Appendix B: Bicycle/Pedestrian Facilities Toolbox and Strategies

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FACILITIES & STRATEGIES TOOLBOX

Along with eliminating gaps in the existing sidewalk network, there are a number of potential treatments that can be used to improve the bicycle and pedestrian network in Ames. These treatments include shared use paths, shared lane markings ("sharrows"), bicycle lanes, paved shoulders, and intersection improvements. Each of these facility types should be planned and design based on the guidance contained in the *AASHTO Guide for the Planning, Design, and Operations of Bicycle Facilities* (although this reference is currently in draft form as of February 2010, the ultimately adopted version should be used) and ITE's *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach.*

SHARED USE PATHS

Shared use paths are bikeways that are physically separated from motorized vehicle traffic by an open space or barrier and either within the roadway right-of-way or within an exclusive right-of-way. Shared use paths may also be used by pedestrians, skaters, wheelchair users, joggers, and other non-motorized users. While it is generally preferable to focus the attention of additional shared use paths on those facilities in exclusive rights-of-way, it is acknowledged that much effort has been placed in the existing system of sidepaths in Ames, and there are a number of projects that provide worthwhile connections and extensions of this system. These connections and extensions are reflected in the list of proposed shared use path projects in the plan.

As noted previously, there is a need for continuity in the system of shared use paths, including width. AASHTO recommends shared use paths generally be 10 to 14 feet wide; paths may be as narrow as 8 feet but only in rare circumstances with limited bicycle traffic, only occasional pedestrian traffic, horizontal and vertical alignments that provide safe and frequent passing opportunities, and where the path will not be subject to regular maintenance vehicle loadings which may cause pavement edge damage.

It is recommended that the City complete a thorough evaluation of all its pathways to determine where improvements in the existing network may be needed to address issues such as narrow widths, obstructions, poor surface condition, cross slopes greater than 1 percent, sudden changes in width or presence of the path, and poor intersection crossing conditions. Further, the City should establish a formal hierarchy of pathways, clarify snow removal policies for pathways, and provide a wayfinding/routing system based on the established hierarchy with kiosks providing maps at key locations.

SHARED LANE MARKINGS ("SHARROWS")

Shared Lane Markings, also known as "Sharrows", are markings that are used in lanes that are shared by bicycles and motor vehicles when a travel lane is too narrow to provide a standard-width bicycle lane. The markings have been incorporated into the 2009 version of the MUTCD. They let motorists know to expect bicyclists, provide lateral positioning guidance to bicyclists, and reinforce good bicycling behavior through the following:

- Discourage bicycle riding within the "door zone" on streets with on-street parking.
- Encourage bicyclists to ride further out into the travel lane rather than hugging the curb, which encourages motorists to give bicyclists more space when passing, rather than squeezing by.
- Discourage wrong-way bicycling.
- Discourage sidewalk bicycling, which is statistically more dangerous than riding with traffic in the roadway.

Situations for Use

- On roadways too narrow for bicycles and motor vehicles to share side by side (typically less than 14-feet wide).
- On roadways with on-street parking.
- Where there are gaps in a bicycle lane (use before a bicycle lane begins or after a bicycle lane ends).
- For designated bicycle routes.
- On a roadway with a hill where there is only enough width to provide a bicycle lane in one direction (provide an uphill bicycle lane, and sharrows in the downhill direction).

General Design Guidance

- Use only on roads with posted speeds of 35 mph or less.
- The MUTCD recommends placement after intersections and not more than every 250 feet thereafter. Other agencies have found that the 250-foot spacing is preferred on roadways with on-street parking, but greater spacing is acceptable for roadways without on-street parking (up to 500 feet).
- On roadways with on-street parking , place laterally a minimum of 11 feet from face of curb or edge of pavement to the center of the marking; a 13-foot lateral placement is preferred, which ensures the centers of the markings are completely outside the "door zone" of larger vehicles such as trucks and SUVs. Bicycle riding within the "door zone" is hazardous, particularly at the edge, where a bicycle handlebar could catch an open door, throwing the cyclist into traffic. For this reason, it is strongly recommended to exceed the minimum lateral placement of the markings from the MUTCD.
- On roadways without on-street parking, the centers of the markings should be placed in the outside lane a minimum of 4 feet from the face of curb or edge of roadway; in lanes 12 feet wide or narrower, it is preferred to place the markings in the center of the lane because lanes of this width are too narrow for a bicycle and motor vehicle to safely share.
- Bicycle warning signs with Share the Road supplemental plaques can be used in conjunction with markings. This may especially be helpful for the first few applications of the markings to help motorists and bicyclists alike understand the meaning of the markings. However, it is recommended to limit the use of these signs so as to limit the amount of sign clutter.

BICYCLE LANES

Bicycle lanes are the portion of a roadway which has been designated by striping, singing, and pavement markings for the preferential or exclusive use of bicyclists. They are most appropriate and most useful on arterial and collector streets. Typically, unless traffic volumes are heavy, bicycle lanes are not needed on residential or local streets.

General Design Guidance

Bicycle lanes should be designed to the minimum standards contained in the *AASHTO Guide for the Planning, Design, and Operation of Bicycle Facilities.* The following are minimum or preferred characteristics:

- Minimum width (no curb and gutter) is 4 feet.
- Minimum width (with curb and gutter) is 5 feet measured from the face of curb. It is desirable to maintain a smooth longitudinal joint between the pavement and the gutter pan. However, if the joint is not smooth, 4 feet of ridable pavement surface should be provided.

- If a full-width bicycle lane cannot be provided, consider providing a wide curb lane/outside travel lane or use shared lane markings.
- If on-street parking is permitted, bicycle lanes should always be placed between the parking lane and the travel lane and have a minimum width of 5 feet. However in areas with substantial parking volume or high turnover, bicycle lane widths adjacent to parking are often increased to 6-7 feet, while the parking width is limited to as little as 7 feet. A narrower parking lane encourages motorists to park closer to the curb. Providing 14 feet for the combined parking lane/ bicycle lane is preferred as it allows cyclists to ride completely outside the "door zone".
- Bicycle lanes should be designated by pavement markings and signs so that more bicyclists will recognize the lanes as an area of the roadway that has been set aside for them to ride, and that they are to ride with traffic when using the bike lane. Riding in the correct direction with traffic can be reinforced through the use of "WRONG WAY' (R5-1b) and "RIDE WITH TRAFFIC" (R9-3cP) signs mounted so that they face bicyclists riding against traffic.

Benefit

- Perceived to encourage bicycling. Studies have shown increased levels of bike commuting trips based on proximity to bicycle facilities.
- Serve as a symbol to many that "bicyclists belong on the road rather than the sidewalk".
- Encourage more predictable behavior by both motorists and bicyclists.
- Allow motorists to pass bicyclists with less delay and with fewer passing conflicts.
- Increased border width to fixed objects.
- Increased turning radius into and out of intersections and driveways.
- Improved sight distances when exiting driveways.
- Buffer to sidewalks and pedestrians.
- Buffer increases comfort of pedestrians and people exiting parked cars.

The "right hook"

- Traffic calming (narrower travel lanes can be adopted).
- Improved turning for trucks and transit.
- Space for disabled vehicles, mail delivery, bus stops, and place for cars to pull into when emergency response vehicles pass.
- Provide structural support to the pavement.

- Discharge water further from the travel lanes.
- Accommodate driver error.
- Provide more intersection and safe stopping sight distance.

Issues/Cautions

- Bicycle lanes at intersections and driveways that are placed to the right of potential right turning vehicle traffic may encourage poor behavior by through bicyclists and right turning motorists and may cause conflicts (i.e., "right hooks"). Bicycle lane striping should be dashed for, at minimum, the last 50 feet prior to an intersection if there is no exclusive right turn lane placed to the right of the bicycle lane. Bicycle lane striping should also be dashed in front of major driveways (those with a significant right turning volume), but can remain solid across minor driveways. To prevent conflicts with right turning vehicles, bicycle lanes must always be placed to the left of exclusive right turn lanes.

(Top) *An example of a bike lane located within the "door zone" of the adjacent parallel parking lane.* (Bottom) *Providing a striped buffer between on-street parking and a bicycle lane is a potential design solution to encourage riding outside the "door zone".*

- Extreme care should be used in providing sufficient bicycle lane width adjacent to parallel on-street parking. Bicyclists should never ride or be forced or encouraged to ride within 3 feet of a parked car (the "door zone"). Crashes involving a bicyclist and an opening car door have **very high potential for serious injury and death.** The *AASHTO Guide for the Planning, Design, and Operation of Bicycle Facilities* illustrates a combined parking lane/bicycle lane of 11 feet (measured from the curb face to the inside bicycle lane stripe), and recommends 13 feet for areas with "substantial parking turnover" (e.g. commercial areas); however, with these dimensions, a bicyclist who rides in the center of the bicycle lane will be within the "door zone." Providing 14 feet for the combined parking lane/bicycle lane allows cyclists to ride completely outside the door zone. Designers should consider not striping a bicycle lane in places where right-of-way or pavement width are insufficient to provide 14 feet; shared lane markings can be used in lieu of bicycle lanes where insufficient width exists to provide a wide enough bicycle lane to ensure safety.
- Bicycle lanes often collect debris and broken glass, and are often overlooked in maintenance and repair, which can potentially make them (or sections of them) unusable. For this reason, it is important to establish a regular program of street sweeping and repair to ensure that bicycle lanes will be usable and free of debris, glass, and potholes.

Implementation Guidance

- Bicycle lanes (and pedestrian facilities) should be considered for implementation on all new roadway projects and resurfacing projects.
- Where possible, roadway lanes should be narrowed for inclusion of signed and marked bicycle lanes. Roadway lanes can be narrowed to 11 feet in nearly all cases, and can be narrowed to 10 feet on urban roadways having low volumes of truck traffic, generally less than 10%. Lanes as narrow as 10 feet can safely accommodate traffic on lower speed roadways. Generally, the outside lane of a roadway needs to be a minimum of 14 feet wide (not including gutter width) to include a standard signed and marked bicycle lane.

This road in Panama City Beach, FL has 10-foot lanes (which easily accommodate large trucks) adjacent to 5-foot designated bike lanes (4 feet of asphalt, plus gutter pan).

- Incorporate bicycle lanes (and other bicycle and pedestrian improvements) into larger funded projects.

A "road diet" project converted Edgewater Drive in Orlando, FL from a 4-lane undivided roadway to 2-lanes with center turn lane and bicycle lanes.

- On roadways with excess vehicle capacity, one or more travel lanes can be eliminated in favor of bicycle lanes and other features such as left turn lanes or on-street parking. This type of roadway project is known as a "Road Diet". The most common type of road diet project is to convert a four-lane undivided roadway to a two-lane roadway with continuous two-way center turn lane and bicycle lanes. On roadways with only two through lanes, prevailing speeds tend to be lower since prudent drivers control the speed of traffic. In other communities across the country, 4-lane roadways with volumes commonly as high as 15,000 vehicles per day have been successfully converted to 3-lanes with little, if any, decrease in traffic volumes. Additionally, these conversions typically result in a significant reduction in the number of crashes, allow the inclusion of on-street bike lanes (generally resulting in a better level of service for both bicyclists and pedestrians), and offer improvements for pedestrian crossings (with median islands, pedestrians can cross one direction at a time with refuge in the center).

The proposed plan includes two road diet projects, one on Duff Avenue and 30th Street, between 13th Street and Hoover Avenue and the other on Lincoln Way between Grand Avenue and Duff Avenue. However, there are other potential candidate roadways that should be considered for future road diets if the Duff Avenue project is judged to be successful. Criteria for other potential projects are existing 4-lane undivided roadways that have future 2035 projected volumes of 15,000 vehicles per day or lower.

PAVED SHOULDERS

Paved shoulders represent the portion of the roadway contiguous with the traveled way, for accommodation of stopped vehicles, emergency use and lateral support of sub-base, base and surface courses, often used by cyclists. They are typically used on rural roadways and highways, and are beneficial for cyclists on roadways that have higher speeds or traffic volumes. Paved shoulders can also provide a place for pedestrians to walk in locations where there is no sidewalk and the roadside is not suitable for walking. Considerations for paved shoulders include the following:

- Use a minimum width of 4 feet, increasing to at least 5 feet if adjacent to curb, guardrail, or other roadside barrier. Wider paved shoulders should be considered in areas with high bicycle usage, a high volume of heavy vehicles, or high speeds (greater than 50 mph).
- To prevent loose gravel from spilling onto the paved shoulder or travel lane, it is advised to pave the first 10-30 feet (or to the right-of-way line) of all unpaved driveways and cross streets.
- If rumble strips are used, a minimum 4-foot clear path from the edge of the rumble strip to the edge of pavement should be provided. Additionally, periodic gaps in the rumble strips should be provided to allow cyclists to cross over them as needed; gaps of at least 12 feet every 40 to 60 feet provide sufficient opportunities for cyclists.

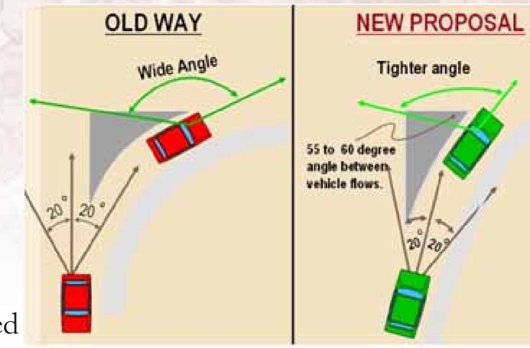
INTERSECTION IMPROVEMENTS

Intersections are places of managed conflict, and are often very intimidating places for pedestrians and bicyclists. The conflicts at intersections is often why pedestrians are witnessed crossing streets away from intersections. Efficiently designed intersections keep numbers of lanes and lane widths under control and costs of roadway systems affordable. Conflict reducing designs provide for: low speed entries and turns, separation of conflicts in time and place, positive guidance, and operations clarity. Intersections can be kept compact and efficient through a combination of appropriately narrow lanes, appropriate curb radii, and curb extensions. Effective use of curb extensions, especially when on-street parking is used, is a common way to assure safe and easy access to streets, minimize pedestrian crossing distances, and maximize the efficiency of signal cycles and intersection performance.

At left, *a poorly designed intersection that fails in safety and efficiency.* At the right, *an example of how the same intersection could be modified to be efficient and safe for pedestrians and motorists alike. The improved condition takes advantage of channelizing islands, medians, median noses and other compact intersection tools. People friendly intersections are capable of moving more traffic than older, larger designs. Due to medians and islands, the crossing distance at the improved intersection would decrease from 177 feet to 50 feet of actual lane exposure.*

Specific features that should be considered to help improve an intersection for non-motorized users include the following:

- **High visibility crosswalk markings –** Well marked crosswalks are essential to good walking environments and alert motorists to pedestrian conflict areas, increase motorists yielding to pedestrians, enhance motorists' recognition of intersections, assist people with visual impairment in their crossings, and attract pedestrians to the best crossing places with the most appropriate sight distances. Zebra or ladder style crosswalk markings are more visible to motorists and should be used in areas of high pedestrian activity or crossing of special emphasis, such as shared use paths. Ladder style markings are preferred by visually impaired people, since the ladder rails (shore lines) help guide them across streets.



- **Right turn channelization –** Overly wide intersections discourage pedestrian use. Right turn channelizing islands (sometimes called "pork chops") minimize pedestrian crossing times and distances. At signalized intersections, the use of right turn islands also reduces the required pedestrian signal clearance interval time (flashing don't walk) due to the shorter crossing distance. However, the current designs of most right turn islands are not friendly to pedestrians, nor as safe as they need to be for mixing pedestrians and motorists. The typical right turn channelization results in higher speeds, less visibility for pedestrians, and more sightline issues for motorists (who have to greatly turn their head to check for gaps in traffic). In contrast, the new approach (sometimes referred to as "Australian rights" or "Gap Acceptance Right Turns"), provides tighter angles, better pedestrian visibility and crossing safety, and improved motorist sightlines. For crossings of channelized right turn lanes where motorist yielding behavior may be problematic, consider raised speed tables between the edge of the roadway and the island. Raised crossings at these locations have proven to increase the instances of motorists yielding to pedestrians and slow speeds in advance of right turns.

- **Median noses -** Median noses can be used to help provide a protective refuge for any pedestrians caught in the middle of the street during a crossing, and also help to control the speeds of left turning vehicles. Noses can be deep (6-12 feet), shallow (2-4 feet), or set behind crosswalks when no further extensions are possible. In rare cases, crosswalks can be skewed a few degrees in order to get median noses to fit when considering vehicle turning paths, although more than a few degrees of skew can be problematic to blind people. Although it is not possible to get median noses on all legs of all intersections, careful attention to design can get placements in many locations.

- **Pedestrian signals -** All signalized intersections require well maintained pedestrian signal heads on all legs. When signal heads are omitted pedestrians may not know when they are permitted to cross. Pedestrian countdown signals end much of the confusion that standard signal heads create ("I only had four seconds to cross the street before the hand started to flash at me"), and give a clear idea of actual time left to complete the crossing. Countdown signals should be used on all new construction projects, and should be used as a retrofit replacement of older pedestrian signals, particularly on multi-lane roadways. In addition, careful attention should be paid to pedestrian clearance intervals. Per the 2009 MUTCD, walking rates of 3.5 feet per second, with 3.0 feet per second in areas with a significant population of seniors or those with disabilities, should be used to determine the length of flashing don't walk intervals. The walk phase for crossings should be no less than 4 seconds, with a minimum 7 seconds a more common time.

- **Leading pedestrian interval -** Provides the pedestrian a head start in crossing at a signalized intersection (typically 3-5 seconds) before motor vehicle traffic is given a green light, and thereby helps to reduce pedestrian conflict with turning vehicles.

- **Yield to Pedestrian blank-out signs -** These signs increase awareness of crossing pedestrians at intersections. Signs typically read "Yield to Pedestrians" during the concurrent movement green signal phase; this message can be displayed automatically during all signal cycles or only when the pedestrian phase has been actuated. During conflicting movement phases, the sign can either be blank, or can read "No Rights on Red" if it desired to prohibit this movement for the benefit of pedestrians legally crossing the path of the right on red movement.

- **Bicycle detection -** Bicycle detector markings show bicyclists the proper positioning at an intersection to trigger a green light. If inductive loops are used for detection, the marking should be placed over either a separate bicycle-specific loop detector (typically in a bicycle lane), or over the most sensitive part of a typical vehicle loop detector. Complimentary signage (R10-22) can be used to reinforce the message to cyclists. Relative to other detection technologies, many agencies have had more success with video detection than microwave or radar technologies in detecting bicyclists.

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