GRINDSTONE TRAIL

Alignment Selection and Design Criteria

MARCH 23, 2012

Project No. 11112.02

Prepared By:
Allstate Consultants, LLC
Columbia, Missouri

Grindstone Trail

Alignment Selection and Design Criteria

March 22, 2011

The purpose of this document is to memorialize the criteria used for design of the Grindstone Trail and to aid in the selection of a preferred alignment.

Executive Summary

On September 27, 2011 Allstate Consultants was authorized to begin work on evaluating alternative trail alignments for a multi-purpose Grindstone Trail connection from the existing trail system at Grindstone Nature Area to Maguire Blvd and to future North and South Fork Grindstone trails to the east. A review of the public record regarding this trail and the trail system in general, lead us to adopt the following purpose and need statements (PN) for the purpose of evaluating alternative alignments. This review included City Council meeting minutes and resolutions, Columbia's Vision plan, the "2010 Parks and Recreation Needs Assessment", the "Columbia Non-Motorized Pilot Program Consumer Awareness and Attitude Research Results of Survey – December 2008" and other project correspondence. The purposes and needs identified were:

PN1. The project must result in a safe and useable facility for the full range of users.

PN2. The project must encourage non-motorized transportation through an efficient connection between the residences and business along the Grindstone Creek corridor and central Columbia.

PN3. The project must encourage increased recreational use through a variety of activities including nature watching, biking and walking.

PN4. The project must be designed to fit into and minimize the overall costs of the larger network of trails, transportation and parks.

PN5. The project must be mindful of environmental impacts.

With these purposes and needs in mind, trail design criteria were then selected to be applied consistently to all trail alignments to be reviewed. These criteria include

- A standard typical section of 10' of pavement with 2' grass shoulders

- Compliant with standards found in Section 1017 of the Access Board Draft Final Guidelines for Outdoor Developments (2009) (Trails)
- Compliant with standards found in AASHTO's guide for the Development of Bicycle Facilities (1999) (Shared use paths)
- All portions of the trail accessible to emergency and maintenance vehicles.

A total of 10 different alignment segments were individually considered (figure 1), but five were ruled out early in the process without a detailed review because they were considered infeasible. Three alignments for the portion of the trail west of Highway 63 (figure 2) and two alignments for the portion of the trail east of Highway 63 (figure 3) were considered to be potentially feasible and received detailed review and analysis. These five alignments were characterized using quantitative measures where possible, and qualitative measures otherwise. In the interest of providing a complete picture, these characterizations were included in the tables regardless of the degree to which they could be directly tied to the purpose and need statements. The alignments were characterized based on

- Impacts on adjacent properties (table 4)
- Impacts on specific destinations (table 5)
- Impacts on potential trail users (table 6)
- Terrain (table 7)
- Public safety (table 8)
- Impacts on environment and sustainability (table 9)
- Maintenance and operations (table 10)
- Initial construction cost (table 11)

Finally, the characterizations that could be directly linked to the purpose and need statements in a meaningful way were related back to the purpose and needs for the final recommendation. Although the yellow alignment did receive the full analysis, it is our opinion that it does not provide an acceptable level of safety or usability. For the portion of the trail west of Highway 63, the Orange alignment is recommended because of the following advantages:

- It is by far the safest alignment because it minimizes steep hills, steep cross slopes and interaction with motorized traffic. (PN1)
- It is the alignment that is the most accessible to the full range of users. (PN1)
- It is the alignment that would most encourage regular and repeated use by the largest percentage of the large number of potential commuters due to its minimization of adverse terrain. (PN2)

The following significant factors were either neutral with regards to selection of the western alignment, or indicated against the Orange alignment. (given that the Yellow alignment is ruled out due to unacceptable usability and safety)

- There was no clear advantage to either of the remaining alignments in terms of recreational use or minimizing the long term non-motorized transportation system. (PN3 and PN4)
- The Orange alignment poses a higher threat to aquatic resources, and the Green alignment poses a higher threat to mature forest. (PN5)
- The Orange alignment clearly has the highest level of direct impact on a few residential property owners, although all alignments have some impacts to some property owners. These impacts are understandably viewed negatively by the most directly impacted current owners. Bridge type selection at the crossing nearest these properties will need to include consideration of the impacts of the bridge on these adjacent properties. Accordingly, it is our plan to attempt to make a low profile bridge work at this location if possible and advisable.

For the portion of the trail east of Highway 63, the Blue alignment is recommended because it has a slight advantage in terms of long term costs. However, the violet alignment is in all ways acceptable and is expected to have the lowest initial construction cost.

In Summary, based on our analysis, our recommendation is that the Orange alignment be selected for the western portion of the trail and that the Blue alignment be selected for the eastern portion, if funding allows.

Project Purpose and Need

The selection of design and alternative evaluation criteria for a multi-use trail should be guided by the project purpose and need to ensure that the trail design addresses the specified purposes at minimum expense. The purpose and need statement is used both to make sure the design fulfills the needs for which the funds were allocated and to prevent "scope creep" which can occur when designers include features for which funding was not approved.

Funds were allocated to this project from the 1/8 cent sales tax extension which was approved in November 2010. Columbia City Council resolution R136-10 which authorized a public hearing on the sales tax extension specifically listed this project, and refers to the Columbia Vision Plan goals including "an extensive, safe network of trails". The 2009 Columbia Vision Commission Report, section 12, "Parks, Recreation, Greenways and Trails", includes vision statement 12.4 which says

> "Trails – an extensive, safe network of trails will accommodate a variety of uses ranging from recreational to non-motorized travelers. This network may include roadway and public transportation infrastructure to connect parks, neighborhoods, schools and businesses."

Vision Plan performance measure 12.4.1, "There is a plan for multi-use trails with projects prioritized (especially to achieve connectivity with new and existing developments)", would indicate that community connectivity is a priority.

In the August 8, 2011 letter to the City Council from the City staff requesting authorization for an agreement with Allstate Consultants LLC for the planning and design of the "Grindstone Creek Recreation Trail" staff stated that "Council had identified this trail as a highly desired project due to its recreational and connectivity value to the residents and businesses located along the Grindstone Creek corridor."

The June 2010 Parks and Recreation Needs Assessment Survey, Findings Report indicates that 76% of Columbia households have need for "walking and biking trails" and 55% have need for "nature trails". The highest scoring facility type under the category of "Most Important Parks and Recreation Facilities" was "walking and biking trails" with 37% of the households voting for it as one of their four most important types of facilities and 17% voting for "nature trails" (5th highest ranked). Sixty-nine percent of respondents were somewhat or very supportive of developing and connecting hard surface walk/bike trails.

The need for a bicycle connection between Concorde Business Park and downtown Columbia was an important factor in making the Grindstone Trail a priority for the City. The trail was recognized by IBM as an important factor in locating the new IBM Technology Service Center in Columbia in a previously existing building. The May 17, 2010 press release from the IBM

website includes the following statement. "The City of Columbia and IBM will also work together to incorporate the new facility into Columbia's Sustainable City program, which includes building bike paths to connect the facility with downtown Columbia". A May 29, 2010 issue of the Columbia Business Times quotes former Mayor Hindman as saying "I can't help but point out that (they) specifically mentioned the trails" in reference to his early discussions with IBM about locating the center in Columbia.

According to the "Columbia Non-Motorized Pilot Program Consumer Awareness and Attitude Research Results of Survey – December 2008" the two biggest challenges facing people who want to walk or bike in Columbia are "Safety Concerns" (45.8%) and "Takes too much time" (18.7%). Eighteen percent of respondents said they typically ride or walk to work. For those who don't currently use alternate modes of transportation (non-motorized), 24.3% said the most important reason was "takes too much time", 21.9% said it was "ability level" and 13.6% said it was "safety concerns".

Upon reviewing these various sources, the following points are clear:

- The trail is intended to provide a connection in the non-motorized transportation system.
- The trail is intended to provide recreation.
- The trail should be designed to meet the needs of walkers, bicyclists, commuters, nature enthusiasts and other recreational trail users.
- The trail should be designed to facilitate the safe interaction of the various users.
- Both "walking and biking trails" and "nature trails" are highly supported in our community.
- Items which are not specifically stated in these sources, relative to this project, but which can be assumed to be applicable for all such projects are:
    - The necessity to meet these needs for a population with the full range of ages and physical abilities.
    - The necessity to minimize costs for both initial construction and for operation and maintenance.
    - The necessity to comply with all environmental regulations and minimize environmental impacts to the maximum degree possible while still meeting project needs.

Given these inputs, it is our recommendation that the purpose and need statement for this trail include the following requirements:

PN1. The project must result in a safe and useable facility for the full range of users.

PN2. The project must encourage non-motorized transportation through an efficient connection between the residences and business along the Grindstone Creek corridor and central Columbia.

PN3. The project must encourage increased recreational use through a variety of activities including nature watching, biking and walking.

PN4. The project must be designed to fit into and minimize the overall costs of the larger network of trails, transportation and parks.

PN5. The project must be mindful of environmental impacts.

Design Criteria

The following general criteria will be applied to the design of the Grindstone Trail insofar as possible regardless of which alignment is selected. In cases where these criteria cannot be met, the City of Columbia Parks Department will be notified and will determine the appropriate procedure for allowing a written exception. To some degree, the comparison of alternatives takes into account the degree to which these criteria can be met for each alternative.

- In general, the trail width and surface will be 10' wide concrete, crowned on one edge with 1% design cross slope (maximum allowed constructed cross slope will be 2%) with 2' grass shoulders on both sides.
- Accessibility design will be compliant with Access Board Draft Final Guidelines for Outdoor Developments (2009), specifically, Section 1017 "Trails" http://www.access-board.gov/outdoor/index.htm. Where these design guidelines are not clear, Federal Highway Administration (FHWA) Guidelines for Designing Sidewalks and Trails for Access, Part II: Best Practices Design Guide (2001) will be used. http://www.fhwa.dot.gov/environment/sidewalk2/index.htm

- The Access Board has also published Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAC) http://www.access-board.gov/prowac/nprm.pdf which may be appropriate for use on portions of the trail which run parallel to existing roads. The most critical requirement from these sources during the selection of a preferred trail alignment is that running slopes greater than 5% will be limited as specified in Table 1017.7.1 which specifies the maximum lengths at slopes between 5 and 12.5%. A comparison of the various sources of guidance for ADA design is included in Table 1.

- Maximum amount of drainage area that will be allowed to drain over the surface of the trail will be 1 acre. This is roughly equivalent to a maximum storm water flow of 2 cfs from the 10 year, 5 minute storm under well vegetated conditions. This is consistent with the existing City of Columbia storm water requirements.

- For the purposes of evaluating alternatives, retaining walls are assumed as necessary where the trail crosses through areas with existing cross slope greater than 4:1. This threshold will be a general guideline for final design, but will vary as needed.

- Criteria for cyclists from AASHTO Guide for the Development of Bicycle Facilities (1999), shared use paths, specifically

    - The project will be generally designed with a design bicycle speed of 20 mph, which is suggested as the minimum design speed for a multi-use trail on page 36 of the AASHTO Guide.

    - The general minimum turn radius for trail alignment will be 100' based on a 20 mph design speed. In some cases where the terrain is difficult, the turn radius will be reduced to 36' with a 12 mph design speed. Signage would be required to notify of the need for reduced speeds. In other locations, such as at intersections and bridge ends, the radius may be even less.

    - Grades greater than 5% will generally be avoided but short sections of steeper grades may be allowed as per the grade Table on page 39 of the AASHTO Guide.

- All portions of the trail should be accessible to emergency and maintenance vehicles. Where vehicles must cross bridges to meet this requirement, the bridges will be designed for HS20 loading. For the purposes of the alternatives analysis, bridges will be assumed to span the floodway.

- Where the trail runs through existing developed areas, a 10' pedway will be provided adjacent to the existing curb. For the purposes of this alternatives comparison, the pedway will be assumed to replace the existing 4' sidewalks.

Table 1. Comparison of Trail Guidelines for ADA compliance		
Access Board Draft Final Guidelines for Outdoor Developments (2009)	**FHWA Guidelines for Designing Sidewalks and Trails for Access, Part II: Best Practices Design Guide (2001), Chapter 14, Shared Use Path Design**	**Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right of Way (PROWAC) (2011)**
http://www.access-board.gov/outdoor/draft-final.pdf	http://www.fhwa.dot.gov/environment/sidewalk2/pdf.htm	http://www.access-board.gov/prowac/nprm.pdf
Requirements for Federal outdoor developed areas including trails.	A guidance document for shared use paths	Applies to accessible paths along public roads
1017.3 Minimum clear width = 36"	14.6 Should be at least 10' wide	R302.3 Minimum width = 4'
1017.4 If width is less than 60", 60x60" passing spaces required at 1000' interval	14.6 Passing spaces not required when shared use trail is at least 60" wide	R302.4 Where the width is less than 5', passing spaces are required.
1017.5 Tread obstacles shall not exceed 0.5"	14.4.3 Vertical changes in level can't exceed 0.25" unless beveled in which case they can't exceed 0.5".	R302.7.2 Vertical changes in level can't exceed 0.25" unless beveled in which case they can't exceed 0.5".
1017.6 Openings in trail surface should be 1/2 " max, but can be 3/4" max	14.4.4 Openings in trail surface should be 1/2 " max, but can be 3/4" max	R302.7.3 Openings limited to 1/2".
1017.7 No more than 30% of the total trail length shall have a running slope steeper than 1:12 (8.3%)	14.5.1 No more than 30% of the total trail length shall have a running slope steeper than 12:1 (8.3%)	**R302.5 When adjacent to public roads, the grade should not exceed the roadway grade. In other places it should not exceed 5% except on ramps.**
1017.7 No slopes steeper than 1:8 (12.5%)	14.5.1 Includes no guidance suggesting that the use of trails steeper than 1:8 is allowed.	R407.2 Ramp runs shall have a running slope between 5 and 8.3 percent maximum.
1017.7 Slopes between 1:20 and 1:12 - max length = 200' max rise=16.7'	14.5.1 Slopes of 1:12 (8.3%) - max length = 200' max rise=16.7'	The rise for any ramp run shall be 2.5' maximum
1017.7 Slopes between 1:12 and 1:10 - max length =30', max rise =3'	14.5.1 Slopes between 1:12 and 1:10 (10%) - max length =30', max rise =3'	
1017.7 Slopes between 1:10 and 1:8 - max length=10', max rise = 1.25'	14.5.1 Slopes between 1:10 and 1:8 (12.5%) - max length=10', max rise = 1.25'	
1017.7.2 Cross slope on concrete asphalt or boards shall not be steeper than 1:48 (2.08%)	14.5.3 Max cross slope 2% on paved and 5% non-paved.	R302.6 Max cross slope=2% max, R407.3 Ramp cross slope=2% max
1017.8 Resting intervals 60" long, full trail width wide or 36" if offline	14.5.2 Resting interval 60" long and width equal to or greater than trail. (offline is encouraged)	R407.6 Landings are required at the top and bottom of each ramp run. Required length =60". Width=trail width.
1017.8 Resting intervals maximum slope = 1:48 (2.08%) in any direction	**14.5.2 Resting interval grade less than 5%, cross slope on paved surfaces less than 2%**	**R407.6.1 Landing slopes shall be 2% max in any direction.**

Table 1. Comparison of Trail Guidelines for ADA compliance		
Access Board Draft Final Guidelines for Outdoor Developments (2009)	**FHWA Guidelines for Designing Sidewalks and Trails for Access, Part II: Best Practices Design Guide (2001), Chapter 14, Shared Use Path Design**	**Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right of Way (PROWAC) (2011)**
1017.8.4 Turning space required if resting intervals are offline		
1017.11 Trail Signs shall include Length of trail or segment, surface type, typical and min tread width, typical and max running slope, typical and max cross slope.	14.8 Signs with specific information about trail conditions recommended	
	14.7 Minimum railing height = 42"	**R409.1 Handrails are required on ramp runs with a rise greater than 6" if they are on the accessible route. Height shall be between 2.8 and 3.2 ft.**

Significant differences are highlighted in bold

Alternative Alignment Evaluation

A natural constraint on the trail alignment options is that all trails must cross under Highway 63 on the north side of Grindstone Creek. Because of this, the alternative alignments are split into eastern and western portions of the trail. Three alternative alignments west of Highway 63, Orange, Yellow and Green have been identified as shown in the attached map and have received detailed review. Additional alternative trail segments were also considered but ruled out prior to detailed review. Two alternative alignments east of Highway 63, Blue and Violet have been identified and have received detailed review. Table 2 describes the routes evaluated and Figure 1 shows all of them. Figures 2 and 3 provide more detail and existing ground profiles for the alignments which were carried forward for detailed study.

A major determinant on trail cost will be the bridge type and size selection. It is not generally cost effective to develop bridge designs during the alignment selection process because some of the bridges may not be needed depending on the alignment selection. However, to produce a fair comparison between alignments, some consideration must be given to the types and lengths of bridges that would be built. Typically on a creek the size of Grindstone Creek we would recommend that pedestrian bridges be elevated to keep the superstructure above the 100 year flood level to minimize maintenance issues relative to the trapping of woody debris. All bridges on all alternate alignments were estimated to cost $100 per square foot of bridge deck, with the bridge decks being 10' in width and the bridge lengths being set as needed to span the floodway. The value of $100 per square foot is based on figure 104.7 of MoDOT's Engineering Policy Guide which details costs for planning level bridge cost estimates. However, for the 2nd Bridge from the West on the Orange alignment, this type of bridge would result in the need for construction of large fill slopes that would significantly block the view of Grindstone Creek from the homes at the end of Bluff Pointe Drive. Although low water bridges may create more maintenance issues, a low water bridge is the initial recommendation for this location to minimize the impacts on these homes. The larger floodway spanning structure was included in the cost estimate to be conservative, but it is expected that a low water bridge would be used at this location which should result in some construction cost savings.

The detailed review of these 5 alignments includes numerous metrics that were selected for comparison. Ward 6 Councilwoman Barbara Hoppe and a group of property owners from the East Pointe subdivision assisted in developing a comprehensive list of metrics. For some metrics, we were able to develop reasonably precise estimates of how each alignment compared with the others. For other metrics, we were able to make qualitative statements regarding the expected drawbacks and benefits of each alignment but were unable to provide quantitative data. These metrics are reported so that the reader will be prompted to consider them and form their own opinion. For example, some metrics are related to the degree to which people will choose to

commute along the alignment instead of drive to work. We do not have a reliable way to predict this, except that it is reported that, on average, 1.5% of trips in Columbia are by bicycle (Get about Columbia). This number gives us an idea of the number of people that might be involved, but doesn't help us decide how many people will choose to commute by bike if we select one alignment over another. So, we have attempted to quantify and discuss some factors that might impact such a decision and leave the outcome up to speculation.

The metrics vary in the degree to which they directly address the project purpose and need. The impact of each metric on achieving the project purpose can be somewhat subjective so we have not attempted to pin this down. We have not generally discussed applicability to purpose and need in the tables, but have included it in our recommendation.

Cost estimates are provided for each alternative alignment that received detailed analysis. These estimates are based on bid prices from the County House and Hominy Trails projects which were bid in the past year. Table 3 details the analysis of these two projects and documents the unit prices that have been used for estimating costs. Table 3 is broken into two sections. The upper section details the items that can be relatively easily quantified for the various alternatives and which make up about 75% of the project costs. The lower half of Table 3 details the various other elements that are estimated based on a typical percentage of the costs described in the upper section. To apply this to each alignment, quantities of the items in the upper portion of Table 3 are estimated and the total cost of these items is estimated based on the unit prices in Table 3. The other items are then estimated as 25% of this total. The costs of easements are then added to this to get the project construction estimate.

The following tables list and discuss these metrics. Each table is broken into three parts. Part A describes the metrics and discuss how they were evaluated and why they were included (when it is not obvious). Part B details the results for the three western alignments. Part C details the results for the two eastern alignments. In cases where there is nothing of significance to say about an alignment as it relates to a metric, we have left that cell blank.

Table 4 reports the metrics for each alignment related to impacts on adjacent properties.

Table 5 reports the metrics for each alignment related to specific destinations in the corridor.

Table 6 reports the metrics for each alignment related to people in nearby neighborhoods and businesses that may use the trail.

Table 7 reports the metrics for each alignment related to the terrain that the trail traverses.

Table 8 reports the metrics for each alignment related to public safety.

Table 9 reports the metrics for each alignment related to the environment and sustainability.

Table 10 reports the metrics for each alignment related to maintenance and operations.

Table 11 reports the metrics for each alignment related to initial construction cost.

Table 2a. Alternative Routes Considered – West Side of Hwy 63 (See Fig 1)		
Route	Description	Comments
~~Red~~	Splitting from the Green alignment in the Waters Moss area and following a valley down to a proposed tunnel under Bluff Point Drive	Evaluated, but not given detailed consideration because of steep grades and need for large pedestrian tunnel. This route could not be made ADA compliant.
Orange	Following the Grindstone Creek Floodplain	This is approximately the alignment originally proposed by the City. Provides the most efficient and level route for commuters. It is also the route with the largest risk from flood damage. The final alignment of this route would have to be carefully selected to minimize wetland impacts.
Yellow	A fairly direct path up to the Waters Moss house and through MFA property then along existing city streets	This route also connects the Waters-Moss house to the trail, but is excessively steep leading to safety concerns and the inability to meet ADA requirements. Utilizes some existing infrastructure which will require significant modification.
Green	A less direct, ADA compliant path up to the Waters Moss house and through MFA property then along existing city streets and dropping back into the Grindstone Creek floodplain behind the Theatre.	This route also connects the Waters-Moss house to the trail and is ADA compliant at the expense of extensive lengths of trail along relatively steep side slopes and ½ mile of nearly 5% longitudinal grade. Utilizes some existing infrastructure which will require significant modification.
~~Magenta~~	An alternate section of the Orange Route along the south side of Grindstone Creek. Proposed as a means to move one of the Orange Bridges to align with Bluff Creek Drive and Bluff Creek Parkway	This was proposed to provide a direct pedestrian connection between Bluff Creek Drive and Bluff Creek Parkway as an auxiliary benefit, but not given detailed consideration because of additional direct impacts to residential private property, steep cross slopes (2:1) and the elevation differential between the trail and the existing roadway termini.
~~Cyan~~	An alternate route for the Green and Yellow alignments to descend back down to Creek Level using East Pointe Drive	Evaluated, but not given detailed consideration because of steep grades as well as the need to extend the trail through residential areas. Could not reasonably be made ADA compliant.

Table 2a. Alternative Routes Considered – West Side of Hwy 63 (See Fig 1)		
Route	Description	Comments
~~Manila~~	An alternate route for the Green And Yellow alignments that would utilize Hillcrest Drive to ascend into the Waters Moss area.	Evaluated but not given detailed consideration because of the steep grades including a 16% grade adjacent to the at-grade mid-block crossing of Old 63 Hwy, a minor arterial. Possibly could be made consistent with PROWAC guidelines, but the accessible path would have very steep grades. Extensive retrofitting of Hillcrest would be required.

Table 2b. Alternative Routes Considered – East Side of Hwy 63 (See Fig 1)		
Route	Description	Comments
Blue	Follows the North Fork of the Grindstone Floodplain and connects to Maguire Blvd just South of the Bridge over the North Fork	This alignment requires an additional bridge, but it is a bridge that would be required for extension of the North and South Fork Grindstone trails. Minimizes length of redundant trail needed and length of trail on steep cross slopes.
Violet	Follows the South Fork of the Grindstone Floodplain and connects to Maguire Blvd just South of the Bridge over the South Fork	This is approximately the alignment originally proposed by the City.
~~Blue-Green~~	An alternate route from the Blue and Violet routes to take the trail up to LeMone Industrial Blvd instead of Maguire	This alignment would connect to existing streets at a much higher elevation requiring much longer steep sections. The long ramp up would not contribute to reducing the length of future trail needed for future North and South fork Grindstone trails. We may not be able to make this route ADA compliant. It was not selected for detailed evaluation.

Table 3. Analysis of County House and Hominy Trail Project Costs.

	Units	Quantity CH	Quantity HB	Average Total Unit Price from Bids CH	Average Total Unit Price from Bids HB	Unit Cost for Estimate G	Total Itemized Cost CH	Total Itemized Cost HB
Concrete Trail	ft	5,682	6,190	$58.76	$59.90	$60.00	$333,869	$370,786
Concrete Trail through Developed	ft	868	0	$33.09	$0.00	$41.25	$28,725	$0
Neighborhood Connector Trails	ft	0	1,013	$0.00	$35.03	NA	$0	$35,468
Grading	ft	6,550	7,203	$17.98	$18.92	$20.00	$117,746	$136,302
Retaining Wall	ft^2	1,583	8,968	$63.19	$30.21	$31.00	$100,017	$270,937
Bridge	ft^2	2,224	2,640	$100.82	$76.77	$100.00	$224,175	$202,683
Stream Protection	per major crossing	3	3	$15,067	$2,804	$12,000	$45,201	$8,411
						Subtotal - Itemized Items	$804,533	$1,016,177

	% of itemized subtotal CH	% of itemized subtotal HB	% of itemized subtotal G	Total Other Costs CH	Total Other Costs HB
Mobilization	7.0%	5.5%		$55,964	$55,906
Drainage	8.1%	8.8%		$64,946	$89,735
Erosion Control	1.7%	2.5%		$13,762	$25,348
ADA Items	1.0%	0.3%		$7,720	$3,013
Pavement Marking	0.3%	0.3%		$2,335	$3,027
Signing	1.1%	0.3%		$8,722	$3,427
Establishing Vegetation	0.9%	0.9%		$7,490	$8,850
Other (typical)	5.1%	7.1%		$40,682	$71,825
Subtotal Non-itemized	25.1%	25.7%	25%	$201,620	$261,131
Other (atypical)	6.9%	2.3%	0%	$55,313	$23,618

CH=County House Trail, HB=Hominy Branch Trail, G=Value used for Grindstone Preliminary Plan
Other (typical)= Other items that would be typically found on a trail project. Other (atypical)=Other items that aren't expected to be needed for Grindstone Trail. These include the gravel side trail, the lighting of the tunnel on the County House Trail, etc.

FIGURE 1
TRAIL ALTERNATES
GRINDSTONE TRAIL PROJECT
COLUMBIA, MISSOURI

STADIUM BLVD

WATERS–MOSS MEMORIAL WILDLIFE AREA

NORTH FORK GRINDSTONE CREEK

SOUTH FORK GRINDSTONE CREEK

OLD 63

GRINDSTONE NATURE AREA

GRINDSTONE CREEK

HIGHWAY 63 SOUTH

HIGHWAY 63 NORTH

MCGUIRE BLVD

RED ALIGNMENT
ORANGE ALIGNMENT
YELLOW ALIGNMENT
GREEN ALIGNMENT
BLUE ALIGNMNT
VIOLET ALIGNMENT
MAGENTA ALIGNMENT
CYAN ALIGNMENT
BLUE GREEN ALIGNMENT
MANILA ALIGNMENT
FUTURE TRAILS
EXISTING TRAILS IMPROVED SURFACE
EXISTING MINOR NATURAL SURFACE

N

SCALE: 1" = 500'

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REVISED:

NOT FOR PRELIMINARY CONSTRUCTION

ALLSTATE CONSULTANTS
3312 LEMONE INDUSTRIAL BLVD.
COLUMBIA, MISSOURI 65201
(573) 875-8799
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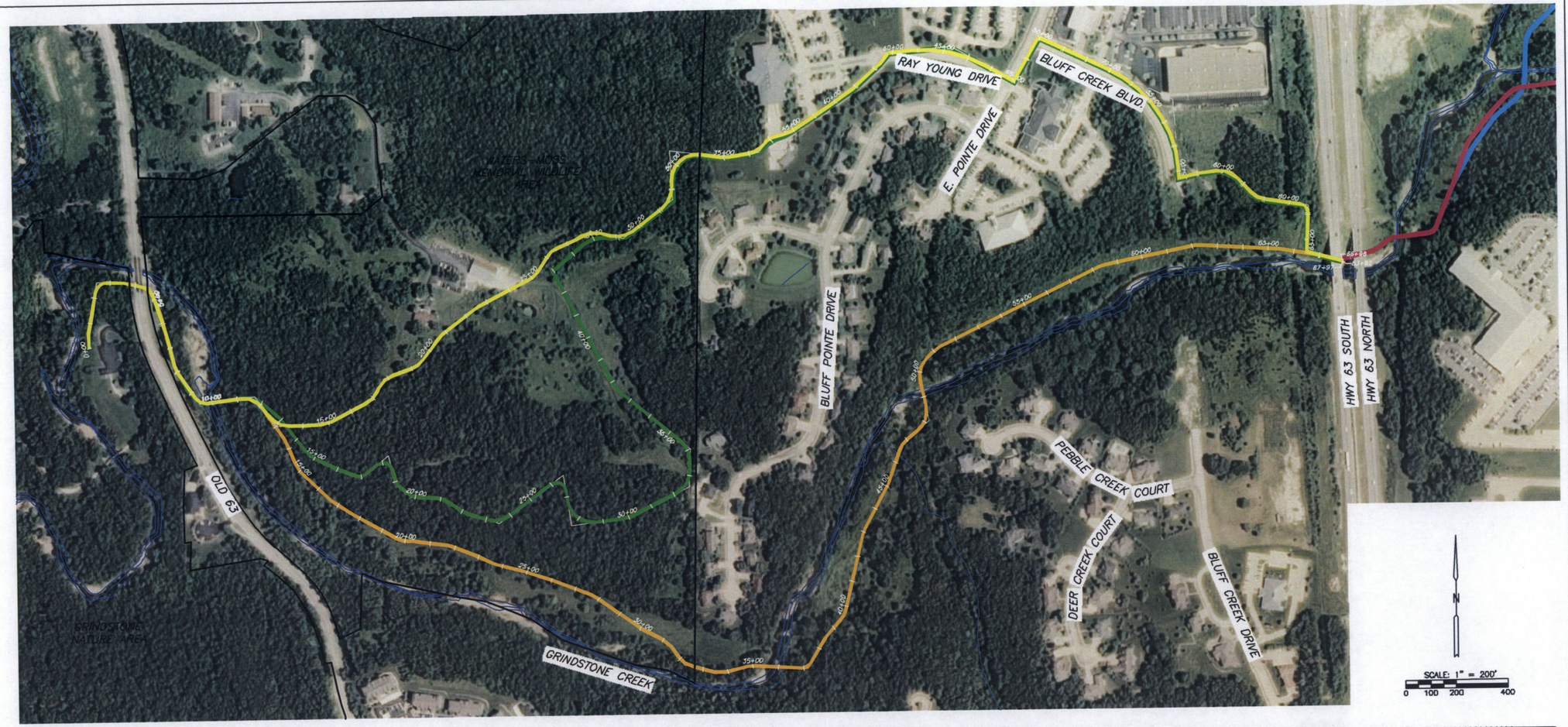
MISUSE OF THIS DRAWING IN ANY MANNER IS STRICTLY PROHIBITED WITHOUT THE WRITTEN APPROVAL OF ALLSTATE CONSULTANTS, LLC

DATE
11-29-11

JOB NUMBER
11112.02

SCALE
1"=500'

SHEET
1



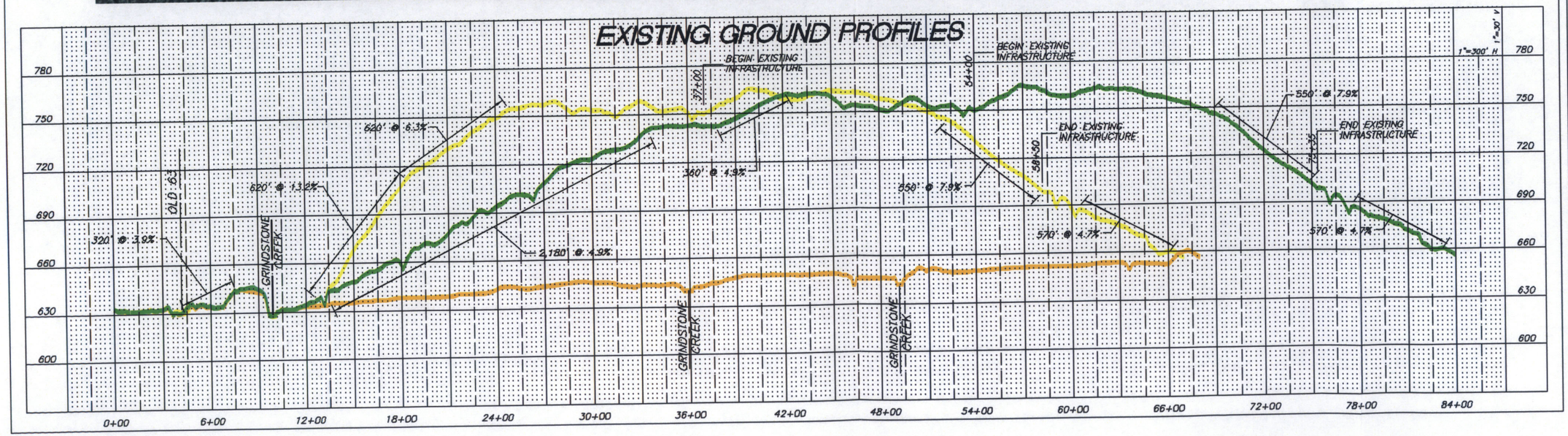


FIGURE 2
ALTERNATE TRAIL ALIGNMENT COMPARISON
WESTERN PORTION (ORANGE, YELLOW & GREEN) GRINDSTONE TRAIL
COLUMBIA, MO

REVISED:

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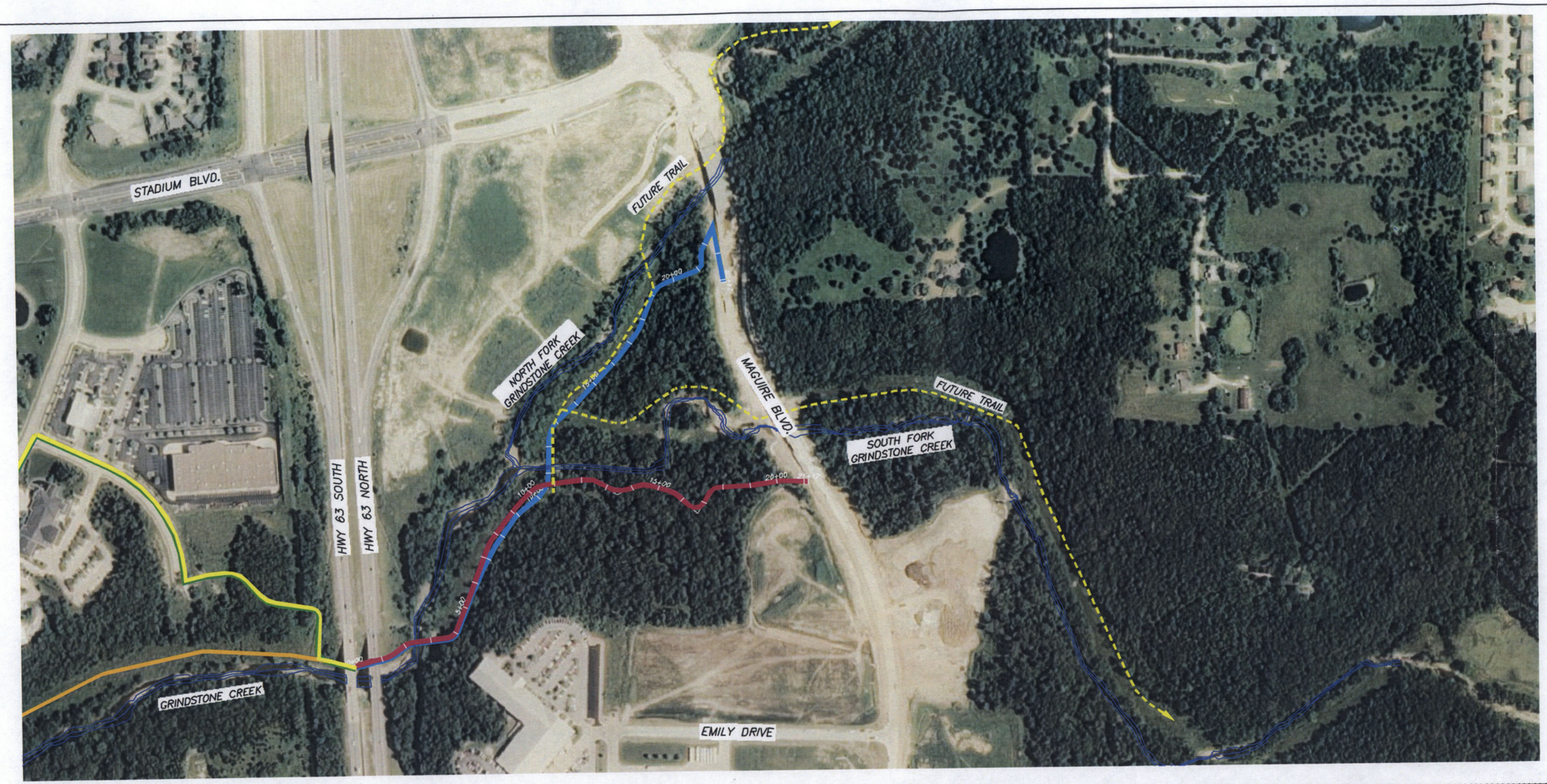
ALLSTATE CONSULTANTS
(573) 875-8799

DATE
11-29-11

JOB NUMBER
11112.02

SCALE
AS SHOWN

SHEET
2



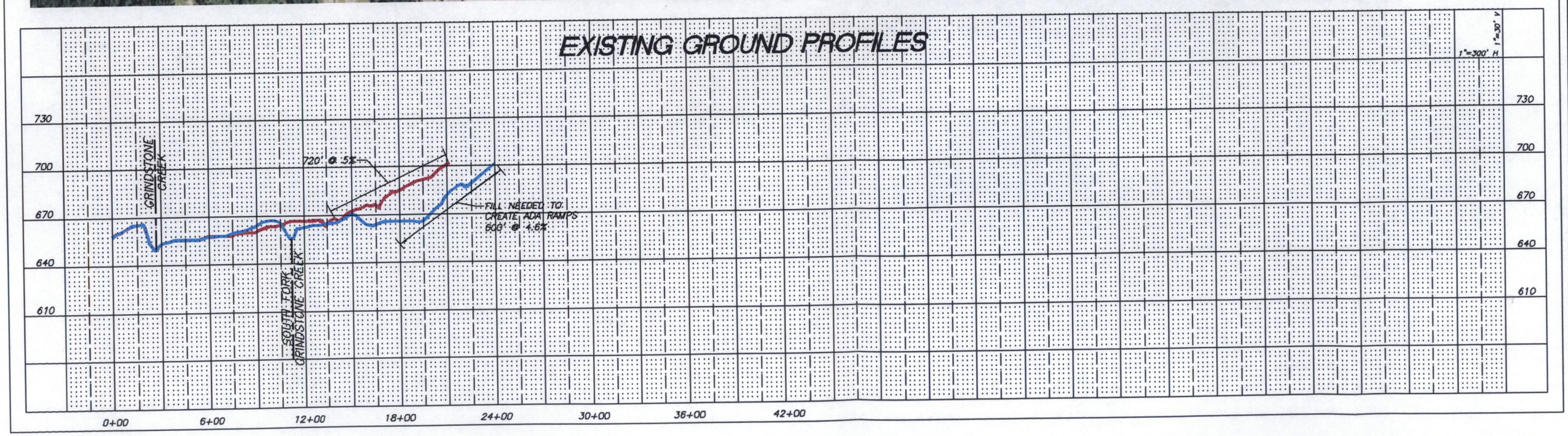


FIGURE 3
ALTERNATE TRAIL ALIGNMENT COMPARISON
EASTERN PORTION (BLUE AND VIOLET) GRINDSTONE TRAIL
COLUMBIA, MO

REVISED:

NOT FOR PRELIMINARY CONSTRUCTION

ALLSTATE CONSULTANTS
ENGINEERING SURVEYING
1901 CHOUTEAU AVENUE
P.O. BOX 104568
JEFFERSON CITY, MISSOURI 65110-4568
(573) 635-0799
(573) 635-2240 FAX
CIVIL STRUCTURAL ENVIRONMENTAL LAND DEVELOPMENT

USE OF THIS DRAWING IN ANY MANNER IS STRICTLY PROHIBITED WITHOUT THE WRITTEN APPROVAL OF ALLSTATE CONSULTANTS, LLC

DATE
11-29-11

JOB NUMBER
11112.02

SCALE
AS SHOWN

SHEET
3

P:\2011\11112.02\Drawings\Trail Alignment\PLOT\PLOT BASE.dwg, 2D PLAN, 11/29/2011 2:45:22 PM, hdrew

ORANGE ALIGNMENT
YELLOW ALIGNMENT
GREEN ALIGNMENT
BLUE ALIGNMNT
VIOLET ALIGNMENT

FUTURE TRAILS
EXISTING TRAILS IMPROVED SURFACE

ADDITIONAL SUBDIVISIONS TO THE EAST INCLUDING SUNRISE ESTATES, EASTPORT VILLAGE, EL CHAPARRAL, THE WOODLANDS AND OLD HAWTHORNE

SHEPARD BLVD. AREA

CROSS CREEK

NORTH FORK GRINDSTONE CREEK

SOUTH FORK GRINDSTONE CREEK

NW OLD 63 APARTMENTS

STADIUM BLVD

EAST POINTE OFFICES

WATERS–MOSS MEMORIAL WILDLIFE AREA

EAST POINTE

GRINDSTONE NATURE AREA

MCGUIRE BLVD

GRINDSTONE CREEK

BLUFF CREEK

HIGHWAY 63

CONCORDE INDUSTRIAL PARK

SE OLD 63 APARTMENTS

OLD 63

SW OLD 63 APARTMENTS

BLUFF CREEK OFFICES

WOODSTOCK

GRINDSTONE PARKWAY

NEW HAVEN RD

N

SCALE: 1" = 1000'

0 500 1000 2000

FIGURE 4
POPULATIONS AFFECTED
GRINDSTONE TRAIL PROJECT
COLUMBIA, MISSOURI

REVISED:

NOT FOR PRELIMINARY CONSTRUCTION

ALLSTATE CONSULTANTS
(573) 875-8799

DATE
11-28-11

JOB NUMBER
11112.03

SCALE
1"=1000'

SHEET
4

Table 4A. Impacts on adjacent property (See Figure 4.)	
Population	**Comments**
Residents of East Pointe	Describe any significant impacts due to proximity to the alignment for the East Point subdivision that aren't detailed below.
Residents of Bluff Creek	Describe any significant impacts due to proximity to the alignment for the Bluff Creek Estates subdivision that aren't detailed below.
Employees of businesses in East Pointe area	Describe any significant impacts due to proximity to the alignment for the businesses in the East Pointe area that aren't detailed below. (MFA, etc)
Property Value Impacts	List the number of properties for which property values would be reasonably expected to be directly affected by the project. The City of Columbia's preliminary presentation on this trail describes several studies indicating that property values increase. Residents of the East Point subdivision report discussions with prospective buyers indicating a reduction in property values.
Number of properties requiring permanent easements/takings	The estimated number of properties from which easements or R/W takings will be required.
Littering	A description of the anticipated changes in litter distribution due to the trail.
Trespass	A description of any anticipated issues with trespass due to people cutting across private property to access the trail.
Summary	A summary of the most significant impacts in this table.

Table 4B. Impacts on adjacent property (Western Trail Alternatives)			
Population	**Alignment**		
	Orange	**Yellow**	**Green**
Residents of East Pointe	If connector trails are provided into East Pointe Subdivision there will be indirect property value impacts to the entire subdivision due to trail access.	There will be indirect property value impacts to the entire subdivision due to trail access.	There will be indirect property value impacts to the entire subdivision due to trail access.
Residents of Bluff Creek	If connector trails are provided into Bluff Creek Estates Subdivision there will be indirect property value impacts to the entire subdivision due to trail access.	No impacts anticipated because the trail will be on the far side of Grindstone Creek with no potential for connection to the neighborhood unless an additional bridge is built.	No impacts anticipated because the trail will be on the far side of Grindstone Creek with no potential for connection to the neighborhood unless an additional bridge is built.
Employees of businesses in East Pointe area	If connector trails are provided into East Pointe Subdivision there will be indirect access to the trail for recreation and commuting.	Will have excellent access to the trail for recreation and commuting.	Will have excellent access to the trail for recreation and commuting.
Property Value Impacts	There will be direct property value impacts to two residential lots.	It will pass through four to five commercial lots. It may provide a benefit to businesses in some cases while limiting future flexibility in others. It will also pass directly behind 5 residential lots that back to Ray Young drive, although they are somewhat shielded by existing terrain.	The trail will come close to and overlook two residential lots, possibly affecting their value. It will pass through four to five commercial lot. It may provide a benefit to businesses in some cases while limiting future flexibility in others. It will also pass directly behind 5 residential lots that back to Ray Young drive, although they are somewhat shielded by existing terrain.

Table 4B. Impacts on adjacent property (Western Trail Alternatives)			
Population	**Alignment**		
	Orange	**Yellow**	**Green**
Number of properties requiring permanent easements/takings	Easements will be needed through two residential lots and four subdivision common areas.	Easements will be needed through four or five commercial properties. An easement will be needed through the Bluff Creek Estates common area.	Easements will be needed through four or five commercial properties. An easement will be needed through the Bluff Creek Estates common area.
Littering	The trail will run directly through two residential lots and may result in additional litter on them.	The trail will run through commercial areas and behind 5 residential lots that back to Ray Young Drive and may result in additional litter on them.	The trail will run through commercial areas and behind 5 residential lots that back to Ray Young Drive and may result in additional litter on them.
Trespass	Travelers are very likely to be tempted to access the trail by traveling down Bluff Pointe Drive and cutting through residential lots. This route will increase the likelihood of trespass by people wishing to access the Creek due to its proximity to the trail.	Travelers may be tempted to access the trail by cutting through the lots on the north side of Bluff Pointe and Kay Pointe drives. The trail will pass through MFA property limiting their options to restrict access along the south edge of their property.	Travelers may be tempted to access the trail by cutting through the lots on the north side of Bluff Pointe and Kay Pointe drives. The trail will pass through MFA property limiting their options to restrict access along the south edge of their property.
Summary	This route clearly has a higher level of direct impacts on individual residential lots.	This route has impacts on more properties, but the impacts may be significantly less intrusive.	This route has impacts on more properties, but the impacts may be significantly less intrusive.

Table 4C. Impacts on adjacent property (Eastern Trail Alternatives)		
Population	**Alignment**	
	Blue	**Violet**
Residents of East Pointe	No significant difference.	No significant difference.
Residents of Bluff Creek	No significant difference.	No significant difference.
Employees of businesses in East Pointe area	No significant difference.	No significant difference.
Property Value Impacts	No significant difference.	No significant difference.
Number of properties requiring permanent easements/takings	No significant difference.	No significant difference.
Littering	No significant difference.	No significant difference.
Trespass	No significant difference.	No significant difference.
Summary	No significant difference.	No significant difference.

Table 5A. Impacts on Specific Destinations	
Destination	**Comments**
Grindstone Creek	Describe the impacts of each alignment on persons wishing to access Grindstone Creek which could contribute to meeting the following needs from the 2010 Parks and Recreation Needs Assessment Survey; nature trails.
Waters Moss Area	Describe the impacts of each alignment on persons wishing to access or use the Waters Moss Area which could contribute to meeting the following needs from the 2010 Parks and Recreation Needs Assessment Survey; walking and biking trails, park shelters and picnic areas, nature trails, indoor shelters/meeting space, mountain bike trails.
Grindstone Nature Area and the current eastern termini of major trail system	Describe the impacts of each alignment to persons wishing to access or use Grindstone Nature Area and the current eastern termini of the major trail system which currently provides for the following needs from the 2010 Parks and Recreation Needs Assessment Survey; walking and biking trails, park shelters and picnic areas, nature trails. This area also provides access to central Columbia via the Hinkson Creek and MKT trails.
Summary	A summary of the most significant impacts in this table.

Table 5B. Impacts on Specific Destinations (Western Trail Alternatives)			
Destination	**Alignment**		
	Orange	**Yellow**	**Green**
Grindstone Creek	This route will provide the most direct access to the portion of Grindstone Creek in the Waters Moss area. The trail project will not purchase easements to provide any other legal creek access points.	This route will provide direct access to Grindstone Creek in the western portion of the Waters Moss area.	This route will provide direct access to Grindstone Creek in the western portion of the Waters Moss area.

Table 5B. Impacts on Specific Destinations (Western Trail Alternatives)			
Destination	**Alignment**		
	Orange	**Yellow**	**Green**
Waters Moss Area	Access to Waters Moss will be from the creek bottoms. Connections to existing primitive trails exist allowing hikers to access the Waters Moss House. Improved trails will be needed if all weather all user access to the Waters Moss House from the Grindstone Trail is deemed necessary. This alignment will have the smallest direct impact on future uses of the area.	The trail will pass through both the upper and lower portions of Waters Moss providing excellent access for all trail travelers. The trail will pass through the middle of the area and will create more constraints on what may be done with the area in the future. For example, it may limit the area's use as a nature preserve.	The trail will pass through both the upper and lower portions of Waters Moss providing excellent access for all trail travelers. The trail will pass through the middle of the area and will create more constraints on what may be done with the area in the future. For example, it may limit the area's use as a nature preserve.
Grindstone Nature Area and the current eastern termini of major trail system	Would provide the easiest access to Grindstone Nature area for those traveling from the East.	Would provide access to Grindstone Nature area for those traveling from the East.	Would provide access to Grindstone Nature area for those traveling from the East.
Summary	The significance of these impacts is highly user dependent and it is difficult to select a most significant impact.	The significance of these impacts is highly user dependent and it is difficult to select a most significant impact.	The significance of these impacts is highly user dependent and it is difficult to select a most significant impact.

Table 5C. Impacts on Specific Destinations (Eastern Trail Alternatives)		
Destination	**Alignment**	
	Blue	**Violet**
Grindstone Creek	The trail project will not purchase easements to provide any legal creek access points along this alignment. However, this route will provide an easy route to both sides of the South Fork and the South side of the North Fork should such easements be granted.	The trail project will not purchase easements to provide any legal creek access points along this alignment.
Waters Moss Area	No significant difference.	No significant difference.
Grindstone Nature Area	No significant difference.	No significant difference.
Summary	No significant difference.	No significant difference.

Table 6A Populations that may use the Trail (see figure 4)	
Population	**Comments**
NW Old 63 Apartments	Descriptions of the anticipated impacts on the estimated 179 residents of the apartments near the trail to the NW, including Ashland Manor. The 2010 census indicates that approximately 179 people reside in this area which is bounded by Old 63, Stadium and the Grindstone and Hinkson Creeks.
Shepard Blvd. Area	Descriptions of the anticipated impacts on the estimated 904 residents in the Shepard Blvd area who could access some of the proposed alignments by crossing Stadium and traveling down local streets in the East Point area to access the trail. This includes multiple subdivisions along Audubon Dr. and Shepard Blvd. The 2010 census indicates that approximately 904 people reside in this area.
East Pointe	The anticipated impacts on the estimated 126 residents in the East Pointe subdivision as related to their use of the trail.
East Pointe Offices	The anticipated impacts on employees and clients of the East Pointe offices area, which includes MFA and the other businesses along East Pointe Drive

Table 6A Populations that may use the Trail (see figure 4)	
Population	**Comments**
Cross Creek	Anticipated impacts on the employees and clients of future businesses in the Cross Creek business district which includes the area along both sides of Stadium Blvd to the East of Hwy 63.
Bluff Creek	The anticipated impacts on the estimated 516 residents in the Bluff Creek Estates subdivision as related to their use of the trail.
Bluff Creek Office	The anticipated impacts on employees and clients of the Bluff Creek business area, which includes the businesses along Bluff Creek Drive
SE Old 63 Apartments	The anticipated impacts on approximately 1,210 residents of apartments to the South of Grindstone Creek and East of Old 63 including Campus Lodge and the Reserve at Columbia as related to their use of the trail.
SW Old 63 Apartments	The anticipated impacts on approximately 776 residents of apartments to the South of Grindstone Creek and West of Old 63 including Copper Beech and Grindstone Canyon as related to their use of the trail.
Concorde Industrial	The anticipated impacts on the estimated 3,000 employees of the Concorde Industrial area, which includes the businesses along Maguire and LeMone Industrial Blvd. to the South of Grindstone Creek.
Woodstock	The anticipated impacts on approximately 327 residents of the Woodstock Subdivision which is North of New Haven Road and West of S. Warren Dr.
Subdivisions to the east along future north and south fork trails	The anticipated impacts on the approximately 5000 residents to the east that could use the Grindstone Trail once the trail is extended further east. With the proposed Stadium extension project, this area is expected to experience growth and the number of residents could grow considerably.
Summary	A summary of the most significant impacts in this table.

Estimated residential populations are from the 2010 census.

Table 6B. Impacts Of Various Alignments On Populations that may use the Trail (Western Trail Alternatives)			
Population	**Alignment**		
	Orange	**Yellow**	**Green**
NW Old 63 Apartments (res pop=179)	Only direct access to trail would be via Grindstone Nature Area	Would have the option to access the trail via Grindstone Nature area or via Hillcrest Drive.	Would have the option to access the trail via Grindstone Nature area or via Hillcrest Drive.
Shepard Blvd. Area (res pop=904)	Unless a connector trail is constructed through the East Pointe subdivision (the cost of which is not included in this cost estimate) the only accesses would be via Shepard Blvd to Old 63 or via Stadium to Old 63 to Grindstone Nature Area or via Stadium to Maguire.	Would have the same options as the Orange alignment plus the option to access the trail by crossing Stadium to East Pointe Drive.	Would have the same options as the Orange alignment plus the option to access the trail by crossing Stadium to East Pointe Drive.
East Pointe (res pop=126)	Unless a connector trail is constructed (the cost of which is not included in this cost estimate) access would be via Stadium to Old 63 to Grindstone Nature Area or via Stadium to Maguire or via the unimproved non-accessible walking trails through Waters Moss which would be accessed via Kays Pointe Dr.	Would have direct access to the trail.	Would have direct access to the trail.

Table 6B. Impacts Of Various Alignments On Populations that may use the Trail (Western Trail Alternatives)			
Population	**Alignment**		
	Orange	**Yellow**	**Green**
East Point Office (res pop=0)	Unless a connector trail is constructed through the East Pointe subdivision (the cost of which is not included in this cost estimate), this alignment wouldn't improve recreational (e.g. lunch break) or commuter routes for these employees.	This alignment would provide direct access for recreational (e.g. lunch break) or commuter use by these employees.	This alignment would provide direct access for recreational (e.g. lunch break) or commuter use by these employees.
Cross Creek (res pop=0)	Would provide the most efficient and safest commute for those accessing trail via Maguire.		
Bluff Creek (res pop=516)	Would allow for a possible future connector trail for direct access to the trail.	No potential for a direct access. Access would be via Grindstone Parkway to Old 63 to Grindstone Nature area or via Grindstone Parkway to Maguire.	No potential for a direct access. Access would be via Grindstone Parkway to Old 63 to Grindstone Nature area or via Grindstone Parkway to Maguire.
Bluff Creek Office (res=0)	Unless a connector trail is added for Bluff Creek Estates there is no significant difference.	No difference in access.	No difference in access.
SE Old 63 Apartments (res pop=1,210)	No significant difference. Access would be via Old 63 to Grindstone Nature Area.	No significant difference. Access would be via Old 63 to Grindstone Nature Area.	No significant difference. Access would be via Old 63 to Grindstone Nature Area.
SW Old 63 Apartments (res pop=776)	No significant difference. Access would be via Old 63 to Grindstone Nature Area.	No significant difference. Access would be via Old 63 to Grindstone Nature Area.	No significant difference. Access would be via Old 63 to Grindstone Nature Area.

Table 6B. Impacts Of Various Alignments On Populations that may use the Trail (Western Trail Alternatives)			
Population	**Alignment**		
	Orange	**Yellow**	**Green**
Concorde Industrial (estimated labor force=3,000)	Would provide the most efficient and safest commute.		
Woodstock (res pop=327)	Would provide the most efficient and safest commute.		
Subdivisions to the east along future north and south fork trails (current res pop=5,000)	Would provide the most efficient and safest commute.		
Summary	This would be the most efficient route for the ~3,000 people working in Concorde Industrial and the Bluff Creek and Woodstock Residential areas (~840 residential population) as well as more than 5,000 people to the East when the trails are extended.	This would significantly improve access for the residents of East Pointe Residential (126 people) and Business areas. Would also add a significantly different option for access for the 904 people in the Shepard Blvd. area.	This would significantly improve access for the residents of East Pointe Residential (126 people) and Business areas. Would also add a significantly different option for access for the 904 people in the Shepard Blvd. area.

Table 6C. Impacts Of Various Alignments On Populations that may use the Trail (Eastern Trail Alternatives)		
Population	**Alignment**	
	Blue	**Violet**
NW Old 63 Apartments (res pop=179)	No Significant Difference	No Significant Difference
Shepard Blvd. Area (res pop=904)	No Significant Difference	No Significant Difference
East Point (res pop=126)	No Significant Difference	No Significant Difference
East Point Office (res pop=0)	No Significant Difference	No Significant Difference
Cross Creek (res pop=0)	Would be a little closer which may impact recreational use slightly.	
Bluff Creek (res pop=516)	No Significant Difference	No Significant Difference
Bluff Creek Office (res=0)	No Significant Difference	No Significant Difference
SE Old 63 Apartments (res pop=1,210)	No Significant Difference	No Significant Difference
SW Old 63 Apartments (res pop=776)	No Significant Difference	No Significant Difference
Concorde Industrial (estimated labor force=3,000)		Would be a little closer which may impact recreational use slightly.
Woodstock (res pop=327)		Would be a little closer which may impact recreational use slightly.
Subdivisions to the east along future north and south fork trails	Would reduce the cost of a future project to connect these populations, but there isn't any apparent difference to their trail usage in the full build out.	
Summary	No significant difference	No significant difference

Table 7A. Terrain Comparison	
Measure	**Comments**
Length (ft)	Total Length of the Trail in feet
Length (mi)	Total Length of the Trail in miles
Starting Elevation (ft)	Existing elevation above mean sea level at the west end of the segment
Ending Elevation (ft)	Existing elevation above mean sea level at the east end of the segment
Average slope measured over 100' increments (%)	The average slope of the trail segment measured by breaking the trail into 100' segments and averaging the slope over all of the segments. This is a measure of how hilly the alignment is.
Total Elevation Gain (ft)	The total elevation gain measured in the west to east direction by adding the absolute value of the increase in elevation over each 100' long segment. This is an estimator of how hilly the trail is.
Total Elevation Loss (ft)	The total elevation loss measured in the west to east direction by adding the absolute value of the decrease in elevation over each 100' long segment. This is an estimator of how hilly the trail is.
Length and slope of longest extended hills	The length and average slope of the longest hills that would need to be traversed along each alignment.
Average cross slope measured over 10' increments – X:1 (%)	The average cross slope of the existing ground measured over the distance from 5' left of centerline to 5' right of centerline. This is an estimator of how difficult it will be to construct the trail. X refers to the horizontal distance that must be traversed to change elevation by 1 ft. So a 4:1 slope is steeper than a 5:1 slope. This measurement includes only the areas of the trail that won't use existing infrastructure. Slope is also reported as a percentage.
Steepest cross slope – X:1 (%)	This is the maximum cross slope encountered along each alignment. It represents the worst cross slope conditions that will be encountered along each alignment. This measurement includes only the areas of the trail that won't use existing infrastructure.
Estimated length of Retaining Wall (ft)	This is the length of trail for which the cross slope exceeds 4:1. For the purposes of this alternatives comparison, it is assumed that any areas with slopes steeper than 4:1 will need retaining walls. Without retaining walls on areas with steep cross slopes, the width of area impacted for construction becomes larger as the shallower slopes needed for slope stability take a longer distance to tie into the existing grade.
Estimated area of Retaining Wall (ft^2)	This is an estimate of the total face area of retaining wall needed assuming retaining walls are used where cross slope exceeds 4:1. This measure is used in the cost analysis. This measurement includes only the areas of the trail that won't use existing infrastructure.

Table 7A. Terrain Comparison	
Measure	**Comments**
Estimated Area of Disturbance (Ac)	This is the estimated area of temporary disturbed area required for each alignment. All vegetation in this area is expected to be disturbed by construction. On steeper cross slopes, this area becomes wider unless retaining walls are used. For cross slopes exceeding 4:1 retaining walls are assumed and this width is set at 35 ft. This measurement includes only the areas of the trail that won't use existing infrastructure. This estimate tends to under predict disturbance for hilly areas because it assumes that the trail will follow exactly along existing grade.
Estimated Disturbance in Forested Areas (Ac)	This is the estimated area of temporary disturbed area required for each alignment that appears to be densely forested. All trees in this area are expected to be disturbed by construction. On steeper cross slopes, this area becomes wider unless retaining walls are used. For cross slopes exceeding 4:1 retaining walls are assumed and this width is set at 35 ft. This measurement includes only the areas of the trail that won't use existing infrastructure. This estimate tends to under predict disturbance for hilly areas because it assumes that the trail will follow exactly along existing grade.
Length of Trail in Stream Buffers (ft)	Length of alignment that is in the inner and outer stream buffer zones. All of the major streams (Grindstone and its two forks) are Type 1 streams with 100' base buffer zones. Steep slopes are common in this area so much of the outer buffer is widened to 150' as per the buffer ordinance. The one minor unnamed stream that enters Grindstone Creek from the Bluff Creek subdivision is a Type 2 stream with 50' base buffer zones. This measure is related to the vegetative impacts, the stream impacts and the endangered species.
Length of Trail in the Floodplain (ft)	This is the length of trail for the entire alignment that is inside the 100 year floodplain as determined by using FEMA Base Flood Elevations, but the more accurate County 2' contours. This is measured as an indicator of the length of trail that would be subject to deposition of debris and sediment.
Length of Trail in the Floodway (ft)	This is the length of trail for the entire alignment that is inside the FEMA Floodway as determined by using FEMA floodway widths, but the more accurate County 2' contours to align the width with the channel and expected high velocity flow areas. This is measured as an indicator of the length of trail that would be potentially subject to scour damage. This measure includes some areas that aren't actually likely to experience scour because the trail would be at existing ground level where the scour isn't currently occurring.
Number of Small Stream Crossings	This is a count of the number of small streams that will be impacted (and moderate to large culverts needed). This measurement includes only the areas of the trail that won't use existing infrastructure. It includes only streams with drainage area of at least 5 acres.
Number of Large Stream Crossings	This will equate to the number of bridges needed over Grindstone Creek and the North and South Forks of Grindstone Creek.

Table 7A. Terrain Comparison	
Measure	**Comments**
Estimated Total Length of Bridge Needed (ft)	This is the estimated total length of all major bridges required. This includes the length to span the floodway and the length needed for fill slopes.
Length of Trail in NWI Areas	This measures the length of trail centerline that passes through areas in the National Wetlands Inventory (NWI). This is measured as a comparative estimator of the difficulty that will be experienced in avoiding and minimizing impacts to wetlands. The NWI typically over-predicts the presence of wetland areas and is often inaccurate, so no attempt was made to avoid NWI areas in laying out preliminary alignments for alternatives. The selected alignment will be modified to minimize impacts on actual wetlands once the location and jurisdictionality of those wetlands are determined, so **this predictor is expected to greatly over-estimate the amount of wetland impact**. This measurement includes only the areas of the trail that won't use existing infrastructure.
Length of Trail Along Existing Sidewalks (ft)	The length of the alignment that is in already developed areas along already developed sidewalks that may require some level of modification.
Length of Trail Not Along Existing Sidewalks (ft)	This measurement includes only the areas of the trail that won't use existing sidewalks. It indicates how much of the trail is through existing apparently undisturbed areas.

Table 7B. Terrain Comparison (Western Trail Alternatives)			
	Alignment		
	Orange	**Yellow**	**Green**
Length (ft)	6,768	6,696	8,392
Length (mi)	1.28	1.27	1.59
Starting Elevation (ft)	633	633	633
Ending Elevation (ft)	656	656	656
Average slope measured over 100' increments (%)	1.7%	4.8%	4.0%

Table 7B. Terrain Comparison (Western Trail Alternatives)			
	Alignment		
	Orange	Yellow	Green
Total Elevation Gain (ft)	71	173	178
Total Elevation Loss (ft)	-44	-146	-151
Length and slope of longest extended hills	320'@3.9% slope	620'@13.2% adjacent to 620'@6.3% and 550'@7.9% adjacent to 570@4.7%	2,180'@4.9% and 550'@7.9% adjacent to 570@4.7%
Average cross slope measured over 10' increments- X:1 (%)	15.6 (6.4%)	9.0 (11.1%)	6.7 (14.9%)
Steepest cross slope X:1 (%)	1.7 (59%)	1.7 (59%)	1.7 (59%)
Estimated length of Retaining Wall (ft)	430	660	1,480
Estimated area of Retaining Wall (ft^2)	2,882	3,982	8,280
Estimated Area of Disturbance (Ac)	6.2	5.7	7.5
Estimated Disturbance in Forested Areas (Ac)	1.6	1.6	3.2
Length of Trail in Stream Buffers (ft)	1,330' in inner zone and 1,960' in outer zone	720' in inner zone and 437' in outer zone	720' in inner zone and 437' in outer zone
Length of Trail in the Floodplain (ft)	5,946	1,135	1,135
Length of Trail in the Floodway (ft)	1,169	0	0
Number of Small Stream Crossings	5	2	4
Number of Large Stream Crossings	3	1	1
Estimated Total Length of Bridge Needed (ft)	491	176	176
Length of Trail in NWI Areas	667	105	105

Table 7B. Terrain Comparison (Western Trail Alternatives)			
	Alignment		
	Orange	Yellow	Green
Length of Trail Along Existing Sidewalks (ft)	0	1630	1630
Length of Trail Not Along Existing Sidewalks (ft)	6770	5060	6760

Table 7C. Terrain Comparison (Eastern Trail Alternatives)		
	Alignment	
	Blue	Violet
Length (ft)	2,408	2,117
Length (mi)	0.46	0.40
Starting Elevation (ft)	658	658
Ending Elevation (ft)	704	702
Average slope measured over 100' increments (%)	4.0%	3.2%
Total Elevation Gain (ft)	67	55
Total Elevation Loss (ft)	-29	-12
Length and slope of longest extended hill	A series of two ADA compliant ramps at 8.2% (410' total length with rest interval)	720'@5%
Average cross slope measured over 10' increments– X:1 (%)	11.8 (8.5%)	6.9 (14.5%)

Table 7C. Terrain Comparison (Eastern Trail Alternatives)		
	Alignment	
	Blue	Violet
Steepest cross slope – X:1 (%)	2.0 (50%)	2.0 (50%)
Estimated length of Retaining Wall (ft)	160	450
Estimated area of Retaining Wall (ft^2)	1004	2202
Estimated Area of Disturbance (Ac)	2.3	2.2
Estimated Disturbance in Forested Areas (Ac)	0.6	1.3
Length of Trail in Stream Buffers (ft)	470' in inner zone and 910' in outer zone	665' in inner zone and 470' in outer zone
Length of Trail in the Floodplain (ft)	1683	876
Length of Trail in the Floodway (ft)	0	0
Number of Small Stream Crossings	0	2
Number of Large Stream Crossings	2	1
Estimated Total Length of Bridge Needed (ft)	285	160
Length of Trail in NWI Areas	1375	0
Length of Trail Along Existing Sidewalks (ft)	0	0
Length of Trail Not Along Existing Sidewalks (ft)	2408	2117

Table 8A. Public Safety Issues	
Measure	**Comment**
On trail safety issues	Qualitative descriptions of public safety issues that trail users may be exposed to in the on-trail environment. For example, the risk of collisions with other trail users, or obstacles adjacent to the trail.
Safety issues relative to existing infrastructure	Qualitative descriptions of public safety issues that trail users may be exposed to as they pass through portions of the trail that utilize existing infrastructure. For example, potential for collisions with automobiles.
Safety issues relative to area residents	Qualitative descriptions of public safety issues that residents in the areas surrounding the trail may be exposed to. For example, possible increase in burglary due to access provided by the trail or risks of collisions with trail users. Although it seems logical that an increase in crime may occur due to improved access, the City has cited multiple studies indicating that crime rates decrease near trails, presumably due to increased likelihood of witnesses. The risks to private property are highly speculative relative to all the other risks which are relatively well established.
Summary	A summary of the most significant impacts in this table considering likelihood and severity of threats.

Table 8B. Public Safety Issues (Western Trail Alternatives)			
Population	**Alignment**		
	Orange	**Yellow**	**Green**
On trail safety issues	Additional stream crossings may increase the risk of flood related incidents.	Excessively steep slopes would produce high levels of risk to mixed users due to increased speed differentials and to cyclists due to high speeds.	Steep cross slopes and retaining walls add risk of "run off the trail" accidents. Additional curves increase risk of collisions with other trail users.

Table 8B. Public Safety Issues (Western Trail Alternatives)			
Population	**Alignment**		
	Orange	**Yellow**	**Green**
Safety issues relative to existing infrastructure		6-8 driveway crossings and 2 street crossings add potential for collisions.	6-8 driveway crossings and 2 street crossings add potential for collisions.
Safety issues relative to area residents	New trail traffic through two residential back yards results in most direct risk of crime to area residents.	Additional traffic near five residences and multiple businesses results in some increased risk. However public access already exists in these locations.	Additional traffic near five residences and multiple businesses results in some increased risk. However public access already exists in these locations. The trail also would provide new access overlooking the back yards of two additional residences.
Summary	Flood risks should never be taken lightly, but are only present at certain times, which reduces their likelihood. The trail will be designed such that there will be no significant risk to users exercising good judgment.	This route is considered to have an unacceptable level of risk because of the high likelihood of severe collisions both due to excessive on-trail speeds and conflicts with automobile traffic.	Everyday risks to trail users may be at an acceptable level along this route but are clearly higher than for the Orange route.

Table 8C. Public Safety Issues (Eastern Trail Alternatives)		
	Alignment	
	Blue	**Violet**
On trail safety issues	The Blue trail would have ADA compliant ramps with sharp turns and 8% slopes, leading to an elevation in risk of collisions and "run of the trail" accidents. Additional stream crossing may increase the risk of flood related incidents.	Steep cross slopes and retaining walls add risk of "run off the trail" accidents. Additional curves increase risk of collisions with other trail users.
Safety issues relative to existing infrastructure	No significant difference.	No significant difference.
Safety issues relative to area residents	No significant difference.	No significant difference.
Summary	It is not clear which alignment is safer.	It is not clear which alignment is safer.

Table 9A. Environmental/Sustainability Issues (Qualitative Narrative)	
Impact	**Comments**
Area Initially Disturbed	This is the amount of virgin (or at least apparently virgin) ground that will be disturbed by each alignment. It does not include impacts in already developed areas because they are previously disturbed.
Utilization of existing infrastructure	A narrative discussion of the extent to which each alignment utilizes existing infrastructure to reduce project impacts.
Minimization of the size of the future system	A narrative discussion of the degree to which each alignment contributes to minimizing the size of the future complete build-out of the trail system.
Surface Water Impacts	A narrative discussion of the comparative impacts of each alignment on waters of the United States. These waters include jurisdictional streams and wetlands as well as other resources that may not be jurisdictional.
Vegetative Impacts	A narrative discussion of the comparative general impacts of each alignment on area vegetation.
Forested Area impacted (acres)	An estimate of the acreage of forested area that is included within each alignment.
Erosion Impacts	A narrative discussion of the comparative impacts of each alignment on erosion and transport of sediment.
Wildlife Corridor Impacts	A narrative discussion of the comparative impacts of each alignment on wildlife corridors.
Greenhouse gas production	A narrative discussion of the comparative impacts of each alignment on greenhouse gas production due to construction activities and reductions in automobile use due to increases in non-motorized transportation.
Human environment	A narrative discussion of the comparative impacts of each alignment on the humans that use the trail.
Endangered species impacts and conservation communities of concern	A narrative discussion of the comparative impacts of each alignment on endangered species and conservation communities. A Missouri Department of Conservation Heritage Review indicates that there is potential for impacts to Indiana Bats, Gray Bats and Karst Topography in this area. In general, removal of trees should occur in the winter and be minimized, especially within 100' of the stream. Disturbance near caves and between caves and the stream should be avoided. Confirmed karst areas should be avoided. No caves or karst are known to exist near any of these alignments.

Table 9A. Environmental/Sustainability Issues (Qualitative Narrative)	
Impact	**Comments**
Summary	A summary of the most significant impacts in this table.

Table 9B. Environmental/Sustainability Issues (Western Trail Alternatives)			
Impact	**Alignment**		
	Orange	**Yellow**	**Green**
Area Initially Disturbed		Smallest disturbed area	Largest disturbed area
Utilization of existing infrastructure	Does not make use of any existing infrastructure	Makes use of 2,100' of existing infrastructure (although modifications would be necessary)	Makes use of 2,100' of existing infrastructure (although modifications would be necessary)
Minimization of the size of the future system	This alternate adds the most immediate length to the overall system. It has the highest potential need for neighborhood connectors which would require additions to the system. If access from the trail to Waters Moss House becomes a priority, additions will be needed. If this access is to be ADA compliant it will need to be around 4000' long.	This alternate adds the least immediate length to the overall system. It will have less need for neighborhood connectors because it serves one neighborhood directly while providing no potential for an access route from another.	This alternate adds nearly as much length to the system as the Orange alignment does, plus adds pavement to widen some of the existing system. It will have less need for neighborhood connectors because it serves one neighborhood directly while providing no potential for an access route from another.
Surface Water Impacts	This alignment has the largest potential for wetland and stream impacts.		
Vegetative Impacts	This alignment impacts the largest riparian area.	This alignment impacts the smallest overall area.	This alignment impacts the largest overall area.

Table 9B. Environmental/Sustainability Issues (Western Trail Alternatives)			
Impact	**Alignment**		
	Orange	**Yellow**	**Green**
Forested Area impacted (acres)			This route is estimated to have twice the impacts on forested areas relative to the other two alignments.
Erosion Impacts	The trail will need to be protected against local scour in areas with high velocity flood flows. Otherwise, the erosion impacts are expected to be smallest on this alignment because of the relatively flat slopes.	This alignment would facilitate erosion problems as storm water follows the proposed alignment down the hill.	Erosion problems can be expected in areas with steep cross slopes.
Wildlife Corridor Impacts	This alignment parallels the stream and would cross any wildlife corridors that are used to connect the stream to the uplands.	This alignment would cross various upland wildlife corridors.	This alignment would cross various upland wildlife corridors.
Greenhouse gas production	This alignment is expected to encourage the highest rate of non-motorized commuting and would therefore result in the lowest level of greenhouse gas production in the long term.		This alignment is expected to require the highest level of earthmoving which would mean higher greenhouse gas production during construction.
Human environment	This alignment provides the least strenuous experience and quickest commute and would provide more easy opportunities for access to the creek. It also provides the least potential for conflict with vehicular traffic resulting in a less stressful experience, especially for parents with small children.	This alignment would provide the most intense exercise opportunities as well as potential for thrilling descents unprecedented in the Columbia trails system. May provide opportunities for scenic overlooks.	This alignment would provide opportunities for moderately intense exercise in the most shaded setting with the highest potential for scenic overlooks. Would provide users with exposure to the largest range of natural settings.

Table 9B. Environmental/Sustainability Issues (Western Trail Alternatives)			
Impact	**Alignment**		
	Orange	**Yellow**	**Green**
Endangered species impacts and conservation communities of concern	This alignment would impact the largest number of trees near the creek.		This alignment would impact the largest overall number of trees.
Summary		The Yellow alignment would have the smallest initial environmental impact, although maintenance, usage and safety issues may make it a less sustainable solution.	

Table 9C. Environmental/Sustainability Issues (Eastern Trail Alternatives)		
	Alignment	
	Blue	**Violet**
Area Initially Disturbed	No significant difference.	No significant difference.
Utilization of existing infrastructure	None	None
Minimization of the size of the future system	This alignment would minimize the future system by reducing the amount of trail that functions solely as a connector to Maguire Blvd.	
Surface Water Impacts	This alignment would have more potential wetland impacts, but these impacts will need to occur eventually to connect the trails to the east.	This alignment has more small stream crossings.
Vegetative Impacts	No significant difference.	No significant difference.

Table 9C. Environmental/Sustainability Issues (Eastern Trail Alternatives)		
	Alignment	
	Blue	**Violet**
Forested Area impacted (acres)		This alignment impacts about twice as much mature forest.
Erosion Impacts		This alignment has steeper cross slopes and is more likely to have erosion problems.
Wildlife Corridor Impacts	No significant difference.	No significant difference.
Greenhouse gas production	No significant difference.	No significant difference.
Human environment	No significant difference.	No significant difference.
Endangered species impacts and conservation communities of concern		Because this trail will impact twice as much forested area, it has a higher level of impact.
Summary	No clear difference.	No clear difference.

Table 10A. Maintenance Issues (Qualitative Narrative)	
	Comments
Flood Damage	A description of the degree to which each alignment is susceptible to damage from high velocity creek flow during flood events.
Sediment deposition	The degree to which each alignment is susceptible to sediment deposition during flood events.
Trail Erosion	Discussion of vulnerability to local erosion due to storm water runoff (other than flood damage described above)
Bridge maintenance	Maintenance issues relative to bridges.
Retaining wall maintenance	Maintenance issues relative to retaining walls.
Traveling surface maintenance	Maintenance issues relative to the traveling surface.
Summary	A summary of the most significant impacts in this table.

Table 10B. Maintenance Issues (Western Trail Alternatives)			
Population	**Alignment**		
	Orange	**Yellow**	**Green**
Flood Damage	This alignment has the highest potential for flood damage. However, the potential for damage is expected to be limited to areas around the bridge ends, which can be designed to withstand flood flows. In areas further from the bridge ends, the trail will be at existing ground level so no significant scour is expected.		

Table 10B. Maintenance Issues (Western Trail Alternatives)			
Population	**Alignment**		
	Orange	**Yellow**	**Green**
Sediment deposition	Because this alignment has much more length in the floodplain it is more susceptible to deposition of sediment in areas with backwater. This will require removal of sediment in some areas after large floods.		
Trail Erosion		This alignment has the highest potential for severe erosion along the trail because of the steep longitudinal slopes.	This alignment has the highest potential for moderate erosion because of the extensive length of trail with steep cross slopes.
Bridge maintenance	This alignment has almost 3 times the length of bridge as the other alignments so it will require additional bridge maintenance.		
Retaining wall maintenance			This alignment has more than three times the retaining wall as the Orange alignment so it will require more maintenance including repairs due to erosion and clogging of under drains.
Traveling surface maintenance	This alignment has the largest area of pavement to maintain, but maintenance will be easier due to the more moderate terrain.		This alignment has the steepest cross slopes which would lead to significant maintenance requirements to repair the trail surface due to slope movement.
Summary	It is not clear that any alignment has a significant advantage.	It is not clear that any alignment has a significant advantage.	It is not clear that any alignment has a significant advantage.

Table 10C. Maintenance Issues (Eastern Trail Alternatives)		
	Alignment	
	Blue	**Violet**
Flood Damage	This alignment has twice as many bridges, so the potential for damage at bridge ends is higher. However, the 2nd bridge will eventually be needed regardless.	
Sediment deposition	This alignment has twice as much length in the floodplain so it is more susceptible to sedimentation from large events. However, much of this trail will be needed in the future regardless.	
Trail Erosion		This alignment has steeper cross slopes and can be expected to have more local erosion problems.
Bridge maintenance	This alignment requires an additional bridge, which would be needed in the future regardless of alignment selection. In the interim, it would require additional bridge maintenance.	
Retaining wall maintenance		This alignment has more than twice the amount of retaining wall which would require maintenance such as erosion repairs and under drain cleaning.
Traveling surface maintenance	This alignment has slightly more area of pavement to maintain, but maintenance will be easier due to the more moderate terrain.	This alignment has the steepest cross slopes which would lead to significant maintenance requirements to repair the trail surface due to slope movement. It would also result in a larger overall system, thus increasing long term maintenance.
Summary	It is not clear that any alignment has a significant advantage.	It is not clear that any alignment has a significant advantage.

Table 11A Cost Comparison Items	
Item	**Comments**
Commentary	General comments about the cost or the cost estimates of each alignment
Constructability Issues	A narrative description of the constructability issues that are expected with each alignment.
Concrete Trail	The estimated cost of concrete trail calculated on a per foot of length basis using historical costs from the County House and Hominy Trail projects.
Bridges	The estimated costs of all bridges over the Grindstone Creek and its North and South forks. Smaller culvert costs are assumed to be included within the other costs categories. Bridge costs are estimated assuming a 10' wide traveling surface on the bridge and a unit cost of $100 per square foot of bridge deck.
Stream Protection at major Crossings	This estimates the costs of providing stabilization of the stream as needed at major stream crossings.
Retaining Walls	The estimated cost of all retaining walls estimated based on an assumption that retaining walls will be required in areas where the cross slope is steeper than 4:1.
Modifications to Existing Infrastructure	The estimated cost to run the trail through existing developed areas. This cost assumes that 10' sidewalks will be built adjacent to the road. No adjustment was made for any existing sidewalks because it is likely that they will need to be removed/replaced to facilitate construction. Costs from the County House Trail were increased by a factor of 25% to provide a 10' trail width to match the width provided by the other alternatives. This does not include typical modifications where the ends of trails connect to existing infrastructure. Such costs are included in the trail cost.
Grading Factor	This is a multiplier that quantifies the relative expense of completing the grading for trail. A factor of 1 is applied for alignments through terrain similar to that of the County House Trail. For more difficult terrains this factor is increased based on engineering judgment to account for the added cost that comes with increased difficulty due to such issues as poor access, larger quantities of earth that must be moved further distances, narrow working area, steep cross slopes, existing obstacles (utilities, driveways), etc. The estimated grading costs per foot of trail are multiplied by this factor.
Grading	This estimates the comparative differences in costs for grading including estimates of the amount of earth that will need to be moved and whether it needs to be moved to the other side of the trail or to some other location. This estimate will under-predict the costs of grading on steep terrains, because it doesn't include earthwork necessary to level out the path longitudinally. Each individual section of trail is estimated using an assumption that the trail will be ideally located at the existing ground level. On hilly terrain, the trail will cross valleys and ridges which will require raising or lowering the trail above or below existing grade. On level ground, the need to fill valleys and cut ridges is minimized.

Table 11A Cost Comparison Items	
Item	**Comments**
Right of Way costs	The estimate of right of way costs is highly speculative, but is based on a base rate per acre for permanent easements and half of that rate per acre for temporary easements to make sure that the comparative cost estimates included some differential based on right of way. Easement areas were calculated assuming that 20' permanent easements would be needed in previously undeveloped areas and 10' permanent easements would be needed in areas with existing sidewalks. Temporary easement areas in previously undeveloped areas were calculated based on cross slope and temporary construction easement areas in previously developed areas were assumed to be 10' wide.
Other (25%)	Because these estimates are not based on detailed plans, there remain numerous items which haven't been estimated. For example, storm sewers, signage, seeding, etc. Such items accounted for approximately 25% of the project costs for the previous trail projects.
Total	The estimated comparative cost for the alignment.

Table 11B Cost Comparison (Western Trail Alternatives)			
	Alignment		
Item	**Orange**	**Yellow**	**Green**
Commentary	This estimate assumes all bridges will span the floodway. However it is likely that the second bridge will be a low water bridge to minimize impacts on neighbors.		The grading factor for this alignment is highly speculative and could be considerably higher.

Table 11B Cost Comparison (Western Trail Alternatives)			
Item	Alignment		
	Orange	Yellow	Green
Constructability Issues			This alignment will be the most difficult to construct due to the length of trail with steep cross slopes. Such areas will make it difficult to stage construction due to the lack of space to work. This terrain also makes this alignment the least predictable with regards to installation and maintenance costs.
Concrete Trail	$377,000	$263,000	$365,000
Bridges	$491,000	$176,000	$176,000
Stream Protection at major Crossings	$36,000	$12,000	$12,000
Retaining Walls	$89,000	$123,000	$248,000
Modifications to Existing Infrastructure	$0	$88,000	$88,000
Grading Factor	1	2	2
Grading	$119,000	$248,000	$312,000
Right of Way costs	$47,000	$30,000	$30,000
Other (25%)	$278,000	$227,000	$300,000
Total	$1,437,000	$1,167,000	$1,531,000

Table 11C Cost Comparison (Eastern Trail Alternatives)		
	Alignment	
Item	**Blue**	**Violet**
Commentary		The grading factor for this alignment is highly speculative and could be considerably higher.
Constructability Issues		This alignment will be the most difficult to construct due to the length of trail with steep cross slopes. Such areas will make it difficult to stage construction due to the lack of space to work. This terrain also makes this alignment the least predictable with regards to installation and maintenance costs.
Concrete Trail	$127,000	$117,000
Bridges	$285,000	$160,000
Stream Protection at major Crossings	$24,000	$12,000
Retaining Walls	$31,000	$68,000
Modifications to Existing Infrastructure	$0	$0
Grading Factor	1.5	2
Grading	$61,000	$74,000
Right of Way costs	$27,000	$28,000
Other (25%)	$132,000	$108,000
Total	$687,000	$567,000

Recommendations.

The five purpose and need statements developed earlier in this report have been used to guide us in evaluating the alignments and weighting the degree to which the various metrics affect our recommendations, so they are repeated here along with discussion of how they inform our recommendation.

PN1. The project must result in a safe and useable facility for the full range of users.

a. The safety issues reported in Table 8 have been compared in light of their expected likelihood and severity. In other words, safety concerns that indicate the potential for fatalities have more weight than concerns that are less severe, and concerns that are highly likely to occur have more weight than concerns that are less likely.

b. It is our opinion that the Orange alignment provides a considerably safer alignment for trail users than the Green alignment because of the lower number of sharp turns and adjacent drop offs. It is also less prone to excessive speed on the part of cyclists traveling downhill and has much less potential for collisions with motorized vehicles. However, the Green alignment is expected to be considerably safer than the Yellow alignment which we do not feel would have an acceptable level of safety. The excessive slopes on the Yellow alignment would result in too great a risk. The Green alignment would require long lengths of relatively steep slopes and a few curves that don't meet the general radius standard and which would have to be signed for lower speeds.

c. The Orange alignment has significantly less total elevation change and so, would be more accessible to a fuller range of users than the Green or Yellow alignments.

d. The Blue alignment has a slight advantage in safety over the Violet alignment because it has a shorter distance with steep cross slopes, but the Violet alignment would have an advantage in that there would be less sharp corners and ramps exceeding 5% longitudinal slope. So, it is unclear whether the Blue or Violet alignment has a safety advantage.

e. The difference in accessibility of the Blue and Violet alignments for the range of users is not significant.

PN2. The project must encourage non-motorized transportation through an efficient connection between the residences and business along the Grindstone Creek corridor and central Columbia.

a. The terrain issues described in Table 7 are expected to have a significant impact on the degree to which the proposed trail encourages additional non-motorized transportation. As evidenced by the Columbia Non-Motorized Pilot Program Consumer Awareness and Attitude Research alternative transportation utilization is strongly linked to safety, travel time and the level of physical effort required. The Orange alignment will clearly provide the quickest and least physically demanding transportation route and it is our opinion that it is also the safest route..

b. The impacts on potential users described in Table 6 also have bearing on this need. The Orange alignment has an advantage for the large numbers of people that could use the trail to provide a safe route into central Columbia. This is especially true in light of the large population that will eventually be connected when the trails extend further east.

c. It is our opinion that more people will choose to commute on the alignment that will provide them with the easiest, safest and most direct access from their beginning and ending points.

d. It is not clear that there is a transportation related advantage to selecting either the Blue or Violet alignment.

PN3. The project must provide opportunities for recreation that encourage increased recreational use through a variety of activities including nature watching, biking and walking.

a. Table 5a describes some potential for providing recreational opportunities that have been identified as highly needed in the 2010 Parks and Recreation Needs Assessment Survey. All alignments provide similar access for most of the listed needs except as noted below.

b. The Green alignment provides direct all user access to virtually all of the Waters Moss area which includes very good additional opportunities for nature trails, picnic areas and meeting rooms. The Yellow alignment provides similar access but would not be suitable for all users. The nature trails in the Waters Moss area would be accessible from all three of the western alignments, but the Green and Yellow alignments would provide more direct access to the picnic areas and possible future meeting rooms. It should be noted that adequate handicap accessible parking is available at the top of the hill within the Waters Moss area, so it is currently accessible to all populations regardless of which alignment is chosen.

c. It is not clear that the addition of paved trails and commuter traffic within the Waters Moss area is appropriate given the natural resources of the area. One of the area's outstanding features is its relatively undisturbed state. Construction of the Green trail would result in approximately 1.7 times as much area being disturbed within Waters Moss as would the Orange or the Yellow Trails. This disturbance would be mostly in forested uplands that have been relatively undisturbed, whereas the Orange alignment would pass mostly through areas previously disturbed and maintained for the sanitary sewer line. The future use of the area has not yet been determined but it is reasonable to assume that the Orange alignment which passes along one edge of the property would be less limiting to future possibilities than would the other two alignments which pass through the heart of the area.

d. Neither the Blue nor the Violet trail is expected to have a significant advantage in terms of recreational opportunities.

PN4. The project must be designed to fit into and minimize the overall costs of the larger network of trails, transportation and parks.

a. The length of newly constructed infrastructure and the degree to which each alignment minimizes the overall footprint of the total transportation system are the best measures with which to evaluate the degree to which each alignment meets this need.

b. The Yellow alignment adds the least length to the total system. The Orange and Green alignments add similar amounts of trail to the immediate system, but the Orange would require more system additions to fully connect the neighborhoods through which it runs.

c. The portion of the Blue and Violet trails that ascends to Maguire Boulevard represents trail that does not provide any redundant use in the overall future trail system. These sections of trail will be dedicated to ascending to (and descending from) Maguire. The portions of these trails that stay down in the floodplain will be used as part of future trails up the forks of the Grindstone. Accordingly, the Blue trail has the advantage in the overall system because it has the shortest length of trail dedicated to ascending to Maguire Blvd.

PN5. The project must be useable for the full range of potential users and must be mindful of environmental impacts.

a. The terrain metrics in Table 7 have a strong impact on the ability of an alignment to meet this need. Of the western alignments, the Orange alignment clearly has

the easiest usability for the full range of users. There is no clear leader in usability between the two eastern alignments.

b. The Yellow alignment has no reasonable chance of being ADA compliant.

c. The Green alignment was laid out to be on the verge of being ADA compliant. If everything goes well, it could be built to just barely meet the requirements. There is also more potential that additional survey and alignment information will indicate that it is not possible to completely meet the ADA requirements without a variance along the Green alignment. The Green and Yellow alignments both include a long section of trail with 7.9% longitudinal slope which is compliant only because it is adjacent to a public road.

d. The Yellow alignment would have the smallest immediate direct impact on the environment. The Orange and Green alignments each have their own environmental issues that are difficult to compare directly. The details of the Orange alignment would need to be carefully selected to try and minimize impacts to the waters of the United States. The forest through which the Green alignment runs is dense and evenly distributed making it virtually impossible to reduce the impacts by making minor modifications to the alignment.

PN6. Additional considerations, not included in the purpose and needs statements

a. The Orange alignment would directly affect two residences to a higher degree than the other alignments would directly affect any other residences. The current owners of these two residences would prefer that some other alignment be selected. While it is likely that the trail will improve property values, the property value benefit would only be derived by owners wishing to relocate which is not the case in this situation. The private setting of these two residences was likely to have been a significant factor in their selection so, if the Orange alignment is selected, it will need to be built with an eye towards minimizing the intrusion.

It is our recommendation as the Engineer of record that the Orange alignment be selected for the western portion of the trail because it provides the most usable and safe facility for the largest number of users. For the Eastern portion of the trail there is a small benefit to selecting the Blue alignment if funding is available for the additional bridge, otherwise the Violet alignment would be a reasonable alternative to provide access to Maguire Blvd.

We also recommend that a future accessible connector be planned to provide an all-user all-weather connection from the south end of Bluff Creek Boulevard (behind the movie theatre) to the Orange alignment. This would be less than 1,000' in length and would provide an accessible connection to the trail for the residents of the East Pointe and Shepard subdivisions and the employees of the East Pointe business area. This route would provide access to the trail with minimal impact on residential neighborhoods and natural areas. Regardless of whether this connector is built, pedestrians from East Pointe will also have access to the Orange alignment via the nature trails in the Waters Moss area which can be accessed at the end of Kays Pointe Drive.

There is an existing system of private trails in the Bluff Creek Estates subdivision that could provide for local pedestrian access to the Orange route. However, it is not a necessary link in the transportation system, so it should be up to Bluff Creek Estates to decide whether to allow access. We consider Old 63 to be an acceptable non-motorized connector for the businesses and residences along the Grindstone Parkway Corridor.