Storage Study Report—Executive Summary

Cucharas Basin
Collaborative Storage Study

Executive Summary

Huerfano County, Colorado

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Executive Summary

The history of the Cucharas Basin is one of
perpetual drought punctuated by a few normal years.
-- Beaver Edmundson, HCWCD Board

The Cucharas River basin is water short, a condition exacerbated by serious lack of storage. In 2015, storage stakeholders formed the Cucharas Storage Collaborative which initiated this study to investigate joint projects meeting the basin's storage needs - opportunities for the collaborative repair, construction, and operation of selected storage structures within the basin.[1]

This reconnaissance-level study assesses the storage needs of the basin and develops options for collective storage development. The results of this study illustrate the prudence of the stakeholders moving forward with a joint project facilitating the storage and most efficient and effective use of water in an enlarged or new storage infrastructure.

This Executive Summary presents the findings, cost estimates and recommendations of the Cucharas Basin Collaborative Storage Study. The attached Study Report provides additional detail and is comprised of the attached task memoranda developed by ParsonsWater Consulting and Applegate Group.

Purpose and Approach

A needs assessment was conducted to determine current and future water demands in the basin. Estimates of the sufficiency of current water supply available to meet these demands were used to illustrate the amount of additional yield and storage necessary to meet shortages. Dam Safety reports and associated information were reviewed to characterize current storage conditions. Site visits to existing and prospective reservoir sites were carried out to identify maintenance needs and opportunities for new storage. Details regarding the storage needs assessment are included in the attached Task 1 report. Additional screening of the storage sites was used to narrow the list of alternatives to arrive at the most promising storage sites to meet Stakeholders' needs. A screening matrix was developed to compare the possible storage options based on volume, technical feasibility, storage yield, operational and administrative factors, and the potential for public benefit. A StateMod modeling platform was developed to assess the yield of various reservoir alternatives and the ability to deliver water to meet estimated water shortages. The effect of Arkansas River calls were not specifically evaluated but would decrease project yields. Scores assigned to the screening thresholds for each storage option, in conjunction with stakeholder feedback provided at eight public meetings, were used to identify a list of five preferred reservoir sites. Feasibility level cost estimates and preliminary design drawings were developed for the preferred sites. Permitting requirements and funding opportunities related to development of joint storage in the basin were identified. Recommendations were made to help direct the shareholders through the next stages of reservoir design and construction. Details regarding these aspects of the storage study are included in the attached Task 2 report.

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1 This study was first identified in a workshop conducted by the Huerfano County Water Conservancy District (HCWCD) with the Division Engineer and his staff in April 2013. A month later, it became part of the District's strategic plan. In 2015 it was included in the Arkansas Basin Implementation Plan's Master Needs List (Project 2015-007). Primary funding was a grant from the Colorado Water Conservation Board's Water Supply Reserve Account, along with matching funds from Huerfano County, the City of Walsenburg, the Town of La Veta, the Cucharas Sanitation and Water District, and the Huerfano County Water Conservancy District.

Storage Needs

Current water demands were tabulated based on water treatment plant deliveries provided by the three local municipal water providers (Cucharas Sanitation & Water District, Town of La Veta, and City of Walsenburg) and records of irrigation diversions maintained by the Colorado Department of Water Resources. Future water demands were estimated based on municipal planning efforts, projected population growth, and a maximum supply (i.e., not limited) to meet the demand associated with approximately 11,000 irrigable acres located within the Cucharas River basin.

MUNICIPAL	**Current Demand**	**Future Demand**
Cucharas S&WD	141 AFY	196 AFY
La Veta	325 AFY	408 AFY
Walsenburg	1,106 AFY	2,212 AFY
Unincorporated	228 AFY	286 AFY
Total	1,800 AFY	3,103 AFY
IRRIGATION	12,980 AFY	33,573 AFY

Municipal demands are typically satisfied in wet and average hydrologic years but face shortages in drought years. Shortages to irrigation demands occur in all but the wettest of years. The current level of infrastructure and water supply are not sufficient to meet anticipated future demands in average to below-average years and during multi-year drought periods. The extent of shortages to future demands was estimated with spreadsheet models over a three-year drought planning scenario.

Additional total storage/supply to cover a three-year drought period was estimated, as follows:

- Cucharas Sanitation & Water District 30 acre-feet to 40 acre-feet
- Town of La Veta 400 acre-feet
- City of Walsenburg 3,200 acre-feet

Irrigation shortages are significant and average approximately 15,000 acre-feet per year under the future demand scenario. With the exception of irrigators, these estimates represent the needs of individual stakeholders. Operations to gain the greatest benefit for all stakeholders would rely on cooperative operations with whatever supplies may be available to meet future demands.

Existing Infrastructure

Only about 30 percent of the approximately 47,000 acre-feet of capacity historically impounded behind 70 dams in the basin is currently available for use and not under dam restriction. The status of existing infrastructure in the basin was determined based on review of decreed storage rights, historical storage contents records, review of Dam Safety reports, and discussions with Division of Water Resources personnel. This information was reviewed with Collaborative stakeholders at public meetings, at which a number of potential reservoir sites were also identified.

Site visits to 26 existing reservoir sites and 7 potential reservoir sites confirmed the lack of ongoing maintenance for the aged dams in the basin, and provided the information needed to estimate the cost of deferred maintenance that would be required to bring existing reservoirs into current day Dam Safety standards. The opportunities and limitations of the new reservoir sites and existing reservoirs that are most promising from an enlargement perspective were used as part of the screening analysis directed towards identification of effective storage options to meet anticipated water shortages.

Screening

A screening matrix was developed using criteria to assist in evaluating each storage alternative. Each alternative was comparatively scored under the selected screening criteria. A weighting factor was applied to each screening criteria to arrive at a weighted score for each storage alternative. Seven scoring thresholds were analyzed, including the following:

1. Storage Volume – Qualitative analysis of vessel size within which water could be stored.
2. Technical Feasibility – Qualitative analysis of complexities of site geology, availability of borrow material, and associated impact of construction.
3. Yield – Quantitative analysis of water that could be stored in priority without injury to existing Cucharas direct flow and storage water rights.
4. Project Cost – Quantitative analysis of the cost efficiency of the sites for comparison purposes, including dam construction, land acquisition, and O&M costs.
5. Operational Factors – Qualitative analysis of level of automation possible and level of coordination necessary among multiple owners.
6. Administrative – Qualitative analysis of permitting requirements, need for detailed water court efforts, and easements.
7. Public Benefit – Qualitative analysis of potential socioeconomic benefit based on recreational benefit provided by an alternative.

The following thirteen sites and three additional integrated operational scenarios were evaluated for the screening task:

Existing Reservoirs

- Britton Ponds Enlargement
- La Veta Lakes Enlargement
- HR Carson #1/#2 Combined Storage
- Daigre Reservoir Enlargement
- City Lake Rehabilitation and Enlargement
- Holita Reservoir Rehabilitation
- Maria Stevens Rehabilitation and Enlargement
- Horseshoe/Martin Joint Use Pool

New Storage Projects

- South Baker Creek Reservoir
- Chaparral Creek Reservoir
- Bruce Canyon Reservoir
- Coler Seepage Reservoir
- White Creek Reservoir

Integrated Operations

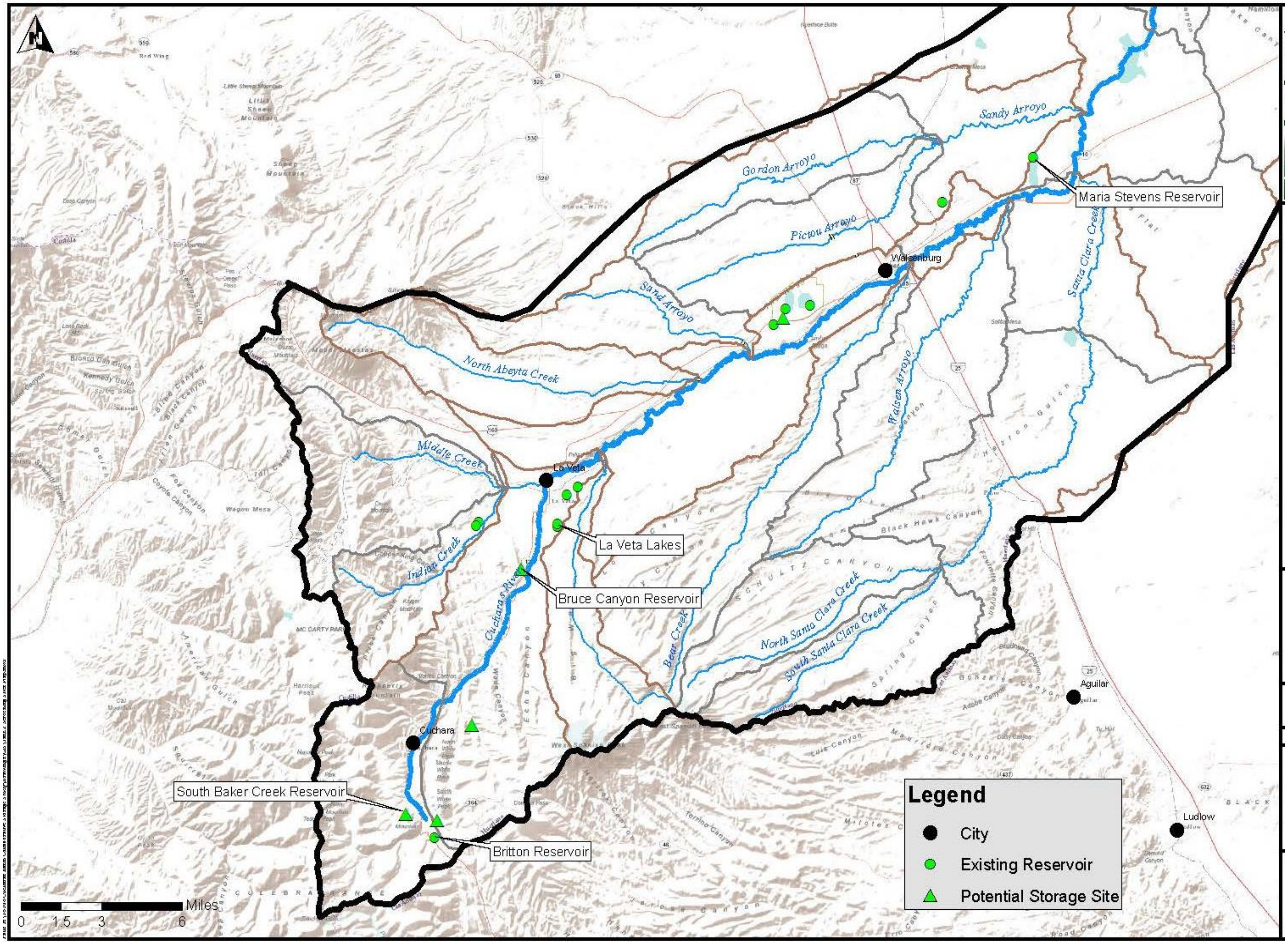
- Maria Lake - Bruce Canyon Exchange
- Change of Use of Unused Senior Rights
- Change Diversion to Coler Inlet Ditch

Based on the screening analysis and user input, the following five sites were selected as preferred sites for development of preliminary design drawings and development of cost estimates. The top five scoring sites are also noted in the figure below.

- South Baker Creek Reservoir
- Britton Reservoir enlargement
- Bruce Canyon Reservoir
- La Veta Lakes combination/enlargement
- Maria Stevens Reservoir enlargement

As noted previously, the Collaborative was established with a focus on cooperative operations throughout the basin in order to gain the greatest benefit for all stakeholders. Water users throughout the basin have different advantages and deficits with physical water supply, location of demands and returns, and the extent to which sites are suitable for development of storage reservoirs. The most efficient way to get physical supply to where the demands are located is by moving water through different reaches of river during high streamflows. This is facilitated by the exchange of water where water is released to the river above the calling right to allow diversion at a location upstream from the point of release. For instance, water could be released from Maria Stevens Reservoir to satisfy the Arkansas River call in exchange for a like amount of water stored under a junior water right upstream at the Butte Ditch for storage in Bruce Canyon Reservoir. Alternately, upstream storage of unused and underused senior storage rights could be affected through an exchange of those rights to a decreed new location of storage.

At a later time, for instance, when a call has been placed on the lower Cucharas River and streamflows are high above Middle Creek, water could be released from Bruce Canyon Reservoir to meet the call and a like amount of water is exchanged upstream to storage in South Baker Creek Reservoir. These operations and similar operations (e.g., upstream storage of changed senior water rights) will require the adjudication of multiple exchange rights to facilitate the movement of water throughout the river for storage and for use – sometimes referred to as ladder exchanges or stair step exchanges. The different rights would identify the various locations of the exchange-from points that have the replacement supply; e.g., Maria Stevens Reservoir, Martin Lake, Butte Ditch, changed water rights at the Mexican Ditch, Ballejos Ditch, Gomez Ditch, and the exchange-to points; e.g., Bruce Canyon Reservoir, South Baker Creek Reservoir, La Veta Lakes. The various locations of demand, supply, and storage infrastructure point to the benefit of the stakeholders moving forward with a joint project where each entity is able to provide certain facets of the supply and infrastructure for the greatest overall benefit to all stakeholders.



Legend
City
Existing Reservoir
Potential Storage Site
Maria Stevens Reservoir
La Veta Lakes
Bruce Canyon Reservoir
South Baker Creek Reservoir
Britton Reservoir
Walsenburg
La Veta
Cuchara
Aguilar
Ludlow
Sandy Arroyo
Gordon Arroyo
Pictou Arroyo
Sand Arroyo
North Abeyta Creek
Middle Creek
Indian Creek
Cucharas River
Bear Creek
North Santa Clara Creek
South Santa Clara Creek
Santa Clara Creek
Walsen Arroyo
Black Hawk Canyon
Miles
0 1.5 3 6

Cost Estimates

Feasibility engineering was completed for the preferred alternatives, including the primary project components and sizes needed. Unlike the Project Cost criterion used in the screening analysis, the feasibility level cost estimates are more detailed and include high level estimates for design, construction, permitting, operations and maintenance, land acquisition, construction oversight, and energy costs. Unit costs were calculated as the ratio of the total cost of the project to the total storage capacity for the project. The unit cost for storage is the primary metric used in cost-benefit analyses, with a range of $10,000 to $20,000 per acre-foot as a threshold for feasible projects. However, these typical unit costs are generally applied to larger (e.g., greater than 1,000 acre-foot of storage volume) reservoirs. Unit costs for smaller reservoirs, similar to four of the preferred reservoir sites, may be higher. Bruce Canyon dam and the enlargement of Maria Stevens Reservoir are the only two projects that have a unit cost for storage volume below $20,000.

Reservoir Alternative / Storage Capacity	Project Cost[1,2]	Unit Cost ($/ac-ft Capacity)
Britton Ponds Enlargement (42 AF)	$6,577,340	$156,602
South Baker Creek Reservoir (122 AF)	$13,101,600	$107,390
La Veta Lakes Enlargement (102 AF)	$6,621,300	$64,915
Bruce Canyon Reservoir (1406 AF)	$19,184,100	$13,644
Maria Stevens Rehab/Enlargement (642 AF)	$8,406,300	$13,094

[1] Project Cost is based on the Construction Cost estimate, and does not include additional engineering design, permitting, land acquisition, or O&M costs.

[2] Deferred maintenance costs for existing reservoir sites are excluded from Project Cost, as it is assumed these costs will be separate from the Collaborative Storage improvements.

Another metric for cost-benefit analyses is the unit cost for project yield, defined as the ratio of the total cost of the project to the average annual yield. These unit costs represent the approximate cost of delivering an acre-foot of water over a 50-year project life. Annual unit costs over a 50-year project life range from approximately $620 to $5,980 per acre-foot.

Reservoir Alternative / Storage Capacity	Delivery (ac-ft/yr)	50-Yr Cost[1,2] ($/ac-ft/yr)
Britton Ponds Enlargement (42 AF)	22	$5,979
South Baker Creek Reservoir (122 AF)	54	$4,852
La Veta Lakes Enlargement (102 AF)	102	$1,298
Bruce Canyon Reservoir (1406 AF)	622	$617
Maria Stevens Rehab/Enlargement (642 AF)	271	$620

[1] 50-Yr Costs are based on construction costs, and do not include additional engineering design, permitting, land acquisition, or O&M costs.

[2] Deferred maintenance costs for existing reservoir sites are excluded from Project Cost, as it is assumed these costs will be separate from the Collaborative Storage improvements

Permitting

Permitting requirements will vary somewhat between the five preferred alternatives, but each alternative project generally will require some level of permits. Based on an initial assessment of permitting requirements, the most difficult projects to permit would be the new on-stream dams: South Baker Creek, Bruce Canyon, and Britton Ponds enlargement. On-stream dams will require a Clean Water Act Section 404 Individual Permit, which are time consuming and costly. Federally funded projects would also be particularly difficult to permit, and may require National Environmental Policy Act (NEPA) permitting, which can vary significantly in cost and timing. Construction within the regulatory floodplain (i.e., South Baker Creek, Bruce Canyon, and Britton Pond) would generally require a floodplain development permit from Huerfano County, and could be an arduous process if the project would result in an impact to the regulatory floodplain. Based on an initial review of threatened and endangered species at the project locations, there are a few threatened species but no endangered species. As a result, Endangered Species Act (ESA) permitting may be relatively simple.

The variability of permitting requirements typically has a significant impact on project schedule. An organized approach to filing permit applications may require on the order of two years and $100,000 - $300,000 to acquire final permits necessary for a project.

Funding Opportunities

The Storage Study and cost-benefit analysis of the preferred reservoir sites provide the Collaborative some direction in its decision making process regarding choosing which way to move forward with development of storage in the basin. There are a number of steps needed to help the progress of that effort, including land acquisition; securing necessary rights-of-way and completing agreements between partners and affected parties; addressing various water rights issues; and finalizing permits and analyses used to support permit applications.

Various funding options were reviewed to support those efforts. The most promising funding options were identified as:

- EPA WIFIA (Water Infrastructure Finance and Innovation Act): loans for regionally significant projects, minimum $5 million project size with maximum 49% of project costs, 35-year maximum term of loan.
- CWCB Water Project Loan program: loans for new construction or rehabilitation of existing raw water storage and delivery facilities, minimum $100,000 loan, 2.55% to 3.30% interest rate, 30-year term of loan.
- CWCB Non-Reimbursable Project Investment Grants: studies and projects to address regional water issues, grant amounts and terms provided by CWCB.
- Water Supply Reserve Funding: competitive grants and loans to address water supply issues, 25% applicant match required.

Some of the loan and grant opportunities are focused on storage opportunities and some are not. Many of the funding opportunities are directed toward basin-wide efforts with multiple beneficiaries that typify the storage alternatives analyzed for the study.

Recommendations

Preliminary design drawings were completed for the five preferred dams, which can be used to support further efforts for dam design and associated investigations. The costs for the various storage projects range widely, in part due to lack of knowledge of underlying site geology, which factors significantly into project cost. Therefore, the primary recommendation from this study is to gather site-specific geotechnical data that can be used to refine the feasibility level designs and cost estimates, resulting in a better understanding of total construction costs. A secondary recommendation is to further investigate the ability of filling and operating new storage capacity without injury to water rights located outside of the Cucharas River basin. One option would be the use of the StateMod model of the entire Arkansas River basin that will be completed as part of the CWCB-sponsored ArkDSS planning effort. That effort is underway and is scheduled for completion in approximately two years. Replacement sources capable of meeting downstream calls do exist in the basin (e.g., Maria Stevens Reservoir, unused senior storage rights, and changed direct flow rights owned by the three municipalities). Further analysis to illustrate their use with operation of one or more exchanges to secure additional storage yield to meet stakeholders' needs is also warranted.

Storage Study Report—Task 1

Cucharas Basin
Collaborative Storage Study

Task 1 Storage Needs Assessment

Huerfano County, Colorado

June 2017

CWCB Contract No. CTGGI 2016-1053

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INTRODUCTION

The Storage Needs Assessment is comprised of two subtasks: the Demand-Supply Analysis (Task 1a) and Infrastructure Assessment (Task 1b). The objectives of these tasks are as follows:

Analyze sufficiency of water supply and associated infrastructure to meet the current and future demands of Collaborative stakeholders. Identify options for water conservation and rehabilitation and/or development of storage capacity that would provide additional yield to meet demands unsatisfied with existing infrastructure. Develop cost estimates associated with the different options recommended for enhancing the stakeholders' yields.

The efforts completed in Task 1a are intended to provide an overview of demands, supply, infrastructure, and operations in the Cucharas River basin. The status of existing reservoirs and associated conveyance infrastructure and investigation of potential storage sites in Task 1b are used to refine the cost estimates beyond a unit acre-foot cost used in previous draft memorandum. The findings presented herein and to be discussed at the July 21, 2016 public meeting are intended to prepare the stakeholders to narrow the list of preferred storage sites for the more detailed yield analysis and cost-benefit analysis to be addressed in Task 2 – Storage Study.

APPROACH

In addition to discussions at the February 2016 and May 2016 public meetings, interviews were held with representatives of each the Collaborative stakeholders and associated water users to identify current and future demands, water supplies, existing infrastructure, and operations used to meet demands. The Water District 16 commissioner, dam safety engineer, and local experts in non-consumptive water uses were also interviewed. Infrastructure maintenance needs, focused on reservoir rehabilitation, were identified. The most recent Division of Water Resources Dam Safety Branch inspection reports for existing dams were reviewed and site visits were completed for existing dams where access was granted. Planned infrastructure developments and storage opportunities were also discussed and reviewed in the field. A variety of hydrologic input and water use records were gathered and reviewed in the context of identifying supply and demand throughout the Cucharas River basin.

A demand-supply analysis was conducted to estimate the sufficiency of existing infrastructure and water supplies to meet current and future demand levels, in dry and average years. The unmet demands were quantified and the amount of storage and/or additional yield necessary to meet the shortages was computed. Site visits to 26 existing reservoirs and 8 proposed reservoir sites were completed during June 2016 in order to better understand how the reservoir sites might provide multiple benefits to Collaborative stakeholders. We accompanied the Dam Safety Engineer, Mark Perry, during the visits to the reservoirs owned and maintained by the city of Walsenburg. Site visits to other locations were approved beforehand by property owners. Representatives from Cucharas Sanitation and Water District participated in site visits to its existing and potential reservoir sites located in the Upper Cucharas River basin. A reporter from the Huerfano World Journal also participated in our field inspection for Wahatoya Reservoir.

The majority of sites under consideration have physical storage capacities (i.e., normal storage, or storage up to the spillway crest elevation) of greater than 25 acre-feet, with only three sites with physical capacity of less than 25 acre-feet. Specifics regarding the status of existing infrastructure and the repair and development needs for existing and proposed sites were used to develop a matrix (see Appendix A) characterizing different attributes of the sites at which we were able to conduct site visits. A similar matrix (Appendix B) was developed for potential new reservoir sites. The matrices can be used to compare and contrast the opportunities and deficits of the various reservoir sites. The matrices and accompanying memorandum should be used by the stakeholders in determining which storage sites should be included in the list of preferred reservoirs for more detailed analysis in Task 2.

Our previous effort to estimate construction and rehabilitation costs used a unit price per acre-foot ($7,500) for developing storage capacity. Rehabilitation costs were estimated as a function of reservoir storage capacity and the age of the dam. This approach was based on limited information for the reservoirs and therefore assumed commonality between reservoirs old and new, small and large. This approach can be misleading since estimates of construction and rehabilitation costs are dependent on the specifics of the storage unit and its location. As evidenced during the site visits, the reservoirs in the basin show a wide range of maintenance needs that are not necessarily directly related to age or size of the structure. The variability in cost between units is demonstrated in the estimates that have been developed for various stakeholders, including the town of La Veta, city of Walsenburg, and Two Rivers Water Company. These studies show a range of rehabilitation costs from $5,000[1] to $15,400[2] per acre-foot of storage capacity, with the wide variation in rehabilitation costs due to the specific rehabilitation requirements for each of the dams. The cost of new dam construction could vary from $540 per acre-foot[3] to $20,000 per acre-foot, with a commonly accepted planning level unit cost of $10,000 per acre-foot. Therefore, development of cost estimates should be deferred in this task and developed for the preferred reservoir sites to be analyzed further in Task 2.

FINDINGS AND RESULTS

The Collaborative stakeholders represent both consumptive and non-consumptive water uses within the Cucharas River basin. Consumptive demands come predominantly from irrigation, municipal supply, and some self-supplied commercial interests. Based on the extent to which data were available, irrigation demand and supplies were analyzed over a 1980 to 2014 study period. This period includes patterns of wet, dry, and average hydrologic years that evidences the variability of water supply in the basin. The period also includes 2002, which is often used to define the dry-year yield for planning purposes. The demands and supplies for municipal entities were analyzed over a sustained drought period with available supply based on dry-year yields. Non-consumptive water uses have not yet been quantified but will be incorporated into the Task 2 analysis as more information becomes available.

A description of the current and future demands identified for the various uses is included below. This information is followed by a discussion of the adequacy of water supplies, infrastructure, and operations to meet the demands.

[1] Based on La Veta North Lake Dam rehabilitation cost estimate from *Storage Feasibility Report, Town of La Veta,* prepared by Colorado River Engineering, Oct 2011, and escalated to 2016 costs.
[2] Based on City Lake rehabilitation cost estimate from *Conceptual Design Report, Walsenburg City Lake Dam and Reservoir*, prepared by RJH Consultants, Inc., Apr 2015, and escalated to 2016 costs.
[3] Based on new roller compacted concrete dam for Cucharas Valley Reservoir, 60,000 acre-foot alternative, *Cucharas Dam Preliminary Design Report*, prepared by GEI Consultants, Inc., March 2010, and escalated to 2016 costs.

WATER DEMANDS

AGRICULTURE

The agricultural demand was estimated for the entire study area, using data developed for the Colorado Division of Water Resources (DWR) Consumptive Use (StateCU) model. The StateCU model estimates water supply-limited crop demands based on irrigated acreage, crop mix, climate data, and river diversions. Livestock water demands are included as part of the agriculture demand.

A 1978 Study on the Water Resources of Huerfano County included an estimate of 11,400 acres irrigated in the Cucharas River basin. This estimate excluded an unknown amount of small, isolated acreage. GIS shapefiles of irrigated acreage (2012) provided by the Division 2 office included 10,860 acres of irrigated land in the Cucharas River basin. The majority of agricultural land is irrigated from the Cucharas River and Middle Creek, as shown on Figure 1 and summarized in Table 1. This is because the mainstem Cucharas River and Middle Creek typically have water throughout the summer irrigation season. Lesser amounts of land are irrigated on Wahatoya Creek, which has water for the majority of the year before drying up in the late-summer months. The remaining areas in the basin have limited water supply and, typically, smaller amounts of irrigated acreage.

Table 1
Cucharas Basin
Irrigated Acreage

Watershed Area	Irrigated Acreage* (approx.)
Upper Cucharas River	2,431
Middle Creek	1,982
Wahatoya Creek	1,540
North Abeyta Creek	387
Western Arroyos	170
Eastern Tributaries	1,642
Lower Cucharas River	2,708
Total	10,860

* Based on DWR 2012 GIS shapefile

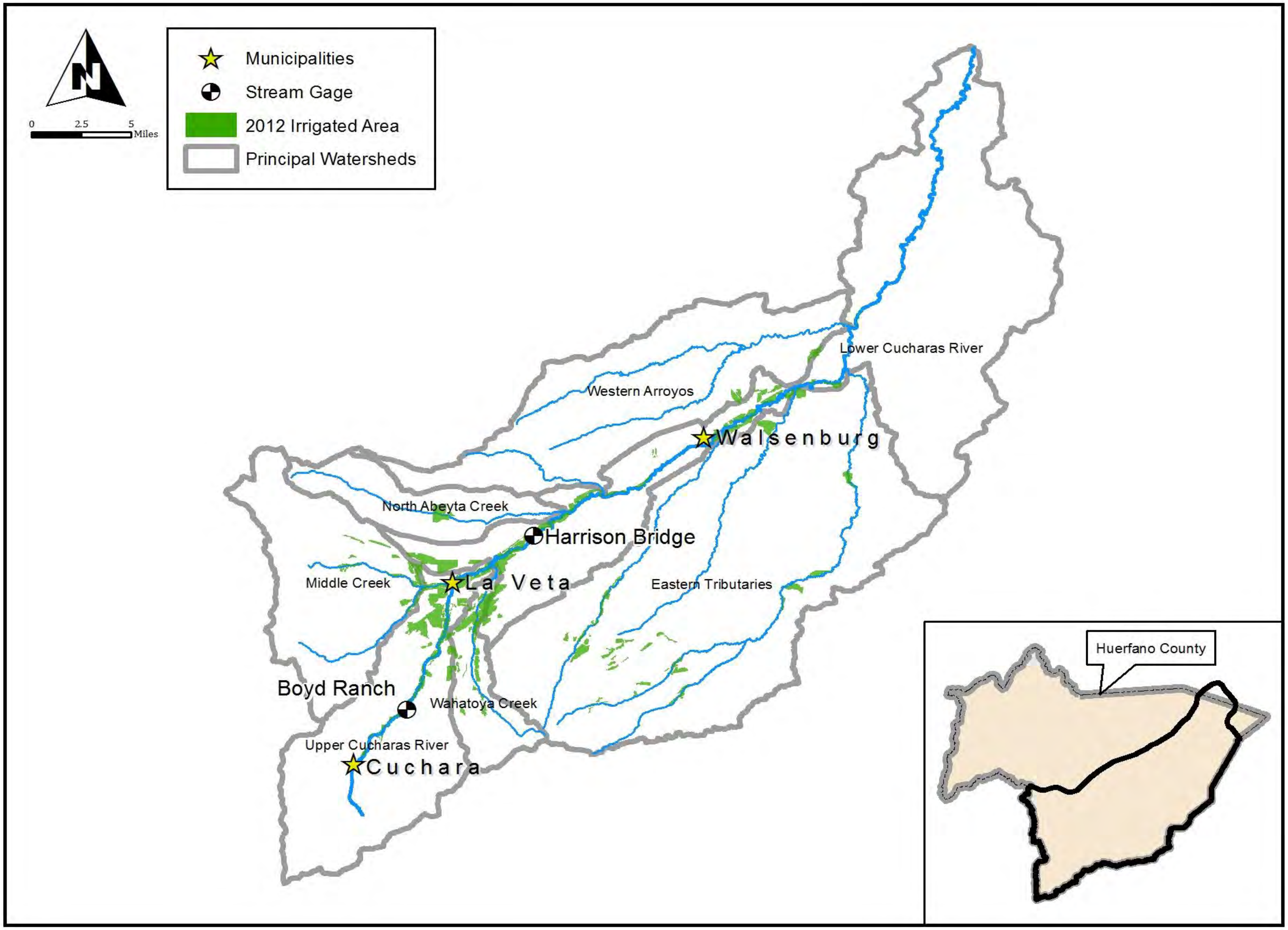


Figure 1 – Cucharas Basin Study Area

An average value of 11,200 irrigated acres from the 1978 and 2012 reports was used to estimate demand and supply over the 1980-2014 period. Future demand was assumed to equal the current demand, which is consistent with the relatively steady amount of land under irrigation over the last 30-plus years.

Agricultural statistical inventory data for counties in Colorado is developed by the National Agricultural Statistical Service (NASS) and is stored in the DWR HydroBase water resources database. Although the crop mix within Huerfano County has changed over the 1980-2014 period, alfalfa hay represents a significant percentage of the irrigated crops over time. Alfalfa was used as the irrigated crop in the StateCU model. The model relied on basin-specific climate data from the Walsenburg weather station.

The potential consumptive use (PCU) represents the maximum amount of water that can be consumed by crop irrigation. A portion of the PCU is satisfied by precipitation. The remaining crop demand is the crop irrigation water requirement (IWR), which represents the maximum consumptive use of water applied to the crops. The average PCU and IWR over the 1980-2014 period is approximately 2.69 acre-feet per acre and 2.07 acre-feet per acre, respectively. The demand for the irrigated lands in the basin totals approximately 23,000 acre-feet per year for both the current scenario and future scenario. The monthly distribution of irrigation demand is presented with diversions and estimated shortages in Table 4.

Water demands for livestock was estimated based on historical county agricultural statistics and water use rates of 10, 3, and 2 gallons per head per day for cattle, hogs, and sheep, respectively. The NASS inventory data was prorated based on the aerial extent of the county that is made up by the Cucharas basin, which is estimated as 48 percent. Livestock counts have reduced over time. Cattle inventory averaged about 25,000 head over the 1980-2014 period. Hog and sheep counts were available, most recently, during the 1980s and therefore do not contribute much to the livestock water demand of about 275 acre-feet per year. The livestock demand is assumed to be satisfied by diversions to irrigation. Livestock water demands may also be met by stock water ponds or storage releases but those operations are not explicitly represented in the analysis.

Municipal, Commercial, and Industrial

Municipal and industrial (M&I) and commercial water demands were estimated based on information gathered from the Cucharas Sanitation & Water District (CSWD), town of La Veta, the city of Walsenburg, and local and state officials. M&I demands were based on service area population, water treatment plant delivery records, system losses, river diversions for direct use and storage, and reservoir operations. The population data was gathered from U.S. Census publications and records maintained by the Colorado Department of Local Affairs (DOLA). This information was supplemented by historical and projected future population data for municipalities and counties, and per capita demand rates. Discussions with County and municipal public officials did not identify any self-supplied commercial demands (i.e., that do not receive their water supply from the municipal providers) in excess of a few acre-feet, Therefore, commercial water demands were not separately analyzed.

The population in Huerfano County has ranged from about 6,000 to 8,000 persons over the last 30 years. The population peaked in the early-2000s and the most recent census (2010) accounted for 6,711 persons. The population served by the public water suppliers in the Cucharas River basin has been on a general downward trend over the same period. The current population of the Cucharas basin is estimated at 5,286 persons.

The annual M&I demand in the Cucharas basin is approximately 1,766 acre-feet. Current demands are a combination of 2010 and 2015 values dependent on the source of data used for the demands. Demands for the unincorporated population are calculated on DOLA county and municipal population data and a per capita use rate of 155 gallons per day, based on information from the Surface Water Supply Index (2010) report.

Table 2 includes the key M&I entities, the percentages of the Huerfano County population included in the Cucharas basin, and the total M&I water demand for both current and future scenarios.

Table 2
Cucharas Basin
Municipal, Commercial and Industrial Demand

Water User	Population*		Demand (ac-ft/yr)	
	2010	2050	2010	2050
Cucharas S&WD	1,400	1,760	107	149
La Veta	793	996	325	408
Walsenburg	3,038	5,121	1,106	2,212
Unincorporated	1,315	1,652	228	287
Total	6,546	6,641	1,766	3,056

* Cucharas S&WD values include year-round and seasonal population.
Walsenburg future values based on city's current planning numbers.

A portion of the current and future CSWD demand accounts for augmentation of evaporative losses (approx. 15 acre-feet per year) from a number of off-channel ponds located throughout the District's service area.

The city of Walsenburg provided future demand estimates for its 50-year planning horizon. The city's water demand in 2065 is estimated to be double the current demand. The increase is attributable to both population growth and expanded demand for commercial interests and other uses. CSWD and the town of La Veta did not provide estimates of future water demands. Future demands for these entities and for the unincorporated population were developed based on the DOLA population projections for Huerfano County. The DOLA projections extend through 2050, at which time the county population is estimated to have grown approximately 26 percent from the 2010 population. The future potable demand for these entities was estimated to be 126 percent of the current demand.

System operations for the municipalities were simulated over a three-year drought planning horizon based on hydrology, yield, and operations during 2002. Future losses from municipal deliveries (pipelines, water treatment plants, etc.) are assumed to be 10 percent of diversions, based on planning estimates provided by the city of Walsenburg. An associated demand that is necessary to incorporate into planning efforts is the loss associated with evaporation from reservoirs. This loss can be significant, especially for storage units located in the lower reaches of the basin where evaporation losses may be up to 20 percent higher than occurs at higher elevations.

CSWD does not currently operate its Britton Ponds; therefore, evaporative loss from these units is not considered to increase the District's water demand. Evaporative losses from the town of La Veta and city of Walsenburg's storage units do increase the municipalities' demand for water. Gross evaporation losses of about 45 inches (3.75 feet) per year are estimated for the area near these two municipalities, based on National Weather Service maps (NOAA NWS-33) that are typically used in water resources analyses.

At full capacity of the reservoirs, the average annual evaporation loss for the Town of La Veta and City of Walsenburg is approximately 120 acre-feet and 1,651 acre-feet, respectively. These values represent the upper bound of evaporative losses since they are based on the maximum surface areas listed in Table 3. We used 85 percent of the maximum evaporation loss for planning purposes in order to address fluctuating water levels. Incorporation of these evaporation losses increases the current and future demands for La Veta and Walsenburg, the values for which are also included in Table 3.

Table 3
Town of La Veta and City of Walsenburg
Reservoir Evaporation and Municipal Demands

Structure Name	Estimated Surface Area (ac)	Evaporation Max. (ac-ft/yr)	Total Demand (ac-ft)*
Town of La Veta			
La Veta Town Lakes	32	120	
	Current Demand		427
	Future Demand		510
City of Walsenburg			
Wahatoya Reservoir	29	109	
Daigre Reservoir	15	56	
City Lake (Walsenburg Reservoir)	44	165	
Horseshoe Reservoir (Lake Miriam)	162	608	
Martin Reservoir (Lake Oehm)	190	713	
	TOTAL	1,651	
	Current Demand		2,509
	Future Demand**		3,615

* Total demand equal to M&I Demand (Table 1) + 85% of Maximum Evaporation loss
** Walsenburg is evaluating potential impacts from additional climate change on future supplies and demands, which are not represented in this table.

Note the three-year operational model developed for this task represents one particular scenario with a certain magnitude and distribution of demands, supplies, operations, and losses for the different water users. Other scenarios with different values can be used for all of the input variables and operations approaches, depending on the planning objective. For example, municipalities could plan for water supply from direct diversions only, without the benefit of storage releases; analyses of sufficiency of supply could use an estimated yield reduced by assumed reductions to available flows in the future; et cetera. Nonetheless, the analyses developed for Task 1 are considered appropriate for planning purposes.

Non-Consumptive Water Use

Based on review of available literature and data and communication with members of the Basin Roundtable and personnel of the U.S. and Colorado Forest Service, Colorado Parks and Wildlife (CPW), and Colorado Watershed Assembly, personnel, one of the demands for non-consumptive uses relate to habitat for native fish species. Other non-consumptive water uses important to river basin operations include, among others, maintenance of watershed health and development of recreational opportunities (fishing, boating, and birding) and new wetlands or other aquatic and riparian habitat. All of the non-consumptive uses can benefit from cooperative multi-use storage in the basin. In addition, there can also be incidental improvements to downstream water quality due to reservoir storage related to reduced selenium and nutrients.

The Colorado Water Conservation Board has water rights for instream flows in the upper reaches of the Cucharas River, White Creek, Dodgeton Creek, and Chaparral Creek. These amounts of these water rights were developed based on information gathered and analyzed by CPW. The demands for water vary over the season, corresponding with the hydrograph (i.e., higher during runoff, lowest during the winter) and range from a maximum of 3.0 cfs on the tributaries and 4.9 cfs on the upper Cucharas River. The instream flow demands are satisfied by native inflows. The diversions and consumptive uses associated with other water uses occur below the instream flow reaches and therefore do not affect the supply to meet these non-consumptive demands.

Various fish species – brook, brown, and rainbow trout and other native fish species have been identified in the Cucharas River and primary tributary watersheds and some reservoirs located in the basin. There are locations where flathead chub, which is a species of concern, have been inventoried. CPW personnel indicated further analysis of current use and flows during the winter and summer months are necessary prior to quantifying flow requirements for fish species.

We have not yet received specific demands (e.g., flow rates, water volumes, or lake levels) for non-consumptive uses in response to our outreach. We have also not been able to identify similar demands or appropriate objectives to be met as part of a storage project. For example, we could develop a water demand related to a certain amount of acres of wetlands vegetation based on a location and size of desired wetland. Nonetheless, increased flows will typically improve riparian habitat and the non-consumptive demands for water would be a second beneficiary for any releases made from upper basin reservoirs for uses further downstream. These conditions would also benefit environmental and recreational demands for water. On this last point, public access to reservoir storage sites could have a notable impact on the tourism-related economy. Current estimates are that only about 20 percent of Huerfano County is public land. The recreational opportunities are limited and the demand is high. This is easily seen by the number of users at Blue Lake and Bear Lake, for example. Therefore, increased availability of publicly accessible storage sites could satisfy some of the recreational demand and provide benefit to the surrounding community.

We will incorporate any non-consumptive demands that are identified into the yield analysis operational model developed in Task 2.

WATER SUPPLY AND SHORTAGES

Agriculture

The majority of water supply for irrigation comes from surface water diversions that are supplemented by storage releases in some locations. Available diversion records for irrigation use from the DWR database were used to estimate the supply for livestock and agriculture. The average annual river diversion to irrigation identified for the 1980-2014 period, after water use by livestock, is 13,100 acre-feet per year, or approximately 1.17 acre-feet per acre. In drought years, such as 2002, diversions for irrigation have been recorded on the order of 16 percent of the average, or approximately 0.20 acre-feet per acre. In some years, not all of the approximately 160 ditches included in this analysis have diversion records maintained, so the actual supply for irrigation is likely higher. In addition, the water supply from wells, springs, and storage releases are difficult to quantify and are not explicitly included in the analysis.

The average annual crop consumptive use from precipitation and diversions in the Cucharas basin is approximately 13,500 acre-feet, on average, for the 1980-2014 period and 5,600 acre-feet during 2002. The average annual crop consumptive use from diversions only is about 6,500 acre-feet, on average, and 1,000 acre-feet during 2002. The analysis assumes conveyance losses of 10 percent associated with river diversions and a maximum farm efficiency of 60 percent associated with the range of irrigation practices, primarily flood irrigation, that are used within the basin. The basin-wide CU rate is 0.58 acre-feet per acre, or approximately 28 percent of the IWR. This leaves an irrigation shortage in excess of 16,500 acre-feet, on average, and over one-and-a-half times as much in a drought year similar to 2002. Storage releases for irrigation do address some of these shortages but the use of storage to meet irrigation demands is considered limited.

Average-year irrigation demands and water shortages for the basin-wide analysis are presented in Table 4. As noted above, the StateCU analysis for this task looked at the basin, in aggregate. More detail regarding the demand and availability of water for the bigger ditches and for the various tributary basins will be available from the water allocation modeling to be completed in Task 2. The more detailed analysis of supplies and demands will also improve the analysis and findings regarding agricultural supply during drought cycles.

Table 4
Cucharas Basin
Irrigation Demands and Shortages

Month	River Diversion (ac-ft)	Demand / IWR (ac-ft)	Consumptive Use (ac-ft)	Shortage (ac-ft)
Jan	51	0	0	0
Feb	47	0	0	0
Mar	175	25	3	22
Apr	767	942	296	646
May	3,066	2,932	1,533	1,399
Jun	4,361	5,114	2,320	2,794
Jul	2,347	5,629	1,267	4,362
Aug	1,193	4,406	644	3,762
Sep	597	3,222	323	2,899
Oct	325	850	128	722
Nov	104	9	5	4
Dec	70	0	0	0
Total	13,103	23,129	6,518	16,611
Per Acre	1.17	2.07	0.58	1.48

MUNICIPAL, COMMERCIAL, AND INDUSTRIAL

The water supplies for the three municipal providers are a combination of direct flow rights and storage units consisting of both reservoirs and treated water storage tanks. The following analysis focuses on the use of direct flow rights and reservoir storage.

Cucharas Sanitation & Water District

CSWD's water rights portfolio consists primarily of direct flow rights on the mainstem Cucharas River and Baker Creek and Dodgeton Creek tributaries. The district's intakes at these locations are alternate points of diversion for CSWD's prorata ownership in the Calf Pasture Ditch and Ballejos Ditch (various amounts, various priorities).

The District has storage rights for Britton Pond Nos. 1, 2, and 3 located near the Town of Cuchara (estimated total capacity of 20 acre-feet) and a storage right for the not-yet-constructed 7,000 acre-foot White Creek Reservoir (aka Cucharas Pass Reservoir) located below the White Peak range and north of the ridge separating the White Creek basin from the upper Cucharas River. The Britton Ponds are apparently not actively used although they could be accessed for supply with the installation of delivery infrastructure. Another storage option identified by CSWD personnel would be development of a new, above-ground reservoir in the Baker Creek drainage. This site would likely require a water court filing for a junior storage right and possibly an alternate point of diversion and exchange of the District's other water rights to the reservoir.

Based on information provided by CSWD personnel and the water commissioner, the direct flow water rights are typically sufficient to meet current demands and may also be sufficient to meet future demands. The direct flow rights are also used to augment evaporative depletions from ponds located within the District service area. The true yield of the water rights is unknown since the District has not experienced a situation where supply has been insufficient to meet demand. Irrespective of the yield associated with its water rights, the District could benefit from additional storage for drought protection.

Future demand, supply, and shortages for CSWD are presented in Table 5. We looked at records of supply from the District's network of intake pipelines to estimate available supply. Diversion data are not complete for all sites for all years. Records of average historical diversions were used for the Task 1 demand-supply analysis. On annual basis, the historical supply is sufficient to meet the Future Demand, as illustrated in Table 5. Yet this analysis illustrates a need for storage to balance months with excess supply against months where the diversions are not sufficient to meet demand.

The water allocation modeling to be completed in Task 2 will estimate the yield of the District's water rights and diversions subject to the priorities of downstream water rights. In addition, storage operations will be simulated to illustrate the benefits from operations with the existing Britton Ponds and new and/or increased storage capacity added to the District's portfolio.

Table 5
Cucharas Sanitation & Water District
Future Demand, Supply, and Shortage

Month	Demand (ac-ft)	Supply (ac-ft)	Year 1, 2, and 3 Shortages (ac-ft)
Jan	9.9	16.5	-6.6
Feb	8.7	13.3	-4.6
Mar	11.8	13.4	-1.6
Apr	12.1	11.7	0.4
May	17.1	14.0	3.1
Jun	26.7	22.3	4.4
Jul	28.1	28.0	0.1
Aug	25.6	14.0	11.6
Sep	21.2	17.8	3.4
Oct	16.9	13.5	3.4
Nov	7.8	17.4	-9.6
Dec	10.4	16.5	-6.1
Total	196	198.3	26.3 shortage
			28.6 excess

Town of La Veta
La Veta's water rights portfolio includes junior rights at the La Veta pipeline (1.48 cfs) and senior rights in the Francisco Daigre Mill Ditch (1.5 cfs of Read 1 and Read 3 priorities) that are diverted for direct use and storage at the La Veta pipeline. The town also owns 41 percent of the Mexican Ditch water right (2 cfs of 4.9 cfs Read 14 priority), which was changed to municipal uses and exchange to the City's diversion and storage facilities.

The District has junior storage rights (416 acre-feet total) for the La Veta Town Lakes. The two lakes are located adjacent to the town's water treatment plant and filled via the La Veta pipeline. The available capacity in the Town Lakes is estimated at approximately 313 acre-feet, with no dead storage.

The Town's direct flow water rights, supplemented by storage releases, is typically sufficient to meet demands in average and wet years. The yield of the direct flow rights during drought years, backed up by water in storage, is sufficient to meet current demands. Using a three-year drought cycle and the yield at the La Veta pipeline during 2012, the town is estimated to have an unmet future demand of about 350 acre-feet total over the drought period. Note the 2012 yield for the La Veta pipeline was used in the analysis since it was less than the yield during the 2002 water year.

Future demand, supply, and shortages for the Town of La Veta are presented in Table 6. The storage operations are not presented in the table but the lakes were operated to release to the demand, as needed, or to divert to storage, in times of excess. The shortages in the table represent the amount and timing of shortages that must be met from other water sources.

Table 6
Town of La Veta
Future Demand, Supply, and Shortage

Month	Demand (ac-ft)	Supply (ac-ft)	Shortages (ac-ft)		
			Year 1	Year 2	Year 3
Jan	37	2	0	0	35
Feb	34	0	0	0	34
Mar	30	8	0	15	23
Apr	25	14	0	13	13
May	41	23	0	21	21
Jun	38	64	0	0	0
Jul	47	37	0	0	0
Aug	62	27	0	32	32
Sep	56	25	0	34	34
Oct	51	27	0	27	27
Nov	46	42	0	8	8
Dec	43	37	0	10	10
Total	510	305	0	159	236

City of Walsenburg

Walsenburg's water rights portfolio includes direct flow rights and storage rights available for diversion and storage at multiple locations. The City's primary diversion point is the Walsenburg Pipeline, located not far upstream of the Town of La Veta. The pipeline conveys water into Wahatoya and Daigre Reservoirs (383 acre-feet total capacity) and continues on to the 472-acre-foot City Lake (aka Walsenburg Reservoir), which essentially serves as a forebay to the City's water treatment plant. The City also owns direct flow water rights in the Coler Ditch (aka Lake Miriam Ditch) that diverts from the Cucharas River above its confluence with North Abeyta Creek. The Coler Ditch is used to convey water to Horseshoe Reservoir and Martin Reservoir (5,254 acre-feet total capacity). These reservoirs, located within Lathrop State Park, are operated to support recreational uses by limiting drawdown and to predominantly serve as backup supply for the city during extreme drought periods. The reservoirs are also used to release small amounts of water to the Cucharas River to augment out-of-priority depletions associated with the supply for the Northlands area and to meet return flow obligations associated with operations with the City's changed water rights. A portion of the water in Horseshoe Reservoir and Martin Reservoir is owned by "Minority Owners"; the amount varies over time. The possible effects of the Minority Ownership are not addressed explicitly in the analysis.

The City direct flow rights consist of early changes of use of its prorata ownership of Read 1, 2, 3, and 4 priorities (the Ackerman rights, 6.875 cfs out of total 7.7453 cfs ownership), a recent change of use of the City's one-sixth ownership of the Gomez Ditch (Read priority 10 for 0.533 cfs and Killian priority 124 for 1.167 cfs), and ownership of an unchanged portion (3.22 cfs) of the 5.605 cfs Walsenburg Ditch water right (Read 5 priority).

The City's direct flow water rights, supplemented by storage releases from its reservoirs located outside of Lathrop State Park is typically sufficient to meet demands in average and wet years. Despite the amount of senior water rights held by the city, the yield during drought years is limited by physical supply available from the Cucharas River. The City estimates its dry-year yield is approximately 2,153 acre-feet, based on conditions evidenced in 2002. This drought-year supply and allowing for the drawdown of Horseshoe Reservoir and Martin Reservoir no more than occurred in 2002 (approx. 1,000 acre-feet total), is considered sufficient to meet the City's current demand. Using a three-year drought cycle and these operational limitations, the city is estimated to have an unmet future demand of about 3,200 acre-feet total over the drought period.

Future demand, supply, and shortages for the City of Walsenburg presented in Table 7. The storage operations are not presented in the table but the reservoirs were operated to release to the demand, as needed, or to divert to storage, in times of excess. The shortages in the table represent the amount and timing of shortages that must be met from other water sources.

Table 7
City of Walsenburg
Future Demand, Supply, and Shortage

Month	Demand (ac-ft)	Supply (ac-ft)	Shortages (ac-ft)		
			Year 1	Year 2	Year 3
Jan	183	235	0	0	0
Feb	188	194	0	0	0
Mar	215	534	0	0	0
Apr	272	161	0	0	0
May	380	130	0	0	83
Jun	487	84	0	347	411
Jul	483	45	0	443	443
Aug	445	13	0	433	433
Sep	356	174	0	200	200
Oct	248	167	0	97	97
Nov	184	197	0	7	7
Dec	175	224	0	0	0
Total	3,615	2,158	0	1,526	1,674

FUTURE SUPPLY

The different water users in the basin have a need for additional supply throughout the year and to provide for drought protection over successive years. The main objective of the Storage Study is to determine how best to maximize the benefit among the various users from the development of new storage capacity in the basin. Opportunities include a combination of the development of new storage, rehabilitation and/or enlargement of existing storage, and cooperative storage operations between stakeholders.

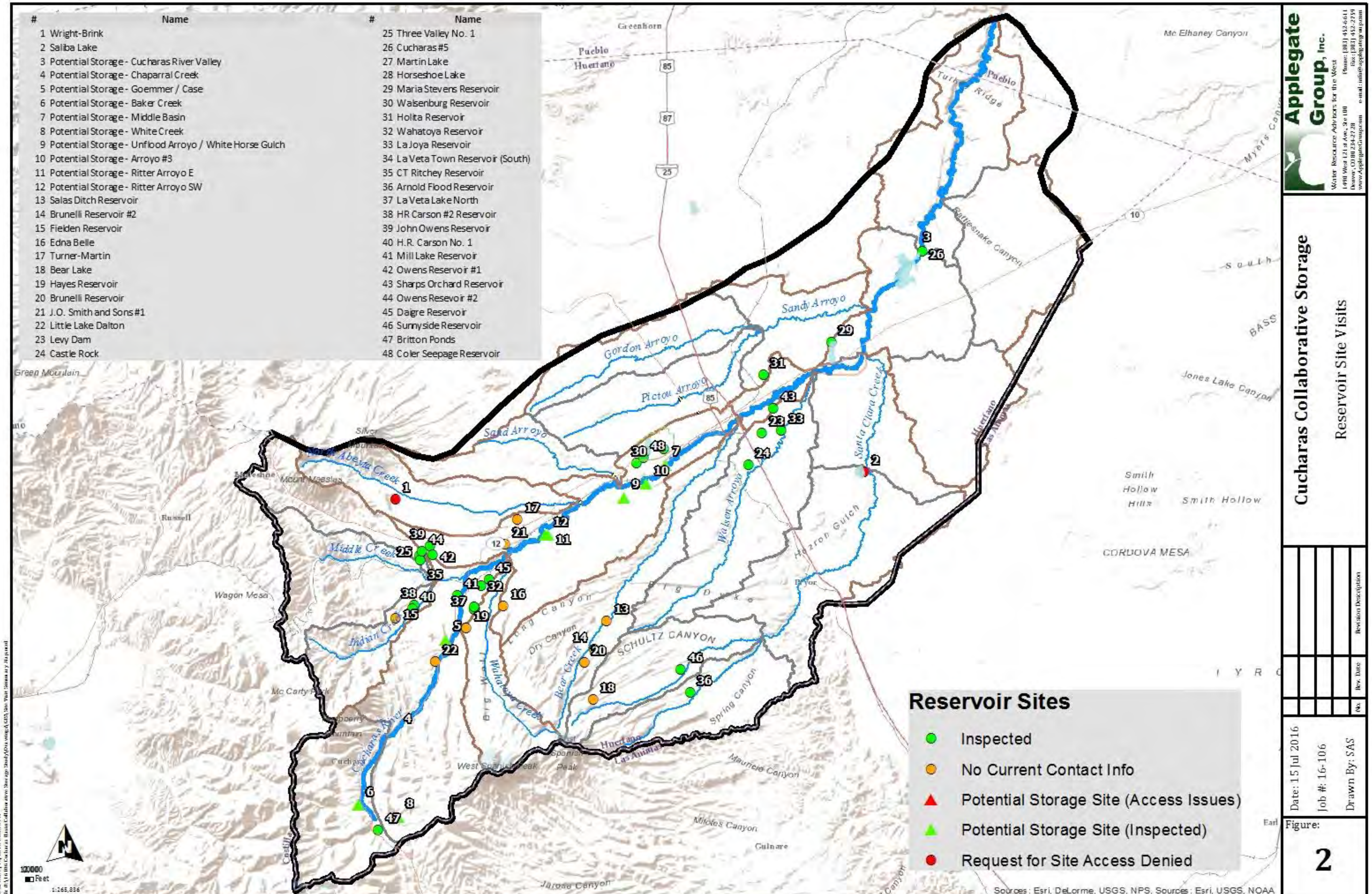
The list of reservoirs originally identified for further review was based, in part, on the availability of dam safety inspection reports that provide a certain amount of detail regarding hazard classification and dam condition. The reports by the Dam Safety Office are completed for jurisdictional dams (i.e., greater than 10 feet in dam height). These reservoirs and other smaller reservoirs were discussed at the public meetings in an effort to identify the most promising storage units.in helping to address shortages to irrigation and M&I demands, and to support non-consumptive uses.

In response to those discussions and to consider the opportunity provided by cooperative operations of multiple smaller reservoirs, we expanded the reservoir list to include storage units with capacity of 25 acre-feet or more. This increased the number of reservoirs under consideration to a total of 42 reservoirs. Site visits to 26 of the reservoirs were carried out in June 2016 (see Figure 2). The remaining 16 sites were not visited for the following reasons:

- Four sites identified in the State's dam database that do not exist (based on aerial photo inspections): Campbell Reservoir, Columbine #2 Reservoir, Willow Reservoir, and Atencio Reservoir (note these sites are not included in Figure 2).
- Two sites where the current owner was contacted, but the owner indicated they do not want to participate in this study: Antonio D Valdez Reservoir and Wright-Brink Reservoir. Note that the owners of Sunnyside Reservoir and Arnold Flood Reservoir allowed us to inspect the dam, but indicated they do not want to participate further in this study.
- Ten sites where current contact information could not be found for the dam owner: Brunelli Reservoir Nos. 1 and 2, Salas Ditch Reservoir, Turner-Martin Reservoir, Edna Belle Reservoir, Fielden Reservoir, Bear Lake, Hayes Reservoir, J.O. Smith and Sons Reservoir #1, and Little Lake Dalton.

Site visits were limited to dam sites where our team received owner approval to access the sites. A summary of the conditions evidenced during those site visits is included in the matrix in Appendix A. The color-coded matrix qualifies dam and site characteristics related to the magnitude of rehabilitation and construction costs and operational advantages anticipated from the reservoir sites.

In addition to the existing reservoirs that were reviewed and inspected, potential new reservoir sites were also identified and inspected where accessible. Our team was able to access 8 of the 10 potential new reservoir sites for site inspections. Field inspections for the potential new reservoir sites were focused on the assessment of the site suitability for dam construction (geotechnical and topographic constraints), ability to gravity feed water to fill the reservoirs, permitting constraints, and likely hazard classification. A summary of the conditions evidenced during those site visits is included in the matrix in Appendix B.



Name
1 Wright-Brink
2 Saliba Lake
3 Potential Storage - Cucharas River Valley
4 Potential Storage - Chaparral Creek
5 Potential Storage - Goemmer / Case
6 Potential Storage - Baker Creek
7 Potential Storage - Middle Basin
8 Potential Storage - White Creek
9 Potential Storage - Unflood Arroyo / White Horse Gulch
10 Potential Storage - Arroyo #3
11 Potential Storage - Ritter Arroyo E
12 Potential Storage - Ritter Arroyo SW
13 Salas Ditch Reservoir
14 Brunelli Reservoir #2
15 Fielden Reservoir
16 Edna Belle
17 Turner-Martin
18 Bear Lake
19 Hayes Reservoir
20 Brunelli Reservoir
21 J.O. Smith and Sons #1
22 Little Lake Dalton
23 Levy Dam
24 Castle Rock
25 Three Valley No. 1
26 Cucharas #5
27 Martin Lake
28 Horseshoe Lake
29 Maria Stevens Reservoir
30 Walsenburg Reservoir
31 Holita Reservoir
32 Wahatoya Reservoir
33 La Joya Reservoir
34 La Veta Town Reservoir (South)
35 CT Ritchey Reservoir
36 Arnold Flood Reservoir
37 La Veta Lake North
38 HR Carson #2 Reservoir
39 John Owens Reservoir
40 H.R. Carson No. 1
41 Mill Lake Reservoir
42 Owens Reservoir #1
43 Sharps Orchard Reservoir
44 Owens Resevoir #2
45 Daigre Reservoir
46 Sunnyside Reservoir
47 Britton Ponds
48 Coler Seepage Reservoir
Reservoir Sites
Inspected
No Current Contact Info
Potential Storage Site (Access Issues)
Potential Storage Site (Inspected)
Request for Site Access Denied
Sources: Esri, DeLorme, USGS, NPS, Sources: Esri, USGS, NOAA
Applegate Group, Inc.
Water Resource Advisors for the West
Cucharas Collaborative Storage
Reservoir Site Visits
Date: 15 Jul 2016
Job #: 16-106
Drawn By: SAS
Figure:
2

ADDITIONAL YIELD NEEDED

Irrigation water shortages occur throughout the watershed, based on both anecdotal information and the analysis presented herein. Agricultural water users may benefit from different conservation measures, including lining ditches and laterals, more use of gated pipe, and sprinkler irrigation. The irrigation shortages would benefit from additional storage in the basin and the source of said storage water would primarily be available along Wahatoya Creek, Middle Creek and its tributaries, and the mainstem of the Cucharas River.

The Cucharas Sanitation & Water District has a need for reservoir storage to balance its excess supply and shortages based on the demand-supply analysis presented above. The District has not fully evaluated the potential for future conservation measures but maintenance of its delivery infrastructure is needed and a potential need for additional storage for treated water has been identified as a possible limitation on future operations that should be explored further.

The Town of La Veta has a shortage of approximately 400 acre-feet to meet its future demand based on the demand-supply analysis presented above. The Town indicated no conservation measures are currently planned but maintenance of its delivery infrastructure will be necessary in the short- to medium-term. The Town changed the use of its Mexican Ditch water rights and has recently installed augmentation stations and recorders on the ditch system. This will enable it to benefit from additional yield during average and wet years when exchange potential exists between the ditch system (located approximately four miles downstream of Walsenburg) and the Town of La Veta. The lack of exchange potential during dry years evidences another demand for additional storage – under the Mexican Ditch and near the town – to allow La Veta to firm up the estimated 122 acre-feet average-year yield of its ownership in the Mexican Ditch. The Town previously estimated a $350K cost for development of a 30 acre-foot reservoir under the Mexican Ditch. The Town's ditch rights, though, would satisfy only a portion of its unmet demand. La Veta's existing storage facilities and options for developing and increasing storage near the town to store Mexican Ditch credits and other supplies are good candidates to be further investigated in the yield analysis and cost-benefits analysis conducted in Task 2.

The City of Walsenburg has a shortage of approximately 3,200 acre-feet to meet its future demand based on the demand-supply analysis presented above. The City has also not fully evaluated the potential for future conservation measures but maintenance of its delivery infrastructure is needed, particularly for City Lake as it may be subject to a storage restriction in the near future. Previous estimates for this rehabilitation effort range between $4.4M and $6.5M. A portion of the City's unmet demand could be satisfied by changing the use of the City's Walsenburg Ditch water right. A rough estimate of the prorata Walsenburg Ditch dry-year yield is on the order of about 300 acre-feet, based on the 2002 diversion records and 40 percent CU rate. Remaining shortages would likely need to come from additional storage capacity and/or relaxation of operational limitations currently in place on its storage units. Rehabilitating La Joya Reservoir to store the city's previously changed Gomez Ditch water rights and other supplies could also be part of the solution.

As noted above, information provided regarding non-consumptive demands has been made available on a mostly qualitative level. Therefore, we have been unable to quantify the non-consumptive demands and shortages. CPW personnel are currently researching their file information and indicated they hope to provide us with recommendations on how best to quantify these demands. Additional information received from CPW, Collaborative stakeholders, and other interested parties will be incorporated into the detailed yield analysis conducted during Task 2.

SITE INSPECTION RESULTS SUMMARY

Site inspections were completed the week of June 20th, and were completed with two teams of two dam engineers. Site inspection reports were completed for each of the 26 existing dams that were inspected. Results of the site inspections are discussed below.

Embankment seepage was the most common dam maintenance issue observed. Seepage was observed to occur through the dam embankments, and was documented either by noting wet soils at the downstream toe of the dam, and/or patches of vegetation at the downstream toe. Embankment seepage is common for earthen and rockfill dams constructed in the early 20th century, primarily because of porous materials and lack of seepage mitigation (e.g., blanket filter and toe drain). Some of the dams have been retrofitted to include toe drains, whether constructed using standard dam construction practice or simply consisting of trenches downstream of the dam to route seepage water away from the downstream toe. It is a common practice to retrofit existing dams by adding a toe drain to safely convey water pressure away from the dam, which could be considered for rehabilitating existing dams. Holita Reservoir is an example of a reservoir that could potentially be enlarged, but current seepage issues would need to be addressed prior to modifying the dam.

Dam embankments within the basin are generally too steep on the upstream side of the dam due to the use of concrete rubble to address erosion. The embankments were not originally designed with proper sloping and riprap with bedding. Dam owners have consequently dumped riprap in an attempt to compensate for wave runup erosion. The City of Walsenburg reservoirs are examples of concrete rubble that has resulted in over-steepened embankments. If existing reservoirs were to be enlarged, the concrete rubble should be removed, and replaced with properly sloped embankments protected by designed riprap and bedding consistent with the underlying embankment material properties.

Dams in the Cucharas basin are generally long (greater than 500 feet), primarily because of the flat topography in the middle and lower portions of the basin. The costs of enlarging or rehabilitating the long embankments would be high because of the high volume of material necessary to treat the entire length of the embankment. Combining existing reservoirs, such as La Veta South and North Town Lakes, or Martin and Horseshoe Reservoirs, was considered but the cost could be elevated as a result of the length of the intervening embankments.

Inspections of the seven potential new reservoir sites generally indicated the following:

- Upper basin storage (i.e., near and upstream of La Veta) typically has ideal geotechnical and topographic conditions for dam construction, but yield to these sites may be fairly limited because of relatively small contributing drainage area.
- Middle basin storage (i.e., between Walsenburg and La Veta) had less ideal topographic conditions, and may be limited to sites on arroyos that drain to the Cucharas River. Storage capacity at these sites is likely limited on the order of 50 acre-feet at a given site. Yield would be relatively high for middle basin storage sites if infrastructure was available to fill

the sites via gravity from the Cucharas River. Otherwise, yield may be limited to unpredictable stormwater runoff with varied volume and timing.

- Lower basin storage (i.e., downstream of Walsenburg) may have yield limited by the exchange potential on the Cucharas River. These sites were generally limited to replacement of existing or previously abandoned reservoir sites such as the Cucharas Valley Reservoir.

SPECIFIC STORAGE OBSERVATIONS AND POTENTIAL SITES FOR FURTHER STUDY

The intent of the storage component of Task 1 is to provide a summary of existing reservoir conditions, and also an initial analysis of potential new reservoir sites. The long list of reservoir sites will be screened to identify a handful (approximately 6 sites) of the most promising sites for the analyses in Task 2. The Task 2 analysis will also include development of conceptual design drawings and feasibility level cost estimates. Conceptual design drawings will include the site plan and profile, and identify the major infrastructure components to either rehabilitate/enlarge existing storage, or construct new storage. Additional detail on the level of information to be included in feasibility level cost estimates is provided below.

Summary tables of existing reservoir and potential new reservoir sites are provided in Appendix A and Appendix B, respectively. These tables should be discussed by stakeholders and used to identify the preferred reservoir sites for Task 2 effort.

The upper basin (upstream from La Veta) has opportunities both for enlargement of existing reservoirs, and for construction of new reservoir sites. Storage facilities located in the upper basin benefit from reduced evaporation losses although physical supply for storage may be limited.

- The Cucharas Sanitation & Water District has existing storage units with the Britton Ponds. These units could possibly be enlarged, lined, and have delivery infrastructure installed at a good cost basis since the storage units are already in place. However, our site inspection indicated these ponds would require a high dam and result in low storage volume as a result of a steep valley (approximately 30 percent grade).

Two existing reservoir sites near the town of La Veta could possibly be rehabilitated and/or expanded, but are located adjacent to the Cucharas River and would need approval from current dam owners.

- The La Veta Town Lakes have embankment seepage and need outlet structures installed. Rehabilitation of the North Lake Dam, including breaching the dam, reconstructing the outlet works, and installing a toe drain filter system has been estimated to cost approximately $410K[4]. The Town's engineer estimated work on the South Lake Dam to address seepage and associated issues would cost on the order of $500K. There is potential to enlargement both reservoirs coincident with the rehabilitation effort. The reservoirs could possibly be expanded by removing the existing berm separating the lakes, and that material could be used as embankment enlargement/replacement material.
- HR Carson #1 and #2 are located approximately 1.5 miles west of the Town of La Veta along Indian Creek upstream of its confluence with Middle Creek. These reservoirs have a total normal storage capacity of approximately 100 acre-feet, but only about 35 acre-feet of that

[4] Based on La Veta North Lake Dam rehabilitation cost estimate from *Storage Feasibility Report*, *Town of La Veta*, prepared by Colorado River Engineering, Oct 2011, and escalated to 2016 costs.

capacity is currently used. There is the potential to enlarge or combine these two reservoirs into one, with a potential increased storage of 50 to 100 acre-feet. These sites were the only existing storage facilities upstream of Middle Creek that we identified for potential expansion, and that could be used to address irrigation shortages along the lower part of Middle Creek.

Four potential new reservoir sites identified in the upper basin on tributaries to the Cucharas River that could be used to make supplement releases to meet irrigation shortages were inspected during out site visits. These upper basin sites would benefit from lower evaporative losses than storage units located lower in the basin. In addition, these sites are appealing since they could be operated to reduce water shortages for users located lower in the river basin and may be good multi-use sites that provide recreational opportunities at and around the reservoir locations.

- The West Baker Creek site is located in the areas of the defunct ski resort. The location is technically advantageous considering the valley shape and geology, and could be filled in part using existing CSWD infrastructure on Baker Creek. There would also be potential for multiple uses/benefits, as a result of public access for fishing to help relieve the overuse of the Bear Lake area further up the basin.
- The Chaparral Creek site would have similar technically advantageous geology and topography for dam construction as West Baker Creek. This site may not have as high of yield as West Baker Creek, and it is uncertain whether it would be possible to gravity fill this site from the Cucharas River. Based on input from the water commissioner, there is an existing diversion from the Cucharas River just downstream of “the Gap” that delivers water to a location on the west side of the Cucharas River at a similar elevation as the Chaparral Creek Reservoir site (approximate elevation 8,020 feet based on the USGS quadrangle map). Without prior owner approval, we were not able to access this site, however we understand the property is currently for sale and the future owners should be contacted to discuss the possible development and operation of storage on the property.
- Another potential reservoir site is located along the west side of the Cucharas River, approximately 2 miles southwest of the Town of La Veta. The location of the Goemmer/Case Reservoir has been previously analyzed for dam construction in a gap within one of the radial basaltic dikes from the Spanish Peaks. Applegate Group has estimated storage capacity at the Goemmer Reservoir site would be approximately 170 acre-feet, assuming a 45-foot high dam (i.e., less than the 50-foot height cutoff for a “large” dam as classified by the Division of Water Resources). The site is well situated with the surrounding geology and may be a good candidate for reservoir storage for multiple beneficiaries. It is our understanding the storage site could be gravity filled from the Cucharas River through an existing ditch. It should be noted that the existing storage right for 125 acre-feet at the Goemmer Reservoir site is a different location approximately 2.5 miles southwest of this Goemmer/Case Reservoir site.
- The White Creek Reservoir site has a conditional 7,000 acre-foot storage right owned by CSWD. The reservoir is tributary to the Cucharas River downstream of the District’s service area but could benefit the District via exchange to local storage and/or augmentation deliveries. The reservoir site could provide benefits to many users in the basin. However, yield for the reservoir located within the upper reaches of White Creek needs to be quantified to determine the viability for this site.

The middle basin (La Veta to Walsenburg) has a few sites that could be rehabilitated or enlarged, and several potential new reservoir sites that would have relatively small storage volume.

- Wahatoya and Daigre Reservoirs could be enlarged if existing dam safety concerns are addressed. Wahatoya Reservoir would need to be modified so the outlet was not constantly pressurized, and the existing spillway would need to be enlarged. The area around the reservoir appears to be sufficient for enlargement of the existing embankment, and the north embankment is an efficient structure in its tie into existing geology.
- The Coler Seepage Reservoir dam was apparently washed out in the 1920s, but could be reconstructed to the existing 108.3 acre-foot absolute storage right. This site is located in Lathrop State Park, and could provide multiple uses (e.g., recreation, municipal, and agricultural irrigation). The cause for the original dam washing out would need to be investigated further, and any new dam would need to be constructed to withstand potential flooding.
- Castle Rock Reservoir (approximately 2.5 miles southeast of Walsenburg) has a normal storage capacity of 126 AF according to the Dam Safety inventory, but the currently abandoned previous storage right was 850 acre-feet. The existing embankment appears in generally good condition, but the outlet would need to rehabilitated (the existing conduit may still need to be properly abandoned). The water yield would need to be quantified to determine how easily/often this reservoir could be filled from Bear Creek via the Castle Rock Ditch.

Potential new storage sites in the middle basin were generally limited to relatively small storage volume locations (approximately 20 to 25 acre-feet) on arroyos that are tributary to the Cucharas River. The yield of these arroyo sites would be limited to stormwater runoff, or could potentially be increased if diversions to these sites could be made from the Cucharas River. However, construction cost would also be lower than some of the higher yield storage sites in the upper basin.

- The Ritter Arroyo had two potential sites on the two forks of the Ritter Arroyo. Both sites would likely be significant hazard because of downstream roads.
- The Unflood Arroyo storage site is approximately one mile southeast of Walsenburg's City Lake. This site could be slightly larger than the Ritter Arroyo site.

Lower Basin (downstream of Walsenburg) storage could be achieved through a combination of enlargement and/or rehabilitation of existing reservoirs. The opportunities for new reservoir sites appeared to be limited to sites near the Cucharas Valley Reservoir.

- Maria Stevens Reservoir is currently restricted to storage of only the senior water right (2,400 acre-feet), but possibly another 850 acre-feet could be added if seepage along the south embankment is addressed. This volume is equal to the junior water right for the reservoir, and is rarely in priority. The current operator of the reservoir is open to the idea of storing more water in the reservoir. The location and existing conveyance infrastructure could make this site available for storage of excess supplies available to other water users. The additional storage may be beneficial to the existing fish population and could serve as a replacement supply for late-season diversions by the upstream users..
- La Joya Reservoir could potentially be enlarged and the current owner is amenable to participating in this study. The reservoir has 238 acre-feet of normal storage capacity. The absolute storage right of 178 acre-feet would need a supplemental storage water right to satisfy the additional 60 acre-feet of active storage capacity. However, the reservoir would require maintenance associated with embankment conditions, including seepage, outlet conditions, spillway capacity, and freeboard requirements.

New storage options in the lower basin would likely be limited to replacement of the Cucharas Valley Reservoir.

- Cucharas Valley Reservoir historically stored over 22,000 acre-feet in the early-1980s, just prior to significant seepage problems resulting in a storage restriction being placed on the dam. The seepage problems have persisted for over 30 years, there is currently a zero storage restriction, and we understand the Dam Safety office has ordered the dam to be breached later this year. Nonetheless, the owner of the site, Two Rivers Company, has indicated its court efforts to reverse that order is likely to succeed and allow the company to further pursue its efforts to reinstate the Cucharas Valley Reservoir as a viable storage unit. Reconstruction costs for Cucharas Valley Reservoir were estimated as $27M in a previous report.[5] The reservoir is located low in the basin. The dam could play a role in basin operations by storing large floods at the bottom of the basin and serve as a replacement source to facilitate upper basin diversions against downstream senior water rights that may have placed a call on the river. Similar to the discussion regarding releases from Maria Stevens Reservoir, the benefit of storage releases from Cucharas Valley Reservoir will need to be compared against the limited exchange potential that exists above the reservoir during low flow periods.

COST ESTIMATES

Specific cost estimates for the long list of reservoirs were not developed in Task 1 due to the wide range of rehabilitation needs, upgrades, and anticipated development needs identified amongst existing and potential new reservoir sites. Identification of a preferred list of 6 reservoir sites through consultation with Collaborative stakeholders will be incorporated into the more analysis to be conducted in Task 2.

Feasibility level cost estimates will be developed by estimating quantities of primary project elements and unit costs based on the following sources:

- Publicly available bid price data for similar work (e.g., Urban Drainage Flood Control District and Colorado Department of Transportation cost databases).
- Cost estimates we have received for previous bids from Colorado contractors.
- Manufacturers' budgetary price estimates.

Feasibility level cost estimates will include the following allowances: 15 percent for unlisted items, and 15 percent for construction contingency. Cost estimates will be consistent with Class 4 estimates as defined by the Association for the Advancement of Cost Estimating (AACE). This class is typically used for conceptual level design (i.e., less than 20 percent complete), and is suitable for use in submitting applications for construction funding.

The cost-benefit analysis conducted on the preferred sites in Task 2 will consider the specific rehabilitation requirements for each existing dam based on its condition and hazard classification and will address the ditch and pipeline infrastructure costs that are associated with the current reservoir configurations. A similar cost-benefit analysis will be completed for potential new

[5] Based on new roller compacted concrete dam for Cucharas Valley Reservoir, 60,000 acre-foot alternative, *Cucharas Dam Preliminary Design Report*, prepared by GEI Consultants, Inc., March 2010, and escalated to 2016 costs.

reservoir sites, and will consider the potential storage volume, potential yield, and constraints associated with geotechnical and topographical conditions. The potential yield and estimated reductions to water shortages from operations estimated in Task 2 will provide another input to the matrix to quantify the benefits of dam rehabilitation or construction and cooperative operations between users, reservoir sites, et cetera that could lead to more efficient systems.

CONCLUSIONS

This report summarizes the current and future demands in the Cucharas Basin and estimated shortages to these demands based on existing water supplies, including storage reservoirs. Reservoir site inspections were completed for 26 of the 42 reservoirs identified in the basin with storage capacity of at least 25 acre-feet. Potential new reservoir sites were also investigated for 10 possible locations, of which we were able to complete site inspections for eight of these sites. This long list of 26 existing reservoirs and 8 potential new reservoir locations will be screened to identify approximately six sites for detailed yield analysis and feasibility level cost estimates in Task 2.

Reservoir sites analyzed for the Task 1 effort are summarized in Figure 2, Appendix A, and Appendix B. The sites described in this memorandum are suggested for consideration by the Collaborative stakeholders, and input from the stakeholders on these sites (or others preferred by the stakeholders) will be useful in completing the screening process at the beginning of Task 2 for determining the short list for the final feasibility level analysis. It should be noted that input from the collaborative stakeholders at this point in the process is critical in shaping the outcome of this study. The final recommendations at the conclusion of this study will identify collaborative storage projects for future design and funding requests, and will be influenced by stakeholder input as well as our engineering analysis.

APPENDIX A -
INSPECTION SUMMARY FOR EXISTING RESERVOIR SITES

Reservoir Name	Other Names	Dam ID	Normal Storage (AF)	Inspection Completed	Inspection Date	Inspection Notes	Maintenance Requirements - See Legend Below					Notes
							Seepage	Outlet	Spillway	Freeboard	Embankment	
50 AF+ RESERVOIRS												
CUCHARAS VALLEY RES	CUCHARAS #5	160108	7,414	YES	6/21/2016		X	X	X		X	ZERO AF RESTRICTION ON RESERVOIR
ANTONIO D VALDEZ RES	SALIBA LAKE	160324	4,880	NO	9/23/2015*	REQUEST FOR ACCESS DENIED		X			X	UNABLE TO INSPECT DAM DUE TO ACCESS ISSUES; MAINTENANCE REQUIREMENTS BASED ON 2015 DAM SAFETY INSPECTION
CAMPBELL RESERVOIR		160104	3,650	NO	N/A	RESERVOIR DOES NOT EXIST	N/A	N/A	N/A	N/A	N/A	RESERVOIR IDENTIFIED FROM DAM SAFETY INVENTORY; NO OTHER INFORMATION FOUND ON CAMPBELL RES. OR CAMPBELL STORAGE RT
MARTIN LAKE	LAKE OEHM	160218	3,077	YES	6/21/2016					X	X	
HORSESHOE LAKE	LAKE MIRIAM	160112	2,760	YES	6/21/2016					X		
COLUMBINE #2 RESERVOIR		160105	2,507	NO	N/A	RESERVOIR DOES NOT EXIST	N/A	N/A	N/A	N/A	N/A	RESERVOIR IDENTIFIED FROM DAM SAFETY INVENTORY; NO OTHER INFORMATION FOUND ON COLUMBINE #2 RES. OR COLUMBINE #2 STORAGE RT
MARIA STEVENS RESERVOIR		160221	2,101	YES	6/21/2016		X			X		
WALSENBURG RESERVOIR	CITY LAKE	160327	430	YES	6/21/2016		X	X	X		X	
HOLITA RESERVOIR		160214	400	YES	6/22/2016		X	X	X	X	X	
WAHATOYA RESERVOIR		160326	330	YES	6/23/2016		X	X	X		X	
LA JOYA RESERVOIR	FARR LAKE	160412	238	YES	6/22/2016		N/A	X	X	X	X	RESERVOIR DRY
DAIGRE RESERVOIR		160109	174	YES	6/23/2016		X	X	X		X	
SUNNYSIDE RESERVOIR		160321	163	YES	6/21/2016	OWNER DOES NOT WANT TO PARTICIPATE IN STUDY	X	X	X	X	X	
CASTLE ROCK		160134	126	YES	6/21/2016		N/A	X	X	X	X	RESERVOIR ABANDONED
LA VETA TOWN RESERVOIR (SOUTH LAKE)	LA VETA LAKE SOUTH	160219	110	YES	6/21/2016		X	X	X	X	X	
COLER SEEPAGE RESERVOIR		#N/A	108	YES	6/23/2016		N/A	N/A	N/A	N/A	N/A	RESERVOIR DOES NOT EXIST
WRIGHT - BRINK		160406	100	NO	N/A	OWNER DOES NOT WANT TO PARTICIPATE IN STUDY	N/A	N/A	N/A	N/A	N/A	
OWENS RESERVOIR NO 1		160238	100	YES	6/23/2016		N/A	X	X		X	RESERVOIR DRY
C T RITCHEY RESERVOIR	HARRY P. DAIGLE	160311	97	YES	6/22/2016		X	X	X	X	X	RESERVOIR ABANDONED
ARNOLD FLOOD RESERVOIR		160127	96	YES	6/21/2016	OWNER DOES NOT WANT TO PARTICIPATE IN STUDY	X	X	X	X	X	
BRUNELLI RES NO 1		160103	85	NO	9/09/2013*	NO CURRENT CONTACT INFO FOR OWNER	X		X	X	X	UNABLE TO INSPECT DAM DUE TO ACCESS ISSUES; MAINTENANCE REQUIREMENTS BASED ON 2013 DAM SAFETY INSPECTION
LA VETA TOWN RESERVOIR (NORTH LAKE)	LA VETA LAKE NORTH	160414	82	YES	6/21/2013			X		X	X	
SALAS DITCH RESERVOIR		160404	72	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	
TURNER - MARTIN		160323	66	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	
EDNA BELLE		160203	65	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	
HR CARSON RESERVOIR NO 2		160409	60	YES	6/22/2016				X		X	
MILL LAKE		160229	53	YES	6/23/2016		N/A	X	X		X	DAM BREACHED
25 - 50 AF RESERVOIRS												
ATENCIO		160128	46	YES	6/22/2016		N/A	N/A	N/A	N/A	N/A	NO EVIDENCE OF RESERVOIR AT REFERENCED LOCATION; DAM SAFETY NOTES INDICATE RESERVOIR MAY NOT HAVE BEEN CONSTRUCTED
SHARPS ORCHARD		160119	45	YES	6/22/2016			X			X	
BRUNELLI RESERVOIR #2		160130	43	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	

APPENDIX A -
INSPECTION SUMMARY FOR EXISTING RESERVOIR SITES

Reservoir Name	Other Names	Dam ID	Normal Storage (AF)	Inspection Completed	Inspection Date	Inspection Notes	Maintenance Requirements - See Legend Below					Notes
							Seepage	Outlet	Spillway	Freeboard	Embankment	
FIELDEN RESERVOIR		160206	42	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	
LEVY RESERVOIR		160220	40	YES	6/22/2016		N/A	X	X	X	X	RESERVOIR DRY; PORTION OF EMBANKMENT LOCATED DURING SITE INSPECTION, BUT NO INFRASTRUCTURE
BEAR LAKE		N/A	40	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	
HAYES RESERVOIR		160213	33	YES	6/22/2016	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A		RESERVOIR INSPECTED FROM ROAD; RESERVOIR EMPTY
CARSON, H. R. #1	H. R. CARSON #1	160132	32	YES	6/22/2016		X	X	X		X	
J. O. SMITH AND SONS #1	SMITH	160120	28	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	
OWENS, JOHN	JOHN OWENS	160302	28	YES	6/23/2016		X	X	X		X	RESERVOIR DRY
THREE VALLEY NO. 1	NEW C.T. RITCHEY DAM	160416	28	YES	6/22/2016		N/A	N/A	N/A	N/A	N/A	RESERVOIR IS A LINED PIT USED FOR AUGMENTATION
LITTLE LAKE DALTON		N/A	26.9	NO	N/A	NO CURRENT CONTACT INFO FOR OWNER	N/A	N/A	N/A	N/A	N/A	
< 25 AF RESERVOIRS												
OWENS RESERVOIR NO 2		160301	18	YES	6/23/2016		N/A				X	RESERVOIR DRY
WILLOW RESERVOIR		160328	15	NO	N/A	RESERVOIR UNABLE TO BE LOCATED	N/A	N/A	N/A	N/A	N/A	NO LOCATION DATA AVAILABLE; SECTION-TOWNSHIP-RANGE NOT PROVIDED IN DECREE OR STRUCTURE SUMMARY
BRITTON PONDS		N/A	4	YES	6/22/2016	HIGH DAM NEEDED (STEEP VALLEY) AND MINIMAL STORAGE (NARROW)		X	X			

Legend

	Seepage	Outlet	Spillway	Freeboard	Embankment
X	No engineered collection system; cloudy	Pressurized without filter/encasement; severe corrosion	Non-existent or severley damaged	< 3 ft	Over steep; dense rodent holes; heavy brush
X	Seepage, but managed with eng collection system	Pressurized with filter/encase; mild corrosion	Undersized; mild erosion	3 to 5 ft	Mildly steep; spare rodent holes; light brush
	No seepage issues	Acceptable and operable	Maintained and sized appropriately	> 5 ft	Riprap protection and approp slope, veg manag

APPENDIX B -
SITE INSPECTION SUMMARY FOR POTENTIAL NEW STORAGE

Evaluation Criteria - See Legend Below

Site Name	Latitude	Longitude	Nearest City	Water Source	Basin Location	Estimated Hazard Class	Site Visit	Potential Storage	Geology	Operations	Yield	Permitting	Public Perception	Cost	Description
GOEMMER / CASE	37.47002	-105.02873	La Veta (u/s)	Cucharas River	Upper Basin	Significant - High	YES	+	+	+	+	+	+	-	RESERVOIR SITE LOCATED ON RILING CREEK, APPROX 2 MILES UPSTREAM (CUCHARAS) FROM LA VETA
W BAKER CREEK	37.35105	-105.10767	Cuchara (u/s)	S. Baker Creek	Upper Basin	Significant - High	YES	+	+	+	+	-	+	-	CHANNEL), UPSTREAM FROM CONFLUENCE WITH BAKER CREEK
WHITE CREEK	37.3425	-105.07199	Cuchara (u/s)	White Creek	Upper Basin	Significant - High	YES	+	+	-	+	-	+	-	RESERVOIR SITE LOCATED APPROX. 1.5 MI SE OF CUCHARAS oF WHITE CREEK
CHAPARRAL CREEK	37.408	-105.06775	Cuchara (d/s)	Chaparral Creek	Upper Basin	Significant	No	+	+	?	+	-	+	-	YIELD DEPENDS ON ABILITY TO GRAVITY FILL FROM CUCHARAS (BRGOCH THINKS FEASIBLE)
MIDDLE BASIN	37.59538	-104.83086	Walsenburg (u/s)	Cucharas River	Middle Basin	High	YES	+	+	+	+	-	+	-	RESERVOIR SITE LOCATED ADJ CUCHARAS IN RIVER VALLEY (EAST OF HORSESHOE/MARTIN RESERVOIRS)
CUCHARAS RIVER VALLEY	37.75363	-104.59884	Walsenburg (d/s)	Cucharas River	Lower Basin	Low - Significant	NO	+	-	+	-	-	-	-	DOWNSTREAM FROM EXISTING CUCHARAS RIVER VALLEY RESERVOIR
RITTER ARROYO SW	37.54494	-104.93868	La Veta (d/s)	Cucharas River	Middle Basin	Significant	YES	-	-	+	-	-	+	+	POTENTIAL RESERVOIR SITE WOULD BE LOCATED IN RITTER ARROYO EAST OF CUCHARAS RIVER AND CR 350
RITTER ARROYO E	37.54501	-104.93702	La Veta (d/s)	Cucharas River	Middle Basin	Significant	YES	-	-	+	-	-	+	+	POTENTIAL RESERVOIR SITE WOULD BE LOCATED IN RITTER ARROYO EAST OF CUCHARAS RIVER AND CR 350
ARROYO 3	37.58166	-104.84836	Walsenburg (u/s)	Cucharas River	Middle Basin	Low - Significant	YES	-	-	+	-	-	+	+	AND 342.2, DUE SOUTH (APPROX. 1.7 MI) OF WALSENBURG RESERVOIR
UNFLOOD ARROYO / WHITE HORSE GULCH	37.57183	-104.86777	Walsenburg (u/s)	Cucharas River	Middle Basin	Significant - High	YES	-	-	+	-	-	+	+	POTENTIAL RESERVOIR SITE LOCATED APPROX. 1 MI SE OF WALSENBURG RESERVOIR

Legend

	Potential Storage	Geology	Operations	Yield	Permitting	Public Perception	Cost
-	<50 ac-ft	Sandy & conducive to erosion	Inability to gravity feed; remote location	Limited to stormwater runoff; exchange pot limited	On-channel permits (CWA 404), Federal Nexus	Minimal public access. Potential water export.	>$10k per ac-ft normal storage
+	>50 ac-ft	Shallow bedrock, low erosion potential	Gravity feed; proximity to water supply	Concistent supply; near demands.	Off-channel location limited permits	Multiple uses and public access	<$10k per ac-ft normal storage

Storage Study Report—Task 2

Cucharas Basin
Collaborative Storage Study

Task 2 Screening and Cost-Benefit Analysis

Huerfano County, Colorado

June 2017

CWCB Contract No. CTGGI 2016-1053

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Huerfano County

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INTRODUCTION

The Screening and Cost-Benefit Analysis is comprised of two subtasks: Water Allocation Modeling (Task 2a) and Cost Estimates (Task 2b). The objectives of these tasks are as follows:

> *Represent physical water supply and ditch and reservoir infrastructure and operations in a prior appropriation based water accounting model. Estimate legal supply of water rights to meet existing demands throughout the basin. Analyze medium list of reservoir sites, including joint storage projects, to estimate storage yield as input for the screening analysis. Rank reservoir alternatives based on screening criteria. Identify preferred list of reservoir sites for which feasibility engineering of size and associated costs of land acquisition, construction, and operations will be estimated. Identify permitting issues and possible funding sources associated with development of the preferred alternatives.*

The efforts completed in Task 2a are intended to quantify the yield of the reservoir sites for wet, dry, and average hydrologic years and to illustrate the potential benefit from storage operations to meet water demands that are otherwise not satisfied. The yield of the existing and potential reservoirs, including joint reservoir operations is used with other screening metrics to determine a short list of sites on which cost-benefit analyses were completed. The findings presented herein and discussed at the May 25, 2017 public meeting provide the stakeholders with a reconnaissance-level analysis of potential storage alternatives and to assist their efforts moving forward with full design, funding, and development of storage in the Cucharas River basin.

APPROACH

In addition to discussions at the July 2016, September 2016, November 2016, January 2017, and March 2017 public meetings, a teleconference was held in late-March 2017 to screen the Task 1 list of reservoir sites to arrive at a short list of preferred reservoir sites. The Water District 16 commissioner, Colorado Parks and Wildlife personnel, State Engineer's Office Division 2 staff, owners of existing dams and local water providers were also interviewed. Commissioner Doug Brgoch made himself available for multiple phone calls and sit down meetings where we walked through maps of ditch layouts, headgate locations, stream networks, et cetera to better understand the movement of water throughout the river basin. Hydrologic input and water use records continued to be gathered and reviewed in the context of identifying the distribution of physical supply and administration throughout the Cucharas River basin. State Engineer's Office Division 2 staff and dam owners and their water resources engineers were engaged to improve the access to reservoir information for the water allocation model.

Reservoir sites were both added to and deleted from the long list of reservoir sites presented in the Task 1 memorandum at the July 2016 meeting. This resulted in a more manageable, medium list of 11 existing and potential reservoir sites for analysis in Task 2. A total of five additional storage opportunities and integrated operations of reservoir were added based on input received during the July 2016 meeting, which brought the total for the Task 2 analysis to 16 alternatives.

Screening criteria were developed and refined with the Collaborative to compare the Task 2 sites. Scoring thresholds for each criterion and the weights assigned to the various criteria were developed to rank the alternatives to help the Collaborative identify a smaller group of preferred reservoir sites for which construction costs would be evaluated.

A detailed water allocation model (the "Yield Model") was developed representing the supplies, demands, and legal entitlements to water in the Cucharas River basin. The model was first calibrated over an historical period of variable hydrologic conditions, based on the historical period from 1980 to 2014. This historical period is representative of a range of hydrologic conditions, and current administrative operations within the Cucharas River basin. The model was then used to estimate the ability of existing water rights and systems operations to meet future demands. The extents of shortages (i.e., unmet future demands) for municipal and irrigation uses represents the potential in-basin use associated with new or enlarged reservoirs.

The Yield Model was used to estimate the average- and dry-year yields associated with the Task 2 reservoirs. These yields represent the ability to store water without injury to water users within the Cucharas River basin. The effect of Arkansas River calls were not specifically evaluated but would decrease project yields. Operations with the individual Task 2 reservoirs to reduce future shortages were also simulated with the model to estimate the beneficial use available from the reservoirs. Subsequent to identification of the preferred reservoir sites during a March 30, 2017 teleconference, groups of two or three of the preferred reservoir sites were operated in tandem in the Yield Model to identify the potential benefits of cooperative operations, as discussed in the Results section. The yield model is discussed in detail in Appendix A.

Feasibility engineering was completed for the preferred alternatives, including the primary project components and sizes needed. Feasibility level cost estimates, including high level estimates for design, construction, permitting, operations and maintenance, land acquisition, and energy costs were developed. Cost-benefit analyses were completed for the preferred list of projects to provide information needed by stakeholders to plan for storage in the basin as efficiently as possible. The model results were then incorporated into the cost-benefit analysis to evaluate complementary reservoir operations. Lastly, the primary factors associated with permitting storage projects were identified to help understand the likely time and cost necessary for this aspect of project management. The approach used in the feasibility engineering and development of cost analyses is discussed in detail in Appendix B. Various funding sources were also researched for use in subsequent phases of the development process.

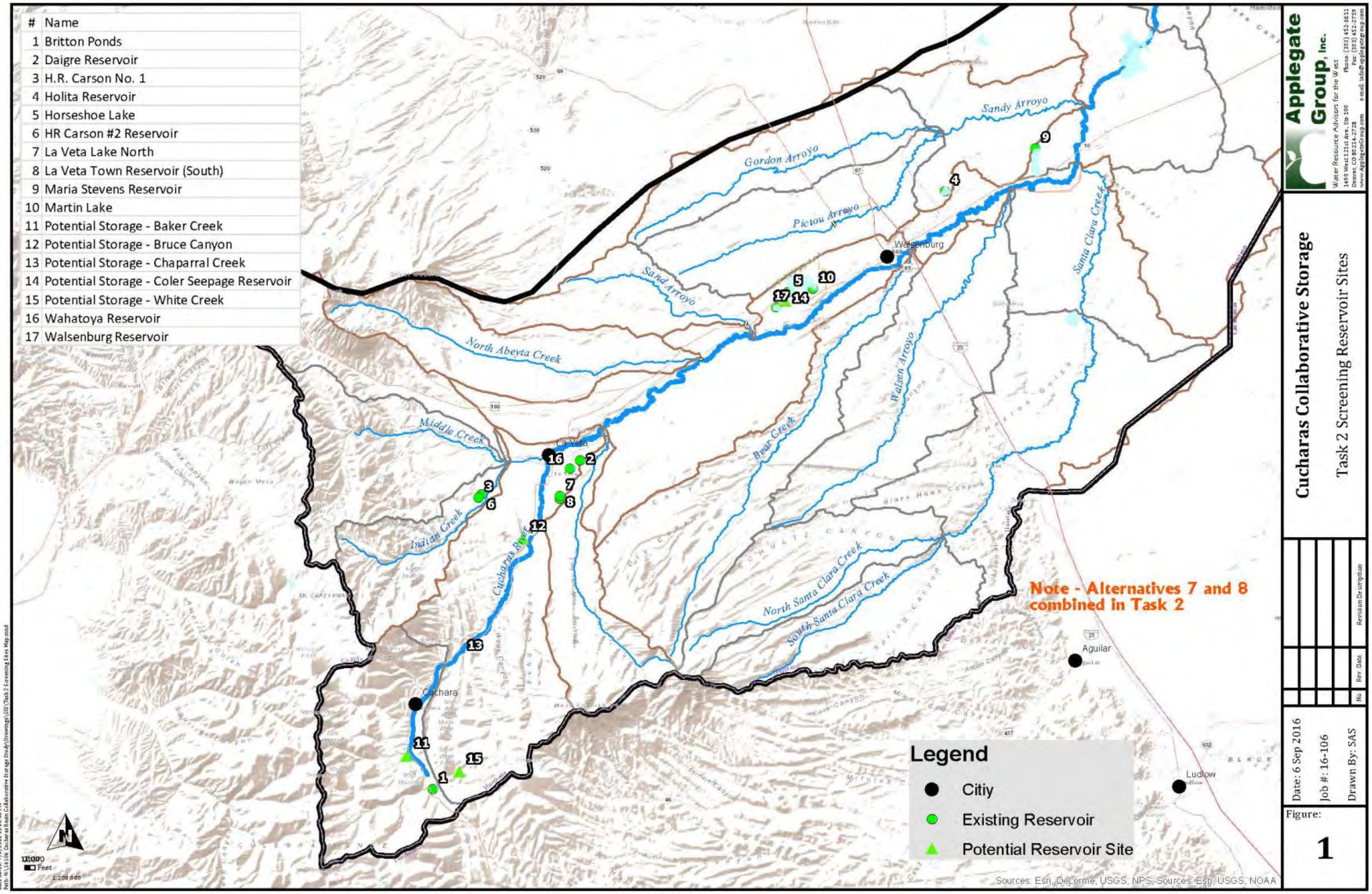

Figure 1
Task 2 Storage Alternatives

FINDINGS AND RESULTS

SCREENING CRITERIA

Screening criteria were defined to provide metrics against which the different reservoir alternatives could be compared. For instance, reservoirs would likely be more difficult to permit and build if they would be a high hazard dam, if the underlying geology would lead to potential seepage or differential settlement, et cetera.

The following seven criteria were defined based on previous work analyzing reservoir alternatives and meetings and discussions with the Collaborative. Weights were assigned to the screening criteria and used to differentiate the relative impact of one criterion versus another.

Screening Criterion	Weight	Screening Criterion	Weight
Storage Volume	3	Operational Factors	3
Technical Feasibility	3	Administrative	3
Yield	5	Public Benefit	2
Project Cost	5		

The yield of the reservoir alternatives was estimated through the use of a prior appropriation model of the entire Cucharas River basin. The other criteria for the reservoir alternatives were developed from, among others, review of dam safety reports, local soil reports and geotechnical data, well permits, rough estimates for embankment volume, dam age and condition, geologic mapping, and necessary easements and structures potentially impacted by dam breaches of the reservoir alternatives. Site visits to the basin during summer 2016 and conversations with property owners, state representatives and others were indispensable for developing input for the screening analysis.

Scoring thresholds were identified to quantify the ease of developing and the potential benefit of each of the reservoir sites. Each reservoir alternative was assigned a score between 1 (low) and 3 (high) either relative to being in the top, middle, or bottom third of the alternatives (e.g., storage volume) or other defined breakpoints (e.g., geologic material, hazard classification). A short summary of the screening criteria and thresholds are discussed below. The scoring thresholds are also tabulated in Appendix C.

STORAGE VOLUME

Storage Volume is a direct indicator of vessel size - bigger reservoirs can physically store more water than smaller reservoirs.

The storage capacity of the Task 2 reservoirs range between 42 acre-feet (Britton Reservoir) and 1,406 acre-feet (Bruce Canyon Reservoir), as summarized in Table 1. Note the Horsetooth/Martin Joint Use Pool alternative was dropped from consideration in Task 2. In addition, there is no increase in storage volume from the Change Diversion to Coler Inlet alternative.

Closer analysis of site characteristics and conversations with dam owners resulted in the storage capacity listed for some of the reservoirs being different than that used in earlier analyses. In particular, the storage capacities for South Baker Creek Reservoir and Bruce Canyon Reservoir have increased and the enlargement capacity for Maria Stevens Reservoir has decreased.

Discussions with the owners of Maria Stevens Reservoir indicate an opportunity may exist for the Collaborative to lease existing storage in combination with a smaller enlargement. This would allow for a significant reduction in capital construction cost and a larger storage capacity (1,000 acre-feet of lease space plus 642 acre-foot enlargement) available for collaborative use than previously analyzed.

Table 1
Storage Volumes

Enlargement of Existing Storage	New / Increased Capacity (acre-feet)
Britton Ponds Enlargement	42 (small dam) 239 (large dam)
La Veta Lakes Enlargement	102
HR Carson #1/#2 combined storage	125
Daigre Reservoir enlargement	100
City Lake	140 (unrestricted) 262 (enlargement)
Holita Reservoir Rehabilitation	330
Maria Stevens Rehab/Enlargement	642 (plus up to 1,000 ac-ft leased)
Horseshoe/Martin Joint Use Pool	---

New Storage Projects	New / Increased Capacity (acre-feet)
South Baker Creek Reservoir	122
Chaparral Creek Reservoir	273
Bruce Canyon Reservoir	1,406
Coler Seepage Reservoir	201
White Creek Reservoir	7,000 (decree) 500 (alternate configuration)

Integrated Operations	New / Increased Capacity (acre-feet)
Maria Lake - Bruce Canyon Exchange	2,048
Change of Use of Unused Senior Rights	670*
Change Diversion to Coler Inlet Ditch	---

*Based on cumulative storage rights for the following reservoirs: Blanche Hamilton, Edna Belle, Fielden, Harry Hamilton, Hayes, La Joya, McDonald, Owens #1, Owens #2, Sharps Orchard, Stevens, Willow, and Willow Creek

The scoring thresholds for storage volume were based on the lower, middle, and upper one-third of the range of storage volume for the 16 sites, to arrive at an approximately equal amount of reservoirs in each of the three scores.

Technical Feasibility

Technical Feasibility looks at the suitability of site geology, site access, and factors affecting ease of construction. The constructability of a stable dam embankment, and inlet/outlet infrastructure were also primary considerations for technical feasibility. The availability of borrow material was a factor as well.

The scoring thresholds for the technical feasibility criterion were based on the following data:

- Local well logs were used to estimate depth to bedrock. Dam foundations are more stable when it is possible to key the foundation into the underlying bedrock. Proper keyways can minimize the potential for differential settling in the dam foundations.
- Bedrock geology was estimated based on a geologic map created for HCWCD in 1978. This map was used to identify the underlying bedrock type, strength, and potential for settling.
- The suitability of onsite borrow material was assessed using soil survey maps from the NRCS.

The scoring thresholds for technical feasibility were as follows:

- Low score: Bedrock depths greater than 20 feet; limited borrow material available for embankment construction; high seepage potential; and high potential for differential settling.
- Medium score: Bedrock depth 10 to 20 feet; most borrow material available for embankment construction; moderate seepage potential; and moderate potential for differential settling.
- High score: Bedrock depth less than 10 feet; all borrow material available for embankment construction; low seepage potential; and low potential for differential settling.

Yield

Yield is the amount of water that can be stored in priority and is able to be used to reduce estimated shortages to future water demands throughout the basin.

The Yield Model was used to analyze historical, current, and future operations within the Cucharas River basin. Model operations were simulated on a monthly basis over the 1980 through 2014 period. This period represents typical wet years (e.g., 1983 and 2005) and dry years (e.g., 2002 and 2006) in the basin. Future demands were based on planning numbers provided by municipal providers and estimates of full supply for agriculture. Instream flow rates recommended by Colorado Parks and Wildlife representatives for planning purposes were incorporated into the model in order to quantify potential non-consumptive demands for water.

Model simulation of future demands with existing infrastructure and operations indicate significant shortages associated with irrigation use in the basin (see Table 2). The model also indicates shortages during dry years for municipal entities, particularly the Cucharas Sanitation and Water District and City of Walsenburg. Shortages were not estimated for the Town of La Veta's future demand primarily due to growth projections that do not exceed historical demands.

Table 2
Future Demands and Simulated Shortages

MUNICIPAL	Demand	Shortage
Cucharas S&WD	196	1.9 (50.5)
La Veta	408	0
Walsenburg	2,212	116 (1,119)
Unincorporated	286	0
Total	3,103	118
IRRIGATION	33,573	14,799

Average annual values (1980 – 2014)
Maximum annual values in parentheses

The raw yield of water available, in priority, for increased storage capacity was estimated with the Yield Model against the generally senior water rights used in the basin to meet the future demands, as discussed above. Raw yield is the volume of water a given reservoir can store in a year, assuming no demand on the stored water, and that the reservoir spills to empty at the end of each year. The yield for new reservoirs was analyzed assuming the reservoirs had a first fill right with a 2017 priority. Existing reservoirs that have absolute and/or conditional storage rights were analyzed based on the decreed priorities. Enlargements in excess of decreed rights were assigned a 2017 priority right in the determination of the raw yield. The model was then run with the reservoirs releasing water to meet the future shortages to get a better idea of the beneficial use available from the reservoir alternative. In these model simulations, carryover storage is counted against the subsequent year's storage right and releases are only made to meet future demands that are short of water. This approach reduces the use of the reservoir below the raw yield values. Changes to various model input, including operational rules and inclusion of dead pools in reservoirs in which stored water is unavailable for release resulted in model results listed for some of the reservoirs being different than that identified in earlier analyses. Model results of yield and use are summarized in Table 3. Note diversions to storage under junior water rights would require replacement water supplies to ensure no injury to out-of-basin senior water rights. Cooperative scenarios with multiple storage units, one of which is Maria Stevens Reservoir, represents aspects of the necessary replacement operations. Other replacement supplies that exist include the changed rights owned by the municipalities - including Ballejos Ditch, Gomez Ditch, and Mexican Ditch, and the unused / underused storage rights included as one of the storage alternatives. Those specific operations are not addressed in the yield model.

Raw yield values are not listed for various alternatives that include the City of Walsenburg's reservoirs. In addition, the Horsetooth/Martin Joint Use Pool alternative was dropped from consideration in Task 2. Delivery and use of Walsenburg's water rights is included in the model with multiple reservoirs operating together. It is difficult to parse out the yield to a City Lake enlargement, for example, from the use of the direct and storage rights in City Lake and the transfer of various water rights between reservoirs to keep the lower storage units full. The amount of deliveries simulated from the enlarged storage capacity is easy to quantify. A similar issue occurs with the integrated operations between Maria Lake and Bruce Canyon Reservoir since the yield of the storage rights is combined by the storage of releases from the lower reservoir, by exchange.

Table 3
Reservoir Alternative Yield and Beneficial Use

Enlargement of Existing Storage	Raw Yield [1] Avg (Dry)	Use (Delivery)	Storage : Use Ratio
Britton Ponds Enlargement (42 AF small dam)	42 (6)	22 [2]	1.9
Britton Ponds Enlargement (239 AF large dam)	139 (6)	110 [2]	2.2
La Veta Lakes Enlargement	102 (53)	102	1.0
HR Carson #1/#2 combined storage	103 (16)	80	1.4
Daigre Reservoir enlargement	---	30	3.3
City Lake (unrestricted)	---	76	1.8
City Lake (enlargement)	---	97	2.7
Holita Reservoir Rehabilitation	234 (178)	129	2.6
Maria Stevens Rehab/Enlargement	1,206 (715) [3]	271	2.4
Horseshoe/Martin Joint Use Pool	---	---	---

[1] Yield of junior storage rights will require replacement supply to satisfy Arkansas River calls
[2]Assumes deliveries to CPW fish flows [3] Includes yield from 1,000 ac-ft lease account

New Storage Projects	Raw Yield [1] Avg (Dry)	Use (Delivery)	Storage : Use Ratio
South Baker Creek Reservoir	56 (0)	54	2.3
Chaparral Creek Reservoir	163 (0)	155	1.8
Bruce Canyon Reservoir	677 (0)	622	2.3
Coler Seepage Reservoir	108 (108)	80	2.5
White Creek Reservoir (7,000 AF)	270 (0)	233	30.0
White Creek Reservoir (500 AF)	171 (0)	151	3.3

Integrated Operations	Raw Yield[1] Avg (Dry)	Use (Delivery)	Storage : Use Ratio
Maria Lake - Bruce Canyon Exchange	---	809	2.9
Change of Use of Unused Senior Rights	658 (534) [4]	300	2.2
Change Diversion to Coler Inlet Ditch	---	36	---

[4] Based on legal availability of storage rights at respective original points of adjudication

The storage to use ratio included in Table 3 provides a comparison of how much use of water one might get from an acre-foot of constructed storage. For example, a ratio of 2 would indicate that 2 acre-feet of raw yield would need to be stored for 1 acre-foot of use to meet local demands. Although a lower ratio would indicate a higher return on investment, the actual benefit is more complicated since the cost per acre-foot of storage space varies between alternatives, as discussed in the Screening Analysis.

The scoring thresholds for the yield criterion were based on splitting the estimated use into the lowest, middle, and upper one-third of the range of reservoir yield, to arrive at an approximately equal amount of reservoirs in each of the three scores.

Project Cost

Project Cost includes a suite of factors, including land acquisition, construction, permitting, operations and maintenance, and energy costs. The use of project cost as a criterion is complicated since it is input used to help identify the reservoirs for which design drawings and project costs are to be developed. Detailed project costs were not developed during the screening phase, but subsequently in the feasibility design phase. Nonetheless, project cost is an important decision point for capital intensive projects. To address the dichotomy, dam size and hazard classification were used as a surrogate for project cost in developing the screening matrix. Smaller and lower hazard dams would have a lower project cost, including lower inflow design floods and the associated smaller emergency spillways, lower design costs, less onerous instrumentation requirements, less stringent seismicity design requirements, and less stringent geotechnical and foundation design requirements. Project cost was qualitatively assessed based on the level of the above design, construction, and operational requirements that would be needed for various size and hazard classifications.

The scoring thresholds for the project cost criterion were based on approximate embankment volume (i.e., the primary driver for construction costs for a zoned earthfill dam), and the dam size and hazard classification with the impacts to costs as described above. Additionally, land costs were a factor for the project cost criterion: sites already owned by one of the Collaborative members were assumed to have lower land acquisition costs than sites that would need to be separately purchased by the Collaborative. Operation and maintenance issues, such as potential monitoring and reporting on seepage, were considered as well.

Scoring thresholds for project cost were as follows:

- Low score: Small high hazard dam or large dam of any hazard classification; upper third of land acquisition costs; and high O&M (more than two of the following): associated with pumped deliveries, wave runup, spillway repair, or deferred maintenance.
- Medium score: Minor high hazard dam or small dams with no public hazard to significant hazard; middle third of land acquisition costs; and medium O&M (one to two of the following): associated with pumped deliveries, wave runup, spillway repair, deferred maintenance.
- High score: Minor dam with no public hazard to significant hazard; lower third of land acquisition costs; and low O&M (dam less than 20 years old).

Operational Factors

Operational Factors looks at ease of operating the reservoirs and how that may be impacted by the need for cooperation between multiple owners and operators. The need for manual operations (intensive operational requirements) was identified for some sites, versus the potential for automated operations (lower operational requirements). The level of coordination that would be required was an operational factor (e.g., multiple owners and water users that would require coordinated operations and water accounting).

The scoring thresholds for operational factors were based on as follows:

- Low score: Manual operation and coordination required between 3 or more water users.
- Medium score: Partially automated operations and coordination required between 1 to 2 water users.
- High score: Fully automated operations; operations for single water user preventing the need for coordination.

ADMINISTRATIVE

The Administrative criterion addresses permitting costs, the need for easements, water court costs, et cetera. Sites with human occupied downstream structures would require higher levels of administrative management (e.g., implementation of Emergency Action Plans). The primary permitting constraint would be for sites that would require a permit with the U.S. Army Corps for placing fill within a jurisdictional water of the U.S. The need for an intergovernmental agreement between multiple owners and water users was also considered in the administrative screening process.

The scoring thresholds for the administrative criterion were as follows:

- Low score: High hazard dam and resulting SEO permit constraints; Individual 404 Permit required for on-channel dam with greater than 1 acre wetland mitigation; IGA needed for multiple owners/water users; easements needed from multiple landowners; potential condemnation required; and water rights change of use required.
- Medium score: Significant hazard dam; Individual 404 Permit for on-channel dam with less than 1 acre of wetland mitigation; IGA needed with 1 to 2 owners/water users; easements needed from 1 land owner; and water rights change of point of diversion.
- High score: Low hazard dam; 404 Nationwide Permit for off-channel dam or enlargement of existing dam; no IGA or easements required; and limited water rights issues (e.g., file for junior storage right).

PUBLIC BENEFIT

Public Benefit criterion predominantly qualifies the socioeconomic benefit of an alternative based on the recreational value it might provide. Yield for multiple users was considered to be a public benefit. Return flows available to benefit multiple users was another public benefit.

The scoring thresholds for the public benefit criterion were:

- Low score: Provides yield for only 1 use and 1 water user; and return flows only benefit one use and one user.
- Medium score: Provides yield for more than 1 use or more than 1 water user; and return flows benefit multiple uses or users.
- High score: Provides yield for more than 1 use and more than 1 water user; and return flows benefit other uses and users.

SCREENING MATRIX

The weighted scores and rank among the alternatives are summarized in Table 4. The screening matrix was presented to and discussed with the Collaborative to help identify a short list of preferred alternatives for which preliminary design drawings and project costs would be estimated. The scores in Table 4 have changed somewhat from those previously discussed. The scores for each of the reservoirs for each of the screening criteria are presented in Appendix D.

Table 4
Screening Matrix

Enlargement of Existing Storage	Weighted Score	Rank
Britton Ponds Enlargement (42 AF small dam)	40	18
Britton Ponds Enlargement (239 AF large dam)	41	16
La Veta Lakes Enlargement	55	3
HR Carson #1/#2 combined storage	47.5	8.5
Daigre Reservoir enlargement	46	12
City Lake (unrestricted)	47.5	8.5
City Lake (enlargement)	45.5	13.5
Holita Reservoir Rehabilitation	55	3
Maria Stevens Rehab/Enlargement	55	3
Horseshoe/Martin Joint Use Pool	45.5	13.5

New Storage Projects	Weighted Score	Rank
South Baker Creek Reservoir	40.5	17
Chaparral Creek Reservoir	47	10
Bruce Canyon Reservoir	56	1
Coler Seepage Reservoir	46.5	11
White Creek Reservoir (500 AF)	50.5	6.5

Integrated Operations	Weighted Score	Rank
Maria Lake - Bruce Canyon Exchange	53	5
Change of Use of Unused Senior Rights	50.5	6.5
Change Diversion to Coler Inlet Ditch	45	15

Throughout the Storage Study, the Collaborative stakeholders have discussed alternatives that include multiple sites with coordinated operations where water can be moved between reservoirs, by exchange. A combination scenario is prudent in a basin that has limited physical supply and has points on the river that dry up most every year. In addition, exchanges and/or replacement water supply would be necessary to realize the estimated yields in the context of calls placed downstream on the Arkansas River. The Yield Model output was analyzed to determine low flows throughout the basin that would limit the exchange of water (see Appendix A). The simulated exchange potential follows what is seen on the ground: the maximum exchange occurs during the spring runoff; more water is typically able to be moved between ditch headgates in the lower basin; and the exchange potential reduces as one moves up the main stem above Middle Creek through the reach where the municipal pipelines are located; and the exchange is further limited as you move through the Gap toward Cuchara and as you try to move water up any of the water-short tributaries in the upper basin. Nonetheless, opportunities for exchange do exist and, in concert with the scores from the Screening Analysis, the Collaborative identified the following five preferred reservoir sites for which drawings and cost estimates would be developed

PREFERRED RESERVOIR ALTERNATIVES

The list of five preferred reservoirs consists of one site in the lower basin and two each in the middle basin and upper basin.

- Maria Stevens Reservoir enlargement
- Bruce Canyon Reservoir
- La Veta Lakes enlargement
- Britton Reservoir enlargement
- South Baker Creek Reservoir

The yield and use of the reservoirs, operated independently, are summarized in Table 3. Cooperative operation of multiple sites, though, could have a broader impact from increased yield and enhanced recreational opportunities. Any increase in yield would then be included in the cost-benefit analysis for a particular multiple reservoir alternative.

The preferred reservoir alternatives were analyzed in four scenarios with groups of three sites each - one each from the lower, middle, and upper basin. Three additional scenarios were analyzed with just two reservoir sites to estimate how a smaller set of storage alternatives might address shortages in the basin. The following sets of reservoirs were simulated in the seven separate scenarios:

- Maria Stevens Reservoir - La Veta Lakes - Britton Reservoir
- Maria Stevens Reservoir - La Veta Lakes - South Baker Creek Reservoir
- Maria Stevens Reservoir - Bruce Canyon Reservoir - Britton Reservoir
- Maria Stevens Reservoir - Bruce Canyon Reservoir - South Baker Creek Reservoir

- Maria Stevens Reservoir - South Baker Creek Reservoir
- Maria Stevens Reservoir - La Veta Lakes
- Bruce Canyon Reservoir - South Baker Creek Reservoir

Model results of beneficial use of the groups of reservoirs are summarized in Table 5. Note there are two columns of Use in Table 5: one for the reservoirs operated as a group (Combined) and the sum of the units operated independently (Sum Solo) from Table 3.

The model output indicates the net benefit of multiple reservoirs from a beneficial use perspective is not significantly different compared to operating the reservoirs individually. In fact, the values in Table

5 show that use of the reservoirs operated independently is typically greater than when operated as a group. This is due primarily because the use of the reservoirs operated independently double counts some releases to meet shortages (i.e., two or three reservoirs operated independently can supply the same irrigation shortage but the shortage can only be supplied once when the reservoirs are operated together). Therefore, the combined use is overstated.

Table 5
Cooperative Reservoir Beneficial Use

Enlargement of Existing Storage	Cumulative Volume	Use (Combined)	Storage : Use Ratio	Use (Sum Solo)
Maria Stevens - La Veta Lakes - Britton	786	362	2.2	380
Maria Stevens - La Veta Lakes - South Baker Ck	866	406	2.1	430
Maria Stevens - Bruce Canyon - Britton	2,090	861	2.4	898
Maria Stevens - Bruce Canyon - South Baker Ck	2,170	892	2.4	947
Bruce Canyon - South Baker Creek	1,528	666	2.3	676
Maria Stevens - La Veta Lakes	744	359	2.1	376
Maria Stevens - South Baker Creek	764	308	2.5	325

One would think that combined operations would provide more water for use than if the reservoirs are operated independently. The model results do not show that to be the case, which is likely because when exchange potential exists a junior right at the upstream location would be able to divert as much water in priority as would be available to store via exchange.

The main benefit identified in the Yield Model from operating multiple reservoirs is the flexibility of the source of water to meet shortages in different parts of the river basin. A result of that dynamic is the upstream reservoirs would be able to maintain higher storage levels, when operated in conjunction with other reservoirs, in contrast to when the upstream reservoirs are operated individually. Higher water levels could translate into improved recreation and tourism. Having multiple reservoirs operated cooperatively would also increase the public benefit with potentially having recreational opportunities that are not as isolated as would occur with a single reservoir. Construction and use of multiple reservoirs also increases the total storage volume that could be used for either exchanges or diversions to junior storage. It would be more feasible to construct multiple reservoirs for the combined storage volume, than to construct one oversized reservoir. This is because each individual reservoir site is limited by physical constraints (e.g., property boundaries, limited impacts to adjacent roads/property, and the inherent topographic conditions).

Note the Yield Model necessarily simplifies the complexities of tributary basin inflows and flexibility provided by on-the-ground river administration. The impact of downstream calls placed on the Huerfano River or Arkansas River are not explicitly represented in the model. The model also operates on a monthly time step. This diffuses the impact of the ability to store during heavy thunderstorms by distributing the inflow from a rain event over the entire month. These points illustrate some of the limitations to the use of the model as it is currently set up. A daily prior appropriation model of the entire Arkansas River basin will be developed as part of the ArkDSS planning effort being overseen by CWCB and DWR. The ArkDSS model is scheduled to be completed within two years and will provide better representation of daily variability of streamflow and interactions between the Cucharas River and the Arkansas River. That model will be able to address some of the limitations identified with the Yield Model and provide for explicit representation of impacts to exchange operations in the Cucharas River basin that utilize lower basin replacement supplies, including storage and changed water rights.

COST ESTIMATES

Opinions of probable cost were developed for completion of the five project dams. These opinions are based on the preliminary drawings dated May 2017. The opinion of probable cost for each reservoir is provided in Appendix B.

At this level of evaluation, cost estimates would meet Class 4 standards of the American Association of Cost Estimators (AACE). Our estimates follow the standards set by the United States Society of Dams (USSD) has guidelines for cost estimating that provide useful information for levels of accuracy, contingencies, etc.

The cost estimates reflect a conceptual level of project definition. The construction cost summaries are based on the major component line items (signified by number of units, unit cost, and/or importance to the project) of construction, the approximate measured quantity of materials for each item, and unit prices based on published bid price data for similar work, manufacturers' budgetary price quotes, and contractor bids for similar jobs reviewed by Applegate Group over the past five years. The sub-total of the major component line items was used as the basis for a construction cost estimate. Since a conceptual cost estimate is based on major component line items of construction, an allowance must be made for the remaining minor component line items. This allowance reflects those items which are individually too small to be listed as major component line items, but when considered together, constitutes a significant enough cost to be included.

Unlisted items can include such things as access development/restoration, disposal site identification/ development, disposal site fees, woody debris collection and disposal, etc. On this project a 10% (typically 0 to 10%) allowance (on the sub-total of the major component line items plus mobilization/demobilization) is made for unlisted items. A conceptual cost estimate must also include an allowance for unknowns, known as contingency. Contingency can include an allowance for incomplete identification of line items associated with the low level of project component refinement, modest changes in project scope, refinement of material quantities, unknown site conditions, and uncertainty in unit prices. On this project a 20% (typically 0 to 25%) allowance (on the sub-total of the major component line items plus mobilization/demobilization) is made for contingency. As the project becomes better defined, the list of construction line items becomes more complete, and fewer unknowns exist, resulting in a reduction in both the unlisted items allowance and contingency allowance.

COST-BENEFIT ANALYSIS

The cost-benefit analysis for the storage projects can be evaluated with standard ratios such as the following:

1. Unit costs for storage volume, defined as the ratio of the total cost of the project to the total storage volume for the project. The unit costs are provided in Table 6 for the five preferred reservoir alternatives. Typical values of $10,000 per acre-foot are used, with a maximum of $20,000 per acre-foot of storage volume. However, these typical unit costs are generally applied to larger (e.g., greater than 1,000 acre-foot of storage volume) reservoirs. Unit costs for smaller reservoirs may be higher.

   Bruce Canyon dam and Maria Stevens enlargement are the only two projects that have a unit cost for storage volume below the $20,000 typical ratio. The Bruce Canyon dam has a unit cost for storage volume of approximately $13,600 per acre-foot of storage. The Maria Stevens enlargement project has a unit cost of approximately $13,100 per acre-foot of storage. The South Baker Creek dam has a unit cost of approximately $107,400 per acre-foot. The La Veta enlargement has a unit cost of approximately $64,900 per acre-foot. The Britton Reservoir dam has a unit cost of approximately $156,600 per acre-foot.

   Unit costs for the combination of the construction of South Baker Creek dam, and the enlargement of Maria Stevens Reservoir would be approximately $28,100 per acre-foot for the combined storage of 764 acre-foot (642 acre-foot enlargement of Maria Stevens Reservoir and 122 acre-foot new storage at South Baker Creek Reservoir). Unit costs for the different combinations of reservoirs would range between approximately $16,300 and $32,500.

2. Unit costs for project yield, defined as the ratio of the total cost of the project to the average annual yield. Unit costs over a 50-year project life are presented in Table 6 ("50-Yr Unit Cost"), and could be compared to typical raw water delivery unit costs for the stakeholders in the Collaborative.

Table 6
Cost Benefit Analysis

Reservoir Alternative and Storage Capacity	Project Cost[1,2]	Unit Cost ($/ac-ft Capacity)	Use (Delivery)	50-Yr Unit Cost ($/ac-ft/yr)
Britton Ponds Construction (42 AF small dam)	$6,577,340	$156,603	22	$5,979
South Baker Creek Reservoir (122 AF)	$13,101,600	$107,390	54	$4,852
La Veta Lakes Enlargement (102 AF)	$6,621,300	$64,915	102	$1,298
Bruce Canyon Reservoir (1406 AF)	$19,184,100	$13,644	622	$617
Maria Stevens Rehab/Enlargement (642 AF)	$8,406,300	$13,094	271	$620

Reservoir Combinations	Project Cost[1,2]	Unit Cost ($/ac-ft Capacity)	Use (Delivery)	50-Yr Unit Cost ($/ac-ft/yr)
Maria Stevens - La Veta Lakes – Britton (786 AF)	$21,604,940	$27,487	362	$1,194
Maria Stevens - La Veta Lakes - South Baker Creek (866 AF)	$28,129,200	$32,482	406	$1,386
Maria Stevens - Bruce Canyon – Britton (2090 AF)	$34,167,740	$16,348	861	$794
Maria Stevens - Bruce Canyon - South Baker Creek (2170 AF)	$40,692,000	$18,752	892	$912
Bruce Canyon - South Baker Creek (1528 AF)	$32,285,700	$21,129	666	$970
Maria Stevens - La Veta Lakes (744 AF)	$15,027,600	$20,198	359	$837
Maria Stevens - South Baker Creek (764 AF)	$21,507,900	$28,152	308	$1,397

[1] Project Cost is based on the Construction Cost estimate, and does not include additional engineering design, permitting, land acquisition, or O&M costs. Those additional costs were estimated elsewhere, and are available in Appendix B.

[2] Deferred maintenance costs for existing reservoir sites are excluded from Project Cost, as it is assumed these costs will be separate from the Collaborative Storage improvements.

PERMITTING ISSUES

The following permitting issue will need to be addressed for the proposed storage projects. Additional information on permitting requirements is provided in Appendix B.

1. A permit to enlarge an existing dam or construct a new dam will be required from the Dam Safety Branch of the Colorado State Engineer's Office.
2. Compliance with the endangered species act will be required to demonstrate no impacts to the following threatened species: Mexican spotted owl, greenback cutthroat trout, Canada lynx, and North American wolverine.
3. Compliance with the Bald and Golden Eagle Protection Act (BGEPA) will be required, as all of the sites are potential habitat.
4. Compliance with the Migratory Bird Treaty Act, as there are 25 to 30 migratory birds at the project sites.
5. A land use permit for areas and activities of state interest will be required from Huerfano County, consistent with Huerfano County Resolution 13-35 Section 7.00.
6. A floodplain development permit will be required from Huerfano County, consistent with Huerfano County Resolution 13-35 Section 4.00.
7. A Clean Water Act Section 404 permit will be required for placement of fill within jurisdictional waters of the U.S. On-channel dam construction will require an Individual Permit. Enlargement of existing dams will require a less onerous Nationwide Permit.
8. A National Environmental Policy Act (NEPA) permit will be required for any project that has a federal nexus (e.g., federal funding or federal permit). If an Individual 404 Permit is required, the NEPA process would be built into the 404(b)(1) permit requirements.
9. A cultural resources survey would be required to determine whether the project would impact items of historic significance.

FUNDING OPPORTUNITIES

The cost estimates and cost-benefit analysis of the preferred reservoir sites are provided to give the Collaborative some direction in its decision making process regarding choosing which way to move forward with development of storage in the basin. There are a number of steps needed to help the progress of that effort, including land acquisition; securing necessary rights-of-way and completing agreements between partners and affected parties; and finalizing permits and analyses used to support permit applications. The full design of dam infrastructure, inlet and outlet structures, and associated operations must also be completed.

These efforts will provide the Collaborative with improved estimates of project cost for which funding will need to be secured. We have investigated various funding options potentially available from the CWCB, USDA (SCS), EPA, CDPHE, FEMA, DOLA, BuRec, CPW, and GOCO. The most promising funding options were identified as the EPA WIFIA, CWCB Water Project Loan program, CWCB Non-Reimbursable Project Investment Grants, and Water Supply Reserve Funding. Although some of the loan and grant opportunities are not focused on storage opportunities, a number of the funding mechanisms do. Some highlights of the most promising options are summarized below. Note a loan feasibility study will likely be needed to be completed and included in any grant / loan applications.

- EPA WIFIA (Water Infrastructure Finance and Innovation Act) - Long term, low-cost supplemental loans for regionally significant projects
  - Eligible projects include those that prevent, reduce, or mitigate the effects of drought, including projects that enhance the resilience of drought-stricken watersheds.
  - Eligible activities include planning, preliminary engineering, design, environmental review; construction, reconstruction, rehabilitation, and replacement activities; and acquisition of real property or an interest in real property, environmental mitigation, construction contingencies, and acquisition of equipment. Minimum project size of $5 million with monies borrowed by local government authorities. WIFIA loan not to exceed 49% of project costs. Interest rate at or equal to US Treasury rate with term of loan not to exceed 35 years.
  - No specific time frame identified for when to make loan application.
  - See www.epa.gov/wifia for further information.

- CWCB Water Project Loan Program
  - Eligible projects include new construction or rehabilitation of existing raw water storage and delivery facilities, including reservoirs, ditches and canals, pipelines, river diversion structures, and water rights purchases.
  - Recommended minimum loan of $100,000 borrowed by private or public entities. Interest rate likely at lower end of 2.55% - 3.30% - with standard term of loan equal to 30 years. (Rates are adjusted throughout the year based on the bond market trends.)
  - Applications for large project loans (>$10 million) must be approved by General Assembly. Applications are due by August 1 to be considered at November CWCB meeting. Funds available after the following July 1, contingent on CWCB Board and legislative approval.
  - Applications for small project loans (<$10 million) need not be approved by General Assembly. Applications accepted throughout the year with anticipated processing and availability of money within five months.
  - See http://cwcb.state.co.us/loansgrants/water-project-loan-program/Pages/main.aspx and/or contact Anna Mauss (anna.mauss@state.co.us, 303.866.3441 x3224) for further information.

- CWCB Non-Reimbursable Project Investment Grants
  - Eligible projects include feasibility studies and projects designed to address region-wide or basin-wide water issues, such as facilitation of solutions to regional water supply problems.
  - Applications due by August 1. Funds available after the following July 1, contingent on CWCB Board and legislative approval.
  - See http://cwcb.state.co.us/loansgrants/water-project-loan-program/Pages/main.aspx and/or contact Kirk Russell (kirk.russell@state.co.us, 303.866.3441 x3232) for further information. Contact with CWCB can provide details on grant amounts and terms of grants.

- CWCB Water Supply Reserve Fund Grants (WSRF) - Competitive grants and loans to address critical water supply issues
  - Eligible projects include studies or analysis of structural projects or activities and technical assistance regarding permitting, feasibility studies and environmental compliance. Note grant approvals typically require 25% match by applicant.

- Preliminary applications to Basin Roundtable due the first of month (August, October, December) for Roundtable approval the subsequent month later. Final application to CWCB due the 25th of the month in which project approved by Roundtable. CWCB review and approval at CWCB meeting two months hence. See CWCB website for details.
- See http://cwcb.state.co.us/LoansGrants/water-supply-reserve-account-grants/Pages/main.aspx and contact Chelsey Nutter (projects@uawcd.com, 719-539-5425) for further information.
- Note Arkansas Basin Roundtable WSRF balance is currently about $10,000 and funding of WSRF accounts is in limbo. The CWCB 2017 Water Projects Bill (HB 17-1248) included a request for $10 million to supplement the WSRF and $10 million, for three years (state fiscal years 2017-18, 2018-19, and 2019-20), for implementation of the State Water Plan (SWP). The SWP funding is another opportunity for storage projects in the Cucharas River basin. After introduction, the 2017 Water Projects Bill passed both houses of the legislature and was forwarded to the governor for signature on May 9 (see http://leg.colorado.gov/bills/hb17-1248 for further information). In the SWP plan three-year funding (that will need annual legislative approval each fiscal year) $3 million per year is anticipated for grants related to new storage to help the water supply gap.

SUMMARY

Various screening criteria were developed with the Collaborative to compare and contrast different aspects of a medium list of 16 reservoir alternatives located throughout the Cucharas River basin. Water rights yield and estimated beneficial use and various aspects affecting the construction costs and operational and permitting requirements for each of the alternatives were scored and compared in a screening matrix. A short list of five reservoir sites was identified by the Collaborative and feasibility level estimates of probable cost were developed for completion of the five project dams. The cost-benefit of construction of the reservoir alternatives identified the two largest sites - Bruce Canyon Reservoir and Maria Stevens enlargement - that have a unit cost for storage volume below $20,000. The unit costs for the smaller reservoir sites – Britton Reservoir, South Baker Creek Reservoir, and La Veta Lakes enlargement – are much higher, by an order of three to eight times higher. Annual use costs over a 50-year assumed project life would range from approximately $600 per ac-ft per year for Bruce Canyon Dam construction and Maria Stevens Reservoir rehabilitation/enlargement, to $6,000 per ac-ft per year for Britton Pond Dam construction.

Preliminary design drawings were completed for all five dams, which can be used to support further efforts for dam design and associated investigations. Opportunities for funding for further steps in the reservoir development process have been highlighted. The outlook for availability of funding from the Arkansas River and State of Colorado Water Supply Reserve funds and other CWCB funding mechanisms has improved due to the passage of the 2017 Projects Bill. Once funding is secured, the next steps for design should be to complete site-specific geotechnical investigation(s). The site-specific geotechnical data can then be used to refine the feasibility level designs and cost estimates, resulting in a better understanding of total construction costs.

Task 2 App A – Model Report

Cucharas Basin Collaborative Storage Study
Task 2 - Appendix A

Water Allocation Modeling Report

Huerfano County, Colorado

June 2017

CWCB Contract No. CTGGI 2016-1053

***Prepared for*:**

Huerfano County

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INTRODUCTION

Estimates of water available to an existing or future water right is contingent on the physical supply available at the location of diversion and the water right's legal entitlement to water in the context of other water rights on the river system. Yield estimates for the reservoir alternatives were analyzed through the development of a water rights-based water allocation and accounting model. The StateMod program, developed and maintained by the Colorado Department of Natural Resources, was chosen for this effort.

A StateMod model data set was developed that represents one hundred percent of the consumptive use in the Cucharas River basin. A 1980 through 2014 study period on a monthly time step was chosen for the analysis since it is representative of wet-, dry-, and average-year hydrology evidenced in the basin. This period is also consistent with the general availability of streamflow data, diversion data, and storage contents data necessary for model simulations. The model is first run to estimate natural flows (aka baseflows), which represent the physical water supply absent man's impact (e.g., historical diversions are added back into gaged flow). The model is then run with the input natural flows to meet the historical structure demands (river diversions and end-of-month storage contents), limited by administrative constraints (direct flow and storage water rights and operating rules). This model run is the Historical data set and is used to calibrate the model against historical conditions, during which various model input are varied to improve the comparison of simulated streamflow, diversions, and storage contents versus the historical record. The calibrated model is then run with existing water rights and operations to meet future demands. This model run is the Baseline data set, against which model runs with various "what-if" scenarios are compared. The what-if scenarios include estimates of the storage yield for the Task 2 reservoir alternatives at their rehabilitated or projected maximum storage capacity. Other scenarios include the integrated operations analyzed in Task 2; e.g., storage of unused water rights; Maria Lake – Bruce Canyon Reservoir exchange, etc. The output from these model analyses represent the yield used to score the alternatives in the screening analysis. The model runs also provide estimates of the extent of Baseline shortages (i.e., unsatisfied demands) that could be met through operation of the various reservoir alternatives.

The yield model represents only the Cucharas River basin, disconnected from the lower Huerfano River and Arkansas River basins. The effect of downstream calls on Cucharas basin operations is not explicitly represented. The yield estimates are therefore provided in the context of in-basin water rights and are appropriate for comparative purposes between the various storage alternatives analyzed. The yield to a junior water right, subject to Arkansas River calls, would be reduced from the yields presented herein. Attaining the yields used to screen the reservoir alternatives would require replacement water available to meet downstream calls. Nonetheless, the model set up and operations are equivalent between all alternative scenarios and model output can be used to quantify the potential benefits of the various storage sites.

The following sections summarize the data input to the model representing river administration, municipal water use, irrigation and other characteristics of the Cucharas River demands, operations, and hydrology. The model calibration, estimated yields output from the model, and potential reductions to Baseline shortages is also presented.

The components of the StateMod model network data set are discussed below to provide the reviewer with a general understanding of the information needed for use in model.
The model network diagram in Figure 1 represents the physical connectivity of model nodes (upstream to downstream order) from the top of the river basin downstream to below Dam No. 5 (aka Cucharas Valley Reservoir).

The model network includes locations (i.e., nodes) where you have, or want to have, information. A list of the model nodes is included in Table 1. The nodes include gages, diversions, reservoirs, and instream flow points/reaches. The reservoir alternatives identified in Task 1 were included in the model network.

Table 1
Cucharas River Basin Yield Model Network Nodes

Gage ID	Gage Name
07114000	Cucharas R @ Boyd Ranch
CRHBLVCO	Cucharas R @ Harrison Bridge
CUCBRCCO	Cucharas River below Dam #5

Reservoir ID	Reservoir Name
1603859	Britton Reservoir
BruceCanRes	Brue Canyon Reservoir
ChaparralRes	Chaparral Reservoir
1603893	Coler Seepage Reservoir
1603712	Cucharas Valley Res
1603720	Daigre Reservoir
1603776	H R Carson Reservoir
1603713	Holita Reservoir
1603717	La Veta Town Reservoir
1603715	Lake Miriam Reservoir
1603716	Lake Oehm Reservoir
16_ASP002	Lower Cuch R Stock Ponds
1603718	Maria Stevens Res
16_ASP001	Middle Cuch R Stock Ponds
1603719	Sharps Orchard Res
1603723	Wahatoya Reservoir
1603724	Walsenburg Reservoir
1603863	White Creek Reservoir

Diversion ID	Diversion Name
1600801	Ezekiel Gribble D
1600822	Forestine D
1600628	Francisco Daigre Mill D
1600577	Gomez D
1600630	Grandote Golf Course
1600578	Guillen D
1600811	Henry Schultze D
1600883	Highland D
1600579	Holita D
1600580	John Brown (Vasquez) D
1600911	John G Cozad D
1600864	Kincaid&Alexander D
1600583	Kincaid D
1600585	La Veta Pl
1600584	Lake Miriam D
1600813	Mauricio Apodaca D
1600604	Mexican D
1600896	North Veta Canon D
1600608	Oso D
1600611	Patterson D
1600796	R B Willis D
1600614	Rocky Flat D
1600616	Romero D
1600797	Smith-Crumley D

Instrm Flow ID	Instream Flow Name
1603000	White Creek Min Flow
1603001	Cucharas Ck Min Flow
1603002	Chaparral Ck Min Flow
1603003	Dodgeton Ck Min Flow
CPW_Cucharas	Cuch blw Wah Ck CPW Flows
CPW_IndianCk	Indian Ck CPW Flows
CPW_SBkrCk	S Baker Ck CPW Flows
CPW_Wahatoya	Wahatoya Ck CPW Flows
CPW3Bridges	Cuch 3 Bridges CPW Flows
CPWBoydRanch	Cuch Boyd Ranch CPW Flows

* "CPW Flows" not decreed - just recommended

Diversion ID	Diversion Name
1600571	Ballejos D
1600828	Barnard&Alexander D
1600572	Beaver Dam D
1600574	Butte D
1600575	Calf Pasture D
1600707	CS&WD Baker Ck Intake
1600825	CS&WD Cuchara Intake
1600827	CS&WD Dodgeton Intk
1600820	Cullom D
1600798	David Hart D
1600776	Denton & McAuliffe D
1600799	Denton D
1600626	Duran D

Diversion ID	Diversion Name
1600986	South Fork Feeder
1600834	South Sandoval D
1600622	Spanish Peaks D
1600847	Trinidad Baca D
1600886	Ute D
1600636	Walsenburg D
1600637	Walsenburg Pl
1600804	Z-Half Circle
16_ADP001	Upper Basin Agg Divn
16_ADP002	Middle Basin Agg Divn
16_ADP003	Middle Ck Agg Divn
16_ADP004	S Abeyta Agg Divn
16_ADP005	Wahatoya Agg Divn
16_ADP006	Bear Ck Agg Divn
16_ADP007	Santa Clara Ck Agg D
16_AMP001_I	Unincorp Inside Use
16_AMP001_O	Unincorp Outside Use
1600579_I	Holita Res Irrigators
1600883_I	Highland D Irrigation
ColerOutlet	Coler Minority Owners
CS&WD_I	Cuchara Inside Use
CS&WD_O	Cuchara Outside Use
LaVeta_I	La Veta Inside Use
LaVeta_O	La Veta Outside Use
Walsnbrg_I	Walsenburg Inside Use
Walsnbrg_O	Walsenburg Outside Use

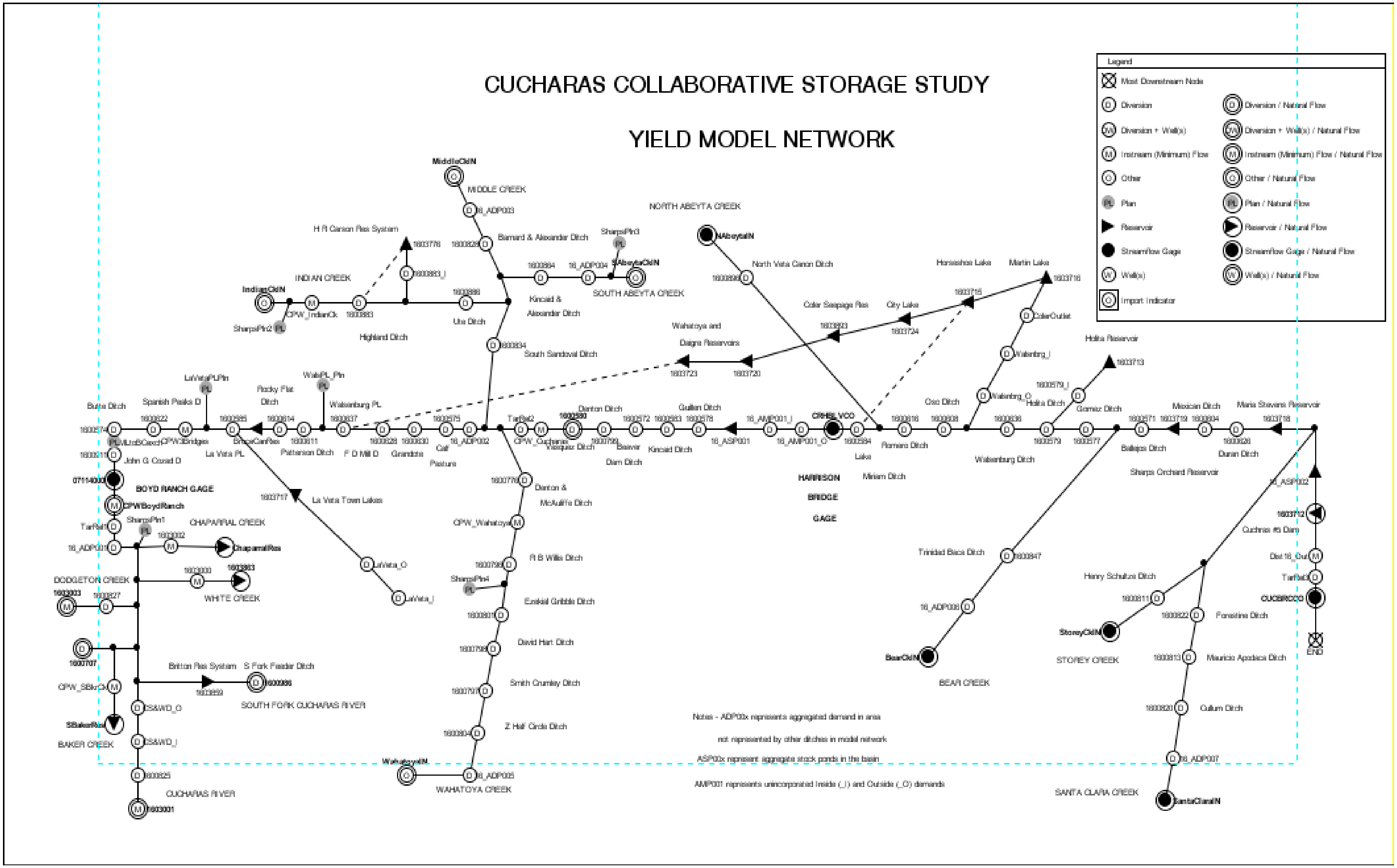


Figure 1
Cucharas River Basin Yield Model Network

Streamflow records represent the physical supply at the stream gage location after river diversions, return flows, and storage operations above the stream gage locations. To represent the legal entitlement to water, the model simulates diversions based on the natural flows (aka baseflows). The baseflows are essentially equal to the gaged streamflows plus consumptive use; therefore, the model needs input of historical streamflows, diversions, return flows, and storage contents. The extents to which instream flows are satisfied are represented in the streamflow record and are not used in calculation of baseflow.

Baseflows at gage locations are calculated using the following formula. Baseflows at stream gage locations are then distributed to ungaged locations, including tributary inflows, as discussed further below.

Baseflow = Gage Flow + Upstream Diversions - Upstream Return Flows + / - Upstream Change in Storage + Upstream Evaporation

The data input to the model and used to calculate historical baseflows include the following:

STREAMFLOWS

- Three stream gages are included on the main stem Cucharas River in the model network. Two of the gages are currently active: the Boyd Ranch gage (USGS ID 07114000) was established in the 1930s and the Harrison Bridge gage (DWR ID CRHBLVCO) records start in October 2000 The gage below Dam No. 5 (DWR ID CUCBRCCO) includes only occasional spot measurements (29 measurements since 1999 provided by the Division of Water Resources – DWR) but it is included in the model network and is necessary to quantify outflows from the river basin in order to maintain mass balance in the model.
- The top of each modeled tributary is represented as an inflow. The model network includes 14 tributary inflow points.

Monthly time series input to the model must be complete over the entire study period. There is no record of monthly outflows from the basin. Efforts were made to calculate basin outflows based on gage and diversion data available on the Huerfano River (Mustang gage, Huerfano Valley Ditch, and gage below this ditch) but these calculations resulted in estimates considered too inconsistent for inclusion in the model. Basin outflows were instead calculated based on a point flow model approach over the period during which the Harrison Bridge gage has been active (2001 - present). This approach resulted in calculated outflows typically higher than the anecdotal information regarding basin outflows provided by the water commissioner. Yet the calculated values were used to ensure the various data input to the model (streamflows, diversions, and storage contents) are consistent. A calculated point flow approach using the Boyd Ranch gage was not used to calculate gage flows for either the Harrison Bridge gage or basin outflow gage prior to 2001. It is typically better to fill missing baseflow data than to first fill missing gage data and then calculate baseflows based on the filled gage data and other filled data (diversions and storage contents).

Various approaches can be used to estimate ungaged tributary basin inflows. The inflows to tributaries are essentially baseflows since there is no upstream consumptive use. Therefore, the tributary inflows were calculated based on a “gain” approach for the baseflows. In this approach, GIS is used to calculate inflow volumes based on tributary drainage areas and average annual precipitation amounts over the drainage areas. The inflow volume is used to estimate the prorata gain from the ungaged tributary in the context of calculated gain or loss at or between gaged locations and their respective area-precip inflow volumes. For example, Wahatoya Creek inflows are calculated based on (Harrison Bridge baseflow minus Boyd Ranch baseflow) times area-precip Wahatoya Creek divided by area-precip at Harrison Bridge. This approach results in tributary inflows having the same distribution over the year (shape) as the gains at the Harrison Bridge gage. This results in a bit of shift in timing between the lower basin tributaries and gains coming into the lower basin from higher elevations. Efforts were made to shift the calculated tributary baseflows back or forth 2 or 4 weeks but these changes did not improve model simulation.

DIVERSIONS

- 45 ditches are modeled explicitly in the model network. The Explicit nodes are the most senior water rights in the basin (generally Read priorities 1 through about 45) and are represented as individual nodes in the model network.
- The more junior, and typically smaller, ditches in the basin are aggregated based on general geographic location and represented as a single node in that geographic area (e.g., Wahatoya Creek, Middle Creek, Cucharas River above Boyd Ranch gage). A total of seven aggregate ditch nodes are included in the model network. This approach supports the representation of one-hundred percent of the consumptive use in the basin while allowing a simplified approach of representation of the smaller users in the basin.
- Municipal demands are represented as individual nodes for the Cucharas Sanitation & Water District, Town of La Veta, City of Walsenburg, and Unincorporated water users.

The official record of Colorado water uses are maintained in the DWR HydroBase database. Available monthly diversion data for all ditches in the river basin were gathered from HydroBase. These records were combined with the infrequent diversion data that might be collected by the water commissioner from water users. Note the smaller and more junior ditches included in the aggregate ditch nodes were combined to represent the aggregated historical diversion record. In order to develop a complete data set of historical diversions for both explicit and aggregate structures, missing data were typically filled via monthly averages, or other information identified specific to ditches.

Some structures required additional analysis. This included separating the storage diversions and irrigation diversions from the single record maintained for the combined Holita Ditch and Walsenburg Ditch diversions. Details regarding these analyses are included in comments input to the commands files that are used in development of StateMod input files.

Diversion records for municipal users were developed based on water use data provided by the municipalities. Diversion data back to 1980, to the extent they were not provided, were calculated using DOLA population data since 1980 and per capita use data calculated based on years for which water use data are available. The historical diversions for the unincorporated population were calculated based on DOLA records and per capita use records estimated as part of the CWCB SWSI planning efforts.

Historical diversions input to the model are summarized in Table 2. Also included for reference are the demands that are used for the Baseline data set in order to estimate the ability of current operations to meet future demands.

Table 2
Irrigation and Municipal Diversions

MUNICIPAL	Historical	Future
Cucharas S&WD	141	196
La Veta	325	408
Walsenburg	1,106	2,212
Unincorporated	228	286
Total	1,800	3,103

Historical values updated after Storage Needs Assessment (Task 1)

IRRIGATION	Historical	Future
Upper Basin	4,549	15,835
Middle Creek	1,123	2,620
Wahatoya Creek	1,215	4,253
Lower Basin	4,997	9,767
Other Tribs	1,097	1,097
Total	12,980	33,573

Average annual values (1980 - 2014)

Physical characteristics are assigned to all ditch nodes to represent system losses and return flow characteristics that are included in the calculation of baseflows and during model simulation. Ditch capacities were set equal to the historical maximum diversion or other value based on discussions with the water commissioner. Absent other information, a default ditch loss factor of 10 percent was used. A default maximum farm efficiency of 60 percent was used based on typical engineering values used to represent flood irrigation practices that are the primary irrigation method in the basin. We met with water commissioner Doug Brgoch to go over maps of irrigated lands and potentially irrigated lands and discuss how the dynamics of irrigation impact streamflows throughout the basin. Return flow locations and percent of return flows to each location input to the model were typically based on the layout of irrigable lands under a ditch and the relative locations of downstream or tributary ditch, gage, or reservoir locations. The timing of return flows is based on the distance of the irrigated parcels to the river. General delay patterns for ditches in the model network are based on relative location of the irrigated lands to the river system; i.e., quicker returns for lands closer to river.

STORAGE CONTENTS

- Twenty reservoirs - 13 existing reservoirs, including the aggregates and 7 potential reservoirs are represented in the model network.
- Similar to the approach outlined for small ditches, the smaller reservoirs, including stock ponds, were aggregated based on general geographic location. Two aggregated stock ponds were included in the model network based on location in the basin; essentially above or below the Cucharas River confluence with Middle Creek. The aggregated nodes represent 540 acre-feet of storage capacity that was developed from a review of the DWR Livestock Water Tank and Erosion Control Dam database. These aggregated structures are assumed to stay full throughout the study period. Therefore, just evaporative losses from the smaller stock ponds are included as historical consumptive use.

Available storage data from HydroBase was pulled from HydroBase. Additional data was pulled from the Division 2 Annual Division Engineer Reports. Dam owners were contacted for any additional records they may have. The City of Walsenburg provided 2008-2013 storage contents data for its various reservoirs and helped the modeling effort through review of the data that were used to represent Walsenburg's historical reservoir operations. Missing data for all reservoirs were filled via linear interpolation for short periods of missing records, generally less than four or five months. Otherwise, the missing data were filled with monthly averages.

Physical characteristics are assigned to all reservoir nodes to represent account capacities and system losses. The latter characteristic was included in the calculation of baseflows. System losses consist of both evaporative loss and seepage. Reservoir evaporation losses were developed for the upper, middle, and lower reaches of the river based on NOAA-NWS 33 gross evaporation amounts and average monthly precipitation from the PRISM database. Annual net evaporation for areas near Cuchara, La Veta, and Walsenburg total approximately 1.8 feet, 2.2 feet, and 2.3 feet, respectively. Seepage losses in aged reservoirs in the basin can be significant. Maximum seepage losses throughout the basin were estimated to total between 1.5 feet and 2 feet per year. Note evaporation and seepage losses are dynamically calculated by the model so these losses have direct impacts on the resultant yield of storage rights and operations.

The capacity of reservoirs input to the model was based on maximum recorded storage contents, storage water rights, or other information provided by dam owners and/or the water commissioner. The default approach was to assign a single account holder to each reservoir. Additional accounts were assigned where additional information was made available (e.g., dead pool / CPW pool at Martin Lake and Horseshoe Lake).

MODEL CALIBRATION

The next step in the modeling effort is to calibrate the model over a representative historical period. Model calibration is an effort to illustrate the Historical data set adequately represents historical conditions. The model is simulated using the calculated baseflows to meet historical demands based on input water rights and operational rules. In the Baseflow mode, the model is essentially run in "backward" mode where the historical water uses are added back into the gage record to calculate the native physical supply. In the Simulate mode, the model is run in the "forward" mode where baseflows are routed down the river and the model tries to meet the historical diversions and historical storage contents based on input water rights, system operations, farm efficiencies, return flow characteristics, et cetera.

Simulated streamflows, diversions, and storage contents are then compared to historical records. Various input (e.g., efficiencies, return flow locations and amounts, system operations, etc.) are modified to improve the closeness of fit between the historical and simulated values.

WATER RIGHTS

The input water rights represent the legal entitlement to water for ditches, reservoirs, and instream flow reaches and locations. The rights input to the model are those decreed to the various model nodes. The StateMod program reads the various input water rights, including the operational rights discussed below, and orders the rights from senior to junior to simulate the use of physical supply (baseflows) via the prior appropriation doctrine.

SYSTEM OPERATIONS

The StateMod program picks the monthly demand for the most senior water right in the basin and diverts the minimum of the physical supply and legal supply to meet the demand. The model then picks the next senior right and corresponding demand and then the next senior right and demand, and so on until all input rights are simulated. These operations are automated for structures that are located on the river. Diverting water to off-channel demands or to release water from reservoirs require user-input operating rules.

Generic rules are available for use in the StateMod model, including carrier diversion to storage or demand, reservoir release to instream flow, and reservoir release to ditches and other reservoirs, either directly or by exchange. Operating rules are assigned priorities by the user so the model can simulate the operations in the context of other input water right priorities for direct flow, storage, and instream flow uses. Priorities assigned to carrier diversions to storage rules are typically set equal to the priority of the storage right. Priorities assigned to reservoir release rules are typically assigned just junior to either the most junior storage right for the reservoir or most junior primary right (direct flow or instream flow) associated with the destination node. This is appropriate since reservoir releases are generally supplemental water supplies used to satisfy the destination demand.

A sample of the rules input to the Yield Model include: 1901 priority storage right to La Veta Lakes though La Veta Pipeline; 1864 priority of Read 3 water right to City of Walsenburg demand and its various reservoirs via the Walsenburg Pipeline; and HR Carson Reservoir release to Highland Ditch demand just junior to H R Carson Reservoir No. 1941 priority storage right.

The StateMod model follows a strict application of the prior appropriation doctrine and the operating rules are simulated consistently between years and therefore do not necessarily represent variations in operations between wet, dry, and average years. The model includes fixed rules operated in a certain order throughout the study period that are representative of operations that occur the majority of the time. This is appropriate for a basinwide model used for planning purposes.

Calibration of basin hydrology is difficult with a deterministic model run on a monthly basis where the dynamics of a river system include tributaries with no record of gaged flows, that provide water to the main stem Cucharas River only during thunderstorms (e.g., Santa Clara Creek), or that dry up for portions of the year for varying lengths of time (e.g., Wahatoya Creek). Model calibration is typically conducted over a subset of the longer model study period (1980 - 2014). This approach is complicated by the fact the Harrison Bridge gage has only been active over an extended drought period and does not have the variability of hydrologic record seen with the Boyd Ranch gage. A complete input data set (i.e., no missing data) was developed over the longer study period for the Yield Model. The data set does represent hydrologic variability over time and space in the model; therefore a calibration period of 1980-2014 was chosen for the model analysis.

The calibration of the model is considered good. Simulated streamflows at the two gages with records during that period (Boyd Ranch 1980-2014 and Harrison Bridge 2001-2014) track reasonably well (see Figures 2 and 3). During very dry periods, the calibration of basin hydrology is considered fair. Simulated deliveries to meet demands are representative of historical supply, as evidenced in shortages to irrigation and municipal demands of less than four percent, on average (see Table 3). Simulated storage contents are good (see Figures 4 and 5). Storage contents simulated in Walsenburg's reservoirs are considered fair due to the complexity of simulation of operations among the five reservoirs (see Figure 6). Note the red line in Figure 2 through Figure 6 represent simulated values; blue lines represent historical values. The blue line is graphed on top of the red line; therefore, instances where only the blue line is visible is indicative of a very close fit of simulated and historical values.

Table 3
Model Calibration Simulated Shortages
(acre-feet per year)

MUNICIPAL

Cucharas S&WD	0.7 (15.1)	
La Veta	0	
Walsenburg	0	
Unincorporated	0.2	
Total	1	< 0.1% of demand

IRRIGATION

Upper Basin	149	
Middle Creek	66	
Wahatoya Creek	207	
Lower Basin	117	
Other Tribs	0	
Total	540	4% of demand

Average annual values (1980 - 2014)
Maximum annual values in ()

Figure 2 - Cucharas River at Boyd Ranch
Gaged and Simulated Flows

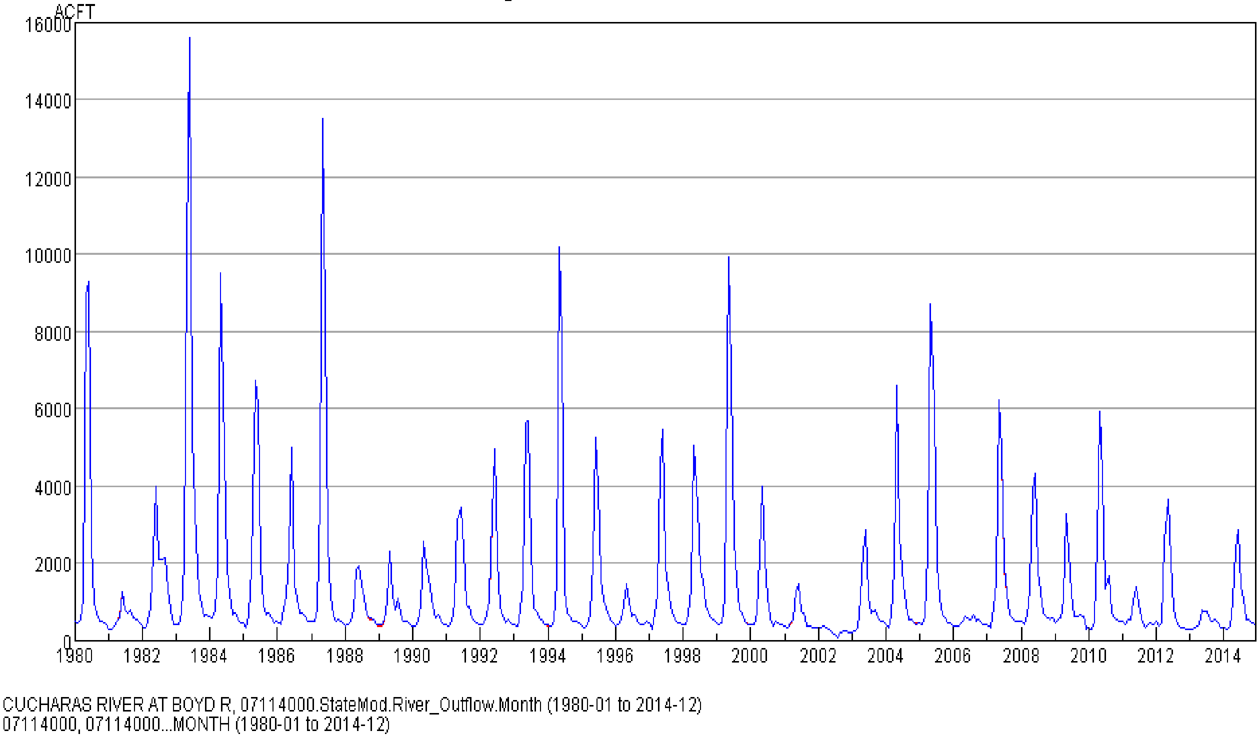
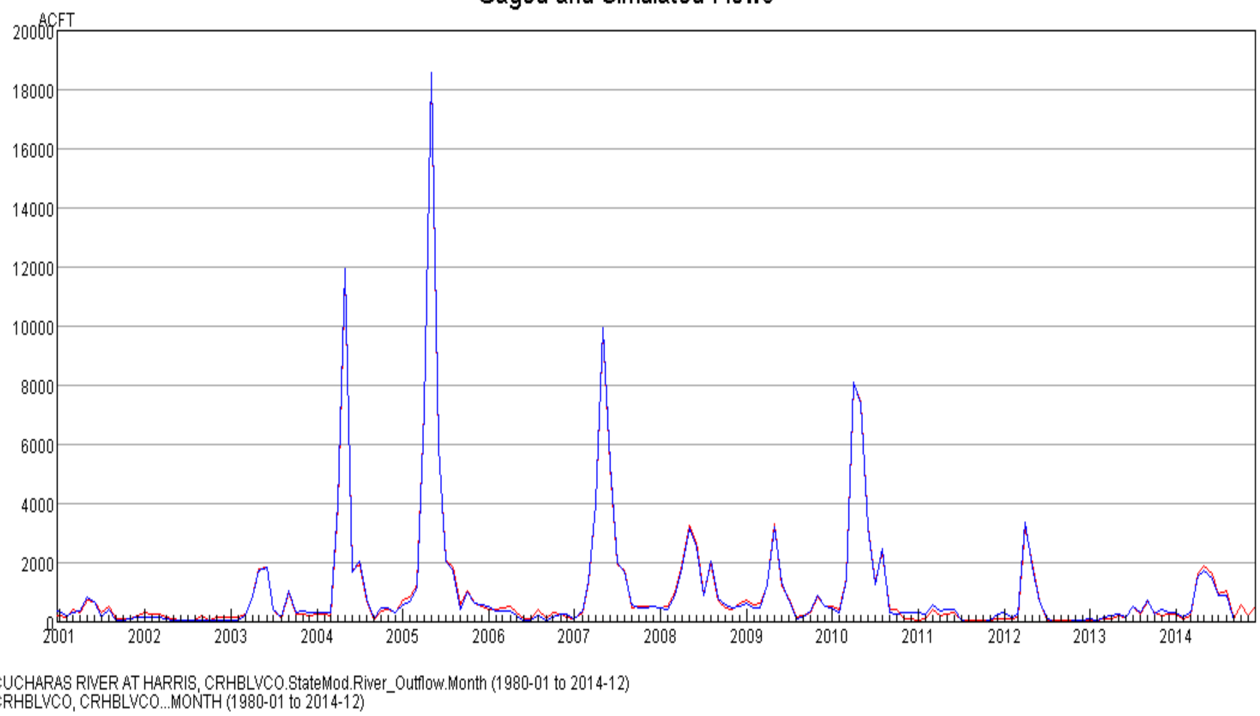


Figure 3 - Cucharas River at Harrison Bridge
Gaged and Simulated Flows



USGS Gage CUCBRCCO - CUCHARAS RIVER BELOW DAM NO. 5
Gaged and Simulated Flows

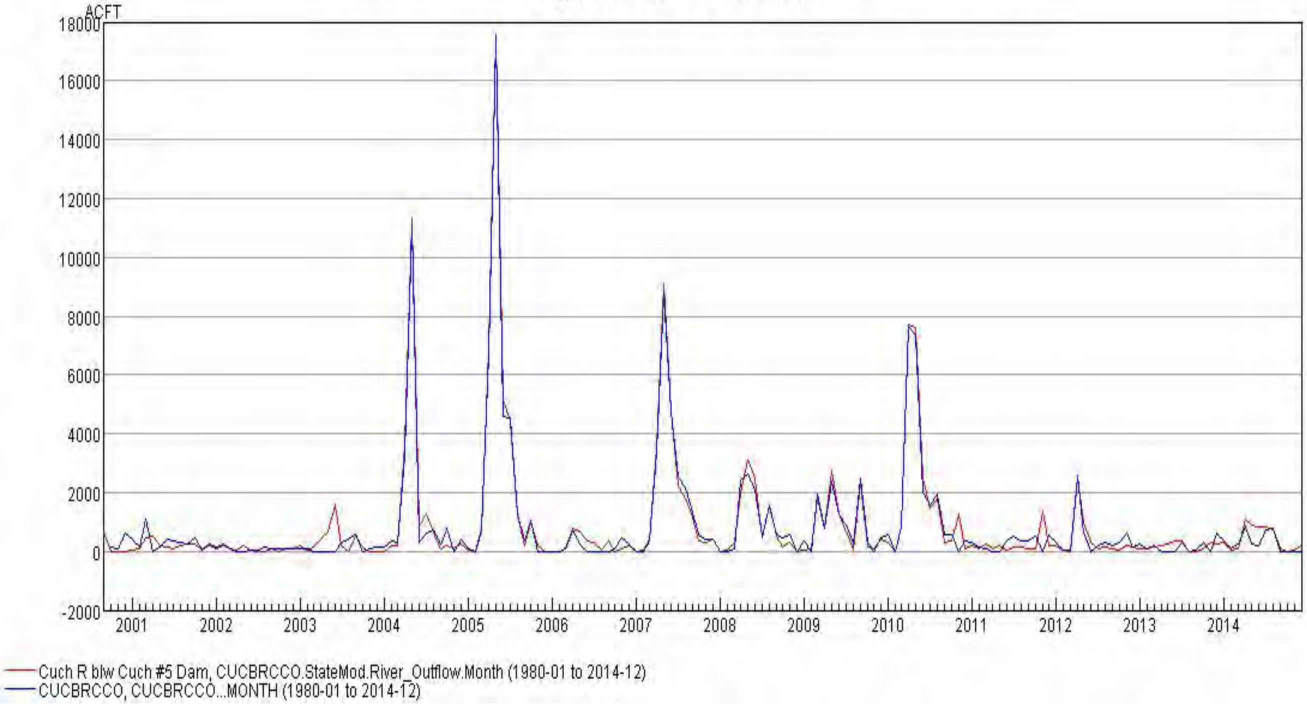
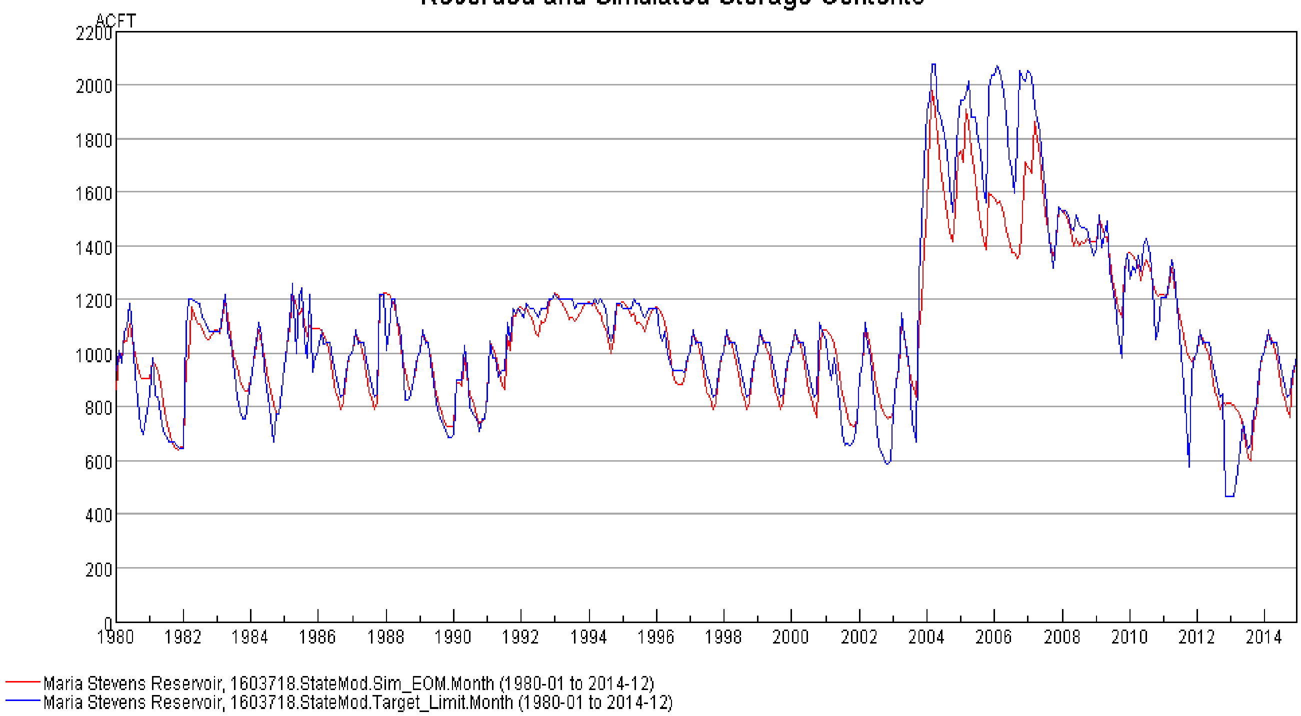
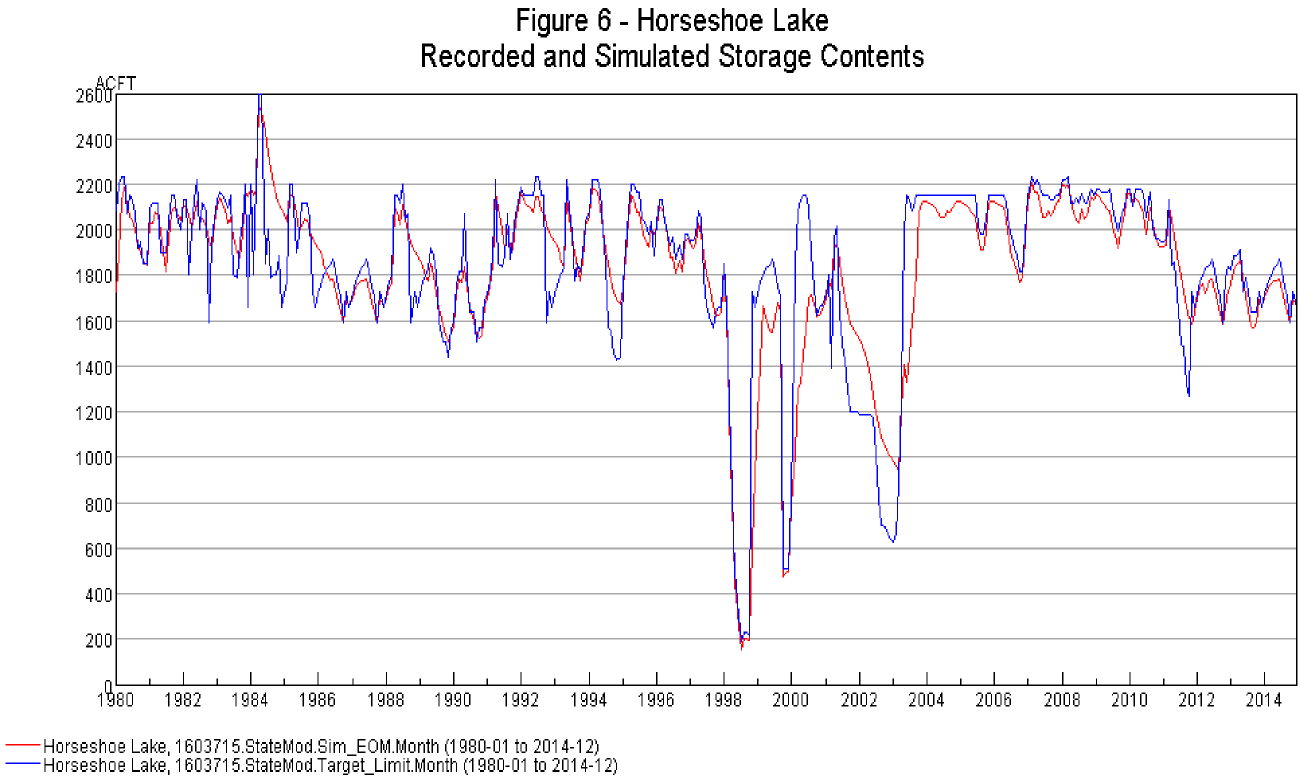


Figure 5 - Maria Stevens Reservoir
Recorded and Simulated Storage Contents





BASELINE DATA SET

Subsequent to the historical calibration, the model is run using current infrastructure and operations to meet future demands based on the historical hydrology. The future demands listed in Table 2 represent planning numbers used by the three municipal providers, population growth anticipated in Huerfano County, and crop demands not limited by water supply. The future demands are used in the Baseline data set to estimate the sufficiency of existing supply and operations to meet growth projections or maximum demand. Model output from the Baseline data set can also be used to investigate the flow available for exchange from any of the model nodes (reservoirs and diversions) to any upstream model nodes.

The Baseline model results illustrate the need, defined by the Baseline shortages, to meet future demands that could be addressed in a change in operations, new infrastructure, et cetera. The simulated shortages to future irrigation and municipal demands are summarized in Table 4.

Table 4
Future (Baseline) Shortages

MUNICIPAL

Cucharas S&WD	1.9 (50.5)	
La Veta	0	
Walsenburg	116 (1,119)	
Unincorporated	0	
Total	118	4% of demand

IRRIGATION

Upper Basin	7,691	
Middle Creek	1,116	
Wahatoya Creek	2,679	
Lower Basin	3,313	
Other Tribs	0	
Total	14,799	44% of demand

Average annual values (1980 - 2014)

Maximum annual values in ()

TASK 2 RESERVOIR ALTERNATIVE YIELDS

Storage yield, the ability to store water in priority, is one of the more important screening criterion in ranking reservoir alternatives. The Baseline data set was simulated to quantify water availability to water rights, existing and conditional, that were not operated historically. These model simulations are used to estimate the yield of the Task 2 reservoir alternatives. Note calls are placed on the Arkansas River below the Cucharas River and Huerfano River close to one hundred percent of the time and these calls are not explicitly represented in the model. Therefore, the ability to attain the estimated yields is contingent on the use of downstream replacement sources to satisfy the Arkansas River call. The yields presented below are, though, indicative of water that can be stored against the full operation of the generally senior in-basin water rights. The model input to estimate the yields are consistent between the various model simulations and the estimated yields are estimate for use in comparisons between the various reservoir alternatives.

The yield available to the reservoir alternatives is completed in two steps. First, the model is run with one reservoir alternative at a time, assuming the reservoir starts each water year empty. The model results represent the raw yield to a certain water right at a certain location to fill the reservoir. The model is then run to estimate the amount of Baseline shortages that could be met with the particular reservoir alternative. The second scenario counts carry over against the following year's storage right(s) and is used to estimate the beneficial use associated with the alternative based on the model representation of basin operations in the future. Note the yields and beneficial use for reservoirs with existing adjudicated rights that have not been fully exercised (e.g., Maria Stevens Reservoir) does not limit the use of that right. For example, storage rights for irrigation use are simulated to meet municipal demands. These operations would include a change in use in water court, which is addressed in the score assigned to these alternatives in the Screening Analysis.

RAW YIELD

The raw yields of the reservoirs over the 1980 - 2014 period are summarized in Table 5.

Table 5
Reservoir Alternatives Yield

Enlargement of Existing Storage	Raw Yield [1] Avg (Dry))
Britton Ponds Enlargement (42 AF small dam)	42 (6)
Britton Ponds Enlargement (239 AF large dam)	139 (6)
La Veta Lakes Enlargement	102 (53)
HR Carson #1/#2 combined storage	103 (16)
Daigre Reservoir enlargement	---
City Lake (unrestricted)	---
City Lake (enlargement)	---
Holita Reservoir Rehabilitation	234 (178)
Maria Stevens Rehab/Enlargement	1,206 (715) [2]
Horseshoe/Martin Joint Use Pool	---

[1] Yield of junior storage rights will require replacement supply to satisfy Arkansas River calls

[2] Includes yield from 1,000 acre-feet lease account

New Storage Projects	Raw Yield [1] Avg (Dry)
South Baker Creek Reservoir	54 (0)
Chaparral Creek Reservoir	163 (0)
Bruce Canyon Reservoir	677 (0)
Coler Seepage Reservoir	108 (108)
White Creek Reservoir (7,000 AF)	270 (0)
White Creek Reservoir (500 AF)	171 (0)

Integrated Operations	Raw Yield [1] Avg (Dry)
Maria Lake - Bruce Canyon Exchange	---
Change of Use of Unused Senior Rights	658 (534) [3]
Change Diversion to Coler Inlet Ditch	---

[3] Based on legal availability of storage rights at respective original points of adjudication

The highest yields are typically estimated at the larger reservoirs. Location is equally important for reservoirs that benefit from higher streamflows available on the Cucharas River main stem, in particular, a) below the Gap and above the municipal pipelines, and b) below Harrison Bridge and above major rights in the lower basin. Note raw yield values are not listed for various alternatives that include the City of Walsenburg's reservoirs. Delivery and use of Walsenburg's water rights is included in the model with multiple reservoirs operating together. It is difficult to parse out the yield to a City Lake enlargement, for example, from the use of the direct and storage rights in City Lake and the transfer of various water rights between reservoirs to keep the lower storage units full. The amount of deliveries simulated from the enlarged storage capacity is easy to quantify (see Table 6). A similar issue occurs with the integrated operations between Maria Lake and Bruce Canyon Reservoir since the yield of the storage rights is combined by the storage of releases from the lower reservoir, by exchange.

BENEFICIAL USE

Operating rules were included to release water from new and enlarged storage capacity to meet the Baseline shortages for all model nodes. The StateMod program operates the rules in sequence, which requires a specific order for the rules. A standard approach was used where the reservoir first released water to meet municipal demands, starting with the municipal provider located closest to the reservoir. The potential for reuse of the effluent from these deliveries was not represented since the amount of municipal shortage that could be satisfied with these releases is relatively minor and not expected to affect the modeled yield markedly.

Releases to the various irrigation demands were included starting with the ditches highest in the basin, including structures located on tributaries, and then moving downstream to the lower basin. This approach allows ditches with shortages lower in the basin to benefit from the return flows associated with storage releases to ditches located higher in the basin. Keep in mind that all storage release rules are assigned priorities junior to the water rights and other supplies used to meet demands. Therefore, even though an operating rule is included in the model, it will not trigger to release water from storage unless the destination demand is not satisfied with its existing water rights.

The beneficial use simulated with the reservoirs over the 1980 - 2014 study period is summarized in Table 6. The storage to use ratio included in the table provides a comparison of how much use one might get from an acre-foot of constructed storage. For example, a ratio of 2 would indicate that 2 acre-feet of raw yield would need to be stored for 1 acre-feet of use to meet local demands. Although a lower ratio would indicate a higher return on investment, the actual benefit is more complicated since the cost per acre-foot of storage varies between alternatives.

Table 6
Reservoir Alternatives Beneficial Use

Enlargement of Existing Storage	Use (Delivery)	Storage : Use Ratio
Britton Ponds Enlargement (42 AF small dam)	22*	1.9
Britton Ponds Enlargement (239 AF large dam)	110*	2.2
La Veta Lakes Enlargement	102	1.0
HR Carson #1/#2 combined storage	80	1.4
Daigre Reservoir enlargement	30	3.3
City Lake (unrestricted)	76	1.8
City Lake (enlargement)	97	2.7
Holita Reservoir Rehabilitation	129	2.6
Maria Stevens Rehab/Enlargement	271	2.4
Horseshoe/Martin Joint Use Pool	---	---

New Storage Projects	Use (Delivery)	Storage : Use Ratio
South Baker Creek Reservoir	54	2.9
Chaparral Creek Reservoir	155	1.8
Bruce Canyon Reservoir	622	2.3
Coler Seepage Reservoir	80	2.5
White Creek Reservoir (7,000 AF)	233	30.0
White Creek Reservoir (500 AF)	151	3.3

Integrated Operations	Use (Delivery)	Storage : Use Ratio
Maria Lake - Bruce Canyon Exchange	809	2.9
Change of Use of Unused Senior Rights	300	2.2
Change Diversion to Coler Inlet Ditch	36	---

EXCHANGE POTENTIAL

The yield analysis described above focuses on reservoirs operating individually. Throughout the Storage Study, the Collaborative stakeholders have discussed alternatives that include multiple sites with coordinated operations. A combination scenario is prudent in a basin that had limited physical supply and has points on the river that dry up most every year.

The exchange potential represents how much water can be moved upstream. The model output was analyzed to determine low flows throughout the basin that would limit the exchange of water. Average monthly exchange potential within the lower basin (Middle Creek down to Maria Stevens Reservoir) and within the upper basin (Cucharas River headwaters down to Middle Creek) is summarized in Table 7. The simulated exchange potential follows what is seen on the ground: the maximum exchange occurs during the spring runoff; more water is typically able to be moved between ditch headgates in the lower basin; and the exchange potential reduces as one moves up the main stem above Middle Creek through the reach where the municipal pipelines are located; and the exchange is further limited as you move through the Gap toward Cuchara and as you try to move water up any of the water-short tributaries in the upper basin. Opportunities for exchange do exist and the variability over the season and between the years (not explicitly represented in Table 7) illustrate the advantage of having access to the operation of multiple exchanges between various diversion and release locations).

PREFERRED ALTERNATIVES

Review of the exchange potential, in concert with the scores from the Screening Analysis and Stakeholder discussion, the Collaborative identified the following five preferred reservoir sites for which drawings and cost estimates would be developed.

- Britton Reservoir
- South Baker Creek Reservoir
- Bruce Canyon Reservoir
- La Veta Lakes
- Maria Stevens Reservoir

COOPERATIVE STORAGE OPERATIONS

The preferred reservoir alternatives were analyzed in four scenarios with groups of three sites each - one each from the lower, middle, and upper basin. Three additional scenarios were analyzed with just two reservoir sites to estimate how a smaller set of storage alternatives might address shortages in the basin. The following sets of reservoirs were simulated in the seven separate scenarios:

- Maria Stevens Reservoir - La Veta Lakes - Britton Reservoir
- Maria Stevens Reservoir - La Veta Lakes - South Baker Creek Reservoir
- Maria Stevens Reservoir - Bruce Canyon Reservoir - Britton Reservoir
- Maria Stevens Reservoir - Bruce Canyon Reservoir - South Baker Creek Reservoir

- Bruce Canyon Reservoir - South Baker Creek Reservoir
- Maria Stevens Reservoir - La Veta South Lake
- Maria Stevens Reservoir - South Baker Creek Reservoir

Each scenario was run to facilitate storage of water in the two or three reservoirs, by priority, to release water to meet Baseline shortages at the three municipalities and irrigation demands throughout the basin. In order to maximize the yield of the system, exchanges were also simulated from the lower basin reservoir to the upper basin reservoir, the lower basin reservoir to the middle basin reservoir, and the middle basin reservoir to the upper basin reservoir.

Table 7

CUCHARAS COLLABORATIVE YIELD MODEL

MONTHLY EXCHANGE POTENTIAL SUMMARY (average cfs)

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
EXCHANGE FROM LOWER BASIN (BELOW MARIA STEVENS RESERVOIR)												
0.3	2.7	5.7	31.3	50.1	12.4	1.4	1.5	0.8	2.1	0.2	0.8	DURAN DITCH
0.3	2.7	5.6	31	49.3	11.2	0.1	0.3	0	1.7	0.2	0.8	MEXICAN DITCH
0.3	2	4.9	30.4	49.3	11.2	0.1	0.3	0	0.7	0	0.5	HARRISON BRIDGE
0.3	1.3	3.6	23.3	43	11.2	0.1	0.3	0	0.7	0	0.5	BELOW WAHATOYA CK
0.2	0.3	0.9	3.7	4	0.4	0.1	0	0	0.1	0	0.1	BOTTOM OF WAHATOYA CK
0.2	0.3	0.9	3.6	3.9	0.3	0	0	0	0	0	0.1	TOP OF WAHATOYA CK
0.3	0.8	2	10.2	11.8	2.1	0.1	0.3	0	0.3	0	0.1	BOTTOM OF MIDDLE CK
0.1	0.2	0.5	2.6	3.3	0.7	0.1	0.2	0	0.1	0	0.1	BOTTOM OF INDIAN CK
0.1	0.2	0.5	2.6	3.3	0.7	0.1	0.2	0	0.1	0	0.1	TOP OF INDIAN CK
0.2	0.4	1	4.7	5.5	0.9	0.1	0.2	0	0.1	0	0.1	TOP OF MIDDLE CK
0.2	0.2	0.5	2.7	3	0.4	0.1	0.1	0	0.1	0	0.1	BOTTOM OF S ABEYTA CK
0.2	0.2	0.5	2.6	3	0.4	0.1	0.1	0	0.1	0	0.1	TOP OF S ABEYTA CK
EXCHANGE FROM MIDDLE BASIN (ABOVE MIDDLE CREEK)												
0.4	0.5	1.2	10.9	31.1	16.9	2.1	0.5	0.5	0.8	0.8	0.6	WALSENBURG PIPELINE
0.4	0.5	1.2	10.9	31.1	16.9	2.1	0.5	0.5	0.8	0.8	0.6	SPANISH PEAKS DITCH
0.4	0.5	1.2	10.9	31.1	16.9	2.1	0.5	0.5	0.8	0.8	0.6	BOYD RANCH
0.2	0.3	0.6	2.1	5.7	4.6	1.1	0.4	0.3	0.4	0.2	0.3	CHAPARRAL CK RES
0	0.1	0.7	4.9	5.7	1	0.4	0.1	0	0.1	0.1	0.2	WHITE CK RES
0.2	0.2	0.5	1.8	4.8	3.8	0.9	0.3	0.3	0.4	0.2	0.3	DODGETON INTAKE
0.1	0.2	0.4	1.8	5.1	3.9	0.8	0.3	0.2	0.3	0.2	0.2	BAKER CK INTAKE
0.1	0.1	0.2	0.9	2.3	1.8	0.5	0.2	0.2	0.2	0.1	0.1	S BAKER CK RES
0	0	0.1	0.4	1.1	0.9	0.3	0.1	0.1	0.1	0.1	0.1	BRITTON RESERVOIR
0.3	0.4	0.9	4	11.2	9.2	1.6	0.5	0.5	0.6	0.4	0.4	CUCHARAS INTAKE

The model output indicates the net benefit of multiple reservoirs from a beneficial use perspective is not significantly different compared to operating the reservoirs individually. In fact, the values in Table 8 show that use of the reservoirs operated independently is typically greater than when operated as a group. This is due primarily because the use of the reservoirs operated independently double counts some releases to meet shortages (i.e., two or three reservoirs operated independently can supply the same irrigation shortage but the shortage can only be supplied once when the reservoirs are operated together). Therefore, the combined independent yield is overstated.

Table 8
Cooperative Reservoir Beneficial Use

Enlargement of Existing Storage	Cumulative Volume	Use (Combined)	Storage : Use Ratio	Use (Sum Solo)
Maria Stevens - La Veta Lakes - Britton	786	362	2.2	380
Maria Stevens - La Veta Lakes - South Baker Creek	866	406	2.1	430
Maria Stevens - Bruce Canyon - Britton	2,090	861	2.4	898
Maria Stevens - Bruce Canyon - South Baker Creek	2,170	892	2.4	947
Bruce Canyon - South Baker Creek	1,528	666	2.3	676
Maria Stevens - La Veta South Lake	744	359	2.1	376
Maria Stevens - South Baker Creek	764	308	2.5	325

Note one concept that was investigated was the use of a lower basin reservoir as a replacement water source to calls on the Arkansas River mainstem. This scenario, though, is not expected to provide much benefit. If a call on the Arkansas River limits Killian and Atwood diversions, junior storage rights would be out of priority. There may be periods during which a call has been placed on the Arkansas River and there is exchange potential in portions of the Cucharas River. The model representation of the basin and cooperative operation of multiple preferred reservoirs already provides for exchange operations and those model runs do not show any significant advantage from a yield and use perspective. Therefore, as the model is currently set up, there is not anticipated to be much additional yield with releasing water to the Arkansas River and being able to store more water into new or enlarged storage capacity.

Additional benefits may be evidenced via storage via the upstream storage statute (e.g., Maria Lakes priority stored at upstream location) or changes of use and storage of existing operating rights or other possible operations. These alternatives were not analyzed as part of this study but could be looked at once the Collaborative identifies a final reservoir / set of reservoirs on which design and construction will be pursued. In addition, estimates of yield could be refined by representing the call on the Arkansas River mainstem to estimate its effect on storage yield for both existing and future Cucharas River operations. Rather than incorporating a fixed set of rules into the Yield Model, the impact of Arkansas River administration on yield and operations would best be addressed by analyzing the variability over the year and between years. Development of a StateMod model of the entire Arkansas River basin will start this spring and the work conducted as part of that ArkDSS effort would provide for the analysis of integrated Cucharas River - Huerfano River - Arkansas River administration.

Task 2 App B Design Report

Cucharas Storage Collaborative Study
Task 2 - Appendix B
Water Division 2, Water District 16

Design Report

Huerfano County, Colorado

June 2017

AG File No. 16-106

***Prepared for*:**

Huerfano County

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INTRODUCTION

Feasibility engineering was completed for five preferred alternatives, including the primary project components and sizes needed. Feasibility level cost estimates, including high level estimates for design, construction, permitting, operations and maintenance, land acquisition, and energy costs were developed.

The following two sites were considered as Tier I sites, and roughly 30 percent design was completed for these sites. Applegate Group does not consider the designs completed for these Tier I sites as full 30 percent design, primarily because of the lack of site-specific geotechnical and geologic data available for the sites. We recommend completing site-specific field investigations, and then revising the designs included in this report based on the site specific geotechnical and geologic data.

1. South Baker Creek Reservoir – construction of a new 122 ac-ft capacity reservoir located between the old Baker Creek Ski Area and the current Town of Cuchara.
2. Maria Stevens Reservoir – enlargement of the existing north and south dams for Maria Stevens Reservoir, located approximately 6 miles northeast of the City of Walsenburg. The enlargement would result in 642 ac-ft of additional storage capacity. It was also assumed that the Cucharas Collaborative would lease an additional 1,000 ac-ft of the existing storage space.

The following three sites were considered Tier II sites, and feasibility level design and cost estimates were completed for these sites.

1. Britton Reservoir – construction of a new 42 ac-ft capacity reservoir located approximately 1.5 miles southeast of the Town of Cuchara. The new dam would be located approximately 500 feet downstream of the most northern existing Britton Pond.
2. La Veta Lakes – enlargement of storage at the existing La Veta Lakes, by raising the north lake dam and combining the two lakes. La Veta Lakes are located approximately 2,000 feet east of the Grandote Golf Course in the Town of La Veta. The enlargement would result in 102 ac-ft of additional storage capacity.
3. Bruce Canyon Reservoir – construction of a new 1,406 ac-ft reservoir located approximately two miles southwest of the Town of La Veta.

METHODS

Dam alignments were determined based on topographic conditions, property ownership, and maximization of storage volume at each of the sites. Two-foot interval topographic contours were developed for each site, based on 5 meter resolution Digital Elevation Model (DEM) obtained from NextMap (2016). NextMap 5 meter DEM data was purchased for coverage of the selected reservoir sites. The DEM data was clipped to isolate selected sites and create more manageable files. Two-foot elevation contours were generated from the DEM data. These 2-foot contours were then used to create Triangulated Irregular Networks (TINs) to estimate stage-storage at the proposed reservoir sites. In the process of creating the TINs, elevation data was converted from meters to feet. Stage-area-capacity data were developed for various dam heights utilizing the 'Polygon Volume' tool in ArcGIS.

Dam size was determined for each of the five alignments based on Rule 4.2.5 from Rules and Regulations for Dam Safety and Dam Construction (Colorado DNR, 2007), as reproduced in Illustration 1 below.

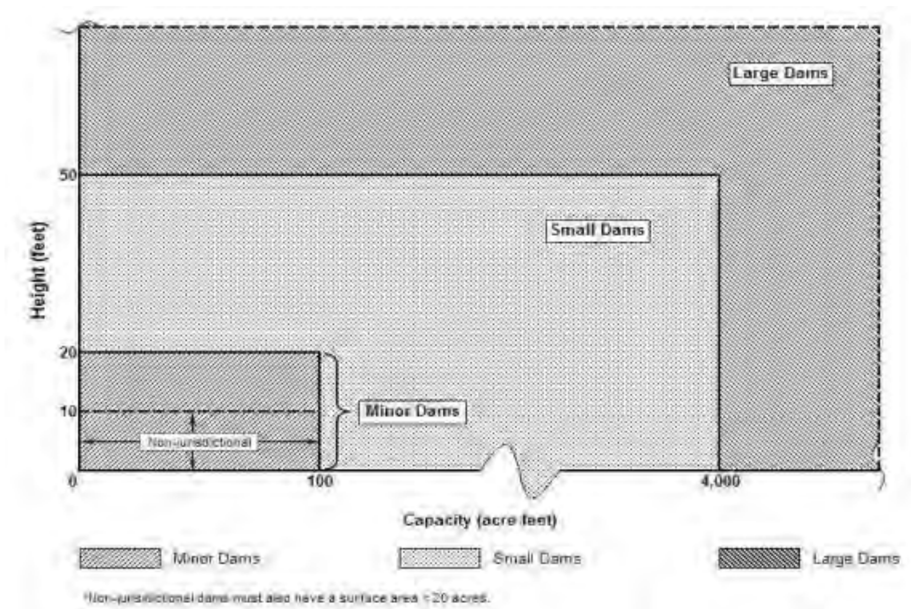


ILLUSTRATION 1. DAM SIZE DETERMINATION (FROM COLORADO DNR, 2007)

Hazard classification for each of the dam sites was based on Rule 4.2.14 from the Rules and Regulations for Dam Safety and Dam Construction (Colorado DNR, 2007) (Illustration 2). A detailed hazard classification analysis was not completed as part of this scope of work, but will be required for final permitting with the Dam Safety Branch of the Colorado Division of Water Resources. In lieu of a detailed hazard classification analysis, the potential for property damage and loss of human life was qualitatively assessed. The qualitative hazard classification was completed based on the area downstream of the proposed dam (e.g., location of part-time and full-time inhabited structures in relation to the likely flow path in the event of a dam breach).

4.2.14.1 **"High Hazard Dam"** is a dam for which loss of human life is expected to result from failure of the dam. Designated recreational sites located downstream within the bounds of possible inundation should also be evaluated for potential loss of human life.

4.2.14.2 **"Significant Hazard Dam"** is a dam for which significant damage is expected to occur, but no loss of human life is expected from failure of the dam. Significant damage is defined as damage to structures where people generally live, work, or recreate, or public or private facilities. Significant damage is determined to be damage sufficient to render structures or facilities uninhabitable or inoperable.

4.2.14.3 **"Low Hazard Dam"** is a dam for which loss of human life is not expected, and significant damage to structures and public facilities as defined for a "Significant Hazard" dam is not expected to result from failure of the dam.

4.2.14.4 **"No Public Hazard (NPH) Dam"** is a dam for which no loss of human life is expected, and which damage only to the dam owner's property will result from failure of the dam.

ILLUSTRATION 2. HAZARD CLASSIFICATION GUIDELINES FROM COLORADO DNR (2007)

Emergency spillway design for each of the sites was based on peak flow data obtained from Colorado Streamstats (2017), and the inflow design flood (IDF) requirements stated in Rule 5.9 in the Rules and Regulations for Dam Safety and Dam Construction (Colorado DNR, 2007). The IDF design flow requirements from Rule 5.9 are provided for reference in Table 1. For IDFs based on the probable maximum precipitation (PMP) event, the PMP was estimated as two times the 500-year peak flow as calculated using Colorado Streamstats. Emergency spillways were assumed to include the following components:

1. Broad-crested weir at the spillway crest elevation, sized to provide a minimum of 1-foot of residual freeboard during the IDF event. It was conservatively assumed that the full IDF rate would pass over the spillway crest. In reality, the flow over the spillway crest would be a lower flow due to attenuating storage in the reservoirs.
2. Riprap rundown channel downstream of the spillway crest, sized for maximum flow velocity of 10 feet per second (i.e., the maximum flow rate permissible for 12-inch median diameter riprap that would not result in scouring of the rundown channel). The longitudinal slope of the spillway rundown channel was targeted to be no steeper than 10H:1V, and the channel width was varied to achieve the maximum flow velocity of 10 feet per second.

TABLE 1. INFLOW DESIGN FLOOD REQUIREMENTS[1]

	Hazard Classification			
Dam Size	High	Significant	Low	NPH
Large	0.90 PMP	0.68 PMP	100 YR	50 YR
Small	0.90 PMP	0.45 PMP	100 YR	25 YR
Minor	0.45 PMP	100 YR	50 YR	25 YR

[1] Based on Table 5.2 from Rule 5.9 (Colorado DNR, 2007) – IDF using Hydrometeorological Reports

The low-level outlet for each of the reservoirs was designed with the following design criteria. Hydraulics were analyzed for each of the outlet pipes, considering both orifice and full pipe flow conditions.

1. Outlet flow rate was based on the requirement to lower the reservoir water level 5 feet in 5 days for emergency drawdown conditions.
2. Outlet alignment selected based on the need to discharge releases directly to the downstream water body, with the most feasible return flow path to the Cucharas River.
3. Minimum 12-inch diameter for the outlet pipe, based on the requirement to be able to inspect and maintain the outlet pipe in the future.

DESIGN DATA

Elevation-area-capacity (EAC) tables and curves were developed for each of the project sites using the 2-foot topographic contours described above. EAC data are provided in Appendix A. Minimum pool elevations assumed for the five reservoirs are summarized in TABLE 2.

TABLE 2. MINIMUM POOL CHARACTERISTICS

Reservoir	Minimum Pool			
	Elevation (ft)	Height (ft)	Surface Area (ac)	Capacity (ac-ft)
Bruce Canyon	7368	41	14.1	189
South Baker	8894	38	2.0	29.4
Britton	9248	20	0.6	5.0
Maria Stevens	5913	11.5[1]	170	1,101
La Veta Lakes	Assumed same as existing operations			

[1] Gage height

Dam size was determined based on Rule 4.2 from Rules and Regulations for Dam Safety and Dam Construction (Colorado DNR, 2007), and as a function of dam height and storage capacity (Table 3).

TABLE 3. DAM SIZE

Reservoir	Height (ft)	Capacity (ac-ft)			Jurisdictional Size
		Total	Dead Pool	Jurisdictional[1]	
Bruce Canyon	77	1406	189	1217	Large
South Baker	66	122	29	93	Large
Britton	48	42	5	37	Small
Maria Stevens Enlargement	22.5	2743	1101	1642	Small
La Veta Lakes	10	415	27	388	Small

[1] Jurisdictional capacity calculated as volume of water at the high-water line, excluding storage below the low-level outlet, consistent with Rule 4.2 from Rules and Regulations for Dam Safety and Dam Construction (Colorado DNR, 2007)

Hazard classification was estimated for each dam location (Table 4) based on the proximity of inhabited structures downstream of the proposed dams. Hazard classification analyses and reports were not completed for this study. Detailed analyses will need to be completed, and reports submitted to the Dam Safety Branch for review and approval prior to progressing further with design. In lieu of formal hazard classification reports, hazard classification was estimated based on potential damage from a theoretical dam breach for structures where people generally live, work, or recreate, or public or private facilities. The potential for loss of life was also qualitatively assessed. Qualitative hazard classification is summarized in Table 4.

TABLE 4. HAZARD CLASSIFICATION FOR DAM SITES

Reservoir	Downstream Area	Downstream Critical Structure		Hazard Classification
		Description	Distance to Structure	
Bruce Canyon	Agricultural	Hwy 12 Town of La Veta	0.28 mi 2.2 mi	Significant
South Baker	Municipal	Hwy 12 Town of Cuchara	0.4 mi 0.5 mi	High
Britton	Municipal	Town of Cuchara	0.3 mi	High
Maria Stevens	Agricultural	Hwy 10	50 ft	Significant
La Veta Lakes	Municipal	Town of La Veta	0.4 mi	Low

Peak flow data for each of the five project sites is summarized in Table 5. Streamstats summary reports for each of the reservoir sites are provided in Appendix B. Inflow design floods (IDF) were based on the recurrence interval flood event required by Dam Safety's Rules and Regulations for Dam Safety and Dam Construction (Table 1). The resulting IDF used in the design of emergency spillways is provided in Table 6.

TABLE 5. PEAK FLOOD DATA FOR DAM SITES

Reservoir	Area (mi^2)	Peak Flood Event (cfs)								
		2 year	5 year	10 year	25 year	50 year	100 year	200 year	500 year	PMF [1]
Bruce Canyon	0.55	9.52	26.3	43.5	72.2	99	132	171	231	462
South Baker	2.14	7.83	15.9	23.3	34.6	44.8	62.5	73.5	108	216
Britton	0.97	3.69	7.72	11.4	17.1	22.5	31.7	37.5	55.7	111.4
Maria Stevens	0.63	24.5	76.6	134	233	328	448	591	823	1646
La Veta Lakes	0.12	2.65	7.48	12.4	20.8	28.6	38.6	49.9	67.9	135.8

[1] PMF estimated as two times the 500 year peak flood event from Colorado Streamstats.

TABLE 6. RESERVOIR INFLOW DESIGN FLOODS

Reservoir	Jurisdictional Size	Hazard Classification	Regulatory IDF	IDF Rate (cfs)
Bruce Canyon	Large	Significant	0.68 x PMP	314
South Baker	Large	High	0.90 x PMP	194
Britton	Small	High	0.90 x PMP	100
Maria Stevens	Small	Significant	0.45 x PMP	741
La Veta Lakes	Small	Low	100-Year	38.6

The State of Colorado and New Mexico are currently revising the rainfall hydrology used for inflow design floods and should have new information in the next year or so. This data would be adopted as the new standard of care to be used in dam design for Colorado. Streamstats is a good first cut at looking at the feasibility level.

DESIGN

Design was completed for Maria Stevens Reservoir enlargement and South Baker Creek Dam construction. The design is roughly being considered 30 percent level design, but should be considered feasibility level design because of the lack of site-specific geotechnical data. The objective of the 30 percent design is to provide the Cucharas Storage Collaborative with the information that would be required for submittal of an application for a loan and/or grant for final design and construction. The "30 percent level design" includes the following:

1. Elevation – Area – Capacity curves were developed for the site topography (Appendix A).
2. Drawings: cover sheet consistent with Dam Safety requirements, site plan, dam plan, outlet profile, and typical spillway section.
3. Cost estimate with 20 percent contingency and 10 percent for unlisted items.

Feasibility level design was then completed for the Bruce Canyon, Britton Ponds, and La Veta Lakes enlargement projects. The feasibility level design includes limited drawings (i.e., the same as for the 30 percent design sites, but without the Dam Safety cover sheet or outlet profile). Cost estimates are provided for the feasibility level design, and include a 20 percent contingency and 10 percent for unlisted items.

Feasibility level design drawings are provided in Appendix C.

GEOTECHNICAL ANALYSIS

Site-specific geotechnical or geologic analyses have not been completed for any of the project sites at this time. The following data were collected for each of the project sites in lieu of site-specific drilling program and lab analyses:

- Soil survey maps (NRCS 2017) (Appendix D)
- Percent clay for borrow material (NRCS 2017) (Appendix E)
- Depth to bedrock based on local well permits (CO DWR 2017) (Appendix F)
- Bedrock geology based on a Huerfano County Water Conservancy District map for bedrock geology (Zorich-Erker Engineering 1978)

The resulting soils and geotechnical data (Table 7) indicate the following key points for the reservoir sites:

1. Soil types are generally favorable for borrow material for earthen dams. Surface soils have a relatively high percentage of clay material, and would require minimal processing to achieve the 20 percent minimum that should be specified for the low permeability core. Local well permits indicate depth to bedrock of greater than 10 feet for all the sites except for La Veta Lakes.
2. Depth to bedrock should be verified with site-specific data. Tying a dam foundation into bedrock is desirable to minimize the potential for differential settlement, potential embankment fracturing and seepage losses. Tying the dam foundation into bedrock will have the greatest economic impact on the feasibility of constructing a dam. Underlying geology will dictate the level of excavation, and foundation treatment that is necessary to build a reliable, safe structure.

3. The underlying bedrock at the South Baker and Britton Pond dam sites is a conglomerate with high potential for differential settlement and seepage. Design approaches would be needed at these sites to mitigate the potential risks of settling in particular (e.g., locating the outlet works tower near a dam abutment where the rock outcrops to provide a more solid foundation, and using higher strength material for the outlet pipe to minimize the potential for seepage path development along the outlet pipe as a result of differential settling).

TABLE 7. SOILS AND GEOTECHNICAL SUMMARY FOR PROJECT SITES

Reservoir	Depth to Bedrock (feet)[1]	Bedrock Description[2]	Primary Soil Type[3]		
			Description	USCS Classification	% Clay
Bruce Canyon	12	Cuchara sandstone/shale (low permeability)	Sandy loam, Clay loam	SC, SW, ML, CL	27
South Baker	40	Sangre de Cristo Conglomerate (high potential for settling and seepage)	Sandy loam	CL, CL-ML	18
Britton	>40	Sangre de Cristo Conglomerate (high potential for settling and seepage)	Clay loam,	CL, CL-ML	23
Maria Stevens	16	Niobrara limestone (moderate permeability)	Silty clay, silt loam	CH, CL	19
La Veta Lakes	3	Cuchara sandstone/shale (low permeability)	Sandy loam, silty loam	SC, ML	20

1 Depth to bedrock based on local well permits (CO DWR 2017)

2 Bedrock description based on Huerfano County Water Conservancy District map for bedrock geology (Zorich-Erker Engineering 1978)

3 Primary soil type based on web soil survey (NRCS 2017)

South Baker Creek Dam is the only large, high hazard dam that was considered for 30 percent design. As a result, a preliminary slope stability sensitivity analysis was completed for the dam. Slope stability analyses are typically completed using site-specific geotechnical data, which has not been collected at this time. In lieu of site-specific geotechnical data, the typical values were estimated based on previous studies and references (Lindeburg 2008, RJH Consultants 2015).

TABLE 8. ESTIMATED GEOTECHNICAL DATA FOR SOUTH BAKER CREEK DAM

Material		Unit Weight (lb/ft^3)	Cohesion (lb/ft^2)	Phi (deg)
Zone	Description			
Shell	Clayey Sand	126.5	100-230	33
Core	Sandy Clay	130.0	300	20
Bedrock	Conglomerate	127.0	0-300	19-22

The results of the stability analysis indicated that the stability for South Baker Creek dam would be most sensitive to the bedrock strength parameters (cohesion and phi angle), and also the unit weight of the clayey sand shell material. Colorado Dam Safety Rules and Regulations require a minimum factor of safety for 1.5 for the steady state loading condition. The resulting factors of safety (FOS) shown in Table 9 indicate that site-specific geotechnical data is critical in determining an acceptable FOS for South Baker Creek Dam. It is recommended that consolidated-undrained triaxial shear test with pore pressure measurement be completed on multiple samples of each of the three relevant soil types shown in Table 9. This geotechnical testing should be completed prior to finalizing 30 percent design for the South Baker Creek Dam.

TABLE 9. STEADY-STATE STABILITY ANALYSIS RESULTS FOR SOUTH BAKER CREEK DAM

Run #	Material		Unit Weight (lb/ft^3)	Cohesion (lb/ft^2)	Phi (deg)	FOS
	Zone	Description				
1	Shell	Clayey Sand	126.5	100	33	1.14
	Core	Sandy Clay	130.0	300	20	
	Bedrock	Conglomerate	127.0	0	19	
2	Shell	Clayey Sand	126.5	100	33	1.36
	Core	Sandy Clay	130.0	300	20	
	Bedrock	Conglomerate	127.0	300	19	
3	Shell	Clayey Sand	126.5	100	33	1.50
	Core	Sandy Clay	130.0	300	20	
	Bedrock	Conglomerate	127.0	300	22	

EMBANKMENT DESIGN

Zoned earthfill embankments were assumed for the South Baker Creek, Britton, and Bruce Canyon Reservoirs. The low permeability core zone, with a minimum of 20 percent clay material, would be constructed from onsite borrow materials with minimal processing to reach the required clay content. The shell material would also be constructed from onsite borrow materials, but processing would not be required. Based on the size of these three dams, it was also assumed that chimney and blanket filters would be constructed to address seepage and stability issues.

Homogeneous earthfill embankments were assumed for the enlargement projects at La Veta Lakes and Maria Stevens Reservoir. This assumption is consistent with the existing embankment construction for these two locations. The clay core, chimney drain, and blanket drain were not assumed for these two dam enlargement projects because of the relatively small dam size.

OUTLET WORKS DESIGN

The outlet works were analyzed for consistency with Colorado Dam Safety's requirement for the ability to draw down the reservoir five feet in five days in the event of a dam safety emergency. Stage-discharge curves were determined for each of the dam sites, and drawdown calculations were then completed to verify the ability to meet the five feet in five days requirement. Stage-discharge curves were calculated as the minimum of orifice-driven flow through the inlet to the low level outlet, and full pipe flow through the low level outlet. Stage-discharge curves and stage-storage curves were then used to calculate the drawdown that would occur in five days (Table 10).

Each of the outlet pipes was assumed to be reinforced concrete-encased to ensure proper consolidation around the outlet pipes, provide structural stability, and to mitigate potential seepage along the outlet pipes. The type of outlet pipe that was assumed for each of the five sites was dependent on the underlying geotechnical conditions for each of the sites. PVC pipe was generally assumed to be an acceptable type of outlet pipe. Steel outlet pipe was assumed for sites with questionable bedrock conditions (e.g., depth to bedrock greater than 10 feet, or low strength bedrock).

TABLE 10. OUTLET WORKS AND DRAWDOWN CALCULATIONS

Reservoir	Outlet				Time to 5' Drawdown (hours)
	Diameter (in)	Type	Length (ft)	Hazen Williams Coefficient	
Bruce Canyon	24	PVC	136	150	35
South Baker	24	Steel	547	100	7
Britton	24	Steel	299	100	3

Reservoir	Outlet				Time to 5' Drawdown (hours)
	Diameter (in)	Type	Length (ft)	Hazen Williams Coefficient	
Maria Stevens	30	PVC	448	150	102
La Veta Lakes	18	PVC	220	150	85

SPILLWAY DESIGN

The emergency spillway for each of the five sites was designed based on the Inflow Design Flood (IDF) as described above, the topographic conditions at the sites, a maximum design velocity for the IDF of 10 feet per second (for compatibility with 18 to 24-inch median diameter riprap scour protection), and a minimum of 1-foot of freeboard above the IDF flow depth. Principal spillways were designed to be independent of the emergency spillways, with various configurations (Table 11).

TABLE 11. PRINCIPAL SPILLWAY CONFIGURATIONS

Reservoir	Principal Spillway Configuration
Bruce Canyon	PVC Standpipe Riser that drains to Concrete Encases PVC Outlet Pipe
South Baker	Inclined Reinforced Concrete Box Culvert on Upstream Face of Dam that Drains to Concrete Encased Steel Outlet Pipe
Britton	Inclined Reinforced Concrete Box Culvert on Upstream Face of Dam that Drains to Concrete Encased Steel Outlet Pipe
Maria Stevens	Concrete Outlet Tower to Concrete Encased PVC Outlet Pipe
La Veta Lakes	Concrete Outlet Tower to Concrete Encased PVC Outlet Pipe

Refinement of this approach in future design phases will determine final configurations. Slope stability in the spillway area could be impacted by having frequent flows over the spillway. A concrete emergency spillway channel is not recommended from the standpoint of maintenance and the potential for movement and subsequent failure during emergency operations. A riprap channel can move over time and still remain functional without impairing dam safety.

The emergency spillway characteristics are summarized in Table 12.

TABLE 12. SPILLWAY DESIGN CHARACTERISTICS

Reservoir	IDF Rate (cfs)	Spillway Slope (%)	Design Bottom Width (ft)	Minimum Depth (ft)	Velocity (ft/s)
Bruce Canyon	314	9.69%	40	1.784	9.458
South Baker	194	11.37%	30	1.665	9.138
Britton	100	9.15%	20	1.606	7.581
Maria Stevens	741	4.62%	80	2.085	8.2
La Veta Lakes	38.6	3.60%	10	1.668	4.8

PERMITTING

Permitting requirements will vary somewhat between the five preferred alternatives, but each alternative project generally will require some level of permits. Potential permitting requirements are summarized in Table 13.

TABLE 13 POTENTIAL PERMITTING REQUIREMENTS

Permit/Agency	Approximate Cost	Approximate Timeframe
CWA 404 (Individual Permit for on-stream Dams)	$100,000	2 years
CWA 404 (Nationwide Permit)	$6,000	3 months
NEPA (for Projects with Federal funding or permits)	$50,000 to $10,000,000	1 to 10 years
Dam Safety	$30,000	6 months
CDPHE 401 Certification (for projects requiring CWA 404 Individual Permit)	$20,000	6 months
Endangered Species Act Section 7 or 10	$25,000 to $100,000	1 year
County "1041" Land Use Permit	$10,000 to $30,000	1 year
County Floodplain Development Permit	$50,000	1 year

The Dam Safety Branch of the State Engineer's Office (SEO) will require a permit for enlargement of an existing dam, or construction of a new dam. Application requirements will include a hydrology report, geotechnical report, design report, instrumentation plan, and construction plans and specifications. The permit fee would be $6 application fee for each $1,000 or fraction thereof of the estimated cost of a proposed project, with a minimum total application fee of $100 and maximum fee of $30,000. The SEO may require six months for review and approval after submittal of the permit application. Engineering design for the SEO permit application plans and specifications could take another six months.

An environmental review was completed using the U.S. Fish and Wildlife Service website for Information for Planning and Consultation (IPaC) (FWS 2017). Resource lists are provided in Appendix G. Endangered Species Act, Section 7 consultation will be required with the U.S. Fish and Wildlife Service for any sites with threatened or endangered species that have habitat within the general project area.

Other FWS permits that may be needed are related to wetlands and migratory birds. Mitigation for impacts to riverine wetlands identified on the Service's Trust Resources List would be required. Mitigation could include in-kind replacement via wetland creation close to the impacted wetlands, or purchase of wetland credits through a wetland bank. Environmental review results are summarized in Table 14.

TABLE 14 ENVRIONMENTAL REVIEW RESULTS (BASED ON FWS 2017)

<table>
<tr><th>Site</th><th>Threatened Species</th><th>Endangered Species</th><th>Critical Habitats</th><th>Wildlife refuges</th><th>No. of migratory birds</th><th>Bald or Golden Eagle?</th><th>Wetlands</th></tr>
<tr><td rowspan="4">South Baker</td><td>Mexican Spotted Owl</td><td rowspan="4">None</td><td rowspan="4">None</td><td rowspan="4">None</td><td rowspan="4">28</td><td rowspan="4">Yes</td><td rowspan="4">None</td></tr>
<tr><td>Greenback Cutthroat Trout</td></tr>
<tr><td>Canada Lynx</td></tr>
<tr><td>North American Wolverine</td></tr>
<tr><td rowspan="4">Maria Stevens</td><td>Mexican Spotted Owl</td><td rowspan="4">None</td><td rowspan="4">None</td><td rowspan="4">None</td><td rowspan="4">26</td><td rowspan="4">Yes</td><td>Fresh water emergent wetland: PEMC</td></tr>
<tr><td>Greenback Cutthroat Trout</td><td>Freshwater Forested/Shrub Wetland: PSSC</td></tr>
<tr><td>Canada Lynx</td><td>Lake: L1UBHx, L2USK</td></tr>
<tr><td>North American Wolverine</td><td>Riverine: R4SBA</td></tr>
<tr><td rowspan="4">Bruce Canyon</td><td>Mexican Spotted Owl</td><td rowspan="4">None</td><td rowspan="4">None</td><td rowspan="4">None</td><td rowspan="4">25</td><td rowspan="4">Yes</td><td rowspan="4">Fresh water emergent wetland: PEMC</td></tr>
<tr><td>Greenback Cutthroat Trout</td></tr>
<tr><td>Canada Lynx</td></tr>
<tr><td>North American Wolverine</td></tr>
<tr><td rowspan="4">Britton</td><td>Mexican Spotted Owl</td><td rowspan="4">None</td><td rowspan="4">None</td><td rowspan="4">None</td><td rowspan="4">28</td><td rowspan="4">Yes</td><td rowspan="4">None</td></tr>
<tr><td>Greenback Cutthroat Trout</td></tr>
<tr><td>Canada Lynx</td></tr>
<tr><td>North American Wolverine</td></tr>
<tr><td rowspan="4">La Veta Lakes</td><td>Mexican Spotted Owl</td><td rowspan="4">None</td><td rowspan="4">None</td><td rowspan="4">None</td><td rowspan="4">25</td><td rowspan="4">Yes</td><td rowspan="2">Freshwater Pond:PUBF</td></tr>
<tr><td>Greenback Cutthroat Trout</td></tr>
<tr><td>Canada Lynx</td><td rowspan="2">Lake: L2UBH</td></tr>
<tr><td>North American Wolverine</td></tr>
</table>

Huerfano County Resolution 13-35 for Land Use Regulations, Section 7.00 for Areas and Activities of State Interest, include guidelines and regulations for matters of State interest to apply to activities and areas in unincorporated areas of the County ("1041 Regulations"). Huerfano County 1041 Regulations include the following requirements (among others): water development and use projects should emphasize the most efficient use of water, beauty of the landscape should be protected, and efficient and economical uses of public resources should be promoted. A 1041 permit application would need to be prepared, including description of effects on floodplains, wetlands, and riparian areas; and a public hearing would be required. A nonrefundable fee of $300 is required for all applicants for a 1041 permit application.

Huerfano County Resolution 13-35 for Land Use Regulations, Section 4.00, Flood Damage Prevention Regulations, require a permit to develop within the regulatory floodplain. Application for a floodplain development permit would be required for construction of new on-channel dams, and require submittal of construction plans and how the natural drainage will be altered by the proposed project. Enlargement of existing dams would not likely require a floodplain development permit. The floodplain development permit would likely require hydraulic modeling of the creek/river for on-channel dams, and determination of effects to the regulatory floodway. The regulatory floodplain may need to be revised for final approval of the floodplain development permit.

The U.S. Army Corps of Engineers will require a Clean Water Act Section 404 permit to authorize fill within a jurisdictional water of the U.S. A Nationwide Permit may be possible (e.g., NWP 3 for maintenance of an existing structure) for enlargement of existing dams. An Individual Permit will likely be needed for construction of a new on-channel dam. The Corps 404 permit would also need to address mitigation techniques for any wetlands that would be inundated by the reservoir enlargement or construction. Wetlands would need to be formally delineated in a report to the Corps, and the jurisdictional status of any potentially affected wetlands would need to be determined by the Corps.

A NEPA process would be triggered if an Individual 404 Permit is required from the Corps. An Environmental Assessment would meet NEPA requirements for projects with minimal anticipated environmental impacts, and a full blown Environmental Impact Statement may be required if environmental impacts are determined to be significant. The time and costs associated with the NEPA process are unclear, but may be significant depending on public input.

A cultural resources survey would need to be completed to determine whether there are items of historic significance near the proposed projects. This survey generally consists of an initial file search with the Colorado Office of Archaeology and Historic Preservation. Following the file search, a field survey may also be required to identify cultural and historic artifacts that could be impacted by the project. Indian Trust assets would also need to be identified, if there is the potential for impacts from dam enlargement or construction.

The National Parks Service offers a National Register of Historic Places. Within Huerfano County there are eight sites denoted as Historic Places. Of the eight, four are located along the main streets of either La Veta or Walsenburg (Francisco Plaza, Huerfano County Courthouse and Jail, Huerfano County High School and Lamme Hospital). The remaining four are located along highways, far from any of the sites (La Veta Pass Narrow Gauge Railroad Depot, Maitland Arroyo Bridge, Montoya Ranch and Veta Pass). None of the sites are located within the five project site areas.

COST ESTIMATES

Opinions of probable cost were developed for completion of the five project dams. These opinions are based on the preliminary drawings dated May 2017. The opinion of probable cost for each reservoir is provided in Appendix H.

The estimated costs reflect the best available construction cost data at the time of the report preparation and are in no way binding or indicative of actual construction costs, which will be bid by the selected contractor.

This description reflects a conceptual level cost estimate, but with appropriate adjustments it can be applied to all construction cost estimates up to and including a bid schedule based final "Engineer's Estimate." At this level of evaluation, cost estimates would meet Class 4 standards of the American Association of Cost Estimators (AACE). The United States Society of Dams (USSD) has guidelines for cost estimating that provide useful information for levels of accuracy, contingencies, etc. Our estimates follow the standards set by this document (USSD 2012).

The following costs reflect a conceptual level of project definition. The construction cost summaries provided herein are based on the major component line items (significant by number of units, unit cost, and/or importance to the project) of construction, the approximately measured quantity of materials for each item, and unit prices based on published bid price data for similar work (CDOT 2017; UDFCD 2017), manufacturers' budgetary price quotes, and contractor bids for similar jobs reviewed by Applegate Group over the past five years. The sub-total of the major component line items was used as the basis for a construction cost estimate. Since a conceptual cost estimate is based on major component line items of construction, an allowance must be made for the remaining minor component line items. This allowance reflects those items which are individually too small to be listed as major component line items, but when considered together, constitutes a significant enough cost to be included. Unlisted items can include such things as access development/restoration, disposal site identification/development, disposal site fees, woody debris collection and disposal, etc. On this project a 10% (typically 0 to 10%) allowance (on the sub-total of the major component line items plus mobilization/demobilization) is made for unlisted items. A conceptual cost estimate must also include an allowance for unknowns, known as contingency. Contingency can include an allowance for incomplete identification of line items associated with the low level of project component refinement, modest changes in project scope, refinement of material quantities, unknown site conditions, and uncertainty in unit prices. On this project a 20% (typically 0 to 25%) allowance (on the sub-total of the major component line items plus mobilization/demobilization) is made for contingency. As the project becomes better defined, the list of construction line items becomes more complete, and fewer unknowns exist, resulting in a reduction in both the unlisted items allowance and contingency allowance.

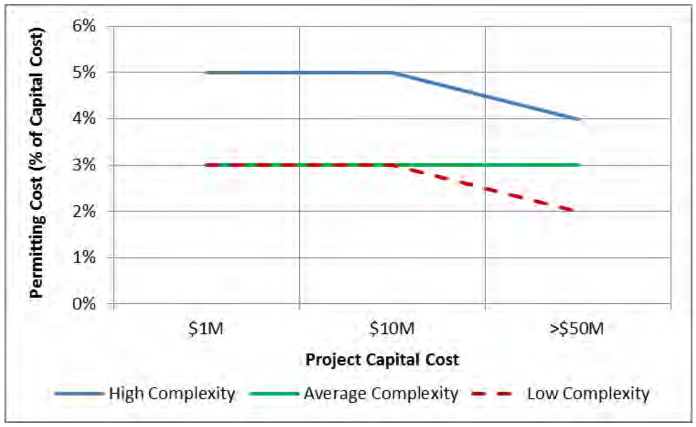
Permitting costs can be one of the most uncertain factors in the overall cost for water projects. A general rule of thumb for estimating permitting costs for a water storage project is about 5 percent of the capital construction costs, but the actual percentage can vary depending on the potential environmental impacts of the project and the required mitigation. Permitting costs were estimated based on project complexity and project size. Permitting cost estimating indices are summarized in Illustration 3, with the complexity of the project being impacted by the following factors:

- Whether a federal nexus is required for the project, which then triggers additional permitting requirements (e.g., NEPA, BLM review, USFS Special Use Permitting, and wildlife mitigation plans)
- The potential assertion of 1041 permitting authority by the county of the project location
- Effects on jurisdictional waters of the United States, and the related federal permitting trigger including consultation with other cooperating agencies (e.g., U.S. Fish and Wildlife Service for Endangered Species Act compliance)
- Crossing of major highways, requiring permitting from the entity with jurisdiction over the road
- For reservoir projects, Dam Safety permitting will be required by the State Engineer's Office
- Effects on river flows and potential impacts on CWCB instream flows

- Whether mitigation of environmental effects is required for permit approvals

High complexity would generally involve both a Federal nexus and a new on-channel dam. Average complexity might involve the local jurisdiction exerting 1041 authority for an off-channel dam. Each project is going to have a unique set of permits and involvement of regulatory agencies.

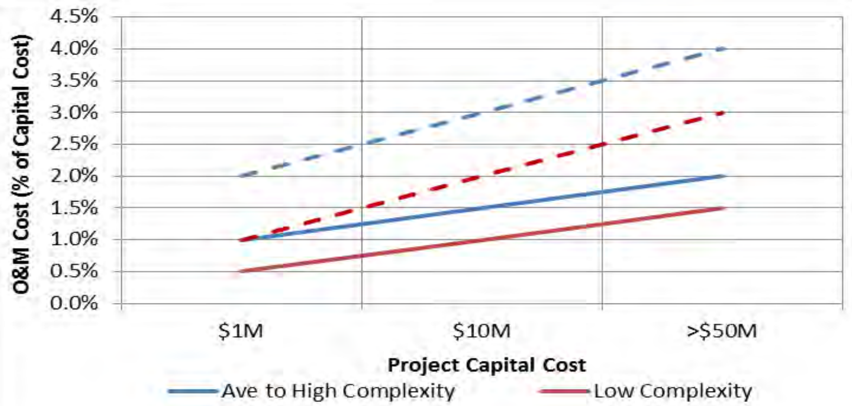
ILLUSTRATION 3. PERMITTING COSTS



O&M costs for deferred maintenance were estimated for the La Veta Lakes and Maria Stevens Reservoir enlargement projects. Specific dam safety related issues (e.g., embankment seepage and spillway capacity) were included in our construction drawings and associated cost estimates for these two enlargement projects. Deferred maintenance costs for Britton ponds were not included in our costs and drawings for the following reasons: 1) the new Britton Reservoir dam would be located downstream of the existing Britton ponds, 2) no modifications are planned to the existing Britton ponds dams, and 3) there were no dam safety related issues identified during our summer 2016 site inspections for the existing Britton pond dams. O&M costs for future operations and maintenance were estimated based on project complexity, project size, and the level of pumping involved with an alternative. O&M cost indices are summarized in Illustration 4, with the complexity of the project being impacted by the following factors:

- Level of O&M to be completed by the Collaborative (lower O&M cost) vs. a contractor (higher O&M cost)
- Accessibility to the project site, and the frequency of required site visits
- Need for instrumentation and monitoring
- The level of operator training required
- Public access to the project site, including recreation or other activities that could increase O&M requirements
- Progressive age of infrastructure (older projects may cost more to maintain)
- The level of mechanization in infrastructure (moving equipment tends to require more regularly scheduled maintenance)
- Infrastructure on Federal lands may have more costly O&M requirements or require using Federal staff for some work

ILLUSTRATION 4. O&M COSTS



Solid Line = no Significant Pumping; Dashed Line = Significant Pumping

Land acquisition costs were assumed to be $5,000 per acre, based on our experience with reservoir construction projects in similar semi-rural Arkansas River Basin lands.

NEXT STEPS

The Cucharas Collaborative will be reviewing the feasibility level design and costs estimates to determine which project(s) they choose to move forward to design. The following next steps should be taken once the final projects are determined for design:

1. Submit applications for grant and loan money to fund the design and construction of the dam(s).
2. Meet with relevant property owners and facility operators to get their input on access, operations, and permitting.
3. Complete a geotechnical investigation including:
    a. Drill multiple borings and collect split spoon samples of surficial soils to be submitted for laboratory analyses. Test pits for borrow evaluation and soils mapping should be completed as well. Analyses should include sieve analysis to determine gradation of the surficial soils, liquid limit and plasticity index to determine clay content, dispersivity testing, proctor compaction test to determine optimal moisture content and dry density, and standard penetrometer tests to determine density.
    b. Complete borings into bedrock along the dam axis to map depth to bedrock and the bedrock properties. This will help to determine whether the dam can be keyed into bedrock, and if a grout cutoff wall will be needed for mitigating seepage. Packer testing would be performed to determine the level of fracturing and the best cutoff to control seepage.
    c. Verify the type and strength of the underlying bedrock material, to aid in dam foundation design. Evaluate potential settlement of the foundation and embankment during construction and long term operation.

   d. Complete consolidated-undrained triaxial shear tests with pore pressure measurement on borrow material and bedrock. The results of these tests will be used to refine the stability analysis results, and also to refine the feasibility design for the dam and foundation.

4. Initiate a discussion with the U.S. Army Corps of Engineers regarding the CWA Section 404 permitting requirements. An initial understanding of project conditions and the Corps' permitting approach will help the Collaborative understand the time and costs associated with this permit.
5. Meet with the Colorado Dam Safety Branch to get their input on initial 30 percent design. It will be important to review Dam Safety files for existing embankments in the area, and get their specific design input at an early stage in the process.

Once all of the above next steps have been completed, the Cucharas Collaborative should initiate the 30 percent design process with a professional engineer.

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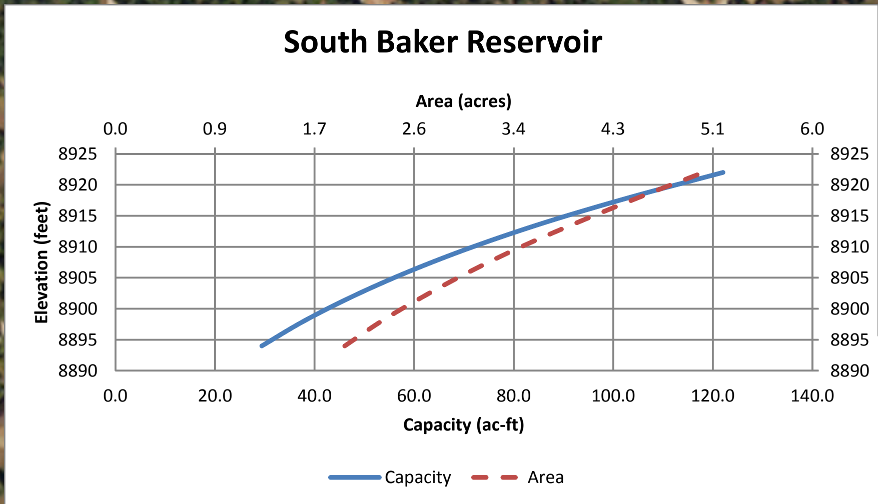

Height	Elevation	Area (ac)	Capacity (ac-ft)
38	8894	2.0	29.4
42	8898	2.3	37.8
46	8902	2.6	47.6
50	8906	3.0	58.9
54	8910	3.5	71.8
58	8914	4.0	86.6
62	8918	4.5	103.4
66	8922	5.0	122.0

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Cucharas Storage Study

South Baker Creek

Date: 13 April 2017

Job #: 16-106

Drawn By: KAB

Figure: **1A**

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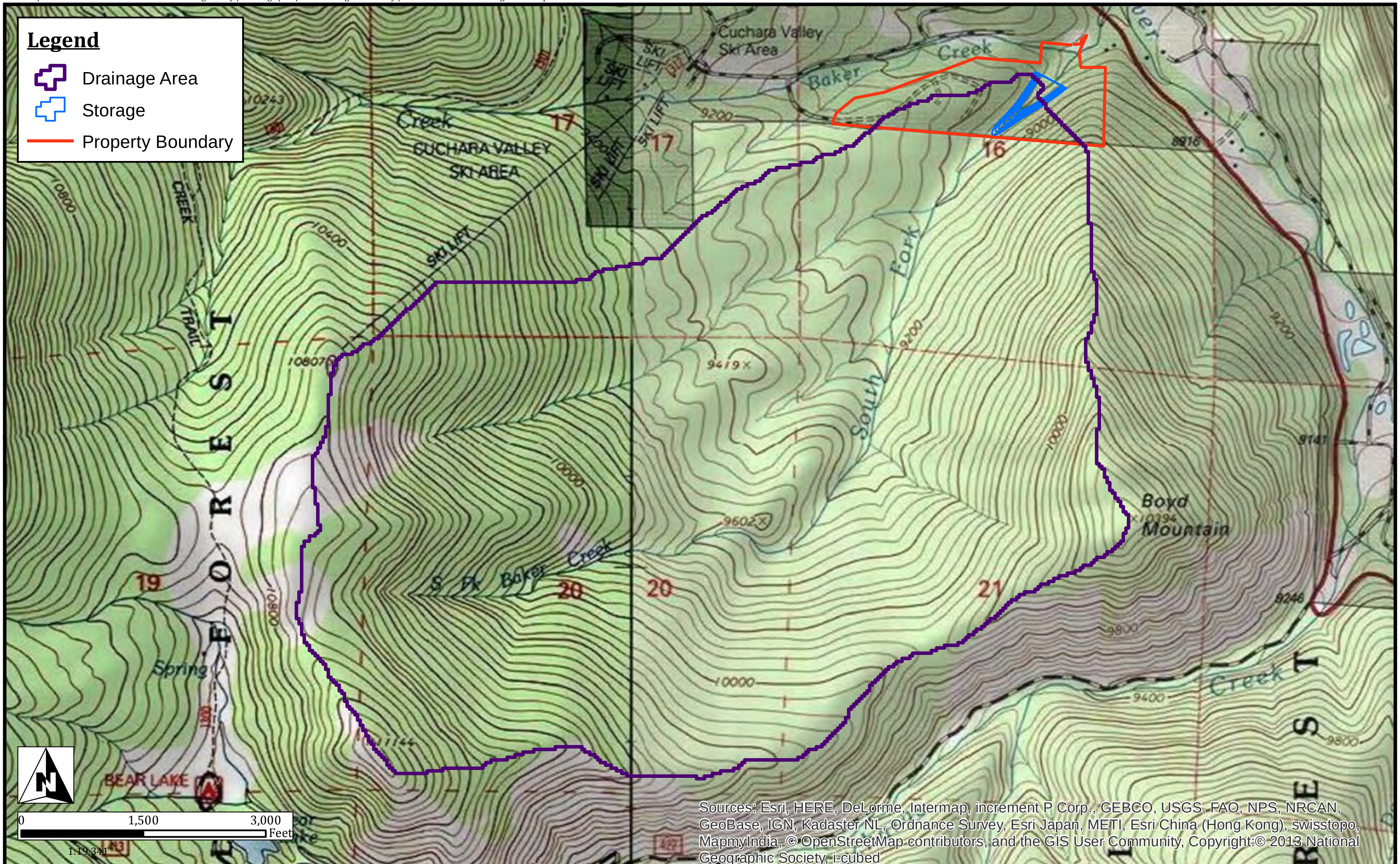

Applegate Group, Inc.
Water Resource Advisors for the West
1490 West 121st Ave., Ste 100
Denver, CO 80234-2728
www.ApplegateGroup.com
Phone: (303) 452-6611
Fax: (303) 452-2759
e-mail: info@applegategroup.com

Cucharas Storage Study

South Baker Creek Drainage Area

Date: 13 April 2017

Job #: 16-106

Drawn By: KAB

Figure: **1B**

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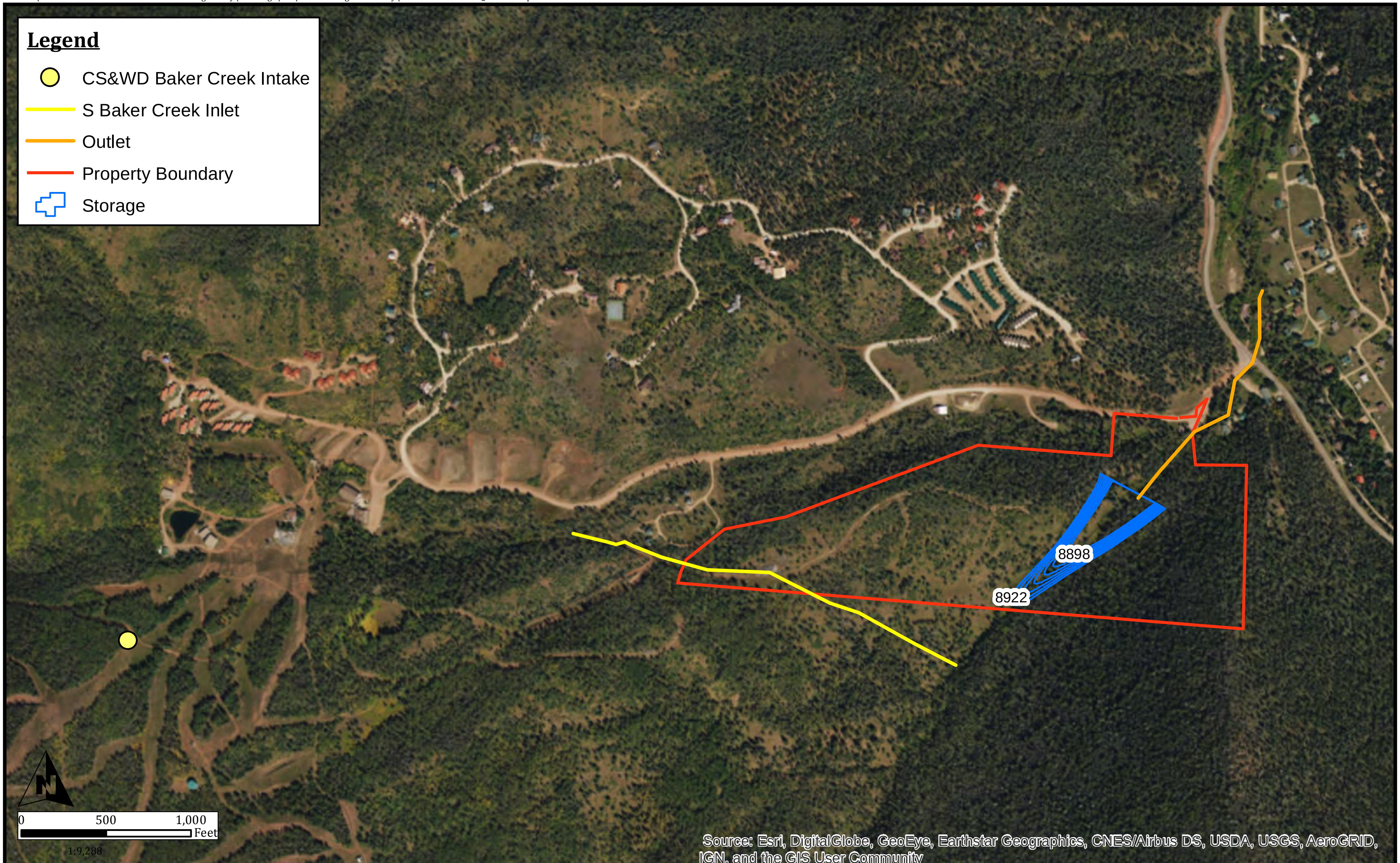

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Cucharas Storage Study

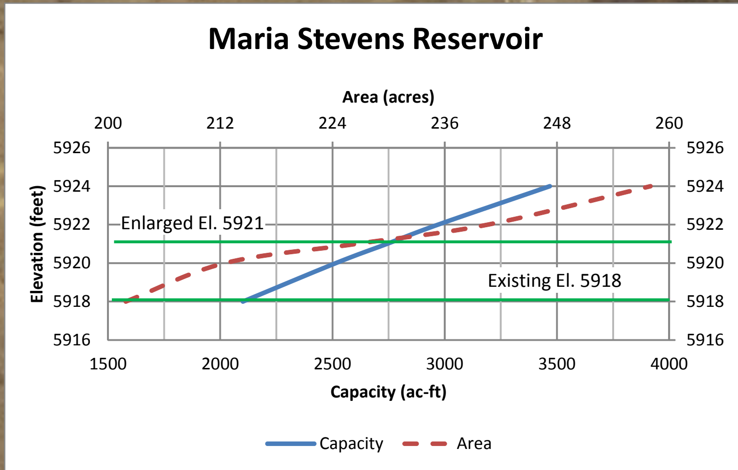
South Baker Creek Inlet and Outlet

Date: 13 April 2017

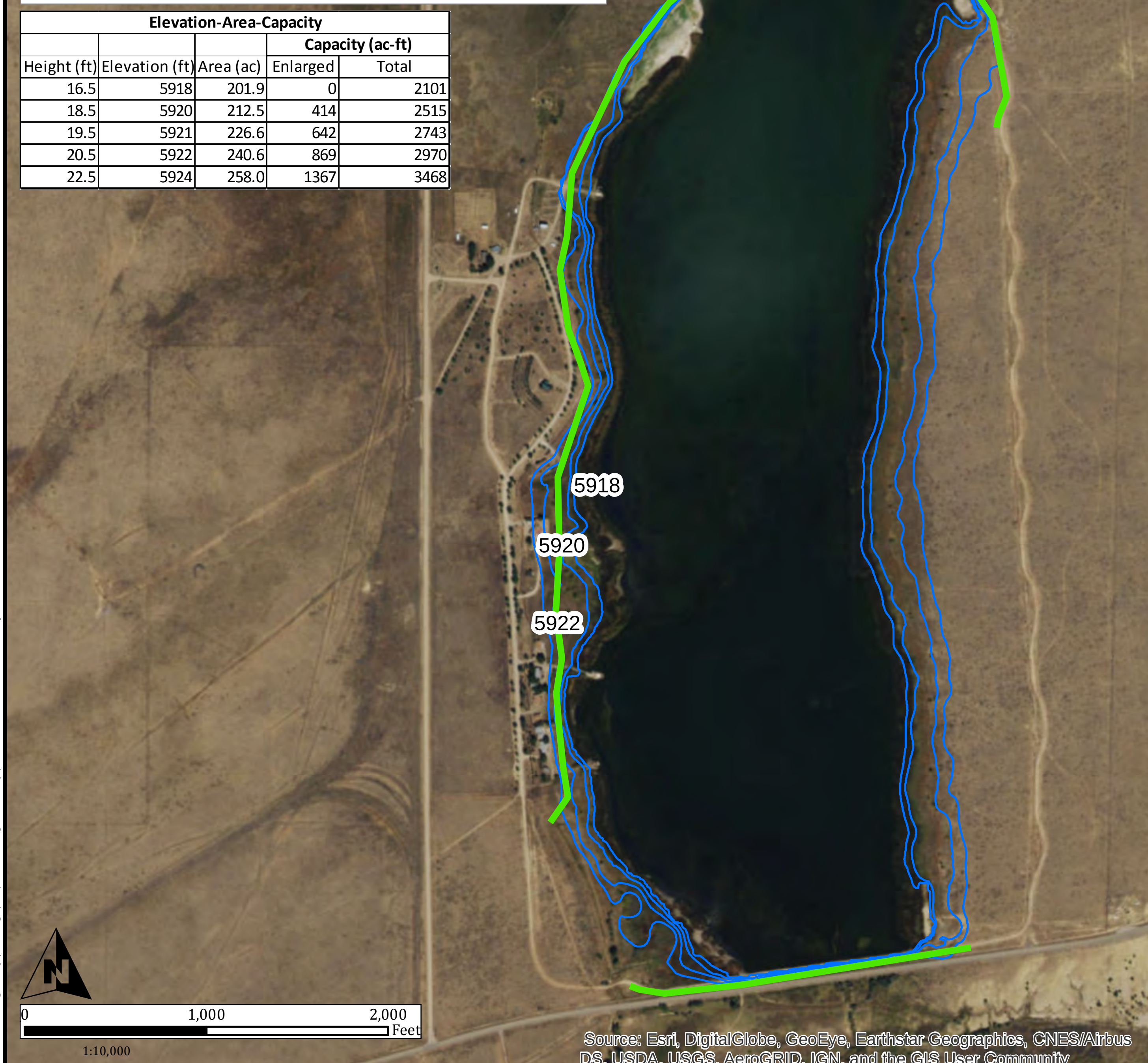
Job #: 16-106

Drawn By: KAB

Figure: 1C



Elevation-Area-Capacity				
			Capacity (ac-ft)	
Height (ft)	Elevation (ft)	Area (ac)	Enlarged	Total
16.5	5918	201.9	0	2101
18.5	5920	212.5	414	2515
19.5	5921	226.6	642	2743
20.5	5922	240.6	869	2970
22.5	5924	258.0	1367	3468



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Path: N:\16106 Cucharas Basin Collaborative Storage Study\Drawings\GIS\Task 2 Storage Feasibility\Maria Stevens Reservoir Base Map.mxd

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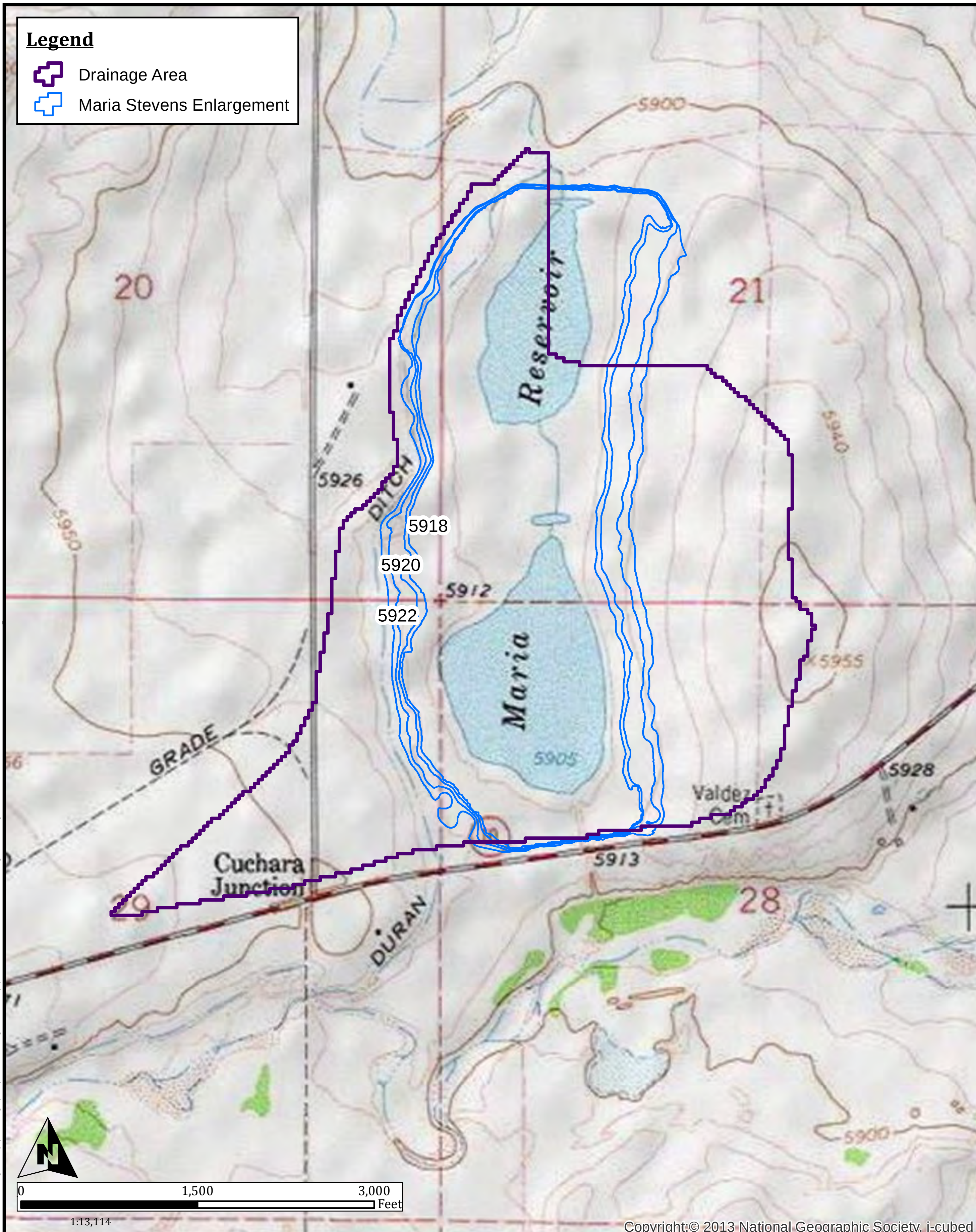
Cucharas Storage Study

Maria Stevens Reservoir Enlargement

Date: 14 April 2017
Job #: 16-106
Drawn By: KAB

Figure:
2A



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Cucharas Storage Study

Maria Stevens Reservoir Drainage Area

Date: 14 April 2017
Job #: 16-106
Drawn By: KAB

Figure: **2B**

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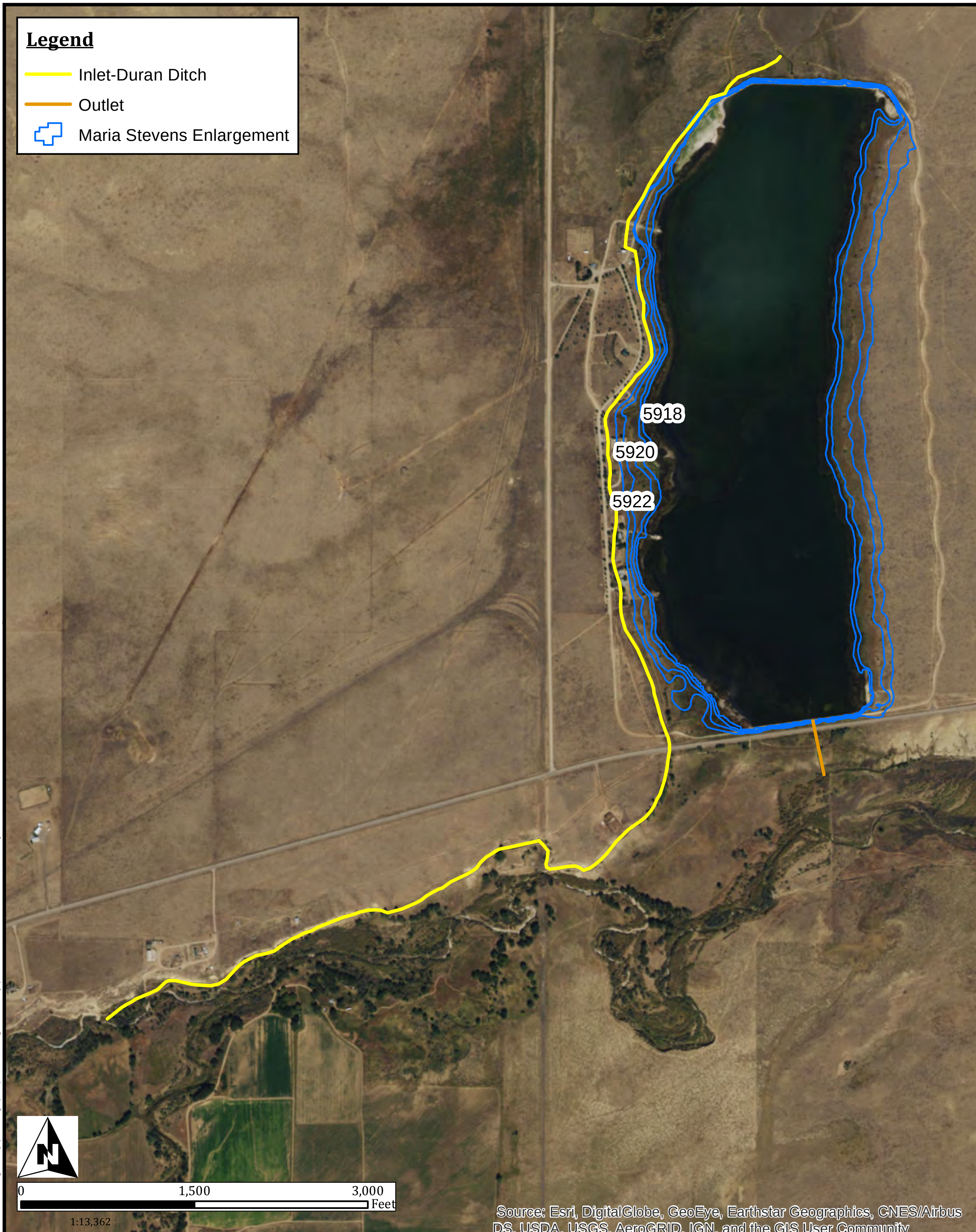

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Cucharas Storage Study

Maria Stevens Reservoir
Inlet and Outlet

Date: 14 April 2017

Job #: 16-106

Drawn By: KAB

Figure:
2C

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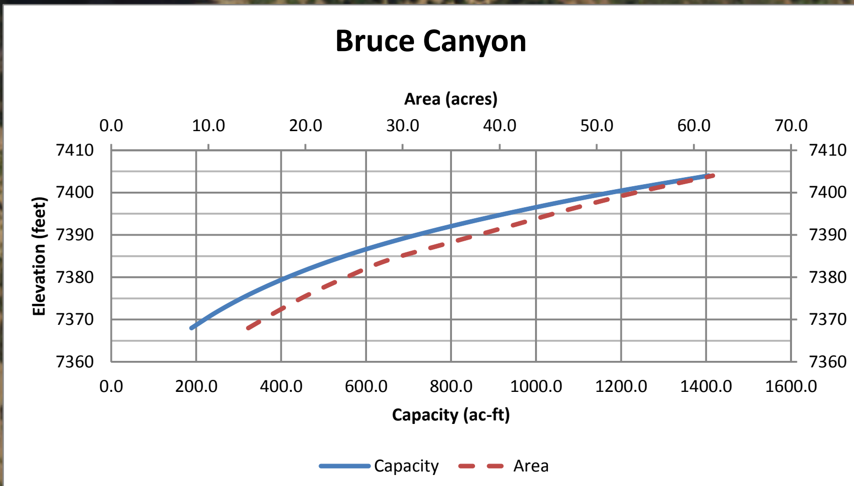
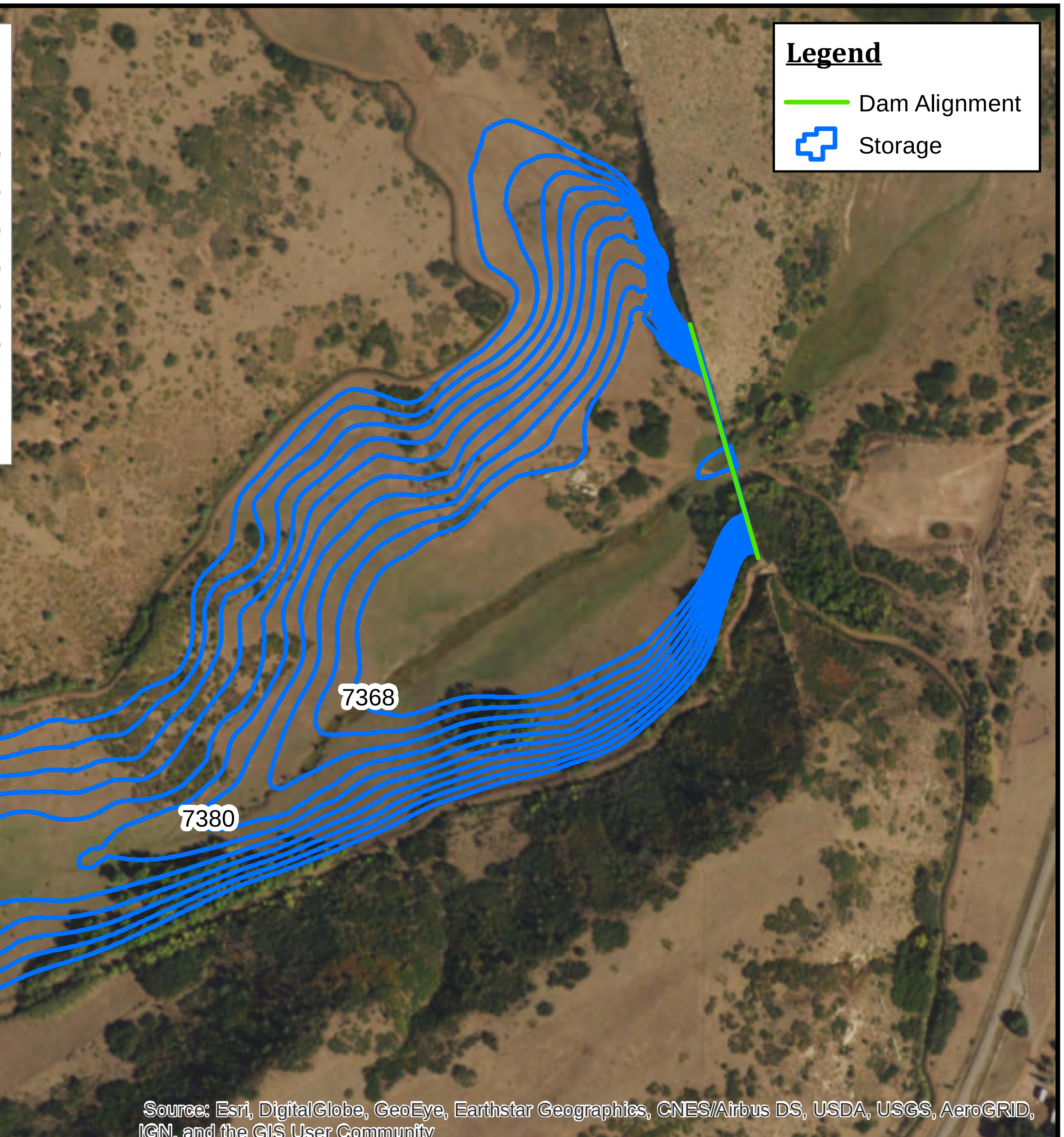


Height (ft)	Elevation (ft)	Area (ac)	Capacity (ac-ft)
1	7328	0.1	0.1
41	7368	14.1	188.9
45	7372	17.1	251.6
49	7376	20.4	326.0
53	7380	24.2	414.6
57	7384	28.4	519.7
61	7388	34.6	645.8
65	7392	40.9	797.7
69	7396	47.1	974.3
73	7400	54.0	1174.9
77	7404	61.9	1406.0



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Cucharas Storage Study

Bruce Canyon Reservoir

Date: 14 April 2017

Job #: 16-106

Drawn By: KAB

Figure:

3A

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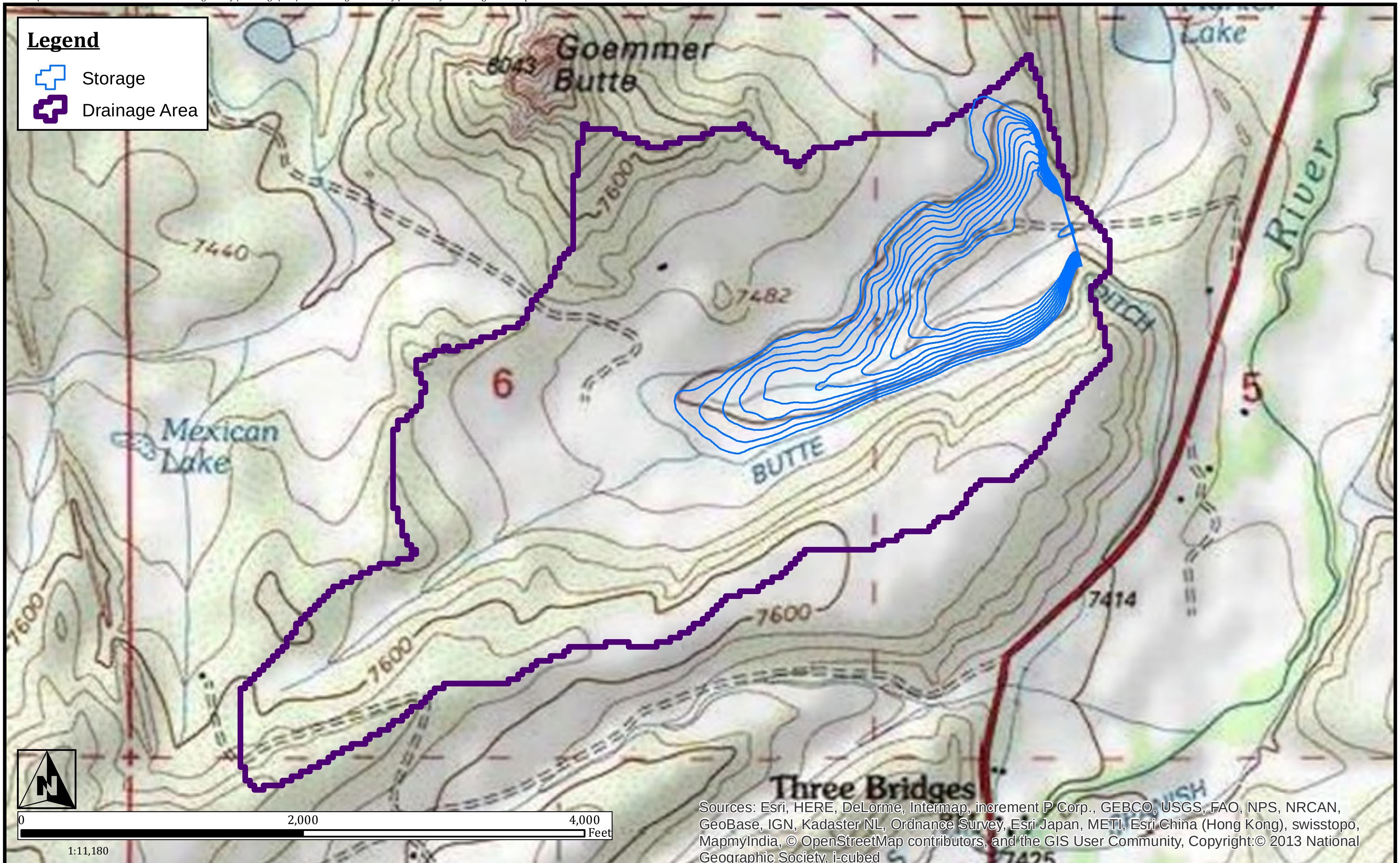

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Cucharas Storage Study

Bruce Canyon Reservoir Drainage Area

Date: 14 April 2017

Job #: 16-106

Drawn By: KAB

Figure:

3B

Date Saved: 5/16/2017 8:53:57 AM
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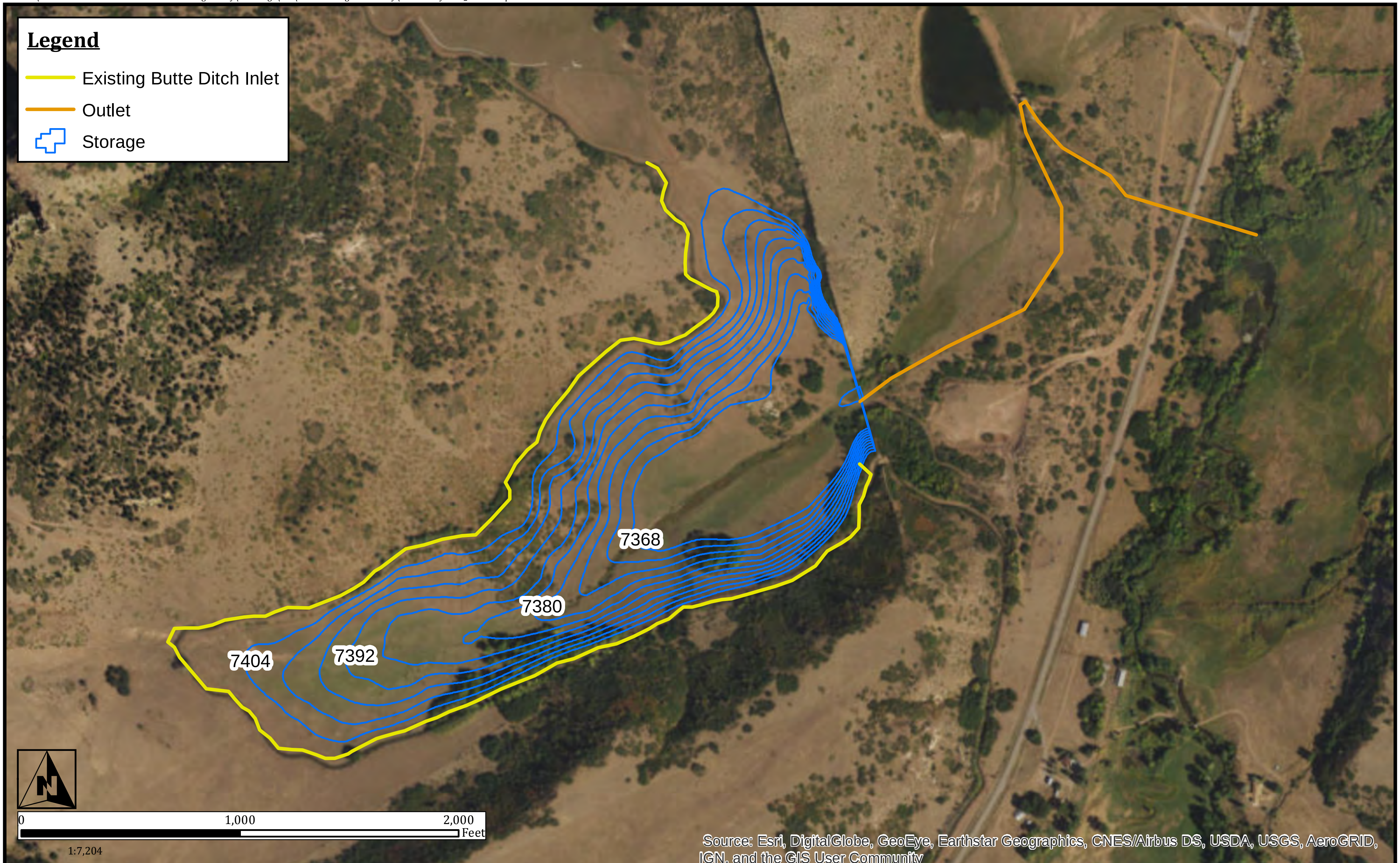

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Cucharas Storage Study

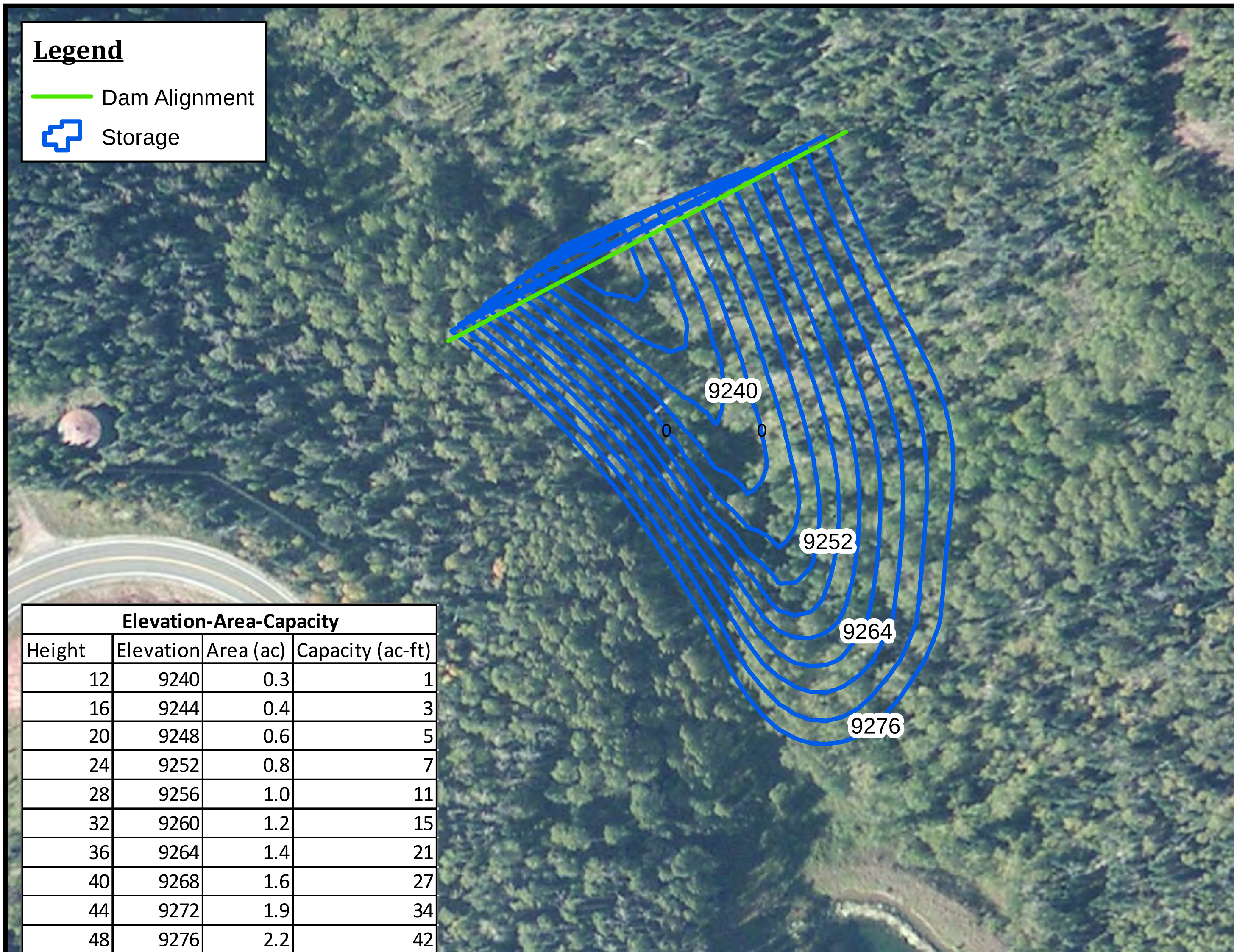
Bruce Canyon Reservoir Inlet and Outlet

Date: 14 April 2017

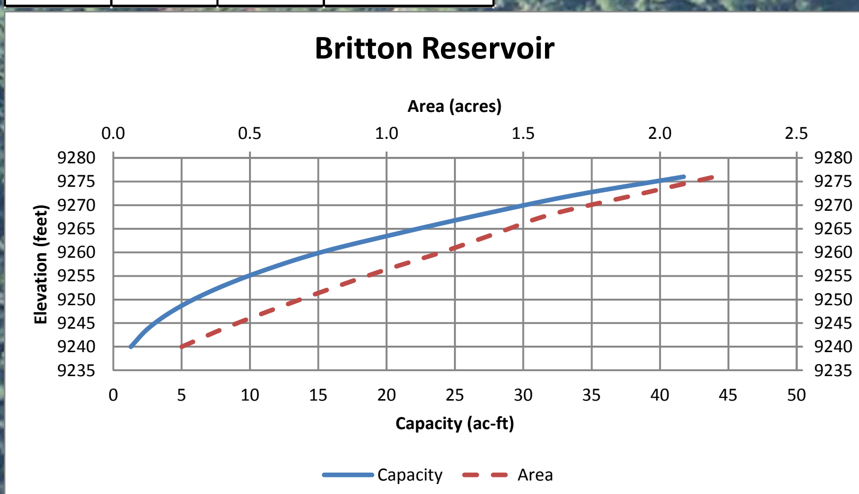
Job #: 16-106

Drawn By: KAB

Figure: **3C**



Elevation-Area-Capacity			
Height	Elevation	Area (ac)	Capacity (ac-ft)
12	9240	0.3	1
16	9244	0.4	3
20	9248	0.6	5
24	9252	0.8	7
28	9256	1.0	11
32	9260	1.2	15
36	9264	1.4	21
40	9268	1.6	27
44	9272	1.9	34
48	9276	2.2	42



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Cucharas Storage Study

Britton Reservoir

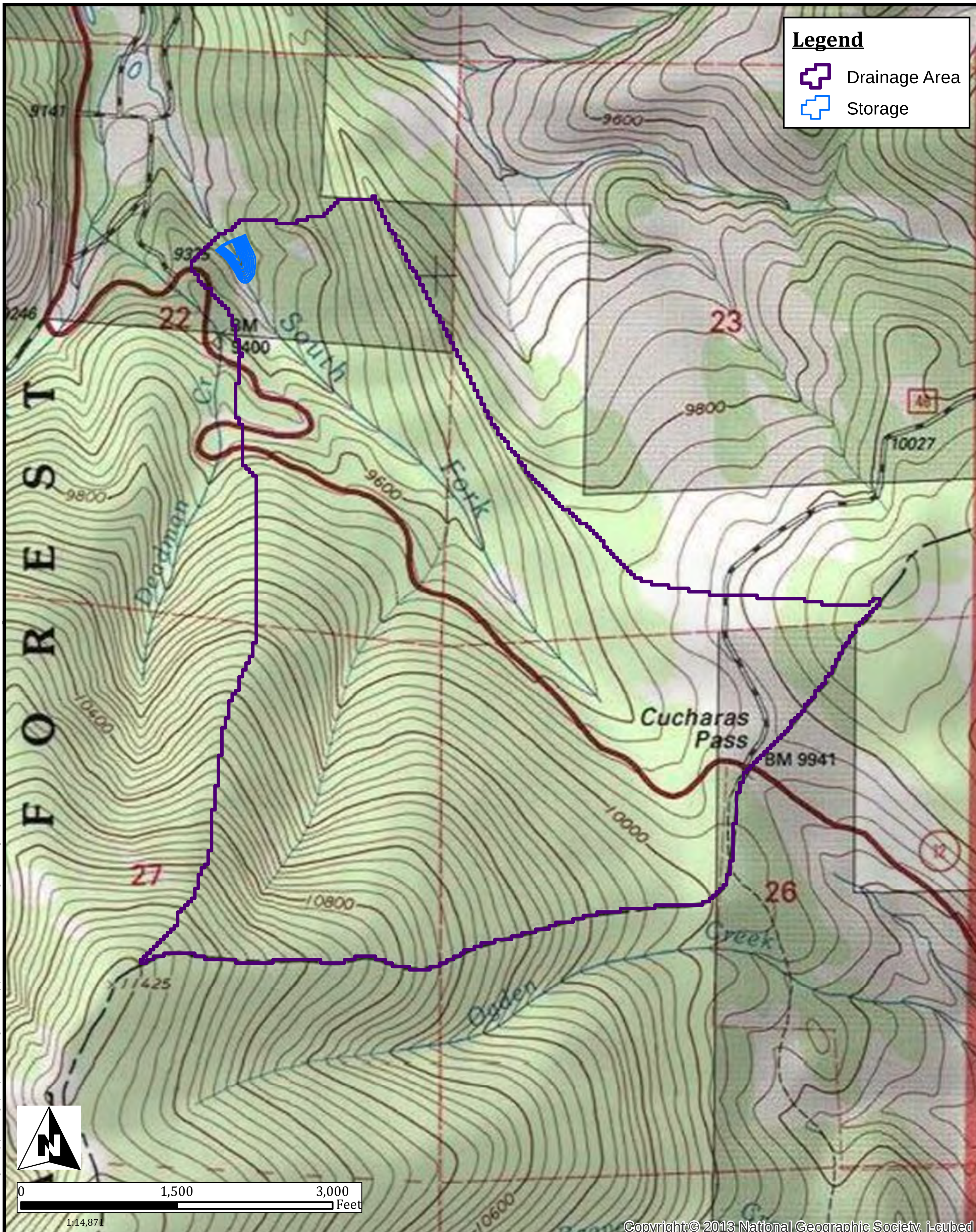
Date: 14 April 2017

Job #: 16-106

Drawn By: KAB

Figure:

4A



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Cucharas Storage Study

Britton Reservoir Drainage Area

Date: 14 April 2017

Job #: 16-106

Drawn By: KAB

Figure:

4B

Date Saved: 5/16/2017 9:56:41 AM
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Cucharas Storage Study

Britton Reservoir Inlet and Outlet

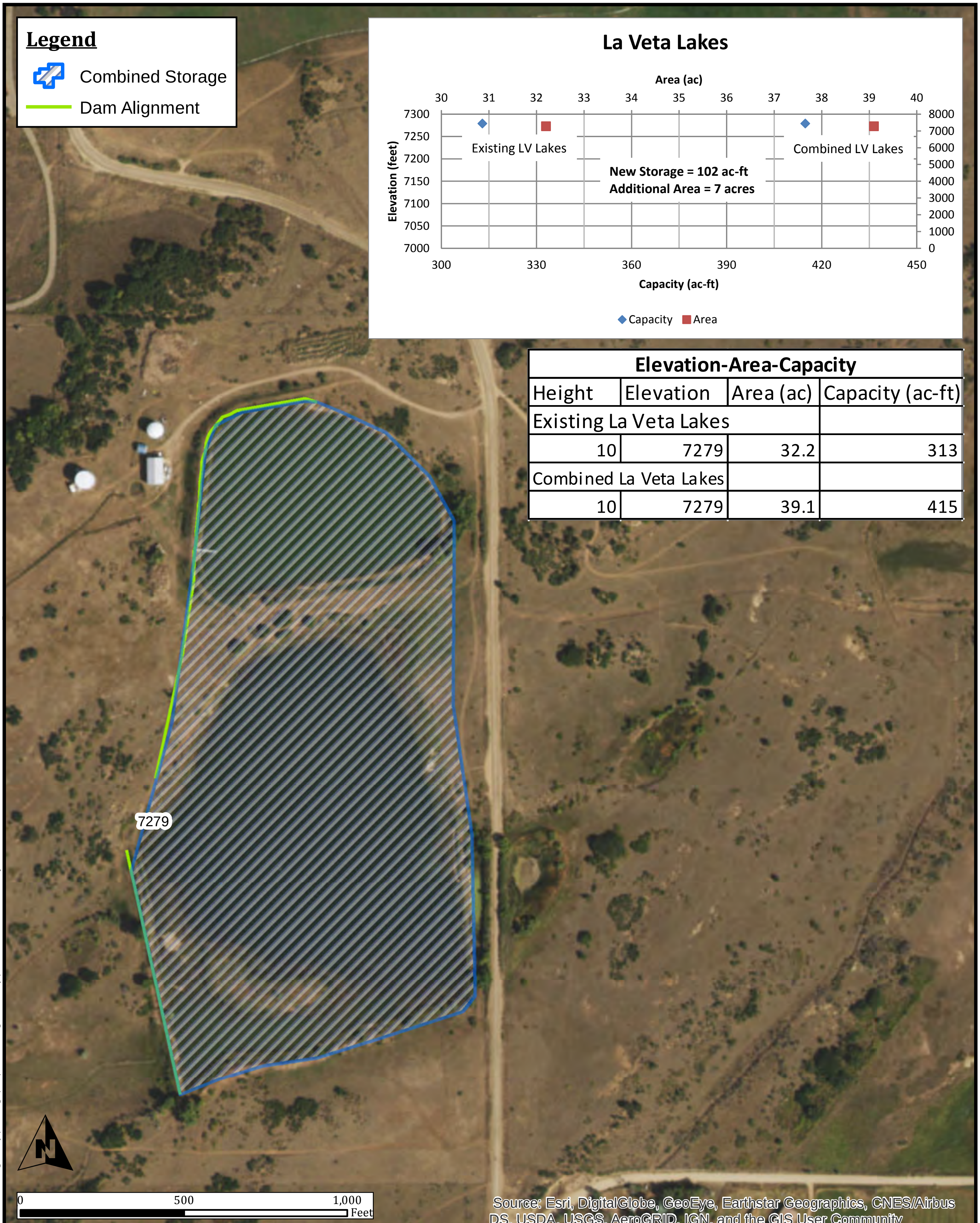
Date: 14 April 2017

Job #: 16-106

Drawn By: KAB

Figure:

4C



Elevation-Area-Capacity			
Height	Elevation	Area (ac)	Capacity (ac-ft)
Existing La Veta Lakes			
10	7279	32.2	313
Combined La Veta Lakes			
10	7279	39.1	415

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Cucharas Storage Study

La Veta South Lake Enlargement

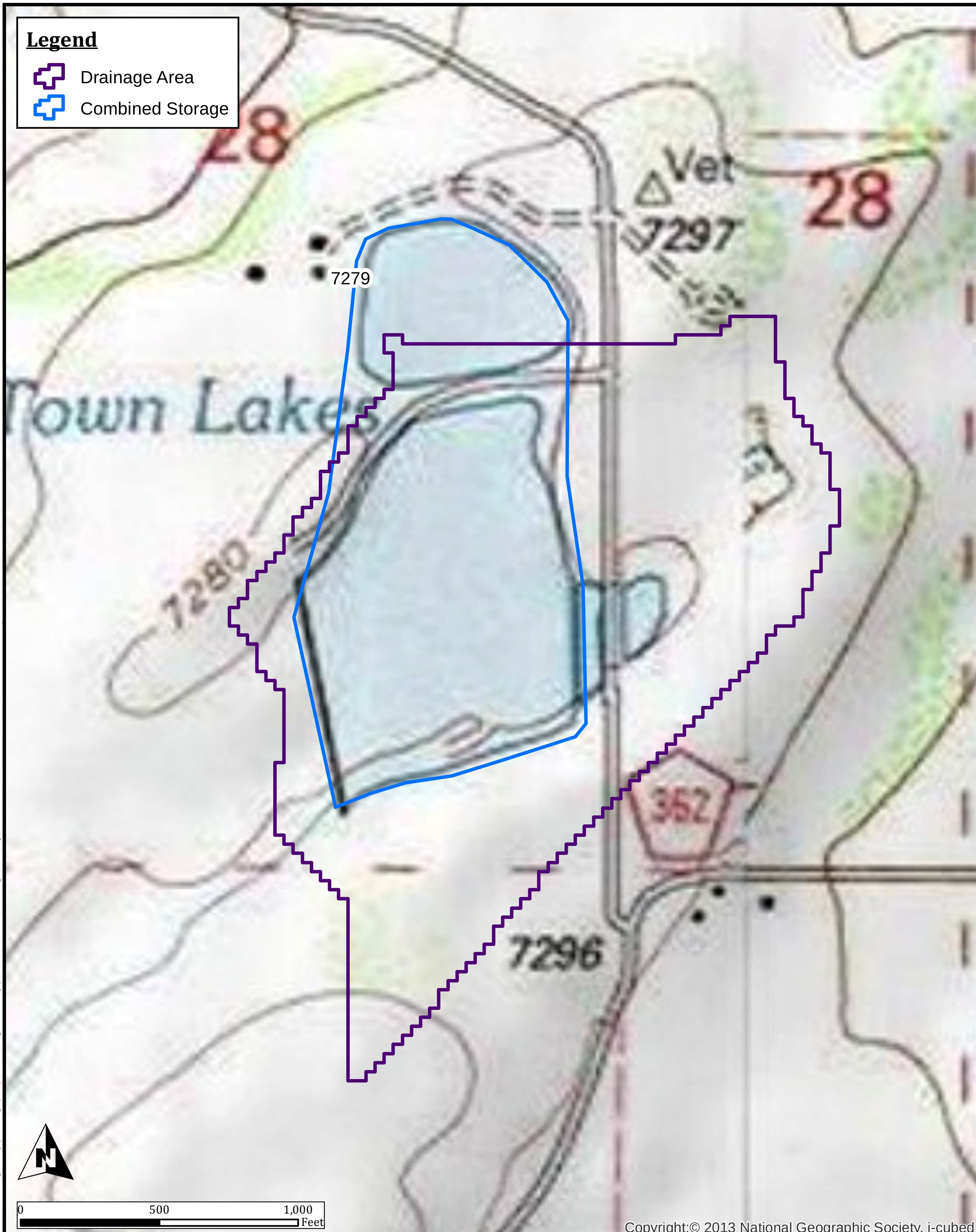
Date: 14 April 2017

Job #: 16-106

Drawn By: KAB

Figure:

5A



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Cucharas Storage Study

La Veta Lakes Drainage Area

Date: 14 April 2017

Job #: 16-106

Drawn By: KAB

Figure:

5B

Date Saved: 5/16/2017 10:20:08 AM
Path: N:\16106 Cucharas Basin Collaborative Storage Study\Drawings\GIS\Task 2 Storage Feasibility\La Veta South Lake Drainage Area Map.mxd

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Cucharas Storage Study

La Veta Lakes Inlet and Outlet

Date: 14 April 2017

Job #: 16-106

Drawn By: KAB

Figure:

5C

Date Saved: 5/16/2017 10:27:41 AM
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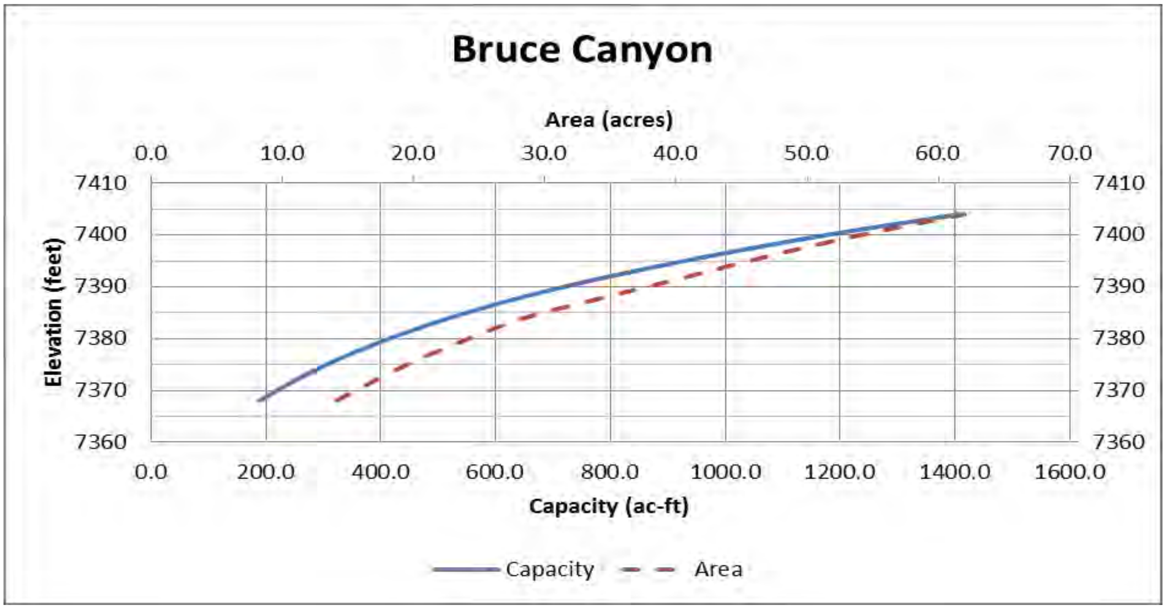
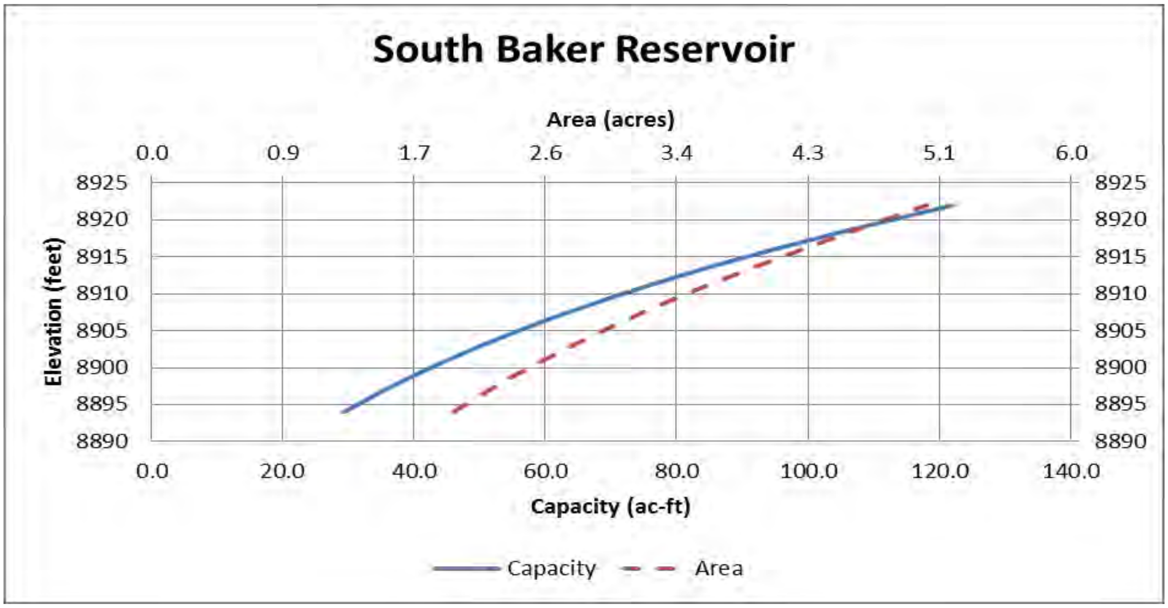
APPENDICES

APPENDIX A

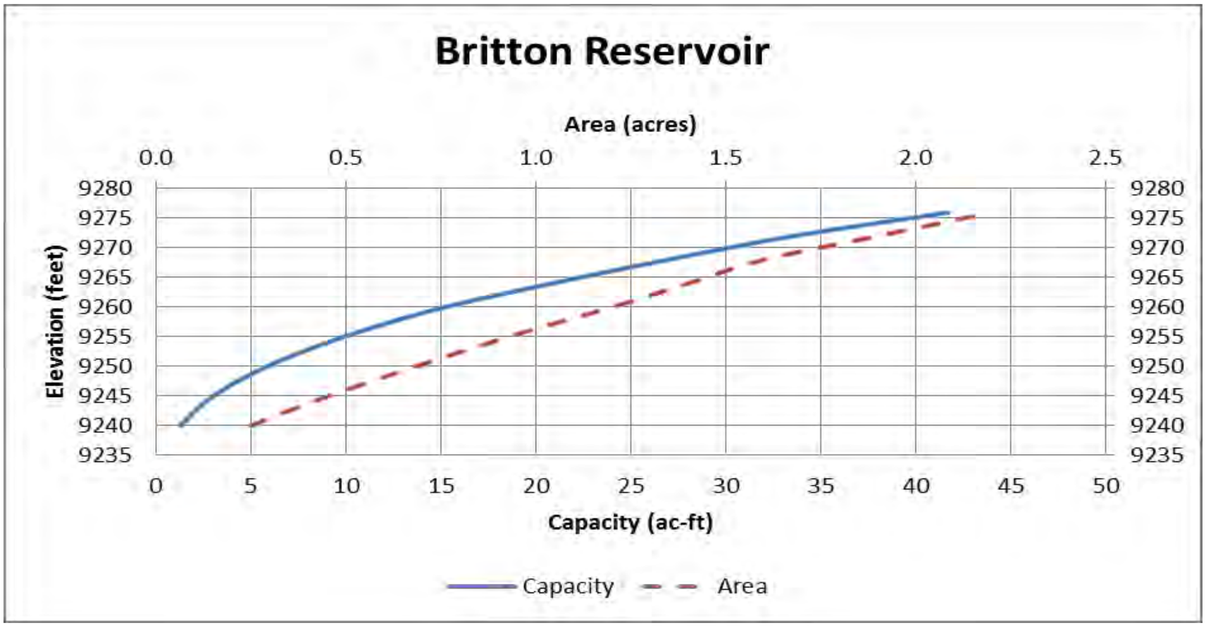
EAC DATA



Elevation-Area-Capacity			
Height (ft)	Elevation (ft)	Area (ac)	Capacity (ac-ft)
1	7328	0.1	0.1
41	7368	14.1	188.9
45	7372	17.1	251.6
49	7376	20.4	326.0
53	7380	24.2	414.6
57	7384	28.4	519.7
61	7388	34.6	645.8
65	7392	40.9	797.7
69	7396	47.1	974.3
73	7400	54.0	1174.9
77	7404	61.9	1406.0

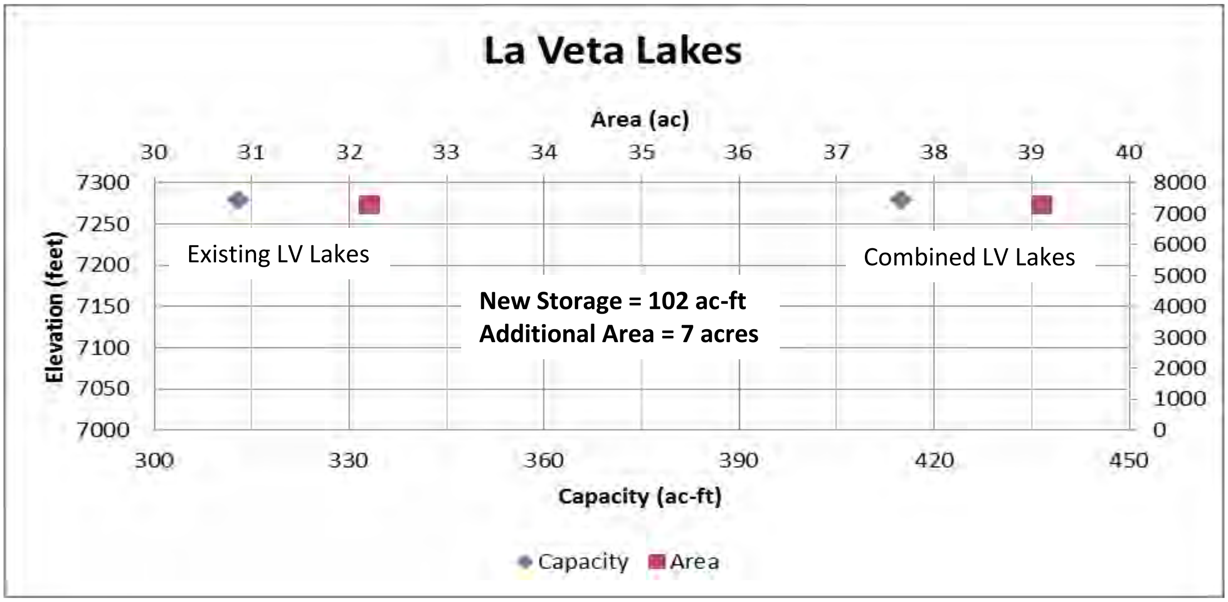


Elevation-Area-Capacity			
Height (ft)	Elevation (ft)	Area (ac)	Capacity (ac-ft)
38	8894	2	29.4
42	8898	2.3	37.8
46	8902	2.6	47.6
50	8906	3	58.9
54	8910	3.5	71.8
58	8914	4	86.6
62	8918	4.5	103.4
66	8922	5	122



Elevation-Area-Capacity			
Height	Elevation	Area (ac)	Capacity (ac-ft)
12	9240	0.3	1
16	9244	0.4	3
20	9248	0.6	5
24	9252	0.8	7
28	9256	1.0	11
32	9260	1.2	15
36	9264	1.4	21
40	9268	1.6	27
44	9272	1.9	34
48	9276	2.2	42

Elevation-Area-Capacity				
Height (ft)	Elevation (ft)	Area (ac)	Capacity (ac-ft)	
			Enlarged	Total
16.5	5918	201.9	0	2101
18.5	5920	212.5	414	2515
19.5	5921	226.6	642	2743
20.5	5922	240.6	869	2970
22.5	5924	258.0	1367	3468



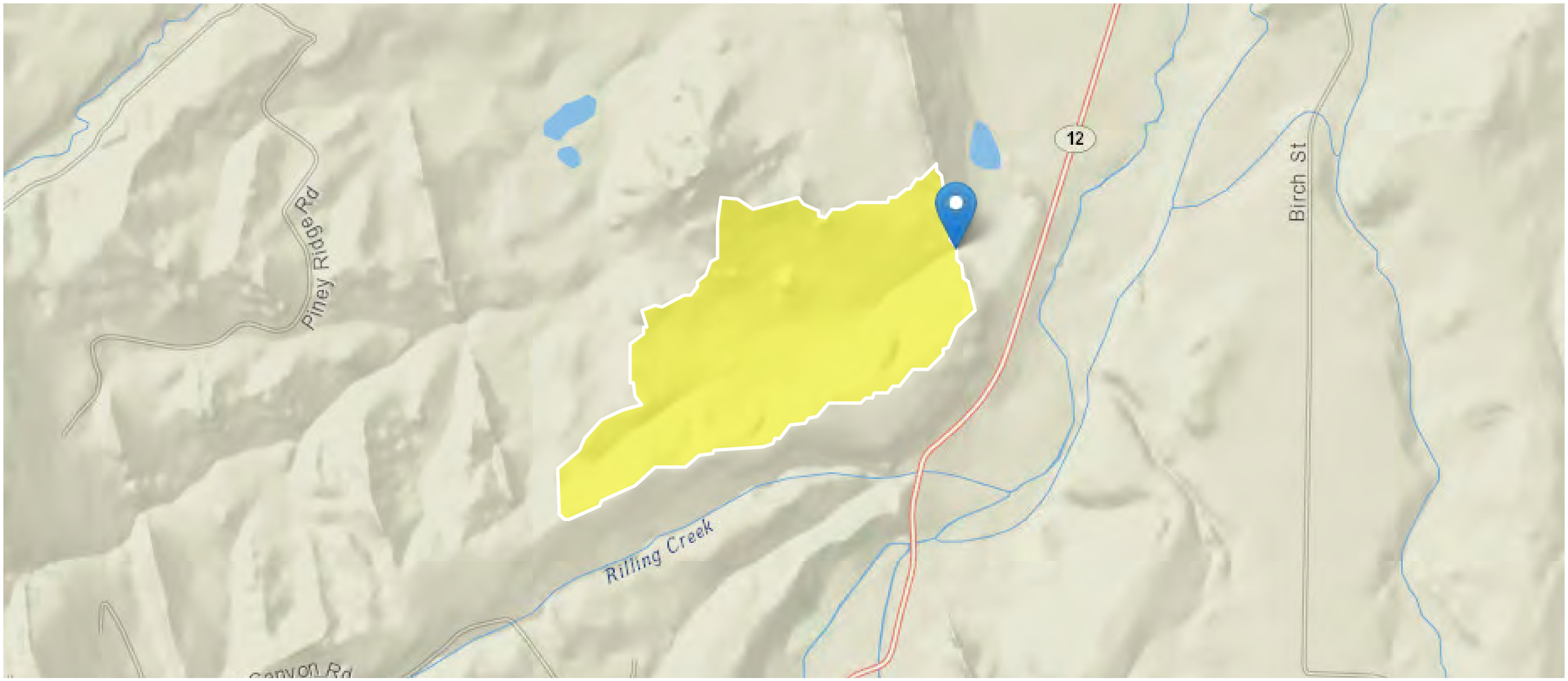
Elevation-Area-Capacity			
Height	Elevation	Area (ac)	Capacity (ac-ft)
Existing La Veta Lakes			
10	7279	32.2	313
Combined La Veta Lakes			
10	7279	39.1	415

Appendix B

StreamStats Reports

Bruce Canyon StreamStats Report

Region ID:
CO
Workspace ID:
CO20170504084111374000
Clicked Point (Latitude, Longitude):
37.46995, -105.02973
Time:
2017-05-04 08:43:30 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.54	square miles
I6H100Y	6-hour precipitation that is expected to occur on average once in 100 years	3.15	inches
OUTLETELEV	Elevation of the stream outlet in feet above NAVD88.	7323	feet
STATSCLAY	Percentage of clay soils from STATSGO	28.53	percent

Peak-Flow Statistics Parameters [100 Percent (0.545 square miles) Foothills Region Peak Flow 2016 5099]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.54	square miles	0.6	2850
I6H100Y	6 Hour 100 Year Precipitation	3.15	inches	2.38	4.89
OUTLETELEV	Elevation of Gage	7323	feet	4290	8270
STATSCLAY	STATSGO Percentage of Clay Soils	28.53	percent	9.87	37.5

Peak-Flow Statistics Disclaimers [100 Percent (0.545 square miles) Foothills Region Peak Flow 2016 5099]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report [100 Percent (0.545 square miles) Foothills Region Peak Flow 2016 5099]

Statistic	Value	Unit
2 Year Peak Flood	9.52	ft^3/s
5 Year Peak Flood	26.3	ft^3/s
10 Year Peak Flood	43.5	ft^3/s
25 Year Peak Flood	72.2	ft^3/s

Statistic	Value	Unit
50 Year Peak Flood	99	ft^3/s
100 Year Peak Flood	132	ft^3/s
200 Year Peak Flood	171	ft^3/s
500 Year Peak Flood	231	ft^3/s

Peak-Flow Statistics Citations

Kohn, M.S., Stevens, M.R., Harden, T.M., Godaire, J.E., Klinger, R.E., and Mommandi, A.,2016, Paleoflood investigations to improve peak-streamflow regional-regression equations for natural streamflow in eastern Colorado, 2015: U.S. Geological Survey Scientific Investigations Report 2016–5099, 58 p. (http://dx.doi.org/10.3133/sir20165099)

South Baker StreamStats Report

Region ID:

CO

Workspace ID:

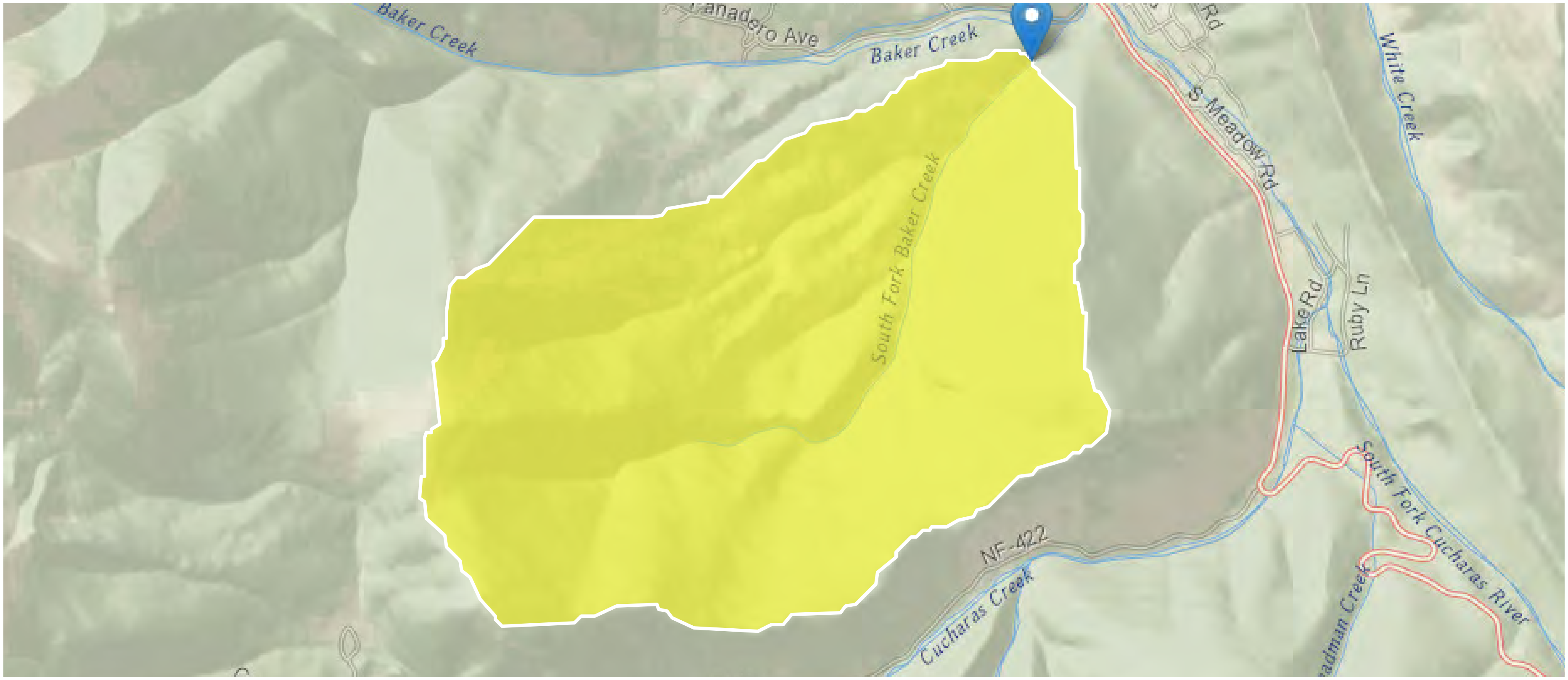
CO20170504085436472000

Clicked Point (Latitude, Longitude):

37.34926, -105.10854

Time:

2017-05-04 08:58:10 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	2.14	square miles
PRECIP	Mean Annual Precipitation	28.04	inches
I6H100Y	6-hour precipitation that is expected to occur on average once in 100 years	3.33	inches
OUTLETELEV	Elevation of the stream outlet in feet above NAVD88.	8874	feet
STATSCLAY	Percentage of clay soils from STATSGO	20.7	percent

Peak-Flow Statistics Parameters [1 Percent (0.0214 square miles) Foothills Region Peak Flow 2016 5099]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.14	square miles	0.6	2850
I6H100Y	6 Hour 100 Year Precipitation	3.33	inches	2.38	4.89
OUTLETELEV	Elevation of Gage	8874	feet	4290	8270
STATSCLAY	STATSGO Percentage of Clay Soils	20.7	percent	9.87	37.5

Peak-Flow Statistics Disclaimers [1 Percent (0.0214 square miles) Foothills Region Peak Flow 2016 5099]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Parameters [99 Percent (2.12 square miles) Rio Grande Region Peak Flow]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.14	square miles	2	517
PRECIP	Mean Annual Precipitation	28.04	inches	19	45

Peak-Flow Statistics Disclaimers [99 Percent (2.12 square miles) Rio Grande Region Peak Flow]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report [1 Percent (0.0214 square miles) Foothills Region Peak Flow 2016 5099]

Statistic	Value	Unit
2 Year Peak Flood	10.9	ft^3/s
5 Year Peak Flood	27	ft^3/s
10 Year Peak Flood	42.7	ft^3/s
25 Year Peak Flood	69.2	ft^3/s
50 Year Peak Flood	94	ft^3/s
100 Year Peak Flood	125	ft^3/s
200 Year Peak Flood	160	ft^3/s
500 Year Peak Flood	213	ft^3/s

Peak-Flow Statistics Flow Report [99 Percent (2.12 square miles) Rio Grande Region Peak Flow]

Statistic	Value	Unit	Average standard error of prediction
2 Year Peak Flood	7.8	ft^3/s	67
5 Year Peak Flood	15.8	ft^3/s	57
10 Year Peak Flood	23.1	ft^3/s	54
25 Year Peak Flood	34.3	ft^3/s	52
50 Year Peak Flood	44.3	ft^3/s	51
100 Year Peak Flood	61.9	ft^3/s	51
200 Year Peak Flood	72.6	ft^3/s	52
500 Year Peak Flood	107	ft^3/s	54

Peak-Flow Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
2 Year Peak Flood	7.83	ft^3/s
5 Year Peak Flood	15.9	ft^3/s
10 Year Peak Flood	23.3	ft^3/s
25 Year Peak Flood	34.6	ft^3/s
50 Year Peak Flood	44.8	ft^3/s
100 Year Peak Flood	62.5	ft^3/s
200 Year Peak Flood	73.5	ft^3/s
500 Year Peak Flood	108	ft^3/s

Peak-Flow Statistics Citations

Kohn, M.S., Stevens, M.R., Harden, T.M., Godaire, J.E., Klinger, R.E., and Mommandi, A.,2016, Paleoflood investigations to improve peak-streamflow regional-regression equations for natural streamflow in eastern Colorado, 2015: U.S. Geological Survey Scientific Investigations Report 2016–5099, 58 p. (http://dx.doi.org/10.3133/sir20165099)

Capesius, J.P., and Stephens, V. C.,2009, Regional Regression Equations for Estimation of Natural Streamflow Statistics in Colorado: U. S. Geological Survey Scientific Investigations Report 2009-5136, 32 p. (http://pubs.usgs.gov/sir/2009/5136/)

Flood-Volume Statistics Parameters [99 Percent (2.12 square miles) Rio Grande Region Max Flow]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.14	square miles	13	517
PRECIP	Mean Annual Precipitation	28.04	inches	19	45

Flood-Volume Statistics Disclaimers [99 Percent (2.12 square miles) Rio Grande Region Max Flow]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Flood-Volume Statistics Flow Report [99 Percent (2.12 square miles) Rio Grande Region Max Flow]

Statistic	Value	Unit
7 Day 2 Year Maximum	4.76	ft^3/s
7 Day 10 Year Maximum	13.8	ft^3/s
7 Day 50 Year Maximum	26.5	ft^3/s

Flood-Volume Statistics Citations

Capesius, J.P., and Stephens, V. C.,2009, Regional Regression Equations for Estimation of Natural Streamflow Statistics in Colorado: U. S. Geological Survey Scientific Investigations Report 2009-5136, 32 p. (http://pubs.usgs.gov/sir/2009/5136/)

Britton StreamStats Report

Region ID:

CO

Workspace ID:

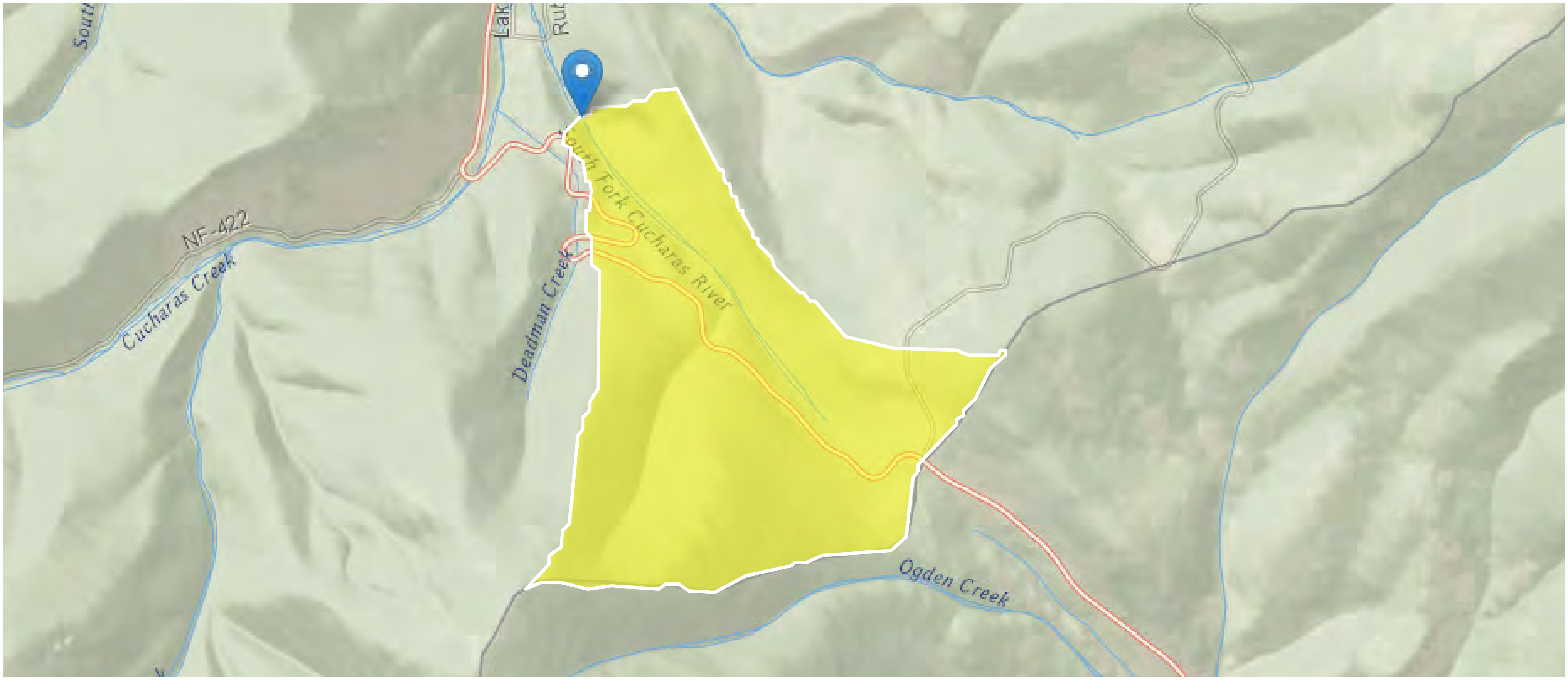
CO20170504092710106000

Clicked Point (Latitude, Longitude):

37.33423, -105.09079

Time:

2017-05-04 09:28:13 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.97	square miles
PRECIP	Mean Annual Precipitation	28.55	inches

Peak-Flow Statistics Parameters [100 Percent (0.966 square miles) Rio Grande Region Peak Flow]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.97	square miles	2	517
PRECIP	Mean Annual Precipitation	28.55	inches	19	45

Peak-Flow Statistics Disclaimers [100 Percent (0.966 square miles) Rio Grande Region Peak Flow]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report [100 Percent (0.966 square miles) Rio Grande Region Peak Flow]

Statistic	Value	Unit
2 Year Peak Flood	3.69	ft^3/s
5 Year Peak Flood	7.72	ft^3/s
10 Year Peak Flood	11.4	ft^3/s
25 Year Peak Flood	17.1	ft^3/s
50 Year Peak Flood	22.5	ft^3/s
100 Year Peak Flood	31.7	ft^3/s
200 Year Peak Flood	37.5	ft^3/s
500 Year Peak Flood	55.7	ft^3/s

Peak-Flow Statistics Citations

Capesius, J.P., and Stephens, V. C.,2009, Regional Regression Equations for Estimation of Natural Streamflow Statistics in Colorado: U. S. Geological Survey Scientific Investigations Report 2009-5136, 32 p. (http://pubs.usgs.gov/sir/2009/5136/)

Maria Stevens StreamStats Report

Region ID:

CO

Workspace ID:

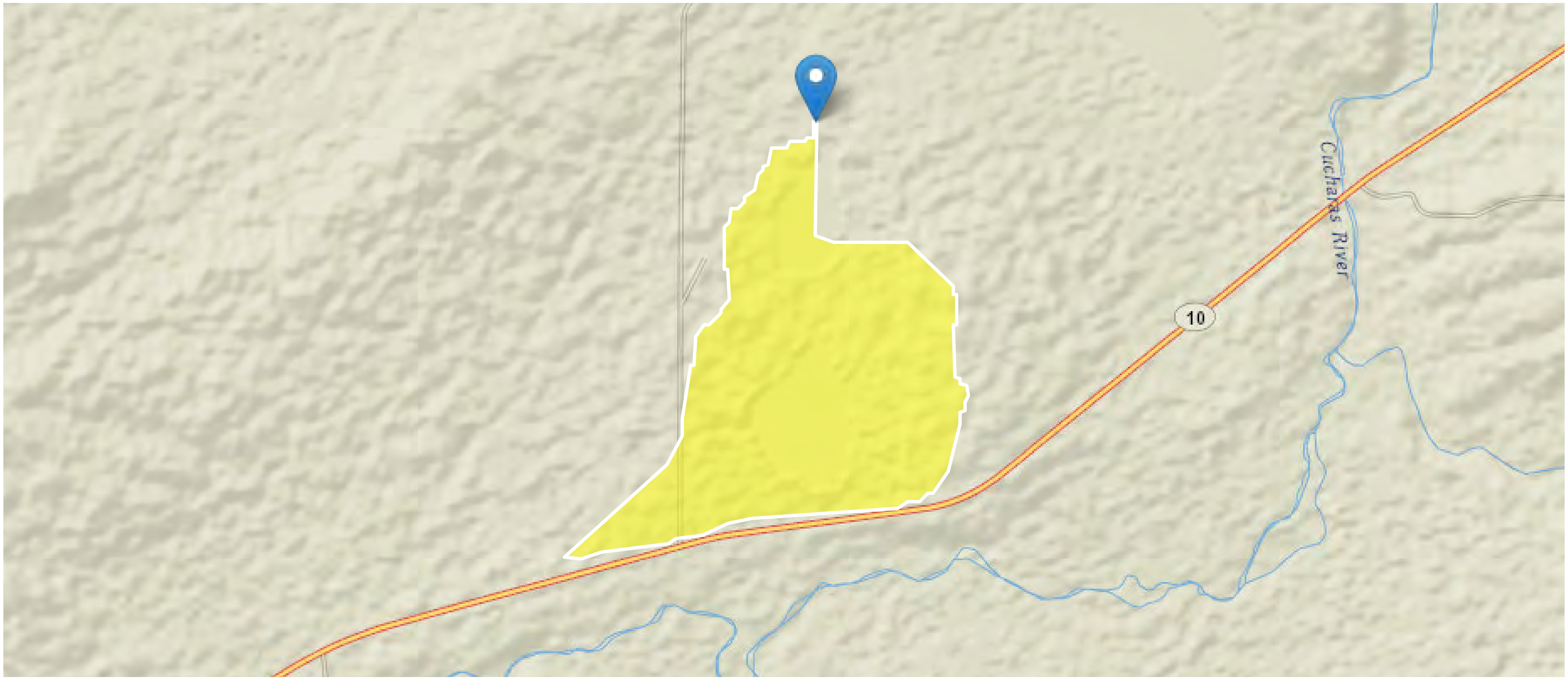
CO20170504093449785000

Clicked Point (Latitude, Longitude):

37.68402, -104.67945

Time:

2017-05-04 09:36:12 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.63	square miles
I6H100Y	6-hour precipitation that is expected to occur on average once in 100 years	3.25	inches
OUTLETELEV	Elevation of the stream outlet in feet above NAVD88.	5906	feet
STATSCLAY	Percentage of clay soils from STATSGO	36.54	percent

Peak-Flow Statistics Parameters [100 Percent (0.631 square miles) Foothills Region Peak Flow 2016 5099]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.63	square miles	0.6	2850
I6H100Y	6 Hour 100 Year Precipitation	3.25	inches	2.38	4.89
OUTLETELEV	Elevation of Gage	5906	feet	4290	8270
STATSCLAY	STATSGO Percentage of Clay Soils	36.54	percent	9.87	37.5

Peak-Flow Statistics Flow Report [100 Percent (0.631 square miles) Foothills Region Peak Flow 2016 5099]

Statistic	Value	Unit	Average standard error of prediction
2 Year Peak Flood	24.5	ft^3/s	117
5 Year Peak Flood	76.6	ft^3/s	87
10 Year Peak Flood	134	ft^3/s	80
25 Year Peak Flood	233	ft^3/s	80
50 Year Peak Flood	328	ft^3/s	83
100 Year Peak Flood	448	ft^3/s	88
200 Year Peak Flood	591	ft^3/s	94

Statistic	Value	Unit	Average standard error of prediction
500 Year Peak Flood	823	ft^3/s	104

Peak-Flow Statistics Citations

Kohn, M.S., Stevens, M.R., Harden, T.M., Godaire, J.E., Klinger, R.E., and Mommandi, A.,2016, Paleoflood investigations to improve peak-streamflow regional-regression equations for natural streamflow in eastern Colorado, 2015: U.S. Geological Survey Scientific Investigations Report 2016–5099, 58 p. (http://dx.doi.org/10.3133/sir20165099)

La Veta Lakes StreamStats Report

Region ID:

CO

Workspace ID:

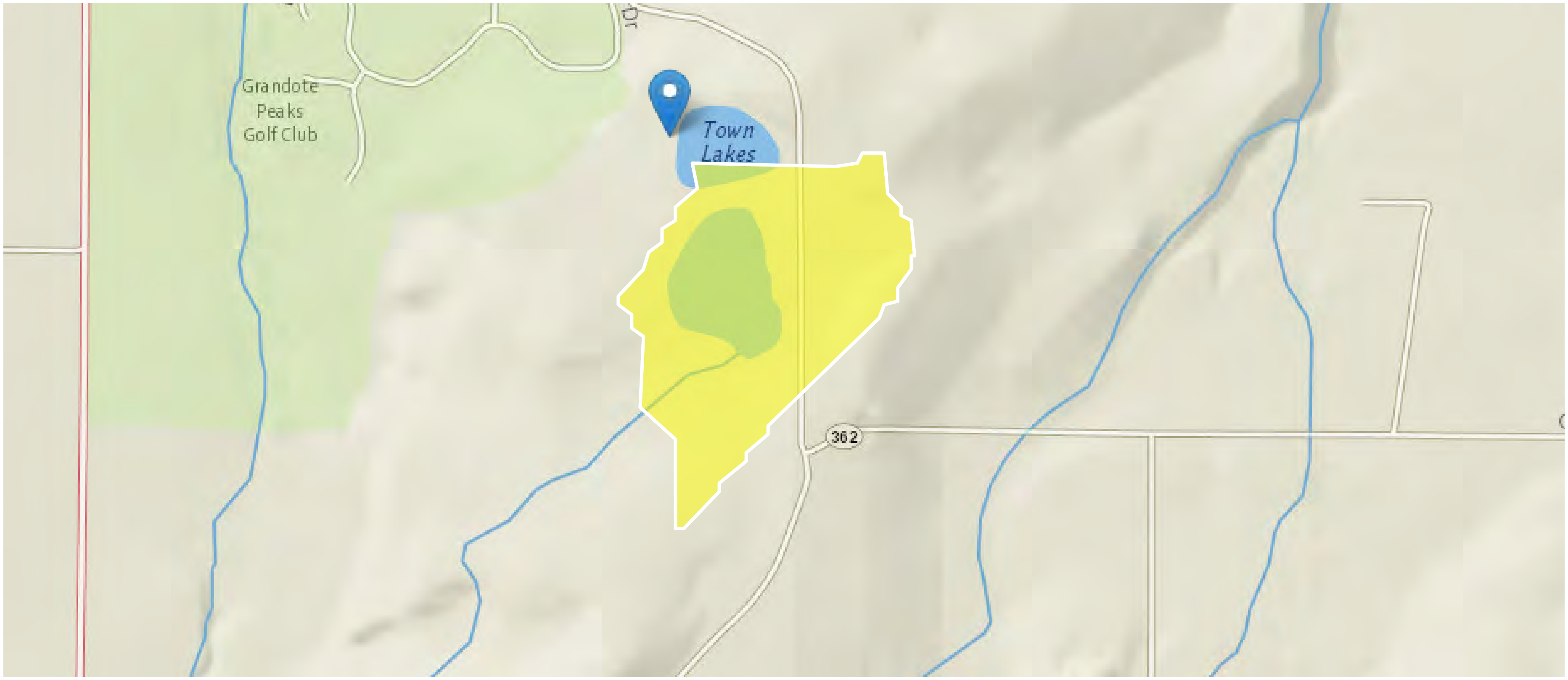
CO20170504094248667000

Clicked Point (Latitude, Longitude):

37.49454, -105.00565

Time:

2017-05-04 09:43:54 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.12	square miles
I6H100Y	6-hour precipitation that is expected to occur on average once in 100 years	3.22	inches
OUTLETELEV	Elevation of the stream outlet in feet above NAVD88.	7262	feet
STATSCLAY	Percentage of clay soils from STATSGO	17.9	percent

Peak-Flow Statistics Parameters [100 Percent (0.122 square miles) Foothills Region Peak Flow 2016 5099]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.12	square miles	0.6	2850
I6H100Y	6 Hour 100 Year Precipitation	3.22	inches	2.38	4.89
OUTLETELEV	Elevation of Gage	7262	feet	4290	8270
STATSCLAY	STATSGO Percentage of Clay Soils	17.9	percent	9.87	37.5

Peak-Flow Statistics Disclaimers [100 Percent (0.122 square miles) Foothills Region Peak Flow 2016 5099]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report [100 Percent (0.122 square miles) Foothills Region Peak Flow 2016 5099]

Statistic	Value	Unit
2 Year Peak Flood	2.65	ft^3/s
5 Year Peak Flood	7.48	ft^3/s
10 Year Peak Flood	12.4	ft^3/s
25 Year Peak Flood	20.8	ft^3/s

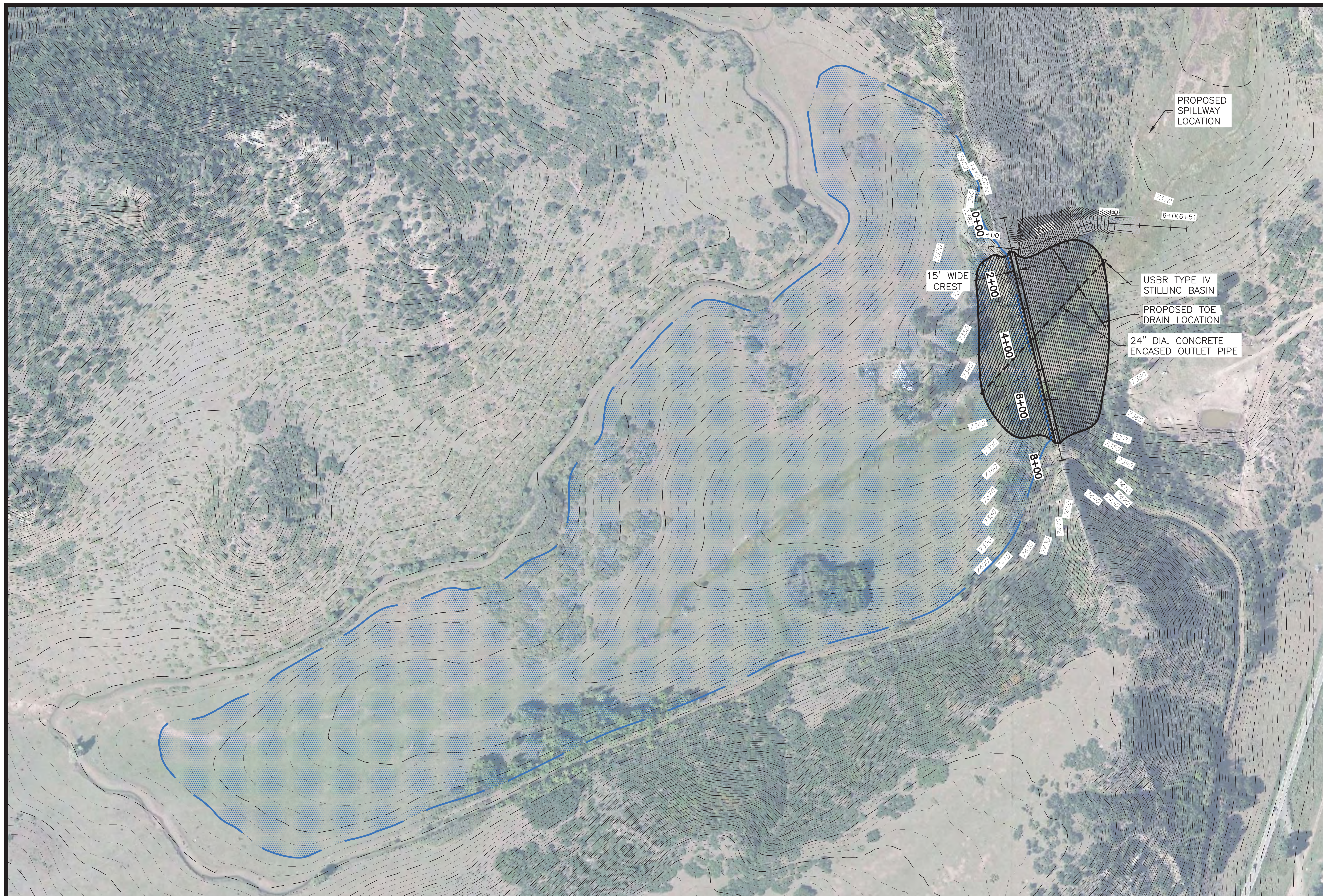
Statistic	Value	Unit
50 Year Peak Flood	28.6	ft^3/s
100 Year Peak Flood	38.6	ft^3/s
200 Year Peak Flood	49.9	ft^3/s
500 Year Peak Flood	67.9	ft^3/s

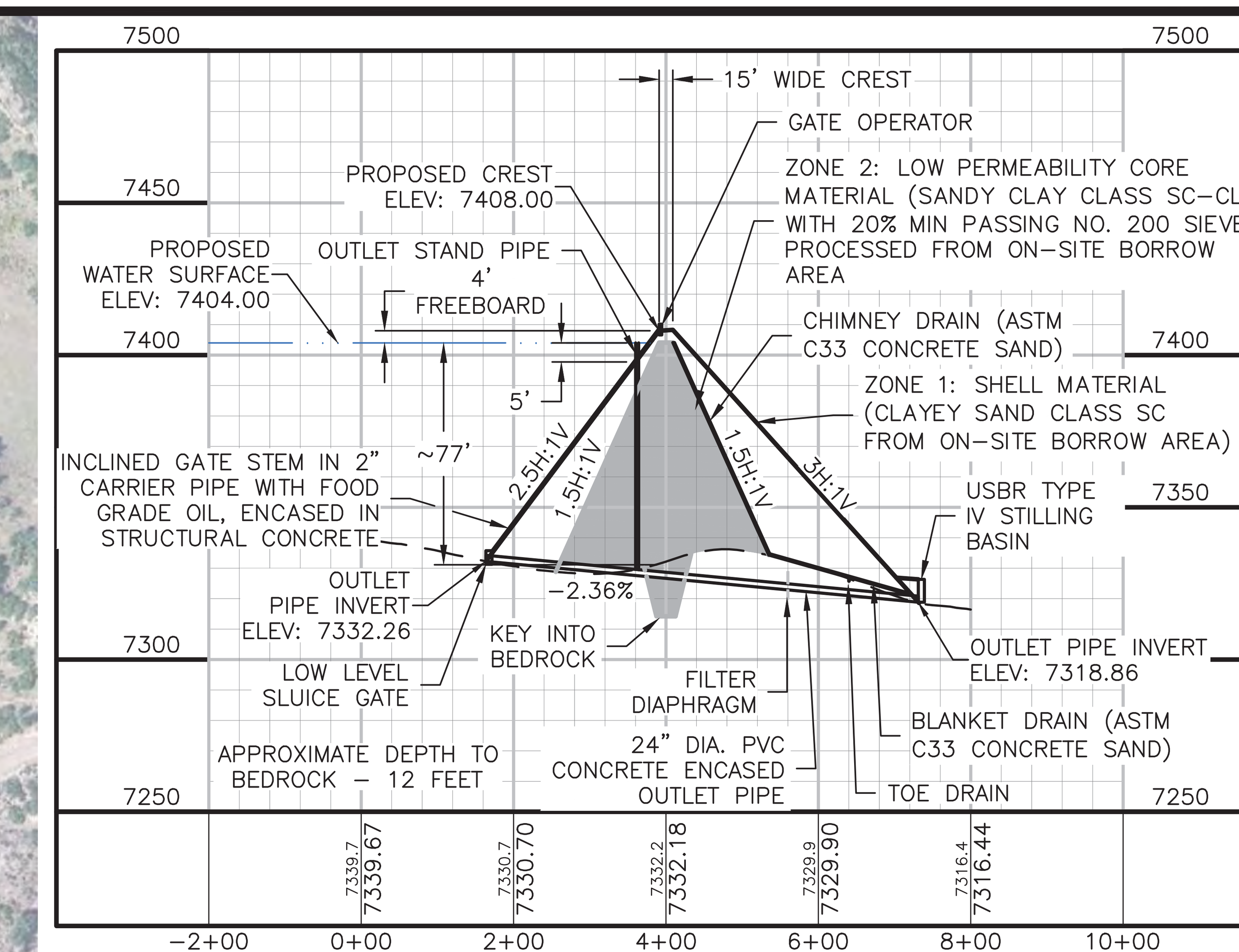
Peak-Flow Statistics Citations

Kohn, M.S., Stevens, M.R., Harden, T.M., Godaire, J.E., Klinger, R.E., and Mommandi, A.,2016, Paleoflood investigations to improve peak-streamflow regional-regression equations for natural streamflow in eastern Colorado, 2015: U.S. Geological Survey Scientific Investigations Report 2016–5099, 58 p. (http://dx.doi.org/10.3133/sir20165099)

APPENDIX C

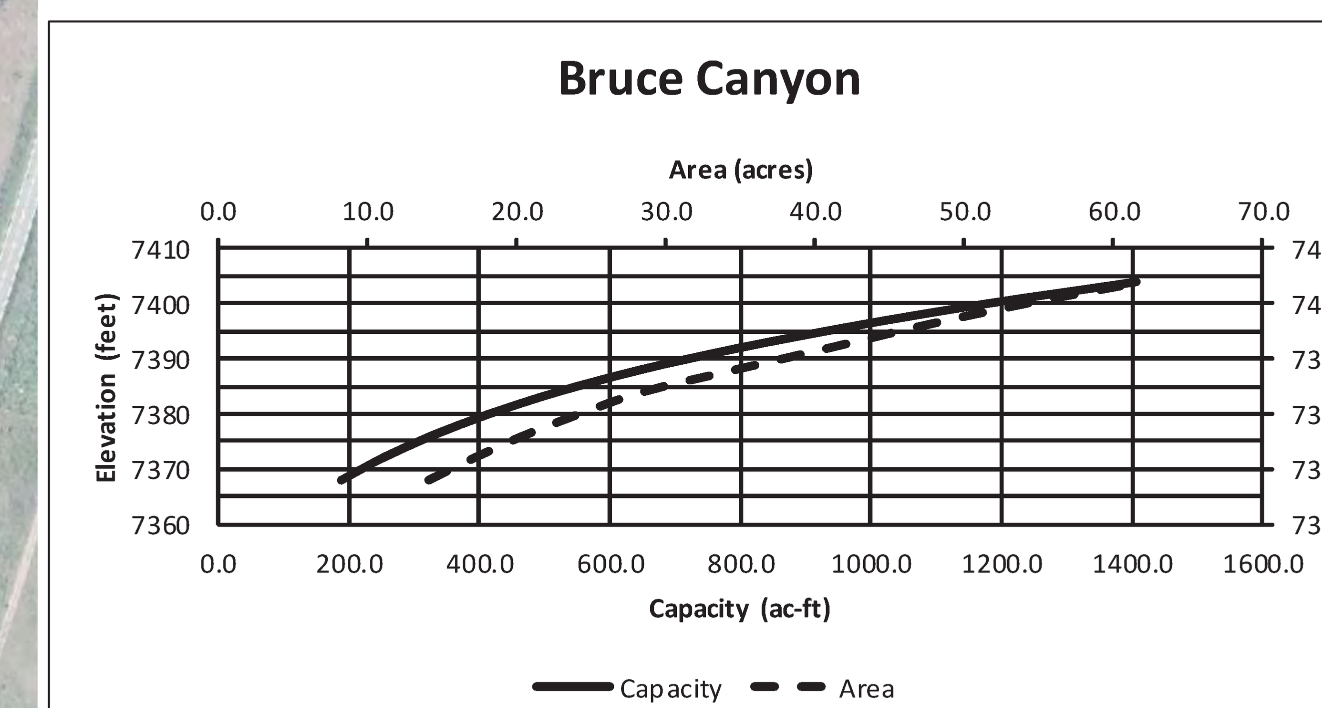
FEASIBILITY LEVEL DESIGN DRAWINGS



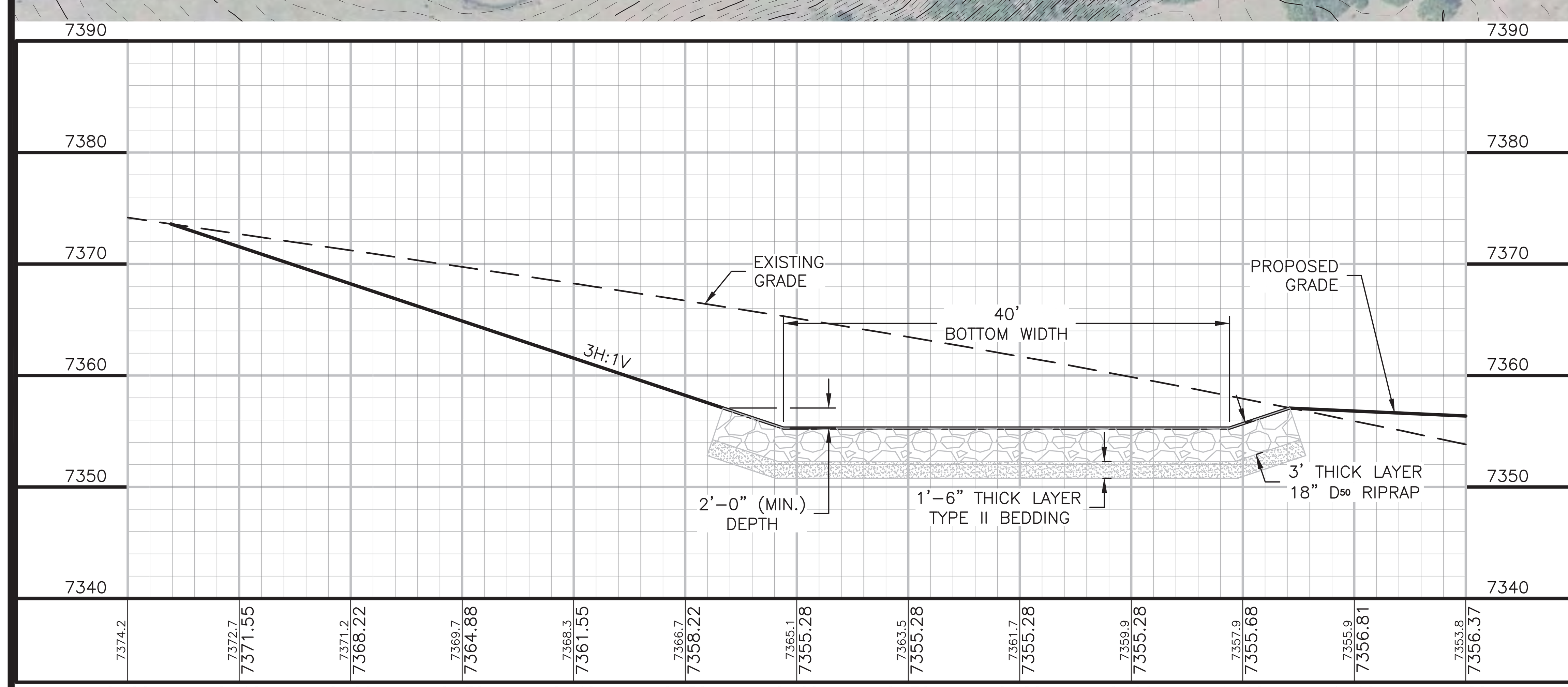


TYPICAL DAM SECTION
SCALE 1" = 200'
1" = 50' VER

DAM FILL VOLUME: 241,959 CY



Height (ft)	Elevation (ft)	Area (ac)	Capacity (ac-ft)
1	7328	0.1	0.1
41	7368	14.1	188.9
45	7372	17.1	251.6
49	7376	20.4	326.0
53	7380	24.2	414.6
57	7384	28.4	519.7
61	7388	34.6	645.8
65	7392	40.9	797.7
69	7396	47.1	974.3
73	7400	54.0	1174.9
77	7404	61.9	1406.0



TYPICAL SPILLWAY SECTION
SCALE 1" = 10' H&V

FEASIBILITY LEVEL CONSTRUCTION PLANS:
DESIGN DRAWINGS WILL SUBSEQUENTLY BE DEVELOPED AND SUBMITTED TO THE STATE FOR APPROVAL FOR CONSTRUCTION

Scale 1" = 200'
1' CONTOUR INTERVAL

200 100 0 200 400 600
SCALE IN FEET

Applegate Group, Inc.
Water Resource Advisors for the West
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Denver, CO 80234
(303) 452-6611
Fax: (303) 452-2759
email: info@applegategroup.com Website: www.applegategroup.com

PROPOSED BRUCE DAM LOCATION

SITE PLAN

CUCHARAS COLLABORATIVE

NO	DATE	BY	CHK'D	DESCRIPTION

REVISIONS

Date: 18/MAY/17
Job No: 16-101
Drawn: LD
Design:
Checked:
Scale: 1" = 200'

Sheet:

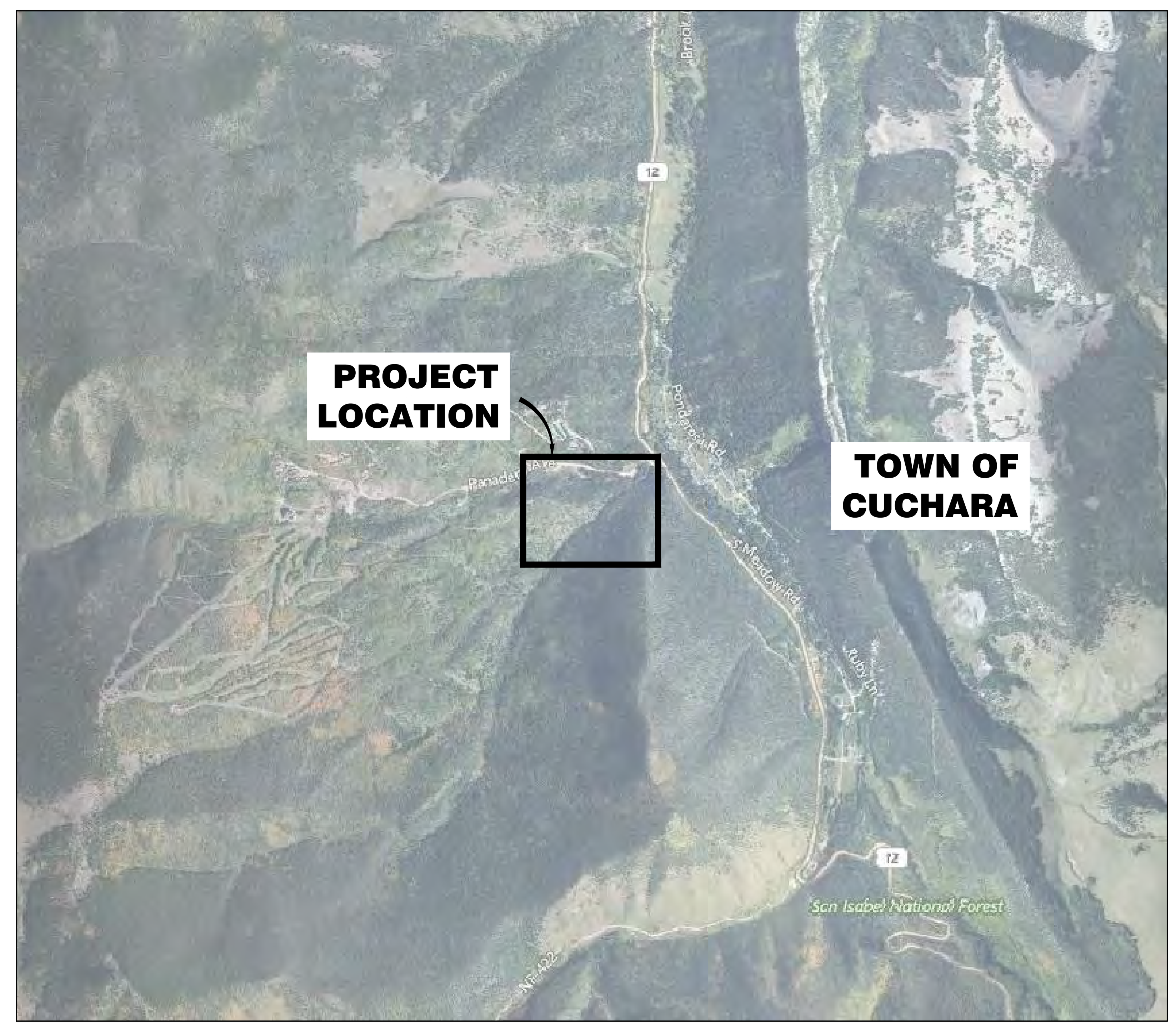
Of:

Filing No. C-

CUCHARAS COLLABORATIVE
SOUTH BAKER CREEK RESERVOIR
FEASIBILITY LEVEL CONSTRUCTION PLANS
HUERFANO COUNTY, COLORADO

MAY, 2017

VICINITY MAP
SCALE 1" = 2000'



2000 1000 0 2000
SCALE IN FEET

OWNER: HUERFANO COUNTY WATER CONSERVANCY DISTRICT
P.O. BOX 442
La Veta, CO 80155
(720) 989-7259

ENGINEER: APPLEGATE GROUP, INC.
1490 W. 121st AVENUE
SUITE 100
DENVER, CO 80234
(303) 452-6611

Sheet List Table

Sheet Number	Sheet Title
1	COVER SHEET
2	SITE PLAN
3	DAM AND SPILLWAY CROSS-SECTIONS
4	SPILLWAY PLAN AND PROFILE

I hereby certify that these plans for the South Baker Creek Reservoir were prepared by me or under my direct supervision for the Cucharas Collaborative.

________________________ Colo. PE No. 43364
Steven A. Smith, P.E.

FEASIBILITY LEVEL CONSTRUCTION PLANS:
DESIGN DRAWINGS WILL SUBSEQUENTLY BE DEVELOPED AND SUBMITTED TO THE STATE FOR APPROVAL FOR CONSTRUCTION

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Fax: (303) 452-2759
email: info@applegategroup.com Website: www.applegategroup.com

SOUTH BAKER CREEK RESERVOIR
COVER SHEET
CUCHARAS COLLABORATIVE

NO	DATE	BY	CHK'D	DESCRIPTION

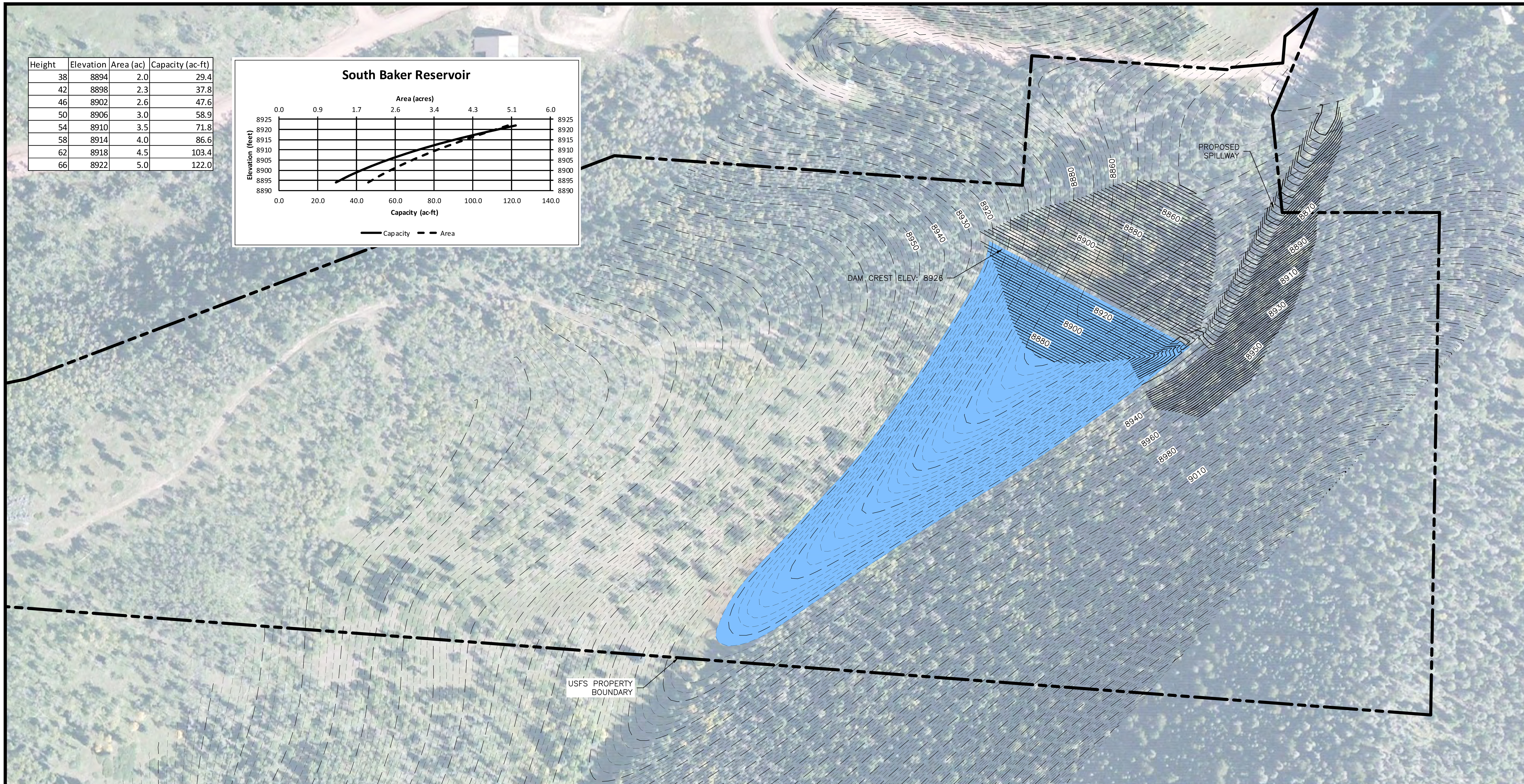
REVISIONS

Date:	05/10/17
Job No:	16-106
Drawn:	TRH
Design:	SS
Checked:	SS
Scale:	AS SHOWN

Sheet: 1
Of: 4

Filing No. C-

Height	Elevation	Area (ac)	Capacity (ac-ft)
38	8894	2.0	29.4
42	8898	2.3	37.8
46	8902	2.6	47.6
50	8906	3.0	58.9
54	8910	3.5	71.8
58	8914	4.0	86.6
62	8918	4.5	103.4
66	8922	5.0	122.0



CUT/FILL VOLUMES FOR DAM AND SPILLWAY COMBINED:

CUT: 16434 CY
FILL: 122437 CY

NET: 106002 CY

FEASIBILITY LEVEL CONSTRUCTION PLANS:
DESIGN DRAWINGS WILL SUBSEQUENTLY BE DEVELOPED AND SUBMITTED TO THE STATE FOR APPROVAL FOR CONSTRUCTION

SCALE 1"=100'
2' CONTOUR INTERVAL

100 50 0 100 200 300
SCALE IN FEET

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email: info@applegategroup.com Website: www.applegategroup.com

SOUTH BAKER CREEK RESERVOIR

SITE PLAN

CUCHARAS COLLABORATIVE

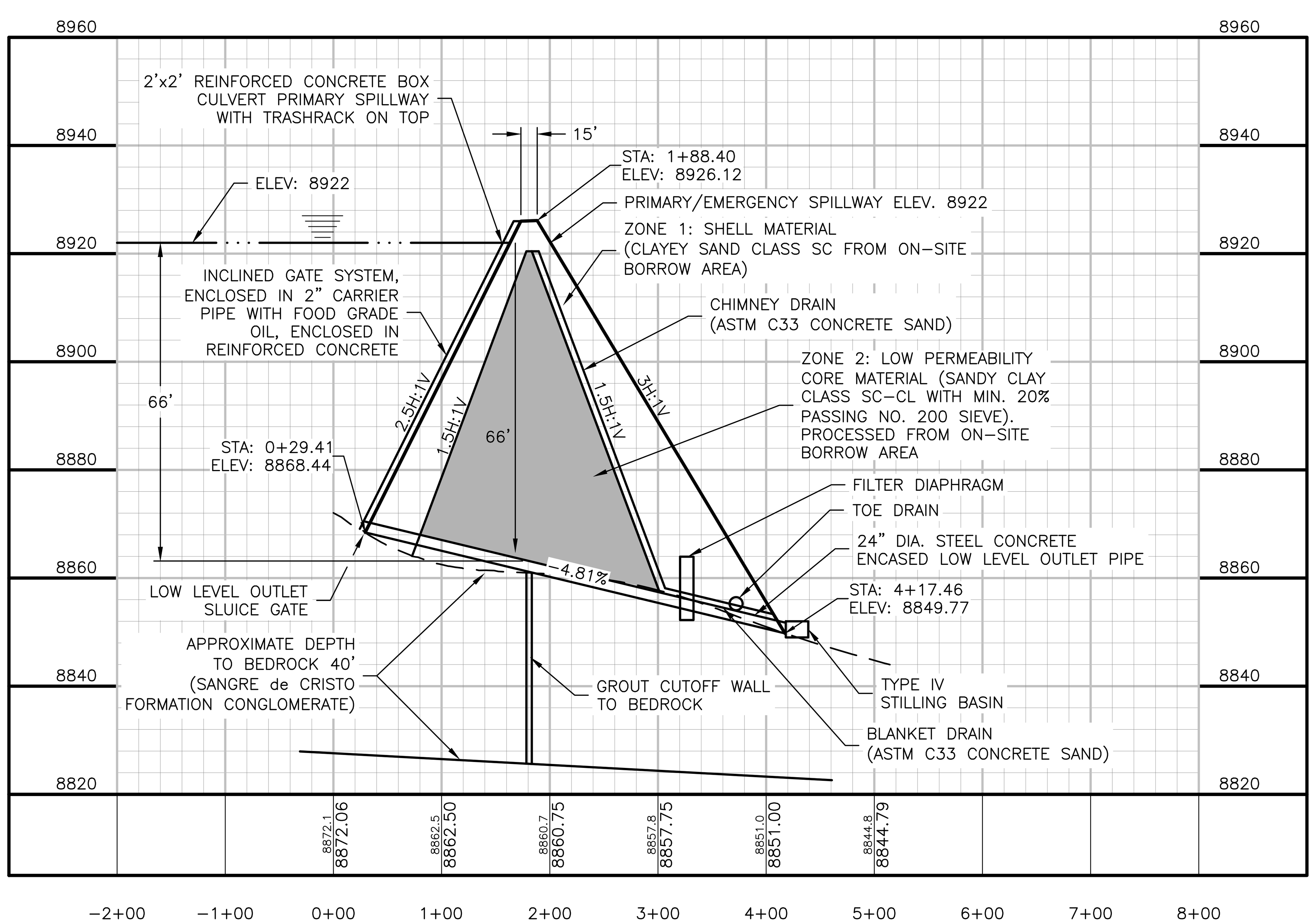
NO	DATE	BY	CHK'D	DESCRIPTION

REVISIONS

Date:	05/10/17
Job No:	16-106
Drawn:	TRH
Design:	SS
Checked:	SS
Scale:	1" = 100'

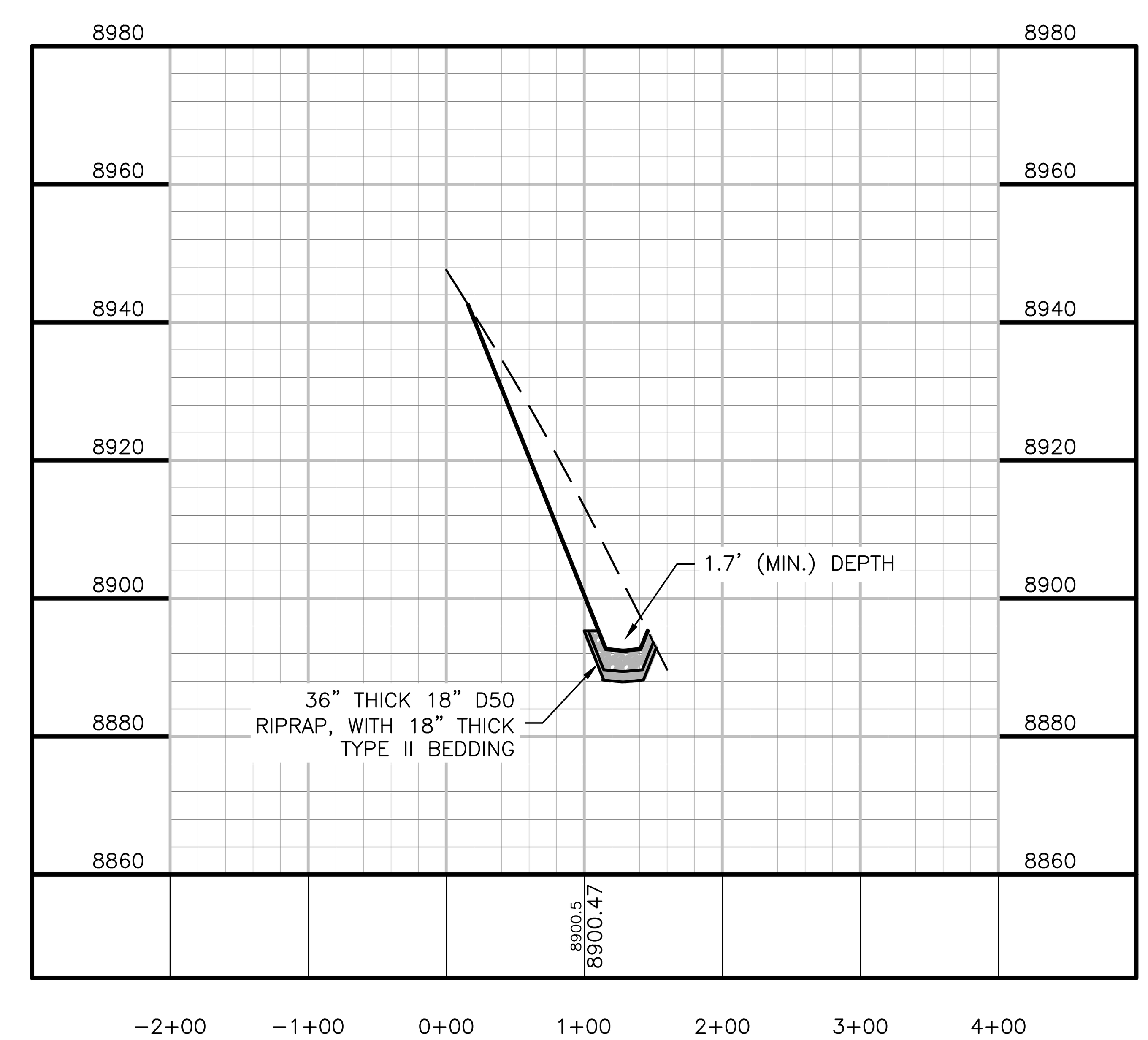
Sheet: 2 Of: 4

Filing No. C-



TYPICAL DAM SECTION
SCALE 1" = 100'
1" = 20' VER

FEASIBILITY LEVEL CONSTRUCTION PLANS: DESIGN DRAWINGS WILL SUBSEQUENTLY BE DEVELOPED AND SUBMITTED TO THE STATE FOR APPROVAL FOR CONSTRUCTION



TYPICAL SPILLWAY SECTION
SCALE 1" = 100'
1" = 20' VER

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SOUTH BAKER CREEK RESERVOIR

DAM AND SPILLWAY TYPICAL CROSS-SECTION

CUCHARAS COLLABORATIVE

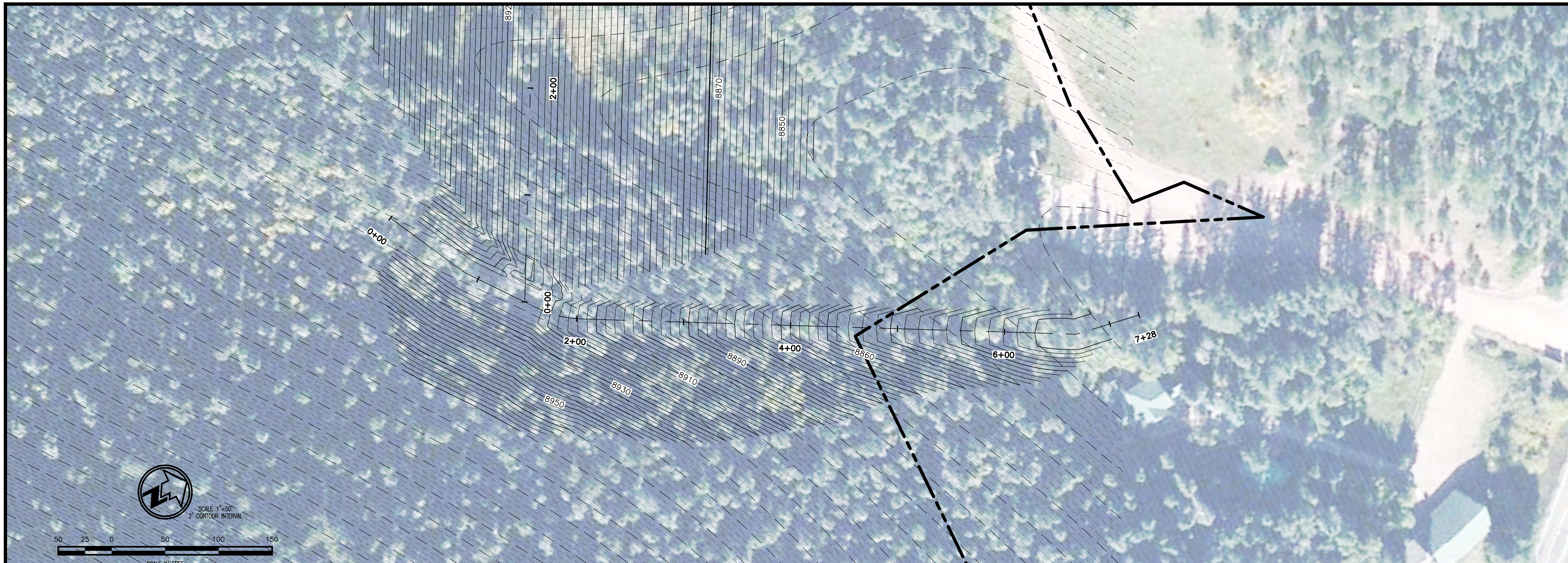
NO	DATE	BY	CHK'D	DESCRIPTION

REVISIONS

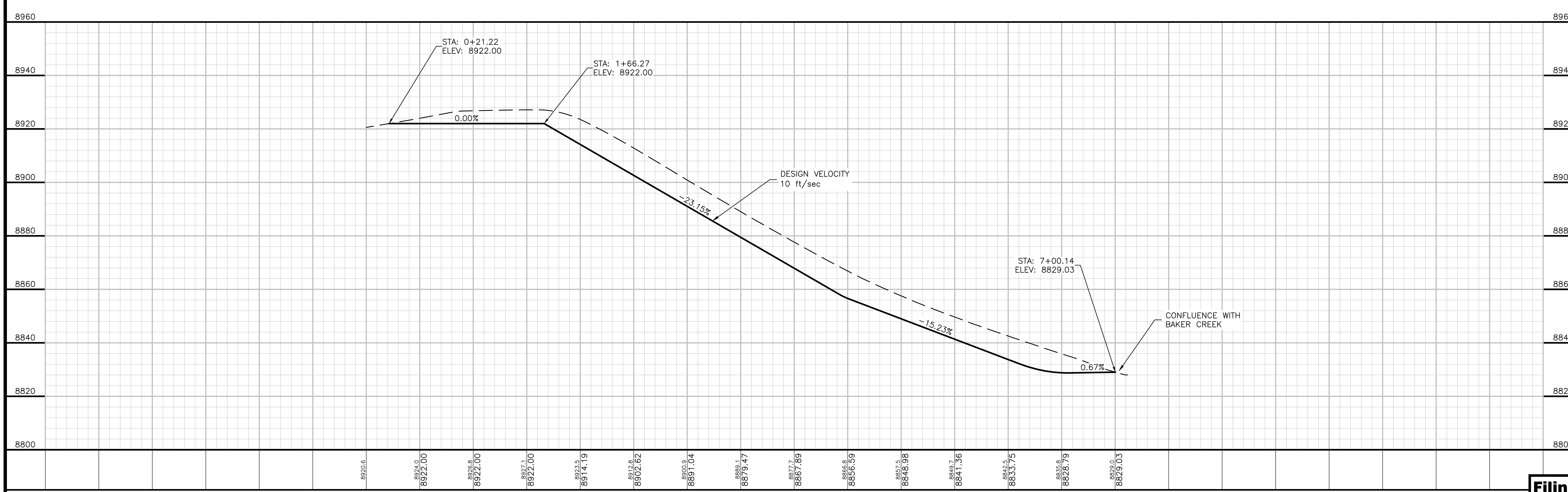
Date: 05/10/17
Job No: 16-106
Drawn: TRH
Design: SS
Checked: SS
Scale: 1" = 100'

Sheet: 3
Of: 4

Filing No. C-



FEASIBILITY LEVEL CONSTRUCTION PLANS:
DESIGN DRAWINGS WILL SUBSEQUENTLY BE DEVELOPED AND SUBMITTED TO THE STATE FOR APPROVAL FOR CONSTRUCTION



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SOUTH BAKER CREEK RESERVOIR

SPILLWAY PLAN AND PROFILE

CUCHARAS COLLABORATIVE

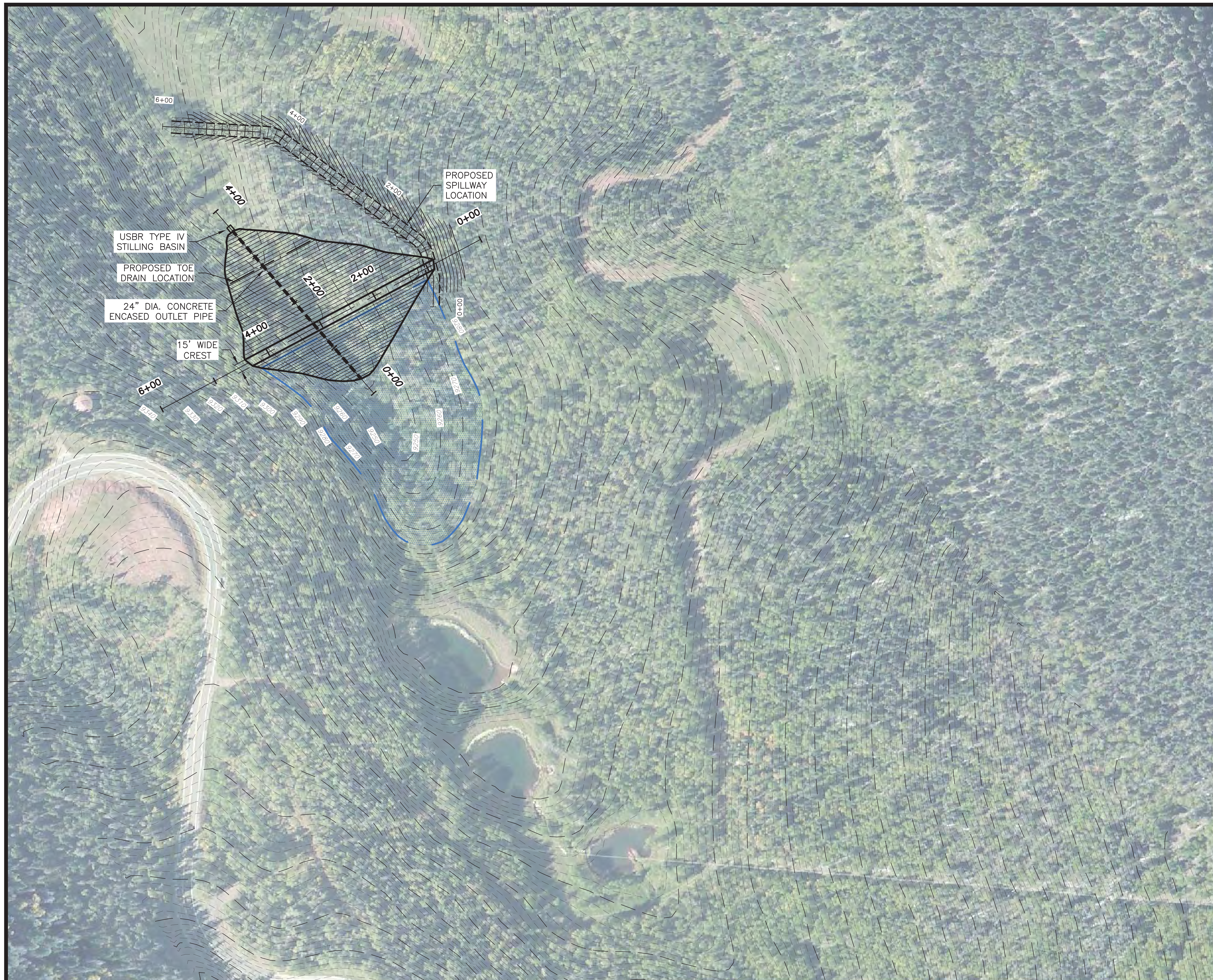
NO	DATE	BY	CHK'D	DESCRIPTION

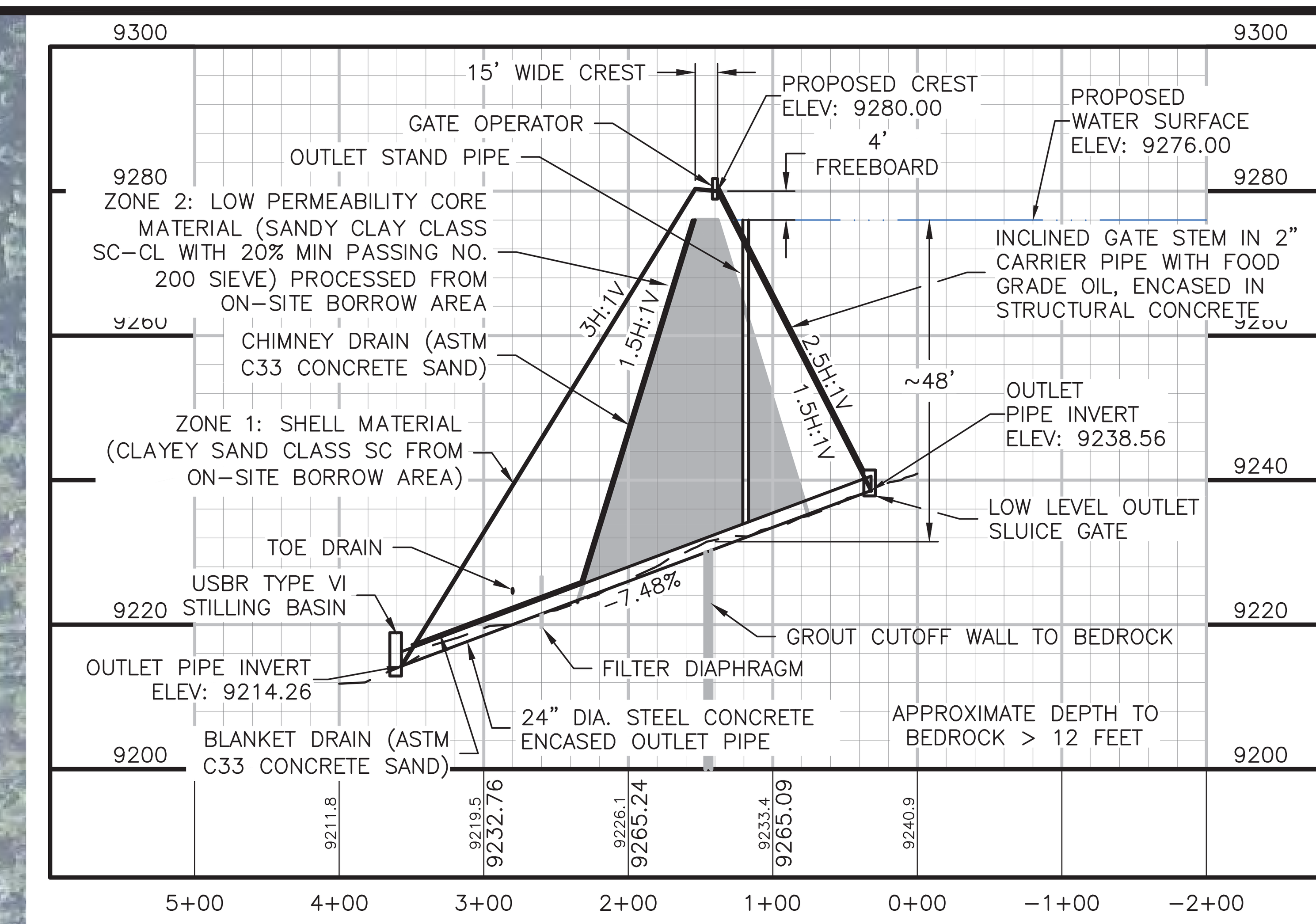
REVISIONS

Date:	05/10/17
Job No:	16-106
Drawn:	TRH
Design:	SS
Checked:	SS
Scale:	1" = 100'

Sheet: 4
Of: 4

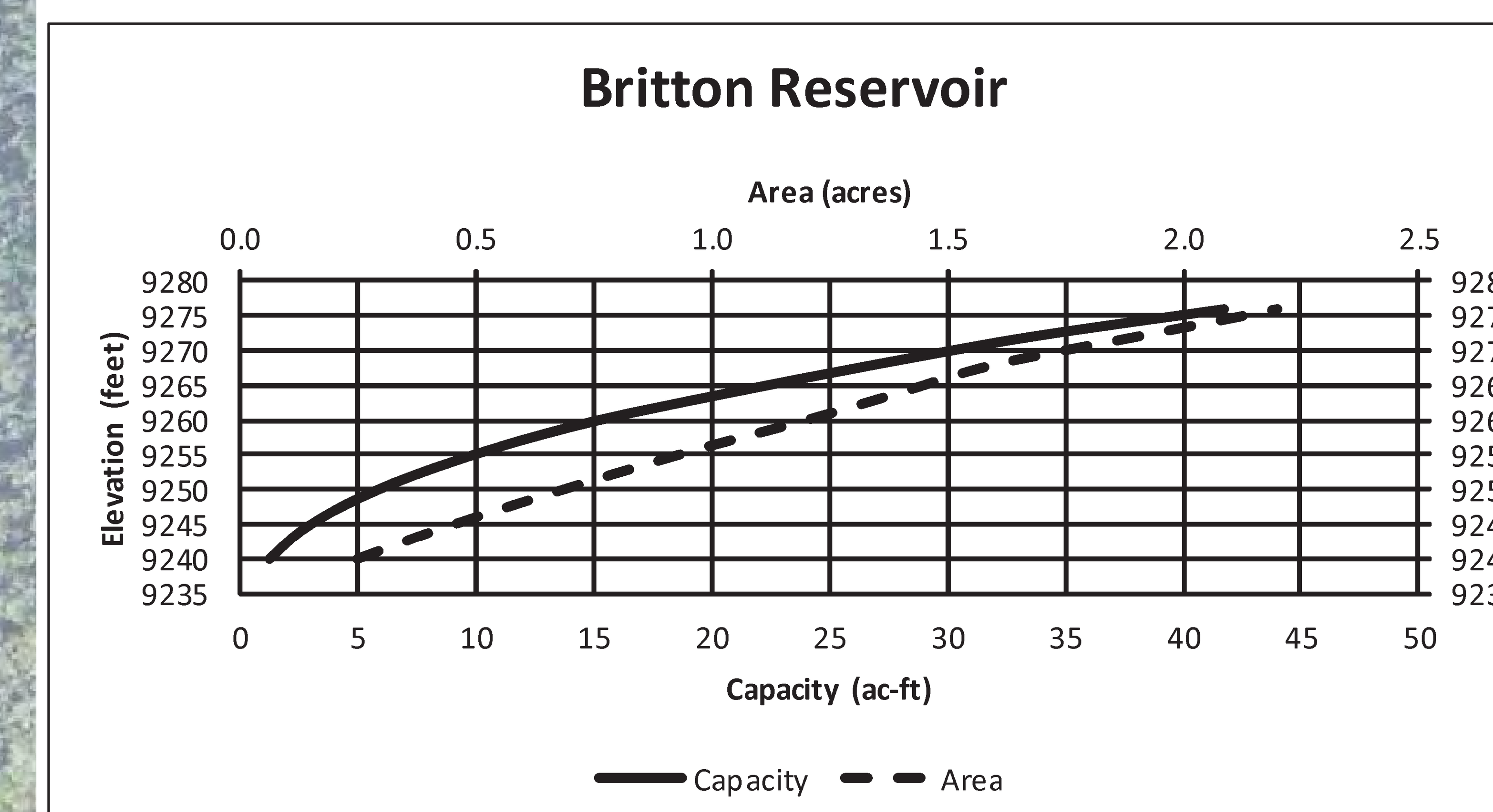
Filing No. C-



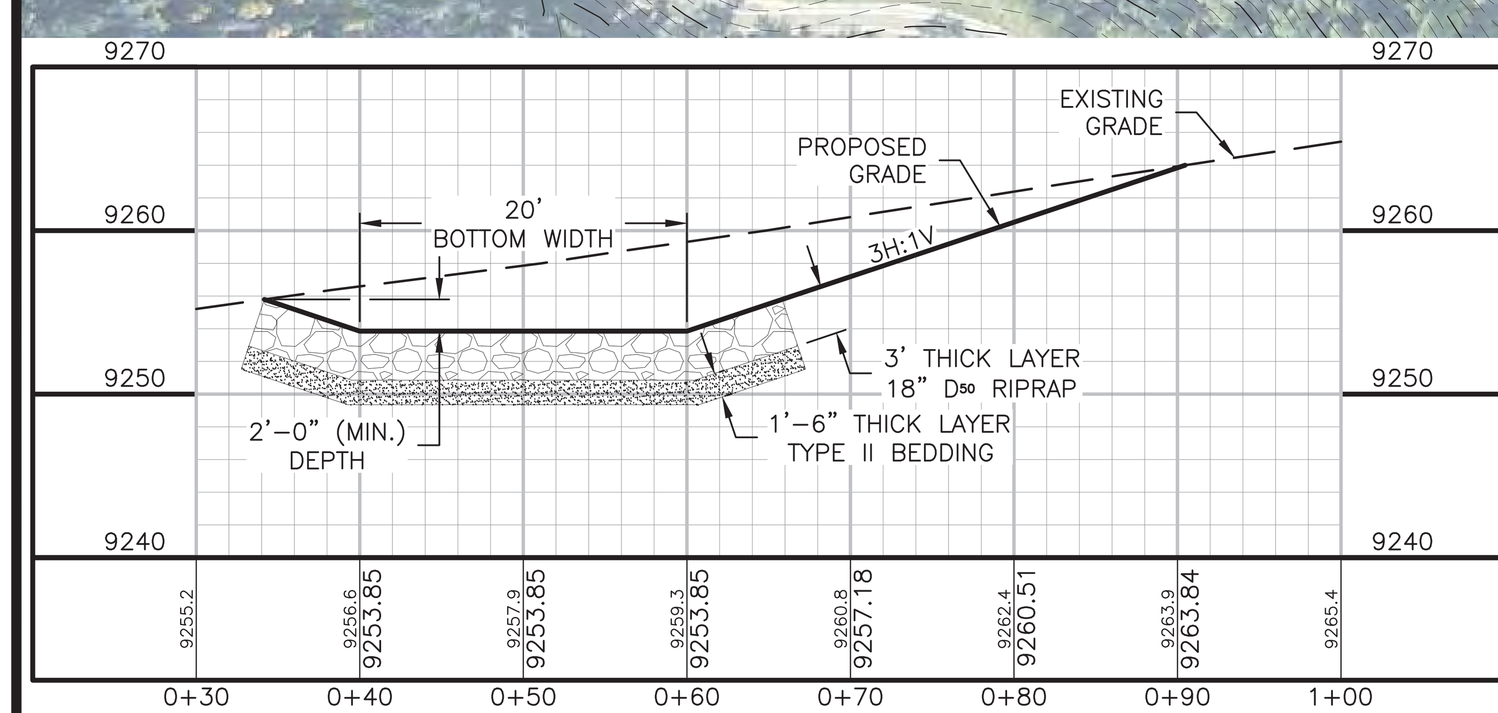


TYPICAL DAM SECTION
SCALE 1" = 100'
1" = 20' VER

DAM FILL VOLUME: 44,858 CY

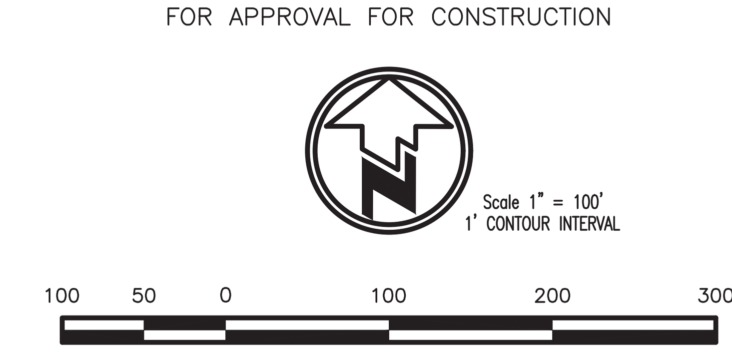


Elevation-Area-Capacity			
Height	Elevation	Area (ac)	Capacity (ac-ft)
12	9240	0.3	1
16	9244	0.4	3
20	9248	0.6	5
24	9252	0.8	7
28	9256	1.0	11
32	9260	1.2	15
36	9264	1.4	21
40	9268	1.6	27
44	9272	1.9	34
48	9276	2.2	42



TYPICAL SPILLWAY SECTION
SCALE 1" = 10' H&V

FEASIBILITY LEVEL CONSTRUCTION PLANS:
DESIGN DRAWINGS WILL SUBSEQUENTLY BE DEVELOPED AND SUBMITTED TO THE STATE FOR APPROVAL FOR CONSTRUCTION



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1490 West 121st Ave., Suite 100
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(303) 452-6611
Fax: (303) 452-2759
email: info@applegategroup.com Website: www.applegategroup.com

PROPOSED BRITTON DAM LOCATION

SITE PLAN AND TYPICAL SECTION

CUCHARAS COLLABORATIVE

NO	DATE	BY	CHK'D	DESCRIPTION

REVISIONS

Date:	18/MAY/17
Job No:	16–101
Drawn:	LD
Design:	
Checked:	
Scale:	1" = 100'

Sheet:

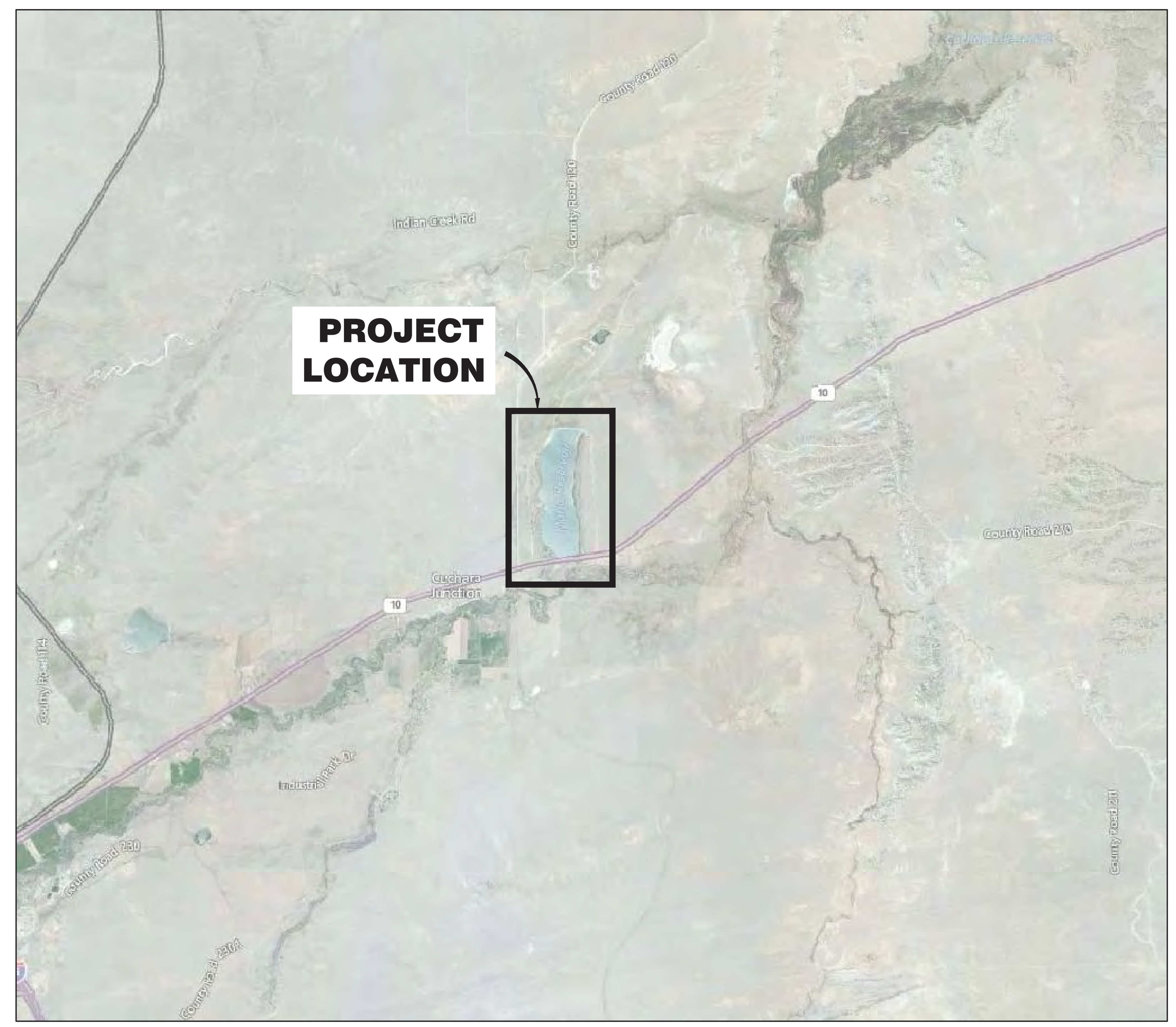
Of:

Filing No. C-

CUCHARAES COLLABORATIVE
MARIA STEVENS DAM ENLARGEMENT
CONSTRUCTION PLANS
HUERFANO COUNTY, COLORADO

MAY, 2017

VICINITY MAP
SCALE 1" = 5000'



5000 2500 0 5000
SCALE IN FEET

Sheet List Table

Sheet Number	Sheet Title
1	COVER SHEET
2	SITE PLAN AND WEST DAM TYPICAL SECTION
3	OUTLET PLAN AND PROFILE
4	SPILLWAY PLAN AND PROFILE

OWNER: **HUERFANO COUNTY WATER CONSERVANCY DISTRICT**
P.O. BOX 442
LA VETA, CO 80155
(719) 989-7259

ENGINEER: **APPLEGATE GROUP, INC.**
1490 W. 121st AVENUE
SUITE 100
DENVER, CO 80234
(303) 452-6611

I hereby certify that these plans for the Marie Stevens Dam Enlargement were prepared by me or under my direct supervision for the Cucharaes Collaborative.

________________________Colo. PE No. 43364
Steven A. Smith, P.E.

FEASIBILITY LEVEL CONSTRUCTION PLANS:
DESIGN DRAWINGS WILL SUBSEQUENTLY BE DEVELOPED AND SUBMITTED TO THE STATE FOR APPROVAL FOR CONSTRUCTION

COLORADO 811
KNOW WHAT'S BELOW. CALL BEFORE YOU DIG.

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Water Resource Advisors for the West
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Denver, CO 80234
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email: info@applegategroup.com Website: www.applegategroup.com

MARIA STEVENS DAM ENLARGEMENT

COVER SHEET

CUCHARAS COLLABORATIVE

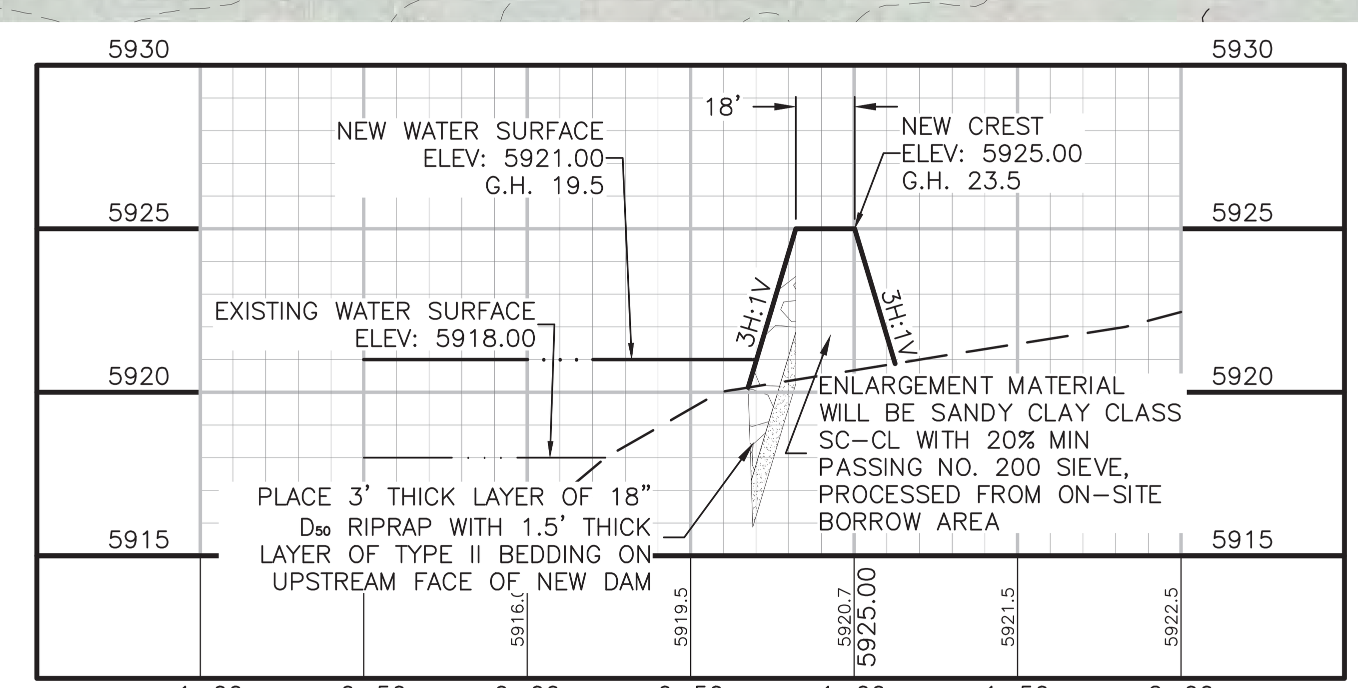
NO	DATE	BY	CHK'D	DESCRIPTION

REVISIONS

Date:	16/MAY/17
Job No:	16-106
Drawn:	LD
Design:	SS
Checked:	
Scale:	As Noted

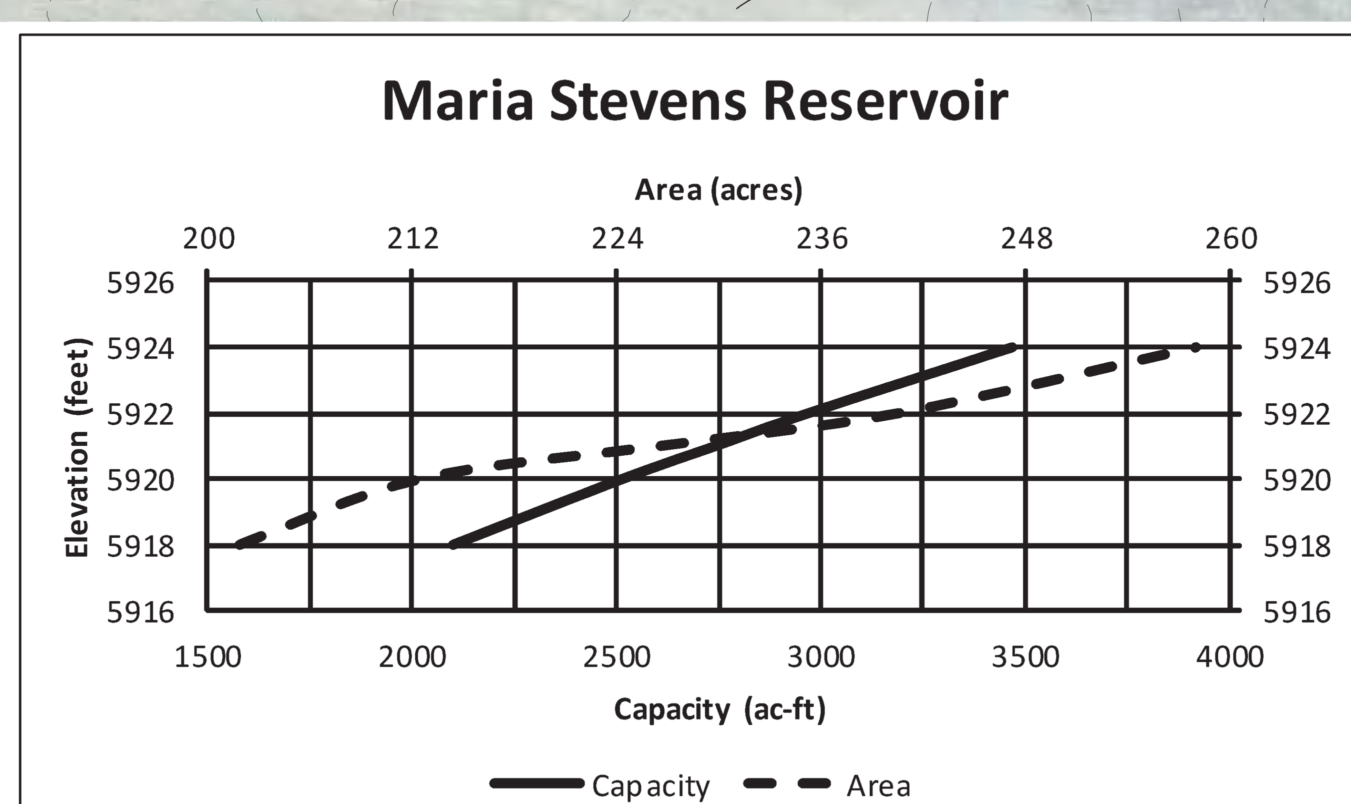
Sheet: **1**
Of:

Filing No. C-

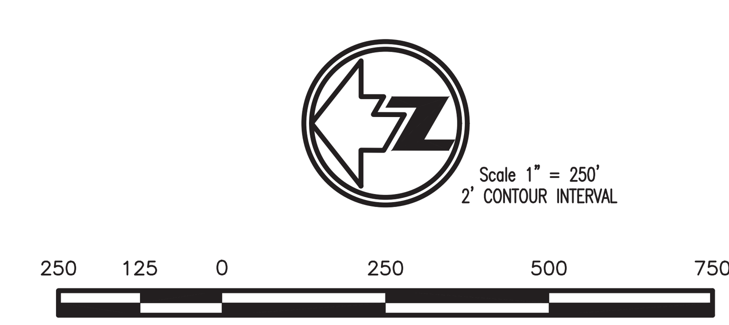


TYPICAL WEST DAM SECTION

SCALE 1" = 50'
1" = 5' VER



Elevation-Area-Capacity				
			Capacity (ac-ft)	
Height (ft)	Elevation (ft)	Area (ac)	Enlarged	Total
16.5	5918	201.9	0	2101
18.5	5920	212.5	414	2515
19.5	5921	226.6	642	2743
20.5	5922	240.6	869	2970
22.5	5924	258.0	1367	3468



NORTH AND WEST DAM GRADING VOLUME: 36,650 CY
SOUTH DAM FILL VOLUME: 11,902 CY

FEASIBILITY LEVEL CONSTRUCTION PLANS:
DESIGN DRAWINGS WILL SUBSEQUENTLY BE DEVELOPED AND SUBMITTED TO THE STATE FOR APPROVAL FOR CONSTRUCTION

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Denver, CO 80234
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Fax: (303) 452-2759
email: info@applegategroup.com Website: www.applegategroup.com

MARIA STEVENS DAM ENLARGEMENT

SITE PLAN AND WEST DAM TYPICAL SECTION

CUCHARAS COLLABORATIVE

NO	DATE	BY	CHK'D	DESCRIPTION

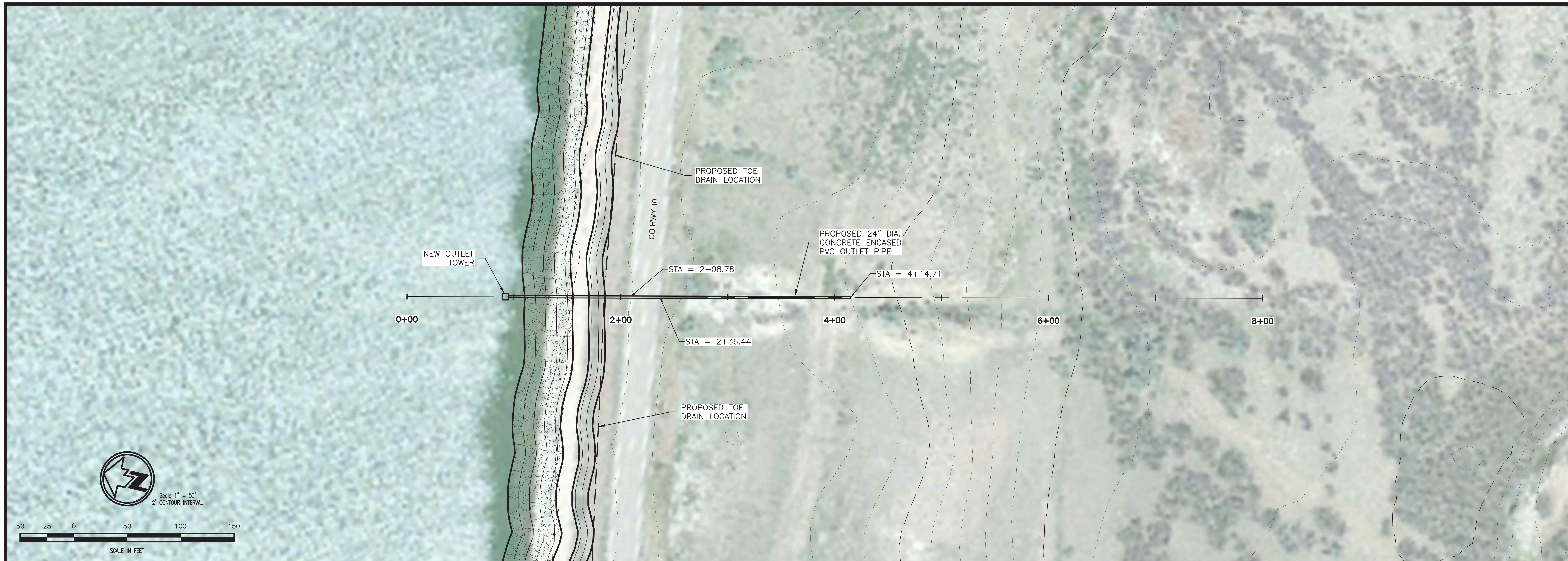
REVISIONS

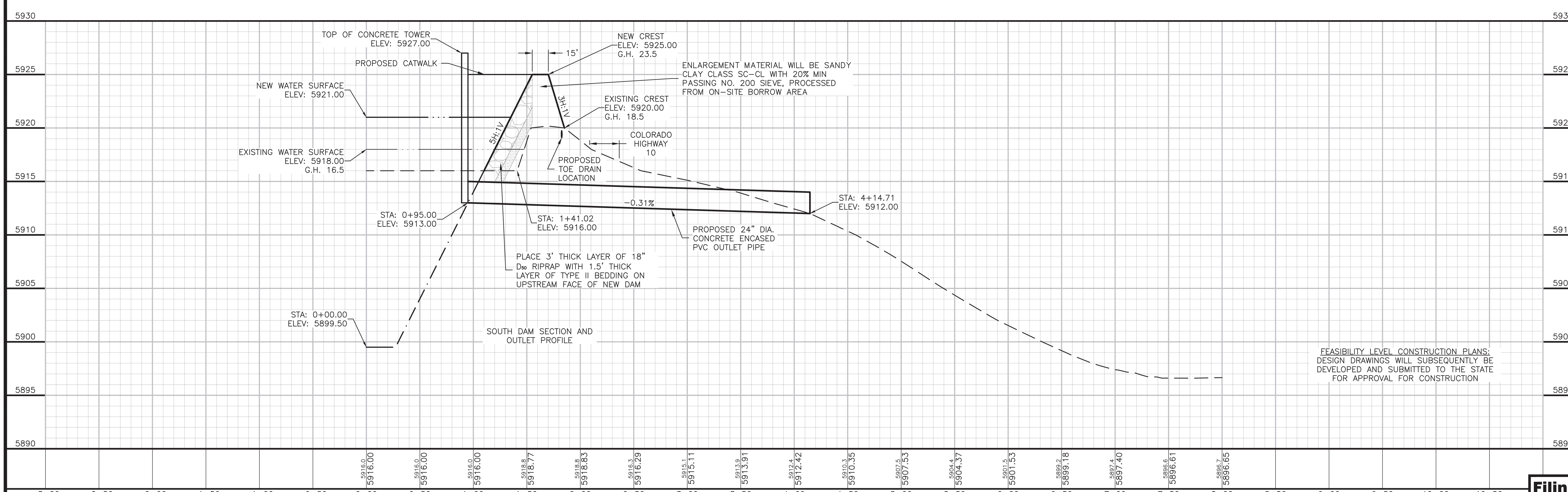
Date: 16/MAY/17
Job No: 16–106
Drawn: LD
Design: SS
Checked:
Scale: 1" = 250'

Sheet: 2

Of:

Filing No. C-





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Denver, CO 80234
(303) 452-6611
Fax: (303) 452-2759
email: info@applegategroup.com Website: www.applegategroup.com

MARIA STEVENS DAM ENLARGEMENT

OUTLET PLAN AND PROFILE

CUCHARAS COLLABORATIVE

NO	DATE	BY	CHK'D	DESCRIPTION

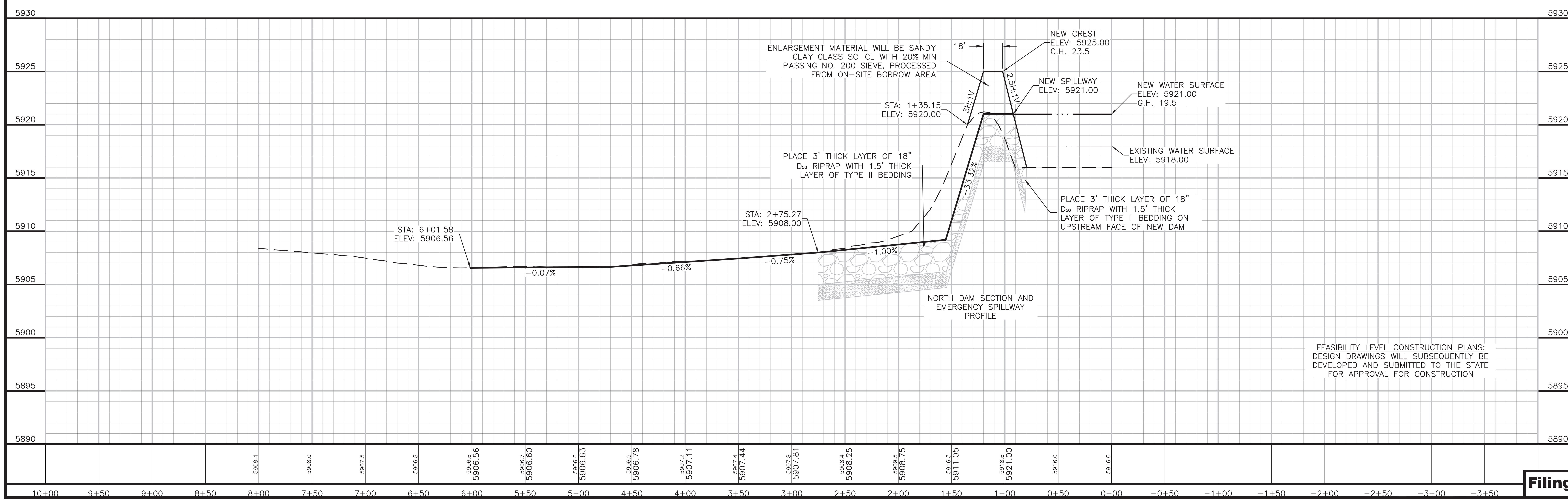
REVISIONS

Date:	16/MAY/17
Job No:	16-106
Drawn:	LD
Design:	SS
Checked:	
Scale:	1" = 50'H / 5'V

Sheet: 3

Of:

Filing No. C-



FEASIBILITY LEVEL CONSTRUCTION PLANS:
DESIGN DRAWINGS WILL SUBSEQUENTLY BE
DEVELOPED AND SUBMITTED TO THE STATE
FOR APPROVAL FOR CONSTRUCTION

Applegate Group, Inc.
Water Resource Advisors for the West
1490 West 121st Ave., Suite 100
Denver, CO 80234
(303) 452-6611
Fax: (303) 452-2759
email: info@applegategroup.com Website: www.applegategroup.com

MARIA STEVENS DAM ENLARGEMENT

SPILLWAY PLAN AND PROFILE

CUCHARAS COLLABORATIVE

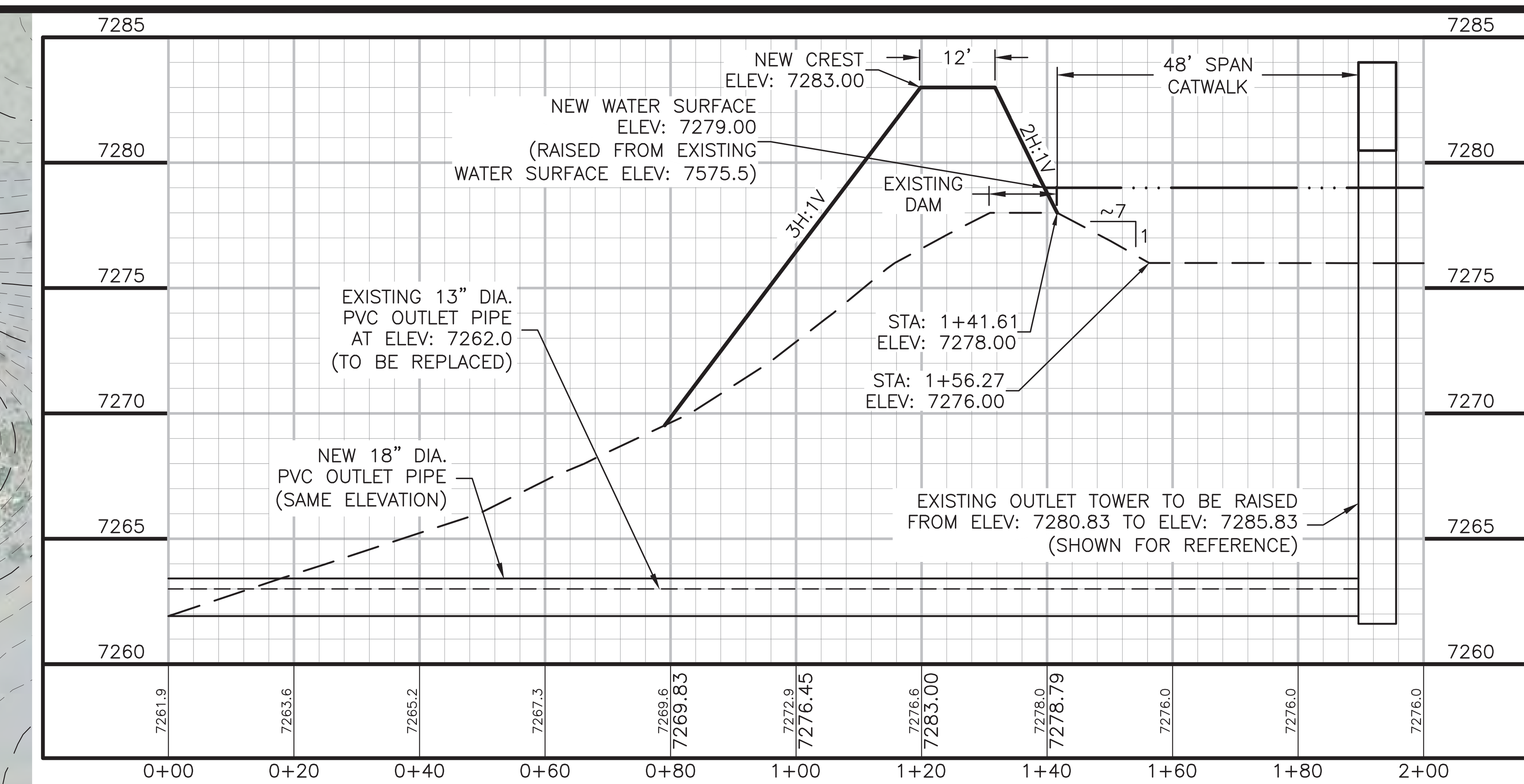
NO	DATE	BY	CHK'D	DESCRIPTION
REVISIONS				

Date:	16/MAY/17
Job No:	16-106
Drawn:	LD
Design:	SS
Checked:	
Scale:	1" = 50'H / 5'V

Sheet: **4**

Of:

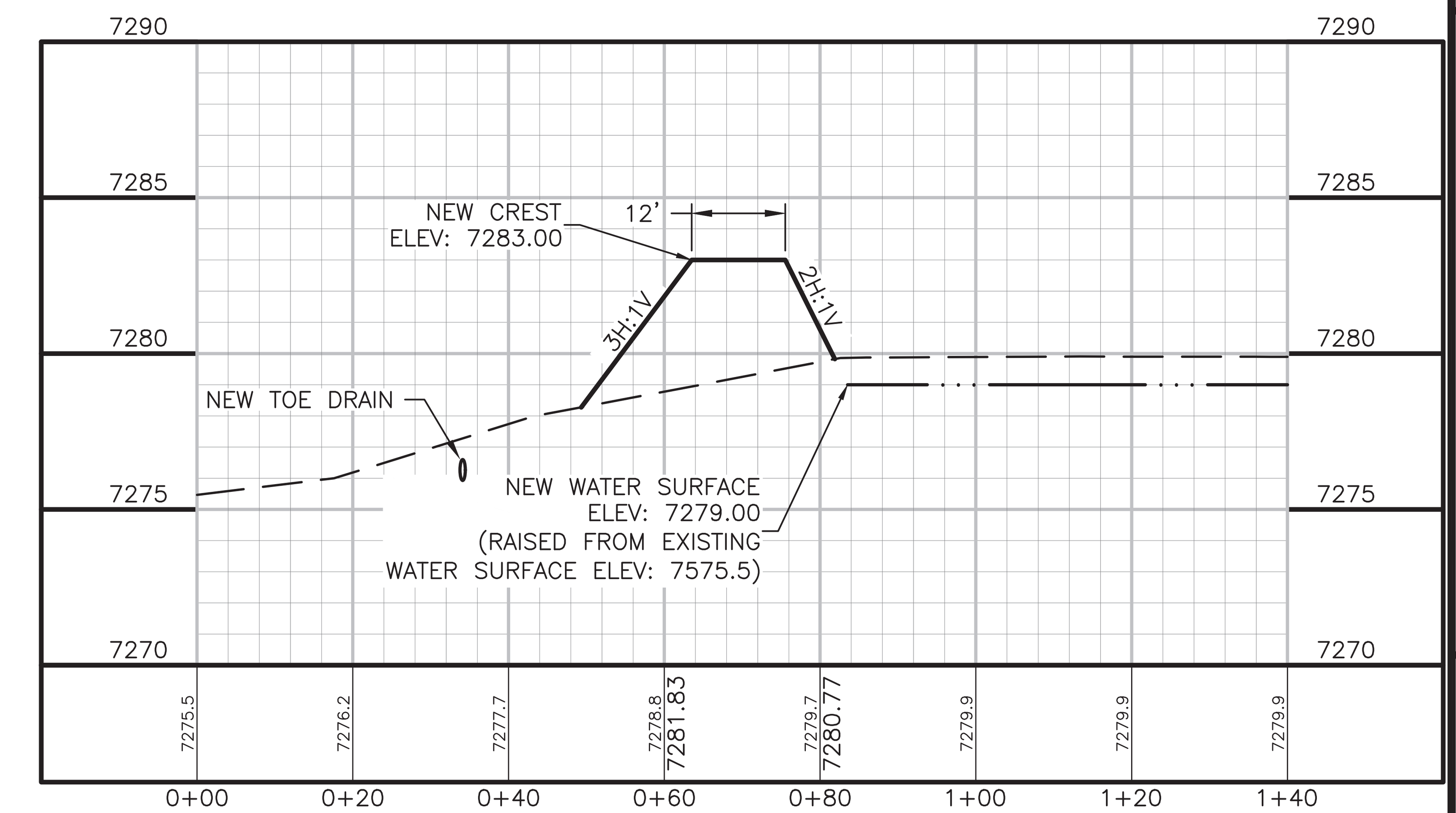
Filing No. **C-**



NORTH DAM TYPICAL SECTION

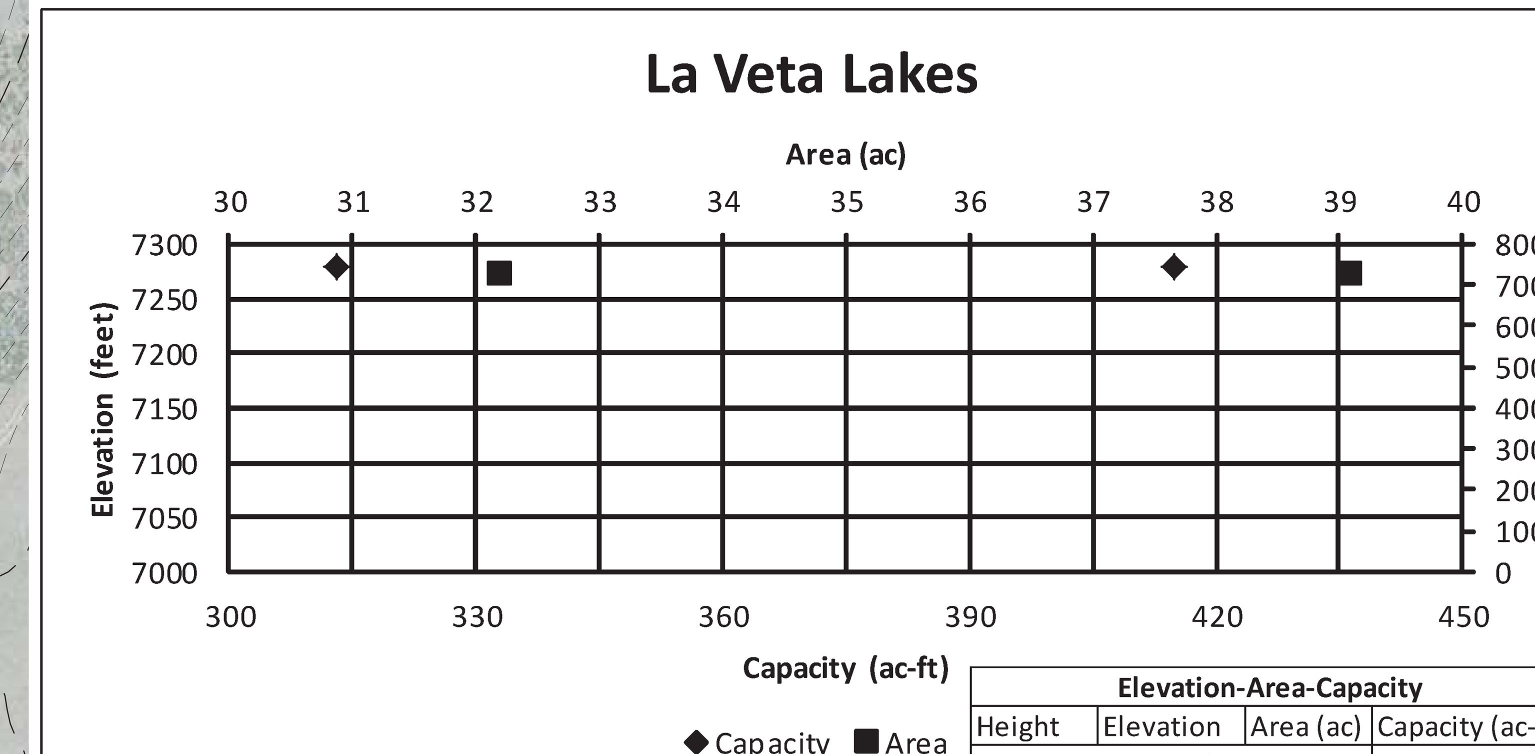
SCALE 1" = 20'
1" = 5' VER

NORTH DAM FILL VOLUME: 10,718 CY
SOUTH DAM FILL VOLUME: 820 CY
EXCAVATION BETWEEN LAKES: 364,407 CY

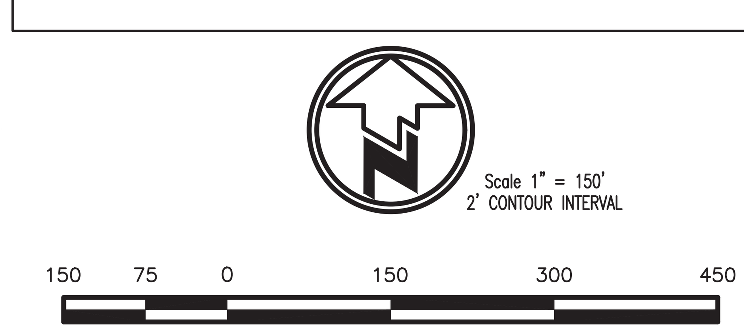


SOUTH DAM TYPICAL SECTION

SCALE 1" = 20'
1" = 5' VER



Elevation-Area-Capacity			
Height	Elevation	Area (ac)	Capacity (ac-ft)
Existing La Veta Lakes			
10	7279	32.2	313
Combined La Veta Lakes			
10	7279	39.1	415



FEASIBILITY LEVEL CONSTRUCTION PLANS:
DESIGN DRAWINGS WILL SUBSEQUENTLY BE DEVELOPED AND SUBMITTED TO THE STATE FOR APPROVAL FOR CONSTRUCTION

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email: info@applegategroup.com Website: www.applegategroup.com

La VETA LAKES ENLARGEMENT

SITE PLAN WITH TYPICAL SECTIONS

CUCHARAS COLLABORATIVE

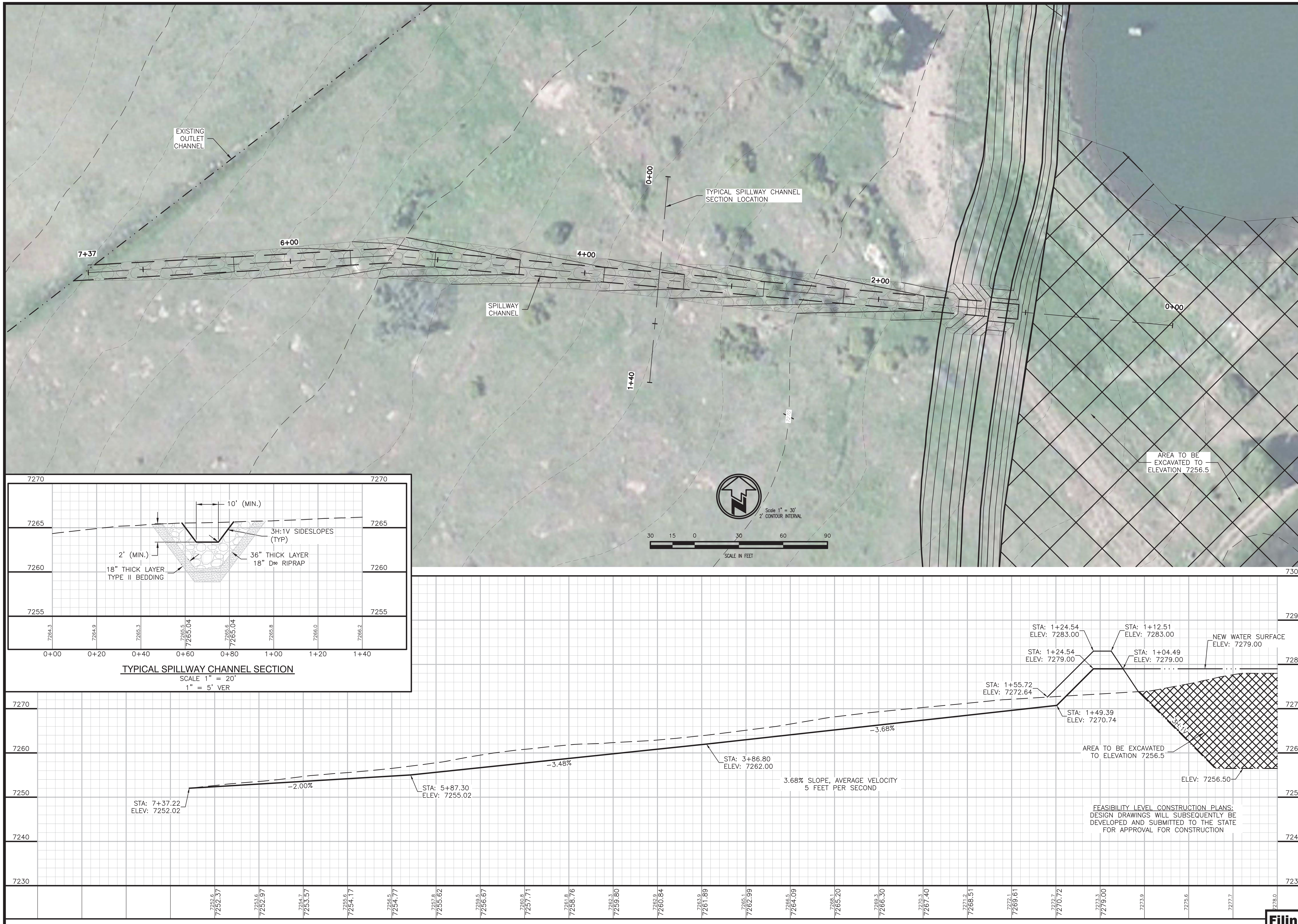
NO	DATE	BY	CHK'D	DESCRIPTION

REVISIONS

Date:	18/MAY/17
Job No:	16-106
Drawn:	LD
Design:	SS
Checked:	
Scale:	As Noted

Sheet: 1
Of:

Filing No. C-



Applegate Group, Inc.
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La VETA LAKES ENLARGEMENT

SPILLWAY PLAN AND PROFILE WITH TYPICAL SECTION

CUCHARAS COLLABORATIVE

NO	DATE	BY	CHK'D	DESCRIPTION

REVISIONS

Date: 18/MAY/17
Job No: 16-106
Drawn: LD
Design: SS
Checked:
Scale: 1" = 30'H / 10'V

Sheet: 2

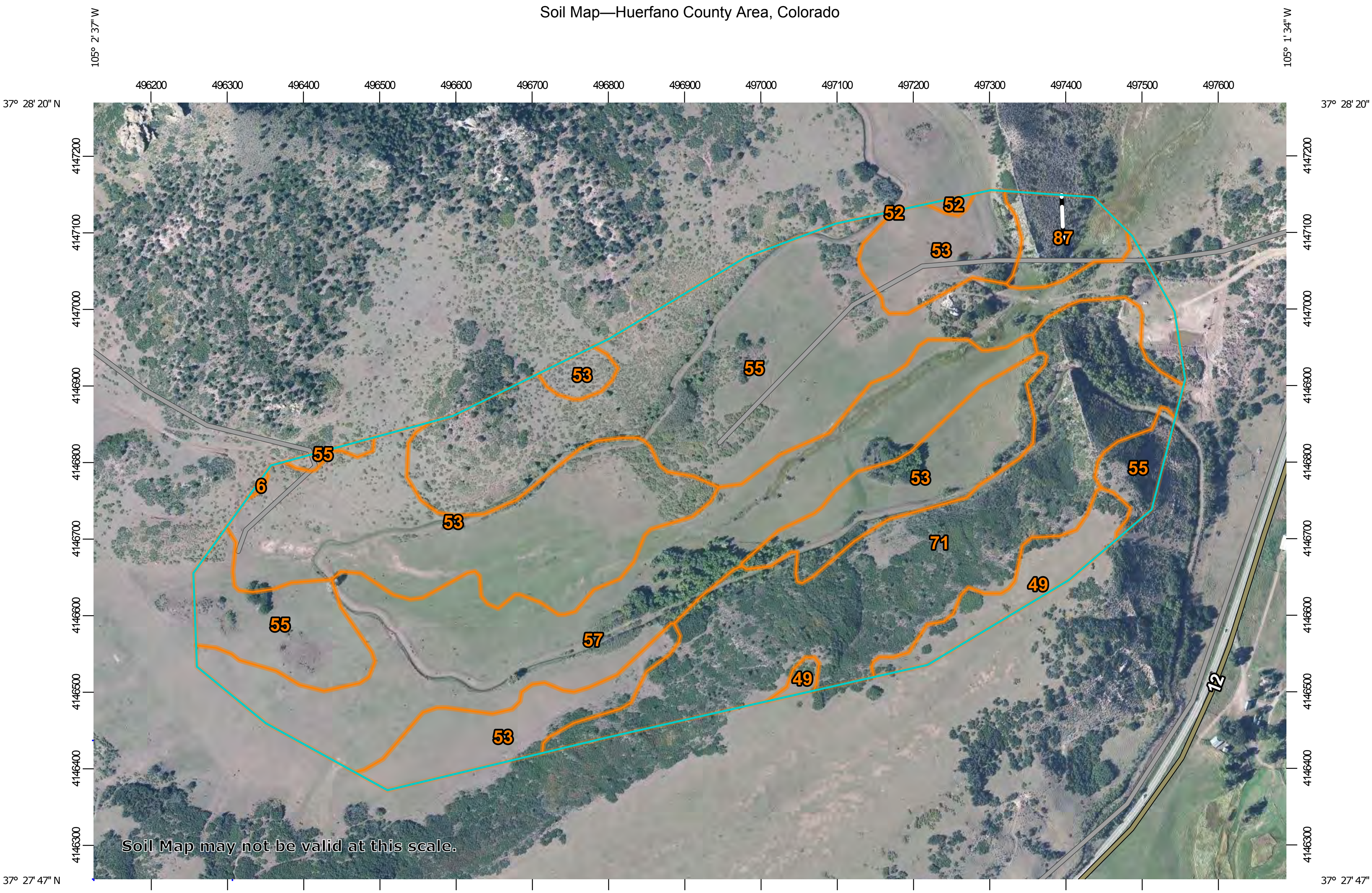
Of:

Filing No. C-

APPENDIX D

SOIL SURVEY REPORTS

Bruce Canyon Soil Map & Classification



Map Scale: 1:7,150 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 100, 200, 400, 600

Feet: 0, 300, 600, 1200, 1800

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huerfano County Area, Colorado
Survey Area Data: Version 13, Sep 23, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

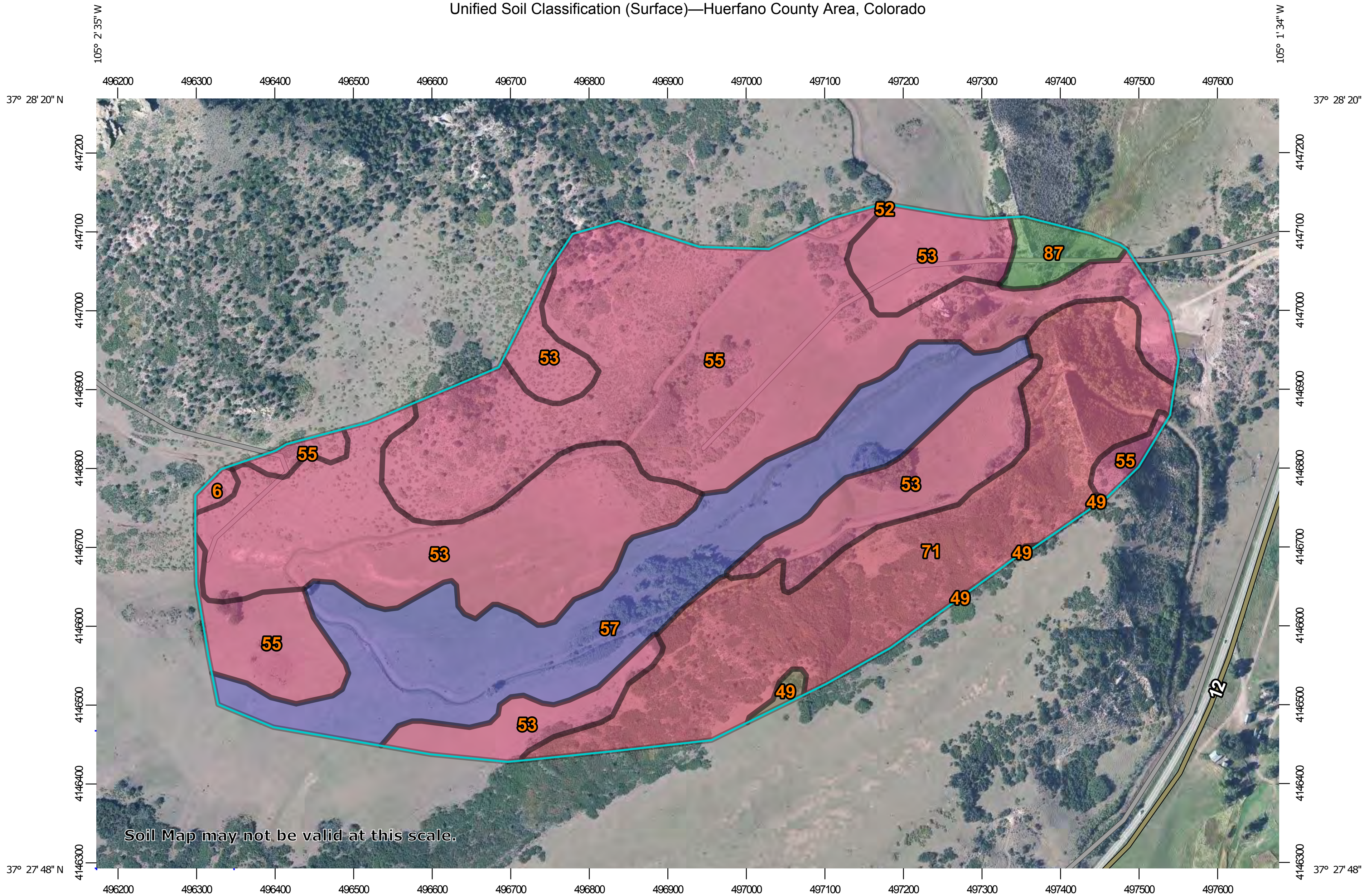
Date(s) aerial images were photographed: Jun 19, 2010—Oct 1, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Huerfano County Area, Colorado (CO627)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
6	Bond-Rock outcrop complex, 15 to 45 percent slopes	0.1	0.0%
49	Morop loam, 2 to 18 percent slopes	4.8	3.1%
52	Noden sandy loam, 1 to 8 percent slopes	0.2	0.2%
53	Noden sandy loam, 8 to 15 percent slopes	42.7	27.5%
55	Noden-Bond sandy loams, 2 to 18 percent slopes	44.0	28.3%
57	Nunn clay loam, 0 to 3 percent slopes	30.3	19.5%
71	Ring cobbly loam, 20 to 45 percent slopes	29.7	19.1%
87	Wahatoya-Rock outcrop complex, 35 to 65 percent slopes	3.6	2.3%
Totals for Area of Interest		**155.3**	**100.0%**

Unified Soil Classification (Surface)—Huerfano County Area, Colorado



Map Scale: 1:6,890 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 100, 200, 400, 600

Feet: 0, 300, 600, 1200, 1800

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

CH
CL
CL-A (proposed)
CL-K (proposed)
CL-ML
CL-O (proposed)
CL-T (proposed)
GC
GC-GM
GM
GP
GP-GC
GP-GM
GW
GW-GC
GW-GM
MH
MH-A (proposed)
MH-K (proposed)
MH-O (proposed)
MH-T (proposed)
ML
ML-A (proposed)
ML-K (proposed)
ML-O (proposed)
ML-T (proposed)
OH
OH-T (proposed)
OL
PT
SC
SC-SM
SM
SP
SP-SC
SP-SM
SW
SW-SC
SW-SM
Not rated or not available

Soil Rating Lines

CH
CL
CL-A (proposed)
CL-K (proposed)
CL-ML
CL-O (proposed)
CL-T (proposed)
GC
GC-GM
GM
GP
GP-GC
GP-GM
GW
GW-GC
GW-GM
MH
MH-A (proposed)
MH-K (proposed)
MH-O (proposed)
MH-T (proposed)
ML
ML-A (proposed)
ML-K (proposed)
ML-O (proposed)
ML-T (proposed)
OH
OH-T (proposed)
OL
PT
SC
SC-SM
SM
SP
SP-SC
SP-SM
SW
SW-SC
SW-SM
Not rated or not available

Soil Rating Points

CH
CL
CL-A (proposed)
CL-K (proposed)
CL-ML
CL-O (proposed)
CL-T (proposed)
GC
GC-GM
GM
GP
GP-GC
GP-GM
GW
GW-GC
GW-GM
MH
MH-A (proposed)
MH-K (proposed)
MH-O (proposed)
MH-T (proposed)
ML
ML-A (proposed)
ML-K (proposed)
ML-O (proposed)
ML-T (proposed)
OH
OH-T (proposed)
OL
PT
SC
SC-SM
SM
SP
SP-SC
SP-SM
SW
SW-SC
SW-SM
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

MAP INFORMATION

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huerfano County Area, Colorado
Survey Area Data: Version 13, Sep 23, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 19, 2010—Oct 1, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Unified Soil Classification (Surface)

Unified Soil Classification (Surface)— Summary by Map Unit — Huerfano County Area, Colorado (CO627)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
6	Bond-Rock outcrop complex, 15 to 45 percent slopes	SC	0.4	0.3%
49	Morop loam, 2 to 18 percent slopes	ML	0.5	0.3%
52	Noden sandy loam, 1 to 8 percent slopes	SC	0.0	0.0%
53	Noden sandy loam, 8 to 15 percent slopes	SC	41.7	28.1%
55	Noden-Bond sandy loams, 2 to 18 percent slopes	SC	47.7	32.1%
57	Nunn clay loam, 0 to 3 percent slopes	CL	27.4	18.4%
71	Ring cobbly loam, 20 to 45 percent slopes	PT	28.7	19.3%
87	Wahatoya-Rock outcrop complex, 35 to 65 percent slopes	GC	2.1	1.4%
Totals for Area of Interest			**148.5**	**100.0%**

Description

The Unified soil classification system classifies mineral and organic mineral soils for engineering purposes on the basis of particle-size characteristics, liquid limit, and plasticity index. It identifies three major soil divisions: (i) coarse-grained soils having less than 50 percent, by weight, particles smaller than 0.074 mm in diameter; (ii) fine-grained soils having 50 percent or more, by weight, particles smaller than 0.074 mm in diameter; and (iii) highly organic soils that demonstrate certain organic characteristics. These divisions are further subdivided into a total of 15 basic soil groups. The major soil divisions and basic soil groups are determined on the basis of estimated or measured values for grain-size distribution and Atterberg limits. ASTM D 2487 shows the criteria chart used for classifying soil in the Unified system and the 15 basic soil groups of the system and the plasticity chart for the Unified system.

The various groupings of this classification correlate in a general way with the engineering behavior of soils. This correlation provides a useful first step in any field or laboratory investigation for engineering purposes. It can serve to make some general interpretations relating to probable performance of the soil for engineering uses.

For each soil horizon in the database one or more Unified soil classifications may be listed. One is marked as the representative or most commonly occurring. The representative classification is shown here for the surface layer of the soil.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

South Baker Soil Map & Classification

Soil Map—Huerfano County Area, Colorado

Map Scale: 1:3,490 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 50, 100, 200, 300

Feet: 0, 150, 300, 600, 900

Map projection: Web Mercator   Corner coordinates: WGS84   Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huerfano County Area, Colorado
Survey Area Data: Version 13, Sep 23, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

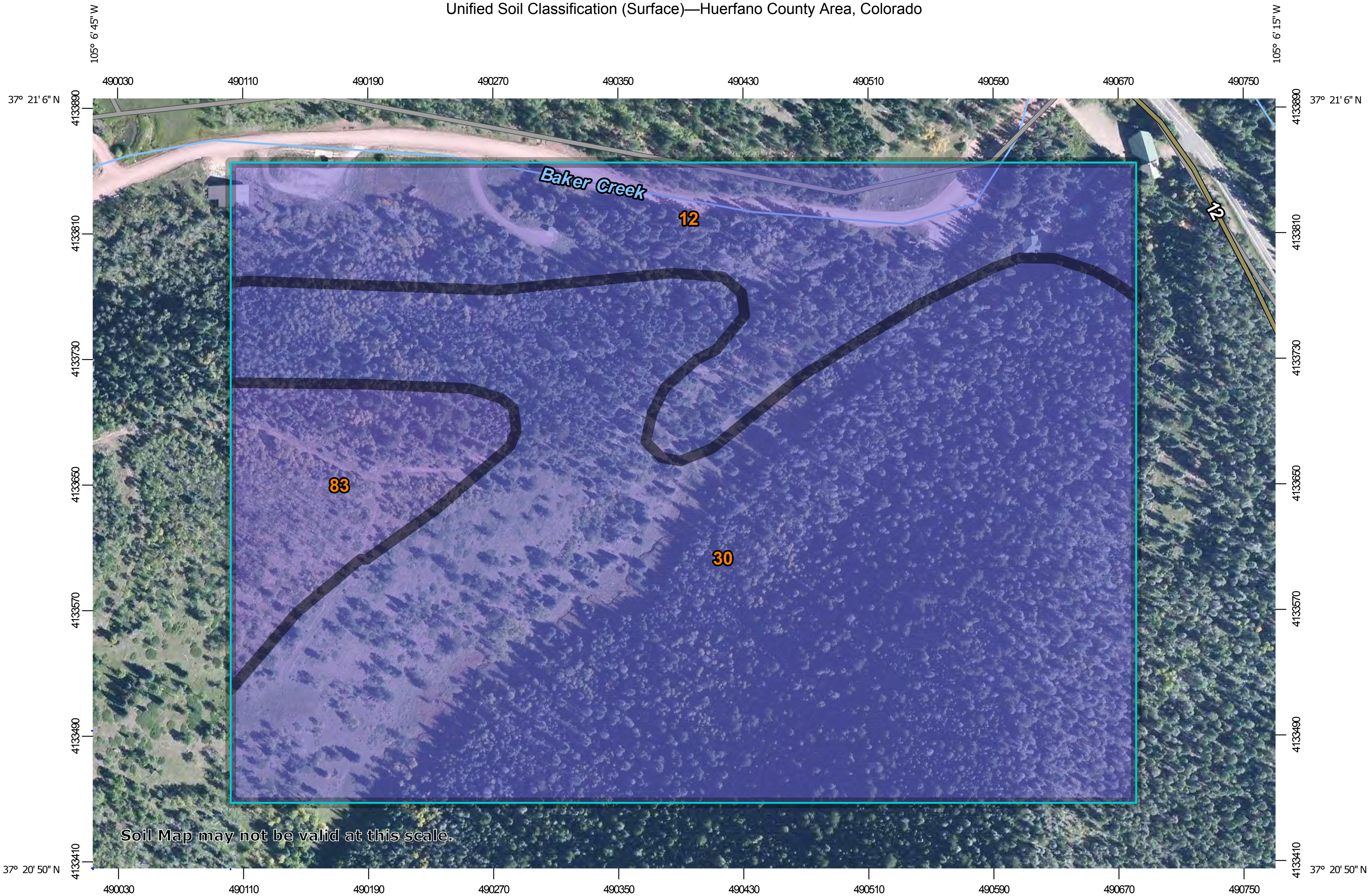
Date(s) aerial images were photographed: Jun 19, 2010—Oct 1, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Huerfano County Area, Colorado (CO627)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
12	Collegiate loam, 1 to 3 percent slopes	13.6	22.8%
30	Leadville fine sandy loam, 25 to 55 percent slopes	40.7	68.4%
83	Uinta-Lakehelen fine sandy loams, 4 to 25 percent slopes	5.3	8.8%
Totals for Area of Interest		**59.5**	**100.0%**

Unified Soil Classification (Surface)—Huerfano County Area, Colorado



Map Scale: 1:3,460 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 50, 100, 200, 300

Feet: 0, 150, 300, 600, 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

CH
CL
CL-A (proposed)
CL-K (proposed)
CL-ML
CL-O (proposed)
CL-T (proposed)
GC
GC-GM
GM
GP
GP-GC
GP-GM
GW
GW-GC
GW-GM
MH
MH-A (proposed)
MH-K (proposed)
MH-O (proposed)
MH-T (proposed)
ML
ML-A (proposed)
ML-K (proposed)
ML-O (proposed)
ML-T (proposed)
OH
OH-T (proposed)
OL
PT
SC
SC-SM
SM
SP
SP-SC
SP-SM
SW
SW-SC
SW-SM
Not rated or not available

Soil Rating Lines

CH
CL
CL-A (proposed)
CL-K (proposed)
CL-ML
CL-O (proposed)
CL-T (proposed)
GC
GC-GM
GM
GP
GP-GC
GP-GM
GW
GW-GC
GW-GM
MH
MH-A (proposed)
MH-K (proposed)
MH-O (proposed)
MH-T (proposed)
ML
ML-A (proposed)
ML-K (proposed)
ML-O (proposed)
ML-T (proposed)
OH
OH-T (proposed)
OL
PT
SC
SC-SM
SM
SP
SP-SC
SP-SM
SW
SW-SC
SW-SM
Not rated or not available

Soil Rating Points

CH
CL
CL-A (proposed)
CL-K (proposed)
CL-ML
CL-O (proposed)
CL-T (proposed)
GC
GC-GM
GM
GP
GP-GC
GP-GM
GW
GW-GC
GW-GM
MH
MH-A (proposed)
MH-K (proposed)
MH-O (proposed)
MH-T (proposed)
ML
ML-A (proposed)
ML-K (proposed)
ML-O (proposed)
ML-T (proposed)
OH
OH-T (proposed)
OL
PT
SC
SC-SM
SM
SP
SP-SC
SP-SM
SW
SW-SC
SW-SM
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

MAP INFORMATION

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huerfano County Area, Colorado
Survey Area Data: Version 13, Sep 23, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 19, 2010—Oct 1, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Unified Soil Classification (Surface)

Unified Soil Classification (Surface)— Summary by Map Unit — Huerfano County Area, Colorado (CO627)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
12	Collegiate loam, 1 to 3 percent slopes	CL	13.0	22.2%
30	Leadville fine sandy loam, 25 to 55 percent slopes	CL	40.7	69.4%
83	Uinta-Lakehelen fine sandy loams, 4 to 25 percent slopes	CL-ML	4.9	8.4%
Totals for Area of Interest			**58.6**	**100.0%**

Description

The Unified soil classification system classifies mineral and organic mineral soils for engineering purposes on the basis of particle-size characteristics, liquid limit, and plasticity index. It identifies three major soil divisions: (i) coarse-grained soils having less than 50 percent, by weight, particles smaller than 0.074 mm in diameter; (ii) fine-grained soils having 50 percent or more, by weight, particles smaller than 0.074 mm in diameter; and (iii) highly organic soils that demonstrate certain organic characteristics. These divisions are further subdivided into a total of 15 basic soil groups. The major soil divisions and basic soil groups are determined on the basis of estimated or measured values for grain-size distribution and Atterberg limits. ASTM D 2487 shows the criteria chart used for classifying soil in the Unified system and the 15 basic soil groups of the system and the plasticity chart for the Unified system.

The various groupings of this classification correlate in a general way with the engineering behavior of soils. This correlation provides a useful first step in any field or laboratory investigation for engineering purposes. It can serve to make some general interpretations relating to probable performance of the soil for engineering uses.

For each soil horizon in the database one or more Unified soil classifications may be listed. One is marked as the representative or most commonly occurring. The representative classification is shown here for the surface layer of the soil.

Rating Options

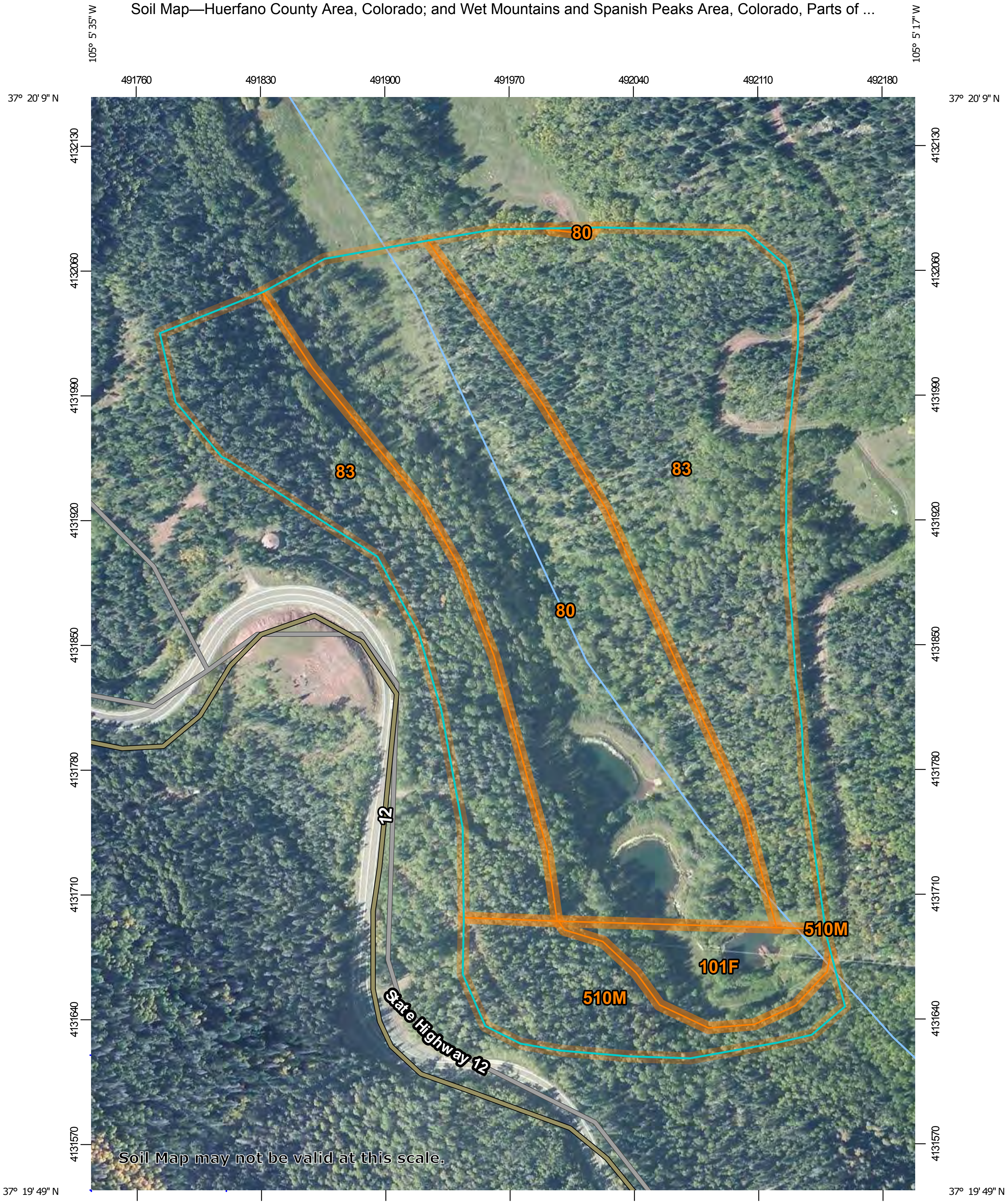
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Britton Soil Map & Classification



Map Scale: 1:2,990 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 40, 80, 160, 240

N

Feet: 0, 100, 200, 400, 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huerfano County Area, Colorado
Survey Area Data: Version 13, Sep 23, 2016

Soil Survey Area: Wet Mountains and Spanish Peaks Area, Colorado, Parts of Custer, Fremont, Huerfano, Las Animas, and Pueblo Counties
Survey Area Data: Version 5, Sep 24, 2014

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

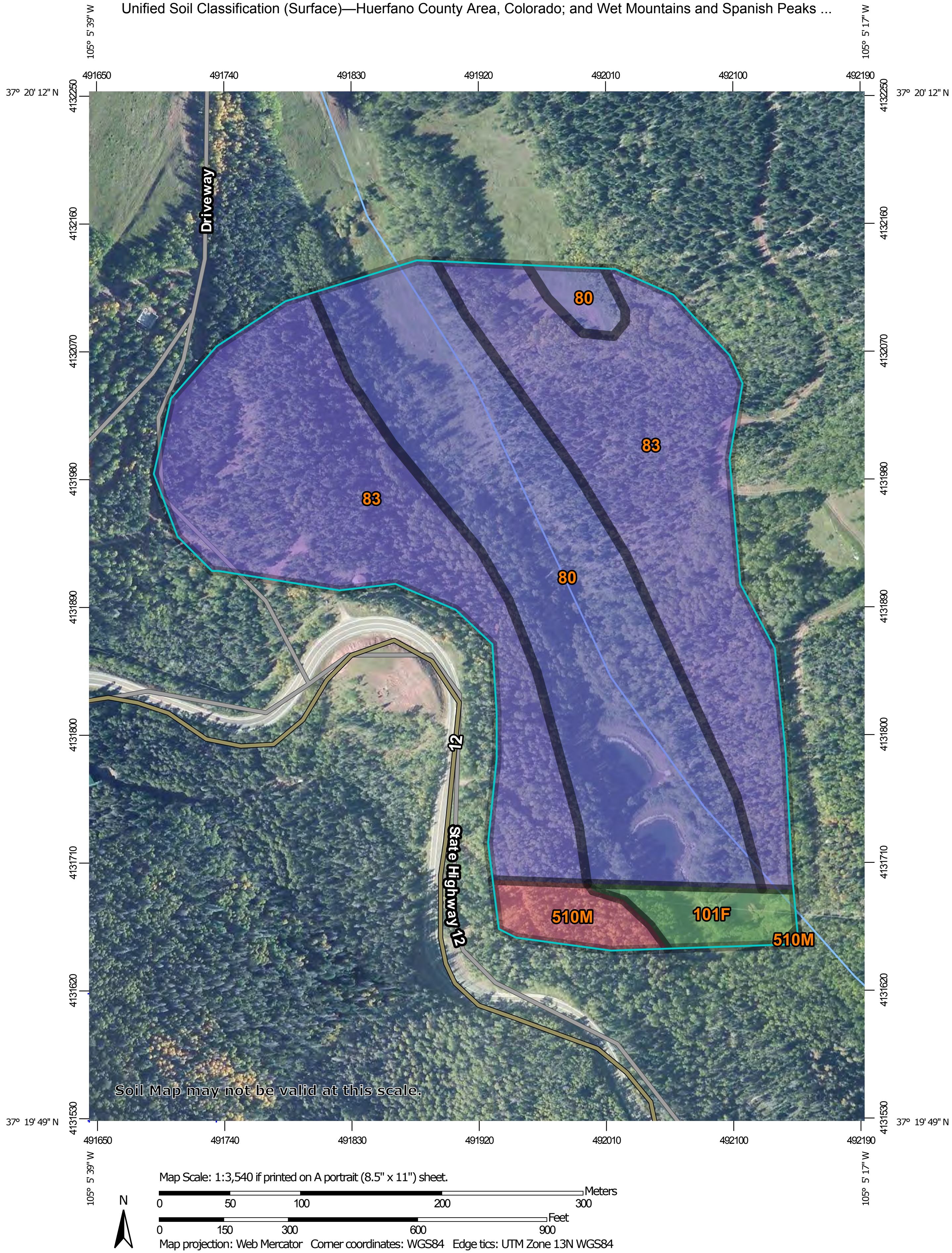
Date(s) aerial images were photographed: Jun 19, 2010—Oct 1, 2010

MAP LEGEND	MAP INFORMATION
	The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Huerfano County Area, Colorado (CO627)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
80	Trag loam, 3 to 12 percent slopes	10.1	36.5%
83	Uinta-Lakehelen fine sandy loams, 4 to 25 percent slopes	14.1	50.8%
Subtotals for Soil Survey Area		**24.2**	**87.3%**
Totals for Area of Interest		**27.7**	**100.0%**

Wet Mountains and Spanish Peaks Area, Colorado, Parts of Custer, Fremont, Huerfano, Las Animas, and Pueblo Counties (CO636)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
101F	Silas family-Cryaquolls association, 0 to 15 percent slopes	1.4	5.0%
510M	Needleton-Ashcroft families complex, 5 to 40 percent slopes	2.1	7.7%
Subtotals for Soil Survey Area		**3.5**	**12.7%**
Totals for Area of Interest		**27.7**	**100.0%**


105° 5' 39" W
105° 5' 17" W
491650
491740
491830
491920
492010
492100
492190
37° 20' 12" N
37° 19' 49" N
4132250
4132160
4132070
4131980
4131890
4131800
4131710
4131620
4131530
Driveway
83
80
83
80
510M
101F
510M
12
State Highway 12
Soil Map may not be valid at this scale.
Map Scale: 1:3,540 if printed on A portrait (8.5" x 11") sheet.
Meters
0
50
100
200
300
Feet
0
150
300
600
900
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- CH
- CL
- CL-A (proposed)
- CL-K (proposed)
- CL-ML
- CL-O (proposed)
- CL-T (proposed)
- GC
- GC-GM
- GM
- GP
- GP-GC
- GP-GM
- GW
- GW-GC
- GW-GM
- MH
- MH-A (proposed)
- MH-K (proposed)
- MH-O (proposed)
- MH-T (proposed)
- ML
- ML-A (proposed)
- ML-K (proposed)
- ML-O (proposed)
- ML-T (proposed)
- OH
- OH-T (proposed)
- OL
- PT
- SC
- SC-SM
- SM
- SP
- SP-SC
- SP-SM
- SW
- SW-SC
- SW-SM
- Not rated or not available

Soil Rating Lines

- CH
- CL
- CL-A (proposed)
- CL-K (proposed)
- CL-ML
- CL-O (proposed)
- CL-T (proposed)
- GC
- GC-GM
- GM
- GP
- GP-GC
- GP-GM
- GW
- GW-GC
- GW-GM
- MH
- MH-A (proposed)
- MH-K (proposed)
- MH-O (proposed)
- MH-T (proposed)
- ML
- ML-A (proposed)
- ML-K (proposed)
- ML-O (proposed)
- ML-T (proposed)
- OH
- OH-T (proposed)
- OL
- PT
- SC
- SC-SM
- SM
- SP
- SP-SC
- SP-SM
- SW
- SW-SC
- SW-SM
- Not rated or not available

Soil Rating Points

- CH
- CL
- CL-A (proposed)
- CL-K (proposed)
- CL-ML
- CL-O (proposed)
- CL-T (proposed)
- GC
- GC-GM
- GM
- GP
- GP-GC
- GP-GM
- GW
- GW-GC
- GW-GM
- MH
- MH-A (proposed)
- MH-K (proposed)
- MH-O (proposed)
- MH-T (proposed)
- ML
- ML-A (proposed)
- ML-K (proposed)
- ML-O (proposed)
- ML-T (proposed)
- OH
- OH-T (proposed)
- OL
- PT
- SC
- SC-SM
- SM
- SP
- SP-SC
- SP-SM
- SW
- SW-SC
- SW-SM
- Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

MAP INFORMATION

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huerfano County Area, Colorado
Survey Area Data: Version 13, Sep 23, 2016

Soil Survey Area: Wet Mountains and Spanish Peaks Area, Colorado, Parts of Custer, Fremont, Huerfano, Las Animas, and Pueblo Counties
Survey Area Data: Version 5, Sep 24, 2014

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 19, 2010—Oct 1, 2010

MAP INFORMATION

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Unified Soil Classification (Surface)

Unified Soil Classification (Surface)— Summary by Map Unit — Huerfano County Area, Colorado (CO627)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
80	Trag loam, 3 to 12 percent slopes	CL	12.1	36.3%
83	Uinta-Lakehelen fine sandy loams, 4 to 25 percent slopes	CL-ML	19.0	57.0%
Subtotals for Soil Survey Area			**31.2**	**93.3%**
Totals for Area of Interest			**33.4**	**100.0%**

Unified Soil Classification (Surface)— Summary by Map Unit — Wet Mountains and Spanish Peaks Area, Colorado, Parts of Custer, Fremont, Huerfano, Las Animas, and Pueblo Counties (CO636)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
101F	Silas family-Cryaquolls association, 0 to 15 percent slopes	GC	1.2	3.5%
510M	Needleton-Ashcroft families complex, 5 to 40 percent slopes	PT	1.1	3.2%
Subtotals for Soil Survey Area			**2.2**	**6.7%**
Totals for Area of Interest			**33.4**	**100.0%**

Description

The Unified soil classification system classifies mineral and organic mineral soils for engineering purposes on the basis of particle-size characteristics, liquid limit, and plasticity index. It identifies three major soil divisions: (i) coarse-grained soils having less than 50 percent, by weight, particles smaller than 0.074 mm in diameter; (ii) fine-grained soils having 50 percent or more, by weight, particles smaller than 0.074 mm in diameter; and (iii) highly organic soils that demonstrate certain organic characteristics. These divisions are further subdivided into a total of 15 basic soil groups. The major soil divisions and basic soil groups are determined on the basis of estimated or measured values for grain-size distribution and Atterberg limits. ASTM D 2487 shows the criteria chart used for classifying soil in the Unified system and the 15 basic soil groups of the system and the plasticity chart for the Unified system.

The various groupings of this classification correlate in a general way with the engineering behavior of soils. This correlation provides a useful first step in any field or laboratory investigation for engineering purposes. It can serve to make some general interpretations relating to probable performance of the soil for engineering uses.

For each soil horizon in the database one or more Unified soil classifications may be listed. One is marked as the representative or most commonly occurring. The representative classification is shown here for the surface layer of the soil.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Maria Stevens Soil Map & Classification


104° 41' 25" W
104° 40' 5" W
527400
527700
528000
528300
528600
528900
529200
37° 41' 21" N
37° 39' 57" N
4171300
4171000
4170700
4170400
4170100
4169800
4169500
4169200
4168900
County Road 120
State Highway 10
10
1
2
17
26
41
77WMC
90
118
WMC
Soil Map may not be valid at this scale.
Map Scale: 1:12,600 if printed on A portrait (8.5" x 11") sheet.
Meters
0
150
300
600
900
Feet
0
500
1000
2000
3000
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huerfano County Area, Colorado
Survey Area Data: Version 13, Sep 23, 2016

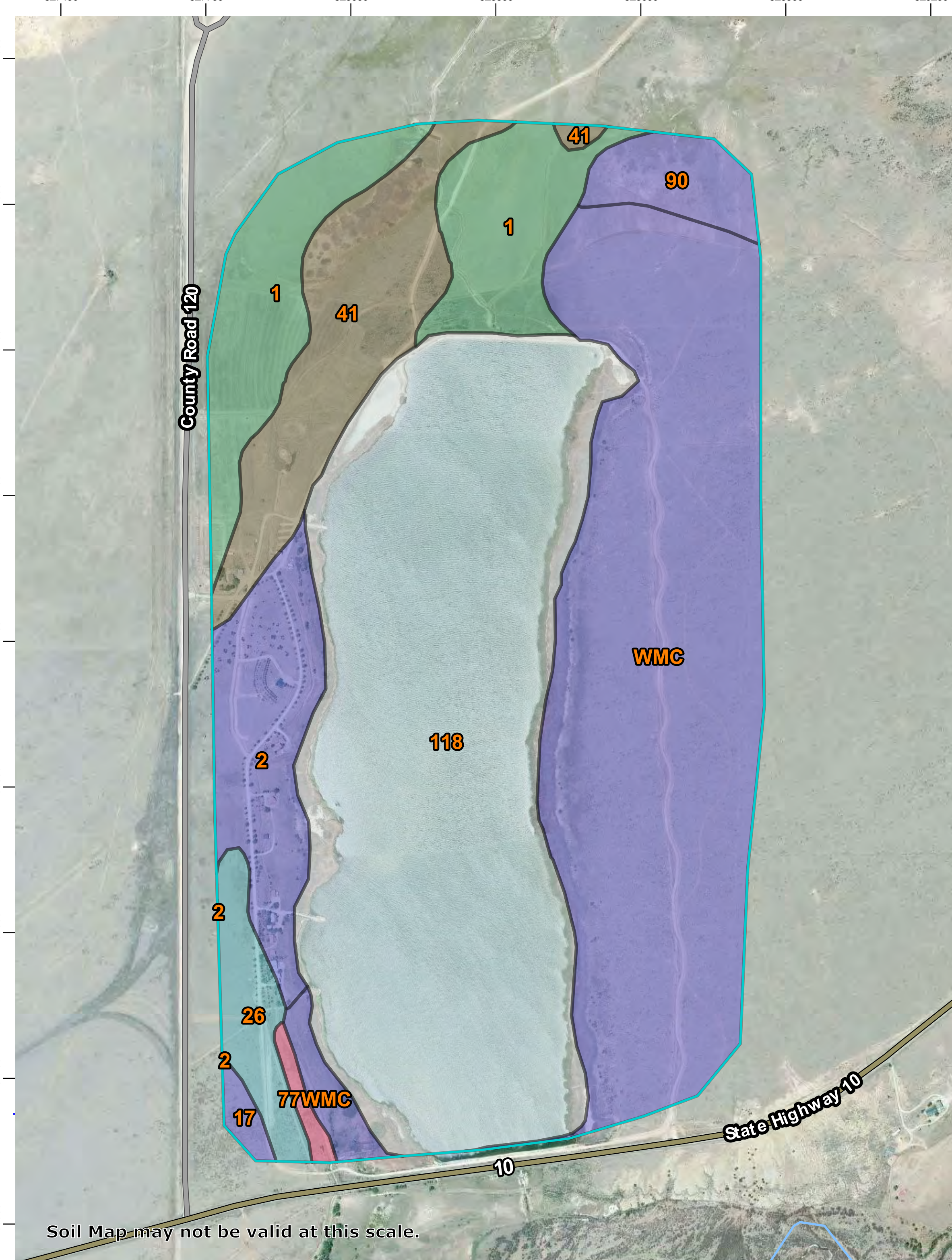
Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 10, 2011—Jun 9, 2011

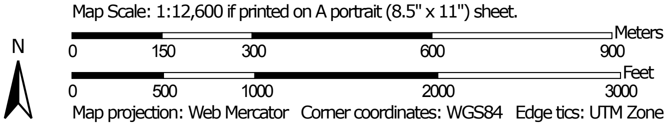
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Huerfano County Area, Colorado (CO627)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1	Apishapa silty clay	58.1	10.2%
2	Baca silt loam, 0 to 3 percent slopes, cool	35.4	6.2%
17	Fort Collins loam, 1 to 3 percent slopes	2.8	0.5%
26	Kim fine sandy loam, 3 to 9 percent slopes	14.4	2.5%
41	Manvel silty clay loam saline, 1 to 5 percent slopes	45.8	8.1%
77	Schamber-Midway complex, 3 to 25 percent slopes	2.5	0.4%
90	Wiley silt loam, 0 to 3 percent slopes, cool	12.9	2.3%
118	Water	212.8	37.5%
WMC	Minqwet-Wiley silt loams, 1 to 4 percent slopes, cool	182.4	32.2%
Totals for Area of Interest		**567.3**	**100.0%**



Map Scale: 1:12,600 if printed on A portrait (8.5" x 11") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- CH
- CL
- CL-A (proposed)
- CL-K (proposed)
- CL-ML
- CL-O (proposed)
- CL-T (proposed)
- GC
- GC-GM
- GM
- GP
- GP-GC
- GP-GM
- GW
- GW-GC
- GW-GM
- MH
- MH-A (proposed)
- MH-K (proposed)
- MH-O (proposed)
- MH-T (proposed)
- ML
- ML-A (proposed)
- ML-K (proposed)
- ML-O (proposed)
- ML-T (proposed)
- OH
- OH-T (proposed)
- OL
- PT
- SC
- SC-SM
- SM
- SP
- SP-SC
- SP-SM
- SW
- SW-SC
- SW-SM
- Not rated or not available

Soil Rating Lines

- CH
- CL
- CL-A (proposed)
- CL-K (proposed)
- CL-ML
- CL-O (proposed)
- CL-T (proposed)
- GC
- GC-GM
- GM
- GP
- GP-GC
- GP-GM
- GW
- GW-GC
- GW-GM
- MH
- MH-A (proposed)
- MH-K (proposed)
- MH-O (proposed)
- MH-T (proposed)
- ML
- ML-A (proposed)
- ML-K (proposed)
- ML-O (proposed)
- ML-T (proposed)
- OH
- OH-T (proposed)
- OL
- PT
- SC
- SC-SM
- SM
- SP
- SP-SC
- SP-SM
- SW
- SW-SC
- SW-SM
- Not rated or not available

Soil Rating Points

- CH
- CL
- CL-A (proposed)
- CL-K (proposed)
- CL-ML
- CL-O (proposed)
- CL-T (proposed)
- GC
- GC-GM
- GM
- GP
- GP-GC
- GP-GM
- GW
- GW-GC
- GW-GM
- MH
- MH-A (proposed)
- MH-K (proposed)
- MH-O (proposed)
- MH-T (proposed)
- ML
- ML-A (proposed)
- ML-K (proposed)
- ML-O (proposed)
- ML-T (proposed)
- OH
- OH-T (proposed)
- OL
- PT
- SC
- SC-SM
- SM
- SP
- SP-SC
- SP-SM
- SW
- SW-SC
- SW-SM
- Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

MAP INFORMATION

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

The soil surveys that comprise your AOI were mapped at 1:24,000.

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Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huerfano County Area, Colorado
Survey Area Data: Version 13, Sep 23, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 10, 2011—Jun 9, 2011

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Unified Soil Classification (Surface)

Unified Soil Classification (Surface)— Summary by Map Unit — Huerfano County Area, Colorado (CO627)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
1	Apishapa silty clay	CH	58.1	10.2%
2	Baca silt loam, 0 to 3 percent slopes, cool	CL	35.4	6.2%
17	Fort Collins loam, 1 to 3 percent slopes	CL	2.8	0.5%
26	Kim fine sandy loam, 3 to 9 percent slopes	SM	14.4	2.5%
41	Manvel silty clay loam saline, 1 to 5 percent slopes	ML	45.8	8.1%
77	Schamber-Midway complex, 3 to 25 percent slopes	SC	2.5	0.4%
90	Wiley silt loam, 0 to 3 percent slopes, cool	CL	12.9	2.3%
118	Water		212.8	37.5%
WMC	Minqwet-Wiley silt loams, 1 to 4 percent slopes, cool	CL	182.4	32.2%
Totals for Area of Interest			**567.3**	**100.0%**

Description

The Unified soil classification system classifies mineral and organic mineral soils for engineering purposes on the basis of particle-size characteristics, liquid limit, and plasticity index. It identifies three major soil divisions: (i) coarse-grained soils having less than 50 percent, by weight, particles smaller than 0.074 mm in diameter; (ii) fine-grained soils having 50 percent or more, by weight, particles smaller than 0.074 mm in diameter; and (iii) highly organic soils that demonstrate certain organic characteristics. These divisions are further subdivided into a total of 15 basic soil groups. The major soil divisions and basic soil groups are determined on the basis of estimated or measured values for grain-size distribution and Atterberg limits. ASTM D 2487 shows the criteria chart used for classifying soil in the Unified system and the 15 basic soil groups of the system and the plasticity chart for the Unified system.

The various groupings of this classification correlate in a general way with the engineering behavior of soils. This correlation provides a useful first step in any field or laboratory investigation for engineering purposes. It can serve to make some general interpretations relating to probable performance of the soil for engineering uses.

For each soil horizon in the database one or more Unified soil classifications may be listed. One is marked as the representative or most commonly occurring. The representative classification is shown here for the surface layer of the soil.

Rating Options

Aggregation Method: Dominant Condition

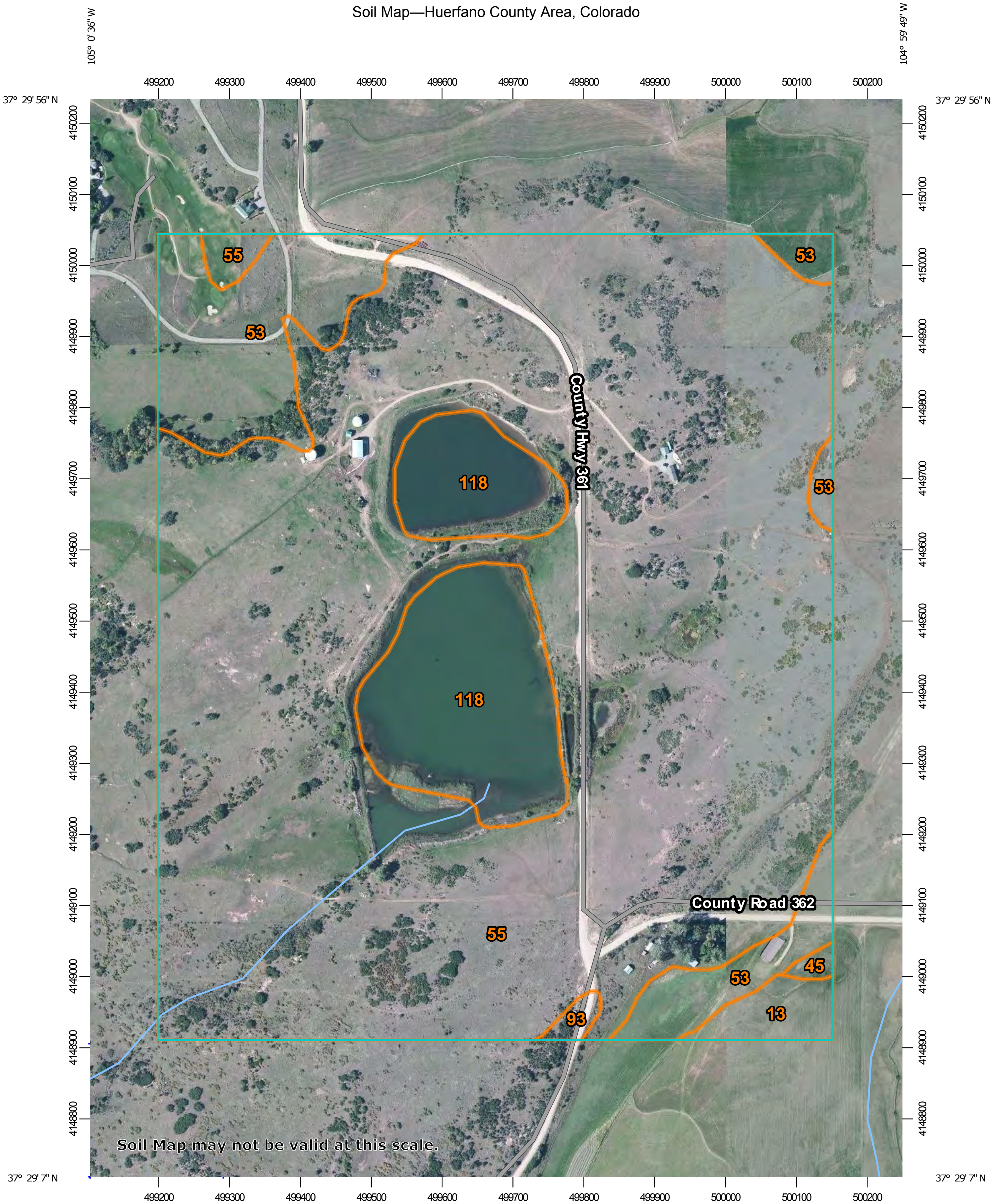
Component Percent Cutoff: None Specified

Tie-break Rule: Lower

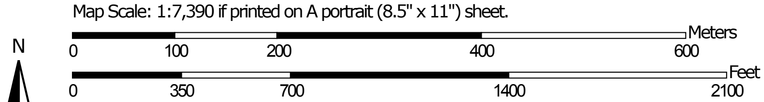
Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

La Veta Soil Map & Classification

Soil Map—Huerfano County Area, Colorado



Map Scale: 1:7,390 if printed on A portrait (8.5" x 11") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huerfano County Area, Colorado
Survey Area Data: Version 13, Sep 23, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

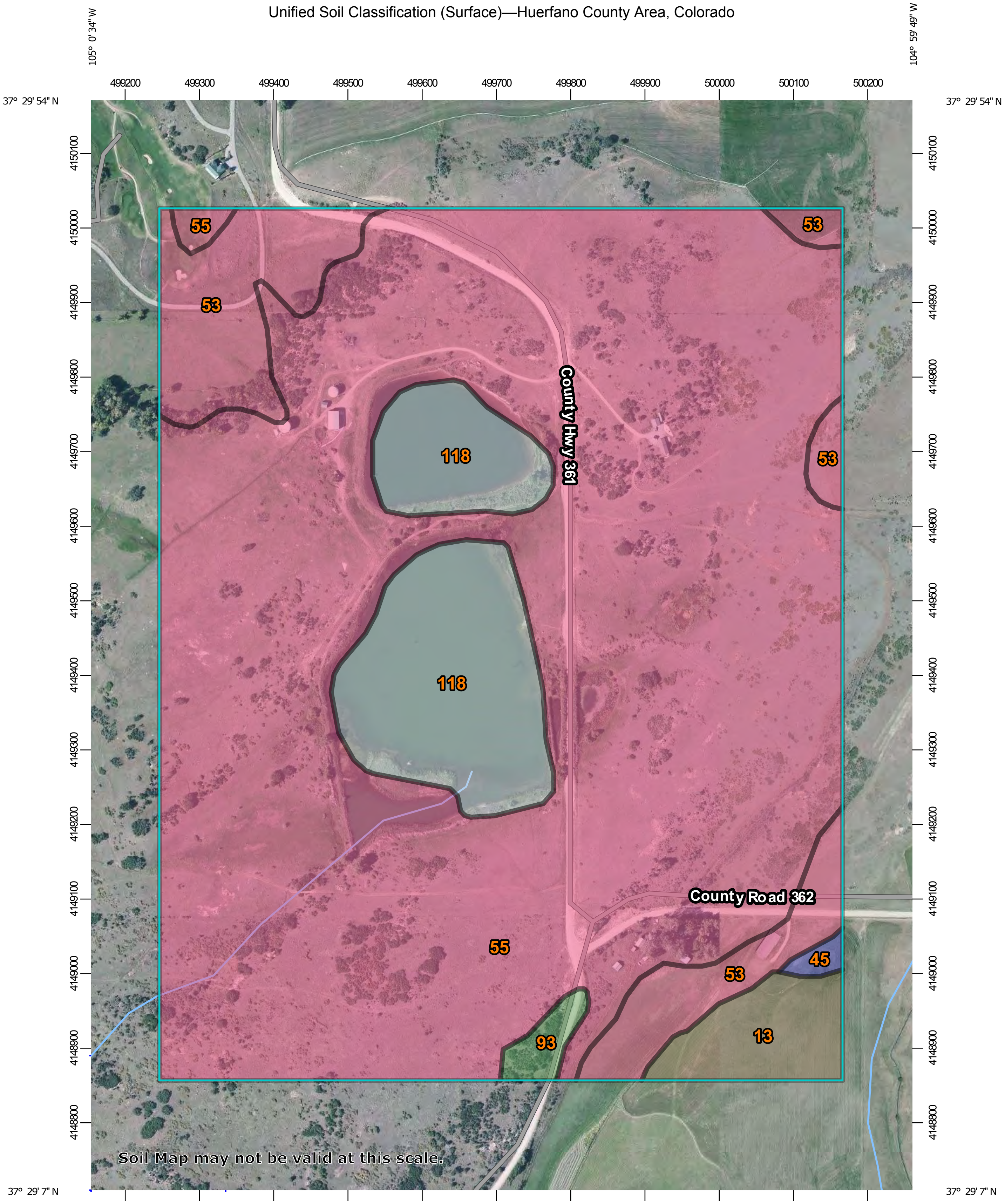
Date(s) aerial images were photographed: Jun 19, 2010—Jun 9, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Huerfano County Area, Colorado (CO627)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
13	Crooked Creek silty clay loam	3.3	1.2%
45	Manzanst silty clay loam, cool, 0 to 3 percent slopes	0.5	0.2%
53	Noden sandy loam, 8 to 15 percent slopes	25.2	9.4%
55	Noden-Bond sandy loams, 2 to 18 percent slopes	210.1	78.4%
93	Willowman gravelly sandy loam, 15 to 30 percent slopes	0.8	0.3%
118	Water	28.1	10.5%
Totals for Area of Interest		**268.1**	**100.0%**

Unified Soil Classification (Surface)—Huerfano County Area, Colorado



Map Scale: 1:7,130 if printed on A portrait (8.5" x 11") sheet.

Meters: 0 100 200 400 600

Feet: 0 300 600 1200 1800

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

CH
CL
CL-A (proposed)
CL-K (proposed)
CL-ML
CL-O (proposed)
CL-T (proposed)
GC
GC-GM
GM
GP
GP-GC
GP-GM
GW
GW-GC
GW-GM
MH
MH-A (proposed)
MH-K (proposed)
MH-O (proposed)
MH-T (proposed)
ML
ML-A (proposed)
ML-K (proposed)
ML-O (proposed)
ML-T (proposed)
OH
OH-T (proposed)
OL
PT
SC
SC-SM
SM
SP
SP-SC
SP-SM
SW
SW-SC
SW-SM
Not rated or not available

Soil Rating Lines

CH
CL
CL-A (proposed)
CL-K (proposed)
CL-ML
CL-O (proposed)
CL-T (proposed)
GC
GC-GM
GM
GP
GP-GC
GP-GM
GW
GW-GC
GW-GM
MH
MH-A (proposed)
MH-K (proposed)
MH-O (proposed)
MH-T (proposed)
ML
ML-A (proposed)
ML-K (proposed)
ML-O (proposed)
ML-T (proposed)
OH
OH-T (proposed)
OL
PT
SC
SC-SM
SM
SP
SP-SC
SP-SM
SW
SW-SC
SW-SM
Not rated or not available

Soil Rating Points

CH
CL
CL-A (proposed)
CL-K (proposed)
CL-ML
CL-O (proposed)
CL-T (proposed)
GC
GC-GM
GM
GP
GP-GC
GP-GM
GW
GW-GC
GW-GM
MH
MH-A (proposed)
MH-K (proposed)
MH-O (proposed)
MH-T (proposed)
ML
ML-A (proposed)
ML-K (proposed)
ML-O (proposed)
ML-T (proposed)
OH
OH-T (proposed)
OL
PT
SC
SC-SM
SM
SP
SP-SC
SP-SM
SW
SW-SC
SW-SM
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

MAP INFORMATION

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huerfano County Area, Colorado
Survey Area Data: Version 13, Sep 23, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 19, 2010—Jun 9, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Unified Soil Classification (Surface)

Unified Soil Classification (Surface)— Summary by Map Unit — Huerfano County Area, Colorado (CO627)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
13	Crooked Creek silty clay loam	ML	7.0	2.6%
45	Manzanst silty clay loam, cool, 0 to 3 percent slopes	CL	0.7	0.3%
53	Noden sandy loam, 8 to 15 percent slopes	SC	22.9	8.6%
55	Noden-Bond sandy loams, 2 to 18 percent slopes	SC	206.4	77.3%
93	Willowman gravelly sandy loam, 15 to 30 percent slopes	GC	1.8	0.7%
118	Water		28.1	10.5%
Totals for Area of Interest			**267.0**	**100.0%**

Description

The Unified soil classification system classifies mineral and organic mineral soils for engineering purposes on the basis of particle-size characteristics, liquid limit, and plasticity index. It identifies three major soil divisions: (i) coarse-grained soils having less than 50 percent, by weight, particles smaller than 0.074 mm in diameter; (ii) fine-grained soils having 50 percent or more, by weight, particles smaller than 0.074 mm in diameter; and (iii) highly organic soils that demonstrate certain organic characteristics. These divisions are further subdivided into a total of 15 basic soil groups. The major soil divisions and basic soil groups are determined on the basis of estimated or measured values for grain-size distribution and Atterberg limits. ASTM D 2487 shows the criteria chart used for classifying soil in the Unified system and the 15 basic soil groups of the system and the plasticity chart for the Unified system.

The various groupings of this classification correlate in a general way with the engineering behavior of soils. This correlation provides a useful first step in any field or laboratory investigation for engineering purposes. It can serve to make some general interpretations relating to probable performance of the soil for engineering uses.

For each soil horizon in the database one or more Unified soil classifications may be listed. One is marked as the representative or most commonly occurring. The representative classification is shown here for the surface layer of the soil.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

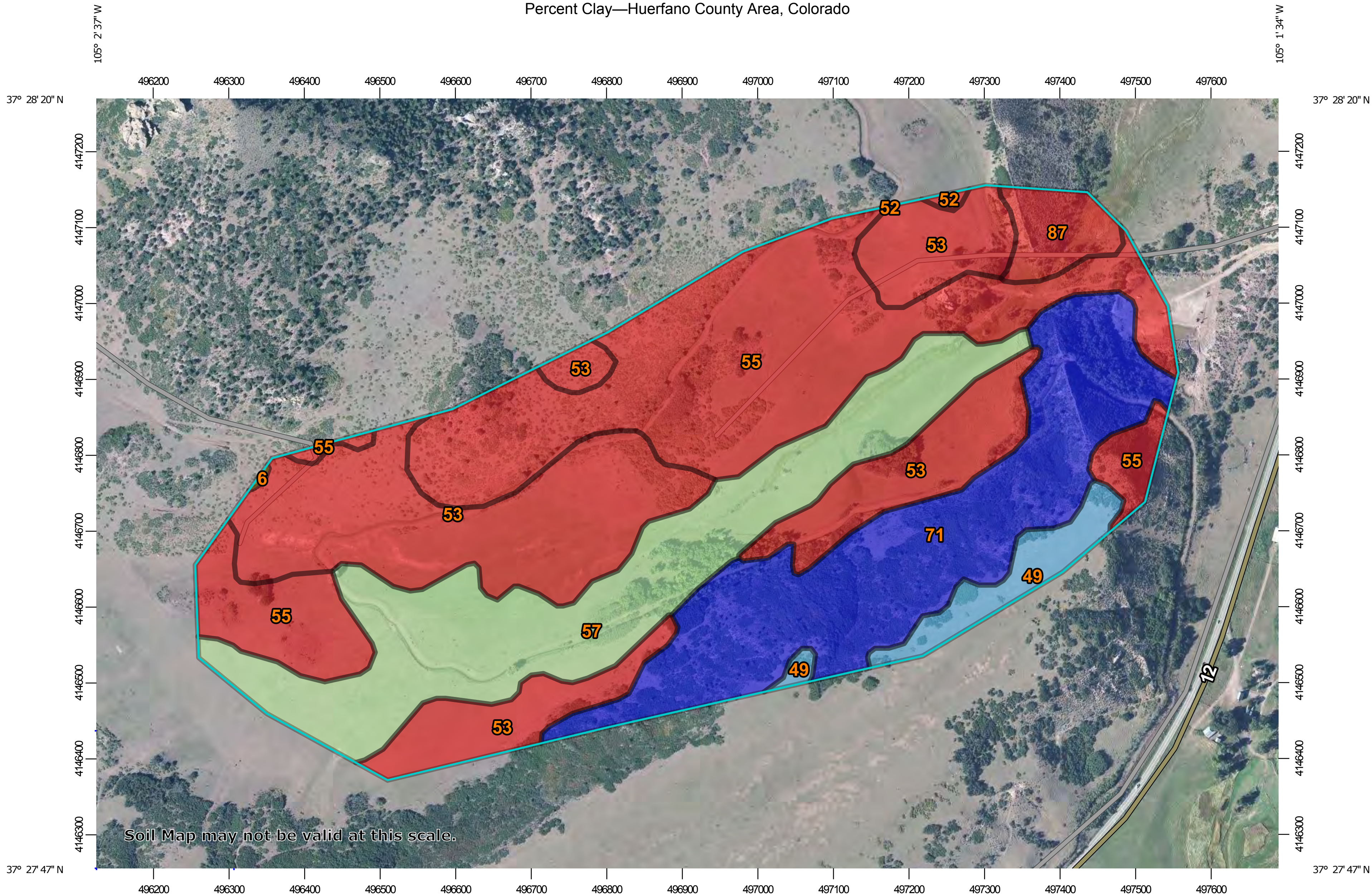
Tie-break Rule: Lower

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

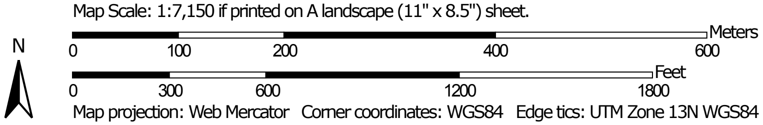
Appendix E

Percent Clay Reports

Bruce Canyon Soil Map



Map Scale: 1:7,150 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

<= 22.8

> 22.8 and <= 26.5

> 26.5 and <= 32.1

> 32.1 and <= 34.0

> 34.0 and <= 35.8

Not rated or not available

Soil Rating Lines

<= 22.8

> 22.8 and <= 26.5

> 26.5 and <= 32.1

> 32.1 and <= 34.0

> 34.0 and <= 35.8

Not rated or not available

Soil Rating Points

<= 22.8

> 22.8 and <= 26.5

> 26.5 and <= 32.1

> 32.1 and <= 34.0

> 34.0 and <= 35.8

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huerfano County Area, Colorado
Survey Area Data: Version 13, Sep 23, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 19, 2010—Oct 1, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Percent Clay

Percent Clay— Summary by Map Unit — Huerfano County Area, Colorado (CO627)				
Map unit symbol	**Map unit name**	**Rating (percent)**	**Acres in AOI**	**Percent of AOI**
6	Bond-Rock outcrop complex, 15 to 45 percent slopes	26.5	0.1	0.0%
49	Morop loam, 2 to 18 percent slopes	34.0	4.8	3.1%
52	Noden sandy loam, 1 to 8 percent slopes	22.5	0.2	0.2%
53	Noden sandy loam, 8 to 15 percent slopes	22.5	42.7	27.5%
55	Noden-Bond sandy loams, 2 to 18 percent slopes	22.5	44.0	28.3%
57	Nunn clay loam, 0 to 3 percent slopes	32.1	30.3	19.5%
71	Ring cobbly loam, 20 to 45 percent slopes	35.8	29.7	19.1%
87	Wahatoya-Rock outcrop complex, 35 to 65 percent slopes	22.8	3.6	2.3%
Totals for Area of Interest			**155.3**	**100.0%**

Description

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. The estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Most of the material is in one of three groups of clay minerals or a mixture of these clay minerals. The groups are kaolinite, smectite, and hydrous mica, the best known member of which is illite.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

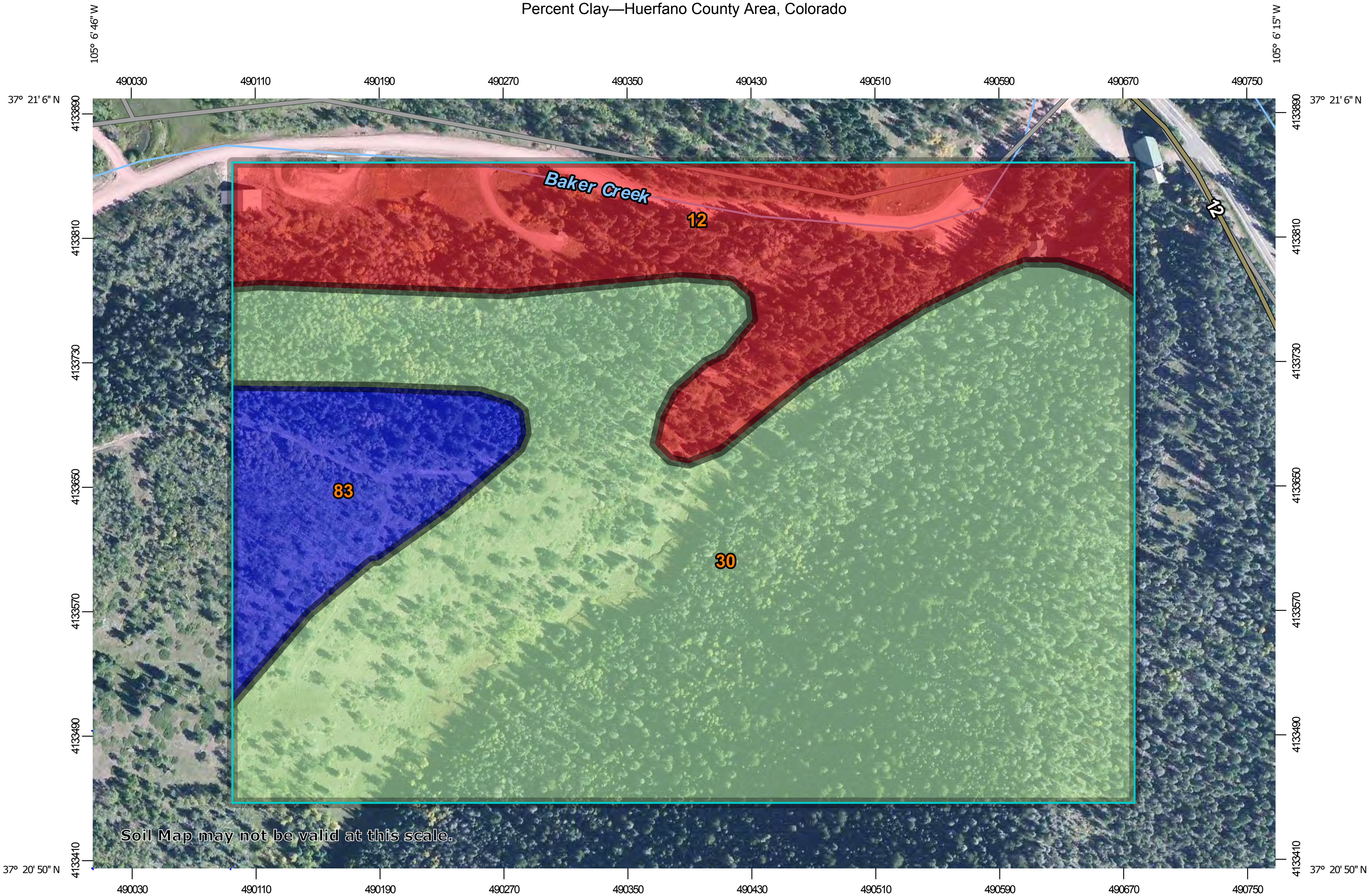
Top Depth: 0

Bottom Depth: 60

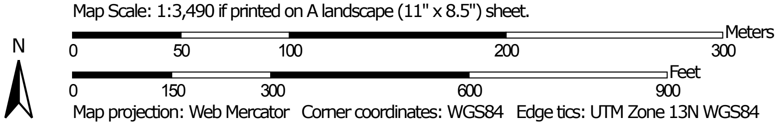
Units of Measure: Inches

South Baker Soil Map

Percent Clay—Huerfano County Area, Colorado



Map Scale: 1:3,490 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

<= 9.0

> 9.0 and <= 20.5

> 20.5 and <= 21.3

Not rated or not available

Soil Rating Lines

<= 9.0

> 9.0 and <= 20.5

> 20.5 and <= 21.3

Not rated or not available

Soil Rating Points

<= 9.0

> 9.0 and <= 20.5

> 20.5 and <= 21.3

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huerfano County Area, Colorado
Survey Area Data: Version 13, Sep 23, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 19, 2010—Oct 1, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Percent Clay

Percent Clay— Summary by Map Unit — Huerfano County Area, Colorado (CO627)				
Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
12	Collegiate loam, 1 to 3 percent slopes	9.0	13.6	22.8%
30	Leadville fine sandy loam, 25 to 55 percent slopes	20.5	40.7	68.4%
83	Uinta-Lakehelen fine sandy loams, 4 to 25 percent slopes	21.3	5.3	8.8%
Totals for Area of Interest			**59.5**	**100.0%**

Description

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. The estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Most of the material is in one of three groups of clay minerals or a mixture of these clay minerals. The groups are kaolinite, smectite, and hydrous mica, the best known member of which is illite.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

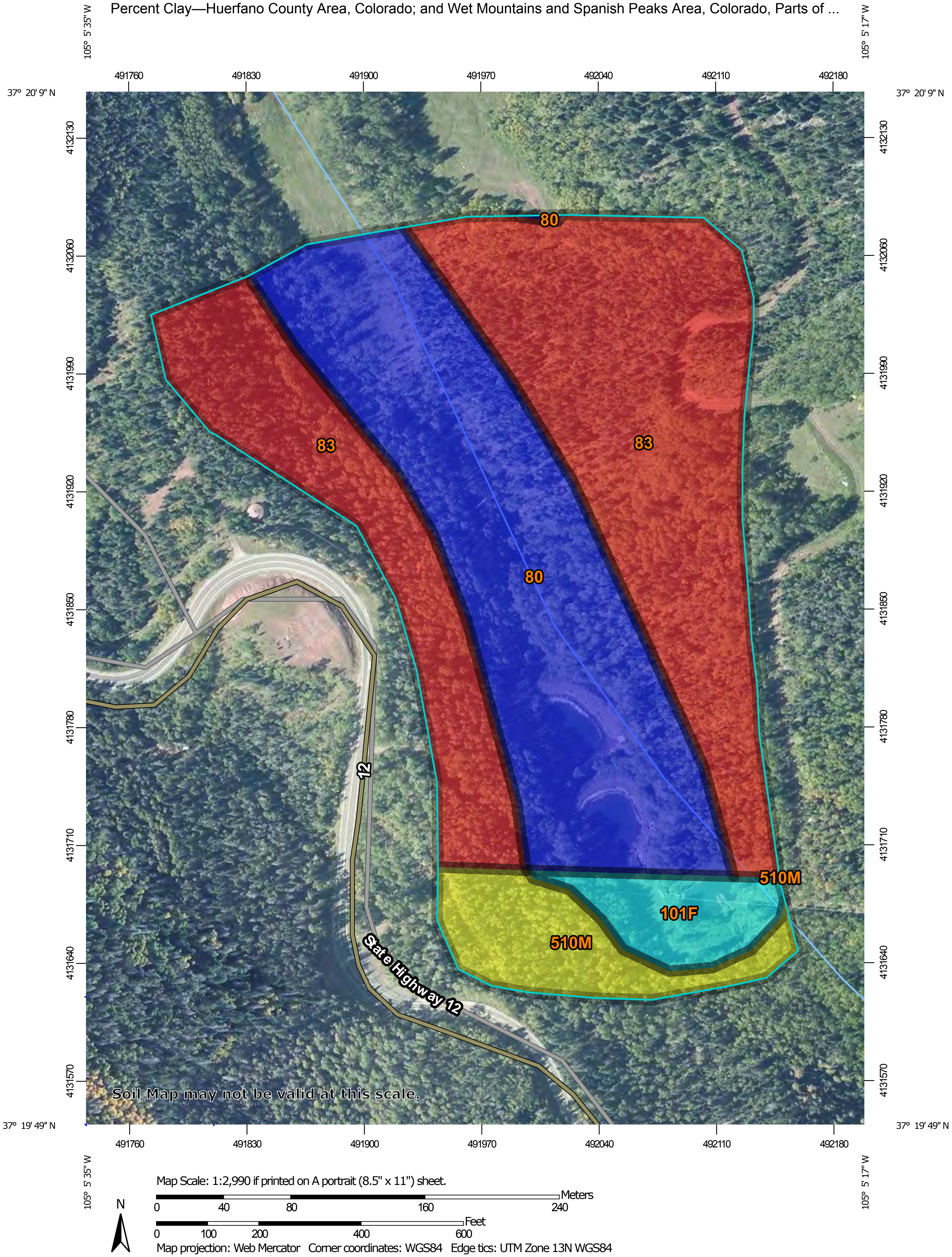
Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 60

Units of Measure: Inches

Britton Soil Map


105° 5' 35" W
105° 5' 17" W
491760
491830
491900
491970
492040
492110
492180
37° 20' 9" N
37° 19' 49" N
4132130
4132060
4131990
4131920
4131850
4131780
4131710
4131640
4131570
80
83
83
80
510M
101F
510M
12
State Highway 12
Soil Map may not be valid at this scale.
Map Scale: 1:2,990 if printed on A portrait (8.5" x 11") sheet.
Meters
0 40 80 160 240
N
Feet
0 100 200 400 600
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- <= 21.3
- > 21.3 and <= 21.8
- > 21.8 and <= 22.0
- > 22.0 and <= 25.1
- Not rated or not available

Soil Rating Lines

- <= 21.3
- > 21.3 and <= 21.8
- > 21.8 and <= 22.0
- > 22.0 and <= 25.1
- Not rated or not available

Soil Rating Points

- <= 21.3
- > 21.3 and <= 21.8
- > 21.8 and <= 22.0
- > 22.0 and <= 25.1
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

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Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huerfano County Area, Colorado
Survey Area Data: Version 13, Sep 23, 2016

Soil Survey Area: Wet Mountains and Spanish Peaks Area, Colorado, Parts of Custer, Fremont, Huerfano, Las Animas, and Pueblo Counties
Survey Area Data: Version 5, Sep 24, 2014

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 19, 2010—Oct 1, 2010

MAP LEGEND	MAP INFORMATION
	The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Percent Clay

Percent Clay— Summary by Map Unit — Huerfano County Area, Colorado (CO627)				
Map unit symbol	**Map unit name**	**Rating (percent)**	**Acres in AOI**	**Percent of AOI**
80	Trag loam, 3 to 12 percent slopes	25.1	10.1	36.5%
83	Uinta-Lakehelen fine sandy loams, 4 to 25 percent slopes	21.3	14.1	50.8%
Subtotals for Soil Survey Area			**24.2**	**87.3%**
Totals for Area of Interest			**27.7**	**100.0%**

Percent Clay— Summary by Map Unit — Wet Mountains and Spanish Peaks Area, Colorado, Parts of Custer, Fremont, Huerfano, Las Animas, and Pueblo Counties (CO636)				
Map unit symbol	**Map unit name**	**Rating (percent)**	**Acres in AOI**	**Percent of AOI**
101F	Silas family-Cryaquolls association, 0 to 15 percent slopes	22.0	1.4	5.0%
510M	Needleton-Ashcroft families complex, 5 to 40 percent slopes	21.8	2.1	7.7%
Subtotals for Soil Survey Area			**3.5**	**12.7%**
Totals for Area of Interest			**27.7**	**100.0%**

Description

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. The estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Most of the material is in one of three groups of clay minerals or a mixture of these clay minerals. The groups are kaolinite, smectite, and hydrous mica, the best known member of which is illite.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

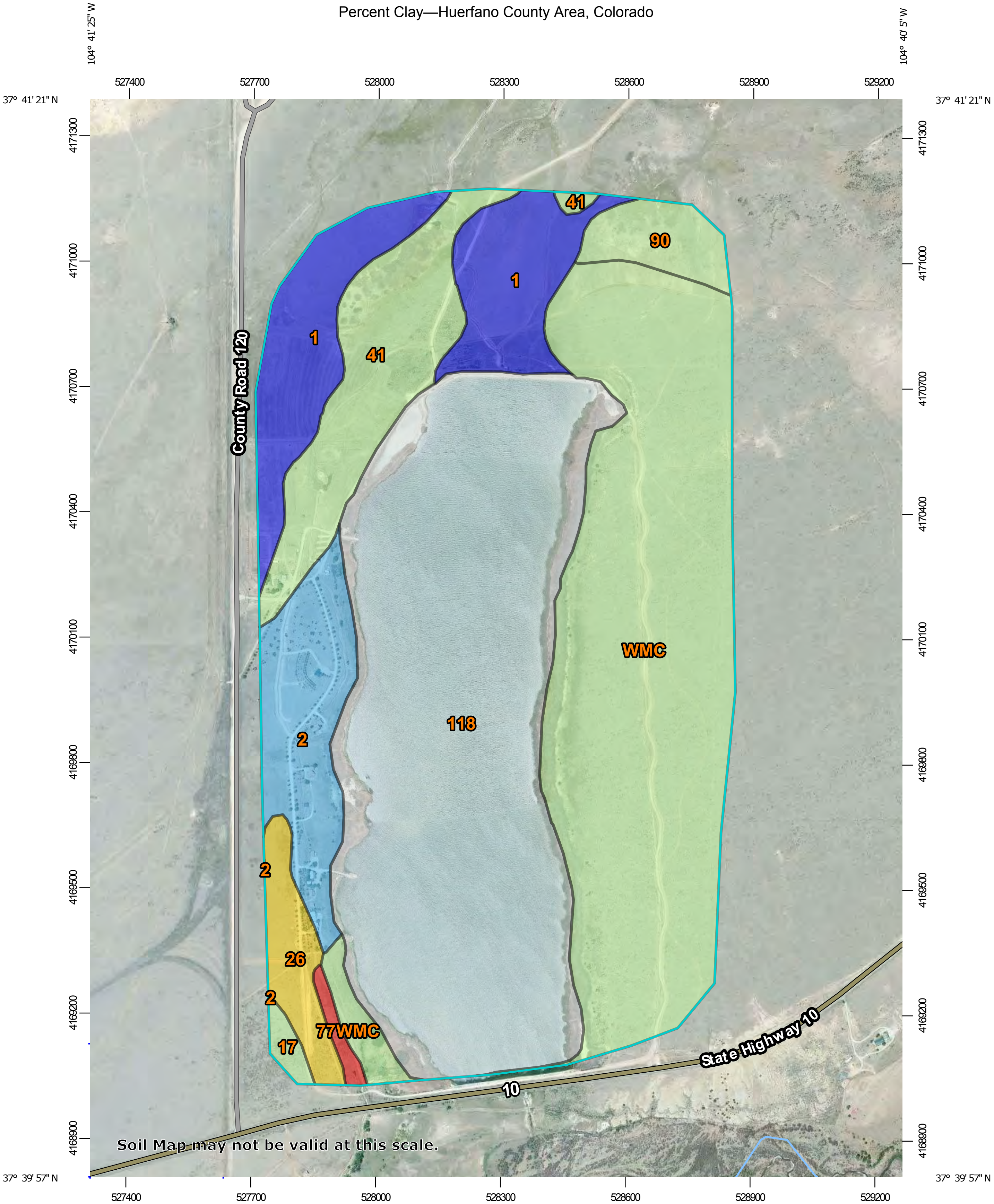
Top Depth: 0

Bottom Depth: 60

Units of Measure: Inches

Maria Stevens Soil Map

Percent Clay—Huerfano County Area, Colorado



Map Scale: 1:12,600 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 150, 300, 600, 900

Feet: 0, 500, 1000, 2000, 3000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

<= 7.8

> 7.8 and <= 24.9

> 24.9 and <= 27.0

> 27.0 and <= 32.7

> 32.7 and <= 47.7

Not rated or not available

Soil Rating Lines

<= 7.8

> 7.8 and <= 24.9

> 24.9 and <= 27.0

> 27.0 and <= 32.7

> 32.7 and <= 47.7

Not rated or not available

Soil Rating Points

<= 7.8

> 7.8 and <= 24.9

> 24.9 and <= 27.0

> 27.0 and <= 32.7

> 32.7 and <= 47.7

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

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Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huerfano County Area, Colorado
Survey Area Data: Version 13, Sep 23, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 10, 2011—Jun 9, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Percent Clay

Percent Clay— Summary by Map Unit — Huerfano County Area, Colorado (CO627)				
Map unit symbol	**Map unit name**	**Rating (percent)**	**Acres in AOI**	**Percent of AOI**
1	Apishapa silty clay	47.7	58.1	10.2%
2	Baca silt loam, 0 to 3 percent slopes, cool	32.7	35.4	6.2%
17	Fort Collins loam, 1 to 3 percent slopes	26.6	2.8	0.5%
26	Kim fine sandy loam, 3 to 9 percent slopes	24.9	14.4	2.5%
41	Manvel silty clay loam saline, 1 to 5 percent slopes	27.0	45.8	8.1%
77	Schamber-Midway complex, 3 to 25 percent slopes	7.8	2.5	0.4%
90	Wiley silt loam, 0 to 3 percent slopes, cool	26.1	12.9	2.3%
118	Water		212.8	37.5%
WMC	Minqwet-Wiley silt loams, 1 to 4 percent slopes, cool	26.1	182.4	32.2%
Totals for Area of Interest			**567.3**	**100.0%**

Description

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. The estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Most of the material is in one of three groups of clay minerals or a mixture of these clay minerals. The groups are kaolinite, smectite, and hydrous mica, the best known member of which is illite.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

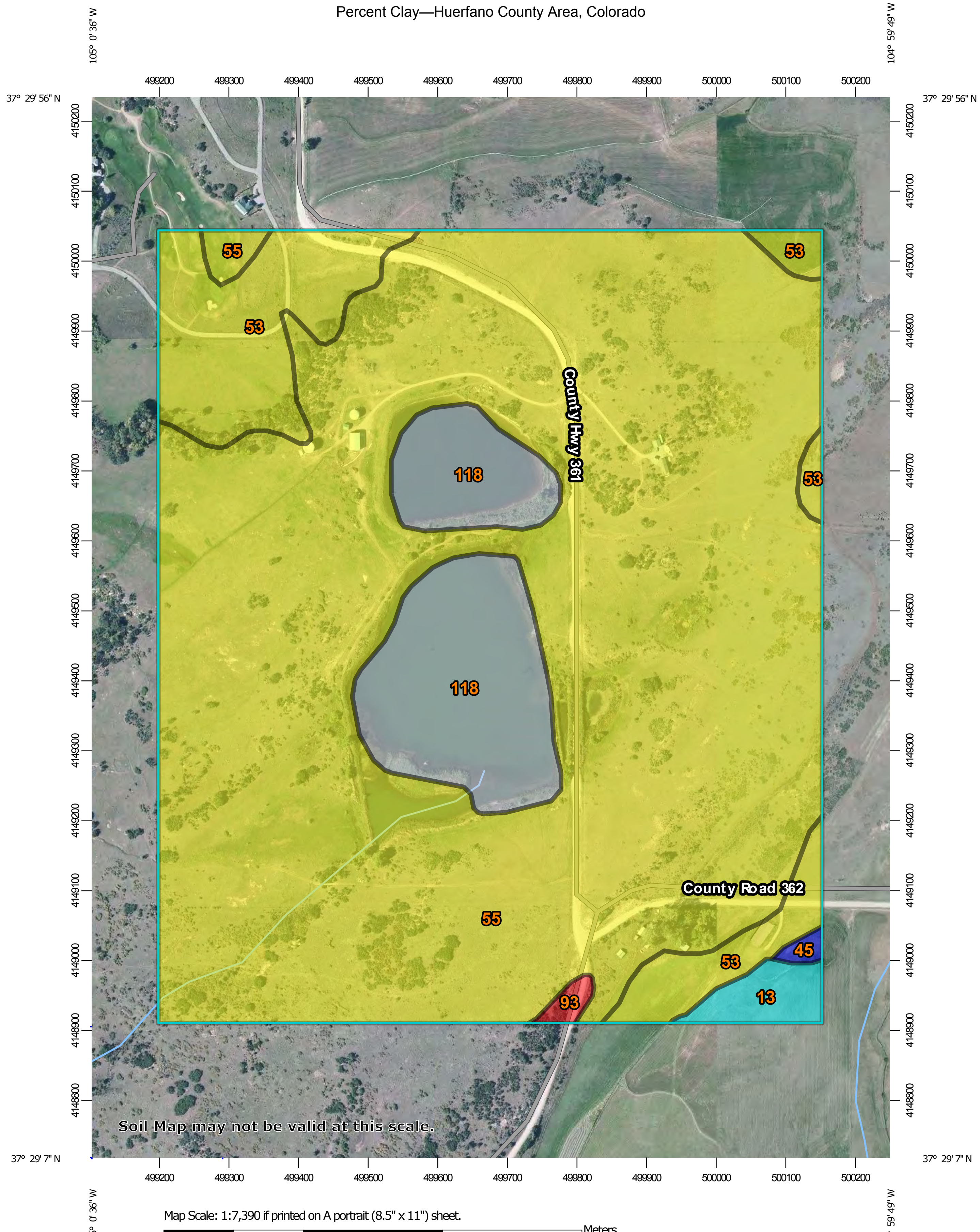
Top Depth: 0

Bottom Depth: 60

Units of Measure: Inches

La Veta Soil Map

Percent Clay—Huerfano County Area, Colorado



Map Scale: 1:7,390 if printed on A portrait (8.5" x 11") sheet.

0 100 200 400 600 Meters

0 350 700 1400 2100 Feet

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- <= 7.9
- > 7.9 and <= 22.5
- > 22.5 and <= 38.0
- > 38.0 and <= 43.3
- Not rated or not available

Soil Rating Lines
- <= 7.9
- > 7.9 and <= 22.5
- > 22.5 and <= 38.0
- > 38.0 and <= 43.3
- Not rated or not available

Soil Rating Points
- <= 7.9
- > 7.9 and <= 22.5
- > 22.5 and <= 38.0
- > 38.0 and <= 43.3
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huerfano County Area, Colorado
Survey Area Data: Version 13, Sep 23, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 19, 2010—Jun 9, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Percent Clay

Percent Clay— Summary by Map Unit — Huerfano County Area, Colorado (CO627)				
Map unit symbol	**Map unit name**	**Rating (percent)**	**Acres in AOI**	**Percent of AOI**
13	Crooked Creek silty clay loam	38.0	3.3	1.2%
45	Manzanst silty clay loam, cool, 0 to 3 percent slopes	43.3	0.5	0.2%
53	Noden sandy loam, 8 to 15 percent slopes	22.5	25.2	9.4%
55	Noden-Bond sandy loams, 2 to 18 percent slopes	22.5	210.1	78.4%
93	Willowman gravelly sandy loam, 15 to 30 percent slopes	7.9	0.8	0.3%
118	Water		28.1	10.5%
Totals for Area of Interest			**268.1**	**100.0%**

Description

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. The estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Most of the material is in one of three groups of clay minerals or a mixture of these clay minerals. The groups are kaolinite, smectite, and hydrous mica, the best known member of which is illite.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 60

Units of Measure: Inches

Appendix F

Well Permits Regarding Depth to Bedrock

Bruce Canyon Well Construction & Test Report

FORM NO. GWS-31 4/2012

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Ste 821, Denver, CO 80203
Main (303) 866-3581 Fax (303) 866-3589 www.water.state.co.us

For Office Use Only

RECEIVED
JUL 09 2014
WATER RESOURCES STATE ENGINEER COLO

1. WELL PERMIT NUMBER: 292804

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Ewing Land & Cattle Co

MAILING ADDRESS: C/O Tim Ewing 9035 Ladue Rd

CITY: St Louis STATE: MO ZIP CODE: 63124

TELEPHONE NUMBER w/area code: 314-712-8484

3. WELL LOCATION AS DRILLED: NE 1/4, NW 1/4, Sec., 8 Twp 30 ☐ N or S, ☒ Range 68 ☐ E or W ☒

DISTANCES FROM SEC. LINES: 10 ft. from ☒ N or ☐ S section line and 2102 ft. from ☐ E or ☒ W section line.

SUBDIVISION: ______, LOT ____, BLOCK ____, FILING (UNIT) ____

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13

Owner's Well Designation: ______
Easting: 497612
Northing: 4145864

STREET ADDRESS AT WELL LOCATION:

4. GROUND SURFACE ELEVATION ______ feet DRILLING METHOD Rotary air

DATE COMPLETED 5/10/14 TOTAL DEPTH 250 feet DEPTH COMPLETED 250 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0-10	Clay	.003	Red	
10-12	Rocks/sand	1"-	Multi	
12-15	Sandstone	.05-	Red	
15-16	Rock/gravel	1"-	Multi	
16-43	Sandstone	.02-	Red	
43-165	Sandstone	.05-	Red	45
165-171	Sandstone	.13-	Red	
171-187	Sandstone	.02-	Red	
187-200	Sandstone	.02-	Gray	
200-250	Sandstone	.05-	Red/black	

Remarks: 2 gpm @ 45'

6. HOLE DIAM (in.)

HOLE DIAM (in.)	From (ft)	To (ft)
11 1/2	0	21
10	21	41
6 1/2	41	250

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
7	Steel	.188	+1	41
4.95	PVC	Sch 40	10	210

PERFORATED CASING: Screen Slot Size (in): .035

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
4.95	PVC	Sch 40	210	250

8. FILTER PACK:
Material ______
Size ______
Interval ______

9. PACKER PLACEMENT:
Type ______
Depth ______

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
Portland	18 bags	108 gal	0-41	Poured

11. DISINFECTION: Type HtH granular Amt. Used 2 cups

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD Timed air lift

Static Level 40 ft. Date/Time measured: 5/10/14 9:00 am, Production Rate 2 gpm.

Pumping Level 210 ft. Date/Time measured 5/9/14 3:30 pm, Test Length (hrs) 2.

Remarks:

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license. If filing online the State Engineer considers entering of licensed contractor name to be compliance with Rule 17.4

Company Name: Ojo Springs Drilling and Well Service, Inc.
Phone w/area code: (719) 738-3580
License Number: 1416

Mailing Address: 601 S. Hendren St. Walsenburg, CO 81089

Sign (or enter name if filing online): Octave G. Blouin
Print Name and Title: Octave G. Blouin Driller
Date: 6/28/14

South Baker Creek Well Permit

WJR-26-77

E

COLORADO DIVISION OF WATER RESOURCES

1313 Sherman Street - Room 818
Denver, Colorado 80203

REC..
JUL 0 8 1982
WATER RESOURCES
STATE ENGINEER
COLO.

THIS FORM MUST BE SUBMITTED WITHIN 60 DAYS OF COMPLETION OF THE WORK DESCRIBED HEREON. TYPE OR PRINT IN BLACK INK.

WELL COMPLETION AND PUMP INSTALLATION REPORT

PERMIT NUMBER 120813

WELL OWNER Hollis L. Woosley

ADDRESS 754 Windrock Dr. San Antonio, Tx 78239

DATE COMPLETED May 18, 19 82

SE ¼ of the NE ¼ of Sec. 16,

T. 31 S, R. 69 W, 6th P.M.

WELL LOG

From	To	Type and Color of Material	Water Loc.

TOTAL DEPTH ____

Use additional pages necessary to complete log.

HOLE DIAMETER

____ in. from ____ to ____ ft.

____ in. from ____ to ____ ft.

____ in. from ____ to ____ ft.

DRILLING METHOD ____

CASING RECORD: Plain Casing

Size ____ & kind ____ from ____ to ____ ft.

Size ____ & kind ____ from ____ to ____ ft.

Size ____ & kind ____ from ____ to ____ ft.

Perforated Casing

Size ____ & kind ____ from ____ to ____ ft.

Size ____ & kind ____ from ____ to ____ ft.

Size ____ & kind ____ from ____ to ____ ft.

GROUTING RECORD

Material ____

Intervals ____

Placement Method ____

GRAVEL PACK: Size ____

Interval ____

TEST DATA

Date Tested ____, 19 ____

Static Water Level Prior to Test ____ ft.

Type of Test Pump ____

Length of Test ____

Sustained Yield (Metered) ____

Final Pumping Water Level ____

PUMP INSTALLATION REPORT

Pump Make Flint & Walling

Type submersible

Powered by 220 HP 1/2

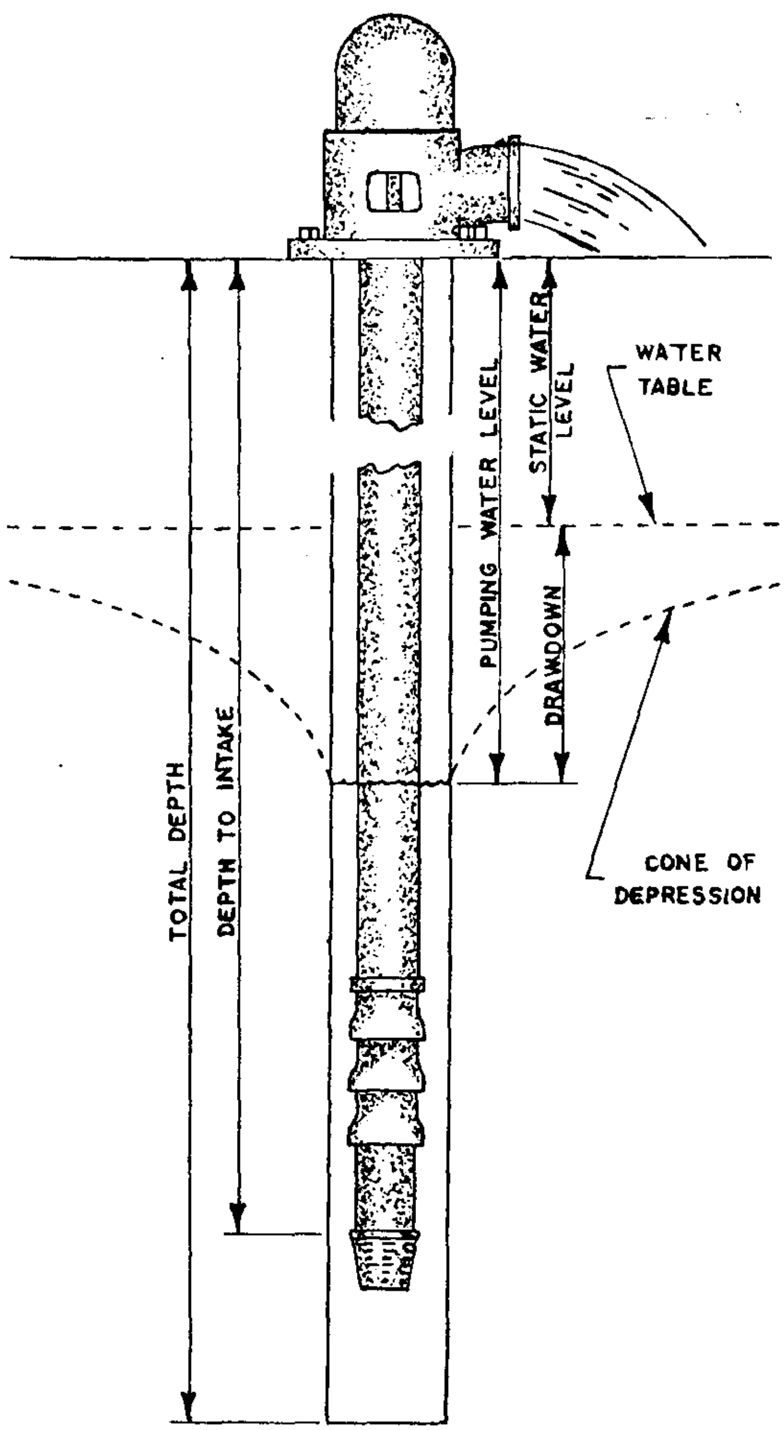
Pump Serial No. 4F10A05 Code 8203

Motor Serial No. K 81 334258910

Date Installed 5/18/82

Pump Intake Depth 45'

Remarks



WELL TEST DATA WITH PERMANENT PUMP

Date Tested 5/18/82

Static Water Level Prior to Test 20'

Length of Test 2 Hours

Sustained yield (Metered) 15 GPM

Pumping Water Level 20'

Remarks

CONTRACTORS STATEMENT

The undersigned, being duly sworn upon oath, deposes and says that he is the contractor of the well or pump installation described hereon; that he has read the statement made hereon; knows the content thereof, and that the same is true of his own knowledge.

Signature Robert L. Lepley License No. 994

State of Colorado, County of Pueblo SS

Subscribed and sworn to before me this 6th day of July, 1982

My Commission expires: 3-24-84, 19

Notary Public Linda Friend

FORM TO BE MADE OUT IN QUADRUPLICATE: WHITE FORM must be an original copy on both sides and signed. WHITE AND GREEN copies must be filed with the State Engineer. PINK COPY is for the Owner and YELLOW COPY is for the Driller.

WJR-26-77

UE

THIS FORM MUST BE SUBMITTED WITHIN 60 DAYS OF COMPLETION OF THE WORK DESCRIBED HEREON. TYPE OR PRINT IN BLACK INK.

COLORADO DIVISION OF WATER RESOURCES
1313 Sherman Street - Room 818
Denver, Colorado 80203

WELL COMPLETION AND PUMP INSTALLATION REPORT

RECEIVED
DEC 02 1981
WATER RESOURCES
STATE ENGINEER
COLO

PERMIT NUMBER 120813

WELL OWNER Hollis L. Woosley

ADDRESS 754 Windrock Dr. San Antonio Texas ZIP 78239

DATE COMPLETED 11-27, 19 81

SE ¼ of the NE ¼ of Sec. 16

T. 31 S, R. 69 W, 6th P.M.

WELL LOG

From	To	Type and Color of Material	Water Loc.
0	3	Soil	
3	20	Clay	
20	40	Gravel	34 ft
40	52	Rock	

TOTAL DEPTH 52

Use additional pages necessary to complete log.

HOLE DIAMETER

10 in. from 0 to 51 ft.

in. from to ft.

in. from to ft.

DRILLING METHOD Cable Tool

CASING RECORD: Plain Casing

Size 5 & kind PVC from 0 to 20 ft.

Size & kind from to ft.

Size & kind from to ft.

Perforated Casing

Size 5 & kind PVC from 20 to 52 ft.

Size & kind from to ft.

Size & kind from to ft.

GROUTING RECORD

Material Cement

Intervals 10

Placement Method By Hand

GRAVEL PACK: Size 3/4

Interval 37 ft

TEST DATA

Date Tested 11-27, 19 81

Static Water Level Prior to Test 22 ft.

Type of Test Pump Well Baler

Length of Test 1 HR

Sustained Yield (Metered) 48 G.P.M.

Final Pumping Water Level 40 FT

PUMP INSTALLATION REPORT

Pump Make ______________________

Type ______________________

Powered by ______________________ HP ______

Pump Serial No. ______________________

Motor Serial No. ______________________

Date Installed ______________________

Pump Intake Depth ______________________

Remarks ______________________

____

WELL TEST DATA WITH PERMANENT PUMP

Date Tested ______________________

Static Water Level Prior to Test ______________________

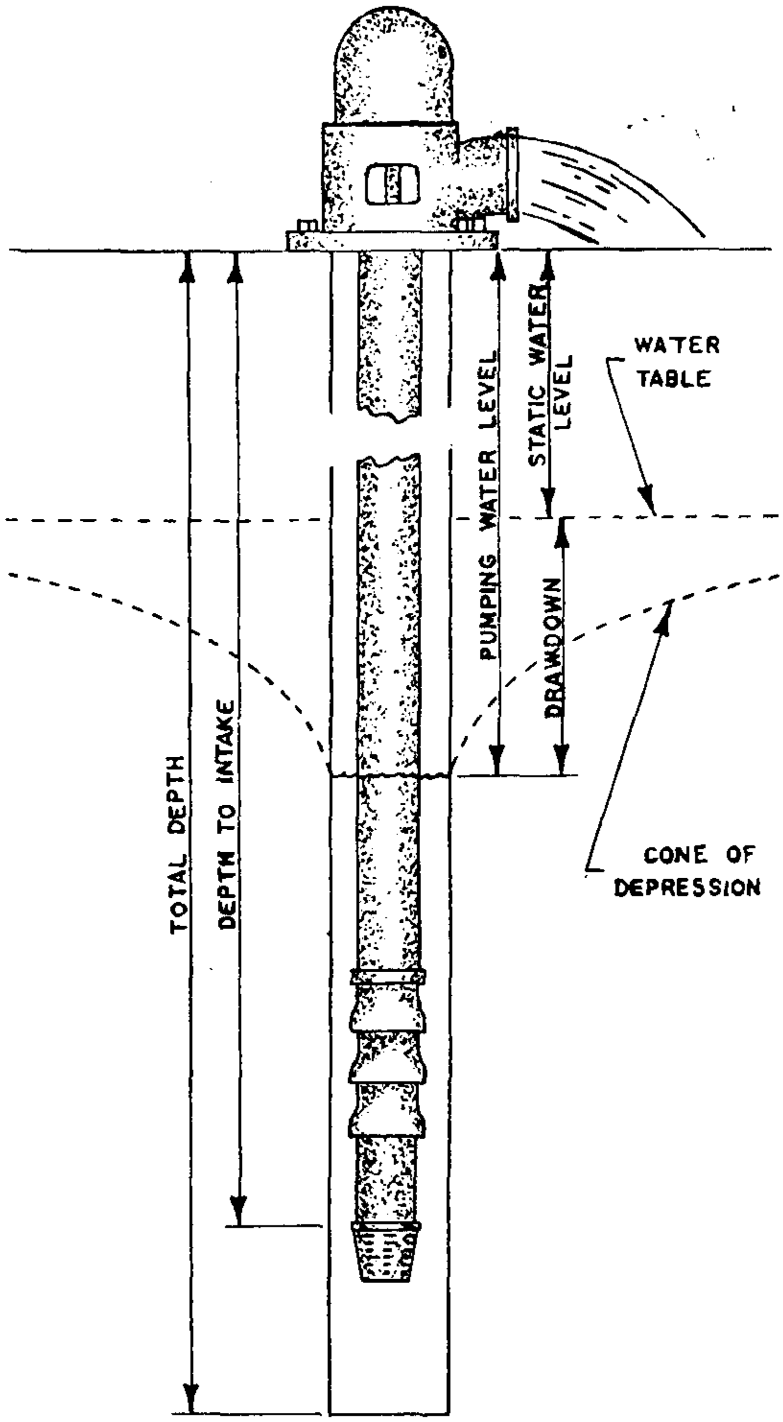
Length of Test ______________________ Hours

Sustained yield (Metered) ______________________ GPM

Pumping Water Level ______________________

Remarks ______________________

____



CONTRACTORS STATEMENT

The undersigned, being duly sworn upon oath, deposes and says that he is the contractor of the well or pump installation described hereon; that he has read the statement made hereon; knows the content thereof, and that the same is true of his own knowledge.

Signature *Robert Pfaffenhauser* License No. *955*

State of Colorado, County of *Huerfano* SS

Subscribed and sworn to before me this *1st* day of *Dec* , 19*81*.

My Commission expires: *7-20* , 19*85*.

Notary Public *[illegible]*
Po Box 61
Walsenburg, Colo 81089

FORM TO BE MADE OUT IN QUADRUPLICATE: WHITE FORM must be an original copy on both sides and signed. WHITE AND GREEN copies must be filed with the State Engineer. PINK COPY is for the Owner and YELLOW COPY is for the Driller.

WRJ-5-Rev. 76

COLORADO DIVISION OF WATER RESOURCES

818 Centennial Bldg., 1313 Sherman St., Denver, Colorado 80203

RECEIVED
JUN 19 1981
WATER RESOURCES
STATE ENGINEER
COLO.

PERMIT APPLICATION FORM

Application must be complete where applicable. Type or print in BLACK INK. No overstrikes or erasures unless initialed.

FOR:
(X) A PERMIT TO USE GROUND WATER
(X) A PERMIT TO CONSTRUCT A WELL
(✓) A PERMIT TO INSTALL A PUMP

( ) REPLACEMENT FOR NO. ____
( ) OTHER ____
WATER COURT CASE NO. ____

(1) APPLICANT - mailing address

NAME Hollis L. Woosley
STREET 754 Windrock Dr.
CITY San Antonio Texas (State) 78239 (Zip)
TELEPHONE NO. ____

(2) LOCATION OF PROPOSED WELL

County HUERFANO
SE ¼ of the NE ¼, Section 16
Twp. 31 S (N,S), Rng. 69 W (E,W), 6 P.M.

(3) WATER USE AND WELL DATA

Proposed maximum pumping rate (gpm) 15

Average annual amount of ground water to be appropriated (acre-feet): 1.0

Number of acres to be irrigated: NONE

Proposed total depth (feet): 310

Aquifer ground water is to be obtained from:
ALLUVIUM

Owner's well designation ____

GROUND WATER TO BE USED FOR:

(X) HOUSEHOLD USE ONLY - no irrigation (0)
( ) DOMESTIC (1) ( ) INDUSTRIAL (5)
( ) LIVESTOCK (2) ( ) IRRIGATION (6)
( ) COMMERCIAL (4) ( ) MUNICIPAL (8)

( ) OTHER (9) ____
DETAIL THE USE ON BACK IN (11)

(4) DRILLER

Name LICENSED
Street ____
City ____ (State) (Zip)
Telephone No. ____ Lic. No. ____

FOR OFFICE USE ONLY: DO NOT WRITE IN THIS COLUMN

Receipt No. 16541 / ____

Basin ____ Dist. ____

CONDITIONS OF APPROVAL

This well shall be used in such a way as to cause no material injury to existing water rights. The issuance of the permit does not assure the applicant that no injury will occur to another vested water right or preclude another owner of a vested water right from seeking relief in a civil court action.

APPROVED FOR HOUSEHOLD USE ONLY, FOR ONE (1) SINGLE FAMILY DWELLING AND NOT TO BE USED FOR IRRIGATION. THE RETURN FLOW FROM THE USE OF THIS WELL MUST BE RETURNED TO THE SAME STREAM SYSTEM IN WHICH THE WELL IS LOCATED.

THE MUNICIPAL OR COUNTY GOVERNMENT SHALL BE CONSULTED WHEN LOCATING THIS WELL, AND THEIR REGULATIONS SHALL BE COMPLIED WITH.

APPLICATION APPROVED

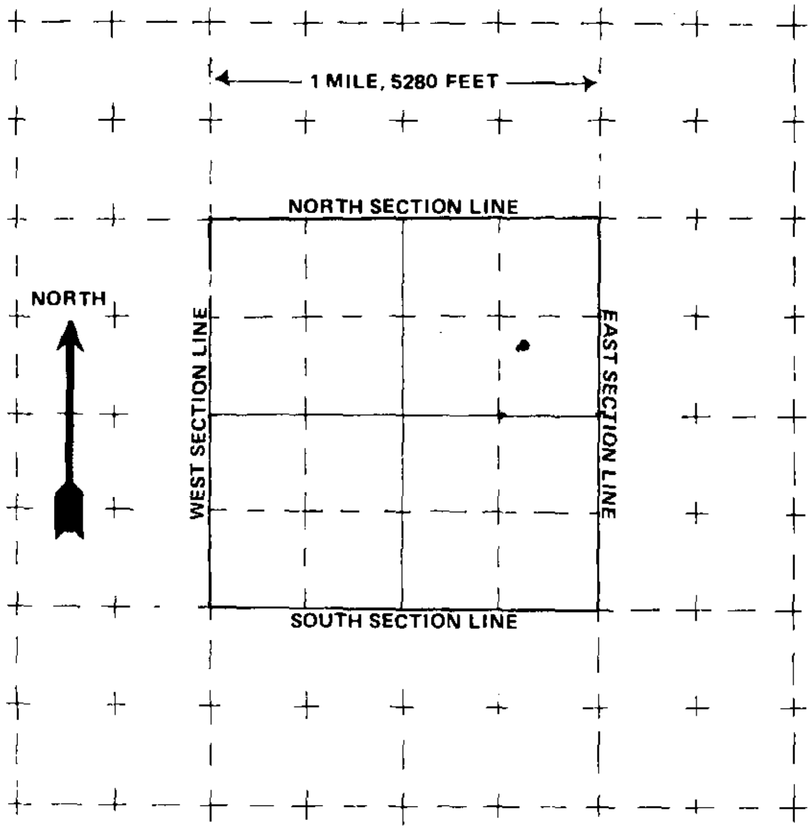
PERMIT NUMBER 120813
DATE ISSUED JUL 13 1981
EXPIRATION DATE JUL 13 1983

Robert A. Longenbaugh
(STATE ENGINEER)

BY Assistant Dewayne R. Schroeder

I.D. 2-16 COUNTY 36

(5) THE LOCATION OF THE PROPOSED WELL and the area on which the water will be used must be indicated on the diagram below. Use the CENTER SECTION (1 section, 640 acres) for the well location.



The scale of the diagram is 2 inches = 1 mile
Each small square represents 40 acres.

WATER EQUIVALENTS TABLE (Rounded Figures)
An acre-foot covers 1 acre of land 1 foot deep
1 cubic foot per second (cfs) . . . 449 gallons per minute (gpm)
A family of 5 will require approximately 1 acre-foot of water per year.
1 acre-foot . . . 43,560 cubic feet . . . 325,900 gallons.
1,000 gpm pumped continuously for one day produces 4.42 acre-feet.

(6) THE WELL MUST BE LOCATED BELOW by distances from section lines.

1800 ft. from NORTH (north or south) sec. line

1200 ft. from EAST (east or west) sec. line

LOT ______ BLOCK ______ FILING # ______

SUBDIVISION N/A

(7) TRACT ON WHICH WELL WILL BE LOCATED Owner: Hollis L Woosley

No. of acres 17.48 . Will this be the only well on this tract? YES

(8) PROPOSED CASING PROGRAM

Plain Casing

6 in. from 0 ft. to 150 ft.

______ in. from ______ ft. to ______ ft.

Perforated casing

6 in. from 150 ft. to 30 ft.

______ in. from ______ ft. to ______ ft.

(9) FOR REPLACEMENT WELLS give distance and direction from old well and plans for plugging it:

N/A

Hollis L. Woosley

(10) LAND ON WHICH GROUND WATER WILL BE USED:

Owner(s): Hollis L Woosley   No. of acres: 17.48

Legal description: SE¼ NE¼ of SEC 16 T31S R67W

(11) DETAILED DESCRIPTION of the use of ground water: **Household use and domestic wells must indicate type of disposal system to be used.**

HOUSEHOLD USE ONLY SEPTIC TANK AND LEACH FIELD DISPOSAL SYSTEM

(12) OTHER WATER RIGHTS used on this land, including wells. Give Registration and Water Court Case Numbers.

Type or right	Used for (purpose)	Description of land on which used
NONE		

(13) THE APPLICANT(S) STATE(S) THAT THE INFORMATION SET FORTH HEREON IS TRUE TO THE BEST OF HIS KNOWLEDGE.

Hollis L Woosley

SIGNATURE OF APPLICANT(S)

Use additional sheets of paper if more space is required.

B

ATTN. RICH BELL

THE WOOSLEY APPLICATION FOR A HOUSEHOLD USE ONLY WELL IS IN ORDER

APPLICANT CAN COMPLY WITH HUERFANO CO. LEACH FIELD REGULATIONS. THE 17.48 ACRES WAS SPLIT BEFORE S.B. 35

O.K. TO ISSUE HOUSEHOLD USE ONLY PERMIT

RECEIVED
JUN 19 1981

THANKS

Ky

Britton Pond Well Permit

WRJ-25-75

TYPE OR PRINT IN BLACK INK. COPY OF ACCEPTED STATEMENT MAILED ON REQUEST.

COLORADO DIVISION OF WATER RESOURCES

818 Centennial Bldg., 1313 Sherman St.
Denver, Colorado 80203

RECEIVED
FEB 23 1981
WATER RESOURCES
STATE ENGINEER
COLO

STATE OF COLORADO
COUNTY OF ______ } SS.

AFFIDAVIT

____ STATEMENT OF BENEFICIAL USE OF GROUND WATER
____ AMENDMENT OF EXISTING RECORD
X LATE REGISTRATION

PERMIT NUMBER 118590

LOCATION OF WELL

THE AFFIANT(S) Fred W. Austin Sr. whose mailing address is P.O. BOX 132 City La Veta Colorado (STATE) 81055 (ZIP)

County HUERFANO
NE ¼ of the NW ¼, Section 22
Twp. 31S (N OR S), Rng. 69 W (E OR W), 6 P.M.

being duly sworn upon oath, deposes and says that he (they) is (are) the owner(s) of the well described hereon; the well is located as described above, at distances of 200 feet from the NORTH (NORTH OR SOUTH) section line and 2300 feet from the WEST (EAST OR WEST) section line; water from this well was first applied to a beneficial use for the purpose(s) described herein on the ____ day of YEAR, 1970; the maximum sustained pumping rate of the well is 15 gallons per minute, the pumping rate claimed hereby is 15 gallons per minute; the total depth of the well is 22 feet; the average annual amount of water to be diverted is 1.5 acre-feet; for which claim is hereby made for DOMESTIC purpose(s); the legal description of the land on which the water from this well is used is NE¼ NW¼ SEC 22 T31S R69W of which ____ acres are irrigated and which is illustrated on the map on the reverse side of this form; that this well was completed in compliance with the permit approved therefor; this statement of beneficial use of ground water is filed in compliance with law; he (they) has (have) read the statements made hereon; knows the content thereof; and that the same are true of his (their) knowledge.

(COMPLETE REVERSE SIDE OF THIS FORM)

Signature(s) Fred W. Austin Sr

Subscribed and sworn to before me on this 20 day of FEBRUARY, 1981

My Commission expires: 1/3/83
(SEAL)

George Lidenvall
NOTARY PUBLIC

12470

FOR OFFICE USE ONLY
Court Case No. ______
Prior ______ Mo. ____ Day ____ Yr ____
Div. 2 Cty. 28
Sec. ____ ____ ¼, ____ ¼, ____ ¼
Well Use ______
Dist. 10 Basin ______ Man. Dis ______

ACCEPTED FOR FILING BY THE STATE ENGINEER OF COLORADO PURSUANT TO THE FOLLOWING CONDITIONS:

MAR 09 1981 Robert A. Longenbaugh
DATE Assistant STATE ENGINEER

BY R.Haubold

Well drilled by UNKNOWN Lic. No. ____________

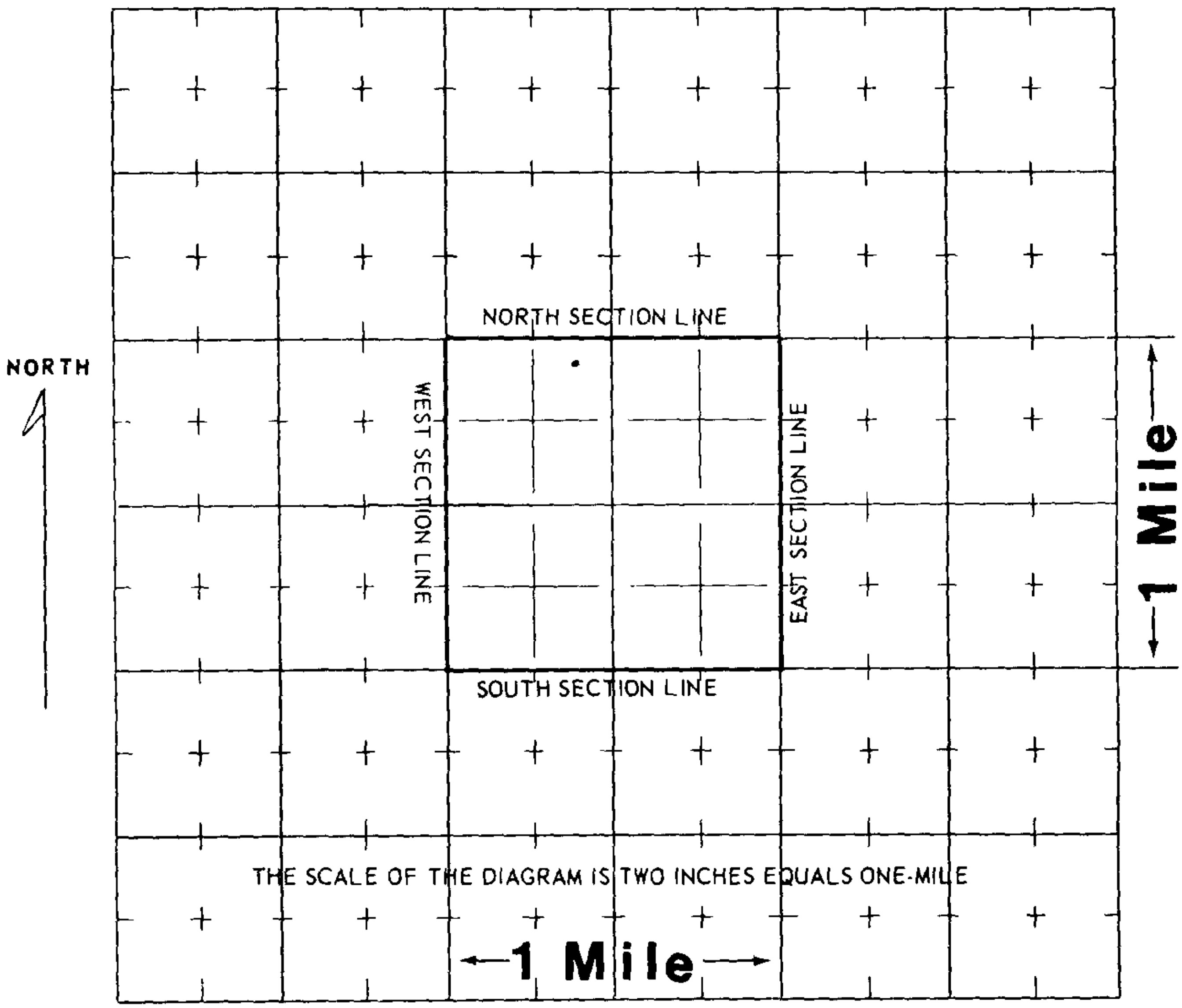
Permanent
Pump installed by ____________ Lic. No. ____________

Meter Serial No. ____________ ☐ Flow Meter Date Installed ____________

Owner of land on which
water is being used ____________

THE LOCATION OF THE WELL MUST BE SHOWN AND FOR LARGE CAPACITY IRRIGATION WELLS THE AREA ON WHICH THE WATER IS USED MUST BE SHADED OR CROSS-HATCHED ON THE DIAGRAM BELOW.

This diagram represents nine (9) sections. Use the **CENTER SQUARE** (one section) to indicate the location of the well, if possible.



WATER EQUIVALENTS TABLE (Rounded Figures)

An acre-foot covers 1 acre of land 1 foot deep.
1 cubic foot per second (cfs) . . . 449 gallons per minute (gpm).
1 acre-foot . . . 43,560 cubic feet . . . 325,900 gallons.
1,000 gpm pumped continuously for one day produces 4.42 acre-feet.
100 gpm pumped continuously for one year produces 160 acre-feet.

**(WHITE AND PINK COPY TO BE FILED WITH THE STATE ENGINEER
PINK COPY WILL BE RETURNED TO OWNER)**

WRJ-2-Rev. 76

COLORADO DIVISION OF WATER RESOURCES

818 Centennial Bldg., 1313 Sherman St., Denver, Colorado 80203

RECEIVED
FEB 23 1981
WATER RESOURCES
STATE ENGINEER
COLO.

PERMIT APPLICATION FORM

Application must be complete where applicable. Type or print in BLACK INK. No overstrikes or erasures unless initialed.

FOR:
(X) A PERMIT TO USE GROUND WATER
(X) A PERMIT TO CONSTRUCT A WELL
(X) A PERMIT TO INSTALL A PUMP
(X) REPLACEMENT FOR NO. LATE REGISTRATION
( ) OTHER
WATER COURT CASE NO.

(1) APPLICANT - mailing address

NAME Fred W. Austin sr.
STREET P.O. Box 132
CITY LaVeta Colorado (State) 81055 (Zip)
TELEPHONE NO. 742-3782

(2) LOCATION OF PROPOSED WELL

County HUERFANO
NE ¼ of the NW ¼, Section 22
Twp. 31 S (N,S), Rng. 65 W (E,W), 6 P.M.

(3) WATER USE AND WELL DATA

Proposed maximum pumping rate (gpm) 15
Average annual amount of ground water to be appropriated (acre-feet): 1.5
Number of acres to be irrigated: LESS THAN ONE
Proposed total depth (feet): 40
Aquifer ground water is to be obtained from: ALLUVIAL
Owner's well designation

GROUND WATER TO BE USED FOR:

( ) HOUSEHOLD USE ONLY - no irrigation (0)
(X) DOMESTIC (1)
( ) LIVESTOCK (2)
( ) COMMERCIAL (4)
( ) INDUSTRIAL (5)
( ) IRRIGATION (6)
( ) MUNICIPAL (8)
( ) OTHER (9)

DETAIL THE USE ON BACK IN (11)

(4) DRILLER

Name PENROSE DRILLING
Street 1412 9th STREET
City PENROSE CO (State) 81240 (Zip)
Telephone No. Lic. No. 1033

FOR OFFICE USE ONLY: DO NOT WRITE IN THIS COLUMN

Receipt No. 12470 /
Basin Dist.

CONDITIONS OF APPROVAL

This well shall be used in such a way as to cause no material injury to existing water rights. The issuance of the permit does not assure the applicant that no injury will occur to another vested water right or preclude another owner of a vested water right from seeking relief in a civil court action.

APPROVED AS A REPLACEMENT OF WELL NO. 118590. THE EXISTING WELL MUST BE PLUGGED AND ABANDONED ACCORDING TO THE REVISED AND AMENDED RULES AND REGULATIONS FOR WATER WELL AND PUMP INSTALLATION CONTRACTORS. THE ENCLOSED AFFIDAVIT MUST BE SUBMITTED WITHIN SIXTY (60) DAYS AFTER THE CONSTRUCTION OF THE NEW WELL, AFFIRMING THAT WELL NO. 118590 WAS PLUGGED AND ABANDONED.

THE MUNICIPAL OR COUNTY GOVERNMENT SHALL BE CONSULTED WHEN LOCATING THIS WELL, AND THEIR REGULATIONS SHALL BE COMPLIED WITH. RGH

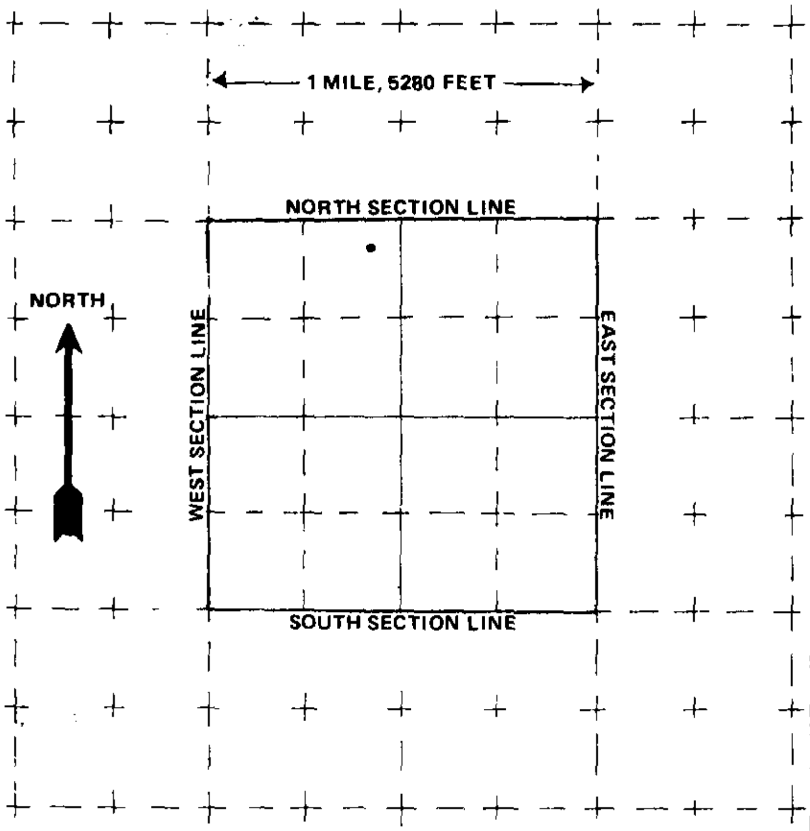
EXPIRED
DATE March 9, 1983

APPLICATION APPROVED

PERMIT NUMBER 118590-A
DATE ISSUED MAR 09 1981
EXPIRATION DATE MAR 09 1983

Robert G. Longenbaugh
Assistant (STATE ENGINEER)
BY R.G. Haubold
I.D. 2-16 COUNTY 28

(5) THE LOCATION OF THE PROPOSED WELL and the area on which the water will be used must be indicated on the diagram below. Use the CENTER SECTION (1 section, 640 acres) for the well location.



The scale of the diagram is 2 inches = 1 mile
Each small square represents 40 acres.

WATER EQUIVALENTS TABLE (Rounded Figures)
An acre-foot covers 1 acre of land 1 foot deep
1 cubic foot per second (cfs) . . . 449 gallons per minute (gpm)
A family of 5 will require approximately 1 acre-foot of water per year.
1 acre-foot . . . 43,560 cubic feet . . . 325,900 gallons.
1,000 gpm pumped continuously for one day produces 4.42 acre-feet.

(6) THE WELL MUST BE LOCATED BELOW by distances from section lines.

200 ft. from NORTH sec. line (north or south)

2300 ft. from WEST sec. line (east or west)

LOT ______ BLOCK ______ FILING # ______

SUBDIVISION N A

(7) TRACT ON WHICH WELL WILL BE LOCATED Owner: FRED AUSTIN

No. of acres 0.5. Will this be the only well on this tract? YES

(8) PROPOSED CASING PROGRAM

Plain Casing

6 in. from 0 ft. to 20 ft.

______ in. from ______ ft. to ______ ft.

Perforated casing

6 in. from 21 ft. to 40 ft.

______ in. from ______ ft. to ______ ft.

(9) FOR REPLACEMENT WELLS give distance and direction from old well and plans for plugging it:

5 FROM OLD WELL
OLD WELL WILL BE
PLUGED

(10) LAND ON WHICH GROUND WATER WILL BE USED:

Owner(s): FRED AUSTIN No. of acres: 0.5

Legal description: NE ¼ OF NW ¼ SEC 22 T 31 S R 69 W

(11) DETAILED DESCRIPTION of the use of ground water: **Household use and domestic wells must indicate type of disposal system to be used.** DOMESTIC SEPTIC TANK AND LEACH FIELD DISPOSAL SYSTEM

(12) OTHER WATER RIGHTS used on this land, including wells. Give Registration and Water Court Case Numbers.

Type or right	Used for (purpose)	Description of land on which used
NONE		

(13) THE APPLICANT(S) STATE(S) THAT THE INFORMATION SET FORTH HEREON IS TRUE TO THE BEST OF HIS KNOWLEDGE.

Fred W. Austin Sr.

SIGNATURE OF APPLICANT(S)

Use additional sheets of paper if more space is required.

90

SUPPLEMENTAL INFORMATION

REQUEST FOR VERBAL APPROVAL

Initial Permit No.
Final Permit No.

Date verbal approval given:

Owner Austin F

Address: LA Veta

Phone 742 3782

Approved Yes [ ] No [ ]
By: O.K. RGL 2/24/81

Driller PENROSE

Lic. No. 1033

Phone

New [ ] Repl. [X] Permit No.

Alt. Pt. Div [ ] T.H. [ ]

Proposed Depth:

Location
County: HUERFANO

Sec. 22 Twp. 31S Rng. 69W
NE ¼ NW ¼

Distances from Sec. Lines

Casing: Plain: Perf:

Date of Construction

Subdivision

ID 2-16 County 28

Date	Initial	Contact and Number	REMARKS
2/25	RB	Ken Cooper 9:55	Wants ~~to~~ verbal on this well
			The last well we checked he did
			not field check and returned it
			to us to return to owner for
			correction.
			This application appears ~~correct~~
			in order. Do we need field check
2/25	RB	10:39 Ken	WATER COMMISSIONER HAS CHECKED

Maria Stevens Well Construction & Test Report

FORM NO. GWS-31 04/2005

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Room 818, Denver, CO 80203
Phone – Info (303) 866-3587 Main (303) 866-3581
Fax (303) 866-3589 http://www.water.state.co.us

For Office Use Only

RECEIVED
NOV 23 2007
WATER RESOURCES
STATE ENGINEER
COLO.

1. WELL PERMIT NUMBER: 65348-F

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: MARIA LAKE GRAZING ASSOC LLP

MAILING ADDRESS: 7393 S ALTON WAY STE 100

CITY: CENTENNIAL STATE: CO ZIP CODE: 80112

TELEPHONE NUMBER: (303) 693-9985

3. WELL LOCATION AS DRILLED: SE1/4, SE1/4, Sec. 20, Twp. 27 ☐ N or ☒ S, Range 65 ☐ E or ☒ W

DISTANCES FROM SEC. LINES: 1200 ft. from ☐ N or ☒ S section line and 70 ft. from ☒ E or ☐ W section line.

SUBDIVISION: ______, LOT ____, BLOCK ____, FILING (UNIT) ____

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☐ Zone 13

Owner's Well Designation: ______
Easting: ______
Northing:

STREET ADDRESS AT WELL LOCATION:

4. GROUND SURFACE ELEVATION ______ feet DRILLING METHOD MUD ROTARY

DATE COMPLETED 9/5/2007 TOTAL DEPTH 42 feet DEPTH COMPLETED 42 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0 3	TOPSOIL			
3-16	ROCK & GRAVEL			10
16-26	SANDY CLAY			
26-33	CLAY			
33-42	SHALE			

Remarks: VARIANCE#2007-115A

6. HOLE DIAM (in.)

HOLE DIAM (in.)	From (ft)	To (ft)
8 5/8"	0	42

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
5.5	PVC	.256	0	12
6.625	STEEL	.188	+2	10

PERFORATED CASING: Screen Slot Size (in): .03

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
5.5	PVC	.256	12	42

8. FILTER PACK:

Material WASHED PEA
Size 3/8
Interval 10-42

9. PACKER PLACEMENT:

Type N/A
Depth

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
N/C	20 GAL	94LB/7G	0-10	PD

11. DISINFECTION: Type HTH Amt. Used 2 CUPS

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD TEST PUMPED

Static Level 10 ft. Date/Time measured: 9/7/2007 10:00, Production Rate 18 gpm.

Pumping Level 38 ft. Date/Time measured 9/7/2007 12:00, Test Length (hrs) 2

Remarks:

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. [The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license.]

Company Name:	Phone:	License Number:
PEARSON DRILLING & PUMP SUPPLY	(719)948-9355	144

Mailing Address: 2997 N. I-25 PUEBLO, CO 81008

Signature: Michael R P

Print Name and Title: MICHAEL R. PEARSON

Date: 11/5/07

La Veta Well Permit

WJR-26-77

E

THIS FORM MUST BE SUBMITTED WITHIN 60 DAYS OF COMPLETION OF THE WORK DESCRIBED HEREON. TYPE OR PRINT IN BLACK INK.

COLORADO DIVISION OF WATER RESOURCES

1313 Sherman Street - Room 818
Denver, Colorado 80203

WELL COMPLETION AND PUMP INSTALLATION REPORT

PERMIT NUMBER 116873

RECEIVED
JUN 22 1981
WATER RESOURCES
STATE ENGINEER
COLO.

WELL OWNER Robert Brgoch

ADDRESS P.O. Box 345 Laveta, Co. 81005

DATE COMPLETED May 7th, 1981

SE ¼ of the SE ¼ of Sec. 28

T. 29 S, R. 68 W, 6th P.M.

WELL LOG

From	To	Type and Color of Material	Water Loc.
0	3	Brown top soil	
3	10	Brown Sandstone	
10	20	Grey Sandstone	
20	21	Red Sandstone	
21	23	Tan Sandstone	
23	28	Red Sandstone	
28	30	Tan Sandstone	
30	32	Red Sandstone	
32	34	Tan Sandstone	
34	50	Grey Sandstone	
50	95	Tan Sandstone	58
95	105	Brown Sandstone	
105	125	Grey Sandstone	
125	135	Light Grey Sandstone	
135	145	Red Sandstone	
145	150	White Sandstone-Streaks of coal	
150	174	Light Greyu Sandstone	
174	180	Red Sandstone	
180	201	Grey Sandstone	190
201	215	Red Sandstone	
215	236	Light grey Sandstone	
236	242	Dark Brown Sandstone	

TOTAL DEPTH 242

Use additional pages necessary to complete log.

HOLE DIAMETER

8 in. from 0 to 20 ft.

6 in. from 20 to 242 ft.

in. from to ft.

DRILLING METHOD Air Percussion

CASING RECORD: Plain Casing

Size 6 5/8 & kind Steel from +1 to 20 ft.

Size 4 & kind Plastic from 8 to 48 ft.

Size 4 & kind Plastic from 68 to 182 ft.

Perforated Casing

Size 4 & kind Plastic from 48 to 68 ft.

Size 4 & kind Plastic from 182 to 242 ft.

Size & kind from to ft.

GROUTING RECORD

Material Cement

Intervals 7 20'

Placement Method Poured

GRAVEL PACK: Size

Interval

TEST DATA

Date Tested 7 May, 1981

Static Water Level Prior to Test 61 ft.

Type of Test Pump Air

Length of Test 2 Hr.

Sustained Yield (Metered) 1 GPM

Final Pumping Water Level N/A

PUMP INSTALLATION REPORT

Pump Make ______

Type ______

Powered by ______ HP ______

Pump Serial No. ______

Motor Serial No. ______

Date Installed ______

Pump Intake Depth ______

Remarks ______

______

WELL TEST DATA WITH PERMANENT PUMP

Date Tested ______

Static Water Level Prior to Test ______

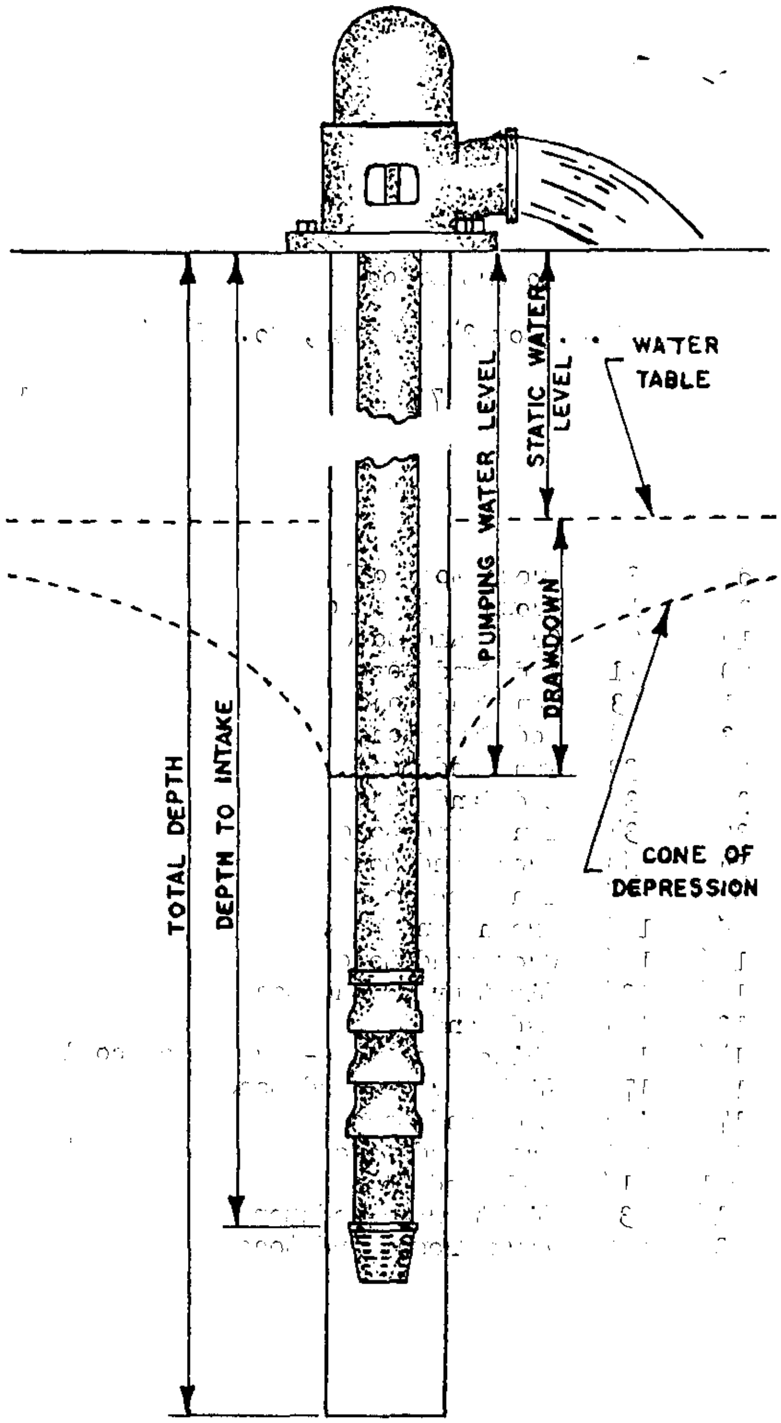
Length of Test ______ Hours

Sustained yield (Metered) ______ GPM

Pumping Water Level ______

Remarks ______

______



CONTRACTORS STATEMENT

The undersigned, being duly sworn upon oath, deposes and says that he is the contractor of the well or pump installation described hereon; that he has read the statement made hereon; knows the content thereof, and that the same is true of his own knowledge.

Signature Nolen Young License No. 997

State of Colorado, County of Fremont SS

Subscribed and sworn to before me this 1 day of June, 19 81.

My Commission expires: December 8, 19 81.

Notary Public Geraldine D. White

FORM TO BE MADE OUT IN QUADRUPLICATE: WHITE FORM must be an original copy on both sides and signed. WHITE AND GREEN copies must be filed with the State Engineer. PINK COPY is for the Owner and YELLOW COPY is for the Driller.

WR-5-R 76

COLORADO DIVISION OF WATER RESOURCES

818 Centennial Bldg., 1313 Sherman St., Denver, Colorado 80203

RECEIVED
OCT - 8 '80
WATER RESOURCES
STATE ENGINEER
COLO.

PERMIT APPLICATION FORM

Application must be complete where applicable. Type or print in BLACK INK. No overstrikes or erasures unless initialed.

FOR:
(X) A PERMIT TO USE GROUND WATER
(X) A PERMIT TO CONSTRUCT A WELL
(X) A PERMIT TO INSTALL A PUMP

( ) REPLACEMENT FOR NO. ______
( ) OTHER ______
WATER COURT CASE NO. ______

(1) APPLICANT - mailing address

NAME Robert Brgoch

STREET P. O. Box 345

CITY La Veta, Colo. 81055 (State) (Zip)

TELEPHONE NO. 742 3386

(2) LOCATION OF PROPOSED WELL

County Huerfano

SE ¼ of the SE ¼, Section 28

Twp. 29 S. (N,S), Rng. 68 W. (E,W), 6th P.M.

(3) WATER USE AND WELL DATA

Proposed maximum pumping rate (gpm) 15

Average annual amount of ground water to be appropriated (acre-feet): 1.5

Number of acres to be irrigated: Less than one

Proposed total depth (feet): 60

Aquifer ground water is to be obtained from:
Alluvial

Owner's well designation ______

GROUND WATER TO BE USED FOR:

( ) HOUSEHOLD USE ONLY - no irrigation (0)
(X) DOMESTIC (1)
( ) LIVESTOCK (2)
( ) COMMERCIAL (4)
( ) INDUSTRIAL (5)
( ) IRRIGATION (6)
( ) MUNICIPAL (8)

( ) OTHER (9) ______

DETAIL THE USE ON BACK IN (11)

(4) DRILLER

Licensed

Name ______

Street ______

City ______ (State) (Zip)

Telephone No. ______ Lic. No. ______

FOR OFFICE USE ONLY: DO NOT WRITE IN THIS COLUMN

Receipt No. 9006 / ______

Basin ______ Dist. ______

CONDITIONS OF APPROVAL

This well shall be used in such a way as to cause no material injury to existing water rights. The issuance of the permit does not assure the applicant that no injury will occur to another vested water right or preclude another owner of a vested water right from seeking relief in a civil court action.

APPROVED PURSUANT TO CRS 1973, 37-92-602 (3)(b)(II) AS THE ONLY WELL ON A TRACT OF 35 ACRES OR MORE DESIGNATED AS 40 ACRES IN SE¼ SE¼, SEC. 28, T. 29S., R. 68W., 6 P.M.

APPROVED FOR DOMESTIC USE, INCLUDING THE IRRIGATION OF NOT OVER ONE ACRE OF HOME GARDENS AND LAWNS.

THE MUNICIPAL OR COUNTY GOVERNMENT SHALL BE CONSULTED WHEN LOCATING THIS WELL, AND THEIR REGULATIONS SHALL BE COMPLIED WITH.

APPLICATION APPROVED

PERMIT NUMBER 116873

DATE ISSUED OCT 20 1980

EXPIRATION DATE OCT 20 1982

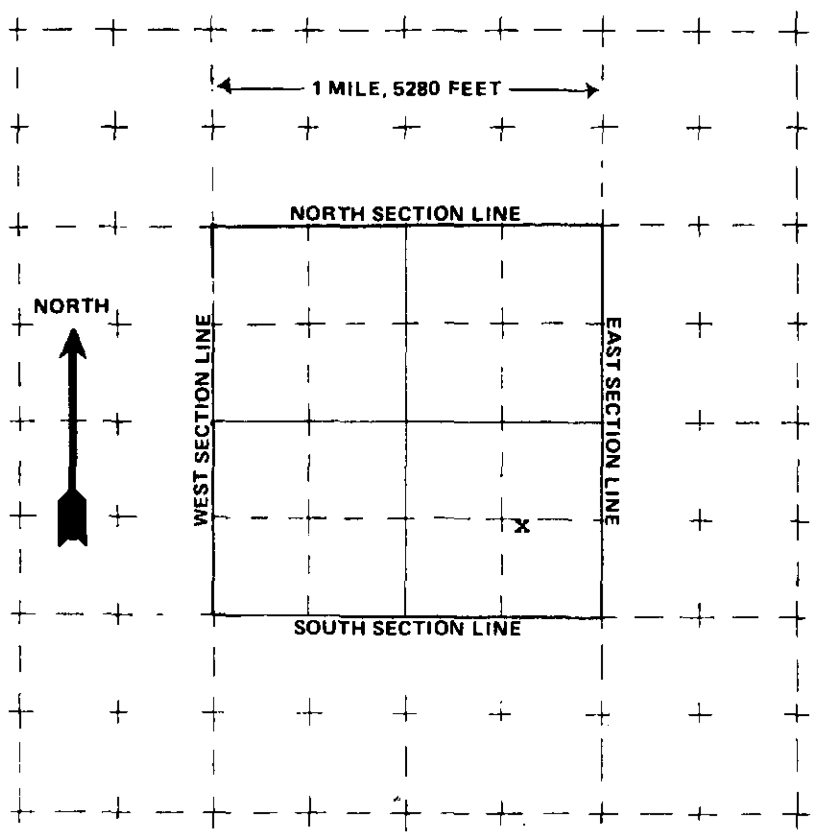
Bruce E. DeBrine

DEPUTY (STATE ENGINEER)

BY Dewayne R. Schroeder

I.D. 2-16 COUNTY 28

(5) **THE LOCATION OF THE PROPOSED WELL** and the area on which the water will be used must be indicated on the diagram below. Use the CENTER SECTION (1 section, 640 acres) for the well location.



The scale of the diagram is 2 inches = 1 mile
Each small square represents 40 acres.

WATER EQUIVALENTS TABLE (Rounded Figures)

An acre-foot covers 1 acre of land 1 foot deep
1 cubic foot per second (cfs) . . . 449 gallons per minute (gpm)
A family of 5 will require approximately 1 acre-foot of water per year.
1 acre-foot . . . 43,560 cubic feet . . . 325,900 gallons.
1,000 gpm pumped continuously for one day produces 4.42 acre-feet.

(6) **THE WELL MUST BE LOCATED BELOW** by distances from section lines.

1200 ft. from South (north or south) sec. line

1200 ft. from East (east or west) sec. line

LOT ______ BLOCK ______ FILING # ______

SUBDIVISION N/A

(7) **TRACT ON WHICH WELL WILL BE LOCATED** Owner: Robert Brgoch

No. of acres 40. Will this be the only well on this tract? yes

(8) **PROPOSED CASING PROGRAM**

Plain Casing

6 in. from 0 ft. to 40 ft.

______ in. from ______ ft. to ______ ft.

Perforated casing

6 in. from 40 ft. to 60 ft.

______ in. from ______ ft. to ______ ft.

(9) **FOR REPLACEMENT WELLS** give distance and direction from old well and plans for plugging it:

N/A

(10) **LAND ON WHICH GROUND WATER WILL BE USED:**

Owner(s): Robert Brgoch No. of acres: 40

Legal description: SE¼ SE¼ Sec. 28 T.29S.,R.68W.

(11) **DETAILED DESCRIPTION** of the use of ground water: **Household use and domestic wells must indicate type of disposal system to be used.**

Domestic use, septic tank and leach field disposal system.

(12) **OTHER WATER RIGHTS** used on this land, including wells. Give Registration and Water Court Case Numbers.

Type or right	Used for (purpose)	Description of land on which used
none		

(13) **THE APPLICANT(S) STATE(S) THAT THE INFORMATION SET FORTH HEREON IS TRUE TO THE BEST OF HIS KNOWLEDGE.**

Robert Brgoch

SIGNATURE OF APPLICANT(S)

Use additional sheets of paper if more space is required.

TREASURER'S OFFICE, HUERFANO COUNTY, COLO. 81089 No 0074

Walsenburg, 7-1- 1980

ceived of:

$ First Half
$ Second Half
$ 503.06 Full

Payment of Taxes of the Year **1979** on the following described property:

LA VETA, CO. ... 81055

TREASURER'S OFFICE JUL 1 1980 HUERFANO COUNTY

	TAX	
	Dollars	Cents
County		
Hospital District		
City of Walsenburg Tax		
Town of La Veta Tax		
La Veta Fire Fund		
Sch. Dist. No. RE-1		
" " " 1 Cap. Res.		
" " " 1 Bond		
" " " RE-2		
" " " RE-2 Cap. Res.		
" " " RE-2 Bonds		
Cemetery Dist.		
Water Cons. Dist.		
Navajo Water Dist.		
Cucharas Water Dist.		
Gardner Water Dist.		
Sheep Tax —		
Predatory Animal Tax "A" —		
Total Tax	493	19
Interest, Real Estate	9	87
Interest, Personal		
Advertising		
Late Filing Penalty		
TOTAL AMT. COLLECTED	503	06

ASSESSED VALUATION	TAX
PERSONAL PROPERTY	
REAL ESTATE	
TOTAL	

73

TREASURER'S OFFICE, HUERFANO COUNTY, COLO. 81089 No 6074

Received of: Walsenburg, 7-1- 1980

$ .... First Half
$ .... Second Half
$ 503.06 Full

Payment of Taxes of the Year **1979** on the following described property:

2 [illegible] 11335
[illegible]
LA VETA, COLO. 81055

[illegible], 310 A. [illegible] THE [illegible] AT A PT. FROM [illegible] THE [illegible] CORNER OF SEC. 27 [illegible]

630 FT, TH. S. 500 FT. TH. W. 630 FT. TH. N. 500 FT. TO PT. OF BEG. CONTAINING 7.45 ACRES. ALL IN SEC. 27-[illegible]

[illegible], SEC. [illegible], 30 A. EXCEPTING 1.21 & .6 A. TO COUNTY
TOTAL ACRES 333.65
[illegible]

Assessed Valuation	Tax		Tax Dollars	Tax Cents
		County		
		Hospital District	501 4 880 $ •503	06 • BS
		City of Walsenburg Tax		
		Town of La Veta Tax		
		La Veta Fire Fund		
		Sch. Dist. No. RE-1		
		" " " 1 Cap. Res.	501 4 880 $ •503	06 • BS
		" " " 1 Bond		
		" " " RE-2		
		" " " RE-2 Cap. Res.	501 4 880 $ •503	06 • BS
		" " " RE-2 Bonds		
		Cemetery Dist.		
		Water Cons. Dist.		
		Navajo Water Dist.		
		Cucharas Water Dist.		
		Gardner Water Dist.		
		Sheep Tax —		
		Predatory Animal Tax "A" —		
		Total Tax	493	19
		Interest, Real Estate	9	87
		Interest, Personal		
		Advertising		
		Late Filing Penalty		
		TOTAL AMT. COLLECTED	503	06

PERSONAL PROPERTY

REAL ESTATE

TOTAL

TREASURER'S OFFICE
JUL 1 1980
HUERFANO COUNTY

Best Copy Available
DCS/IMU

13

APPENDIX G

IPAC RESOURCE LISTS

Bruce Canyon IPaC Resource List

IPaC **U.S. Fish & Wildlife Service**

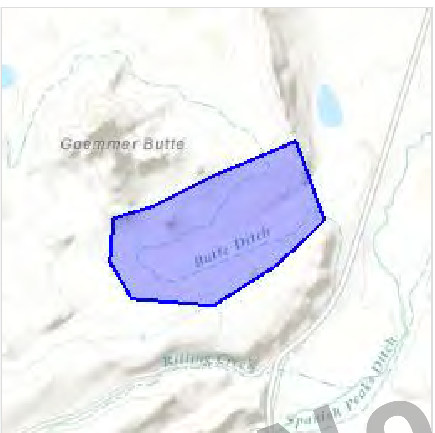
IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Huerfano County, Colorado



Local office

Colorado Ecological Services Field Office

(303) 236-4773
(303) 236-4005

MAILING ADDRESS

Denver Federal Center
P.O. Box 25486
Denver, CO 80225-0486

PHYSICAL ADDRESS
134 Union Boulevard, Suite 670
Lakewood, CO 80228-1807

http://www.fws.gov/coloradoES
http://www.fws.gov/platteriver

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] are managed by the Endangered Species Program of the U.S. Fish and Wildlife Service.

---

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.

The following species are potentially affected by activities in this location:

Birds

NAME	STATUS
Mexican Spotted Owl *Strix occidentalis lucida* There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/8196	Threatened

Fishes

NAME	STATUS
Greenback Cutthroat Trout *Oncorhynchus clarki stomias* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2775	Threatened

Mammals

NAME	STATUS
Canada Lynx *Lynx canadensis* There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/3652	Threatened
North American Wolverine *Gulo gulo luscus* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5123	Proposed Threatened

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any activity that results in the take (to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct) of migratory birds or eagles is prohibited unless authorized by the U.S. Fish and Wildlife Service[3]. There are no provisions for allowing the take of migratory birds that are unintentionally killed or injured.

Any person or organization who plans or conducts activities that may result in the take of migratory birds is responsible for complying with the appropriate regulations and implementing appropriate conservation measures.

---

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Conservation measures for birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Year-round bird occurrence data http://www.birdscanada.org/birdmon/default/datasummaries.jsp

The migratory birds species listed below are species of particular conservation concern (e.g. Birds of Conservation Concern) that may be potentially affected by activities in this location. It is not a list of every bird species you may find in this location, nor a guarantee that all of the bird species on this list will be found on or near this location. Although it is important to try to avoid and minimize impacts to all birds, special attention should be made to avoid and minimize impacts to birds of priority concern. To view available data on other bird species that may occur in your project area, please visit the AKN Histogram Tools and Other Bird Data Resources. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

NAME	SEASON(S)
Bald Eagle Haliaeetus leucocephalus https://ecos.fws.gov/ecp/species/1626	Year-round
Black Rail Laterallus jamaicensis https://ecos.fws.gov/ecp/species/7717	Breeding
Black Rosy-finch Leucosticte atrata https://ecos.fws.gov/ecp/species/9460	Year-round
Brewer's Sparrow Spizella breweri https://ecos.fws.gov/ecp/species/9291	Breeding
Brown-capped Rosy-finch Leucosticte australis	Year-round

Burrowing Owl Athene cunicularia https://ecos.fws.gov/ecp/species/9737	Breeding
Cassin's Finch Carpodacus cassinii https://ecos.fws.gov/ecp/species/9462	Year-round
Ferruginous Hawk Buteo regalis https://ecos.fws.gov/ecp/species/6038	Wintering
Golden Eagle Aquila chrysaetos https://ecos.fws.gov/ecp/species/1680	Year-round
Grace's Warbler Dendroica graciae	Breeding
Lewis's Woodpecker Melanerpes lewis https://ecos.fws.gov/ecp/species/9408	Year-round
Loggerhead Shrike Lanius ludovicianus https://ecos.fws.gov/ecp/species/8833	Year-round
Long-billed Curlew Numenius americanus https://ecos.fws.gov/ecp/species/5511	Breeding
Mountain Plover Charadrius montanus https://ecos.fws.gov/ecp/species/3638	Breeding
Olive-sided Flycatcher Contopus cooperi https://ecos.fws.gov/ecp/species/3914	Breeding
Peregrine Falcon Falco peregrinus https://ecos.fws.gov/ecp/species/8831	Breeding
Pinyon Jay Gymnorhinus cyanocephalus https://ecos.fws.gov/ecp/species/9420	Year-round

Prairie Falcon Falco mexicanus https://ecos.fws.gov/ecp/species/4736	Year-round
Rufous Hummingbird selasphorus rufus https://ecos.fws.gov/ecp/species/8002	Migrating
Sage Thrasher Oreoscoptes montanus https://ecos.fws.gov/ecp/species/9433	Breeding
Short-eared Owl Asio flammeus https://ecos.fws.gov/ecp/species/9295	Wintering
Swainson's Hawk Buteo swainsoni https://ecos.fws.gov/ecp/species/1098	Breeding
Virginia's Warbler Vermivora virginiae https://ecos.fws.gov/ecp/species/9441	Breeding
Western Grebe aechmophorus occidentalis https://ecos.fws.gov/ecp/species/6743	Breeding
Williamson's Sapsucker Sphyrapicus thyroideus https://ecos.fws.gov/ecp/species/8832	Breeding

What does IPaC use to generate the list of migratory bird species potentially occurring in my specified location?

Landbirds:

Migratory birds that are displayed on the IPaC species list are based on ranges in the latest edition of the National Geographic Guide, Birds of North America (6th Edition, 2011 by Jon L. Dunn, and Jonathan Alderfer). Although these ranges are coarse in nature, a number of U.S. Fish and Wildlife Service migratory bird biologists agree that these maps are some of the best range maps to date. These ranges were clipped to a specific Bird Conservation Region (BCR) or USFWS Region/Regions, if it was indicated in the 2008 list of Birds of Conservation Concern (BCC) that a species was a BCC species only in a particular Region/Regions. Additional modifications have been made to some ranges based on more local or refined range information and/or information provided by U.S. Fish and Wildlife Service biologists with species expertise. All migratory birds that show in areas on land in IPaC are those that appear in the 2008 Birds of Conservation Concern report.

Atlantic Seabirds:

Ranges in IPaC for birds off the Atlantic coast are derived from species distribution models developed by the National Oceanic and Atmospheric Association (NOAA) National Centers for Coastal Ocean Science (NCCOS) using the best available seabird survey data for the offshore Atlantic Coastal region to date. NOAANCCOS assisted USFWS in developing seasonal species ranges from their models for specific use in IPaC. Some of these birds are not BCC species but were of interest for inclusion because they may occur in high abundance off the coast at different times throughout the year, which potentially makes them more susceptible to certain types of development and activities taking place in that area. For more refined details about the abundance and richness of bird species within your project area off the Atlantic Coast, see the Northeast Ocean Data Portal. The Portal also offers data and information about other types of taxa that may be helpful in your project review.

About the NOAANCCOS models: the models were developed as part of the NOAANCCOS project: Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf. The models resulting from this project are being used in a number of decision-support/mapping products in order to help guide decision-making on activities off the Atlantic Coast with the goal of reducing impacts to migratory birds. One such product is the Northeast Ocean Data Portal, which can be used to explore details about the relative occurrence and abundance of bird species in a particular area off the Atlantic Coast.

All migratory bird range maps within IPaC are continuously being updated as new and better information becomes available.

Can I get additional information about the levels of occurrence in my project area of specific birds or groups of birds listed in IPaC?

Landbirds:

The Avian Knowledge Network (AKN) provides a tool currently called the "Histogram Tool", which draws from the data within the AKN (latest,survey, point count, citizen science datasets) to create a view of relative abundance of species within a particular location over the course of the year. The results of the tool depict the frequency of detection of a species in survey events, averaged between multiple datasets within AKN in a particular week of the year. You may access the histogram tools through the Migratory Bird Programs AKN Histogram Tools webpage.

The tool is currently available for 4 regions (California, Northeast U.S., Southeast U.S. and Midwest), which encompasses the following 32 states: Alabama, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North, Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin.

In the near future, there are plans to expand this tool nationwide within the AKN, and allow the graphs produced to appear with the list of trust resources generated by IPaC, providing you with an additional level of detail about the level of occurrence of the species of particular concern potentially occurring in your project area throughout the course of the year.

Atlantic Seabirds:

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAANCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Facilities

Wildlife refuges

Any activity proposed on National Wildlife Refuge lands must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGES AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

This location overlaps the following wetlands:

FRESHWATER EMERGENT WETLAND
PEMC

A full description for each wetland code can be found at the National Wetlands Inventory website: https://ecos.fws.gov/ipac/wetlands/decoder

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

South Baker IPaC Resource List

IPaC

U.S. Fish & Wildlife Service

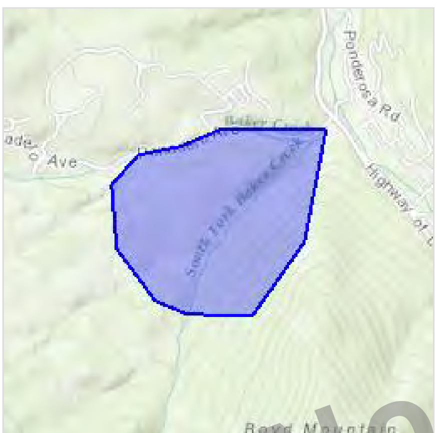
IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Huerfano County, Colorado



Local office

Colorado Ecological Services Field Office

(303) 236-4773
(303) 236-4005

MAILING ADDRESS

Denver Federal Center
P.O. Box 25486
Denver, CO 80225-0486

PHYSICAL ADDRESS
134 Union Boulevard, Suite 670
Lakewood, CO 80228-1807

http://www.fws.gov/coloradoES
http://www.fws.gov/platteriver

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] are managed by the Endangered Species Program of the U.S. Fish and Wildlife Service.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.

The following species are potentially affected by activities in this location:

Birds

NAME	STATUS
Mexican Spotted Owl *Strix occidentalis lucida* There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/8196	Threatened

Fishes

NAME	STATUS
Greenback Cutthroat Trout *Oncorhynchus clarki stomias* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2775	Threatened

Mammals

NAME	STATUS
Canada Lynx *Lynx canadensis* There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/3652	Threatened
North American Wolverine *Gulo gulo luscus* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5123	Proposed Threatened

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any activity that results in the take (to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct) of migratory birds or eagles is prohibited unless authorized by the U.S. Fish and Wildlife Service[3]. There are no provisions for allowing the take of migratory birds that are unintentionally killed or injured.

Any person or organization who plans or conducts activities that may result in the take of migratory birds is responsible for complying with the appropriate regulations and implementing appropriate conservation measures.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Conservation measures for birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Year-round bird occurrence data http://www.birdscanada.org/birdmon/default/datasummaries.jsp

The migratory birds species listed below are species of particular conservation concern (e.g. Birds of Conservation Concern) that may be potentially affected by activities in this location. It is not a list of every bird species you may find in this location, nor a guarantee that all of the bird species on this list will be found on or near this location. Although it is important to try to avoid and minimize impacts to all birds, special attention should be made to avoid and minimize impacts to birds of priority concern. To view available data on other bird species that may occur in your project area, please visit the AKN Histogram Tools and Other Bird Data Resources. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

NAME	SEASON(S)
Bald Eagle Haliaeetus leucocephalus https://ecos.fws.gov/ecp/species/1626	Year-round
Black Rail Laterallus jamaicensis https://ecos.fws.gov/ecp/species/7717	Breeding
Black Rosy-finch Leucosticte atrata https://ecos.fws.gov/ecp/species/9460	Year-round
Brewer's Sparrow Spizella breweri https://ecos.fws.gov/ecp/species/9291	Breeding
Brown-capped Rosy-finch Leucosticte australis	Year-round

Burrowing Owl Athene cunicularia https://ecos.fws.gov/ecp/species/9737	Breeding
Cassin's Finch Carpodacus cassinii https://ecos.fws.gov/ecp/species/9462	Year-round
Ferruginous Hawk Buteo regalis https://ecos.fws.gov/ecp/species/6038	Wintering
Golden Eagle Aquila chrysaetos https://ecos.fws.gov/ecp/species/1680	Year-round
Grace's Warbler Dendroica graciae	Breeding
Juniper Titmouse Baeolophus ridgwayi	Year-round
Lewis's Woodpecker Melanerpes lewis https://ecos.fws.gov/ecp/species/9408	Year-round
Loggerhead Shrike Lanius ludovicianus https://ecos.fws.gov/ecp/species/8833	Year-round
Long-billed Curlew Numenius americanus https://ecos.fws.gov/ecp/species/5511	Breeding
Mountain Plover Charadrius montanus https://ecos.fws.gov/ecp/species/3638	Breeding
Olive-sided Flycatcher Contopus cooperi https://ecos.fws.gov/ecp/species/3914	Breeding
Peregrine Falcon Falco peregrinus https://ecos.fws.gov/ecp/species/8831	Breeding
Pinyon Jay Gymnorhinus cyanocephalus https://ecos.fws.gov/ecp/species/9420	Year-round

Prairie Falcon Falco mexicanus https://ecos.fws.gov/ecp/species/4736	Year-round
Rufous Hummingbird selasphorus rufus https://ecos.fws.gov/ecp/species/8002	Migrating
Sage Thrasher Oreoscoptes montanus https://ecos.fws.gov/ecp/species/9433	Breeding
Short-eared Owl Asio flammeus https://ecos.fws.gov/ecp/species/9295	Wintering
Swainson's Hawk Buteo swainsoni https://ecos.fws.gov/ecp/species/1098	Breeding
Veery Catharus fuscescens	Breeding
Virginia's Warbler Vermivora virginiae https://ecos.fws.gov/ecp/species/9441	Breeding
Western Grebe aechmophorus occidentalis https://ecos.fws.gov/ecp/species/6743	Breeding
Williamson's Sapsucker Sphyrapicus thyroideus https://ecos.fws.gov/ecp/species/8832	Breeding
Willow Flycatcher Empidonax traillii https://ecos.fws.gov/ecp/species/3482	Breeding

What does IPaC use to generate the list of migratory bird species potentially occurring in my specified location?

Landbirds:

Migratory birds that are displayed on the IPaC species list are based on ranges in the latest edition of the National Geographic Guide, Birds of North America (6th Edition, 2011 by Jon L. Dunn, and Jonathan Alderfer). Although these ranges are coarse in nature, a number of U.S. Fish and Wildlife Service migratory bird biologists agree that these maps are some of the best range maps to date. These ranges were clipped to a specific Bird Conservation Region (BCR) or USFWS Region/Regions, if it was indicated in the 2008 list of Birds of Conservation Concern (BCC) that a species was a BCC species only in a particular Region/Regions. Additional modifications have been made to some ranges based on more local or refined range information and/or information provided by U.S. Fish and Wildlife Service biologists with species expertise. All migratory birds that show in areas on land in IPaC are those that appear in the 2008 Birds of Conservation Concern report.

Atlantic Seabirds:

Ranges in IPaC for birds off the Atlantic coast are derived from species distribution models developed by the National Oceanic and Atmospheric Association (NOAA) National Centers for Coastal Ocean Science (NCCOS) using the best available seabird survey data for the offshore Atlantic Coastal region to date. NOAANCCOS assisted USFWS in developing seasonal species ranges from their models for specific use in IPaC. Some of these birds are not BCC species but were of interest for inclusion because they may occur in high abundance off the coast at different times throughout the year, which potentially makes them more susceptible to certain types of development and activities taking place in that area. For more refined details about the abundance and richness of bird species within your project area off the Atlantic Coast, see the Northeast Ocean Data Portal. The Portal also offers data and information about other types of taxa that may be helpful in your project review.

About the NOAANCCOS models: the models were developed as part of the NOAANCCOS project: Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf. The models resulting from this project are being used in a number of decision-support/mapping products in order to help guide decision-making on activities off the Atlantic Coast with the goal of reducing impacts to migratory birds. One such product is the Northeast Ocean Data Portal, which can be used to explore details about the relative occurrence and abundance of bird species in a particular area off the Atlantic Coast.

All migratory bird range maps within IPaC are continuously being updated as new and better information becomes available.

Can I get additional information about the levels of occurrence in my project area of specific birds or groups of birds listed in IPaC?

Landbirds:

The Avian Knowledge Network (AKN) provides a tool currently called the "Histogram Tool", which draws from the data within the AKN (latest,survey, point count, citizen science datasets) to create a view of relative abundance of species within a particular location over the course of the year. The results of the tool depict the frequency of detection of a species in survey events, averaged between multiple datasets within AKN in a particular week of the year. You may access the histogram tools through the Migratory Bird Programs AKN Histogram Tools webpage.

The tool is currently available for 4 regions (California, Northeast U.S., Southeast U.S. and Midwest), which encompasses the following 32 states: Alabama, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North, Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin.

In the near future, there are plans to expand this tool nationwide within the AKN, and allow the graphs produced to appear with the list of trust resources generated by IPaC, providing you with an additional level of detail about the level of occurrence of the species of particular concern potentially occurring in your project area throughout the course of the year.

Atlantic Seabirds:

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAANCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Facilities

Wildlife refuges

Any activity proposed on National Wildlife Refuge lands must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGES AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

THERE ARE NO KNOWN WETLANDS AT THIS LOCATION.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Britton Pond IPaC Resource List

IPaC **U.S. Fish & Wildlife Service**

IPaC resource list

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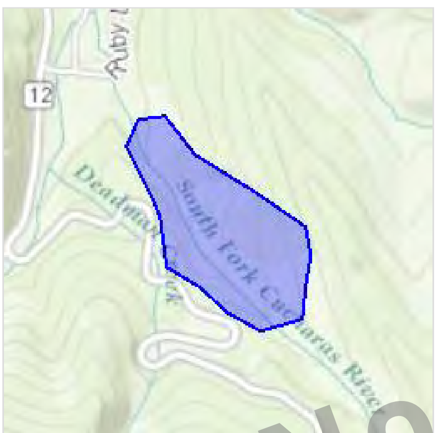
Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Huerfano County, Colorado



Local office

Colorado Ecological Services Field Office

(303) 236-4773
(303) 236-4005

MAILING ADDRESS

Denver Federal Center
P.O. Box 25486
Denver, CO 80225-0486

PHYSICAL ADDRESS
134 Union Boulevard, Suite 670
Lakewood, CO 80228-1807

http://www.fws.gov/coloradoES
http://www.fws.gov/platteriver

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] are managed by the Endangered Species Program of the U.S. Fish and Wildlife Service.

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.

The following species are potentially affected by activities in this location:

Birds

NAME	STATUS
Mexican Spotted Owl *Strix occidentalis lucida* There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/8196	Threatened

Fishes

NAME	STATUS
Greenback Cutthroat Trout *Oncorhynchus clarki stomias* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2775	Threatened

Mammals

NAME	STATUS
Canada Lynx *Lynx canadensis* There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/3652	Threatened
North American Wolverine *Gulo gulo luscus* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5123	Proposed Threatened

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any activity that results in the take (to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct) of migratory birds or eagles is prohibited unless authorized by the U.S. Fish and Wildlife Service[3]. There are no provisions for allowing the take of migratory birds that are unintentionally killed or injured.

Any person or organization who plans or conducts activities that may result in the take of migratory birds is responsible for complying with the appropriate regulations and implementing appropriate conservation measures.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Conservation measures for birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Year-round bird occurrence data http://www.birdscanada.org/birdmon/default/datasummaries.jsp

The migratory birds species listed below are species of particular conservation concern (e.g. Birds of Conservation Concern) that may be potentially affected by activities in this location. It is not a list of every bird species you may find in this location, nor a guarantee that all of the bird species on this list will be found on or near this location. Although it is important to try to avoid and minimize impacts to all birds, special attention should be made to avoid and minimize impacts to birds of priority concern. To view available data on other bird species that may occur in your project area, please visit the AKN Histogram Tools and Other Bird Data Resources. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

NAME	SEASON(S)
Bald Eagle Haliaeetus leucocephalus https://ecos.fws.gov/ecp/species/1626	Year-round
Black Rail Laterallus jamaicensis https://ecos.fws.gov/ecp/species/7717	Breeding
Black Rosy-finch Leucosticte atrata https://ecos.fws.gov/ecp/species/9460	Year-round
Brewer's Sparrow Spizella breweri https://ecos.fws.gov/ecp/species/9291	Breeding
Brown-capped Rosy-finch Leucosticte australis	Year-round

Burrowing Owl Athene cunicularia https://ecos.fws.gov/ecp/species/9737	Breeding
Cassin's Finch Carpodacus cassinii https://ecos.fws.gov/ecp/species/9462	Year-round
Ferruginous Hawk Buteo regalis https://ecos.fws.gov/ecp/species/6038	Wintering
Golden Eagle Aquila chrysaetos https://ecos.fws.gov/ecp/species/1680	Year-round
Grace's Warbler Dendroica graciae	Breeding
Juniper Titmouse Baeolophus ridgwayi	Year-round
Lewis's Woodpecker Melanerpes lewis https://ecos.fws.gov/ecp/species/9408	Year-round
Loggerhead Shrike Lanius ludovicianus https://ecos.fws.gov/ecp/species/8833	Year-round
Long-billed Curlew Numenius americanus https://ecos.fws.gov/ecp/species/5511	Breeding
Mountain Plover Charadrius montanus https://ecos.fws.gov/ecp/species/3638	Breeding
Olive-sided Flycatcher Contopus cooperi https://ecos.fws.gov/ecp/species/3914	Breeding
Peregrine Falcon Falco peregrinus https://ecos.fws.gov/ecp/species/8831	Breeding
Pinyon Jay Gymnorhinus cyanocephalus https://ecos.fws.gov/ecp/species/9420	Year-round

Prairie Falcon Falco mexicanus https://ecos.fws.gov/ecp/species/4736	Year-round
Rufous Hummingbird selasphorus rufus https://ecos.fws.gov/ecp/species/8002	Migrating
Sage Thrasher Oreoscoptes montanus https://ecos.fws.gov/ecp/species/9433	Breeding
Short-eared Owl Asio flammeus https://ecos.fws.gov/ecp/species/9295	Wintering
Swainson's Hawk Buteo swainsoni https://ecos.fws.gov/ecp/species/1098	Breeding
Veery Catharus fuscescens	Breeding
Virginia's Warbler Vermivora virginiae https://ecos.fws.gov/ecp/species/9441	Breeding
Western Grebe aechmophorus occidentalis https://ecos.fws.gov/ecp/species/6743	Breeding
Williamson's Sapsucker Sphyrapicus thyroideus https://ecos.fws.gov/ecp/species/8832	Breeding
Willow Flycatcher Empidonax traillii https://ecos.fws.gov/ecp/species/3482	Breeding

What does IPaC use to generate the list of migratory bird species potentially occurring in my specified location?

Landbirds:

Migratory birds that are displayed on the IPaC species list are based on ranges in the latest edition of the National Geographic Guide, Birds of North America (6th Edition, 2011 by Jon L. Dunn, and Jonathan Alderfer). Although these ranges are coarse in nature, a number of U.S. Fish and Wildlife Service migratory bird biologists agree that these maps are some of the best range maps to date. These ranges were clipped to a specific Bird Conservation Region (BCR) or USFWS Region/Regions, if it was indicated in the 2008 list of Birds of Conservation Concern (BCC) that a species was a BCC species only in a particular Region/Regions. Additional modifications have been made to some ranges based on more local or refined range information and/or information provided by U.S. Fish and Wildlife Service biologists with species expertise. All migratory birds that show in areas on land in IPaC are those that appear in the 2008 Birds of Conservation Concern report.

Atlantic Seabirds:

Ranges in IPaC for birds off the Atlantic coast are derived from species distribution models developed by the National Oceanic and Atmospheric Association (NOAA) National Centers for Coastal Ocean Science (NCCOS) using the best available seabird survey data for the offshore Atlantic Coastal region to date. NOAANCCOS assisted USFWS in developing seasonal species ranges from their models for specific use in IPaC. Some of these birds are not BCC species but were of interest for inclusion because they may occur in high abundance off the coast at different times throughout the year, which potentially makes them more susceptible to certain types of development and activities taking place in that area. For more refined details about the abundance and richness of bird species within your project area off the Atlantic Coast, see the Northeast Ocean Data Portal. The Portal also offers data and information about other types of taxa that may be helpful in your project review.

About the NOAANCCOS models: the models were developed as part of the NOAANCCOS project: Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf. The models resulting from this project are being used in a number of decision-support/mapping products in order to help guide decision-making on activities off the Atlantic Coast with the goal of reducing impacts to migratory birds. One such product is the Northeast Ocean Data Portal, which can be used to explore details about the relative occurrence and abundance of bird species in a particular area off the Atlantic Coast.

All migratory bird range maps within IPaC are continuously being updated as new and better information becomes available.

Can I get additional information about the levels of occurrence in my project area of specific birds or groups of birds listed in IPaC?

Landbirds:

The Avian Knowledge Network (AKN) provides a tool currently called the "Histogram Tool", which draws from the data within the AKN (latest,survey, point count, citizen science datasets) to create a view of relative abundance of species within a particular location over the course of the year. The results of the tool depict the frequency of detection of a species in survey events, averaged between multiple datasets within AKN in a particular week of the year. You may access the histogram tools through the Migratory Bird Programs AKN Histogram Tools webpage.

The tool is currently available for 4 regions (California, Northeast U.S., Southeast U.S. and Midwest), which encompasses the following 32 states: Alabama, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North, Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin.

In the near future, there are plans to expand this tool nationwide within the AKN, and allow the graphs produced to appear with the list of trust resources generated by IPaC, providing you with an additional level of detail about the level of occurrence of the species of particular concern potentially occurring in your project area throughout the course of the year.

Atlantic Seabirds:

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAANCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Facilities

Wildlife refuges

Any activity proposed on National Wildlife Refuge lands must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGES AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

THERE ARE NO KNOWN WETLANDS AT THIS LOCATION.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Maria Stevens IPaC Resource List

IPaC **U.S. Fish & Wildlife Service**

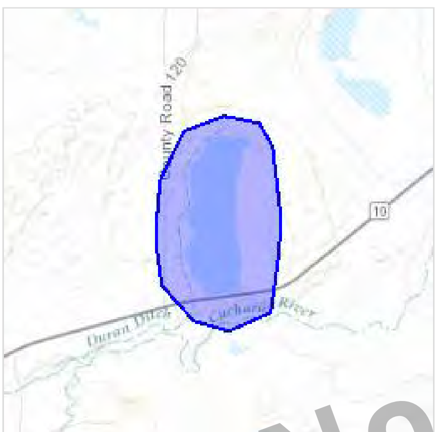
IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Huerfano County, Colorado



Local office

Colorado Ecological Services Field Office

(303) 236-4773
(303) 236-4005

MAILING ADDRESS

Denver Federal Center
P.O. Box 25486
Denver, CO 80225-0486

PHYSICAL ADDRESS
134 Union Boulevard, Suite 670
Lakewood, CO 80228-1807

http://www.fws.gov/coloradoES
http://www.fws.gov/platteriver

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] are managed by the Endangered Species Program of the U.S. Fish and Wildlife Service.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.

The following species are potentially affected by activities in this location:

Birds

NAME	STATUS
Mexican Spotted Owl *Strix occidentalis lucida* There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/8196	Threatened

Fishes

NAME	STATUS
Greenback Cutthroat Trout *Oncorhynchus clarki stomias* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2775	Threatened

Mammals

NAME	STATUS
Canada Lynx *Lynx canadensis* There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/3652	Threatened
North American Wolverine *Gulo gulo luscus* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5123	Proposed Threatened

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any activity that results in the take (to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct) of migratory birds or eagles is prohibited unless authorized by the U.S. Fish and Wildlife Service[3]. There are no provisions for allowing the take of migratory birds that are unintentionally killed or injured.

Any person or organization who plans or conducts activities that may result in the take of migratory birds is responsible for complying with the appropriate regulations and implementing appropriate conservation measures.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Conservation measures for birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Year-round bird occurrence data http://www.birdscanada.org/birdmon/default/datasummaries.jsp

The migratory birds species listed below are species of particular conservation concern (e.g. Birds of Conservation Concern) that may be potentially affected by activities in this location. It is not a list of every bird species you may find in this location, nor a guarantee that all of the bird species on this list will be found on or near this location. Although it is important to try to avoid and minimize impacts to all birds, special attention should be made to avoid and minimize impacts to birds of priority concern. To view available data on other bird species that may occur in your project area, please visit the AKN Histogram Tools and Other Bird Data Resources. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

NAME	SEASON(S)
American Bittern Botaurus lentiginosus https://ecos.fws.gov/ecp/species/6582	Breeding
Bald Eagle Haliaeetus leucocephalus https://ecos.fws.gov/ecp/species/1626	Year-round
Black Rail Laterallus jamaicensis https://ecos.fws.gov/ecp/species/7717	Breeding
Black Rosy-finch Leucosticte atrata https://ecos.fws.gov/ecp/species/9460	Year-round

Brewer's Sparrow Spizella breweri https://ecos.fws.gov/ecp/species/9291	Breeding
Burrowing Owl Athene cunicularia https://ecos.fws.gov/ecp/species/9737	Breeding
Cassin's Finch Carpodacus cassinii https://ecos.fws.gov/ecp/species/9462	Year-round
Ferruginous Hawk Buteo regalis https://ecos.fws.gov/ecp/species/6038	Year-round
Golden Eagle Aquila chrysaetos https://ecos.fws.gov/ecp/species/1680	Year-round
Grace's Warbler Dendroica graciae	Breeding
Lewis's Woodpecker Melanerpes lewis https://ecos.fws.gov/ecp/species/9408	Breeding
Loggerhead Shrike Lanius ludovicianus https://ecos.fws.gov/ecp/species/8833	Year-round
Long-billed Curlew Numenius americanus https://ecos.fws.gov/ecp/species/5511	Breeding
Mountain Plover Charadrius montanus https://ecos.fws.gov/ecp/species/3638	Breeding
Olive-sided Flycatcher Contopus cooperi https://ecos.fws.gov/ecp/species/3914	Breeding
Peregrine Falcon Falco peregrinus https://ecos.fws.gov/ecp/species/8831	Breeding

Pinyon Jay Gymnorhinus cyanocephalus https://ecos.fws.gov/ecp/species/9420	Year-round
Prairie Falcon Falco mexicanus https://ecos.fws.gov/ecp/species/4736	Year-round
Rufous Hummingbird selasphorus rufus https://ecos.fws.gov/ecp/species/8002	Migrating
Sage Thrasher Oreoscoptes montanus https://ecos.fws.gov/ecp/species/9433	Breeding
Short-eared Owl Asio flammeus https://ecos.fws.gov/ecp/species/9295	Wintering
Snowy Plover Charadrius alexandrinus	Breeding
Swainson's Hawk Buteo swainsoni https://ecos.fws.gov/ecp/species/1098	Breeding
Virginia's Warbler Vermivora virginiae https://ecos.fws.gov/ecp/species/9441	Breeding
Western Grebe aechmophorus occidentalis https://ecos.fws.gov/ecp/species/6743	Breeding
Williamson's Sapsucker Sphyrapicus thyroideus https://ecos.fws.gov/ecp/species/8832	Breeding

What does IPaC use to generate the list of migratory bird species potentially occurring in my specified location?

Landbirds:

Migratory birds that are displayed on the IPaC species list are based on ranges in the latest edition of the National Geographic Guide, Birds of North America (6th Edition, 2011 by Jon L. Dunn, and Jonathan Alderfer). Although these ranges are coarse in nature, a number of U.S. Fish and Wildlife Service migratory bird biologists agree that these maps are some of the best range maps to date. These ranges were clipped to a specific Bird Conservation Region (BCR) or USFWS Region/Regions, if it was indicated in the 2008 list of Birds of Conservation Concern (BCC) that a species was a BCC species only in a particular Region/Regions. Additional modifications have been made to some ranges based on more local or refined range information and/or information provided by U.S. Fish and Wildlife Service biologists with species expertise. All migratory birds that show in areas on land in IPaC are those that appear in the 2008 Birds of Conservation Concern report.

Atlantic Seabirds:

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About the NOAANCCOS models: the models were developed as part of the NOAANCCOS project: Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf. The models resulting from this project are being used in a number of decision-support/mapping products in order to help guide decision-making on activities off the Atlantic Coast with the goal of reducing impacts to migratory birds. One such product is the Northeast Ocean Data Portal, which can be used to explore details about the relative occurrence and abundance of bird species in a particular area off the Atlantic Coast.

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Can I get additional information about the levels of occurrence in my project area of specific birds or groups of birds listed in IPaC?

Landbirds:

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The tool is currently available for 4 regions (California, Northeast U.S., Southeast U.S. and Midwest), which encompasses the following 32 states: Alabama, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North, Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin.

In the near future, there are plans to expand this tool nationwide within the AKN, and allow the graphs produced to appear with the list of trust resources generated by IPaC, providing you with an additional level of detail about the level of occurrence of the species of particular concern potentially occurring in your project area throughout the course of the year.

Atlantic Seabirds:

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAANCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Facilities

Wildlife refuges

Any activity proposed on National Wildlife Refuge lands must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGES AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

This location overlaps the following wetlands:

FRESHWATER EMERGENT WETLAND
- PEMC

FRESHWATER FORESTED/SHRUB WETLAND
- PSSC

LAKE
- L1UBHx
- L2USK

RIVERINE
- R4SBA

A full description for each wetland code can be found at the National Wetlands Inventory website: https://ecos.fws.gov/ipac/wetlands/decoder

Data limitations

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The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

La Veta IPaC Resource List

IPaC **U.S. Fish & Wildlife Service**

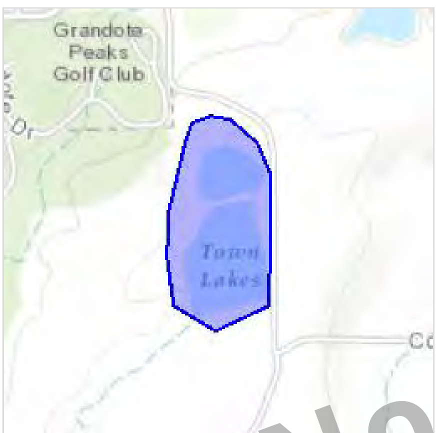
IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Huerfano County, Colorado



Local office

Colorado Ecological Services Field Office

(303) 236-4773
(303) 236-4005

MAILING ADDRESS

Denver Federal Center
P.O. Box 25486
Denver, CO 80225-0486

PHYSICAL ADDRESS
134 Union Boulevard, Suite 670
Lakewood, CO 80228-1807

http://www.fws.gov/coloradoES
http://www.fws.gov/platteriver

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] are managed by the Endangered Species Program of the U.S. Fish and Wildlife Service.

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.

The following species are potentially affected by activities in this location:

Birds

NAME	STATUS
Mexican Spotted Owl *Strix occidentalis lucida* There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/8196	Threatened

Fishes

NAME	STATUS
Greenback Cutthroat Trout *Oncorhynchus clarki stomias* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2775	Threatened

Mammals

NAME	STATUS
Canada Lynx *Lynx canadensis* There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/3652	Threatened
North American Wolverine *Gulo gulo luscus* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5123	Proposed Threatened

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any activity that results in the take (to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct) of migratory birds or eagles is prohibited unless authorized by the U.S. Fish and Wildlife Service[3]. There are no provisions for allowing the take of migratory birds that are unintentionally killed or injured.

Any person or organization who plans or conducts activities that may result in the take of migratory birds is responsible for complying with the appropriate regulations and implementing appropriate conservation measures.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Conservation measures for birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Year-round bird occurrence data http://www.birdscanada.org/birdmon/default/datasummaries.jsp

The migratory birds species listed below are species of particular conservation concern (e.g. Birds of Conservation Concern) that may be potentially affected by activities in this location. It is not a list of every bird species you may find in this location, nor a guarantee that all of the bird species on this list will be found on or near this location. Although it is important to try to avoid and minimize impacts to all birds, special attention should be made to avoid and minimize impacts to birds of priority concern. To view available data on other bird species that may occur in your project area, please visit the AKN Histogram Tools and Other Bird Data Resources. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

NAME	SEASON(S)
Bald Eagle Haliaeetus leucocephalus https://ecos.fws.gov/ecp/species/1626	Year-round
Black Rail Laterallus jamaicensis https://ecos.fws.gov/ecp/species/7717	Breeding
Black Rosy-finch Leucosticte atrata https://ecos.fws.gov/ecp/species/9460	Year-round
Brewer's Sparrow Spizella breweri https://ecos.fws.gov/ecp/species/9291	Breeding
Brown-capped Rosy-finch Leucosticte australis	Wintering

Burrowing Owl Athene cunicularia https://ecos.fws.gov/ecp/species/9737	Breeding
Cassin's Finch Carpodacus cassinii https://ecos.fws.gov/ecp/species/9462	Year-round
Ferruginous Hawk Buteo regalis https://ecos.fws.gov/ecp/species/6038	Wintering
Golden Eagle Aquila chrysaetos https://ecos.fws.gov/ecp/species/1680	Year-round
Grace's Warbler Dendroica graciae	Breeding
Lewis's Woodpecker Melanerpes lewis https://ecos.fws.gov/ecp/species/9408	Year-round
Loggerhead Shrike Lanius ludovicianus https://ecos.fws.gov/ecp/species/8833	Year-round
Long-billed Curlew Numenius americanus https://ecos.fws.gov/ecp/species/5511	Breeding
Mountain Plover Charadrius montanus https://ecos.fws.gov/ecp/species/3638	Breeding
Olive-sided Flycatcher Contopus cooperi https://ecos.fws.gov/ecp/species/3914	Breeding
Peregrine Falcon Falco peregrinus https://ecos.fws.gov/ecp/species/8831	Breeding
Pinyon Jay Gymnorhinus cyanocephalus https://ecos.fws.gov/ecp/species/9420	Year-round

Prairie Falcon Falco mexicanus https://ecos.fws.gov/ecp/species/4736	Year-round
Rufous Hummingbird selasphorus rufus https://ecos.fws.gov/ecp/species/8002	Migrating
Sage Thrasher Oreoscoptes montanus https://ecos.fws.gov/ecp/species/9433	Breeding
Short-eared Owl Asio flammeus https://ecos.fws.gov/ecp/species/9295	Wintering
Swainson's Hawk Buteo swainsoni https://ecos.fws.gov/ecp/species/1098	Breeding
Virginia's Warbler Vermivora virginiae https://ecos.fws.gov/ecp/species/9441	Breeding
Western Grebe aechmophorus occidentalis https://ecos.fws.gov/ecp/species/6743	Breeding
Williamson's Sapsucker Sphyrapicus thyroideus https://ecos.fws.gov/ecp/species/8832	Breeding

What does IPaC use to generate the list of migratory bird species potentially occurring in my specified location?

Landbirds:

Migratory birds that are displayed on the IPaC species list are based on ranges in the latest edition of the National Geographic Guide, Birds of North America (6th Edition, 2011 by Jon L. Dunn, and Jonathan Alderfer). Although these ranges are coarse in nature, a number of U.S. Fish and Wildlife Service migratory bird biologists agree that these maps are some of the best range maps to date. These ranges were clipped to a specific Bird Conservation Region (BCR) or USFWS Region/Regions, if it was indicated in the 2008 list of Birds of Conservation Concern (BCC) that a species was a BCC species only in a particular Region/Regions. Additional modifications have been made to some ranges based on more local or refined range information and/or information provided by U.S. Fish and Wildlife Service biologists with species expertise. All migratory birds that show in areas on land in IPaC are those that appear in the 2008 Birds of Conservation Concern report.

Atlantic Seabirds:

Ranges in IPaC for birds off the Atlantic coast are derived from species distribution models developed by the National Oceanic and Atmospheric Association (NOAA) National Centers for Coastal Ocean Science (NCCOS) using the best available seabird survey data for the offshore Atlantic Coastal region to date. NOAANCCOS assisted USFWS in developing seasonal species ranges from their models for specific use in IPaC. Some of these birds are not BCC species but were of interest for inclusion because they may occur in high abundance off the coast at different times throughout the year, which potentially makes them more susceptible to certain types of development and activities taking place in that area. For more refined details about the abundance and richness of bird species within your project area off the Atlantic Coast, see the Northeast Ocean Data Portal. The Portal also offers data and information about other types of taxa that may be helpful in your project review.

About the NOAANCCOS models: the models were developed as part of the NOAANCCOS project: Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf. The models resulting from this project are being used in a number of decision-support/mapping products in order to help guide decision-making on activities off the Atlantic Coast with the goal of reducing impacts to migratory birds. One such product is the Northeast Ocean Data Portal, which can be used to explore details about the relative occurrence and abundance of bird species in a particular area off the Atlantic Coast.

All migratory bird range maps within IPaC are continuously being updated as new and better information becomes available.

Can I get additional information about the levels of occurrence in my project area of specific birds or groups of birds listed in IPaC?

Landbirds:

The Avian Knowledge Network (AKN) provides a tool currently called the "Histogram Tool", which draws from the data within the AKN (latest,survey, point count, citizen science datasets) to create a view of relative abundance of species within a particular location over the course of the year. The results of the tool depict the frequency of detection of a species in survey events, averaged between multiple datasets within AKN in a particular week of the year. You may access the histogram tools through the Migratory Bird Programs AKN Histogram Tools webpage.

The tool is currently available for 4 regions (California, Northeast U.S., Southeast U.S. and Midwest), which encompasses the following 32 states: Alabama, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North, Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin.

In the near future, there are plans to expand this tool nationwide within the AKN, and allow the graphs produced to appear with the list of trust resources generated by IPaC, providing you with an additional level of detail about the level of occurrence of the species of particular concern potentially occurring in your project area throughout the course of the year.

Atlantic Seabirds:

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAANCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Facilities

Wildlife refuges

Any activity proposed on National Wildlife Refuge lands must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGES AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

This location overlaps the following wetlands:

FRESHWATER POND
PUBF

LAKE
L2UBH

A full description for each wetland code can be found at the National Wetlands Inventory website: https://ecos.fws.gov/ipac/wetlands/decoder

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

APPENDIX H

COST ESTIMATES

Engineers Opinion of Probable Construction Cost (Feasibility Level)

Applegate Group, Inc.

1490 W. 121st Ave.
Suite 100
Denver, CO 80234
Phone: (303) 452-6611
Fax: (303) 452-2759

Maria Stevens Enlargement

(Excluding Deferred Maintenance Costs)

Job No. : 16-106
By: SAS
Date: 6/20/2017
Client: Cucharas Collaborative

Description of Work	Item	Item Description	Units	Quantity	Unit Cost	Total Cost
Enlargement of a small, significant hazard off-channel dam		**Administration**				
	1a	Mobilization	%		5%	$ 302,100
	1b	Bonds and Permits	%		2%	$ 120,800
		Site Preparation				
	2a	Dewatering and Water Control	LS	1	$ 40,000	$ 40,000
	2b	Clearing and Grubbing	AC	10.4	$ 10,000	$ 104,000
	2c	Erosion and Sediment Control	LS	1	$ 15,000	$ 15,000
	2d	Construction Surveying	LS	1	$ 20,000	$ 20,000
	2e	Geotechnical Investigation	LS	1	$ 10,000	$ 10,000
		Earthwork				
	3a	Stripping and Stockpiling Topsoil	CY	16779	$ 8	$ 134,200
	3b	Excavation & Processing Borrow Material	CY	49,000	$ 25	$ 1,225,000
	3c	Excavate South Dam for Placement of New Outlet	CY	850	$ 18	$ 15,300
	3d	Dam Placement	CY	48,000	$ 15	$ 720,000
	3e	Furnish and Place 18" D50 Riprap	CY	17491	$ 95	$ 1,661,600
	3f	Furnish and Place Type II Granular Bedding	CY	8,746	$ 125	$ 1,093,200
		Dam Structures and Outlet Works				
	4a	Furnish and Place 30" C905 PVC Encased Outlet Conduit Pipe	LF	320	$ 800	$ 256,000
	4b	Furnish and Place Structural Concrete Outlet Tower	CY	15	$ 1,100	$ 17,000
	4c	Furnish and Place 30" Sluice Gate on Outlet Tower	LS	1	$ 25,000	$ 25,000
	4d	Furnish and Place Low Level Outlet Trashrack	LS	1	$ 2,000	$ 2,000
	4e	Furnish and Place Filter Diaphragm	CY	33	$ 250	$ 8,300
	4f	Furnish and Place 24" Riprap for Emergency Spillway Channel	CY	2,222	$ 140	$ 311,100
	4g	Furnish and Place Type II Bedding for Emergency Spillway Channel	CY	1,111	$ 125	$ 138,900
		Site Reclamation				
	5a	Seeding	AC	10.4	$ 7,500	$ 78,000
	5b	Place topsoil	CY	16,779	$ 10	$ 167,800
		Construction Subtotal				**$ 6,465,300**
		Unlisted Items	%		10%	$ 647,000
		Contingency	%		20%	$ 1,294,000
		Construction Total				**$ 8,406,300**
		Permitting	%		1%	$ 84,100
		Land Acquisition	AC	14.6	$ 5,000	$ 73,000
		Engineering	LS	1	$ 130,000	$ 130,000
		Construction Observation	LS	1	$ 60,000	$ 60,000
		Annual O&M Costs	LS	1	$ 20,000	$ 20,000
		Total				**$ 8,773,400**

Engineers Opinion of Probable Construction Cost (30% Design)

Applegate Group, Inc.
1490 W. 121st Ave.
Suite 100
Denver, CO 80234
Phone: (303) 452-6611
Fax: (303) 452-2759

South Baker Creek Reservoir

Job No. : 16-106
By: SAS
Date: 5/18/2017
Client: Cucharas Collaborative

Description of Work	Item	Item Description	Units	Quantity	Unit Cost	Total Cost
Construction of a new large, high hazard dam on South Baker Creek		**Administration**				
	1a	Mobilization	%		5%	$ 470,900
	1b	Bonds and Permits	%		2%	$ 188,400
		Site Preparation				
	2a	Dewatering and Water Control	LS	1	$ 90,000	$ 90,000
	2b	Clearing and Grubbing	AC	4.9	$ 15,000	$ 73,500
	2c	Erosion and Sediment Control	LS	1	$ 15,000	$ 15,000
	2d	Construction Surveying	LS	1	$ 20,000	$ 20,000
	2e	Geotechnical Investigation	LS	1	$ 15,000	$ 15,000
		Earthwork				
	3a	Stripping and Stockpiling Topsoil	CY	7921	$ 8	$ 63,400
	3b	Excavation & Processing Core Borrow Material	CY	66150	$ 25	$ 1,653,800
	3c	Excavation & Processing Shell Borrow Material	CY	56350	$ 25	$ 1,408,800
	3d	Spillway Cut	CY	16434	$ 17	$ 279,400
	3e	Spillway Fill	CY	300	$ 15	$ 4,500
	3f	Dam Placement	CY	122500	$ 15	$ 1,837,500
	3g	Grout Cutoff Wall - Dam Crest 40' deep	LF	285	$ 2,510	$ 715,400
	3h	Grout Cutoff Wall - Dam Crest 20' deep	LF	120	$ 1,255	$ 150,600
	3i	Excavation for Inlet Channel	LF	2800	$ 17	$ 47,600
	3j	Furnish and Place 18" D50 Riprap for Emergency Spillway	CY	2520	$ 95	$ 239,400
	3k	Furnish and Place Type II Granular Bedding Emergency Spillway	CY	1,260	$ 125	$ 157,500
		Dam Structures and Outlet Works				
	4a	Furnish and Place 24" Steel Encased Outlet Conduit Pipe	LF	423	$ 2,135	$ 903,100
	4b	Furnish and Place 2'x2' Inclined Concrete Box Culvert Primary Spillway	CY	36	$ 1,100	$ 39,700
	4c	Furnish and Place 4'x4' Trashrack for Primary Spillway Inlet	LS	1	$ 4,000	$ 4,000
	4d	Furnish and Place 24" Sluice Gate for Low-Level Outlet	LS	1	$ 20,000	$ 20,000
	4e	Furnish and Place Type VI Stilling Basin	LS	1	$ 15,000	$ 15,000
	4f	Furnish and Place Low Level Outlet Trashrack	LS	1	$ 2,000	$ 2,000
	4g	Furnish and Place Stilling Basin Grate	LS	1	$ 5,000	$ 5,000
	4h	Furnish and Install Piezometers	LS	4	$ 4,000	$ 16,000
	4i	Furnish and Place Filter Diaphragm	CY	33	$ 250	$ 8,300
	4j	Furning and Place Chimney and Blanket Drain	CY	7,415	$ 200	$ 1,483,000
	4k	Furnish and Place ASTM C33 Concrete Sand for Toe Drain	CY	92	$ 200	$ 18,300
	4l	Furnish and Place Toe Drain (6" Diameter)	LF	275	$ 60	$ 16,500
		Site Reclamation				
	5a	Seeding	AC	4.9	$ 7,500	$ 36,800
	5b	Place topsoil	CY	7,921	$ 10	$ 79,200
		Construction Subtotal				**$ 10,077,600**
		Unlisted Items	%		10%	$ 1,008,000
		Contingency/Missing Items	%		20%	$ 2,016,000
		Construction Total				**$ 13,101,600**
		Permitting	%		2.5%	$ 327,600
		Land Acquisition	AC	6.9	$ 5,000	$ 34,500
		Engineering	LS	1	$ 135,000	$ 135,000
		Construction Observation	LS	1	$ 70,000	$ 70,000
		Annual O&M Costs	LS	1	$20,000.0	$ 20,000
		Total				**$ 13,688,700**

Engineers Opinion of Probable Construction Cost (Feasibility Level)

Applegate Group, Inc.

1490 W. 121st Ave. Suite 100
Denver, CO 80234
Phone: (303) 452-6611
Fax: (303) 452-2759

Bruce Canyon Reservoir

Job No. : 16-106
By: SAS
Date: 5/18/2017
Client: Cucharas Collaborative

Description of Work	Item	Item Description	Units	Quantity	Unit Cost	Total Cost
Construction of a new large, significant hazard dam		**Administration**				
	1a	Mobilization	%		5%	$ 689,600
	1b	Bonds and Permits	%		2%	$ 275,800
		Site Preparation				
	2a	Dewatering and Water Control	LS	1	$ 90,000	$ 90,000
	2b	Clearing and Grubbing	AC	6.6	$ 15,000	$ 99,000
	2c	Erosion and Sediment Control	LS	1	$ 15,000	$ 15,000
	2d	Construction Surveying	LS	1	$ 20,000	$ 20,000
	2e	Geotechnical Investigation	LS	1	$ 15,000	$ 15,000
		Earthwork				
	3a	Stripping and Stockpiling Topsoil	CY	10,648	$ 8	$ 85,200
	3b	Excavation & Processing Core Borrow Material	CY	119,900	$ 25	$ 2,997,500
	3c	Excavation & Processing Shell Borrow Material	CY	134,310	$ 25	$ 3,357,800
	3d	Excavation of Emergency Spillway Channel	CY	7,200	$ 17	$ 122,400
	3e	Dam Placement	CY	242,000	$ 15	$ 3,630,000
	3f	Grout Cutoff Wall - 10' deep	LF	200	$ 627	$ 125,400
	3g	Furnish and Place 18" D50 Riprap for Emergency Spillway	CY	2,678	$ 95	$ 254,400
	3h	Furnish and Place Type II Granular Bedding for Emergency Spillway	CY	1,339	$ 125	$ 167,400
		Dam Structures and Outlet Works				
	4a	Furnish and Place 24" C905 PVC Encased Outlet Conduit Pipe	LF	570	$ 800	$ 456,000
	4b	Furnish and Place Structural Concrete for Inclined Gate Stem	CY	37	$ 1,100	$ 40,700
	4c	Furnish and Place 24" Sluice Gate for Low-Level Outlet	LS	1	$ 20,000	$ 20,000
	4d	Furnish and Place Type VI Stilling Basin	LS	1	$ 15,000	$ 15,000
	4e	Furnish and Place Low Level Outlet Trashrack	LS	1	$ 2,000	$ 2,000
	4f	Furnish and Place Filter Diaphragm	CY	1.2	$ 250	$ 300
	4g	Furnish and Place Chimney and Blanket Drain	CY	10,600	$ 200	$ 2,120,000
	4h	Furnish and Place ASTM C33 Concrete Sand for Toe Drain	CY	100	$ 200	$ 20,000
	4h	Furnish and Place Toe Drain	LF	300	$ 60	$ 18,000
		Site Reclamation				
	5a	Seeding	AC	6.6	$ 7,500	$ 49,500
	5b	Place topsoil	CY	7,099	$ 10	$ 71,000
		Construction Subtotal				**$ 14,757,000**
		Unlisted Items	**%**		10%	$ 1,475,700
		Contingency/Missing Items	%		20%	$ 2,951,400
		Construction Total				**$ 19,184,100**
		Permitting	%		2%	$ 383,700
		Land Acquisition	AC	9.3	$ 5,000	$ 46,500
		Engineering	LS	1	$ 150,000	$ 150,000
		Construction Observation	LS	1	$ 80,000	$ 80,000
		Annual O&M Costs	LS	1	$ 20,000	$ 20,000
		Total				**$ 19,864,300**

Engineers Opinion of Probable Construction Cost (Feasibility Level)

Applegate Group, Inc.
1490 W. 121st Ave.
Suite 100
Denver, CO 80234
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Fax: (303) 452-2759

Britton Reservoir

Job No. : 16-106
By: SAS
Date: 5/18/2017
Client: Cucharas Collaborative

Description of Work	Item	Item Description	Units	Quantity	Unit Cost	Total Cost
Construction of a new small high hazard dam on S Fork Cucharas River		**Administration**				
	1a	Mobilization	%		5%	$ 236,400
	1b	Bonds and Permits	%		2%	$ 94,600
		Site Preparation				
	2a	Dewatering and Water Control	LS	1	$ 90,000	$ 90,000
	2b	Clearing and Grubbing	AC	2.3	$ 15,000	$ 34,500
	2c	Erosion and Sediment Control	LS	1	$ 15,000	$ 15,000
	2d	Construction Surveying	LS	1	$ 20,000	$ 20,000
	2e	Geotechnical Investigation	LS	1	$ 15,000	$ 15,000
		Earthwork				
	3a	Stripping and Stockpiling Topsoil	CY	3,711	$ 8	$ 29,700
	3b	Excavation & Processing Core Borrow Material	CY	22,000	$ 25	$ 550,000
	3c	Excavation & Processing Shell Borrow Material	CY	25,093	$ 25	$ 627,300
	3d	Excavation of Emergency Spillway Channel	CY	3,800	$ 17	$ 64,600
	3e	Spillway Cut	CY	3,900	$ 17	$ 66,300
	3f	Spillway Fill	CY	7	$ 15	$ 100
	3g	Dam Placement	CY	44,848	$ 15	$ 672,700
	3h	Grout Cutoff Wall - Dam Crest 40' deep	LF	100	$ 2,510	$ 251,000
	3i	Grout Cutoff Wall - Dam Crest 20' deep	LF	365	$ 1,255	$ 458,100
	3j	Furnish and Place 18" D50 Riprap for Spillway	CY	2,056	$ 95	$ 195,300
	3k	Furnish and Place Type II Granular Bedding for Spillway	CY	1,028	$ 125	$ 128,500
		Dam Structures and Outlet Works				
	4a	Furnish and Place 24" Steel Encased Outlet Conduit Pipe	LF	325	$ 2,135	$ 693,900
	4b	Furnish and Place 2'x2' Inclined Concrete Box Culvert Primary Spillway	CY	67	$ 1,100	$ 73,300
	4c	Furnish and Place 4'x4' Trashrack for Primary Spillway Inlet	LS	1	$ 4,000	$ 4,000
	4d	Furnish and Place 24" Sluice Gate for Low-Level Outlet	LS	1	$ 20,000	$ 20,000
	4e	Furnish and Place Type VI Stilling Basin	LS	1	$ 15,000	$ 15,000
	4f	Furnish and Place Low Level Outlet Trashrack	LS	1	$ 2,000	$ 2,000
	4g	Furnish and Place Stilling Basin Grate	LS	1	$ 5,000	$ 5,000
	4h	Furnish and Install Piezometers	EA	4	$ 2,500	$ 10,000
	4i	Furnish and Place Filter Diaphragm	CY	33	$ 250	$ 8,300
	4j	Furning and Place Chimney and Blanket Drain	CY	3,100	$ 200	$ 620,000
	4k	Furnish and Place ASTM C33 Sand for Toe Drain	CY	50	$ 200	$ 10,000
	4l	Furnish and Place Toe Drain (6" Diameter)	LF	150	$ 60	$ 9,000
		Site Reclamation				
	5a	Seeding	AC	2.0	$ 7,500	$ 15,000
	5b	Place topsoil	CY	2,474	$ 10	$ 24,740
		Construction Subtotal				**$ 5,059,340**
		Unlisted Items	%		10%	$ 506,000
		Contingency	%		20%	$ 1,012,000
		Construction Total				**$ 6,577,340**
		Permitting	%		3%	$ 197,400
		Land Acquisition	AC	3.3	$ 5,000	$ 16,500
		Engineering	%		3.0%	$ 198,000
		Construction Observation	LS	1	$ 80,000	$ 80,000
		Annual O&M Costs	LS	1	$ 20,000	$ 20,000
		Total				**$ 7,089,240**

Engineers Opinion of Probable Construction Cost (Feasibility Level)

Applegate Group, Inc.
1490 W. 121st Ave.
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Denver, CO 80234
Phone: (303) 452-6611
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La Veta Lakes Enlargement

(Deferred Maintenance Costs Not Included)

Job No. : 16-106
By: SAS
Date: 6/20/2017
Client: Cucharas Collaborative

Description of Work	Item	Item Description	Units	Quantity	Unit Cost	Total Cost
Enlargement of a small, low hazard off-channel dam		**Administration**				
	1a	Mobilization	%		5%	$ 239,200
	1b	Bonds and Permits	%		2%	$ 95,700
		Site Preparation				
	2a	Dewatering and Water Control	LS	1	$ 30,000	$ 30,000
	2b	Clearing and Grubbing	AC	3	$ 8,000	$ 20,800
	2c	Erosion and Sediment Control	LS	1	$ 15,000	$ 15,000
	2d	Construction Surveying	LS	1	$ 20,000	$ 20,000
	2e	Geotechnical Investigation	LS	1	$ 5,000	$ 5,000
		Earthwork				
	3a	Stripping and Stockpiling Topsoil	CY	4190	$ 8	$ 33,500
	3b	Excavation & Processing Borrow Material	CY	11800	$ 25	$ 295,000
	3c	Excavation and On-site Wasting of Excess Material	CY	353200	$ 10	$ 3,532,000
	3d	Excavate South Lake Toe for Installation of New Toe Drain	CY	5185	$ 10	$ 51,900
	3e	Dam Placement	CY	11800	$ 15	$ 177,000
		Dam Structures and Outlet Works				
	4a	Remove Existing Concrete Encased 13" PVC Outlet	LF	125	$ 80	$ 10,000
	4b	Furnish and Place 18" C905 PVC Encased Outlet Conduit Pipe	LF	190	$ 650	$ 123,500
	4c	Modify Structural Concrete Outlet Tower	LS	1.0	$ 20,000	$ 20,000
	4d	Modify Existing Access Bridge	LS	1	$ 10,000	$ 10,000
	4e	Furnish and Place 18" Sluice Gate on Outlet Tower	LS	1	$ 18,000	$ 18,000
	4f	Furnish and Place Low Level Outlet Trashrack	LS	1	$ 2,000	$ 2,000
	4g	Furnish and Place Filter Diaphragm	CY	33	$ 250	$ 8,300
	4h	Furnish and Place 36" Riprap for Emergency Spillway Channel	CY	1,733	$ 140	$ 242,700
	4i	Furnish and Place Type II Bedding for Emergency Spillway Channel	CY	867	$ 125	$ 108,300
		Site Reclamation				
	5a	Seeding	AC	3	$ 7,500	$ 19,500
	5b	Place topsoil	CY	4,195	$ 10	$ 41,900
		Construction Subtotal				**$ 5,119,300**
		Unlisted Items	%		10%	$ 478,000
		Contingency	%		20%	$ 1,024,000
		Construction Total				**$ 6,621,300**
		Permitting	%		1%	$ 66,300
		Land Acquisition	AC	3.7	$ 5,000	$ 18,500
		Engineering	LS	1	$ 100,000	$ 100,000
		Construction Observation	LS	1	$ 50,000	$ 50,000
		Annual O&M Costs	LS	1	$ 20,000	$ 20,000
		Total				**$6,876,100**

TASK 2, APPENDIX C
CUCHARAS STORAGE STUDY SCORING THRESHOLDS

Screening Criteria	Low 1	Medium 2	High 3
New Storage Volume	<140 AF	140 AF to 300 AF	>300 AF
Technical Feasibility	Bedrock depth >20'.	Bedrock depth >10'.	Bedrock depth < 10'.
	Limited embankment riprap borrow material available onsite.	Most embankment riprap borrow material available onsite.	All embankment riprap borrow material available onsite, including low permeability core material.
	High seepage potential (highly permeable foundation material requiring foundation grouting), e.g., fractured sandstone.	Moderate seepage potential (fine grained materials with moderate permeability), e.g., Cuchara Formation sandstone.	Low seepage potential (low permeability sub-surface), e.g., Pierre Shale.
	High potential for settling (weak bedrock, coarse grained material).	Moderate settling potential (weak bedrock or coarse grained material).	Low settling potential (hard bedrock).
Yield	0 to 33 percentile, based on yield of all alternatives modeled	34 to 66 percentile, based on yield of all alternatives modeled	67 to 100 percentile, based on yield of all alternatives modeled
Project Cost	Capital cost >$15k per AF capacity.	Capital cost $10k to $15k per AF capacity.	Capital cost <$10k per AF capacity.
	O&M associated with >2 of the following: pumped deliveries, wave runup, vegetation, outlet/spillway repair, and general deferred maintenance (dam >40 yrs old).	Medium O&M associated with 1 to 2 of the following: pumped deliveries, wave runup, vegetation, outlet/spillway repair, and general deferred maintenance (dam 20 to 40 yrs old).	Low O&M: deferred maintenance (dam <20 yrs old), automated outlet, modern materials (e.g., HDPE outlet) preventing short-term O&M requirements.
Operational Factors	Manual operations, no telemetry or automation.	Partially automated operations. Telemetry/automation on some appurtenant structures, but not all.	Fully operated outlet and inlet, including telemetry.
	Coordination required between 3 or more water users.	Coordination required between 1 to 2 water users.	Operations for a single water user, preventing need for coordination.
Administrative	Downstream occupied structures and possible loss of life in dam failure (high hazard dam; SEO permit constraints).	Downstream structural damage possible if dam fails, but no loss of life (significant hazard).	Isolated location, with minimal downstream damage if dam fails (low hazard).
	404 Individual Permit needed (on-channel dam) with > 1 acre wetland mitigation.	404 Individual Permit (on-channel dam) with <1 acre wetland mitigation.	404 Nationwide Permit required (off-channel dam).
	IGA needed for multiple owners and water users.	IGA needed with 1 to 2 owners and water users.	No IGA needed.
	Easements needed from multiple land owners. Potential condemnation required.	Easements needed from 1 land owner. Potential condemnation required.	No easements needed.
Public Benefit	Provides yield for only 1 use and 1 water user.	Provides yield for >1 use OR >1 water user.	Provides yield for >1 use and >1 water user, or greater than 2 water users.
	Non-consumed water does not benefit other uses or users.	Non-consumed water benefits other uses or users.	Non-consumed water benefits other uses or users.

APPENDIX D
Cucharas Collaborative Storage Alternatives Screening Matrix

	Score 1 (low project viability) to 3 (high project viability)							
Description	**Storage Volume**	**Technical Feasibility**	**Yield**	**Project Cost**	**Operational Factors**	**Administrative**	**Public Benefit**	**Weighted Score**
Enlargement of Existing Storage								
Britton Ponds enlargement (42 AF small dam)	1	1	1	2	2.5	2.5	2	40
Britton Ponds enlargement (239 AF large dam)	2	1	1.5	1	2.5	2	3	41
La Veta Lakes enlargement	1	3	2	2.5	2.5	3	2	55
HR Carson #1/#2 combined storage	1	2	1.5	3	1.5	2.5	2	47.5
Daigre Reservoir enlargement	1	2	1.5	2	3	1.5	3	46
City Lake unrestricted	1	2	1.5	2	3	3	1.5	47.5
City Lake enlargement	2	1	2	2	3	1.5	1.5	45.5
Holita Reservoir Rehab	3	2	3	2	1.5	2.5	1.5	55
Maria Stevens Rehab/Enlargement	3	2	3	2	1.5	2.5	1.5	55
Horseshoe/Martin Joint Use Pool	1	3	1	3	1	2.5	1.5	45.5
New Storage Projects								
S Baker Creek Reservoir	1	1	1.5	1.5	2.5	2	3	40.5
Chaparral Creek Reservoir	2	1	2.5	1.5	2.5	1.5	3	47
Bruce Canyon Reservoir	3	2	3	1.5	2.5	2	2.5	56
Coler Seepage Reservoir	2	2	1.5	3	1.5	1.5	1.5	46.5
White Creek Reservoir (500 AF)	3	2	2.5	1.5	1.5	2	2.5	50.5
Integrated Operations								
Maria Lake - Bruce Canyon Exchange	3	2	3	1.5	1.5	2	2.5	53
Change of Use of Unused Senior Rights	3	2	3	1.5	1.5	1.5	2	50.5
Change to Coler Inlet Ditch	1	2.5	1	2	2.5	3	1.5	45