
Appendix GG
Adaptive Management Plan

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the environment*

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CHATFIELD REALLOCATION PROJECT ADAPTIVE MANAGEMENT PLAN

Prepared for—

U.S. Army Corps of Engineers,
Omaha District
1616 Capitol Avenue
Omaha, Nebraska 68102

Prepared by—

ERO Resources Corporation
1842 Clarkson Street
Denver, Colorado 80218
(303) 830-1188

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ERO Resources Corp.
1842 Clarkson Street
Denver, CO 80218
(303) 830-1188
Fax: (303) 830-1199
www.eroresources.com
ero@eroresources.com

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Introduction

This adaptive management plan (AMP) provides a framework for how uncertainties regarding impacts and/or mitigation will be addressed for a variety of resources that may be affected by the Selected Plan (Alternative 3) for the proposed Chatfield Reallocation Project (project). Adaptive management was addressed in several sections of the draft Feasibility Report/Environmental Impact Statement (FR/EIS) and its Appendix K (Compensatory Mitigation Plan (CMP)). Comments on the draft FR/EIS requested that the final FR/EIS provide information on adaptive management in a more consolidated fashion and provide more information on how adaptive management will be used.

This AMP consolidates and adds to information previously provided in the draft FR/EIS. For the purposes of this AMP, “adaptive management” refers to actions taken as part of the project to:

- Reduce and/or address uncertainties associated with impact estimates and proposed mitigation;
- Provide contingent plans if needed for proposed mitigation and management;
- Serve as part of the feedback loop between mitigation monitoring and mitigation actions that will lead to appropriate adjustment; and
- Provide new and enhanced applications by learning through management and information from all sources as they become available.

The AMP addresses the following resources and management actions:

- Target environmental resources (Preble’s meadow jumping mouse (Preble’s), bird habitat, and wetlands);
- Tree clearing within the fluctuation zone;
- Weed control within the fluctuation zone;
- Water quality;
- Operations; and
- Fisheries and downstream aquatic habitat.

These resources and management actions have uncertainties, will be monitored, and are likely to require adjustments to their proposed management plans and actions. The impacts and mitigation associated with other resources (vegetation, wildlife,

socioeconomics, and recreation) are unlikely to require iterative adjustments informed by monitoring, as is the case for the resources and management actions addressed by the AMP.

Framework

The following components for the AMP provide a framework that can be built upon as more information becomes available through monitoring of impacts, mitigation, and resource management.

1. Establish Core Objectives – Each resource or management action subject to adaptive management will have a defined core objective or set of core objectives. The core objectives are those objectives that are not proposed to be modified by adaptive management. The means of achieving the core objectives may be changed through the adaptive management process.
2. Identify Uncertainties – For each resource or management action, the potential uncertainties that are currently known and for which adaptive management may be needed will be identified.
3. Develop Contingencies – For each identified uncertainty, a corresponding potential adjustment to the currently identified action will be identified. The identified contingency or adjustment could be modified in the future, but given what is currently known, is the recommended course of action.

Each of the resources and management actions discussed in this AMP establish core objectives, identify uncertainties, and develop corresponding contingencies. As currently feasible, monitoring and success criteria are presented or incorporated by reference to the CMP.

This framework will provide the information needed for reviewers to know what uncertainties have been identified and the contingencies developed to address these uncertainties, and will also provide the flexibility to revise the AMP in the future as needed. The AMP helps to cement the relationship among future impact assessment and the implementation of mitigation and monitoring by identifying the potential uncertainties that could affect impact assessment and mitigation, and identifying contingencies and adjustments that can be explored to address these uncertainties. Monitoring of impacts and mitigation will provide important information and feedback for an iterative process of refining actions to minimize impacts and address uncertainties.

The AMP directly supports the CMP (Appendix K of the FR/EIS). The CMP provides detail on mitigation, monitoring, reporting, and associated costs.

Oversight

Implementation of the AMP will require oversight. The AMP will inform and guide adjustments and modifications to the mitigation and management that is currently proposed. These adjustments and modifications will require review and oversight to make sure they are needed, sound approaches are taken, and that they are aligned with achieving the core objectives. The FR/EIS established oversight responsibilities for mitigation and monitoring, and these responsibilities will also extend to adaptive management as discussed below.

The U.S. Army Corps of Engineers (Corps), the Colorado Department of Natural Resources (CDNR), and the water users (Chatfield Water Providers) will each have complementary responsibilities for ensuring the accomplishment of the reallocation, and of the CMP, the Recreation Modification Plan, and the AMP (the Plans).

The Corps and the CDNR will enter into a Water Storage Agreement (WSA) setting out their respective obligations for reallocating the designated water supply storage, and for accomplishing the Plans. The CDNR will then execute subagreements, identical in their terms and conditions, with each of the Chatfield Water Providers. The subagreements will set out the responsibilities of the Chatfield Water Providers to the CDNR for funding the reallocation of the water supply storage under the WSA, and for undertaking the CDNR's obligations to the U.S. Government under the WSA for implementing the Plans. The subagreements, however, will not affect the ultimate duty of the CDNR and the U.S. Government to fulfill their reciprocal obligations under the WSA, unless the WSA is suitably modified by mutual consent of the Corps and the CDNR. However, the Corps continues to have discussions with the State and the Chatfield Water Providers to further refine the legal relationship between the entities.

After execution of the WSA, the Chatfield Water Providers will place the funds then judged necessary to satisfy all of the nonfederal obligations under the WSA into an escrow account with funds necessary to implement the AMP including associated monitoring, reporting, and mitigation measures unless otherwise stated for a particular

resource issue. The Chatfield Water Providers will supplement the escrow fund if the Project Coordination Team (PCT) determines that additional funding is necessary to meet all of the nonfederal obligations. The Chatfield Water Providers will also create a new nonprofit corporation called the Chatfield Reservoir Mitigation Company as a vehicle for facilitating the coordinated management of the process for implementing the Plans.

In accordance with the terms of the WSA, senior management oversight of the implementation of the Plans will reside in the PCT, consisting of senior management representation from the Corps, the CDNR, and the Chatfield Water Providers. The PCT shall consult on the progress of the nonfederal work being undertaken pursuant to the Plans, with a view toward anticipating and offering solutions to potential problems to the Plans' scheduled completion and make recommendations to the Omaha District Commander. The Corps has the final authority on acceptance or rejection of the PCT's recommendations.

The PCT can create advisory committees if it determines that the advice from such committees may be helpful. Such advisory committees would be created to provide review and comments upon the activities conducted to implement all of the mitigation obligations. Two such committees, the Technical Advisory Committee (TAC) and the Operations Advisory Committee, will be created to provide assistance with technical and operational issues including implementation of and any revisions to the AMP. The PCT will have discretion to accept or reject, in whole or in part, the recommendations from its advisory committees. The PCT will approve a charter governing membership and decision making for any advisory committees that it creates. The TAC will tentatively be comprised of representatives from the following:

- Environmental organizations;
- Chatfield Water Providers;
- Colorado Division of Parks and Wildlife (CPW);
- Chatfield State Park;
- Douglas County Land Trust or other land conservation organization;
- Colorado Water Conservation Board and/or CDNR;
- Denver Water;
- Corps;
- U.S. Environmental Protection Agency (EPA);

- U.S. Fish and Wildlife Service (USFWS); and
- Other “in-stream” interests, including governmental and nongovernmental downstream water interests.

The TAC will provide review and comments on technical components of the implementation process including the following:

- Suitability of private properties for lands protection and enhancement that occur outside the off-site target mitigation area;
- Management plans for off-site properties;
- Technical questions regarding proposed adjustments to mitigation resulting from the adaptive management process;
- An Annual Monitoring Report; and
- Other aspects of the project requested by the PCT.

The Operational Advisory Committee will provide review and comments on mitigation obligations related to operational issues. The principal goal of the committee is to facilitate efficient collective operations. The committee would tentatively be composed of the following:

- All of the Chatfield Water Providers;
- A Denver Water representative; and
- A Colorado State Engineers Office representative.

The AMP presents broad guidelines for conducting adaptive management for the Chatfield Reservoir reallocation project. By its very nature, the AMP will become more specific as mitigation and management plans become more specific. The AMP is a living plan that will be revised as needed to address new uncertainties and needed adjustments, and incorporate new information from monitoring and other sources.¹ Annual monitoring reports will include information on needed and proposed adjustments and uncertainties. Once the details of a resource mitigation plan are finalized, a corresponding detailed plan will be developed identifying uncertainties and detailed

¹ Unless addressed in specific management plans for mitigation properties, adaptive management will not be triggered by natural disasters that may impact mitigation once mitigation has been completed, nor for any additional impacts caused by the storage or release of water not associated with reallocation of storage that are not identified as significant impacts in the final FR/EIS and project decision documents (e.g., flood releases).

contingencies for each proposed mitigation action. All mitigation monitoring reports and revisions to the AMP will be submitted to the PCT and TAC for review and comment.

Schedule

The schedule for implementing adaptive management is variable. By their very nature, adaptive management actions are implemented on an “as needed” basis and as informed by monitoring. Table 1 provides a schedule of how adaptive management will likely be implemented.

Table 1. Schedule for adaptive management measures.

Resource/Issue	Monitoring	Adaptive Management Measures	Frequency
Target Environmental Resources (impacts and mitigation)	Annual	Implement contingencies	As needed
Tree Clearing within the Fluctuation Zone	Following inundation	Remove dead and severely stressed trees when they pose a significant risk to visitor, boater, or dam safety/operations and other contingencies	As needed
Weed Control within the Fluctuation Zone	Annual	Follow iterative process for weed control	Annual
Water Quality	Annual	Water quality monitoring and assessment	Annual
		Remove vegetation (see Tree Clearing within the Fluctuation Zone)	As needed
		Control weeds (see Weed Control within the Fluctuation Zone)	Annual
		Dynamic water quality modeling	Annual
		Altering inflow and outflow	As needed
Structural measures	As needed		
Operations	First 3 years of operations	Conduct studies to determine the effects of operations and how operations might lessen	First 3 years of operations
		Develop revised operations plan based on first 3 years of operations and studies	As feasible
Aquatic Life and Fisheries	Annual	Determine target seasonal schedule of releases and maximum flow rates	First 3 years of operations
		Determine operations that could promote strategic releases	First 3 years of operations
		Adjust operations to benefit aquatic life	As feasible

Target Environmental Resources

The draft FR/EIS identified Preble's habitat, bird habitat, and wetlands as resources of particular concern and warranting specific mitigation strategies for the estimated adverse impacts on those resources. These resources are referred to as the "target environmental resources." The CMP is designed to offset the adverse impacts on the target environmental resources associated with the reallocation of storage space and effects of inundation under Alternative 3. The CMP also includes actions to offset adverse impacts associated with the relocation of recreation facilities and use of borrow areas, the impacts of which have been separately identified. The CMP is designed to replace the lost ecological functions and values of the target resources from both types of actions. The impacts and corresponding mitigation requirements for each of these actions are identified in Section 6.0 of the CMP and Chapter 4 of the draft FR/EIS. Monitoring of impacts and mitigation is addressed in Section 7.4 of the CMP. Success criteria for mitigation are presented in Section 6.0 of the CMP.

The adverse impacts estimated for the target environmental resources are a conservative maximum estimate of the impacts. The impact estimate assumes that all of the target environmental resources below the maximum pool elevation of 5,444 feet mean sea level (ft msl) would be lost. As a practical matter, the estimated maximum impacts may not occur as discussed in Section 5.0 of the CMP. Section 6.0 of Appendix C of the CMP sets forth an extensive monitoring protocol for monitoring impacts and mitigation. Implementation of the CMP is expected to produce quantitative and qualitative benefits for the target environmental resources. The quantitative benefits will be measured by monitoring the ecological functional units (EFUs) gained. EFUs are the currency used by the CMP to estimate impacts and mitigation. Exceptions include Preble's critical habitat mitigation on the South Platte River arm and mature cottonwood woodlands. These exceptions to the use of EFUs are discussed in Sections 5.0 and 6.3 of the CMP.

Core Objectives

The CMP established the following core objectives, and any adjustments to the CMP must meet these core objectives.

1. Provide up to 796 EFUs to offset the 796 EFUs conservatively estimated to be permanently lost with reallocation, comprised of up to 211 EFUs for noncritical Preble's habitat, up to 65 EFUs for West Plum Creek critical habitat, up to 396 EFUs for bird habitat, and up to 124 wetland habitat EFUs that will contribute to the estimated maximum total of 796 EFUs conservatively estimated to be permanently lost.²
2. Mitigate for the conservatively estimated loss of 1.3 miles of designated critical Preble's habitat along the South Platte River arm.
3. Compensate for the conservatively estimated loss of 42.5 acres of mature cottonwood bird habitat by protecting up to 22.5 acres of cottonwood woodlands off-site and creating up to 13 acres (on-site) and 10 acres (off-site) of cottonwood recruitment areas, all of which will contribute to the compensatory mitigation goal of 796 EFUs.

Uncertainties

Adaptive management will be used to address uncertainties that potentially affect compensatory mitigation activities. Monitoring will determine the degree to which issues and events adversely affect or limit proposed compensatory mitigation activities, as well as document benefits greater than estimated for the CMP. It is anticipated that the range of uncertainties will narrow as monitoring of impacts and mitigation provide additional information regarding uncertainties. As discussed in Section 7.4.2 of the CMP, monitoring will be concluded when all of the core mitigation objectives are met. Some of the mitigation objectives may be adjusted through the process of monitoring and adaptive management, but it is anticipated that the core objectives will persist. The Corps will determine when all mitigation objectives have been successfully met and adaptive management is no longer required. The following are uncertainties that could require adjustments to the methods used to achieve objectives in the CMP as currently proposed.

- All of the compensatory mitigation measures may not be completely successful;
- Some compensatory mitigation activities may provide more benefit than currently estimated;
- Impacts associated with inundation may be less than have been conservatively estimated for the CMP;
- Not all private property owners targeted for land protection may be willing to enter into agreements to protect their property or portions of their property at a fair market price; and

² The 796 EFUs assume all habitat below 5,444 ft msl will be lost. This estimate will be adjusted based on monitoring of impacts.

- Other opportunities may become available to provide mitigation determined to be of value to the target environmental resources.

Contingencies

The following strategies will be used to adaptively manage issues and events that adversely affect or limit proposed compensatory mitigation:

- Broaden the geographic scope of the target off-site mitigation area identified in the CMP (CMP, Figure 25) to increase the potential for protection of private lands or enhancement of public lands;
- Employ corrective actions to unsuccessful mitigation activities (e.g., grade adjustments, reseeding, replanting, increased weed control, fencing, and temporary irrigation);
- Reconsider the use of approved wetland mitigation banks;
- Investigate opportunities to partner on future regional conservation and mitigation projects;
- Adjust operations by Chatfield Water Providers in either the storage or release of water without adversely affecting the yield of the Chatfield Water Providers as identified in this reallocation project;
- Investigate incentives or other options for private land owners who are unwilling to enter into agreements to protect their property or portions of their property at fair market rates;
- Adjust impact assessment and mitigation based on monitoring associated with the tree management plan; and
- Other measures agreed upon by the PCT and the Chatfield Water Providers that are appropriate to address mitigation issues.

Tree Clearing within the Fluctuation Zone

A Tree Management Plan (TMP) was developed to address the removal of trees that would be inundated under Alternative 3 or 4 (FR/EIS, Appendix Z). Under Alternative 3, as proposed in the TMP, the majority of trees between 5,432 ft msl (the current high water elevation) and 5,439 ft msl would be removed prior to raising the pool elevation. Selected trees in some areas may be retained for fisheries or wildlife habitat. These areas of retained trees will be determined based on a review by the Corps and CPW.

Monitoring will follow inundation events to determine tree mortality and to select trees for removal. In addition, some of the cut trees could be moved to elevations above 5,444 ft msl to provide downed woody debris for enhancement of Preble's habitat. The modeling results indicate that trees would likely be killed at elevations up to 5,439 ft msl, and would not likely be killed above 5,440 ft msl. The results are less clear for the area

between 5,439 and 5,440 ft msl. It is possible that some portion of the trees in this area could survive the expected frequency of inundation. The area between 5,439 and 5,444 ft msl includes approximately 61.1 acres of trees. The TMP takes a conservative approach by proposing to remove trees up to 5,439 ft msl, and to use an iterative approach to address trees above 5,439 ft msl that entails leaving these trees in place and then monitoring the trees for signs of severe stress and mortality; and removing unhealthy and dead trees from this area on an as-needed basis prior to filling to eliminate potential risks to visitor and dam safety/operations. Dead trees could be a potential hazard to boaters and other park visitors, and to dam operations. The trees would also be difficult to remove after inundation occurred. Because of these safety and logistical concerns, it was decided that trees that would most likely be impacted by inundation should be removed before inundation occurs.

CPW operates Chatfield State Park and despite the safety and logistical concerns listed here, more flexibility regarding tree removal may result in less damage to the environmental and recreational assets. Therefore, the AMP allows the Chatfield Water Providers, working with CPW, to propose to remove fewer trees below 5,439 ft msl, and to use the same iterative approach to address trees above 5,439 ft msl as described above. This iterative approach could also involve experimenting with various actions by elevation and area to inform the overall plan for managing trees within the fluctuation zone.

Core Objectives

The following core objectives are established for the TMP and any adjustments to the TMP must meet these core objectives:

1. Limit tree clearing to areas where trees have a high likelihood of being killed by inundation.
2. Leave trees in selected areas below 5,439 ft msl for fish and wildlife habitat, to the degree practicable and safe.
3. Decisions on trees removed (including stumps) and trees retained, must consider dam, boater, and visitor safety.
4. Maximize the use of downed trees for fish and wildlife habitat.
5. Remove downed woody material from the area below 5,439 ft msl to minimize impacts on water quality except as placed or retained for aquatic and wildlife habitat.

Uncertainties

Adaptive management will be used to address uncertainties that potentially affect implementation of the TMP. There is some degree of uncertainty in estimating the elevation at which trees would likely survive inundation. The uncertainty is due in part to the reservoir model, the availability and timing of water for storage, how reservoir operations would occur under the proposed reallocation, and in part due to predicting how the trees would respond to inundation. A conservative approach has been taken by limiting the trees to be removed to those areas where it is highly likely that the trees would be killed (i.e., up to 5,439 ft msl). The following are uncertainties that could require adjustments to the methods used to implement the TMP:

- The degree of tree survival below the new high water elevation of 5,444 ft msl;
- The exact area and location of trees to be cleared;
- Locations and size of tree stands to be retained below 5,439 ft msl;
- Locations of where downed trees will be used for aquatic habitat enhancement;
- Locations of where downed trees will be used for Preble's habitat enhancement; and
- The degree of new tree establishment in the upper portions of the new fluctuation zone.

Contingencies

The following will be used to adaptively manage uncertainties that can affect implementation of the TMP:

- Monitor the trees between 5,432 and 5,444 ft msl, specifically looking at any trees retained below 5,439 ft msl, for signs of severe stress and mortality, and remove unhealthy and dead trees from this area on an as-needed basis when they pose a significant risk to visitor, boater, or dam safety/operations.
- Monitor the trees between 5,432 and 5,444 ft msl, specifically looking at any trees retained below 5,439 ft msl, to determine if adjustments to impact estimates and mitigation are needed.
- The Corps and CPW will work together to identify areas where trees will need to be removed prior to storing water in the reallocated conservation pool to eliminate significant risks to visitor, boater, or dam safety/operations.
- The Corps and CPW will work together to identify areas where removed trees will be placed to enhance aquatic habitat prior to storing water in the reallocated conservation pool. Methods to secure the trees and eliminate significant risks to visitor, boater, or dam safety/operations will also be determined.
- The Corps, CPW, and USFWS will work together to identify areas where removed trees will be placed to enhance Preble's habitat.

- Monitor the establishment of cottonwoods and willows above and below the new high water line of 5,444 ft msl as discussed below.
- The Corps and CPW will evaluate trees within the reallocated pool after water has been stored and trees have been inundated, and based on their evaluation will notify the Chatfield Reservoir Mitigation Company of the trees that need to be removed based on significant risks to visitor, boater, or dam safety/operations.

Once the annual cycle of the reservoir drawdown has been established for a few years, a successional sequence of vegetation can be expected at the upper end of the fluctuation zone. This fringe of vegetation would be closely linked to a gradient of soil moisture conditions. The zone of saturated soils above the new high water elevation would extend for variable distances from the upper end of the drawdown zone depending on soil texture, slope, and the upgradient conditions including the normal depth of the water table. This successional sequence could lead to the establishment of cottonwoods and willows in these areas that could require adjustments to impact estimates and mitigation required (i.e., impacts associated with inundation may be less than were conservatively estimated in the CMP).

Weed Control within the Fluctuation Zone

The proposed reallocation of storage at Chatfield Reservoir is predicted to result in a greater magnitude and frequency of reservoir level fluctuations compared to historical reservoir operations. When exposed, the expanded fluctuation zone provides potential habitat for the establishment of weeds. A review of regional reservoirs indicates some potential for the establishment of weeds within the expanded fluctuation zone, although the degree to which weeds would become established in an expanded fluctuation zone is uncertain (Comparative Review of Reservoir Fluctuation Zone, Appendix HH of FR/EIS). The control of weeds within the fluctuation zone will require a program of monitoring that informs weed control measures.

Core Objectives

The following core objectives must be met in controlling weeds within the fluctuation zone:

1. Eradicate all “A List” weeds on the State’s noxious weed list (www.colorado.gov/cs/Satellite/ag_Conservation/CBON/1251618780047).

2. Eradicate salt cedar (*Tamarisk ramosissima*).
3. Control leafy spurge (*Euphorbia esula*), Russian olive (*Elaeagnus angustifolia*), cocklebur (*Xanthium strumarium*), and all “B List” species on the state’s noxious weed list.

Uncertainties

Adaptive management will be used to address uncertainties associated with the establishment and control of weeds within the fluctuation zone. Monitoring will determine which weeds invade the fluctuation zone, their distribution, and methods that prove effective in their eradication and control. The following are uncertainties that could require adjustments to weed control in the fluctuation zone.

- It is currently unknown if weeds will invade the fluctuation zone;
- It is currently unknown which weeds may become established in the fluctuation zone;
- It is currently unknown which methods prove most effective for controlling or eradicating a specific weed species;
- Weed species, not currently known to the region, could invade the fluctuation zone in the future; and
- New methods of weed control and eradication may become available in the future and could be effective in controlling and eradicating weed species found in the fluctuation zone.

Contingencies

The following iterative process will be used to address uncertainties associated with controlling weeds within the fluctuation zone and will need to be incorporated into a weed control program:

1. Monitoring and mapping the fluctuation zone annually for weeds;
2. Identifying areas requiring weed control or eradication;
3. Selecting the appropriate treatment for control or eradication;
4. Properly implementing the selected treatment for control or eradication;
5. Post-treatment monitoring to determine the effectiveness of control or eradication methods;
6. Adjusting treatment as required; and
7. Continuing monitoring and treating as needed throughout the life of the project.

The establishment of desirable vegetation will be considered as a means to control weeds. This may include the periodic seeding of desirable species within elevations of the fluctuation zone estimated to be inundated infrequently. Exceptions to the

establishment of desirable vegetation include the swim beach or other portions of the fluctuation zone where vegetation may not be desirable.

Monitoring will inform the effectiveness of treatments, but it is likely that new weed treatments will be developed in the future, which will need to be tested. It is also possible that weeds not currently known to occur in the region could invade the fluctuation zone. It will be important for the Chatfield Reservoir Mitigation Company to contract with individuals and firms for monitoring and controlling weeds who are up to date on new weeds found in the region and new weed treatments. Section 6.1.1.2 and Appendix F of the CMP establishes success criteria for weed control.

Water Quality

Water quality concerns for the Chatfield Reservoir reallocation focus on potential change to water quality from expansion of the hypolimnion and inundation of shoreline areas within the reservoir with increased pool levels. Nutrient analysis and water quality modeling show uncertainty in the potential water quality impacts from increased internal nutrient (i.e., phosphorus) loading due to higher pool levels. There is uncertainty whether increased inundated vegetation and the expansion of the hypolimnion and anaerobic sediments will increase internal phosphorus loading to the extent that promulgated water quality standards and the identified Total Maximum Annual Load (TMAL) may be exceeded. Site-specific water quality standards have been promulgated for Chatfield Reservoir to manage phosphorus enrichment, and a TMAL for phosphorus is being implemented by the Chatfield Watershed Authority (CWA). The current phosphorus-associated water quality standards and Assessment Criteria for Chatfield Reservoir are:

Water Quality Standards:

Phosphorus (Total) = 0.030 mg/L

Chlorophyll = 10 µg/L

Measured through samples that are representative of the mixed layer from July through September, with an allowable exceedance frequency of 1 in 5 years.

Assessment Criteria (used when assessing whether the water body is in attainment of the specified standard):

Phosphorus (Total) = 0.035 mg/L

Chlorophyll = 11.2 µg/L

Summer averages, 1-in-5 year allowable exceedance frequency (CDPHE-WQCC 2013).

The current TMAL identified for Chatfield Reservoir for phosphorus, to attain the chlorophyll and phosphorus water quality standards, is 19,600 pounds per year (lbs/yr) under a median inflow of 100,860 acre-feet per year (AF/yr). Figures 1 and 2 display the current phosphorus-associated water quality standards and TMAL for Chatfield Reservoir related to historical Chatfield Reservoir data (CWA 2013). The monitoring of both chlorophyll and phosphorus is a focus because both have an established water quality standard and both relate to potential increased internal nutrient loading due to higher pool levels.

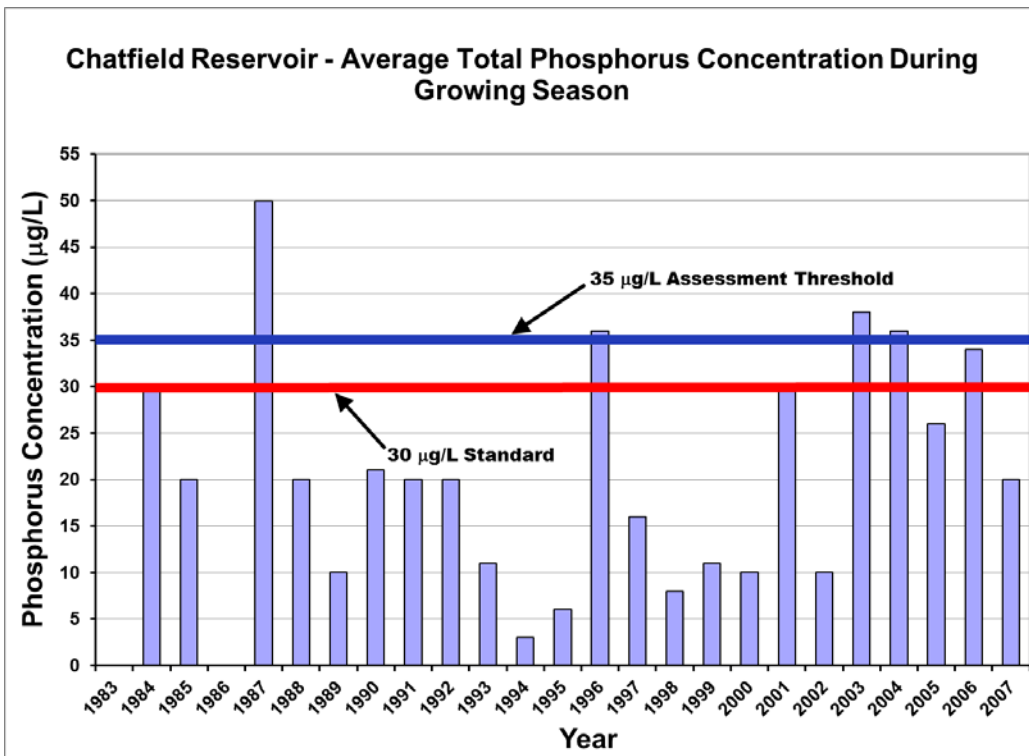
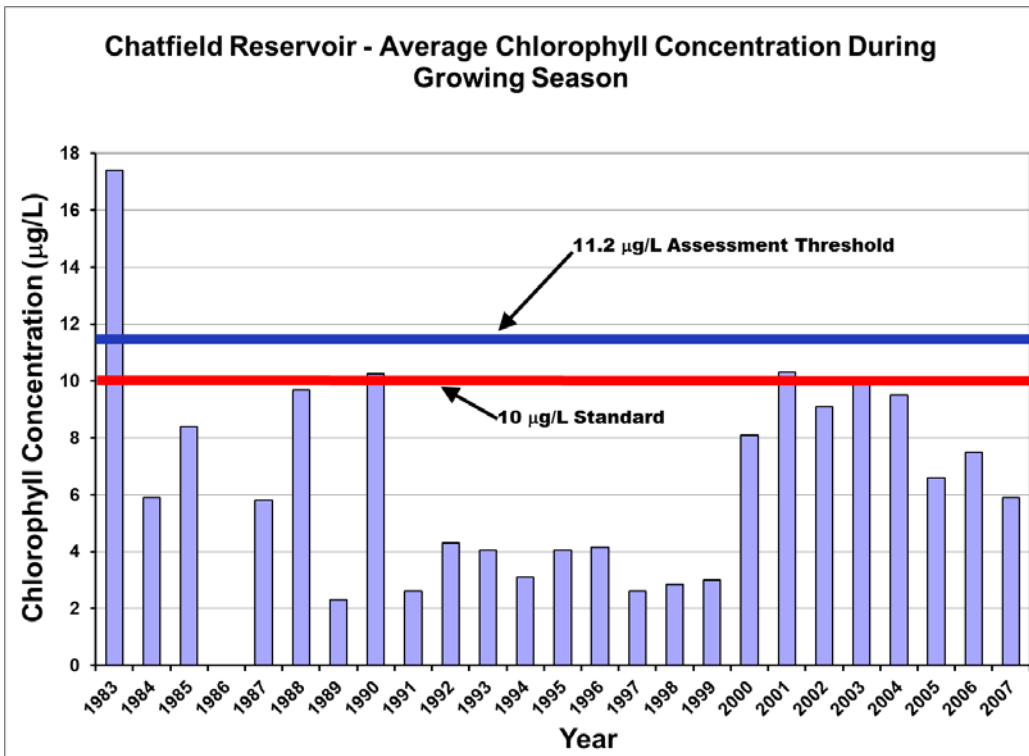


Figure 1. Current chlorophyll and total phosphorus water quality standards related to historical Chatfield Reservoir water quality conditions (from <http://www.chatfieldwatershedauthority.org/regulations.html>).

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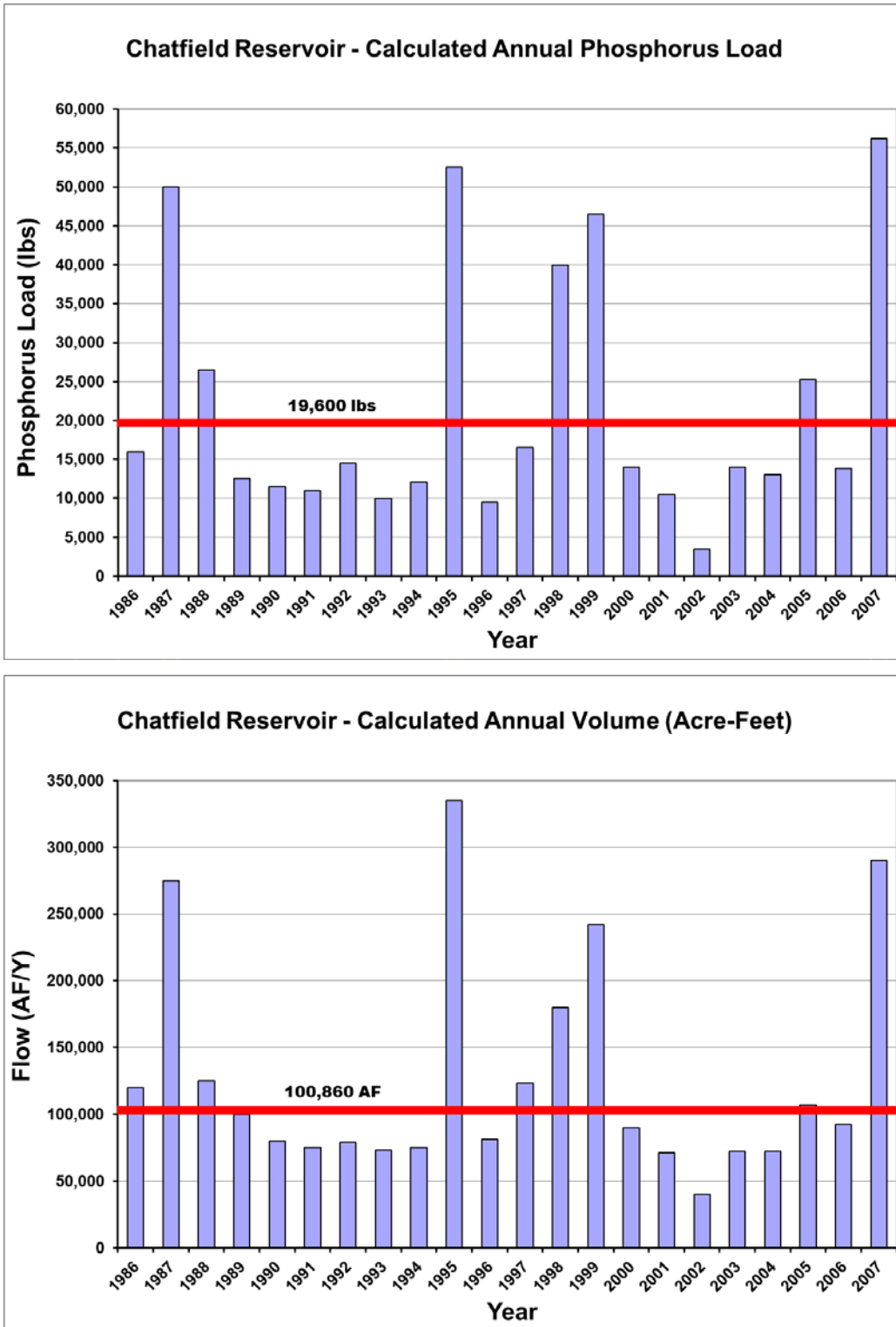


Figure 2. Identified phosphorus TMAL and median inflow conditions related to historical Chatfield Reservoir conditions (from <http://www.chatfieldwatershedauthority.org/regulations.html>).

The water quality uncertainty associated with the Chatfield Reservoir reallocation is partially a result of past water quality monitoring deficiencies. It was generally concluded, based on readily available water quality data, that Chatfield Reservoir did not experience extensive hypoxic conditions in the hypolimnion that established during the summer. However, recent water quality monitoring data and a more investigative assessment of historical water quality data indicate that is not the case, and in fact, the reservoir likely experiences regular hypoxic conditions in the hypolimnion throughout the summer. Water quality monitoring deficiencies regarding the Chatfield Reservoir reallocation will be identified and corrected with future water quality monitoring conducted at Chatfield Reservoir. The AMP recognizes that the Chatfield Water Providers are responsible for their portion of water quality monitoring only; not for correcting past deficiencies nor for the entire monitoring and modeling efforts needed to address all of the water quality issues in Chatfield Reservoir. To assess potential water quality impacts from the Chatfield Reservoir reallocation, ongoing water quality modeling will be implemented at Chatfield Reservoir to address water quality uncertainties, provide input to contingency planning, and facilitate feedback between mitigation monitoring and mitigation actions if necessary. One suggested approach is using a dynamic water quality model. One example of a dynamic water quality model is the CE-QUAL-W2 (W2) model. W2 is a water quality and hydrodynamic model in two dimensions (longitudinal and vertical) for rivers, estuaries, lakes, reservoirs, and river basin systems. In reservoir settings, W2 models basic physical, chemical, and biological processes such as temperature, nutrient, algae, dissolved oxygen, organic matter, and sediment relationships while accounting for flow dynamics within the reservoir. Water quality monitoring would be implemented to collect the information needed to facilitate the initial and ongoing application of a dynamic water quality model to Chatfield Reservoir. Application of the dynamic water quality model could facilitate addressing water quality uncertainties and contingency planning, and provide feedback for possible mitigation actions. The Chatfield Water Providers, through the Chatfield Reservoir Mitigation Company, will be responsible for funding their share of water quality

monitoring and modeling costs and the mitigation actions related to their use of reallocated space as required by the Corps.

Core Objectives

The following are the core objectives for water quality:

1. Internal loading from “new” anoxic sediments attributed to reallocation pool level increases will not cause water quality standards for chlorophyll and total phosphorus or the total phosphorus TMAL to be exceeded.
2. Internal loading from “newly” inundated vegetation attributed to reallocation pool level increases will not cause water quality standards for chlorophyll and total phosphorus or the total phosphorus TMAL to be exceeded.
3. Expansion of hypoxic conditions and potential release of reduced contaminants from anaerobic sediments will not cause other water quality standards (i.e., other than chlorophyll and total phosphorus) to be exceeded.

Uncertainties

Adaptive management will be used to address the following uncertainties associated with reallocation regarding water quality at Chatfield Reservoir.

- Water quality analysis shows there may be uncertainty regarding internal nutrient (i.e., phosphorus) loading from increased hypoxic conditions and associated anaerobic sediments.
- Water quality could be adversely affected by shoreline erosion associated with increased water level fluctuations.
- The hypoxic area could expand and potentially increase the release of reduced contaminants from anaerobic sediments and increase methylation of mercury within the reservoir.
- Vegetation establishment within the fluctuation zone that would eventually be inundated could increase internal nutrient loading.

Contingencies

The following approach using a dynamic water quality model could be executed to adaptively manage water quality uncertainties regarding the Chatfield Reservoir reallocation.

Water Quality Monitoring and Assessment

Water quality monitoring would be implemented at Chatfield Reservoir to allow for the initial and ongoing application of a dynamic water quality model and assessment of reservoir water quality conditions for compliance with water quality standards. Dynamic

water quality modeling would require the appropriate monitoring of reservoir, inflow, and outflow water quality conditions. Appropriate water quality data will be collected in Chatfield Reservoir to assess compliance with promulgated water quality standards criteria. This information will be used to help determine if mitigation actions need to be taken. The Chatfield Water Providers will be responsible for monitoring and modeling that are related to reallocation and are in addition to the efforts now being made by the CWA that do not already satisfy the following monitoring or modeling objectives. It is the intent of the AMP that the Chatfield Water Providers and CWA work together on Chatfield Reservoir water quality issues. The following monitoring and modeling actions should be planned and implemented in close coordination with the CWA to avoid duplication of efforts. The following identifies monitoring objectives and specific data needs for water quality monitoring and assessment regarding the Chatfield Reservoir reallocation.

Monitoring Objective 1 – Conduct Water Quality Monitoring to Characterize the Spatial and Temporal Occurrence of Water Quality Conditions in Chatfield Reservoir

The water quality in Chatfield Reservoir is subject to spatial and temporal variability. Water quality conditions in reservoirs are a reflection of their watersheds and can also vary widely over time in response to climatic and seasonal influences. A thorough understanding of the spatial and temporal variability of water quality conditions in Chatfield Reservoir is needed to model water quality and assess potential water quality impacts from reallocation.

Specific Data Needs

- Conduct monthly (April through October) depth-profile measurements (minimum 1-meter increment) at three locations in Chatfield Reservoir: 1) a deepwater location near the dam, 2) a mid-reservoir location characteristic of deepwater areas of the South Platte River arm, and 3) a mid-reservoir location characteristic of the Plum Creek arm of the reservoir. The following constituents should be measured as part of the depth-profile measurement: 1) temperature, 2) dissolved oxygen, 3) pH, 4) oxidation-reduction potential, and 5) chlorophyll *a*.
- Conduct monthly (April through October) analysis of near-surface and near-bottom water quality conditions to include: 1) phosphorus (total, dissolved, and reactive); 2) nitrogen (total Kjeldahl, ammonia, and nitrate-nitrite); 3) organic carbon (total and dissolved); 4) carbonaceous biological oxygen demand (CBOD); 5) alkalinity; 6) total dissolved solids; 7) total suspended solids; 8)

- sulfate; 9) silica; 10) chlorophyll *a* (near-surface only); 11) phytoplankton; 12) zooplankton; and 13) Secchi depth.
- Conduct monthly (May, July, and September) analysis of near-surface and near-bottom water quality conditions for metals (total and dissolved metals scan).

Monitoring Objective 2 – Conduct Water Quality Monitoring to Determine if Reallocation has Impacted Water Quality Conditions in Chatfield Reservoir – Determine if Water Quality Standards have been Exceeded

Likely water quality constituents, with promulgated state water quality standards, that could be impacted by the Chatfield Reservoir reallocation include total phosphorus, chlorophyll *a*, ammonia, metals, and *E. coli* bacteria. These constituents will need to be monitored in Chatfield Reservoir to determine if the reallocation has caused water quality standards for these constituents to be exceeded. The water quality monitoring results and water quality standards attainment assessment will be included in an Annual Water Quality Monitoring Report that is presented to the TAC and PCT.

Specific Data Needs

- Conduct water quality monitoring to meet Monitoring Objective 1, which will provide the data needed to assess compliance for total phosphorus, chlorophyll *a*, ammonia, and metals.
- Conduct weekly (May through September) analysis of water samples collected at designated swimming beaches for *E. coli* bacteria.

Monitoring Objective 3 – Conduct Water Quality Monitoring to Facilitate Application of a Dynamic Water Quality Model to Chatfield Reservoir

A dynamic water quality model can predict water quality conditions in Chatfield Reservoir that cannot efficiently be empirically monitored. Water quality modeling also allows for evaluation of water quality impacts and facilitates scenario testing. Calibration of a water quality model with empirical information collected at Chatfield Reservoir is important to increase the accuracy of the model application to the reservoir. Derived model coefficients for Chatfield Reservoir can be used in lieu of default values to improve the results of the modeling application. Once the Chatfield Reservoir water quality model has been “validated,” it can confidently be used to facilitate water quality management decisions regarding reallocation.

Specific Data Needs

- Conduct water quality monitoring to meet Monitoring Objective 1, which will provide the in-reservoir water quality data needed to apply a dynamic water quality model to Chatfield Reservoir.
- Maintain year-round flow gauging stations on the South Platte River and Plum Creek that are representative of the inflows to Chatfield Reservoir. Consider adding temperature logging to the gauging stations.
- Conduct biweekly (April through September), monthly (October through March), and storm event (April through September) water quality sampling of the South Platte River and Plum Creek inflows to Chatfield Reservoir. Sampled inflow constituents should include: 1) temperature; 2) dissolved oxygen; 3) pH; 4) specific conductance; 5) organic carbon (total and dissolved); 6) CBOD; 7) phosphorus (total, dissolved, and reactive); 8) nitrogen (total kjeldahl, ammonia, and nitrate-nitrite); 9) total dissolved solids; 10) total suspended solids; 11) silica; and 12) alkalinity.
- Conduct annual sampling of bottom sediments from deepwater areas of Chatfield Reservoir. Collected sediments should be analyzed for labile and refractory nutrients, labile and refractory organic matter, and metals. The sediments should also be tested to determine nutrient flux under anoxic conditions.

Monitoring Objective 4 – Conduct Water Quality Monitoring to Evaluate the Effectiveness of Implemented Mitigation Measures to Alleviate Water Quality Impacts Attributed to Reallocation

Implemented mitigation measures to address water quality impacts from the Chatfield Reservoir reallocation need to be monitored to evaluate their effectiveness. This will allow for ineffective measures to be identified and the pursuance of alternative measures. It will also allow for the identification of successful measures that can be documented for future application.

Specific Data Needs

- Conduct monitoring as needed and specific to the water quality impact being addressed.

Inundated Vegetation

The following actions will be taken to monitor inundated vegetation regarding the Chatfield Reservoir reallocation.

- Remove vegetation below 5,439 ft msl to minimize the introduction of nutrients associated with inundation, as discussed under Tree Management within the Fluctuation Zone of this AMP.
- Control weeds within the fluctuation zone that could increase nutrient levels when inundated.

- Monitor the establishment of vegetation within the fluctuation zone that could increase nutrient levels when inundated.

Dynamic Water Quality Modeling

An initial application of a dynamic water quality model could be attempted using historic water quality, meteorological, pool level, and flow data. Annual models would be developed where historical data allow. If sufficient historical data are lacking, an initial application of a dynamic water quality model would be based on newly collected data. Once initially developed, a dynamic water quality model would be applied annually on an ongoing basis. Water quality, meteorological, pool level, and flow data for the past year would be used to develop a specific model for the year. As the annual models are developed, they could be used to further assess water quality in Chatfield Reservoir and help determine if water quality has been adversely impacted by reallocation. If adverse impacts are identified, the model could be used to conduct scenario testing of possible water quality mitigation measures. If core objectives are threatened, a dynamic water quality model could be used to scope out the water quality concern, and, if appropriate, identify mitigation measures that could be implemented. Mitigation measures to manage water quality could include, but are not limited to:

- Altering inflow and outflow to better manage flushing flows and hydraulic residence time; and
- Implementing “structural” measures to reduce hypoxia (e.g., aeration, mixing, and bottom-withdrawal).

The following identifies objectives and decision points for water quality modeling regarding the Chatfield Reservoir reallocation.

Modeling Objective 1 – Annually Apply the Dynamic Water Quality Model to Chatfield Reservoir to Assess Water Quality Impacts from Reallocation and Report the Findings

- Water quality monitoring, modeling and results will be included in an Annual Water Quality Modeling Report completed by the Chatfield Water Providers, in cooperation with the CWA, that includes the results from data obtained from the monitoring and modeling, assesses the information, and identifies potential water quality impacts resulting from reallocation.
- The Annual Water Quality Modeling Report will be presented to the TAC by no later than March 1 of the year following the year the monitoring report addresses. The TAC will review the report and make recommendations to the PCT regarding

the water quality assessment findings, significant impacts, and potential mitigation measures if necessary.

- The PCT will consider the recommendations of the TAC and determine if the reallocation has had a significant adverse effect on the water quality of Chatfield Reservoir based on the model results, the Annual Water Quality Modeling Report, and recommendations from the TAC and agencies. The determination of the PCT will be forwarded to the Corps for concurrence or comment.

Modeling Objective 2 – If the PCT Concurs with the Recommendation from the TAC that Significant Adverse Water Quality Impacts from Reallocation are Identified, Use the Water Quality Model to Evaluate Possible Mitigation Measures that can be Implemented to Address Identified Water Quality Impacts

- TAC would identify possible water quality mitigation measures that can be implemented to address water quality impacts.
- The water quality model from Modeling Objective 1 would be used by the Chatfield Water Providers to scenario test the effectiveness of possible mitigation measures identified by TAC. The results would be reported to TAC.
- TAC would review the results of the scenario tests and report on the effectiveness evaluation of possible water quality mitigation measures and recommend to the PCT mitigation measures to be implemented.
- PCT would provide comment/agreement on water quality mitigation measures to be implemented and submit recommendations for those mitigation measures to be implemented by the Chatfield Water Providers to the Corps for concurrence.

Modeling Objective 3 – Evaluate the Effectiveness of the Implemented Mitigation Measures

- Determine the effectiveness of implemented water quality mitigation measures evaluated from collected water quality data and water quality modeling. The findings would be included in the Annual Water Quality Monitoring Report and Annual Water Quality Modeling Report prepared by the Chatfield Water Providers and would be presented to TAC.
- TAC would review and comment on the effectiveness of implemented water quality mitigation measures in addressing water quality impacts and identify if additional mitigation measures should be considered if necessary, and would make recommendations to PCT.
- Based on the model results, the Annual Water Quality Modeling Report, and recommendations from TAC and the agencies (e.g., EPA and CDPHE), PCT would determine annually by May 1 if current mitigation measures need to continue to be implemented, if current mitigation measures need to be adjusted, if new mitigation measures need to be implemented, and if new mitigation measures need to be tested; and, if so, which new mitigation measures should be tested. The PCT will submit recommendations to the Corps for concurrence.

Feedback and Learning

The following actions will be taken to provide feedback and learning opportunities regarding the Chatfield Reservoir reallocation.

- Determine if mitigation actions need to be taken based on an assessment of collected water quality data and findings of the modeling.
- If mitigation actions are needed, use modeling to identify effective and reasonable actions that can be implemented.
- Properly implement selected water quality mitigation actions.
- Assess implemented water quality mitigation actions for effectiveness.
- As necessary, adjust implemented mitigation actions or implement new mitigation actions as determined by effectiveness assessments.
- Continue water quality monitoring and mitigation actions as needed.
- Determine when monitoring, modeling, or mitigation is no longer needed.

Critical Low Flows

Appendix J of the FR/EIS determined that the proposed Chatfield Reservoir reallocation could potentially reduce critical low flows in the South Platte River immediately downstream of Chatfield Dam by storing an average of 19 AF of water annually instead of releasing the water to the river during critical low-flow periods (Appendix J, Section 3.4). Appendix J also stated that it is difficult to determine if an average annual reduction of 19 AF of discharge from Chatfield Dam during critical low-flow periods will have significant adverse impacts on water quality in the South Platte River because the calculated critical low flows in the South Platte River quickly increase in a short distance downstream of Chatfield Dam.

The relatively small amount of water (19 AF), the relatively short reach of potentially affected river (about 1 mile), and relative infrequency of occurrence of the critical low-flow periods (currently an average of about 4 days per year) raises uncertainties regarding the potential effects on water quality associated with the estimated annual storage of 19 AF during crucial low-flow periods in the South Platte River below Chatfield Dam.

The existing critical low flows for water quality management of the South Platte River immediately downstream from Chatfield Reservoir are taken to be the monthly acute low flows identified by modeling for the “Below Chatfield” site as part of the nitrate total maximum daily load (TMDL) developed for Segment 14 (Appendix J,

Section 3.3.1 and Table 3-3). The nitrate TMDL for Segment 14 was deemed most sensitive to possible changes in critical low flows in the South Platte River downstream of Chatfield Reservoir and, therefore, is used here as the critical low-flow target for the reach of the South Platte River between Chatfield Dam and Marcy Gulch. The critical low flows for this reach are shown in Table 2.

Table 2. Acute (1-day) low flows for the 10-year period October 1, 1999 through September 30, 2000 for the South Platte River below Chatfield Dam to Marcy Gulch (from Appendix J of FR/EIS).

Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Below Chatfield (cubic feet per second)	0.2	0.3	0.4	0.7	5.3	2.0	0.2	0.6	0.2	0.1	0.1	0.2

In order to avoid potential adverse effects on water quality during critical low-flow periods, the Chatfield Water Providers will pass flows through Chatfield Dam to the South Platte River during storage events that occur during critical low flows or would cause critical low flows. The passed flow will equal the critical low flow for the month (Table 2), as measured at the Below Chatfield Gage (PLACHACO Gage). The occurrence of critical low flows will be determined by monitoring the Below Chatfield Gage and the critical low flows in Table 2. Flows measured by this gage are posted by the Colorado Division of Water Resources at http://www.dwr.state.co.us/SurfaceWater/data/detail_graph.aspx?ID=PLACHACO and are accessible by the public.

The Chatfield Water Providers also have the option of performing studies and monitoring to determine the effects of storage in the reallocated space on water quality during critical low flows or at times that would reduce existing flows to critical low flows or lower. This approach requires the following:

- Submission by the Chatfield Water Providers to the TAC of a proposed study and monitoring approach.
- Review and comment by the TAC of the proposed study and monitoring approach with recommendations to the PCT.
- Approval of the study and monitoring approach by the PCT including any requested changes to the proposed study and monitoring approach.

- Implementation of the approved study and monitoring by the Chatfield Water Providers.
- Reporting by the Chatfield Water Providers to the TAC on the results of the approved study and monitoring. .
- Determination and identification by the TAC regarding the need for any measures to avoid, minimize, or compensate for any adverse effects on water quality associated with storing water in Chatfield Reservoir during critical low-flow periods. This determination will be based on the results of the approved study and monitoring approach. Recommended mitigation measures are also submitted if necessary.
- TAC submits recommendations to PCT for review and approval. PCT provides input and/or approval of TAC recommendations and forwards recommendations to the Corps for concurrence.
- Development by the Chatfield Water Providers, in coordination with the TAC, of any required mitigation measures. All mitigation measures would have been approved by the Corps in the recommendations by the PCT to the Corps.
- Implementation of all approved mitigation measures by the Chatfield Water Providers.
- Annual monitoring of mitigation measures and reporting on their success or needed corrective actions to the Corps.
- Implementation and monitoring of any required corrective actions and reporting on their success to the Corps.

As described above, the Chatfield Water Providers will pass flows through Chatfield Dam to the South Platte River during storage events that occur during critical low flows or would cause critical low flows until an alternate plan supported by the above-described studies and monitoring is approved by the Corps.

Operations

There is an interest by the Chatfield Water Providers (organized as the Chatfield Reservoir Mitigation Company), the State of Colorado, and the Corps to determine if the reallocated storage in Chatfield Reservoir can be operated in a manner to reduce adverse effects on the target environmental resources and recreation or enhance these resources while still meeting the needs of the Chatfield Reservoir reallocation. The estimate of impacts on the target environmental resources is based on the maximum potential impact associated with the selected alternative. The maximum impact assessment conservatively assumes that any of the target environmental resources that will be inundated (i.e., occur

below an elevation of 5,444 feet msl) will be lost. It is anticipated that some of these maximum estimated impacts are unlikely to occur for the following reasons:

- The reallocation storage will not be completely full every year;
- The reallocation storage will not remain full in the years it does fill; and
- Some vegetation, particularly between 5,439 feet and 5,444 feet msl, will likely tolerate infrequent and/or short-term flooding and will not be lost.

The Tree Management Plan (Appendix Z of the FR/EIS) and discussion in this AMP proposes the removal of trees up to 5,439 feet msl, assuming that all trees below 5,439 feet msl will be lost to inundation. For areas between 5,439 and 5,444 feet msl, an adaptive management approach will be used that entails leaving these trees in place and monitoring the trees for signs of severe stress and mortality; and removing unhealthy and dead trees from this area on an as-needed basis to eliminate potential risks to visitor and dam safety/operations.

For the purposes of the CMP, it is estimated that about 10 percent of the impacts are either unlikely to occur or will be offset by newly established vegetation. Of the estimated 616 acres of vegetation that will be lost to inundation under the selected alternative, a net increase of about 31 acres of vegetation, or about 5 percent of the estimated lost vegetation, is expected to develop above 5,444 feet as discussed in Section 4.6 of the FR/EIS. As discussed above, the impacts have been conservatively estimated and it is estimated that, similar to the net expected gains in vegetation, about 5 percent of the conservatively estimated impacts will not occur. Monitoring will determine if the last 10 percent of impacts occur (gains in vegetation and overestimation of impacts), and the CMP will be adjusted (increased or decreased mitigation) to match the impacts.

Two operational approaches are currently being considered to minimize impacts on environmental and recreational resources and are described below. It is possible the elements of these two potential approaches could be combined to develop a single operational scenario, or another operational scenario could be developed.

Core Objectives

The following core objectives are established for the operations plan:

1. Determine a target elevation range and seasonal schedule of storage and releases that would minimize adverse effects on the target environmental resources and recreation.
2. Determine operations that could meet the target elevation and seasonal schedule of storage and releases on a “best effort” basis without adversely affecting the yield of the Chatfield Water Providers as identified in this reallocation project.
3. Annually monitor the effects of storage in the reallocated space on the target environmental resources.
4. Continue to explore ways to adjust operations as circumstances allow minimizing adverse effects on the target environmental resources and recreation.
5. Provide feedback and revisions as needed to the CMP regarding the need for more or less mitigation based on operation of the reallocated storage.

Uncertainties

Adaptive management will be used to address uncertainties associated with the effects of inundation and operations of the reallocated storage. The uncertainties associated with the effects of inundation are discussed in the previous sections on the Target Environmental Resources and the Tree Management Plan. The uncertainties associated with operations include:

- How a coordinated operations plan could affect project yield.
- If a target elevation range for water surface elevations and a schedule for water storage and releases for the reallocated space can be identified that could benefit the target environmental resources and recreation.
- How frequently the Chatfield Water Providers are able to meet the objectives of an operations plan designed to minimize adverse impacts and/or benefit the target environmental resources and recreation.
- Changes in water law or water administration.
- Changes in water availability due to climate change or other phenomena.
- Changes in the Chatfield Water Providers.
- Changes in the Chatfield Water Providers’ needs or relative allocations of storage.
- Changes in the Chatfield Water Providers’ water systems, which could affect operations.
- Results from monitoring that provide ongoing information on the effects of inundation on the target environmental resources.
- Effects on other resources that need to be considered in reservoir operations (e.g., weeds, water quality, and downstream aquatic habitat).

Contingencies

As part of this AMP, the PCT and the Chatfield Reservoir Mitigation Company will explore ways to adjust their management and operation of the reallocated storage to further minimize impacts on the target environmental resources considering system constraints and project yield. The ability to minimize these impacts may be opportunistic and/or programmatic. However, these opportunities also may be limited by water rights, costs, or other constraints. Opportunistic operations to minimize impacts associated with inundation that will be explored by the Chatfield Reservoir Mitigation Company include:

- Reducing water elevations at Chatfield Reservoir to a targeted elevation range during the growing and recreation season;
- Moving water from Chatfield Reservoir to other facilities when water levels are above a targeted elevation range during the growing and recreation season; and
- Developing an agreement and an accounting system among the Chatfield Water Providers and other Chatfield Reservoir users (e.g., Denver Water) that would allow storage exchanges in other facilities to be repaid at Chatfield Reservoir outside of the growing season when water elevations at the reservoir are above a targeted elevation range during the growing and recreation season.

A preliminary operations plan follows.

- A. Each Chatfield Water Provider is Responsible for its Own Operations
 - a. Each Chatfield Water Provider will make its own independent determination to use its water rights to store water in Chatfield Reservoir.
 - b. Each Chatfield Water Provider will be responsible for informing the State Engineer daily of exercising its water rights to store or release water from Chatfield Reservoir.
 - c. Each Chatfield Water Provider will keep its own accounting and do its own reporting to the State Engineer as requested by the State Engineer.
 - d. The State Engineer's daily compilation of the storage or release of water in Chatfield Reservoir by various entities (believed to be known as the Chatfield Check Sheet) will be shared daily with all entities having a Corps-approved right to store in Chatfield Reservoir.
 - e. Evaporation losses on water stored in Chatfield Reservoir will be assessed daily upon each entity storing water in Chatfield Reservoir in proportion to the amount of water stored using a uniform methodology for calculating evaporation as determined by the State Engineer. The evaporation loss will be shown on the State Engineer's Chatfield Check Sheet.
- B. Conditions for the First 3 Years of Allowed Operations in Chatfield Reservoir
 - a. Storage and release operations will be allowed after the recreation modifications necessary to ensure the appropriate recreation experience have been completed and the operations will be in accordance with the WSA.

Restrictions on storing water under the CMP are the temporary cap on storage above 5,442 feet in elevation until the mitigation has been fully implemented and implementing the mitigation per the mitigation milestones presented in the CMP. However, because much of the mitigation addressed in the CMP is subject to this AMP and may change due to operations or experience, the Corps will work closely with the Chatfield Water Providers and CDNR to allow storage as soon as possible so long as appropriate mitigation is complete.

- b. During the first 3 years of operations, studies will be conducted as part of the AMP to determine the effects of the unrestricted operations. The studies will inform the PCT of potential operational restrictions, either in the storage of water or releases of water, which might lessen recreational or environmental impacts or increase benefits of the project. The PCT will take this information into account at the bimonthly operations meetings.
 - c. If conditions arise during the 3-year period that indicate unforeseen operational actions would clearly be beneficial (e.g., releases of water to avoid killing large cottonwood trees), and such operations are approved by the PCT and are consistent with the FR/EIS and project decision document, then such actions will be discussed at the bimonthly meetings and may be taken in coordination with all Chatfield Water Providers, within system constraints and preservation of project yield.
- C. Conditions after the First 3 Years of Allowed Operations
- a. The PCT will review and revise the process for determining ongoing operations to ensure the issues as described below are fully considered and included as goals of operations.
 - b. The Chatfield Reservoir Mitigation Company will give full consideration to procedures and programs that allow implementation of recommendations of the AMP studies.
 - c. The AMP studies will be conducted and continue as described in the CMP.

The operations plan may be modified by the Chatfield Reservoir Mitigation Company with input from the PCT to further minimize and avoid impacts on the target environmental resources and recreation. As experience is gained from system operations, the Chatfield Reservoir Mitigation Company will review the existing operations plan and give full consideration to future operations to take advantage of any practicable opportunities to further minimize impacts on the target environmental resources and recreation. Any revised operations plan will be submitted to the PCT for review to be forwarded to the Corps for approval, and will include the following: The operations plan is an ongoing and iterative process by the Chatfield Reservoir Mitigation Company, the PCT, and the Corps. As the primary operator of Chatfield Reservoir, the Corps will have

final approval of proposed operations. The PCT will include discussion and recording of the following items:

- Identify the targeted elevations at various times in which water storage will be managed, at the Chatfield Water Providers' option, to minimize impacts on the target environmental resources and/or maximize recreational benefits;
- List criteria for the operations plan;
- Provide an estimation of the impacts that will be avoided – expressed in EFUs;
- List any needed changes to the CMP associated with the operations plan;
- Provide a description of constraints and exceptions that affect the operations plan;
- Suggest future refinements to the operations plan;
- Consider system constraints and effects on project yield; and
- Consider effects on recreation associated with the operations plan.

The operations plan may be designed to minimize impacts on the target environmental resources between the new ordinary high water mark and 5,444 feet in elevation. For the purposes of implementing the CMP, it has been assumed that the last increment (10 percent) of off-site mitigation may not be needed due to conservative impact assumptions previously described, and its need will be based on the results of monitoring and adaptive management. If the Chatfield Reservoir Mitigation Company determines that the proposed operations plan or a revised operations plan is not practicable, the Chatfield Reservoir Mitigation Company may be unable to obtain credit for avoided impacts. In this case, the CMP will provide mitigation for the maximum estimated impacts expressed in EFUs, and the CMP mitigation milestone schedule will be revised to reflect the need to provide 100 percent of the maximum estimated mitigation identified in Section 7.2 of the CMP. The maximum estimated impacts can be revised by the Corps based on information submitted by the Chatfield Reservoir Mitigation Company demonstrating the maximum impacts estimated to occur have not occurred and/or are unlikely to occur.

Collective Operational Scenario that Could Reduce Environmental Impacts

The Chatfield Water Providers have worked with representatives from the EPA and Colorado Water Conservation Board to develop and evaluate a range of potential mitigation scenarios for operating the reallocated storage in a manner that has the goal of minimizing impacts on environmental resources while meeting the needs of the Chatfield

Water Providers for use of the reallocated storage. After evaluating a variety of operational scenarios, the EPA and Chatfield Water Providers focused on one potential operational scenario that appears to come closest to meeting these goals. The following is a description of this potential operational scenario, the benefits it could provide, the steps needed to determine the feasibility of implementing the scenario, and how implementation of the scenario would affect the CMP. While this potential operational scenario may be worked out in the future, there are no guarantees or agreements in place that would require this scenario to be implemented. The FR/EIS evaluated impacts without assuming such a scenario would occur. If this particular scenario does not occur, there would be no additional adverse impacts compared to what has been evaluated in the FR/EIS.

The operational scenario under consideration is intended to cooperatively manage water stored in the reallocated space at a potentially higher reservoir level. Per a 1979 agreement with the State of Colorado (1979 agreement), Denver Water makes its “best efforts” to manage its water stored in Chatfield Reservoir to maintain reservoir levels above 20,000 AF of storage between May 1 and August 31 (summer season) to benefit reservoir recreation. Management of these water levels has also benefited the target environmental resources of wetlands and riparian habitat. Denver Water’s commitments under the 1979 agreement would be unchanged by the potential future operational scenario being proposed.

The historical management of Chatfield Reservoir has led to the development of wetland and riparian habitats, including extensive cottonwood woodlands, around the upper portions of the reservoir. The historical management and Denver Water’s best efforts under the 1979 agreement have accomplished two key management objectives during the summer season: 1) maintained relatively high reservoir levels, and 2) minimized fluctuation. The EPA and Chatfield Water Providers are hopeful that more frequent higher reservoir levels during the summer season in the reallocated space should lead to the development of similar resources in the future.

As proposed, the operational scenario would involve all of the Chatfield Water Providers implementing “collective operations” of the reallocated storage using the

Chatfield Water Providers' best efforts to maintain water levels at or above a new target water level elevation during the same summer season of May 1 to August 31. Since the water rights for the water that would be stored by the Chatfield Water Providers in the reallocated storage space have a fairly junior priority for storage (i.e., the Chatfield Water Providers would on average be able to fill the entire reallocated space less than 50 percent of the time), in some years the Chatfield Water Providers would not have the legal priority and/or physical availability of water to store water in the reallocated space.

To potentially keep water levels higher during the summer season, other water sources and storage capabilities would be needed to supplement the Chatfield Water Providers' ability to store water in the reallocated space. The only water provider capable of providing this supplemental storage water is Denver Water. The Chatfield Water Providers have had discussions with Denver Water regarding a possible cooperative operational scenario where Denver Water would store water in unused reallocated storage space when it has water available that cannot otherwise be managed, and would withdraw its water when needed. For instance, Denver Water has a minimum flow requirement on the South Platte River between Strontia Springs Reservoir and Chatfield Reservoir. Occasionally, Denver Water's existing pool in Chatfield Reservoir is insufficient to manage the minimum flows. During those conditions, Denver Water could store its minimum flows in available reallocated space. Denver Water also has a 1977 storage right for Chatfield Reservoir, which is senior to the storage rights of the Chatfield Water Providers. There would be occasional opportunities to store water in available space using Denver Water's 1977 Chatfield Reservoir storage right. These operations would be on an "as available" basis; there would be no requirement for Denver Water to store water in the reallocated space, and no expectation as to how or when the water would be withdrawn.

This cooperative operational scenario, which would increase water levels during the summer season in some years, while meeting the needs of those storing water in the reallocated space, will require cooperation and other multifaceted negotiations between the Chatfield Reservoir Mitigation Company and Denver Water. In preliminary discussions between Denver Water and the Chatfield Water Providers, Denver Water

officials have determined that they may be open to participating in the operational scenario, but need to perform further analysis to ensure that participation in the operational scenario will have no adverse impact on Denver Water.

Denver Water officials would like to discuss Denver Water's role in the scenario with the CDNR. Similarly, the Chatfield Reservoir Mitigation Company needs to coordinate with the Corps to determine if Denver Water's storage in the reallocated space would affect the approved cost of storage for the Chatfield Water Providers. The Chatfield Water Providers are in discussions with Colorado State Parks, which could also shape this operational scenario. Any proposal is subject to Corps' approval.

If the cooperative operational scenario were implemented and successful at reducing impacts on the target environmental resources, implementation of the CMP would need adjustment to compensate for fewer impacts on the target environmental resources. The Chatfield Reservoir Mitigation Company will be responsible for any adjustment of the CMP associated with the operational scenario. Impacts and gains would be estimated using EFUs as described in Section 4.0 of the CMP.

The CMP would be adjusted to address:

- The estimated EFUs of temporary loss;
- The proposed mitigation for temporary loss;
- Any additional adjustments to compensatory mitigation associated with implementation of the operational scenario (e.g., a gain in target environmental resources); and
- Other issues that may arise with implementation of the cooperative operational scenario.

Any adjustment to the CMP will be documented in a formal request to the PCT for its approval and will include the information required for such a request as stated in Section 7.5.1 of the CMP. Implementation of the operational scenario would be subject to the same mitigation objectives (Section 5.0), monitoring (Section 7.4), reporting (Section 7.4.1), and adaptive management (Section 7.5) requirements as other mitigation measures undertaken with implementation of the CMP.

Aquatic Life and Fisheries

Within Chatfield Reservoir, the CPW currently conducts a walleye broodstock program that includes an annual egg-taking process used to populate multiple Colorado reservoirs with the popular game fish. Since an abrupt release of pool levels has been shown in the past to have significant adverse impacts on walleye reproductive success, the Coordinated Reservoir Operations Plan is expected to include a provision to limit the release of water stored in the reallocated pool during critical seasonal periods. The critical period for the walleye broodstock program is from March 1 to April 15. Monitoring by CPW will be used to verify that the provisions of the Coordinated Reservoir Operations Plan limiting the magnitude of releases from the reallocated pool provide the desired protections from adverse release events or will inform if adjustments to operations are needed to benefit the walleye broodstock program.

While downstream aquatic habitat is not anticipated to be significantly negatively affected by the reallocation, it is a concern by CPW that deserves attention under this AMP. At a minimum, the Chatfield Water Providers will work closely with CPW and others to ensure the flows are not negatively impacted from current conditions in order to minimize any potential for adverse impacts. Additionally, the release of water stored in the reallocated pool by the Chatfield Water Providers throughout the year, but especially in the summer and fall, has the potential to benefit the South Platte River downstream of Chatfield Reservoir during the periods when aquatic life and fisheries are stressed from either low flows, high temperatures, or both. The Coordinated Reservoir Operations Plan is expected to include a provision addressing this potential benefit and encouraging the strategic timing of releases from the reservoir to be made such that the beneficial effects of such releases are maximized to the extent feasible while fully meeting the needs of the Chatfield Water Providers. This operation also will be monitored using information routinely collected by CPW to determine if adjustments in the operations can increase the likelihood of providing benefits to downstream aquatic habitat.

Core Objectives

The following core objectives are established for the aquatic life and fisheries under this AMP:

1. Determine a target seasonal schedule of releases and maximum flow rate that would minimize adverse effects on CPW's walleye broodstock program and that can be implemented in the operations plan on a "best efforts" basis without adversely affecting the yield of the Chatfield Water Providers.
2. Determine operations that could promote strategic releases from Chatfield Reservoir to reduce the stressors on the aquatic habitat and therefore benefit the South Platte River downstream of Chatfield Reservoir on a "best efforts" basis without adversely affecting the yield of the Chatfield Water Providers.
3. Annually monitor the aquatic life and fisheries provisions of the operations plan for effectiveness.
4. Continue to explore ways to adjust operations as circumstances allow to minimize adverse effects and maximize benefits to the aquatic life and fisheries within and below the reservoir.
5. Provide feedback and revisions as needed regarding the need for possible adjustments to the operations plan based on the ongoing experiences operating the reallocated storage pool.

Uncertainties

Adaptive management will be used to address uncertainties associated with the effects of operations of the reallocated storage related to the walleye broodstock program and to the aquatic life and fisheries in the South Platte River below Chatfield Reservoir.

The uncertainties associated with operations related to aquatic life and fisheries include:

- How the provisions of a coordinated reservoir operations plan relating to aquatic life and fisheries would affect project yield of the Chatfield Water Providers.
- Factors other than reservoir operations that could adversely affect the success of the walleye broodstock program or the health of the walleye populations within Chatfield Reservoir.
- Factors other than releases from Chatfield Reservoir that could adversely affect the aquatic life and fisheries of the South Platte River below Chatfield Reservoir such as alterations in flow from changes in water use by others, climate change, threats to aquatic life such as disease or invasive species, flood events, toxic spills, and increased public use.
- Given the mix of Chatfield Water Providers, their differing needs, and the legal and physical availability of water to store in the reallocated space, how frequently the Chatfield Water Providers will be able to meet the objectives of an operations plan that includes downstream releases designed to minimize adverse impacts and/or benefit aquatic life and recreation?

- Changes in the Chatfield Water Providers' water systems that could affect operations.
- Changes made to the physical habitat of the South Platte River from habitat, drainage, or flood improvement projects.
- Future water demands unrelated to this project, which could change flow patterns in the South Platte River and impact aquatic life.

Contingencies

The following iterative process will be used to address uncertainties associated with aquatic life and fisheries:

- The operations plan includes multiple regularly scheduled meetings involving the CPW, Chatfield Water Providers, and others where the current conditions relating to operations will be discussed and future operational actions will be forecasted.
- Monitoring the status of the aquatic life and fisheries both within and downstream of Chatfield Reservoir are part of the regular activities conducted by CPW. CPW will share this information with the Chatfield Water Providers at the periodic operations meetings.
- CPW will be given the opportunity at the operations meetings to discuss the status and make recommendations for improvements of operations at Chatfield Reservoir relating to both the walleye broodstock program and the fishery in the South Platte River downstream of Chatfield Reservoir.
- Any alterations to the operations plan related to aquatic life and fisheries can be proposed, discussed, and mutually agreed upon by the CPW, Chatfield Water Providers, and Corps as part of the regular business of the operations meetings.

References

Chatfield Watershed Association (CWA). 2013. Regulatory activity. Available at: <http://www.chatfieldwatershedauthority.org/regulations.html>.

Colorado Department of Public Health and Environment Water Quality Control Commission (CDPHE-WQCC). 2013. Regulation No. 38 Classifications and Numeric Standards for South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin. 5CCR 1002-38. Effective: March 1, 2013.