

SOUTHEASTERN COLORADO WATER AND STORAGE NEEDS ASSESSMENT ENTERPRISE PREFERRED STORAGE OPTIONS PLAN



SUBMITTED TO

**Southeastern Colorado Water Conservancy
District and Enterprise Board**

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Section 1 – Introduction and Background

The Preferred Storage Options Plan (PSOP) for the Southeastern Colorado Water Conservancy District (the District), described in this report, was formulated during the period from March 1999 through August 2000. The PSOP has been formulated in response to an identified need for additional reservoir storage space within the Arkansas Basin to meet the long-term water supply needs of municipal, industrial, and agricultural water users comprising the District. The storage need was identified in a report prepared by GEI Consultants, Inc. (GEI) entitled “Future Water and Storage Needs Assessment” dated December 1998 (hereinafter referred to as the “GEI Study”). As described in this report chapter, the planning process was conducted in a cooperative, collaborative manner, with ample opportunities for stakeholder involvement including water users, natural resources agencies, environmental groups, and the interested public

1.1 Scope of the Planning Effort

The scope of work for the planning completed for the PSOP is considered to be “feasibility level.” Studies were conducted in sufficient detail to identify and evaluate water development alternatives to select a preferred plan for which major investments in environmental, engineering, and legal studies are justified. The GEI Study was a District-wide, “reconnaissance-level” assessment of future water and storage needs. While needs for additional storage were identified, the GEI study stopped short of undertaking a detailed hydrological operations study to evaluate how new storage would be operated and obtaining specific commitments from water users with stated storage needs to participate in a District-wide plan.

1.2 Description of the Planning Process

Formulation of the PSOP followed the guiding principles and coordination procedures identified in the Memorandum of Agreement (MOA), as outlined in Section 1.2.2. Initial definition of the storage alternatives was based on the results of the GEI Study, which included a preliminary screening analysis of alternative storage and non-structural water management options. Based on this analysis, the Storage Study Committee (SSC) and the

Southeastern Colorado Water and Storage Needs Assessment Enterprise (the Enterprise) Board selected six storage options for further evaluation. These options are considered to have the greatest advantages in terms of water storage while having relatively lesser environmental impacts than many of the alternatives identified in the GEI Study.

Site-specific data were gathered or developed for each of the storage options, including: anticipated inundation area; environmental baseline (terrestrial and aquatic resources, wildlife, wetlands, threatened and endangered species, etc.); cultural resources; socioeconomic baseline information; and anticipated permitting/regulatory compliance issues. Technical information also was developed including preliminary assessment of engineering feasibility and estimates of associated construction and implementation costs. As described later in the report, discussions were held with all of the key natural resources and permitting agencies to identify key issues associated with each storage option. Hydrologic modeling was performed for five combination alternatives formulated from the six storage options, using various combinations of the storage options. Results of the hydrologic modeling provided information on anticipated changes to stream flows and reservoir levels, as well as the ability to make preliminary assessments of potential in-stream and reservoir water quality issues.

A large volume of data, analytical results, and other information was condensed into reports on the following topics:

- Cultural Resources
- Socioeconomic Impacts
- Environmental Issues
- Water Quality Issues
- Permitting Issues
- Engineering Reports¹
- Modeling Subcommittee Report

These reports were reviewed and used as the basis for preparing a first draft PSOP report. The draft report was prepared by District staff, working with GEI, and reviewed by the SSC during the period of February through March 2000. Review comments and input were incorporated between early April and late May 2000 and a final draft dated June 8, 2000 was completed for review and discussion by the SSC, other District entities, and the public.

¹ Reports by U.S. Bureau of Reclamation on Raising Pueblo Dam, Black & Veatch's report review of the Bureau's studies on Pueblo Dam and Black & Veatch's report on the other storage options.

Public comments on the draft PSOP were obtained and documented in Appendix A of this final report. Participant, agency, and public comments also are reflected in changes made to the June 8, 2000 draft report included in this final report. Additional information about conduct of the process and participation by key study participants is prescribed below in Sections 1.2.1 through 1.2.4.

1.2.1 SECWCD/Assessment Enterprise

The Enterprise was created to undertake a comprehensive evaluation of the future water and storage needs of all water users within the District and to develop a detailed plan and associated structural and non-structural water management projects to meet these needs through the year 2040. The Enterprise Board of Directors includes all the directors appointed to the Board of Directors of the District.

The Enterprise is the contracting entity for study support provided by GEI for the Phase I - Future Water and Storage Needs Assessment and the Phase II - Preferred Storage Options Plan described in this report. The Enterprise also contracted with the Bureau of Reclamation for a study of the feasibility and cost of raising Pueblo Dam to provide additional storage, and with Black & Veatch to review work performed by the Bureau of Reclamation. Funding for work contracted by the Enterprise to the consultants was obtained from water supply entities within the District, as well as the Colorado Water Conservation Board (CWCB). Water supply entities also provided “in-kind” services. A major portion of work effort was completed by a consultant team that contracted directly with CSU. This work was conducted in conformance with the terms of a MOA executed between the Enterprise and CSU.

1.2.2 Memorandum of Agreement (MOA)

In 1996, CSU approached the District to request an allocation of storage space in the Frypan-Arkansas (Fry-Ark) Project in which to store non-Project water. The District believed it was important to study the water and storage needs within the entire District prior to making a decision on CSU’s request. The District formed the Enterprise, which contracted with GEI to complete the future Water and Storage Needs Assessment. CSU, and other water users, participated in the GEI Study and in the SSC and provided both financial assistance and “in-kind” services.

The CSU request for storage space in the Project was based on completion of a detailed Water Resource Plan, which identified projects designed to meet CSU’s water needs through the year 2040. As part of their planning process, CSU developed a detailed model of Fry-Ark Project operations and undertook collection of technical and environmental data to

support the Federal process for water project permitting. In early 1999, the Enterprise and CSU executed a MOA to facilitate cooperative development of the PSOP. Key provisions of the MOA include:

- Agreement to establish a framework to meet the identified water storage needs of CSU and other entities in the District.
- Commitment to cooperative development of a Preferred Storage Options Plan for the District through the SSC process established during the GEI Study.
- Assignment of specific responsibilities for completion of the technical, environmental, financial, and institutional policy studies and legislative actions required to formulate the PSOP. Under terms of the MOA, the Enterprise focused its efforts on evaluation of storage options and development of the PSOP report. CSU's efforts focused on the technical and environmental studies of each alternative and hydrologic modeling of operations involving storage of non-Project water in Project storage space and Project water in non-Project storage space.
- Agreement to cooperate and coordinate efforts between the Enterprise and CSU during any necessary legislative action or Bureau of Reclamation policy discussion that may be required to implement the PSOP.
- The MOA also included a provision relative to water rights filings and their relation to formulation of the PSOP.

1.2.3 Role of the Storage Study Committee (SSC)

The SSC was organized in 1996 and has been meeting regularly since that time. During Phase I (Needs Assessment), the SSC provided continuous input during the development of population and water demand projections, evaluation of water and storage needs, and initial screening of potential storage options.

The SSC helped to develop the scope of work for preparing the PSOP and met frequently during the Phase II work. Between March 1997 and May 2000, the SSC grew from 15 to over 40 members, with increasing participation by resource agency personnel, environmental and recreational interest groups, and the public. Most SSC meetings were attended by 20 to 30 participants.

Several studies undertaken in Phase II involved closer involvement by certain SSC members. A Modeling Subcommittee was formed to provide guidance and input to the modeling

process from municipal and agricultural water managers and resource agency personnel experienced in water resources operations in general, and the Arkansas River Basin in particular. A Financing Subcommittee was also formed from interested SSC members for guidance and input relative to financing options and financial evaluation methods. A report prepared by the Financing Subcommittee was summarized for inclusion in this PSOP report.

The following is a listing of individuals, their organizations, and their involvement on the SSC and its subcommittees:

Storage Study Committee Members and Subcommittee Members

<u>Individual</u>	<u>Organization</u>
Ralph Adkins	SECWCD
Ron Aschermann	SECWCD
Jeff Anderson	Lamar
Steve Arveschoug	SECWCD (Staff)
Dale Baker	CWPDA
Ken Baker	UAWCD
Bob Barnhart	Holbrook Canal
Elmer Bauman	Catlin Canal
Larry Bishop	Widefield
Jeanette Bryan	AGUA
Joe Cantrell	Security
Steve Douglas	Pueblo
Paul Fisher	Canon City
Paul Flack	CDPOR
Ron Gasser	Penrose
Roy Gertson	Buena Vista
Denzel Goodwin	SECWCD
Brett Gracely	CSU
Scott Hahn	Salida
Don Halffield	Las Animas Consolidated
Bob Hamel	Ark-River Outfitters

Alan Hamel	SECWCD/Pueblo Bd. of Water Works
Loren Hawkins	AGUA
Rich Hayes	Pueblo West
Roy Heald	Stratmoor Hills
Sean Herrin	Friends of the Arkansas
Don Higbee	LAWMA
Joe Kelley	La Junta
Gerald Kelso	USBR
Gerry Knapp	Aurora
Doug Krieger	CDOW
Larry Lasha	Florence
Grady McNeil	CDOW
Steve Mallot	Catlin Canal
Steve Miller	CWCB (Staff)
Bill Mullen	Bessemer Ditch
Tom Musgrove	USBR
Bud O'Hara	West Pueblo Ditch
Steve Reese	Arkansas Headwaters
Allen Ringle	Colorado Canal
John Russell	Las Animas
Philip Saletta	CSU
Dave Sarton	SECWCD
Darryl Schulz	Rocky Ford
Edith M. Seppi	Lake County
Tom Simpson	SECWCD (Staff)
Tom Thomas	Trout Unlimited
Orville Tomky	SECWCD

Manuel Torrez	Fort Lyon Canal
James Valliant	Coop. Extension
Wayne Whittaker	Catlin Canal
Ron Woolsey	Fountain

1.2.4 Consulting Services

Consulting engineering and environmental services were provided on the Phase II PSOP by consultants contracted to the Enterprise and CSU. The consulting firms and their responsibilities are summarized below:

Consultants Retained by Enterprise

Responsibilities

GEI Consultants
(Lead-Dick Westmore)

Preparation of PSOP Report, participation on Modeling Subcommittee, identification/evaluation of non-structural measures, advice to District staff during Phase II.

Black & Veatch
(Lead-David Egger)

Review of Pueblo Reservoir Enlargement study and cost estimates prepared by the Bureau of Reclamation

Consultants Retained by CSU

Responsibilities

Montgomery Watson (MW)
(Lead-Lloyd Gronning)

Lead firm for technical evaluations of storage options managing work of subconsultants identified below. Primarily responsible for hydrologic modeling, water quality studies, and regulatory/permitting issues identification.

Black & Veatch (Subconsultant to MW)
(Lead-David Egger)

Engineering evaluations of potential storage options and preparation of cost estimates for structural water management options.

ERO (Subconsultant to MW)
(Lead-Steve Dougherty)

Environmental inventory and issues identification.

Pioneer Archaeological Consultants, Cultural resources inventory.
Inc. (Subconsultant to MW)
(Lead-Jenny Anderson)

Charles F. Cortese, Ph.D. Socioeconomic studies.
(Subconsultant to MW)

The consultants working for the Enterprise and CSU maintained close communications throughout the process leading to formulation of this PSOP.

1.2.5 Study Phases I and II

The Enterprise has designated preparation of the PSOP as Phase II of the Water and Storage Needs Assessment Project. The Phase I effort, undertaken in 1997-98, involved studies and evaluations leading up to publishing the GEI Study. In general, Phase I involved inventory of current and projected future water supplies and forecasts of future population and water use within the District. Phase II involves formulation and evaluation of storage alternatives to meet the needs identified in Phase I.

1.3 Acknowledgements

The draft report was prepared by GEI Consultants, Inc., with major contributions by Steve Arveschoug, Tom Simpson, and Phil Reynolds of the District and Lloyd Gronning, formerly of Montgomery Watson. The report draft was reviewed by members of the SSC who are listed and acknowledged in Section 1.3.3. District staff took the lead for incorporating review comments received on the draft report and editing to convert the draft into this final report. The cooperation of the SSC members in providing timely review inputs and direction is gratefully acknowledged

Section 2 – Project Purpose and Need

2.1 Overview

The native water resources of the Arkansas River Basin have been intensively developed to meet municipal, agricultural, and industrial water needs. In response to growing demands for water, irrigators and municipal water suppliers have completed projects to divert water from the Colorado River Basin. One of these trans-mountain diversion projects is the Fryingpan-Arkansas (Fry-Ark) Project, which was completed during the 1964 to 1990 period. The Southeastern Colorado Water Conservancy District (the District) was created in 1958 to sponsor implementation of the Fry-Ark Project.

The District (Figure 2.1) covers a large area and parts of 9 counties supplying imported water to 69 municipal water providers (cities, towns, and special districts), 30 ditch companies irrigating 280,600 acres, and 4 well augmentation organizations. Current (1997) population within the District is approximately 621,000 persons. Projections made during Phase I (GEI, 1998) indicate that by 2040, District population will be between 1.2 and 1.6 million persons. Population growth and increased demand for water, primarily in the Fountain Valley and Pueblo areas, but also in smaller communities within the District, will require that existing water management infrastructure be improved and expanded.

In 1996, CSU approached the District to request that a portion of the storage space in the Fry-Ark Project, currently allocated for Project water storage, be dedicated for use by CSU. Studies completed by consultants for CSU indicated that a pipeline from Pueblo Reservoir, together with dedicated storage space, would be a viable, cost-effective element of a long-range plan to meet water needs in the CSU service area. This project is known as the Southern Delivery System, which would bring water from Pueblo Reservoir in a new pipeline, parallel to the Fountain Valley Pipeline, and terminating at a new storage facility on Jimmy Camp Creek.

Before acting on CSU's request, the District completed a study of District-wide water and storage needs (the GEI Study). The District is the legal agency responsible for repayment of the reimbursable costs of the Fry-Ark Project and for making Project water available for agricultural and municipal uses. The GEI Study included forecasts of future population and water needs within the District. Both municipal and agricultural water needs, and associated water storage requirements, were identified on a District-wide basis through the year 2040.

As described in subsequent sections, additional water storage capacity is required in order to meet the future water needs of the District's water users. Rather than having each water provider or water user pursue its own storage project independently, the District believes that a regional storage solution, benefiting the District as a whole, will be more cost-effective and have less environmental impact.

INSERT Figure 2.1

2.2 Forecast Water Demands

Currently, average annual water demand in the District is nearly 1 million acre-feet, of which 85 percent is agricultural water use. The Arkansas River Basin native water supply is over-appropriated. Creation of additional water storage in the Basin will not develop any “new” water. Additional reservoir storage capacity will, however, allow water users in the Basin to more fully use and better manage their existing water resources.

There are several “external” pressures on the water resources of the Arkansas Basin. The City of Aurora, which is outside of the District and the Basin, has water rights in both the Upper Basin and Lower Basin. The final outcome of litigation between the States of Colorado and Kansas over the Arkansas River flows at the State Line likely will be decided in the 2000-2001 time frame. Although a financial settlement appears most likely, Colorado conceivably might have to deliver additional water to Kansas to compensate for prior flow depletions issued by alluvial well pumping. The most immediate result of the litigation has been the requirement to fully augment alluvial wells in the Lower Basin, placing additional demands on the surface water resources of the Basin.

The need for additional storage to meet long-range water management objectives of the District’s water users is based on the water supply versus water demand evaluations presented in the GEI Study and summarized in Section 2.3.

Municipal use within the District in 1997 was 148,000 af (GEI, 1998). Assuming future agricultural demand will be equal to current use, total water demand in the District is forecast to be between 1,086,000 and 1,178,000 af by the year 2040. Municipal and industrial demand in the year 2040 is forecast to be between 253,000 and 345,000 af, assuming an industrial demand outside the municipal sector of 10,000 af per year. As municipal demand increases, the percentage of total demand that is agricultural use will decrease from 85 percent to between 71 and 77 percent of the total water demand within the District.

2.2.1 Municipal and Industrial Water Demand

Population growth within the District boundaries is presented on Figure 2.2 for two cases, a Base and High projection scenario. As described in the GEI Study, the Base projection is considered to be a “most likely” projection with a 50 percent probability of being exceeded. The High projection represents a more optimistic view of future economic growth. The High projection has an estimated exceedance probability of 15 percent. The High projection was selected for use in planning. As described later in this report, water project development can be effectively staged so that growth rates can be evaluated prior to implementing later stages of the project.

INSERT FIGURE 2-2 - Base and High Population Projections

Per capita water use for each of the major municipal entities in the District was established based on historical water usage. The larger cities in the District are in compliance with the Colorado Water Conservation Board’s water conservation guidelines, and all have implemented their own water conservation programs. Recognizing that water conservation will be an important element of any long-range water development plan, the future per capita water use of the District’s municipal entities is predicted to be 10 to 12 percent lower than at present. The current average per capita use is 213 gallons per capita per day (gpcd). In the future, the per capita usage is predicted to be 182 gpcd, on a District-wide basis based on effective conservation programs being in place. CSU has an aggressive conservation program in place that is expected to reduce the future water use of customers in their service area from 207 gpcd to 179 gpcd. Colorado Springs will account for nearly 55 percent of the District’s future municipal water demand. Similar conservation programs have been or are being implemented in Pueblo, Pueblo West, Lamar, La Junta, Canon City, Security, and Widefield.

Under the base projection, municipal water demand in the District is projected to be 243,500 af by the year 2040, as indicated on Figure 2.3. This includes the projected 10-12 percent reduction in demand due to conservation measures. Under the High projection, municipal water demand is projected to be 335,000 af in 2040. Projected water demands for municipal entities in the District in 2040 are summarized below:

MUNICIPAL DEMANDS IN SECWCD IN ACRE-FEET

Location	1998	Base Year 2040 Forecast	High Year 2040 Forecast
Entities West of Pueblo	14,900	27,950	30,720
Pueblo Board of Water Works	26,360	39,080	67,120
Pueblo West	2,620	8,540	8,540
Fountain Valley Entities ⁽¹⁾	90,680	148,110	207,390
Entities East of Pueblo	13,560	19,790	21,240
Total	148,120	243,470	335,010

⁽¹⁾ Includes Colorado Springs, Fountain, Security, Widefield, and Stratmoor Hills.

Results from the year 2000 Census should be reviewed to assess potential impacts on projections of future water demand.

INSERT FIGURE 2-3 - Base and High Water Demand Forecasts

In addition to municipal demand, which includes light industrial and commercial usage metered by the municipal water providers, Public Service Company of Colorado has identified a future need of 10,000 af of storage for cooling water needed for power generation.

2.2.2 *Agricultural Water Demand*

Agricultural water demand in the District has been estimated based on historical water use. The majority of historical agricultural water use in the District has been supplied by direct flow from the Arkansas River. In a dry year, supplemental sources, such as Fry-Ark Project and groundwater supplies, play a more important role in supplying water for agricultural use. In a dry year, direct flow represents only 65 percent of the agricultural use, with storage and transmountain sources plus groundwater supplying 35 percent of the water.

In an average year, surface water sources account for most of the agricultural use (747,600 af; 91 percent), with well pumping making up the remainder (77,400 af; 9 percent). During the months of July-September, the supplemental sources provide up to 45 percent of the agricultural supply, primarily from water stored in reservoirs or alluvial aquifers. Continued maintenance of these supplemental sources in terms of their timing and availability is critical to the health of the agricultural economy within the District and the Arkansas Basin as a whole. A summary of agricultural water use in the District is provided below:

**SUMMARY OF AGRICULTURAL WATER USE IN SECWCD
 (1986 - 1995)**

Source of Supply	Average Year		“Wet” Year (1995)		“Dry Year” (1991)	
	(af)	(%)	(af)	(%)	(af)	(%)
Direct Flow	594,053	71.4%	856,119	85.8%	455,719	64.8%
Fry-Ark Project	32,268		5,562		40,697	
Winter Water at Pueblo Reservoir	31,010		9,540		40,546	
Other Transmountain ⁽¹⁾	22,443		13,530		16,894	
Other Storage	73,981		57,016		53,633	
Subtotal	159,702	19.2%	85,648	8.6%	151,770	21.6%
Well Pumping	78,820	9.5%	55,507	5.6%	95,398	13.6%
Total	832,575	100.0%	997,274	100.0%	702,887	100.0%

Note: Data are from a variety of sources, including the Colorado SEO, USGS, and others.

⁽¹⁾ This water is leased from M&I users and is likely not to be available in the future.

2.3 Ability of the Fry-Ark Project to Meet Future Water Demands

The Fry-Ark Project provides supplemental water for municipal and agricultural water users in the District. To date, municipal entities in the District have not needed their full Fry-Ark Project entitlements, which total 51 percent of the Project yield, or approximately 41,000 af, on average. As population grows within the District, municipal entities (particularly CSU and the other Fountain Valley entities) will increase their use of Fry-Ark water. As municipal use of Project water increases, there will be less Project water available to allocate to agricultural users. Project water currently not used by the municipal entities is available for agricultural use. Projections indicate that most of the municipal entities will be using their full Project allocation by the year 2020.

Water supply “shortfalls” were estimated in the GEI Study by comparing current water supplies with future demands for the major municipal entities of the District, assuming that Project water allocations for each entity would be used to meet as much of the demand as possible. The analysis did not include any re-allocation of Project water among entities. Results for the high demand projection are summarized below:

Region	Year	Project Supply Shortfall (af) High Forecast				
		Current	2010	2020	2030	2040
Entities West of Pueblo		0	0	0	390	2,060
Pueblo West		0	0	0	0	0
Pueblo		0	0	0	0	0
Fountain Valley		0	500	24,800	50,400	79,700
Entities East of Pueblo		0	0	0	0	0
	Total	0	500	24,800	50,790	81,760

⁽¹⁾ Apparent needs in year 2000 based on reported water supplies. Deficits assumed to be met by Fry-Ark Project water by year 2010.

The majority of the future water shortfalls are projected to occur in the Fountain Valley Authority (FVA) area. An additional 24,800 af of water will be needed by the year 2020, increasing to 81,800 af by the year 2040. Approximately 88 percent of this additional water demand is forecast to occur in the CSU service area; however, all the FVA entities will require some additional water by the year 2020. An additional 2,100 af of water will be required by the entities west of Pueblo by the year 2040.

Both Pueblo West and Pueblo appear to have adequate water supplies to meet their long-range needs. However, both entities are projecting a need for storage to regulate their decreed sources of supply. The entities east of Pueblo also appear to have adequate water to meet their needs through the year 2040. They will be using more of their Project water allocation in future years.

2.4 Storage Needs

The projected water supply shortfalls do not necessarily translate directly into specific storage needs for each municipal entity. However, individual entities have identified future storage needs based on their own water planning processes. It should be noted that these

planning processes vary widely within the District in terms of depth of analysis supporting the storage need. For example, CSU has conducted detailed evaluations of its storage needs to support a request for 45,000 af of storage. Of the year 2040 FVA shortfall shown in the preceding table, approximately 72,400 af will occur in the CSU service area. The “shortfall” for CSU is the need to develop additional storage and delivery capacity to allow existing water rights to be fully used. For the FVA entities and several other cities and water districts, earlier work assumed that future shortfalls would be met by developing local supplies. This may require storage equal to three times the projected shortfall volume. Pueblo, Pueblo West, and St. Charles Mesa have identified future storage needs, despite the apparent absence of projected water supply shortfalls in the GEI Study. Storage is reported to be needed by these entities to improve the management of developed supplies and to provide drought protection. A summary of municipal storage needs is presented below:

Municipal Entity	Storage (af)
CSU	45,000
Other FVA Entities	22,000
Florence	2,300
Other Entities West of Pueblo	3,700
Pueblo Board of Water Works	20,000
Pueblo West Metropolitan District	5,500
St. Charles Mesa	3,600
Public Service Company of Colorado	5,000
Total	107,100

During the GEI Study, participants recognized that storage also could be needed for two agricultural uses: firm storage space for Winter Water and for regulating replacement water for well pumping. Storage volumes of 40,000 af (Winter Water) and 26,000 af (augmentation water) were identified in order to meet these objectives (GEI, 1998). With this 66,000 af agricultural storage component, the total storage need identified in the GEI Study was estimated to be 173,100 af (GEI, 1998). There also may be other currently unidentified needs for storage.

As described in Section 3.4, the system hydrologic modeling indicates that a dedicated pool of 40,000 af for Winter Water storage would not materially improve the ability to deliver Winter Water to program participants. As the preferred storage options planning work progressed during 1999-2000, several of the well augmentation organizations developed preliminary estimates of storage needs. These estimates suggested that the 26,000 af capacity for well augmentation supplies estimated in the earlier study by GEI may be too high. In addition, it was considered to be unlikely that agricultural interests would be able to fund development of new storage capacity on their own.

Based on these considerations, the District decided to assess whether additional storage capacity could be developed and used to benefit the District as a whole, including agricultural water users. The result of these considerations is the concept of “District Water Management Storage,” which is included in the preferred storage options plan. The District Water Management Storage (DWMS) would fulfill a variety of needs, as follows:

- Improved Management of Winter Water. By having dedicated storage space into which Winter Water spills at Pueblo Reservoir could be stored for later use by irrigators, potential adverse impacts of municipal carryover and re-operation could be minimized.
- Storage for Capturing Spills of Re-operation Water.
- Management of Well Augmentation Supplies and Project return flows.
- Storage for a Water Bank, or to manage temporary water transfers from agricultural to municipal users under Interruptible Supply (IS) agreements.
- Storage Space for Leasing by interested water users on a short- or long-term basis.

The exact volume of this DWMS needs to be verified through further discussions with interested users and further definition of Water Bank and Interruptible Supply concepts currently under discussion by the District and entities in a District. However, a volume of 10,000 to 15,000 af is believed to be reasonable for the current level of planning. The volume of the District’s storage space was established on a preliminary basis based on the following considerations:

- Re-operation of the Project is expected to increase the frequency and volume of Winter Water spills. Modeling completed for the preferred storage options plan indicates that Winter Water spills could average 4,860 af higher per year in comparison to a scenario in which dedicated storage is provided for Winter Water.

- During the GEI Study, a comparison was made between monthly irrigation well depletions and potentially available irrigation return flows. This comparison indicated a potential difference of 16,000 to 17,000 af, based on a future Project delivery of approximately 40,000 af to agricultural users.
- The required storage space for a water bank or to facilitate interruptible supply agreements will be dependent on the number of eventual participants and their water needs. A volume of 5,000 af in new storage space appears to be appropriate, in light of the potential ability to use several existing storage reservoirs to facilitate interruptible supply transfers between agricultural and municipal water users.

In summary, the District Water Management Storage would meet the following objectives:

Element	Volume (af)
Storage for capture of Winter Water spills as a result of re-operation	5,000
Storage for well augmentation and return flow regulation	5,000
Water bank and interruptible supply storage	5,000
Total	15,000

2.5 Consequences of Not Implementing the Preferred Plan

Implementation of the preferred plan described in Section 5 of this report will provide the storage needed to meet the long-range water management objectives of the District and the water users who are within the District. A primary advantage of the preferred plan is that it represents a regional solution and, therefore, will help to minimize the potential for proliferation of smaller storage projects that cumulatively could cause greater environmental, social, and economic impacts to the region. Potential consequences of not implementing the preferred plan include:

- Individual municipal entities, both within and outside of the District, could pursue developing their own, individual reservoir projects, such as Tennessee Creek, Box Creek, Hayden Ranch, Elephant Rock, and others proposed during recent years.

- Implementation of smaller, more geographically diverse projects could make it more difficult to achieve established resource agency goals for managing stream flows on the Arkansas between Turquoise Lake and Pueblo Reservoir.
- The full potential of the Fry-Ark Project to meet regional water management needs, which is achievable through re-operation, would not be realized. This could result in building as much as 48,500 af of additional storage capacity.
- Loss of the opportunity to implement a project (or projects) that meet regional needs rather than individual local needs.
- Potentially greater adverse environmental impacts could occur. The preferred plan relies on reservoir enlargements to meet new storage needs. Enlargements generally are expected to have fewer environmental consequences than constructing new dams and reservoirs to provide the same volume of storage.

In addition to these consequences, the lack of adequate water storage would adversely impact the ability of municipalities to meet their water service commitments. This could result in significant water shortages, economic losses, and public hardship. As described previously, the projected needs for additional storage have assumed that active, successful water conservation plans are in place in the municipal sector throughout the District, resulting in a decrease in the per capita water use on a District-wide basis. The demand projection for additional storage assumes that this level of conservation will be achieved.

Section 3 – Formulation of Alternative Plans

3.1 Water Management and Development Options

There are many water management and development options available for meeting the long-range needs of water users in the District. As documented in the GEI Study, additional reservoir storage capacity is essential to meeting future water demands of the Fountain Valley cities and other municipal entities in the District over the next 40 years. Storage is needed primarily to fully utilize existing water rights and develop reusable return flows. While water conservation in the municipal sector will play a key role in managing the rate of growth in future water demands, it will not be a “stand-alone” solution to meeting long-range water needs. Conjunctive management of surface and ground water does not appear promising as an alternative to building new surface reservoir storage capacity. Local geologic conditions and already high water tables in the alluvial aquifers suggest limited potential for conjunctive operations. Improved sharing of water between agricultural and municipal users, through interruptible supply agreements and water banking, appears to be feasible. In fact, discussion of these concepts has been renewed in the basin. These water management concepts may, however, require additional storage rather than being an alternative to building additional storage space for District users.

3.2 Phase I Study Results

During the Phase I water and storage needs assessment, the District’s consultants, and the SSC identified and reviewed 31 storage options, including: new dams and reservoirs (both mainstream and off-channel); enlargements of existing reservoirs; and re-operation of existing Fry-Ark storage facilities. An initial screening was performed and 14 options were evaluated in greater detail based on cost, environmental and permitting challenges, anticipated social impacts, and operational effectiveness. Based on this more detailed analysis, eight higher-ranking options were identified. These included: re-operation of the Fry-Ark Project storage; Lake Meredith enlargement; Turquoise Lake enlargement; Pueblo Reservoir enlargement; an enlargement of the proposed Williams Creek Reservoir; gravel-lakes storage development; a new dam and reservoir on Clear Creek; and a new dam and reservoir on Tennessee Creek. Based on expected permitting challenges and governance issues, the SSC decided to focus efforts during Phase II on the first six options.

Developments of new storage on Clear Creek and Tennessee Creek were not considered during the Phase II planning effort.

3.3 Description of Storage Options

The preferred plan for meeting the water storage needs within the District will most likely be a combination of Fry-Ark Project re-operation and construction of additional storage capacity. Re-operation involves storing non-Project water in currently available Project storage space. This is a non-structural solution for meeting a significant portion of the identified need for water storage to meet year 2040 water demands. By virtue of location, importance to current District-wide water management, and cost factors, the enlargement of existing Project reservoirs is an attractive solution to meeting identified storage needs. Several new dam projects also have been identified. The enlargement of both Project and non-Project reservoirs has been investigated. A potentially important element of future water management for the District is the potential to store Project water in non-Project facilities, such as Lake Meredith. Re-operation of Project facilities to allow storage of non-Project water, storage of Project water in non-Project space, and raising of existing Project dams (Turquoise and Pueblo) will require extensive institutional and legal reviews and perhaps changes to legislation authorizing the Fry-Ark project.

3.3.1 Fry-Ark Project Re-operations

The potential for re-operating storage in the Fry-Ark Project has been studied in the past by the USBR and engineering consultants for CSU. Building on these studies, Montgomery Watson (MW), under contract to CSU, performed a comprehensive evaluation of re-operation potentials as part of the development of the preferred storage options plan for the District. The modeling studies were performed with the oversight of the District, the USBR, and members of the Modeling Subcommittee. This section of the report presents an overview of the re-operation concept; results of the detailed modeling investigations by MW; and discussion of key policy, institutional, and cost issues that will need to be addressed.

The Fry-Ark Project reservoirs include Ruedi on the West Slope and Turquoise, Mt. Elbert, Twin Lakes, and Pueblo on the East Slope. Of the total active conservation storage in the East Slope reservoirs (417,223 af), 111,822 af is non-Project storage in what is termed long-term contract space, and 305,401 af is Project storage. Under current policies, a participating District entity can store non-Project water in Project storage space under “if-and-when” contracts.

3.3.1.1 Overview of the Re-operation Concept

Stated simply, Fry-Ark Project re-operation involves the reallocation of existing storage space and/or modifying current operational policies of the East Slope Project reservoirs (i.e., Arkansas Basin facilities). The goal of re-operation is to allow entities that currently benefit from the Project to use Project storage to help maximize the yield of their non-Project water rights. Two re-operation scenarios were considered.

Re-operation Scenario A — A portion of project storage space would be reallocated as non-Project storage by modification of the Project District's Allocation Principles and Project Operational Policies of the District and the USBR. The amount of Project storage space would be reduced with a corresponding increase of non-Project storage space.

Re-operation Scenario B — Under this concept, an entity could store both its Project water and non-Project water in Project space, subject to the Allocation Principles and Operational Policies of the District.

3.3.1.2 Verification of Re-operation Space

Studies of both re-operation scenarios were made using an operational model developed by MW specifically for evaluating the preferred storage options plan. Model results indicated that storage space for Project water could be reduced without affecting project yields or the ability of the Project to meet demands. Under Re-operation Scenario A, Project storage could be reduced by approximately 23,000 af without affecting the Project's ability to meet demands. Under Re-operation Scenario B, Project storage could be reduced by 48,000 to 51,000 af without affecting the yield of the Fry-Ark Project or its ability to meet future water demands. This re-operation space then would be available to fulfill needs for non-Project water storage identified in the GEI Study. As described in Section 3.4, the model was structured to fully and accurately represent the operation of the Project under future demand conditions (i.e., all participants obtain their full allocations of Project water) and under the Allocation Principles and operating policies and procedures of the District.

During the modeling effort, MW examined the potential benefits of providing 40,000 af of firm storage for Winter Water in Project reservoirs. While dedicating storage space for Winter Water does reduce the number and volume of spills of Winter Water in storage, it will not result in a significant increase in Winter Water deliveries. Depending on the ultimate configuration of the preferred plan, providing 40,000 af of firm space for Winter Water could increase average deliveries of Winter Water by 600 to 2,700 af per year. It does not appear that dedicating space in the Project for Winter Water storage will provide a

sufficient enough increase in delivery potential to justify significant interest by irrigation interests in the District.

3.3.1.3 Potential Allocation of Re-operation Space

Several entities needing additional storage capacity could benefit from the identified 48,000 to 51,000 af of re-operation space. Based on model simulations, CSU could effectively use up to 19,000 af (39 percent) of the re-operation space to store water by exchange and maximize the yield of a portion of their imported water supplies. Other municipal entities could benefit in similar ways, including the Pueblo Board of Water Works, the other FVA entities, St. Charles Mesa Water District, and entities west of Pueblo. These entities currently have storage allocations in the Project. Model results indicate that these entities could meet between 50 and 100 percent of their storage needs from within the re-operation space. For planning, the following allocations were used, based on a re-operation space of 48,500 af and assuming 57 percent of the total storage need for each entity, except for CSU, could be provided by re-operation:

Entity	Amount of Re-operation Storage (af)
CSU	19,000
FVA (excluding CSU)	12,600
Pueblo Board of Water Works	11,400
St. Charles Mesa Water District	2,100
City of Florence	1,300
Other Entities West of Pueblo	2,100
Total	48,500

The allocations of re-operation space could change during subsequent phases of planning and implementation. However, the total identified storage need for District entities far exceeds the available re-operation space. Because re-operation space will be the least costly storage available to District entities, it most likely will be used to the fullest extent possible by those entities with Project storage allocations who need more storage capacity.

3.3.1.4 Policy/Institutional Issues With Re-operation

There are a myriad of policy, institutional, and legal issues that will need to be successfully addressed in order to implement Re-operation Scenario B. To the maximum extent possible, the operations model logic and constraints were tailored to address the operating policies and procedures and Allocation Principles that form the basis for successfully operating the Fry-Ark Project to meet its authorized objectives. Guiding principles for project planning and simulation model development in this regard include:

- Re-operation will not affect the yield of the Project from its West Slope and East Slope water rights.
- Re-operation will not increase West Slope diversions beyond those to which the Project and other participating entities are legally entitled.
- Re-operation will not diminish the ability of agricultural users to store water in Project facilities under the Winter Water Storage decree.
- Re-operation will not reduce the flow of the Arkansas River below Pueblo Dam below 100 cfs.
- No injury, as defined under Colorado Water Law, will occur to existing water rights due to re-operation of Project storage space.

The following paragraphs highlight key assumptions used in the model to maintain the integrity of Project operations and protect existing beneficiaries of the Fry-Ark Project.

USBR Contracts

A contract between the District and the USBR was signed on October 23, 1981 for repayment of the District's share of the reimbursable cost for project construction. The project has been operated historically to generate revenues from water sales so that the repayment contract can be fulfilled. Future operations must not affect the District's ability to repay the USBR. Of the total 305,325 af of active Project storage, 159,000 af is municipal carryover space for Project water. The remaining 146,325 af is unallocated Project storage. Non-Project water can be stored in the Project space but must be spilled to accommodate Project water. Under Re-operation Scenario B, the re-operation storage identified to be available by the operations model (48,500 af) would essentially become long-term contract space, available to an entity contracting for that space. The entity could use its share of the space to store non-Project water.

Project Spill Priorities

Amendment No. 4 of the District's Contract with the USBR governs the priority of reservoir spills. Water is evacuated from the project reservoirs in the following order:

1. Water stored under "if-and-when" contracts for entities which will use the water outside of the District boundaries;
2. Water stored under "if-and-when" contracts for entities which will use the water within the District;
3. Winter Water stored in excess of 70,000 af;
4. Non-Project water stored under contracts with municipal entities within the boundaries of the District (limited to 163,100 af);
5. Winter Water less than 70,000 af;
6. Project water accumulated from the Arkansas River and its tributaries under the District's East Slope water rights.

Under Re-operation Scenario B, the spill priorities listed above would not be changed and entities would be allowed to store non-Project water in Project storage space. Re-operation space would be under the fourth spill priority above.

Allocation Principles

The District's Allocation Principles (November 29, 1979) provide for distribution of Project yield and storage among participating entities, as follows:

Entity/Category	Allocation (%)	Yield ⁽¹⁾ (af/yr)	Storage (af)
FVA	25%	20,100	78,000
Arkansas Valley-East of Pueblo	12%	9,640	37,400
Arkansas Valley-West of Pueblo	4%	3,216	12,400
Pueblo	10%	8,040	31,200
Subtotal (Municipal)	51%	41,004	159,000
Irrigated Agriculture	49%	39,396	---
Unallocated Storage	---	---	146,401
Total	100%	80,400	305,401

(1) Yield is based on long-term average expected yield of 80,400 af. Yields are not guaranteed. Annual allocation would be based on that year's yield times the allocation percentage.

Re-operation Scenario B was structured to maintain the yield of the Project (80,200 af for the 1966-96 hydrology), while providing non-Project water storage for municipal entities. Future demands on Project water were assumed to be 51 percent municipal and 49 percent agricultural, consistent with the Allocation Principles.

The relationship between entities requesting storage and having access to carryover storage in the Project, and the current Project storage allocation is provided below:

Project Participants With Storage Needs	Storage Project Allocation (af)	Storage Request (af)
CSU	55,700 ⁽¹⁾	45,000
Other FVA Entities	22,300 ⁽¹⁾	22,000
Entities East of Pueblo	37,400	3,600 ⁽²⁾
Entities West of Pueblo	12,400	6,000 ⁽³⁾
Pueblo Bd. of Water Works	31,200	20,000
Total	159,000	96,600

⁽¹⁾ Storage allocation for CSU and other FVA entities is based on the 1979 FVA Contract. Remainder is storage need for other entities.

⁽²⁾ St. Charles Mesa Water District = 3,600 af.

⁽³⁾ City of Florence = 2,300 af.

As described in Section 3.4 of the report, the model was run to determine the amount of inflow needed to meet demands with storage of 96,600 af without re-operation. Average inflow of 147,633 af would be required for the 30-year simulation period. With re-operation, the same demand could be met with 48,000 to 51,000 af of storage depending on the scenario studied. Detailed studies for CSU indicate that 19,000 af of re-operation storage would be effective in partially meeting CSU’s long-term water need. Re-operation would be as effective, or more so, in meeting the storage need identified for other entities (FVA, St. Charles Mesa, Florence, and Pueblo).

Minimum Flows Below Pueblo Dam

Re-operation storage will facilitate additional river exchanges that could impact stream flows below Pueblo Dam. Currently, the model results show an average monthly minimum flow below the dam of approximately 100 cubic feet per second (cfs) and a minimum flow of 49 cfs, which would occur very infrequently. (The model did not set minimum stream flow criteria below Pueblo Reservoir.) Normally, flows below the dam are 100 cfs or higher. The issue of in-stream flow below Pueblo Dam is being discussed by concerned parties, including Pueblo, the District, Colorado Division of Wildlife, and others. Absent a firm guideline, the

model results with respect to flows below Pueblo Dam, are assumed to be acceptable for developing a preferred storage options plan.

Monitoring of Water Quality Impacts

A major concern of the irrigators and municipalities in the Lower Basin has been, and continues to be, declining water quality primarily relating to elevated levels of total dissolved solids (salinity). Water exchanges, while operated to avoid injury relative to water quantity, are perceived to contribute to declining water quality in the Lower Basin. Despite the apparent lack of negative impacts on water quality (see Section 4.2), implementation of Fry-Ark Project re-operation, and/or any of the other storage options, should include a program of intensive water quality data collection and evaluation. This program should begin as soon as possible and continue throughout the initial 20 to 30 years of PSOP operations. This data base would serve to establish a pre-Project baseline and for taking corrective actions if water quality impacts are observed.

Municipal Outlet Capacity at Pueblo Dam

Pueblo Dam includes an outlet for municipal releases to the Pueblo Board of Water Works and for the Arkansas Valley entities east of Pueblo. Currently, releases from Pueblo Reservoir are being made to the river. Pueblo's municipal diversion is located downstream of the dam. The Pueblo Board of Water Works is planning to tap the outlet at the dam. The outlet also includes capacity for a pipeline to serve the Valley entities east of Pueblo; however, the pipeline termed the "Valley Pipeline" was authorized but not constructed. Although construction of this Valley Pipeline does not appear feasible at this time, any re-operation of storage in Pueblo Reservoir must not compromise delivery capacity from the dam that would be used to supply the Valley Pipeline.

Other Operational Factors and Cost

The re-operation of Fry-Ark Storage under Scenario B would also include the following provisions:

- Storage of Project water would take precedence over the storage of all non-Project water, including any non-Project water that may be in storage when Project water becomes available.

- All allocations of re-operation storage will be subject to approval of the District Board, consistent with the Allocation Principles and Operation Policies of the District.
- There will be a cost associated with use of the re-operated storage space to be borne by the participating entities.
- Participants in Re-operation Scenario B will be required to pay for their annual allocations of Project water consistent with current contracts.

The cost for USBR administrative, legal, permitting, and NEPA compliance activities required to implement re-operation is conservatively estimated to be \$7.3 million. This is equivalent to \$150 per af of re-operation storage (48,500 af).

3.3.2 Other Non-Structural Measures

In addition to re-operation of the Fry-Ark Project, the study team also investigated two other non-structural water management measures for possible implementation. These options include interruptible supply (IS) agreements and creation of a water bank. As discussed in Appendix B, these concepts could be applied to facilitate temporary transfer of agricultural water to municipal uses. Both measures have been implemented in other locations with varying degrees of success. Their implementation in the Arkansas Basin, as part of the PSOP (or separately), will depend on the ability of municipal and agricultural water users to overcome the obstacles identified in Appendix B and reach agreement on key issues relative to water lease and/or rental prices, implementation entity, infrastructure for water conveyance, and similar issues. Significant engineering and legal studies will be needed to resolve water transfer issues no matter which of the two options would be implemented.

Water users in the Lower Basin have started a dialogue about how to implement temporary water transfers so that irrigators can take advantage of their valuable water rights without causing the potential economic impacts when permanent transfers of water are made.

While the study team and District staff recognize that more discussion and evaluation will be needed, we recommend that the PSOP include provision for incorporating water banking and IS agreements in the final plan. To this end, a provisional amount of storage for these purposes has been included in the District Water Management Storage (Section 2.4). Further study and specific discussions between agricultural and municipal water entities interested in these measures are recommended for the near term.

3.3.3 *Enlargement of Storage at Existing Reservoirs*

3.3.3.1 Project Reservoirs

Enlargement of Pueblo Dam and Reservoir and Sugarloaf Dam/Turquoise Lake are judged to be technically feasible based on investigations by the USBR (1999) and Black and Veatch (B&V, 2000). The USBR studied raising Pueblo Dam and their findings were reviewed by B&V. Raising Sugarloaf Dam to enlarge Turquoise Lake was studied by B&V. Their findings will be reviewed by the USBR.

Pueblo Reservoir Enlargement

Technical Issues. Three enlargements of Pueblo Reservoir were evaluated — 25,000, 60,000, and 75,000 af as indicated below:

Pueblo Reservoir	Existing Reservoir	Capacity Increase (af)		
		25,000	60,000	75,000
Top of Active Storage (ft)	4880.5	4885.8	4892.7	4895.5
Top of Joint Use Pool (ft)	4893.8	4898.4	4904.2	4906.7
Spillway Crest Elevation (ft)	4898.7	4903.0	4908.6	4910.9
Top of Dam (ft)	4925.0	4925.0	4927.0	4929.0

For the 25,000 af option, the spillway crest would be raised 4.3 feet and the dam crest would remain at its present elevation. For 60,000 and 75,000 af enlargements, the spillway crests would be raised by 9.9 and 12.2 feet, respectively, while the dam crest would be raised by 2 feet and 4 feet, respectively, using a parapet wall. The spillway crest would be raised using conventional concrete to reshape the spillway ogee to a higher elevation. Although a gated spillway option was studied by the USBR, they concluded (and B&V concurred) that an ungated spillway would be preferred for cost, technical, and operational reasons. In addition to modifying the spillway crest and dam crest, a variety of other measures will need to be implemented to maintain a safe, reliable dam structure. These include: rock bolts to increase spillway stability; additional drainage measures to control uplift pressures; post-tensioned tendons to reduce tensile stresses at the heel of the concrete dam under higher reservoir levels; and a stability berm extension along the left embankment portion of the dam. The USBR is in the process of further evaluating the flood hydrology at Pueblo Reservoir. This

work could affect the risk analysis for the dam, which is the basis for the current enlargement concepts.

Environmental and Permitting Issues. Pueblo Reservoir enlargement will involve a major Federal action requiring permitting and intensive review under the guidelines of the National Environmental Policy Act (NEPA) and preparation of an Environmental Impact Statement (EIS). Effects to wetlands, the wildlife inhabiting those wetlands, and bald eagles will be significant issues. Wetland permitting and mitigation likely will be challenging but feasible. A variety of institutional issues will need to be addressed between the USBR, the District, and entities participating in the Project.

Implementation Cost. Cost estimates for raising Pueblo Dam were developed by the USBR. B&V evaluated the costs associated with modifying facilities (railroad, paved roads, waterline, sewer line), recreational amenities (marinas, campgrounds, picnic areas), and environmental mitigation measures associated with Pueblo Dam and Reservoir. Total project cost for enlarging Pueblo Dam and Reservoir is expected to range from \$43 to \$110 million:

Major Cost Item	Cost in \$ Million		
	25,000 af	60,000 af	75,000 af
General Condition	1.4	2.9	4.3
Dam Construction	17.4	31.0	37.9
Facilities modification, recreational amenities, mitigation	9.2	19.2	28.6
Construction Cost	28.0	53.1	70.8
Permitting and NEPA	2.2	4.2	5.7
USBR Legal, Administrative and Engineering Costs	13.2	25.0	33.2
Total Project Cost	\$43.4M	\$82.3M	\$109.7M
Unit Cost (\$/af)	\$1,730	\$1,370	\$1,460

Turquoise Reservoir Enlargement

Technical Issues. Two enlargements of Turquoise Reservoir, which would be achieved by raising Sugarloaf Dam, have been identified by B&V (2000), as indicated below:

Turquoise Reservoir	Existing Reservoir	Capacity Increase (af)	
		11,950	19,600
Top of Active Storage (ft)	9869.4	9876.0	9880.1
Spillway Crest Elevation (ft)	9869.4	9876.0	9880.1
Top of Dam (ft)	9879.0	9883.5	9887.5

B&V appears to have concluded, based on their review of original dam construction, performance history, and site and geological conditions, that raising the dam significantly more than associated with the larger capacity shown above (i.e., more than 19,600 af) could pose more challenging technical and construction issues because the limits of a parapet wall raise would be exceeded.

The 11,950 af of additional capacity would be created by raising the normal maximum pool and morning-glory spillway crest by 6.6 feet. For extreme flood routing, the dam crest would be raised with construction of a 4-foot high parapet wall on the upstream side of the dam crest. The larger 19,600 af capacity increase would require raising the embankment crest by 4 feet in addition to providing a 4-foot-high parapet wall on the upstream side of the dam crest. The operating pool and spillway crest elevation would be raised by 10.7 feet to provide the 19,600 af of additional water conservation storage space and flood-routing capacity.

Environmental and Permitting Issues. Turquoise Reservoir enlargement is not expected to have significant environmental issues provided there are no significant changes in flow that affect aquatic resources or water quality downstream. An Environmental Assessment (EA) or EIS will be required to document impacts associated with raising Sugarloaf Dam to enlarge Turquoise Lake. The USBR would be the likely lead agency. (An EIS will be required if the Turquoise enlargement is part of a larger development.)

Implementation Cost. Cost estimates for raising Sugarloaf Dam were developed by B&V. Total project cost, including modifications to the dam, facilities modification, permitting, and environmental investigation is estimated to be \$8.3 million for the 11,950 af enlargement and \$14.5 million for the 19,600 af enlargement.

Major Cost Item	Cost in \$ Million	
	11,950 af	19,600 af
General Conditions	0.7	1.2
Dam Construction	2.8	6.1
Facilities Modification Construction and Mitigation	1.9	2.0
Permitting and NEPA	0.4	0.8
USBR Legal, Administrative and Engineering Costs	2.5	4.4
Total Project Cost	\$8.3M	\$14.5M
Unit Cost (\$/af)	\$690	\$740

3.3.4 Enlargement of Non-Project Reservoir (Lake Meredith)

Five dam raise alternatives were evaluated for Lake Meredith, providing between 15,000 and 75,000 af of additional storage capacity. Any enlargement of Lake Meredith Reservoir by CSU would be subject to the stipulation with Proxy Group in Water Course Cases 84CW62, 84CW63, and 84CW64. Enlargement by the District or another entity would be subject to approval by the Lake Meredith Reservoir Company Board. Dam modification concepts and preliminary cost estimates were developed by URS, Greiner, Woodward-Clyde (URS) in 1998. URS concluded that raising the dam by up to 13 feet (75,000 af of additional capacity) would be technically feasible. Based on the URS work, B&V prepared updated cost estimates for the following reservoir enlargements:

Lake Meredith	Existing Reservoir	Capacity Increase (af)				
		15,000	25,000	40,000	55,000	75,000
Normal Pool Elev. (ft)	4254.2	4256.0	4258.0	4260.0	4262.0	4265.0
Top of Dam Elev. (ft)	4257.0	4261.0	4263.0	4265.0	4267.0	4270.0
Nominal Increase in Normal Pool Elev. (ft)	---	2	4	6	8	11

Principal elements of cost for raising the dam include: placing embankment fill material; providing drainage and seepage control; providing upstream slope protection (soil cement or riprap) to control wave erosion; armoring a portion of the dam with RCC to act as an emergency spillway; and constructing a new multi-level intake and outlet works and a morning-glory type spillway to pass up to the 100-year flood. The morning-glory would discharge to a spillway outlet conduit. A key consideration at Lake Meredith is the length of the embankment, which for the largest dam raise will be nearly 4 miles. Seepage has historically been a problem at Lake Meredith and measures to control the rate of seepage, and to safely collect and convey seepage that does occur, will be critical design issues.

3.3.4.1 Environmental and Permitting Issues

Lake Meredith enlargement faces a significant wetland permitting hurdle that may be difficult to overcome. It is expected to be difficult to gain approval for the inundation of up to 1,200 acres of wetlands and then to develop successful mitigation for this loss. The magnitude of impacted wetlands is sufficiently large to require a specific cost provision for acquiring wetlands elsewhere as the assumed method of mitigation. An EIS most likely would be required. If part of a larger project involving Project facilities or if Project water is stored in an enlarged Lake Meredith, the USBR appears to be the likely lead agency. As a stand-alone project, the Corps of Engineers seems to be the most likely Federal agency to take the permitting lead for an enlarged Lake Meredith.

3.3.4.2 Implementation Costs

Costs estimated for the Lake Meredith enlargement were developed by B&V using previous work by URS. Total cost including dam modifications, permitting and NEPA compliance, and potential mitigation range from \$37.4 to \$92.1 million, as summarized below:

Major Cost Item	15,000	25,000	40,000	55,000	75,000
General Conditions	3.9	6.2	7.8	8.4	9.4
Dam Construction	9.1	10.3	13.3	14.6	18.1
Facilities Modification Construction and Mitigation	16.7	31.4	38.6	41.4	44.5
Permitting and NEPA	2.4	3.8	4.8	5.2	5.7
Legal, Administrative and Engineering Costs	4.5	7.2	9.0	9.7	10.8
Land Acquisition	0.8	1.6	2.3	2.8	3.6
Total Project Cost	\$37.4M	\$60.5M	\$75.8M	\$82.1M	\$92.1M
Unit Cost (\$ per af)	\$2,490	\$2,420	\$1,900	\$1,490	\$1,230

3.3.5 New Storage Reservoirs

Williams Creek Dam and Reservoir

Technical Issues. Williams Creek Reservoir is an integral part of CSU's long-range water resources plan. Preliminary engineering for Williams Creek Dam has been completed by CH2M Hill. This new dam, located on Williams Creek, a tributary of Fountain Creek, would be a zoned embankment dam and would include an outlet works with selective withdrawal capability and a spillway to protect the dam from overtopping. To fill the reservoir, a canal or pipeline would be constructed from a point on Fountain Creek to the new reservoir. The Williams Creek channel below the dam would need to be modified to accept sustained flows during periods when stored return flows are exchanged for water diverted higher in the Basin. Pertinent data are summarized below.

Williams Creek Reservoir	Storage Volume		
	10,000 af	30,000 af	51,000 af
Dam Crest Elevation	5468	5497	5510
Normal Maximum Pool Elevation	5458	5487	5500
Nominal Dam Height, (ft)	50	79	110

Storage capacity is limited by site topography and exchange potential. Currently, CSU believes that 15,000 af of storage will be required at Williams Creek to meet its water management objectives. Therefore, only the 30,000 and 51,000 af options provide potential to meet the objectives of other water users who might want to partner in development of the project. Storage potentials in Williams Creek for District participants other than CSU would be 15,000 af (for the 30,000 af option) and 36,000 af (for the 51,000 af option). CH2M Hill concluded that constructing a dam at the Williams Creek site to the heights outlined previously would be technically feasible.

Environmental and Permitting Issues. Williams Creek Reservoir construction will need to address species of concern (mountain plover and prairie dog) and wetland impacts (about 12 acres for a 15,000 af reservoir). These impacts likely can be mitigated and the needed authorizations gained to construct the project.

An EA or EIS will be required. The most likely lead federal agency would be the Corps of Engineers.

Implementation Cost. Williams Creek Dam and Reservoir would have total implementation cost ranging from \$25.5 to \$98.2 million, as summarized below:

Major Cost Item	Reservoir Capacity (af)		
	10,000	30,000	51,000
General Conditions	2.7	7.7	10.3
Dam Construction	10.7	41.4	58.6
Facilities Modification Construction and Mitigation	7.0	9.6	10.4
Permitting and NEPA	1.6	4.7	6.3
Legal, Administrative and Engineering Costs	3.1	8.8	11.9
Land Acquisition	0.4	0.7	0.7
Total Project Cost	\$25.5M	\$72.9M	\$98.2M
Unit Cost (per af)	\$2,550	\$2,430	\$1,930

Gravel Lakes Storage

Technical Issues. The development or conversion of sand and gravel mine pits into water storage facilities is gaining popularity along Colorado's Front Range, particularly along the South Platte River and its larger tributaries. These facilities often are used in exchange plans, wherein municipal return flows are stored and released in exchange for water diverted from upstream sources.

The Colorado State Engineer has promulgated strict rules on allowable leakage into these reservoirs so that adjacent groundwater levels and associated water rights are not impacted. Unless leakage criteria are met, operation of the gravel lakes storage will be subject to the same augmentation requirements as alluvial wells. To meet the strict leakage criteria, the lakes must be lined, either with an impervious earth liner or a soil-bentonite slurry wall around the pit. The slurry walls usually are keyed into underlying bedrock to cut off seepage.

Gravel lakes range in size from a few acres to over 100 acres in surface area. The lakes usually are 20 to 30 feet deep, creating storage capacities of 500 to 2,000 af. Storage is filled by gravity inlet channels or by pumping. The lakes are drained by deep gravity outlets or by pumping.

Gravel lakes can be developed after mining is completed or concurrent with mining operations. For previously mined pits, the slurry wall method is applied. For development during mining, either lining method can be used, with method selection depending on the availability of impervious materials and mine dewatering requirements. A gravel pit currently being mined near Pueblo is being developed for future storage. An impervious earth liner in the form of a clay berm is being constructed as mining progresses.

Because of their limited storage capacity and location, gravel lakes may be best suited to local municipal applications rather than part of regional water storage and management options.

Environmental and Permitting Issues. Gravel lakes storage is expected to have relatively fewer environmental issues and permitting challenges in comparison to conventional water storage options. They usually are on private land and most of the environmental issues and impacts, particularly riverine habitat and wetlands, are addressed in obtaining the mining permit.

Environmental compliance is not expected to be required unless gravel lakes storage is included as part of a larger storage development plan that is permitted under NEPA.

Neither an EA or EIS is expected to be required for stand-alone development of gravel lakes storage.

Implementation Cost. Costs to develop gravel lakes storage are highly dependent on site conditions and whether development occurs concurrently with mining or after mining is completed. B&V estimates implementation costs to be \$1,090 per af for concurrent development (new lake) and \$3,920 per af for conversion of an existing pit/lake into a lined water storage facility. These costs do not include conveyance facilities for filling and draining the reservoirs. Costs in the Denver area have been somewhat lower, based on GEI's experience, within a range of \$1,500 to \$3,000 per af, excluding conveyance costs.

3.4 Water System Modeling

A major element in evaluating potential alternatives and identifying a preferred plan for meeting District storage needs is the hydrologic modeling analysis completed by MW. A detailed report covering the modeling work and an Executive Summary of that report have been completed and reviewed by the SSC. The summary of modeling work provided in this section of the report provides backup for selection of the preferred plan.

The water resources simulation model is intended to serve the following purposes in selection of a PSOP for the Arkansas Basin.

1. Examine the opportunity for Project re-operations given the inflow and demand schedules established for Project and non-Project entities.
2. Examine the operations of the additional storage space for each of the alternatives.
3. Determine if there are any "fatal flaws" or hydrologic limitations for any of the potential storage alternatives.
4. Determine the impact of existing and proposed operations on Arkansas River flows and reservoir levels.
5. Determine the most effective and efficient alternatives for storage of additional water in the Arkansas River basin.

A computer simulation model of the Fry-Ark Project and the proposed storage alternatives was developed to analyze each of the storage alternatives with the projected storage requests. Because none of the storage alternatives individually could meet the full 173,100 af of storage initially requested, five (5) scenarios utilizing a combination of the alternatives were formulated. The scenarios provide a means of identifying river and

reservoir impacts due to the proposed alternatives. From these scenarios, limitations and “fatal flaws” can be identified, and a general evaluation of the alternatives can be performed.

Simulations of storage operation scenarios were developed using a MODSIM model of monthly hydrology for the 1966-95 period. Project inflows in the model include West Slope imports through the Boustead Tunnel and native East Slope Arkansas River water rights. No new water rights for diversions from the West Slope were modeled. Demands were established in the model based on full utilization of Project water by agricultural interests and those municipal entities needing Project water to help meet their year 2040 water demands. Non-Project inflows and demands were simulated based on specific information provided by CSU, the Pueblo Board of Water Works, and other water supply entities requesting storage; a regression analysis for Winter Water use; and information collected previously by GEI (1998). Simulation modeling for the five scenarios was performed for two cases: 1) firm storage (40,000 af) for Winter Water is provided in the new storage space, and 2) firm storage for Winter Water is not provided. Storage capacities for Scenarios A through E are summarized in Table 3.1. Modeling to assess available storage space for re-operations was based on the guidelines discussed in Section 3.3.1.

TABLE 3.1 Storage Scenarios Evaluated in the Initial Hydrologic Modeling

The Winter Water Storage Program was simulated both with 40,000 af of firm storage and non-firm storage under existing policies and current spill priorities. When municipal Project water demands are fully realized, Winter Water is projected to spill 5 out of the 30 years, with an average annual spill of 7,449 af. Firm storage of Winter Water decreases the volume of spills, but does not decrease the number of years with spills. The decrease in the volume of Winter Water spilled does not result in a significant increase in Winter Water deliveries. The average annual deliveries increase from 22,116 af per year with non-firm storage to 23,489 af per year with firm storage. This is primarily because, even with firm storage, Winter Water can only be carried over until May 1 of the following year. This results in firm storage increasing the volume of Winter Water that is unused and released from Project storage.

Modeling results indicate that non-Project water in Project space under re-operations generally spills 2 out of 30 years, with average annual spills ranging from 884 af to 1,107 af. Generally, the volume of non-Project water spilled is less under firm Winter Water storage than non-firm Winter Water storage. During the years of non-Project spills, Project accounts for the re-operations entities are generally full except for the occasional year when non-Project water is spilled by Winter Water. During these years, instead of storing non-Project water in Project space through re-operations, the entities would need to find space in other storage facilities, exchange with other users, sell to other users, or allow the water right to remain unused and flow downstream.

The simulation model was used for each of the five scenarios to evaluate impacts on stream flows and reservoir levels. A key finding of the model is that the location of storage, as reflected by the five scenarios (Table 3.1) has little effect on stream flow impacts (i.e., the impacts are very similar for all five scenarios).

For the stream flow gages above Pueblo Reservoir (Figures 3.1 through 3.4), the impact analysis generally shows that stream flows increase compared with historical flow records during the summer months and decrease slightly during the winter months. Because the simulated ultimate annual demands are higher than under historical conditions, peak flows tend to be higher and there is a general increase in the volume of water moved annually from the upper basin to the lower basin. The Fountain Creek gage shows a general increase in annual flow due to the increase in return flows from Colorado Springs, Fountain, Widefield, and Security.

The Colorado Division of Natural Resources has recommended to the USBR under a voluntary flow program that a minimum flow of 250 cfs be maintained at the Wellsville gage throughout the year, and that a minimum flow of 700 cfs be maintained from July 1 through August 15. The USBR has recognized the 250/700 cfs in-stream flow recommendations and operated the Project in recent years so that these flows are

maintained. However, because these in-stream flows are not legally required, the simulation model was not coded so that these in-stream flows would be met. Based on the simulation results summarized on Figure 3.3, for Wellsville, the recommended in-stream flows are met during 92.3 percent of the months during the simulation. If the USBR were to continue to operate the Project to meet the in-stream flows, the impact on Project and non-Project yield would probably be negligible.

FIGURES 3.1/3.2 - Mean Monthly Streamflow, Arkansas River near Malta
Mean Monthly Streamflow, Arkansas River near Granite

(1 page)

FIGURES 3.3/3.4 - Mean Monthly Streamflow, Arkansas River at Wellsville
Mean Monthly Streamflow, Arkansas River above Pueblo

(1 page)

The Arkansas River Above Pueblo gage is located just downstream of Pueblo Reservoir approximately 7 miles west of Pueblo, and is upstream of Pueblo Board of Water Works' existing water treatment plant diversions. Figure 3.4 shows the average monthly historical and simulated discharge at the Above Pueblo gage for the average of all scenarios. The simulated mean monthly stream flow shows little difference compared to the historical mean monthly stream flow. The absolute minimum simulated stream flow at the gage is 49 cfs in April of 1982 under Scenario A. It should be noted that although the Pueblo Board of Water Works currently diverts below the Above Pueblo gage, the model was developed with the Pueblo diversion taken directly out of Pueblo Reservoir in accordance with future plans. However, the resulting decrease in flow at the gage is generally offset due to the increase in demand from those entities east of Pueblo, which require additional releases to be made from Pueblo Reservoir. Future agricultural diversions are generally assumed to be the same as historical agricultural diversions.

As shown on Figure 3.5, little change in flow regime is predicted at the Avondale gage. Stream flows in Fountain Creek are expected to increase substantially (Figure 3.6).

In general, it was found that there are few limitations and no hydrologic or operational fatal flaws for the storage alternatives evaluated. However, additional information which was considered in the alternatives evaluation can be inferred from the modeling results, as follows:

- Re-operations: The effective storage for re-operations (Scenario B) is approximately 48,000 to 51,000 af, with the storage volume highly dependent upon the location of structural storage improvements that the volume would replace. A volume of 48,500 af accounts for slightly more than 50 percent of the total storage request of the entities participating in re-operations.
- Pueblo Reservoir Enlargement: Pueblo Reservoir can be utilized through its full range of potential storage enlargements. Pueblo Reservoir allows the most flexibility for exercise of water rights, exchanges, and general water delivery.
- Turquoise Reservoir Enlargement: The model shows that with the inflow locations given and the potential for exchange of storage from Twin Lakes to Turquoise Reservoir, there is adequate inflow to fill Turquoise and keep the reservoir full during most months of the simulation. Evaporation from Turquoise Reservoir is less than from other Arkansas Basin reservoirs. However, due to channel losses in the Arkansas River, some of this lower evaporation loss is offset by increased channel losses.

FIGURES 3.5/3.6 - Mean Monthly Streamflow, Arkansas River near Avondale
Mean Monthly Streamflow, Fountain Creek at Pueblo

(1 page)

- Lake Meredith Enlargement: The analysis shows that there is adequate demand downstream of Lake Meredith, primarily for Fry-Ark deliveries and well augmentation groups, for even the greatest potential enlargement volumes. Under all scenarios in which Lake Meredith is enlarged to its full potential, the reservoir operates through its complete range of available storage, releasing storage to downstream demands in dry years and storing inflows in wet years. The most significant drawback to Lake Meredith enlargement is its efficiency. This is primarily due to the shallow depth and large surface area of the reservoir, which increases evaporation, and the conveyance losses between the Arkansas River and Lake Meredith.
- Gravel Lakes Storage: No limitations were found regarding the use of gravel lakes storage. Typically, a small storage volume can be utilized through its full range of potential storage capacities. The key constraint for this alternative will be identifying feasible sites that are located conveniently to points of demand.
- Williams Creek Reservoir Enlargement: Enlargement of the proposed Williams Creek Reservoir is primarily beneficial only for those entities that have inflows in the Fountain Creek Basin to fill the reservoir. This primarily includes the FVA entities. The analysis shows that, because of its smaller surface area and deeper storage pools, the reservoir provides fairly efficient storage, and allows storage of return flows which can be exchanged to Pueblo Reservoir, similar to CSU's use of the reservoir. However, given the inflows and demand schedules in this analysis, the maximum enlargement of Williams Creek Reservoir should be limited to approximately 9,000 af, for a total storage volume of 21,000 af.

Each of the five scenarios was ranked by assigning a score based upon hydrologic and operational factors. Scores range from one to ten, with ten being the best possible score. These factors primarily include, but are not limited to, operational flexibility (such as location, ability to store available inflows, and ability to deliver to demand locations) and storage efficiency (which includes evaporation and conveyance losses). Because all of the alternatives provide benefits to water delivery in the basin and have few limitations and no fatal flaws, all alternatives were assigned scores above a neutral score of five. Rankings which consider other decision criteria, such as environmental impacts, water quality impacts, cultural impacts, and socio-economic impacts, have been developed in separate reports. A summary of the rankings assigned to each alternative is provided below:

Scenario	Score ⁽¹⁾
Turquoise Reservoir Enlargement	9
Pueblo Reservoir Enlargement	8
Re-operations (Scenario B)	7
Gravel Lakes Storage	7
Lake Meredith Enlargement	6
Williams Creek Reservoir	6
Average	7.2

⁽¹⁾ Note: Highest possible score indicating the best performance for water management flexibility is 10.

Turquoise Reservoir enlargement and Pueblo Reservoir enlargement have the highest scores. Turquoise Reservoir enlargement provides relatively efficient storage due to the low evaporation rate and is able to serve all demands in the basin. Due to its location in the basin, Pueblo Reservoir enlargement provides significant operational flexibility with slightly less efficient storage than Turquoise Reservoir due to increased evaporation rates.

Re-operations provides significant operational flexibility and relatively efficient storage, but does not provide firm storage. Gravel Lakes storage provides some benefits in operational flexibility due to their distributed locations, but because each individual reservoir provides only a small portion of the overall storage requirement, the alternative becomes slightly less efficient than other alternatives, and may provide for more operational challenges.

Lake Meredith enlargement and Williams Creek Reservoir expansion were scored just below Re-operations and Gravel Lakes. The primary drawbacks to Lake Meredith enlargement are evaporation and conveyance losses, which decrease storage efficiency. The primary drawback to Williams Creek Reservoir is its location, which limits the volume of water that is available to fill the reservoir.

3.5 Formulation of Potential Plans

The total identified storage need for water users within the District is 122,100 af, as identified below:

Entity	Storage Requirement (af)
Specific Storage Needs (GEI Study, 1998)	
CSU	45,000
Other FVA Entities	22,000
Entities West of Pueblo	3,700
Florence	2,300
Winter Water Program	40,000 ⁽¹⁾
Storage to Regulate Replacement Water for Well Pumping	26,000 ⁽¹⁾
Subtotal	139,000
Additional Requests by District Entities	
Pueblo Board of Water Works	20,000
Public Service Company	5,000
Pueblo West Metropolitan District	5,500
St. Charles Mesa	3,600
Subtotal	34,100
Total (GEI Study, 1998)	173,100
Deduct Winter Water and Replacement Water (40,000 and 26,000 (af)	-66,000
Add District Water Management Storage	15,000 ⁽²⁾
Total	122,100

1. These storage needs are identified, but subject to agricultural water users' ability to pay. A portion of these identified storage needs could be met by District Water Management Storage.
2. This storage capacity could be used to meet a variety of water management purposes in the District, including Winter Water supplies management, well augmentation water storage, water banking, and/or storage of interruptible supply water storage.

During discussions of storage plan formulation, the District identified the need for providing up to 15,000 af of new storage to meet a variety of local water management objectives. Among these objectives are:

- Better management of Winter Water by having a dedicated storage pool into which Winter Water spilled at Pueblo Reservoir could be stored for late use by irrigators.
- Management of well augmentation supplies and Project return flows.

- Storage for a Water Bank, or to manage temporary water transfers from agricultural to municipal users under Interruptible Supply (IS) agreements.
- Storage space for leasing by interested water users on a short- or long-term basis.

The exact volume of this District Water Management Storage needs to be verified through further discussions with interested users and further definition of Water Bank and Interruptible Supply concepts currently under discussion by the District and entities in the Lower Basin. However, the volume of 15,000 af is believed to be suitable for the current level of project planning.

During the Phase I Water Needs Assessment, a wide range of storage options are identified and evaluated (GEI, 1998). From 31 separate storage alternatives, 6 were selected by the District and the SSC for further evaluation in Phase II:

Storage Options	Storage Potential (af)	Base of Storage Potential Estimate
1. Re-operation (Non-structural)	48,500	Modeling analysis (Section 3.4)
2. Pueblo Reservoir Enlargement	75,000	USBR estimated site limit
3. Lake Meredith Enlargement	75,000	URS - practical site limit
4. Turquoise Lake Enlargement	19,590	B&V maximum size with no major reconstruction
5. Williams Creek	39,000 ⁽¹⁾	CH2M Hill - estimated site limit
6. Gravel Lakes Enlargement	13,000	GEI - potential may be much higher
Total	270,090	

⁽¹⁾ Total storage is 51,000 af with 12,000 af required by CSU.

Because no individual storage option above meets the full storage need, combinations of storage options were evaluated.

During preparation of the simulation modeling study, MW identified five storage Scenarios A through E to meet storage need of 173,100 af. These scenarios are summarized in Table 3.1, as noted previously. MW also evaluated storage operations for the condition in which firm Winter Water storage of 40,000 af is not provided (i.e., total storage is 133,100 af).

The storage locations and distributions shown in Table 3.1 were simulated using the model described in Section 3.4 of this report to assess a range of potential impacts, including: changes in monthly flows at key stream gaging stations; storage efficiency (inflows for each

storage option required to meet demands); and changes in reservoir levels at Pueblo, Turquoise, and Meredith.

The District and SSC believe that storage options involving gravel lakes or Williams Creek should be considered as local storage options rather than part of a regional project. The modeling completed by MW did not initially consider the 15,000 af of District water management storage. Operation of water management storage has not been specifically defined; however, this storage most likely will replace the need for firm Winter Water storage and storage for well augmentation.

Table 3.2 presents a sixth scenario, which represents the replacement of firm Winter Water storage (40,000 af) and storage for well augmentation supplies (26,000 af) with a 10,000 to 15,000 af storage pool for District water management. This storage would be used to meet a variety of District objectives, as described previously. The plan shown in Table 3.2 places all new storage in enlarged reservoirs that are part of the Fry-Ark Project, which is well positioned to meet both municipal and agricultural water supply objectives. As described in Section 4, storage at Pueblo and Turquoise has the best performance in terms of water management and storage efficiency and fewer water quality impacts. Storage costs at these locations are generally lower than other options; however, environmental effects and permitting challenges may be more significant than the other options studied.

As shown in Table 3.1, re-operation has a significant effect on the cost of storage. Scenario E, which has no re-operation component, has costs in excess of \$1,300 per af, while the other scenarios modeled by MW have costs generally under \$1,100 per af. The scenario with District Water Management Storage has a cost of \$800 per af, as indicated in Table 3.2.

Table 3.2 identifies how the storage at various locations under this scenario could potentially be divided among the entities needing storage and the estimated cost to each entity needing storage. The costs shown in Table 3.2 are provided to give an indication of a potential cost distribution without consideration of an entity's ability-to-pay and without giving any consideration to other possible cost allocations, such as those that might emerge from consideration of the amount of historic project repayments that have been contributed by various entities and water user types.

INSERT TABLE 3.2 - POTENTIAL STORAGE LOCATIONS & COSTS

Section 4 – Evaluation of Alternative Storage Plans

Alternative plans for developing storage capacity to meet District-wide water management objectives through the year 2040 are presented in Section 3. Hydrologic modeling was completed for five of the plans to evaluate how the storage, both re-operation storage and new reservoir capacity, could potentially impact stream flows and reservoir levels in comparison to historical operations. The alternative plans were formulated using the six storage options selected by the District and SSC following completion of the GEI Study. The six options are: re-operation of the Fry-Ark Project; enlargement of storage capacities in Turquoise Lake, Pueblo Reservoir, and Lake Meredith; enlargement of proposed storage at the Williams Creek Reservoir site; and construction of new storage at various gravel lakes sites.

Alternatives A through E, described in Chapter 3, involve various combinations of the six storage options. Hydrologic modeling was completed for each of these alternatives, with results summarized in Section 3.4. After the modeling work was completed, two additional storage alternatives were identified. These alternatives were not modeled directly; however, their potential impacts on stream flows in the Arkansas River would be similar to those identified for Alternatives A through E. This determination is based on the findings that the stream flow effects associated with operation of Alternatives A through E, do not vary significantly, despite the fact that these alternatives represent significantly different locations and capacities for new reservoir storage capacity. Many of the impacts identified in the technical and environmental studies, especially the changes to stream flows of the Arkansas River, are independent of storage alternatives being considered. Additional water will be imported, up to decreed amounts, to meet year 2040 demands. This change will affect stream flows and will occur even if no additional storage is provided. The stream flow impacts associated with the preferred storage options plan are anticipated to be similar to those described for Alternatives A through E. Once the preferred plan is selected by the SSC, and the Enterprise Board, hydrologic modeling will be prepared for the selected plan.

4.1 Water Supply Performance

The results of hydrologic modeling described in Section 3.4 were evaluated to determine how the six storage options (re-operation; Turquoise, Pueblo, and Lake Meredith enlargements; Williams Creek; and gravel lakes) when implemented in various combinations would compare in terms of their performance as potential water supplies for the District entities. Two major evaluation factors were considered:

- Operational flexibility (as measured by location, ability to store available inflows, and ability to deliver to points of demand)
- Storage efficiency (projects with low evaporation and conveyance losses are more efficient)

The Turquoise Lake enlargement and the Pueblo Reservoir enlargement were judged to have the best performance in terms of the above-noted factors. Re-operation would provide similar benefits in comparison to the Turquoise and Pueblo enlargements; however, re-operation does not provide firm storage space. Turquoise Lake is located high in the basin; therefore, it can effectively serve a large number of potential users and is subject to lesser rates of evaporation. Although lower in the Basin, the Pueblo Reservoir enlargement provides significant operational flexibility and better storage efficiency than all other options except the Turquoise Lake enlargement. Storage in gravel lakes provides flexibility and fairly good storage efficiency; however, individual gravel lakes projects are small (probably less than 3,000 af) and will not provide significant operational flexibility for meeting regional water management objectives. The lowest ranking storage options, in terms of water supply performance, are the Lake Meredith enlargement and Williams Creek Reservoir. The primary drawbacks to the Lake Meredith enlargement are relatively higher rates of evaporation and potentially high conveyance losses which decreased storage efficiency. The location of Williams Creek limits the reservoir filling opportunities and effectiveness in meeting the water storage objectives of entities other than CSU.

4.2 Stream Flow and Water Quality Impacts

Projected changes to stream flows at key locations on the Arkansas River for various alternative project developments are documented in Section 3.4. In general, each alternative would have about the same effect on historic stream flows with increased average flow during the months of May, June, and July and, depending on locations along the river, somewhat higher flows to somewhat lower flows in the August through April period. At the Wellsville gage, the average flow in June may increase by up to 250 cfs. The modified flows will, on average, exceed the minimum stream flows recommended by the Colorado Department of Natural Resources (250 cfs throughout the year and 700 cfs from July 1 through August 15). As described in detail in the Modeling Report, a significant amount of stream flow data have been generated for various gaging station locations. These data are available to the resource agencies and interested public, so that changes in stream flow from historic levels can be examined by month for a model simulation period from 1966 to 1995.

Preliminary assessments were made of potential water quality impacts that may be expected with implementation of the storage options and the alternatives described in Section 3. Qualitative assessments were made relative to lake eutrophication, lake stratification, salinity, nutrients, and metal loadings in the reservoirs and Upper Arkansas River. A

simplified mass-balance model of the Lower Arkansas River was used to assess potential salinity and selenium impacts. Overall, there appear to be no water quality impacts, associated with the alternatives that would preclude any of them from implementation. As described in Chapter 3, implementation of re-operation should include a program of increased water quality monitoring in the Basin. Water quality impacts of the Fry-Ark re-operations would be essentially the same as described below for Project reservoir enlargements. Summaries of anticipated water quality issues associated with the storage options and alternative storage developments are provided below:

Reservoir Water Quality Impacts

- Enlarging Pueblo Reservoir could result in minor degradation of reservoir water quality. Increased reservoir retention time could encourage accumulation of nutrients, eutrophication, and algae problems. These impacts would probably continue to be confined to coves and other shoreline areas where water is not well mixed. Long-term average salinity in the reservoir may improve under any of the scenarios compared to historical conditions.
- Enlarging Turquoise Lake would have no significant reservoir water quality impacts. Water quality in Turquoise Lake would remain excellent and very similar to existing conditions under any of the enlargement alternatives and storage scenarios.
- Enlarging storage in Lake Meredith may have adverse impacts on lake water quality. Increased reservoir depth and retention time appear likely to aggravate existing problems with lake stratification and eutrophication. Long-term salinity and selenium concentrations are estimated to increase by up to 10 percent, depending on the alternative ultimately developed. Larger lake surface areas may result in more significant water quality impacts. Potential changes in the salinity of Lake Meredith outflows may make the water less suitable for irrigation of alfalfa, corn, and other moderately salt-tolerant crops in the Lower Basin. A data collection and modeling program is recommended to better understand potential water quality impacts of physical and operational changes to Lake Meredith prior to enlargement. Greater “turn-over” of storage in Lake Meredith could increase the current problem of fish loss from the reservoir. This issue would need to be addressed in permitting.
- Gravel lakes may be small storage facilities having short retention times. They could be managed to have water quality similar to the Arkansas River.
- Enlargement of the proposed Williams Creek Reservoir may tend to aggravate water quality problems associated with storage of high-nutrient reclaimed water. The reservoir is likely to become highly eutrophic during summer months. A larger Williams Creek than currently planned by CSU needs could increase the potential for

stratification and eutrophication. Mitigation measures have been proposed by CSU for water quality management in a smaller reservoir; more aggressive measures would be required for an enlarged reservoir. If Williams Creek Reservoir releases are made to Williams Creek rather than to a pipeline, increasing the reservoir size could aggravate downstream erosion problems and increase the need for channel stabilization measures. Also, a larger reservoir volume and associated releases could compromise the effectiveness of channel stabilization efforts.

Stream Water Quality Impacts

- All of the storage alternatives would result in lower flows during winter months and higher flows during spring/summer irrigation periods, compared to historical averages in the Upper Arkansas River. Decreased winter flows could lead to higher constituent concentrations during those months. In addition, higher flows during springs runoff periods could increase erosion and mobilization of pollutants accumulated in channel sediments. Overall, it is not expected that any of these possible water quality changes would be significant.
- Each alternative that was modeled indicated higher mean monthly discharges throughout the year on Fountain Creek. This is independent of any new storage project, but is related to increased water demands in the basin. Flow increases would adversely impact sediment erosion conditions along lower Fountain Creek, and increased sediment and associated pollutant loads to the lower Arkansas River.

Based on the water quality review conducted to date, the six storage options were given scores reflecting their relative performance in terms of water quality issues. The range of scores is 1 to 10, with a score of 1 indicating an alternative with a potential water quality fatal flaw and a score of 10 indicating an alternative with no identified water quality problems.

Turquoise Reservoir enlargement was given the highest score (9) because it would result in insignificant changes to existing water quality. Moderate scores of 7 to 8 were assigned to Pueblo Reservoir enlargement and gravel lakes storage, indicating the need for possible future mitigation measures, probably through managed operation of the storage facilities.

Low scores were assigned to the Lake Meredith enlargement and a potential enlargement of the proposed Williams Creek Reservoir due to the possibly significant water quality degradation that would be associated with each alternative. In each case, significant additional study would be required to develop more accurate forecasts of potential water quality changes. Potentially costly mitigation measures could be required to obtain the necessary environmental permits in light of potential significant water quality impacts of certain alternatives.

- Spring/summer irrigation periods, compared to historical averages in the Upper Arkansas River. Decreased winter flows could lead to higher constituent concentrations during those months. In addition, higher flows during springs runoff periods could increase erosion and mobilization of pollutants accumulated in channel sediments. Overall, it is not expected that any of these possible water quality changes would be significant.
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4.3 Environmental Issues

The environmental studies supporting formulation of the PSOP address potential adverse impacts and beneficial effects that may result from the alternative actions under consideration. Federal, state, and local environmental regulations and permitting requirements affecting the feasibility of water development projects were also evaluated.

Natural resource issues considered in the preliminary evaluation included:

- Wetlands
- Federally listed species
- Other State or Federal sensitive species
- Wildlife
- Aquatic life

Preliminary environmental evaluations are based primarily on existing information. Reconnaissance field reviews were conducted for Pueblo Reservoir, Lake Meredith, Williams Creek, and several gravel lake storage sites. The field reviews did not include detailed surveys for species of concern or jurisdictional wetland delineations. Professional judgment, and experience with other water resource developments, were used to identify the potential effects associated with the alternatives. The environmental evaluation for each of the six storage options focused on the project size that could potentially have the greatest effects (i.e., the reservoir enlargement option with the largest expansion in storage).

Based on the preliminary review of environmental issues, the following conclusions have been drawn.

- Fry-Ark Project re-operation impacts are not likely to be significant, unless there are major changes to flows that potentially cause significant adverse effects to aquatic resources and water quality. An issue that may need to be addressed is the possible listing of the Colorado River cutthroat trout and West Slope flow depletions. Re-operation will likely involve a major Federal action requiring an EIS to be completed.
- Pueblo Reservoir enlargement also will require an EIS. Anticipated effects on wetlands, the wildlife inhabiting those wetlands, and bald eagles will be significant issues. Wetland permitting and mitigation likely will be challenging, but feasible.
- Turquoise Reservoir enlargement should not have significant environmental issues, provided that there are no significant changes in flow that adversely affect aquatic resources or downstream water quality. CDOW has indicated their concerns about potential reductions in reservoir productivity at both Turquoise Lake and Twin Lakes in light of Turquoise enlargement and Project re-operations. These issues will need to be addressed in subsequent studies.
- Lake Meredith enlargement faces a significant wetland-permitting hurdle that may be difficult to overcome. It may be difficult to gain approval for the inundation of 1,200 acres of wetlands and to develop successful compensatory mitigation for this loss.
- Storage in gravel lakes does not appear to have significant environmental issues. Environmental authorizations usually can be addressed as part of gravel pit development and reclamation.

- The proposed Williams Creek Reservoir will need to address species of concern (mountain plover, prairie dog, and Arkansas darter) and wetland impacts. These impacts likely can be mitigated and the needed authorizations gained.
- Potential changes in stream flow in the upper Arkansas River could adversely impact aquatic resource habitat in the winter and during peak flow periods. Potential changes in stream flow in the lower Arkansas below Pueblo may improve the quality of the fish habitat; however, no definitive studies have been performed as yet to confirm this potential. Substantial year-round increases in Fountain Creek stream flow would adversely impact small fish and aquatic habitat, but increases in flow are likely to occur regardless of the alternative actions being considered.
- Changes in water quality directly, associated with alternative storage developments, are generally expected to be minor and are not likely to result in significant adverse impacts to aquatic resources. A possible exception is the potential increase in salinity and eutrophication at Lake Meredith.

Table 4.1 provides an overview of the environmental permitting considered at this time to be likely for each storage option.

Insert Table 4.1 - Environmental Permitting

INSERT PAGE 2 TABLE 4.1

4.4 Cultural Resource Issues

Cultural resources in the study areas for each storage option were inventoried from a variety of data and record sources. The inventory identified 236 recorded sites having cultural significance, as follows:

**SUMMARY OF CURRENTLY KNOWN
 CULTURAL RESOURCE SITES**

Location	Number of Potentially Significant Cultural Resource Sites ⁽¹⁾			
	Prehistoric	Historic	Both Pre-Historic and Historic	Total
Pueblo Reservoir	89	—	—	89
Turquoise Lake	9	3	—	12
Twin Lakes ⁽²⁾	72	28	33	133
Lake Meredith	—	—	—	—
Williams Creek	—	—	—	—
Gravel Lakes	—	2	—	2
Total	170	33	33	236

⁽¹⁾ Note that 170 of the total sites are only minimally recorded and may require re-evaluation.

⁽²⁾ Included in the inventory because of re-operation. Enlargement of Twin Lakes is not included in any of the alternatives being evaluated.

Re-operation would not involve any changes to the physical features at Pueblo Reservoir, Twin Lakes, or Turquoise Lake. Therefore, no further cultural resources work is anticipated to be required for re-operation. Enlargement of Pueblo Reservoir is likely to require a significant cultural resources investigation. The 89 recorded sites at Pueblo Reservoir are judged to be minimally recorded and would need to be re-visited and documented according to present-day recording standards. The area between the present high water line and the raised pool high water line, and not previously surveyed, will need to be inventoried as well.

The likelihood is high that there are a large number of previously unrecorded pre-historic and historic sites in the area. Many of these may be significant and require thorough study, documentation, and mitigation. Although the impact area at Turquoise Lake will be much smaller than at Pueblo Reservoir, little inventory has been completed and fairly intensive efforts are anticipated to be needed in order to document cultural resources and

undertake the mitigation of significant sites. Similar efforts would be required at Lake Meredith and Williams Creek Cultural resource studies at previously mined gravel pits converted to water storage would be much less complex because of pre-existing mining disturbance and clearances obtained during mine permitting.

For the current level of planning, the team has made conservative assumptions about the requirements for identifying, recording, and mitigating cultural resources. These are reflected in significant allowances for mitigation included in the cost estimates presented in Chapter 3 of this report. There are no known cultural resource issues that could potentially block implementation of any of the storage options or alternatives.

4.5 Socio-Economic Issues

The Arkansas River Basin exhibits significant social and economic diversity. The Upper Basin depends heavily on tourism and recreation to maintain its economic well-being, particularly since the decline of the mining industry. The cities, suburbs, and towns of the Fountain Valley and Pueblo areas have diverse economies and populations that are experiencing both the benefits (and down sides) of the economic expansion that is taking place in Colorado and nationwide. The Lower Basin has not enjoyed the benefits of economic growth or expansion of tourism and recreation. It continues to rely on a fragile agricultural economy. These socio-economic realities affect how the storage options and alternatives are perceived by the public and evaluated in terms of recreation, agriculture, visual and aesthetic resources, and construction impacts.

Upper Basin interests, and recreation interests as a whole, appear to be primarily concerned with the impacts of re-operation and reservoir enlargements on stream flows and reservoir levels. Any loss of river-based recreational opportunities (rafting, kayaking, float and wade fishing, etc.) could have adverse economic impacts in the Upper Basin. Construction of the enlargements at Turquoise Lake and Pueblo Reservoir will require in-kind replacement and likely enhancement of existing recreation facilities. However, recreation will be impacted during construction of the dam modifications and new recreation facilities. Generally, the enlarged Project reservoirs are perceived to have a positive impact on the quality of flat-water recreation. Project reservoir re-operation and enlargements will have an affect on stream flows, but not too significantly, as documented in Section 3.4 of this report. Enlargement of Lake Meredith and development of gravel lakes for water storage are expected to have positive effects on recreation and the local economy in the Lower Basin, through creation of more fishery and aquatic bird habitat.

Agricultural interests are concerned about the potentials for increasing water exchanges and reductions in water quality in the Lower Basin, which they perceive could result from

re-operation or reservoir enlargements. The agricultural economy is fragile, at best. Any added costs to irrigators for protecting their water rights, or for dealing with lowered water quality, could have significant economic impacts in the Lower Basin. The Winter Water Storage Program is vital to the Lower Basin. Providing firm Winter Water storage, or at least protecting Winter Water in the current Project spill priority, is believed by agricultural interests to be essential for maintaining the economic well-being of the Lower Basin.

Visual and aesthetic impacts associated with re-operation, reservoir enlargements, and new reservoirs primarily relate to periods of reservoir drawdown, during which shorelines would be exposed. Raising Lake Meredith would reduce or eliminate views of the lake from the adjacent road. Raising Turquoise Lake with a parapet wall would change the visual character of the area. During construction, visual and aesthetic impacts are expected due to construction equipment and activities. Construction-related impacts are expected to be the most significant at Pueblo Reservoir because of the heavy recreational use of the State park facilities. During construction, use of facilities may decline, thereby adversely affecting businesses operating at the park as well as the local economy. Similar though smaller magnitude construction impacts are expected with the Turquoise Lake enlargement. Also, local interests have expressed concern about air and water quality during construction of the Turquoise Lake dam raise. Each alternative involving construction will provide a short-term increase in local employment and economic activity during the construction period.

4.6 Permitting and Regulatory Issues

The primary Federal regulatory requirements for water projects are those administered under the general requirements of the National Environmental Policy Act (NEPA). Under NEPA, either an EIS or EA is required to study the impacts of the proposed developments. The USBR and other agencies contacted have indicated that the USBR will be the most likely agency to lead this effort. Permits will be required from both Federal and local agencies. A list of the preliminary regulatory issues and permitting requirements is shown in Table 4.2.

During 1999, meetings were held with eight Federal and state agencies that have regulatory or operational responsibilities that will have significant input to the permitting of the storage alternatives:

- U.S. Bureau of Reclamation (USBR)
- U.S. Army Corps of Engineers (Corps)
- U.S. Fish and Wildlife Service (USFWS)
- U.S. Environmental Protection Agency (EPA)

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- U.S. Forest Service (USFS)
- U.S. Bureau of Land Management (BLM)
- Colorado Division of Parks (CDOP)
- Colorado Division of Wildlife (CDOW)

Insert Table 4.2 - Preliminary Regulatory Issues and Permitting Requirements

Insert 4.2 again

As owner and operator of the Fry-Ark Project, the USBR is the likely lead agency for the permitting process. Comments received from the agencies during the meetings included:

- Wetlands at all enlargement sites will need to be documented and addressed in the mitigation plan.
- Threatened and endangered species will likely be encountered at many of the sites.
- The loss of recreation and other facilities at all reservoirs will need to be addressed.
- There are concerns regarding the impacts on river and reservoir water quality due to operations of the proposed facilities.
- There are concerns regarding the inundation of established waterfowl areas and wildlife habitat.
- There are interests in continuing the annual instream flow augmentation program for the Arkansas River.

An initial ranking was developed concerning the project alternatives, based on their comparative difficulty in project permitting. None of the projects has a fatal flaw that would preclude successful permitting. The projects are ranked below based on a 1 to 10 scale with 10 being the most favorable (least difficult to permit). Rankings for the six storage options are based on the input from the permitting agencies and understanding of the permitting issues for other major water projects in Colorado.

**PRELIMINARY RANKING OF ALTERNATIVES BASED ON
 PERMITTING AND REGULATORY ISSUES**

Storage Project Alternative	Scores⁽¹⁾
Gravel Lakes Storage	8
Project Re-operations	6
Lake Meredith Enlargement	5
Williams Creek Reservoir Enlargement	5
Pueblo Reservoir Enlargement	3
Turquoise Reservoir Enlargement	3

⁽¹⁾ Scores noted 10 as least difficult to 1 being most difficult.

Project re-operation has a score of 6, in terms of comparative permitting difficulty. Concerns have been raised with regard to the indirect impacts of project re-operations; however, no construction or additional inundation would occur. The reservoir enlargements for Turquoise and Pueblo Reservoir have a score of 3. Lands would be inundated causing concerns with wetlands, wildlife habitat, and recreational facilities. The Lake Meredith enlargement, in contrast, was assigned a score of 5 because of fewer anticipated impacts and permitting issues. However, as the Lake Meredith enlargement would impact wetlands and wildlife habitat, significant permitting issues would still be present. The gravel lakes reservoirs were judged as the least difficult to permit (score of 8). The Williams Creek reservoir enlargement was assigned a score of 5, with issues similar to Lake Meredith, namely wetlands and wildlife concerns.

4.7 Costs

Costs to develop the combined storage alternatives range from \$115 to \$200 million as indicated in Section 3.5. The total cost per acre-foot of storage developed varies from \$800 to \$1,480. Development of storage at Turquoise Lake is the least costly option, except for re-operation. Pueblo Reservoir enlargement is less costly than the Lake Meredith enlargement for storage capacities less than approximately 60,000 af. Based on cost considerations alone, the plan for storage development should include re-operation, Turquoise Lake enlargement, and enlargement of Pueblo Reservoir.

4.8 Summary of Evaluation

The environmental, cultural, socio-economic, and permitting considerations, described previously in this chapter, indicate that no single alternative has significant advantages over another. Table 4.3 provides a summary of the performance of each storage option in terms of the specific evaluation issues discussed in Sections 4.1 through 4.7. Re-operation has the lowest cost and fewest expected environmental effects. The Turquoise Lake enlargement appears to have fewer environmental impacts than all the options, except for re-operation. Enlarging Pueblo Reservoir may have significant requirements for cultural resource and recreation mitigation, as well as various environmental permitting challenges. However, it has significant advantages to terms of meeting water supply objectives. The Lake Meredith enlargement appears to have potentially the greatest challenges due to adverse water quality and wetland impacts. These impacts increase substantially with larger increases in storage at Lake Meredith. Gravel lakes storage and the Williams Creek enlargement do not meet regional storage objectives due to their location, size limitations, and relatively higher cost. Based on these factors and others relating to performance and implementability, the preferred plan, described in Chapter 5, was selected. It includes re-operation of the Fry-Ark Project, enlargement of Pueblo Reservoir, and enlargement of Turquoise Lake.

INSERT TABLE 4.3

Section 5 – Description of the Preferred Storage Options Plan

The preferred plan for developing water storage to meet long-term water management in the District will be implemented in two phases that comprise non-structural and structural elements. Implementation of the plan will provide the reservoir storage to meet the water supply needs of participating District entities between now and the year 2040. Phase 1 will involve re-operation of storage in the Fry-Ark Project to better meet near- and long-term water management needs of Project beneficiaries that require storage. Phase 2, which could be implemented in several stages, over time, involves construction of additional reservoir storage capacity by enlarging two Fry-Ark Project reservoirs (Pueblo Reservoir and Turquoise Lake).

5.1 Phase 1: Fry-Ark Project Re-operation

The potential to re-operate storage in the Fry-Ark Project to provide 48,500 af of capacity in which participating entities could store both Project and non-Project water has been documented through detailed engineering and water operations modeling studies. Two re-operation scenarios were evaluated using the model. Re-operations Scenario B was selected for inclusion in the preferred plan, because it provided the most re-operation space and does not affect Project yield, as would Re-operation Scenario A. Under Re-operation Scenario B, any municipal entity that currently is a Project beneficiary, could elect to use their allocated storage space to store non-Project water in Project space, subject to the Allocation Principles and policies of the District and Project spill priorities. Re-operation will not involve any structural modifications to Fry-Ark Project storage facilities. The re-operation storage could meet a large portion of the identified municipal water storage needs, as indicated below:

Municipal all Entities Currently Having Project Storage	Re-operation Storage (af)	Estimated Storage Need (af)
CSU	19,000	45,000
Other FVA Entities	12,600	22,000
Pueblo ⁽¹⁾	11,400	20,000
St. Charles Mesa	2,100	3,600
Florence	1,300	2,300
Other Entities West of Pueblo	2,100	3,700
Total	48,500	96,600

⁽¹⁾ The Board of Water Works of Pueblo has already obtained a storage contract similar to a “Re-operations Storage Contract” for up to 15,000 acre-feet. Contract No. 00XX6C0049 was recently executed between The United States and the Board of Water Works.

Re-operation could meet approximately 50 percent of the identified storage need for municipalities that currently are beneficiaries of the Fry-Ark Project.

5.1.1 M&I Re-operation Storage Contracts

Implementation of Fry-Ark Project re-operations will involve execution of contracts for use of the identified re-operation storage space (48,500 af) to store non-Project water. These would be long-term contracts between the USBR, participating entities, and the District. Water stored in the re-operations storage space would be subject to the same spill priority as the current storage of non-Project water in the non-Project space available in Project reservoirs (i.e., Spill Priority 4). Water thus stored would be subject to spill before Winter Water in storage, in amounts up to 70,000 af, is spilled. However, Winter Water in storage in amounts more than 70,000 af, would be spilled by non-Project water in the re-operated storage space.

Water stored in re-operated space would be subject to spill by Project water, primarily during times when the District’s East Slope Arkansas River water rights are in priority. During these periods, Project water would be available to offset spills of non-Project water from the re-operation space in accordance with the District’s Allocation Principles and Policies, and would be sold at applicable Project water rates, including surcharges.

Implementation of a Fry-Ark Project re-operation plan will require some up-front expenditures for engineering, legal and administrative services to support the permitting and NEPA compliance efforts believed to be required, as well as possible legislative initiatives.

Current project operating policies and constraints must govern re-operation so that existing users of the Fry-Ark Project and the Winter Water Storage Program are not adversely impacted. Current Fry-Ark Project spill priorities and Allocation Principles will be maintained. However, municipal entities participating in re-operation will be able to decide how they wish to use the re-operation space (i.e., for Project or non-Project water storage, or both). Municipal entities participating in re-operation will be able to use their allocated Project storage in Project reservoirs to maximize the yield from their existing non-Project water rights. FVA entities may use re-operations space within the 78,000 acre-feet of space available for their Project storage. Eligible entities East of Pueblo may use re-operations space within the 37,400 acre-feet of space available for their Project storage. Eligible entities West of Pueblo may use re-operations space within the 12,400 acre-feet of space available for their Project storage. Pueblo may use re-operations space within the 31,200 acre-feet of space available for their Project storage. Demand for re-operations storage may require the District to make additional distributions of storage space within the current allocations for the entities located both East and West of Pueblo.

Water stored by municipal entities in re-operated space is expected to come from several sources: exchanged water (e.g., CSU return flows exchanged to Pueblo Reservoir); water rights transferred and exchanged (e.g., Colorado Canal water rights owned by municipal entities); water purchased and transferred to other uses; and transfer and storage of water from upstream reservoirs.

Re-operation storage for CSU would facilitate exchanges from Fountain Creek to Pueblo Reservoir and exchanges between Lake Meredith and Pueblo Reservoir, as well as storage of water from existing rights in the Upper Basin. Other entities would store native Arkansas River water under their own priorities, regulate return flows by exchange, or use storage for regulation of existing sources of supply. This space could be operated and used with existing water rights and would not require any additional water diversions from the Colorado River Basin. Pueblo Board of Water Works would use its storage contract, which is similar to “Re-operations Storage Contracts” for storage of reusable trans-mountain exchanges, existing trans-mountain water rights, and existing native water rights and to facilitate exchanges from Pueblo Reservoir to Twin Lakes and Clear Creek Reservoir.

5.1.2 Agricultural Interests in Re-operation

Earlier evaluations of re-operating the Fry-Ark Project to store non-Project water in Project space raised concerns about the impacts of such storage on the Winter Water Storage Program, as well as the District’s ability to store East Slope water under its 1939 water rights. The hydrologic modeling developed by Montgomery Watson to evaluate re-operation addressed both of these concerns. The model was configured so that East Slope water would

be stored when in priority and in accordance with the Spill Priorities established by the District's contract with the USBR.

Re-operation of the Project for non-Project water storage was evaluated for two cases: 1) non-firm Winter Water storage, and 2) firm Winter Water storage. Results of the modeling indicate that providing 40,000 af of firm Winter Water storage decreases the frequency of Winter Water spills, but does not significantly increase average Winter Water deliveries. On average, for the 30-year simulation period, 40,000 af of firm storage for Winter Water is projected to increase Winter Water deliveries by less than 1,400 af per year. Re-operation without firm storage is expected to cause a slight increase in the frequency of Winter Water spills. Under current operations, Winter Water is projected to spill 5 years in 30, with an average spill of 7,450 af. With re-operation, and depending on other storage elements provided, Winter Water spills without firm storage could increase to 6 years in 30, with an average spill of 8,090 af. These effects are considered to be relatively minor and methods to compensate agricultural water users for these spills have been identified.

Payment for Winter Water storage in the Project would be required even if Winter Water is spilled, and the USBR will expect payment for allocated Project water to replace Winter Water spills. Therefore, the District proposes that entities participating in the Winter Water Storage Program be credited for any Winter Water spilled. This re-operation spill credit would be applied to purchasing Project water to replace the Winter Water that was spilled. The credit would not be made unless Project water was purchased after the spill. This would assure that "excess" water is not stored in anticipation of a spill of Winter Water. The credit also could be applied to storage of next year's Winter Water. Funds for the credit to Winter Water could be made available through a surcharge, as described later in the chapter.

Re-operation will not require any modifications of existing Project storage facilities. The storage provided in Pueblo Reservoir, and/or Turquoise Reservoir, could be used by CSU and the other Fountain Valley entities through existing and planned conveyance system improvements, including upgrading of the Otero Pumping Station and construction of the Southern Delivery System pipeline, which generally will parallel the existing Fountain Valley Pipeline. Pueblo is implementing a project to divert its water at Pueblo Dam. Yield from re-operated Fry-Ark storage would be conveyed in the river or by exchange to diversions supplying St. Charles Mesa, Florence, and other entities west of Pueblo. The costs to implement Fry-Ark Project re-operation will be for permitting; NEPA compliance; public review; USBR engineering, legal, and administrative costs, and potential compensation to the Winter Water Storage Program for additional spills caused by re-operation.

5.1.3 Institutional Requirements

Re-operation of Fry-Ark Project facilities may or may not require further legislative authorization to execute contracts for storage of non-Project water in Project space. District staff believes that implementation of re-operations may be accomplished utilizing existing authorizing legislation for the Fryingpan-Arkansas Project as the basis of authority. The District currently is discussing legislative issues with the USBR to define the scope of work and timeline of legislative, legal, and administrative activities by the USBR and the District. Re-operation is not expected to require any changes to the District's Allocation Principles. Therefore, approval by the District Court should not be required. Some changes to the District's allocation policies may be implemented at the discretion of the District's Board.

During preparation of the plan, preliminary meetings were held with Federal resource agencies and the USBR. The consensus is that the USBR role in implementing the re-operation of the Project likely will be a major Federal action requiring preparation of an Environmental Impact Statement (EIS) in compliance with the National Environmental Policy Act (NEPA). The USBR likely will be the lead Federal agency for EIS preparation.

The issue of Water Court actions relative to re-operation has yet to be defined. To the extent that re-operation storage is used for storing water rights under existing decrees that allow storage of water in Project reservoirs, water court actions are not anticipated. Re-operation will not involve any diversions of Project water in excess of the District's currently decreed West Slope Project water rights. Re-operation is not expected to have any impact on flows in the Arkansas River at the state line. However, significant interest in re-operation from West Slope water users and the State of Kansas is expected.

5.1.4. Development Cost and Timeline

Implementation of Fry-Ark re-operation is estimated to cost as much as \$7,400,000. This cost estimate is based primarily on the anticipated engineering, permitting, legal, and administrative costs that would be incurred during the implementation phase.

The timeline for implementing Fry-Ark Project re-operations is driven by the time required to conduct project permitting under NEPA and to prepare an EIS. Assuming finalization of a preferred plan by the District in 2000 and willingness of the USBR to proceed, the NEPA process could begin in early 2001. Four to five years will be required to complete the NEPA process, address and resolve legal and institutional issues, and execute contractual agreements between the USBR, the District, and participating entities. Therefore, if the necessary approvals and authorizations are obtained in a timely fashion, re-operation storage most likely would be available to participating entities by 2005. The NEPA process will include consultation with state and federal resource agencies, conduct of various environmental, water quality, instream flow, and other types of studies, and preparation of draft and final EIS documentation.

Re-operations will benefit those municipal entities currently having storage in the Fry-Ark Project. The following table summarizes the prorated share of re-operations cost, based on the amount of storage provided to potential beneficiaries.

Entity	Re-operation Storage (af)	Percent of Storage	Prorated Cost (\$ Million)
CSU	19,000	51.3%	\$3.8
Other FVA Entities ⁽¹⁾	12,500	33.8%	\$2.5
Pueblo ⁽²⁾	11,500		
St. Charles Mesa	2,100	5.7%	\$0.4
Florence	1,300	3.5%	\$0.3
Other Entities West of Pueblo	2,100	5.7%	\$0.4
Total	48,500	100.0%	\$7.4

⁽¹⁾ Security, Fountain, Widefield, and Stratmoor Hills.

⁽²⁾ The Board of Water Works of Pueblo has already obtained storage contract similar to a “Re-operations Storage Contract” for up to 15,000 acre-feet. Contract No. 00XX6C0049 was recently executed between The United States and the Board of Water Works. The prorated costs are based on re-operations storage of 37,000 acre-feet.

If the entities in the above tabulation choose not to participate in re-operation, their share would be prorated among the remaining entities on an as-requested basis. Re-operation costs would be shared by the entities benefiting from the re-operation storage space provided. The \$7.4 million estimate translates to \$200 per af of re-operation storage assuming that the full identified re-operation potential is realized.

The value of re-operation storage to municipal entities could be expressed in terms of the cost of developing conventional reservoir storage to meet the same storage objective. The cost of new storage to meet identified District needs is estimated to range from \$700 to \$2,300 per af, with the average cost being approximately \$1,200 per af. From this perspective, the value of re-operation storage to municipal entities is potentially 6 times the estimated cost of re-operation (\$200 per af). This cost comparison suggests that surcharges established to generate revenues to help fund other elements of a long-range water management plan for the District would not place excessive burdens on municipal beneficiaries.

5.1.5 Contribution of Re-operation to Total Storage Need

Re-operation storage of 48,500 af will meet an estimated 28 percent of the total 173,100 af of storage need originally identified in the GEI Study (1998). The need for additional storage among those entities that would benefit from re-operation most likely will not develop at the same time. For example, CSU requires its re-operation allocation to be available by the year 2010 (or sooner) so that it can proceed with its Southern Delivery System. Having additional firm storage in Pueblo Reservoir also may be essential before CSU would be willing to

commit funds to the Southern Delivery System. Based on the GEI Study, the other Fountain Valley entities also will require storage capacity early in the planning period. Storage needs for Florence and other towns west of Pueblo are expected to develop in the 2015 to 2020 time frame. Pueblo’s need for storage is less urgent than CSU’s, but is anticipated to develop in the middle of the planning period (2020). The storage need for St. Charles Mesa is expected to occur toward the beginning of the planning period in order to provide drought security. Generally, re-operation will meet storage objectives of qualifying entities as follows:

Entity	Re-operation Storage (af)			New Storage Capacity ⁽²⁾ (af)	Total Storage Need ⁽³⁾ (af)
	2005 ⁽¹⁾	2015-2020	Subtotal Re-operation		
CSU	19,000	---	19,000	26,000	45,000
Other FVA Entities	5,000	7,500	12,500	9,500	22,000
Pueblo ⁽⁵⁾	---	11,500	11,500	8,500	20,000
St. Charles Mesa	2,100	---	2,100	1,500	3,600
Florence	---	1,300	1,300	1,000	2,300
Other Entities West of Pueblo	---	2,100	2,100	1,600	3,700
Total	26,100	22,400	48,500	48,100	96,600⁽⁴⁾

(1) Soonest on-line date for re-operation is anticipated to be 2005.

(2) To be provided by raising existing dams. New storage needed to fulfill storage needs of entities participating in re-operations.

(3) Storage need for entities currently having Project storage (GEI, 1998).

(4) Storage only for those municipal entities with Project storage. Total storage need for all District entities is greater.

(5) The Board of Water Works of Pueblo has already obtained storage contract similar to a “Re-operations Storage Contract” for up to 15,000 acre-feet. Contract No. 00XX6C0049 was recently executed between The United States and the Board of Water Works. The Board of Water Works of Pueblo continues to express an interest in obtaining 20,000 acre-feet of firm storage.

5.1.6 Conditions for Re-operation

Several pre-existing conditions affect how re-operation can be effectively implemented and operated and should be considered prerequisite to re-operation of the Project.

In addition to minimizing potential impacts to Winter Water storage and adhering to the District’s Allocation Principles and Operating Policies, re-operation must be structured and administered to maintain an acceptable minimum level of stream flow immediately below Pueblo Dam. Based on modeling results and inputs from concerned water users and agencies, the District proposes that the plan adopt a 100 cfs target minimum flow

immediately downstream of Pueblo Dam. This may limit exchange potentials during certain periods.

The south outlet works at Pueblo Dam is sized to accommodate releases to the Arkansas Valley Pipeline, which was authorized but not constructed under the Project, and for releases to the Pueblo Board of Water Works. The south outlet works capacity for the Valley Pipeline is 30.9 cfs and for the Pueblo Board of Water Works is 278 cfs. While construction of the Valley Pipeline does not appear feasible at this time, any re-operation of storage in Pueblo Reservoir must protect the integrity of the delivery capacity from the dam that would supply the pipeline. New uses of the south outlet works would have to assure that capacity for the Arkansas Valley Pipeline is not compromised.

Declining water quality in the Lower Basin is a critical issue. The District believes that water users benefiting from having the re-operations space will need to make strong commitments to ongoing and potentially expanded programs of the U.S. Geological Survey for monitoring water quality.

5.2 Phase 2: Additional Reservoir Storage

To fully meet identified long-term water storage and management needs of District entities, new reservoir storage will be required. For example, CSU has an identified storage need of 45,000 af to meet its year 2040 water demands. Only 19,000 af of this need can be met by Phase 1 Project re-operations. Similarly, the other FVA entities (Security, Widefield, Fountain, and Stratmoor Hills) can benefit from re-operation, but will require additional storage to fully meet their year 2040 water demands. Pueblo, St. Charles Mesa, Florence, and several towns west of Pueblo also require storage to meet water needs over the next 40 years. These entities can potentially benefit from the re-operation storage provided in Phase 1, but are likely to require additional storage space based on forecasted water and storage needs. Pueblo West and Public Service Company of Colorado do not have the ability to store water in the Project at the present time, but have indicated their potential interest to participate in building new storage to meet a range of future needs within the District.

5.2.1 District Water Management Storage

To fully meet identified long-term water storage and management needs of District entities, new reservoir storage will be required. For example, CSU has an identified storage need of 45,000 af to meet its year 2040 water demands. Only 19,000 af of this need can be met by Phase 1 Project re-operations. Similarly, the other FVA entities (Security, Widefield, Fountain, and Stratmoor Hills) can benefit from re-operation, but will require additional storage to fully meet their year 2040 water demands. Pueblo, St. Charles Mesa, Florence, and several towns west of Pueblo also require storage to meet water needs over the next 40 years. These entities can potentially benefit from the re-operation storage provided in Phase 1, but are likely to require additional storage space based on forecasted water and storage

needs. Pueblo West and Public Service Company of Colorado do not have the ability to store water in the Project at the present time, but have indicated their potential interest to participate in building new storage to meet a range of future needs within the District.

- Improved management of Winter Water. By having dedicated storage space into which Winter Water spills at Pueblo Reservoir could be stored for later use by irrigators, potential adverse impacts of municipal carryover and re-operation could be minimized.
- Management of well augmentation supplies and Project return flows.
- Storage for a Water Bank, or to manage temporary water transfers from agricultural to municipal users under Interruptible Supply (IS) agreements.
- Storage space for leasing by interested water users on a short- or long-term basis.

The exact volume of this District Water Management Storage needs to be verified through further discussions with interested users and further definition of Water Bank and Interruptible Supply concepts currently under discussion by the District and entities in the District (see Appendix B). The District believes that consensus may be reached on a volume of up to 15,000 af. The cities participating in re-operation and enlargement of the Project would help fund this District storage in recognition of the economic benefits they are deriving by their ability to participate in cost-effective storage developments that have been made possible by the participation of the entire District in implementing and repaying the original Fry-Ark Project. The exact location of the District Water Management Storage is yet to be determined. The District Water Management Storage could be located within existing non-project facilities and/or as a part of enlarged Project facilities, subject to terms and conditions to be determined. Priorities for the use of District Water Management Storage will also need to be established. The use of District Water Management Storage to store Fry-Ark Project return flows will require Water Court approval to allow for exchange and storage of such return flows. Terms and conditions to prevent injury to other water users will need to be negotiated or determined by the Water Court.

The District's Water Management Storage would be provided in lieu of the previously identified needs for firm Winter Water storage space (40,000 af) and augmentation water storage (26,000 af). The total storage need then would be reduced from 173,100 af to 122,100 af, of which 48,500 af would be provided by Phase 1 Re-operation. Phase 2 storage needs are identified below:

	Phase 1 Re-operation (af)	Phase 2 New Storage (af)	Total (af)
CSU	19,000	26,000	45,000
Other FVA Entities	12,500	9,500	22,000
Pueblo	11,500	8,500	20,000
St. Charles Mesa	2,100	1,500	3,600
Florence	1,300	1,000	2,300
Other Entities West of Pueblo	2,100	1,600	3,700
Pueblo West	---	5,500	5,500
Public Service Co.	---	5,000	5,000
District Water Management	---	10,000-15,000	10,000-15,000
Total	48,500	68,600-73,600	117,100-122,100

The 73,600 acre-feet of additional storage could be provided by enlarging Turquoise Lake and Pueblo Reservoir. Initially, consideration was given to providing some of the storage at an enlarged Lake Meredith. However, storage of Lake Meredith is less efficient and water quality issues may be significant (see Section 4.2). Also, concerns exist relative to the wetlands at Lake Meredith that would be inundated by an enlargement of the reservoir surface area. For these reasons, storage at Lake Meredith was not included in the preferred storage options plan.

5.2.2 Enlargement of Existing Storage Facilities

Phase 2 of the plan includes staged implementation of storage capacity increases first at Pueblo Reservoir and then at Turquoise Reservoir. Increased storage at these locations will involve raising existing dams and modifying ancillary facilities, including spillways and outlet works, recreation facilities, and other infrastructure.

The amount of storage provided at the enlarged reservoirs will be dependent on the participation by entities needing storage capacity beyond that provided by Phase 1 re-operations.

The location and distribution of storage in the enlarged reservoirs has tentatively been established, for purposes of this report, as follows:

	Storage (af)
New Storage Capacity	
Pueblo Reservoir Enlargement (Stage 1)	54,000 ⁽¹⁾
Turquoise Lake Enlargement (Stage 2)	19,600 ⁽²⁾
Total New Storage	73,600⁽³⁾

- (1) Storage potential is larger (up to 75,000 af).
- (2) Maximum capability of the site without major reconstruction of the existing dam.
- (3) Excludes both previously identified firm Winter Water storage and well augmentation storage, but provides up to 15,000 af District water management storage.

The new storage capacity could be located differently than presented above, in order to minimize cost, or meet other plan objectives. The storage location and distribution presented above is based on providing storage higher in the basin, as well as the individual storage needs of participating entities. Additional storage at Turquoise Lake is the least costly on a per af basis. This fact, coupled with benefits associated with storage higher in the basin (including lower evaporation, instream flow management opportunities, and delivery flexibility), suggest that as much new storage as possible be developed at Turquoise Lake.

5.2.3 Allocation and Operation of New Storage Space

The possible allocation of new storage space in the reservoirs to participating entities is identified below:

Entity	New Storage Space (af)		Total (af)
	Pueblo	Turquoise	
CSU	16,000	10,000	26,000
Other FVA Entities	9,500	---	9,500
Pueblo	5,000	3,500	8,500
St. Charles Mesa	1,500	---	1,500
Florence	1,000	---	1,000
Other Entities West of Pueblo	---	1,600	1,600
Pueblo West	5,500	---	5,500
Public Service Co.	5,000	---	5,000
District Water Management	10,500	4,500	15,000
Total	54,000	19,600	73,600

The location of new storage provided for participating entities is based on input from the entities and preliminary engineering judgements, and is subject to further discussion and subsequent modification. The District’s management storage is split between Pueblo Reservoir and Turquoise Lake. This affords flexibility and opportunities to capture Winter Water spills, regulate well augmentation supplies, and meet other District-wide objectives, including water banking and facilitation of interruptible supply agreements between agricultural and municipal water users.

New storage space developed for the cities in enlarged Project reservoirs would be used exclusively to meet the cities’ demands. In order to protect Project repayment, the District believes that it should have some control over the right to store water in unused space on an if-and-when available basis (i.e., when storage is not being used by the cities) and that new storage space for the cities should not be used to store non-project water that is intended for resale and that would compete with the sale of Project water. However, the exact terms and conditions on the use of the enlarged storage space will need to be negotiated between the water users, the District, and Reclamation.

The use of re-operations storage space should be the first option for the cities needing additional space. For cities with the option to use both re-operation space and new space in the enlarged reservoirs, the District would impose a limited surcharge of \$1 per acre-foot of water stored by a participating city in the new storage space (charged against the maximum storage level during the year), if the entity was not making payment for the use of at least 20 percent of the re-operations space available for its use. This surcharge is designed to

encourage the full use of re-operations storage and compensate the Project for lost revenues due to reduced if-and-when and re-operations storage.

5.2.4 Institutional Requirements

Issues related to enlarging the two Project reservoirs will be similar to those presented for re-operation (Section 5.1.3). New capacity will be provided for storing non-Project water behind raised Project dams. This will not affect current storage allocations. Therefore, the District's Court-approved Allocation Principles will not need to be amended, so District Court approval of such amendments would not be required. At its discretion, the District's Board may modify the District's Allocation Policies.

Approval of reservoir enlargements also would be considered major Federal actions requiring preparation of an EIS and NEPA compliance. To the extent that new storage is used for storing water under existing decrees, water court actions may not be required. It may be desirable, however, to obtain a junior storage enlargement decree for additional reservoir capacity. The new storage is intended for regulation of existing water supplies within the District. No increase in West Slope Project diversions, beyond those permitted under the Project's West Slope water rights, is planned. Both Project re-operations and new storage are planned to be operated so that all downstream water rights are satisfied in priority. Therefore, no changes in the Lower Basin flow regime (including state line flows) are anticipated. Despite these considerations, both West Slope interests and the State of Kansas are expected to express keen interest in additional storage capacity development.

5.2.5 Development Costs and Timeline

Developing new storage for District water users will cost approximately \$740 per af (Turquoise Lake enlargement) to \$1,400 per acre-foot at Pueblo. These costs are not feasible to consider for agricultural interests. However, the storage costs are relatively attractive from a municipal perspective. Along the Front Range, a variety of storage projects with costs in the range of \$1,000 to \$2,500 per af have been implemented or are moving forward through the planning, permitting, and implementation phases.

The storage allocations and costs to develop new storage, as well as re-operation storage, are presented in Table 5.1.

**Table 5.1
Storage Locations and Costs for Participating Entities**

LOCATION OF STORAGE					
Entity	Total Storage	New Storage Capacity (Acre-feet)			
		Reoperation Storage	Pueblo	Turquoise	Total
Colorado Springs Utilities	45,000	19,000	16,000	10,000	26,000
Other FVA	22,000	12,500	9,500		9,500
Pueblo	20,000	11,500	5,000	3,500	8,500
St. Charles Mesa	3,600	2,100	1,500		1,500
Florence	2,300	1,300	1,000		1,000
Other Entities West of Pueblo	3,700	2,100		1,600	1,600
Pueblo West	5,500		5,500		5,500
PSCo	5,000		5,000		5,000
Winter Water					
Augmentation Water					
Subtotal	107,100	48,500	43,500	15,100	58,600
District Management Storage	15,000		10,500	4,500	15,000
Total	122,100	48,500	54,000	19,600	73,600
STORAGE COSTS					
Entity	Cost	Cost of Reoperation	Pueblo	New Storage Cost Turquoise	Total
Colorado Springs Utilities	\$33,600,000	\$3,800,000	\$22,400,000	\$7,400,000	\$29,800,000
Other FVA	\$15,800,000	\$2,500,000	\$13,300,000	\$0	\$13,300,000
Pueblo ⁽¹⁾	\$9,600,000	\$0	\$7,000,000	\$2,600,000	\$9,600,000
St. Charles Mesa	\$2,500,000	\$400,000	\$2,100,000	\$0	\$2,100,000
Florence	\$1,700,000	\$300,000	\$1,400,000	\$0	\$1,400,000
Other Entities West of Pueblo	\$1,600,000	\$400,000	\$0	\$1,200,000	\$1,200,000
Pueblo West	\$7,700,000	\$0	\$7,700,000	\$0	\$7,700,000
PSCo	\$7,000,000	\$0	\$7,000,000	\$0	\$7,000,000
PSCo	\$7,000,000	\$0	\$7,000,000	\$0	\$7,000,000
Winter Water	\$0	\$0	\$0	\$0	\$0
Augmentation Water	\$0	\$0	\$0	\$0	\$0
Subtotal	\$79,500,000	\$7,400,000	\$60,900,000	\$11,200,000	\$72,100,000
District Management Storage	\$18,000,000	\$0	\$14,700,000	\$3,300,000	\$18,000,000
Total	\$97,500,000	\$7,400,000	\$75,600,000	\$14,500,000	\$90,100,000
Cost per Acre-Foot	\$800	\$200	\$1,400	\$740	\$1,220

⁽¹⁾ The Board of Water Works of Pueblo has already obtained storage contract similar to a “Re-operations Storage Contract” for up to 15,000 acre-feet. Contract No. 00XX6C0049 was recently executed between The United States and the Board of Water Works. The prorated costs are based on re-operations storage of 37,000 acre-feet.

The cost estimates presented in Table 5.1 are based on engineering evaluations completed by the USBR (for Pueblo Dam) and by B&V (review of USBR costs for Pueblo Dam raise and original work to develop costs for the Turquoise enlargement).

5.2.6 Implementation and Potential Staging Plan

Implementation of the storage development plan will involve a major permitting and NEPA compliance effort. Projects could be permitted individually. However, water agencies are moving to a programmatic approach, wherein permits are secured for implementation of an entire plan, with periodic review and updating rather than a full-scale NEPA process for each structural element of the plan.

The PSOP can be implemented in two phases — Phase 1: Re-operation and Phase 2: Additional Reservoir Storage. Opportunities may exist to stage construction of the reservoir enlargements planned for Phase 2 in order to match supply with demand and avoid “overbuilding.” Figure 5.1 presents the estimated need for storage over the 2000 to 2040 planning horizon and shows how re-operation (Phase 1) and additional storage capacity (Phase 2) could be brought on line to meet the demand. This graph is based on understandings about the water infrastructure needs and water demand forecasts for entities that have identified needs for additional storage. Key assumptions are:

- The full storage need (45,000 af) for CSU will develop by the year 2015. Approximately 25,000 af of storage will need to be in place for CSU by the year 2010.
- The other FVA entities (Fountain, Security, Widefield and Stratmoor Hills) will need 22,000 af of storage by 2040. The staging analysis assumes that the other FVA entities will need the 22,000 af of storage by 2030 with at least 11,000 af available by 2020.
- The entities west of Pueblo, including Florence, will begin to need storage in 2020 with 1,100 af of storage needed in 2030 and 6,000 af by 2040.

Pueblo’s demand for more storage is long term, perhaps beyond the year 2040. However, the staging analysis assumed the storage need would begin to develop in 2015 with 20,000 af required by the year 2030.

Insert Figure 5.1

- Pueblo West may need storage in the near future with the full storage need (5,500 af) realized by the year 2020, when the community approaches build out. We have assumed that 5,500 af of storage should be in place by 2010.
- The storage demand curve assumes that St. Charles Mesa will require its storage (3,600 af) to be in place by 2020, with 1,800 af needed by 2010.
- Public Service Company of Colorado's storage need is dependent on construction of additional generating capacity. The storage demand curve in Figure 5.1 assumes that more storage begins to be required in 2010, with full demand (5,000 af) realized in 2020.
- The District's water management storage will be used for Winter Water and augmentation water regulation, in addition to meeting other potential needs. The need for District storage is estimated to develop early in the implementation period, with full demand for the management storage realized in the year 2010.

In addition to the amount of storage, the location of the storage space is important. CSU is depending on the Southern Delivery System (a pipeline from Pueblo Reservoir to the City) to meet its long-range water needs. Therefore, storage at Pueblo Reservoir is critically important, providing benefits to other users as well. Developing re-operation storage will be undertaken in Phase 1 of the overall plan. The storage need develops quickly during the 2000 to 2010 time frame. As shown on Figure 5.1, re-operation provides the needed capacity during this time frame.

Phase 2 would be implemented beginning in the 2010 timeframe. In Phase 2, the first increment of capacity would be raising Pueblo Dam to increase storage capacity. The Turquoise Lake enlargement would be implemented after the Pueblo enlargement. If studies by the USBR relative to the safety of Sugarloaf Dam and its potential enlargement are completed with adequate lead time and show no fatal technical flaws, the Turquoise enlargement might be implemented before, or concurrently with, the Pueblo Reservoir enlargement. The staging plan depicted on Figure 5.1 indicates one possible staging scenario. There could be others. For example, the Pueblo Reservoir enlargement could be completed in two stages. Based on studies completed for the PSOP, it appears that a Pueblo Reservoir enlargement of 25,000 af would have the fewest potential environmental impacts and would not require raising the crest of the dam. This would be the first stage of Pueblo's enlargement. A second stage of the enlargement then could be built later in the planning period, when needs for additional storage are further defined. The key conclusion is that the storage development could be staged in increments to meet storage needs, avoid "overbuilding," maintain flexibility, and defer expenditures if necessary to match funding availability.

While staging of implementation has a variety of advantages in terms of economics, matching supply to demand, and flexibility, it does require some up-front attention in terms of engineering, environmental and financial studies. The goal of this up-front work would be to develop sufficient definition of the individual projects and their impacts to enable permitting of the entire program.

Permitting and environmental compliance for Phase 2 elements would be concurrent with Phase 1 under the assumption, to be confirmed with the USBR and permitting agencies, that permits and approvals for contracting future project elements can be obtained in advance as part of the up-front permitting work and that adequate assurances can be obtained that permits and approvals will be valid at these later dates. Major activities before each future stage is constructed would include design engineering, bidding, and construction. Significantly less time and money will be necessary for supplemental environmental compliance if the USBR and permitting agencies can assure that up-front work will be considered valid. A general schedule of near-term and future activities associated with project implementation is presented on Figure 5.2.

The issues associated with implementation of the preferred plan will need to be discussed in detail with the USBR. Approval of the re-operation plan, planning and design of modifications to the two Project dams, preparation of the EIS, and management of the permitting process will be under USBR control. The U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, U.S. Forest Service, Colorado Division of Wildlife, Colorado Division of Parks and Outdoor Recreation, and many other State and Federal agencies will have responsibilities for, and be involved in, reviewing and permitting at least some of the elements of the preferred plan.

5.3 Financing Options

Phase 1 – Re-operations (\$7.4 million over 15 years)

- Costs for development of re-operations storage would be shared by the entities wanting to use re-operations storage space. Each entity's cost would be determined by their proportionate share of the re-operations space.
- Participation would be determined in advance by executing a Memorandum of Agreement (MOA) with all municipal entities that want to make use of the re-operation space.

INSERT FIGURE 5.2

- The District will initiate a Re-operations Fund. This fund will be generated by a surcharge for use of the re-operations space provided in the PSOP. The Re-operations Fund would be used to help provide for the Winter Water Spill Credit (estimated cost approximately \$25,000 per year).
- Re-operations space would be made available under contracts with the Bureau of Reclamation. Those contracts would include a Bureau charge (presently the in-District rate for temporary storage is approximately \$14 per af).
- The initial cost for Re-operations includes \$100,000 to initially fund the spill credit. This is necessary in case of a spill in the first year.

Phase 2 – New Storage-Enlargements

- Pueblo Reservoir and Turquoise Enlargements (73,600 af; total cost: \$90.1 million in year 2000 dollars).
- The costs of reservoir enlargements in Phase 2 would be borne by the participating entities.
- The District Water Management Storage space (5,000 to 15,000 acre-feet), which would be provided as part of any Fry-Ark Project enlargements, will be funded in two parts. The first 5,000 acre-feet will be funded 100% by the entities participating in the storage enlargements. The funding for the next 5,000 to 10,000 acre-feet is yet to be determined. The District Water Management Storage could be located within existing non-project facilities and/or part of enlarged project facilities, subject to terms and conditions to be determined.
- There would be charges in the future for the use of the District Water Management Storage to pay for the O&M costs associated with this space.

5.3.1 Water Activities and Other Funds

The purpose of the Water Activities Fund will be to pay for various District expenses, including its involvement in Phase I and Phase II of the PSOP. Specifically, the fund will support the following:

- Meet existing SOD repayment obligations. (Years 2001 thru 2025)
- Establish an O&M reserve fund and prepare for the possible transfer of Fry-Ark Project O&M responsibilities to the District. (Years 2001 thru 2017)

Surcharge schedules of proposed rates to establish the Water Activities, Re-operations and DWMS Funds are shown below:

Water Activity Fund	Proposed Rates/Acre-foot			Potential Annual Revenue (\$)
	In District (\$)		Out of District (\$)	
	Agric.	M&I		
Project Water	\$1.25	\$2.00		\$90,000
Carryover Water	**	\$2.25		\$202,000
If & When		\$1.00	\$6.00	\$25,000
Winter Water	\$.25			\$10,000
Return Flows	\$.50	\$.50		\$7,500
Water Activities Total				\$335,000

- (1) In years when agricultural carryover is approved, the Board will establish a carryover rate for agricultural water.

The Water Activities Fund would begin in 2001 and provide for SOP repayment, an O&M reservoir fund and prepare for possible transfer of O&M.

Re-operations Surcharge Schedule				
Re-operations		\$1.00		\$30,000
Re-Operations Total				\$30,000

The Re-operations Fund would begin upon execution of re-operations contracts. The Re-ops surcharge would be applied only to re-operations storage and be utilized to fund the Winter Water Spill Credit.

District Water Management Storage Fee				
DWMS	\$4.00	\$15.00	\$25.00	\$30,000
DWMS Total				\$30,000

The DWMS Fund would begin upon completion of the first enlargement and be utilized for O&M expenses associated with the DWMS. The DWMS fee would be applied to the users of DWMS only. At this time, the exact amounts are not known. This chart is for demonstration purposes and the numbers will be adjusted at the time that the appropriate amounts are determined.

5.3.2 Other Considerations

The PSOP outlined herein is based on currently estimated storage needs of those entities forecast to need additional storage in the future to meet increasing water demands to the year 2040. If certain entities decide not to participate in the plan, then the storage space may be reallocated among the continuing participants in a manner consistent with storage needs, staging opportunities, permitting strategies, and other considerations. At some time as yet undetermined, it will be necessary to establish a firm date by which potential participants in the storage development must commit to the project. Also, entities desiring to participate in re-operation may wish to move forward with their implementation more quickly than other

entities. If they are willing to “front-end” the cost, others would be able to participate later in return for payment of their fair share of the total cost.

Section 6 – Recommendations to the Enterprise Board

In summary, the preferred plan includes Phase 1: re-operation of the Fry-Ark Project to allow municipal Project beneficiaries to store non-Project water in Project space and Phase 2: the staged implementation of enlargements to the storage capacities at Pueblo Reservoir and Turquoise Lake.

Based on the work completed to date, it appears that implementation of a long-range plan, which includes Project re-operation and new reservoir storage capacity, to meet the future water and storage needs of the District, is technically feasible. There do not appear to be any “fatal flaws” that would prevent implementation or cause excessive delays in gaining the needed Federal permits. Costs to develop new reservoir storage appear reasonable in comparison to other options available to District entities.

We recommend that the Southeastern Colorado Water and Storage Needs Assessment Enterprise Board take the following actions to move forward with implementation of the PSOP.

- Hold discussions with the USBR to develop and finalize a process and schedule for implementation of Fry-Ark Project re-operation, conduct of the permitting process, and engineering of the enlargements of storage capacities at Turquoise Lake and Pueblo Reservoir. Secure commitments from the USBR relative to their participation in plan implementation from detailed engineering through permitting, final design, and construction. This should be in the form of an MOU between the District Enterprise Board and the USBR.
- Establish a basis of authority for the implementation of Project re-operations utilizing existing Fryingpan-Arkansas Project authorizing legislation. The Enterprise and District staff also should continue to work on federal legislation as a second track toward establishing the necessary authorizations for Project re-operation and for enlargements of Project reservoirs.
- Develop a “preliminary” Implementation Committee. The Implementation Committee will be charged with the responsibility of working through the operational details of the PSOP and the exact terms of the MOA (see next bullet point) that were not fully addressed by the PSOP Report. Those details include: 1) exact capacity, location, and priority uses for the District Water Management Storage (DWMS); 2) financial responsibilities for the development of the DWMS; 3) limitations on the use of enlarged (new)

storage space and the requirements for use of re-operations storage; 4) commitments to the 100 cfs “minimum target flow” below Pueblo Dam and the resulting operational limitations; 5) terms and conditions concerning the District’s filing for an exchange water right to manage Project Water return flows; 6) finalization of the surcharge schedule; 7) the operation of the Winter Water Spill Credit; and 8) determination of how to proceed with a water right filing on enlarged storage space.

The Implementation Committee will have 90 days, beginning from the date of adoption of these recommendations, to draft recommendations on these PSOP implementation details and present them to the Enterprise Board of Directors.

- Execute a Memorandum of Agreement (MOA) with entities wishing to participate in re-operations and enlargements of existing storage reservoirs. The MOA would clarify roles, commitments, level of participation, cost sharing, and other details related to re-operation and use of enlarged space. Commitments to the PSOP are essential for justifying the purpose and need for the project, which is an important element of NEPA compliance.
- File for a water right decree for the exchange for Project Water return flows into Pueblo Reservoir and/or other storage facilities to allow for more effective management of these return flows for well augmentation.
- Based on discussions with the USBR and results of the engineering and environmental studies completed to date, develop a detailed schedule and budget for plan implementation.
- Draft, in consultation with Reclamation, and request introduction of “project-specific” legislation for consideration by the U.S. Congress that would authorize the Bureau of Reclamation to conduct a feasibility study on the enlargement of the Pueblo Reservoir and Turquoise Reservoir, as proposed by the PSOP. Then, pursue authorization for the enlargement of these reservoirs.

- The Enterprise and District should continue to facilitate and encourage discussions relative to implementing other non-structural water management measures, including interruptible supply agreements and water banking. As this work is completed, the impacts of these measures on the volume of District Water Management Storage should be assessed and appropriate revisions made to sizing of new storage space under the PSOP.
- Begin discussions with the City of Aurora regarding their possible participation in the development of DWMS and the proposed enlargements to determine whether benefits to the District and the Arkansas Valley can be derived through such cooperation.
- Continue to inform the public about the PSOP and facilitate transition into the public process prescribed under NEPA.