

City Park Mile High Loop 2015 Trail Condition and Assessment

The following assessment is provided to Denver Parks and Recreation by the City Park Alliance to assist with recommendations for maintenance and rehabilitation of the Mile High Loop trail in City Park. All decisions on maintenance, and capital construction in City Park are to be directed through the City of Denver's Parks and Recreation department.

Overview of Impacts to the Mile High Loop:

The Mile High Loop is a continuous 5 kilometer trail which follows the 5,280 foot contour line at City Park in Denver, Colorado. The loop trail is composed of compacted crusher fines. The crusher fines form a compacted surface which, when properly maintained, provides a running and walking surface that is more forgiving on the body than a hardened surface, while simultaneously providing a dense matrix which keeps out encroaching vegetation.

Impacts to the Mile High Loop are continuous and varied and include:

- Irrigation – The Mile High Loop is different from many urban crusher fine trails in that it travels directly through the park as opposed to circumnavigating the exterior of the park. This increases irrigation impacts as it is not as simple to reduce irrigation in the interior of the park as opposed to along the park's edge. The irrigation system at City Park is complex and provides significant water to the park. While there are zones of the park that are not irrigated and retain a more native vegetative cover, areas of significant usage in the park need significant irrigation in order to maintain continuous vegetative cover to reduce erosion and sedimentation in the park. Without significant irrigation, vegetative cover in the park would rapidly degrade during times of heavy usage from numerous park events. While it would be ideal to move irrigation heads to better optimize delivery of water and reduce impacts to the loop trail, the first step (in 2015) will be to fix poor areas of the trail by adding addition crusher fines, compacting, crowning, and shaping the trail to allow for better drainage. Through ongoing evaluation, it will be possible to determine areas where additional efforts may be needed such as moving sprinkler heads or employing enhanced protection using geosynthetics or by facilitating water movement through swales or subsurface drains.
- Multi-modal traffic – The Mile High Loop receives significant traffic from runners, walkers, maintenance vehicles. While the compacted crusher fine trail can handle the impacts from slow moving light weight vehicles such as golf carts, all efforts should be made to reduce vehicular traffic on trails. A well compacted crusher fine trail will be able to handle the impacts of light bike traffic without additional maintenance provided that curves on the trail are kept to a large radius where possible.
- High usage – The crusher fine trail provides a unique world class running urban running surface. This is appreciated by both younger and older runners due as it not as hard on the joints and muscles as is running on impervious surfaces such as cement or concrete. Usage on the trail is considerable. When the Mile High Loop was closed down during construction in 2014, there were 10,000 page views on the City Park Alliance Mile High Loop web page over the period of

one month. This high usage creates an especially significant impact during spring months.

Many mountain trails close down during periods of thaw to protect trail integrity, however, this is not possible with the Mile High Loop, which is used every day of the year. This usage pattern means that trail maintenance will be ongoing and necessary in order to maintain an optimal surface.

- Low-lying areas and cross slopes – Low lying areas or areas with a shallow cross slope can be a significant impediment to maintaining a crusher fine surface. These can be fixed by crowning the trail surface, providing extra material to get the trail above the surrounding grade, or by sloping the trail properly direct runoff and run-on.
- Run-on from impervious surfaces – The Mile High Loop trail crosses several different types of surfaces. Shallow grades between the trail surface and adjacent impervious surfaces along the Mile High Loop reduce trail impacts, however these junctures still impact the trail by increasing sediment transport onto the trail and through rutting where vehicles veer off of impervious surfaces onto the trail.

About Crusher Fine Trails:

(Excerpted from - *Building Crusher Fines Trails* - 2002 Lois Bachensky, USDA Forest Service and the Trails Design and Management Handbook – 1993, Troy Parker, Pitkin County Open Space and Trails Program)

What are crusher fines?

Crusher fines are small particles of crushed rock. Generally, they are the leftovers from rock crushing operations, but at times the rock can be ground especially to make the crusher fines. To make a good trail surfacing material, they should have a range of particle sizes from a fine dust up to a specified 3/8" maximum particle size. With proper subgrade preparation and drainage, the crusher fines trail should remain stable for many years in all weather conditions.

A crusher fine trail combines the rustic feeling of a natural surface trail with a surface type that's durable (but not concrete or asphalt). The natural gravel-like surface feels more like a trail than a hard surfaced path and fits in well with primitive settings.



Crusher fines trail along an active railroad in Burlington, Washington

Critical Issues for Crusher Fine Trails

Water, drainage, existing soil types, and the types of usage are the primary considerations for designing and constructing crusher fine trails. Crusher fines are highly susceptible to washouts from running water, particularly if fines become saturated such as during spring snowmelt.

Selection of Crusher Fine Material

Crusher fines are available in various stone types, colors, and particle sizes, but not all crusher fines are suitable for trails. Tradeoffs may need to be made between the surface smoothness and erosion resistance, between colors and rock types, and between choice and availability.

The rock must be crushed into irregular and angular particles to allow interlocking into a tight matrix. The more angular the particles, the better. Rounded particles like pea gravel or decomposed granite never mechanically lock together.

The crushed rock must have adequate fines and some natural binders in order to cement the particles together after the fines are moistened, compacted, and allowed to dry. The fines, when laid to a depth of 4 to 5 inches, should bind to each other in a consolidated slab which is porous yet resistant to water falling on the surface.

Crusher fines in their purest form have no soil mixed in, they are pure crushed stone. Gravel and crusher fines differ from one another in that gravel is screened to remove the fines which contain the

natural binders/ceements. Gravels remain loose because of dead air or pore space within the matrix which allow them to drain well and resist compaction.

Crusher fines retain their inherent soil cements and binders which promote soil compaction. Fines that contain too many rounded particles (like some decomposed granites) are more difficult to interlock and often yield a loose and unconsolidated surface. Angular particles like andesite, dolomite, and certain types of granite can easily be wetted and compacted to meet the ADAAG.

A good indication of the strength of a rock binder is the hardness of the parent rock. The harder the source rock, the stronger the binders will be. Crushed rock contains the original rock cements and binders within the rock dust. These binders, combined with water and then compacted with a vibratory roller or plate compactor should produce a solid, compacted surface that resists significant deformation from hiking boots and mountain bike tires.

Particle size for crusher fines on trails should be 3/8" minus. Fines from granite or other suitable hard stone works best. The ideal particle size distribution is one where there are enough small particles to completely fill the voids between the larger ones. One good distribution to use is:

Sieve Size % Passing	
Particle Size	% of Passing
3/8"	100%
#4	90 - 100%
#8	55 - 80%
#16	40 - 70%
#30	25 - 50%
#200	6 - 15%

If the gradation of crusher fines does not meet the 6% passing the #200, clay fines may be added and mixed with the aggregate to do the job.

Color

Crusher fines will have exactly the same color as the rock from which they are ground. The color should either match or complement the native stone and surroundings of the site, but color is of secondary importance to the structural characteristics of the fines. If the crusher fine surface needs to be patched in the future, the fines added should be from the same rock source or the colors may not match.

Cost and Quantity Estimates

Crusher fines are not expensive, but the cost of delivery can equal or exceed the cost of the material. An 8' wide contractor built crusher fine trail in the Denver area costs between \$4 and \$5 per foot, not including the cost of site preparation and infrastructure such as retaining walls, and bridges. This compares with \$12 to \$15 per linear foot for concrete. The fines cost about \$35.00 per cubic yard delivered in the metro area.

The fines weigh approximately one ton per cubic yard before compaction. When determining quantities, calculate the cu. yds. needed for the length, width and depth of surfacing, and then add 20 to 30% to compensate for compaction.

Also, consider ordering and stockpiling additional fines for future maintenance since it is often difficult to match the colors and composition from other sources.

Crusher Fines For Accessible Trails

Since crusher fine trails are not always smooth enough or hard enough, they do not fulfill all the requirements of a fully accessible trail. To make the surface harder and smoother, lime or some other stabilizing agents may be added to the crusher fines so that it will set up harder and remain that way for longer periods of time.

For accessible trails, try to keep the outslope and crown to 2% maximum. In locations where surface pitch could divert a wheelchair into a dangerous place, the cross slope should be as close to 0% as possible.

Selecting a Crusher Fines Trail Construction Method

One method of placing the crusher fines involves excavation of a trench, and backfill with crusher fine material. Prior to placing the crusher fines, a 5" deep trench should be cut slightly wider than the desired width of the trail. Adequate excavated material should be placed along the edges of the cut to use later as backfill. Drainage collection ditches and schedule 40 plastic pipe may then be placed before laying the crusher fines. To avoid maintenance problems associated with pipes plugging up, consider using concrete lined swales or dips to move water across the trail.

Underlying soils should be analyzed to determine the need for geotextiles. Certain clays, organic soils, and high moisture soils most likely will require placement of a non-degradable geotextile. The fabric will help prevent the crusher fines from mixing with the soft soils below. The geotextile is easily hand laid using utility knives for cutting and wire staples for securing. If needed, a growth inhibitor such as "Casoron G-4 or G-10" may be applied.

After the fabric is placed, the crusher fines are spread and smoothed with shovels, mcleods and other hand tools. Leveling bars may be used to smooth the surface to a 2% cross slope toward the downhill side for drainage or the surface may be crowned to drain to both sides of the trail. The crusher fines should be spread to a depth necessary to meet the desired compacted crusher fine thickness. (For example, spread 7" to 8" deep to get a 5" compacted depth)

After initial smoothing and compacting, the trail edges are back-filled and dressed smooth. Finally, the trail surface is re-compacted with rollers or vibratory compactors. During the compaction process, the crusher fines should have some moisture to help "cement" the material when it dries. To ensure adequate moisture, fines may be



A vibratory plate compactor

sprayed with water during the crushing process to give them 4 to 5% water content. If this is not possible, and fines are dry at the time of compaction, use a very fine mist type hose and spray the fines sparingly. Using too much water will cause the crusher fines to become mushy or run off. The disturbed edges should be raked smooth and seeded.

Site Preparation

Subgrade, slope, curves, and other components should be designed by engineers to the same standard as a paved trail surface. Special attention should be given to drainage to ensure all water is conveyed away from or underneath the trail. Concrete is recommended for areas where erosive flows are unavoidable.

Underlying soils need to be analyzed to determine soil suitability. Certain clays, organic soils, and high moisture soils require special preparation, such as placement of a geotextile. The fabric helps prevent fines from mixing with soft soils below and helps control damage from vegetation.

High clay content soils typically cause trails to be slick and muddy when wet. They also take longer to dry out since their extra fine particles don't give up water easily. Trail treads surfaced with 4-6 inches of compacted fines over a landscape fabric can eliminate many of the problems associated with soils and climate. Landscape fabrics or geotextiles are also the key to preventing vegetation from growing into the trail and preventing commingling of the crusher fines with the natural soils.

If the surface of a crusher fines trail becomes loose and uncompacted over time it can often be wetted, reshaped and recompacted provided the fines have not sifted to the bottom and the larger particles floated to the top. Poor compaction can be the result of a variety of influences that include improper wetting and compacting during installation, lack of particle angularity, trail grades greater than 6%, and/or inadequate amounts of natural soil cements or lack of fines in the parent material that act as binders. Some "refreshing" of trail surfacing material is required on a routine basis. Trail tread grades over 6% will require significantly more maintenance since they tend to unravel or erode faster.

SOME OTHER CRUSHER FINES TRAILS IN DENVER AND NEARBY

Washington Park perimeter trail, Denver Parks & Rec (VOC 1993). 2.2 mile 7' wide running trail around park.

Cheesman Park perimeter trail, Denver Parks & Rec (VOC 1986). 3/4 mile 7' wide running trail around park.

Living Waters Interpretive Trail, Belmar Park, Lakewood (VOC 1989). 3/4 mile 8' wide bike and ped trail across rolling prairie ecosystem.

Metro Area and Boulder, Semi-urban or Rustic

Boulder Creek Trail, City of Boulder (built 1986-92). Several miles of 5-6' wide pedestrian-only and 80-10' wide bike-ped paths along much of creek, well-designed and constructed for durability and aesthetics.

National Center for Atmospheric Research, Boulder, crusher fines trail system (VOC 1989). Steep grades, scenic overlooks, extremely heavy use, tricky drainage; good use of drainage dips, culverts, and swales, 5-7' wide trails.

Summit Lake (Mt. Evans), Denver Mountain Parks (VOC 1990). Steep grades, heavy use, difficult drainage, tundra site, 6' wide, 1200' long.

Flower Trail, Eldorado Canyon State Park (VOC 1991). 4000' long 6-8' wide trail up old railroad grade at 4%. South Trailhead, Mesa Trail, Boulder Open Space, near Eldorado Springs (VOC 1992). Short loop trails around heavily-used picnic area.

Chautauqua Park, Boulder Mountain Parks (Boulder 1990). Road base used to harden heavily used eroding trails, heavy use of water bars and steps, mixed success.

Maintenance for Crusher Fine Trails:

The following Best Management Practices (BMPs) should be employed for the Mile High Loop. The main goals in maintaining the Mile High Loop should focus on:

1. Keeping crusher fines from becoming saturated with water;
2. Preventing concentrated flows of runoff from reaching crusher fine surfaces; and
3. Quickly and efficiently draining crusher fine surfaces before water can form a concentrated flow across the fines.

BMPs Appropriate for the Mile High Loop:

Crowning

Crowning should be used to convey water from the center of the trail to the edges of the trail. A 2% grade is recommended for all areas of the Mile High Loop to facilitate drainage. In areas where there is minimal cross-sectional gradient which results in stagnant water movement, crowning of up to a 10% grade can be considered. Crowning can be measured and created through the use of leveling bars. Grade breaks along the trail are unnecessary on the Mile High Loop due to the shallow gradients along the trail.

Extending Trail Curves

If bicycle traffic is using the crusher fines trail and speeds may exceed 15 MPH, curves of less than a 50' radius, should be avoided. If there are persistent areas of trail degradation from bicycle usage, than extending trail curves may be considered as a long-term solution.

Outsloping

An outsloped trail is one that is lower on the downhill side of the trail than it is on the upslope side of the trail. Outsloping lets water sheet flow across the trail naturally. Outsloping should be used in areas where there is a significant gradient (>2%) between the inside and outside edge of the trail. Outsloping can be measured and created through the use of leveling bars with angles of up to 5 percent. Loss of outslope is the first maintenance problem that develops on all trails.

Trail Elevation

If the crusher fines trail is crossing a flat area with no cross slope, the trail needs to be raised slightly above the surrounding ground to ensure the water drains off the trail surface. If there is some cross slope, the pitch of the trail surface should be in the same direction as the slope. This preserves the natural drainage patterns at the site. Most maintenance specifications propose a trail elevation of 2-4" above surrounding grade. Since most areas of the Mile High Loop have little to no cross slope elevation and significant irrigation impacts, a 4" trail elevation should be considered as the norm.

Ditching

A ditch above the trail may be needed if concentrated or heavy flows can reach the trail from the upslope area. Ditches on both sides of the trail may be needed when the trail is crowned and goes through a wet area. Ditching should also be considered to convey water from impervious areas if it is possible to convey water from the ditch using a french drain, level spreader, or other mechanism which equalizes flows to distribute concentrated flows into laminar sheet flow.

Intermittent Trail Closure

The Mile High Loop could be closed intermittently to reduce erosive impacts. Trails are dynamic and change with seasons. As frost thaws and releases water, the dirt resettles and the organic matter from fall leaf litter blends to create a new generation of trail dirt. While it would be ideal to manage the Mile High Loop to close during seasonal changes, this is not realistic due to the several microclimates along the trail, the heavy year-round usage, and the unpredictable Denver climate. A more useful application of intermittent trail closures is during significant events where signage and maps could be used to direct operators of heavy equipment off of the crusher fine trails and onto impervious surfaces designed to better support that loading.

Geosynthetics

Geosynthetic materials are increasingly used to provide additional stabilization where natural methods are not effective for soft or water-saturated trails. Geotextiles or geonets use a single layer of fabric or larger geogrids can be considered where there is persistent trail washout. Geosynthetics should only be considered as a last resort, as they require a different set of maintenance and installation procedures. Improper installation of the subgrade necessary to support substantial vehicle loading at the City Park Pavillion necessitated the removal and repaving of the geogrid supported stormwater infiltration gallery in 2014.

Should geosynthetics be considered, it may be more appropriate to consider incorporating encapsulated free draining rock. This technique, referred to as the sausage technique, involves encapsulating a layer of free draining rock between layers of geotextile and potentially conveying water from the free draining layer using flexible or perforated pipes.

Subsurface Drainage

Subsurface drainage may be used in areas where there is a high degree of saturation and is most effective when there is an adjacent swale or waterbody into which water can be directly conveyed. Subsurface drainage BMPs are varied and include use of course non-angular aggregate which freely drains into adjacent swales or waterbodies either directly or conveyed using porous plastic pipes within the media. To a lesser effect, subsurface drainage is facilitated in all crusher fine trail construction by preparing the trail with a very minor inverse slope underground which conveys subsurface water away from the trail.

Mechanical Grooming

Given the intense usage and year-round usage of the Mile High Loop trail, mechanical grooming should be considered on an annual basis or on a semi-annual basis in the spring and the fall if particular problem areas persist. Mechanical grooming removes the material from the top of the trail and replaces it back on the trail in a uniform fashion. This action is particularly helpful in smoothing out light elevation changes. Grooming also reduced impacts from sediment and debris accumulated on trails from construction activity by allowing the natural bonding action of crusher fines to re-form the intended dense matrix which further repels dirt and debris composed of larger particle sizes.

Key Areas for Maintenance:



Ten key areas needing specific attention on the Mile High Loop are outlined in the following. Cones in the following pictures are shown to provide a sense of scale with alternating cones at ten foot intervals.

Problem Area 1



Description:

This area is highly saturated throughout summer months due to irrigation flows being consolidated in a low lying area with no cross slope.

BMP Recommendations (including Fill):

- 160 cubic feet of fill (60x.33x8)

cubic feet fill needed is defined as the length of trail to repair in feet X 0.33

- o 0.33 = 4" to be added to trail for drainage in problem areas
- o (x8) Trail is variable in width and a mean width of 8 feet is used calculations
- o 20% compaction is not factored as roughly only 80% of the trail will be raised in an effort to provide adequate sloping and to avoid a dropoff on the trail edge

- Crowning of the trail from the center with no outsloping
- Trail elevation of 4" above surrounding grade

Problem Area 2



Description:

This area is highly saturated throughout summer months due to irrigation flows being consolidated along the interior edge of the trail. A second unofficial trail has been formed where the crosswalk at 23rd Avenue and York Street ends. This area is particularly eroded as it has not been designed to be a trail.

BMP Recommendations (including Fill):

- 156 cubic feet of fill ($50 \times .33 \times 8$) (132) + ($30 \times .5 \times 5 \times 1.2$) (24)
- cubic feet fill needed is defined as the length of trail to repair in feet X 0.33
 - o $0.33 = 4"$ to be added to trail for drainage in problem areas
 - o ($\times 8$) Trail is variable in width and a mean width of 8 feet is used calculations
 - o ($\times 5$) A 5 foot width (0.5) was used for the fill on the access trail from the corner
 - o 20% compaction is not factored to existing trail as roughly only 80% of the trail will be raised in an effort to provide adequate sloping and to avoid a dropoff on the trail edge
 - o 20% compaction was factored in for new trail fill (1.2)
- Elevation of the trail 4" above grade with an outslope following grade
- Backfill or formal excavation and trail preparation where the newly formed trail meets the Mile High Loop
- Consider a drainage ditch if rills continue to form

Problem Area 3



Description:

This area includes a slope varying from 2-5 degrees. In this picture, the direction of slope is from the foreground to the background. Water pools and creates a large section of mud during summer months at the toe of the slope.

BMP Recommendations (including Fill):

- 80 cubic feet of fill (30x.33x8)
- cubic feet fill needed is defined as the length of trail to repair in feet X 0.33
 - o $0.33 = 4"$ to be added to trail for drainage in problem areas
 - o (x8) Trail is variable in width and a mean width of 8 feet is used calculations
 - o 20% compaction is not factored as roughly only 80% of the trail will be raised in an effort to provide adequate sloping and to avoid a dropoff on the trail edge
- Elevation of the trail 4" above grade with both crowning and a slope following grade to the street intersection
- Consider a drainage ditch on the downhill side if rilling/pooling continues

Problem Area 4



Description:

This area is highly saturated throughout summer months due to irrigation flows being consolidated in a low lying area with no cross slope.

BMP Recommendations (including Fill):

- 160 cubic feet of fill (60x.33x8)
- cubic feet fill needed is defined as the length of trail to repair in feet X 0.33
 - o $0.33 = 4"$ to be added to trail for drainage in problem areas
 - o (x8) Trail is variable in width and a mean width of 8 feet is used calculations
 - o 20% compaction is not factored as roughly only 80% of the trail will be raised in an effort to provide adequate sloping and to avoid a dropoff on the trail edge
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- Crowning of the trail from the center with no outsloping
- Trail elevation of 4" above surrounding grade

Problem Area 5



Description:

This area is highly saturated throughout summer months due to irrigation flows being consolidated throughout this portions of the trail. This area is affected in winter by slight shading from a large grove of trees which creates differential melting.

BMP Recommendations (including Fill):

- 160 cubic feet of fill (60x.33x8)
- cubic feet fill needed is defined as the length of trail to repair in feet X 0.33
 - o $0.33 = 4"$ to be added to trail for drainage in problem areas
 - o (x8) Trail is variable in width and a mean width of 8 feet is used calculations
 - o 20% compaction is not factored as roughly only 80% of the trail will be raised in an effort to provide adequate sloping and to avoid a dropoff on the trail edge
- Elevation of the trail 4" above grade with an outslope following grade

Problem Area 6



Description:

This area is highly saturated throughout summer months due to flows and sediment being delivered from the uphill immediately adjacent impervious surface. A slope exists which conveys water from the road onto the trail.

BMP Recommendations (including Fill):

- 80 cubic feet of fill ($30 \times .33 \times 8$)
- cubic feet fill needed is defined as the length of trail to repair in feet X 0.33
 - o $0.33 = 4"$ to be added to trail for drainage in problem areas
 - o ($\times 8$) Trail is variable in width and a mean width of 8 feet is used calculations
 - o 20% compaction is not factored as roughly only 80% of the trail will be raised in an effort to provide adequate sloping and to avoid a dropoff on the trail edge
- Elevation of the trail 4" above grade with crowning to distribute run-on away from the trail
- Future consideration of using elevation, porous materials or level spreaders to drain roadway runoff prior to intersection with the trail
- Signage to restrict maintenance vehicles and event vehicles using the road from using the loop trail.

Problem Area 7



Description:

Areas 7 and 8 are low lying areas that are hit particularly hard with irrigation runoff. These areas are often impassable for the majority of the summer due to high run-on and minimal cross-slope.

BMP Recommendations (including Fill):

- 158 cubic feet of fill (60x.33x8)
- cubic feet fill needed is defined as the length of trail to repair in feet X 0.33
 - o $0.33 = 4"$ to be added to trail for drainage in problem areas
 - o (x8) Trail is variable in width and a mean width of 8 feet is used calculations
 - o 20% compaction is not factored as roughly only 80% of the trail will be raised in an effort to provide adequate sloping and to avoid a dropoff on the trail edge
- Crowning of the trail from the center with no outsloping
- Trail elevation of 4" above surrounding grade
- Planting of trees to the north of the trail to replace former tree islands and to provide additional infiltration and interception of irrigation
- Consider subsurface drainage to "Little Lake" via the adjacent drainage swale if problems persist

Problem Area 8



Description:

Areas 7 and 8 are low lying areas that are hit particularly hard with irrigation runoff. These areas are often impassable for the majority of the summer. A second trail which veers to the right of the Mile High Loop in this picture was created by foot traffic when this portion of the trail was closed during construction of a museum expansion and roadway improvements from 2012-2014.

BMP Recommendations (including Fill):

- 158 cubic feet of fill (60x.33x8)
- cubic feet fill needed is defined as the length of trail to repair in feet X 0.33
 - o $0.33 = 4"$ to be added to trail for drainage in problem areas
 - o (x8) Trail is variable in width and a mean width of 8 feet is used calculations
 - o 20% compaction is not factored as roughly only 80% of the trail will be raised in an effort to provide adequate sloping and to avoid a dropoff on the trail edge
- Crowning of the trail from the center with no outsloping
- Trail elevation of 4" above surrounding grade
- Re-vegetation of the trail that was created during museum construction
- Consider ditching which connects to subsurface drainage to "Little Lake" if problems persist

Problem Area 9



Description:

This area is a new segment of the trail that was created when it was necessary to re-orient the trail to accommodate reclaimed water infrastructure (aka “purple pipe). This area has impacts from bicycle traffic as it both connects the bike trail in the park to the intersection of Colorado Boulevard and 17th Avenue and incorporates an acute angled arc. Mechanical grooming of the trail in October, 2014 greatly improved the surface in this area.

BMP Recommendations (including Fill):

- 136 cubic feet of fill (50x.33x8)
- cubic feet fill needed is defined as the length of trail to repair in feet X 0.33
 - o $0.33 = 4"$ to be added to trail for drainage in problem areas
 - o (x8) Trail is variable in width and a mean width of 8 feet is used calculations
 - o 20% compaction is not factored as roughly only 80% of the trail will be raised in an effort to provide adequate sloping and to avoid a dropoff on the trail edge
- Elevation of the trail 4" above grade with an outslope following grade

Problem Area 10



Southern Extent of Area 10



Northern Extent of Area 10

Description:

The Mile High Loop borders a hardened surface in three areas. Along York Street, the Mile High Loop borders a sidewalk. In this area, the Mile High Loop reduces to a width of 36". Along Colorado Boulevard, the Mile High Loop borders a sidewalk with a width of 30". In this section, where the Mile High Loop intersects the lawn in front of the Denver Museum of Nature and Science (i.e., "the Mountain View"), the loop trail is anywhere between 10" wide and non-existent.

This is a long stretch of trail needing repair. It is 650 feet long. Additional impacts to this section occur from rill erosion associated with the H2O Odyssey fountain pumps and a storm sewer outfall near this area's southern extent.

BMP Recommendations (including Fill):

- Direct water from the storm sewer outfall either away from the trail or level the water into laminar sheet flow prior to intersection the trail
- Fill needed = 4,134 cubic feet ($650 \times 67 \times 1.2 \times 8$)
- cubic feet fill needed is defined as the length of trail to repair in feet X 0.67
 - o $0.67 = 8"$ depth for new trail construction
 - o (x8) Trail is variable in width and a mean width of 8 feet is used calculations
- 20% compaction (1.2) is factored in for new trail construction

*Preferred option – Complete removal of the hardened trail for the entire 650 foot length of this section and re-installing a crusher fine trail in this area. This area of hardened surface is no longer necessary for maintenance, since the concrete walkway adjacent to the H2O Odyssey fountain now serves as a better route for maintenance vehicles.

Delivery and Quantity of Materials Needed on the Mile High Loop for the April 22, 2015 Rehabilitation:

On April 22, the Mile High Loop will be restored. Labor will be provided primarily through the Starbucks Day of Work, with additional participation by Registered Neighborhood Associations, interested public, and

It is the goal of City Park Alliance to rehabilitate the entire Mile High Loop during this period.

Prior to the delivery of materials, City Park Alliance will mark the trail and provide laminated Standard Operating Procedure specification sheets to guide volunteers on how to rehabilitate the trail based on each marked area as requested to support Denver Parks and Recreation. Where possible, compaction, wetting, and re-compaction should be utilized in all areas. The use of vibratory plate compactors, a miniature dump truck with smooth tread tires, several leveling bars, a portable water source and delivery of materials

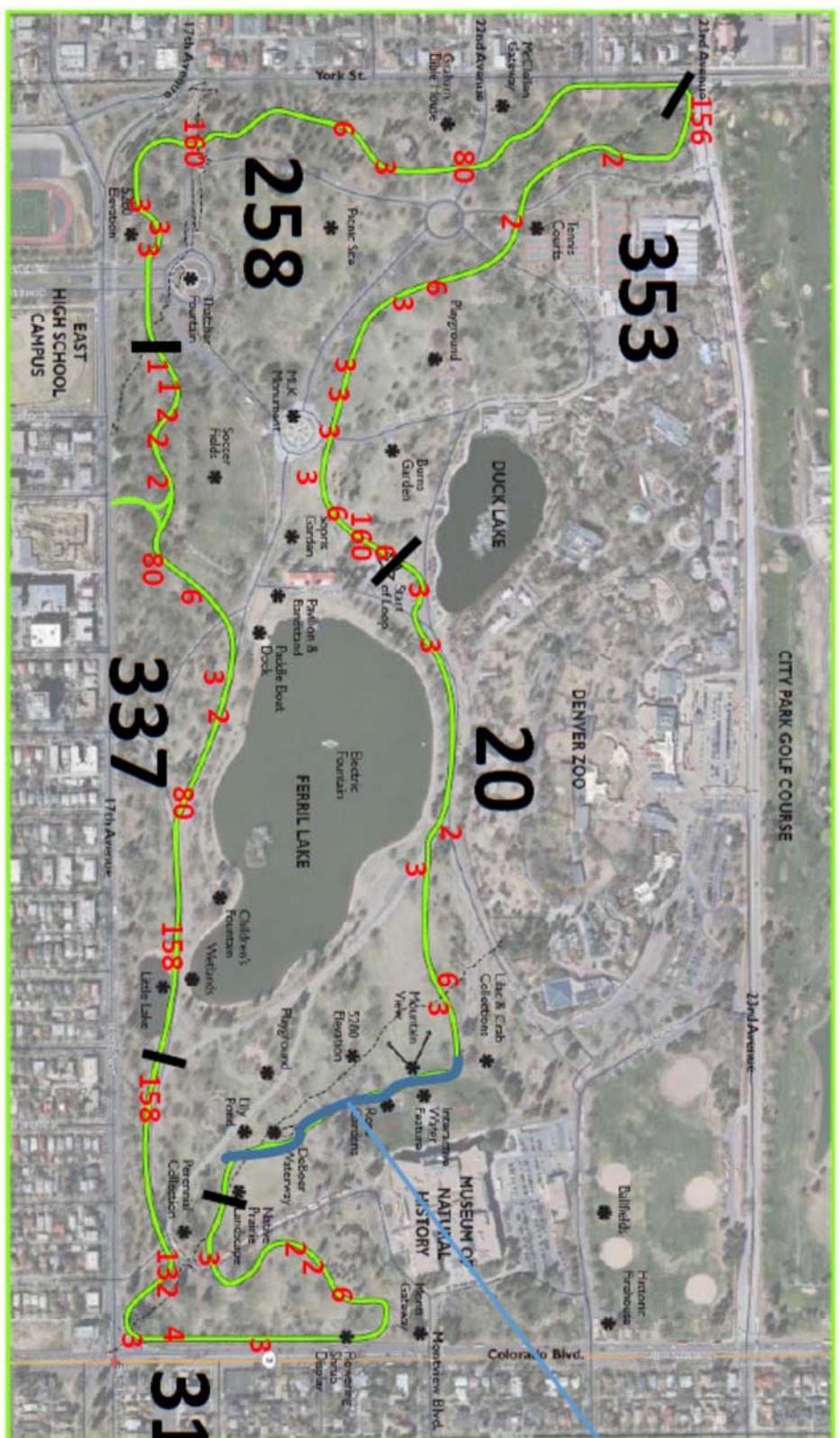
The following assessment provides the quantity of crusher fines needed and provides quantities of crusher fines that are needed for each kilometer of trail. Quantities are provided in cubic feet of material necessary. Larger fonts indicate areas where crusher fines should be delivered and are marked at points accessible to concrete roads. A total quantity of 1,281 cubic feet of material (48 cubic yards) is recommended for this initial project. A follow-up delivery of 10 cubic yards of material is also being recommended for delivery on a later date (e.g., June 5) to address irrigation impacts recognized after the April 22 rehabilitation.

Costs/Material Estimates:

- ~\$1,780 - 48 cubic yards crusher fines with \$100 surcharge for delivery to multiple locations
- ~\$700 – Equipment rental if needed
- ~\$300 – Water/supplies to support volunteers
- ~\$450 –Follow-up delivery of 10 cubic yards crusher fines with \$100 surcharge

Problem Area 10 Additional Costs:

- ~\$330 – Cut asphalt - \$.51 per linear foot minimum charge
- ~\$6,500 - Remove asphalt 6,500 sf estimate
- ~\$5,425 - 155 cubic yards crusher fines
- ~\$6,500 – Install/site prep costs
- ~\$1,000 – Site re-vegetation



4,134 cf
for full
replacement
not
included in
per/km total



SCALE IN FEET
300
600

Cubic feet of materials needed.
Large numbers indicate cubic feet per km

LEGEND

- ~ Trail Alignment
- 5200 Contour
- ★ Start of Loop
- * Existing Point of Interest