

Trail Condition Monitoring

Boulder Open Space and Mountain Parks

Southern Trail Study Areas



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Southern Trail Study Areas Trail Condition Monitoring Report

- **Eldorado Mountain/Doudy Draw Trail Study Area**
- **Marshall Mesa/Southern Grasslands Trail Study Area**

Background & Intent

Boulder's Open Space and Mountain Parks (OSMP) department manages over 140 miles of designated trails. OSMP lands receive an estimated 5.3 million visits each year (OSMP 2005). Trends indicate that visitation will continue to increase into the future (OSMP 2004). Increasing levels of use could impact the trail system, affect the quality of the visitor experience, and alter the condition of natural resources.

One of the goals of the OSMP Visitor Master Plan's (VMP) is to ensure that the designated trail system provides a high quality visitor experience while protecting and preserving environmental resources. To achieve this goal, it is essential to provide and maintain a sustainable trail system. The VMP calls for annual designated trail condition monitoring.

The purpose of this monitoring project is to assess the compliance of our trail system with sustainability standards (Attachment A). Trail condition monitoring identifies unsustainable trail segments, documents the location and condition of constructed features and provides management recommendations or prescriptions for trail maintenance and sustainability.

This monitoring report provides managers with information to allocate staffing and resources strategically, and to prioritize trail maintenance projects. Trail monitoring will also describe the condition of trails and trail features, enabling managers to document and communicate the extent and location of regular trail maintenance needs. This information can be used in conversations with the Open Space Board of Trustees, City Council and interested members of the community.

Methods¹

Trails were divided into segments based upon their combined *trail class* and *designed use*. Trail class refers to a trail's level of development and designed use refers to the allowed use on the trail which controls how it is designed, built and maintained. Each segment was visited in the field. OSMP staff measured

¹ A detailed protocol for trail condition monitoring is available upon request from the OSMP department.

trail parameters and compared the measurements to trail standards for a given trail class and designed use. Those sections of the trail out of compliance with standards require maintenance or, in some cases, more significant response such as reconstruction.

In addition to measuring parameters related to the trail standards, OSMP also collected information about other maintenance issues such drainage problems, erosion and trail braiding. These were detected by direct observation of evidence such as muddy areas, gullies and loose rocks. The department has no standards for erosion, drainage problems or trail braiding because they are unacceptable wherever they occur and therefore require maintenance.

For ease of communication, the term “area of concern” refers to portions of trail that are either out of compliance or exhibit maintenance issues. The following list contains the indicators that were monitored to identify areas of concern.

Trail Parameters Related to Design Standards	Maintenance Issues
Trail grade	Drainage
Tread width	Erosion
Outslope	Braiding
Clearing width, height	
Surface material	
Turn radius	

Staff also inventoried and evaluated constructed features as part of this project. Constructed features are human-made structures designed to help maintain a trail’s sustainability, by diverting water, retaining sediment, or raising the level of the tread. Examples include retaining walls, turnpikes, bridges, waterbars, steps, or culverts. Constructed features condition classes are described in Table 1.

Table 1: Condition Classes and Descriptions for Constructed Features

Condition Class	Description
Routine Maintenance	Feature is FUNCTIONING WITHIN STANDARD as designed and is within normal maintenance cycle (generally at a cost of less than 20% of replacement)
Repair/Rehab	Feature is in DISREPAIR , may or may not be useable, but needs to be repaired to bring feature to standard (generally at a cost between 21% & 50% of replacement)
Replace in-kind	Feature is DYSFUNCTIONAL and beyond it’s designed lifecycle or has deteriorated to a point where unable to perform as designed or constructed (generally at a cost of over 51% of new construction and includes demolition and removal of existing)
Decommission	Feature is NOT NEEDED for the operation of the trail or is inappropriate for the setting and should be removed from system with no replacement planned.
Expansion	Feature is basically functioning as designed but is UNDERSIZED . Would typically be lengthened or widened, but in some cases size may be reduced.
Alter Function	Modify feature to CHANGE FUNCTION to either increase capacity, change function, or durability.
Install New	NEW Feature is needed.

Trail condition monitoring was conducted in the **Marshall Mesa/Southern Grasslands** (MM/SG) and **Eldorado Mountain/Doudy Draw** (EM/DD) **Trail Study Areas** (TSAs) (see Figure 1) during July and August of 2007. Certain segments of the Doudy Draw Trail in the EM/DD TSA were not surveyed because of plans for trail maintenance and reconstruction during the study period.

Extensive database development time for this project was a one-time cost shared across all TSAs. Estimates of time to complete monitoring are given below:

Preparation:	45 days - Trails Management Framework and Protocol development (one time) 4 days - Data dictionary and TMO (standards) development (one time)
	<hr/> Subtotal: 49 days
Fieldwork:	5 days - Survey MM/SG TSA (8 trails - 12 miles) 2 days - Survey EM/DD TSA (3 trails - 3 miles)
	<hr/> Subtotal: 7 days
Post-processing:	2 days - GPS export to GIS, editing 5 days - GIS map production 1 day - database reporting
	Subtotal: 8 days
GRAND TOTAL	64 days = 13 weeks inclusive
	15 days for EM/DD and MM/SG TSA specific work

Trail Condition Monitoring - Designated Trails Surveyed Southern Trail Study Areas

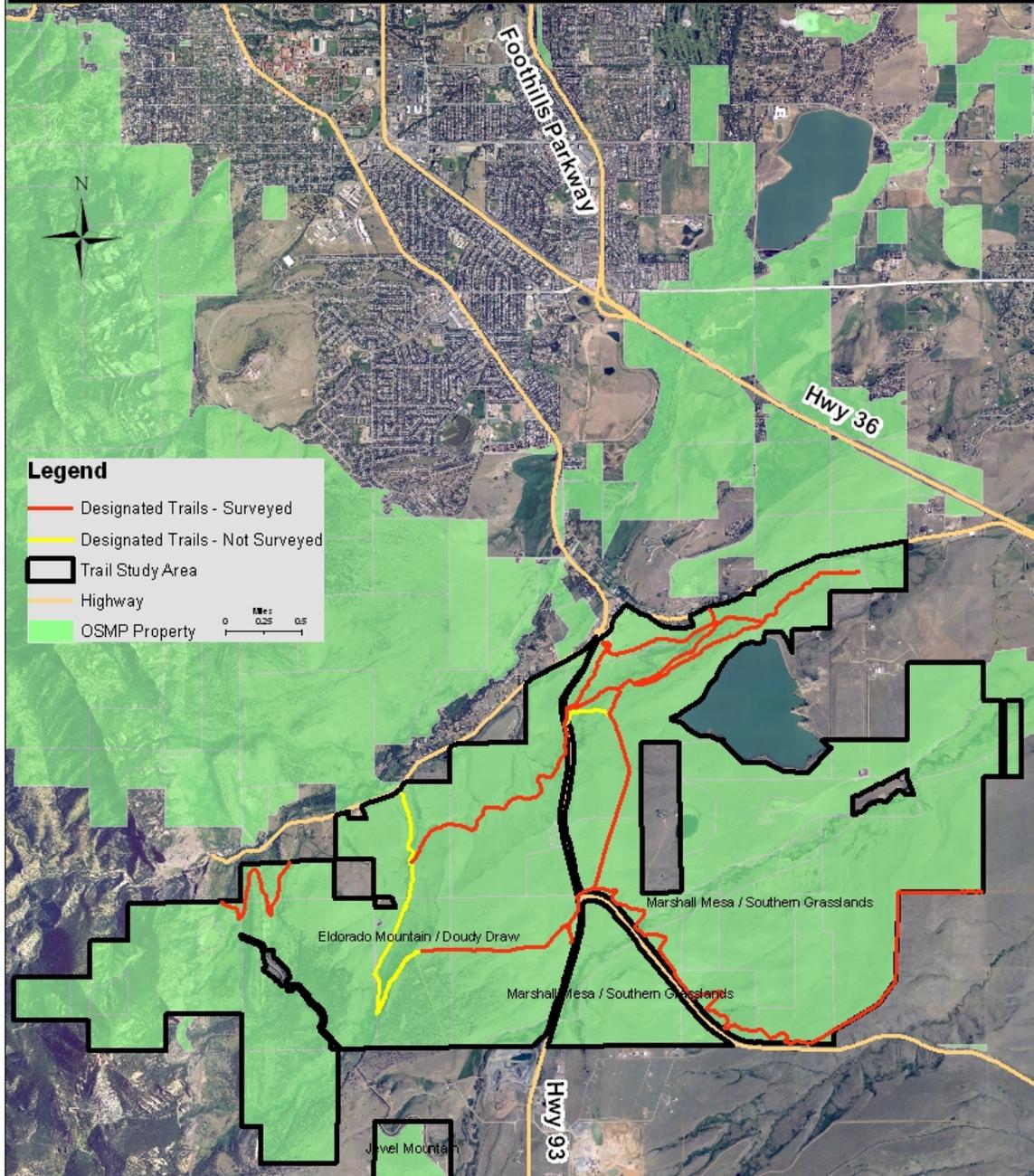


Figure 1: Designated trails surveyed for trail condition monitoring in Southern TSA's.

Results

Marshall Mesa / Southern Grasslands Trail Study Area

Trail Condition

Approximately 12.5 miles of trail were surveyed in the MM/SG TSA. Five percent of the trail system identified as either out of compliance with standards or exhibiting other maintenance issues. These areas of concern total about 3,618 feet or 1,103 meters (0.69 miles). The trail with the highest percentage in areas of concern is the Greenbelt Plateau Trail. Maps showing the location and extent of areas of concern in the MM/SG TSA are included as Attachment B. Details about the areas of concern are included in Attachment C.

Tables 2 and 3 show the percentages of areas of concern for **trails** and **trail segments** within the MM/SG TSA.

Table 2: Areas of concern for each **trail** in the MM/SG TSA. *The shaded areas in tables 2 and 3 identify trails with less than five percent of their length in undesirable condition.*

Trail Name	% of Total Trail Length with Areas of Concern
Greenbelt Plateau	12%
Coal Seam	11%
Marshall Valley	8%
Marshall Mesa	7%
Community Ditch	6%
Coalton	3%
High Plains	3%
Cowdrey Draw	0%
Marshall Valley Accessible	0%

Table 3: Areas of concern for each **trail segment** in the MM/SG TSA.

Trail Name	Trail Seg ID	% of Trail Segment Length with Areas of Concern
Community Ditch	102.02	27%
Greenbelt Plateau	103.02	26%
Coal Seam	113.01	11%
Greenbelt Plateau	103.01	10%
Marshall Valley	114.03	10%
Marshall Mesa	104.01	7%
Coalton	109.01	3%
High Plains	112.01	3%
Community Ditch	102.01	2%
Marshall Valley	114.02	1%
Cowdrey Draw	111.01	0%
Marshall Valley	114.01	0%
M. Valley Accessible	106.01	0%

Figure 1 shows the factors most responsible for non-compliance with standards. Figure 2 shows the relative proportion of different types of maintenance issues.

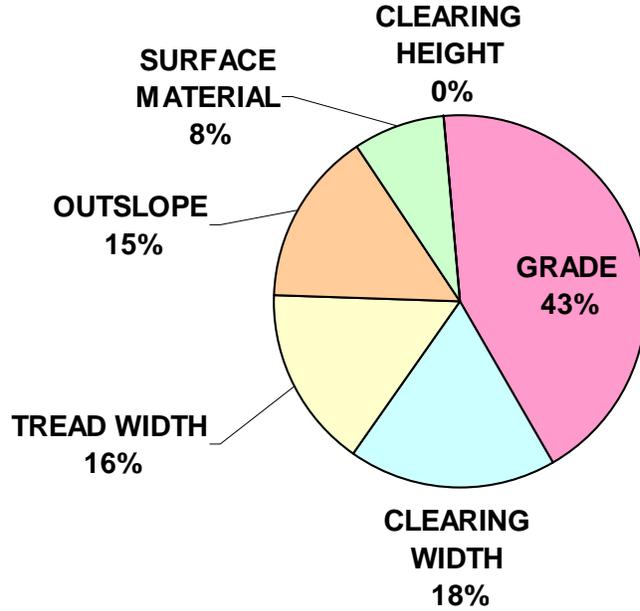


Figure 2: Contribution of various trail sustainability factors to **non-compliance** in the MM/SG TSA. (total distance of trail out of compliance = 2,653ft or 809m)

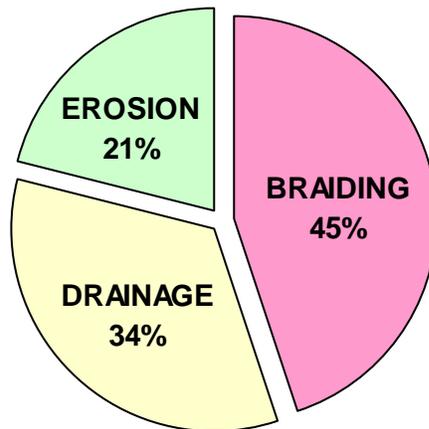


Figure 3: Contribution of various **maintenance issue** categories in the MM/SG TSA. (total distance of trail with maintenance issues = 965ft or 294m)

Constructed Features

Figure 3 shows the condition class distribution of the 122 constructed features associated with trails in the MM/SG TSA. Three fourths of the features are functioning within standard. Maps showing the location and condition of constructed features in the MM/SG TSA are included as Attachment D. Details about the constructed features are included in Attachment C.

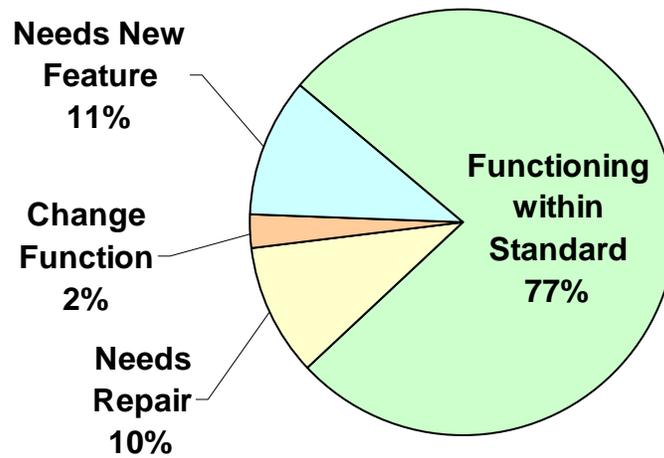


Figure 4: Condition class of constructed features in the MM/SG TSA.

Eldorado Mountain / Southern Grasslands Trail Study Area

Trail Condition

Approximately three miles of trail were surveyed in the EM/DD TSA. Six percent of the total length of trail segments surveyed was assessed to be out of compliance. No maintenance issues were identified. The non-compliant distance along trails in the TSA totals 962 feet or 293 meters (0.18 miles). Maps showing the location and extent of areas of concern in the EM/DD TSA are included as Attachment E. Details about the areas of concern are included in Attachment C.

Table 4 shows the percentage of areas of concern for each **trail segment** within the EM/DD TSA. The Doudy Draw trail segment 101.04 exhibited the highest percentage of maintenance concerns.

Table 4: Areas of concern for each surveyed **trail segment** in the EM/DD TSA.

Trail Name	Trail Seg ID	% of Trail Segment Length with Areas of Concern
Doudy Draw	101.04	15%
Greenbelt Connector	115.02	10%
Greenbelt Connector	115.01	0%
Fowler	108.01	0%
Fowler	108.02	0%

Figure 4 shows the factors most responsible for non-compliance with standards. Trail grade is the factor associated with the majority of trail condition concerns in the TSA.

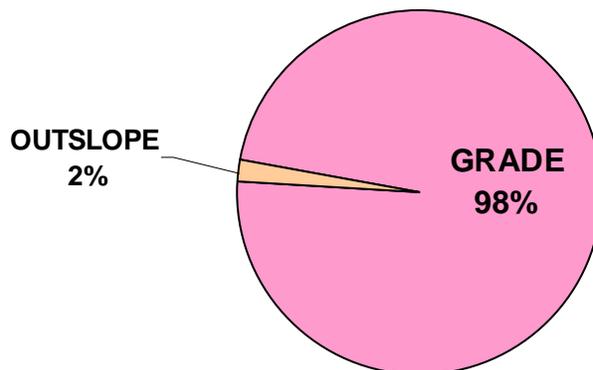


Figure 5: Contribution of various trail sustainability factors to **non-compliance** in the EM/DD TSA. (total distance of trail out of compliance = 962ft or 293m)

Constructed Features

Figure 5 shows the condition class distribution of the 9 constructed features associated with trails in the EM/DD TSA. Maps showing the location and condition of constructed features in the EM/DD TSA are included as Attachment F. Details about the constructed features are included in Attachment C.

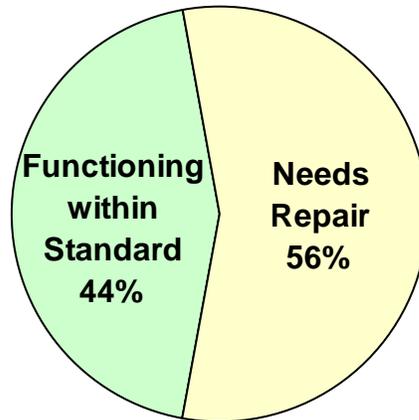


Figure 6: Condition class of constructed features in the EM/DD TSA.

Discussion

Marshall Mesa / Southern Grasslands Trail Study Area

Trail condition

All designated trails in the MM/SG TSA were surveyed (12.5 miles). Five percent of this trail system is either out of compliance with standards or exhibiting other maintenance issues. Taken together these two categories are referred to as areas of concern.

The trail with the highest percentage in areas of concern is the Greenbelt Plateau Trail. This trail is comprised of two segments (103.01, 103.02). Trail segment 103.02 is exhibiting areas of concern for 26% of its length (1,074 ft). This could be a red flag signaling an unsustainable design.

Surprisingly, the Coal Seam and Marshall Valley Trails had the 2nd and 3rd highest percentage in areas of concern, respectively, even though these trails were newly constructed in 2006. The Coal Seam Trail in particular is showing signs of trail widening, braiding, and a couple of drainage issues. Although trail reroutes are not necessary, certain sections of these trails will require extensive

maintenance in order to be sustainable for the types and volume of use they receive.

Table 3 shows the percentages of areas of concern for trail segments. The Community Ditch Trail segment 102.02 is exhibiting the highest percentage in areas of concern. Certain sections of this segment have extensive erosion, grade, and braiding issues. This segment could also be a candidate for a reroute in order to have a sustainable design.

Trail segment 114.03 (Marshall Valley Trail) also exhibits a high percentage in areas of concern. There are some tread outslope and drainage issues needing maintenance, but a trail reroute is not necessary.

The majority of trail segments in the East TSA has sustainable designs and should require only routine maintenance. The following locations are where trail reroutes are recommended:

1. Sections of the Community Ditch trail segment 102.02 have trail grades between 15-18%. Steep grades combined with the current design, lack of erosion control structures and/or lack of routine maintenance has led to a very large gully forming in the original trailway. Consequently users have formed a parallel trail braid. Considerable time and effort will be needed to address the unsustainable issues in this trail segment.
2. Sections of the Greenbelt Plateau trail segment 103.02 have tread widths of 8-9 feet. The location of the trail contributes to most of this trail segment's issues. The side slope of the surrounding terrain is relatively low. This leads to difficulties diverting water from running down the trail. Consequently the trail *is* the local drainage. This leads to erosion, gullies, ruts, and exposed rocks or abundance of loose rocks. Users widen the trail in order to avoid these eroded areas. Considerable time and effort will be needed to address the unsustainable issues in this trail segment.
3. A section of the Marshall Mesa trail is in need of a possible reroute. The trail follows the fall line and a deep eroded gully has formed. Users have formed a parallel trail braid to avoid this area.

Types of Non Compliance/Maintenance Issues

Trail grade is the contributing factor to almost half of the non-compliant portions, and trail braiding contributed to about half of the maintenance issue portions. Steep grades can cause many problems if not addressed properly. Water run-off traveling unobstructed down steep grades gains velocity, which then leads to erosion: ruts, gullies, and abundance of loose rock. People avoid these areas by traveling around them. This response results in trail braiding and/or widening.

Steep grades can be addressed either by installing steps or drain dips/waterbars to decrease the velocity of run-off to help prevent erosion.

Two portions out of compliance with grade (one on Marshall Mesa Trail, one on the Coalton Trail) have been addressed in this way. Log steps have been installed on the Marshall Mesa Trail and are functioning up to standard.

Drain dips have been installed on the Coalton Trail and are also functioning up to standard.

A long portion of the Greenbelt Plateau Trail is out of compliance with grade.

The installment of drain dips is recommended to address this issue.

Drainage problems contributed to about a third of the maintenance issues. The types of soil found in the MM/SG TSA could be one of the reasons for this, but also the placement of the trail accounts for this as well. Some portions are in low-lying or flat areas. Constructing small drains combined with applying fill material can mitigate many of these drainage issues.

Constructed Features

Three fourths of the 122 constructed features associated with trails in the MM/SG TSA are functioning within standard. One-tenth are in need of repair, such as drain dips and culverts requiring extensive cleaning to regain proper function. A wooden bridge on the Community Ditch Trail segment 102.02 and one on the Greenbelt Plateau Trail segment 103.02 are in need of repair. Approximately 13 drain dips are recommended to be installed to assist with grade or drainage issues associated with certain trail segments.

Eldorado Mountain / Southern Grasslands Trail Study Area

Trail condition

Three of the five trail segments surveyed within the EM/DD TSA, Fowler 108.01, 108.02, and the Greenbelt Connector 115.01, were in compliance with OSMP trail standards and did not exhibit maintenance issues. The Doudy Draw Trail segment 101.04 was assessed to be out of compliance for fifteen percent of its total length. All non-compliant portions were due to trail grade, with values of 9-15%. The standard for this combined trail class and designed use is 6%. These portions may require reroutes in order to achieve compliance with OSMP trail standards.

A short section of the Greenbelt Connector Trail segment 115.02 has an outslope issue in need of maintenance to comply with standards for wheelchair accessibility – the designed use for this segment.

Types of Non-compliance

Trail grade contributed to the majority (98%) of the non-compliant portions documented along the surveyed trail segments within the EM/DD TSA. These grade issues are all located on the Douby Draw Trail segment 101.04. This trail segment's improved surface (roadbase) might help in slowing down the rate of erosion, but some of the steep grades will need to be addressed to achieve sustainability.

Constructed Features

There are 9 constructed features associated with the trail segments surveyed in EM/DD TSA. Four features are functioning within standard and five are in need of repair, which are all culverts requiring extensive cleaning to regain proper function.

New Trail Construction

Several new trails are proposed for the EM/DD TSA. Staff will return to the area after these trails are completed to document trail condition.

Attachments

- A. Trail Design Standards
- B. Maps of Areas of Concern in the MM/SG TSA
- C. Details About Areas of Concern and Constructed Features in the MM/SG and EMDD TSAs
- D. Maps of Constructed Features in the MM/SG TSA
- E. Maps of Areas of Concern in the EM/DD TSA
- F. Maps of Constructed Features in the EM/DD TSA

Literature Cited:

City of Boulder Open Space and Mountain Parks (OSMP). 2005 Visitor Master Plan. Accessed. 6/19/2007.
