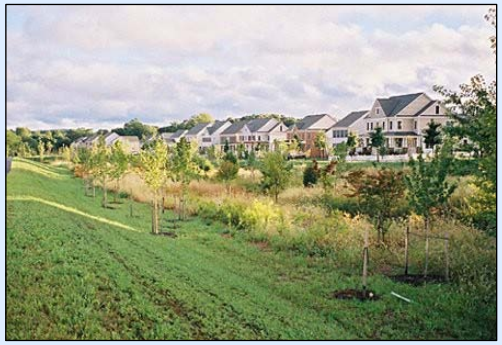
Pennsylvania Standards for Residential Site Development



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PREAMBLE

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Over the past decade, the trend in land planning has been towards design techniques that encourage a more sustainable[1], low-impact[2] form of development. These innovative planning and design techniques are intended to reduce the impact that development has on the land by minimizing impervious area, and conserving natural resources and open space. In recent years, Commonwealth agencies (PaDEP and DCED, for example) have been promoting these planning and design techniques, suggesting that their implementation will reduce infrastructure costs associated with land development. However, there is a wide gap between the desire to effect these changes and the ability of local municipal officials to efficiently implement them through revisions to local codes and ordinances.

Project Objectives:

- **To develop residential site development standards, tailored to Pennsylvania, that can be used to assist municipalities in updating their land development standards.**
- **To promote responsible and affordable development.**
- **To base standards on current science and engineering.**

Obstacles to Sustainable Residential Development

Many, if not most, residential development ordinances which exist at the time of this writing include obstacles to the implementation of sound design practices. In a 1999 study[3] , the Pennsylvania Housing Resource/ Research Center (PHRC) reviewed residential land development practices in the Commonwealth to assess local regulatory practices. The PHRC found two issues that frequently emerged in commentary on local subdivision and land development regulatory policy.

The first, noted most often by conservationists and design professionals, was the general lack of creativity in the design and development of residential land. This shortcoming was widely considered to be a result of the lack of flexibility within individual zoning and subdivision ordinances. While this inflexibility results in consistency within a municipality, it does not permit the design creativity necessary to effect sustainable development.

The second issue, raised by builders and developers, was the lack of consistency among site improvement design standards from one municipality to another. This results in awkward inconsistencies in lot size and building coverage characteristics, road widths, sidewalk locations, and other infrastructure configurations at municipal boundaries. In turn, these inconsistencies frequently result in confusion and unnecessary costs due to plan and construction changes.

Inflexibility and lack of regulatory consistency among municipalities was also identified as an issue in a report by the Governor's Center for Local Government Services published in 2001. Many of the design standards targeted in that report, titled *Reducing Land Use Barriers to Affordable Housing*, are the same as those identified in the PHRC report. Significant issues are identified as barriers to affordable housing in this report:

- Zoning standards favor conventional site design rather than creative design techniques that may reduce infrastructure costs.
- Lot dimensions, such as frontage width, front setbacks, side yard requirements, etc., can be excessive, adding unnecessarily to costs.
- Lot size and coverage are typically rigid standards that do not permit flexibility in design.
- Street widths and standards are excessive and are unrelated to expected uses and traffic.
- Stormwater management design standards are rigid and do not encourage or allow for thoughtful low-impact development concepts.
- Parking standards are often excessive and inflexible, resulting in the creation of unnecessarily large impervious areas.

It has also been observed that state regulatory policy and existing local land-use ordinances are sometimes at odds. This was evidenced in 2003 when the Commonwealth introduced a new stormwater management policy. Many of the design elements required to implement creative stormwater solutions under that policy—such as the use of permeable surface materials, reductions in road widths use of roadside swales, elimination of curbs where possible, etc.—are currently not permitted under many local subdivision ordinances.

Based on these findings ordinances there is a clear need to provide new tools and standards to assist local governments in updating their to facilitate and promote sustainable and economically responsible residential development.

The Challenge

With over 2,500 units of local government in Pennsylvania, updating residential development ordinances poses a challenge. Many municipalities do not have the professional planning or engineering staff needed to coordinate this effort. Recognizing this reality and in response to the need for regulatory improvement to promote responsible and affordable development within the Commonwealth, an effort was undertaken to create recommended standards for residential site development that could be easily understood, and efficiently implemented by municipalities. This document is the product of that effort. It is intended to assist municipalities and other stakeholders by providing a set of model standards on which to base improvements to local ordinances.

Early in the planning process for this document it was recognized that, for this document to succeed, it would need broad-based assistance from all stakeholder groups involved in the residential development process. For this reason, a stakeholder consortium was brought together to oversee and provide input to the document's development. This group included representatives from a cross section of the residential development industry including builders, developers, site contractors, local municipal officials, state agency representatives, design professionals, planners, and environmental groups. The efforts of this consortium have contributed significantly to the creation of this document.

Goal of This Document

The underlying goals of this effort are to provide site development standards that are:

- easily understood and can be efficiently implemented by municipalities;
- supported by key regulatory agencies, environmental organizations, and design professionals;
- optimize life cycle costs considering initial costs and maintenance;
- based on current engineering knowledge and science;
- embrace low-impact, sustainable development methodologies;
- reduce regulatory inconsistency that currently exists; and
- improve opportunities for non-vehicular movements for mobility, and for pedestrian health and safety.

This document includes development standards for subdivision roads, parking, trails and sidewalks, stormwater management, potable water systems, sanitary sewer systems, and grading. Guidelines for subdivision planning and zoning issues such as community character (residential vs. mixed use, etc.), lot density, open space, etc. are not included, however, Chapter 1 provides commentary on planning and site design considerations.

Application and Use

This document is presented in a recommended standards and related commentary format. The regulatory provisions of the document are located in the center of each pair of pages with commentary on the edges, in a gray box. The purpose of this format is to enhance understanding of the recommended standards by providing illustrated and written explanations that demonstrate the intent of regulations.

The document format also facilitates ease of municipal adoption and implementation. It is intended that this document be used as a tool to update municipal land development and subdivision ordinances within the Commonwealth.

Adopting the model standards set out in this document will help achieve the following:

- Create more consistency among the many municipal standards for residential subdivisions and site improvement that currently exist in Pennsylvania.
- Eliminate unnecessary construction and maintenance costs.
- Minimize impervious coverage to the extent practical, consistent with the Commonwealth's stormwater management policy.
- Provide design flexibility and promote diversity through performance-oriented site improvement standards.
- Facilitate development review by providing a solid basis for technical determinations.

It is recognized that residential development standards are not fixed for all time. Some of the model standards in this document will be affected by population trends, census data, and other factors that change with time. It

is recommended that standards adopted by municipalities be re-visited at least every five years to ensure continued appropriateness.

[1] Development which strives to balance economic and social needs and pressures with resource conservation.
[2] An approach to land development that uses various design and impact mitigation practices to conserve and protect natural resource systems while reducing infrastructure cost.
[3] Residential Site Improvement and Subdivision Design Standards: A Review, PHRC, Penn State University, July 1999.

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CHAPTER 1: SITE DESIGN CONSIDERATIONS

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The purpose of this document is to provide reassure readers what is discussed can in fact be built. One way to provide that is through profiling case studies of exemplary residential site developments that are built or in the process of being constructed in Pennsylvania. The developments included in these case study profiles are located throughout the state in either rural or more-suburan locations. Each features one or more goals for site development that are highlighted in the various chapters of this publication and help to promote environmentally and economically responsible residential development.

Site Design Considerations

1.0 INTRODUCTION

When new developments are proposed, they should be designed to create vibrant, healthy living environments befitting of their unique location. A community's land is one of its key resources and how it is used and developed is a responsibility of the community's elected officials (Ref. 1). Many issues and factors must be considered when determining a vision for a community's future. As the Preamble states, many communities in Pennsylvania fall short in determining an appropriate vision for the future and ensuring that this vision can become reality through sound land use policies.

Figure 1.0. Crawford Square
All over Pennsylvania, communities are beginning to understand the benefits of low impact development. Here townhouses front a community green at Crawford Square in Pittsburgh.

The over-riding objective of this document is the presentation of recommended engineering standards for residential site design that promote responsible, sustainable, and affordable development. These standards are presented as options, with a range of choices to satisfy given objectives. It is anticipated that most municipalities can benefit from these standards, however each must consider their own unique situation to determine how and where the standards should be adopted.

Engineering design standards, however, are only part of what is needed to facilitate the development of a healthy community. In this context "healthy" relates to a community's economic health as well as the health and well-being of its residents. To enhance a community's future health and well-being, responsible planning and zoning considerations are needed.

This chapter provides a brief overview of the factors and issues that should be considered in thinking about your community's future and how those can be addressed, including a "Top 10 Community Checklist" to assist officials and residents in making necessary changes for their community's future health and well-being. Each checklist item is discussed in more detail throughout Chapter 1. Also included throughout this chapter in the gray side-bar are a series of case study communities. These are actual, built communities in Pennsylvania that have one or more of the characteristics advocated in this document.

Site Design Considerations

Top 10 Community Checklist

☐ **1: Policies**

When were your community's Comprehensive Plan and Land Use ordinances last updated? Have you ensured that these ordinances have not been outpaced by changes in your community's goals, population, technology and/or the economy?

☐ **2: Interconnections**

Does your community have an official map that delineates where you desire to have future streets, trails, open spaces, and utilities?

☐ **3: Citizen Engagement**

Have citizens been involved when your community makes changes to its planning policies and ordinances?

☐ **4: Recreation**

Does your community have a recreation plan that clarifies what areas are to remain in permanent open space and distinguish between various recreational opportunities, such strolling parks, trails, playgrounds, gardens and/or ballfields?

☐ **5: Environment**

Does your community have a plan for the open space that respects the area's ecological functions, clarifying what is to remain in permanent open space, and encompassing environmentally sensitive lands, and natural and/or agricultural features?

☐ **6: Community Character**

Has your community defined what it feels is special about the places where you live, work and play? Have you worked to protect that elusive, but important thing called "community character"?

☐ **7: Building Placement**

Do your community's ordinances for building design and their placement on a site seek to maintain or enhance a neighborhood's character?

☐ **8: Housing**

Does your community permit different types of housing, not only as housing for those with a variety of incomes, but housing that produces distinctive places – as opposed to similar subdivisions?

☐ **9: Flexiblity**

Are your ordinances structured to provide flexiblity in how developers can achieve your community's desires?

☐ **10: Infrastructure and Maintenance Costs**

Do your community's policies consider resource and energy use in regards to construction, the development process, its products and the costs associated with each?

Pennsylvania Case Studies

SUMMERSET AT FRICK PARK

Illustration 1-a. New Community Park

Source: LaQuatra Bonci Associates, Michael Haritan

When completed, this 238-acre community will include a total of 713 housing units comprised of 336 single-family homes, 121 townhouses, and 256 apartment units. It will be built in three phases over several years.

Summerset at Frick Park embraces its unique context. It is a public/private effort that develops a former brownfield site while reclaiming, restoring, and beautifying lost park lands and critical environmental areas.

This land reuse and land reclamation project, located on a former slag heap, establishes a new mixed-use community and extends and rehabilitates an existing urban park. In redeveloping the site, almost 140 acres will be dedicated to the expansion of Pittsburgh's historic Frick Park and the creation of new neighborhood parks. A stream, watershed and the surrounding hillsides will be restored and a trail system developed to provide riverfront access.

The completed mixed land use project is highlighted

Site Design Considerations

The intent of Chapter 1 is to understand land development as a balance among community vision (what people want), environmental stewardship (respect for the environment), fiscally responsible public services (operation and maintenance of utilities and infrastructure), and economic viability (providing affordable housing consistent with employment needs) as well as promoting consideration for the integration of all elements of design to achieve a community design befitting its context.

1.1 POLICIES

√ ***When were your community's Comprehensive Plan and Land Use ordinances last updated? Have you ensured that these have not been outpaced by changes in your community's population, goals, economy and/or advances in technology?***

Figure 1.1. Site Development Plan
Requiring site development plans that clearly explain what will be preserved and what type of development will occur and where, makes it easier for everyone to better understand the proposal.(Source: PA-DCNR)

Municipalities have the right to control the look and function of land uses, and can encourage development that fits – not fights – the residents desires residents (Ref. 1). This right is established in the Pennsylvania Municipalities Planning Code (MPC) (Ref. 14, Section 105). A community's desired future can be orchestrated by sound land use ordinances, which have their foundation in the community's adopted Comprehensive Plan.

1.1.1 Comprehensive Plan

A Comprehensive Plan is a policy document that identifies the desired physical, social, economic and environmental future of a municipality based on current conditions and the citizens' vision of the next five to ten years. This document is a thorough description – in words, maps and pictures – that translates the community's vision into a plan that will maximize quality of life, describe economic opportunities, and enhance the benefits

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provided by an area's natural environment. The primary uses of the Comprehensive Plan are to:

- Keep citizens informed about the goals of the community;
- Guide public infrustructure investments;
- Provide guidance to private investors and land holders for the appropriate use of property; and
- Establish a roadmap to evaluate progress towards achieving the vision.

The Comprehensive Plan balances community desires, legal requirements affecting land use, and market forces (Ref. 1). A Comprehensive Plan will vary in complexity depending on a community's population and its desires for future growth and development. A Comprehensive Plan may also reveal the desire to partake in multi-municipal planning where adjacent municipalities have similar issues and/or where sharing information about land uses would be beneficial to several municipalities.

The most important tools for carrying out the Comprehensive Plan are the Zoning and Subdivision/Land Development Ordinances. Ensuring that these key ordinances are consistent with your community's Comprehensive Plan will encourage the type of quality development desired by the community (Ref. 1).

1.1.2 Zoning Ordinance

Zoning is rooted in powers granted to the municipality through the MPC.

According to the MPC the purpose of zoning is to (Ref. 14; Ref. 3):

- Protect the health, safety, and welfare of its citizens.
- Promote coordinated development.
- Prevent blight, congestion, loss of life and property.
- Accommodate all uses and a "fair share" of the area's regional growth.

Zoning Ordinances may not be very exciting reading. However, when one looks around their community and countryside, the things that are liked and disliked are the direct result of zoning decisions, or the lack of them. Zoning can determine if buildings and specific land uses enrich or depress our communities. Zoning can control whether parks and open spaces are effectively integrated into a residential area. Zoning can explain the community's land use wishes to developers and residents, before planning or building begins. Since any deviation from Zoning ordinances requires a trip to the Zoning Hearing Board, municipalities should consider how to accommodate and anticipate these deviations. Every site is unique and therefore "one size fits all" ordinance provisions are often not effective. Ordinances that build in flexibility make it easier for a developer to accommodate the municipality's goals. For example, allowing a percent of the housing

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by:

- High standard multi-type housing units, including EPA Energy Star certification for all homes
- Restoration and day-lighting of one of the area's last urban streams
- Restoration of the health and biological diversity of an aquatic ecosystem
- Restoration and expansion of wetlands and park lands
- New park trails and a new soccer field

During design and planning, more than 400 community meetings were held, resulting in a series of conditions that were approved by the City of Pittsburgh Planning Commission and incorporated into the final land development plan. By engaging citizens in this process, communication was enhanced and public resistance minimized.

By September 2005, 79 single-family homes had been completed and occupied, and 40 rental apartments had been completed and rented.
(Source: Urban Redevelopment Authority of Pittsburgh; 10,000 Friends of Pennsylvania)

Illustration 1-b. Single-Family Detached Homes

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FARMVIEW

Illustration 1-c. View of Farmland from Street

From the public street, everyone enjoys the permanently preserved views of the farm. A land trust manages the farmland, as highlighted in the sign.

Farmview is a single-family home community designed in a clustered development style that permanently preserves 51% of the site. The design is "density-neutral," meaning that the developer built the same number of homes, but on smaller lots. The developer and Lower Makefield Township worked together for 18 months in the 1990s to rewrite the township's zoning ordinance, resulting in the Farmland Cluster Ordinance. This new code allowed the building of homes on half-acre lots where previously only lot sizes of one acre or more were allowed. The community's design conserved 213 acres of the 418-acre site, including 145 acres of cropland and 68 acres of mature woods. While 59% of the original farmland was needed for development, 41% categorized as prime agricultural land of statewide importance was preserved in addition to nearly all of the wooded areas. By reducing the developable land area and lot width, Farmview realized savings in construction costs and promises lower, long-term public maintenance costs.

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lots (10-15%) to be exempt from setbacks enables a site's design to accommodate property anomalies such as rock outcrops, existing trees, etc., and will also help avoid "cookie cutter" development when every lot meets the exact same setbacks. Promoting flexibility in zoning ordinances can facilitate environmental conservation and might help lower development costs and possibly the eventual operations and maintenance costs that fall to the municipality.

Zoning gives municipal leaders the power to create pleasing and efficient places. It is crucial, therefore, that a community's Zoning Ordinance be thoughtfully crafted and up to date. Upon reviewing the recommended development standards included in the remainder of this document, it may likely be necessary to change your municipality's current Zoning Ordinance to reflect these standards. For example, the parking information in Chapters 2 and 4 is often discussed in Zoning Ordinances.

1.1.3 Subdivision/Land Development Ordinance

Figure 1.2. Planning Policy Relationships
All three policies -- Comprehensive Plan, Subdivision and Land Development, and Zoning -- are interrelated.

The Subdivision/Land Development Ordinance must also be current and consistent with the community's Comprehensive Plan. The Subdivision/Land Development Ordinance deals more with the specific details of a development, such as the width of streets, requirements for water and sewer lines, sidewalks, and so forth. These details are the focus of this publication, and the recommended standards provided in the following chapters have been written with the intent of assisting communities in bringing their regulations up to date with the most current engineering science, design practice and experience, and professional knowledge regarding these issues. This publication's recommended standards can serve as a solid foundation upon which a community can revise and update their ordinances.

Site Design Considerations

1.2 INTERCONNECTIONS

√ Does your community have an Official Map that delineates where you desire to have future streets, trails, open spaces, and utilities?

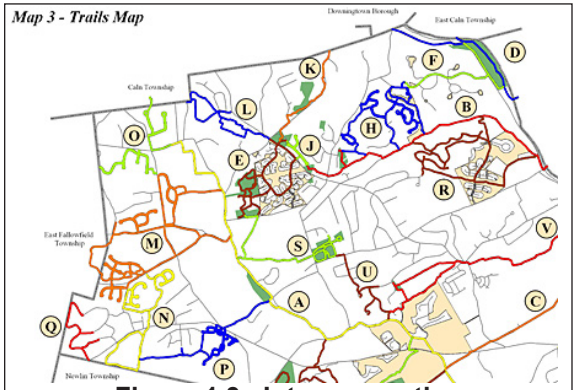

Figure 1.3. Interconnections
This map excerpt shows the extensive network of pedestrian and bicycle connections that are part of the "Greenways, Trails, and Gateways Plan for West Bradford Township." (Source: West Bradford Township, Chester County)

Many important components of communities are actually systems that function better when they are not isolated, but rather, are interconnected to form networks or functional units. Streets, trails, farmlands, sewer/ water lines, drainageways, etc., are some examples that serve their purposes more effectively if interconnections are considered. A well-delineated, hierarchical street network that considers future development and needs, for example, will serve current and future community residents' transportation needs more efficiently, ensure a safe network for emergency responders, and can be planned to avoid future congestion as a community grows. The viability of working lands is greatly enhanced when farms and farming-related businesses, such as feed supply stores, are retained as a unit and not allowed to become fragmented (Ref. 4).

1.2.1 Official Map

In Pennsylvania, a municipality can make an Official Map of all or a portion of the community to show existing and proposed public lands, roads, and facilities (Ref. 14, Article IV; Ref. 3). This is an excellent tool for implementing recommendations from the community's Comprehensive Plan. This map is intended to serve as a formal public record to indicate where the municipality is likely to require future right-of-ways, easements, and/ or land for new roads, drainageways, utilities, recreation facilities, and so on. This map enables property owners to make their future development plans with the knowledge of what the municipality has planned, and it can often reduce land acquisition costs by virtually ensuring that critical land segments will remain available for these future municipal needs and goals.

An Official Map can be used to show any or all of these types of land uses (Ref. 14; Ref. 3):

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The preserved farmland was donated by the developer to a newly created Lower Makefield Farmland Preservation Corporation, a local conservation organization composed of local farmers, township residents and an elected official liaison. The farmland is leased to farmers in the community through multi-year agreements that encourage adoption of traditional farming practices. The developer also donated 68 acres of woodland to the township to support local conservation efforts in creating an extended network of forest habitat and wildlife travel corridors.

Although many were at first skeptical of building 322 large homes (2,600–3,700 sq. ft.) on lots which were often less than a half-acre in a marketplace consisting primarily of one-acre lots, brisk sales made it the fastest selling development in its price range in the county. Its success prompted other developers to create additional conservation-based cluster subdivisions, resulting in the preservation of 500 acres of farmland in the vicinity.

Illustration 1-d. Farmview Development Plan

Modified from source: Growing Greener (Ref. 29)
Most houses have a permanent view of either farmland or mature woods.

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LANTERN HILL

Illustration 1-e. Single-Family Homes Spaced Similar to Adjacent Doylestown Setting

Source: Carter van Dyke Associates

Lantern Hill at Doylestown was developed on a previously contaminated manufacturing brownfield site. It is now a mixed-use traditional neighborhood located within the historic borough of Doylestown. It serves as an example of collaboration between developer and local municipalities to achieve responsible land planning, open space preservation, and architectural integrity while satisfying the growing demand for new residential and commercial development. The 18.5-acre site was remediated with PA DEP Land Recycling and Environmental Remediation Standards Act 2 clearance before the planned development. Lantern Hill now consists of 117 residences, and 62,400 square feet of office and retail space, pocket parks, and walking paths. As the brownfield site was already situated in a developed area, the community design could easily connect to existing infrastructure.

The residential units were designed after the traditional Victorian style of the area, including bright colors, porches, and variations in size and materi-

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- public streets, grounds, parks, watercourses, environmentally sensitive areas, and open space reservations
- pedestrian, railroad, and transit ways
- flood and stormwater areas and facilities

This Official Map approach can ensure that new developments will be connected to existing and future street extensions and designed in a coordinated manner. The Map can help establish pedestrian and biking networks that are linked to important and desirable destinations, making these community-serving uses more attractive and valuable to residents and visitors alike. A planned system of interconnecting sidewalks and trails can provide safe pedestrian routes among neighborhoods, stores, schools, and parks. This is best implemented when planned as part of a new development, although existing neighborhoods can be retrofitted to accommodate a pedestrian/ bike network. Officials and citizens should also be alert to recreational opportunities presented by abandoned rail and road right-of-ways (Ref. 1).

Official Maps can further assist in future health and safety precautions by being used to reserve resources needed to protect current and future drinking water supplies, such as recharge areas (Ref. 4). A municipality can also identity contiguous woodlands, sensitive natural resources, such as wetlands, and their connection to other important natural areas, such as flood plains and critical drainageways, which can aid in stormwater management and flood control.

Setting aside these lands can also have economic benefits. The positive impact on property values of conserved open space has been documented in numerous studies. For example, in Columbus, Ohio, property values of similar homes were up to 23% greater if they faced open space. In Boulder, Colorado, properties adjacent to greenbelts averaged 32% more in value than those located a half-mile away. In Philadelphia, a park accounted for 33% of the value of land adjacent to it (Ref. 12).

1.3 CITIZEN ENGAGEMENT

√ ***Have citizens been involved when your community makes changes to its planning policies and ordinances?***

Each community is comprised of a variety of people with multiple interests and backgrounds - teachers, parents, business owners, police, students, couples, singles, and senior citizens, to name a few. Every public decision affects these groups in different ways. While elected officials have been selected by the populace to represent their interests, community

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planning processes benefit greatly from soliciting and receiving input from a cross-section of the community. Elected officials need to take initiative and invite citizens to participate in a community's decision making. However, it is the quality of participation efforts that determines whether the citizenry will take ownership of the decisions that will affect the future quality of life in the community.

1.3.1 Community Volunteers

Figure 1.4. Citizen Engagement
Children are community stakeholders, too. Their ideas often provide a fresh look at the topic. Involving kids usually means parents get interested too –which helps build momentum.
(Source: Pennsylvania Environmental Council)

Whenever a community looks to make changes to its planning policies and ordinances, community volunteers should be engaged as much as possible to assist municipal staff, officials, and/or professional consultants (Ref. 1). This not only helps to keep costs down, but it may even help to meet the matching requirements for outside funding. Most importantly, citizen involvement strengthens the community commitment to the process and its product -- citizen "buy in" and acceptance of the results are much greater if people know that community volunteers -- their friends and neighbors -- are actively involved (Ref. 5).

It is often difficult to engage citizens in the process of planning for the future of their community. However, once they begin earnest observation of their town and realize they can make a difference, participation is forthcoming (Ref. 5). Volunteers can be engaged in a variety of ways. For example, they can help collect data, conduct interviews, or survey current housing conditions. They should also be part of gathering perceptual data, which involves learning about citizens' opinions, ideas, and desires for the future.

1.3.2 Collecting Perceptual Data

Perceptual data can be collected in many ways -- including community-wide meetings, and smaller informal discussion that are targeted towards specific issues or interest groups. Visual preference surveys can be a fun way to learn about personal opinions, which most everyone likes to express. These types of surveys can focus on key community issues and can challenge people to think anew about the basis for their preferences. Mapping is another fun way to engage community residents. This can be done at a community

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als. The mixture of housing types and costs have attracted a variety of residents to form the community. The residential units include 9 single-family detached homes, 76 townhomes, 24 back-to-back manor homes, and 8 twin homes.

Streets in the development are walkable and attractive through the use of off-street parking in rear alleys and curvilinear streets. Downtown Doylestown is a short walking distance from Lantern Hill residences, providing opportunities to walk to work. Office space on the site provides further opportunity for pedestrian commuting.

The commercial portion of the development uses design techniques such as limiting building height to three stories and use of four small buildings to maintain the same character and scale as the residential portion of the community.

Stormwater is controlled within the development through the use of planted green spaces.

Illustration 1-f. Multifamily Housing Faces Small Green with Gazebo

Source: Carter van Dyke Associates

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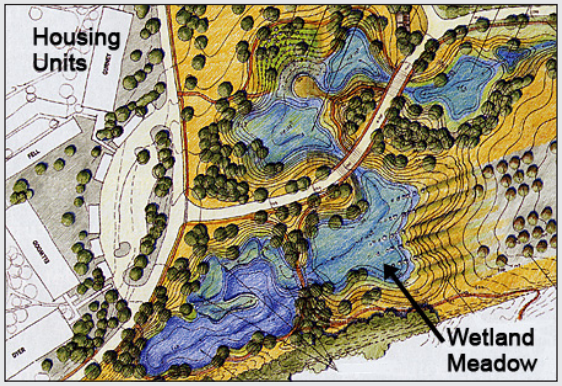
PENNSWOOD VILLAGE

Illustration 1-g. Plan View of Stormwater Management Facilities



Source: Landscape Architecture Magazine, Sept. 2006

Pennswood Village, located on 82 acres in Newtown, Bucks County, PA. The early 1980s development is a non-profit Continuing Care Retirement Community. Although not exclusively a Quaker community, Pennswood is guided by values that foster community, simple and functional environmental design, and consensus planning. The approximately 450 residents of Pennswood live in a variety of apartment styles within twelve single- or two-story buildings.

In the late 1990s, Pennswood Village sought a new plan for expansion and stormwater management. During large flood events, runoff from the adjacent Route 413 and other nearby buildings overflowed the existing retention basin and flooded the residential area of the village. Through group consensus within the community and working with a team of interdisciplinary professionals, the design achieved preservation of the historical landscape character, avoided development on former farmland, and preserved open space. An aesthetically designed system of stormwater retention now not only prevents flooding, but serves as an entrance to

Site Design Considerations

meeting or by inviting people to stop by a public place, such as a school or library, to draw or paste stickers on a map indicating what they like or dislike about the issue at hand (Ref. 1). Mapping is also an excellent way to engage senior citizens and the youth of a community. It is important to try a variety of ways to involve citizens and get an objective opinion of the community.

The final outcome of public policy making should be the result of weighing values and making judgments based on the many individuals and groups that are able to present their needs and wishes. However, municipal leaders also must be mindful of their responsibility to children, low-income residents, and others whose voices may not otherwise be heard (Ref. 1).

1.4 RECREATION

√ ***Does your community have a Recreation Plan that clarifies what areas are to remain in permanent open space and distinguish between various recreational opportunities, such strolling parks, trails, playgrounds, gardens and/or ballfields?***

Figure 1.5. Recreation
All ages and abilities find trail use to be an enjoyable outing. These people are using a rail-trail in York County. (Source: PA-DCNR)

Community open space serves many purposes, including, but not limited to, recreational opportunities, environmental and public health benefits, and increased land values. Visual and physical access to quality open space can also improve the quality of life and health of a community. A sense of community spirit and enhanced social interaction can occur through public interaction at local parks, tot lots and recreation areas (Ref. 2).

The quality and availability of recreation facilities affects the attractiveness of your community as a place to live. Studies have shown that in the last 10 years people are looking for “quality of life” amenitiesm, such as access to open space, when deciding where to live. “Knowledge workers,” today’s new economic workforce, prefer communities with a diverse range of outdoor recreation. A National Association of Realtors survey shows that 57% of home buyers would choose a house close to a park over one that was not (Ref. 8).

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1.4.1 Human Health Benefits

Parks and recreation also have human health benefits. A high percentage of Pennsylvania's population is overweight or obese. According to the PA Department of Health, 60% of adults are overweight and 24% are obese (Ref. 10). In the last ten years, 73% of Americans do not get the recommended 30 minutes of moderate physical activity on most days of the week. Making recreation facilities convenient, right in their own neighborhood, could assist residents in being more physically active. In fact, studies show that 51% of adults agree that more accessible and affordable recreation facilities would help them be more active (Ref. 10).

A community should strive to provide publicly accessible open space that is of a quality that will be valued and used by both current and future residents. Your municipality may require the dedication of land for recreation as long as several requirements are met. This includes land that is:

- Accessible to the development;
- Consistent with a recreation plan adopted by the municipality; and
- Reasonably related in both amount and location to the use anticipated by residents of the development.

Instead of land dedication, the municipality may permit a developer to make a contribution that would be combined with others to provide a larger or higher-quality recreation facility (Ref. 1).

1.5 ENVIRONMENT

√ ***Does your community have a plan for open space that respects the area's ecological functions, clarifying what is to remain in permanent open space, and encompassing environmentally sensitive lands and natural or agricultural features?***

Less developed areas contribute to an area's visual and cultural assets by providing views of forests and open fields. These areas also serve important functions related to stormwater run-off absorption, ground water recharge, and wildlife habitat. These key benefits, along with others previously mentioned, are the primary role of open spaces (Ref. 2).

For a municipality, the loss of "things that used to be there" is not just cause for nostalgia, the loss can cause real problems. For example, when the natural absorption and stormwater management functions of a mature wooded area are cleared and replaced with

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the community, provides recreational open space, and has created wetland habitat for a variety of flora and fauna. This system appears as an undulating natural meadow with wetland areas. Since the installation of this system, no runoff from the community property has impacted the adjacent creek, even in heavy storm events. The planting design serves both functional and aesthetic purposes, consisting of species native to the area.

This project now serves as an example of successful and attractive community stormwater management.

Illustration 1-h. Meadow

Source: Landscape Architecture Magazine, Sept. 2006

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PANTOPS

Illustration 1-i. Depressed Center Island

Generous open space (65%), narrow roads and vegetated stormwater facilities, such as this center island, help to make this an environmentally responsive development.

Pantops is a rural preservation community of single-family homes on 113 acres, of which 65% remain as permanent open space. The lot sizes range from 1 to 3.7 acres and are clustered in small groupings with generous open space between the groups. The developer had site plan approvals for subdividing the entire site into 2- to 5-acre lots; however, in the mid-1990s when Patton Township enacted new Rural Preservation Design Standards, the developer reworked the plans. They hired a local landscape architect to develop site design plans that respected the site's rolling topography, wildlife habitat and beautiful views. The Rural Preservation Design Standards, part of the Township's Agriculture zoning district, require that at least 50% of the tract remain in open space.

The developers were concerned about increasing growth beginning to surround their forested perimeters. They wanted to create a rural setting guaranteed to stay that way. The site plan's open

Site Design Considerations

a large impervious parking lot, flooding downstream could result. One of the most effective ways to protect important environmental features is to encourage new development to locate where existing infrastructure is available. This can be accomplished by the transfer or purchase of development rights, thereby "relocating" those development rights to an area of the municipality that has the infrastructure and capacity to handle it. Another effective way to help protect valued open spaces is to permit a certain housing yield, but then allow the houses to be situated on smaller lots, thereby resulting in the remainder of the site being preserved as permanent open space. This type of development is sometimes called "cluster" development as the development is located or "clustered" on less environmentally sensitive parts of a site. The remaining open space can be used for stormwater management, community on-lot waste water facilities, agriculture, and/or natural parklands.

Figure 1.6. Environment
New Street Ecological Park in Lititz, Lancaster County, was a public-private community partnership to restore a degraded stream. The result is a more stable natural system with improved water quality. (Source: LandStudies, Environmental Restoration and Planning)

Policies and regulations that protect open space resources are not just an ideal -- they are practical tools for conserving the functionality of the larger community landscape. Delineating and protecting these resources help you assess how the specific details of your community can have a positive effect on public health, safety, welfare and fiscal soundness -- the very functions that your municipal government is empowered to protect.

Permanently preserved open space provides economic advantages regarding real estate values. Homes adjacent to permanently preserved open space sell for more and accrue more quickly than those farther from open space (Ref. 8).

1.6 COMMUNITY CHARACTER

√ ***Has your community defined what it feels is special about the places where you live, work and play? Have you worked to protect that elusive but important thing called "community character"?***

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Certain aspects of the physical beauty and/ or setting of a community elicit pride among its residents. The character of a community or neighborhood is typically defined by the presence and quality of elements, such as architectural design and its relationship to a street, sidewalk/ bikeway design, the presence of landmark structures and public places, and the quality of landscaping and signage (Ref. 5). While the consideration of these elements are typically discussed in terms of "aesthetics," they do play a significant role in establishing the quality-of-life for a community (Ref. 6). Tourist destinations and resort communities have long understood the importance of retaining cherished community character attributes, and now many other communities are also realizing they do not want to lose that which makes their own community special. Studies have also shown that the unique character and identity of a place can serve as economic advantage as more regions complete for new companies, residents, and tourists (Ref. 15).

1.6.1 Legal Basis

Figure 1.7. Community Character
Stone Gateway Pavilion and Walls – Summerset at Frick Park community spaces reflect the character of the adjacent, historic Frick Park, Pittsburgh. (Source: LaQuatra Bonci Associates, Landscape Architects)

The old adage "beauty is in the eye of the beholder" may cause some to worry that creating policies related to protecting aesthetics are too subjective. This, however, has not proven to be the case so long as the "standards are well articulated and applicants for new construction or change are given good notice of what is required of them" (Ref. 6, p. 11). A key U.S. Supreme Court case in 1978 set the stage for courts to uphold regulations whose primary basis is aesthetics.

> …[W]e emphasize what is not in dispute…This court has recognized, in a number of settings, that states and cities may enact land-use regulations or controls to enhance the quality of life by preserving the character and the desirable aesthetic features of a city… (*Penn Central Transportation co. v. New York City*, 438 U.S. 104 (1978) at 129) (Ref. 6, p. 7).

Municipalities are increasingly inserting provisions in their zoning and subdivision/ land development codes to protect key attributes of community character (Ref. 5). These ordinances cover a variety of issues, such as tree and vegetation protection, historic structures and districts, signage controls, scenic vista protection, cell-tower controls, and site landscaping requirements. Thousands of communities nationwide

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space was designed to be contiguous with adjacent agricultural and/or natural areas to preserve wildlife corridors. The township's parkland requirement was met through the creation of bike and nature paths, which were deeded to the township. The property was developed in three phrases and is nearly built-out. Wooded lots sold in early phases for $100,000, a record high for the area. Pantops illustrates the effect of open space on property values. Those adjoining open spaces sell at higher values than properties across the street that do not.

Native plants were used for all common and open-space landscaping. The developer installed signage to designate natural areas and for homeowner education. Non-structural stormwater controls were employed, such as wetlands and bioretention areas sited in naturally-occurring drainage and retention areas. Cul de sac islands were designed with center depressions and no curbing to filter stormwater. Road widths in the first two phases were 18 feet to reduce paving costs and stormwater runoff. An on-site fire department passing/turning radius demonstration caused the township to change the minimum street widths to 20 feet for Phase 3.

Illustration 1-j. Bioretention

Naturally low portions of the site remain undeveloped to serve as bioretention areas and, as a bonus, become a scenic feature—a wildflower meadow.

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EAGLEVIEW

Illustration 1-k. Narrow Tree-lined Streets with Sidewalks

Eagleview is a mixed-use planned development of over 800 acres that when fully built out will include 825 residential units, about 3.5 million square feet of corporate office, R&D, medical, YMCA, hotel, daycare, neighborhood and regional shopping areas, restaurants, educational and recreational facilities. Eagleview will ultimately provide employment for nearly 10,000 individuals and housing for a population of over 2,000 people.

The design and planning for Eagleview strive to overcome the fragmentation typical of suburban development. It is an integrated community designed to foster an intimate, village-like atmosphere.

The residential and corporate areas are in close proximity, connected not only by roads, but also by an extensive network of footpaths, bike trails, and greenways, which also tie into a county-wide trail system. A two-acre town center with a large commons area provides the place where the residential and corporate communities meet.

Site Design Considerations

have adopted historic district or landmark preservation controls to preserve and enhance community character. This includes hundreds in Pennsylvania, both large (Philadelphia, Pittsburgh) and small (Village of Dillsworth in Birmingham Township, Chester County). For example, the Village of Dillsworth's historic preservation ordinance is used to determine the appropriateness of proposed changes within the historic district, and to convey to residents and developers what types of changes would be least harmful to the district's unique characteristics (Ref. 5).

For communities where woodlands are important contributors to community character, standards have been enacted to protect them. For example, Lower Allen Township in Cumberland County restricts the maximum amount of a site that can be cleared to 15%. The town of McCandless in Allegheny County varies the percent of woodland to be preserved based on the stand's maturity and size (Ref. 5).

Preserving community character includes not only building quality, but the enhancement of the local economy and social institutions as well as the protection of the surrounding area. Sprawling, dispersed growth in a community can drain a community's vitality while also destroying valued farmland and open spaces (Ref. 16). Balancing the amount and quality of growth adjacent to already developed areas, as well as reinforcing the character and appeal of the existing community, provide the best strategies for success (Ref. 5).

1.7 BUILDING PLACEMENT

√ Do your community's ordinances for buildings seek to maintain or enhance a neighborhood's character?

Carefully configured lots and how buildings are placement upon them can allow for the best use of land, affect the walkability of a neighborhood, and accommodate the changing needs of residents over time. How a building looks, its placement on a site and its relationship to adjacent structures and the immediate surroundings are some of the most significant influences on the character of a community, furthering the points related to community character discussed above (Ref. 7). Ordinances should allow for flexibility in how a building is designed to encourage creativity in meeting your municipality's goals.

Site Design Considerations

Figure 1.8. Buildings
For the construction of these new townhouses in Lewisburg, the designer/ developer was asked to reflect the setbacks and the characteristics of historic housing nearby.

1.7.1 Building / Site Relationship Factors

Below are four factors that should be considered related to building design:

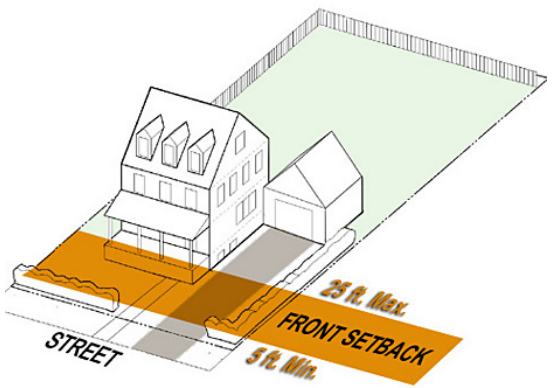

Figure 1.9. Setback
A variety of setbacks within a desired range creates visual interest along the streetscape and allows for usable yard space in the rear. Note that the garage is setback further than the front façade to provide adequate room for parking and to give the house more prominence from the street. (Modified from source: PennSCAPEs, Ref. 2)

- Setbacks – The setback is the distance a building is located from a front, side or rear property line. Unfortunately, ordinances for new structures sometimes ignore the established setback or build-to lines in the immediate area. The result can be new structures that are in stark contrast to the established community character, such as buildings set back substantial distances from the street. To provide a sense of enclosure for the street and to create, or reinforce, a pedestrian-friendly environment, a growing number of municipalities require that new buildings be sited in a manner that respects existing, traditional setback lines (Ref. 5).

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Eagleview embraces innovative planning and design techniques that incorporate the principles of Traditional Neighborhood Design and Smart Growth. In addition, advanced techniques for centralized storm water management and ground water recharge have been found to be successful.

Eagleview would not have been possible without the support and imagination of the local governments of Uwchlan and Upper Uwchlan Townships. New zoning regulations were created, tested, and revised over several years to permit new methods of planning, including provisions for small-lot, alley-served homes and the juxtaposition of a variety of uses. Likewise, cooperation and coordination with numerous environmental organizations allowed new concepts for open space preservation and environmental integrity to be incorporated in the planning.

The developer makes presentations and provides tours for visiting educational and governmental groups who wish to see how these planning principles result in a special community. (Source: The Hankin Group; 10,000 Friends of Pennsylvania)

Illustration 1-I. Extensive Open Spaces for Recreation and Preservation

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CHESTERBROOK

Illustration 1-m. Homes at Chesterbrook

Source: Wallace, Roberts, and Todd

The mixed-use community of Chesterbrook was developed on an 864-acre site in Chester County, PA. The community site is within commuting distance of downtown Philadelphia, offering urban convenience. The suburban setting also adjoins the Valley Forge National Historic Park.

The residential portion of the development plan includes 177 single-family homes, 1,238 townhomes, and 765 units in mid-rise apartments.

A total of 150 acres of the site is dedicated to a corporate center within the community hosting 1.45 million square feet of office space, nine restaurants, a 120,000 square-foot shopping center, a day-care facility, and a 250-room hotel.

357 acres, approximately 40% of the site, are dedicated to recreational open space and habitat, with 200 acres of this portion permanently dedicated to preservation. Seven miles of trails connect Ches-

Site Design Considerations

Ordinances that specify a small front yard setback can encourage more neighborly interactions, the use of porches, and increased public safety (Ref. 1). Another important consideration regarding the front setback is how much room will then be available in the rear yard. With lots becoming smaller to accommodate different lifestyles and to provide for affordable housing, it is important that the house placement maximize usable yard space. Communities might also consider setting a minimum and a maximum front setback. This provides flexibility in house location while also establishing the desired relationship of the building to the street (Ref. 2). In other instances, a code might require larger setback distances to protect scenic vistas and/or trees within the setback area. For example, three communities along the Three-Rivers Parkway in Allegheny County -- Findlay Township, Rosslyn Township and Carnegie Borough -- adopted a recommended 100-foot scenic-buffer building setback in their regulations (Ref. 5).

- Orientation -- Traditionally, the main facade of a building fronted the street and had a clearly marked or prominent entryway. Today, buildings -- both commercial and residential -- often turn their back on streets, completely altering the feel of a community. Commercial buildings are particularly notorious in this regard. Many communities now require that the primary entrance to a building face the street, to reinforce the street as a community space (Ref. 2). There are also communities that seek to enhance a setting comfortable for the pedestrian and therefore limit the placement of garage doors facing the street, or require that garages be set back farther than the front façade of the house to give the latter more prominence on the street.

- Building design -- Many contemporary codes contain standards governing the design, appearance and accessibility of new structures. A building design consideration that is growing in popularity is “visitablity,” also called inclusive home design. The goal is to ensure that a majority of new homes built include features that make the home easier for people with a mobility impairment to live in and/or visit. With an aging population it is unacceptable that most new homes being built today include barriers that can be easily avoided. Relative to a building’s relationship to the site is landform grading that allows at least one entry with no steps (Ref. 20).

  It is also possible to address building appearance by considering some basic details such as building massing, roof types and lines, materials, the height and placement of windows or the height and width of porches along a street. This not only maintains the neighborhood character but can also support property values in existing areas (Ref. 1). It should be noted that these standards must not be vague. For example, Lower Pottsgrove Township, Montgomery County’s Village District requires that new buildings be sensitive to the historic architectural context of the village. This is not to suggest prescriptive building design, but rather that new buildings respect the scale and character of existing buildings

Site Design Considerations

and the larger neighborhood context.

- Lot size -- Communities can accommodate a significant number of new housing units and businesses without destroying their essential character if that new development is consistent with the area's historic development patterns. Large lot, suburban-style development provides a stark contrast to the character of villages and towns. Because of its larger lot sizes and miles of roads, this type of development drives up the cost of housing and consumes valued open space. Smaller lots, townhouses and mixed uses of buildings help to maintain the vitality and affordability of a community. By encouraging a range of lot sizes and widths, including higher densities with smaller lots sizes, a community can enable a greater diversity of housing choices (for more about housing, see the next section, below) (Ref. 5).

1.8 HOUSING

√ ***Does your community permit different types of housing, not only as housing for those with a variety of incomes, but housing that produces distinctive places -- as opposed to similar subdivisions?***

Figure 1.10. Housing
Townhouses at the Summerset at Frick Park community are designed to fit in with their adjacent single-family detached neighbors.

Some of the liveliest communities are those that encourage a mix of land uses. Many municipalities are establishing mixed-use zoning districts that encourage and even require several uses rather than the more common separation of uses. That separation of uses is a characteristic of what is called "Euclidean zoning," which evolved from the 1926 U.S. Supreme Court decision from Euclid, Ohio. That type of land use regulation is at the heart of the dispersed suburban pattern that has been transforming our countryside for the past 40+ years (Ref. 5).

1.8.1 Mixing Uses

Most small towns have a pleasant mix of uses because they evolved and developed prior to the implementation of Euclidean zoning. Contemporary ordinances are attempting to

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terbrook with the adjacent Valley Forge National Historical Park.

The Chesterbrook development connects residents and local commuters with public transportation routes on SEPTA and connects with regional rail lines. Chesterbrook's own interchange at Route 202 connects with the nearby turnpike and express-way.

The developer held many work sessions to solicit public opinion and demonstrate the benefits of the plan for natural and fiscal environments within Tredyffrin Township.

With a strong market response and appreciating property values, this mixed-use community is a regional success.

Illustration 1-n. Open Space and Trail

Source: Wallace, Roberts, and Todd

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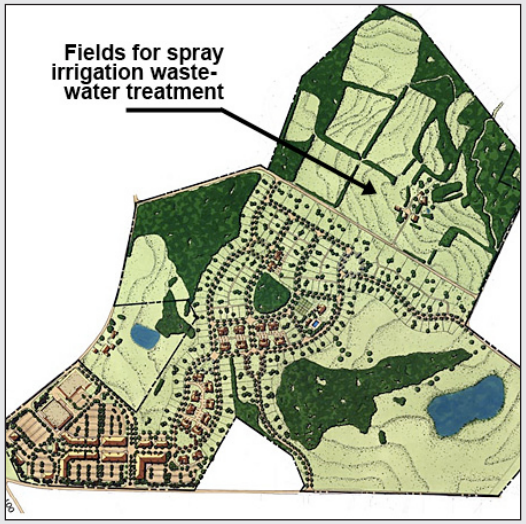
WEATHERSTONE

Illustration 1-o. Open Space Used for Wastewater Treatment



Source: Hankin Group, Ref. 30

The community of Weatherstone in West Vincent Township, Chester County, is designed as a walkable village surrounded by preserved open space. Nearly two-thirds of Weatherstone's 300 acre site is retained in recreational and permanent open space. The community design includes many small neighborhood parks, playgrounds, trails, and preserved natural areas. Much of that retained open space is used for land application wastewater treatment.

The developer constructed their own wastewater treatment plant, which includes ponds and spray irrigation applied to fields on the north portion of the site. The spray fields are planted in orchard grass and a local farmer harvests the crop three times a year to make hay. The original farmstead sits on 10 of the 300 acres. To preserve this important part of

Site Design Considerations

move away from the Euclidean-based approach of separating uses and are recognizing the benefits of mixed uses. In Pennsylvania, communities can adopt a Planned Residential Development (PRD) provision to encourage mixed use development that integrates different dwelling types with employment, commercial and civic uses. For example, Manheim Township in Lancaster County has adopted PRD regulations that allow neighborhood commercial uses within residential areas (Ref. 5). Ferguson Township, Centre County, has recently adopted a TTN (Traditional Town Neighborhood) which capitalizes on the 2000 MPC amendment that allows Traditional Neighborhood Zoning Districts (Ref. 14, Section 701-A). Ferguson Township's ordinance allows six different types of housing ranging from single-family detached and semi-detached to two-family dwellings and mixed-use buildings, where residential use is a component of the structure.

One of the reasons communities are shying away from single-use zoning is that it produces a homogeneity of housing that also means a lack of diversity within the population. If housing choices in a community do not provide for diversity of incomes, recent college graduates, fireman, teachers, elderly on fixed-incomes, and so on, will be excluded (Ref. 11). By providing the opportunity for a range of housing types in a neighborhood, your community can help to create a diverse population that can accommodate all ages and a variety of income levels. The result will be a richness in both the physical and social fabric of the neighborhood (Ref. 2). In addition, research shows that a community's overall economic performance improves when compact, mixed-use development is present. It can help to foster more diverse labor markets, vibrant community centers, and efficient transportation systems (Ref. 13).

1.9 FLEXIBILITY

√ Are your ordinances structured to provide flexiblity in how developers can achieve your community's desires?

Every piece of ground proposed for development or redevelopment is unique. Many current ordinances are quite rigid and attempt to have everything conform to a specific approach. This is not only ineffective, but it is producing problems in communities. There are many ways that municipalities can be more flexible in how they approach new development and get the results they desire. As examples, a municipality can facilitate the development process, or it can allow alternatives by providing a range of choices that can be employed to satisfy an objective, or approvals can be based on performance or outcome rather than exact prescription, or a municipality can provide incentives to encourage developer exploration of a goal.

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1.9.1 Facilitate Approval Process

Figure 1.11. Flexibility
By saving the woodland grove across the street, the developer created an amenity for these houses, saved on development costs, and did not have to plant street trees on the retained woods side of the street.

Designing and building a new residential development is expensive. The municipal approval process and meetings, professional designers' fees, etc., all take time, energy, and resources. Due to these financial obligations, most developers take the "path of least resistance" and least cost to meet municipal policies. Therefore, one of the best ways for a municipality to get what it wants is to make an ordinance that supports it be "by right." This means that if a developer meets all of the regulatory standards in their development proposal, they will not be required to present their plans at extra meetings or special hearings in order to receive development approval. Often, even "conditional use" approvals can deter a developer as the time (and therefore money) required to receive that approval is an unknown. A conditional use means that the municipality can set reasonable conditions that, if met, will allow the use to be built. Since those conditions are often unknown until the municipal approval process has started, this process makes developers less sure about the outcome.

1.9.2 Allow Alternatives

There are many instances in which a community can offer a developer alternatives, such as allowing a range of different lot sizes or a variety of residential housing types.

If tree preservation is important to your community, consider ordinances that waive or reduce other landscaping requirements if existing trees on the site are retained. In Pennsylvania there are several examples. Montgomery Township in Montgomery County has a sliding scale of credit towards supplemental planting requirements for preserving existing trees. They seek to encourage developers to meet the site's tree planting requirements through preservation of existing trees. Depending on their size, preserved trees can count for between 1-6 new trees (larger trees receive greater credit). Another example is Tinicum Township in Bucks County, which waives the planting of new street trees if trees are preserved along a new street (Ref. 5).

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the area's history, this portion of the property was sold off separately, including a deed restriction to limit future development and retain the farmstead complex.

The developed part of the property is designed with tree-lined streets to create a village setting. There are 273 single family homes and townhouses along with shops, offices a proposed grocery store, restaurants and a new branch of the Chester County Library. Much of the new construction uses stone and other materials that reflect those found in the original farmstead buildings. The site is served nearby by both bus and trail public transportation.

West Vincent Township had been considering creating a village ordinance and had begun working with the Natural Lands Trust when the developer approached them. The developer and their design team worked with the township and their consultants to write the ordinance that enabled this community to be built. The process took about five years to secure all of the approvals. Because of their unique wastewater approach, part of the time was consumed in working with soil scientists, engineers and the state Department of Environmental Protection.

One of the approaches that helped all to gain comfort with a new village ordinance was to prepare a "by-right comparison." When the process started, the existing zoning on the site allowed warehouse distribution and two-acre lot residential development. A trial development plan that looked at what could be done then, "by right", yielded a better understanding of allowed uses and housing numbers, which enabled the discussion to progress towards alternatives. (Ref. 30, June 2005 interview with Bob and Richard Hankin.)

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BRIGHTON

Illustration 1-p. Alley-access Garage

Brighton includes alleys and some garages with carriage homes above. Source: Millfield Construction (Ref. 26)

Brighton is a mixed-use community that provides a variety of residential types and densities, including single-family homes and townhomes. The community is located just 10 minutes from Lancaster on 53 acres. Construction started in 1997 and the development is now more than half built out. Manheim Township allowed Traditional Neighborhood Development (TND) as an option, as well as the possibility of increasing the community's density through the transfer of development rights (TDR).

The developer was excited about trying a development that combined these approaches. Brighton became the first community in Lancaster County to incorporate many TND features, such as alley access to rear garages, having offices or small living units (Carriage Homes) over the garage, pedestrian-oriented design such as brick sidewalks, trails, and a local elementary school and neighborhood shops within walking distance. The development also features community greens with a fountain,

Site Design Considerations

1.9.3 Perfomance-based Approvals

Chapter 2 includes discussions about sizing a street's width based on the expected traffic volume. This type of ordinance is performance-based in that the requirements are derived from how it will need to perform, rather than a one-size-fits-all approach. This flexibility in street design may "free up" money that would have gone into extra asphalt. Street widths greater than necessary to accommodate the anticipated traffic, especially for low-volume residential traffic, mean more expenditure for streets. By having a reduced road width, the developer can realize significant road construction savings. For example, a 36-foot wide road is approximately 44% more costly than a 24-foot wide street, and nearly twice as expensive as an 18-foot wide street. Reduced expenditure for road construction can benefit the community by enabling that infrastructure money to be transferred from unnecessary asphalt to desirable neighborhood amenities, such as street trees and sidewalks, without impacting the cost of the home or lot (Ref. 5).

1.9.4 Incentives

Providing bonuses is a common way to encourage flexibility in how a development is designed. For example, if the preservation of open space is important, then consider allowing a developer to build a few more units if they set aside more open space than required. For example, East Bradford Township in Chester County has an overlay district that protects a scenic river corridor. They encourage sensitive development by offering density incentives and a streamlined development-review process (Ref. 5).

Communities throughout Pennsylvania are beginning to recognize that housing for many is becoming unaffordable. Workforce housing, for those in occupations such as emergency responders, teachers, nurses, and maintenance and janitorial workers, is becoming a topic that municipalities can no longer ignore. Local firms, hospitals, etc., are having problems hiring and retaining employees due to rising housing and rental prices (Ref. 18). Often developers can be encouraged to include a percentage of workforce housing within a new development through incentives. Some approaches being used include density bonuses and fast-track permitting. Another strategy is to allow an additional small unit above a garage with rear (alley) access to easily gain an affordable housing unit (Ref. 19).

1.10 Infrastructure and Maintenance Costs

√ Do your community's policies consider resource and energy use in regard to construction, the development process, its products and the costs associated with each?

Site Design Considerations

It is well documented that communities in which development is more disbursed and disconnected have higher financial burdens due to increased costs for infrastructure and services (Ref. 13). This same principle holds true at the site-scale level. If more land is disturbed and moved, and if roadway lengths are longer, then more energy and costs will be required for both the construction process and the community's future maintenance. With increasing energy costs, an individual house's energy use requirements are also of great interest today.

By requiring more compact development and/or preserving open spaces, your municipality can decrease the energy impacts of new development as well as future maintenance costs. For example, a typical single-family development designed as a conventional 1-acre subdivision would require 9,800 linear feet of street. A PRD (Planned Residential Development) design on the same site with the same number of units (76 units on 129 acres), only at 1/2-acre lot sizes, would require only 4,130 linear feet of road. Therefore, less than half the amount of land disturbance and pavement is required for the same number of housing units (Ref. 5). As a bonus, that neighborhood could also enjoy land that is dedicated to open spaces and parks which, as previously discussed, have multiple community benefits. A development with even smaller lots or a greater variety of unit types could further reduce the energy consumption and materials required to build this development.

Natural hydrologic (surface water) systems such as floodplains, wetlands, and drainage swales provide many valuable "engineering functions" at practically no cost. It is only when the integrity of these systems is disturbed that their functions have to be replaced with expensive man-made alternatives, which cost both money and energy resources to build and maintain. For example, floodplains and wetlands, which naturally absorb storm water like a sponge, are often replaced by detention ponds that are expensive to construct, use valuable land and will require future maintenance. By requiring site designers to identify a property's existing natural systems, and integrate them into a new development's design rather than destroy them, the municipality will require less energy to be expended on the development and developers can enjoy cost savings by not having to replace those natural systems with man-made structures (Ref. 5).

The energy and expense required to remove existing trees as compared to the benefits they provide are important considerations for a community. Environmentally, trees perform a number of functions naturally during their life-span, at no cost, which provide universal benefit to everyone. For example, trees help improve the air quality by releasing oxygen and absorbing pollution. Trees also help to stabilize soil and decrease storm water runoff. Removing a mature tree and replanting a smaller tree within the now compacted soils will have a much lower capacity to slow and infiltrate stormwater. Stands of trees can

Pennsylvania Case Studies

gazebo, play areas and gardens, as well as a large meadow and a bike trail that connects to neighboring areas.

The developer hired a local landscape architecture and planning firm to prepare comparative development analyses and alternative development options. This team enjoyed a supportive township environment where the Board of Supervisors and Planning Commission participated in work sessions and provided strong guidance. They worked together for about a year in the mid-1990s and ended up with modifications to the ordinance, which is not surprising since this was the first time it was used. The township's comprehensive plan was well defined, which enabled the designers to easily explain how this development's concept fit the township's goals. Analysis showed that the economics of TDR made sense since purchasing the rights from the township's "bank" enabled the density to increase from 2.2 dwellings/ acre (allowed under Planned Residential development) to 2.95 with the purchased development rights-nearly a 30% increase.

Illustration 1-q. Townhouses Face Green Space

Brighton's townhouses face a community green and fountain. Source: Millfield Construction (Ref. 26)

MILLCREEK

Pennsylvania Case Studies

Illustration 1-r. Homes at Millcreek

Source: Charter Homes (Ref. 27).

The Millcreek neighborhood, on 87 acres in W. Lampeter Township, Lancaster County, is an example of growth with land and resource preservation. The developer sought partnerships among the builder, township, planning officials, fire and police departments, and adjacent residents to create a unique development plan. A new ordinance, the Neighborhood Design Option (NDO), was created to allow Millcreek, and future township growth, to be planned more creatively. Through collaboration, Millcreek was developed with respect for natural resources, to promote diversity among residents, and to preserve local characteristics of Lancaster County.

Millcreek includes a mix of 80 townhomes, 54 carriage homes (two homes side by side) and 103 single-family homes. The design provides a variety of housing types, styles, floorplans, and prices. Home sites are smaller at 5 to 6 single-family homes per acre on the site. This adds to the neighborhood feel and allows preservation of open space. Homes have deep front porches and garages in the rear to create an attractive and social streetscape. The

Site Design Considerations

also serve as windbreaks that help to moderate cold winter squalls and in the summer they provide shade to reduce heat build-up. It is because of the realization of these many benefits that communities are thinking ahead. Rather than incurring costs both during the development process for their removal and in the future to have mechanized or engineered structures perform the same functions as the trees, municipalities are requiring the protection of these valuable resources during the planning and design of new developments (Ref. 5).

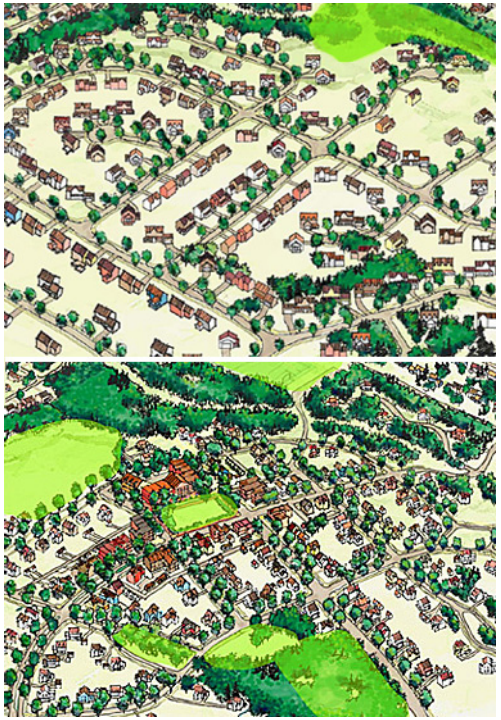

Figure 1.12. Infrastructure and Maintenance Costs
Alternative site designs show the difference between 16% open space (top) and 40% open space (bottom). Along with the benefits open space provides, the bottom design also resulted in over 2 acres less pavement needed for streets. (Source: PennSCAPEs)

Architects and developers are paying more attention to siting buildings in ways that will keep the home's energy use to a minimum. This can include buffering the building from winds and positioning the structure to receive beneficial winter sunlight and shade it from the hot summer sun. Subdivision and land development ordinances can support these approaches by recognizing siting issues like orientation to the path of the sun or positioning buildings below hilltops, rather than on top of them (Ref. 1). The U.S. Green Building Council is introducing standards for energy-efficient building for residential construction. This program is called LEED™ (Leadership in Energy and Environmental Design) and has been well received throughout the country for commercial building construction (Ref. 17). The Green Building Association of Central Pennsylvania has adopted the LEED rating system (Ref. 28). A municipality could consider asking developers to make a percentage of the development's housing meet one of the LEED levels of certification to encourage energy resourcefulness.

Site Design Considerations

1.11 CONCLUSION

Citizens and municipal officials have the power to design a community that can become what everyone envisions – they really do hold the keys to quality development. The negative impacts of development that are seen all too often can be prevented. Communities struggling with how to approach these issues can make use of this publication to get started. The remaining chapters provide guidance about updates to municipal Subdivision and Land Development ordinances.

An important first step in making changes to how your community will grow and develop is to review the "Top 10 Community Checklist" on page 1-3 and take time to thoroughly answer these questions. By assembling a group of committed citizens and municipal officials, a community can move forward by engaging residents in determining what needs to be done. A first step for this team might be to identify the key policy tools (Comprehensive Plans and Ordinances) that need to be brought up to date. They should determine what sections or elements of the regulatory tools need to be revised. The team can then put together a plan of action to complete those updates and establish what, if any, assistance they need from their County planner or others who are equipped to provide assistance, such as the Governor's Center for Local Government Services, and other groups that have municipal assistance programs.

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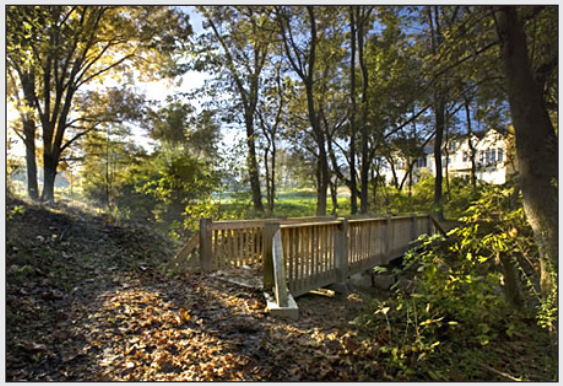
sidewalks, trails, and narrow, curbed streets at Millcreek add to its community character.

The community is adjacent to Mill Creek on a site full of woodlands, steep slopes, and open fields. The finished development allows for 31 acres of open space, including three main features: The Meadow, The Great Lawn, and The Woodlands. These were valuable, useable spaces for residents at the start of the development process and serve as aesthetic and functional preserved open spaces. 11.5 acres of the site will be donated to W. Lampeter Township for recreational access by the public.

Tree preservation was one goal of the development. Homes were built at a distance from the creek to preserve woodlands and allow vegetation to act as a filter for groundwater runoff into the creek.

An old bank barn on the site was preserved and restored to be used by the community for events. A new building, "The Farmhouse", was built on the site to host the sales office, a general store, and coffee shop.

Illustration 1-s. Millcreek Trails



Source: Charter Homes (Ref. 27)

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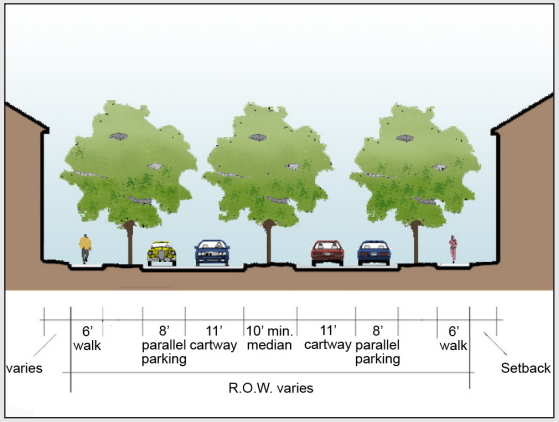
CHAPTER 2: STREET STANDARDS



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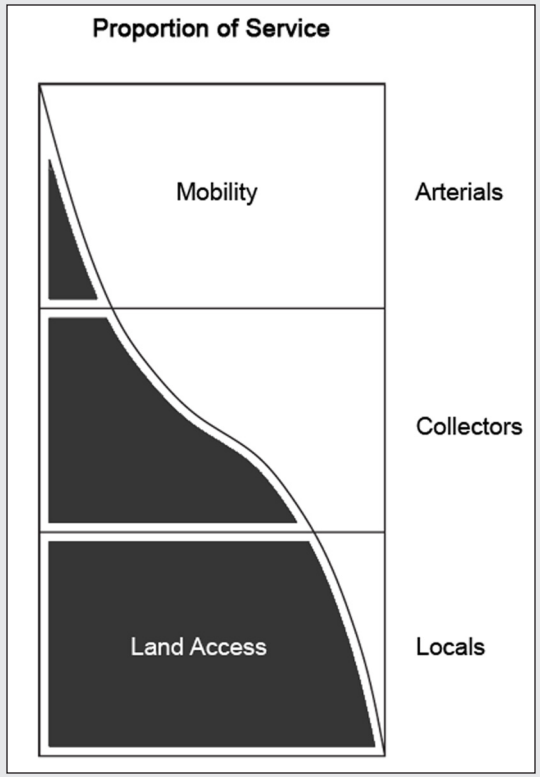


Source: AASHTO (Ref. 1)

Land access refers to entering and exiting individual properties. While this diagram refers to the importance of vehicular access over vehicular mobility, in a local street setting, individual properties are also accessed by those on foot; therefore, the pedestrian mode of access is also of importance when designing local streets.

Recommended Standards

2.0 OVERVIEW

Federal and state transportation agencies categorize streets by function into three classes: locals, collectors, and arterials. As illustrated in Illustration 2-a, this classification scheme is characterized by a continuum in function between land access and mobility. Most, if not all, subdivision streets in Pennsylvania can be classified as local or lower-end collector streets. As such, these streets are a subset of the traditional Department of Transportation classification system.

This chapter provides standards for residential streets. In the context of this document, residential street classification and standards encompass both pure residential land uses, and a mix of residential and community-serving commercial land uses. Safe residential streets are attained by specifying street geometries that discourage excessive speeds, emphasize access, and minimize conflicts between pedestrian and vehicular movements.

The recommended standards presented in this chapter assist with meeting the goal of providing safe residential streets. Recognizing the many sub-classifications possible for residential streets, the American Association of State Highway and Transportation Officials (AASHTO) recommends (as a first step in the design process) that each street be defined in terms of its specific function within the community (Ref. 1, Page 13). Section 2.2 of this chapter presents a street classification system which meets the functional requirements of municipal streets in Pennsylvania. Section 2.3 provides general street and parking design guidance, and sections 2.4 through 2.9 provide specific geometric and other design standards for each class of residential street. Section 2.10 and the Appendix contain a series of typical construction details for street design and construction.

The overriding goal of this chapter is to provide standards that not only meet the need for safe and efficient movement of vehicles and pedestrians, but also minimize environmental impacts, and construction and maintenance costs.

Recommended Standards

2.1 PURPOSE AND STRATEGY

2.1.1 Purpose

The primary purpose of residential and mixed-use streets is to provide local access to individual properties. These streets may also function as collectors to distribute traffic having an origin or destination at a residential or community-commercial / business property to a higher-level collector or arterial. Residential streets shall promote:

a. safe and efficient movement of vehicular, pedestrian and bicycle traffic;

b. cost efficiency that takes into consideration land use, construction, and future maintenance; and

c. environmental stewardship and sustainability by minimizing adverse impacts on the natural environment.

2.1.2 Strategy

The design and planning of residential and mixed-use streets shall:

a. use the functional classification system presented in Section 2.2;

b. follow the natural contours of the land and preserve natural features whenever practical;

c. minimize traffic speed and volume, noise, congestion, and hazards to pedestrians;

d. minimize the amount of paved area; and

e. provide an affordable and maintainable street system that serves the residents in the community.

2.2 FUNCTIONAL CLASSIFICATION SYSTEM

Residential streets provide a variety of functions within residential neighborhoods. Each street within a residential neighborhood shall be designed to reflect the overall purpose it is intended to serve. Proposed or existing streets shall be classified according to their function. The function of the street shall provide the basis for residential street design.

The following classification systems shall be used to identify street function.

The residential street classifications include:

Commentary

Residential streets are commonly used for purposes other than efficient traffic movement. The design of residential and mixed-use streets must consider and balance community needs, including lot access, visual aesthetics, parking, drainage, utility access, pedestrian and bicycle circulation, emergency access, and maintenance. Above all, since these are streets where epople live, creating a safe environment for pedestrians, as well as vehicle circulation, is critical.

Pursuing strategy “b” may mean departing from strict compliance with the street grade standards in sections 2.4.7, 2.5.8, 2.6.7, and 2.7.1. The intent of any such variance will be to minimize site impacts and preserve natural site features while maintaining a safe street.

Strategy “d” will minimize stormwater run-off impacts and reduce construction and maintenance costs.

The intent of strategy “e” is to promote appropriate street widths (travel-way and parking lane) to meet, but not exceed, community needs.

Different types of residential streets have different characteristics with regard to density of residences and land use. Consequently, a single design for a typical residential street is not practical. A functional classification system differentiates between the various types of residential streets in order to provide a design that best meets the needs of the community.

Commentary

The American Association of State Transportation Officials (AASTO) presents street classification as a hierarchy of movements beginning with the "main movement" defined by the highest volume streets. The functional classification system presented here is presented from a residential access perspective, moving from the lowest classification of street which provides individual lot access, to higher classifications with greater emphasis on mobility and efficiency of traffic movement.

The traffic volume limits used throughout this document are based on a measure of average daily traffic (ADT). Average Daily Traffic (ADT) is defined by AASHTO (Ref. 1) as the total volume of traffic on a street during a given time period (in whole numbers of days), greater than one day and less than one year, divided by the number of days in the time period. ADT is a count of all traffic on a street (in both directions) for the given time period. This unit of measure is consistent with the Institute of Transportation Engineers trip generation rates. Trip generation is measured as the total number of trip ends (origin or destination) measured at a particular driveway. For residential street design purposes, ADT is assumed to be based on trip generation rates (trip ends per day or trips per day [TPD]) as defined in the most current version of *The Trip Generation Handbook*, Institute of Transportation Engineers (Ref. 10).

Residential Access Streets normally serve only those residences located on that street or within the immediate neighborhood. Traffic volumes are low; therefore, a street can be designed that is not excessive and that meets the needs of the community within a reasonable footprint. Typical residential access streets are illustrated below:

Recommended Standards

- Residential access streets
- Residential Collectors
- Residential mixed-use collectors
- Special use streets (alleys, divided streets, and stub streets)

Non-residential street classifications include:

- Commercial / industrial access streets
- Municipal Collectors
- Municipal Arterials

The recommended standards provided in this chapter are provided for residential street classifications.

Streets classifications are based on average daily traffic (ADT) volume. Estimated ADT is to be based on trip generation rates in trips per day (TPD) as defined in Section 2.3.13. A trip distribution analysis will be required to determine each streets usage within a residential development to assure that appropriate design standards are met.

2.2.1 Residential Access Streets

Residential access streets provide direct access to individual residential properties abutting that street. They carry traffic that has its destination or origin on that street or from within the local neighborhood.

Recommended Standards

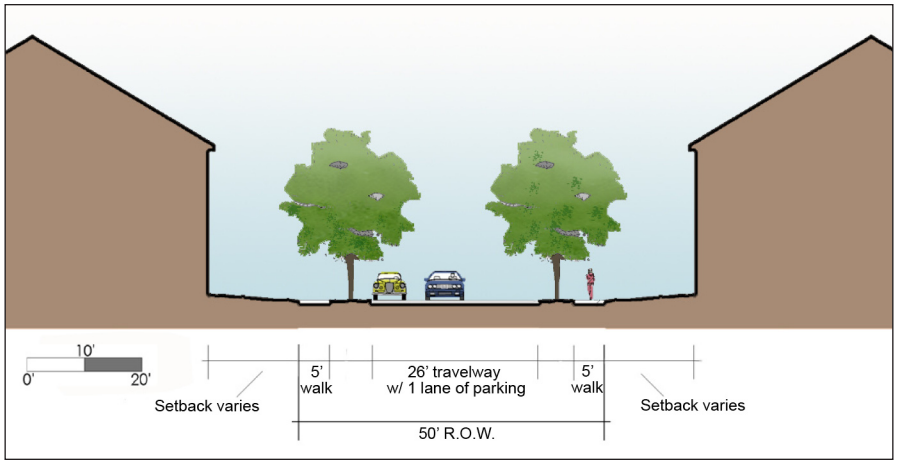


Figure 2.1. Residential Access
Modified from Source: The Hamer Center for Community Design Assistance (Ref. 2)

Residential access streets play a significant role in defining the character of neighborhoods. Residences along these streets also serve as the origin and destination for non-motorized circulation (walking or cycling). These streets should therefore be designed to be pedestrian- and bicycle-friendly (Figure 2.1).

Residential access streets offer levels of service commensurate with low design speeds and short vehicular trip routes. Through traffic is discouraged on these streets. Reflecting neighborhood character and creating a pedestrian-friendly environment is of higher importance than vehicular mobility.

2.2.1.1 Traffic Volume -- Residential Access Street

Limiting traffic volumes for each residential access street class are tabulated in Table 2-1. Traffic volumes shall be computed using trip generation rates provided in Table 2-8.

Table 2-1. Residential Access Street Limiting Traffic Volumes

Street Class	Limiting Traffic Volume (ADT)
RA-A	
Single Access	300
Multiple Access	800
RA-B	1600

Commentary

Illustration 2-b.

Eagle View Subdivision, Chester County
Source: The Hamer Center for Community Design Assistance (Ref. 2)

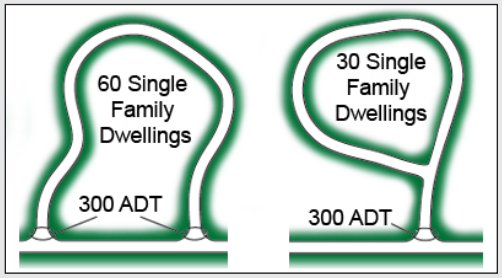
Greyhampton Subdivision, Centre County

The traffic volume limits for residential access streets are based on the standards in Residential Streets (Ref. 5). This document was developed through a partnership among the National Association of Home Builders, the American Society of Civil Engineers, the Institute of Transportation Engineers, and the Urban Land Institute. These standards are not based on specific research; rather, they represent a consensus that reflects the experience and judgment of these organizations.

Commentary

Ilustration 2-c compares a residential street with two access points with a loop street. The loop street only has one point of connection with a higher-order street. The number of single-family dwellings indicated is based on a trip generation rate of 10 trips per day, as tabulated in Table 2-8.

Illustration 2-c. Street Access Points



Modified from Source: Bucks County Planning Commission (Ref. 4)

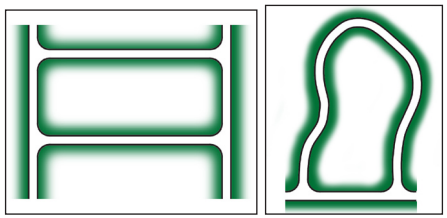
The limiting traffic volume for single access streets is based on Appendix D of the International Fire Code (Reference 19).

Limiting traffic volumes for single-access streets are based on a desire to minimize the risk of any one residence being cut-off from emergency services in the event the street is blocked, while at the same time recognizing these street types as valuable and viable development and planning options. The traffic limit for self-looping streets is 50% greater than that for cul-de-sacs because the residents in the loop can exit the loop in either direction.

Residential collectors may take a number of forms. Illustration 2-d shows a residential collector connecting development, and Illustration 2-e shows a residential collector in a more interconnected grid pattern.

Recommended Standards

Streets connected at both ends are “through streets” (Figure 2.2).

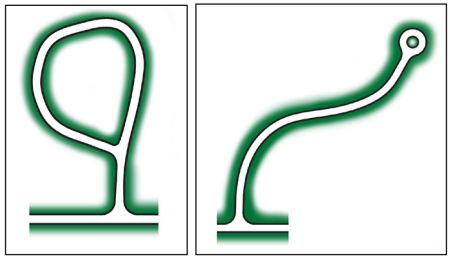


Straight Loop

Figure 2.2. Through Streets

Modified from Source: Bucks County Planning Commission (Ref. 4)

Single access streets (self-looping streets and cul-de-sacs) are a sub-classification of residential access streets that have only one access point. Self-looping streets and cul-de-sacs are limited to an average daily traffic volume (ADT) of 300 trips per day. See Figure 2.3.



Self-Looping Cul-de-sac

Figure 2.3. Single Access Streets

Modified from Source: Bucks County Planning Commission (Ref. 4)

Design standards for residential access streets are provided in Section 2.4.

2.2.2 Residential Collectors

Residential collectors provide mobility out of residential neighborhoods and serve to link residential access streets and / or entrances to multi-family residential complexes. Their primary function is to collect and distribute residential traffic to collectors and other higher-level streets. They may include some limited individual lot and driveway access although such access, is discouraged.

Recommended Standards

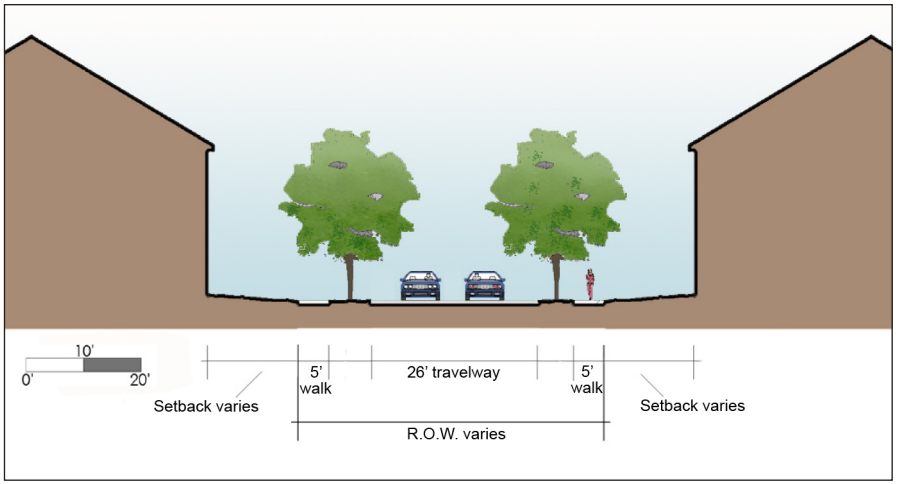


Figure 2.4. Residential Collector
Modified from Source: The Hamer Center for Community Design Assistance (Ref. 2)

Neighborhood character shall be of equal importance to vehicular mobility in the design of residential collectors. Within these corridors bicycle and pedestrian movements are secondary to vehicular movements. However, it is recommended that bicycle and pedestrian facilities be included within these corridors, and that appropriate separation and buffering be provided to avoid conflicts. See chapter 3 for more details.

Commentary

Illustration 2-d. Collector Connects Developments

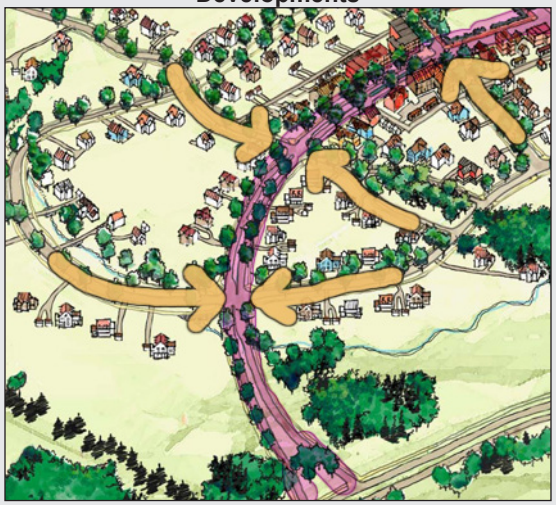
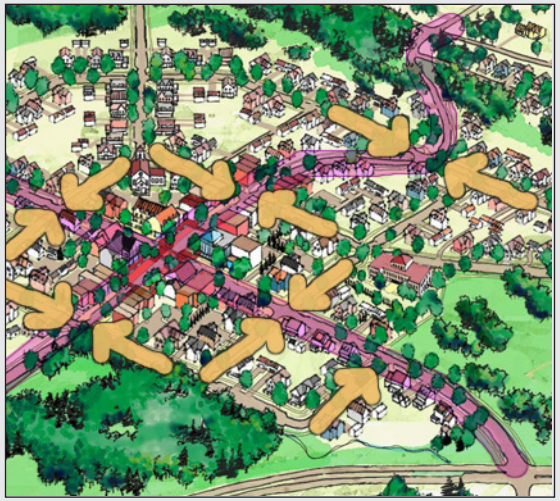


Illustration 2-e. Collector in Grid Setting



In many cases, streets functioning as collectors in developments built before the adoption of this standard were designed with continuous lot frontage and on-street parking. For this reason, lot frontage

Commentary

and parking are not restricted when defining streets existing at the time of the adoption of this standard.

Parking is restricted on residential collectors to promote mobility and minimize pedestrian conflicts. This requirement may be waived along portions of the corridor to meet special needs such as community facilities, ballfields, etc. Other than these exceptions, parking along these streets should be discouraged.

The authors are unaware of any other street classification scheme that includes a purely residential collector. Collectors are typically considered to carry traffic from multiple sources with no upper limit on traffic loading. As defined here, a residential collector is intended to be part of a residential neighborhood. The upper limit provided is based on the need to limit the size of streets within strictly residential neighborhoods for health and safety reasons. Higher traffic loads should be limited to Municipal collectors or higher-level streets.

The maximum Average Daily Trips (ADT) of 3,000 vehicle trips is established to minimize conflicts due to the number of turning movements onto and off residential collector streets.

Residential mixed-use collectors can take on distinctly different characteristics depending on the neighborhood type and development style.

Recommended Standards

2.2.2.1 Traffic Volume - Residential Collectors

Residential collectors shall be limited to an average daily traffic volume (ADT) of 3,000. If the anticipated traffic volume exceeds this value, the street shall be classified as a street of higher order and PennDOT standards shall be used.

Design standards for residential collectors are provided in section 2.5.

2.2.3 Residential Mixed-Use Collectors

Residential mixed-use collectors provide access to a mix of residential and neighborhood commercial uses. They also serve as residential collectors, and connectors between residential neighborhoods and higher-order streets. In the design of residential mixed-use collectors, reflecting neighborhood character is of equal importance to mobility.

Recommended Standards

Figure 2.5. Two Sided Parking
Modified from Source: The Hamer Center for Community Design Assistance (Ref. 2)

Residential dwellings along mixed-use collectors typically include quad houses, townhouses, or multi-family units that are accessed through off-street parking lots, alleys, or shared entry-ways. Access to driveways of individual dwelling units should be discouraged on mixed-use collectors.

On-street parking may be used for access to neighborhood commercial properties, and to accommodate spill-over parking for residential properties.

Mixed-use collectors may also serve as origin and destination nodes for pedestrians and cyclists. Pedestrian and bicycle access needs shall be accommodated along these street corridors.

2.2.3.1 Traffic Volume -- Residential Mixed-Use Collector

Residential mixed-use collectors are limited to an average traffic volume of 2,000 ADT. If the anticipated traffic volume exceeds this value, the street shall be classified as a street of higher-order, and the design shall be based on PennDOT standards.

Design standards for this street classification are provided in section 2.6.

2.2.4 Special Use Streets

Special use streets include alleys and divided streets and stub streets.

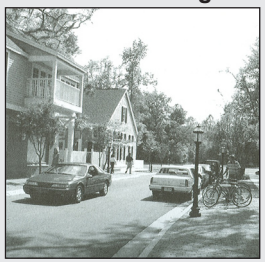
2.2.4.1 Alley: Alleys provide rear-lot access to abutting properties. To discourage through traffic and parking, they are intentionally narrow. They can provide the primary vehicular access to a property or serve as secondary access. Where appropriate, ancillary units such as garage

Commentary

Illustration 2-f.

First floor retail with offices and/or residences above.

Illustration 2-g.



Mixture of different housing types.
Source: The Hamer Center for Community Design Assistance (Ref. 2)

Uses along residential / mixed-use collectors serve as origins and destinations not only for vehicles, but also for pedestrians and bicycles. The maximum average daily traffic volume of 2,000 vehicle trips recognizes the collector characteristics of these streets, and also the need to minimize conflicts among pedestrians, bicycles, and vehicles.

As a primary vehicular access, alleys enable properties to have an unencumbered public front facing

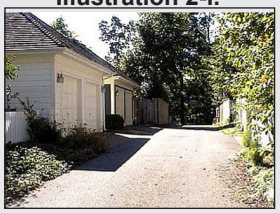
Commentary

the street by eliminating the need for driveways. Alleys were used frequently in older villages in Pennsylvania, as shown here at the left below.

Illustration 2-h.

Alley in a historic village (Boalsburg, PA) Source: The Hamer Center for Community Design Assistance (Ref. 2)

Illustration 2-i.



Alley in newer development (Kentlands, MD) Source: The Hamer Center for Community Design Assistance (Ref. 2)

The use of alleys can create an ordered, pedestrian-scaled front to a property by permitting service and maintenance functions in less visible locations. Modern use of alleys is illustrated above, right.

Divided streets are used to create community character and provide esthetic value. They can also be used to split traffic around and preserve existing significant natural features.

Illustration 2-j.

Typical Parkway

Illustration 2-k.

Typical Boulevard

Source: The Hamer Center for Community Design Assistance (Ref. 2)

Recommended Standards

convertions and in-law units face directly onto an alley.

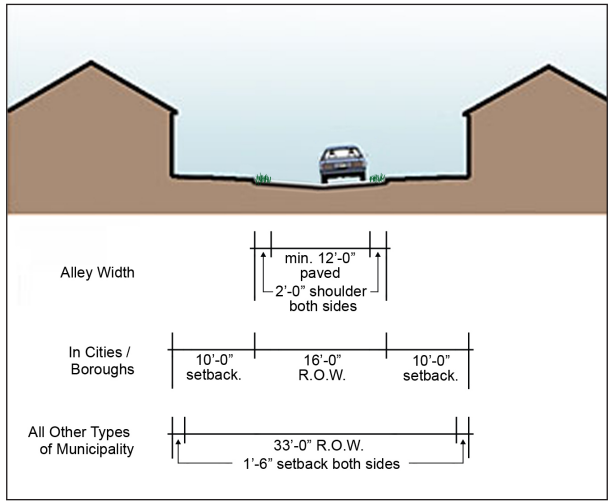


Figure 2.6. Alley Widths
Modified from Source: The Hamer Center for Community Design Assistance (Ref. 2)

2.2.4.2 Divided Streets: Divided streets are residential collectors or residential mixed-use collectors with a planted or natural median that separates opposing traffic lanes.

There is no limiting traffic volume for divided streets. However, if the average traffic volume exceeds 3,000 ADT, the street horizontal and vertical geometry shall be designed based on PennDOT standards for collector streets.

Recommended Standards

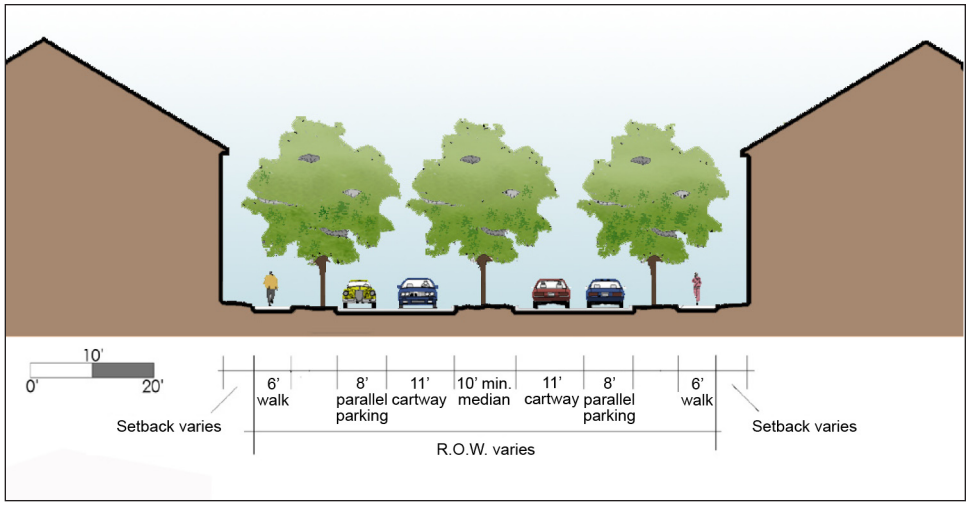


Figure 2.7. Boulevard with Parking
Source: The Hamer Center for Community Design Assistance (Ref. 2)

a. *Parkway* – A divided street with no parking, often uncurbed, with limited or no direct lot access. Parkways are typically more rural in nature, and median width may vary along its length to accommodate natural features.

b. *Boulevard* - A divided street, often curbed, where parking is permitted along its length at designated locations, or secondary access streets that run parallel to boulevard cartway. Some direct lot access is permitted. Boulevards are typically more urban in nature.

2.2.4.3 Stub Streets: A stub street is a portion of a street constructed as a part of a development or development phase that is to be extended when the adjacent property is developed. Stub streets are permitted in the following cases:

a. *Residential access, collector, and residential mixed-use collector streets* may be constructed as stub streets within subsections of a phased development for which the proposed street extension has been approved as part of the development masterplan.

b. *Residential collector and mixed-use collector streets* may also be constructed as stub streets to adjoining properties not included in the development plan if the future extension of the street is anticipated or planned.

Commentary

The creation of stub streets provides an opportunity for interconnection of neighborhoods which has many advantages. It provides more direct routes between local destinations and eliminates the need to funnel traffic of local origin and destination onto higher-volume streets; encourages pedestrian and bicycle travel to local destinations; and provides efficiency in school bus routing, transit services, emergency access, and municipal services of all kinds. In addition, interconnectivity of neighborhoods encourages development of community commercial uses within neighborhoods and promotes

Commentary

more of a community or small-town atmosphere.

Many municipalities own and maintain non-residential streets. Non-residential street definitions are provided here for the sake of clarity. However, design standards for these street types are not provided in this document.

These streets typically serve the lots in industrial or business parks.

Existing streets should be classified based on function and traffic volume. Existing streets do not need to meet design standards for the particular classification of streets outlined here.

Traffic patterns are used to control traffic movement and speed. Slow and yield-flow patterns are used along residential access streets to minimize traffic speed and pedestrian-vehicle conflicts.

Recommended Standards

2.2.5 Non-Residential Streets

Streets that do not provide access to residential or community-serving commercial properties.

2.2.5.1 Commercial / Industrial Access Streets: Commercial / industrial access streets provide direct access to commercial / industrial properties abutting that street. They carry traffic that is commercial in nature, and has its destination or origin on that street or from within the local industrial / commercial area.

2.2.5.2 Municipal Collector: Municipal collector streets function primarily to provide mobility between communities and business centers; they link important traffic generators within the municipality. They also provide land access for strip business and commercial centers and provide direct links to higher-order, state-owned streets.

Municipal collector streets should be designed in accordance with standards for PennDOT collector and arterial streets.

2.2.6 Existing Streets

Each existing street abutting or affecting the design of a subdivision or land development shall be classified according to its function, design, and use by the municipality at the request of the applicant, or during plan review. The classification of existing streets shall take into account the hierarchy outlined in this section, and may also include higher orders as determined by the municipality.

2.3 GENERAL DESIGN STANDARDS

2.3.1 Traffic Patterns

The street standards presented here are shown in the traffic flow patterns illustrated in Figure 2.8, and described below:

Recommended Standards

Free-flow: Free-flow traffic requires a unique lane for traffic moving in each direction. Free-flow streets shall have a marked center line.

Slow-flow: Slow-flow traffic occurs when parked vehicles and / or constricted lane widths restrict the passing space available to vehicles moving in opposite directions. Slow-flow streets shall not have a marked centerline except in the vicinity of intersections.

Yield-flow: Yield-flow occurs when two-way traffic is impossible when parked vehicles are present. Yield-flow streets should not have a marked centerline except in the vicinity of intersections.

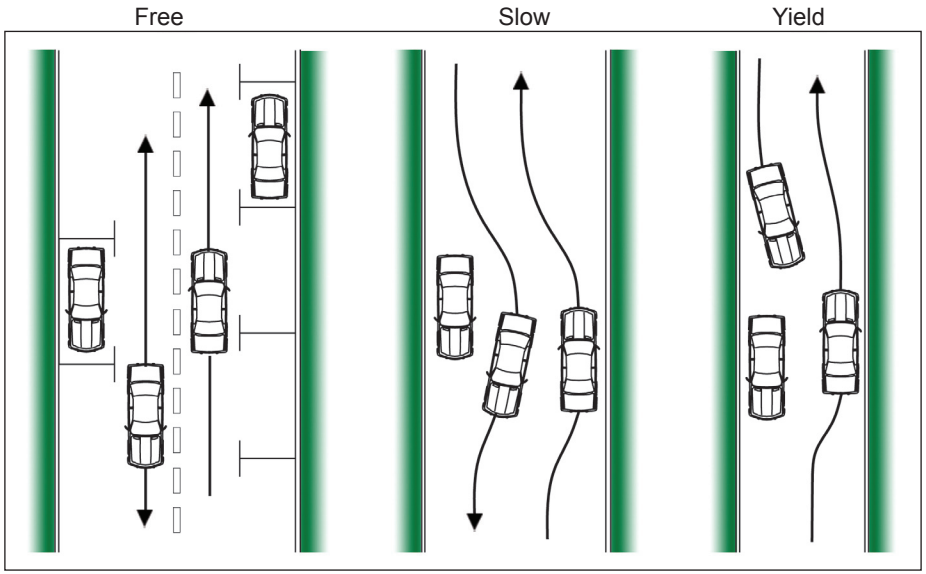


Figure 2.8. Types of Traffic Flow.
Modified from Source: National Association of Homebuilders et al., *Residential Streets* (Ref. 5)

2.3.2 On-Street Parking

Angled or parallel on-street parking may be used to meet all or a part of the parking requirement defined in chapter 4. On-street parking can serve to slow the adjacent travelway-lane traffic as well as to provide a buffer between street traffic and pedestrians.

Angled on-street parking shall be designed in accordance with the dimensions in Table 2-2.

Commentary

In a free-flow traffic pattern, each lane is only used to facilitate traffic movement.

In a slow-flow pattern, lanes are wide enough to accommodate two-way traffic but are narrow enough that if there is a parked car along the side of the street, some drivers will choose to stop and yield the right-of-way to the oncoming driver.

In a yield-flow pattern, some motorists must stop and yield the right-of-way to oncoming vehicles. For decades prior to the 1960s, yield flow was the widely accepted norm for local streets. Yield operation continues to be explicitly endorsed in the AASHTO Greenbook (Ref. 1), which acknowledges the condition of “one unobstructed moving lane where opposing conflicting traffic will yield and pause on the parking lane until there is sufficient width to pass.“ However, yield traffic patterns raise safety concerns (pedestrian and vehicular), and may delay emergency responses. Special consideration should be given to adequate site distance. For these reasons, yield traffic flow patterns should only be considered for low-volume Residential Access Streets as specified in Section 2.4.2.

In high-density residential and mixed-use residential areas, on-street parking can be used to create an effective barrier between streets and sidewalks. Also, in many instances on-street parking creates less impervious area than off-street parking which must include additional travel and access isles.

Commentary

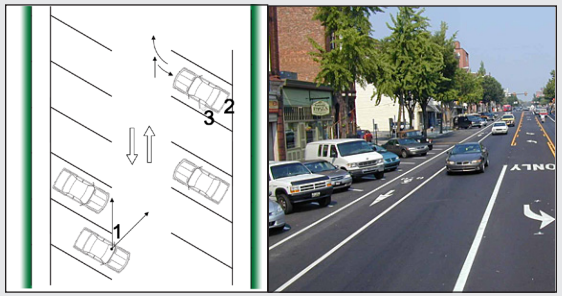
Although angled on-street parking is permitted, it's use is only recommended where traffic volume and speed are sufficiently low to not pose significant risk of an accident when vehicles back into the travel lane.

Many communities are requiring back-in only angled parking to enhance safety. All parking requires a backing movement, either as the vehicle is parked or when the vehicle leaves the space. Backing into a defined, empty parking space is safer than edging out into a travel lane where the view is obstructed by adjacent parked vehicles. Doing the backing movement as the vehicle pulls in, rather than as it pulls out has several advantages: 1) when exiting, the driver can more easily see the traffic flow without pulling into the travel lane, 2) loading/ unloading at the rear (trunk) happens at the safety of the sidewalk, rather than out in the travel lane, and 3) the open door directs people (children) easily to the sidewalk, rather than the need to step back near or in the travel lane to close the door and then walk to the sidewalk. See Illustration 2-1.a, below.

Angled on-street parking dimensions are based on the values reported in angled off-street parking with additional parking space width and length for pedestrian safety.

Illustration 2-l. Back-in Only Angled Parking

a. **b.**



High Street, Pottstown, PA Source: Tom Hylton

Recommended Standards

Table 2-2. On-Street Angled Parking Dimensions

Stall Angle (degrees)	**S*** Stall Width (ft)	**C*** Stall Length (ft)	**D*** Stall Depth (ft)	**O*** Front Over-hang (ft)	**A*** Minimum Lane Width (ft)
45	10	14.1	20	2.1	12 / 14**

* See Figure 2-9 for definition.

** 12-foot width applies to two-way traffic; 14-foot width applies to one-way traffic (Boulevard, for example).

Modified from Source: Stover, V.G., and F.J. Koepke (Ref. 6, 1988 Edition)

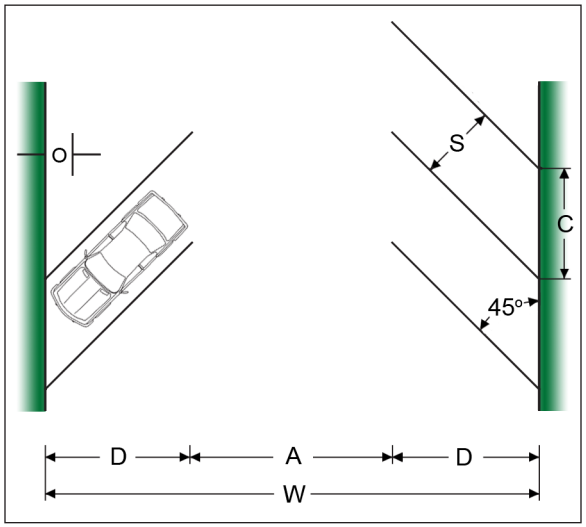


Figure 2.9. Parking Adjacent to Street

Where curb overhang is allowed, the stall depth (D) may be reduced by the front overhang (O). If a sidewalk exists at the curb, the combined width of the curb and sidewalk shall be sufficient to permit a 3-foot unobscured walkway width (i.e., the minimum width of sidewalk plus curb shall be 3 feet plus the dimension "O").

Parallel on-street parking spaces shall be 23 feet long. The parking lane width shall be as specified in Tables 2-9, 2-10, 2-14, and 2-16.

Recommended Standards

2.3.3 Intersections

Design standards for the intersection of residential streets follow:

2.3.3.1 Intersection Horizontal Alignment: Streets should intersect each other at 90-degree angles. Where this is not possible, a 50-foot section of the lower-order street (or street with lower traffic volume) should be angled to meet the higher volume street at a 90-degree angle (Figure 2.6).

Commentary

The length of on-street parking is based on the length necessary to parallel-park a standard or mid-sized automobile. Many communities are adding painted-striping to guide drivers into a specific spot along the parking lane. The stripes between the spaces help to decrease the time needed to pull into and out of a parallel space because maneuvering room has been set aside.

Illustration 2-m. Striped Spaces for Parallel Parking

College Ave., State College, PA

Intersections are points of conflict and potential hazard. The readily obvious assignment of right-of-way that is inherent to three-way intersections, together with substantially fewer conflict points, makes the three-way intersection much safer than a four-way intersection.

Right-angle intersections are the most comfortable for drivers, and provide the most direct view of approaching traffic.

If local site conditions require an acute-angled intersection, and preclude bending the angled street, the municipal authority can consider waiving this requirement. Suggested maximum intersection angles are provided in Table 2-2. Note that adequate sight distance must be provided for all

Commentary

intersections.

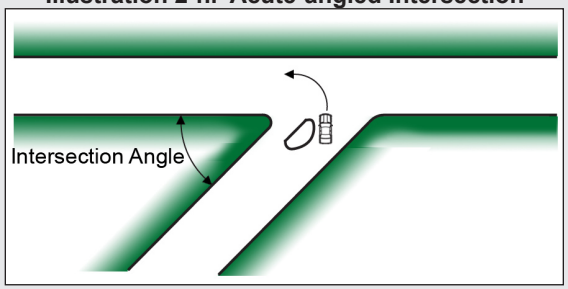
Table 2-3. Intersection Alignment Angle

Intersection Type	Minimum Intersection Angle *
Arterial - Residential Collector	≥ 80 0
Collector - Collector	≥ 70 0
Collector - Residential Access	≥ 70 0

* See Figure 2.10 for angle alignment
Source: Stover, V.G., and F.J. Koepke (Ref. 6)

Another method of compensating for a badly angled intersection is to install an island that separates traffic and channels the left-turn traffic (see Illustration 2-k). These islands must be designed to accommodate the occasional truck or large emergency vehicle. Appropriate radii must be provided. In cases where appropriate radii cannot be met, the islands should be designed to be mountable.

Illustration 2-n. Acute-angled Intersection



Modified from Source: National Association of Homebuilders et al., *Residential Streets* (Ref. 5)

Intersections should be spaced far enough apart to not interfere with each other and restrict egress capacity. Reference 6 (chapter 6) provides a detailed analysis of the factors affecting intersection and access drive spacing. Since the spacing required to minimize egress conflicts is dependent

Recommended Standards

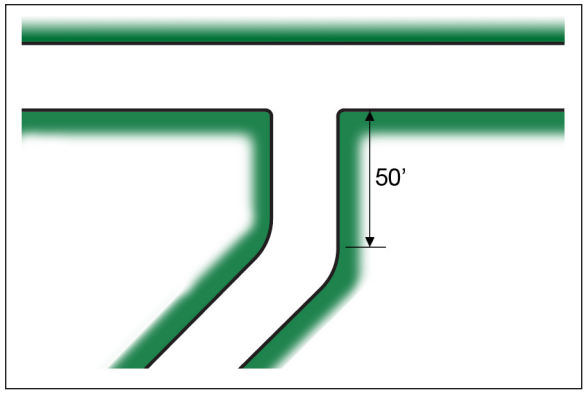


Figure 2.10. Realignment of an Angled Street
Modified from Source: National Association of Homebuilders et al., *Residential Streets* (Ref. 5)

2.3.3.2 Intersection Spacing: The spacing of streets or other driveway access locations along a particular street shall be as indicated in Table 2-5. Residential driveways as defined in section 2.3.4.1 are exempt from this standard except for corner lots on or adjacent to a residential collector or residential/mixed use collector street. These residential driveways must meet the intersection spacing standards in Table 2-5.

Recommended Standards

Table 2-4. Intersection Spacing

Through-Street Classification	Intersection Spacing "S" (Edge of pavement or curb corner to corner spacing; see Figure 2-5)
Residential Access	125 feet
Residential Collector	175 feet
Residential/Mixed-Use Collector	250 feet
Higher-Order Non-Residential Street	> 325 feet *

* To be determined by municipality or PennDOT based on traffic characteristics of the higher-order street. PennDOT standards for signalized intersections require a 500-foot separation between adjacent intersections.

Modified from Source: Stover, V.G., and F.J. Koepke (Ref. 6)

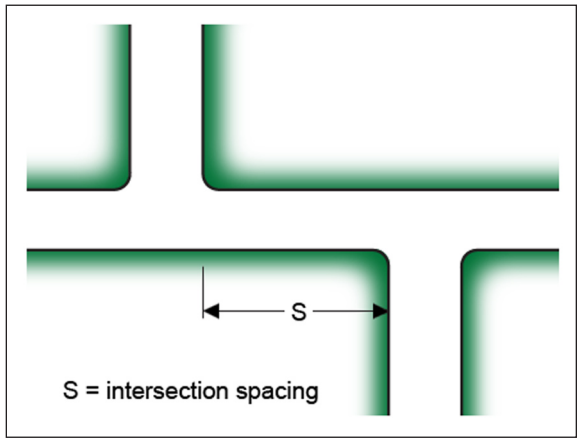


Figure 2.11. Intersection Spacing

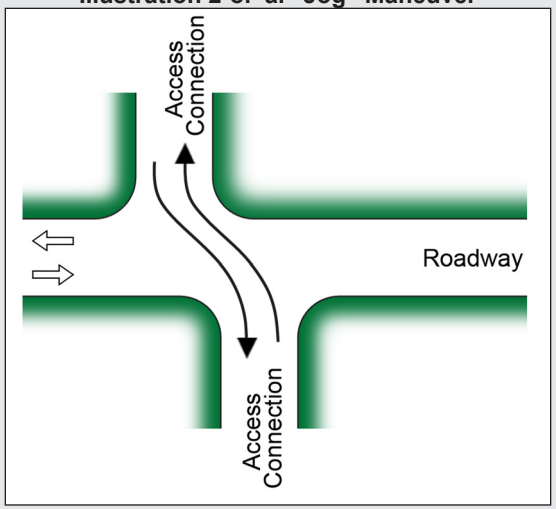
Modified from Source: National Association of Homebuilders et al., *Residential Streets* (Ref. 5)

Commentary

on traffic volumes, trip directions, and turning movements, it is difficult to develop recommended standards for intersection spacing. The intersection spacing guidelines identified in Table 2-3 are based on considerations presented in Reference 6 and simplified recommendations suggested in Reference 5. These recommendations are also intended to minimize traffic conflicts resulting from "jogging" or "corner-cutting". Drivers make a "jog" movement when intersections on opposite sides of the street are too closely spaced (Figure 2-o a).

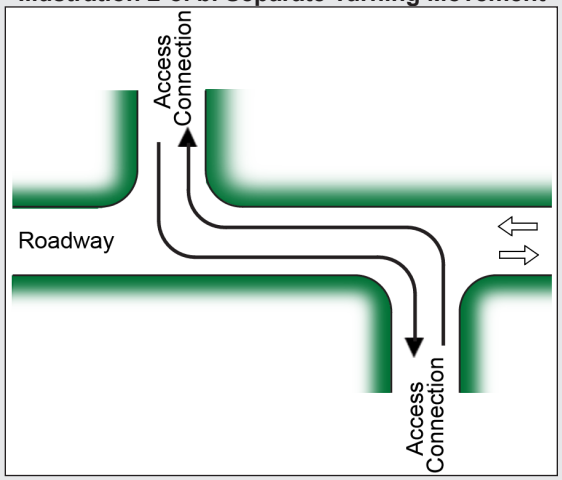
Table 2-4 specifies intersection spacing "S", where "S" is the edge of pavement or curb-line corner to corner distance between intersecting streets as illustrated in Figure 2-11. These standards apply to cross intersections as well as off-set intersections.

Illustration 2-o. a. "Jog" Maneuver



Commentary

Illustration 2-o. b. Separate Turning Movement



Modified from Source: National Association of Homebuilders, et al., *Residential Streets* (Ref. 5)

Intersection spacing requirements are dependent on traffic volumes, trip directions, and frequency of turning movements. It is recommended that intersections be aligned wherever possible.

Curb/edge-of-pavement radii is the radius of the circle joining the intersecting street edges. As this radius increases, the paving cost and pedestrian crossing distances for the intersection increase, dangerous incomplete stops become more frequent, and drivers make turns at higher speeds. However, if this radius is inadequate, traffic conflicts can arise, and vehicles might drive over curbs or rut shoulders and the adjacent landscape (Ref. 5).

The curb radii in Table 2-5 were determined through a detailed analysis of vehicle-turning movements. This analysis was based on the following assumptions and conditions:

- A single-unit truck (SU), as defined in Reference 1, was used at all intersections to define curb radii. Typical trash collection

Recommended Standards

2.3.3.3 Intersection Curb/ Edge Pavement Radii: Minimum required intersection curb/edge-of-pavement corner radii are given in Table 2-5.

Table 2-5. Minimum Required Curb/ Edge Pavement Radii -- Without Bulbouts

Intersection Type	Connecting Street Paved Widths	Minimum Curb Radii (ft)
Residential Access to Residential Access		
Curbed (see note 1)	18/20-ft connecting to 18/20-ft	20
	18/20 ft connecting to 26/28 ft	15
	26/28 ft connecting to 26/28 ft	15
Uncurbed	18/20 ft connecting to 18/20 ft	40
	18/20 ft connecting to 18/20 ft with intersection curbing (see note 2)	20

Recommended Standards

Residential Access to Residential Collector Curbed Uncurbed	18/20 ft (RA) connecting to 26 ft (RC) 26/28 ft (RA) connecting to 26 ft (RC) 18/20 ft (RA) connecting to 24 ft (RC) 18/20 ft (RA) connecting to 24 ft (RC) with intersection curbing (see note 2)	25 20 40 25
Residential Collector to Residential Collector Curbed (see note 3) Uncurbed	26 ft connecting to 26 ft 24 ft connecting to 24 ft 24 ft connecting to 24 ft with intersection curbing (see note 2)	20 40 25
Residential Access to Residential Mixed-Use Collector (Curbed)	18/20 ft (RA) connecting to 38 ft (RMC) 26/28 ft (RA) connecting to 38 ft (RMC) 18/20 ft (RA) connecting to 22/30 ft (RMC) 26/28 ft (RA) connecting to 22/30 ft (RMC)	15 10 25 15
Residential Collector to Residential Mixed-Use Collector -- Curbed	26 ft (RC) connecting to 38 ft (RMC) 26 ft (RC) connecting to 22/30ft (RMC) (see note 4)	20 40
Residential Mixed-Use Collector to Residential Mixed-Use Collector -- Curbed (see note 5)	38 ft (RMC) connecting to 38 ft (RMC) 38 ft (RMC) connecting to 30 ft (RMC) 22/30 (RMC) connecting to 22/30 ft (RMC)	10 20 20

Notes:

1. To permit access to the full pavement width by the WB-50 design vehicle, parking shall be restricted within 50 feet of the intersection measured along the curb-line.
2. The use of curbing at the intersection of uncurbed streets is intended to keep the wheel path of turning vehicles on the pavement surface. Figure 2-12 illustrates intersection curb placement along otherwise uncurbed streets.
3. Requires design vehicle to occupy approximately 10% of opposing lane. This can be avoided by using a 25-foot curb radius.
4. The curb radius may be reduced to 25 feet if it is acceptable to allow the SU design vehicle to occupy up to 50% of the opposing lane of traffic to make the turning

Commentary

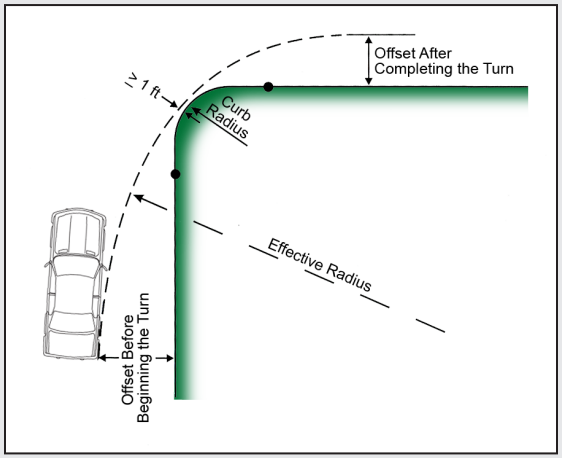
vehicles, service vehicles, emergency service vehicles, and school busses (conventional and large) have turning radii similar to, but slightly shorter than, the SU design vehicle. It was assumed that the SU vehicle could use both lanes of a residential access roadway to negotiate turns, but on other street types it would be restricted to the lane defining its directional movement.

- The SU design vehicle coupled with its stated turning path lane restrictions defined the limiting turning radius at all intersections. An Intermediate Semitrailer (WB-50), as defined in Reference 1, was used to further define curb radii at all intersections where commercial deliveries would need access. It was assumed that the WB-50 design vehicle would use the full width of the street on both legs of the intersection to negotiate a turn. Some communities restrict delivery times to early morning, when traffic is lighter, to reduce the possibilities of traffic conflicts with the WB-50 vehicles.

When street widths accommodate on-street parking, the beginning and end of the turn is off-set from the curb by a distance equal to the parking lane width (see Illustration 2-p), making the available effective turning radius much larger than the curb radius.

Commentary

Illustration 2-p. Effective Turning Radius at Residential Intersections



Modified from Source: Stover, V.G., and F.J. Koepke (Ref. 6)

Bulb-outs may be used in conjunction with on-street parking to provide a shorter crossing distance for pedestrians, and produce a "choker" that helps reduce vehicle speed (see section 2.3.8.1). When used in residential areas (see Illustration 2-n), they may also reduce impervious area.

Illustration 2-q. Illustration of Bulb-out

Source: Stover, V.G., and F.J. Koepke (Ref. 6)

Recommended Standards

movement. If vehicles similar in size to the SU design vehicle will use the intersection infrequently, it may be desirable to reduce the curb radii to reduce impervious area and pedestrian crossing distance at the intersection. It is noted that the pedestrian crossing distance would be reduced by 24 feet if the corner radii are reduced from 40- to 25 feet (Ref. 21).

5. To permit access to the full pavement width by the WB-50 design vehicle, parking shall be restricted within 40 feet of the intersection as measured along the curb-line.

The minimum intersection curb / edge-of-pavement radii identified in Table 2-5 are based on the street widths indicated. If wider streets are specified, smaller intersection curb / edge-of-pavement radii may be appropriate. Any reduction in the specified radii must be supported by documentation specifying an appropriate design vehicle and demonstrating that the vehicles corresponding turning movements can be adequately accommodated by the proposed curb / edge-of-pavement radii.

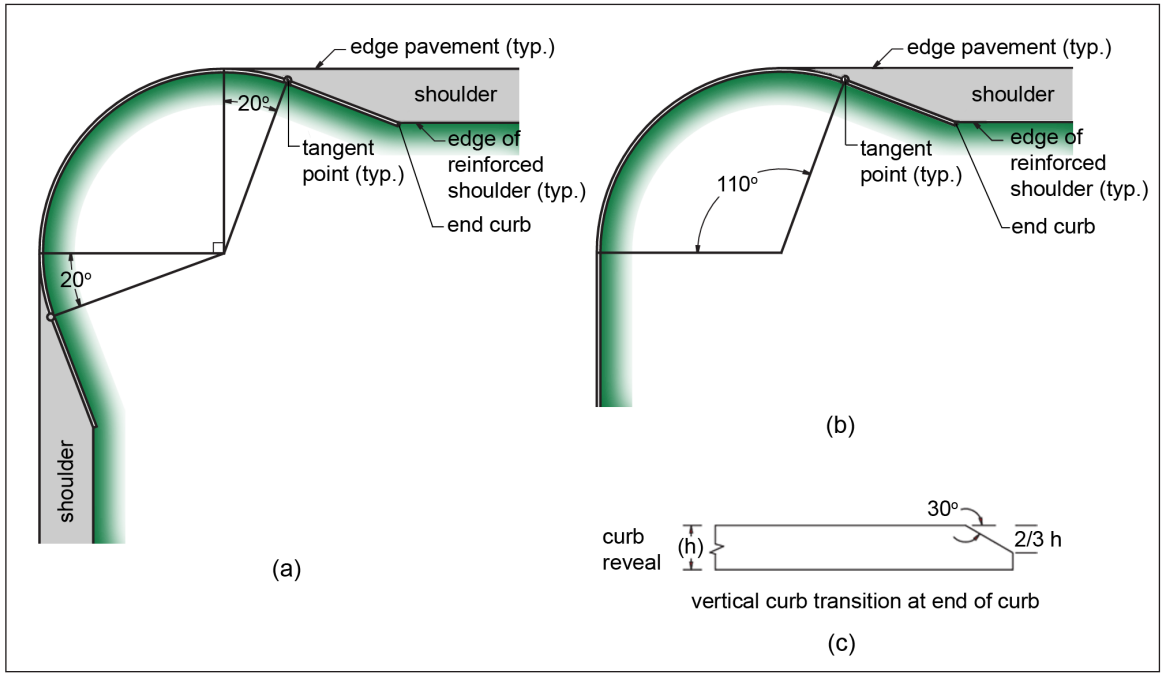


Figure 2.12. Intersection Curb Transition

(a) Uncurbed street to uncurbed street, (b) curbed street to uncurbed street, (c) End curb transition
Modified from Source: Stover, V.G., and F.J. Koepke (Ref. 6)

Recommended Standards

When a municipal street intersects State right-of-way, PennDOT standards for curb and edge of pavement radii apply.

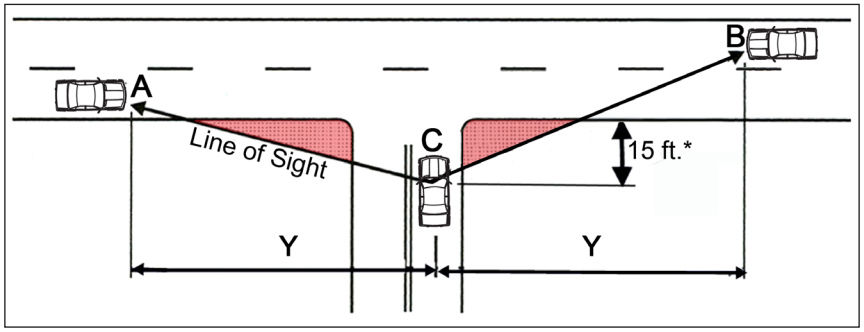
When a curbed street intersects with an uncurbed street, provide a curb transition as illustrated in Figure 2.12.

When bulb-outs (Section 2.3.8.1) are used at intersections, the resulting effective street width at the bulb-out shall be used to determine an appropriate curb radii. If bulb-outs are designed to be mountable, the full street width may be used.

When a municipal street intersects a State right-of-way, PennDOT standards for curb / edge-of-pavement radii shall apply.

2.3.3.4 Intersection Sight Distance: Whenever a proposed street intersects an existing or proposed street of higher-order or traffic volume, the street of lower-order or traffic volume shall be made a stop street. The street of lower order or traffic volume shall also be designed to provide a minimum clear line-of-sight as defined in Figure 2.13 and Table 2-6.

The clear sight triangle is defined by a line of sight from the position of the eye of the driver (3.5 feet above the street surface) in the stopped vehicle, to the position of an oncoming vehicle in either lane approaching the intersection. The elevation of the sight-line at the approaching vehicle is taken as 3.5 feet above the street surface to represent the approach vehicle driver's eye. The base of the triangle is defined as the corner sight distance ("Y" in Figure 2.13). Points A and B of the clear sight triangle are located along the centerline of the approaching travel lanes. Point C is located at the center of the stopped vehicle's lane and 15 feet behind the intersecting street edge-of- pavement.



* a 10-foot off-set distance may be used when residential access streets intersect other residential access streets.

Figure 2.13. Minimum Intersection Sight Distance

Modified from Source: Stover, V.G., and F.J. Koepke (Ref. 6)

Commentary

Key areas along an intersection approach and across the corners of the intersection should be clear of obstructions that might block a driver's view of oncoming traffic. These areas are known as clear sight triangles.

The elevation of the sight-line at the approaching vehicles is taken as 3.5 feet to ensure the entering driver's ability to judge the rate of closure of, and gap size between, approaching vehicles.

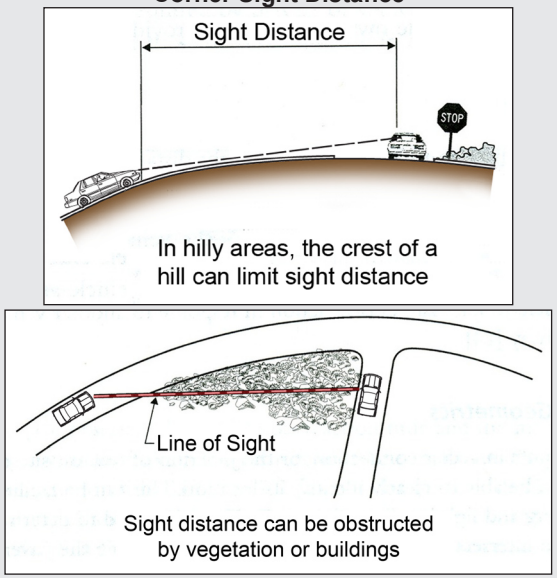
The corner sight distance is dependent on the approaching traffic speed, reaction time and decision time of the entering driver, street grades, and other factors. The minimum intersection sight distances in Table 2-6 and Figure 2.13 are based on PennDOT standards at the time of this writing (Chapter 2, Reference 18).

The reduced site triangle off-set of 10 feet for residential access streets intersecting other residential access streets reflects the reduced risk of an incident at these intersections, and permits reduced yard setbacks.

The intersection line-of-sight could be obstructed by vertical alignment, or horizontal obstructions in the site triangle, or a combination of both. This is illustrated in Illustration 2-r.

Commentary

Illustration 2-r. Obstructions to Corner Sight Distance

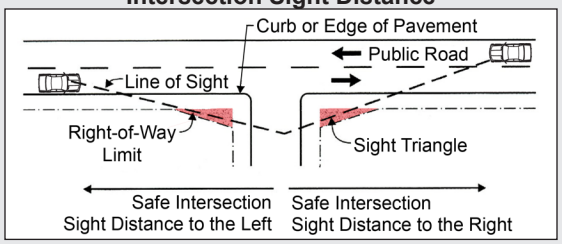


Modified from Source: Stover, V.G., and F.J. Koepke (Ref. 6)

The standards for clear site distance used here are based on data presented in References 1 and 6. These standards were derived from field observations of driver gap-acceptance behavior (Ref. 9).

Methods of ensuring maintenance of the line-of-sight sight triangles are illustrated in Illustration 2-s.

Illustration 2-s. Methods of Preserving Intersection Sight Distance



a. Sight triangle incorporated as right-of-way

Recommended Standards

Table 2-6. Minimum Intersection Sight Distance (passenger cars)

Design Speed (mph)	Sight Distance (Y) (ft.)
20	225
25	280
30	335
35	390
40	445
45	500
50	555
55	610

The site distance values in Table 2-6 apply to a vehicle starting from a stop on a street grade not exceeding 3%, and entering or crossing a two-lane, two-way street. If the rear tires of the stopped vehicle are resting on a grade steeper than 3%, the sight distances in Table 2-6 should be increased by 10%. If the through street contains a median or includes more than one through lane in either direction, an adjustment should be made to the sight distance as follows:

$$Y = 1.47\ V\ (7.5 + 0.5 \times AL)$$

Where:

Y = site distance (ft)
V = through street design speed (mph)
AL = number of additional travel lanes (count lanes in both directions)

Note: Any median width should be converted to equivalent lanes by dividing the median width by 12 feet.

Embankments, buildings, fences, landscaping, crops, parking, tree overhangs, signs, etc., shall be designed so that they do not interfere with the sight distance anywhere within the sight triangle from an elevation of 2 feet above the ground to 8 feet above the ground.

Areas within the clear sight triangle shall be dedicated as additional right-of-way or shall be maintained in a sight easement.

Recommended Standards

2.3.3.5 Intersection Approach Grade for Stop Streets: Intersection approaches, where vehicles stop while waiting to proceed, shall be designed with an approach pavement grade less than + 3%. The limiting approach grades can be increased to 5% if it can be shown that ice and snow conditions will not create a significant problem.

On residential access streets, the approach grade shall be maintained for a minimum distance of 25 feet from the intersection along the minor street from the edge of cartway on the through street. For all other street classifications, a minimum distance of 50 feet shall be maintained.

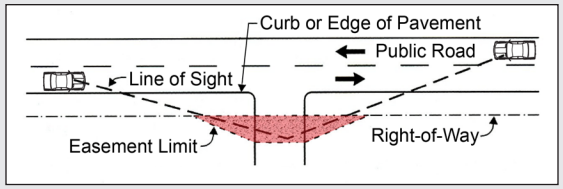
2.3.3.6 Turn Bays and Deceleration lanes: Turn bays and deceleration lanes shall be constructed when warranted by a traffic impact study (see section 2.3.14). When warranted, turn bay and deceleration lane geometry shall be designed in accordance with PennDOT standards (Ref. 18).

2.3.4 Driveways

a. *General:* Driveways shall be located, designed, constructed and maintained in such a manner as not to interfere or be inconsistent with the design, maintenance, and drainage of the street.

b. *Approach:* All driveway entrances shall be designed to maintain proper drainage from the street. Where the street is curbed, driveway approaches shall be installed to maintain continuation of flow along the gutter-line. Alternatively, a gutter-line may be formed in the pavement across the driveway entrance to ensure proper drainage.

Commentary



b. Sight triangle protected by acquisition of use (easement)
Modified from Source: Stover, V.G., and F.J. Koepke (Ref. 6)

The limiting street grades (less than 3%) are based on minimizing hazards from snow and ice, and allowing for unimpeded vehicle acceleration from a stop. In areas where snow and ice are not of particular concern, street grades could be increased to 5% (Ref. 1 and 5) as long as an appropriate adjustment is made to the stopping sight distance in section 2.3.3.4.

The length of the minimum approach grade is reduced to 25 feet for residential access streets to minimize site grading impacts. This is justified by the low design speed of these streets.

Turn bays and deceleration lanes provide for safety and efficiency on streets. Limited traffic volumes on residential access streets typically don't warrant these features. However, these features should be provided whenever they are warranted based on a traffic impact study.

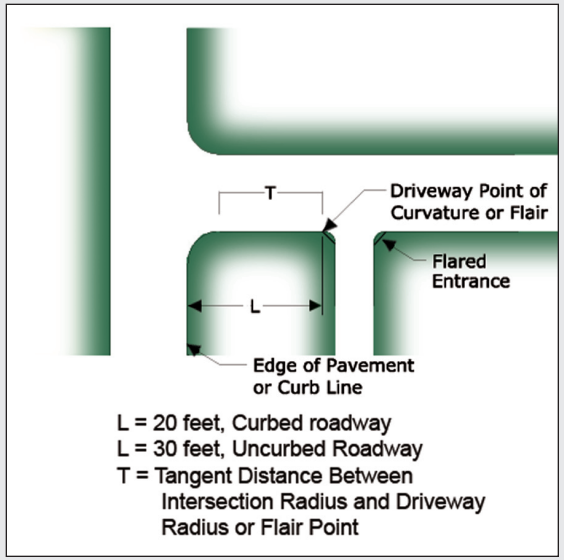
In this context, proper drainage means that drainage from and along the street within the right-of-way is maintained. Where the street is curbed, an adequate flow-line must be maintained along the gutter so runoff is not directed into the driveway entrance. This can be accomplished by ensuring that the driveway elevation rises at least to the curb height along the entrance profile prior to dropping to the desired grade. Where the street is not curbed, entrance grading shall direct runoff to a street swale

Commentary

and away from the driveway entrance.

The minimum distance from intersection standards are as specified in PA Code Title 67, Chapter 441.8. To minimize vehicle conflicts, a larger separation distance should be used when possible. This requirement may be waived only if the intersecting street radius extends along the property frontage to the extent that compliance is physically impossible. See Illustration 2-t for a graphic description of specified distances.

Illustration 2-t. Driveway Off-set from Intersection



Comparable to a PennDOT minimum use driveway (PA CODE Title 67, Chapter 441.8). Illustration 2-u shows a typical shared driveway.

Recommended Standards

c *Minimum distance from Intersections:* The distance from the edge of pavement of the intersecting street to the point of curvature of the driveway edge of pavement or curb radius shall be a minimum of 20 feet on curbed streets and 30 feet on uncurbed streets. For flared driveways, measurement shall be to the beginning of the flair. In no case shall the tangent distance between the intersection radius and driveway radius or flair point be less than 10 feet.

d. *Corner lots:* When bounded by streets of two different street classifications, driveways for corner lots shall gain access from the street of lower classification. However, access shall be permitted from the street of higher classification in the following cases:

1. if no other reasonable access is available; and
2. when grading limitations or other restrictions dictate that access be from the higher-order street.

e. *Property line clearance:* Except for joint-use driveways, no portion of any access shall be located outside the property frontage boundary line.

f. *Sidewalk Crossing:* If a sidewalk is present, the sidewalk pavement material shall be continued across the driveway width. See Figure 2.14.

Figure 2.14. Concrete Sidewalk Continues Across Driveway

2.3.4.1 Driveways to Single-family Dwellings, Duplex Houses, or Apartments with Five Units or Fewer:

a. *Joint driveways:* Joint or common driveways serving no more than three (3) single-family dwellings are permitted and shall be designed in accordance with the standards

Recommended Standards

of this section.

b. *Curb Cut:* The minimum curb cut or driveway width at the cartway edge shall be 10 ft. The maximum curb cut or driveway width at the cartway edge shall be 20 ft.

c. *Curb return entrance:* A curb return entrance is illustrated in Figure 2.15. When curb return entrances are used, the curb shall have a minimum 3-foot radius. However, any driveway entering into a PennDOT right-of-way shall be designed in accordance with PA Code Title 67, Chapter 441.

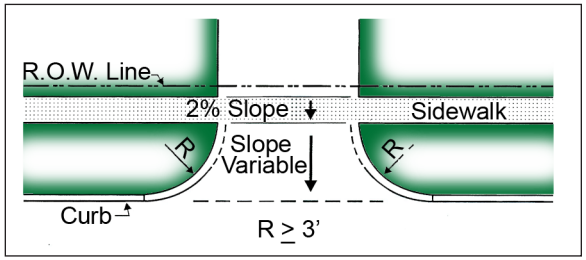


Figure 2.15. Typical Curb Return Entrance

Note: for driveways entering into PennDOT ROW, design shall be in accordance with standards in PA Code Title 67, Chapter 441.

Modified from Source: AASHTO (Ref. 1)

d. Flared entrances: When flared driveway entrances are used, a minimum 2-foot flair shall be provided. A typical flared entrance is illustrated in Figure 2.16.

Commentary

Illustration 2-u. Shared Driveway

Modified from Source: National Association of Homebuilders, et al. *Residential Streets* (Ref. 5)

The driveway return radius standard is from Reference 1, p. 402. A 5-foot radius is common practice.

The 2-foot flare width provides an effective driveway width similar to that of a 3-foot curb radius.

Commentary

An entrance radius slightly larger than the curb return entrance radius is specified for non-curbed driveway entrances to minimize shoulder run-off.

Excessive changes in driveway grade at the entrance or along the profile will cause the front or rear bumper to drag on the surfaces of the street or driveway. The 8% change in grade at driveway entrances is based on PennDOT standards in Reference 18.

When the change in grade at a point along the driveway is less than 10%, field rounding will provide an adequate transition. However, when the change in grade equals or exceeds 10%, a vertical curve should be provided.

The standards here have been adapted from chapter 7 of Reference 6 and modified to reflect

Recommended Standards

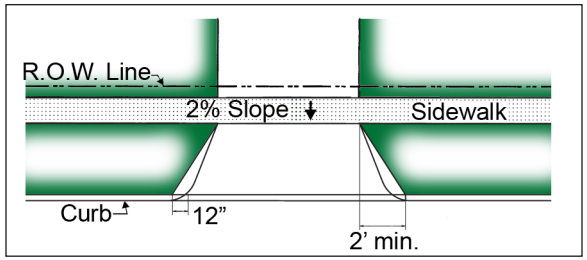


Figure 2.16. Typical Flared Driveway Entrance
Modified from Source: AASHTO (Ref. 1)

e. Non-curbed entrance: Non-curbed driveway entrances shall have a minimum edge-of-pavement radius of 5 feet as illustrated in Figure 2.17.

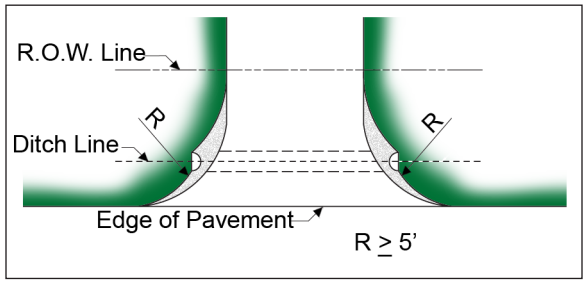


Figure 2.17. Typical Non-curbed Driveway Entrance
Modified from Source: AASHTO (Ref. 1)

f. Driveway Profile: Driveway profiles shall provide efficient access to the abutting residential street, allow for low-speed 90-degree turns into the driveway, and provide safe access to the residential garage or parking area. The following standards shall apply:

1. The algebraic change in grade between the street cross slope and the driveway approach apron shall be less than or equal to 8%.

2. When the algebraic change in grade at any point along the driveway exceeds 10%, a vertical curve having a length specified in Table 2-7 shall be used.

Recommended Standards

Table 2-7. Length of Vertical Curves for Extreme Changes in Driveway Grade

Algebraic Change in Grade (%)	Length of Vertical Curve	
	Sag	Crest
10	25	10
15	35	20
20	45	30
25	55	40

3. Driveway grades shall not exceed 10% for the first 18 feet from the street edge of pavement. In addition, the driveway grade shall not exceed 10% in any area used for designated parking along the driveway, or within 20 feet of garage entrances.

4. Driveways serving residential dwellings should they generally be less than 15%, but in no case should exceed 20%.

2.3.4.2 Entrance Drives for Multi-family Developments and Off-street Parking Lots:

1. Except as outlined in section 2.3.4, all driveway entrances onto public rights-of-way shall be designed in accordance with PennDOT entrance standards as defined in PA Code, Title 67, Chapter 441.

2. With the exception of driveways outlined in section 2.3.4.1, all private driveways and streets shall be designed in accordance with the standards for public streets in Sections 2.5 through 2.8.

2.3.5 Easements

To economize on the loss of site area, easements may be used in lieu of rights-of-way for utilities, sidewalks, snow storage, sight triangles, slope maintenance areas, etc., whenever possible. Streets, curbs, street gutters, and cross drainage pipes and culverts must be placed in the street right-of-way.

Commentary

PennDOT standards (Reference 18).

An 18-foot area at the driveway entrance provides vehicles with a transition and landing area at the entrance from which to safely enter the street. On steep driveways, this area also provides a safe parking area when inclement weather prevents the vehicle from driving the remaining length of the driveway.

Easements grant rights of passage through and/or use of privately owned property. Easements provide the same access to utilities as rights-of-way (Ref. 13, p. 62). The use of easements may allow the placement of utility lines along the shortest path, thereby decreasing both the overall length of the line and the associated costs.

Legal rights to easement land areas are typically assigned to the municipality, utility company, and/or home owners. Easement areas across lots are maintained by the owners, saving the municipality upkeep funds. (Adopted from Reference 14, p. 25.)

Commentary

Rights-of-way used for utilities, sidewalks, snow storage, sight triangles, slope maintenance areas, or other design elements shall be subject to review to ensure that the minimum required right-of-way width does not unfairly contribute to an increase in housing cost through an associated reduction in density. (Adapted from Reference 14, p. 25)

A center-crowned street cross-section facilitates pavement drainage at the street edge.
Pavement cross-slopes between 2% and 6% are recommended in Reference 1. A 3% cross slope is recommended for residential streets. Cross slopes less than 2% will not provide adequate pavement cross drainage. Steeper cross slopes produce enhanced pavement drainage and narrower gutter flow widths (less spread) for the same gutter flow rate. Cross slopes greater than 4% may result in some driver discomfort.

Cross slopes greater than 4% are sometimes used on multi-lane streets to provide adequate pavement cross drainage. For multi-lane streets, PennDOT cross-slope standards based on pavement drainage requirements should be followed.

Traffic-calming measures are mainly used to address speeding and to reduce the volume of cut-through traffic on neighborhood streets. These issues can create an atmosphere in which non-motorists are intimidated, or even endangered, by motorized traffic. By addressing high speeds and cut-through volumes, traffic calming can increase both the real and perceived safety of pedestrians

Recommended Standards

2.3.6 Rights-of-way

Rights-of-way shall be set aside to provide adequate space for the construction and maintenance of streets, shoulders, curbs, street gutters, and cross drainage pipes and culverts. They may also accommodate sidewalks, snow storage, sight triangles, slope maintenance areas, and utilities such as water, sewer, storm drainage, electrical service, cable TV, and gas lines where appropriate.

2.3.7 Travelway Cross Section

With the exception of alleys and divided streets, residential streets shall be constructed with a center-crowned street cross-section as illustrated in Figure 2.18. Cross slopes between 2% and 4% are appropriate for residential streets.

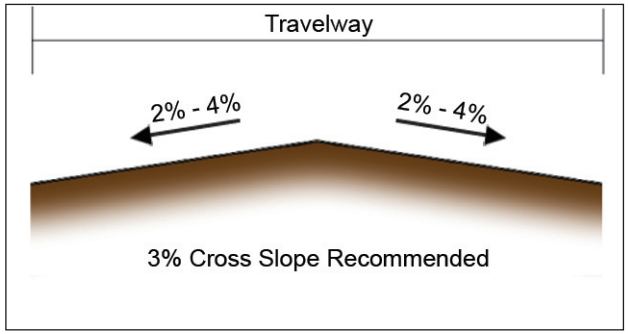


Figure 2.18. Crowned Pavement Section

For streets having more than one travel lane in each direction, PennDOT standards for street cross slope should be followed.

2.3.8 Traffic Calming

Traffic calming measures are techniques designed to slow traffic and reduce cut-through traffic volumes in residential neighborhoods. The minimum road width standards contained in this chapter were established to enhance traffic calming. The measures included in the following sub-sections may be used to further enhance traffic calming.

Traffic calming measures shall be designed in accordance with the standards in Reference 12, *Pennsylvania's Traffic Calming Handbook.*

Recommended Standards

2.3.8.1 Intersection -- Bulb-Outs

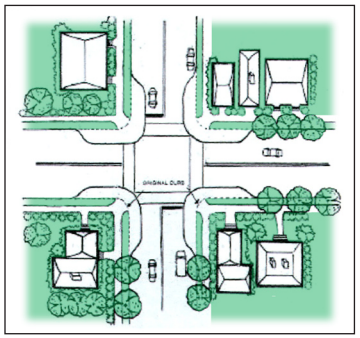


Figure 2.19.
Intersection Bulb-Outs
Source: PennDOT (Ref. 12)

Bulb-outs are curb extensions used to narrow the paved street width, typically at places where pedestrians cross. They usually extend the width of a parking lane, about 6- to 8-feet from the conventional curb line. They are appropriate for use on all residential street classifications. Typical reasons for their use include:

- Reduce pedestrian crossing distance
- Improve the line-of-sight for pedestrians
- Make pedestrians more visible to oncoming traffic
- Slow traffic by funneling it through a narrower street opening
- Slow vehicles making a right turn by reducing the effective curb radius

Bulb-out design should consider the following elements:

- Adequate drainage must be provided. Ponding may occur along the curb-line or on the sidewalk if adequate provision is not made for drainage.
- Consideration should be given to the need for snow and ice removal.
- Vertical curbs are recommended to create a positive barrier. However mountable curbs can be used if necessary to accommodate turning trucks and busses.
- Mid-block bulb-outs should be combined with crosswalks whenever possible.

For additional guidance and for future updates, see Reference 12, ch. 5, pp. 24-25.

Commentary

and bicyclists, and improve the quality of life within neighborhoods (Ref. 12).

Several traffic-calming measures are included as a part of other standards. For example, narrow street widths are promoted as a part of the street standards for each street classification, and bulb-outs are included as an option under intersection cartway radius definitions in section 2.3.3.

Bulb-outs are perhaps the most common traffic-calming technique. They greatly reduce the time needed for pedestrians to cross an intersection and help to clearly define the parking lane. Bulb-out configurations also improve pedestrian visibility at intersections. Bulb-outs have been observed to reduce travel speeds by up to 5 mph (Ref. 12). However, when the bulb-out width is less than the width of the parking lane, little reduction in travel speed is realized.

Illustration 2 - v. Bulb-Out

Bulb-outs are typically used at intersections. However, they can be used at mid-block locations where there is significant pedestrian activity (near schools, for example), where a block is long and a mid-block crossing is desired, or to address speeding. Bulb-outs are also sometimes referred to as curb extensions, knockdowns or chokers.

Commentary

Raised intersections have been observed to have only a minor affect on vehicle speed (Ref. 12). The effectiveness of raised intersections can be enhanced through the use of textured surface materials.

Illustration 2 - w. Raised Intersection

Source: Pedestrian and Bicycle Information Center (Ref. 26)

Recommended Standards

2.3.8.2 Intersection -- Raised

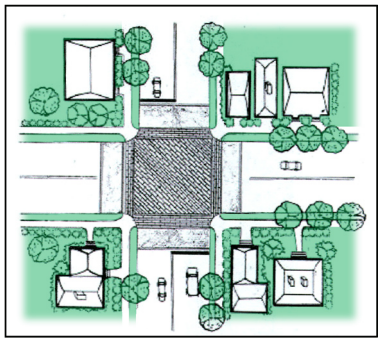


Figure 2.20.
Raised intersection
Source: PennDOT (Ref. 12)

Raised intersections comprise the entire intersection, including the associated crosswalks. The intersections are raised 3-inches to 6-inches above street level. Raised intersections function to lower travel speeds and decrease conflicts between vehicles and pedestrians by better demarcating crossing areas and elevating pedestrians above the street level. They are most appropriately used where there is high pedestrian activity in residential / mixed-use areas.

Design considerations include:

- The ramp grade of 4% to 8% should be maintained on the approach to the raised intersection.
- Use of tactile measures to warn visually impaired people of the location of the cross walk and raised intersection.
- Use of appropriate drainage elements.
- All ADA requirements must be met.
- Consideration must be given to snow and ice removal.

For additional guidance and for future updates, see Reference 12, ch. 5, pp. 48-49.

Recommended Standards

2.3.8.3 Intersection -- Traffic Circle

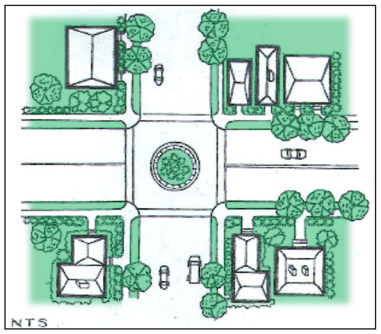


Figure 2.21. Traffic Circles
Source: PennDOT (Ref. 12)

Traffic circles are raised islands located in the center of an unsignalized intersection. All traffic must negotiate the circle and circulate in a counterclockwise direction. Their primary function is to improve the efficiency and safety of stop-sign controlled (2-way or 4-way) intersections.

Traffic circles can be used on any street where traffic volumes are less than 3,500 trips per day, but should not be used where there may be a significant pedestrian crossing volume or high left-turn movements.

Other design considerations include:

- Turning analysis should be completed to ensure that the design vehicle can negotiate the circle.
- Careful consideration needs to be given to intersection paving and drainage. can be used if necessary to accommodate turning trucks and busses.
- For safety, street lighting should be considered in the vicinity of traffic circles.
- Provisions should be made for snow and ice removal.

For additional guidance, including recommended geometric standards, and for future updates, see Reference 12, ch. 5, pp. 34-36.

Commentary

The curve of a traffic circle forces the driver to slow down and pay attention to other vehicles. Traffic circles have been observed to reduce accidents at intersections and reduce the speed of vehicles traveling along an uncontrolled street at two-way stop intersections. Traffic circles are most effective at reducing speeds when several are used in a series. On average, speeds are reduced by 4 to 6 mph in the vicinity of circles.

Illustration 2 - x. Traffic Circle

Source: Pedestrian and Bicycle Information Center, Ref. 26.

However, traffic circles may make it difficult for emergency vehicles, busses, and trucks to turn left. In addition, emergency vehicles experience delays (5 to 8 seconds per circle) when traveling straight through traffic circles (Ref. 12); therefore, they should not be used along emergency response routes.

Commentary

Diagonal diverters may be expected to reduce traffic volumes by 20 to 70% (most reductions around 35%) (Ref. 12). Unless the neighborhood is confined to a limited area, installing a single diverter may merely shift through traffic to other local streets. Diagonal diverters generally need to be installed in a group or cluster to effectively route traffic to collector and arterial roadways.

Illustration 2 - y. Diagonal Diverter

Chicanes work by deflecting the vehicle path and thereby shortening the driver's sight distance. Chicanes have been observed to reduce travel speeds inside the chicanes by 5 to 13 mph, and in the vicinity of the chicanes by 1 to 6 mph (Ref. 12).

Recommended Standards

2.3.8.4 Intersection - Diagonal Diverter

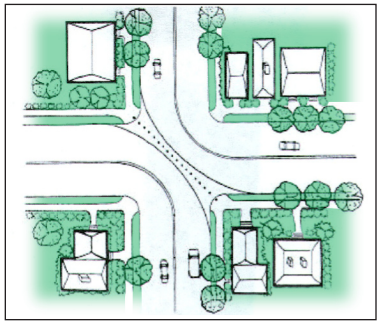


Figure 2.22.
Diagonal Diverter
Source: PennDOT (Ref. 12)

A diagonal diverter is a physical barrier placed diagonally across a four-way intersection. Their purpose is to eliminate through traffic. They are most appropriately used on residential access or residential / mixed-use streets to control traffic flow through a neighborhood. A variety of diverter designs are possible.

Design considerations should include:

- The diverter radius should be appropriate for the street design speed or a reduction in speed should be posted.
- The design and location of diverters shall be coordinated with emergency response agencies.
- Include curb cuts and breaks in diverters to accommodate pedestrian and bicycle movements.
- Diverters should be clearly visible at all times. Use painted curbs, delineation, street lights, and advance warning directional arrow signs.

For additional guidance, including recommended geometric standards, and for future updates, see Reference 12: Ch. 5, p. 48-49

2.3.8.5 Chicanes

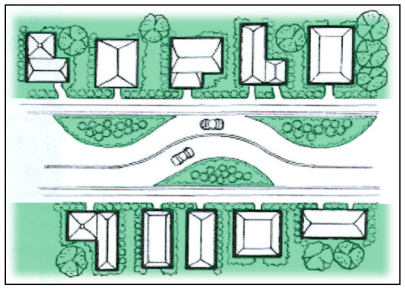


Figure 2.23. Chicanes
Source: PennDOT (Ref. 12)

Chicanes are a series of three curb extensions staggered on alternating sides of the street at mid-block locations. The primary function of chicanes is to slow vehicles by making motorists weave through the extensions.

Chicanes are appropriate for use on two-lane, two-way streets as well as one-lane, one-way streets. Chicanes can be used on any street classification with traffic volumes less than 3,500 vehicles per day. However, they are not recommended in areas where they may interfere with driveway access, or where traffic volumes are low or unbalanced (movements predominantly in one direction). For these reasons, their use is not recommended on residential access streets.

Recommended Standards

For additional guidance and for future updates, see Reference 12, ch. 5, pp. 26- 27.

2.3.8.6 Raised Median Islands

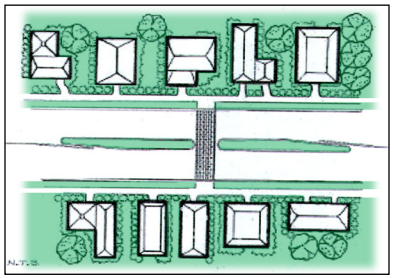


Figure 2.24.
Raised Median Islands
Source: PennDOT (Ref. 12)

Median islands are narrow islands between travel lanes that can be designed to accommodate pedestrians through breaks in the curbing and landscaping. They can be used at intersections or mid-block. The primary function of raised median islands is to reduce the crossing distance for pedestrians by allowing them to cross half the street at a time. Although the travel lanes do not change width, the median island creates the perception that the width is narrower.

Design considerations include:

- Driveway and intersection location must be considered when determining median island location and length.
- Width: 6- to 8 feet to comfortably accommodate pedestrians.

Commentary

Illustration 2 - z. Chicanes

Source: Pedestrian and Bicycle Information Center, Ref. 26.

Chicanes have been observed to lose their effectiveness when motorists have the opportunity to cross the center-line and maintain nearly a straight line of travel (Ref. 12). This may happen on low-volume roadways or when traffic movements are primarily one-directional.

Raised median islands can also be used to visually enhance the street if landscaped appropriately. They are also effective in preventing passing movements, and can be used in combination with chicanes to keep vehicles from crossing the middle line.

Commentary

Illustration 2 - aa. Raised Median Island

Raised median islands have also been found to result in a small reduction in travel speed (2 to 3 mph) if they create a local reduction in travel-way width (Ref. 12).

Each speed table / hump design has unique speed-reducing characteristics based on profile, height, length, and spacing. Reference 12 provides detailed information on the effectiveness of each design.

Illustration 2 - bb. Speed Table/Hump

Source: Pedestrian and Bicycle Information Center, Ref. 26.

Recommended Standards

- Length: 12- to 20 feet minimum needed to result in some reduction in travel speed.
- Provisions should be made for snow and ice removal.

For additional guidance and for future updates, see Reference 12: Ch. 5, p. 30, 32.

2.3.8.7 Speed Table / Hump

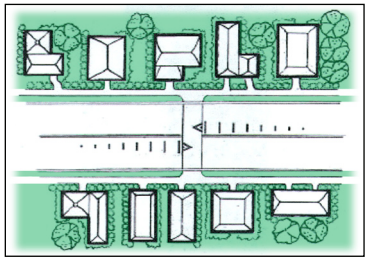


Figure 2.25.
Speed Table / Hump
Source: PennDOT (Ref. 12)

A speed table/ hump is a raised surface on the roadway that is typically 3- to 4-inches in height, and 12- to 20-feet in length. They are primarily used at mid-block locations for speed reduction. The use of speed humps should be limited to application on residential access streets.

A variety of speed hump designs have been developed (Watts, Seminole County, Gwinnett County, etc.) and tested. Specific design details and application recommendations for each are outlined in Reference 12. Speed humps have been found to be a very effective means of vehicle speed reduction.

Design considerations include:

- Hump height, length, and profile
- Spacing/ location along the street
- Drainage
- Appropriate signage and pavement markings
- Should not be installed on curves
- Cannot be used on streets without curbs unless restrictive signing or fencing is used adjacent to the hump

Recommended Standards

- Should not be used on emergency response routes
- Consideration should be given to snow and ice removal

For additional guidance and for future updates, see Reference 12: Ch. 5, p. 38- 45.

2.3.8.8 Raised Crosswalk

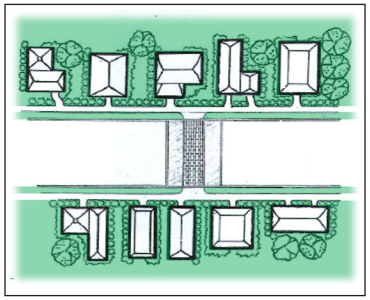


Figure 2.26.
Raised Crosswalk
Source: PennDOT (Ref. 12)

Raised crosswalks are similar to speed tables/ humps, though these are marked and elevated for pedestrian crossing purposes. Raised crosswalks serve as an extension of the sidewalk at mid-block locations or intersections. Their purpose is to reduce vehicle speeds and improve the visibility of pedestrians by clearly defining crossing locations. They are most appropriately used in areas of significant pedestrian crossing activity along residential access and residential / mixed-use streets. Their use is not recommended along residential collector roadways or primary emergency response routes.

Design considerations include:

- Use of tactile measures to warn visually impaired people of the location of the cross walk
- Appropriate placement of signage to alert drivers of crosswalk
- The ramp grade of 4% to 8% should be maintained on the approach to the raised crosswalk
- Appropriate drainage elements must be considered in the design
- All ADA requirements must be met
- Consideration must be given to snow and ice removal

For additional guidance, including recommended geometric standards, and for future updates, see Reference 12, ch. 5, pp. 46-47.

2.3.9 Street Landscaping

Street trees are usually planted within a buffer area between the street edge and the sidewalk (see chapter 3, Section 3.1.2, “Buffering”). Street landscaping shall be designed to fit the scale and character of the development. The following standards shall be applied

Commentary

Speed table / humps should be distinguished from speed bumps, which may be encountered in parking lots. Speed bumps are 3 to 6 inches high and 1 to 3 feet in length. Speed bumps result in significant vertical displacement at low speeds, but are not appropriate as traffic-calming measures on through streets.

Due to their width, markings or material change, and their elevation change, raised crosswalks provide both a visual and physical device for slowing traffic. Raised crosswalks have been observed to reduce speeds an average of 6 mph (Ref. 12). The effectiveness of raised crosswalks can be enhanced through the use of textured surface materials.

Illustration 2 - cc. Raised Crosswalk

In addition to efficient circulation for vehicles and pedestrians, residential streets should also

Commentary

create positive aesthetic qualities for residents and visitors. Street trees grow to become one of the larger elements of the street environment, yet they are instrumental in creating a comfortable, human-scaled space (see Illustration 2-dd). Along with helping to naturalize a street, street trees also minimize air pollution and create shade, which reduces summer temperatures in that area (Ref. 2).

Illustration 2-dd. Tree Canopy

Tree canopy assists in creating a pleasant pedestrian space along the street
Source: The Hamer Center for Community Design Assistance (Ref. 2)

Much of the character of older neighborhoods is derived from the mature street trees that form a canopy over the entire street (Ref. 5).

When plant materials for a streetscape are selected, the image and scale of the neighborhood, location of utilities, traffic control devices, street-lighting hardware, traffic clearances, as well as intersection clear sight triangles should be considered (Ref. 5).

The choice of tree species should take into consideration their mature height and spread, the root system's potential for damaging sidewalks and street pavements, maintenance requirements, and

Recommended Standards

(Ref. 22).

a. Plant trees on both sides of the street with spacing as follows:

   1. Under 30-foot spread at maturity: 15-35 feet on center
   2. 31 to 50-foot spread at maturity: 25-55 feet on center
   3. Over 50-foot spread at maturity: 40-80 feet on center

b. Plant trees on only one side of the street as an option when the street is adjacent to a significant feature that precludes planting on both sides of the street, such as:

   1. Preserved hedgerows or woods
   2 Open space or conservation areas
   3. Common green or central open space

c. When a less formal arrangement is desired, or where more screened views or more filtered views are deemed appropriate, groupings of smaller trees may be used to replace the trees specified in a above.

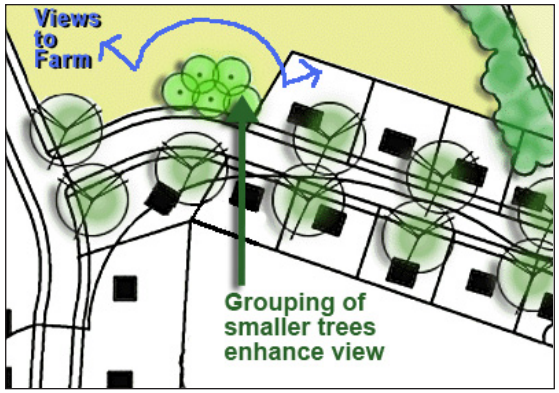


Figure 2.27. Smaller Street Trees Alternative
Less-formal street tree layout is appropriate due to adjacent farm views
Modified from Source: Judith Larkin (Ref. 22)

d. When possible, retain existing trees located within the proposed right-of-way. These will be counted toward fulfillment of the street tree requirements specified above.

e. Street trees should be planted at least 3 feet behind the back-of-curb. If the street is not

Recommended Standards

curbed, street trees shall not be planted within the clear zone.

2.3.10 Street Lighting

Residential street lighting shall be required only where there is concern for public safety. When installed, street lighting shall meet the standards of this section. Standards for the lighting for non-vehicular pedestrian and bicycle paths and walkways shall be as specified in chapter 3.

Pole Height: All pole-mounted luminaires used to illuminate residential streets within the municipality shall have a pole height such that the maximum elevation of the bottom of the luminaire does not exceed 25 feet above the street surface. Municipal streetlights mounted on signal poles, existing utility poles, or where utility easements will conflict with the streetlights mounted according to the requirements of this section shall be exempted from the height requirements as set forth under this section.

Shielding: All municipal streets shall be shielded in accordance with the following standard:

Initial luminaire output < 2,000 lumens No shielding required

Initial luminaire output > 2,000 lumens Fully shielded

A fully shielded luminaire is one in which all light emitted by the fixture, either directly from the lamp or a diffusing element, or indirectly by reflection or refraction from any pan of the luminaire, is projected below the horizontal as determined by photometric test or certified by the manufacturer. Any structural part of the light fixture providing this shielding must be permanently attached.

Commentary

adaptability to the specific street environment (Ref. 5).

Shrubs selected for right-of-way planting should be low growing or, in the case of large shrubs, tolerant of under-trimming. Low shrubs and ground covers with vigorous root systems can be effective for erosion control on slopes within the right-of-way (Ref. 5).

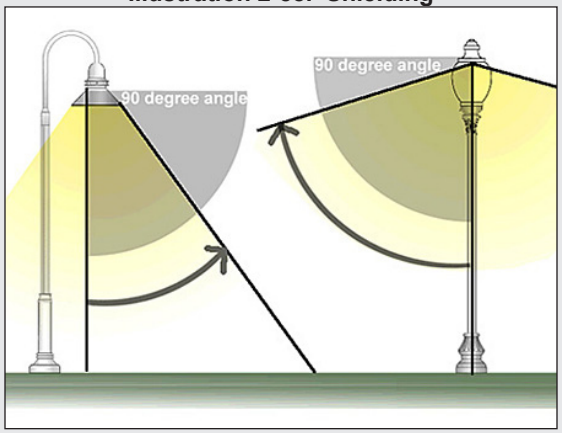
Before planting trees or shrubs near streetlights, check their photosensitivity. Continuous exposure to streetlights can cause abnormal growth in certain trees and shrubs. In northern states where salt is used on the streets for snow and ice removal, salt-tolerant species should be selected (Ref. 5).

Residential street lighting, where used, does not serve the same purpose as highway lighting. Vehicles traveling at slow speeds can easily traverse residential streets at night without external lighting. For pedestrian safety, street lights should be considered at intersections and other locations where there is risk of pedestrian / bicycle and vehicle conflicts (see chapter 3).

Shielding is required to avoid unnecessary light pollution of the night sky. Light rays that are not directed toward the ground serve no purpose, are a waste of energy, can produce glare, and will reduce the view of stars in the night sky. Most lighting manufacturers have several fixtures that comply with these requirements, often called “Dark Sky lights.”

Commentary

Illustration 2-ee. Shielding



Shielding can occur invisibly inside the fixture, as on the right, or be a visible part of the light fixture, as shown on the left.

Source: Clearwater Conservancy (Ref. 23)

Recommended Standards

2.3.11 Signage and Signalization

The developer shall provide all necessary street signs and traffic signalization as may be required by local, State, or Federal regulations. In addition, the following standards shall apply:

1. The design and placement of traffic control and other street signs placed within public right-of-way shall follow the requirements specified in the most current edition of the *Manual of Uniform Traffic Control Devices for Streets and Highways* (Ref. 11).

2. On non-public streets, all traffic control signs must be designed in accordance with the most recent version of Reference 11. Non-traffic control signs on non-public streets do not have to meet these standards.

3. At least one street-name sign pole shall be placed at each intersection identifying all crossing street names. Signs shall be placed so they do not obstruct sight distances, and shall be under light standards if present. The design of street-name signs shall be consistent, of a style appropriate to the community, of a uniform size and color, and erected in accordance with any local standards.

4. At signalized intersections, street signs shall be located on the overhead arm supporting the traffic signal, or otherwise suitably suspended over the intersection. Street

Recommended Standards

clearance shall be a minimum of 15 feet from the bottom of any sign or supporting equipment and the top of the paved surface.

2.3.12 Streets and Special Hazard or Environmental Conservation Areas

Streets shall be laid out to avoid hazardous and special environmental conservation areas such as areas of unstable soils, steep slopes, large ravines, floodplains, stormwater critical drainage-ways, riparian areas, and other environmentally sensitive areas. Where it is necessary to cross these areas, crossings should be perpendicular or near perpendicular to the feature.

2.3.13 Trip Generation Rates

Trip generation rates shall be based on the most recent data published by the Institute of Traffic Engineers (ITE) for the proposed use or housing type. Table 2-8 presents trip generation rates from Reference 10. More current data from ITE, or data from local or regional traffic studies prepared in accordance with ITE standards, may be used in place of the data in Table 2-7.

Table 2-8. Trip Generation Rates for Residential Housing Units

Housing type	Average weekday vehicle trips per day (TPD)
Single-family detached	10 *
Residential condominium / townhouse	5.9
Apartment (average)	
Low rise (3 stories or fewer)	6.6
High rise (more than 3 stories)	4.2
Mobile home	5.0
Retirement senior living (avg)	
Senior housing – detached	3.7
Senior housing – attached	3.5
Assisted living	2.7
Senior continuous-care village	2.8
Planned unit development	7.4

Note: Land use definitions and trip generation rates from Ref. 10. Reported values may be superseeded by rates reported in the latest update to Ref. 10.
*9.6 reported in Reference 10.
Source: Institute of Transportation Engineers (Ref. 10).

Commentary

Unstable soils are soils with high shrink-swell or slip potential. Stormwater critical drainage-ways are swales or other discharge channels that serve an important natural stormwater control function. Examples include floodplains (storage potential) and wide karstic drainage-ways (natural infiltration potential).

The Institue of Traffic Engineers defines vehicle trips per day as the average number of vehicle trip ends per day per independent variable (dwelling units, employees, etc.) counted at the site's driveway (Reference 10). For example, leaving a dwelling unit and returning counts as two trip ends or two trips per day.

Commentary

Trip Generation Studies are required to estimate traffic loads iin order to define street class and the design standards appropriate for each street.

Using the values from Table 2-8, 800 trips per day is equivalent to 80 single family homes, or 135 townhouses.

Street width is dependent on the vehicle width, traffic volume, parking requirements, and traffic pattern.

The design vehicle assumed for residential access streets is a single unit truck (SU) as defined by the American Assoc. of State Highway and Transportation Officials (Ref. 1). As defined, a

Recommended Standards

2.3.14 Traffic Studies

A Trip Generation Study shall be performed for all proposed residential developments. This study shall document the anticipated traffic distribution and loads within the development based on the trip generation rates provided in Table 2-8. The anticipated traffic load must support the design street classification used for all streets.

A Traffic Impact Study shall be performed for all developments generating total traffic volumes greater than 800 trips per day as determined by using the trip generation rates specified in Table 2-8. The traffic impact study shall include an analysis of the need, if any, for signals, turn lanes, additional travel lanes, and other street improvements for internal and adjacent streets.

Traffic impact studies are to be prepared in accordance with the local municipal ordinance on traffic impact studies. If no such ordinance has been adopted (by either the municipality or the county), then the traffic study shall be prepared in accordance with PennDOT requirements.

2.4 DESIGN STANDARDS FOR RESIDENTIAL ACCESS STREETS (RA)

Residential access streets (RA) are classified as Type A (RA-A), and Type B (RA-B). Design standards for each class follow.

2.4.1 Design Speed

Type A	20 mph
Type B	25 mph

2.4.2 Street Width

Tables 2-9 through 2-12 provide design matrices for use in establishing street width. Also see Appendices A and B.

Recommended Standards

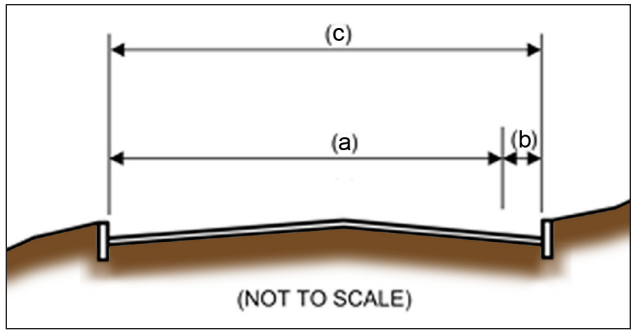


Figure 2.28. Cross-Section Profile -- Curbed Residential Access Street

Table 2-9. Residential Access Type A -- Curbed

Traffic Pattern	Parking Type	(a) Travelway Width* (ft.)	(b) Parking Lane Width (ft.)	(c) Street Width (curb to curb)
Yield **	One Side or Alternating Sides	10	8	18
Slow	Alternating Sides	18	8	26
Free	No Parking	18	n/a	18
Free	One Side	18	8	26

* All travelway widths are for two-way streets; for one-way use ½ of travelway width except for "yield" traffic pattern.

** Use only when ADT less than or equal to 300.

Table 2-10. Residential Access Type B -- Curbed

Traffic Pattern	Parking Type	(a) Travelway Width* (ft.)	(b) Parking Lane Width (ft.)	(c) Street Width (curb to curb)
Slow	Alternating Sides	20	8	28
Free	No Parking	20	n/a	20
Free	One Side	20	8	28
Free	Two Sides	20	8 each side	36

* All travelway widths are for two-way streets; for one-way use ½ of travelway width

Commentary

single-unit truck has a width, wheelbase, and turning radius larger than standard service vehicles (including trash trucks), conventional and large school buses, and conventional single-unit fire and rescue vehicles.

With the exception of the yield pattern, 9-foot wide travel lanes are provided. References 1, 2, 4, 5, and 6 all recommend 9 feet as a minimum lane width for low-volume residential access streets. By design, these lane widths make driving at high speeds uncomfortable enough to ensure non-vehicular safety. A 10-foot lane width is provided for the yield pattern to allow clearance between parked cars and the travel lane.

It is further noted that although a 7-foot minimum parking lane is suggested in several references (1, 2, 4, 5, and 6), an 8-foot parking lane is recommended due to the more narrow lane width.

It is noted that Appendix D of the International Fire Code (Ref. 19) specifies a minimum street width of 26 feet when there is a fire hydrant along the access route or street. This allows a pumper truck to be stopped at the hydrant and permit other emergency vehicles to pass by as they proceed to the site of the fire. The same accessibility can be provided by designing a pull-off for the tanker truck adjacent to the fire hydrant. This pull-off should have a minimum length of 24 feet.

A travel lane width of 10 feet is used in all cases for type B residential access streets. This lane width allows for slightly greater ease of vehicle movement.

Commentary

Where parking is permitted on the shoulder, it is recommended that the outer six (6) feet of the 8-foot wide shoulder be stabilized grass. Grass shoulders will help to retard surface runoff and, to some degree, enhance infiltration. Maximizing grassed shoulder width will also create a narrower perceived street width, promoting slower vehicular travel speeds. However, wider gravel widths may be appropriate on higher volume curved streets to accommodate rear wheel-turning movements characteristic of larger trucks on curved streets.

Traffic volumes and speeds on residential access streets permit shared use of the cart-way by bicycles and motorized vehicles. The omission of separate travel lanes for bicycles minimizes the street pavement width, thereby reducing construction and maintenance costs, as well as minimizing stormwater impacts.

Recommended Standards

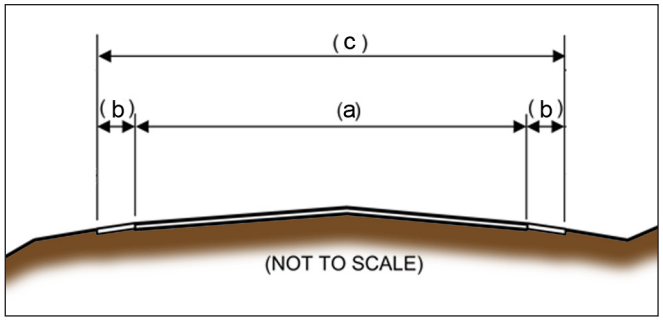


Figure 2.29. Cross-Section Profile -- Residential Access Street with Reinforced Shoulder

The first 2-feet of a "reinforced shoulder" shall be gravel in accordance with PennDOT standards for gravel shoulders. The remaining width of reinforced shoulder may be either a continuation of a gravel shoulder, stabilized grass, or a combination of both. Stabilized grass shoulders shall be constructed using a soil stabilizing geo-fabric or grid under a grass surface which will support occasional parking.

Table 2-11. Residential Access Type A -- Reinforced Shoulder

Traffic Pattern	Parking Type	(a) Travelway Width* (ft.)	(b) Shoulder Width (each side) (ft.)	(c) Street Width (shoulder to shoulder)
Free	No Parking	18	2 each	22
Free	One Side	18	2 on one side, 8 on parking side	28
Free	No Parking	18	8 each	34

* All travelway widths are for two-way streets; for one-way use ½ of travelway width

Table 2-12. Residential Access Type B -- Reinforced Shoulder

Traffic Pattern	Parking Type	(a) Travelway width* (ft.)	(b) Shoulder width (each side) (ft.)	(c) Street width (shoulder to shoulder)
Free	No Parking	20	2 each	24
Free	One Side	20	2 on one side, 8 on parking side	30
Free	Two Sides	20	8 each side	36

* All travelway widths are for two-way streets; for one-way use ½ of travelway width

Recommended Standards

2.4.3 Bicycle Access

On residential access streets bicycles shall share the street with other vehicles. No additional street width shall be provided for bicycles (see more in chapter 3).

2.4.4 Pedestrian Access

To promote a pedestrian-friendly neighborhood character, it is recommended that sidewalks and / or pedestrian trails be provided in all residential developments. As a general guideline, sidewalks should be provided along residential type A and B streets for medium- to high-density developments. More details about sidewalks are provided in chapter 3.

2.4.5 On-street Parking

The amount of on-street parking provided shall not exceed the requirements of section 4.1 in chapter 4 by more than 10%. If parking is to be provided along only a portion of the street, the street width should be reduced in areas where parking will not be provided. Bulb-outs and other appropriate transition elements should be used to accommodate changes in street width (see 2.3.8 for more about bulb-outs).

Individual parking spaces along residential access streets shall not be delineated by pavement markings. However, adequate signage shall be provided to clearly designate on-street parking areas. This is particularly important where parking is limited to one side only, or where parking alternates from one side to the other.

2.4.6 Right-of-way Width

Rights-of-way shall be set aside to provide adequate space for the construction and maintenance of streets, shoulders, curbs, street gutters, and cross-drainage pipes and culverts. They may also accommodate sidewalks, snow storage, sight triangles, slope maintenance areas, and utilities such as water, sewer, storm drainage, electrical service, cable TV, and gas lines where appropriate.

The minimum right-of-way width for residential access streets shall be 50 feet.

2.4.7 Street Slope

a. *Longitudinal Slope:* 12% maximum
0.5% minimum

Steeper slopes may be permitted for short distances upon approval by the municipal

Commentary

The requirement for sidewalks here is to separate pedestrian and vehicular and bicycle traffic in moderate- to high-density subdivisions. However, pedestrian and bicycle trails should be considered for all residential developments.

These slopes are based on recommendations from the American Assoc. of State Highway and Transportation Officials (Ref. 1), the Hamer Center

Commentary

for Community Design (Ref. 2), and the Institute of Transportation Engineers (Ref. 6), and a desire to minimize the disturbance caused by excessive cut and fills.

Residential access streets should be constructed at a line and grade consistent with the surrounding terrain to minimize disturbance. Grades up to 17% are acceptable for short distances in hilly or mountainous terrain as long as icing is not considered to be a significant hazard. A short distance as intended here would generally be less than 200 feet.

Where ADA-accessible sidewalks are required adjacent to the street, maximum street grades may be limited to 5% (see chapter 3).

The recommended minimum horizontal curve radii are as suggested in Reference 5 and are based on friction factors and other data reported in Reference 1. These values were established such that the lateral force exerted in the curve causes the driver to experience a feeling of discomfort when negotiating a curve at the design speed. The recommended minimum radii are twice as large as radii at imminent skidding on a level, dry surface for average tire tread conditions (a safety factor of 2 with respect to radius). When considering the effect of negative cross-slope (super-elevation) caused by the street's cross-slope on vehicles entering curves to the left, the recommended radii result in safety factors against imminent skidding of 1.8 and 1.9 for 3% and 2% cross slopes, respectively.

Recommended Standards

engineer.

b. *Maximum longitudinal slope within 50 feet of intersections: See section 2.3.3.5.*

2.4.8 Horizontal Curvature

Horizontal curvature on residential streets shall be designed without super-elevation to minimize vehicular travel speeds. The minimum street curvature (radius) for residential access streets shall be as follows:

Type A	90 feet
Type B	165 feet

These values are to be measured at the center-line of the street. The minimum tangent length between reverse curves shall be 50 feet.

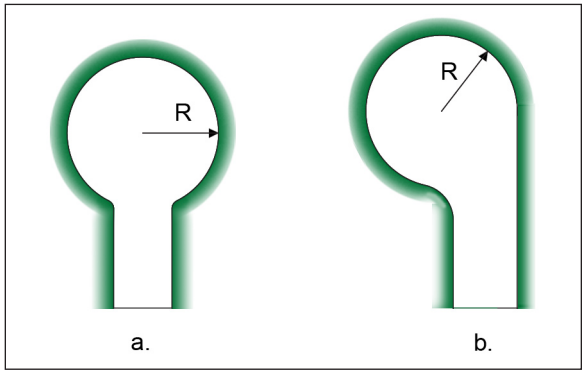
2.4.9 Cul-de-sacs

Cul-de-sacs are single access streets (single means of ingress and egress), and include a turn-around at the end. Cul-de-sac streets shall meet the design standards for a type "A" residential access street (RA-A).

2.4.9.1 Cul-de-sac Turnarounds: Cul-de-sac turnarounds can be a variety of shapes, including circular, "T", and "Y". Figures 2.14 through 2.16 illustrate several configurations.

Recommended Standards

a. ***Circular turnarounds without center islands:*** The minimum allowed paved radius of a circular cul-de-sac without a center island shall be 42 feet. If parking is to be provided around the cul-de-sac, the minimum paved radius allowed shall be 55 feet.



a. centered b. off-center

Figure 2.30. Circular Turnarounds Without Center Islands
Modified from Source: National Association of Homebuilders et al., *Residential Streets* (Ref. 5)

If a fire hydrant is located adjacent to the cul-de-sac bulb, the minimum cul-de-sac radius shall be 48 feet (58 feet if parking is permitted around the cul-de-sac perimeter)

A minimum 28-foot transition radius shall be installed between the cul-de-sac street and the cul-de-sac bulb.

b. ***Circular turnarounds with center islands:*** Minimum radii for circular turnarounds with center islands are the same as for circular turnarounds without center islands (see section 2.4.10.1a above). For centered islands, the minimum allowed travel lane width shall be 24 feet. To minimize pavement within the cul-de-sac, the travel

Commentary

A 42-foot radius turn-around can accommodate a 180-degree continuous turning movement by single-unit vehicles. This movement may require bumper curb overhang. A 45-foot radius turn-around would accommodate a 180-degree continuous turning movement by single-unit vehicles without curb-overhang (computed from clearances and minimum turning radius from Reference 1 and Reference 5).

A 55-foot radius turn-around can accommodate a 180-degree continuous turning movement by single-unit vehicles with sufficient clearance for an 8-foot parking lane around the perimeter of the turn-around (computed from clearances and minimum turning radius' from Reference 1).

Note that a 35-foot radius cul-de-sac meets the minimum requirements in Appendix D of Reference 19 for the case where no fire hydrant is adjacent to the cul-de-sac. However, this does not provide adequate room for continuous turning movements for service vehicles and school busses. Therefore, a 42-foot minimum radius is recommenced. It is also noted that a 40-foot radius cul-de-sac must be maintained to qualify for liquid fuels funds.

The additional radius needed when fire hydrant is adjacent to the cul-de-sac permits emergency vehicles to pass a pumper truck stationed at the hydrant during a fire. Alternatively, a pull-off could be used adjacent to the hydrant for emergency vehicle access (Reference 19).

The minimum 28-foot transition radius is based on the design vehicle turning radius.

To reduce the amount of paving, turnarounds may have center islands. However, adequate turning and maneuvering space must be provided. To expedite turning movements, the street pavement should be wider at the rear of the center island as illustrated in Figure 2.14b. Center islands create

Commentary

an attractive landscape area, and can be used for stormwater management and snow storage (Ref. 5).

Illustration 2- ff Cul-de-sac Center Island

Center island in cul-de-sac serves stormwater management purpose.

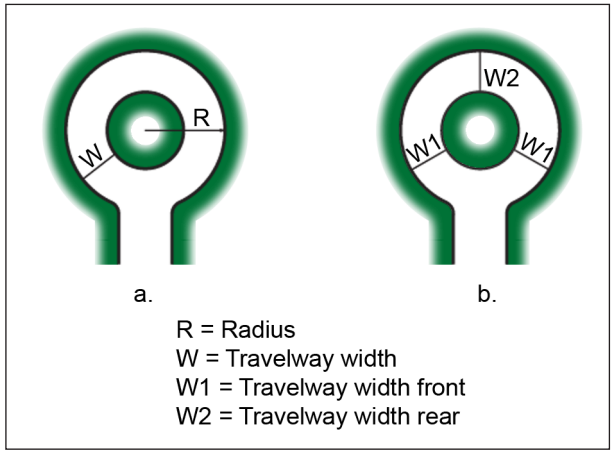
Illustration 2-gg Retangular Center Island

Center island is more rectangular in shape to relate to the adjacent housing (Washington's Landing, Pittsburgh, PA) Source: The Hamer Center for Community Design Assistance (Ref. 2)

Site designers should use the circular cul-de-sac as a basic standard; however, where possible, creative solutions that enhance the character of the community are encouraged, such as the turnaround in Illustration 2-gg where the dead-end street configuration relates to the site design and adjacent

Recommended Standards

lane can be offset as shown in Figure 2.16b with a 20-foot travel lane at the front (W1) and a 24 foot travel lane at the rear (W2). If parking is to be accommodated on the cul-de-sac, an 8-foot parking lane shall be added adjacent to the travel lane.



a. centered b. off-set

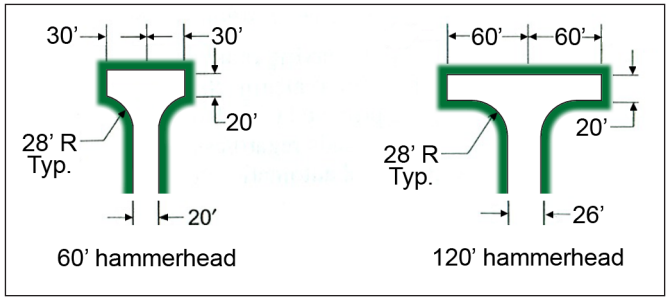
Figure 2.31. Circular Turnarounds with Center Islands
Modified from Source: National Association of Homebuilders et al., *Residential Streets* (Ref. 5)

When a fire hydrant is located adjacent to the cul-de-sac, the minimium cul-de-sac radius shall be increased as specified in Section 2.4.10.1a.

A minimum 28 foot transition radius shall be installed between the cul-de-sac street and the cul-de-sac bulb.

Recommended Standards

c. ***"T" and "Y" type turnarounds:*** The use of "T" or '"Y" turnarounds is allowable on cul-de-sacs serving 10 or fewer homes. The dimensions of a "T" turn-around are illustrated in Figure 2.32. Similarly a "Y" turnaround can be constructed with the same leg dimensions. .



a. No fire hydrant b. Fire hydrant adjacent to turnaround

Figure 2.32. "T" Turnarounds
Modified from Source: National Association of Homebuilders et al., *Residential Streets* (Ref. 5)

d. ***Cul-de-sac Length:*** As a single access street, cul-de-sacs are limited to serving no more than 30 single-family residential units.

2.4.10.2 Cul-de-sac Right-of-way: The minimum acceptable right-of-way for cul-de-sacs shall be 10 feet beyond the edge of pavement.

2.5 DESIGN STANDARDS FOR RESIDENTIAL COLLECTOR STREETS (RC)

2.5.1 Design Speed

A 35 mph design speed shall be used for the design of residential collector streets

2.5.2 Lot Access Restrictions

Commentary

architecture.

The use of "T" (sometimes refered to as hammerhead) or "Y" shaped turnarounds requires that all vehicles make a back-up movement when turning. However, they require less paving, their construction and maintenance costs are lower, and they provide greater flexibility in land planning and the location of homes.

Appendix D of the International Fire Code (Ref. 19) limits cul-de-sac length to 750 feet unless some form of secondary access is provided. As of this writing, this portion of the International Fire code has not been adopted by Pennsylvania and can not be enforced. However, safety of residents and emergency vehicle access should be a consideration when establishing cul-de-sac length.

This is an average value modified from AASHTO recommendations in Reference 1. The design speed is based more on function than terrain.

Commentary

Whenever possible, residential collector streets should have no lots directly fronting onto or gaining access from the collector street. When site or other conditions make this impossible, the amount of residential frontage indicated in Table 2-19 is allowed. This table sets out the percentage of the total length of collector streets along which residential streets may front or gain access.

The street widths are intended to minimize impervious areas while meeting the collector function. They are based on AASHTO guidelines (Ref. 1).

The use of curbing is discouraged along residential collectors to enhance opportunities to use street swales for water quality enhancement. Curbing should be provided where street drainage could cause erosion (typically when street grades exceed 4%, or where cut-slope limitations prohibit the use of street swales). Curbing should also be used to delineate the edge of pavement where appropriate.

Recommended Standards

Lot frontage and vehicular access shall be discouraged along residential collectors. Allowable access frontage is indicated in Table 2-13.

Table 2-13. Allowable Access Frontage on Residential Collector Streets

ADT*	< 1,200	1,200 – 1,599	1,600 – 2,000	> 2,000
Frontage Length**	20%	10%	5%	0%

* ADT: Average Daily Trips
** Listed as a percentage of total collector street length

Only lots having frontages of 100 feet or greater may access on to residential collector streets. Space shall be provided on these lots for turnaround movements so that vehicles will not have to back out of driveways. Lots less than 100 feet in width shall only have vehicular access via a rear alley.

2.5.3 Street Width

Tables 2-14 and 2-15 provide design matrices for use in establishing street width for residential collectors. Also see Appendices A and B.

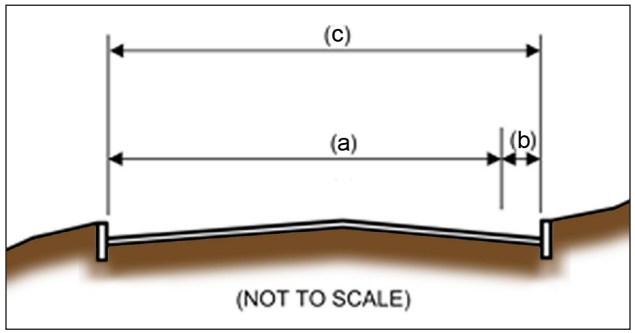


Figure 2.33. Cross-Section Profile -- Curbed Residential Collector Street

Table 2-14 .Residential Collector -- Curbed

Traffic Pattern	Parking Type	(a) Travelway Width* (ft.)	(b) Parking Lane Width (ft.)	(c) Street Width (curb to curb)
Free	No Parking	24	n/a	26**

* All travelway widths are for two-way streets; for one-way use ½ of travelway width

Recommended Standards

** One additional foot is provided on each side of the striped travelway to provide for a drainage gutter.

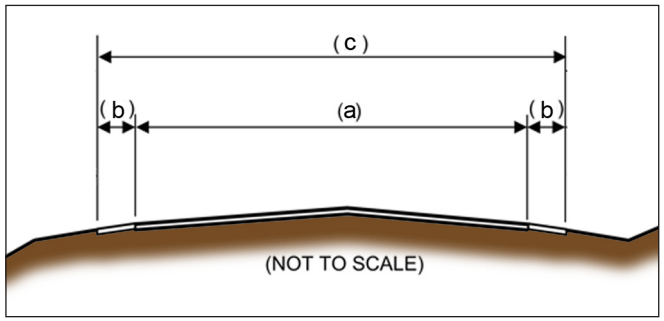


Figure 2.34. Cross-Section Profile -- Residential Collector with Reinforced Shoulder

The first 2-feet of a "reinforced shoulder" shall be gravel in accordance with PennDOT standards for gravel shoulders. The remaining width of reinforced shoulder may be either a continuation of a gravel shoulder, stabilized grass, or a combination of both. Stabilized grass shoulders shall be constructed using a soil stabilizing geo-fabric or grid under a grass surface which will support occasional parking.

Table 2-15 .Residential Collector -- Reinforced Shoulder

Traffic Pattern	Parking Type	(a) Travelway Width* (ft.)	(b) Shoulder width (each side) (ft.)	(c) Street width (shoulder to shoulder)
Free	No Parking	24	6 each	36

* All travelway widths are for two-way streets; for one-way use ½ of travelway width

2.5.4 On-street Parking

Parking is not permitted along residential collectors.

2.5.5 Bicycle Access

Where required, bicycle access shall be provided along residential collector streets either through the addition of a bicycle lane at the edge of the pavement, or by an adjacent bicycle path. Bicycle lanes and paths shall be designed in accordance with the standards in chapter 3.

Commentary

Parking is restricted along residential collectors to minimize impervious area, discourage lot frontages, and enhance traffic flow.

Collector streets can serve as bicycle and pedestrian corridors as well as corridors to move motorized vehicles. Where possible, a bicycle lane should be clearly marked. A waiver of the requirement to accommodate bicycles may be considered if there is no reasonable or safe connection for bicycle access beyond the subdivision.

Commentary

The requirement for sidewalks or pedestrian pathways may be waived if adequate pedestrian accessibility is provided by other means.

A 50-foot right-of-way width is recommended if curbing is used along the entire length of the street. If portions of the street are uncurbed, a 60-foot right-of-way is recommended. Some variability of right-of-way should be permitted to accommodate site-specific conditions, and help maximize the area available for lots.

These standards are based on recommendations in References 1, 5, and 6, and a desire to minimize the disturbance caused by excessive cut and fills.

Residential collector streets should be constructed at a line and grade consistent with the surrounding terrain to minimize disturbance. Grades up to 12% are acceptable for short distances (approximately 200 feet) in hilly or mountainous terrain as long as icing is not considered to be a significant hazard.

Where ADA-accessible sidewalks are required adjacent to the street, maximum street grades may be limited to 5%. (See chapter 3).

Residential streets should be designed without super-elevation because of the frequency of cross-

Recommended Standards

2.5.6 Pedestrian Access

Where required, sidewalks or pedestrian pathways shall be constructed along residential collector streets provided that there is a reasonable and safe destination for pedestrians along or connecting to the walkway. Sidewalks and pedestrian pathways shall be designed in accordance with the standards in chapter 3.

2.5.7 Right-of-way Width

The rights-of-way shall be established to provide adequate space for the construction and maintenance of streets, shoulders, curbs, street gutters, and cross-drainage pipes and culverts. They may also accommodate sidewalks, snow storage, sight triangles, slope maintenance areas, and utilities such as water, sewer, storm drainage, electrical service, cable TV, and gas lines where appropriate.

The right-of-way width for residential collector streets shall be as follows:

- Minimum 50 feet
- Maximum 65 feet

Right-of-way widths shall be established in even 5- foot increments.

2.5.8 Street Slope

a. *Longitudinal Slope:* 10% maximum
0.5% minimum

Steeper slopes may be permitted for short distances upon approval by the municipal engineer.

b. *Maximum longitudinal slope within 50 feet of intersections:* See Section 2.3.3.5

2.5.9 Horizontal Curvature

The minimum allowable street curvature (radius) for residential collector streets is 440 feet.

Recommended Standards

This value is to be measured along the center-line of the street. The minimum tangent length between reverse curves shall be 100 feet.

Commentary

streets, alleys, and driveways. The minimum horizontal curvature radius is based on friction factors reported in Reference 1. These friction factors were established such that the lateral force exerted in the curve causes the driver to experience a feeling of discomfort when negotiating the curve at the design speed. This criterion results in a safety factor of approximately 2 for lateral skidding (safety factor is the ratio of the friction factor for imminent skidding to the friction factor for discomfort).

The recommended minimum street curvature of 440 feet ignores the affective negative superelevation caused by the street cross slope on vehicles entering curves to the left (Reference 1). For these vehicles the factor of safety against imminent skidding is reduced to 1.8 for streets having cross slopes of 3% and 1.9 for streets having cross slopes of 2%. In addition, a greater feeling of discomfort will be experienced. To maintain a safety factor of 2 for all vehicles, a minimum curvature of 490 feet should be maintained.

Note that if street superelevation is being used, minimum horizontal curvatures should be based on standards in the current version of Reference 1 for superelevated streets.

2.6 DESIGN STANDARDS FOR RESIDENTIAL MIXED-USE COLLECTORS (RMC)

2.6.1 Design Speed

A 30 mph design speed shall be used for the design or residential mixed-use collector streets.

This is an average value modified from AASHTO recommendations in Reference 1. The design speed is based more on function than on terrain.

2.6.2 Street Width

Tables 2-16 and 2-17 provide design matrices for use in establishing street width for residential mixed-use collectors. Also see Appendices A and B.

Lane widths are used to permit access by delivery vehicles but maintain a relatively narrow street to discourage high traffic speeds. This width is based on AASHTO guidelines in Reference 1.

Commentary

An 8-foot parking lane is used to provide a measure of comfort in entering and exiting vehicles adjacent to moving traffic. It is anticipated that parking will be provided along residential mixed-use collectors for access to neighborhood commercial facilities.

Curbed streets are recommended where street access to neighborhood commercial properties is desired.

Recommended Standards

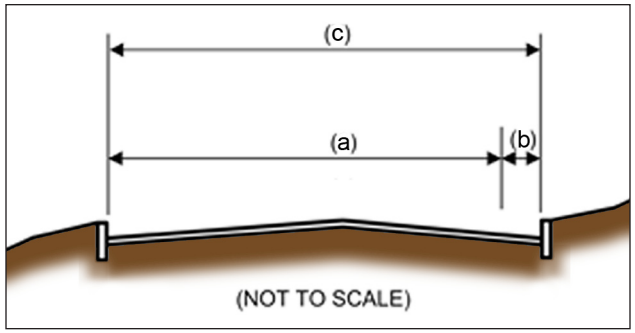


Figure 2.35. Cross-Section Profile -- Curbed Residential Mixed-Use Collector Street

Table 2-16. Residential Mixed-Use Collector -- Curbed

Traffic Pattern	Parking Type	(a) Travelway Width* (ft.)	(b) Parking Lane Width (ft.)	(c) Street Width (curb to curb)
Free	No parking	22	0	22
Free	One lane	22	8	30
Free	Two lanes	22	8 each side	38

* All travelway widths are for two-way streets; for one-way use ½ of travelway width

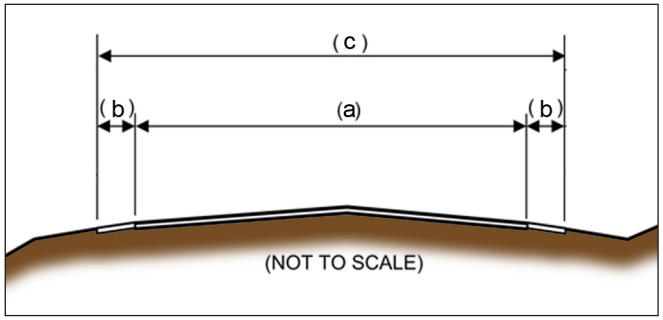


Figure 2.36. Cross-Section Profile -- Residential Mixed-Use Collector with Reinforced Shoulder

The first 2-feet of a "reinforced shoulder" shall be gravel in accordance with PennDOT standards for gravel shoulders. The remaining width of reinforced shoulder may be either a continuation of a gravel shoulder, stabilized grass, or a combination of both. Stabilized grass shoulders shall be constructed using a soil stabilizing geo-fabric or grid under a grass surface which will support occasional parking.

Recommended Standards

Table 2-17. Residential Mixed-Use Collector -- Reinforced Shoulder

Traffic Pattern	Parking Type	(a) Travelway Width* (ft.)	(b) Shoulder width (each side) (ft.)	(c) Street Width (shoulder to shoulder)
Free	No Parking	22	6 each	34

* All travelway widths are for two-way streets; for one-way use ½ of travelway width

2.6.3 On-street Parking

All on-street parking shall be delineated with white striping and shall meet the standards of section 2.3.2.

2.6.4 Bicycle Access

When provided, bicycle access shall be located as follows:

On-street parking: Locate bicycle paths off travel lanes and buffered from vehicular traffic.

No on-street parking: A bicycle lane may be designed as a part of the street.

Bicycle lanes and bicycle paths shall be design in accordance with the standards in chapter 3.

2.6.5 Pedestrian Access

Sidewalks or pedestrian path ways shall be provided along residential mixed-use collectors. Sidewalks and pedestrian path ways shall be designed in accordance with the standards in chapter 3.

2.6.6 Right-of-way Width

The rights-of-way shall be established to provide adequate space for the construction and maintenance of streets, shoulders, curbs, street gutters, and cross drainage pipes and culverts. They may also accommodate sidewalks, snow storage, sight triangles, slope maintenance areas, and utilities such as water, sewer, storm drainage, electrical service, cable TV, and gas lines where appropriate.

Commentary

On-street parking is encouraged for access to neighborhood commercial properties.

Bicycle access to neighborhood commercial and multi-family residential properties is encouraged. To avoid conflicts between bicycles and parked cars, bicycle lanes should not be a part of the street pavement when on-street parking is specified.

Sidewalks or pedestrian pathways shall be provided as necessary to provide pedestrian accessibility to neighborhood commercial and multi-family residential properties. Appropriate buffering should be provided between pedestrians, bicycles, and motorized vehicles within these corridors.

A 50-foot right-of-way width is recommended if curbing is used. Some variability in right-of-way should be permitted to accommodate site-specific conditions, and help maximize the area available for lots.

Commentary

The 8% street grade limitation is intended to provide comfortable street access to neighborhood commercial properties. Residential mixed-use collector streets should be constructed at a line and grade consistent with the surrounding terrain to minimize disturbance. Where ADA-accessible sidewalks are required adjacent to the street, maximum street grades may be limited to 5%.

Residential streets should be designed without superelevation because of the frequency of cross-streets, alleys, and driveways. The minimum horizontal curvature is based on friction factors reported in Reference 1. These friction factors were established such that the lateral force exerted in the curve causes the driver to experience a feeling of discomfort when negotiating the curve at the design speed. This criteria results in a safety factor of approximately 2 for lateral skidding (safety factor is the ratio of the friction factor for imminent skidding to the friction factor for discomfort).

The recommended minimum street curvature of 275-feet ignores the affective negative superelevation caused by the street cross slope on vehicles entering curves to the left. For these vehicles the factor of safety against imminent skidding is reduced to 1.8 for streets having cross slopes of 3% and 1.9 for streets having cross slopes of 2%. In addition, a greater feeling of discomfort will be experienced. To maintain a safety factor of 2 for all vehicles, a minimum curvature of 320 feet should be maintained.

Recommended Standards

The right-of-way width for residential mixed-use collector streets shall be as follows:

- Minimum 50 feet
- Maximum 65 feet

Right-of-way widths shall be established in even, 5-foot increments.

2.6.7 Street Slope

a. *Longitudinal slope:* 8% maximum
0.5% minimum

b. *Maximum longitudinal slope within 50 feet of intersections:* See section 2.3.3.5

2.6.8 Horizontal Curvature: The minimum allowable street curvature (radius) for residential mixed-use collector streets is 275 feet. This value is to be measured along the center-line of the street. The minimum tangent length between reverse curves shall be 100 feet.

Recommended Standards

2.7 DESIGN STANDARDS FOR ALLEYS

When used, alleys shall be designed in a linear or curvilinear grid configuration. Rear lot alleys can be accessed from perpendicular side streets and/or side lot alleys. The spacing between rear lot alley access points shall not exceed 600-feet measured from edge of right-of-way to edge of right-of-way as illustrated in Figure 2.37.

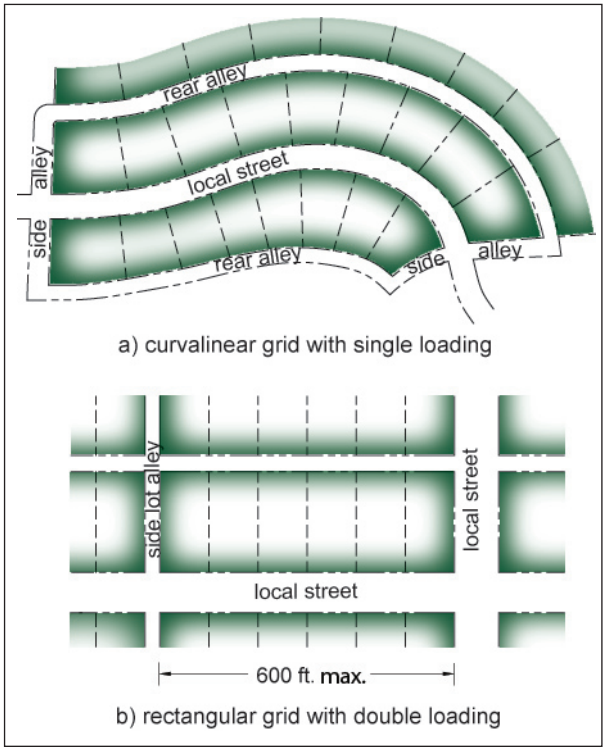


Figure 2.37. Alley Layout

2.7.1 Geometric Standards

Minimum paved cart-way	12 ft.
Curbs	Not permitted
Minimum shoulder width	2 ft. (stabilized grass or gravel)
Minimum right-of-way	16 ft. (20 ft. recommended)
Pavement cross slope	Inverted; 2% min and 6% max (see Figure 2.38)
Longitudinal slope	No limitations; Alley slope should not exceed 25%
Horizontal curvature	No limitations

Commentary

Alleys provide rear lot access. They have historically been used in small-town, grid-type subdivision configurations. However, they are also adaptable to configurations characteristic of rural or suburban cluster developments. Alleys are particularly useful when lot frontages are less than 80 feet.

A 12-foot cart-way provides for one clear travel lane. When vehicles approach each other from opposite directions, both vehicles must yield and pull onto the shoulder to pass. Curbs along alleys would interfere with passing movements and are not permitted. Some communities choose to make alleys one-way to avoid the need for vehicles to pass.

The longitudinal slope of alleys should follow the natural grade.

At the time of this writing, only cities and boroughs

Commentary

can collect liquid fuels taxes for rights-of-way less than 33 feet. To meet this requirement, a 33-foot alley right-of-way may be appropriate in some instances. Figure 2.39 compares a 16-foot alley right-of-way with 10-foot building setback, with a 33-foot alley right-of-way having a 12-foot cart-way and 1.5-foot building set-back. Where feasible, it is recommended that the right-of-way be reduced to a 12-foot cart-way.

Pavement cross-slope is inverted to accommodate alley drainage.

Temporary standing for up to 15 minutes is intended to permit short-term loading and unloading of vehicles. State Code Title 67, Chapter 601.6, prohibits parking in the traffic lane of any street.

An 8-foot spread will result in a very thin layer of

Recommended Standards

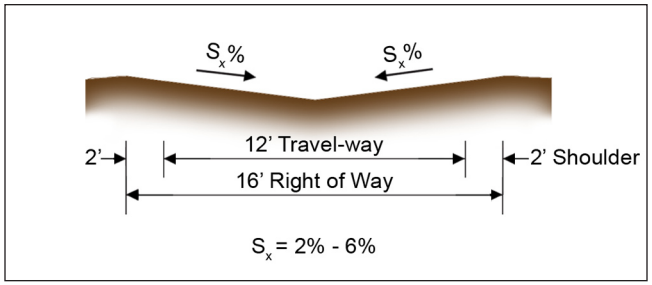


Figure 2.38. Alley Cross Section -- Inverted Crown

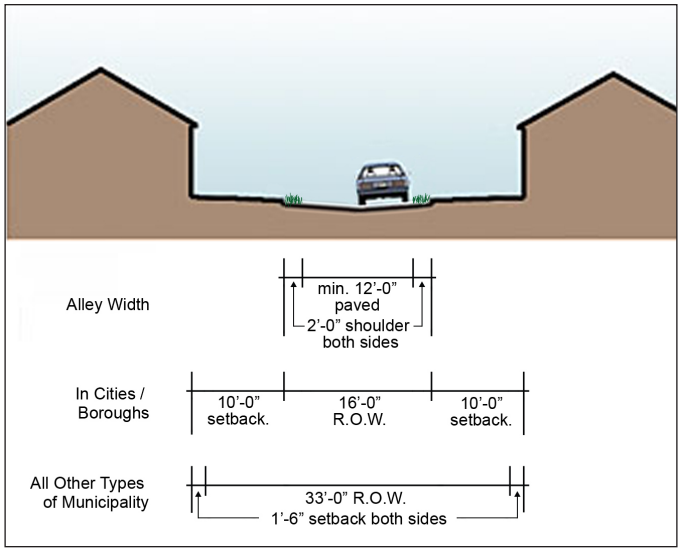


Figure 2.39. Alley Right-of-way

Source: The Hamer Center for Community Design Assistance (Ref. 2)

2.7.2 Parking

Parking is not permitted within alley rights-of-way. Adequate parking for residents and visitors must be provided on-lot or in separate, dedicated parking facilities. Temporary standing to the side of the right-of-way is permitted for up to 15 minutes as long as sufficient space exists for a vehicle to pass within the right-of-way.

2.7.3 Drainage

Recommended Standards

Drainage inlets shall be located along alley center-lines to limit the flow spread on the pavement to less than 8 feet during a 10-year-frequency event.

2.8 DIVIDED STREETS

With the exception of the cross-sectional geometry, boulevards and parkways shall be designed to the same standards as residential collectors.

2.8.1 Street Width

Tables 2-18 and 2-19 provide a design matrix for use in establishing street width for boulevards and parkways. Also see Appendices C and D.

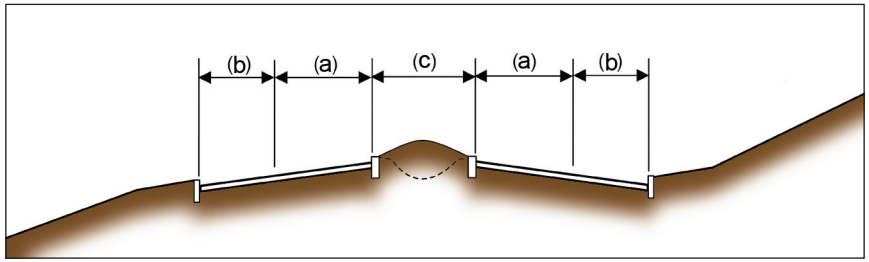


Figure 2.40. Cross-Section -- Divided Street, Boulevard with Curb

Table 2-18. Divided Streets -- Boulevard with Curb

Parking Type	(a) Lane Width* (ft.)	(b) Parking Lane Width (ft.)	(c) Minimum Median Width (ft.)
No parking	11	0	10
Parallel	11	8	10
Angled parking ***	****	18	10

* Provide the number of lanes necessary to accommodate anticipated traffic
** Stabilized grass is acceptable
*** Only permitted where anticipated traffic volume is less than 1,500 ADT
**** Lane width must accommodate backing movement from parking space

Commentary

water under the wheel path of a standard vehicle. At the slow travel speeds characteristic of alleys, this will not cause a safety hazard.

In urban and growth expansion areas, boulevards can be designed to include a secondary access street on either side of the main travel lanes. In these instances, the access streets should be divided from the main travel lanes by a median. This condition is typical in older regions, especially when residential uses face boulevard streets. For a range of boulevard street types, see *The Boulevard Book: History, Evolution, Design of Multiway Boulevards* (Ref. 20).

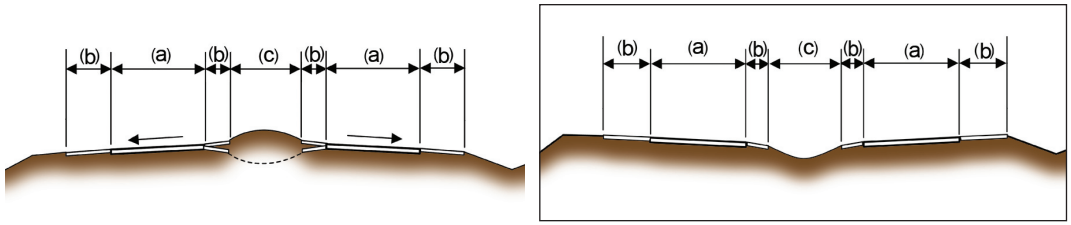
If travel lanes are designed to slope towards median, curbs can be designed with breaks to allow stormwater to drain into median, as shown in Illustration 2-hh.

Illustration 2-hh. Curb with Breaks for Drainage

Commentary

Restricting the number of lots that gain access from a stub street is intended to restrict their use for lot access except for those limited occasions when no other means of access is available based on site geometrics.

Recommended Standards



a. Parkway with drainage away from median b. Parkway with drainage toward median

Figure 2.41. Cross-Section Profile -- Divided Street, Parkway with Reinforced Shoulder

Table 2-19. Divided Streets - Parkway with Reinforced Shoulder

Parking Type	(a) Lane Width* (ft.)	(b) Shoulder Width (ft.)	(c) Minimum Median Width (ft.)
No parking	11	4 one side + 2 one side = 6	10

* Provide the number of lanes necessary to accommodate anticipated traffic.

2.8.2 On-street Parking

All on-street parking shall be delineated with white striping and shall meet the standards of Section 2.3.2.

2.8.3 Right-of-way Width

The rights-of-way shall be established to provide adequate space for the construction and maintenance of streets, shoulders, curbs, street gutters, and cross-drainage pipes and culverts. They may also accommodate sidewalks, snow storage, sight triangles, slope maintenance areas, and utilities such as water, sewer, storm drainage, electrical service, cable TV, and gas lines where appropriate.

2.9 STUB STREETS

Stub streets can be constructed for the future extension of residential access, collector, and mixed use collector streets as specified in section 2.2.4.3. Stub streets shall be designed in accordance with its street classification based on anticipated traffic volume and function.

No more than four (4) lots may gain access from a stub street. However, a temporary

Recommended Standards

turn-around must be provided if any residential lots gain access from the stub street. To reduce land disturbance, the temporary turn around shall comply with “T” or “Y” turnaround standards in Section 2.4.10.1.c.

2.10 RESIDENTIAL STREET CONSTRUCTION DETAILS

The street construction details contained herein are minimum standards. These standards are adequate to provide safe, durable residential streets. In no case shall a proposed design provide for less than these standards require. Designs in excess of these standards shall be required when conditions warrant. Materials and construction methods shall comply with the latest edition of PennDOT specifications contained in PennDOT Publication 408.

The municipality may approve alternate designs for material type, depth, and width when sound engineering analysis proves the acceptability of the alternate. In no instance shall a proposed alternate design be less than the minimum requirement contained herein.

2.10.1 Street Cross Section

The major elements of a street cross section include travel lanes, parking lanes, shoulder and curb areas, and area outside the defined street that can be used to provide for drainage, utility location (water, sewer, storm drainage, power, cable, gas, phone, etc), sidewalks, and landscaping. In addition to defining the location of critical cross-section elements, the sections define permissible cross slopes for each or the cross-section elements. The full cross-sections for curbed streets, uncurbed streets, alleys, parkways, and boulevards are provided in Figures 2.54 through 2.58 of Appendices A through D.

2.10.2 Pavement Structure

The pavement structure for each street classification shall be as identified in Figure 2.42. These pavement sections are based on an assumed subgrade strength defined by a California Bearing Ratio (CBR) of 3. Equivalent or alternate pavement sections may be used as defined below:

1. *Equivalent Pavement Section*: An equivalent pavement section is one that has the same Design Structural Number (SN) as the sections defined in Figure 2.42. The design structure number is given by the following equation:

$$SN = a_1d_1 + a_2d_2m_2 + \ldots + a_id_im_i$$

Commentary

A CBR of 3 is considered to represent a poor subgrade condition with a roadbed soil modulus of approximately 4,500 psi.

Structural coefficients tabulated in Reference 24 are provided in the following table for convenience.

Commentary

Table 2.-20. Structural Coefficients for Common Flexible Pavement Materials

Pavement Component	Structural Coefficient
Surface Course:	
Superpave 9.5 mm, 12.5 mm, 19 mm, 25 mm, (wearing and binder courses)	0.44
ID-2, ID-3 (wearing and binder courses)	0.44
FB-1, FB-2 (wearing and binder course)	0.20
FJ-1, FJ-1C, FJ-4 (wearing and binder course)	0.35
Base Course:	
Plain Cement Concrete (PCBC)	0.50
Lean Cement Concrete (LCBC)	0.40
Superpave 25 mm, 37.5 mm, base course	0.40
Bituminous Concrete (BCBC)	0.40
Crushed Aggregate (CABC)	0.14
Crushed Aggregate, Type DG (CABCDG)	0.18
Aggregate – Bituminous (ADDC)	0.30
Aggregate – Cement (ACBC)	0.40
Aggregate – Lime – Pozzolan (ALPBC)	0.40
Subbase:	
Open Graded Subbase	0.11
No. 2A Subbase	0.11
Asphalt Treated Permeable Base Course (ATPBC)	0.20
Cement Treated Permeable Base Course (CTPBC)	0.20

Recommended Standards

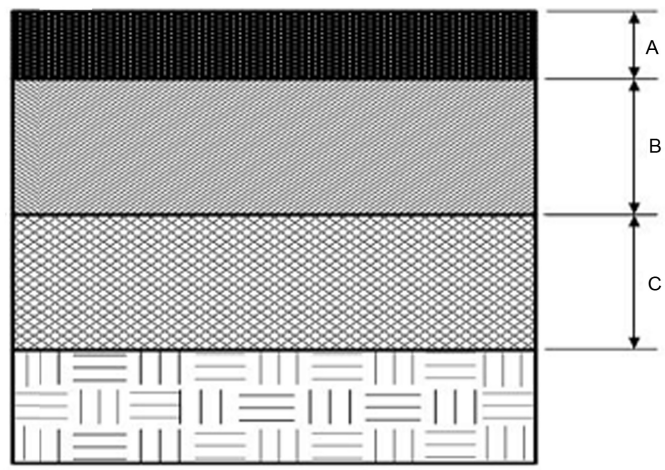
Where:

SN = Design Structural Number
a_i = Structural coefficient for layer i
d_i = Thickness of layer i
m_i = Drainage coefficient for layer i

Values of a_i and m_i, and minimum pavement layer thicknesses shall be in accordance with current PennDOT standards (see Reference 24).

Layer thicknesses for Equivalent Pavement Structures shall be provided in 0.5-inch increments.

Computations supporting the use of an Equivalent Pavement Section must be submitted and approved prior to use of an equivalent section. Said computations are to be prepared and sealed by a professional engineer licensed to practice in the Commonwealth of Pennsylvania.



(Not to Scale)

Recommended Standards

Course Designation		Street Classification			
		Residential and Residential Mixed-Use Collectors	Residential Access, Residential Collector, and Mixed-Use Collector	Residential Access	
		ADT < 3,000	ADT < 2,000	ADT < 1,000	ADT < 400
A	Bituminous Surface Course	1.5 inches	1.5 inches	1.5 inches	1.5 inches
B	Bituminous Base Course	6.0 inches	3.5 inches	4.0 inches	3.0 inches
C	Granular Subbase	6.0 inches	6.0 inches	6.0 inches	6.0 inches
Section Design Structural Number		3.7	3.3	2.7	2.5

Figure 2.42. Roadway Pavement Structure Detail

2. *Alternate Pavement Section*: Alternate pavement sections shall be allowed if street subgrade CBR values are demonstrated to be 4 or greater. Alternate pavement sections shall conform to the PennDOT full-depth pavement design procedure outlined in the most current version of Reference 24.

   The following information must be submitted in support of a request for use of an Alternate Pavement Section:

   a. Laboratory report documenting field and laboratory test procedures and results supporting a CBR value equal to or greater than 4. This report is to be certified by a professional geologist or engineer in responsible supervision of the laboratory testing who is licensed to practice in the Commonwealth of Pennsylvania.
   b. Pavement design computations sealed by a professional engineer licensed to practice in the Commonwealth of Pennsylvania.

2.10.3 Curb Detail

Figures 2.43 through 2.48 illustrate a variety of curb details that are applicable to residential streets.

Commentary

Rubblized Cement Concrete	0.20

Source: Ref. 24

Reference 24 recommends the that drainage coefficient, m_i, be set equal to 1.0 for all flexible pavement materials, and provides minimum and maximum layer thicknesses for various combinations of surface, base, and subbase materials.

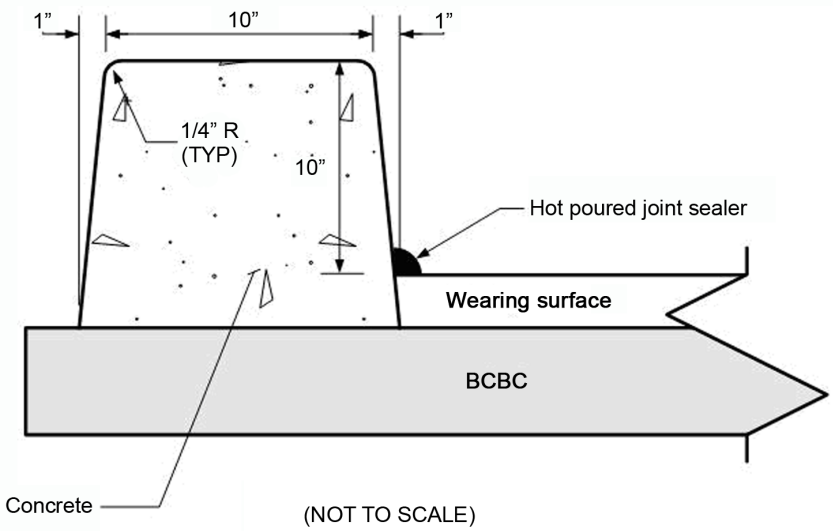
The pavement layer thicknesses identified in Figure 2.42 are based on PennDOT pavement design procedures as defined in Reference 24. The following assumed design values were used to determine the pavement section structural numbers identified in Figure 2.42.

Design Period: 25 years
Reliability: 85%
Standard Deviation: 0.45
Effective Roadbed Soil Modulus: 4500 psi (CBR = 3)
Serviceability Loss Due to Frost Heave:
1.5 local access streets
1.2 collectors
Total Design Serviceability Loss:
0.7 local access streets
0.5 collectors

In addition, axle loadings were considered for typical annual axle loads from passenger vehicles, school busses, garbage trucks, delivery trucks, trash and refuse pick-up, commercial delivery semi trucks and moving vans.

If a roadbed subgrade CBR value of 5 is found for a site, and all other pavement design parameters are assumed to remain as identified above, residential and mixed use collector streets with ADT < 3000 could be constructed with a 4-inch bituminous concrete base course instead of a 6-inch bituminous base course. Using 2006 cost data (Ref. 25) this equates to a savings of $20 per linear foot for a 30-foot wide street.

Recommended Standards



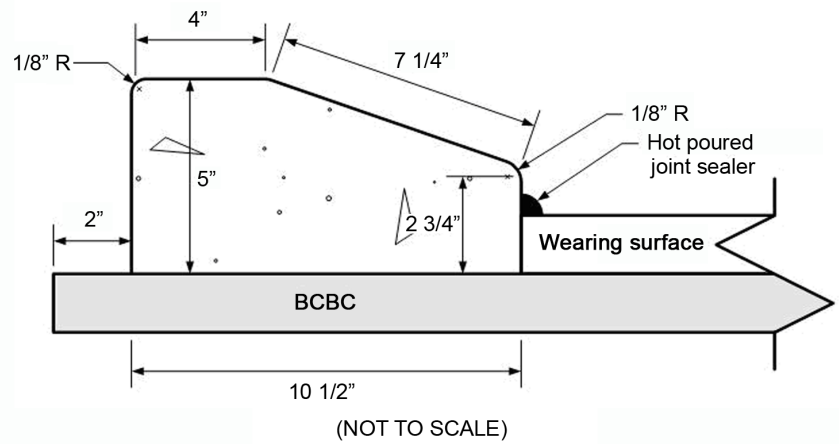
NOTES:

(1) Concrete to be class A except with a maximum slump of 1 1/2”.

(2) Place concrete using a slip form process on a bituminous concrete base coarse.

(3) Longitudinal joints to be as specified on a PaDOT RC-64 and in Publication 408, Section 705.4. Contraction joints to be as specified in Publication 408, Section 630.3.

Figure 2.43. Vertical Face Extruded Curb Detail



NOTES:

(1) Concrete to be class A except with a maxiumum slump of 1 1/2”.

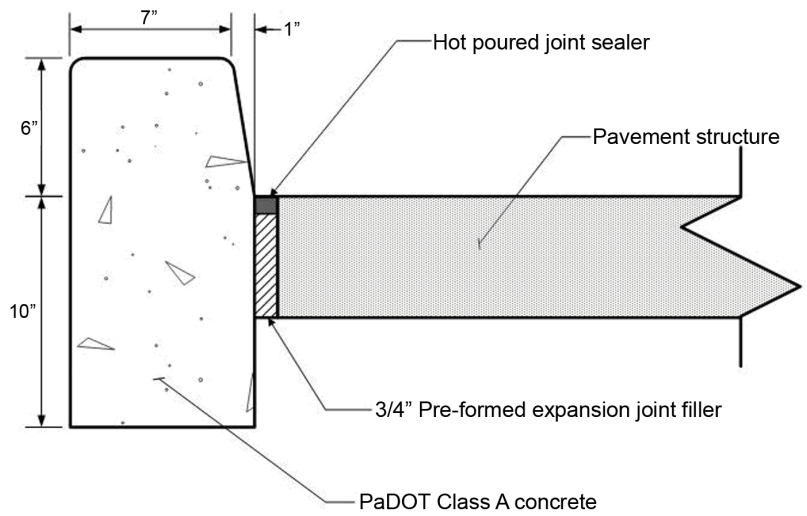
(2) Place concrete using a slip form process on a bituminous concrete base coarse.

(3) Longitudinal joints to be as specified on PaDOT RC-64 and in PaDOT Publication 408, Section 705.4

(4) Contraction joints to be as specified in PaDOT Publication 408, Section 630.3.

Figure 2.44. Mountable Extruded Curb Detail

Recommended Standards



(NOT TO SCALE)

NOTES:

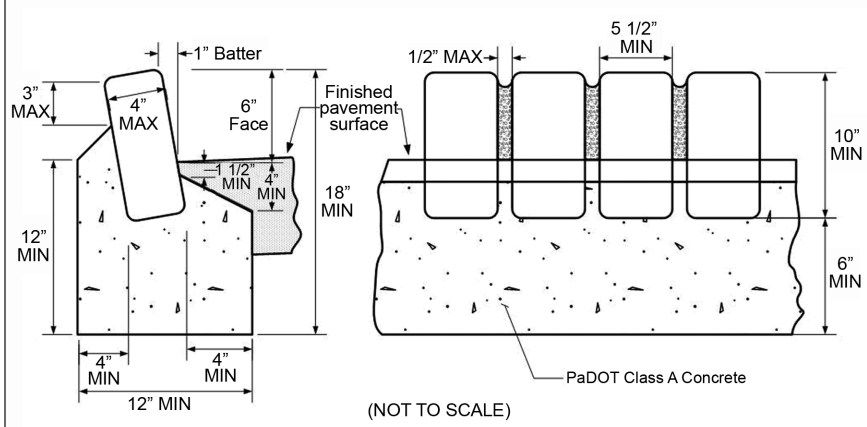
(1) All materials and installation to be in accordance with PaDOT Publication 408, section 630.

(2) Place 3/4” Pre-molded expansion joint filler material at structures (including adjacent sidewalks) and at the end of the work day.

(3) All corners to be rounded to a 1/4” radius.

(4) Space contraction joints in uniform lengths (maximum 20”, minimum 4’). Contraction joints to be as detailed on PaDOT RC-64.

Figure 2.45. Mountable Extruded Curb Detail



(NOT TO SCALE)

NOTES:

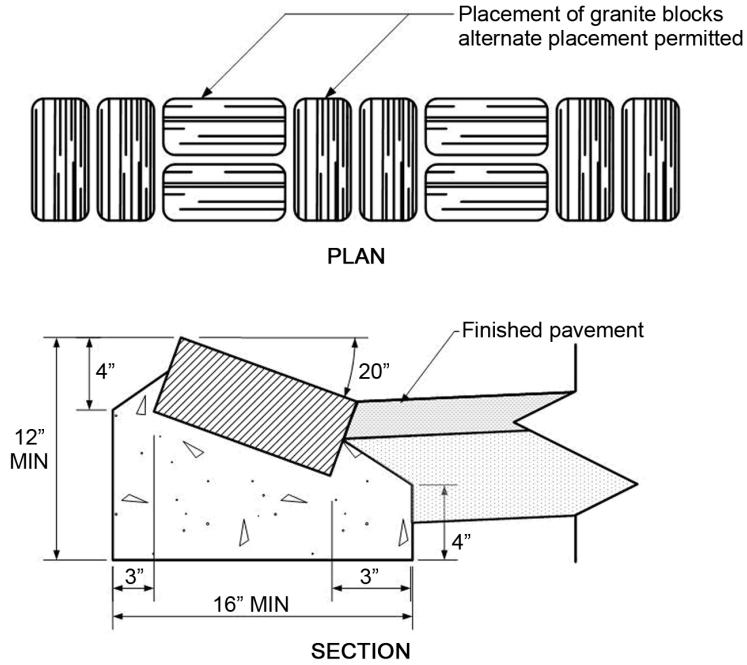
(1) Joints to be 1/2” wide using cement mortar struck with concrete tool.

(2) Concrete to be PaDOT Class A.

(3) Place 3/4” pre-molded expansion joint filler at structures and at the end of the day.

Figure 2.46. Granite Block Vertical Curb Detail

Recommended Standards



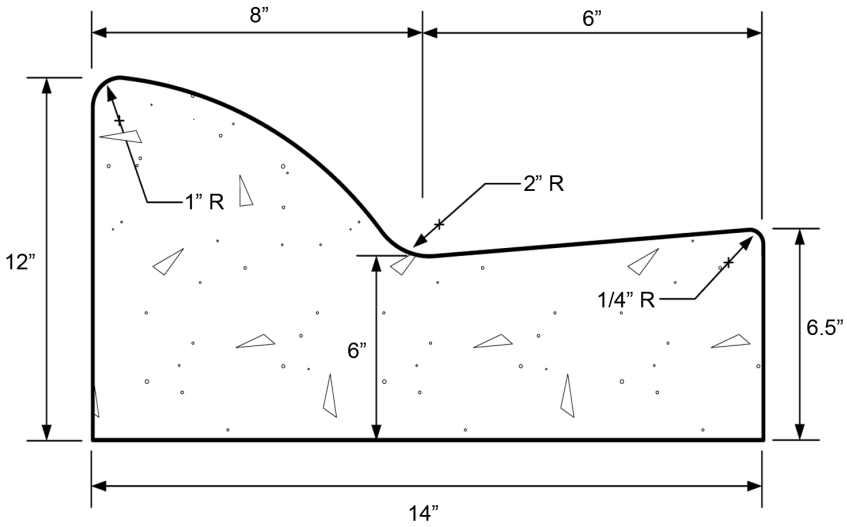
(NOT TO SCALE)

NOTES:

(1) Concrete to be PaDOT Class A.

(2) Place 3/4” pre-molded expansion joint filler at structures and at the end of work day.

Figure 2.47. Granite Block Mountable Curb Detail



(NOT TO SCALE)

NOTES:

(1) Concrete to be PaDot Class A.

(2) Place 3/4” pre-molded expansion joint filler material at structures (including adjacent sidewalks) and at the end of the the work day.

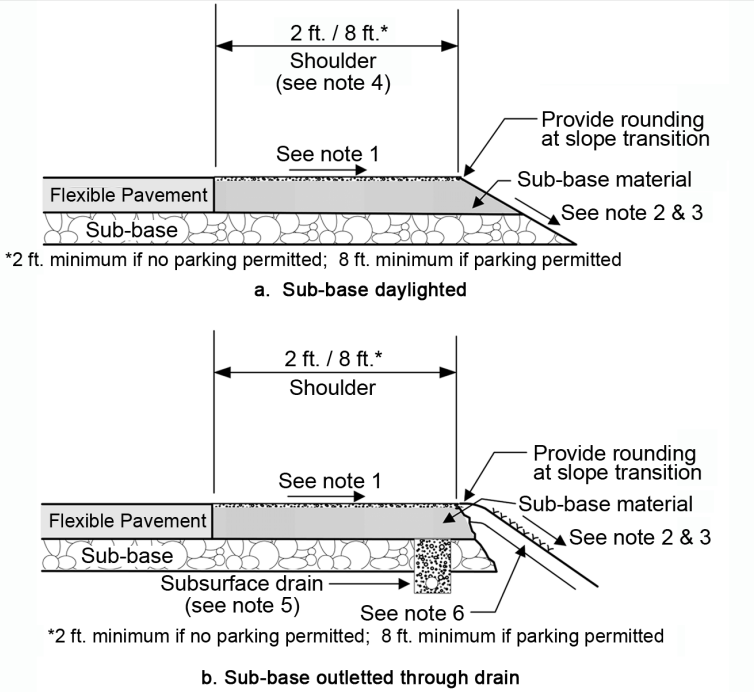
(3) Space contraction joints in uniform lengths (20’maxiumum and 4’ minimum).

Figure 2.48. Concrete Rolled Curb and Gutter Detail

Recommended Standards

2.10.4 Shoulder Structure

Uncurbed streets shall be constructed with shoulder areas in accordance with the detail in Figure 2.49 and 2.50.



NOTES:

(1) Slope shoulder at 4% to 6%; sub-base to follow same slope as shoulder surface.

(2) Slope variable to 4:1 (H:V) maximum.

(3) Subsurface drain shall be used where sub-base is not outletted.

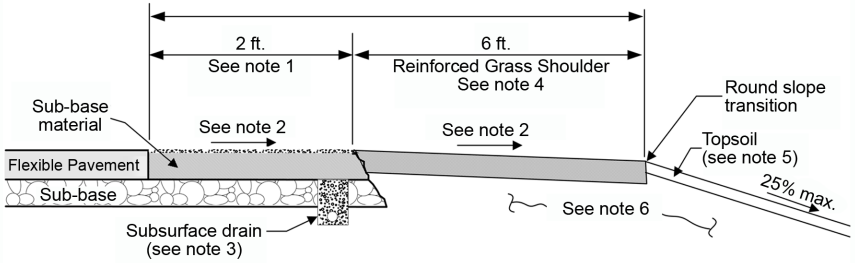
(4) Shoulder material and construction to be PaDOT type 3 shoulder as specified in latest version of PaDOT publication 408 and 70m (RC-25).

(5) Subsurface drain to be constructed as specified in latest version of PaDOT publication 408 & 70m (RC-30).

(6) Provide 4 inches of topsoil minimum over embankment material (fill section) or natural subsoil (cut section). Tamp and seed/sod.

Figure 2.49. PA DOT Type 3 Shoulder Detail

Shoulder Detail with Reinforced Grass Parking Strip



NOTES:

(1) Materials and construction to be PaDOT type 3 as specified in latest version of PaDOT publication 408 and 70m (RC-30).

(2) Shoulder slope 4% - 6%; sub-base to follow same slope as shoulder suface.

(3) Subsurface drain to be constructed as specified for subsurface drains in latest version of PaDOT publication 408 & 70m (RC-30).

(4) Grass shoulder to be reinforced using geotextile or other product to support AASHTO HS-20 loading. Reinforcement to be installed per manufacturers recommendations.

(5) Provide a minimum of 4 inches of topsoil over embankment fill or natural subsoil. Tamp and seed/sod. If cut is in rock provide minimum 1 foot topsoil as seed bed.

(6) Embankment fill (fill section) or natural subsoil (cut section).

Figure 2.50. Shoulder Detail with Reinforced Grass Parking Strip

Recommended Standards

2.10.5 Driveway Curb-Cut Details

Driveway curb-cuts shall be constructed as illustrated in Figures 2.51 – 2.53.

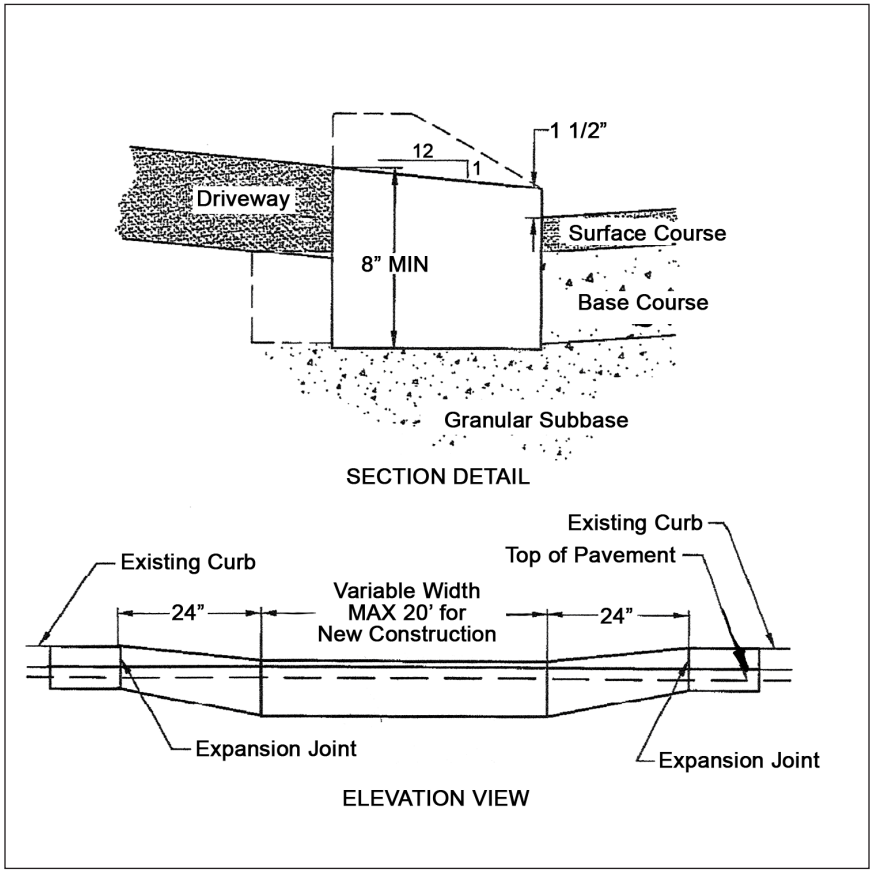


Figure 2.51. Driveway Curb-cut Detail for Extruded Curbs

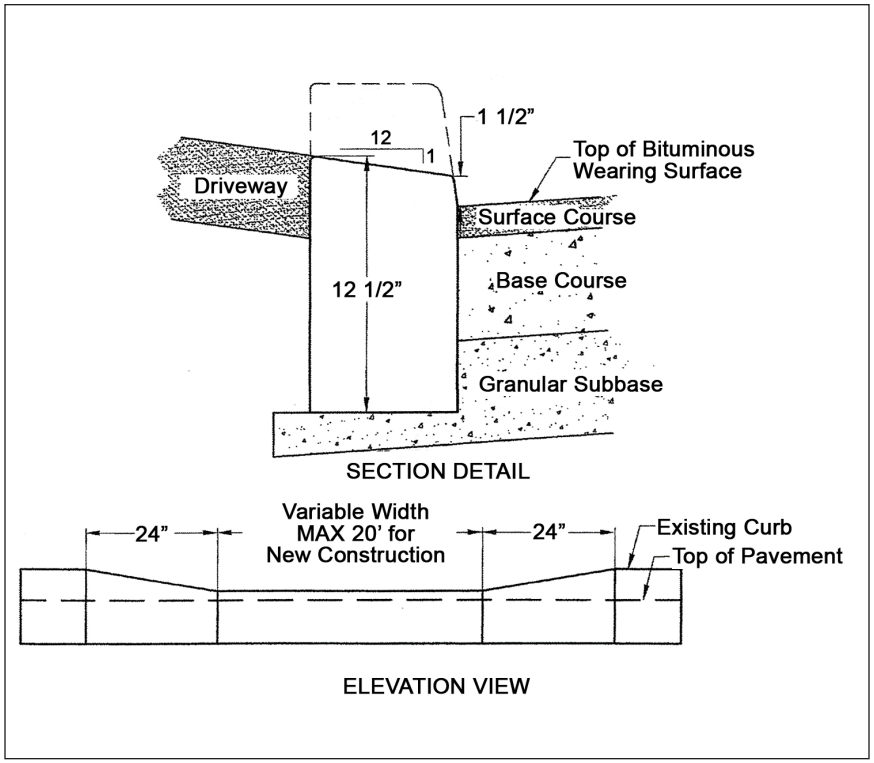


Figure 2.52. Driveway Curb-cut Detail for Full Depth Vertical Face Curb

Recommended Standards

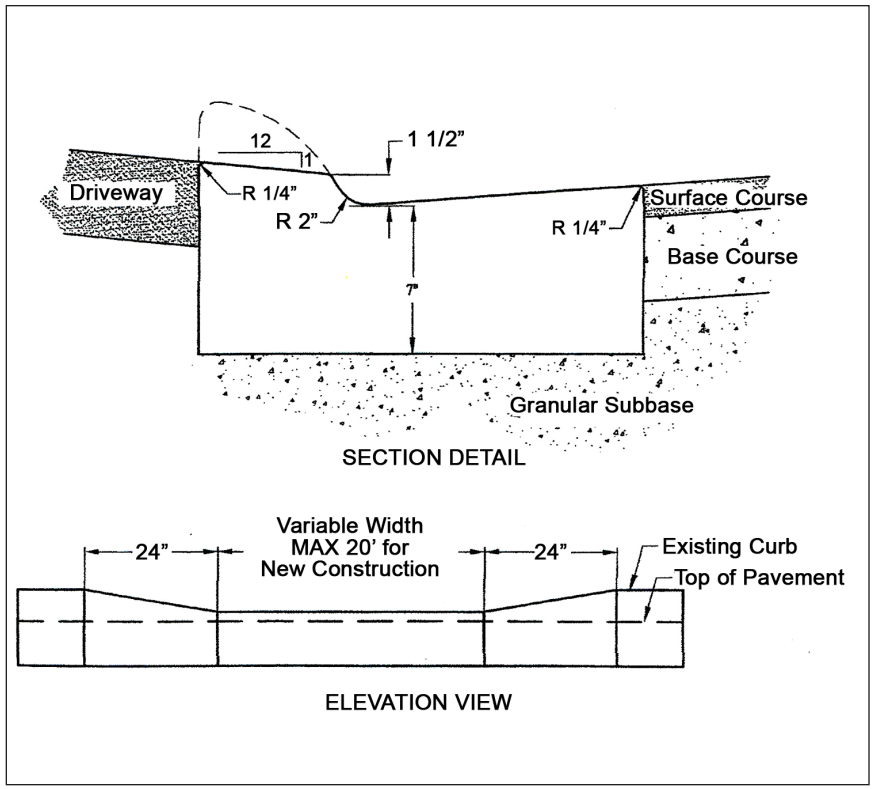


Figure 2.53. Driveway Curb-cut Detail for Rolled Curb

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www.walkinginfo.org

Appendix A - Curbed Streets

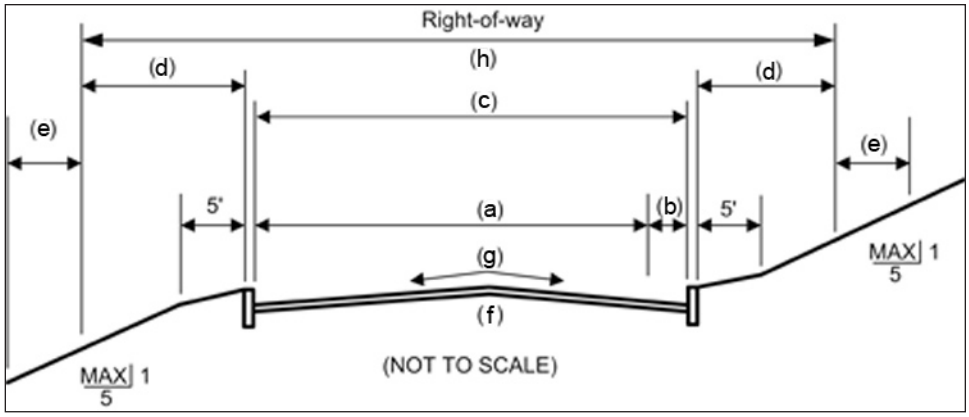

Figure 2.54. Cross-Section -- Curbed Streets

Table 2-9. Residential Access Type A -- Curbed

Traffic Pattern	Parking Type	(a) Travelway Width* (ft.)	(b) Parking Lane Width (ft.)	(c) Street Width (curb to curb)
Yield **	One Side or Alternating Sides	10	8	18
Slow	Alternating Sides	18	8	26
Free	No Parking	18	n/a	18
Free	One Side	18	8	26

* All travelway widths are for two-way streets; for one-way use ½ of travelway width except for "yield" traffic pattern.
** Use only when ADT less than or equal to 300.

Table 2-10. Residential Access Type B - Curbed

Traffic Pattern	Parking Type	(a) Travelway Width* (ft.)	(b) Parking Lane Width (ft.)	(c) Street Width (curb to curb)
Slow	Alternating Sides	20	8	28
Free	No Parking	20	n/a	20
Free	One Side	20	8	28
Free	Two Sides	20	8 each side	36

* All travelway widths are for two-way streets; for one-way use ½ of travelway width

Table 2-14 .Residential Collector - Curbed

Traffic Pattern	Parking Type	(a) Travelway Width* (ft.)	(b) Parking Lane Width (ft.)	(c) Street Width (curb to curb)
Free	No Parking	24	n/a	26**

* All travelway widths are for two-way streets; for one-way use ½ of travelway width
** One additional foot is provided on each side of the striped travel-way to provide for a drainage gutter.

Appendix A - Curbed Streets (cont.)

Table 2-16. Residential Mixed-Use Collector -- Curbed

Traffic Pattern	Parking Type	(a) Travelway Width* (ft.)	(b) Parking lane Width (ft.)	(c) Street Width (curb to curb)
Free	No Parking	22	0	22
Free	One Lane	22	8	30
Free	Two Lanes	22	8 each side	38

* All travelway widths are for two-way streets; for one-way use ½ of travelway width

(a) Travelway width: See Tables 2-9, 2-10, 2-14, 2-16
(b) Parking lane width: See Tables 2-9, 2-10, 2-14, 2-16
(c) Curb to curb street width:
See Tables 2-9, 2-10, 2-14, 2-16
(d) Sidewalk / utility area within right-of-way (also see chapter 3, section 3.1.1, Sidewalk Location)
Width: Variable depending on cartway width.
Ground Slope: A maximum cross slope of +2% shall be maintained for a 5 foot distance behind the curb. Beyond this point, a maximum cross-slope of 4 horizontal to 1 vertical shall be permitted. If a sidewalk is to be located within this area, a 2% ground cross-slope (positive or negative) shall be maintained from the edge of curb to 3 feet beyond the outside edge of sidewalk. If utilities are to be located within this area, a minimum 10-foot width utility corridor shall be provided having a maximum cross slope of 5 horizontal to 1 vertical (+20%).
(e) Sidewalk / utility easement area outside right-of-way
Width: As needed.
Ground Slope: If utilities are to be maintained in this area, a minimum 10-foot width utility corridor shall be proviced having a maximum cross-slope of 5 horizontal to 1 vertical (+20%). If a sidewalk is located within this area a 2% ground cross-slope (positive or negative) shall be maintained across the sidewalk and within 3 feet of either side of the sidewalk.

(f) Crown Location: Centered on the travelway except for residential access type A. streets where it shall be located along one curb-line.
(g) Pavement cross slope:
2% minimum
4% maximum
(h) Right-of-way width: 50 feet. On residential collectors this width may be increased if a traffic study documents the need for more than one lane in each direction.

Appendix B - Uncurbed Streets

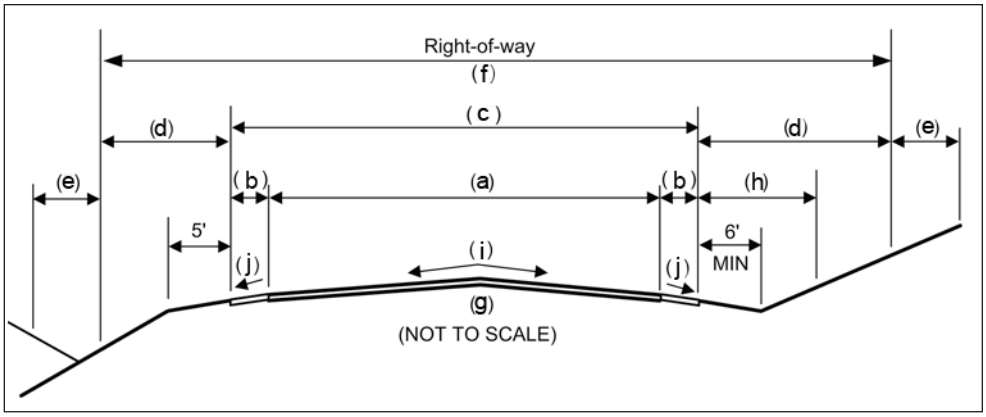

Figure 2.55. Cross-Section -- Uncurbed Streets with Reinforced Shoulder

Table 2-11. Residential Access Type A -- Reinforced Shoulder

Traffic Pattern	Parking Type	(a) Travelway Width* (ft.)	(b) Shoulder Width (each side) (ft.)	(c) Street Width (shoulder to shoulder)
Free	No Parking	18	2 each	22
Free	One Side	18	2 on one side, 8 on parking side	28
Free	No Parking	18	8 each	34

* All travelway widths are for two-way streets; for one-way use ½ of travelway width

Table 2-12. Residential Access Type B -- Reinforced Shoulder

Traffic Pattern	Parking Type	(a) Travelway width* (ft.)	(b) Shoulder Width (each side) (ft.)	(c) Street width (shoulder to shoulder)
Free	No Parking	20	2 each	24
Free	One Side	20	2 on one side, 8 on parking side	30
Free	Two Sides	20	8 each side	36

* All travelway widths are for two-way streets; for one-way use ½ of travelway width

Table 2-15. Residential Collector -- Reinforced Shoulder

Traffic Pattern	Parking Type	(a) Travelway Width* (ft.)	(b) Shoulder Width (each side) (ft.)	(c) Street width (shoulder to shoulder)
Free	No Parking	24	6 each	36

* All travelway widths are for two-way streets; for one-way use ½ of travelway width

Table 2-17. Residential Mixed-Use Collector -- Reinforced Shoulder

Traffic Pattern	Parking Type	(a) Travelway Width* (ft.)	(b) Shoulder Width (each side) (ft.)	(c) Street Width (shoulder to shoulder)
Free	No Parking	22	6 each	34

* All travelway widths are for two-way streets; for one-way use ½ of travelway width

Appendix B - Uncurbed Streets (cont.)

(a) Edge pavement to edge pavement street width:
See Tables 2-11, 2-12, 2-15, 2-17.

(b) Stabilized shoulder width:
See Tables 2-11, 2-12, 2-15, 2-17.

(c) Edge shoulder to edge shoulder street width:
See Tables 2-11, 2-12, 2-15, 2-17.

(d) Sidewalk / utility / drainage area within right-of-way:

	When in a cut section	When in a fill section
Width	Variable depending on street width and R.O.W.	Variable depending on street width and R.O.W.
Ground Slope	The maximum slope from the edge of swale to the right-of-way line shall be 4 horizontal to 1 vertical (25%). • If utilities are maintained within this area the utility corridor shall have a minimum width of 10 feet and a maximum ground cross slope of 5 horizontal to 1 vertical (20%). • If a sidewalk present, see Chapter 3 for standards (section 3-1).	The ground slope shall be maintained at no more than the shoulder slope -2% for a distance of 5 feet beyond the edge of the stabilized shoulder. Beyond this point the ground slope shall not exceed 4 horizontal to 1 vertical (25%) to the toe of slope. • If utilities are maintained within this area, the utility corridor shall have a minimum width of 10 feet and a maximum ground cross slope of 5 horizontal to 1 vertical (20%). • If a sidewalk is present adjacent to the roadway on the fill side, a 12-foot drainage swale must be located adjacent to the edge of shoulder similar to that on the cut side [see note (h)], and see Chapter 3 for sidewalk standards (section 3-1).

(e) Sidewalk / utility / drainage easement area outside right-of-way:
Width: As needed.
Ground Slope: If utilities are to be located within this area a the ground cross-slope shall not exceed 5 horizontal to 1 vertical (20%) to accommodate utility maintenance. If sidewalks and drainageways are to be included in this area, cross slopes shall be as previously described.

(f) Right-of-way width: 50 feet. On residential collectors this width may be increased if a traffic study documents the need for more than one lane in each direction.

(g) Crown Location: Centered on the travelway except for residential access type A streets where it may be located along one edge of pavement line.

(h) Drainage swale geometry (see chapter 5, Storm Water Conveyance Section)
Swale width: 12 foot minimum; as necessary to for adequate drainage.
Side slopes: 4 horizontal to 1 vertical maximum.

(i) Pavement cross-slope:
2% minimum to 4% maximum

(j) Shoulder cross-slope:
4% minimum to 6% maximum

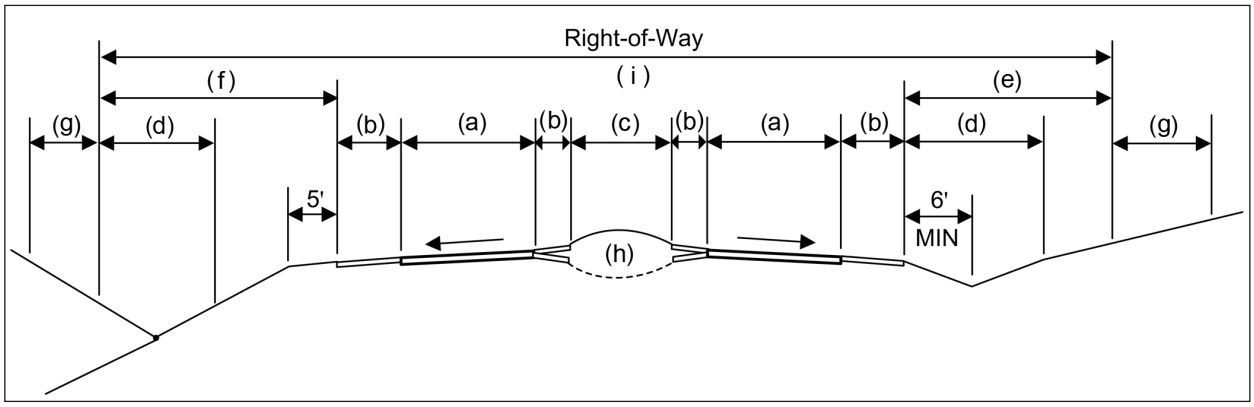

Figure 2.57. Cross-Section -- Parkway with Reinforced Shoulder, Drainage Away from Median

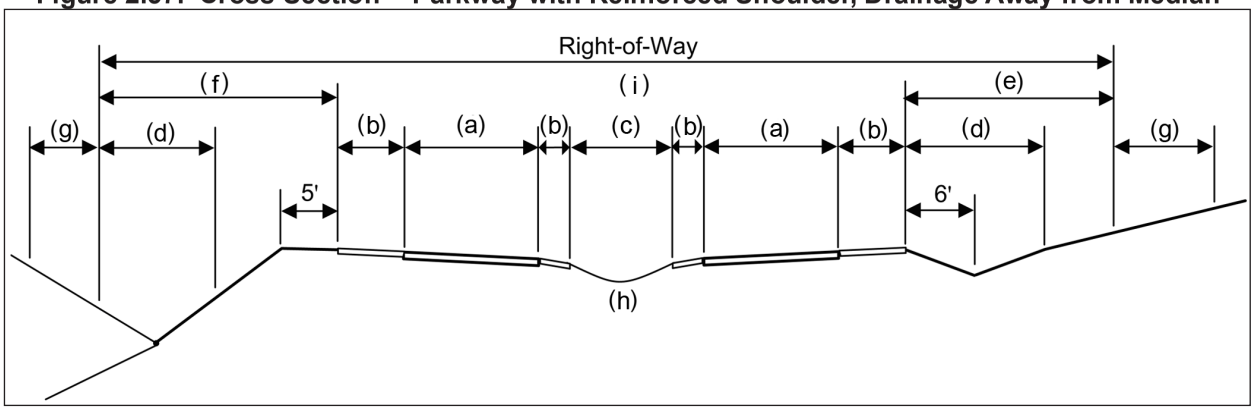

Figure 2.58. Cross-Section -- Curbed Streets with Reinforced Shoulder, Drainage towards Median

Table 2-19. Divided Streets -- Parkway with Reinforced Shoulder

Parking Type	(a) Lane Width* (ft.)	(b) Shoulder Width (ft.)	(c) Minimum Median Width (ft.)
No parking	11	4 one side + 2 one side = 6	10

* Provide the number of lanes necessary to accommodate anticipated traffic.

(a) Travelway
- Width: See Table 2-19
- Cross-slope: 2% to 4%

(b) Left stabilized shoulder
- Width: See Table 2-19
- Cross-slope: Travelway cross slope +2%

(c) Minimum median width
- See Table 2-19

(d) Drainage swale
- Location: Adjacent to shoulder or at toe of fill slope
- Shape: "V-ditch"
- Width: As needed for adequate drainage; 12-foot minimum
- Side-slopes: 4 horizontal to 1 vertical maximum

(e) Utility / sidewalk / drainage area inside right-of-way in cut section
- Minimum width: 10 feet
- Maximum ground slope: A drainage swale shall be located adjacent to the edge of shoulder [see note (6)]. The maximum slope from the edge of swale to the right-of-way line shall be 4 horizontal to 1vertical (25%). If utilities are maintained within this area the utility corridor shall have a minimum width of 10 feet and a maximum ground cross-slope of 5 horizontal to 1 vertical

Appendix C - Parkways (cont.)

(20%). If a sidewalk is located within this area, the sidewalk shall have a maximum cross-slope of 2% which shall extend for 3 feet on either side of the sidewalk.

(f) Utility / sidewalk / drainage area inside right-of-way in fill section

Minimum width: 10 feet

Maximum ground Slope: The ground slope shall be maintained at no more than the shoulder slope -2% for a distance of 5 feet beyond the edge of the stabilized shoulder. Beyond this point the ground slope shall not exceed 4 horizontal to 1 vertical (25%) to the toe of slope. If utilities are maintained within this area, the utility corridor shall have a minimum width of 10 feet and a maximum ground cross slope of 5 horizontal to 1 vertical (20%). A drainage swale shall be located at the toe of slope as defined in note (6). If a sidewalk is to be included adjacent to the roadway a 12-foot drainage swale must be located adjacent to the edge of shoulder similar to that on the cut side [see notes (6) and (7)].

(g) Utility / sidewalk / drainage easement outside right-of-way

Width: As necessary.

Maximum ground slope: When underground utilities are located in this area, the maximum ground slope shall be 5 horizontal to 1 vertical. For a sidewalk located in this area, the maximum ground slope for 3 feet on either side of the sidewalk shall be +2%. For drainage swales within this area, see note (6).

(h) Median area geometry

Shape: crowned or inverted

Maximum ground cross-slope: + 25%

(i) Minimum right-of-way width: 92 feet

Appendix D - Boulevards

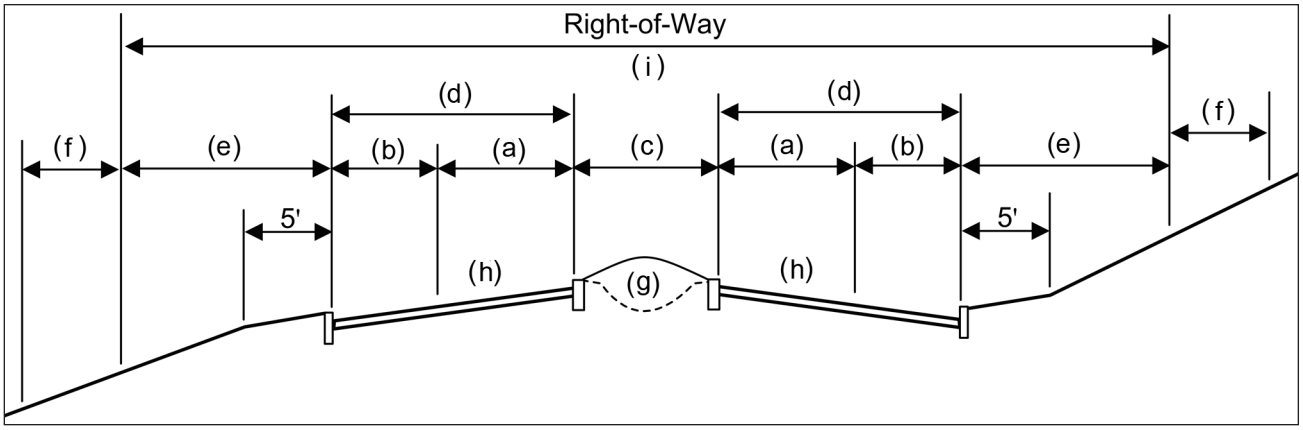

Figure 2.56. Cross-Section -- Boulevard with Curb

Table 2-18. Divided Streets -- Boulevard with Curb

Parking Type	(a) Lane Width* (ft.)	(b) Parking Lane Width (ft.)	(c) Minimum Median Width (ft.)
No Parking	11	0	10
Parallel	11	8	10
Angled Parking ***	****	18	10

* Provide the number of lanes necessary to accommodate anticipated traffic
** Stabilized grass is acceptable
*** Only permitted where anticipated traffic volume is less than 1500 ADT
**** Lane width must accommodate backing movment from parking space

(a) Travelway width: See Table 2-18
(b) Parking isle width: See Table 2-18
(c) Minimum median width: See Table 2-18
(d) Cartway width: See Table 2-18
(e) Sidewalk / utility area within right-of-way
Width: Variable depending on cartway width.
Ground Slope: A maximum cross slope of +2% shall be maintained for a 5-foot distance behind the curb. Beyond this point, a maximum cross slope of 4 horizontal to 1 vertical shall be permitted. If a sidewalk is to be located within this area, a 2% ground cross-slope (positive or negative) shall be maintained from the edge of curb to 3 feet beyond the outside edge of sidewalk. If utilities are to be located within this area, a minimum 10-foot width utility corridor shall be provided having a maximum cross slope of 5 horizontal to 1 vertical (+20%).
(f) Sidewalk / utility easement area outside right-of-way
Width: As needed.
Ground Slope: If utilities are to be maintained in this area, a minimum 10-foot width utility corridor shall be proviced having a maximum cross-slope of 5 horizontal to 1 vertical (+20%). If a sidewalk is located within this area a 2% ground cross-slope (positive or negative) shall be maintained across the sidewalk and within 3 feet of either side of the sidewalk.
(g) Median area geometry
Shape: Mounded or inverted (invert for stormwater management function)
Max. Ground Slope
4 horizontal to 1 vertical (+25%)
18 feet for angled parking
(h) Cartway cross-slope: Minimum +2% Maximum +4%
Negative cross- slopes indicate drainage towards median.
(i) Right-of-way width: 60 feet.

CHAPTER 3: PEDESTRIAN AND BICYCLE CIRCULATION

Contents

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Illustration 3-a. Sidewalk and Trail

Well designed and appropriately located sidewalks and trails are an asset to a neighborhood. They can make biking and walking become viable alternatives to motorized transportation for shopping, going to school or work, and for recreation.

Overview

3.0 OVERVIEW

Non-vehicular circulation refers to facilities such as sidewalks, trails, and bike lanes provided for non-motorized circulation and access. These facilities serve as critical links in the transportation network of a neighborhood by providing residents access within the neighborhood as well as non-vehicular connectivity to adjacent neighborhoods, commercial districts, schools, businesses, offices, and recreational areas. Connections between neighborhoods are critically important. Developments should not be self-contained islands, but should mesh with adjacent communities, linking streets, sidewalks, parks, and trails in ways that allow people to move freely.

Sidewalks and trails enrich a community's quality of life on many levels. They provide accessibility to people with disabilities, enabling them to better participate in the community; they invite strolling and shopping for all residents, and provide for recreational opportunities, promoting healthier living; and they provide an alternative to the use of motorized modes of transportation.

The location and design of sidewalks, trails, and bikeways requires careful consideration to maximize their usefulness to the community. All potential users, including people with disabilities, should be included in design considerations. It is often useful to include local residents or other community members in the design process to help maximize the usefulness of new proposed pedestrian facilities. This can be accomplished through one or more public meetings. Pedestrian facilities should be safe, attractive, convenient, and easy to use. Facilities that are inadequate or inappropriate to a community's needs discourage use and waste money and resources (Ref. 1).

This chapter provides guidance for the design of sidewalks, trails and bike lanes. Since these facilities provide a fundamental service to the public, they should be designed to meet the needs of the widest possible range of potential users. The overriding goals of the recommended design standards contained here are to provide accessibility and to encourage residents to make walking and biking viable and enjoyable modes of circulation within and among neighborhoods.

Recommended Standards

3.1 SIDEWALKS

Sidewalks are pedestrian facilities, typically parallel to and adjacent to streets, which provide non-vehicular access to homes and neighborhood commercial facilities. They are not intended as bicycle circulation routes, although small children may ride bicycles on sidewalks for safety reasons.

All sidewalks shall be designed to promote accessibility and shall include the following characteristics:

- Wide pathways without obstacles;
- Moderate grades and cross slopes;
- Rest areas outside of the pedestrian zones in high-density areas;
- Firm, stable, and slip-resistant surfaces;
- Buffering from traffic;
- Shade where possible;
- Convenient, safe, and easy street crossings; and
- Adequate lighting to ensure safety.

3.1.1 Location

Since sidewalks provide the “right-of-way” for the public, they primarily exist in a corridor that is located between the edge of a roadway and the residential property line (see figures 2-19 to 2-24), extending along the sides of streets between street corners. Sidewalks may also be located just outside the street right-of-way in an on-lot easement, and in other locations throughout the subdivision as warranted, for pedestrian access and for connections to

Commentary

Sidewalks and other elements of the public right-of-way present unique challenges to accessibility as a result of space limitations, roadway design needs, slope, and terrain. The Architectural and Transportation Barriers Compliance Board (ATBCB) has drafted guidelines for accessibility in the public right-of-way (Ref. 7). This section includes many of the recommendations for sidewalk design identified in Reference 7. However, this section should be reviewed for compliance when a final rulemaking is issued by the ATBCB.

The need for lighted sidewalks and trails should be based on the need for public safety. Excessive lighting and light pollution should be avoided. When necessary, all sidewalk and trail light fixtures shall include appropriate cut-off luminaries.

Illustration 3-b. Typical Sidewalk

Locating the sidewalk just outside the right-of-way in an on-lot easement allows for a narrower right-of-way, and promotes shorter set-back distances between the edge of the roadway and building front. This is sometimes desired to promote community

Commentary

character. Placing the sidewalk in an on-lot easement also allows more unobstructed room within the right-of way for location of utilities.

Illustration 3-c. Sidewalk in an Easement

The 125-foot frontage and 22,000 square foot lot size criteria are based on common practice and the consensus of a consortium of stakeholder group representatives who provided oversight and input to the development of these guidelines. The stakeholder group included representation from state and local regulatory agencies (PennDOT, DEP, DCED, and municipal officials), design professionals (engineers, surveyors, landscape architects, planners), environmental groups, and builder / developers.. Where sidewalks are not provided along road frontages, paths/trails and/or bike lanes should be considered to provide non-vehicular connections to adjacent neighborhoods and other destinations (existing or planned).

The location of sidewalks along one side of the street has been promoted as a way to minimize impervious areas for better stormwater management. However, sidewalks make up only a small percentage of the impervious area within a neighborhood, and neighborhood character and accessibility

Recommended Standards

adjacent communities.

Sidewalks located adjacent to streets shall be provided in all residential neighborhoods having lot sizes less than or equal to 22,000 square feet (1/2 acre).

Sidewalks shall be located on both sides of streets having average lot frontages (width at the front setback line) equal to or less than 100 feet. Where average lot frontages are greater than 100 feet but less than 125 feet, sidewalks shall be located along at least one side of the street.

Sidewalks shall also be provided along both sides of all residential / mixed-use collector roadways. In addition, sidewalks or accessible pathways should be considered along all residential collector roadways to enhance pedestrian connectivity among neighborhoods, commercial centers, and other pedestrian destinations.

As a minimum, sidewalks should be located along one side of all residential access roadways. However, for accessibility, it is recommended that sidewalks be located along both sides of residential access roadways in higher density developments. In addition, sidewalks shall be located along both sides of all residential / mixed-use collectors.

A waiver of the requirement for sidewalks will be considered for small subdivisions

Recommended Standards

(typically less than or equal to 30 lots) where there is no current or planned future connection to external pedestrian destinations, and traffic volumes are low enough that the street itself may serve as an adequate means of pedestrian connectivity between residences within the subdivision.

3.1.2 Buffering

A buffer zone or planting strip having a minimum width of 3 feet shall be included between the back of curb and the near edge of the sidewalk. If trees are to be planted in this buffer, the minimum buffer width shall be 5 feet. In higher density urban settings, the buffer zone may consist of planters and / or pedestrian furniture as illustrated in Figure 3.1. In these cases a minimum buffer width of 5 feet shall be maintained.

Figure 3.1. Sidewalk Buffering
Modified from Source: DCED, PSATS (Ref. 11)

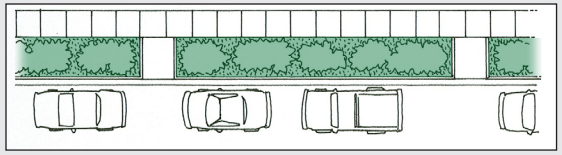
When on-street parking is provided, the parking lane provides an additional buffer between pedestrians and vehicular traffic. In this case an additional pedestrian buffer is not required. Also see section 2.3.9, Street Landscaping.

Commentary

should always be used as the primary justifications for sidewalk location. Additionally, drainage from sidewalks can be directed to a vegetated buffer or swale area between the cartway edge and the sidewalk for stormwater management purposes (see Chapter 4).

Examples of occasions in which a waiver might be appropriate would include isolated subdivisions on single cul-de-sacs or loop streets serving no more than 30 lots, and having no connection to other pedestrian destinations.

Illustration 3-d. Periodic Curb Ramps for Pedestrian Access



Modified from Source: FHWA, 2001; Ref. 3

Where on-street parking is provided, and a planting strip is located adjacent to the curb or swale line, periodic curb ramps should be provided to facilitate

Commentary

pedestrian access onto the sidewalk as shown in Illustration 3-d.

A 4-foot wide sidewalk allows pedestrians to walk side by side and to pass without requiring anyone to step off the sidewalk.

Although 4-foot sidewalks are acceptable, a 5-foot wide sidewalk allows pedestrians to pass more comfortably and provides adequate room for wheel chairs or strollers to pass or be maneuvered side-by-side. It is suggested that 5-foot or wider sidewalks be considered along Residential Access Type B and higher street classifications.

It is also noted that the additional 1 foot of side-walk width does not add significantly to stormwater impacts since sidewalks typically drain to adjacent grassed areas.

Additional effort is required for mobility on steep grades for pedestrians with disabilities and the elderly. However, sidewalk grades are difficult to control because sidewalks typically follow the path and grade of the street or terrain adjacent to the street. Minimum residential access street grades in mountainous terrain can range up to 12% (or more for short distances).

Rest areas with room for wheelchairs and benches improve the design of a level landing by providing

Recommended Standards

3.1.3 Sidewalk Width

Sidewalks shall be constructed to a minimum width of 4 feet (Ref. 6). However, where pedestrian traffic may be high, such as in high-density developments and along residential mixed-use / collectors, a sidewalk width of 5 feet or greater should be used. Sidewalk width, as defined here, shall be exclusive of any curb width.

Where sidewalks are less than 5 feet in width, passing spaces having a minimum width of 5 feet and length of 5 feet shall be provided at a maximum interval of 100 feet (Ref. 7). This width is needed for wheelchair users to pass one another (see figure 3.2) or to turn around (Ref. 6). Passing space shall also be provided at all sidewalk intersections. In addition, a clear line-of-sight shall be maintained between passing spaces.

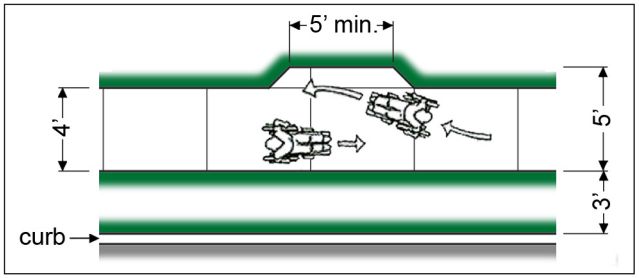


Figure 3.2. Passing Space on Narrow Sidewalks
Modified from Source: FHWA, 2001; Ref. 3

3.1.4 Grade (Longitudinal Slope)

Where the sidewalk is located within or immediately adjacent to the street right-of-way, its grade shall not exceed the grade of the street. Sidewalks in other locations should follow the natural terrain to minimize grading and land disturbance.

When sidewalk grades exceed 5%, landing areas should be provided at 100-foot intervals. The landing area should be at least 5 feet by 5 feet to allow enough space for a wheelchair to stop without blocking the flow of other pedestrians. On sidewalks narrower than 5 feet, extra width should be provided in landing areas as illustrated in Figure 3.2. The slope of landing areas should not exceed 2% in any direction. Rest areas can be located adjacent to landing areas. Refer to section 3.2.1.7 for rest area standards.

Recommended Standards

Where landing areas cannot be provided at a 100-foot spacing, the sidewalk should be widened to a minimum width of 6 feet to permit wheel chairs to travel in a zigzag motion to reduce the grade they must travel (see illustration 3-e).

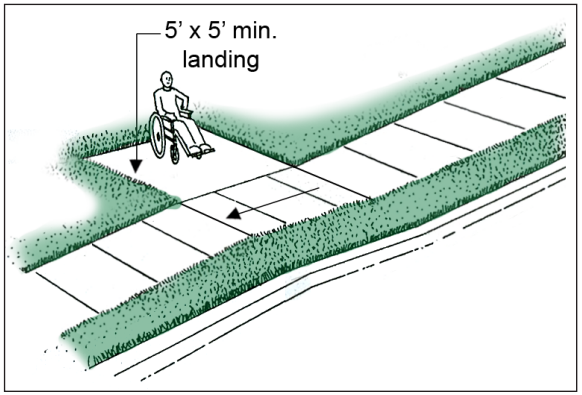


Figure 3.3. Typical Landing Area with Adjacent Rest Area
Modified from Source: FHWA, 2001; Ref. 3

3.1.5 Cross Slope

Sidewalks shall be constructed with a cross slope of 1% to 2% (see figure 3.4), with a construction tolerance of ¼ inch in 10 feet. On sidewalks with longitudinal slopes exceeding 3%, a cross slope of 2% shall be provided to promote sidewalk drainage.

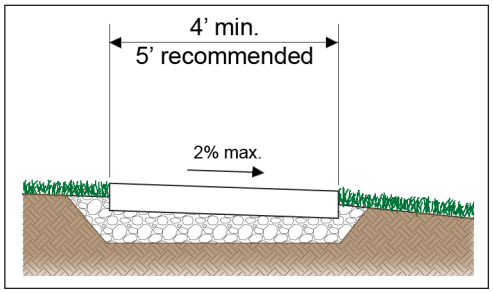
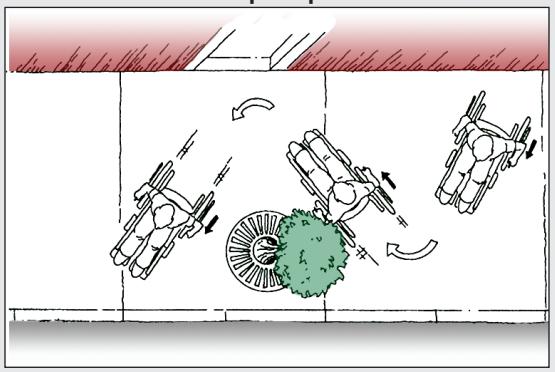


Figure 3.4. Sidewalk Section

Commentary

a resting point that will not impede the flow of other pedestrians (Figure 3.3). Additionally, if sidewalks must be constructed on steep slopes, a wide sidewalk can be used to allow wheelchair users to travel in a zigzag motion to reduce the grade they must travel (see Illustration 3-e).

Illustration 3-e. Wheelchair Path on Steep Slopes.



Modified from Source: FHWA, 2001; Ref. 3

The maximum cross slope of 2% is based on Americans with Disabilities Act requirements (see Ref. 2).

When the ground surface is graded to within 1 inch of the sidewalk surface, grass and other vegetation often become a barrier to cross drainage, and cause the sidewalk to function as a drainage-way as shown in Illustration 3-e. This is counter to the desired effect of having the runoff filter through the grass for stormwater management benefit, and can result in ice build-up in the winter.

One alternative would be to create a drop-off of about 2 inches between the sidewalk surface and the adjacent ground surface. However, this could pose an ankle-twisting hazard to pedestrians walk-

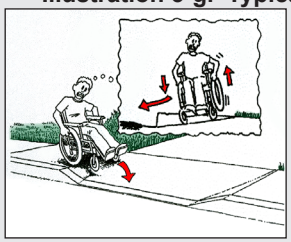
Commentary

ing close to the edge of the sidewalk. This risk is minimized for 5-foot wide and wider sidewalks. Therefore, a positive drop-off should only be used for sidewalks having widths of 5 feet or greater.

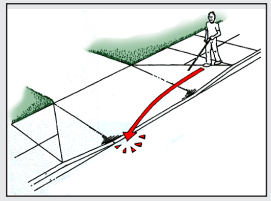
Illustration 3-f. Improper Sidewalk Drainage

Driveway ramps provide a means for vehicles to negotiate an elevation change between the street and the driveway. When the ramp for the motorist crosses the pedestrian's path of travel, significant cross slopes and changes in cross slope are created within the pedestrian area of sidewalks which can be hazardous to pedestrians with and without disabilities (see Illustration 3-e).

Illustration 3-g. Typical Driveway Hazards



a. Severe grade change



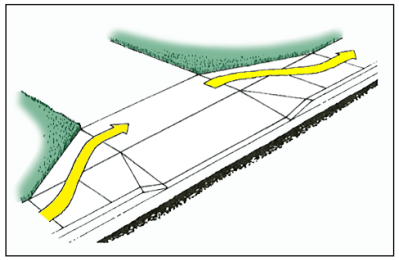
b. Hazard to visually impaired due to uneven walkway

Modified from Source: FHWA, 2001; Ref. 3

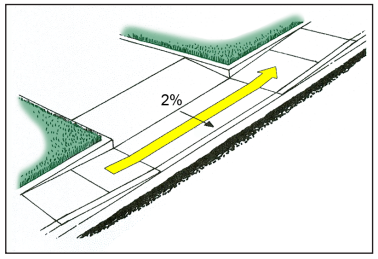
Recommended Standards

3.1.6 Driveway Crossings

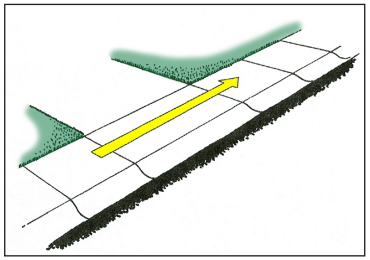
Driveway crossings shall be designed such that the drivers and pedestrians can use them efficiently and safely. Sidewalk slopes in the vicinity of driveways shall not cause unsafe conditions for pedestrians, and shall meet requirements of the Americans with Disabilities Act. Sidewalk grade shall in no case exceed 8.33% (12 horizontal to 1 vertical). Sidewalk cross slopes shall not exceed 2%. Several acceptable designs are illustrated in Figure 3.5.



a. Jog Level Path



b. Ramp Sidewalk Down to Driveway



c. Rolled Curbs

Figure 3.5. Acceptable Driveway Crossing Designs Where Sidewalk Surface is Not Uneven

Modified from Source: FHWA, 2001; Ref. 3

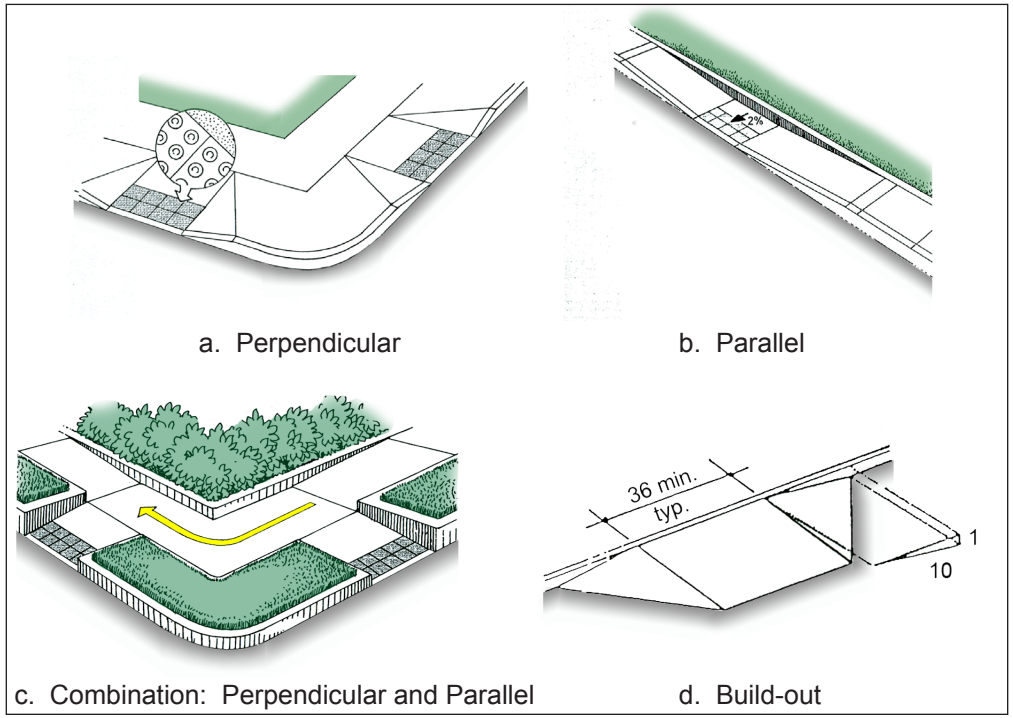
Recommended Standards

3.1.7 Curb Ramps

Curb ramps designed in accordance with the most recent revisions to the Americans with Dissabilities Act (ADA) guidelines shall be provided at all locations where sidewalk cross roadways (See Reference 2).

To help visually impaired people negotiate the change between curb and street when a ramp is present, surface material changes are required on the ramps. See 3.1.7.4 for details about "detectable warnings".

3.1.7.1 Curb Ramp Location and Configuration: Curb ramps can be perpendicular to the curb, parallel to the curb, a combination of parallel and perpendicular, or built-up beyond the curb line. Figure 3.6 illustrates typical curb configurations.



a. Perpendicular

b. Parallel

c. Combination: Perpendicular and Parallel

d. Build-out

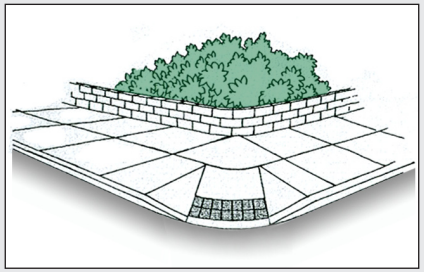
Figure 3.6. Curb Ramp Configurations
Modified from Source: FHWA, 2001; Ref. 3

Commentary

Curb ramps are critical to providing access between the sidewalk and the street for people who use wheelchairs, and would otherwise be excluded from the sidewalk due to the barrier created by the curb. However they can create major legibility barriers for people with vision impairments who rely on the curb to identify the transition point between the sidewalk and the street. Reference 3 provides a comprehensive coverage of the location and design of curb ramps.

Detailed information on each ramp configuration type identified in Figure 3.6 is provided in Reference 3.

Illustration 3-h. Unsafe Radial Curb Ramp



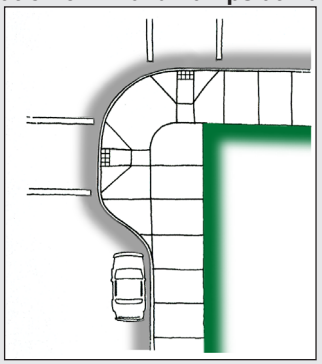
Modified from Source: FHWA, 2001; Ref. 3

The use of radial curb ramps may seem practical; however, they are not safe. Radial curb ramps direct pedestrians into the middle of the intersection, thus making it more difficult to safely negotiate to the other side, especially for visually impaired persons.

Where sidewalks are narrow or space is limited, bulb-outs can be used to extend the area for curb ramps as shown in Illustration 3-g.

Commentary

Illustration 3-i. Curb Ramps at Bulb-out



Modified from Source: FHWA, 2001; Ref. 3

These ramp grades are as reported under the Americans with Disabilities Act as specified in Reference 2.

Recommended Standards

3.1.7.2 Curb Ramp Design Grades: Curb ramps shall be constructed with a ramp grade less than or equal to 8.33% (12 horizontal to 1 vertical). Side flairs shall not exceed a slope of 10% (10 horizontal to 1 vertical) as long as there is a 4-foot clear distance parallel to the axis of the curb ramp at the top of the ramp. Otherwise, the maximum side flair slope shall be 8.33% (12 horizontal to 1 vertical). In addition, the cross slope on a ramp shall not exceed 2%. These design grades are illustrated in Figure 3.7.

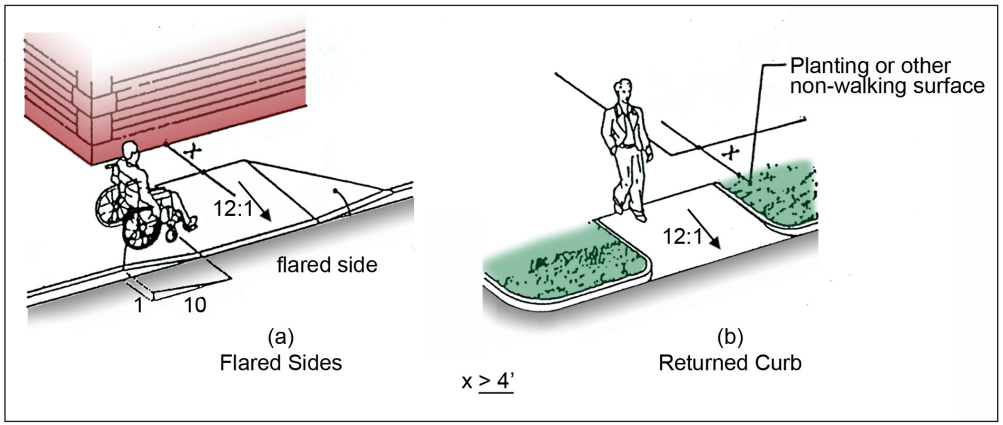


Figure 3.7. Curb ramp grades
Modified from Source: FHWA, 2001; Ref. 3

3.1.7.3 Recommended Curb Ramp Design Principles: The following design principles shall be applied to the design of curb ramps (adapted from Reference 3):

Recommended Standards	Commentary
• Provide a level maneuvering area or landing at the top of the ramp.	Landings are critical to allowing wheelchair users space to maneuver on or off of the ramp. In addition, pedestrians who are continuing along the sidewalk will not have to negotiate a surface with a changing grade or cross slope.
• Design ramp grades that are perpendicular to the curb.	Ramps to assist mobility are unstable if one side is lower than the other or if the full base of support (all four wheels on a wheelchair) are not in contact with the surface. This commonly occurs when the bottom of the curb ramp is not perpendicular to the curb.
• Place the curb ramp within the marked crosswalk area.	Pedestrians outside of the marked crosswalk are less likely to be seen by drivers because they are not in an expected location.
• Design the ramp so that it doesn't require turning or maneuvering on the ramp surface.	Maneuvering on a steep grade can be very hazardous for people with mobility impairments.
• Provide a curb ramp grade that can be easily distinguished from surrounding terrain; otherwise, use detectable warnings.	Gradual slopes make it difficult for people with vision impairments to detect the presence of a curb ramp.
• Design the ramp with a grade of approximately 7% + 1% (do not exceed 8.33% [12 horizontal to 1 vertical]).	Shallow grades are difficult for people with vision impairments to detect, but steep grades are difficult for those using assistive devices for mobility.
• Design the ramp and gutter-line with a cross slope equal to + 2%.	Ramps should have a minimum cross slope so users do not have to negotiate a steep grade and cross slope simultaneously.
• Provide adequate drainage to prevent the accumulation of water or debris on or at the bottom of the ramp.	Water, ice, or debris accumulation will decrease the slip resistance of the curb ramp surface.
• Transitions from ramps to gutter and streets shall be flush. Avoid lips and other sudden level changes adjacent to ramps.	Maneuvering over any vertical rise can cause wheelchair users to propel forward when wheels hit this barrier.
• Align the curb ramp with the crosswalk so there is a straight path of travel from the top of	Where curb ramps are aligned with the cross-walk,

Commentary

people using wheelchairs can build up momentum in the crosswalk in order to get up the curb ramp grade. This alignment is also useful for people with vision impairments.

Clearly defined edges assist users with vision impairments to identify the presence of the ramp.

Without a detectable warning, people with vision impairments may not be able to identify the boundary between the sidewalk and the street. Additional information on the design of detectable warnings can be found in Reference 4.

Asphalt and concrete are the most common surfaces for sidewalks. However, some sidewalks are designed using decorative materials such as brick or cobblestones. Although these surfaces may improve the aesthetic quality of the sidewalk, they may also create significant vibration for wheelchair users. These surfaces tend to buckle with freeze thaw cycles and can create a tripping hazard.

Recent research shows promise for a new sidewalk material made of recycled rubber from shredded vehicle tires. The material, which is hard and firm, appears to be more resilient than concrete and friendly to street trees and their roots. The freeze-thaw cycles of winter do not affect the material's performance. (Ref. 12)

Recommended Standards

the ramp to the center of the roadway to the curb ramp on the other side.

- Provide clearly defined and easily identified edges or transitions on both sides of the ramp to contrast with the sidewalk.

3.1.7.4 Detectable Warnings: Detectable warnings are textured surface features built in or applied to walking surfaces or other elements to warn visually impaired people of hazards on a circulation path. Detectable warnings should be placed at the boundary between the bottom of the curb ramp and the street, and shall be constructed as specified in the most current edition of Reference 4.

3.1.8 Surface Materials

Sidewalk surfaces shall be firm, stable, and slip resistant when dry. Acceptable surface materials include concrete, unit pavers, asphalt, stone, and brick. Materials, and material placement shall not result in any significant variation in surface elevation.

3.1.9 Sidewalk Details

Typical concrete and asphalt sidewalk details are illustrated in Figures 3.8 and 3.9, respectively.

Recommended Standards

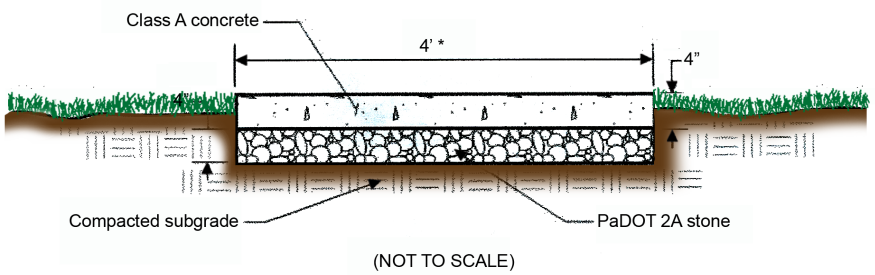


Figure 3.8. Concrete Sidewalk Detail

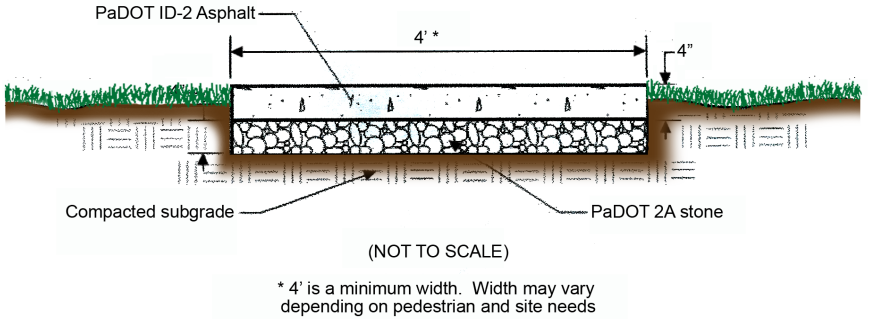


Figure 3.9. Asphalt Sidewalk Detail

3.2 TRAILS

Trails are joint pedestrian and bicycle circulation facilities that are typically physically separated from motor vehicular traffic by open space, a physical barrier, or both. In addition to serving as circulation facilities, trails often serve as recreational facilities supporting multiple exercise opportunities such as walking, bicycling, and skating. All shared-use trails and paths shall be designed to promote accessibility.

Trails are sub-classified by function into types: core circulation trails and minimum disturbance trails.

Commentary

Trails attract a variety of user groups who often have conflicting needs. The most significant conflict is the difference in travel speed between those walking, and bicyclists and in-line skaters. Conflicts are especially significant for people who cannot react quickly to hazards, such as those with mobility impairments. Designers and planners should be aware of potential conflicts between user groups and employ innovative solutions whenever possible. For example, provide appropriate pavement

Commentary

markings and signage, and ensure sufficient separation for users traveling at different speeds.

From a planning perspective, communities should consider development of an interconnected network of trails and pathways that would provide access among neighborhoods, commercial and business centers, and through maintained open space. (See Site Design Considerations, Ch. 1.)

Illustration 3-j. Overlook Summerset at Frick Park

Source: LaQuatra Bonci Associates, Michael Haritan (Ref.10)

The 5-foot buffer width specified is an absolute minimum separation; a greater width should be used whenever possible. Planting, existing or new, should also be used where possible to enhance the buffering effect. On curved streets site distance restrictions may limit the height of any buffer plant materials.

Buffering higher speed trail users from casual users

Recommended Standards

3.2.1 Core Circulation Trails

Core circulation trails are paved multi-purpose facilities whose primary function is to provide pedestrian interconnectivity between neighborhoods and other destinations. They are used primarily for walking and biking. These trails have the heaviest use. These trails could also be used for emergency access (see section 3.3.3).

3.2.1.1 Location

Core circulation trails should be located to provide pedestrian circulation through and between neighborhoods, and to other recreational and commercial destinations. Core circulation trails can also be used as a substitution for sidewalks to provide circulation routes parallel to residential collector streets.

Core circulation trails shall be located within public rights-of-way or easements to which access is not restricted.

Any trail identified on the official map of the municipality that crosses over or adjacent to the land included within the development proposal shall be designed and installed as a part of the infrastructure improvement for the development. The municipal approving authority may waive this requirement at their discretion.

3.2.1.2 Buffering

By definition, core circulation trails located adjacent to streets are to be buffered from motor vehicle traffic. This can be done through the use of vegetated buffers (see Figure 3.10) or physical barriers. A minimum buffer width of 5 feet shall be maintained between the street back of curb or edge of shoulder, and the near edge of the trail.

Recommended Standards

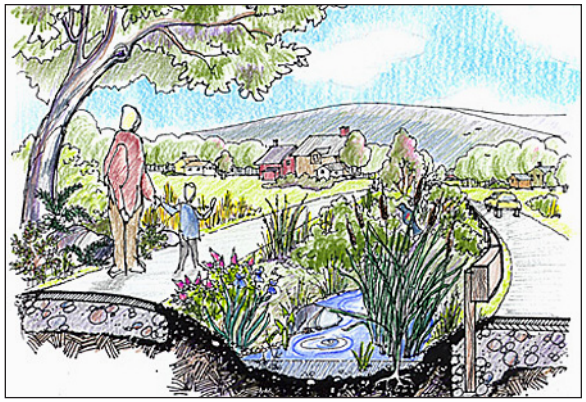


Figure 3.10. Trail Buffering
Source: LandStudies, Inc.

Circulation trails shall also be designed to safely accommodate both higher-speed and casual trail users. In areas where conflicts are anticipated, casual trail users shall be buffered from the higher-speed users. In both cases, adequate signage should be used to promote the desired separation.

3.2.1.3 Surface Materials

Core circulation trails shall have surfaces that are firm, stable, and slip resistant when dry. Acceptable surface materials include asphalt, concrete, crusher run stone, soil stabilizing agents mixed with native soils or other natural materials and aggregates. Material and material placement shall result in a smooth surface without significant variation in surface elevation.

Paved surfaces (asphalt or concrete) shall be used in areas that are subject to flooding or drainage problems, have steep terrain, or where bicyclists or in-line skaters will make up a significant percentage of users.

3.2.1.4 Width

The recommended minimum paved or stabilized width of a core circulation trail shall be 8 feet. In high-use urban areas widths of 12 foot to 14 foot are recommended. Core circulation trails shall also include a 2-foot graded shoulder on both sides of the stabilized path. (See details in Figures 3.16 and 3.17).

Commentary

can be accomplished through the use of different trail materials, trail separation, and clear signage. Illustration 3-k provide an example of user buffering.

Illustration 3-k. Trail User Separation

Surface material and condition significantly affect which user groups will be capable of negotiating the terrain. Core circulation trails that have been built using crushed aggregate generally are unusable by in-line skaters and slow the speed of bicyclists (which may be desirable in some instances).

Trail width is dependent on type and frequency of anticipated use. If limited use is anticipated, the width of core circulation trails may be reduced to 6 feet, however if it is to be a shared use trail, 10 feet might be a more appropriate width.

Commentary

These recommended grades and segment lengths are similar to those provided in Reference 5.

Bicyclists can maintain speeds in excess of 30 mph. Therefore, when bicyclists are anticipated to make up a significant percentage of users, more stringent vertical and horizontal geometric design standards must be met to ensure the safety of bicyclists and other trail users.

Periodic rest areas are beneficial for all core circulation trail users, and particularly for people with mobility impairments. Rest areas are especially crucial when grades exceed 8%. A typical rest area is shown in Illustration 3-g.

Recommended Standards

Where buffering is used to separate casual trail users from higher-speed users, a minimum trail width of 5 feet shall be used on each side of the buffer. In high use urban areas, a 6- to 7-foot width is recommended.

3.2.1.5 Grade

Core circulation trails shall be designed to follow the natural terrain to the extent practical. Where possible, grades should be maintained at or below 5%. Steeper sections may be used to minimize the extent of site disturbance and grading. When designing steep segments of core circulation trails, the following segment length restrictions shall be followed:

Less than 8% grades	No restriction on segment length
8% < grade < 10%	Max segment length = 300 ft.
10% < grade < 12.5%	Max segment length = 100 ft.
Greater than 12.5% grade	Max segment length = 50 ft.

3.2.1.6 Horizontal and Vertical Alignment

When bicyclists are anticipated to be significant users of the core circulation trail, curves for horizontal and vertical alignment shall be designed in accordance with the standards in the most current version of Reference 5.

3.2.1.7 Rest Areas

Rest areas along core circulation trails should be designed with the following characteristics:

- Maximum 5% grade parallel to path / trail.
- Maximum 2% cross slope on paved surfaces.
- Maximum 5% cross slope on unpaved surfaces.
- Width equal to or greater than trail segment leading to rest area.
- Minimum length of 5 feet if no amenities provided. Length must provide room for any amenities (benches, etc) plus 5 feet for wheel chair space.
- Change in grade from path / trail to rest area less than + 2%.

Recommended Standards

3.2.1.8 Cross slope and Drainage

Maximum cross slope for paved surfaces	2%
Maximum cross slope for unpaved surfaces	5%

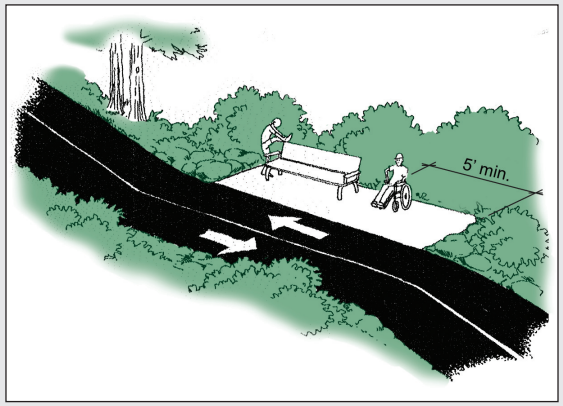
Standards from Reference 5.

To provide for drainage on trails with minimal cross slopes, the land surface on at least one side of the trail should be graded to be lower than the trail surface. When there is a natural surface cross slope from one side of the trail to the other, the pitch of the trail should be in the direction of the land cross slope so that sheet drainage from uphill can continue unobstructed downhill across the trail.

Side swales shall be used adjacent to trails when it is necessary to intercept uphill runoff before it crosses the trail. Excess runoff and runoff velocity can cause damage to trail surface materials, may be a nuisance or hazard to trail users (particularly resulting from snow melt and re-freeze in colder climates), or may result in the deposition of silt and debris from above onto the trail.

Commentary

Illustration 3-l. Typical Rest Area with 5' Minimum Landing for Wheelchair



Modified from Source: FHWA, 2001; Ref. 3

Severe cross slopes can make it difficult for wheelchair users and other pedestrians to maintain balance. The impact of cross slopes are compounded when combined with steep grades.

Typical examples of trail cross slope and drainage are illustrated below:

Illustration 3-m. Slight Trail Cross slope

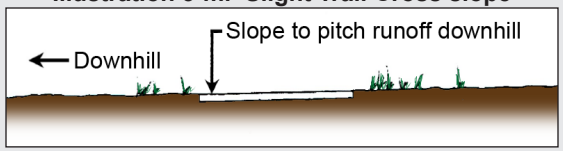
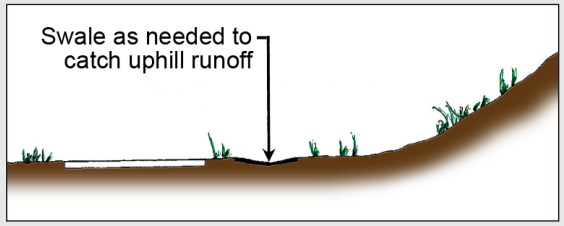


Illustration 3-n. Interception Swale Adjacent to Trail



Commentary

Illustration 3-o. Stop Sign Where Trail Intersects Street

Recommended Standards

3.2.1.9 Intersections

To avoid conflicts at intersections, the following guidelines should be followed (all from Reference 8):

- Design intersection geometry as close to a "T" or "+" as possible;
- Use 8-foot corner radii;

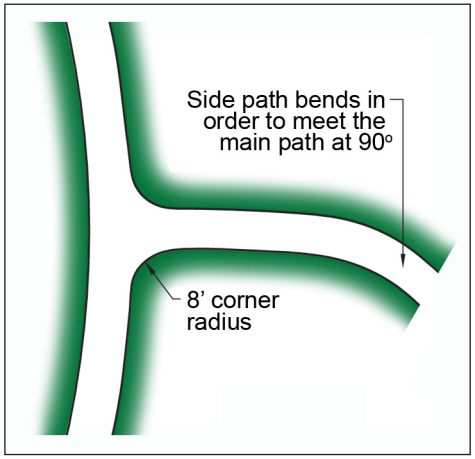


Figure 3.11. "T" Intersection

- To avoid cross traffic conflicts on high use trails, off-set 4-way intersections and create two "T" intersections;

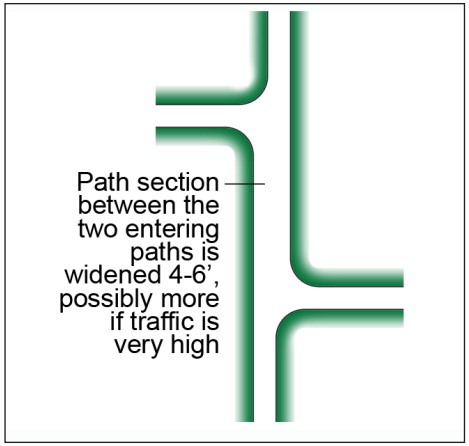


Figure 3.12 Off-Set Intersections

- Provide adequate directional and traffic control signage;
- Avoid confusing and complex intersections;

Recommended Standards

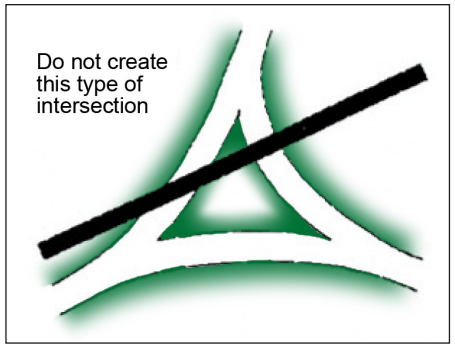


Figure 3.13. No Confusing Intersections

- For user safety and comfort, adequate sight lines should be provided;

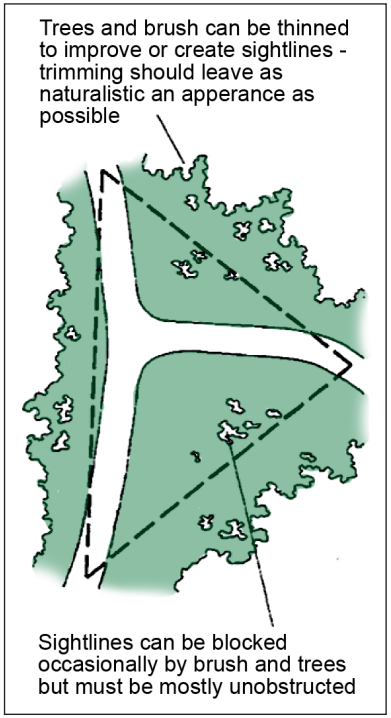


Figure 3.14. Typical Sight Lines

Commentary

Commentary

Illustration 3-p. Picture of Flooding Signage

Illustration 3-q. Picture of Mileage Signage

Recommended Standards

3.2.1.10 Signs

All trails shall include adequate regulatory and informational signs.

All regulatory signs shall conform to the proposed standards for bicycle signs in the *Manual on Uniform Traffic Control Devices* (Ref. 9), and shall be placed as illustrated in Figure 3.15.

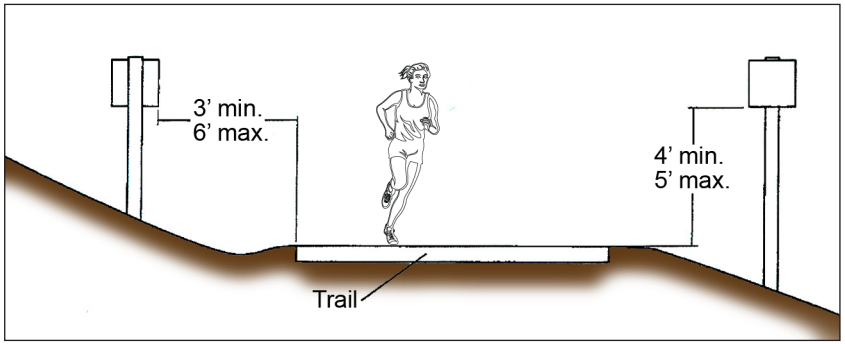


Figure 3.15. Trail Sign Location

Modified from Source: the Manual on Uniform Traffic Control Devices, Ref. 11

Typical regulatory signs include:

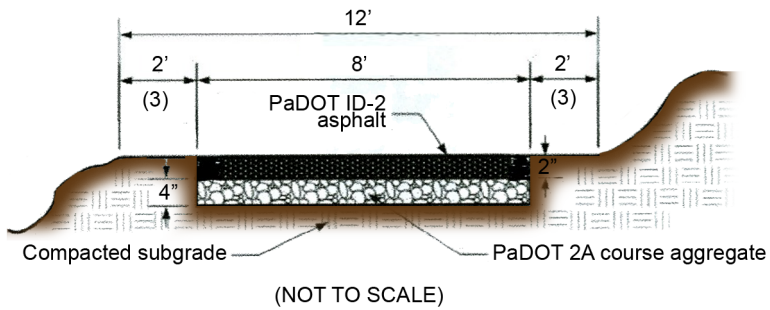
- Stop, yield, and stop ahead warnings;
- Unexpected or hazardous conditions warnings;
- Turn and curve warnings;
- Intersection signs; and
- Purpose and restricted usage signs.

Informational signs may be placed at trailheads and other appropriate locations along trails. Typical informational signs would include trail head identification, mileage indicators, signs identifying features of special interest along the trail, etc.

3.2.1.11 Trail Details

Typical core circulation trail details are illustrated in Figures 3.16 and 3.17.

Recommended Standards



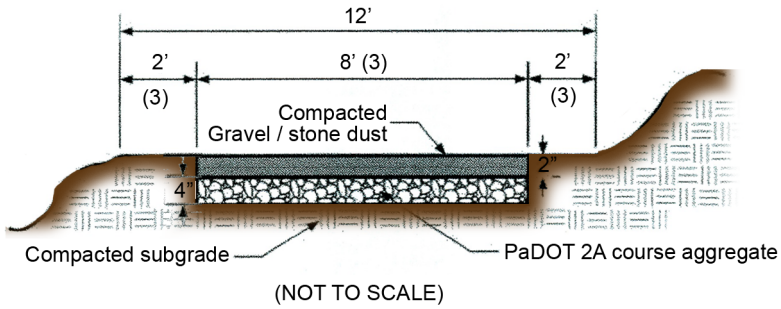
NOTES:

(1) Standard width 8'. If heavy usage is anticipated then greater width may be required. For limited use trails, narrow width may be acceptable

(2) Suitable for bike and pedestrian use

(3) Provide 2' graded shoulder

Figure 3.16 Core Circulation Trail Section, Asphalt Surface



NOTES:

(1) Suitable for equestrian use; all-terrain (mountain) bicycle use and hiking.

(2) Susceptible to wash-out on slopes greater than 5%

(3) Stabilized surface width to be based on anticipated usage

Figure 3.17 Core Circulation Trail Section, Crusher Run Gravel Surface

3.2.2 Minimum Disturbance Trails

Minimum disturbance trails are intended to provide recreational opportunities and access to

Commentary

Commentary

Illustration 3-r. Soft Trail Surface

Recommended Standards

unique site features while producing a minimal impact on the landscape. Typically, examples include nature trails, recreational trails, and trails to specific points of interest (historic, scenic, etc.). Figure 3.18 illustrates a typical example.

Figure 3.18. Scenic Overlook on Tudek Park Trail

3.2.2.1 Location

Minimum disturbance trails shall be located in public rights-of-way or in unrestricted easements within the development. The minimum easement width should be 10 feet. All residents shall have equal right to gain access to these trails.

3.2.2.2 Surface Materials

The trail surface material shall provide a stable surface for its intended use, keeping in mind the desire to minimize the amount of land disturbance. Typical trail surfaces materials would include grass, stabilized grass, compacted gravel, wood chips, etc. Adequate drainage should be provided under the selected surface to minimize rutting and other damage during wet periods.

Recommended Standards

3.2.2.3 Design Standards

Specific design standards for width, grade, cross slope, horizontal alignment, etc., will depend on the specific purpose of the trail and the desire for minimum land disturbance. Sections of a trail may be stepped or terraced to accommodate natural terrain. Trail design must consider anticipated trail use and wear. The design shall include adequate temporary and permanent erosion and sedimentation control, and drainage measures.

3.2.2.4 Intersections and Signage

Intersection and signage shall be as identified in sections 3.2.1.9 and 3.2.1.10.

3.2.2.5 Rest Areas

Rest areas should be provided at regular intervals along minimum disturbance trails. In particular, opportunities for rest should be provided where terrain is moderate to steep.

Commentary

Minimum impact trails are typically designed to provide access to open space and greenways within a municipality. It can be anticipated that they will be used for walking, jogging, mountain biking, and x-country skiing.

Minimum disturbance trails should be designed to follow natural terrain and fit with the existing landscape. Reference 8 provides excellent guidance on the design of minimum disturbance trails. It is not intended that all minimum disturbance trails be handicapped accessible.

Illustration 3-s. Minimum Disturbance Trail

Rest areas should include some form of seating and trash receptacles. Rustic benches and container enclosures made of wood should be considered.

Most bicycle travel in Pennsylvania now occurs on streets and highways without striped bike lanes. In many instances streets are safe and efficient for bicycle travel that do not have signing and striping. However, delineation of bicycle lanes along roadways provides for more predictable movements

Commentary

by both bicyclists and motorists, enhancing bicycle safety within the corridor. Due to their low traffic volume, striped bike lanes will typically not be necessary along residential access streets.

Width standards were compiled from Reference 5.

Bike lane configurations shown in Figure 3.19 would be typical of residential collectors.

Bike lane configurations shown in Figure 3.20 are typical of residential mixed-use collectors.

Recommended Standards

3.3 BIKE LANES

Delineated bike lanes should be considered along residential collector and residential / mixed use collector roadways where significant bicycle demand is anticipated, and where delineation of bicycle lanes will enhance the safety of bicyclists.

Bike lanes shall be one-way facilities; two-way bike lanes along the same side of the roadway are not permitted unless they are designed as shared-use paths / trails.

3.3.1 Width

Typical bike lane widths and configurations are illustrated in Figures 3.19 and 3.20.

Figure 3.19 illustrates bike lanes along streets where parking is prohibited. As indicated, if no curb exists, the minimum bike lane width shall be 4 feet. If the roadway is curbed, the minimum bike lane width shall be 5 feet to accommodate drainage along the gutter line.

Figure 3.20 illustrates bike lanes along streets where parking is permitted. As indicated, the minimum width bike lane shall be 5 feet for cases in which a parking lane exists.

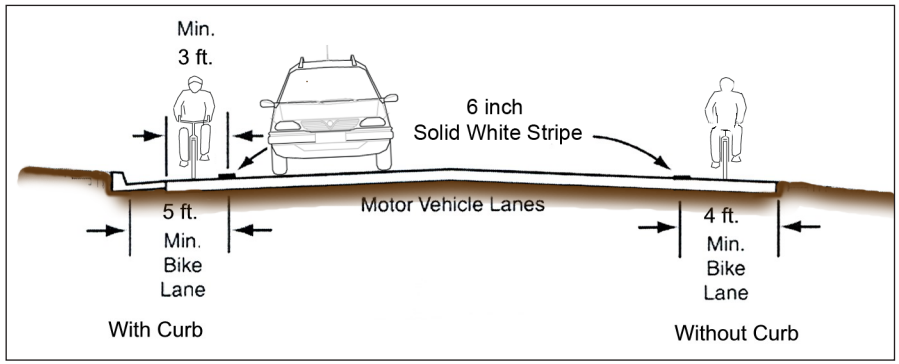


Figure 3.19. Bicycle Lanes Along Streets Where Parking is Not Permitted
Modified from Source: Task Force on Geometric Design, Ref

Recommended Standards

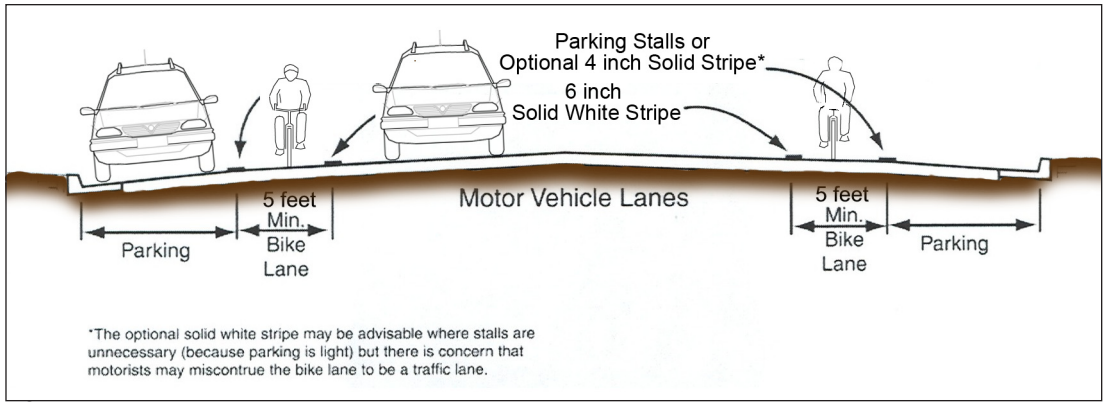


Figure 3.20. Bicycle Lanes Along Streets With Parking Lanes
Modified from Source: Task Force on Geometric Design, Ref. 5

3.3.2 Pavement Markings

Bike lanes require standard markings as illustrated in Figure 3.21.

Commentary

Commentary

Recommended Standards

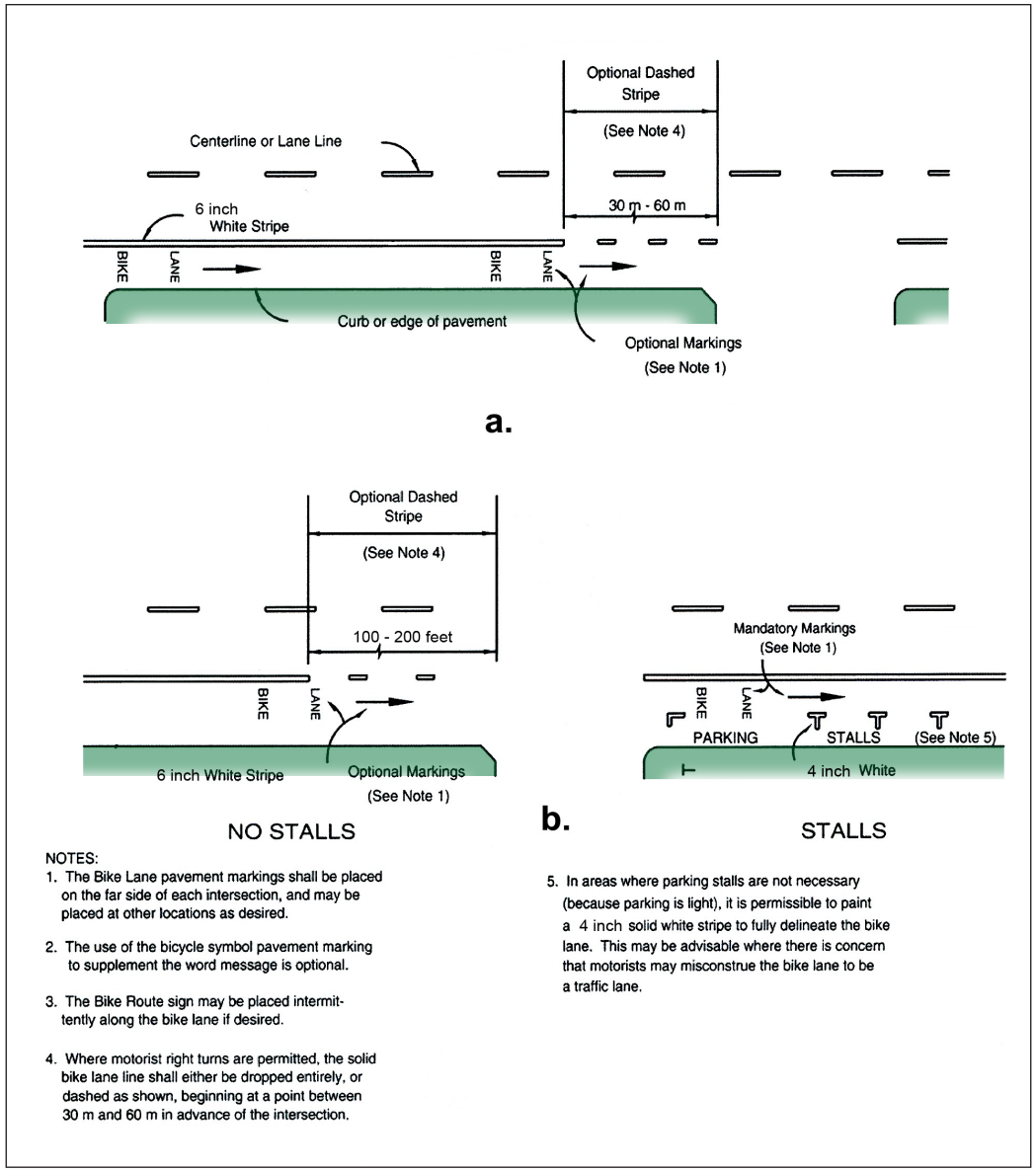


Figure 3.21. Bicycle Lane Pavement Markings; a. Residential Collectors (no parking) b. Residential / Mixed Use Collectors (Parking Permitted)

Modified from Source: Task Force on Geometric Design, Ref. 5

Recommended Standards

3.3.3 Emergency Access Walkways/Trails

a. Walkways that accommodate fire vehicles may be permitted in extreme or unusual cases and are subject to approval.

b. Newly constructed overhead obstructions at a roadway or fire walkway must have a minimum of fifteen (15)-feet clearance in order for a fire vehicle to pass safely underneath.

c. Fire walkways must be a minimum of twelve (12)-feet wide and designed to withstand the weight of a fire vehicle (twenty [20] tons minimum).

d. Fire walkways shall be linked to the roadways by means of a curb cut and ramp to the elevation of any fire walk or drive. Grades on fire walkways or fire lanes shall not exceed 10%.

e. Provisions shall be made to ensure access to the fire walkways. No parking shall be permitted within fifteen (15) feet of access to fire walkways. A chain shall be placed across the entrance to the fire land or walkway, of one-fourth (1/4)-inch noncase hardened steel. The location of the chain shall be approved by the Fire Marshal.

Commentary

References

References

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6. American Association of State Highway and Transportation Officials, “Guide fo the Planning, Design, and Operation of Pedestrian Facilities, Washington, D.C., July 2004.

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8. Parker, Troy Scott, Trails Design and Management Handbook, Perpared for the Open Space and Trails Program, Pitkin County, Colorado, Revision 1.1, January 1994. http://www.trailbuilders.org/resources/links_resources/Pitkin_Trail_Design_Intro.pdf

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10. LaQuatra Bonci Associates, Michael Haritan.

11. DCED, PSATS, Food for Thought -- Healthy Communities workshop, 2004.

12. Rubbersidewalks, Inc., www.rubbersidewalks.com

CHAPTER 4: PARKING STANDARDS

Contents

List of Graphics

Commentary

Illustration 4-a. Off-street Parking Lot for Multi-Family Residences

Multifamily residences are adjacent to and above neighborhood-serving businesses at the Orenco Station community in Oregon. Here, rear-access garages and a small well-landscaped parking lot are tucked in behind the buildings.

Illustration 4-b. On-street Parking with Pavers

On-street parking can be made to feel less like a large road through the use of pavers at the parking spaces. These pavers might also be used as a pervious surface for stormwater management purposes. This street is at Reston Town Centre in Virginia.

Recommended Standards

4.0 OVERVIEW

Adequate parking shall be provided for all dwellings and neighborhood commercial uses included within residential and mixed-use developments. Adequate parking includes parking to accommodate residents, visitors, and service vehicles for all residential dwellings, and sufficient spaces to provide convenient access to neighborhood commercial and business uses. On-street and off-street parking are both acceptable means of meeting this requirement. Details regarding on-street parking are provided in section 2.3.2 and throughout chapter 2 as related to each different street type.

It is recognized that adequate parking is necessary for all private and public facilities. Providing excessive parking, however, not only drives up initial development costs (and the associated cost of housing and other items to consumers), it also unnecessarily increases maintenance costs associated with both on-street and off-street parking areas. It also produces unnecessary environmental impacts related to the excess impervious surface area. These environmental impacts translate into additional costs for stormwater impact mitigation. Responsible design of parking facilities must consider the specific conditions and context of the parking needs within a community, and how the parking needs can best be served while minimizing construction and maintenance costs, and environmental impacts. Responsible design also considers how parking components, such as landscaped islands, might be designed to also serve a stormwater management function. Shared parking for complimentary uses and creative, minimal impact, over-flow parking for occasional uses shall always be considered as alternatives to excessive hardscaped parking areas.

Recommended Standards

4.1 PARKING RATES

4.1.1 Parking Rates for Residential Dwelling Units

Parking for residential developments shall be computed by summing the parking needed for the residents of each dwelling unit plus the parking requirements for visitors, service, and emergency vehicles.

Parking for residents of individual dwelling units shall be computed as specified in Table 4-1.

Table 4-1. Parking for Residential Dwellings

Housing Unit Type / Size	Parking Spaces (per dwelling unit)
Single-Family Detached	2.0
Townhouse, Duplex, Quad	1.7
Apartments / Condos	
3 or more bedrooms	1.4
1 or 2 bedrooms	1.2
Efficiency	1.0

(1) Rates independent of ownership

Source: McCourt, Ref. 1

Commentary

Parking standards are often provided in a Municipal Zoning Ordinance. Where this is the case, zoning ordinance parking standards should be revised to be consistent with those presented in this section.

The parking standards in Table 4-1 are based on data reported by the Institute of Transportation Engineers (Ref. 1). Reference 1 is the most comprehensive compilation of parking data available at this writing. Individual values reported in Table 4-1 are based on the following data:

Single-Family Detached: Parking rate based on 6 studies on a suburban site in Glendale, California in 1978, and a Portland, Oregon study relating household ownership with vehicle ownership using 2000 Census data.

Townhouse, Duplex, Quad: Parking rates based on studies at 5 townhouse study sites in urban / suburban areas of California and New Jersey between 1981 and 2000. All studies on owner-occupied units. Average development size was 120 units. Since no study data are available for duplex and quad units, those numbers were extrapolated from the above noted studies.

Apartments / Condos: Parking rates based on data from over 44 studies at mostly suburban sites in 7 different states. One study site was in Devon, PA. Most of the studies were conducted between 1980 and 2000. Some study data from the 1960s were also used. The values reported are from the low-/mid-rise apartment land use classification (less than 5 stories in height). Several sites provided data that correlated parking demand with number of bedrooms. Values reported are an interpretation of the data reported.

Commentary

With the exception of the data for single-family detached dwellings, the parking data reported in Table 4-1 did not differentiate between vehicles owned by residents or visitors. Therefore, the parking rates for other than single-family detached dwellings are conservative since they may include some visitor parking.

Reference 1 presents the range of parking demand data observed from study sites, as well as the 33rd and 88th percentile values for each land use classification. Some data also demonstrate a correlation between parking demand rates in urban vs. suburban areas. The values reported here reflect suburban parking demands. Parking needs might be less in more urbanized areas with access to public transportation.

Reference 1 should be consulted for more information on specific parking data. Data from local parking studies may be used to supersede the average values reported here. In some cases, less parking may be appropriate (for example, age-restricted senior living communities). In other cases, more parking may be required (for example, student housing complexes).

Reference 1 also provides information on how to conduct a scientific parking study.

Reference 4 was the only document found that reported spillover parking values. This reference acknowledges that the values reported are intuitive, and that spillover parking needs would reasonably vary based on community and dwelling unit character.

The spillover parking values reported in Table 4-2 are based on the following:

Single-Family Detached: Value from Reference 4.

Townhouse, Duplex, Quad: Reference 4 specified a value of 1.0 for townhouses. This value was

Recommended Standards

Parking for visitors, service vehicles, emergency vehicles, and others is referred to as spillover parking. Spillover parking rates for residential dwellings are specified in Table 4-2.

Table 4-2. Spillover Parking for Residential Dwellings

Housing Type	Spillover Parking Spaces
Single-Family Detached	1.5 spaces per dwelling unit
Townhouse, Duplex, Quad	0.25 spaces per dwelling unit
Apartment	0.2 spaces per bedroom *

* Efficiency apartments count as 1 bedroom.

Recommended Standards

4.1.2 Parking Rates for Retirement Communities

Parking for retirement communities and facilities shall be allocated as outlined in Table 4-3. The retirement community classifications identified in Table 4-3 are defined as follows.

Congregate Care: Independent living with centralized amenities including dining, house keeping, and social/recreational activities. Limited medical services may or may not be provided. Residents live in separate apartments.

Assisted Living: Complexes that provide routine oversight or assistance with activities necessary for independent living. Separate living quarters for residents. Services include dining, housekeeping, and social/recreational activities. Medical administration and transportation services may also be provided. Skilled medical services are not required by residents. Residents live in separate apartments. Assisted living bridges the gap between congregate care / independent living and nursing homes.

Convalescent / Nursing Home: Facilities that provide care for persons who are not able to care for themselves.

Continuing Care: Facilities that provide multiple elements of senior living. Complexes may include multiple levels of senior living and care, including independent living, congregate care, assisted living, and convalescent facilities. Independent living housing may include detached or attached single-family units or apartments.

Senior living communities that do not meet one of the retirement facility classifications identified above shall provide parking in accordance with the rates in Table 4-1.

Commentary

reduced to 0.25 since the base parking rate in Table 4-1 includes some spillover parking.

Apartment: Reference 4 specifies 0.5 for all apartments. This value was reduced to 0.2 per bedroom since the base parking rate may include some spillover and it is intuitive to assume that the larger the apartment, the greater the over-flow demand.

It is recommended that community-specific adjustments be made to spill-over parking rates based on local experience. A reasonably low value should be selected to minimize site imperviousness.

Special consideration is appropriate for the reduced parking requirements within retirement communities.

Commentary

The data in Table 4-3 were compiled from Reference 1. Specific parking rates identified in Table 4-3 are based on the following study data:

Congregate care: Parking rate based on one study in Portand, Oregon (2000).

Assisted Living: Parking rate is based on data from 12 sites in mostly suburban settings in Illinois (1), Virginia (1), California (2), New Jersey (3), and New York (5). All studies were conducted between 1988 and 2002.

The intent of including neighborhood-serving commercial and business uses within residential neighborhoods is to encourage convenient pedestrian access to these facilities. Parking for neighborhood commercial and business uses should take into consideration the estimated percentage of employees and customers who will either walk or ride bicycles to the business. It should always be a goal to minimize parking for neighborhood commercial and business establishments.

On-street parking is permitted for neighborhood commercial and business uses and can be considered as a way to accommodate some of the required parking. Designers should note, however, that when on-street parking is used, additional conflicts among all users of the street are introduced and care should be used in selecting parking placement.

Recommended Standards

Table 4-3. Parking for Retirement Facilities

Housing Unit Type / Size	Parking Spaces (per dwelling unit)
Congregate Care	0.4 per resident
Assisted Living	0.3 per resident
Nursing Home	0.9 per employee
Continuing Care	Use parking rates from Table 4-1 and Table 4-3 for appropriate sections of the continuing care complex.

4.1.3 Parking for Neighborhood Commercial and Business Uses

Parking for neighborhood commercial and business uses shall be computed as follows:

Base parking X (100 – percentage community walk-in business) / 100

Base parking shall be estimated from values in Table 4-4.

Recommended Standards

Table 4-4. Base Parking for Neighborhood Commercial and Business Uses

Business Type	Total Parking Spaces
Office	0.9 per employee
Medical-Dental Clinic	3.5 per 1,000 sq. ft. GFA*
Retail	4.5 per 1,000 sq. ft. GLA**
Convenience Store	3.4 per 1,000 sq. ft. GFA*
Restaurant (no bar / lounge)	0.35 per seat
Restaurant (with bar / lounge)	0.47 per seat
Fast Food (drive-thru)	9.9 per 1,000 sq. ft. GFA*
Fast Food (no drive-thru)	12.4 per 1,000 sq. ft. GFA*
Drugstore	1.8 per 1000 sq. ft. GFA*
Bank, Walk-In	2.5 per 1,000 sq. ft. GFA*
Bank, Drive-In	3.5 per 1,000 sq. ft. GFA*
Church	0.16 per seat

Source: McCourt, Ref. 1.

*GFA = Gross Floor Area
**GLA = Gross Leasable Area

Commentary

Data in Table 4-4 were compiled from Reference 1. Note that the study sites were generally suburban, and access was typically vehicle-dependent. Appropriate adjustment should be made for anticipated walk-in business or where access to public transportation is convenient.

4.2 ON-STREET PARKING

See section 2.3.2 and each different street-type in chapter 2 for on-street parking standards.

On-street parking, off-street parking or a combination of the two are acceptable means of meeting the parking requirements outlined in this chapter.

4.3 OFF-STREET PARKING

Off-street parking includes driveways, carports, garages, and parking lots. Parking on driveways, carports, and garages wholly contained on private lots for single-family dwellings (single-family detached homes, townhomes, and quad or similar units on individual deeded lots) are listed in section 4.3.1. Common parking lots for multifamily dwellings and common parking lots for over-flow parking within other types of developments are listed in section 4.3.3.

While off-street parking can be used to satisfy some of the parking needs, the availability of off-street parking, particularly in high-density developments, will likely be needed to accommodate all anticipated vehicle storage. The use of off-street parking keeps the street clear for snowplowing, emergency vehicles, and delivery vehicles. The selection of on-street versus off-street parking should also consider that off-street parking requires more square-feet of impervious surface per space than on-street spaces, due to egress drives and travel aisle lanes.

4.3.1 Parking for Single-Family Dwellings on Individual Lots

Parking spaces in carports, garages, and driveways on individual lots for single-family

Commentary

The parking bay size in garages and carports is based on a standard space allowed for a vehicle in a typical parking lot. The width has been increased slightly over values specified in Reference 6 to accommodate full-swing opening of car doors for ease of access.

Sixty sq. ft. of storage space provides a 6 ft. by 10 ft. storage / workshop adjacent to the parking spaces. This is considered an adequate garage oversize to provide for typical home-owner uses that might otherwise restrict the use of the parking space. This is simply an intuitive number based on experience.

The reduction in counted parking spaces in garages and carports recognizes that storage and other homeowner uses frequently restrict parking.

The limitation restricting the allocation of parking within the street right-of-way is intended to keep cars from blocking pedestrian access along sidewalks, and from blocking clear site lines along and in the vicinity of the street.

Recommended Standards

dwellings can be counted towards the parking requirement only for the dwelling on the lot and its spillover.

Minimum dimensions for off-street parking spaces on individual lots shall be as follows.

a. *Garages and Carports*: Parking bays in garages and carports shall be at least 18-feet long and 10-feet wide. These spaces shall be centered on garage doors to provide convenient and unobstructed ingress and egress.

Garages and carports having a minimum storage areas equal or greater than 60 sq. ft. at the rear or side of the carport / garage may count all garage and carport parking towards the parking requirement for that unit.

The allowable number of dimensioned parking spaces in garages and carports that do not meet the storage area requirement indicated above shall be one less than the number of dimensioned spaces.

b. *Driveways to Single-Family Residences*: Parking spaces along driveways to single-family residences can be stacked (one behind another and side to side), and shall be at least 20-feet long by 8-feet wide. These parking spaces do not need to be striped. Only on-lot driveway area can be counted towards the parking requirement for residential driveways accessing residential access streets or streets of higher classification. Driveway area to within 3 feet of the edge-of-pavement can be allocated to parking space for residential driveways accessing alleys. A drive isle does not have to be maintained when considering spaces in driveways.

4.3.2 Common Parking Lots

For multifamily dwellings, parking shall be in common lots in accordance with the standards of this section. This section also applies to parking lots serving neighborhood commercial and business uses, recreation areas within developments, as well as common parking lots for overflow parking within residential neighborhoods necessary to meet the parking space requirements of section 4.1.

Recommended Standards

4.3.2.1 Location

Off-street parking lots shall be located to the side or rear of buildings and shall not be located within the front yard.

Figure 4.1. Parking Lot Located at the Rear of Building
These offices, set within a residential context, have their parking lots located at the rear of their lots. Note that the parking is also screened from the adjacent street by a row of shrubs.

4.3.2.2 Geometric Elements

The geometric elements of parking lot design include parking stall arrangement and size, desired traffic circulation, and island radii, spacing, and configuration. These elements shall be established considering anticipated vehicle loads, turnover rates, vehicle size, and the need for emergency vehicle access.

Stall and Aisle Geometry: Figure 4.1 provides parking space and aisle dimensions for standard and mid-sized vehicles. Alternate geometric standards may be used if justified based on a realistic estimate of the facilities use, and supported through a recognized engineering reference (Reference 1 for example).

Commentary

To reinforce the residential scale and qualities of a neighborhood, building facades should be more prominent along a street. Placing parking in front of a building or store has more of a suburban strip-mall feel, which does not reflect the qualities of a walkable community. Parking placed along the side of a building, particularly for neighborhood commercial uses, will provide adequate adjacencies and access for the buildings users, shoppers, etc.

Parking lot design is a complex mix of various design elements, including

- Site constraints,
- Parking demand,
- Anticipated turnover rate,
- Vehicle size,
- Desire for safe circulation,
- Minimizing impervious area, and
- Meeting landscape needs for aesthetics and shade.

No one design will fit all situations. Each design will be unique and must provide a safe, functional, and environmentally friendly facility. Reference 3 is an excellent reference for parking lot circulation and geometry.

Parking stall dimensions in Table 4-5 are based on

Commentary

a desire to minimize impervious area while maintaining sufficient distance between vehicles All values are based on data presented in Reference 3.

It is noted that off-street angled parking spaces may be designed for either forward or reverse (backward) entry. See further explanations about angled parking in chapter 2, section 2.3.2.

End-islands are an integral part of the design of parking lots. They define the area and geometry of the intersection of a parking aisle and the internal circulation aisles. They provide an element of safety by protecting cars parked at the end of each row and providing a clear visual site distance at the corner.

Recommended Standards

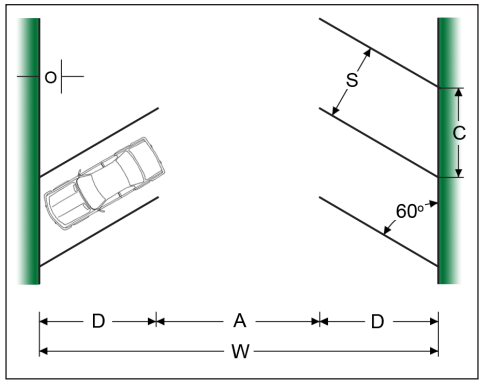


Figure 4.2. Parking Stall and Access Isle Geometry.

Table 4-5. Parking Stall Dimensions

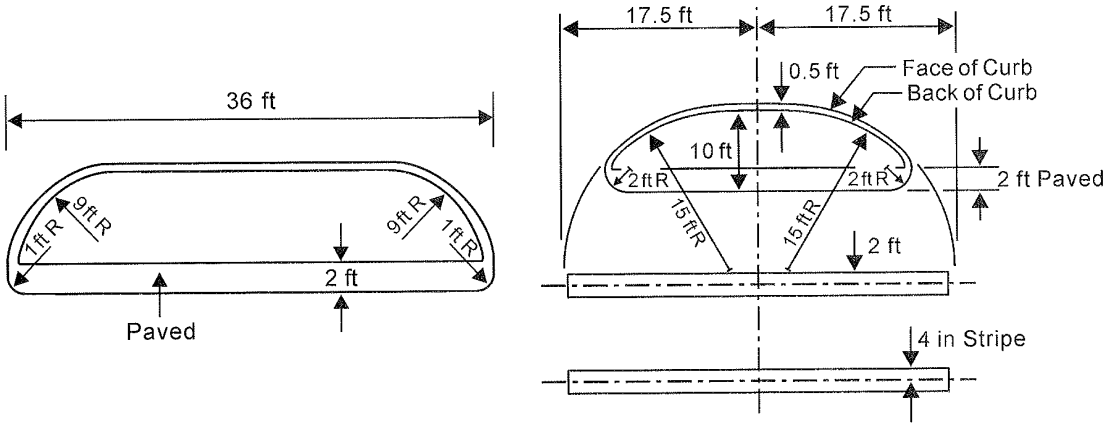
Stall Angle (degrees)	**S** Stall Width (ft.)	**C** Stall Length (ft.)	**D** Stall Depth (ft.)	**O** Front Over-hang (ft.)	**A*** Aisle Width (ft.)	**W** Module Width (ft.)
90	9	9.5	18	3	24	60
60	9.5	11.0	20.5	2.6	16**	57**
45	9.5	13.4	19.5	2.1	14**	53**

* Value modified based on Reference 6.
** Accommodates one-way traffic only. For 2-way traffic, use A = 24 feet and W = 65 feet or 63 feet for 60- and 45-degree angled parking, respectively.

If a sidewalk exists at the curb, the combined width of the curb and sidewalk shall be sufficient to permit a 3-foot unobscured walkway width (i.e., the minimum width of sidewalk plus curb shall be 3 feet plus the dimension “O”). Where curb overhang will not interfere with pedestrian flow or impact adjacent landscaping, the stall depth (dimension “D”) may be reduced by the front overhang (dimension “O”).

End Islands: End islands shall be delineated by raised curbs surrounding a landscaped area. A 2-foot wide paved sidewalk shall be provided behind the curb adjacent to the end parking stall. Figures 4.2 and 4.3 illustrate typical end-island designs for 90-degree and 60-degree parking, respectively. Part (a) of each figure illustrates an end island that can be used in occasional use or low-volume parking lots constructed as spill over lots; Part (b) illustrates the end island that should be used in a constant use lot at multi-family and commercial facilities.

Recommended Standards

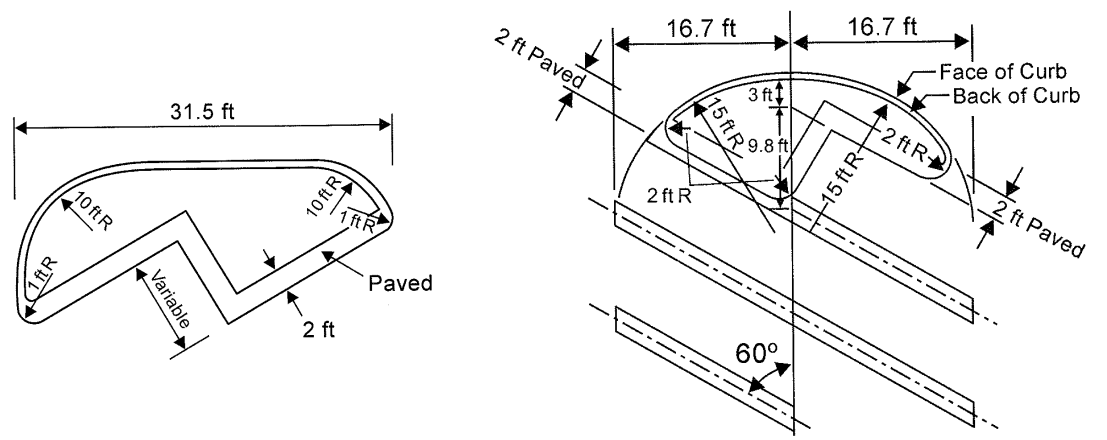


(a) End Section for Occasional Use Lots

(b) End Island for Constant Use Lot

Figure 4.3. Typical End-Island Design for 90 Degree Parking

Source: Stover and Koepke, Ref. 3



(a) End Section for Occasional Use Lots

(b) End Island for Constant Use Lot

Figure 4.4. Typical End-Island Design for 60-Degree Parking

Source: Stover and Koepke, Ref. 3

Commentary

End-islands can take on a variety of shapes. The end-islands illustrated in Figures 4.3 and 4.4 represent typical designs that accommodate necessary planting areas as well as meet traffic flow needs.

Placing a paved strip along the parked side of the end-island creates a convenient walkway for pedestrians entering or exiting cars on that side and protects landscape plantings in the island. See Illustration 4-c below:

Illustration 4-c. Landscape Island Access Walkway. (a) trampled vegetation; (b) paved access walkway

(a)

(b)

Source: Stover and Koepke, Ref. 3

Commentary

It is noted that the end-islands having corner radii as identified in part (a) of Figures 4.2 and 4.3 may require passenger cars to swing into the opposing lane of traffic when entering the traffic aisle (see Illustration 4-b, below). While this might be acceptable for occasional-use or low-volume lots, it will create traffic flow conflicts in constant-use or higher-volume lots.

While the configuration in part (b) of Figures 4.2 and 4.3 permit the design passenger car to swing into the aisle without encroaching on the opposing lane of traffic, it provides a smaller landscape area and exposes the car parked adjacent to the island. If these considerations become a concern, the island width should be increased from 10 feet to 15 feet.

Illustration 4-d. Small Radius End-island Causing Car to Swing into Opposing Lane

Source: Stover and Koepke, Ref. 3

Landscape strips function to break-up unsafe diagonal movements through large parking lots. They are also esthetic features that serve as locations for parking lot landscaping, and can be used as locations for pole lights and stormwater facilities. Linear planting strips are encouraged rather than numerous small one-tree islands, as that arrangement is better for long-term tree health and is easier for parking lot maintenance, such as snow removal.

Recommended Standards

Ground cover or shrubs that grow higher than 2 feet should be avoided in end islands to maintain clear intersection sight lines.

Landscape Strips: A minimum ten-foot wide continuous planted median shall be installed in off-street parking areas approximately every third parking module as illustrated in Figure 4.5. Other design options may be approved provided that the intent of “breaking up” large areas of parking is met. Saving existing interior trees may be credited toward this requirement.

Recommended Standards

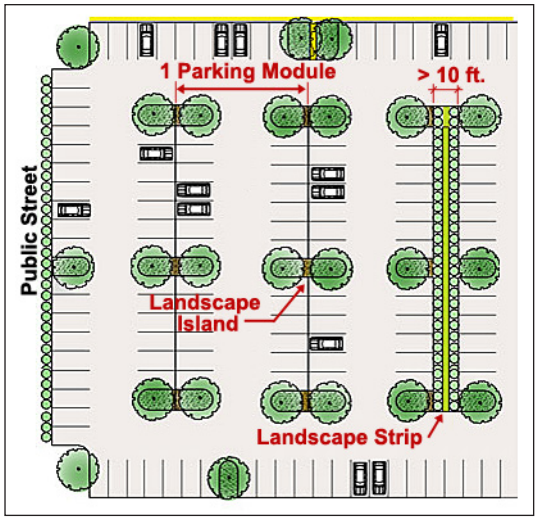


Figure 4.5 Landscape Strip and Islands

Modified from Source: Rockville, SC ordinance, Ref. 6, prepared by the VICgroup

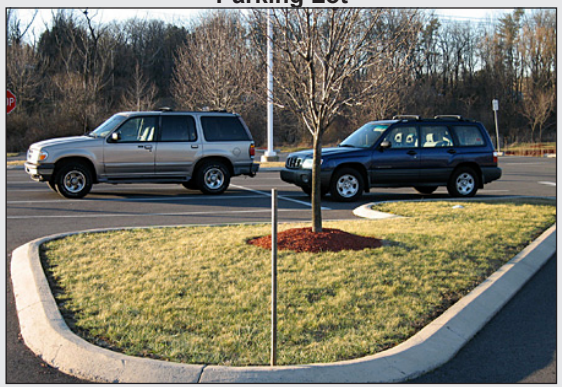
Landscape Islands: Landscape islands may be located as illustrated in Figure 4.4 to reduce the length of parking bays, provide locations for light poles, and facilitate landscaping.

Commentary

Illustration 4-e. Parking Strip in Small Parking Lot

A landscaped central strip is part of a well-landscaped parking lot near a neighborhood-serving commercial area in Bucks County.

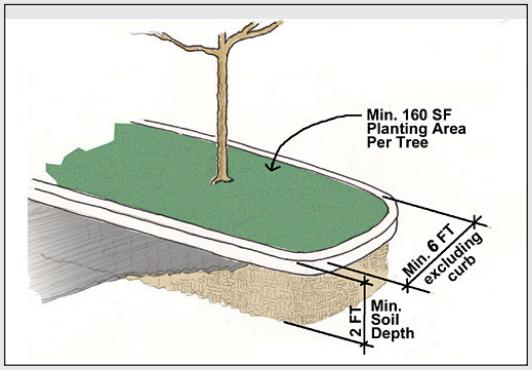
Illustration 4-f. Internal Landscape Island in Parking Lot



Landscape islands provide green space, can assist with stormwater management and help control the flow of traffic within a parking lot.

Commentary

Illustration 4-g. Minimum size for planting islands



For a tree to grow adequately within a parking lot, the island in which it is planted must be of a certain size. An island shaped like a typical parking space at 9' x 18' would be 162 SF. A square footage dimension is provided so that oddly shaped islands can be accommodated if the parking lot design necessitates it.

Parking lot landscaping not only enhances the aesthetics of a parking area, but it also is intended to provide shade and help reduce the heat island effect of paved parking areas. This is why larger canopy trees are preferred.

Recommended Standards

4.3.2.3 Landscaping

Parking lots larger than 18 spaces and/or 5,500 square feet shall provide at least one shade tree for every nine (9) parking spaces. Lots of this size shall also provide screening along all public street frontages. In addition, the following requirements shall be met:

1. Trees shall be located in internal planting islands or linear strips or along the perimeter of the parking lot.

2. Planting areas shall be no less than 160 square feet per tree with a minimum width of six (6) feet, not counting the curb.

3. Trees planted as a part of parking lot landscaping shall be of a non-columnar, shade-tree variety with an expected height at maturity of at least thirty (30) feet. All trees shall be a minimum of two inches in caliper at the time of installation.

4. The standards for all trees and shrubs, including the minimum height, root ball size, number of branches, and width, shall conform with the *American Standard for Nursery Stock* published by the American Association of Nurserymen for that type of tree or shrub at the time of installation. (Ref. 7)

Recommended Standards

5. Parking lots shall be graded so that landscape islands do not impound water, unless surface impoundment is required as a method of on-site retention of stormwater.

6. Landscape islands should be composed of well-prepared structured soil and thoroughly cultivated and amended so as to support healthy plant growth. Depending on a soil analysis, soil preparation shall require incorporation of 20% - 30% organic matter (composted leaves or other approved product) by volume, tilled to a minimum of 5" (Ref. 8). Adequate drainage, mulching, and irrigation shall be provided for landscape medians and islands.

7. Parking shall be partially screened from the view of public streets by evergreen plantings, fencing, or walls. The height shall be minimum of 3 feet; plantings must attain a height of 3 feet within three years of installation.

Commentary

Illustration 4-h. Bio-Swale in parking lot island

Source: Dr. Stuart Echols, Penn State

By having depressed rather than raised landscape islands and strips, those components of parking lots can provide an additional stormwater management function. Even if the site engineering or subsurface will not enable them to serve infiltration purposes, these areas can still collect and perform the first-flush cleansing before the stormwater runoff enters the system.

For the health and vitality of the plantings, the planting areas must be free of construction debris and the soil compacted during construction must be amended.

To help enhance the residential character of the neighborhood, views of parked cars need to be diminished. The requirements provide an element of safety in that one can still see into the parking lot, but the more prominent view at the street frontage will be that of landscaping, not car grills.

Commentary

Illustration 4-i. Screen parking view from streets

Shown here is a visual simulation that depicts the difference between no screening and a screen consisting of a low fence with planting in front of it.

Site designers are encouraged to retain trees rather than paving over those pervious surfaces, where practical. Offering a small reduction in the number of spaces that need to be provided can serve as an incentive to do this. The amount of reduction can be determined only after taking into consideration any unique site conditions and the impact of the reduction on parking needs for the use. The reduction of parking shall only occur where the trees being protected are within the parking area.

Recommended Standards

4.3.2.4 Tree Preservation

A 5 to 20% reduction in the number of parking spaces required on the site shall be allowed to the extent that the reduction in the amount of required pavement will preserve existing healthy trees in an undisturbed, natural condition. The amount of reduction can be determined only after taking into consideration any unique site conditions and the impact of the reduction on parking needs for the use, and must be agreed upon by both the applicant and the municipal staff.

Recommended Standards

4.3.2.5 Signage

Adequate signage shall be provided to facilitate traffic flow. At a minimum, stop signs shall be provided at locations where parking aisles intersect circulation roadways, and at parking lot access points onto public streets and roadways.

4.3.2.6 Pavement Section

Off-street parking areas and perimeter travel lanes shall be designed with pavement sections as specified in Figure 4.5. As indicated in Figure 4.5, parking lot pavement sections

Commentary

Illustration 4-j. Trees Preserved in Parking Lot

Source: Dr. Stuart Echols, Penn State

The design of this parking lot took into consideration the value of two large, healthy oak trees. The islands were generously sized to accommodate the existing root area of the trees. It would obviously be years before newly planted trees could attain this size and provide equivalent shade and stormwater mitigation benefits.

Illustration 4-k. Stop Sign at Internal Parking Lot Circulation

This sign indicates that the parking lot aisle traffic must stop and yield to any cars traveling in the internal circulation lanes of this parking lot.

Commentary

Light load lots are intended to provide an economical alternative to on-street parking for spillover parking in single-family residential neighborhoods. A typical light-load lot would provide access for up to 250 autos per day plus 10 or less two axle step delivery trucks with single-axle loads less then 6,000 lbs. per week. With the exception of emergency situations, these lots should not be subject to single axle loads in excess of 8,000 lbs. Note that other vehicle load combinations are possible and should be permitted as long as it is demonstrated that the anticipated loads will not exceed 500 ESAL's.

Moderate-load lots are typical of parking lots for multi-family units (townhouses and garden apartments) individually and in combination with neighborhood commercial uses where an alternate means of access (service road, for example) is provided for moving vans and other large delivery vehicles. A typical moderate loading would be 700 or fewer autos per day, 30 or less step delivery trucks per week (2 axles with single axle loads few than 6000 lbs), and 8 or fewer large delivery or service vehicles (3 axles with single axle loads less than 8,000 lbs.) With the exception of emergency situations, these lots should not be subject to single axle loads in excess of 16,000 lbs. Note that other vehicle load combinations are possible and should be permitted as long as it is demonstrated that the anticipated loads will not exceed 1,500 ESAL's

Moderately heavy load lots would be typical of large multi-family developments (townhouses and garden apartments) individually or in combination with neighborhood commercial uses, where an alternate means of access is provided (service road, for example) for moving vans and other semi tractor trailer trucks. A typical moderate loading would be 4000 or fewer autos per day, 60 or fewer step delivery trucks per week (2 axles with single-

Recommended Standards

are a function of anticipated traffic loads. Anticipated traffic loads are defined are as follows.

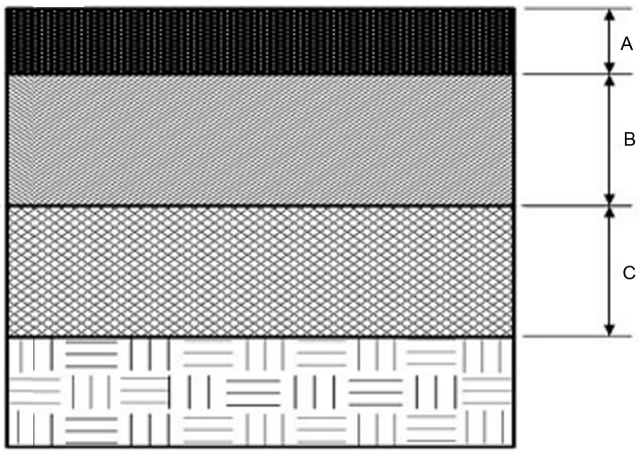
Light Load Lots: Parking lots subject to 500 or less ESAL's (equivalent 18-kip single axle loads) during a 25-year design period. Small step delivery vehicles having 2 axles with single-axle loads up to 6,000 lbs. may have regular access to these lots. However, these lots are not appropriate for access by tri-axle delivery or other large service vehicles, including moving vans. Construction vehicles shall not access finished surfaces on lots intended for light loads.

Moderate Load Lots: Parking lots subject to 1500 or less ESAL's during a 25-year design period. Step delivery vehicles and service vehicles having 2 axles with single-axle loads up to 8,000 lbs. may have regular access to these lots. However, these lots are not appropriate for larger single-unit service vehicles and semi tractor trailer trucks, including moving vans. Construction vehicles may access the base course pavement on these lots as long as the combined B and C layer structure number is greater than 2.0.

Moderately Heavy Load Lots: Parking lots subject to 6,000 or less ESAL's during a 25-year design period. Step delivery vehicles and service vehicles having single-axle loads up to 16,000 lbs. may have regular access to these lots. However, these lots are not appropriate for regular access by semi tractor trailer trucks, including moving vans. Construction vehicles may access the base course pavement on these lots as long as the combined B and C layer structure number is greater than 2.0.

The approving authority may require computations documenting expected axle loads for parking areas to support the pavement section selected.

Recommended Standards



(Not to Scale)

Layer Designation	Layer Description	Light Load	Moderate Load	Moderately Heavy Loads
A	Bituminous Wearing Course	2.5	1.5	1.5
B	Bituminous Concrete Base Course	none	3.0	3.5
C	Granular Base	4.0	4.0	6.0
Minimum Structure Number		1.5	2.0	2.5

Figure 4.6. Parking Lot Pavement Layer Thickness Specifications

4.3.2.7 Lot Driveway Entrance

Parking lot entrances onto all public streets shall be designed in accordance with Pennsylvania State Code, Title 57, Chapter 441, Access to and Occupancy of Highways by Driveways and Local Roads.

4.3.2.8 Accessibility

Common parking lots serving multifamily dwellings, commercial and business uses, and other recreational uses shall provide parking for the physically disabled in accordance with

Commentary

axle loads less than 6000 lbs), and 8 or fewer large delivery or service vehicles (3 axles with single-axle loads less than 16,000 lbs.) Note that other vehicle load combinations are possible and should be permitted as long as it is demonstrated that the anticipated loads will not exceed 6,000 ESAL's.

Commentary

Shared parking is when two or more land uses share the same parking spaces. By taking into account different peak parking demands, shared parking areas reduce the total number of parking spaces required compared with simply adding together the parking requirements of each individual land use. The major benefit of shared parking is a reduction in the land devoted to parking, especially in the amount of paved surface which minimizes stormwater impacts and preserves more land for green space or additional development density.

Land uses often involved in specific shared parking arrangements include offices, restaurants, retail, colleges, churches, cinemas, hotels/motels, and special event situations. Shared parking is often inherent in mixed-use or neighborhood commercial developments that house one or more businesses that are complementary, ancillary, or support other activities. Table 2-a provides an example of peak parking demand periods for various land uses.

Recommended Standards

the requirements of the Americans with Disabilities Act (Public Law 101-336), and local, State, and Federal codes which implement the Act (Ref. 2).

Accessible spaces shall be provided in accordance with Table 4-6 for all off- and on-street parking for multi-family residences and neighborhood commercial uses. Accessible spaces do not need to be provided for single-family dwellings.

Table 4-6. Accessible Parking Space Requirements

Total Spaces for Use	Minimum Van-accessible Spaces Required
1 to 25	1
26 to 50	2
51 – 75	3

Note: At least one space must be van-accessible.

4.4 SHARED PARKING

In the interest of minimizing impacts from impervious land areas optimizing the use and allocation of parking facilities, the planning commission may recommend, and the municipal authority may authorize a reduction in the number of required parking spaces for multiple use developments or for uses that are located near one another, and that have different peak parking demands and operating hours. Shared parking shall be subject to the following standards.

1. ***Location***: All uses that participate in a single shared parking plan shall be located on the same lot or on lots that share a common boundary. The shared parking lot shall be developed and used as though the uses on the lots were a single unit.

2. ***Shared Parking Study***: A shared parking study shall be prepared and submitted to the approving authority along with the development plans for the shared parking. The shared parking study shall clearly establish those uses that will use the shared spaces at different times of the day, week, month and/or year, including seasonal or mode adjustment factors. The study shall:

   a. Be based on the most current Urban Land Institute (Ref. 4) or International Transportation Engineers (Ref. 5) parking study methodology, or other generally accepted methodology;

Recommended Standards

b. Address the size and type of activities, the composition of occupants, and the anticipated peak parking and traffic loads;

c. Provide for a reduction by not more than 50% of the combined parking required for each use;

d. Provide for no reduction in the number of spaces reserved for persons with disabilities;

e. Address the risk of a future change in use that might impact or otherwise affect the use of shared parking, and identify a reserve area to be used if future parking expansion is required; and

f. Be sealed by the engineer of record for the project.

3. ***Agreement for Shared Parking Plan***: A shared parking plan shall be enforced through written agreement. An attested copy of the agreement between the owners of record shall be submitted to the approving authority. Proof of recordation of the agreement shall be presented to the municipality prior to issuance of a zoning permit for the project. The agreement shall:

a. List the names and ownership interest of all parties to the agreement and contain the signatures of those parties;

b. Provide a legal description of the land or parcel(s) whose uses are to be included in the shared parking plan;

c. Include a site plan showing the area of the parking parcel, access drives, and any area that must be maintained in green space for the possible future expansion of the parking area;

d. Provide a legal description of the parking parcel or easement including any access isles and parking reserve areas, and designate and reserve this area for shared parking unencumbered by any conditions that would interfere with its use;

e. Agree and expressly declare the intent for the covenant to run with the land and bind all parties and all successors in interest to the covenant;

f. Assure the continued availability of the spaces for joint use and provide assurance that all spaces will be usable without charge to all participating uses;

Commentary

Table 2-a. Peak Parking Demand Periods

Weekday Peaks	Evening Peaks	Weekend Peaks
Banks Schools Distribution Facilities Factories Offices Professional Services	Hotels Auditoriums Restaurants & Bars Theaters Meeting Halls Residential Dwellings	Religious Institutions Parks Retail Shops Malls

References 4 and 5 provide additional detailed information on shared parking.

Commentary	Recommended Standards
	g. Describe the obligations or each party, including the maintenance responsibility to retain any identified reserved open space (if applicable) for additional parking spaces if the need arises; h. Incorporate the shared parking study by reference; and i. Describe the method by which the covenant shall, if necessary, be revised. 4. ***Change in Use***: Should any of the shared parking uses be changed, or should a representative of the municipality find that any of the conditions described in the approved shared parking study or agreement no longer exist, or if the municipal authority determines that insufficient parking is an issue, the owner shall have the option of submitting a revised shared parking study and an amended shared parking agreement in accordance with the standards of this subsection or of providing the number of spaces required for each use as if computed separately. If the municipal authority determines that the revised shared parking study or agreement does not satisfy parking needs of the proposed uses, the shared parking request shall be denied, and no certificates of occupancy shall be issued until the full number of parking spaces are provided. 5. ***Revocation of Permits***: Failure to comply with the shared parking provisions of this subsection shall constitute a violation of this Code, and shall specifically be cause for revocation of a certificate of occupancy.

References

References

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CHAPTER 5: STORMWATER MANAGEMENT AND CONVEYANCE FACILITIES

Contents

List of Graphics

Commentary

Illustration 5-a. Swale with Check Dam

In Pennsylvania, local governments have the authority to establish standards for the design and construction of stormwater management facilities. In addition, Pennsylvania's Stormwater Management Act of 1978 (Act 167) requires that counties prepare stromwater management plans for designated watersheds. These plans include stormwater ordinances that must be adopted by the municipalities comprising each specific watershed. Stormwater ordinances based on watershed Act 167 Plans approved by the Department of Environmental Protection subsequent to July 2001 include provisions that address peak rate, volume, and water quality. The standards in these ordinances are based on specific watershed characteristics and, as such, supersede the more general requirements contained in section 5.3 of this document.

Recommended Standards

5.0 OVERVIEW

Stormwater facilities collect, convey, and manage surface runoff from a developed site. Collection and conveyance facilities include general site grading, inlets, pipes, and swales or channels that are designed to move water to stormwater management facilities or to discharge points at the property boundary. Stormwater management facilities include structural and non-structural practices intended to manage the volume, rate, and quality of stormwater runoff.

All land disturbance activities impact the magnitude and characteristics of stormwater discharged from a site. These changes can be positive or negative. Activities that reduce impervious area and the overall intensity of development can have a positive impact on the environment by reducing the volume and peak-rate of runoff, and improving the quality of runoff leaving the site. However, activities that increase impervious area and/ or compact pervious areas increase the volume and peak-rate off, and reduce the overall quality of water leaving the site; these changes often result in flooding, surface erosion, streambank erosion, and environmental degradation of habitat within receiving waters. The goal of stormwater facilities, is to manage the quantity and quality of post development surface runoff, and to provide for the safe conveyance of surface flows to downstream receiving waters.

The recommended standards contained in this chapter comply with the Comprehensive Stormwater Management Policy issued by the Pennsylvania Department of Environmental Protection on September 28, 2002. The recommended standards are designed to be generally applicable on a Statewide basis. Stormwater ordinances based on unique watershed characteristics as defined by a stormwater management plan developed under Pennsylvania Act 167 and approved by the Department of Environmental Protection subsequent to July 2001 shall supersede the standards contained herein.

Recommended Standards

5.1 GENERAL PROVISIONS

5.1.1 Purpose

The purpose of these standards is to minimize stormwater impacts from development activities, and to promote the health, safety and welfare within the municipality through provisions designed to:

a. Meet water quality requirements under State law, including regulations at Title 25, Chapter 93 of the Pennsylvania Code;
b. To the extent possible, preserve natural drainage systems;
c. Protect the quality and quantity of water resources within individual watersheds;
d. Prevent erosion of stream banks and beds;
e. Provide for proper operation and maintenance of stormwater facilities; and
f. Provide standards to meet National Pollutant Discharge Elimination System (NPDES) permit requirements.

5.1.2 Authority

The municipality is empowered to regulate these activities by the authority of the following Acts:

a. Act of July 31, 1968, P.L. 805, No. 247, "The Pennsylvania Municipalities Planning Code", as amended.
b. Act of October 4, 1978, P.L. 864 (Act 167), 32 P.S. Section 680.1, et seq., as amended, the "Stormwater Management Act."

5.1.3 Applicability

All regulated activities and all activities that may affect stormwater runoff, including land de-

Commentary

The design of stormwater facilities and best management practices requires a high level of competence and scientific understanding in hydrology, hydraulics, soils, geology, and hydropedology. Owing to the complexity of site level stormwater facility design, and the potential for significant down-gradient impacts if appropriate design practices are not employed, all elements of the proposed stormwater management plan must be certified to and sealed by an appropriately licensed design professional. This may require certifications by more than one professional to cover all aspects of the design (for example, a soil scientist and a professional engineer).

In accordance with state law, it is illegal for any licensed professional to certify or seal a design or analysis that is not within the professional's area of competent practice or experience. Appropriately licensed Civil Engineers have historically certified stormwater management plans owing to their expertise in surface water hydrology and hydraulics. However, these same design professionals may require additional education in soils, soil physics, and hydropedology prior to being qualified to certify and seal stormwater management plans that include engineered infiltration practices.

In addition, since design liability lies with the certifying design professional(s) and not regulatory staff, regulatory reviews shall be limited to administrative and compliance issues. However, if operation and maintenance of stormwater facilities is to be the municipality's responsibility, regulatory staff may direct the design professional to evaluate alternate designs and comment on the appropriateness of said designs.

Municipal stormwater ordinances enacted under the provisions of PL 864 (Act 167) subsequent to July 2001, include provisions for stormwater peak,

Commentary

volume, and water quality control as required under Federal NPDES regulations. In addition, it is the intent of the Act 167 program that these ordinances be based on watershed-specific characteristics, data analysis, and knowledge of local flood conditions. Since the standards contained here are intended to provide sufficient flexibility to be applicable state-wide, the more watershed specific standards resulting from Act 167 planning activities supersede the stormwater management standards recommended here. Creative solutions for the mitigation of stormwater impacts are encouraged. The U.S. Environmental Protection Agency web site (Ref. 21) maintains a list of up-to-date publications and resources describing stormwater impact mitigation techniques.

The one acre of disturbed area trigger for post construction stormwater management plans is based on State NPDES Permit Requirements. Ordinances based on Act 167 Plans or Permit requirements for Municipal separate storm sewer systems may dictate a lower threshold.

Recommended Standards

velopment or earth disturbance, are subject to these regulations. Where this chapter does not include provisions for a particular technique or method, the design and construction shall be in accordance with (in order of preference) the Pennsylvania Stormwater Management Manual (Ref. 1), Urban Drainage Design (Ref. 2), or other manual of practice for stormwater conveyance and management.

5.2 REQUIREMENTS

All regulated land development and earth disturbance activities within the municipality shall manage and control surface runoff in accordance with the standards set forth herein.

A Post-Construction Stormwater Management Plan (PCSMP), prepared in accordance with the standards in this chapter, shall be submitted to the municipal authority for all land development projects disturbing more than 1 acre.

For land development projects disturbing less than 1 acre, a formal Post-Construction Stormwater Management Plan is not required. However, best management practices shall be used to mitigate potential stormwater impacts to downgradient properties, structures, and/or waterways.

The project PCSMP shall be signed and sealed by an appropriately licensed design professional (a design professional licensed by the State of Pennsylvania to practice engineering, geology, or other profession within the limitations defined in Title 49 of the Pennsylvania State Code).

The representative of the municipal approving body as well as all other State and local regulatory staff shall limit their review of a submitted stormwater plan to administrative compliance issues.

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5.2.1 Post-Construction Stormwater Management Plan

Post-Construction Stormwater Management Plans shall include the following information to demonstrate compliance with the requirements of this chapter:

a. Narrative and graphics as necessary to outline the overall stormwater management concept for the project including identification and location of all proposed stormwater best management practices;

b. Evaluation and documentation of existing site conditions as they relate to the management of storm runoff. The following minimum information shall be included.

- Mapping and narrative description of site topography, surface cover, existing structures and structure remnants, soils, geology and all significant environmental features, including steep slope areas, significant vegetation, wetlands, seeps, springs, etc.

- An interpretive narrative describing existing site soils and their structure as these relate to hydropedologic processes occurring on the site. In addition to providing soil and soil profile descriptions, this narrative shall identify depth to seasonal high water tables and depth to bedrock, and provide a description of all subsurface elements (fragipans and other restrictive layers, geology, etc.) that influence the direction and rate of subsurface water movement. A qualitative assessment of the site's contribution to annual aquifer recharge shall be made, along with identification of any restrictions or limitations associated with the use of engineered infiltration facilities .

- A narrative description of the site soils investigation and justification for the level of detail included.

- Description of and justification for field infiltration/permeability testing with respect to the type of test and test locations).

- Justification for design infiltration/permeability rates used in the analysis of individual BMPs.

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Establishing an appropriate level of detail for soil mapping and assessment is the responsibility of the design professional based on his judgment and specific project characteristics (including development density, risk of hazards, etc.).

Hydropedologic processes control how water moves through the soil. Understanding the hydropedologic processes controlling subsurface water movement at a site is critical to the successful selection and placement of appropriate engineered infiltration facilities. It also helps to define when and where engineered infiltration facilities are not appropriate.

The level of detail associated with a site soils investigation will depend on project goals, site characteristics, as well as economic considerations. It is critical that the project soil scientist be involved in developing an appropriate soils investigation plan.

Appropriate evaluation should test the hydrologic characteristics of the most restrictive layer. The infiltration/permeability testing method used should provide a reasonable estimate of this value. Percolation tests ("perc test"), conducted in accordance with procedures outline in title 25, section 73.15 of the Pennsylvania code, were designed for the design of on-lot wastewater facilities and are gener-

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ally not appropriate for the design of engineered infiltration systems.

Appropriate separation distances between natural and/or engineered infiltration practices and other critical features are a function of a variety of site and critical feature characteristics, including:

- Soil type, structure, and profile;
- Potential for restrictive layers in soil;
- Topography;
- Geology/depth to bedrock;
- Volume of surface water directed to the management facility;
- Surface water contamination risk;
- Type of "other feature"';
- Location of "other feature" (up or down gradient);
- Etc.

Due to the extreme variability in surface and subsurface conditions across the state and from site to site, it is impossible to establish uniform separation distances that would apply in all cases. Establishing appropriate separation distances is the responsibility of the design professional and should be based on the above factors. (See also commentary associated with "Special Management Areas", section 5.4.5.)

Being overly conservative in setting separation distances will result in a need for more land area to serve the same development function and number of units. This impact is contrary to the goal of minimizing the area of disturbance and associated environmental impacts resulting from land development.

Since design liability lies with the certifying design professional(s) and not with municipal regulatory staff, regulatory comments shall be limited to administrative compliance issues, and the adequacy

Recommended Standards

c. Documentation illustrating and justifying separation distances between natural or engineered infiltration practices and other critical features is needed. An appropriate separation distance should be used between engineered infiltration facilities and the following critical features:

    - Water supply wells (individual or community);
    - On-lot septic systems;
    - Building foundations; and
    - Underground utility lines and trenches;
    - Sinkholes (unless an appropriate reverse filter is specified for the sinkhole).

d. Hydrologic analysis and computations documenting compliance with the standards in section 5.4, including a description of the modeling approach, rainfall–runoff model used, assumptions and limitations of the model as applied, and all analysis results.

e. Stormwater Best Management Practice design documentation shall include all assumptions, computations, and details for each practice used. A reference for the design guidance used, shall also be provided.

f. Analysis and computations for the sizing and design of all conveyance and hydraulic control structures to demonstrate compliance with section 5.5. Details shall be provided for all stormwater control structures.

g. An operations and maintenance narrative for all elements of the stormwater management system.

5.2.2 Plan Review

The stormwater management plan shall be reviewed by a Qualified Municipal Representative. Plan review shall focus primarily on administrative compliance issues, and the adequacy of engineering support documentation. Recommendations for design changes can be suggested by the municipal representative. If a change suggested by the municipal repre-

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sentative is deemed inappropriate by the licensed stormwater professional, documentation shall be provided demonstrating the scientific basis for the suggested change. However, the final determination of appropriateness for any suggested changes shall be the responsibility of the licensed stormwater professional.

After review, the Qualified Municipal Representative shall provide a written recommendation for the municipality to approve or disapprove the Post-Construction Stormwater Management Plan. If the plan is not recommended for approval, the Qualified Municipal Representative shall state the reasons for disapproval in writing. The Qualified Municipal Representative may also recommend approval of the Post Construction Stormwater Management Plan with conditions, and if so, shall provide the conditions for approval in writing.

The Post-Construction Stormwater Management Plan (see also section 5.2.1) plan review and recommendations shall be completed within the time allowed by the Municipalities Planning Code for reviewing land development plans.

5.2.3 Field Modifications

During construction, if it is found that soils and other field conditions are not as assumed in the approved stormwater management plan, and these changed conditions would result in a malfunction or failure of the approved stormwater management facilities, construction of said stormwater facilities shall be halted, and appropriate revisions shall be made to the stormwater management plans. These field changes shall be designed by the developers' Stormwater Design Professional, and reviewed and approved by the Qualified Municipal Representative prior to proceeding with construction of said stormwater facilities. These modifications will then be reflected in the As-Built Survey (see section 5.2.4).

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of the engineering support documentation provided.

If the Qualified Municipal Representative disagrees with respect to the appropriateness of a proposed stormwater management practice, the following options exist for resolution and approval:

a. An alternate approach or management practice acceptable to the Qualified Municipal Representative and the Licensed Stormwater Professional can be used.

b. An appropriately licensed municipal representative can design the suggested plan change and prepare any necessary stormwater analysis and/or engineering support documentation, and construction details for the change. This information shall be provided to the applicant's design engineer for inclusion in the permit documents and construction plans. In addition, a statement shall be placed on the permit documents and construction plans waiving the licensed professional's liability for that aspect of the design and making the licensed municipal representative liable for any future damage and repairs resulting from that aspect of the stormwater management plan. This statement shall be signed by the applicant's licensed stormwater professional and an appropriate agent of the municipality.

Commentary

Illustration 5-b. Natural Drainage Area

Natural drainage area is preserved and used as a focal amenity. The houses face this natural open space.

Land development activities impact the peak discharge rate, volume, and quality of surface produced by a land area. Mitigating these impacts requires design flexibility, and the use of both natural and constructed facilities.

Guidance for the integration of site design with stormwater controls through the use of non-structural BMPs is provided in chapters 4 and 5 of Reference 1. These approaches will often require creativity and flexibility in zoning and other municipal standards. For example, protecting sensitive and special value areas, minimizing disturbed areas, and allowing room for decentralization of stormwater functions may require lot sizes and configurations not permitted in conventional zoning districts. For a given site yield (number of lots or homes), the use of smaller lots will permit a developer to protect and conserve sensitive or special value resources and open space. This approach also has cost benefits for the municipality: the use of smaller lots will minimize street and utility length, reducing opera-

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5.2.4 As-Built Surveys, Completion Certificate, and Final Inspection

The developer shall be responsible for completing an “as-built survey” of all stormwater BMP’s and other facilities included in the approved Post-Construction Stormwater Management Plan. The as-built survey and an explanation of any discrepancies with the design plans shall be submitted to the municipality.

The submission shall include a certification of completion from the site engineer verifying that all permanent stormwater BMPs have been constructed according to the plans and specifications and approved revisions thereto.

After receipt of the completion certification by the municipality, the municipality may conduct a final inspection.

5.3 APPROACH

Stormwater management planning shall strive first to minimize stormwater impacts through an integration and retention of natural site characteristics, and site layout and design. This can be accomplished through the use of non-structural stormwater best management practices as identified in Reference 1, including:

1. Protection of sensitive and special value resources critical to site stormwater management;
2. Use of cluster development techniques;
3. Minimizing disturbed area;
4. Minimizing impervious areas;
5. Re-vegetation and reforestation of disturbed areas;
6. Decentralization of stormwater functions; and
7. Source control of pollutants.

After maximizing the use of non-structural practices, structural or built management practices shall be integrated into the design to further mitigate anticiptated impacts. Structural practices include, but are not limited to, the following as described in Reference 1:

1. Infiltration beds, basins, and trenches;
2. Raingardens and bioretention areas;
3. Dry wells and seepage pits;

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4. Vegetated swales and filter strips;
5. Infiltration berms and retentive grading;
6. Vegetated roofs;
7. Rainwater capture and re-use systems;
8. Constructed wetlands;
9. Retention / detention basins;
10. Water quality filters and hydrodynamic structures; and
11. Restoration BMP's, such as riparian buffer restoration, landscape restoration, soils amendment and restoration, and floodplain restoration.

Responsible stormwater management design demands that stormwater issues and options be considered early in the design process. Evaluation of existing site soils, topography, and other natural features must be completed as part of the preliminary design process to maximize opportunities for stormwater mitigation.

5.4 SITE IMPACT MITIGATION STANDARDS

The hydrologic standards for stormwater management design and analysis presented here meet State water quality standards as specified in Title 25, Chapter 93 of the Pennsylvania Code. The design of specific stormwater best management practices shall be in accordance with guidance provided in the *Pennsylvania Stormwater Best Management Practices Manual* (Ref. 1) or other appropriate design guidance (see Ref. 21, for example).

5.4.1 General

All stormwater management designs shall respect natural drainage divides and the character of discharges to adjacent properties. Any change in these drainage characteristics shall require prior authorization by the Qualified Municipal Representative.

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tion and maintenance costs for the municipality and municipal authorities.

Maximizing the use of non-structural controls will typically reduce, but not eliminate, the need for structural controls. Design standards for structural controls are contained in chapter 6 of Reference 1.

Illustration 5-c. Vegetated Swale

State water quality requirements for post-construction stormwater runoff can be met through the use of stormwater best management practices (BMPs), including site design, which mitigate the negative impacts of development on runoff peak, volume, and quality.

The standards contained in this section are intended as minimum standards generally applicable throughout Pennsylvania. These standards are recommended for application in all municipalities or locations where stormwater standards have not been developed using watershed-specific data in accordance with the Pennsylvania Stormwater Management Act of 1978 (Act 167) as interpreted

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subsequent to July 2001.

In addition, it is recognized that the design of stormwater Best Management Practices (BMP) is an evolving science. The Pennsylvania Stormwater BMP Manual (Ref. 1) is only one source of information. New and innovative approaches for the design of stormwater BMP's are encouraged. The EPA Low Impact Development web site (Ref. 21) is continually updated to reflect new approaches and design procedures for stormwater impact mitigation.

The intent of this regulation is to maintain, to the extent practical, the pre-development direction and character of discharges from a site. Minor changes in drainage divides may be acceptable as long as they don't result in significant off-site impacts. In addition, flow concentration at the development site boundary may be acceptable if there will be little or no impact to adjacent properties.

The purpose for controlling the peak rate of runoff is to protect downstream property and infrastructure from damage and inconvenience caused by nuisance and severe flooding. These impacts are a natural consequence of land development practices (see Ref. 1, chapter 2).

The compliance criteria are based on the following:

a. The 24-hour rainfall events are used because a 24-hour storm produces a design storm of sufficient duration to generate peak runoff rates for moderate to large watersheds, and at the same time, contain high-intensity, short-duration peak rainfall amounts that result in peak floods for small drainage areas.

b. The discrete storm events (1-yr., 2-yr., 10-yr., and 100-yr.) were selected to cover the range of events typically analyzed in engineering hydrologic analysis (up to the 100-yr. event),

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5.4.2 Peak Runoff Rate Control

The peak surface runoff rates discharged from a site subsequent to development shall not exceed pre-development peak discharge rates.

Compliance with this standard shall be documented through analysis of runoff resulting from the one (1)-, two (2)-, ten (10)-, and one hundred (100)-year return period twenty-four (24)-hour rainfall events.

In addition, the following conditions shall be used for analysis:

1. Design storm precipitation values shall be based on partial duration series statistics.

2. Existing non-forest areas shall be considered meadow or its equivalent in good hydrologic condition.

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5.4.2.1 Peak Rate Control Exemptions

A. Any site at which the increase in post-development peak runoff rates is determined to be negligible by the Qualified Municipal Representative is exempt from the requirement to provide peak rate control. In support of this exemption, it must be shown that the downstream conveyance systems have adequate capacity to convey the additional discharge without flooding or otherwise adversely affecting downstream properties. This exemption does not waive the requirement for implementation of designs for volume control, water quality control, or stormwater conveyance.

   Written documentation and computations supporting a request for this waiver must be submitted to the Qualified Municipal Representative for review and consideration. This exemption can only be used if authorized by the Qualified Municipal Representative.

B. Peak rate controls may be waived in special cases when it can be demonstrated that the rapid release of stormwater from a site will reduce peak flood levels in tributary streams and waterways. Any such request for a waiver of peak rate control must be supported by adequate documentation and engineering analysis. This documentation must demonstrate a flood peak reduction in the receiving waterway for all flood events as demonstrated through analysis of the 2-year, 10-year, and 100-year design 24-hour storm events. The final determination on the waiver request shall be made by the Qualified Municipal Official.

5.4.3 Volume Control

Stormwater management facilities shall be designed to capture and manage the net increase in surface runoff volume resulting from proposed site development activities for runoff events having return periods equal to or less than two years. This increase in volume is referred to as the design capture volume.

Compliance with this standard shall be documented through analysis of runoff resulting from the 2-year, 24-hour rainfall event. This event shall be referred to as the volume control

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maintain focus on control of more frequent extreme events (see Ref. 7), and maintain reasonableness in the number of events that must be included in the stormwater analysis. Practice has also demonstrated that the 25-yr. and 50-yr. events are adequately managed by the outlet control for the 10-year event and don't need to be analyzed separately.

The intent of this exemption is to eliminate the need for multiple or "piggyback" detention facilities as a result of minor changes in imperviousness or land use upstream of existing stormwater control facilities. A 5% increase in peak runoff rate is suggested as the benchmark for defining "negligible".

The intent of this exemption is to permit the advance release of discharges from sites located in lower portions of a watershed ahead of flows from areas further upstream in the watershed. The goal of these early releases is to reduce downstream peak flood levels.

The purpose of volume control is to mitigate the impacts resulting from the increase in surface runoff volume characteristic of land development activities. Rain falling on a parcel of ground either infiltrates, is intercepted by surface depressions and vegetation and evaporates, or runs off the surface. Volume increases result from surface compaction, removal of vegetation and topsoil, and the cre-

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ation of impervious surfaces. The impacts include changes in *stream morphology* (exhibited through channel erosion), a *reduction in groundwater recharge*, and a potential increase in downstream *flooding*.

The volume control standard presented is based on the following justification:

a. *Channel Stability (morphology)*: Henderson (Ref. 15) summarizes research by Nixon, and Wolman and Leopold, indicating that bank-full steam flow (considered to be the dominant channel forming discharge) occurs with a frequency of approximately 6 to 9 months based on a count of all storms. A count of all storms is a frequency measure similar to return periods based on partial duration series statistics. Therefore, a 1-year 24-hour design storm based on partial duration series precipitation statistics is appropriate and conservative from a channel stability / degradation perspective.

b. *Groundwater Recharge*: Groundwater recharge occurs variably across a watershed. In general it can be stated that a significant percentage of the total recharge occurring within a watershed will occur in discrete locations, and not uniformly across the watershed. From watershed to watershed, the percentage of annual precipitation that becomes recharge can vary significantly. The most efficient way to maintain recharge within a watershed is to identify the critical recharge areas and protect them.

   In lieu of a study to identify recharge specific characteristics within individual watersheds and on land development sites, all that can be done is make an educated generalization of the recharge impact that should be mitigated. The recharge potential and resulting deficit recommend in these standards are based on the potential maximum (soil) retention, S, defined

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design storm. In addition, the following criteria shall apply:

a. Design storm precipitation values shall be based on partial duration series statistics.

b. Existing non-forest areas shall be considered meadow or its equivalent in good hydrologic condition.

c. Non-structural stormwater best management practices (as specified in Chapter 5 of the Pennsylvania Stormwater Best Management Practices Manual [Ref. 1]) shall be used to the maximum extent practical to minimize the design capture volume resulting from the proposed development activities. Volume credits for the use of non-structural stormwater best management practices shall be computed as specified in Chapter 8 of the Pennsylvania Stormwater Best Management Practices Manual (Ref. 1).

d. After maximizing the use of non-structural stormwater best management practices, the remaining design capture volume shall be eliminated from the surface discharge stream through the use of a non-discharge alternative such as natural or engineered infiltration, evapotranspiration, consumptive re-use, or a combination of these practices.

e. When it is demonstrated that no environmentally sound or cost effective non-discharge alternative exists on a site to completely remove the design capture volume from the surface discharge stream, extended detention practices may be used to manage the release of the increased site discharge. When extended detention releases are used to manage any portion of the design capture volume, it shall be demonstrated that the resulting release rates will maintain and protect the quality of receiving surface waters. This requirement will be considered met when the extended detention release rate standards specified in paragraph g of this section are met.

f. Minimum Recharge Volume: A portion of the design capture volume represents lost recharge potential. The recharge deficit created by land development activities shall be restored using natural or engineered infiltration practices. The recharge deficit is established as the minimum recharge volume. An estimate of the recharge deficit shall be made using the following relationship:

$$\mathbf{RD = A_d\,(Spre - Spost) / 12}$$

Where:
RD = Recharge deficit to be mitigated (ac-ft)

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A_d = Site disturbed or impacted area (including undisturbed areas compacted by construction equipment) (acres)
S pre = $(s_1a_1 + s_2a_2 + \ldots s_ia_i)$ pre / $(a_1 + a_2 + \ldots + a_i)$ pre
S post = $(s_1a_1 + s_2a_2 + \ldots s_ia_i)$ post / $(a_1 + a_2 + \ldots + a_i)$ post
$s_1, s_2 \ldots s_i$ = potential maximum retention for each cover complex combination (inches).
$a_1, a_2 \ldots a_i$ = area for each cover complex (acres)
Spre = Pre-development potential maximum retention (inches)
Spost = Post-development potential maximum retention (inches)

The potential maximum retention identified above is as defined in Ref. 27 and is given by the following equation:

$$S = (1000 / CN) - 10$$

Where:

CN = NRCS Runoff Curve Number

The recharge deficit (RD) is best mitigated through the use engineered infiltration facilities which introduce this volume into the subsoil. However, surface infiltration techniques may be used to mitigate this volume. Volume credits identified under item c above may be applied to the recharge deficit.

A waver of the minimum recharge volume shall be granted when it is demonstrated that infiltration of this volume will pose an unacceptable risk of economic loss down-gradient of the engineered infiltration facility.

g. When extended detention practices are used to mitigate all or a portion of the design capture volume, the single or cumulative maximum flow rate resulting from extended detention releases shall not exceed 25% of the receiving channel's estimated dominant discharge (DD25). Compliance with this standard shall be assumed when the following conditions are met:

- Limit extended detention release rates from individual sites to their proportionate share of the DD25 value in all tributary streams to a limiting point-of-interest having a drainage area at least 20 times the project site area tributary to that point. The maximum extended detention release rate shall be evaluated at the site discharge point, at the limiting point-of-interest, and at all steam junctions between these two points. The maximum extended detention release rate shall be computed as follows:

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in the *Natural Resource Conservation Services National Engineering Handbook*, Part 630, Hydrology (Ref. 27). The method presented allows the user to relate recharge deficit to pre- and post-development cover-complex curve numbers, a familiar parameter to most design professionals involved in stormwater management analysis.

However, it must be emphasized that the recharge requirement established here is only an approximation intended to be used as a design tool in the absence of a more rigorous analysis of recharge within a specific watershed.

c. *Prevent Downstream Flooding*: In addition to peak rate, the increase in post-development runoff volume can contribute to an increase in flooding. The additional volume control provided by mitigating the increased runoff from the 2-year event, beyond that necessary for channel stability and groundwater recharge, provides an additional level of protection against flood impacts.

Site design shall always attempt to maximize the use of natural or structural volume removal practices. However, it is recognized that the complexity of site soils and geologic conditions, coupled with the potential risk of down gradient impacts (water in basements, saturated slope failures, potential for sinkhole formation, saturation of down-gradient on and off-site land areas, etc.) will not always permit complete mitigation of the increased volume of runoff resulting from the volume control design storm. For this reason, extended detention is included as a volume control option.

The implementation of the Commonwealth's antidegradation requirements codified in Title 25, Chapter 93.4c of the Pennsylvania State Code, require that persons proposing a new, additional or increased discharge in high quality or exceptional value waters demonstrate that

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- no environmentally sound and cost effective non-discharge alternative exists, and
- that the discharge will maintain and protect the existing quality of receiving surface waters.

The intent of the extended detention release rate standards in paragraph g of this section is to ensure that individual and potential cumulative extended detention release rates from developing sites within a watershed do not pose a threat to downstream channel stability or degradation. Mitigating the threat of channel instability eliminates the degradation risk associated with an increase in surface runoff volume. However, the use of extended detention release rates as a runoff volume management tool should only be used when it can be demonstrated that there is no environmentally sound or cost effective volume removal alternative available.

When the design capture volume can not be completely mitigated using volume removal practices, and downstream flooding is a concern, consideration should be given to requiring that post development peak runoff rates be controlled to magnitudes less than pre-development values. Reduced peak release rates should be established based on consideration of environmental impact and flood damage risk.

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MEDR = [SA / WA] X DD25

Where:

MEDR = the maximum extended detention release rate (cfs);
SA = Site area tributary to the analysis point-of-interest (acres);
WA = Watershed area tributary to the analysis point-of-interest (acres); and
DD25 = Twenty-five percent of the estimated watershed dominant discharge at the point-of-interest.

The dominant discharge is defined as the surface runoff resulting from the 1-year, 24-hour rain event using partial duration series precipitation statistics.

- Extended detention release rates shall be set so that the time to discharge the extended detention volume is greater than 24 hours and less than 72 hours. In both cases, basin release times shall be measured to when 80 percent of the extended detention volume has been released. If the maximum extended detention release rate identified in b and c above does not permit the release of at least 80% of the extended detention volume in less than 72 hours, consideration should be given to permitting a larger extended detention release rate.

Engineered infiltration practices designed to mitigate all or a portion of the design capture volume, introduce more water into sub-soils than occurred naturally. Therefore, an understanding of local soil characteristics and structure, engineering properties of soils, and soil-water physics as it relates to the movement of water through soils is critical to the responsible design of infiltration facilities. Every effort shall be made to safely remove as much of the design capture volume as possible from the site surface discharge stream. However, subsurface conditions (soils and geology) may restrict the volume that can be safely removed through natural or engineered infiltration practices. The final design infiltration volume and rate shall be established by a licensed design professional qualified to perform said services. Documentation substantiating said volumes and rates shall be submitted as part of the Post Construction Stormwater Management Plan.

Adequate pre-treatment of stormwater shall be provided prior to infiltration of stormwater originating from the following areas to minimize health and safety risks:

a. Stormwater from areas of high – pollutant loading. High-pollutant loading areas are areas in industrial and commercial developments where solvents and/or petroleum products are loaded/unloaded, stored, or applies; areas where pesticides

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are loaded/unloaded or stored; areas where hazardous materials are expected to be present in greater than "reportable quantities" as defined by the United States Environmental Protection Agency (EPA at 40 CFR 302.4; and areas with high risk for spills of toxic materials, such as gas stations and vehicle maintenance facilities.

b. Industrial stormwater exposed to "source material." "Source Material" means any material(s) or machinery located at an industrial facility that is directly or indirectly related to process manufacturing, or other industrial activities, which could be a source of pollutants in any industrial stormwater discharge to ground water. Source materials include, but are not limited to, raw materials; intermediate products; final products; waste materials; by-products; industrial machinery and fuels; and lubricants, solvents, and detergents that are related to process, manufacturing, or other industrial activities that are exposed to stormwater. Coal mine reclamation areas may be included in this category when infiltrated water would aggravate or create acid mine drainage to tributary streams.

c. Coal Mine Reclamation Areas - A partial or complete waver of the volume control standards shall be considered if adequate pre-treatment can not be provided and a health and safety risk would result if infiltration practices were used.

5.4.4 Water Quality Control

Water quality control shall be implemented using the following treatment standards and practices.

5.4.4.1 Treatment Practices

Particulate associated pollutants are best treated by stormwater management practices that filter or permit the settlement of suspended solids. Filtering practices include:

- Street sweeping (removes large particulate matter from paved surfaces);
- Runoff filtering through vegetative areas (vegetated filter stripes, grassed swales, etc.); and
- Manufactured inlet filters.

Settling practices include:

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Nonpoint source pollution occurs when rainfall, snowmelt, or irrigation runs over land or through the ground, picks up pollutants, and deposits them into rivers, lakes, and coastal waters, or introduces them into the groundwater. According to EPA (Ref. 23), agricultural practices are the leading source of water quality impairment to our rivers, lakes and estuaries.

Runoff from land development activities is also identified as an important source of nonpoint pollution (Ref. 23). The most significant water quality impact from developing land areas is the increase in runoff volume and peak-rate generated from

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the built impervious area. These increased runoff volumes and rates can result in significant instability and erosion in receiving channels, which can contribute to habitat degradation.

Developed land areas have also been observed to produce other pollutant loads associated primarily with transportation sources and turf and garden management. These include oil, grease, and toxic metals from motorized vehicles; nutrients and pesticides from turf management and gardening; viruses and bacteria from failing septic systems; and road salts. Sediments and solids constitute the largest volume of pollutant loads to receiving waters in urban areas (typically reported as Total Suspended Solids [TSS]). In addition, dissolved pollutants (reported as nitrates and nitrites) from some heavily fertilized lawns and planting areas have also been identified as a nonpoint source pollutant in urban runoff.

Although it is important to minimize overall pollutant loading to receiving waters, it is also important to recognize that residential development may reduce nonpoint pollutant loadings when compared with some pre-development land uses. For example, farmland and pasture have been observed to produce higher concentrations of Total Suspended Solids and Total Phosphorus, and nitrite and nitrates than many residential developments (Ref. 24 and 25 provide examples).

Suspended pollutants are typically scoured from the land surface near the beginning of storm events (referred to as the “first flush”). This results in a spike in pollutant levels in receiving waters in advance of the runoff peak, followed by a significant drop in concentration levels. In contrast, the concentration of dissolved pollutants has been observed to remain fairly constant during storm events, with some dilution evident during the peak runoff period (Ref. 1).

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- Wet ponds;
- Dry ponds with forebay settling areas;
- Dry extended detention ponds;
- Constructed wetlands; and
- Manufactured hydrodynamic/vortex structures.

Figure 5.1. Constructed Wetland

In addition, all natural and engineered infiltration practices will also filter particulate matter. Where heavy sediment loads of silt and sand size particles are anticipated, the runoff stream should be appropriately filtered before it reaches any infiltration practices.

Dissolved pollutants are best treated by practices that include vegetative uptake functions. These practices include:

- Bio-retention areas/rain-gardens;
- Vegetated swales;
- Vegetated areas behind berms and other retentive grading areas;
- Constructed wetlands;
- Wet ponds; and
- The dispersed discharge of surface waters to natural undisturbed areas.

Any practice that infiltrates surface runoff into natural vegetated topsoils (A horizon soils) or a designed planting bed containing 20-30% organic material can be used to treat dissolved pollutants. Planting beds should be designed in accordance with standards for same in Reference 1.

Application and design guidance for individual water quality practices is provided in the *Pennsylvania Stormwater Best Management Practices* Manual (Ref. 1).

Recommended Standards

5.4.4.2 Water Quality Standards

The following water quality standard shall be met:

Achieve an 85% reduction in post-development particulate associated pollutant load (as represented by Total Suspended Solids), an 85% reduction in post-development total phosphorus loads, and a 50% reduction in post-development solutes (as represented by NO3-N), all based on post-development land use.

This standard is intended as a performance-based goal. It does not represent specific effluent limitations but a composite efficiency expectation for use in selecting appropriate management practices.

This standard shall be considered met when one of the following criteria are satisfied:

1. The Design Capture Volume is completely removed from the surface discharge stream, and 90% of site disturbed area is controlled by a water quality BMP. In addition, complete Worksheet 10 from the Pennsylvania Stormwater BMP Manual (Ref. 1) for nitrate compliance; or

2. Computationally demonstrate compliance with water quality standard by estimating pollutant loadings for the proposed development and pollutant load reductions resulting from specific site BMP's as outlined in Tables 5.1 and 5.2 below. In addition, complete Worksheet 11 from the Pennslvania Stormwater BMP Manual (Ref. 1) for nitrate compliance.

Post-development pollutant loadings shall be computed for the land cover classifications and loading rates indicated in Table 5.1. The pollutant load for each component to be treated shall be computed using the following equation:

Pollutant Load = [EMC, mg/l] X [Treated WQV, ac ft] X [2.7, unit conversion]

Where:
EMC = the event mean concentration of the pollutant (mg/l)
WQV = 0.5 X QIMPV + 0.25 X QPERV)/12
QPERV = Qualifying pervious area (acres) *
QIMPV = Qualifying impervious area (acres) *

* Qualifying pervious and impervious areas are identified by the described land cover classifications in the Table 5.1.

Commentary

The suggested water quality standards are intended to capture and collect the "first flush" runoff from medium- to high-volume streets and parking areas, and the initial surface runoff from moderately to heavily maintained lawn and planting areas. Golf courses and professionally maintained athletic fields would be examples of heavily maintained areas; moderately maintained lawn areas would typically be expected in subdivision of 30 lots of larger having one-quarter acre or smaller lot sizes, where the cost of houses is at or above the median housing price for the region.

The data reported in Reference 1 indicate that rooftops, low-volume (traffic) streets and parking lots, residential driveways, playcourts, etc., do not produce significant concentrations of suspended or dissolved pollutants. Therefore, these impervious areas are excluded from the water-quality volume calculation.

In addition, research has established that a significant majority of water-quality impacts from paved land areas are associated with the "first flush" described above. This first flush has typically been defined as the first 0.5 inches of runoff from impervious land areas.

Capturing the initial 0.5 inches of surface runoff from impervious areas (CN = 98) results in capture and treatment of the runoff resulting from over 60% of the rainfall falling annually on these surfaces. Similarly, capturing the initial 0.25 inches of runoff from maintained landscapes (average CN = 77) results in capture and treatment of the runoff resulting from about 92% of the annual rainfall falling on these surfaces. The rainfall percentages reported here are based on data presented in Appendix F of Reference 16.

Commentary

Recommended Standards

Table 5.1. Typical Pollutant Loadings by Land Cover Classification.
(Modified from Ref. 1 to reflect land cover definitions characteristic of this manual)

Land Cover Classification	TSS (EMC in mg/l)	Total Phosphorus (EMC in mg/l)	Nitrate-Nitrite (EMC, mg/l as N)
Residential Lawns (avg lot size < ¼ ac)	180	0.4	0.44
Commercial Lawn Area	180	2.22	1.46
Commercial Planting Beds	55	1.34	0.73
Golf Course Greens and Fairways	305	1.07	1.84
Grassed Athletic Fields	200	1.07	1.01
Athletic Courts	60	0.46	0.47
Residential Driveways	60	0.46	0.47
Low Volume Streets	86	0.36	0.47
Medium Volume Streets	113	0.33	0.58
High Volume Streets	261	0.40	0.83
Low Volume Parking Lots	58	0.15	0.39
High Volume Parking Lots	120	0.39	0.6

Table 5.2. Summary of Pollutant Removal Percent Efficiencies of Stormwater BMP
Source: Ref. 1

Comprehensive BMP List		Pollutant Removal		
		TSS	TP	NO3
Non-Structural BMP's				
5.4.1	Protect Sensitive / Special Value Features	SC	SC	SC
5.4.2	Protect / Conserve / Enhance Riparian Areas	SC	SC	SC
5.4.3	Protect / Utilize Natural Flow Pathways in Overall Stormwater Plan Design	30	20	0
5.5.1	Cluster uses at Each Site: Build on the Smallest Area Possible	SC	SC	SC
5.5.2	Concentrate uses Area-wide through Smart Growth Practices	SC	SC	SC
5.6.1	Minimize Total Disturbed Area – Grading	40	0	0

Recommended Standards

5.6.2	Minimize Soil Compaction in Disturbed Areas	30	0	0
5.6.3	Re-vegetate and re-forest Disturbed Areas using Native Species	85	85	50
5.7.1	Reduce Street imperviousness	SC	SC	SC
5.7.2	Reduce Parking Imperviousness	SC	SC	SC
5.8.1	Rooftop Disconnection	30	0	0
5.8.2	Disconnection from Storm Sewers	30	0	0
5.9.1	Street Sweeping	85	85	50
Structural BMP's				
6.4.1	Porous Pavement with Infiltration Bed	85	85	30
6.4.2	Infiltration Basin	85	85	30
6.4.3	Subsurface infiltration Bed	85	85	30
6.4.4	Infiltration Trench	85	85	30
6.4.5	Rain Garden / Bioretention	85	85	30
6.4.6	Dry Well / Seepage Pit	85	85	30
6.4.7	Constructed Filter	85	85	30
6.4.8	Vegetated Swale	50	50	20
6.4.9	Vegetated Filter Strip	30	20	10
6.4.10	Infiltration Berm and Retentive Grading	60	50	40
6.5.1	Vegetated Roof	85	85	30
6.5.2	Rooftop Runoff – Capture and Reuse	100	100	100
6.6.1	Constructed Wetland	85	85	30
6.6.2	Wet pond / Retention Basin	70	60	30
6.6.3	Dry Extended Detention Basin	60	40	20
6.6.4	Water Quality Filter	60	50	20
6.7.1	Riparian Buffer Restoration	65	50	50
6.7.2	Landscape Restoration	85	85	50
6.7.3	Soil Amendment and Restoration	85	85	50
6.8.1	Level Spreader	20	10	5
6.8.2	Special Detention Areas – Parking Lot, Rooftop	0	0	0

Consideration shall also be given to potential thermal impacts to receiving waters from

Commentary

Commentary

Special management areas pose unique restrictions and challenges for implementation of infiltration and other stormwater best practices. The most significant of these limiting characteristics are outlined below. Guidance is provided in Reference 1 for the application of specific BMP's within these environments.

Brownfields: Contaminated soils on brownfields sites can limit the use of infiltration practices. Contaminated soils can be completely removed from the site, isolated and capped, or blended with clean soil to meet state public health and safety requirement as a part of an overall stormwater management plan.

Karst Areas: The complexities of karst systems demand more rigorous scrutiny of geologic setting than other areas. In these areas, natural infiltration occurs across wide areas of the landscape through conducive natural soil structure, closed depressions, and sinkholes. Development activities significantly alter these natural characteristics and concentrate infiltration functions. With appropriate care, the standards proposed here can be implemented successfully on many sites in karst regions.

Mined Lands: Disturbed lands that have been surface mined or deep mined pose a significant threat to water quality. Rainfall that percolates through residual mine wastes on the land surface or into and through deep mines becomes extremely acidic prior to emerging as stream base-flow or through hillslope springs and seeps. Infiltration practices implemented on these sites will have the same result.

Recommended Standards

stormwater discharges. Anticipated thermal impacts shall be mitigated to the maximum extent possible. Cooling can be achieved through the use of below ground storage or vegetative shading as examples.

5.4.5 Special Management Areas

Unique areas and development activities warrant special consideration from a stormwater management perspective. These areas include:

- Brownfields
- Karst areas (areas underlain by limestone and dolomite formations)
- Mined lands
- Areas close to water supply wells
- Areas close to surface water supplies, and special protection waters
- Urban land areas
- The development of highways and roadways

Due to the unique risk of pollution or undesirable downstream impacts that might result from the use of engineered infiltration and other stormwater control practices in these areas, it may be necessary to waive strict compliance with the design standards of section 5.4.3. In addition, the development of highways and roadways pose their own unique design challenges that may necessitate variance in the application of stormwater controls.

The design of stormwater management facilities in special management areas must consider the unique nature of these areas while attempting to minimize off-site impacts from stormwater runoff. Stormwater management planning in these areas should be coordinated with the Qualified Municipal Representative as well as appropriate agency personel early in the design process to identify appropriate standards to be applied on a project by project basis. Chapter 7 of Reference 1 shall provide general guidance about the design of stormwater management facilities in Special Management Areas.

Recommended Standards

Figure 5.2. Bioswale in Parking Lot

Commentary

Areas Close to Water Supply Wells: Care must be exercised to ensure that infiltration practices don't pose a risk of groundwater pollution near water supply wells.

Areas Near Surface Water Supplies and Special Protection Waters: Again, care must be exercised to ensure that stormwater practices don't pose any significant risk of pollution to these areas.

Urban Land Areas: The intensity of land development in most urban centers not only creates dense development of impervious surfaces on the surface, but also results in complex web of underground utilities (water, wastewater, stormwater, gas, electric, communications infrastructure, etc.). This results in limited area for the construction of stormwater best practices. In addition, the design of stormwater infiltration facilities must consider potential risks to downgradient foundations, and utilities.

Highways and Roadways: Highways and roads face the following specific challenges in managing stormwater:

- The need to manage stormwater while maintaining safe road conditions;
- Limited ROW space (especially on betterment projects);
- As linear systems, roads cross many local watershed divides;
- High percentage of imperviousness;
- Extent of land disturbance and compaction necessary within ROW;
- Potential for hazardous material spills;
- Use of deicing chemicals, salts, and anti-skid;
- High concentration of pollutants per acre; and
- Potential for significant thermal impacts.

The above items individually and in combination pose significant challenges for highway projects.

Commentary

The most common hydrologic analysis methodology used in Pennsylvania for stormwater management design is the NRCS curve number method (TR-55 tabular hydrograph method [Ref. 3] or the TR-20 unit hydrograph model [Ref. 4]). This methodology is recommended because it has a sound scientific basis and was originally developed as a rainfall to runoff volume transformation tool. References 3, 5, 6, 7, 8, 9, and 11 provide additional information on the curve number methods, including discussions of appropriate application and limitations. Many of the limitations identified for the curve number methods also apply to other available hydrologic analysis tools.

The rational method was originally developed as a rainfall intensity to peak runoff rate transformation tool for developed urban areas. Its application for runoff volume computations, particularly under undeveloped conditions, is questionable.

The NRCS models and methods recommended are based on data collected from actual watersheds. In contrast to this, stormwater management analysis for land development activities is often conducted using property lines to define drainage boundaries. Drainage areas based on property boundaries are not true watersheds and are referred to here as “hypothetical” drainage areas. It is known that these hypothetical drainage areas do not respond like natural watersheds. Peak runoff rates from hypothetical drainage areas are often much smaller than comparable runoff rates from natural watersheds of the same size. This often results in post-development nuisance flooding since the models over-estimate the pre-development runoff magnitude.

Recommended Standards

5.4.6 Calculation Methods

The following calculation methods shall be used for all stormwater management analyses unless otherwise authorized by the Qualified Municipal Representative.

The conversion of a design rainfall event to a runoff event shall be performed using one of the following methodologies. The size criteria are based on drainage area size, including site area and all off-site areas draining across the development.

Up to one-hundred (100) acres: NRCS’s Cover Complex Method (TR-55 or TR-20)

Over one-hundred (100) acres: NRCS’s Cover Complex Method as implemented in TR-20 or one of the hydrologic methods implemented in HEC-HMS or HEC-1.

A rational hydrograph method (Modified Rational, or Universal Rational) may be used for any site less than or equal to two (2) acres in size without prior authorization from the Qualified Municipal Representative. These methods may also be used for sites between two (2) and twenty (20) acres in size where the Qualified Municipal Representative has approved the methods use. In this case the licensed design professional must make a written request to the Qualified Municipal Representative explaining why the use of the Rational Method is more appropriate than the NRCS’s methods for the site in question.

If other methods are proposed, a detailed discussion of the hydrologic method used, its applicability to specific site conditions, and a discussion of method assumptions and limitations shall be included in the stormwater management plan narrative.

Commercial software packages that use the basic computational methods of TR-55 or TR-20 are permitted.

In addition, the following standards are established for specific elements of the computational analysis methods:

a. Design runoff hydrographs shall be developed based on the most current PennDOT regional twenty-four (24)-hour rainfall depths (Ref. 17), or NOAA Atlas 14 data (Ref. 18).

b. The NRCS Type II precipitation distribution shall be used to establish the rainfall distribution for stormwater management hydrologic analysis.

c. The NRCS’s dimensionless unit hydrograph “k” factor of 484 shall be used for both

Recommended Standards

pre- and post-development stormwater analyses unless a different value is found to be appropriate based on watershed-specific data analysis.

d. NRCS published curve numbers shall be used as the rainfall-to-runoff transformation parameter. However, when supported by sound scientific reasoning and data, and approved by the qualified municipal representative, published curve numbers may be modified to more appropriately reflect actual surface runoff response.

e. NRCS curve numbers (CN) shall be rounded to the nearest whole number for use in pre-packaged hydrologic models.

f. Area weighting of curve numbers may only be done for land areas having curve numbers that vary by a magnitude of 5 or less.

g. The NRCS's method of determining unconnected impervious area adjustments for CN can be used for distinctly defined impervious land areas that flow onto pervious areas in a dispersed manner. The method may only be used to calculate runoff from site impervious areas that actually flow across pervious areas. The method cannot be applied to the entire site using average weighted CN values.

h. Areas draining to closed depressions must be modeled by removing the volume from the pre-development condition. However, the designer may assume that infiltration in the closed depression does not occur during a design runoff event. Areas draining to closed depressions may also be used to adjust peak runoff rates for the post-development analysis. This allowance has been developed to entice designers to intentionally design or leave in place small closed depressions that can serve as infiltration areas during rain events. The site designer is responsible to document downstream impacts if the closed depression were removed.

i. The following Time of Concentration (Tc) computational methodologies shall be used unless another method is pre-approved by the Qualified Municipal Representative:

- Pre-development -- NRCS's Lag Equation.
- Post-development; commercial, industrial, or other areas with large impervious areas (greater than 20% impervious area) -- NRCS's Segmental Method.
- Post-development; residential, cluster, or other low impact designs less

Commentary

Adjustments in curve numbers on some sites may be appropriate. However, any variation from published curve numbers and conventional engineering practice must be supported by observed runoff conditions and data, and/or a clear description of how curve number may change as a result of landscape position in a local portion of a watershed as documented in Reference 26.

It should be recognized that the CN is only a design tool with a large degree of statistical variability. Use of other than whole number increments in CN is not justified.

When curve number weighting is used for land areas represented by curve numbers that vary by a magnitude greater than 5, the watershed runoff will be significantly reduced. This is especially problematic with pervious/impervious combinations: "combination of impervious areas with pervious areas can imply a significant initial loss that may not take place" (Ref. 3).

The time of concentration (Tc) represents the average condition that best reflects the hydrologic response of the area. For example, large impervious areas bordered by small pervious areas may not consider the effect of the pervious areas in the Tc computation. If the designer wants to consider the affect of the pervious area, runoff from the pervious and impervious areas must be computed separately with the hydrographs being combined to determine the total runoff from the area.

Under no circumstance will the post-development

Commentary

Tc be greater than the pre-development Tc for any watershed or sub-watershed analysis. This includes when the designer has specifically used swales to reduce flow velocities. In the event that the designer believes that the post-development Tc is greater, it shall still be set equal to the pre-development Tc for post-development analysis.

The purpose of limiting peak flow reporting to tenths of a cfs is to recognize the accuracy and precision limitations of hydrologic modeling procedures. Small differences, generally those less than 10% between pre- and post-development discharge rates, should be permitted when no negative downstream impacts will result.

This check is used to determine if flooding may occur due to poor modeling choices specifically related to the time of concentration. The check will frequently yield higher values if a watershed's impervious area is located primarily near the watershed outlet or point of interest.

It is the responsibility of the licensed design profession to determine the standard of practice appropriate for individual stormwater management practices. However, it is the licensed design professional's responsibility to ensure that all design assumptions and computations are clearly documented.

Recommended Standards

than or equal to 20% impervious area -- NCRS's Lag Equation.

j. All lined stormwater management ponds in carbonate and non-carbonate areas must be considered impervious and may not be used as pervious areas for stormwater management computations. "Lined" here means lined with synthetic liners or Bentonite. All other compacted soil liners will be considered to be HSG D for hydrologic computations.

k. All pre- and post-development comparisons of peak flows shall be rounded to tenths of a cubic feet per second.

l. An Impervious Area Flash (IAF) analysis shall be conducted for all sites. The analysis requires that the watershed impervious area be modeled without the pervious areas. The time of concentration should also be determined from the impervious areas only. If the IAF analysis results in a higher post-development peak runoff rate, this higher value must be reported for the final design/comparison.

m. Stormwater management ponds must provide safe passage of the one-hundred (100)-year return period peak runoff rate assuming that all of the principal spillway orifices are fully clogged, and the principal spillway overflow is 50% clogged. A six (6)-inch minimum freeboard must also be maintained above the resulting "maximum" water surface elevations (W.S.E.). Embankment emergency spillways can be assumed to be unclogged. Stormwater management ponds with embankments completely made up of natural undisturbed soils (fully in "cut") or where roadways act as the emergency spillway, are permitted. However, the Design Engineer must verify downstream stability and control.

n. The hydrologic and hydraulic design of all structural stormwater best management practices shall be designed in accordance with the standards contained in the *Pennsylvania Stormwater Best Management Practices* Manual (Ref. 1) or other manual of design practice as deemed appropriate by the licensed design professional. All design shall follow current standards of engineering practice, including clear documentation of all assumptions and computations.

Recommended Standards

5.5 CONVEYANCE SYSTEM STANDARDS

Storm drainage conveyance systems consist of storm sewer pipes, swales, and open channels. Computational methods for design of conveyance systems shall be based on the following standards.

5.5.1 General

1. Stormwater conveyance systems shall be designed based on a ten (10)-year design storm and a one-hundred (100)-year check storm. All stormwater pipe systems shall be sized to convey the ten (10)-year design event without causing a pressure flow condition in any segment of the conveyance system.

2. Piped stormwater conveyance and collection systems shall have a minimum diameter of fifteen (15) inches. A waiver of this requirement will be considered for pipes discharging from stormwater detention or infiltration facilities where flow must first pass through a restriction less than fifteen (15) inches in diameter. In addition, Twelve (12)-inch culverts may be used at driveway crossings if they can adequately pass the design flows. In no case shall a stormwater conveyance pipe be less than six (6) inches in diameter.

3. It shall be demonstrated that adequate and safe conveyance exists for the one-hundred (100)-year check storm.

4. Culverts crossing under roadways shall be designed on the basis of a twenty-five (25) year rainfall event at a design headwater depth of two (2) feet above the crown of pipe. In addition, two (2) feet of freeboard must be maintained between the roadway centerline elevation and the design water level on the upstream side of the crossing.

5. Any storm drain within State or Federal rights-of-ways or that falls under the design criteria of any higher authority must meet the requirements of that agency in addition to the minimum requirements of this ordinance.

6. Stormwater conveyance system stability (swales, open channels, and pipe discharge aprons) shall be computed using a ten (10)-year return period peak runoff rate and/or as required by PA DEP Chapter 102, whichever is greater.

7. When located in undedicated land, stormwater conveyance systems shall be placed within a drainage easement not less than ten (10) feet wide as approved by the

Commentary

Pressure flow in stormwater pipe systems occurs when the combination of flow magnitude and energy losses in pipes and conveyance structures results in water backing-up in manholes to a depth greater than the pipe diameter. This condition is often referred to as “surcharging.”

Minimum pipe sizes are typically established to minimize the risk of clogging. The intent of the waiver here is to allow for smaller pipe in the specific case outlined where clogging would typically not be expected.

Easement widths for stormwater conveyance systems should be set to permit access to the pipe

Commentary

or swale for maintenance purposes. The easement should encompass the entire width of swales or other surface drainage-ways. Adequate width should be included in easements for pipe systems to permit safe excavation of the pipe for maintenance purposes.

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Qualified Municipal Representative. Easement width shall be established to provide adequate access to the conveyance system for maintenance purposes. If drainage easements are adjacent to a municipal right-of-way, the Municipal Representative may approve a narrower easement.

8. The use of properly designed, graded and turfed drainage swales is encouraged in lieu of structural storm sewers. In addition to carrying the required discharge without excessive erosion, consideration should always be given to designing grass-lined swales to provide increased surface contact time and enhanced infiltration characteristics.

9. Inlet types and inlet assemblies shall conform to the Pennsylvania Department of Transportation Standards for Roadway Construction as approved by the Municipality.

   a) Inlets shall, at a minimum, be located at the lowest point of street intersections to intercept the stormwater before it reaches pedestrian crossing, or at sag points of vertical curves in the street alignment that provide a natural point of ponding of surface stormwater.

   b) Where the municipality deems it necessary due to special land requirements, special inlets may be approved.

      1. The interval between inlets collecting stormwater runoff shall be determined in accordance with DM-2, chapter 10, section 5, “Capacity of Waterway Areas” (Ref. 17).

      2. In curbed roadway sections, the maximum encroachment of water on the roadway pavement shall not exceed half of a through traffic lane or one (1) inch less than the depth of curb during the ten (10)-year design storm of five (5)-minute duration. Inlets shall be provided to control the encroachment of water on the pavement. When inlets are used in a storm system within the right-of-way limits of a street in lieu of manholes, the spacing of such inlets shall not exceed the maximum distance of four hundred fifty (450) feet.

10. Accessible drainage structures shall be located on a continuous storm sewer system at all vertical dislocations, at all locations where a transition in storm sewer pipe sizing is required, at all vertical and horizontal angle points exceeding five (5) degrees, and at all points of convergence of two (2) or more influent storm sewer mains. The construction locations of accessible drainage structures shall be as indicated on the land development drainage plan or area drainage plan approved by the municipality.

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11. When evidence available to the municipality indicates that existing storm sewers have sufficient capacity as determined by hydrograph summation and are accessible, the subdivider may connect their stormwater facilities to the existing storm sewers so long as the peak rate of discharge does not exceed the amount permitted by this ordinance.

5.5.2 Hydrologic Design Standards

1. Recommended computational methods (models) for the design of stormwater conveyance systems, based on site or watershed drainage area, are as follows.

Table 5.3 Recommended Computational Methods

Up to two-hundred (200) acres in size	Rational Method
Between two-hundred (200) acres and one-and-one-half (1.5) square miles in size	HEC-1 PSRM TR-20
Over one-and-one-half (1.5) square miles in size	PSU-IV with the carbonate adjustment factor at the discretion of the Qualified Municipal Representative

Other methods may be used as approved by the Qualified Municipal Representative.

2. Rainfall intensities as reported in the most current edition of Reference 17 shall be used to establish peak flow rates for design.

3. Rational Coefficients used are to be from Rawls et al. (Ref. 19), *PA DOT Design Manual* 2-10 (Ref. 17) or other acceptable source. The Design Engineer may choose to use the following Rational C coefficients to conservatively estimate pipe or channel flows. However, it is recommended that they be used only for storm drains up to twenty-four (24) inches in diameter.

   All impervious areas: C = 0.95
   All pervious areas: C = 0.30

4. For stormwater conveyance system design, the time of concentration (Tc) can be computed by any method that best represents surface conditions tributary to each inlet. For any drainage area smaller than five (5) acres in size, a Tc of five (5) minutes may

Commentary

Adequate and safe conveyance may include surcharging of inlets and surface discharges. However, it implies that there will be a safe route for all flows without causing flooding or structural damage to buildings and other infrastructure facilities.

For pipe sizes exceeding 24 inches, more accurate selection or Rational C values may be appropriate to avoid excess costs associated with pipe sizes that are overly conservative.

Commentary

The licensed design professional maintains liability for the design of all civil infrastructure. Therefore, the specific design tools and methods used for conveyance system design are the responsibility of the licensed professional.

Vegetated channels provide additional opportunity for stormwater impact mitigation. The vegetation acts as a filter to enhance deposition of suspended solids, providing a water quality benefit. In addition, infiltration can occur across the wetted channel surface.

Grassed swales are commonly used instead of curb and gutter drainage systems in low- to moderate density (16 to 21% impervious) single-family residential developments. Since grassed swales do not function well with high volumes or velocities of stormwater, they have limited application in highly urbanized or other highly impervious areas. However, swales may be appropriate for use in these areas if they are constructed in series or as pretreatment facilities for other BMPs. Grassed swales are usually located within the right-of-way when used to receive runoff from subdivision or rural roadways. They may also be installed within drainage easements along the side or rear of residential lots. Grassed swales can be strategically located within the landscape to intercept runoff from small impervious surfaces (small parking lots, rooftops, etc.) as a component of a subdivision-wide or development-wide BMP strategy. Water quality swales are appropriate for the same development conditions as those listed for grassed swales with

Recommended Standards

always be assumed at the discretion of the Design Engineer (for the post-development condition), without needing to provide supporting documentation.

5.5.3 Hydraulic Design Standards

Computational procedures for the hydraulic design of stormwater conveyance systems (pipes and swales) shall follow methods and procedures outlined in the *NRCS National Engineering Handbook*, Part 640:Hydrology (Ref. 5), *The Federal Highway Administration's Urban Drainage Design Manual*, HEC-22 (Ref. 2), *PennDOT Design Manual* Part 2, Chapter 10 (Ref. 17), *The Pennsylvania Stormwater Best Management Practices Manual* (Ref. 1), or other manual of engineering practice.

5.5.4 Open Channels and Swales

Where possible, vegetated surface channels and swales should be used for stormwater conveyance. When designed appropriately, surface swales can be used to help mitigate peak runoff rates, runoff volume, and stormwater quality. For specific information on design options and plant materials, see References 1 and 21.

The use of properly designed, graded and turfed drainage swales is encouraged in lieu of structural storm sewers. In addition to carrying the required discharge without excessive erosion, consideration should always be given to designing vegetation-lined swales to provide increased surface contact time and enhanced infiltration characteristics.

Figure 5.3. Vegetated Swale Filters Street Run-off

Recommended Standards

5.5.5 Pipe Systems

If open channels or swales are not an option due to steep slopes or other limiting factors, piped systems shall be used for stormwater conveyance. Stormwater conveyance shall occur in underground piped systems. The following pipe materials, bedding, and backfill standards shall be used for piped conveyance systems.

5.5.5.1 Pipe Materials

Materials used in the construction of storm sewers shall be constructed of reinforced concrete, ductile iron, or corrugated polyethylene, or when approved by the municipal engineer, corrugated metal. The most cost-effective materials shall be permitted that conform to local site conditions and reflect the relevant operations, maintenance, and system character of the municipal stormwater system. Specifications referred to, such as ASTM or AWWA, etc., should be the latest revision in effect at the time of application.

1. The following apply to reinforced concrete pipe:
   a. Circular reinforced concrete pipe and fittings shall meet the requirements of ASTM C76.

   b. Elliptical reinforced concrete pipe shall meet the requirements of ASTM C507.

   c. Joint design and joint material for circular pipe shall conform to ASTM C443.

   d. Joints for elliptical pipe shall be bell and spigot or tongue and grove sealed with butyl, rubber tape, rubber ring gaskets, or external sealing bands conforming to ASTM C877.

   e. All pipe shall be Class III unless loading conditions call for stronger pipe (i.e., higher class).

   f. The depth of cover over the concrete pipe shall be as designated by the American Concrete Pipe Association in Table 5.4 below.

Commentary

the addition of higher densities of development (16 - 37% impervious) due to the increased pollutant removal capability.

Commentary

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Table 5.4. Minimum Depth of Cover Over Concrete Pipe

Pipe diameter (inches)	AST (Class)	Minimum cover (surface to top of pipe – inches)
12	III IV V	17 12 7
15	III IV V	16 11 7
18	III IV V	16 10 6
24	III IV V	15 6 6
30	III IV V	10 6 6
36 and above	III IV	6 6

Minimum depth of coverage as designated by the American Concrete Institute

2. Ductile iron pipe shall conform to ANSI/AWWA C151/A21.51.

   Joints shall conform to ANSI/AWWA C111/A21.11 or ANSI/AWWA C115/A21.15, as appropriate.

   Pipe shall be designed in accordance with ANSI/AWWA C150/A21.50. The outside of the pipe shall be coated in accordance with ANSI/AWWA C151 A21.51 and the inside lined in accordance with ANSI/AWWA C104/A21.4.

   Ductile iron pipe shall be installed in accordance with AWWA C600.

3. Corrugated polyethylene pipe shall conform to AASHTO M252 for three thorough ten (10) inches (standard drainage too big, and AASHTO mpg for 1,050 mm to 1,200mm diameter pipe), AASHTO M294 for sizes twelve (12) inches to 36 inches in diameter.

   Materials shall conform to ASTM D3350, Standard Specification for Polyethylene Plas-

Recommended Standards

tics Pipe and Fittings Materials. Pipe joints and fittings shall be compatible with the pipe material and shall conform to the same standards and specifications as the pipe material. Pipe couplers shall not cover less than one full corrugation on each section of pipe.

Installation shall be in accordance with ASTM D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications. Backfill material shall be placed in six (6)-inch lifts and compacted to 95% minimum dry density, per AASHTO T99. In areas of high ground water tables, design engineers shall check for flotation.

4. Corrugated metal pipe shall meet the requirements and be installed in accordance with the standards that follow:

   a. In areas with acid waters, engineers may specify the use of aluminum alloy pipe. In neutral/alkaline waters, aluminum, aluminum-coated steel Type 2, and polymeric-coated steel may be used. In all cases, the environmental limitations outlined in Table 5.5 must be met.

      Water pH and resistivity values must fall within the ranges in Table 5.5. Samples should be measured in accordance with ASTM G51 and G57. Avoid sampling water during storm events or for two days following a storm to ensure more typical readings. If there are severe corrosive conditions (pH 4), fiber-bonded steel pipe should be used.

Table 5.5. Environmental Limits for Corrugated Metal Pipe

Pipe Type	pH	Resistivity Values (ohm-cm)
Aluminum	4-9	>500
Aluminum-coated type 2	5-9	>1500
Polymeric coated	5-9	>1500
Fiber bonded	<4	-

   b. If the design flow velocity is greater than ten (10) feet per second, a one-half (1/2) bituminous coating and paved invert shall be provided in accordance with ASTM A849 (AASHTO M190).

   c. Minimum depth of coverage shall be as specified in Table 5.6.

Commentary

Commentary

Recommended Standards

Table 5.6. Minimum Depth of Cover for Corrugated Metal Pipe

Pipe Diameter (inches)	Minimum cover Top of pipe to bottom of flexible pavement or top of rigid pavement (inches)
12 – 48	12 inches
54 inches or more	Per manufacturers recommendations

d. Corrugated aluminum pipe shall conform to the requirements of ASTM B745 (AASHTO M196) for Types I, II, IR, IIR, and III.

e. Corrugated Aluminum-coated steel Type 2 pipe shall conform to the requirements of ASTM A760 (AASHTO M36) for Types I, II, IR, IIR, and III, and have an aluminum one-ounce type 2 coating as specified in ASTM A929 (AASHTO M274)

f. Corrugated polymeric-coated steel pipe shall conform to the requirements of ASTM A762 (AASHTO M36) for Types I and II and have a polymeric 10/10 coating as specified in ASTM A742 (AASHTO M246).

g. Corrugated fiber-bounded steel pipe shall conform to the requirements of ASTM A760 (AASHTO M36) for Types I and II and have an aramid fiber composite coating as specified in ASTM A885. In addition, the pipe shall be bituminous coated as specified in ASTM A849 (AASHTO M190).

h. Corrugated metal pipe shall be fabricated with annual corrugations by riveted lap joint construction or with helical corrugations and a continuous weld or lock seam extending from end to end of each length of pipe.

i. Connecting bands shall be manufactured in accordance with ASTM A760 (Steel) or B745 (Aluminum) and have the same base metal and coating as the corrugated metal pipe. All pipe ends shall be annularly reformed a minimum of two corrugations.

j. Fittings and end sections shall be of the same base metal and coating as the corrugated metal pipe.

k. Corrugated metal pipe shall be installed per ASTM A798 (Steel) or ASTM B788.

l. Maximum cover and structural design of corrugated metal pipe shall be per ASTM A796 (Steel) of ASTM B790.

Recommended Standards

5.5.5.2 Pipe Bedding and Backfill

Pipe bedding and backfill shall be provided as illustrated in Figure 5.4 and as described below:

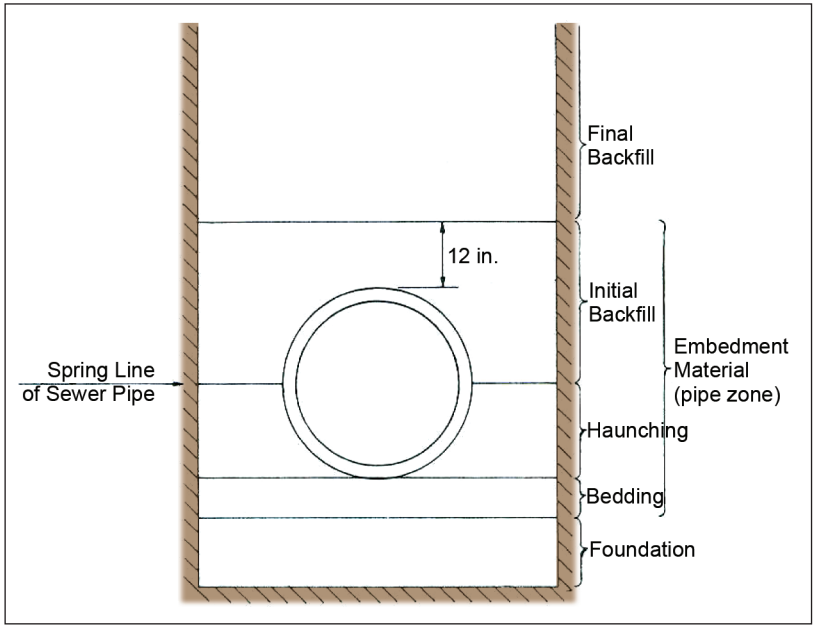

Figure 5.4. Pipe Bedding

Foundation - The foundation shall be excavated in natural material unless existing soils at this level have high organic content or are highly compressible.

Bedding - A minimum of 6 inches of bedding material to be provided. Bedding to be a well-graded, uncompacted stone that will provide adequate pipe support without damaging the pipe surface (typically less than 0.75 inches in diameter).

Haunching - Haunching shall extend to the pipe spring line, and shall consist of crushed stone or sand, or a well-graded granular material of intermediate size (typically less than 0.75 inches in diameter). Sand shall not be used if the pipe zone area is subject to a fluctuating groundwater table or where there is a possibility of the sand migrating into the pipe bedding material.

Commentary

Pipe bedding and backfill is critical to pipe's ability to safely support soil loads within the trench. The function of each of the five bedding zones are as follows.

The foundation provides the base for the pipe-soil system. The designer should be most concerned with providing a stable base. Highly organic or compressible soils are not suitable for the foundation area.

Bedding material provides the interface between the pipe and its foundation, and has an important influence on the distribution of the reaction against the bottom of the sewer pipe. The condition of the bedding influences the ultimate strength and function of the pipe. Uncompacted AASHTO #8 coarse aggregate or similar material serves well as bedding material.

The soil placed at the sides of the pipe from the bedding up to the spring line is the haunching. The care with which this material is placed is critical to the performance of the pipe. Poorly compacted material in this area will result in a concentration of reaction at the bottom of the pipe. PennDOT 2A coarse aggregate or similar material meets the requirements of haunching material.

Commentary

Initial backfill is the material that covers the pipe, and its function is to protect the pipe from damage by subsequent backfill and to ensure a uniform distribution of load over the top of the pipe. PennDOT 2A or similar stone serves well as initial backfill in the pipe zone.

Final backfill is not critical to the pipe, and does not affect its performance. The most significant issue with final backfill is settlement. Where settlement is critical (like under paved surfaces) final backfill material should be composed of select material that is easily densified. In areas not under pavement or traffic loads, excavated material can be used as final backfill.

Recommended Standards

Initial Backfill - The initial backfill shall extend from the spring line to 12 inches above the pipe crown. This material shall be carefully tamped to compact the stone but not damage the pipe. For flexible pipe, initial backfill shall be a material that will develop a uniform and relatively high density with little compactive effort. Clay materials shall not be used for initial backfill.

Final Backfill - Under-paved areas, final backfill shall be a uniformly graded, granular material that is easily densified to minimize future settlement. This material shall be placed in 4-to 8-inch lifts and compacted to 95% SPD.

Under unpaved areas, final backfill may consist of excavated material, placed in 8-inch lifts and compacted to a near pre-excavation density that will minimize the risk of future settlement. However, soils with a high organic content, or a high shrink-swell rating shall not be used as final backfill.

Trench width shall be as follows.

- For pipe smaller than thirty (30) inches in diameter,
  Pipe Dia + 2 feet

- For pipe equal to or larger than thirty (30) inches in diameter,
  Pipe Dia + 3 feet

Trench backfilling shall be done in such a way as to prevent dropping of material directly on top of a sewer pipe through any significant vertical distance. When placing material with a bucket, the bucket shall be lowered so that the shock of falling earth will not cause damage to the pipe.

Bedding and backfill for any pipe material not covered by this manual shall be installed in accordance with manufacturer's recommendations.

5.5.6 Inlets, Catch Basins, Manholes, and Outlets

1. Inlets, catch basins, and manholes shall be designed in accordance with PA DOT standards. Bicycle-safe grates shall be used.

2. Inlet spacing depends on the inlet capacity and gutter flow spread. However, in no case shall inlets be spaced more than four-hundred (400) feet apart.

   Inlet capacity shall be established based on procedures for pavement drainage in *Urban*

Recommended Standards

Drainage Design, Hydraulic Engineering Circular (HEC) Number 22, U.S. Department of Transportation, Federal Highway Administration, 1996 or more current edition.

3. Manholes shall be precast concrete or concrete block, coated with two coats of Portland cement or mortar outside the manhole. Masonry brick may be used to make vertical adjustments to rims, as long as the adjustments are twelve (12) inches or less. In acidic soils, all manholes shall have two (2) coats of black bitumastic waterproofing applied per the manufacturer's instructions.

4. If precast manhole barrels and cones are used, they shall conform to ASTM Specification C478, with round rubber gasketed joints conforming to ASTM Specification C923. Both ASTM specifications are incorporated herein by reference. Maximum absorption shall be 9% in accordance with ASTM Specification C478, Method A.

5. If precast manholes are used, the top riser section shall terminate less than one (1) foot below the finished grade and the manhole cover shall be flush with the finished grade.

6. Manhole frames and covers shall be of cast iron, conforming to ASTM Specification A48, Class 30, incorporated herein by reference, and be suitable for H-20 loading capacity. Manhole covers in remote locations may have a locking device.

7. Outlet grates, fences, and other safety features for stormwater management facilities shall conform with PA DOT standards where appropriate.

8. The channel should be, insofar as possible, a smooth continuation of the pipe. The pipe may be laid through the manhole and the top half removed by saw cut. The completed channel should be U-shaped. The channel height shall be three-fourths of the diameter of the pipe.

9. The bench should provide good footing for a workman, and a place where minor tools and equipment can be laid. It must have a slope of four 4-8%.

5.6 PROHIBITIONS

5.6.1 Non-Stormwater Discharges

Any drain or conveyance, whether on the surface or subsurface, which allows any non-stormwater discharge, including sewage, process wastewater, and wash water to enter the waters of this Commonwealth, is prohibited.

Commentary

Commentary

Recommended Standards

Discharges, which may be allowed if they do not significantly contribute to pollution to the waters of this Commonwealth, are identified in Table 5.7. In the event that the Municipality or DEP determines that any of the discharges identified in Subsection 701.B, significantly contribute to pollution of the Waters of this Commonwealth, the Municipality or DEP will notify the responsible person(s) to cease the discharge.

Table 5.7. Allowable Stormwater Discharges

-Discharges from fire fighting activities	-Flows from riparian habitats and wetlands
-Potable water sources, including dechlorinated water line and fire hydrant flushings	-Uncontaminated water from foundations or from footing drains
-Irrigation drainage	-Lawn watering
-Air conditioning condensate	-Dechlorinated swimming pool discharges
-Springs	-Uncontaminated groundwater
-Water from crawl space pumps	-Water from individual residential car washing
-Pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred (unless all spill material has been removed) and where detergents are not used	-Routine external building wash down (which does not use detergents or other compounds)

5.6.2 Roof Drains

Roof drains and sump pumps shall be disconnected from structural storm sewer system where possible. These discharges shall be directed to cisterns, vegetated areas (lawn or garden areas) or to other infiltration BMP's.

5.6.3 Alteration of Stormwater Best Management Practices and Facilities

No person shall modify, remove, fill, landscape, or alter any stormwater facility or practice that has been approved as a part development plan without the written approval of the municipality.

5.7 OPERATION AND MAINTENANCE

Stormwater management facilities shall be regularly maintained to ensure that they func-

Recommended Standards

tion at design capacity, and to prevent health hazards associated with debris buildup and stagnant water. An operations and maintenance plan identifying specific maintenance maintenance and operation requirements for all stormwater BMP's shall be prepared for all projects which include water quantity or water quality best management practices. For projects requiring the preparation of a post construction stormwater management plan, the operations and maintenance plan shall be included as part of said plan.

Maintenance and upkeep responsibility for stormwater facilities depends on facility ownership. If the storm drains, catch-basins, culverts, and /or other features of the stormwater system are part of a public drainage system, then the municipality or an appropriate public entity shall be responsible for for maintenance and upkeep. If part or all of the residential stormwater management system is privately owned, then the privately owned portion of the system must be privately maintained.

In cases where there is a common ownership of property that is not part of a publicly owned drainage system, a homeowner's association or similar permanent entity may be established as the agent responsible for upkeep, absent an agreement with the municipality or other appropriate public entity.

5.8 EROSION AND SEDIMENT CONTROL

All development applications which involve grading or excavation shall conform to the requirements of Title 25, Chapter 102 of the Pennsylvania State Code, and implemented and enforced by the Pennsylvania Department of Environmental Protection. In addition, the following standards shall be followed

1. No changes shall be made in the contour of the land; no grading, excavating, removal, or destruction of the topsoil, trees, or other vegetative cover of the land shall be commenced within a proposed subdivision or land development tract until such time that a plan for minimizing erosion and sedimentation control has been reviewed by the County Conservation District or the Pennsylvania Department of Environmental Protection and approved by the municipal authority, unless there has been a determination by the County Conservation District or the Pennsylvania Department of Environmental Protection that erosion and sedimentation plans are not necessary.

2. The following measures are effective in minimizing erosion and sedimentation and shall be included where possible in the context of the development plan.

    a. Minimize the disturbed area and the duration of exposure to a practical minimum;

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b. Preserve significant natural features and minimize cut-and fill-operations.;

c. Preserve and restore natural vegetation where possible;

d. Stabilize disturbed soils by permanent vegetation and/or by engineered erosion control and drainage measures as soon as practical in the development process, but no later than 14 days after disturbance occurs;

e. Protext exposed critical areas during development with temporary vegetation and/or mulching;

f. Effectively mitigate and control the increased surface runoff during and after development;

g. Use debris basins, sediment basins, and silt traps to contain sediment in the runoff water until the disturbed area is stabilized;

h. Establish basin and perimeter controls at the commencement of the work on the site;

i. Protect and stabilize earth storage piles within thirty (30) days; and

j. Install earth or paved interceptors and diversions at the top of cut or fill slopes where there is a potential for erosive surface runoff.

3. In order to prevent pollution of any watercourse and to reduce erosion of soil, sediment control devices shall be installed prior to any grading, filling, or excavation. Such devices shall be designed to retain sediment on the site.

4. Within thirty (30) days after completion of grading, all surfaces disturbed by vegetation removal, grading, haul roads, or other construction activity that alters natural vegetative cover, are to be revegetated to control erosion, unless covered with impervious or other improved surfaces authorized by approved plans. Erosion controls may include any combination of engineered or vegetative measures.

5.9 EXISTING WETLANDS

No subdivision or land development shall involve uses, activities, or improvements that

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Commentary

would entail encroachment into, the regarding of, or the placement of fill in wetlands in violation of State or Federal regulations. Applicants must submit evidence that if wetlands are present on the site, the Pennsylvania Department of Environmental Protection and the U.S. Army Corps of Engineers have been contacted to determine the applicability of State and Federal wetland regulations. Municipal approval shall be contingent on full compliance with any requirements of any regulatory agency, and no action of the municipal planning body shall be relied on in lieu of a permit issued by the appropriate agency.

5.10 FLOODPLAINS

Floodplain areas shall be established and preserved on all development sites. In addition, floodplain areas shall be delineated on development plans as provided below:

a. A one-hundred (100-year floodplain shall be established for all watercourses and shall be delineated by one of the following methods:

    1. A FEMA flood Insurance Study.
    2. A floodplain study prepared by an agency of the county, State, or U.S. Government.
    3. A floodplain report or study prepared and certified to by a Professional Engineer registered in the Commonwealth of Pennsylvania duly qualified by education and experience to perform such duties.

b. Whenever a floodplain boundary is located within or along a lot, the plan shall include the boundary of the floodplain, along with the elevation or location dimensions from the centerline of the watercourse; a plan note that the floodplain shall be kept free of structures, fill, and other encroachments; and a plan note that floor elevations for all structures adjacent to the floodplain shall be two (2) feet above the one-hundred (100)-year flood elevation.

The above provisions shall not be construed to prohibit the following construction activities within floodplains:

a. Stormwater management facilities;
b. Stream improvements whose sole purpose is to improve aquatic habitat and that are approved by the Pennsylvania Fish Commission;
c. Farm ponds;
d. Flood-proofing and flood hazard reduction structures to protect existing buildings;
e. Water-oriented uses (except buildings), e.g., docks, piers, boat launching ramps, hatcheries, etc.;
f. Water monitoring devices;

Commentary	Recommended Standards

g. Culverts, bridges, and their approaches for floodplain crossings by streets, access drives, and driveways; and
h. Other fill activities as authorized under a permit issued by the U.S. Army Corps of Engineers, Pennsylvania Department of Environmental Protection, or other authorizing agency.

State regulations for encroachments within floodplains are contained at Title 25, Chapter 105 of the Pennsylvania State Code.

Any subdivision or land development proposal, which includes encroachments into a Federally mapped floodplain, must include evidence that the applicant has contacted and gained approval for said encroachments from the Pennsylvania Department of Environmental Protection (Waterways, Wetlands, and Erosion Control Division), and the Federal Emergency Management Agency.

5.11 ENFORCEMENT AND PENALTIES

5.11.1 Right of Entry

Following advance written notice and due process, municipal officials shall have the right to enter private property to inspect the condition of stormwater structures and facilities.

5.11.2 Inspection

SWM BMPs shall be inspected by the facility owner according to the following list of frequencies:

1. Annually for the first five (5) years.

2. Once every three (3) years thereafter.

3. During or immediately after the cessation of a ten (10)-year or greater storm.

5.11.3 Enforcement

It shall be unlawful for a person to undertake any regulated activity except as provided in an approved SWM Site Plan. It shall also be unlawful for a person to fail to take any regulatory action required by ordinance.

Recommended Standards

It shall be unlawful to alter or remove any control structure required by the Post-Construction Stormwater Management Plan.

Inspections regarding compliance with the SWM Site Plan are a responsibility of the municipality.

5.11.4 Penalties

(This is a place holder. Municipalities should ask their solicitors to provide appropriate wording for this section.)

Commentary

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Appendix 5.A Definitions

Appendix 5.A Definitions

Infiltration rates are measured in units of length / time.

Agricultural Activities -- The work of producing crops and raising livestock, including tillage, plowing, disking, harrowing, pasturing and installation of conservation measures. Construction of new buildings or impervious area is not considered an agricultural activity.

Applicant -- A landowner or developer who has filed an application for approval to engage in any regulated activities.

BMP (Best Management Practice) -- Activities, facilities, measures, or procedures used to manage the volume, rate, and quality of stormwater runoff.

Carbonate -- A sediment formed by the organic or inorganic precipitation of mineral compounds characterized by the fundamental chemical ion CO3, the principal element in limestone and dolomite strata.

Channel -- A perceptible natural or artificial waterway, which periodically or continuously contains moving water having a definite bed and banks, which confine the water.

Check Storm -- The magnitude and temporal distribution of precipitation of a particular extreme probability of occurrence (e.g., 100-year storm) and duration (e.g., typically 24 hours), used to check how stormwater management and conveyance systems will function under extreme flooding conditions. The check storm is typically a 100 year, 24 hour precipitation event.

Closed Or Undrained Depression -- In a Karst geologic area a distinct bowl-shaped depression in the land surface; size and amplitude are variable; drainage is internal. It differs from a sinkhole in that the ground surface is unbroken and usually occurs in greater density per unit area.

Dam -- An artificial barrier, together with its appurtenant works, constructed for the purpose of impounding or storing water or another fluid or semifluid, or a refuse bank, fill or structure for highway, railroad or other purposes which does or may impound water or another fluid or semifluid.

Design Capture Volume -- The difference between the pre-development and post-development runoff from a 1-year, 24-hour design rainfall event for a specific development site.

Design Storm -- The magnitude and temporal distribution of precipitation from a storm event measured in probability of occurrence (e.g., a 5-year storm) and duration (e.g., 24 hours), used in the design and evaluation of stormwater management systems.

Detention Basin -- An impoundment structure designed to manage stormwater runoff by temporarily storing the runoff and releasing it at a predetermined rate.

Developer -- A person, partnership, association, corporation, or other entity, or any responsible person therein or agent thereof, that undertakes any Regulated Activity of this ordinance.

Development Site -- The specific tract of land for which a regulated activity is proposed.

Appendix 5.A Definitions (cont.)

Drainage Conveyance Facility -- A Stormwater Management Facility designed to transmit stormwater runoff and to include streams, channels, swales, pipes, conduits, culverts, storm sewers, etc.

Drainage Easement -- A right granted by a landowner to a grantee, allowing the use of private land for stormwater management purposes.

Drainage Permit -- A permit issued by the township governing body after the drainage plan has been approved. Said permit is issued prior to or with the final township approval.

Drainage Plan -- The documentation of the stormwater management system, if any, to be used for a given development site.

Drainage Way -- The natural or man-made path of surface water from a given area.

Erosion -- The movement of soil particles by the action of water, wind, ice, or other natural forces.

Erosion and Sediment Pollution Control Plan -- A plan that is designed to minimize accelerated erosion and sedimentation.

Existing Conditions -- The initial condition of a project site prior to the proposed construction.

Extended Detention Release Volume -- The portion of the capture volume not managed through natural or engineered infiltration or consumptive re-use techniques. This volume is released to receiving waters over a 48 to 72 hour period to minimize downstream impacts.

First Flush -- The initial surface runoff resulting from a rainfall event which usually picks-up dry pollutant deposition on surfaces and washes it into receiving waters. The first flush is usually considered to be the first one-half inch of surface runoff, resulting from a rainfall event.

Flood -- A general but temporary condition of partial or complete inundation of normally dry land areas from the overflow of streams, rivers, and other waters of this Commonwealth.

Floodplain -- Any land area susceptible to inundation by water from any natural source or delineated by applicable Department of Housing and Urban Development, Federal Insurance Administration Flood Hazard Boundary -- mapped as being a special flood hazard area.

Floodway -- The channel of the watercourse and those portions of the adjoining floodplains that are reasonably required to carry and discharge the 100-year frequency flood. Unless otherwise specified, the boundary of the floodway is as indicated on maps and flood insurance studies provided by FEMA. In an area where no FEMA maps or studies have defined the boundary of the 100-year frequency floodway, it is assumed -- absent evidence to the contrary - that the floodway extends from the stream to 50 feet from the top of the bank of the stream.

Freeboard -- A vertical distance between the elevation of the design high-water and the top of a dam, levee, tank, basin, or diversion ridge. The space is required as a safety margin in a pond or basin.

Grassed Waterway -- A natural or constructed waterway, usually broad and shallow, covered with erosion-resistant grasses, used to conduct surface water from cropland.

Appendix 5.A Definitions (cont.)

Groundwater Recharge -- Replenishment of existing natural underground water supplies.

Hydropedology -- The science that soil moisture and how water moves through soils and subsoils.

Impervious Surface -- A surface that prevents the percolation of water into the ground.

Impoundment -- A retention or detention basin designed to retain stormwater runoff and release it at a controlled rate.

Infiltration Rate -- The infiltration rate of a soil is related to the soil's final infiltration capacity and represents the rate at which water enters the soil/air interface at the top of the soil profile. Infiltration rates are measured in units of length / time.

Inlet -- A surface connection to a closed drain; a structure at the diversion end of a conduit; the upstream end of any structure through which water may flow.

Interceptor -- A channel, berm, or dike constructed across a slope for the purpose of intercepting stormwater, reducing the velocity of flow, and diverting it to outlets where it may be disposed.

Karst -- A type of topography that is formed over limestone, dolomite, or gypsum by bedrock solution, and that is characterized by closed depressions or sinkholes, caves, and underground drainage (from AGI, Glossary of Geology, 1972).

Land Development -- (1) the improvement of one lot or two or more contiguous lots, tracts, or parcels of land for any purpose involving (a) a group of two or more buildings, or (b) the division or allocation of land or space between or among two or more existing or prospective occupants by means of, or for the purpose of streets, common areas, leaseholds, condominiums, building groups, or other features; (2) any subdivision of land; (3) development in accordance with Section 503(1.1) of the Pennsylvania Municipalities Planning Code.

Land/Earth Disturbance -- Any activity involving grading, tilling, digging, or filling of ground or stripping of vegetation or any other activity that causes an alteration to the natural condition of the land.

Land Use -- The primary application employed in an area.

Licensed Professional -- See Registered Professional.

Main Stem (Main Channel) -- Any stream segment or other runoff conveyance facility used as a reach in the Spring Creek hydrologic model.

Natural Conservation Areas -- A natural area protected during development for its water quality or recharge enhancing abilities.

Outfall -- Point where water flows from a conduit, stream, or drain.

Outlet -- Points of water disposal from a stream, river, lake, tidewater or artificial drain.

Appendix 5.A Definitions (cont.)

PA DEP -- Pennsylvania State Department of Environmental Protection.

Penn DOT -- Pennsylvania State Department of Transportation.

Peak Discharge -- The maximum rate of stormwater runoff from a specific storm event.

Percolation Rate -- The rate at which water moves through a soil profile. Percolation rates are measured in units of time / length.

Pipe -- A culvert, closed conduit, or similar structure (including appurtenances) that conveys stormwater.

Point Discharge -- Any discernible, confined and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, or conduit from which stormwaster is or may be discharged, as defined in state regulation at PA Code Title 25, Chapter 92.1.

Qualified Municipal Representative -- A professional engineer licensed in the Commonwealth of Pennsylvania and duly appointed by the subject municipality as their representative. In the event that a Stormwater Utility is formed, all references to the Municipal Engineer shall be considered to also imply the Stormwater Utility Engineer.

Recharge Volume -- The volume of water that is required to be recharged from developed sites.

Registered Professional -- An individual registered in and licensed by the State of Pennsylvania, including land surveyors, landscape architects, architects, engineers, and geologists.

Regulated Activity -- Any land disturbance activity that requires the preparation of a Stormwater Management Plan.

Retention Basin -- An impoundment in which stormwater is stored and not released during the storm event. Stored water may be released from the basin at some time after the end of the storm.

Return Period -- The average interval, in years, within which a storm event of a given magnitude can be expected to recur. For example, the 25-year return period rainfall has a 4% probability of occurring in any given year.

Runoff -- Any part of precipitation that flows over the land surface.

Safe Passage -- The routing of peak runoff events, usually the 100-year design event, safely through a structure without failure of that structure.

Scour -- Generally refers to the change in a channel configuration provoked by sediment imbalance, due to natural or man made causes, between the supply and transport capacity of the channel.

Sediment Basin -- A barrier, dam, retention or detention basin located and designed to retain rock, sand, gravel, silt, or other material transported by water.

Sheet Flow -- Runoff that flows over the ground surface as a thin, even layer, not concentrated in a channel.

Appendix 5.A Definitions (cont.)

Sinkhole -- A localized, gradual or rapid sinking of the land surface to a variable depth, occurring in areas of carbonate bedrock; generally characterized by a roughly circular outline, a distant breaking of the ground surface and downward movement of soil into bedrock voids.

Spillway -- A depression in the embankment of a pond or basin that is used to pass peak discharge greater than the maximum design storm controlled by the pond.

Stabilization -- The proper placing, grading and/or covering of soil, rock or earth to ensure their resistance to erosion, sliding or other movement.

Storm Sewer -- A system of pipes and/or open channels that convey intercepted runoff and stormwater from other sources, but excludes domestic sewage and industrial wastes.

Stormwater -- The surface runoff generated by precipitation reaching the ground surface.

Stormwater Management Facility -- Any structure, natural or man-made, that, due to its condition, design, or construction, conveys, stores, or otherwise affects stormwater runoff. Typical stormwater management facilities include, but are not limited to, detention and retention basins, open channels, storm sewers, pipes, and infiltration structures.

Subarea -- The smallest drainage unit of a watershed for which stormwater management criteria have been established in the Stormwater Management Plan.

Surface Waters of the Commonwealth -- Any and all rivers, streams, creeks, rivulets, impoundments, ditches, watercourses, storm sewers, lakes, dammed water, wetlands, ponds, springs, and other bodies or channels of conveyance of water on the land surface, or parts thereof, whether natural or artificial, within or on the boundaries of the Commonwealth of Pennsylvania, but excluding water at facilities approved for wastewater treatment such as wastewater treatment impoundments, cooling water ponds and constructed wetlands used as part of a wastewater treatment process.

Swale -- A natural low-lying stretch of land or minor man made conveyance channel, which gathers or carries surface water runoff.

SWM -- Stormwater management.

Topography -- The general configuration of a land surface or any part of the earth's surface, including its relief and position of its natural and man-made features. The natural or physical surface features of a region, considered collectively as to its form.

Undetained Area -- An area of a site that cannot be routed to a stormwater management facility because of its location; generally small areas around access drives or below stormwater management facilities.

Volume Credits -- A deduction from the required volume or amount. In this ordinance it implies a reduction in the volume of water to be treated or otherwise managed as a part of the stormwater impact mitigation plan.

Watercourse -- A channel or conveyance of surface water, such as a stream or creek, having defined bed and banks, whether natural or artificial,

Appendix 5.A Definitions (cont.)

with perennial or intermittent flow.

Water Quality Volume -- Volume of runoff required to be controlled from a site in a water quality BMP.

Waters of the Commonwealth -- Any and all rivers, streams, creeks, rivulets, impoundments, ditches, watercourses, storm sewers, lakes, dammed water, wetlands, ponds, springs, and other bodies or channels of conveyance of surface and underground water, or parts thereof, whether natural or artificial, within or on the boundaries of the Commonwealth of Pennsyvlania, but excluding water at facilities approved for wastewater treatment such as wastewater treatment impoundments, cooling water ponds and constructed wetlands used as part of a wastewater treatment process.

Watershed -- The entire region or area drained by a river or other body of water, whether natural or artificial, a drainage basin or sub-basin.

Waters of the Commonwealth -- Any and all rivers, streams, creeks, rivulets, ditches, watercourses, storm sewers, lakes, dammed water, wetlands, ponds, springs, and all other bodies or channels of conveyance of surface and underground water, or parts thereof, whether natural or artificial, within or on the boundaries of this Commonwealth.

Water Table -- Upper surface of a layer of saturated material in the soil.

Wetland -- Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs, ferns, and similar areas.

CHAPTER 6: WASTEWATER FACILITIES

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6.0 INTRODUCTION

All residential developments must be served by wastewater collection and treatment facilities. Options for new developments include expansion of existing community wastewater systems, construction of individual wastewater treatment systems, or the construction of a new community wastewater collection and treatment facilities. New community treatment systems can range from small to medium-size conventional systems, or alternate systems including land-based wastewater treatment systems. The Pennsylvania Clean Streams Law (PA Code, Title 25, Chapter 91) and the Pennsylvania Sewage Facilities Act (Act 537 of 1996, as amended) require that any person planning to construct a new wastewater collection or treatment facility shall first obtain permits from the Pennsylvania Department of Environmental Protection.

The terms used to describe the methods of wastewater treatment are frequently not used consistently, which can lead to a great deal of confusion. This document is consistent in its use of terms as defined by the PA Code.

The terms “individual” and “on-lot” are frequently used interchangeable, but they are not the same in the regulations. On-lot is used to refer to systems that involve a soil-based treatment, either a soil absorption area or a spray field. On-lot is also used to refer to systems that use a retention tank that is periodically pumped, with the waste being taken to another facility for disposal. Individual refers to a sewage facility serving a single lot. It can refer to an on-lot system such a septic tank and leach field or a system that doesn’t utilize soil renovation such as a Small Flow Treatment Facility.

According to the U.S. Census Bureau, decentralized or on-lot wastewater systems serve nearly 25% of U.S. households. The demand for housing has pushed residential development into rural areas typically not served by existing public wastewater treatment facilities. As a result, almost 40% of new developments in Pennsylvania require some type of wastewater facility. The required septic field size coupled with necessary isolation distances often result in the need for lots in developments supported by on-lot septic systems to be larger and larger rather than smaller and/or clustered. As a result, large lot developments are adding significantly to urban sprawl, and the loss of environmentally sensitive lands, and rural open space.

To accommodate the need for housing and the pressures for development within rural areas, protect environmental resources, and maintain open space, treatment alternatives that accommodate smaller, clustered lots are necessary. This requires that traditional views of wastewater treatment be reconsidered, and more innovative on-lot treatment options be permitted.

Recommended Standards

This chapter provides standards and guidance for the design of individual and community-based systems, including collection and conveyance systems, based on PA Code, Title 25, chapters 71-73 (Reference 1).

This document only addresses gravity conveyance systems because they are the most common and to prevent the document from becoming too cumbersome. Standard engineering practice should be used in the design of vacuum and pressure systems.

6.1 GENERAL

6.1.1 Authority and General Requirements

a. Procedures for the design of wastewater facilities are included in the Pennsylvania Sewage Facilities Act (Act 537, as amended) (Ref. 3). This act:

- Requires proper planning and permitting of all types of wastewater facilities;
- Requires permitting of individual and community on-lot wastewater systems; and
- Provides for uniform standards for the design of on-lot systems.

b. Wastewater facilities planning, design, and construction shall be conducted in compliance with current PA DEP regulations. All sewage facilities planning shall also be coordinated with the local municipality.

c. No lot may be developed or subdivided unless suitable for an approved wastewater treatment system.
Exceptions:

i. Minor plat adjustments: Wastewater treatment facilities shall not be required for subdivisions that are plat adjustments, that is, where no new lots are created.

Commentary

Permitting and Planning Forms
The following planning and permitting forms are available from the PA DEP eLibrary at http://164.156.71.80/wxod.aspx. (Ref. 2)

Sewage Facilities Planning Module Application Mailer
(3800-CD-WSFR0359)
Used by anyone proposing a new land development project. This is the first step in the permitting process. The information provided will be used by the DEP to determine if sewage facilities planning is necessary for your project, and if so, what forms are appropriate.

Municipal officials and the municipality's Sewage Enforcement Officer should be consulted in the development of the project.

Pennsylvania Natural Diversity Inventory (PNDI)

The "Policy for Pennsylvania Natural Diversity Inventory (PNDI) Coordination During Permit Review and Evaluation" (400-0200-001) requires that a PNDI database search be conducted regardless of which planning modules

Commentary

are applicable.

A self-conducted "PNDI Project Planning Environmental Review" search can be conducted by accessing the Pennsylvania Natural Heritage Web Site (Ref. 4).

Or, a "PNDI Project Planning and Environmental Review Form" (PNDI Form), available through the Pennsylvania Natural Heritage web site (Ref. 4) can be submitted to request that DEP staff conduct the database search.

Request for Planning Waiver and Non-Building Declaration (3800-FM-WSFR0349) (formally known as "Form B") can be downloaded from the PA DEP eLibrary (Ref. 2) at http://164.156.71.80/wxod.aspx
This form is used to propose subdivisions that do not involve the creation of new sewage facilities. It can only be used when there is no present or future need for wastewater treatment on the project site. This form may not be used as a means to simply defer wastewater planning.

The Planning Waiver and Non-Binding Declaration is not intended to be a deed restriction preventing a future owner from subdividing the property.

Recommended Standards

ii. Subdivision Plans with no proposed development: Subdivisions and land development for which no development of buildings or improvements to the land are proposed need not provide wastewater treatment, provided a properly executed Request for Planning Waiver and Non-Building Declaration has been submitted to and approved by the PA DEP. Where a waiver is approved by DEP, the final plan and deed for land shall include the following notation:

For Plans Where Sewage Facilities are not Required.

As of the date of this deed/plot plan recording, the property/subdivision described herein is and shall be dedicated for the express purpose of _____ _____use. No portion (or lot number(s) _____) of this property/subdivision are approved by _____(Municipality) or the Department of Environmental Protection (DEP) for the installation of any sewage disposal facility. No permit will be issued for the installation, construction, connection to or use of any sewage collection, conveyance, treatment or disposal system (except for repairs to existing systems) unless the municipality and DEP have both approved sewage facilities planning for the property/subdivision described herein in accordance with the Pennsylvania Sewage Facilities Act (35 P.S. Sections 750.1 et seq.) and regulations promulgated thereunder. Prior to signing, executing, implementing or recording any sales contract or subdivision plan, any purchaser or subdivider of any portion of this property should contact appropriate officials of _____ (municipality), who are charged with administering the Sewage Facilities Act to determine the form of sewage facilities planning required and the procedure and requirements for obtaining appropriate permits or approvals.

Recommended Standards

d. No plans shall be approved or recorded until the wastewater treatment system is approved according to applicable regulations.

In addition, as-built drawings that document the horizontal and vertical location and details of any new wastewater collection, conveyance and treatment facilities shall be submitted to and approved by the local wastewater regulatory authority prior to Final Plat approval. As-build drawings are not required for individual on-lot septic systems.

e. Wastewater conveyance systems shall not be used to carry stormwater.

f. Wastewater treatment standards detailed within this section shall be applicable to all subdivision and land developments, whether utilizing public or private streets or driveways serving as private streets. In the case of a subdivision or land development utilizing private streets, the developer shall provide appropriate easements and execute a recordable covenant with the municipality or wastewater authority for the purpose of permitting access for operation and maintenance of said wastewater facilities.

g. Flood proofing: All wastewater sewer systems located in flood-prone areas, whether public or private, shall be flood-proofed. The following is a partial list of steps to be taken to flood-proof wastewater facilities:

- The top-of-casting elevation of manholes shall be located one (1) foot above the established 100-year flood level or regulatory flood elevation.
- Watertight manhole frame and covers shall be used.
- Above-grade treatment facilities shall be protected to one (1) foot above the established flood level or regulatory flood elevation by levees or other flood-proofing technique.

6.1.2 Availability of Public Sewage Facilities

a. If the site is within an area planned for sewer service by a Municipal Act 537 Sewage Facilities Plan or Capital Improvement Program, and if a collection system conveying wastewater to a public wastewater treatment facility is available within the following distances and has adequate capacity, then all lots within the subdivision and/or land development shall be connected to the existing wastewater collection system:

Maximum distance from property boundary (not structure) to wastewater conveyance facility requiring connection to said collection facility.

Commentary

Backflow valves are designed to block the drain pipes temporarily and prevent flow into the house, which can cause damage and serious health hazards (Ref. 5).

The Pennsylvania Sewage Facilities Act (Act 537, as amended) (Ref. 2) requires proper planning of all types of wastewater facilities, permitting of individual and community on-lot wastewater treatment systems and provides for uniform standards for designing on-lot treatment systems. The standards contained in this section are reproduced from Reference 2.

Commentary

The standard noted in section 6.1.2.a for the maximum distance to connect a subdivision to a wastewater treatment conveyance system is based on the Lancaster County Subdivision and Land Development Ordinance. A review of ordinances from across the state shows a lot of variety in the way this issue is treated. Distances in ordinances range for 200 to 2,000 feet. Other ordinances didn't specify a distance but used vague language such as "when deemed possible" that would allow for inconsistent application. The standard used in this document was selected for its ability to be applied consistently and fairly based on the size of the development.

In Second Class Townships, the Code (Ref. 20) states that properties or principal buildings within 150 feet shall connect to sanitary sewer systems.

Recommended Standards

- Single lot of unit — two hundred (200) feet
- Two lots or units — four hundred (400) feet
- Three lots or units — six hundred (600) feet
- Four lots or units — eight hundred (800) feet
- Five to fifteen lots or units — one thousand (1,000) feet
- More than fifteen lots or units — one mile

For developments of more than 15 units that are less than one mile from an existing public sewer conveyance system, a waiver of the requirement to connect may be granted by the local approving authority. Said waiver must be requested in writing by the developer, and must be supported by adequate justification. Adequate justification shall include a statement from the licensed design professional identifying the adequacy of the proposed treatment method, economic considerations, and consideration of the requirements of the municipal wastewater treatment facilities plan.

For developments of greater than fifteen (15) units, which are more than one mile from an existing system, the wastewater facilities strategy shall be determined on a case-by-case basis, taking into consideration the density of development, economic considerations and the requirements of the municipal wastewater treatment facilities plan. Refer to section 6.2.1.f when the developer is required to oversize the conveyance system for a development future.

b. The municipality reserves the right to require a Feasibility Report to compare on-lot versus community or public wastewater treatment options.

c. When the proposed development is not consistent with the approved Act 537 Sewage Facilities Plan, the applicant must request a revision to the plan to support the proposed development

d. Where a development site is within the municipalities proposed sewer service area as defined through an approved Act 537 plan or a capital improvements plan, but is further away from the existing conveyance system than specified in section 6.1.2.a above, the developer shall have the option to request that the local sewer authority extend the existing lines to his site. If the authority agrees to extend the sewer line, the developer shall be responsible to reimburse the authority for the cost of a length of sewer line extension equivalent to the maximum extension distance defined in the requirements of section 6.1.2.a.

If the sewer line is not extended to the site, the developer shall install sewer lines, including lateral connections to the edge of the road right-of-way, as may be necessary

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to provide adequate service to each lot when connection with the public wastewater system is made. The sewer lines shall be suitably capped at the limits of the subdivision, and the laterals shall be capped at the right-of-way line. The sewer installation shall include the construction of all necessary sewer lines within the development as are necessary for future connection to the public wastewater system. All components of the system shall be designed and constructed in accordance with the standards of the PA DEP, this ordinance, and applicable sewer authority standards.

6.1.3 Classification of Wastewater Facilities

Title 25, Chapter 71 of the Pennsylvania Code classifies wastewater facilities as follows.

Individual Sewage Systems -- A system of piping, tanks or other facilities, serving a single lot and collecting and disposing of sewage in whole on in part into the soil or into waters of the Commonwealth or by means of conveyance to another site for final disposal. The term includes:

Individual on-lot sewage system -- An individual sewage system that uses piping, tanks or other facilities for collecting, treating and disposing of sewage into a soil absorption area or spray field or by retention in a retaining tank.

Individual sewerage system -- An individual sewage system that uses pipes, tanks, or other facilities for collection, treatment, and disposal of sewage other than renovation in a soil absorption area, or retention in a retaining tank.

Community Sewage System -- A sewage facility, whether publicly or privately owned, for the collection of sewage from two or more lots, or two or more equivalent dwelling units and the treatment or disposal, or both, of the sewage on one or more of the lots or at another site. The term includes:

Community onlot sewage system -- A system of piping, tanks or other facilities serving two or more lots and collecting, treating and disposing of sewage into a soil absorption area or retaining tank located on one or more of the lots or at another site.

Community sewerage system -- A publicly or privately owned community sewage system that uses a method of sewage collection, conveyance, treatment and disposal other than renovation in a soil absorption area, or retention in a retaining tank.

Commentary

The classification scheme outlined here uses consistency in terminology to characterize wastewater systems. The meaning of each term is as follows:

Individual - Refers to a sewage facility serving a single lot.

Community – Refers to sewage facilities including collection, conveyance, treatment and disposal of wastewater from two or more lots.

Onlot sewage – Refers to a wastewater facility that uses a soil absorption area or retaining tank for treating and disposing of sewage.

Sewerage – Refers to a wastewater facility that uses a treatment and disposal method other than renovation in a soil absorption area or retention tank.

Commentary

A community wastewater facility is a publicly or privately owned system that includes wastewater collection, conveyance, treatment and disposal. These facilities include both large authority-operated wastewater facilities serving a single municipality or several municipalities, to smaller facilities designed to treat the waste from two or more dwelling units or lots. Treatment methods include conventional "plants", small modular package facilities, as well as oil-based treatment systems. The *PA Sewage Enforcement Officer Manual* provides examples and image of many different types of wastewater treatment systems.

The terms "on-lot" and "sewerage" are used in state regulations to distinguish where the wastewater is treated.

On-lot is used to refer to systems that involve a soil-based treatment, either a soil absorption area or a spray field. On-lot is also used to refer to systems that use a retention tank that is periodically pumped, with the waste being taken to another facility for disposal.

Sewerage is used to refer to any treatment method that does not use soil-based waste renovation techniques, or does not use retention tanks.

The term "conventional" is used to refer to treatment systems that are explicitly identified in state regulations as being a demonstrated method of treatment when used in the manner specifically recognized by the regulation. The term does not include alternate or experimental systems.

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6.2 COMMUNITY WASTEWATER FACILITIES

6.2.1 General

Community wastewater facilities shall be designed in accordance with the most current version of the *PA DEP Domestic Wastewater Facilities Manual* (Ref. 6). In addition, the following general requirements shall be met:

a. Wherever practical, wastewater sewers shall be installed and connected to a public wastewater treatment facility.

b. The Final Plan Application for the land development or subdivision shall include certification from the applicable authority that the capacity exists to accommodate the need. Application shall also include a statement from the applicable authority indicating the approval of the plans for design, installation and possible financial guarantee.

c. If the applicable authority does not have sufficient capacity, the municipality shall not approve a final subdivision or land development plan.

d. The wastewater sewer systems improvement shall be extended to the boundary line of the development or subdivision to provide access to service by adjacent properties. All such improvements shall be designed as to accommodate the future needs of the municipality with respect to wastewater treatment service as included in the Act 537 Municipal Sewage Facilities Plan or Capital Improvement Plan.

e. No on-lot (soil-based) wastewater treatment system shall be used at any time upon any property that has been connected to a public wastewater sewer system.

f. When plans for future development necessitate oversizing or grade changes, the municipality or utility authority may enter into an agreement with the developer to address the fair share of the cost of improvements not required for the proposed development. If the developer needs to oversize the system to accommodate future development on adjoining property, there should be cost-sharing between the developer and the municipality for the over-sizing.

g. The applicant shall submit details of all planned sewer facilities including conveyance, treatment, and disposal, as applicable to the municipality and/or utility authority, for review and approval to ensure compliance with this section.

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6.2.2 Conveyance System

6.2.2.1 Design and Placement -- General

a. Sewer lines within Municipal Right-of-Way: When sewer lines are located within the municipal right-of-way, they shall be located as follows:

   i. When located under the paved roadway, sanitary sewer manholes shall be located at or near the centerline of the paved roadway, but at least five (5) feet from the edge of pavement.

   ii. When located adjacent to the paved roadway, sanitary sewer manholes shall be located at least ten (10) feet inside the right-of-way line.

   iii. When conditions require that sewer facilities (manholes, pipes, or other facilities) come within ten (10) feet of the right-of-way line, a construction easement shall be provided outside the right-of-way sufficient to maintain a 20 foot construction zone centered on the sewer pipe.

b. Sanitary sewer lines located outside Municipal Right-of-way: Sanitary sewer lines located outside the municipal right-of-way shall be located in a Sanitary Sewer Easement. These easements shall be a minimum of twenty (20)-feet wide for wastewater sewers that are not more than fifteen (15)-feet deep, and a minimum of thirty (30)-feet wide for sanitary sewers more than fifteen (15)-feet deep. The depth of sewer shall be measured from the design invert of the pipe to the surface of the proposed final grade.

   Where the easement is located adjacent to a right-of-way, the municipality or authority may approve a narrower easement.

c. Sanitary sewer easements shall be in a form approved by the municipality and/or utility authority.

d. Except where shallower depths are permitted by the municipality or utility authority, sewer lines, including laterals, shall be constructed at least three (3) feet below the proposed grade (as measure from the top of the pipe to the grade elevation).

e. Wastewater piping shall be shall be placed at slopes that equal or exceed the minimum slopes identified in Table 6-1 (or more current values as identified in a more current version of Reference 6):

Commentary

To provide service, wastewater collection lines typically must run adjacent to each lot in a development. They typically run adjacent to either the front or rear property lines; the exact location depends on the proposed development configuration, topography, utility corridor limitations, and maintenance considerations. Utility corridor limitations include development density, the location of other utilities, and the placement of other site or development amenities (landscaping, sidewalks and trails, etc.).

Consideration should be given to accessibility and the cost of repair when locating wastewater lines; for convenience, wastewater collection lines are often run in public rights-of-way, under the roadway pavement or adjacent to it. Wastewater lines located under the pavement provide convenient access to manhole locations, however, pipe repair requires that the street be torn up and repaired. When sewer lines are placed in the right-of-way, a utility corridor or backyard easement, the roadway is not disturbed for pipe repair but there are difficulties in accessing the manholes with cleaning equipment, and street trees can conflict with underground pipes in the right-of-way.

Easements provide the right to use the land for the sewer and also provide the right of entrance for maintenance.

Commentary

Some flexibility should be provided in permitting for slopes slightly less than those required as long as two foot per second, full-flow velocity is maintained.

The per-capita flow of 100 gallons per day is an average value assumed to include normal infiltration and inflow. This value has been used as the average per capita flow since the 1960s. The current trend towards low-flow appliances, shower restrictors, and low-flow toilets (required under the Pennsylvania building code), coupled with construction practices that have reduced or eliminated inflow and infiltration for new construction, may warrant

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Table 6-1. Gravity Slope Standards

Pipe Size (inches)	Slope (feet per 100 feet)
6	0.60
8	0.40
10	0.28
12	0.22
14	0.17
15	0.15
16	0.14
18	0.12
21	0.10
24	0.08
27	0.067
30	0.058
36	0.046

Source: PA DEP, *Domestic Wastewater Facilities Manual*, Ref. 6

f. Sanitary sewer pumping stations shall be considered where gravity system design leads to excessive sewer depths that are not economically justifiable.

6.2.2.2 Sizing and Flow Criteria

a. Wastewater conveyance facilities shall be sized according to the most current edition of the PA DEP Domestic Wastewater Facilities Manual (Ref. 6). The following standards are current as of this writing:

   i. New wastewater conveyance systems should be designed on the basis of an average daily per capita flow of not less than one-hundred (100) gallons per day unless a lower design per-capita flow rate can be established based on actual measured flow data.

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ii. A peaking factor shall be applied to the average daily per-capita flow to accommodate the peak flow (Illustration 6-a).

iii. Generally, sanitary sewers should be designed to carry, when flowing full, not less than the following daily per-capita contributions of domestic wastewater, exclusive of wastewater from non-residential users:

- Laterals and sub-main sewers -- 400 gallons per capita per day.
- Main, trunk interceptor and outfall sewers -- 250 gallons per capita per day. These values should be reduced when an average daily per-capita flow of less than 100 gallons is justified.

iv. Alternate Method -- Deviations from the above sanitary sewer design flows may be used when justified by data analysis. When deviations from the above design flows are proposed, a description of the procedure used to establish the design flows shall be documented and submitted to the reviewing authority for consideration prior to system design.

v. Minimum wastewater pipe size -- No public sewer carrying untreated wastewater should have a diameter less than eight (8) inches. Refer to section 25.1 of the Domestic Wastewater Facilities Manual (Ref. 6) for exceptions to minimum pipe size.

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the use of a lower design per-capita flow rate. However, the use of a lower value must be justified (see paragraph iv).

Wastewater flows vary throughout the day (see Appendix 6.D) Conveyance systems must be designed to accommodate the expected peak flow rate. This is typically considered to be the average daily flow multiplied by some peaking factor. The design flow of 400 gallons per capita per day and 250 gallons per capita per day here assume peaking factors of 4 and 2.5, respectively. In general, the greater the tributary population, the lower the peaking factor; flow peaks are dampened or averaged with larger populations. Illustration 6-b provides a graphic illustrating suggested peaking factors as a function of population.

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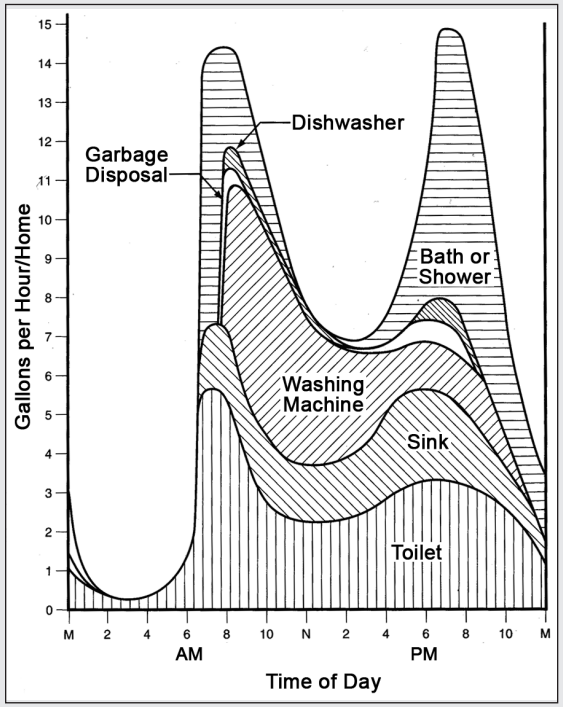
Illustration 6-a. Hourly Variation of Wastewater Flow



Source: *Land Development Handbook,* 2nd Edition. The Dewberry Companies. McGraw-Hill. New York, 2002, Ref. 7

Computation of an alternate wastewater flow may be appropriate based on the use of low-flow appliances and other water-conserving practices. Appropriate design flows can be based on local water use data (usually requires analysis of one-year worth of data), or other sources of measured water use for conditions similar to those proposed (for example, see chapter 3 of Ref. 9).

Assuming an average per-capita flow of 100 gallons/day and a peaking factor of 5 (based on data from Ref. 11), Table 6-a indicates the number of

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housing units that can be served by the minimum 8" sanitary sewer as a function of pipe slope. Manning's n for PVC pipe is 0.013. Pipes are assumed to be flowing full.

Table 6-a. Number of Single-Family Dwellings Served by an 8-inch Diameter Wastewater Pipe

Type of Housing	Average Number of Residents [a]	Maximum Number of Housing Units Tributary to an 8-inch PVC Sewer Pipe at the Given Slopes					
		0.5%	1%	2%	3%	4%	5%
Single-Family Dwelling	2.7	88	125	177	217	251	280
Small Apartment Buildings (less than 5 units)	2.45	97	138	195	239	276	309
Medium Apartment Buildings (5 to 20 units)	1.75	137	193	274	335	387	433
Large Apartment Buildings (20 to 50 units)	1.6	149	211	299	367	423	473
High Rises (more than 50 units)	1.4	171	242	342	419	484	541

[a] Average number of residents per household by structure type is based on Census 2000, Pennsylvania data.

If pipes are assumed to be flowing half full, the number of housing units at each slope will be

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reduced to one half of the number presented in the table.

The following factors should be considered when selecting material for a wastewater sewer system:

- Flow characteristics -- friction coefficient
- Life expectancy and use experience
- Resistance to scour
- Resistance to acids, alkalis, gases, solvents, etc.
- Ease of handling and installation
- Physical strength
- Type of joint -- water tightness and ease of assembly
- Availability and ease of installation of fittings and connections
- Availability in sizes required
- Cost of materials, handling, and installation

Reinforced PVC, ductile iron, and concrete pipe are the most common types of pipe used for wastewater sewer systems, but there are special situations where other types such as Acrylonitrile-Butadiene-Styrene (ABS) and Cement-Lined Asbestos may be an option. Descriptions along with advantages and disadvantages of various pipe materials are provided below (from Ref. 8).

Polyvinyl Chloride (PVC) Pipe

Advantages

- Light weight
- Long laying lengths (in some situations)
- High-impact strength
- Ease in field cutting and tapping

Disadvantages

- Subject to attack by certain organic

Recommended Standards

6.2.2.3 Materials

a. Pipe materials used in the construction of gravity sanitary sewers shall be PVC, reinforced concrete, or ductile iron. Other pipe materials may be used if warranted and justified. All pipe and appurtenances shall comply with AWWA and ASTM standards referenced in this paragraph. Where nonmetallic pipe is installed, a metallic locator tape shall also be installed above the pipe.

   i. ***PVC sewer pipe*** shall have bell and spigot ends, and O-ring rubber gasketed joints. PVC pipe and fittings shall conform to ASTM D3034, with a minimum wall thickness designation of SDR 35, or shall conform to ASTM F679, F789, F794, or F949 with a designated pipe stiffness of PS-46.

      1. The plastic material from which the pipe and fittings are extruded shall be impact types of PVC, unplasticized, having high mechanical strength and maximum chemical resistance, conforming to Type 1, Grade 1, of the specification for rigid polyvinyl chloride compounds, ASTM D1784.

      2. Pipe shall be free from defects, such as bubbles or other imperfections, in accordance with accepted commercial practices. Test results demonstrating that the pipe meets ASTM D2444 for impact and ASTM D2321 for deflection and pipe stiffness shall be provided when requested by the municipality or utility authority.

      3. Joints shall conform to ASTM D3212. Rubber-ring gaskets shall conform to ASTM F477. The gasket shall be the sole element depended upon to make the joint watertight.

      4. The pipe shall be installed as specified in ASTM D2321 and as specified in the wastewater sewer trench detail (Figure 6.1). When pipe is to be installed in unstable soil or excessive ground water, a determination regarding special precautions, such as poured concrete slabs, shall be made by the municipal engineer or utility authority engineer.

      5. Bedding, haunching, and initial backfill material shall be placed in accordance with the sewer detail Figure 6.1. All material shall be clean and free flowing, and shall meet all ASTM C33 specifications for quality and soundness.

Recommended Standards

ii. Reinforced concrete pipe shall be used only in sizes twenty-four (24) inches and larger, and shall meet all the requirements of ASTM C76. All pipe shall be Class III strength installed with Class C ordinary bedding, except in the following conditions where stronger pipe may be required:

1. For depths less than three (3) feet, measured from the top of the pipe, installed under traffic area, Class IV pipe shall be required.

2. The presence of clay soils, poor bedding conditions, or other unusual loading conditions shall be given special consideration and the developer shall submit an engineering analysis to the municipality or authority for approval.

Commentary

chemicals
- Subject to excessive deflection when improperly bedded and haunched
- Limited range of sizes available
- Subject to surface changes affected by long-term ultra-violet exposure

Concrete Pipe

Advantages
- Wide range of structural and pressure strengths
- Wide range of nominal diameters
- Wide range of laying lengths

Disadvantages
- High weight
- Subject to corrosion where acids are present
- Subject to shear and beam breakage when improperly bedded

Ductile Iron Pipe

Advantages
- Long laying lengths
- High pressure and load bearing capacity
- High-impact strength
- High beam strength

Disadvantages
- Subject to corrosion where acids are present
- Subject to chemical attack in corrosive soils
- High weights

Cement-lined Asbestos Pipe

Advantages
- Long laying lengths (in some situations)
- Wide range of strength classifications
- Wide range of fittings available

Commentary

Disadvantages
- Subject to corrosion where acids are present
- Subject to shear and beam breakage when improperly bedded
- Low beam strength

Cast Iron Pipe

Advantages
- Long laying lengths (in some situations)
- High pressure and load bearing capacity

Disadvantages
- Subject to corrosion where acids are present
- Subject to chemical attack in corrosive soils
- Subject to shear and beam breakage when improperly bedded
- High weight

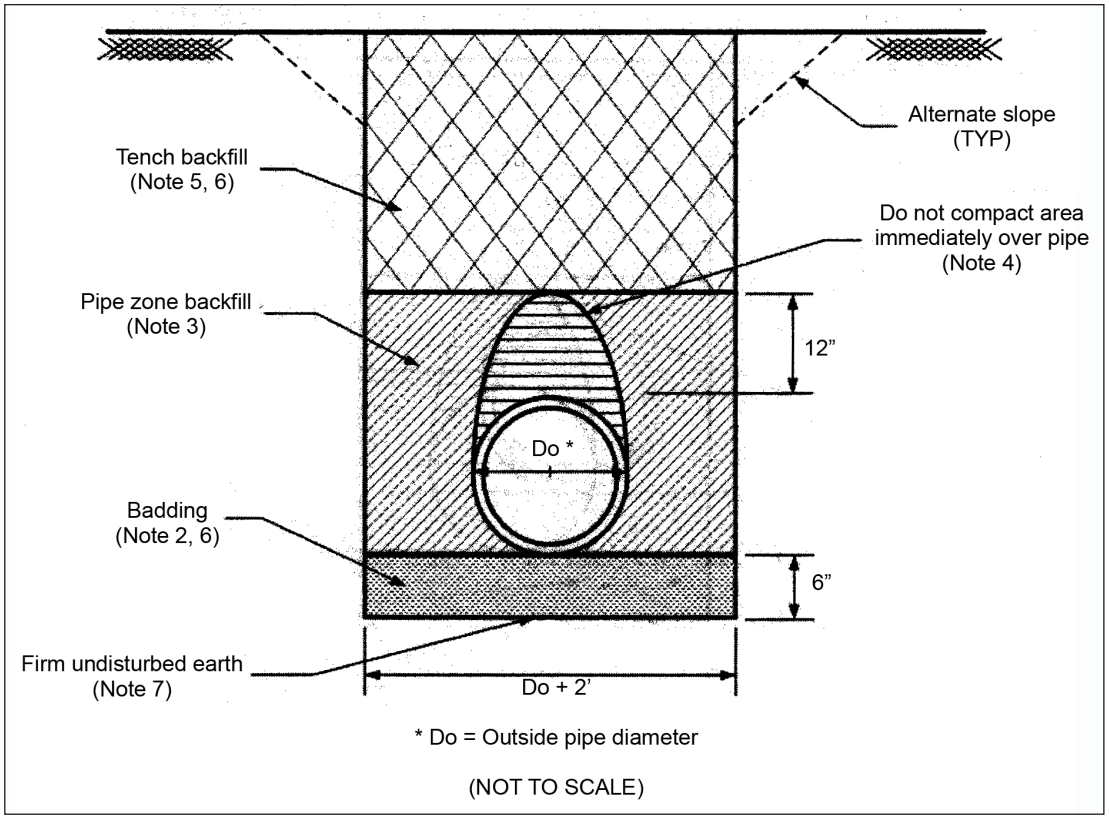
Steel Pipe

When used in wastewater sewers, it usually is specified with interior protective coatings or linings (polymeric, bituminous).

Advantages
- Light weight
- Long laying lengths (in some situations)

Disadvantages
- Subject to corrosion where acids are present
- Subject to chemical attack is corrosive soils
- Difficulty in making lateral connections
- Poor hydraulic coefficient (unlined corrugated steel pipe)
- Subject to excessive deflection when improperly bedded or haunched

Recommended Standards



NOTES:

1. When trench backfill exceeds twenty (20) feet or is less than three (3) feet, use reinforced concrete or Class 52 ductile iron pipe.
2. Bedding is to be un-compacted PennDOT 2A coarse aggregate.
3. The pipe zone backfill is to be well compacted PaDOT 2A coarse aggregate. Place and compact pipe zone backfill in four (4) inch lifts to a level one (1) foot above the pipe crown.
4. Do not compact material immediately over the pipe as shown.
5. Trench backfill shall be suitable material placed in four (4) to eight (8) inch lifts and is to compacted to ninety-five (95) percent standard proctor density (SPD). Where the trench passes under pavement, the trench backfill shall be PennDOT 2A coarse aggregate.
6. Suitable material is material containing no debris, organic material, frozen material or larger stones with a diameter greater than one-half (1/2) the thickness of the compacted layers being placed.
7. If unsuitable material exists at the base of the trench, undercut as directed and backfill with suitable material to the bottom of the bedding layer.

Figure 6.1. Sanitary Sewer Line Trench Detail

Recommended Standards

iii. ***Ductile iron pipe*** shall be used for installation where sewer pipe may be subject to high internal or external pressures. Ductile iron pipe can be used as an alternate to concrete pipe in areas where fill depths are less than three (3) feet or greater than twenty (20) feet. Ductile iron pipe should also be used to span areas where bedding support could be lost such as at stream crossings, and in areas where there is a reasonable probability of sinkhole formation.

1. Ductile iron pipe shall be Class 52 with rubber gasketed joints that conform to ANSI/AWWA C111/A21.11. Gasketed flanges can be used where the pipe must connect to flanged fittings.

2. The outside of the pipe shall be coated with a uniform thickness of hot applied asphaltic coasting, and the inside shall be lined with cement in accordance with ANSI/AWWA C104/A21.4.

3. In corrosive soils or in sewers that receive discharge from a force main where hydrogen sulfide is present, ductile iron pipe with polyethylene coating shall be used to protect the inside and outside of the pipe.

b. Inverted siphons and outfalls shall be constructed of ductile iron pipe or PVC pipe, as specified above. Inverted siphons shall consist of a minimum of two (2) pipes with provisions for flushing. Flow control gates shall be provided in the chambers. (Refer to Section 25.1 of Ref. 6).

c. For other than PVC pipe, pipe and manhole bedding shall be provided as specified in Reference 8, *Gravity Sanitary Sewer Design and Construction, ASCE Manual on Engineering Practice, No. 60*. Any pipe material not covered by this manual shall be installed in accordance with the manufacturer's recommendations.

i. The municipality or the authority may require the developer to provide the opinion of a professional engineer regarding the suitability of the on-site material to be used as backfill. The municipality or authority shall rely of this opinion.

ii. Where the on-site material is deemed suitable, the professional's opinion shall specify the appropriate installation methods for the material. Where the on-site material is deemed not suitable, the opinion shall specify modification or replacement of the material and the appropriate installation methods for the specified material.

Commentary

- Subject to turbulence abrasion

Acrylonitrile-Butadiene-Styrene (ABS) Pipe

Advantages
- Light weight
- Long laying lengths (in some situations)
- High impact strength
- Ease in field cutting and tapping

Disadvantages
- Limited range of sizes available
- Subject to environmental stress cracking
- Subject to excessive deflection when improperly bedded and haunched
- Subject to attack by certain organic chemicals
- Subject to surface change effected by long-term ultra-violet exposure

Table 6-b Typical size ranges and descriptions of common sewer pipe material

Type of pipe	Typical size range (in)	Description
Cement-lined asbestos	4-36	Weighs less than other commonly rigid pipes. May be susceptible to acid corrosion and hydrogen sulfide attack, but if properly cured with steam at high pressure (autoclave process), may be used even in environments with moderately aggressive waters of soils with high-sulfate content.

Commentary

Ductile iron	4-54	Often used for river crossings and where the pipe must support unusually high loads, or where unusual root problems are likely to develop. Ductile-iron pipes are susceptible to acid corrosion and hydrogen sulfide attack, and therefore should not be used where the groundwater is brackish, unless suitable protective measures are taken.
Reinforced concrete (RCP)	12-144	Readily available in most localities. Susceptible to corrosion of interior if the atmosphere over wastewater contains hydrogen sulfide, or from outside if buried in an acid or high sulfate environment.
Prestressed concrete	16-144	Especially suited to long transmission main without building connections and where precautions against leakage are required. Susceptibility to corrosion (the same as reinforced concrete).
Polyvinyl chloride (PVC)	4-15	A plastic pipe used for sewers as an alternative to cement-line asbestos and vitrified clay pipe. Lightweight but strong. Highly resistant to corrosion.

Source: Metcalf & Eddy, Inc., 1981, Ref. 10

The maximum distance between manholes is based on the length of pipe that can be cleaned with avail-

Recommended Standards

Recommended Standards

6.2.2.4 Manholes

a. *Manhole location:* Manholes shall be located at all sewer pipe junctions and at locations where a change in pipe slope is required. In a straight section of pipe on constant grade, manholes should be spaced no more than four-hundred (400) feet apart.

b. *Manhole construction:* Manhole construction shall comply with the standards in *ASCE Manual on Engineering Practice No. 60* (Reference 8) and shall meet the following requirements.

i. Manholes shall be precast concrete or concrete block. Manhole barrels shall be a minimum of four (4) feet in diameter when serving sewers twenty-four (24) inches or less in diameter and shall be a minimum of five (5) feet in diameter when serving sewers greater than twenty-four (24) inches in diameter

Where manholes are precast, the base and first section shall be monolithically cast. Concrete block shall be coated with two coats of Portland cement mortar.

Precast concrete or concrete block shall be sealed with two coats of an acceptable waterproofing tar, asphalt, or polyplastic alloy, with enough time allowed between the seal coasts to bond.

ii. When a smaller sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method of securing these results is to place the 0.8 depth point of both sewers at the same elevation.

iii Where pipe size varies, crowns of pipes shall be matched, unless authorized otherwise by the approving authority.

iv Flow channels shall be placed in all manhole bases. Flow channels shall be smooth and accurately shaped to a semi-circular bottom conforming to the inside of

Commentary

able equipment. The required separation distance should be increased or decreased as necessary to permit cleaning the length of run between manholes.

Typical manhole details are illustrated in illustrations 6-c thru 6-l in Appendix 6.C.

Commentary	Recommended Standards

the adjacent sewer sections.

v. Drop connections shall be made where the invert of any inlet pipe is two (2) feet or more higher than the invert out of the manhole.

vi. If precast manhole barrels and cones are used, they shall conform to ASTM C478, with round rubber-gasketed joints conforming to ASTM C443. Maximum absorption shall be nine (9) percent, in accordance with ASTM C478, Method A.

Manholes be watertight.

The top riser section of precast manholes shall terminate less than eighteen (18) inches below the finished grade to provide for proper adjustment.

vii. Manhole frames and covers shall be of cast iron conforming to ASTM A48, Class 30, or ductile iron conforming to ASTM 536, and shall be suitable for H-20 loading capacity.

All manholes covered in unpaved rights-of-way or in remote areas shall be provided with a locking device, as specified by the municipality or utility authority.

The words “SANITARY SEWER” shall be cast integrally into the manhole cover.

viii. Manholes shall be supplied with flexible, watertight adaptors, such as inserts or gaskets, conforming to ASTM C923 and suitable for the pipe material used.

ix. Masonry units shall conform to the following requirements:

1. Brick shall be manufactured using clay or shale, burned, and meeting the requirements of ASTM C-62.

2. Concrete block masonry units shall be manufactured in solid precast segmented units and meet the requirements of ASTM C-139.

3. The use of a Type S, or equivalent, mortar should be used in below ground applications.

6.2.2.5 Laterals and Cleanouts

Laterals and cleanouts shall comply with the following standards:

Recommended Standards

a. One (1) or two (2) dwelling units may be served from a single sewer lateral connection to the main. When two (2) dwelling units are connected through a single lateral connection, the lateral connection is referred to as a "common lateral connection".

   Where site conditions allow, two dwellings may be served by a single common lateral connection between the sewer main and the edge of right-of-way or sewer easement. The single lateral from the main can be split using a "y" connection at the property or easement line. The lateral shall only be shared to the edge of the right-of-way so no additional easement or maintenance agreement is needed.

b. The service lateral from the sewer main to the cleanout located at the edge of the right-of-way or sewer easement shall be considered an integral part of the sanitary sewer system. Sewer laterals shall be constructed of schedule 40 or SDR 35 PVC pipe having a four (4) inch minimum diameter. The following pipe materials may also be used:

   - cast-iron soil pipe, extra heavy;
   - ABS plastic pipe, SDR 35; or
   - ductile iron pipe.

   Common laterals (see section 6.2.2.5 a.) shall have a six (6)-inch minimum diameter.

   Service laterals shall be constructed at a minimum 2% slope.

c. Wye connections shall be the same material as the sewer main. Saddles shall be used only for connection to an existing main.

d. Cleanouts shall be provided at fifty (50)-foot intervals in all four (4)-inch diameter sewer laterals and at one-hundred (100)-foot intervals in all six (6)-inch sewer laterals.

e. Bends in laterals shall be made using standard fittings. A riser and cleanout shall be provided immediately upstream of any bends in lateral lines.

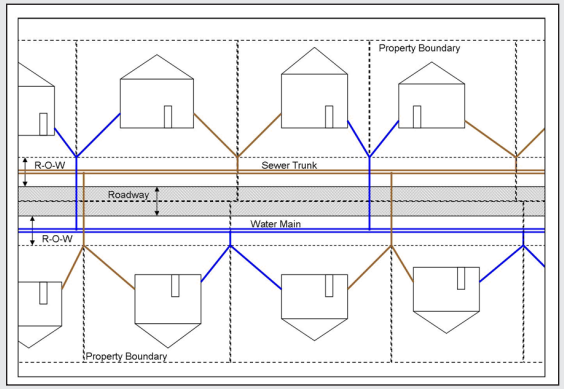
f. All cleanouts shall be fitted with either a metallic cap or a non-metal cap fitted with a metallic plug that is suitable for locating the cleanout. Caps shall have a depressed or inverted nut.

g. Connections beyond the edge of right-of-way or sewer easement are under the jurisdiction of the Plumbing Subcode of the Uniform Construction Code through the plumbing subcode official. The pipe size, slope, and specifications shall comply with the regula-

Commentary

Common lateral connections can be used to minimize the number of main connections and, thus, minimize the associated initial and maintenance costs. Fewer lateral connections will also minimize utility conflicts within the right-of-way. Illustration 6.g shows how a development might use common laterals for water and sewer connections. Illustration 6.h provides a detail of the wye connection.

Illustration 6-b. Common Lateral Connection



Common lateral connection branching to individual homes at the intersection of the right-of-way and property boundary.

See Appendix 6.C for Illustrations 6-c to 6-l for standard details.

Commentary

Locating wastewater sewers in streets or other public properties is generally preferred for ease of maintenance and to avoid conflicts with property owners. If sewers must be placed on private property, an easement should be dedicated to provide the right of access for construction, inspection, maintenance and repair.

Where possible, wastewater sewers should not be located near water supply pipes. Sometimes avoidance is not possible, in which case common practice is to use a pressure-type pipe with mechanical joints. The pipe may also be encased in concrete.

Recommended Standards

tions and requirements of the Plumbing Subcode of the Uniform Construction Code.

Typically, laterals should have a 2% slope. A 1% slope is an option when necessary.

h. Deep-Cut Laterals

i. Where elevations of main sewers and service connections are such that require lateral trenching of over seven (7) feet, a riser connection off the main shall be made.

ii. Riser assemblies consist of a Wye inserted in the main sewer with an elbow for plumb. Place a six (6)-inch diameter riser pipe of a length terminating at a height allowing the shallow lateral trenching. Place an elbow on the riser pipe and extend lateral to two (2) feet inside the property line and cap off.

iii. Where appropriate, place a Wye on top of riser pipe and extend to surface, properly capped for a clean-out.

iv. Sewer main and riser pipe shall be encased to the height of elbow or Wye with Class B concrete, at a minimum of six (6) inches thick.

6.2.2.6 Vertical and Horizontal Separation of Sanitary Sewer and Potable Water Lines

Refer to Ref. 6 for the most up-to-date standards.

a. Vertical Separation

i. Whenever sewers must cross under water mains, the sewer shall be laid at such an elevation that the top of the sewer is at least eighteen (18) inches below the bottom of the water main. When the elevation of the sewer cannot be varied to meet this requirement, the water main shall be raised to provide this separation, for a distance of ten (10) feet extending on each side of the sewer

ii.. Where less than eighteen (18) inches vertical separation exists between the water and sewer lines, the sewer line shall be encased in Class B concrete for ten (10) feet on either side of the water main.

iii. If possible, one full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.

iv. The sewer line shall be pressure-tested to assure water tightness prior to backfilling.

Recommended Standards

v. Where possible, sewers crossing water mains shall be constructed so that the sewer joints will be equidistant and as far as possible from the water main joints.

vi. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main.

vii. Where a wastewater sewer line crosses over or under a utility other than water supply, a vertical separation of twelve (12) inches shall be maintained between them.

b. Horizontal Separation

i. Whenever possible, sewers shall be laid at least ten (10) feet horizontally, from existing or proposed water mains.

ii. If local conditions prevent a lateral separation of ten (10) feet, a sanitary sewer line may be laid closer than ten (10) feet to a water main if:
- It is laid in a separate trench; or if
- It is laid in the same trench, with the water main located at one side of a bench of undisturbed earth; and if
- In either case the elevation of the top (crown) of the sewer is at least eighteen (18) inches below the bottom (invert) of the water main.

6.2.3 Conventional Sewerage Treatment Facilities

Conventional sewerage treatment facilities include all facilities that use a means of treatment and disposal other than renovation in a soil absorption area or retention in a retaining tank.

a. The design of a community sewerage systems shall comply with PA Code Title 25, Chapters 71 through 73 (Reference 1) and the guidance of the *PA DEP Domestic Wastewater Facilities Manual* (Reference 6).

b. The engineer/develop shall confer with the PA DEP before proceeding with the design of detailed plans for wastewater treatment facilities.

c. Space shall be provided to allow for plant expansion in the event of a population expansion or requirement for additional treatment.

Commentary

It is recommended that a wastewater treatment plant be located at least 250 feet from occupied dwellings and recreational areas.

The direction of prevailing winds should be considered when locating a treatment plant.

The varied design flow terminology used wastewater facility often creates confusion. Table 6-c summarizes the name, general definition, and typical

Commentary

application of the commonly used design flow parameters. Refer to the current version of Ref. 6 for up-to-date terminology.

Table 6-c. Summary of Design Parameters

Design Flow Parameter	General Definition	Typical Application
Annual Average Flow	The total flow received at the facility during any one calendar year divided by 365 (the number of days in that period).	• The "nominal" design flow of a facility. • Used for cost comparisons and annual estimates of O&M costs. • Used for water quality modeling. • Used for evaluating Act 537 plan updates. • Used to determine allowable mass loadings in NPDES permits.
Monthly Average Flow	The total flow received at the facility during any one calendar month divided by the number of days in that month.	• A flow reporting parameter used in discharge monitoring reports.
Maximum Monthly Average Flow	The highest monthly average flow during any one calendar year.	• Determine the overall hydraulic design of the facility. • Used for evaluating Act 537 plan updates and planning modules. • Is the "hydraulic capacity" for Chapter 94 determinations? • Establishes the monthly average flow limitation on NPDES permit.

Recommended Standards

d. Sewage treatment facilities, including all electrical and mechanical equipment, shall be protected from physical damage by the 100-year flood. The treatment plant shall be designed to remain fully operational and accessible during the 25-year flood.

Recommended Standards

e. Design Flow

i. For municipal systems and subdivision of over one hundred and fifty (150) homes, the design annual average flow shall be based on one hundred (100) gallons per capita per day, with a twenty-four (24)-hour runoff period.

ii. The design annual average flow for plans serving less than one hundred and fifty (150) homes shall be based on seventy-five (75) gallons per capita per day, with a sixteen (16)-hour runoff period.

iii. Any deviation from these values shall be based on actual data for water consumption and projected or anticipated flow due to infiltration (during high groundwater conditions).

6.2.4 Community On-lot Treatment Systems

6.2.4.1 Conventional Community On-lot Treatment Systems

a. Design for a community on-lot wastewater system shall be based on the sewage

Commentary

Peak Hourly Flow	The maximum flow rate received at the facility averaged over a period of one hour.	• Designing clarifiers, chlorine contact tanks, and other hydraulically sensitive units.
Peak Instanta-neous flow	The maximum instantaneous flow rate received at the facility at any given time.	• Designing comminutors, pump stations, piping, and units subject to peak flow conditions.
Minimum Hourly Flow	The least flow rate received at the facility over a period of one hour.	• Designing pump stations, and other units sensitive to excessive deten-tion times.

At the state level, the PA DEP defines design flow on a number of people rather than Equivalent Dwelling Units (EDU) because the number of people in a unit varies across the state. Use census data to determine the local EDU.

For assistance in developing a community sewage manage-

Commentary

ment program refer to the *EPA Handbook for Managing Onsite and Cluster (Decentralized) Wastewater Treatment Systems* (Ref. 11) and *Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems* (Ref. 12).

Flow information for building types other than those presented in Table 6-1 that might be part of a mixed-use community can be found in Title 25 of the PA Code in Chapter 73, Section 17, Subsection b.

According the PA Code, Title 25, Chapter 73 (Ref. 1), alternative wastewater treatment systems provide a classification for innovative and alterative technology that has been developed through the experimental program, by application of existing technologies from other disciplines or through technological advances from other areas of the country. The alternate wastewater treatment system permit provides a method for use of proven technologies without constant changes to the regulations with

Recommended Standards

flow data found in PA Code, Chapter 73, Section 17 Sewage Flows (Ref. 1), as reproduced below in Table 6.2. Refer to Reference 1 for sewage flows for other commercial and institutional establishments.

Table 6.2 Flows for the Design of Community On-lot Wastewater Treatment Systems

Type of Establishment	Gallons/Unit/Day	
Residential	Gallons/unit	BOD/unit
Multiple family dwellings and apartments, including townhouses, duplexes and condominiums	400	1.13
Single family residences	400*	.90

*For units of 3 bedrooms or less; for each bedroom over 3, add 100 gallons

c. The treatment facility(ies), disposal and reserve area(s), and any pump station(s) shall be located on a separate nonresidential lot that shall be dedicated to the municipality.

d. Each on-lot community system is required to provide a reserve area in the event that the system should fail. The reserve area shall be located within soils suitable to support such a system. The suitability of the reserve area shall be determined at the same time that the suitability of the main area is determined.

e. An agreement guaranteeing maintenance of the system shall be prepared by the developer subject to the approval of the municipality. The agreement shall be noted in the deed for each connecting lot and shall specify the responsibilities of each property owner for the proper functioning and maintenance of the system.

6.2.4.2 Alternate Community On-lot Treatment Systems

a. Alternate systems shall be considered for community on-lot systems when any of the following conditions apply:

   i. to solve an existing pollution or public health problem;
   ii. to overcome specific site suitability deficiencies, or as a substitute for systems described in this chapter on suitable lots;
   iii. to overcome specific engineering problems related to the site or its proposed use; or
   iv. to utilize under varying site conditions an experimental design, either in whole or in part, which has been deemed successful by the Department.

b. By definition, alternate systems are on-lot systems, so residential systems shall be sized

Recommended Standards

in accordance with flow values in Table 6-1 or as updated through an amendment or other revision to PA chapter 73, section 17, Sewage Flows (Ref. 1). Also refer to Reference 1 (chapter 73, section 17) for sewage flows for other commercial and institutional establishments.

c. If wastewater flow is in excess of 10,000 gallons per day, refer to the *PA DEP Manual for Land Application of Treated Sewage and Industrial Wastewater* (Ref. 14) for additional design requirements.

Figure 6.2. Land Application of Treated Sewage
Source: West Bradford Township
These spray irrigation fields are located in Chester County.

Commentary

changing technology approvals.

The PA DEP document entitled *Alternate System Guidance* (362-0300-007) (Ref. 13) provides technical standards and design assistance for alternative on-lot systems. As of the publication of the Alternate System Guidance document in February 2006, the allowable alternate systems include:

- Alternate Individually Designed Composting Toilet
- Flow Equalization
- Alternate Peat Based System Options
- Free Access Gravity Sand Filter System Option
- CO-OP RFS III System Option
- Leaching Chambers
- Alternate Aggregates
- Grey water Systems
- At-Grade Bed Systems
- Modified Subsurface Sand Filter for Fast Percolation, Shallow Bedrock Sites with No Water Table Present
- Shallow Placement Pressure Dosed System
- Drip Irrigation System
- Steep Slope Elevated Sand Mound Beds on Slopes Between 12 and 15% and Percolation Rates of 3-30 minutes per Inch
- A/B Soil System (ABS System)
- Non-Infiltration, Evapotranspiration Bed Contained Within a Greenhouse

The PA DEP *Manual for Land Application of Treated Sewage and Industrial Wastewater* (362-2000-009, 10/1997) (Ref. 14) provides information on applicability, permitting, and basic design for large-volume and community on-lot wastewater systems. A large-volume on-lot system will handle wastewater flows in excess of 10,000 gallons per day. A community on-lot system serves two or more

Commentary

Equivalent Dwelling Units (EDUs).

Alternative On-Lot Technology Research: Soil-Based Treatment Systems (Ref. 15) published by the Delaware Valley College Research and Demonstration Center for On-Lot Systems and Small Flow Technology provides guidance for subsurface drip irrigation community systems and treatment data from application to areas with different land uses.

These flow standards are as specified in chapter 73 of Reference 1.

An individual sewage system is a system of piping, tanks or other facilities serving a single lot and collecting and disposing of wastewater in whole or in part into the soil or into waters of the Commonwealth or by means of conveyance to another site for final disposal.

The terms "on-lot" and "sewerage" are used in the state regulations to distinguish where the wastewater is treated.

On-lot is used to refer to systems that involve a soil-based treatment, either a soil absorption area or a spray field. On-lot is also used to refer to systems that use a retention tank that is periodically pumped and waste is taken to another facility for treatment.

Recommended Standards

6.3 INDIVIDUAL ON-LOT SYSTEMS

6.3.1 Design Flow Criteria

a. Wastewater treatment systems for single-family dwellings, not served by a community treatment system, shall be designed based on a minimum flow of 400 gallons per day (gpd) for all dwellings having three (3) bedrooms or fewer. The minimum flow of 400 gpd shall be increased by 100 gpd for each bedroom over three (3).

6.3.2 Conventional Individual On-lot Systems

a. Individual, on-lot treatment systems for single-family dwelling units shall be sized according to the regulations in PA Code Chapter 73 based on the type of treatment to be used.

b. According to Act 357, if neither an active nor a capped wastewater sewer system is installed, easements for sewer installation at a later time must be designated.

c. Approval of the Planning Module from DEP shall be required before approval from the municipality.

d. No septic tank, privy vault, or other similar receptacle shall be connected to a public sewer system

e. No person may install, award a contract for construction of or construct an individual or community on-lot sewage system, or install, construct, occupy or use a building to be served by that system without first obtaining the applicable permits.

f. A permit shall be required for alterations or connections to an existing individual or com-

Recommended Standards

munity on-lot sewage system when the alteration or connection requires the repair, replacement or enlargement of a treatment tank or retention tank, or the repair, replacement, disturbance, modification or enlargement of a soil absorption area or spray field or the soil within or under the soil absorption area of spray field.

g. Soil percolation tests shall be conducted in accordance with the requirements of PA Code, Title 25, chapter 73.15 (Ref. 1).

h. A replacement treatment location may be required if soils are marginal as determined by the PA DEP.

i. If soils are not suitable for a conventional individual on-lot wastewater treatment system, a Small Flow Treatment Facility (SFTF) may be considered. See section 6.4 of this ordinance.

j. Facility Location:

   i. The perimeter of on-lot wastewater treatment facilities shall be recorded in the property deed.

   ii. The location of each individual on-lot wastewater treatment system (and each replacement location if a replacement location is required) as well as any required isolation distances required by the PA DEP shall be shown on the plans.

   iii. All isolation distances must be contained within the property boundary.

   iv. On-lot wastewater treatment facilities shall be set back from street right-of-way a sufficient area to accommodate future street improvements without disturbing the function of the treatment.

   v. On-lot wastewater treatment systems shall be located and/or designed to avoid impairment to them, or contamination from them, during flooding.

   vi. The area reserved for the on-lot wastewater treatment system (and the area of the replacement location if a replacement location is required) for each lot must be fenced and protected from any disturbance during all phases of construction until the issuance of an occupancy permit.

   vii. On-lot wastewater facilities may be located within common and/or restricted open space in lieu of location(s) on the specific lot(s) to be served, where approved by

Commentary

Sewerage is used to refer to any treatment method that does not renovate waste within the soil or retain in a retention tank.

The term "conventional" is used to refer to treatment systems that are explicitly stated within the regulation as being a demonstrated method of treatment when used in a manner specifically recognized by the regulation. The term does not include alternate or experimental systems.

The type and character of the on-lot wastewater treatment system to be installed should be determined on the basis:

- Location
- Topography
- Available area
- Soil characteristics
- Permeability
- Groundwater elevation

The treatment area to be provided shall be determined by the results of:

- Percolation test
- Soil classification
- Depth of water table
- Other tests as may be deemed necessary

Specific design standards for conventional on-lot wastewater systems can be found in PA Code Chapter 73 regulations. The most common type of individual on-lot system installed in Pennsylvania is a septic tank with absorption area. The following standards or most current regulations should be used in the design of a septic system

a. Standards for Septic Tanks
   i. The minimum liquid septic tank capacity for any installing is 900 gallons.
   ii. The minimum septic tank capacity shall be

Commentary

calculated from Table 6-d using the estimated flows from above.

iii. Septic tanks may be connected in series to attain required capacity.

Table 6-d. Minimum Septic Tank Capacity Based on Sewage Flow

Design Flow (gpd)	Tank Capacity (gallons)
0 – 500	(3.5 x flow exceeding 400 gpd) + (900)
500 – 5,000	(1.5 x flow exceeding 500 gpd) + (1,250)
5,000 – 7,500	(1.45 x flow exceeding 5,000 gpd) + (8,000)
7,500 – 10,000	(1.35 x flow exceeding 7,500 gpd) + (11,625)
Over 10,000	1.50 x the daily flow

b. Standards for Absorption Area

Minimum absorption area required for on-lot treatment is based on the amount of flow and the soil percolation rates as shown in Table 6-e below.

Recommended Standards

the Municipality in accordance with applicable zoning regulation.

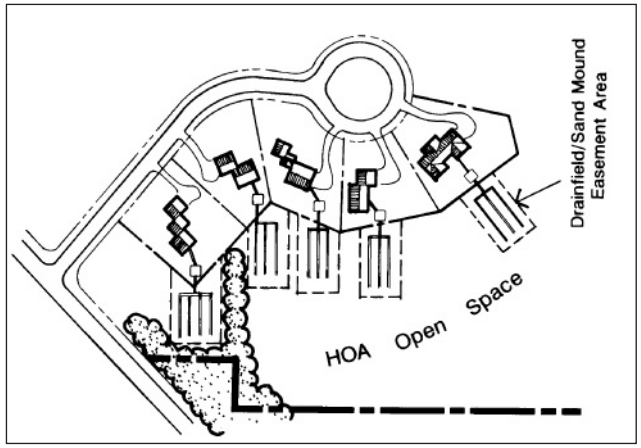


Figure 6.3. On-lot Facilities in Common Open Space
Source: Growing Greener, Ref. 22
Housing lots can be smaller by locating each house's wastewater facility in the community's common open space.

viii. Where any individual on-lot wastewater facilities are located within common or restricted open space not part of the individual lot being served, the location(s) of such facilities shall be monumented and easements satisfactory to the municipality shall be established to require and enable the maintenance of such facilities by the appropriate parties.

ix. Cleanouts shall be provided at the junction of the building drain and building sewer.

x. Cleanouts shall be proved at intervals of not more than one hundred (100) feet.

xi. Bends ahead of the treatment tank shall be limited to forty-five (45) degrees or less where possible. If ninety (90)-degree bends cannot be avoided, they shall be made with two (2) forty-five (45)-degree bends.

xii. The grade of the building sewer shall be at least one eighth (1/8) inch per foot, or a 1% slope; however, the grade of the ten (10) feet of building sewer immediately preceding the treatment tank may not exceed one-fourth (¼) inch per foot, or a 2% slope.

Recommended Standards

Commentary

Table 6-e. Minimum Absorption Area Required for Treatment Tank Effluent

	Square Feet of Aggregate Area per Gallon per Day	
Average Percolation Rate (Min/in)	**All Systems Except Elevated Sand Mounds and Sub-surface Sand Filters**	**Subsurface Sand Filters and Elevated Sand Mounds**
Less than 3.0[D]	Unsuitable	Unsuitable
3 - 5[C]	Unsuitable	1.50[AB]
6 - 15[C]	1.19[B]	1.50[AB]
16 - 30[C]	(Avg. Perc Rate - 15) x (0.040) + 1.19[B]	1.50[AB]
31 - 45[C]	(Avg. Perc Rate - 30) x (0.030) + 1.79[B]	(Avg. Perc Rate - 30) x (0.026) + 1.50[AB]
46 - 60[C]	(Avg. Perc Rate - 45) x (0.028) + 2.24[B]	(Avg. Perc Rate - 45) x (0.022) + 1.89[A]
61 - 90[C]	(Avg. Perc Rate - 60) x (0.023) + 2.66[A]	(Avg. Perc Rate - 60) x (0.020) + 2.22[A]
91 - 120[ACD]	Unsuitable	(Avg. Perc Rate - 90) x (0.017) + 2.82[A]
121 - 150[CD]	Unsuitable	(Avg. Perc Rate - 120) x (0.015) + 3.33) (1.05)[A]
151 - 180[CD]	Unsuitable	(Avg. Perc Rate - 150) x (0.014) + 3.78) (1.10)[A]
Greater than 181[CD]	Unsuitable	Unsuitable

Notes:

A Pressure dosing required.

B One-third reduction may be permitted for use of an aerobic tank.

C May be considered for experimental or alternate proposals.

D Unsuitable for subsurface sand filters

Commentary

Siting Considerations
According to PA Code, Title 25, 73.12 (at time of this publication):

When locating a proposed absorption area or spray field areas, the following characteristics should be avoided.

1. The slope of the proposed absorption area or spray field is greater than 25%.
2. The area is identified by completed Federal Flood Insurance mapping as a floodway. Where there is no flood mapping, a flood way extends 50 feet from the top of the stream bank as determined by the local agency.
3. One or more rock outcrops exist within the proposed absorption area.
4. In areas underlain by limestone, depressions left by earlier sinkholes exist either in whole or in part within the proposed absorption area or spray field.

Absorption areas or spray fields may not be placed in or on fill unless the fill has remained in place for a minimum of 4 years to allow restoration of natural permeability.

Minimum Horizontal Isolation Distances
According to PA Code, Title 25, 73.13 (at time of this publication):

If conditions warrant, greater isolation distances may be required for any of the features listed below.

1. The minimum horizontal isolation distances between the feature named and treatment tanks, dosing tanks, lift pump tanks, filter tanks and chlorine contact/storage tanks:

    a. Property line, easement or right-of-way

Recommended Standards

Recommended Standards

Commentary

- 10 feet.
b. Occupied buildings, swimming pools and driveways - 10 feet.
c. An individual water supply or water supply system suction line - 50 feet.
d. Water supply line under pressure - 10 feet.
e. Streams, lakes or other surface waters - 25 feet.
f. A cistern used as a water supply - 25 feet.

2. The minimum horizontal isolation distances between the feature named and the perimeter of the aggregate in the absorption area:
a. Property line, easement or right-of-way -- 10 feet.
b. Occupied buildings, swimming pools and driveways -- 10 feet.
c. An individual water supply or water supply system suction line -- 100 feet.
d. Water supply line under pressure -- 10 feet.
e. Streams, water courses, lakes, ponds or other surface water -- 50 feet (for this requirement, wetlands are not considered surface waters).
f. Other active on-lot systems -- 5 feet.
g. Surface drainageways -- 10 feet.
h. Mine subsidence areas, mine bore holes or sink holes -- 100 feet.
i. Rock outcrop or identified shallow pinnacle -- 10 feet.
j. Natural or manmade slope greater than 25% -- 10 feet.
k. A cistern used as a water supply -- 25 feet.
l. Detention basins, retention basins and stormwater seepage beds -- 10 feet.

3. The minimum horizontal isolation distances between the feature named and the wetted perimeter of the spray field:

Commentary

a. Property lines, easements or right of ways -- 25 feet.
b. Occupied buildings and swimming pools -- 100 feet.
c. An individual water supply or water supply suction line -- 100 feet.
d. A cistern used as a water supply -- 25 feet.
e. Water supply line under pressure -- 10 feet.
f. Streams, watercourses, lakes, ponds or other surface waters -- 50 feet. (for this requirement, wetlands are not considered surface waters).
g. Mine subsidence, boreholes, sinkholes -- 100 feet.
h. Roads or driveways -- 25 feet.
i. Unoccupied buildings -- 25 feet.
h. Rock outcrop -- 25 feet.

4. The area within the wetted perimeter of the spray field may not be sited over an unsuitable soil profile.

The PA DEP document entitled *Alternate System Guidance* (362-0300-007) (Ref. 13) provides technical standards and design assistance for alternative on-lot systems. As of the publication of the *Alternate System Guidance* document in February 2006, the allowable alternate systems include:

- Alternate Individually Designed Composting Toilet
- Flow Equalization
- Alternate Peat Based System Options
- Free Access Gravity Sand Filter System Option
- CO-OP RFS III System Option
- Leaching Chambers
- Alternate Aggregates

Recommended Standards

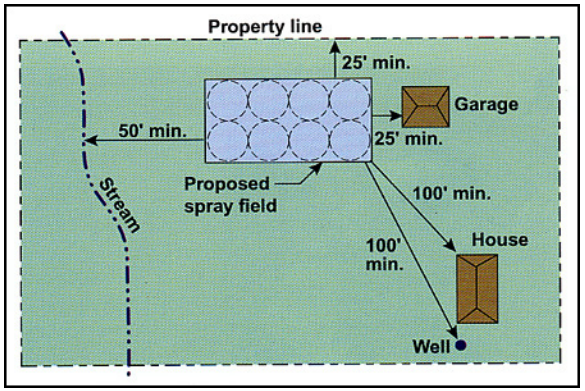


Figure 6.4. Isolation Distances for Spray Fields
Source: SEO Field Manual, Ref. 21

6.3.3 Alternate Individual On-lot Systems

a. Alternate systems shall be considered for individual on-lot systems in any of the following cases:
   i. To solve an existing pollution or public health problem;
   ii. To overcome specific site suitability deficiencies, or as a substitute for systems described in this chapter on suitable lots;
   iii. To overcome specific engineering problems related to the site or its proposed use; or
   iv. To utilize under varying site conditions an experimental design, either in whole or in part, which has been deemed successful by the department.

b. By definition, alternate systems are on-lot systems, so residential systems shall be sized in accordance with chapter 73, section 17 of Reference 1 (current values also provided in Table 6.2). Also refer to chapter 73, section 17 of Reference 1 for sewage flows for other commercial and institutional establishments.

Recommended Standards

Commentary

- Grey water Systems
- At-Grade Bed Systems
- Modified Subsurface Sand Filter for Fast Percolation, Shallow Bedrock Sites with No Water Table Present
- Shallow Placement Pressure Dosed System
- Drip Irrigation System
- Steep Slope Elevated Sand Mound Beds on Slopes Between 12 and 15 percent and Percolation Rates of 3-30 Minutes per Inch
- A/B Soil System (ABS System)
- Non-Infiltration, Evapotranspiration Bed Contained Within a Greenhouse

Alternative On-Lot Technology Research: Soil-Based Treatment Systems (Ref. 15) published by the Delaware Valley College Research and Demonstration Center for On-Lot Systems and Small Flow Technology provides an overview and treatment data for six alternative on-lot wastewater treatment systems that are appropriate for the climate, geology and soil conditions found throughout Pennsylvania. The systems were adjusted conventional systems in an attempt to improve their effectiveness on non-prime agricultural soils. The soil types varied from somewhat poorly drained to well drained and slopes varied from 1 to 24%.

6.4 SMALL FLOW SYSTEMS

If several dwellings, producing not more than two thousand (2,000) gallons per day of wastewater, cannot be connected to a wastewater sewer system, and if site soils are not suitable for a conventional individual or community on-lot wastewater treatment systems, a Small Flow Treatment Facility (SMTF) may be considered.

Small Flow Treatment Facilities consist of the following components:

- Building Sewer

A Small Flow Treatment Facility (SFTF) is intended to serve single-family residences, duplexes and small commercial establishments that generate 2,000 gallons per day or less of domestic wastewater.

The treated effluent from a small flow treatment facility may be discharged to a flowing stream or a

Commentary

dry stream channel depending on local site conditions. The final determination of an appropriate discharge location shall be made by a professional knowledgeable in this area, including knowledge of sewage treatment, local soils and geology, hydropedology, hydrology, and other sciences necessary to assess the potential health and safety risk associated with specific discharge points.

According the PA Code, Title 25, Chapter 73 (Ref. 1), the PA DEP recognizes the existence of technologies designed for on-lot wastewater treatment that are not specifically addressed in the regulation, as well as technologies from other disciplines that may be applied to the design or construction of an on-lot wastewater treatment system. Experimental wastewater system permits provide a method for the testing and evaluation of new concepts and technologies applicable to on-lot treatment. Experimental permits may be limited in number on a statewide basis. The PA DEP will determine the number of experimental permits that may be issued for a specific experimental technology or design.

The Experimental On-lot Wastewater Treatment Verification Program (381-2208-001) (Ref. 17) pro-

Recommended Standards

- Treatment Tanks
  - Septic Tank
  - Aerobic Treatment Tank
- Filter Distribution System
- Filtration System
  - Subsurface sand filter
  - Recirculating subsurface sand filter
  - CO-OP RFS III Recirculating Filter
  - Accessible sand filter system
- Disinfection
  - Chlorination
  - Ultraviolet radiation
- Outfall Sewer

The design of Small Flow Treatment Facilities shall be in accordance with standards outlined in the *Small Flow Treatment Facilities Manual* (Reference 16).

6.5 EXPERIMENTAL WASTEWATER TREATMENT SYSTEMS

a. Experimental systems may be considered for individual or community systems in the following cases:

   i. to solve an existing pollution or public health problem.
   ii. to overcome specific site suitability deficiencies, or as a substitute for conventional systems (as listed in Reference 1).
   iii. to overcome specific engineering problems related to the site or its proposed uses.
   iv. to evaluate new concepts or technologies applicable to on-lot disposal/treatment.
   v. to evaluate the applicability to on-lot disposal of established concepts or technologies having successful use as comparable applications in the field of engineering.
   vi. to demonstrate a design having successful use in other jurisdictions under environmental conditions similar to or more restrictive than those in Pennsylvania.
   vii. to utilize, under varying site conditions, an experimental design, either in whole or in part, which has been deemed successful by the PA DEP.

b. By definition, experimental systems are on-lot systems, so experimental residential systems shall be sized in accordance with standards in Reference 1 (PA chapter 73, section 17) or any amendments. Applicable flow rates are provided in Table 6.2. Also refer to Reference 1 (PA Code, chapter 73, section 17), or any updates to same, for sewage flows for other commercial and institutional establishments.

Recommended Standards

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vides the procedure to evaluate new concepts and technologies in on-lot wastewater treatment.

For updated information from the Water Management Innovative Technology Program, check their web page at http://www.depweb.state.pa.us/watersupply/cwp/view.asp?a=1282&Q=449683&watersupplyNav=| or search for the keyword: Innovative. This site describes how a technology is first tested at a qualified testing center, is moved to field testing, and, if appropriate, is upgraded from an "Experimental" method to an "Alternate" method.

References

References

1. The Pennsylvania Code – Title 25: Environmental Protection, Chapter 71: Administration of Sewage Facilities Planning Program, Chapter 72: Administration of Sewage Facilities Permitting Program and, Chapter 73: Standards for On-lot Sewage Treatment Facilities (available on the web at http://www.pacode.com/secure/data/025/025toc.html).

2. Pennsylvania Department of Environmental Protection e-Library. http://164.156.71.80/WXOD.aspx

3. Pennsylvania Department of Environmental Protection, Act 537: Pennsylvania Sewage Facilities Planning Act, Document Number: 3800-BK-DEP1416, March 2004.

4. Pennsylvania Natural Heritage Program, PNDI Project Planning Environmental Review, http://www.naturalheritage.state.pa.us

5. Federal Emergency Management Agency. Install Sewer Backup Valves. http://www.fema.gov/plan/prevent/howto/how2007.shtm.

6. Pennsylvania Department of Environmental Protection, Domestic Wastewater Facilities Manual, Document ID: 362-0300-001, October 1, 1997 (available on the web at the PA DEP e-Library: http://164.156.71.80/WXOD.aspx).

7. The Dewberry Companies, Land Development Handbook, 2nd Edition, McGraw-Hill, New York, 2002.

8. Gravity Sanitary Sewer Design and Construction, ASCE Manual on Engineering Practice, No. 60, prepared by the Joint Task Force of the American Society of Civil Engineers and the Water Pollution Control Federation, New York, 1982.

9. Melcalf & Eddy, Inc. Wastewater Engineering: Treatment and Reuse, 4th Edition, McGraw-Hill Higher Education, New York, NY, 2003.

10. Gravity Sanitary Sewer Design and Construction, ASCE Manual on Engineering Practice, No. 60, prepared by the Joint Task Force of the American Society of Civil Engineers and the Water Pollution Control Federation, New York, 1982.

11. Metcalf & Eddy, Inc., Wastewater Engineering: Collection and Pumping of Wastewater, McGraw-Hill Book Company, New York, 1981.

12. U.S. Environmental Protection Agency, Handbook for Managing Onsite and Cluster (Decentralized) Wastewater Treatment Systems, EPA No. 832-B-05-001, December 2005 (available on the web at http://cfpub.epa.gov/owm/septic/home.cfm).

13. U.S. Environmental Protection Agency, Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems, EPA 832-B-03-001, March 2003 (available on the web at http://cfpub.epa.gov/owm/septic/home.cfm).

14. Pennsylvania Department of Environmental Protection, Alternate System Guidance, Document Number: 362-0300-007, September 20, 2003 (available on the web at the PA DEP e-Library: http://164.156.71.80/WXOD.aspx).

15. Pennsylvania Department of Environmental Protection, Manual for Land Application of Treated Sewage and Industrial Wastewater, Document Number: 362-2000-009, October 15, 1997 (available on the web at the PA DEP e-Library: http://164.156.71.80/WXOD.aspx).

References (cont.)

16. Hepner, L., D. Linde, C. Weber, and D. Smith. Alternative On-Lot Technology Research: Soil-Based Treatment Systems, Delaware Valley College, Research and Demonstration Center for On-Lot Systems and Small Flow Technology, Doylestown, 2005.

17. Pennsylvania Department of Environmental Protection, Alternate System Guidance, Document Number: 362-0300-007, September 20, 2003 (available on the web at the PA DEP e-Library: http://164.156.71.80/WXOD.aspx).

18. Pennsylvania Department of Environmental Protection, Small Flow Treatment Facilities Manual, Document Number: 362-0300-002, November 22, 2003 (available on the web at the PA DEP e-Library: http://164.156.71.80/WXOD.aspx).

19. Pennsylvania Department of Environmental Protection, Experimental On-lot Wastewater Treatment Verification Program, Document Number: 381-2208-001, July 3, 2004 (available on the web at the PA DEP e-Library: http://164.156.71.80/WXOD.aspx).

20. The Second Class Township Code, Section 2502. Sanitary Sewer Connections. http://www.psats.org/townshipcode/index.html

21. Field Manual for Pennsylvania Sewage Enforcement Officers, Pennsylvania State Association of Townships Supervisors and the Pennsylvania Department of Environmental Protection.

22. Growing Greener: Conservation by Design, Natural Lands Trust, September 2001.

Appendix 6.A Definitions

Appendix 6.A Definitions

Absorption Area -- A component of an individual or community sewage system in which liquid from a treatment tank seeps into the soil; it consists of an aggregate-filled area containing piping for the distribution of liquid and the soil or sand/soil combination located beneath the aggregate.

Alternate Sewage System -- a method of demonstrated on-lot wastewater treatment and disposal not described in the regulations, PA Code, Title 25, chapter 72.

Building Sewer -- In pluming, the extension from the building drain to the public sewer or other place of disposal; also called house connection.

Buried Sand Filter -- A system of piping, sand media, aggregate and collection piping in a buried liner used for the intermittent filtration and biochemical treatment of sewage.

Community Sewage System -- any system, weather publicly or privately owned, for the collection of sewage or industrial wastes of a liquid nature from two or more lots, and the treatment and/or disposal of the sewage or industrial waste on one or more of the lots or at any other site

Conventional Sewage System -- a system employing the use of demonstrated on-lot sewage treatment and disposal technology in a manner specifically recognized by the regulations promulgated under PA Code, Title 25, chapter 72. The term does not include alternate sewage systems or experimental sewage systems.

Dosing Pump -- The pump housed in a dosing tank which provides a measured volume of sewage effluent to the pressurized distribution system in an absorption area.

Equivalent Dwelling Unit -- For the purpose of determining the number of lots in a subdivision only as it relates to the determination of planning exemptions and fees for planning module reviews under this chapter, that part of a multiple family dwelling or commercial or industrial establishment with flows equal to 400 gpd. These flow figures are not intended to be used for the calculation of flows for the design of community sewerage systems or for the allocation of flows related to community sewerage systems. Community sewerage system flows for design and permitting purposes shall be calculated using the procedures established in the Department's Domestic Wastewater Facilities Manual.

Experimental Sewage System -- a method of on-lot sewage treatment and disposal not described in the regulations promulgated under PA Code, Title 25, chapter 72 which is proposed for the purpose of testing and observation.

Filter Tank -- The tank housing the piping and sand of the free access sand filter.

Free Access Sand Filter -- An accessible system of tanks, dose piping, sand media, aggregate and collection piping used for the intermittent filtration and biochemical treatment of sewage.

Geotextile - Material consisting of mesh polypropylene, polyester, nylon or similar material, used to prevent migration of fine aggregate into coarser aggregate.

Appendix 6.A Definitions (cont.)

Individual Residential Spray Irrigation System -- an individual sewage system permitted under Act 537 that serves a single dwelling and that treats and disposes of sewage using a system of piping, treatment tanks and soil renovation through spray irrigation

Individual Sewage System -- a system of piping tanks or other facilities serving a single lot and collecting and disposing of sewage in whole or in part into the soil or into any waters of the Commonwealth of PA or by means of conveyance to another site for final disposal.

Large Volume On-lot Sewage System -- An individual or community on-lot sewage system with a design capacity to discharge subsurface sewage flows that are in excess of 10,000 gpd.

Lateral Sewer -- a sewer that discharges into a branch to the sewer and has no other common sewer tributary to it.

Lift Pump -- A submersible pump used to convey effluent to the sand filter and from the sand filter to the chlorine/retention tank.

Limiting Zone -- A soil horizon or condition in the soil profile or underlying strata that includes one of the following:

(i) A seasonal high water table, whether perched or regional, determined by direct observation of the water table or indicated by soil mottling.
(ii) A rock with open joints, fracture or solution channels, or masses of loose rock fragments, including gravel, with insufficient fine soil to fill the voids between the fragments.
(iii) A rock formation, other stratum or soil condition that is so slowly permeable that it effectively limits downward passage of effluent.

Main Sewer

(1) in larger systems, the principal sewer to which branch sewers and submains are tributary; also called trunk sewer. In small systems, a sewer to which one or more branch sewers are tributary
(2) In pluming, the public sewer to which the house or building sewer is connected

NSF -- National Sanitation Foundation.

Retaining Tank -- A watertight receptacle which receives and retains sewage and is designed and constructed to facilitate ultimate disposal of the sewage at another site. The term includes:

(i) Chemical toilet -- A permanent or portable nonflushing toilet using chemical treatment in the retaining tank for odor control.
(ii) Holding tank -- A tank, whether permanent or temporary, to which sewage is conveyed by a water-carrying system.
(iii) Privy -- A tank designed to receive sewage where water under pressure is not available.
(iv) Incinerating toilet -- A device capable of reducing waste materials to ashes.
(v) Composting toilet -- A device for holding and processing human and organic kitchen waste employing the process of biological degradation through the action of microorganisms to produce a stable, humus-like material.
(vi) Recycling toilet -- A device in which the flushing medium is restored to a condition suitable for reuse in flushing.

Sewage Enforcement Officer -- An official of the local agency who reviews permit applications and sewage facilities planning modules, issues permits as authorized by the act and conducts investigations and inspections that are necessary to implement the act and the regulations thereunder.

Appendix 6.A Definitions (cont.)

Small Flow Treatment Facilities - An individual or community sewerage system designed to adequately treat sewage flows not greater than 2,000 gpd for final disposal using a stream discharge or other disposal methods approved by the department.

Small Flow Treatment Facility -- An individual or community sewerage system designed to adequately treat sewage flows not greater than 2,000 gpd for final disposal using a stream discharge or other methods approved by the department.

Solids Retainer -- A deflection device at the outlet tee or baffle of a septic tank designed to deflect buoyed solids from escaping the tank.

Spray Field -- Piping, spray heads and ground surface to the outside edges of the wetted perimeter, used for the application and treatment of the sewage effluent in an individual residential spray irrigation system.

Treatment tank -- A water-tight tank designed to retain sewage long enough for satisfactory bacterial decomposition of the solids to take place. The term includes the following:

(i) Septic tank -- A treatment tank that provides for anaerobic decomposition of sewage prior to its discharge to an absorption area.

(ii) Aerobic sewage treatment tank -- A mechanically aerated treatment tank that provides aerobic biochemical stabilization of sewage prior to its discharge to an absorption area.

Trunk Sewer -- a sewer that receives many tributary branches and serves a large territory.

Undisturbed soil -- Soil or soil profile, unaltered by removal or other man-induced changes, except for agricultural activities, which would adversely affect the siting or operation of on-lot systems.

Wastewater (or Sewage) -- A substance that contains the waste products or excrement or other discharge from the bodies of human beings or animals and noxious or deleterious substances being harmful or inimical to the public health, or to animal or aquatic life, or to the use of water for domestic water supply or for recreation. The term includes any substance that constitutes pollution under The Clean Streams Law.

Wastewater (or Sewage) Facilities -- A system of sewage collection, conveyance, treatment and disposal that will prevent the discharge of untreated or inadequately treated sewage or other waste into waters of this Commonwealth or otherwise provide for the safe and sanitary treatment and disposal of sewage or other waste. The term includes:

(i) Individual sewage system -- A system of piping, tanks or other facilities serving a single lot and collecting and disposing of sewage in whole or in part into the soil or into waters of this Commonwealth or by means of conveyance to another site for final disposal. The term includes:

(A) Individual on-lot sewage system -- An individual sewage system that uses a system of piping, tanks or other facilities for collecting, treating and disposing of sewage into a soil absorption area or spray field or by retention in a retaining tank.

(B) Individual sewerage system -- An individual sewage system that uses a method of sewage collection, conveyance, treatment and disposal other than renovation in a soil absorption area, or retention in a retaining tank.

(ii) Community sewage system -- A sewage facility, whether publicly or privately owned, for the collection of sewage from two or more lots, or two or more equivalent dwelling units and the treatment or disposal, or both, of the sewage on one or more of the lots or at another site.

(A) Community on-lot sewage system -- A system of piping, tanks or other facilities serving two or more lots and collecting, treating and disposing of sewage into a soil absorption area or retaining tank located on one or more of the lots or at another site.

(B) Community sewerage system -- A publicly or privately owned community sewage system that uses a method of sewage collection,

Appendix 6.B Additional Resources

conveyance, treatment and disposal other than renovation in a soil absorption area, or retention in a retaining tank.

Appendix 6.B Additional Resources

The following documents can be found in the PA DEP e-Library at http:/164.156.71.8D/WXOD.aspx

Administration of Fee Collection for Planning Module Reviews (362-2207-008, 10/2001)
Alternate Systems Guidance (362-0300-007)
Domestic Wastewater Facilities Manual: A Guide for the Preparation of Applications, Reports and Plans (362-0300-001 10/97)
Experimental On-lot Wastewater Technology Verification Program (381-2208-001)
Impact of the Use of Subsurface Disposal Systems on Groundwater Nitrate Nitrogen Levels
Implementation Guidance for Evaluation Wastewater Discharges to Drainage Ditches and Swales (391-2000-014)
Manual for Land Application of Treated Sewage and Industrial Wastewater (362-2000-009, 10/1997)
Small FlowTreatment Facilities Manual (362-0300-002)
Technical Decision Making & the Use of conventional Technology, Alternate Technology, Experimental Technology, and Best Technical Guidance (BTG) in On-lot Sewage System Repair Situations (362-2208-003)
Water Quality Anti-degradation Implementation Guidance (391-0300-002, 11/2003)

Additional information can be found on the PA DEP website at www.dep.state.pa.us, keyword wastewater

National Small Flows Clearinghouse (NSFC) at http://www.nesc.wvu.edu/nsfc/nsfc_index.htm .
The NSFC provide objective information about onsite wastewater collection and treatment systems for communities of fewer than 10,000 people.

National Onsite Demonstration Program (NODP) at http://www.nesc.wvu.edu/nodp/nodp_index.htm
The NODP was developed to encourage the use of alternative, onsite wastewater treatment technologies to protect public health, ensure water quality, and sustain the environment in small and rural communities.

The National Decentralized Water Resources Capacity Development Project (NDWRCDP) at http://www.ndwrcdp.org/
The NDWRCDP's goal is to support research and development to improve our understanding and strengthen the foundations of training and practice in the field of onsite/decentralized wastewater treatment.

Appendix 6.C Sewer Details

Illustration 6-c. Typical Plan View of Manhole

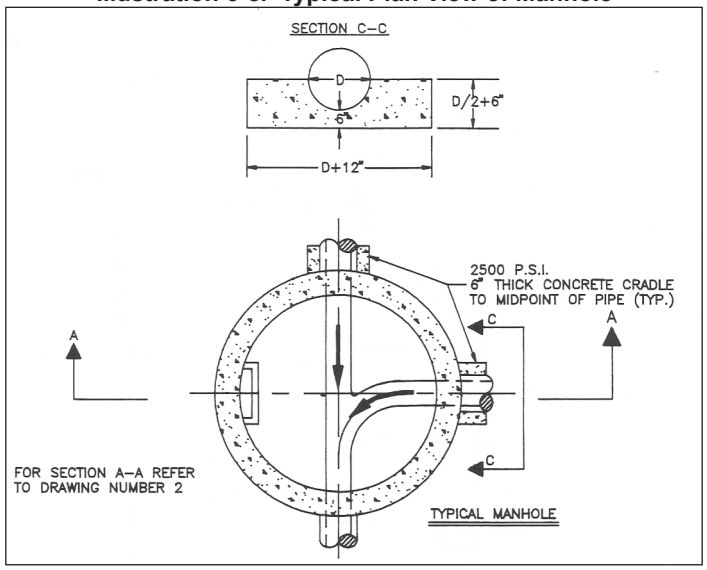


Illustration 6-d. Typical Plan view of Drop Manhole

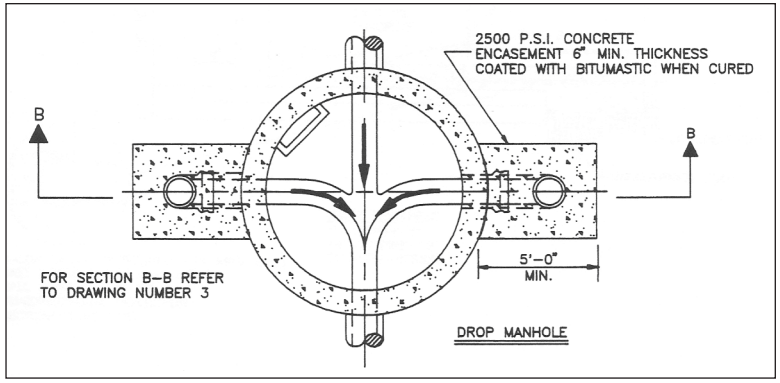


Illustration 6-e Cast-in-place Base/Precast Wall Sections

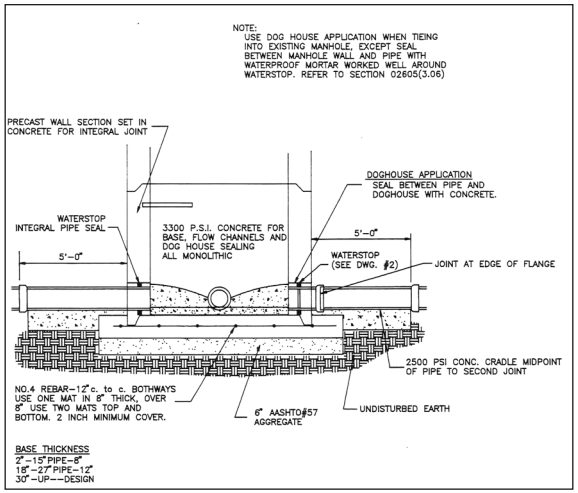
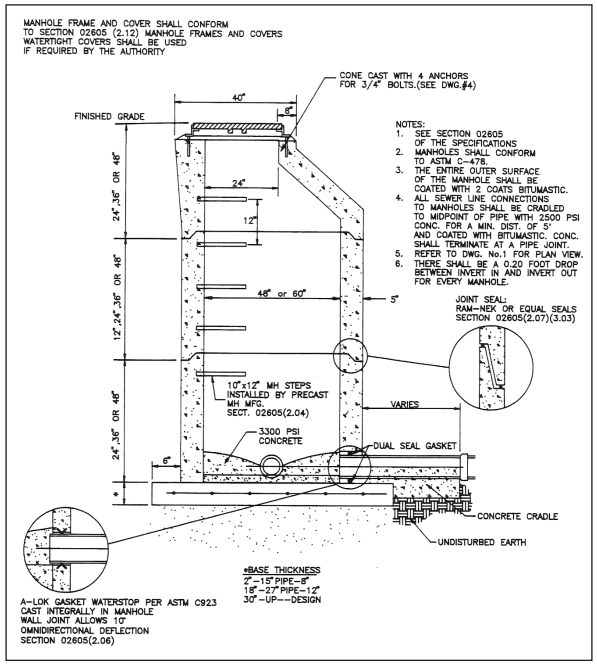


Illustration 6-f. Typical Manhole Showing Precast Base and Wall Sections



Appendix 6.C (cont.)

Illustration 6-g. Drop Manhole Detail

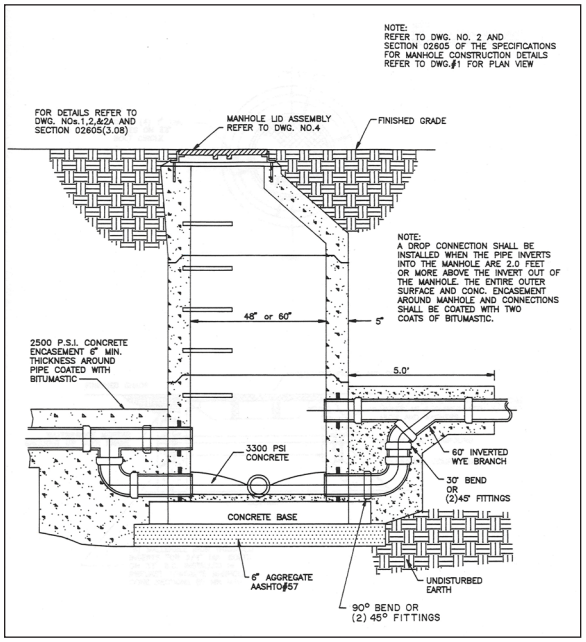


Illustration 6-h. Typical Lateral and Marker

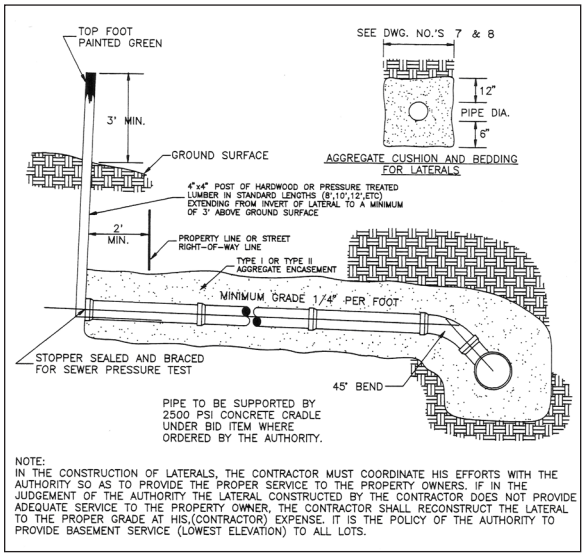
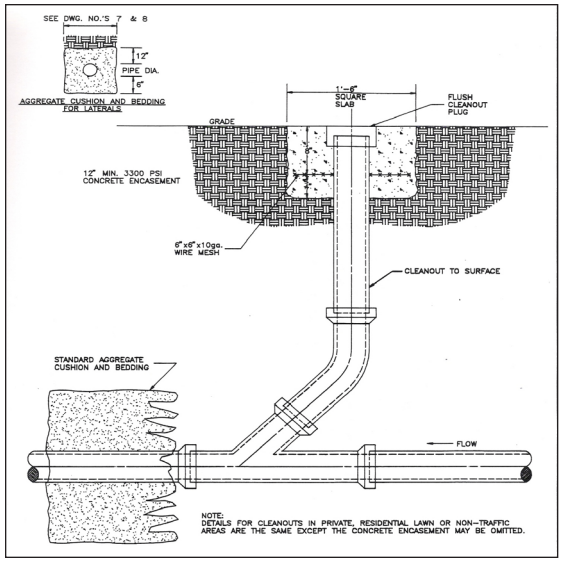


Illustration 6-i. Typical Clean-out Detail



Concrete encasement is only needed when the clean-out is placed in pavement to protect the pipe from cracking. When placed in pavement, the plug should terminate at grade. When the clean-out is located in a yard, consideration should be given to protecting against cracking and inflow and infiltration. Location at grade may lead to increased inflow and infiltration while a higher pipe may be broken during lawn maintenance or cut by homeowners.

Appendix 6.C (cont.)

Illustration 6-j. Typical Clean-out for Private Collection System Parking Lot

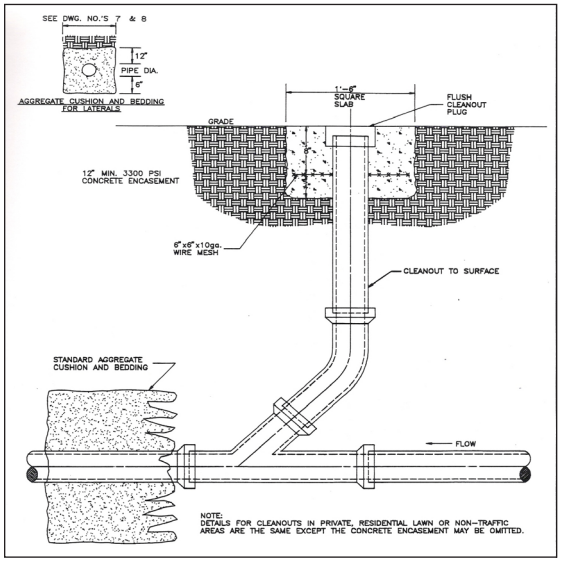


Illustration 6-k. Typical Cleanout Under Street

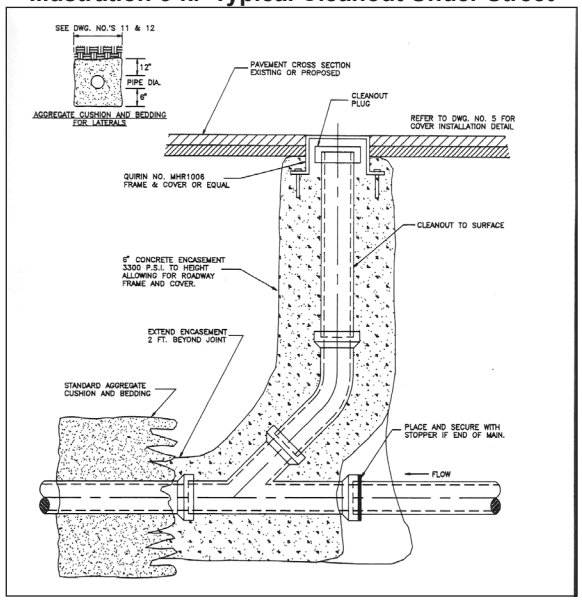
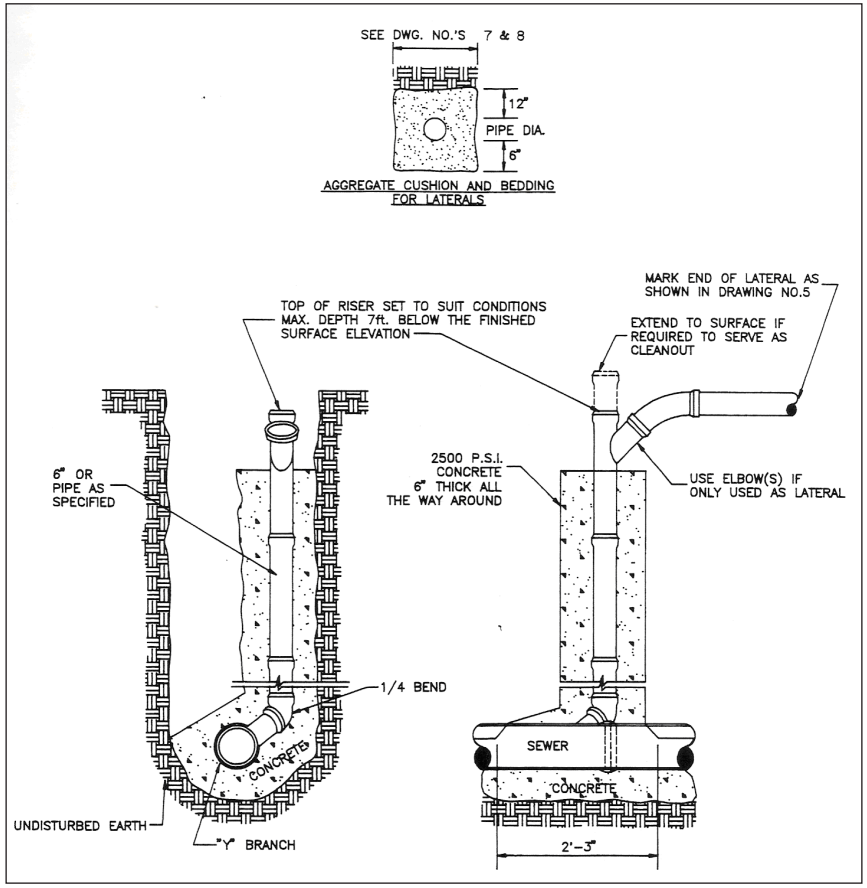
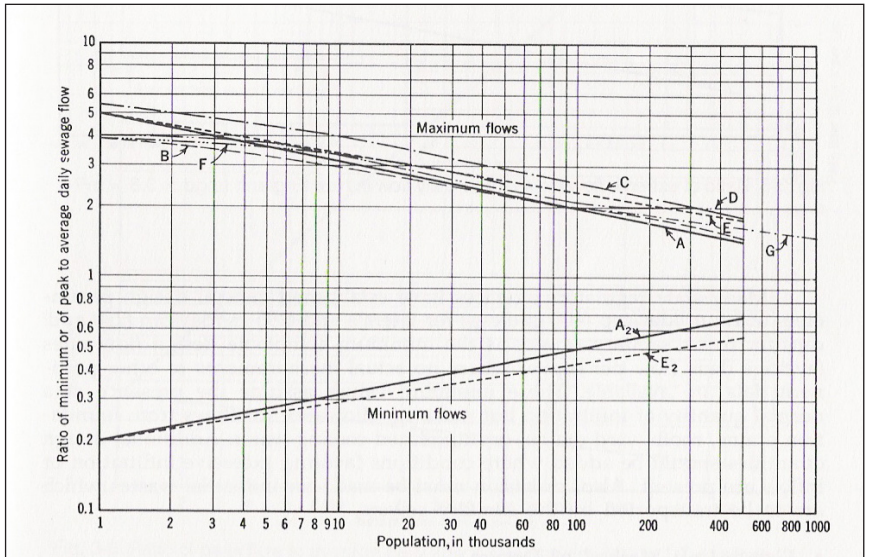


Illustration 6-l. Typical Deep Cut Lateral



Appendix 6.D Peaking Factors for Wastewater Flows

Illustration 6-m. Peaking Factors for Wastewater Flows



* Curve A source: Babbitt, H. E., "Sewerage and Sewage Treatment." 7th Ed., John Wiley & Sons, Inc., New York (1953).
Curve A_2 source: Babbitt, H. E., and Baumann, E. R., "Sewerage and Sewage Treatment." 8th Ed., John Wiley & Sons, Inc., New York (1958).
Curve B source: Harman, W. G., "Forecasting Sewage at Toledo under Dry-Weather Conditions." *Eng. News-Rec.* **80**, 1233 (1918).
Curve C source: Youngstown, Ohio, report.
Curve D source: Maryland State Department of Health curve prepared in 1914. In "Handbook of Applied Hydraulics." 2nd Ed., McGraw-Hill Book Co., New York (1952).
Curve E source: Gifft, H. M., "Estimating Variations in Domsetic Sewage Flows." *Waterworks and Sewerage*, **92**, 175 (1945).
Curve F source: "Manual of Military Construction." Corps of Engineers, United States Army, Washington, D.C.
Curve G source: Fair, G. M., and Geyer, J. C., "Water Supply and Waste-Water Disposal." 1st Ed., John Wiley & Sons, Inc., New York (1954).
Curves A_2, B, and G were constructed as follows:

Curve A_2, $\frac{5}{P^{0.107}}$

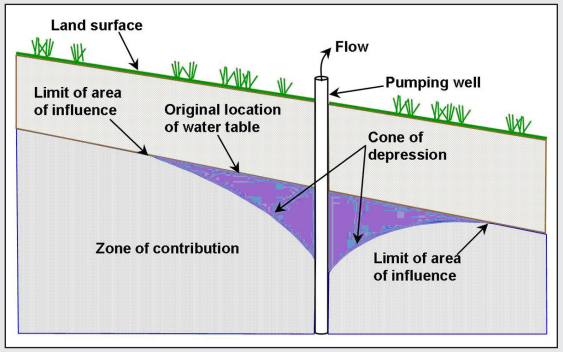
Curve B, $\frac{14}{4+\sqrt{P}}+1$

Curve G, $\frac{18+\sqrt{P}}{4+\sqrt{P}}$

in which P equals population in thousands.

Source: ASCE Manual of Practice, Ref. 8

CHAPTER 7: POTABLE WATER SUPPLY STANDARDS



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Commentary

Illustration 7-a. Potable Water

It is important that every home be assured a safe, potable water supply.

Recommended Standards

7.0 INTRODUCTION

Potable water in Pennsylvania is provided by a range of sources: private well, privately owned and operated community systems, municipalities and municipal authorities, and public utilities.

Each type of water system is subject to different regulations and regulatory agency oversight. For example, public water systems operated either by a municipality serving solely within its corporate limits or by a municipal authority are regulated by PA DEP under state-enacted regulatory programs and delegated federal regulatory programs. By contrast, a public utility is authorized and regulated by the Pennsylvania Public Utility Commission and also is subject to the system construction and operation regulations of the PA DEP. Additionally, water systems located within the Delaware River Basin and the Susquehanna River Basin are subject to regulatory oversight by the Delaware River Basin Commission and Susquehanna River Basin Commissions, respectively. Because of these systems, the regulatory agencies, and the applicable regulations for these systems frequently use the same terms to mean different things, it is important to check the source of your regulations before proceeding with a water system design.

Municipal authorities are subject to the Pennsylvania Municipal Authorities Act found in Title 53 of the Pennsylvania Consolidated Statutes. The Pennsylvania Public Commission's regulates public utilities under Title 66 of the Pennsylvania Consolidated Statutes and regulations found in Title 52 of the Pennsylvania Code. PA DEP regulation of public water supplies falls under chapter 109 of the Pennsylvania Code.

Pennsylvania does not have any state level regulations controlling the construction or use of individual private water wells that pump less than an average daily flow of 10,000 gallons per day over a 30-day period (although some county health departments have well permit requirements). Individual well owners are responsible for the health of their own water. Preventing contamination of water supplies is much easier and cheaper than dealing with a water quality problem after the fact. Poor water quality is often a direct result of an improperly constructed well. Therefore, it is very important to follow sanitary well construction guidelines even though there are currently no state regulatory requirements for private wells.

For the purpose of managing our groundwater supplies, the legislature enacted the Water Planning Act (Act 220) in December 2002. Act 220 requires the PA DEP to update the State Water Plan and determine how much water we have, how much we use, and how much will be available in the future. The Act requires any commercial, industrial, agricultural, or individual activity that withdraws or uses 10,000 or more gallons of water per day, averaged over any 30-day period, to register and periodically report their water use to DEP. Those

Recommended Standards

activities that use less than 10,000 gallons per day may choose to register voluntarily.

Chapter 7 focuses primarily on standards for private wells because, for the most part, this is the only system over which the municipality can exercise direct regulatory control. Terms used in this chapter are defined in Appendix 7.A.

7.1 GENERAL

a. Each dwelling unit and each commercial or industrial building in all subdivisions and land developments hereafter granted approval shall have an adequate supply of potable water for domestic use.

b. All water supply facilities, whether public or private, located in any designated floodplain district shall be floodproofed up to the regulatory flood elevation.

c. Abandoned well(s) on a property shall be sealed properly before development to prevent contamination of the aquifer.

d. Requirements of an applicable River Basin Commission shall be abided.

Commentary

The vocabulary and definitions used throughout this chapter are from chapter 109 and correspond to the design criteria documents from the PA DEP.

The owner of a property can be held liable for contamination that an old, abandoned well causes or spreads. Therefore, it is important that an abandoned well is sealed before construction activity begins on the site. Refer to Reference 2 for information about well abandonment procedures.

In some areas a River Basin Commission may have local requirements. Check with the local authority for additional guidance in water use planning.

- Delaware River Basin Commission (DRBC): http://www.state.nj.us/drbc/
- Susquehanna River Basin Commission (SRBC): http://www.srbc.net/
- Ohio River Basin Commission: (859) 257-5141
- Interstate Commission on the Potomac River Basin (ICPRB): (301) 984-1908.
- Great Lakes Commission: www.glc.org or www.greatlakes.net

Commentary

A public water system (PWS) is defined as a system that provides water to the public for human consumption, and that serves at least 15 service connections or at least 25 people daily for at least 60 days per year (Ref. 4). A public water system includes collection, treatment, storage and distribution facilities under the control of the operator of the system and used in connection with the system. The term also includes collection or pretreatment storage facilities not under control of the operator that are used in connection with the system. Public water system permit requirements can be found in Subchapter E of Chapter 109 of the Pennsylvania Code. Illustration 7-b shows the relationship of water systems.

Public water supplies are categorized as either community or noncommunity water systems.

A community water system (CWS) is defined as a public water system that serves at least 15 service connections that are used by year-round residents or regularly serves at least 25 year-round residents.

A noncommunity water system is categorized as either a transient or nontransient water system. A nontransient noncommunity water system is defined as a noncommunity water system that serves at least 25 of the same people for at least 6 months of the year. If the noncommunity water system is not a nontransient system, it is considered to be a transient system.

Recommended Standards

7.2 PUBLIC WATER SUPPLY

a. If a public water system is proposed for a new development, the developer must first obtain a construction permit from the PA DEP as required by Pennsylvania Code, chapter 109. Specific Permit requirements are found in subchapter E.

b. A public water system may not be designed or constructed in a manner that creates a cross-connection.

c. Whenever an existing or approved water system is accessible to a proposed project, a distribution system shall be provided to furnish an adequate supply of water to each unit.

d. When documentation is received, applicants shall submit to the Municipality documentation in the form of a copy of Certificate of Public Convenience from the Pennsylvania Public Utility Commission that the project is located in an area served by a public utility and a statement that the utility has the capacity to serve the project at the time of application; or a cooperative agreement or an agreement to serve the project from a bonafide cooperative association of lot owners or from a municipal corporation, authority, or utility.

e. Where a regional system is not accessible, particularly where on-site wastewater treatment systems are to be used, a community water supply may be required. If such a system is provided, it shall be approved by the PA DEP, and appropriate measures shall be provided to ensure adequate maintenance.

f. Water supply facilities should be designed on the following basis (Ref. 3.):

System Component	Minimum Capacity
Raw water pumping & transmission facilities	Maximum daily demand with consideration to finished water storage and fire flow demands
Treatment facilities system	Shall exceed the maximum daily demand of the system
Finished water storage	To meet peak hourly demands with consideration to fire flow demands. One day's storage is the recommended minimum
Distribution system piping, pump stations and appurtenances	Provisions for maximum daily and peak hourly demand at a minimum pressure as specified in section 7.4

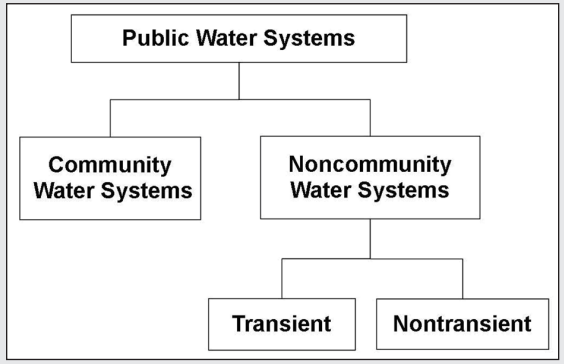
Recommended Standards

g. A new community water system shall be designed to provide an adequate supply of finished water during periods of peak demand. To assure continued service in the event of source contamination or outage, the design shall provide a minimum of one (1) day of reserve capacity based on average daily demand or usage. Reserve capacity may be provided through finished water storage. In addition, reserve capacity may be provided through sources and interconnections not likely to be subject to the same contamination event. Sources and interconnections used for reserve capacity shall be permitted according to PA Code, chapter 109.

h. Finished water storage facilities shall be completely enclosed to prevent contamination of the finished water supply.

Commentary

Illustration 7-b. Categories of Public Water Systems



Source: *PA DEP Public Water Supply Manual*, Ref. 4

Community Water Supply systems shall be designed and permitted in accordance to the *PA DEP Public Water Supply Manual*, Part II: Community Design Standards (Ref 3).

Noncommunity Water Systems shall be designed according to *PA DEP Public Water Supply Manual* Part IV: Noncommunity System Design Standards (Ref. 4).

Any PWS that is not a Community Water System is considered to be a noncommunity water system. Noncommunity water systems are categorized as either transient or nontransient. These systems may be supplied by a single water well but they are considered Public Water Supply systems because the public is served by it.

A nontransient noncommunity water system is defined as a noncommunity water system that serves at least 25 *of the same people* for at least 6 months of the year. Examples of nontransient noncommunity water systems are schools, hospitals, commercial establishments and industrial parks. These

Commentary

examples are non-transient because it is assumed that there would be least 25 of the same employees or students being served by the system, making them nontransient users.

If the noncommunity water system is not a non-transient system, it is considered to be a transient system. Examples of transient noncommunity systems are restaurants, churches and campgrounds. These examples are transient because it is assumed that the users will vary so that fewer than 25 people will consistently be served. A larger restaurant with more than 25 employees would be a nontransient noncommunity system.

The standard noted in 7.2.i for the maximum distance to connect a subdivision to a water distribution system is based on the Lancaster County Subdivision and Land Development Ordinance. A review of ordinances from across the state showed a great deal of variety in the way this issue is treated. Distances ranged from 200 to 2,000 feet. Others didn't have specific distance requirements but used vague language such as "when deemed possible" that would allow for inconsistent application. The standard used in this document was selected for its ability to be applied consistently and fairly based on the size of the development.

Recommended Standards

i. If a water system is available within the following distances and has adequate supply, then all lots within the subdivision and/or land development shall be allowed to connect to the existing water distribution system:

Maximum distance from nearest lot line to water distribution system requiring connection to said water system:

One (1) unit	two hundred (200) feet
Two (2) units	four hundred (400) feet
Three (3) to five (5) units	five hundred (500) feet
Ten (10) or more units	one thousand (1,000) feet

Recommended Standards

j. Point-of-Entry (POE) Devices
If a Point of Entry (POE) device is to be used as part of a water treatment system, the public water supplier shall be responsible for control of the POE devices installed under a permit according to PA Code Title 25 § 109.503(a)(2) (relating to public water system construction permits). This includes the installation, operation and routine maintenance of each device.

A public water supplier that installs a POE device shall obtain and maintain a right-of-access to the house, building or other facility where the POE device is installed in the form of a covenant running with the land.

7.3 PRIVATE WATER WELLS

a. Where no public water is accessible, and a private centralized water supply and distribution system is not required, water shall be furnished by the owner on an individual lot basis. If wells are installed on each lot, the well shall be of the drilled type, cased and grout sealed in the bedrock.

b. Water wells shall be isolated from wastewater treatment absorption fields and shall be protected from surface water run-off.

c. Disinfection of a home groundwater source should be performed after completing construction of a new well or spring supply (Ref. 6).

d. All on-site wells shall be shown on all plans.

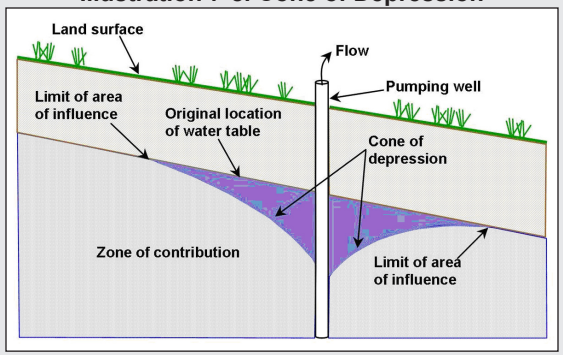
e. Areas where the groundwater comes within ten (10) feet of the soil surface should be avoided (Ref. 13).

f. If wells are installed on each lot and the lot also contains its own wastewater treatment system, the well shall be of the drilled type, cased and grout-sealed into the bedrock. The well will be required to have a production of not less than six gallons per minute as established by bailer tests and certified by the well driller. Before being placed in consumer use, it shall be disinfected by the use of sodium hyperchlorite or other acceptable solutions and a sample bacteriological examination performed by a licensed water analyst.

Commentary

A Point-of-Entry device is a treatment device used as an alternative to central treatment that is installed on a public water line or service connection to a house, building or other facility for the purpose of reducing contaminants in the water distributed throughout the house, building or facility.

Illustration 7-c. Cone of Depression



Pumping creates a cone of depression or an area of drawdown where the water table surface is lower around the well.

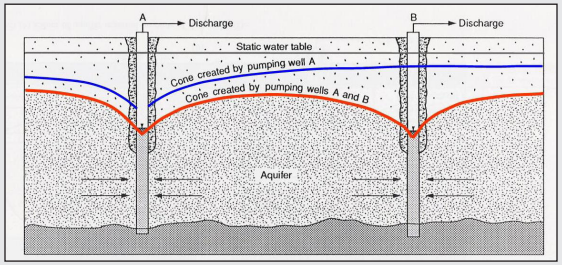
Well owners have a right to reasonable use of the groundwater beneath their land; however, as neighborhoods and communities expand, private water wells may compete for the available groundwater (Ref 15).

As water is pumped from a well, the groundwater table is depressed. When many homes in a subdivision are all using individual wells, the cones of depressions may overlap, causing even further depression of the water table (Illustration 7-d). This

Commentary

can require the drilling of deeper wells.

Illustration 7-d. Overlapping Cones of Depression Causing a Competition for Groundwater.



Source: Corbitt

Private water supplies are currently unregulated in Pennsylvania. Therefore, homeowners who have their own private water supplies are not protected by any regulations or standards (Ref. 6).

There are no state requirements for well construction materials, yield or quality. State law does require drillers to have a valid rig permit and a Water Well Drillers License. They must also give the state and homeowner a copy of the Water Well Completion report. This report describes where, when and how the well was constructed (Ref. 6).

Open rock wells in fractured rock aquifers are the most common type of private water well in Pennsylvania. The typical well has steel casing set in bedrock with a borehole that taps groundwater in the fractures of the rock (see illustration 7-d).

Recommended Standards

7.3.1 PA DEP Recommended Guidelines for Installing a Private Sanitary Water Well in Bedrock

a. Wells should be sited at least one-hundred (100) feet away from sources of contamination such as septic system leach fields, roads, fuel tank and barnyards. Ideally, the well should be located uphill from these pollution sources.

b. Casing. The casing should be new and ASTM standards. Casing should be at least twenty (20) feet in length and extend at least five (5) feet into sound bedrock. The casing should extend at least twelve (12) inches above the land surface -- more if the area is subject to water accumulations that might enter the well.

   The driller should ensure that the casing seals off shallow water.

c. Drive Shoe. In most cases a drive shoe should be used to protect the casing from cracking and splitting during installation into bedrock.

d. Pitless Adapter. The pitless adapter should be manufactured by a reputable company and installed so that it is watertight.

e. Casing Grout. The annual space created between the wall of the boring and the well casing should be filled with a watertight sealant, such as a cement-based grout, or a grout and clay mixture. To ensure a watertight seal, the annular space should be filled from bottom to top by placing a pipe in the annular space and pumping the sealant as the pipe is withdrawn. The annual space should be grouted from the casing bottom to at least the base of the pitless adapter. For long casing lengths, the driller should grout at

Recommended Standards

least thirty (30) feet of casing to the pitless adapter.

The driller should ensure that grout is not placed into the open rock portion of the well.

f. Well Construction Steps for Driller

   i. Drill the well hole into firm bedrock, install and grout the casing.

   ii. Allow the grout to cure.

   iii. Drill the hole to the desired depth.

   iv. Develop the well by cleaning out the fine material.

   v. Estimate the well yield.

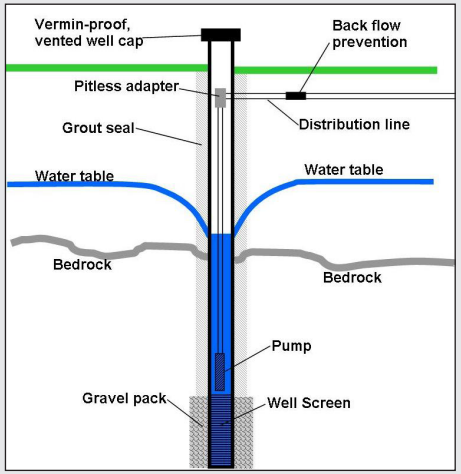
   vi. Disinfect the well to kill any organisms that were introduced during the construction.

g. The owner must be provided a copy of the well construction record that includes information on the well depth, water level, well yield and the depth of the pump.

h. Well cap. The well should be topped with a vermin-proof, vented cap that can be locked.

Commentary

Illustration 7-e. Schematic of a Private Water Well Installed in Bedrock



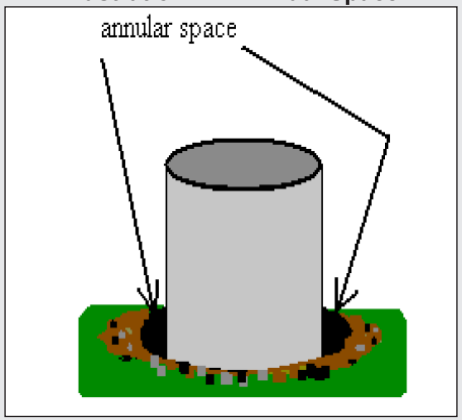
Source:

Below the casing, the lower portion of the borehole is the intake through which water enters the well. The intake may be an open hole in bedrock or it may be screened and gravel-packed, depending upon the geologic conditions (Illustration 7-e).

A Pitless Adapter diverts water laterally below the frost line from the well to a storage tank. It allows the well casing to extend above the ground surface. It provides a watertight subsurface connection for buried pipe installation below the frost line, thereby eliminating the need for a pit. Where a submersible pump is installed in the well, the use of a pitless adapter allows the pump to be installed or removed without disturbing the underground discharge pipe (see Illustration 7-e).

Commentary

Illustration 7-f. Annual Space



Source: Ref. 6

Annual space is created between the wall of the boring and the casing. If not properly sealed, the annular space becomes an avenue for pollution to move into the water supply. Sealing this space with grout prevents surface water from seeping down along the casing directly into the groundwater.

Well caps required an air vent to equalize the air pressure between the inside of the casing and the atmosphere. It is also essential that the cap be vermin-proof to reduce the risk on contamination from insects and small rodents (Illustration 7-g).

Illustration 7-g. Vermin-proof Well Cap.

Source: WI DNR

Recommended Standards

Recommended Standards

Commentary

Wells that provide 10 to 20 gallons per minute typically meet all the requirements for a household. Lower-yielding wells can be usually made adequate for most domestic purpose by drilling deeper. A deeper borehole acts a storage tank (Ref. 15). Also, a water storage tank can be placed in the basement to compensate for a low-yielding well.

7.4 DISTRIBUTION SYSTEM

For community systems that do not fall under the jurisdiction of a public, or other authority, the following standards for water distribution system capacity, layout, and materials shall apply.

7.4.1 Capacity

a. The water supply system shall be adequate to handle the necessary flow, based on complete development of the tract.

b. When plans for future development necessitate oversizing of the water supply system, the municipality or utility authority may enter into an agreement with the developer to address the fair share of costs allocable to each party.

c. Distribution systems and distribution system modifications shall be designed and constructed to maintain normal operating pressures as specified in chapter 109 of the Pennsylvania Code.

d. The demand rate for all uses shall be considered in computing the total system demand.

e. Design flow rates for water distribution systems shall be based on the peak hourly demand. Where fire protection is provided through the potable drinking water system, the system shall be capable of providing the greater of the following flows at the pressures identified in :

- The required fire demand (see section 7.6) plus the maximum daily demand, or
- The maximum hourly demand.

As of this writing, normal operating pressures specified in Chapter 109 of the Pennsylvania Code are as follows:

- For Average Daily flows/demand -- Not less than twenty-five (25) pounds per square inch gauge (PSIG), nor greater than one-hundred twenty-five (125) pounds per square inch gage (PSIG).
- For Peak Hourly flows/demand -- Not less than twenty-five (20) pounds per square inch gage (PSIG) nor greater than one-hundred fifty (150) pounds per square inch gage (PSIG)
- Hourly Minimum flows/demand -- Not more than one-hundred fifty (150) pounds per square inch gage (PSIG). This generally occurs with zero (0) flow in the system (static pressure only).

Average Daily Demand is the average amount of water used each day during a one-year period for the entire system.

Maximum Daily Demand is the average rate of consumption on the maximum day. The maximum day is the 24-hour period during which the highest consumption total is recorded in the latest three-year period (Ref. 7).

Commentary

Maximum Hourly Demand is the maximum amount of water used in a single hour, in any day, in a three-year period expressed in gallons per minute.

The variability in peaking factor is primarily a function of the number of dwelling units being constructed. Table 7.a provides an example tabulation of peak hourly flow rates as a function of the total number of houses served. Table 7.a can be used as a guide to assist in determining appropriate peaking factors.

Common design practice is to use a peaking factor for the Maximum Daily Flow (PF1) of 1.5 and a peaking factor for the Maximum Hourly Flow (PF2) of 3.0.

Table 7-a. Design Standards for Peak Hourly Flow

Total Houses Served	Peak Hourly Flows (gallons / minute / house)
5	8.0
10	5.0
50	3.0
100	2.0
250	1.3
500	0.8
750	0.7
1,000 or more	0.6

Source: New Jersey Code, Title 5, Chapter 21 as amended through July 2002, Ref. 9

Illustration 7-h shows the layout of a looped system to allow for continued water supply to as many consumers as possible in the event of a shutdown.

Recommended Standards

The maximum daily demand and the maximum hourly demand shall be determined from local water use data. If local water use data are unavailable, design water demand for residential uses shall be computed as follows:

Maximum Daily Demand = PF1 X Average Daily Demand

Maximum Hourly Demand = PF2 X Average Daily Demand

Appropriate engineering judgment shall be applied in the selection of an appropriate peaking factor.

Table 7.2. Typical Peaking Factor Ranges

Typical System Peak Flow Characteristics as Ratios of Average Daily Flows	
Average Daily Flow	1.0
Maximum Daily Flow (PF1)	1.3 – 1.8
Peak Hourly Flow (PF2)	2.5 – 6.0

Modified from Source: Sweitzer and Flentje, Basic Waterworks Management, Ref. 8

7.4.2 System Design and Placement

a. Distribution mains of the overall system shall be connected into loops so that the supply may be brought to the consumer from more than one direction.

b. In balancing loops in the design, the Hardy-Cross, or an equivalent, method shall be used.

Recommended Standards

c. Dead-end lines shall be permitted within the design of a looped system provided that there is a maximum of twenty (20) dwelling units (or 50 dwelling units temporarily) on a dead-end line. When dead-end lines are used, they shall be provided with a hydrant or blow off at the terminus as a means of flushing.

d. Generally, water mains shall be configured to form a loop system to enhance the continual supply of fresh water. When dead ends occur on new mains, they shall all be closed with cast iron plugs and caps, with a blowoff valve, with a concrete anchor, or fire hydrant. Concrete anchors (thrust blocks) shall be provided at all vertical and horizontal bends.

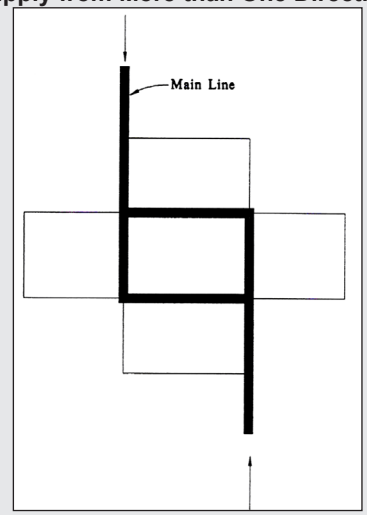
e. There shall be no physical connection between a public or private potable water supply system and a sewer which will permit the passage of any sewage or polluted water into the potable water supply.

f. Blowoffs shall not be connected to any sanitary sewer or be submerged in any manner that will permit back siphonage in the distribution system.

g. Valves, except on a permitted dead-end, shall be located on distribution mains so that no more than one hydrant would be out of service as a result of a single water main

Commentary

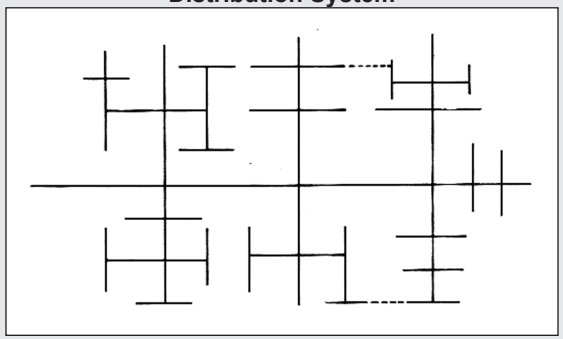
Illustration 7-h. A Looped System to Bring Supply from More than One Direction



Source: Ref. 10

The restriction on dead-end lines is intended to maintain water quality by eliminating stagnant zones within the distribution system, and provide more consistent water pressure (characteristic of looped systems). See Illustration 7-I.

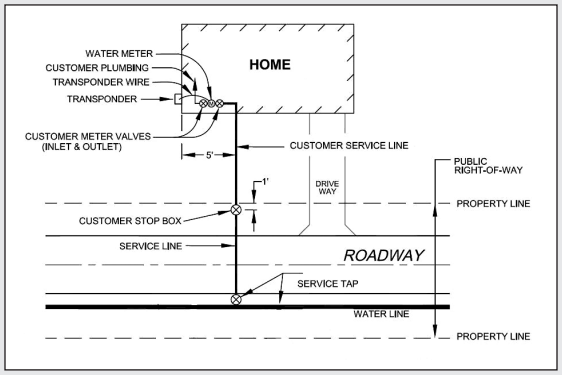
Illustration 7-i. Potential Dead-ends can be Connected to Eliminate Stagnant Zones with the Distribution System



Source: Ref. 11

Commentary

Illustration 7-j. A Typical Layout of a Building Service Connection.



Recommended Standards

break. They shall be located in all small branches off larger mains and, where eight (8)-inch or larger main lines intersect, a valve shall be located in each branch. At street intersections, valves shall be located near pipe intersections for ease in finding in the event of a water-main break.

h. In addition to the above requirements, water mains shall be valved so that not more than one-fifth (1/5) of a mile will be affected by a single water main break. Geared valves on sixteen (16)-inch mains or larger shall be furnished when required by the Municipality or water authority.

i. Gate valves shall be cast-iron body with double-disc gates, bronze mounted conforming to AWWA C500 or resilient-seated wedge, non-rising stem mechanical joint conforming to AWWA C509.

j. Butterfly valves shall conform to AWWA C504. The type of valve to be used shall be specified by the municipality or water authority.

k. Valve interior openings shall be full size, and valves on sixteen (16)-inch mains or larger shall be geared and have suitable bypasses.

l. Valve boxes shall be of the adjustable type with the cover marked (WATER) and the direction of the value operation indicated.

m. No pipe shall be placed on private property unless the owner of the land is to own or operate the pipe, or an easement deeded to the municipality or water authority is obtained.

n. All easements shall be a minimum of ten (10) feet wide unless depth of pipe, soil conditions, or additional utilities require wider. Where the easement is located adjacent to a right-of-way, the municipality or authority may approve a narrower easement.

o. A building service connection shall consist of a corporation stop at the main, a curb stop, and a water meter.

Recommended Standards

p. When the meter is located outside a building, an additional shut-off valve shall be installed on the discharge side of the meter. When the meter is located inside a building, a valving shall be in accordance with the Plumbing Subcode of the PA Uniform Construction Code.

q. Curb stops and water meters shall be located as specified by the public or private water supplier.

r. Common water service connections shall be permitted where allowed by the Plumbing Subcode of the Uniform Construction Code.

s. Where water system extensions are constructed by a developer and meter fees are not paid by the developer, the water meter(s) shall be furnished by the developer and shall be of a manufacture and type approved by the municipality or water authority. The meter(s) shall read in volume units as determined by the municipality or water authority. Where meter fees are paid by the developer, the meter(s) shall be furnished by the municipality or water authority.

7.4.3 Pipe Sizes and Materials

a. Pipe size shall comply with the following requirements:

i. Water mains shall be a minimum diameter of eight (8) inches except at the end of a permanent cul-de-sac, unless another size is required for fire flow or other criteria. A six (6)-inch main may be used when it serves not more than twenty (20) dwelling units and only one (1) fire hydrant.

ii. Building service connection pipe shall have a minimum diameter of three-quarters (3/4) of an inch.

iii. The design capacity of water mains shall be such as to maintain a minimum pressure of 20 pounds per square inch (psi) at street level under all flow conditions.

b. Pipe material used in the construction of water mains shall be cement-lined ductile iron pipe, prestressed concrete cylinder pipe, reinforced concrete pressure pipe, or PVC pipe. All pipe and appurtenances shall comply with the applicable AWWA standards in effect at the time of application.

i. Ductile iron pipe, appurtenances, and fittings shall comply with the following standards:

Commentary

Water supply pipe should not be oversized. Oversized pipes that supply more water than is used allows water to lay in the pipes and increases the chance for bacteria growth. Standard engineering practice and good judgment should be used in the sizing of water pipes to ensure that the demand is met without leaving water stagnant in the distribution system.

Commentary	Recommended Standards

ANSI/AWWA C110/A21.10 (fittings)
C111/A21.11 (gasket joints)
C115/A21.15 (flanged joints)
C151/A21.51 (pipe)

- Thickness shall be designed in accordance with ANSI/AWWA C1150/A21.50.
- Ductile iron pipe shall be cement mortar-lined in accordance with ANSI/AWWA C104/A21.4.
- Joints shall be gasketed, push-on joints or mechanical iron pipe shall be covered with an asphaltic, epoxy-type coating. In aggressive soils, ductile iron pipe wrapped in polyethylene in accordance with ANSI/AWWA C105/A21.5 shall be used.

ii. Prestressed concrete cylinder pipe with rubber and steel joints shall conform to ANSI/AWWA C301.

- Reinforced concrete pressure pipe (steel cylinder) type shall meet ANSI/AWWA C300.
- Concrete pressure pipe (bar-wrapped steel cylinder type) shall meet ANSI/AWWA C303.

iii. PVC pipe, appurtenances, and fittings shall conform to ANSI/AWWA C900 or AWWA C909 for pipe sizes four (4) inches to twelve (12) inches and shall conform to AWWA C905 for sizes fourteen (14) inches through thirty-six (36) inches.

- Joints shall be elastomeric-gasket couplings of a corresponding size. Laboratory performance requirements, as specified in ASTM D3139, shall be met. Solvent-cement coupling shall not be permitted.
- PVC pipe installations shall be provided with a metallic locator tape.

iv. Where transitions to flanged fittings are made, adapters approved by the municipality or water utility authority shall be used.

v. Building service connection pipe shall be type K copper or polyethylene (PE) pressure pipe that complies with ANSI/AWWA C901.

Recommended Standards

c. Ductile iron pipe shall be used at all locations where water lines cross sewer lines and are separated by less than twelve (12) inches vertically. At these locations a twenty (20)-foot section of ductile iron pipe shall be installed centered on the sanitary sewer line.

d. Ductile iron pipe shall also be used any time a water line crosses a stream or active drainage-way. The ductile iron pipe should extend for a distance of twenty (20) feet on either side of the stream bank.

e. Pipe bedding and backfill shall be installed in accordance with the pipe manufacturer's recommendations.

f. To avoid settlement under paved roadways, PennDOT 2A stone should be used to backfill waterline trenches when they pass under paved roadways.

7.5 FIRE PROTECTION

a. All fire protection facilities shall be designed in accordance with the most recent edition of International Fire Code (Ref. 12).

7.5.1 Fire-Flow Requirements

a. Fire Flow is the flow rate of a water supply, measured at twenty (20) pounds per square inch (psi) residual pressure within the distribution system that is available for fire fighting.

b. The fire chief, or other municipal authority, is authorized to reduce the fire-flow requirements for isolated building or a group of buildings in rural areas or small communities where the development of full fire-flow requirements is impractical.

c. The fire chief is authorized to increase the fire-flow requirements where conditions indicate an unusual susceptibility to group fires or conflagrations. An increase shall not be more than twice that required for the building under consideration.

d. For information regarding water supplies for fire-fighting purposes in rural and suburban areas in which adequate and reliable water supply systems do not exist, the fire code official is authorized to utilize NFPA 1142 or the International Urban Wildland Interface Code.

Commentary

Refer to Chapter 8 of this ordinance for standards for fire protection facilities that do not utilize the potable water distribution system.

Recommended Standards of section 7.5.1 apply only to public water distribution systems.

Commentary	Recommended Standards

e. Fire-flows are based on building density, construction techniques, and total floor area. The total floor area included in the fire-flow calculation area shall be the total floor area of all floor levels within the exterior walls, and under the horizontal projections of the roof of a building.

f. The minimum fire-flow requirements for one- and two-family dwellings having a fire-flow calculation area that does not exceed three-thousand six hundred (3,600) square feet shall be one-thousand (1,000) gallons per minute with a duration of two hours.

g. Fire-flow and flow duration for dwellings having a fire-flow calculation area in excess of three-thousand six hundred (3,600) square feet shall not be less than that specified in Appendix B of the International Fire Code (Ref. 12).

h. The minimum fire flow and flow duration for buildings other than one- and two-family dwellings shall be as specified in Appendix B of the International Fire Code (Ref. 12).

7.5.2 Fire Hydrants

a. The minimum number and spacing of fire hydrants shall be as specified in Appendix C of the most current edition of the International Fire Code. For one- and two-family dwellings the hydrants shall have a spacing not exceeding five-hundred (500) feet. In addition, the maximum distance from any point along the road frontage at the right-of-way line to a hydrant shall be two-hundred-fifty (250) feet.

b. Size, type and installation of hydrants shall conform to the following specifications:

- Size, type, and installation of hydrants shall conform to the AWWA Standard for Dry-Barrel Fire Hydrants, ANSI/AWWA C502.
- Hydrants shall have at least three (3) outlets: one (1) outlet shall be a pumper outlet; the other outlets shall be at least two and one-half (2-1/2)-inch nominal size.
- The pumper outlet shall face the street. All outlets and nozzles shall be at least twelve (12) inches above the adjoining grade.
- When a concrete slab is provided around the hydrant riser, the flange at which the hydrant connects to the riser shall be at least two inches above the adjacent grade.

Recommended Standards

- Street main connections for fire hydrants shall not be less than six (6) inches in diameter.
- Hose threads on outlets shall be compatible with existing municipal equipment and shall either conform to NFPA 1963, or shall match existing municipal requirements.
- A valve shall be provided on connections between hydrants and street mains.
- All pipes, fittings, and appurtenances supplying fire hydrants shall be AWWA or ASTM approved.
- All fire hydrants hall conform to NFPA Standard 291.

c. Whenever the water supply system contains sufficient capability or is planned to have such capability within two (2) years from the date of the Final Plan approval, fire hydrants shall be provided.

d. A hydrant may be used in place of blow-offs at all low points and at high points within the distribution system to serve as a system blow-off.

Commentary

References

References

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2. PA DEP. DEP Groundwater Monitoring Guidance Manual Chapter 7: Well Abandonment Procedures. Document No. 383-3000-001. 12/1/01.
3. PA DEP. Public Water Supply Manual, Part II: Community Design Standards. Document No. 383-2125-108. 5/6/06.
4. PA DEP Public Water Supply Manual. Part IV: Noncommunity System Design Standards. Document No 383-2128-108. 5/21/01.
5. PA DEP. Summary of Key Requirements for the Phase II and Phase V/Wellhead Protection Rules. Document No 383-0810-105. 3/13/02.
6. A DEP. Guidelines for Installing Private Water Wells in Bedrock. Document No. 3800-FS-DEP2450.
7. Insurance Services Office (ISO). Fire suppression Rating Schedule, New York: ISO, 1998.
8. Sweitzer, R.J., M.E. Flentje, & F.B. Smith. Basic water works manual. American Concrete Pressure Pipe Association, Chicago, 1958.
9. Division of Codes and Standards, New Jersey Administrative Code, Title 5, Chapter 21, New Jersey Department of Community Affairs, last amended July 2002.
10. Dion, T.R. Land Development for Civil Engineers, 2nd Edition, John Wiley & Sons, Inc., New York, 2002.
11. Hammer, Mark J. Water and Waste-Water Technology, John Wiley & Sons, Inc., New York, 1975.
12. International Fire Code. International Code Council, Inc., Country Club Hills, Illinois, 2003.
13. Master Well Owner Network. Private Water System Management. Penn State. College of Agricultural Sciences. Available online at: http://mwon.cas.psu.edu/.
14. Cote, Arthur. Operation of Fire Protection Systems: A Special Edition of the Fire Protection Handbook. National Fire Protection Association, Inc., Massachusetts, 2003.
15. PA DEP. Understanding Your Drinking Water Well. Document No. 3800-FS-DEP2780. 7/05.

Appendix 7.A Definitions

Appendix 7.A Definitions

Annular Space -- The space between two (2) cylindrical objects, one of which surrounds the other, such as the space between a drill hole and a casing pipe and a liner pipe.

Aquifer -- A geological formation that contains and transmits water.

Average Daily Demand -- The average amount of water used each day during a one-year period for the entire system.

Back Siphonage -- The flowing back of used, contaminated, or polluted water from a plumbing fixture or vessel or other sources into a potable water supply pipe due to negative pressure in such pipe.

Backflow -- The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from any source or sources other than its intended source.

Casing -- An impervious durable pipe placed in a well to prevent the walls from caving in and to seal off surface drainage or undesirable water, gas or other fluids and prevent them from entering the well.

Community Water System -- A public water system that serves at least fifteen (15) service connections used by year-round residents or regularly serves at least twenty-five (25) year-round residents.

Cross-connection -- An arrangement allowing either a direct or indirect connection through which backflow, including backsiphonage, can occur between the drinking water in a public water system and a system containing a source or potential source of contamination, or allowing treated water to be removed from any public water system, used for any purpose or routed through any device or pipes outside the public water system, and returned to the public water system. The term does not include connections to devices totally within the control of one or more public water systems and connections between water mains.

Groundwater -- Water within the earth below the water table within the zone of saturation. Groundwater includes both water under water table conditions and confined with deep aquifers.

Grout -- A permanent water tight joint or connection made by filling with concrete or other approved impervious material between the casing and the undisturbed formation surrounding the well or between two (2) strings of casing.

GUDI -- Groundwater under the direct influence of surface water.

a. Any water beneath the surface of the ground with the presence of insects or other macroorganisms, algae, organic debris or large diameter pathogens such as Giardia lamblia and Cryptosporidium, or significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity or pH which closely correlate to climatological or surface water conditions
b. The term does not include finished water.

Appendix 7.A Definitions (cont.)

Maximum Daily Demand -- The average rate of consumption on the maximum day. The maximum day is the 24-hour period during which the highest consumption total is recorded in the latest three-year period (Reference A).

Maximum Hourly Demand -- The maximum amount of water used in a single hour, or any day, in a three-year period expressed in gallons per minute.

Noncommunity Water System -- A public water system that is not a community water system.

Nontransient Noncommunity Water System -- A noncommunity water system that regularly serves at least twenty-five (25) of the same persons over six (6) months per year.

Pitless Adapter -- A device or assembly of parts that will permit water to pass through the wall of the well casing or extension thereof, and that provides access to the well and to the parts of the water system within the well in a manner to prevent entrance of pollution into the well and the water produced.

Point-of-entry (POE) Device -- A treatment device used as an alternative to central treatment that is installed on a public water line or service connection to a house, building or other facility for the purpose of reducing contaminants in the water distributed throughout the house, building, or facility.

Public Water System -- A system which provides water to the public for human consumption that has at least fifteen (15) connections or regularly serves an average of at least twenty-five (25) individual daily at least sixty (60) days out of the year. The term includes collection, treatment, storage and distribution facilities under control of the operator of the system and used in connection with the system. The term includes collection or pretreatment storage facilities not under control of the operator that used in connection with the system. The term also includes a system that provides water for bottling or bulk hauling for human consumption. Water for human consumption includes water that is used for drinking, bathing and showering, cooking, dishwashing or maintaining oral hygiene.

Source -- The place from which water for a public water system originates or is derived, including, but not limited to, a well, stream, reservoir, pond, lake or interconnection.

Surface Water -- Water open to the atmosphere or subject to surface runoff. The term does not include finished water.

System --

a. A group of facilities used to provide water for human consumption including facilities used for collection, treatment, storage and distribution. The facilities shall constitute a system if they are adjacent or geographically proximate to each other and meet at least one of the following criteria:

   i. The facilities provide water to the same establishment that is a business or commercial enterprise or an arrangement of residential or nonresidential structures having a common purpose and includes mobile home parks, multi-unit housing complexes, phased subdivisions, campgrounds, and motels.
   ii. The facilities are owned, managed, or operated by the same person.

Appendix 7.A Definitions (cont.)

iii. The facilities have been regulated as a single public water system under the Federal Safe Drinking Water Act (42 U.S.C.A. § § 300f-300j-10) or the Pennsylvania Sate Drinking Water Act (35 P.S. § § 721.1-721.17).

b. This definition may not be interpreted to require two or more currently regulated public water systems to become one system.

Transient Noncommunity Water System -- A public water system that is not a community, nontransient noncommunity, bottled or vended water system, nor a retail water facility or a bulk water hauling system.

Wellhead Protection Area -- The surface and subsurface area surrounding a water well, well field, spring or infiltration gallery supplying a public water system, through which contaminants are reasonably likely to move toward and reach the water source. A well head protection area shall consist of the following zones:

a. Zone I. The protective zone immediately surrounding a well, spring or infiltration gallery which shall be a one-hundred (100) to four-hundred (400)-foot radius depending on site-specific source and aquifer characteristics.
b. Zone II. The zone encompassing the portion of the aquifer through which water is diverted to a well or flows to a spring or infiltration gallery. Zone II shall be one-half (1/2) mile radius around the source unless a more detailed delineation is approved.
c. Zone III. The zone beyond Zone II that contributes surface water and groundwater to Zones I and II.

Wellhead Protection Program -- A comprehensive program designed to protect a well, spring or infiltration gallery used by a public water system from contamination.

Appendix 7.B Additional Resources

Appendix 7.B Additional Resources

Wellowner www.wellowner.org

Standard Methods for the Examination of Water and Wastewater, latest edition.

The following sources are available from the PA DEP e-Library http://164.156.71.80/WXOD.aspx

PA DEP. Fact Sheet. For Planners, Builders and Developers: Identifying a Community Water System (CWS). Document Number 3800-FS-DEP4072. 6/2/06.

PA DEP. Public Water Supply Manual, Part VII: Cross-Connection Control/Backflow Prevention. Document Number 383-3100-111

PA DEP. Guidance to Public Water Systems. Document Number 383-2100-108. 1/1/05.

PA DEP. Safe Drinking Water Program Compliance Strategy. 383-0810-102. 10/10/97.

PA DEP. PWS Manual Part V: Operations and Maintenance.383-3110-111. 11/1/97.

PA DEP. DEP Approval Guide for Noncommunity Water Systems. 383-2100-208. 8/5/00.

PA DEP. Summary of Key Requirements for Community Water Systems. 383-0810-101. 11/26/01.

PA DEP. Summary of Key Requirements for Nontransient Noncommunity Water Systems. 383-0810-301. 3/13/02.

PA DEP. Summary of Key Requirements for Transient Noncommunity Water Systems. 383-0810-201. 8/1/98.

CHAPTER 8: OTHER UTILITIES

Contents

List of Graphics

Commentary

For communities that want long-lived and healthy street trees, determining the location of utilities must be an early part of the planning process for new developments. Both underground utilities and tree roots, as well as overhead utilities and tree height (and branching) are important considerations. Understanding and accommodating the needs of both utilities (access, etc.) and the needs of trees (root zone and mature height) will result in a better situation for both. The increasing interest in using alleys in development plans means that utilities can be located in the rear, which frees up the front for street trees.

Recommended Standards

8.0 INTRODUCTION

Utility trenches for electricity, cable TV, phone, etc., can take up a large amount of space in the road right-of-way and create conflicts with each other and the potable water, sanitary sewer, and storm sewer systems. A common or shared utility trench will reduce utility conflicts and excess costs by eliminating multiple trenches.

8.1 GENERAL

1. Where possible all electric, telephone and cable television utility lines shall be placed underground. All utilities shall be installed in a manner which will allow safe and ready access for the installation and maintenance of other utilities.

2. Lines connecting utility service to each lot shall be installed in accordance with the standards of the utility company providing such service.

8.1.1 Act 287: PA OneCall

In accordance with the provisions of Act 287, all developers, contractors, etc., will contact all applicable utilities and accurately determine that locations and depth of all underground utilities within the boundaries of the tract proposed for development, prior to excavation. A list of the applicable utilities and their phone numbers shall appear on the plans submitted to review and proof shall be presented to the Township prior to final plan approval.

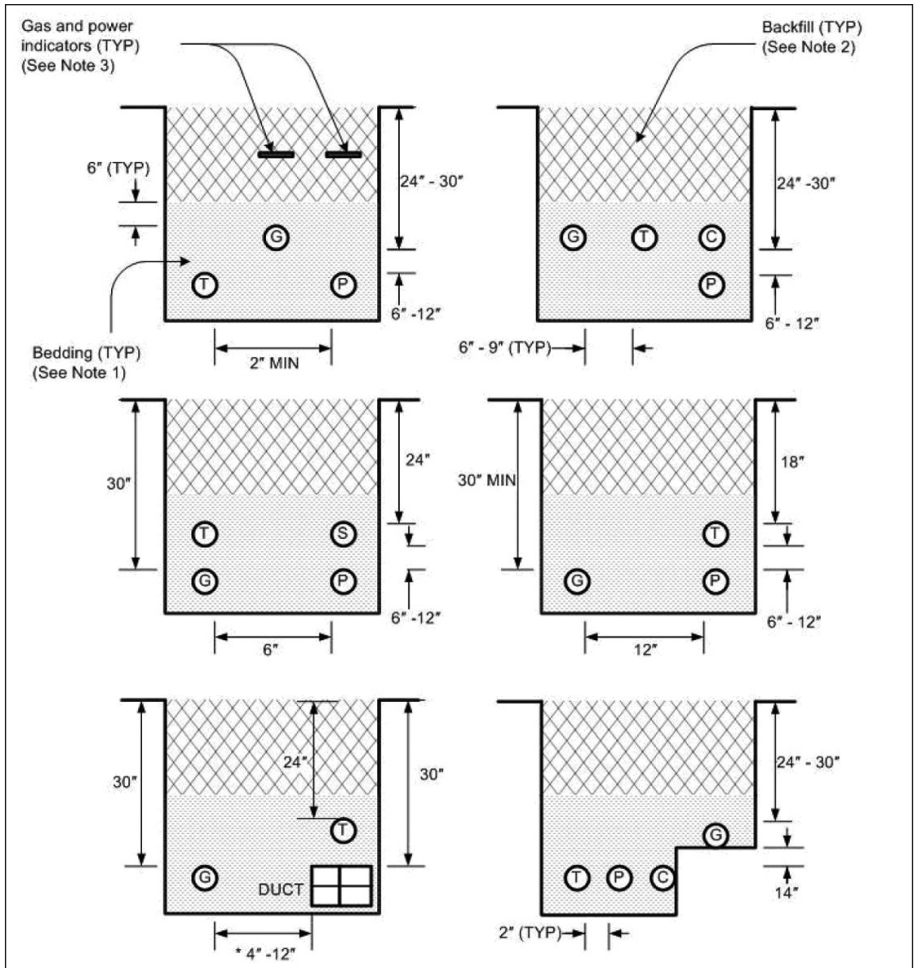
8.2 LOCATION

Where practicable, all utilities, with the exception of on-site laterals, shall be located in public rights-of-way. Where this is not possible, utility easements shall be located on or adjacent to rear or side lot lines to the fullest extent possible. (See also section 8.4.)

8.3 TRENCHING AND BACKFILL STANDARDS

Where practicable, utility lines shall share a common utility easement and a common utility trench, as shown in Figure 8.1.

Recommended Standards



NOTES:

(1) Bedding to be PaDOT 2A coarse aggregate or equivalent.

(2) Backfill to be suitable material reasonably free of organics (see PaDOT Publication 408 Section 206.2 (a) 2). Backfill under paved roadways to be PaDOT 2a coarse aggregate or equivalent.

(3) Gas and/or power indicators shall be layed 12" below finished grade (typical for all trenches).

Figure 8.1. Common Utility Trench Configurations

Source: University Area Joint Authority, Ref. 2

Commentary

Commentary

Utility easement width should be set to provide sufficient room to access the utility for maintenance and repair. Consideration should be given to both access and excavation needs.

Illustration 8-a. Utility easement adjacent to right of way

To aid in the development of healthy street trees, some communities require that utilities be located in an easement adjacent to the right-of-way. Conversely, the utilities could be located in a narrower strip between the street and sidewalk and there could be a requirement to plant street trees on the house side of the sidewalk.

Recommended Standards

8.4 EASEMENTS

1. To the fullest extent possible, easements shall be adjacent to property lines.

2. Utility easements outside street rights-of-way shall be a minimum of 10 feet in width or as otherwise determined by the appropriate utility company, except that easements lying parallel to and abutting street rights-of-way may be reduced to a minimum width of 5 feet. All other easements outside street rights-of-way shall be centered on or adjacent to rear or side lot lines where feasible.

3. Nothing shall be constructed, placed, or planted within the area of an easement that would adversely affect the function of the easement.

8.5 ALTERNATE FIRE PROTECTION SYSTEMS

1. When fire protection is not provided by a public water system, an alternate system consisting of underground or other water storage systems may be installed. When such a system is installed, it shall comply with the following standards.

   a. Underground reservoirs shall be located in the public right-of-way or within easements on private lots. Said easements shall be approved by the Municipality. The Municipal Engineer and the Municipal Fire Marshall shall approve reservoir locations.

Recommended Standards

b. Reservoirs shall be constructed to the standards required for underground, nonpotable water storage tanks. These storage tanks of NFPA 1142 (Ref. 1) shall also provide a suitable connection for coupling equipment currently in use by the fire company. The Municipal Engineer and Fire Marshal shall approve the design and installation of any underground nonpotable water storage tanks.

2. When a proposed subdivision includes an existing or proposed pond or wet stormwater basin, a dry hydrant system may be installed. These facilities must be provided with an all-weather access drive sufficient to permit ingress and egress of emergency vehicles to the drafting site.

3. Where any reservoir, dry hydrant, and/or associated equipment is located on private property, the final subdivision plan shall include appropriate easement provisions that assure access to the facility by the fire company and municipality for the purposes of operations, maintenance, and monitoring.

4. All dry hydrant systems shall be designed and constructed to provide a minimum flow of 1,000 gpm.

5. Dry hydrant connections shall conform to NFPA 1963, Standards for Fire Hose Connections.

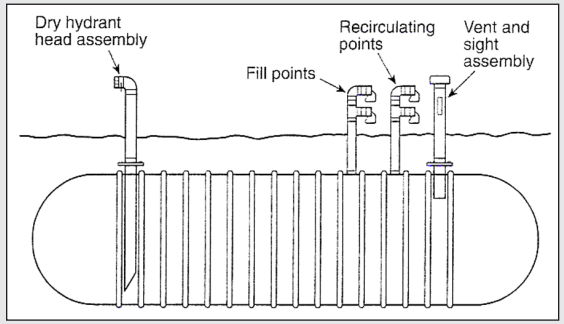
6. If the water supply is located on private property, a water usage agreement shall be developed.

Commentary

There are many different options for providing nonpotable water for fire protection. These facilities are auxiliary to standard fire fighting equipment and typically not to be designed to be the sole source of water. Underground tanks are typically 2,000 to 3,000-gallon tanks providing the first attack of fire fighting. Underground tanks are sized to the average house size. Refer to Reference 1 for sizing criteria.

Dry hydrants within a development can allow for decreased road widths because of the reduced need for tanker trucks during a fire.

Illustration 8-b. Typical Underground Storage Tank for Fire Protection (Ref. 1)



Commentary

Illustration 8-c. Typical Fill and Vent Pipes for an Underground Storage Tank as Shown in Illustration 8-b (Ref. 1)

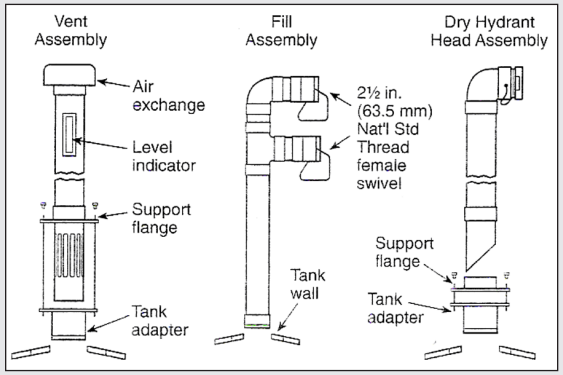


Illustration 8-d. Typical Above Ground Water Storage Tank (Ref. 1)

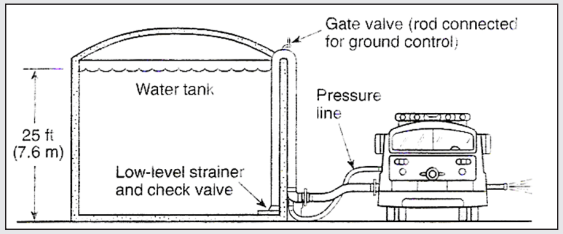
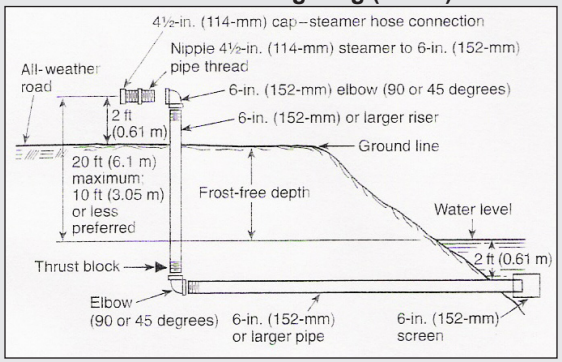


Illustration 8-e. A Dry Hydrant can be Attached to Reservoir or Pond to Provide Non-potable Water for Fire Fighting (Ref. 1)



Recommended Standards

Recommended Standards

Commentary

Illustration 8-f. Freeze Protection for a Dry Hydrant May be Needed to Prevent Damage and Maintain Water Access (Ref 1)

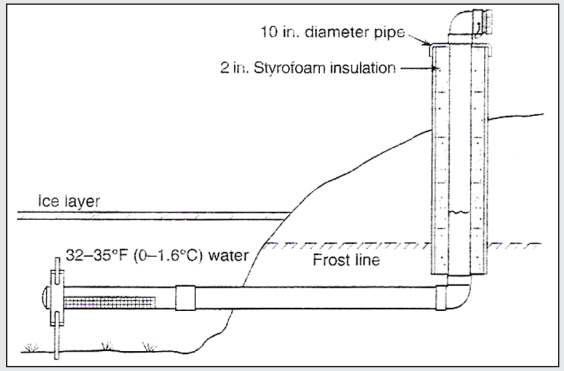
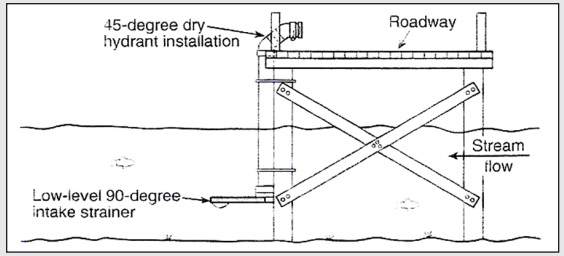


Illustration 8-g. A Dry Hydrant can be Installed in a River or Stream with Access from a Bridge (Ref. 1)



References

References

1. National Fire Protection 1142, Standard on Water Supplies for Suburban and Rural Fire Fighting, Chapter 9, Dry Hydrants.

2. Standards document, University Area Joint Authority, State College, PA.