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Appendix B
Tri-Lakes Water Control Plans

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WATER CONTROL PLAN COVER PAGE

The Omaha District Water Control and Water Quality Section acquired contingent approval of the Chatfield, Cherry Creek, and Bear Creek Water Control Plans from the Northwestern Division Missouri River Basin Water Management (MRBWM) office. Following the Record of Decision (ROD) and the Water Storage Agreement (WSA) for the Chatfield Reservoir Reallocation Study, the Omaha District Water Control and Water Quality Section will submit a request for final approval for Chatfield, Cherry Creek, and Bear Creek's active Water Control Plans.

Reallocation would not impact the primary flood risk management purpose of Chatfield reservoir. During Tri-Lakes system flood control storage evacuation for Level I (small flood events), as defined in Appendix B – Tri-Lakes Water Control Plans, the reallocation of flood control storage at Chatfield slightly increases releases and affects the timing and duration of releases made from Cherry Creek and Bear Creek though the primary flood risk management purpose for Cherry Creek and Bear Creek is not affected. There is no change to system flood control storage evacuation releases during Level II (large flood events), as defined in Appendix B – Tri-Lakes Water Control Plans. The reallocated flood control storage space of 20,600 acre-feet (10 percent) at Chatfield Reservoir reduces the overall Tri-Lakes system storage percentage for Chatfield Reservoir from 65 percent without reallocation to 63 percent with reallocation. Due to Chatfield reallocation, the percentage of flood control storage space in Level I (small flood events) at Chatfield Reservoir is decreased, and increased in Level I (small flood events) at Cherry Creek and Bear Creek Reservoirs.

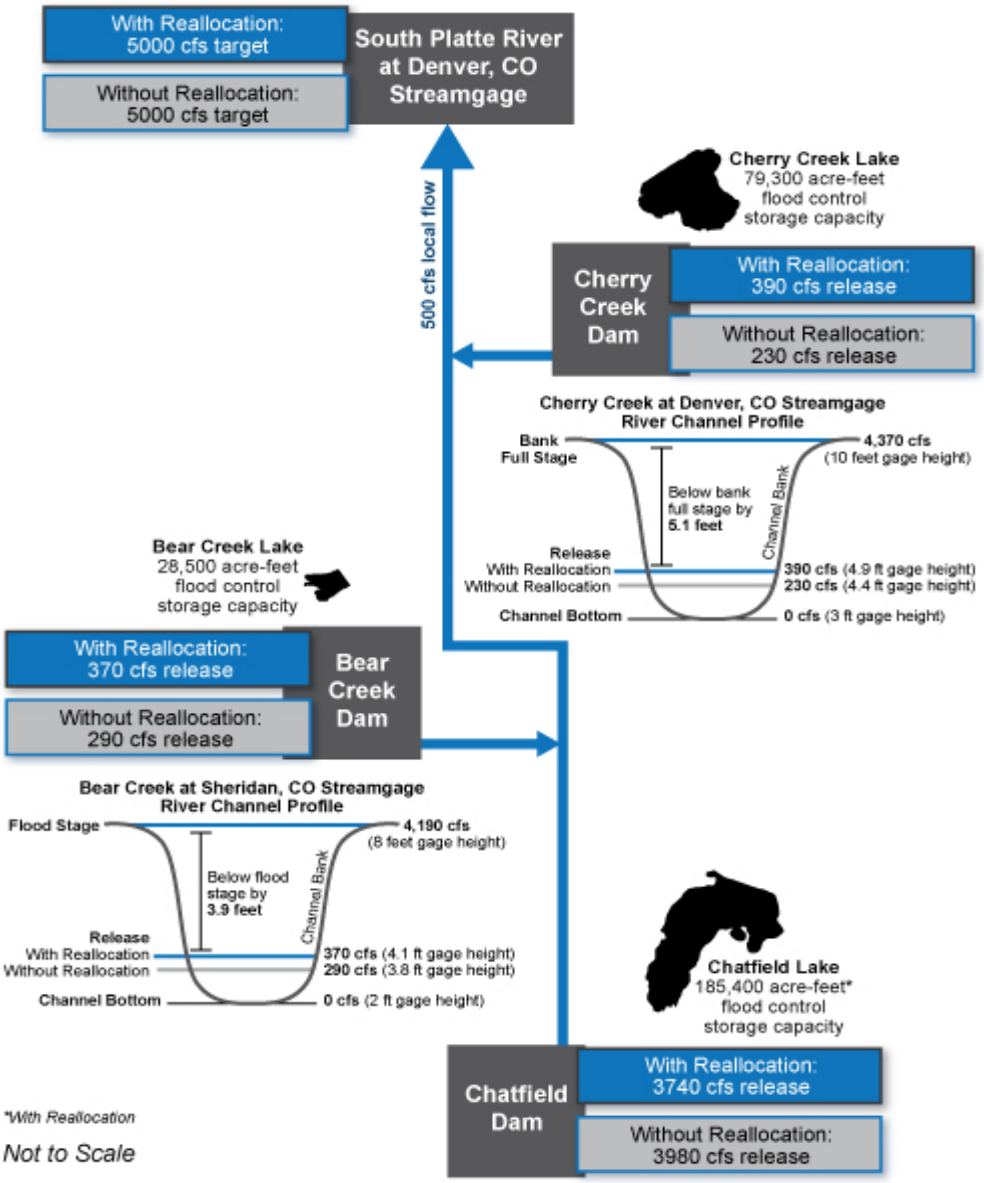
The time to evacuate the system storage during Level I flood events is not increased due to the reallocation nor does it increase the volume of water stored at Bear Creek and Cherry Creek thus it does not increase risk to the Bear Creek and Cherry Creek Dam embankments.

Figure 1 illustrates an example when all three projects are occupying flood control space at the same time. Assumptions for this example are: (1) reservoir inflow at Chatfield is 1500 cfs, at Cherry Creek is 40 cfs and at Bear Creek is 230 cfs (based on average inflow during evacuation of the top 3 reservoir pools), (2) the local flow downstream of the dams is 500 cfs, and (3) the flow target past the South Platte River at Denver, Colorado stream gage is 5,000 cfs. The increase in flood control releases from Bear Creek and Cherry Creek result in stage increases below the dams of less than half a foot. This is 3.9 feet below flood stage on Bear Creek and 5.1 feet below bank full stage on Cherry Creek. These releases are non-damaging, in-channel flows.

Figure 1

Chatfield Reservoir Flood Control Storage Reallocation

Example of Tri-Lakes system flood control storage evacuation for Level I (small flood events)



Relationship between Table 12 of Appendix H and Section 7-05 of Appendix B

The peak releases in Table 12 of Appendix H – Hydrology Report are not relatable to the Tri-Lake system evacuation as outlined in the Chatfield, Cherry Creek, and Bear Creek Water Control Plans in Appendix B – Tri-Lakes Water Control Plans, Section 7-05. Table 12 in Appendix H reflects peak flows that are not coincident with peak releases from all three projects since peak releases from all three projects would not occur simultaneously. Section 7-05 in Appendix B shows the coincident releases from each project, which would not occur during peak flows downstream.

Appendix B-1
Chatfield Water Control Plan

7-01. General Objectives. Engineering Regulation 1110-2-1400, dated 24 April 1970, assigns the Corps of Engineers (Corps) reservoir regulation responsibilities in the Missouri River basin to the Missouri River Division Engineer, now the Northwestern Division Missouri River Basin Water Management (MRBWM) office. This engineering regulation permits delegation of certain reservoir regulation responsibilities to the District Engineer, in whose area the project is located. The responsibilities for assembly and interpretation of data affecting current reservoir regulation and for carrying out routine regulation of Chatfield Reservoir, according to plans agreed on in advance, have been delegated to the Omaha District Engineer. The Division Engineer, through the MRBWM office, monitors and reviews the regulation activities performed by the Omaha District. Plate 9-1 shows the organizational chart for the Omaha District in regards to Chatfield Reservoir regulation.

An agreement between the United States of America and the State of Colorado dated March 1979 describing the state engineer's release responsibility for downstream water rights when Chatfield pool elevation lies between 5423 to 5432 feet can be found in Exhibit II. A separate agreement, dated September 2013, between the United States of America and the State of Colorado also found in Exhibit II, describes the requirements between the agencies within the joint-use flood control and water supply zone (elevation 5432 to 5444 feet).

Chatfield Dam will be regulated for flood control primarily to prevent damage to the metropolitan area of Denver from floods originating on the South Platte River upstream of the dam and will also be regulated to provide for general recreation and fish and wildlife recreation purposes. Project regulation for these purposes is described in the following sections.

7-02. Constraints. The control point for Chatfield Dam regulation is 5,000 cfs at the South Platte River at Denver stream gage. It is important to note that the 5,000 cfs flow target also includes Cherry Creek and Bear Creek Dam releases as well as incremental runoff downstream of each of the dams. Flood control operation is described in detail in section 7-05. Channel capacity varies widely downstream of the dam. Immediately downstream of the dam flows of 5,000 cfs will exceed the South Platte River channel capacity in some areas. Through Denver the channel capacity is much higher, with some locations able to contain flows of 24,000 cfs. Downstream from Denver through the rural areas the natural channel flows wide and shallow and the present channel capacity is less than 5,000 cfs in some high-yield agricultural areas. Protection afforded these areas above and below Denver, therefore, will not be as great as that through Denver. In addition, it would require considerably more storage space to control the reservoir design flood if releases were restricted to less than 5,000 cfs.

Normally, increases in releases should not exceed 500 cfs per day. Release reduction rates should consider downstream impacts. Preferably, releases should be reduced at

a similar rate of 500 cfs per day. However, if a higher rate of change is necessary to accommodate operational circumstances, releases may be increased or reduced at an accelerated rate. The release may even be reduced to a maximum of zero flow in a single gate change if required. Examples of downstream impacts include environmental, water quality, and bank failure. There should be communication with stakeholders if these rates of change will be exceeded.

Unforeseen problems, such as levee breaks and streambank erosion, could limit discharges during flood control operation.

7-03. Overall Plan for Water Control. The normal regulation of Chatfield Reservoir involves responsibilities of the State of Colorado and of the Corps. Refer to Exhibit II for more information.

a. State of Colorado Responsibilities - The State of Colorado will be represented by the Colorado State Engineer. The State Engineer is responsible for administration of all State water laws and accounting for ownership of all water stored in the conservation zone (5385.0-5432.0 feet) of the reservoir. The State Engineer is responsible for satisfying all downstream water requirements below the Chatfield Project, including irrigation and/or water supply diversions, flows for the fish hatchery, and normal river flows. Under normal circumstances the State Engineer will determine what daily river release rates are necessary to meet the downstream water requirements and will issue the necessary regulation release orders directly to the Tri-Lakes Project Office for releases to be made from the conservation pool. However, as determined by the Corps' Omaha District dam safety officer, should any dam safety issues arise, the Corps will assume all regulation decisions.

The State of Colorado and the Corps will regulate the joint-use pool (5432.0 – 5444.0 feet) for water supply and flood control, respectively. When reservoir levels are in the joint-use zone, the Corps will operate for flood control purposes when reservoir pool levels are forecasted by the Corps to rise above elevation 5444.0 feet. At that time the Corps may initiate releases to minimize the maximum reservoir pool elevation. If mountain snowpack totals early in the runoff season are high and models indicate a very high runoff during the snowmelt period, it may be prudent to maintain the pool level lower than 5444.0 feet in anticipation of high runoff and possible flood control releases.

Tri-Lakes Project Office personnel will make all gate changes to valves physically located before the stilling basin, which include the east and west service and low flow gates in the outlet works. At the discretion and under the supervision of the State Engineer, personnel of the irrigation and/or water supply districts may perform the physical operation of the outlet gate valves at their impact basins to supply water directly from the reservoir to their respective water supply ditches. The Colorado

Division will control their releases to the planting base at the valve located at the connection to the 54 inch irrigation pipe. The State Engineer will monitor and control the amount of water taken by each ditch. The State Engineer will be responsible for maintaining up-to-date stage-discharge tables for downstream reservoir river release flow and for providing those tables to the Corps on a timely basis so that the Corps can maintain accurate monthly reservoir reports. The State Engineer through the canal operating agency will furnish the Tri-Lakes Project Office with the daily canal discharge. Further responsibilities of the State Engineer are presented in the operating agreement between the State Engineer and the District Engineer, Exhibit II.

b. Corps of Engineers Responsibilities - The operation of Chatfield Reservoir involves two units of the Corps Omaha District as described in sections 7-03-b-1 and 7-03-b-2 below. Plate 9-1 shows the organizational chart for the Omaha District in regards to Chatfield Reservoir regulation. Additional responsibilities of the Corps are also outlined below.

(1) Water Control and Water Quality Section, Engineering Division. The Omaha District, Water Control and Water Quality Section is responsible for matters pertaining to the regulation of the reservoir. This office prepares the official forecasts for the Corps. Throughout the year the Water Control and Water Quality Section monitors reservoir releases made from the conservation and joint-use pools by the State Engineer. When the pool level is in or forecasted by this office to enter the exclusive flood control pool, this office is responsible for scheduling reservoir releases to attain optimum flood control benefits and control of project storage to assure regulation in conformance with the authorized functions of the project. The Water Control and Water Quality Section is responsible for procurement of necessary snow pack, precipitation, streamflow, and reservoir elevation data, while also making advanced estimates of streamflow from snow cover and/or rainfall reports for regulation purposes and to alert field operating personnel of potential flood occurrences. The Water Control and Water Quality Section prepares the monthly reservoir report (MRD Form 0168) for Chatfield Reservoir, which contains the official daily elevation, inflow, and outflow, see Plate 9-2. Issuance of reservoir regulation orders as outlined in section 7-03-b-4 is also performed by the Water Control and Water Quality Section.

(2) Tri-Lakes Project Office, Operations Division. The Operations Division plans and directs the maintenance and physical operation of the project. They establish the standards of maintenance and provide proper staffing of operating personnel at the Tri-Lakes Project Office to accomplish these objectives. The Tri-Lakes Project Office staff performs all gate changes at Chatfield Dam. This office has agreed to initiate email or telephone correspondence for reservoir releases in excess of 1500 cfs or an increase in release of more than 500 cfs with the Urban Drainage and Flood Control District, a local agency that coordinates releases with local county emergency managers.

(3) Flood Period Organization. The normal organization of the Omaha District is somewhat modified during a flood period to cover the additional duties made necessary by the flood emergency. These duties are to: 1) operate the flood control reservoirs for maximum risk mitigation; 2) collect and disseminate flood information; 3) protect Corps of Engineers' property and works; 4) obtain engineering data; and 5) in extreme emergency, assist in relief and rescue work. These activities take precedence over normal work and are performed by those employees of the District who have been trained for specific emergency duties. In case of purely local flooding in a reservoir controlled basin, such as Chatfield or Cherry Creek, only those units of the District Organization concerned with the normal operation of the reservoir are placed in an emergency status. A directory of regulation personnel is shown in the Standing Instructions to the Dam Tender, Exhibit I.

(4) Regulation Orders. When it is the responsibility of their respective offices as indicated in section 7-01, the State Engineer and the Omaha District Water Control and Water Quality Section will issue regulation orders directly to the Tri-Lakes Project Office. All requests for regulation of project releases, other than regulation responsibilities of the State Engineer, will be referred to the Water Control and Water Quality Section for approval and issuance of orders. All regulation orders will normally be issued verbally and then confirmed in writing as official signed orders as soon as possible. An official reservoir regulation order will be issued in writing by the Water Control and Water Quality Section for all gate changes made at Chatfield Dam, those initiated by the State Engineer and otherwise. Tri-Lakes Project Office personnel will record the gate setting for each gate change in the pool report spreadsheet, which can be accessed by the Water Control Manager to complete the written order. A copy of all orders issued by the Water Control and Water Quality Section will be furnished to the State Engineer and the Tri-Lakes Project Office. Under normal circumstances this copy will contain a brief statement giving the background and reasons for issuance of the order. In the case of a dam safety issue or major flood control release, the signed reservoir regulation order should contain sufficient details to describe the reasoning of the reservoir regulation decision. In the case of a deviation from the water control plan, the reservoir regulation order should note that a signed deviation approval from the MRBWM office has been acquired.

(5) Emergency Organization. It is not anticipated that any emergency organization other than described in section 7-03-b-3 will be required. However, under the provisions of the Standing Instructions to Dam Tender, reference section 7-04, communication failure during a flood event may result and isolate the dam tender, thus making that person the sole project operating organization.

(6) Coordination with Other Agencies. Daily project operating data and miscellaneous hydrologic information will be exchanged between the Project Office, the

State Engineer and the Water Control and Water Quality Section. Cooperation is also maintained with the U.S. Geological Survey and Colorado Division of Water Resources relative to the collection and reporting of precipitation amounts, stream stages, and discharge. The Natural Resources Conservation Service provides snow pack and runoff forecasts, and the National Weather Service provides precipitation and stream gage forecasts.

(7) Communication. Telephone and email facilities are presently available for communication between the Project Office, State Engineer, and Water Control and Water Quality Section. In event of loss of these means of communication, the dam tender may communicate via vehicular travel between the respective offices noted above and/or via cellular phone.

7-04. Standing Instructions to Dam Tender. Exhibit I contains the Standing Instructions to Dam Tender. The Standing Instructions to the Dam Tender provide detailed instructions for regulation of project releases and storage under emergency conditions, such as communication failure. This failure may result and isolate the dam tender, thus making that person the sole project operating organization. Regulation orders issued verbally will be confirmed in writing as official signed orders as soon as possible.

7-05. Flood Control. Chatfield Dam and Reservoir will be regulated for flood control to mitigate risk to the metropolitan area of Denver from floods originating on the South Platte River upstream of the project location.

In general, the developed method of flood control regulation of Chatfield Reservoir may be classified as Method C, defined in EM 1110-2-3600. This represents a combination of the concept of reducing downstream damaging stages as much as possible during each flood with the currently available storage space, with consideration of control of floods of project design magnitude.

The Corps and the State of Colorado will regulate the joint-use pool (5432.0 – 5444.0 feet) for flood control and water supply, respectively. When reservoir levels are in the joint-use zone, the Corps will operate for flood control purposes when reservoir pool levels are forecasted by the Corps to rise above elevation 5444.0 feet. At other times the State of Colorado will regulate for water supply purposes. The Corps will issue a snow melt runoff inflow forecast to the State of Colorado in the event of an above normal snowpack. An annual teleconference or face-to-face meeting will be scheduled in February to discuss the flood outlook due to snow melt runoff.

If the Corps forecast indicates that Chatfield Reservoir will rise above 5444.0 feet due to snowmelt or rainfall runoff the Corps will contact the State of Colorado and follow-up in writing. At that time the Corps may initiate releases to evacuate all or a percentage

of the joint-use storage space to minimize the maximum reservoir pool elevation.

The Corps shall ultimately determine the percentage of the joint-use space to be evacuated for the purpose of flood control. This amount will be communicated with the State of Colorado. The Corps will not assure refill of the joint-use storage space released downstream for flood control purposes. Flood storage evacuation of Chatfield Reservoir must be coordinated with Cherry Creek and Bear Creek Reservoirs. Regulation plans are given in the following paragraphs.

a. Rising Pools/Flood Inflow Period. During flood inflow periods and/or rising pool levels, Chatfield, Cherry Creek, and Bear Creek Reservoirs will be regulated to assure safe control of each flood event. Releases from the dams will be based on forecasted and observed inflows and pool levels as well as downstream flows. During periods of forecasted flood inflows or while the pool level is in the flood control zone, releases will generally be kept as large as possible to meet the 5,000 cfs target at the South Platte River at Denver stream gage. This target includes releases from Chatfield, Cherry Creek, and Bear Creek Dams as well as incremental runoff below the dams. Releases from the three dams from the forecasted flood onset to the complete evacuation of flood storage will be at the discretion of the Water Control and Water Quality Section.

The normal allowable increase in releases at Chatfield Dam is 500 cfs/day. There have been many occasions when the daily change in releases exceeded the normal maximum of 500 cfs/day with largest being 1170 cfs/day in May 1984. The maximum outlet works discharge capacity from Chatfield is 8300 cfs at a pool elevation of 5500 feet. The historic maximum release from Chatfield, at the time of publication, was 3350 cfs in July 1995.

b. Design Assumptions for Flood Control Storage. Rainfall runoff from major storm events occurs so rapidly in this area that a shortened time window is afforded for thoroughly evaluating downstream flood conditions. In order to provide the best downstream flood control, in the reservoir design of Chatfield and Bear Creek Projects, no releases were planned during flood events. The original design was based on experience in operating Cherry Creek Reservoir. Chatfield Project design storage was based on releasing no water for five days after the heaviest portion of the rainfall, then initiating a release of 500 cfs and increasing releases of 500 cfs a day until a release of 5,000 cfs was achieved. This design assumes no releases from Bear Creek or Cherry Creek and no incremental runoff downstream of the projects to the control point, the South Platte River at Denver stream gage. Bear Creek Project design storage was based on releasing no water for two days, then progressively increasing releases as the flood pool was filled, to a maximum of 1,500 cfs. Cherry Creek Reservoir was designed to store all flood inflows, but studies are underway evaluating the adequacy of Cherry Creek Reservoir's storage during large rain events.

With the top of the joint-use zone at elevation 5444 feet, the maximum pool elevation during the Reservoir Design Flood (RDF) does not stay below the spillway crest (elevation 5500 feet) when using the original design criteria of a 5-day shutdown period with a 500 cfs per day stepped-release. Alternative design criteria for reservoir operations included a) a shutdown period adjusted to 2 days while the stepped-release remained 500 cfs per day and b) a shutdown period at 5 days and increased the stepped-release to 1,300 cfs per day. During the RDF both alternatives resulted in a maximum pool elevation below the spillway crest, see Figure 7-1 and 7-2. Both alternatives are considered acceptable design assumptions; reference the "Antecedent Flood Study, Tri-Lakes Reallocation Feasibility Study, December, 2005" and the "Impact of Storage Reallocation on Reservoir Releases at the Chatfield Dam near Denver, CO, November 2010".

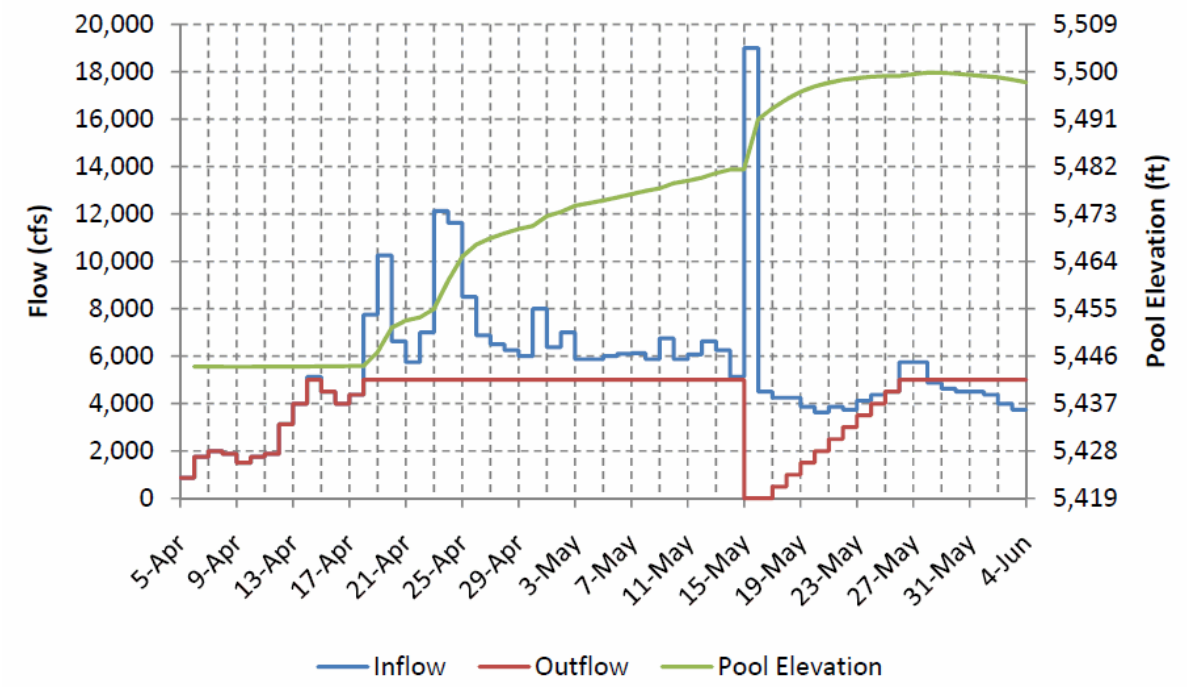


Figure 7-1: RDF pool elevations with a starting elevation of 5444 feet using the 1998 capacity, a 2-day shutdown period, and a 500 cfs per day stepped-release.

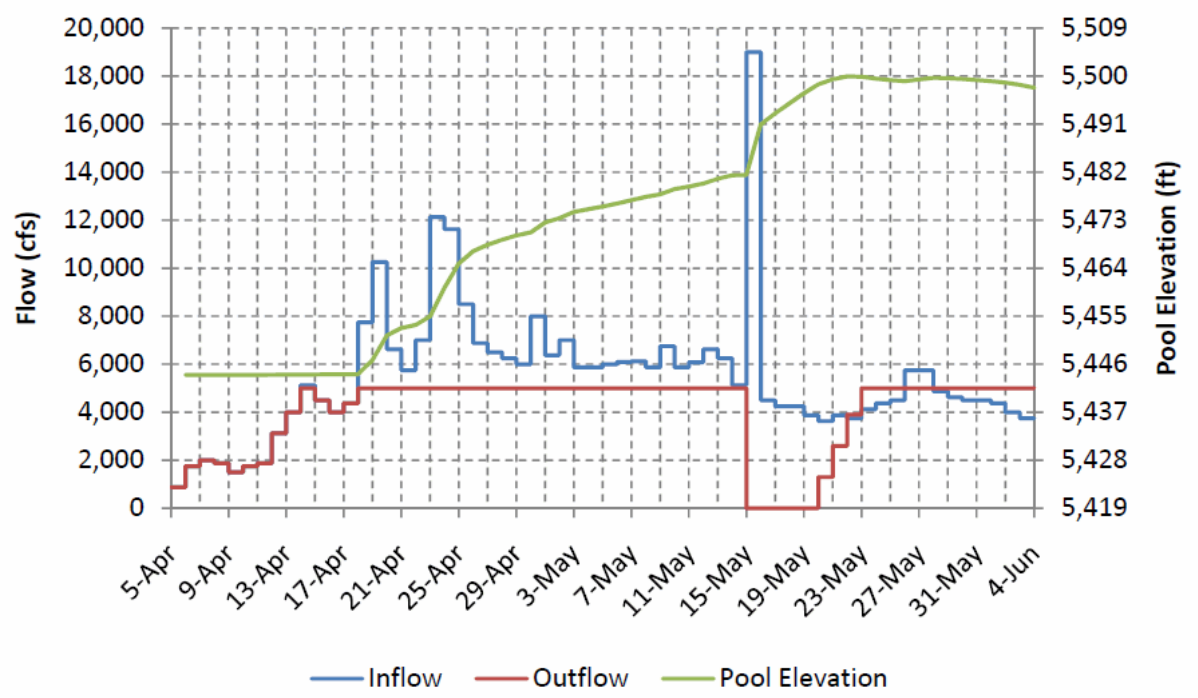


Figure 7-2: RDF pool elevations with a starting elevation of 5444 feet using the 1998 capacity, a 5-day shutdown period, and a 1,300 cfs per day stepped-release.

During flood control operations, the primary consideration in determining reservoir releases will continue to be keeping releases as large as possible to meet the 5,000 cfs target at the South Platte River at Denver stream gage. However, consideration will also be given to the design assumptions for the shutdown period and rate of stepping up releases. This will ensure adequate capacity for the Chatfield Reservoir to control the Reservoir Design Flood without uncontrolled spillway releases or compromising flood control benefits downstream.

c. Surcharge Storage. The surcharge storage zone at Chatfield reservoir includes reservoir pool levels between the spillway crest elevation of 5500.0 feet and the maximum pool level of 5521.6 feet. For large flood events that cause reservoir pool levels to rise above the spillway crest elevation, it is expected that Chatfield Reservoir will be making a high release of up to 5,000 cfs from the outlet works. As the reservoir levels rise above the spillway crest, the releases from the outlet works may be reduced so that the combined flow from the outlet works and spillway is still within the 5,000 cfs target at the South Platte River at Denver stream gage. At reservoir pool elevations above 5502.1, the spillway flow alone would be 5,000 cfs or higher and the outlet works release may be set at zero under those conditions. After the reservoir pool level peaks and pool levels fall to near the spillway crest, outlet works releases may be increased to meet the 5,000 cfs target at the South Platte River at Denver stream gage.

d. System Operating Plan for Flood Storage Evacuation. The following paragraphs describe the system regulation plan for flood storage evacuation in the Tri-Lakes projects when more than one project has storage in the flood control pool. If Bear Creek and Cherry Creek have empty flood control pools, Chatfield's flood control storage will be evacuated to pool elevation 5444 feet with releases to target 5,000 cfs at the South Platte River at Denver stream gage. The normal allowable rate of increase in releases at Chatfield Dam is 500 cfs/day.

System or coordinated regulation of Cherry Creek, Chatfield, and Bear Creek Reservoirs will be necessary only after flood flows have entered the reservoirs and during flood storage evacuation. When water has accumulated in the flood storage zones of these projects, an equal protective balance of flood storage kept vacant should be maintained during pool evacuation. This balance is based on establishing an equal risk in each project of filling the remaining flood control space from a similar subsequent flood. The storage remaining should provide equal protection at each project against runoff from rainfall of standard project flood magnitude. Flood storage evacuation will continue at Chatfield Dam until the pool elevation falls to 5444 feet, at which time coordination will resume with the State Engineer.

Two storage levels are established in each project. Generally, the upper Level II of storage space approximates the volume of the rainfall standard project flood. In Chatfield, Level II amounts to 160,000 acre-feet (af), the volume of the rainfall standard project flood. As the entire flood control space in both Cherry Creek and Bear Creek Reservoirs was designed mainly for protection from the sudden occurrence of a rainfall standard project flood and not from the longer duration mountain snowmelt flood, 95 percent of this space was assigned to Level II. The remaining five percent of flood storage space in Cherry Creek and Bear Creek Reservoirs is allotted a lower evacuation rate at the downstream control point, the South Platte River at Denver stream gage. This space was assigned to Level I to provide for a transition from flood releases to conservation releases and to lessen unnecessary slugging of high releases for small encroachments into the flood pools. The lower evacuation rate of the five percent of storage will not significantly affect the project flood control function. However, since individual design criteria for both the Chatfield and Cherry Creek Projects were based on releasing 5,000 cfs out of each project and not a target of 5,000 cfs at the South Platte River at Denver stream gage, which includes incremental runoff and releases from Chatfield, Cherry Creek, and Bear Creek following the flood peak, strict adherence to these evacuation criteria should be followed. Tables 7-1 and 7-2 present a tabulation of storage in the three projects assigned to each level and desired evacuation flow to be targeted at the control point, South Platte River at Denver stream gage, depending on storage level, percent of storage space filled, and time of year. This system procedure is also presented in the Water Control Manuals for Cherry Creek Dam and Reservoir and Bear Creek Dam and Reservoir.

Table 7-1 lists the storage and elevations based on the following surveys: Cherry Creek (2007), Chatfield (2010), and Bear Creek (2009).

Table 7-1
FLOOD REGULATION STORAGE LEVELS

	Level I			Level II		
	Elevation (feet)	Storage (AF)	Incr. Storage (AF)	Elevation (feet)	Storage (AF)	Incr. Storage (AF)
Cherry Creek	5550.0	12,600		5554.4	16,500	
	to 5554.4	16,500	3,900*	to 5598.0	91,900	75,400
Chatfield***	5444.0	47,700		5455.3	73,100	
	to 5455.3	73,100	25,400**	to 5500.0	233,100	160,000
Bear Creek	5558.0	1,800		5569.2	3,300	
	to 5569.2	3,300	1,500*	to 5635.5	30,300	27,000

* 5 percent of total flood pool
** Total Flood Control Storage (233,100 af) minus 47,700 af = 185,400 af; 185,400 af minus Standard Project Rainfall Flood (160,000 af) = 25,400 af
*** Flood Control pool in 1973 Chatfield Preliminary Reservoir Regulation Manual indicates the base of the flood control pool at elevation 5430.0 feet. The base of the flood control pool was changed to 5432.0 feet in March 1979 (see Exhibit II, Memorandum of Understanding between COE and State of CO). The base of the exclusive flood control pool was changed to 5444.0 feet in 2013 (see Exhibit II, Memorandum of Understanding between COE and State of CO) in response to the reallocation of flood control storage to joint-use flood control and water supply.
Note: Based on area/capacity surveys from 2007 for Cherry Creek, 2010 for Chatfield, and 2009 for Bear Creek.

Table 7-2
DESIRED CONTROLLED FLOW TARGET - DENVER STREAM GAGING STATION

April - July:

Any Reservoir at Level II - 5,000 cfs
All Reservoirs at Level I, with one or more, more than 50% filled - 5,000 cfs
All Reservoirs at Level I, and all less than 50% filled - 4,000 cfs

August – March

Any Reservoir at Level II - 5,000 cfs
All Reservoirs at Level I, with one or more, more than 50% filled - 4,000 cfs
All Reservoirs at Level I, and all less than 50% filled - 3,000 cfs

Water will be released from the reservoir with the highest percent of storage in the highest level occupied until the storage balance or the percent of storage filled, for the

same level, is the same in all reservoirs. Plate 7-3 displays the parallel reservoir balance for the three projects in percent of storage space filled for the two levels.

When all three reservoirs have the same percentage of storage in the same level, equal balance has been achieved. For example, all reservoirs are in balance at 50% full in Level II at the following cumulative storage levels: Chatfield, 153,000 af; Cherry Creek, 54,000 af; Bear Creek, 16,800 af. Table 7-3 gives the parallel reservoir balance for the three projects in percent of storage space filled for the two levels based on the amount in the incremental storage column for each level as shown in Table 7-1. When all reservoirs have the same remaining balance of storage, the storage should be kept in balance or the percent of storage filled should be kept the same until all water is evacuated. Table 7-3 shows percent of storage depletion required out of each reservoir to enable continued parallel reservoir balance for all combinations of the three projects that may contain storage. For example, a total of 100 af of flood control storage occupied among the Tri-Lakes projects would reflect an equal balance for Level I - Balance Combination C when Bear Creek had no flood control storage, Chatfield had 87 af (87%) of storage, and Cherry Creek had 13 af (13%) of storage.

TABLE 7-3
UPPER SOUTH PLATTE RESERVOIR SYSTEM
PERCENTAGE OF STORAGE DEPLETION REQUIRED OUT OF EACH RESERVOIR TO ENABLE A CONTINUED PARALLEL RESERVOIR BALANCE
(Values are in percent)

LEVEL II (see Table 7-1 for Elevations)			
Balance Combination	Chatfield	Bear Creek	Cherry Creek
A	61	10	29
B	86	14	0
C	68	0	32
D	0	26	74
LEVEL I (see Table 7-1 for Elevations)			
Balance Combination	Chatfield	Bear Creek	Cherry Creek
A	82	5	13
B	94	6	0
C	87	0	13
D	0	28	72

Following is an example illustrating how an equal parallel reservoir balance is maintained during storage evacuation using Table 7-3. This example assumes (1) all three reservoirs are in an equal balanced condition as indicated by balance combination A of Level II of Table 7-3, (2) a control point flow of 5,000 cfs is targeted at the South Platte River at Denver stream gage, and (3) there are no downstream channel constraints below the three projects. Values tabulated are average daily flows in cfs. After the total release on line 3 is determined, the estimated inflow into the three projects is totaled on line 4. The difference between this total on line 4 (inflow) and line 3 (release needed from 3 projects) represents the total storage depletion from the 3 projects on line 5. Table 7-3 is utilized to determine what percent of this storage is required out of each reservoir to enable a continued parallel reservoir balance. The difference between the estimated inflow and storage depletion for each project represents the required release from that project. The total release from the 3 projects represents the required total release needed to target the desired flow at the South Platte River at Denver stream gage, with an allowance for incremental flow. A release of 1 cfs over a 24 hour period is equivalent to 2 af of storage.

1.	Desired flow at South Platte River at Denver Stream Gage					5,000
2.	Incremental flow* between 3 projects and Denver Gage**					500
3.	Total release needed from 3 projects					**4500**
		Chatfield		Bear Creek	Cherry Creek	Total
4.	Estimated inflow**	1,100		0	100	1,200
5.	Storage depletion***	(61%) 2,000		(10%) 300	(29%) 1,000	3,300
6.	Required release	3,100		300	1,100	**4,500**

* Incremental flows are flows that enter the stream downstream of dam releases
** Values to be estimated
*** Values from Table 7-3

e. Regulation Schedule. Regulation rule curves for flood control regulation on Plate 7-2 were developed by methods described in section 4-05 of EM 1110-2-3600, primarily for use during large floods or during emergency regulation. The rule curves will serve as a basis for regulation when other information may not be available. The rule curves are based on a rainfall runoff recession. The curves display the minimum releases for any combination of pool elevation and recession inflow, to assure effective use of the total flood control storage by 1) filling the remaining flood control storage, 2) reducing the maximum flood release, and 3) reducing the magnitude of changes in release rates. As these release rates are minimum values, actual flood control release rates will be kept as large as feasible, to meet the 5,000 cfs target at the South Platte River at Denver stream gage.

7-06. Recreation. The demand for water-based recreation near the large metropolitan city of Denver is substantial. The Chatfield Project satisfies part of the demand. The sediment pool serves as the recreation pool. In order to initially fill the

sediment pool, local interests agreed to allow storing of water for recreation, recognizing the eventual depletion effects of the sediment pool. In this respect, the Governor of Colorado, by letter of intent, obligated the State to provide sufficient water to fill the reservoir to the multi-purpose pool elevation of 5432.0 feet and to replace annual evaporation losses. The joint-use storage space between 5432 feet and 5444 feet will be operated for multiple purposes, which include flood control, recreation, fish and wildlife, and water supply. The Omaha District will operate this zone for flood control purposes when the reservoir levels are forecasted by the Corps to rise above 5444 feet, see section 7-05 for flood control regulation requirements.

The Corps will continue to maintain a closely coordinated planning effort with the State of Colorado, Department of Natural Resources, and Colorado State Parks. The Corps constructed recreational areas upstream from the dam that the State of Colorado leases, operates, and maintains for recreation use. Visitation to the Chatfield Project grew from 288,000 in 1976 to approximately 5,240,000 visits per year in FY01 through FY10.

The City of Littleton and South Suburban Recreation and Park District developed the recreation facilities along the South Platte River channel in the portion of the project downstream from the area acquired for Chatfield Dam and Reservoir with Federal financial assistance.

7-07. Water Quality. On-going urbanization will impact Chatfield Reservoir water quality, which in turn could impact future releases. Refer to section 4-08 for water quality information.

The Chatfield Basin Water Quality Authority maintains an on-going program that involves water quality monitoring and management of some upstream activities such as sewage treatment.

7-08. Fish and Wildlife. Fish and wildlife is an authorized project purpose at the Chatfield Project.

The basic premise of the flood control aspect of the water control plan is to release stored waters in the flood control zone of the reservoir as soon as possible following inflow from a flood event. This premise may be consistent with management of the fish and wildlife resources of the project as it reduces to a minimum the possible impacts to aquatic and terrestrial wildlife and habitat.

During the 1980's some temporary storage in the flood control zone of Chatfield Reservoir occurred at least once during every year. However, most of the years the water was less than three feet above 5432.0 feet, the base of the previous exclusive flood control and top of conservation pool, and the flood storage was of very short

duration. In only two of the years did flood storage exceed five feet above 5432.0 feet, the base of the previous exclusive flood control and top of conservation pool. In those two years the storage period was brief; stored water was released as soon as downstream conditions allowed. The shoreline vegetation is relatively tolerant of short periods of inundation so that the shallower, short duration flood events may not cause permanent damage. Longer duration events, however, may result in adverse impacts to shoreline vegetation. Inundation of shoreline and upland vegetation for periods longer than two to three weeks would either seriously injure or kill most of the vegetation as did happen in 1995. In such cases, barren mudflats may occur and a period of succession would ensue that could take several years before the vegetation returned to pre-flooding conditions. The areas also could be seeded or sodded and weed control will be an issue.

Because Chatfield Reservoir is a relatively shallow, plains reservoir, it is primarily a warm-water fishery. Normal operations and normal springtime floodwater inflows would have little effect on the fishery from a water temperature standpoint. Flood inflows could, however, have a temporary negative impact on the lake fishery if high inflows in suspended solids cause the water to become turbid. High turbidity reduces light levels in the lower depths of the lake and interferes with oxygen transfer (breathing) in the aquatic life forms in the lake. As temporary storage increases water residence time, suspended solids will tend to settle out. Settling of particulates may result in the surface waters becoming less turbid, but degradation of organic matter associated with settling particles may deplete oxygen in deeper waters while burial of bottom dwelling organisms may increase sediment oxygen demand.

The outlet works have only a single level for releases. Thus it is not possible to mix water from multiple levels to manage for a particular species of fish.

Chatfield Reservoir is not a primary waterfowl habitat area. It is not on a major migration flyway and it lacks the vegetation and cover necessary for it to be an important stopover point during spring or fall migration. Some local nesting of a few common waterfowl species likely occurs at the project. Larger numbers of Canada Geese use the reservoir as a roosting area in the fall and winter. Normal flood control operations would not be expected to have any significant impacts on such waterfowl nesting.

The U.S. Fish and Wildlife Service (F&WS) has responsibility for oversight of the Endangered Species Act. The F&WS maintains that temporary storage of floodwaters in upstream reservoirs may have impacts on species that depend on the Platte River downstream for part of their life requisites. The federal agencies that are responsible for manipulations of the Platte River system upstream are said to have some responsibilities for protection of those downstream species. The problem is complex; the major elements to it follow:

a. Detention of upstream floodwaters in upstream reservoirs reduces the peak and the overall volume of the effects the flood would otherwise have on downstream areas. The Platte River in Nebraska, for instance, no longer is impacted by heavy and prolonged spring flooding that once periodically scoured the channel and kept trees from gaining a foothold. Where the channel was once wide, shallow, and relatively treeless, it is now narrower, deeper, and heavily tree-covered in many areas. Each upstream reservoir adds to the situation in a cumulative manner.

b. The main species of concern on the central Platte River in Nebraska are the whooping crane, least tern, pallid sturgeon, and piping plover. All of these species have been designated as federally threatened or endangered. Upstream impoundments and increased depletions from the Platte River have adversely influenced habitat for these downstream species because they have changed the timing and volume of flows. These adverse impacts have accumulated over the past 40 years or more, and continue to influence the flood plain environment.

c. The South Platte Watershed within and upstream of Chatfield Park is designated as critical habitat for the Preble's Meadow Jumping Mouse. In the last century, widespread habitat loss and fragmentation due to development, water diversions, overgrazing, water pollution, and gravel and sand mining resulted in a rapid decline of the already rare Preble's populations. It is currently listed as a threatened species in Colorado by both the State and Federal government. Implementation of the joint-use zone (5432-5444 feet) may adversely impact the Preble's habitat if operation of the joint-use zone results in damage to shoreline, wetland or riparian habitat.

7-09. Water Supply. Denver Water, through a 1979 contract with the Colorado Water Conservation Board and Colorado State Parks, is entitled to the use of 11,134 af of storage in Chatfield Reservoir from elevation 5423 to 5,432 feet. Denver Water's use of the storage is subject to conditions in the 1979 contract for maintaining water levels for recreation. Under the terms of the 1979 contract, Denver Water commits to use best efforts to keep the reservoir above 20,000 af (current elevation 5,426.32 feet) from May 1 to August 31 of each year. Denver Water cannot lower the reservoir below elevation 5,423 feet except during severe and prolonged drought conditions as determined by the Colorado Water Conservation Board and agreed to by the Corps. In 2013, the Chatfield Reallocation FR/EIS was finalized. See Exhibit II, for the agreement between the Corps and the State of Colorado, dated September 2013, describing the requirements between the agencies within the joint-use flood control and water supply zone (5,432 and 5,444 feet). See section 7-05 for flood control regulation requirements.

The City Ditch is a carrier ditch that is currently owned and operated by the City of Englewood. It was constructed in 1860 and its original dimensions were approximately

10 feet wide and 20 feet wide at the channel bottom and top of bank, respectively. The original head gate for the diversion of flow from the South Platte River was located near the headwaters of the Chatfield Reservoir conservation pool at about elevation 5425.0 feet. The water rights embodied in the City Ditch diversions are some of the earliest in the area. The current diversion for the City Ditch is through the Chatfield manifold. The ditch has been piped except for some short sections within Englewood. In 2002, the ditch was terminated at the Interstate 25 crossing in Denver, so the northern terminus for the ditch is now a blow-off device near Harvard Gulch in Denver. Being a carrier ditch, it serves customers with raw water in much the same manner as treated water customers are served from a pressure main.

The Plum Creek Pump Station is located on the north side of State Highway No. 75 between City Ditch and the South Platte River. Its purpose is to convey raw water diversions from City Ditch and lift them from elevation 5400.0 feet to 5570.0 feet for further distribution. The development consists of a diversion structure on City Ditch and an earthen stilling reservoir as a source of supply for the suction header serving lift pumps. At the reservoir, a frame structure is located over the inlet control. The pump station was constructed in 1955 and has been well maintained. The intake and pumping plant are below elevation 5426.0 feet.

The Last Chance Ditch is operated as an irrigation and water supply ditch by stockholders owning shares in the Last Chance Ditch Company No. 2. At the inception of the Chatfield Project, the stock list included 31 individual owners of which the City of Aurora owned a controlling interest of about 50.1 percent of the stock. Other municipal owners are Denver Water and the Centennial Water and Sanitation District. The original head gate was located just upstream from the Denver Water's former Kassler Water Treatment Plant and just within the upper limits of the Chatfield Reservoir flood control pool. The current diversion is through the Chatfield manifold to the Last Chance control valve near C-470. The City of Aurora diverts its Last Chance Ditch shares through its intake at Strontia Springs Reservoir.

The Nevada Ditch is a combination irrigation and carrier ditch largely owned by the municipalities of Denver, Englewood, and Littleton. Stock records show 260 shares outstanding, of which about 92 percent are owned by the three cities and the rest by individuals. The former diversion point was in the Chatfield Dam embankment area. The head works and ditch facilities were badly damaged in the 1965 flood but have since been rebuilt. Ditch facilities were damaged again by high flows during May of 1969 but have since been restored to service. Current diversion is through the Chatfield manifold to the Nevada control valve near C-470.

The Chatfield State Fish Unit (SFU) was constructed as a component of the required mitigation due to the original construction of Chatfield Reservoir. The SFU is not operated as a full scale hatchery, as was originally intended, due to the lack of a

reliable water supply. The SFU does have decreed water rights for the operation of the facility. However, when Denver exercises its more senior Chatfield Reservoir storage and exchange rights, flows through the SFU can be shut off. Therefore the SFU is currently operated as holding facility for fish that have been hatched and reared at other locations. These fish are eventually stocked in streams and lakes primarily within the Denver Metro area. When water is available, it is delivered via the 54 inch pipeline that also serves the City and Nevada Ditches. The Corps has allocated 30 cfs of the pipeline capacity to the Division of Wildlife for use at the SFU. If reliable water could be secured, the facility could still be expanded into a full sized hatchery, potentially for both warm and cold water production. This would be an important asset to the Division and the region as population increases and new water projects will increase the demand for fish stocking, particularly in and near the Front Range. At this time it is unknown whether the reallocation of storage space in Chatfield Reservoir will augment or further reduce the available water supply to the SFU.

a. Future Development. The continued growth of the need for water for domestic, irrigation, and industrial uses will tend to assure the further development of water supplies for use in the South Platte River basin.

7-10. Hydroelectric Power. None at this project.

7-11. Navigation. None at this project.

7-12. Drought Contingency Plans. No plan has been developed at this time. Guidance concerning the development of drought contingency plans is being reviewed and updated. A drought contingency plan for Chatfield Dam and Reservoir will be coordinated with stakeholders following the approval of the updated guidance.

7-13. Flood Emergency Action Plans. Normal flood regulation of the Chatfield Reservoir is accomplished by specific regulation orders to the Tri-Lakes Project Office from the Omaha District Water Control and Water Quality Section. However, it is conceivable that communication may be disrupted between these offices at times when project events may require changes in existing regulation instructions in order that the project may more properly perform its authorized function. In order that the Tri-Lakes Project Office may have appropriate information and instructions for modifying existing regulation orders, a procedure has been developed to guide the project in determining project operations under such an emergency. This procedure is given under the Emergency Regulation part of the Standing Instructions to the Dam Tender, Exhibit I. This procedure is defined to begin with a failure in communications between the Tri-Lakes Project Office and the Omaha District Water Control and Water Quality Section personnel at a time when the reservoir is rising rapidly, high inflows are indicated, excessive rainfall has occurred, flooding below the dam is occurring or appears imminent, or when a combination of any of these is occurring. During such emergency

periods, regulation of project releases will be made by the Tri-Lakes Project Office in accordance with the instructions given in Exhibit I. Continuing efforts will be made to re-establish communications.

7-14. Deviation from Normal Regulation. Deviations from the release schedule will be made if conditions at the time are such that improved reservoir regulation will result. For example: (1) releases according to the schedule should not exceed downstream channel capacity unless the safety of the dam is in question; or (2) temporary delays of a few days duration in evacuation of flood storage will be considered to mitigate damages and/or for special circumstances downstream. Deviations require prior approval from the Northwestern Division Commander except as noted in section 7-14-a. Requests to deviate from normal regulation of the project fall into one of the categories described below.

a. Emergencies. Deviations from the release schedule will be made if emergency conditions exist upstream or downstream of the dam. Examples of these types of emergencies include dam safety emergencies, downstream chemical spills, drownings, and facility failures. During an emergency activity, the Omaha District will inform the MRBWM office of its activities as soon as possible. Written confirmation of the deviation, including a description of the cause of the emergency, will be furnished as soon as practicable to the MRBWM office as shown in NWDR 1110-2-6.

b. Unplanned Minor Deviations. A deviation is a proposed plan of operations that do not follow the approved water control plan. A typical example of activities that would create the potential for unplanned minor deviations would be modifications of bridge and utility crossings. In evaluating requests for these types of deviations, the Omaha District will consider upstream watershed conditions, potential flood threats, the amount of water in storage at Chatfield Reservoir, and whether any alternative measures could be taken that would not require a deviation. Written request of the deviation and a description of the cause will be furnished to the MRBWM office as shown in NWDR 1110-2-6.

c. Planned Deviations. Deviations from the release schedule will be made if conditions at the time are such that improved reservoir regulation will result. All conditions such as data on flood potential, lake and watershed conditions, possible alternative measures, benefits to be expected, and probable effects on other authorized and useful purposes will be analyzed. Planned deviations will be coordinated with all appropriate entities, including locals and state offices and a written request will be furnished to the MRBWM office as shown in NWD 1110-2-6.

7-15. Rate of Release Change. Normally, increases in releases should not exceed 500 cfs per day. Release reduction rates should consider downstream impacts. Preferably, releases should be reduced at a similar rate of 500 cfs per day. However, if

a higher rate of change is necessary to accommodate operational circumstances, releases may be increased or reduced at an accelerated rate. The release may even be reduced to zero flow in a single gate change if required. Examples of downstream impacts include environmental, water quality, and bank failure.

Consideration should be given to limit reservoir drawdown to less than 2 feet per day if embankment stability is in question. This drawdown guidance should only be used if practical and reasonable to do so.

Appendix B-2
Cherry Creek Water Control Plan

7-01. General Objectives. Engineering Regulation 1110-2-1400, dated 24 April 1970, assigns Corps of Engineers (Corps) reservoir regulation responsibilities in the Missouri River basin to the Missouri River Division Engineer, now the Northwestern Division Missouri River Basin Water Management (MRBWM) office. This engineering regulation permits delegation of certain reservoir regulation responsibilities to the District Engineer, in whose area the project is located. The responsibilities for assembly and interpretation of data affecting current reservoir regulation and for carrying out routine regulation of Cherry Creek Reservoir, according to plans agreed on in advance, have been delegated to the Omaha District Engineer. The Division Engineer, through the MRBWM office, monitors and reviews the regulation activities performed by the Omaha District. Plate 9-1 shows the organizational chart for the Omaha District in regards to Cherry Creek Reservoir regulation. Exhibit II contract between the United States of America and the State of Colorado, describes the operation of Cherry Creek for different pool elevations and reservoir zones.

The flood control storage of Cherry Creek Reservoir will be regulated primarily to prevent damage through the city of Denver from floods originating on Cherry Creek upstream of the project location. Secondary purposes include, when feasible, the minimizing of flood damages along the South Platte River in Denver and in downstream agricultural areas.

Fish and wildlife was not initially included as a project purpose; however, an objective was added to store and release basin flows to facilitate the management of fish and wildlife. Other objectives are to maintain and manage the land and water resources to support a diversity of fish and wildlife and to preserve, protect, and interpret threatened and endangered species and unique and important ecological resources.

7-02. Constraints. The control point for Cherry Creek Dam regulation is 5,000 cfs at the South Platte River at Denver stream gage. It is important to note that the 5,000 cfs flow includes Bear Creek and Chatfield Dam releases as well as incremental runoff downstream of each of the dams. Flood control operation is described in detail in section 7-05. Channel capacity varies widely downstream of the dam. Downstream inundation mapping for a reservoir release of 5,000 cfs from Cherry Creek Dam to the confluence with the South Platte River was finalized in March 2013 and depicts areas of out-of-bank flow. The sustained non-damaging channel capacity of Cherry Creek is likely between 4,000 and 5,000 cfs. Downstream channel concerns, gate vibration, manpower to make gate changes, and travel time for releases to impact downstream areas are items that may constrain operations.

Normally, increases in releases should not exceed 500 cfs per day. Release reduction rates should consider downstream impacts. Preferably, releases should be reduced at a similar rate of 500 cfs per day. However, if a higher rate of change is necessary to accommodate operational circumstances, releases may be increased or reduced at an accelerated rate. The release may even be reduced to flow in a single gate change if

required. Examples of downstream impacts include environmental, water quality, and bank failure. There should be communication with stakeholders if these rates of change will be exceeded.

a. Coordination with State Water Laws. At the request of the Governor, the Chief of Engineers has permitted the State of Colorado to maintain a conservation pool in the Cherry Creek Reservoir. Management of the conservation pool for recreational use, administration of water rights, and determination of reservoir evaporation are accomplished by the Division of Parks and Recreation in cooperation with the Colorado State Engineer. Extensive coordination is required between the Corps and the State while the pool level is within the conservation zone. It is essential that regulation be in accordance with the water requirements and irrigation laws of the State of Colorado, while also safeguarding the State's right to maintain storage in the conservation pool. Releases of small inflows, which cause pool rises slightly in excess of the conservation zone, are closely coordinated with the State Engineer. As such storage would have little or no effect in subsequent flood operations, releases generally can be made at slow rates more useful to irrigation interests. The release rates recommended by the State Engineer will normally be followed in such instances if no conflict with the flood control function would result.

b. Problems to be Encountered in Regulating Reservoir. Several factors exist that must be considered in regulation of the project:

(1) The Cherry Creek Project was authorized primarily to provide flood control through Denver from floods originating on Cherry Creek. Project releases must be carefully coordinated with incremental inflows to Cherry Creek below the dam so that project releases, when combined with the natural inflows, do not exceed the capacity of the Cherry Creek channel through Denver. Consideration must also be given to the combination of Cherry Creek flows with flows on the South Platte River through Denver to provide as much flood control on the South Platte River as possible consistent with the primary function of providing flood control along Cherry Creek through Denver.

(2) In regulating the reservoir, the restrictive capacity of the Cherry Creek channel through Denver, and especially through the area upstream of downtown Denver, may affect the maximum release that can be made from the project. The lined portion of the channel has deteriorated from lack of maintenance and infrequent use over the past several years. Willow growth and small rock dams in the unlined portion also pose a restriction to higher releases. The State Engineer has frequently indicated a preference for maximum releases of 2500 cfs insofar as practical. A steady release of 525 cfs was made for approximately twelve days during mid-August 1965 with no adverse effect. Although hydraulic studies indicate a probable channel carrying capacity of near 5000 cfs, any releases in excess of 1000 cfs must be carefully observed in the field. Annual sediment flushing releases of up to 1300 cfs have been made without problems, although these releases were of only a15-minute duration.

Project releases should be kept as high as practical based on field observations, but not exceeding 5000 cfs while the reservoir is below the spillway crest.

(3) Existence of the conservation pool presents several problems in regulation of the reservoir. The outlet gates are normally kept closed to retain the conservation pool. The project will not directly pass all inflows through the reservoir, including those flows less than 5000 cfs considered in the 1946 agreement as usable by downstream irrigation interests. The State Engineer is responsible for dealing with any water rights administration. When the reservoir is above the top of conservation zone releases will be determined by the Corps based on the primary requirements for flood control, reference Section 7-05 for details. Due consideration to the recommendations of the State Engineer will determine how much of the conservation storage will be evacuated following any inflow event.

(4) Subsequent to completion of the Cherry Creek Project, extensive commercial and residential development has occurred in the Sand Creek and Tollgate Creek flood plain downstream of the Cherry Creek spillway. Channel capacities have been restricted by encroachment and major damage will occur in the event of spillway use. If high inflows require use of the spillway, maximum utilization of the Cherry Creek channel through Denver should be considered to reduce the amount of discharge throughout the spillway and the associated damages along Sand and Tollgate Creeks.

(5) Extensive residential development has occurred on the properties adjacent to project boundaries, sometimes below the maximum pool elevation. This could cause problems trying to regulate the system of reservoirs (Cherry Creek, Bear Creek, and Chatfield). Public safety in these areas could also become a concern, due to the rapid rise of pool levels during storms of the design magnitude.

(6) During the flood of June 1965 an extensive amount of debris entered the reservoir and collected along the embankment near the intake tower. Since the flood inflow volume was rather small it was held in the reservoir until the debris could be removed. Releasing water while debris surrounds the tower could result in debris lodging in the gate slots and prevent closure of gates, with a resultant loss of all conservation storage. It is conceivable that larger gate openings or higher pool levels would remove the threat of obstruction in the gate passageway. Considerable dead timber is now lying in the reservoir above the conservation pool level and along the channel in the upper reaches of the basin. Careful attention should be given to the debris problem in future regulation of the reservoir.

(7) Cherry Creek, Bear Creek, and Chatfield Dam outflows require close coordination. Problems arise in maintaining appropriate storage balances considering storm recurrence and reservoir conditions within each project. Water rights and water ownership of temporarily impounded water require close coordination with the State Engineer's office.

(8) Revised PMF and design storm routings indicate inadequate flood control storage volume at the project. A Dam Safety Modification Study addressing this concern was initiated in FY 2013 and is scheduled to be completed in FY 2016. The study will develop and evaluate potential alternatives to reduce risks associated with Cherry Creek Dam. Regulation of the project will require close monitoring of Cherry Creek Reservoir and basin conditions.

7-03. Overall Plan for Water Control. The normal regulation of Cherry Creek Reservoir involves responsibilities of the State of Colorado and of the Corps. Refer to Exhibit II for more information.

The Definite Project Report, dated January 1944, did not present a detailed plan of conservation regulation for Cherry Creek Reservoir because no provision had been made for conservation storage in the reservoir. Following the retention of surplus runoff during the spring of 1957, a conservation pool was established in the reservoir at the request of the State Engineer. With the approval granting the State of Colorado authority to maintain a conservation pool in Cherry Creek Reservoir, the operating plan for flood control was revised to include plans for both conservation and flood control. The following paragraphs discuss in detail the current plan for regulation of the conservation storage. Section 7-05 describes flood control operation in detail. Pool storage zones and elevations are shown in a schematic on Plate 7-1.

a. State of Colorado Responsibilities - The regulation plan for the conservation zone (5504 - 5550.0 feet) is to store all inflows in excess of downstream water requirements. Requirements for the retention or release of storage while the reservoir is below elevation 5550.0 feet will be determined by the Colorado State Engineer consistent with water laws of Colorado. Normally the State Engineer will make requests for release of water directly to the Omaha District Water Control and Water Quality Section. Upon notification and concurrence with such proposed releases, the Water Control and Water Quality Section will issue a regulation order to the Tri-Lakes Project Office specifying the amount and duration of releases to be made. If an actual emergency exists involving drowning, present or probable damage to the public works downstream from the dam, or events of a similar nature, the State Engineer may issue release instructions to the Tri-Lakes Project Office for immediate action. The Tri-Lakes Project Office will confirm such action with the Water Control and Water Quality Section as soon as possible.

(1) Regulation Process. When it is the responsibility of the State of Colorado as indicated in section 7-03-a, the Colorado State Engineer will contact the Omaha District, Water Control and Water Quality Section for a regulation change due to downstream water rights. The State Engineer determines the necessary release with approval from the Water Control and Water Quality Section. The Water Control and Water Quality Section then contacts the Tri-Lakes Project Office with the regulation

change. The two Corps offices discuss the regulation change, and as long as there are no constraints the change is performed. An official reservoir regulation order will be issued in writing by the Water Control and Water Quality Section. Tri-Lakes Project Office personnel will record the gate setting for each gate change in the pool report spreadsheet which can be accessed by the Water Control Manager to complete the written order reservoir regulation order. A copy of all orders issued by the Water Control and Water Quality Section will be furnished to the State Engineer and the Tri-Lakes Project Office. Under normal circumstances, this copy will contain a brief statement giving the background and reasons for issuance of the order.

b. Corps of Engineers Responsibilities - The operation of Cherry Creek Reservoir involves two units of the Corps Omaha District as described in sections 7-03-b-1 and 7-03-b-2 below. Plate 9-1 shows the organizational chart for the Omaha District in regards to Cherry Creek Reservoir regulation. Additional responsibilities of the Corps are also outlined below.

(1) Water Control and Water Quality Section, Engineering Division. The Omaha District, Water Control and Water Quality Section is responsible for matters pertaining to the regulation of the reservoir. This office prepares the official forecasts for the Corps. Throughout the year the Water Control and Water Quality Section monitors reservoir releases made from the conservation pool by the State Engineer. When the pool level is in or forecasted by this office to enter the exclusive flood control pool, this office is responsible for scheduling reservoir releases to attain optimum flood control benefits and control of project storage to assure regulation in conformance with the authorized functions of the project. The Water Control and Water Quality Section is responsible for procurement of necessary snow pack, precipitation, streamflow, and reservoir elevation data, while also making advanced estimates of streamflow from snow cover and/or rainfall reports for regulation purposes and to alert field operating personnel of potential flood occurrences. The Water Control and Water Quality Section prepares the monthly reservoir report (MRD Form 0168) for Cherry Creek Reservoir, which contains the official daily elevation, inflow, and outflow, see Plate 9-2. Issuance of reservoir regulation orders as outlined in section 7-03-b-4 is also performed by the Water Control and Water Quality Section.

In the interest of regulation of the Cherry Creek Reservoir to serve the functions of (1) maintenance of the conservation pool, (2) control of flood flows on Cherry Creek, and (3) sediment flushing operations, while at the same time yielding incidental benefits to downstream irrigation interests and providing operational flexibility, it is desirable to maintain a small transition storage zone of approximately one foot between elevations 5550.0 and 5551.0 feet. In regulation of the conservation storage pool, the State Engineer will endeavor to keep the reservoir at or above elevation 5550.0 feet as inflows will permit. Numerous occasions arise when small Cherry Creek inflows or rainfall on the immediate reservoir area cause small increases in the pool level, many of which will cause the pool to exceed elevation 5550.0 feet. The release of these small

volumes will cause frequent and difficult gate operation. The quantity of water so released would also be insufficient in most instances to be practical or beneficial to State water users. If the State Engineer has no call for releases, these small inflows will be accumulated in the reservoir to a maximum elevation of 5551.0 feet. Upon reaching elevation 5551.0 feet, the Water Control and Water Quality Section will issue a regulation order to the Tri-Lakes Project Office to release this accumulated storage at a rate agreed upon between the Water Control and Water Quality Section and the State Engineer. The releases will be continued until the pool has receded to elevation 5550.0 feet. However, while the reservoir is between elevations 5550.0 and 5551.0 feet, the reservoir level may fluctuate as necessary without requiring frequent small reservoir releases. The schedule of releases will be coordinated between the State Engineer's Office and the Water Control and Water Quality Section.

(2) Tri-Lakes Project Office, Operations Division. The Operations Division plans and directs the maintenance and physical operation of the project. This Division establishes the standards of maintenance and provides proper staffing of operating personnel at the Tri-Lakes Project Office to accomplish these objectives. The Tri-Lakes Project Office staff performs all gate changes at Cherry Creek Dam. This office organized an informal agreement with the Colorado State Engineer that one gate change per week be made for downstream water rights. This was in response to no longer staffing a full-time dam tender on site at Cherry Creek Dam. This office has also agreed to initiate email or telephone correspondence for reservoir releases in excess of 40 cfs with the Urban Drainage and Flood Control District, a local agency that coordinates releases with local county emergency managers.

(3) Flood Period Organization. The normal organization of the Omaha District is somewhat modified during a flood period to take care of the additional duties made necessary by the flood emergency. These duties are to: 1) operate the flood control reservoirs for maximum protection; 2) collect and disseminate flood information; 3) protect Corps of Engineers' property and works; 4) obtain engineering data; and 5) in extreme emergency, assist in relief and rescue work. These activities take precedence over normal work and are performed by those employees of the District who have been trained for specific emergency duties. In case of purely local flooding in a reservoir controlled basin, such as Cherry Creek or Chatfield, only those units of the District Organization concerned with the normal operation of the reservoir are placed in an emergency status. A directory of regulation personnel is shown in the Standing Instructions to the Dam Tender, Exhibit I.

(4) Regulation Orders. Whether it is the responsibility of the State Engineer or the Omaha District Water Control and Water Quality Section, the Water Control and Water Quality Section will issue all regulation orders to the Tri-Lakes Project Office. All regulation orders will normally be issued verbally and then confirmed in writing as official signed orders as soon as possible. An official reservoir regulation order will be issued in writing by the Water Control and Water Quality Section for all

gate changes made at Cherry Creek Dam. Tri-Lakes Project Office personnel will record the gate setting for each gate change in the pool report spreadsheet, which can be accessed by the Water Control Manager to complete the written order. A copy of all orders issued by the Water Control and Water Quality Section will be furnished to the State Engineer and the Tri-Lakes Project Office. Under normal circumstances, this copy will contain a brief statement giving the background and reasons for issuance of the order. In the case of a dam safety issue or major flood control release, the signed reservoir regulation order should contain sufficient details to describe the reasoning of the reservoir regulation decision. In the case of a deviation from the water control plan, the reservoir regulation order should note that a signed deviation approval from the MRBWM office has been acquired.

(5) Emergency Organization. It is not anticipated that any emergency organization other than described in section 7-03-b-3, as described above, will be required. However, under the provisions of the Standing Instructions to the Dam Tender, reference section 7-04, communication failure during a flood event may result and isolate the dam tender, thus making that person the sole project operating organization.

(6) Coordination with Other Agencies. Daily project operating data and miscellaneous hydrologic information will be exchanged between the Project Office, the State Engineer and the Water Control and Water Quality Section. Cooperation is also maintained with the U.S. Geological Survey and Colorado Division of Water Resources relative to the collection and reporting of precipitation amounts, stream stages, and discharge. The Natural Resources Conservation Service provides snow pack and runoff forecasts, and the National Weather Service provides precipitation and stream gage forecasts.

(7) Communication. Telephone and email facilities are presently available for communication between the Project Office, State Engineer, and Water Control and Water Quality Section. In event of loss of these means of communication, the dam tender may communicate via vehicular travel between the respective offices noted above and/or via cellular phone.

7-04. Standing Instructions to Dam Tender. Exhibit I contains the Standing Instructions to Dam Tender. The Standing Instructions to the Dam Tender provides detailed instructions for regulation of project releases and storage under emergency conditions, such as communication failure. This failure may result and isolate the dam tender, thus making that person the sole project operating organization. Regulation orders issued verbally will be confirmed in writing as official signed orders as soon as possible.

7-05. Flood Control. Cherry Creek Dam and Reservoir will be regulated for flood control to mitigate risk to the metropolitan area of Denver from floods originating on

Cherry Creek upstream of the project location. Operation of the Cherry Creek Project will require both individual and system reservoir regulation.

a. Operation of Cherry Creek Reservoir as an Individual Project. Before 1985, the developed method of flood control regulation of Cherry Creek Reservoir was Method A defined in EM 1110-2-3600. This method is based on the concept of reducing downstream damaging stages as much as possible during each flood with the currently available storage space. After 1985, the method of flood control regulation became Method C. Method C is a combination of Methods A and B. Method B is regulation based on control of the project design flood. Method C allows some flexibility during certain times of the year, such as when pool levels are low, and then fixes the schedule of releases as the pool reaches certain critical levels. This change has been made to help improve the safe passage of major flood events that could cause emergency spillway discharges into the Tollgate Creek basin. It is imperative that the pool be drawn down to at least the half of the flood control zone prior to the occurrence of the spillway design flood. A release rate to a maximum of 5000 cfs from the Cherry Creek outlet works will ensure that no floodwaters are stored in the upper half of the flood control zone for more than 5 days. This will allow the project to contain a standard project flood on top of a half-full starting pool without diverting water into the adjacent Tollgate Creek basin. Evacuation of flood control storage from Cherry Creek Reservoir as an individual project will only occur when no flood storage is occupied in Bear Creek or Chatfield Reservoirs.

(1) Release Rates During Flood Inflows. When the reservoir is in the range of elevation 5551.0 to 5610.6 feet (spillway crest, surveyed in April 2008) and rising as a direct result of stream runoff, consideration will be given to utilizing release rates shown on Plate 7-2. This regulation schedule, or rule curve, was developed from procedures outlined in Chapter 4 of EM1110-2-3600 and illustrate the minimum release rates necessary to control the indicated inflow within the remaining flood control storage capacity of the reservoir. While the minimum release rates on Plate 7-2 are intended primarily as guidelines, actual release rates will be kept as large as feasible up to the maximum 5000 cfs target at the South Platte River at Denver, Colorado streamgage while minimizing flood risk on Cherry Creek and on the South Platte River below Cherry Creek. When the reservoir elevation reaches a half full flood pool, the reservoir release will be kept as large as feasible to meet the 5000 cfs target at the South Platte River at Denver, Colorado streamgage to decrease the risk of spillway flows.

(2) Outlet Works Release Rates During Flood Evacuation. When the reservoir inflow has peaked and the reservoir level becomes stationary or begins to fall, releases will be scheduled, consistent with downstream conditions, to evacuate the accumulated flood storage as rapidly as practical. In view of the severe shortage of water for irrigation along the South Platte River, it is also in the best interest of the government, when practical, to release stored flood waters at a rate beneficial to irrigation interests if such release rates will not unduly interfere with the primary flood

control function of the project. The release rates indicated on Plates 7-2 and 7-3 represent the minimum rate of release required to evacuate the reservoir in a practical period of time. The release rates on Plates 7-2 and 7-3 are based on an evacuation time of 8 days for the April-July period and a time of 10 days for the September-February period for pool levels above elevation 5572.0 feet. The evacuation time was lengthened to a maximum of 15 days for progressively lower pool levels. These evacuation times were selected as that which will reasonably allow for sufficient storage withdrawal in advance of subsequent flood reoccurrences. Consideration will be given to utilizing the evacuation rates shown on Plates 7-2 and 7-3 although higher rates will be utilized whenever feasible. While Plates 7-2 and 7-3 list flood control as the primary objective, some incidental conservation benefits will also be realized, particularly in evacuation of small or medium size floods.

(3) Spillway Releases. When the reservoir rises above the spillway crest elevation 5610.6 feet, releases will occur through the ungated spillway channel into West Tollgate Creek, and then into Tollgate Creek and Sand Creek, thus bypassing the Cherry Creek basin through the city of Denver as depicted in Plate 4-32. Since completion of the Cherry Creek Project, considerable residential and commercial development has taken place in the Tollgate and Sand Creek flood plains. Large spillway releases could result in considerable damage. The Corps has neither fee title nor flowage easements to lands along the channels. In order to decrease the possibility of spillway discharges, evacuation of the flood pool should be scheduled as soon as downstream conditions permit.

b. System Operating Plan for Flood Control Evacuation. System or coordinated regulation of Cherry Creek, Chatfield, and Bear Creek will be necessary only after flood flows have entered the reservoirs and during flood storage evacuation. When water has accumulated in the flood control storage zone of these projects, an equal protective balance of flood control storage kept vacant should be maintained during pool evacuation. This balance is based on establishing an equal risk in each project of filling the remaining flood control space from a similar subsequent flood. The storage remaining should provide equal protection at each project against runoff from rainfall of standard project flood magnitude. Flood storage evacuation will continue at Cherry Creek Dam until the pool elevation falls to 5550 feet, at which time coordination will resume with the State Engineer.

Two storage levels are established in each project. Generally, the upper Level II of storage space approximates the volume of the rainfall standard project flood. In Chatfield, Level II amounts to 160,000 acre-feet (af), the volume of the rainfall standard project flood. As the entire flood control space in both Cherry Creek and Bear Creek Reservoirs was designed mainly for protection from the sudden occurrence of a rainfall standard project flood and not from the longer duration mountain snowmelt flood, 95 percent of this space was assigned to Level II. The remaining five percent of flood storage in Cherry Creek and Bear Creek Reservoirs is allotted a lower evacuation rate

at the downstream control point, the South Platte River at Denver stream gage. This space was assigned to Level I to provide for a transition from flood releases to conservation releases and to lessen unnecessary slugging of high releases for small encroachments of the flood pools. The lower evacuation rate of this five percent of storage will not significantly affect the project flood control function. However, since individual design criteria for both the Chatfield and Cherry Creek Projects were based on releasing 5,000 cfs out of each project and not a target of 5,000 cfs at the South Platte River at Denver stream gage, which includes incremental runoff and releases from Chatfield, Cherry Creek and Bear Creek following the flood peak, strict adherence to these evacuation criteria should be followed. Tables 7-1 and 7-2 present a tabulation of storage in the three projects assigned to each level and desired evacuation flow to be targeted at the control point, South Platte River at Denver stream gage, depending on storage level, percent of storage space filled, and time of year. This system procedure is also presented in the Water Control Manuals for Chatfield Dam and Reservoir and Bear Creek Dam and Reservoir.

Table 7-1 lists the storage and elevations based on the following surveys: Cherry Creek (2007), Chatfield (2010), and Bear Creek (2009).

Table 7-1
FLOOD REGULATION STORAGE LEVELS

	Level I			Level II		
	Elevation (feet)	Storage (AF)	Incr. Storage (AF)	Elevation (feet)	Storage (AF)	Incr. Storage (AF)
Cherry Creek	5550.0	12,600		5554.4	16,500	
	to 5554.4	16,500	3,900*	to 5598.0	91,900	75,400
Chatfield***	5444.0	47,700		5455.3	73,100	
	to 5455.3	73,100	25,400**	to 5500.0	233,100	160,000
Bear Creek	5558.0	1,800		5569.2	3,300	
	to 5569.2	3,300	1,500*	to 5635.5	30,300	27,000

* 5 percent of total flood pool
** Total Flood Control Storage (233,100 af) minus 47,700 af = 185,400 af; 185,400 af minus Standard Project Rainfall Flood (160,000 af) = 25,400 af
*** Flood Control pool in 1973 Chatfield Preliminary Reservoir Regulation Manual indicates the base of the flood control pool at elevation 5430.0 feet. The base of the flood control pool was changed to 5432.0 feet in March 1979. The base of the exclusive flood control pool was changed to 5444.0 feet in 2013 in response to the reallocation of flood control storage to joint-use flood control and water supply.
Note: Based on area/capacity surveys from 2007 for Cherry Creek, 2010 for Chatfield, and 2009 for Bear Creek.

Table 7-2
DESIRED CONTROLLED FLOW TARGET - DENVER STREAM GAGING STATION

April – July:

Any Reservoir at Level II - 5000 cfs
All Reservoirs at Level I, with one or more, more than 50% filled - 5000 cfs
All Reservoirs at Level I, and all less than 50% filled - 4000 cfs

August - March:

Any Reservoir at Level II - 5000 cfs
All Reservoirs at Level I, with one or more, more than 50% filled - 4000 cfs
All Reservoirs at Level I, and all less than 50% filled - 3000 cfs

Water will be released from the reservoir with the highest percent of storage in the highest level occupied until the storage balance or the percent of storage filled, for the same level, is the same in all reservoirs. Plate 7-4 displays the parallel reservoir balance for the three projects in percent of storage space filled for the two levels. When all three reservoirs have the same percentage of storage in the same level, equal balance has been achieved. For example, all reservoirs are in balance at 50% full in Level II at the following storage levels: Chatfield, 153,000 af; Cherry Creek, 54,000 af; Bear Creek, 16,800 af. Table 7-3 was developed to determine when this condition of equal balance has been achieved. Table 7-3 gives the parallel reservoir balance for the three projects in percent of storage space filled for the two levels based on the amount in the incremental storage column for each level as shown in Table 7-1. When all reservoirs have the same remaining balance of storage, the storage should be kept in balance or the percent of storage filled should be kept the same until all water is evacuated. Table 7-3 shows percent of storage depletion required out of each reservoir to enable continued parallel reservoir balance for all combinations of the three projects that may contain storage. For example, a total of 100 af of flood control storage occupied among the Tri-Lakes projects would reflect an equal balance for Level I - Balance Combination C when Bear Creek had no flood control storage, Chatfield had 87 af (87%) of storage, and Cherry Creek had 13 af (13%) of storage.

TABLE 7-3
UPPER SOUTH PLATTE RESERVOIR SYSTEM
PERCENTAGE OF STORAGE DEPLETION REQUIRED OUT OF EACH RESERVOIR TO ENABLE A CONTINUED PARALLEL RESERVOIR BALANCE
(Values are in percent)

LEVEL II (see Table 7-1 for Elevations)			
Balance Combination	Chatfield	Bear Creek	Cherry Creek
A	61	10	29
B	86	14	0
C	68	0	32
D	0	26	74
LEVEL I (see Table 7-1 for Elevations)			
Balance Combination	Chatfield	Bear Creek	Cherry Creek
A	82	5	13
B	94	6	0
C	87	0	13
D	0	28	72

Following is an example illustrating how an equal parallel reservoir balance is maintained during storage evacuation using Table 7-3. This example assumes (1) all three reservoirs are in an equal balanced condition as indicated by balance combination A of Level II of Table 7-3, (2) a control point flow of 5000 cfs is targeted at the Denver gage, and (3) there are no downstream channel constraints below the three projects. Values tabulated are average daily flows in cfs. After the total release on line 3 is determined, the estimated inflow into the three projects is totaled (line 4). The difference between this total (inflow) and line 3 (release needed from 3 projects) represents the total storage depletion from the 3 projects. Table 7-3 is then utilized to determine what percent of this storage is required out of each reservoir to enable a continued parallel reservoir balance. The difference between the estimated inflow and storage depletion for each project represents the required release from that project. The total release from the 3 projects represents the required total release needed to target the desired flow at the South Platte River at Denver stream gage, including an allowance for incremental flow. A release of 1 cfs over a 24 hour period is equivalent to 2 af of storage.

1. Desired flow at South Platte River at Denver Stream Gage							5,000
2. Incremental flow* between 3 projects and Denver Gage**							500
3. Total release needed from 3 projects							**4500**
		Chatfield		Bear Creek		Cherry Creek	Total
4. Estimated inflow**		1,100		0		100	1,200
5. Storage depletion***	(61%)	2,000	(10%)	300	(29%)	1,000	3,300
6. Required release		3,100		300		1,100	**4,500**

* Incremental flows are flows that enter the stream downstream of dam releases
** Values to be estimated
*** Values from Table 7-3

7-06. Recreation. The demand for water-based recreation near the large metropolitan city of Denver is substantial. The Cherry Creek Project satisfies part of the demand. The multi-purpose pool, elevation 5504 to 5550 feet, is operated for multiple purposes, which include recreation, flood control, and fish and wildlife. The lands at the three Tri-Lakes projects are not used for hunting due to the urban character of the area. In order to initially fill the multi-purpose pool, local interests agreed to allow storing of water for the pool, recognizing the eventual depletion effects of the multi-purpose pool.

The Corps will continue to maintain a closely coordinated planning effort with the State of Colorado, Department of Natural Resources, and Colorado State Parks. The Corps constructed recreational areas upstream from the dam that the State of Colorado leases, operates, and maintains for recreation use. Visitation to the Cherry Creek Project grew from 1,233,000 in 1976 to approximately 5,850,000 visits per year in FY01 through FY10.

7-07. Water Quality. Although the Corps does not have specific responsibilities

related to water quality at Cherry Creek Reservoir, all management activities will be executed to protect and enhance the quality of water resources. Refer to section 4-08 for water quality information.

The Cherry Creek Basin Water Quality Authority (CCBWQA) maintains an on-going program that involves water quality monitoring.

7-08. Fish and Wildlife. Fish and wildlife is an authorized project purpose at the Cherry Creek Project.

The basic premise of the flood control aspect of the water control plan is to release stored waters in the flood control zone of the reservoir as soon as possible following inflow from a flood event. This premise may be consistent with management of the fish and wildlife resources of the project as it reduces to a minimum the possible impacts to aquatic and terrestrial wildlife and its habitat.

Certain species of fish, such as the northern pike, require flooded grassy shoreline for successful spawning. This must also occur during a certain period in the early spring and lake levels must be slowly rising. For Cherry Creek Reservoir, such a scenario would be unlikely because the typical spring runoff occurs later in the year and would possibly cause a sudden, rather than a gradual, rise.

Cherry Creek Reservoir is mostly a warm-water fishery because it is a relatively shallow, plains reservoir. Normal operations and normal springtime floodwater inflows would have little effect on the fishery from a water temperature standpoint. Flood inflows could, however, have a very negative impact, at least temporarily, on the lake fishery if the inflows were high in suspended solids by making the water turbid. High turbidity has the effect of reducing light levels in the lower depths of the lake and of interfering with oxygen transfer (breathing) in the aquatic life forms in the lake. As temporary storage increases water residence time, suspended solids will tend to settle out. Settling of particulates may result in the surface waters becoming less turbid, but degradation of organic matter associated with settling particles may deplete oxygen in deeper waters while burial of bottom dwelling organisms may increase sediment oxygen demand.

The outlet works have only a single level for releases. Thus it is not possible to mix water from multiple levels to manage for a particular species of fish.

Cherry Creek Reservoir is not a primary waterfowl habitat area. It is not on a major migration flyway and it lacks the vegetation and cover necessary for it to be an important stopover point during spring or fall migration. Some local nesting of a few common waterfowl species likely occurs at the project. Larger numbers of Canada Geese use the reservoir as a roosting area in the fall and winter. Normal flood control

operations would not be expected to have any significant impacts on such waterfowl nesting.

The U.S. Fish and Wildlife Service (F&WS) has responsibility for oversight of the Endangered Species Act. The F&WS maintains that temporary storage of floodwaters in upstream reservoirs may have impacts on species that depend on the Platte River downstream for part of their life requisites. The federal agencies that are responsible for manipulations of the Platte River system upstream are said to have some responsibilities for protection of those downstream species. The problem is complex; the major elements to it follow:

a. Detention of upstream floodwaters in upstream reservoirs reduces the peak and the overall volume of the effects the flood would otherwise have on downstream areas. The Platte River in Nebraska, for instance, no longer is impacted by heavy and prolonged spring flooding that once periodically scoured the channel and kept trees from gaining a foothold. Where the channel was once wide, shallow, and relatively treeless, it is now narrower, deeper, and heavily tree-covered in many areas. Each upstream reservoir adds to the situation in a cumulative manner.

b. The main species of concern on the central Platte River in Nebraska are the whooping crane, least tern, pallid sturgeon, and piping plover. All of these species have been designated as federally threatened or endangered. Upstream impoundments and increased depletions from the Platte River have adversely influenced habitat for these downstream species because they have changed the timing and volume of flows. These adverse impacts have accumulated over the past 40 years or more, and continue to influence the flood plain environment.

7-09. Water Supply. There is no water supply storage at the project at the present time.

7-10. Hydroelectric Power. None at this project.

7-11. Navigation. None at this project.

7-12. Drought Contingency Plans. No plan has been developed at this time. Guidance concerning the development of drought contingency plans is being reviewed and updated. A drought contingency plan for Cherry Creek Dam and Reservoir will be coordinated with stakeholders following the approval of the updated guidance.

7-13. Flood Emergency Action Plans. A procedure has been developed to determine project operations under emergency conditions so that the Tri-Lakes Project Office staff has appropriate information and instructions for modifying their existing regulation orders. This procedure is given under the Emergency Regulation part of the Standing Instructions to the Dam Tender (See Exhibit I). The procedure is defined to

begin with a failure of communications between the Tri-Lakes Project Office and the Omaha District Water Control and Water Quality Section personnel at a time when the reservoir is rising rapidly, high inflows are indicated, excessive rainfall has occurred, flooding below the dam is occurring or appears imminent, or when a combination of any of these is occurring. During such emergencies, regulation of project releases will be made by the Tri-Lakes Project Office in accordance with the release schedule given in Exhibit I. Continuing effort will be made to re-establish communications. The dam will be attended at all times during an emergency.

7-14. Deviation from Normal Regulation. Deviations from the release schedule will be made if conditions at the time are such that improved reservoir regulation will result. For example: (1) releases according to the schedule should not exceed downstream channel capacity unless the safety of the dam is in question; or (2) temporary delays of a few days duration in evacuation of flood storage will be considered to mitigate damages and/or for special circumstances downstream. Deviations require prior approval from the Northwestern Division Commander except as noted in section 7-14-a. Requests to deviate from normal regulation of the project fall into one of the categories described below.

a. Emergencies. Deviations from the release schedule will be made if emergency conditions exist upstream or downstream of the dam. Examples of these types of emergencies include dam safety emergencies, downstream chemical spills, drownings, and facility failures. During an emergency activity, the Omaha District will inform the MRBWM office of such activities as soon as possible. Written confirmation of the deviation, including a description of the cause of the emergency, will be furnished as soon as practicable to the MRBWM office as shown in NWDR 1110-2-6.

b. Unplanned Minor Deviations. Temporary delays of a few days duration in evacuation of flood storage will be considered to mitigate damages and/or for special circumstances downstream. A typical example of activities that would create the potential for unplanned minor deviations would be modifications of bridge and utility crossings. In evaluating requests for these types of deviations, the Omaha District will consider upstream watershed conditions, potential flood threats, the amount of water in storage in Cherry Creek Reservoir, and whether any alternative measures could be taken that would not require a deviation. Written request of the deviation and a description of the cause will be furnished to the MRBWM office as shown in NWDR 1110-2-6.

c. Planned Deviations. Deviations from the release schedule will be made if conditions at the time are such that improved reservoir regulation will result. All conditions such as data on flood potential, lake and watershed conditions, possible alternative measures, benefits to be expected, and probable effects on other authorized and useful purposes will be analyzed. Planned deviations will be coordinated with all appropriate entities, including locals and state offices, and a written request will be

furnished to the MRBWM office as shown in NWD 1110-2-6.

7-15. Rate of Release Change. Normally, increases in releases should not exceed 500 cfs per day. Release reduction rates should consider downstream impacts. Preferably, releases should be reduced at a similar rate of 500 cfs per day. However, if a higher rate of change is necessary to accommodate operational circumstances, releases may be increased or reduced at an accelerated rate. The release may even be reduced to zero flow in a single gate change if required. Examples of downstream impacts include environmental, water quality, and bank failure.

Consideration should be given to limit reservoir drawdown to less than 2 feet per day if embankment stability is in question. This drawdown guidance should only be used if practical and reasonable to do so.

Appendix B-3
Bear Creek Water Control Plan

7-01. General Objectives. Engineering Regulation 1110-2-1400, dated 24 April 1970, assigns Corps of Engineers (Corps) reservoir regulation responsibilities in the Missouri River basin to the Missouri River Division Engineer, now the Northwestern Division Missouri River Basin Water Management (MRBWM) office. This engineering regulation permits delegation of certain reservoir regulation responsibilities to the District Engineer, in whose area the project is located. The responsibilities for assembly and interpretation of data affecting current reservoir regulation and for carrying out routine regulation of Bear Creek Reservoir, according to plans agreed on in advance, have been delegated to the Omaha District Engineer. The Division Engineer, through the MRBWM office, monitors and reviews the regulation activities performed by the Omaha District. Plate 9-1 shows the organizational chart for the Omaha District in regards to Bear Creek Reservoir regulation. Exhibit II, a contract between the United States of America and the State of Colorado dated March 1988, describes the operation of Bear Creek for different pool elevations and reservoir zones.

Bear Creek Dam will be regulated for flood control primarily to prevent damage to the metropolitan area of Denver from floods originating on Bear Creek upstream of the dam and will also be regulated to provide for general recreation and fish and wildlife recreation purposes. Project regulation for these purposes is described in the following sections.

7-02. Constraints. The control point for Bear Creek Dam regulation is 5,000 cfs at the South Platte River at Denver stream gage. It is important to note that the 5,000 cfs flow includes Cherry Creek and Chatfield Dam releases as well as incremental runoff downstream of each of the dams. Flood control operation is described in detail in section 7-05. Channel capacity varies widely downstream of the dam. Downstream channel concerns, gate vibration, manpower to make gate changes, and travel time for releases to impact downstream areas are items that may constrain operations.

Normally, increases in releases should not exceed 200 to 300 cfs per day. Release reduction rates should consider downstream impacts. Preferably, releases should be reduced at a similar rate of 200 to 300 cfs per day. However, if a higher rate of change is necessary to accommodate operational circumstances, releases may be increased or reduced at an accelerated rate. The release may even be reduced to zero flow in a single gate change if required. Examples of downstream impacts include environmental, water quality, and bank failure. There should be communication with stakeholders if these rates of change will be exceeded.

7-03. Overall Plan for Water Control. The normal regulation of Bear Creek Reservoir involves responsibilities of the State of Colorado and of the Corps. Refer to Exhibit II for more information.

Normal operations at Bear Creek Reservoir specify that outflows equal inflows. Since the top of the multi-purpose pool is also the crest of the ungated weir, no specific

regulation of the water levels is anticipated when the pool elevation is above the elevation of the weir. Regulation for conservation will normally be automatic in that incoming water will flow via gravity over the weir crest. However, when the pool elevation is below the elevation of the weir, low level releases may need to be made for water rights administration. Two low level gated outlets are provided to permit releases of water from the multi-purpose pool for reservoir drawdown if the need arises. Fine regulation of low flow releases will be completed by a gate-within-a-gate (1-foot square opening) on each of the two service gates in the gate structure.

a. State of Colorado Responsibilities - As requested by the State of Colorado, releases below the top of the multipurpose pool (elevation 5558.0 feet, msl) will be made to supply irrigation and/or water supply diversions and normal river flows insofar as water is available. When the reservoir is at or below elevation 5558.0 feet, msl, releases will be made as directed by the Colorado State Engineer to satisfy all downstream water rights. To satisfy these rights the State has specified that, insofar as practical, the reservoir must be regulated so that reservoir inflow equals outflow except during periods of flood operations. The State Engineer will issue release changes directly to the Tri-Lakes Project Office when the pool elevation is below the top of the multipurpose pool (5558 feet). Exhibit II, a contract between the United States of America and the State of Colorado, describes the operation of Bear Creek for different pool elevations and reservoir zones.

b. Corps of Engineers Responsibilities - The operation of Bear Creek Reservoir involves two units of the Corps Omaha District as described in sections 7-03-b-1 and 7-03-b-2 below. Plate 9-1 shows the organizational chart for the Omaha District in regards to Bear Creek Reservoir regulation. Additional responsibilities of the Corps are also outlined below.

(1) Water Control and Water Quality Section, Engineering Division. The Omaha District, Water Control and Water Quality Section is responsible for matters pertaining to the regulation of the reservoir. This office prepares the official forecasts for the Corps. Throughout the year the Water Control and Water Quality Section monitors reservoir releases made from the conservation pool by the State Engineer. When the pool level is in or forecasted by this office to enter the exclusive flood control pool, this office is responsible for scheduling reservoir releases to attain optimum flood control benefits and control of project storage to assure regulation in conformance with the authorized functions of the project. The Water Control and Water Quality Section is responsible for procurement of necessary snow pack, precipitation, streamflow, and reservoir elevation data, while also making advanced estimates of streamflow from snow cover and/or rainfall reports for regulation purposes and to alert field operating personnel of potential flood occurrences. The Water Control and Water Quality Section prepares the monthly reservoir report (MRD Form 0168) for Bear Creek Reservoir, which contains the official daily elevation, inflow, and outflow, see Plate 9-2. Issuance

of reservoir regulation orders as outlined in section 7-03-b-4 is also performed by the Water Control and Water Quality Section.

(2) Tri-Lakes Project Office, Operations Division. The Operations Division plans and directs the maintenance and physical operation of the project. This Division establishes the standards of maintenance and provides proper staffing of operating personnel at the Tri-Lakes Project Office to accomplish these objectives. The Tri-Lakes Project Office staff performs all gate changes at Bear Creek Dam. This office has agreed to initiate email or telephone correspondence for reservoir releases in excess of 500 cfs with the Urban Drainage and Flood Control District, a local agency that coordinates releases with local county emergency managers.

(3) Flood Period Organization. The normal organization of the Omaha District is somewhat modified during a flood period to take care of the additional duties made necessary by the flood emergency. These duties are to: 1) operate the flood control reservoirs for maximum protection; 2) collect and disseminate flood information; 3) protect Corps of Engineers' property and works; 4) obtain engineering data; and 5) in extreme emergency, assist in relief and rescue work. These activities take precedence over normal work and are performed by those employees of the District who have been trained for specific emergency duties. In case of purely local flooding in a reservoir controlled basin, such as Bear Creek or Chatfield, only those units of the District Organization concerned with the normal operation of the reservoir are placed in an emergency status. A directory of regulation personnel is shown in the Standing Instructions to the Dam Tender, Exhibit I.

(4) Regulation Orders. When it is the responsibility of their respective offices as indicated in section 7-03-a and -b, the State Engineer and the Omaha District Water Control and Water Quality Section will issue regulation orders directly to the Tri-Lakes Project Office. All requests for regulation of project releases, other than regulation responsibilities of the State Engineer, will be referred to the Water Control and Water Quality Section for approval and issuance of orders. All regulation orders will normally be issued verbally and then confirmed in writing as official signed orders as soon as possible. An official reservoir regulation order will be issued in writing by the Water Control and Water Quality Section for all gate changes made at Bear Creek Dam, those initiated by the State Engineer and otherwise. Tri-Lakes Project Office personnel will record the gate setting for each gate change in the pool report spreadsheet, which can be accessed by the Water Control Manager to complete the written order. A copy of all orders issued by the Water Control and Water Quality Section will be furnished to the State Engineer and the Tri-Lakes Project Office. Under normal circumstances, this copy will contain a brief statement giving the background and reasons for issuance of the order. In the case of a dam safety issue or major flood control release, the signed reservoir regulation order should contain sufficient details to describe the reasoning of the reservoir regulation decision. In the case of a deviation from the water control plan, the reservoir regulation order should note that a signed deviation approval from the

MRBWM office has been acquired.

(5) Emergency Organization. It is not anticipated that any emergency organization other than described in section 7-03-b-3 will be required. However, under the provisions of the Standing Instructions to the Dam Tender, reference section 7-04, communication failure during a flood event may result and isolate the dam tender, thus making that person the sole project operating organization.

(6) Coordination with Other Agencies. Daily project operating data and miscellaneous hydrologic information will be exchanged between the Project Office, the State Engineer and the Water Control and Water Quality Section. Cooperation is also maintained with the U.S. Geological Survey and Colorado Division of Water Resources relative to the collection and reporting of precipitation amounts, stream stages, and discharge. The Natural Resources Conservation Service provides snow pack and runoff forecasts, and the National Weather Service provides precipitation and stream gage forecasts.

(7) Communication. Telephone and email facilities are presently available for communication between the Project Office, State Engineer, and Water Control and Water Quality Section. In event of loss of these means of communication, the dam tender may communicate via vehicular travel between the respective offices noted above and/or via cellular phone.

7-04. Standing Instructions to Dam Tender. Exhibit I contains the Standing Instructions to Dam Tender. The Standing Instructions to the Dam Tender provides detailed instructions for regulation of project releases and storage under emergency conditions, such as communication failure. This failure may result and isolate the dam tender, thus making that person the sole project operating organization. Regulation orders issued verbally will be confirmed in writing as official signed orders as soon as possible.

7-05. Flood Control. Bear Creek Dam and Reservoir will be regulated for flood control to mitigate risk to the metropolitan area of Denver from floods originating on Bear Creek upstream of the project location. Operation of the Bear Creek Project will require both individual and system reservoir regulation.

a. Operation of Bear Creek Reservoir as an Individual Project. In general, the developed method of flood control regulation of Bear Creek Reservoir may be classified as Method C, defined in EM 1110-2-3600. This represents a combination of the concept of reducing downstream damaging stages as much as possible during each flood with the currently available storage space, with consideration of control of floods of project design magnitude. Evacuation of flood control storage from Bear Creek Reservoir as an individual project will only occur when no flood storage is occupied in Cherry Creek or Chatfield Reservoirs.

During flood or apparent flood situations, Bear Creek releases will be reduced to as low as zero in an effort to reduce downstream flooding or essential downstream water right requirements as determined by the State. The standard project rainfall flood design routing assumed no release for two days. The 300-year, 60-day inflow volume design routing assumed releases as given by the reservoir release schedule in Table 7-1. However, due to short peaking times, this may not be possible in all instances. Following cessation of downstream flooding and stabilization of stream flows, releases will be made in accordance with the release schedule outlined in Table 7-1.

Table 7-1
BEAR CREEK RESERVOIR RELEASE SCHEDULE

Reservoir Elevation Feet, msl		Release Rate (cfs)
From	To	
5558.0	5611.5	Streamflow up to 500
5611.5	5625.0	1000
5625.0	5635.5	1500
5635.5	5667.0	2000

Deviations from the release schedule will be made if conditions at the time are such that improved reservoir regulation will result. For example, 1) releases according to the schedule should not exceed downstream channel capacity unless the safety of the dam is in question and 2) temporary delays of a few days duration in evacuation of flood storage will be considered so the water can be utilized by downstream users.

Evacuation of flood storage should be made as soon as practical after the flood event. Releases should be made at the highest practical rate to permit rapid drawdown of the flood pool for control of subsequent flood events. In view of the severe shortage of water for irrigation along the South Platte River, it is also in the best interest of the government, when practical, to release stored flood waters at a rate beneficial to irrigation interests if such release rates will not unduly interfere with the primary flood control function of the project.

In determination of the spillway design routing, no water was released through the gated outlet works. However, in event of actual surcharge and spillway operation, release of water through the gated outlet must be considered. The release schedule specifies a release of 2000 cfs in the portion of the surcharge zone between the top of the flood zone (elevation 5535.5 feet, msl) and the spillway crest (elevation 5567.0 feet, msl). The gated outlets should also be utilized to provide a gradual transition of project

releases from gated surcharge operation (pool level just below spillway crest) and spillway surcharge operation (pool level above spillway crest).

b. System Operating Plan for Flood Control Evacuation. System or coordinated regulation of Cherry Creek, Chatfield, and Bear Creek Reservoirs will be necessary only after flood flows have entered the reservoirs and during flood storage evacuation. When water has accumulated in the flood control storage zone of these projects, an equal protective balance of flood control storage kept vacant should be maintained during pool evacuation. This balance is based on establishing an equal risk in each project of filling the remaining flood control space from a similar subsequent flood. The storage remaining should provide equal protection at each project against runoff from rainfall of standard project flood magnitude. Flood storage evacuation will continue at Bear Creek Dam until the pool elevation falls to 5558 feet, at which time coordination will resume with the State Engineer.

Two storage levels are established in each project. Generally, the upper Level II of storage space approximates the volume of the rainfall standard project flood. In Chatfield, Level II amounts to 160,000 acre-feet (af), the volume of the rainfall standard project flood. As the entire flood control space in both Cherry Creek and Bear Creek Reservoirs was designed mainly for protection from the sudden occurrence of a rainfall standard project flood and not from the longer duration mountain snowmelt flood, 95 percent of this space was assigned to Level II. The remaining five percent of flood storage in Cherry Creek and Bear Creek Reservoirs is allotted a lower evacuation rate at the downstream control point, the South Platte River at Denver stream gage. This space was assigned to Level I to provide for a transition from flood releases to conservation releases and to lessen unnecessary slugging of high releases for small encroachments of the flood pools. The lower evacuation rate of this five percent of storage will not significantly affect the project flood control function. However, since individual design criteria for both the Chatfield and Cherry Creek Projects were based on releasing 5,000 cfs out of each project and not a target of 5,000 cfs at the South Platte River at Denver stream gage, which includes incremental runoff and releases from Chatfield, Cherry Creek, and Bear Creek following the flood peak, strict adherence to these evacuation criteria should be followed. Tables 7-2 and 7-3 present a tabulation of storage in the three projects assigned to each level and desired evacuation flow to be targeted at the control point, South Platte River at Denver stream gage, depending on storage level, percent of storage space filled, and time of year. This system procedure is also presented in the Water Control Manuals for Cherry Creek Dam and Reservoir and Chatfield Dam and Reservoir.

Table 7-2 lists the storage and elevations based on the following surveys: Cherry Creek (2007), Chatfield (2010), and Bear Creek (2009).

Table 7-2
FLOOD REGULATION STORAGE LEVELS

	Level I			Level II		
	Elevation (feet)	Storage (AF)	Incr. Storage (AF)	Elevation (feet)	Storage (AF)	Incr. Storage (AF)
Cherry Creek	5550.0	12,600		5554.4	16,500	
	to 5554.4	16,500	3,900*	to 5598.0	91,900	75,400
Chatfield***	5444.0	47,700		5455.3	73,100	
	to 5455.3	73,100	25,400**	to 5500.0	233,100	160,000
Bear Creek	5558.0	1,800		5569.2	3,300	
	to 5569.2	3,300	1,500*	to 5635.5	30,300	27,000

* 5 percent of total flood pool
** Total Flood Control Storage (233,100 af) minus 47,700 af = 185,400 af; 185,400 af minus Standard Project Rainfall Flood (160,000 af) = 25,400 af

*** Flood Control pool in 1973 Chatfield Preliminary Reservoir Regulation Manual indicates the base of the flood control pool at elevation 5430.0 feet. The base of the flood control pool was changed to 5432.0 feet in March 1979. The base of the exclusive flood control pool was changed to 5444.0 feet in 2013 in response to the reallocation of flood control storage to joint-use flood control and water supply.

Note: Based on area/capacity surveys from 2007 for Cherry Creek, 2010 for Chatfield, and 2009 for Bear Creek.

Table 7-3
DESIRED CONTROLLED FLOW TARGET - DENVER STREAM GAGING STATION

April – July:

Any Reservoir at Level II - 5000 cfs
All Reservoirs at Level I, with one or more, more than 50% filled - 5000 cfs
All Reservoirs at Level I, and all less than 50% filled - 4000 cfs

August - March:

Any Reservoir at Level II - 5000 cfs
All Reservoirs at Level I, with one or more, more than 50% filled - 4000 cfs
All Reservoirs at Level I, and all less than 50% filled - 3000 cfs

Water will be released from the reservoir with the highest percent of storage in the highest level occupied until the storage balance or the percent of storage filled, for the same level, is the same in all reservoirs. Plate 7-4 displays the parallel reservoir balance for the three projects in percent of storage space filled for the two levels. When all three reservoirs have the same percentage of storage in the same level, equal balance has been achieved. For example, all reservoirs are in balance at 50% full in

Level II at the following storage levels: Chatfield, 153,000 af; Cherry Creek, 54,000 af; Bear Creek, 16,800 af. Table 7-4 was developed to determine when this condition of equal balance has been achieved. Table 7-4 gives the parallel reservoir balance for the three projects in percent of storage space filled for the two levels based on the amount in the incremental storage column for each level as shown in Table 7-2. When all reservoirs have the same remaining balance of storage, the storage should be kept in balance or the percent of storage filled should be kept the same until all water is evacuated. Table 7-4 shows percent of storage depletion required out of each reservoir to enable continued parallel reservoir balance for all combinations of the three projects that may contain storage. For example, a total of 100 af of flood control storage occupied among the Tri-Lakes projects would reflect an equal balance for Level I - Balance Combination C when Bear Creek had no flood control storage, Chatfield had 87 af (87%) of storage, and Cherry Creek had 13 af (13%) of storage.

TABLE 7-4
UPPER SOUTH PLATTE RESERVOIR SYSTEM
PERCENTAGE OF STORAGE DEPLETION REQUIRED OUT OF EACH RESERVOIR TO ENABLE A CONTINUED PARALLEL RESERVOIR BALANCE
(Values are in percent)

LEVEL II (see Table 7-2 for Elevations)			
Balance Combination	Chatfield	Bear Creek	Cherry Creek
A	61	10	29
B	86	14	0
C	68	0	32
D	0	26	74
LEVEL I (see Table 7-2 for Elevations)			
Balance Combination	Chatfield	Bear Creek	Cherry Creek
A	82	5	13
B	94	6	0
C	87	0	13
D	0	28	72

Following is an example illustrating how an equal parallel reservoir balance is maintained during storage evacuation using Table 7-4. This example assumes (1) all three reservoirs are in an equal balanced condition as indicated by balance combination A of Level II of Table 7-4, (2) a control point flow of 5000 cfs is targeted at the Denver gage, and (3) there are no downstream channel constraints below the three projects. Values tabulated are average daily flows in cfs. After the total release on line 3 is determined, the estimated inflow into the three projects is totaled (line 4). The difference between this total (inflow) and line 3 (release needed from 3 projects) represents the total storage depletion from the 3 projects. Table 7-4 is then utilized to determine what percent of this storage is required out of each reservoir to enable a continued parallel reservoir balance. The difference between the estimated inflow and storage depletion for each project represents the required release from that project. The total release from the 3 projects represents the required total release needed to target the desired flow at the South Platte River at Denver stream gage, including an allowance for incremental flow. A release of 1 cfs over a 24 hour period is equivalent to 2 af of storage.

1. Desired flow at South Platte River at Denver Stream Gage							5,000
2. Incremental flow* between 3 projects and Denver Gage**							500
3. Total release needed from 3 projects							**4500**
		Chatfield		Bear Creek		Cherry Creek	Total
4. Estimated inflow**		1,100		0		100	1,200
5. Storage depletion***	(61%)	2,000	(10%)	300	(29%)	1,000	3,300
6. Required release		3,100		300		1,100	**4,500**

* Incremental flows are flows that enter the stream downstream of dam releases
** Values to be estimated
*** Values from Table 7-4

7-06. Recreation. The demand for water-based recreation near the large metropolitan city of Denver is substantial. The Bear Creek Project satisfies part of the demand. The multi-purpose pool, elevation 5528 to 5558 feet, is operated for multiple purposes, which include recreation, flood control, and fish and wildlife. The majority of water surface recreation areas in the Bear Creek Reservoir zone of influence are either too small to accommodate boating activity or are used as water supply reservoirs in which body contact recreation and boating activities are prohibited. Bear Creek Reservoir is large enough for boating and provides an excellent fishery. The lands at the three Tri-Lakes projects are not used for hunting due to the urban character of the area. In order to initially fill the multi-purpose pool, local interests agreed to allow storing of water for the pool, recognizing the eventual depletion effects of the multi-purpose pool. Exhibit III is a copy of the letter from the State Division of Game, Fish, and Parks indicating the State's obligation to furnish water for recreation in the Bear Creek multi-purpose pool. The State must provide sufficient water to fill the reservoir to the multi-purpose pool elevation of 5558.0 feet, msl and to replace annual evaporation losses.

The Corps will continue to maintain a closely coordinated planning effort with the State of Colorado, Department of Natural Resources, and Colorado State Parks. The Corps constructed recreational areas upstream from the dam that the State of Colorado leases, operates, and maintains for recreation use. Visitation to the Bear Creek Project grew from 30,800 in 1982 to approximately 1,495,000 visits per year in FY01 through FY10.

7-07. Water Quality. When Bear Creek Reservoir is in the flood control zone water quality is not a factor in the function of this project (reference Bear Creek Design Memorandum No. PB-9 Outlet Works, paragraph 4.3.2.5). Also, refer to section 4-08 for water quality information.

The Bear Creek Watershed Association maintains an on-going program that involves water quality monitoring and management of some upstream activities such as sewage treatment.

7-08. Fish and Wildlife. Fish and wildlife is an authorized project purpose at the Bear Creek Project.

Normal operations at Bear Creek Lake specify that outflows equal inflows. The basic premise of the flood control aspect of the water control plan is to release stored waters in the flood control zone of the reservoir as soon as possible following inflow from a flood event. This is consistent with optimum management of the fish and wildlife resources of the project as it reduces to a minimum the possible impacts to terrestrial wildlife and its habitat.

Bear Creek Reservoir is a cold water fishery because it is located near the Hogback Ridge of the Rocky Mountains and is fed by two mountain streams. The outlet works have only a single level for releases. Thus, it is not possible to mix water from multiple levels to manage for a particular species of fish. Normal operations and normal springtime flood water inflows have little effect on the fishery from a water temperature standpoint. Flood inflows could, however, have a negative impact, at least temporarily, on the lake fishery and even on the creeks at the upstream limits of the lake if the inflows were high in suspended solids, thus making the water turbid. High turbidity has the effect of reducing light levels in the lower depths of the lake and of interfering with oxygen transfer (breathing) in the aquatic life forms in the lake. As temporary storage increases water residence time, suspended solids will tend to settle out. Settling of particulates may result in the surface waters becoming less turbid, but degradation of organic matter associated with settling particles may deplete oxygen in deeper waters while burial of bottom dwelling organisms may increase sediment oxygen demand.

Bear Creek Reservoir is not a primary waterfowl habitat area. It is not on a major migration flyway and it lacks the vegetation and cover necessary for it to be an important stopover point during spring or fall migration. Some local nesting of a few

common waterfowl species likely occurs at the project. Larger numbers of Canada Geese use the reservoir as a roosting area in the fall and winter. Normal flood control operations would not be expected to have any significant impacts on such waterfowl nesting.

The U.S. Fish and Wildlife Service (F&WS) has responsibility for oversight of the Endangered Species Act. The F&WS maintains that temporary storage of floodwaters in upstream reservoirs may have impacts on species that depend on the Platte River downstream for part of their life requisites. The federal agencies that are responsible for manipulations of the Platte River system upstream are said to have some responsibilities for protection of those downstream species. The problem is complex; the major elements to it follow:

a. Detention of upstream floodwaters in upstream reservoirs reduces the peak and the overall volume of the effects the flood would otherwise have on downstream areas. The Platte River in Nebraska, for instance, no longer is impacted by heavy and prolonged spring flooding that once periodically scoured the channel and kept trees from gaining a foothold. Where the channel was once wide, shallow, and relatively treeless, it is now narrower, deeper, and heavily tree-covered in many areas. Each upstream reservoir adds to the situation in a cumulative manner.

b. The main species of concern on the central Platte River in Nebraska are the whooping crane, least tern, pallid sturgeon, and piping plover. All of these species have been designated as federally threatened or endangered. Upstream impoundments and increased depletions from the Platte River have adversely influenced habitat for these downstream species because they have changed the timing and volume of flows. These adverse impacts have accumulated over the past 40 years or more, and continue to influence the flood plain environment.

7-09. Water Supply. The semiarid climate east of the Rocky Mountains, with its low annual precipitation and the rapid growth in population, has made water a jealously guarded element of life in Colorado. The continued growth of the need for water for domestic, irrigation, and industrial uses will tend to assure the further development of water supplies for use in the South Platte River basin. The strategic location of the Tri-Lakes Project reservoirs near the city of Denver and their capacity make them an important factor for inclusion in any water program. Irrigation and water rights play an important part in use and regulation of flows of streams within the State of Colorado. Water rights are jealously guarded and the State of Colorado has requested regulation of the Cherry Creek, Bear Creek, and Chatfield Projects to protect these interests.

Bear Creek provides a valuable source of water supply for the South Platte River basin. It is estimated that 11 percent of the average annual runoff at the Denver gaging station on the South Platte River is from Bear Creek. Bear Creek's contribution would be more except that much of its water is utilized within the basin. As is typical of the South Platte

River basin, water resources of the Bear Creek basin are over appropriated. Stream runoff appropriations are administered by the Colorado State Engineer under a priority system of water rights. Under this system, appropriations with senior water rights have prior claim to stream flows, and junior water rights are satisfied only when stream flow is sufficient to first fulfill priority rights. The aggregate of existing water rights on the water resources of the Bear Creek basin exceeds the normal range of runoff experience.

Since construction of Bear Creek Dam, the Omaha District entered into two temporary one-year storage contracts for municipal and industrial water supply under Section 6 of the Flood Control Act of 1944 (Public Law 34, 78th Congress), pending development of a long-term contract under the Water Supply Act of 1958 as amended (43 U.S.C. 390 b-f). The first contract dated September 17, 1987 was for 25 af with the Indian Hills Water District. This contract has been renewed each year.

Most of the water rights diversions from Bear Creek were originally intended for agricultural purposes and the decrees were for irrigation or agricultural uses. With urbanization in the basin, there has been a gradual change from agricultural to other uses, such as domestic, industrial, and irrigation of golf course areas and lawns. Table 7-5 lists the average monthly stream flow loss or gain and the maximum monthly loss between the Morrison and Sheridan stream gaging stations.

Table 7-5
BEAR CREEK AVERAGE MONTHLY WATER DEPLETION IN CFS
Between Morrison and Sheridan Stream Gaging Stations
(1928 - 1974 Period)

Month	Gain or Loss	Maximum Loss - Year	
January	+ 6.5	- 4	1945
February	+ 5.2	- 20	1936
March	+ 0.6	- 16	1936
April	+ 2.3	- 25	1938
May	+12.1	- 133	1936
June	- 38.0	- 130	1936
July	- 47.4	- 127	1949
August	- 37.4	- 104	1930
September	- 29.7	- 115	1938
October	- 7.9	- 84	1939
November	0	- 13	1960
December	+ 5.0	- 6	1949

Five major ditches operate on Bear Creek between Morrison and Sheridan. Most of this water is diverted to storage facilities for municipal or agricultural use. These ditches and the approximate appropriation for each are listed in Table 7-6.

Table 7-6
Bear Creek Basin Ditches

DITCH	WATER RIGHT APPROPRIATION	LOCATION
Harriman	25 cfs	downstream edge of Morrison
Ward	5 cfs	Bear Creek Reservoir Tail Race
Hodson	2 cfs	south side of Kipling Street
Pioneer Union	2.5 cfs	Bear Creek Reservoir Tail Race
McBroom	1 cfs	1/8 mile upstream of Sheridan gage

7-10. Hydroelectric Power. None at this project.

7-11. Navigation. None at this project.

7-12. Drought Contingency Plans. No plan has been developed at this time. Guidance concerning the development of drought contingency plans is being reviewed and updated. A drought contingency plan for Bear Creek Dam and Reservoir will be coordinated with stakeholders following the approval of the updated guidance.

7-13. Flood Emergency Action Plans. A procedure has been developed to determine project operations under emergency conditions so that the Tri-Lakes Project Office staff has appropriate information and instructions for modifying their existing regulation orders. This procedure is given under the Emergency Regulation part of the Standing Instructions to the Dam Tender (See Exhibit I). The procedure is defined to begin with a failure of communications between the Tri-Lakes Project Office and the Omaha District Water Control and Water Quality Section personnel at a time when the reservoir is rising rapidly, high inflows are indicated, excessive rainfall has occurred, flooding below the dam is occurring or appears imminent, or when a combination of any of these is occurring. During such emergencies, regulation of project releases will be made by the Tri-Lakes Project Office in accordance with the release schedule given in Exhibit I. Continuing effort will be made to re-establish communications. The dam will be attended at all times during an emergency.

7-14. Deviation from Normal Regulation. Deviations from the release schedule will be made if conditions at the time are such that improved reservoir regulation will result. For example: (1) releases according to the schedule should not exceed downstream channel capacity unless the safety of the dam is in question; or (2) temporary delays of

a few days duration in evacuation of flood storage will be considered to mitigate damages and/or for special circumstances downstream. Deviations require prior approval from the Northwestern Division Commander except as noted in section 7-14-a. Requests to deviate from normal regulation of the project fall into one of the categories described below.

a. Emergencies. Deviations from the release schedule will be made if emergency conditions exist upstream or downstream of the dam. Examples of these types of emergencies include dam safety emergencies, downstream chemical spills, drownings, and facility failures. During an emergency activity, the Omaha District will inform the MRBWM office of its activities as soon as possible. Written confirmation of the deviation, including a description of the cause of the emergency, will be furnished as soon as practicable to the MRBWM office as shown in NWDR 1110-2-6.

b. Unplanned Minor Deviations. Temporary delays of a few days duration in evacuation of flood storage will be considered to mitigate damages and/or for special circumstances downstream. A typical example of activities that would create the potential for unplanned minor deviations would be modifications of bridge and utility crossings. In evaluating requests for these types of deviations, the Omaha District will consider upstream watershed conditions, potential flood threats, the amount of water in storage in Bear Creek Reservoir, and whether any alternative measures could be taken that would not require a deviation. Written request of the deviation and a description of the cause will be furnished to the MRBWM office as shown in NWDR 1110-2-6.

c. Planned Deviations. Deviations from the release schedule will be made if conditions at the time are such that improved reservoir regulation will result. All conditions such as data on flood potential, lake and watershed conditions, possible alternative measures, benefits to be expected, and probable effects on other authorized and useful purposes will be analyzed. Planned deviations will be coordinated with all appropriate entities, including locals and state offices, and a written request will be furnished to the MRBWM office as shown in NWD 1110-2-6.

7-15. Rate of Release Change. Bear Creek does not have any constraints (see release schedule in Section 7-05). However, based on past experience, increases in releases should be limited based on unforeseen downstream conditions, approximately 200 cfs to 300 cfs per day. Preferably, releases should be reduced at a similar rate. However, if a higher rate of change is necessary to accommodate operational circumstances, releases may be increased or reduced at an accelerated rate. The release may even be reduced to zero flow in a single gate change if required. Examples of downstream impacts include environmental, water quality, and bank failure.

When the reservoir is above elevation 5638.5 feet, msl consideration should be given to limiting reservoir decline to less than 2 feet per day, if possible, due to the steep

embankment along the dam face. Below the 5638.5 feet, msl elevation, rate of decline is not as critical due to the flatter slopes on the embankment. This drawdown guidance should only be used if practical and reasonable to do so.