Chapter 2

General Planning Concepts for Stormwater Management and Overview of Low-Impact Site Design and Smart Growth Concepts

Stormwater planning was instituted out of the necessity to move stormwater runoff from impervious surfaces to prevent localized flooding, with little regard for water quality. A system of underground pipes was developed to quickly move the excess stormwater into streams and coastal waters. Over time, the U.S. Environmental Protection Agency (EPA) determined that, while this system minimized the risk of flooding, stormwater flow was carrying a large number of pollutants into natural waterways and harming the ecosystems that inhabited them, which led to the development of Phase I and II Stormwater Regulations. For the purposes of this manual, the planning concepts associated with stormwater runoff management have been broken down into two broad categories: Smart Growth Concepts and Low-Impact Development. However, no single approach or strategy will work for every community. Each community should evaluate its unique conditions and characteristics to determine the most appropriate approach or combination of approaches. Smart Growth and Low-Impact Development categories will overlap in many places and, in some cases, may be used interchangeably. Additional discussion of the BMPs suggested below can be found in Chapter 4.

Smart Growth Concepts

Smart Growth encourages economic growth that helps the economy while also protecting the environment, and revitalizing existing communities. Although many of its goals are focused on development rather than environmental protection, evidence shows that implementing a Smart Growth program has a number of environmental benefits. Core principles include directing new growth toward established areas and promoting a compact and mixed-use pattern of development as well as a greater reliance on transit, walking, and biking. Some of the many tools governments may use to implement Smart Growth include zoning, street design, and open space conservation. The EPA formed the Smart Growth Network as a means to provide information about strategies to make growth compatible with environmental quality and to share best practices being implemented around the country. The Smart Growth Network's publication *This Is Smart Growth* describes program benefits in the following way, "When communities choose smart growth strategies, they can create new neighborhoods and maintain existing ones that are attractive, convenient, safe, and healthy. They can foster design that encourages social, civic, and physical activity. They can protect the environment while stimulating economic growth. Most of all, they can create more choices for residents, workers, visitors, children, families, single people, and older adults—choices in where to live, how to get around, and how to interact with the people around them. When communities do this kind of planning, they preserve the best of their past while creating a bright future for generations to come" (International City/County Management Association, not dated).

What Are the Key Elements of Smart Growth?

Smart Growth lays out a series of principles to guide development based on research and experience. The ultimate goal of these principles is to help communities experience the benefits of economic growth while also expanding opportunities and improving quality of life. The principles below provide guidance for how that might occur:

Ten Smart Growth Principles

- Provide for a compatible mixture of land uses
- Take advantage of compact building design
- Create a range of housing opportunities and choices
- Create walkable neighborhoods
- Foster distinctive, attractive communities with a strong sense of place
- Preserve open space, farmland, natural beauty, and critical environmental areas
- Strengthen and direct development towards existing communities
- Provide a variety of transportation choices
- Make development decisions predictable, fair and cost effective
- Encourage community and stakeholder collaboration in development decisions

Typical Components of Smart Growth Development

Smart Growth offers a number of strategies that may be used as BMPs to produce a better stormwater management program at the state, county or local level. Developers may also incorporate several of the design strategies, listed below, in their stormwater prevention plan preparation to improve their project's ability to manage stormwater. Mississippi does not have a comprehensive statewide law on Smart Growth, as do Florida and Maryland. However, the State does have existing statutes and permits related to stormwater management, which encourage the utilization of many of the following Smart Growth strategies. Through the State's existing statutes on stormwater management, however, it encourages the MS4s in its jurisdiction to employ many of the following Smart Growth strategies.

Regional Planning

Regional planning encourages cities to look beyond their political boundaries to find solutions to larger stormwater management problems. Intergovernmental cooperation at a watershed level can improve the water quality of streams, rivers, and other water bodies that cross political lines. Benefits include a reduction in imperviousness by directing development to appropriate areas, identifying and preserving critical ecological and open space resources, and making the best use of land that is already served with infrastructure and a high level of impervious surface cover. Regional planning organizations in

Mississippi include the State's Planning and Development Districts and its four Metropolitan Planning Organizations, which focus on transportation planning. The Department of Marine Resources protects coastal waters in the southern part of the state. County-wide utility authorities provide services to multiple city and rural jurisdictions. In many situations, city and county governments may also find it advantageous to work together to address issues of regional water quality.

Infill Development

Infill development occurs on previously undeveloped lots within urban areas. It has the benefit of being served by existing water, wastewater, transportation and other infrastructure. The EPA indicates in its model Phase II permit (available at http://www.epa.gov/npdes/pubs) that cities may use infill development as a post-construction minimum control measure. Local governments most commonly indicate to developers where they would like infill to occur through their zoning ordinance, usually administered by a jurisdiction's planning department. The zoning ordinance itself governs features of development such as the maximum size of structures on a lot, the lot coverage, parking required, and landscaping regulations. Some jurisdictions also use financial or regulatory incentives to encourage developers to locate specific types of development in designated areas. A primary benefit of infill development is that it reduces the level of impervious cover in undeveloped areas and does not require building new roads, parking and other surfaces that reduce stormwater infiltration, groundwater flow and aquifer recharge.

Redevelopment

Redevelopment is similar to infill except that it refers to properties that have already been developed for another use. These sites are likely to be covered with impervious surface and to be of limited to no value to the stormwater management system. A redevelopment program might be administered through a "Main Street" or Brownfields program, which surveys and markets a number of potential sites for redevelopment. In the planning stages of a redevelopment project, developers must consider existing street and circulation patterns, zoning codes, and the suitability of building configurations to contemporary use. Benefits of redevelopment include bringing more active uses to an area and increasing the tax rolls. By recycling these sites and granting them new life, governments also reap the broader benefits of development on an existing property by reusing impermeable surface and preserving land at the outer fringe. Redevelopment strategies are further discussed in the *Planning Section* of Chapter 4.

Development Districts

Cities or counties establish development districts to set apart specific areas in which to achieve comprehensive planning and urban design goals. These areas are characterized by more complex and coordinated rezoning, transportation and planning efforts, and generally require a higher degree of cooperation among different entities to encourage development. The districts are most commonly outlined in the city or county's zoning ordinance, and administered by planning departments. However, they may also be created through a specific plan or policy to address an issue such as Brownfields redevelopment. Among the most common types of development districts are Main Street districts, Brownfields redevelopments, Transit-Oriented Districts (TODs), and Business Improvement Districts (BIDs). Development districts specifically associated with a Smart Growth approach include Smart Code, Traditional Neighborhood Developments (TNDs), and Unified Development Ordinances. As with “infill development” and “redevelopment,” this strategy improves stormwater management by directing new growth toward already developed locations instead of toward green sites at the city’s fringe. These districts may also set standards for transportation networks and other infrastructure that reduces impermeable coverage and improves stormwater management. Development Districts are further discussed in the *Planning Section* of Chapter 4.

Tree and Canopy Programs

Preserving mature trees and encouraging new tree planting provides a number of environmental benefits. Increasingly, urban forestry policies are focusing on developing a full canopy, rather than just requiring the preserving or planting of individual trees. A more complete tree canopy system improves stormwater management by more effectively capturing rainwater, controlling erosion, and absorbing and filtering many of the pollutants associated with stormwater runoff. Tree ordinances are typically implemented by public works or parks departments. Local extension agents may also be able to provide better information about what types of trees are appropriate and provide the maximum environmental benefits for an area. There are a number of strategies to improve the quality of tree canopy, including street tree ordinances, pedestrian plans, and tree planting programs. Urban Forestry may be adopted specifically as a BMP in a stormwater management program and is discussed further in Chapter 4.

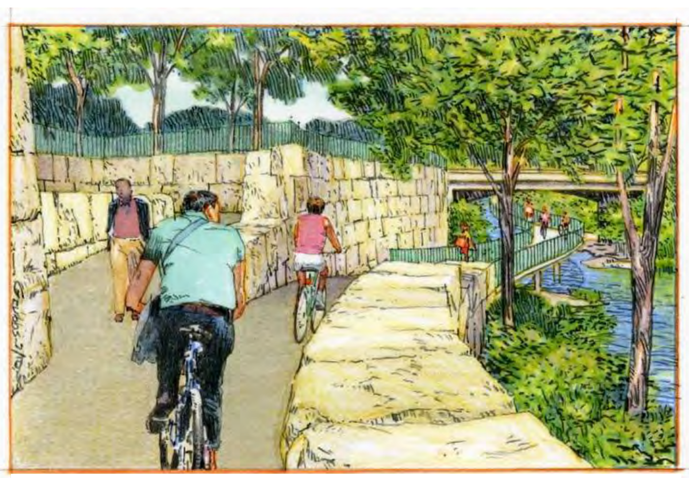
Parking Policies for Parking Reductions

Many areas have an oversupply of parking because of zoning that focuses on minimum parking requirements for each land use. Considering that a one-inch rainstorm on a one-acre meadow would produce 218 cubic feet of runoff, a parking lot of the same size would produce 3,460 cubic feet (Schueler, 1995). The more parking in a community, the greater the amount of impervious surface cover and the bigger the challenge for stormwater management. Parking policies are usually administered by planning departments or departments of public works through zoning and subdivision ordinances. To reduce impervious surface, communities can redefine how parking demand is determined and ultimately reduce the overall number of parking spaces. Some strategies to manage the amount of parking provided in a community include parking overlay districts, on-street parking, combining spaces into structured parking garages, shared parking, and parking pricing. Green parking technologies, such as pervious pavers, help promote the infiltration of stormwater in parking spaces. Making pedestrian trips more pleasant and attractive can also reduce parking demand. This strategy can bring about significant improvements in a jurisdiction's stormwater management system. (See the *Street Design and Patterns*, *Green Parking*, *Pervious Interlocking Concrete Paving*, *Pervious Asphalt Pavement*, and *Pervious Concrete* practices in Chapter 4.)

Fix It First Infrastructure Policies

The buildings in mature neighborhoods and commercial districts are typically served by an infrastructure network that provides users with safe, clean, comfortable shelter from the elements. Roads connect them with other locations in the area, drinking water is provided, and storm and sanitary sewers safely control the disposal of excess water. Public works departments generally maintain roadways, while local water departments or regional utility authorities often provide water and wastewater services and maintain the systems. "Fix It First" policies prioritize repairs to keep existing infrastructure in working order before investing in new roads and infrastructure. A policy of systematically replacing older sewer infrastructure lowers the frequency of stormwater-related problems. Sewer overflows during heavy rains, for example, are often caused by deteriorating or over-extended pipes. Fix It First policies help ensure older areas of town remain attractive to new investment and improve the success of local efforts to promote redevelopment or infill.

Smart Growth Street Designs



Smart Growth Design Concept (graphic by McCann Adams Studio, Austin, TX)

Designing Smart Growth streets requires thinking about more than the fastest way to get a car from one destination to another. It involves planning a well-connected network of transportation options for drivers, transit users, pedestrians, and bicyclists. Street design standards may be defined by the local public works department or by local subdivision guidelines, which are generally administered by planning departments. Smart Growth designs are characterized by narrower roadways and a lower degree of impervious surface. This equates to a reduction in the width of residential streets, and increased opportunities for filtration of common neighborhood pollutants such as sediment, bacteria, and nutrients.

For the larger network, it means connecting streets through neighborhoods and to each other. The hierarchical model of neighborhood street, collector road, and arterial street produces more paved surface than a Smart Growth design, using multiple turning lanes, wide intersections and access lanes to minimize congestion that stems in part from many disconnected roadways spilling into a larger system. The stormwater performance of Smart Growth street systems can also be improved by policies that reduce the amount of runoff entering curbs and gutters. Better connected streets improve the rate of pedestrian and other non-motorized trips. By reducing the width of all the streets in the transportation network, Smart Growth street design increases opportunities for infiltration of common pollutants (sediment, bacteria, and nutrients). (See the *Street Design and Patterns*, *Alternative Turnarounds*, *Eliminating Curbs and Gutters*, and *Narrower Residential Streets* practices in Chapter 4.)

Stormwater Utilities

The State of Mississippi currently administers stormwater regulations through the Department of Environmental Quality. County or city governments prepare local Stormwater Management Plans at the local level and enforce regulations through regular inspections. Many states have taken an additional step, investigating where the rate structure of other utility programs, such as electricity and gas service, might be unintentionally subsidizing new growth at the expense of more cost-efficient service areas. A stormwater utility establishes an organization where a user helps finance stormwater improvements related to growth and development.

Integrating Smart Growth and Stormwater Management

After several years of focusing on the impact of individual development sites or subdivisions on stormwater management, there is now greater interest in how new developments impact neighborhoods and watersheds. Research by the EPA found that high-density housing development of up to eight units an acre produces a lower total runoff per year than eight homes spread across eight acres. If those eight units are sited in an area that is already developed, it potentially frees unused land for conservation. This research supports Smart Growth's contention that infill development, or denser growth that occurs in urbanized areas, is more environmentally friendly than low-density sprawling neighborhoods. Even though development at one unit per acre appears greener, the percentage of paved surface per lot is usually much greater, leading to a higher level of runoff. Landscaped lawns also have compacted surfaces from repeated maintenance that do not always perform at a higher level than paved areas. The North Central Texas Council of Governments set out to improve their region's stormwater with a guide of how different common planning tools could be adapted to better manage regional runoff (EPA, 2005). Employing the concepts of Smart Growth to stormwater management and using available planning tools helps shift the focus toward development in appropriate areas and with techniques that ultimately lessen the impact on a region's waterways.

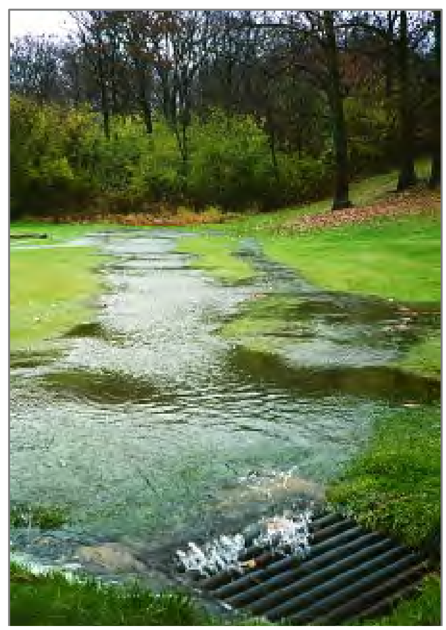


Figure 1 Stormwater Runoff (Source: James M. Pease, National Institute of Health)

Low-Impact Development

Low-Impact Development, or LID, is "an innovative stormwater management approach with a basic principle that is modeled after nature: manage rainfall at the source using uniformly distributed decentralized micro-scale controls" (LID, 2007). It is the practice of taking steps during the design stage of development to minimize changes to the hydrologic cycle (runoff and infiltration after a storm). LID strategies integrate green space, native landscaping, natural hydrologic functions, and various other techniques to reduce runoff from developed land (NRDC, 2001). These types of practices encourage infiltration and reduce the volume of stormwater discharged from the site. Many innovative site designs and stormwater management practices are grouped together under the heading of LID, but true LID strategies have certain key distinctions. The key distinctions of LID include the following:

- Stormwater management at a local scale to minimize impact of development on the local watershed.
- Ecosystem-based. Development is designed as a functional part of the ecosystem (not apart from it).
- Relies on advanced technologies more than conservation and growth management (Smart Growth plans).

LID promotes hydrologic function at the lot level. It addresses stormwater through small, cost-effective landscape features and integrated management practices, also known as IMPs.

Integrated Management Practices

The term IMP is used to define controls that are integrated throughout the project and provide landscape amenities. The terms BMP and IMP are frequently used interchangeably. When Integrated Management Practices are linked together, they form *BMP trains* that address water quantity and water quality in succession. Such a train could be created by linking a rain barrel (overflow) to a rain garden, and the overflow drain of the rain garden to a constructed wetland.

History of LID

Many communities are turning to LID practices to assist with stormwater management. Conventional solutions to handling stormwater runoff are not always compatible with community interests, or local, state, and federal water quality regulations. Prince George's County, Maryland, is known as the originator of the LID movement, and has pioneered many stormwater-management practices and protective policies since the early 1980s. The State of Wisconsin has also promoted LID since the late 1980s, but dates to the early 1900s in the origin of sustainable products such as Milorganite, a fertilizer used in the golf course industry made from the byproduct of the Milwaukee sanitary sewer system.

What Are the Key Elements of LID?

The key elements of LID include the following:

- Conservation
- Small-scale controls
- Customized site design
- Pollution prevention and education
- Directing runoff to natural areas

The preservation of native trees, understory vegetation, and natural drainage processes is important in LID development. They are enhanced by small-scale controls on the lot level that mimic natural hydrology. The customized design of LID controls protects hydrologic processes, reduces pollutant loads, and sends stormwater to areas of infiltration to facilitate groundwater recharge.

Planners, engineers, and other design professionals should consider using LID because it enhances the local environment, protects public health, improves community livability, and saves developers and local governments' money. Use of LID practices can often provide a 25%-30% reduction in costs associated with site development, stormwater fees, and maintenance for residential developments. These savings are recognized through reductions in clearing, grading, pipes, ponds, inlets curbs, and paving.

Low-Impact Development practices are easily applied to open space, roof tops, streetscapes, parking lots, sidewalks, and medians. The preservation of existing open space or the creation of new open space allows for large conservation areas where stormwater can infiltrate into the ground and promote groundwater recharge. Rooftop gardens or green roofs provide excellent insulation in warm climates and reduce heat island effects in urban environments. LID promotes narrow streets and driveways, which reduce impervious surfaces as well as flooding and pollution from stormwater. Typically, there are no curbs and gutters in LID developments, and houses are generally closer to the street. Shared driveways are also quite common.

Typical LID design components

Components generally considered in LID design include vegetation, pervious surfaces, and bioretention systems. Vegetation removes water through evapotranspiration and assists in pollutant removal through nutrient cycling. Pervious surfaces allow stormwater to infiltrate into underlying soils, promoting groundwater recharge and pollutant processing while reducing the volume of rainwater runoff. Bioretention systems detain water long enough for infiltration and pollution removal to occur. Bioretention systems may be designed as buffer strips, rain gardens, stormwater wetlands, and grass swales.

Bioretention Areas

Bioretention areas, also known as bioretention filters or rain gardens, capture and temporarily store water. Water is conveyed to the treatment

Figure 2 Rain Garden (Source: lid-stormwater.net)

area as sheet flow. Bioretention areas can be designed to capture the first inch of rain and allow it to soak into the soil, watering the plants in the rain garden. Rain gardens are typically saucer-shaped depressions that have six to eighteen inches of water when completely filled with stormwater. They are designed to detain water long enough for infiltration and pollutant removal to occur, but not cause mosquito problems.

Rain gardens are attractive gardens that typically use native plants. Native plants should be used because they are more drought tolerant and require less maintenance. Pollutant removal is facilitated by microbes that live in the soil and interact with the plant roots. Rain gardens are designed to drain within 24 to 48 hours, eliminating potential mosquito habitat. Pathogens are left high and dry as water is absorbed.

Landscaping is critical to the performance and functioning of a rain garden. A diversity of plant types should be included to replicate a natural ecosystem. Trees should be spaced at least 10 feet apart, hardwood mulch should be used (not pine bark; it floats), and plants should be both water tolerant and drought tolerant.

Rain gardens come in many shapes and sizes and can be used in commercial and residential landscapes, parking lots and medians, highway drainage, and on golf courses. There are several different types of rain gardens, and the design can be modified to fit many uses. Rain gardens often take advantage of existing low spots, are excavated and filled with amended soil to aid in the drainage process, and may include an overflow drain—consisting of a perforated pipe or an existing stormwater outlet that has been raised to aid the ponding of water. Bioretention areas are further discussed in Chapter 4.

Rain Barrels and Cisterns

Rain barrels are small roof stormwater recapture systems that store residential rooftop runoff for localized use. Water collected in a rain barrel would normally flow through a gutter system or from a roof onto the ground, potentially causing erosion. A rain barrel can save approximately 1,300 gallons of water during peak summer months of normal rainfall. For every inch of rain that falls on a catchment area of 1,000 square feet, approximately 600 gallons of rainwater can be collected. All systems should use covered barrels or cisterns that keep the water from accumulating leaves and other contaminants. Perhaps the simplest use of a rain barrel is to situate the barrel under one of the gutter downspouts and use the water on sensitive indoor plants. Storing rainwater for garden and outdoor work use helps recharge groundwater naturally by slowing down and reducing stormwater runoff.

Cisterns work on the same principle as rain barrels but typically have a large storage capacity. Modern cisterns are manufactured of plastic and may or may not be completely enclosed. They often have a lid made of the same material as the cistern, which is removable by the user. In the United States, cisterns are predominantly used for irrigation; however, some areas promote reuse of gray water (water from hand washing, dish washing, etc.) for toilet flushing.

Filter Strips, Vegetated Swales, and Constructed Stormwater Wetlands

Filter strips can be designed as landscape features within parking lots or other areas to collect flow from large impervious surfaces. Vegetated swales use grass or other vegetation to reduce runoff velocity and allow infiltration, while high-volume flows are channeled away safely. They function as alternatives to curb and gutter systems. Wetlands can be constructed to treat stormwater runoff by storing stormwater and trapping pollutants. These practices are outlined in detail in Chapter 4.

Pervious Paving

Pervious pavements allow air and water to pass through the surface, providing groundwater recharge. "If used properly, porous pavements can facilitate biodegradation of the oils from cars and trucks, help rainwater infiltrate soil, decrease urban heating, replenish groundwater, allow tree roots to breathe, and reduce total runoff, including the magnitude and frequency of flash flooding" (Ferguson, 2005). In his book, *Porous Pavements*, Ferguson identifies nine categories of porous pavement: decks, open-celled paving grids, open-graded aggregate, open-jointed paving blocks, plastic geocells, porous asphalt, pervious concrete, porous turf, and soft paving.

Mixing Structural and Nonstructural Post-Construction BMPs

Mixing structural and nonstructural post-construction BMPs allows for flexibility in creating appropriate BMP efficiency and cost reductions for pollutant removal. The resulting configuration resembles a *BMP train*, or a string of mix-and-match BMPs that are customized to a site's pollutant situation. There are now several BMP calculators (typically Excel format) that calculate the train's efficiency and cost.

The benefits of LID provide a high level of water quality treatment. LID tends to control volume of the first flush (first ½ inch to 1 inch) of runoff. It is cost effective for developers and local governments, and is aesthetically pleasing. LID increases quality of water in local streams, rivers, lakes or bays. It also controls impacts to our natural ecosystems through selective BMP implementation. Instead of large investments in complex and costly centralized conveyance and treatment infrastructure, LID allows for the integration of treatment and management measures into urban site features. This involves strategic placement of distributed lot-level controls that can be customized to more closely mimic a watershed's hydrology and water quality regime. The result is a hydrologically functional landscape that generates less surface runoff, less pollution, less erosion, and less overall damage to lakes, streams, and coastal waters.

Better Site Design

The Center for Watershed Protection has collected 22 principles of planning and site design into its "Better Site Design: A Handbook for Changing Development Rules in Your Community." The principles discussed in this section of the MDEQ Manual are primarily geared toward an audience of planners, engineers, developers and officials working in the development of new communities. As with LID and Smart Growth, many of these principles overlap the ideas presented by LID and Smart Growth while others can be used in conjunction with LID and Smart Growth ideals for the best possible site design.

The Better Site Design handbook groups the 22 principles into three sections: Residential Streets and Parking Lots, Lot Development, and Conservation of Natural Areas.

Residential Streets and Parking Lots

These principles are focused on reducing the impervious cover caused by paving for residential streets and parking areas.

Principle 1: Street Width

Residential streets should be designed so that the minimum necessary pavement is utilized for travel lanes, on-street parking, and emergency, maintenance and service vehicles access.

Principle 2: Street Length

Incorporate alternative street layouts so that street length can be decreased, thereby increasing the number of homes per unit length.

Principle 3: Right-of-Way Width

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

Principle 4: Cul-De-Sacs

Alternative turnarounds should be considered in place of traditional cul-de-sacs. The number of residential street cul-de-sacs should be reduced and should have the minimum required radius allowed to accommodate emergency and maintenance vehicles.

Principle 5: Vegetated Open Channels

Vegetated open channels should be incorporated for stormwater treatment and conveyance where density, topography, soils, and slope allow.

Principle 6: Parking Ratios

Current local parking ratios should be enforced as both a maximum and a minimum for a particular land use in order to prevent excess parking space construction. Existing parking requirements should be assessed in light of local and national experience to see if lower ratios are warranted and feasible.

Principle 7: Parking Codes

Parking codes should be reviewed and revised to lower parking requirements, especially in areas where mass transit and shared parking are available.

Figure 3 Parking Lot Retention (Source: EPA)

Principle 8: Parking Lots

Options such as providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials in overflow parking areas can help reduce the overall imperviousness of parking lots.

Principle 9: Structured Parking

Shared and structured parking reduces impervious surfaces but can often be cost prohibitive. Offering economic incentives can help encourage the development of these types of parking.

Principle 10: Parking Lot Runoff

Create functional landscaping areas such as bioretention areas and filter strips, which can aid in the treatment of stormwater runoff from parking lots.

Lot Development

The lot development principles deal with increasing open space while reducing site imperviousness through setback, frontage, sidewalk and driveway restrictions.

Principle 11: Open Space Design

Promote open space design that incorporates smaller lot sizes. Open space design not only reduces impervious surface area but also reduces construction costs, conserves natural areas, provides community recreational space, and promotes watershed protection.

Principle 12: Setbacks and Frontages

Reducing side yard setbacks allows narrower frontages to reduce total road length. Reducing front yard setback requirements allows shorter driveway lengths. Both practices will reduce the overall imperviousness of the community.

Principle 13: Sidewalks

Advocate for alternatively designed sidewalks in residential subdivisions. Locating sidewalks on only one side of the street reduces total site imperviousness while still connecting pedestrian areas.

Principle 14: Driveways

Promote alternative driveway options such as permeable paving and shared driveways.

Principle 15: Open Space Management

Development of community open space should include designated management and responsibly authority for managing both natural and recreational open spaces.

Principle 16: Rooftop Runoff

Avoid routing rooftop runoff directly onto impervious surfaces such as driveways, roadways or into the stormwater conveyance system. Instead, direct rooftop runoff to yards, open channels or other vegetated areas to allow infiltration.

Conservation of Natural Areas

Principles 17-22 address codes and ordinances that promote the conservation of natural areas. These principles help to reduce stormwater runoff pollution by promoting hydrologic functions found naturally within microwatersheds.

Principle 17: Buffer Systems

In development, buffer systems create naturally vegetated buffer along perennial streams, which generally encompasses the 100-year floodplain, steep slopes, and freshwater wetland areas.

Principle 18: Buffer Maintenance

The riparian buffer needs to be preserved, restored, and maintained with native vegetation to function properly throughout the delineation, plan review, construction, and occupancy stages of development.

Principle 19: Clearing and Grading

Clearing and grading of natural vegetation should be limited to the extent possible to allow lot development, access roads and fire protection. Community open spaces should include areas of mature-growth native vegetation that can be protected from future development.

Principle 20: Tree Conservation

Tree conservation can be accomplished by planting additional vegetation, clustering tree areas, and promoting the use of native plants. Community open space, street rights-of-way, parking lot islands, and other landscaped areas can be managed to promote natural vegetation.

Principle 21: Conservation Incentives

Conservation incentives such as density compensation, buffer averaging, property tax reduction, stormwater credits, and by-right open space development should be used to encourage conservation of stream buffers, forests, meadows, and other natural areas.

Principle 22: Stormwater Outfalls

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