Chapter 4: Design Elements

The following section of the Toolkit provides decision makers and designers, with information they need to make decisions about what complete streets elements can be included in their projects. Chapter 2 addressed the different land use or context throughout municipalities, mode priorities for the contest, and construction project types. Chapter 3 presented the different street typology category of roads that can be found throughout Cuyahoga County along with a menu of possible elements that can be considered for complete street projects. This chapter goes further in depth to provide descriptions of the various design elements, and in some cases references to design standards for the elements. This chapter serves as a reference for picking and choosing elements to include in your project, but should not be considered absolute. There are hundreds of complete street elements available and these are just a few that are recommended.

Volume One of the ODOT Location and Design (L&D) Manual, except as modified herein, is considered applicable to all Cuyahoga County sponsored Highway/Bridge improvements. Where references are made to the State, Bureau/Engineer of Location and Design, or any other term designating any representative or employee of the State, or the Department of Transportation, as found in Volume One of the ODOT L&D Manual, such references shall mean Cuyahoga County, CCDPW, the Cuyahoga County Engineer, the Cuyahoga County Chief Highway Design Engineer and the Cuyahoga County Chief Bridge Design Engineer.

For the purposes of applying design standards, the CCDPW complete street elements shall be split in to the following categories:

- Right-of-way Considerations,
- Pedestrian Facilities,
- Transit Facilities,
- Bicycle Facilities,
- Stormwater and Landscaping, and
- Parking Management.

For further information on design elements:

NACTO. (2013). *Urban Street Design Guide.* Retrieved November 21, 2013, from http://nacto.org/usdg/

Mid-Ohio Regional Planning Commission. (2012). *Complete Streets Toolkit - A Guide for Central Ohio Communities.* Detailled explanations of design elements, chapter on parking management highlights supply side and demand side strategies; http://www.morpc.org/trans/CS_Toolkit_Web_Lo_Res.pdf

Cape Cod Commission. (2012, October). *Complete Streets/ Living Streets - A Design Manual for Cape Cod.* http://archives.lib.state.ma.us/bitstream/handle/2452/205612/ocn851096305.pdf?sequence=1

North Carolina. (2012, July). *Complete Streets - Planning and Design Guidelines.* (pages 94ff.) for details on intersections and design standards as well as measurements; http://www.completestreetsnc.org/wp-content/themes/CompleteStreets_Custom/pdfs/NCDOT-Complete-Streets-Planning-Design-Guidelines.pdf

Prepared for Federal Highway Administration by Bushell, M. A., Poole, B. W., Zegeer, C. V., & Rodriguez, D. A. (n.d.). list detailed cost information on design elements in their publication *Costs for Pedestrian and Bicyclist Infrastructure Improvements. A Resource for Researchers, Engineers, Planners, and the General Public.* http://katana.hsrc.unc.edu/cms/downloads/Countermeasure%20Costs_Report_Nov2013.pdf

4.1 Right-of-way (ROW) Considerations

The public right-of-way should promote flexibility as well as transportation choices. The ROW does not need to accommodate all users at all times but should by designed such that users and transportation modes are accommodated in a safe, balanced and effective manner taking into account the surrounding community context and land uses.

Alternate Routes – Removing or recommending alternative routes for bicycle, truck, or other vehicular traffic from routes where that vehicle is not the main user is important for allowing the intended users to safely use the system.

Road Diet – Lane reduction or channelization technique used to slow vehicular traffic and improve traffic flow. Often in an urban or suburban area, the existing ROW is already completely used. The goal of this method is to reduce traffic lanes and speeds while staying within the existing ROW. There are many options available that can improve access for pedestrians and cyclists, while not having a negative impact on vehicular traffic for the intended use of the road. Some options for a road diet include:

- Wider sidewalks >6 feet,
- Planting strips >3 feet,
- Landscaped median with breaks and turn lanes at key locations,
- Visual stormwater treatments such as bioretention cells,
- Bicycle lanes, or
- Chicanes.

Traffic Calming – A combination of physical and traffic related (signal) measures installed to reduce the negative effects of motor vehicles, alter driver behavior, and improve conditions for other roadway users. The goals of traffic calming can be to increase quality of life, create safe and attractive streets, reduce speeds of motor vehicles, and promote pedestrian, bicycle, and transit use. Some methods of traffic calming include:

- Reduce the road width by narrowing lanes, widening sidewalks, creating pedestrian refuges, or converting from one to two way streets.
- Install vertical modifications like speed bumps, speed tables, or raised pedestrian crossings.
- Install horizontal modifications like chicanes, pedestrian refuges, parklets, or intersection islands.
- Restrict access by either removing left turn options, put in a cul-de-sac, or create pedestrian or bicycle only zones.

Chicane – An "s" shaped diversion in the driving path. It is created by constructing curved protuberances into the vehicle travel path forcing the vehicle to maneuver though a narrowed mid-block section. They can be installed to reduce traffic to one direction, forcing the other to wait, or bi-directional. Chicanes calm traffic by both visual and physical constraints. Chicanes can be used as pedestrian "bump-outs" to reduce the traveled width for pedestrians. See figure 18

Figure 20: Residential Chicane in Lakewood

One-Way / Two-Way Conversion – Many streets in urban areas were designed to be one-way streets to create a perceived improvement on traffic flow. However, many of those streets are underutilized during off-peak hours and create hazardous conditions. Vehicles stop less on one-way streets, travel more miles due to confusion of the street network, drive at higher speeds, and discourage business due to lack of visibility. For these reasons, and many more, one-way streets across the country are being converted back to two-way streets.[37]

[37] Jaffe, Eric (2013) The Atlantic Cities Place Matters, Accesses 12/26/13 http://www.theatlanticcities.com/commute/2013/01/case-against-one-way-streets

Street Lighting – Street lights are an important safety feature for both vehicles and pedestrians. Studies have shown that properly lit roadways can reduce the number of crashes, particularly crashes involving pedestrians by up to 50%[38]. In addition to safety improvements, lighting can be used for aesthetic purposes. Lighting can improve both the safety and enjoyment of a district for users.

Weekend Driving Restrictions – Restricting traffic on some streets during non-peak hours, particularly weekends, will improve the safety of pedestrians and cyclists in areas that have high concentrations of these users. Converting a busy street to a pedestrian only commercial district can allow for festivals, outdoor cafes, street vendors, and other attractions that increase the quality of life and commercial appeal of a district. An example of this is Market Ave in the Market District in Ohio City. On weekends in the summer the street is closed to vehicular traffic to allow artists to display their wares and provide space for a pop-up market in the public space.

4.2 Pedestrian Facilities

Walking is the most basic mode of transportation, yet pedestrians tend to be the most vulnerable users of the streets. Most crashes involving pedestrians occur when a person crosses the road and a vehicle turns at an intersection. That places special challenges on re-designing intersections to improve pedestrian safety.

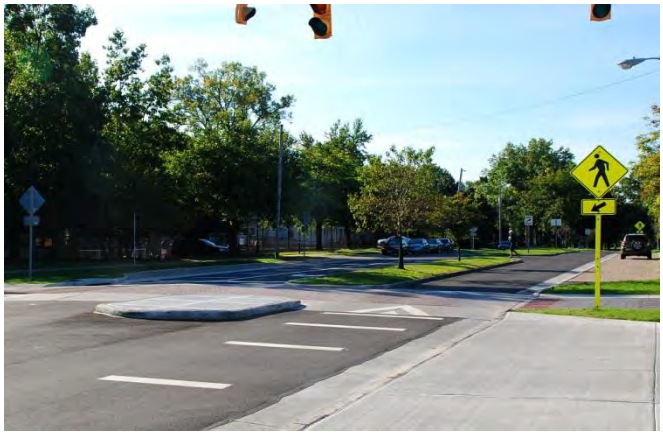

Figure 21: Pedestrian and Traffic calming enhancements on Belvoir Blvd. University Heights

Sidewalks – Sidewalks are the primary access for pedestrians in all urban and suburban areas. They should be included in every facility, unless excluded for ROW reasons. All sidewalks should be at least 4 feet wide with 5 feet width preferred. In business districts, 10 feet wide sidewalks should be included to provide enough width for large volumes of pedestrian traffic. Sidewalks should follow the ODOT and CCDPW standards. Additional standards may be in place in individual municipalities. CCDPW Supplement for further detail.

[38] Schwab, R.N., Walton, N.E., Mounce, J.M., and Rosenbaum, M.J. (1982) Synthesis of Safety Research Related to Traffic Control and Roadway Elements-Volume 2, Chapter 12: Highway Lighting. Report No. FHWA-TS-82-233. Federal Highway Administration.

Sidewalk Furniture – Benches and other furniture are desirable enhancements for commercial, commuter, neighborhood, and transit spine street types. Benches provide places for people to comfortably wait for a transit, particularly people who are older. Benches and other furniture should be installed to not encroach in traveled way for pedestrians, making sure ADA requirements are still met for all pedestrian paths (4 feet clear path). Each municipality should ensure the aesthetic and technical requirements are met with the design.

Signalized Crosswalks – Providing appropriate signalization for pedestrians at both intersection and mid-block crosswalks is an important safety feature that must be included in street design. The volume of pedestrians using the crossing, the speed of traffic on the street, and the type of signals for vehicular traffic must all be taken into account when determining is a signal is necessary. An area that has a high elderly population or an intersection that is at an off-angle might require signalization for pedestrians. The signals must take in to account all users and be accessible to all per ADA requirements. Proper installation and maintenance of signal buttons and installation of countdown timer ped-heads help pedestrians safely use the crosswalk at the correct time to provide a safe environment for all users.

Mid-block Crossing - Many designers and planners assume that pedestrians will only cross at intersections. However, pedestrians are likely to cross at mid-block locations if the closest intersection is out of the way. People take the most direct route possible. Providing a legal mid-block crossing for pedestrians makes the roads safer for all users. Some mid-block crossings may warrant a signal, and these should be considered when constructing pedestrian improvements.

Scramble Phase – At intersections that are busy with both vehicular traffic and pedestrian traffic, a scramble phase can eliminate conflict points between pedestrians and vehicles. In a scramble phase, traffic signals are programmed for a vehicle "all-red" phase while allowing pedestrians free access across the intersection. This allows pedestrians the ability to cross busy roads without worrying about right or left turning vehicles. The scramble should be initiated by pedestrian push buttons to eliminate unnecessary delay for vehicular traffic. Scramble intersections should always have "No Right Turn on Red" signs for vehicular traffic.

For more details on Pedestrian Facilities:

ODOT Location and Design Manual Volume 1, section 306 provides detailed guidance on sidewalks and buffer zones.
http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Location%20and%20Design%20Manual/Section_300_Jan_2014.pdf

Cuyahoga County Supplement to ODOT Location and Design Manual Volume 1 – Roadway Design
http://publicworks.cuyahogacounty.us/pdf_publicworks/en-US/DesignStandards-GeneralProvsn/DesignStandards_11-2013.pdf

Goat Path – Pedestrians tend to take the easiest route possible, avoiding extra walking when given the opportunity. The resulting path is called a "goat path." Designing sidewalk and connections should take these in to account. If pedestrians take a natural path to get to a location, sidewalks or a formal trail should be installed. Otherwise a barrier should be erected to encourage pedestrians to stay on the intended path. Areas where grass is worn away in goat paths lead to erosion and possibly unsafe entrance to facilities.

Buffer Zones – The width of non-used area between the traveled way and pedestrian traffic, sometimes known as the tree lawn or utility strip, should provide adequate width for the safety of pedestrians. This area provides the opportunity for decorative vegetation or stormwater management systems. Ideally, complete streets should include a minimum of 2 feet buffer room between the traveled way and pedestrian traffic. In a business district, 10 feet sidewalks may preclude the ability to include a buffer strip, but they should be included whenever possible.

Figure 22: Goat Path

Figure 23: Pedestrian Refuge Island

Refuge Island – An island in the middle of a large street provides an area of refuge for pedestrians while not encumbering vehicular traffic with a long signal phase. It is also a benefit at crossing where there is not a signal, but still multiple lanes of traffic. Current design standards does not provide enough time for some pedestrians to cross multiple lanes. An island gives pedestrians a place to wait for the signal to change in their favor again. It also provides a location for pedestrians to wait when they have a clear path from one direction of traffic, but not from the other.

Winter Maintenance – Maintaining pedestrian facilities is paramount to its success in the northeast Ohio winters. Pedestrians are year-round users of all facilities, and safety is their first concern. Shoveling, de-icing, and other winter maintenance must be accounted for in the design of pedestrian facilities.

4.3 Transit Facilities

Complete streets designs are an opportunity for communities to invest in transit shelters and possibly to dedicate street lanes to buses to improve the speed for transit riders. Other opportunities are connected with intersection timing, placement and frequency of transit stops, and pedestrian access. Communities are strongly encouraged to work with RTA on identifying opportunities to improve bus access in their community

RTA provides quality, economic and safe public transportation via rail, bus and paratransit throughout Cuyahoga County. The RTA transit network functions as a vital part of a balanced transportation system, one that achieves an optimal mix of automotive, transit and non-motorized transportation types. Through changes in decisions regarding transportation priorities, land use and development location, RTA aims to be the first choice for regional transportation and a one-stop source for integrated transportation information in the region. Increased interest in urban living among young people and empty nesters, higher fuel prices and reduced driving, and other factors indicate that demand for transit services will continue to steadily increase, while driving, which has now been declining for several years, is likely to continue to decline. This gives RTA the opportunity to increase its share of the transportation market, by steadily improving its quality of service, marketing and operating efficiency.

RTA's planning efforts are guided by its strategic plan titled "Re: Imagine RTA - 2010-2020 Strategic Plan". The vision of the plan is that RTA will be the preferred mode of transportation in the greater Cleveland area. The plan identifies Priority Transit Corridors that have relatively high population and employment densities.

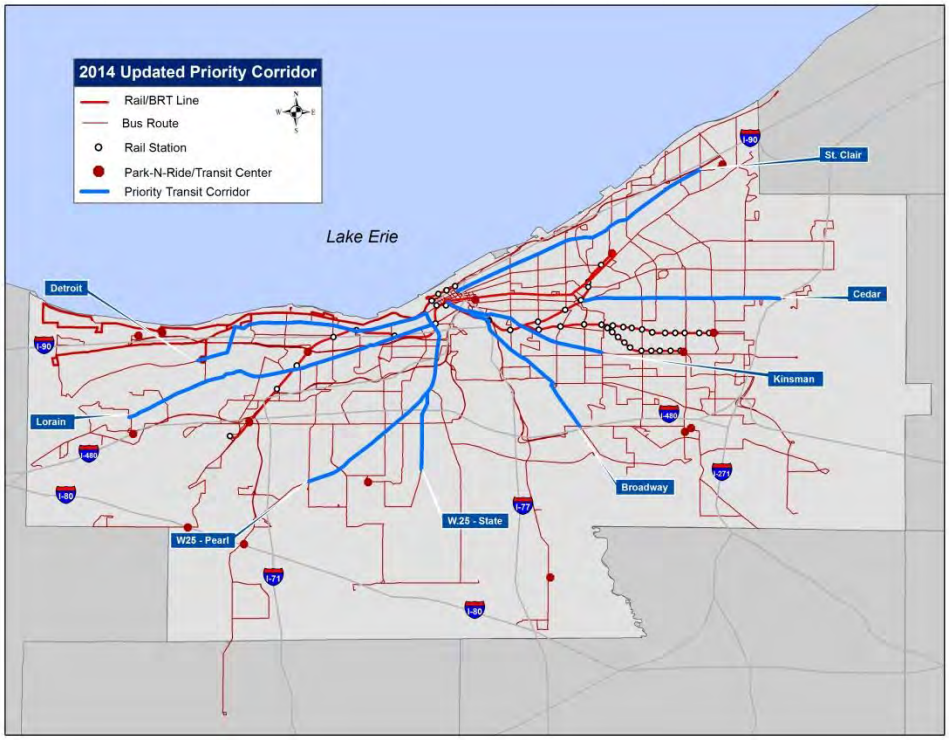

Figure 24: RTA Priority Transit Corridors

RTA will focus on these corridors for future transit improvements as funding becomes available. The goals set forth by the plan to help achieve this vision include:

- RTA will continue to put customer needs first.
- RTA will focus on ensuring access to employment and educational opportunities for regional residents.
- RTA will provide services cost effectively.
- RTA will support regional approaches to transportation and land use planning that reinforce investment in existing employment and population centers, infrastructure and services.
- RTA will improve services to suburban employment centers.
- RTA will provide special transportation service support to those who need it most.
- RTA will provide services at a sustainable level given its financial resources.
- RTA will increase its contribution to sustaining our natural environment.

Transit Center – Provides an attractive, safe, clean and comfortable environment for RTA customers while they wait to transfer between bus services. A typical transit center includes an indoor climate-controlled waiting area with real-time customer information signs.

Furniture at Stops – "RTA seeks to provide seating and shelter at bus stops and rail stations if sufficient space is available and 50 or more daily riders are expected to use the shelter. RTA installs and services waste receptacles only on RTA property. Each municipality decides whether to install and service waste receptacles in the public right-of-way." (RTA Policy adopted 12-17-13)

Real-Time Information – Real-time bus and train arrival information is available online via NextConnect (nextconnect.riderta.com) or by phone. HealthLine stations and the busier rail stations have real-time information displays. These displays are also installed at transit centers and should be considered at bus stops.

Smart-Pay Systems – RTA plans to phase in a "Smartcard" system that will allow passengers to simply tap their fare card on the "Smartcard" reader on the fare box, and the fare will be deducted from the card. No time frame has been set.

Distance Between Bus Stops – During 2014-2016, RTA will gradually implement a new guideline calling for approximately 880 feet (1/6 mile) between bus stops. However, this is only a ***guide and not a fixed distance***. The following criteria are considered when deciding on exact stop placements: safety, pedestrian access, bus routing, transfer points, land use, topography, and location of trip generators.

Figure 25: ADA Accessible Green Line Station at Warrensville Center Rd in Shaker Heights

ADA Accessibility – All bus stops and transit facilities must be designed to meet the most recent ADA standards.

Bus Bulbs – As defined in the 2012 NACTO USDG, bus bulbs "are curb extensions that align the bus stop with the parking lane, allowing buses to stop and board passengers without ever leaving the travel lane." Bus bulbs increase transit reliability as they eliminate the need for buses to pull out of and back into traffic after dropping off or picking up passengers. They also provide a shorter crossing distance for pedestrians if there is a crosswalk is at the same location as the bus stop. When used, bus bulbs should be designed to accommodate the minimum 35 feet turning radius for right-turning buses.

Transit Priority Signalization – Signal priority for transit vehicles has been implemented on Euclid for HealthLine buses, which provides travel time savings for passengers by recognizing when a bus is at the intersection and giving the bus a green light. Where appropriate, RTA is supportive of implementing this in other transit corridors throughout their system (especially on the Priority Transit Corridors identified in the RTA Strategic Plan).

Protected Bus Way – A traffic lane exclusively dedicated to buses. This can be an all-day restriction (HealthLine and Superior Avenue) or only during the peak hours (St. Clair Avenue and Clifton Boulevard). Bus lanes remove transit vehicles from the normal traffic stream and ensure that buses can move quickly without being impeded by congestion. Dedicated lanes matter most in heavily congested areas.

Bicycles on Bus – Beginning in 2001, RTA began installing bicycle racks on to buses as part of the Rack-n-Roll program. Today, 100% of RTA busses have racks that hold either two (2) or three (3) bicycles or a designated bike area on the bus (HealthLine). And, up to 50,000 people take advantage of the bike racks every year! These bike racks greatly increase the availability of multi-modal transit throughout the greater Cleveland area.

For more details on Transit Waiting Environments (TWE)

The Greater Cleveland Regional Transit Authority provides design guidance for TWE. These are actually in the process of being updated and incorporated into a larger Bus Stop Guidelines document.
Transit Waiting Environments: An Ideabook For Making Better Bus Stops
http://www.riderta.com/sites/default/files/twe/TWEIdeabook.pdf

4.4 Bicycle Facilities

Cyclists may include the weekend warriors, joy riders, or even commuters - in fact people who live within 3 to 5 miles of their work place can easily bike to work within 20 to 30 minutes. For millennials, having the choice of biking to work becomes more and more important when choosing a place to live and choosing a home. When it comes to cycling, complete streets does not mean adding a bike lane to every road, but it does mean providing a regional network of bike friendly streets that provide "protected" bike lanes that connect neighborhoods to major destinations and employment centers.

Figure 26: Bike Lane at Big Creek at Fernhurst Avenue in Parma Heights

To get more people on bicycles, cities are identifying bicycle facility treatments that provide stress-free cycling environments for people of all ages and abilities. Below are facility types that should be considered when implementing complete streets.

4.4.1 Bicycle Infrastructure

Widened Shoulders (Rural) – Paved roadway shoulders on rural roadways provide a suitable area for bicycling, with few conflicts with faster moving motor vehicle traffic. Most rural bicycle travel on the state highway system is accommodated on shoulder bikeways.

Figure 27: Protected Contra-Flow Bike Lane in N.Y.C.

Bike Lanes – Removing bicycles from shared paths with other vehicles (pedestrians or cars) is an excellent way to remove conflict and reduce accidents. A bike lane is a lane of traffic dedicated to use by bicycles. On roads where there is no curb, a 4 foot wide bike lane in each direction is sufficient. In areas where there are curbs, bike lanes should be at least 5 feet wide. Bike lanes can be used in conjunction with a road diet or installed when a street is being widened or has wide shoulders. Providing a painted buffer between the

bicycle and vehicular traffic further increases safety for both user groups. Refer to the ODOT Manual of Uniform Traffic Control Devices (MUCTD) Part 9 for design guidance for bicycle lanes.

Contra-Flow Bike Lanes – This type of bicycle lane is most efficient in a city or commercial area where one-way streets are prevalent. A bike lane is added on a one-way street, in the opposite direction from vehicular traffic. A yellow center line stripe is necessary to make this system work properly. It allows cyclists to avoid long detours and use low volume streets. Bike lane widths should be standard width and accompanied with bike lane arrows and signs indicating the direction of flow and warning cars to their presence. U.S. Federal Highway Authority (FHWA) has indicated contra-flow bike lanes can be implemented if signage and pavement markings are compliant with MUTCD.

Figure 28: Contra-flow Bike Lanes

Cycle Track (Protected Bike Lane) – These facilities physically separate the motor vehicles from bicycle traffic by a barrier. Bicycle traffic is removed from the vehicular traveled way by a physical barrier, often bollards, planters or concrete barrier, and allowed to travel in a dedicated space. Protected bike lanes can be one-way or two-way. When designing protected bike lanes it is important to utilize signage and/or dedicated bicycle signals to manage conflicts at intersections and driveways. Two-way bike lanes can be installed on either one side of the highway or in the center. Some special considerations when installed these facilities are turning movements, street crossings, and driveways. Additional signage for both cyclists and motor vehicles should be used so the intent of the path is known and movements are predictable.

Buffered Bike Lanes - Buffered bike lanes are similar to conventional bike lanes but are paired with a designated painted buffer space that further separated bicycles from motor vehicle traffic (see figure 20 for example). Guidance from NACTO suggested that the buffer be at least 18 inches wide.

**Figure 29: Buffered Bike Lane, Edgehill Road,
Collaboration of Cleveland and Cleveland Heights, Ohio**

4.4.2 Pavement Treatment, Amenities and Signage

Shared Roadway – On a shared roadway, bicyclists and motorists share the same travel lanes. A motorist will usually have to cross over into the adjacent travel lane to pass a bicyclist. Shared roadways are common on neighborhood streets and on rural roads and highways. There are two treatments that enhance shared roadways for cyclists:

- **Wide Outside Lane** – Where shoulder bikeways or bike lanes are warranted but cannot be provided due to severe physical constraints, a wide outside lane may be provided to accommodate bicycle travel. A wide lane usually allows an average size motor vehicle to pass a bicyclist without crossing over into the adjacent lane.

- **Bicycle Boulevards** – A modification of the operation of a local street to function as a through street for bicycles while maintaining local access for automobiles. Traffic calming devices control traffic speeds and discourage through trips by automobiles. Traffic controls limit conflicts between automobiles and bicycles and give priority to through bicycle movement.

Figure 30: Bicycle Boulevard, City of Columbus, Ohio

- **Shared Lanes Markings (Sharrows)** – This is the most common type of bicycle facility being used. It consists of "sharrows" and signage placed along the roadway to indicate to drivers that bicycles are on the road and in the traveled lane. It is important to note that sharrows are not a facility type; it is a pavement marking with a variety of uses to support a complete bikeway network. Sharrows should not be used as a substitute for bike lanes or protected bike lanes where space permits or these more separated types of bicycle facilities are needed for safety.

  Placement of sharrow's is very important. If lanes are less than 12 feet, they should be placed in the center of the lane to encourage cyclists to take then lane when necessary. This will encourage cars to change lanes to pass the cyclists. If the lane is 12 feet or more, the symbol may be painted offset centered at 4 feet from edge of traveled way. In areas of on street parking, sharrow symbol shall be installed 12 feet from edge of pavement to allow for an 8 feet parking lane and 4 feet door swing clearance. Sharrows should not be used on roads with posted speed limits higher than 35 mph.

Green Pavement/Paint - Green colored pavement is often used to increase the visibility of the facility especially in conflict areas (at driveways, intersections and areas where illegal on-street parking is a concern). ODOT has received interim approval for agencies to use green colored pavement in bike lanes

Bicycle Parking – There are many options for bicycle parking and the desired style varies based on use, volume, and location. When designing bicycle parking, many variables should be taken in to consideration. Many city ordinances include requirements for vehicle parking at businesses, but not bicycle parking. Including bicycle parking requirements will increase available legal parking for bicycles

and discourage bicycles from being locked to streets signs, trees, and fences. These include but are not limited to volume of bicycles, length of storage, sidewalk width, and street type. Bicycle corrals are another option for bicycle parking that should be used when sidewalk space is limited and bicycle traffic is heavy. A single vehicle parking spot is blocked off and a bicycle rack is installed. This option allows for a large number of bicycles to safely park while minimizing the impacts to other facility users. Bicycle corrals can be installed on the street, in a parking lot, or in a parking garage. In the space that was previously occupied by one or two motor vehicles, up to 20 bicycles can park, a 10 times improvement, while advertising that the area businesses and the community support cyclists.

Painted Bike Boxes – A colorized area at a signalized intersection provides a place for bicycles to safely wait for the signal to change. These boxes are used to reduce bike-car conflicts, particularly right turns made by cars across a bike lane, increase cyclist visibility, and give cyclists a head start once the light turns green. Bike boxes should be wide enough to include the entire traveled lane and the bike lane on a road and long enough to provide space for multiple bicycles. Bike boxes work best when used in conjunction with a bike lane on streets with high bicycle traffic volumes.

Bike Signals – Providing bicycles with signals at signalized intersections helps the entire intersection to move more efficiently. Using a traditional 3 lens system similar to motor vehicles, these signals provide information to bicycles and pedestrians for safe passage. They can be used to provide a protected phase for cyclists, decrease conflicts with motor vehicles and pedestrians, and discourage illegal and unsafe crossing. Signals should be installed with cycle-tracks and can be installed at all signalized intersections. There are 3 main types of signals for bicycles:

- **Active Warning Beacons** - These are similar to pedestrian crossings. They are user-activated flashing beacons typically used at mid-block crossings. These are useful where a bike path crosses a road and there is no signal or intersection.

- **Bicycle Signal Heads** - In conjunction with traditional signal heads, these bike signals are used to provide clarity and increase safety at intersections. They can be timed to allow for bicycle or car only phases to reduce the number of turning movement conflicts. These can also be used in conjunction with painted bike boxes to allow the bicycles time to clear the intersection before motor-vehicles are permitted to move.

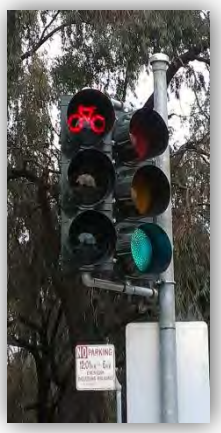

Figure 31: Bicycle Signal Head

Signal detection and actuation for traditional signal heads should be installed to improve safety for cyclists in locations without heave vehicular traffic or where bicycle signal heads are installed. Induction loops or video detection are both able to be used for this purpose. When induction loops are installed, a bicycle detector pavement marking should be installed as well to indicate to cyclist where they need to stop to properly activate the signal.

Bicycle Route Signage – A complete bicycle network should include route signage to inform bicyclists of the preferred bicycle route and upcoming destinations. Some route signage includes distance in time and miles to the destinations that the bicycle route connects.

For more details on bike infrastructure

Federal Highway Administartion Bicycle Safety Guide and Countermeasure Selection System (BIKESAFE).
This resource helps support the U.S. Department of Transportation's new pedestrian and bicycle safety initiative. BIKESAFE provides practitioners with the latest information available for improving the safety and mobility of those who bike.
http://www.pedbikesafe.org/BIKESAFE/

4.5 Stormwater Management and Landscaping

The water quantity from heavy rainfall events and snow melt in Northeast Ohio is overwhelming the area's sewer infrastructure and waterways. Since the sewer and storm water pipes in Cuyahoga County were built almost 100 years ago, there is a major need to rethink how storm water is handled on streets. Impervious surfaces such as buildings, roads, sidewalks, driveways and parking lots covered by impenetrable materials, or even soils compacted by urban development are an environmental concern because of the impact on water quality and quantity. Runoff from impervious surfaces picks up sediment and pollutants which eventually discharges into local streams and waterways. Streets and sidewalks are one of the largest categories of public impervious cover, accounting for roughly 8.2% of the land use within Cuyahoga County. Stormwater was historically drained off of paved surfaces quickly and efficiently through combined and separate storm sewer outfalls, to avoid hazardous flooding. This approach exacerbates the problem associated with stormwater runoff, such as flooding and erosion, thus polluting our streams and waterways. New stormwater management approaches use a combination of functional landscaping and engineered strategies to distribute and manage stormwater and melting snow.

4.5.1 Green Infrastructure and Landscaping for Stormwater Management

In 1972, the Federal Clean Water Act was enacted as a response to the growing concern of the quality of the nation's water supply. Part of the Act made it illegal to discharge pollutants from a point source to the waters of the United States without compliance with a National Pollutant Discharge Elimination System (NPDES) permit. An amendment in 1987 made the EPA the regulatory in charge of overseeing this program. In Ohio, it is the responsibility of each individual Municipal Separate Storm Sewer System (MS4) to obtain an NPDES permit and ensure discharge from their community meets state and federal regulations.

The following design options incorporate various green infrastructure tools and functional landscaping to reduce stormwater runoff at the source, infiltrate runoff into the soil to recharge groundwater as well as filter pollutants that otherwise end up in the Lake Erie Watershed. Not all landscaping is used as stormwater management. Communities should ensure that they are able to meet regulatory requirements for their specific project. Functional landscaping items can improve the aesthetic appeal of a project through streetscapes, as well as make the facility more enjoyable for users.

It's beneficial to slow the water down and capture it at the source. Incorporating landscaping alternatives along the roadways can improve water quality, reduce or control stormwater volume, as well as pedestrian and bicycle safety. Green infrastructure also enhances the aesthetics of the right-of-way, while alleviating urban heat islands and absorbing air pollutants and rainfall.

Alternative Post Construction BMP for Stormwater – In areas of very limited space, when no other post construction BMP (best management practice) is feasible, the use of an alternative post construction BMP may be allowed, with Ohio Environmental Protection Agency (OEPA) permission. Communities should refer to the current ODOT L&D Volume 2 manual for allowable BMPs on roadway projects.

Manufactured Systems – Large structural devices, underground, used to remove total suspended solids (TSS) from the stormwater prior to release to the main system. In order to be approved, these devices must show greater than 80% TSS removal in both field and laboratory conditions. These systems can only be used for water quality and not water quantity.

Figure 32: Permeable Pavers Columbus, Ohio

Permeable Pavement - Permeable pavement is an alternative to asphalt or concrete surfaces that allows stormwater to drain through the porous surface to a stone reservoir underneath. The reservoir temporarily stores surface runoff before infiltrating it into the subsoil. The appearance of the alternative surface is often similar to asphalt or concrete, but it is manufactured without fine materials and instead incorporates void spaces that allow for storage and infiltration. Underdrains may also be used below the stone reservoir if soil conditions are not conducive to complete infiltration of runoff. Permeable Pavement may be used as a landscaping feature in addition to other stormwater management systems. Permeable pavement is best used as part of a treatment train, but if designed properly, it can be used on its own to mitigate stormwater runoff.

Permeable pavers are an aesthetic alternative to permeable pavement which promotes groundwater recharge. Permeable interlocking concrete pavements (PICP) are concrete block pavers that create voids on the corners of the pavers (figure 29). Concrete grid paver (CGP) systems are composed of concrete blocks made porous by eliminating finer particles in the concrete which creates voids inside the blocks; additionally, the blocks are arranged to create voids between blocks. Plastic turf reinforcing grids (PTRG) are plastic grids that add structural support to the topsoil and reduce compaction to maintain permeability. Grass is encouraged to grow in PTRG, so the roots will help improve permeability due to their root channels. An additional benefit of permeable pavement is a reduction of ice on the surface. Water infiltrating through the pavement doesn't have time to sit on the surface and freeze, thus reducing the deicing materials required.

Inlet Protection – Inlet protection devices, also known as hydrodynamic separators, are flow-through structures with a settling or separation unit to remove sediments, oil and grease, trash, and other stormwater pollutants. This technology may be used as pre-treatment for other stormwater management devices. Inlet protection devices are commonly used in potential stormwater "hot spots"—areas where higher concentrations of pollutants are more likely to occur, such as gas stations.

Riparian Buffers – A riparian, or forested, buffer is an area along a shoreline, wetland, or stream where development is restricted or prohibited. The primary function of aquatic buffers is to physically protect and separate a stream, lake, or wetland from future disturbance or encroachment. If properly designed, a buffer can provide stormwater management and can act as a right-of-way during floods, sustaining the integrity of stream ecosystems and habitats.

Figure 33: Biofilter, Columbus, Ohio

Vegetated Biofilters – Filter strips are bands of dense vegetation planted downstream of a runoff source. The use of natural or engineered filter strips is limited to gently sloping areas where vegetative cover can be established and channelized flow is not likely to develop. Filter strips are well suited for treating runoff from roads and highways, roof downspouts, very small parking lots, and impervious surfaces. They are also ideal components for the fringe of a stream buffer, or as pretreatment for a structural practice. Vegetated biofilters and filter strips are typically used as part of a treatment train, but can be used on their own for water quality requirements.

Figure 34: Rain Garden

Bioretention Cells – A bioretention cell or rain garden is a depressed area with porous backfill (material used to refill an excavation) under a vegetated surface. These areas often have an underdrain to encourage filtration and infiltration, especially in clayey soils. Bioretention cells provide groundwater recharge, pollutant removal, and runoff detention. Bioretention cells are an effective solution in parking lots or urban areas where green space is limited.

Tree Boxes – Tree box filters are in-ground containers used to control runoff water quality and provide some detention capacity. Often pre-manufactured, tree box filters contain street trees, vegetation, and soil that help filter runoff before it enters a catch basin or released from the site. Tree box filters can help meet a variety of stormwater management goals, satisfy regulatory requirements for new development, protect and restore streams, control CSOs, retrofit existing urban areas, and protect reservoir watersheds. The compact size of tree box filters allows volume and water quality control to be tailored to specific site characteristics. Tree box filters provide the added value of aesthetics while making efficient use of available land for stormwater management. Typical landscape plants (for example, shrubs, ornamental grasses, trees and flowers) are an integral part of the bioretention system. Ideally, plants should be selected that can withstand alternating inundation and drought conditions and that do not have invasive root systems, which may reduce the soil's filtering capacity. The older styles of tree boxes with elevated curb should be removed and replaced with recessed trees.

Figure 35: Green Roof on Bicycle Shelter Columbus, Ohio

Vegetated Roofs – Green roofs consist of an impermeable roof membrane overlaid with a lightweight planting mix with a high infiltration rate and vegetated with plants tolerant of heat, drought, and periodic inundations. In addition to reducing runoff volume and frequency and improving runoff water quality, a green roof can reduce the effects of atmospheric pollution, reduce energy costs, and create an attractive environment. They have reduced replacement and maintenance costs and longer life cycles compared to traditional roofs. Bus stops and bicycle parking shelters are excellent candidates for vegetated roofs within the right-of-way.

Green Parking - Green parking refers to several techniques that, applied together, reduce the contribution of parking lots to total impervious cover. Green parking lot techniques include: setting maximums for the number of parking lots created; minimizing the dimensions of parking lot spaces; utilizing alternative pavers in overflow parking areas; using bioretention areas to treat stormwater; encouraging shared parking; and providing economic incentives for structured parking). Other options include solar powered parking meters and smart-park systems with real-time parking availability within a structure or district.

Bioswales – Grassed swales are shallow grass-covered hydraulic conveyance channels that help to slow runoff and facilitate infiltration. The suitability of grassed swales depends on land use, soil type, slope,

imperviousness of the contributing watershed, and dimensions and slope of the grassed swale system. In general, grassed swales can be used to manage runoff from drainage areas that are less than 4 hectares (10 acres) in size, with slopes no greater than 5 percent. Use of natural, low-lying areas is encouraged and natural drainage courses should be preserved and utilized.

Recessed Curbs – Curbs and gutters transport flow as quickly as possible to a stormwater drain without allowing for infiltration or pollutant removal. Eliminating curbs and gutters can increase sheet flow and reduce runoff volumes. Sheet flow, the form runoff takes when it is uniformly dispersed across a surface, can be established and maintained in an area that does not naturally concentrate flow, such as parking lots. Maintaining sheet flow by eliminating curbs and gutters and directing runoff into vegetated swales or bioretention basins helps to prevent erosion and more closely replicate predevelopment hydraulic conditions. A level spreader, which is an outlet designed to convert concentrated runoff to sheet flow and disperse it uniformly across a slope, may also be incorporated to prevent erosion

Alternative Deicing Materials – While many communities use plants that are accustomed to salt and help mitigate the damage caused by its use, deicing runoff is still a problem for many reasons. The use of alternate deicers can reduce polluted water going in to the lakes and rivers through runoff and stormwater systems. Some rock salt alternatives are:

Figure 36: Salt brine solution being applied as pre-treatment City of Beavercreek, Ohio

- **Acetate Deicers** – Both Potassium Acetate and Calcium Magnesium Acetate are used as deicers. Often used for runway deicing, potassium acetate is a liquid deicer that prevents the ice and snow from bonding to the pavement surface. It is effective at temperatures significantly below freezing. This solution is less toxic to plants and animal and works quickly.
- **Calcium Chloride** – This deicer is effective up to -25°F. It is less harmful to plants and animals, attracts moisture to help melt snow. It is typically combined with standard road salt to speed up the melting process. However, it can be expensive, it keeps pavement wet, and can be corrosive to metal and concrete.
- **Corn or Beet Base** – This is an all-natural agricultural based product that can be mixed with other solution based deicing methods to reduce the impacts on the environment while increasing the effectiveness of the product. The addition of naturally derived base fluids helps lower the freezing point of other salt based solutions and reduces the amount of corrosive material placed on roadways. It can be used for pre-treating roadways as well as post-precipitation treatment.
- **Magnesium Chloride** – This deicer is slightly more expensive than other options, but it performs well at low temperatures and better for roads and the environment. This chemical compound is

safe for animals and plants. It also is less corrosive than standard salt deicers, reducing long term costs of roadways. This product typically costs about $22 per lane mile.

- **Salt Brine** – Best when placed on roads prior to precipitation, salt brine is a very effective proactive deicing agent. This solution prevents ice from sticking to the roadway surface, preventing the problem before it begins. According to the City of Beavercreek, Ohio, the cost for pre-treating a road with about $2.58 per lane mile. This treatment can be up to 10 times more effective ice maintenance than post-snow treatment with rock salt. [1]
- **Sand** – This method of treatment does not melt ice. It is typically used mixed with other deicers as it only creates a friction surface on ice. Sand is less corrosive and doesn't directly harm plants and animals, but it does impact the environment by clogging drains and increasing silt in waterways.

4.5.2 Non-Stormwater Management Landscaping

Decorative Vegetation – Incorporating decorative vegetation into a streetscape is important to make the user experience enjoyable. The use of native plants is particularly important. Native plants add beauty to landscapes while providing many benefits. They require little long-term maintenance if planted properly because they naturally grow in this climate. They also have longer root systems that help reduce erosion and protect water quality. Vegetation can also play an important role in neighborhoods by reducing energy costs. Large trees that provide shade help keep energy costs down for residents.

For more details on Stormwater:

The Ohio Environmental Protection Agency Division of Surface Water regulates stormwater to reduce the impact of pollutants.
http://epa.ohio.gov/dsw/storm/index.aspx

ODOT office of hydraulics
http://www.dot.state.oh.us/Divisions/Engineering/Hydraulics/Pages/default.aspx

Cuyahoga Soil and Water Conservation District
http://www.cuyahogaswcd.org/

Northeast Ohio Regional Sewer District
http://www.neorsd.org/stormwater-watersheds.php

Ohio Department of Natural Resources
http://soilandwater.ohiodnr.gov/

Vegetated Planters on Streets (Parklet) – This enhancement temporarily or permanently uses space within the existing ROW (parking spaces, unused bus stops) to provide space for public use. The use can include seating, landscaping, bicycle parking, and other spaces that people find enjoyable. They can also be used to assist with parking restrictions in commercial districts.

Figure 37: Parklet

Street Furniture – Street furniture is a great way to incorporate local distinction to a complete street. Benches and trash cans can be very basic and provide seating for consumers and ensure the streets are kept clean. But, they can also be a way to exhibit local artists and create a theme for a district. Working with local artists, the vision for the area can be incorporated in to the style of benches, trash cans, and street art. Street furniture must be functional, but it can also enhance the experience for all users.

4.6 Parking Management

Managing parking is one way to encourage alternative modes of travel. Throughout the county and therefore becomes a significant land use and transportation strategy. Proper management of parking can help municipalities make districts safer and traffic flow smoother throughout a region. City managers must look at the intent of a street or system of streets and determine which parking restrictions are appropriate for the determined use of a street. If a street is designated for commercial use, allowing parking at all times can encourage consumers to stop on their way home from work. Contrasting that, a commuter street should focus on quick movement of vehicles, so parking should not be allowed during peak hours. Each street must be looked at individually based on the intended use, and then assigned parking restrictions that are suitable. There are also other ways in which a community can increase quality of life and decrease impacts to the environment that can be accomplished through parking. Idle engine restrictions reduce the CO2 that enters the environment. Permeable paving and landscaped parking facilities increase the aesthetic appeal of a neighborhood while reducing the amount of stormwater entering the treatment system.

Truck Parking Considerations – Trucks must be considered for parking accessibility on most non-commuter or boulevard streets. Most transit, commercial, and even residential streets should take in to account truck access and parking in their design. Trucks can be restricted to parking during certain times of day in high-traffic areas in order to reduce the impacts to traffic flow. Removing trucks from main streets is also an option, provided there is an alternative access location, such as an alley.

Restricted Parking – There are many options for restricting parking on a street. Parking can be eliminated at certain times of day, days of the week, or limited to residents of the neighborhood. Each of these can benefit a district for different reasons. Removing parking from a commercial district on weekends, when there are more pedestrians, will make the street safer for pedestrians and cyclists. Rush hour parking restrictions can help traffic flow through a commuter district more efficiently.

Metered Parking on Streets – There are multiple ways to use metered parking to impact the street in question. A low limit on the amount of time people can park (i.e. 1 hour max limit) will increase the number of consumers that have access to the spaces and increase turnover. A higher limit (i.e. 4 hours) will encourage people to park and then wander a district allowing them time to browse, shop, and visit restaurants. In a region with ample off-street parking available, more expensive parking meters will encourage people to park in lots that are placed around a district reducing the amount of traffic traveling through a neighborhood.

Valet Parking – Valet parking is a way to restrict parking on a main street during busy hours while also providing a method for people to access the area. Strategically placing the valet station at the beginning and end of a district will minimize vehicular traffic through the area allowing for free movement of pedestrians. If valet parking is offered in addition to through traffic, pavement width must be taken in to consideration. Valet traffic can severely impede traffic flow and cause erratic movement from vehicles attempting to bypass the valet service leading to unsafe traffic patterns.

Drivers Side Buffer – Providing a driver side buffer strip on busy streets can increase the safety for drivers, vehicular traffic, and bicycles. A 2 -3 foot concrete or planted buffer strip allows the driver to exit his/her car without stepping immediately in to moving traffic. It also helps avoid bicycles being "doored" by a car door opening suddenly.

No Parking – There are some instances when a complete ban on parking is the preferred method of parking management. Streets that are designated for transit or pedestrian access only would have a complete parking ban. This will allow for safe facilities for the pedestrians and smooth traffic movement for transit. Commuter streets are another example of where full parking bans may be appropriate. In order for commuter streets to function as they are designed, parking must be restricted during peak hours but if there are no access points along a commuter street, a full parking ban could be beneficial.

Alternate Access Locations – Limiting vehicular access to a district by providing alternate access or parking locations is another way to promote safe streets for pedestrians and bicycles. With an alternate access, vehicles are removed from a main street and relocated to a side street.

Figure 38: No Parking and Alternate Access Locations, Lakewood

One-Side Parallel Parking – Limiting on-street parking to one side of a street allows for the other side of the street to be dedicated to other users without increasing the ROW or pavement width. The 8-10 feet of additional pavement width can be used for bike lanes, additional sidewalk width, or a bus lane. Many streets are under-utilized for on-street parking during most hours and can easily be converted to 1 side parking.

Widened Shoulders – In many areas of Cuyahoga County, there are streets with no curbed edges. In these locations, widened shoulders should be considered for many reasons. One reason is to allow for vehicles to park safely out of the traveled way. Many of these rural-type streets are near parks, schools, and houses all of which make use of on-street parking. A widened shoulder provides a location for vehicles to park but reduces the cost because of the reduced pavement build-up.

Idle Engine Restrictions – Only three municipalities in the State of Ohio (Maple Heights, Cleveland, and South Euclid) have restrictions on vehicle idling. When engines are allowed to idle (engine on but vehicle not moving) resources are used and pollution is emitted. Enacting an anti-idling law in your municipality can increase air quality and quality of life.