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An Introduction to Better Site Design

Few watershed management practices simultaneously reduce pollutant loads, conserve natural areas, save money, and increase property values. Indeed, if such "wonder practices" were ever developed, they would certainly spread quickly across the nation. As it turns out, these practices have existed for years. Collectively called "better site design," the techniques employ a variety of methods to reduce total paved area, distribute and diffuse stormwater, and conserve natural habitats. Despite their proven benefits and successful local application, better site design techniques often fail to earn the endorsement of local communities. In fact, many communities simply prohibit their use.

"Better site design" is a fundamentally different approach to residential and commercial development. It seeks to accomplish three goals at every development site: to reduce the amount of impervious cover, to increase natural lands set aside for conservation, and to use pervious areas for more effective stormwater treatment. To meet these goals, designers must scrutinize every aspect of a site plan—its streets, parking spaces, setbacks, lot sizes, driveways, and sidewalks— to see if any of these elements can be reduced in scale. At the same time, creative grading and drainage techniques reduce stormwater runoff and encourage more infiltration.

Why is it so difficult to implement better site design in so many communities? The primary reason is the outdated development rules that collectively govern the development process: a bewildering mix of subdivision codes, zoning regulations, parking and street standards, and drainage regulations that often work at cross-purposes with better site design. Few developers are willing to take risks to bend these rules with site plans that may take years to approve or that may never be approved at all.

In 1997, a national site planning roundtable was convened to address ways to encourage better site design techniques in more communities. The participants represented the diverse mix of organizations that affect the development process (listed in Table 1) and provided the technical and real world experience to make better site design happen. After two years of discussion, the roundtable endorsed 22 better site design techniques that offer specific guidance that can help achieve one of the basic better site design goals. These techniques are organized into three areas:

1. Residential Streets and Parking Lots
2. Lot Development
3. Conservation of Natural Areas

These techniques are not intended to be strict guidelines, and their actual application should be based on local conditions. The remainder of this article introduces each of the better site design techniques, describes some of the barriers to their wider use, and suggests ways to overcome these impediments.

Residential Streets and Parking Lots

As much as 65% of the total impervious cover in the landscape can be classified as "habitat for cars," which includes streets, parking lots, driveways, and other surfaces designed for the car. Consequently, 10 better site design techniques address ways to reduce car habitat in new developments.

Figure 1: A Neotraditional Community in Gaithersburg, MD
Better site design techniques have been successfully applied in a growing number of communities like the Kentlands.

Table 1: Organizations Represented at the National Site Planning Roundtable (CWP,1998b)

The following organizations participated in a two-year long process to craft and refine the 22 model development principles. For a full look at the national consensus agreement, consult our web site at www.cwp.org.

American Association of State Highway Transportation Officials
American Forest Association
American Institute of Architects
American Planning Association
American Public Works Association
American Rivers
American Society of Civil Engineers
American Society of Landscape Architects
Chesapeake Bay Program
Community Associations Inc.
The Conservation Fund
Office of Comprehensive Planning, County of Fairfax, VA
Howard Research and Development Corporation
an affiliate of the Rouse Company
Institute of Transportation Engineers
International City/ County Management Association
Land Trust Alliance
Linowes & Blocher
Loiederman Associates, Inc.
Michael T. Rose Company
Montgomery County Council
Natelli Communities
National Association of Home Builders
National Realty Committee
Natural Resources Defense Council
Prince Georges County
Department of Environmental Resources
U.S. EPA
Office of Sustainable Ecosystems and Communities
U.S. Fire Administration
Urban Land Institute
Urban Wildlife Resources

Design residential streets for the minimum required pavement width needed to support travel lanes, on-street parking, and emergency, maintenance, and service vehicle access. Street widths should be based on traffic volume.

In some communities, residential streets can be 32, 36, and even 40 feet wide, despite the fact that they only serve a few dozen homes. These wide streets are the greatest source of impervious cover in most subdivisions. Wide residential streets are created by blanket applications of high volume and high speed design criteria, the perception that on-street parking is needed on both sides of the street, and the perception that they provide unobstructed access for emergency vehicles.

Communities have a significant opportunity to reduce impervious cover by revising their street standards to widths of smaller residential access streets. Residential streets widths should be designed to handle expected traffic volumes, provide adequate parking, and ensure access for service, maintenance, and emergency vehicles. Two strategies can help to narrow streets: using queuing streets (see Figure 2) and critically evaluating the need for on-street parking on both sides of the street. Several national engineering organizations have recommended residential streets as narrow as 22 feet in width (ASSHTO, 1994 and ASCE, 1990).

Reduce the total length of residential streets by examining alternative street layouts to determine the best option for increasing the number of homes per unit length.

Conventional Street

Queuing Street

(photos by Randall Arendt)

Figure 2: Queuing Streets as a Technique for Minimizing Street Width
While traditional streets are composed of two travel lanes and parking on either side of the road, queuing streets have one designated travel lane and two queuing lanes that can be used for travel or parking.

It stands to reason that a longer street network produces more impervious cover and greater development costs than a shorter one, yet most communities do not even consider whether a shorter street network can serve individual lots on residential streets. It is generally assumed that the cost of constructing roads is sufficient incentive to assure short street networks. Streets are designed to accommodate rapid, smooth traffic flow, and consequently, total street length is rarely the most important design consideration.

There is no one street layout guaranteed to minimize total street length in residential developments. Instead, site designers are encouraged to analyze different layouts to see if they can reduce street length.

Wherever possible, residential street right-of-way widths should reflect the minimum required to accommodate the travel-way, the sidewalk, and vegetated open channels. Utilities and storm drains should be located within the pavement section of the right-of-way wherever feasible.

In many communities, a single right-of-way width of 50 feet or more is applied to all residential street categories. While a wide right-of-way does not necessarily create more impervious cover, it requires more clearing and consumes land that could be used for achieving a more compact site design. By redesigning each of the main components of the right-of-way (ROW), the total width of the ROW can be sharply reduced. Techniques include reducing street width, narrowing sidewalks or restricting them to one side, narrowing the distance between street and sidewalk, and installing utilities beneath street pavement. Combined, these techniques narrow the ROW by 10 to 25 feet.

Minimize the number of residential street cul-de-sacs and incorporate landscaped areas to reduce their impervious cover. The radius of cul-de-sacs should be the minimum required to accommodate emergency and maintenance vehicles. Alternative turnarounds should be considered.

Many communities require the end of cul-de-sacs to be 50 to 60 feet in radius, creating large circles of needless impervious cover. There are several different options to reduce the impervious cover created by traditional cul-de-sacs. One option is to reduce the radius of the turnaround bulb. Several communities have implemented this successfully and the smaller radii can range from 33 to 45 feet. Since vehicles only use the outside of a cul-de-sac when turning, a second option is to create a pervious island in the middle of the cul-de-sac, creating a donut-like effect. A third option is to replace cul-de-sacs with loop roads and hammerheads (see Figure 3).

Where density, topography, soils, and slope permit, vegetated open channels should be used in the street right-of-way to convey and treat stormwater runoff.

Communities often require that curbs and gutters be installed along residential streets, which quickly convey stormwater runoff and associated pollutant loads directly into the stream. In contrast, open channels can remove pollutants by infiltration and filtering, and are also often less expensive than curb and gutter systems.

New engineering techniques have greatly improved the performance of conventional roadside ditches, which have traditionally suffered from erosion, standing water and increased pavement maintenance. One alternative is dry swales, which are designed both to convey the 10 year storm and treat a water quality stream through a sandy loam filter along the roadway (see Figure 4).

The required parking ratio governing a particular land use or activity should be enforced as both a maximum and a minimum in order to curb excess parking space construction. Existing parking ratios should be reviewed for conformance, taking into account local and national experience to see if lower ratios are warranted and feasible.

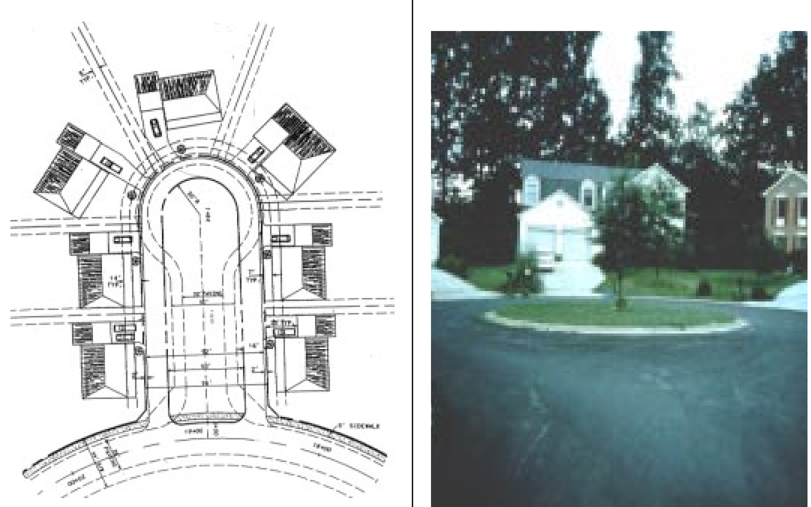

Figure 3: Two Alternatives to the Traditional Cul-de-Sac
A loop road or a pervious island in the middle are two alternatives that can significantly reduce impervious cover.

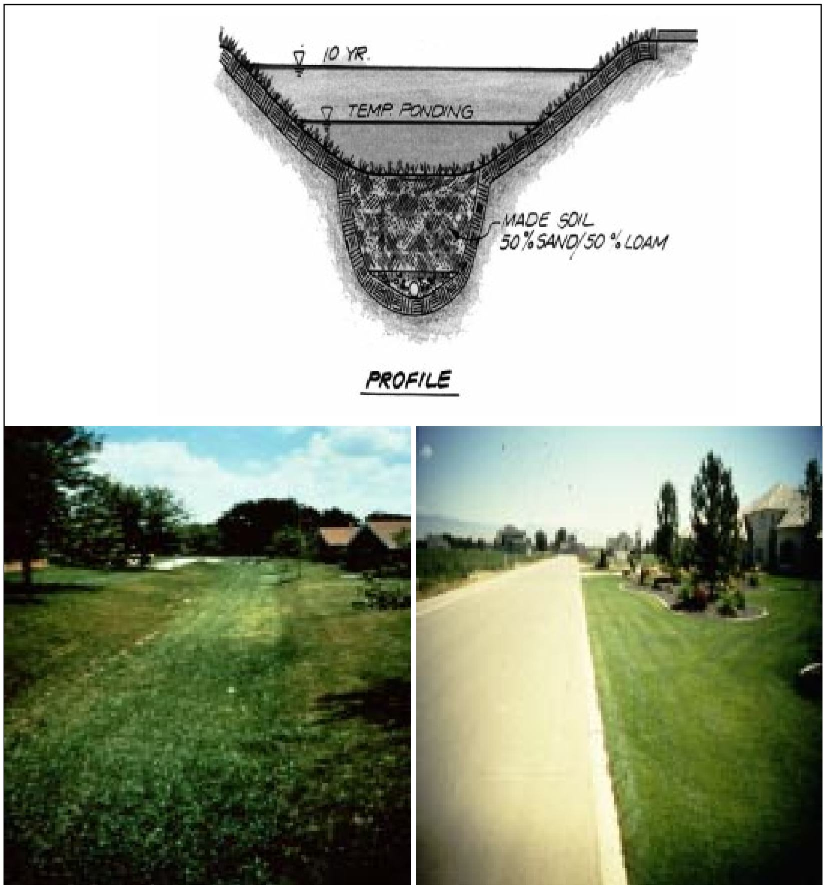

Figure 4: Profile and Two Examples of Open Vegetated Channels

Open vegetated channels allow for infiltration and treatment of stormwater on-site. A dry swale is typically designed to convey the 10 year storm, while treating smaller events with a subsurface composed of a sand and loam filler that treats the runoff before it enters a stream.

Many communities routinely build more parking spaces than are needed to meet actual parking demands. This is a result of using outdated or overly generous local parking codes to determine minimum parking ratios.

Communities should check their local codes to ensure that both a minimum and a maximum number of parking spaces are set for each building project (see Table 2 for recommended maximum parking spaces). By referring to national, regional and/or local studies, communities can evaluate their parking needs more accurately, thereby reducing the creation of unnecessary parking spaces. Even small reductions in parking can reduce construction and stormwater management costs. As it turns out, shrinking parking lots is critical in reducing the impact of commercial development (see article 46).

Parking codes should be revised to lower parking requirements where mass transit is available or enforceable shared parking arrangements are made.

Despite the fact that parking lot size can shrink dramatically if credits for shared parking or mass transit are provided, only a handful of communities require or encourage developers to use these tools. Shared parking allows adjacent land uses to share parking lots if peak parking demands occur during different times of the week. Mass transit can reduce the number of vehicle trips, which translates directly into smaller parking lots.

Despite challenges, several communities have successfully provided parking credits for shared parking for reducing the total number of parking spaces created. One such example is Oakland, California, where a thorough study of short and long term parking demand was conducted. By taking an inventory of existing land uses, parking, and occupancy; and by considering vacancy factors, mass transit access, low auto ownership, and operations of special use facilities, the study concluded that parking rate for office space could be reduced from three spaces to 1.44 spaces per 1,000 gross square feet (ITE, 1995).

Reduce the overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials in the spillover parking areas where possible.

Reducing the size of parking stall dimensions represents another opportunity to reduce impervious cover. The length and often the width of a typical parking stall can often be reduced by a foot or more. Parking codes can also be amended to require a fixed percentage of smaller stalls for compact cars. Lastly, while permeable parking surfaces can be more expensive to install and maintain, the use of these materials in the 10 to 20% of the lot that will be used for spillover parking can reduce stormwater treatment costs.

Table 2: Recommended Parking Demand Ratios for Selected Land Uses (CWP, 1998b)

Land Use	Better Site Design Parking Ratios
Single Family Homes	2 spaces or less per dwelling unit*
Professional Offices	3.0 spaces or less per 1000 ft^2
Retail	4.0 to 4.5 spaces or less per 1000 ft^2

* can be accommodated in driveway

Provide meaningful incentives to encourage structured and shared parking to make it more economically viable.

The type of parking facility in a development site is usually determined by the cost of land balanced against the cost of constructing parking. In suburban and rural areas, the low cost of land makes surface parking more cost-effective than building a garage. In highly urban areas, garages may be a more economical option, since land costs are at a premium.

Vertical parking structures can significantly reduce impervious cover by reducing acreage converted to parking. However, given the economics of surface parking versus garages, it is unlikely that garages will become the norm without incentives. Incentives for defraying some of the costs of parking garages could include tax credits, stormwater waivers or bonuses for density, floor area or building height. A simple way to save on the cost of garages is to incorporate them below or on the first floor of buildings, thereby reducing the structural cost for parking.

Wherever possible, provide stormwater treatment for parking lot runoff using bioretention areas, filter strips, and/or other practices that can be integrated into required landscaping areas and traffic islands.

Although parking lots are a significant source of stormwater pollution, many communities do not require developers to provide stormwater quality control. In other communities, opportunities to minimize and treat stormwater runoff at the parking lot are often overlooked. Parking lots can be made more attractive at the same time they treat stormwater. Bioretention areas, dry swales, perimeter sand filters, and filter strips are all effective at treating stormwater within the parking lot. Figure 5 provides a schematic diagram and example of a bioretention facility.

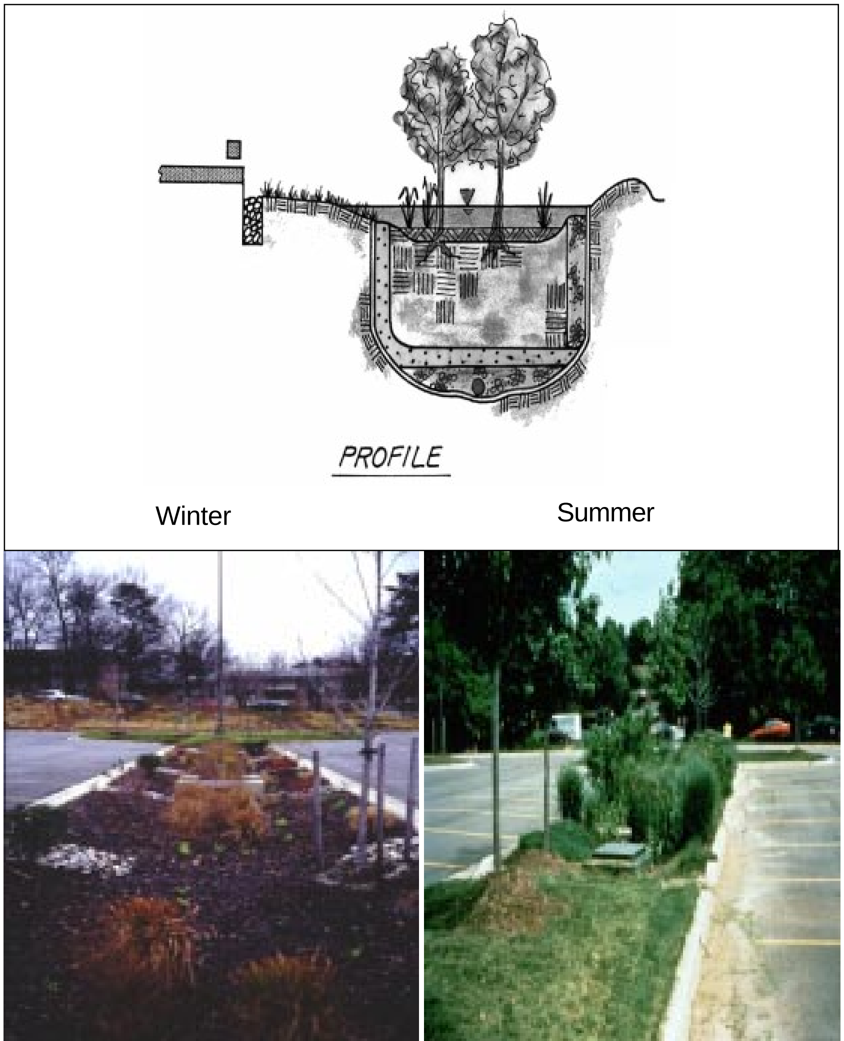

Figure 5: Profile of Parking Lot Bioretention Facilities
Bioretention areas can be designed for parking lots or on-site residential stormwater treatment, and can be an attractive landscaping feature in all seasons.

Lot Development

Many opportunities exist to reduce impervious cover in residential developments by modifying the shape, size, and layout of residential lots. Perhaps the greatest opportunity is to shift from conventional subdivisions to open space or cluster subdivisions.

Advocate open space design subdivisions incorporating smaller lot sizes to minimize total impervious area, reduce total construction costs, conserve natural areas, provide community recreational space, and promote watershed protection.

Open space subdivisions cluster houses into a smaller portion of the development site, leaving more of the site as natural open space. Figure 6 illustrates the differences between a conventional and an open space subdivision. Open space subdivisions have been documented to reduce impervious cover, stormwater runoff, and construction costs (see the second feature article in this issue for more details). While open space subdivisions are not always feasible in dense residential zones (more than six dwelling units per acre), communities that can utilize this technique should consider making open space subdivisions a by-right development option.

Although open space subdivisions (also known as cluster design) have been advocated by planners for many years, they are often prohibited or severely restricted by local zoning regulations. In 95% of communities surveyed by Heraty (1992), clustering is a voluntary, rather than a mandatory, development option. In addition, open space subdivisions often require a special exception or zoning variance (i.e. they are not a by-

Conventional Subdivision | Open Space Subdivision

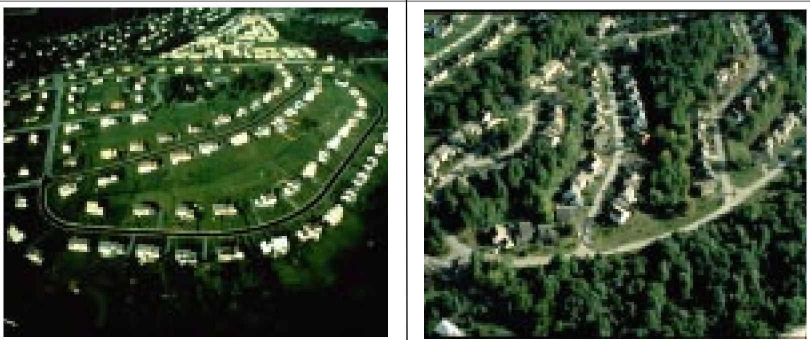

Photo courtesy: Randall Arendt | Photo courtesy: Randall Arendt

Figure 6: Examples of Conventional and Open Space Site Designs
Many conventional developments are designed using a cookie-cutter approach. Open space site designs preserve more of the existing vegetation and reduce the amount of land that is cleared and graded for individual lots.

Long Front Setback | Reduced Front Setback

Figure 7: Examples of Long and Reduced Front Setbacks
Smaller front setbacks can reduce site impervious cover, but many current subdivision codes have strict requirements that govern setbacks.

right form of development) which requires more review time. Consequently, open space designs are not always widely exercised by developers.

Relax side yard setbacks and allow narrower frontages to reduce total road length in the community and overall site imperviousness. Relax front setback requirements to minimize driveway lengths and reduce overall lot imperviousness.

Many current subdivision codes have very strict requirements that govern lot geometry, including setbacks and lot shape. These criteria constrain site planners from designing open space or cluster developments that can reduce impervious cover. Smaller front and side setbacks, often essential for open space designs, are typically not allowed or require a zoning variance that may be difficult to obtain.

Relaxing setback requirements allows developers to create attractive, compact lots that are marketable and livable (see Figure 7). For example, side yard setbacks can be as close as five feet from detached housing without specific fire protection measures. Often, fears about fire safety, noise, parking capacity and sight distance impairment are cited as impediments to shorter setbacks, but the reality is that these concerns can be overcome with careful design.

Promote more flexible design standards for residential subdivision sidewalks. Where practical, consider locating sidewalks on only one side of the street and providing common walkways linking pedestrian areas.

Most subdivision codes require sidewalks on both sides of residential streets, constructed of impervious concrete or asphalt, four to six feet wide, and two to 10 feet from the street. While these codes are intended to promote pedestrian safety, sidewalks should not be designed so rigidly. Instead, the general goal should be to improve pedestrian movement by diverting it away from street traffic. Often, a sidewalk on one side of the street is sufficient. In fact, in a study of pedestrian accidents associated with sidewalks, there was a negligible difference in accident rates when sidewalks were reported on just one side of the street versus sidewalks on both sides of the street (NHI, 1996).

Communities should also consider reducing the sidewalk width of sidewalks to three to four feet and placing them further from the street. Sidewalk design should emphasize the connections between neighborhoods, schools, and shops, instead of merely following the road layout (Figure 8). In addition, sidewalks should be graded to drain to front yards rather than the street. These alternatives reduce impervious cover and provide practical, safe, and attractive travel paths.

Reduce overall lot imperviousness by promoting alternative driveway surfaces and shared driveways that connect two or more homes together.

Most local subdivision codes are not very explicit as to how driveways should be designed. Most simply require a standard apron to connect the street to the driveway but do not specify width or surface material for driveways. Typical residential driveways are 12 feet wide for one car driveways and 20 feet wide for two. Shared driveways are discouraged or prohibited by many communities.

Shared driveways can reduce impervious cover, and can work when maintenance agreements and easements can be enforced. By specifying narrower driveways, promoting permeable paving materials, and allowing two-track driveways or gravel and grass surfaces, communities can sharply reduce the typical 400 to 800 square feet of impervious cover created by each driveway (see Figure 9).

Clearly specify how community open space will be managed and designate a sustainable legal entity responsible for managing both natural and recreational open space.

Open space subdivisions encourage the preservation of common areas that must be effectively managed. Surveys of local open space regulations, however, revealed that open space was poorly defined in most communities (Heraty, 1992). Less than a third required that open space be consolidated. Only 10% required that a portion of open space be maintained as natural cover, and few specified which uses were allowed or excluded in the open space areas. Some communities are wary of open space because they feel that community associations may lack financial, legal, or technical resources to effectively maintain their common areas.

In reality, open space maintained in a natural condition costs up to five times less to maintain than lawns. Communities should explore more reliable methods to assure that responsibility is taken for open space management. Effective methods include creating a community association, or shifting responsibility to a land trust or park through a conservation easement.

Direct rooftop runoff to pervious areas such as yards, open channels, or vegetated areas and avoid routing rooftop runoff to the roadway and the stormwater conveyance system.

Often, local codes discourage the storage and treatment of rooftop runoff on individual lots, thus bypassing opportunities to promote filtering or infiltration in the front or back yard. Most subdivision codes require that yards have a minimum slope to ensure drainage away from homes. The slope helps move runoff away from the home to prevent nuisance ponding, basement flooding, or ice formation on driveways or sidewalks. However, these concerns are only significant within 10 or 15 feet from the home foundation.

Sending rooftop runoff over a pervious surface before it reaches an impervious one can decrease the annual runoff volume from residential development sites by as much as 50%. Techniques to treat rooftop runoff in the yard include directing flow into small bioretention areas that encourage sheet flow across vegetated areas (see Figure 10) or infiltrate runoff in trenches, dry wells, or french drains.

Conservation of Natural Areas

Conservation of natural areas is integral to better site design, and the last six techniques deal with conserving and managing natural areas at the development site. These techniques include stream buffers, clearing and grading, tree conservation and stormwater treatment. To fully utilize these techniques, communities may need to offer developers both flexibility and incentives.

Create a variable width, naturally vegetated buffer system along all perennial streams that also encompasses critical environmental features such as the 100-year floodplain, steep slopes and freshwater wetlands.

This technique establishes a three-zone buffer system to protect streams, shorelines and wetlands at the development site (Figure 11). These three zones are distinguished by the types of allowable uses unique to each zone. In addition, the buffer should incorporate the 100-year floodplain, steep slopes, and freshwater wetlands to fully protect the water quality of streams, help treat stormwater, and enhance the quality of life for residents (Schueler, 1995).

Figure 8: Using Flexible Design Standards for Sidewalks
Creating sensible pathways can produce safe, pedestrian friendly communities.

Figure 9: Examples of Different Types of Shared Driveways
Shared driveways can help reduce the amount of impervious cover created for parking.

Figure 10: Alternative Runoff Management
Two alternatives for managing rooftop runoff are bioretention areas and rain barrels.

Shoreline Buffer	A Forested Buffer

Figure 11: Development vs. Buffer
A buffer is more than a setback from the stream or shoreline. Native vegetation cover should be retained within part of the buffer to protect the water quality, treat stormwater, and enhance natural beauty.

Buffers are noted for their economic benefits as well, including include increased property values, reduced flood damages, and sediment removal costs savings. A model stream buffer ordinance and regional samples can be downloaded from our website at www.cwp.org.

The riparian stream buffer should be preserved or restored with native vegetation. The buffer system should be maintained through the plan review delineation, construction, and post-development stages.

While establishing a buffer is paramount to better site design, assuring that the forest buffer is safeguarded from clear cutting is just as essential. Many communities have stream buffer ordinances, but a line drawn on a map is virtually invisible to contractors and landowners. Few communities require that buffer lines be marked. A strong buffer ordinance should outline the legal rights and responsibilities for management and maintenance during construction and for the long term. An effective buffer program should also indicate who is responsible for these issues and address measures to reestablish buffers using native vegetation. Figure 12 illustrates two techniques for preserving and maintaining natural areas and buffers.

Clearing and grading of forests and native vegetation at a site should be limited to the minimum amount needed to build lots, allow access, and provide fire protection. A fixed portion of any community open space should be managed as protected green space in a consolidated manner.

Most communities allow the entire development site to be cleared and graded, with a few exceptions in specially regulated areas such as jurisdictional wetlands, steep slopes, and floodplains. Since areas that are conserved in their natural state retain their natural hydrology and are not exposed to erosion during construction, it is desirable to conserve as much original soil at the site as possible. Clearing should be limited to the minimum area required for building footprints, construction access, and safety setbacks. Existing tools that could be adapted to limit clearing include erosion and sediment control ordinances, grading ordinances, forest conservation or tree protection ordinances, and open space development. One study has shown that providing grassed lots can add $750 to the value of a lot as compared to bare lots (Harbor and Herzog, 1999). For more information on clearing and grading, see articles 36, 37, 53 and 54.

Conserve trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and conserving native vegetation. Wherever practical, incorporate trees into community open space, street rights-of-way, parking lot islands, and other landscaped areas.

Few communities require that a percentage of trees and native vegetation be conserved during the development process. In fact, many communities promote the use of lawns instead of native vegetation. However, native trees, shrubs, and grasses contribute to the quality of the environment, create a sense of place, and increase property values. Tools that can be used for tree conservation include adopting forest conservation ordinances, encouraging open space design, planting street trees in the rights-of-way, adopting clearing and grading restrictions to preserve trees and native vegetation, and adding landscaping requirements for parking lots.

Incentives and flexibility should be encouraged to promote conservation of stream buffers, forests, meadows, and other areas of environmental value. In addition, off-site mitigation should be encouraged where it is consistent with locally adopted watershed plans.

A small number of communities require conservation of non-regulated areas such as stream buffers, forests, and meadows. Even fewer provide meaningful incentives for developers to conserve more natural areas than they are required to. To combat this problem, communities may want to offer increased flexibility and incentives to reward developers for conserving natural areas.

Methods to encourage conservation include by-right open space development, buffer flexibility, property tax credits, density bonuses, transferrable development rights, and providing credits for reduced stormwater management requirements. Stormwater credits exist for natural area conservation, disconnecting rooftop runoff, and routing sheetflow to buffers (MDE, 2000).

Buffer Reforestation	Tree Conservation Area
	

Figure 12: Two Techniques for Natural Areas and Buffers
Buffer reforestation and tree conservation are two important techniques for maintaining natural areas, including buffers. Buffer lines should be clearly marked to protect from clearing and grading both during and after construction.

New stormwater outfalls should not discharge unmanaged stormwater into jurisdictional wetlands, sole-source aquifers, or sensitive areas.

Stormwater runoff generated from impervious cover can represent a significant threat to the quality of wetlands, surface water and groundwater. While many communities are beginning to require stormwater quality practices, they are often poorly matched to site conditions and watershed objectives.

Stormwater practices can be designed to be effective, attractive and relatively easy to maintain. A well-designed stormwater practice should add value to a community while meeting stormwater management objectives. For new criteria on the design of stormwater practices, refer to the *Maryland Stormwater Manual* available online: http://www.mde.state.md.us/ environment/wma/

Summary

For many communities, implementing better site design may require that development rules be changed, and this process is not an easy one. Advocates of better site design are likely to have to answer some difficult questions from fire chiefs, lawyers, traffic engineers, developers, and many others in the community. Will a proposed change make it more difficult to park? Lengthen response times for emergency vehicles? Increase risks to community residents and children? Progress toward better site design will require more local governments to examine their current practices in the context of a broad range of concerns, such as how the changes will affect development costs, local liability, property values, public safety, and a host of other factors.

Better site design has considerable potential to reduce the environmental impacts of new development sites, and when adapted properly, of redevelopment sites as well. Better site design is a particularly useful strategy in watersheds where future development is projected to approach or slightly exceed impervious cover thresholds. It should be kept in mind, however, that better site design alone cannot adequately protect most watersheds. It must be combined and integrated with other watershed protection tools, such as watershed planning, land conservation, erosion and sediment control and the rest. These caveats notwithstanding, better site design is the one of the few watershed protection tools that simultaneously provides dividends for watershed advocates, developers and the community as a whole. Consequently, communities are encouraged to invest in the local site planning roundtable process that can make it happen. -***HYK***

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