CHAPTER 9. DESIGN GUIDELINES

9.1. INTRODUCTION

In developing and implementing the Comprehensive Local-Regional Bikeways Plan, MVRPC is demonstrating its commitment to improving bicycling in the Miami Valley. When looking to implement on- and off-street bikeways throughout the region, the standard design manuals offer limited solutions.

The design concepts presented in this chapter are based on current bikeway design guidelines for typical bikeway situations provided in the Ohio Department of Transportation (ODOT) Guidelines for the Design of Bicycle Facilities, the American Association of State Highway and Transportation Officials (AASHTO) Guide for the Development of Bicycle Facilities, and the Manual on Uniform Traffic Control Devices (MUTCD) 2003, Part 9 Traffic Controls for Bicycle Facilities. The design guidelines use these documents as a baseline for minimum conditions, and are intended to facilitate creative solutions for a wide range of bicycle facility types. These treatments draw upon creative solutions used in other states as well as European cities. These designs are conceptual at this stage, and must be reviewed further before being applied to actual situations. Strong design guidelines will allow MVRPC and local entities to improve the quality of the bikeway network by applying the highest standard of bicycle safety, comfort, and convenience.

The following are key principles for these guidelines:

- All roads in the Miami Valley are legal for the use of bicyclists, (except those roads designated as limited access facilities which prohibit bicyclists). This means that most streets are bicycle facilities, and should be designed and maintained accordingly.

- Bicyclists have a range of skill levels, ranging from inexperienced and casual riders (e.g., children and recreational cyclists) to utilitarian and experienced cyclists (e.g., adults who are capable of sharing the road with motor vehicles). These groups are not always exclusive – some elite level athletes still like to ride on shared use paths with their families, and some recreational bicyclists will sometimes use their bicycles for utilitarian travel.

- At a minimum, facilities should be designed for experienced cyclists, with a goal of providing for less experienced cyclists to the greatest extent possible. In areas where specific needs have been identified (for example, near schools) the needs of appropriate types of bicyclists should be accommodated.

- Design guidelines are intended to be flexible and can be applied with professional judgment by designers. Specific national and state guidelines are identified in this document, as well as design treatments that may exceed these guidelines.

- The Miami Valley should have a complete network of on-street bikeways connecting seamlessly with existing and proposed shared use paths. These two systems should be interconnected to make it possible for all destinations in the region to be accessible by bicycle.

9.2. NATIONAL AND STATE GUIDELINES/BEST PRACTICES

The following is a list of references and sources utilized to develop design guidelines for the Comprehensive Local-Regional Bikeways Plan. Many of these documents are available online and are a wealth of information and resources available to the public.
9.3. BICYCLE FACILITY TYPES

Table 26 summarizes the most common on- and off-street bikeway facility types. The table describes functions associated with each facility type, along with general design features. The following sections describe the various bikeway types and appropriate design elements in greater detail.

Table 26. Bicycle Facility Types and Design Elements

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Width</th>
<th>Surface</th>
<th>Treatment</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bike Lanes</td>
<td>5'-6'</td>
<td>Asphalt</td>
<td>On-street lane striped and signed to ODOT standards</td>
<td>For bicyclists on roadways</td>
</tr>
<tr>
<td>Shoulder Bikeways</td>
<td>4'-8'</td>
<td>Asphalt</td>
<td>Appropriate on rural roads; gravel driveway approaches should be paved to prevent gravel from spilling onto the shoulder</td>
<td>Accommodate bicyclists (and sometimes pedestrians) on rural roadways</td>
</tr>
<tr>
<td>Signed Shared</td>
<td>Varies</td>
<td>Asphalt</td>
<td>May either be a low volume (less than 3,000 cars per day) roadway with traffic calming and</td>
<td>Used for designated bicycle routes; can include signage and pavement</td>
</tr>
</tbody>
</table>
Facility Type | Width | Surface | Treatment | Function |
--- | --- | --- | --- | --- |
Roadways | | | signage to create a safe shared use environment; OR a higher volume roadway with wide outside lanes (14'-16') | markings |
Bicycle Boulevards | Varies | Asphalt | Multiple traffic calming treatments combined with bike lanes and/or signed shared roadways to create priority streets for bicyclists | Provides a continuous facility on streets with varying widths, volumes and speeds |
Wide Curb Lanes | 12'-14' | Asphalt | Smooth pavement, bicycle compatible storm grates | For skilled bicyclists who are capable of sharing the road with motor vehicles |
Shared Use Paths | 10'-14' | Asphalt, concrete or other smooth hard surface | Designed to ODOT standards; separated from roadway by planting strip or vertical curbing | Typical application for regional and local paths; accommodates bicyclists, pedestrians, wheelchairs; minimizes potential path crossing conflicts with autos |

### 9.4. BIKE LANES

Designated exclusively for bicycle travel, bike lanes are separated from vehicle travel lanes with striping and also include pavement stencils. Bicycle lanes are most appropriate on Arterial and Collector streets where higher traffic volumes and speeds indicate a need for greater separation.

Many commuter bicyclists would argue that on-street facilities are the safest and most functional facilities for bicycle transportation. Bicyclists have stated their preference for marked on-street bicycle lanes in numerous national surveys. The fact is that many bicyclists – particularly less experienced riders – are far more comfortable riding on a busy street if it has a striped and signed bike lane. Bike lanes help to define the road space for bicyclists and motorists, reduce the chance that motorists will stray into the cyclists’ path, discourage bicyclists from riding on the sidewalk, and remind motorists that cyclists have a right to the road. One key consideration in designing bike lanes in an urban setting is to ensure that the bike lane and adjacent parking lane are wide enough so that cyclists have enough room to avoid a suddenly opened vehicle door. Table 27 summarizes appropriate bike lane widths under various circumstances.

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIKE LANE WIDTH</td>
</tr>
<tr>
<td>RECOMMENDED GUIDELINE:</td>
</tr>
<tr>
<td>Bike lanes alongside parking lanes should be at least 5’ wide. They may be widened to 6’ if space is available and the parking lane has been widened to 9’. Bike lanes alongside curbs should be at least 4’ wide exclusive of gutter pan. This is due to the following:</td>
</tr>
<tr>
<td>Debris tends to collect in the gutter, having been swept there by passing motor vehicles</td>
</tr>
<tr>
<td>An increased likelihood of hitting a pedal on the curb by riding in/too close to the gutter</td>
</tr>
<tr>
<td>An uneven longitudinal joint leads to increased crashes</td>
</tr>
<tr>
<td>A steeper cross slope in the gutter pan</td>
</tr>
<tr>
<td>A bicyclist riding close to the curb is less likely to be seen by motorists at cross streets</td>
</tr>
<tr>
<td>Bicycle lanes wider than 5’ alongside parking lanes may be desirable under one or more of the following conditions:</td>
</tr>
<tr>
<td>Traffic volumes (including truck or bus volumes)/speeds are high</td>
</tr>
<tr>
<td>Bicycle volumes are high</td>
</tr>
<tr>
<td>Wider bike lane will not encourage illegal parking or driving in the bicycle lane to bypass congestion</td>
</tr>
<tr>
<td>MINIMUM STANDARD:</td>
</tr>
<tr>
<td>The minimum bike lane width standard should be 5’ (exclusive of gutter pan). The minimum width standard adjacent to on-street parking should be 5’.</td>
</tr>
</tbody>
</table>
PARKING LANE WIDTH
RECOMMENDED GUIDELINE:
The recommended guideline for parking lane width is 8’. Parking lanes may be of narrower width if specifically required for other modes, with preference to transit over motor vehicle traffic. 9’ parking lane width is recommended where one or more of the following conditions exists (assuming space is available):
Parking turnover is high (metered parking, commercial areas)
Higher concentration of wide vehicles in parking lane (trucks, buses, etc.)
It is preferable to narrow travel lanes to encourage slower speeds
Widening the parking lane moves the bike lane away from the curb and keeps motorists near the middle of the road, increasing sight distances for traffic on cross-streets
MINIMUM STANDARD:
The minimum parking lane width standard should be 7’.

TRAVEL LANE WIDTH
RECOMMENDED GUIDELINE:
Travel lanes adjacent to a bike lane should be at least 11’ wide. Travel lanes can be as wide as 14’ in specific instances where it is necessary to provide additional roadway space. In the absence of designated truck routes and/or high capacity transit lines, additional curb to curb width should be allocated according to the following priority: (1) bicycle and pedestrian circulation, (2) transit operations, and, (3) private vehicle operations.
MINIMUM STANDARD:
The minimum standard for travel lane width should be 10’.


Part 3 of the MUTCD covers roadway markings, while Part 9 addresses signs, pavement markings and highway traffic signals specifically relating to bicycle operation on both roadways and shared use paths.

Section 3B.22 (Preferential Lane Word and Symbol Markings), Section 9C.04 (Markings for Bike Lanes) and Section 9B.04 (Bicycle Lane Signs (R3-17, R3-17a, R3-17b)) provide the baseline standard for striping, marking and signing bike lanes.

Section 3B.22 – Preferential Lane Word and Symbol Markings

The standard states, “When a lane is assigned full or part time to a particular class or classes of vehicles, preferential lane markings shall be used. Signs or signals shall be used with preferential lane word or symbol markings. All preferential lane word and symbol markings shall be white. All preferential lane word and symbol markings shall be positions laterally in the center of the preferred-use lane.” The standard continues by noting that, “Where a preferential lane use is established, the preferential lane shall be marked with one or more of the following symbol or word markings for the preferential lane use specified:…..Bicycle lane – the preferential lane use marking for a bicycle lane shall consist of a bicycle symbol or the word marking BIKE LANE.” Figure 32 depicts an example of bike lane markings.
Section 9C.04 – Markings for Bike Lanes

The guidance notes that, “Longitudinal pavement markings should be used to define bicycle lanes.” The standard states that, “If used, the bicycle lane symbol marking shall be placed immediately after an intersection and other locations as needed. The bicycle lane symbol marking shall be white. If the word of symbol pavement markings are used, Bicycle Lane signs shall also be used, but the signs need not be adjacent to every symbol to avoid overuse of the signs.”

Section 9B.04 – Markings for Bike Lanes

The standard for Bicycle Lane Signs states, “The BIKE LANE (R3-17) sign shall be used only in conjunction with marked bicycle lanes as described in Section 9C.04, and shall be placed at periodic intervals along the bicycle lanes.”

It is recommended to place bike lane stencils to alert motorists and cyclists of the exclusive nature of bike lanes. For long street segments with few intersections, the appropriate frequency of stencils is calculated by multiplying the street’s design speed by 40. For instance, stencils should be placed every 1,400 feet on streets with a 35 MPH design speed.

9.4.2. Other Bike Lane Treatments

Addressing Drainage Grates and other Obstacles

Bike lanes should be provided with adequate drainage to prevent ponding, washouts, debris accumulation and other potentially hazardous situations for cyclists. Drainage grates should be bicycle-safe (see Figure 33). When an immediate replacement of an incompatible grate is not possible, a temporary correction of welding thin metal straps across the grates perpendicular to the drainage slots (4 to 5 inches apart, center-to-center spacing) should be considered. Bike lanes should also have a smooth riding surface, and utility covers should be adjusted flush with the street surface. Furthermore, raised pavement markings (e.g., reflectors and truncated domes) can cause steering difficulties for bicyclists, and should not be used to delineate bike lanes.

9.5. SHOULDER BIKEWAYS

On most rural roadways, shoulder bikeways are appropriate, accommodating cyclists with few conflicts with motor vehicles. A four to six-foot wide paved shoulder is recommended to allow a cyclist to ride far enough from the edge of the pavement to avoid debris, yet far enough from passing motorists to avoid conflicts (see Figure 34).
肩道自行车道可以在自行车使用量高的道路上添加，如在半农村住宅区或靠近市区的地方。在学校的区域或其他使用率高的地方，用条纹和标记肩道作为自行车道可能是合适的。即使在交通量适中的道路上也应添加标线和测量的肩道，可以改善道路上骑自行车者的情况。在交通量高的道路上添加全宽的肩道可能在地形不佳的区域是必要的。

9.6.  共享道路

共享道路通常是最常见的自行车道类型，它们是交通量较低的街道，配备适当的限速标志，让自行车和汽车可以共享相同的行驶车道。这些街道通常有两条车道，有或没有邻接的路边停车。高交通量的街道也可以设计为共享道路，前提是其外侧车道要足够宽（14-16英尺宽）。应该注意的是，街道上的较宽外侧车道只吸引有经验且自信的骑自行车者。

下面的章节描述了各种共享道路的处理方法。

9.6.1. 自行车大道

较低交通量的街道，如果增加额外的设施来满足自行车的需求，通常被称为“自行车大道”。自行车大道是通过交通缓冲措施和其他街景处理来开发的，目的是降低交通量并提供安全和方便的自行车旅行。适当的处理方法取决于许多因素，包括交通量、车辆和自行车的循环方式、街道的连通性、街道的宽度、物理约束和其他参数。大多数自行车大道都可以通过相对低成本的措施，如新标牌、铺装标记和信号改善来提供相对便宜的处理方法，以提高自行车道的使用和安全性。其他潜在的处理方法包括路缘扩展、中央分隔带、路边停车分隔带和其他在合理成本内且与除雪和紧急车辆通行相兼容的措施。应该注意的是，许多自行车大道的处理都可以同时改善行人。路缘扩展，例如，可以降低机动车在街道上的速度，通过创建一个视觉“狭颈”来影响机动车。它们也可以缩短行人过街的距离，从而改善行人环境。

自行车大道应用

下面的章节描述了几个自行车大道的实例。这些处理方法根据它们的“强度”水平，以五个主要类别分组，其中Level 1代表最低强度的处理方法，它在相对低成本下可以实施。应该注意的是，每个连续的应用“级别”也可能包括（如必要）前一应用的处理方法。此外，某些处理方法可以属于多个类别，因为它们可以实现多个目标。

**Level 1: 标牌**

自行车道标牌是一个相对低成本且有效的处理方法，它可以改善自行车道环境，尤其是在交通量适中且相对低成本的自行车道上。标牌下面可以服务作为导航和安全目的。
Wayfinding Signs

Bicycle wayfinding signs should be installed along the Miami Valley’s bicycle boulevards and other cycling routes.

MUTCD Guidelines

There are no standards prescribed for wayfinding or guide signs in the current MUTCD. However, there are several sections that do address wayfinding signage along bicycle routes.

**Section 9B.19 – Bicycle Route Guide Signs** provides the following guidance: “If used, Bicycle Route Guide (D11-1) signs should be provided at decision points along designated bicycle routes, including signs to inform bicyclists of bicycle route direction changes and confirmation for route direction, distance, and destination. If used, Bicycle Route Guide signs should be repeated at regular intervals so that bicyclists entering from side streets will have an opportunity to know that they are on a bicycle route.

**Section 9B.20 – Bicycle Route Signs** provides the option of establishing a unique identification (route designation) for a State or local bicycle route using the Bicycle Route (M1-8) sign.

**Section 9B.21 – Destination Arrow and Supplemental Plaque Signs** for Bicycle Route Signs provides the option of mounting Destination (D1-1b and D1-1c) signs or directional arrow signs (M7-1 through M7-7) below the Bicycle Route Guide sign to furnish additional information.

Optional Signage Design

Shown in Figure 35, the City of Portland, Oregon has found great success in using a slightly different bicycle route sign than identified in the MUTCD. The City of Portland sign differs in three primary ways:

- It incorporates the Bicycle Route Guide Sign, the Destination Arrow, and the Directional Arrow signs all on one sign
- It provides for the inclusion of multiple destinations on one sign
- It includes time to destination as well as distance

Warning Signs

On bicycle boulevards with higher vehicle and bicycle volumes, agencies should also consider installing additional warning signs advising motorists to the presence of cyclists. This signage would also be effective in areas with higher numbers of bicycle trips, such as streets leading to the regional trail system.

MUTCD Guidelines
Section 9B.17 – Bicycle Warning Sign notes that a Bicycle Warning sign (W11-1) alerts the road user to unexpected entries into the roadway by bicyclists and other crossing activities that might cause conflicts. As an option, a supplemental plaque with the legend AHEAD or XXX FEET may be used with the Bicycle Warning sign.

Section 9B.18 – Other Bicycle Warning Signs provides the option for the installation of additional warning signs such as BIKEWAY NARROWS on bicycle facilities to warn bicyclists of conditions not readily apparent. In addition, in situations where there is a need to warn motorists to watch for bicyclists traveling along the highway, the SHARE THE ROAD (W16-1) plaque may be used in conjunction with the W11-1 sign (see Figure 36).

**Level 2: Pavement Markings**

A variety of pavement marking techniques can effectively improve bicycling conditions along bicycle boulevards.

**On-Street Parking Delineation**

*MUTCD Guidelines*

Section 3B.18 – Parking Space Markings in the MUTCD provides support for the marking of on-street parking.

Delineating on-street parking through paint or other materials clearly indicates where a vehicle should be parked, and can discourage motorists from parking their vehicles too far into the adjacent travel lane. This helps cyclists by maintaining a wide enough space to safely share a travel lane with moving vehicles while minimizing the need to swerve farther into the travel lane to maneuver around parked cars. In addition to benefiting cyclists, delineated parking spaces also promote the efficient use of on-street parking by maximizing the number of spaces in high-demand areas, such as the University of Dayton.

**Directional Pavement Markings**

*MUTCD Guidelines*

The MUTCD currently provides no guidance on the use of directional pavement markings for bicyclists, although Section 9C.01 – Function of Markings provides this general support: “Markings indicate the separation of the lanes for road users, assist the bicyclist by indicating assigned travel paths, indicate correct position for traffic control signal actuation, and provide advance information for turning and crossing maneuvers.”

Directional pavement markings effectively lead cyclists along a bicycle boulevard (and reinforce cyclists that they are on a designated route). The markings can take the form of small bicycle symbols (about one foot in diameter) placed every 600-800 feet along a linear corridor (see Figure 37). When a bicycle boulevard travels along several streets (with multiple turns at intersections), additional markings accompanied by directional arrows are provided to guide cyclists through turns and other

![Figure 36. MUTCD Bicycle Warning Sign (W11-1) with supplemental plaque (W16-1)](image)

![Figure 37. Example of a directional pavement marking](image)
Directional pavement markings also visually cue motorists that they are traveling along a bicycle route and should exercise caution.

**Shared Lane Markings (“Sharrows”)**

Shared lane markings (also known as “sharrows”) are high-visibility pavement markings that help position bicyclists within the travel lane. These markings are often used on streets where dedicated bicycle lanes are desirable but are not possible due to physical or other constraints (see Figure 38 and Figure 39). Sharrows are placed strategically in the travel lane to alert motorists of bicycle traffic, while also encouraging cyclists to ride at an appropriate distance from the “door zone” of adjacent parked cars. Placed in a linear pattern along a corridor (typically every 100-200 feet) at a minimum of 11 feet from the face of curb, sharrows also encourage cyclists to ride in a straight line so their movements are predictable to motorists. These pavement markings have been successfully used in many small and large communities throughout the U.S. Sharrow markings made of thermoplastic tend to last longer than traditional paint.

**MUTCD Guidelines**

The shared lane marking is not currently approved for use by the MUTCD. The National Committee on Uniform Traffic Control Devices (NCUTCD) has recommended to the Federal Highway Administration (FHWA) that this marking be included in the next edition of the MUTCD, expected to be published in 2009.

The draft language notes that sharrows should not be placed on roadways with a speed limit over 35 MPH, and that when used the marking should be placed immediately after an intersection and spaced at intervals no greater than 250 feet thereafter.

**Level 3: Intersection Treatments**

Described below, a variety of intersection treatments can be used to safely and conveniently facilitate bicycle travel on bicycle boulevards.

**Stop Sign Placement**

Placing stop signs on cross-streets approaching a bicycle boulevard can facilitate convenient through bicycle travel. A reduced number of stop signs on a designated bicycle route enables riders to maintain their momentum and exert less energy with fewer “stops and starts.” This treatment should be used judiciously to...
minimize the potential for increasing vehicle speeds on the bicycle boulevard. Additionally, appropriate traffic control measures should be used where bicycle boulevards intersect major streets.

**Bicycle Detection at Signalized Intersections**

Several treatments can be used to streamline bicycle travel where bicycle boulevards approach intersections with actuated signals. In-pavement bicycle loop detectors can sense a bicyclist’s presence (in the way that vehicle loop detectors sense automobiles) and trigger the signal to provide a “green” phase for the cyclist. Bicycle loop detectors should be placed within the bicyclist’s expected path (including left turn lanes and shoulders), and should be accompanied with a pavement marking indicating the optimal location for detection (see Figure 40). Vehicle loop detectors can also be used for bicycle detection, provided they are located within the bicycle travel path and their “sensitivity” levels are adjusted for cyclists.

Similar to pedestrian activation buttons, bicyclist activation buttons can also be used at signalized intersections as long as they do not require cyclists to dismount or make unsafe leaning movements (see Figure 41). These devices should be placed as close to the street as possible in a location that is unobstructed by parked vehicles or motorists making right-hand turns.

**Half Signals**

Because bicycle boulevards generally travel along lower-volume minor streets, they typically have minimal treatments to accommodate bicycle/pedestrian crossings when they approach major streets. In situations where there are few “crossable” gaps and where vehicles on the major street do not stop for pedestrians and cyclists waiting to cross, “half signals” could be installed to improve the crossing environment. Half signals include pedestrian and bicycle activation buttons and may also include bicycle loop detectors on the bicycle boulevard. Many of these models have been used successfully for years overseas, and their use in the United States has increased dramatically over the last decade. Discussed in the “Signals and Signal Warrants” section (later in this chapter), a variety of half signal applications could be used on the region’s bicycle boulevard network.

**Curb Extensions**

Curb extensions slow vehicle traffic by creating a visual “pinch point” for approaching motorists. Typically constructed within the on-street parking lane, these devices can calm vehicle traffic passing through or turning at an intersection. Curb extensions also benefit cyclists and pedestrians on cross-streets by reducing...
the crossing distance within the roadway (see Figure 42). Curb extensions should be designed with sufficient radii to accommodate the turning movements of snowplows, school buses and emergency vehicles.

**Medians/Refuge Islands**

Medians are elevated or delineated islands that break up non-motorized street crossings into multiple segments (see Figure 43). Where shared roadways intersect major streets at unsignalized intersections, medians can be used to simplify bicyclist and pedestrian crossings on the major street. Appropriate signage should be installed on the major street to warn motorists of bicyclist/pedestrian crossings. Additionally, vegetation within the median should be low to maintain adequate sight distances for both motorists and bicyclists/pedestrians. Medians can also be used along the bicycle boulevard to create a visual pinch point for motorists as well as to accommodate mid-block bicycle/pedestrian crossings.

Figure 42. Intersection before and after installation of curb extensions

Figure 43. Crossing with a median/refuge island
**Level 4: Traffic Calming**

Traffic calming treatments on bicycle boulevards improve the bicycling environment by reducing vehicle speeds to the point where they generally match cyclists’ operating speeds, enabling motorists and cyclists to safely co-exist on the same facility. Specific traffic calming treatments are described below.

**Chicanes**

Chicanes are a series of raised or delineated curb extensions on alternating sides of a street forming an S-shaped curb, which reduce vehicle speeds through narrowed travel lanes (see Figure 44). Chicanes can also be achieved by establishing on-street parking on alternate sides of the street. These treatments are most effective on streets with narrower cross-sections.

**Mini Traffic Circles**

Mini traffic circles are raised or delineated islands placed at intersections, reducing vehicle speeds through tighter turning radii and narrowed vehicle travel lanes (see Figure 45). These devices can effectively slow vehicle traffic while facilitating all turning movements at an intersection. Mini traffic circles can also include a paved apron to accommodate the turning radii of larger vehicles like fire trucks or school buses.

**Speed Humps**

Shown in Figure 46, speed humps are rounded raised areas of the pavement requiring approaching motor vehicles to reduce speed. These devices also discourage through vehicle travel on a street when a parallel through route exists.

**Level 5: Traffic Diversion**

Traffic diversion treatments maintain through bicycle travel on a street while physically restricting through vehicle traffic. These treatments direct through vehicle traffic onto parallel higher-order streets while accommodating bicyclists and local vehicle traffic on the bicycle boulevard. Traffic diversion is most effective when higher-order streets can sufficiently accommodate the diverted traffic associated with these treatments.

**Choker Entrances**

Choker entrances are intersection curb extensions or raised islands allowing full bicycle passage while restricting vehicle access to and from a bicycle boulevard (see Figure 47). When they approach a choker entrance at a cross-street, motorists on the bicycle boulevard must turn onto the cross-street while cyclists...
may continue forward. These devices can be designed to permit some vehicle turning movements from a cross-street onto the bicycle boulevard while restricting other movements.

**Traffic Diverters**

Similar to choker entrances, traffic diverters are raised features directing vehicle traffic off the bicycle boulevard while permitting through bicycle travel (see Figure 48).

![Figure 47. Choker entrance of two-way local street](image1)

![Figure 48. Traffic diverter](image2)
Figure 49. Sample bicycle boulevard treatments
9.7. **BICYCLE-FRIENDLY INTERSECTIONS**

Intersections represent one of the primary collision points for bicyclists. Generally, the larger the intersection, the more difficult it is for bicyclists to cross. Oncoming vehicles from multiple directions and increased turning movements make it difficult for motorists to see non-motorized travelers.

Most intersections do not provide a designated place for bicyclists. Bike lanes and pavement markings often end before intersections, causing confusion for bicyclists. Loop and other detectors, such as video, often do not detect bicycles.

Bicyclists wanting to make left turns can face quite a challenge. Bicyclists must either choose to behave like motorists by crossing travel lanes and seeking refuge in a left-turn lane, or they act as pedestrians and dismount their bikes, push the pedestrian walk button located on the sidewalk, and then cross the street in the crosswalk. Bicyclists traveling straight also have difficulty maneuvering from the far right lane, across a right turn lane, to a through lane of travel. Furthermore, motorists often do not know which bicyclist movement to expect.

9.8. **INNOVATIVE ON-STREET BICYCLE FACILITIES**

9.8.1. Colored Bike Lanes

Some cities use colored bike lanes to guide cyclists through major vehicle/bicycle conflict points. These conflict areas are locations where motorists and cyclists must cross each other's path (e.g., at intersections or merge areas). Cyclists are especially vulnerable at locations where the volume of conflicting vehicle traffic is high, and where the vehicle/bicycle conflict area is long. Colored bike lanes typically extend through the entire bicycle/vehicle conflict zone (e.g., through the entire intersection, or through the transition zone where motorists cross a bike lane to enter a dedicated right-turn lane, see Figure 50).

Although colored bike lanes are not an official standard at this time, they continue to be successfully used in other cities. Portland, Oregon and Copenhagen, Denmark use blue and green bike lanes, while Vancouver, British Columbia uses red bike lanes in select locations. This treatment typically includes accompanying signage alerting motorists of vehicle/bicycle conflict points (see Figure 51).
9.8.2. **Cycletracks**

Cycletracks, used widely around the world and gaining popularity in the U.S., take a variety of forms. The most common cycletrack characteristics include reallocation of existing roadway or sidewalk space for bicycle use, combined with physical separation between bicyclists and motorists/pedestrians (see Figure 52 and Figure 53). Although exhibiting physical characteristics of off-street paths, cycletracks are intended for the exclusive use of bicyclists. These facilities typically accommodate one-way bicycle traffic, though two-way cycletracks exist. Cycletracks work best under the following circumstances:

- When placed along roadways with few street and driveway intersections (to minimize occurrences of parked or standing vehicles blocking the bikeway)
- When adequate intersection treatments exist to address bicyclist/motorist conflicts
- When adequate parallel pedestrian facilities exist so that the cycletrack is not considered a shared use path
- Where adequate treatments exist to minimize interference with transit stops
- When an equivalent bikeway exists in the opposite direction that is more attractive to bicyclists than riding the wrong way on a one-way cycletrack
- When regular sweeping and cycletrack maintenance provisions exist

![Figure 52. Cycletrack in Copenhagen, Denmark](image1)

![Figure 53. Cycletrack concept](image2)
9.8.3. **Contra-flow Bike Lanes**

Shown in Figure 54, contra-flow bike lanes enable bicyclists to safely ride in the opposite direction of vehicle traffic on one-way streets. The facility is placed on the opposite side of vehicle travel lanes (to the motorists’ left), and separated from traffic with a double yellow line or extruded curb. This informs motorists that bicyclists are riding legally in a dedicated lane. Contra-flow lanes work best under the following circumstances:

- When alternate routes require excessive out-of-direction travel
- When alternate routes include unsafe or uncomfortable streets with high traffic volumes and/or no bicycle facilities
- When the contra-flow lane provides direct access to bicyclist destinations on the street under focus
- When few intersecting streets, alleys or driveways exist on the side of the contra-flow lane
- When bicyclists can safely and conveniently re-enter the traffic stream where the contra-flow lane ends

To ensure bicyclist safety on streets with contra-flow lanes:

- Signs should be posted at intersecting streets, alleys and driveways informing motorists to expect two-way traffic
- Intersection traffic controls along the street (e.g., stop signs and traffic signals) should also be installed and oriented toward bicyclists in the contra-flow lane
- On-street parking should be prohibited between the contra-flow lane and the curb to prevent motorists from crossing the bicycle travelway
9.8.4. Shared Bus/Bike Lanes

Typically situated adjacent to the curb, shared bike/bus lanes are used where sufficient width exists for a bus lane, but not for separated bus and bike lanes. Generally such multiple uses are operationally acceptable unless considerable bus and bicycle traffic exists. High bus and bicycle volumes may create a “leap frog” effect with buses and bikes passing each other frequently. Shown in Figure 55, combined bicycle/bus lanes should include appropriate signage and pavement markings indicating the lane’s purpose (e.g., to prevent motorists from using the lane as a right-turn lane).

9.8.5. Bike Box/Advanced Stop Line

As bicyclists and motorists approach a signalized intersection, bike boxes assign priority to bicyclists. Shown in Figure 56, bike boxes incorporate several treatments, including:

- A striped bike lane: Allows bicyclists to safely maneuver to the “head of the line” of stopped vehicles
- An advanced vehicle stop bar located several feet upstream from the intersection: Provides a space for bicyclists to move directly in front of the vehicle at the head of the line, increasing motorists’ visibility of bicyclists
- Bicycle pavement markings in the bike box: Advises motorists to stay out of the bike box
- Signage: Advising motorists to stay out of the bike box
- No Right Turn on Red signs: Prevents motorists from occupying the bike box while waiting for a gap in the cross-street traffic stream

Bike boxes offer several advantages:

- Enabling cyclists to move to the head of the line, bike boxes reduce bicyclist waiting time and increase the likelihood that a cyclist would not have to wait more than one signal cycle for a green light
- Cyclists at the head of the line can avoid breathing exhaust fumes from vehicles idling at the intersection
- Bicyclists making left turns can safely position themselves in the bike box in front of motor vehicle traffic, as opposed to merging with vehicle traffic as they approach the intersection
9.9. SHARED USE PATHS

As MVRPC and local communities improve and expand the regional shared use path network, several design issues should be taken into consideration. Shared use paths should be designed to accommodate two-way bicycle and pedestrian traffic, and typically should have their own rights-of-way (for a minimum of 75 percent of their length to reinforce the experience of traveling on a path). The paved surface should consist of asphalt or concrete (or a durable unpaved surface that is smooth and meets ADA requirements).

Figure 57 below depicts the recommended cross-section for shared use paths in the region. To accommodate multiple users and to sufficiently serve bi-directional traffic, shared use paths should be 10 to 14 feet wide. Narrower path widths may be allowed (8’ minimum, according to AASHTO) in physically constrained areas. Wider path widths are recommended in areas where user volumes are expected to be high. Soft shoulders (at least 2 feet wide) should be provided on both sides of the path, and a wider shoulder should be provided to accommodate runners and joggers where space permits. Soft shoulders may consist of bark or wood chips.

Figure 57. Recommended shared use path cross-section

Bollards can be placed at path/roadway crossings to permit bicycle/pedestrian access while restricting vehicle access. Removable or unlockable bollards should replace any gates along the region’s existing paths, as gates complicate path access for cyclists and mobility-impaired users. Removable and unlockable bollards also maintain easy path access for maintenance and emergency vehicles. It is also important that lighting or other high-visibility treatments accompany bollards so that riders may see them at night and in inclement weather.

Table 28 highlights additional design recommendations for the Miami Valley’s shared use path network. The recommendations are based on experience in other communities, as well as guidelines prescribed by AASHTO and other design publications.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paved width</td>
<td>10'-14' (8’ in constrained areas)</td>
</tr>
<tr>
<td>Soft surface width (unpaved trails)</td>
<td>6’ minimum</td>
</tr>
<tr>
<td>Shoulder width</td>
<td>2’ minimum</td>
</tr>
<tr>
<td>Lateral clearance between path and adjacent signs</td>
<td>3’-6’</td>
</tr>
<tr>
<td>Overhead clearance</td>
<td>8’ minimum</td>
</tr>
<tr>
<td>Separation from parallel roadway</td>
<td>5’ minimum</td>
</tr>
<tr>
<td>Grade/running slope</td>
<td>5% maximum</td>
</tr>
<tr>
<td>Cross-slope</td>
<td>2% maximum</td>
</tr>
<tr>
<td>Fence height</td>
<td>54 inches</td>
</tr>
<tr>
<td>Bollards</td>
<td>5’ minimum between bollards</td>
</tr>
</tbody>
</table>
9.9.1. Shared Use Paths along Roadways

Shared use paths should not be placed directly adjacent to roadways (e.g., with minimal or no separation) for a variety of reasons:

- Half of bicycle traffic would ride against the normal flow of vehicle traffic, contrary to the rules of the road.
- When the path ends, cyclists riding against traffic tend to continue to travel on the wrong side of the street, as do cyclists making their way to the path. Wrong-way bicycle travel is a major cause of vehicle/bicycle crashes.
- At intersections, motorists crossing the path often do not notice bicyclists approaching from certain directions, especially where sight distances are poor.
- Bicyclists on the path are required to stop or yield at cross-streets and driveways, unless otherwise posted.
- Stopped vehicles on a cross-street or driveway may block the path.
- Because of the closeness of vehicle traffic to opposing bicycle traffic, barriers are often necessary to separate motorists from cyclists. These barriers serve as obstructions, complicate facility maintenance and waste available right-of-way.
- Paths directly adjacent to high-volume roadways diminish users’ experience by placing them in an uncomfortable environment. This could lead to a path’s underutilization.

Shared use paths can successfully be placed along roadways, provided several design considerations are met:

- A minimum 5-foot buffer should be provided between the path and roadway to address potential conflicts between motorists and path users.
- There are few vehicle/path user conflict points (e.g., cross-streets and driveways).
- There is a commitment to provide path continuity along the corridor.
- The path can be terminated at each end onto streets with good bicycle and pedestrian facilities or onto another safe, well-designed path through appropriate street crossing treatments.
- The path should not take the place of bicycle/pedestrian facilities (e.g., sidewalks and bicycle lanes) on the parallel street.

These issues should be carefully considered as the region develops shared use paths along roadways.

9.9.2. Sidewalks as Shared Use Paths

In some Miami Valley communities, sidewalks have been striped and signed as shared use paths. Although these facilities are attractive for some users, they present several challenges. Sidewalks are typically designed for pedestrian speeds and maneuverability and are not safe for higher bicycle speeds. Conflicts are common between pedestrians traveling at low speeds (e.g., exiting stores, parked cars, etc.) and bicyclists, as are conflicts with fixed objects (e.g., utility poles, mailboxes, parked cars extending into the sidewalk from a driveway). Walkers, joggers, skateboarders and in-line skaters can (and often do) change their speed and direction almost instantaneously, leaving bicyclists insufficient reaction time to avoid collisions.

Similarly, pedestrians often have difficulty predicting the direction an oncoming cyclist will take. At intersections, motorists are often not looking for bicyclists who are traveling at higher speeds than pedestrians entering a crosswalk area, particularly when motorists are making a turn. Sight distance is often impaired by
buildings, walls, fences and shrubs along sidewalks, especially at driveways. In addition, bicyclists and pedestrians often prefer to ride or walk side-by-side when traveling in pairs. Sidewalks are typically too narrow to enable this to occur without serious conflict between users.

It should also be noted that developing extremely wide sidewalks does not necessarily add to the safety of sidewalk bicycle travel. Wide sidewalks might encourage higher speed bicycle use and can increase the potential for conflicts with motorists at intersections, as well as pedestrians with fixed objects.

9.9.3. Path/Roadway Crossings

The most basic crossing type is an unmarked, unsignalized crossing, at which a bicyclist or pedestrian waits for a gap in traffic to cross. The lack of markings or signals at most crossings can be very intimidating for bicyclists and pedestrians, and may be challenging enough to discourage people from choosing those modes of transport. However, in most cases, roadway crossings can be properly designed at-grade to a reasonable degree of safety and meet existing traffic and safety standards.

Roadway crossings should comply with AASHTO, ODOT and MUTCD standards and guidelines. Evaluation of roadway crossings involves analysis of vehicular and path user traffic patterns, including speeds, street width, traffic volumes (average daily traffic, peak hour traffic), line of sight, and path user profile (age distribution, destinations). This Plan identifies the most appropriate crossing options given available information, which must be verified and/or refined through the actual engineering and construction document stage.

9.9.4. Crossing Prototypes

The proposed path/roadway crossing treatments described below are based on established standards, published technical reports, and experiences from cities around the country. Path/roadway crossings in the Miami Valley will generally fit into one of five basic categories:

- Type 1: Marked/Unsignalized
- Type 1+: Marked/Enhanced
- Type 2: Route Users to Existing Signalized Intersection
- Type 3: Signalized/Controlled
- Type 4: Grade-separated crossings

Type 1: Marked/Unsignalized Crossings

A Marked/Unsignalized crossing (Type 1) consists of a crosswalk, signing, and often no other devices to slow or stop traffic (see Figure 58). The approach to designing crossings at mid-block locations depends on an evaluation of vehicular traffic, line of sight, path traffic, use patterns, vehicle speed, road type and width, and other safety issues such as the proximity of schools. The following thresholds recommend where unsignalized crossings may be acceptable:

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5 MUTCD, AASHTO Guide for the Development of Bicycle Facilities.

6 Federal Highway Administration (FHWA) Report, “Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations.”

7 In particular, the recommendations in this Plan are based in part on experiences in cities like Portland (OR), Seattle (WA), Tucson (AZ), and Sacramento (CA), among others.
• Maximum traffic volumes:
  • $\leq 9,000-15,000$ ADT
  • up to $15,000$ ADT on two-lane roads, preferably with a median.
  • up to $12,000$ ADT on four-lane roads with median.
• Maximum travel speed:
  • 35 mi/h
• Minimum line of sight:
  • 25 MPH zone: 155 feet
  • 35 MPH zone: 250 feet
  • 45 MPH zone: 360 feet

If well designed, crossings of multi-lane higher volume arterials over 15,000 ADT may be unsignalized with features combining some or all of the following: excellent sight distance, sufficient crossing gaps (more than 60 per hour), median refuges, advance stop bars with appropriate signage, and/or active warning devices like flashing beacons or in-pavement flashers. These are referred to as Type 1 Enhanced (Type 1+).

On roadways with low to moderate traffic volumes (<12,000 ADT) and a need to control traffic speeds, a raised crosswalk may be the most appropriate crossing design to improve pedestrian visibility and safety. These crosswalks are raised 75 mm above the roadway pavement, similar to speed humps, to an elevation that matches the adjacent sidewalk. The top of the crosswalk is flat and typically made of asphalt, patterned concrete, or brick pavers. Brick or unit pavers should be discouraged because of potential problems related to pedestrians, bicycles, and ADA requirements for a continuous, smooth, vibration-free surface. Tactile treatments are needed at the sidewalk/street boundary so that visually-impaired pedestrians can identify the edge of the street. Costs can range from $5,000 to $20,000 per crosswalk, depending on the width of the street, the drainage improvements needed, and the materials used for construction.

A flashing yellow beacon may be used, preferably one that is activated by the bicyclist or pedestrian, rather than operating continuously. This equipment, while slightly more expensive, will help keep motorists alert. The costs will range between $5000 and $15,000 depending on the need for poles with arms and overhead mounted signals.

**Type 2: Route Users to Existing Signalized Intersection**

Crossings within 250 feet of an existing signalized intersection with pedestrian crosswalks are typically diverted to the signalized intersection for safety purposes (see Figure 59). For this option to be effective, barriers and signing may be needed to direct path users to the signalized crossings. In most cases, signal modifications would be made to add pedestrian detection and to comply with the ADA. In many cases, such as on most paths paralleling to roadways, crossings are simply part...
of the existing intersection and are not a significant problem for path users.

**Type 3: Signalized/Controlled Crossings**

New signalized crossings (see Figure 60) may be recommended for crossings that meet pedestrian, school, or modified warrants, are located more than 250 feet from an existing signalized intersection and where 85th percentile travel speeds are 40 MPH and above and/or ADT exceeds 15,000 vehicles. Each crossing, regardless of traffic speed or volume, requires additional review by a registered engineer to identify sight lines, potential impacts on traffic progression, timing with adjacent signals, capacity, and safety.

Signals are normally activated by push buttons, but also may be triggered by motion detectors. The maximum delay for activation of the signal should be two minutes, with minimum crossing times determined by the width of the street. The signals may rest on flashing yellow or green for motorists when not activated, and should be supplemented by standard advanced warning signs. Typical costs for a signalized crossing range from $150,000 to $250,000.

**Type 4: Grade-separated Crossings**

Grade-separated crossings may be needed where ADT exceeds 25,000 vehicles, and 85th percentile speeds exceed 45 MPH (see Figure 61 and Figure 62). Safety is a major concern with both overcrossings and undercrossings. In both cases, path users may be temporarily out of sight from public view and may have poor visibility themselves. Undercrossings, like parking garages, have the reputation of being places where crimes occur. Most crime on paths, however, appears to have more in common with the general crime rate of the community and the overall usage of the path than any specific design feature.

Design and operation measures are available which can address user concerns. For example, an undercrossing can be designed to be spacious, well lit, equipped with emergency cell phones at each end and completely visible for its entire length prior to entering.

Other potential problems with undercrossings include conflicts with utilities, drainage, flood control, and maintenance requirements. Overcrossings pose potential concerns about visual impact and functional appeal.

**9.9.5. Half Signals**

In situations where there are few “crossable” gaps and where vehicles do not stop for pedestrians waiting to cross (or because of multiple lanes, it is unsafe to cross in front of a stopped vehicle), several innovative bicycle/pedestrian traffic signal options exist. Many of these models have been used successfully for years overseas, and their use in America has increased dramatically over the last decade.
**Pelican**

A Pelican (Pedestrian Light Control Activated Crossing) signal incorporates a standard red-yellow-green signal light that rests in green for vehicular traffic until a pedestrian wishes to cross and presses the button. The signal then changes to yellow, then red, while Walk is shown to the pedestrian. The signal can be installed as either a one-stage or two-stage signal, depending on the characteristics of the street. In a two-stage crossing, the pedestrian crosses first to a median island and is then channelized along the median to a second signalized crossing point. At that point, the pedestrian then activates a second crossing button and another crossing signal changes to red for the traffic while the pedestrian is given a Walk signal. The two crossings only delay the pedestrian minimally and allow the signal operation to fit into the Arterial synchronization, thus reducing the potential for stops, delays, accidents, and air quality issues. A Pelican crossing is quite effective in providing a pedestrian crossing at mid-block locations when the technique can be integrated into the roadway design.

**Puffin**

A Puffin (Pedestrian User Friendly Intelligent Crossing) signal is an updated version of a Pelican crossing. The signal consists of traffic and pedestrian signals with push-button signals and infrared or pressure mat detectors (see Figure 63). After a pedestrian pushes the button, a detector verifies the presence of the pedestrian at the curbside. This helps eliminate false signal calls associated with people who push the button and then decide not to cross. When the pedestrian is given the Walk signal, a separate motion detector extends the Walk interval (if needed) to ensure that slower pedestrians have time to cross safely. Conversely, the signal can also detect when the intersection is clear of pedestrians and return the green signal to vehicles, reducing vehicle delay at the light. Puffin signals are designed to be crossed in a single movement by the pedestrian, unlike the Pelican signal, which can be designed to cross in either one or two stages.

**Hawk**

A Hawk (High-Intensity Activated Crosswalk) signal is a combination of a beacon flasher and traffic control signaling technique for marked crossings. The beacon signal consists of a traffic signal head with a red-yellow-red lens. The unit is normally off until activated by a pedestrian. When pedestrians wish to cross the street, they press a button and the signal begins with a flashing yellow indication to warn approaching drivers. The flashing yellow is then followed by a solid yellow, advising the drivers to prepare to stop. The signal is then changed to a solid red, at which time the pedestrian is shown a Walk indicator. The beacon signal then converts to an alternating flashing red, allowing motorists to proceed after stopping at the crosswalk, while the pedestrian is shown the flashing Don’t Walk signal.

**9.9.6. Trailheads**

Good access to a path system is a key element for its success. Trailheads (formalized parking areas) serve the local and regional population arriving to the path system by car, transit, bicycle or other modes. Trailheads
provide essential access to the trail system and include amenities like parking for vehicles and bicycles, restrooms (at major trailheads), and posted maps. A central information installation also helps users find their way and acknowledge the rules of the path. They are also useful for interpretive education about plant and animal life, ecosystems and local history (see Figure 65, Figure 66, and Figure 67).

Figure 65. Major trailhead

Figure 66. Trailhead with small parking area

Figure 67. Informational kiosk and information sign
Trail Maintenance and Safety

Trail management and maintenance are important components of the off-street bikeway network. The psychological effects of good maintenance can be a highly effective deterrent to vandalism and littering. When new trails are developed, the managing agency effectively becomes a new neighbor to adjacent landowners located along the trail corridor. As a neighbor to the various communities along the trail corridor, the managing agency has an on-going relationship with those communities, and the state of maintenance along the trail is a significant factor in the success or failure of that relationship. Though statistics show that trails are generally safe places for people, the managing agency of any trail cannot afford to be complacent about maintenance. Trails must be proactively managed and maintained.

Maintenance Guidelines

A high level of path maintenance is critical to the overall success and safety of the path system. Maintenance includes such activities as pavement stabilization, landscape maintenance, facility upkeep, sign replacement, fencing, mowing, litter removal, painting, and pest control. However, the effects of a good maintenance program are not limited to the physical and biological features of the trails:

- A high standard of maintenance is an effective way of helping advertise and promote trails as a regional and state recreational resource;
- The psychological effects of good maintenance can be an effective deterrent to vandalism, litter, and encroachments;
- Good maintenance is necessary to preserve positive public relations between adjacent land owners and government;
- Good maintenance can help make enforcement of regulations on trails more efficient. Local clubs and interest groups will take pride in “their” path and will be more apt to assist in protection of the path system.
- A proactive maintenance policy will help improve safety along the Miami Valley’s trails.

A successful maintenance program requires continuity and a high level of citizen involvement. Regular, routine maintenance on a year-round basis will not only improve trail safety, but will also prolong the life of these facilities. Maintenance activities required for safe trail operations should always receive top priority. The following should be part of the maintenance checklist:

Paved Surface Maintenance

Cracks, ruts and water damage will have to be repaired periodically. In addition, vegetation control will be necessary on a regular basis.

Where drainage problems exist along trails, ditches and drainage structures will need to be kept clear of debris to prevent wash outs. Checks for erosion along trails should be made monthly during the wet season, and immediately after any storm that brings flooding to the local area.

The trail surface should be kept free of debris, especially broken glass and other sharp objects, loose gravel, leaves and stray branches. Trail surfaces should be swept periodically.

Vegetation and Pest Management

In general, visibility between plantings should be maintained so as to avoid creating the feeling of an enclosed space. This will also give trail users good, clear views of their surroundings, which enhances the aesthetic experience. Under-story vegetation along trail corridors should not be allowed to grow higher than 36 inches.
Tree species selection and placement should be made that minimizes vegetative litter on the trail and root uplifting of pavement. Vertical clearance along the trail should be periodically checked and any overhanging branches over the path should be pruned to a minimum vertical clearance of 10 feet.

The trail system moves through a variety of landscape settings. Some basic measures should be taken to best protect the trail investment. This includes regular mowing of grass 6 to 8 feet on each side of the trail, and a quarterly mowing 50 to 100 feet wide along both sides of the trail to prevent invasion of plants into the pavement area. Wherever possible, weed control should be accomplished by mechanical means. This is especially true along drainage ways crossing the path. Innovative weed control methods such as grazing and steaming should be explored. Use of chemical sprays should be limited to use only on those plants that are harmful to the public.

**Litter and Illegal Dumping**

Litter along trail corridors should be removed by staff or volunteer effort. Litter receptacles should be placed at access points such as trailheads. Litter should be picked up once a week and after any special events held on the path, except where specially designed trash cans have been installed throughout the region.

Alternatively, some trails could be signed “pack it in, pack it out.” This technique has been met with mixed results, but if maintenance funds are not available to meet trash removal needs it is best to remove trash receptacles.

Illegal dumping should be controlled by vehicle barriers, regulatory signage and fines as much as possible. When it does occur, it must be removed as soon as possible in order to prevent further dumping. Neighborhood volunteers, friends groups, alternative community service crews and inmate labor should be used in addition to maintenance staff.

**Signage**

A bi-monthly check on the status of signage should be performed with follow-up as necessary.

**Fencing**

Use of fencing for border control (for residential security) is strongly discouraged. The first preference will be to plant shrubs, trees and use temporary fencing to establish privacy. As the need arises, fencing requests should be evaluated on a case-by-case basis. Property lines should be clearly surveyed and field marked in a way that is useful for the maintenance staff and the trail neighbors.

**Trailheads**

The specialized facilities at trailheads will require frequent inspections and maintenance. Restrooms must be cleaned on a regular basis. Site furniture and lighting should be kept in good repair.

Table 29 summarizes a recommended maintenance schedule for the regional trail system. On-street bikeways generally should be maintained per the standards of the relevant agency.
Table 29. Trail Maintenance Guidelines

<table>
<thead>
<tr>
<th>Item</th>
<th>Frequency/Extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspections</td>
<td>Seasonal - at both beginning and end of summer</td>
</tr>
<tr>
<td>Signage replacement</td>
<td>1 - 3 years, inspect bi-monthly</td>
</tr>
<tr>
<td>Pavement markings replacement</td>
<td>1 - 3 years, inspect bi-monthly</td>
</tr>
<tr>
<td>Major damage response (fallen trees, washouts, flooding)</td>
<td>Repair as soon as possible</td>
</tr>
<tr>
<td>Pavement sealing, potholes</td>
<td>5 - 15 years</td>
</tr>
<tr>
<td>Introduced tree and shrub plantings, trimming</td>
<td>Every 1-3 years</td>
</tr>
<tr>
<td>Culvert inspection</td>
<td>Before winter and after major storms</td>
</tr>
<tr>
<td>Cleaning ditches</td>
<td>As needed</td>
</tr>
<tr>
<td>Trash disposal</td>
<td>Weekly during high use; twice monthly during low use</td>
</tr>
<tr>
<td>Lighting repair</td>
<td>Repair as soon as possible, monitor on a regular basis</td>
</tr>
<tr>
<td>Pavement sweeping/blowing</td>
<td>As needed, before high use season; weekly in fall</td>
</tr>
<tr>
<td>Maintaining culvert inlets</td>
<td>Inspect before the onset of the wet season, then again in early fall</td>
</tr>
<tr>
<td>Shoulder plant trimming (weeds, trees, brambles)</td>
<td>Twice a year: middle of growing season and early fall. Overhanging branches should be trimmed back to 10' above trail</td>
</tr>
<tr>
<td>Site furnishings, replace damaged components</td>
<td>As needed</td>
</tr>
<tr>
<td>Graffiti removal</td>
<td>Weekly, as needed</td>
</tr>
<tr>
<td>Fencing repair</td>
<td>Inspect regularly for holes and damage, repair immediately</td>
</tr>
<tr>
<td>Shrub/tree irrigation for introduced planting areas</td>
<td>Periodically during summer months until plants are established</td>
</tr>
<tr>
<td>Litter pick-up</td>
<td>Weekly for high use; twice a month for low use</td>
</tr>
<tr>
<td>Mowing</td>
<td>6'-8' wide bi-weekly; 50'-100' wide quarterly</td>
</tr>
</tbody>
</table>

9.9.8. Trail Safety and Security

Trail safety is a major concern of both trail users and adjacent property owners. Creating a safe trail environment goes beyond design and law enforcement and should involve the entire community. The most effective and most visible deterrent to illegal activity on trails will be the presence of legitimate trail users. Getting as many “eyes on the corridor” as possible is a key deterrent to undesirable activity. There are several components to accomplishing this as outlined below:

Provide good access to the trail system

Access ranges from providing conveniently located trailheads, to encouraging the construction of sidewalks to accommodate access from private developments adjacent to the trail. Access points should be inviting and signed so as to welcome the public onto the trail.

Good visibility from adjacent neighbors

Neighbors adjacent to the trail can potentially provide 24-hour surveillance and can become the region’s biggest ally. Though some screening and setback of the trail is needed for privacy of adjacent neighbors, complete blocking out of the trail from neighborhood view should be discouraged.
High level of maintenance

A well-maintained trail sends a message that the community cares about the public space. This message alone will discourage undesirable activity along the trail.

Programmed events

Community events along the trails will help increase public awareness and thereby attract more people to use the path. Neighbors and residents can help organize numerous public events along the trail that will increase support for the trail. Events might include a daylong trail clean-up or a series of short interpretive walks led by long-time residents or a park naturalist.

Community projects

The support generated by community groups could be further capitalized by involving neighbors and friends of the trail in a community project. Ideas for community projects include volunteer planting events, art projects, interpretive research projects, or even bridge building events. These community projects are the strongest means of creating a sense of ownership along the trail that is perhaps the strongest single deterrent to undesirable activity along the trail.

Adopt-a-Trail Program

Nearby businesses, community institutions, and residential neighbors often see the benefit of their involvement in trail development and maintenance. Businesses and developers may view a nearby trail as an integral piece of their site planning and be willing to take on some level of responsibility for the trail. Creation of an adopt-a-trail program should be explored to capitalize on this opportunity and build civic pride.

Trail Watch Program

Partnering with local and county law enforcement, a trail watch program would provide an opportunity for local residents to become actively involved in crime prevention along trails in the Miami Valley. Similar to Neighborhood Watch programs, residents are brought together to get to know their neighbors, and are educated on how to recognize and report suspicious activity.

Safety Inspections

Regular inspection of trails and associated amenities is a key factor to trail safety. Periodic visual inspections should be conducted by relevant agency work crews and can help identify and correct problems before they become an issue. A fallen tree or limb for example can be readily removed from the trail or coned off to divert users away from the hazard until such time as maintenance crews can remove the hazard. A written record of inspections is recommended and will help create a database of information that can assist agencies in several ways. Written records can reveal safety trends and use patterns that can assist with prioritizing of maintenance dollars. Written records also can help protect agencies from potential liability, providing documentation of diligent maintenance practices targeted towards protection of the public. A typical inspection record should include:

- Inspection reports noting any hazards that have been found along the trail along with remedial action. This should note basic items such as debris, wash outs, or other obstructions
- Monthly inspections should be conducted of the trail system. These inspections should document the condition of the trails and notes should be made of any potential hazards (e.g., cracks, erosion, overhead vegetation, etc.). Corrective actions should be integrated into the next 30-day work plan.
- Quarterly visual and operational inspections should be made of the trail amenities such as benches, signage, drinking fountains, bike racks, etc. Recommended corrective actions should be made and be integrated into a 3-month maintenance work plan.

Agencies responsible for trail maintenance could set up a resident response system so that problems with the trail can be systematically recorded if maintenance crews are unable to visit the trail daily.

Various design and programmatic measures can be taken to address safety issues on a trail. Table 30 summarizes key safety issues and strategies for minimizing impacts.

### Table 30. Trail Safety and Security Recommendations

<table>
<thead>
<tr>
<th>Safety Issue</th>
<th>Recommended Improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unwanted vehicle access on the path</td>
<td>• Utilize landscaping to define the corridor edge and path, including earth berms and large boulders.</td>
</tr>
<tr>
<td></td>
<td>• Use bollards at intersections.</td>
</tr>
<tr>
<td></td>
<td>• Pass a motorized vehicle prohibited ordinance and sign the path.</td>
</tr>
<tr>
<td></td>
<td>• Create a Path Watch Program and encourage citizens to photograph report illegal vehicle use of the corridor.</td>
</tr>
<tr>
<td></td>
<td>• Lay the trail out with curves that allow bike/ped passage, but are uncomfortably tight for automobile passage.</td>
</tr>
<tr>
<td>Privacy of adjacent property owners</td>
<td>• Encourage the use of neighborhood friendly fencing and also planting of landscape buffers.</td>
</tr>
<tr>
<td></td>
<td>• Clearly mark path access points.</td>
</tr>
<tr>
<td></td>
<td>• Post path rules that encourage respect for private property.</td>
</tr>
<tr>
<td></td>
<td>• Strategically placed lighting.</td>
</tr>
<tr>
<td>Litter and dumping</td>
<td>• Post path rules encouraging pack-it-in/pack-it-out etiquette.</td>
</tr>
<tr>
<td></td>
<td>• Place garbage receptacles at trailheads.</td>
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<td></td>
<td>• Strategically-placed lighting, utilizing light shields to minimize unwanted light in adjacent homes.</td>
</tr>
<tr>
<td></td>
<td>• Manage vegetation within the right-of-way to allow good visual surveillance of the path from adjacent properties and from roadway/path intersections.</td>
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<tr>
<td></td>
<td>• Encourage local residents to report incidents as soon as they occur.</td>
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<tr>
<td></td>
<td>• Remove dumpsites as soon as possible.</td>
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<tr>
<td>Trespassing</td>
<td>• Clearly distinguish public path right-of-way from private property through the use of vegetative buffers and the use of good neighbor type fencing.</td>
</tr>
<tr>
<td></td>
<td>• Post path rules that encourage respect for private property.</td>
</tr>
<tr>
<td>Crime</td>
<td>• Manage vegetation so that corridor can be visually surveyed from adjacent streets and residences.</td>
</tr>
<tr>
<td></td>
<td>• Select shrubs that grow below 3’ in height and trees that branch out greater than 6’ in height.</td>
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<td></td>
<td>• Place lights strategically and as necessary.</td>
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<td></td>
<td>• Place benches and other path amenities at locations with good visual surveillance and high activity.</td>
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<td></td>
<td>• Provide mileage markers at quarter-mile increments and clear directional signage for orientation.</td>
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<td></td>
<td>• Create a “Path Watch Program” involving local residents.</td>
</tr>
<tr>
<td></td>
<td>• Proactive law enforcement. Utilize the corridor for mounted patrol training.</td>
</tr>
<tr>
<td>Private use of corridor</td>
<td>• Attempt to negotiate win/win solutions with property owners.</td>
</tr>
<tr>
<td></td>
<td>• Eliminate where detrimental impact to path cannot be reasonably ameliorated.</td>
</tr>
<tr>
<td>Local on-street parking</td>
<td>• Post local residential streets as parking for local residents only to discourage path user parking. Place &quot;no outlet&quot; and &quot;no parking&quot; signs prior to path access points.</td>
</tr>
</tbody>
</table>
9.10. **END-OF-TRIP FACILITIES**

End-of-trip facilities include a safe location and appropriate type of bicycle parking, as well as a location to change from bicycling clothing into work appropriate clothing. These facilities encourage and support bicycling in a region, and will require MVRPC to form partnerships with local jurisdictions and corporations to effectively address end-of-trip facility needs.

### 9.10.1. Bike Parking

Bicycle parking can be broadly defined as either short-term or long-term parking:

**Short-term parking:** Bicycle parking meant to accommodate visitors, customers, messengers and others expected to depart within two hours; requires approved standard rack, appropriate location and placement, and weather protection.

**Long-term parking:** Bicycle parking meant to accommodate employees, students, residents, commuters, and others expected to park more than two hours. This parking is to be provided in a secure, weather-protected manner and location.

#### Short-Term Parking

Short-term bicycle parking facilities are intended to provide short-term bicycle parking, and include racks which permit the locking of the bicycle frame and at least one wheel to the rack and support the bicycle in a stable position without damage to wheels, frame or components. Short-term bicycle parking is currently provided at no charge at most locations. Such facilities should continue to be free, as they provide minimal security, but encourage cycling and promote proper bicycle parking.

Table 31 summarizes bike rack placement guidelines, while Figure 68 and Figure 69 illustrate appropriate rack design elements. Some of these guidelines can be incorporated into zoning codes or parking codes, coupled with requirements or incentives to provide bicycle parking.

<table>
<thead>
<tr>
<th>Design Issue</th>
<th>Recommended Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Rack Height</td>
<td>To increase visibility to pedestrians, racks should have a minimum height of 33 inches or be indicated or cordoned off by visible markers.</td>
</tr>
<tr>
<td>Signing</td>
<td>Where bicycle parking areas are not clearly visible to approaching cyclists, signs at least 12 inches square should direct them to the facility. The sign should give the name, phone number, and location of the person in charge of the facility, where applicable.</td>
</tr>
<tr>
<td>Design Issue</td>
<td>Recommended Guidance</td>
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<td>----------------------</td>
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<tr>
<td>Lighting</td>
<td>Lighting of not less than one foot-candle illumination at ground level should be provided in all bicycle parking areas.</td>
</tr>
<tr>
<td>Frequency of Racks on Streets</td>
<td>In popular retail areas, two or more racks should be installed on each side of each block. This does not eliminate the inclusion of requests from the public which do not fall in these areas. Areas officially designated or used as bicycle routes may warrant the consideration of more racks.</td>
</tr>
<tr>
<td>Location and Access</td>
<td>Access to facilities should be convenient; where access is by sidewalk or walkway, curb ramps should be provided where appropriate and ADA compliant. Parking facilities intended for employees should be located near the employee entrance, and those for customers or visitors near the main public entrances. (Convenience should be balanced against the need for security if the employee entrance is not in a well traveled area). Bicycle parking should be clustered in lots not to exceed 16 spaces each. Large expanses of bicycle parking make it easier for thieves to operate undetected.</td>
</tr>
<tr>
<td>Locations within Buildings</td>
<td>Provide bike racks within 50 feet of the entrance. Where a security guard is present, provide racks behind or within view of a security guard. The location should be outside the normal flow of pedestrian traffic.</td>
</tr>
<tr>
<td>Locations near Transit Stops</td>
<td>To prevent bicyclists from locking bikes to bus stop poles - which can create access problems for transit users, particularly those who are disabled - racks should be placed in close proximity to transit stops where there is a demand for short-term bike parking.</td>
</tr>
<tr>
<td>Locations within a Campus-Type Setting</td>
<td>Racks are useful in a campus-type setting at locations where the user is likely to spend less than two hours, such as classroom buildings. Racks should be located near the entrance to each building. Where racks are clustered in a single location, they should be surrounded by a fence and watched by an attendant. The attendant can often share this duty with other duties to reduce or eliminate the cost of labor being applied to the bike parking duties; a cheaper alternative to an attendant may be to site the fenced bicycle compound in a highly visible location on the campus. For the long-term parking needs of employees and students, attendant parking and/or bike lockers are recommended.</td>
</tr>
<tr>
<td>Retrofit Program</td>
<td>In established locations, such as schools, employment centers, and shopping centers, the City should conduct bicycle parking audits to assess the bicycle parking availability and access, and add in additional bicycle racks where necessary.</td>
</tr>
</tbody>
</table>

![Figure 68. Inverted “U” Rack](image1)

*Figure 68. Inverted “U” Rack*

*Figure 69. Ribbon, Spiral and Freestanding Racks*
Where racks are not possible on sidewalks (because of narrow sidewalk width, sidewalk obstructions, or other issues), bicycle parking can be created in the street where on-street vehicle parking is allowed. Two possible options for creating parking in the street include clustered racks in a car parking space protected by bollards or curbs (see Figure 70), and racks installed on sidewalk curb extensions where adequate sight distance can be provided. Installing bicycle parking directly in a car parking space incurs only the cost of the racks and bollards or other protective devices.

A curb extension is more expensive to install, and can be prohibitively expensive if substantial drainage and/or utility work is necessary. Costs may be less if the curb extension is installed as part of a larger street or pedestrian improvement project. While on-street bicycle parking may take space away from the automobile parking, there are ways to mitigate auto parking loss: Additional auto parking spaces can be created by consolidating driveways, moving fire hydrants, or otherwise finding places where it may be possible to admit auto parking where it is currently prohibited. Options for combining bicycle and motorcycle parking also exist.

On-street bicycle parking may be installed at intersection corners or at mid-block locations. Mid-block on-street parking may be closer to cyclists’ destinations, although it could force cyclists to dismount and walk to the parking site if access from the street is difficult or dangerous. Combining a mid-block pedestrian crossing with mid-block on-street parking facilities could mitigate this situation.

**Long-Term Parking**

Long-term bicycle parking facilities are intended to provide secure long-term bicycle storage. Long-term facilities protect the entire bicycle, its components and accessories against theft and against inclement weather, including snow and wind-driven rain. Examples include lockers, check-in facilities, monitored parking, restricted access parking, and personal storage.

Long-term parking facilities are more expensive to provide than short-term facilities, but are also significantly more secure. Although many bicycle commuters would be willing to pay a nominal fee to guarantee the safety of their bicycle, long-term bicycle parking should be free wherever automobile parking is free. Potential locations for long-term bicycle parking include transit stations, large employers and institutions where people use their bikes for commuting, and not consistently throughout the day (see Figure 71). An advantage of lockers is that they can be configured to more easily accommodate different styles of bicycles, such as recumbent bicycles (see Figure 72).
Attended Parking Facilities

Attended bike parking is analogous to a coat check – your bike is securely stored in a supervised location. An organization called The Bikestation® Coalition is promoting enhanced attended parking at transit stations.

The Bikestation® concept is now in use in several California cities and in Seattle, Washington. Bikestations® offer secured valet bicycle parking near transit centers. What makes Bikestations® distinctive are the supplemental amenities that may be offered at the location – bicycle repair, cafes, showers and changing facilities, bicycle rentals, licensing, etc. (see Figure 73). Bikestations® become a virtual one-stop-shop for bicycle commuters.

Attended bicycle parking can be offered at some special events. For example, the Marin County, California Bicycle Coalition sponsors valet parking at many festivals. The Sonoma County, California Bicycle Coalition sponsors valet parking at the downtown Santa Rosa Farmer’s Market, and secured bicycle parking is offered at AT&T Park in San Francisco.