



Riverdale Bluffs Open Space

Master Plan

Adams County Parks, Open Space, & Cultural Arts Department

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Acknowledgments

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Introduction

The Riverdale Bluffs Open Space (the Bluffs) is a 226-acre, undeveloped parcel of rolling and sometimes steep prairie landscape overlooking the South Platte River Valley and the distant downtown Denver skyline. Located a half a mile west of the South Platte River, at Riverdale Road and 136th Avenue in Adams County, the Bluffs are an important addition to an already open space-rich area of the County. The site is adjacent to the County's Regional Park, Riverdale Dunes Golf Course, a County owned, 81-acre, open space property and is located less than one mile away from the County's Willow Bay Open Space and the South Platte River Greenway. The Bluffs location creates a fantastic opportunity to connect directly to these regionally significant recreational areas. The site is also located in a rapidly developing area, and adjacent to Riverdale Ridge High School and Rodger Quist Middle School, and could become a significant recreational amenity for the surrounding neighborhoods, as well as more regional County residents who are interested in taking advantage of this open space's unique resources.

The Riverdale Bluffs property was purchased by Adams County using Open Space Sales Tax Grant Funds. This funding required a conservation easement to be placed on the property. The easement, held by Commerce City, restricts land uses that are inconsistent with the site's open space values, including active or motorized recreation. The easement permits passive uses such as hiking, cycling, and wildlife viewing.

During the development of this master plan the County acquired the Baumgartner property, an adjacent 15.5-acre parcel southeast of the original Bluffs property that will become part of the Riverdale Bluffs experience. This former residence, situated at the top of a bluff, is anticipated to be developed into a nature center by the County. Preliminary planning for this site was performed as part of this master plan to identify site access, parking, and potential open space trails that would complement the Bluffs facilities, however master planning for the former Baumgartner residence will occur at a later date.

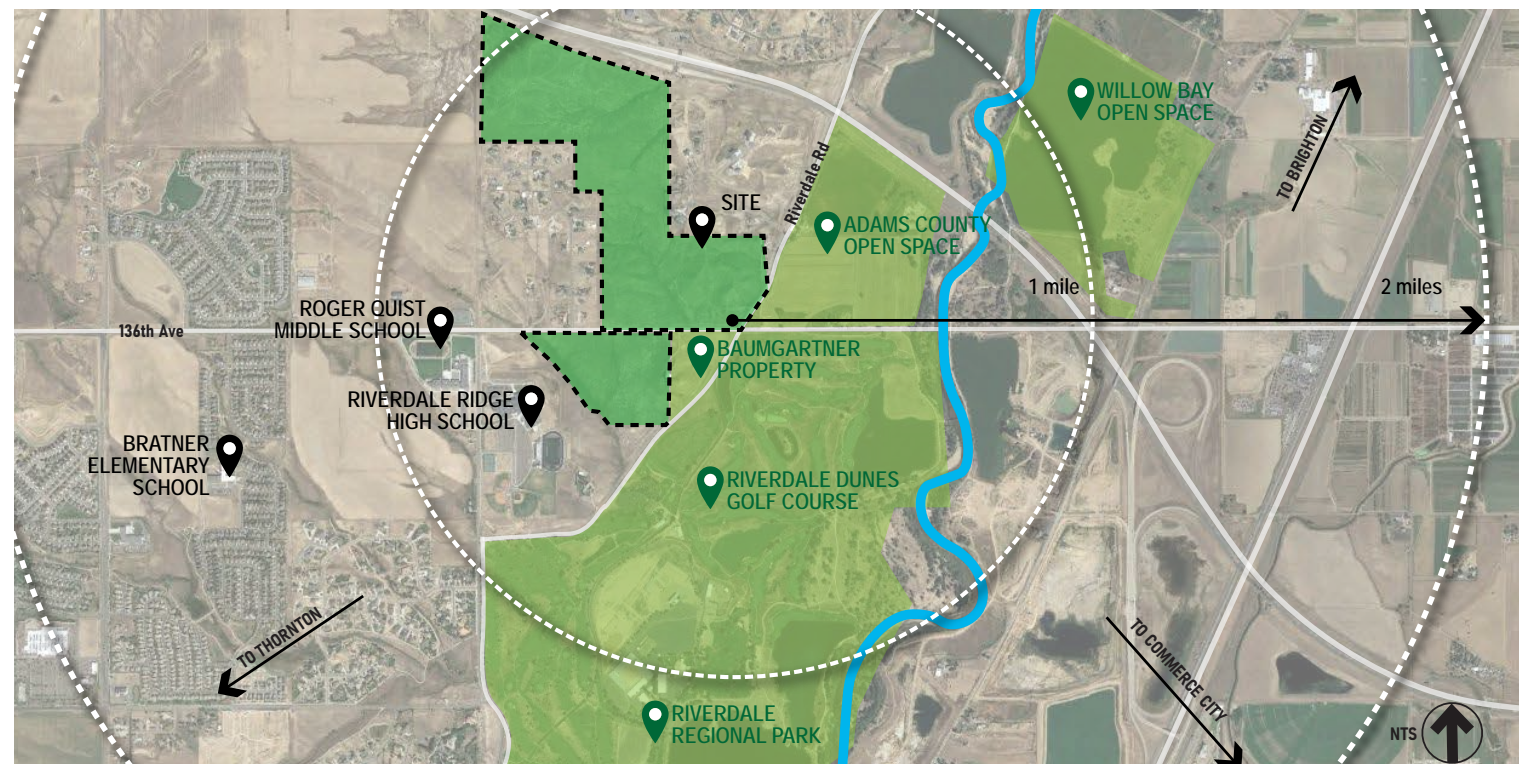


Figure 1. Map shows the regional context of Riverdale Bluffs property and proximity of Adams County recreation and open space network.

Purpose of the Master Plan

The overarching objective of this master planning process has been to identify the best use of this open space resource for Adams County and its residents. To achieve this, the project team's primary objectives included:

- Analysis of the open space's natural resources and recreational potential;
- Evaluation of the regional context to identify opportunities for connectivity and improvements that would enhance and complement the larger Adams County open space system;
- Identification of a range of appropriate recreational activities for the site;
- Development of a range of appropriate land management guidelines to protect the open space resource;
- Engagement of the residents of Adams County into the planning process to provide guidance and feedback on the desired vision for the park;
- Refinement of proposed site improvements and land use recommendations into a coherent open space master plan that will guide the future development of the Riverdale Bluffs.



Figure 2: A bird's-eye view of the Bluffs and the adjacent neighborhoods.



Figure 3: A view of the Bluffs central drainage looking northwest.



Figure 4: A view of the Bluffs' varying topography and drainage network.

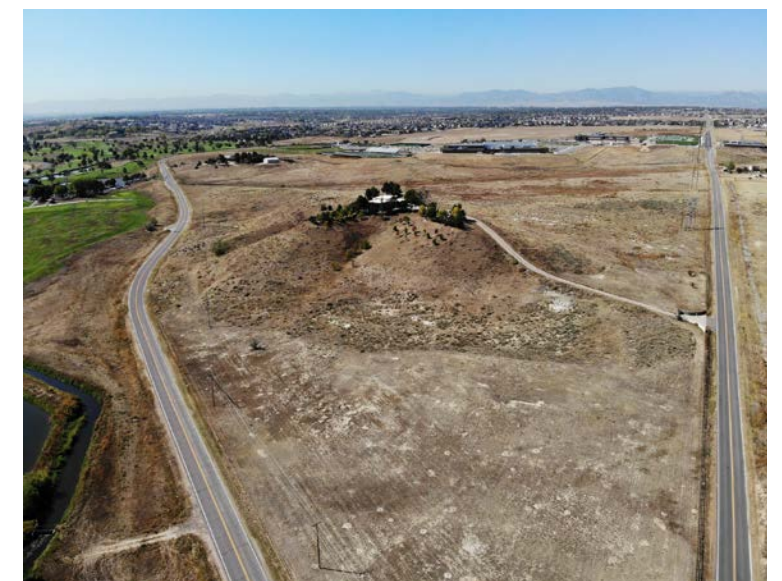


Figure 5: A bird's-eye view of the Baumgartner Property.

An Important Resource

In an effort to understand this important recreational and natural resource, the multi-disciplinary design team, which included an ecologist, trails planner, landscape architects and civil engineers, visited Riverdale Bluffs to study the site's topography, natural vegetation and recreation potential. Upon visiting the Bluffs, the site's major recreation draw becomes clear. The tall bluffs and rolling hills welcome visitors and invite them to explore the variable landscape. The tall bluffs offers visitors dramatic views toward the South Platte River and the Riverdale Regional Park to the east, the downtown Denver skyline to the south, and the Rocky Mountain Front Range to the west. This site could become a regional destination for those looking to climb to the top of the main bluff and take in its tremendous views.

Through the analysis of the open space's natural resources and recreational potential, spatial constraints onsite created a unique design challenge for the project team. At 226 acres, the site is approximately one mile across in the north-south direction, and of variable width in the east-west direction, but on average about a half mile wide. In some areas the site is only 900 feet wide—a distance of less than three football fields, which feels narrow in this wide-open prairie environment, especially with the encroaching residential subdivisions on each side of the open space. On the other hand, there are some very scenic areas of the site that

provide an expansive open space experience, especially from a high point near the northwest limits of the site, and along the prominent drainage that traverses the south parcel, just west of the Baumgartner property.

After numerous visits to the site by the multi-disciplinary team, the initial vision of developing the site into a trails-focused recreational resource started to coalesce.

General **guiding principles** developed by the team for the master planning process included the following:

- **Facilitate appropriate recreational use:** Although a valuable natural resource, the Bluffs site has been severely degraded over the years, resulting in significant areas of disturbance, weeds, and erosion. It is not a pristine natural resource, and may take many decades to restore. Recreational trail use and other passive recreation that takes advantage of the unique high points, views, and rolling topography have been identified as appropriate uses for the site, but should be developed in a responsible manner that does not further degrade the resource;

- **Enhance regional connectivity:** Given the proximity of the Bluffs to the South Platte River and Greenway, and the future east-west E-470 trail, this open space can play a primary role in connecting the communities and neighborhoods that lie to the west of the South Platte River and Riverdale Road to the South Platte River Greenway. Creating better multi-modal connections to and from the Bluffs should be a priority;
- **Plan for diverse recreational amenities:** Ones that attract the residents of nearby neighborhoods as well as destination users from other parts of the County. Consider the potential use of the open space by students at the adjacent high school and middle school (cross country running, mountain biking, other academic-focused field trips). Create one-of-a-kind recreational attractions that are not available in other nearby areas;
- Integrate improvements for the Bluffs open space with the newly acquired Baumgartner property to create a seamless open space experience;
- Develop a long-term approach to incrementally improve habitat and vegetation at the Bluffs.

Public Engagement

After performing the site analysis and developing the guiding objectives for the master plan, the team focused on conducting a robust public process that included two public meetings which engaged the public in assisting the team in the development of master plan recommendations for the site. Each public meeting featured a presentation of potential concepts for site improvements followed by an on-line opinion poll providing an opportunity to vote on their preferences. The public's feedback was a primary resource that the team used to make decisions about what activities and improvements should be included in the master plan. (See the detailed description of the public process, and results of the public opinion polls in the appendix.)



Figure 6: Viewshed looking southeast to primary drainage with main bluff on the left.



Figure 7: A view of the primary drainageway looking north.



Figure 8: Drainage way south of 136th Avenue.

Natural Resources Inventory

The Riverdale Bluffs site is characterized by steep bluffs above the South Platte River floodplain to the east, and gently rolling hills to the north that are intersected by multiple dry gullies. The site is dry and receives little runoff from offsite drainage basins. The low areas, drainage gullies and swales have more dense vegetative cover than the steeper slopes due to concentrations of moisture, however all but one of these “drainages” are dominated by upland species, with only one gully in the southwest corner of the property receiving enough precipitation runoff to support wetlands. The main central swale that runs northwest to southeast through the site has more notably lush vegetation than the adjacent slopes, and also supports some woody shrubs that are uncommon in the rest of the site.

The property is dominated by shortgrass prairie and mixed grassland communities, consisting of both native prairie species and abundant nonnative weed species. Higher quality grassland areas include the steep slopes of the main bluff on the east side of the property, and the gully in the northwest corner, which consist of higher-quality shortgrass prairie communities that are dominated by native prairie species. Species identified in the shortgrass prairie include: blue grama, buffalo grass, common sunflower, soapweed yucca, and prickly pear cactus. This plant community is pervaded by cheatgrass, a non-native invasive grass species that is present in a large portion of the site. Species that were observed within the mixed grassland vegetation community included blue grama, buffalo grass, soapweed yucca, sand dropseed, ring muhly, squirreltail, slimflower, scurfpea, purple prairie clover, hairy false goldenaster, common sunflower, prickly pear cactus, burningbush, winterfat, yellow rabbitbrush, and sand sagebrush. Weeds and invasive plants in this community include field bindweed, prickly russian thistle, and cheatgrass.

There are only a few living trees on the site, the largest of which is located near the historic entrance gate at the northeast corner adjacent to Riverdale Road. Given its location, this tree was likely planted by a previous land owner. The site has an extensive history of disturbance primarily due to energy extraction activities (oil & gas), uncontrolled recreation (off road vehicles use etc.), and previous use of the site as a private residence (since demolished). As a result, much of the original native grassland vegetation has been disturbed and taken over by noxious weeds. Soils are dominated by gravelly-sand and silty-clay soils, with high erodibility on excessive slopes. Erosion issues can be mitigated through proper trail design, construction, and management. These soils are also prone to severe rutting when they are wet, which can be problematic for trail management in the winter months, resulting in trail damage, trail widening and braiding, and degraded visitor experiences.

Note: A small colony of prairie dogs exist on the east side of the site just north of 136th Avenue. It will likely be impacted by proposed trailhead improvements.

Recommendations:

- Continue to control isolated patches of noxious weeds such as scotch thistle and common mullein with a variety of methods, including chemical herbicide and mechanical treatments. The objective should be to minimize the spread of these species within the site;
- Evaluate the options available for improving the coverage of native grass species and controlling cheatgrass. This weed species is difficult and expensive to control with chemical weed control, and mechanical control is not practical. While overseeding the site with more desirable grass species may have some benefit, the long-term history of weed proliferation has resulted in the development of a significant weed seed bank in the site soils that would be difficult to overcome without more aggressive (and expensive) methods, potentially including controlled burns, and /or replacement of topsoil;
- The site’s trails and recreational amenities should be located and designed to encourage visitors to use and stay on provided trails;
- Areas disturbed during the construction of site improvements, and other bare areas throughout the site should be seeded using best practices for soil preparation, seeding, mulching, and maintenance (including re-seeding if necessary). Seed mixes should consist of native prairie species that are appropriate for the site;
- All disturbed areas, including trail corridors, should be monitored for vegetation condition and noxious weeds for up to three years beyond construction. Any new noxious weed infestations should be aggressively controlled;
- Seeded areas steeper than 4(H):1(V) should be stabilized with erosion control blanket instead of mulch;
- Identify opportunities for small-scale, experimental restoration of native grassland species on the site, using a combination of mechanical and chemical treatments, drill seeding, overseeding, and monitoring. If successful, these methods could be used at a larger scale to work towards large patches of native prairie within the open space;
- Consider management measures to reduce trail damage during wet conditions, including a light crusher-fine overlay of trails during construction, and/or trail closures during extended wet conditions (typically in winter).

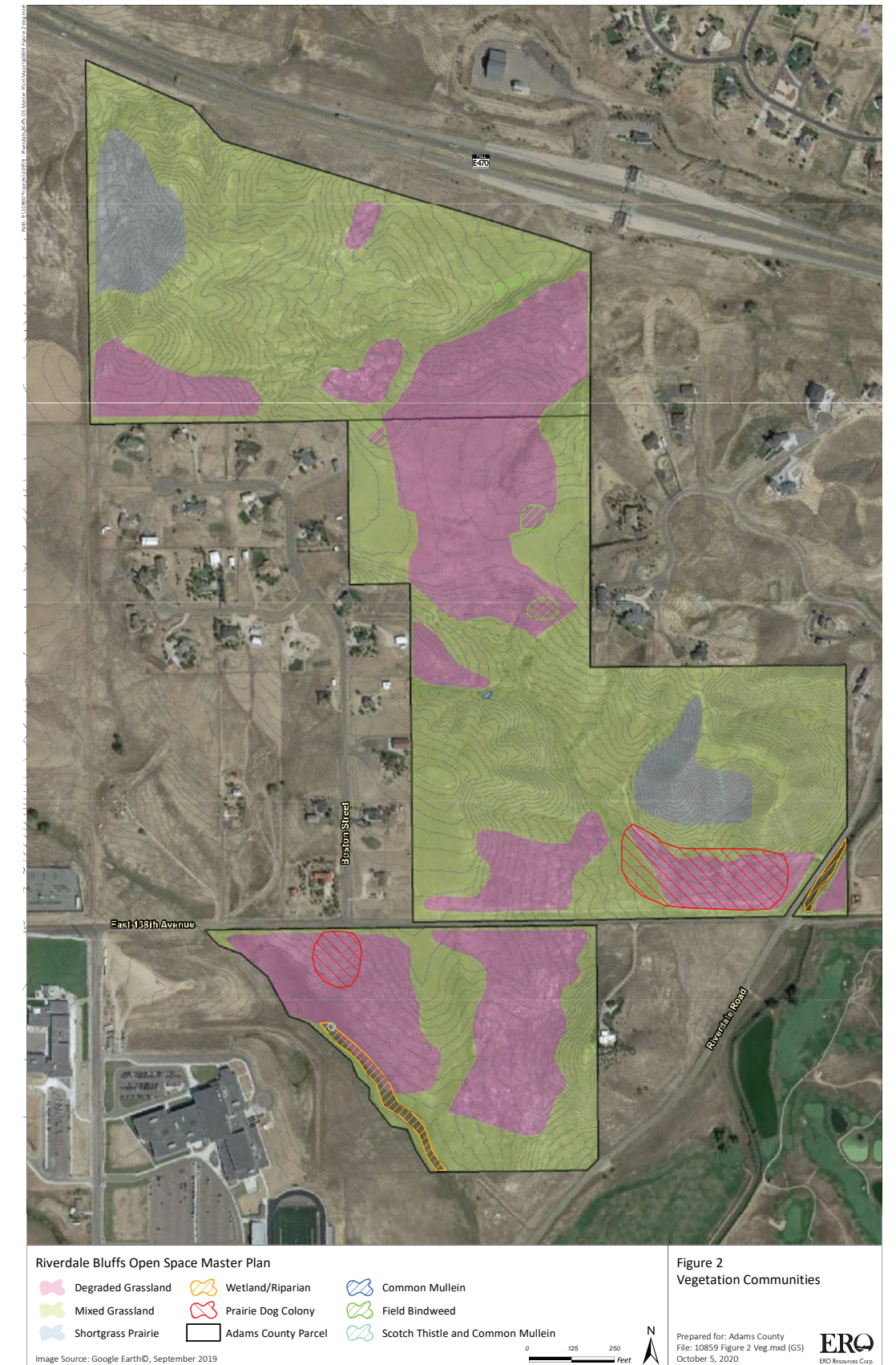


Figure 9: ERO Resources Corporation conducted a vegetation assessment, including noxious weed identification, and mapped the present vegetation communities across the site. ERO identified shortgrass prairie, mixed grassland, degraded grassland and wetland/riparian at the Riverdale Bluffs Open Space.

Riverdale Bluffs Vision

With the completion of the Site Analysis, the development of the project Design Principles, and the feedback received from the Public Engagement Process, a vision of Riverdale Bluffs began to emerge as an open space oriented around a diverse network of trails connecting users across the site to overlooks and open space amenities. The site's terrain offers the chance to provide a variety of trail types for users of all ages and abilities. The vision included ADA accessible walking trails, stair climbing trails, soft surface running trails, mountain biking downhill trails, and kids biking loops.

The majority of the trails at the Bluffs were envisioned to be local trails, designed to move users through, over and around the rolling Bluffs landscape. However, through a recently emerging partnership opportunity, an important regional trail connection will also be part of the Riverdale Bluffs recreational experiences. This trail is the E-470 Regional Trail, which had long been planned by the E-470 Authority to parallel the E-470 highway along the northern boundary of the Riverdale Bluffs property. Through a partnership between E-470 and Adams County, the trail will now be routed through the Bluffs, providing very significant regional trail connections between the Bluffs and the South Platte Greenway to the east, and in the future, to Thornton, and the quickly growing neighborhoods to the west.

The proposed E-470 trail will cross the site from the northwest corner to the southeast corner near Riverdale Road and 136th. It will traverse the northern edge of the site before turning south and passing along the south side of the main bluff, adjacent to the main Bluffs trailhead. Heading east, the trail will cross Riverdale Road via an overpass, and then will continue east on Adams County Open Space property to a junction with the South Platte Greenway. A feasibility study of the trail alignment through the Bluffs was performed by the master planning team, and found that the alignment of the E-470 trail through the Bluffs would not unduly impact the original vision of a trail oriented open space, as it is generally separate from the internal circulation routes. In addition, the paved regional trail will provide an

important additional recreational amenity for the open space, and for the County recreational network as a whole. The proposed alignment of the E-470 trail through the Bluffs was approved by the E-470 Authority board, and subsequently an IGA has been developed between Adams County and the Authority to authorize Adams County to move forward with the design of this trail connection.



Figure 10: Viewshed from top of the Sunflower Loop, looking south towards 136th.

The vision for the Bluffs, that was approved by the public and Adams County staff, includes the following:

Trails*



E-470 TRAIL WITH SOFT SURFACE SHOULDER



CRUSHER FINES TRAIL*



SINGLETRACK TRAIL*

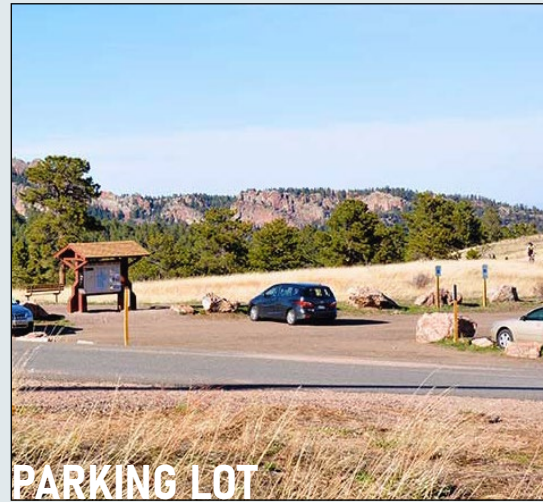


KIDS SKILLS LOOP



STAIR CLIMBER TRAIL

Trailhead & Visitor Facilities



PARKING LOT



RESTROOMS



PICNIC AREAS & SHELTERS



SIGNAGE & KIOSKS

Destination Overlooks



SEATING



OVERLOOK SHADE STRUCTURE



INTERPRETIVE SIGNAGE & MAPS








PEDESTRIAN OVERPASS

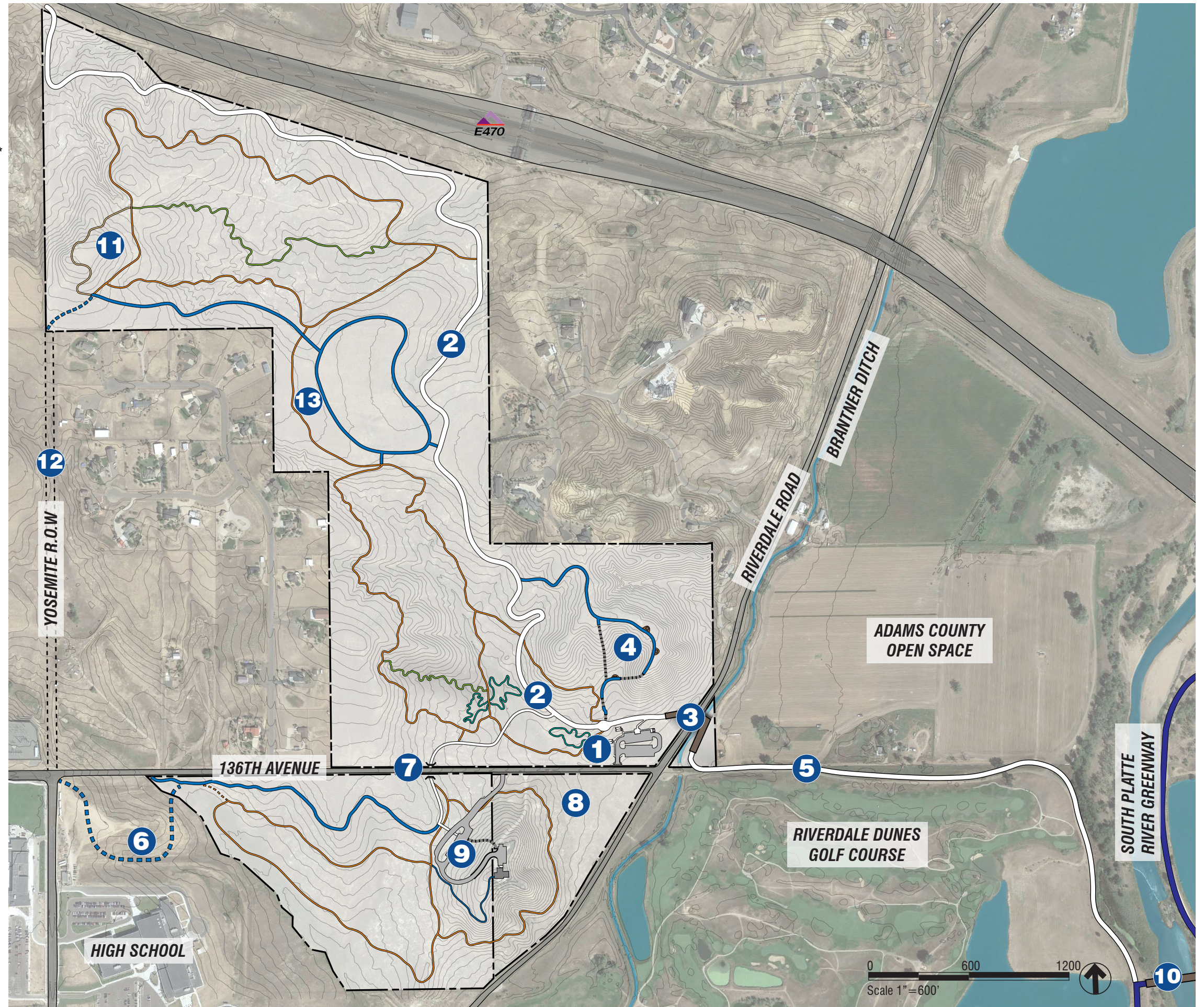
* Equestrian use is allowed at all Adams County Open Spaces. No specific equestrian use only trails are proposed at Riverdale Bluffs but equestrian use is permitted on all primary soft surface trails and singletrack multi-use trails (with the exception of the soft surface trail to the bluff overlook, which includes stairs).

MASTER PLAN OVERVIEW

Map Legend

-  E-470 REGIONAL TRAIL (10' WIDE CONCRETE WITH 4' SOFT SHOULDER)
-  PRIMARY SOFT SURFACE TRAIL (6' TO 10' WIDE CRUSHER FINES)*
-  FUTURE SOFT SURFACE TRAIL (CONCEPTUAL)
-  SINGLETRACK TRAIL - MULTI-USE (2' TO 3' WIDE, EARTHEN)*
-  FUTURE SINGLETRACK TRAIL (CONCEPTUAL)
-  SINGLETRACK TRAIL - PEDESTRIAN ONLY (2' TO 3' WIDE, EARTHEN)
-  SINGLETRACK TRAIL - BICYCLE ONLY (2' TO 3' WIDE, EARTHEN)
-  BICYCLE SKILLS LOOP - BICYCLE ONLY (2' TO 3' WIDE, EARTHEN)
-  STAIR-CLIMBER TRAIL - PEDESTRIAN ONLY (5' TO 6' WIDE, CONCRETE STEPS AND CRUSHER FINES)
-  SOUTH PLATTE RIVER GREENWAY TRAIL
-  PROPERTY LINE
-  1 TRAILHEAD & PARKING LOT
-  2 E-470 TRAIL
-  3 PEDESTRIAN OVERPASS OVER RIVERDALE ROAD
-  4 BLUFF OVERLOOK
-  5 REGIONAL TRAIL CONNECTION FROM BLUFFS TO SOUTH PLATTE RIVER GREENWAY
-  6 ADA CONNECTION TO LOCAL SCHOOLS AND SIDEWALK ALONG 136TH AVENUE TO THE WEST (SHOWN CONCEPTUALLY)
-  7 136TH UNDERPASS
-  8 BAUMGARTNER PROPERTY
-  9 BAUMGARTNER PARKING LOT (SHOWN CONCEPTUALLY)
-  10 SOUTH PLATTE RIVER GREENWAY
-  11 SINGLE TRACK TRAIL - PEDESTRIAN ONLY TO NORTHWEST HIGH POINT/OVERLOOK
-  12 EXISTING PUBLIC ROW
-  13 TO BE DETERMINED IF SINGLETRACK TRAIL IS SEPARATE OR CO-LOCATED WITH PRIMARY SOFT SURFACE PATH

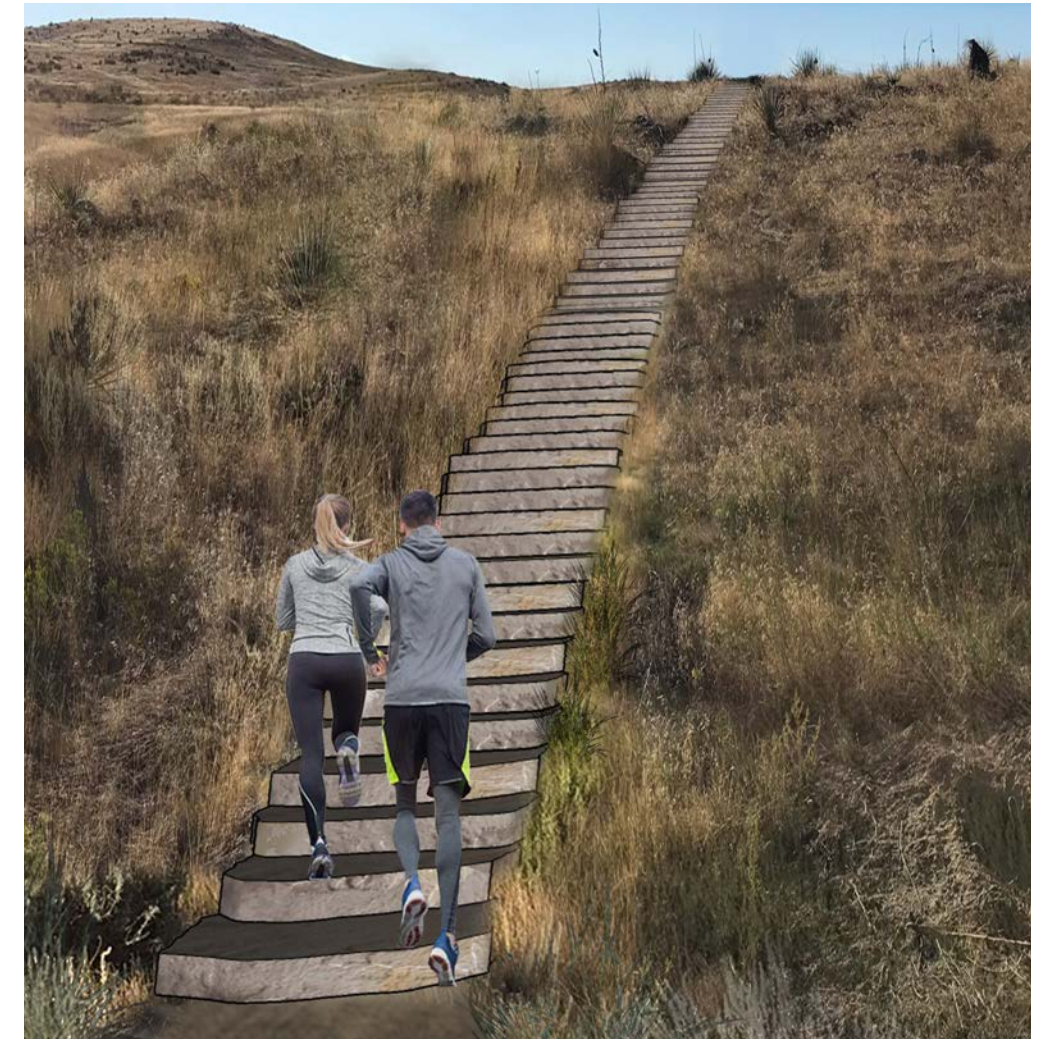
*Equestrian use allowed on primary soft surface trails and singletrack multi-use trails, with the exception of the soft surface trails leading up to point 4, the bluff overlook area.



SITE PERSPECTIVES



① Bluffs Overlook

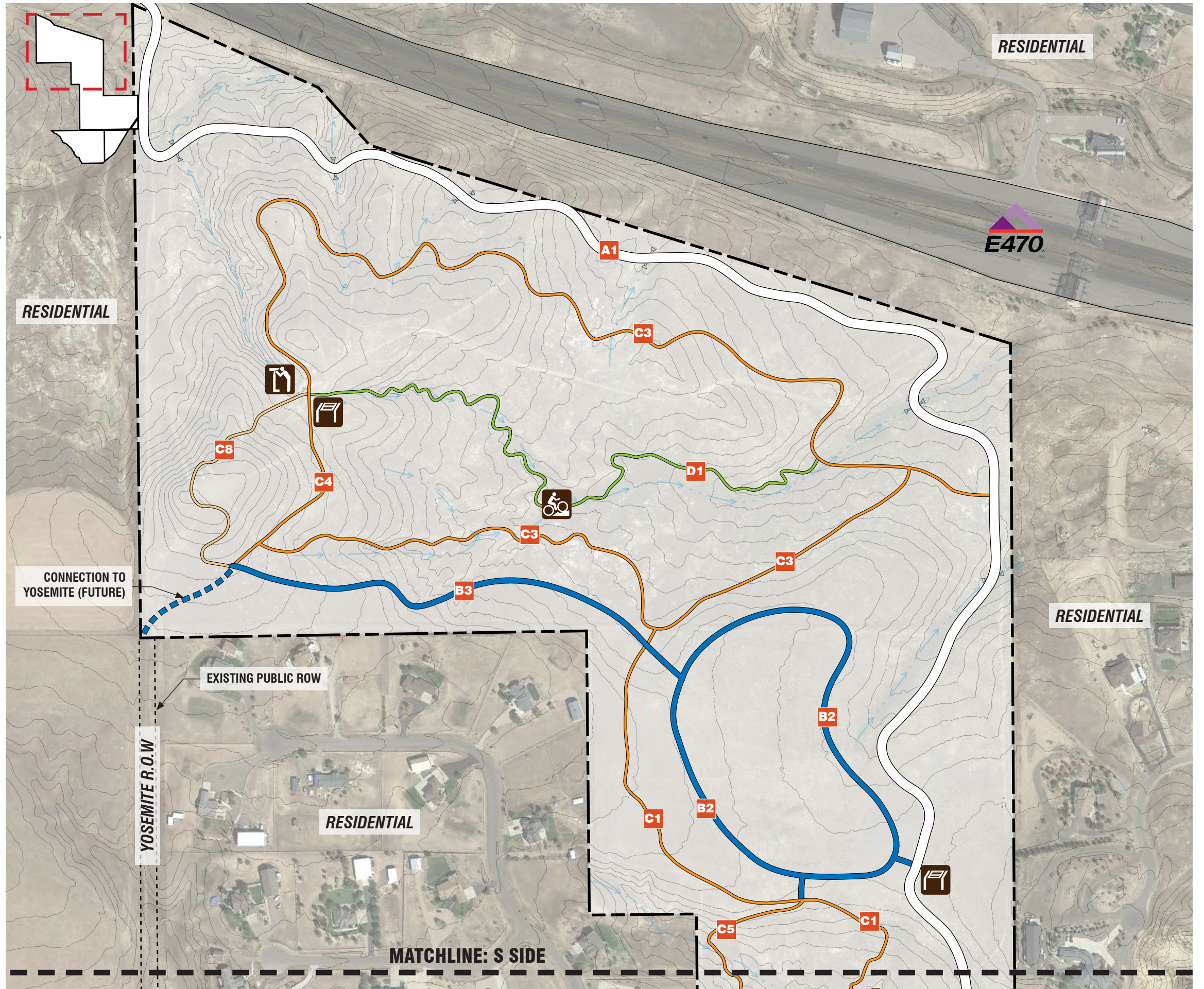


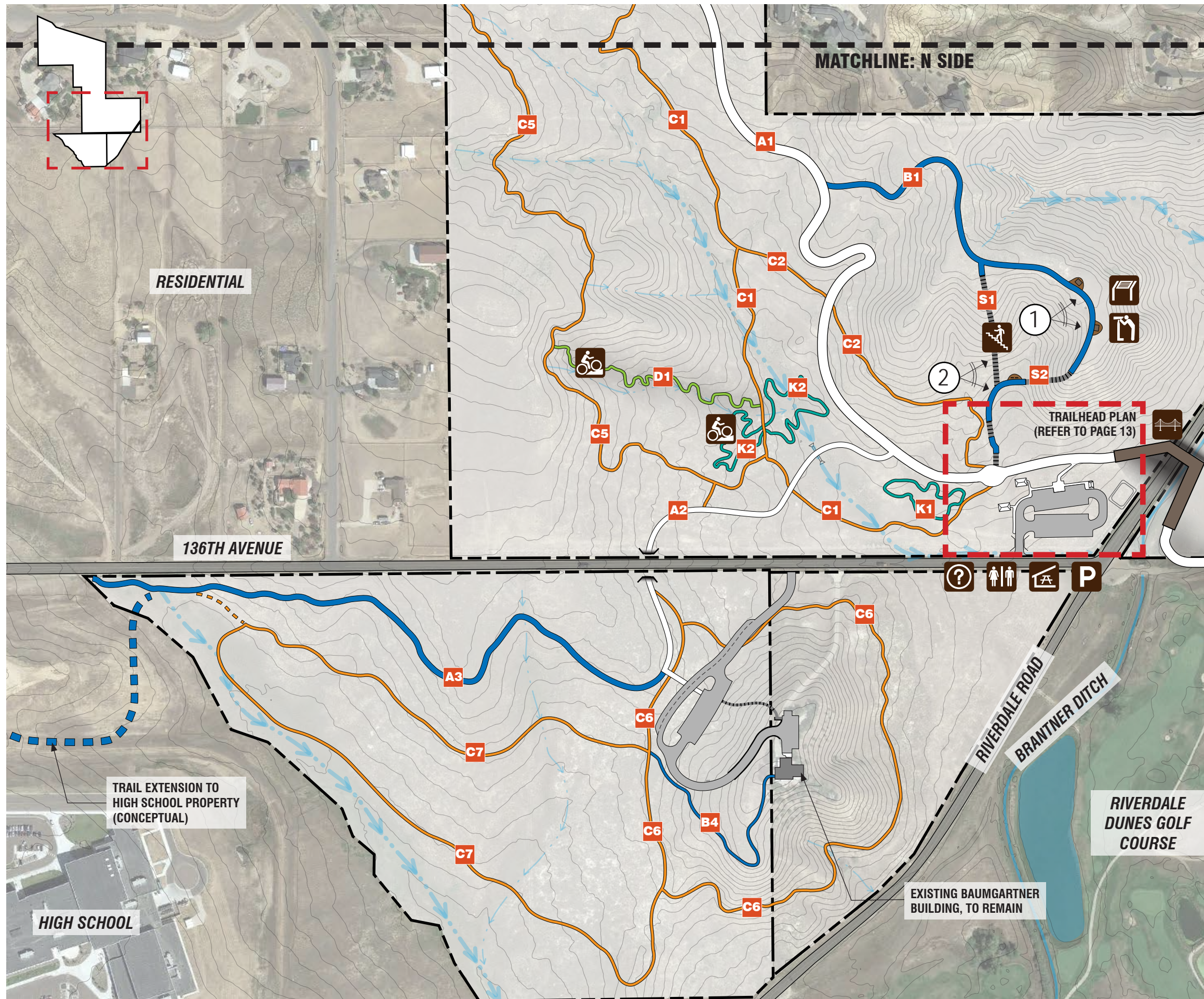
② Stair Climber Trail

DETAILED MASTER PLAN

Map Legend

-  E-470 REGIONAL TRAIL (10' WIDE CONCRETE WITH 4' SOFT SHOULDER)
-  PRIMARY SOFT SURFACE TRAIL (6' TO 10' WIDE CRUSHER FINES)
-  FUTURE SOFT SURFACE TRAIL (CONCEPTUAL)
-  SINGLETRACK TRAIL - MULTI-USE (2' TO 3' WIDE, EARTHEN)
-  SINGLETRACK TRAIL - PEDESTRIAN ONLY (2' TO 3' WIDE, EARTHEN)
-  SINGLETRACK TRAIL - BICYCLE ONLY (2' TO 3' WIDE, EARTHEN)
-  PROPERTY LINE
-  CULVERT
-  DRAINAGE WAY
-  TRAIL SEGMENT DESCRIPTION - SEE PAGES 10 & 11
-  INTERPRETIVE SIGN
-  MOUNTAIN BIKE ONLY TRAIL
-  SCENIC OVERLOOK





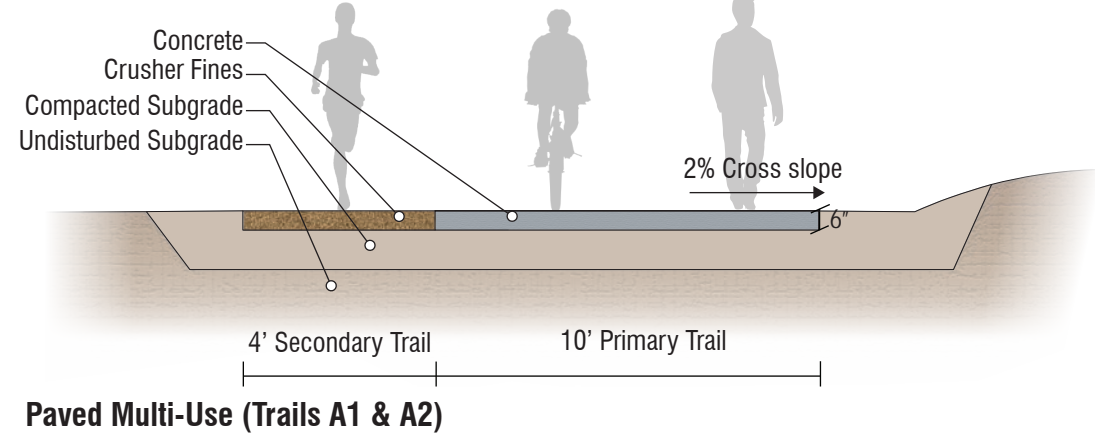
DETAILED MASTER PLAN

Map Legend

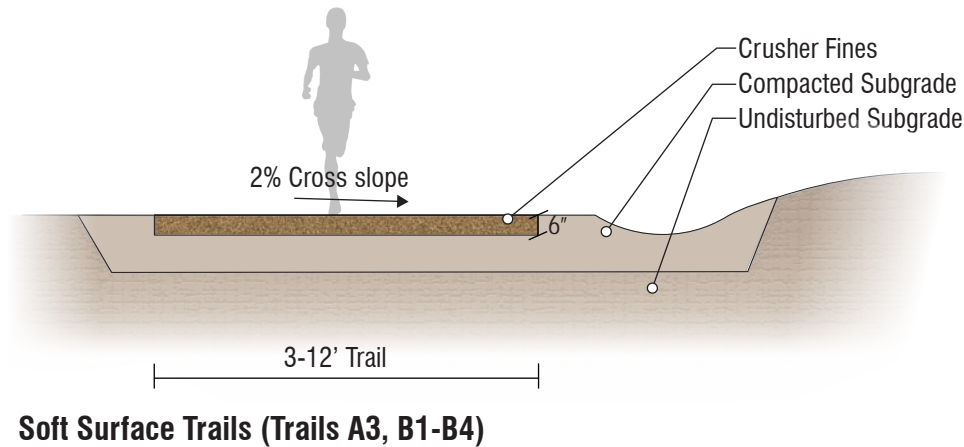
- E-470 REGIONAL TRAIL (10' WIDE CONCRETE WITH 4' SOFT SHOULDER)
- NEIGHBORHOOD CONNECTOR TRAIL
- PRIMARY SOFT SURFACE TRAIL (6' TO 10' WIDE CRUSHER FINES)
- FUTURE SOFT SURFACE TRAIL (CONCEPTUAL)
- STAIR-CLIMBER TRAIL - PEDESTRIAN ONLY (5' TO 6' WIDE, CONCRETE STEPS AND CRUSHER FINES)
- SINGLETRACK TRAIL - MULTI-USE (2' TO 3' WIDE, EARTHEN)
- FUTURE SINGLETRACK TRAIL (CONCEPTUAL)
- SINGLETRACK TRAIL - BICYCLE ONLY (2' TO 3' WIDE, EARTHEN)
- BICYCLE SKILLS LOOP - BICYCLE ONLY (2' TO 3' WIDE, EARTHEN)
- PROPERTY LINE
- CULVERT
- DRAINAGE WAY
- SAND FILTER DRAINAGE INFRASTRUCTURE
- TRAIL SEGMENT DESCRIPTION - SEE PAGES 10 & 11
- PARKING
- PICNIC SHELTER
- RESTROOM
- INFORMATION
- BRIDGE
- INTERPRETIVE SIGN
- STAIRS
- MOUNTAIN BIKE ONLY TRAIL
- SCENIC OVERLOOK
- PERSPECTIVES RENDERINGS - SEE PAGE 7
- TRAILHEAD PLAN EXTENT - SEE PAGE 13



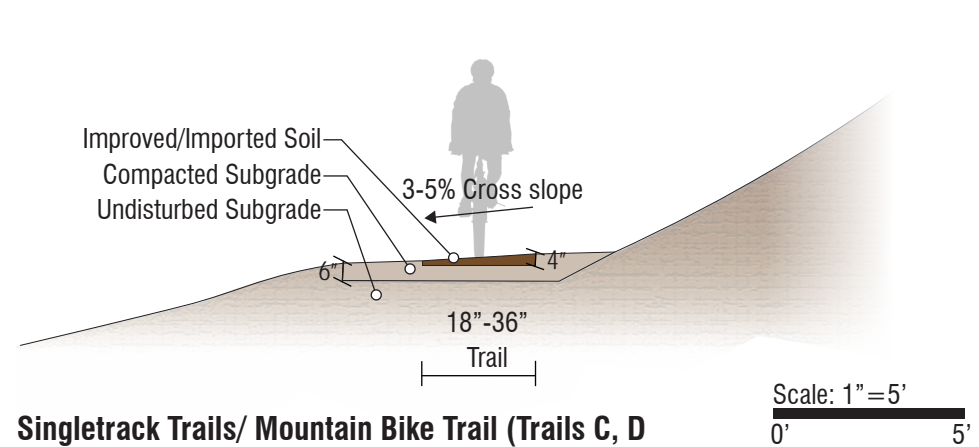
TYPICAL TRAIL SECTIONS: Scale 1"=5'



Paved Multi-Use (Trails A1 & A2)



Soft Surface Trails (Trails A3, B1-B4)



Singletrack Trails/ Mountain Bike Trail (Trails C, D)

TRAIL NARRATIVE: Refer to trail segments on Detailed Master Plan Maps

A1 Trail A1: E-470 Regional Trail

Type: Concrete Paved Multi-Use Trail

Length: 1.5 mile *Width:* 10' wide with 4' crusher fines shoulder

Difficulty: Easy

Purpose: Regional multi-use trail connector; also connects trail loops within the park.

Design + Construction Considerations:

- Requires pedestrian overpass crossing at Riverdale Road;
- Trail to be ADA accessible throughout;
- Wherever possible, trail should meet AASHTO trail standards for design speed, radii, shoulder widths, railings, warning and wayfinding signage etc.;
- Provide culverts to manage drainage across trail;
- Alignment needs to be coordinated with other open space trails for safety and to minimize short-cutting.

A2 Trail A2 + **A3** Trail to 136th Ave / Adjacent Neighborhood

Type: Concrete Paved (A2) / Soft Surface Connection Trail (A3)

Length: 0.7 mile *Width:* 8' wide *Difficulty:* Easy

Purpose: Provides connection from 136th Avenue to Riverdale Bluffs Trailhead. Also creates connection to Riverdale Ridge High School, and Rodger Quist Middle School.

Design + Construction Considerations:

- Will require an underpass crossing of 136th Ave;
- During final design, a detailed evaluation of the flood flows over-topping 136th Avenue will be required to properly design trail crossing over tributary in a manner to not worsen existing conditions for flooding of 136th Avenue during large rain events;
- Provide culverts for drainage flows in minor gullies crossing trail alignment and for managing concentrated cross drainage;
- Trail should be designed to interface/connect with parking lot on the Baumgartner Property;
- Trail to be ADA accessible throughout;
- Wherever possible, trail should meet AASHTO trail standards for design speed, radii, shoulder widths, railings, warning and wayfinding signage etc.;
- Alignment needs to be coordinated with other open space trails for safety and to minimize short-cutting;
- Potential future repaving of crusher fines segment (A3) in concrete if trail receives high traffic from adjacent neighborhoods.

B1 Trail B1: Bluff Access Trail

Type: Soft Surface Trail

Length: .5 mile *Width:* 10'-12' wide *Difficulty:* Easy

Purpose: Provides an easy route to the top of the bluff from the E-470 Trail for pedestrians and bikers. Also provides vehicle access for maintenance and special events. Is an alternative for those who do not want to climb the stair-stepper trails that ascend the southwest side of the bluff from the trailhead, and can also be combined with the stair stepper routes for intensive training (running up stair steps, descending down the trail).

Character: Wide, pedestrian-friendly, soft surface trail to dramatic overlooks. Will likely be one of the most highly-used trails in the open space.

Design + Construction Considerations:

- Trail to be ADA accessible;
- Needs to accommodate maintenance vehicle access
- Signage to instruct bikers to use slow speed may be required.

B2 Trail B2: Sunflower Loop

Type: Soft Surface Trail (with possible adjacent singletrack secondary trail)

Length: 0.5 mile *Width:* 6-8' *Difficulty:* Easy

Purpose: Provides a short and gentle walking loop for casual visitors using the E-470 Trail. Provides access to Trail B3 that climbs up to the northwestern ridge of Riverdale Bluffs, with views to the mountains to the west.

Character: A pleasant, soft surface path wide enough for 2 or 3 people to walk side by side. The loop is situated on a saddle and offers views in many directions, and is named after the many sunflowers that bloom in the native grass areas in the summer. Bicycle use on this trail should be permitted, but managed (open to kids on bikes, but designed to not be an attraction for most mountain bikers). Good location for dispersed seating and interpretive signage along trail. Could potentially be used by bikers instead of adjacent single-track trails during soggy conditions.

Design + Construction Considerations:

- Crusher fines paving (or similar);
- ADA Accessible.

B3 Trail B3: Future Yosemite Entry Trail

Type: Soft Surface Trail

Length: .3 mile *Width:* 6-8' wide *Difficulty:* Easy

Purpose: Provides a short out-and-back from Sunflower Loop (Trail B2) to the northwestern ridge, and future connection to Yosemite Street if/when Yosemite becomes a public street.

Character: A soft surface path wide enough for 2 or 3 people to walk side by side. Bicycle use should be approved, but managed (open to kids on bikes, but designed to not be an attraction for most mountain bikers). Good location for dispersed seating and interpretive signage along trail. Could potentially be used by bikers instead of adjacent single-track trails during soggy conditions.

Design + Construction Considerations:

- Crusher fines paving (or similar);
- ADA accessible trail if possible.

B4 Trail B4: Baumgartner Saddle Trail

Type: Soft Surface Trail

Length: 800 feet *Width:* 3-6' *Difficulty:* Easy to Moderate

Purpose: Provides access from lower south parking to the Baumgartner residence as an alternative to stairs or the driveway. Also provides access from the Baumgartner residence to the Bluffs trail network.

Character: A narrower soft surface path wide enough for 2 people to walk side by side. Excellent views to open space and distant views of downtown Denver to the south and southeast. Intended to be a rustic pedestrian-oriented trail.

Design + Construction Considerations:

- Trail will have about an 8% slope;
- Consider how trail will interface with parking area and natural surface trails. Locate trail to discourage short-cutting to C6;
- Possibly align trail adjacent to driveway as a "soft-sidewalk" to provide secondary access to the Baumgartner residence and reduce exploration of this trail by other trail users;
- Grade exceeds limits of typical "crusher-fine" surface; assess other soil blends for improved durability.

C1 Trail C1: Singletrack Trail

Type: Singletrack – Multi-use

Length: 0.8 mile *Width:* 30-36" *Difficulty:* Easy

Purpose: This serves as the primary natural surface trail to access the rest of the system. Combined with Trail C2, it creates a ~1 mile loop; and with Trail C5, a ~1.4-mile loop, each immediately accessible from the trailhead.

Character: Typical front-country singletrack. Design for multi-use with occasional passing zones. Allow obstacles and protrusions only where cross-slope is sufficient to prevent braiding.

Design + Construction Considerations:

- Careful design will be required to manage user conflicts at intersections and nodes interfacing with the Bike Skills Loops. The southern 1/3 of trail will likely need to be elevated and have puncheons and/or timber-culverts to accommodate runoff from large storms;
- Northern segment of trail parallels walking-oriented Trail B2 (Sunflower Loop) to provide continuous riding experience, and prevent user conflicts. This segment is located on fairly flat terrain, so surfacing material may need to be thicker and more crowned/sloped than usual to adequately drain. Anticipated lift-n-tilt construction with native soil base and all-weather (imported material) top layer;
- Co-locate intersections with Trails B2 and C3 to reduce number of intersections and related wayfinding signage needs.

C2 Trail C2: Singletrack Trail

Type: Singletrack – Multi-use

Length: 0.2 mile *Width:* 24-30" *Difficulty:* Easy

Purpose: Provides a short loop near the trailhead with a true "trail" experience vs the concrete or crusher fine paths.

Character: Typical front-country singletrack. Design for multi-use with occasional passing zones. Allow obstacles and protrusions where cross-slope is sufficient to prevent braiding.

Construction Considerations:

- Careful design will be required to minimize shortcutting at the southeast end.

C3 Trail C3: Singletrack Trail

Type: Singletrack – Multi-use

Length: 1.2 miles *Width:* 18-30" *Difficulty:* Intermediate

Purpose: Creates a north loop, slightly further afield than very casual visitors will reach. Despite overlooking Highway E-470, this trail has the most potential to feel less-developed and slightly more challenging in character. Also provides access and re-access to the Trail D1 (downhill) mountain bike experience.

Character: Typical front-country singletrack. Design for multi-use with occasional passing zones. Allow obstacles and protrusions only where cross-slope is sufficient to prevent braiding. Utilizes topographic undulations to reduce bike speeds and influence viewsheds.

Design + Construction Considerations:

- Locate to utilize cross-slopes for drainage and reducing trail widening. Match curvature to natural flow unless sufficient anchors exist to prevent braiding.

C4 Trail C4: Singletrack Trail

Type: Singletrack – Multi-use

Length: 1.2 miles *Width:* 18-30" *Difficulty:* Intermediate

Purpose: Connects Trail C3 to B3. Provides access to high point overlook at intersection with C3. Also provides access and re-access to the Trail D1 (downhill) mountain bike experience.

Character: Design for multi-use with occasional passing zones. Allow obstacles and protrusions only where cross-slope is sufficient to prevent braiding. Utilizes topographic undulations to reduce bike speeds and influence viewsheds.

Design + Construction Considerations:

- Locate to utilize cross-slopes for drainage and reducing trail widening. Match curvature to natural flow unless sufficient anchors exist to prevent braiding.

C5 Trail C5: Singletrack Trail

Type: Singletrack – Multi-use

Length: .6 mile *Width:* 24-30" *Difficulty:* Easy

Purpose: Combined with Trail C1, this trail creates a ~1.4-mile loop immediately accessible from the trailhead. Paired with trail to the north, it provides a 3+ mile loop.

Character: Typical front-country singletrack. Design for multi-use with occasional passing zones. Allow obstacles and protrusions only where cross-slope is sufficient to prevent braiding. Create enough curvature and undulation to reduce bike speeds.

Construction Considerations:

- The southern portion should be sited to be inconspicuous from the concrete path and use micro-topography to achieve drainage. This trail will need a short spur to the concrete path near the underpass.

C6 Trail C6: Singletrack Trail

Type: Singletrack – Multi-use

Length: .6 mile *Width:* 30-36" *Difficulty:* Easy

Purpose: This serves as the primary natural surface trail on the south side of 136th and is accessible from the Baumgartner residence.

Character: Typical front-country singletrack. Design for multi-use with occasional passing zones. Allow obstacles and protrusions only where cross-slope is sufficient to prevent braiding. Utilize topographical undulations for drainage and to create a rolling character that reduces bicycles speeds.

Design + Construction Considerations:

- Careful design will be required to manage congregation at intersections and nodes interfacing with the southern trailhead and underpass. Sloughing soils may influence tread width.

C7 Trail C7: Singletrack Trail

Type: Singletrack – Multi-use

Length: .7 mile *Width:* 18-24" *Difficulty:* Intermediate

Purpose: This is the western half of the main loop on the south parcel. (Combined with the full Trail C6 it forms a loop of just over 1.3 miles). This trail is readily accessible from the high school making it a likely candidate for short field trips, and training opportunity for high school running or biking teams.

Character: Typical front-country singletrack. Design for multi-use with occasional passing zones. Allow obstacles and protrusions only where cross-slope is sufficient to prevent braiding. Create enough curvature and undulation to reduce bike speeds.

Construction Considerations:

- This loop has 2 crossings of a significant drainage tributary that can have significant flows during rain events. These crossings should be reinforced (or should utilize culverts) to withstand anticipated flood flows;
- Match curvature to natural flow unless sufficient anchors exist to prevent braiding.

C8 Trail C8: Singletrack Trail

Type: Singletrack – Pedestrian Only

Length: 950 feet *Width:* 24-36" *Difficulty:* Moderate

Provides pedestrian only access to the high point at the north end of the property. Would reduce user conflicts for those wishing to climb to the top of the bluff from the B3 trail and future Yosemite Road connection.

Character: A narrower singletrack trail with excellent views to open space and E-470. Intended to be a rustic pedestrian-oriented trail.

Design + Construction Considerations:

- Trail will have about an 6% slope;
- Typical front-country single track.

D1 Trail D1: Difficult Downhill Track

Type: Mountain Bike Optimized (downhill only)

Length: 0.5 mile *Width:* 24-48" *Difficulty:* Intermediate with Difficult options

Purpose: Provide an intermediate-level mountain bike optimized experience where cyclists can improve skills; easily "sessioned" by climbing either lobe of Trail C3. Provides the final descent at the end of a ride where cyclists can enjoy speed/challenge without worrying about conflict with hikers or uphill traveling cyclists.

Character: Bike-optimized front-country singletrack. A flowing, serpentine trail with natural and constructed berms, small to medium earthen jumps, drops up to 24", and gully crossings. Nearly constant OTFs of Intermediate+ to Difficult levels of difficulty; all rollable, no gaps, long transition zones. Introduces the concepts of rollers, pumping, and timing.

Design + Construction Considerations:

- Use the gully to constrain the area, provide drainage, create a rhythm, and visually conceal the trail. Reduce grade and tighten curves near bottom for speed control before intersection;
- Utilize Risk Management tools in design of OTFs;
- Total linear feet of tread may be nearly the double the nominal length in order to provide lots of options and opportunity for

progression;

- Consider a mid-way connection south to C3 for "sessioning" either half of D1.

D2 Trail D2: Intermediate Downhill Track

Type: Mountain Bike Optimized (downhill only)

Length: .25 mile *Width:* 24-48" *Difficulty:* Easy+ with Intermediate+ options

Purpose: Provides a beginner-level mountain bike optimized experience where cyclists can improve skills; easily "sessioned" by climbing the south end of C5. Provides the final descent at the end of a ride where cyclists can enjoy speed/challenge without worrying about conflict with hikers.

Character: Bike-optimized front-country singletrack. A flowing, serpentine trail with natural and constructed berms, small earthen jumps and gully crossings. Several OTFs of no more than Intermediate and Intermediate+ difficulty; all rollable, no gaps, long transition zones.

Design + Construction Considerations:

- Use the gully to constrain the area, provide drainage and create a serpentine rhythm. Reduce grade and tighten curves near bottom for speed control before intersection.

K1 Trail K1: Skills Loop A

Type: Bicycle Skills Loop

Length: .1 mile in ~ .3 acre *Width:* 24-48" *Difficulty:* Novice

Purpose: Provide a facility for young kids and beginner adult riders to learn the basic skills of riding a bicycle on trails. Provides tightly incremental progression to develop foundational balance, coordination, operational familiarity and confidence on a bicycle.

Design + Construction Considerations:

- Look to Skillz Loop at Valmont Bike Park for a sample of skill-building features, orientation, and fall-zones;
- Accessible from main parking area, but buffered for safety and comfort.

K2 Trail K2: Skills Loop B

Type: Bicycle Skills Loop

Length: .4 mile in ~ 1.5 acre *Width:* 24-48" *Difficulty:* Beginner

Purpose: Provide a facility for young kids and beginner adult riders to build upon the basic trail ridings skills developed in Loop A (K1). Create next-level incremental progression of balance, coordination, operational familiarity and confidence on a bicycle. Introduce cornering, line selection, weight shifts, additional texture, momentum skills and playful features.

Design + Construction Considerations:

- Look to Dirt 101 and The Glades at Valmont Bike Park for a sample of skill-building features, orientation, and fall-zones;
- Accessible from C1 and A2, but buffered to not interfere with other visitors.

S2 Trail S1: Stair Stepper Trail

Type: Soft Surface with Stair-Stepper Trail (pedestrian use only)

Length: 360 feet *Width:* 6-8 feet *Difficulty:* Easy - Moderate

Purpose: Provides a direct pedestrian route from main parking area / trailhead to top of bluff. Anticipated to be popular route for visitors who may not be typical open space trail users. Overlook at top of bluff provides exceptional views, interpretive signage, and seating. Stair-steppers up the bluff also provides a unique training experience for visitors who are interested in "incline"-type fitness opportunity. Trail can be "sessioned" with Trail S2, or B1 +C2 to create training loops.

Design + Construction Considerations:

- Recommend stairs be constructed out of precast concrete stair units. (Refer to Stair-Stepper detail and perspective rendering). This is the less-steep of the 2 proposed Stair Stepper routes that will easily accommodate both uphill and downhill pedestrian use;
- Average slope is 4.8%. Need for hand railings is not anticipated, but should be further evaluated during final design.

S2 Trail S2: Stair-Stepper Trail

Type: Soft Surface with Stair-Stepper Trail (pedestrian use only; potential "Uphill Only) circulation designation.

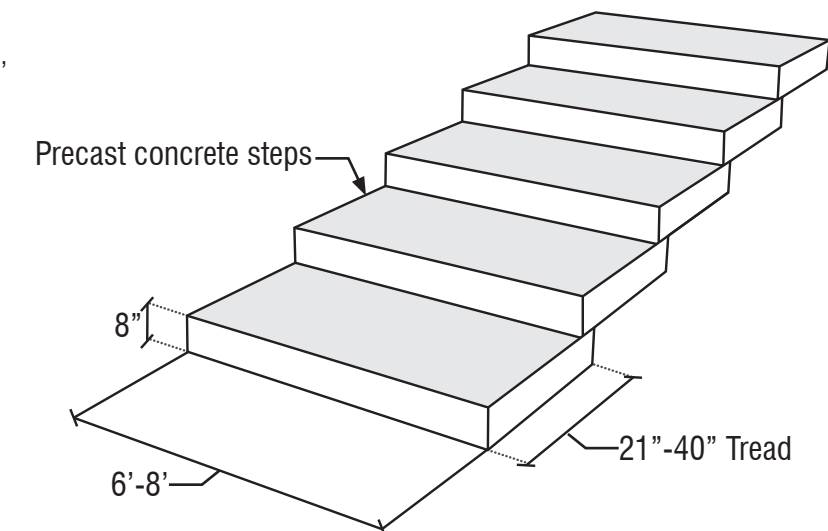
Length: 400 feet *Width:* 6-8 feet *Difficulty:* Moderate

Purpose: Provides a direct pedestrian route from main parking area /trailhead to top of bluff. Anticipated to be popular route for tourists / visitors who may not be typical open space trail users. Stairs up the bluff also provides a unique training experience for visitors who are interested in "incline"-type fitness opportunity. Trail can be "sessioned" with Trail S1, or B1 +C2 to create training loops. Potential designation as "Uphill only" pedestrian route due to steepness of stair-stepper segment.

Design + Construction Considerations:

- Recommend stairs be constructed out of precast concrete stair units. (Refer to Stair-Stepper detail and perspective rendering). This is the steeper of the 2 Stair Stepper routes currently proposed, and may be challenging for downhill use. Maximum slope is 37%. Hand railings will likely be required, especially if downhill use is permitted. Further evaluation of stair location and construction will be required during final design.

Stair Axon for Trails S1 & S2



OPTIONAL TRAIL FEATURES

Optional Trail Features, or OTFs, are natural or man-made obstacles in the trail or alongside the trail that require bike handling skills to ride. OTFs are fun for riders and they provide skill building and progression opportunities. In the case of bridges, rollers, berms and rock armored trail, they can also serve to improve sustainability. They can range from easy to expert level, and are often opportunistic in that they take advantage of existing site elements and characteristics for much of, or part of, their challenge.

Identifying the best feature to develop along a trail route requires intimate knowledge of the terrain, the flow of the trail, and the “clientele,” or user group that will likely be using any particular feature in a particular location. As such, these features cannot be located or assigned during the master planning process, but need to occur during construction document development, or possibly during construction as design-build elements. The OTF images included on this page are to illustrate of the types of features that could be developed by the final designer for the Riverdale Bluffs Open Space.



BANKED TURNS: These exciting and variable features can be built using earth or out of wood.



ROLLOVERS: Fallen logs and boulders along a trail are common natural features, and can also be created in trail segments where they do not tend to naturally occur. These can also be developed in combinations or progressions that increase skill required to successfully negotiate the obstacle.



BOARDWALKS AND LADDER BRIDGES: These features can be functional, i.e., to allow trail users to cross wet areas, but are also popular mountain bike trail features that can be built with varying width, twist and undulation.












DROPS AND JUMPS: These can be drops off of natural features, such as logs or rocks, or built-up elements such as decks, or tables. A jump has a positive take—off angle which sends the rider into the air. A drop has a flat or negative take-off angle so it sends the rider downward. The two require different skill and technique.

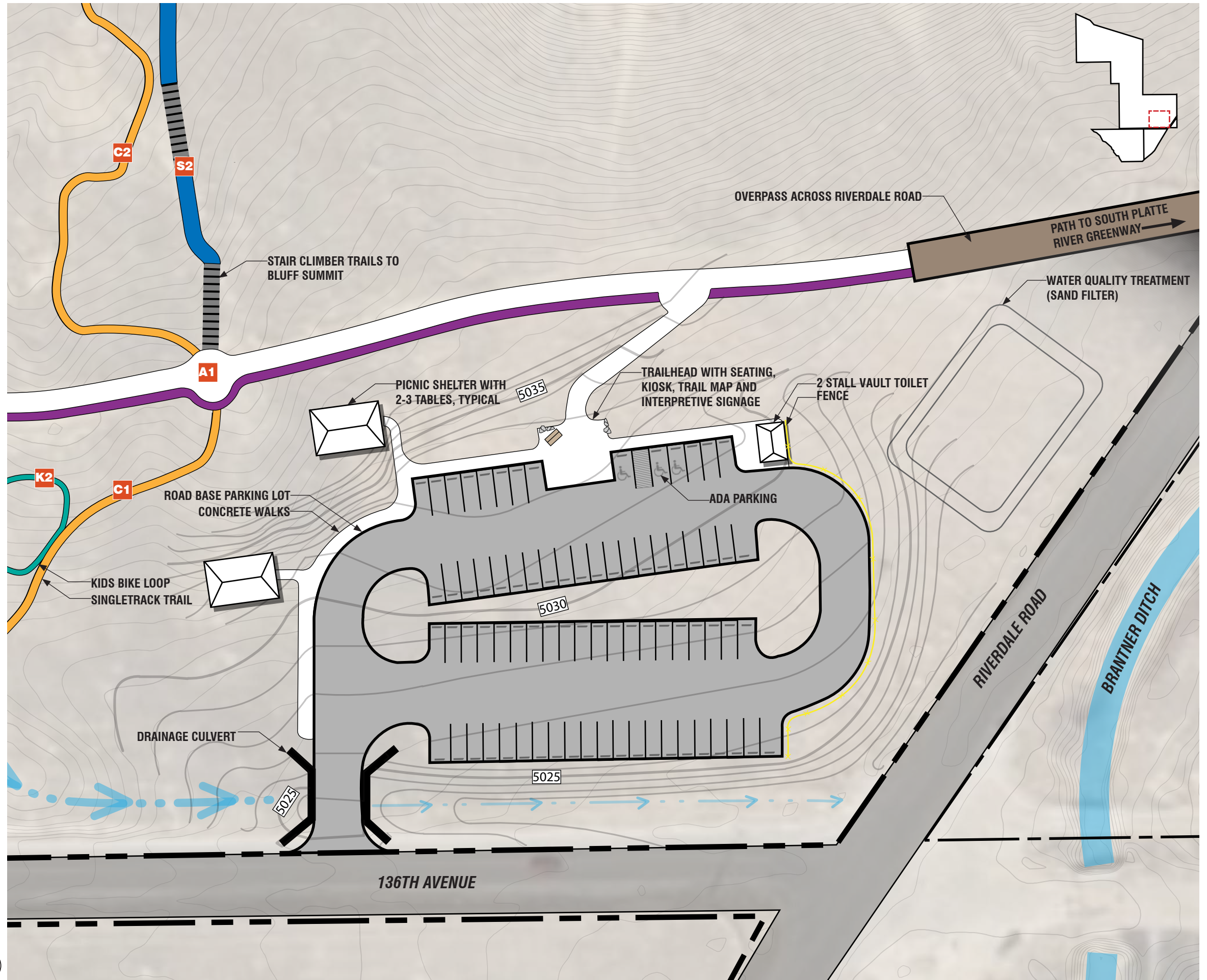


SKINNIES AND LOG RIDES: These elevated and narrow riding surfaces help to develop balance skills. These elements can be built from fallen trees, split logs, milled planks, or dimensional lumber. They can also be straight, curved, or angled.

TRAILHEAD PLAN

Map Legend

-  E-470 REGIONAL TRAIL (10' WIDE CONCRETE WITH 4' SOFT SHOULDER)
-  PRIMARY SOFT SURFACE TRAIL (6' TO 10' WIDE CRUSHER FINES)
-  STAIR-CLIMBER TRAIL - PEDESTRIAN ONLY (5' TO 6' WIDE, CONCRETE STEPS AND CRUSHER FINES)
-  SINGLETRACK TRAIL - MULTI-USE (2' TO 3' WIDE, EARTHEN)
-  BICYCLE SKILLS LOOP - BICYCLE ONLY (2' TO 3' WIDE, EARTHEN)
-  DRAINAGE WAY
-  CONTOUR ELEVATION
-  TRAIL SEGMENT DESCRIPTION - SEE PAGES 10 & 11
-  PROPERTY LINE



Appendix

Project Process	i
Natural Resources Inventory	ii
Site Tour	v
Drainage Report	vi



PROJECT PROCESS

Involvement of Adams County Staff and Stakeholders

To understand existing conditions and stakeholder's concerns at the Bluffs, the consultant team conducted several information-gathering meetings and site visits with County representatives and key stakeholders. The first tier of stakeholders/interested parties engaged was staff with Adams County Open Space. Meetings were held on-site with the planning/design team and management team representatives. Staff members were able to provide clear objectives for the project and discuss feasibility of objectives with the design team. The consultant team then engage the public through public meetings and visitor survey (summary of meetings and survey results below). This public involvement strategy allowed each stakeholder group provided insight on their respective concerns and desires for the site.

1st Public Meeting

The consultant team worked with Adams County to develop an informative, virtual public meeting presentation (COVID-19 protocols required the meeting to be held virtually). The goal of the 1st meeting was to present initial site findings, from the consultants site visits and meetings with County staff, and gather stakeholder input on potential master plan improvement opportunities for the Bluffs. We presented on the background of the site and surrounding landscape, provided analysis of ecological features, and created a site tour, with viewsheds and drone imagery, to acquaint stakeholders with existing site features and proximity to other recreational amenities. The attendees were encouraged to participate in the Q&A portion of the presentation where they could engage with representatives from the design team and County officials. Meeting attendees were also given the opportunity to provide their input through an online survey.

Visitor Survey #1

The consultant team designed a brief visitor survey to collect feedback on what site improvements could be made, and what visitors would like to see at the Bluffs property. Over 50 people completed the survey, providing the consultant team with insight into the stakeholder's concerns, and desires for the project area. The results from this survey helped inform the next phase of the master planning process.

Visitor Survey Results

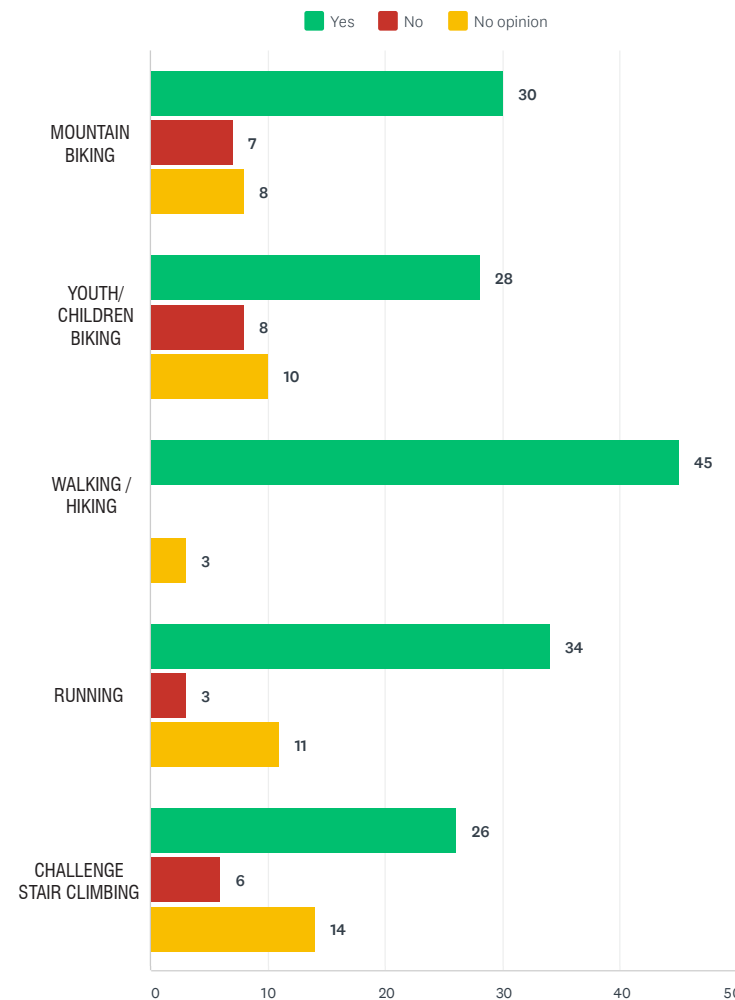
Walking/hiking, running and biking were the most popular activities respondents wished to see at the Bluffs.

The following design elements would be viewed as a **positive improvement** by the majority of visitors:

- Adding small picnic areas rather than large, more intruding picnic area/structure;
- Providing more educational/interpretive signage & art;
- Ensure the natural prairie landscape and wildlife are protected.

The biggest concern with the development of the property is **security** for the users onsite and the surrounding neighborhoods.

Survey Results Summary



Development of Master Plan Alternatives

After the 1st Public meeting and receiving feedback from the visitor survey, the design team assessed the trail alignments, bluffs access across the site and opportunities to build upon regional connections. Through collaboration with stakeholders and other government & quasi-government agencies, the team developed options for the E-470 trail alignment, regional trail connectors and connections to local schools. The team also coordinated with the City of Thornton to investigate a functional pedestrian connection between Quebec and the South Platte River Greenway.

2nd Public Meeting

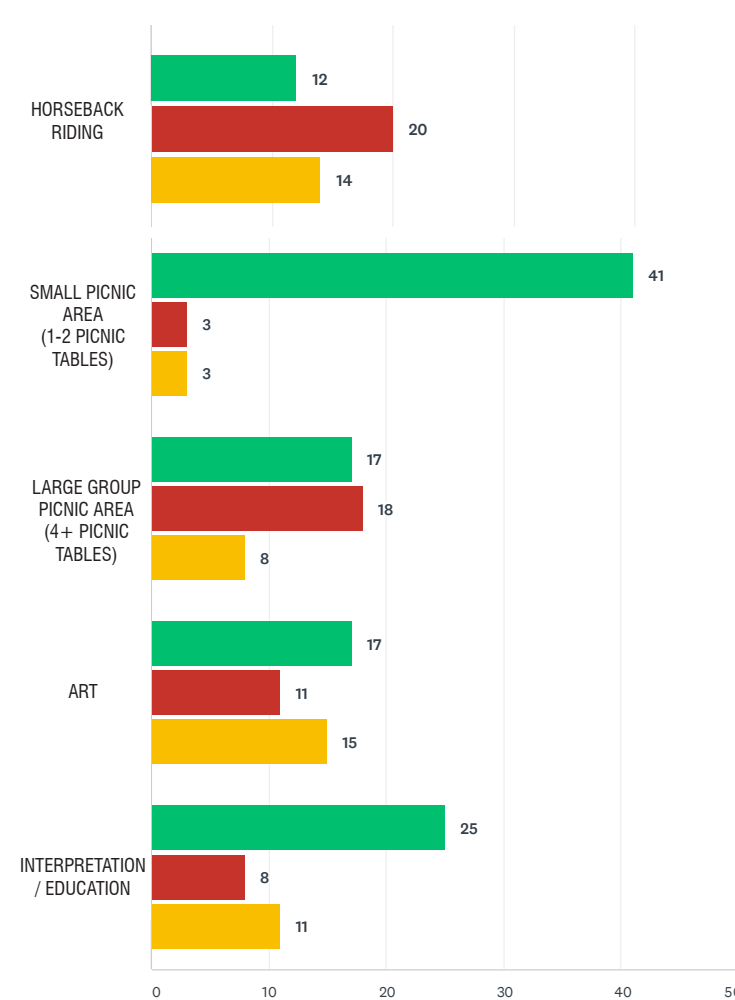
The goal of the 2nd public meeting was to present master plan options for the Bluffs to the public. The meeting included a recap of the existing site conditions, site constraints, shared survey findings from the first public meeting. The consultants then shared recommendations for improvements in the area including trail alignments, visitor amenities and overall vision plan for the site. After the meeting, attendees were encouraged to provide their feedback on the master plan development through a link provided.

Second Public Meeting Comments

Overall, responses to the master plan components were positive. Most respondents commented wanting equestrian trails and access onsite.

Master Plan Refinement

After both public meetings, the consultant team refined the master plan to create a comprehensive plan that meets the needs of stakeholders, creates a safe and multifunctional recreation experience and protects the natural resources onsite.



October 8, 2020

TO: Paul Thomas, Stream Landscape Architecture
FROM: Marie Russo, ERO Resources Corporation
RE: Riverdale Bluffs Vegetation Assessment

Introduction

On September 15, 2020, ERO Resources Corporation (ERO) conducted a vegetation assessment, including noxious weeds identification, of the Riverdale Bluffs Open Space project area (2020 assessment) (Figure 1, project area). Riverdale Bluffs Open Space is an Adam County Open Space property and is roughly bounded by E-470 to the north, Riverdale Road to the east and south, and Yosemite Street to the west. The methods and results of the 2020 assessment are described below.

Methods

The 2020 assessment included visually assessing different vegetation communities and searching for noxious weed species listed on the Colorado Noxious Weed List (Colorado Department of Agriculture 2020). The vegetation communities and populations of noxious weeds found during the 2020 assessment were mapped on aerial photographs, as shown on Figure 2.

Results

Vegetation communities identified at Riverdale Bluffs Open Space include shortgrass prairie, mixed grassland, degraded grassland, and wetland/riparian.

Shortgrass Prairie

Species that were observed within the shortgrass prairie vegetation community included blue grama (*Bouteloua gracilis*), buffalo grass (*Bouteloua dactyloides*), cheatgrass (*Bromus tectorum*), common sunflower (*Helianthus annuus*), soapweed yucca (*Yucca cf. glauca*), and prickly pear cactus (*Opuntia species*).

Mixed Grassland

Species that were observed within the mixed grassland vegetation community included blue grama, buffalo grass, cheatgrass, soapweed yucca, sand dropseed (*Sporobolus cryptandrus*), ring muhly (*Muhlenbergia torreyi*), squirreltail (*Elymus elymoides*), slimflower scurfpea (*Psoralidium tenuiflorum*), purple prairie clover (*Dalea purpurea*), hairy false goldenaster (*Heterotheca villosa*), field bindweed (*Convolvulus arvensis*), common sunflower, prickly pear

cactus, burningbush (*Bassia scoparia*), prickly Russian thistle (*Salsola tragus*), winterfat (*Krascheninnikovia lanata*), yellow rabbitbrush (*Chrysothamnus viscidiflorus*), and sand sagebrush (*Artemisia cf. filifolia*).

Degraded Grassland

The degraded grassland vegetation community was comprised of species such as sand dropseed, cheatgrass, common sunflower, field bindweed, hairy false goldenaster, burningbush, prickly Russian thistle, and crested wheatgrass (*Agropyron cristatum*).

Riparian/Wetland

The wetland/riparian vegetation community was comprised of species such as witchgrass (*Panicum capillare*), foxtail barley (*Hordeum jubatum*), western wheatgrass (*Pascopyrum smithii*), smooth brome (*Bromus inermis*), barnyardgrass (*Echinochloa crus-galli*), broadleaf cattail (*Typha latifolia*), and devil's beggartick (*Bidens frondosa*).

Noxious Weeds

The entire property contains cheatgrass (List C species). Additional noxious weeds observed include common mullein (*Verbascum thapsus*, List C species), Scotch thistle (*Onopordum acanthium*, List B species), and field bindweed (*Convolvulus arvensis*, List C species).

In addition to the vegetation communities, two active prairie dog colonies were observed in the southern portion of the project area.

References

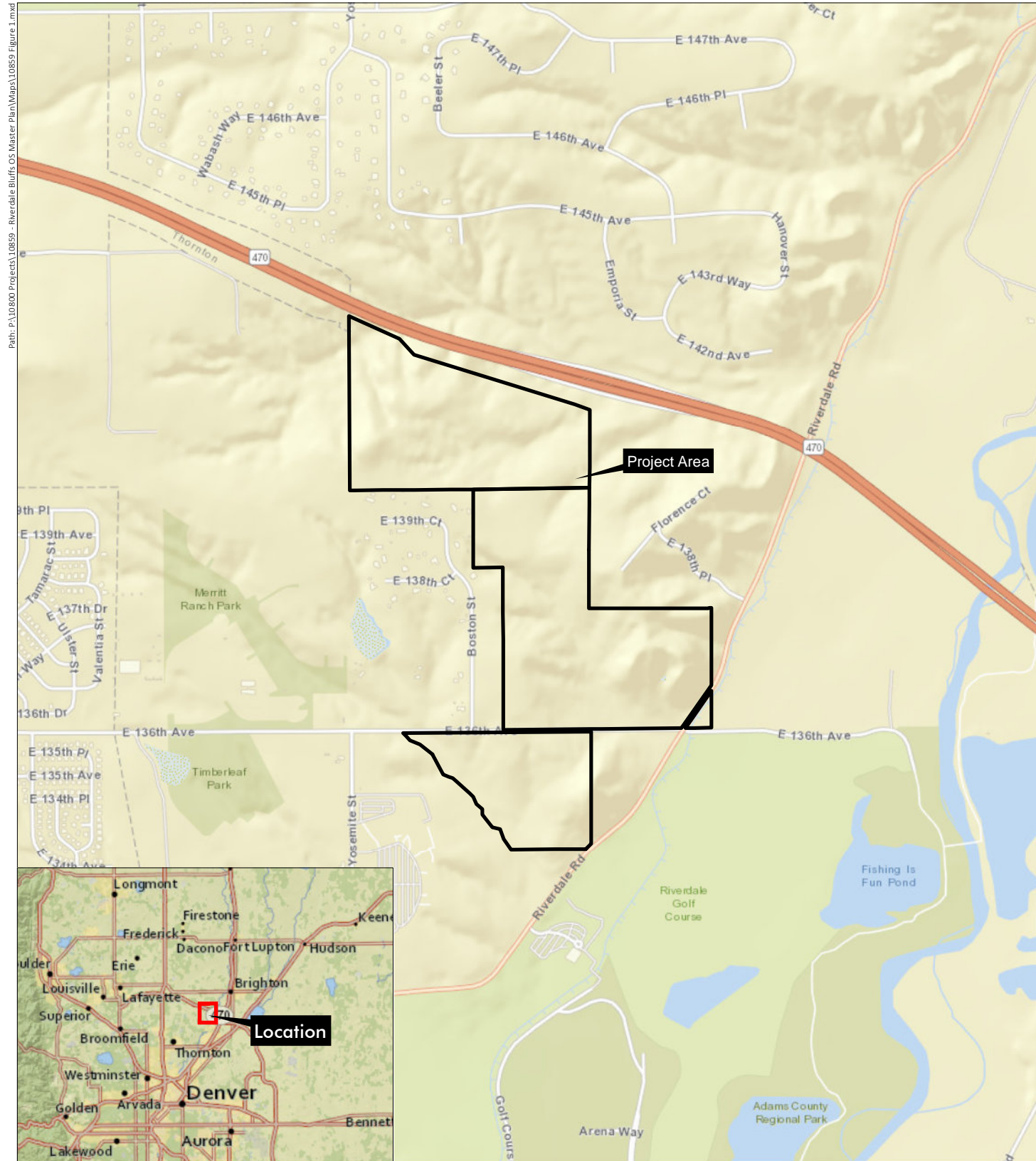
Colorado Department of Agriculture. 2020. Colorado Noxious Weeds (including Watch List), effective June 20, 2020. Available at: <https://www.colorado.gov/pacific/agconservation/noxious-weed-species>. Last accessed: September 20, 2020.

Attachments: Figures 1 and 2

Denver
1842 Clarkson St.
Denver, CO 80218
303.830.1188

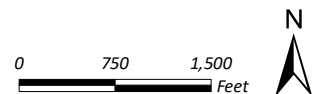
Durango
1015 ½ Main Avenue
Durango, CO 81301
970.422.2136

Hotchkiss
P.O. Box 932
161 South 2nd St.
Hotchkiss, CO 81419
970.872.3020



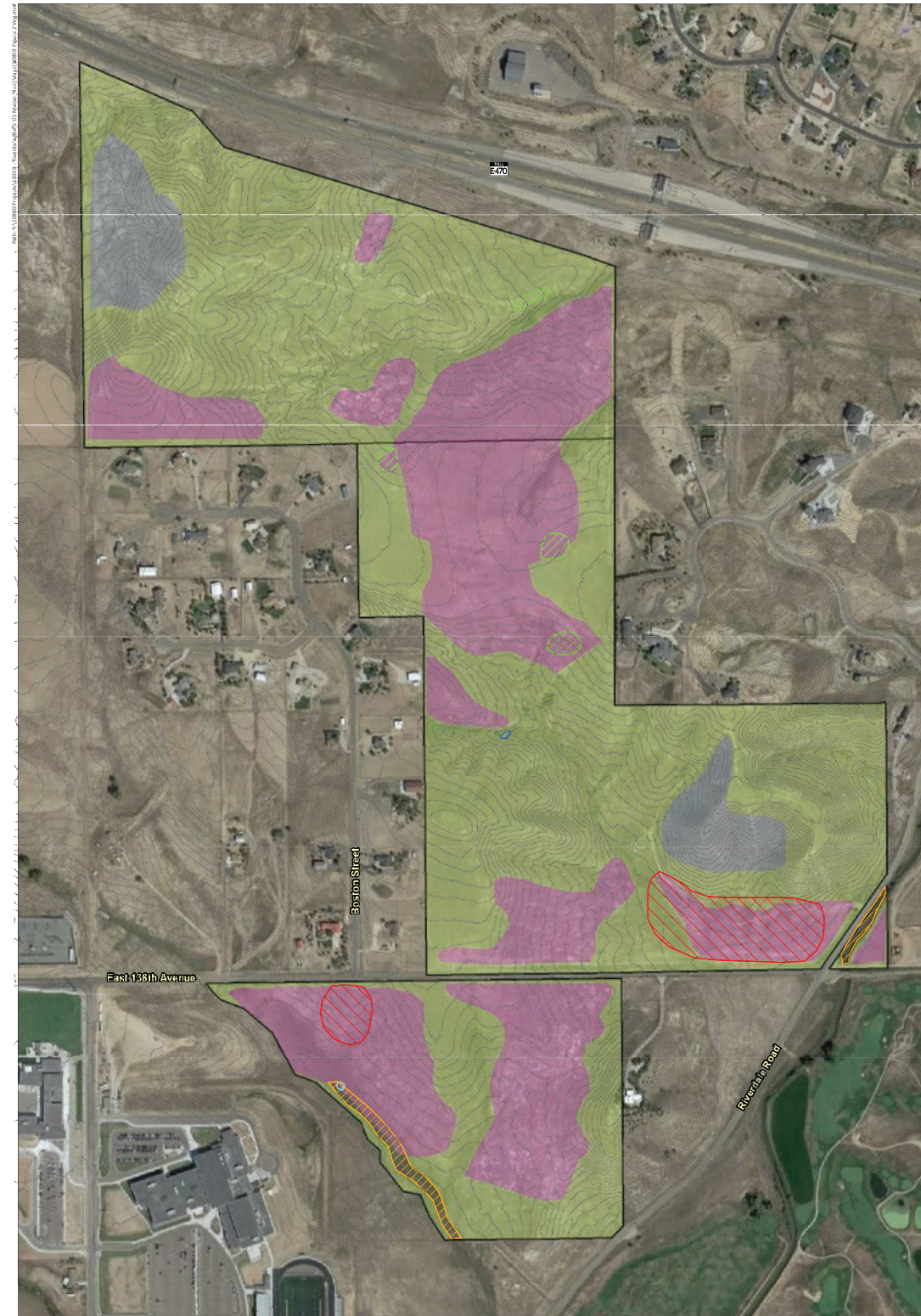
Riverdale Bluffs Open Space Master Plan

Sections 22 and 27, T1S, R67W; 6th PM
 UTM NAD 83: Zone 13N; 510660mE, 4421800mN
 Longitude 104.875220°W, Latitude 39.946257°N
 USGS Eastlake, CO Quadrangle
 Adams County, Colorado



**Figure 1
Vicinity Map**

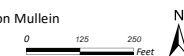
Prepared for: Adams County
 File: 10859 Figure 1.mxd (GS)
 October 5, 2020



Riverdale Bluffs Open Space Master Plan

- Degraded Grassland
- Wetland/Riparian
- Common Mullein
- Mixed Grassland
- Prairie Dog Colony
- Field Bindweed
- Shortgrass Prairie
- Adams County Parcel
- Scotch Thistle and Common Mullein

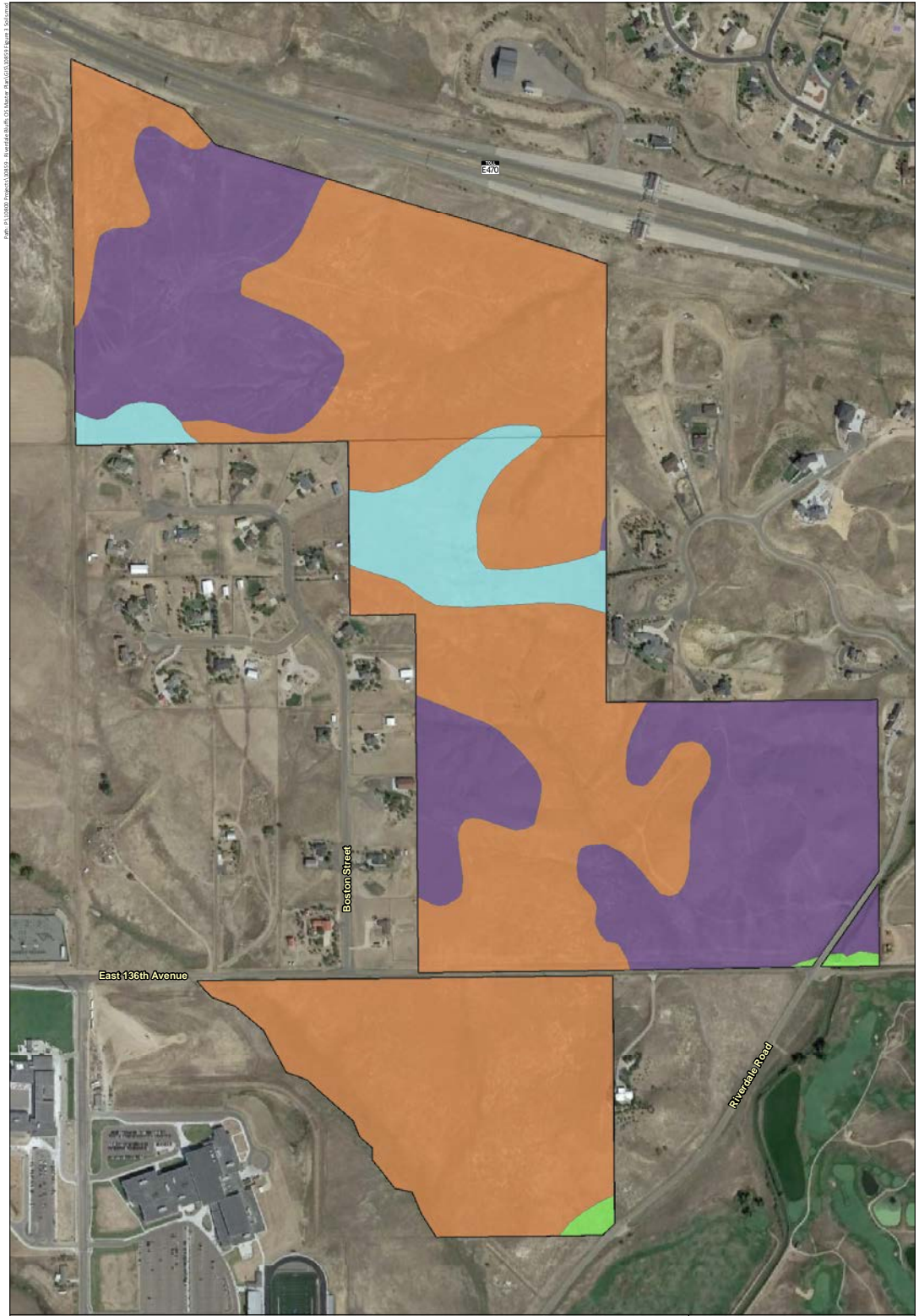
Image Source: Google Earth®, September 2019



**Figure 2
Vegetation Communities**

Prepared for: Adams County
 File: 10859 Figure 2 Veg.mxd (GS)
 October 5, 2020





Riverdale Bluffs Open Space Master Plan		Figure 3 Soils
Adams County Parcel	Samsil-Shingle complex, 3 to 35 percent slopes	
Gravelly land-Shale outcrop complex	Ulm loam, 3 to 5 percent slopes	Prepared for: Adams County File: 10859 Figure 3 Soils.mxd (G5) October 5, 2020
Nunn clay loam, 1 to 3 percent slopes		

Image Source: Google Earth®, September 2019

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ERO
ERO Resources Corp.

SITE TOUR



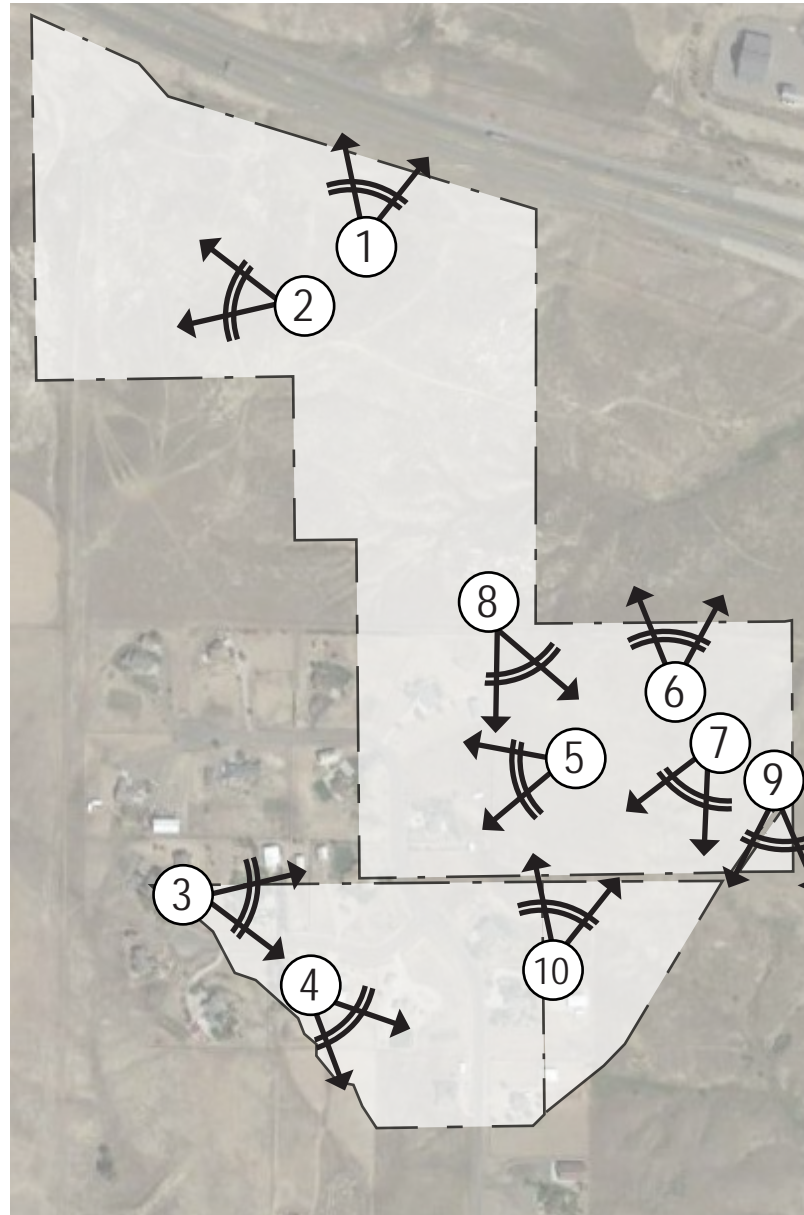
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MEMO

- Overnight
- Regular Mail
- Hand Delivery
- Other: _____

To:	Paul Thomas, PLA and Annie Morgan Stream Landscape Architecture
From:	Amy Gabor, PE, CFM and Michelle Danaher PE, CFM
RE:	Riverdale Bluffs Preliminary Drainage and Access Memo
Date:	January 17, 2022
Project #:	020-1801

Introduction

The purpose of this memorandum is to summarize the conceptual drainage design for the proposed Riverdale Bluffs parking lot and trail system located northwest of Riverdale Road and 136th Avenue in Adams County, Colorado. The proposed development for the site includes creating a trail system including hard and soft surface trails, connecting to the regional E-470 trail system. A parking lot will be constructed for the park, with access from 136th Avenue.

Parking Lot Water Quality and Detention

A sand filter was conceptually sized to provide water quality and detention for the proposed parking lot, per the Urban Storm Drainage Criteria Manual: Volume 3. The tributary impervious area to the proposed Sediment Control Measure (SCM) is 1.13 acres and the parking lot is wholly within hydrologic soil group A, based on the NRCS Web Soil Survey maps. A map of the hydrologic soil groups is attached. The site characteristics generally support permeable pavement, bioretention, sand filter, or regional water quality treatment as options, which can be explored more in final design. A full infiltration sand filter was chosen for the conceptual design because the site appears to potentially support infiltration, inflows are relatively small, with a peak flow of 4 cubic feet per second (cfs) in the 100-year event, and it may be a more cost-effective option compared to other alternatives. In final design, a geotechnical investigation will be required to verify infiltration rates and that the bedrock and ground water levels are greater than 5-feet deep.

The required detention volume is 0.22 acre-feet. A 3-foot deep sand filter with 4:1 side slopes (horizontal: vertical), which includes 1-foot of freeboard, would be constructed east of the proposed parking lot. The basin was sized for the full impervious area of the parking lot. Based on access from 136th Avenue, all of the flow will likely not be able to be conveyed to the sand filter. Efforts should be made in final design to convey as much water as possible from the parking lot to the sand filter. Conceptual calculations are attached.

Trail Culverts

The Colorado Urban Hydrograph Procedure (CUHP) was used to analyze a representative basin to size trail crossings for the 10-year storm event. The 10-year peak is approximately 5 cfs. Where the regional trail crosses local drainages, 18-inch reinforced concrete pipes (RCPs) with flared end sections and inlet trash racks, as required by criteria, would be installed. 18-inch RCPs are the minimum recommended size for culvert crossings. Seven of these smaller crossings were identified in the conceptual design along proposed concrete trail.

The concrete trail will also cross the South Platte River Northern Tributary 7, south of 136th Avenue. The South Platte River Northern Tributary 7 is currently a Zone A floodplain. This designation could change when the draft Flood Hazard Area Delineation (FHAD) that is being completed by Olsson is ultimately submitted to FEMA in the future. The *Brantner Gulch and Tributaries Draft Major Drainageway Plan* prepared by Olsson in April 2020 (Draft MDP) shows a total future land use peak flow of 154 cfs in the 10-year storm event at Design Point S106T, just south of 136th Avenue. A 6-foot wide by 4-foot high reinforced concrete box culvert (RCBC) was conceptually sized to convey the 10-year flows under the trail. In existing conditions, 136th Avenue overtops. During final design, the floodplain impacts of the improvements should be evaluated to ensure that the overtopping condition on 136th Avenue is not adversely impacted by the proposed infrastructure.

The single track and soft trail crossings will require some level of protection at the concentrated flow crossings to prevent washouts and additional maintenance needs. These crossings could be in the form of culvert crossings, or a hardened surface with scour protection, depending on the level of protection desired. Hardened crossings at the drainage level could cause trail hazards, such as wet trails, or ice, to form more frequently. The recommendation is that the paths generally stay above a 10-year water surface elevation adjacent to the drainages.

Detailed capacity calculations will be completed for each crossing with final design. A pipe capacity calculation is attached.

Access Road Culvert and Channel Improvements

A natural drainage flows through the site toward the parking lot. The Draft MDP shows this approximate tributary area represented by Subbasin S04, with a 100-year peak flow of 92 cfs at Design Point S104. The existing drainage overtops Riverdale Road and 136th Avenue and are ill-defined east of Riverdale Road.

The drainage flows would be routed around the parking lot with minor grading improvements on the west side of the parking lot. Stormwater flows would then be routed under the access road in four 24-inch RCPs sized for the 100-year event of 92 cfs. Minor grading improvements are proposed to be completed to keep the flows east of the access road out of the parking lot, and then tie into existing conditions, allowing flows to overtop 136th Avenue and Riverdale Road. To convey the 100-year flows of 92 cfs, a 6-foot wide, 2.8-foot-deep channel with 4:1 side slopes and a 0.3% longitudinal slope would be required. Additional depth would be required for freeboard.

To eliminate overtopping of Riverdale Road and 136th Avenue, drainage improvements would be needed downstream of Riverdale Road as well as completing channel improvements upstream of Riverdale Road to prevent overtopping. Improvements to cross the Brantner Ditch would also be required. An alternative that could be considered in final design would be to install a box culvert and fill in the bottom of the culvert to support future improvements at Riverdale Road. An 8-foot wide by 2-foot high RCBC would provide adequate capacity for the interim park conditions. If, and when, a culvert is installed to convey flows across Riverdale Road, a channel could be constructed, and the bottom of the culvert would be opened so additional infrastructure at the access road would not be required.

Vehicular Access Considerations

The parking lot to the Riverdale Bluffs property is planned to have vehicular access from 136th Avenue at a new access point located approximately 250 feet west of Riverdale Road. This section of the memorandum summarizes the requirements related to the location and configuration of the access and any additional improvements that may be needed for the planned driveway.

This section of 136th Avenue is not classified in any street map of Adams County, so it is assumed to be considered a rural highway. It is a two-lane road with a posted speed of 35 mph and no turn (auxiliary) lanes near the proposed site. The Adams County access standards are generally aligned with the State Highway Access Code which would result in a R-B classification. This is a rural highway with moderate to high speeds and low volumes. In this scenario full-movement access is appropriate to a parcel if appropriate spacing from other access points or intersections and sight distance can be achieved.

Spacing on a R-B highway shall be at the sight distance for the roadway, which is 250 feet based on the posted speed of 35 mph. As final design is completed, this distance should be maintained (measure between the ends of curb returns).

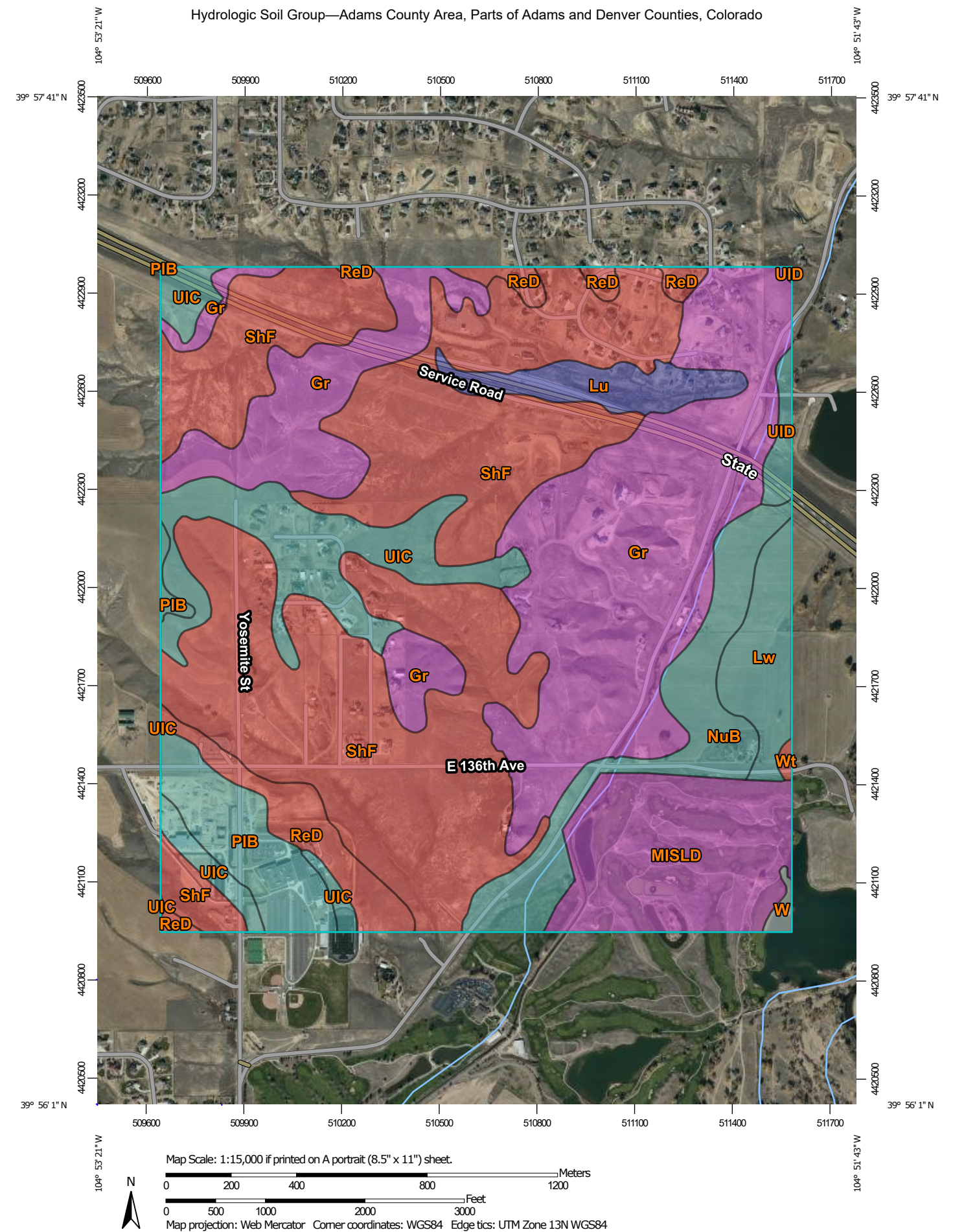
Speed change or auxiliary lanes are required for left turn lanes when the turning volume is greater than 25 vehicles per day (vph) and for right turn lanes when the volume is greater than 50 vph. Based on the proposed size of the park (225 acres) and rates found in the ITE Trip Generation Manual for a Public Park (LUC 411), it would be expected that a typical weekday peak hour would attract approximately 22 inbound trips and the typical weekend peak would attract inbound 35 trips. Depending on the distribution of those trips, from the east or the west, it is possible that the left-turning inbound traffic would exceed the 25 vph threshold. There is an exception for the turn lane requirement for when the adjacent thru volume is less than 150 vph. Additionally, it is possible that another parking lot would be constructed in the future when the full traffic volume generation is being produced which could further dissipate turning traffic. All this discussion is to say that as the site plan is finalized it may be appropriate to verify the need for auxiliary lanes with a detailed impact analysis. Further coordination with Adams County should be performed to determine if this is required.

References

- Olsson, Inc. April 2020. *Brantner Gulch and Tributaries Draft Major Drainageway Plan.*
- Urban Drainage and Flood Control District. November 2010. *Urban Storm Drainage Criteria Manual: Volume 3, Best Management Practices*
- US Department of Agriculture, Natural Resources Conservation Service. January 2022. *Hydrologic Soil Group for Adams County Area, Parts of Adams and Denver Counties, Colorado.*


Attachments

- Hydrologic Soils Group Map
- MHFD Detention Calculations – Sand Filter
- Culvert Capacity Calculations
- Channel Calculations








Hydrologic Soil Group

MAP LEGEND

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

Soils

Soil Rating Polygons





-  A
-  A/D
-  B
-  B/D
-  C
-  C/D
-  D
-  Not rated or not available

Soil Rating Lines


-  A
-  A/D
-  B
-  B/D
-  C
-  C/D
-  D
-  Not rated or not available

Soil Rating Points






-  A
-  A/D
-  B
-  B/D

-  C
-  C/D
-  D
-  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 1:20,000.

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: Adams County Area, Parts of Adams and Denver Counties, Colorado
 Survey Area Data: Version 18, Aug 31, 2021

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

Date(s) aerial images were photographed: Oct 3, 2018—Dec 4, 2018

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 symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Gr	Gravelly land-Shale outcrop complex	A	259.0	26.5%
Lu	Loamy alluvial land	B	23.9	2.4%
Lw	Loamy alluvial land, moderately wet	C	27.4	2.8%
MISLD	Gravel pits	A	78.5	8.0%
NuB	Nunn clay loam, 1 to 3 percent slopes	C	55.0	5.6%
PIB	Platner loam, 0 to 3 percent slopes	C	36.8	3.8%
ReD	Renohill loam, 3 to 9 percent slopes	D	34.8	3.6%
ShF	Samsil-Shingle complex, 3 to 35 percent slopes	D	376.2	38.5%
UIC	Ulm loam, 3 to 5 percent slopes	C	76.0	7.8%
UID	Ulm loam, 5 to 9 percent slopes	C	7.0	0.7%
W	Water		2.2	0.2%
Wt	Wet alluvial land	D	1.1	0.1%
Totals for Area of Interest			977.9	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

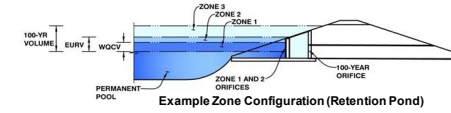
Tie-break Rule: Higher

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: Riverdale Bluffs Master Plan (020-18010)

Basin ID: Proposed Parking Lot Detention



Watershed Information

Selected BMP Type =	SF	
Watershed Area =	1.13	acres
Watershed Length =	400	ft
Watershed Length to Centroid =	200	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	100.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Group C/D =	0.0%	percent
Target WQCV Drain Time =	12.0	hours
Location for 1-hr Rainfall Depths =	Thornton - Chic. Center	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.038	acre-feet
Zone 2 Volume (100-year - Zone 1) =	0.180	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.218	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft ³
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H _{total}) =	2.00	ft
Depth of Trickle Channel (H _{tc}) =	N/A	ft
Slope of Trickle Channel (S _{tc}) =	N/A	ft/ft
Slopes of Main Basin Sides (S _{main}) =	4	H:V
Basin Length-to-Width Ratio (R _{LW}) =	2	

Initial Surcharge Area (A _{ISV}) =	0	ft ²
Surcharge Volume Length (L _{ISV}) =	0.0	ft
Surcharge Volume Width (W _{ISV}) =	0.0	ft
Depth of Basin Floor (H _{f1(0.00)}) =	0.00	ft
Length of Basin Floor (L _{f1(0.00)}) =	85.4	ft
Width of Basin Floor (W _{f1(0.00)}) =	42.7	ft
Area of Basin Floor (A _{f1(0.00)}) =	3,645	ft ²
Volume of Basin Floor (V _{f1(0.00)}) =	0	ft ³
Depth of Main Basin (H _{main}) =	2.00	ft
Length of Main Basin (L _{main}) =	101.4	ft
Width of Main Basin (W _{main}) =	58.7	ft
Area of Main Basin (A _{main}) =	5,950	ft ²
Volume of Main Basin (V _{main}) =	9,502	ft ³
Calculated Total Basin Volume (V _{total}) =	0.218	acre-feet

Optional User Overrides

0.83	inches
1.11	inches
1.38	inches
1.79	inches
2.15	inches
2.54	inches
3.58	inches

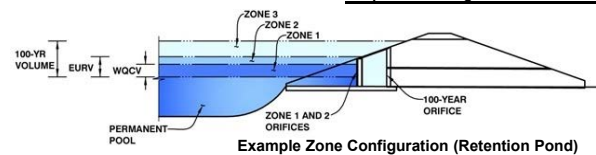
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft ²)	Optional Override Area (ft ²)	Area (acre)	Volume (ft ³)	Volume (ac-ft)
Media Surface	0.00		85.4	42.7	3,645		0.084		
Zone 1 (WQCV)	0.43		88.8	46.1	4,098		0.094	1,664	0.038
	0.50		89.4	46.7	4,174		0.096	1,953	0.045
	1.00		93.4	50.7	4,734		0.109	4,179	0.096
	1.50		97.4	54.7	5,326		0.122	6,693	0.154
Zone 2 (100-year)	2.00		101.4	58.7	5,950		0.137	9,510	0.218
	2.50		105.4	62.7	6,607		0.152	12,648	0.290
	3.00		109.4	66.7	7,295		0.167	16,122	0.370
	3.50		113.4	70.7	8,015		0.184	19,949	0.458
	4.00		117.4	74.7	8,768		0.201	24,143	0.554
	4.50		121.4	78.7	9,552		0.219	28,722	0.659
	5.00		125.4	82.7	10,368		0.238	33,700	0.774
	5.50		129.4	86.7	11,217		0.257	39,095	0.898
	6.00		133.4	90.7	12,097		0.278	44,922	1.031
	6.50		137.4	94.7	13,009		0.299	51,197	1.175
	7.00		141.4	98.7	13,953		0.320	57,937	1.330
	7.50		145.4	102.7	14,930		0.343	65,156	1.496
	8.00		149.4	106.7	15,938		0.366	72,872	1.673
	8.50		153.4	110.7	16,978		0.390	81,100	1.862
	9.00		157.4	114.7	18,051		0.414	89,856	2.063
	9.50		161.4	118.7	19,155		0.440	99,156	2.276
	10.00		165.4	122.7	20,291		0.466	109,016	2.503
	10.50		169.4	126.7	21,460		0.493	119,452	2.742
	11.00		173.4	130.7	22,660		0.520	130,481	2.995
	11.50		177.4	134.7	23,892		0.548	142,117	3.263
	12.00		181.4	138.7	25,157		0.578	154,378	3.544
	12.50		185.4	142.7	26,453		0.607	167,279	3.840
	13.00		189.4	146.7	27,781		0.638	180,836	4.151
	13.50		193.4	150.7	29,141		0.669	195,066	4.478
	14.00		197.4	154.7	30,534		0.701	209,983	4.821
	14.50		201.4	158.7	31,958		0.734	225,605	5.179
	15.00		205.4	162.7	33,414		0.767	241,947	5.554
	15.50		209.4	166.7	34,903		0.801	259,025	5.946
	16.00		213.4	170.7	36,423		0.836	276,855	6.356
	16.50		217.4	174.7	37,975		0.872	295,453	6.783
	17.00		221.4	178.7	39,560		0.908	314,835	7.228
	17.50		225.4	182.7	41,176		0.945	335,018	7.691
	18.00		229.4	186.7	42,824		0.983	356,016	8.173
	18.50		233.4	190.7	44,504		1.022	377,847	8.674
	19.00		237.4	194.7	46,217		1.061	400,526	9.195
	19.50		241.4	198.7	47,961		1.101	424,069	9.735
	20.00		245.4	202.7	49,737		1.142	448,493	10.296
	20.50		249.4	206.7	51,546		1.183	473,812	10.877
	21.00		253.4	210.7	53,386		1.226	500,044	11.479
	21.50		257.4	214.7	55,258		1.269	527,203	12.103
	22.00		261.4	218.7	57,163		1.312	555,307	12.748
	22.50		265.4	222.7	59,099		1.357	584,371	13.415
	23.00		269.4	226.7	61,067		1.402	614,411	14.105
	23.50		273.4	230.7	63,068		1.448	645,444	14.817
	24.00		277.4	234.7	65,100		1.494	677,484	15.553
	24.50		281.4	238.7	67,164		1.542	710,549	16.312
	25.00		285.4	242.7	69,260		1.590	744,654	17.095
	25.50		289.4	246.7	71,389		1.639	779,815	17.902
	26.00		293.4	250.7	73,549		1.688	816,048	18.734
	26.50		297.4	254.7	75,741		1.739	853,369	19.591
	27.00		301.4	258.7	77,966		1.790	891,794	20.473
	27.50		305.4	262.7	80,222		1.842	931,340	21.381
	28.00		309.4	266.7	82,510		1.894	972,022	22.315
	28.50		313.4	270.7	84,831		1.947	1,013,856	23.275
	29.00		317.4	274.7	87,183		2.001	1,056,858	24.262
	29.50		321.4	278.7	89,567		2.056	1,101,044	25.276
	30.00		325.4	282.7	91,983		2.112	1,146,430	26.318

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Riverdale Bluffs Master Plan (020-18010)**

Basin ID: **Proposed Parking Lot Detention**



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.43	0.038	Filtration Media
Zone 2 (100-year)	2.00	0.180	
Zone 3			
Total (all zones)		0.218	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth = ft (distance below the filtration media surface)
 Underdrain Orifice Diameter = inches

Calculated Parameters for Underdrain
 Underdrain Orifice Area = ft²
 Underdrain Orifice Centroid = feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice = ft (relative to basin bottom at Stage = 0 ft)
 Depth at top of Zone using Orifice Plate = ft (relative to basin bottom at Stage = 0 ft)
 Orifice Plate: Orifice Vertical Spacing = inches
 Orifice Plate: Orifice Area per Row = inches

Calculated Parameters for Plate
 WO Orifice Area per Row = ft²
 Elliptical Half-Width = feet
 Elliptical Slot Centroid = feet
 Elliptical Slot Area = ft²

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (optional)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Orifice Area (sq. inches)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Orifice Area (sq. inches)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice = ft (relative to basin bottom at Stage = 0 ft)
 Depth at top of Zone using Vertical Orifice = ft (relative to basin bottom at Stage = 0 ft)
 Vertical Orifice Diameter = inches

Calculated Parameters for Vertical Orifice
 Vertical Orifice Area = ft²
 Vertical Orifice Centroid = feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe))

Overflow Weir Front Edge Height, H_o = ft (relative to basin bottom at Stage = 0 ft)
 Overflow Weir Front Edge Length = feet
 Overflow Weir Grate Slope = H:V
 Horiz. Length of Weir Sides = feet
 Overflow Grate Type =
 Debris Clogging % = %

Calculated Parameters for Overflow Weir
 Height of Grate Upper Edge, H_i = feet
 Overflow Weir Slope Length = feet
 Grate Open Area / 100-yr Orifice Area =
 Overflow Grate Open Area w/o Debris = ft²
 Overflow Grate Open Area w/ Debris = ft²

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

Depth to Invert of Outlet Pipe = ft (distance below basin bottom at Stage = 0 ft)
 Circular Orifice Diameter = inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate
 Outlet Orifice Area = ft²
 Outlet Orifice Centroid = feet
 Half-Central Angle of Restrictor Plate on Pipe = radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage = ft (relative to basin bottom at Stage = 0 ft)
 Spillway Crest Length = feet
 Spillway End Slopes = H:V
 Freeboard above Max Water Surface = feet

Calculated Parameters for Spillway
 Spillway Design Flow Depth = feet
 Stage at Top of Freeboard = feet
 Basin Area at Top of Freeboard = acres
 Basin Volume at Top of Freeboard = acre-ft

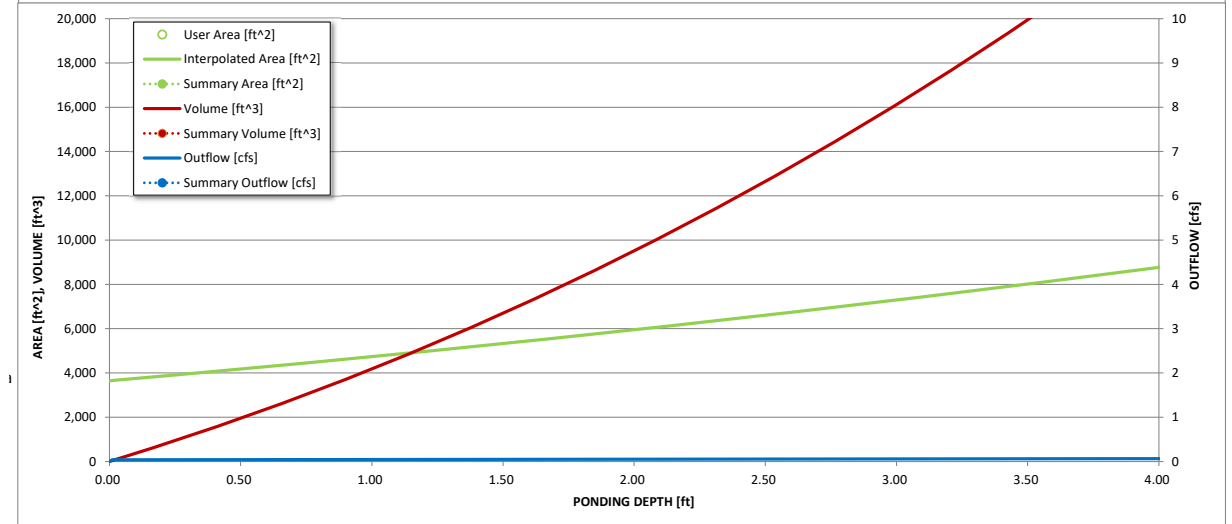
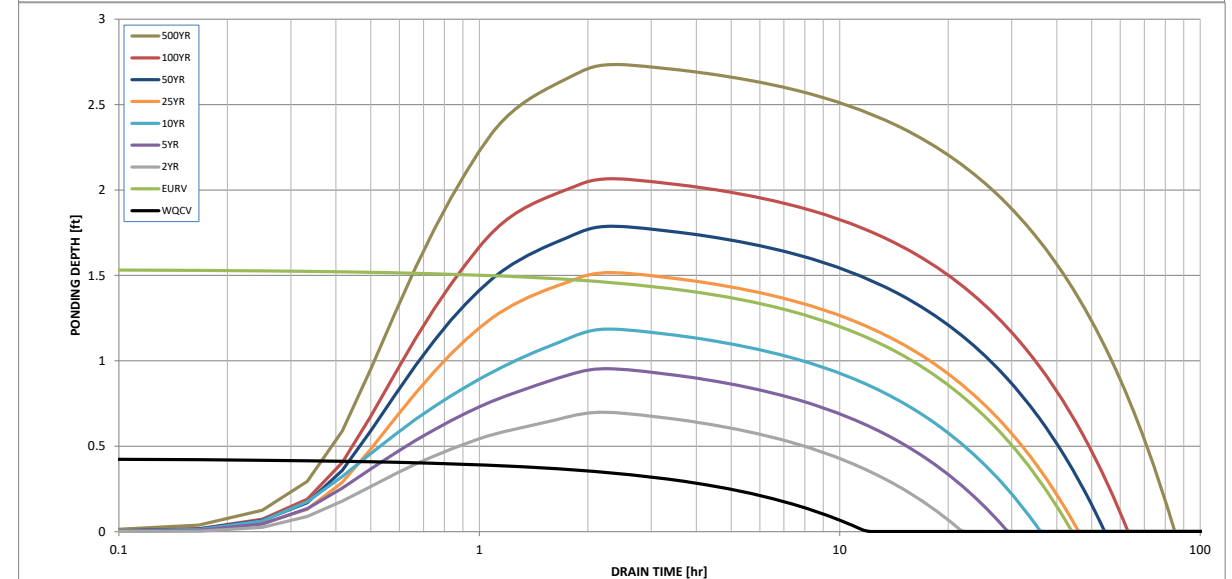
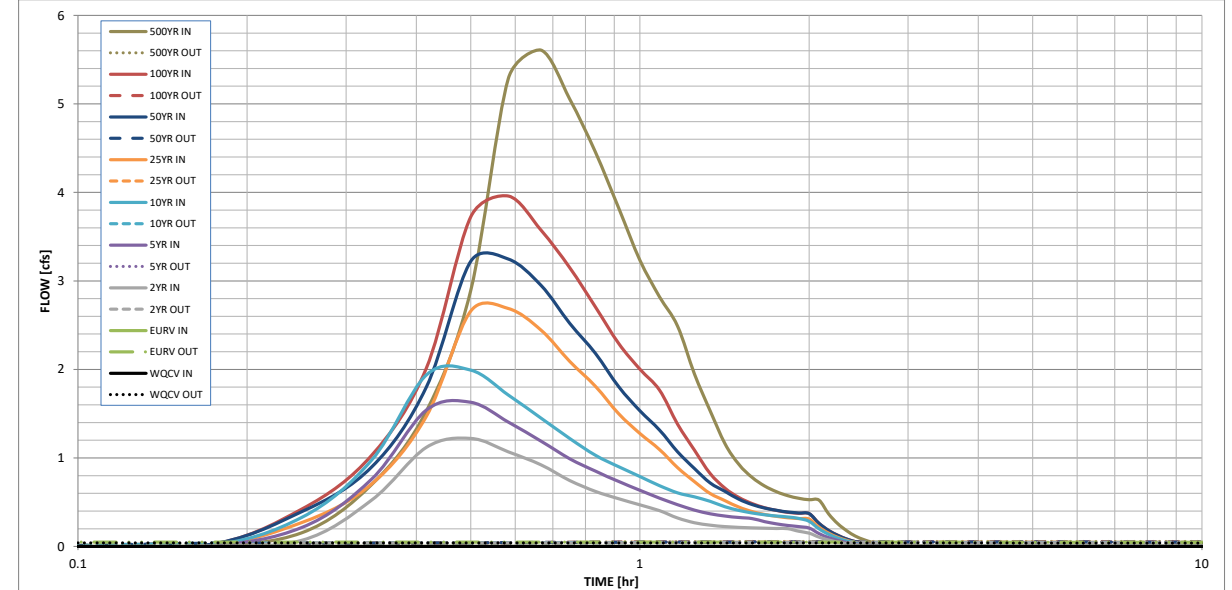
Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period									
One-Hour Rainfall Depth (in)	N/A	N/A	0.83	1.11	1.38	1.79	2.15	2.54	3.58
CUHP Runoff Volume (acre-ft)	0.038	0.158	0.072	0.099	0.125	0.164	0.199	0.237	0.337
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	0.072	0.099	0.125	0.164	0.199	0.237	0.337
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	0.0	0.0	0.0	0.0	0.3	0.6	1.4
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.00	0.00	0.01	0.03	0.25	0.53	1.25
Peak Inflow Q (cfs)	N/A	N/A	1.2	1.6	2.0	2.7	3.2	4.0	5.6
Peak Outflow Q (cfs)	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	10.8	4.6	1.3	0.2	0.1	0.0
Structure Controlling Flow	Filtration Media	Filtration Media	Filtration Media	Filtration Media	Filtration Media	Filtration Media	Filtration Media	Filtration Media	Filtration Media
Max Velocity through Grate 1 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours)	12	43	21	28	35	44	52	61	82
Time to Drain 99% of Inflow Volume (hours)	12	44	22	29	36	46	54	62	84
Maximum Ponding Depth (ft)	0.43	1.54	0.70	0.95	1.19	1.52	1.79	2.07	2.73
Area at Maximum Ponding Depth (acres)	0.09	0.12	0.10	0.11	0.11	0.12	0.13	0.14	0.16
Maximum Volume Stored (acre-ft)	0.038	0.159	0.064	0.091	0.116	0.155	0.189	0.227	0.326

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)



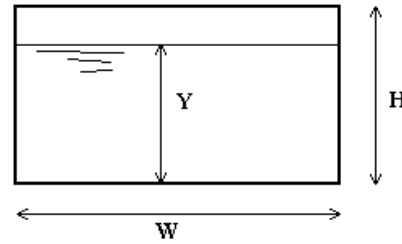
S-A-V-D Chart Axis Override

	X-axis	Left Y-Axis	Right Y-Axis
minimum bound	<input type="text"/>	<input type="text"/>	<input type="text"/>
maximum bound	<input type="text"/>	<input type="text"/>	<input type="text"/>

BOX CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Riverdale Bluffs Master Plan (020-18010)
 Box ID: SPR North Trib 7 Proposed Culvert



Design Information (Input)	
Box conduit invert slope	So = 0.0200 ft/ft
Box Manning's n-value	n = 0.0150
Box Width	W = 6.00 ft
Box Height	H = 4.00 ft
Design discharge	Q = 154.00 cfs
Full-flow capacity (Calculated)	
Full-flow area	Af = 24.00 sq ft
Full-flow wetted perimeter	Pf = 20.00 ft
Full-flow capacity	Qf = 380.72 cfs
Calculations of Normal Flow Condition	
Normal flow depth (<H)	Yn = 1.72 ft
Flow area	An = 10.33 sq ft
Wetted perimeter	Pn = 9.44 ft
Flow velocity	Vn = 14.91 fps
Discharge	Qn = 154.00 cfs
Percent of Full Flow	Flow = 40.4% of full flow
Normal Depth Froude Number	Fr _n = 2.00 supercritical
Calculation of Critical Flow Condition	
Critical flow depth	Yc = 2.74 ft
Critical flow area	Ac = 16.41 sq ft
Critical flow velocity	Vc = 9.38 fps
Critical Depth Froude Number	Fr _c = 1.00

Channel Calculations

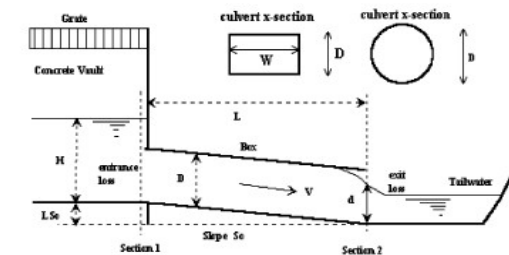
Description	100-Year	Design Flow	Depth	Slope	Left Side Slope	Right Side Slope	Bottom Width	Manning's n	Capacity	Velocity
	(cfs)	(cfs)	(ft)	(ft/ft)	(H:1)	(H:1)	(ft)		(cfs)	(fps)
Channel - S104	92.00	92.00	2.8	0.003	4	4	6	0.06	91.67	1.90

$$Q = VA = \left(\frac{1.49}{n} \right) AR^{\frac{2}{3}} \sqrt{S}$$

CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Riverdale Bluffs Master Plan (020-18010)
 ID: SPR North Trib 7 Proposed Culvert



Design Information (Input):

Circular Culvert: Barrel Diameter in Inches D = inches
 Inlet Edge Type (Choose from pull-down list)

OR:

Box Culvert: Barrel Height (Rise) in Feet H (Rise) = 4.00 ft
 Barrel Width (Span) in Feet W (Span) = 6.00 ft
 Inlet Edge Type (Choose from pull-down list) Square Edge w/ 90 deg. Headwall & 15 deg. Flared Wingwall

Number of Barrels # Barrels = 1
 Inlet Elevation at Culvert Invert Elev IN = 5065 ft
 Outlet Elevation OR Slope So = 0.02 ft/ft
 Culvert Length L = 16 ft
 Manning's Roughness n = 0.015
 Bend Loss Coefficient K_b = 0
 Exit Loss Coefficient K_e = 1

Design Information (calculated):

Entrance Loss Coefficient K_e = 0.20
 Friction Loss Coefficient K_f = 0.08
 Sum of All Loss Coefficients K_Σ = 1.28
 Minimum Energy Condition Coefficient KE_{low} = 0.3658
 Orifice Inlet Condition Coefficient C_d = 0.58

Calculations of Culvert Capacity (output):

Backwater calculations required to obtain Outlet Control Flowrate when H_{Wo} < 0.75 * Culvert Rise

Headwater Surface Elevation (ft)	Tailwater Surface Elevation (ft)	Inlet Control Equation Used	Inlet Control Flowrate (cfs)	Outlet Control Flowrate (cfs)	Controlling Culvert Flowrate (cfs)	Flow Control Used
5066.00		Min. Energy. Eqn.	15.61	#N/A	#N/A	#N/A
5067.00		Min. Energy. Eqn.	44.12	#N/A	#N/A	#N/A
5068.00		Regression Eqn.	81.81	96.27	81.81	INLET
5069.00		Regression Eqn.	124.94	161.92	124.94	INLET
5069.80	5065.68	Regression Eqn.	159.07	205.66	159.07	INLET
5070.00		Regression Eqn.	167.21	215.71	167.21	INLET

Processing Time: 78.13 ms



MASTER PLAN COST OPINION FOR:

Adams County - Riverdale Bluffs

Master Plan

August 12, 2022

TOTAL \$8,064,295.64
 SUBTOTAL (NO CONTINGENCY) \$6,360,571.21
 CONTINGENCY \$1,703,724.43

Description	Bid Quant.	Unit	Unit Price	Total Cost
BASE BID				
TRAILHEAD AREA				\$1,211,659.86
30% Contingency	1	LS	\$ 255,984.48	\$255,984.48
Mobilization, Survey, & Erosion Control	1	LS	\$ 102,393.79	\$102,393.79
Clearing & Grubbing	97,097	SF	\$ 0.07	\$6,796.79
Earthwork	2,600	CY	\$ 22.00	\$57,200.00
Parking Lot, Subgrade Prep + Road Base Paving	33,115	SF	\$ 4.00	\$132,460.00
Concrete Paving	7,020	SF	\$ 12.00	\$84,240.00
Picnic Areas	2	EA	\$ 51,000.00	\$102,000.00
Double Vault Toilet	1	LS	\$ 95,000.00	\$95,000.00
Trailhead Kiosk	1	EA	\$ 20,000.00	\$20,000.00
Gateway Signage	1	EA	\$ 20,000.00	\$20,000.00
Park ID Signage	3	EA	\$ 14,000.00	\$42,000.00
Benches	3	EA	\$ 2,000.00	\$6,000.00
Site Boulders	8	EA	\$ 650.00	\$5,200.00
Electrical + Site Lighting at Parking Lot	2	EA	\$ 12,500.00	\$25,000.00
Entry Road Drainage Culverts & Headwall	1	LS	\$ 89,700.00	\$89,700.00
Drainage Improvements + Water Quality	1	LS	\$ 144,900.00	\$144,900.00
Seeding, Soil Prep and Fine Grading	56,962	SF	\$ 0.40	\$22,784.80
TRAIL SYSTEM (excluding E-470 trail)				\$2,450,966.30
30% Contingency	1	LS	\$ 517,809.78	\$517,809.78
Mobilization, Survey, & Erosion Control	1	LS	\$ 207,123.91	\$207,123.91
Clearing & Grubbing	307,892	SF	\$ 0.07	\$21,552.44
Earthwork	5,702	CY	\$ 18.00	\$102,630.67
Concrete Paving (Baumgartner Connector)	13,500	SF	\$ 12.00	\$162,000.00
136th Underpass	1	LS	\$ 299,000.00	\$299,000.00
136th Connector Trail Channel Crossing	1	LS	\$ 79,580.00	\$79,580.00
Stair Climber, S1 (Steps Only)	105	EA	\$ 350.00	\$36,750.00
Stair Climber, S2 (Steps Only)	98	EA	\$ 350.00	\$34,300.00
Crusher Fines Trail--6 Feet Wide	5,280	SF	\$ 4.50	\$23,760.00
Crusher Fines Trail--8 Feet Wide	59,216	SF	\$ 4.50	\$266,472.00
Crusher Fines Trail--10 Feet Wide	15,785	SF	\$ 4.50	\$71,032.50
Kids Bike Loop A + B	1	LS	\$ 49,920.00	\$49,920.00
Singletrack Trail	27,186	SF	\$ 12.00	\$326,232.00
Singletrack Trail, Features	1	LS	\$ 62,500.00	\$62,500.00
Downhill Singletrack Trail	4,303	SF	\$ 14.00	\$60,242.00
Shade Kiosk at Overlooks	2	EA	\$ 20,000.00	\$40,000.00
Boulder Seating at Overlooks	7	EA	\$ 650.00	\$4,550.00
Interpretive Signs	8	EA	\$ 2,500.00	\$20,000.00
Trail Map Signs	3	EA	\$ 1,200.00	\$3,600.00
Trail ID Signage	33	EA	\$ 300.00	\$9,900.00
Seeding, Soil Prep, and Fine Grading	115,580	SF	\$ 0.45	\$52,011.00
E-470 TRAIL				\$4,401,669.48
30% Contingency	1	LS	\$ 929,930.17	\$929,930.17
Mobilization, Survey, & Erosion Control	1	LS	\$ 371,972.07	\$371,972.07
Clearing & Grubbing	391,132	SF	\$ 0.07	\$27,379.24
Earthwork - Trail East side of Riverdale	1,786	CY	\$ 14.00	\$25,004.00
Earthwork - Trail West side of Riverdale	13,644	CY	\$ 18.00	\$245,592.00
Riverdale Rd Pedestrian Overpass	1	LS	\$ 920,000.00	\$920,000.00
Concrete Paving - Trail in Riverdale Bluffs	86,680	SF	\$ 12.00	\$1,040,160.00
Crusher Fines Shoulder	34,672	SF	\$ 4.50	\$156,024.00
Concrete Paving - Trail East of Riverdale	32,140	SF	\$ 12.00	\$385,680.00
Trail Drainage (Culverts, etc)	1	LS	\$96,495.00	\$96,495.00
Drainage Crossings: 18-inch RCP	112	LF	\$ 150.00	\$16,800.00
Drainage Crossings: 18 inch FES and Toewall	14	EA	\$ 2,875.00	\$40,250.00
Drainage Crossings: 18 inch FES and Trashrack	14	EA	\$ 2,300.00	\$32,200.00
Drainage Crossings: Riprap Outlet Protection	9	EA	\$ 805.00	\$7,245.00
Seeding, Soil Prep, and Fine Grading	237,640	SF	\$ 0.45	\$106,938.00
TOTAL				\$8,064,295.64
SUBTOTAL (NO CONTINGENCY)				\$6,360,571.21

