Riparian Reconnect 2019-2020 Project Implementation Grant

Final Report

Prepared for Colorado Water Plan Grants – Environmental and Recreation

Attn: Chris Sturm

February 4, 2021

Colorado Open Lands

Grant Amount: $84,290

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COLORADO OPEN LANDS

EcoMetrics

Stream and Riparian Monitoring, Assessment and Restoration

Introduction

The Riparian Reconnect program aims to recover some of the environmental and recreation water benefits that were lost following a century and a half of land use that culminated in the "buy and dry" transfer of irrigation water from most of the South Platte Headwaters to downstream municipalities. Many of the irrigated lands from which agricultural water was transferred were originally wet riparian habitats along small anastomosing creeks, wetland, and beaver complexes. Agricultural conversion in the 1800s through mid-1900s—including stream channelization, entrenchment, and clearing riparian vegetation—was the main cause of habitat loss, but most riparian habitats retained some aquatic and wetland function during this period while they were being flood irrigated. Buy and dry water transfers over the past several decades, however, left much of the region in a condition with entrenched streams and dried or degraded riparian habitat resulting in a loss of environmental and recreational water use benefits.

The Riparian Reconnect program aims to mitigate this "gap" in environmental and recreation water benefits by implementing simple treatments that reconnect entrenched streams, rehydrate dried riparian areas, and reinvigorate natural processes. By restoring natural hydrological, geomorphological, and biological processes Riparian Reconnect aims to improve local habitat (for recreationally important game fish and wildlife as well as native species), watershed-wide hydrological function, sustainability, and resilience to flood, fire, drought, and human disturbance. Funding from this CWCB Water Plan grant was used to support Riparian Reconnect in this approach by establishing about 360 acres of riparian protection and implementing treatments on two stream restoration projects in the South Platte Headwaters in the Tarryall Creek basin (**Tarryall Notch Ranch**) and in the South Fork South Platte basin (**Twelvemile Ranch**). An additional third smaller project in the North Fork South Platte basin (Elk Creek Highlands) was initially scoped for funding under this grant, but that project became unfeasible. We report on each of these projects separately below.

Tarryall Notch Ranch project

Background

Tarryall Notch Ranch has been a focus of riparian Reconnect conservation and restoration efforts since being evaluated and identified as a priority in 2007 (Gillilan Associates, 2007). At that time, it was severely degraded due to 160 years of hard land use, and this situation presented an excellent opportunity to achieve functional lift by mitigating these historical ecological stressors and initiating natural recovery through process-based restoration. The guiding image for this project, as originally stated, is to restore the natural riparian condition along this acutely disrupted portion of Tarryall Creek (EcoMetrics, 2009b). The condition of this reach was extremely degraded, but prior to disturbance the habitat would have been characterized by a lush cover of native willow shrubs within a beaver dam-influenced aquatic and riparian wetland ecosystem. Our long-term vision is to see this pristine condition restored to the reach. The project area was a "gap" in an otherwise continuous belt of well-functioning riparian shrub habitat extending along Tarryall Creek from its headwaters in the mountains down into South Park. From a landscape perspective, successful restoration of this reach means repairing the gap and reestablishing connectivity and improving an important migration corridor (EcoMetrics, 2009b).

The property was protected under a conservation easement in 2008 and restoration treatments began in 2008, starting with a radical change in riparian land management. An aggressive willow-planting effort was completed over several phases in May 2008, May 2009, and August 2009 supported by a CWCB Watershed Restoration Program grant along with funding from other partners. Willow plantings and revised land management treatments successfully restored dense shrub cover in the stream corridor on most of the property, meeting or exceeding project performance criteria for riparian vegetation recovery (EcoMetrics, 2009a) (EcoMetrics, 2009b) (EcoMetrics, 2010) (EcoMetrics, 2011) (EcoMetrics, 2012) (EcoMetrics, 2013). While riparian vegetation improved drastically, hydrologic condition remained impaired through 2018 due to unmitigated incision and entrenchment (EcoMetrics, 2018a). Although stream channelization and entrenchment (*i.e.,* floodplain disconnect) were recognized as problems early on, these issues were not directly addressed due to concerns that directly reestablishing natural flow paths and riparian hydrology might be misunderstood by water rights regulators at that time. Our strategy for restoring natural hydrological functions, therefore, was based on a long-term goal of promoting and sustaining natural processes such as anastomosing, aggradation, and wetland expansion due to wood accumulation and beaver activity.

In the years leading up to 2018, we had often observed beaver sign on the property, indicating their presence, but none had yet taken residence or begun building dams. Retention of woody material was minimal, and there was little Indication of anastomosis, aggradation, or wetland expansion. The stream was maintaining an entrenched (SEM stage 1-3) form with a relatively dry and drained riparian zone. 2012 and 2018 were exceptional drought years with no overbank flows even during runoff, and in both years we observed significant drought stress and mortality to willows in the riparian zone on the upper reach of the property (where the stream is steeper and more confined through an alluvial fan of clay soil). Willows on the lower reach (lower gradient, unconfined, organic soil) seemed to do alright in drought years, probably due to better hyporheic connectivity and groundwater influence, but the water table was depressed around the channel and vegetation consisted of more mesic and facultative species than expected (EcoMetrics, 2018a). Although the lower reach flows through a fen that is highly controlled by groundwater discharge, wetland delineation in 2018 showed areas of significant drying near the channel with some sections converted to upland. In the absence of beaver dams and wood accumulation, the entrenched channel has continued to function as a drain, efficiently routing water, sediment, and organic materials through the reach. Adaptive management recommendations were made to address these concerns on both reaches.

Methods

In 2018, we proposed a treatment plan (EcoMetrics, 2018a) as adaptive management to catalyze the recovery of a natural pre-disturbance SEM Stage-0 stream condition by mimicking the missing functions of natural beaver dams and wood jams until these natural processes were able to resume functioning on their own. The proposed treatments were intended to restore riverscape hydrological conditions by stimulating channel aggradation and anastomosis, raising stream stage and water table elevation, and increasing the frequency of floodplain activation. The strategy also aimed improve beaver habitat suitability by creating more deep water and structural cover—both of which continued to be limiting on the reach—to promote colonization of the reach by active beaver colonies. Sustainable recovery of a

dynamic and complex Stage 0 condition, a prerequisite to meeting long-term project restoration goals and objectives, ultimately depends on the reestablishment and survival of beaver on the reach.

We proposed three treatment plan alternatives to meet these objectives (EcoMetrics, 2018a).

- Plan A prescribed the construction of 25 beaver dam analogs (BDAs) and/or aggradation structures to mimic the effects of beaver dams and wood jams plus 14 feeder swales intended to initiate channel branching and frequency of floodplain activation. This plan aimed to treat the upper reach and most of the lower reach.
- Plan B called for 17 BDAs and/or aggradation structures plus 7 feeder swales covering the upper reach and wo small portions of the lower reach.
- Plan C called for 10 BDAs and/or aggradation structures on just the upper reach.

Plan C was selected as the course of action because it is the most conservative, least invasive, and least expensive approach. It addresses the immediate and urgent concern by reducing the risk of losing recovered willow communities along the upper reach to escalating drought stress. The Riparian Reconnect team agreed that, while restoration could be catalyzed by constructing BDAs on the entrenched channel through the lower reach, there was no urgent need to intervene since woody species were continuing to thrive and expand. Unlike the upper reach, there is some deep water and cover on the lower reach. Beaver habitat suitability was marginal, but it had been slowly and gradually improving over the 10 years of monitoring due to expanding woody riparian vegetation. Because there was no immediate risk of decline, we agreed that invasive measures (constructing BDAs) were not immediately necessary, and we could afford to continue patiently waiting for beavers to colonize the reach on their own from adjacent sites.

Gillilan and Associates directed the implementation of treatments, with assistance from FlyWater and EcoMetrics in August 2019. The treatment plan was adapted in the field, as described in a construction report (Gillilan Associates, 2019) to ultimately include construction of 9 *aggradation structures* on the primary (entrenched) channel and 2 smaller grade control structures (speed bumps) on secondary channels. Ten bank notches were also cut in locations that would activate overbank flows to side channels and swales during annual peak flow discharge.

As (Gillilan Associates, 2019) points out, the structures that were built are not technically beaver dam analogs (BDAs) because they differ from beaver dams and most analogs of beaver dams in significant ways. Aggradation structures, like the ones used on this project, are deformable grade structures constructed of cobble bed material and wood with a long riffle-like backslope ramp. They are intended to raise stage and grade in the entrenched channel to "*reconnect annual peak flows to currently perched floodplain*" and to trap bedload during their temporary (roughly 5-10-year) expected lifespan to effectively raise the bed elevation via aggradation. They also provide short-term benefits of deep pool habitat and cover which improves suitability of the site for dispersing beavers, increasing the odds that they will recolonize the reach. The aggradation structures on Tarryall Notch Ranch are like those we used to treat DM Ranch on the South Fork South Platte (Gillilan Associates, 2018a) and on the Upper Fourmile project (Gillilan Associates, 2018b) but more robust to accommodate the steeper stream slope,

the narrower floodplain, and the high volume of bedload transport observed on this reach of Tarryall Creek (Gillilan Associates, 2019) as well as landowner expectations. EcoMetrics (2021a) provides a summary of the treatments applied in 2019 and the initial response through 2020. This report is attached as Appendix A.

Results

The specific objectives related to 2019 treatments on the upper reach of Tarryall Notch Ranch were to promote increase the frequency of overbank flow, increase the duration of riparian area saturation. Both responses were evident in the first season (Appendix A, sheets 3-8) (EcoMetrics, 2021a). The main reason to increase overbank flow and duration of riparian saturation is to support the continued growth and regeneration of recently restored ripaian shrubs which were succombing to drought stress and mortality after the 2018 drought season, and initial indications are positive (Appendix A, sheet 9) (EcoMetrics, 2021a). Beavers colonized the lower reach in fall of 2018. The colony survived through 2020 and expanded their area of influence through 2020 (Appendix A, sheets 10-13) (EcoMetrics, 2021a). The combined effects of the treatments on the upper reach and beaver activity on the lower reach resulted in a massive increase in proportion of the riparian area that is seasonally and perennially saturated (Appendix A, sheets 14-15) and 2400% in the amount of deep pool area (Appendix A, sheet 16) (EcoMetrics, 2021a). These responses represent direct increases in the quality and quantity of habitat for aquatic and riparian species and improved beaver habitat suitability on both reaches.

Detailed monitoring is underway, with funding available to continue observations through the 2021 season. EcoMetrics will continue monitoring beaver populations (number of persistent colonies), beaver activity (number of dams and extent of beaver pond area), extent of woody riparian vegetation cover, wetland expansion (delineation using hydrology, soil, and vegetation factors), proportion of the riparian area perennially or seasonally saturated, and deep pool area with residual depth greater than 1.5 feet.

Conclusions and Discussion

The Tarryall Notch Ranch project illustrates both the power of process-based restoration as well as the need for a long view when using these approaches. When we first assessed this reach, it was difficult to imagine it ever recovering to a functional Stage-0 beaver complex. Or at least it was clear that getting to that point would be a long process. Time can be a valuable asset, however, if natural processes can be employed to do most of the restoration work. The primary objective of our initial projects on Tarryall Notch Ranch was to reestablish native woody vegetation cover, which at that time was all but absent on the property. On the lower reach, a simple change in land management worked to reestablish good cover of tall willows, but it took the better part of a decade.

On the upper reach, where stunted or browsed willows were not present, the recovery was hastened by planting hundreds of whole willows and thousands of willow stems. The whole willow transplants, along with improved grazing management, had an immediate effect—providing woody vegetation cover and willow canopy over most of that reach, albeit in a thin strip along the confined stream channel. And after about a decade, the surviving willow stems and some naturally regenerated willows had grown to full adult stature, adding to the woody vegetation density and size distribution. These treatments

appeared to be on track to fully meet the objective. The rosy outlook changed in 2018, however. 2018 was an extreme drought year with no significant runoff, and by August many of the transplanted willows appeared to be dead or dying due to drought stress, a pattern that was also observed in the previous drought year 2012. We presumed that transplanted willows would develop root structure deep enough to tap into stable groundwater, but observations in 2018 suggest that, at least on this reach, overbank flows are needed to provide adequate hydrology. This led to concerns that simply transplanting vegetation without addressing underlying hydrological issues (channel entrenchment) might ultimately fail.

The initial restoration premise was that if woody riparian vegetation could be restored to the property it would attract beavers, beaver dams, and wood accumulation to reverse the impacts of channel entrenchment. This is currently happening on the lower reach. It has not yet begun on the steeper upper reach. The aggradation structure treatments applied in 2019 are an adaptive management measure to mimic the effects of beaver dams, improving riparian hydrology and increasing habitat suitability on the reach. If these treatments succeed, we expect to see decreasing levels of entrenchment, adequate riparian hydrology (even in drought years), and increasing frequency of beaver activity over time. Although it has only been one year, the treatments are meeting expectations. Indicators such as the proportion of riparian zone that is saturated and the amount of deep pool area on the reach are meeting objectives. Whether the structures will successfully reverse entrenchment by raising the elevation of the riverbed via aggradation is still undetermined. We will evaluate this objective after the next event with significant bedload transport. We will also continue monitoring the other indicators.

We are especially pleased with the progress of restoration on the lower reach of Tarryall Notch Ranch. Woody riparian vegetation continues to expand, and it seems to be immune to drought stress, even in the driest years, due to more stable groundwater levels. So far, only one beaver colony has established on the reach and there are only 2 new beaver new dams. But even this modest level of beaver activity is inducing massive ecological lift. By raising head at the upper end of this reach, the new beaver dams increased surface water area by 400% from 21 to 104 hectares. Springs several hundred meters away were recharged and began flowing perennially. In 2020, the second season after the beaver dams appeared, huge swaths of cinquefoil (a mesic shrub that had come to dominate the riparian zone) were being drowned out. The proportion of sedges and other aquatic species are increasing. These trends are increasing habitat suitability for more beavers throughout the reach. It now seems not only possible, but probable, that expanding beaver populations may drive the complete restoration of this channelized reach to a pre-disturbance Stage-0 condition.

We are reminded of the need for a long view in process-based restoration. Restoration of the lower reach of Tarryall Notch Ranch has been a long process that is still unfolding. Effectiveness of the treatments would have been difficult to predict using performance standards based on immediate before-after comparisons or 2-year trends because at that point the important changes had just begun. Changes are still underway on Tarryall Notch Ranch. Recovery processes are still unfolding, and we will continue monitoring them to track the progress of restoration.

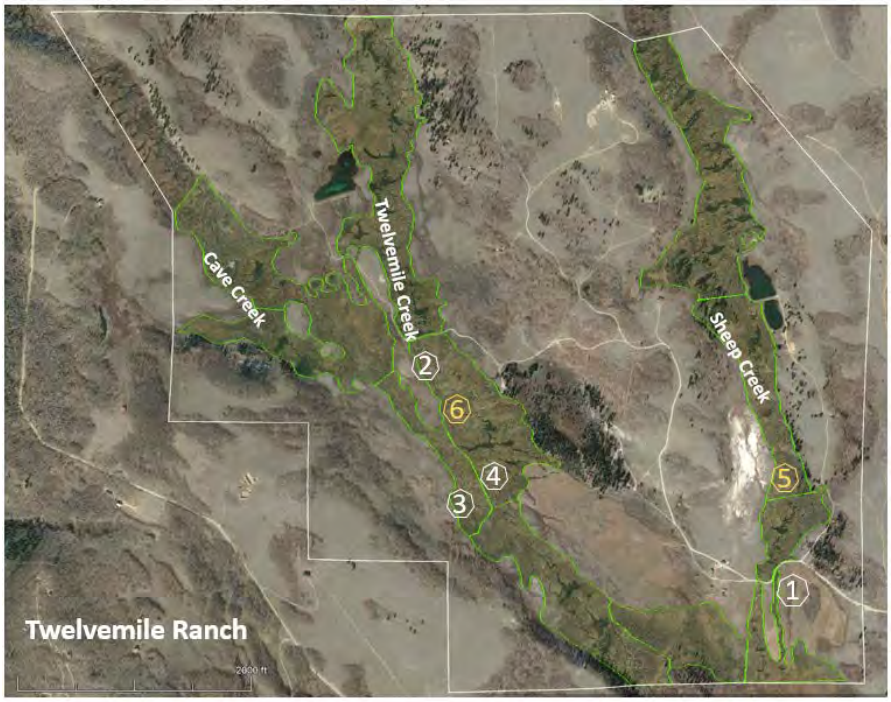
Twelvemile Ranch project

Background

Twelvemile Ranch is an 840-acre property in Park County Colorado with a conservation easement held by Colorado Open Lands. Three first order perennial headwaters streams (Sheep Creek, Twelvemile Creek, and Cave Creek) flow through it, with a combined valley length of about 3.6 miles that support more than 260 acres of acres of riparian and wetland habitat. This riverine wetland habitat complex may be the most expansive of any private property in the South Platte Headwaters. The primary use of the property is natural open space that provides passive recreation for the landowners, a club formed in the 1940s limited to about 20 families. The current members greatly appreciate the natural condition of the ranch, its natural beauty, and the fish and wildlife benefits provided by its relatively unimpacted natural habitat. They especially appreciate the importance of beavers, since both trout and waterfowl would be scarce on these tiny creeks were it not for the aquatic habitat beavers create and maintain. The property also has a small ranching component with about 40 acres of irrigated hay meadow, a small herd of cattle, and a ranch headquarters. The other use is residential, with a network of unimproved roads connecting the 20 or so cabin sites. These factors make Twelvemile Ranch an ideal setting for conservation and stewardship to promote natural land values and ecosystem services.

Existing conditions are described in a detailed assessment report which also outlines a scope of work for priority restoration and stewardship projects on Twelvemile Ranch (EcoMetrics, 2018b). The guiding vision for these projects is to promote the ecological health of the expansive riparian and wetland area associated with the three streams on the property: Sheep Creek, Twelvemile Creek, and Cave Creek. The health and function of these habitats depends to a large extent on persistence of beavers as keystone species. Restoration and management recommendations are therefore focused on mimicking, promoting, and sustaining beaver activity on the property. In addition to restoring beaver to reaches where they have been absent, projects aimed specifically at managing beaver activity using coexistence strategies to reduce conflicts with ranch infrastructure and activities such as roads, irrigation diversions, and ditches.

The scope outlined for the first three years of the partnership with Riparian Reconnect included 4 priority projects and 2 potential future projects (EcoMetrics, 2018b, sheets 8-12) summarized in figure 1.



Twelvemile ranch project priorities (as outlined in original scope of work)

1. **Sheep Creek road crossing (began 2019)**
2. **Twelvemile Creek road crossing (began 2019)**
3. **Cave Creek beaver restoration (2019-2020)**
4. **Twelvemile Healey wetland restoration and diversion project (began 2020)**
5. **Sheep Creek spot treatments (potential future project)**
6. **Twelvemile Creek spot treatments (potential future project)**

Figure 1 Twelvemile Ranch project priorities for 2019-2021.

Methods

1. Sheep Creek road crossing

The main road into Twelvemile Ranch crosses Sheep Creek through an active Stage-0 beaver complex. The stream passes through the road via one primary culvert and two smaller secondary culverts. The road is susceptible to flooding when beavers plug the culverts or build dams high enough to divert flows over the road. Daily maintenance by ranch staff has been necessary in most summer and fall seasons to manage these issues. The goal of the Sheep Creek road crossing project is to use flow devices to manage the risk of road flooding and/or damage while reducing the maintenance burden on Twelvemile Ranch. After consulting with Mike Callahan of the Beaver Institute and Beaver Solutions, EcoMetrics settled on a plan to use a fence-and-pipe device, which was installed in 2019. Appendix B, sheets 2 and 5 provide details on the flow device and how it was installed to help manage the situation at the Sheep Creek road crossing (EcoMetrics, 2021b).

2. Twelvemile Creek road crossing

The ranch road crossing at Twelvemile Creek involved a suite of flow devices. Like the crossing at Sheep Creek, the goals were to promote and sustain beaver complex habitat while managing the risk of road flooding and/or road damage and reducing Twelvemile Ranch's maintenance burden. Treatments were

focused on two locations where constant maintenance has been necessary to manage beaver activity in the past. In one area, EcoMetrics installed two Keystone fences and one large pond leveler. In the other, a series of two pond levelers were employed. Both area plans were developed in consultation with Mike Callahan of the Beaver Institute and Beaver Solutions. Appendix B, sheets 3-6 details these treatment methods (EcoMetrics, 2021b).

3. Cave Creek beaver restoration

Cave Creek upstream from the confluence with Twelvemile Creek (Cave Creek Reaches 2 and 3) were identified as the highest priority restoration opportunity on Twelvemile Ranch. Reach 3 was treated in 2019 with 35 beaver dam analogs (BDAs), and another 16 BDAs were built on Reach 2 in 2020 (see Appendix C, sheets 7-9) to mimic the function of natural beaver dams and promote beaver recolonization by improving habitat suitability. A variety of techniques were used in BDA construction, some supported by posts and others without posts. All BDAs were constructed using locally sources natural materials (willow stems, slash, sod, cobble, and gravel). On some, woven coir (coconut fiber) logs were used to create an organic biodegradable porous core (see Appendix B, sheets 10-16) (EcoMetrics, 2021b).

4. Twelvemile Healey wetland restoration and diversion maintenance

An entrenched channel 3-4 feet deep incised when a series of beaver dams breached between 2014 and 2019 on Twelvemile Creek near the Healey Ditch, draining the wetland and rendering the diversion point inoperable (see Appendix B, sheets 17-19) (EcoMetrics, 2021b). Waiting for beavers to return was not an option because of the need to divert water for irrigation, so the partners focused on efforts to restore the wetland area using BDAs. Due to the depth and width of the newly incised channel, we initially considered machine-built aggradation structures (similar to those constructed on the Tarryall Notch Ranch) to repair breached beaver dams, but limited on-site materials, high cost, and risk of damage from heavy equipment in this wetland environment made this approach undesirable. As an alternative, Twelvemile Ranch offered volunteer labor and equipment to build 6 post-assisted BDAs (see Appendix B, sheet10) (EcoMetrics, 2021b). The core of the BDAs will be built of coir log lifts, native willow, sod, and gravel. Ranch staff and volunteers will complete construction of the BDAs in spring/summer 2021 with supervision by EcoMetrics.

Results

At both the Sheep Creek and Twelvemile Creek road crossings, culvert blockage and road flooding have so far been alleviated. At both sites, beavers are still present and active in the area but have not built dams that impact the roads or culverts. The fence-and-pipe device carried the full discharge of Sheep Creek all season in 2020 and required no maintenance. On Twelvemile Creek, the upper of 2 pond leveler devices in Area 2 diverted full outflow from the road-adjacent pond most of the year in 2020. Flow through the lower pond leveler kicked in during runoff. The Keystone fences in Area 1 kept beavers from blocking the two culverts through 2019 and 2020. Maintenance on these structures involved cleaning debris from the fences once in 2019 and twice in 2020. The pond leveler on Area 1 worked to prevent road flooding, but it required significant maintenance. Beavers chewed through one of the plastic pipes in 2020 and stuffed it with sticks and mud. The pipe was cleaned out and the exposed pipe was covered with wire mesh fence to protect it. The structures have so far prevented

road flooding and road damage, decreased maintenance burden, and allowed for coexistence with active beavers. EcoMetrics will continue monitoring and reporting on the function of devices, frequency of conflict (culvert blockage or road flooding), maintenance needs, and beaver activity in the area.

The 35 BDAs on Reach 3 of Cave Creek were built in fall 2019, giving us one season to observe the response. The structures on most complexes raised stage to or above bankfull during the modest 2020 runoff (see Appendix B, sheet10) (EcoMetrics, 2021b). About 3/4 of the BDAs maintained stage and pool area upstream the structures, but about 1/4 became leaky. The leaky structures still functioned but held water at a lower stage. They were easily repaired by packing them with more sod and willow material. Detailed monitoring is underway, with funding available to continue observations through the 2021 season. EcoMetrics will continue monitoring beaver populations (number of persistent colonies), beaver activity (number of dams and extent of beaver pond area), riparian vegetation, wetland expansion (delineation using hydrology, soil, and vegetation factors), proportion of the riparian area perennially or seasonally saturated, and deep pool area with residual depth greater than 1.0 feet.

Conclusions and Discussion

It is early to draw conclusions about the performance towards project objectives, but we are cautiously optimistic. We will be monitoring the projects on Twelvemile Ranch as part of the Riparian Reconnect program to evaluate the effectiveness of mimicking, promoting, and sustaining natural processes in the restoration of beaver streams.

The flow devices on Sheep and Twelvemile Creek road crossings were effectively installed and have so far eliminated or greatly reduced the amount of maintenance needed to protect the roads and culverts. Beavers are still active just upstream of both roads, so at this point the objectives are being met. We are still learning from the function of the flow devices and fences to see if and how we might do things differently ion future projects. One lesson we learned was to protect exposed areas of corrugated pipe where beavers can hear running water and possibly be triggered to chew through and plug them. According to Mike Callahan at the Beaver Institute, this happens on about 1% of flow devices he has installed but it is an issue to be considered, particularly in remote areas where devices are not checked regularly.

Building 51 BDAs on Cave Creek provided a good opportunity to experiment with various designs and construction techniques. By the end, we of the installation process we found ourselves relying less on posts to support the structures. For BDAs less than about 1.5 foot tall, postless designs seemed adequate and were about 5 times more efficient to build. We will monitor their performance versus post-assisted BDAs. On post-assisted BDAs, we discovered quickly that using 2 or more rows of posts was more effective than one row because it helped create a wider and more stable base. Using coir logs in addition to native materials is one innovation we introduced on other projects and decided to test more broadly on Cave Creek. Using coir logs greatly decreases the amount of harvested material (willow slash, gravel, sod) and labor needed to build a good foundation for BDAs, but it does introduce more cost. Coir logs are made of woven coconut fiber, so they are porous, natural, and biodegradeable. But they are imported (usually from far away) so they do introduce nonnative material. The fate of coir logs in the system and the effectiveness of coir log BDAs will be another focus of our near-term monitoring

efforts. We will be testing the effectiveness of even bigger BDAs on the Twelvemile Creek Healey project. The BDAs we will be constructing on this reach in 2021 will be up to 3 feet tall and 30 feet wide, requiring several lifts of coir logs and/or native material to build the base below post-woven willow crests. This project will be considered a success if the BDAs can maintain water elevations that support wetland hydrology on the reach and water supply to the normal Healey Ditch diversion point. We have begun monitoring with the goal of evaluating how well those objectives are being met, and we also look forward to learning more about the potential and limitations of BDA treatments in larger creeks.

Actual Expense Budget

Colorado Water Conservation Board						
Water Plan Grant - Exhibit B Actual Budget and Schedule						
Prepared Date: February 4, 2021						
Name of Applicant: Colorado Open Lands						
Name of Water Project: Riparian Reconnect Project Implementation						
Project Start Date: April 1, 2019						
Project End Date: December 31, 2021						
Task No.	**Task Description**	**Task Start Date**	**Task End Date**	**Grant Funding Request**	**Match Funding**	**Total**
1	Tarryall Notch Ranch stream/riparian restoration	4/1/2019	12/31/2021	$32,391	$45,097	$77,488
2	Twelvemile Ranch stream/riparian restoration	4/1/2019	12/31/2021	$51,899	$63,891	$115,790
			Total	$84,290	$108,987	$193,277

Colorado Water Conservation Board

Water Plan Grant - Detailed Budget Actuals

Prepared Date: February 4, 2021
Name of Applicant: Colorado Open Lands
Name of Water Project: Riparian Reconnect Project Implementation

Riparian Reconnect - Park County, South Platte Headwaters Beaver Stream Restoration

	Project Total	CWCB Funds	Matching Funds
Task 1 - Tarryall Notch Ranch stream/riparian restoration	**$77,488**	**$32,391**	**$45,097**
Project coordination	$5,425	$2,500	$2,925
Assessment and design	$8,955	$0	$8,955
Permitting	$2,301	$0	$2,301
Restoration treatments	$31,406	$24,890	$6,516
Monitoring, study, report	$29,400	$5,001	$24,399
Contingency/maintenance (10%)	$0	$0	$0
Task 2 - Twelvemile Ranch stream/riparian restoration	**$115,790**	**$51,899**	**$63,891**
Project coordination	$5,305	$2,500	$2,805
Assessment and design	$10,182	$0	$10,182
Permitting	$250	$0	$250
Beaver management treatments	$18,763	$15,500	$3,263
Restoration treatments	$56,290	$32,334	$23,956
Monitoring, study, report	$25,000	$1,565	$23,435
Contingency/maintenance (10%)	$0	$0	$0
TOTAL	**$193,277**	**$84,290**	**$108,987**

Appendix A:

EcoMetrics. (2021a). *Tarryall Notch Ranch-Riparian Reconnect Stewardship and Restoration Project: 2019-2020 project summary and initial response.*

Tarryall Notch Ranch-Riparian Reconnect Stewardship and Restoration Project

2019-2020 project summary and initial response

Prepared by EcoMetrics
For Colorado Open Lands
January 31, 2021

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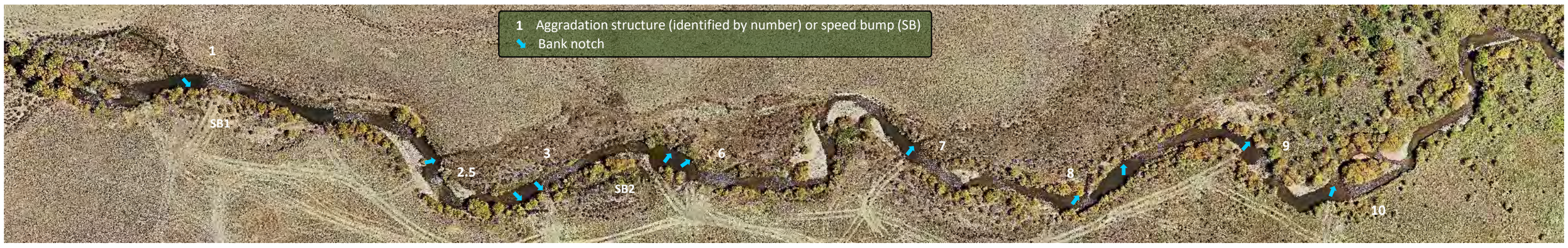
Tarryall Notch Ranch – 2019 treatments, upper reach



Tarryall Notch Ranch – 2019-2020, upper reach initial response to 2019 treatments

1 Aggradation structure (identified by number) or speed bump (SB)
↘ Bank notch

Tarryall Notch Ranch – 2017-2020, Upper reach, segment 1

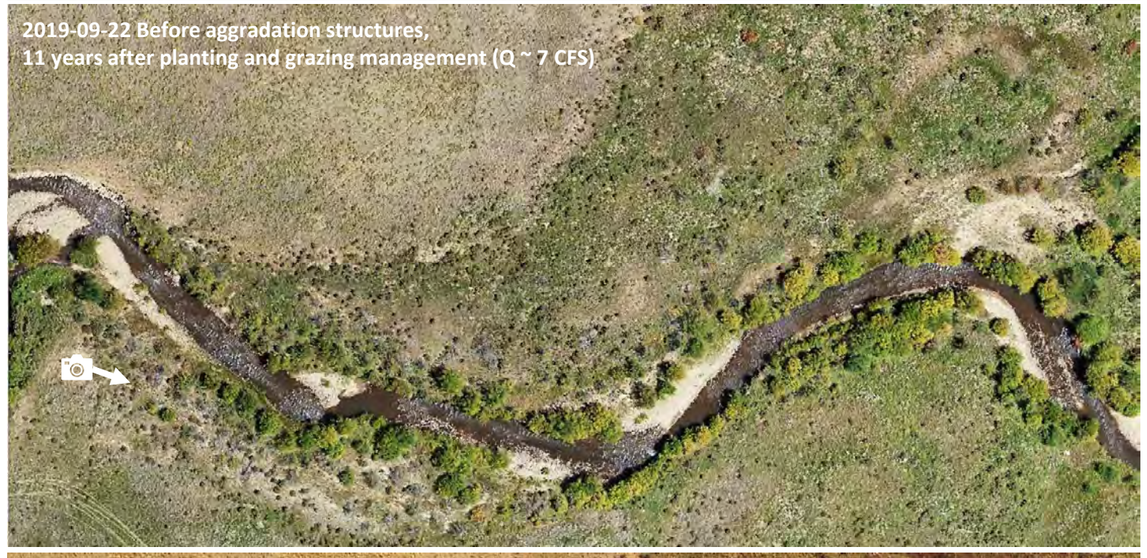
Upper reach, segment 1

Tarryall Notch Ranch – 2017-2020, Upper reach, segment 2

Tarryall Notch Ranch – 2017-2020, Upper reach, segment 3

Tarryall Notch Ranch – 2008-2020 upper reach response


2013-09-27 5 years after planting and grazing management initiated
(Q ~ 20 CFS)


2019-09-22 Before aggradation structures,
11 years after planting and grazing management (Q ~ 7 CFS)


2020-06-07 First year after aggradation structures,
11 years after planting and grazing management
(Q ~ 69 CFS)


2008-05-23 After planting willows in pilot project


2013-07-26 5 years after planting and grazing management initiated (Q ~ 20 CFS)


2020-07-17 1 year after Aggradation structures, 12 years after planting and grazing management initiated

Tarryall Notch Ranch – 2008-2020 response

2013-09-27 5 years after planting and grazing management initiated (Q ~ 20 CFS)

2019-09-22 Before aggradation structures, 11 years after planting and grazing management (Q ~ 7 CFS)

2020-06-07 First year after aggradation structures during a mild runoff (Q ~ 69 CFS)

2020-07-17 after runoff (Q ~ 21 CFS)

2008-05-21 (Q ~ 43 CFS)

2013-09-27 (Q ~ 20 CFS)

2020-07-17 (Q ~ 21 CFS)

Tarryall Notch Ranch –Drought-stressed willow response to improved riparian hydrology

New growth on drought-stressed willows during the 2020 season indicates a positive response to improved riparian hydrology (all photos from 2020-07-17, after a mild runoff).

Tarryall Notch Ranch – 2008-2020 response

Tarryall Notch Ranch – 2008-2020 response

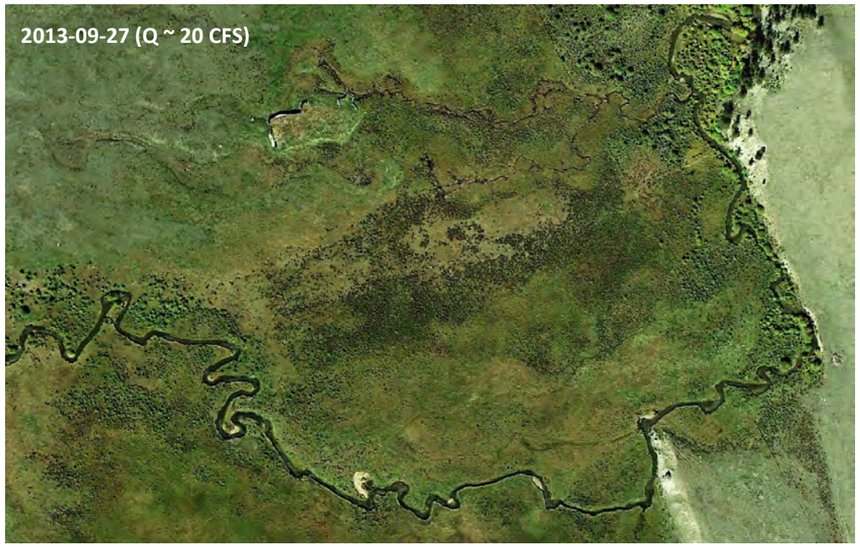
2009-08-03 (Q ~ 15 CFS)

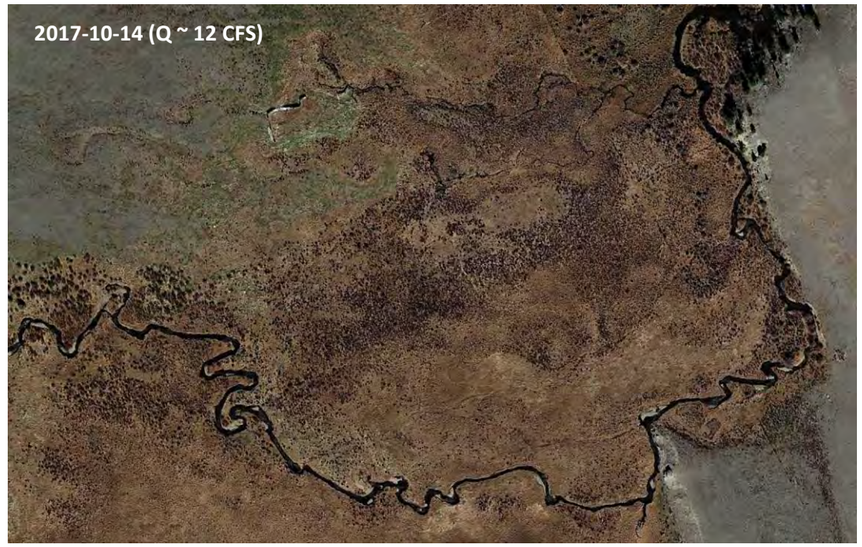
2013-07-26 (Q ~ 17 CFS)

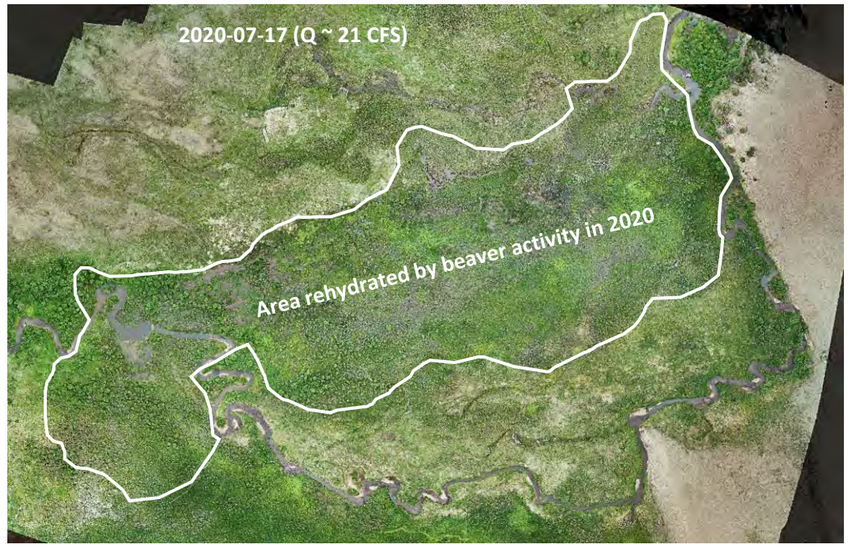
2020-07-17 (Q ~ 21 CFS)

Tarryall Notch Ranch – 2008-2020 response

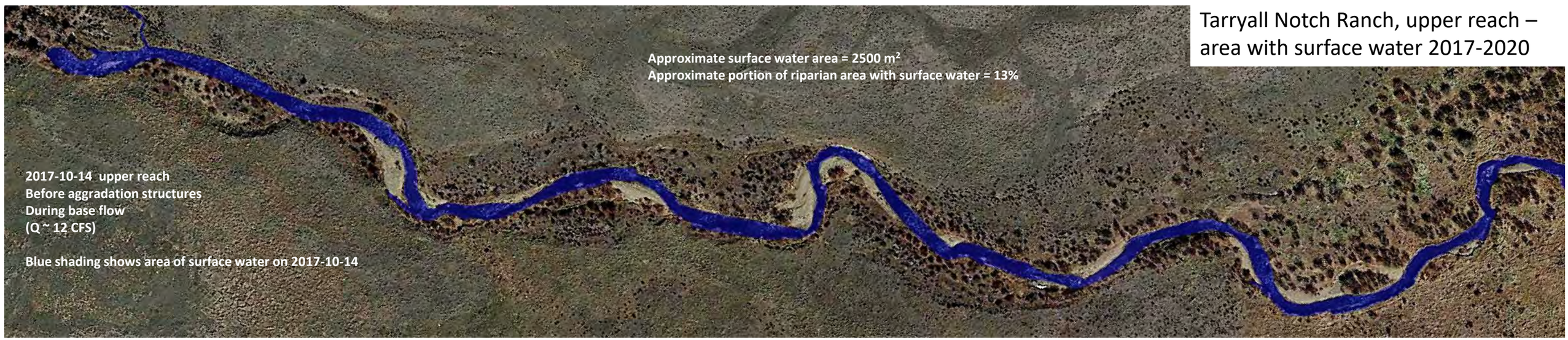
Tarryall Notch Ranch – 2008-2020 response, lower reach

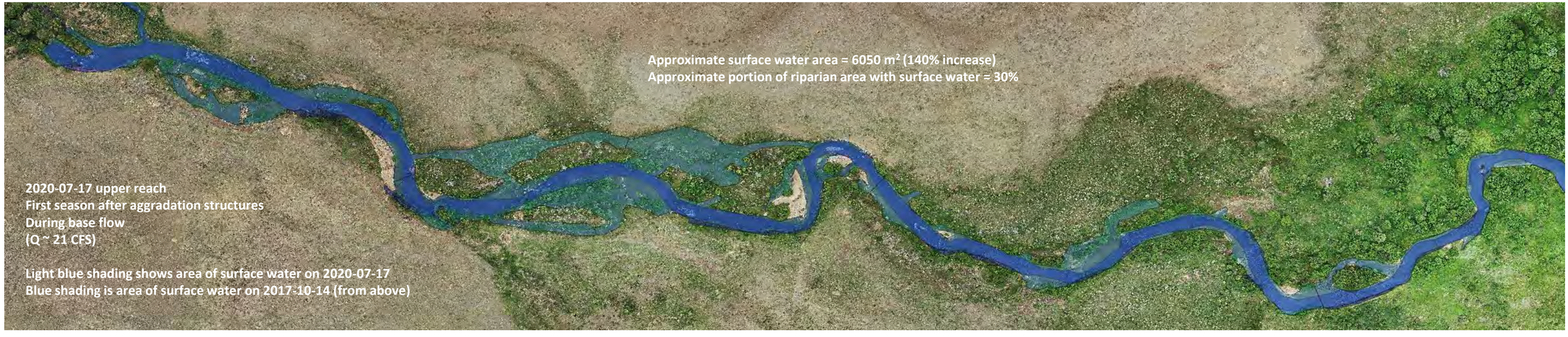






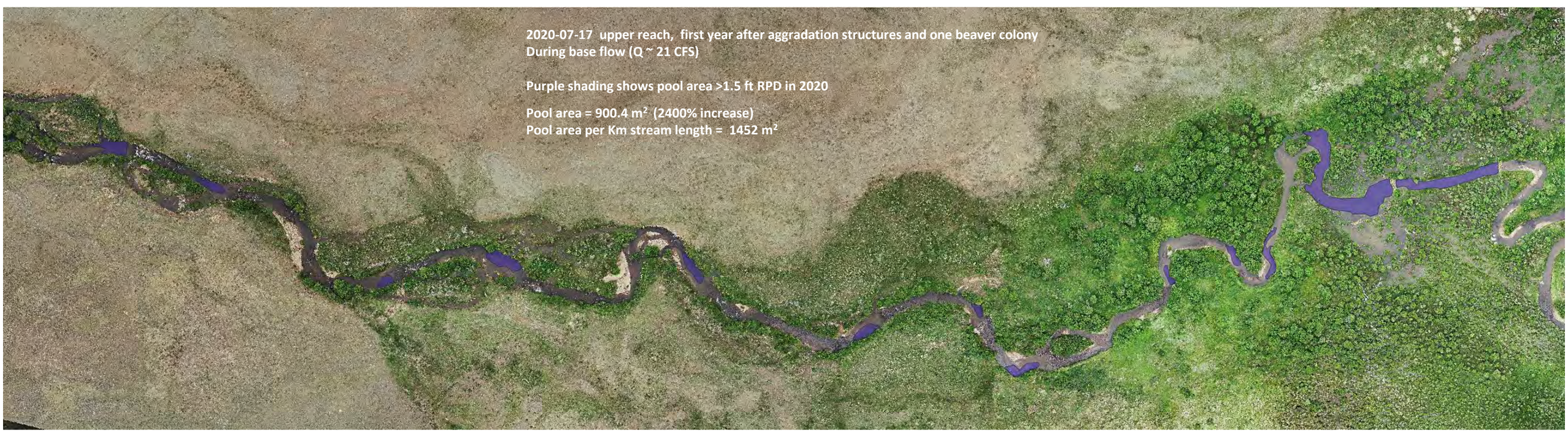
Tarryall Notch Ranch, upper reach – area with surface water 2017-2020





Tarryall Notch Ranch, lower reach – area with surface water 2017-2020

Tarryall Notch Ranch, upper reach –
Pool area with RPD > 1.5 ft 2019-2020



Appendix B:

EcoMetrics. (2021b). *Twelvemile Ranch-Riparian Reconnect Stewardship and Restoration Project: 2019-2020 project summary and initial response.*

Twelvemile Ranch-Riparian Reconnect Stewardship and Restoration Project

2019-2020 project summary and initial response

Prepared by EcoMetrics
For Colorado Open Lands
January 31, 2021

Twelvemile ranch project priorities (as outlined in original scope of work)

1. Sheep Creek road crossing (began 2019)
2. Twelvemile Creek road crossing (began 2019)
3. Cave Creek beaver restoration (2019-2020)
4. Twelvemile Healey wetland restoration and diversion project (began 2020)
5. Sheep Creek spot treatments (potential future project)
6. Twelvemile Creek spot treatments (potential future project)

Contents

1. Sheep Creek road crossing (began 2019)

The ranch access road crosses Sheep Creek, a broad Stage-0 beaver complex. A fence-and-pipe flow device was installed in 2019 to protect the road from flooding, coexistence with beaver populations, and reduce maintenance burden. The goal is to maintain beaver complex habitat while protecting the road.

↑ Prior to the flow device, ranch managers had to manually remove the beaver dam (left circle) and unplug the culvert (left circle) daily to prevent flooding over the road (blue arrows).

↓ Overview of the Sheep Creek culvert area. The flow device is location is drawn in.

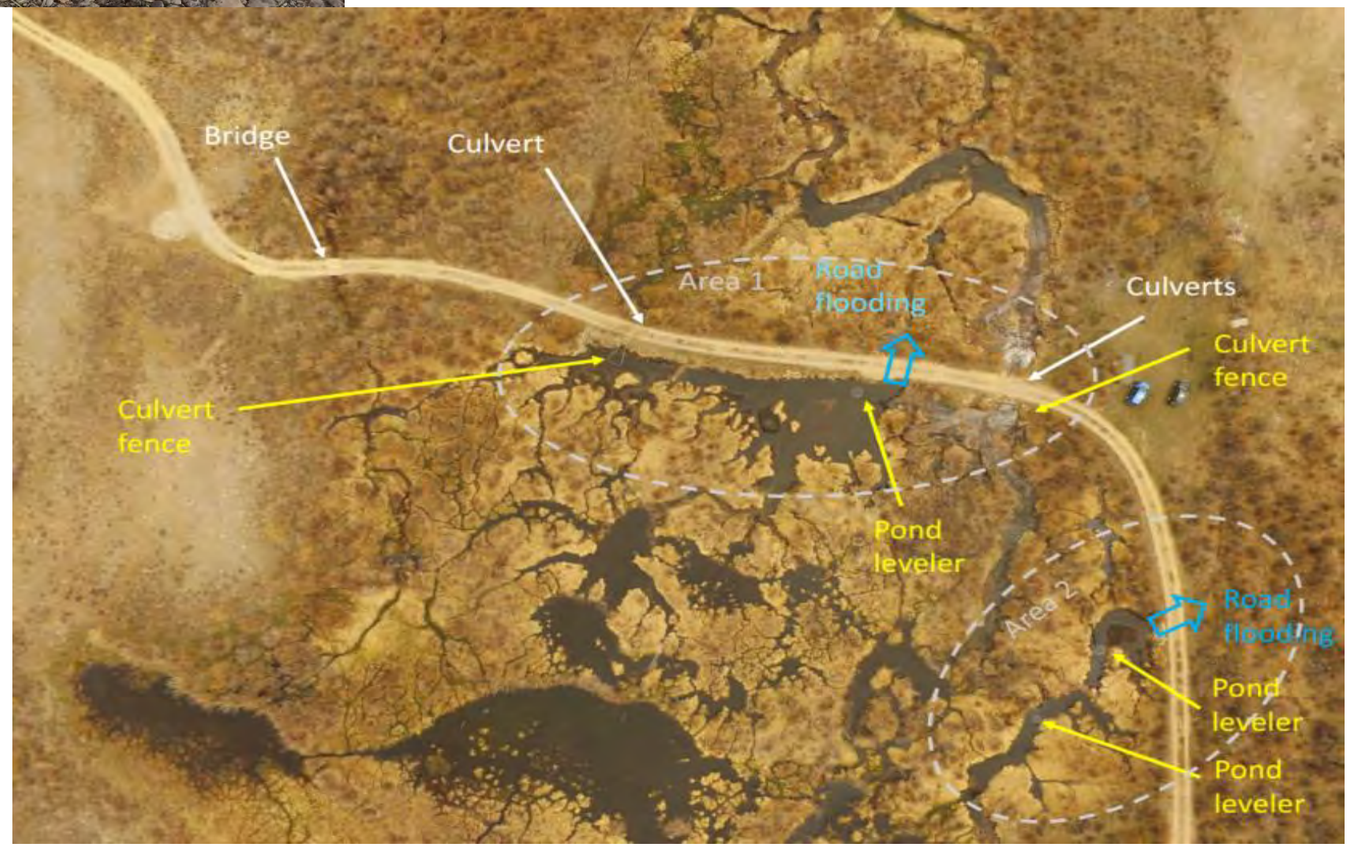
↑ Two views of the fence-and-pipe flow device installed at the road to prevent beaver activity from flooding the road. A fence prevents beavers from plugging the culvert. Beavers can dam the creek upstream, but flow through a pipe prevents water level from rising above a certain height. A dome-shaped cage around the inlet to the pipe keeps beavers from plugging it. ↓

2. Twelvemile Creek road crossing (began 2019)

The ranch road crosses Twelvemile Creek, a broad Stage-0 beaver complex. A series of Keystone fences and pond leveler flow devices were installed in 2019 to protect the road from flooding, coexistence with beaver populations, and reduce maintenance burden. The goal is to maintain beaver complex habitat while protecting the road.

↑ **A pond leveler prevents road flooding by limiting the height of the beaver dam. When the dam approaches a level that threatens the road, more water flows through the pipes, eliminating the stimulus that triggers beavers to build the dam higher. (The rocks in the photo above were added in 2020.)** ↓

↓ **Overview of the Twelvemile Creek culvert area. The flow device locations are indicated.**

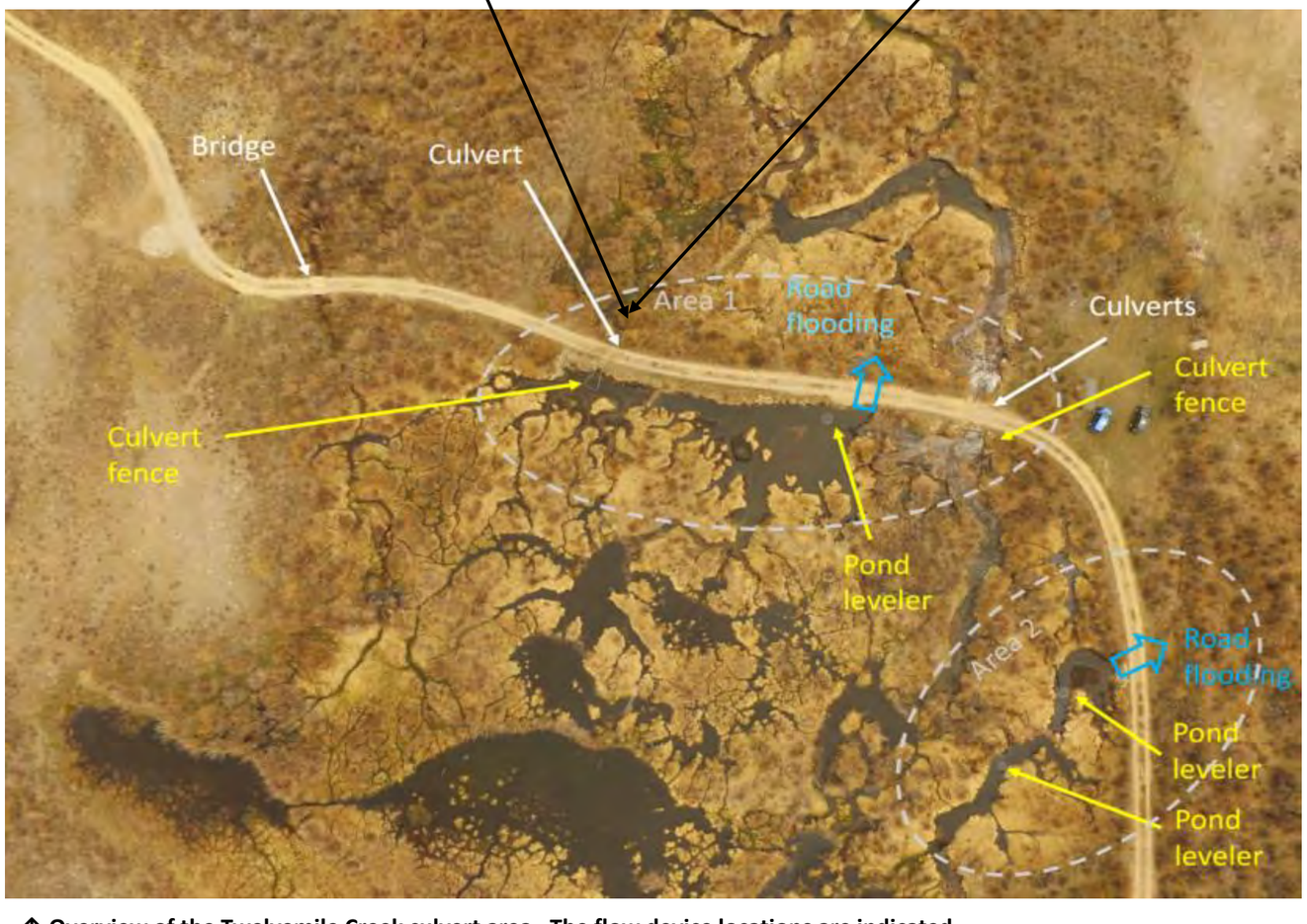


Twelvemile Creek road crossing

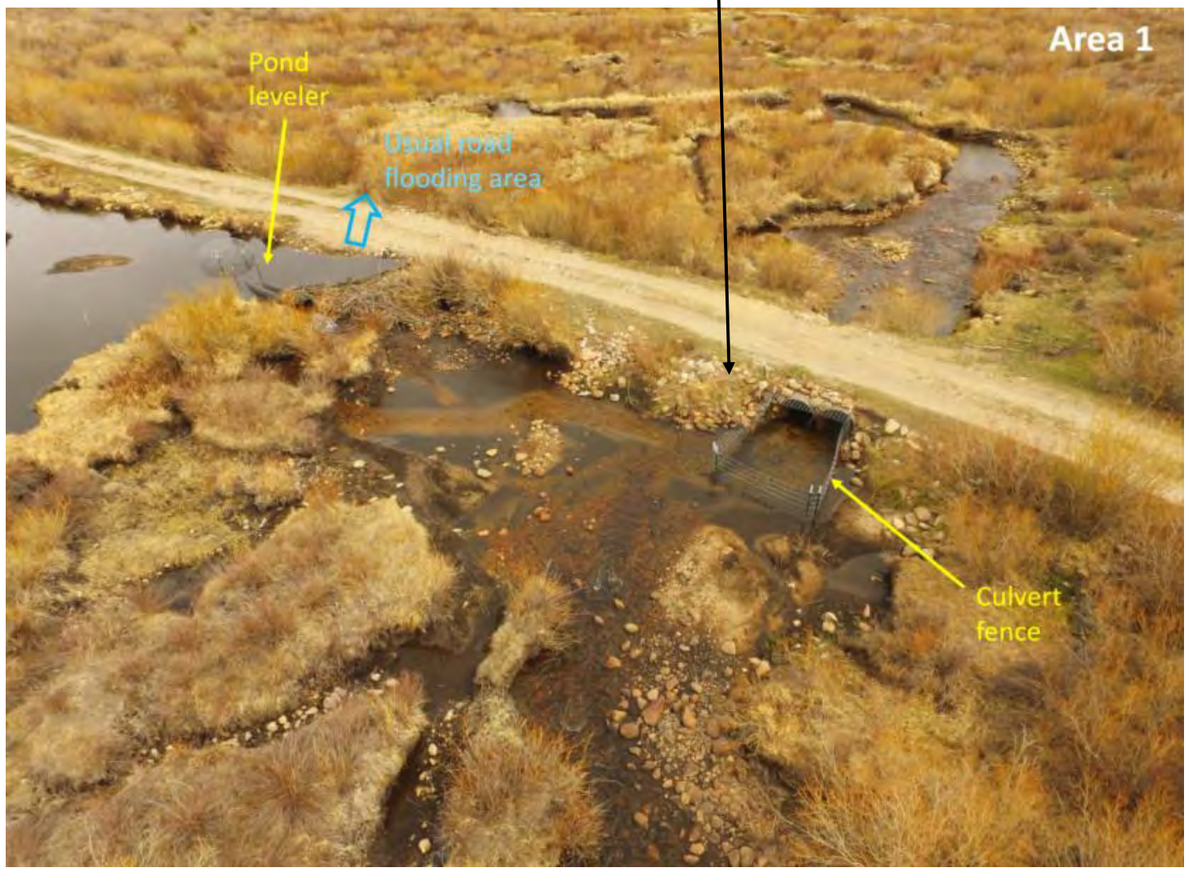
In area 1, Keystone fences prevent beavers from plugging the two culverts.

Keystone fence on east culvert (1 year after installation)

Keystone fence on west culvert (1 year after installation)

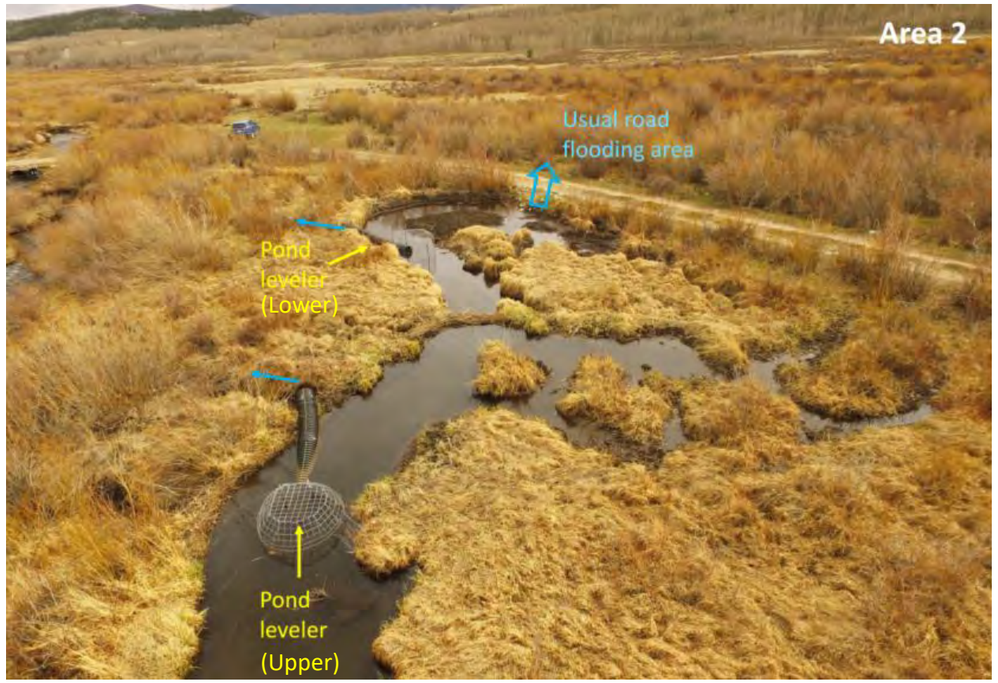


↑ **Overview of the Twelvemile Creek culvert area. The flow device locations are indicated.**

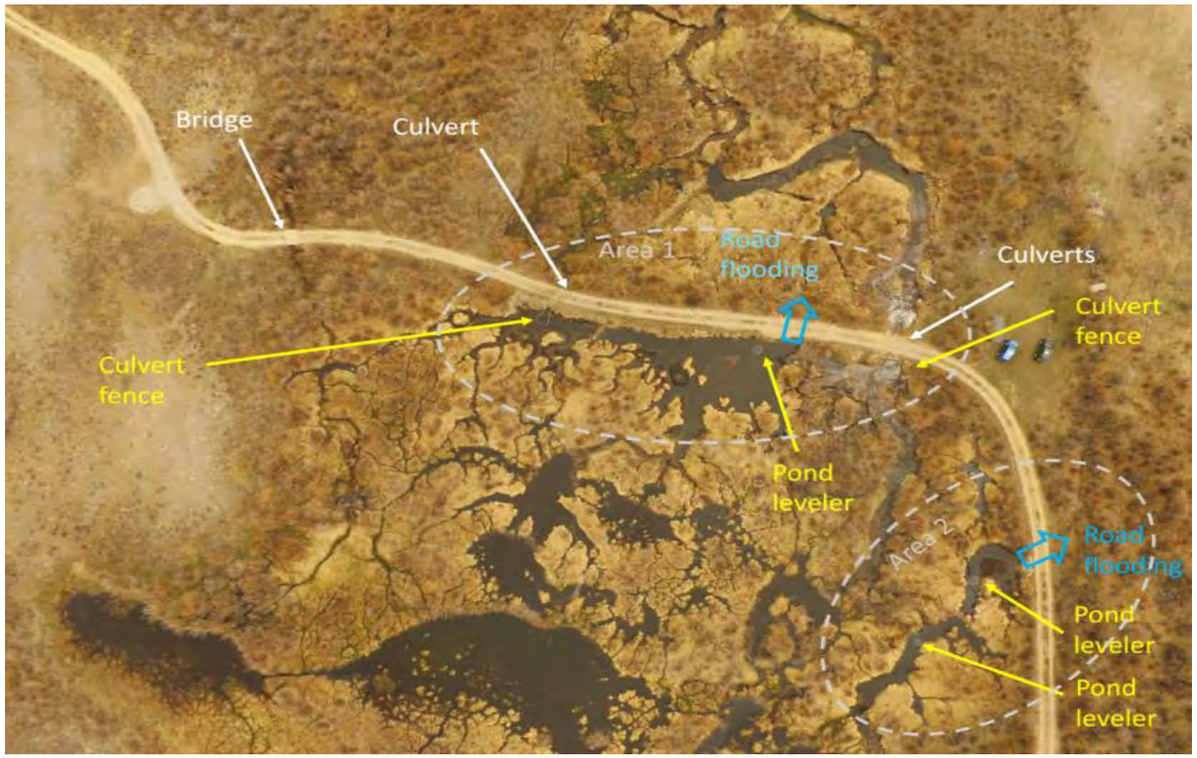


Twelvemile Creek road crossing

In area 2, a series of two pond levelers prevents beavers from building dams high enough to flood the road. Water from the ponds is diverted back to the main channel and culverts.



Upper of two pond levelers. During low flow periods, this flow device carries all flow. ↓



↑ Overview of the Twelvemile Creek culvert area. The flow device locations are indicated.

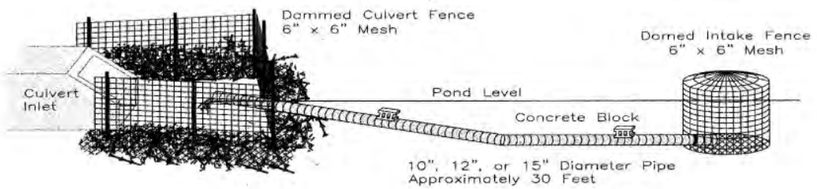
← Lower of two pond levelers. For most of the season when streamflow is low, the upstream leveler (background) carries full flow. The secondary downstream leveler (foreground) kicks in when streamflow is high.

Flow devices used to promote coexistence with beaver and beaver habitat on Twelvemile Ranch

BEAVER SOLUTIONS — *Fence and Pipe Flow Device*

A Fence and Pipe flow device is a very effective method to protect culverts or spillways in manmade dams from beaver damming. A Flexible Pond Leveler™ pipe maintains a steady flow of water, while an exclusion fence keeps all beaver damming away from the culvert or spillway. See diagram.

Beaver damming on the culvert fence does not raise the water level due to the permanent leak created by the pond leveler pipe. The pipe system controls the pond at a safe level and prevents flooding damage to the road or manmade dam, while the fence ensures the culvert remains completely open.



FENCE AND PIPE DIAGRAM
(Side View)

The pipe outlet elevation determines the pond level. This end of the pipe can be adjusted up or down if a higher or lower pond level is desired. Water will continuously flow from the pipe outlet unless the pond level drops below the peak of the pipe.

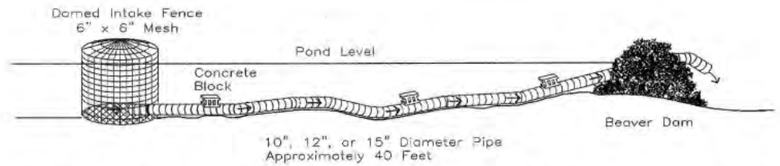
The domed intake fence prevents beavers from hearing or feeling the flow of water into the pipe. Therefore they ignore the intake end of the pipe, and only dam on the culvert fence where they hear the water flowing.

Unlike road culverts, Flexible Pond Leveler™ pipes do not need to be sized to handle catastrophic storm events because heavy storm runoff will simply flow over the top of the dam on the fence and through the unblocked culvert or spillway. Some mild pond fluctuations are possible following very wet periods, but the pond will be controlled at a safe level.

With routine maintenance this flow device will remain effective for many years. Since our customer's satisfaction and our reputation are very important to us, we offer an optional low cost Maintenance Plan which includes our "Worry-Free Guarantee" at no additional cost. See attached. However, if you prefer to do the maintenance, we are always available to answer any questions at no charge because we are committed to the success of our flow devices, your satisfaction and our good reputation.

BEAVER SOLUTIONS — *Flexible Pond Leveler™*

When flooding from a beaver dam threatens human property, health or safety, a Beaver Solutions Flexible Pond Leveler™ pipe system can be a very effective solution. This flow device will create a permanent leak through the beaver dam that the beavers cannot stop. This eliminates the need for repeated trapping despite the presence of beavers.



In order for these pipe systems to be effective, they must be designed so that beavers cannot detect the flow of water into the pipe. The Flexible Pond Leveler™ does this by surrounding the submerged intake of the pipe with a large cylinder of fencing which is placed in as deep water as possible. This prevents the beavers from detecting the flow of water into the pipe. As a result, the beavers do not try to clog the pipe, and a safe water level can be maintained.

The height of the pipe in the dam determines the pond level (see diagram). Water will flow through the pipe unless the pond level drops below the peak of the pipe. The pipe is set in the dam at the desired pond level, and can be adjusted up or down if necessary.

Unlike road culverts, Flexible Pond Leveler™ pipes do not need to be sized to handle catastrophic storm events because heavy storm runoff will simply flow over the top of the dam. Following the storm the pipe will return the pond to the normal level.

When installing a pipe system it is very important to lower a pond only enough to protect human interests. The more a pond is lowered the more likely it is beavers will build a new dam to render the pipe ineffective. Lowering a beaver pond by up to one vertical foot is generally not a problem.

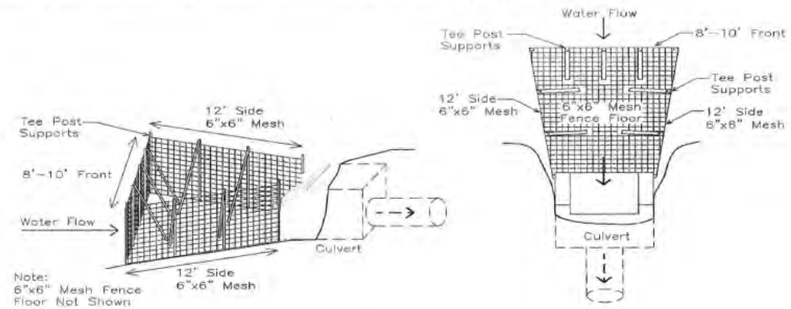
Whenever a freestanding dam must be lowered by two feet or more, a single round of trapping may be needed prior to installing the pipe. Following trapping new beavers relocating into the area are more likely to tolerate the smaller pond without new problematic dam building because they do not have the memory of the larger pond.

With routine maintenance this flow device will remain effective for many years. Since our customer's satisfaction and our reputation are very important to us, we offer an optional low cost Maintenance Plan which includes our "Worry-Free Guarantee" at no additional cost. However, if you prefer to do the maintenance, we are always available to answer any questions at no charge because we are committed to long term success, your satisfaction and our good reputation.

BEAVER SOLUTIONS — *The Keystone Fence™*

Road culverts are the most common beaver damming problem we encounter. Beavers often dam in culverts because with a little bit of work the entire roadbed becomes a large dam. To a beaver, a road bed with a culvert probably looks like a dam with a hole that must be repaired.

The Keystone Fence™ eliminates beaver damming of culverts. Beaver Solutions™ has installed several hundreds of these devices with a 95% success rate despite the continued presence of beavers. This device eliminates the cost of continued culvert clearing, repairs and trapping.



There are 3 reasons why the Keystone Fence™ is so effective at protecting culverts from beaver damming. First, damming 30 to 50 feet of fence is a lot more work for the beavers than simply plugging a narrow culvert. This discourages damming. See diagram. Second, if beavers begin to dam near the culvert the fence forces their damming away from the culvert which also discourages them. Third, if the beavers are determined to dam the fence, as they dam on the fence the opening that the water flows into becomes wider and wider. Therefore less water is moving through the fence where the beavers are damming. The decreasing water flow through the fence at the point of damming further decreases the damming stimulus for beavers.

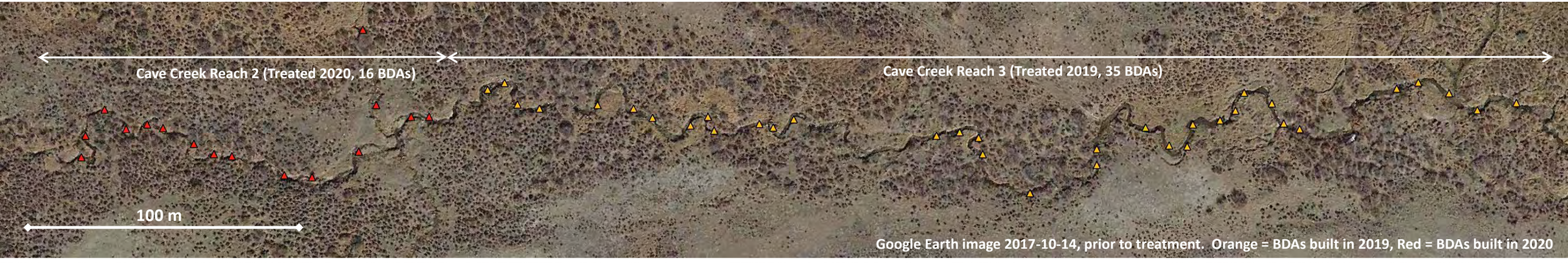
Note, any device exposed to the seasons and the beavers will require some maintenance. While our Keystone Fences™ are designed to be very low maintenance, this maintenance is important. Quarterly all floated leaves and sticks should be cleared from the fence in order to keep the beavers from damming on it. When this routine maintenance is performed as recommended, the Keystone Fence™ will remain effective for many years.

Since our customer's satisfaction and our reputation are very important to us, we offer an optional low cost Maintenance Plan which includes our "Worry-Free Guarantee" at no additional cost. See attached. However, if you prefer to do the maintenance, we are always available to answer any questions at no charge because the success of your flow device, your satisfaction and our good reputation are very important to us.

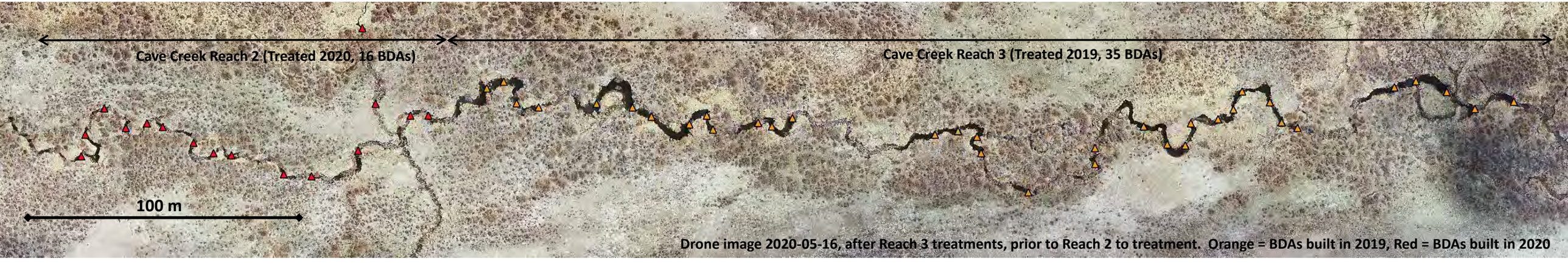
3. Cave Creek beaver restoration (treated in 2019-2020)

Stage-0 beaver complex habitat is widespread on the three streams of Twelvemile Ranch, making it one of the key private conservation properties in the South Platte headwaters. Nevertheless, some reaches have degraded due to the loss of beavers for long periods of time. Cave Creek was identified as the highest priority for restoration and treated over two phases. 35 beaver dam analogs (BDAs) were built on Reach 3 in 2019 and 16 more BDAs were built on Reach 2 in 2020. The purpose of BDAs is to mimic the function of real beaver dams by raising water stage and water table elevation to restore wetland. The treatments also aim to promote recolonization of the reaches by beavers by improving habitat suitability with more deep water, cover, and stimulated willow growth.

↑ In 2018, before treatment, most of Cave creek was an incised single-thread channel running through abandoned dry beaver complex habitat.



Google Earth image 2017-10-14, prior to treatment. Orange = BDAs built in 2019, Red = BDAs built in 2020



Drone image 2020-05-16, after Reach 3 treatments, prior to Reach 2 to treatment. Orange = BDAs built in 2019, Red = BDAs built in 2020

Cave Creek Reach 2 (Treated in 2020, 16 BDAs)

Drone image 2020-05-16, after Reach 3 treatments, prior to Reach 2 to treatment.
Orange = BDAs built in 2019, Red = BDAs built in 2020

Drone image 2020-07-09, during Reach 2 treatments
Orange = BDAs built in 2019, Red = BDAs built in 2020
Arrows indicate BDAs that were in place at the time of this photo.

Cave Creek Reach 3 (Treated in 2019, 35 BDAs)

Google Earth image of Cave Creek Reach 3 from 2017-10-14, prior to treatment.

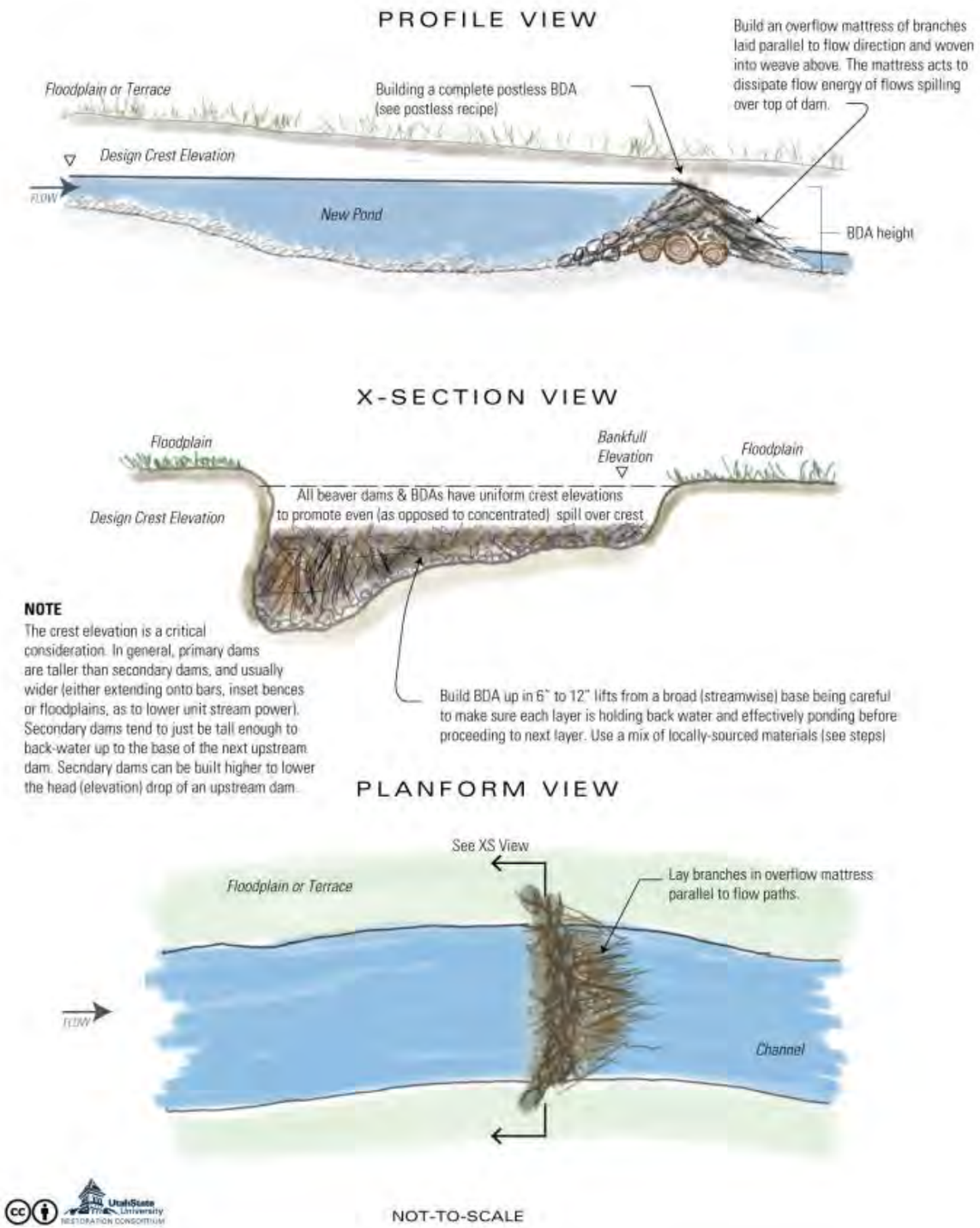
50 m

Drone image of Cave Creek Reach 3 from 2020-05-16 after treatment.

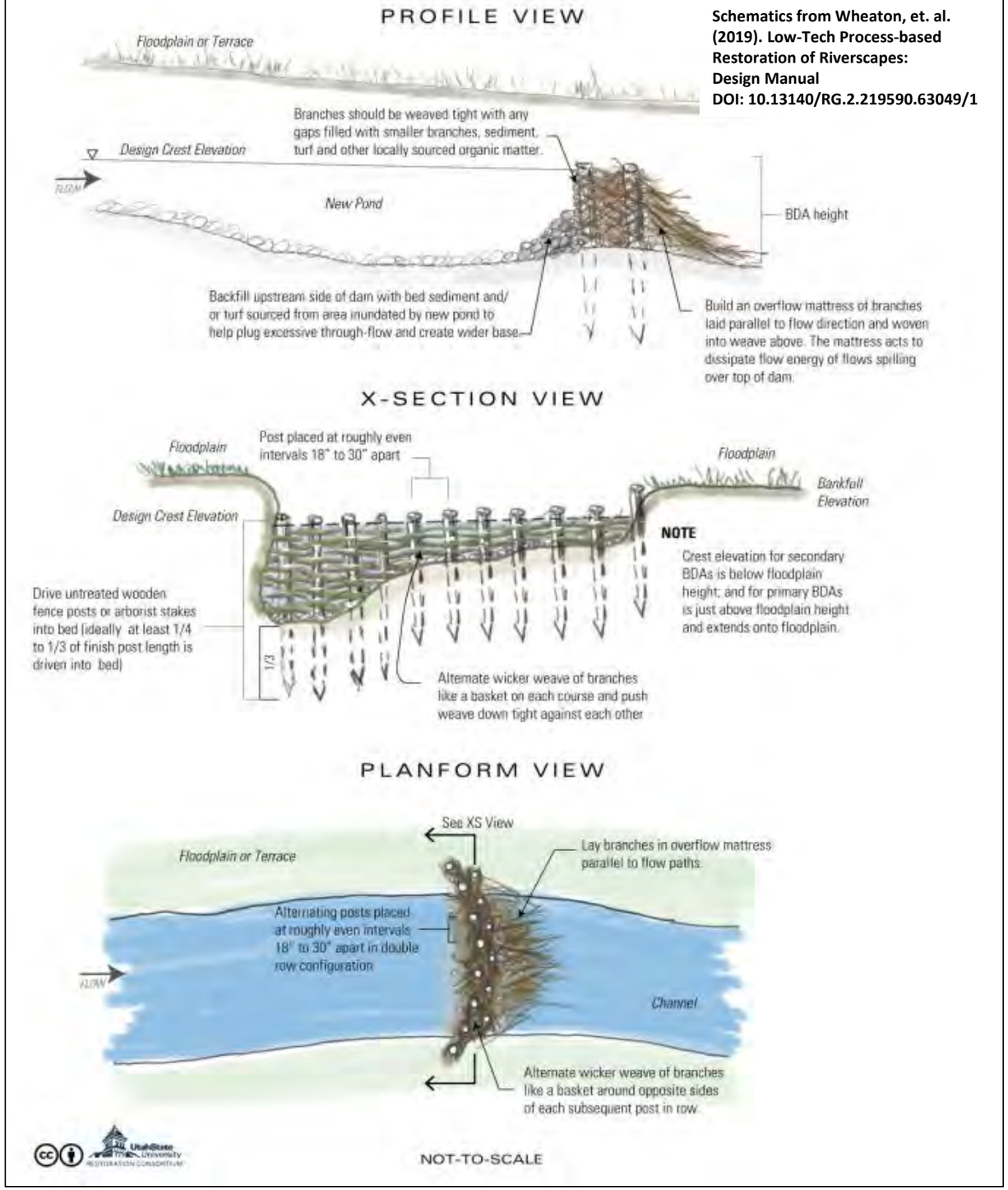
50 m

BDA treatments on Cave Creek

Schematics for a typical BDA structure as built on Cave Creek. Postless BDAs on Cave Creek range from 0.6 to 1.8 feet tall and were constructed using locally-harvested willow, rocks, sod, and gravel. In some cases, coir (coconut fiber) logs were used to build the BDA core.



Schematics for a typical post-assisted BDA structure as built on Cave Creek. Post-assisted BDAs on Cave Creek range from 1.2 to 2.2 feet tall with locally-harvested willow, rocks, sod, and gravel supported by untreated wooden posts driven into the stream bed. In some cases, coir logs were used to build the BDA core.



Schematics from Wheaton, et. al. (2019). Low-Tech Process-based Restoration of Riverscapes: Design Manual
DOI: 10.13140/RG.2.219590.63049/1

BDA treatments on Cave Creek


Typical post-assisted BDAs 2020-07-11 at low flow


Harvesting sod for the BDA core

← Postless BDAs are the first choice

Posts are very labor-intensive ↓


Weaving willow


Coir log core


BDAs “stacking water” to raise stage


Supervision


Typical post-assisted BDA


Documenting initial response


More willow

BDA treatments on Cave Creek

← Installing a BDA on Cave Creek, Reach 2

BDA treatments on Cave Creek

← Installing a BDA on Cave Creek, Reach 2

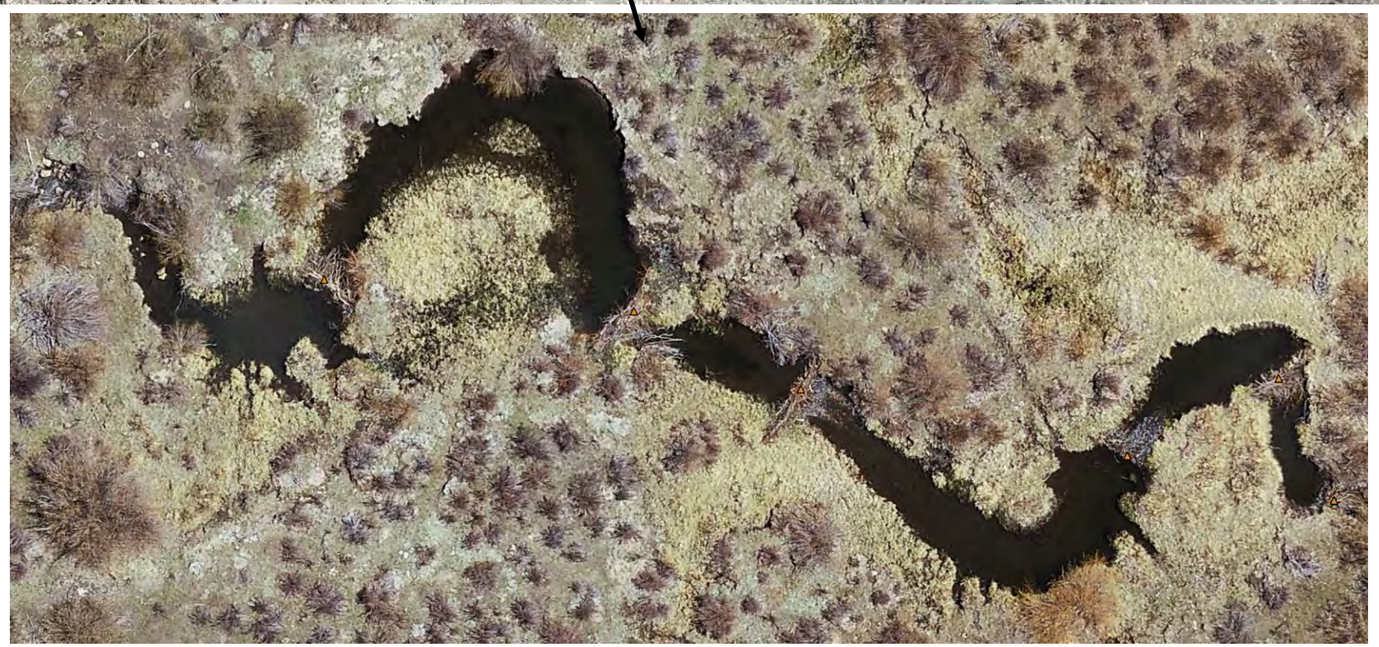
BDA treatments on Cave Creek

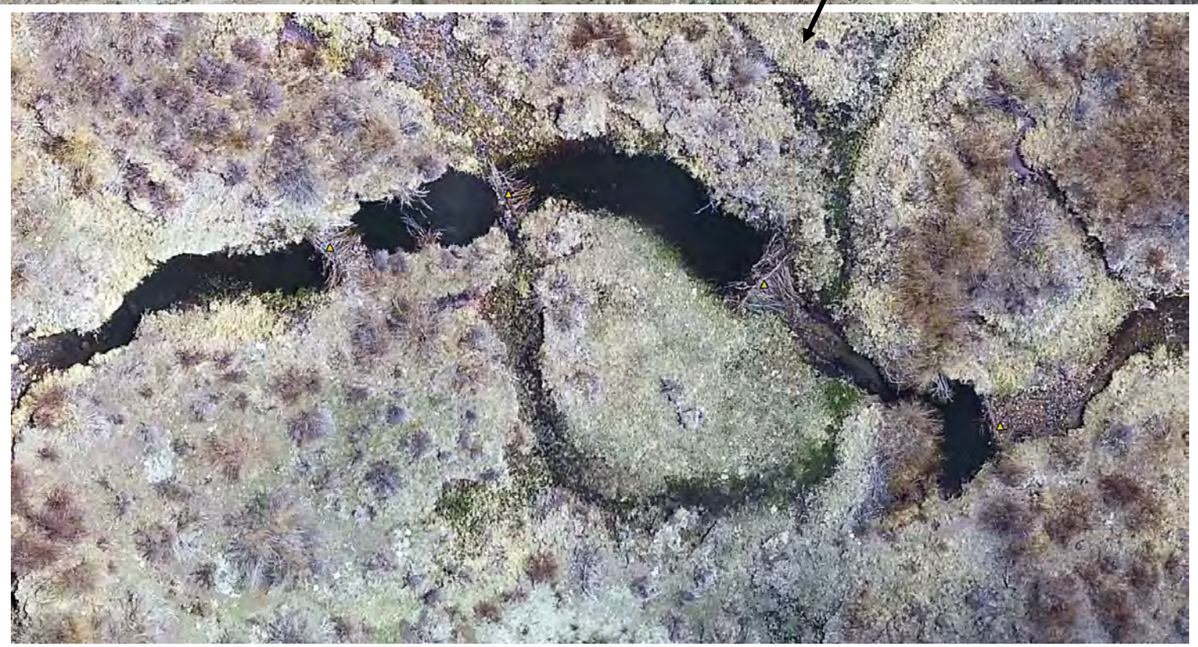
↓ BDAs constructed by hand on Cave Creek →

BDA treatments on Cave Creek

Drone image 2020-05-16 of upper reach during low flow, first season after treatment

50 m





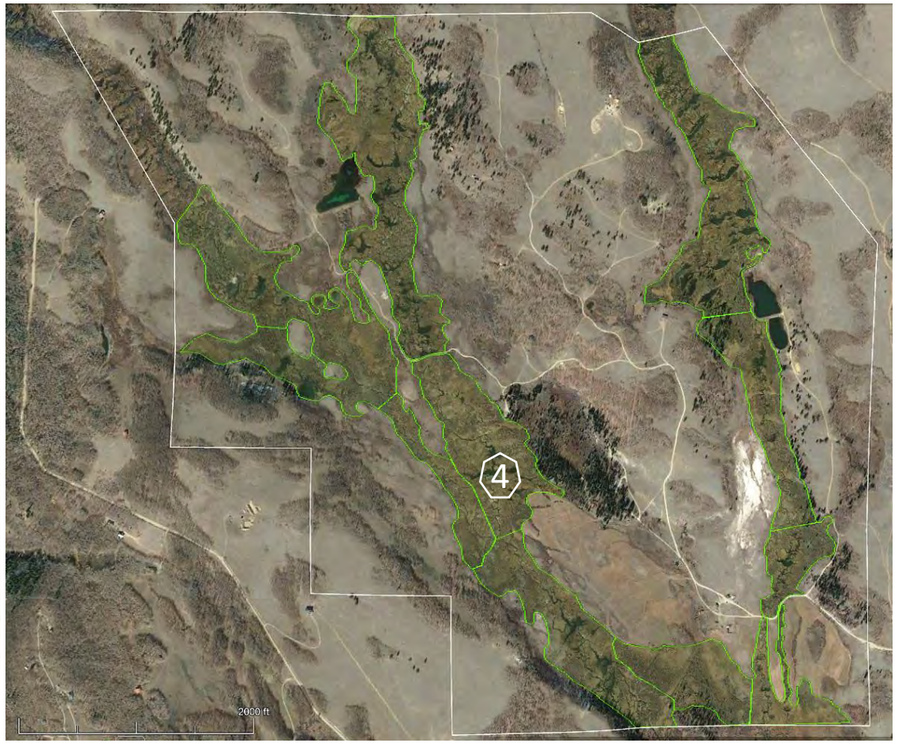
BDA treatments on Cave Creek

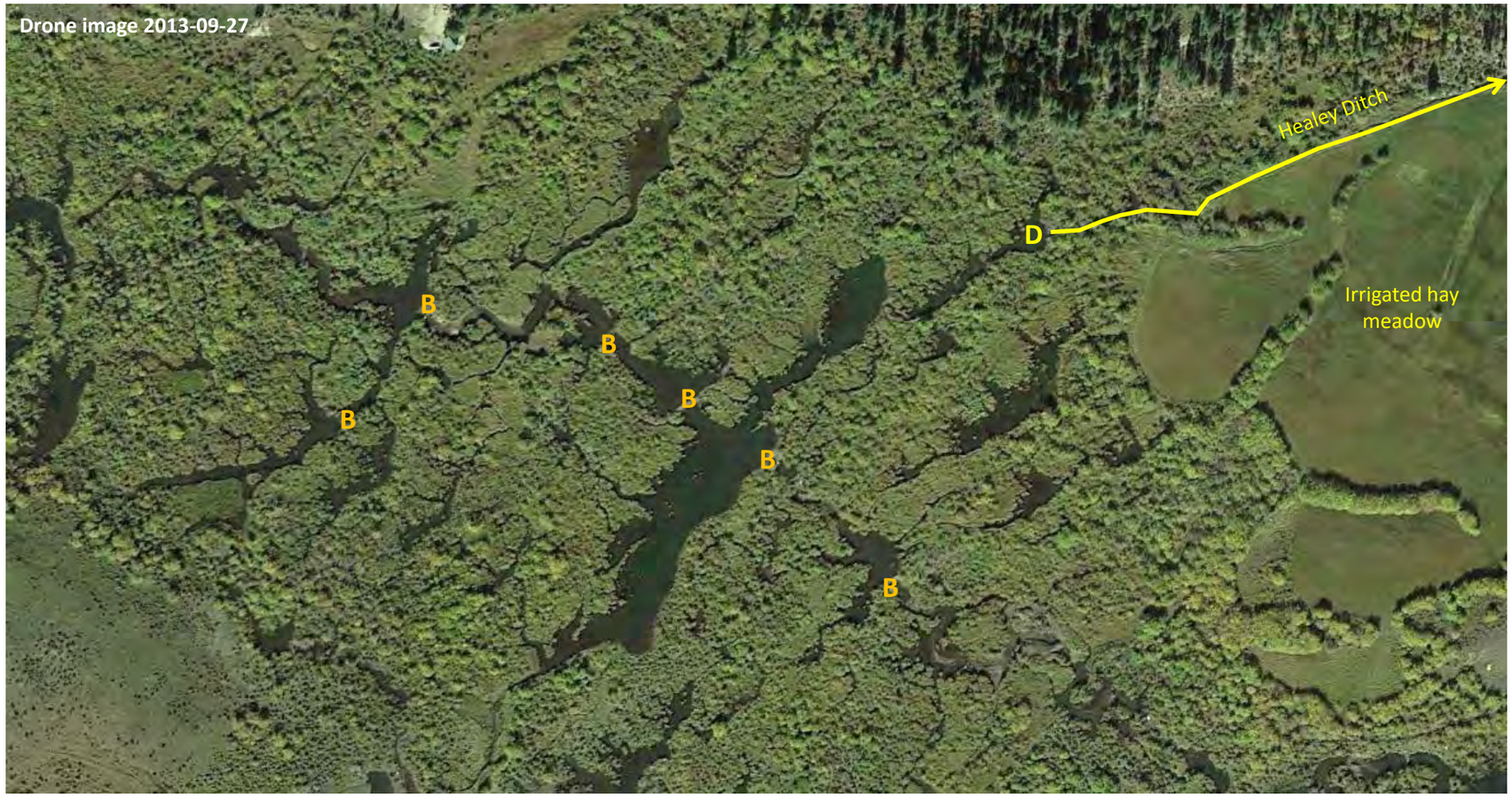
The mild runoff in spring of 2020 gave us a chance to see the performance of BDAs on Reach 2 (built in 2029) during moderate flow (approximately 8-10 CFS). Effective treatments raised stage and induced floodplain activation at this discharge. All these photos are from 2020-06-22.

4. Twelvemile Healey project (treatments initiated in 2020, to be completed in 2021)

Restoring a wetland complex to fix an inoperable irrigation system

↑ Water levels dropped 2-4 feet across the wetland when beaver activity ceased and dams breached, rendering the Healey Ditch diversion point inoperable.



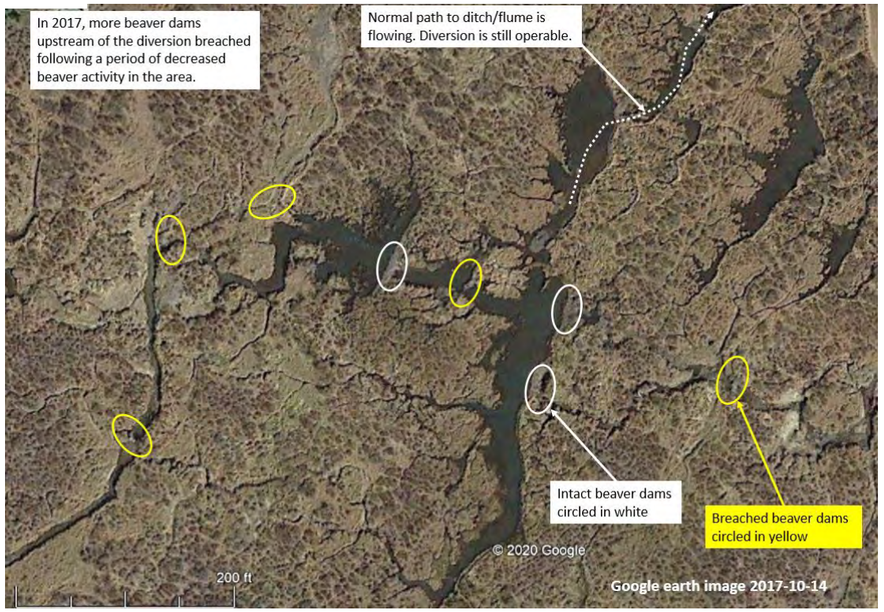


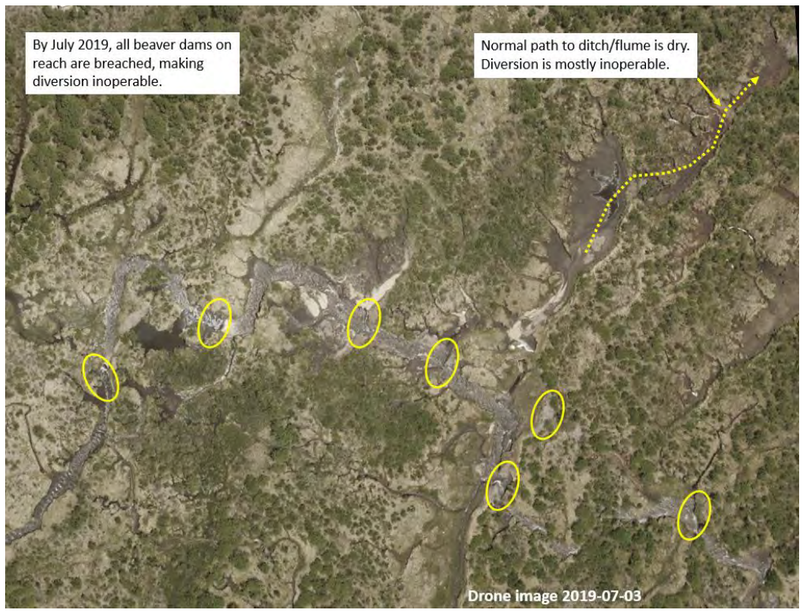
The problem

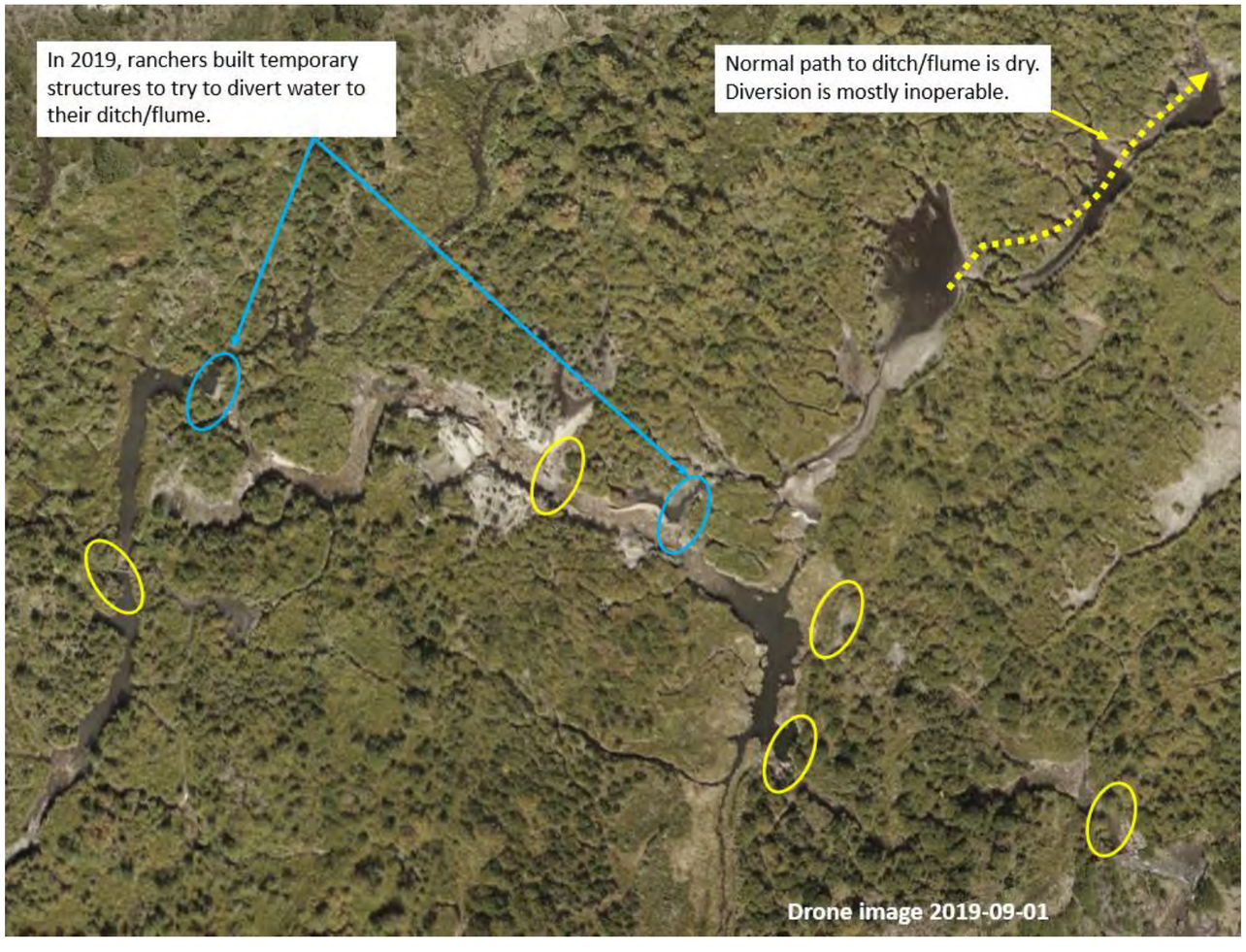
← Water for the Healey Ditch (an 11-CFS water right) has been historically diverted from the Twelvemile Creek beaver complex (at the point marked "D") as shown in this 2013 aerial image. When beaver activity decreased and beaver dams began breaching between 2014-2019, water supply to the diversion point dried up (see next sheet). As the beaver dams breached (at the points marked "B") a deeply entrenched channel formed, and this drained the wetland complex. By 2019, water was no longer dependably available at the diversion point (point D). Restoring water supply to the Healey Ditch is a top priority for Twelvemile Ranch and Colorado Open Lands. Restoring wetland habitat and preventing further habitat loss are priorities for both parties, as well. Maintaining functional headwaters streams and wetland is also important to the State, the County, and citizens who appreciate nature, fish, and wildlife. The drained wetland is therefore a problem on many fronts.

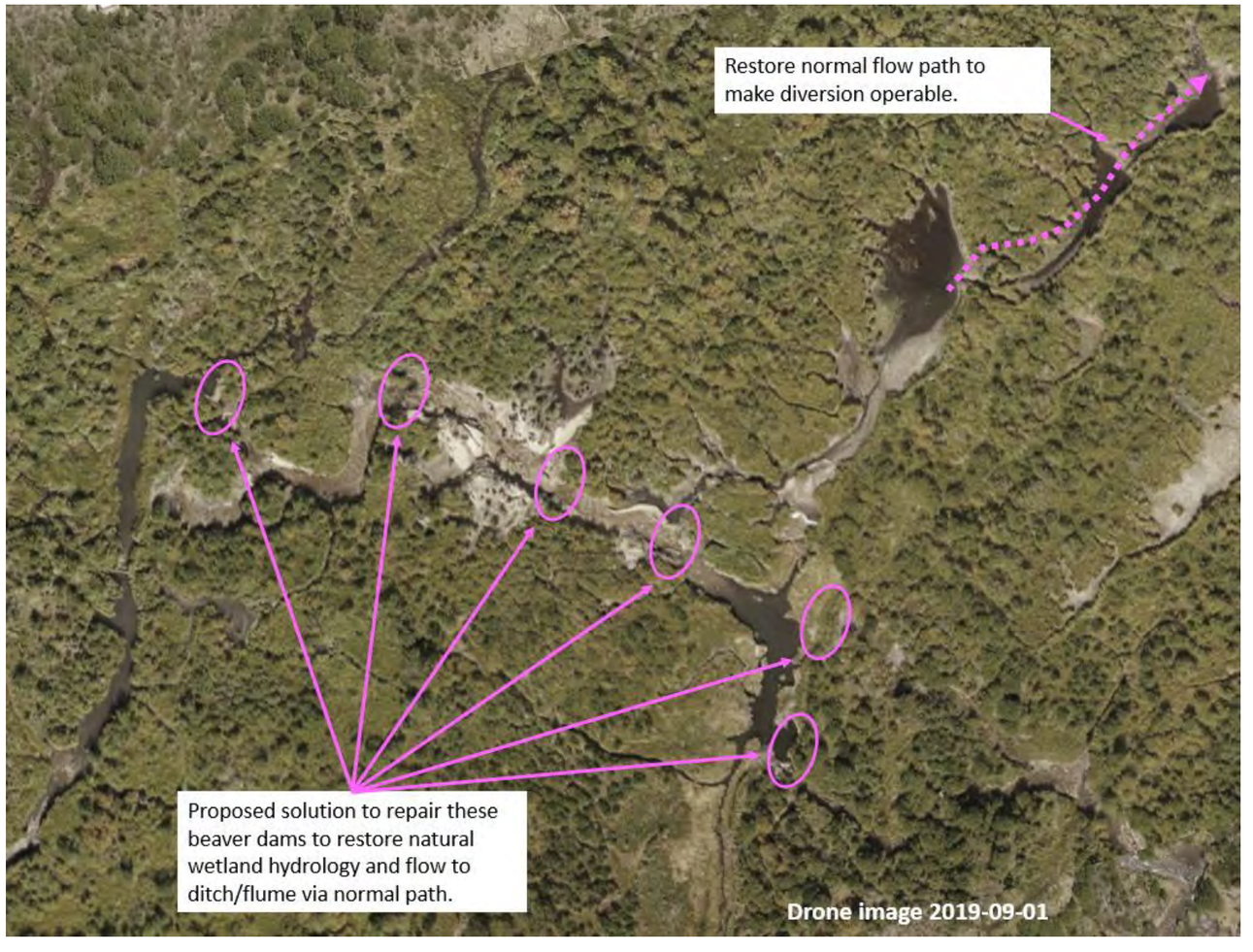
When it comes to water resources, water rights normally trump ecological benefits. So, the usual response to problems like this typically involve high-cost engineering solutions aimed at controlling water supply to the ditch. We are offering an alternative solution. If the irrigation system worked fine while the beaver complex was intact; and if it failed after beaver activity subsided and beaver dams began failing; then perhaps restoring beavers and an active beaver complex can restore the irrigation system. This alternative is proposed as a way to service the water right while protecting and restoring wetland—the way it's been done for more than a century.

Healey project: A developing problem and possible solution









Healey project: A developing problem and possible solution

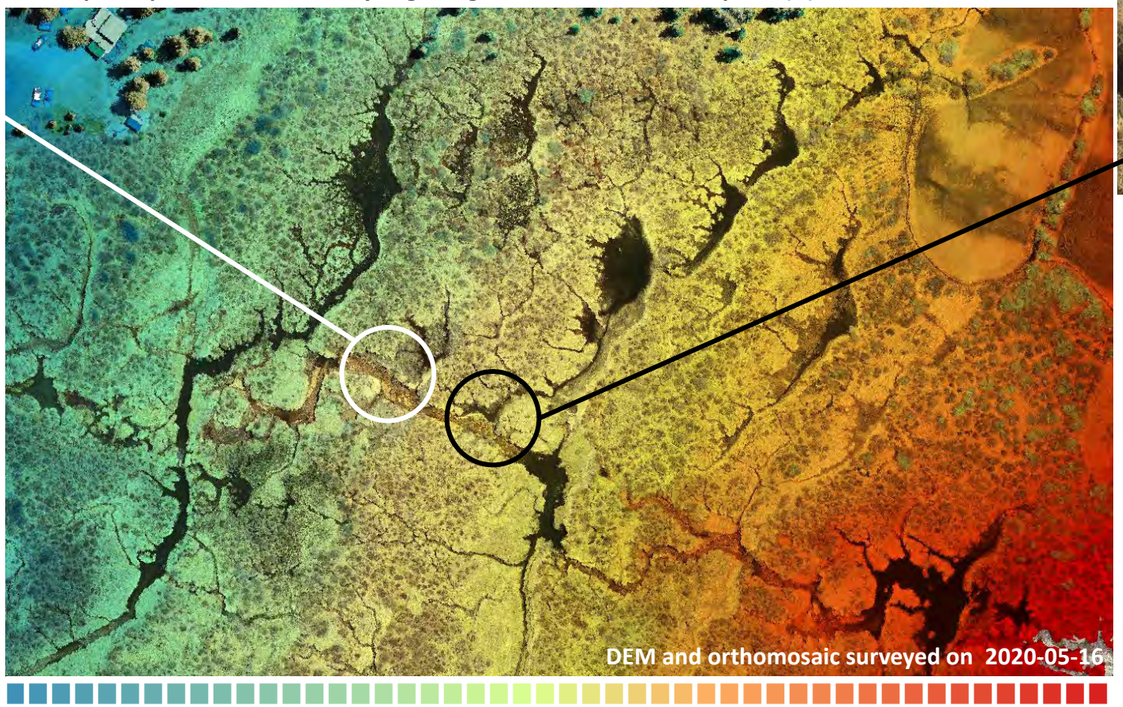
↑ Critical dam on 2019-06-12 before it breached

↑ After the dam breached

↑ Twelvemile Ranch partners aim to repair beaver dams by hand. Work commenced October 2020 until halted by winter.

↑ Lack of beaver activity, failing beaver dams, channel incision, and dropping water levels observed in 2018 spelled trouble for water use and wetland on Twelvemile Creek at the Healey Diversion area, and these problems manifest fully when the remaining dams breached in 2019. With estimates for using heavy equipment to restore the area coming in at more than $50,000, partners opted to try hand-built BDAs first. Installation of post-assisted BDAs with coir log foundations began in October 2020 and will be completed in 2021 using labor provided by Twelvemile Ranch volunteers.

A topo map shows the difficulty in getting water to the diversion point (D) in the incised condition. ↓



↑ Efforts to divert water after the dams failed.

↑ BDA treatments aim to raise stage and restore wetland. Work commenced October 2020 until halted by winter.

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