CHATFIELD STORAGE REALLOCATION PROJECT

TECHNICAL ADVISORY COMMITTEE (TAC)
TAC RECOMMENDATION DOCUMENT - No. 06

SUBJECT: Evolution of On-site Environmental Mitigation - Rev 03 (signed)

Date: July 11, 2016

Purpose:

This document serves as the basis of the TAC recommendation on the subject noted above.

Background:

The on-site environmental mitigation design has undergone a series of refinements since the FR/EIS Compensatory Mitigation Plan (CMP) was prepared in 2013. The FR/EIS conceptual designs, described in Section 6.1 of the CMP (FR/EIS Appendix K) envisioned a series of mitigation areas near the South Platte River and Plum Creek created utilizing sheet pile cutoff walls in an attempt to increase groundwater elevations, creating riparian and wetlands habitat in upland areas.

Soon after the signing of the Record of Decision in 2014, it became apparent that this approach would be ineffective as any groundwater mounding upstream of the sheet pile cut-offs would be temporary until the alluvial aquifer re-attained equilibrium at the original pre-cutoff wall elevation, leaving mitigation areas dehydrated.

In 2013 and 2014, Muller Engineering revisited the concept and proposed mitigation areas within or adjacent the South Platte River, Plum Creek and lower Marcy Gulch riparian zones that would be hydrated from various riverine and pond sources through diversions and conveyance systems consisting of open flow channels and pipelines. Although potentially effective, this conceptual refinement raised water rights issues due to the dual perceptions of:

1) diverting and conveying surface flows, and

2) creating wetlands out of upland areas.

Also, during this time, it became apparent that habitat was rapidly being lost to Plum Creek channel degradation that is lowering the water table and dehydrating the riparian corridor and associated wetlands and woodlands. During the EM2 preliminary design, the consultant proposed, and the CRMC agreed, that mitigation measures should both protect existing habitat and reclaim degraded habitat to mitigate project impacts and gain greater on-site EFU lift.

A similar process has occurred on the South Platte River due to 2015 high flows that resulted in the channel reoccupying an abandoned oxbow and flowing through Titan Lakes 1 and 2. If no action is taken this change could result in this alignment becoming the primary channel, threatening a large area of prime riparian woodlands and wetlands. Therefore, the preliminary design was further refined from the 2014 concept to include Plum Creek and South Platte River channel stabilization that will increase the water table elevation, rehydrate the riparian zone and reclaim degraded riparian habitat while protecting existing habitat.

In addition, the current design concept includes improvements of the Titan Lake and Cigar Pond shorelines to provide Preble's meadow jumping mouse habitat. These shorelines currently contain little PMJM habitat value, but once modified can provide maximum EFU lift, connectivity and increased variability to existing South Platte River riparian zone habitat. The potential shoreline improvements on these ponds were identified in Figures 18 and 19 contained in Section 6.1 of the CMP.

In addition to providing more resilient and sustainable mitigation habitat, the design has been refined to eliminate potential water right requirements by working within existing riparian corridors and restoring degraded wetlands, woodlands and riparian vegetation communities and protecting existing high quality habitat. This refined approach has the potential to increase on-site mitigation credits and reduce the need for off-site credits, an objective that is stated in the FR/EIS.

Recommendations

Based on the recommendations contained in the FR/EIS (July 2013) and the FWRMP (Jan 2014), on-site mitigation concepts have evolved over time, from one of simplistic structures intended to increase groundwater elevations and hydrate upland areas to create riparian, woodland and wetland habitats to protecting and rehydrating existing riparian zones to reestablish and protect riparian, woodland and wetland habitats. The current design concept maintains the intent to utilize increased groundwater elevations to hydrate these habitats, but in a way that improves and protects areas of natural habitat, eliminates water right concerns and, by stabilizing drainage channels, will provided a resilient, sustainable mitigation environment that will potentially reduce adaptive management requirements.

Recommendations for moving forward with on-site mitigation include the following additional actions:

- Accept the preliminary design refinements to locate mitigation areas within the South Platte River and Plum Creek riparian zones. Lower Marcy Gulch mitigation will remain as conceived in the Muller Engineering 2014 plan that provided the supporting analysis for the adaptive management refinements to the FR/EIS included in the Fish, Wildlife and Recreation Mitigation Plan approved by the State in 2015.

- Utilize the stabilization of the South Platte River and Plum Creek channels to restore and protect existing riparian zones by continued hydration of prime habitat and rehydration of existing habitat.

- Calculate EFU lift resulting from the protection of existing habitat as the difference between the current baseline EFUs and EFUs that will result from habitat degradation plus any habitat improvements that can be gained by the mitigation above and beyond the current baseline.

- Include PMJM habitat improvements along the Titan Lake and Cigar Pond shorelines adjacent to the South Platte River riparian zone.

Reference Documents

Muller Engineering Company, 2016. Project Development and History. (attached)

FR/EIS, Appendix K (CMP), Section 6.1, July, 2013. (attached)

Muller Engineering Company, 2013, Plum Creek Stream Stability Assessment Chatfield State Park (not attached- available in TAC Zoho folder: TAC Documents: Meetings: 04-July 8 2016: 06 Evolution of On-site Env Mit design)

Muller Engineering Company, 2014, Conceptual Design of Onsite Environmental Mitigation for Chatfield Reservoir Reallocation Project (not attached- available in TAC Zoho folder: TAC Documents: Meetings: 04-July 8 2016: 06 Evolution of On-site Env Mit design)

Requested Action

The TAC is requested to accept the refined approach to on-site environmental mitigation.

Request Rationale

The reclamation of degraded riparian zone habitat is consistent with the intent of the CMP in the FR/EIS that recognized refinements to the feasibility level study would be required for implementation of the Project. Providing improvements to degraded habitat in the South Platte River and Plum Creek riparian zones is compliant with this intent of the FR/EIS and further refines accepted concepts developed subsequent to the FR/EIS. Improving habitat along the Titan Lake and Cigar Pond shorelines adjacent to the South Platte River riparian zone is in conformance with the FR/EIS recommendation to maximize on-site mitigation EFUs, while increasing habitat benefits through increased habitat connectivity and diversity.

TAC Recommendation

The TAC recommends implementation of refined mitigation design concepts in the South Platte River and Plum Creek riparian zones that will benefit from stabilization of the destabilized drainage channels, increase hydration of degraded riparian areas, protect current prime habitats and increase habitat connectivity and diversity. The TAC reiterates its previous recommendation that Plum Creek restoration and stabilization occur as soon as practicable.

TAC Voting

The TAC members in attendance voted on July 8, 2016 on this Recommendation, in accordance with the TAC Charter Section C. In addition one TAC member reviewed the materials in advance of the meeting and gave his proxy to the Chairman with the prior approval of the PCT. The vote tally was 15 votes to "agree"; 0 votes to "accept"; and 0 votes to "reject" the Recommendation. The

recommendation is based on the total votes for "agree" and "accept". TAC adopted voting procedures also require that any Member voting to "reject" a recommendation to propose alternative(s) for consideration to move the issue forward.

TAC Rationale

The reclamation of degraded riparian zone habitat is consistent with the intent of the CMP in the FR/EIS that recognized refinements to the feasibility level study would be required for implementation of the Project. Providing improvements to degraded habitat in the South Platte River and Plum Creek riparian zones is compliant with this intent of the FR/EIS and further refines accepted concepts developed subsequent to the FR/EIS. Improving habitat along the Titan Lake and Cigar Pond shorelines adjacent to the South Platte River riparian zone is in conformance with the FR/EIS recommendation to maximize on-site mitigation EFUs, while increasing habitat benefits through increased habitat connectivity and diversity.

On behalf of the TAC:

Kevin Urie
Chair

Jennifer Anderson
Vice-Chair

Reference Documents

MEMORANDUM

Project:	Chatfield Storage Reallocation Project
To:	Barbara Biggs, Program Manager, CDM Smith Steve Lowry, Program Manager, CDM Smith
CC:	Ted Johnson, CDM Smith
From:	Jim Wulliman, Muller Engineering (EM2)
Date:	June 21, 2016
Subject:	Project Development and History

This memorandum documents the development and history of the Chatfield Storage Reallocation Project with regards to onsite environmental mitigation.

FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT

The Chatfield Storage Reallocation Project began in 1996, when the Colorado Water Conservation Board (CWCB), as the project sponsor on behalf of 15 water providers, formally requested that USACE consider reallocating space within Chatfield Reservoir. This led to a thorough and comprehensive evaluation of the proposed action, documented in the combined Feasibility Report and Environmental Impact Statement (FR/EIS). USACE served as the lead agency for this effort, which was undertaken in cooperation with the State of Colorado and the water users. Multiple alternative projects were investigated and impacts thoroughly explored. The recommended alternative called for storage of up to 20,600 AF of water in Chatfield Reservoir between elevations 5432 and 5444 for municipal and industrial, agricultural, and habitat uses.

A Record of Decision (ROD) was issued on May 29, 2014, marking the approval of the project based on the federal FR/EIS process.

COMPENSATORY MITIGATION PLAN

Appendix K of the FR/EIS comprises the Compensatory Mitigation Plan (CMP), prepared by ERO Resources and Tetra Tech with a final revision date of July, 2013. The CMP lays the groundwork for the environmental mitigation plan, addressing guiding principles, objectives, a proposed system for quantifying impacts and mitigation using "ecological functional units" (EFUs), proposed mitigation activities, implementation process, and probable costs.

To best compensate for adverse environmental effects, the CMP is ecologically based. Rather than using the typical mitigation approach of tracking impacts and mitigation using acres of impacts to resources, the "currency" of the CMP is EFUs. This ecological functions approach was taken because of the substantial geographic overlap in the target environmental resources (Preble's meadow jumping mouse, birds, and wetlands). The EFUs capture the ecological functions provided by the individual target environmental

resources as well as their overlap. To ensure a diversity and balance of mitigation activities, minimum levels of mitigation activities were established for Preble's meadow jumping mouse, birds, and wetlands that will contribute to meeting the overall goal to replace lost ecological functions and values of Preble's habitat, bird habitat, and wetlands associated with adverse impacts of reallocation. The result is that mitigation activities will provide the maximum combined ecological benefit rather than focusing on resource-specific activities.

To provide an ecologically meaningful assessment of impacts to the overlapping habitats of the target environmental resources, an ecological functioning index (EFI) was developed for each habitat type (see CMP Appendix C Ecological Functions Approach for details). The EFI is a unitless measure that rates habitat components for the target environmental resources on a scale of zero to one. The EFIs for the target environmental resource habitat components were multiplied by acres of impacts to determine the number of impacted EFUs for each target environmental resource. For example, if a habitat type has an EFI of 0.5 for Preble's and 12 acres of the habitat are lost, six Preble's EFUs would be lost. The total number of EFUs impacted is the sum of EFUs provided in the impact area for each target environmental resource. A similar approach is used to calculate predicted EFUs that would result from mitigation activities.

Calculations of on-site baseline and predicted mitigation EFUs in the CMP were based on the best available data at the time of the FR/EIS, which was a mix of information from desk-top reviews, limited fieldwork, and very broad habitat conversion concepts. Predicted mitigation EFU lift was estimated by assuming that in most of the mitigation areas, existing upland grassland habitat would be converted, on average, to about 20 percent wetland palustrine scrub-shrub, 20 percent forested upland, and 60 percent riparian shrublands.

The CMP concluded that 165 acres of onsite mitigation would be feasible, creating 85 EFUs with a probable cost of $22.6 million. Onsite mitigation was broken down into areas above the maximum water supply pool of elevation 5444 and proposed borrow areas below 5444, as summarized in Table 1.

Table 1. Summary of On-site Mitigation Information from CMP

	EFUs Created	Area of Mitigation, AC	EFU per AC	Opinion of Probable Cost
On-site Mitigation				
Environmental mitigation above El 5444	68	105	0.65	$ 22,223,489
Environmental mitigation in borrow areas below El 5444	17	60	0.28	$ 411,109
Subtotal	**85**	**165**	**0.51**	**$ 22,634,598**

The CMP proposed onsite environmental mitigation adjacent to Plum Creek, the South Platte River, Marcy Gulch, and Deer Creek. All of these areas except Deer Creek were considered in subsequent design studies; Deer Creek is an existing wetlands mitigation area constructed in association with the Colorado

Department of Transportation (CDOT). The wetland reportedly has issues related to water supply and was judged to be already maximized for mitigation opportunities in its current configuration.

Several habitat conversion techniques were described in the CMP for creating onsite environmental mitigation areas. The techniques were oriented toward creating wetter conditions to support wetland and transitional herbaceous species, trees and shrubs and convert upland grasslands to habitat favoring the Preble's Meadow Jumping Mouse (PMJM) and birds. The habitat conversion techniques included:

1. Lowering existing ground surfaces via excavation to get planted areas in closer vertical proximity to existing water tables.
2. Using sheet piling to raise existing water tables to place groundwater in closer vertical proximity to planted areas.
3. Directing surface water flows into mitigation areas.
4. Combinations of the above techniques.

Each of the habitat conversion techniques would be supplemented by planting and revegetation efforts with species favorable for the desired habitat enhancement.

Figure 1 shows a representative graphic from the CMP illustrating potential locations for onsite environmental mitigation along Plum Creek.

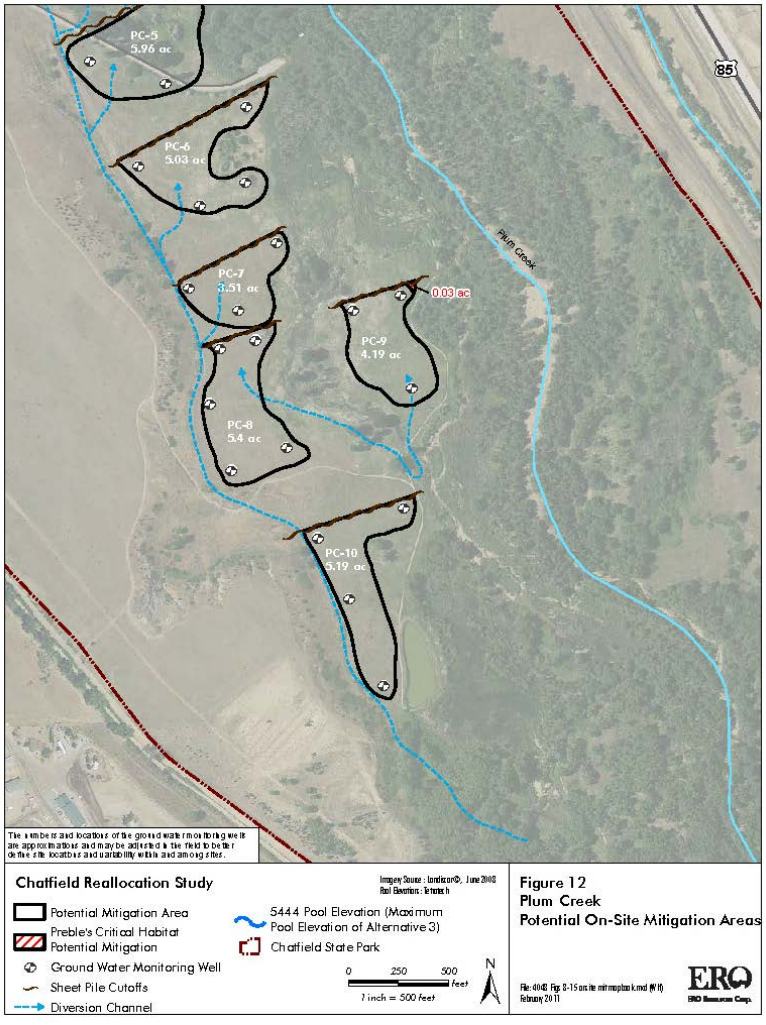


Figure 1. Example Habitat Mitigation Along Plum Creek from 2013 CMP

INVESTIGATION OF ONSITE WATER TABLE CONDITIONS

It was recognized in the CMP that subsequent field investigations would be necessary to gain an understanding of water table elevations and seasonal fluctuations in the vicinity of proposed mitigation areas. These investigations were undertaken by ERO Resources beginning in April, 2011 and continuing through March, 2014. A total of 71 groundwater monitoring wells were drilled and casings installed in proposed mitigation sites to allow periodic measurements of water table levels.

Table 2. Depth to Water Table, 2011 through 2013

	Depth from Ground Surface to Water Table (ft)	
Location	**Seasonal High Water Table**	**Seasonal Low Water Table**
Plum Creek Lower Terrace Area	0-5	6-8
Plum Creek Upper Terrace Area	6-13	10-14
South Platte Oxbow Area	3-6	5-9
South Platte Willow Creek Area	2-5	9-12
South Platte North Mitigation Area	5-8	7-9
South Platte Former Chatfield Wetlands Area	5-8	6-10
South Platte Borrow Area	4-14	7-16
Marcy Gulch Area	6-13	10-17

Maximum and minimum water table elevations at the wells were recorded and are summarized to the nearest foot in Table 2. As can be seen, the seasonal high water table was within 2 to 3 feet of the ground surface in several areas adjacent to Plum Creek and the South Platte River; elsewhere the depth to the seasonal high water table varied from 4 to 14 feet. The seasonal low water table ranged from 5 to 17 feet below the ground surface. The relatively low water table in many of the proposed mitigation areas represented a technical challenge addressed further in a subsequent design effort, described below.

FURTHER DEVELOPMENT OF ONSITE ENVIRONMENTAL MITIGATION IMPROVEMENTS

Muller Engineering Company was engaged starting in 2011 to work along with Ray Sperger of Ark Ecological Services and Mary Powell of ERO to assist in further developing onsite environmental mitigation concepts. The team undertook a thorough field reconnaissance of potential onsite mitigation areas, initiated investigations of soils and infiltration rates within the Park, and created plots and charts of the water table depth data recorded by ERO to aid with applying the information to the conceptual design of habitat mitigation improvements.

One of the critical elements of the mitigation design is how to convert from upland conditions to a wetter hydrology capable of supporting wetlands and riparian shrubs and trees. The investigation of groundwater conditions revealed that the water table is close to the existing ground surface in a handful of areas during just a portion of the year. In areas where the water table is not close to the surface, it would be difficult

to create widespread raises in the water table locating individual runs of sheet piling downstream of the pockets of habitat mitigation shown in the CMP; it was felt that much longer runs of sheet piling would be necessary to keep the water table from slipping around the piling and create a regional lift in the water table.

Of the possible habitat conversion techniques described in the CMP (summarized in Section 1.3.2), the primary approaches explored for the conceptual design was the use of locally shallow water table and the spreading of surface flows within the environmental mitigation areas. Spreading surface flows in existing or created secondary channels has been used successfully along Cherry Creek to promote favorable hydrology and enhance riparian vegetation and habitat. Photo 1 illustrates a created secondary channel along Cherry Creek at the 17 Mile House Open Space in Arapahoe County.

Photo 1. An example of enhanced habitat in a created secondary channel along Cherry Creek at the 17 Mile House.

PLUM CREEK DEGRADATION ASSESSMENT

During a field reconnaissance to assess environmental mitigation opportunities within the Park as part of the design effort above, an area of severe degradation was discovered along Plum Creek. Multiple parallel channels had eroded up to ten feet deep in the downstream reaches of Plum Creek. Photo 2 shows an 8-foot high headcut in the west channel observed in February, 2012 approximately 400 feet north of the central Plum Creek parking lot. Photo 3 shows degradation observed in the middle channel of Plum Creek.

Photo 2. Eight-foot high headcut in the west channel of Plum Creek discovered during a field reconnaissance in February 2012.

Photo 3. Degradation in the middle channel of Plum Creek had lowered the invert and adjacent water table by approximately 10-feet.

The riparian vegetation adjacent to the eroded Plum Creek channel reaches was severely impaired and numerous trees were dead or dying as a result of the drop in water level associated with the erosion, as

shown by Photo 4. Plant communities formerly typified by wetland species had gown sparse and become dominated by weeds.

Photo 4. Channel lowering and the associated drop in water table had led to die-off of trees and sparse, weedy undergrowth.

The Plum Creek corridor was experiencing environmental impacts from a degradation process that was independent from the proposed reallocation project. If the degradation continued unchecked, it would lead to extensive impacts to the Plum Creek riparian corridor and the water quality of Chatfield Reservoir. Due to these current and potential future impacts, the Chatfield Reservoir reallocation water users authorized Muller to undertake an assessment of Plum Creek stability concurrent with developing a conceptual design of onsite environmental mitigation. The assessment was based on a qualitative evaluation of the Plum Creek channel stability that included a review of previous studies, a field reconnaissance with photo log to document then current channel conditions, and stream profile evaluations.

Recommendations for stabilization measures and an initial opinion of probable construction costs (OPCC) were included in the summary report entitled *Draft Plum Creek Stream Stability Assessment*, dated April 2, 2013. The improvements were based on filling in the degraded channels and reestablishing a shallower, wider flow distribution and a higher water table to support a reinvigorated riparian corridor. Approximately $7.0M of stabilization improvements were recommended in the degraded lower reach of Plum Creek and about $3.2M of improvements were recommended further upstream in the west channel.

Appendix B includes several summary figures from the Plum Creek Stability Assessment illustrating channel conditions that existed in the 2012-2013 timeframe. The figures indicate the habitat area that had been impacted by the channel degradation that occurred in the lower reach and an even larger impact area predicted to degrade in the future if the channel headcuts and erosion continue to move upstream unchecked.

CONCEPTUAL DESIGN OF ONSITE ENVIRONMENTAL MITIGATION

The environmental mitigation approaches discussed in Section 1.3.4 were further developed and a set of eight drawings were prepared to illustrate the proposed conceptual design of mitigation areas along the South Platte River, Plum Creek, and Marcy Gulch within the Park. The conceptual design evolved beyond the initial approaches shown in the CMP and was anticipated to provide at least the same number of acres and EFUs of mitigation as was identified in the CMP. The conceptual design was finalized in a report dated March 2014 including the conceptual design drawings and an OPCC that remained within the overall budget identified in the CMP.

The conceptual design did not assess water supply or water rights aspects of the reallocation project or onsite environmental mitigation. It was the assumption of the CMP that the consumptive use of water for new environmental mitigation areas would not exceed the evapotranspiration associated with the wetlands, shrubs, and trees estimated to be lost with reallocation. The CMP stated that the Chatfield water providers would secure the necessary water rights if it is determined that a water right is required for environmental mitigation. These assumptions remained in effect for the purposes of the conceptual design.

FLUCTUATION ZONE ANALYSIS

An analysis of potential water surface fluctuation in Chatfield Reservoir was prepared by Muller, ERO, and Ark Ecological during the work on the onsite environmental mitigation conceptual design. The analysis was not intended as a prediction of actual future fluctuations, but was meant to illustrate the possible trends in fluctuation based on several inflow and outflow assumptions.

The baseline data used for the evaluation were the actual measured inflows to and outflows from the reservoir for the years 1987 through 2010 and the resulting actual water surface fluctuations for those years. Inflows of water to the water supply storage pool were assumed to comprise the portions of the actual inflow to the reservoir that the proposed reallocation water users would have had the legal right to store based on their anticipated water rights. Information on historic inflows, outflows, and water surface in the reservoir as well as estimates of legal inflows to the storage pool were provided in spreadsheet form by Centennial Water and Sanitation District (CWSD).

Outflows from the water supply storage pool were based on three scenarios of releases from the reservoir, shown in Table 3. The first scenario represented a relatively quick drawdown, the second comprised a moderate drawdown, and the third assumed that all the water stored would be held through the summer and then released starting September 1.

Table 3. Assumed release scenarios for fluctuation analysis

	Release Rate Per Day, AF											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Scenario 1	0	0	0	0	80.7	149.3	192.3	192.0	48.0	2.9	3.0	2.9
Scenario 2	0	0	0	0	18.8	61.5	165.2	165.2	145.9	26.6	27.3	20.2
Scenario 3	0	0	0	0	0	0	0	0	237.6	229.9	211.5	0

An example of the results for one year is shown in Figure 2. The analysis creates a tool to review multiple operational possibilities for future modifications to Chatfield Reservoir. The potential variability in the water surface elevation during the growing season was portrayed, providing a means to evaluate the impacts of a fluctuating water surface on the mortality of trees and other vegetation adjacent to the reservoir.

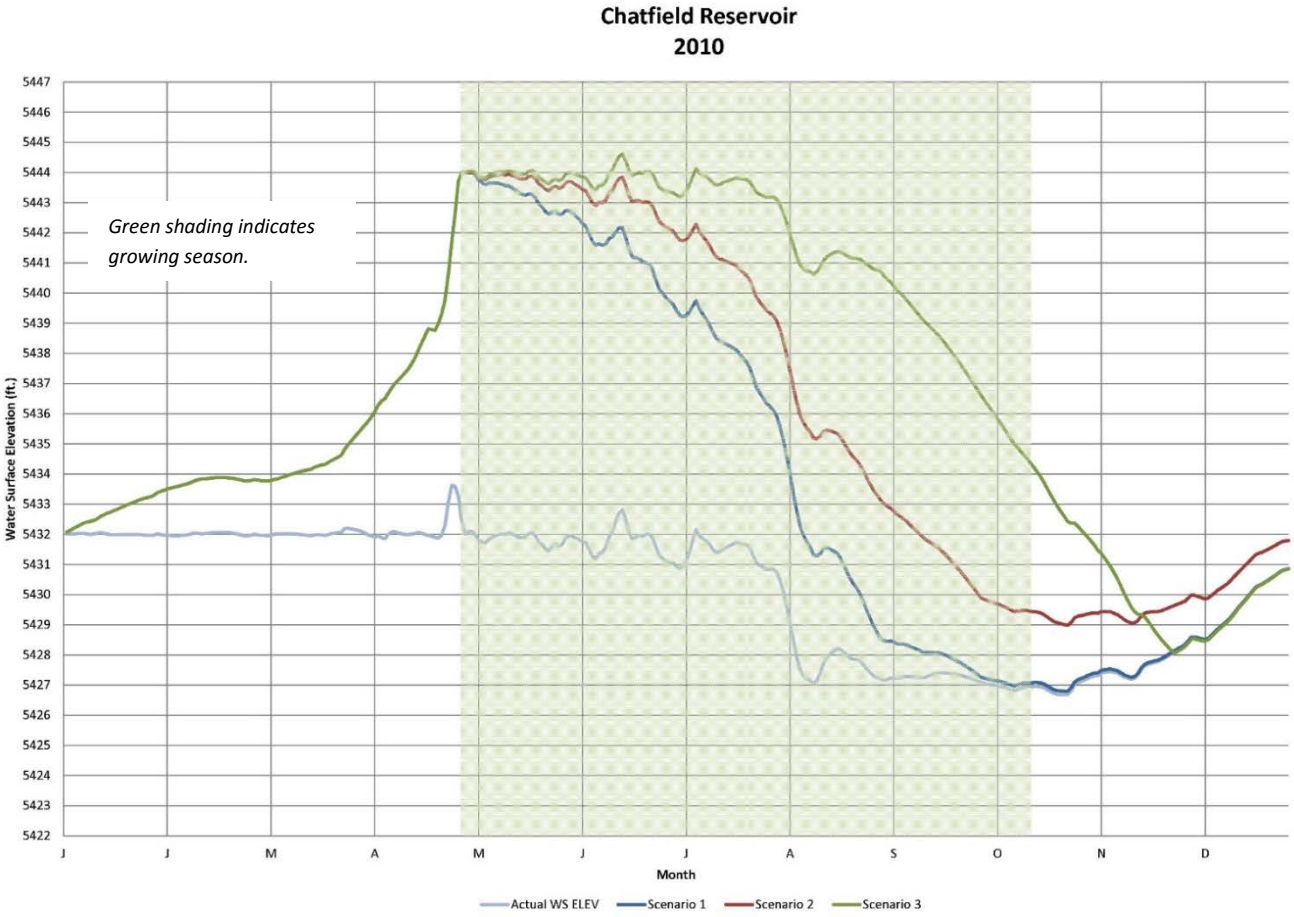


Figure 2. Example Results for Fluctuation Zone Analysis

SHORELINE IMPROVEMENTS

Another evaluation completed during the work on the conceptual design of onsite environmental mitigation pertained to bank stabilization and user access improvements along the steep eastern shoreline located between the South Platte River inlet and the marina. A variety of measures was evaluated and reviewed with CPW representatives. Figure 3 on the following page depicts the measures that were identified as priority improvements, consisting of bank stabilization at the overlook south of the Park office and several access ramps and steps leading from the campgrounds down to beach areas that will allow boater access. An OPCC prepared for this work totaled $716,093.

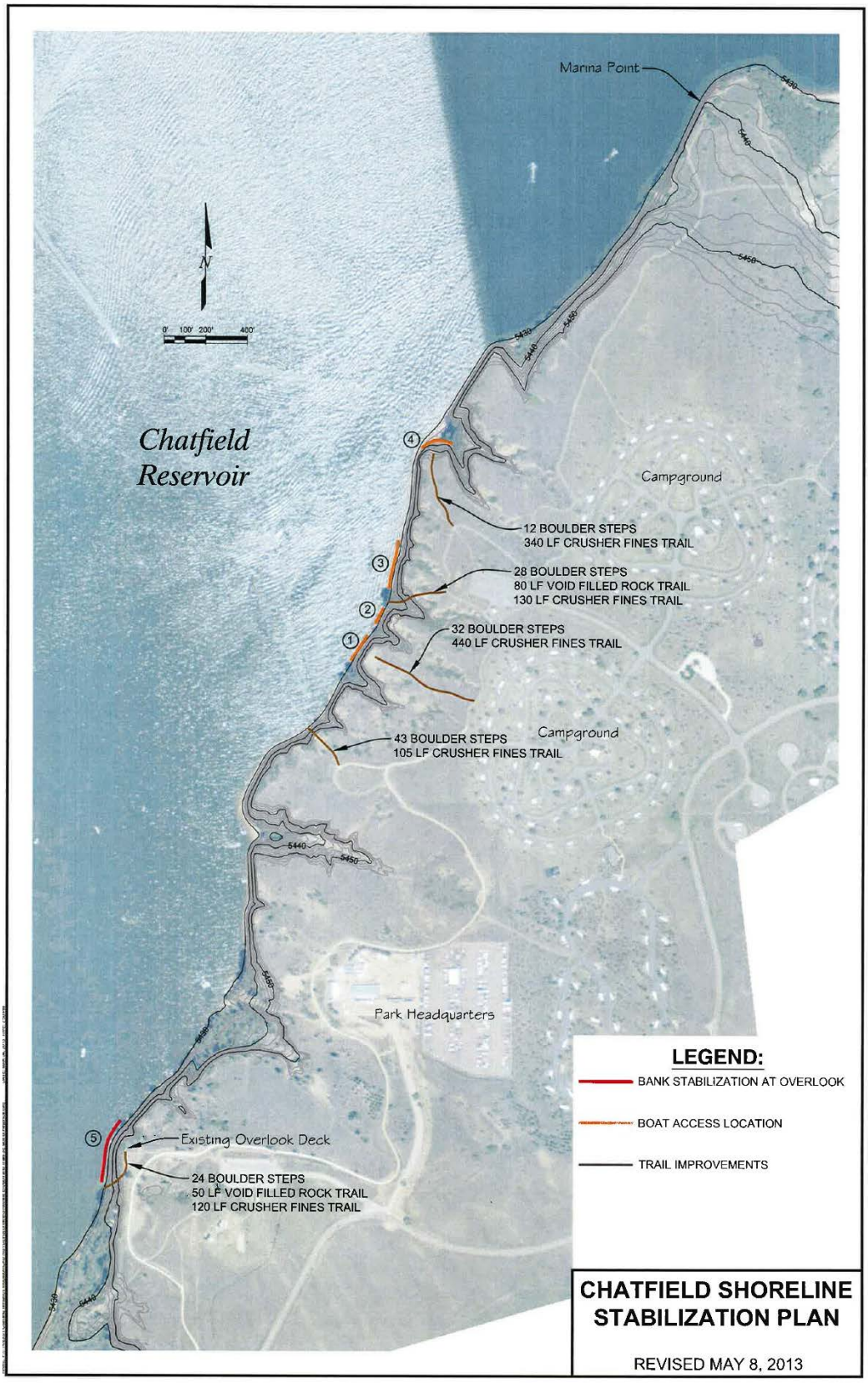


Figure 3. 2013 Plan for Shoreline Stabilization and User Access Improvements

FISH, WILDLIFE, AND RECREATION MITIGATION PLAN (122.2 PLAN)

A Fish, Wildlife and Recreation Mitigation Plan was prepared in response to State-specific requirements for the project stipulated in Colorado Revised Statute (CRS) §37-60-122.2. The Plan, also referred to as the 122.2 Plan, identifies actions that the Chatfield Reservoir Storage Reallocation project participants will implement to mitigate unavoidable adverse impacts the Chatfield Reallocation Project will have on fish, wildlife, and recreation.

Included in the mitigation measures identified in the 122.2 Plan are Plum Creek stabilization improvements (discussed in Section 1.3.5) to a funding level of $6M and shoreline stabilization and user access improvements (discussed in Section 1.3.8 and shown in Figure 3) funded at $716,093.

The Plan also includes improvements in the South Platte River to enhance aquatic habitat, funded at a level of $369,600 upstream of the reservoir and $265,000 downstream of the reservoir.

PUMPING TEST

As part of the conceptual design of onsite environmental mitigation for the Chatfield Reallocation Project, Muller Engineering Company, with assistance from Naranjo Civil Constructors, conducted pump testing at two existing groundwater-fed ponds along Plum Creek (the Turtle Pond) and the South Platte River (the Discovery #2 Pond). The purpose of the testing was to gain information on potential pond recharge rates and on representative infiltration rates for existing soil and vegetation conditions in areas adjacent to the ponds that are being considered for environmental mitigation. This information, in turn, was intended to inform future design efforts related to supplying and distributing water to environmental mitigation improvements in Chatfield State Park.

The pump testing was proposed in 2012; however, the field work was not approved by USACE until 2015. The testing took place in August, 2015.

Photo 5. The 6-inch pump used for the field testing provided a flowrate of approximately 1300 gallons per minute (GPM) for evaluating pond drawdown and infiltration capacity.

Several conclusions developed based on the results of the pump testing in Chatfield State Park are included below.

1. The observed recharge rates in the Turtle Pond and the Discovery #2 Pond were unexpectedly low for groundwater-fed ponds (equivalent to approximately 20 to 30 gpm). These ponds in their existing condition would not be good candidates to supply water for vegetation associated with onsite environmental mitigation.
2. Signs of past surface irrigation practices along the west terraces of Plum Creek are evident in the field and helped to inspire the conceptual layout of environmental mitigation improvements for the upper terrace of Plum Creek (Muller 2014). The conceptual design would emulate the kind of surface spreading of water that would have historically occurred using flood irrigation from the ditch. However, the observed infiltration rates in the ditch were extremely high (approximately 18 iph at the end of the test) and the sheet flow infiltration rates in vegetated areas observed during this pump test were an order of magnitude greater than infiltration rates estimated in the same area by observing water drawdown in test pits excavated 12 to 30 inches deep (CTL Thompson 2012).
3. The observed sheet flow infiltration rates -- high due to the influences of the uncompacted organic topsoil layer with mature vegetation and root systems – indicate that the water supply volume required for flow spreading approaches would be substantial. Significantly more water would be needed to convey and distribute water via surface spreading than the actual water needs of the plants associated with the environmental mitigation.

Based on the results of the pump test, it was recommended that the use of flow spreading approaches on Plum Creek and the South Platte River environmental mitigation areas be scaled back and that alternate strategies be pursued as much as possible to create hydrology favorable for environmental mitigation. As mentioned in Section 1.3.2, these methods include:

- Lowering existing ground surfaces via excavation to get planted areas in closer vertical proximity to existing water tables.
- Raising existing water tables to place groundwater in closer vertical proximity to planted areas. This latter method fits in well with the goal of restoring Plum Creek and raising its degraded channel invert.

AUTHORIZATION OF CHATFIELD STORAGE REALLOCATION PROJECT

The Chatfield Storage Reallocation Project received authorization to move forward in 2014 with two major milestones being achieved:

1. Record of Decision was signed by USACE on May 29, 2014, marking the approval of the federal FR/EIS process.
2. Water Storage Agreement was signed on October 9, 2014, completing the State authorization process.

With these two milestones in place, the Chatfield Reservoir Mitigation Company (CRMC) was formed to implement the project. A consultant team was selected to serve as Program Manager for the project; this

team is led by CDM Smith with assistance from Leonard Rice Engineers. Preliminary design services for the project were organized into the following areas and consultant teams were contracted with undertaking a targeted scope of services in each area.

- EM1 Independent Technical Review for Environmental Mitigation
- EM2 On-Site Environmental Mitigation
- EM3 Sugar Creek Off-Site Environmental Mitigation
- EM4 East Plum Creek Site (on hold)
- EM5 Off-Site Environmental Mitigation
- RM1 Marina
- RM2 On-Site Recreational Mitigation

With the exception of EM4, these teams have been moving forward with preliminary design tasks with project coordination and communications with CRMC, CPW, and USACE orchestrated by the Program Manager.

PRELIMINARY DESIGN OF ONSITE ENVIRONMENTAL MITIGATION FEATURES

The scope of the current preliminary design effort for EM2 was laid out in the request for proposals prepared for the work and includes the following elements:

1. Onsite environmental mitigation and borrow area reclamation along the South Platte River, Plum Creek, and lower Marcy Gulch generally in the areas initially shown in the FR/EIS (USACE 2013) and refined in the subsequent Conceptual Design report (Muller, 2014), or as revised and refined during the preliminary design process.
2. Plum Creek Restoration, as discussed in the 122.2 Plan (CPWC 2014).
3. Fluctuation zone habitat enhancements.
4. South Platte River aquatic habitat enhancement upstream of Chatfield Reservoir, mentioned in the 122.2 Plan.

The intent was to use the initial concepts that have been developed in the referenced documents for the proposed measures identified in 1 and 2 above and to revise and refine these concepts as necessary in the preliminary design phase to achieve the overall project goals.

ADDITIONAL CONCEPTUAL DESIGN ADDED FOR CENTRAL PLUM CREEK AND TITAN LAKE

The degradation in the lower reach of Plum Creek has grown more severe in the two to three years since the Plum Creek Stabilization Plan was prepared. The main headcut on the west channel has continued to advance upstream, accelerating to a rate exceeding 600 feet per year. This ever worsening condition in Plum Creek comprises a serious negative impact on the existing habitat of the Plum Creek riparian corridor, and also a threat to the environmental mitigation measures planned adjacent to the creek. The channel degradation threatens to lower the water table in the area where environmental mitigation measures are planned, impacting planned measures as well as large areas of existing desirable habitat. Photo 6 and Photo 7 depict the recent degradation in the west channel of Plum Creek.

Photo 6. Eroding Plum Creek channel advancing through a former parking lot.

Photo 7. Recent advancement of Plum Creek degradation occurring in the spring of 2016.

Likewise, prolonged high flows in the South Platte River during the summer of 2015 has caused erosion in a former oxbow channel of the South Platte adjacent to Titan Lake, an east bank gravel pit lake excavated starting in the 1950s. This erosion caused a breach of the river into Titan Lake, depositing a large delta of sediment projecting into the lake. The high flows also scoured out the north spillway channel of Titan Lake and dropped the level of the lake by about six feet. Photo 8, Photo 9 and Photo 10 show some of the damage that has occurred. Figures 4 through 6 show aerial images of the oxbow channel area in 1955 (with the river in the oxbow channel), 2014 (with a straighter river alignment and inactive oxbow channel), and 2015 (showing eroded oxbow channel, delta deposit, and lowered lake level).

Photo 8. Eroded portion of historic oxbow channel

Photo 9. Large delta of sediment deposited into Titan Lake.

Photo 10. Erosion at Spillway on North End of Titan Lake

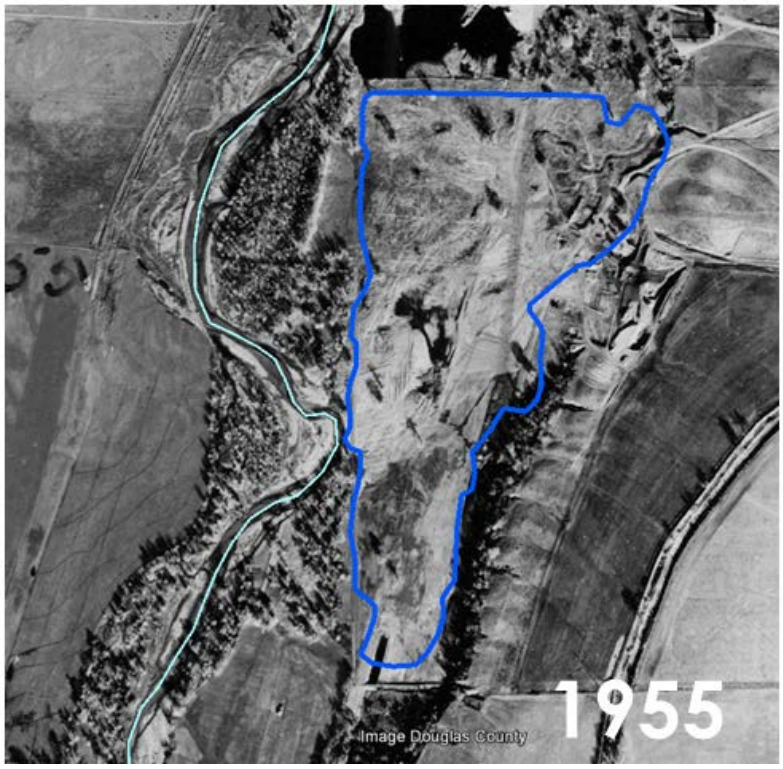


Figure 4. 1955 Aerial Image of S. Platte River at the Future Location of Titan Lake

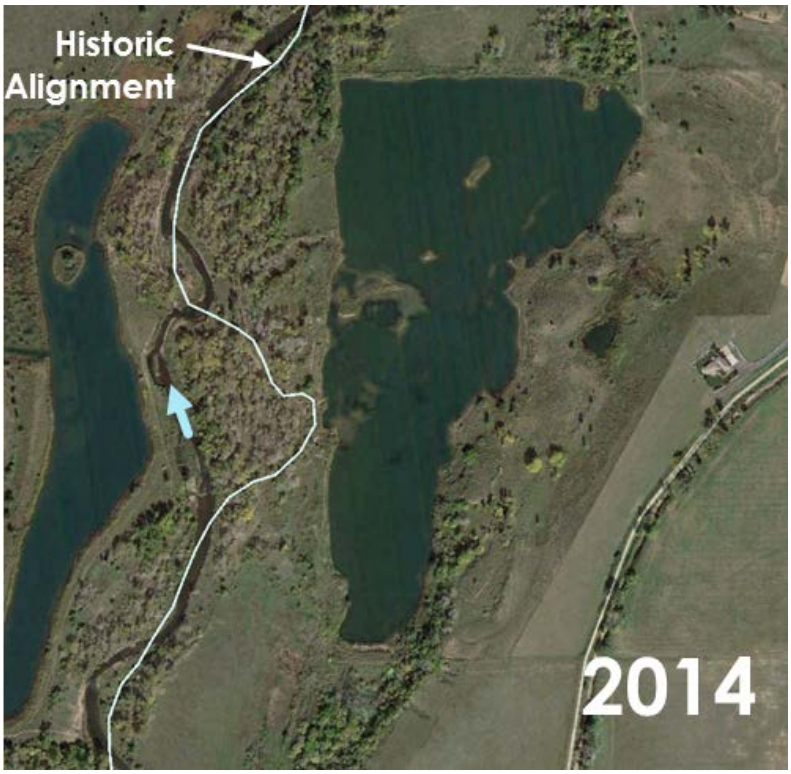


Figure 5. 2014 Aerial Image of the S. Platte River at Titan Lake, prior to 2015 Breach

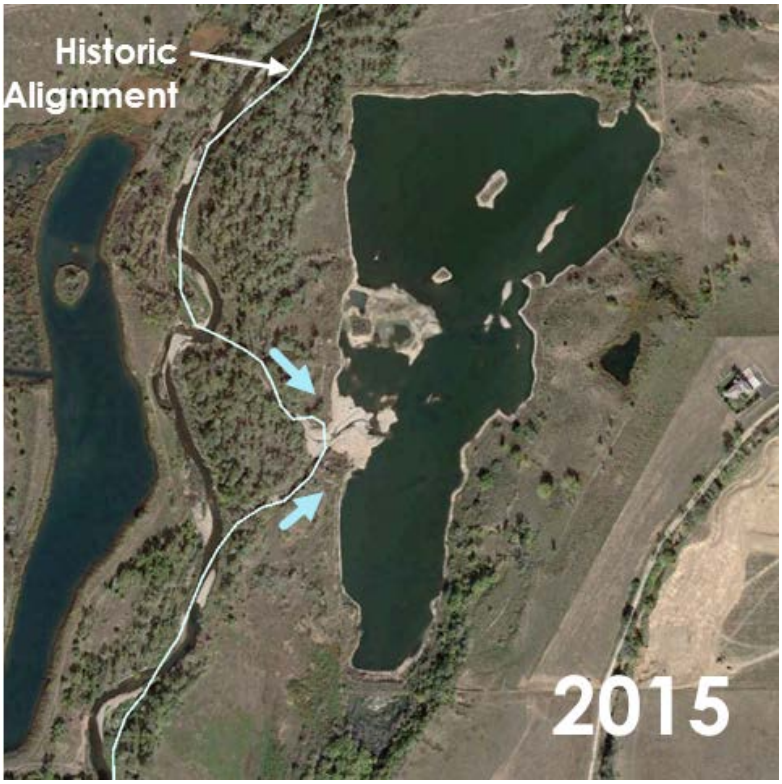


Figure 6. 2015 Aerial Image of the S. Platte River at Titan Lake after the 2015 Breach

This has set up the potential for another high flow event to cut through the remaining river bank and rerouting the South Platte River alignment through Titan Lake and the next lake to the north before returning to the current riverbed. If this realignment were to occur, dramatic negative consequences would result, including the complete dewatering of 4000 feet of the current South Platte River channel, impacts to the aquatic habitat, and creating an eroded vertical headcut approximately 20 feet high that would work its way upstream first from Titan Lake to the river and then continuing up the river.

Addressing the degradation that will predictably occur in the central reach of Plum Creek and maintaining a healthier stream configuration will protect valuable existing habitat. This protection of resources has the opportunity of translating into EFU lift. Addressing the risk of the South Platte River rerouting itself through the gravel pit lakes may also provide the means to protect existing resources before they are fully impacted and may translate into EFU lift for the project.

Because of the negative consequences of doing nothing and the positive value in protecting and enhancing desirable habitat, the CRMC chose to add a conceptual design of measures to address the degradation potential in the central reach of Plum Creek and the erosion damage in the South Platte River at Titan Lake. Although not to the same level of detail as the preliminary design of the remainder of the onsite environmental mitigation measures, a conceptual design will provide a sense for the possible costs and the potential EFU lift that may be associated with addressing threats in the central reach and at Titan Lake.

Some initial schematic layouts of work in these areas are provided in the June 2016 preliminary design submittal; additional detail will be provided for these areas in a follow-up submittal in late July 2016.

JUNE 2016 PRELIMINARY DESIGN SUBMITTAL

The June 2016 preliminary design submittal draws on the project development and history that has been summarized in this memorandum. Concepts have evolved to develop an approach for Plum Creek, the South Platte River, and Marcy Gulch that integrates each of the central stream features with their adjacent floodplains and aims to undertake environmental mitigation in the context of functional, wide, healthy riparian corridors. The preliminary design seeks to enhance aquatic and terrestrial habitat, expand habitat connectivity, improve stream stability, and increase the interaction between the streams and their floodplains -- in one comprehensive, integrated project.

Developing favorable hydrology for the environmental mitigation has evolved as well; a generally natural, passive approach is used, where vegetation will be established in proximity to the water table by restoring and raising the water table where it had been lowered as a result of stream degradation and channel incision, by grading high terrace areas lower to be closer to the water table (and the top of the bankfull channel), and by encouraging spills of high flows out into adjacent floodplain benches.

The preliminary design drawings illustrate these concepts, showing plan views of grading and planting plans as well as profiles, sections, and details. While progressing in a positive way since the first FR/EIS concepts were considered, these plans will continue to undergo refinement as the project moves through the preliminary design review phase and into final design.

6.1 On-Site Mitigation

On-site mitigation is mitigation that will occur on property owned by the United States and managed by the Corps in the vicinity of Chatfield Reservoir. On-site mitigation will include two categories of activities: 1) activities associated with compensatory mitigation for assumed permanent impacts to targeted environmental resources, and 2) activities associated with restoring nonpermanent impacts. Permanent impacts are assumed for all targeted environmental resources below 5,444 feet in elevation and within the permanent footprint of relocated recreation facilities, including buildings, parking lots, trails, and permanent roads. Additionally, on-site mitigation will include restoring areas disturbed by recreation relocation activities, but not within the permanent footprint of relocated facilities. These areas include borrow areas, temporary haul roads, and filled areas not permanently impacted by relocated facilities. In these

areas, mitigation will consist of restoring disturbed areas to conditions similar to those present prior to disturbance.

The amount of on-site mitigation will be maximized to the degree practicable. The following describes the on-site mitigation actions for impacts to Preble's habitat. These mitigation actions will also provide EFUs that will benefit birds and wetlands. Upon approval of the Federally Recommended Plan, preliminary plans will be prepared and submitted for Corps' approval prior to the development of final design documents. This process is described in Sections 6.1.1.1 and 7.1.1.

6.1.1 Compensatory Mitigation

Several types of on-site mitigation activities are proposed to convert habitat from one type to another and also to enhance existing habitat. Examples of habitat conversion include changing upland grasslands to shrublands or wetlands, and changing upland shrublands to wetland shrublands. Two examples of enhancing existing habitat are increasing shrub cover in existing wetland shrublands by planting more shrubs and performing weed control in any habitat type to increase cover of native species. The greatest gain in EFUs will be from habitat conversion activities. The greatest gain in EFUs per acre would result from converting upland grasslands to wetland habitat that also provides high value riparian habitat for Preble's. A total of 158 acres of wetlands are targeted for creation by compensatory mitigation, which is equal to the maximum acres of wetlands that would be lost.

Most on-site mitigation areas targeted for habitat conversion are currently upland grasslands. Wetland areas typically have saturated soils within 12 inches of the surface for a significant portion of the growing season. As a result, habitat conversion will primarily be accomplished by manipulating ground surface elevations and surface and ground water to provide hydrology adequate to support mesic riparian vegetation and wetlands. Most habitat conversion activities will require heavy equipment and earthwork. Three primary habitat conversion activities are proposed for on-site mitigation areas:

- Install sheet pile cutoff structures to raise the ground water table closer to the surface (Figure 1);
- Create new secondary channels, ditches, or backwaters to bring surface water to mitigation areas (Figure 2); and

- Modify surface topography to lower the ground surface closer to ground water or to better retain surface water (Figure 1).

These conversion activities have been successfully applied in numerous locations with similar conditions along the Colorado Front Range, including in a Preble's habitat enhancement project on East Plum Creek in Castle Rock (Figure 3). Other successful projects in Preble's habitat on Cherry Creek include those at 17-Mile House (Figure 4), Stroh Ranch (Figure 5), and Apache Plume Outfall (Figure 6).

In many cases, a combination of the three activities will likely be necessary to create successful mitigation conditions. The exception is the two borrow areas below 5,444 feet in elevation. Because they will have been excavated as borrow areas and because they will be in close proximity to ground water, sheet piles will not be used, surface water will not be diverted, and only a small amount of grading will be necessary to create suitable mitigation areas.

Installing sheet pile cutoff structures will entail driving interlocking sheets of 20-foot-tall, 25-inch-wide, 0.5-inch-thick steel sheets into the ground. In most locations, the sheets will be driven flush with the existing surface elevation. Where the sheet pile crosses a stream, it may extend 1 to several feet above the channel bottom, creating a grade-control structure that effectively raises the elevation of the channel behind it. Structures with a vertical face of taller than 1 foot are designed to minimize barriers to movement of fish and other aquatic organisms, per guidance from the Corps Denver Regulatory Office. The sheets will extend for some distance across the floodplain, perpendicular to the flow line of the stream. The concept behind installing sheet pile is to intercept ground water as it moves below the surface of the floodplains of Plum Creek and the South Platte River. As the ground water encounters the sheet pile, it will back up behind it, and flow in all directions until it reaches the edges of the structure and can pass beyond it. As the ground water backs up behind the structure, it gets closer to the surface and is eventually close enough to the existing or excavated surface to support wetland and riparian vegetation. Extending the sheet pile across the floodplain allows the channel to move in response to sediment movement along the stream. The conceptual design takes into account the dynamic nature of Plum Creek. The sheet pile cutoffs would be wide enough across the floodplain to accommodate channel migration. This technique has been used successfully on Plum Creek, Cherry Creek, Piney Creek, and Sand Creek.

Figure 1. Habitat Conversion Techniques

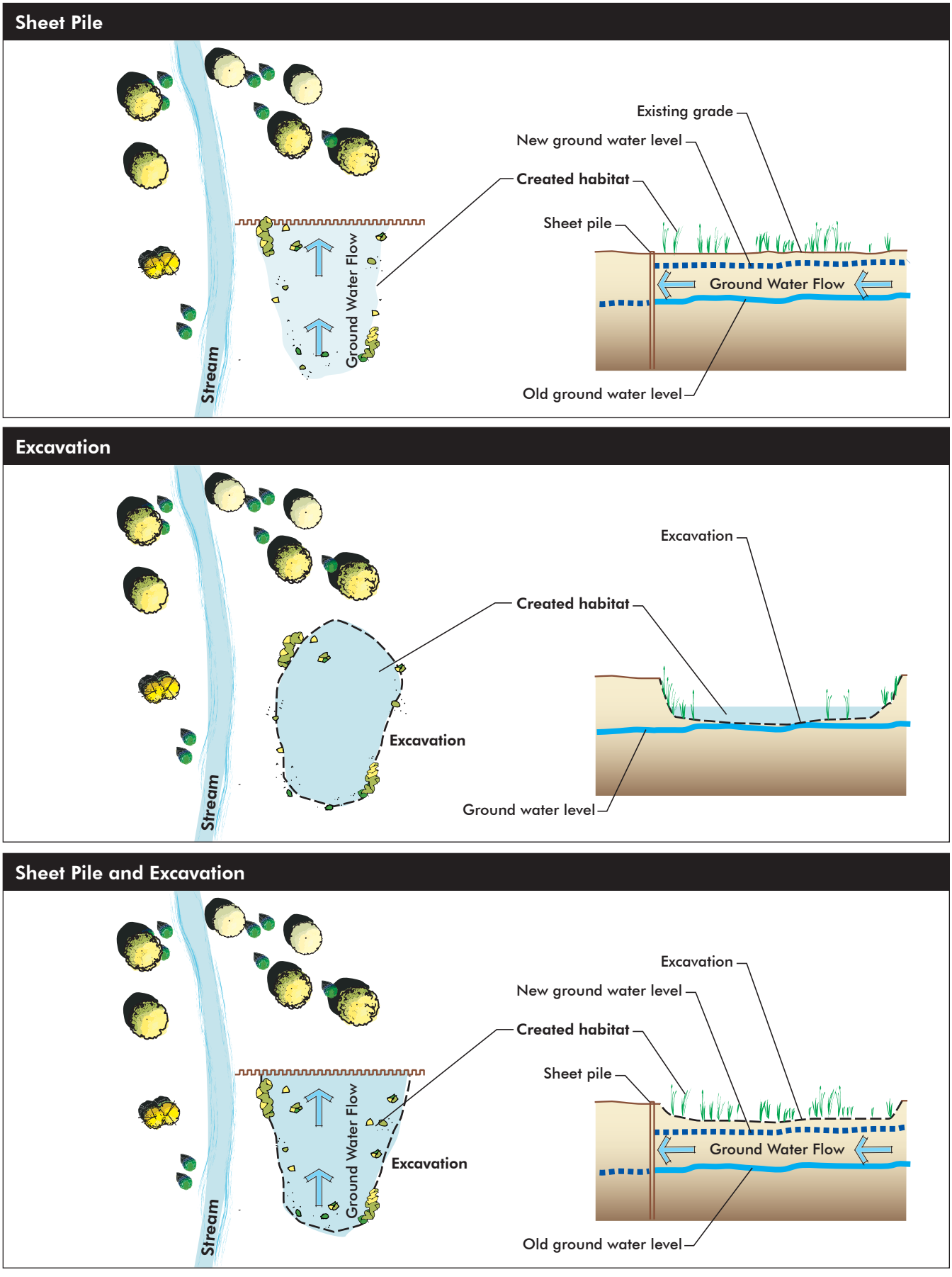


Figure 2. Habitat Conversion Techniques, Cont.

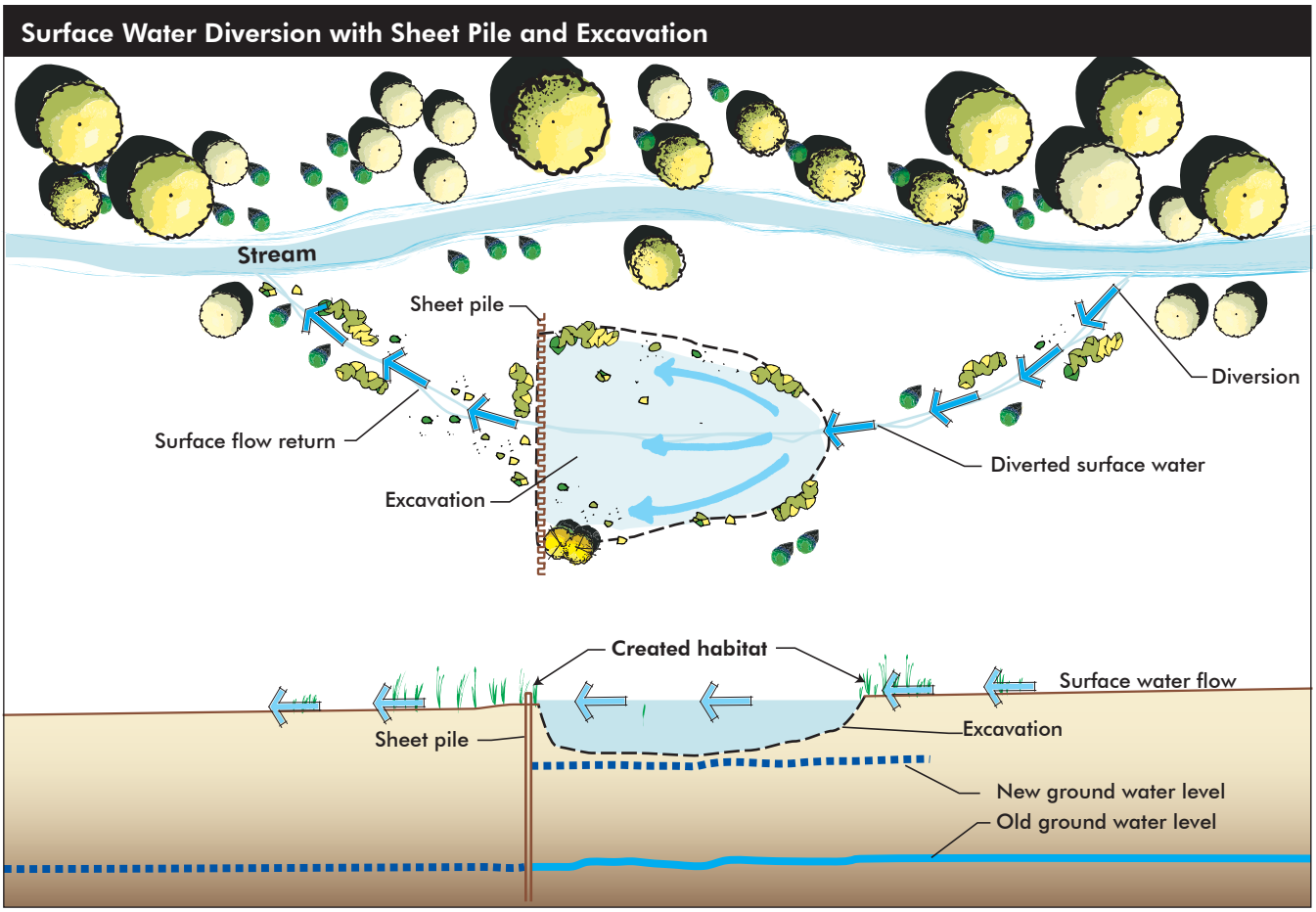


Figure 3 - Example of sheet pile cutoff drop structure on East Plum Creek in Castle Rock, Colorado used to enhance Preble's habitat.

Figure 4 - Aerial photo of Cherry Creek at 17-Mile House stream restoration project. The project included the creation of a new secondary channel to distribute surface water. (Photo courtesy of Muller Engineering Company).

Figure 5 - Cherry Creek at Stroh Ranch stream restoration project. Looking upstream at small riffle structure. Wetlands have expanded upstream of the structure.

Figure 6 - Cherry Creek at Apache Plume Outfall. Looking downstream at expanded Preble's habitat behind low sheet pile cutoff wall. Cutoff wall is visible at about the middle of the photo, just before the stream bends out of sight.

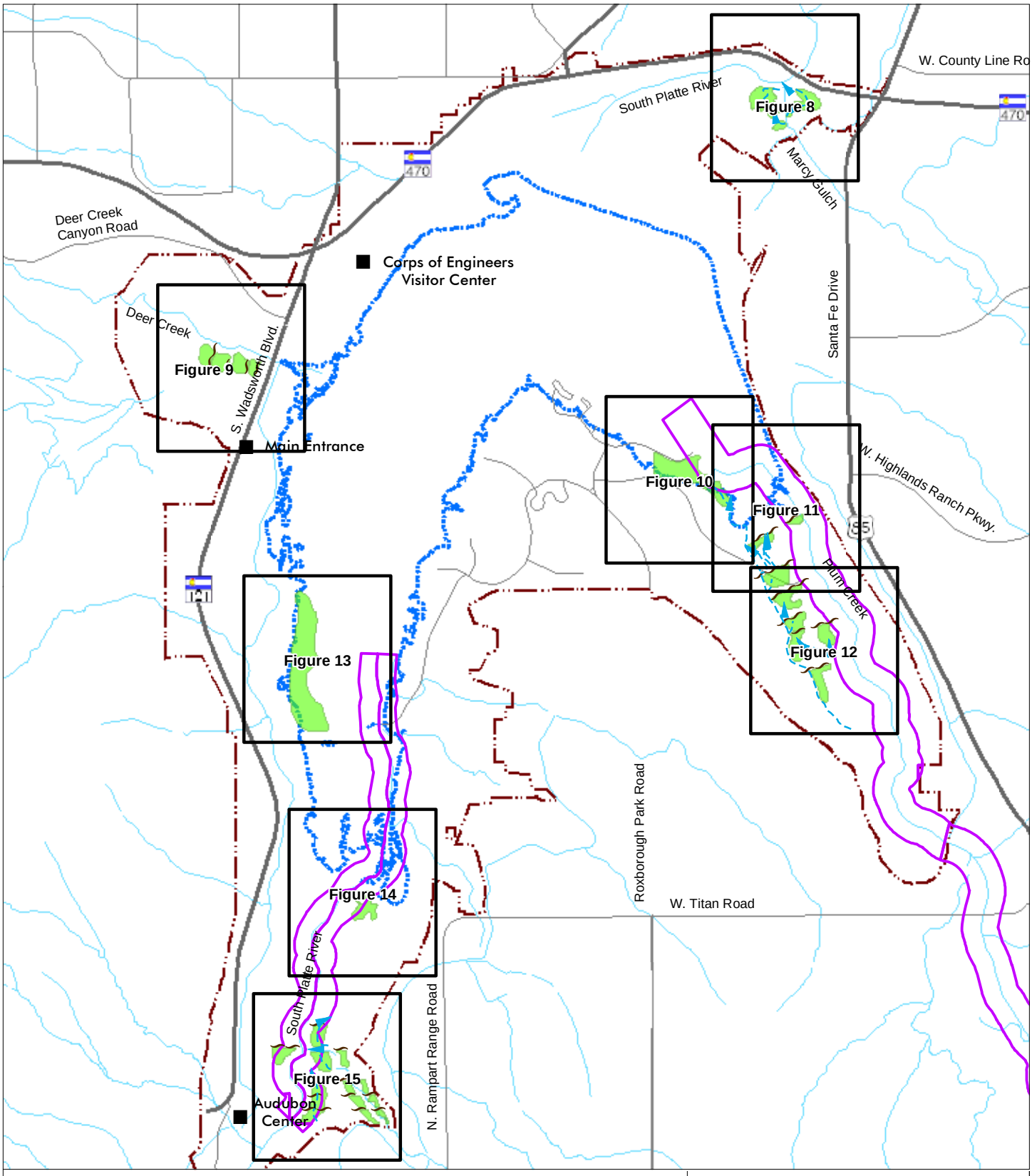
Constructing secondary channels, ditches, and backwaters is a means to convey and spread surface water to areas and to increase water available to support vegetation. If enough water is made available within the root zone, habitat will convert from one type to another. This approach often makes use of existing abandoned channels or oxbows to minimize earthwork.

Excavation lowers the ground surface to near the ground water. Topsoil is typically salvaged and stored for reuse following removal of subsoil. The depth of excavation depends on how far the ground water is below the ground surface. Depending on site conditions, up to several feet of material could be removed.

Based on data gathered on existing conditions in proposed on-site mitigation areas subsequent to publication of the draft FR/EIS, it is likely that most of the mitigation areas will be created by distributing surface water by means of channels and ditches. Ground water in most areas is too deep below the surface to use as a reliable source of water to support successful mitigation conditions. Sheet pile will still be used in some locations to protect against erosion and to aid in saturating the soil with surface water behind the sheet pile. Upon approval of the Federally Recommended Plan, preliminary plans will be prepared and submitted for Corps' approval prior to the development of final design documents. Those plans will be based on information gathered from ground water monitoring wells that have been established in the proposed mitigation areas and on the detailed topographic survey that has been conducted for each mitigation area. The plans will adhere to relevant Corps' and State Parks' standard practices and guidelines for plantings and revegetation, including the Corps' Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams and Appurtenant Structures (Corps 2009a). Once detailed plans and specifications are prepared, on-site mitigation construction will begin. Following construction, mitigation areas will be monitored to document progress toward the number of EFUs anticipated to be gained at each mitigation area.

6.1.1.1 Proposed Activities

Using information available during preparation of the draft FR/EIS, 29 on-site mitigation areas were proposed in the project area – two along Marcy Gulch, four along Deer Creek, 10 along Plum Creek, and 13 along the South Platte River (Figure 7 through Figure 15). The proposed mitigation areas were selected to be close to potential sources of ground and surface



Chatfield Reallocation Study

Pool Elevations: Tetratech

- Potential Mitigation Area
- Preble's Critical Habitat
- Sheet Pile Cutoffs
- Figure Index
- 5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)
- Chatfield State Park

0 1,750 3,500 feet

1 inch = 3,500 feet

N

Figure 7
Locations of Potential On-Site Mitigation Areas

File: 4048 Fig 7 locs onsite mit.mxd (WH)
February 2011

ERO Resources Corp.

The numbers and locations of the ground water monitoring wells are approximations and may be adjusted in the field to better define site locations and variability within and among sites.

Chatfield Reallocation Study

- Potential Mitigation Area
- Ground Water Monitoring Well
- Sheet Pile Cutoffs
- Diversion Channel
- 5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)
- Chatfield State Park

Imagery Source : Landiscor©, June 2008
Pool Elevations: Tetratech

0 250 500 feet
1 inch = 500 feet

N

Figure 8
Lower Marcy Gulch
Potential On-Site Mitigation Areas

File: 4048 Figs 8-15 onsite mit mapbook.mxd (WH)
February 2011

ERO Resources Corp.

The numbers and locations of the ground water monitoring wells are approximations and may be adjusted in the field to better define site locations and variability within and among sites.

Chatfield Reallocation Study

- Potential Mitigation Area
- Ground Water Monitoring Well
- Sheet Pile Cutoffs
- Diversion Channel
- 5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)
- Chatfield State Park

Imagery Source : Landiscor©, June 2008
Pool Elevations: Tetratech

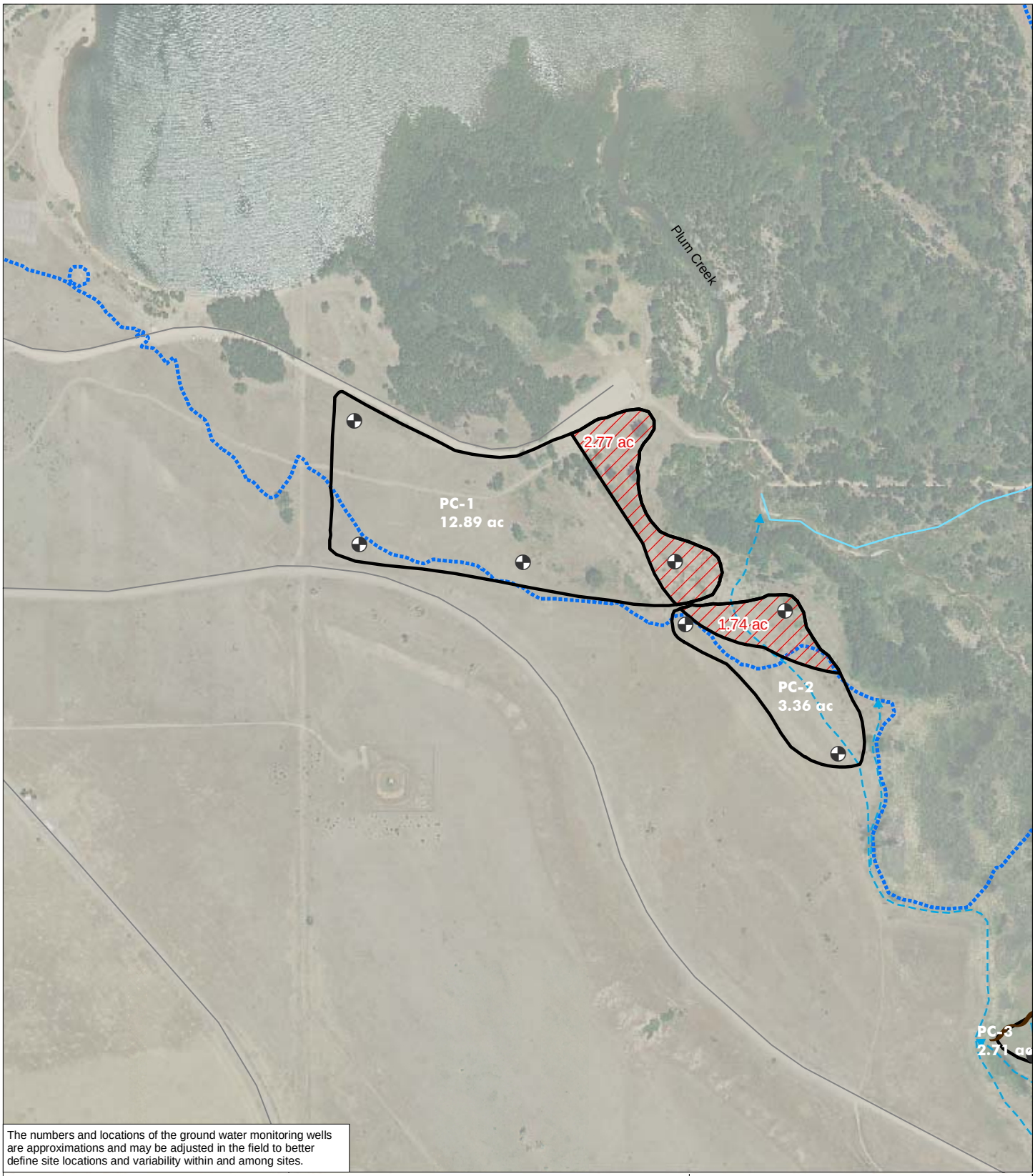
0 250 500 feet
1 inch = 500 feet

N

Figure 9
Deer Creek
Potential On-Site Mitigation Areas

File: 4048 Figs 8-15 onsite mit mapbook.mxd (WH)
February 2011

ERO Resources Corp.



The numbers and locations of the ground water monitoring wells are approximations and may be adjusted in the field to better define site locations and variability within and among sites.

Chatfield Reallocation Study

Imagery Source : Landiscor©, June 2008
Pool Elevations: Tetratech

- Potential Mitigation Area
- Preble's Critical Habitat Potential Mitigation
- Ground Water Monitoring Well
- Sheet Pile Cutoffs
- Diversion Channel
- 5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)
- Chatfield State Park

0 250 500 feet
1 inch = 500 feet

N

Figure 10
Plum Creek
Potential On-Site Mitigation Areas

File: 4048 Figs 8-15 onsite mit mapbook.mxd (WH)
February 2011

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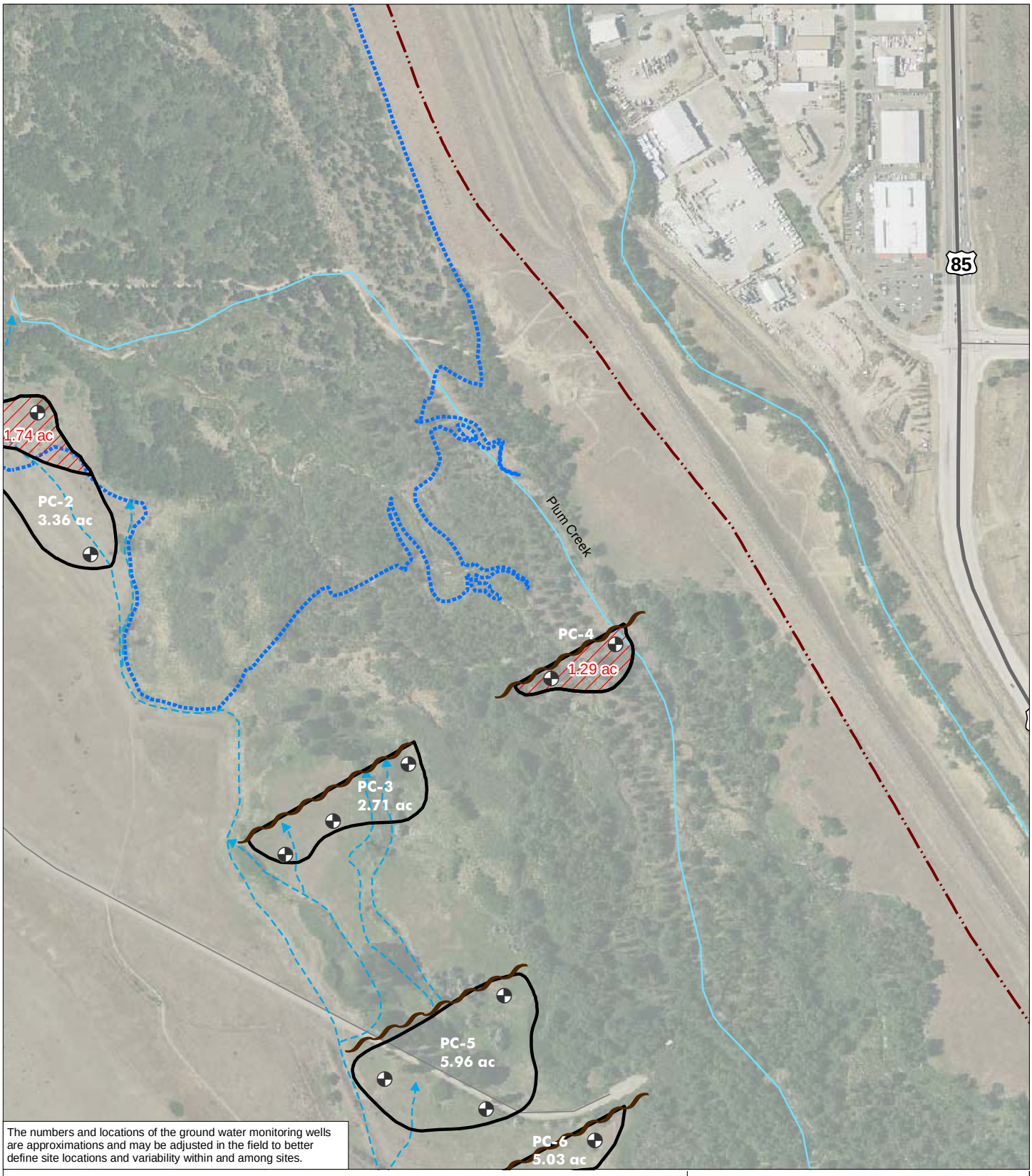
ERO Resources Corp.



The numbers and locations of the ground water monitoring wells are approximations and may be adjusted in the field to better define site locations and variability within and among sites.

Chatfield Reallocation Study

- Potential Mitigation Area
- Preble's Critical Habitat Potential Mitigation
- Ground Water Monitoring Well
- Sheet Pile Cutoffs
- Diversion Channel
- 5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)
- Chatfield State Park

Imagery Source : Landiscor©, June 2008
Pool Elevations: Tetratech

0 250 500 feet
1 inch = 500 feet

N

Figure 11
Plum Creek
Potential On-Site Mitigation Areas

File: 4048 Figs 8-15 onsite mit mapbook.mxd (WH)
February 2011

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ERO Resources Corp.

The numbers and locations of the ground water monitoring wells are approximations and may be adjusted in the field to better define site locations and variability within and among sites.

Chatfield Reallocation Study

Imagery Source : Landiscor©, June 2008
Pool Elevations: Tetratech

- Potential Mitigation Area
- Preble's Critical Habitat Potential Mitigation
- Ground Water Monitoring Well
- Sheet Pile Cutoffs
- Diversion Channel
- 5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)
- Chatfield State Park

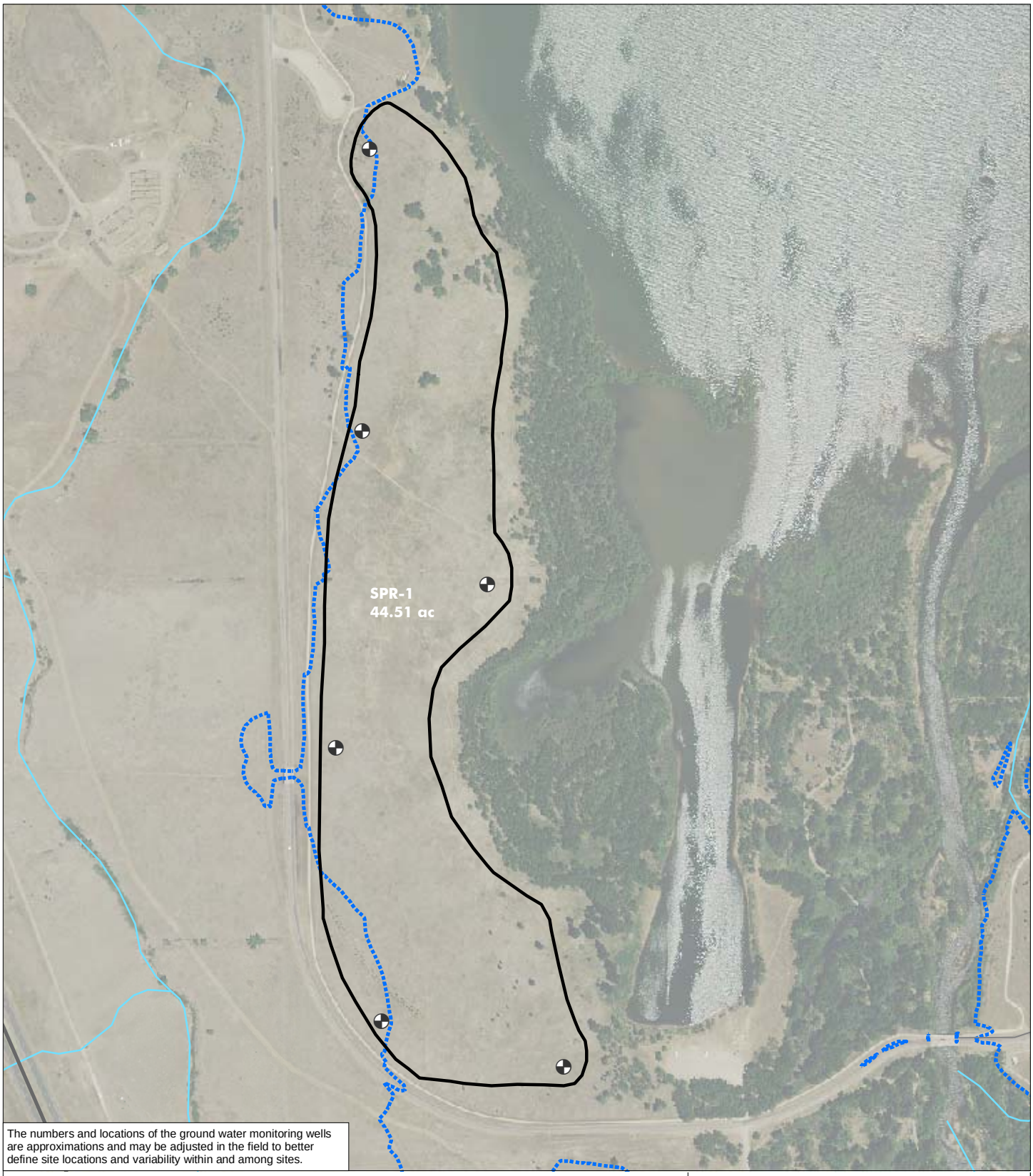
0 250 500 feet
1 inch = 500 feet

N

Figure 12
Plum Creek
Potential On-Site Mitigation Areas

File: 4048 Figs 8-15 onsite mit mapbook.mxd (WH)
February 2011

ERO Resources Corp.



The numbers and locations of the ground water monitoring wells are approximations and may be adjusted in the field to better define site locations and variability within and among sites.

Chatfield Reallocation Study

Potential Mitigation Area
Ground Water Monitoring Well
Sheet Pile Cutoffs
Diversion Channel
5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)
Chatfield State Park

Imagery Source : Landiscor©, June 2008
Pool Elevations: Tetratech

0 250 500 feet
1 inch = 500 feet

N

Figure 13
South Platte River
Potential On-Site Mitigation Areas

File: 4048 Figs 8-15 onsite mit mapbook.mxd (WH)
February 2011

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ERO Resources Corp.

The numbers and locations of the ground water monitoring wells are approximations and may be adjusted in the field to better define site locations and variability within and among sites.

Chatfield Reallocation Study

Potential Mitigation Area
Preble's Critical Habitat Potential Mitigation
Ground Water Monitoring Well
Sheet Pile Cutoffs
Diversion Channel
5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)
Chatfield State Park

Imagery Source : Landiscor©, June 2008
Pool Elevations: Tetratech

0 250 500 feet
1 inch = 500 feet

N

Figure 14
South Platte River
Potential On-Site Mitigation Areas

File: 4048 Figs 8-15 onsite mit mapbook.mxd (WH)
February 2011

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The numbers and locations of the ground water monitoring wells are approximations and may be adjusted in the field to better define site locations and variability within and among sites.

Chatfield Reallocation Study

Imagery Source : Landiscor©, June 2008
Pool Elevations: Tetratech

- Potential Mitigation Area
- Preble's Critical Habitat Potential Mitigation
- Ground Water Monitoring Well
- Sheet Pile Cutoffs
- Diversion Channel
- 5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)
- Chatfield State Park

0 250 500 feet
1 inch = 500 feet

N

Figure 15
South Platte River
Potential On-Site Mitigation Areas

File: 4048 Figs 8-15 onsite mit mapbook.mxd (WH)
February 2011

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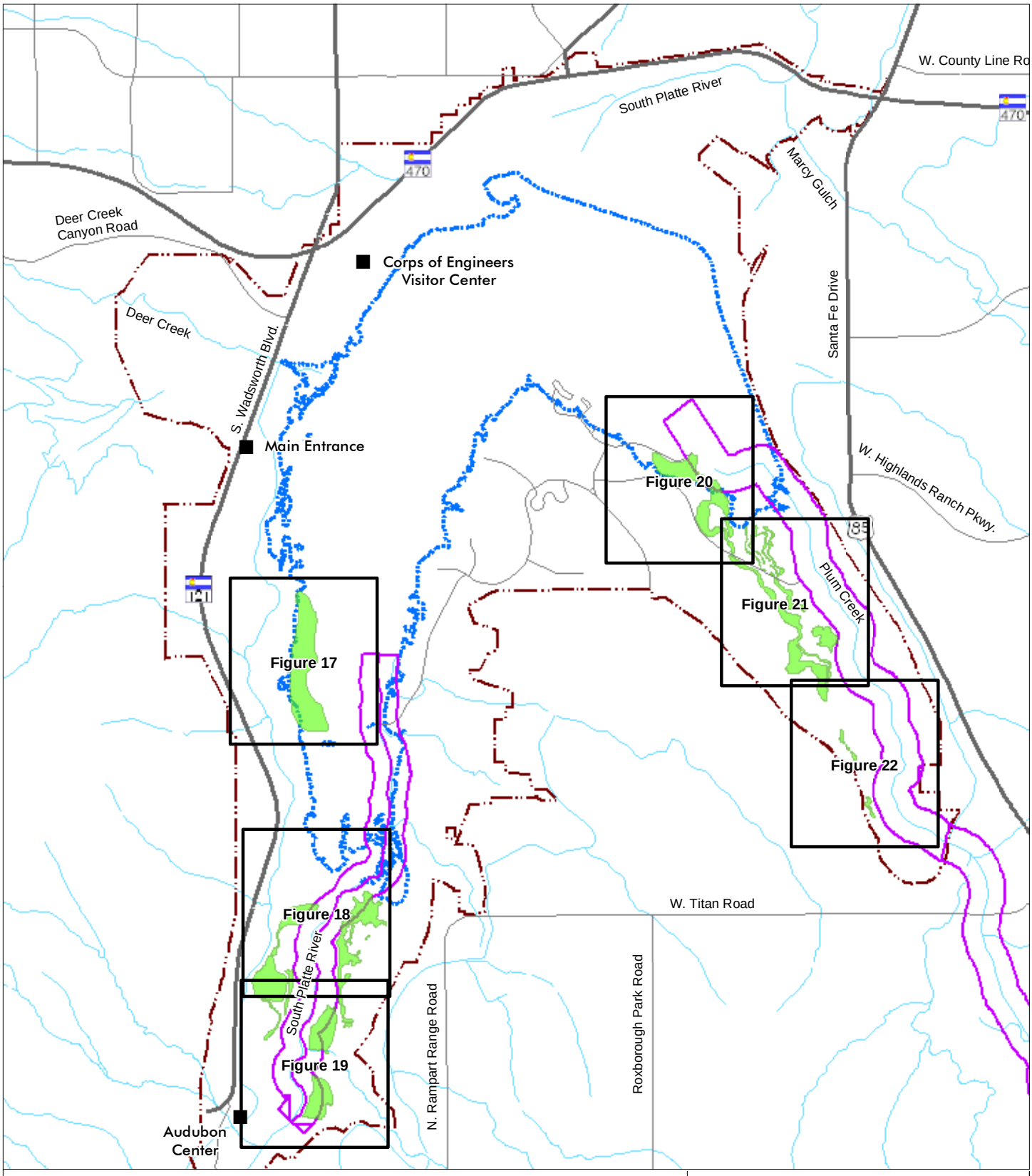
water and to maximize EFU mitigation credits. Two of the mitigation areas will be established in two borrow areas below elevation 5,444 (Figure 10 and Figure 12). The areas will be excavated for material that will be used as part of the recreation facility relocation activities. If not used as mitigation areas, the borrow areas would be restored to upland grasslands. The borrow areas are proposed for use as mitigation areas because they are located below the proposed maximum pool elevation, which means it is likely that ground water will be close to the surface and will be capable of supporting riparian and wetland habitats.

The on-site mitigation areas proposed in the draft CMP were conservative, rough outlines of areas estimated to have the best opportunities to provide mitigation that will result in a significant gain in EFUs. Subsequent to publication of the draft FR/EIS, locations and limits of potential on-site mitigation areas were reevaluated based on data generated by the following activities that have occurred subsequent to publication of the draft FR/EIS:

- Topographic mapping at 1-foot contour intervals;
- Installation and monitoring of ground water monitoring wells in locations indicated on Figure 8 through Figure 15;
- Delineation of any wetlands in proposed mitigation areas;
- Identification of areas of existing desirable vegetation to avoid disturbing them during design and construction;
- Sampling and evaluation of soils for permeability;
- Development of preliminary grading plans; and
- Continued development of the habitat field evaluation to finalize the ecological functions model to eventually determine the number of existing EFUs and EFU impacts based on existing site conditions.

Data analyses determined that surface and ground water conditions in the four mitigation sites proposed along Deer Creek and seven sites along Willow Creek, a tributary to the South Platte River, were unsuitable for successful mitigation efforts. However, other sites along the South Platte River and Plum Creek were expanded or added (Figure 16 through Figure 22). Preliminary estimates of acres of on-site mitigation and EFU mitigation credits for the revised mitigation areas are higher than estimates contained in the draft CMP. Although preliminary estimates of on-site acres and EFUs are higher than those in the draft CMP, preliminary cost estimates for the revised mitigation areas are no higher, and may be lower, than the draft CMP cost estimates. The anticipated reduction in the use of sheet pile reduces construction costs.



Chatfield Reallocation Study

Pool Elevations: Tetratech

- Potential Mitigation Area
- Preble's Critical Habitat
- Figure Index
- 5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)
- Chatfield State Park

0 1,750 3,500 feet

1 inch = 3,500 feet

N

Figure 16
Revised Locations of Potential On-Site Mitigation Areas

File: 4048 Fig 16 revised locs onsite mit.mxd (WH)
January 2013

ERO Resources Corp.

Chatfield Reallocation Study

- Potential Mitigation Area
- Ground Water Monitoring Well
- 5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)
- Chatfield State Park

Imagery Source : Landiscor©, June 2008
Pool Elevations: Tetratech

0 250 500 feet
1 inch = 500 feet

N

Figure 17
South Platte River
Revised Potential On-Site Mitigation Areas

File: 4048 Figs 17-22 rev onsite mit mapbook.mxd (WH)
January 2013

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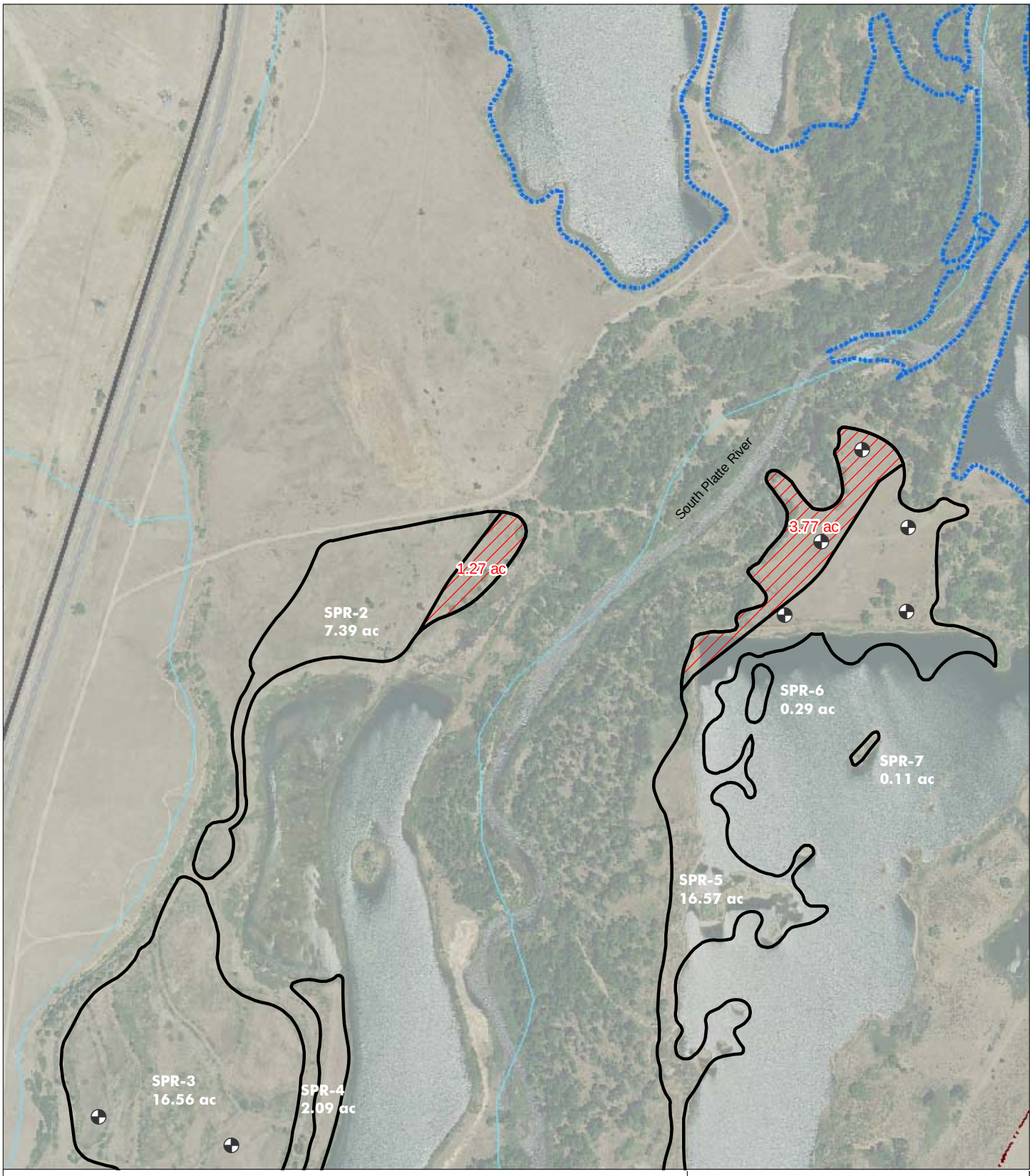


Chatfield Reallocation Study

Potential Mitigation Area

Preble's Critical Habitat Potential Mitigation

Ground Water Monitoring Well

5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)

Chatfield State Park

Imagery Source : Landiscor©, June 2008
Pool Elevations: Tetratech

0 250 500 feet

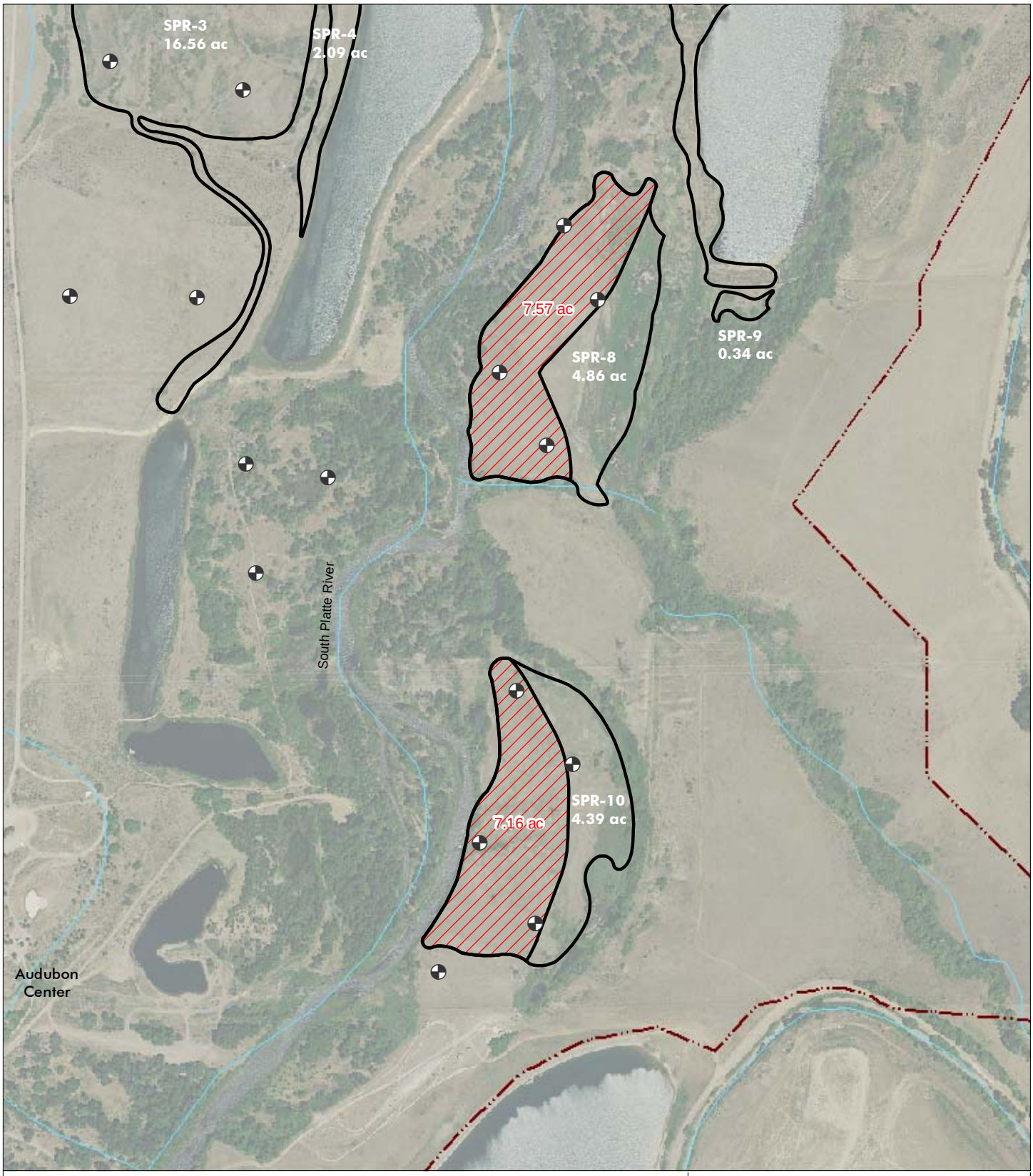
1 inch = 500 feet

N

Figure 18
South Platte River
Revised Potential On-Site Mitigation Areas

File: 4048 Figs 17-22 rev onsite mit mapbook.mxd (WH)
January 2013

ERO Resources Corp.



Chatfield Reallocation Study

- Potential Mitigation Area
- Preble's Critical Habitat Potential Mitigation
- Ground Water Monitoring Well
- 5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)
- Chatfield State Park

Imagery Source : Landiscor©, June 2008
Pool Elevations: Tetratech

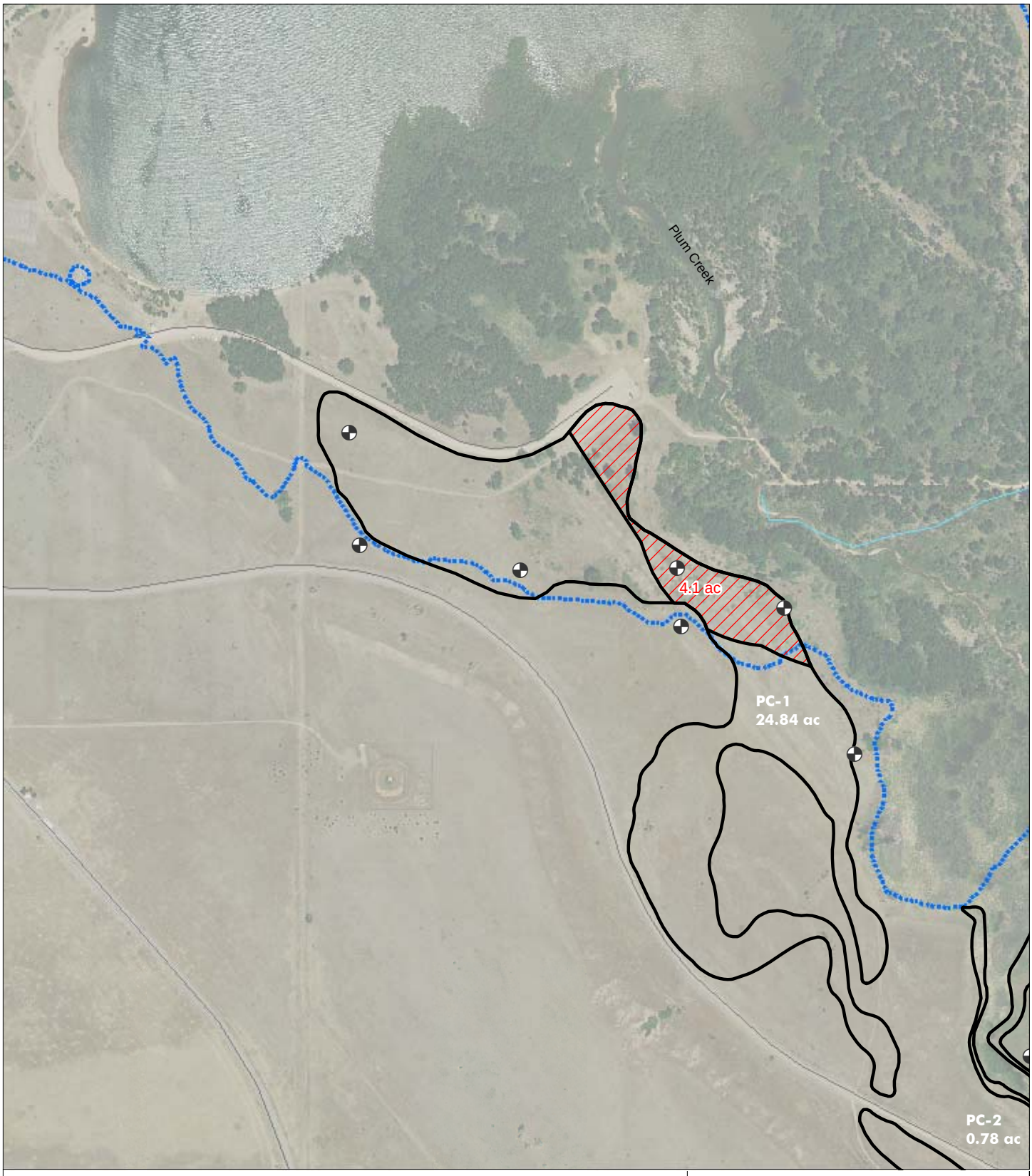
0 250 500 feet
1 inch = 500 feet

N

Figure 19
South Platte River
Revised Potential On-Site Mitigation Areas

File: 4048 Figs 17-22 rev onsite mit mapbook.mxd (WH)
January 2013

ERO Resources Corp.



Chatfield Reallocation Study

Potential Mitigation Area

Preble's Critical Habitat Potential Mitigation

Ground Water Monitoring Well

5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)

Chatfield State Park

Imagery Source : Landiscor©, June 2008
Pool Elevations: Tetratech

0 250 500 feet

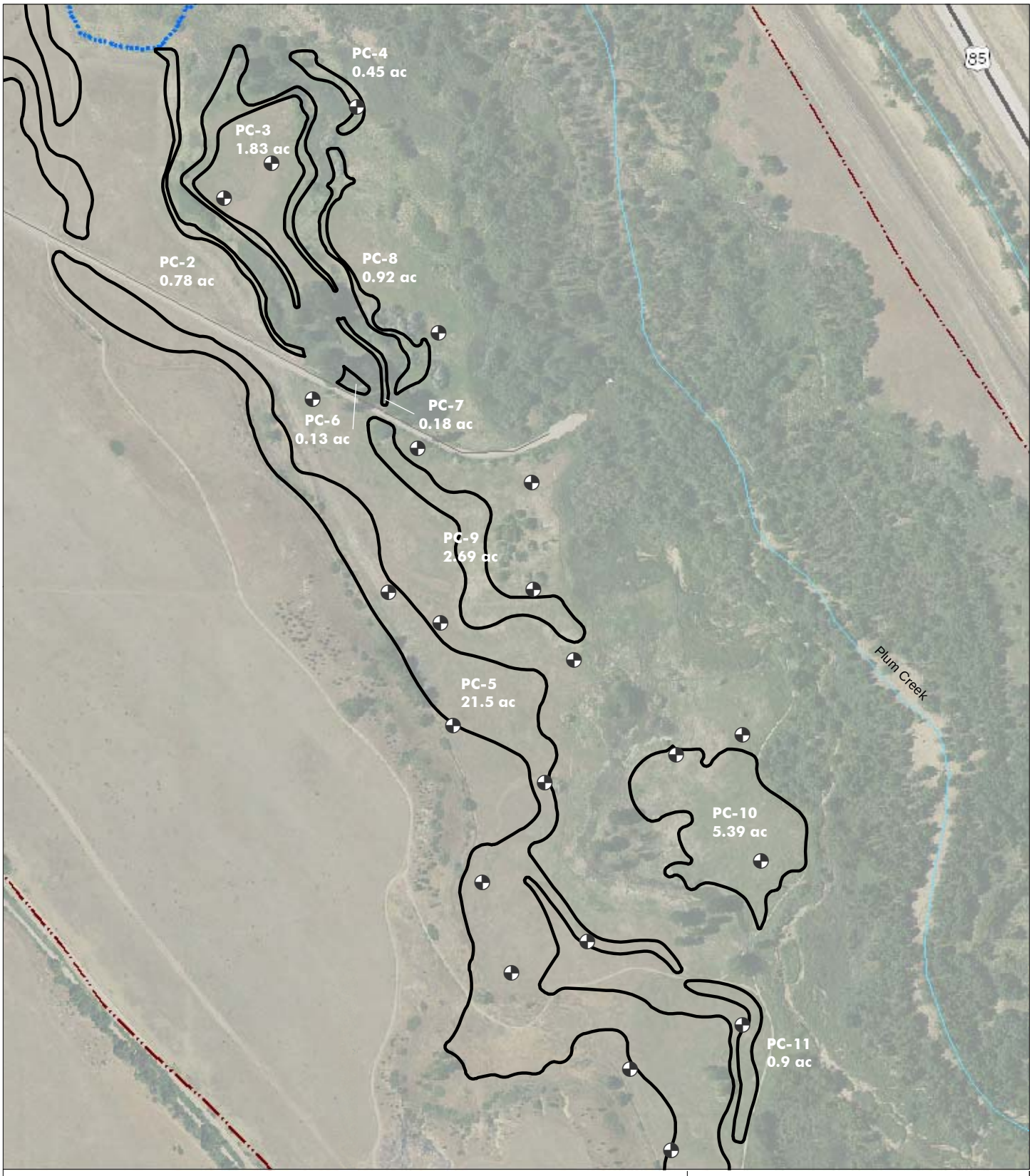
1 inch = 500 feet

N

Figure 20
Plum Creek
Revised Potential On-Site Mitigation Areas

File: 4048 Figs 17-22 rev onsite mit mapbook.mxd (WH)
January 2013

ERO Resources Corp.



Chatfield Reallocation Study

- Potential Mitigation Area
- Ground Water Monitoring Well
- 5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)
- Chatfield State Park

Imagery Source : Landiscor©, June 2008
Pool Elevations: Tetratech

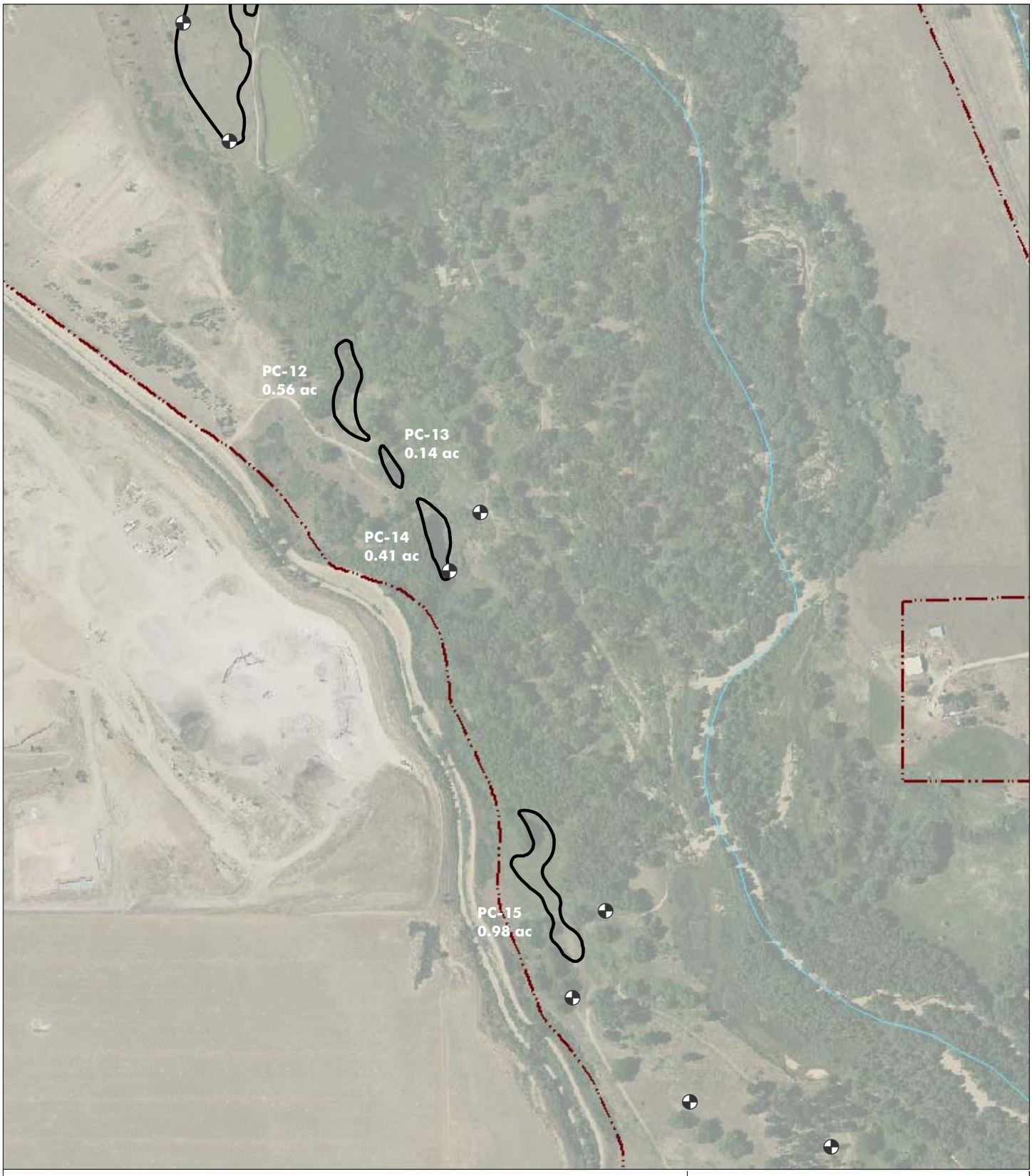
0 250 500 feet
1 inch = 500 feet

N

Figure 21
Plum Creek
Revised Potential On-Site Mitigation Areas

File: 4048 Figs 17-22 rev onsite mit mapbook.mxd (WH)
January 2013

ERO
ERO Resources Corp.



Chatfield Reallocation Study

- Potential Mitigation Area
- Ground Water Monitoring Well
- 5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)
- Chatfield State Park

Imagery Source : Landiscor©, June 2008
Pool Elevations: Tetratech

0 250 500 feet
1 inch = 500 feet

N

Figure 22
Plum Creek
Revised Potential On-Site Mitigation Areas

File: 4048 Figs 17-22 rev onsite mit mapbook.mxd (WH)
January 2013

ERO Resources Corp.

Although different than revised estimates, the draft CMP EFU mitigation credits, acres, and costs are used throughout the remainder of this document because they are more conservative estimates and because estimates will be further refined when site-specific mitigation plans are finalized.

The final extent, location, and number of mitigation areas will change as additional site analyses and designs are completed, but the number of on-site EFU mitigation credits will be maximized and are anticipated to generate at least the minimum number of credits described in Section 6.1.3.

Engineers and wetland ecologists will continue to better define on-site mitigation opportunities and will ultimately produce detailed, site-specific plans to provide the most EFUs in the most cost-efficient manner. These plans will include the following:

- Location map showing where the activity will occur within Chatfield State Park;
- A description of what will occur within the mitigation site, including anticipated acres and noncritical habitat EFUs for planned habitat types;
- CMP view of mitigation site at a scale of 1"=100';
- Cross sections and profiles of mitigation site for those activities involving earthwork that will alter the existing ground surface elevation at a scale of 1"=50';
- A plan for the salvage and use of topsoil for all activities that involve earthwork;
- Water sources, if a supportive hydrologic regime is required (e.g., wetlands);
- Erosion control plan;
- A list of plant materials to be used including species (common and scientific name), type (e.g., balled and burlap tree, container, bare root, and stakes), size, quantity, and schedule;
- A planting and/or seeding plan including specifications for planting, plant spacing, temporary irrigation, and mulching. Seeding plans will include species (common and scientific name), percent of species in seed mix, seeding rate, seed bed preparation, seed application, schedule, and mulching;
- Plans requiring an engineered structure will include a review and stamp by a registered engineer;
- Weed control plan; and
- Monitoring plan to determine success (Section 6.1.1.2).

6.1.1.2 Success Criteria

Each compensatory mitigation area will be monitored annually for at least 5 years after completion of the mitigation activities (Section 7.4). The on-site mitigation areas will be designed to support a mixture of wetland palustrine scrub-shrub, forested riparian, and riparian

shrublands. The following criteria relate to these created habitat types. Compensatory mitigation areas will be considered successful when these criteria have been met for at least 3 consecutive years without intervening remedial activities:

- For each planned habitat type, herbaceous cover will be at least 90 percent of the herbaceous cover of the reference area for that habitat type. Habitat type reference areas will be established in nearby areas of undisturbed habitat similar to that planned in the mitigation areas.
- At least 80 percent survival of planted trees and shrubs (including volunteers and vegetative reproduction). Species composition will be representative of species planted.
- State-listed A and B noxious weed species will be managed to comply with current State management guidelines for Jefferson and Douglas counties. State-listed A noxious weed species will be eradicated and in no case will State-listed B species make up more than 10 percent of vegetative cover.
- In areas designed as wetlands:
  - At least 50 percent of the species will consist of species rated as facultative or wetter, and
  - A least one primary or two secondary indicators of wetland hydrology will be present. These indicators of hydrology will be according to the *Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region* (Corps 2008).
  - For plant establishment, temporary watering past year one of planting will be considered a remedial activity.

6.1.1.3 Cottonwood Regeneration Areas

To compensate for the loss of mature cottonwood habitat, the draft CMP designated 13 acres in on-site mitigation areas SPR-2, SPR-3, and SPR-5 as cottonwood regeneration areas. Based on the revised mitigation areas, at least 13 acres in SPR-5 north of the gravel lake (Figure 18) and SPR-8 (Figure 19) are designated as cottonwood regeneration areas. The final grades and hydrology of these areas will be conducive to the establishment of a combination of cottonwood seedlings and planted trees. Cottonwood seedling areas will consist of gravely and sandy soils saturated during the early portion of the growing season. Surface water will be diverted to seedling areas until the root systems are developed enough to reach the ground water table.

6.1.1.4 Water Supply for Mitigation

The approach for creation of wetlands and cottonwood woodlands is to select and modify mitigation sites as needed to provide a supportive hydrology to sustain the wetland and riparian vegetation. Establishing wetland vegetation and cottonwoods will, in many instances, require a temporary supplemental water supply. The 158 acres of wetlands proposed to be created and the

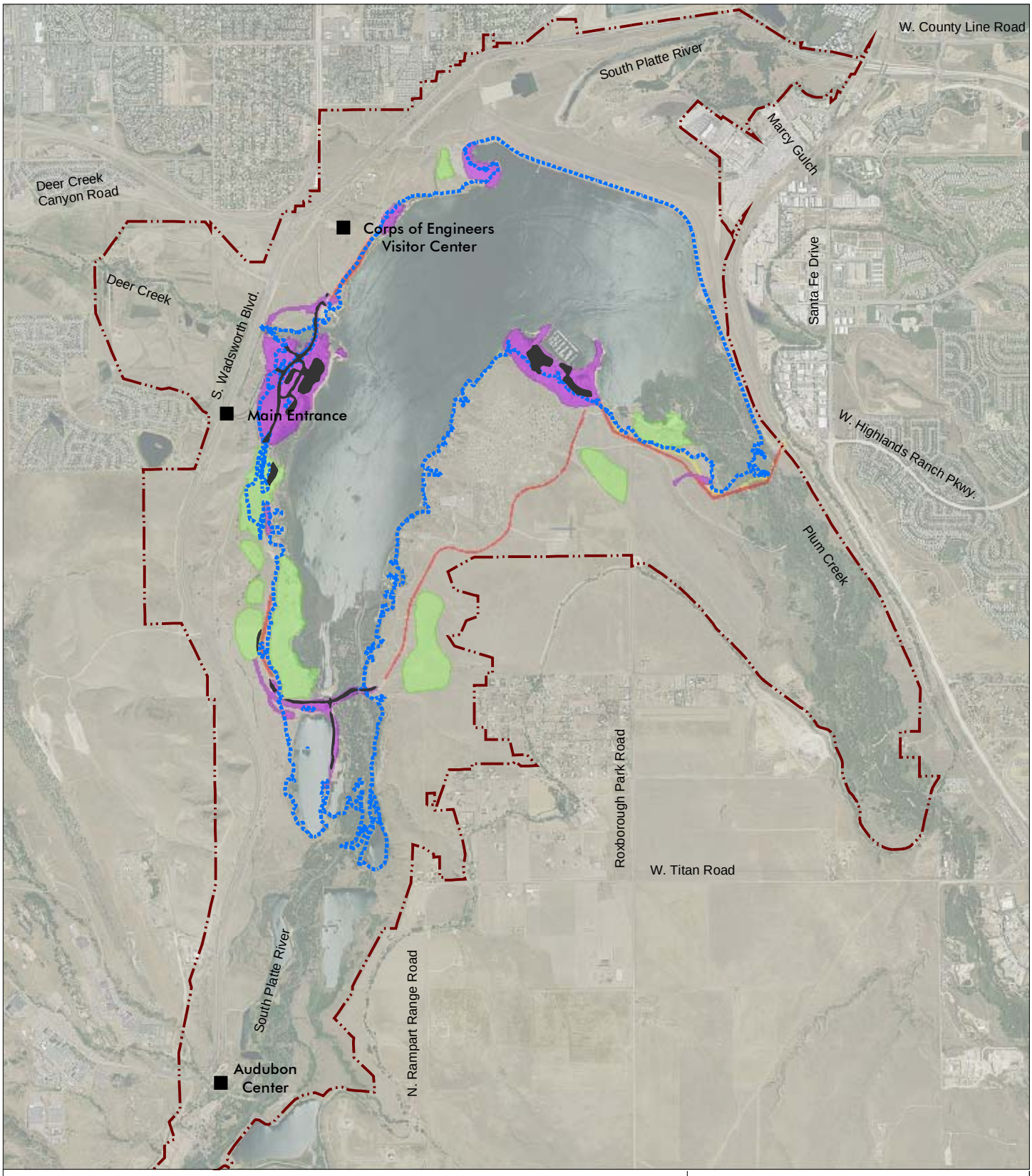
22.5 acres of cottonwood woodlands to be created do not exceed the maximum acres of wetlands and cottonwoods that have been estimated to be inundated by reallocation. Therefore, the transpiration (consumptive use) associated with the proposed creation of wetlands and cottonwood woodlands would not exceed the consumptive use of the wetlands and cottonwood woodlands estimated to be lost with reallocation. It is the policy of the Denver Regulatory Office of the Corps and the Colorado State Engineer's Office not to require water rights for wetland and riparian mitigation that does not exceed the consumptive use of the resources that will be lost. The Chatfield Water Providers will secure the necessary water rights and augmentation supplies if it is determined that a water right or permanent plan of augmentation is required for the mitigation.

6.1.2 Restoration of Borrow and Fill Areas

In addition to on-site compensatory mitigation for permanent impacts associated with inundation and recreation facility relocation, impacts to borrow areas above 5,444 feet in elevation and to fill areas and temporary roads will be mitigated in-place by restoring the areas to conditions similar to those present prior to disturbance (Figure 23). The two borrow areas below 5,444 feet in elevation will be used as compensatory mitigation areas (Section 6.1.1.1). Construction plans for the borrow and fill areas will include plans and specifications that follow restoration and revegetation guidelines developed for use in these areas (Appendix F). The guidelines include sections on soil preparation, seeding, mulching, and monitoring and maintenance. The restored areas will be monitored annually to ensure progress toward specific success criteria (Appendix F). Preliminary construction plans, specifications, and cost estimates for restoration of the borrow and fill areas are included in the recreation facilities relocation plan (EDAW 2009). Upon approval of the Federally Recommended Plan, preliminary plans will be prepared and submitted for Corps' approval prior to the development of final design documents.

6.1.3 Anticipated On-Site Compensatory Mitigation EFUs and Acreages

Once the mitigation areas were selected, the number of acres, potential EFU credits, and estimated costs for each potential on-site compensatory mitigation area were calculated (Table 3). As previously discussed, to be conservative, the estimates and examples are based on the mitigation areas depicted in Figure 7 and not the revised areas depicted in Figure 16. Figure 24 shows an example of how the net gain in EFUs, or EFU credits, were calculated for a habitat



Chatfield Reallocation Study

- Borrow Area
- New Trail
- Recreation Facility Relocation
- Utility/Haul Road
- Non-Habitat
- 5444 Pool Elevation (Maximum Pool Elevation of Alternative 3)
- Chatfield State Park

Imagery Source : Landiscor©, June 2008
Pool Elevations: Tetratech

0 1,750 3,500 feet

1 inch = 3,500 feet

N

Figure 23
Impacts Associated with Recreation Facility Relocation and Borrow Areas

File: 4048 Figure 23 Rec Facs and Borrow areas.mxd (GS)
February 2013

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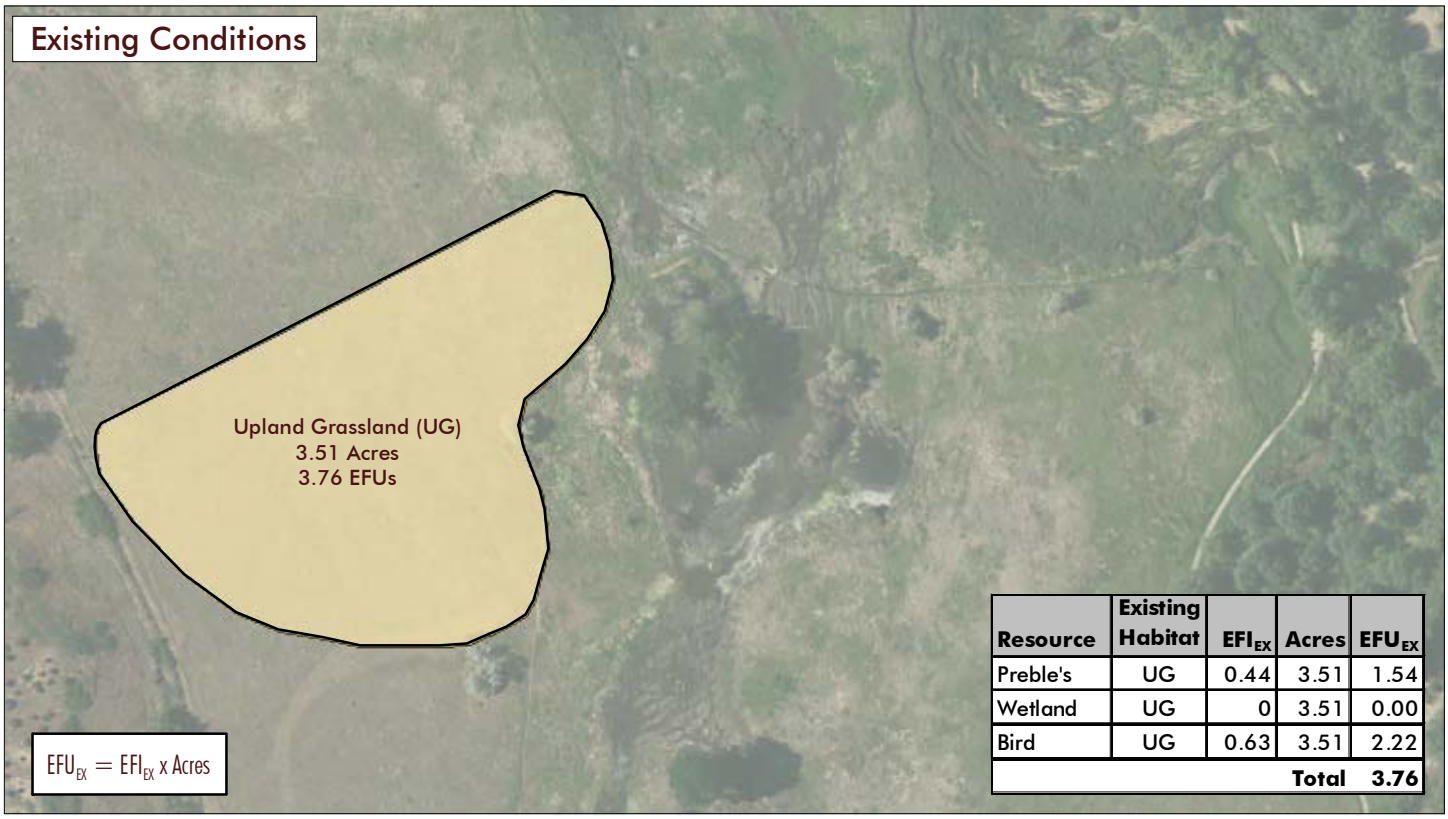
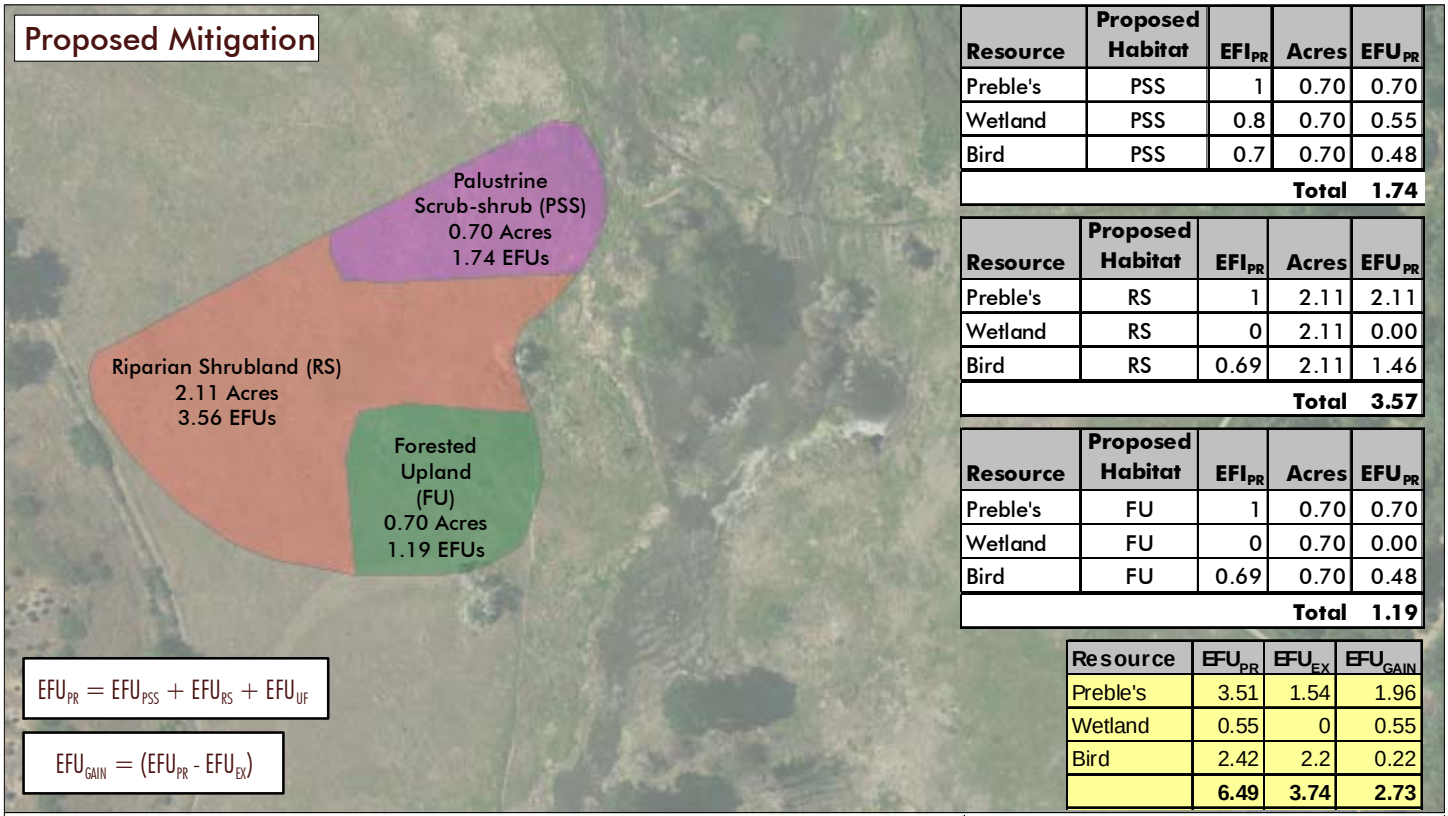


Resource	Existing Habitat	EFI_{EX}	Acres	EFU_{EX}
Preble's	UG	0.44	3.51	1.54
Wetland	UG	0	3.51	0.00
Bird	UG	0.63	3.51	2.22
			Total	**3.76**



Resource	Proposed Habitat	EFI_{PR}	Acres	EFU_{PR}
Preble's	PSS	1	0.70	0.70
Wetland	PSS	0.8	0.70	0.55
Bird	PSS	0.7	0.70	0.48
			Total	**1.74**

Resource	Proposed Habitat	EFI_{PR}	Acres	EFU_{PR}
Preble's	RS	1	2.11	2.11
Wetland	RS	0	2.11	0.00
Bird	RS	0.69	2.11	1.46
			Total	**3.57**

Resource	Proposed Habitat	EFI_{PR}	Acres	EFU_{PR}
Preble's	FU	1	0.70	0.70
Wetland	FU	0	0.70	0.00
Bird	FU	0.69	0.70	0.48
			Total	**1.19**

Resource	EFU_{PR}	EFU_{EX}	EFU_{GAIN}
Preble's	3.51	1.54	1.96
Wetland	0.55	0	0.55
Bird	2.42	2.2	0.22
	6.49	**3.74**	**2.73**

Chatfield Reallocation Study

Potential Mitigation Area

EFI_{EX} = Existing EFI
EFU_{PR} = Proposed EFUs
EFU_{EX} = Existing EFUs
EFU_{GAIN} = Net gain in EFUs

Image Source: Landiscor©, June 2008

This example is based on site PC-7. Subtotals and totals may differ due to rounding.

0 100 200 feet
1 inch = 200 feet
N

Figure 24
Example Calculation of Net Gain in EFUs From Habitat Conversion Activities

File: 4048 Fig 24 EFU Gain Calc Sample.mxd (WH)
February 2013

ERO Resources Corp.

conversion activity at mitigation site PC-7. Net gains in EFUs were calculated in a similar manner for all of the on-site compensatory mitigation areas. There would be no net change in EFUs from borrow and fill areas and temporary roads restored in place (Figure 23), so they are not addressed in this section. The following general assumptions were used to provide estimates of EFUs anticipated to result from mitigation activities and estimates of costs for each of the proposed on-site mitigation areas.

Table 3. Acres, EFUs, and Estimated Costs of Proposed On-Site Habitat Compensatory Mitigation Areas (exclusive of the restoration of borrow areas and other temporary disturbances).

Proposed On-site Mitigation Area	Figure Number	Acres		Estimated Gain Preble's EFUs	Estimated Gain Bird EFUs	Estimated Gain Wetland EFUs	Estimated Total Gain in EFUs	Estimated Cost
Lower Marcy Gulch								
LMG-1[1]	Figure 8	10.52		0.00	0.47	7.27	7.82	$ 913,530
LMG-2[1]	Figure 8	6.89		0.00	0.41	5.40	5.81	$ 600,320
Deer Creek								
DC-1	Figure 9	4.00		0.00	1.30	0.45	1.75	$ 639,012
DC-2	Figure 9	4.07		0.00	0.89	0.42	1.31	$ 748,037
DC-3	Figure 9	3.74		0.00	1.78	0.59	2.37	$ 659,194
DC-4	Figure 9	1.82		0.00	0.42	0.29	0.71	$ 468,192
Plum Creek								
PC-1[2]	Figure 10	15.66		7.22	0.77	2.04	10.03	$ 89,347
PC-2[1]	Figure 10	5.10		2.85	0.31	0.81	3.96	$ 581,944
PC-3	Figure 11	2.71		1.05	0.07	0.30	1.41	$ 758,088
PC-4	Figure 11	1.29		0.24	-0.03	0.06	0.27	$ 471,198
PC-5	Figure 11	5.96		3.34	0.36	0.94	4.64	$ 1,159,240
PC-6	Figure 12	5.03		2.82	0.30	0.79	3.91	$ 1,131,533
PC-7	Figure 12	3.51		1.96	0.21	0.55	2.73	$ 783,373
PC-8	Figure 12	5.40		3.02	0.32	0.85	4.20	$ 887,976
PC-9[1]	Figure 12	4.22		2.33	0.25	0.66	3.24	$ 784,530
PC-10	Figure 12	5.19		2.91	0.31	0.82	4.04	$ 1,005,013
South Platte River								
SPR-1[2]	Figure 13	44.51		6.21	-1.34	1.75	6.62	$ 253,244
SPR-2[1]	Figure 14	5.74		1.81	0.34	0.90	3.05	$ 650,408
SPR-3	Figure 15	4.01		0.44	0.24	0.63	1.31	$ 712,626
SPR-4	Figure 15	3.82		0.32	0.12	0.30	0.74	$ 870,405
SPR-5	Figure 15	4.50		2.48	0.26	0.70	3.43	$ 831,480
SPR-6	Figure 15	1.71		0.96	0.10	0.27	1.33	$ 397,381
SPR-7	Figure 15	8.55		0.72	0.49	1.32	2.53	$ 1,682,706
SPR-8	Figure 15	1.47		0.80	0.09	0.23	0.23	$ 336,160
SPR-9	Figure 15	0.95		0.53	0.06	0.15	0.74	$ 232,896
SPR-10	Figure 15	1.74		0.98	0.10	0.28	1.36	$ 401,581
SPR-11	Figure 15	0.92		0.46	0.04	0.13	0.63	$ 218,496
SPR-12	Figure 15	1.44		0.81	0.09	0.23	1.12	$ 337,949
SPR-13	Figure 15	0.97		0.48	0.05	0.13	0.66	$ 256,307
Totals		**165.45**		**46.27**	**8.94**	**29.70**	**84.91**	**$18,862,165**

[1]LMG-1, LMG-2, PC-2, and SPR-2 will be created by excavation only. No sheet pile will be used.
[2]PC-1 and SPR-1 are located in proposed borrow areas that are below the maximum pool elevation of 5,444 feet. Sheet pile will not be used in these areas and earthwork will be done as part of the recreation facility relocation. Potential EFUs for these areas are calculated assuming starting condition of upland grasslands.

Assumptions for calculating anticipated gain in EFUs:

1. Gains in EFUs from mitigation areas within currently mapped habitat are calculated using existing EFUs (Figure 24).
2. Gains in EFUs from mitigation areas beyond currently mapped habitat are estimated using CDOW riparian mapping equivalencies (Appendix C, Section 5.1).
3. Gains in EFUs include EFUs gained from mitigation activities in on-site critical habitat.
4. In most of the mitigation areas, existing upland grassland habitat will be converted on average to about 20 percent wetland palustrine scrub-shrub, 20 percent forested upland, and 60 percent riparian shrublands.
5. As shown in Table C-1 of Appendix C, following mitigation activities, the three habitat types in the mitigation areas will have the following EFIs for target resources:

    a. Palustrine scrub-shrub: Preble's – 1.0 (high value riparian), birds – 0.69 (shrubs (riparian)), and wetlands – 0.79 (palustrine scrub-shrub);
    b. Forested upland: Preble's – 1.0 (high value riparian), birds – 0.69 (trees), and wetlands – 0 (upland); and
    c. Riparian shrublands: Preble's – 1.0 (high value riparian), birds – 0.69 (shrubs (riparian)), and wetlands – 0 (upland).

6. In mitigation areas LMG-1 and LMG-2 (Figure 8), 100 percent of the habitat will be converted to one or more wetland habitat types.
7. Mitigation areas SPR-2, SPR-3, and SPR-5 (Figure 14 and Figure 15) are designated as cottonwood regeneration areas and 100 percent of the habitat will be converted to riparian trees.
8. Mitigation areas on Marcy Gulch and Deer Creek do not include Preble's EFUs because they are outside of known occupied Preble's habitat.

Weed control for the mitigation sites is part of the success criteria and mitigation credit will not be given for weed control in areas disturbed by mitigation activities. Detailed calculations of gains in EFUs are contained in Appendix G.

Assumptions for cost estimates:

1. Cost estimates include compensatory mitigation activities in on-site critical and noncritical habitat.
2. The earthwork, seeding, and mulching costs for PC-1 and SPR-1, which will be in the proposed borrow areas below 5,444 feet in elevation, are included in the recreation facility relocation costs.
3. Sheet pile cutoff structures will be used in 23 of 29 nonborrow area mitigation areas. Sheet pile is not proposed in six sites due to site-specific conditions.
4. Nonborrow areas will require salvage, storage, and reapplication of topsoil and removal of 2 feet of subsoil.
5. Excess excavated material will be disposed of off-site.
6. Sheet piles will extend 20 feet below the ground surface.

7. Mitigation area survey, design, construction administration, and contractor mobilization are 20 percent of estimated project costs (estimate based on professional judgment of Joe Juergensen, P.E., Muller Engineering Company).
8. All mitigation sites will receive the same revegetation treatment of native seeding and tree and shrub planting for each habitat type.
9. Line item cost estimates are based on average unit costs in the Urban Drainage and Flood Control District (District) Bid Tabulation software that compiles information on competitive bids for 35 channel improvement projects with District funding from 2010 to 2012.

More detailed assumptions and calculations are contained in Appendix G. Better defined estimates of on-site mitigation acres and estimated costs will be developed as the site-specific mitigation plans are finalized prior to issuance of the decision documents. Estimates of on-site mitigation EFUs will be revised based on field evaluations and the final site-specific mitigation area plans.

In addition to habitat conversion activities, there are opportunities for habitat enhancement, particularly along Plum Creek and the South Platte River. For example, significant channel degradation along Plum Creek has lowered the water table, adversely affecting adjacent wetland and riparian vegetation. Numerous cottonwood and peachleaf willow trees have died because of the change in hydrology and former wetland areas have transitioned to mesic or upland conditions. Approaches to restoring the degraded channel reach are being studied to determine potential gains in EFUs from restoration and from prevention of additional habitat degradation if the channel instability is not addressed.

Generally, the number of compensatory EFUs gained from enhancement activities, such as weed control, will be lower than those gained from habitat conversion activities such as converting upland grasslands to shrub-scrub wetlands. Because EFUs gained through habitat enhancement such as weed control will be relatively small, they are not included in current calculations of EFUs anticipated to result from on-site mitigation activities. Habitat enhancement activities may be implemented as part of adaptive management (Section 7.5).

Using currently available mapping and estimates of EFUs, 165 acres on-site will be converted to a mosaic of riparian shrublands (89 acres), wetlands (33 acres), and riparian forest (43 acres), and will provide a total of 85 compensatory EFUs. The 85 EFUs will include 3 West

Plum Creek CHU EFUs, 43 noncritical habitat Preble's EFUs, 9 bird EFUs, and 30 wetland EFUs.

6.1.4 Summary of On-Site Noncritical Habitat Mitigation

Based on the best information currently available and using conservative approximations of potential mitigation acreage and EFUs, the following will occur on-site:

- Conversion of about 134 acres of uplands to Preble's habitat that will enhance 17 acres of Upper South Platte CHU habitat, 6 acres of West Plum Creek CHU habitat, and 111 acres on noncritical habitat, which will provide a net gain of 43 noncritical habitat Preble's EFUs and 3 West Plum Creek CHU EFUs;
- Enhancement of about 165 acres of upland grassland bird habitat to habitat that will provide a net gain of 9 bird EFUs;
- Creation or enhancement of about 47 acres of wetlands that will provide a net gain of 30 wetland EFUs;
- Restoration and revegetation of about 173 acres of borrow and fill areas, and areas disturbed by utility realignment and haul roads to upland grasslands, resulting in no net change in EFUs; and
- Creation of about 13 acres of cottonwood regeneration.

Section 6.3.2.5 includes several tables that summarize impacts, on-site mitigation, and off-site mitigation.

6.2 Off-Site Mitigation

The CMP focuses mitigation efforts first in on-site areas. However, it is recognized that mitigation requirements will exceed what is available within on-site areas. Therefore, additional mitigation sites will be identified off-site, primarily on private lands upstream of Chatfield State Park in the Plum Creek and West Plum Creek watersheds (Figure 25). The final number and extent of off-site mitigation areas will be determined by how many EFU credits are generated from each mitigation area.

For on-site mitigation, calculating EFU credits gained by mitigation activities, such as habitat conversion of upland grassland to a scrub-shrub wetland, is a relatively straightforward process of determining the number of EFUs in the area prior to mitigation activities and the number of EFUs in the area after mitigation activities. The net gain in EFUs will be credited to offset impacts.