Appendix HH
Comparative Review of Reservoir Fluctuation Zone
Chatfield Reallocation Project

Consultants in Natural Resources and the environment

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COMPARATIVE REVIEW OF RESERVOIR FLUCTUATION ZONE CHATFIELD REALLOCATION PROJECT

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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COMPARATIVE REVIEW OF RESERVOIR FLUCTUATION ZONE CHATFIELD REALLOCATION PROJECT

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Background

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. Historically, water levels at Chatfield Reservoir fluctuated a maximum of about 9 feet. Alternative 3 for the proposed reallocation is estimated to have a maximum fluctuation of up to 21 feet (Draft FR/EIS, Table 4-7). However, the maximum conservation pool elevation with reallocation of 5,444 feet mean sea level (msl) would be infrequently reached. For about 82 percent of the days for the period of record, stored water would not reach 5,444 msl (Draft FR/EIS, Table 4-7). Based on the range of values between the first and third quartile of data for all years in the period of record combined, the fluctuation with reallocation (Alternative 3) would increase up to 7.1 feet (Draft FR/EIS, Figure 4-16). Within the growing season, the reallocated pool level during an average year would approximate 5,440 feet msl with fluctuations of about plus or minus 2 feet (Draft FR/EIS, Figure 4-15).

Purpose

This report examines the fluctuation zones of reservoirs in the region to help determine the range of potential conditions that could occur within the expanded fluctuation zone at Chatfield Reservoir. Some of the comments on the Draft FR/EIS expressed concern regarding the appearance and characteristics of the fluctuation zone associated with reallocation. These comments characterized the future expanded fluctuation zone as a bathtub ring, mudflat, and area dominated by weeds. This report provides additional information on the range of possible conditions for the new fluctuation zone and the likely characteristics of the fluctuation zone of Chatfield Reservoir associated with reallocation.

Approach

The fluctuation zones of the following reservoirs were assessed for this study:

- Barr Lake
- Bear Creek Lake
- Cherry Creek Reservoir
- Jackson Reservoir
- John Martin Reservoir
- Pueblo Reservoir

Chatfield Reservoir was also visited to confirm past observations. These reservoirs were selected because they have a variety of characteristics in common with Chatfield Reservoir and exhibit diversity in the range of reservoir fluctuations (Table 1). Each reservoir is somewhat unique with characteristics formed by the landscape in which it occurs and how the reservoir is operated. However, all of these reservoirs have some characteristics in common with Chatfield Reservoir. All of the reservoirs reviewed occur within the plains of eastern Colorado and have managed recreation associated with the reservoir and its fluctuation zone. Each reservoir was visited in October 2012. The site review focused on examining the fluctuation zone for type of substrate (sand, mud, gravel, cobble, or rock); vegetation establishment; weeds; and general appearance. The year 2012 presented a great opportunity to assess the fluctuation zones of these reservoirs. The unusually high snowpack and runoff of 2011 filled most reservoirs and the unusually dry conditions of 2012 substantially lowered the reservoirs. These back-to-back extremes facilitated a review of the characteristics of exposed fluctuation zone.

Table 1. Comparison of reservoirs reviewed.

Reservoir	Surface Water (acres)	Park Management	Recreation	Annual Visitation[1]	Use of Water Stored	Degree of Reservoir Fluctuation	On-Channel/ Off-Channel
Barr Lake	1,950	CDPW	Boating, fishing, wildlife observation, waterfowl hunting, hiking trails, picnicking, environmental education, and equestrian trails	104,912	Irrigation	Large	Off-channel

Reservoir	Surface Water (acres)	Park Management	Recreation	Annual Visitation[1]	Use of Water Stored	Degree of Reservoir Fluctuation	On-Channel/ Off-Channel
Bear Creek	110	City of Lakewood	Bike, hike, and equestrian trails; fishing; boating; picnicking; and wildlife observation	450,000	Flood	Minor	On-channel
Chatfield	1,423	CDPW	Bike, hike, and equestrian trails; fishing; boating; picnicking; camping; marina; hot air balloon port; environmental education; swim beach; and model airplane field	1,505,499	Flood; water supply	Moderate	On-channel
Cherry Creek	880	CDPW	Bike, hike, and equestrian trails; fishing; boating; picnicking; camping; marina; swim beach; and wildlife observation	1,437,452	Flood	Moderate	On-channel
Jackson	2,511	CDPW	Boating, fishing, wildlife observation, hunting, camping, picnicking, and swim beach	162,345	Irrigation	Large	Off-channel
John Martin	11,444	CDPW	Boating, fishing, wildlife observation, picnicking, camping, hiking, hunting, and swim beach[2]	147,533	Flood;	Large	On-channel

Reservoir	Surface Water (acres)	Park Management	Recreation	Annual Visitation[1]	Use of Water Stored	Degree of Reservoir Fluctuation	On-Channel/ Off-Channel
Pueblo	5,399	CDPW	Boating; fishing; wildlife observation; bike, hike, and equestrian trails; picnicking; swim beach[2], and marinas.	1,804,805	Flood; water supply	Large	On-channel

[1]All visitation is for FY 2009-2010 except for Chatfield, which is 2006-2007, Cherry Creek, which is for 2007-2008, and Bear Creek which is for 2011.
[2]Swim beach at this park is located below the dam.

The review of the reservoir fluctuation zone focused on areas at each reservoir that are managed for recreation and were readily accessible. Vegetation considered weeds are those species listed on the State of Colorado's noxious weeds list (www.colorado.gov/cs/Satellite/ag_Conservation/CBON/1251618780047; accessed October 27, 2012). Although not listed on the state's noxious weed list, cocklebur (*Xanthium strumarium*) was also considered a weed because it is not native, frequently invades drawdown areas, and its bristly fruits can be a nuisance to recreationists. Photos of key characteristics were taken at each reservoir and are presented in this report.

Report Organization

This report first presents observations on each of the six reservoirs assessed in separate sections. The soils (substrate of the fluctuation zone), weeds, and vegetation within the fluctuation zone are discussed for each reservoir reviewed. The final section of this report presents comparisons of the characteristics of the fluctuation zones of the reservoirs reviewed with Chatfield Reservoir and based on these comparisons discusses what is likely to occur in the fluctuation zone of the reallocated flood control pool of Chatfield Reservoir. Photos showing characteristics of the fluctuation zone are presented in Appendix A.

Barr Lake

Barr Lake occurs at the northeastern edge of the Denver metropolitan area (Figure 1). Barr Lake is an off-channel reservoir that is filled by the O'Brian Canal that diverts water from the

South Platte River. Water is stored in the lake for irrigation. Reservoir levels fluctuate substantially each year in response to irrigation deliveries and filling. The reservoir and lands surrounding the reservoir are managed as Barr Lake State Park.

Soils

At the time of observation, the elevation of the water in Barr Lake was very low and portions of what is typically lake bottom were exposed (Photo 1). The soils of the fluctuation zone are comprised of sand. The only muddy areas observed were exposed lake bottom next to the open water.

Weeds

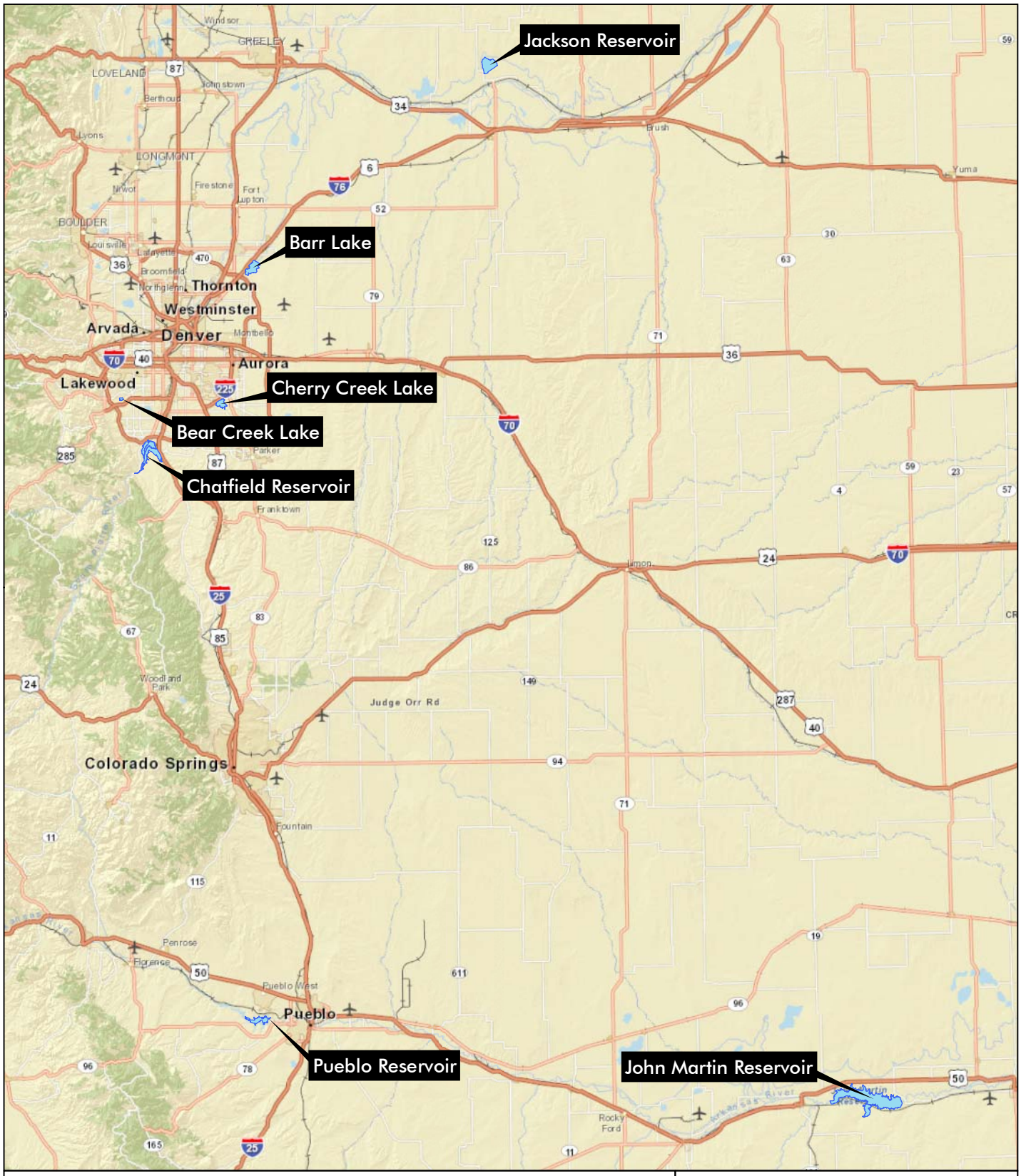
Scattered patches of weeds were observed within the fluctuation zone. Small patches of cocklebur and scattered individuals of puncturevine (*Tribulus terrestris*) were observed within the fluctuation zone. Spiney cocklebur (*Xanthium spinosum*), but not the common cocklebur observed at Barr Lake is on the state "watch list" and puncturevine is on the State "C List" (widespread; stopping the continued spread not practicable).

Other Vegetation

Much of the upper portions of the fluctuation zone is vegetated with herbaceous species commonly associated with moist soils and drawdown areas. Smartweed (*Polygonum* spp.) and suckleya (*Suckleya suckleyana*) comprised most of the vegetation (Photos 2 and 3). The vegetation was generally low in stature. The suckleya had a prostrate growth form and the knotweed formed dense patches 1 to 2 feet tall. Cottonwoods along the shoreline showed obvious high water marks, indicating that the trees had been inundated for some period of time about 2 to 3 feet deep (Photo 4).

Other Observations

The upper portion of Barr Lake is managed as a wildlife refuge with numerous bird watching overlooks (Photo 5). The vegetation within the fluctuation zone appears to attract waterfowl (when inundated) and shore birds when exposed.



Reservoir Fluctuation Zone Study Reservoir Locations

Figure 1
Vicinity Map

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October 2012

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Bear Creek Lake

Bear Creek Lake is in the southwest Denver metropolitan area and is formed by a dam at the confluence of Turkey Creek and Bear Creek (Figure 1). The reservoir was constructed by the U.S. Army Corps of Engineers (Corps) for flood control. Reservoir levels fluctuate within a relatively narrow range compared to the other reservoirs reviewed. The lake and its surrounding lands are managed by the City of Lakewood as a park.

Soils

At the time of the on-site review, the exposed fluctuation zone was about 10 feet wide in most locations (Photo 6). The fluctuation zone substrate is comprised of sand. No mudflats were observed. There are some fines where Bear Creek and Turkey Creek flow into the reservoir (Photo 8).

Weeds

Very little vegetation was observed within the exposed fluctuation zone. No noxious weeds were observed in the fluctuation zone.

Other Vegetation

Minimal vegetation was observed within the fluctuation zone. Scattered individuals of knotweed and goosefoot were observed (Photo 7).

Cherry Creek Reservoir

Cherry Creek Reservoir occurs in the southeast Denver metropolitan area and is formed by a dam on Cherry Creek (Figure 1). The reservoir was constructed by the Corps. Relative to the reservoirs reviewed, Cherry Creek Reservoir has a moderate degree of fluctuating water levels (Photo 9). The reservoir and lands surrounding the reservoir are managed as Cherry Creek State Park.

Soils

The fluctuation zone substrate is comprised of sand, the only observed mudflat occurred on the delta formed where Cottonwood Creek flows into the reservoir (Photo 11). Cottonwood

Creek drains the plains region of Arapahoe and Douglas counties and transports clay and silt sized materials to Cherry Creek Reservoir to form the mudflat delta.

Weeds

Very little vegetation was observed within the fluctuation zone. The only noxious weed observed at the higher limits of the fluctuation zone was leafy spurge (*Euphorbia esula*). Russian olive (*Elaeagnus angustifolia*) occurs near the ordinary high water mark (OHWM) and appears to be controlled within the state park. Leafy spurge and Russian olive are noxious weeds on the State "B List" (control to stop the continued spread of these species).

Other Vegetation

At and above the OHWM there are numerous seedlings and saplings of plains cottonwood (*Populus deltoides* subsp. *monilifera*) and coyote willow (*Salix exigua*). Wetland vegetation has become established at the mudflat/delta area at Cottonwood Creek and extensive wetlands occur at the upper end of the reservoir where Cherry Creek has formed a delta. This area has been designated as a wetland preserve.

Other Observations

The exposed reservoir shoreline along much of the reservoir was about 40 to 50 feet wide and estimated to be about 4 to 5 feet below the OHWM. The distance between the bathrooms/change facilities and the edge of the water at the swim beach was about 380 feet at the time of the site review (Photo 10).

Jackson Reservoir

Jackson Reservoir is in northeast Colorado about 8 miles north of the town of Wiggins and is used to store water for irrigation (Figure 1). The reservoir is off-channel north of the South Platte River and is filled by the Jackson Lake Inlet Canal, which diverts water from the nearby South Platte River. Jackson Reservoir is subject to widely varying water levels that produce a large fluctuation zone (Photo 12). The reservoir and lands on the west and south sides of the reservoir are managed as Jackson Lake State Park.

Soils

The fluctuation zone substrate is comprised of sand. At the time of the site review, reservoir water levels had declined substantially, exposing a portion of the reservoir bottom where organics and fines have accumulated. The exposed bottom formed a narrow muddy border around the water's edge (Photo 13). The soils in this area were soft and muddy, but would support travel. Except for this narrow exposed area of reservoir bottom, the fluctuation zone was a sandy beach and not a mudflat (Photo 12).

Weeds

Vegetation, including noxious weeds, has established in portions of the fluctuation zone. Salt cedar (*Tamarisk ramosissima*) seedlings occurred in concentric rings within portions of the fluctuation zone (Photo 17). Salt cedar is a State "B List" species, which has been designated for control to stop its continued spread. Although hundreds of salt cedar seedlings were observed, no mature salt cedars were observed. Salt cedar is likely controlled by CDPW, as CDPW has noted that control of noxious weeds is one of the challenges faced by park management (CSP 2010b). Cocklebur also occurred in scattered patches within the fluctuation zone (Photo 18).

Other Vegetation

Portions of the fluctuation zone were vegetated (Photo 16). All of the vegetation appeared to have become established during the 2012 growing season. Commonly occurring vegetation includes knotweed, goosefoot, three-square (*Schoenoplectus pungens*), and barnyard grass (*Echinochloa crus-galli*). Additionally, numerous cottonwood seedlings form concentric rings in portions of the fluctuation zone, similar to what is described above for salt cedar.

Other Observations

The exposed reservoir shoreline was extensive at the time of the site review. The reservoir is valued for its abundant wildlife and bird watching opportunities (CSP 2010b). At the time of the site review, numerous shore birds and hundreds of snow geese were using the reservoir (Photo 14). Jackson Lake State Park is ranked one of the "Top 15 Park Beaches" by a national camping service (CSP 2010b). At the time of the site review, the walk from the change rooms and bathrooms was about 615 feet to the swim beach and about 280 feet from the swim beach to the nearest porta-potty (Photo 15).

John Martin Reservoir

John Martin Reservoir is about 5 miles east of Las Animas, Colorado (Figure 1). The reservoir was constructed by the Corps on the Arkansas River for flood control. The reservoir is subject to widely fluctuating water levels (Photo 19). Portions of the reservoir and lands adjacent to the northeast shore and below the dam are managed as John Martin Reservoir State Park.

Soils

Dakota sandstone outcrops and cliffs border the reservoir (Photo 20). The fluctuation zone substrate is comprised of sand, broken sandstone, and cobble associated with the Arkansas River alluvium. Similar to Pueblo Reservoir, the upper ends of inlets at John Martin Reservoir have a finer substrate. Only one muddy area was observed within the state park and it occurred at the margin of the shoreline adjacent to the water's edge (Photo 22). This area supported a wetland with saturated soils.

Weeds

Similar to Pueblo Reservoir, the inlets of John Martin Reservoir support vegetation within the fluctuation zone, including weeds. Cocklebur and salt cedar were commonly observed within the fluctuation zone within inlets (Photo 21). Of the reservoirs reviewed for this study, John Martin Reservoir was the only reservoir where mature salt cedar was commonly observed (Photo 23).

Other Vegetation

The John Martin Reservoir fluctuation zone was generally void of vegetation except for the inlet areas described above. In addition to cocklebur and salt cedar commonly occurring in these areas, vegetation also includes barnyard grass, witchgrass (*Panicum capillare*), three-square, and nut sedge (*Cyperus* spp.). Similar to Pueblo Reservoir, plains cottonwoods are established on the tops of the cliffs that border the reservoir more than 20 feet above the reservoir water levels at the time of the site review (Photo 24).

Other Observations

John Martin Reservoir is one of the premier birding locations in the interior Untied States, with about 375 resident and migratory bird species. The reservoir has been designated by the Audubon Society as an "Important Bird Area" (CSP 2010c).

Pueblo Reservoir

Pueblo Reservoir is about 10 miles west of Pueblo, Colorado and is formed by a dam on the Arkansas River (Figure 1). The reservoir was constructed by the U.S. Bureau of Reclamation. The reservoir is subject to widely fluctuating water levels (Photo 25). The reservoir and portions of lands north, south, and below the reservoir are managed as Lake Pueblo State Park. The reservoir is used to store water for municipal and industrial uses, irrigation, flood control, and recreation.

Soils

Outcrops and cliffs of shale and limestone border the fluctuation zone of Pueblo Reservoir. The shale, limestone, and Arkansas River alluvium combine to produce a substrate in the fluctuation zone that varies from large broken blocks of rock, to shards of shale and limestone, to finer substrates. Most of the substrate is sand size or larger. However, there are areas of finer substrate, particularly in reservoir inlets formed by drainages and washes that border the reservoir. These inlet areas typically have a flatter grade than the surrounding fluctuation zone or in some instances may have a gradient away from the reservoir (i.e., form depressions within the fluctuation zone). These flatter areas and depressions accumulate fines and typically have soils that are moister than the rest of the fluctuation zone, and are likely muddy at times.

Weeds

Weeds were observed in the scattered inlet portions of the fluctuation zone (Photos 28, 29, and 30). Some salt cedar seedlings were observed within these areas, as well as more mature individual salt cedars scattered around the reservoir above the OHWM. Cocklebur commonly occurred in the inlet portions of the fluctuation zone.

Other Vegetation

Most of the Pueblo Reservoir shoreline is unvegetated. As discussed above, the inlet portion of the fluctuation zone supports vegetation. In addition to the weeds discussed above, vegetation in these areas also include annual sunflower (*Helianthus annus*), coyote willow, curly cup gumweed (*Grindelia squarrosa*), plains cottonwood, and witchgrass (Photo 27). Water levels in Pueblo Reservoir fluctuates greatly. At the time of the site review, water levels were an estimated 20 to 25 feet below the reservoir's high-water elevation. Cottonwoods and willows appear to become established within the fluctuation zone during periods of prolonged drawdowns and are subsequently inundated and killed during higher water levels (Photo 26). The cycle appears to repeat periodically.

Also of note is the common occurrence of plains cottonwoods and coyote willows on top of the cliffs that border the reservoir (Photo 31). It is clear from erosion, soils, and drift deposits that the tops of these cliffs are inundated, at least briefly, during periods of high-water levels; however, these areas were 20 to 25 feet higher than reservoir water levels at the time of the site review.

Other Observations

Despite the large fluctuation in reservoir water levels, Lake Pueblo State Park has about 1.8 million annual visitors. Of all of the state parks reviewed for this study in October, Lake Pueblo State Park had the most visitors observed at the time of the site review.

Study Findings

The review of the fluctuation zones of the reservoirs studied indicates the following that could be used to assess the potential conditions associated with an expanded fluctuation zone of a reallocated Chatfield Reservoir. Each of the following are discussed in greater detail below:

- Mudflats were rarely observed at any of the reservoirs reviewed and are unlikely to commonly be a component of the fluctuation zone at Chatfield Reservoir.
- Noxious weeds were not commonly observed within the fluctuation zone of the reservoirs reviewed and are unlikely to become a significant problem for the fluctuation zone at Chatfield Reservoir.
- The establishment of vegetation within the fluctuation zone can vary widely in terms of vegetation cover and species composition.

- The reservoirs reviewed provide significant wildlife habitat even with, and sometimes because of, their broad fluctuation zones.
- Reservoirs with substantial elevational swings in the fluctuation zone continue to support substantial recreation visitation.

Mudflats

Mudflats were rarely observed at the reservoirs reviewed. When observed, mudflats were limited to the deltas of drainages that imported fines to the reservoir, the exposed bottom of the reservoir, or at the heads of inlets. Despite a wide range of geology and soils at the reservoirs, the substrate of the fluctuation zone was dominated by sand-sized or larger particles. The consistency of the substrate lacking fines that would produce a muddy substrate is likely a function of water storage and wave action suspending finer material and depositing the fines in the reservoir bottom.

The substrate of the fluctuation zone at Chatfield Reservoir was comprised of coarser material than most of the reservoirs reviewed. Over the long term, expanding the fluctuation zone at Chatfield Reservoir is unlikely to change the current composition of the substrate of the shores of Chatfield Reservoir, which are comprised primarily of coarse sands and pea-sized gravel. It may take a few years of inundation and wave action associated with reallocation to suspend fines within the expanded fluctuation zone and deposit them in the reservoir bottom.

The South Platte River and Plum Creek form the two arms of Chatfield Reservoir. Both drainages bring sediment into the reservoir, but Plum Creek has formed a larger delta and appears to import more fines into the reservoir than the South Platte River. If mudflats were to form when reservoir levels were low, they would most likely be limited to the Plum Creek delta area. The substrate of the beaches and shoreline of the South Platte River arms are likely to continue to be comprised of sands and pea-sized gravel.

Weeds

Noxious weeds were uncommonly observed within the fluctuation zones of the reservoirs reviewed. Exceptions include areas of concentrated salt cedar seedlings observed at Jackson Reservoir and mature salt cedar at the higher elevations of the fluctuation zone of Pueblo and John Martin reservoirs. Other noxious weed species (puncturevine, Russian olive, and leafy

spurge) were observed infrequently. Although not on the state's list of noxious weeds, cocklebur was observed in the fluctuation zone of Jackson, Pueblo, and John Martin reservoirs and was common in the inlets of John Martin and Pueblo reservoirs. Drawdown areas can provide suitable habitat for cocklebur and the cocklebur fruit can be a nuisance to reservoir visitors.

Based on the review of regional reservoirs and existing conditions at Chatfield Reservoir, noxious weeds are not likely to become a problem with an expanded fluctuation zone at Chatfield Reservoir. With the exception of Barr Lake, the majority of the fluctuation zones reviewed were unvegetated. Vegetation at these reservoirs tended to become established in pockets where conditions were favorable such as inlets and coves with shorelines of fairly flat gradients (Photos 21, 29, and 30). At some reservoirs (John Martin, Pueblo, and Jackson), these favorable areas had salt cedar seedlings and mature cocklebur. However, only John Martin and Pueblo reservoirs had mature salt cedar within the fluctuation zone and salt cedar was only common at John Martin Reservoir. The lack of mature salt cedar at the other reservoirs could be a function of water levels that routinely inundate and kill the seedlings or control by CDPW, or a combination of these. Regarding the potential for an increase of weeds within the Chatfield Reservoir reallocation fluctuation zone, the important facts are:

- Mature salt cedars were an issue only at John Martin and Pueblo reservoirs. These reservoirs are located in the lower Arkansas River where salt cedar is prevalent.
- Salt cedar has been observed at Chatfield State Park, but to date does not commonly occur in the park.
- Salt cedar does not appear to be an issue at the Denver metro reservoirs (Chatfield Reservoir, Barr Lake, Bear Creek Lake, and Cherry Creek Reservoir).

Based on this information, salt cedar is unlikely to be an issue at Chatfield Reservoir. However, because it is a noxious weed that can readily establish in the drawdown habitat created by an expanded fluctuation zone, it will be important to monitor for its presence and eradicate any establishment. This should be addressed in the monitoring and adaptive management plans for the Chatfield Reservoir reallocation.

Similar to salt cedar, cocklebur is currently not a problem at the Denver metro reservoirs (but was common at Pueblo and John Martin reservoirs). Some cockleburs were observed at Barr Lake, but their numbers and distribution were limited. Drawdown areas can provide suitable

habitat for cocklebur establishment, and once established, can be challenging to control. Based on observations at Cherry Creek Reservoir and Bear Creek Lake, it is unlikely that cocklebur will become a weed issue at Chatfield Reservoir. However, similar to salt cedar, it will be important to monitor for its presence and eradicate any establishment. It will be particularly important to control cocklebur at the swim beach and prevent cocklebur plants from producing fruits that would be a nuisance to swim beach users. Periodic tilling or disking of the swim beach could prevent cocklebur plants from producing fruits should cocklebur plants colonize the swim beach. This should be addressed in the monitoring and adaptive management plans for the Chatfield Reservoir reallocation.

Weeds within the fluctuation zone can negatively affect the aesthetics and recreation users' experience. However, it is clear from the annual visitation data in Table 1 that weeds do not substantially impair visitation. Pueblo Reservoir, with its widely fluctuating water levels and weedy inlets, has an annual visitation of more than 1.8 million visitors.

With the exception of cocklebur and salt cedar at Pueblo and John Martin reservoirs, weeds were not an issue at the reservoirs reviewed. This may be due to weed control by CDPW and the City of Lakewood. If this is the case, it demonstrates CDPW's history and ability to properly manage weeds within the fluctuation zone of the reservoirs, and the likely ability to do so for an expanded fluctuation zone at Chatfield Reservoir.

Other Vegetation

The establishment of vegetation within the fluctuation zone varied considerably among the reservoirs reviewed. Barr Lake had the broadest distribution of vegetation within the fluctuation zone (Photos 2 and 3). The other reservoirs typically had pockets of vegetation within the fluctuation zone, often associated with inlets and deltas. Several observations of the reservoirs reviewed could apply to an expanded fluctuation zone at Chatfield Reservoir:

- Prolonged drawdowns can lead to the establishment of vegetation within the fluctuation zone. The extensive smartweed at Barr Lake and plains cottonwood and coyote willow saplings at Pueblo Reservoir provide examples.
- The most commonly observed situation was a lack of living vegetation within the majority of fluctuation zones.

- Living vegetation, such as smartweed at Barr Lake, appears to be an attractant to wildlife. The fruits of smartweed are used by waterfowl, shorebirds, and songbirds as a food source (Martin et al. 1951).

It is challenging to estimate if vegetation will become established within the expanded fluctuation zone of Chatfield Reservoir due to the variation observed at the reservoirs reviewed. Prolonged drawdowns may lead to the establishment of cottonwoods and willows at the water's edge for a few years that will then be inundated and killed as seen at Pueblo Reservoir. Consistent drawdowns during the growing season that provide moist soils could produce well-developed vegetation within the fluctuation zone as seen at Barr Lake. The most common situation observed at the reservoirs reviewed was the majority of the fluctuation zone void of vegetation with pockets of vegetation at inlets and deltas. It is likely this will also be the situation at Chatfield Reservoir.

Observations of plains cottonwoods 20 or more feet above the current water levels at Pueblo and John Martin reservoirs indicate these trees can become established and survive at the higher elevations of the reservoir fluctuation zones, even with extended drawdowns (Photos 24 and 31). Similar situations at Chatfield Reservoir could lead to the recruitment of cottonwoods at the higher elevations of the expanded fluctuation zone. Establishment of new cottonwoods will need to be monitored and addressed as part of future impacts analysis and mitigation.

Wildlife Habitat

All of the reservoirs reviewed provide important wildlife habitat. Barr Lake has a nature center and the upper portion of the lake is designated as a wildlife refuge. The upper portion of Cherry Creek Reservoir is designated as a wetlands preserve. John Martin Reservoir is recognized as one of the premier birding locations in the interior U.S., including the designation from the Audubon Society as an important bird area (CSP 2010c). Some of these reservoirs have greater fluctuation than those predicted for Chatfield Reservoir, but provide great habitat for wildlife and bird watching opportunities. Based on the history of these reservoirs, it is likely that Chatfield Reservoir will continue to provide important wildlife habitat with an expanded fluctuation zone.

Recreation

Although recreation was not a focus of this study, it is impossible not to observe some recreational opportunities and constraints at the reservoirs reviewed. There has been much discussion regarding the swim beach at Chatfield Reservoir and how the distance between the change rooms/bathrooms and the water's edge will adversely affect the visitor's experience. During the review, the distance from the bathrooms/change rooms to the water's edge at Chatfield Reservoir was about 160 feet. Two of the reservoirs reviewed (Cherry Creek and Jackson) had swim beaches managed by CDPW. At Cherry Creek Reservoir, the distance from the bathroom/change facilities to the water's edge was about 380 feet. At Jackson Reservoir, the distance from the bathroom/change facilities to the start of the swim beach was about 615 feet and the closest porta-potty was about 280 feet. Jackson Lake State Park advertises that it is ranked as one of the top 15 park beaches by a national camping service (CSP 2010b) and Cherry Creek State Park has an annual visitation of about 1.4 million (FY 2007-2008), many of whom use the swim beach. It appears visitors are willing to walk greater distances if the swim beach is of high quality.

The design for the new swim beach at Chatfield Reservoir calls for the beach to have the shortest distance feasible between the water's edge and bathroom/change facilities. However, it appears that a greater distance between facilities and the water does not necessarily correlate with reduced visitor use.

The swim beach is but one example of how CDPW successfully manages the vagaries of reservoir fluctuations at their state parks. Reservoirs in Colorado's arid environment draw recreationists. By their very nature, reservoir levels fluctuate and the fluctuating reservoir levels create challenges as well as opportunities. Reservoir fluctuations create issues with use of boat ramps, docks, and marinas; fisheries; and weeds. The fluctuating reservoir levels can also create habitat for shorebirds and waterfowl and provide bird watching opportunities. Despite the management challenges, CDPW continues to successfully manage state parks associated with reservoirs in a way that is attractive to the public. Two of the reservoirs reviewed have more than 1 million visitors annually (FY 2007-2008). Management challenges associated with an expanded fluctuation zone at Chatfield Reservoir will arise, but it is unlikely that they will be issues that CDPW are not currently successfully addressing at other state parks associated with

reservoirs. The monitoring, mitigation, and adaptive management plans for the Chatfield Reservoir reallocation will need to adequately support CDPW in its future management of Chatfield Reservoir.

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APPENDIX A —

PHOTO LOG

Barr Lake

Photo 1 - View of fluctuation zone from the boat ramp.

Barr Lake

Photo 2 - Dense growth of smartweed in upper portions of the fluctuation zone.

Barr Lake

Photo 3 - Clumps of smartweed with prostrate goosefoot growing between the clumps.

Barr Lake

Photo 4 - Wildlife observation platform with views of vegetated portions of the fluctuation zone.

Barr Lake

Photo 5 - Cottonwoods near the reservoir high-water elevation with water marks from inundation.

Bear Creek Lake

Photo 6 - Typical shoreline at Bear Creek Lake.

Bear Creek Lake

Photo 7 - Exposed portion of Bear Creek Lake.

Bear Creek Lake

Photo 8 - Exposed substrate and some muddy areas at the Turkey Creek delta area.

Cherry Creek Reservoir

Photo 9 - Typical shoreline at Cherry Creek Reservoir.

Cherry Creek Reservoir

Photo 10 - Swim beach with facilities patio in the foreground.

Cherry Creek Reservoir

Photo 11 - Mudflat and wetland at the Cottonwood Creek delta.

Jackson Reservoir

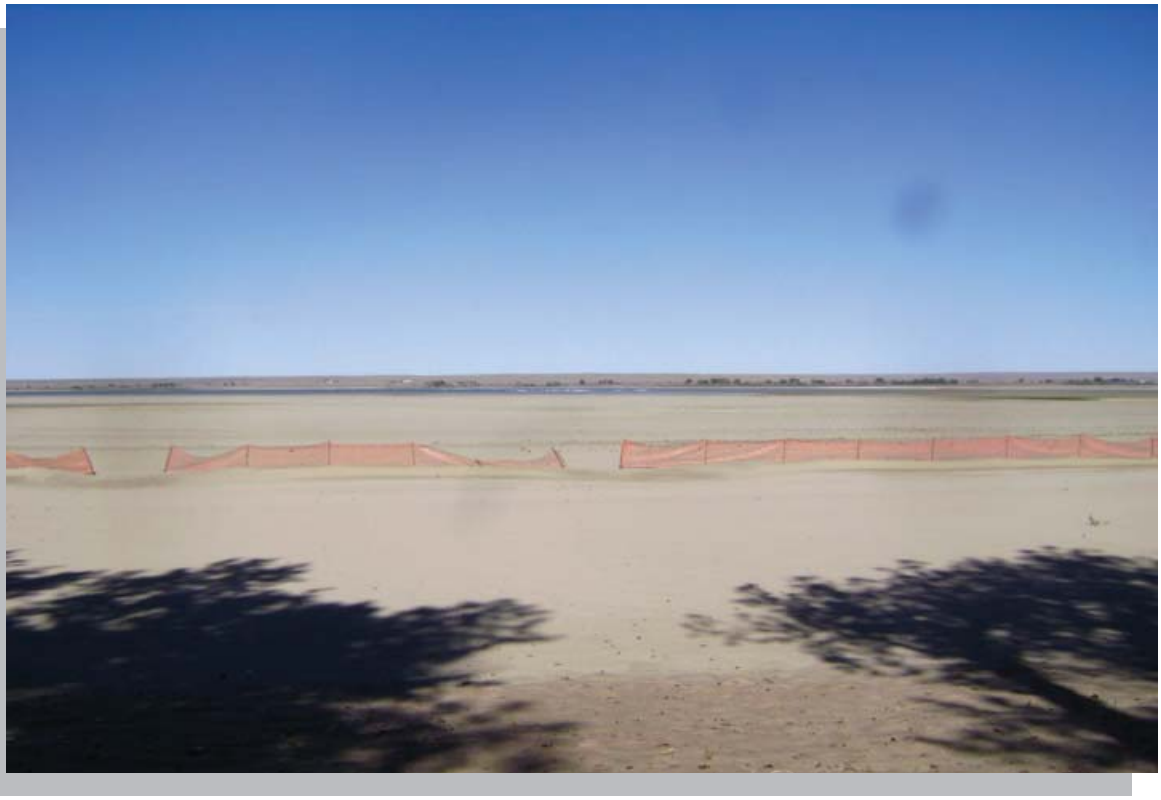
Photo 12 - Overview of fluctuation zone with very little vegetation.

Jackson Reservoir

Photo 13 - Exposed muddy reservoir bottom next to open water and shorebirds.

Jackson Reservoir

Photo 14 - Snow geese along the reservoir shoreline.



Jackson Reservoir

Photo 15 - Swim beach.

Jackson Reservoir

Photo 16 - Vegetation within the fluctuation zone. Threesquare mixed with rows of plains cottonwood seedlings.

Jackson Reservoir

Photo 17 - A row of salt cedar seedlings.

Jackson Reservoir

Photo 18 - Scattered cockleburs in the foreground with salt cedar row in the background.

John Martin Reservoir

Photo 19 - Overview of the fluctuation zone.

John Martin Reservoir

Photo 20 - Much of the reservoir is bordered by steep sandstone cliffs.

John Martin Reservoir

Photo 21 - Cockleburs form concentric rings along the shoreline of an inlet.

John Martin Reservoir

Photo 22 - Mudflat and wetland at the head of an inlet.

John Martin Reservoir

Photo 23 - Mature salt cedar at higher elevations of the fluctuation zone.

John Martin Reservoir

Photo 24 - Cottonwoods on top of the sandstone cliff 20 to 25 feet above the elevation of the water.

Pueblo
Reservoir

Photo 25 - Overview of the fluctuation zone.

Pueblo
Reservoir

Photo 26 - Cottonwoods and willows established at lower water levels and subsequently inundated.

Pueblo
Reservoir

Photo 27 - Cottonwoods established at the upper portion of the fluctuation zone.

Pueblo
Reservoir

Photo 28 - Cocklebur (rust brown color) within the fluctuation zone of an inlet.

Pueblo Reservoir

Photo 29 - Overview of fluctuation zone. Background shows how vegetation is associated with inlets formed by draws. The rusty brown vegetation is cockleburs and the yellow vegetation is cottonwoods.

Pueblo Reservoir

Photo 30 - Relatively bare fluctuation zone in the foreground with patches of cockleburs (rusty brown) and cottonwoods (yellow) in the background associated with draws and inlets.

Pueblo
Reservoir

Photo 31 - Cottonwoods established at the top of the fluctuation zone about 20 to 25 feet above the water level.