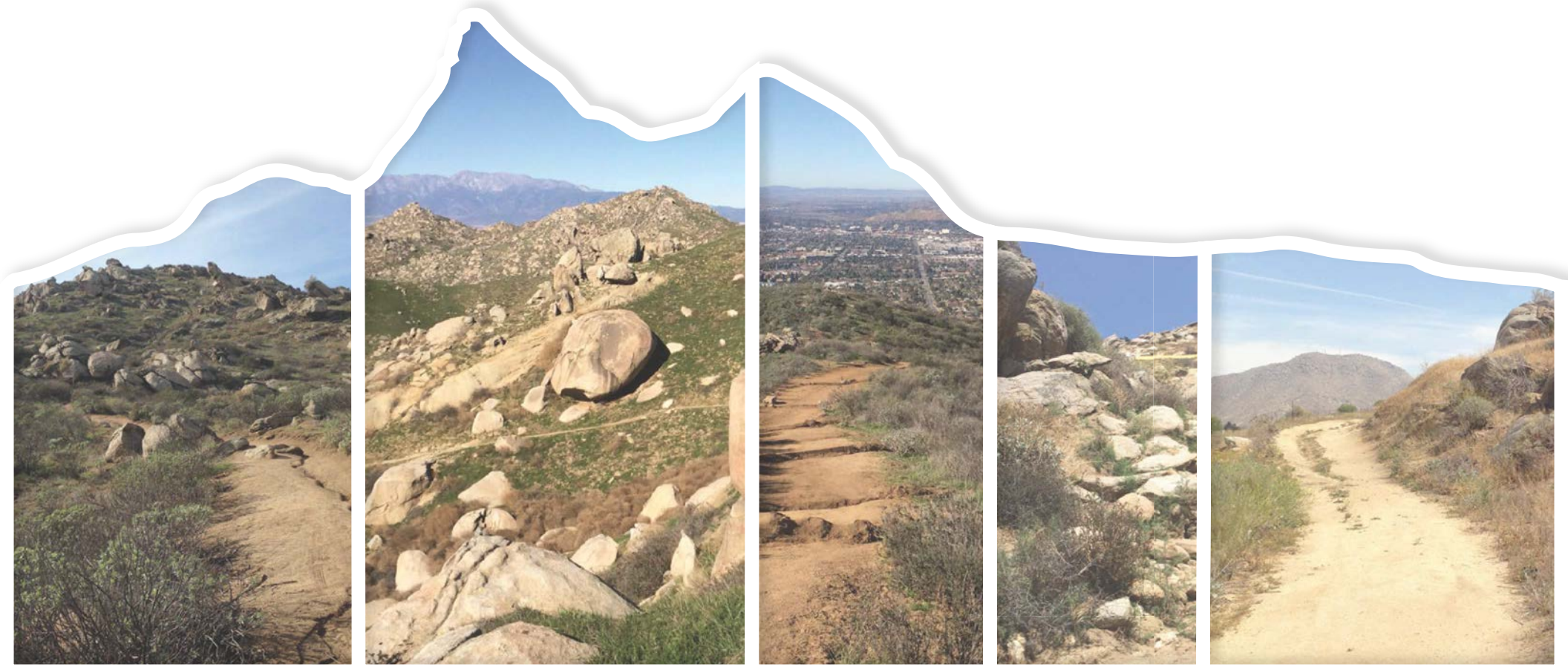
# Box Springs Mountain Reserve Comprehensive Trails Master Plan

*Riverside County, CA*
*November 2015*



# Acknowledgements

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# 1

# Introduction

The Box Springs Mountain Reserve Comprehensive Trails Master Plan includes an assessment of the Reserve's existing trail network and staging areas, as well as connectivity opportunities with adjoining communities and areas. This plan includes analysis of natural features, existing trail alignments, sustainability, usage patterns, user groups, and connectivity with neighboring parks, trails, schools and city facilities. The trails and staging area analyses are intended to support the County of Riverside Regional Park and Open-Space District in determining future development project needs.

> ***"Americans are seeking trail opportunities as never before. No longer are trails only for the rugged individualists pursuing a solitary trek through breathtaking wilderness…users include young people and senior citizens, families, individuals and organized groups, people with disabilities and the physically fit."***
>
> ~ Trails for All Americans Report

## 1.1 Study Area

Box Springs Mountain Reserve (Reserve) is located in Riverside County, California as seen in Figure 1-1. The Reserve shares borders with the City of Riverside to the west and the City of Moreno Valley to the south and east. Although the Reserve serves as the primary study area, the entire study area extends slightly beyond the Reserve boundary to encompass Pigeon Pass Road to the east, the Highgrove area to the north, the City of Riverside to the west and the City of Moreno Valley to the south as seen in Figure 1-2. The study area within the Reserve includes both public and privately-owned land as shown in Figure 1-3. Several linear connections, including the Perris Valley rail line and the proposed Gage Canal Trail, are also included in the study area.

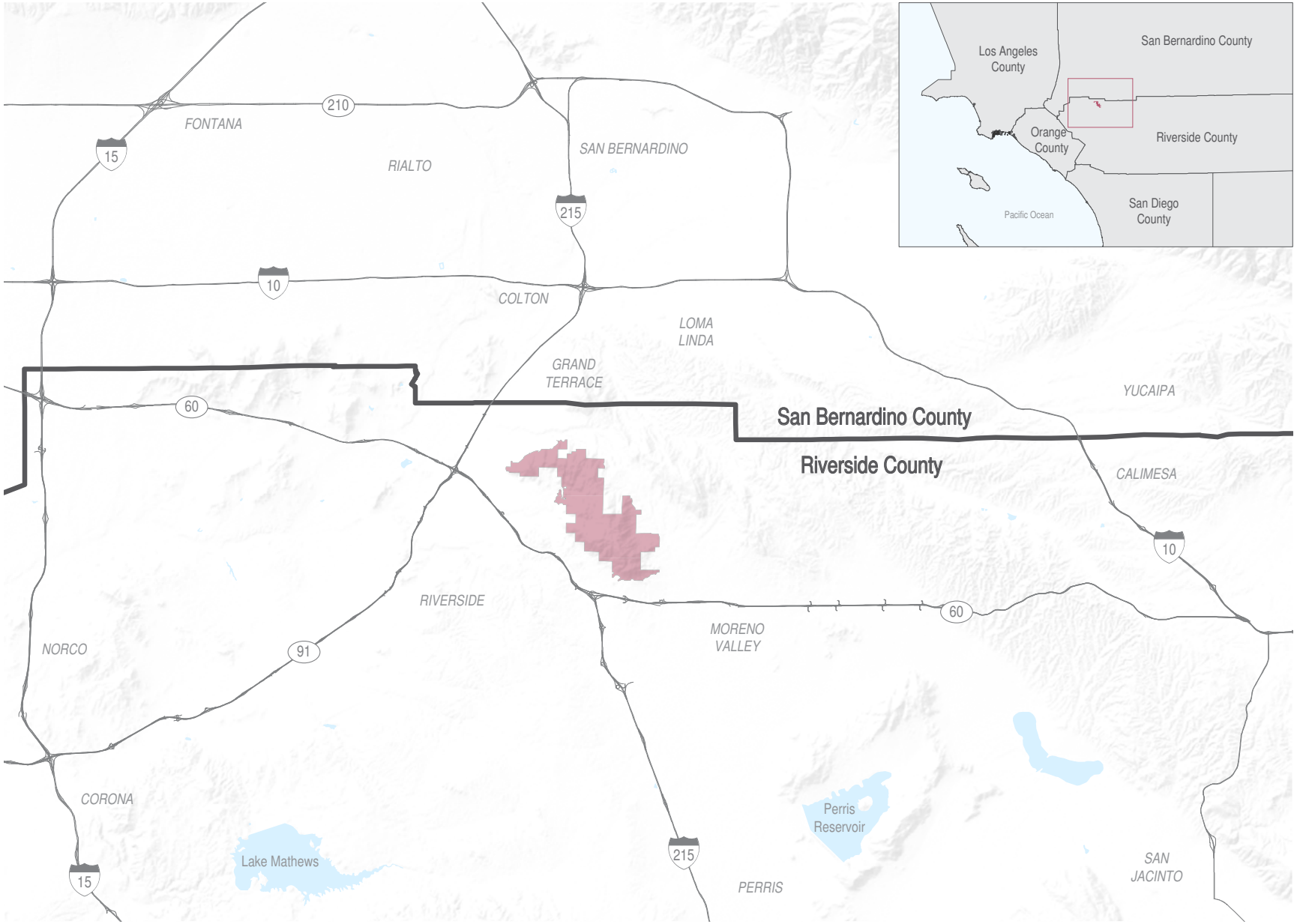
The Reserve is 3,400 acres in size and is comprised of 2,457 acres of Riverside County Regional Parks and Open-Space District land, 88 acres of Western Riverside Conservation Authority land, and 855 acres of private land. The Reserve includes most, but not all of Box Springs Mountain, along with a series of peaks. The highest peak in the range is called Box Springs Mountain and rises to 3,083+ feet. This represents an elevation gain of roughly 2,256 feet from the City of Riverside and 1,452 feet from the City of Moreno Valley. The Reserve's namesake spring is located on the western slope within a canyon terminating at Two Trees Road. Additional riparian areas supporting seasonal springs occur within the Reserves' deeper canyons.

The Reserve is primarily categorized as a chamise chaparral ecosystem, but also includes coastal sage scrub. Typical of these ecosystems, the Reserve contains mostly low shrubs and few shade trees, primarily along riparian zones near the mountain's base. Large areas of the Reserve slopes are non-native grassland, particularly in the northern half.

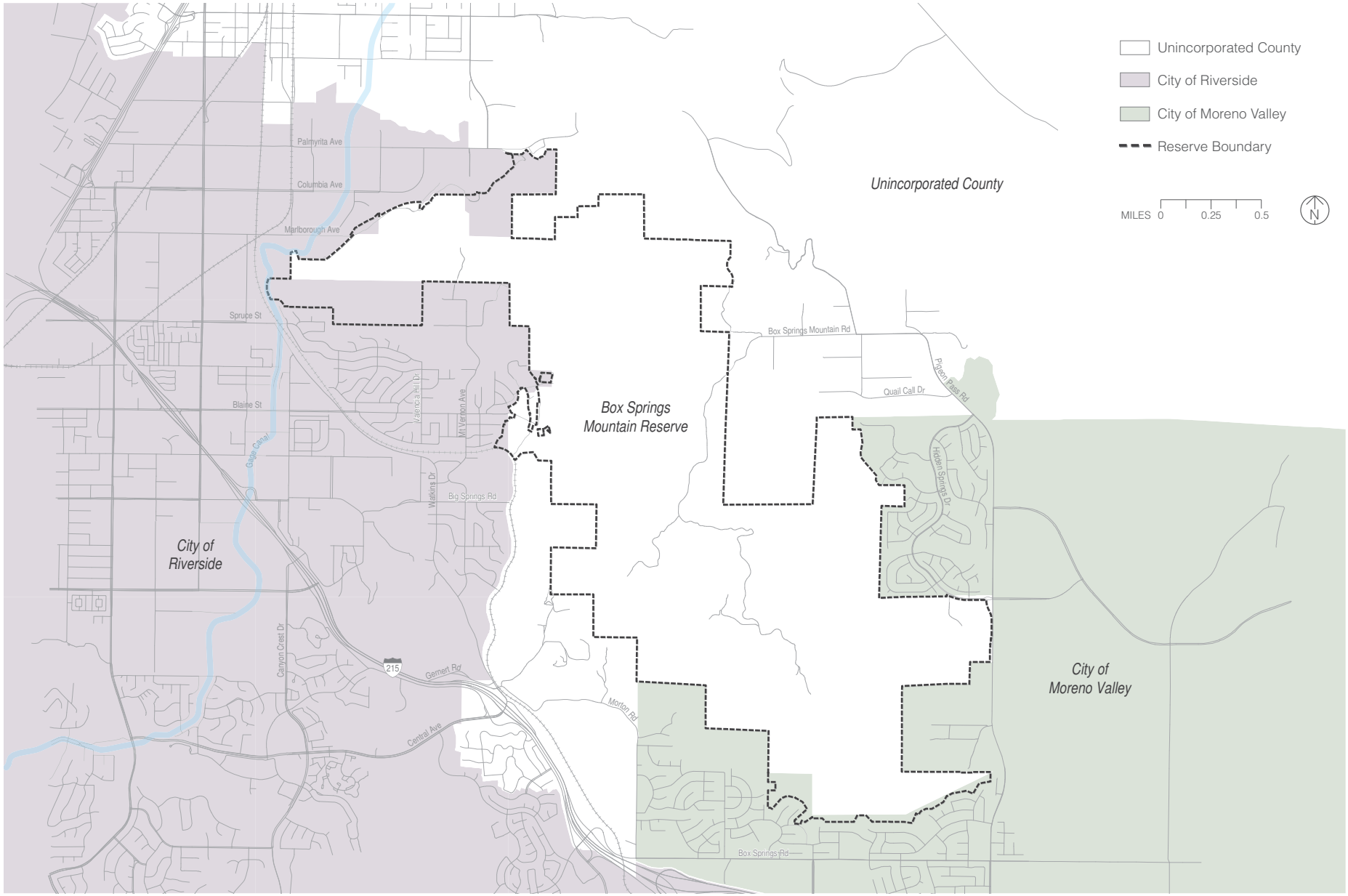
The Reserve is home to native and non-native animals, including snakes, lizards, coyotes, bobcats, mountain lions, bears, deer and burros. Two sensitive species, burrowing owls and California gnatcatchers, have been identified in the area. Visually, the Reserve is highlighted by distinctive rock outcroppings composed primarily of large outcrops of granitic boulders.

In addition to the natural elements, the Reserve includes several manmade structures and markings. There are two prominent concrete structures in the shape of an "M" on the Moreno Valley side (constructed in the mid 1960s) and a "C" (constructed in 1957) overlooking the University of California, Riverside (UCR) campus. Boulders along the "M" and "C" Trails have significant graffiti, as do boulders elsewhere in the Reserve, particularly near the top of the mountain along Box Springs Mountain Road. Other manmade structures include two residences and a number of broadcasting and cellular telephone towers. Grinding rocks or morteros are rumored to exist near Pigeon Pass Road. A stagecoach stop existed in the Pigeon Pass area and was an important water stop for horses and people.

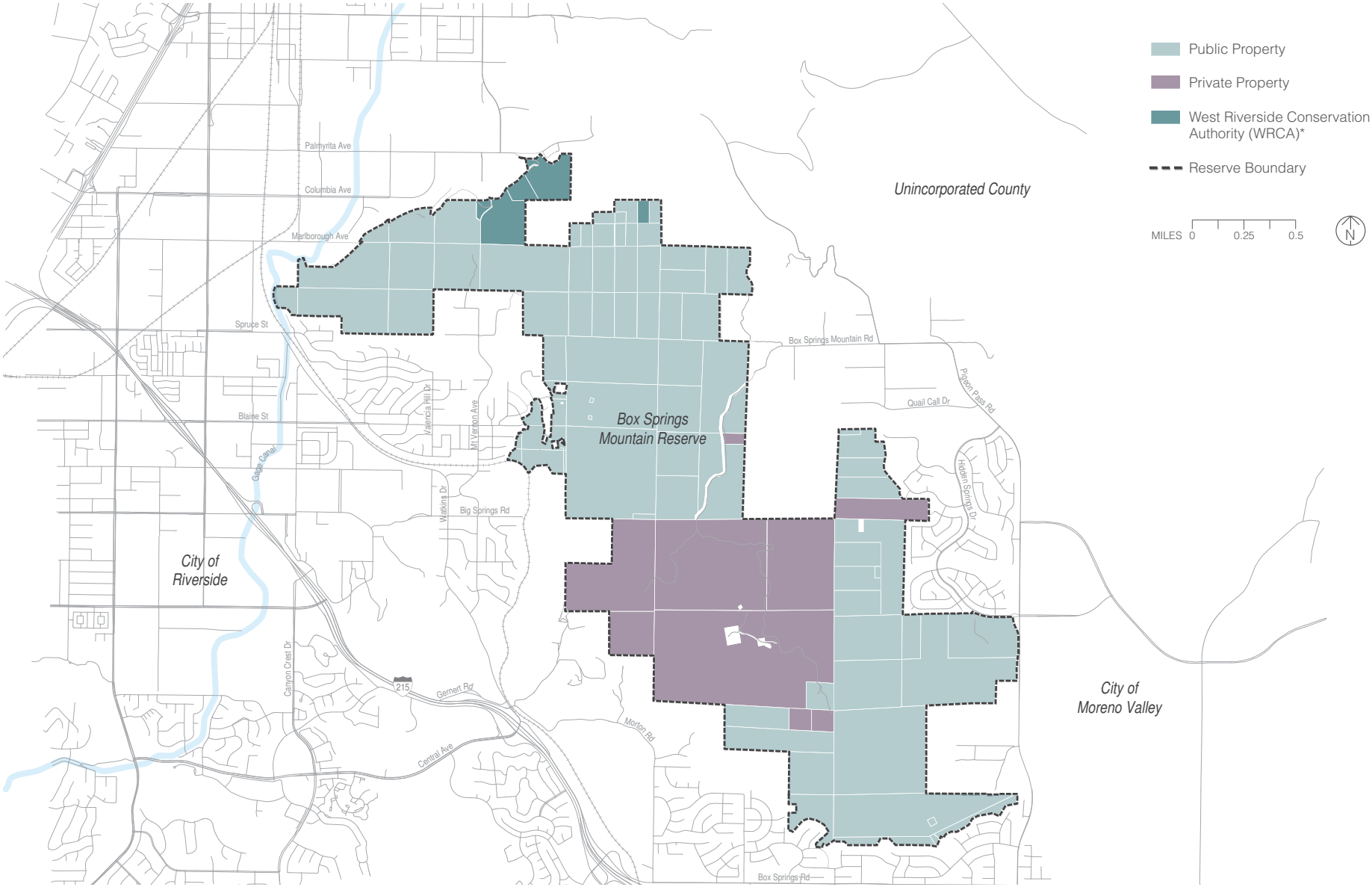
**Figure 1-1: Study Area (Regional)**



## Figure 1-2: Study Area (Local)



## Figure 1-3: Ownership




*Managed by the Riverside County Regional Parks and Open-Space District as part of the Box Springs Mountain Reserve.

## 1.2 Document Overview

The Box Springs Mountain Reserve Trails Master Plan provides an overview of existing conditions as well as recommendations for future improvements. The plan includes conceptual-level analysis and design and is intended to serve as a guide for future improvements.

### Trail Connections

This plan provides recommendations for trail facilities that create a well-connected, comprehensive trail network. Recommendations for trail connections and staging areas within the various jurisdictions are identified using an analysis of regional connectivity. In addition, the plan incorporates alignment solutions that provide connections to major neighborhoods, regional trails and local destinations. The plan also assesses inter-jurisdictional staging and access constraints into the Reserve due to the future Perris Valley Line Metrolink expansion, State Route 60 and adjacent private land holdings. The land along several trail segments have not yet been acquired.

A portion of the plan includes a bicycle/pedestrian corridor along the Perris Valley Line for students traveling between the UCR campus and the City of Moreno Valley, as well as future Metrolink stations. The rail line lies along the Reserve's southwestern boundary was identified through the public input process for the Moreno Valley Bicycle Master Plan as a potential popular bicycle commuting route.

### Consistency with Existing Plans

This plan ensures a high degree of consistency with existing plans of several jurisdictions and agencies, including the Riverside County Regional Park and Open-Space District, the City of Riverside, the City of Moreno Valley and the University of California, Riverside.

Several of these jurisdictions or agencies have plans identifying the same alignments and areas (for trails, paths, routes and staging areas) as this plan. Alignments most relevant to this plan are as follows:

- Hidden Springs Area (natural surface trails)
- Springbrook Wash (natural surface trails)
- The Reserve to Sycamore Canyon Park (natural surface trails)
- Perris Valley Line (Class I multi-use path)
- Gage Canal (Class I multi-use path)
- Big Springs Road (Class II bicycle lane)
- Marlborough Road (Class II bicycle lane)
- Pigeon Pass Road (Class II bicycle lane)
- Watkins Drive (Class II bicycle lane)
- Morton Road (Class III bicycle route)
- Hunter Park/Marlborough Avenue Metrolink Station (joint-use staging area)

### Design Guidelines (Chapter 5)

Based on a review of existing plans and documents, as well as industry best practices, this plan addresses design and construction practices for a sustainable, natural surface, multipurpose recreational trail system within the Reserve. The recommended Reserve trail development guidelines are based on existing County of Riverside Trail Design Standards, as well as regional and national design guidelines for natural surface open space trails. National standards include those the International Mountain Bicycling Association (IMBA) and the National Park Service, acknowledged sustainable trail design experts.

The trail guidelines are to be used for future trail development projects and to update the County's open space trail systems standards. The plan also includes inter-jurisdictional pedestrian/bicycle and railroad crossings precedents and recommended railroad crossing design standards.

## Cost Estimates (Chapter 6)

Estimated linear foot costs were developed for trail design and maintenance methods for new construction and existing trail renovation work.

## Implementation Plan (Chapter 7)

The plan's implementation chapter identifies various methods for creating a phasing plan along with initial prioritization of the proposed trail improvements. The initial prioritization is based on documented use and District needs.

# 2

# Existing Conditions

This chapter provides a description of existing conditions for trails and staging areas within the Reserve. Each of the existing trails is discussed in detail and includes information on slope, sustainability, topography, access, connections and other environmental attributes. Additionally, each of the staging areas (both existing and proposed) is discussed, including information on surrounding context, trails connected to, general site shape, topography and amenities (e.g. shade trees, restrooms, water source, etc.).

> ***"If people are going to use trails then they need attractive, safe, accessible, convenient to use paths and walkways in their neighborhoods…trails need to be a part of everyone's daily lives. No one should be more than a 5-minute walk from a trail."***
>
> ~ Robert Searns

## 2.1 Existing Trails

As seen in Figure 2-1, this plan identifies seven existing trails within the Reserve. A detailed assessment for each of the existing trails is provided in this chapter. These trails include:

1) Sugarloaf Trail
2) Skyline Loop Trail #1
3) Skyline Loop Trail #2
4) Two Trees Trail
5) Edison Trail
6) "C" Trail
7) "M" Trail

Although there are additional, "informal" trails within the Reserve, they were not subjected to the same analysis and prioritization procedures as the seven listed above. However, some of these existing "informal" trails are in good condition and appear to be sustainable. As a result, several of these "informal" trails were retained in part or in full as proposed trails. All proposed trails are discussed in more detail in Chapter 4.

*Burros Commonly Seen within Box Springs Mountain Reserve*

> ***"Trails consolidate and connect communities,rather than encourage them to expand and fragment."***
>
> ~ David Burwell

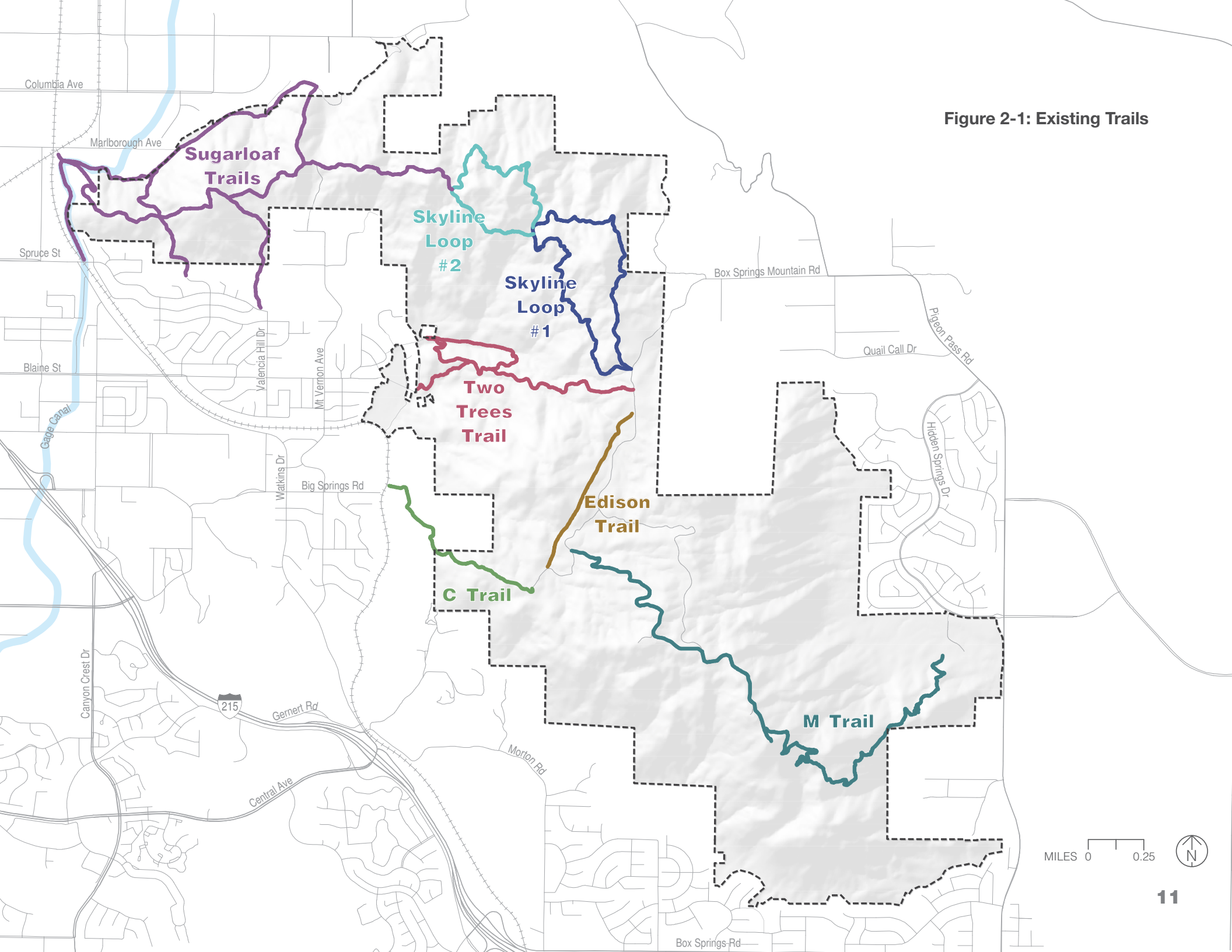



**Figure 2-1: Existing Trails**

*North Side of Sugarloaf Mountain (Approximately 33 Percent Slope)*

*Existing Dirt Road at Base of Sugarloaf Mountain*

## Sugarloaf Trails

The Sugarloaf Trails lie at the northwest corner of the Reserve, on and around Sugarloaf Mountain, and extend from Marlborough Avenue in the west to the Skyline Loop Trail #2 in the east. The Sugarloaf Trails total 5.8 miles and include six different segments, including two substantial west-east segments, one running along the ridgeline and the other along the mountain's base, as well as four segments providing north-south connections. Each trail is unique, with its own average slope.

Overall, the Sugarloaf Trails perform poorly in terms of sustainability and user experience, with an average slope of 15.47 percent and a full 30 percent with slopes exceeding 20 percent. Portions of the Sugarloaf Trails double as proposed Lower Circumference Trail segments, helping to close the loop in the northwest portion of the Reserve. (The Circumference Trails are among proposed trails described in more detail in Chapter 4, Recommendations.)

**Figure 2-2: Sugarloaf Trails Slopes**

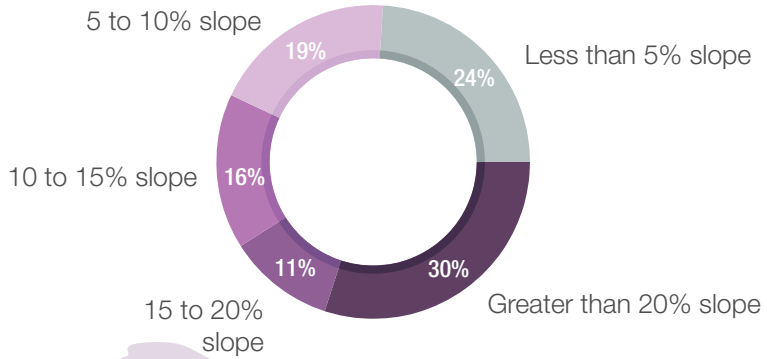
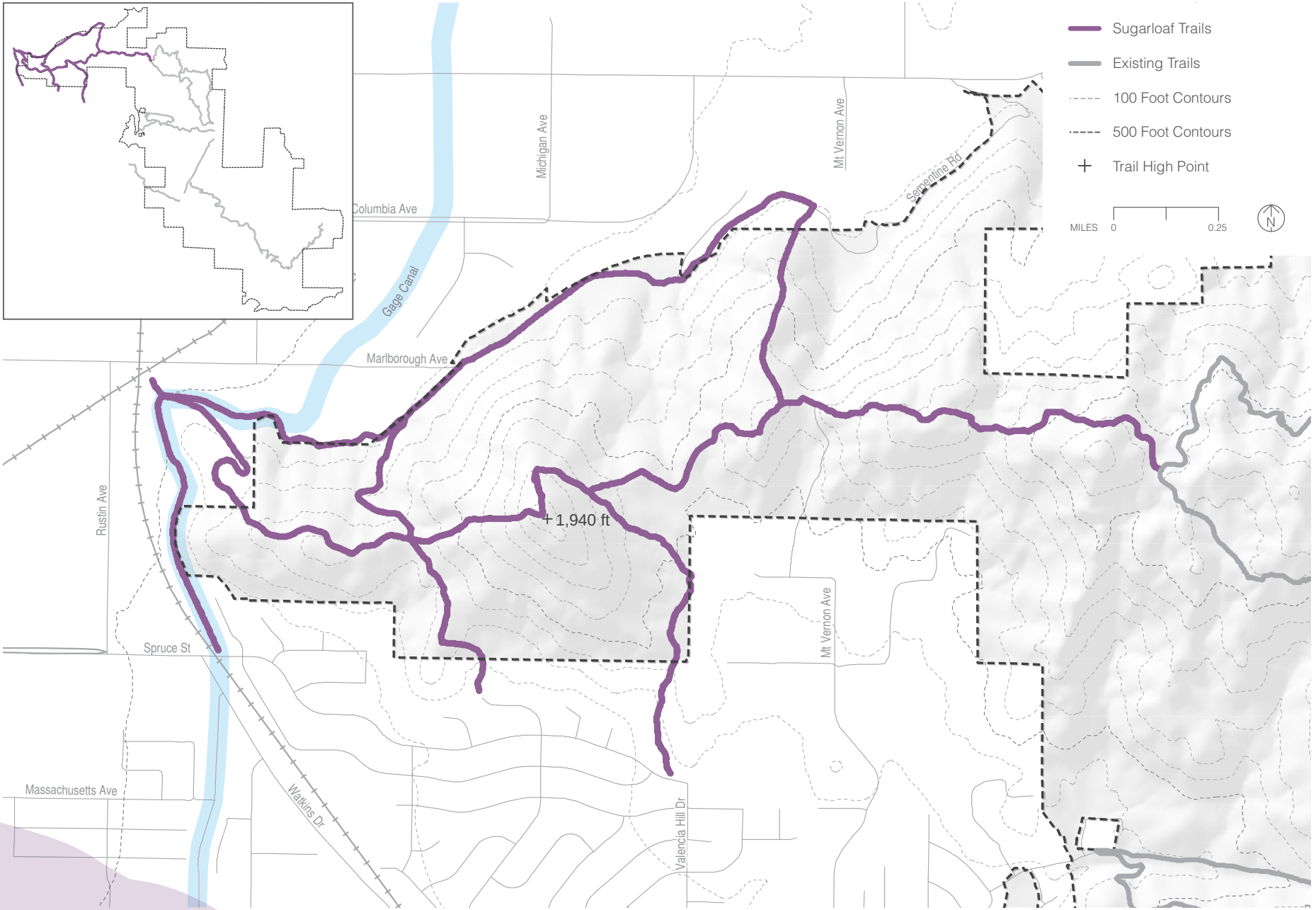


**Figure 2-3: Sugarloaf Trails**



*Skyline Loop Trail #1 Typical Character*

*View of UC Riverside area from Skyline Loop Trail #1*

## Skyline Loop Trail #1

The Skyline Loop Trail #2 is accessed primarily from the Box Springs Mountain Road staging area. It is 2.5 miles long and extends from the Skyline Loop Trail #2 in the northwest to Box Springs Mountain Road in the southeast. It has the gentlest overall slopes of the trails analyzed for this plan.

Overall, this trail's alignment reflects sustainable design principles, with over half of the trail falling between 5 and 10 percent slope. However, steep (15 to 20 percent) and very steep segments (>20 percent) bring the trail's average slope to 10.63 percent. Similar to Skyline Loop Trail #2, Skyline Loop Trail #1 was designed with water-shedding cross slope and takes advantage of large boulders, which help to stabilize trail tread and to shed water.

Several residents indicated that they no longer use either Skyline Loop Trail due to a thorny invasive plant that has infiltrated the trail and created a hazard for dogs. This invasive plant is most likely goathead, or *Tribulus terrestris,* which has seeds that easily puncture bicycle tires or shoes.

**Figure 2-4: Skyline Loop Trail #1 Slopes**

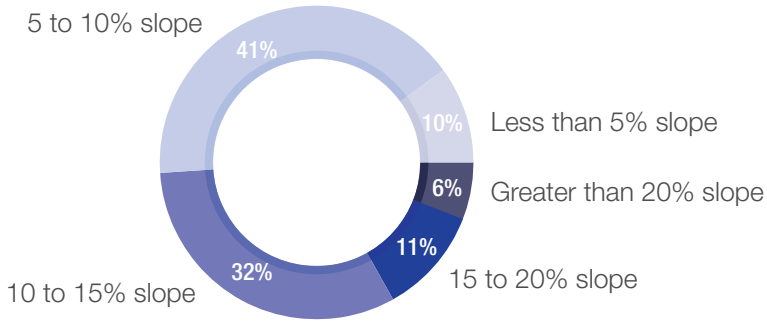
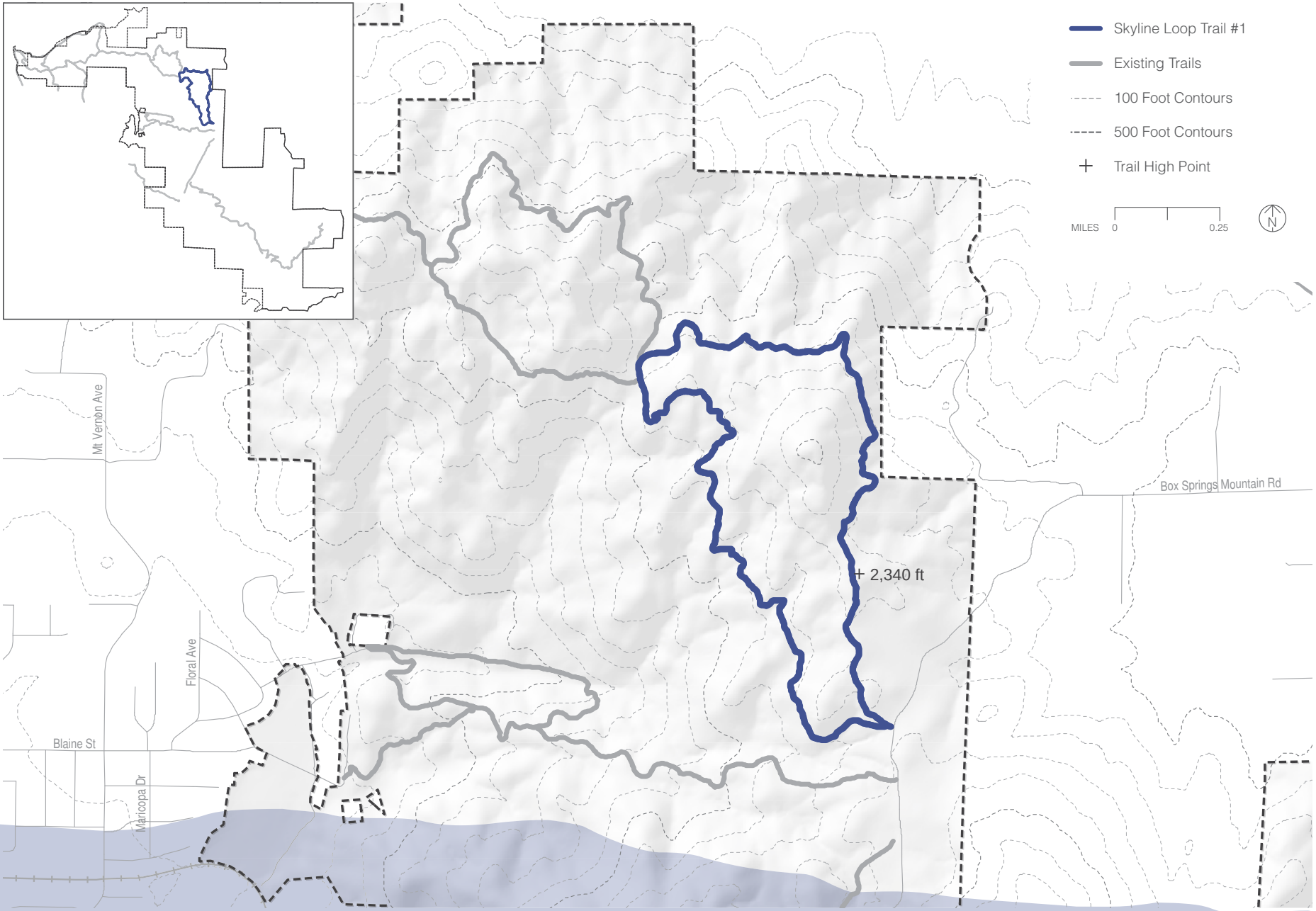


**Figure 2-5: Skyline Loop Trail #1**



*Skyline Loop #2 Typical Routing*

*Skyline Loop #2 Typical Trail Character*

## Skyline Loop Trail #2

The Skyline Loop Trail #2 is accessed most readily from the existing Box Springs Mountain Road staging area via the Skyline Loop Trail #1 at nearly the same elevation. It is 1.5 miles long and extends from the Sugarloaf Peak area in the northwest to the Skyline Loop Trail #1 to the southeast. It is a contour trail loop, meaning that it hugs the mountain's natural slopes, traveling generally parallel with the contours. Overall, this trail reflects sustainable design principles, with nearly half of the trail falling between 5 and 10 percent slope. Sections of steep (15 to 20 percent) and very steep (>20 percent) trail, however, bring the trail's average slope to 12.64 percent. The story told by the data, a gentle contour trail, punctuated by steep sections, was corroborated by fieldwork. However, fieldwork also revealed that several of the steeper pitches take advantage of water-shedding cross slopes and rock slabs and were anchored by large boulders, two elements that mitigate steepness impacts.

Of the seven existing trails evaluated, the Skyline Loop Trails #1 and 2 appear to have been designed and constructed as singletrack recreational trails with user enjoyment and long-term sustainability in mind.

**Figure 2-6: Skyline Loop Trail #2 Slopes**

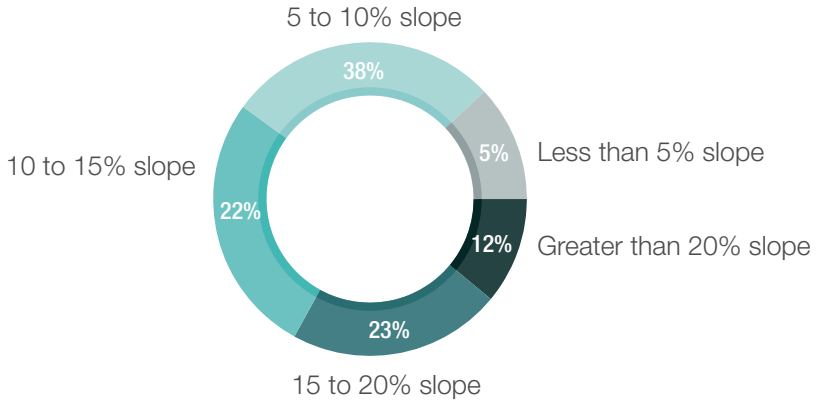
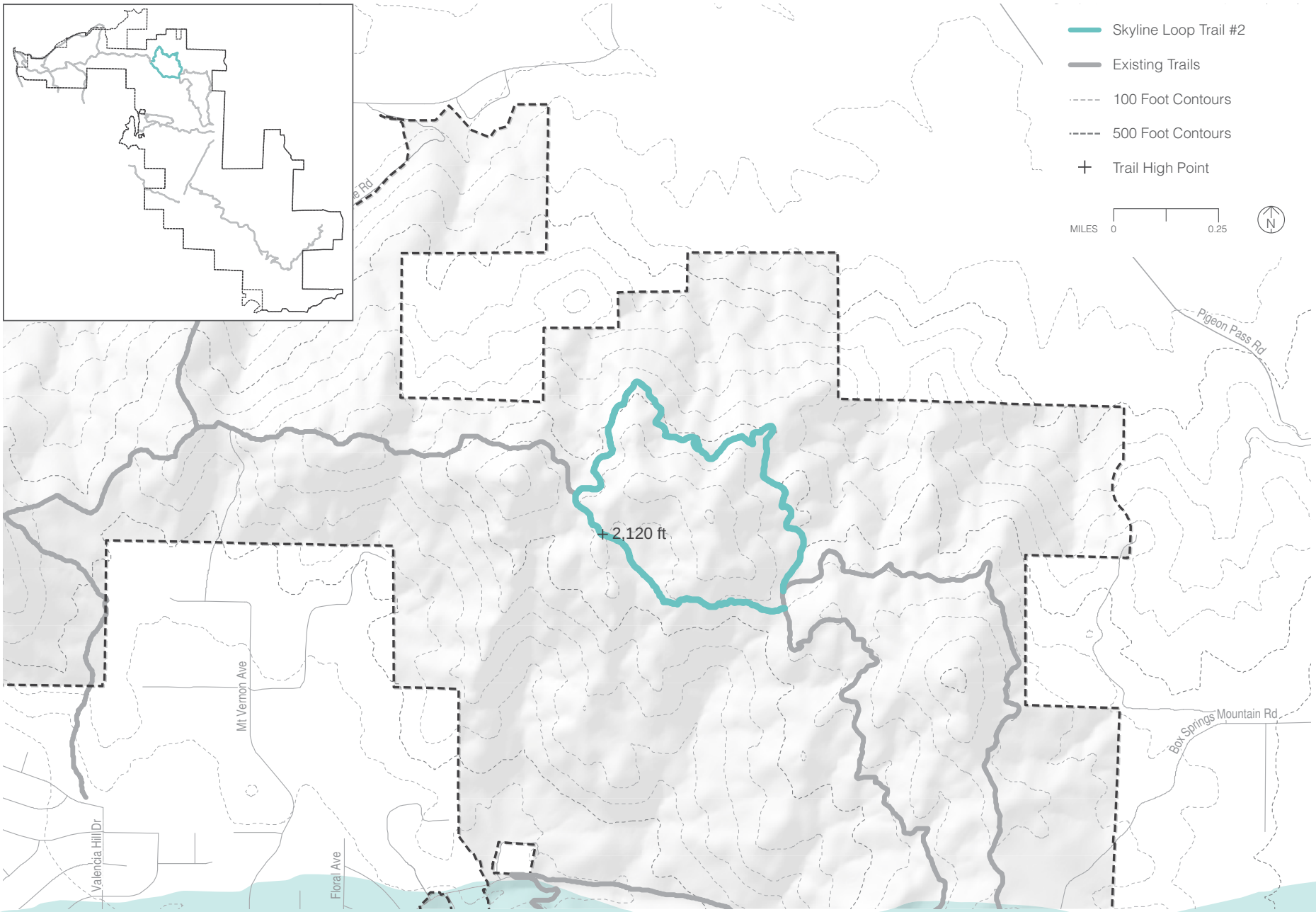


**Figure 2-7: Skyline Loop Trail #2**



*Two Trees Trail Near Top at Box Springs Mountain Road*

*Two Trees Trail with Top of Box Springs Mountain in Background*

## Two Trees Trail

The 2 mile long Two Trees Trail is easily accessed from a small trailhead at the end of Two Trees Road at the bottom of the mountain to the west or from the Box Springs Mountain staging area at the top of the mountain to the east. This trail, as constructed, is very unsustainable. Nearly 75 percent exceeds 10 percent slope and 22 percent exceeds 20 percent slope. Its slope averages 14.33 percent. Erosion is clearly evident in the trail's deep ruts and soil deposits along the edges. The trail also shows evidence of continual widening due to trail users moving to the periphery to avoid heavily eroded portions.

Even so, the Two Trees Trail is a favorite among local users and was noted as the most heavily traveled during fieldwork that typically occurred during the day on weekdays. The trail generally goes straight up and down the slope and utilizes few boulders or other natural elements to shed water and stabilize soil. Interventions in the form of grade dips with pressure-treated timbers were installed near the top just below Box Springs Mountain Road, but have not achieved the desired effect. Post-rain fieldwork revealed new rutting and trailside soil deposits, likely due to this segment's excessive grade and ever-widening alignment.

**Figure 2-8: Two Trees Trail Slopes**

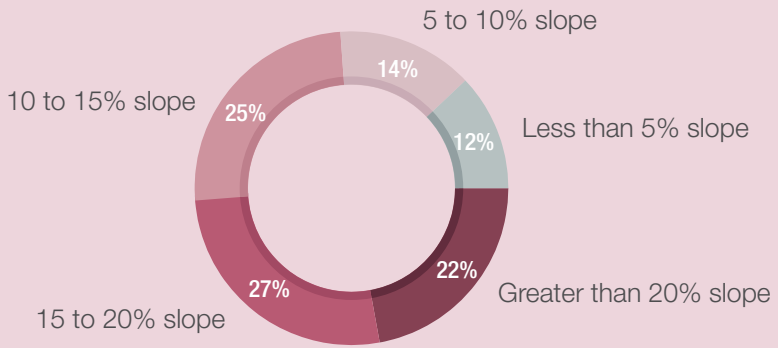
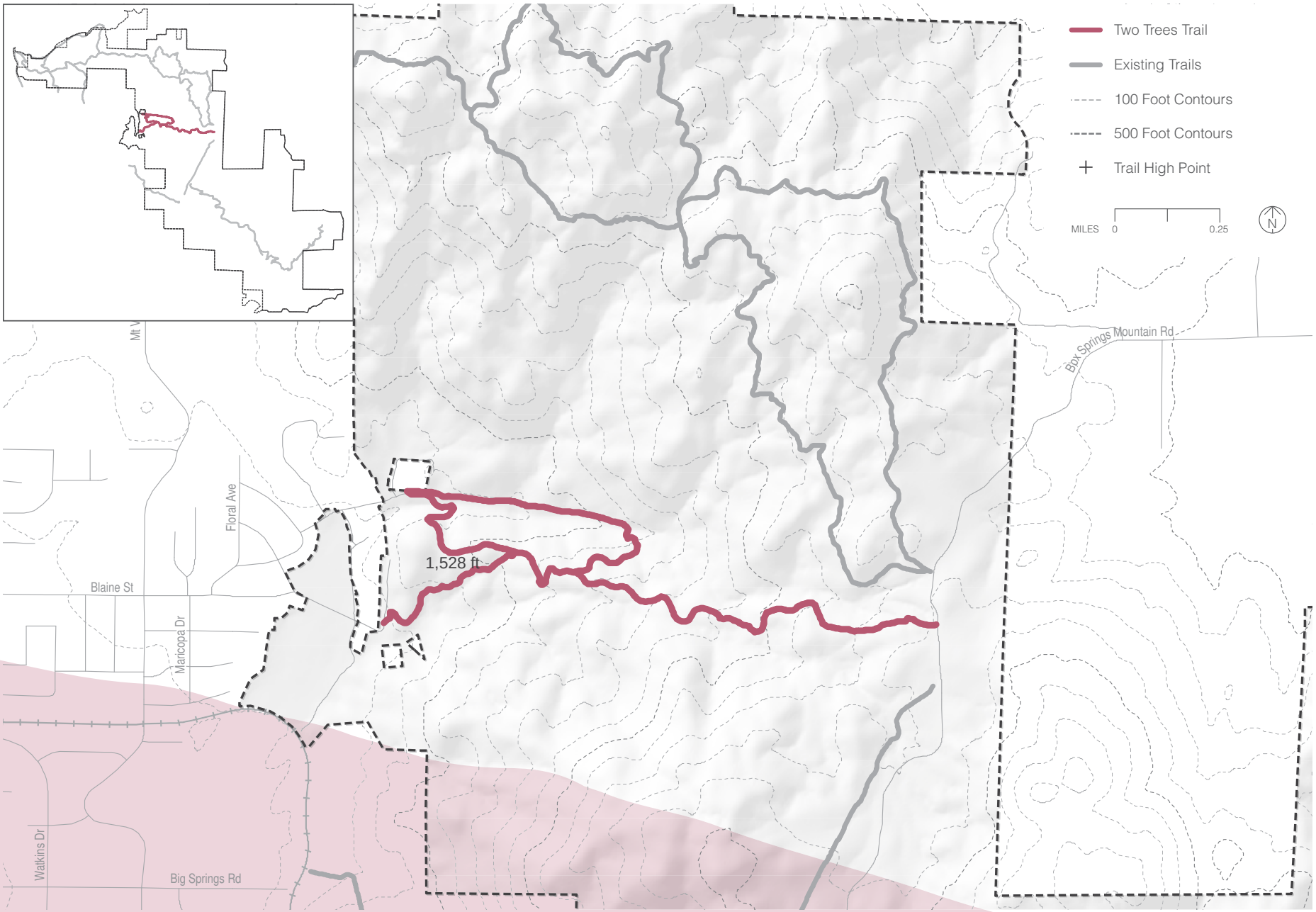


**Figure 2-9: Two Trees Trail**



*North End of Edison Trail Approaching Box Springs Mountain Staging Area*


*South End of Edison Trail at Box Springs Mountain Road*

## Edison Trail

The 0.8 mile long Edison Trail extends from the existing staging area at the top of the mountain on Box Springs Mountain Road in the northeast to near the Henry Broadcasting Company towers in the southwest. As the name implies, the trail follows a power line for the majority of its length. Overall, the trail is relatively flat (average slope: 9.14 percent), which means that it has generally held up well and is accessible to a range of users.

This trail serves as a connector between the Box Springs Mountain staging area and the popular "C" and "M" Trails. There are, however, several segments that exceed the recommended sustainable slope and are severely eroded. Field observation and public input, especially from equestrians, indicates that these segments are severe enough to deter some users or cause them to seek detours.

This occasional, excessive slope is caused by the trail's linear alignment, the result of laying out a power line access road straight across the land, without adequate regard for the underlying topography and future maintenance requirements.

**Figure 2-10: Edison Trail Slopes**

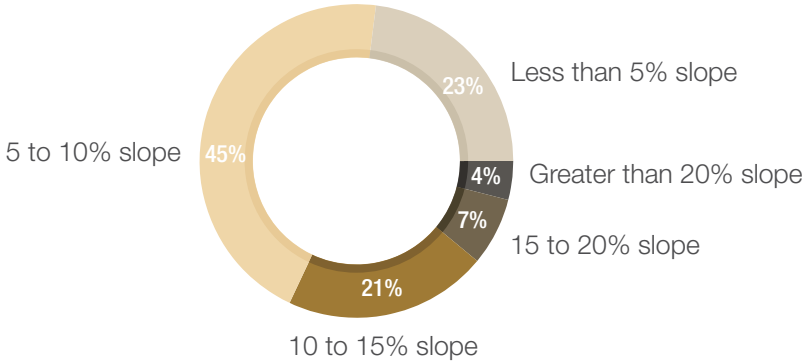
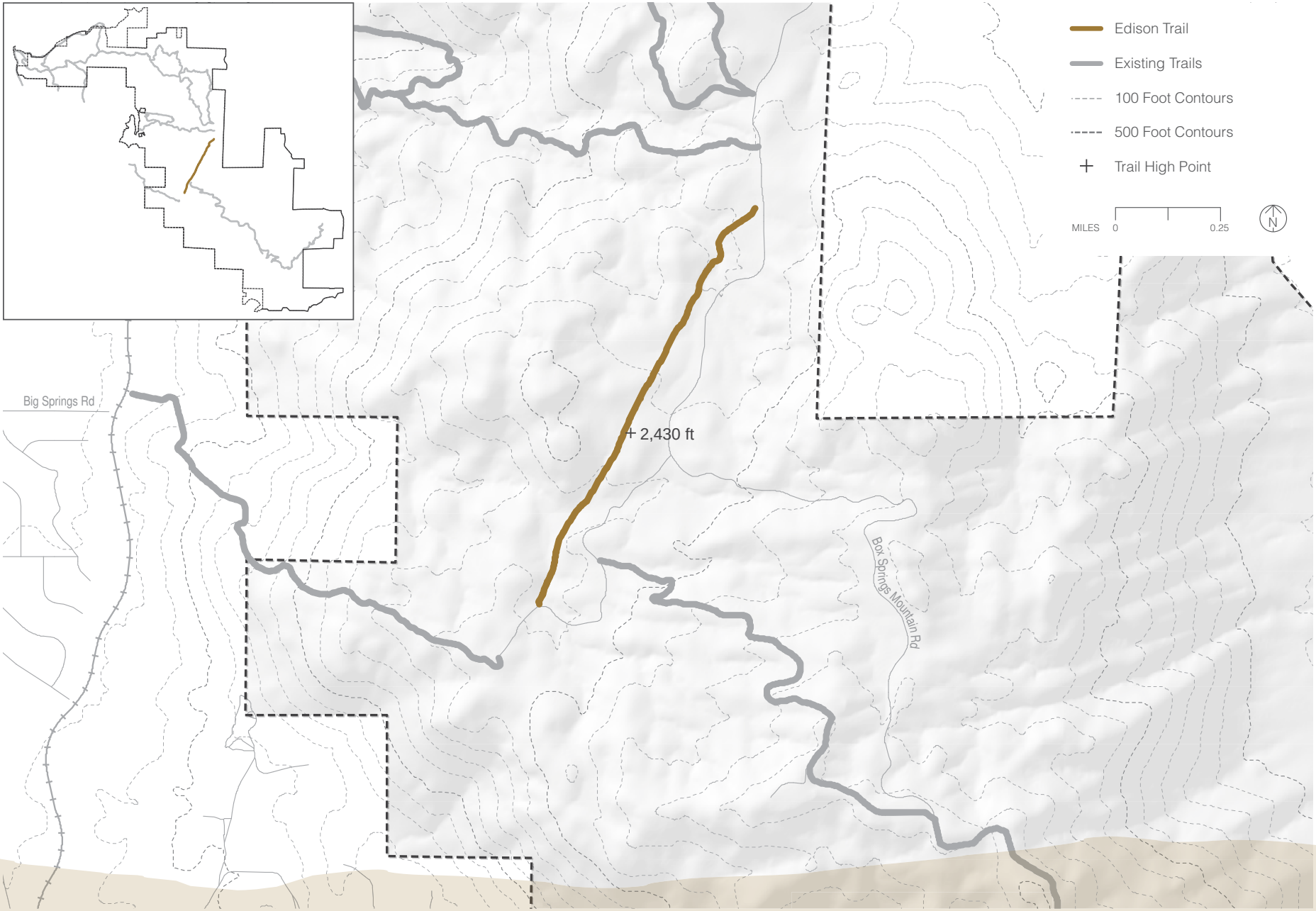


**Figure 2-11: Edison Trail**



*"C" Trail's Steep, Eroded Typical Conditions*

*"C" Trail's Worst Segment Just Below the "C"*

## "C" Trail

While not an authorized entry point, the "C" Trail is primarily accessed from Big Springs Road and Islander Park at the bottom of the mountain, as well as from the Box Springs Mountain staging area and Edison Trail at the top. It extends from the end of Big Springs Road in the northwest to a radio tower to the southeast. This 0.95 mile trail is by far the steepest of the seven trails studied, with an average slope of 24.5 percent and 52 percent exceeding 20 percent slope. The extremely steep slope was confirmed by fieldwork that revealed badly rutted trail tread, exposed rocks, trail widening and multiple closely spaced parallel routes. Some segments are virtually unwalkable without using one's hands.

The concrete "C" for which the trail is named was built primarily by UCR students in 1957. Hiking the "C" Trail has since become a tradition and this route up the mountain is a UCR student favorite. Many students access the trail via an unauthorized crossing of the Perris Valley Line rail tracks. Unfortunately, the "C" Trail and the area surrounding the "C," in particular, has suffered from significant graffiti, as well as litter such as beverage cans and broken bottles.

**Figure 2-12: "C" Trail Slopes**

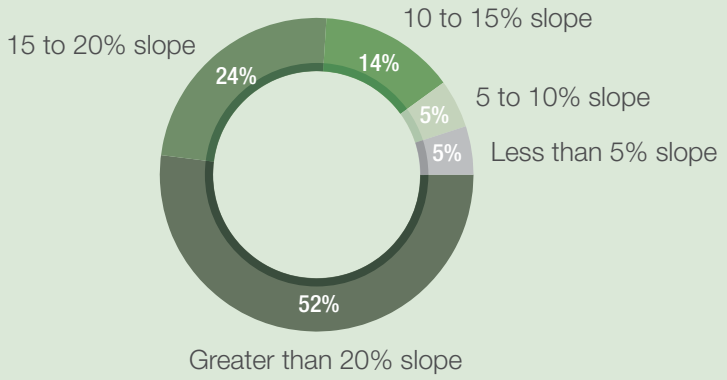
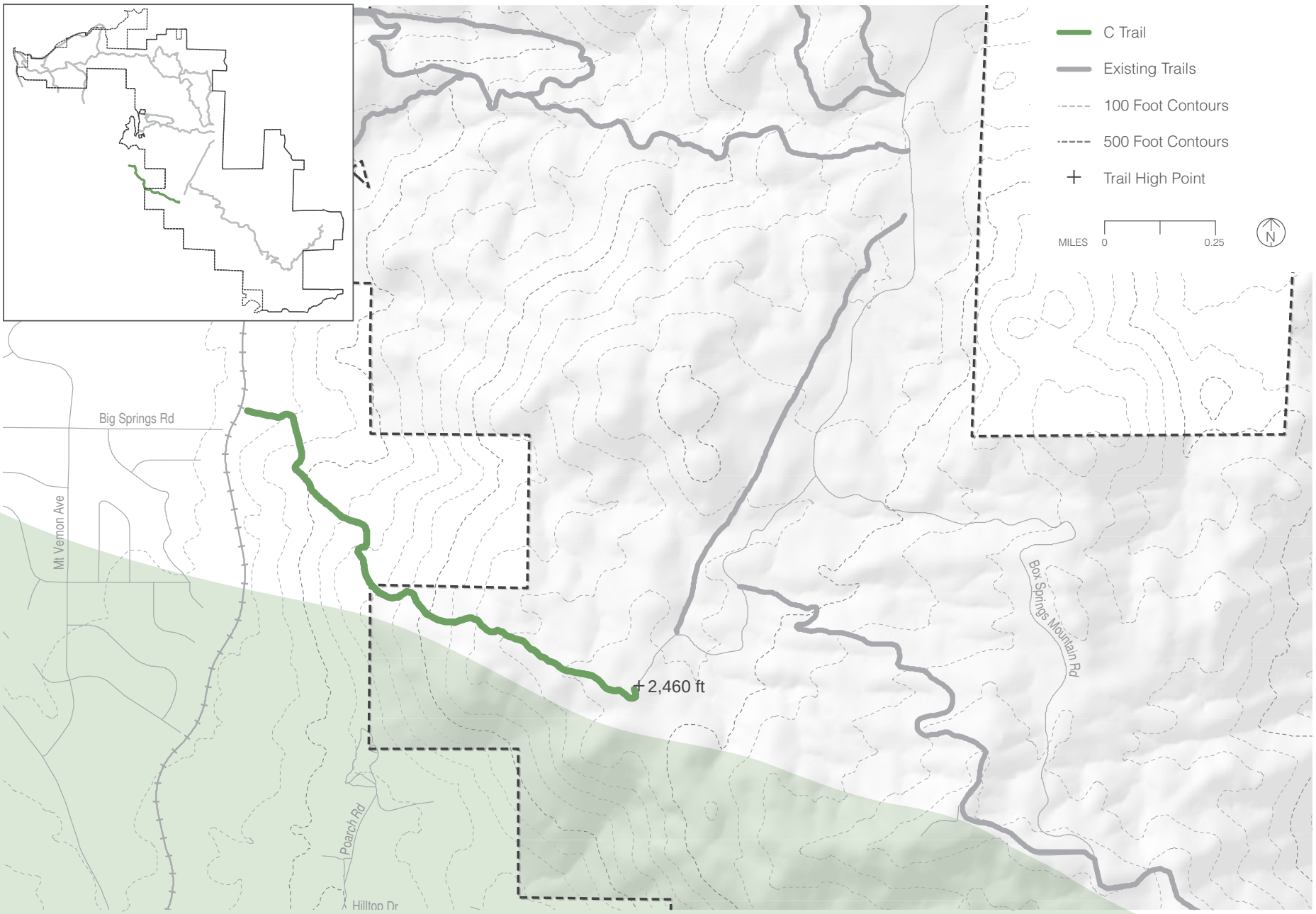


**Figure 2-13: “C” Trail**



*"M" Trail Near Hidden Springs Staging Area*

*"M" Trail Near Top*

## "M" Trail

The "M" Trail is accessed primarily from the existing Hidden Springs staging area at the bottom of the mountain off Pigeon Pass Road in Moreno Valley and, to a lesser extent, from the Box Springs Mountain staging area at the top. The 3.7 mile trail extends from the Hidden Springs staging area in the east to (near) the Edison Trail in the west. The trail, as a whole, appears to be fairly average in terms of slope, with 40 percent under 10 percent and 60 percent over 10 percent, and a relatively low average slope (12.07 percent).

The "M" Trail, however, is really a tale of two trails. While the segment between the "M" and the Edison Trail is primarily along a ridgeline and quite flat, the segment between the Hidden Springs staging area and the "M" is very steep and suffers from erosion caused by unsustainable design. This trail segment includes a series of switchbacks stacked so closely above each other that they encourage trail "cutting," leading to further erosion (See Chapter 5, Design and Maintenance).

**Figure 2-14: "M" Trail Slopes**

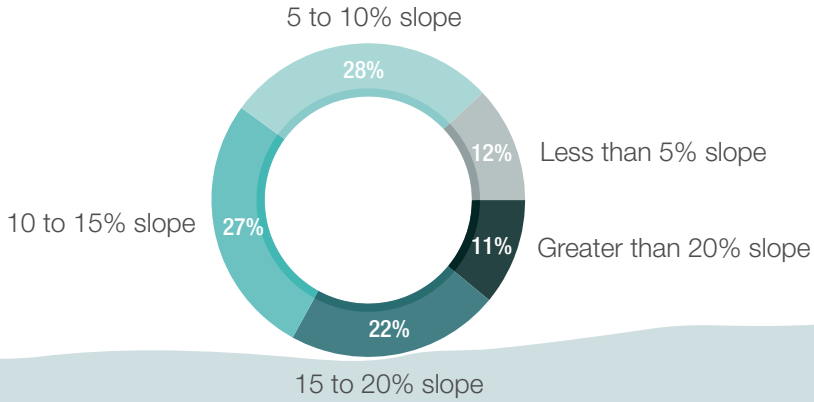
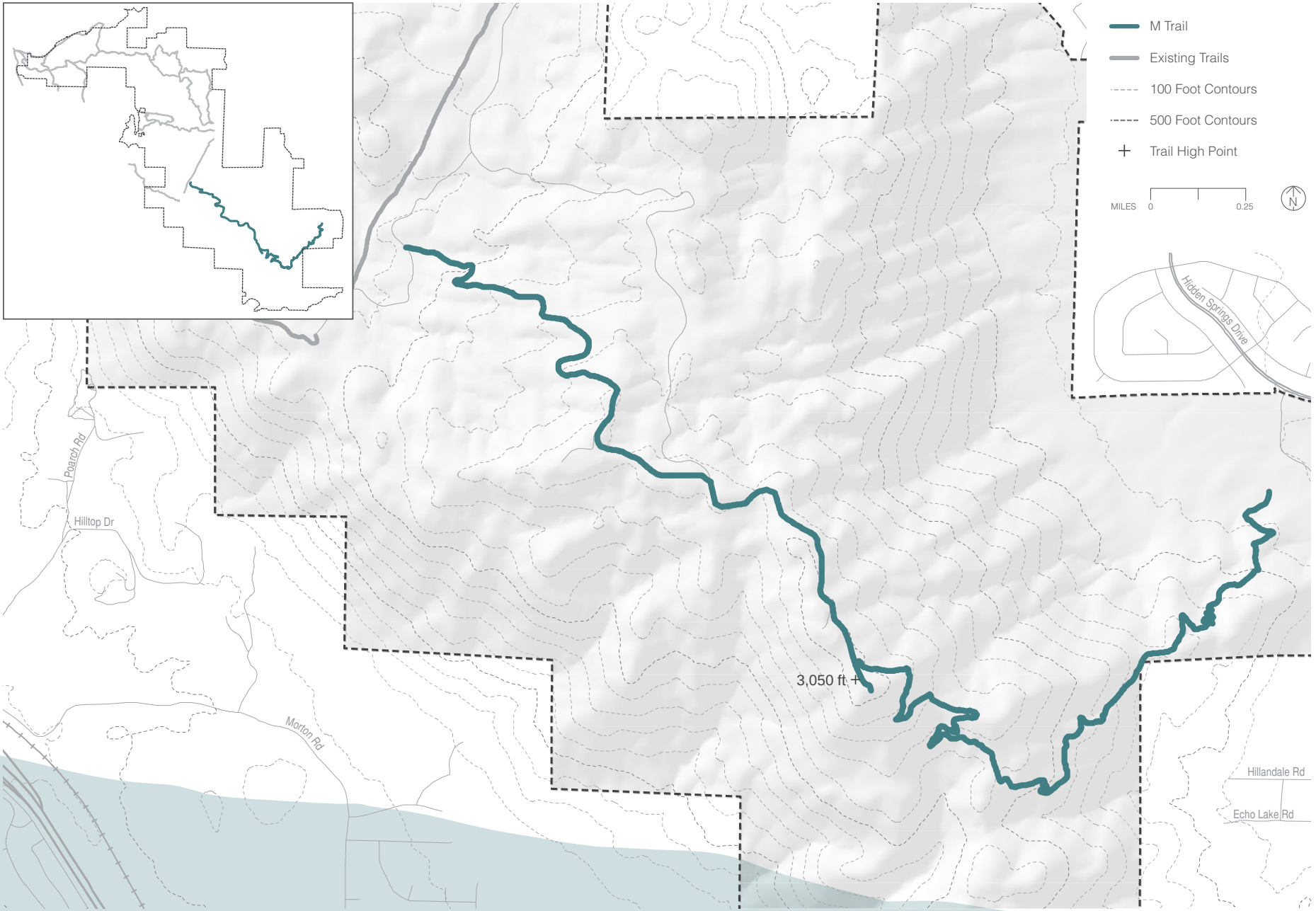


**Figure 2-15: “M” Trail**



## 2.2 Staging Areas

This chapter provides information for both existing and proposed staging areas. As seen in Figure 2-16, there are two existing staging areas and seven proposed staging areas including:

1) Hidden Springs Drive (Existing)
2) Box Springs Mountain Road (Existing)
3) East Blaine Street (Proposed)
4) Sugarloaf/Bike Skills Park (Proposed)
5) Islander Park – Rail Crossing (Proposed)
6) Islander Park – Big Springs (Proposed)
7) Islander Park – Linden Street (Proposed)
8) Hunter Park/Marlborough Avenue Metrolink Station Parking Lot (Proposed)
9) Morton Road (Proposed)

Preliminary staging area locations were based on providing an even distribution around the Reserve perimeter, serving as many existing and proposed trails as possible, and ensuring a basic level of feasibility. Basic feasibility involved selecting sites that were sufficiently large, publicly owned, and equipped with convenient vehicle access and sustainable grades. For the purposes of comparison, all staging areas – existing and proposed – were assumed to be a half acre minimum, a size large enough to accommodate multiple uses, including equestrian use.

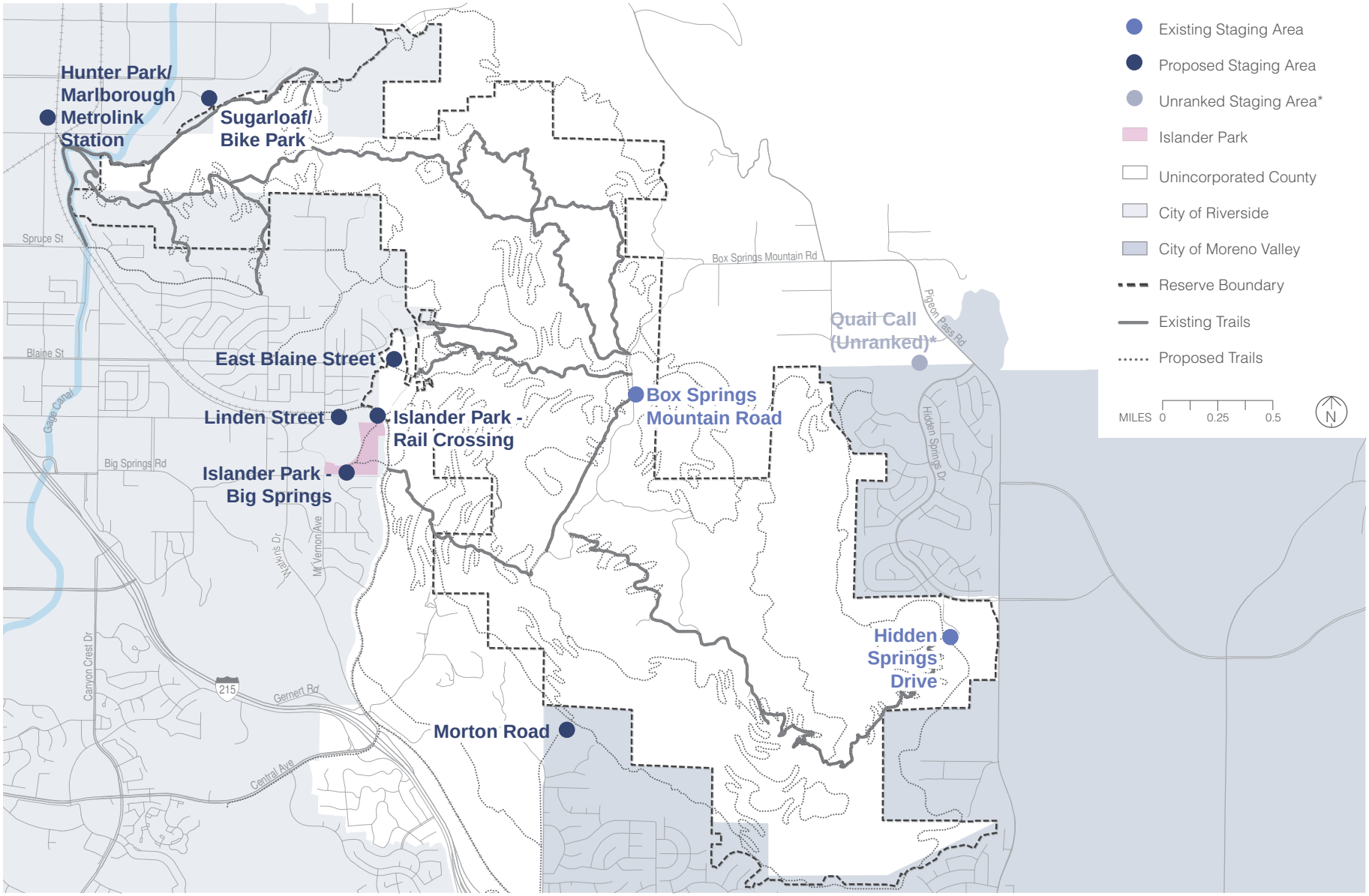
In addition to the "even distribution" criterion, three different staging areas were selected in close proximity within Islander Park[1] as seen in Figure 2-16. This was due to the recognized importance of Islander Park as a current crossing location and a link between the City of Riverside, UCR and the Box Springs Mountain Reserve (See Appendix for community comments). It is not the intent to implement three staging areas in such close proximity. Instead, the intent is to construct the best feasible staging area.

The exact locations of proposed staging areas are not fixed. Modifications to staging area locations and dimensions may change due to further analysis of issues including, but not limited to, property ownership, inter-agency coordination, public input, environmental impacts and sensitive species. Proposed staging areas are discussed in terms of both their existing conditions and likely future conditions.

Proposed trails noted in the following sections are described in detail in Chapter 4 - Recommendations.

1) The polygon representing Islander Park (Figure 2-16) displays only a portion of what is commonly known as "Islander Park." The remainder of the land south and east of the Perris Valley Rail Line belongs to the Riverside County Regional Park and Open-Space District and two private landholders.

## Figure 2-16: Existing and Proposed Staging Areas

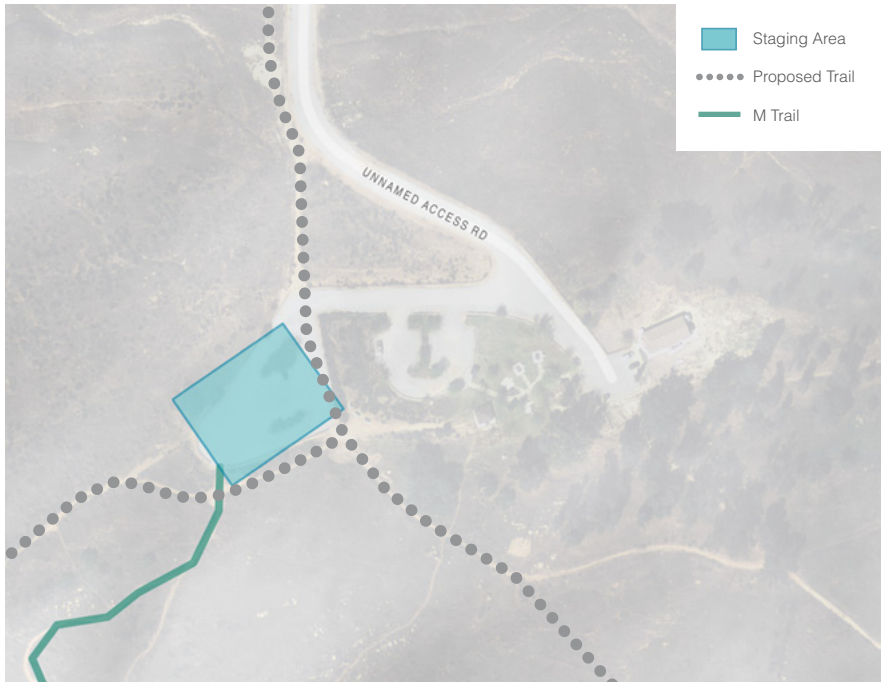



*In support of even distribution, another potential, future staging area was also considered, but not ranked: the "Quail Call" site at Moreno Valley's Hidden Springs Park, Phase II. This site was not ranked because the City of Moreno Valley does not plan to develop this site for recreation in the near term, but remains an attractive staging area option.

## Hidden Springs Drive Staging Area (Existing)

Hidden Springs Drive Staging Area is within the Reserve at the northwest edge of the City of Moreno Valley, about a quarter mile southwest of the intersection of Pigeon Pass Road and Hidden Springs Drive. It is bounded by suburban residential development to the north, high school and middle schools to the east and the Reserve to the west. It is the only existing "full service" staging area, with restrooms, potable water, a picnic area, parking spaces large enough to accommodate equestrian staging and several shade trees, primarily California Pepper trees. The site most directly serves the "M" Trail. It also provides a connection to the proposed Lower Circumference Trail and a proposed, easy loop trail. The site is relatively flat.

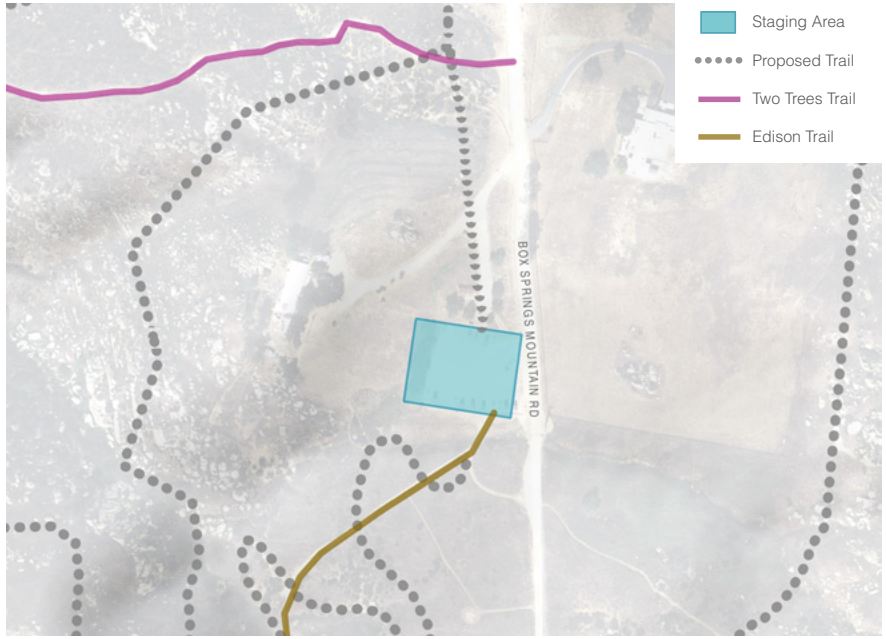
**Figure 2-17: Hidden Springs Drive Staging Area**




## Box Springs Mountain Road Staging Area (Existing)

Box Springs Mountain Road Staging Area is located in the center of the Reserve, at the top of the mountain. It is the only one not located at the open space perimeter. It includes a parking lot, a water source, a portable restroom, an information kiosk and several shade trees, primarily California Pepper trees. This staging area is accessible by vehicle via Box Springs Mountain Road, though equestrian (i.e. trailer) access may be limited due to the road's steepness and surface texture. Because of its central location, this site serves the majority of trails, including the Upper and Lower Circumference Trails, the "M" Trail, the "C" Trail, the Two Trees Trail and Skyline Loop Trails #1 and 2. Though the staging area is officially closed at night, Box Springs Mountain Road remains open, and the section between the access points to the Two Trees Trail and Skyline Loop Trail #1 appears to get nighttime use based on litter and graffiti there. This segment of Box Springs Mountain Road offers panoramic views of the City of Riverside and the mountains beyond and is quite wide, allowing users to park along it.

**Figure 2-18: Box Springs Mountain Road Staging Area**

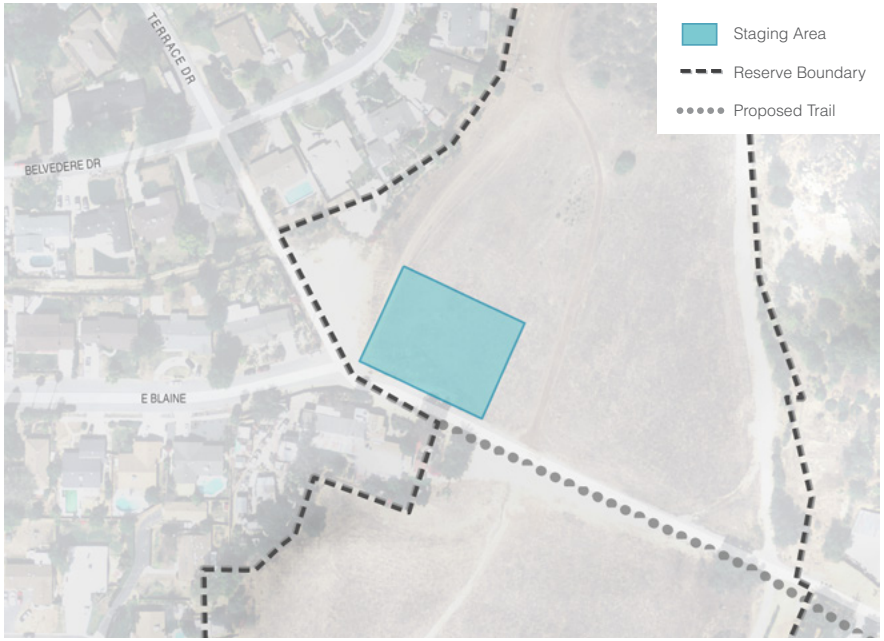


## East Blaine Street Staging Area (Proposed)

East Blaine Street Staging Area is located within the Reserve at the eastern end of East Blaine Street. It lies between suburban residential development to the west and open space, low density residential development and the Reserve to the east. This site currently serves the Two Trees Trail and would provide continued and improved service to the proposed re-routed Two Trees Trail, as well as the proposed Lower Circumference Trail. The site is mostly flat and cleared. It is currently functioning as a parking lot. It is just east of the Perris Valley Line and so does not require an additional rail crossing.

The East Blaine site can also serve as an alternate staging area for the "C" Trail.

**Figure 2-19: East Blaine Street Staging Area**

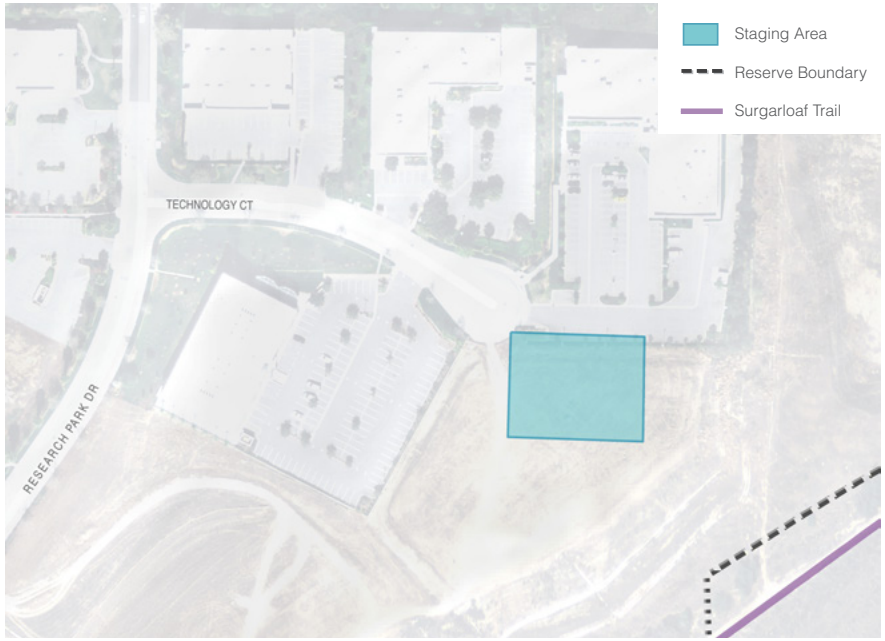



## Sugarloaf/Bike Park Staging Area (Proposed)

Sugarloaf/Bike Park Staging Area is located in the City of Riverside, at the end of Technology Court and roughly 500 feet from Columbia Avenue and 1,000 feet from the proposed Gage Canal Trail. The site is bounded by office/industrial park development to the north and the Reserve to the south. The area to the northeast (Highgrove) is under development and, once built, will include homes and internal trails, as well as tie-ins to the Reserve trails.

This staging area site is unique in that it is envisioned to potentially include a bike skills park. The bike skills park/staging area would most directly serve the proposed Lower Circumference Trail, the Sugarloaf Trails and the proposed Gage Canal. It would also be located less than a mile from the Hunter Park/Marlborough Avenue Metrolink Station. The site is flat due to grading in conjunction with adjacent development and therefore has no vegetation. Coordination with the City of Riverside would be required to develop this site.

**Figure 2-20: Sugarloaf/Bike Park Staging Area**



## Islander Park – Rail Crossing Staging Area (Proposed)

Islander Park – Rail Crossing Staging Area is located within Islander Park in the City of Riverside, where the Perris Valley Line makes an turn near Watkins Drive. The site is located between suburban residential development to the west and the Reserve to the east. The staging area would serve the "C" Trail and the proposed "C" Trail Re-route, as well as the proposed Lower Circumference Trail and the proposed paved, multi-use paved path between Moreno Valley and the UCR area. The site is relatively flat compared to Islander Park overall and has little vegetation. It is adjacent to a wash or drainage and may experience occasional inundation. If sited at the curve of the rail line, as proposed, this staging area would require some sort of rail crossing, through coordination with the Riverside County Transit Commission (RCTC), to be a viable option, as well as coordination with the City of Riverside. (See Chapter 5 for rail crossing design standards and the Appendix for community comments regarding desire for safe rail crossings.)

### Figure 2-21: Islander Park – Rail Crossing Staging Area


## Islander Park – Big Springs Staging Area (Proposed)

Islander Park – Big Springs Staging Area is located within Islander Park, a quarter mile southwest of the proposed Islander Park - Rail Crossing site. Its surroundings are similar to those of its counterpart site, as are the trails potentially served. The site would take advantage of the existing developed portion of Islander Park, but would likely require some improvements and expansion to function as a staging area (to be determined by the City of Riverside Parks, Recreation and Community Services Division). The area is relatively flat with some shrubs, but no trees. Site development would require coordination with the City of Riverside. UCR students currently cross the Perris Valley Line at Big Springs Road to access the "C." This site would provide a connection to the Mt. Vernon Avenue rail crossing, potentially eliminating the need for a crossing at the east end of Big Springs Road. However, making use of this crossing to connect with Reserve trails would require modifying an existing sound wall, significant grading and a retaining wall to support a connecting trail parallel to the tracks. Both the existing sound wall and the potential connecting trail would be located on RCTC property and used by Metrolink, and would need approval from both agencies.

### Figure 2-22: Islander Park – Big Springs Staging Area

## Linden Street Staging Area (Proposed)

Linden Street Staging Area is located adjacent to Islander Park in the City of Riverside to the west of the proposed Islander Park – Rail Crossing Staging Area. The site is surrounded by suburban residential development to the west and the Reserve to the east. The site provides access to the proposed Lower Circumference Trail, the "C" Trail and proposed "C" Trail Re-route. The exact location of this staging area, at Mt. Vernon Avenue, is intended to take advantage of the existing at-grade crossing. As previously noted, to use the existing Mt. Vernon Avenue at-grade crossing, modifications to an existing sound wall and potentially significant grading and a retaining wall would be required to provide a connection between the parking area and the Reserve trail system, which would require approval from both RCTC and Metrolink. This privately owned site is mostly flat with little vegetation. It is bordered by the rail line to the north and partially paved Linden Street to the south.

### Figure 2-23: Linden Street Staging Area


## Hunter Park/Marlborough Avenue Metrolink Station Parking Lot Staging Area (Proposed)

Hunter Park/Marlborough Avenue Metrolink Station Parking Lot Staging Area is located at the Hunter Park/Marlborough Avenue Metrolink Station, in the City of Riverside. (See Appendix for community comments regarding desire for connections via a circumference trail, especially connecting Moreno Valley and UCR.) The site is under development as a light rail station serving Metrolink's Perris Valley Line. It is surrounded by office parks and warehousing and is nearest to the proposed Lower Circumference Trail, Sugarloaf Trails and the proposed Gage Canal Trail. This site lies on the west side of a major roadway and a rail line and does not connect directly to any of the existing or proposed trails. Unpaved routes between this proposed staging area and the Reserve trails are therefore unlikely. Coordination with RCTC would be required to implement the staging area.

### Figure 2-24: Hunter Park Staging Area

## Morton Road Staging Area (Proposed)

Morton Road Staging Area is located within the County of Riverside, but outside the Reserve boundary. The site is nestled above suburban residential development to the south (Moreno Valley), the Reserve to the north and east, and open space and potential development to the west. This site would primarily provide access to the proposed Lower Circumference Trail, a trail along Morton Road and another through the adjacent undeveloped open space. The location of this potential staging area will be governed by future development and would therefore require coordination with its private landholders. The site is the steepest of all the staging area sites analyzed and would require grading.

**Figure 2-25: Morton Road Staging Area**

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# 3

# Methodology

Methodologies were developed to assess both the trails and staging areas and to define potential new trails and staging areas. Primary methods included “performance assessment” and “trail alignment development.” Trails and staging areas were assessed using matrices, including metrics and weights known to influence performance. Trails were developed according to a defined set of typologies. Each type of trail was intended to serve a unique purpose and complement other trails, forming a network.

Another, informal method of assessing and developing trails and staging areas was community input. Community input was particularly helpful in better understanding the existing conditions and potential of trails and staging areas within the Reserve. Community input can be found in Appendix A.

> ***“The need is for diversity and variety in trail systems; long and short, hard and easy, close and far, and for different kinds of users. The greatest need at this time, however, is for day-use opportunities, which must be close to or even inside major population centers.”***
>
> ~ Robert Lucas

## 3.1 Performance Assessment

The main method used to assess trails and staging areas was the application of matrices, including metrics known as either positive or negative trail and staging area characteristics. The exact metrics were refined or eliminated as appropriate, especially eliminating metrics that did not distinguish among the various trails and staging areas. (View quality, for instance, was removed because views are good from all trail alignments.)

Weights were then applied to these metrics to reflect their relative importance. Applying metrics and weighting to each trail and staging area was intended to provide a rigorous and data-driven evaluation. Both metrics used and weights applied are described in the following section. Rankings, the ultimate outcome of the matrices, are presented and discussed in Chapter 4, Recommendations.

### Trail Performance Metrics

Trail matrix inputs included broad goals related to providing positive trail experience, supporting trail maintainability, minimizing user safety impacts and private property concerns. Goals are supported by more concrete objectives and quantifiable performance measures, all of which are listed in Table 3-1. Weights applied to the above performance measures reflect project goals, public input and trail design best practices. Objectives 1b, 3 and 5 were weighted strongly (1.5) because they influence all trail users' accessibility and experience. Objective 6, which minimizes impacts to adjacent private property owners, was also weighted strongly, in part because of the levels of graffiti and vandalism observed to be impacting the Reserve. Objectives 1 and 4 were assigned relatively low weights (0.5) because, though they add value, they are not essential to general trail access and enjoyment.

Table 4-1 provides the trail rankings, according to the performance measures in Table 3-1, and highlights the measures that most strongly influenced rankings.

**Table 3-1: Trail Performance Metrics**

| Goal | Objective | | Performance Measure | Unit | Weight |
|---|---|---|---|---|---|
| Provides an enjoyable trail experience | 1a. | Accommodate and appeal to a variety of non-motorized trail users | Trail accommodates pedestrian, equestrian and bicycle uses. Percent of trail length less than or equal to 5 percent grade | Percent | 0.5 |
| | 1b. | | Trail optimizes compliance with accessibility standards by minimizing long steep grades. | Average slope | 1.5 |
| | 2. | Highlight points of interest | Trail offers connectivity to, and/ or between, one or more points of interest. | Y/N | 1 |
| | 3. | Provides visual interest and aesthetic appeal | Trail offers opportunities to experience different ecological environments. (Vegetation) | Number of plant communities intersected | 1.5 |
| | 4. | Provide opportunities for shade | Trail within native, non-riparian wooded habitat. (Wooded Vegetation) | Percentage of trail that intersects shaded areas | 0.5 |
| Supports trail maintainability | 5. | Built according to best practices, in terms of sustainable design | Trail takes advantage of natural cross slopes (2-60 percent). | Average cross slope | 1.5 |
| Minimizes user safety impacts and private property concerns | 6. | Minimize land use conflicts | Adjoining land uses present potential for trespass, vandalism, privacy concerns, and/or user safety concerns for trail users. (Number of private property owners) | Number of private property owners | 1.5 |

> ***Few actions can do more to make urban areas safer, healthier, prettier, and more environmentally balanced than setting aside corridors or trails for walking, biking, wildlife watching, and just plain breaking up the monotony of cars and concrete.***
>
> ~ James Snyder

## Staging Area Performance Metrics

Staging area matrix inputs included broad goals related to positive site characteristics, property ownership and safety. Goals are supported by more concrete objectives and quantifiable performance measures, all of which are listed in Table 3-2.

Weights applied to each performance measure reflect project goals, public input and staging area siting and design best practices. Objective 6, "physical safety" had by far the top priority weighting factor (2), a reflection that much of the existing trail network is difficult to access by emergency personnel. Objectives 1, 2 and 5 were weighted strongly because they are associated with the feasibility of the most basic staging areas. Objectives 3, 4 and 7 were assigned relatively low weights because they relate more to comfort and specific user groups (e.g. equestrians will be the only user group strongly affected by Objective 3 because not all staging areas are intended to provide equestrian facilities).

Table 4-5 provides the staging areas rankings, according to the performance measures in Table 3-2, and highlights of the measures that most strongly influenced the rankings.

**Table 3-2: Staging Area Performance Metrics**

| Goal | Objective | Performance Measure | Unit | Weight |
|---|---|---|---|---|
| Site Characteristics | 1. Site avoids steep grades/grading requirement | Average site grade | Percent Slope | 1 |
| | 2. Site serves multiple trails | Number of trails within 0.25 miles of trail head | Count | 1 |
| | 3. Site directly connects to preserve via natural surface route(s) | Connecting surface type(s) to trail head (natural or paved) | Yes/No | 0.5 |
| | 4. Site offers access to utilities for future restrooms and drinking fountains | Distance from nearest utility hook-ups (Water, sewer, electricity) | Miles | 0.5 |
| Site owned and managed by Riverside County Parks Department | 5. Site avoids/minimizes property acquisition required | Located on private property | Yes/No | 1 |
| Safety | 6. Physical safety: Site is easily accessed by emergency personnel | Distance to nearest fire station | Miles | 2 |
| | 7. Personal safety: site is visible, not secluded | Population density within 0.25 miles of staging area | Population/ Acre | 0.5 |

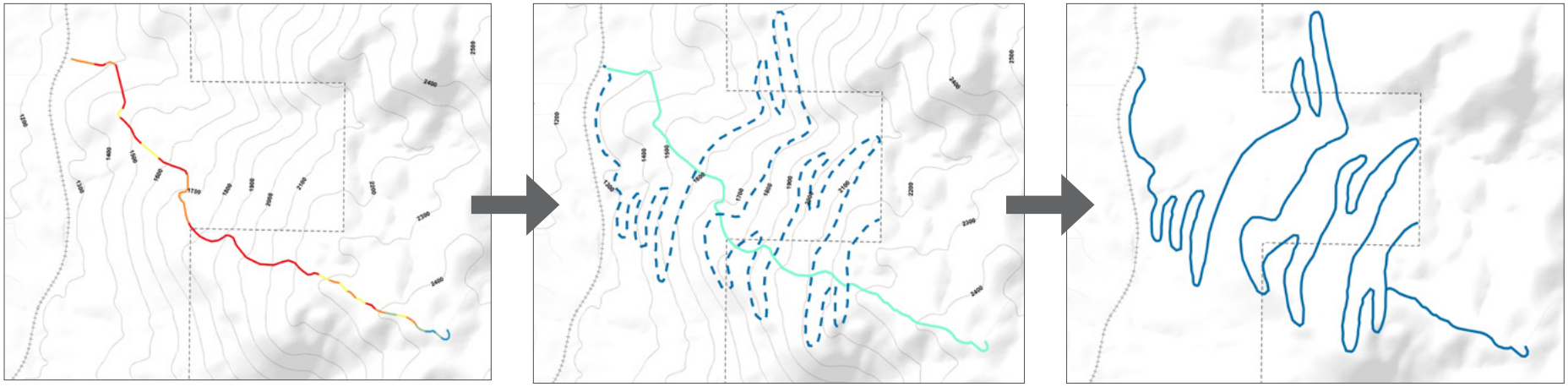
## 3.2 Trail Alignment Development

Methods used to define proposed trails included multiple strategies such as re-routing of some existing trails, circumference loop creation, providing intra-Reserve connections, vista or viewpoint opportunities and improved local and regional connections.

### Trail Re-routing

Despite several existing trails' state of disrepair, they are beloved and well used. The proposed trails development took advantage of slope analysis conducted as part of the existing trails evaluation. The average slope was analyzed per 100 foot trail segment, rather than for entire trails. Color coding these 100 foot segments in the GIS model provided a readily understandable visual assessment of the variable existing conditions throughout each trail and revealed that many can be significantly improved by simply rerouting the worst, or least sustainable, segments.

Improving sustainability meant decreasing trail slope along its overall length, while maintaining adequate trail cross slope to promote sheet flow off the trail rather than allowing water to channel and run down the trail, causing ruts. In practice, both of these aims can usually be addressed by more closely following the Reserve's natural contours. 100 foot contour intervals were added to the map and unsustainable trails or segments were re-routed to align with the prevailing slope as closely as possible. New routing generally follows existing trail routing to maintain access to existing popular destinations, but with more sustainable routing that many users will also find more interesting and enjoyable.



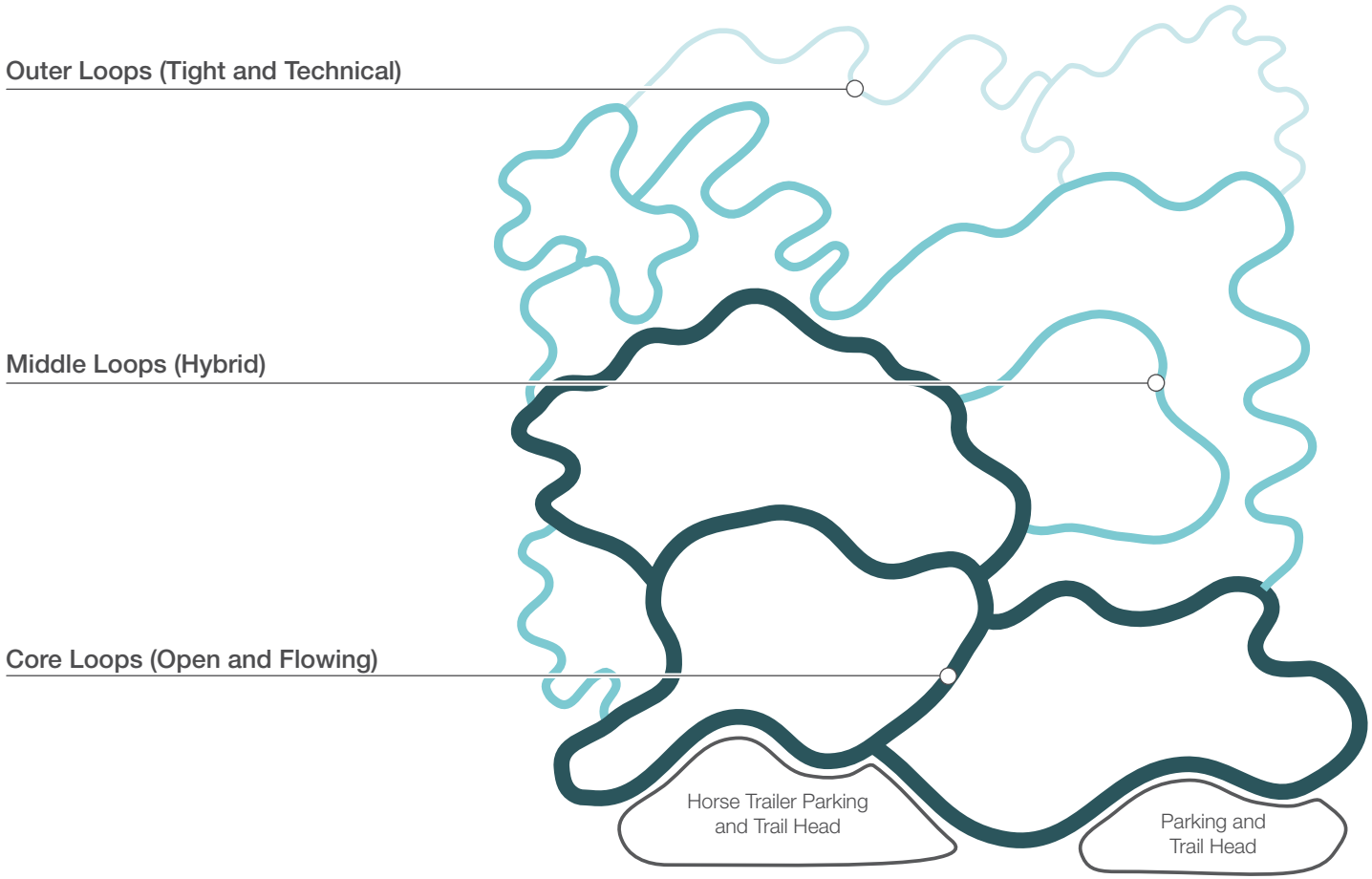
*Existing Trail Slope at 100 Foot Intervals*

*Trail Re-Route Along Natural Contours*

*Refined Trail (Re-Route)*

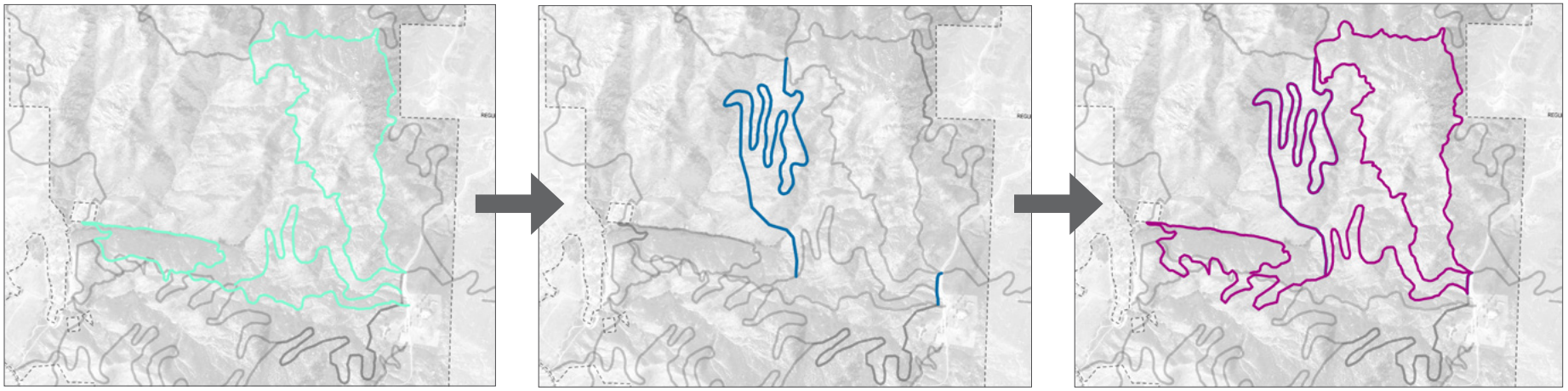
## Circumference Trails

Based on precedents in many other open space areas to provide multiple loop opportunities, the project team defined two Circumference Trails, one near the base of the mountain and one upslope and closer to the mountain top. These trails generally followed contours, but were routed around any significant constraints (e.g. riparian areas, private property, etc.). These trails, in addition to connecting the existing, somewhat disjointed trails, provide greatly increased routing options and more varied trail experiences. These trails allow users to string several segments together, allowing them to create larger and smaller loops as desired. Providing more variety is also important to supporting different kinds of trail uses, such as long distance cross-country or technical mountain biking, short to long distance runs or hikes, after work dog walking, etc. This type of trail design, also known as a "stacked loop system," is demonstrated in the figure below. The actual Circumference Trails are presented and further described in Chapter 4.



## Intra-Trail Connections

Connections were also provided where reasonable to better link existing and proposed trails. Similar to the Circumference Trails, these trails generally follow contours, but deviated when required. These smaller connector trails added yet more trail options. Notably, many of the trail options form short loops, ideal for more casual trail users or those looking for variety in their trail experience.



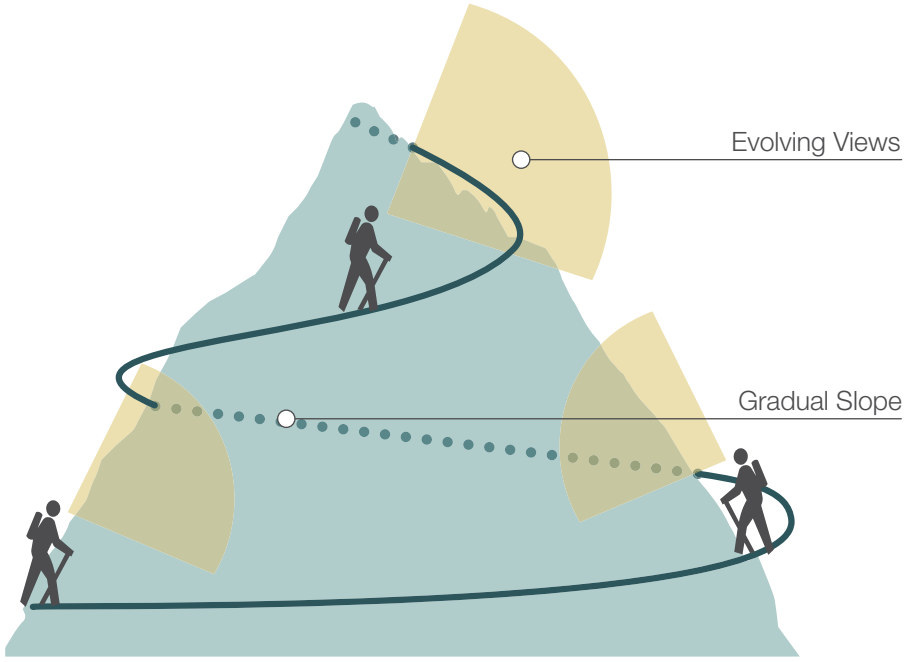
*Existing Disconnected Trail Segments*

*Proposed Intra-Trail Connections*

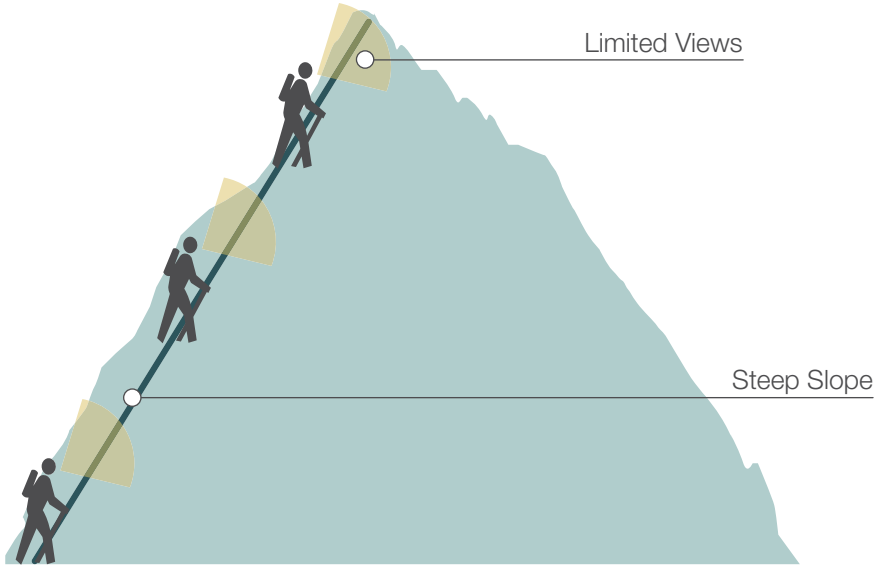
*Refined Loop Trail*

## Vista Opportunities

It is common in open space to find “informal” trails leading to high points, often very steep and rutted. This proposed trail type was borne of this desire for trail users to reach summits, feel a sense of achievement and look out over the vistas below. These proposed short winding routes around some of the Reserve’s peaks are intended to provide these desired vistas while maintaining trail sustainability and a positive trail user experience. By winding around the peaks and following the contours, sustainable grades can be more easily maintained than is commonly found on “informal” routes to high points. Winding around the peaks will also provide users evolving vistas of the surrounding area during their trips up and down, rather than being forced to concentrate solely on avoiding slipping on the typically very steep, rutted trails often leading to peaks.




**Vista Trail**




**“Informal” Trail**

**10,000**

Additional residents served by
local and regional connection trails

## Local and Regional Connections

The methodology for creating the proposed trail system included considering the local and regional connections throughout and surrounding the study area. As seen in Figure 3-1, there are a variety of local and regional destinations including:

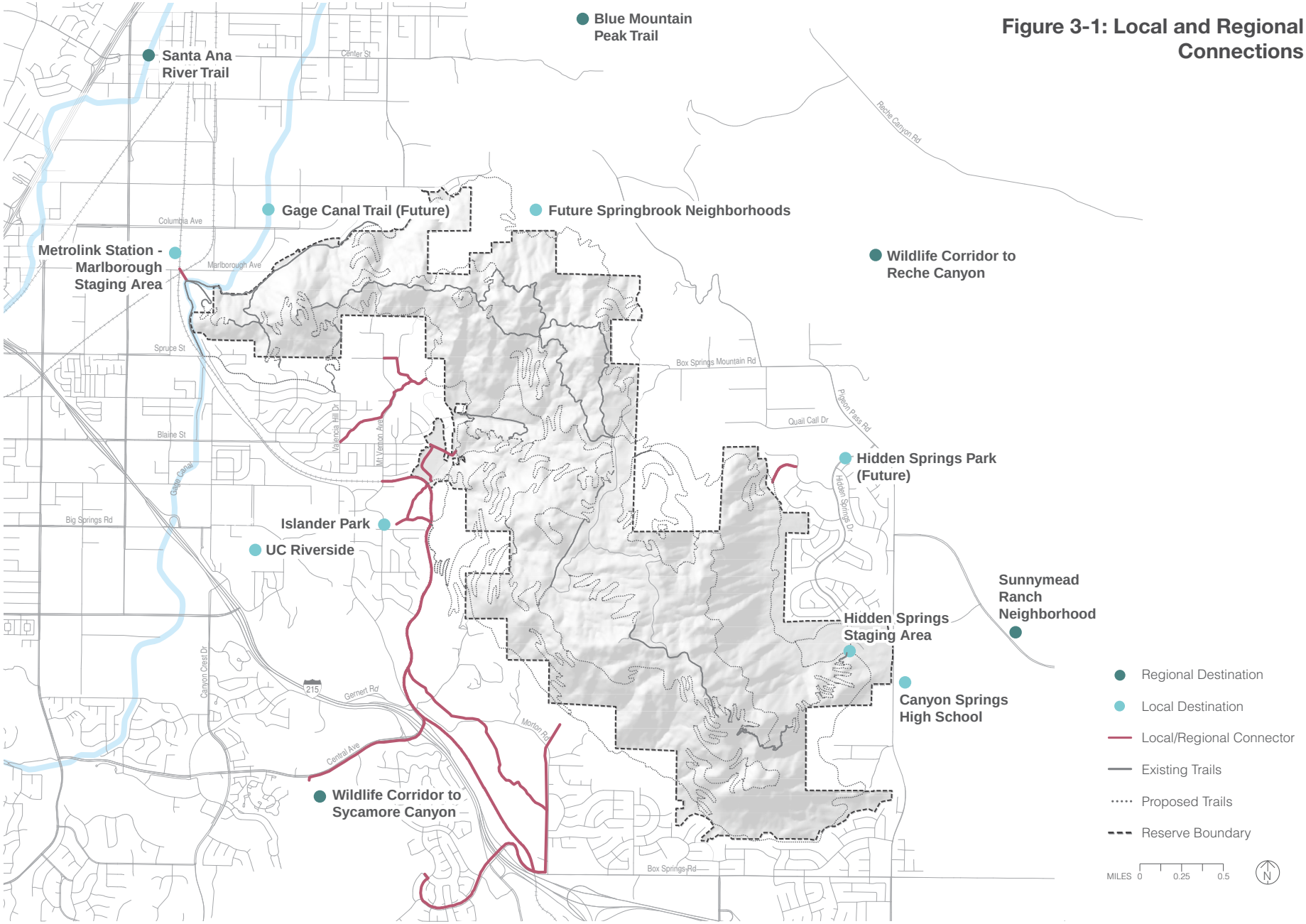
- UCR Campus
- Islander Park (Potential new Staging Facility at Islander Pool Parking Lot)
- Future Gage Canal Trail (Spruce and Watkins)
- Santa Ana River Trail (access from Center Street)
- Metrolink Stations - (Marlborough Avenue, etc.)
- Canyon Springs High School
- Sunnymead Ranch Neighborhood: Hidden Springs Trail
- Hidden Springs Staging Area
- Highgrove Area: Future Springbrook Neighborhoods
- Blue Mountain Peak Trail, Grand Terrace
- Wildlife Corridor to Reche Canyon
- Wildlife Corridor to Sycamore Canyon Wilderness

To ensure that good connections were made, the above destinations and areas were encoded as points and a visual analysis was used to determine whether connections between these points and the Reserve could be made via existing and proposed trails, existing street networks or a combination of the two. When appropriate, new, formal connections (trails) were proposed between the listed destinations and the Reserve.

In some instances, direct or literal connections to the above areas and destinations were neither possible nor desirable. For examples, connections to the Santa Ana River Trail and the Reche and Sycamore Canyon Wilderness Areas and the Blue Mountain Peak Trail needed to remain fairly diagrammatic due to their distance from the Reserve and their lack of a distinct center. To identify one particular route would be overly prescriptive where several possible origins, destinations and routes may exist. In such cases, general connectivity is implicitly understood.

The construction of local and regional connection trails would provide service to an additional 10,000 residents surrounding the Reserve trails (based on GIS analysis of the surrounding Census tracts).

## Figure 3-1: Local and Regional Connections



## 3.3 Staging Area Development

Unlike the trails analysis that addressed existing facilities only, staging area analysis included both existing and proposed sites. The staging area analysis process differed from that of trails because there were too few existing staging areas (two) for comparison. Adding a number of proposed staging areas allowed for greater, meaningful comparison within the analysis process. Proposed staging areas were developed according to the criteria listed below.

The process of developing new staging areas used the same criteria for both types - those that may accommodate equestrian use and those that may accommodate hiking and biking only. The criteria for all staging areas includes:

1) Even/Equitable Distribution: distributed relatively evenly around the Reserve, particularly at the base of the mountain and along the proposed Lower Circumference Trail
2) High Level of Service: located to maximize service to both existing and proposed trails
3) Adequate Space: located on sites with ample space to accommodate a variety of trail uses, including equestrian use where possible (1/2 acre)
4) Public Land: located on publicly held land, if possible; staging areas located on private land, provided property acquisition is feasible
5) Flat Land: located on relatively flat land to minimize grading requirements (slope is five percent or less)

> ***"Trail design should seek to accomplish three objectives, these are the satisfaction of the user, protection of resource, and cost effectiveness."***
>
> ~ Joseph Wernex

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# 4

# Recommendations

This chapter includes recommendations for proposed trails and staging areas. The trails section begins with a summary of the existing trail assessment results. These results provide rankings indicating the level of effort required to bring the trails to appropriate standards for sustainability and user experience. This summary is followed by recommendations for each trail including trail re-routes, circumference trails, intra-trail connections, vista opportunities, and local-regional connections. Details for each of the proposed trails include trail length, elevation change, connections, access and environment.

The staging area section begins with a summary of the staging area assessment results for both existing and proposed staging areas. Like trails, these results include rankings indicating the level of effort required by each staging area to meet sustainability and user experience standards. Details for each of the existing and proposed staging areas, including surrounding context, trails connected to and site amenities, are provided in Chapter 2.

Should construction of the proposed trails and staging areas point to the need for land acquisition, further study and coordination with property owners and other agencies would be required. This plan does not identify the need to acquire land.

> ***"Trails and parks are as necessary to communities as roads, sewer systems and utility grids."***
>
> ~ Peter Harnick

## 4.4 Proposed Trail Network

The proposed trail network comprises segments of both existing and new trails. This plan recommends a total of 68.5 miles of new trails and 5.9 miles of trails to be abandoned due to unsustainability and poor user experience. Of the 68.5 miles of new trails, roughly 39 percent are circumference trails, 34 percent are trail re-routes, 13 percent are local-regional connectors, 10 percent are connector trails, and four percent are vista trails.

Each of the proposed trails are described in detail in the following sections. Note that since this is a "planning level" document, it provides conceptual alignments only. These alignments, paired with the design guidelines in Chapter 5, are intended to provide general guidance. Precise alignments and design details would be required prior to construction of trails and staging areas.

### Trail Assessment

To determine the best locations for the proposed trail network, the existing trails were first assessed (Table 4-1). The assessment included rankings and performance measure highlights. Rank indicates the level of effort required to improve each trail and does not imply prioritization of improvements. For example, many of the trails that ranked "low," indicating a high level of effort required to improve them, became candidates for re-routing among the proposed trails (See Section 4.3). Ranks are supplemented by performance measure highlights, which provide additional background information (i.e. why the trail ranked as it did).

> ***"A variety of factors are necessary for sustainable, low-impact trails. By carefully fitting the trail profile to the local topography, erosion will be minimized, increasing natural surface's durability and sustainability."***
>
> ~ NPS Natural Resource Management Reference Manual # 77

**Table 4-1: Trail Assessment**

| Trail | Level of Effort Required for Improvement | Performance Measure Highlights | |
|---|---|---|---|
| Skyline Loop #1 | 1 | • Does not traverse multiple ecological communities<br>• Does not include shade opportunities | • Takes advantage of natural cross slopes<br>• No land use conflicts<br>• No private property impacts |
| Skyline Loop #2 | 1 | • Does not traverse multiple ecological communities<br>• Does not include shade opportunities | • Takes advantage of natural cross slopes<br>• No land use conflicts<br>• No private property impacts |
| Sugarloaf Trail | 3 | • Though average slope is fairly high (15%), comparatively large share of trail (24%) has slope of 5% or less | • Traverses multiple ecological communities |
| Edison Trail | 4 | • Trail minimizes long, steep grades<br>• Traverses multiple ecological communities<br>• Includes some shade opportunities | • Does not take advantage of natural cross slopes<br>• Includes land use conflicts<br>• Potential private property impacts |
| Two Trees Trail | 5 | • Comparatively small percentage of trail (12%) has slope of 5% or less<br>• Traverses multiple ecological communities | • Includes several shade opportunities<br>• Includes land use conflicts |
| “M” Trail | 6 | • Does not traverse multiple ecological communities<br>• Does not include shade opportunities | • Takes advantage of natural cross slopes<br>• Includes land use conflicts |
| “C” Trail | 7 | • Extremely small portion of trail (5%) has slope of 5% or less<br>• Large percentage of trail has long, steep grades<br>• Includes comparatively high connection to points of interest (twice as many as other trails) | • Does not traverse multiple ecological communities<br>• Does not include shade opportunities<br>• Does not take advantage of natural cross slopes<br>• Includes land use conflicts<br>• Potential private property impacts |

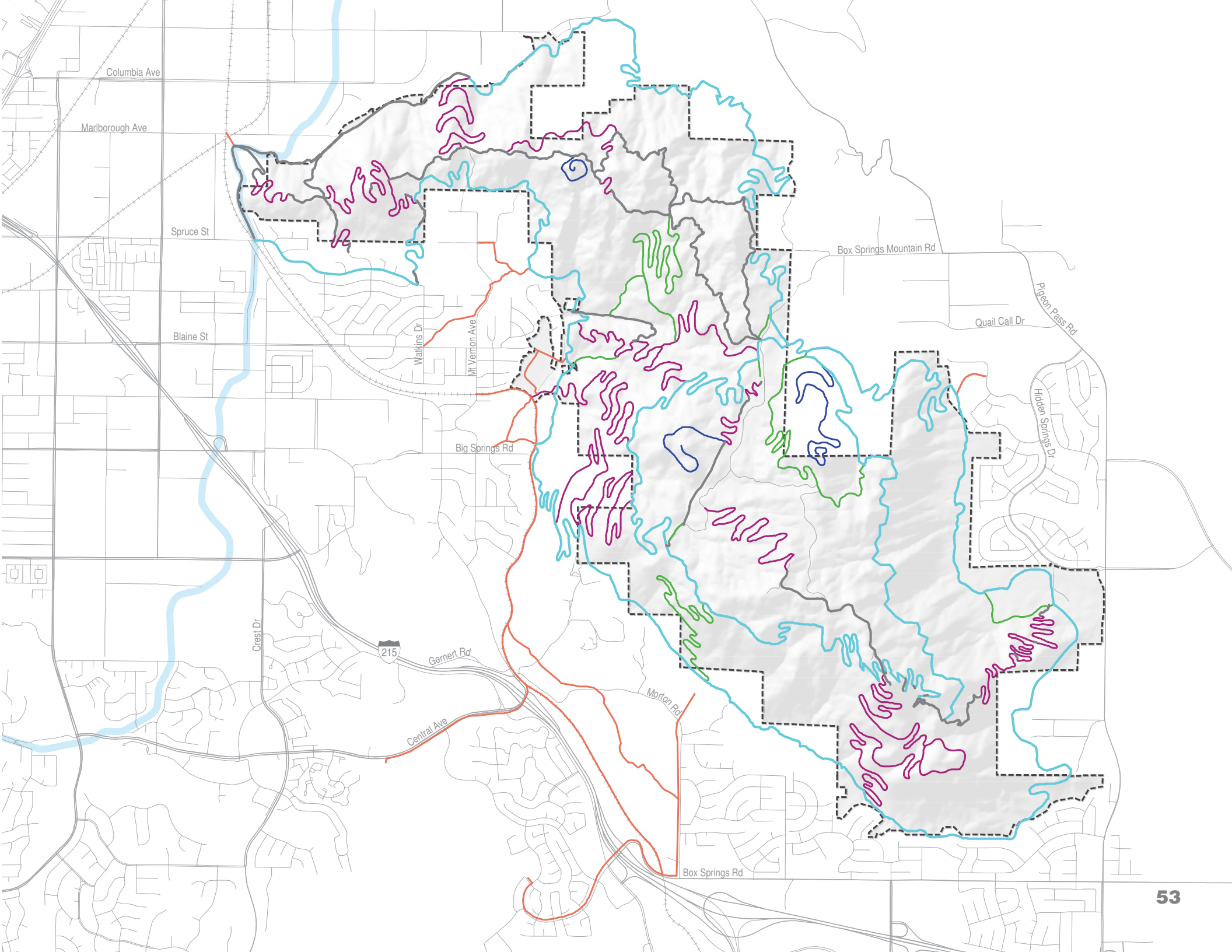
**Figure 4-2:**

# Proposed Trail Network

- Existing Trail
- Circumference Trail
- Intra-Trail Connector
- Vista Trail
- Trail Re-Route
- Local-Regional Connector
- Reserve Boundary

MILES 0 0.25 0.5

N


Columbia Ave
Marlborough Ave
Spruce St
Blaine St
Watkins Dr
Mt Vernon Ave
Big Springs Rd
Box Springs Mountain Rd
Quail Call Dr
Pigeon Pass Rd
Hidden Springs Dr
Crest Dr
215
Gernert Rd
Central Ave
Morton Rd
Box Springs Rd

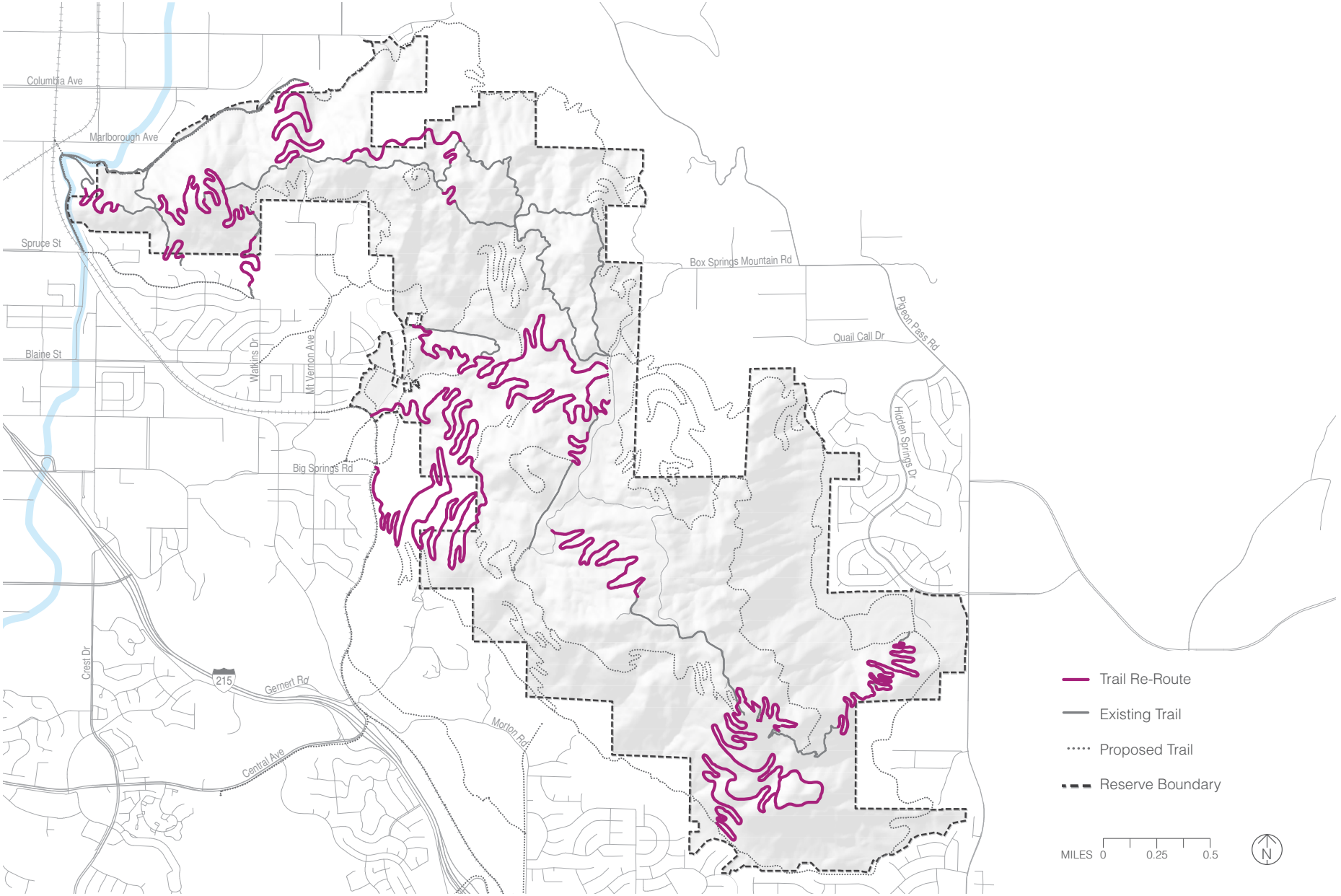
## 4.5 Trail Re-routes

Trail re-routes were driven primarily by the goals of improving both trail sustainability and user experience. These two major goals go hand-in-hand. Using trail system design best practices, as well as community input, this plan proposes multiple possible experiences. In particular, it recommends the provision of "technical" trail options serving many of the existing trail routes. These trails would offer alternate routes for mountain bikers, trail runners and hikers seeking a more challenging experience. These trails would likely be routed to take advantage of a trail corridor's boulders and rock slabs to create a more technical or challenging experience than the other routes that would circumvent such site elements. The total length of all trail re-routes is 25.7 miles.

Trail re-routes are shown in Figure 4-3 and the details for each trail re-route are included in the following section.

> ***"No factor in trail construction is more important than proper drainage, and many sections of good trail are damaged and destroyed by erosion that could have been prevented."***
>
> ~ Guy Arthur

**Figure 4-3: Trail Re-Routes**



## Skyline Loop Trail #2 Re-route

Skyline Loop #2 re-route extends from the Sugarloaf Trails in the north to the Skyline Loop #1 in the south. Since the existing trail's slope analysis indicated only small unsustainable segments, only these "problem" segments were re-routed as part of the Skyline Loop #2 re-route. The vast majority of the existing loop was retained.

**Trail Length**

0.34 mile

**Elevation Change**

Not applicable (negligible elevation change)

**Trail Connections**

Skyline Loop Trail #1, Intra-Trail Connector 1 (Figure 4-11), Sugarloaf Trail (Figure 4-5), and Sugarloaf Trail Re-route – Technical (Figure 4-5)

**Trail Access**

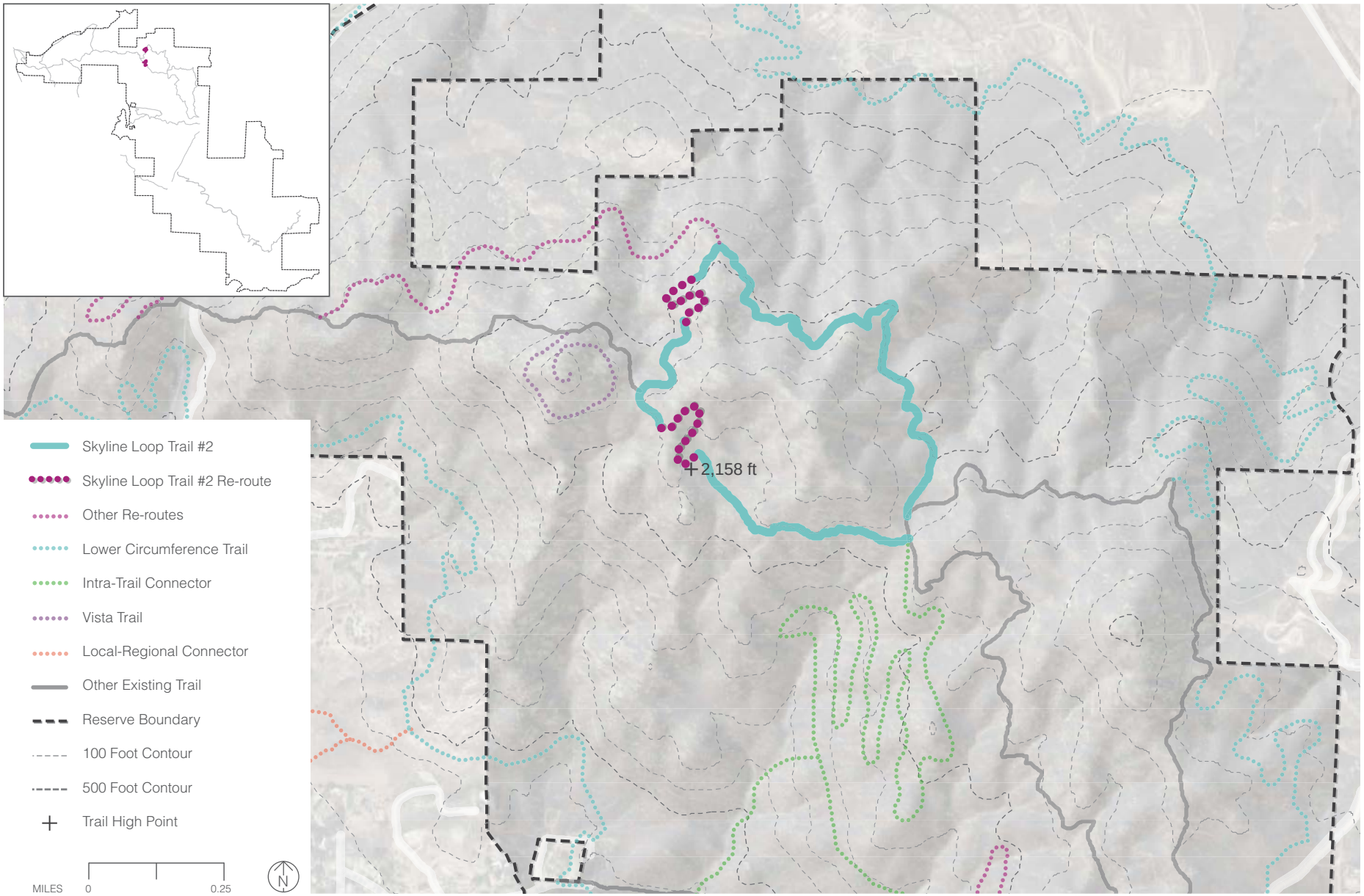
Direct: No direct access

Indirect: Box Springs Mountain Road staging area (via Skyline Loop #1), Sugarloaf/Cycle Park staging area (via Sugarloaf Trail) and the trailheads along the Lower Circumference Trail

**Environment**

Trail crosses no major riparian or shade tree areas

**Figure 4-4: Skyline Loop Trail #2 Re-routes**



## Sugarloaf Trail Re-route

Sugarloaf Trail re-route is not one, but five, fairly short re-routes of unsustainable segments of the existing Sugarloaf Trails. As with several of the other re-routed trails, much of the existing Sugarloaf Trails could be retained, with re-routing addressing only the most problematic segments.

**Trail Length**
3.12 miles

**Elevation Change**
Not applicable (elevation varies)

**Trail Connections**
Skyline Loop Trail #2 (Figure 4-4), Vista Trail 2 (Figure 4-12), Lower Circumference Trail (Figure 4-10), and Local-Regional Connector 1 (Figure 4-13)

**Trail Access**
Staging areas at Hunter Park/Marlborough Metrolink Station and Sugarloaf/Cycle Park (Proposed); trailheads along Lower Circumference Trail

**Environment**
Trail crosses no major riparian or shade tree areas

## Sugarloaf Trail – Technical 1

The Sugarloaf Trail re-route - Technical 1 extends north of an existing Sugarloaf Trail, paralleling it for less than a mile, and terminates at the northern point of Skyline Loop #2. This trail is one of two technical trails intended to provide a more challenging experience, while maintaining a sustainable design and an enjoyable user experience. As a standalone, “offshoot” route, this trail provides an opportunity to experience a more challenging trail.

**Trail Length**
0.77

**Elevation Change**
Not applicable (negligible elevation change)

**Trail Connections**
Skyline Loop Trail #2 (Figure 4-4) and Sugarloaf Trail (Figure 4-5)

**Trail Access**
Staging areas at Hunter Park/Marlborough Metrolink Station and Sugarloaf/Cycle Park, trailheads along Lower Circumference Trail

**Environment**
Trail crosses no major riparian or shade tree areas

## Sugarloaf Trail Re-route – Technical 2

The Sugarloaf Trail re-route - Technical 2 extends from the Lower Circumference Trail, near Mt. Vernon Avenue, at base of the mountain to the existing Sugarloaf – Ridgeline – Trail at the top. This trail is the second of two technical trails intended to provide a more challenging experience, while maintaining a sustainable design and an enjoyable user experience. It is more of a re-route than the Technical 1 Trail, retaining the general direction of the existing trail, but fundamentally reworking the alignment.

**Trail Length**
1.66

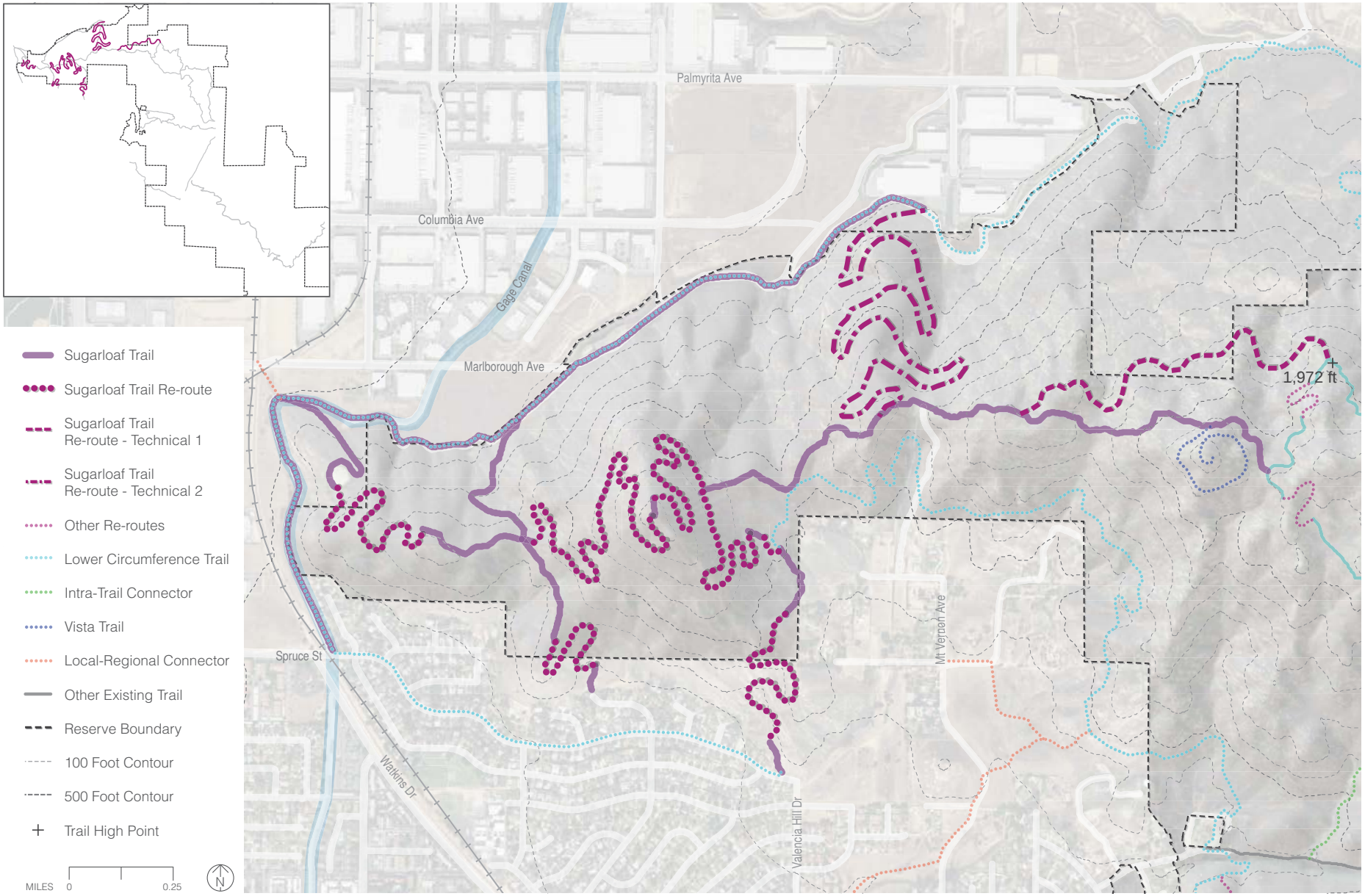
**Elevation Change**
~500 feet

**Trail Connections**
Lower Circumference Trail (Figure 4-10), Sugarloaf Trail (Figure 4-5)

**Trail Access**
Staging areas at Hunter Park/Marlborough Metrolink Station and Sugarloaf/Cycle Park, trailheads along Lower Circumference Trail

**Environment**
Trail crosses no major riparian or shade tree areas

**Figure 4-5: Sugarloaf Trail Re-routes**



## Edison Trail Re-route

Edison Trail re-route extends from the Box Springs Mountain Road staging area in the northeast to the “M” Trail in the southwest. The existing Edison Trail is mostly flat and is one of the more sustainable trails, requiring relatively little re-routing. Slope analysis and community input, however, did indicate “problem areas” where the trail’s virtually straight alignment crosses small steep canyons. The two re-routed sections are needed for sustainability and user enjoyment, but additional areas may also be considered for re-routing to increase trail interest (See Design Guidelines). The plan recommends combining the re-routes with the remaining sustainable segments to form a refined Edison Trail.

**Trail Length**

0.64 miles

**Elevation Change**

Not applicable (negligible elevation change)

**Trail Connections**

Direct: “M” Trail (Figure 4-8), Intra-Trail Connector 5 (Figure 4-11), Intra-Trail Connector 6 (Figure 4-11), Vista Trail 1 (Figure 4-12)

Indirect: Upper Circumference Trail (Figure 4-10), Two Trees Trail (Figure 4-7), Intra-Trail Connector 6 (Figure 4-11)

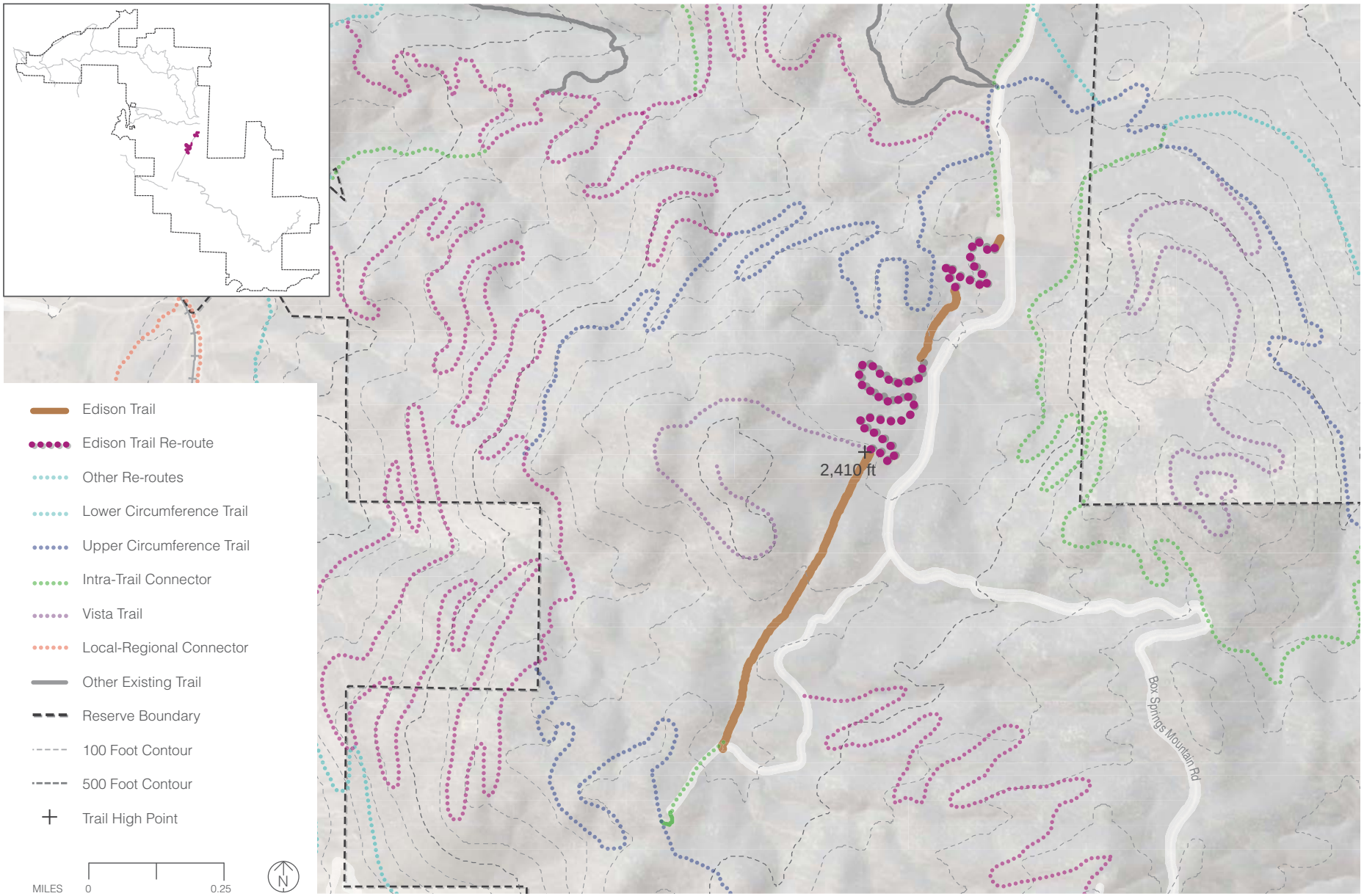
**Trail Access**

Box Springs Mountain Road staging area

**Environment**

Trail crosses no major riparian or shade tree areas

**Figure 4-6: Edison Trail Re-routes**



## Two Trees Trail Re-route

Two Trees Trail re-route extends from about 1,000 feet north of the existing Two Trees Trail at the base of the mountain to the upper terminus of the existing Two Trees Trail. The approximate upper third of the trail re-route doubles as a segment of the Upper Circumference Trail.

**Trail Length**
2.99

**Elevation Change**
~900 feet

**Trail Connections**
Lower and Upper Circumference Trails (Figure 4-10) and Intra-Trail Connector 3 and 5 (Figure 4-11)

**Trail Access**
Direct: Proposed East Blaine Street staging area or existing Box Springs Mountain Road staging area

Indirect: Islander Park staging area (e.g. Big Springs Road, Linden Street or Perris Valley Line) or one of many recommended trail heads

**Environment**
Trail crosses riparian or shade tree areas

## Two Trees Trail Re-route – Technical

Two Trees Trail - Technical re-route runs north of the Two Trees Trail re-route, extending from roughly the midpoint of the standard re-route to the Upper Circumference Trail at the top of the mountain. This trail deviates from the existing Two Trees route to (a) avoid excessive trail density (and trail cutting) and (b) avoid a drainage area just to the south.

**Trail Length**
1.09

**Elevation Change**
~550 feet

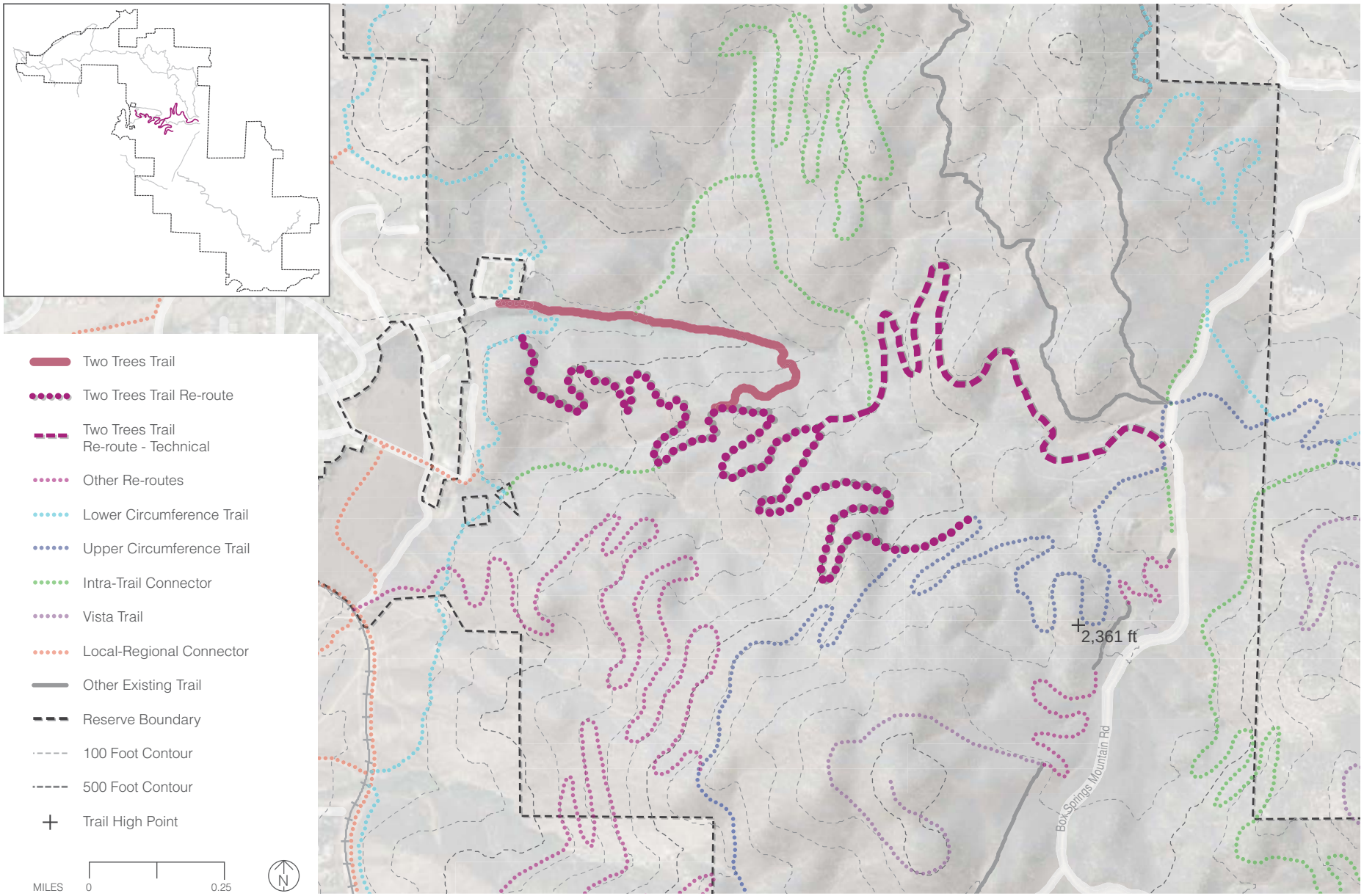
**Trail Connections**
Upper Circumference Trail (Figure 4-10), Two Trees Re-Route (Figure 4-7), and Intra-Trail Connector 1 (Figure 4-11)

**Trail Access**
Direct: proposed East Blaine Street staging area or existing Box Springs Mountain Road staging area

Indirect: Islander Park staging area (e.g. Big Springs Road, Linden Street or Perris Valley Line) or one of many recommended trail heads

**Environment**
Trail alignment intended to cross few riparian or shade tree areas

**Figure 4-7: Two Trees Trail Re-routes**



## "M" Trail Re-route

"M" Trail re-route extends from the Hidden Springs Drive staging area at the base of the mountain to the Edison Trail near the top. The trail follows the general alignment of the existing trail as closely as possible, while adhering to the principles of sustainable and enjoyable trail design. As identified in the slope analysis of existing trails, the existing "M" Trail is highly variable, in terms of slope and sustainability. The most unsustainable upper and lower thirds of the trail would be re-routed, while the existing middle portion was retained.

**Trail Length**
4.71 miles

**Elevation Change**
~550 feet

**Trail Connections**
Upper and Lower Circumference Trails (Figure 4-10), the "M" Trail Reroute – Technical (Figure 4-8), the Edison Trail (Figure 4-6), and Intra-Trail Connector 9 (Figure 4-11), which forms a relatively flat one mile loop near the "M" Trail trailhead

**Trail Access**
Hidden Springs Drive staging area

**Environment**
Trail crosses no major riparian or shade tree areas

## "M" Trail Re-route – Technical

"M" Trail re-route – Technical extends from the Lower Circumference Trail, near Del Amo Street (Moreno Valley), at the bottom of the mountain to the Existing "M" Trail at the top of the mountain. This trail's alignment deviates strongly from that of the other "M" Trail re-route, and are alike only in providing connections to the "M." This was driven largely by the desire to provide an alternate more challenging trail and topography that restricted the route (i.e. It would have been difficult to provide a technical route closer to the "M" Trail re-route, without violating principles of sustainable and enjoyable trail design).

**Trail Length**
4.17 miles

**Elevation Change**
~1,150 feet

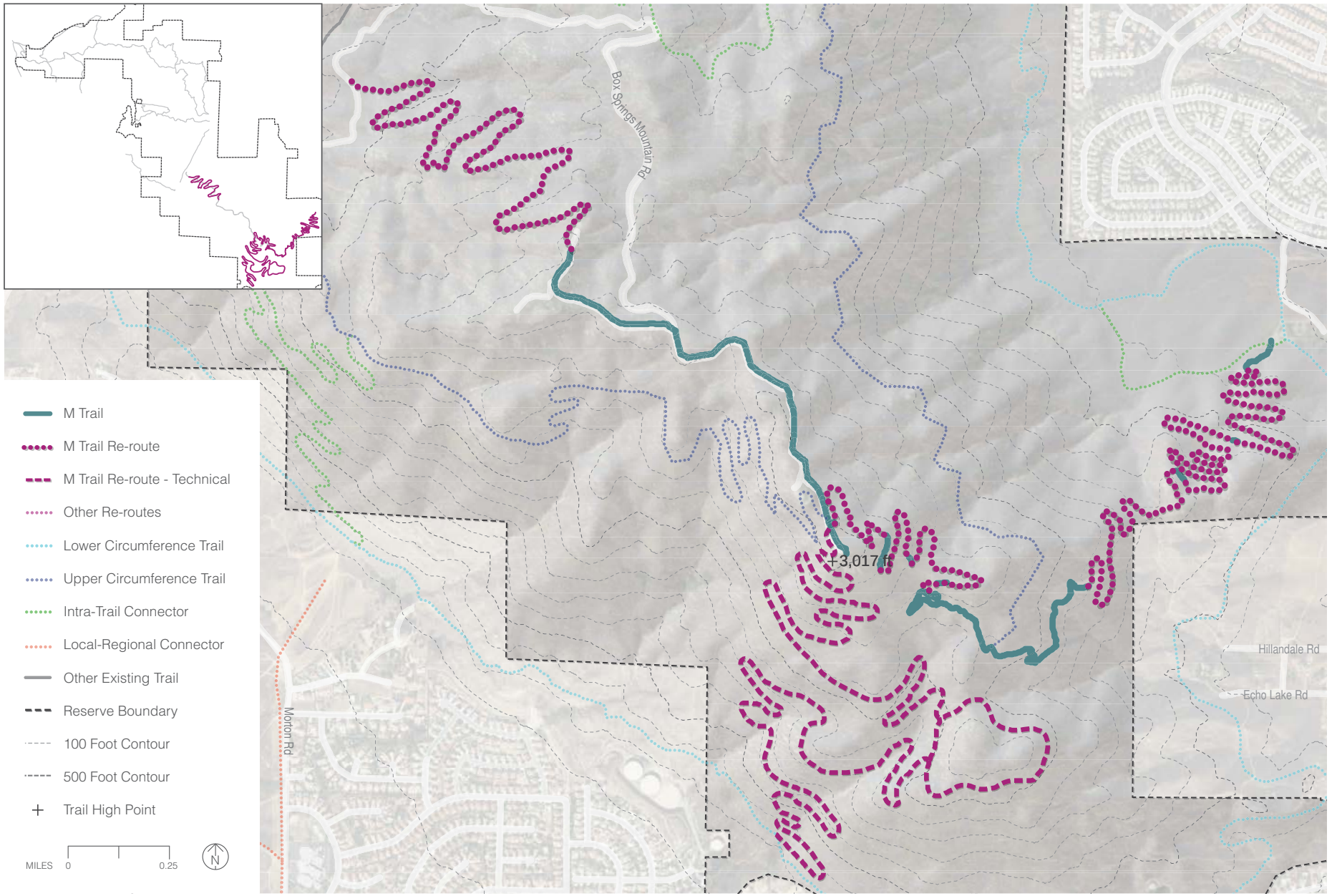
**Trail Connections**
Upper and Lower Circumference Trails (Figure 4-10) and "M" Trail Re-route (Figure 4-8)

**Trail Access**
Direct: Trailheads along Lower Circumference Trail

Indirect: Hidden Springs Drive or Morton Road staging areas

**Environment**
Trail crosses no major riparian or shade tree areas

**Figure 4-8: "M" Trail Re-routes**



## "C" Trail Re-route

"C" Trail Re-route extends from the proposed rail-side multi-use path, near the eastern end of Big Springs Road at the bottom of the mountain to approximately 675 feet northeast of the "Big C." Because the existing "C" Trail is so rutted and otherwise damaged, proposed re-routes employed no portion of it, but attempted to follow its general trajectory. It therefore follows the existing trail's general alignment as closely as possible, but adheres to sustainable and enjoyable trail design principles. As is typical of sustainable trail design, this re-route's reduced slope adds a significant increase in trail length, which is not a negative for recreational trails. Due to this re-route, portions of this trail fall beyond the Reserve boundary.

**Trail Length**
3.75 miles

**Elevation Change**
~1,000 feet

**Trail Connections**
Direct: Lower and Upper Circumference Trails (Figure 4-10), the "C" Trail Re-route – Technical (Figure 4-9), and the Local-Regional Connector 5 - the multi-use path between Moreno Valley and UCR (Figure 4-13)

Indirect: Edison Trail (Figure 4-6), Intra-Trail Connector 7 (Figure 4-11)

**Trail Access**
Islander Park staging area (e.g. Big Springs Road, Linden Street or Perris Valley Line), the existing Box Springs Mountain Road staging area or one of the many recommended trail heads

**Environment**
Trail runs adjacent to a riparian area, with shade tree areas, near the mountain's base

## "C" Trail Re-route – Technical

"C" Trail re-route - Technical extends from the proposed rail-side multi-use path, from near the eastern end of Linden Street at the bottom of the mountain to about 675 feet northeast of the "Big C" at the top of the mountain. (It adjoins the "C" Trail re-route previously described.) Though the "start" and "end" of this trail are nearly coincident with that of the other "C" Trail re-route, the majority of this trail deviates strongly from the existing trail alignment. By veering north of the existing alignment, this trail still provides a access to the "C," improved sustainability and user experience, while including the added benefit of being fully contained within the Reserve. Because this trail is proposed in addition to the standard "C" Trail re-route, it provides the chance to create a more technical trail alternative.

**Trail Length**
2.49 miles

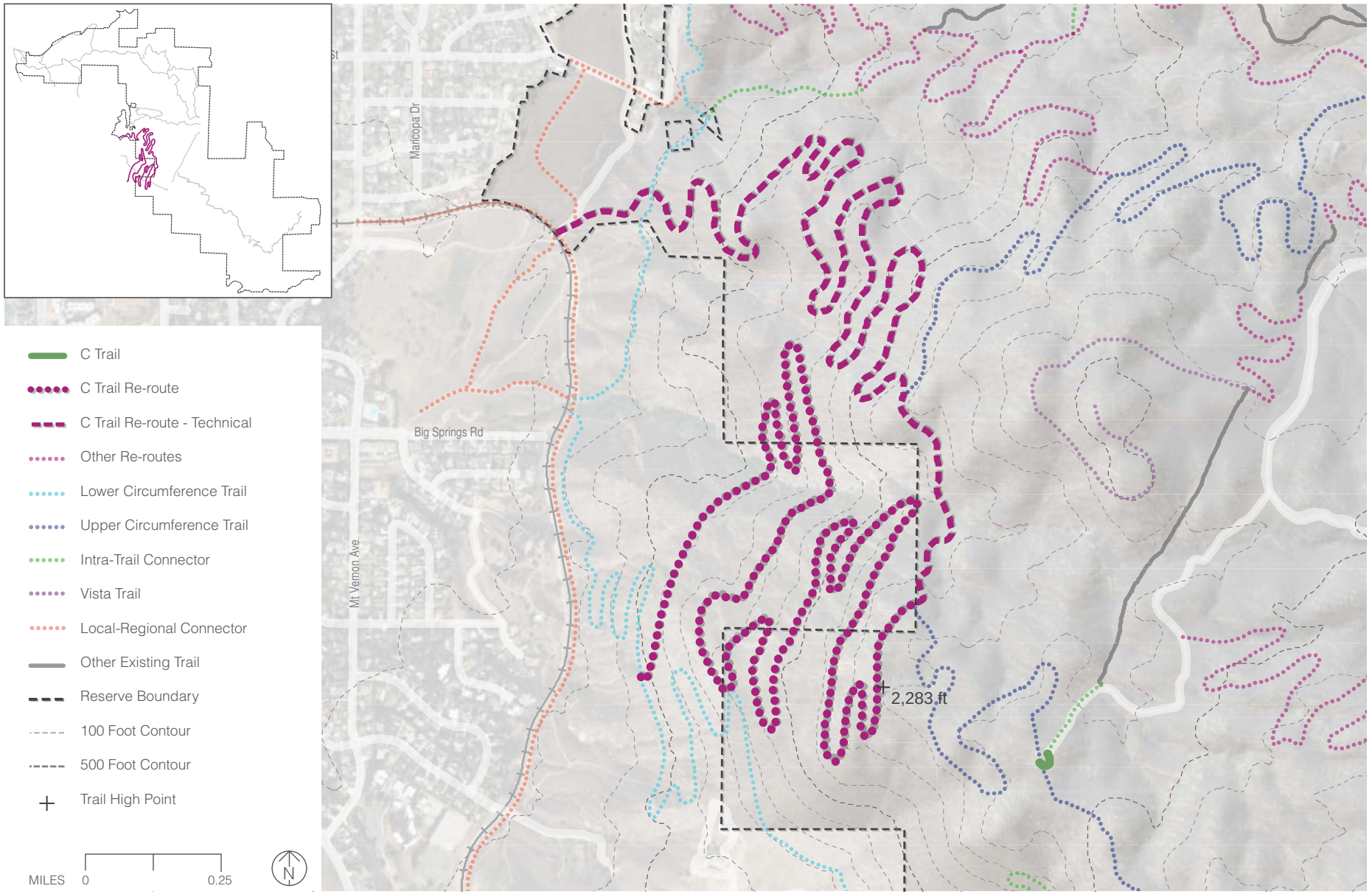
**Elevation Change**
~1,050 feet

**Trail Connections**
Lower and Upper Circumference Trails (Figure 4-10), the "C" Trail Re-route (Figure 4-9), and the Local-Regional Connector 5 - the multi-use path between Moreno Valley and UCR (Figure 4-13)

**Trail Access**
Islander Park staging area (e.g. Big Springs Road, Linden Street or Perris Valley Line), the existing Box Springs Mountain Road staging area or one of the many recommended trail heads

**Environment**
Trail crosses no major riparian or shade tree areas

**Figure 4-9: “C” Trail Re-routes**



## Circumference Trails

This plan proposes Upper and Lower Circumference Trails with a total length of 23.38 miles. These loops are based on a "stacked loop" trail system concept that employs trails of varying widths and grades, with the gentlest and widest occurring nearest the staging areas, with increasingly challenging trails farther out into the open space (see the "Circumference Trails" section in Chapter 3). These loops form the primary connections between all the other trails, providing far more choices than "out-and-back" trails. Both trails form full loops around the mountain, but at different elevations. The Upper and Lower Circumference Trails join briefly near the eastern border of the Reserve, just west of Quail Call Drive. The loop trails also use some segments of other proposed trails to complete their circuits.

### *Lower Circumference Trail*

Lower Circumference Trail encircles the entire base of the mountain and – more or less – follows the Reserve boundary. The trail swings outside of the Reserve, where necessary, to maintain a sustainable grade and enjoyable trail experience. The Lower Circumference Trail uses part of the existing Sugarloaf Trail network in the northeast for continuity.

**Trail Length**
17.41 miles

**Elevation Change**
Not applicable (Trail is intended to follow mountain's natural contours and gain as little elevation as possible)

**Trail Connections**
Sugarloaf Trail (Figure 4-5), Two Trees Trail (Figure 4-7), "C" Trail (Figure 4-9); "M" Trail (Figure 4-8), Intra-Trail Connector 3, 4, 6, 8 and 9 (Figure 4-11), and all Local-Regional Connector Trails (Figure 4-13)

**Trail Access**
All staging areas and all trailheads

**Environment**
Trail crosses both riparian and non-riparian areas, with latter category predominating

### *Upper Circumference Trail*

The Upper Circumference Trail encircles the mountain further up than the Lower Circumference Trail and provides direct or near direct connections to several of the Reserve's popular destinations: The "M," the "C" and the summit at Two Trees. The trail lies mostly within the Reserve boundaries, but crosses it at its northeast corner to expand the trail network, while maintaining a sustainable grade and enjoyable trail experience. The Upper Circumference Trail uses parts of several other existing and proposed trails for continuity: Two Trails re-route, "C" Trail re-route – Technical, "M" Trail re-route, Connector Trail 6 and the Lower Circumference Trail.

**Trail Length**
6.81 miles

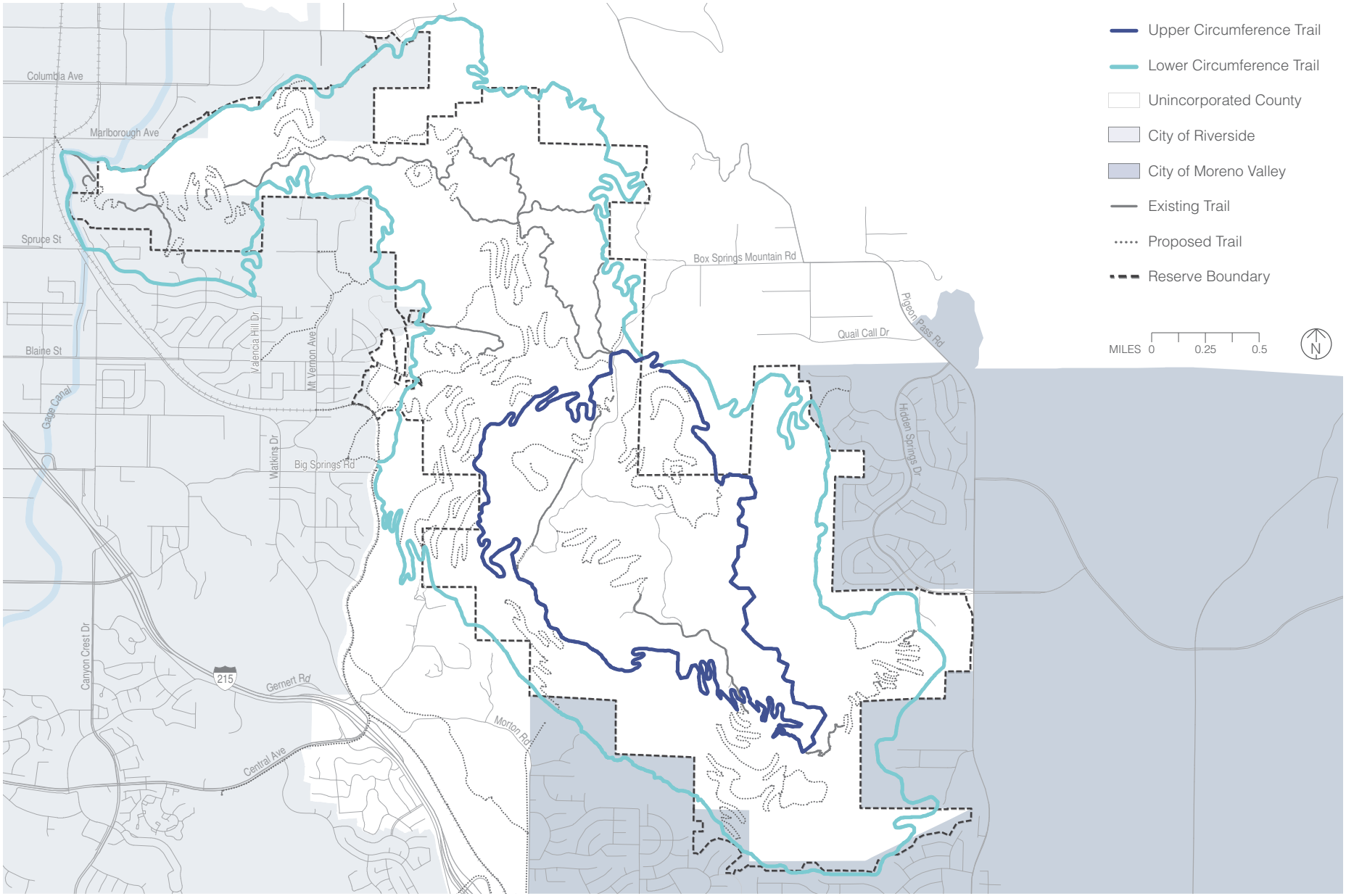
**Elevation Change**
Not applicable (Trail intended to follow mountain's natural contours and gain as little elevation as possible)

**Trail Connections**
Two Trees Trail (Figure 4-7), "C" Trail (Figure 4-9); "M" Trail (Figure 4-8), Intra-Trail Connector 4, 5, 6, 7 and 8 (Figure 4-11)

**Trail Access**
Indirect access via other trails

**Environment**
Trail crosses both riparian and non-riparian areas, with latter category predominating

## Figure 4-10: Circumference Trails



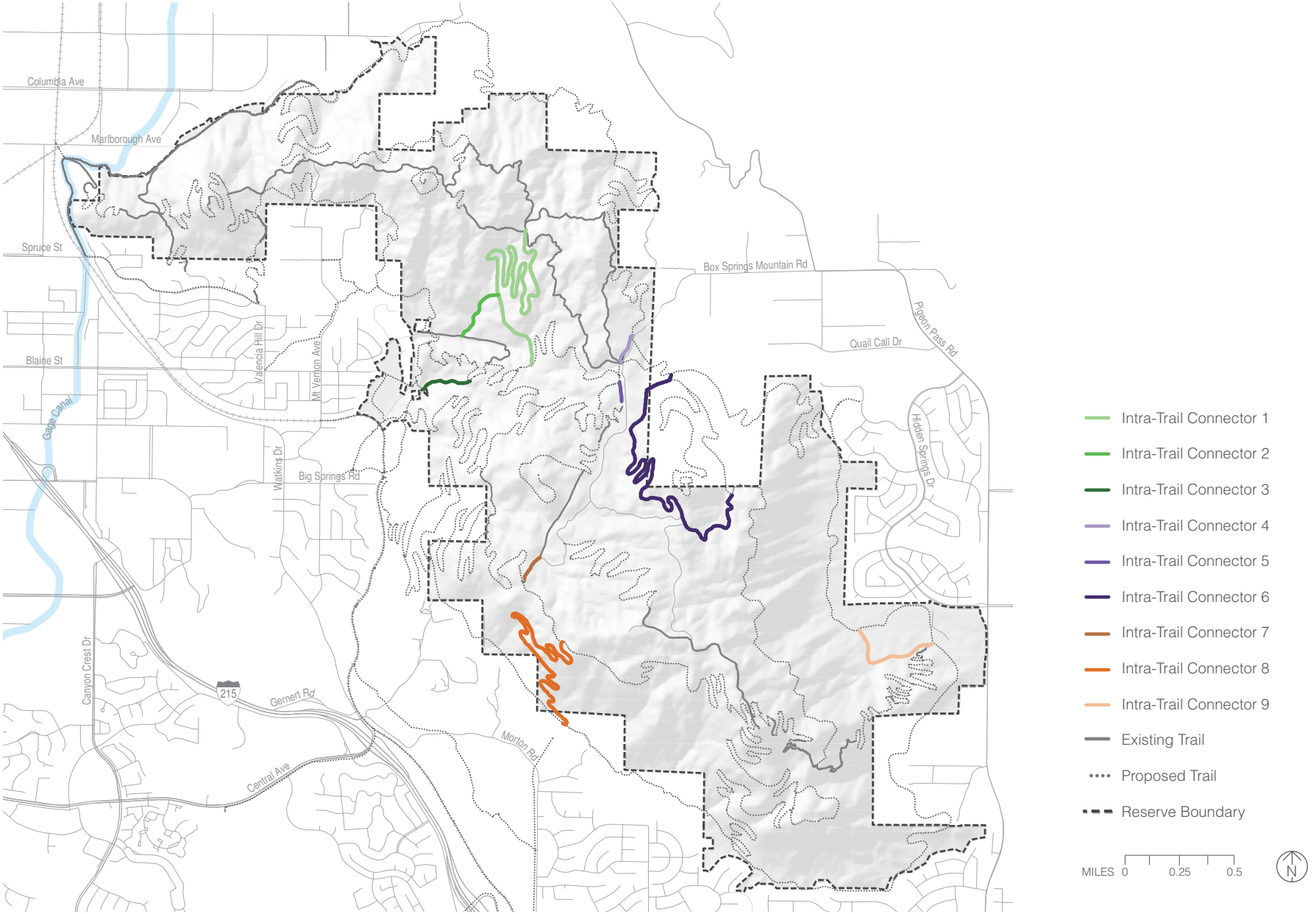
## Intra-Trail Connections

This plan proposes 7.03 miles of Intra-Trail Connections. These new trails are a secondary class of trail, providing generally short connections between other primary trails (e.g. Existing trails, Trail Re-routes and Circumference Trails). These trails are purely utilitarian – bridging gaps and creating new loops – where they are very short (< 0.50 mi) or are trails in their own right – providing a distinct trail - where they are longer (>1.5 mi). Examples of more significant trails are Intra-Trail Connector 1, Intra-Trail Connector 6 and Intra-Trail Connector 8. A summary of the information on Intra-Trail Connectors in provided in Table 4-1.

### Table 4-2: Intra-Trail Connections

| Trail | Length (mi) | Elevation Change, approximate (ft) | Trail Connections |
|---|---|---|---|
| Intra-Trail Connector 1 | 2.19 | 300 | Skyline Loops<br>Two Trees Trail – re-route Technical |
| Intra-Trail Connector 2 | 0.28 | 350 | Connector Trail 1<br>Existing Two Trees Trail |
| Intra-Trail Connector 3 | 0.23 | 300 | Lower Circumference Trail<br>Two Trees Trail re-route |
| Intra-Trail Connector 4 | 0.14 | Not applicable<br>(negligible elevation change) | Lower Circumference Trail<br>Upper Circumference Trail |
| Intra-Trail Connector 5 | 0.09 | Not applicable<br>(negligible elevation change) | Upper Circumference Trail<br>Two Trees Trail – re-route<br>Box Springs Mountain Road staging area |
| Intra-Trail Connector 6 | 1.96 | 100 | Upper Circumference Trail<br>Lower Circumference Trail |
| Intra-Trail Connector 7 | 0.12 | Not applicable<br>(negligible elevation change) | Edison Trail<br>“C” Trail<br>Upper Circumference Trail |
| Intra-Trail Connector 8 | 1.55 | 850 | Upper Circumference Trail<br>Lower Circumference Trail |
| Intra-Trail Connector 9 | 0.47 | 100 | Lower Circumference Trail<br>“M” Trail re-route |
| **TOTAL** | **7.03** | | |

**Figure 4-11: Intra-Trail Connections**



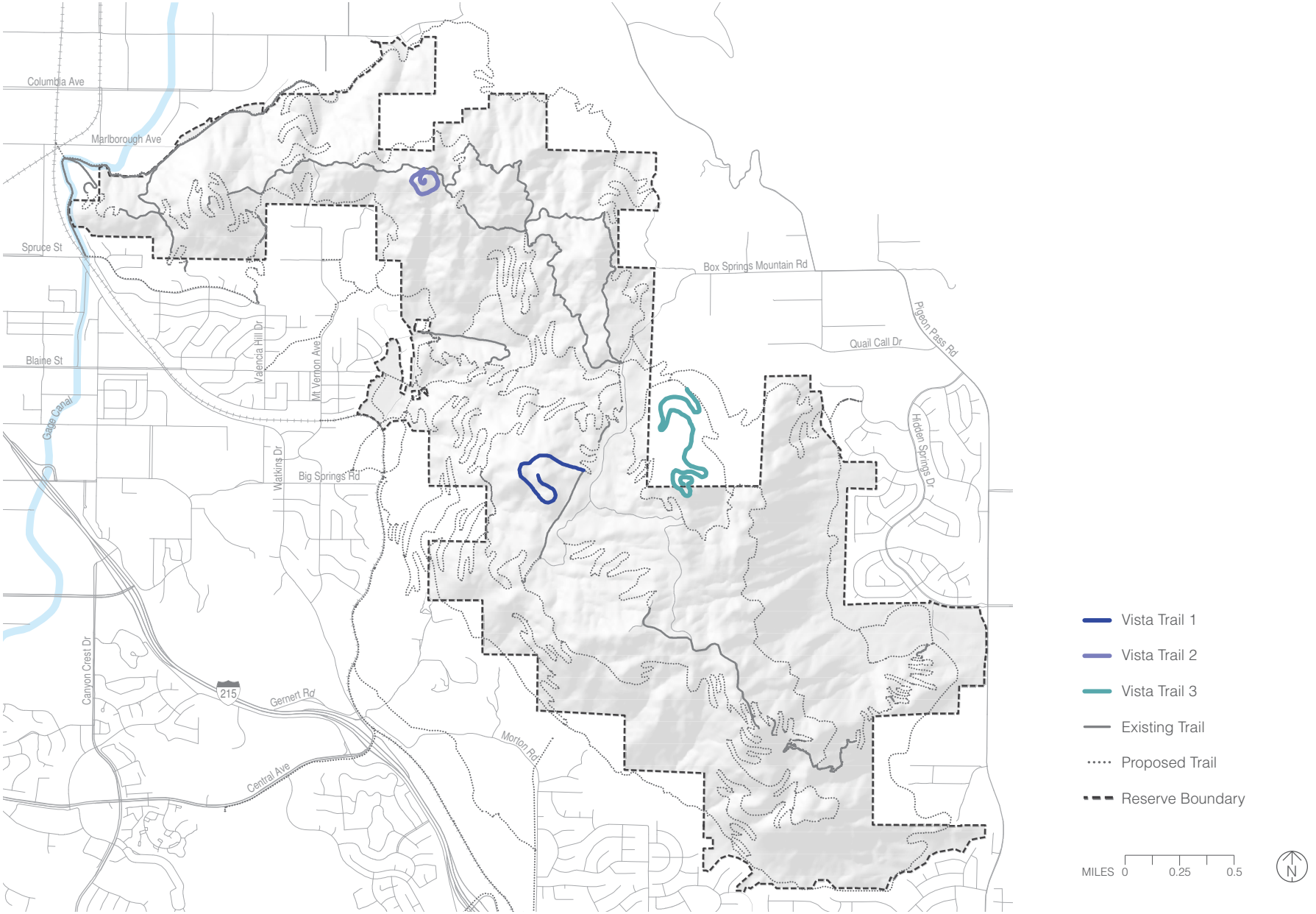
## Vista Opportunities

Vista opportunities provide overlooks while maintaining sustainable grades and a positive user experience. Vista Opportunities were identified by locating peaks that could be, but are not yet, accessible via existing and proposed trails. This plan recommends three Vista Opportunities, totaling 2.6 miles, summarized in Table 4-3 and are described in Chapter 3.

### Table 4-3: Vista Opportunities

| Trail | Length (mi) | Elevation Change, approximate (ft) | Trail Connections |
|---|---|---|---|
| Vista Trail 1 | 0.72 | 100 | Edison Trail |
| Vista Trail 2 | 0.43 | 100 | Sugarloaf Trail |
| Vista Trail 3 | 1.46 | 450 | Upper Circumference |
| **TOTAL** | **2.61** | | |

**Figure 4-12: Vista Opportunities**



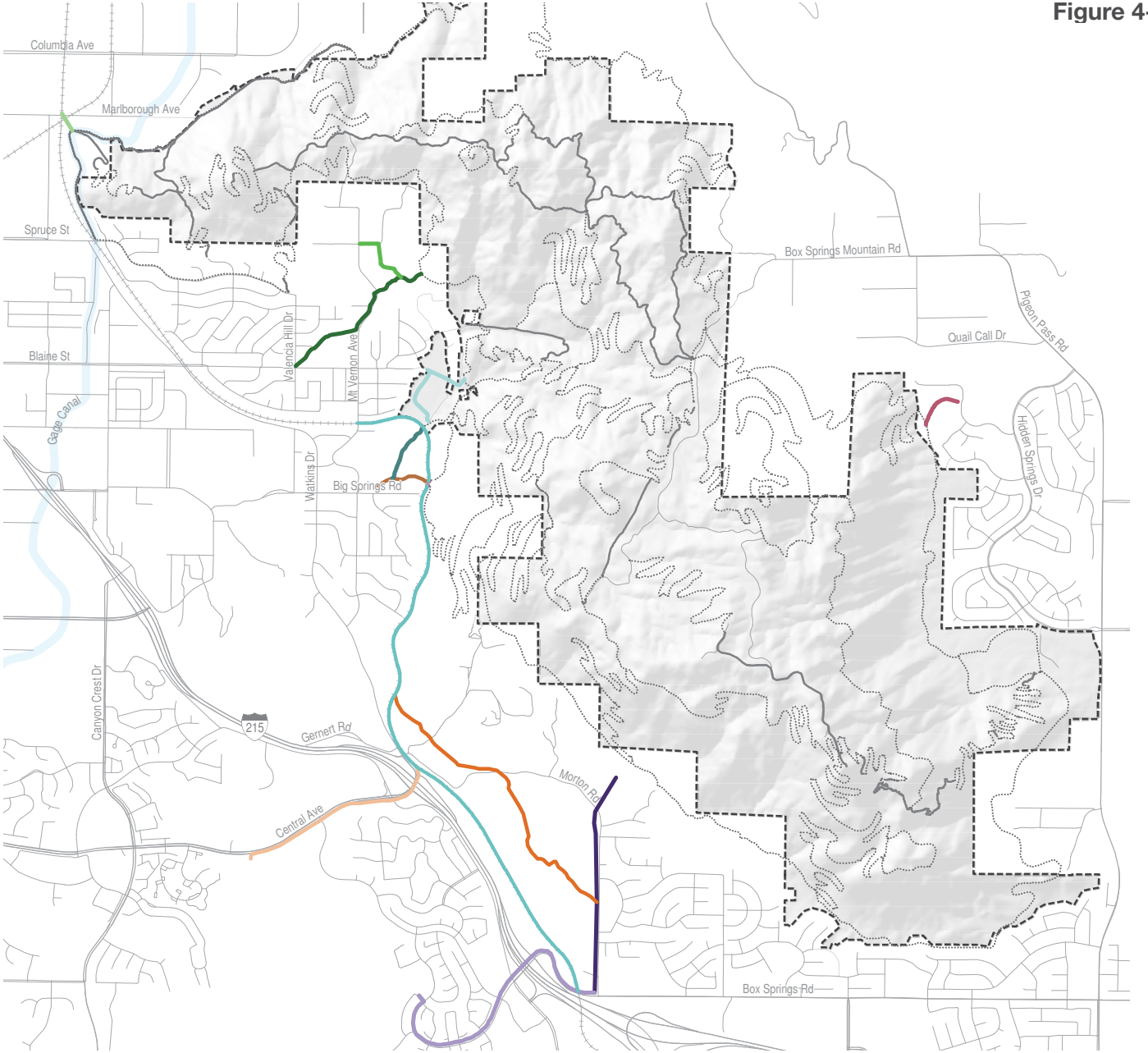
## Local and Regional Connections

The local and regional connections, seen in Table 4-4, provide a link between Reserve trails and local/regional destinations. These trails are anticipated to support recreation, utilitarian purposes or both, depending on the trail. The primary backbone of the Local-Regional Connector trails is the Local-Regional Connector 5, a Class I multi-use path alongside the Perris Valley Line and providing a "low-stress" utilitarian connection between the Cities of Riverside and Moreno Valley. This recommendation found ample support in previous and current local and regional plans (e.g. as a regional "Future Opportunity" in Moreno Valley's Bicycle Master Plan, as a "Proposed Trail" in the City of Riverside's Bicycle Master Plan and as a "Primary City Trail" in its Trails Master Plan, through a legal settlement between the Friends of Riverside Hills and RCTC, as well as through community input for this plan).

### Table 4-4: Local and Regional Connections

| Trail | Length (mi) | Primary Connection | Other Trail Connections |
|---|---|---|---|
| Local-Regional Connector 1 | 0.08 | Hunter Park/Marlborough Avenue Metrolink Station to Sugarloaf Mountain | Lower Circumference Trail, Sugarloaf Trails |
| Local-Regional Connector 2 | 0.26 | Mt. Vernon Avenue to Lower Circumference Trail | Local-Regional Connector 3 |
| Local-Regional Connector 3 | 0.69 | Blaine Street to Lower Circumference Trail | Local-Regional Connector 2 |
| Local-Regional Connector 4 | 0.41 | East Blaine Street staging area to Lower Circumference Trail | Lower Circumference Trail, "C" Trail re-route – Technical |
| Local-Regional Connector 5 | 2.88 | Box Springs Road rail crossing to Mt. Vernon Avenue rail crossing | Lower Circumference Trail, Local-Regional Connector 1, 2, 3, 8 and 10, "C" Trail re-route, "C" Trail re-route – Technical |
| Local-Regional Connector 6 | 0.25 | Islander Park – Big Springs staging area to Local-Regional Connector 5 and "C" Trail re-route – Technical | Lower Circumference Trail |
| Local-Regional Connector 7 | 0.22 | Islander Park – Big Springs staging area to Local-Regional Connector 5 and Lower Circumference Trail | "C" Trail re-route (Indirect) |
| Local-Regional Connector 8 | 1.28 | Local-Regional Connector 11 (Morton Road) to Local-Regional Connector 5 | Lower Circumference Trail (Indirect) |
| Local-Regional Connector 9 | 0.83 | Local-Regional Connector 5 to Sycamore Canyon | Local-Regional Connector 8, Lower Circumference Trail |
| Local-Regional Connector 10 | 1.18 | Local-Regional Connector 11 (Morton Road) to Sycamore Highlands Park | Local-Regional Connector 5, Local-Regional Connector 8 |
| Local-Regional Connector 11 | 0.89 | Box Springs Road to Morton Road staging area | Local-Regional Connector 5, 8, & 10 |
| Local-Regional Connector 12 | 0.20 | Lower Circumference Trail to Hidden Springs Park | Not applicable: Not adjacent to other trails |
| **TOTAL** | **8.93** | | |

## Figure 4-13: Local-Regional Connections



> ***Trails offer a new way of looking at how a community's cultural, historic, recreational and conservation needs fit into an overall picture that also includes economic growth. With their emphasis on connections…trails allow community leaders to consider how existing parks and open spaces can become part of a network of green that supports wildlife, pleases people, and attracts tourists and clean industry.***
>
> ~ Office of Greenways and Trails

## 4.6 Proposed Staging Areas

This plan proposes nine staging areas, including two existing and seven new locations. The new staging areas were selected according to the methodology described in Section 3.5, Staging Area Development. Three of the new proposed staging areas are located at Islander Park, though - as mentioned previously - the intent is not to recommend the construction of all three, but rather the further study of all three options to determine the best location.

### Staging Area Assessment

The nine staging areas proposed by this plan are included in Table 4-5. The assessment includes ranks and performance measure highlights. As with trails, ranks indicate the level of effort required to improve the staging areas, rather than their prioritization for improvements, and are supplemented by performance measure highlights, which provide additional background information (i.e. why the staging area ranked as it did).

**Table 4-5: Staging Area Assessment**

| Staging Area | Level of Effort Required for Improvement | Performance Measure Highlights |
|---|---|---|
| East Blaine Street | 1 | • Relatively flat site<br>• Near utility hook-ups<br>• Public property<br>• Personal safety: near population densities |
| Hidden Springs Drive (Existing) | 2 | • Public property<br>• Near fire station<br>• Personal safety: not near population densities |
| Islander Park - Rail Crossing | 3 | • Relatively flat site<br>• Public property<br>• Personal safety: near population densities |
| Sugarloaf/Cycle Park | 4 | • Relatively flat site<br>• Private property<br>• Relatively near fire station<br>• Personal safety: not near population densities |
| Islander Park - Big Springs | 5 | • Relatively flat site<br>• Public property<br>• Personal safety: near population densities |
| Box Springs Mountain Road (Existing) | 6 | • Served greatest number of trails<br>• Public property<br>• Personal safety: not near population densities |
| Hunter Park/ Marlborough Metrolink Station Parking Lot | 7 | • Does not provide natural surface connection to trails<br>• Public property<br>• Personal safety: not near population densities |
| Linden Street | 8 | • No trails served within 0.25 miles of trail head<br>• Private property<br>• Personal safety: near population densities |
| Morton Road | 9 | • No trails served within 0.25 miles of trail head<br>• Private property<br>• Personal safety: not near population densities |

# 5

# Design and Maintenance

This chapter summarizes facility standards and guidelines likely to affect the recommended Reserve natural surface trails network, as well as the paved pathway proposed along the adjacent rail line. Note that for clarity, paved routes are called “paths” or “pathways” and natural surfaced routes are referred to as “trails.” Where information can apply to both facility types, they are referred to as “routes.”

The two route types addressed in this chapter are natural surface open space trails within the Reserve and a (Class I) shared-use paved pathway along the Perris Valley Line railroad tracks running immediately adjacent to the Reserve along its western boundary. This shared-use path would connect the City of Moreno Valley with the University of California, Riverside campus neighborhood and the City of Riverside.

Shared-use paved pathway design is governed by specific State standards (Caltrans Highway Design Manual (HDM) Chapter 1000 - Bikeway Planning and Design), while natural surface trail design is governed by local or regional guidelines due primarily to the strongly site-specific nature of local topography, soils and other siting variables.

Depending on specific application, much of the following standards and guidelines can apply to both paved and natural surface facilities, while others are specific to paved or unpaved facilities. They are therefore organized as follows in this chapter:

**Section 5.1:** General guidelines and standards
**Section 5.2:** Share-used paved path standards
**Section 5.3:** Open space natural surface trails guidelines
**Section 5.4:** Railroad crossing design standards

Federal, state and local environmental regulations apply to trails and other forms of development, regardless of the level of improvement. Prudent trail design strives to limit impacts, including avoiding siting in sensitive areas. The application of design standards and guidelines coupled with impact avoidance and protective measures can offset most potential impacts.

## 5.1 General Guidelines and Standards

### Transportation Facilities Versus Recreational Trails

Non-motorized facilities serve two general purposes: transportation and recreation. Distinct design standards and guidelines apply to each category as described in the following sections. Note that natural surface trails are not subject to the relatively stringent design standards applicable to paved paths.

#### *Transportation Facilities*

Transportation facilities typically pass through or connect developed areas and serve as part of a multimodal transportation system. These facilities may be required to meet transportation facility design standards to be eligible to receive state or federal funding, comply with owner or regulatory agency access or design standards, or to secure approval of an encroachment permit within State right-of-way.

California Streets and Highways (S&H) Code Section 887 defines a "non-motorized transportation facility" as a facility designed primarily for the use of pedestrians, cyclists or equestrians. It may be designed primarily for one of these uses or as a joint-use facility. The code further states that a non-motorized transportation facility may be part of the highway (such as a shoulder) or separated from highway traffic for exclusive non-motorized use (such as a shared-use path or sidewalk).

Transportation facilities must comply with ADA Accessibility Guidelines for Buildings and Facilities (ADAAG). All standards set forth in Caltrans Highway Design Manual Chapter 1000 must be met for a bikeway to serve as a transportation facility. (See appendix for accessibility standards.)

#### *Recreational Trails and Paths*

Recreational trails and paths function as routes, but are also destinations. They typically connect and traverse open space areas and natural features, rather than developed areas. The Federal Highway Administration (FHWA) describes recreational trails or paths as those designed to provide a primarily recreational experience. Using them is a choice made by those desiring the experience they provide. Recreation trails or paths should provide access for users with disabilities to the same range of experiences offered to other site users. This means that some portion should be designed to reach destinations or points of interest and travel through various environments, where feasible. Providing access to people with disabilities is best achieved by providing route information in multiple formats and by minimizing grade, cross slope, barriers and unstable surfaces.

While both paved paths and unpaved trails may be shared-use facilities supporting various users, transportation routes are intended to serve primarily a connectivity purpose and therefore require a hard all-weather surface rather than a natural surface. They may be desirable scenic routes as well, but that is not their emphasis. Instead, the shortest routes and gentlest grades are desired.

### Facility Type Selection

Site conditions, particularly steep topography, can limit the trail or path facility types appropriate for a given segment. For example, Caltrans recommends Class I shared-use paths be limited to a maximum grade of five percent (except for short segments). For grades greater than five percent, a pathway meeting Class I standards is likely to require switchbacks, depending on the grade and slope length. Long, steep slopes can therefore create circuitous routes. Natural surface recreational trail guidelines allow for somewhat steeper grades where conditions allow, but wherever possible, an overall maximum of five percent is recommended to support sustainability by minimizing erosion requiring ongoing repairs.

Transportation paths typically serve a wide range of user types and connect residential land uses with transit, commercial, institutional, office, educational and recreational uses. Due to these characteristics, transportation paths are more likely than recreational paths to offset vehicular trips, potentially easing roadway congestion and reducing greenhouse gas emissions.

While natural surface trails serving a recreational purposed are less expensive to construct than paved shared-use paths, grant funding is more generally available for facilities that serve transportation needs with hard all-weather surfacing.

## Federal Standards and Guidelines

### *American Association of State Highway and Transportation Officials (AASHTO)*

Shared-Use Paths

Shared use paths allow for two-way, off-street bicycle and pedestrian and other non-motorized uses. These facilities are often built in parks, along rivers, railroads, beaches and in greenbelts or utility corridors where right-of-way exists and where there are few conflicts with motorized vehicles.

AASHTO Design Guidelines

- Minimum for a two-way shared-use path (only recommended for low traffic situations): 10 feet
- Recommended for high-use areas with multiple user types such as joggers, cyclists, rollerbladers and pedestrians: 12 feet or more
- Eight foot width may be used for a short distance due to physical constraints
- Lateral clearance: Two feet or greater shoulder on both sides.
- Overhead clearance: Eight feet minimum, 10 feet recommended.
- Maximum design speed for shared-use paths: 20 mph. Speed bumps or other surface irregularities should not be used to slow bicycles
- Recommended maximum grade: Five percent
- Steeper grades can be tolerated for a maximum of 500 feet

Where separation is less than five feet from a roadway, a physical barrier or railing should be provided. Protective railings, fences, or barriers should be a minimum of 42 inches. A 48 inch railing height is recommended at sharp curves, particularly on bridge approaches. To prevent snagging pedals or handlebars, vertical balusters are not recommended for railings designed to provide protection for cyclists.

### *Federal Highway Administration (FHWA)*

The United States Department of Transportation (USDOT) has adopted a policy statement that cycling and walking facilities will be incorporated into all transportation projects unless exceptional circumstances exist. FHWA references the use of the best currently available standards and guidelines, such as AASHTO and the MUTCD. Also, all federally funded transportation enhancement (TE) projects must be in full compliance with ADAAG.

Manual of Uniform Traffic Control Devices (MUTCD)

The MUTCD defines the standards used by road managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways and private roads open to public traffic. The MUTCD is published by the FHWA under 23 Code of Federal Regulations (CFR), Part 655, Subpart F. The MUTCD is a compilation of national standards for all traffic control devices, including road markings, highway signs and traffic signals. It is periodically updated to accommodate the nation's changing transportation needs and address new safety technologies, traffic control tools and traffic management techniques.

The MUTCD is the national standard, but state transportation agencies differ in how they comply with MUTCD standards. Some states adopt the MUTCD as their standard. Other states adopt the national MUTCD along with a state supplement that might prescribe which of several allowable options are selected for the state's specific purposes. Still other states, California included, use the national MUTCD as the basis for developing their own State Traffic Control Device manuals, which must be in substantial conformance to the national MUTCD. Caltrans adopted the latest California MUTCD (CA MUTCD) in January 2012.

Designing Sidewalks and Trails for Access, Part II of II: Best Practices Design Guide

This 2001 document provides planning, assessment and design guidance for trails. It defines a trail as a path of travel for recreation and/or transportation within a park, natural environment, or designated corridor not classified as a highway, road, street or sidewalk. Within this document, in Chapter 12 (planning) and Chapter 13 (assessment), recreation trails and shared-use paths are discussed as one unified topic. In terms of design, they are given separate chapters (Chapters 14 and 15).

## State Standards and Guidelines

### *California Department of Transportation (Caltrans)*

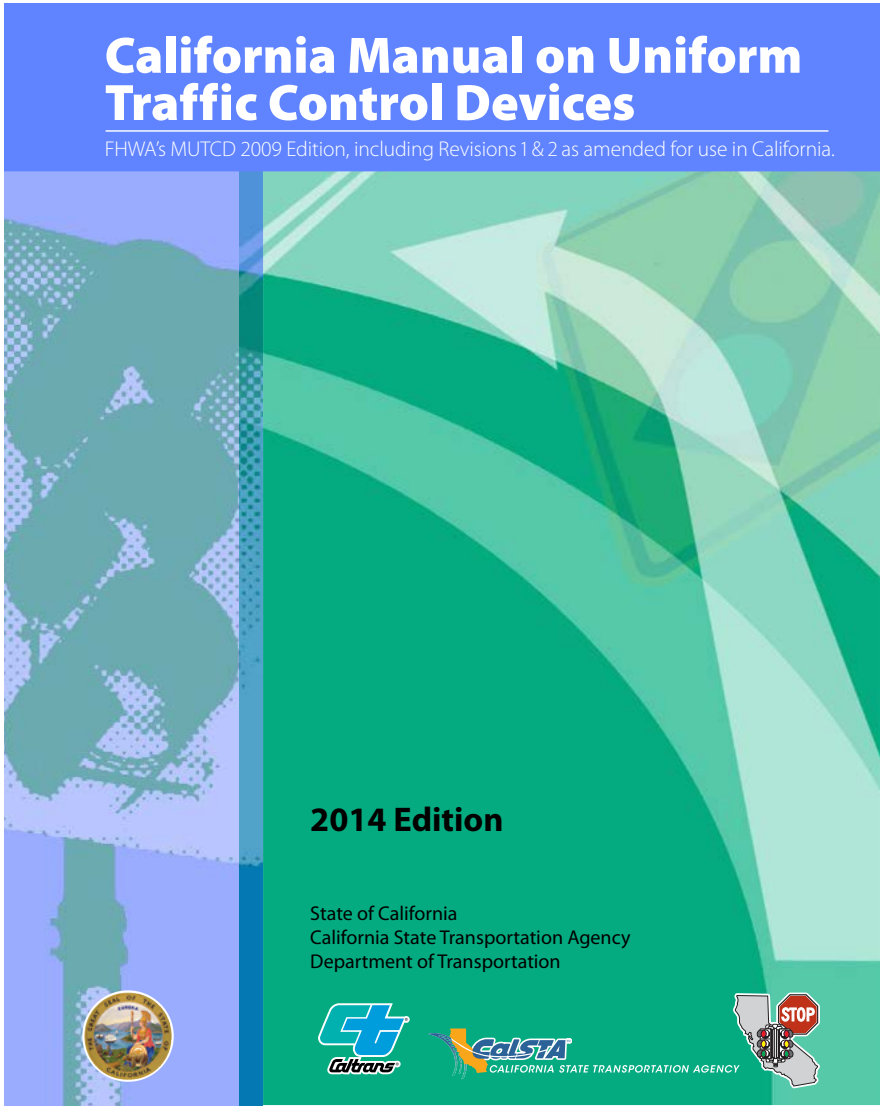
Highway Design Manual (HDM)

Caltrans staff and non-Caltrans project managers and planners proposing designs for projects within Caltrans right-of-way use the State of California, Department of Transportation (Caltrans) Highway Design Manual. Its design standards cover a wide array of focus areas including drainage, pavement and basic design policies. Chapter 1000 specifically focuses on bikeway planning and design and is applicable within California anywhere bikeway construction funding may be sought. The entire document is available online at: www.dot.ca.gov/hq/oppd/hdm/hdmtoc.htm

California Manual of Uniform Traffic Control Devices (CA MUTCD)

The California MUTCD (CA MUTCD) is published by Caltrans to formalize uniform standards and specifications for official traffic control devices across the State. Traffic control devices are defined as all signs, signals, markings and other devices used to regulate, warn, or guide traffic, placed on, over, or adjacent to a street, highway, pedestrian facility, or bikeway by authority of a public agency or official having jurisdiction, or, in the case of a private road, by authority of the private owner or private official having jurisdiction. The CA MUTCD is not applicable to privately owned and maintained roads or commercial establishments in California, unless the particular city or county enacts an ordinance or resolution to that effect.

The CA MUTCD 2014 edition incorporates the FHWA's MUTCD (2009 Edition) and includes all policies on traffic control devices issued by Caltrans issued since January 2010 and other changes necessary to update previous documents. The CA MUTCD does not supersede Caltrans' Standard Plans, Standard Specifications or its Special Provisions publications, but all CA MUTCD standard statements must be met.




*California Manual of Uniform Traffic Control Devices*

## Potential Features

The primary goal of this master plan is to establish a sustainable open space trail system serving the surrounding communities and the region as a recreational destination. Such a system's design features may include associated amenities such as staging areas, trail heads, vista points, surface treatments, plant material, bridges, fencing and signage, for examples. These may be part of natural surface trail and paved path development, or both, depending on location specifics.

### *Trail Heads*

Trail heads are non-vehicular neighborhood access points connecting the Reserve trail system with the surrounding communities that can also function as rest and orientation points, especially where two or more trails meet. They are smaller and have fewer facilities than staging areas, but should provide users the following limited features:

» Seating (Benches)
» Hitching posts
» Shade trees
» Directional signs
» Water for hikers, cyclists, riders, dogs and horses (optional)
» No parking

### *Staging Areas*

Staging areas are to be provided at multiple locations roughly equidistant around the Reserve perimeter. They are intended to provide parking and trail access for other than local neighborhood users, particularly for those driving to the Reserve from the surrounding region. They should provide users the following:

» Shade trees (or optional shade structure)
» Seating (benches)
» Picnic tables
» Bicycle racks (no long-term storage)
» Fencing and hitching rail
» Small corral
» Water for hikers, cyclists, riders, dogs and horses
» Entry road drive and monumentation
» Interpretive and directional signage
» Trash receptacles
» Off–street parking for 20 vehicles
» Portable toilets (2) or as needed for special events
» Restrooms (optional)
» Minimal security lighting (optional)
» Pull-through spaces for 15 horse trailers (at specific staging areas)
» Corral or horse tie-ups (at specific staging areas)
» Landscaping (as needed)

### *Rest Areas, Turnouts and Vista Points*

Rest Areas

Periodic rest areas are beneficial for all shared-use path or trail users, particularly for people with mobility impairments who typically expend more effort to walk. Rest areas are especially crucial when grade or cross slope demands increase. The frequency of rest areas should vary depending on the terrain and intended use and heavily used shared-use paths or trails should have more frequent rest opportunities. Rest areas provide an opportunity for users to move off the trail or path, instead of remaining on it to stop and rest. Having separate rest areas on both sides of the trail or path is preferred when there is a higher volume or higher traffic speeds as it reduces trail and path users' need to cross in front of other users. If a rest area is only provided on one side of the trail or path, it should be on the uphill side. In general, rest areas should have the following design characteristics:

» Grades not exceeding five percent
» Cross slopes on paved surfaces not to exceed two percent and cross slopes on non-paved surfaces not to exceed five percent
» Firm and stable surface
» Width equal to or greater than the width of the trail segment leading to and from the rest area
» Minimum length of 86 inches
» Minimal grade and cross slope change where connecting with pathway

Seating can be particularly important for people with disabilities and who may have difficulty getting up from a seated position on the ground. Some seating should have backrests to provide support when resting and at least one armrest to provide support to help disabled users resume a standing position. Accessible seating should provide the same benefits as seating for users without disabilities. For example, providing space for a wheelchair facing away from an attractive view would not be appropriate.

Turnouts

A turnout is defined as either a widened section of trail that allows faster traffic to pass or a side path that allows users to pull over and rest off the main trail. Turnouts should have:

» Widened pathway
» Seating (bench)
» Shade trees and native vegetation
» Directional and/or mileage signs
» Trash receptacle
» Fencing as needed

Vista Points

This is a type of turnout/rest area specifically focused on scenic views, overlooks. Vista points will have similar features as turnouts. In general, interpretive signage may be especially appropriate at culturally significant viewpoints.

### *Shade Structures*

A shade structure is an open frame design that may be provided as an option at staging areas. However, wherever possible, shade is planned to be provided by trees, especially native species.

### *Restrooms*

Portable toilets are an interim facility that may be provided in the early years of a staging area's development. Portable toilets may also be brought in temporarily for special events. A restroom or comfort station building is an optional facility that may be provided at a later date at a staging area if demand warrants it.

*Moab Canyon Pathway (Moab, UT)*

*Trailside Park (Park City, UT)*

### *Fencing*

Fencing may be necessary to protect sensitive resources, but its presence can backfire by drawing attention to an otherwise concealed resource. If the intent is to keep users on the route away from the resource, other methods may be more effective, especially careful route design that maximizes users' experience, which fencing can significantly degrade. In particular, route design can be managed to limit visual access and even to direct views away from sensitive resources, particularly by manipulating trail horizontal and vertical alignment and installing landscaping. Fencing should be regarded as a last resort. Four general conditions are defined below, with applicable fencing standards.

None Needed

The majority of the plan area falls into this category.

Low Security

This fencing provides a minimal level of access control and is intended to blend with its surroundings in an aesthetic manner. It would be used in areas where trespass is not likely, but where adjacent uses, sensitive species or habitats would benefit from some assurance from disturbance. This fencing type would be wood with wood cross members or galvanized cable between the posts. It would be roughly waist high and at least 42 inches high if adjacent to shared-use paths.

Medium Security

This fencing would be used for more stringent access control, such as immediately adjacent to sensitive private properties or other land uses where more positive access control is desired. This fencing would be six feet tall and be designed to exclude humans and dogs. It could be standard galvanized chain link or may be coated if a less conspicuous appearance is desired. In general, matte black is the least visually prominent compared to bare galvanizing.

*Low Security Fencing*

*Medium Security Fencing*

High Security

This fence type would be relatively costly and so would be used only where necessary due to adjacent land uses or hazards from which trail users must be restricted. This fencing would be eight feet tall and likely to be galvanized or powder-coated welded metal designed to be difficult to climb. This is usually accomplished with closely spaced vertical heavy gauge wire or very closely spaced horizontal wire, both of which eliminate the need for horizontal members that could provide hand or toe holds. Conventional picket fencing may also be appropriate.

*High Security Fencing*

*Decorative Chainlink Fencing*

### *Landscaping*

Where installed, landscaping will be confined to developed areas along the trails, primarily at staging areas and trail heads. All planting should be regional native species and native trees are planned as the primary shading method. Additional native shrub plantings should be incorporated into these locations where needed to help integrate them with surrounding habitats and for visual screening where needed.

### *Signage and Trail System Branding*

A branding program for the Reserve trail system should convey a uniform quality, credibility and experience to the users and communities it serves. Through the integration of graphics, signage, trail elements and amenities, it can visually enhance the trail experience, encourage trail usage and make trails more comfortable for the user by providing location referencing. The Reserve trail system should implement the following branding guidelines.

Trail systems with clear thematic branding support consistent messaging. Incorporating the branding in amenities such as site furnishings, fencing and gates, lighting, hardscape and structures, signage and art pieces help reinforce the Reserve brand or “sense of place.” Some trail elements and amenities that can incorporate such branding are described in the following sections.

#### Site Furnishings

Site furnishings such as drinking fountains, benches, shade structures, trash receptacles and bicycle parking can have design qualities that reinforce a Reserve theme. A consistent family of furnishings supports continuity and reinforces the overall trail system look and feel. There are a wide variety of options to choose from in terms of style and materials. Selections should be based on the desired trail system theme, as well as life cycle costs.

#### Fencing and Gates

Fencing can serve multiple purposes along trail facilities, including access control, visual screening, channeling of trail users and reducing liability concerns. Where fencing and gates are needed, they can help reinforce the desired trail theme and brand. Decorative fencing can add visual interest to a trail and could be used as gateway elements or adjacent to neighborhoods to help establish the trail as a unique and memorable place.

*Salinas River Trail Branding (San Luis Obispo, CA)*

Trail Structures

Trail structures, particularly at staging areas, such as retaining walls, seat walls, shade structures and other physical enhancements can have design qualities that reinforce the Reserve theme. Concepts that can be investigated include a consistent use of materials, form, finishes and color.

Public Art

Creative applications for an inspirational art program that both provides beauty and learning opportunities can help reinforce the Reserve brand or a "sense of place." Local artists can be commissioned to provide art for the trail system, making it unique, entertaining and memorable. Themes should draw from the local natural and cultural environment. Many trail art installations function as or are incorporated into signs, benches, shelters, or even pavement surface.

### *Lighting*

Lighting allows specific areas to be used at night and provides safety for trail users. Lighting should be considered at staging areas only. Lighting should not be considered where nighttime use is not expected, next to sensitive wildlife habitat areas, or adjacent to residential neighborhoods near the proposed trail system. In general, lighting is not recommended beyond what is deemed absolutely necessary.

Where needed, matching or complimenting light fixture style and types with other site furnishings will strengthen the overall look and feel of the trail system staging areas. Light output color should be considered, since consistent color illumination will visually enhance and link the staging areas at night. All light sources should provide a similar warm white color light.

There are a wide variety of lighting options to choose from in terms of style and material selection, as well as energy efficiency. A qualified lighting expert should be consulted before making any lighting design decisions. Doing so can reduce up-front fixed costs and long-term energy costs. As appropriate, dark sky-compliant lighting should be selected to minimize light pollution cast into the sky while maximizing light cast onto the ground. Solar powered light fixtures should be utilized where possible for new installations or for retrofit projects.

*Dark Sky Compliant Bollard Lighting*

### *Traffic Control and Wayfinding Signage and Markings*

Signs that clearly describe the shared-use route conditions are an essential component to enhance access. Signs should be provided in an easy to understand graphic format with limited text. Instead of using relative terms like “difficult” or “easy,” providing accurate, objective information about actual trail conditions will allow people to assess their own interests, experience and skills and to determine whether a particular route is appropriate or provides access to them if they use assistive devices. Providing users with route condition information is strongly recommended for the following reasons:

- Users are less likely to find themselves in unsafe situations if they understand route demands before beginning.
- Frustration is reduced and people are less likely to have to turn around on a trail because they can identify impassible situations, such as steep grades, before they begin.
- Users can select trails that meet their skill level and desired experience.
- The level of satisfaction increases because the user is able to select a route that meets his or her expectations.
- If more difficult conditions will be encountered, users can prepare for the skill level and equipment required.

Objective information about the route conditions (e.g., grade, cross slope, surface, width, obstacles) is preferable to subjective difficulty ratings (e.g., easier, most difficult). Because subjective ratings of difficulty typically represent the perceptions of the person making the assessment, the ratings may not be accurate or appropriate for the full range of route users. Individuals with respiratory or heart conditions, as well as individuals with mobility impairments, are more likely to have different interpretations of route difficulty than other users.

A variety of information formats can be used to convey objective route information. The format type should conform to management agency policy. Written information should also be provided in alternative formats, such as Braille, large print, or an audible format. For example, signage text can also be made available using digital means, such as via QR tags. In addition, simplified text and reliance on universal graphic symbols will provide information to individuals with limited reading abilities.

The type and extent of the information provided will vary depending on the trail, environmental conditions and expected users. It is recommended that the following information be objectively measured and conveyed to the user through appropriate information formats as necessary for the particular route:

- Route name
- Permitted users (if applicable)
- Route length
- Elevation change over total length and maximum elevation obtained
- Average running grade and maximum grades that will be encountered
- Average and maximum cross slopes
- Average tread width and minimum clear width
- Surface type
- Surface firmness, stability and slip-resistance

Project signage may include directional, destination, distance, regulatory/advisory and interpretive. Directional and other typical signage will occur primarily at staging areas, trail heads and anywhere users may conveniently intersect the route system.

Route distance markers may occur on a regular interval of at least once per mile and more likely every half mile. These markers are useful to first responders to locate injured persons.

Interpretive signage may occur almost anywhere to coincide with a point of public interest, but will likely be more condensed at staging areas, trail heads and vista points where users are more likely to spend time off the trail surface resting or enjoying the view.

A comprehensive signage system ensures that information is provided regarding safe and appropriate use. Signage should establish consistency for the style, font and colors used on all signage and to present a unified appearance to promote organization and branding of the Reserve trails as a unified system.

Three basic sign types are proposed: regulatory, wayfinding and interpretive. For all but regulatory signs, the signage for this plan area should be comprehensively designed as a definitive signature element that ties the experience of this segment together with the rest of the Riverside County trail system. Reserve has a variety of existing signage.

Regulatory

Regulatory signage must conform to the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) and the AASHTO Guide for the Planning, Design and Operation of Pedestrian Facilities.

Regulatory signs should state route usage rules and regulations associated, as well as identify the managing agency, organization or group. The route regulations message should promote both user safety and enjoyment. It is important to post route use regulations at key access points such as staging areas and trail heads, as well as through the use of maps and informational materials. Route signage should also be coordinated with County and adjacent city networks.

Typical Route Regulation Signs:

- Route identification, reassurance and confirmation
- Guidance and distance to trail destinations and key points of interest
- Safety features and user safety
- Warnings of known hazards
- Hours of use
- Pedestrian, bicycle, equestrian and vehicular control
- Dog leash requirements
- Alcoholic beverages are not permitted
- No smoking allowed
- Notice of restrictions where use control is necessary
- Do not wander off of trail onto adjacent properties
- Protection of resources


*Regulatory Signage - Juan Bautista de Anza Trail (Atascadero, CA)*


*Wayfinding Signage - White Tanks Regional Park (Maricopa, AZ)*

Wayfinding

The Reserve trails network should be signed in tandem with other alternative transportation routes, such as bicycle routes in neighboring jurisdictions, connecting trails, historic and/or cultural walking tours, and wherever possible, local transit systems such as the Perris Valley Line. A comprehensive wayfinding signage system ensures that information is readily available regarding location and appropriate route use. Signage should establish font and color consistency and present a uniform character to promote the Reserve trails as a unified system. Informational text on signs should use sans-serif fonts when possible. QR codes linking to maps or other information may be appropriate.

*Guide Signs*

Mainly within public rights-of-way and along rail lines outside the open space, bicycle routes are identified using the standard "Bike Route" sign. The CA MUTCD allows for an alternative bicycle route sign to reflect a numerical route or name designation. Supplemental signs and plaques can be used to direct users to destinations (e.g. "Islander Park" or "UCR").

*Directional Signs*

Directional and other typical signage will occur primarily at staging areas, trail heads and anywhere users may conveniently intersect the route system. Directional signs provide route and distance information to major destinations and amenities. Directional signs should be installed at access points and major intersections. In additions, roadway names should be evident wherever shared-use pathways or natural surface trails cross them.

*Distance Markers*

Trail or path markers provide users the visual assurance that they are on a specific route. They can double as distance markers on a regular interval of at least once per mile or every half mile. Distance markers are useful for both user and first responder orientation.

*Kiosks*

Kiosks provide visitors with information to orient themselves, learn of site opportunities, rules and regulations, hours of operation, and local events such as volunteer activities for the Reserve trail system. Kiosk design and style should coordinate with the character and branding developed for the overall sign system. The kiosk should be readily identifiable as an information source and provide elements such as bulletin boards, regional maps, rules and regulations and accessibility advisories.


*Guide Signage - UC Irvine (Irvine, CA)*

*Kiosk Along Ranier Trail (Issaquah, WA)*

Interpretive and Educational

Interpretive signs enhance the trail or path experience by providing information about the area's history and culture. Signs may feature local ecology, people, environmental issues and other educational information. They may be placed at scenic view areas or in relation to specific elements being interpreted. They can take on many forms including textual messages, plaques, markers, panels and demonstrations.

Interpretive signage may occur almost anywhere to coincide with a point of public interest, but will likely be more condensed at the staging areas, trail heads and vista points where users are more likely to spend time off the actual trail or path surface resting or enjoying the view. Because interpretive signs need to relate directly to site needs, no specific guidelines have been established for their format. However, interpretive signs should be concise and an integral part of an overall area sign plan, including the wayfinding signs mentioned previously. They can also include supplementary information via QR tags.

*Interpretive Signage - San Dieguito River Park (Del Mar, CA)*

### *Bridges*

Bridges create opportunities for overlooks, habitat protection, loop trails and trail connections, as well as provide maintenance, operational and emergency service access. Riparian crossings may be needed within the Reserve, especially along the lower slopes. Likely potential use, cost-effectiveness and physical constraints will drive location selection.

Type

Bridges should be level and avoid a step-up if the trail is intended to be ADA-compliant. Wood trail bridges can provide cost-effective minor drainage crossings while supporting route character. Since wood's life span is limited, composite lumber may be considered as a alternative deck material, especially if equestrian use is anticipated. If bridge height is greater than 30 inches, guard rails should be at least 42 inches higher than the deck surface. Spans greater than 10 feet should generally be engineered and may require site-specific geotechnical work. It should be noted that long span wood construction requires similar requirements for abutments and foundation supports as steel truss bridges. Prefabricated steel truss bridges are commonly used with parks and trail environments for long span crossings. They can clear spans of over 100 feet, with virtually unlimited lengths possible with intervening supports.


*Interpretive Signage - Salinas River Trail (San Luis Obispo, CA)*

Additional design considerations for prefabricated steel truss bridges include finishes such as weathered (Cor-Ten) steel, paint or galvanizing and deck options such as cast-in-place reinforced concrete, precast planks, open grating or composite or wood decking. Prefabricated steel truss bridges are available in a variety of design styles and truss types to accommodate site aesthetics and clearance requirements.

Siting

Bridge siting will be determined primarily by abutment constraints due to geomorphology, potential cultural resources, elevation differences and horizontal and vertical alignments. A geotechnical investigation is recommended for potential bridge crossing locations. Abutments and decks should be located outside of potential flows wherever feasible. Areas of environmental concern, such as wetlands or sensitive species, should be identified as part of the bridge siting process. Prefabricated bridges generally create less environmental impacts than site-constructed types.

Length

Typically, the most cost-effective structures are those with horizontal alignments constructed perpendicular to the crossing resulting in the shortest bridge spans. Bridge length will also be constrained by some of the siting constraints mentioned above.

Width

Proposed bridges should be typical of those commonly used for trails and should be a minimum of three feet wide for open space trails and 12 feet wide for Class I paths. When a wider multi-purpose bridge is needed to accommodate high use levels, or to support maintenance or patrol vehicles, bridges would be a minimum of 20 feet wide and constructed to required vehicle load rating.

Railing

AASHTO specifies that minimum pedestrian bridge railing height should be 42 inches high. Bridges designed for bicycle traffic should be equipped with bicycle railings. If deemed necessary, rub-rails attached to the rail to prevent snagging should be deep enough to protect a wide range of bicycle handlebar heights. Vertical balusters are not recommended for railings designed to provide protection for bicycles since snagging of bicycle pedals or handlebars may occur. Railings are not required on small bridges serving open space trails.

*Prefabricated Steel Truss Bridge - Murrieta Creek Trail (Wildomar, CA)*

*Wood and Cor-Ten Steel Bridge - Millennium Trail (Park City, UT)*

### *Boardwalks*

Boardwalks are commonly used to span sensitive areas such as riparian zones, unavoidable wet areas or depressions. They can also be used to provide trail access in areas where grading and filling may harm tree roots or create trail surfaces that wildlife will not cross. Boardwalks should be considered in relation to environmental impacts, available budget, potential user needs, operations and management issues.

Materials

For boardwalk deck construction, wood lumber is typical, but composite lumber provides a longer useful life compared to wood, is a heavier material resistant to floating in flood prone sites and the pronounced texture provides good grip. While composite lumber is typically costs more than wood, its durability can make it more cost-effective over the life of the structure. This is of particular concern where significant equestrian use is anticipated.

Height from Ground

Boardwalk height should be set to allow for small animal movement under the structure, a minimum of six inches above grade. Footings will vary depending on soil conditions and geotechnical investigation may be advisable.

Width

Boardwalk width in open space should be a minimum of three feet when no rail is required. A eight foot width is preferred in areas with high anticipated or shared use and whenever rails are used.

Railings

Boardwalks less than 30 inches above grade may not require a railing according to current building standards, but curb rails are highly recommended. Boardwalks higher than 30 inches above grade require a 42 inch high railing. AASHTO recommends 42 inch high railings on any structure or path more than 30 inches above adjacent grade.

*Rustic Rock Slab Bridge - Armstrong Trail (Lake Tahoe, CA)*

*Highway Underpass - HT Trail (Sedona, AZ)*

### *Drainage Crossings*

The trail system may require small drainage crossing structures. To minimize potential impacts, trail or path design shall give careful consideration to ponding and the prevention of erosive fill blocking existing drainage patterns. Drainage structures may require review and permitting from agencies such as the California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers and the Regional Water Quality Control Board.

Culverts

A culvert is a drain or pipe that allows water to flow under a road, railroad, trail or similar obstruction typically surrounded by soil. Culverts are generally smaller than bridges, ranging from small pipes to large reinforced concrete structures. A culvert can be a cost-effective solution in bridging a minor drainage crossing. Culverts should be provided at appropriate intervals and should be sized to convey expected drainage flows. Consideration should be given to providing design provisions such as rock edge and energy dissipaters to prevent downstream erosion due to the culvert clogging with debris and associated damage if flows overtop the trail. Larger culverts can be used for trail or path undercrossings.

Causeways

Causeways are raised portions of trails or paths in poorly drained soils or where seeps moisten soil tread. Trail tread or path surface is elevated above wet ground using a permeable fill material as a base. Causeway edges may incorporate small boulders or rock rip-rap to contain the permeable fill. Adding rock and elevating the route allows water to drain to the side and help prevent widening when users walk or ride at the edge of damp areas.

For paved shared-use paths, causeway design criteria should meet AASHTO and Caltrans design recommendations. Construction and detailing depends on water table and site surface flows. A stable paving base must be established while allowing for water flow under the path. Base materials should be designed so as not to be compromised by future water flows. Fill must be mineral coarse-grained or granular material, or small, well-graded angular rocks. Causeways are not intended for use to cross wetlands.

*Boardwalk - Salinas River Trail (Paso Robles, CA)*

*Boardwalk - San Dieguito River Park (Del Mar, CA)*

## 5.2 Paved Shared-Use Path Design Standards

This plan primarily addresses a natural surface open space trail system within the Reserve. However, an emphasis on connectivity also drove planning for a shared-use path along the existing rail line to serve as part of the regional transportation system, specifically connecting the City of Moreno Valley and the UCR campus area, as well as to support recreation, such as walking, running, cycling and in-line skating. The following sections addresses design issues applicable to paved shared-use paths only.

Paved path design standards were based primarily on Caltrans Highway Design Manual (HDM) Chapter 1000 - Bikeway Planning and Design for bikeways and the Riverside County General Plan, Parks and Recreation Element, Trail Standards. The AASHTO Guide for the Development of Bicycle Facilities defines a shared-use path as being physically separated from motor vehicular traffic by an open area or barrier. Shared-use paths should always be designed for pedestrians even if the primary anticipated users are cyclists.

The State of California recognizes three bikeway types, but for this master plan, outside of the Reserve's natural surface trails, only Class I multi-use paths are applicable. Class I paths are facilities with exclusive right-of-way for cyclists, pedestrians and other non-motorized users, with vehicle cross flows minimized. Experience has shown that if significant pedestrian or other use is anticipated, a completely separate facility may be advisable to minimize conflicts. The anticipated range of users and forecast level of use by different user groups should dictate specific facility design.

At a minimum, Class I multi-use paths require an eight foot paved surface with two foot clear, graded shoulders on both sides. For moderate to high-use segments, a wider paved surface should be considered, with 10 to 12 feet now common, and even wider in specific locations with particularly heavy use. In areas where a variety of users are expected, expanded unpaved shoulders should be included. Class I multi-use paths immediately parallel and adjacent to highways must be separated from vehicle traffic by a five foot horizontal separation or a two foot separation with an appropriate barrier, per the CA HDM. Under certain circumstances, Caltrans may approve exceptions to the Class I multi-use path design standards, such as where encroaching bridge abutments limit available pathway space.

*Culvert (Atascadero, CA)*

Various user types can be expected to take advantage of multi-use paths. For example, bicycle commuters are likely to prefer relatively straight and contiguous routes, while recreational riders, including those on mountain bikes, are likely to be less concerned with efficiency and speed since this path may well be their preferred access route to get to Reserve's open space trails. Also, while not a concern for mountain bikers, road cyclists and other small wheeled users such as in-line skaters and skateboarders need smooth paving due to their narrower tires or small wheels that can be more easily deflected by obstacles or surface irregularities. Depending on individual inclination and ability, joggers and runners may prefer either paved or natural surfaces. Equestrians do not generally use paved surfaces.

Since shared-use paths provide a transportation function, new shared-use paths should be built to accommodate people with disabilities. It is recommended that information, including signage, be provided at all path entrances, clearly conveying objective information to path users, including data about grade, cross slope, surface and width.

While directness and connectivity are key criteria for Class I pathways, careful design can support a user experience that can make the pathway a more memorable experience that users will want to repeat. It is often the physical layout that literally shapes the pathway user's perspective.

Studies show that most pathway users' preference is for alignments that prevent them from being able to see too far down the pathway from any specific point. This occasional long distance view obstruction creates a sense of mystery that piques users' interest and subconsciously encourages them to keep moving forward. This is especially important for children, in whom this is most pronounced. Basically, good design combats boredom.

Careful design helps to make the pathway appear to be part of the pre-existing natural landform. In some locations, the pathway's vertical curvature could also be accentuated for short sections. The combination of horizontal curvature and subtle vertical curvature can be made particularly effective by placing the horizontal curves at the lowest point of vertical curves. In practice, pathway design should therefore avoid excessively long straight alignments.

While this may be difficult to accomplish along a rail corridor such as proposed by this master plan, it should be addressed wherever possible, such as taking advantage of any additional available right-of-way width. These modifications will, of course, only be feasible to the extent they fit within a designated corridor and can accommodate adequate sight distances. However, even subtle side-to-side and up-and-down variations are noticeable to most users, along with shade trees and views, which combine to help make their pathway experience more memorable. Such segments tend to become user favorites and therefore generate more use within overall pathway systems.

*Class I Multi-use Path - Santa Ana River Trail (Anaheim, CA)*

*Class I Multi-use Path - Moab Canyon Pathway (Moab, UT)*

## 5.3 Natural Surface Trail Design Guidelines

This comprehensive trails master plan is meant to be the fundamental tool land managers will use to coordinate existing and proposed trail activities and serve as a decision guide regarding natural surface trail routing, funding and implementation.

Trail sustainability's foundational principles echo the American Society of Landscape Architects (ASLA) policies to protect, respect, enhance and restore visual resources, open space, wildlife habitat, native species, wetlands and water quality values, as well as parallel federal land management agency stewardship principles to manage resources for future generations. Planning and designing sustainable trails is based upon the following premises:

- Natural and cultural resource protection
- Appropriate origins, destinations and linkages
- Providing recreational accessibility
- Appropriate cross slopes and grades
- Appropriate solutions for intended uses
- Comprehensive fieldwork to study and develop feasible routes
- Agency/volunteer group partnerships

The following parameters will drive planning and designing sustainable natural surface trails for the Reserve:

- Users will be hikers, trail runners, equestrians and mountain bikers
- Highest use volumes can be expected closest to trail heads and staging areas
- Year-round use is expected
- Land area is sufficient to accommodate expected users and uses
- Monetary and labor resources are likely to be scarce
- Decisions must be based upon long-term impacts or life cycle costs

Trail design is a creative endeavor, especially in mountainous areas. It involves identifying and determining corridor appropriateness on the ground to ensure feasibility while preserving the intended trail experience. Being an observant regular trail user and participating in actual trail construction are the best ways to accumulate trail design skills.

### *Design Guidelines*

This master plan's primary goal is to establish guidelines for a sustainable open space natural surface trail system as a recreational destination serving the communities around Reserve, as well as the surrounding region. The following design guidelines are intended to enhance public welfare and safety and to minimize maintenance requirements. For example, recommended natural surface trail routes limit grades and impacts to riparian areas wherever possible. Perhaps even more important, the recommended routes are intended to provide a true trail experience, taking advantage of the Reserve's unique characteristics and scenic views.

*Class I Multi-Use Path - Santa Ana River Trail (Anaheim, CA)*

Compared to the relatively stringent requirements underpinning paved pathway design, open space trail design is relatively unrestricted. This is due primarily to the strongly site-specific nature of local topography, soils, weather, hydrology, user types and other variables. Natural surface trail design therefore tends to be steered by guidelines that apply to a particular region. In fact, the concept of "standards" is generally not applied to natural surface trails. While some universal siting criteria apply, local conditions generally drive design at the site-specific level. This flexibility is further supported by the fact that publicly accessible trails within open space are generally indemnified from damages due to injuries sustained while using them.

The following general open space trails siting and design guidelines underpin subsequent sections:

- Trails and associated facilities siting and design should minimize impacts to sensitive resources and habitats and public access decisions should respect biological resources.
- Trails and facilities should be designed to discourage and prevent intrusion into adjacent environmentally sensitive areas.
- New trails and facilities should avoid using wildlife crossings.
- In most cases, trail facilities should be sited at the edge of resource areas.
- Trails and associated facilities construction should not occur on highly erosive soils.
- Where landscaping is required, only native species should be used. The use of nonnative invasive plant species should be prohibited.
- Trails should be constructed to any prominent features or viewpoints likely to attract users to prevent off-trail trampling of adjacent habitat.
- Environmentally sensitive grading techniques, drainage management and vegetation buffers should be used for trail and associated facility runoff absorption and filtration.
- Grade reversals and other erosion control measures should be employed as needed to prevent accelerated runoff and soil loss.
- Staging areas should be accessible from public roadways.
- New facilities should minimize lighting impacts.
- Trails should be designed with users in mind, including providing a variety of experiences.

*White Tanks Regional Park (Maricopa, AZ)*

*McDowell Regional Park (Fountain Hills, AZ)*

Four key references were used as guidance for this master plan:

1) Riverside County Regional Park and Open-Space District (RCRPOSD) "Draft Trail Development Standards"
2) National Park Service "Guide to Sustainable Mountain Trails: Assessment, Planning & Design"
3) Naturescape LLC "Natural Surface Trails by Design - Physical and Human Design Essentials of Sustainable, Enjoyable Trails"
4) International Mountain Bicycling Association (IMBA) "Trail Solutions: IMBA's Guide to Building Sweet Singletrack"

The RCRPOSD Standards define the relevant trail types and minimum standards by which new trails should be developed and against which existing trails should be assessed within Riverside County. The most pertinent standard is the "Regional Trail within Open-Space Area" that defines a 24-48 inch wide natural surface tread. While this standards provide some minimum design criteria and construction methods with which to comply, it does not provide sufficient on-the-ground guidance to ensure resulting trails are sustainable.

The Park Service Guide is especially relevant to open space trails system planning, including assessing existing alignments, analyzing proposed routes and restoring abandoned unsustainable routes. Its emphasis is system planning, but provides valuable design and maintenance insights.

The Naturescape guidelines emphasize the more experiential aspects of trail design and does an excellent job of linking sustainability and user trail experience. It also ties trail experience to specific design elements, such as how switchback placement and design affects user perceptions.

IMBA's "Trail Solutions" may appear to be mountain biking-centric, but IMBA is widely regarded as the knowledge leaders in sustainable trail planning, design, construction and maintenance for all user types. This is because IMBA made trail sustainability an advocacy focus from its founding in 1988, emphasizing innovative trail management solutions.

Their guidelines build upon techniques and practices applied for decades by the United States Forest Service (USFS), back to the Civilian Conservation Corps (CCC) in the 1930s, and even ancient Roman road builders. IMBA's expertise has generated sustainable trails development across North America, Asia, Australia and Europe. In particular, six sustainable trail elements were borrowed from the National Park Service:

» Supports current and future use with minimal impact to the area's natural systems.
» Produces negligible soil loss or movement while allowing vegetation to inhabit the area.
» Recognizes that pruning or removal of certain plants may be necessary for proper maintenance.
» Does not adversely affect the area's animal life.
» Accommodates existing use while allowing only appropriate future use.
» Requires little rerouting and minimal long-term maintenance.

The last of these is likely the most critical when it comes to long-term trail system success because the combination of maintenance funding and volunteer labor are both finite, if not scarce, resources.

IMBA's principles of sustainable trails (Pages 55-86) identify critical situations to avoid, as well as essential sustainability elements, summarized below. (Note that two of IMBA's elements address grade, emphasizing its importance in sustainability, and that all of the other references concur.)

Critical situations to avoid include routing trails along the "fall line" or through flat areas.

> *"Fall line trails usually follow the shortest route down a hill – the same path that water flows. The problem with fall line trails is that they focus water down their length. The speeding water strips the trail of soil, exposing roots, creating gullies, and scarring the environment."*

> *"Flat terrain lures many trail builders with the initial ease of trail construction. However, if a trail is not located on a slope, there is the potential for the trail to become a collection basin for water. The trail tread must always be slightly higher that the ground on at least one side of it so that water can drain properly."*

*Examples of Excessively Steep Trails Suffering from Recurring Erosion and Widening as Users Move Outward to Avoid Ruts*

The two most basic trail design goals are:
1) Ensure they readily shed water
2) Provide an experience that encourages users to stay on the trail

These goals are closely linked and will address most trail issues. The following five essential elements help to accomplish these two goals.

Half Rule

The Half Rule is simply that a trail's slope should not exceed half the slope of the hillside or sideslope that the trail traverses. If the slope does exceed half the sideslope, it is considered a fall line trail because water is more likely to flow down the trail than across it. For example, if a trail traverses a 20 percent sideslope, trail slope should not exceed 10 percent. This rule applies to trails routed across both gentle and steep slopes.

Five Percent Average

In general, trail grades should be limited to five percent maximum average, with steeper grades for short segments. This guideline reflects the fact that trails with an overall average slope of five percent of less are more sustainable than steeper trails. This does not mean that the entire trail must remain below five percent, but that the average slope from point A to point B should remain below five percent. (The 2004 IMBA guide called for a 10 percent average, but many trail design professionals agree that five percent is more workable, both for sustainability and user experience.)

While much of the Reserve's topography allows for reasonable grades, rocky areas can usually accommodate steeper trails due to their erosion resistance. Routing over rock slabs and boulders functions quite well since erosion is virtually eliminated. However, prolonged steep grades should still be avoided, not just to prevent potential erosion, but to support positive user experience.

In the rockiest areas where topography is particularly challenging, trail routing should be carefully considered to determine if less steep alignments exist. If no alternative workable routes can be found, appropriate construction may be needed to limit grades to the recommended five percent maximum average. This may include elements such as dry laid stone retaining walls, which are typically part of switchback construction.

For the Reserve, the most challenging trail routes will be where there is little surface other than rock, but “building” such trails can be done at minimal cost since minimal soil needs to be moved. In many cases, this will be limited to transitions onto and off of rock outcrops or boulders. For longer segments like this, marking can be done with paint dots or stacked rock cairns.

Since County criteria call for multi-use trails, stairs are not recommended, unless risers can be kept low and their runs long enough to accommodate adult mountain bikes and horses (six feet minimum).

Outslope

Trail outslope is the measure of how much lower the outer edge of a trail is than the inward edge. Trails should not be constructed with an inward slope because this traps water on the trail tread and forces it to flow down the trail. The RCRPOSD standard states the outslope of a trail should measure between two and five percent. IMBA recommends that the outslope of all trails be five percent to encourage water to flow across the trail as sheet flow and not concentrate on or flow down the trail. (The sole situation where insloping is appropriate is at switchbacks, and then only at the back edge for a short distance, daylighting at the downhill side.)

By utilizing these critical situations to avoid and key elements of sustainable trail design, the Reserve’s existing trails can be assessed for sustainability and evaluated for re-design in conformance with sustainable practices, as well as applying these principles to proposed new trails.

In addition to the physical aspects of sustainable trail design, resource management concerns must also be addressed. Direct and indirect impacts associated with recreational trails need to be considered relative to any cultural and historical resources, as well as biological.  If sensitive resources are identified, nearby trails should be assessed for potential impacts and management decisions made regarding permanent or seasonal closures, or re-routed to avoid or minimize impacts.

*Natural Surface Trail - Blazing Saddles Trail (Santee, CA)*

*Natural Surface Trail - Kolob Canyon Trail (Zion National Park, UT)*

Maximum Sustainable Grade

While open space trails are generally exempt from grading limits, it is considered best design practice to limit grades wherever possible. This reduces construction impacts and costs, as well as long-term maintenance such as erosion repair. In addition, users may go out of their way to avoid excessively steep trail segments, especially long ones, potentially widening existing trails, damaging adjacent and downslope habitat, particularly streambeds below the trail.

The maximum sustainable grade is the steepest trail slope that can be sustained based on local conditions. Variables to consider include the Half Rule, soil type, amount of rock, annual rainfall, grade reversals, user types, use level and level of difficulty. The maximum sustainable grade should never exceed the Half Rule.

Calculating maximum sustainable trail grade is a complicated process that requires a high level of trail building knowledge and experience. When in doubt, trails should be designed with conservative grade.

Grade Reversal

Grade reversals are the points at which a climbing trail levels out then descends 10-50 feet before rising again. These changes in slope channel water off the trail at the low points, preventing it from gaining more volume, momentum and erosive power if it were allowed to continue flowing down the trail.

> *"Most trails will benefit from grade reversals every 20 to 50 feet, depending on soil type and rainfall. Grade reversals can help trails endure, even with minimal maintenance. Older trails often have a deeply compacted, concave trail tread that collects water. With regular grade reversals, this water will only be trapped on the trail for a short distance before it can drain. Grade reversals effectively divide the trail into short, individual watersheds, so the drainage characteristics of one section of trail won't affect any other section."*

*Natural Surface Trail - Noble Canyon Trail (Cleveland National Forest, CA)*

*Natural Surface Trail - Highland Valley Trail (San Dieguito River Park, CA)*

Natural Surface Trail Width

The RCRPOSD Standards' "Regional Trails – In Open Space" is the closest analog to the natural surface singletrack trails existing and proposed throughout the Reserve. While a trail tread width of 24-48 inches with an additional 24" buffer on each side is reasonable for a regional "backbone" trail, and for trails around the Reserve circumference, this width is not likely to be achievable or desirable for trails traversing the Reserve's rocky, boulder-strewn, mountainous slopes. Particularly considering local conditions, minimizing trail width accomplishes the following:

- Minimizes construction costs
- Minimizes erosion and subsequent maintenance
- Minimizes environmental, hydrological and visual impacts
- Preserves open space character
- Provides design flexibility
- Maximizes user experience

*Natural Surface Trail - Lucky 5 Trail (Rancho Cuyamaca State Park, CA)*

> ***"Designers should observe proposed or existing routes in all seasons to help determine new corridor suitability for trail development, as well as the level of improvement or rerouting required to achieve sustainability for rebuilt trails."***
>
> ~ NPS Natural Resource Management Reference Manual # 77

*Natural Surface Trail - Overlook Trail (Elfin Forest Recreational Reserve, CA)*

## Specific Construction Techniques

### *Tread Cutting*

Well constructed, properly sloped and well compacted trail tread can be achieved by following these pointers:

- Work across the trail for efficiency when cutting tread
- Outslope trail approximately 10 percent (1 inch in 10 inches) to allow for drainage
- Remove all vegetative material from the trail tread and allow for drainage off the trail's edge
- Backslope trail approximately 1:1 (45 degree angle) to allow for quick revegetation; Backslope may approach 5:1. Shallower backslope reduces the potential for sloughing onto the trail tread
- Improve inadequate surfaces with imported materials only as necessary.
- In rocky terrain, soil is often at a premium. Broadcast or dispose of excess materials only as needed

### *Grade Reversal*

Grade reversals redirect surface flows and reduce subsequent maintenance of otherwise well built trails. Trail builders refer to well placed grade reversals as "surfing the contour."

Grade reversals should be installed on trails where normal cross slope will not allow for adequate drainage. Careful study of adjacent topography often yields insight into maximizing trail protection, while minimizing structures required. For example, large boulders on the uphill side of the trail are often ideal grade reversal high points.

- Take advantage of natural features when selecting locations.
- Natural dips or bends in the trail are often good locations for grade reversals
- Avoid areas without a drainage outlet
- Create drainage a outflow basin toward downhill side of trail, uphill of grade reversal and at least four inches deeper than trail level
- Verify function during or following a rain event

*Natural Surface Trail - Redtail Trail (Simpson Park, CA)*

*Maintenance on Natural Surface Trail - Rattlesnake Trail (Elfin Forest Recreational Reserve, CA)*

### *Stone Retaining Wall*

Stone retaining walls allow trails to be built where they normally would not be, or to improve otherwise unsustainable conditions. Retaining walls are labor-intensive and are best built by experts.

- Begin by cutting a footing off the trail edge so that the finished wall will be off the trail tread
- Daylight the footing for drainage
- Stack larger stones intermingled with medium stones near the foundation and fill voids with smaller stones. More contact between stones means more friction and a better built wall
- Stagger joints vertically and horizontally
- Materials excavated from the trail corridor can be used as backfill

*Stone Retaining Wall - Upper Valley Trail (Quechee, VT)*

### *Switchback*

Switchbacks are used where necessary to change trail direction. Switchbacks often involve retaining walls, are labor-intensive and are best built by expert crews.

- Eight foot interior radius is required to accommodate multiple uses, especially horses or mountain bikes.
- Stone retaining walls can be used as a landing on which trail users can turn.
- Freestanding retaining walls may be required to separate the switchback's upper and lower legs.
- Drainage is required, especially slight outslope above the uphill leg close to the landing, which should be slightly convex.

*Switchback - JEM Trail (Hurricane, UT)*

## Layout Guidelines

### *Challenging Trails*

The Reserve holds great potential for a memorable open space trail system. The hikers, runners, equestrians and mountain bikers expected to take advantage of the trail system represent a wide range of desires, abilities and preferences, even within user groups. A diverse trail network with a variety of trail experiences ensures happy users.

This was supported by public comments to include challenging routes for more experienced users, with routes ranging from nearly flat trails with mild meanders to trails traversing rocky areas with frequent direction and elevation changes. In some locations, these can be parallel or nearly parallel routes. All of these trail "styles" can be sustainably routed, especially if their design takes advantage of the stability provided by the Reserve's abundant rock outcrops, slabs and boulders. In addition, trails that traverse rock features are the most sustainable and are potentially less costly to construct and maintain.

### *Stacked Loop System*

Wherever possible, trail systems should form loops. This enhances user experience by providing multiple options while reducing impacts by not requiring all users to go out and back via the same route. Users from nearby neighborhoods will especially appreciate the ability to hike or ride without having to retrace their steps on the return leg.

It is common practice to design open space trail networks as "stacked loops." These are networks that site milder trails with limited challenges closest to staging areas so that children and less experienced adults can enjoy them as they acquire trail experience (see "Circumference Trails" section in Chapter 3). Over time, they develop the ability to cover longer distances on progressively more challenging trails with more elevation change farther from staging areas. A difficulty rating signage system is often used for open space trail systems and may be appropriate for the Reserve trails, especially where challenging trails are implemented.

*Challenging Trail - Jordan Trail (Coconino National Forest, AZ)*

*Challenging Trail - Rock Creek Trail (Bishop, CA)*

### *Avoid the "Zipper"*

Especially where rock outcrops limit alignment options, appropriate mountain trail routing necessarily involves switchbacks. Unfortunately, many mountainous open space trails experience erosion damage at the switchbacks because they were stacked directly above and below each other instead of spacing them out more laterally across the slope the trail traversed. In many cases, this was done even when space was available to space them out further.

This "zipper" effect has three consequences. The first is that water running off upper switchbacks flow directly onto lower ones, concentrating runoff and eroding the trail. This repeated channeling causes progressive damage that requires recurring repairs during and after every rainy season. Even if the switchbacks were properly graded, this can occur because care was not taken to direct runoff away from the next switchback below.

The second issue is that some trail users in a hurry save time by "cutting" the switchbacks because they can readily see how close together they are. This generally occurs when they are returning from a hike or ride and heading downhill. The eroded "zipper" can even mislead users into thinking they are on an appropriate route.

The third issue is user boredom. Anecdotal evidence suggests that when hikers, in particular, encounter closely spaced repetitive switchbacks, they are more prone to cut across them than to stay on the trail. These effects combined create the worst erosion situations. Users cutting the switchbacks go around the rutting caused by the runoff erosion, further damaging the slope. The result can be a braided series of ruts, and often quite deep due to concentrated flow velocities.

The solution is to avoid creating a "zipper" of switchbacks by taking advantage of the available slope. Instead of stacking switchbacks, routing should laterally traverse the slope at a sustainable grade for some distance before switching back, taking care to keep the switchbacks far enough apart to discourage cutting. Wherever possible, switchbacks should not be visible from other switchbacks. There is the potential to accomplish this on Box Springs Mountain due to interesting terrain and abundant large boulders around which trails can be routed. Ideally, switchbacks should be visually "anchored" by large boulders or rock outcroppings.

*"Zipper" Trail - "M" Trail (Box Springs Mountain Reserve, CA)*

*"Zipper" Trail - Cowles Mountain Trail - Mission Trails Regional Park, CA)*

### *Bike Skills Parks*

The continual increase in mountain biking has led to a boom in the popularity of bike skills parks. Placing them at open space staging areas allows riders to hone their skills while waiting for their friends. They also provide a fun venue that can encourage local kids to ride there instead of building illegal jumps in sensitive areas. Related to that, first responders can much more easily tend to injuries at a staging area rather than having to get to the victim out in the open space.

Bike skills parks can be a great community asset providing a managed arena for beginner to expert skill development, including kids and their parents. While a relatively new idea, bike skills parks are simply another recreational amenity, analogous to the skate parks that many cities already provide and successfully manage. Compared to other typical park facilities, bike parks are relatively inexpensive to build and maintain, especially with volunteer support that many enjoy.

The League of American Bicyclists' (LAB) Bicycle Friendly Community program supports facilities like bike skills parks and pump tracks because they encourage kids to ride more. In general, kids have shorter attention spans, less stamina and prefer to ride shorter distances than adults. Anecdotal evidence suggests that having fun, shorter riding venues helps to keep them interested in riding into adulthood. Since the City of Riverside is an LAB Bronze level Bicycle Friendly Community, facilities like bike parks could be a significant factor in future upgrade applications.

Bike skills park planning guidance is available from the International Mountain Biking Association (IMBA).

*Mammoth Bike Park (Mammoth Lakes, CA)*

*Valmont Bike Park (Boulder, CO)*

## 5.4 Recommended Railroad Crossing Design Standards

Railroad crossings are either at-grade or grade separated. Grade separated crossings include overpasses and underpasses. Each of these categories are explained in more detail in the following sections.

The standards for each category represent a synthesis of best practices, culled from several sources. This is reasonable given the fact that this planning document does not specify any particular rail crossings, and therefore any rail authority, but rather suggests potential crossing needs based on recommended trails and staging areas.

Should a new crossing be pursued in the future, the relevant rail agency's guidelines should be followed (e.g. Riverside County Transportation Commission, Metrolink or Burlington Northern/Santa Fe Pacific RR). The three aforementioned agencies are alike in their policies regarding new non-motorized crossings of their rail lines. All agencies permit all crossing types, provided they are designed safely, but favor overcrossings, discourage at-grade crossings and are ambivalent regarding undercrossings.

### At-Grade Crossings

At-grade trail crossing require the same general design and operational considerations as street or highway crossings. This is true whether provided alongside a full street or as a standalone at-grade trail crossing. General at-grade design and operational principles relate to the removal of obstructions, crossing geometry, illumination and crossing surfaces.

*Note: The following text provides an overview of guidelines for at-grade crossings; they are by no means exhaustive. For further detail, see references at the end of this section.*

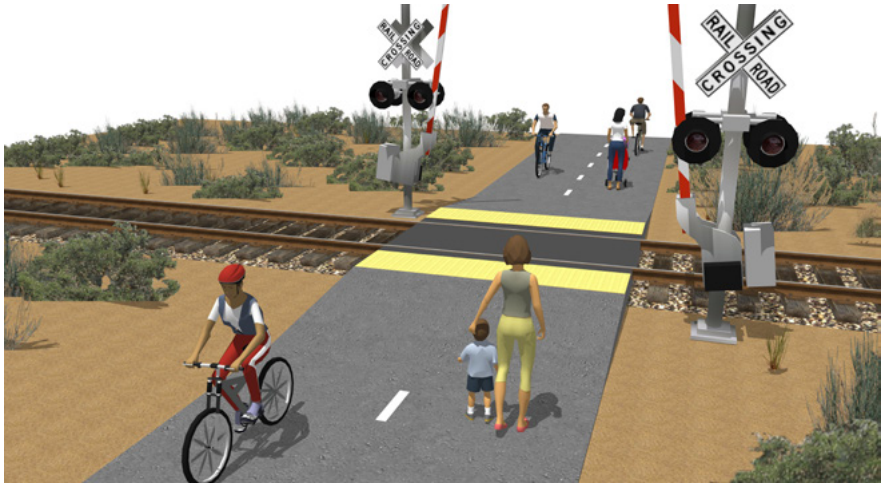
#### *Removal of Obstructions*

Removal of obstructions is most important at three key areas: Approach, Corner and Clearing Sight Distances.

The approach relates to the area between the trail users and the crossing. Common obstructions in this area include signage, traffic control devices, utility fixtures, vegetation and billboards. All material not needed for safe operation of the crossing should be removed.

Corner obstructions often exist within the sight triangle, typically caused by structures, topography, vegetation, movable objects or weather (fog or snow). Wherever possible, sight line deficiencies should be improved by removing obstructions, re-grading embankments or realigning the street/trail approach. If it is, for some reason, infeasible to address sight line deficiencies, supplemental traffic control devices, such as enhanced advance warning signs, STOP or YIELD signs, or reduced speed limits (advisory or regulatory) should be evaluated.

Clearing sight distance refers to visibility available to a street/trail user along the track when stopped ahead of the grade crossing. This area alongside tracks is often enhanced with vegetation to minimize air and noise pollution impacts on adjacent land uses. This area should be kept as clear (free of vegetation and other obstructions) as possible. If clearing is infeasible, flashing light signals with gates, closure, or grade separation should be considered.



*Example At-Grade Crossing*

### *Crossing Geometry*

Crossing Geometry includes the topics of Horizontal Alignment, Vertical Alignment and Right-of-Way and Roadside (clear zone).

Horizontal Alignment

Horizontal alignment refers to the way in which the street/trail intersects the railroad crossing. A crossing as close to 90 degrees, with no nearby driveways or cross streets, is desired. This layout enhances the trail user's (or driver's) view of the crossing and reduces conflicting vehicular movements from driveways and cross streets. Crossings along street/trail or rail curve should be avoided, if possible. If crossings cannot be realigned to improve visibility, the installation of active traffic control systems or closure of the crossing may be warranted.

Vertical Alignment

*Vertical alignment* refers to the position of the street/trail in relation to the crossing. The positioning of the street/trail slightly above the tracks provides optimal visibility for those crossing. Due to routine track maintenance, some complications at the interface of the tracks and street/trail may arise (See the FHWA's Railroad-Highway Grade Crossing Handbook for further guidance[1]).

### *Illumination*

Illumination at crossings assists road users, including bicyclists and pedestrians, in traversing the crossing at night and may be effective in reducing nighttime collisions. Because more than 90 percent of all crossings have commercial power available, illuminating most crossings is technically feasible. Special care should be taken to use appropriate light fixtures and placement, given the previous guidelines regarding obstructions and crossing geometry.

1) http://safety.fhwa.dot.gov/xings/com_roaduser/07010/sec04c.cfm#j

### *Warning Devices*

Warning devices are another important means of ensuring safety at at-grade crossings, especially when sight distances are poor due to obstructions or geometric issues. At the very least, existing at-grade crossings typically have some sort of passive warning devices (e.g. railroad "crossbucks" or railroad crossing signs). At sites with a greater potential for conflict, enhanced warning devices should be provided. The MUTCD contains standards for signs, pavement markings, audible signals and other devices used to regulate, warn, or guide traffic, placed on, over, or adjacent to a street, highway, pedestrian facility, or bikeway by authority of a public agency having jurisdiction.

### *Crossing Surfaces*

Crossing surfaces are important for two reasons. Uneven crossing surfaces may cause trail users (and drivers) to be distracted by the surface and look away from the crossing itself, thereby increasing the chance of conflict in the crossing. Uneven or fractured surfaces may also cause trail users or drivers to trip or lose control of their vehicles.

Crossing surfaces may be divided in two main categories: monolithic (poured in place, cannot be removed without destroying them) and sectional (fabricated off-site and installed, can be removed – and replaced – without destroying them). Monolithic crossing are typically made of asphalt, poured-in-place concrete or cast-in-place rubber. Sectional crossings panels typically consist of treated timbers, reinforced concrete, steel, high density polyethylene or rubber. The AREMA Manual of Railway Engineering, Part 8, provides guidelines for the construction of rail crossings, including information on crossing width, profile and alignment of crossings and approaches, drainage, ballast, ties, rails, flange widths, and new or reconstructed track through a crossing[2].

2) https://www.arema.org/publications/mre/index.aspx

### *Special Considerations for Trail Users*

Special Considerations for Trail Users, including pedestrians, cyclists and other non-motorized vehicles, must be made in order to ensure their comfort and safety. Primary issues are the slower speeds of trail users (than motor vehicles) and added sensitivity to crossing surface and steep grades.

Trail User Speeds

Trail user speeds impact sight distances, geometric design and the length of warning signals for approaching trains. Issues with sight distances, and sight triangles in particular, should be based on the fastest expected trail users (probably bicyclists and in-line skaters). These users' faster speeds will require greater visibility (i.e. fewer obstructions and optimal geometry, as described above). This is especially true at non-signalized crossings. Trail user speeds will also determine the amount of time required for crossing. Contrary to geometric design, which is based on the fastest expected users, operational design and warning signals, in particular, should be designed with the slowest expected trail users in mind. Most railroad safety references and FRA Roadway Worker Safety rules (49 CFR 214), specify that upon the approach of a train, enough warning must be given to allow someone on the track to have at least 15 seconds between the time they are clear of the track and the train arrives. This guideline applies to railroad personnel, who are prepared to vacate the tracks with proper warning. Average trail user, who are most likely not familiar with typical rail operations hazards, would need additional warning time.

Crossing Surface

Crossing surface is especially important for trail users with wheeled vehicles (e.g. bicycles, wheel chairs and in-line skates). As with motor vehicle rail crossings, the angle at which trails and tracks meet should be as close to 90 degrees as possible. The greater the crossing deviates from this ideal crossing angle, the greater the potential for cyclist's front wheels to be trapped in the flangeway[3], causing loss of steering control and potential fall injury. The impact of poor track-trail alignment is exacerbated by the high number of expected wheeled vehicle users on trails. If the crossing angle is less than approximately 45 degrees, an additional paved shoulder of sufficient width should be provided to permit the bicyclist to cross the track at a safer, preferably perpendicular, angle. If realignment is infeasible, one way to solve the problem created by the flangeway gap is to use a compressible "flangeway filler."

3) Flangeway is the space between the rail and the adjoining pavement edge.

Crossing Grade

Crossing grade is specified by the AASHTO Bike Guide and the ADA for shared use paths. If a crossing is intended to be ADA accessible, trail grades should not exceed five percent. While trail grades over five percent are allowed for short distances in specific circumstances, they are not recommended for crossing approaches. In general, the trail approach should be flush with the track. Steep grades on either side of the track can cause bicyclists to lose control, may distract trail users at the crossing and may block sight lines.

### *Other Pedestrian and Bicyclist Safety Measures*

Other pedestrian and bicyclist safety measures include passive and active devices. Passive devices include fencing, swing gates, pedestrian barriers, pavement markings and texturing and refuge areas. Active devices include flashers, audible active control devices, automated pedestrian gates and pedestrian signals.

According to the FHWA's Railroad-Highway Grade Crossing Handbook, "These devices should be considered at crossings with high pedestrian traffic volumes; high train speeds or frequency; extremely wide crossings; complex highway-rail grade crossing geometry with complex right-of-way assignment; school zones; inadequate sight distance; and/or multiple tracks. All pedestrian facilities should be designed to minimize pedestrian crossing time, and devices should be designed to avoid trapping pedestrians between sets of tracks."

## Grade Separated Trail Crossings: Overpasses and Underpasses

Like at-grade crossings, there is a significant amount of overlap between vehicular and trail grade separated crossings. Similar to at-grade crossings, many of the standards pertaining to roads also apply to trails and supplemental information is added where appropriate. The standards for both overpass and underpass crossings, in their most generic forms, are described in the following section. Note that, consistent with California Class I multi-use path standards, minimum bridge widths should be 10 feet wide (eight feet minimum) and buffered by a two foot "shy space" on either side.

### *Overpass Crossings*

Several standards apply to both general overhead structures and trail structures, equally (e.g. horizontal and vertical clearances, lighting, drainage and erosion). Distinct standards for trail overpasses primarily relate to railing and fencing. Standards governing both general overhead structures and trails are outlined in the following section.

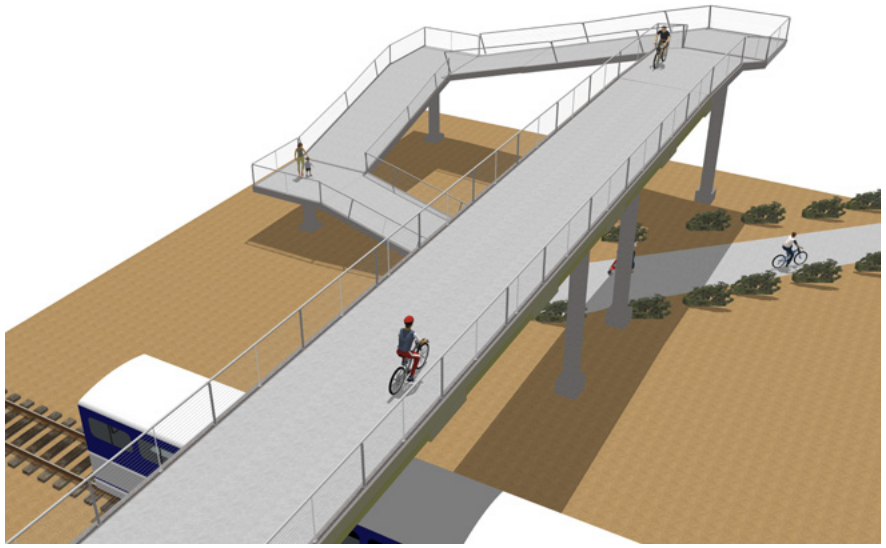
### *All Overpass Standards*

The following paragraphs explain the basic standards of overhead structures, the most generic structure, of which overpass trail crossings are a part. These standards are followed by specific items relating to trail overpasses. Ultimately, all overhead structures should be designed in accordance with AREMA, AASHTO and the MUTCD.

Design

If possible, contractors should develop a work plan that enables the tracks to remain open during the construction of the overhead structure. The overhead structure should not be built using a cast-in-place method because it represents the greatest rail service disruption. Instead, pre-fabricated methods are encouraged.

*Example Overpass Ramp*



*Example Overpass Bridge*

Permanent Clearances

Permanent clearances are intended to accommodate future tracks, future track raises, access roads and drainage ditch improvements. Proposed vertical and horizontal clearances shall be adjusted so that the sight distance to railroad signals is not reduced unless signals are to be relocated as part of a proposed grade separation project. The clear zone, within the permanent clearance envelope, shall be clear of all objects such as trees, signage, utility poles and other objects.

Permanent Vertical Clearances

The minimum permanent vertical clearance permitted by the Code of Federal Regulation is 23' - 4" measured from the top of the highest rail to the lowest obstruction under the structure. The 23'- 4" permanent vertical clearance can not be violated due to superstructure deflection. Additional vertical clearance may be required under special circumstances, including, but not limited to correction of sag in the track, construction requirements and future track raise.

Permanent Horizontal Clearances

All piers and abutments should be located outside the railroad right-of-way limits. If this is not feasible, all piers and abutments should be located more than 25 feet measured perpendicular from centerline of the nearest existing or future track. The absolute minimum horizontal clearance requiring special review, and subject to site conditions, is 18 feet measured perpendicular from the centerline of the track to the face of the pier protection wall.

Lighting

All new or modified overhead structures exceeding 80 feet in width should provide a lighting system to illuminate the track area. Subject to the local railroad representative, lighting shall be provided for all structures less than eighty (80) feet in width in areas where switching is performed or where high vandalism and/or trespassing have occurred. Care should be taken to avoid placing lighting in locations that may cause train engineers to mistake it for train signals or interfere with sight distances. All lighting should be directed downward.

Drainage and Erosion

Drainage from overhead structures should be diverted away from the railroad right-of-way at all times. If drainage employs downspouts in columns, they should be connected to the storm drain system or allowed to drain into drainage ditches. Concrete splash blocks or aggregate ditch lining should be included at the downspout discharge areas. Downspouts should be placed behind the face of all piers. If overhead structural elements (e.g. abutments, piers or columns) interfere with drainage, an alternative means of handling longitudinal drainage should be provided.

### *Overpass Standards for Trails*

Rail and Fence Standards

Rail and fence standards for trail overpasses differ substantially from those for vehicular overpasses. While vehicular standards require poured-in-place concrete railing to "retain and re-direct errant vehicles,[4]" due to user characteristics, trail overpasses require only railing. Trail overpasses, due to their user particulars, also require fencing.

The 2002 AASHTO "Standard Specifications for Highway Bridges" imposes stringent requirements for railing height. Section 2.7.2.2.1 of the specifications states, "The minimum height of a railing used to protect a bicyclist shall be 54-inches, measured from the top of the surface on which the bicycle rides to the top of the top rail." Section 2.7.3.2.1 states, "The minimum height of a pedestrian railing shall be 42-inches measured from the top of the walkway to the top of the upper rail member." In addition to guidelines governing safety, the AASHTO guide recommends considerations of "appearance and freedom of view." Standards for appearance and freedom of view are not prescribed, but left to the discretion of the project engineer.

4) http://www.up.com/cs/groups/public/documents/document/pdf_rr_grade_sep_projects.pdf

Standards also exist regarding the size of the openings between horizontal and vertical elements. In accordance with the "LRFD Bridge Design Specifications," these standards prevent objects from falling or being pushed through the railing onto the travel way below. Section 2.7.2.2 of the 2002 "Standard Specifications for Highway Bridges," states "Within a band bordered by the bikeway surface and a line 27 inches above it, all elements of the railing assembly shall be spaced such that a six inch sphere will not pass through any opening. Between 27 and 54-inches above the bikeway surface, elements shall be spaced such that an eight inch sphere will not pass through any opening."

The BNSF Railway – Union Pacific Railroad's Guidelines for Railroad Grade Separation Projects also stipulates that a curved or straight fence be combined with the barrier rail to "prevent climbing an provide positive means of protecting railways and their employees from objects thrown by pedestrians or motorists. The minimum combined height of a barrier rail with curved fence should be eight feet or with a straight fence, 10 feet. The fencing should extend to the limits of the railway right-of-way or a minimum of 25 feet beyond the centerline of the outermost track, future track or access road, whichever is greater.

### *Underpass Crossings*

Most guidelines recommend overpass crossings over underpass crossings. This is primarily due to the tendency of underpass crossings to flood and drain poorly, requiring significant, drainage-related countermeasures. Underpass crossings, by virtue of supporting tracks, trains and other rail-related construction material, also require significant structural countermeasures. Even so, in some instances, underpass crossings may be the preferred or only option. The level of detail required for the construction of underpasses is inappropriate for this overview and is better explained elsewhere (e.g. the BNSF Railway – Union Pacific's Guidelines). This section discusses the basic standards associated with underpasses.

### *All Underpass Standards*

Design

Similar to overhead structures, a work plan should be developed that allows tracks to remain open during underpass construction. Also similar to overhead structures, underpasses should not be built using a cast-in-place method, because it represents the greatest rail service disruption. The use of pre-fabricated methods is encouraged.

Design Loads

According to the BNSF Railway – Union Pacific's Guidelines, underpass structures should be designed for the following loads:

- Live load and impact as specified in AREMA. For multiple track structures, live load shall be calculated based on the assumption that the track(s) can be located anywhere on the bridge with a defined horizontal clearance to the handrail[5] and a maximum track spacing of 13 feet.
- Dead load shall include up to 30 inches of ballast from top of deck to the top of tie and all other applicable dead load.
- Seismic design shall comply with the criteria of the current edition of AREMA, Chapter 9 - Seismic Design for Railway Structures.
- Additional loads shall be applied as specified in Chapters 8, 9, and 15 of AREMA, as applicable.

Access to Underpass Structure

All underpass grade separated structures should include access to each end of the bridge for railroad off-track maintenance equipment. Access may be provided on the bridge itself, or via a separated bridge or a roadway with turnarounds.

Fences and Handrails

Handrails with fencing should be provided on both sides of the deck and meet FRA and OSHA requirements. Handrails and fences should be simple designs that require minimum maintenance and meet clearance requirements. Fences are required over all roadways, trails and sidewalks.

5) See Section 6.6.1 of the BNSF Railway – Union Pacific's Guidelines for details.

Materials and Construction Details

As noted in this section's introduction, the specific underpasses requirements include a heightened level of attention to construction materials and detail. Standards cover topics including material composition, characteristics, fabrication, post-processing and certification. Chapter 8 of the current edition of AREMA and the BNSF Railway – Union Pacific's Guidelines include detail on the follow topics and should be consulted for further information:

- Concrete Requirements
- Reinforcing Steel Requirements
- Prestressing Strand Requirements
- Structural Steel Requirements
- Sacrificial Beams, Fascia Beams and Impact Protection Devices
- Superstructure
- Deck Type
- Composite Deck
- Waterproofing
- Steel Superstructure
- Diaphragms or Cross Frames
- Mechanically-Connected: Bottom Flanges and Intermediate Stiffeners
- Painting of Steel Structures
- Concrete Superstructure
- Tie Rods
- Substructure
- Piers
- Abutments

Skew

Similar to at-grade crossings, but for structural rather than "line of sight" reasons, the preferred angle of intersection between centerline of track and centerline of bridge supports transverse to the track is 90 degrees. The minimum intersection angle allowed is 75 degrees for concrete substructures and 60 degrees for steel substructures.

Future Track and Access Road

Planning for underpasses should verify the need and requirements for future tracks and/or access road for each project.

Permanent Vertical Clearances

(Permitted clearances for roadways and trails differ. See section entitled "Underpasses for Trails for vertical trail vertical clearance specifications).

Permanent Horizontal Clearances

The horizontal clearances from the centerline of the nearest track to any bridge component shall, in all cases, conform to AREMA requirements except in cases of curved tracks, where the minimum increase in clearance shall be six inches. Proposed structures that accommodate multiple tracks, future tracks and existing tracks should be designed for a minimum of 20 foot spacing measured centerline to centerline. The same clearance standards apply to deck widths.


*Example Underpass Crossing*

Approach Slab

Undercrossing standards require an approach slab for skewed abutments. The BNSF Railway – Union Pacific's Guidelines offer the following guidance: "The bridge end of the approach slab shall be skewed and doweled with the abutment while the other end of the approach slab is perpendicular to the centerline of track to insure uniform subgrade stiffness for the ties immediately adjacent to the bridge. The approach slab shall be constructed symmetrically to the centerline of the track and shall be a minimum of 12 feet wide and extend parallel to the track a minimum of 3 feet beyond the back edge of the abutment."

Drainage

The superstructure should maintain a minimum longitudinal grade of 0.2 percent to ensure adequate drainage. The designer may provide drainage toward one end of the structure, or when the structure's length is excessive, provide adequate deck grades to provide bi-directional drainage. For concrete decks, a longitudinal collection system should be provided on top of the waterproofing along the face of parapet or curb to drain water to storm drain systems. If an approach grade descends toward the bridge, drainage from the approach should be diverted to an appropriate system to prevent drainage onto the bridge.

Inadequate drainage facilities can severely compromise the superstructure integrity. When designing drainage facilities for a structure, the BNSF Railway – Union Pacific's Guidelines suggest two important criteria to keep in mind:

1) Drains should be constructed of corrosion resistant material and the use of PVC shall not be permitted.
2) Drains should not discharge on other bridge elements or traffic passing underneath the structure. The drip groove located on the bottom of the deck slab or fascia beam shall end three feet before the face of the abutment.

### *Underpass Standards for Trails*

All pipe and concrete box culverts should be designed per railroad requirements and any applicable sections of AREMA. For safety and operational considerations, confined structures are discouraged. To improve safety and sight distance, all structures should be tangent without curvature. The vertical and horizontal clearance of pedestrian structures should be subject to the project site and structure length (though vertical clearance should be no less than eight feet). The line of sight, historical security data and available lighting shall be used for determining the required size of opening.

## REFERENCES

### *At-Grade Crossings*


http://www.dot.state.mn.us/research/TS/2013/201323.pdf
http://safety.fhwa.dot.gov/xings/com_roaduser/07010/
http://www.fhwa.dot.gov/environment/recreational_trails/publications/rwt/


### *Grade Separated Crossings*


http://www.up.com/cs/groups/public/documents/document/pdf_rr_grade_sep_projects.pdf
https://bookstore.transportation.org/item_details.aspx?id=2211
http://sccrtc.org/wp-content/uploads/2012/10/section+5+-+trail+design+standards.pdf
http://design.transportation.org/Documents/BikeRailHeight,NCHRP20-7(168)FinalReport.pdf

# 6

# Cost Estimates

The following chapter provides preliminary cost estimates for the proposed Box Spring Mountain trail network. The estimates include linear foot costs for trail design and maintenance for both new trail construction and existing trail renovation. In addition, the cost estimates include categories that cost estimation typically does not include, such as permitting and utility connection fees.

> ***"We have overbuilt many roadways in America. We can afford to do that. We cannot afford to overbuild our trails. For in making them "better," we make the experience worse."***
>
> ~ Dan Burden

## 6.1 Costs Validation

Construction and maintenance cost estimates were developed from data and methodologies derived from a variety of sources. Because trail costs vary widely across the country, multiple estimates were collected to help validate costs for this master plan's specific location.

Example trails cost estimates were reviewed from the United States Forest Service (USFS), the National Park Service (NPS), the National Trails Training Partnership, the International Mountain Bicycling Association (IMBA) and sites in other mountainous western states. These and other resources were analyzed to help construct and validate the preliminary construction and maintenance cost estimates.

To adjust for inflation, the Bureau of Labor Statistics' Consumer Price Index Inflation Calculator was used. According to the Bureau, inflation tends to fluctuate between 1.5 to three percent per year with an average recent annual inflation of 2.25 percent. The latest figure of just under one percent was incorporated into the preliminary cost estimates.

http://www.bls.gov/data/inflation_calculator.htm

To compare national and Riverside County norms, a regional cost factor was used, the Department of Defense (DOD) Area Cost Factor. This rating is based on the difference between an overall national construction cost average and that of a specific site, in this case based on the installation nearest the Reserve, March RAFB. Because March RAFB is so close to Box Springs Mountain and the Area Cost Factor takes into account local effects, it was thought this would be a valid comparison. This factor was 1.19, or 19 percent higher than the national average, fairly average for southern California. This figure was also incorporated into the cost estimates as an additional line item for information purposes.

http://www.usace.army.mil/Portals/2/docs/2015_PAX_3.2.1_DoD_Area_Cost%20Factors_dated_25%20Mar_%2015_Final.pdf

### Example Trails Cost Estimates

1. USFS - Trails Unlimited Website
   According to the website: "Construction costs vary so widely it is impossible to provide accurate cost estimates here. But the range of cost per mile has been from $2,500 to $12,000 per mile for new construction. Trails Unlimited has provided maintenance at a range of $2,500 to $6,000 per mile, higher costs per mile for very heavy maintenance where structures (retaining walls & drains) were involved."

   Note that these figures do not include potentially costly items such as utility hookups and permit fees.

   http://www.fs.fed.us/trailsunlimited/services/construction.shtml

2. NPS - Handbook for Trail Design, Construction and Maintenance

3. National Scenic Trail – North County Trail Handbook 1998

   http://www.nps.gov/noco/learn/management/upload/NCT_CH9.pdf

4. National Trails Training Partnership – Trail Operations and Maintenance

   http://www.americantrails.org/resources/ManageMaintain/index.html

5. International Mountain Bike Association (IMBA) – Trail Solutions – Page 188

   https://www.imba.com/catalog/book-trail-solutions

6. Delta Junction Trails Association – Delta Junction, Alaska – Appendix D – Trail Costing

   http://www.deltajunctiontrails.com

7. Cottonwood Park Trails Enhancement - Town of Mancos, Colorado - Appendix B – Cost Estimates.

## 6.2 Preliminary Cost Estimates

The following preliminary construction and maintenance cost estimates allow an estimator to modify inputs based on particular project parameters to obtain a project total cost per linear foot or mile. The estimator can also modify the Area Cost Factor and the Inflation Factor Multiplier for future planning purposes or to account for different locations.

The cost per linear foot or mile can vary widely depending on what is needed for that particular project. An example of this cost variance is utility hookups are $20,000. Another major variable is the cost of hand construction, which is approximately twice that of machine built trail. The biggest variable is total trail project length. When larger distances are inserted into the estimate spreadsheet, the cost per linear foot or mile drops significantly.

For the purposes of this master plan, the example imported into the preliminary construction cost estimate was a mile of trail in typical Box Spring Mountain Reserve conditions. No utility hookups or permitting fees were included and hand work was limited to 1,000 linear feet of the 5,280 foot total. The resulting linear foot cost was $14.00.

The same trail segment example imported into the preliminary maintenance cost estimate yielded a linear foot cost of $2.26 per year.

## Table 6-1: Preliminary Construction Cost Estimate

| Note: These costs are preliminary and do not reflect the level of refinement the plan will be adjusted to for specific projects. | | Unit Quantities | Unit of Measure | Unit Price (Installed) | Sub-total Cost | Contractor Profit and Markup (15%) | Full Program Budget |
|---|---|---|---|---|---|---|---|
| Trail Length | | 5,280 | LF | | | | |
| **1 - Trail Design / Flagging** | | | | | | | |
| 1.1 | Easy Conditions | | LF | $0.25 | $0 | $0 | $0 |
| 1.2 | Typical Conditions | 5,280 | LF | $0.50 | $2,640 | $396 | $3,036 |
| 1.3 | Difficult Conditions | | LF | $0.85 | $0 | $0 | $0 |
| 1.4 | Boundary Verification | 1 | LS | $5,000.00 | $5,000 | $750 | $5,750 |
| 1.5 | Control / Topographic survey | 1 | LS | $5,000.00 | $5,000 | $750 | $5,750 |
| **2 - Permits** | | | | | | | |
| 2.1 | Stormwater Pollution Plan | | LS | $3,500.00 | $0 | $0 | $0 |
| 2.2 | Permits (404, 1600 CA Fish & Wildlife), 401) | | LS | $4,000.00 | $0 | $0 | $0 |
| 2.3 | CEQA Filing Fee | | LS | $1,500.00 | $0 | $0 | $0 |
| **3 - Layout** | | | | | | | |
| 3.1 | Layout | 5,280 | LF | $0.35 | $1,848 | $277 | $2,125 |
| 3.2 | Clearing and Grubbing (Light) | 1,500 | SF | $0.50 | $750 | $113 | $863 |
| 3.3 | Clearing and Grubbing (Heavy) | 0 | SF | $1.50 | $0 | $0 | $0 |
| 3.4 | Grading (Light) | 2,500 | SF | $0.50 | $1,250 | $188 | $1,438 |
| 3.5 | Grading (Heavy) | | SF | $1.50 | $0 | $0 | $0 |
| 3.6 | Seeding and Mulching | | SF | $0.15 | $0 | $0 | $0 |
| **4 - Trail Construction by Machine** | | | | | | | |
| 4.1 | Easy Conditions | 0 | LF | $1.20 | $0 | $0 | $0 |
| 4.2 | Typical Conditions | 4,280 | LF | $3.00 | $12,840 | $1,926 | $14,766 |
| 4.3 | Difficult Conditions | | LF | $6.50 | $0 | $0 | $0 |
| 4.4 | Equipment Mobilization | 1 | LS | $1,500.00 | $1,500 | $225 | $1,725 |
| 4.5 | Equipment Demobilization | 1 | LS | $1,500.00 | $1,500 | $225 | $1,725 |
| **5 - Trail Construction by Hand** | | | | | | | |
| 5.1 | Easy Conditions | 0 | LF | $3.00 | $0 | $0 | $0 |
| 5.2 | Typical Conditions | 1,000 | LF | $6.00 | $6,000 | $900 | $6,900 |
| 5.3 | Difficult Conditions | 0 | LF | $12.00 | $0 | $0 | $0 |

| | | Unit Quantities | Unit of Measure | Unit Price (Installed) | Sub-total Cost | Contractor Profit and Markup (15%) | Full Program Budget |
|---|---|---|---|---|---|---|---|
| **6 - Supplies & Miscellaneous** | | | | | | | |
| 6.1 | Crushed Rock | | CY | $35.00 | $0 | $0 | $0 |
| 6.2 | Crushed Rock Transported and placed | | CY | $45.00 | $0 | $0 | $0 |
| 6.3 | Geotextile Fabric | | LF | $0.75 | $0 | $0 | $0 |
| **7 - Support Facilities** | | | | | | | |
| 7.1 | Trail / Path Signage | 1 | LS | $2,500.00 | $2,500 | $375 | $2,875 |
| 7.2 | Temporary Erosion Control | 500 | LF | $1.30 | $650 | $98 | $748 |
| 7.3 | Switchback Construction | 5 | LS | $1,000.00 | $5,000 | $750 | $5,750 |
| 7.4 | Utility Connection (Water) | 0 | EA | $20,000.00 | $0 | $0 | $0 |
| 7.5 | Utility Connections (Power) | 0 | EA | $20,000.00 | $0 | $0 | $0 |
| 7.6 | Utility Connections (Sewer) | 0 | EA | $20,000.00 | $0 | $0 | $0 |
| 7.7 | Irrigation Meter | 0 | EA | $5,000.00 | $0 | $0 | $0 |
| 7.8 | Utility Fees | 1 | EA | $2,500.00 | $2,500 | $375 | $2,875 |
| **8 - Other** | | | | | | | |
| 8.1 | Project Management | 40 | HR | $150.00 | $6,000 | $900 | $6,900 |
| | | | | | | **Project Subtotal** | **$63,225** |
| | | | | | | 2015 Inflation Factor Multiplier (0.99%): | $569 |
| | | | | | | Bond - Payment and Performance (1%): | $632 |
| | | | | | | Contingency (15%): | $9,484 |
| | | | | | | **Project Total** | **$73,910** |
| | | | | | | **Project Total Cost per Linear Foot** | **$14.00** |
| | | | | | | **Project Total Cost per Mile** | **$73,910** |
| | | | | | | Box Springs Mountain Area Cost Factor (+19%) | $14,043 |

Note: Refer to Bureau of Labor Statistics: CPI Inflation Calculator. The consumer price index will fluctuate from year to year.

Note: Refer to Department of Defense (DOD): Area Cost Factors for approximate project location.

## Table 6-2: Preliminary Maintenance Cost Estimate

| Note: These costs are preliminary and do not reflect the level of refinement the plan will be adjusted to at the next submittal. | | Unit Quantities | Unit of Measure | Unit Price (Installed) | Sub-total Cost | Contractor Profit and Markup (15%) | Full Program Budget |
|---|---|---|---|---|---|---|---|
| Trail Length | | 5,280 | LF | | | | |
| **1 - Trail Inspection** | | | | | | | |
| 1.1 | Monthly | 2 | HR | $80.00 | $160 | $24 | $184 |
| 1.2 | Quarterly | | HR | $80.00 | $0 | $0 | $0 |
| 1.3 | Yearly | | HR | $80.00 | $0 | $0 | $0 |
| **2 - Tread Maintenance** | | | | | | | |
| 2.1 | Slough and Slide Removal | 5 | EA | $44.00 | $220 | $33 | $253 |
| 2.2 | Grubbing Rocks/roots/stumps | 2 | EA | $44.00 | $88 | $13 | $101 |
| 2.3 | Fixing Potholes | 14 | EA | $44.00 | $616 | $92 | $708 |
| 2.4 | Fixing Ruts | 2 | EA | $44.00 | $88 | $13 | $101 |
| 2.5 | Re-compaction | 5 | EA | $44.00 | $220 | $33 | $253 |
| **3 - Trail Maintenance-Vegetation** | | | | | | | |
| 3.1 | Brush/cleaning areas (light) | 300 | SF | $0.50 | $150 | $23 | $173 |
| 3.2 | Brush/cleaning areas (heavy) | 150 | SF | $1.50 | $225 | $34 | $259 |
| 3.3 | Trapping Rodents | 2 | EA | $25.00 | $50 | $8 | $58 |
| 3.4 | Re-Seeding and Mulching | 50 | SF | $1.00 | $50 | $8 | $58 |
| 3.5 | Tree Removal | 2 | EA | $10.00 | $20 | $3 | $23 |
| 3.6 | Backslope Grooming | 100 | SF | $1.25 | $125 | $19 | $144 |
| **4 - Litter and Trash Removal** | | | | | | | |
| 4.1 | Monthly | 1 | LS | $1,100.00 | $1,100 | $165 | $1,265 |
| 4.3 | Remove Litter | 200 | SF | $0.10 | $20 | $3 | $23 |
| **5 - Graffiti and Vandalism Control** | | | | | | | |
| 5.1 | Painting | | LS | $100.00 | $0 | $0 | $0 |
| 5.2 | Biodegradable Solvent | | LS | $100.00 | $0 | $0 | $0 |
| 5.3 | Sand Blasting | | LS | $100.00 | $0 | $0 | $0 |

| | | Units Quantities | Unit of Measure | Unit Price (Installed) | Sub-total Cost | Contractor Profit and Markup (15%) | Full Program Budget |
|---|---|---|---|---|---|---|---|
| **6 - Sign Maintenance** | | | | | | | |
| 6.1 | Sign repair/rehabilitation | 4 | LS | $250.00 | $1,000 | $150 | $1,150 |
| 6.2 | Sign Replacement | 2 | EA | $250.00 | $500 | $75 | $575 |
| 6.3 | Blaze repainting and maintenance | 4 | EA | $28.00 | $112 | $17 | $129 |
| 6.4 | Cairn Repair | 2 | EA | $150.00 | $300 | $45 | $345 |
| 6.5 | Barricade/closure device repair | 1 | EA | $250.00 | $250 | $38 | $288 |
| **7 - Trail Maintenance-Erosion Control** | | | | | | | |
| 7.1 | Re-hydroseed | 300 | SF | $0.25 | $75 | $11 | $86 |
| 7.2 | Jute Netting | 200 | SF | $2.50 | $500 | $75 | $575 |
| **8 - Structure Maintenance** | | | | | | | |
| 8.1 | Bridge Repair | 1 | LS | $500.00 | $500 | $75 | $575 |
| 8.2 | Retaining Wall Repair | 2 | LS | $500.00 | $1,000 | $150 | $1,150 |
| 8.3 | Fence/Gate/Stile repair | 1 | LS | $500.00 | $500 | $75 | $575 |
| 8.4 | Shelter Repair | 2 | LS | $500.00 | $1,000 | $150 | $1,150 |
| | | | | | | **Project Subtotal** | **$10,199** |
| | | | | | | 2015 Inflation Factor Multiplier (0.99%): | $92 |
| | | | | | | Bond - Payment and Performance (1%): | $102 |
| | | | | | | Contingency (15%): | $1,530 |
| | | | | | | **Project Total** | **$11,923** |
| | | | | | | **Project Total Cost per Linear Foot** | **$2.26** |
| | | | | | | **Project Total Cost per Mile** | **$11,923** |
| | | | | | | Box Springs Mountain Area Cost Factor (+19%) | $2,265 |

# 7

# Implementation

Implementation of the recommended trail network will be a phased process that will require coordination between a number of municipalities, design and construction professionals and volunteer groups. The initial phasing plan will be based on district needs and require prioritization of the recommendations provided in Chapter 4.

> ***"If there is one essential ingredient to creating trails and trail systems, it is people. All the land and financing in the world will not blaze a trail if there are not people championing the project."***
>
> ~ Bay Area Ridge Trail Council

## 7.3 Phasing Plan

Appropriate implementation phasing can be difficult to determine within an open space trails system. Those such as the Box Springs Mountain Reserve can be especially difficult due to the relatively large number of new and re-routed trails.

One method to determine appropriate trail phasing is to prioritize the routes based on a prescribed set of criteria such as the National Park Service (NPS). This set of established criteria evaluates five standard factors to select from a list of trail alternatives during budgeting and schematic design. The NPS factors are paraphrased below:

1. Does the trail protect Reserve resources?
2. Does the trail provide educational and interpretive experiences?
3. Does the trail protect employee and public health, safety and welfare?
4. Does the trail improve management efficiency and sustainability?
5. Does the trail provide other advantages to the Reserve, such as user experience improvement?

By asking how each project meets the criteria, assigning attributes of quantifiable difference between each project, and assigning a rating score, trails that meet non-monetary factors can be compared and defined for further study and comparison in the design process. This evaluation can then be correlated with initial and life cycle costs to help management make decisions on which project segments should be built first.

Another method, which can be conducted in tandem with the previous criteria-based method, is an analysis of current trail use to determine the greatest needs. This can be done using an online or mobile application such as Strava, which provides detailed real-time trail use mapping. This method can prioritize the routes receiving the most use as shown on the “heat map” in Figure 7-1. This method should utilize both the runner and cyclist modes on Strava. However, evaluators should beware that this prioritization method may not be sufficient on its own and should be confirmed using additional methods. Strava can only provide usage data based on trail users that utilize the mobile application. Due to the fact that not all trail users will use Strava, trails that are highly frequented may not reflect the actual trail usage.

Strava also sells more detailed data, called Strava Metro, for planners and managers seeking deeper insight and analysis for use with geographic information systems (GIS) software. Strava bases licensing costs on the number of Strava members in the requested geographic area.

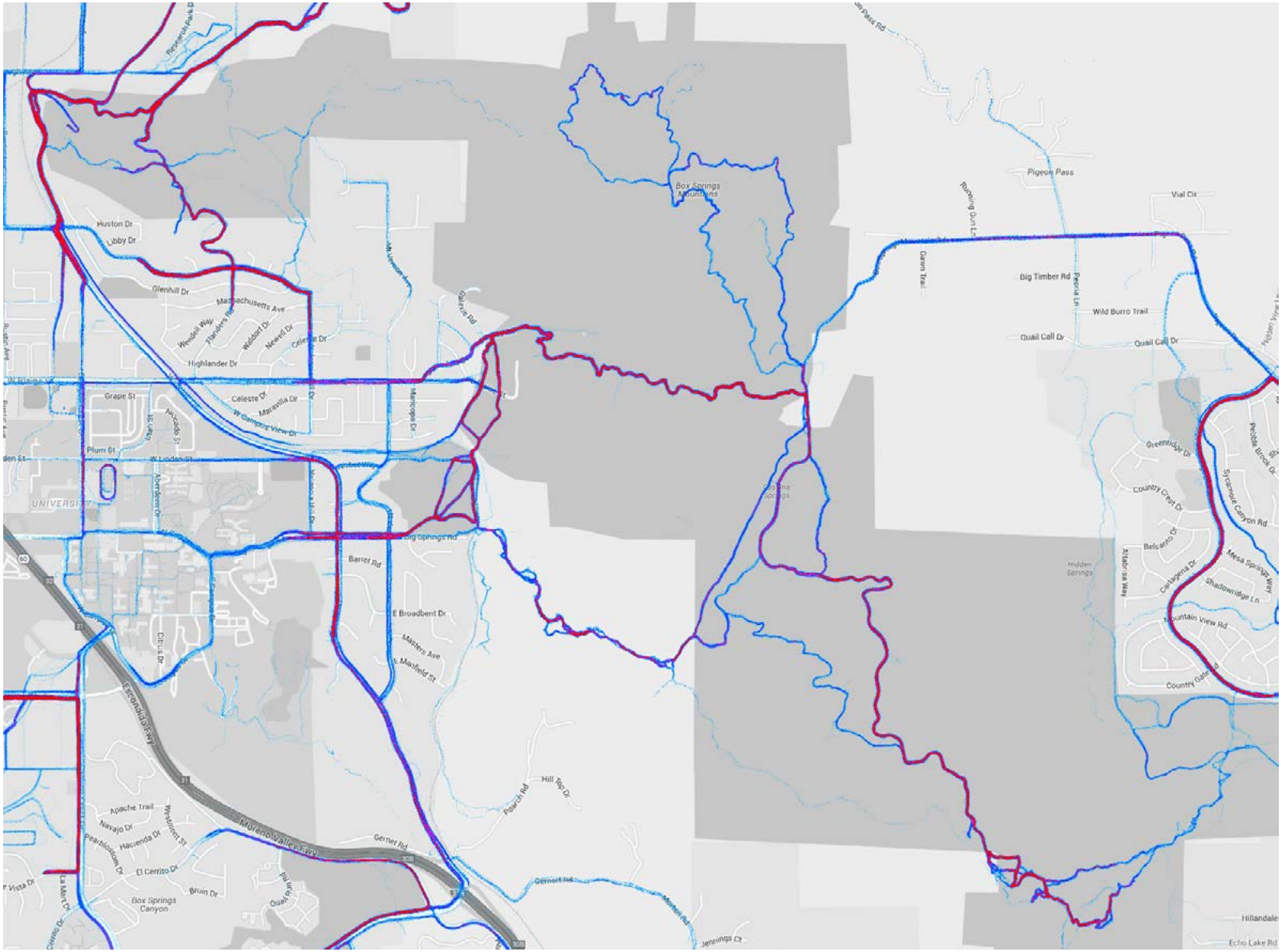
For greater objectivity, prioritization can also be accomplished using a GIS network analysis model that employs use data like Strava Metro, and other data sources, such as elevation, aspect and proximity to staging areas, trail heads, population centers and regional transportation. Similar to the modeling used in bikeway planning to prioritize projects for funding and implementation, this method evaluates each segment and node as a system to determine which ones will provide the most overall benefit, and therefore should be prioritized for early action.

## 7.4 Trail Improvement Prioritization

In consultation with Riverside County Parks and Open-Space District, it was determined that the greatest value would be gained from addressing the trails that need the most improvement first. This will help prevent further damage to the trails themselves as well as protect areas downhill. Based on the recommendations provided in Chapter 4, the following trails would require the most improvements: “C” Trail, “M” Trail and Two Trees Trails. The effort necessary to improve these trails is due to excessive grades that cause erosion. The required improvements cannot be fully addressed through remedial actions such as grade reversals and other small-scale on-site remedies. Instead, substantial segments of these trails will require trail re-routing design and construction.

It is also recommended that the proposed Circumference Trail segments should be included in initial prioritization due to the valuable loop system they provide, especially for users in the neighborhoods surrounding the Reserve.

**Figure 7-1: Strava Heat Map**



## 7.5 Volunteer Participation

At specific locations where considerable earthwork is needed, including the proposed “C” Trail, “M” Trail, and Two Trees Trails re-routes, as well as other new trails, professional services will be required. However, volunteers can perform follow-up and detail work. In addition, volunteers can perform smaller re-routes or repairs on existing trails where needed to keep them sustainable.

Many open space managers maintain successful long-term relationships with volunteer groups, especially IMBA-affiliated mountain bike clubs with knowledgeable, trained “trail bosses.” In many cases, managers have come to rely on such groups for trail maintenance, but also call on them for specific trail construction projects, such as finishing professional builders’ initial machine work, or actually constructing trails where only human power is needed.

For the Reserve, volunteers could come from UCR organizations, trails advocacy groups, service clubs, high school mountain bike teams, and the Girl and Boy Scouts, especially Eagle Scout candidates. Trail building projects are often accomplished as part of volunteer organization’s public service requirements.

*Rotary Club - San Dieguito River Park (Del Mar, CA)*

*San Diego Mountain Biking Association (San Diego, CA)*

*San Diego Mountain Biking Association - Mission Trails Park (San Diego, CA)*

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# Appendix

## A.1 Community Input

The following information provides a summary of the issues that were discussed at the community meeting held on May 20, 2015:

1) Staging at Two Trees
2) Bathrooms at 1-2 acre staging areas only
3) Provide access to north side of Sugarloaf Mountain via advanced mountain bike trails that connect into Bike Skills Park Staging.
4) Add emergency vehicle access to an underpass under Linden
5) Trail connection to Sycamore Canyon Park
6) More trail direction and warning signs about wildlife
7) "No motorized dirt bike" signs
8) Educational signage about trail etiquette (cutting switchbacks, cyclists, equestrians)
9) More challenging options for bikers and hikers other than lower grade switchback trails.
10) Improve road to top of Box Springs Mountain for equestrian access
11) Edison trail interest and re-route to help with erosion
12) Locate unofficial trail to spring off Edison trail (marked on map)
13) Need access into trails from Central and Watkins
14) Rate and rank trails by accessibility and difficulty and map
15) Separate bicycles and equestrians
16) Connection from Edison to "C" trail
17) Access into Springbrook Wash
18) Increased distance on "C" trail is a problem
19) Connector trail to Reche Canyon
20) Need more challenging trails with steepness for different users
21) Better directional signage from neighborhoods into Box Springs

## A.2 ADA Requirements for Shared-use Paths

### Background

For most shared-use paths, cyclists are the primary user group. Cyclists include tandem, recumbent and hand powered three-wheelers. Road racing wheelchairs capable of reaching speeds of over 30 mph on downhill sections may use shared-use paths and have the same rights and privileges as cyclists. In many cases, the design requirements for cyclists are similar, if not more stringent, than the design requirements for pedestrians with disabilities. For example, people who use wheelchairs can generally travel over small changes in level. However, because cyclists are often traveling at higher speeds and need smooth surfaces. Although people with vision impairments can identify a three inch high edge protection in a path environment, edge protection lower than a 42 inch railing can be dangerous for a cyclist.

For this plan, the majority of the accessibility recommendations for shared-use paths are based on the AASHTO guidelines. Additional issues, such as protruding objects (not addressed in the AASHTO bicycle facility guide) are also included. However, grade recommendations in this plan are based on those developed by the Regulatory Negotiation Committee for Outdoor Developed Areas because the maximum grades identified for cyclists in the AASHTO bicycle facility guide do not satisfactorily address the needs of some people with mobility impairments.

#### *ADA Regulation Amendment (28 CFR part 35)*

A federal ADA ruling went into effect in March 2011 that requires managers of public facilities, including trails, to accommodate people with disabilities who wish to use various types of non-wheelchair powered vehicles for access. By law, an assessment and policy prepared by the managing agency is the only limiting factor on the types of vehicles or devices that visitors may use. However, an agency does not have to modify its facilities to accommodate the allowed devices, so the access requirement is significantly different than for other ADA access rules.

## Sidewalks and Pedestrian Routes

The federal accessibility guidelines for sidewalks, street crossings and other elements of the public rights-of-way are contained in the Proposed Guidelines for Public Rights-of-Way, July 2011 and are available at www.access-board.gov/prowac/index.htm. These guidelines cover facilities for pedestrian circulation and use in the right-of-way, including walkways and sidewalks, street or highway shoulders where pedestrians are not prohibited, crosswalks, islands and medians, overpasses and underpasses, on-street parking spaces and loading zones and equipment, signals, signs, street furniture and other features provided for pedestrians. They contain detailed guidance and links to other technical standards and guidelines, such as the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) and the Guide for the Planning, Design and Operation of Pedestrian Facilities, AASHTO, July 2004. The guidelines are proposed rules that are expected to be adopted as law in the near future. The July 2011 Proposed Guidelines are an update of the 2005 Revised Draft Guidelines.

The guidelines define two types of pedestrian facilities:

1) Pedestrian Access Route - A continuous unobstructed walk within a pedestrian path that provides accessibility.
2) Pedestrian Circulation Path - A prepared exterior or interior way of passage provided for pedestrian travel.

In California, the Division of the State Architect (DSA) develops, adopts and publishes regulations to address the state's own standards for access to people with disabilities to comply with ADA and, in some cases, exceed the federal standards. See: California Access Compliance Reference Manual, Division of the State Architect, 2011 or latest version.

## Rules for Shared-use Paths

Shared-use paths (also called multi-use paths) often serve recreational purposes while providing off-street transportation routes for pedestrians, cyclists, in-line skaters and others. There are no adopted federal rules or guidelines specific to the design of shared-use paths for access to people with disabilities. The Access Board initiated rulemaking to address shared-use paths after comments from the public urged the Board to specifically address access to shared-use paths since they are distinct from sidewalks and trails. Shared-use paths, unlike most sidewalks, are physically separated from streets by an open space or barrier. They also differ from trails because they are designed not just for recreation purposes, but for transportation as well. These supplemental accessibility guidelines specific to shared-use paths will be part of the guidelines for pedestrian facilities in the public right-of-way. The primary general design standard for shared-use paths is the AASHTO Guidelines for Bicycle Facilities.

## Recreational Trails

Recreational trails must be designed to be accessible by people with disabilities, where feasible, but there are separate, more flexible standards for recreational trails from those of urban bicycle and pedestrian transportation facilities and routes that connect developed facilities. The standards include exceptions and exemptions for trails where meeting standards would detract from the resources that the trail is accessing, or where this is physically infeasible. The federal guidelines are contained in the Guidelines for Outdoor Developed Areas, dated December 2009, available at www.access-board.gov/outdoor/.

These guidelines cover trails, outdoor recreation access routes, beach access routes and picnic and camping facilities. The Guidelines are proposed rules expected to be adopted into law as written. No changes are expected.

The Guidelines define two types of trail facilities:

1) Outdoor Recreation Access Route - A continuous unobstructed path designated for pedestrian use that connects accessible elements within a picnic area, camping area, or designated trail head.
2) Trail - A route designed, constructed, or designated for recreational pedestrian use or provided as a pedestrian alternative to vehicular routes within a transportation system.

## Architectural and Transportation Barrier Compliance Board (Access Board)

The Americans with Disabilities Act (ADA) of 1990 had major significance for those who plan and design any type of publicly-used facility, including trails. The Access Board is responsible for developing accessibility guidelines for new construction and alterations of facilities subject to the ADA, which applies to state and local government facilities, places of public accommodation and commercial facilities, or virtually every type of facility open to the public, including bicycle and pedestrian facilities, paths and trails.

The Access Board has developed accessibility guidelines for public rights-of-way, including walkways and sidewalks, parking areas and associated features. Final guidelines have been published for Outdoor Recreation Areas, including Outdoor Recreation Access Routes between developed facilities and trails. The Access Board has also developed guidelines for shared-use paths. The Supplemental Rule to Address Access to Shared Use Paths is currently in the public comment phase and has not been finalized or formally adopted.

## Shared-use Path Access

Creating a shared-use path that provides access for people with disabilities involves more than the path itself. Ensuring that an accessible pathway leads to the shared-use path must also be considered and access points along the shared-use path should be accessible to people with disabilities. Also, the facilities around the trail should also be designed for access. For example:

» Trail head and destination areas with parking and bathrooms should conform to ADAAG requirements for accessible parking and bathrooms.
» Elements, such as picnic areas, should be connected with a pathway that meets the accessible design recommendations for shared-use paths.
» Signage at access points should conform to ADAAG requirements for font size, font type and contrast.

While pathways connecting with shared-use paths should provide the same accessibility standard as the path itself, tread width may be adjusted based on expected use levels.

## User Group Conflicts

Shared-use paths attract a variety of user groups with potentially conflicting needs. For examples, pedestrians may be affected by sudden physical environment changes and by other trail users, such as cyclists, who generally travel at higher speeds. However, shared-use path conflicts are especially an issue for people who cannot react quickly to hazards, such as some of those with mobility impairments.

To improve the shared-use path experience for all users, including people with disabilities, designers and planners should be aware of potential conflicts and employ innovative solutions whenever possible. Conflicts can be reduced by:

» Providing information, including signage, in multiple formats that clearly indicates permitted uses and rules of conduct
» Ensuring that the shared-use path provides sufficient width and an appropriate surface for everyone, or providing alternate paths for different types of users
» Providing sufficient separation for users traveling at different speeds (For example, if volume and space permits, cyclists and pedestrians should have different lanes or pathways.)
» Providing the necessary amenities for all users (For example, cyclists require bicycle racks or lockers.)
» Considering the needs of people with disabilities within all of the user groups permitted on the path (For example, many individuals with disabilities may use a longer hand cycle or wider tricycle design that may not be compatible with standard bicycle racks, bathroom stalls, or lockers of limited width. Longer and wider equipment may need additional maneuvering space in restrooms and when transferring from the chair to benches.)

## Surface Conditions

Paved paths will typically be asphalt or concrete, and rarely polymer-stabilized decomposed granite. Since bicycles are easily deflected by surface irregularities, care must be taken to maintain a smooth surface and to avoid longitudinal gaps. Striping or other surface markings must be non-skid paint or tape designed for the purpose. A regular sweeping plan will be necessary, especially wherever a paved path must be installed low enough to accumulate debris from winter storm flows, such as dipping down to pass under a bridge. Since they will be inundated more often than other segments, these specific locations should be more durably constructed, such as using concrete.

Surface condition is a significant factor in how easily a person with a disability can travel along a shared-use path. The accessibility of the shared-use path surface is determined by a variety of factors including:

» Surface material
» Surface firmness and stability
» Slip-resistance
» Changes in level
» Size and design of surface openings

Shared-use paths are generally paved with asphalt or concrete, but may also use prepared surfaces such as crushed stone, native soils or aggregates mixed with soil stabilizing agents. Popular trails passing through developed areas are commonly surfaced with asphalt or concrete to maximize surface longevity and to support uses such as cycling and in-line skating, as well as ADA compliance.

Shared-use path surfacing material significantly affects which user groups will be capable of negotiating the terrain. Paths intended to be shared-use should not be surfaced with crushed aggregate because they will be unusable by in-line skaters and some cyclists.

### *Surface Firmness, Stability and Slip-resistance*

Shared-use path surface firmness, stability and slip-resistance affects all users, but is particularly important for people using mobility devices such as canes, crutches, wheelchairs, or walkers.

Firmness is a function of how much a surface resists deformation by indentation when a person walks or wheels across it. A firm surface is ne that does not compress significantly under the forces exerted.

Stability is the degree a surface remains unchanged by applied force so that when the force is removed, the surface returns to its original condition. A person walking or maneuvering a wheelchair on it does not significantly alter stable surfaces.

Slip-resistance is based on the frictional force necessary to permit a person to move across a surface without slipping. A slip-resistant surface does not allow a shoe, wheelchair tires, or a crutch tip to slip when crossing the surface.

Shared-use paths should have a firm and stable surface because when a person walks or wheels across a surface that is not firm and stable, energy that would otherwise cause forward motion instead deforms or displaces the surface or is lost through slipping. A slip-resistant surface reduces the possibility of a person's shoes, crutch tips, or tires sliding across the surface.

Asphalt and concrete are firm and stable in virtually all conditions. Other materials, such as crushed stone or decomposed granite, can be firm and stable under most conditions, especially if compacted. To improve natural firm surface longevity, polymer-based bonding agents should be considered.

Under dry conditions, most asphalt and concrete is fairly slip-resistant. Shared-use paths should be designed to be slip-resistant during weather conditions typical for the region. U.S. Access Board Technical Bulletin #4 addresses slip-resistance in further detail.

### *Abrupt Level Changes*

Changes in level are defined as the maximum vertical change between two adjacent surfaces. Problematic examples that may occur along shared-use paths include uneven transitions between the path and bridges or adjacent trails, cracks caused by clay shrink/swell, or a change in the natural ground level (often caused by seismic activity or tree roots).

Although abrupt level changes are not desirable for people with mobility impairments, they are potentially even more of an issue for cyclists and in-line skaters. Abrupt changes can also cause pedestrians to trip and fall. The risk is particularly acute for those who have difficulty lifting their feet off the ground or who have limited vision and may be unable to detect the level change. Catching a wheel on an obstacle or level change can easily tip wheeled devices as the individual's momentum continues forward despite the wheels having suddenly stopped. Minimizing or eliminating abrupt level changes will greatly improve shared-use path safety for all users. For paved shared-use paths, the following recommendations should be followed:

» Vertical level changes should not be incorporated in new construction
» If unavoidable, small level changes up to a quarter inch may remain vertical without edge treatment
» A beveled surface with a maximum slope of 50 percent should be added to small level changes between a quarter and a half inch
» Level changes such as curbs exceeding half an inch should be ramped or removed

### *Openings*

Openings are spaces or holes in the paved tread surface. On recreation trails, openings may occur naturally, such as a crack in a rock surface. On paved shared-use paths, however, openings are usually constructed, such as spaces between the planks of a boardwalk that allow water to drain from the surface. A grate is an example of an opening with a framework of latticed or parallel bars that prevents large obstacles from falling through a drainage inlet, but permits water and some sediment to pass through.

Another example of an opening is a flangeway gap at a railroad crossing. Wheelchair casters or walkers, crutch and cane tips, in-line skate wheels and narrow road bicycle tires of can get caught in poorly placed grates or gaps, creating a serious safety hazard.

If at all possible, openings should not be within the paved shared-use path surface. Instead, openings such as drainage grates should be located outside the path tread. When placing openings in the shared-use path cannot be avoided, employ the following specifications:

» Width - The size of the open space should not permit a half an inch diameter sphere to pass through the opening. If a wider gap is unavoidable because of existing design constraints, it may be acceptable to extend the width to a maximum of three quarters of an inch.
» Orientation - If the open space is elongated, it must be oriented so that the long dimension is perpendicular to the dominant direction of travel.

### *Grade and Cross Slope*

People with mobility impairments find negotiating steep grades difficult due to the additional effort required to travel over sloped surfaces. Manual wheelchair users may travel rapidly downhill, but will be significantly slower uphill because more energy is required to traverse sloped surfaces than level surfaces. Powered wheelchairs use more battery power on steep grades to compensate for the difficult terrain. Also, both powered and manual wheelchairs are less stable on sloped surfaces, particularly if wet (or frozen).

Steep running grades are particularly difficult for users with mobility impairments when resting opportunities are not provided, but even less severe grades that extend over longer distances may tire users as much as shorter, steeper grades.

In general, running grades on paved shared-use paths should not exceed five percent and the most gradual slope possible should be used. If steeper segments are incorporated into the shared-use path, the total running grade exceeding 8.33 percent should be less than 30 percent of the total trail length. In general, the lengths of the steep sections should be minimized and kept free of other access barriers.

Because negotiating a steep grade requires considerable effort, users should not be required to exert additional energy to simultaneously deal with other factors, such as steep cross slopes and vertical level changes. When designing maximum grade segments, the following recommendations should be used:

» 8.3 percent for a maximum of 200 feet
» 10 percent for a maximum of 30 feet
» 12.5 percent for a maximum of 10 feet

The recommended maximum grades are similar to those recommended in the 1999 AASHTO Guide for the Development of Bicycle Facilities, but the maximum distances are significantly shorter.

Near the top and bottom of the maximum grade segments, the grade should gradually transition to less than five percent. In addition, rest intervals should be provided within 25 feet of the top and bottom of a maximum grade segment. Rest intervals may be located on the shared-use path, but should ideally be located adjacent to the path for the safety of all users. Well-designed rest intervals should have the following characteristics:

» Grade not exceeding five percent
» Cross slopes on paved surfaces not exceeding two percent
» Firm and stable surface
» Width equal to or greater than the width of the path segment leading to and from the rest interval
» Minimum length of 60 inches
» Minimum change of grade and cross slope on the segment connecting the rest interval with the shared-use path

### *Cross Slope and Drainage*

Severe cross slopes can make it difficult for wheelchair users and other pedestrians to maintain their lateral balance because they must work against the force of gravity. Cross slopes can cause wheelchairs to veer downhill and create problems for individuals using crutches who cannot compensate for the height differential that cross slopes create. The impacts of cross slopes are compounded when combined with steep grades or surfaces that are not firm and stable.

Cross slope can therefore be a barrier to people with mobility impairments. However, some cross slope is necessary to drain water quickly off of shared-use paths. The negative effect cross slopes have on pedestrian mobility must be balanced against the necessity of including cross slopes to provide adequate drainage. The minimum cross slope necessary should be used for paved shared-use paths. For asphalt and concrete, a cross slope of two percent should be adequate.

### *Width*

Shared-use path width not only affects pedestrian usability, but also determines the other types of users who can use the path. Factors such as the movement patterns of designated user groups should be considered. For example, in-line skaters' propulsive lateral foot motion is wider than pedestrians' stride. In addition, shared-use paths should be designed to accommodate high-speed users in both directions.

Shared-use path tread should be at least 10 feet wide. A minimum of eight feet may be used on shared-use paths that will have limited use. Shared-use paths should also have graded areas at least two feet on either side of the path. On shared-use paths with heavy volumes of users, tread width should be increased to a range from 12 to 14 feet. (These width guidelines reflect both state and federal standards.)

### *Passing Space*

Generally, passing spaces are not necessary on paved shared-use paths because path width exceeds the recommended dimensions that require a passing space. If a paved shared-use path is narrow, periodic passing spaces of at least 60 inches wide by 86 inches long should be provided.

### *Protruding Objects*

Protruding objects are anything that overhangs or protrudes into the shared-use path tread whether or not the object touches the surface. Examples of protruding objects include light posts, poorly maintained vegetation and signs. People with vision impairments who use guide dogs for navigation are able to avoid obstacles in the pathway up to 80 inches high. Objects that protrude into a shared-use path higher than that may not be noticed because most pedestrians require less than 80 inches of headroom.

People with vision impairments who use canes to navigate can easily detect objects on shared-use paths below 27 inches. However, objects that protrude into the pathway between 27 inches and 80 inches are more difficult to discern because the cane will not always come in contact with the object before the pedestrian comes in contact with the object.

Ideally, objects should not protrude into any portion of the clear tread width of shared-use paths. If an object must protrude into the travel space, it should not extend more than four inches. Also, a vertical clearance of eight feet should be provided rather than the 80 inches needed for pedestrians, to accommodate other shared-use path users, such as cyclists. On shared-use paths where there is the potential for emergency or maintenance vehicles access, it may be necessary to increase the vertical clearance. In addition, when an underpass such as a tunnel is used, 10 feet of vertical clearance is recommended.

### *Railings*

Low forms of edge protection, such as curbs, are not recommended on shared-use paths because of the negative impact they can have on cyclists. If edge protection is needed, it should be a railing with a minimum height of 42 inches. In some situations, it may also be beneficial to provide a gripping surface for pedestrian use in addition to the protective railing. If a handrail is included as part of the railing design, it should meet the specifications in ADAAG 4.26.