4) pursue projects and other strategies, including the CWCB's Instream Flow Program, that benefit consumptive

water users, the riparian and aquatic environments, and stream recreation; and 5) recognize the importance of environmental and recreational benefits derived from agricultural water use, storage reservoirs, and other consumptive water uses and water management. The IBCC recognizes that quantification of nonconsumptive needs and further identification of projects or methods to meet those nonconsumptive needs is necessary.

While there is general agreement that the status quo is not desirable and that a mix of solutions will be needed, there is not agreement on the specific quantities of water that will be needed for each strategy. However, there is agreement that in order to balance meeting municipal, agricultural, and nonconsumptive needs, Colorado will need a mix of new water supply development for West Slope and East Slope uses, conservation, completion of IPPs, and agricultural transfers. The CWCB and IBCC have agreed that all parts of this four-pronged framework are equally important and should be pursued concurrently.

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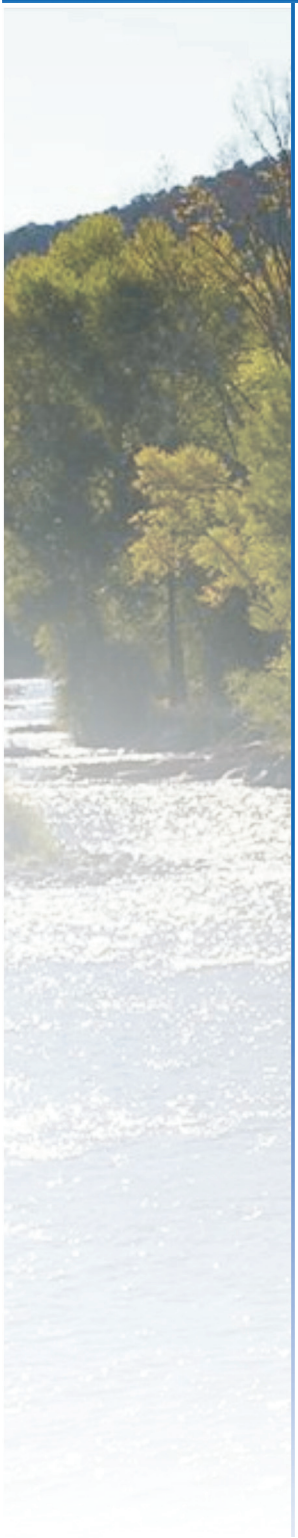

Section 8
Recommendations

With the completion of the Statewide Water Supply Initiative (SWSI) 2010, the Colorado Water Conservation Board (CWCB) has updated its analysis of the state's water supply needs and recommends Colorado's water community enter an implementation phase to determine and pursue solutions to meeting the state's consumptive and nonconsumptive water supply needs. This will be accomplished through the following recommendations.

These recommendations do not necessarily represent a statewide consensus. The CWCB has deliberated on the information contained in SWSI 2010 and has put forth its view of how to move forward.

1. Actively encourage projects to address multiple purposes, including municipal, industrial, environmental, recreational, agricultural, risk management, and compact compliance needs.
2. Identify and utilize existing and new funding opportunities to assist in implementing projects and methods to meet Colorado's consumptive and nonconsumptive water supply needs.
3. Continue to lead the dialogue and foster cooperation among water interests in every basin and between basins for the purpose of implementing solutions to Colorado's water supply challenges.
4. Support water project proponents and opponents in resolving conflict and addressing concerns associated with implementing identified projects and processes (IPPs) that will reduce the municipal and industrial (M&I) water supply gap. Identify IPPs that could be implemented by 2020.
5. Support meeting Colorado's nonconsumptive water needs by working with Colorado's water stakeholders to help:
    - Promote recovery and sustainability of endangered, threatened, and imperiled species in a manner that allows the state to fully use its compact and decreed entitlements.
    - Protect or enhance environmental and recreational values that benefit local and statewide economies.
    - Encourage multi-purpose projects that benefit both water users and native species.
    - Pursue projects and other strategies, including CWCB's Instream Flow Program, that benefit consumptive water users, the riparian and aquatic environments, and stream recreation.
    - Recognize the importance of environmental and recreational benefits derived from agricultural water use, storage reservoirs, and other consumptive water uses and water management.

6. Help meet Colorado's agricultural water supply needs by incorporating agricultural water needs into the development of water supply portfolios and supporting the implementation of multi-purpose agricultural water supply projects.
7. In order to determine the appropriate combination of strategies (IPPs, conservation, reuse, agricultural transfers, and the development of new water supplies) and portfolios to meet the water supply needs, CWCB will identify what it considers is achievable for each portfolio element and how those portfolio elements could be implemented.
8. Evaluate multi-purpose projects or packages of projects to develop new water supplies for use on the West Slope and the Front Range.
9. Develop and support risk management strategies so that Colorado can fully use its compact and decree entitlements to best balance Colorado's diverse water needs.
10. Support, encourage, and incentivize water providers in planning for and implementing M&I active conservation best management practices and other demand management strategies.
11. Work with water providers to identify opportunities where additional water could be made available by increased regional cooperation, storage, exchanges, and other creative opportunities.
12. Continue the evaluation of Colorado's water supply availability in all basins to help provide water users with viable analysis tools.
13. Help safeguard Colorado's water supply during times of drought by incorporating drought mitigation and response in statewide and local water supply planning.
14. Support local water supply planning.
15. The CWCB, in consultation with other state agencies, shall develop and implement a plan to educate and promote stewardship of water resources that recognizes water's critical role in supporting the quality of life and economic prosperity of all Coloradoans.
16. Establish a 6-year planning cycle for assessing Colorado's long-term consumptive and nonconsumptive water needs and support the implementation of projects and methods to meet those needs.

Section 9
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John Hickenlooper
Governor

Mike King
Executive Director, Department of Natural Resources

Jennifer Gimbel
Director, Colorado Water Conservation Board

http://cwcb.state.co.us