### 2.3.1 Street Width and Length

Significant reduction to impervious cover can be accomplished by minimizing street width and length. (Figure 2.3.1.a) Accordingly, streets should be designed as narrow and short as possible for intended use. Careful design of streets can satisfy concerns regarding parking, safety, and traffic congestion. Conventional standards include a 32' wide roadway composed of two 7' parking lanes on either side of two 9' wide moving traffic lanes. With only one 8' wide parking lane, two 10' wide travel lanes are standard.

*Figure 2.3.1a Narrow Residential Streets with Adjacent Bio-swales*

*Photo Courtesy of: Washington State University*

Recommended practices for designing road width and length include (CWP, 1988):

- Base design on average daily traffic volume calculated by the number of actual trips per day,
- Provide safe and efficient access for emergency vehicles,
- Design for the minimum required pavement to support traffic and parking, and
- On-street parking lanes should serve as traffic lanes (also known as a "queuing lane").

For urban streets with parking on both sides actual width is recommended at 32'. The recommended actual width of a neighborhood street with parking on one side is 24', while local street width is recommended at 18' and a gravel alley has recommended width of 14'.

Benefits from these practices include (CWP, 1998):

- Reduction in impervious cover,
- Reduction in the speed of traffic provides greater safety for pedestrians,
- Significant savings in cost of paving, clearing and grading, infrastructure, long-term pavement maintenance and stormwater management.

A savings of approximately $150 per linear foot can be achieved by shortening roads (CBP, 1993). [This includes savings achieved through reduced pavement and stormwater control].

### 2.3.2 Right-of-Way Width

A street right-of-way is an area where streets, sidewalks, utilities, and sometimes stormwater features are located. Often, the entire right-of-way is cleared in preparation for grading and road construction, potentially resulting in unnecessary loss of trees and vegetation. Limiting the cleared land width reduces the amount of land disturbed. Reducing the right-of-way makes more land available for housing lots and facilitates designing a compact land plan.

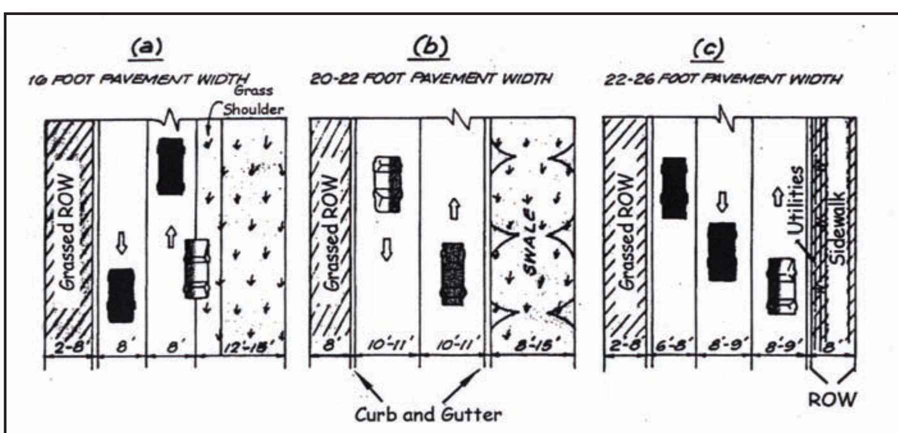
Conventionally, a right-of-way width of 50-60 feet is applied to all residential streets. Recommended design practices include (CWP, 1998):

- Reduce cleared width to minimum required to facilitate roadway, sidewalk, and vegetated open channels,
- Utilities should be "bundled" and located within the pavement section of the right-of-way when possible,
- Reduce rights-of-way by 10 to 25 feet by decreasing pavement and sidewalk width and bundling utilities within the pavement section, and
- Encourage the use of natural stormwater practices within rights-of-way such as bioretention swales and grassed filter strips that reduce the use the cleared area to treat stormwater runoff.

Recommended design options for a narrower right-of-way on residential streets (CWP 1998 pp 43-47) include: (Figures 2.3.2.a-c)

*Figure 2.3.2a-c*
*Road Scenarios*

*Image Courtesy of:*
*Better Site Design,*
*Schueler, 1995*



- **36’ Road Scenario**

  16’ Pavement Width – Two 8’ Wide Travel Lanes

  One 8’ Grassed Utility Easement

  One 12’ to 18’ Grass Shoulder with Parking

- **38’ Road Scenario**

  20’ to 22’ Pavement Width – Two 10’ to 11’ Wide Travel Lanes

  One 8’ Grassed Utility Easement

  One 8’ to 15’ Swale

- **42’ Road Scenario**

  22’ to 26’ Pavement Width – Two 8’ to 9’ Travel Lanes with One 6’ to 8’ Emergency or Parking Lane

  One 8’ Grassed Utility Easement

  One 8’ Sidewalk

Primary benefits include:

- Opportunity for on-site stormwater control and treatment,
- Reduces area to be cleared, resulting in a cost benefit, and
- More land available for development or green space.

### 2.3.3 Cul-De-Sacs & Alternative Turnarounds

A cul-de-sac is a dead-end residential street often used in conventional subdivisions. Typically, the terminal end is a large “bulb” that carries a radius of 50’ to 60’, entirely impervious and almost never fully utilized for turning purposes. There are alternative turnaround designs that serve the intended purpose while significantly reducing the area of impervious cover. (Figures 2.3.3.a and 2.3.3.b)

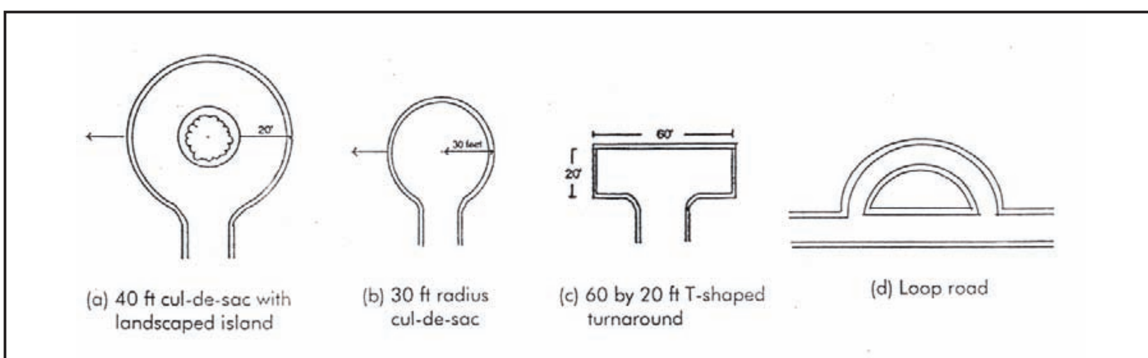



*Figure 2.3.3a Subdivision Turnaround Designs*

*Photo Courtesy of: Better Site Development,*

*Figure 2.3.3b Conventional Cul-de-Sac in Subdivision*

*Photo Courtesy of: Pbase.com*

| Turnaround Option | Impervious Area (1,000 sf) |
|---|---|
| 40' Radius Cul-De-Sac | 5.024 |
| 40' Radius Cul-De-Sac with Island | 4.397 |
| 30' Radius Cul-De-Sac | 2.826 |
| 30' Radius Cul-De-Sac with Island | 2.512 |
| Minimum T-Shaped Turnaround | 1.250 |

*Table 2.2: Impervious Cover Created by Various Turnaround Options (Schuleler, 1995)*

Recommended practices include (CWP, 1998):

- Reduce the radius of the turnaround bulb to 45' or less,
- Use interconnected streets to minimize the number of cul-de-sacs,
- Place a pervious island in the center of the turnaround and landscape with water-absorbing plants to facilitate storage and treatment of stormwater, (Figure 2.3.3.c) and

*Figure 2.3.3c Cul-de-Sac with Maple Tree*

*Image Courtesy of: Pbase.com*

- Consider alternatives to circular cul-de-sacs like the T-Shaped turnaround, which can generate 75% less impervious cover than a 40’ radius circular turnaround and the loop road, which provides multiple accesses and can carry twice the traffic volume of a cul-de-sac. (Figure 2.3.3.d)

Benefits include (CWP, 1998):

- Reduced impervious surface area,
- Attractive to homebuyers due to lower traffic and sense of privacy, and
- Landscaped islands can be designed as rain gardens for stormwater control.

*Figure 2.3.3d T-Shaped Turnaround in Subdivision*

*Image Created by: Patrice Cook*

### 2.3.4 Sidewalks and Driveways

Excessive sidewalk and driveway requirements can increase the amount of impervious area within a site, further preventing infiltration of stormwater runoff into the soil. As much as 20% of the impervious cover in a residential subdivision consists of driveways and sidewalks (CWP, 1998). Recommended practices include:

- Locate sidewalks on only one side of the street,
- Use sidewalk widths of 5 feet in high-use areas, and 4 feet in other areas,
- Specify narrower driveway widths,
- Reduce the length of driveways by relaxing street and side yard setbacks,
- Allow use of permeable surfacing materials, such as crushed rock or shell, for sidewalk and driveway construction,
- Create driveways as two parallel strips with vegetation between them instead of one large expanse of concrete, and
- Sidewalks should be graded so that they drain to the adjacent bioretention swales or rain gardens, as opposed to the street.

Benefits from these practices include (CWP, 1998):

- ◆ Reduces impervious area,
- ◆ Allows for greater on-site infiltration of stormwater if bio-swales and rain gardens are used, and
- ◆ Cost savings in construction and maintenance due to reduction in amount of paving.

### 2.3.5 Parking and Parking Lots

Since parking lots, like streets and on-street parking, can be the largest impervious collectors of pollutants and debris, it is imperative to reduce these impervious surfaces and non-point source pollutants running off of these areas with common, practical, strategies referred to as "green parking".

Parking ratios are the number of parking spaces that must be provided based on land use as established by local governing bodies. They are typically based on the minimum number of spaces needed to support peak parking hour(s). Studies summarized below have shown that typically, far more spaces are built than are actually needed:

| Conventional Minimum Parking Ratios | | | |
|---|---|---|---|
| **Land Use** | **Parking Requirement** | | **Actual Average Parking Demand** |
| | **Parking Ratio** | **Typical Range** | |
| **Single Family Homes** | 2 spaces per dwelling unit | 1.5 – 2.5 | 1.11 spaces per dwelling unit |
| **Shopping Center** | 5 spaces for 1000 ft | 4.0 – 6.5 | 3.97 per 1000 ft GFA |
| **Convenience Store** | 3 spaces for 1000 ft | 2.0 – 10.0 | - |
| **Industrial** | 3.3 spaces for 1000 ft | 0.5 – 2.0 | 1.48 per 1000 ft GFA |
| **Medical Office** | 1 space for 1000 ft | 4.5 – 10.0 | 4.11 per 1.48 per 1000 ft GFA |
| GFA = gross floor area of a building without storage or utility spaces. | | | |

*Table 2.3: Conventional Minimum Parking Standards (ITE, 1987; Smith, 1984 and Wells, 1994*)

Recommended practices include (CWP, 1998): (Figure 2.3.5.a)

*Figure 2.3.5a Reduced Parking Stalls with Permeable Paving Strips*

*Photo Courtesy of: Washington, D.C. Navy*

- Limit the number of required parking spaces to meet actual average parking demand,
- Reduce the dimensions of parking stalls by 6” to 1’ off their current length and width,
- Create more spaces for compact cars,
- Pervious materials are recommended for use to pave a variety of lower usage areas including overflow parking, emergency and service lanes. (A wide variety of alternative materials are available including modular pavers, gravel, crushed shell, grass pave, turf blocks, and porous concrete), (Figure 2.3.5.b)

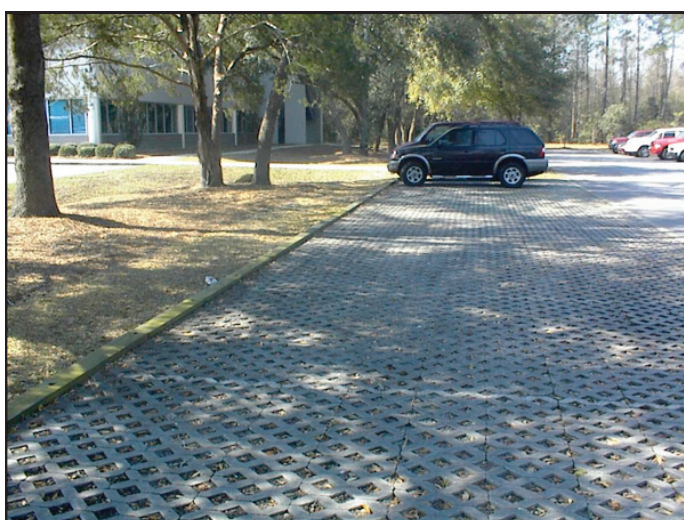


*Figure 2.3.5b Permeable Pavers Used for Overflow Parking*

*Photo Courtesy of: Dan Fischer*

- Reduce the volume of stormwater runoff by requiring landscaped areas be used for stormwater management. (Landscaped areas can include parking islands which can be used as bioretention areas, dry swales, or filter strips), and
- Encourage shared parking and promote structured parking (multi-level lots). (In urban areas, especially commercial areas, high parking ratios make green parking techniques, especially shared parking and structured parking, a practical approach to reducing overall impervious coverage.)

Primary benefits from reduction of excess parking spaces, minimization of parking stall dimension, and encouragement of shared parking and multi-level garages include (CWP, 1998):

- Decreases impervious cover and related stormwater runoff,
- Reduces construction and maintenance cost. [Cost per conventional space can range from $1,200 to $1,500, an indication that a reduction in the required number of spaces would result in a cost savings in construction or maintenance (Markowitz, 1995)], and
- Conserves land; building a parking structure is costly but takes up no more impervious area than a single level parking lot. (Therefore, in an urban setting, multi-level structures may be a financial incentive for developers).

### *2.4 Lot Development*

The third step in the green growth design process involves locating individual homes sites within the buildable area of the tract.   Primary consideration is given to the natural contours of the land, especially when siting building lots to minimize land-disturbing activities such as clearing and grading.  In addition, the dimensions of a lot can be modified to reduce overall impervious areas and then used to accommodate stormwater management features.

Conventional subdivisions require certain distance setbacks along all sides of the lot that often restrict a site designer's ability to design compact developments and reduce impervious surfaces and related runoff problems.   The requirements should be adjusted to reasonable distances in an exchange for less paved area and more green space.

Recommended practices include (CWP, 1998): (Figure 2.4.a)

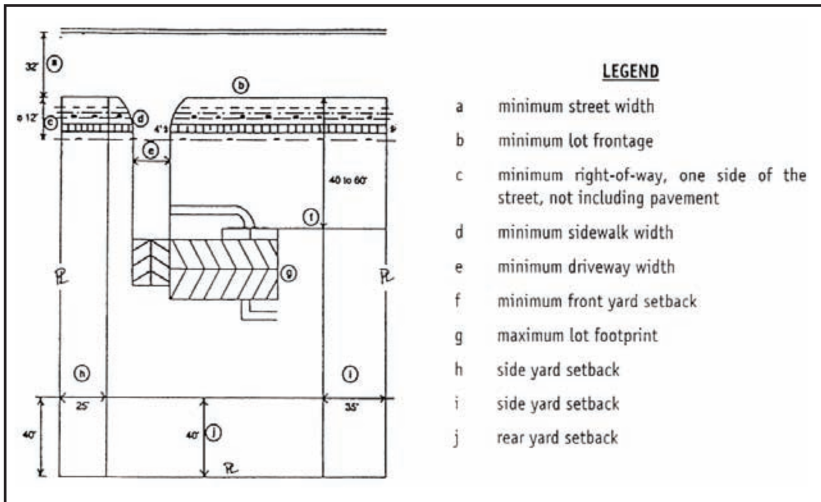



*Figure 2.4a LID Lot Design*

*Image Courtesy of: Better Site Design, Schueller, 1995*

(Note: Some of these practices may require variances from local ordinances.)

- Allow for relaxed front, side, and rear yard set backs,
- Allow for narrower frontages,
- Minimize driveway lengths to reduce overall lot imperviousness by relaxing front setback requirements,
- Encourage the use of common green or open space, and
- Use low impact stormwater strategies such as rooftops gardens, rain gardens, and bioretention swales to reduce the adverse effects of runoff.

Benefits of these practices include (CWP, 1998):

- Reduction in total impervious area by 40% or more when compared to conventional subdivision lot layouts, particularly if narrower streets can be utilized,
- Lower construction cost by reduced clearing, grading, and paving,
- Conserves trees and natural areas,
- Can protect watershed by reducing annual stormwater runoff volume by as much as 60% and, accordingly, stormwater pollution by a corresponding amount, and
- Highly desirable amenity of green space creates higher market value for lots and faster value appreciation.

## 2.5 Stormwater Management

Human impact can disrupt or destroy many of the processes that allow the natural landscape to perform its hydrological function of releasing cleansed water to the ocean and to the local groundwater. Stormwater runoff generated from impervious cover can be a significant threat to the quality of wetlands, surface water, and groundwater. Research has shown:

- Wetlands can be adversely affected by the quality and quantity of stormwater it receives from upstream areas (Azous, 1997).
- Sole source aquifers can be contaminated if stormwater pollutants are discharged underground (Written and Horsley, 1995).
- Stormwater pollutants can be directly attributed to the closure of beaches and shellfish beds.
- Fish and wildlife habitat can be degraded from erosion and sedimentation.

Stormwater management should seek to control both the quality and quantity of stormwater runoff created from new development activity. Quantity control is achieved by use of "constructed" wetlands and ponds, which help minimize flooding and protect downstream channels from accelerated erosion. Quality control is achieved through implementation of stormwater best management practices (BMP) like enlarged vegetated buffers, bio-retention swales, and infiltration basins that use natural processes to remove harmful non-point source pollutants. (CWP, 1998). (Figure 2.5.a)

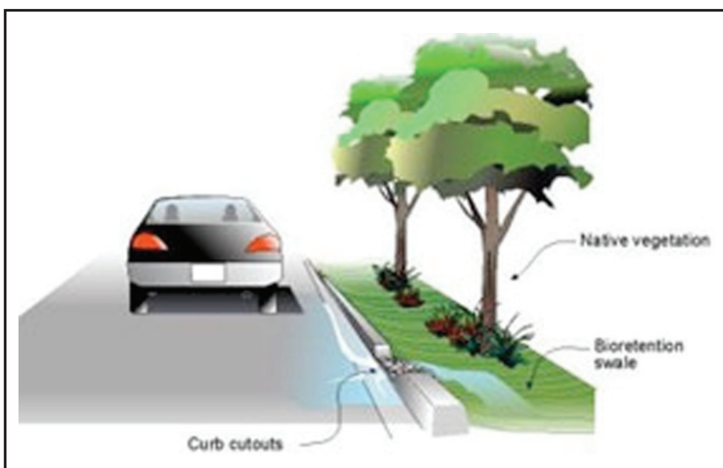



*Figure 2.5a Curb Cuts Schematic*

*Image Courtesy of: Pierce County WA and AHBL, Inc.*

To become more effective, stormwater management must incorporate low impact site design in its process for solving stormwater problems "*at the source*". With its focus on reduction of impervious cover and utilization of green space for stormwater treatment, low impact site design practices can greatly facilitate reduction of the volume of stormwater runoff that must be treated.

The following practices can be implemented at the site design stage:

- Where feasible, alleys, parking stalls, paths, driveways, sidewalks, and light-duty service roads should employ permeable paving,
- Overflow parking should have perimeter filter strips or bioretention areas,
- Use bioretention swales or filter strips along alleys and in parking lot medians to provide stormwater treatment and storage, (Figure 2.5.b) and
- Preserve areas with native vegetation for runoff control and buffering of environmentally sensitive areas.

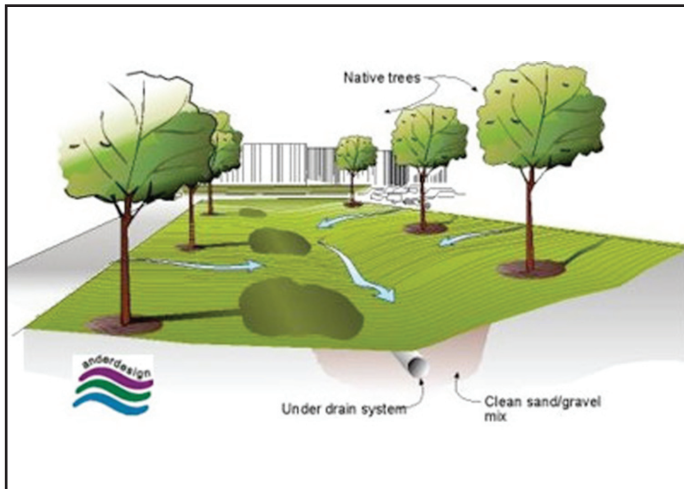



*Figure 2.5b Bio-swale Schematic*
*Image Courtesy of: Pierce County WA and AHBL, Inc.*

While these are basic examples of how site design practices can improve stormwater management, BMPs are the primary method of stormwater control. These practices, their physical description, application, and resulting benefits, are discussed in detail in Chapter 3.

## *2.6 Design Comparison*

In this section, we compare the "conventional" method of development to two residential land plans that use the "conservation design" and the "new urbanist" approach to lot development – two methods that have received an increasing amount of attention in recent years. The two forms created for the Tupelo Tract are termed the "Community Preserve" and the "Village". Both of these plans promote two main principles: 1) to use land more efficiently by building compact communities and 2) tailor fit the development plan to the site's natural characteristics. These land plans were applied to the Tupelo Tract and are compared to one another to show the economic, environmental, and social benefits of *designing with the landform.*

The most obvious advantage of the non-conventional design is the preservation of natural green space and the resultant water quality benefits.  Other benefits of the non-conventional low impact, compact development approach include:

- The per-lot cost of infrastructure including roads, piping and other utilities is substantially reduced,
- Extensive surrounding green spaces gives residents a feeling of being connected to nature,
- The reduction of impervious surfaces per lot and the incorporation of alternative stormwater measures into the landscape design lessen the negative impact on the environment,
- The sizing of the community to allow for and promote walking, bicycling and other non-automotive transportation can reduce local automobile usage and consequently road maintenance and air pollution,
- Compact designs promote the interaction and proximity of residents, and large amounts of open space promote the development of the human relationships that comprise a real community, and
- Compact design considers and incorporates forested buffers and green space areas that serve as critical habitat for local wildlife.

The following is an overview of these development types both individually and comparatively amongst each other.  It includes the definition of the strategy with visual support of the designs shown in Figures 2.6.2 a-c.