Sustainable Neighborhood Road Design

A Guidebook for Massachusetts Cities and Towns

MAY 2011

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AMERICAN PLANNING ASSOCIATION – MASSACHUSETTS CHAPTER

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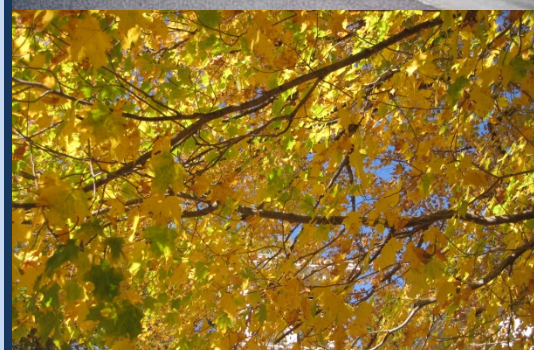

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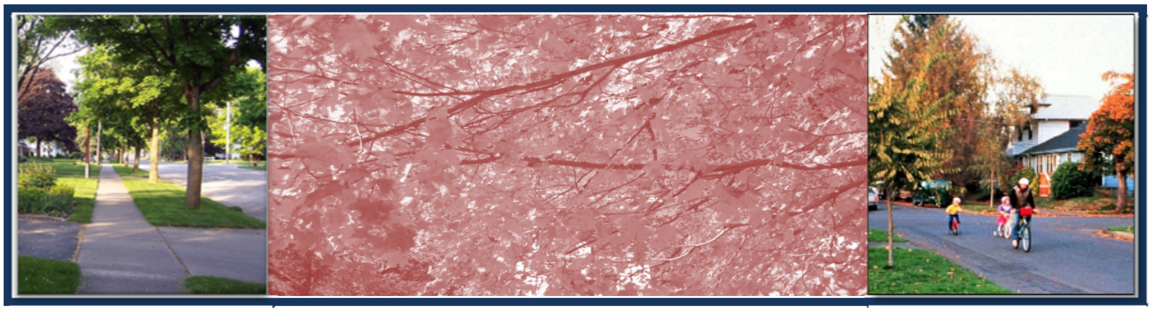
This guidebook was made possible by contributions from the project Steering Committee:

American Planning Association – Massachusetts Chapter
Peter Lowitt, FAICP
Steve Sadwick, AICP

Home Builders Association of Massachusetts
Jeffrey Rhuda
Mark Kablack, Esq.
Jonathan Flood
Ben Fierro III, Esq.

Consultants
Eaton Planning, Chris Kluchman, AICP
Waterman Design Associates, Mike Scott, PE, Paula Thompson PE
Frank DiCesare, Editor



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Foreword

Mass Audubon
Advocacy Department
Six Beacon Street, Suite 1025 ▲ Boston, Massachusetts 02108

This *Neighborhood Road Design Guidebook* is an important new tool for municipal officials, and Mass Audubon is pleased to support it. The design of local roadways has tremendous impact on habitat, water resources, community character, and municipal infrastructure. Updating local subdivision and road design standards will guide your community on a path toward a more sustainable future -- environmentally, economically, and for a high quality of life.

Traditional approaches to roadway design have a basis in engineering, but there are better ways to develop roads and subdivisions. Narrower roads often are actually safer than wide roads. Good designs encourage walking and biking, providing health and social interaction benefits while reducing transportation related energy consumption. Reducing the footprint of development and retaining natural vegetation minimizes the amount of soil subject to erosion during construction, while providing visual buffers, windbreaks, and wildlife habitat. Native plants require little care, and less irrigation water is needed for landscaping.

Many regulations discourage, sometimes unintentionally, the use of Low Impact Development (LID) for stormwater management. LID minimizes impacts on natural water flows and quality by retaining and infiltrating runoff through plants and soils rather than gathering it through pipes and catch basins into large detention basins and outfalls. As climate change is leading to more frequent intense storm events punctuated by frequent droughts, LID provides a cost-effective way to keep water local and reduce flooding.

The design standards presented in this guidebook offer benefits to developers, municipalities, and homeowners. Less pavement and piping to convey runoff is less expensive to build and maintain. And the result is a walkable, attractive setting that helps preserve the nature of Massachusetts for the benefit of both people and wildlife.

Sincerely,

John. J. Clarke
Director of Public Policy & Government Relations

Chapter 1: Background and Introduction

Why Are Planners and Homebuilders Writing this Guidebook?

Local governments in Massachusetts may not control the design of high volume roads or state roads within their boundaries. However, local Subdivision Standards *do* specify the design and construction rules by which residential roads are constructed. Once roads in a new residential subdivision are completed, most of them become public roads and a local government asset. The home building community brings design and construction expertise in its engineers and landscape architects, who design roads to meet local standards.

> **Welcome to the Neighborhood Road Design Guidebook.**
>
> The guidebook is a tool for local planners, Planning Boards, Public Works Directors, neighbors and development applicants, and is made possible by a joint effort of the American Planning Association – Massachusetts Chapter and the Home Builders Association of Massachusetts.
>
> It is crucial to take steps that will make roadway development more sustainable. The guidebook does that by offering standards that work for Massachusetts communities, which produce less stormwater runoff and encourage various transportation options.
>
> This guidebook focuses on residential neighborhood roads, and is a companion to the award-winning MassHighway *Project Development & Design Guide, 2006*, which emphasizes context sensitive design.

There are many instances, however, when local road standards may be at odds with new "best practices" that designers want to incorporate into new roads. Furthermore, some of these innovative practices face hurdles in the local road approval process:

1. Local governments may require waivers or a variance for narrower roads or alternative road configurations that create pedestrian friendly places, reduce the need for grading and pavement, and cost less to build and maintain.

2. Neighborhood roads that fit into the local "context" for example a narrow lane or alley with drainage swales instead of piped stormwater systems and street lights where there are few residential lots may not be allowed by local road standards.

3. Low Impact Development (LID) techniques for stormwater management which improve both water quality and water quantity problems.

Residential roads in suburban development are estimated to use up 10 percent to 20 percent of a new development's land area. (Forman: 330). The design, construction and maintenance of roads are important when considering the sustainability of new development. What is Sustainable Development? "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (United Nations). Sustainable Development must address the current and future social, economic, and natural environments.

This guidebook includes a glossary at the back that defines certain terms for the user. These "defined terms" are indicated in the text with this font. Whenever you see this font, check the glossary for a definition.

Since roads are part of development, it follows that the planning and development community ask itself, what are sustainable roads? Sustainable roads are those which are not overbuilt and which minimize the impact of stormwater runoff, limit the use of excess materials, and provide for non-vehicular travel. Such roads have a "lighter footprint" in that they have fewer negative effects on the natural environment. Nevertheless, it is sometimes difficult for builders to construct sustainable roads because Massachusetts cities and towns use varying standards for neighborhood roads. Many of these standards require roads that are over-designed and do not provide for non-vehicular travel.

1.1 Benefits to Developers and Municipalities

Building narrower roads and using more low impact development (LID) measures and less traditional collection and piping of stormwater offers many economic and environmental benefits to both developers and municipalities: .

- Narrower roads are less costly to construct and maintain. They require less land clearing and grading, less base material and asphalt, less sanding and plowing, and less repaving.
- LID can often be less expensive to construct and maintain than traditional stormwater systems, but many developers and communities are not aware of this and often have the opposite impression. Centralized stormwater collection systems that rely on catch basins, pipes, and large detention basins are often costly to construct and maintain. In contrast, vegetated roadside swales only require litter removal and periodic mowing. By keeping stormwater managed in small areas where it drains to vegetated

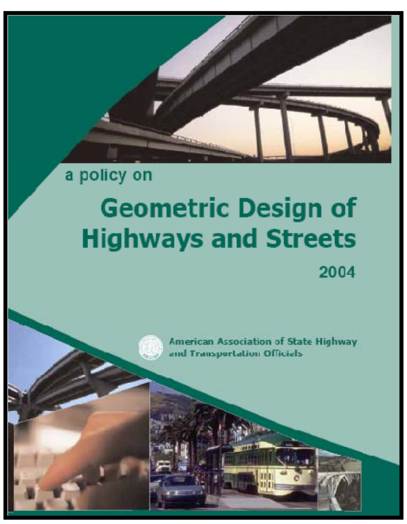
LID sites, developers avoid spending a lot of money on piping and concrete structures, and municipalities don't need to maintain them.

- Reducing the size or "footprint" of roads, maintaining natural vegetation when developing a site, and incorporating plantings and LID features throughout a development creates a more attractive and valuable place to live.
- There are also costs to stormwater LID measures. Swales require long-term maintenance. Built up silt must be removed so that the long-term infiltration function is maintained.

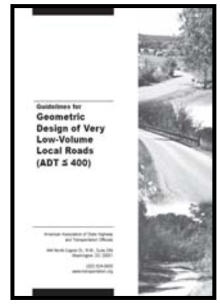
Project Goals

1. Reduce environmental impacts of roadway development, operation and maintenance;
2. Encourage Context Sensitive Solutions (CSS) in residential roadway design;
3. Provide specific guidelines and references for municipal application;
4. Encourage consistency in approach and rationale in residential roadway design across Massachusetts;
5. Promote inter-connectivity of roads;
6. Promote pedestrian and non-motorized access;
7. Promote universal accessibility;
8. Promote innovative techniques for stormwater management;
9. Reduce maintenance costs of roadways and stormwater systems;
10. Provide guidance for the design of neighborhood scale residential roads.

1.2 This Guidebook's Relationship to Other Manuals and Standards



Professional engineers, public safety officials, abutting property owners, planners, conservation commission members, and elected officials need a source that is widely accepted as a logical starting point for sustainable road design. The *Neighborhood Road Design Guidebook* will help local decision makers improve road design. The guidebook will also offer steps to encourage walking and biking while allowing LID to proceed. There are other important standards referenced in this guidebook, which are listed in Table 1. This publication is not meant to replace existing publications such as the Geometric Design of Highways and Streets (also known as the AASHTO Green Book), which are carefully developed and updated through professional organizations. However, those



generalized design manuals and codes are often silent about how roads can be designed to match local context and encourage best management practices such as LID. This guidebook supplements those publications. Figure 1 illustrates some of the existing standards that preclude Planning Boards from realizing to the desired future for their respective communities.

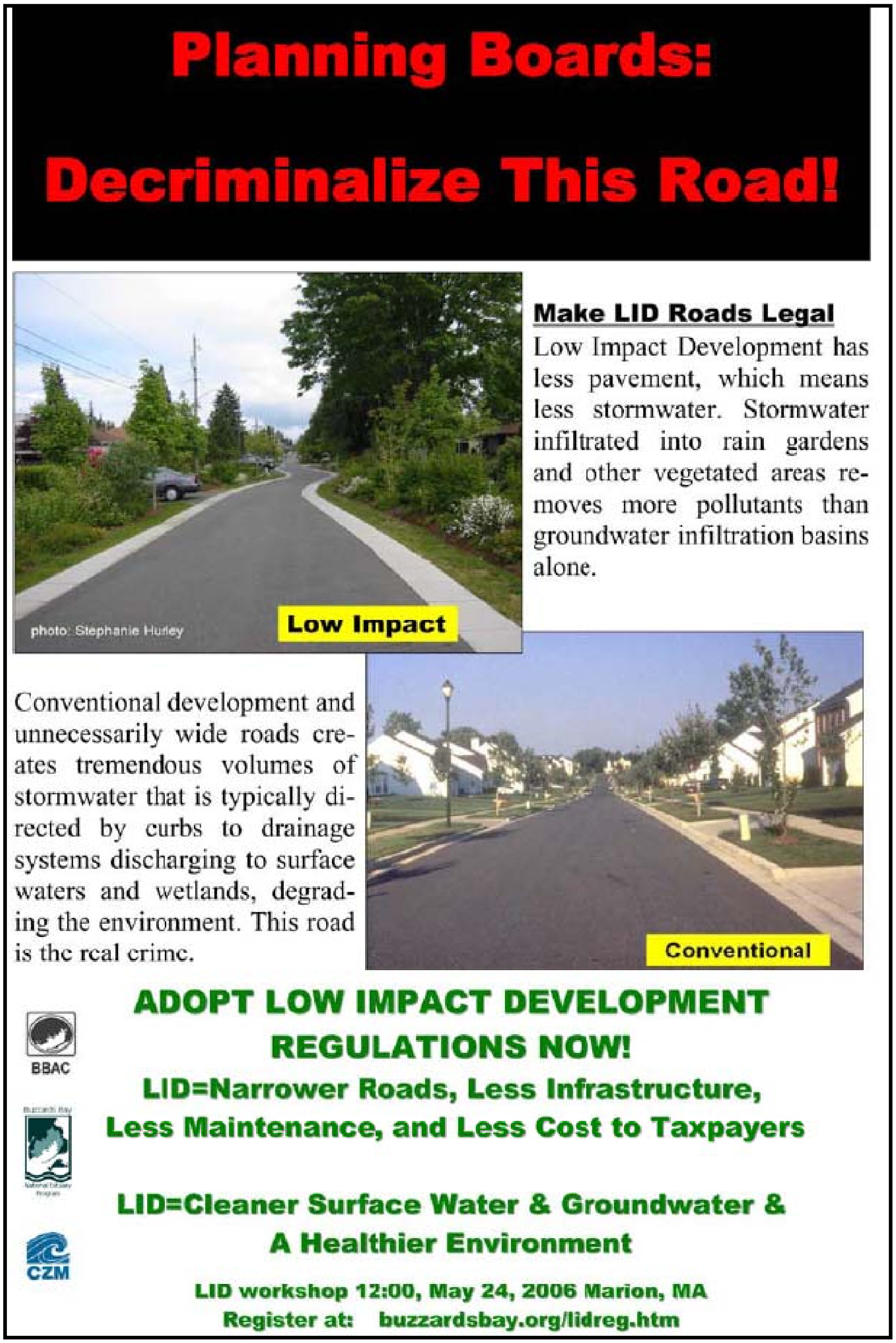
Table 1: Existing and New Publications related to Road Design

Title	Publication	Notes
Green Book American Association of State Highway and Transportation Officials (AASHTO Green Book)	2004, 5th Edition	Geared to highways; only has two categories: urban or rural.
Geometric Design of Very Low Volume Roads (AASHTO Low Volume)	2001	Many local residential roads fit this category.
MassDOT Project Development and Design Guide (MassDOT)	2006	Informative guidelines that apply to state roads and higher volume local roads if project is state funded.
Context Sensitive Solutions for Major Urban Thoroughfares for Walkable Communities	ITE Recommended Practice, 2010	Created for larger urban roads such as boulevards, explains CSS.
Neighborhood Street Design Guidelines	ITE Recommended Practice, 2010	Guidance in the overall layout and design of transportation elements for new neighborhood developments.
Uniform Fire Code – Appendix K, Street Design for Life Safety	2009/2010 published by International Code Council	Amendments pending approval in 2010.
Massachusetts Low Impact Toolkit	Metropolitan Area Planning Council (MAPC)	Web-based tool with print outs for local implementation.
Residential Streets, Third Edition	American Society of Civil Engineers (ASCE)	Edited by Walter M. Kulash, review of best practices.

1.3 Disclaimer

It is important to note that these guidelines are intended to provide guidance and direction when designing roads. They should be deemed flexible in order to account for the specific traffic, vehicle, user volumes, and roadway characteristics at any given location, and be sensitive to any unique or unusual situations. Sound engineering and planning judgment will be used to produce designs in keeping with the context of the adjacent land uses and surrounding road network.

Figure 1: Poster from Buzzards Bay Promoting Alternative Road Design



Source: Buzzardbay.org

Why Neighborhood Roads?

Neighborhood roads are an important part of the transportation network. Nevertheless, there are few references for local public works staff or planners to check for appropriate standards. The AASHTO Green Book is often used, but it is aimed at larger volume roads that are designated as either "urban" or "rural". In reality, many roads do not fall into these categories. There are sub-collectors, access roads, and other road types that need better definition and specific design guidelines.

Over time the design and function of neighborhood roads have changed. One result of these changes is the disconnected "lollipop" layout of residential cul-de-sacs. Another change in road design has been the gradual widening of neighborhood roads, as if they had to accommodate large moving or fire trucks every day of the week. There is a movement to put roads on a Road Diet to reduce their width during the design process. This guidebook includes many tools to assist with these efforts.

Finally, every city and town has the right to define the standards for its own neighborhood roads. Because of this right, applicants and engineers who create new residential development often face a wide range of requirements from town to town. In some cases these standards hinder them from building "better" neighborhood roads such as those with less vehicular space, more pedestrian amenities, less harmful stormwater runoff, and more in context with the existing landscape.

This guidebook provides users with a series of guiding principles, design factors and recommended guidelines for adoption so that the "best practices" listed above are allowed to be built with minimum resistance from local reviewers. These suggestions will not solve all the issues that come up with each specific design project. However, this guidebook should be a useful toolbox for all participants.

As the MassDOT Development and Project Design Guide states:

> *Much like minor collectors, local roads are sometimes designed to provide shared accommodation for all users. Local requirements should be used to determine the cross-section required for these roadways. On some low-volume local roads in residential areas, shared streets that do not allow motor vehicles to pass simultaneously are acceptable. The*

designer may need to consider traffic calming measures to ensure that motor vehicle speeds are appropriate for shared use of the roadway.

Source Mass Highway 2006 Highway Design Manual (Section 5.3.4.4)

1.4 Make Neighborhood Roads More Sustainable

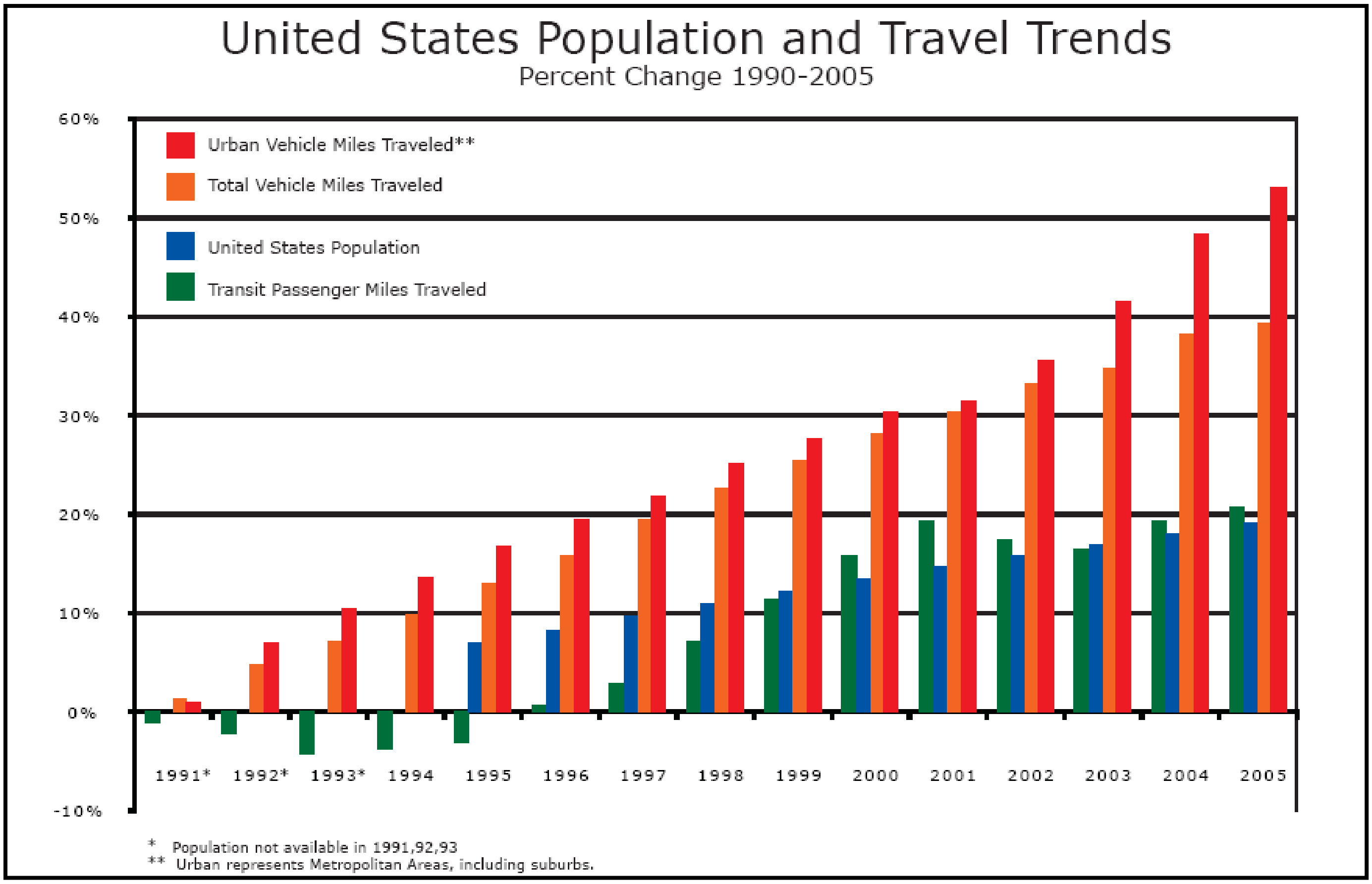
Narrower roads, good community design standards, and use of stormwater LID have benefits for local economies, community and social structure, and the environment:

- Reduces construction, future repair and maintenance costs to developers and municipalities because less pavement, less piping, and fewer engineered stormwater structures are required;
- Reduces paving area which means less plowing and easier winter maintenance;
- Builds multi-modal roads that are more attractive. Walkable communities support healthy lifestyles, interactions with neighbors, and a high quality of life;
- Reduces impervious surfaces, minimizes loss of natural soils and vegetation, and increases use of plantings along roadsides and in medians. These practices reduce harmful effects to water and air quality and loss of wildlife habitat;
- Reduces the amount of pavement by narrowing road widths. Local governments can see the following positive effects from the Road Diet approach:
  - Fewer materials needed, especially oil-based products such as asphalt;
  - Stormwater runoff reduced and water quality improved;
  - Reduce urban heat island effect by reducing the amount of paved area.
- Preserve existing vegetation and increase the amount of street trees:
  - Add shade in developed areas;
  - Absorb harmful Carbon Dioxide (CO_2) and emit oxygen;
- Improve Air Quality:
  - Accommodate bikes and pedestrians and decrease Vehicle Miles Traveled (VMT) by encouraging walking and reducing the length of vehicle trips;
  - Provide multi-modal roads with options for non-motorized travel to encourage human behavioral changes such as walking and bicycling more. These actions reduce air pollutants.

1.5 Increase Road Safety

The steady increase in drivers and the explosion of Vehicle Miles Traveled (VMT) in the United States is well documented, as shown in Figure 2.

Figure 2: U.S. Population and Vehicle Miles Traveled



Source: Bureau of Transportation Statistics

1.6 Maintain Good Emergency Response Access

In addition to road safety, fire and ambulance access to residences is very important. In terms of neighborhood road design, the following factors are important to responders:

- Allow large equipment access to all homes;
- Insure appropriate speed and volume on all roads;
- Design roads with width that allows motorists to pull over and be passed by emergency responders;
- Give responders enough room for "incident deployment" (generally 16-20 feet).

Common Ground With Emergency Providers

The Congress of New Urbanism (CNU) is working with emergency responders to refine street design. They proposed a change to the International Fire Code (IFC) to add an appendix that lays out a "code" for flexible road design, which should help local professionals seek common ground on road design alternatives.

Source: www.cnu.org/emergency response

Here are some observations from an Urban Land Institute article about the importance of balancing of goals in determining road design guidelines:

> *The street widths in this article do not represent dramatic reductions from what might be considered typical. However, a few feet can make a difference in livability and environmental impact. A typical medium-size city has more than 500 miles (804 km) of residential streets, and a five-foot (1.5-m) reduction in street width equates to a 300-acre (121.4-ha) reduction in asphalt. …*
>
> *The nation's largest manufacturer of fire trucks, Pierce, has cab widths varying from 100 to 102 inches (254 to 259 cm). Standard mirrors add ten inches (25.4 cm) to cab widths on each side (although new mirrors are available that add only six inches [15.2 cm]). Body widths range from 96 to 101 inches (244 to 256 cm). Outrigger spreads on ladder trucks are typically 16 feet (4.8 m) wide. Hence, there is rarely justification for more than 16 feet (4.8m) of clearance, and in low-rise areas where ladder trucks are unnecessary; a clear width of 12 feet (3.6 m) should suffice.*

Source: Urban Land Institute, Urban Land, August 2007.

User Guide

This guidebook is intended for a range of professionals and lay readers, as described in Table 2. The guidebook is written to be "accessible" for a variety of readers. All of the participants in Table 2 should review the recommended standards and procedures and to use them as a *guide* to amending existing rules, or for justification for proposing an alternative design. These are not mandatory regulations.

Table 2: Intended Users and the Relationship to Neighborhood Road Design

User	Responsibilities
Transportation Planner	✓ Establish community vision and goals for local transportation. ✓ Work with citizens to improve existing transportation network. ✓ Develop and evaluate concepts and local standards using this guidebook and other resources.
Transportation/Civil Engineer	✓ Prepare and certify residential land division concepts, drawings, and road designs. ✓ Identify context, design controls and parameters, constraints and parameters of proposed road design. ✓ Work with interdisciplinary teams to resolve design obstacles. ✓ Prepare and review preliminary and final engineering plans.
Land Use Planner/Planning Director	✓ Develop long-range plans (Master Plans) that include land use and transportation elements. ✓ Provide objective advice and leadership to interdisciplinary review teams.
Other Design Professionals: • Architect • Urban Designer • Landscape Architect	✓ Authority to apply local standards and alternative proposals. ✓ Maintain quality of life and safety of new and existing neighborhoods.
Stakeholders • Developers and Applicants • Elected Officials • Planning Boards • Zoning Board of Appeals • Local, regional and state agencies • Citizens and Abutters	✓ Compliance with local zoning and road standards in new residential development. ✓ Request road design standards based on those presented in this guidebook. ✓ Legislative authority to amend municipal regulations. ✓ Authority to apply local standards and alternative proposals. ✓ Maintain quality of life and safety of new and existing neighborhoods.

Source: Adapted from ITE Context Sensitive Solutions

The guidebook is organized into chapters by topic. The first chapter contains background information and purpose. Table 3 lays out the organization of the guidebook.

Table 3: Guidebook Organization

Chapter Title	Material addressed
1. Introduction and Background	Why is this guidebook important and how can you use it?
2. Local Context	How to determine whether the project needs narrow, medium, or wide neighborhood road. These distinctions allow finer tuning of road design controls.
3. Design Controls	Guidelines and suggestions on specific road design elements.
4. Construction Guidelines	Brief descriptions of basic construction standards.
Glossary	List of acronyms and terms used in the guidebook.
Literature Cited	Work used to develop this guidebook.
Resources	List of resources, websites and other manuals and guidebooks.
Index	Page references for terms found in the glossary.

Chapter 2: Local Context

Determine Type of Project – Use Local Context

The AASHTO Green Book identifies only two types of roads: "rural" and "urban". However, there are many types of roads in Massachusetts. The 2006 Massachusetts Department of Transportation Project Development & Design Guide (MassDOT) instructs designers to consider a range of factors when determining the basic controls for road design. Many of the guidelines suggested in Chapter 3 reference the MassDOT guidelines. The Institute for Transportation Engineers (ITE) offers factors for consideration in its new proposed practice, Context Sensitive Solutions. The guidebook suggests four types of neighborhood roads as described in Table 4.

Guidelines for identifying and selecting a context zone include the following.

1. *Consider both the existing conditions and the plans for the future, recognizing that thoroughfares often last longer than adjacent buildings.*
2. *Assess area plans and review general, comprehensive and specific plans, zoning codes, and community goals and objectives, which often provide detailed guidance on the vision for the area.*
3. *Compare the area's predominant land use patterns, building types, and land uses to the characteristics.*
4. *Pay particular attention to residential densities, commercial floor-area ratios, and building heights.*
5. *Consider dividing the area into two or more context zones if an area or corridor has a diversity of characteristics that could fall under multiple context zones.*
6. *Identify current levels of pedestrian and transit activity or estimate future levels based on the type, mix, and proximity of land uses. This is a strong indicator of urban context.*
7. *Consider the area's existing and future characteristics beyond the thoroughfare design, possibly extending consideration to include entire neighborhoods or districts.*

Source: ITE Context Sensitive Solutions for Major Urban Thoroughfares for Walkable Communities.

This guidebook recommends that road design standards be applied to <u>*both*</u> Open Space Residential Design (OSRD) and conventional subdivisions, as well as public and private roadways.

Follow the steps below before reviewing the specific neighborhood road guidelines in Chapter 3. First, think about the type of road that might be right for the proposed project. Is it going to be a narrow, medium, or wide road? Is it an alley or lane? Table 5 has the numeric guidelines for these four neighborhood road categories.

Table 4: Description of Neighborhood Road Types

Neighborhood Road Type	Description
Wide Road	Walkable, low speed (25 mph), primarily serving abutting property. These roads may connect residential neighborhoods with each other, connect residential neighborhoods with commercial and other districts, and connect local roads to arterials. Freight and goods movements are restricted to local deliveries only.
Medium Road	Walkable, low speed (20 mph) road designed to connect residential neighborhoods with each other and serve abutting property.
Narrow Road	Low speed (20 mph) thoroughfare primarily serving abutting property.
Alley	Very low-speed (15 mph) vehicular driveway located to the rear of properties, providing access to parking, service areas and rear uses such as secondary units, as well as an easement for utilities.

Source: Adapted from ITE Context Sensitive Solutions

2.1 What Type of Residential Project Is It?

Regardless of the road's status (public, private, conventional, or open space subdivision) its type should be based on the surrounding context. Ask the following questions when considering road design for new roads or redevelopment of existing roads:

1. What are the size and design of adjacent roads?

2. How many existing and/or new dwelling units will be served by the subject road?

3. How many and what types of road connections to existing and future roads will be made by the subject road?

4. What is the general setting of the subject road? For example, if it runs through an area with no streetlights or piped stormwater sewers, then (unless there are compelling reasons to do otherwise) the new road requirements should match that of the surrounding area.

2.2 Development Types: From the Least to Most Intensive

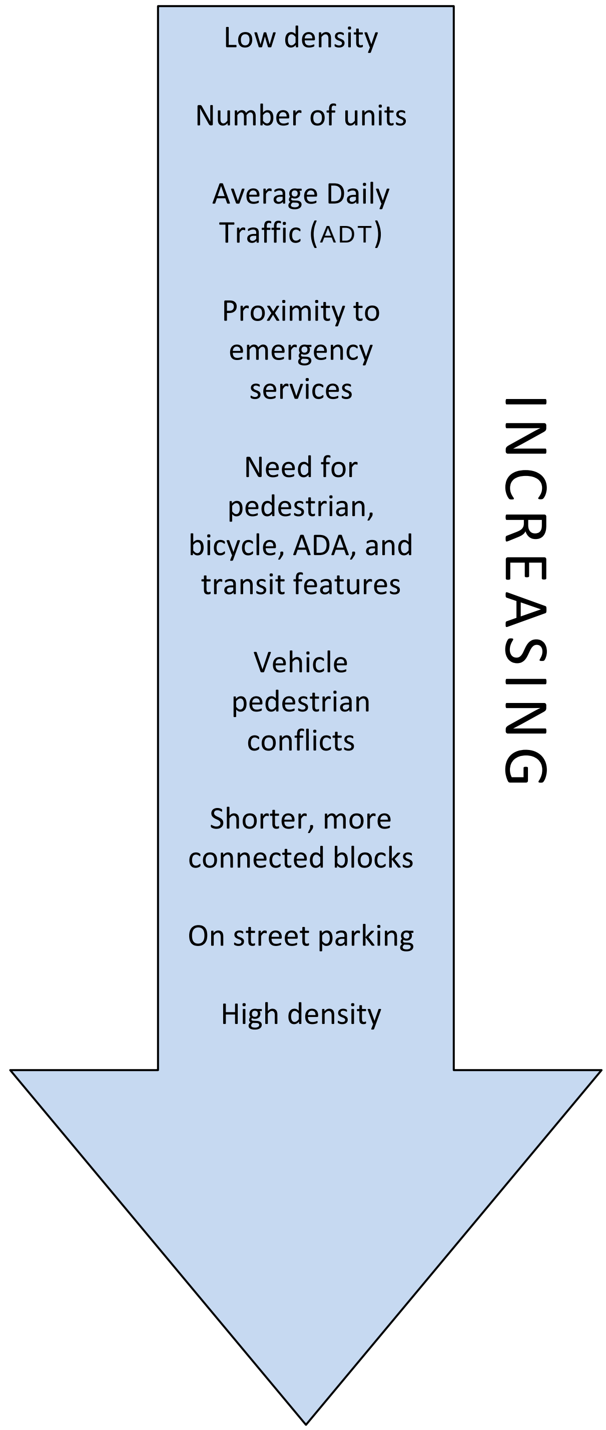
1 Least intense: New homes are generally built with on-site septic systems, and lots must be one to two acres or greater.

2 Low intensity: New homes are built relying on public or on site community water and sewer systems, and the minimum lot size per dwelling unit is about one acre.

3 Medium intensity: New homes are connected to public water and sewer systems, the minimum lot size per unit ranges from 43,560 to 15,000 square feet, on street parking is more prevalent and walking and bicycling connections are more important.

4 Compact intensity: New homes are connected to public water and sewer systems, the minimum lot size per unit ranges from 15,000 to 5,000 square feet, on-street parking is more prevalent, block layout is smaller, there are fewer cul-de-sacs, and connectivity, pedestrian, bicycle and transit amenities are very important.

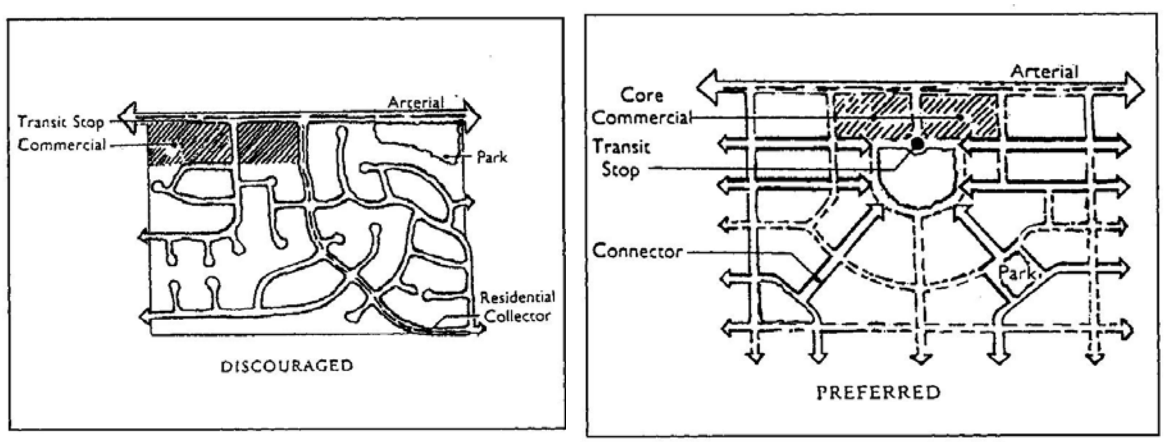
5 Most intense: New homes are connected to public water and sewer systems, the minimum lot size per unit ranges from 5,000 to 2,500 square feet, dwellings are taller, multi-family units are allowed, block layout is smaller or pre-existing and connectivity, pedestrian, bicycle and transit amenities are essential.



2.3 Importance of Connected Road System

It is important to keep in mind that the *pattern* of road development is just as important, if not more important, then individual road design. Some of the design guidelines in Chapter 3 of this guidebook include recommendations for other factors beyond how the right-of-way should be built out. One of the reasons for these additional factors is to increase "connectivity," which is illustrated in Figure 3.

Figure 3: Comparison of Disconnected and Connected Road Network



Source: Neighborhood Street Design Guidelines, Oregon Transportation and Growth Management Program.

In many areas, cul-de-sac and dead end street development are necessary because of existing development such as houses, railroads, or natural barriers such as slopes or water bodies. When possible, however, a more connected road system has many benefits:

- Additional emergency service provider access;
- Dispersal of traffic, and reduction of traffic volumes on collector roads;
- Additional means for non-auto travel without creating easements or inviting trespass on private property;
- Additional road frontage for building.

Some ways to achieve increased connectivity include:

1. Create incentives/mandates for small block lengths, discourage cul-de-sacs where possible, and other measures.

2. Establish the type and size of blocks. For example, set a maximum perimeter distance and specify driveway locations without constructing too many on a collector.

3. If there is to be a connection to a future neighborhood road (for example, a subdivision which ends at an undeveloped property line), consider requiring future road connections. One way to do this is to create a one – foot strip of Right of Way (ROW) at the property line that is dedicated to the municipality for control.

4. Include requirements for trails, sidewalks, and easements to allow for pedestrian/non-vehicular connections where road connections are not possible.

2.4 Importance of Operations and Enforcement

As outlined by the various stakeholders who participate in neighborhood road design, use, and maintenance, the designs in this guidebook require coordination and cooperation among local governmental departments. Some of the design features shown in Chapter 3 may present different road configurations than the department of public works and life safety personnel are familiar with. New approaches require coordination, collaboration, and cooperation among the staff in these two departments, and the planning and community development staff.

Many concerns about new or alternative road design can be addressed with a change in operation or management practices that are not overly burdensome. The following operations and management issues should be considered during the road design process, including the practicalities of existing municipal equipment, personnel, and training:

1. Snow plowing and snow storage for vehicle and pedestrian movements;

2. Stormwater runoff, storage and drainage;

3. Equipment such as fire trucks, snow plows, garbage vehicles, and utility trucks that use the roads;

4. Local practice regarding public and private utility location and access to utilities for repair;

5. Local practice related to tree maintenance in the right-of-way and adjacent properties.

Chapter 3: Design Guidelines

Introduction to Design Guidelines

The best way to use this guidebook is to consider all the detailed descriptions and not merely rely on the summary table and/or cross sections. It is not possible to address adequately the various situations in summary form.

Design Features in this chapter:

3.3	Design Speed	3.9	Cul-de-sac Design	3.15	Utilities
3.4	Road Offsets	3.10	Turnaround Dimensions and Design	3.16	Residential "Loading Areas"
3.5	Minimum Centerline Offsets	3.14	Common Driveway Guidelines	3.17	Road Lighting
3.6	Tangents between Reverse Curves	3.12	Grade	3.18	Street Trees
3.7	Pedestrian Ways, Sidewalks and Pedestrian Easements	3.13	Design Vehicle	3.19	Road Location
3.8	Turning Radii at Intersections	3.14	Low Impact Development (LID) and Stormwater Management	3.20	Traffic Calming Measures

Components of Neighborhood Road Design

This guidebook presents the guidelines in three formats:

1. Table 5. This table has many design elements in one place for an "at a glance" reference.
2. Cross Sections (also known as "plates"). These plates illustrate the design of narrow, medium, wide and alley neighborhood roads.
3. Detailed descriptions of 18 different neighborhood road design features. Each of these features includes three subsections: "Guiding Principles," "Supporting Information," and "Suggested Guidelines". Some of them include excerpts from relevant studies, design reference manuals, and other information from jurisdictions that have adopted these design elements and guidelines.

Overarching Guiding Principles

The following two passages illustrate how professional associations and government agencies are recommending changes in road design. These are some of the sources used to support the designs in this guidebook. These can also be sources for those seeking additional information. The resources section at the end of the guidebook contains a full list of additional references.

Reduce Design Speed

"…the American Society of Civil Engineers (ASCE) Subdivision and Site Plan Standards Committee has developed some recommended subdivision and site plan standards in cooperation with the US Department of Housing and Urban Development. These standards establish maximum design speeds of 20 and 25 miles an hour for "access" and "sub collector" streets, respectively. It is hoped that as these matters receive more focus and consideration, other agencies will acknowledge the logic in the concept of these lower speeds."

Source: Prepared by: C. "Rick" Chellman, P.E. For the Urban Land Institute, April, 2000 (Adapted from Oregon Smart Development Street Design Guidelines, also by C. "Rick" Chellman, P.E.)

The *Massachusetts Smart Growth Toolkit* recommends the following actions:

- *Keep speeds low on neighborhood roads.*
- *Site planning practices that reduce the creation of impervious area in new residential and commercial developments and therefore reduce the water quality requirements for the site should be encouraged whenever feasible. Examples of progressive site design practices that minimize the creation of impervious cover include:*

Narrower residential road sections	*Permeable spill-over parking areas*
Shorter road lengths	*Smaller parking demand ratios*
Smaller turnarounds and cul-de-sac radii	*Smaller parking stalls for a percentage of lots*
Angled one way parking	*Smaller front yard setbacks*
Cluster subdivisions	*Shared parking and driveways*
More creatively designed pedestrian networks	

Source: Adapted from the Massachusetts Smart Growth Toolkit and LID Model Bylaw, MAPC.

3.1 Dimensional Guidelines– Cross Sections

Guiding Principles

As shown by the previous citations from an engineering organization and advice from a government toolkit, one of the key factors for the neighborhood road guidelines in this section is to limit the Design Speed. Design Speed is different from the posted speed limit. Design Speed and therefore the operating speed of motor vehicles are important factors in determining other elements of roadway design. Design Speed in turn influences the requirements for the Stopping Sight Distance (SSD), the curve radii, the centerline radii, and other factors covered in this Chapter.

Supporting Information

These cross sections are based on guidance from AASHTO Green Book and the MassDOT Project Design Guide. For more information, see MassDOT Chapter 5 and AASHTO Green Book Chapter 4.

Suggested Guidelines

These are specified in Table 5 and Figures 4 through 8.

Table 5: General Parameters for Residential Road Design

Parameter	Single Use Residential Wide	Single Use Residential Medium	Single Use Residential Narrow	Single Use Residential Alley
Traveled Way				
Typical ADT	4,999 < 1,500	1,499 <400	399 < 0	100 < 0
Design speed	25-30 mph	20 mph	20 mph	15 mph
Operating Speed	20-25 mph	20 mph	15-20 mph	15-20 mph
Number of Through Lanes	2	2	2	1
Lane Width	10-12 feet	10-12 feet	10 feet	9-10 feet
Shoulder	2 feet	2 feet	2 feet	2 feet
Bike Lanes	Shared road Or 6 feet wide	Shared road	Shared road	Shared road
Utility Easement Width	---	----	10 feet	10 feet
Range of ROW Width	40-50 feet	36-40 feet	33-36 feet	20 feet
Roadside				
Desirable Roadside Width (pedestrian, swale, and planting strip)	5.5-12 feet	5.5-10 feet	5.5 feet	None
Grass Plot/Planting Strip	0-6 feet	0-6 feet	0-6 feet	None
Minimum Sidewalk Width	4 feet one side ok	4 feet / Shared road	Shared road	Shared road
Street Lighting	At intersections and pedestrian scale lighting at residential driveways.	At intersections and pedestrian scale lighting at residential driveways.	At intersections and pedestrian scale lighting at residential driveways.	At intersection with road
Intersections				
Traffic control	Stop signs, 4-way yield	4-way yield	4-way yield	Yield exiting alley
Curb Radii	15-25 feet	15-25 feet	15-20 feet	15 feet

Source: Format is adapted from the ITE CSS Table 11.3 General Parameters for Vehicle Mobility Priority Collectors, the guidelines are derived by the authors.

3.2 Right of Way Cross Sections and Plans

Figure 4: Wide Road Cross Section

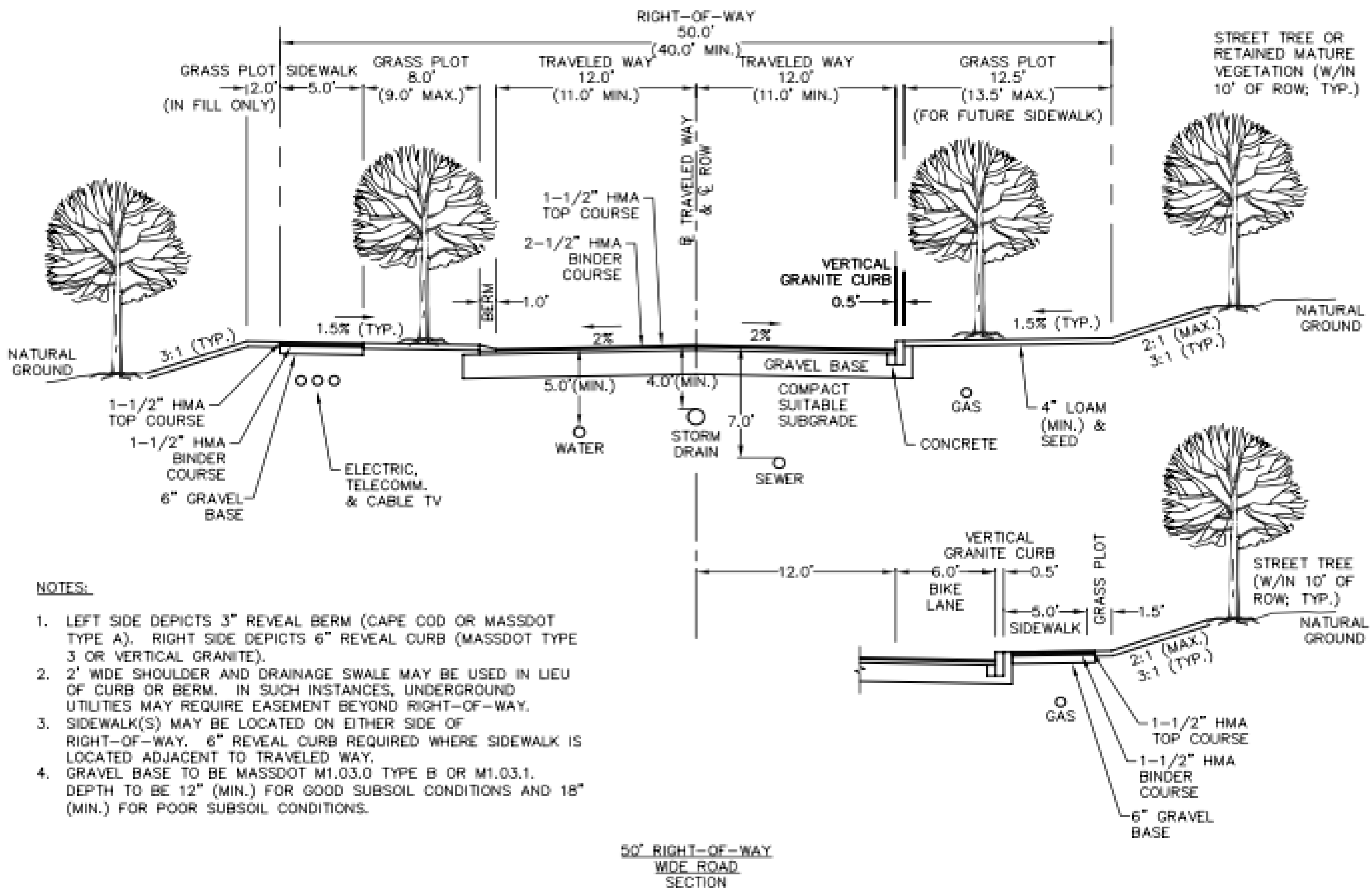


Figure 5: Medium Road Cross Section

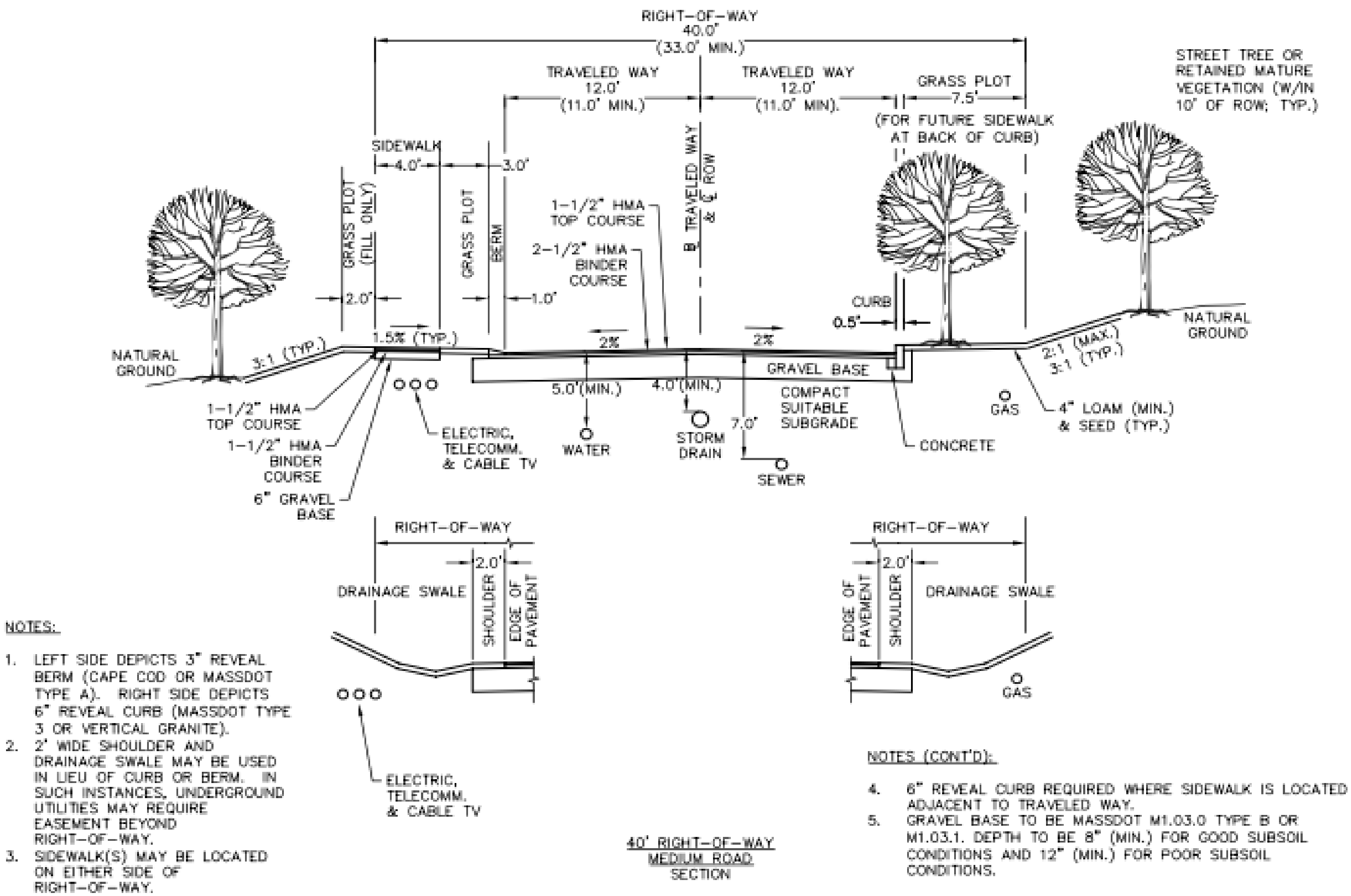
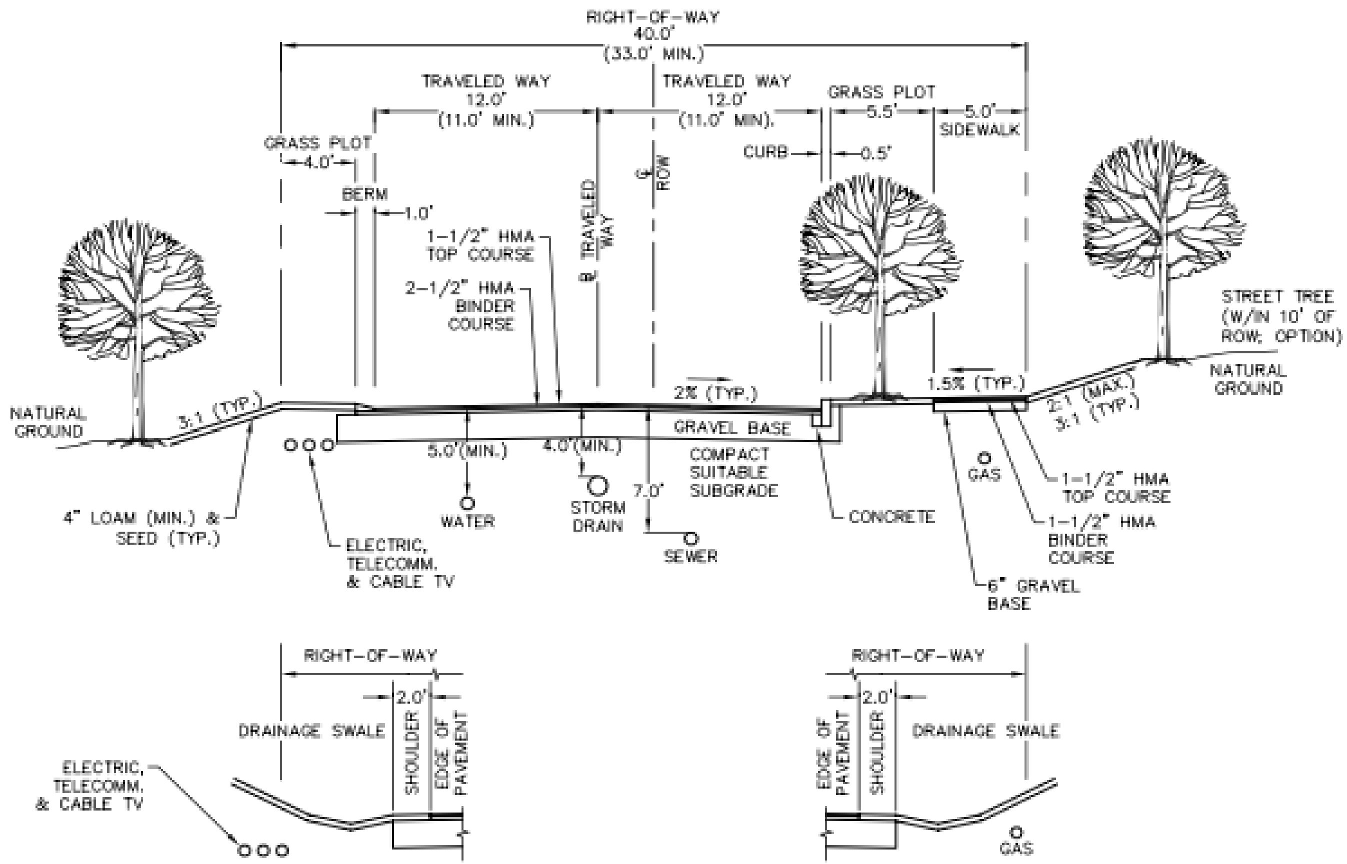


Figure 6: Medium Road Non-Centered Cross Section



NOTES:

1. LEFT SIDE DEPICTS 3" REVEAL BERM (CAPE COD OR MASSDOT TYPE A). RIGHT SIDE DEPICTS 6" REVEAL CURB (MASSDOT TYPE 3 OR VERTICAL GRANITE).
2. 2' WIDE SHOULDER AND DRAINAGE SWALE MAY BE USED IN LIEU OF CURB OR BERM. IN SUCH INSTANCES, UNDERGROUND UTILITIES MAY REQUIRE EASEMENT BEYOND RIGHT-OF-WAY.

40' RIGHT-OF-WAY
NON-CENTERED
MEDIUM ROAD
SECTION

NOTES (CONT'D):

3. 6" REVEAL CURB REQUIRED WHERE SIDEWALK IS LOCATED ADJACENT TO TRAVELED WAY.
4. GRAVEL BASE TO BE MASSDOT M1.03.0 TYPE B OR M1.03.1. DEPTH TO BE 8" (MIN.) FOR GOOD SUBSOIL CONDITIONS AND 12" (MIN.) FOR POOR SUBSOIL CONDITIONS.

Figure 7: Narrow Road Cross Section

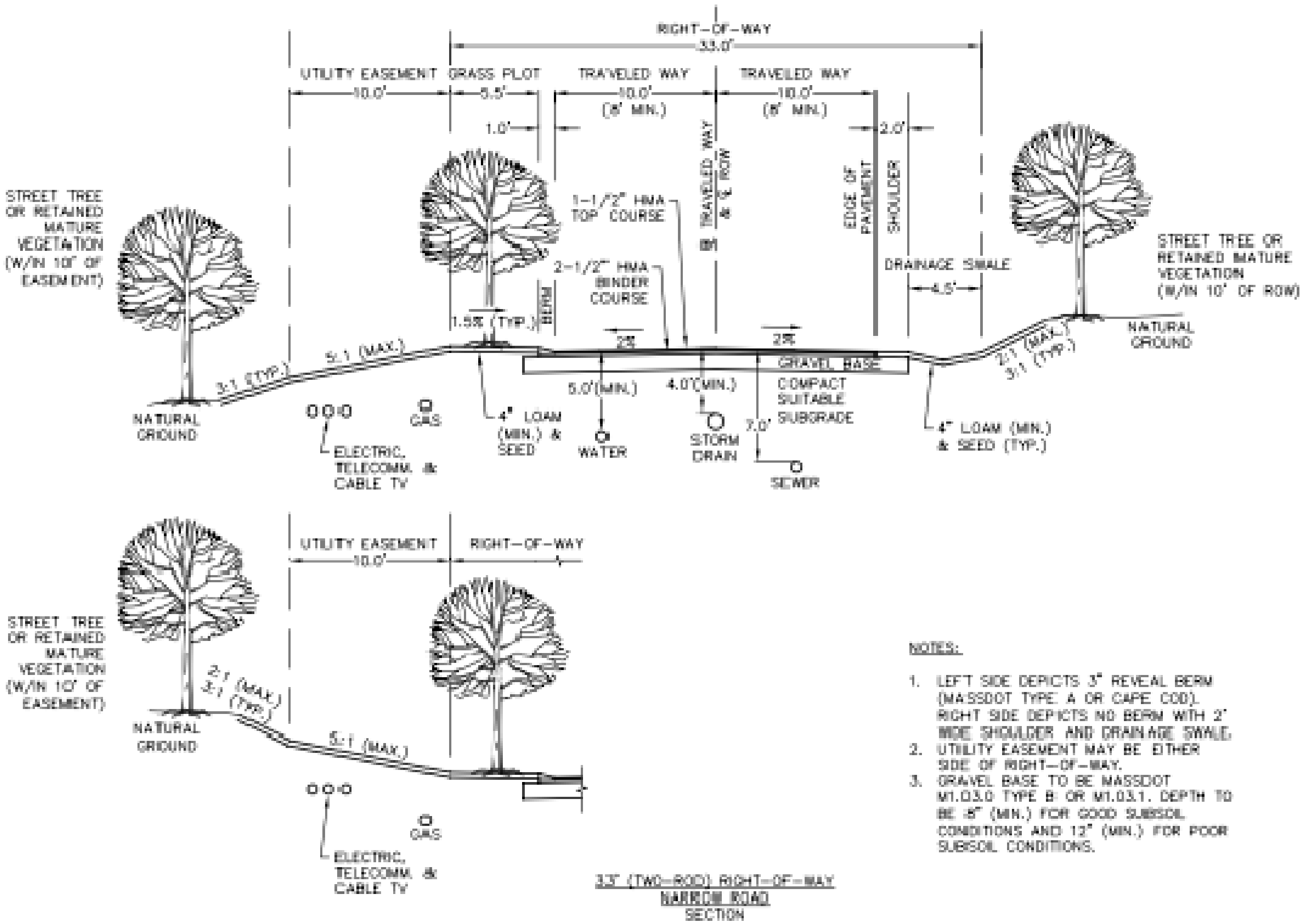
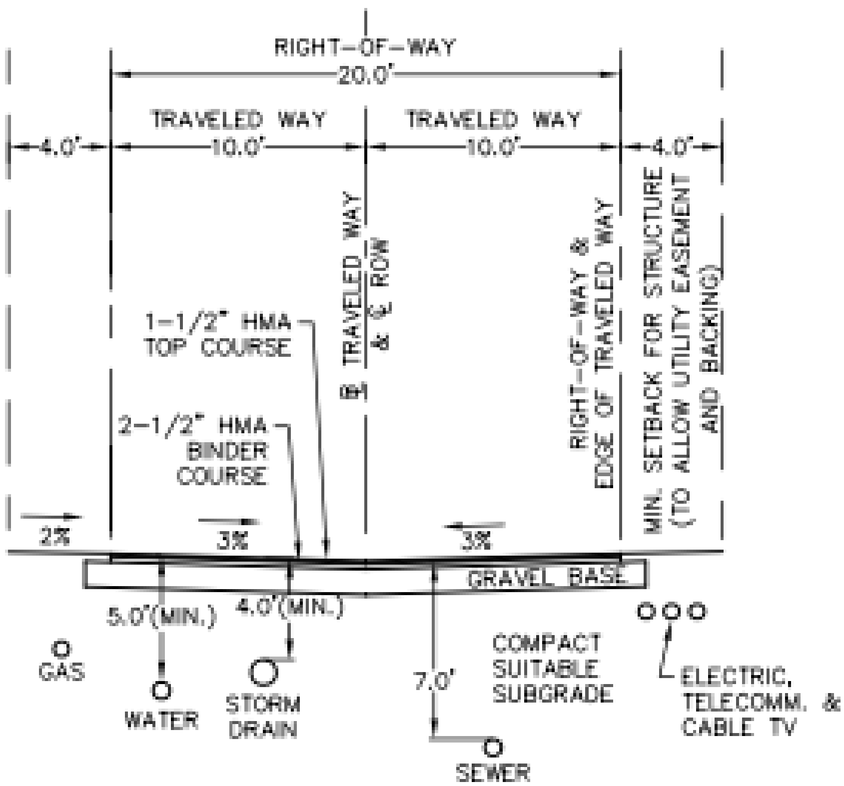


Figure 8: Alley/Lane Cross Section



20' RIGHT-OF-WAY
ALLEY
SECTION

NOTES:

1. INVERTED CROWN WITH CENTER DRAINAGE.
2. GRAVEL BASE TO BE MASSDOT M1.03.0 TYPE B OR M1.03.1. DEPTH TO BE 12" (MIN.) FOR GOOD SUBSOIL CONDITIONS AND 18" (MIN.) FOR POOR SUBSOIL CONDITIONS.

3.3 Design Speed

Guiding Principles

Reduce speeds on neighborhood roads. As mentioned in the beginning of this Chapter, Design Speed is one of the most significant choices made by an engineer in creating the overall road design. When Design Speed is lower, roads may be designed with tighter curves, shorter Stopping Sight Distances (SSD), and narrower widths. SSD is the distance traveled while the driver understands it is necessary to stop, applies the brake, and comes to a stop.

Supporting Information

The posted speed limit is different from Design Speed. Enforcement of slow speeds along new neighborhood roads is important. The design features that can be incorporated with slower presumed Design Speed will result in slower vehicle travel. Massachusetts General Laws (MGL) Chapter 90 Sections 17 and 18 govern appropriate speed limits for thickly settled areas. Speed Limits for existing roads may not be reduced without support from engineering studies. However, neither of these sections specifically addresses establishment of speed limits for new roads, instead they specify speed limits for existing roads. In light of the above, we recommend designing and signing speeds of less than 25 miles per hour for new local roads that are based on design speeds of 15 to 20 miles per hour. See also MassDOT section 3.6 and AASHTO Green Book, section 5.2

Suggested Guidelines

Table 6 includes the required SSD for certain Design Speed. The neighborhood road type is indicated in the left column.

Table 6: Design Speed

Type of Road	Design Speed	Stopping Sight Distance
Alley or Lane	15 mph	80 feet
Narrow Road Low volume, adjacent open space, topographic constraints	20 mph	115 feet
Medium Road Higher volume	20 mph	115 feet
Wide Road Highest volume, more connectivity and adjacent distractions	25- 30 mph	155 feet

Exhibit 3-8 from the Massachusetts Project Development and Design Manual (MassDOT) has additional information about SSD. The applicable portion of this table is reproduced in part below for reference.

Exhibit 3-8 Motor Vehicle Stopping Sight Distance (only the applicable sections are reproduced)

Motor Vehicle Stopping Sight Distances							
	Stopping Sight Distance (ft) by Percent Grade						
		Downgrade			Upgrade		
Design Speed	0%	3%	6%	9%	3%	6%	9%
20 mph	115	116	120	126	109	107	104
25 mph	155	158	165	173	147	143	140
30 mph	200	205	215	227	200	184	179
35 mph	250	257	271	287	237	229	222

Source: MassDOT Project Development & Design Guide, 2006.

3.4 Road Offsets

Guiding Principles

Intersections should be offset to avoid creating multiple entry points onto a through road in a short distance, which, in turn, may create distractions for drivers and introduce conflicting turning movements. Additionally, road jogs (offset roads on opposite sides of a through road) may make it difficult to determine if a stop condition is ahead and/or which driver has the right of way. Figure 9 illustrates this concept.

Supporting Information

Many local subdivision regulations stipulate a minimum distance to allow flexibility in design while avoiding the creation of building lots surrounded by multiple roadways. Another important aspect of establishing a minimum road offset is to avoid driver confusion and traffic conflicts that may be created by road offsets.

See also MassDOT Section 6.8 and AASHTO Green Book Chapter 9.

Suggested Guidelines

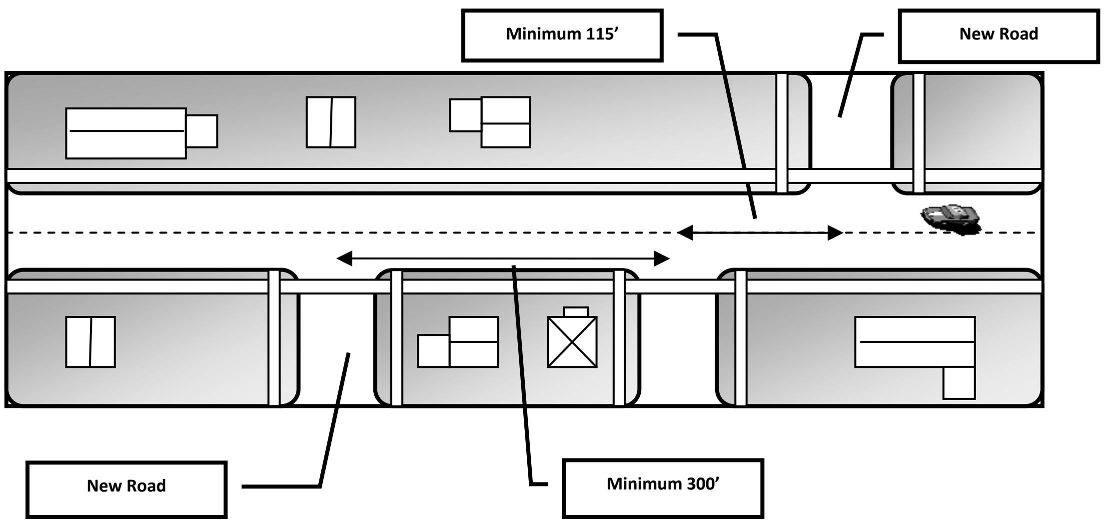
1. Road offsets on the same side of road – 300 feet minimum for narrow and medium roads.

2. Road offsets on the opposite side. This suggestion is a function of SSD it is generally 115 feet.

3. Road offset angle – near 90º preferred, 60º minimum

4. Sight distance at intersections – maintain required SSD on through (non-stopping) roadway. Also consider Intersection Sight Distance in MassDOT, section 3.7.4.

Figure 9: Road Offsets

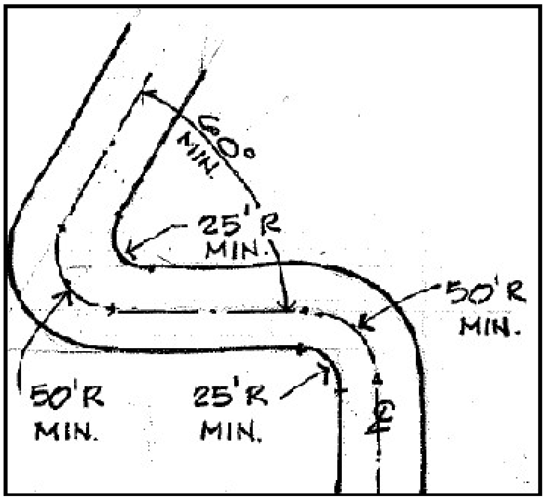


3.5 Minimum Centerline Radius

Guiding Principles

Smaller centerline radii means a tighter curve is allowed, which slows traffic and allows for more flexible road layout. Figure 10 illustrates how centerline radii are measured. Minimum design centerline radii are sometimes difficult to find for design speeds less than 25 miles per hour. Using accepted methods of calculation, the following shows the criteria for minimum centerline radius for design speeds of 25 mph and less.

Figure 10: Illustration of Centerline Radii



Source: City of Fort Worth, Texas

Supporting Information

See also MassDOT Section 4.2 and AASHTO Green Book Chapter 5.

Here is an example of how one city allows for variations in Centerline Radii:

> *"For all local residential streets, the minimum centerline radius is 100 feet. This standard is set to keep the design speed consistent, as well as to provide safety. Exceptions may be allowed for access lanes and low volume streets in the following situations:*
>
> 1. *To facilitate traffic calming.*
> 2. *To connect the proposed street to other developments.*
> 3. *To protect natural resources.*
> 4. *When there are no alternate property configuration designs available (long or odd-shaped parcels) which would maximize development area by increasing lot frontage or achieving density goals. For a centerline radius shorter than 100 feet, traffic calming features such as signing, striping, and traffic markers may be required. Parking on curves with less than 100 feet centerline radius is prohibited."*

Source: City of Eugene, Oregon, Public Improvement Design Manual

Suggested Guidelines

1. **50 feet minimum**

   Stopping Sight Distance:
   - For narrow road maintain 115′ SSD;
   - Easements beyond right-of-way may be required to restrict obstructions and to allow maintenance within sight lines.

2. **110 feet minimum**
   Stopping Sight Distance:
   - For medium road; maintain 115′ SSD;

3. **180 feet minimum**
   Stopping Sight Distance:
   - For wide road maintain 155′ SSD;

3.6 Tangents Between Reverse Curves

Guiding Principles

Similar to centerline radii a smaller tangent allows for tighter curves, slower traffic and more flexible road layout. Centerline radii must be adequate for operation of public safety vehicles, as well as occasional use by larger vehicles. In areas where public sewer is to be located in the right-of-way, greater centerline radii may be necessary to facilitate such underground utilities.

Supporting Information

See MassDOT section 4.2.

Suggested Guidelines

1. Use normal crowned section and avoid superelevation (MassDOT Tables 4.8 and 4.9);

2. Avoid short tangents; use reverse curves if tangent would be less than 100 feet.

3.7 Pedestrian Ways, Sidewalks and Pedestrian Easements

Guiding Principles

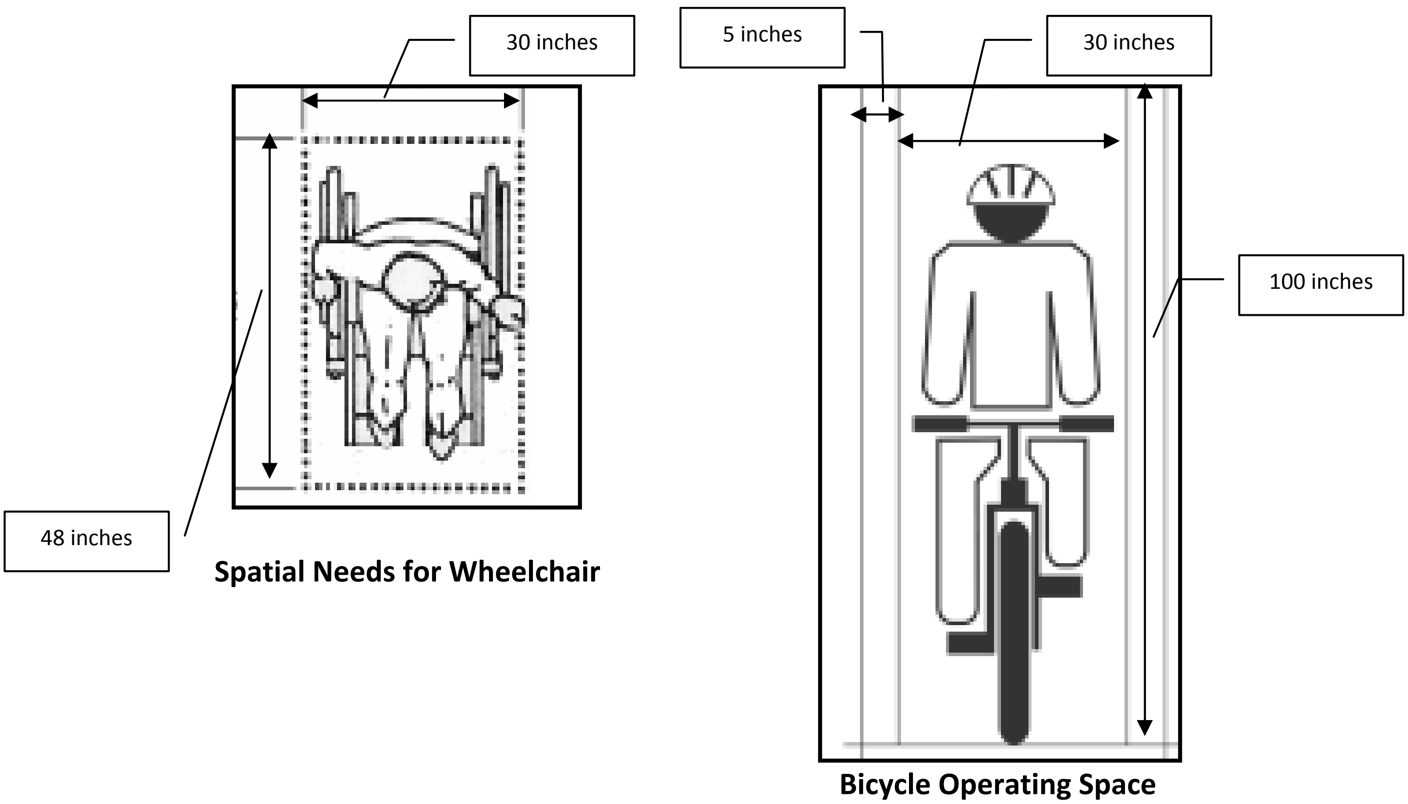
Provide appropriate space to allow universal accesses for walkers, disabled, and bicycle travel and other wheeled vehicles such as strollers or scooters. Placement of sidewalks on one side or the other of a neighborhood road is subject to several considerations:

- Location of existing adjacent sidewalks;
- Grade and slope of roadway (avoid sidewalks on the bottom of slope to reduce puddles);
- Location of existing vegetation and above-ground utilities that will remain in place.

Supporting Information

There are several sources for guidance on sidewalk and accessible design. The Massachusetts Architectural Access Board (MA-AAB) has specific guidance for Massachusetts. The federal Americans with Disability Act (ADA) is a companion to the MA-AAB. AASHTO has a Guide for the Planning, Design and Operation of Pedestrian Facilities, and Section 5.3 in MassDOT addresses these facilities.

Figure 11: Illustrations of Common Wheelchair and Bicycle Dimensions



Source: Neighborhood Street Design Guidelines, Oregon Transportation and Growth Management Program.

Suggested Guidelines

1. Sidewalks must be ADA and MA AAB compliant. Figure 11 illustrates common dimensions for wheelchairs and bicycles.
   a) Sidewalk width – 4 feet minimum (5 feet preferable). Width is measured exclusive of curb where adjoining curb. When there is a MassDOT Type A berm or Cape Cod berm, the sidewalk should be located three feet from that curb surface.
   b) Cross slope - 1.8% typical (2% max)
   c) Slope of ramps - 7.5% typical (8% max.)

d) Landings - 5′ x 5′ pad with a slope ≤ 1.8% typical (2% max.);
e) Must have a physically detectable warning panel (refer to MassDOT drawing number E107.6.5)
e) Carry sidewalk grade through residential driveway (refer to MassDOT drawing number E107.7.0)

2. Encourage a grass plot (also known as a Planting Strip) between roadway and sidewalk in suburban/urban neighborhoods.

3. Encourage pedestrian easements and off road paths where necessary. These are recommended when road connections cannot be made. A sample trail easement can be found on the Massachusetts Department of Conservation Resources (DCR) Greenways and Trails program's website, http://www.mass.gov/dcr/stewardship/greenway/publications.htm.

4. Acknowledge that in some cases, the roadway will be the pedestrian way (e.g. where there are few units, you are using the narrow road cross section, or an alley or lane).

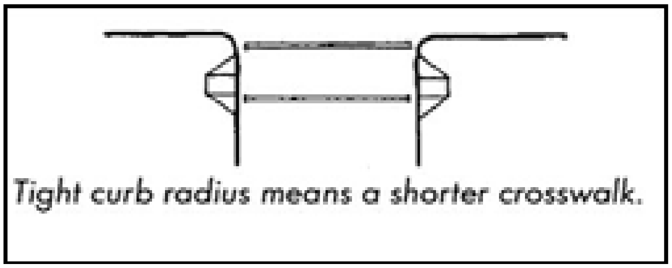
5. Add more pedestrian amenities in more compact development areas such as road crossings, curb-bulb extensions, ramps at intersections, benches, trashcans, and other amenities.

3.8 Turning Radii at Intersections

Guiding Principles

Narrower, low speed and volume roads can have tighter curb radii both for pavement widths and right-of-way widths. This allows for slower traffic movements and narrower pedestrian crossings. A larger curb radius, such as 30 feet or more, is easier for large vehicles to enter the road, but means a longer walk for pedestrians. Proper curbing materials must be considered to prevent damage to the curbs during snow removal/plowing operations. Figure 12 illustrates the direct connection for pedestrians when the curb radius is tight. Figure 13 shows the importance of parking management where curbs have a narrower radius.

Figure 12: Curb Radii and Pedestrian Movement



Source: WalkArlington.com

Supporting Information

MassDOT Section 6.7.2 and AASHTO Green Book Chapter 3 and Chapter 9, City of Charlotte, North Carolina, Urban Street Design Guidelines, Chapter 5 and Appendix C.

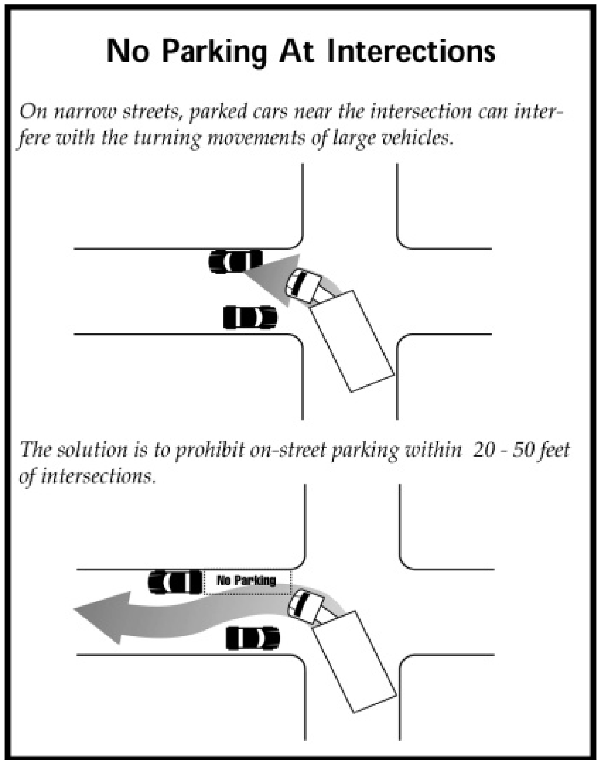
Example of Tighter Curb Radii

"In the case of Local Streets, curb-to-curb width must also be considered. In most cases, the width of the street is the critical factor in determining the necessary curb radii for Local Streets.

While Local Streets are typically narrower than Non-Local Streets, there is also more flexibility in applying the design vehicle encroachment guidelines, since it is generally assumed that the full width of available pavement can be used to "receive" the turning vehicle. This, of course, must take into account the traffic volumes, function, adjacent land uses and specific conditions of the street being designed."

Source: City of Charlotte, North Carolina

Figure 13: No Parking at Intersections



Source: Oregon Neighborhood Street Design

Table 7 is an example of a chart that includes a hierarchy of turning radii from Charlotte, North Carolina. This chart shows how the relationship of the two intersecting roads might affect varying curb radii.

Table 7: Charlotte, North Carolina, Curb Radii for Local Road Intersections (in feet)

From\To	Res. Narrow	Res. Medium	Res. Wide	Com. Narrow	Com. Wide	Industrial
Res. Narrow	35					
Res. Medium	20	15				
Res. Wide	15	15	10			
Com. Narrow	20	15	25	35		
Com. Wide	15	15	15	30	10	
Industrial	30	25	15	40	25	50

Res. = Residential Com. = Commercial

The city of Charlotte, NC provides the following guidelines for developing street layouts and designs:

- *The overall street pattern: depending on the size and layout of the adjacent street system, it may be appropriate to design smaller radii at* *most intersections (e.g. along a Main Street), while accommodating larger vehicles at fewer select locations along designated routes.*

- *The presence of a bike lane: the additional width created by a bike lane makes the effective curb radius larger. Therefore, the actual curb radius can usually be smaller when a bike lane exists.*
- *The presence of a raised median or pedestrian refuge island: may require larger radii to prevent vehicles from encroaching onto the median. Alternatively, particularly for "gateway" medians on Local Streets, medians may have aprons to allow larger vehicles to turn without damaging landscaping or curbs.*
- *Skewed or oddly shaped intersections: may dictate larger or smaller radii than the guidelines would otherwise indicate.*
- *Lane configuration or traffic flow: intersections of one-way streets, locations where certain movements are prohibited (left or right turns), or streets with uneven numbers of lanes (two in one direction, one in the other) will also affect the design of curb radii.*
- *On street parking: the presence or absence of on street parking will directly affect the curb radii required to accommodate the design vehicle.*
- *Again, while the goal is to provide the smallest radii possible, the design should be tested to be sure it can adequately accommodate the expected typical design vehicle, based on the specific traffic and roadway conditions of the project area.*

Source: City of Charlotte, NC Curb Radii Standards

Suggested Guidelines

1. Curb radii: 20 feet minimum (may be up to 35 feet for narrower intersecting roads);
2. Right of way (ROW) radii: 30 feet minimum (accommodate pavement radii and 5 foot sidewalk);
3. If parking is allowed on the street, establish limits on parking near corners to provide additional room for large vehicles as shown in Figure 13.

3.9 Cul-de-sac Design

Guiding Principles

The connected road network is of primary importance to a functioning and efficient road network. It also reduces response time for public safety officials. Limiting through connections increases trip length and discourages walking or biking unless there are pedestrian easements which create a "fused grid" even where roads do not connect. Cul-de-sacs should be avoided and connected roads established where possible. In all cases, turnarounds must accommodate local public safety vehicles.

Supporting Information

AASHTO Green Book Chapter 5.

Figure 14: LID Cul-de-sac Compared to Asphalt Cul-de-sac

Source: Source: MAPC, Low Impact Development Principles, Techniques and Implementation, presentation

Suggested Guidelines

1. Cul-de-sacs should be discouraged unless site specific conditions such as existing development, environmental constraint (slope, wetland, riparian body, etc.) or other constraint (railroad right-of-way, and lot configuration), create practical needs for their use.

2. Where possible, encourage loop roads instead of cul-de-sacs.

3. Incorporate LID measures such as vegetated islands into cul-de-sac design as shown in Figure 14 and Figure 16.

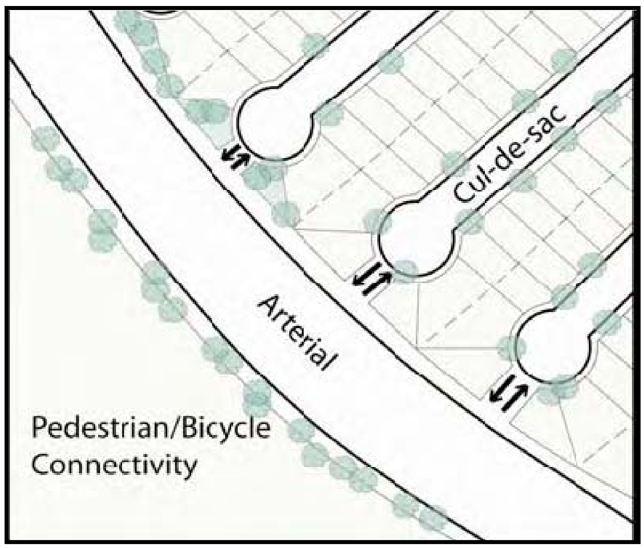
4. When cul-de-sac design is necessary, create pedestrian easements to allow non motor vehicle connection between dead end roads as shown in Figure 15.

5. Maximum length: Consider public water and other firefighting/emergency response requirements. Measure the maximum

length from the existing road entrance so if an existing dead end street is being extended the maximum length applies to the entire road.

6. Hammerhead turnaround should be permitted (30' minimum curb radii; 45' minimum center lane radii, head adequate for three point turn maximum, and accommodate local fire fighting vehicle).

Figure 15: Pedestrian Connections From Cul-de-sac Roads



Source: City of Fort Worth, Street Development standards

3.10 Turnaround Design and Dimensions

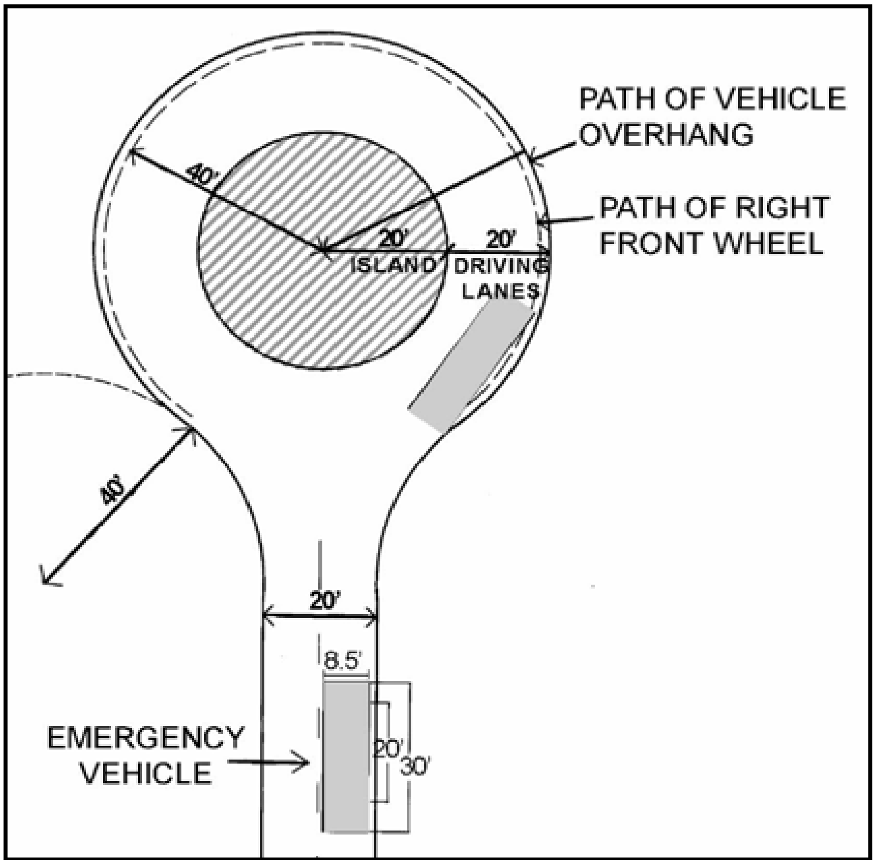
Guiding Principles

A minimum amount of pavement should be used for hammerhead turnarounds and cul-de-sac "bulbs." Encourage vegetated areas in the middle of cul-de-sac bulbs instead of asphalt. In all cases, turnarounds must accommodate local public safety vehicles. Massachusetts Fire Code 527 CMR requires 20 foot drive lanes.

Supporting Information

AASHTO Green Book Chapter 5.

Figure 16: Example of Cul-de-sac Dimensions With Vegetated Island



Source: MAPC, Low Impact Development Principles, Techniques and Implementation, presentation.

Suggested Guidelines

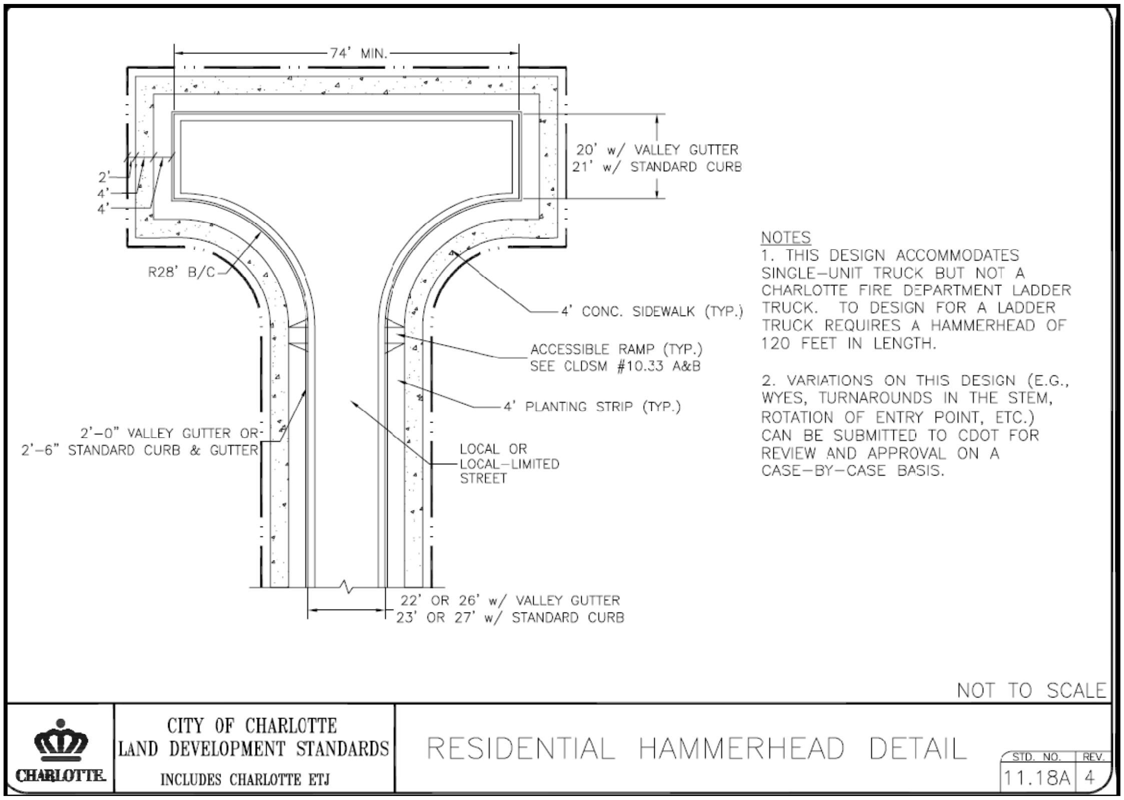
1. Roadway width: 50 foot outside radius
   Note: National Fire Prevention Association (NFPA) 1141 5.2.10 requires 60 feet to the outside of the turn.

2. Cul-de-sac ROW width: 55 foot radius (allows 5 foot grass strip or sidewalk within ROW).

3. Vegetated islands should be installed in the center of a turnaround, either for stormwater treatment or vegetated swales. Figure 16 shows an illustration of this design.
   a. Provide a fifteen foot minimum radius for island which must accommodate minimum pavement width within ROW.
   b. Consider incentives to promote cul-de-sacs with vegetated islands.

4. Hammerhead turnaround design in accordance with MassDOT 3.9.4 and Figure 17.

Figure 17: Hammerhead Design



Source: City of Charlotte, VA

3.11 Common Driveway Guidelines

Guiding Principles

Common driveways allow access to more than one dwelling unit from a public road. These driveways accommodate existing site topography, reduce the need for paved surfaces, and reduce the impact to natural landscape features. Common driveways may be narrower and steeper than public roadways and may be preferable to minor roadways in situations where significant landscape features can be preserved. Many current local zoning bylaws and subdivision regulations encourage common driveways in lieu of more restrictive roadway designs that result in significant land clearing and construction effort.

Supporting Information

MassDOT section 15.2.3 and 527 CMR 10.03, which requires a minimum of 18 feet clear width.

Suggested Guidelines

1. Use a common driveway for a maximum of two to six single family homes or choose a maximum number of lots, or maximum total square footage of dwelling area.

2. Pavement width: 16 to 18 feet (must have a minimum of 18 feet clear per 527 CMR 10.03).

> Ask your fire chief, will s/he accept a common driveway less than 18 feet wide? Are there special circumstances that apply to a particular development that make a narrower driveway the better alternative?

3. Gravel pavement is acceptable.

4. Grade: 12 percent (can increase to 15 percent depending on existing topography). Maintain 100′ SSD.

5. Centerline Alignment: 50 feet minimum center line radius (maintain 80-foot SSD).

6. Drainage: LID swales recommended as described in Section 3.14. Drainage must be managed in accordance with 310 CMR 10.05(6).

3.12 Grade

Guiding Principles

It is important to allow neighborhood roads flexibility in design and location in order to minimize pavement and maximize the flexibility of the development, especially for infill sites and limited land areas. In all cases, an adequate stopping (leveling) area must be provided when a roadway reaches an intersection with a stop condition.

Supporting Information

See MassDOT Section 4.3.

Suggested Guidelines (shown in

Table 8: Grade Guidelines

Feature	Guidelines	Notes
Minimum grade	0.8 percent	Drainage, icing
Maximum grade for an Open Space Subdivision	12 percent	Authority having jurisdiction
Maximum grade for a Conventional Subdivision	10 percent	
Maximum Grade for Turnaround	5 percent	
Vertical curves	80' SSD 115' SSD 155' SSD	low volume ↓ high volume
Leveling area (stop condition at intersections)	2 percent max for 150' 3 percent max for 100'	Longer depending on climate Longer leveling run depending on grade, climate and traffic volume

3.13 Design Vehicle

Guiding Principles

Local government departments need to work together to discuss and determine the appropriate design vehicles for the town's or city's roads. The term design vehicle is used to identify the types of motor vehicles used when designing a new road. A "control vehicle" is one that infrequently uses a planned road. Larger vehicles such as trucks require a wider turn radius; therefore the road designer's decision to use large trucks as a design vehicle instead of a control vehicle means that the road must have larger turn radii, larger width, and other potentially "oversized" designs. Decisions about design vehicles vary from designer to designer and will likely be different for every local government and may change over time. The following suggestions may help provide some consistency.

Access for Emergency Responders

"… with respect to emergency vehicles, it is often extremely helpful to set up a test route in a parking lot. Such test routes can include example turning and maneuvering conditions that may be temporarily striped or - better yet - marked with cones and parked vehicles. In this manner, actual drivers of the actual vehicles in question may sample the proposed conditions and adjustments, if any, may be made in advance of actual construction."

Source: Prepared by: C. "Rick" Chellman, P.E.

For the Urban Land Institute, April, 2000 (Adapted from Oregon Smart Development Street Design Guidelines, also by C. "Rick" Chellman, P.E.)

Supporting Information

MassDOT section 3.3.3 provides guidance for design vehicles, including Exhibit 3-6, Design Vehicle Dimensions which is reproduced below:

MassDOT Exhibit 3-5, Design Vehicle Dimensions

Vehicle	Vehicle Length	Vehicle Width	Operating Width (1)
Passenger Cars and Light Trucks	19.0 feet	7.0 feet	9.0 feet
School Bus	36.0 feet	8.0 feet	10.0 feet
Transit Bus	40.0 feet	8.5 feet	10.5 feet
Single Unit Truck (2)	30.0 feet	8.0 feet	10.0 feet
Tractor-Trailer	55.0 feet	8.5 feet	10.5 feet

Source: A Policy on the Geometric Designs of Streets and Highways, AASHTO, 2004. Chapter 2 Design Controls and Criteria

(1) Assuming one foot clearance on both sides of vehicles.

(2) The single unit design vehicle is currently used to model emergency response vehicle operations.

Source: MassDOT Project Development & Design Guide, 2006.

In addition, there are national organizations such as the Institute for Transportation Engineering (ITE) that recognize the importance of designing for the correct context, which is often referred to as "context sensitive design." Also known as CSS. One important factor in the appropriate context, is to choose the right design vehicle. ITE notes:

> *The practitioner should select the largest design vehicle that will use the facility with considerable frequency (for example, bus on bus routes, semi-tractor trailer on primary freight routes or accessing loading docks, etc.). In general, the practitioner may consider the use of a single-unit truck design vehicle as an appropriate design vehicle where the mix of traffic and frequency of large vehicles is unknown. Two types of vehicles are recommended.*
>
> *<u>Design vehicle</u>—must be regularly accommodated without encroachment into the opposing traffic lanes. A condition that uses the design vehicle concept arises when large vehicles regularly turn at an intersection with high volumes of opposing traffic (such as a bus route).*
>
> *<u>Control vehicle</u>—infrequently uses a facility and must be accommodated, but encroachment into the opposing traffic lanes, multiple-point turns, or minor encroachment into the roadside is acceptable. A condition that uses the control vehicle concept arises when occasional large vehicles turn at an intersection with low opposing traffic volumes (such as a moving van in a residential neighborhood or once per week delivery at a business) or when large vehicles rarely turn at an intersection with moderate to high opposing traffic volumes (emergency vehicles).*

Source: ITE Context Sensitive Solutions

Suggested Guidelines/Approach

1. Work with Department of Public Works staff to review constraints of vehicles such as snow plows and garbage trucks. Recognize that narrower roads take fewer passes to clear with snow plows.

2. Work with the Fire and Police Departments to review the needs of their vehicles.

3. *Most importantly* – set up a test course, where revised Guidelines for travel lane and ROW widths, curb radii, centerline radii, are "mocked up" with cones. Have local officials drive their vehicles around these to see what happens. They may be surprised at how "small and tight" they can turn their vehicles.

4. Discuss the pros and cons of having an occasional road blockage while a large moving van maneuvers on local roads.

5. Discuss possibility of prohibiting obstacles that might project into the traveled way, such as trees, light poles, mailboxes, and hydrants. Consider restrictions on the placement of these items in subdivision approval conditions.

3.14 Low Impact Development (LID) and Stormwater Management

Guiding Principles

1. Minimize impermeable surfaces: Avoid paving or compacting soils where it is not necessary. This could mean a narrower driveway, road, a smaller parking area, or use of alternative materials which reintroduce water back into the soil.

2. Use "Natural Drainage" to create gentle slopes to slow water flow. When stormwater moves slowly through a system more pollutants are filtered and more water infiltrates or evaporates. A pipe is designed to move water at top velocities. Re-grading a ditch with gentler side slopes and a moderately sloping broad channel allows water to percolate into the soil. Channel bottoms slopes can be made gentler by adding "steps." Generally sites with longitudinal slopes greater than eight percent are unlikely candidates for bio swale elements. Figure 18 shows what a residential bio swale looks like.

Figure 18: Stormwater Swale

Source: GreenSpace, Stormwater Management By Green Design, http://209.205.95.211/joomla/green/index.php/business-trends/153-storm-water-management-by-natures-design.

3. Stormwater quantity can be reduced by amending soils and adding vegetation.

Amended soils: Adding organic compost or mulch to soil improves its ability to support plants and absorb stormwater. Healthy soil is the backbone of natural drainage systems.

Adding vegetation: Trees and vegetation catch rainfall before it reaches the ground reducing the amount of stormwater runoff. Native shrubs, perennials and small trees planted in natural drainage systems slow the movement of stormwater, encourage infiltration and provide bio-remediation of pollutants.

Longitudinal Slope: Grade elevation through the length of the swale should be flat or gradual.

Supporting Information

There are many sources for information on LID. Massachusetts specific guidelines and manuals can be found at the Massachusetts Department of Environmental Protection (DEP) website. The Metropolitan Area Planning

Council (MAPC) has a LID Toolkit website with links to many of the national sites.

The National Association of Home Builders (NAHB) has information about the costs and benefits of LID at the Toolbase.org website: National Association of Home Builders Toolbase.org information on LID.

Suggested Guidelines

1. Use LID methods where practicable.

2. Natural Drainage is recommended for very low volume roads such as alleys or lanes with slope less than 5 percent. However, when septic systems must be put in front yards, consider Title 5 and Department of Environmental Protection (DEP) requirements in order to allow for 10 to 15 feet between an open drainage that flows to a surface water supply and a septic system. The septic system requirements for some subdivisions will be part of the "context" that neighborhood road design should incorporate.

3. Allow for curbless roads when LID methods are used. Sometimes "inverted" curbs are specified so that stormwater can sheet off of a road and into swales or infiltration basins.

4. Allow pervious pavement for selected road surfaces and sidewalk and bike lanes. See Chapter 4, construction Guidelines for more information about pervious pavement design.

5. Design to Massachusetts Department of Environmental Protection Stormwater Management Standards for all projects.

Tools from other Jurisdictions

The University of New Hampshire Stormwater Center has excellent publications and research on use of LID techniques in New England. The Resource section of this guidebook includes their full contact information.

City of Seattle

Design information on the various types of *swales is provided in the [City of Seattle] Stormwater Manual. The information provided here is specific to placing swales within the street ROW. To aid the designer, the City [of Seattle] has compiled the following Natural Drainage Swale details that can be found in the ROWIM:*

- *Bioretention Swale*
- *Bioretention Swale with Underdrain*

- *Conveyance Swale*
- *Curb Drain Cut Opening for Swale*
- *Concrete Inlet, Channel and Grate*
- *Log Weir*
- *Curb Extensions*
- *Tree Planting within Bioretention Swale*

3.15 Utilities

Guiding Principles

Provide adequate space in or near the right of way for public and private utilities. Plan to put public and private utilities underground for new developments when practicable. When utilities are below grade, they are out of harm's way during wind, snow, and ice storms. Public utility companies provide construction details and methodologies for more secure underground power, telecommunications and cable TV installation. A benefit of such construction is reduced "clutter" along the road side and improved aesthetics.

Supporting Information

MassDOT Section 5.7 and AASHTO Green Book Chapter 5.

Suggested Guidelines

1. Utilities in developments over three units should be underground where possible.

2. Utilities should be placed in the ROW or in a 10-foot utility easement. The following suggested guidelines apply to a utility easement:
    a. Place easement parallel to ROW where possible.
    b. Increase width of easement if required by private utility offset requirements.
    c. Maintain minimum distances (three feet) between gas, electric, cable, phone, etc.
    d. Measure between edges of encasement when used, not center to center.

3.16 Residential "Loading Areas"

Guiding Principles

Accommodate new trends for joint mailboxes, visitor parking areas, fire cisterns, or other special needs for a variety of residential development products.

Supporting Information

Areas for community mail boxes and school bus stops may be designed in accordance with the dimensional standards found in local zoning bylaws and subdivision standards for off street parking and loading. These areas should be properly lighted and designed in accordance with MA-AAB regulations to provide an accessible route from adjoining sidewalks and/or pathways.

Suggested Guidelines

1. Community mailbox: allow for an eight-foot wide pull off lane, 25 feet long, and transition curbs to normal road width over 15 feet at each end;

2. Fire Cistern(s): allow for an eight-foot wide pull off lane, 50 feet long, and transition curbs to normal road width over 25 feet at each end;

3. Parallel On-street Parking: allow for an eight-foot wide pull off lane, 22 foot long stall length, and transition curbs to normal road width over 15 feet at each end;

4. Bus Stops: allow for a ten-foot wide pull off lane, 50 foot long pull out length, and transition curbs to normal road width over 25 feet at each end.

3.17 Street Lighting

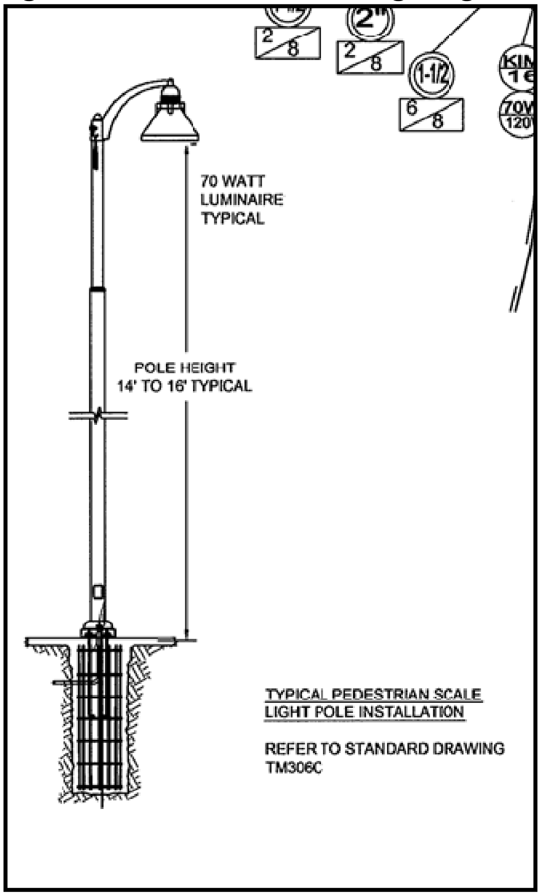
Guiding Principles

Use pedestrian scale lighting as shown in Figure 19. Use energy efficient lighting and do not specify too much lighting where it is not needed or it does not fit with the neighborhood context. For example, narrow roads in an area that has low population may not need street lighting. Any lighting system should comply with the recommendations of the International Dark-Sky Association, whose goal is "To preserve and protect the nighttime environment and our heritage of dark skies through quality outdoor lighting." For more information, visit www.darksky.org.

Supporting Information

AASHTO Green Book Chapter 5.

Figure 19: Pedestrian Scale Lighting



Source: City of Eugene, Oregon

Suggested Guidelines

1. Location and spacing standard: Street lights should be considered at intersections and as frequently as the local road context requires. Due to the wide variety of contexts for neighborhood roads throughout Massachusetts, it is impossible to state a specific spacing standard.

2. Amount: Install pedestrian scale lighting near driveways and group mailboxes, loading, and bus stops.

3. Type and design: Use energy efficient light bulbs, shielding that has "full cut off" housing and designs that are dark sky compliant.

3.18 Street Trees

Guiding Principles

Street trees and vegetated areas should be part of all neighborhood roads. Local governments should encourage the retention of existing vegetation if they allow it to count towards the required site landscaping percentages. Trees and vegetation absorb carbon dioxide and help to improve air quality.

Supporting Information

Studies have shown the following air quality benefits of urban trees:

- A 60 percent reduction in road level particulates on tree-lined roads vs. roads with no trees
- Reduction in nitrogen dioxide, sulfur dioxide, carbon monoxide, cadmium, chromium, nickel and lead levels
- A 50 percent reduction in noise.

Source: Dr. Kim D. Coder, "Identified Benefits of Community Trees and Forests."

See also MassDOT Chapter 13.

Suggested Guidelines

1. Tree Spacing: Trees should be installed every 40 feet along both sides. Spacing can be increased where trees are retained within the ROW and within the roadside area (generally 20 feet adjacent to ROW limits). Retained vegetation should count towards landscaping and street tree requirements.

2. Tree Location: Trees should be installed within the ROW or within the roadside area. If street trees are not within the ROW, then they should be within an easement that allows for municipal tree trimming.

3. Tree Variety: A variety of native deciduous or coniferous (locality driven) plants should be used. Invasive species that are listed on the Massachusetts Invasive Plant List should be prohibited.

4. Tree Size: Trees should be properly sized and stabilized by guyed wires to ensure vigor.

5. Vegetation in stormwater bio swales and shrubs in cul-de-sac islands should count towards the street tree requirement.

6. Consider using a tree box also called a tree filter box (Figure 20) where site constraints would affect tree growth or there is concern about root damage to subdivision improvements such as sidewalks.

Figure 20: Tree Filter Box in Milton, Massachusetts

Source: Neponset Watershed Association. Photo of tree filter box in Milton, MA. http://www.neponset.org/Stormwater.htm

3.19 Road Location

Guiding Principles

Avoid natural resource areas where possible. Comply with Conservation Commission and state environmental rules when approaching or encroaching on wetland areas.

Supporting Information

MassDOT Chapter 3 and AASHTO Green Book Chapter 2.

Suggested Guidelines

1. Alternate road configurations to avoid sensitive natural areas and steep slopes.

2. Locate routes parallel to ridgelines whenever possible.

3.20 Traffic Calming Measures

Guiding Principles

Traffic calming may not apply for new residential roads, but it may be a part of the mitigation measures that can be applied to adjacent neighborhood roads. Mitigation for speeding or heavy traffic through a residential neighborhood is significant in order to create livable roads – that is to say roads where residents feel safe to walk, ride bicycles, and enjoy their neighborhood.

Traffic calming is an important part of retrofitting existing neighborhoods to keep the atmosphere human scaled as opposed to vehicle scaled. Below are some considerations for choosing traffic calming measures, followed by a table listing measures appropriate for residential roads. There are no "standards" for this section. Installation and use of traffic calming should be reviewed on a case by case basis, using the information suggested below and in other resources.

Supporting Information

Table 9 shows the variety of types of traffic calming and when they are appropriate. The following text and Figure 21 and Figure 22 illustrate a few of these methods. Here are some pointers from the City of Seattle:

- *Vehicle speed is more critical than volume in terms of safety and should be addressed first where there are constraints.*
- *Neighborhood involvement is important to successful implementation. Rationale for traffic-calming and management measures should be explained clearly to community residents and installation of these treatments should incorporate public input.*

Table 9: Best Management Principles for Traffic Calming

Traffic Calming Device	Typical Use	Residential Roads (non-arterial)
Curb bulbs	Pedestrian Crossing Conditions	●
On-street parking (parallel and angle)	Conditions Along Roads	●
Streetscape improvements (street trees, lighting, street furniture, special paving treatments)	Conditions Along Roads	●
Signs	Managing Traffic	●
Speed cushions (for 25 mph or below)	Managing Traffic	●●
Gateway treatments	Pedestrian Crossing Conditions	●
Neighborhood speed watch program	Managing Traffic	●
Limited access	Managing Traffic	●
All-way stop	Managing Traffic	●
Chicanes	Managing Traffic	●
Chokers	Managing Traffic	●
Diverters	Managing Traffic	●
Partial road closure	Managing Traffic	●
Pedestrian districts (woonerfs)	Pedestrian Crossing Conditions	●
Speed humps	Managing Traffic	●
Traffic circles	Managing Traffic	●

Legend: Appropriate for Consideration (●) May be Applicable (●●)

Source: adapted from the Seattle Right of Way Instruction Manual, http://www.seattle.gov/transportation/rowmanual/manual/6_5.asp accessed November 12, 2009.

Figure 21: Illustration of Chicane

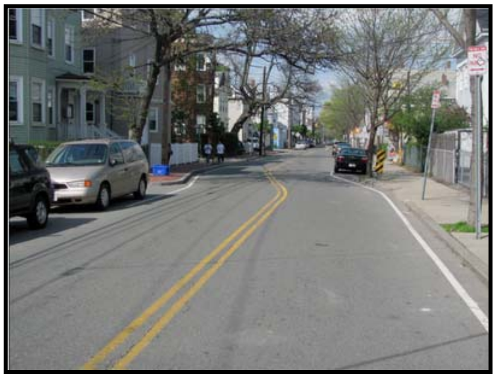
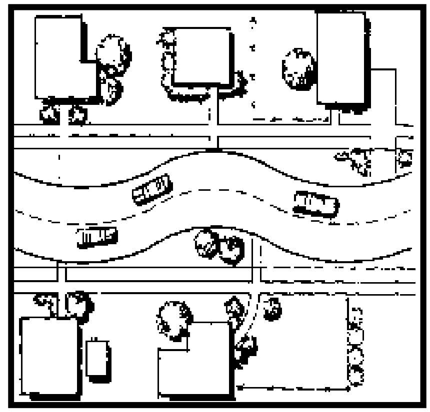


Photo of Chicane



Plan view of Chicane

Source: Left: Chicanes on Columbia Street, Cambridge, MA http://calmstreetsboston.blogspot.com Right: Traffic Calming illustrations: http://www.ite.org/traffic/tcdevices.asp

1. *Traffic-calming and management measures should fit into, and preferably enhance, the street environment.*

2. *Traffic-calming designs should be predictable and easy to understand by drivers and other users.*

3. *Devices that meet multiple goals are usually more acceptable. For example, a raised crosswalk may be more understandable to motorists than a speed hump. The former has a clear goal, whereas the latter may be perceived as a nuisance.*

4. *Treatments need to be well designed and based on current available information on their applications and effects. Information on U.S. experiences with various traffic-calming measures can be found in ITE.*

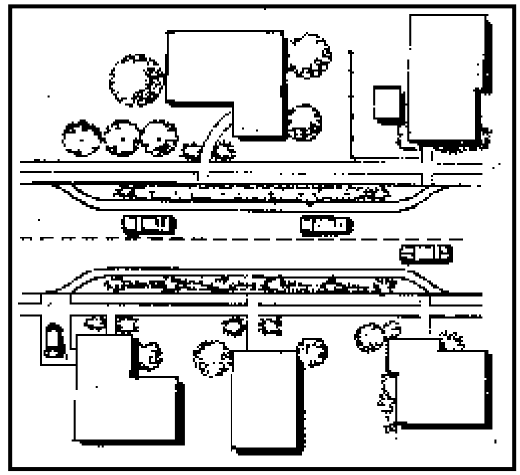
5. *Devices should accommodate emergency vehicles. Emergency response times shall be considered.*

6. *Traffic-calming areas or facilities should be adequately signed, marked, and lit to be visible to motorists.*

7. *Treatments need to be spaced appropriately to have the desired effect on speed —too far apart and they will have a limited effect, too close and they will be an unnecessary cost and annoyance. Devices usually need to be spaced about 300 to 500 feet apart. If they are spaced too far apart, motorists may speed up between them. This is particularly the case where the devices are added onto the street (e.g., speed humps).*

Figure 22: Illustration of a Choker

Photo of Choker



Plan view of Choker

Source: Left: Project for Public Spaces, http://www.pps.org/livememtraffic/#BULBS%20-%20CHOKERS%20-%20NECKDOWNS
Right: Traffic Calming illustrations: http://www.ite.org/traffic/tcdevices.asp

1. *Whole street designs are usually able to create an environment that supports slower speeds for the entire length.*

2. *Facilities should not be under-designed or they will not work. Keeping the slopes too gradual for a speed table or curves too gentle for a chicane will not solve the problem and will appear as a waste of money and may ruin chances for future projects.*

3. *Traffic-calming measures should accommodate bicyclists, pedestrians, and people with disabilities.*

4. *Devices should be thought of as elements of a traffic calming system and be placed to improve pedestrian conditions throughout an area.*

Chapter 4: Construction Guidelines

4.1 Dimensional Guidelines (Depth)

Guiding Principles

Materials specified for the road surfaces should include the ability to replace required materials with newer products, as long as an applicant can provide proof of the durability and quality of the replacement material.

Supporting Information

MassDOT Section 5.5.3 and AASHTO Green Book Chapter 4.

Suggested Guidelines

1. Roadway Depth:
    a. 1 ½ inch Top Course on 2 ½ Binder Course Hot Mix Asphalt (HMA) (these are minimums; traffic volume and subgrade dependent);
    b. 12-inch gravel base (MassDOT M.1.03.0 Type B or M 1.03.1), traffic volume and subgrade dependent, may warrant under drains in cut sections;
    c. Remove unsuitable subgrade.

2. Pervious asphalt should be based on specifications such as those found in the *University of New Hampshire Stormwater Center Design Specifications for Porous Asphalt Pavements and Infiltration Beds*, or other similar publications.

3. Gravel is acceptable on very low volume narrow roads. Road grades should not exceed 5 percent and natural drainage is required.

4.2 Curbing Guidelines

Guiding Principles

See the guiding principles and cross sections in Section 3.2 of this guidebook for background about the recommended approach and design for curbing.

Supporting Information

MassDOT Section 5.5.3 and AASHTO Green Book Chapter 4 for construction guidelines and Chapter 5 for general curbing design.

Suggested Guidelines

1. Narrow roads: A sidewalk must be at least four feet as measured from the back of the curb. It must also consist of granite at intersection radii where plowing is a consideration and at the curb inlet of catch basins.
   a. Natural drainage is allowed on all rural roads where possible, which is shown in Figure 23.
   b. MassDOT Type "A" or Cape Cod Berm: A sidewalk must be located at least three feet from the back of the berm. See "Cape Cod Berm" entry in Glossary for an illustration. Curbing must consist of granite at roadway intersection radii where plowing is a consideration and at the inlets of catch basins where leaf litter/clogging is a consideration.

2. Medium and Wide Roads: Granite (MassDOT Type VA or VB) or bituminous (MassDOT Type-3). A sidewalk may be located adjacent to the back of the curb.

3. Allow for alternative curbing when LID measures are being used (i.e., curb breaks, turn-out ditches, paved swales, valley gutters, etc.).

Figure 23: Illustration of Natural Drainage

Source: Franklin, MA, Best Development Practices

4.3 Sidewalks

Guiding Principles

See the guiding principles and cross sections in Section 3.2 of this guidebook for background about the recommended approach and guidelines for design and location of sidewalks.

Supporting Information

See MassDOT Section 5.3.1 and AASHTO Green Book Chapter 4 for construction guidelines and Chapter 5 for general design of sidewalks.

Suggested Guidelines

1. Bituminous or Portland cement – light colored surface treatments and/or pavers allowed for variability/aesthetic considerations.

2. No sidewalks (narrow roads, alleys and lanes) – when appropriate.

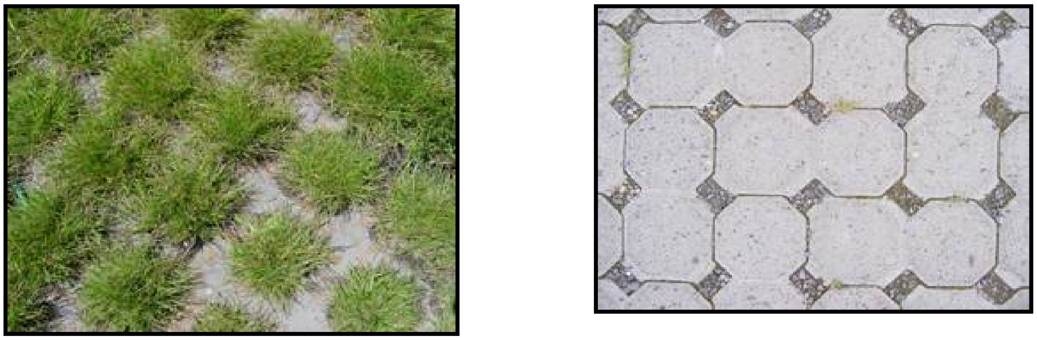
3. Alternative or Permeable Pavements (asphalt, pervious):
    a. When appropriate in accordance with the guiding principles and design parameters (see section 4.4 below).
    b. Projects should use specifications such as UNHSC pervious asphalt pavement and City of Seattle, ROWIM, or other similar specifications. www.unh.edu/erg/cstev/pubs_specs_info/unhsc_pa_spec_09_09.pdf or http://www.seattle.gov/transportation/rowmanual

4.4 Alternative/Permeable Pavement

Guiding Principles

One technique of LID is to install pervious pavement, shown in Figure 24, or alternative pavement surface that accommodates travel and allows water to infiltrate into the groundwater, recharging local water supplies and reducing stormwater runoff.

Figure 24: Pervious Pavement



Source: Massachusetts Low Impact Development Toolkit.

Suggested Guidelines

Instead of suggested numeric guidelines, we are providing a set of tools and links to Massachusetts manuals.

Supporting Information and Design Tools from other jurisdictions

See the DEP publication Volume 2: Structural BMP.

City of Seattle *Right of Way Improvements Manual (ROWIM)* has the following section on permeable pavement:

Permeable pavement is a paving system which allows the rainfall to percolate into an underlying soil or aggregate storage reservoir, where stormwater is stored and infiltrated to underlying subgrade, or removed by an overflow drainage system. Permeable pavements reduce impermeable surfaces and can be used to achieve City of Seattle water quality requirements and flow control requirements.

1. *At this time, permeable pavements are limited to non-street surfaces, such as sidewalks and driveways.*

2. *The surface layer of a permeable pavement system is the wearing course. Categories of wearing courses include:*
   a. *Permeable Asphalt Concrete: Permeable asphalt concrete is open-graded asphalt with reduced fines and stable air pockets encased within it that allow water to drain to the base below. Aggregate binders and additives can be added to increase durability. Like conventional concrete it is laid with traditional asphalt paving equipment.*
   b. *Permeable Cement Concrete: Permeable cement concrete is similar to permeable concrete in that the mixture omits the fines to create stable air pockets encased within it. Depending upon the mix design, permeable cement concrete can have a rougher surface than conventional cement.*
   c. *Interlocking Concrete Pavers: Interlocking concrete paver blocks themselves are not always permeable, but they are typically installed with gaps between them to allow stormwater to infiltrate into the subsurface. The gaps, typically*

10 percent of the surface area, are filled with a permeable material, usually small clean stone.

d. Open-Celled Paving Grid with Vegetation: Open-celled paving grids consist of a rigid grid composed of concrete or a durable plastic that is filled with a mix of sand, gravel, and topsoil for planting vegetation. The cells can be planted with a variety of grasses or low-growing groundcovers. The support base and the ring walls prevent soil compaction and reduce rutting and erosion by supporting the weight of traffic and concentrated loads.

e. Open-Celled Paving Grid with Gravel: The same open-celled grid structure is employed but the voids in the rings are filled with a mix of gravel.

3. *Any permeable pavement wearing course proposed for use in the street ROW must be on the Permeable Pavement Wearing Course Approved list for [Seattle] City ROW Applications.*

4. *Permeable Cement Concrete, which has been approved for use in the street ROW, must use the Standard Specification for Permeable Pavement.*

5. *Permeable pavement systems for stormwater code compliance can be designed as a facility for 100 percent impervious area credit, or as a surface for 50 percent impervious area credit. Design information on these two types of permeable pavement systems are provided in the Stormwater Manual. The information provided here is specific to placing permeable pavement within the street ROW. To aid the designer, the City has compiled the following Permeable Pavement Design details for project designers to evaluate, modify and incorporate into their Street Improvement Plans:*
   - *Permeable Pavement Sidewalk (Figure 6-23)*
   - *Permeable Pavement Facility, Sidewalk (Figure 6-24)*
   - *Permeable Pavement Facility, Sidewalk, Check Dam, Interceptor (Figure 6-25)*
   - *Permeable Pavement Facility in Planting Strip (Figure 6-26)*

Source: City of Seattle, Right of Way Improvement Manual

4.5 Erosion Control Plans

Guiding Principles

Construction of roadways should include Best Management Practices (BMP) to reduce water pollution through sediment in stormwater runoff from construction areas.

Supporting Information

MassDOT Chapter 8 Drainage and Erosion Control. Section 8.5 covers drainage control during construction.

Suggested Guidelines

1. Require development of a stormwater management and erosion control plan for construction activities. Such plans help the munidipality gain

approval of their NPDES permit requirements to comply with the Clean Water Act. Be sure that the plan includes a maintenance program and provides for inspection by local authority:

a. Encourage limits to clearing within the right-of-way to the minimum necessary to construct roadway, drainage, sidewalk, and utilities, and to maintain site lines. Clearing and grubbing of entire right-of-way should be discouraged.
b. Contractors should be encouraged to reestablish permeability of soils that have been compacted by construction vehicles.

4.6 Management Plan and Operation and Maintenance Plan for LID

Guiding Principles

Construction of roadways should include BMPs to reduce water pollution through sediment in stormwater runoff from construction areas.

Supporting Information

As Massachusetts communities gain experience with controlling erosion during construction and installation of LID infiltration measures, there will be more samples of adopted Operation and Maintenance plans and Construction Manuals with best practices. The University of New Hampshire Stormwater Center (UNHSC) provides ongoing research for the New England climate.

Suggested Guidelines

1. Review stormwater management and erosion control management plans required by DEP.

2. When LID methods are used, require LID Operations & Maintenance Plan. Check the Massachusetts Department of Environmental Protection DEP or the LID Toolkit for templates of these documents.

Glossary

AASHTO. American Association of State Highway and Transportation Officials. Mission: "The American Association of State Highway and Transportation Officials advocates transportation-related policies and provides technical services to support states in their efforts to efficiently and safely move people and goods."

AASHTO Green Book. Shorthand description of the standard reference book, *Geometric Design of Highways and Streets*. The primary road design guidebook published by AASHTO.

ADA, Americans with Disabilities Act, Federal legislation that provides for access for people with disabilities. ADA standards are used in concert with MA-AAB.

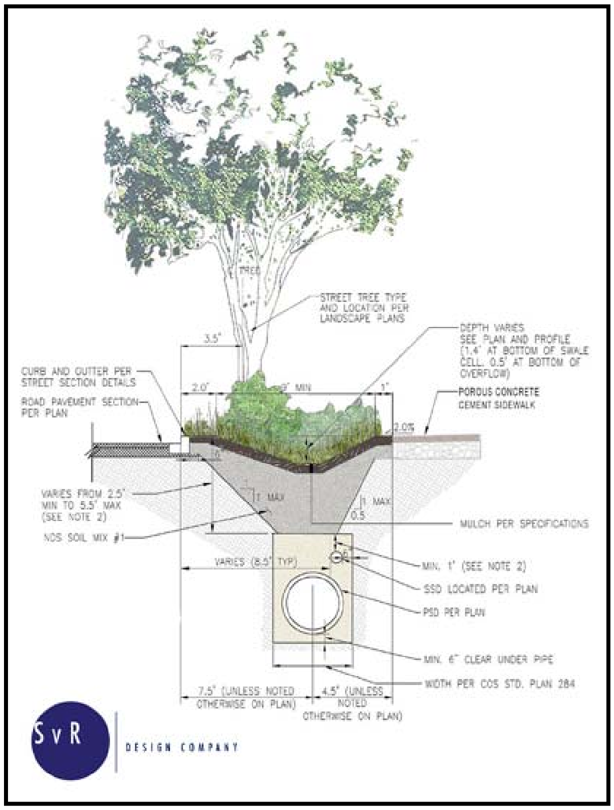
ASCE. American Society of Civil Engineers. A professional organization comprised of civil engineers. http://www.asce.org/

Average Daily Traffic (ADT). A measurement of the amount of traffic on a road. Used to set thresholds that help define the context of an area.

Best Management Practices (BMP). Any activities, prohibitions, programs or means to prevent or reduce the discharge of pollutants into waters of the United States.

Bio Swale. A man made vegetated swale designed to capture, infiltrate, and clean stormwater. These drainage features usually runs parallel to the road. Figure 25 illustrates this technique.

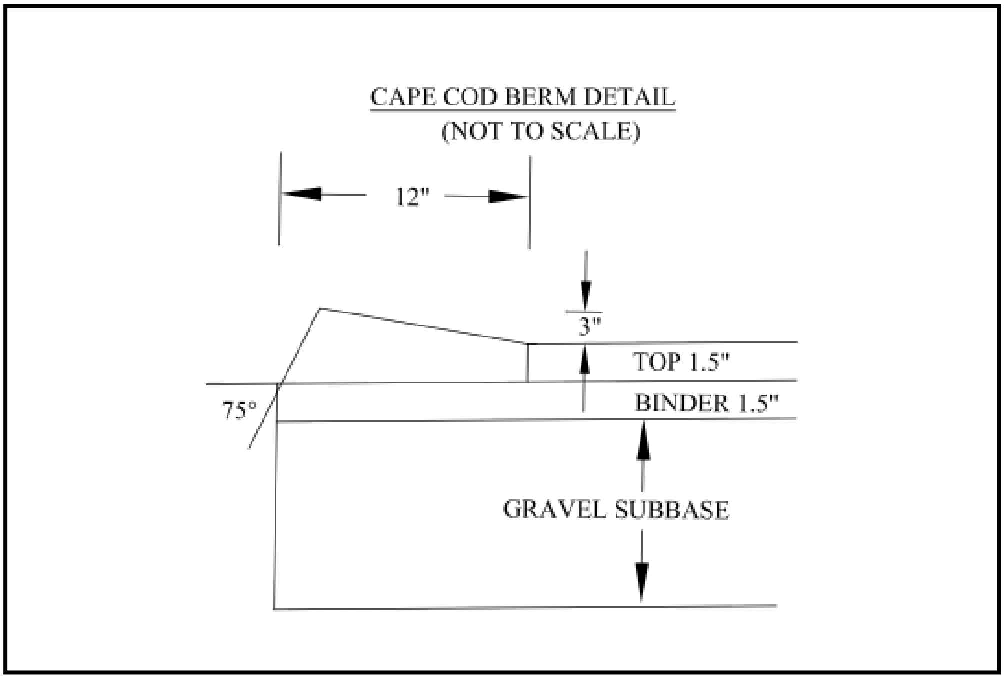
Figure 25: Bio Swale



Source: Greg Giraldo, SvR Design Company, Design for Bio Swale in High Point community in Seattle, WA. http://www.washington-apa.org/documents/sections/pugetsound/newsPSS/pssNewsJanMar07.html

Cape Cod Berm. A type of curbing composed of poured asphalt angled at the edge of the roadway as shown in Figure 26.

Figure 26: Illustration of a Cape Cod Berm



Source: City of Springfield, Massachusetts, DPW, February 27, 2006, Detail #0015

Centerline Radius / centerline radii. Measurement of the sharpness of the curve in a roadway.

Centerline. "**A** smooth longitudinal line that defines the mid point of a roadway at any given distance." Source, MassDOT.

Context Sensitive Solution (CSS). From MassDOT glossary, "Collaborative, interdisciplinary approach to develop a transportation facility that fits its physical setting and preserves scenic, aesthetic, historic, and environmental resources, while maintaining safety and mobility for all users."

Country Drainage. See Bio Swale.

Curb radius / curb radii. The angle or sharpness of a corner as measured at an intersection.

Cross Section. An illustration of dimensional guidelines for roads, right of way, and roadside areas.

Cul-de-sac. A local road with a single vehicular ingress and egress with a turnaround at the end. See the following illustrations: Figure 14, Figure 15, Figure 16, and Figure 27.

Dark Sky. An approach to limit upward facing artificial light so that the night sky is darker. Techniques that enhance dark sky protection include street lights designed to face downward without allowing artificial light to leak out to the side or top.

Department of Environmental Protection, Massachusetts (DEP) State agency responsible for permitting and regulating activities in natural resource areas, regulates stormwater runoff. Publishes the Massachusetts Stormwater Handbook.

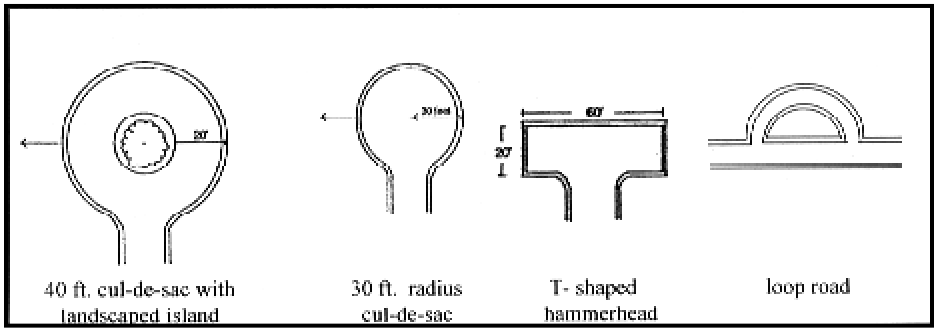
Design Speed "A selected speed used to determine various geometric features of a roadway." Source, MassDOT.

Energy efficient. Any product that uses less energy than a conventional product that it would replace. (from www.usgreenbuilding.com).

Green Infrastructure. "An adaptable term used to describe an array of products, technologies, and practices that use natural systems – or engineered systems that mimic natural processes – to enhance overall environmental quality and provide utility services. As a general principal, green infrastructure techniques use soils and vegetation to infiltrate, evapotranspirate, and/or recycle stormwater runoff." Source: http://www.epa.gov

Hammerhead / Hammerhead turnaround.
An alternative road turnaround to a cul-de-sac. This concept is illustrated in Figure 17 and Figure 27.

Figure 27: Road End Alternatives



Source: http://www.stormwatercenter.net

Heat island effect. A term used to describe the effect that impervious surfaces have in urbanized areas which results in higher temperatures. The U.S. Environmental Protection Agency says, *"The term "heat island" describes built up areas that are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F (1–3°C) warmer than its surroundings. In the evening, the difference can be as high as 22°F (12°C). Heat islands can affect communities by increasing summertime peak energy demand, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and mortality, and water quality."* *Source: http://www.epa.gov/hiri/*

Hot Mix Asphalt (HMA). A type of pavement consisting of aggregate and asphalt cement binder.

Institute for Transportation Engineers (ITE) An international educational and scientific association of transportation professionals who are responsible for meeting mobility and safety needs. www.ite.org/

Low Impact Development (LID). A Low Impact Development approach uses a more decentralized approach; the idea is to reduce the amount of stormwater runoff and treat it closer to the source using smaller, less expensive techniques. Basic design strategies seek to reduce the amount of land covered by impervious surface such as rooftops and paved areas. LID also uses techniques that allow stormwater to infiltrate into the ground such as bioretention areas and bio swales. LID site designs protect natural features that improve water quality.

Massachusetts Architectural Access Board (MA-AAB). The Architectural Access Board (AAB) is a regulatory agency within the Massachusetts Office of Public Safety. Its legislative mandate states that it shall develop and enforce regulations designed to make public buildings accessible to, functional for, and safe for use by persons with disabilities. http://www.mass.gov

Massachusetts Department of Transportation Project Development & Design Guide, 2006 (MassDOT). Released in January 2006, the multiple award winning Project Development and Design Guide, with its most recent award of August 5th, 2007, serves as a national model for developing better road and bridge projects. http://www.mhd.state.ma.us

Metropolitan Area Planning Commission (MAPC). Boston area regional planning agency, that has information on Low Impact Development, Bicycle and Pedestrian facilities and planning, and Smart Growth. http://www.mapc.org/.

Multi-modal. From MassDOT glossary, "Serving multiple user groups, including motor vehicles, pedestrians, bicyclists, and transit vehicles."

Natural Drainage. See Bio Swale.

National Pollutant Discharge Elimination System (NPDES). A national program under Section 402 of the Clean Water Act for regulation of discharges of pollutants from point sources to waters of the United States. Discharges are illegal unless authorized by an NPDES permit. The type of NPDES permits for many local governments in Massachusetts are referred to as NPDES MS4 Phase II permits. These are for towns with a separate municipal stormwater sewer system (MS4). Phase II indicates smaller systems, such as towns and cities in urban areas with less than 100,000 population.

Open Drainage. See Natural Drainage and Bio Swale.

Open Space Residential Development (OSRD). A type of development review and design that encourages development planning based on a site assessment of existing natural features. Generally, dwelling units are allowed at higher densities and closer proximity in trade for preservation of greater open space area.

Planting Strip / Park Strip. A section of land intended to be planted with trees, shrubs, or other vegetation between the sidewalk and the curb.

Pedestrian access easement. An easement created for the purpose of providing pedestrian access to a property or from one public road to another.

Plate. See Cross Section.

Reverse Curve. From MassDOT glossary, "Two simple curves joined together, but curving in opposite directions."

Right of Way (ROW). From MassDOT glossary, "The land acquired for or devoted to transportation purposes."

Road diet. From MassDOT glossary, "Allocation of the pavement width of the street in a manner that gives more space to pedestrians, bicycles, and parking, reducing the width of the motor vehicle traveled way."

Sight Stopping Distance (SSD). Measurement of the distance to perceive and react to a condition plus the distance to stop.

Smart Growth. As articulated by MAPC means "developing and preserving land in a way that gives high-quality neighborhoods for all residents; preserves the built and natural heritage; expands choice and opportunity in housing, jobs, and transportation; and is fair for people of all backgrounds."

Superelevation. From MassDOT glossary, "Geometric design element employed to counterbalance the centrifugal force, or outward pull, of a vehicle traversing a horizontal curve; refers to the method of banking the roadway by attaining a vertical difference between the inner and outer edges of pavement."

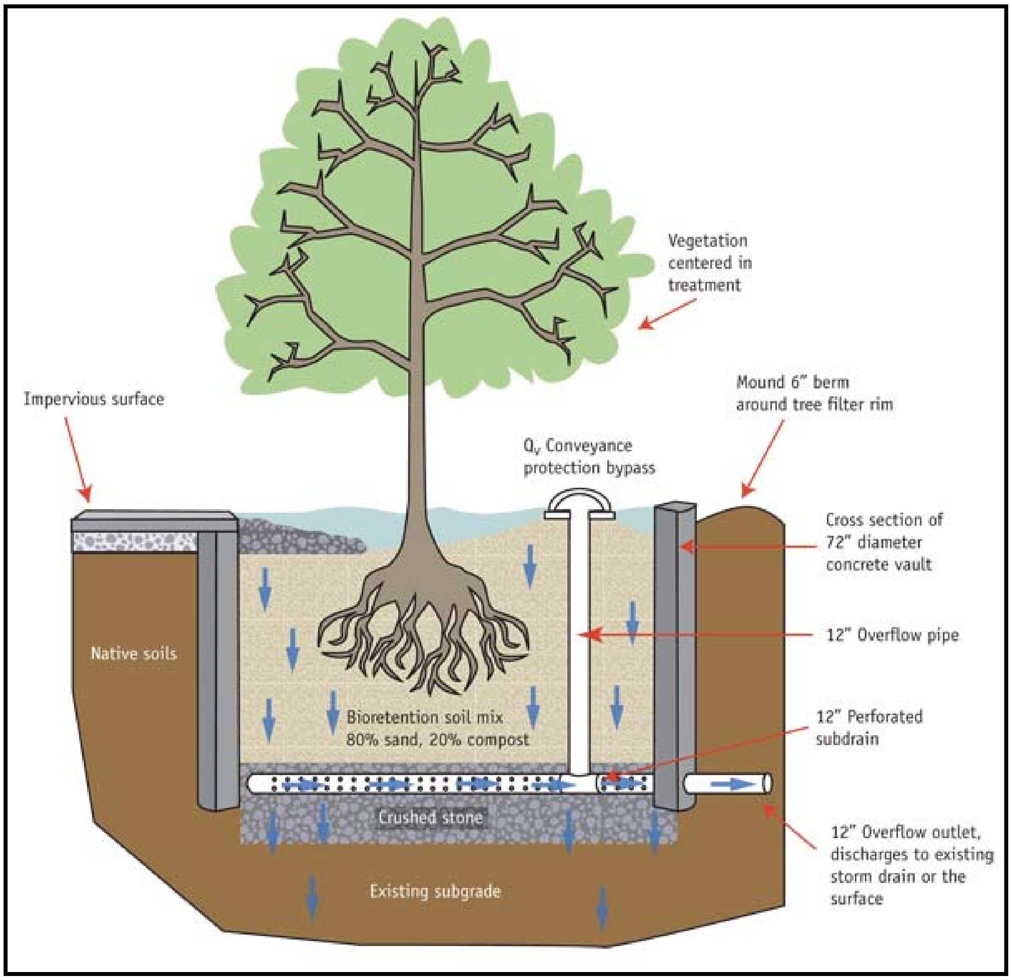
Sustainable Development. As defined by the United Nations, this term means "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Traffic Calming. A concept for reducing motorist speed, decreasing traffic volume and increasing safety for pedestrians and nonmotorized vehicles. Usually involves installation of speed humps, traffic circles, or similar devices.

Tree Filter Box / Tree Box / Tree Box Filter. These containers are one of many BMPs that can improve water quality from road stormwater runoff. The tree boxes are usually placed adjacent to a road adjacent to and underneath a sidewalk. The structures contain soil and a small tree or shrub, and usually drain to an outlet pipe. The tree roots, the soil, and microorganisms filter contaminants from street runoff. The filtered water then flows down through the box, into the outlet pipe, and through underground pipes until it is released into a nearby stream. Figure

28 shows how this process works. With a tree filter box, a stream receives cleaner water than it would have otherwise.

Figure 28: Tree Filter Box



Source: University of New Hampshire, Stormwater Center, 2007 Annual Report. http://ciceet.unh.edu/unh_stormwater_report_2007/treatments/tree_box/design.php. Note: Drawing is not to scale.

Turning radius / turning radii. The measurement of the smallest circular turn (ie. U-turn) that a vehicle is capable of making.

Vehicle Miles Traveled (VMT). A measurement of total vehicle miles traveled, which is used to track vehicle use over time.

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