CITY OF COLUMBIA, MISSOURI
PUBLIC WORKS DEPARTMENT

October 15, 2013

Kevin Dunn
Federal Highway Administration

Subject: RTE: Use of Alternate Pavement Markings for Bicycle Boulevards

Kevin,

Attached please find a revised Request To Experiment (RTE) for the use of markings on Bike Boulevards.

Background: Bike Boulevards typically are local residential streets that incorporated changes to encourage bicycle traffic while discouraging "cut-through" traffic by motor vehicles. Various infrastructure methods are being used to implement them. Several years ago, the City of Columbia implemented a bike boulevard on a temporary pilot basis using a combination of centerline striping, dotted striping and shared lane markings. Since the initial results were positive, this RTE is being submitted to further measure and document the effectiveness of the treatment.

Details of the experiment are attached. The experiment will measure the effectiveness of the treatment by measuring vehicle and bicycle traffic volumes. In addition it will evaluate the position and interaction of motor vehicles and bicyclists as well as motorist speeds.

Since this is a different application using existing devices, it is not protected by patent or copyright. In the event the experiment creates substantial safety hazards that warrant removal prior to the planned end of the experiment, the City of Columbia will discontinue the experiment and remove the markings.

Sincerely,

John D. Glascock, PE
Director

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City of Columbia, Missouri
Request to Experiment:
Use of Alternate Pavement Markings for Bicycle Boulevards
October 2013

U.S. Department of Transportation
Federal Highway Administration

Prepared by: **City of Columbia, Missouri Non-Motorized Transportation Pilot Program (NMTPP)**

Approved: John Glascock

John Glascock, PE
City of Columbia, Missouri Public Works Director

Table of Contents	
ELEMENT	**PAGE**

For more information on this request to experiment, please contact
City of Columbia Bike/Pedestrian Coordinator Ted Curtis
at 573.489.8853 or via e-mail at CTCURTIS@GoColumbiaMO.com.

BACKGROUND

The City of Columbia, Missouri has a growing network of on-street bikeways including bike lanes and shared roadways, as well as a trail network that links to a significant statewide trail, the Katy Trail. These facilities serve a wide geographic area within the city and are intended to both encourage bicycling and increase motorist awareness of the presence of bicyclists. The City of Columbia addresses requirements for new bicycle and pedestrian facilities in a 2006 update to the City Street Standards[1].

Columbia was designated as one of four Federal Non-Motorized Transportation Pilot Program (NTPP) communities. These funds were used to plan, design and construct additional bicycle and pedestrian facilities to encourage a modal shift to non-motorized transportation. With Columbia's population growth and a planned modal shift, the potential exists to incorporate additional experimental facilities as part of the Federal NTPP. This document is a request to the Federal Highway Administration to experiment with the use of alternative pavement marking treatments on existing and planned on-street bikeways designated as bicycle boulevards.

NATURE OF THE PROBLEM

The concept of a bicycle boulevard is to maintain low motor vehicle volumes and speeds that prioritize bicycles over motor vehicles, and optimize bicycle travel with measures such as traffic calming features (to reduce the differential between vehicle and bicycle speeds) or traffic diversion (to reduce the number of vehicles). Shared lane markings have been used nationally and on bicycle boulevards in Columbia to indicate where the cyclist should ride (which is generally away from the 'door zone' of parked vehicles). However, shared lane markings only identify the sharing of the roadway, not bicycle priority, making the pavement on bike boulevards the same as shared streets. In general, the use of a shared lane marking alone does not serve to prioritize bicycles on the low volume and low speed streets envisioned for bicycle boulevards. The following sections describe four typical problems experienced along Bicycle Boulevards in Columbia.

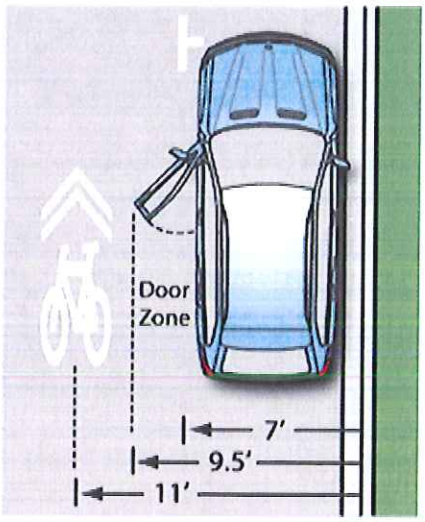

Figure 1 - Shared Lane Markings can encourage bicyclists to ride outside of the door zone of parked cars

Problem 1: Street position by bicyclists
Bicyclists tend to ride towards the rightmost edge of the roadway, particularly when they encounter other vehicles. This situation is potentially dangerous for the cyclist when there is on-street parking, as they may ride in the 'door zone' of adjacent parked cars. The width of the 'door zone' is generally assumed to be 2.5 feet from the edge of the parking lane.

Problem 2: Improper position of vehicles when passing bicyclists When a motorist passes a bicyclist on a bicycle boulevard, the motorist should move into the adjacent travel lane to give the cyclist a wide berth. Some motorists, however, pass the cyclist at a very close distance while remaining within the same travel lane. This situation can be related to Problem 1, for if the cyclist is hugging the right side of the lane, motorists may think they have enough room to pass the cyclist without moving into the adjacent travel lane.

Problem 3: Improper yielding/confusion when two cars pass near a cyclist
Similar to Problem 2, when oncoming vehicles pass each other in the presence of a cyclist, the motorist traveling in the same direction as the cyclist sometimes stays within the travel lane and passes the cyclist at close distance. The desired behavior is for the motorist traveling in the same direction as the cyclist to yield to oncoming traffic and then pass the cyclist.

Problem 4: High motorist speeds or volumes
Pavement markings recommended for bicycle boulevards do not provide an impact that results in minimizing motor vehicle speeds or volumes, which have a strong effect on the comfort of bicyclists. The application of pavement markings, along with other treatments, should result in motorists, other than those who live along the street, diverting their travel to an adjacent street, or, at the very least, lower vehicle speeds.

DESCRIPTION OF PROPOSED EXPERIMENT

Bicycle boulevards are low-volume, low-speed streets modified to enhance bicyclist comfort by using treatments such as signage, pavement markings, traffic calming and/ or traffic reduction, and intersection modifications. The Manual on Uniform Traffic Control Devices (MUTCD) includes guidance on the use of Shared Lane Markings and way finding signage on bicycling routes. Many cities have combined these and other approved elements such as traffic calming and crossing treatments in order to optimize routes along lower order streets for bicycle and pedestrian travel. These routes are generally referred to as bicycle boulevards (also known as "neighborhood greenways"). The MUTCD does not provide formal guidance on implementing bicycle boulevards.

The City of Columbia Department of Public Works has conducted research and determined that shared lane markings alone do not distinguish bicycle boulevards from other roadways with shared lane markings, and have not been sufficient to clarify expected lane position behavior of motorists and bicyclists on bicycle boulevards. The City of Columbia is interested in using a combination of shared lane markings, skip dash lines and dotted lines, all approved in the Manual of Uniform Traffic Control Devises, but used together in a different combination (thus the experiment) for pavement markings on existing bicycle boulevards to indicate where motorists and bicyclists should position themselves in the roadway, promoting a bicycle oriented street. The results of using pavement markings individually have been positive, but the combination has not in a manner specific for a bicycle boulevard, which has led to this formal request to experiment.

The City of Columbia bicycle boulevard projects will include route signing, pavement markings, medians that prioritize bike and pedestrian movements but restrict motor vehicle movements, infrastructure improvements at signalized major street crossings, pedestrian improvements at offset intersections, protected non-signalized crossings and pedestrian improvements (sidewalk and curb ramps). The pavement marking described below is the unique element of this project and the one that will be studied. To isolate the effects of the proposed pavement markings, all project elements will be implemented prior to the pre-application data collection. The pavement markings will be implemented several months later, after which the post-application data collection will take place.

The City of Columbia proposes to apply a combination of dotted and dashed pavement markings to indicate the proper position of bicyclists and motorists. The treatment consists of a yellow dashed line along the centerline of the roadway and white dots 6' to the right and left of the

yellow skip line. Shared lane markings will be placed every 250' in between the yellow dashed and the white dotted lines. The yellow lines will indicate the center of the roadway. The intended behavior of a bicyclist is to ride over the shared lane markings between the yellow dashed centerline and the white dotted line. Vehicles are intended to straddle the white dotted lines, on the right side of the center line. A vehicle is expected to pass a bicyclist by moving into the other lane. Similarly, when two vehicles must pass in the presence of bicycles, the car traveling in the same direction as the bicycle should yield to oncoming traffic and then pass the bicyclist by crossing into the other lane. The bicyclist typically will move to the right and allow motor vehicles to pass.

Treatment 1 – Shared Lane Markings

To address Problem 1 (described earlier), the City proposes to use of a combination of the yellow skip centerline, and shared lane markings as part of its bicycle boulevard pavement marking. Shared lane markings will be placed at approximately 250' spacing along the bicycle boulevard, and located in the correct position for Treatment 2 implementation, between the yellow skip and the white dotted lines described in Treatment 2 below. The shared lane markings will encourage people on bicycles to properly position themselves in the roadway at an appropriate distance from the curb as well as the "door zone" of adjacent parked cars. This will reinforce to all users where bicyclists should be riding, promoting a more comfortable shared-use environment for all users. See Figure 2 below which illustrates the shared lane markings, which represent Treatment 1.

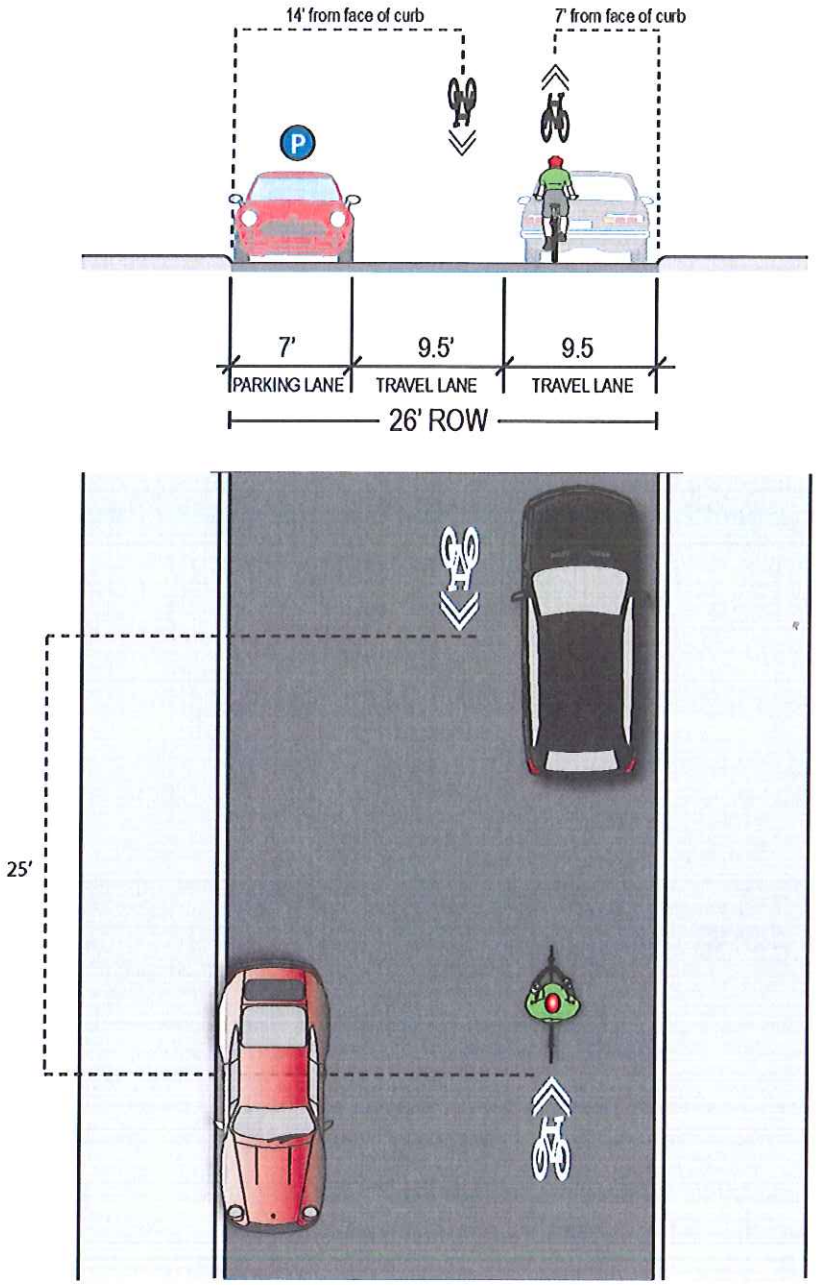

Figure 2 – Proposed Treatment 1 markings

Treatment 2

Treatment 2 addresses issues related to improper vehicle position when passing a bicycle. To address this problem, the City proposes to apply a yellow dashed line along the centerline of the roadway and white dots 6' to the right the yellow line in each direction. The shared lane marking identified in Treatment 1 will be in between.

The desired behavior is for motor vehicles to straddle the white dotted line when bicyclists are not present. When passing a bicyclist, the motorist will move into the opposite travel lane. When two opposing vehicles must pass in the presence of a bicyclist, the vehicle traveling in the same direction as the bicyclist will yield to oncoming traffic before passing the bicyclist. These pavement markings also serve to visually narrow the roadway, which may result in reduced motor vehicle speeds. The proposed markings may also clearly indicate these streets as routes

with bicycle priority, which may result in reduced motor vehicle volumes as motorists choose other routes.

See Figure 3 below for an illustration of this treatment.

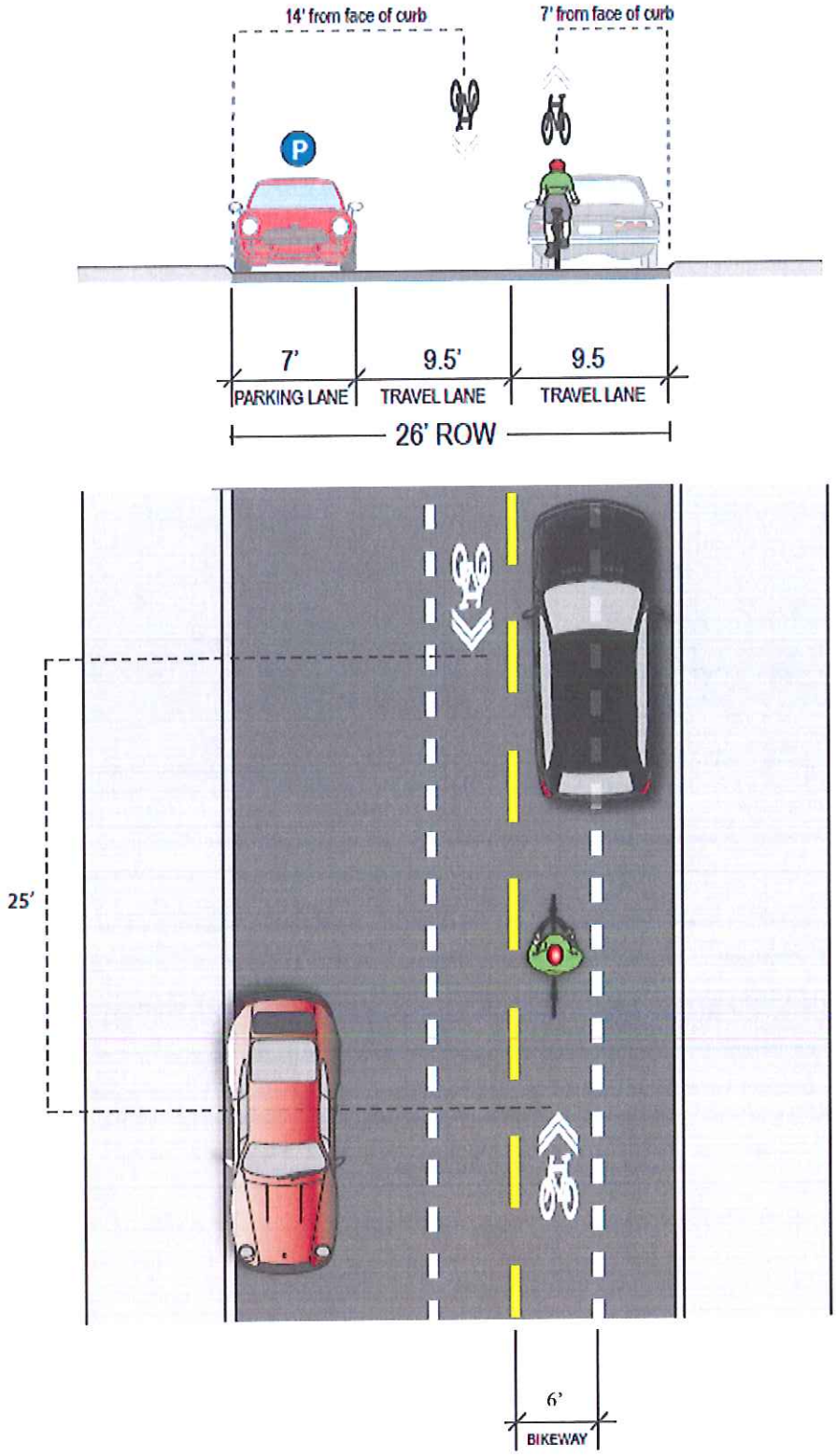

Figure 3 - Proposed Treatment 2 markings

SCOPE AND WORK PLAN

Summarized in Table 1, the City of Columbia proposes to collect data regarding the proposed pavement markings to City-maintained bicycle boulevards. The table specifies the proposed treatment type for each location where data will be collected.

Table 1 – Proposed Data Collection Locations

Street	Segment and Treatment Type*				
	Treatment	From	To	Parking Orientation	Timeframe
E Forest Ave	1	N Providence Rd	Grand Ave	On south side of road	Fall 2014
E Forest Ave	2	N Providence Rd	Grand Ave	On south side of road	Spring 2015
Banks Ave	1	Sexton Rd	Dean St	On east side of road	Fall 2014
Banks Ave	2	Sexton Rd	Dean St	On east side of road	Spring 2015
Edgewood	1	W Broadway	Maupin Rd	On east side of road	Fall 2014
Edgewood	2	W Broadway	Maupin Rd	On east side of road	Spring 2015

* Treatments would be applied to each street segment, between intersections.

Proposed Data Collection Methodology

The City of Columbia has contracted with Alta Planning + Design (Alta) to coordinate data collection activities. Prior to and after placement of the experimental bicycle boulevard treatment (pavement markings), Alta will focus on observed measurable behavior through field data collection using several or all of the following techniques:

- Before and after videos at specific periods, indicating bicycle and vehicle lane position
- Motor vehicle volumes
- Motor vehicle speed surveys
- Bicycle volumes (including age and gender)
- User intercept surveys
- Resident surveys
- Field observations at specific times and dates

Using these data collection techniques, the following observations will be recorded:

- Motor vehicle and bicycle volumes
- Motor vehicle speeds
- Bicyclists' behavior, including bicyclist position in presence and absence of motorists, presence or absence of parked vehicle, sidewalk riding.
- Motorists' behavior, including vehicle position in presence and absence of bicyclist, vehicle position in presence and absence of opposing vehicle.
- Relative distance between motorists and cyclists when passing
- Frequency of bicycle/motor vehicle crashes or near misses
- Durability of the pavement markings
- Bicyclist perception of safety
- Motorists understanding and perception of the markings (through resident surveys)

These observed measurable data will be collected in the field over the course of the study period. Alta will be responsible for collecting data via its own professionals, trained volunteers, or outside resources such as contractors for videotaping. Data will be collected at three locations during a weekday and weekend period, for two hours each, once before the treatment is applied and once after.

SCHEDULE

Table 3 presents the proposed bicycle boulevard pavement markings experiment schedule. The schedule assumes FHWA approval by fall of 2013. As described in the description of the

experiment, all elements of the bicycle boulevard (including a centerline marking and shared lane markings), with the exception of the additional skips to the pavement markings, will be installed by summer 2014. Data will then be collected in the fall of 2014. Pending FHWA approval of the RTE, the skip dash centerline and dotted lines 6' on either side of the centerline will be implemented in early spring of 2015. Data will be collected following a period of time that will allow bicyclists and motorist to become acclimated to the additional markings to assess the effectiveness of the skip dash pavement markings that will supplement the shared lane markings. This data will be collected in the spring of 2015. The final report will be developed following the compilation of data.

Table 3 – Proposed Bicycle Boulevard Pavement Markings Experiment Schedule

Task	Summer 2013	Fall 2013	Winter 2013	Summer 2014	Fall 2014	Winter 2014	Spring 2015	Summer 2015
Submit RTE to FHWA								
Finalize Specific Data Collection Point Locations								
Install Bike Boulevard Treatments including Shared Lane Markings								
Collect "SLM Pavement Marking" Data								
Install Dashed Line Pavement Markings								
Collect "Experimental Combined Pavement Marking" Data								
Synthesize and Analyze Data								
Prepare Report Summarizing Data Analysis Results and Conclusions								

EVALUATION PROCEDURES/MEASURES OF EFFECTIVENESS

After data collection is complete, City of Columbia staff will work with Alta to determine if there were measurably significant changes in the following behavioral areas listed below. If positive changes are noted, the City of Columbia will suggest that the treatments be considered as an option and included in a future MUTCD revision. These behavioral changes include:

- Improved bicyclist behavior, including riding in the appropriate location as indicated by the shared lane marking symbol.
- Improved motorist behavior, including driving in the appropriate location when following and passing bicyclists.
- Awareness of proper lane placement for bicyclists and motorists.
- Understanding of the pavement treatments by motorists and cyclists.
- Reductions in motor vehicle volumes and/or speeds

REPORTING

Reporting will be submitted as specified by FHWA and submitted to the Columbia City Council, Missouri Department of Transportation, FHWA Missouri Division Office and FHWA National Headquarters Office. This will include semi-annual progress reports for the duration of the experimentation and a copy of the final results to the FHWA's Office of Transportation Operations within three months of the conclusion of the experiment.

ADMINISTRATION

The City of Columbia will be the sponsoring agency with support as needed from consultants including Alta. The proposed bicycle boulevard pavement markings are not protected by patent or copyright.

REMOVAL OF EXPERIMENT

The City of Columbia will be utilizing MUTCD approved movement markings in ways that establish different operational meaning of the pavement markings; therefore, the City agrees to remove the skip markings within three months of completion of the study if necessary, based on the ultimate decision by FHWA. In the event FHWA reaches a decision that changes to the MUTCD are warranted to include the bicycle boulevard pavement markings, the experiment will be permanent. In the event the experiment creates substantial safety hazards that warrant removal prior to the planned end of the experiment, the City of Columbia will discontinue the experiment, and remove the markings.

REFERENCES

1. City of Columbia, *Street Standards*, Accessed https://www.gocolumbiamo.com/Council/Code_of_Ordinances_PDF/Street_Standards/ on June 7, 2004.
2. National Association of City Transportation Officials (NACTO). *Urban Bikeway Design Guide.* Accessed http://nacto.org/cities-for-cycling/design-guide/bicycle-boulevards/ on Jun 25, 2013.
3. FHWA, *BIKESAFE Bicycle Countermeasure Selection System*, Accessed http://www.bicyclinginfo.org/bikesafe/ on June 25, 2013.
4. Ewing, Reid and Brown, Steven. (2009). *U.S. Traffic Calming Manual.*