Chapter 11: Green Site Design Factors

11.1 Introduction

The information in this chapter was developed and written by the Center for Watershed Protection's Stormwater Manager's Resource Center (SMRC), a 501(c)3 organization located in Ellicott City, Maryland. This and other information can be found at:

http://www.stormwatercenter.net/

The information in this chapter covers green design considerations for developments and is not in itself exhaustive. There are other sources for green planning information and Montgomery County encourages all architects and engineers to explore greener alternatives for design. Because of the diversity of information, any design changes that are not already pre-approved by the Montgomery County Building and Codes Department or by the Storm Water Control and Management Program must be carefully researched and reviewed before implementation to insure that the designs fulfill all the needs of the community and do not inadvertently create health and safety hazards for County citizens.

There are references to other CWP Fact Sheets throughout the chapter. These fact sheets are available at the web address listed above. These sheets may provide more in depth material for the subjects presented here.

11.2 Alternative Pavers

Alternative pavers are permeable or semi-permeable surfaces that can replace asphalt and concrete and can be used for driveways, parking lots and walkways. From a storm water perspective, this is important because alternative pavers can replace impervious surfaces, creating less storm water runoff. The two broad categories of alternative pavers are paving blocks and other surfaces including gravel, cobbles, wood, mulch, brick, and natural stone. While porous pavement is an alternative paver, as an engineered storm water management practice, it is discussed in detail in the Porous Pavement Fact Sheet.

Paving blocks

Paving blocks are cement or plastic grids with gaps between them. Paving blocks make the surface more rigid and gravel or grass planted inside the holes allows for infiltration. Depending on the use and soil types, a gravel layer can be added underneath to prevent settling and allow further infiltration.

Other alternative surfaces

Gravel, cobbles, wood, and mulch also allow varying degrees of infiltration. Brick and natural stone arranged in a loose configuration allow for some infiltration through the gaps. Gravel and cobbles can be used as driveway material and wood and mulch can be used to provide walking trails.

Applicability

Alternative pavers can replace conventional asphalt or concrete in parking lots, driveways, and walkways. At the same time, traffic volume and type can limit application. For this reason, alternative pavers for parking are recommended only for overflow areas. In residential areas, alternative surfaces can be used for driveways and walkways, but are not ideal for areas that require handicap accessibility.

Siting and Design Criteria

Accessibility, climate, soil type, traffic volume and long term performance should be considered along with costs and storm water quality controls when choosing paving materials. Use of alternative pavers in cold climates will require special consideration since snow shovels are not practical for many of these surfaces. Sand is particularly troublesome if used with paving blocks since the sand that ends up in between the blocks cannot effectively wash away or be removed. In addition, salt used to deice can also infiltrate directly into the soil and cause potential groundwater pollution.

Soil types will affect the infiltration rates and should also be considered when using alternative pavers. Clayey soils (D soils) will limit the infiltration on a site. If groundwater pollution is a concern, use of alternative pavers with porous soils should be carefully considered.

The durability and maintenance cost of alternative pavers also limits use to low traffic volume areas. At the same time, alternative pavers can abate storm water management costs. Used in combination with other better site design techniques, the cumulative effect on storm water can be dramatic.

Benefits

The most obvious benefit of utilizing alternative pavers includes reduction or elimination of other storm water management techniques. Applied in combination with other techniques like bioretention and green parking, pollutant removal and storm water management can be further improved. (See Bioretention and Green Parking Fact Sheets for more information.)

Limitations

Alternative pavers are not recommended for high traffic volumes for durability reasons. Access for wheelchairs is limited with alternative pavers. In addition, snow removal is also difficult since plows cannot be used, sand can cause the system to clog, and salt can be a potential pollutant.

Effectiveness

Alternative pavers all provide better water quality effectiveness than conventional asphalt or concrete and the range of effectiveness depend on the type of paver used. Table 1 provides a list of pavers and the range of water quality effectiveness achievable by different types of alternative pavers.

Table 1. Water Quality Effectiveness of Various Pavers (BASMAA, 1998)

Material	**Water Quality Effectiveness**
Conventional Asphalt/ Concrete	Low
Brick (in a loose configuration)	Medium
Natural Stone	Medium
Gravel	High
Wood Mulch	High
Cobbles	Medium

Costs

The range of installation and maintenance costs of various pavers is provided in Table 2. Depending on the material used, installation costs can be higher or lower for alternative pavers than conventional asphalt or concrete, but maintenance costs are almost always higher.

Table 2. Installation and Maintenance Costs for Various Pavers (BASMAA, 1997)		
Material	**Installation Cost**	**Maintenance Cost**
Conventional Asphalt/ Concrete	Medium	Low
Brick (in a loose configuration)	High	Medium
Natural Stone	High	Medium
Gravel	Low	Medium
Wood Mulch	Low	Medium
Cobbles	Low	Medium

References

Bay Area Stormwater Management Agencies Association (BASMAA). *Start at the Source: Residential Site Planning and Design Guidance Manual for Stormwater Quality Protection*. BASMAA, San Francisco, CA. January 1997.

Center for Watershed Protection. *Better Site Design: A Handbook for Changing Development Rules in Your Community.* Center for Watershed Protection, Inc., Ellicott City, MD. 1998.

Schueler, Thomas R. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*. Metropolitan Washington Council of Governments, Washington, DC. 1987.

Schueler, Thomas R. *Urban Runoff in the Washington Metropolitan Area.* Metropolitan Washington Council of Governments, Washington, DC. 1983.

Smith, David R. *Life Cycle and Energy Comparison of Grass Pavement and Asphalt Based on Data and Experience from the Green Parking Lot*. The Heritage Conservation and Recreation Service, Order No. A-4331-4. 1981.

Smith, David R. and Sholtis, David A. *An Experimental Installation of Grass Pavement.* The Heritage Conservation and Recreation Service, Order No. A-4331-4. 1981.

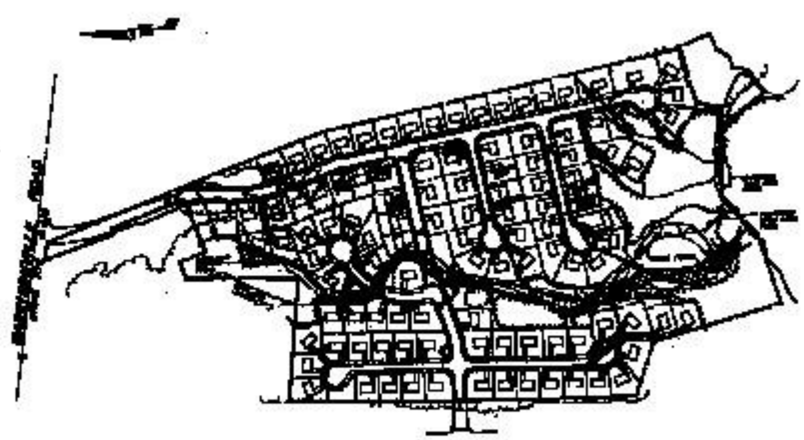
11.3 Open Space Design

Description

Open space design, also known as conservation development or cluster development, is a better site design technique that concentrates dwelling units in a compact area in one portion of the development site in exchange for providing open space and natural areas elsewhere on the site. The minimum lot sizes, setbacks and frontage distances for the residential zone are relaxed in order to create the open space at the site. Open space designs have many benefits in comparison to the conventional subdivisions that they replace: they can reduce impervious cover, storm water pollutants, construction costs, grading, and the loss of natural areas. However, many communities lack zoning ordinances to permit open space development, and even those that have enacted ordinances may need to revise them to achieve greater water quality and environmental benefits.

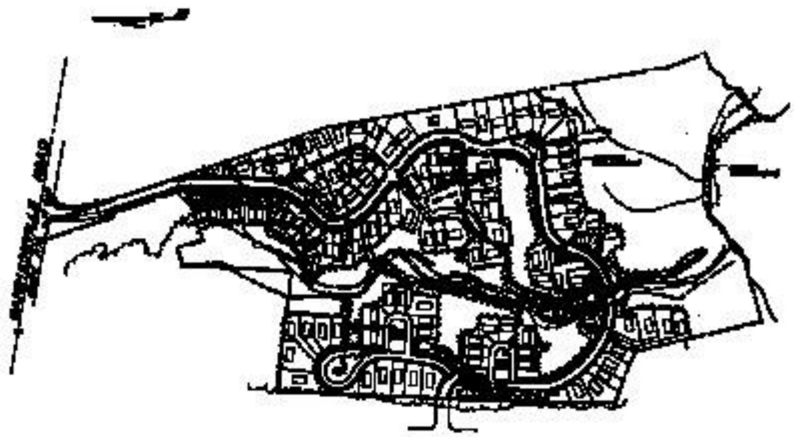
It should also be noted that the benefits of open space design can be amplified when it is combined with other better site design techniques such as narrow streets, open channels and alternative turnarounds (see Narrow Streets and Alternative Turnarounds Fact Sheets).

This site (Figure 1) represents a typical single-family residential subdivision developed in the early 1990's in the Chesapeake Bay watershed. Lots are a uniform size and shape, cul-de-sacs dominate the landscape, existing natural resources (forests, streams, wetlands) are only moderately protected, street widths are excessively wide, driveway widths and lengths create unnecessary impervious cover, and lawn turf is the dominant feature in the developed site. Total impervious cover: 12.0 acres (27% of total site).



This site design (Figure 2) incorporates many of the principles of open space design. Specifically, lots are narrower and varied in shape, existing natural resources (forests, streams, wetlands) have been preserved wherever possible, a significant portion of the site is retained as natural open space, street widths are narrow, houses are closer to the road thus creating shorter driveway lengths, a minimum 100 ft. buffer is provided along all intermittent and perennial streams, storm water is managed in a "treatment train" with bioretention facilities coupled with a wet extended detention pond, and lawn turf is minimized. Total impervious cover: 9.1 acres (20% of total site).

Figure 2. Medium-Density Residential Site - Innovative Design



Applicability

The codes and ordinances that govern residential development in many communities do not allow developers to build anything other than conventional subdivisions. Consequently, it may be necessary to enact a new ordinance or revise current development regulations to enable developers to pursue this design option. See the Open Space Ordinances in the Ordinance Category.

Open space design is widely applicable to most forms of residential development. The greatest storm water and pollutant reduction benefits typically occur when open space design is applied to residential zones that have larger lots (less than two dwelling unit per acre). In these types of large lot zones, as great deal of natural or community open space can be created by shrinking lot sizes. However, open space design may not always be a viable option for high density residential zones, redevelopment or infill development, where lots are small to begin with and clustering will yield little open space. In rural areas, open space design may need to be adapted, especially in communities where shared septic fields are not currently allowed by public health authorities.

Open space design can be employed in nearly all geographic regions of the country with the result of different types of open space being conserved (forest, prairie, farmland, chaparral, or desert).

Siting and Design Conditions

Several site planning techniques have been proposed for designing effective open space developments (Arendt, 1997, and DE DNREC, 1997). Often, a necessary first step is adoption of a local ordinance that allows open space design within conventional residential zones. Such ordinances specify more flexible and smaller lot sizes, setbacks, and frontage distances for the residential zone, as well as minimum requirements for open space and natural area conservation. Other key elements of effective open space ordinances include requirements for the consolidation and use of open space, as well as enforceable provisions for managing the open space on a common basis.

Limitations

There are a number of real and perceived barriers to the wider acceptance of open space designs by developers, local governments and the general public. For example, despite strong evidence to the contrary, some developers still feel that open space designs are less marketable than conventional residential subdivisions. In other cases, developers contend that the review process for open space design is more lengthy, costly, and potentially controversial than that required for conventional subdivisions, and thus, not worth the trouble.

Local governments may be concerned that homeowner associations lack the financial resources, liability insurance or technical competence to maintain open space adequately. Finally, the general public is often suspicious of cluster or open space development proposals, feeling that they are a Trojan horse for more intense development, traffic and other local concerns.

In reality, many of these misconceptions can be directly addressed through a clear open space ordinance and by providing training and incentives to the development and engineering community.

Maintenance Considerations

Once established, common open space and natural conservation areas must be managed by a responsible party able to maintain the areas in a natural state in perpetuity. Typically, the open space is protected by legally enforceable deed restrictions, conservation easements and maintenance agreements. In most communities, the authority for managing open space falls to a homeowner or community association or a land trust.

Annual maintenance tasks for open space managed as natural areas are almost non-existent, and the annual maintenance cost for managing an acre of natural area is less than $75 (CWP, 1998). It may be useful to develop a habitat plan for natural areas that may require periodic management actions.

Effectiveness

Recent redesign research indicates that open space design can provide impressive pollutant reduction benefits compared to the conventional subdivisions they replace. For example, the

Center for Watershed Protection (1998) reported that nutrient export declined by 45% to 60% when two conventional subdivisions were redesigned as open space subdivisions. Other researchers have reported similar levels of pollutant reductions when conventional subdivisions were replaced by open space subdivisions (Maurer, 1996; DE DNREC, 1997; Dreher, 1994; and SCCCL, 1995). In all cases, the reduction in pollutants was due primarily to the sharp drop in runoff caused by the lower impervious cover associated with open space subdivisions. And indeed, in the redesign studies cited above, impervious cover declined by an average of 34% when open space designs were utilized.

Along with reduced imperviousness, open space designs provide a host of other environmental benefits lacking in most conventional designs. These developments reduce potential pressure to encroach on resource and buffer areas, as enough open space is usually reserved to accommodate resource protection areas. As less land is cleared during the construction process, the potential for soil erosion is also greatly diminished. Perhaps most importantly, open space design reserves 25% - 50% of the development site in green space that would not otherwise be protected, preserving a greater range of landscapes and habitat "islands" that can support considerable diversity in mammals, songbirds and other wildlife.

Cost Considerations

Open space developments can be significantly less expensive to build than conventional subdivisions. Most of the cost savings are due to savings in road building and storm water management conveyance costs. In fact, the use of open space design techniques at a residential development in Davis, California provided an estimated infrastructure construction costs savings of $800 per home (Liptan and Brown, 1996). Other examples demonstrate infrastructure costs savings ranging from 11 to 66%. The following table lists some of the projected construction cost savings generated by the use of open space redesign at several residential sites.

Table 1. Projected Construction Cost Savings for Open Space Designs from Redesign Analyses

Residential Development	Construction Savings (%)	Notes
Remlik Hall [1]	52	Includes costs for engineering, road construction, and obtaining water and sewer permits
Duck Crossing [2]	12	Includes roads storm water management, and reforestation
Tharpe Knoll [3]	56	Includes roads and storm water management
Chapel Run [3]	64	Includes roads, storm water management, and reforestation
Pleasant Hill [3]	43	Includes roads, storm water management, and reforestation

Rapahannock [2]	20	Includes roads, storm water management, and reforestation
Buckingham Greene [3]	63	Includes roads and storm water management
Canton, Ohio[4]	66	Includes roads and storm water management
Sources: [1] Maurer, 1996; [2] CWP, 1998; [3] DE DNREC, 1997; [4] NAHB, 1986		

While open space developments are frequently less expensive to build, developers find that these properties often command higher prices than homes in more conventional developments. Several regional studies estimate that residential properties in open space developments garner premiums that are 5 to 32% higher than conventional subdivisions and moreover, sell or lease at an increased rate. In Massachusetts, cluster developments were found to appreciate 12% faster than conventional subdivisions over a twenty year period (Lacey and Arendt, 1990). And in Atlanta, the presence of trees and natural areas measurably increased the residential property tax base (Anderson and Cordell, 1982).

In addition to being aesthetically pleasing, the reduced impervious cover and increased tree canopy associated with open space development reduces the size and cost of downstream storm water treatment facilities. The resulting cost savings can be considerable, as the cost to treat the quality and quantity of storm water from a single impervious acre can range from $2,000 to a staggering $50,000. The increased open space within a cluster development also provides a greater range of locations for more cost-effective storm water practices. Clearly, open space developments are valuable from an economic as well as an environmental standpoint

References

Anderson, L.M. and H.K. Cornell. "Residential Property Values Improved by Landscaping With Trees." *Southern Journal of Applied Forestry* pp 162-6.

Arendt, Randall. 1994. *Rural by Design*. American Planning Association. Planners Book Service. Chicago, IL

Arendt, Randall. 1996. *Conservation Design for Subdivisions: A Practical Guide to Creating Open Space Networks.* American Planning Association Planners Book Service. Chicago, IL

Center for Watershed Protection (CWP). 1998. *Better Site Design: A Handbook for Changing Development Rules in Your Community*. Ellicott City, MD.

Delaware Department of Natural Resources and Environmental Control (DE DNREC) and The Environmental Management Center of the Brandywine Conservancy. 1997. *Conservation Design for Stormwater Management.*

Dreher, D.W. and T.H. Price. 1994. *Reducing the Impacts of Urban Runoff: The Advantages of Alternative Site Design Approaches*. Northeastern Illinois Planning Commission. Chicago, Il.

Lacey, J. and R. Arendt 1990. *An Examination of Market Appreciation for Clustered Housing with Permanently Protected Open Space*. Center for Rural Massachusetts, Amherst, MA. 14 pp.

Liptan, T. and C.K. Brown. 1996. *A Cost Comparison of Conventional and Water Quality-Based Stormwater Designs.* City of Portland. Bureau of Environmental Services. Portland, OR. 16 pp.

Maurer, George. 1996. *A Better Way to Grow: For More Livable Communities and a Healthier Cheasapeake Bay.* Chesapeake Bay Foundation, Annapolis, MD.

Montgomery County (Pennsylvania) Planning Commission. *Guidelines for Open Space Management in the Land Preservation District.* Norristown, PA

National Association of Homebuilders (NAHB). 1986. *Cost Effective Site Planning*. Washington, D.C.

Schueler, Thomas R. 1995. *Site Planning for Urban Stream Protection.* Center for Watershed Protection. Ellicott City, MD.

South Carolina Coastal Conservation League (SCCCL). 1995. "Getting a Rein on Runoff: How Sprawl and Traditional Towns Compare." *SCCCL Land Development Bulletin* (Number 7). Charleston, SC.