

**FINAL INTEGRATED FEASIBILITY REPORT/ENVIRONMENTAL IMPACT STATEMENT
(FR/EIS)
FOR THE
CHATFIELD RESERVOIR STORAGE REALLOCATION STUDY**

Lead Agency: U.S. Army Corps of Engineers, Northwestern Division, Omaha District

Abstract: The U.S. Army Corps of Engineers proposes to reallocate 20,600 acre-feet of storage from the exclusive flood control pool to the conservation pool at Chatfield Reservoir. Chatfield Reservoir is well placed to help meet this objective for the following reasons: the reservoir provides a relatively immediate opportunity to increase water supply storage without the development of significant amounts of new infrastructure; it lies directly on the South Platte River (efficient capture of runoff); and it provides an opportunity to gain additional use of an existing federal resource.

The additional storage would be used for municipal and industrial water supply, agriculture, recreation, and fishery habitat protection and enhancement purposes. In addition to the no action plan, Penley Reservoir combined with gravel pit storage, three other alternatives were evaluated: non-tributary ground water (NTGW) combined with gravel pit storage, reallocation of 20,600 acre-feet and 7,700 acre-feet combined with NTGW and gravel pit storage. The Selected Plan, reallocation to allow an additional 20,600 acre-feet of water supply storage; would reallocate storage from the flood control pool to the conservation pool. Under this alternative, the base elevation of the flood control pool would be raised from 5,432 to 5,444 feet above mean sea level (msl), but the reallocation of storage for this project only involves the volume between 5,432 and 5,444 feet msl. This alternative would provide storage to help meet part of the growing demand for water in the Denver Metro by using existing federal infrastructure, and lessening the dependence on NTGW.

The Selected Plan meets all federal National Economic Development (NED) goals providing \$8.42 million in annual NED benefits to total annual NED project costs of \$7.92 million. It provides an average year yield of 8,539 acre-feet at less cost than other alternatives for water supply. Mitigation will be required to offset impacts to terrestrial based effects (wetland and riparian habitats, including Preble's meadow jumping mouse critical habitat). Positive environmental effects to the fisheries supported by the reservoir include the inundation of terrestrial habitats which will result in increased habitat structure for use by fish and other aquatic life. Additionally, increased shoreline inundation will enhance productivity at virtually every trophic level in the aquatic food web. The Colorado Department of Natural Resources (CDNR), through its agencies and non-federal project partners, will complete 100 percent of the integral work at no cost to the federal government per the 1958 Water Supply Act and Section 103(c)(2) of the Water Resources Development Act of 1986. Cost of the project is estimated to be \$179,000,000. The Omaha District Corps of Engineers may decide to perform the work related to modification or instrumentation of the dam or other Chatfield Project safety features, as well as modifications to project operating documents and processes. The district would also retain responsibility for oversight of the CDNR work and inherent government responsibilities, including agency approvals and decisions. The Corps work is estimated to cost \$1,730,000 and will be funded 100 percent non-federal. The proposed CDNR work is integral to the reallocation project, because all the work and features are essential components of the Selected Plan, would otherwise have been performed by the Corps, are not inherent governmental responsibilities and are not already a task required to be performed by the non-federal sponsor (such as Land, Easements, Rights-Of-Way, Relocation, and Disposal Areas). All the work is eligible to be performed by CDNR, because it is within the non-federal cost-share, which for water supply is 100

percent non-federal. Design and construction activities will include on-site and off-site environmental mitigation; modification/re-construction of all impacted recreation facilities; utility relocations; earthwork and shoreline contouring; road, bridge and parking lot construction; demolition, clearing, and grubbing; and vegetation management. Design and construction of environmental mitigation features and recreation modifications will follow Corps standards and regulations, as well as applicable federal laws governing non-federal construction. All plans will be approved by the Corps. The Assistant Secretary of the Army for Civil Works approval of this FR/EIS and determination of whether the proposed CDNR work items are integral will identify what CDNR work might be eligible for Section 116 credit. The acceptance of the work and the affording of credit towards the non-federal share will be determined by the Omaha District inspection and certification in accordance with the terms of the Water Storage Agreement.

The reallocation of flood storage to water supply storage would primarily result in greater and more frequent reservoir pool fluctuations at Chatfield Reservoir, but the impact on downstream flood frequency is negligible.

Comments: Please send comments or questions on this Final Feasibility Study/Environmental Impact Statement to: U.S. Army Corps of Engineers, CENWO-PM-AA, Attention: Gwyn Jarrett, 1616 Capitol Avenue, Omaha, NE 68102-4901, telephone (402) 995-2717, or by email: chatfieldstudy@usace.army.mil. The official closing for receipt of comments will be 30 days from the date of which the notice of Availability of the Final Feasibility Study/Environmental Impact Statement appears in the Federal Register.

CHATFIELD RESERVOIR STORAGE REALLOCATION

Final Integrated Feasibility Report

and

Environmental Impact Statement

July 2013



**US Army Corps
of Engineers®**

project. In addition, Section 116 directed the Secretary to collaborate with the CDNR and local interests to determine costs to be repaid for reallocated storage (as determined under Section 808, as amended) that reflect the limited reliability of the resource and the capability of non-federal interests to make use of the reallocated storage space.

This report presents the integrated Feasibility Study and EIS and economic justification required by Section 808, as amended, which the Secretary will consider prior to deciding whether to reassign a portion of the flood control storage space to joint flood control-conservation purposes.

1.1.2 Background

The CWCB requested that the Corps consider reallocating space within Chatfield Reservoir for water supply purposes, on behalf of a group of 12 water users (or water providers) in the Denver metropolitan area. While water supply remains primarily a non-federal responsibility, based on current federal authorities (described in Section 1.4), the Federal Government should participate and cooperate with states and local interests in developing such water supplies in connection with multi-purpose projects. The federally-owned Chatfield Reservoir provides an opportunity to help local communities in the Denver metropolitan (Metro) area to meet a growing demand for water. Therefore, it is the purpose of this study to identify alternatives, compare those alternatives, and select the best alternative for meeting the needs based on solid planning principles.

With the main problem being defined as increasing water demand in the Denver Metro area that exceeds available water supplies, the purpose and need statement is as follows:

The purpose and need is to increase availability of water, providing an additional average year yield of up to approximately 8,539 acre-feet of municipal and industrial (M&I) water, sustainable over the 50-year period of analysis, in the greater Denver Metro area so that a larger proportion of existing and future water needs can be met.

The primary objective of the reallocation is to help enable water providers to supply water to local users, mainly for municipal, industrial, and agricultural needs, in response to rapidly increasing demand. Chatfield Reservoir is well placed to help meet this objective for the following reasons: the reservoir provides a relatively immediate opportunity to increase water supply storage without the development of significant amounts of new infrastructure; it lies directly on the South Platte River (efficient capture of runoff); and it provides an opportunity to gain additional use of an existing federal resource.

Three reservoirs, consisting of Chatfield Reservoir, in conjunction with Cherry Creek and Bear Creek reservoirs (i.e., Tri-Lakes), are managed as a system by the Corps to provide flood protection to the Denver Metro area. This flood protection function is still critically important today and cannot be compromised.

With approximately 1.5 million visitor days annually, Chatfield State Park is one of the most heavily utilized parks, and one of the most vital components, of the Colorado State Parks system. Given its close proximity to both the Denver Metro area and the foothills, Chatfield State Park provides a valuable and unique opportunity for the public to connect to the natural world through camping,

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boating, hiking, fishing, biking, horseback riding, and wildlife viewing. Colorado Parks and Wildlife¹ works to protect and enhance fish and wildlife habitat at and around Chatfield State Park.

1.1.3 Project Location

Chatfield Reservoir is located southwest of Denver, at the confluence of the South Platte River and Plum Creek within the South Platte River Basin. The study area encompasses the area in the immediate vicinity of Chatfield Reservoir and extends downstream to where the river intersects the Adams/Weld county line. The reservoir's location is directly on the South Platte River, or "on-channel."

1.1.4 Study Sponsor

The Chatfield Reservoir storage reallocation study is being conducted jointly between USACE and the local sponsor, the CWCB. The study costs for the project were divided evenly between these two agencies.

1.1.5 Cooperating Agencies

There are a number of entities that have been invited by the Corps to participate in the Chatfield Reservoir storage reallocation study as Cooperating Agencies and Special Technical Advisors. These include selected federal, state, and local government entities, the project participants (i.e., water providers), and several environmental groups. The Cooperating Agencies and Special Technical Advisors were given the opportunity to participate in project meetings and review and comment on the Preliminary Draft chapters of the Feasibility Report/Environmental Impact Statement (FR/EIS). Coordination with agencies and compliance with environmental statutes and regulations are described in Appendix S, including coordination letters.

1.2 Study Objectives

1.2.1 Problems and Opportunities

The water resource problem to be addressed is the inadequate supply of water to meet increasing water supply demand in the Denver Metro area over the next 50 years due to the combined effects of population growth, depletion of nonrenewable groundwater sources, and agricultural water providers' need for augmentation water for alluvial wells.

Problems

1. Population growth resulting in increased M&I water demands:

The CWCB's "Statewide Water Supply Initiative" (SWSI) estimates the state's population will be between 8.6 and 10.3 million in 2050 compared to a 2010 population of 5.0 million. The SWSI includes several "Identified Projects and Processes" (IPPs), including the Chatfield Reallocation Project, to meet the needs of the Denver Metro area. Even with the IPPs, it is expected that a significant gap in water supply availability would remain (potentially 262,700 to 435,000 acre-feet).

¹On July 1, 2011, Colorado State Parks and the Colorado Division of Wildlife merged to form Colorado Parks and Wildlife.

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over 17.7 million dollars, based on July 1974 price levels. Approximately 90.5 percent of the net annual benefits were for flood risk management and the remaining 9.5 percent were for recreation (USACE, 2002a).

Section 4 of the Flood Control Act of 1944 authorized USACE to construct, maintain, and operate public park and recreation facilities at Corps reservoirs. The Preliminary Master Plan for Chatfield Dam and Reservoir was approved in June 1966. This plan stated that USACE would construct basic initial facilities for public use and access. Initial development included roads, parking areas, boat ramps, boat docks, camping facilities, shade shelters, picnic facilities, overlook development, a bathing beach, change house, fish cleaning stations, sanitary facilities and disposal systems, electric distribution, water supply, signs, tree planting, seeding, landscaping, fencing, and cleanup of existing building sites (USACE, 2002a). The Colorado Department of Game Fish and Parks, now the Colorado Department of Natural Resources (CDNR) was responsible for obtaining water rights to maintain the conservation pool and contracted with the city and county of Denver in 1979 to provide this water. As described in Section 1.5, the existing multipurpose-conservation pool contains water storage rights held by the Denver Water Department (Denver Water).

In July 1974, USACE leased 5,378 acres of land and water to the state of Colorado for the use and benefit of the CDNR and Division of Parks and Outdoor Recreation, also known as Colorado State Parks, for what is now known as Chatfield State Park. On December 31, 1981, USACE, CDNR, Colorado Division of Wildlife¹ (CDOW), and Colorado State Parks were signatories to a sublease of CDNR-leased lands on the downstream side of Chatfield Dam to CDOW for development of fish production and rearing area development including water supply lines, drain lines, ponds, raceways, roads, and parking areas (USACE, 2002a). The Chatfield State Fish Unit (SFU), also known as the Chatfield Fish Planting Base, is located on the leased lands below Chatfield Dam and receives its water supply from Chatfield Reservoir via a 24-inch diameter pipeline that is supplied by a 54-inch diameter water supply pipe that also feeds City Ditch and Nevada Ditch. Another water supply pipe that is 48 inches in diameter extends downstream of Chatfield Dam to feed the Last Chance Ditch.

The Metropolitan Water Supply Investigation (MWSI) began in 1993 to explore a cooperative approach to meeting future water supply needs of the Denver Metro area. The investigation focused on opportunities to increase water supply without the development of significant amounts of new infrastructure. The study identified Chatfield Reservoir as an important potential source of water storage, highlighting its location on the mainstem of the South Platte River, its capacity compared to the upstream reservoirs, and its proximity to metropolitan area supply systems (Hydrosphere Resource Consultants, 1999). The Chatfield Work Group formed within the framework of MWSI and worked with the Colorado Water Conservation Board (CWCB) and USACE to further investigate the possibilities of either reallocating flood storage or recreation storage. This Chatfield Reservoir storage reallocation project under consideration evolved from an assessment of existing contractual agreements, regulatory requirements, operational constraints, and additional studies and investigations.

¹ On July 1, 2011, Colorado State Parks and the Colorado Division of Wildlife merged to form Colorado Parks and Wildlife.

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redefined as an integrated pool with other water providers. The reallocation will only occur between 5,432 feet msl and 5,444 feet msl.

The reallocated storage space in the conservation pool would be filled using water rights belonging to a consortium of 12 water providers listed in Table 1-1. This reallocation would enable the providers to better manage existing and future water supplies to be used for municipal, industrial, agricultural, recreational, and fish and wildlife needs in response to population growth in the Denver Metro area. The maximum reallocation under consideration for this Chatfield Reservoir storage reallocation study is 20,600 acre-feet, representing an increase in the permanent pool to 5,444 feet msl, an increase of 12 feet. The Corps will not assure refill of joint use space released downstream for flood control purposes. Flooding and damages caused by flooding, will not be the responsibility of the Corps.

**Table 1-1
Colorado Water Providers Requesting Storage Space in Chatfield Reservoir**

Entity Requesting Storage	Nature of Entity	Purpose of Use of Storage	Maximum Storage Reallocation (acre-feet)	Percent of Costs and Storage Reallocation
Downstream Water Providers				
Unassigned ¹	TBD	Unassigned	3,561	17.3
Central Colorado Water Conservancy District (WCD)	Agricultural	Agricultural ⁸	2,849	13.8
Colorado Parks and Wildlife ^{6,7}	Governmental: State Agency	Recreation	1,000	4.9
Denver Botanic Gardens at Chatfield	Governmental: City and County of Denver	Recreation and Agriculture ⁸	40	0.2
Western Mutual Ditch Company	Agricultural	Agricultural ⁸	1,425	6.9
Upstream Water Providers				
Unassigned ¹	TBD	Unassigned	564	2.7
Castle Pines Metropolitan District (MD) ³	Local government serving Denver suburban area	Municipal and Industrial ²	785.6	3.8
Castle Pines North Metropolitan District (MD) ³	Local government serving Denver suburban area	Municipal and Industrial ²	941.5	4.6
Town of Castle Rock ³	Municipality	Municipal and Industrial ²	1013.1	4.9
Centennial Water and Sanitation District (WSD) ³	Local government serving Denver suburban area	Municipal and Industrial ²	6434.9	31.2
Center of Colorado Water Conservancy District (WCD)	Governmental: Park County	Municipal and Industrial ²	131.3	0.6
Colorado Water Conservation Board	Governmental: State Agency	Recreation	100	0.49
Mount Carbon Metropolitan District (MD)	Local government serving Denver suburban area	Municipal and Industrial ²	400	1.9
South Metro Water Supply Authority (SMWSA) ³ Includes storage for the following entities ⁴ :	Local governments providing water supplies to Denver suburbs	Municipal and Industrial ²	1354.3	6.6
Arapahoe County Water and Wastewater Authority			121.6	0.59
Castle Pines North MD			64.3	0.31

Entity Requesting Storage	Nature of Entity	Purpose of Use of Storage	Maximum Storage Reallocation (acre-feet)	Percent of Costs and Storage Reallocation
Castle Pines MD			1.1	0.005
Centennial WSD			487.2	2.37
Cottonwood WSD			64.3	0.31
Pinery WSD ⁵			64.3	0.31
Stonegate Village MD			64.3	0.31
Town of Castle Rock			487.2	2.37
Total			20,600	100%

¹The City of Aurora and Roxborough WSD are in the process of withdrawing from the Project. Their combined share of the reallocated storage of 4,125.3 acre-feet is designated as unassigned and will be reassigned to one or more of the water providers or others at a future date.

²Municipal and Industrial uses may include domestic, mechanical, manufacturing, and industrial uses; power generation; fire protection; sewage treatment; street sprinkling; irrigation of parks, lawns, gardens, and grounds; and augmentation and replacement, recharge, use as a substitute water supply, and exchange for water supplies also dedicated to these types of uses.

³Note that these entities are requesting their own storage space in Chatfield Reservoir, and are also seeking storage space as members of the South Metro Water Supply Authority. Their portion of SMWSA's storage space would be allotted as described below in note 4.

⁴The South Metro Water Supply Authority is an entity that provides coordination of regional planning efforts to develop renewable water supplies for its members. The SMWSA is requesting storage space in Chatfield Reservoir that would be used by eight of its members: Arapahoe County Water and Wastewater Authority, Castle Pines Metropolitan District, Castle Pines North Metropolitan District, Town of Castle Rock, Centennial WSD, Cottonwood WSD, Stonegate Village Metropolitan District, and Denver Southeast Suburban Water and Sanitation District doing business as Pinery Water and Wastewater District. SMWSA's storage space would be allocated among these eight members as shown in the table. Note that some of these SMWSA members are also seeking storage space as their own entity (i.e., not under SMWSA); these are shown in the table and include Castle Pines MD, Castle Pines North MD, Centennial WSD, and Town of Castle Rock.

⁵The Pinery WSD is also known as Denver Southeast Suburban Water and Sanitation District. ⁶ The Colorado Water Conservation Board (CWCB) is temporarily holding the shares of Colorado Parks and Wildlife (CPW).

⁷On July 1, 2011, Colorado State Parks and the Colorado Division of Wildlife merged to form Colorado Parks and Wildlife.

⁸ Although three of the water providers are listed as needing storage for agricultural uses, the municipal and industrial cost sharing contained in the Water Supply Act of 1958 will be used for the full reallocation, as the overall context for the reallocation to the CDNR is the enhancement of municipal and industrial water supply for the Denver region in a manner equitable to all water providers. This context is described further in Section 1.9 of this Report and is recognized by the authorizing statute, Section 808 of the WRDA of 1986, which lists a variety of potential purposes for storage use, including agriculture, but references the Water Supply Act of 1958 as governing the repayment of the storage costs.

MD = Metropolitan District
WSD = Water and Sanitation District

The specific water providers and their CWCB-approved allocations in Table 1-1 were arrived at by consensus of all interested water providers in the following manner. At the request of the Corps and the CWCB, a subcommittee of water providers was formed in June 2004 to determine the allocation among interested water providers of the potentially available 20,600 acre-feet of storage space in Chatfield Reservoir. The subcommittee held 11 meetings over a six-month period to develop a consensus on a fair and equitable storage space allocation. The process emphasized that all potentially interested water providers know of, and have an opportunity to obtain, storage space in Chatfield Reservoir on an equal footing, if such storage space was made available. Extensive efforts were made to have as many potentially interested water providers aware of the process as possible. Thirty water providers participated in the process. Some water providers attended early meetings but then chose not to attend later meetings or otherwise be involved in the process. Sixteen water providers ultimately determined they desired storage space in Chatfield Reservoir and would pay a share of feasibility study costs and cooperate by providing technical information with no guarantee that storage space would be made available. Initially this group, which included municipal,

project authorization to develop the plan and conduct the analyses required for the Chief of Engineers to determine whether the reallocation is feasible and economically justified.

1.6 Purpose and Need Statement

With the main problem being defined as increasing water demand in the Denver Metro area, the next task is to define the project planning objectives, which go hand in hand with a specifically defined purpose and need statement. The statement of purpose and need is important in determining the range of alternatives to be evaluated in this combined FR/EIS as required by NEPA. The purpose and need statement is as follows:

The purpose and need is to increase availability of water, providing an additional average year yield of up to approximately 8,539 acre-feet of municipal and industrial (M&I) water, sustainable over the 50-year period of analysis, in the greater Denver Metro area so that a larger proportion of existing and future water needs can be met. The average year yield is the average amount of water per year that the water providers (not including Hock Hocking or Parker WSD) would have been able to store in Chatfield during the 1942-2000 period of record (POR) if Chatfield Dam had existed during the entire POR. Calculations for each water provider were based on inflows during each year of the POR, the effective date of each water provider's water rights, a maximum total storage for all water providers of 20,600 acre-feet, and whether water providers had effluents (non-natural flows) from water rights upstream that could be recaptured in Chatfield for later re-use. Due to a combination of relatively low inflows in most years and the relatively low seniority of water rights held by the water providers, 20,600 acre-feet would have been able to be stored in Chatfield Reservoir in only 16 of the 59 years in the POR.

The action is a component in the overall effort to meet the water supply needs of the greater Denver Metro area, and it would contribute to meeting a portion of those needs. One alternative considered the reallocated storage space in Chatfield Reservoir would be filled using existing or new water rights, including wastewater return flows and other decreed water rights, belonging to a consortium of water providers. The primary objective of the reallocation is to help enable water providers to supply water to local constituents, mainly for municipal, industrial, and agricultural needs, in response to rapidly increasing demand. Chatfield Reservoir is well placed to help meet this objective, because the reservoir provides a relatively immediate opportunity to increase water supply storage without the development of significant amounts of new infrastructure, it lies directly on the South Platte River (efficient capture of runoff), and it provides an opportunity to gain additional use of an existing federal resource.

As Colorado's population is projected to approximately double by 2050 (CWCB, 2011), there is a significant impact on water planning and management strategies in the Denver Metro area. Some of the water providers in the Denver Metro area (mainly downstream of Chatfield Reservoir) rely mainly on junior surface water rights, surface water exchanges and agricultural transfers, and existing/new gravel lake storage, while others (South Metro providers mainly upstream of Chatfield Reservoir) rely most heavily on nonrenewable, nontributary groundwater (NTGW). Increased reliance on nonrenewable NTGW for permanent water supply brings serious reliability and sustainability concerns. As the NTGW source becomes less reliable, it will become more expensive to obtain. Because its availability is not reliant on weather patterns, NTGW provides a very important supply of water during drought. Because the Chatfield Reservoir storage reallocation

groundwater availability and future development may be limited unless surface water supplies are developed and delivered to these areas to supplement the limited groundwater. Most water providers indicated they would not be able to meet the 2030 demands. Estimated demand in the South Platte River Basin by 2050 is 409,700 acre-feet per year (CWCB, 2009). Estimated demand met by identified projects and processes, as well as additional water conservation, totals 319,100 acre-feet per year (about 78 percent of future needs), leaving a 90,600 acre-foot gap (or 22 percent) in the South Platte River Basin.

The South Platte River Basin is broken into six subbasins, but areas surrounding the project area include Denver Metro and South Metro subbasins. In Adams, Denver, and Jefferson Counties (Denver Metro Subbasin), estimated demand met by identified projects and processes include a total of 108,100 acre-feet per year (using the following conservation measures), leaving a 12,500 acre-foot gap (or 10 percent) of the anticipated 2030 demand of 120,600 acre-feet in the Denver Metro Subbasin. The identified projects and processes are:

- Active water conservation (e.g., metering, increasing water rate pricing, rebates for efficient water using appliances, incentives for reducing high water use landscaping, and restrictions on amount of lawn area).
- Existing supplies.
- Denver Northern Firming (Denver Water's transbasin diversion from Grand County).
- The City of Thornton's agricultural water conversion project with the Water Supply and Storage Company.
- Agricultural transfers.
- New storage (including gravel lakes) and reservoir enlargements.
- Reuse for nonpotable irrigation of parks and golf courses and other landscaping.
- Treating lower quality water sources.

In Arapahoe, Douglas, and Elbert Counties (South Metro Subbasin), estimated demand met by identified projects and processes include a total of 38,300 acre-feet per year (using the following conservation measures), leaving a 50,300 acre-foot gap (or 56 percent) (CWCB 2004). The identified projects and processes are:

- Active water conservation (e.g., metering, increasing water rate pricing, rebates for efficient water using appliances, incentives for reducing high water use landscaping, restrictions on amount of lawn area)
- Implementation of South Metro Conjunctive Use Plan or alternative
- Rueter-Hess Reservoir
- Aurora Long-Range Plan

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supply needs now and in the future and inventory current and future projects and processes that local and regional entities are planning to fulfill the water supply needs.

The SWSI report first looked at the predicted increase in the state's population. Colorado's population is projected to double between the years 2000 and 2050 (CWCB, 2009). Similar growth rates are expected during the same time period within the South Platte River Basin, which includes the Denver Metro area (CWCB, 2004, 2009). Based upon the rates of growth, expected per capita M&I water use, and a specified level of long-term water conservation by the area's M&I water providers, SWSI predicted that the South Platte River Basin would require about 1.2 million acre-feet of water by 2050 for M&I purposes (medium scenario demand projection, CWCB, 2009). This volume represents a 409,000 acre-foot increase over current (i.e., 2000) water supplies in the basin. Local and regional projects and processes, as reported in SWSI, are predicted to provide for about 78 percent of the identified M&I water supply gap, leaving approximately 90,000 acre-feet of unmet needs.

The 12 prospective recipients of storage space in Chatfield Reservoir (i.e., "water providers") each have immediate and future water needs influencing their actions to acquire new Chatfield storage space. The municipal water providers must supply water to the growing metropolitan area population and are therefore stretched beyond current supplies by the water provider's growth projections referenced above. The water providers project their demand to increase from 250,000 acre-feet in 2010 to at least 340,000 acre-feet in 2050. The drought of 2002 to 2007 emphasized to water providers that, despite increased levels of water conservation measures, their existing water supplies have a greater vulnerability to periods of water scarcity than previously realized and that additional water development activities, including expanding existing surface water storage facilities, are urgently needed to provide adequate water for the growing population during future droughts.

2. Water need has resulted in the reliance of some municipal water providers on nonrenewable Denver Basin groundwater:

Ten municipal water providers seeking Chatfield storage space, collectively serving over 200,000 residents and businesses in the south portion of the Denver Metro area, are presently using a high percentage of nonrenewable Denver Basin groundwater supplies as their primary water source until more reliable surface water supplies can be developed. The use of Denver Basin groundwater for municipal water supplies has been determined in a recent study to be an unacceptable long-term supply, a path of severely increasing costs and currently reduced water availability and reliability that will continue to worsen in the future (Black & Veatch et al., 2003). The water providers who are now using Denver Basin groundwater have a need to reduce their dependency on this nonrenewable water source if the long-term availability of these sources during periods of drought is to be preserved. This water is legally reusable; however, the practical ability to reuse usually involves recapture (either downstream or upstream by exchange) and storage of effluent after discharge to a stream.

spring runoff is projected to shift earlier in the spring, and late-summer flows may be reduced (Ray et al., 2009).

3.3.2 Surface Water Hydrologic Conditions

The primary sources of water in Colorado are snowmelt and stormwater runoff. These sources discharge into Rocky Mountain rivers and lakes and provide the water supply for one-quarter of the nation. East of the Continental Divide, the Arkansas, Missouri, North and South Platte, and Yellowstone Rivers flow toward the Gulf of Mexico. On the east side of the mountains, water supports agriculture, municipal supplies, and recreation (Stohlgren, 2005).

The South Platte River originates as snowmelt in central Colorado at an elevation of about 12,500 feet. From its source, the river flows southeastward, then northeastward, and after crossing the Colorado-Nebraska border, flows almost due east to join the North Platte River. The South Platte River is about 450 miles long and drains approximately 24,300 square miles (USGS, 2005). The Platte River flows through Nebraska and joins the Missouri River south of Omaha, Nebraska.

In the South Platte River Basin, stream water quality generally depends more on adjacent land use than on upstream land use because upstream water often is removed from the river by diversions. The SWSI (CWCB, 2004), which used U.S. Geological Survey (USGS) 1992 National Land Cover Data, found that approximately one-third of the South Platte River Basin is publicly owned. The majority of those lands are forest areas in the mountains. Western portions of the basin and montane and subalpine areas are primarily forested, while the High Plains region is mainly grassland and planted/cultivated land. According to USGS (1998), rangeland comprised 41 percent of the land use in the South Platte River Basin in 1992–1995, but this use had a relatively small effect on water quality because of the lack of overland flow and minimal water use. Irrigated agriculture comprised only 8 percent of the land area in the basin in 1992–1995 but accounted for 71 percent of the water use in 1990 (USGS, 1998). Urban lands comprised only 3 percent of the basin in 1992–1995 but accounted for 12 percent of the water use in 1990, or 27 percent if power generation is considered an urban water use (USGS, 1998). The SWSI (CWCB, 2004) reports gross water use for the South Platte River Basin in 2003. Self-supplied industrial use and M&I use, combined, comprised 23 percent (772,400 acre-feet per year) of the total demand. Agricultural use accounted for the remaining 77 percent (2,606,000 acre-feet per year) in 2003 (CWCB, 2004). Comparing these studies, irrigated agriculture use of surface water in South Platte Basin appears to have increased from 71 percent in 1990 to 77 percent in 2003. Urban water use appears to have increased from 12 percent in 1990 to 23 percent in 2003.

Historical (1942 to 2000) data from South Platte River stream gages and Chatfield Reservoir operations (beginning after the reservoir was constructed) were entered into a Corps' computer model (HEC-5). A detailed description of the modeling effort is described in Chapter 4 and included in Appendices H and I. The hydrology of the reservoir pool elevations, the flows coming into the reservoir from upstream, and the flows leaving the reservoir have varied considerably during the 61-year POR. The record captures cycles of wetter and drier periods. Drought is a regular feature in Colorado (Colorado State University 2007). In the 1900s alone, four prolonged dry spells occurred, beginning with one in the 1910s. Another in the 1930s caused the dust-bowl period. The second worst drought on record occurred in the 1950s. A series of hot, dry summers following a period of

mitigation adjustments based on actual conditions. The adaptive management strategy is presented in Appendix GG and will be executed with involvement of many additional entities, including the CWCB, the Project Coordination Team, and the Technical Advisory Committee. Table 4-1 summarizes the main areas of uncertainty identified in this FR/EIS and how adaptive management will address them. A detailed assessment of impacts for every affected resource follows in the remaining sections of Chapter 4.

4.2 Geology and Soils

The four proposed alternatives could have potential adverse impacts on geology and soils. Specific issues include possible impacts of the alternatives on geologic hazards (mass wasting and flooding) and possible impacts on soils (erosion and compaction). Mass wasting is a general term used for any downslope movement of rock, soil, snow, or ice under the influence of gravity, including landslides, creep, rock falls, and avalanches. Potential damages from downstream flooding are addressed in Section 4.15. The remaining issues are evaluated by alternative in the following sections.

4.2.1 Alternative 1—No Action

Under Alternative 1, reservoir levels and operations at Chatfield Reservoir would remain unchanged (Table 4-2 and Figure 4-1). Mass wasting, flooding, soil erosion, and soil compaction near the reservoir would not be affected under this alternative. The primary source of sediment deposition into Chatfield Lake is watershed sheet, rill, and gully erosion; the secondary source is shoreline erosion (USACE, 2007). However, to achieve sufficient water storage, additional facilities, pumps, and pipelines would be constructed by the non-federal entities. Groundwater would be pumped, agricultural water rights would be purchased, and services would be reduced. Several of these changes could affect geology and soil resources.

**Table 4-2
Area of Inundation Beyond Current Operations at Chatfield Reservoir Under Each Alternative**

Alternative	Conservation Pool Elevation (feet msl)	Total Area That Would Be Inundated at Maximum Pool Elevation (acres)	Area Beyond Current Operations That Would Be Inundated at Maximum Pool Elevation (acres)
1	5,432	1,507	0
2	5,432	1,507	0
3	5,444	2,094	587
4	5,437	1,722	215

Following the assumptions of ground disturbance outlined in Chapter 2, this alternative could include up to 506 acres of disturbance related to gravel pit water storage (Table 2-7), and up to 377 acres of disturbance related to water storage facilities (i.e., Penley Reservoir) (Table 2-6). The impact to geology and soils related to these potential projects would depend on the affected geologic units, slopes, and soil types. In general, geologic hazards would not likely be increased under this alternative, especially because the proposed Penley Reservoir would be constructed off-channel (as opposed to impounding a stream for storage). Soils would be compacted and likely irreversibly committed in areas of ground disturbance. Although these projects would be implemented on private lands, they should be coordinated with the Corps' Regulatory office as early as possible in the project planning process in regard to Section 404 and Section 401 permit actions, appropriate NEPA documentation, and other requirements.

4.6.1 Alternative 1—No Action

Cottonwoods are not currently found within the normal conservation pool of 5,432 feet msl. Significant adverse impacts on trees have not been observed during past flood events that have caused short-term spikes in the pool elevation. Pool elevation data from the Tri-Lakes Office at Chatfield indicated that there were three high-water events from the period of 1975 to 2006. These occurred in 1980, 1983, and 1995. The maximum water level reached approximately 5,448 feet msl. During these events, the pool was above 5,432 feet msl for about 45 to 70 days. These events did not result in significant adverse impacts on trees (Rios, 2007; Sitoski, 2007).

Output from the hydrology model (Appendix H) indicates that there is only 1 year in the POR where the pool elevation in the growing season is above 5,432 feet msl for more than 30 days. The maximum duration above 5,432 feet msl was 37 days. The maximum pool elevation reached for more than 30 days was 5,443 feet msl, 11 feet above the normal pool elevation. The maximum pool elevation reached was 5,459 feet msl, 27 feet above the normal pool elevation. There are no years when a pool elevation of 5,432 feet is exceeded for the entire growing season.

Based on the historical data and the modeling results, adverse impacts on vegetation, especially trees, are not expected above the normal pool elevation of 5,432 feet msl. Resulting acreage loss to vegetation for Alternative 1 is not included here as it is assumed there are no impacts.

Inundation of Penley Reservoir would result in the loss of deciduous oak and mesic upland shrub plant communities. These communities are not unique to this area and occur in other regions throughout Colorado (NDIS, 2008a). Pipeline construction associated with Penley Reservoir would result in the conversion of seven land cover types including deciduous oak, mesic upland shrub, tallgrass prairie, midgrass prairie, foothills/mountain grassland, dryland agriculture, and irrigated agriculture (Figure 3-3). Because the pipeline would be buried underground, impacts to vegetation would be temporary and habitat loss would not be significant. Construction-related traffic can introduce non-native and noxious weeds into the area; thus, appropriate weed control measures would be used to avoid these types of impacts.

The downstream gravel pits are currently being mined (or are already mined out) for gravel and are therefore unvegetated. Inundation of these pits would not result in the loss of vegetation. However, temporary impacts to vegetation may occur during construction of the gravel pit infrastructure; these impacts will be minimized by revegetating with native plants as soon as practicable after infrastructure installation.

4.6.2 Alternative 2—NTGW/Downstream Gravel Pits

Under Alternative 2, reservoir levels and operations at Chatfield Reservoir would remain unchanged. Thus, vegetation at Chatfield Reservoir would not be adversely impacted. As in Alternative 1, there would be no impacts on vegetation from the conversion of downstream gravel pits to water reservoirs. However, temporary impacts to vegetation may occur during construction of the gravel pit infrastructure; these impacts will be minimized by revegetating with native plants as soon as practicable after infrastructure installation. Under Alternative 2, Penley Reservoir would not be constructed, thus vegetation in the Penley area would not be affected.

4.18.1 Alternative 1—No Action

Review of state site files indicate that pipeline and infrastructure installation would adversely impact the Atchison, Topeka & Santa Fe Railroad (ATSF), a cultural resource that is eligible for NRHP listing. The ATSF was chartered in 1859 and was a major rail link between the Plains and the Rocky Mountain regions. A segment of the ATSF built in 1887 east of the town of Sedalia, Colorado, would be adversely affected by the proposed construction of the Plum Creek Reservoir Pipeline near the proposed Plum Creek Reservoir (Figure 2-1). The High Line Canal was constructed in 1883 for water control purposes. The Denver & Rio Grande Railroad was built in 1871, just two years after the completion of the first transcontinental railroad. After review of state site files, no NRHP-listed, eligible, or potentially eligible sites were identified in the proposed Penley Reservoir or the gravel pit locations associated with this alternative.

4.18.2 Alternative 2—NTGW/Downstream Gravel Pits

Alternative 2 proposes using NTGW and four downstream gravel pits for storage. No NRHP-listed, eligible, or potentially eligible cultural resources would be affected by this alternative.

4.18.3 Alternative 3—20,600 Acre-Foot Reallocation

The implementation of Alternative 3 would result in the inundation of 587 additional acres around the lake (Table 4-2). The effects of shoreline erosion are anticipated to be slight as changes to the target pool would occur slowly over a period of seasonal variation. Previous archeological investigations have identified 10 prehistoric and historic sites that are located within the zone of potential inundation. The proposed change in pool elevation associated with Alternative 3 would not adversely affect any NRHP-listed or potentially eligible properties.

4.18.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

In addition to the reallocation, another 5,379 acre-feet would be obtained from NTGW and/or other storage, and downstream gravel pits under Alternative 4. The potential effects on cultural resources from conversion of downstream gravel pits to water storage reservoirs and use of NTGW are disclosed under Alternatives 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2.

Alternative 4 would result in the inundation of 215 additional acres of shorefront around the lake. As in Alternative 3, alterations in the target pool would occur slowly, minimally affecting shoreline erosion during seasonal drawdown and filling. Based upon the results of Dominguez et al. (2007), it is concluded that no significant cultural resources would be adversely affected by the proposed change in pool level.

4.18.5 Reduction and Mitigation of Potential Impacts

It is recommended that project-generated adverse impacts on the linear NRHP-eligible property (the ATSF) be avoided by direct-drill installation of proposed pipelines beneath the affected property. If adverse impacts on the properties cannot be avoided in this manner, then mitigation of adverse impacts should be undertaken by thorough documentation of the affected property in accordance with the Colorado State Historic Preservation Office (SHPO) guidelines and standards.