Introduction

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Trail termini (endings/beginnings) at roadways are a subset of trail-roadway junctions, which include full intersection crossings. For a more thorough discussion of trail-roadway intersections, see the *Trail Intersection Design Handbook*.

The intent of this document is to improve the state of the art for trail terminus design in terms of assisting trail user transition to the roadway system and vice versa. This document does not consider such trail end/head amenities as buildings and rest room facilities for examples.

All trail-roadway junctions should be designed under the assumption that bicyclists and other non-motorists may wish to exit the trail to the roadway and access the trail from the roadway. It is especially important to design trail termini with this in mind.

Figure 1, which is Figure 9-2 from page 9B-11 of the *Manual on Uniform Traffic Control Devices* (MUTCD), depicts the heretofore customary signing for beginning and ending a bicycle trail.

But designing a trail terminus with a road should be more than just ending the trail and placing a few signs. At trail ending intersections with roads, trail users will be making the shift from the trail to the roadway system. Bicyclists, skaters, and pedestrians will be using the roadway to access the trail. The design of the junction should accommodate their needs and provide for seamless transitions.

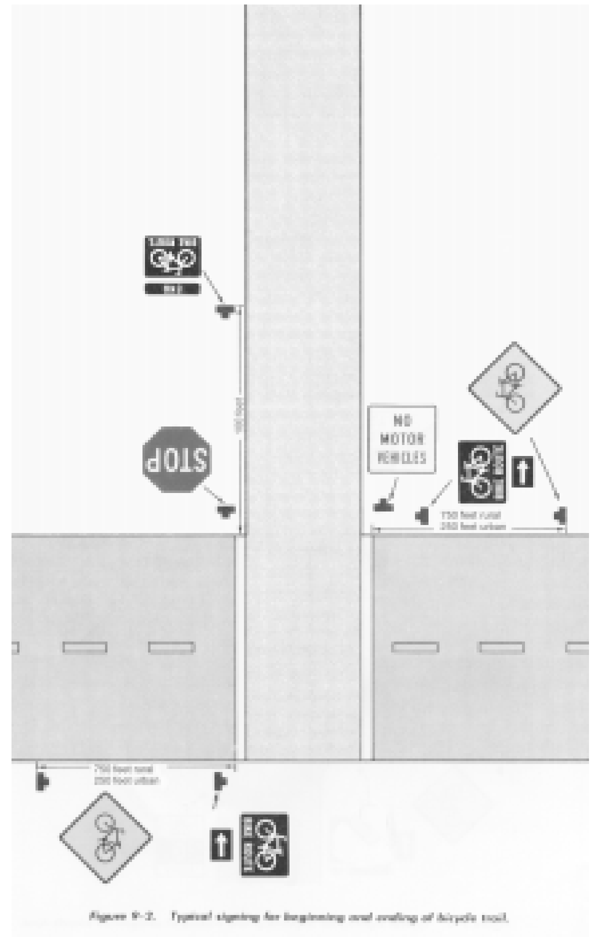


Figure 1. Specifications from the MUTCD.

General Guidelines

Not all trails end at right angles with two-lane roads as depicted in the MUTCD figure, although this is generally a more desirable goal when compared to endings at roads of four or more lanes. Like roadway-roadway intersections, trail-roadway junctions can be of a variety of configurations and range from simple to complex. The goal should be to design so that potentially complex situations are simplified.

The following guidelines are suggested when designing trail termini. See also the *Trail Intersection Design Handbook* for additional guidelines when constructing trail intersections.

General Guidelines for Designing Trail Termini

1. Analyze the tasks of both trail users (bicyclists, skaters, and pedestrians) and motorists, and study the discrepancies between planned for and actual behavior. The design should take into account trail user desire lines.
2. Terminate the trail at the lowest point of the street hierarchy possible. It is generally better to end on a minor residential street than on a principle arterial if the choice exists. Trail users can then work their way up the street hierarchy to their destination or their highest point of comfort.
3. Provide sidewalks along the intersecting road for pedestrians, and recognize that some bicyclists may also use these whether specifically intended for bicyclists or not. Sidewalks may be carefully designed to accommodate bicyclists in limited and special circumstances.
4. Include positive guidance such as signs, pavement markings, and channelization to induce bicyclists to ride on the proper side of the road, with traffic.
5. Provide educational materials for bicyclists, skaters, and pedestrians.
6. If the trail is terminated on a one-way street, consider a contra-flow bicycle lane to enhance bicycle transportation opportunities, and to accommodate inevitable would-be wrong way riders.
7. Restrict parking near the trail terminus, as would be done for a street or driveway junction.
8. A trail-roadway terminus can be an excellent location to implement motor vehicle traffic calming measures.
9. Where the trail ends at a busy midblock location, consider a jug handle design to assist left turning road bicyclists in making a right angle crossing to access the trail.

Education

A Place for Education Intervention

Trail endings are ideal locations to place signs, printed materials, and bulletin boards with educational messages for bicycling safely on roads. Communities with bikeway maps, which typically include concise educational messages with graphics, can make these available from a covered information center. An actual map or an enlargement can be mounted on a bulletin board under plexiglass.

Friendly reminder of courteous behavior.

Bicycling educational and promotional handouts should be available.

Catchy phrases and informative graphics can reinforce positive messages as shown in the following example.

Using Sidewalks

Spoke 'n' Words for Bicyclists

- **Ride a Safe Bicycle**. Make sure the bicycle is the correct size for you, is in proper working order, and that you are competent with all operating controls.
- **Be Well Outfitted**. Use bright clothing during the day, front and rear lights and reflectors at night, a helmet, and stiff soled footwear.
- **Go With the Flow**. Behave as though you are operating a vehicle—because you are! *Ride Right* with traffic, not facing traffic, and obey all laws, signs, and signals. *Two wheels or four, the law is the law*.
- **Know these Skills.** Be able to ride a straight line, including while starting and stopping, riding very slowly, "shoulder checking," and hand signaling. Learn how to "quick turn," "quick dodge," and "panic stop."
- **Use Street Smarts.** Watch out for road hazards like potholes and gravel, and motor vehicles turning left in front of you and coming out of driveways or side streets. Ride at least a door's width from parked cars. Use proper destination positioning—don't go straight in a right turn lane for example.
- **Be cautious not timid; assertive not aggressive**. Don't ride in the gutter pan, near the extreme edge of the road, or on the sidewalk. Ride confidently and in control, like you've been there, done that.

Source: Wayne Pein, University of North Carolina Highway Safety Research Center.

Using a Sidewalk as a Transition to the Road

It is widely recognized that sidewalk bicycle riding should be discouraged. Still, there may be certain situations when riding on a sidewalk provides a reasonable alternative to road riding, assists with the transition to the roadway or trail, or is the best compromise of an otherwise bad situation. A sidewalk designed to accommodate bicyclists along with pedestrians is more appropriately called a sidepath.

The city of Madison, WI recognizes there are situations where, because of infrastructural restrictions or bicyclist desire lines, sidewalk riding is likely. In those cases, efforts are made to minimize the negative consequences of sidewalk riding by designing the sidepath to better accommodate bicyclists.

Widened sidewalk.

Contra-flow Bicycle Lanes

If sidewalks are to be used for bicycling, the following guidelines are recommended. The sidepath should be:

- an option to using the roadway, and not the sole design facility. The roadway should be easily accessible from the trail and vice versa;
- used for a short distance only, cross few driveways, and have sight lines as clear as practicable at driveways;
- continuous over driveways, rather than interrupted by the driveway cut. Stop bars and/or stop signs and WATCH FOR BICYCLES signs should be considered to control and alert crossing motorists;
- wider than standard, signed for the presence of bicycle traffic (BICYCLES USING SIDEWALK; LOOK RIGHT FOR BICYCLISTS), and ideally be of a contrasting color to the "normal" sidewalk.

Don't do this. Provide a full width curb cut.

Contra-flow Bicycle Lanes

If the trail terminates on a one-way street, it may be desirable to provide a contra-flow bicycle lane. According to the 1995 *Oregon State Bicycle and Pedestrian Plan*, a contra-flow bicycle lane may be considered if:

- it provides substantial time savings;
- it affords direct access to high-use destinations;
- it improves safety because of reduced conflicts as compared to the longer route;
- there are few intersecting driveways, alleys or streets on the side of the contra-flow lane;
- bicyclists can safely and conveniently re-enter the traffic stream at either end of the section;
- a substantial number of bicyclists are already using the street facing traffic;
- there is sufficient street width to also accommodate a normal with-flow bicycle lane.

In special circumstances, a contra-flow bicycle lane may be used on a very low volume one-way street without the use of a with-flow bicycle lane. Three such examples exist on the Oregon State University campus where there is low motor vehicle volume and high bicycle volume.

The Oregon plan specifies the following design features for contra-flow bicycle lanes:

- place the contra-flow lane on the right side of the street (to the motorists' left);
- separate the contra-flow lane from on-coming motor vehicle traffic with a double yellow line to indicate that the

bicyclists are riding on the street legally, in a dedicated travel lane;

- install ONE WAY Except For Bicycles, DO NOT ENTER Except For Bicycles, WATCH FOR BICYCLES ON LEFT signs on cross streets and driveways;
- existing traffic signals should be fitted with special signals for bicyclists with either loop detectors or easily reached push-buttons.

The contra-flow bicycle lane should also be evaluated for the installation of bicycle stop sign R1-1 or yield sign R1-2 at any intersections, as well as for any other applicable signs as described in the MUTCD.

A contra-flow bicycle lane.
Source: *Oregon State Bicycle and Pedestrian Plan.*

Introduction to Case Studies

Five diverse trail termini intersections were examined at locations across the country. These were the:

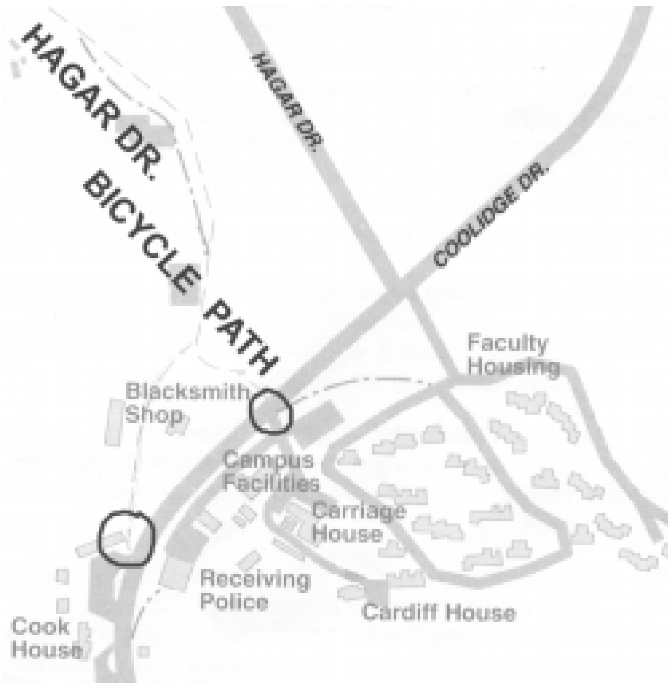
- Hagar Drive Bicycle Path on the University of California at Santa Cruz;
- Libba Cotton Trail in Carrboro, North Carolina;
- Pinellas Trail in Tarpon Springs, Florida;
- Starkweather Creek Bicycle Path in Madison, Wisconsin;
- Lake Hollingsworth Path in Lakeland, Florida.

Each situation is physically described, and observations and analysis of bicyclist movements are discussed. A drawing depicting the intersection and bicyclist design movements (those intended by the designer via the configuration of the intersection) and desire line movements (those that the bicyclists actually perform or would like to perform) is provided. Lastly, recommendations for improving the intersection are offered. For all case studies except the Pinellas Trail, a second drawing shows the intersection with the suggested changes.

It is important to emphasize that the drawings are representations only and are not to precise scale. Furthermore, recommendations are based on sound principles of transportation engineering, but no engineering studies were performed, as this was beyond the scope of the examinations. Detailed engineering analysis is necessary to ensure the feasibility of any intersection reconstruction.

Case Study I- Hagar Drive Bicycle Path

Hagar Drive Bicycle Path, University of California at Santa Cruz



The Hagar Drive Bicycle Path has two termini on Coolidge Drive.

Description

This one mile asphalt path on the UCSC campus is aptly called a bicycle path because pedestrians are excluded (skaters are allowed) and walk on its dirt “shoulder” which becomes a separate pedestrian path. It has an average slope in excess of 4% and is a main shortcut route for bicycle commuters.

The north end the path terminates at the end of the music building parking lot. There is very little motor vehicle traffic, making this an ideal terminus. The south end is of particular interest and forks into two one-way legs, one for riders outbound from campus, the other for inbound. Each leg terminates at Coolidge Drive, a two lane road with bicycle lanes, and the primary campus entranceway.

The outbound leg merges “freeway style” with the bicycle lane on Coolidge Drive. There is a DO NOT ENTER sign and pavement marking prohibiting wrong way riding, with a supplementary sign of Exit Only, No Pedestrians.

Further northeast on Coolidge Drive, the inbound leg makes a right-angle intersection with Coolidge Drive and is opposite, but slightly offset, from a busy Campus Facilities driveway. A less busy dirt driveway to the Blacksmith Shop is also adjacent to the bicycle path.

Traffic counts on Coolidge Drive indicate 12,000 - 14,000 ADT, including about 160 large buses and a significant number of service and delivery vehicles. Posted speed limit is 35 mph. Rough estimates suggest between 700 and 1,000 bicyclists.

Figure 2 depicts the intersections of both legs of the Hagar Drive Bicycle Path with Coolidge Drive.

Case Study I- Hagar Drive Bicycle Path

Case Study I- Hagar Drive Bicycle Path

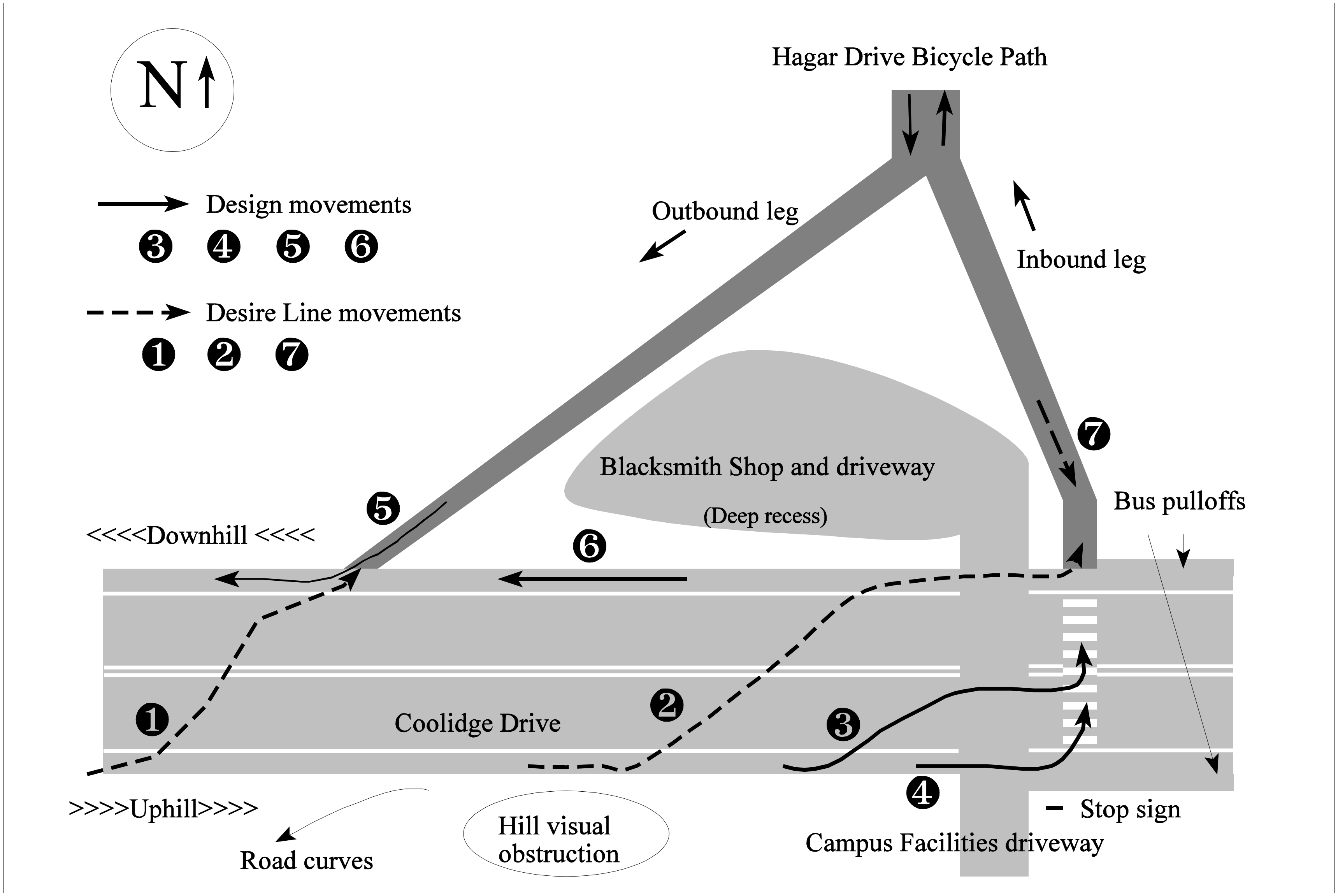


Figure 2. The Hagar Drive Bicycle Path, University of California at Santa Cruz.

Case Study I- Hagar Drive Bicycle Path

Observations and Analysis

Exiting the path.

The merge design seems to work well. This is because of clear sight lines and the similar speeds of bicyclists both on the path (movement ❺) and on the bicycle lane (movement ❻). A small number of bicyclists go the wrong way on the inbound leg (movement ❼) and do so to access the Campus Facilities driveway. Hagar Drive, which has bicycle lanes, parallels the path a short distance to the east, and there are no destinations between these facilities. Thus, there is no real need for bicyclists to make a left turn onto Coolidge Drive when exiting the path—most would have used Hagar Drive.

Merging from the path to the bicycle lane (movement ❺).

Accessing the path.

As designed, the bicyclist is required to proceed further uphill (than where the outbound leg of the bike path merges) on the Coolidge Drive bicycle lane and make a left turn at the ladder crosswalk to access the inbound leg, “design” movement ❸ or ❹. It is a bit of a stretch to call these design movements, as nothing, such as a left turn bay, jug handle, or pavement marking, is provided to facilitate their execution.

A substantial percentage of bicyclists cross over Coolidge Drive prematurely and either go up the outbound leg (movement ❶) ignoring the DO NOT ENTER warnings, or ride the wrong way in the westbound Coolidge Drive bicycle lane before turning left onto the inbound leg of the path (movement ❷).

There are related reasons for this behavior. First, left turns can be difficult at this location due to: (a) heavy and high speed differential motor vehicle traffic (bicyclists are moving very slowly due to ascending); (b) conflicts at the crosswalk from turning motor vehicles at the Campus Facilities and Blacksmith Shop driveways, and the nearby bus pullouts; and (c) lack of left turn pockets. Second, riding the wrong way up the outbound leg of the path (movement ❶) requires less climbing and time than proceeding further up Coolidge Drive to access the inbound leg, movements ❸ and ❹.

Case Study I- Hagar Drive Bicycle Path

Case Study I- Hagar Drive Bicycle Path

Wrong way on the outbound leg of the path (movement ❶).

For these reasons, many bicyclists choose to cross over Coolidge Drive whenever the opportunity arises. It is simply more convenient for bicyclists to do so rather than adhere to the prescribed “design” methods.

Recommendations
Transportation officials are currently working to redesign and reconstruct the intersection. Signalization has been considered but is not warranted at this time. The project, which is intended to also improve motor vehicle operations, proposes to:

- widen Coolidge Drive to provide left turn pockets in both directions;
- relocate the two bus stops to a new location;
- widen and reconfigure the existing inbound leg to accommodate two-way traffic;
- shave the hillside on the southeast side of Coolidge Drive to improve sight lines;
- prepare the pavement with an eye to future signalization of the intersection.

Initially, there was some interest in closing the outbound merge leg and rerouting all bicycle traffic through the inbound leg. Bicyclists were critical of this, and that idea has been dropped.

These proposed changes are necessary and adequately address some of the difficulties that bicyclists face when attempting to make a left turn and access the path. They do not address bicyclists’ desire to minimize physical effort and time expended, however. This could be accomplished by reconfiguring the outbound merge leg for two-way bicycle traffic and enabling inbound bicyclists to access this part of the path which is lower on the hill. Without an engineering study, it is unclear whether this is a viable option because the curve in Coolidge Drive restricts sight lines of high speed, downhill, westbound motor vehicle traffic, making a left turn by bicyclists at this location a potentially risky maneuver.

Figure 3 reflects the reconfiguration of the inbound leg for two-way bicycle traffic and aligning it with the Blacksmith Shop driveway. Left turn bays have also been added which would likely reduce or eliminate movements ❷ and ❹.

Case Study I- Hagar Drive Bicycle Path

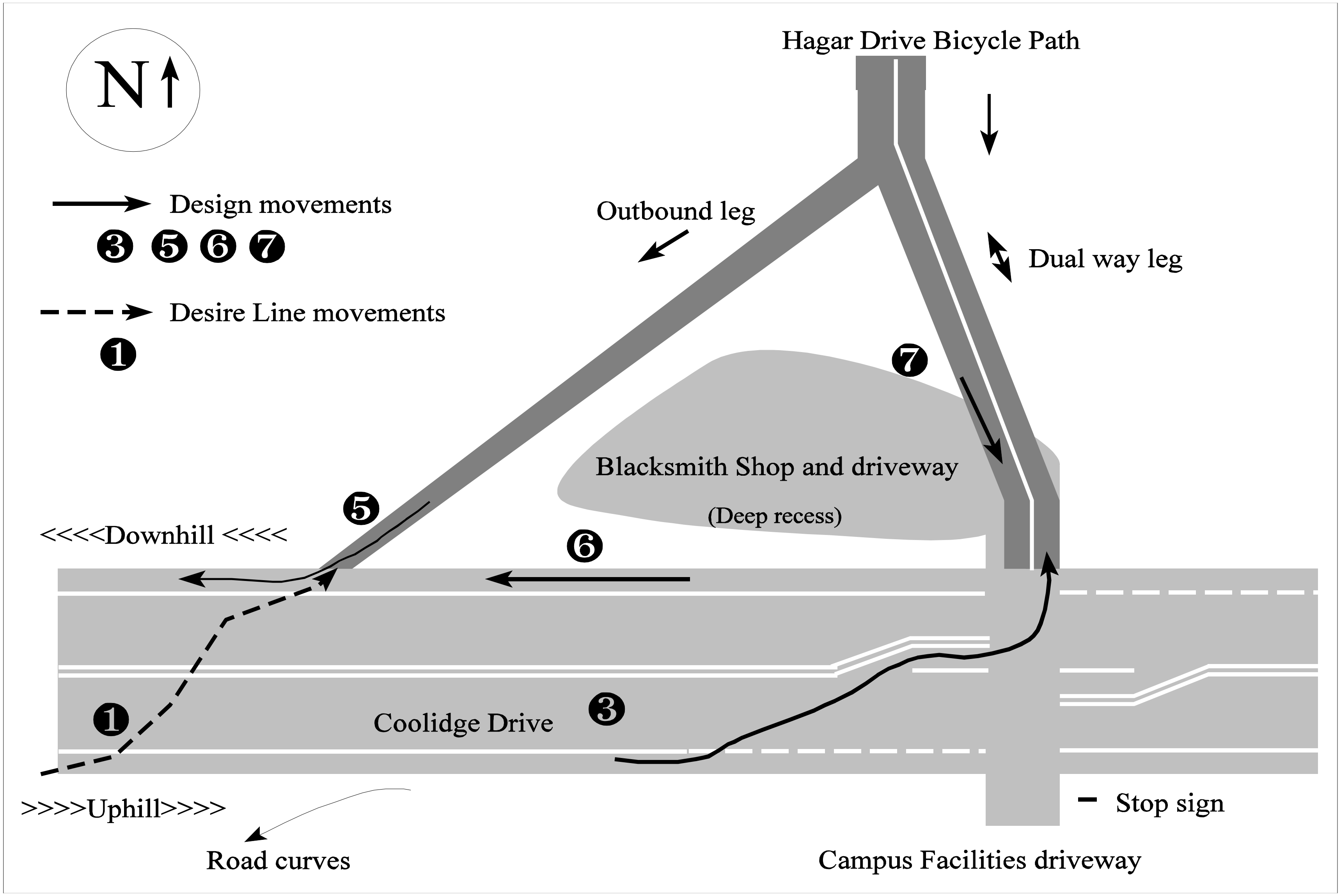


Figure 3. The Hagar Drive Bicycle Path, Santa Cruz, California. Depicted with recommended changes.

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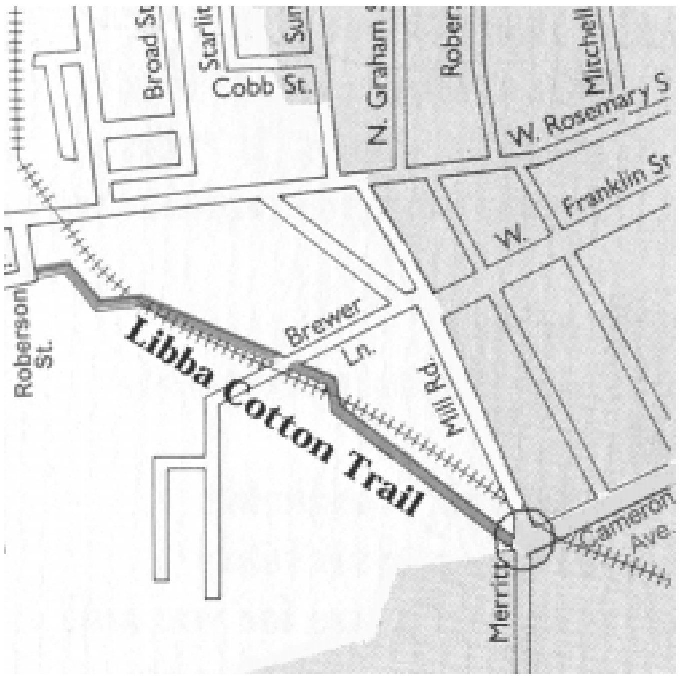
Case Study II- Libba Cotton Trail

Libba Cotton Trail, Carrboro, North Carolina



The Libba Cotton Trail bypasses a busy commercial area.

Description

This multi-use trail is flat, 0.4 mile long, and is in an active but lightly used, slow speed railroad corridor. Approximately 700-1000 bicyclists and a much smaller number of pedestrians per day use this shortcut between Carrboro and Chapel Hill, NC, primarily for going to and from the University of North Carolina at Chapel Hill.

The west end terminates at the right angle bend of Roberson Street, a short, low volume, and low speed commercial 2-lane street. There is nothing remarkable about this terminus, though the curb cut apron is too steep, making an abrupt transition to the roadway surface. It functions adequately due to the infrequent and very slow motor vehicle traffic.

The east end terminates offset at a skew to the T-intersection of Merrit Mill Road and Cameron Avenue. This intersection is signalized with a short cycle to reduce delay, and an exclusive pedestrian phase on immediate call stops all motorized traffic.

Merrit Mill is 2 lanes with a left turn lane, 20 mph north of the trail and 35 mph to the south. Cameron Avenue is 3 lanes (center two-way turn lane), has part time bicycle/parking lanes, and is a primary access road to the university. Worn dirt paths serve as "sidewalks" near the intersection (on the south side the dirt path becomes a legitimate bricked sidewalk approximately 150 ft east of the intersection).

Figure 4 depicts the Libba Cotton Trail terminus at Merrit Mill Road and Cameron Avenue.

Case Study II- Libba Cotton Trail

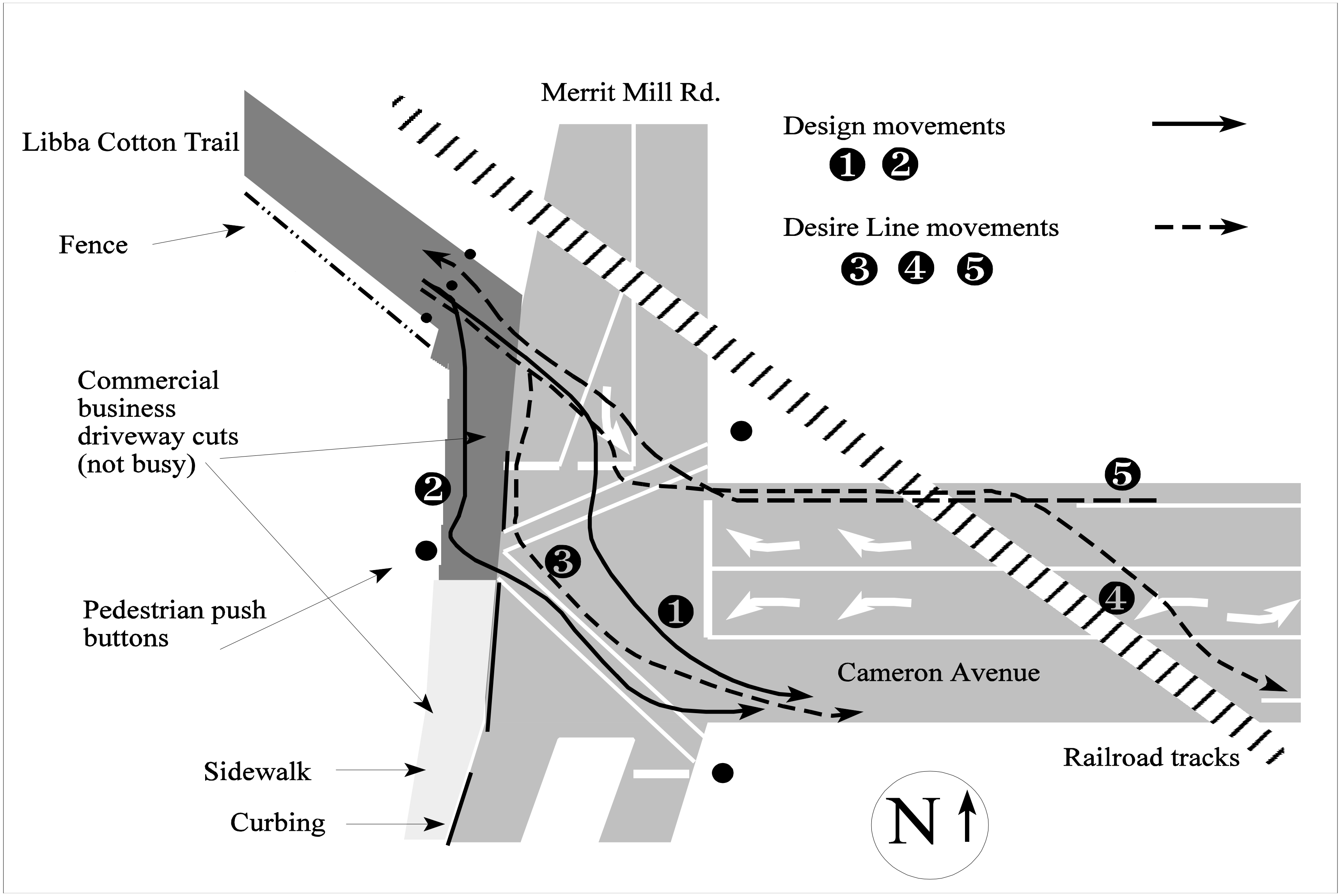


Figure 4. The Libba Cotton Trail, Carrboro, North Carolina.

Case Study II- Libba Cotton Trail

Observations and Analysis

Exiting the trail

In a ½ hour mid-morning period, 36 bicyclists exited the trail. Most bicyclists, 27 (75%), performed "design" movement ❶, a vehicular style on-road left turn. Though referred to here as a design movement, nothing in particular has been done to facilitate this movement.

For movement ❷, the bicyclist is directed, still off-road, to the pole-mounted pedestrian push button and walk/don't walk indicator. Two bicyclists performed this maneuver, though neither used the pushbutton. Pedestrians exiting the trail also perform this movement.

Four bicyclists executed desire line movement ❸, a left turn from the through lane. No motor vehicles were present to cause a conflict resulting from this improper turn method. Desire line movement ❹ is characterized by wrong way riding followed by a midblock crossover to the correct side of the road. Three used this technique.

Accessing the trail

No effort in the design has been made to assist bicyclists to the trail. All bicyclists accessing the trail from Cameron Avenue follow desire line movement ❺ which is the natural line. The precise lines bicyclists follow vary somewhat depending upon the cross motor vehicle traffic situation on Merrit Mill Road, and whether motor vehicles are stacked, obstructing the trail entranceway.

Pedestrians are accommodated with a pushbutton and standard design crosswalk. The crosswalk is angled slightly away from the desired alignment to the trail, somewhat increasing walking distance

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Natural line movement ❺ to access the trail.

Case Study II- Libba Cotton Trail

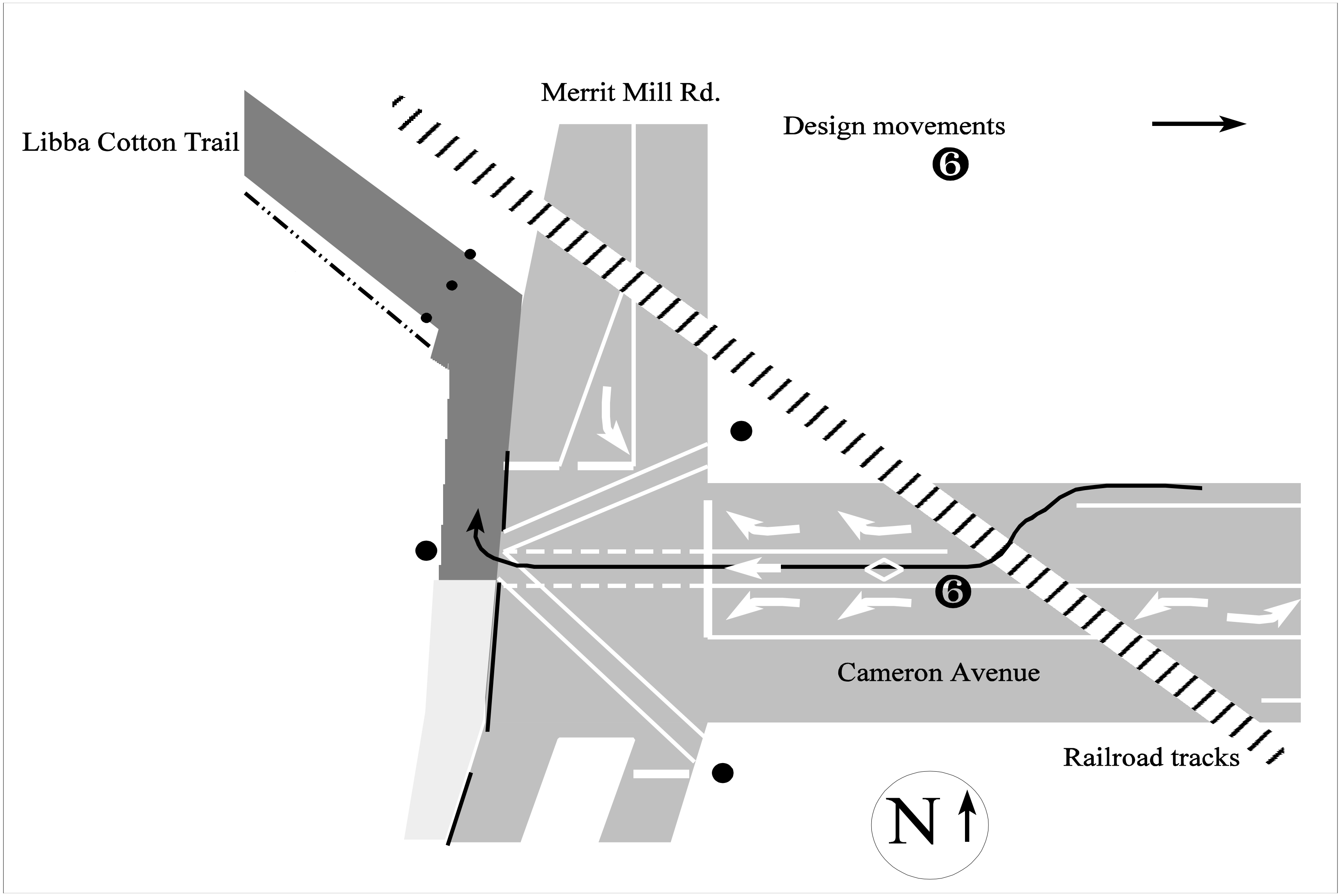

Figure 6. The Libba Cotton Trail, Carrboro, North Carolina. Depicted with recommended changes.

Case Study II- Libba Cotton Trail

Recommendations

This intersection performs adequately because of low motor vehicle speeds, clear sight lines, and a short traffic signal cycle which reduces bicyclist frustration and potential for infractions. Bicyclists can choose their level of comfort and convenience when exiting the trail by making vehicular style movement ❶, or pedestrian style movement ❷.

It may be beneficial to erect a “DO NOT BLOCK TRAIL” sign for southbound motor vehicles on Merrit Mill Road to help ensure bicyclist movement ❺ access to the trail.

Another potential design solution for accessing the trail would be to provide a straight through bicycle pocket with dashed bicycle lane channelization to enable bicyclists to cross the road at a 90 degree angle (design movement ❻ on Figure 5). Still, in spite of this option it is likely bicyclists would continue to prefer the more direct movement ❺.

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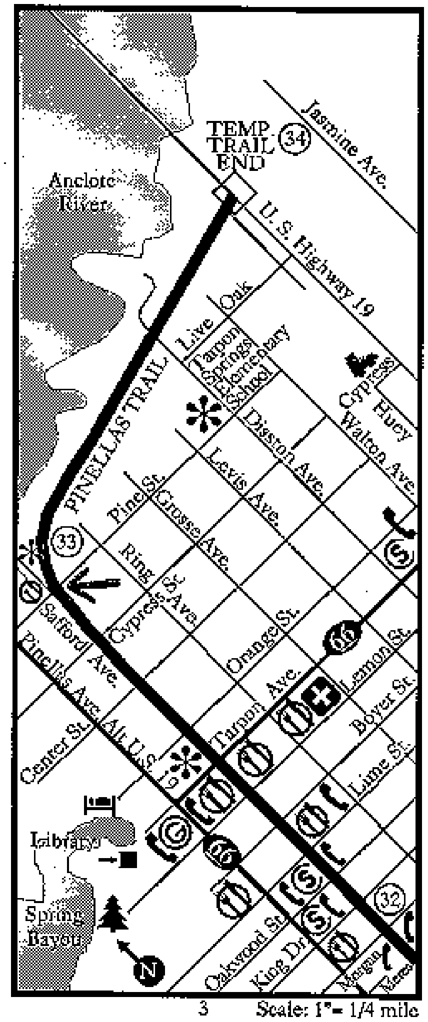
Case Study III- Pinellas Trail

Pinellas Trail, Tarpon Springs, Florida.



The Pinellas Trail traverses many roads.

Description

Nearly 30 miles long, the multi-use Pinellas Trail crosses more than 80 roadways through several jurisdictions in Pinellas County, Florida.

In Tarpon Springs, the trail is in a raised abandoned railroad bed in the center of Safford Avenue. Traveling north, at Pine Street the raised bed ends and trail users are directed to cross the northbound lane of Safford Avenue to a refuge area, then cross Pine Street at a crosswalk. Trail users have the right-of-way, as the Pine Street/Safford Avenue intersection is a 4-way stop for motor vehicles and the stop signs are in advance of the trail crosswalks.

North of Pine Street, the trail occupies it's own alignment separate from Safford Avenue. One block further north of Pine Street, a short spur trail reconnects with Safford Avenue, which at this point has bicycle lanes and a sidewalk on the west side, giving trail users dedicated facilities for access to the popular sponge docks tourist area. A short stretch of sidewalk serves as a jug handle sidepath for southbound bicyclists on Safford Avenue, enabling a right angle crossing of the roadway. Four-way stop signs control this trail terminus.

Safford Avenue is 25 mph and very low volume with a residential character in this section of the trail.

Figure 6 shows this unique area of the Pinellas Trail.

Case Study III- Pinellas Trail

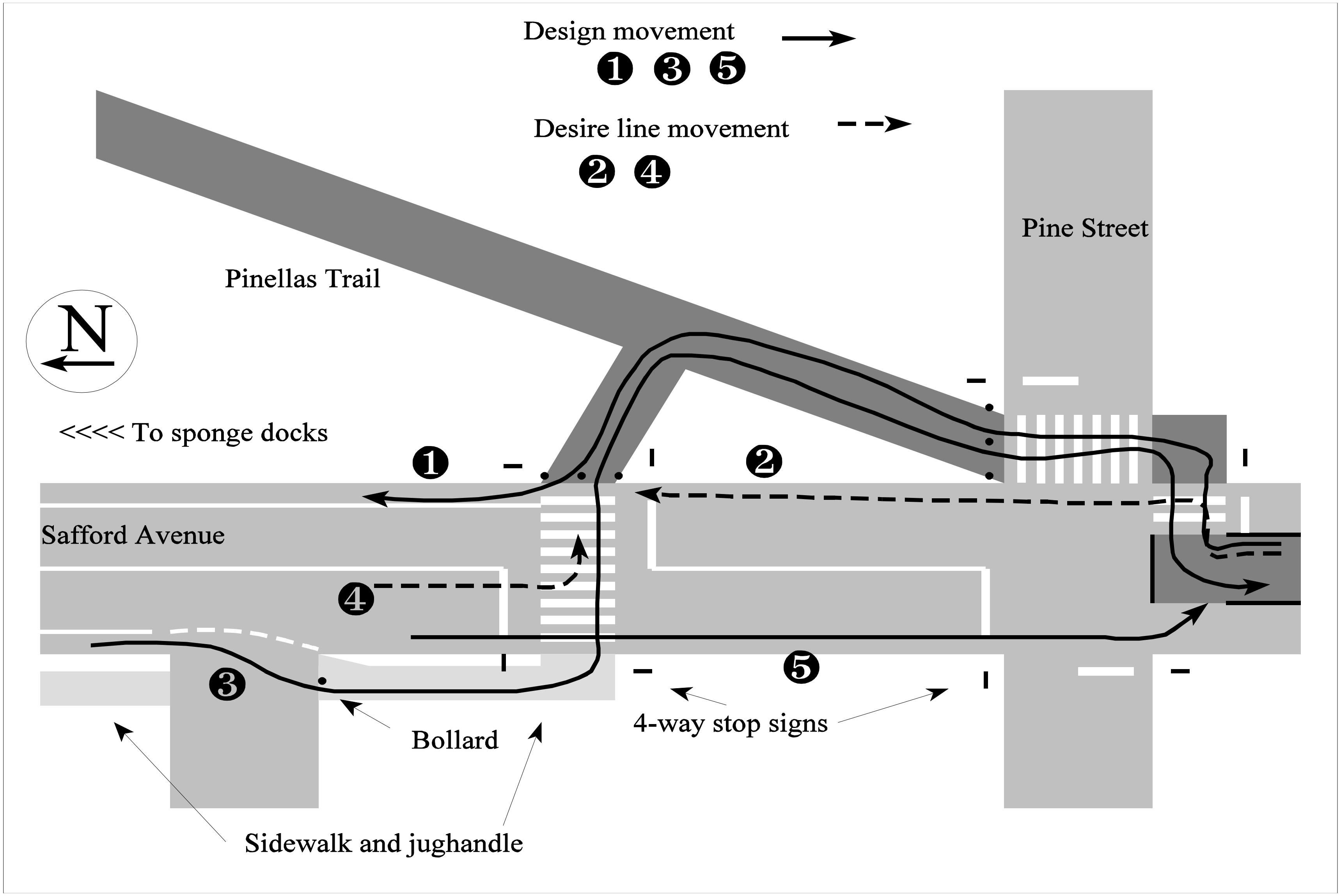


Figure 7. The Pinellas Trail, Tarpon Springs, Florida.

Case Study III- Pinellas Trail

Observations and Analysis
This section has been designed with the philosophy of giving trail users the opportunity to choose their level of comfort in making the transition from trail to roadway and vice versa.

Northbound bicyclists
Design movement ❶ provides novice bicyclists and pedestrians with a conservative transition to the bicycle lanes and sidewalk on Safford Avenue. In practice, most bicyclists, especially those who are repeat users, follow the more direct desire line movement ❷, even though no special bicycle facilities are provided for a short stretch of Safford Avenue.

Southbound bicyclists
Design movement ❸ provides bicyclists with a right angle crossing of Safford Avenue for accessing the trail. Desire line movement ❹ is likely used by bicyclists wanting a more direct return to the trail, and movement ❺ by those desiring an even more direct route to the trial southbound.

Recommendations
The overall design of this section of the trail seems to work well. Bicyclists negotiating the Safford Avenue/Pine Street intersection are not required to stop as are motorists. This performs adequately due to thoughtful design forcing turns and slow speed by bicyclists, and the low speed and volume of motor vehicles.

Bicycle lanes could be striped just north of Pine Street on Safford Avenue, though motorized traffic is quite benign here. The bicycle lanes would simply serve a continuous bicycle facilities function.

The sidepath jug handle enabling movement ❸ is a design most appropriate where the roadway carries significant traffic. This is not the case in this situation, so the design can be considered very conservative. The stop sign on Safford Avenue also makes a bicycling jug handle unnecessary. The bollard on the sidepath jug handle is an unnecessary motor vehicle deterrent and hazard to bicyclists.

The jug handle design is appropriate for pedestrians, however. Pedestrians are adequately accounted for with the use of the sidewalk, though future development in this area may necessitate the addition of a sidewalk on the east side of Safford Avenue.

The four-way stop at the trail jug handle crosswalk is overly restrictive. Either the trail or the roadway should be stopped, but not both.

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Case Study IV- Starkweather Creek Bicycle Path

Starkweather Creek Bicycle Path, Madison, Wisconsin

Description

This one mile long asphalt path provides an important commuter link to bicyclists in the northeast area of Madison with the downtown and University of Wisconsin areas. It also provides off-road access to the Madison Area Technical College.

The path terminus is on Anderson Street approximately 200 feet from the intersection with Wright Street. Both streets are four lanes, and no turning lanes are present. Anderson Street has wide outside lanes and Wright Street bicycle lanes. This intersection is signalized with pedestrian pushbuttons at all four corners.

A full width curb cut enables easy access to Anderson Street, and a widened sidewalk recognizes that some bicyclists will be more comfortable staying off-road en route to the Anderson Street/Wright Street intersection. Rounded corners at the path/sidewalk interface facilitate this transition.

Figure 7 shows this trail terminus and the typical bicyclist movements.

Rounded corners.

Bicycle paths are signed like roadways in Madison.

Case Study IV- Starkweather Creek Bicycle Path

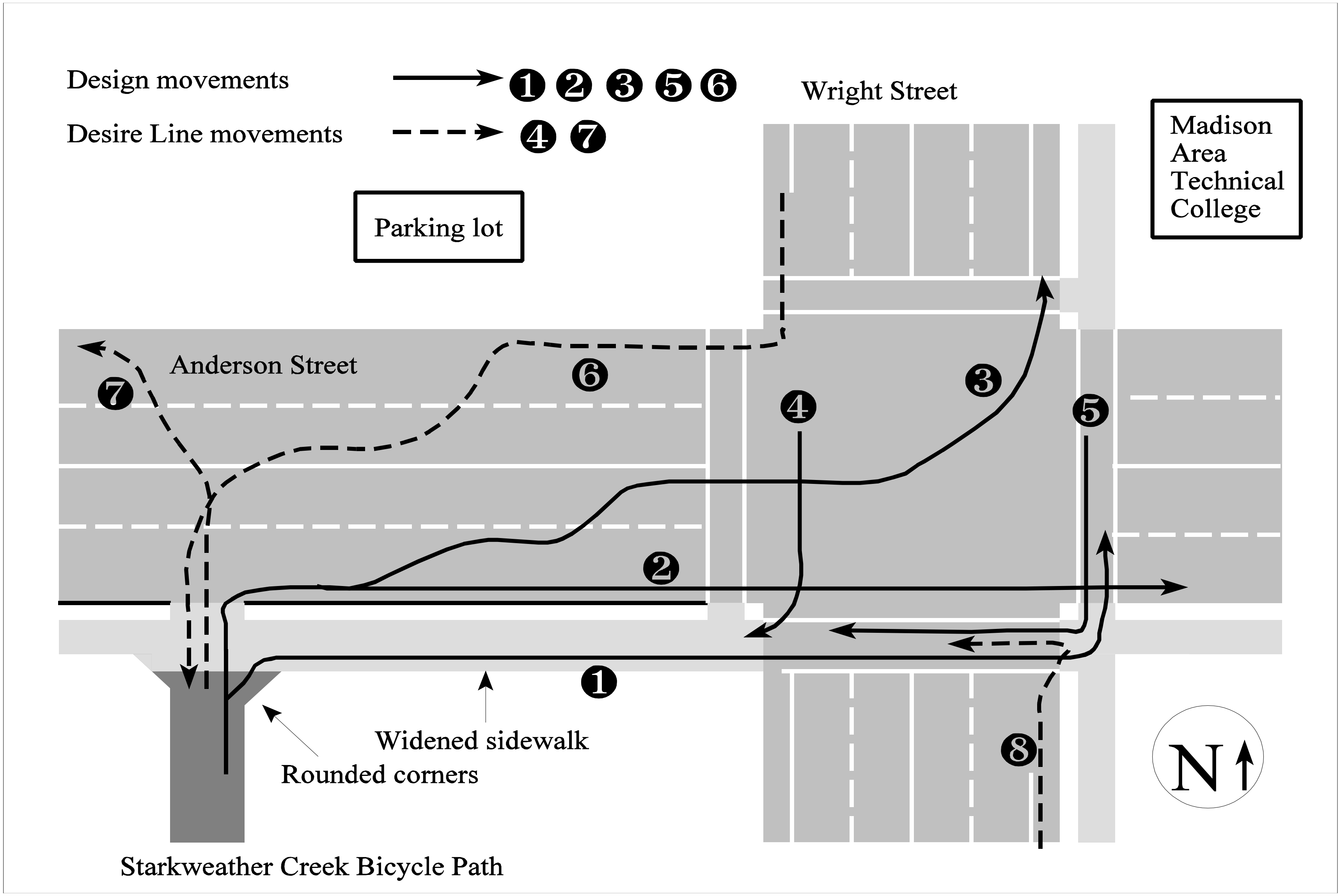


Figure 8. Starkweather Creek Bicycle Path, Madison, Wisconsin.

Case Study IV- Starkweather Creek Bicycle Path

Observations and Analysis
Most bicyclists that use the path are going to or coming from the Madison Area Technical College or further east on Anderson Street. The path terminus design allows the bicyclist the choice of using the roadway or the sidewalk, though the lack of a median refuge makes using the roadway less likely.

Exiting the path
Most bicyclists turn right heading east along Anderson Street and perform design movement ❶, riding on the sidepath, or ❷, using the curb cut to enter the street. “Design” movement ❸ is a vehicular style left turn, though no particular design feature facilitates this movement for bicyclists. It is just an option.

No provisions are made for bicyclists wishing to turn left onto Anderson Street, desire line movement ❼.

Accessing the path
Because of the difficulty of making a left turn due to the absence of a median refuge, desire line movement ❻ is not likely. Most bicyclists approaching from the north or east access the path via the widened sidewalk using movements ❹ and ❺. Bicyclists approaching from the south on Wright Street are likely to use movement ❽, a near side pedestrian style left turn.

Recommendations
Ideally, Anderson Street should have a median refuge area protected by raised curbing to better enable bicyclists exiting the path to cross and make a left turn onto Anderson Street, movement ❼. A refuge would also make accessing the trail via movement ❻ more practical.
Movement ❽ could be assisted by providing an advance curb cut on Wright Street, essentially creating a sidewalk jug handle, to make the 90 degree turn easier to perform.

These recommended changes are shown in Figure 8.

Case Study IV- Starkweather Creek Bicycle Path

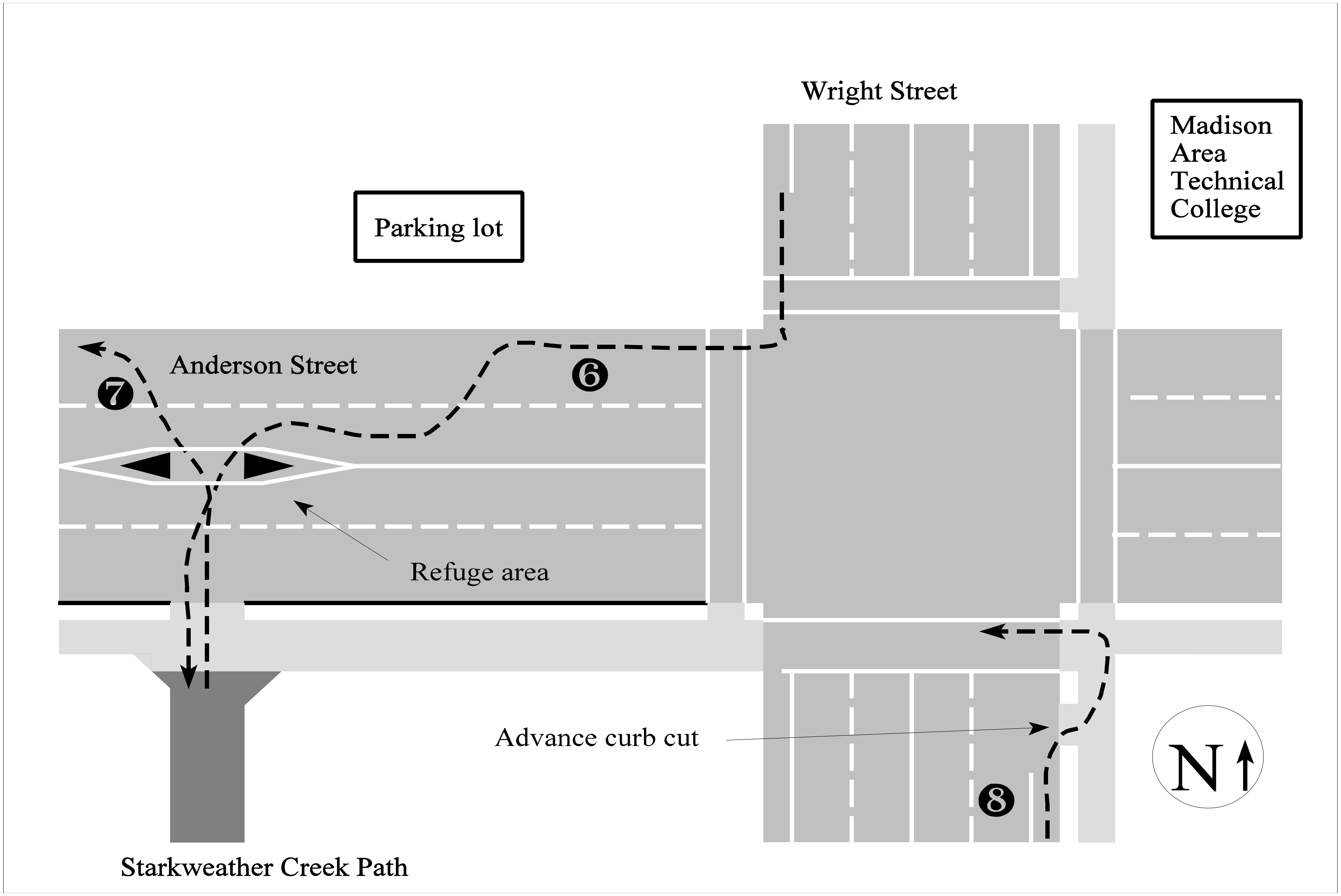
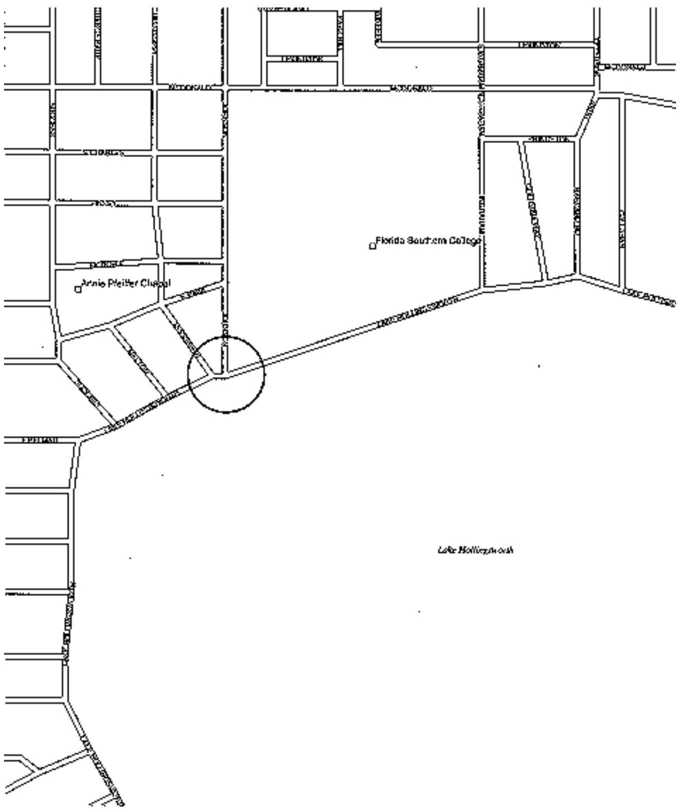


Figure 9. Starkweather Creek Path, Madison, Wisconsin. Depicted with recommended changes.

Case Study V- Lake Hollingsworth Trail

Lake Hollingsworth Trail, Lakeland, Florida.



The path encircles Lake Hollingsworth.

Description

This is a 2.8 mile long, bi-directional, asphaltic surface recreational trail which circles Lake Hollingsworth between the lake and Lake Hollingsworth Drive. Significant numbers of bicyclists, skaters, and pedestrians use the trail. To reduce conflicts with high speed bicyclists and other trail users, a bicycle lane was constructed on the lake side only of Lake Hollingsworth Drive.

Lake Hollingsworth Drive is a collector roadway with a posted speed limit of 30 mph and ADT of 9919. Johnson Avenue was formerly a bi-directional local street with an ADT of 2305 that has been reconstructed as a one-way roadway with motor vehicle travel restricted to the northbound direction. A northbound bicycle lane and a southbound contraflow bicycle lane are provided. A street scape style sidewalk, parking, and landscaping are also located on the right side of the roadway. Johnson Avenue provides access to the campus of Florida Southern College, Lake Morton, and the Lakeland Public Library. Neither signal nor sign control the intersection.

Figure 9 depicts the typical movements at this unique interface of facilities.

Case Study V- Lake Hollingsworth Trail

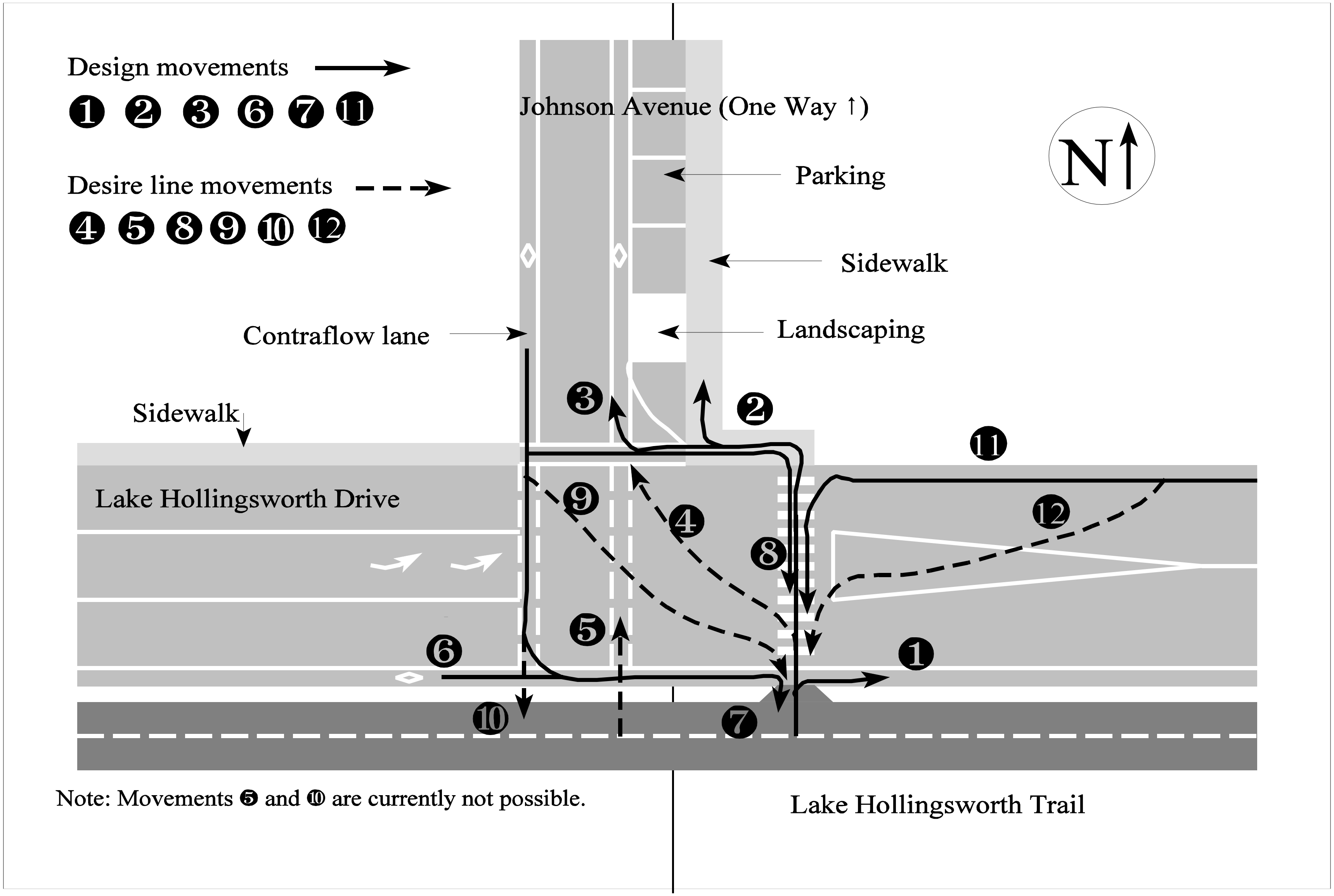


Figure 10. Lake Hollingsworth Trail, Lakeland, Florida.

Case Study V- Lake Hollingsworth Trail

Observations and Analysis

Exiting the trail

Design movement ❶ gives bicyclists curb cut entrance to the bicycle lane on Lake Hollingsworth Drive. Design movement ❷ directs bicyclists to the ladder crosswalk and then sidewalk. Design movement ❸ entails a similar course, but the bicyclist proceeds from the sidewalk to the bicycle lane on Johnson Street. Desire line movement ❹ is a more direct line to the bicycle lane.

Desire line movement ❺ would have the bicyclist cross Lake Hollingsworth Drive in the dashed bicycle lane crossing, but this maneuver is not possible without a curb cut.

Accessing the trail

Design movement ❻ gives bicyclists on the Lake Hollingsworth bicycle lane curb cut access to the path. Design movement ❼ entails crossing Lake Hollingsworth Drive in the dashed crossing lane from the contra-flow bicycle lane and making a 90 degree left turn to the bicycle lane, followed by a right turn through the curb cut. Design movement ❽ involves a near side pedestrian style left turn followed by a right turn to the ladder crosswalk and curb cut. Desire line movement ❾ is the natural line a bicyclist takes to enter the existing curb cut.

Desire line movement ❿ would have the bicyclist cross directly from the contra-flow lane to the path, but this maneuver is not possible without a curb cut. Movement ⓫ is a pedestrian style left turn and movement ⓬ is a vehicular style turn following the more natural line.

Recommendations

The pavement markings across Lake Hollingsworth Drive for the bicycle lanes on Johnson Avenue indicate what would be the efficient "design" crossing maneuvers, but the lack of curb cuts prevents direct connection to the trail. Provision of curb cuts would enable these movements, greatly simplifying and improving bicyclist access to and egress from the path. The existing curb cut would then be used principally by pedestrians, improving bicyclist and pedestrian separation. Novice bicyclists may also be less inclined to ride on the Johnson Street sidewalk. It may be beneficial to provide pavement markings in the new curb cuts indicating the correct direction of travel.

Figure 10 shows the principle bicyclist movements when the recommended curb cuts and other design improvements (as follow) are added.

The contra-flow bicycle lane is not supported by appropriate signs or pavement markings. A R1-1 bicycle stop sign should be erected to control bicyclists crossing Lake Hollingsworth Drive. EXCEPT FOR BICYCLES placards should be added to the ONE-WAY signs. Streets and major driveways along Johnson Avenue should have WATCH FOR BICYCLES ON LEFT signs. The contra-flow bicycle lane should be separated with a double yellow line.

Signs on Lake Hollingsworth Drive consist of bicycle advance warning W11-1 only. These should be augmented with W8-10 placards designating the intersection as a trail crossing.

Case Study V- Lake Hollingsworth Trail

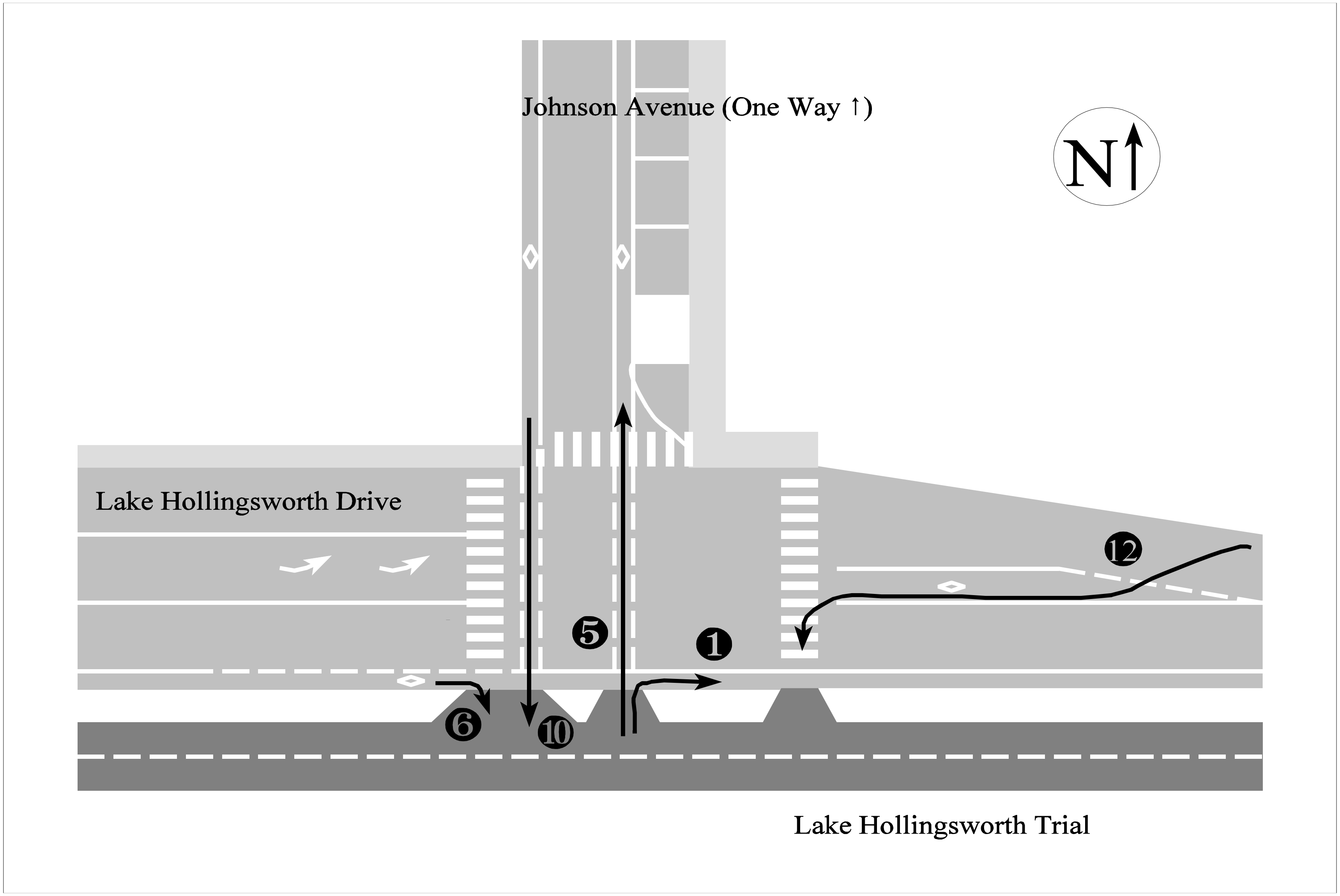


Figure 11. Lake Hollingsworth Trail, Lakeland, Florida. Depicted with recommended changes.

Summary

The crosswalk over Johnson Avenue should be the same ladder pattern as the Lake Hollingsworth Drive crosswalk. A ladder crosswalk for pedestrians should also be applied across Lake Hollingsworth Drive adjacent to the bicycle lane crossing on the west side of the intersection.

Ideally, the trail should have a larger setback from Lake Hollingsworth Drive to provide storage space for queued bicyclists trying to cross the roadway. Relocation of the trail would also increase the separation of time between roadway and trail conflicts that bicyclists face when accessing the trail.

The bicycle lane on Lake Hollingsworth Drive should be dashed on the approach to Johnson Avenue so as to not be overly restrictive for bicyclists wishing to turn left in the left turn lane. The painted median area could be re-striped as a bicycle only left turn pocket for west bound riders wishing to access the trail.

Summary

While all of the of the General Guidelines listed on page two are important, the first one is fundamental enough to justify repeating.

> Analyze the tasks of both trail users and motorists, and study the discrepancies between planned for and actual behavior. The design should take into account trail user desire lines.

Deviations between expected and actual behavior can be explained two ways:

- the behavior intended by the designer is too complex for the user—his skills are overestimated;
- the expected behavior is too inconvenient for the user.

Analyzing the tasks of the intended users should occur early in the design process and focus on trying to determine:

- the extent to which the expectations of the motorists and trail users will correspond regarding right-of-way;
- which mistakes trail users and motorists could make;
- how high the risk is that they will make these mistakes;
- how serious will making a mistake be. The severity of a mistake is largely determined by the direction, mass, and speed of vehicles.

The significance of designing trail intersections with consideration for trail user desire lines likewise cannot be over emphasized. The case studies described herein verify that trail users choose their route based on directness and personal comfort as much as on intersection design and traffic safety considerations.

The case studies demonstrate a variety of “real world” design problems and solutions. A split trail, sidewalk, sidewalk jug handle, median, pavement marking channelization, and simple curb cuts are used to facilitate the trail-roadway interface. The studies also illustrate that trails are best considered as non-motorized roads used by bicycle vehicles and pedestrians, each with their own unique design user characteristics and requirements.